AUTONOME PROVINZ BOZEN - SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE

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Amtsdirektor | Direttore dell'ufficio

Projekt | Progetto

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SANIERUNG DER BRÜCKE 15 ESCHENLOHE
Gemeinde St. Pankraz

Sanierung der Brücke 15 Eschenlohe – L.S. 9 bei km 7,750 in der Gemeinde St. Pankraz

RISANAMENTO DEL PONTE 15 ESCHENLOHE
Comune San Pancrazio

Risanamento del ponte 15 Eschenlohe - S.P. 9 al km 7,750 nel Comune di San Pancrazio

AUSFÜHRUNGSPROJEKT - PROGETTO ESECUTIVO

Planinhalt | Contenuto

NACHWEISE DES VERSTÄRKTEN TRAGWERKS
VERIFICHE DELLA STRUTTURA RINFORZATA

–

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1.2

Planer | Progettisti

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INGENIEURTEAM STUDIO DI INGEGNERIA
BERGMEISTER

06-154 Sanierung der Brücke 15 Eschenlohe LS9 bei km 7,750

06-154 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

AUSFÜHRUNGSPROJEKT
PROGETTO ESECUTIVO

Nachweise des verstärkten Tragwerks
Verifiche della struttura rinforzata

Der Planer | il progettista
dott. dott. ing. Walter Weis

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1 Allgemeines

1.1 Beschreibung der Verstärkungsmaßnahmen

Dieser Bericht betrifft die statischen Nachweise des verstärkten Tragwerks der Brücke 15 Eschenlohe LS9 bei km 7,750 im Ultental.

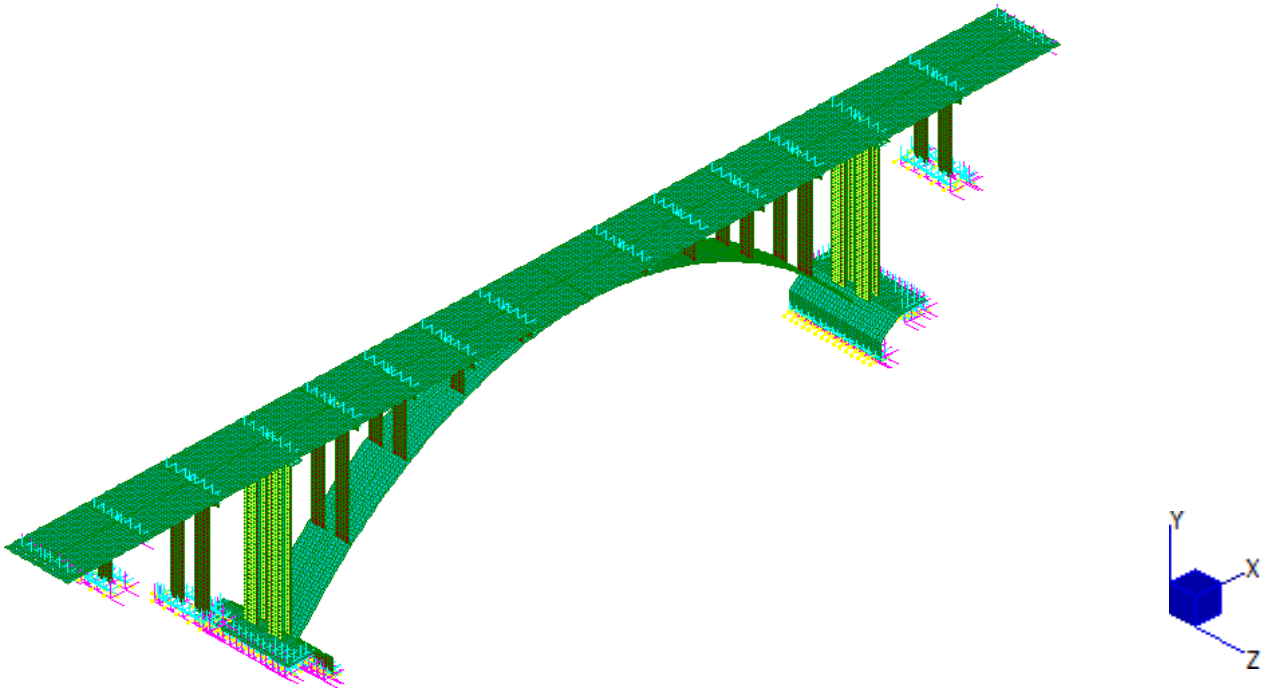
Folgende Verstärkungsmaßnahmen sind geplant:

-Neue Pfeiler- und Kämpferfundamente oberhalb der Bestehenden. Die gesamten Lasten werden über Mikropfähle in den Untergrund abgeleitet. Die Tragfähigkeit der bestehenden Gründung wird nicht angesetzt und ist eine Sicherheitsreserve.

-Ergänzungsbeton auf allen Seiten des Bogens. Die im Ergänzungsbereich eingebaute Bewehrung ersetzt vollständig die Bestandsbewehrung. Der bestehende Betonquerschnitt arbeitet auf Druck und Schub mit. Die Zellen des Hohlkastens werden zur Steigerung der Tragfähigkeit des Bogens mit Beton gefüllt. Zurzeit sind die Zellen aufgrund der kleinen Abmessungen in vielen Bereichen nicht oder nur schwer zugänglich.

-Ergänzungsbeton auf allen Seiten der Pfeiler und Bogenstiele. Die im Ergänzungsbereich eingebaute Bewehrung ersetzt vollständig die Bestandsbewehrung. Der bestehende Betonquerschnitt arbeitet auf Druck und Schub mit.

3D Ansicht des Berechnungsmodells (Endstand):



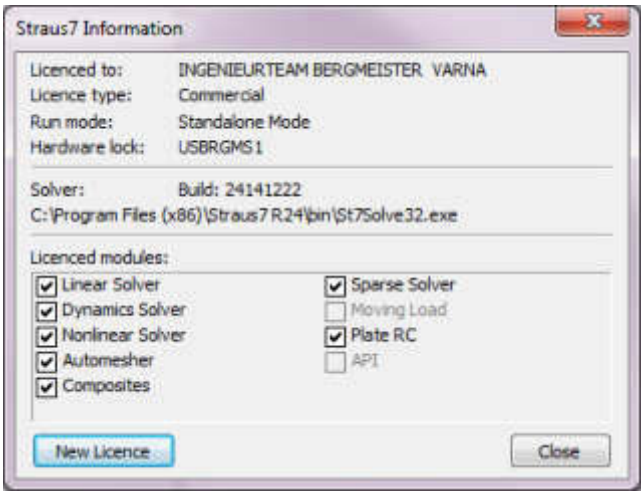
1.2 Normen

Die Bemessung des Bauwerks erfolgt laut Ministerialdekret D.M. 17.01.2018

Weitere, im Ministerialdekret nicht spezifizierte aber erforderliche Nachweise erfolgen laut den aktuellen Eurocodes.

1.3 Berechnungssoftware

Die elektronische Berechnung erfolgt mit der FEM-Software Straus7 Version 2.4.6 B6b.



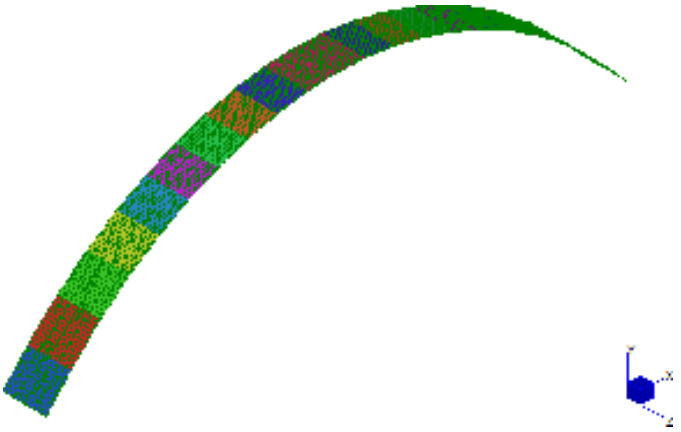
1.4 Rechenmodell

Das globale 3d-Rechenmodell (Endstand) der Brücke besteht aus:

- 17430 Knoten
- 343 Stäben
- 15590 Schalenelementen (Vierknotenelemente)

Im Rechenmodell ist immer der Gesamtquerschnitt modelliert. Da der Ummantelungsbeton und Bestandsbeton einen ähnlichen E-Modul haben ist dies zulässig. In den Nachweisen wird die Bestandsbewehrung nicht berücksichtigt. Nur die neue Bewehrung im Bereich der Betonummantelung wird in den Nachweisen berücksichtigt. Nach abgeschlossener Verstärkung erhält der Bestandsquerschnitt fast nur Druckspannungen.

Querschnitte im Berechnungsmodell (Endstand):



-Schalenelemente Bogen mit 2,32m -> Abschnitt zwischen Achse 2 und 2,5, zwischen Achse 11,5 und 12

-Schalenelemente Bogen mit 2,15m -> Abschnitt zwischen Achse 2,5 und 3, zwischen Achse 11 und 11,5

-Schalenelemente Bogen mit 2,01m -> Abschnitt zwischen Achse 3 und 3,5, zwischen Achse 10,5 und 11

-Schalenelemente Bogen mit 1,90m -> Abschnitt zwischen Achse 3,5 und 4, zwischen Achse 10 und 10,5

-Schalenelemente Bogen mit 1,80m -> Abschnitt zwischen Achse 4 und 4,5, zwischen Achse 9,5 und 10

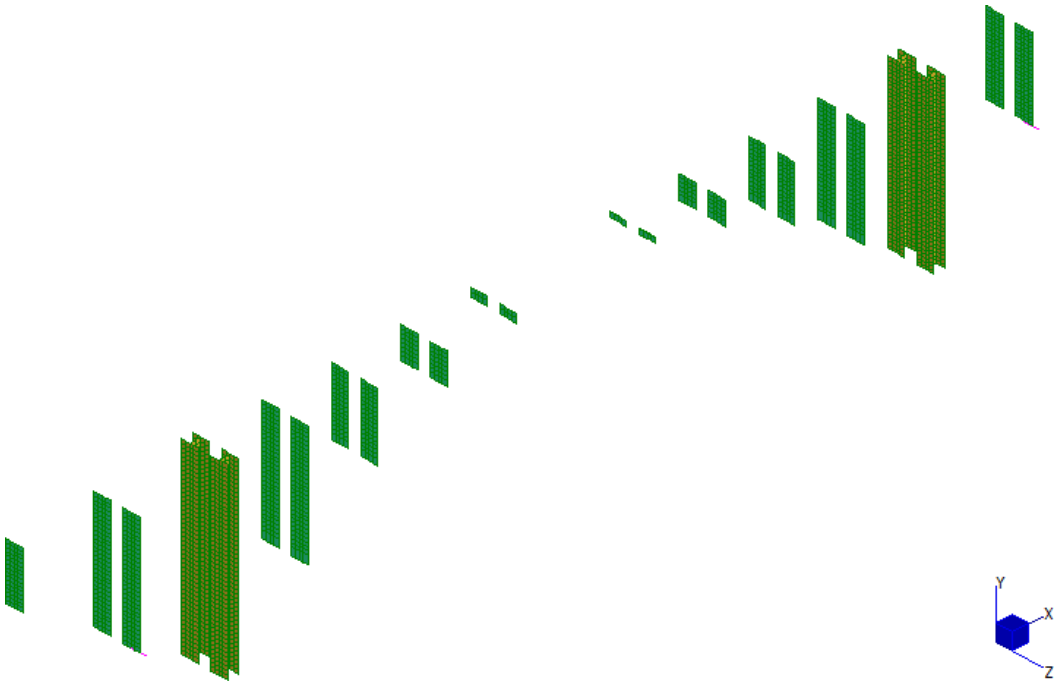
-Schalenelemente Bogen mit 1,72m -> Abschnitt zwischen Achse 4,5 und 5, zwischen Achse 9 und 9,5

-Schalenelemente Bogen mit 1,65m -> Abschnitt zwischen Achse 5 und 5,5, zwischen Achse 8,5 und 9

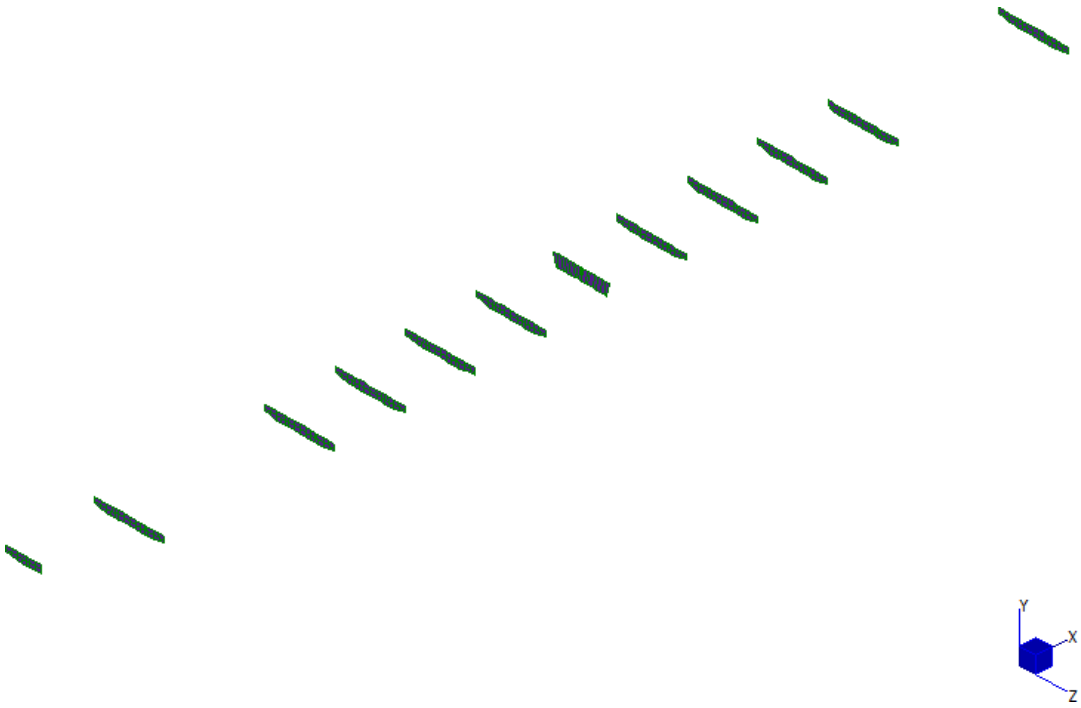
-Schalenelemente Bogen mit 1,60m -> Abschnitt zwischen Achse 5,5 und 6, zwischen Achse 8 und 8,5

-Schalenelemente Bogen mit 1,56m -> Abschnitt zwischen Achse 6 und 6,5, zwischen Achse 7,5 und 8

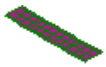
-Schalenelemente Bogen mit 1,52m -> Abschnitt zwischen Achse 6,5 und 7, zwischen Achse 7 und 7,5

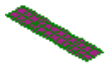


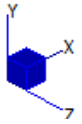
-Schalenelemente für Stiele und Pfeiler mit 0,76m



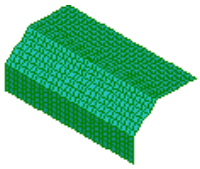
-Schalenelemente für Querträger oberes Pfeilerende 1,26m

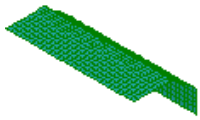


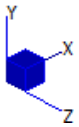




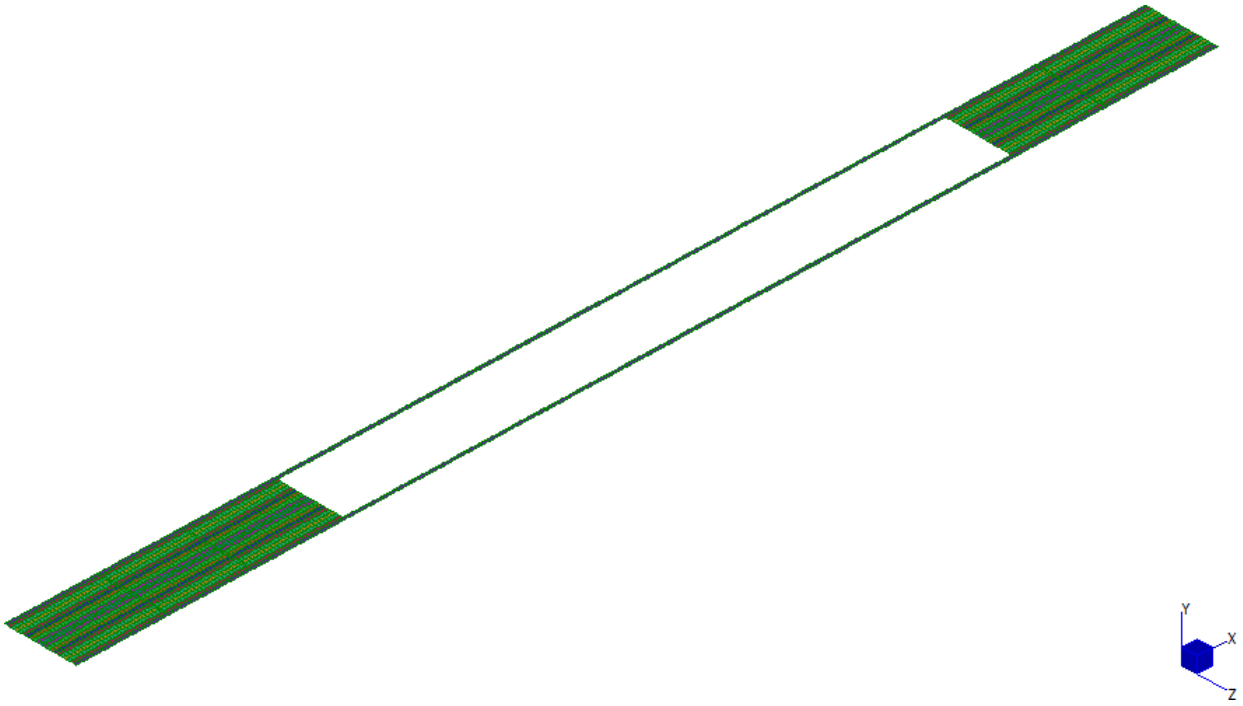
-Schalenelemente für Querträger Achse 2 und 12 ->1,26m



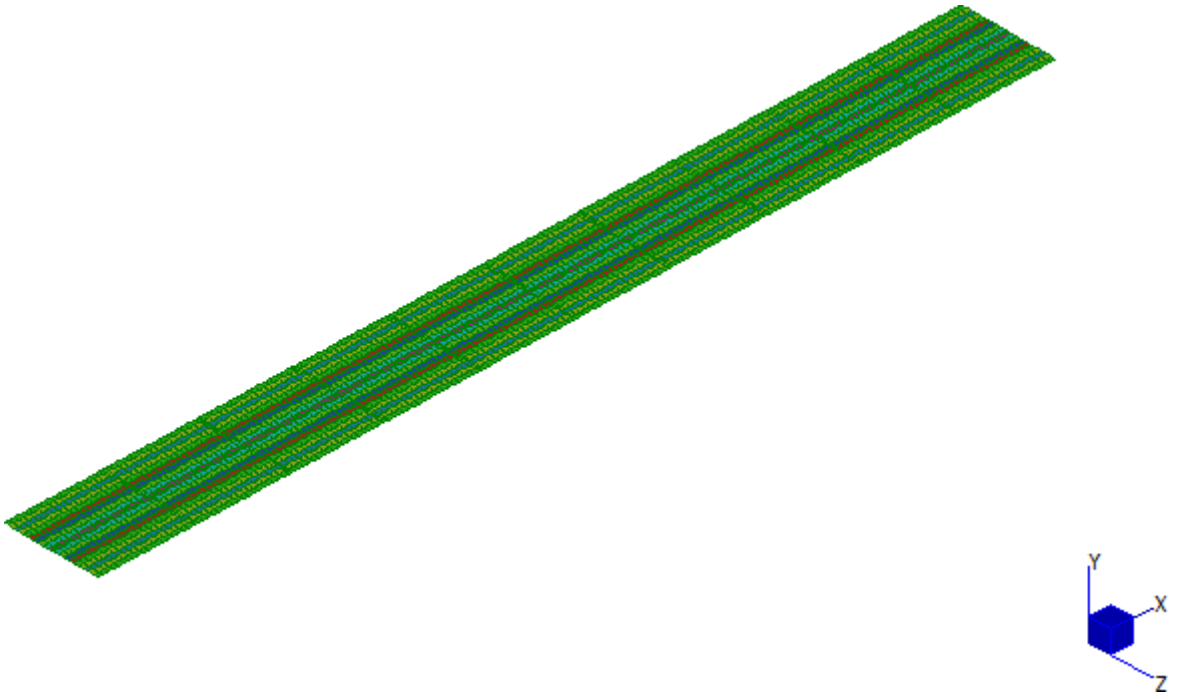




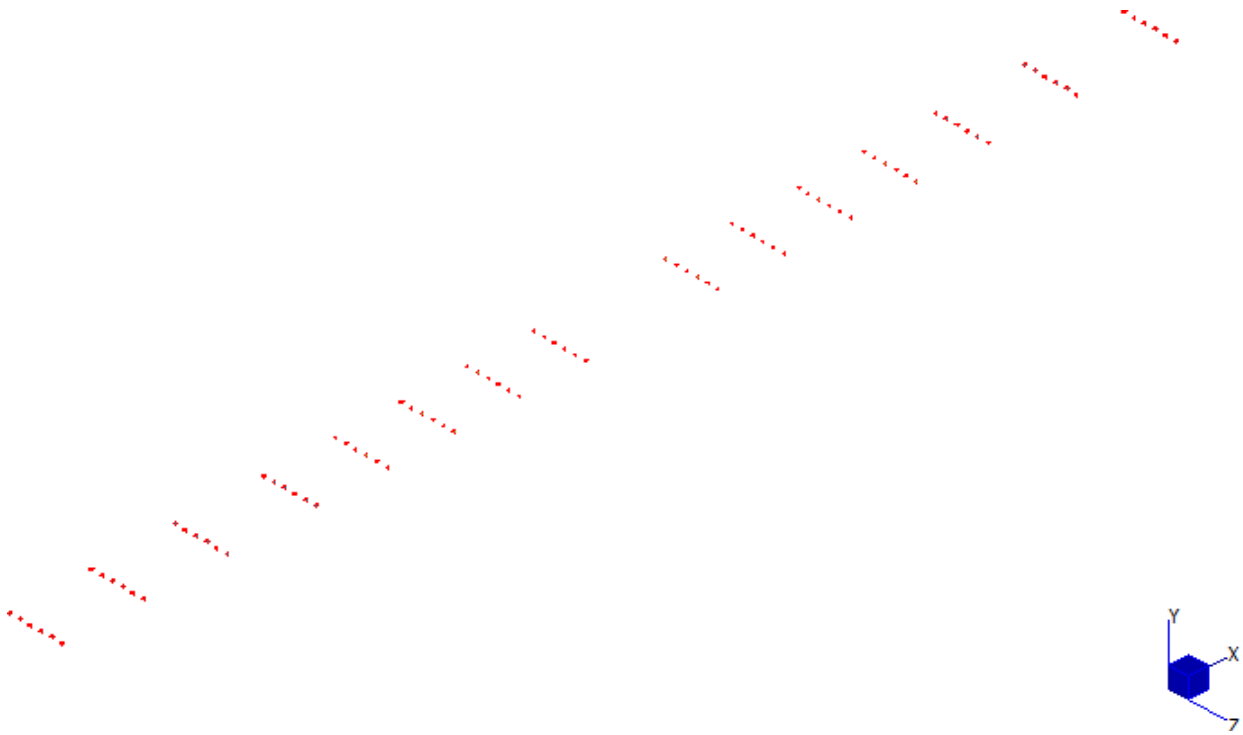
-Schalenelemente Kämpferfundamente 2,0m



-Schalenelemente Fahrbahnplatte, Stärke: 60cm, 59cm, 58cm, 56cm, 55cm, 54cm, 53cm, 51cm, 30cm



Schalenelemente Fahrbahnplatte, Bereiche mit reduzierter Stärke: 45cm, 44cm, 43cm, 41cm, 40cm, 39cm, 38cm, 36cm



-Elastomerlager 300x400x72; 250x300x48; 300x400x60

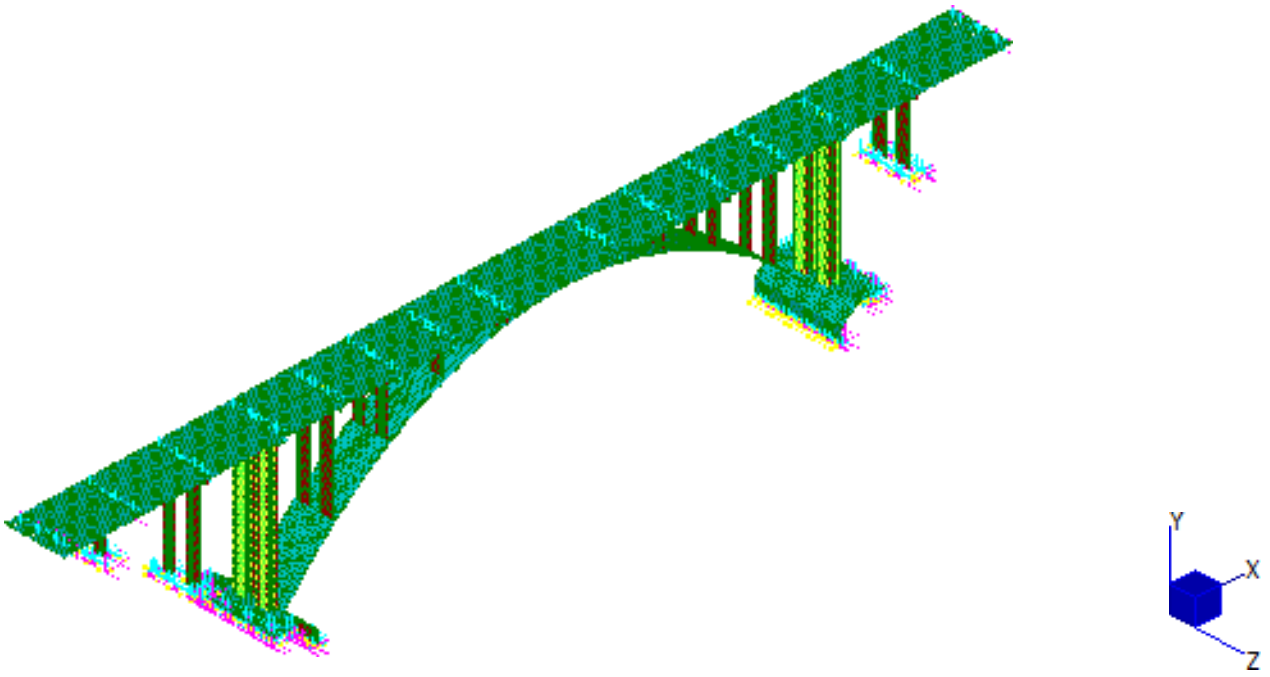
-Mikropfähle

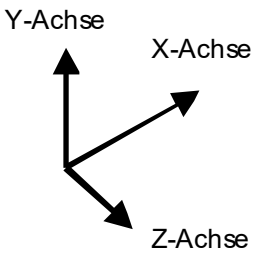
1.5 Lokales und globales Koordinatensystem

Die positive globale X-Achse zeigt ca. in Brückenlängsrichtung.

Die positive globale Y-Achse zeigt vertikal nach oben.

Die positive globale Z-Achse zeigt ca. in Brückenquerrichtung (Rechte-Hand-Regel).





1.6 Materialien

Beton Bogen Bestand: Rck30

Charakteristische Druckfestigkeit fck = 30,0MPa*0,83=24,9MPa

Bemessungsdruckfestigkeit fcd = α_cc*f_ck/γ_M*= 0,85*24,9MPa/1,5 = 14,11MPa

Ec = 30.000,0MPa

Temperaturdehnungskoeffizient: α_t = 1,0*10^(-5)

Betondeckung c=2,0cm

Laut Bestandspläne wurde ein Beton mit Zementgehalt 350kg/m³ (R730) verwendet.

Für alle Bauteile sind Bestandspläne sind vorhanden. Die Geometrie entspricht den Bestandsplänen.

An 5 Stellen wurde die Druckfestigkeit (mittels Bohrkernentnahme) überprüft. Siehe Anlage Materialprüfung. Der Kenntnisstand laut cap. 8.5.4 NTC 2018 ist hoch „LC3“. Der Abminderungsfaktor „FC“ für die angesetzten Materialkennwerte beträgt 1,0.

Beton Pfeiler Bestand: Rck25

Charakteristische Druckfestigkeit fck = 25,0MPa*0,83=20,8MPa

Bemessungsdruckfestigkeit fcd = α_cc*f_ck/γ_M*= 0,85*20,8MPa/1,5 = 11,8MPa

Ec = 30.000,0MPa

Temperaturdehnungskoeffizient: α_t = 1,0*10^(-5)

Betondeckung c=2,0cm

Laut Bestandspläne wurde ein Beton mit Zementgehalt 300kg/m³ verwendet.

Für alle Bauteile sind Bestandspläne sind vorhanden. Die Geometrie entspricht den Bestandsplänen.

An 22 Stellen wurde die Druckfestigkeit (mittels Bohrkernentnahme) überprüft. Siehe Anlage Materialprüfung. Der Kenntnisstand laut cap. 8.5.4 NTC 2018 ist hoch „LC3“. Der Abminderungsfaktor „FC“ für die angesetzten Materialkennwerte beträgt 1,0.

Beton Kämpferfundament und Pfeilerfundamente Bestand: Rck20

Charakteristische Druckfestigkeit fck = 20,0MPa*0,83=16,6MPa

Bemessungsdruckfestigkeit fcd = α_cc*f_ck/γ_M*= 0,85*16,6MPa/1,5 = 9,40MPa

Ec = 30.000,0MPa

Temperaturdehnungskoeffizient: α_t = 1,0*10^(-5)

Betondeckung c=2,0cm

Siehe Anlage: Materialprüfung

Laut Bestandspläne wurde ein Beton mit Zementgehalt 300kg/m³ verwendet.

Für alle Bauteile sind Bestandspläne sind vorhanden. Die Geometrie entspricht den Bestandsplänen.

Der Kenntnisstand laut cap. 8.5.4 NTC 2018 ist hoch „LC3“. Der Abminderungsfaktor „FC“ für die angesetzten Materialkennwerte beträgt 1,0.

Bewehrung Bestand: AQ 50

Streckgrenze fyk = 270,0MPa

Bemessungswert der Streckgrenze fyd = fyk/γs = 270,0MPa/1,15 = 234,8MPa

Laut Bestandspläne wurde der Bewehrugsstahl AQ50 verwendet.

Für alle Bauteile sind Bestandspläne sind vorhanden. Die Geometrie entspricht den Bestandsplänen.

Der Kenntnisstand laut cap. 8.5.4 NTC 2018 ist hoch „LC3“. Der Abminderungsfaktor „FC“ für die angesetzten Materialkennwerte beträgt 1,0.

Beton Brückenplatte, Widerlager, Fundamente und Verstärkungen: C30/37

Charakteristische Druckfestigkeit fck = 30,0MPa

Bemessungsdruckfestigkeit fcd = α_cc*f_ck/γ_M*= 0,85*30,0MPa/1,5 = 17,0MPa

Ec = 33.000,0MPa (In der elektronischen Berechnung mit 30.000MPa gerechnet)

Temperaturdehnungskoeffizient: α_t = 1,0*10^(-5)

Betondeckung c=5,0cm

Betonstahl Verstärkungen: B450C

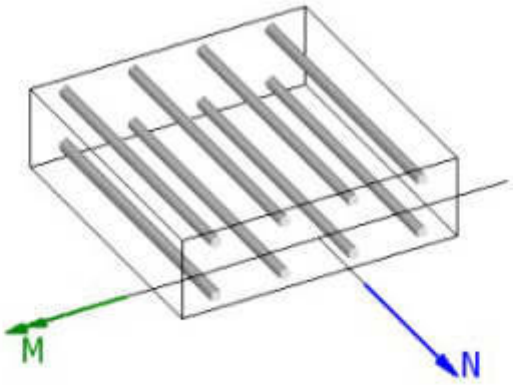
Streckgrenze fyk = 450,0MPa

Bemessungswert der Streckgrenze fyd = fyk/γs = 450,0MPa/1,15 = 391,3MPa

1.7 Automatische Berechnung der erforderlichen Bewehrung

Beschreibung wie ausgehend von den Platten/Schalenschnittgrößen das Bemessungsprogramm automatisch die erforderliche Bewehrung berechnet:

- **Elasto-plastic iteration**

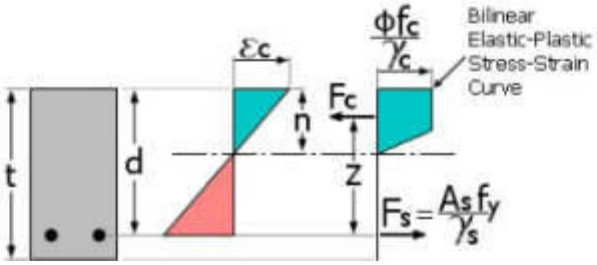


Replaces the rectangular stress block with a bilinear elastic-plastic stress-strain curve for the concrete, determined from the values Ec and εc entered in the Concrete tab. Although EC2 recommends the use of parabolic-rectangular shape stress block, the use of elastic-plastic and rectangular stress blocks are also allowed as differences in results are usually small. A similar bilinear elastic-plastic stress-strain curve is used for the steel.

a. **Include membrane forces**
   If set, membrane forces are included in the elasto-plastic iteration.

b. **Allow compression reinforcement**
   If set, reinforcement may be added when the concrete is in compression and the compressive stress in the concrete exceeds the allowable limit.

c. **Add reinforcement to limit compressive strain**
   If set, reinforcement may be added when the concrete compressive strain exceeds the allowable limit. This option is only available when compression reinforcement is allowed



Iterative Solution of Reinforced Concrete

The nonlinear material behaviour of a steel reinforced concrete slab, where the steel is represented as a smeared uniform layer of a constant thickness, can be determined by using a layered approach, similarly to the laminated composite material and the nonlinear material analysis of plates and shells. For the reinforced concrete analysis, the slab is divided into a number of thin layers with each layer being either concrete or steel, depending on the reinforcement layout. This approach allows us to consider both membrane and bending loads on the composite.

Note that if the Reinforcement Layout sets the bar diameter to zero for any layers, the iterative approach below does not attempt to place steel on those layers; the final reinforcement solution will rely on steel being placed only on the layers where a non-zero bar diameter has been specified. A non-zero bar diameter therefore signals to the algorithm that steel may be placed there, but the amount of steel to be placed is determined by the algorithm described below (i.e. by the module).

The constitutive equation for the slab and concrete composite can be described by:

$$\begin{Bmatrix} \mathbf{N} \\ \mathbf{M} \end{Bmatrix} = \begin{bmatrix} \mathbf{C} & \mathbf{B} \\ \mathbf{B} & \mathbf{D} \end{bmatrix} \begin{Bmatrix} \boldsymbol{\varepsilon}^m \\ \boldsymbol{\kappa} \end{Bmatrix}$$

where:

$$\mathbf{N} = \begin{Bmatrix} N_x \\ N_y \\ N_{xy} \end{Bmatrix} = \int_{-h/2}^{h/2} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} dz = \sum_{k=1}^{N} \int_{h_{k-1}}^{h_k} \begin{Bmatrix} \sigma_x(z) \\ \sigma_y(z) \\ \tau_{xy}(z) \end{Bmatrix} dz$$

is the resultant force vector, which has units of force per unit length, and:

$$\mathbf{M} = \begin{Bmatrix} M_x \\ M_y \\ M_{xy} \end{Bmatrix} = \int_{-h/2}^{h/2} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} z \, dz = \sum_{k=1}^{N} \int_{h_{k-1}}^{h_k} \begin{Bmatrix} \sigma_x(z) \\ \sigma_y(z) \\ \tau_{xy}(z) \end{Bmatrix} z \, dz$$

is the resultant moment vector, which has units of moment per unit length. N and M are obtained from the finite structural element solution as stress and moment resultants on the plate element.

C is the extensional stiffness matrix (membrane elasticity matrix) defined by:

$$\mathbf{C} = \sum_{k=1}^{N} (h_k - h_{k-1}) \overline{\mathbf{Q}}_k$$

D is the bending stiffness matrix defined by:

$$\mathbf{D} = \frac{1}{3}\sum_{k=1}^{N}\left(h_k^3 - h_{k-1}^3\right)\overline{\mathbf{Q}}_k$$

and B is the extensional/bending coupling matrix defined by:

$$\mathbf{B} = \frac{1}{2}\sum_{k=1}^{N}\left(h_k^2 - h_{k-1}^2\right)\overline{\mathbf{Q}}_k$$

where $\overline{\mathbf{Q}}_k$ is the elasticity matrix for layer k (which may be either concrete or steel), and the matrices C, B,and D are symmetric.

$\boldsymbol{\varepsilon}^0$ is the mid-plane membrane strain vector and $\boldsymbol{\kappa}$ is the plate curvature vector.

In the case of nonlinear material behaviour (both concrete and steel), $\overline{\mathbf{Q}}_k$ is a function of the strain in the layer, leading to a set of nonlinear equations which may be solved using standard Newton-Raphson iteration.

Note that although each ply in the reinforced concrete composite may exhibit nonlinear stress-strain behaviour, the assumption of linear strain variation through the composite slab thickness is made.

2 Lastaufstellung

2.1 Lastfall 1: Strukturelles Eigengewicht

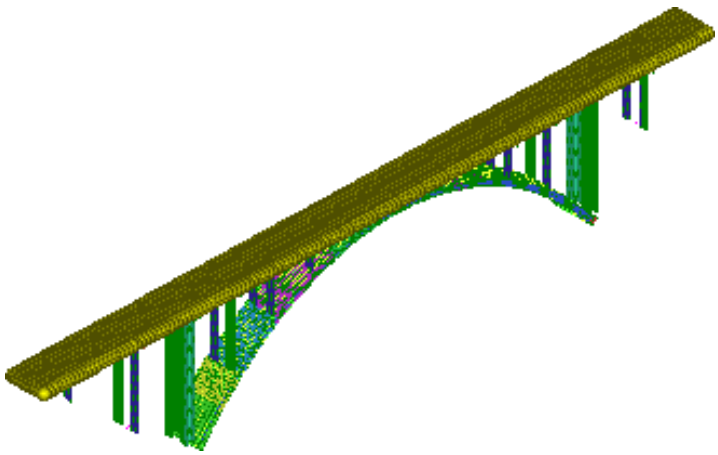
Das Strukturelle Eigengewicht des Unterbaus und Überbaus (inkl. Bestandsquerschnitte) wird mit 25,0kN/m³ automatisch berechnet.

Eigengewicht neue Fahrbahnplatte Felder vor und nach Bogen : 5,43m²*25,0kN/m3 = 135,8kN/m

Eigengewicht neue Fahrbahnplatte Bogenbereich : 4,02m²*25,0kN/m3 = 100,5kN/m

2.2 Lastfall 2: Permanente Auflast

Asfalt: 0,15m*7,5m * 24,0kN/m³ =	27,0kN/m
Randbalken Bereich ober FBPL: 2*0,3m*25,0kN/m³*1,4m =	21,0kN/m
Randbalken Bereich Auskragung: 2*0,25m*0,8m*25,0kN/m³ =	10,0kN/m
Leiteinrichtung + Geländer: 2*10,0kN/m =	20,0kN/m
SUMME =	**78,0kN/m**



2.3 Lastfall 3: Konstante Temperaturänderung +24,5°C

Berechnung der extremen Außenlufttemperaturen laut DM 17.01.2018:

Zone 1 -> T_min = -15-4*a_s/1000 = -15-4*800m/1000 = -18°C

Zone 1 -> T_max = 42-6*a_s/1000 = 42-6*800m/1000 = +37°C

Für Betonkonstruktionen (Typ3) beträgt die minimale konstante Temperatur der Brücke laut EN 1991-1-5 6.1.1 T_e,min = T_min + 8 = -18°C+ 8 =-10°C

Für Betonkonstruktionen (Typ3) beträgt die maximale konstante Temperatur der Brücke laut EN 1991-1-5 6.1.1 T_e,max = T_max + 2 = 37°C+ 2 =39°C

Annahme Aufstelltemperatur: T0 = 14,5°C

Die konstante Temperaturänderung (Erwärmung) beträgt: ΔT = 39°C-14,5°C = 24,5°C

2.4 Lastfall 4: Konstante Temperaturänderung -24,5°C

Es wird die konstante Abkühlung des Tragwerks von 24,5°C angesetzt.

2.5 Lastfall 5: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient der FBPL von 10,0°C (Oberseite wärmer als Unterseite) angesetzt.

2.6 Lastfall 6: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient der FBPL von 8,0°C (Unterseite wärmer als Oberseite) angesetzt.

2.7 Lastfall 7: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient des Bogens von 5,0°C (Oberseite wärmer als Unterseite) angesetzt.

2.8 Lastfall 8: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient des Bogens von 5,0°C (Unterseite wärmer als Oberseite) angesetzt.

2.9 Lastfall 9: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient der Pfeiler von 5,0°C (Vorderseite wärmer als Hinterseite) angesetzt.

2.10 Lastfall 10: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer)

Temperatureinwirkungen EN 1991-1-5.

Es wird der Temperaturgradient der Pfeiler von 5,0°C (Hinterseite wärmer als Vorderseite) angesetzt.

2.11 Lastfall 11: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Konstante Temperaturänderung +24,5°C

2.12 Lastfall 12: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Konstante Temperaturänderung +24,5°C

2.13 Lastfall 13: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Konstante Temperaturänderung +24,5°C

2.14 Lastfall 14: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Konstante Temperaturänderung +24,5°C

2.15 Lastfall 15: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Konstante Temperaturänderung +24,5°C

2.16 Lastfall 16: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Konstante Temperaturänderung +24,5°C

2.17 Lastfall 17: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Konstante Temperaturänderung -24,5°C

2.18 Lastfall 18: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Konstante Temperaturänderung -24,5°C

2.19 Lastfall 19: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Konstante Temperaturänderung -24,5°C

2.20 Lastfall 20: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Konstante Temperaturänderung -24,5°C

2.21 Lastfall 21: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Konstante Temperaturänderung -24,5°C

2.22 Lastfall 22: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Konstante Temperaturänderung -24,5°C

2.23 Lastfall 23: Schwinden -15°C

Um das Schwinden zu berücksichtigen wird die konstante Temperaturänderung aller Bauteile -15°C angesetzt.

2.24 Lastfall 24: Wind in Längsrichtung (+X)

-Winddruck $p = q_r * c_e * c_p * c_d = 0,423 kN/m^2 * 2,81 * 1,0 * 1,0 = 1,19 kN/m^2 * c_p$

c_p = Formkoeffizient (aerodynamischer Beiwert)

$q_r = 0,5 * \rho * (v_r)^2 = 0,5 * 1,25 kg/m^3 * (26,0 m/s)^2 = 422,5 N/m^2 = 0,423 kN/m^2$

$v_r = v_b * c_r = 25,0 m/s * 1,04 = 26,0 m/s$

$v_b = v_{b,0} * c_a = 25,0 m/s * 1,0 = 25,0 m/s$

$c_r = 0,75 * sqrt(1-0,2 * ln(-ln(1-1/T_R))) = 0,75 * sqrt(1-0,2 * ln(-ln(1-1/100))) = 1,04$

T_R = 100 Jahre

$c_e = (k_r)^2 * c_t * ln(z/z_0) * (7 + c_t * ln(z/z_0)) = (0,22)^2 * 1,0 * ln(40m/0,3m) * (7 + 1,0 * ln(40m/0,3m)) = 2,81$

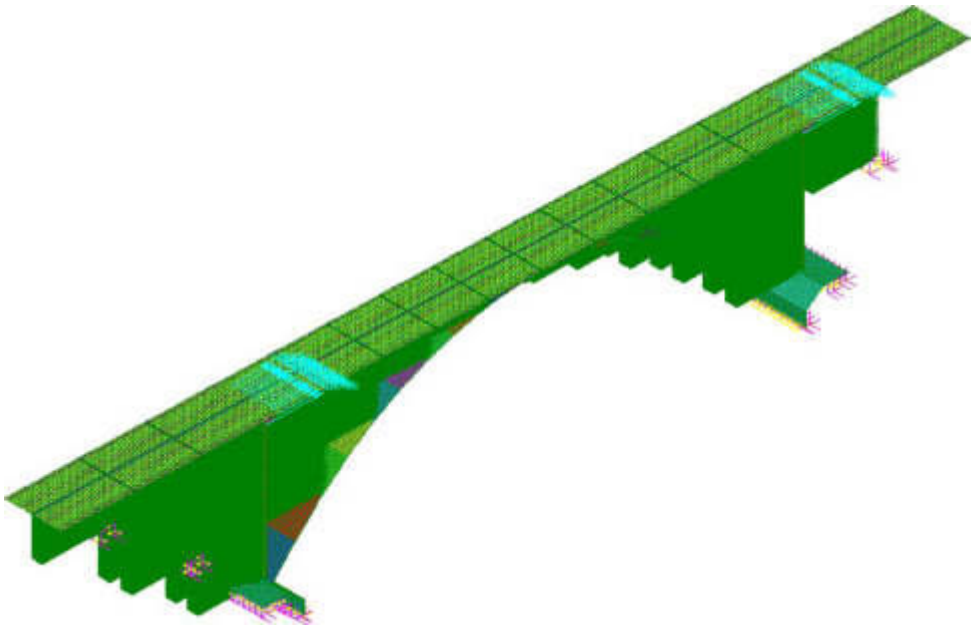
Klasse B, Zone IV

Pfeiler und Querträger:

Gesamtbreite je Pfeiler = 2,26m

Formkoeffizient 2,4 siehe EN1991-1-4 8.3.1

Windkraft pro m = 1,19kN/m²*2,4 (Formkoeffizient)= 2,86kN/m



2.25 Lastfall 25: Wind in Längsrichtung (-X)

Siehe Lastfall: Wind in Längsrichtung (+Z)

2.26 Lastfall 26: Wind in Querrichtung (+Z)

Fahrbahnplatte:

Gesamthöhe 0,75m+3,0m Verkehrsband = 3,75m

Formkoeffizient 1,3 siehe EN1991-1-4 8.3.1

Windkraft pro m = 1,19kN/m²*1,3 (Formkoeffizient)*3,75m = 5,80kN/m

Pfeiler:

Gesamtbreite je Pfeiler =0,76m

Formkoeffizient 1,3 siehe EN1991-1-4 8.3.1

Windkraft pro m = 1,19kN/m²*1,3 (Formkoeffizient)*0,76m = 1,18kN/m

Pfeilerkopf: 1,19kN/m²*1,3(Formkoeffizient)*1,1m*1,26m = 2,14kN

Bogen:

Formkoeffizient 1,3 siehe EN1991-1-4 8.3.1

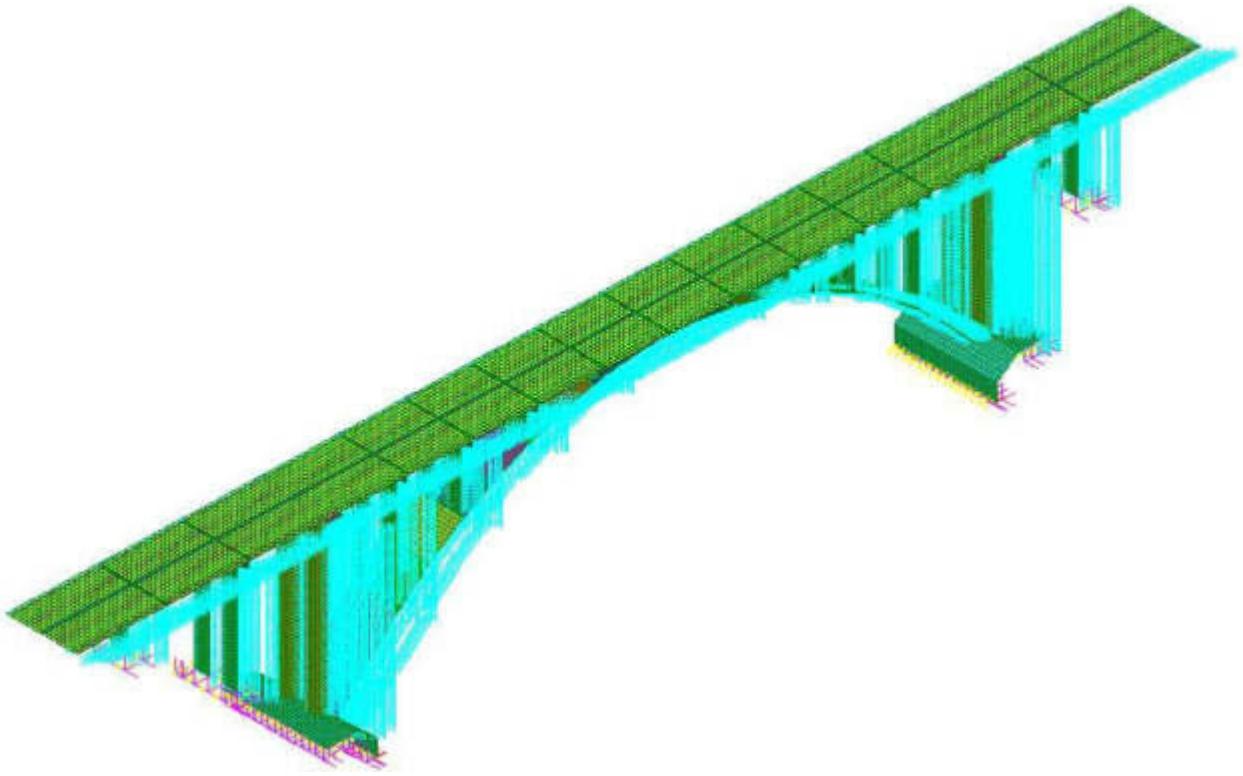
Windkraft pro m = 1,19kN/m²*1,3 (Formkoeffizient) = 1,55kN/m²

H-Pfeiler bei Kämpfer:

Gesamtbreite je Pfeiler =2,26m

Formkoeffizient 2,0 siehe EN1991-1-4 8.3.1

Windkraft pro m = 1,19kN/m²*2,0 (Formkoeffizient)*2,26m = 5,38kN/m

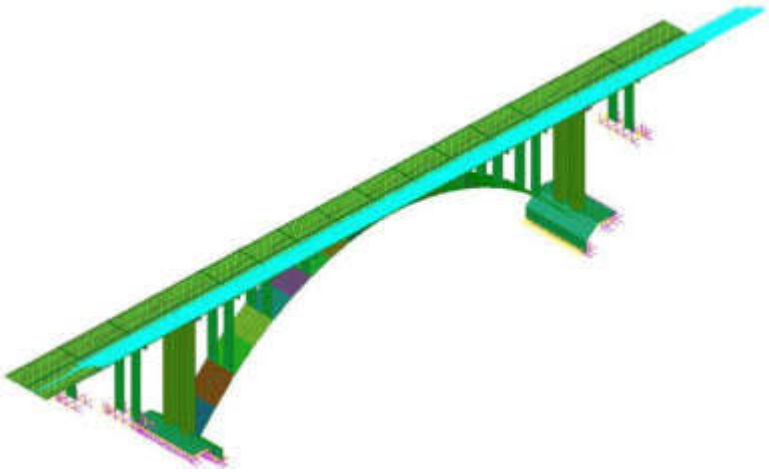


2.27 Lastfall 27: Wind in Querrichtung (-Z)

Siehe Lastfall: Wind in Querrichtung (+Z)

2.28 Lastfall 28: Bremsen in X

Die Horizontalkraft 900kN wurde als Linienlast gleichmäßig verteilt auf der gesamten Länge aufgebracht.

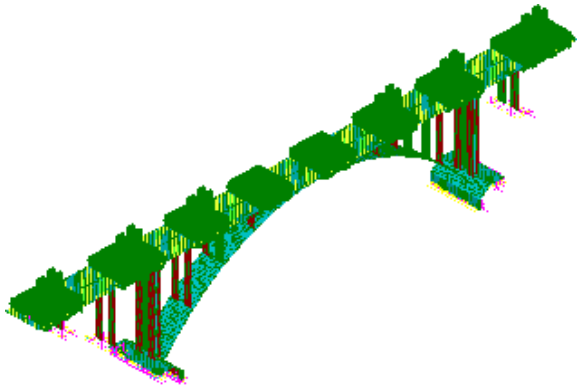


2.29 Lastfall 29: Bremsen in -X

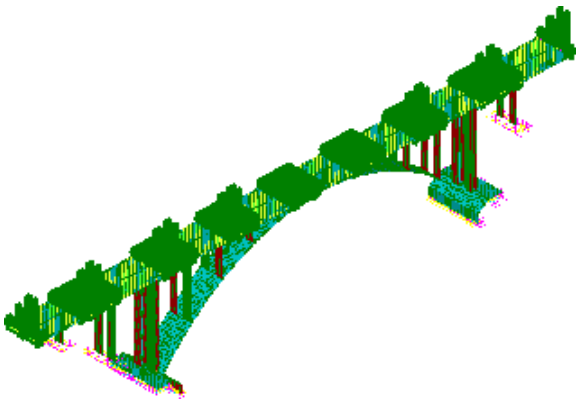
Die Horizontalkraft 900kN wurde als Linienlast gleichmäßig verteilt auf der gesamten Länge aufgebracht.

2.30 Lastfall 30 bis 123: Verkehrslasten LM1

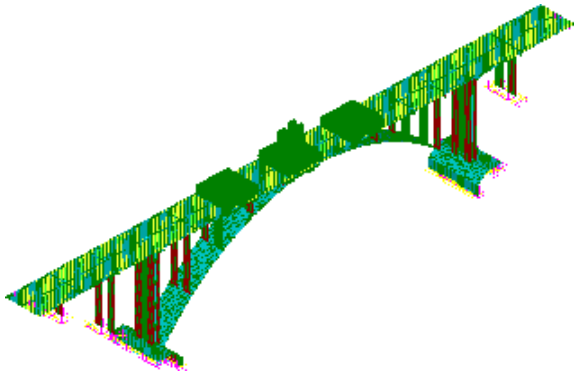
30: LM1_M_+Z_1_Feldmoment



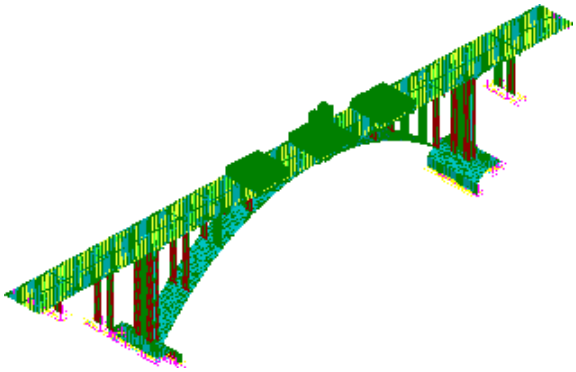
31: LM1_M_+Z_2_Feldmoment



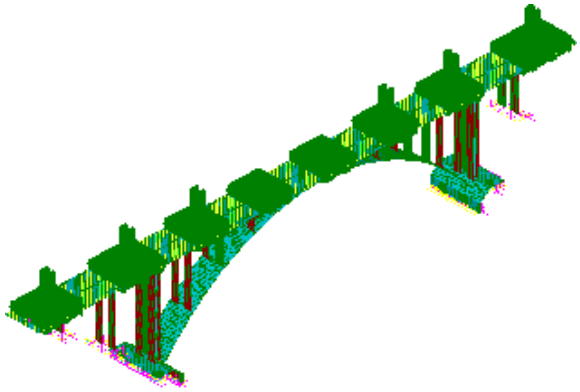
32: LM1_M_+Z_3_Feldmoment



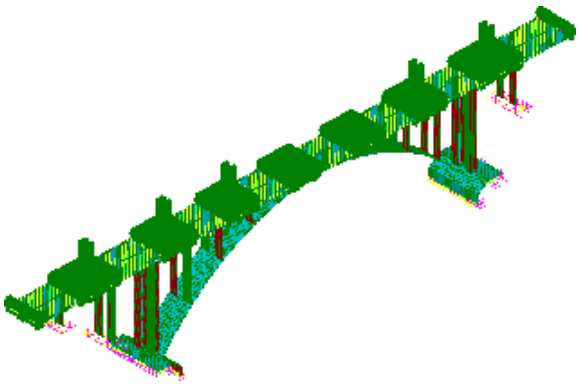
33: LM1_M_+Z_4_Feldmoment



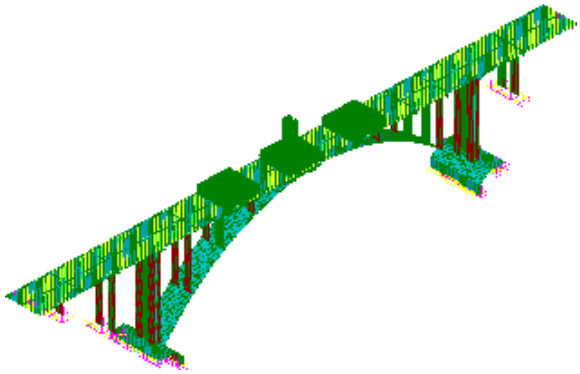
34: LM1_M_MITTE_1_Feldmoment



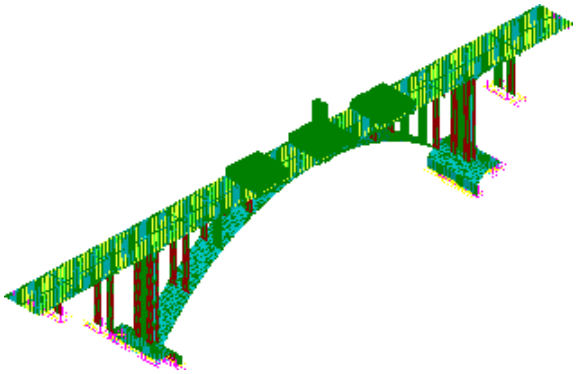
35: LM1_M_MITTE_2_Feldmoment



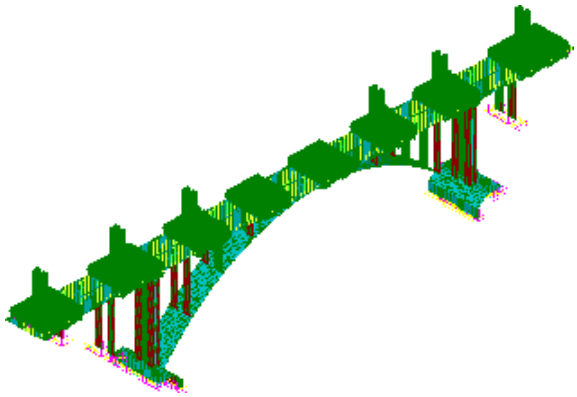
36: LM1_M_MITTE_3_Feldmoment



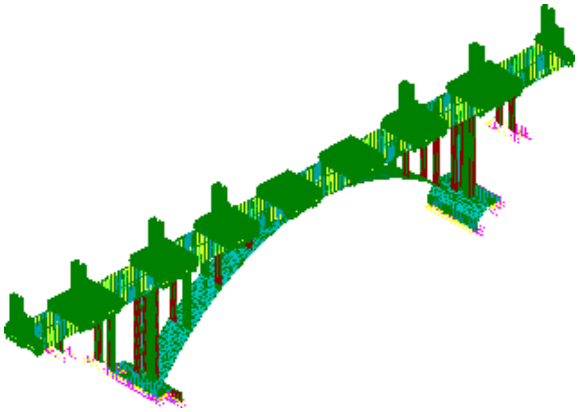
37: LM1_M_MITTE_4_Feldmoment



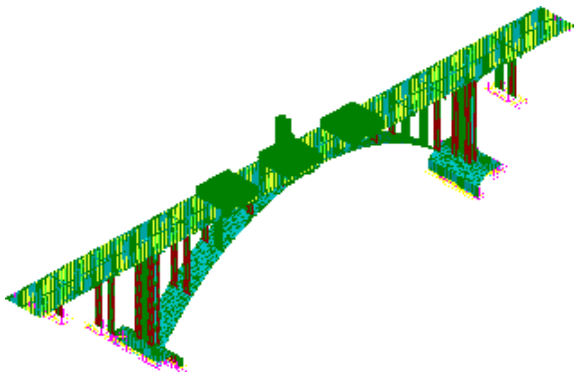
38: LM1_M_-Z_1_Feldmoment



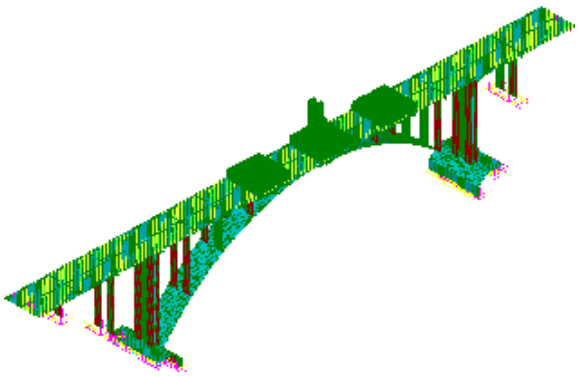
39: LM1_M_-Z_2_Feldmoment



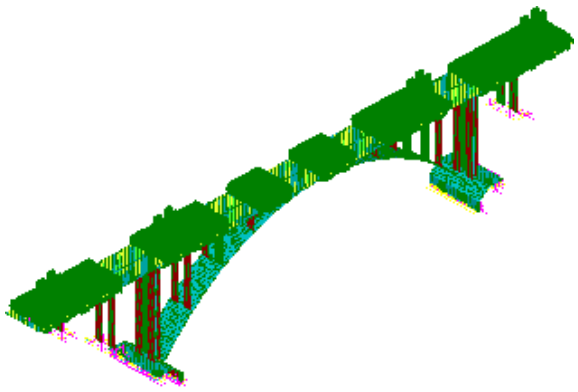
40: LM1_M_-Z_3_Feldmoment



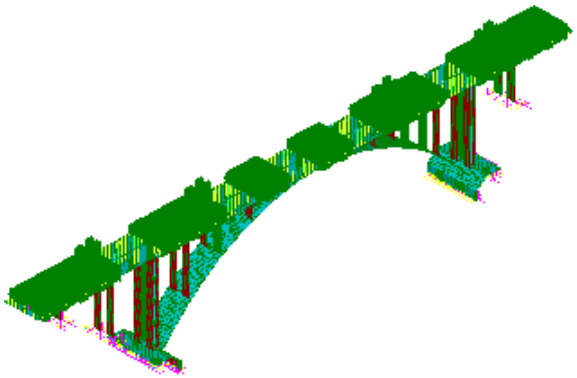
41: LM1_M_-Z_4_Feldmoment



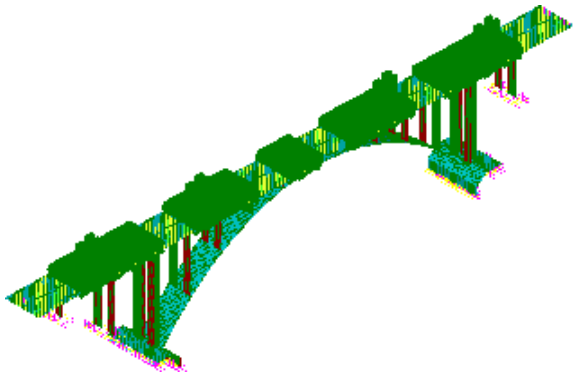
42: LM1_M_+Z_1_Stützmoment



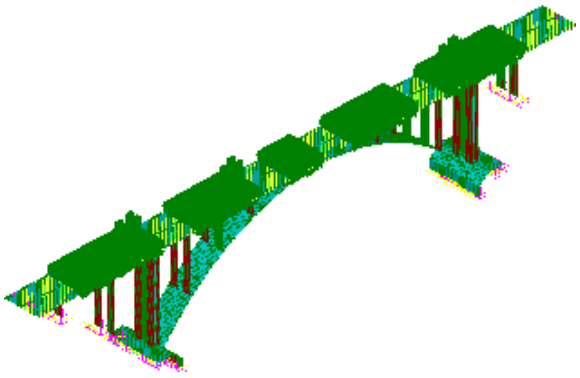
43: LM1_M_+Z_2_Stützmoment



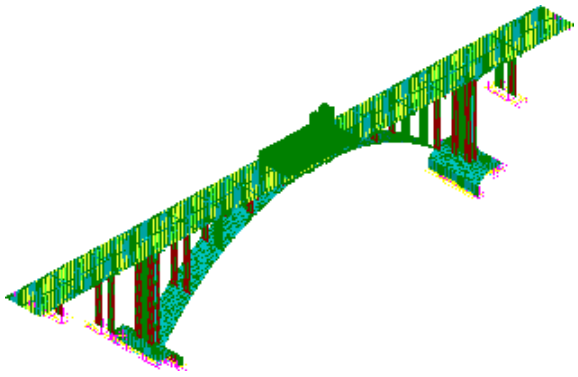
44: LM1_M_+Z_3_Stützmoment



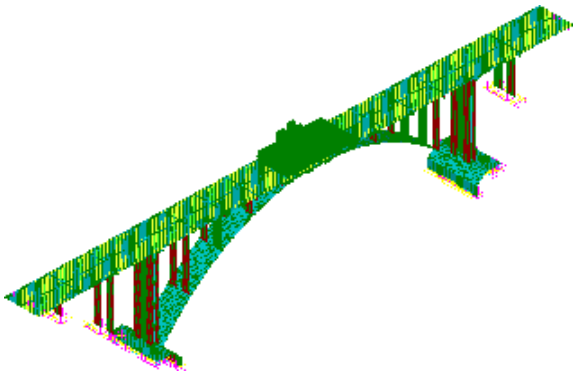
45: LM1_M_+Z_4_Stützmoment



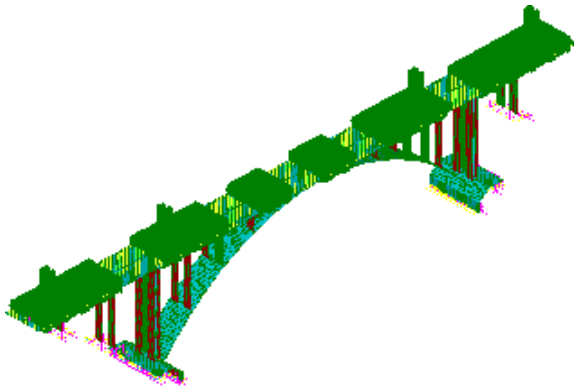
46: LM1_M_+Z_6_Stützmoment



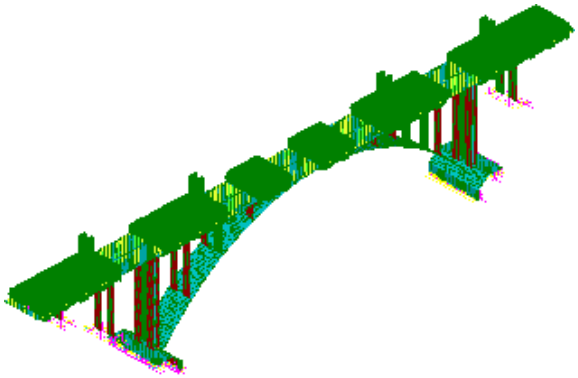
47: LM1_M_+Z_5_Stützmoment



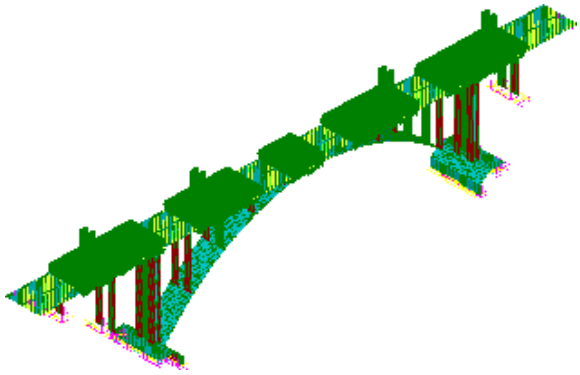
48: LM1_M_MITTE_1_Stützmoment



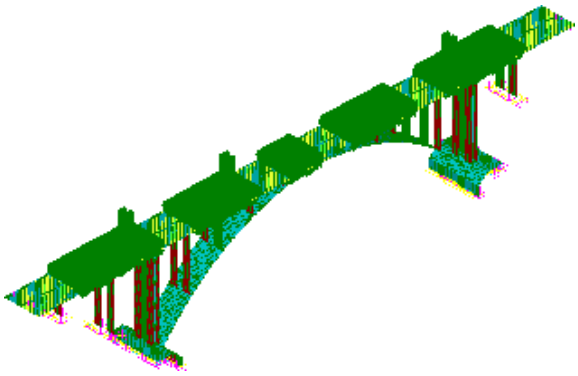
49: LM1_M_MITTE_2_Stützmoment



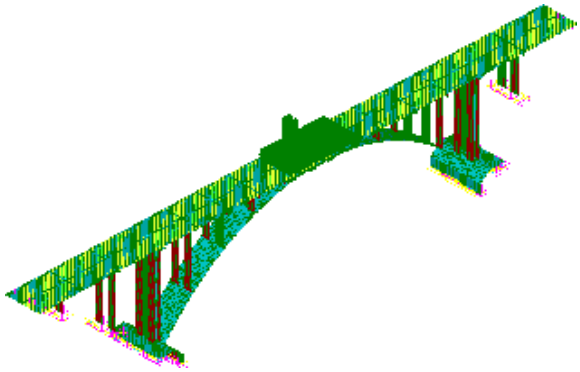
50: LM1_M_MITTE_3_Stützmoment



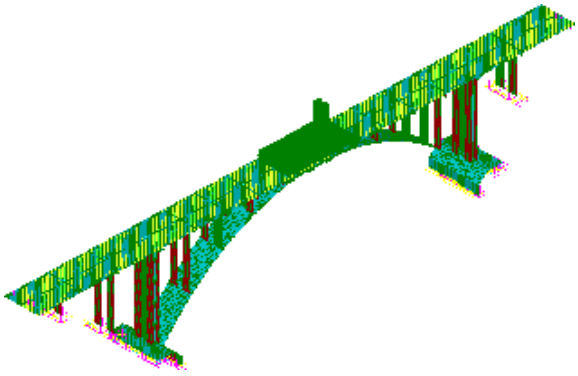
51: LM1_M_MITTE_4_Stützmoment



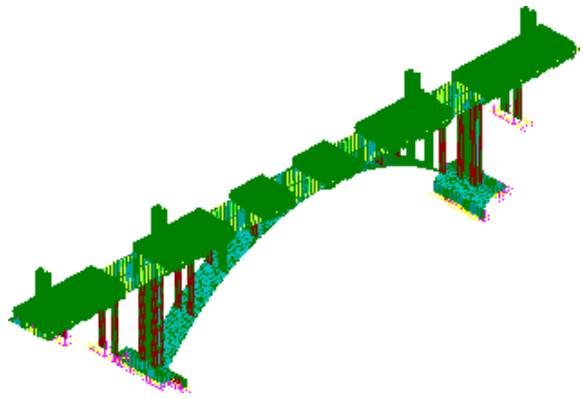
52: LM1_M_MITTE_5_Stützmoment



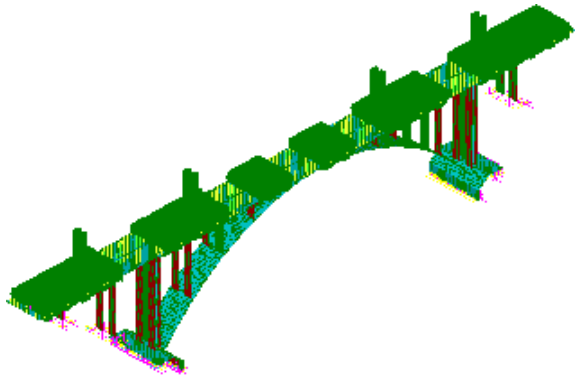
53: LM1_M_MITTE_6_Stützmoment



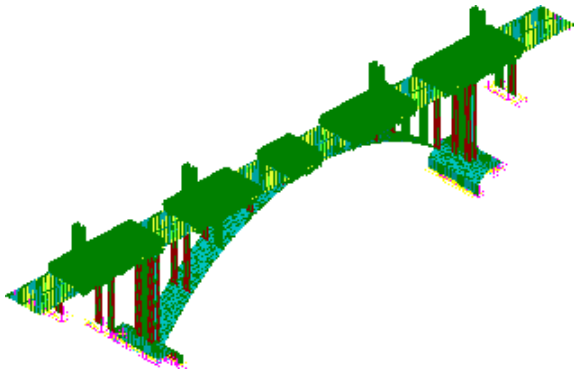
54: LM1_M_-Z_1_Stützmoment



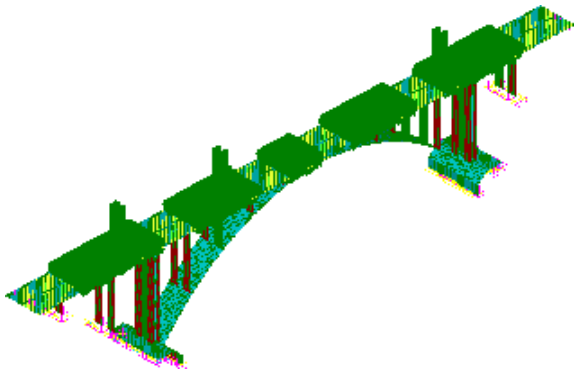
55: LM1_M_-Z_2_Stützmoment



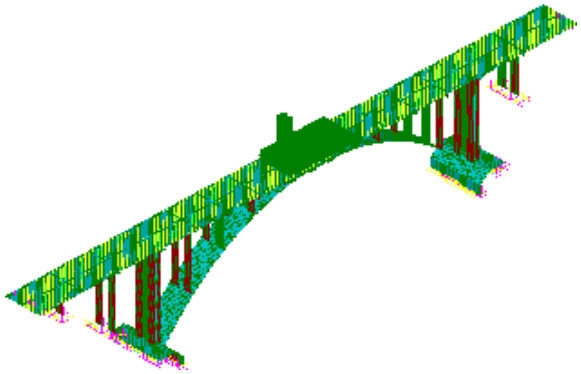
56: LM1_M_-Z_3_Stützmoment



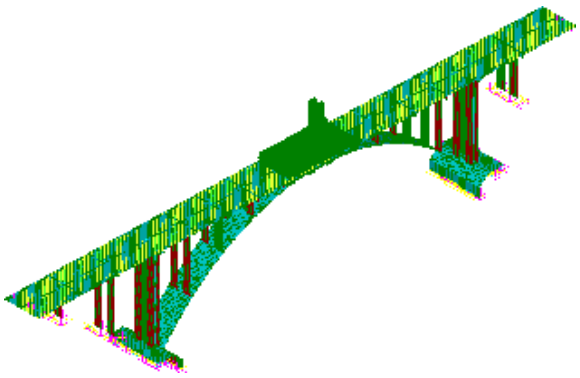
57: LM1_M_-Z_4_Stützmoment



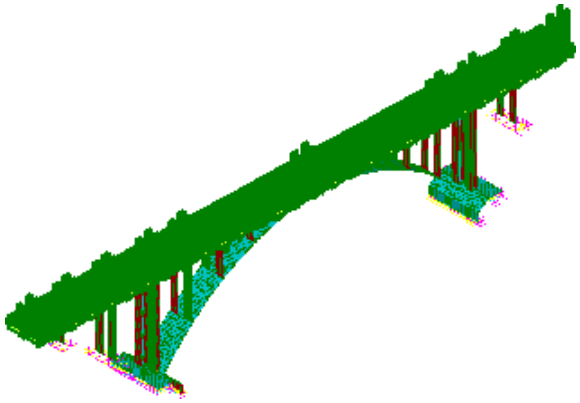
58: LM1_M_-Z_5_Stützmoment



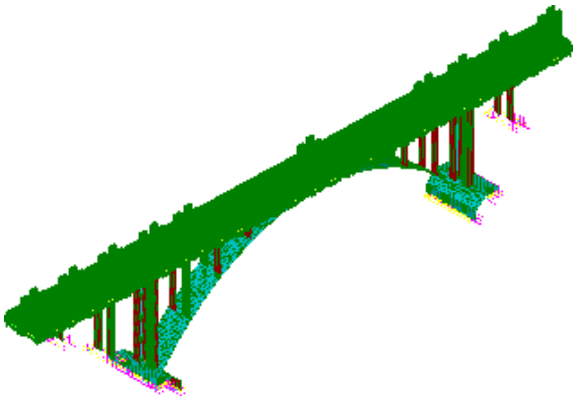
59: LM1_M_-Z_6_Stützmoment



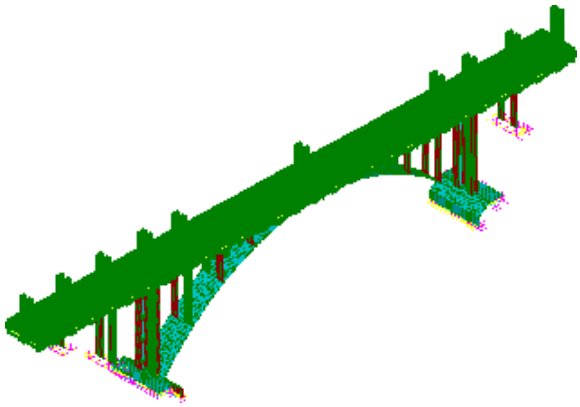
60: LM1_Q_+Z_1



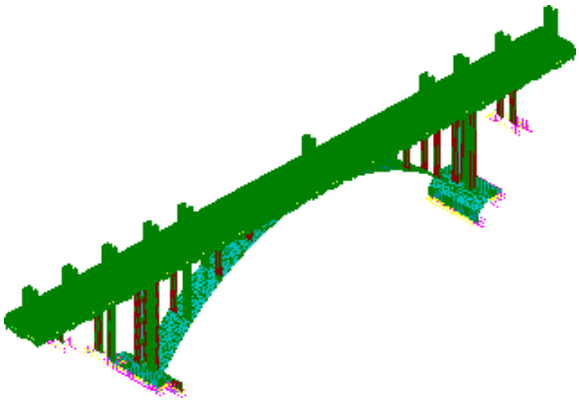
61: LM1_Q_+Z_2



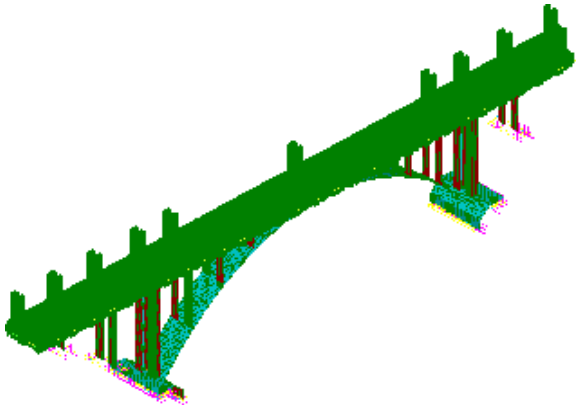
62: LM1_Q_MITTE_1



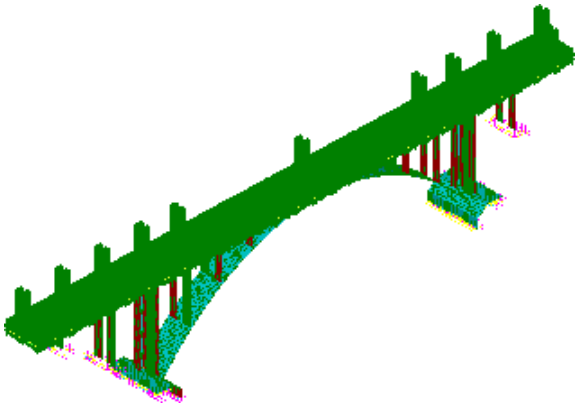
63: LM1_Q_MITTE_2



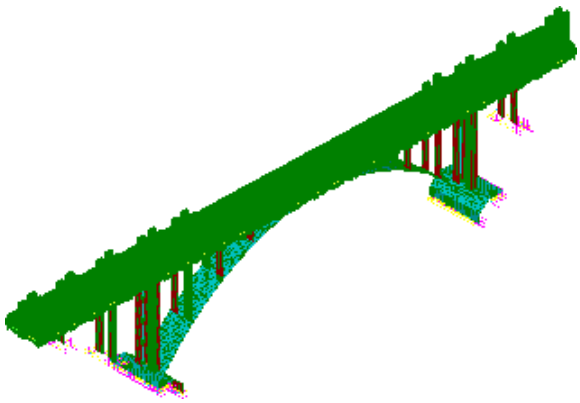
64: LM1_Q_-Z_1



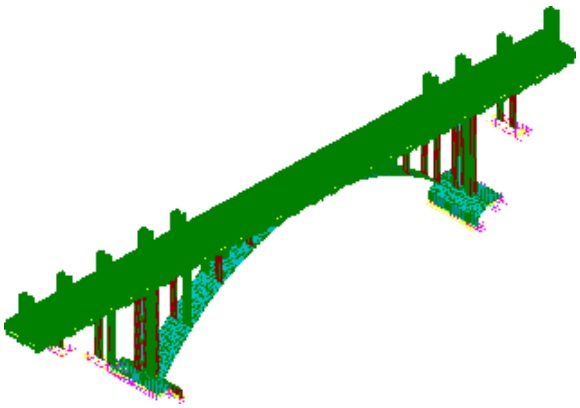
65: LM1_Q_-Z_2



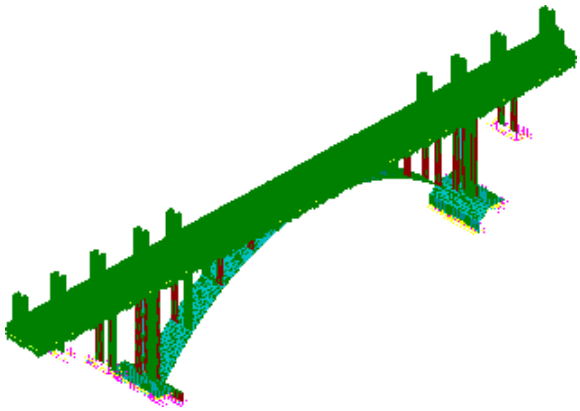
66: LM1_AchseA1,A2,1,2,3,11,12,13,B_+Z



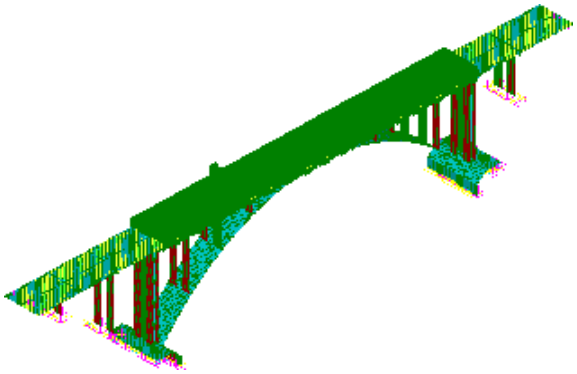
67: LM1_AchseA1,A2,1,2,3,11,12,13,B_MITTE



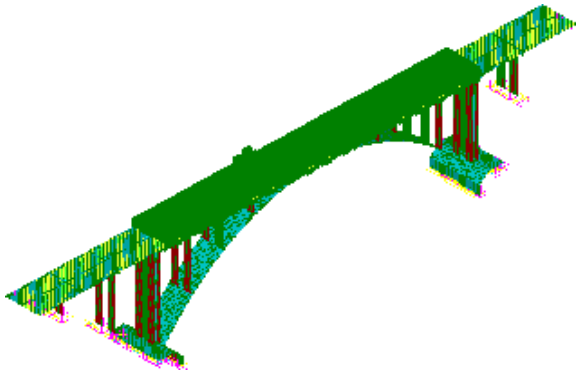
68: LM1_AchseA1,A2,1,2,3,11,12,13,B_-Z



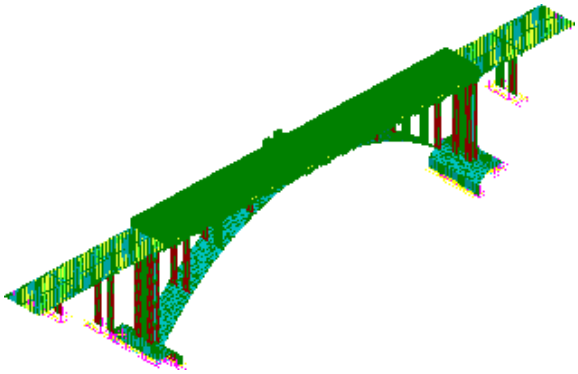
69: LM1_Ganze Bogen+Achse4_+Z

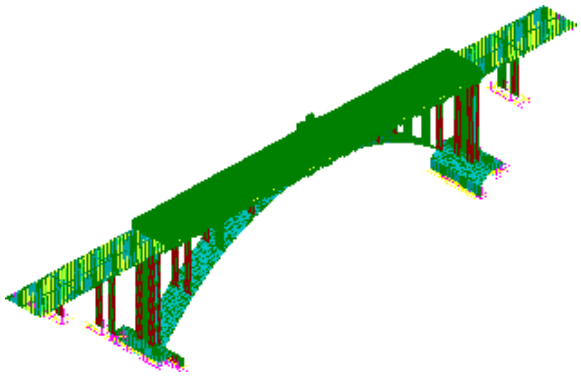
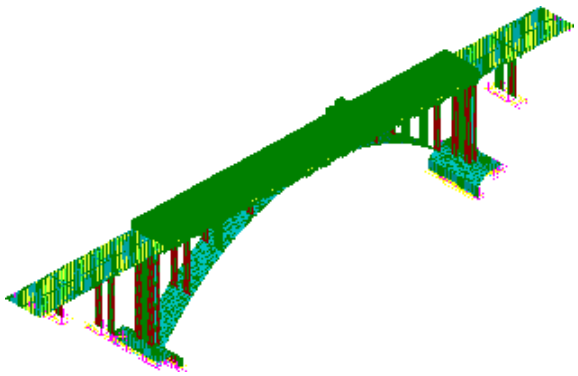
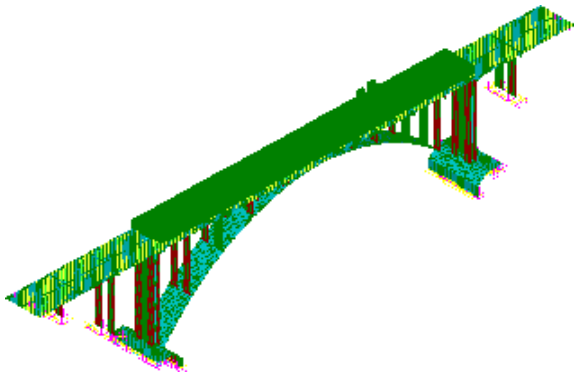
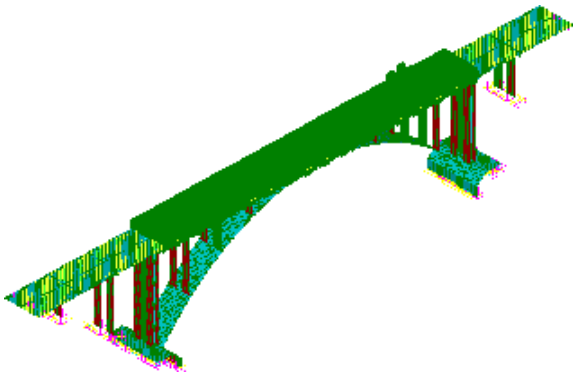
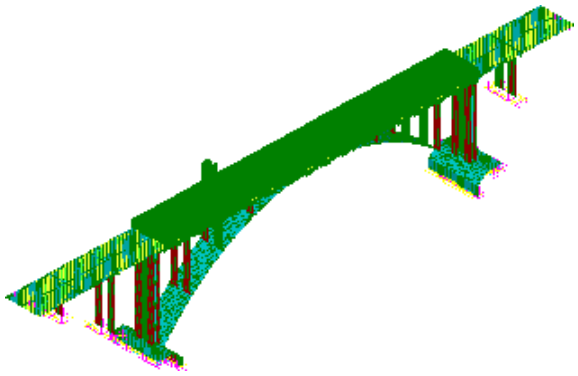
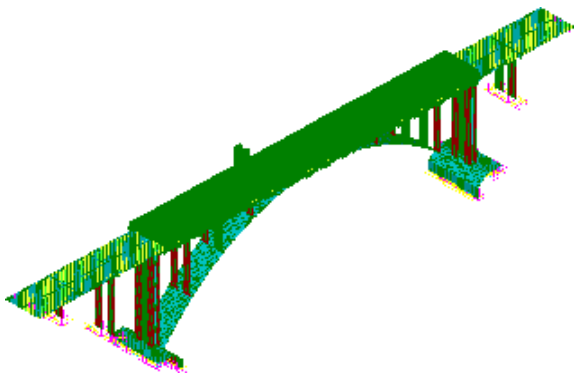


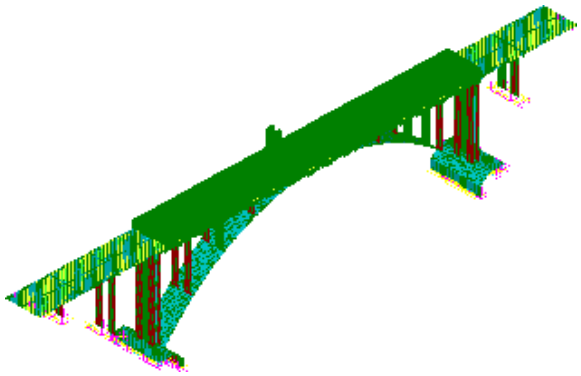
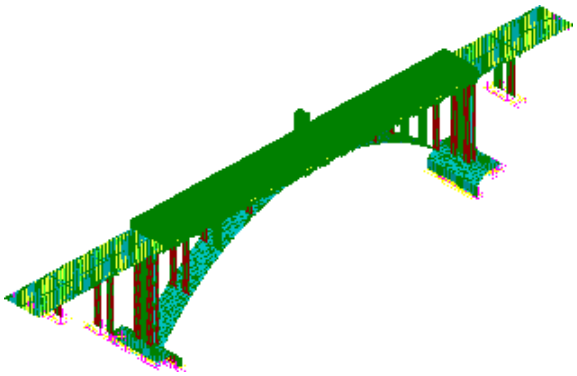
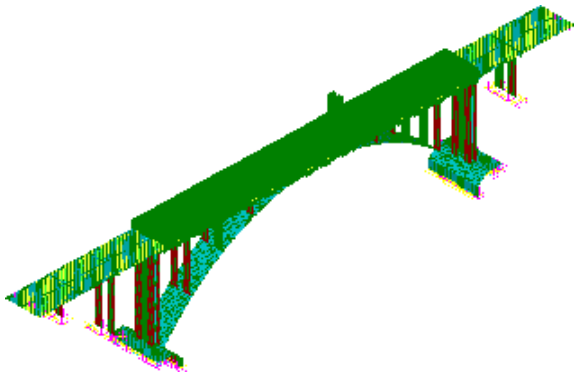
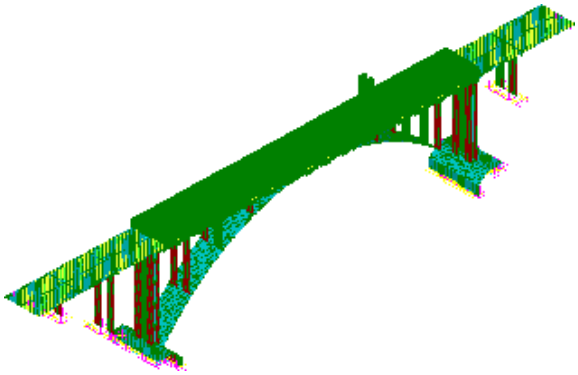
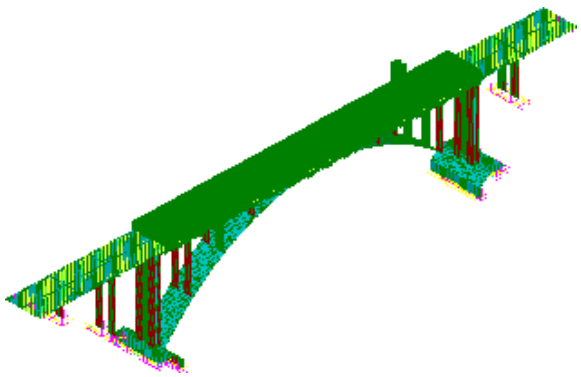
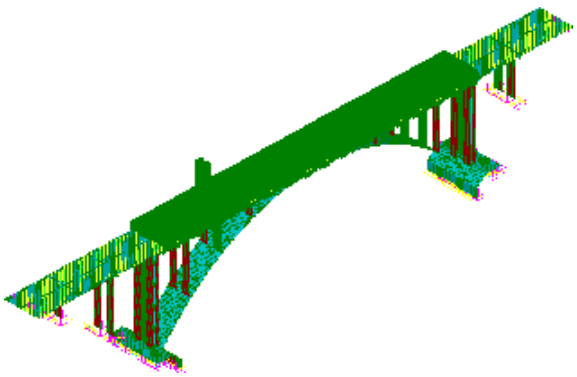
70: LM1_Ganze Bogen+Achse5_+Z

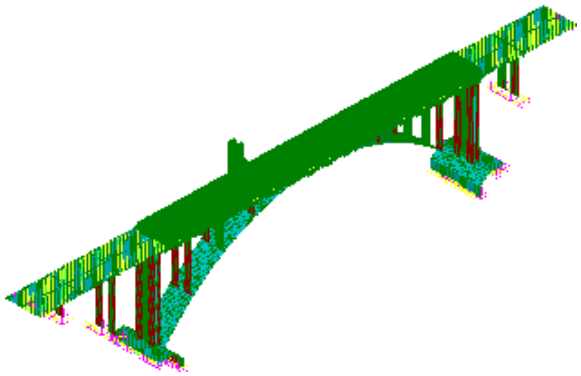
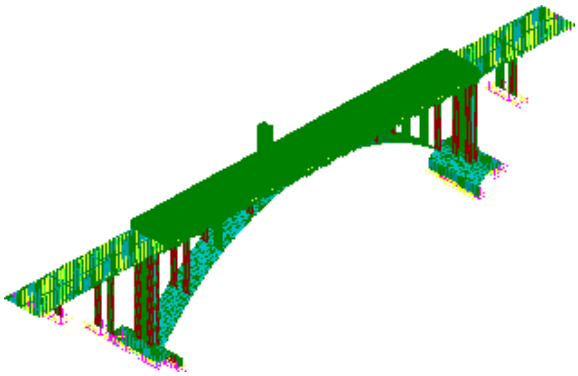
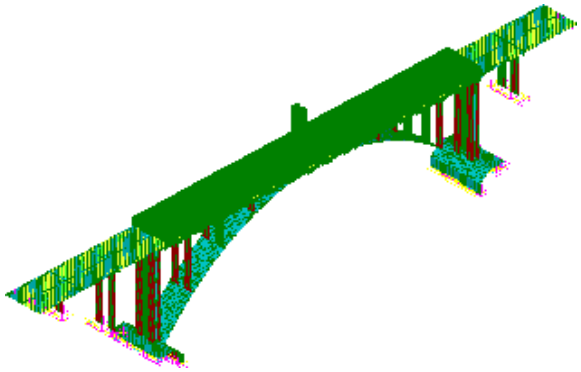
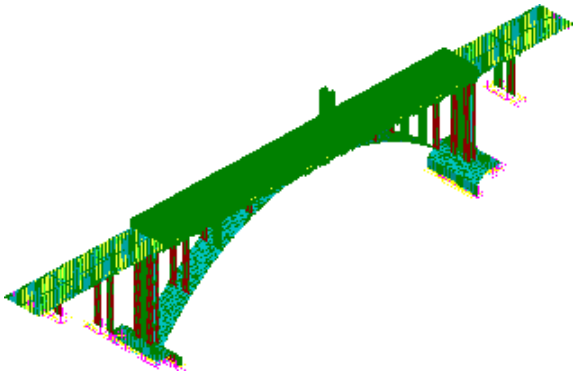
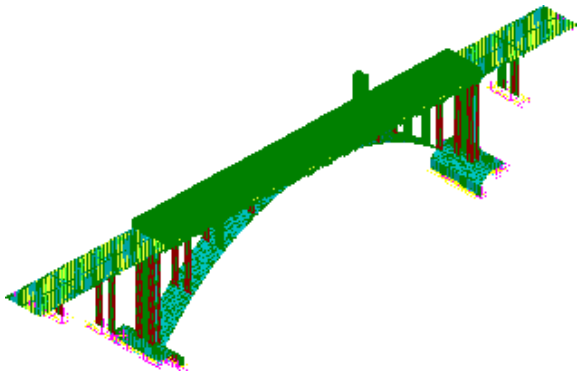
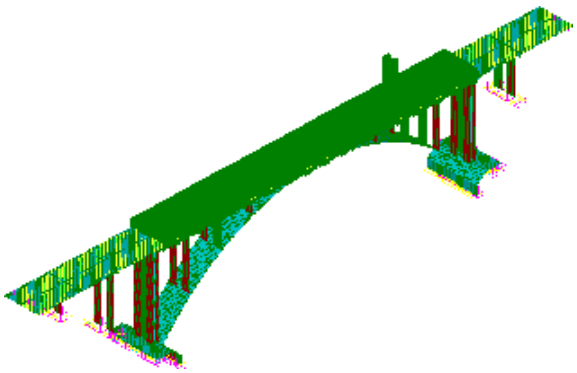


71: LM1_Ganze Bogen+Achse6_+Z

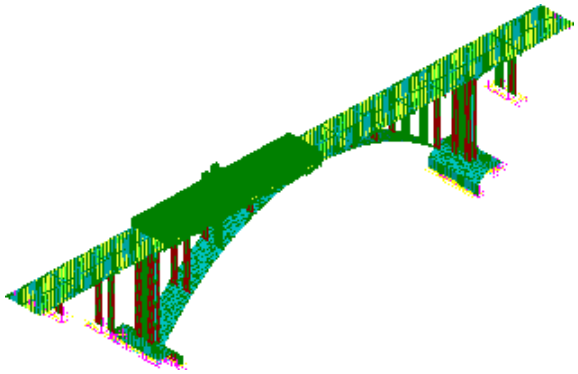


72: LM1_Ganze Bogen+Achse7_+Z 	73: LM1_Ganze Bogen+Achse8_+Z 
74: LM1_Ganze Bogen+Achse9_+Z 	75: LM1_Ganze Bogen+Achse10_+Z 
76: LM1_Ganze Bogen+Achse4_MITTE 	77: LM1_Ganze Bogen+Achse5_MITTE 

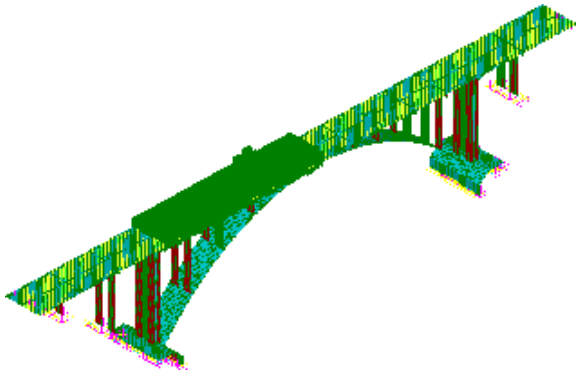
78: LM1_Ganze Bogen+Achse6_MITTE 	79: LM1_Ganze Bogen+Achse7_MITTE 
80: LM1_Ganze Bogen+Achse8_MITTE 	81: LM1_Ganze Bogen+Achse9_MITTE 
82: LM1_Ganze Bogen+Achse10_MITTE 	83: LM1_Ganze Bogen+Achse4_-Z 

84: LM1_Ganze Bogen+Achse5_-Z 	85: LM1_Ganze Bogen+Achse6_-Z 
86: LM1_Ganze Bogen+Achse7_-Z 	87: LM1_Ganze Bogen+Achse8_-Z 
88: LM1_Ganze Bogen+Achse9_-Z 	89: LM1_Ganze Bogen+Achse10_-Z 

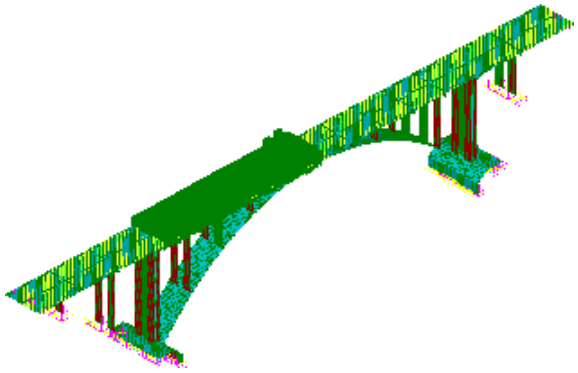
90: LM1_Halbe Bogen (Lana)+Achse4_+Z



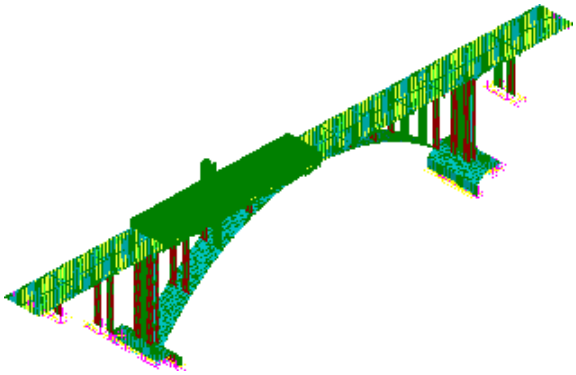
91: LM1_Halbe Bogen (Lana)+Achse5_+Z



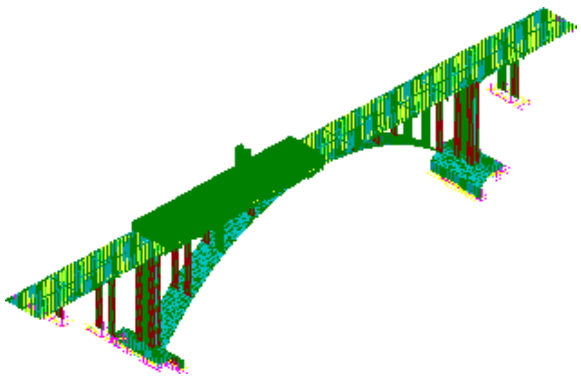
92: LM1_Halbe Bogen (Lana)+Achse6_+Z



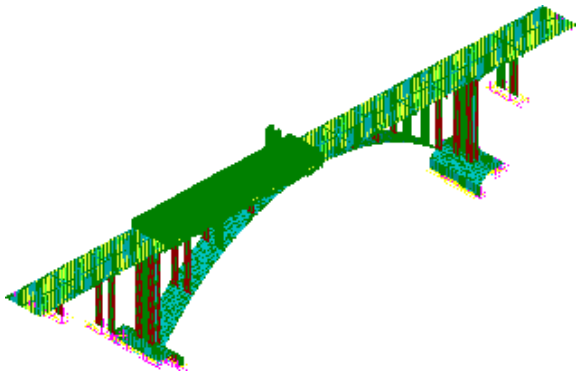
93: LM1_Halbe Bogen (Lana)+Achse4_MITTE



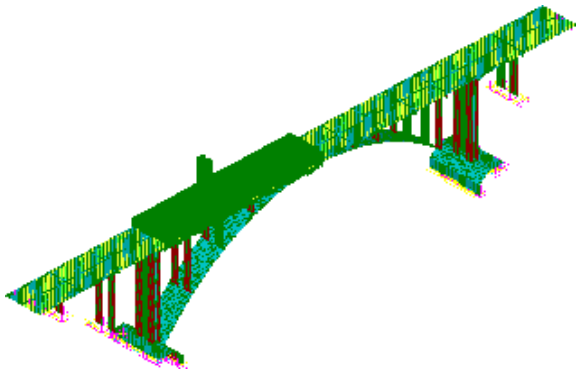
94: LM1_Halbe Bogen (Lana)+Achse5_MITTE



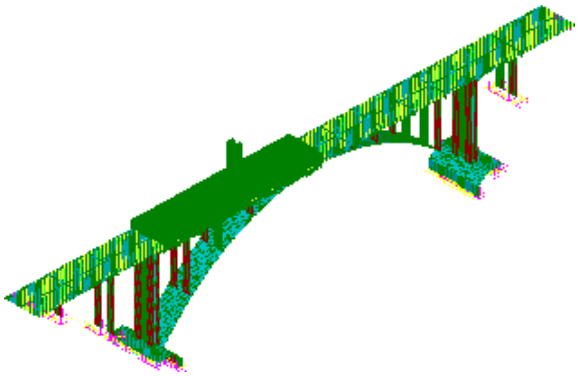
95: LM1_Halbe Bogen (Lana)+Achse6_MITTE



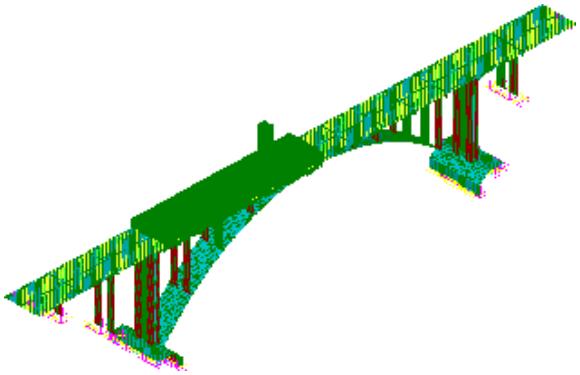
96: LM1_Halbe Bogen (Lana)+Achse4_-Z



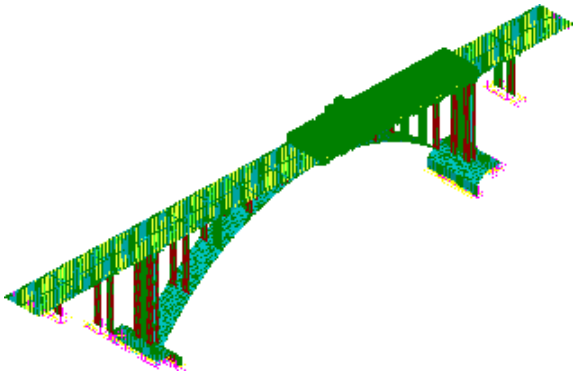
97: LM1_Halbe Bogen (Lana)+Achse5_-Z



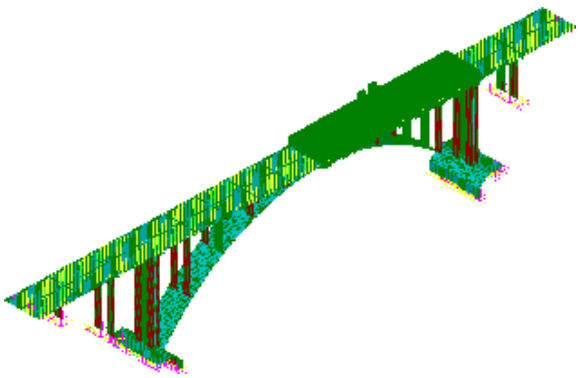
98: LM1_Halbe Bogen (Lana)+Achse6_-Z



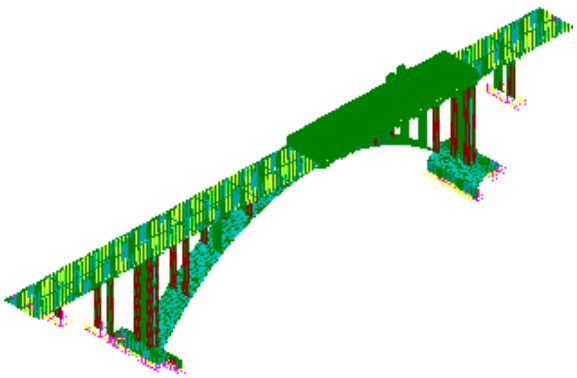
99: LM1_Halbe Bogen (St.Pankratz)+Achse8_+Z

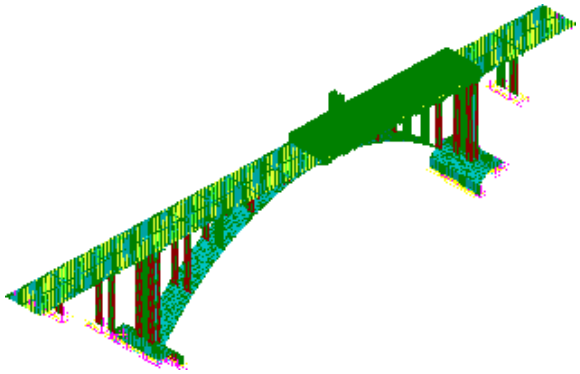
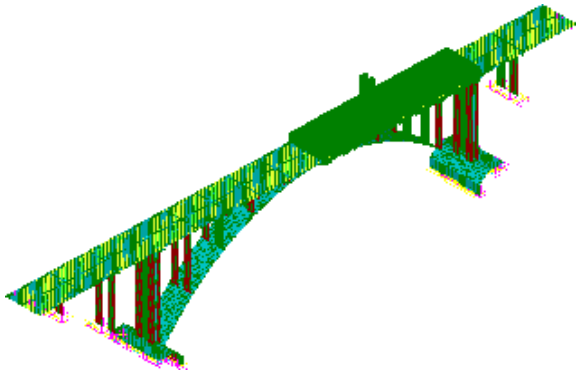
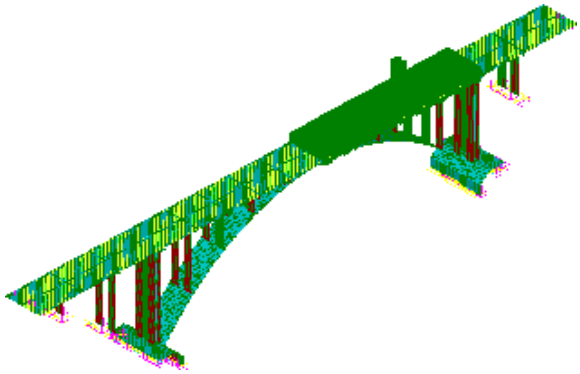
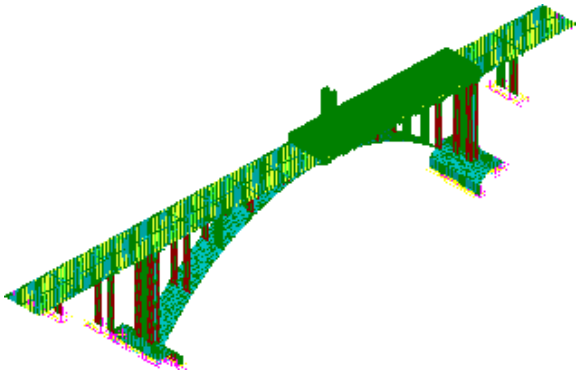
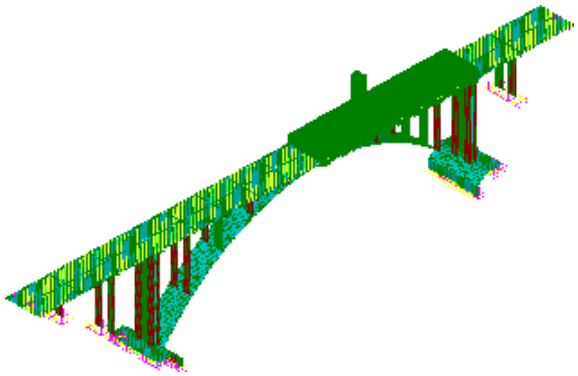
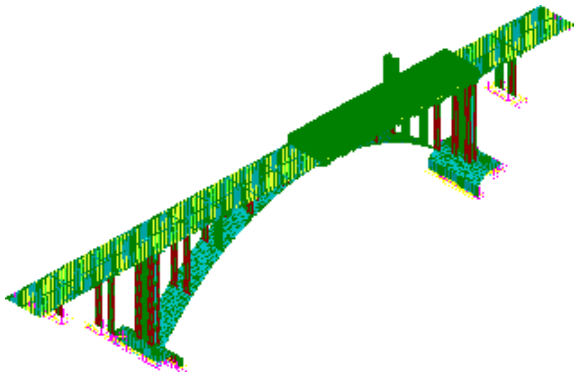


100: LM1_Halbe Bogen (St.Pankratz)+Achse9_+Z

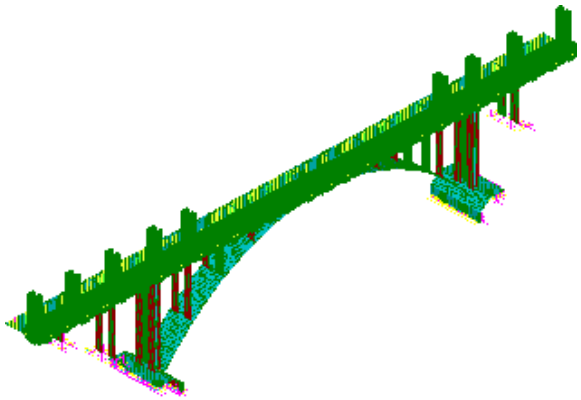


101: LM1_Halbe Bogen (St.Pankratz)+Achse10_+Z

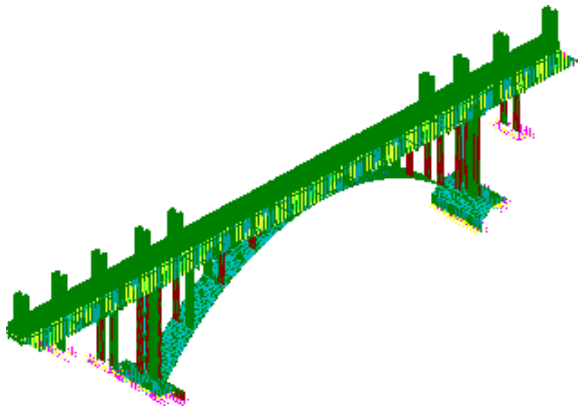


102: LM1_Halbe Bogen (St.Pankratz)+Achse8_MITTE 	103: LM1_Halbe Bogen (St.Pankratz)+Achse9_MITTE 
104: LM1_Halbe Bogen (St.Pankratz)+Achse10_MITTE 	105: LM1_Halbe Bogen (St.Pankratz)+Achse8_-Z 
106: LM1_Halbe Bogen (St.Pankratz)+Achse9_-Z 	107: LM1_Halbe Bogen (St.Pankratz)+Achse10_-Z 

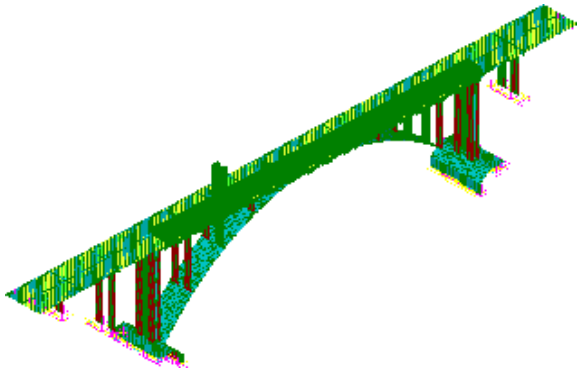
108: LM1_nur 1 Spur_Achse
A1,A2,1,2,3,11,12,13,B_+Z



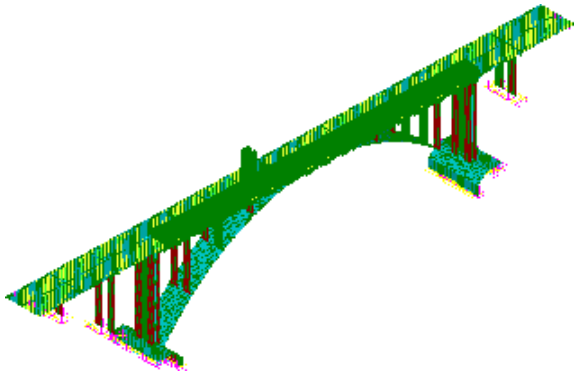
109: LM1_nur 1 Spur_Achse
A1,A2,1,2,3,11,12,13,B_-Z



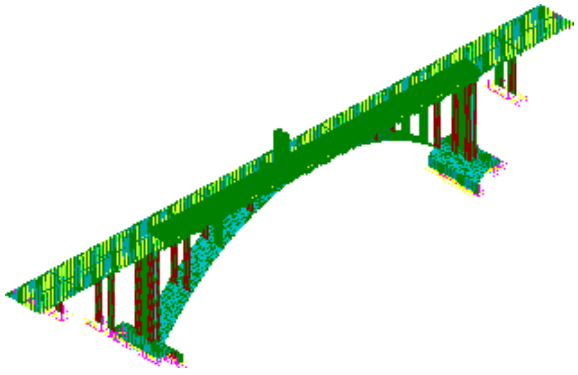
110: LM1_nur 1 Spur_Achse 4_+Z



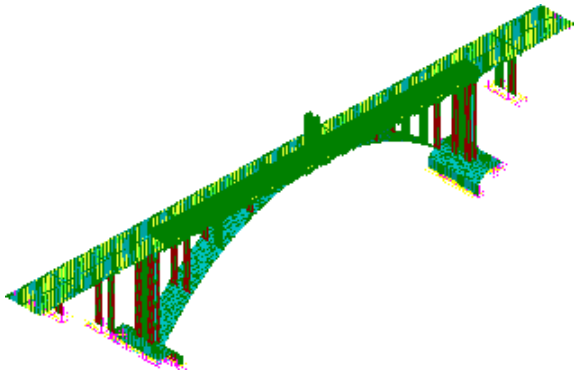
111: LM1_nur 1 Spur_Achse 5_+Z

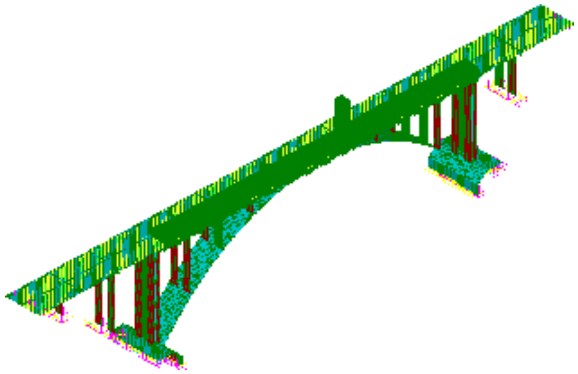
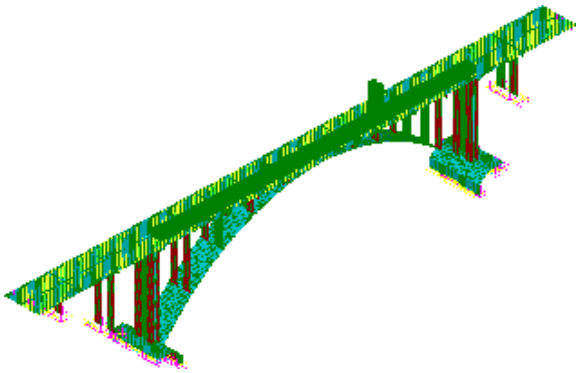
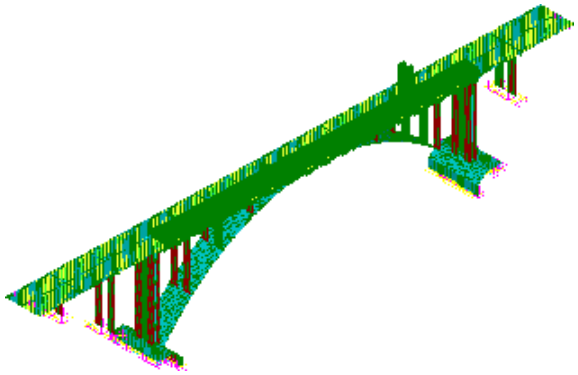
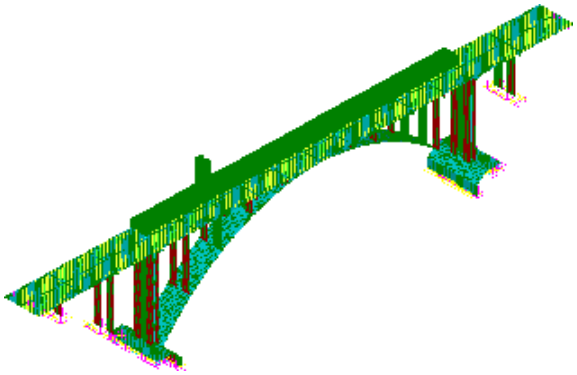
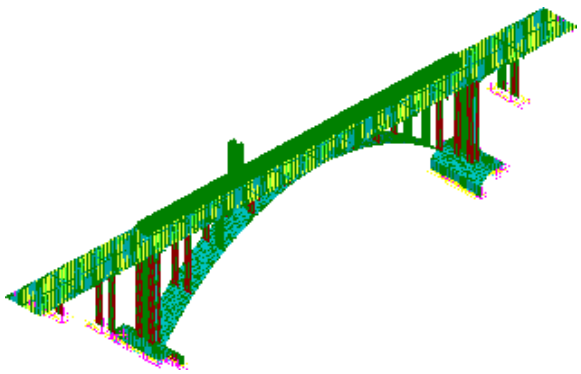
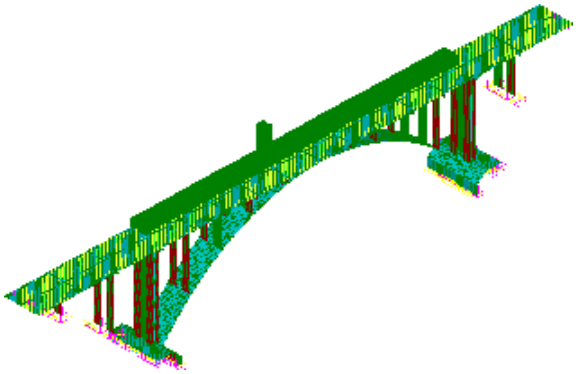


112: LM1_nur 1 Spur_Achse 6_+Z

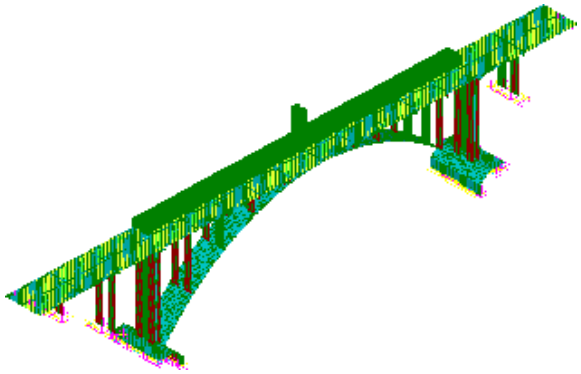


113: LM1_nur 1 Spur_Achse 7_+Z

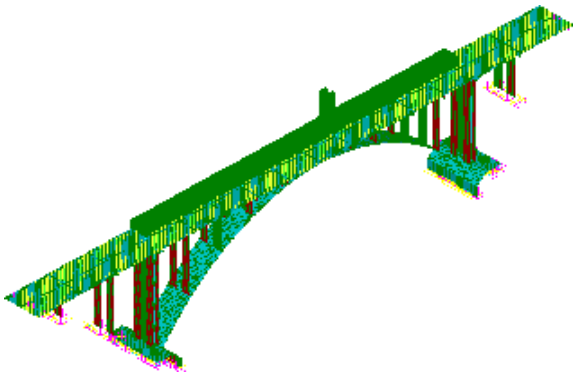


114: LM1_nur 1 Spur_Achse 8_+Z 	115: LM1_nur 1 Spur_Achse 9_+Z 
116: LM1_nur 1 Spur_Achse 10_+Z 	117: LM1_nur 1 Spur_Achse 4_-Z 
118: LM1_nur 1 Spur_Achse 5_-Z 	119: LM1_nur 1 Spur_Achse 6_-Z 

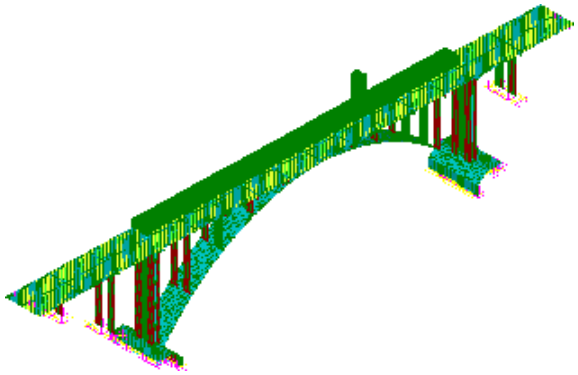
120: LM1_nur 1 Spur_Achse 7_-Z



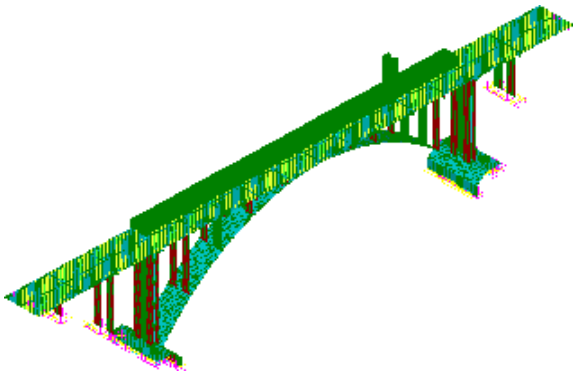
121: LM1_nur 1 Spur_Achse 8_-Z



122: LM1_nur 1 Spur_Achse 9_-Z

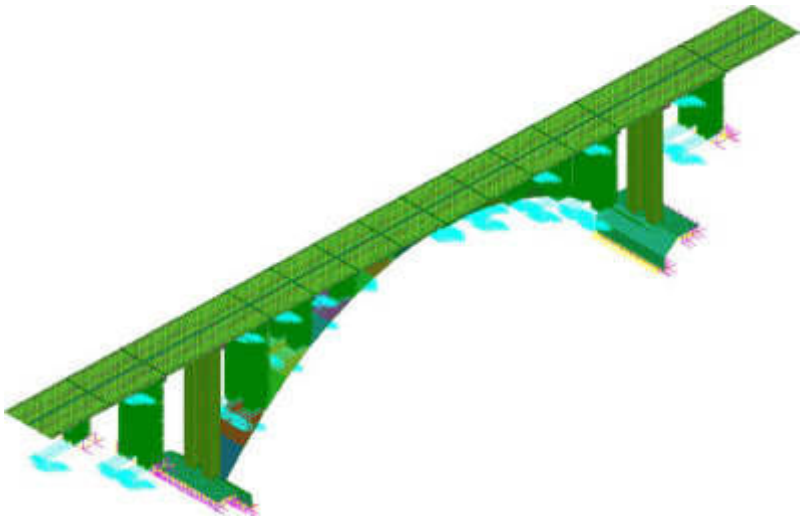


123: LM1_nur 1 Spur_Achse 10_-Z



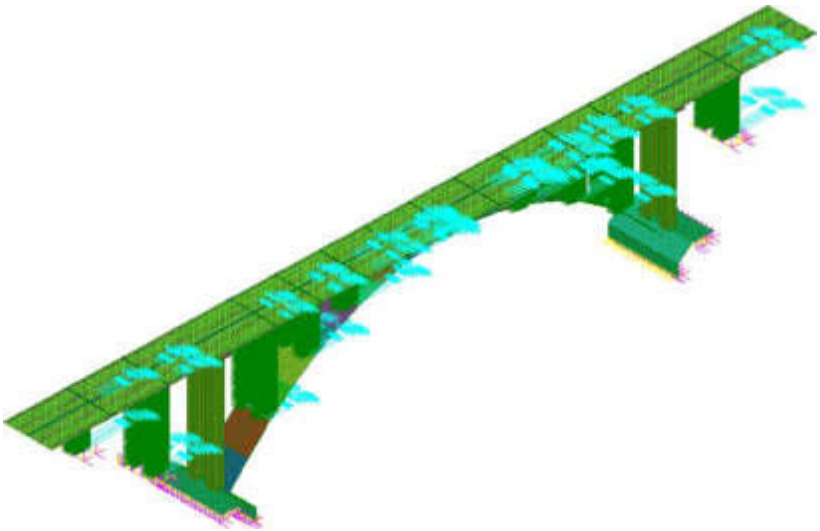
2.31 Lastfall 126: Ersatzlast für Imperfektion Pfeiler +X

Sie Angesetzten Ersatzlasten (Knotenlasten) erzeugen dieselben Schnittgrößen wie die laut Norm vorgesehenen Imperfektionen (Säbelkrümmung) bei bekannter Normalkraft. Siehe Nachweistabellen Pfeiler und Stiele.



2.32 Lastfall 127: Ersatzlast für Imperfektion Pfeiler -X

Sie Angesetzten Ersatzlasten (Knotenlasten) erzeugen dieselben Schnittgrößen wie die laut Norm vorgesehenen Imperfektionen (Säbelkrümmung) bei bekannter Normalkraft. Siehe Nachweistabellen Pfeiler und Stiele.

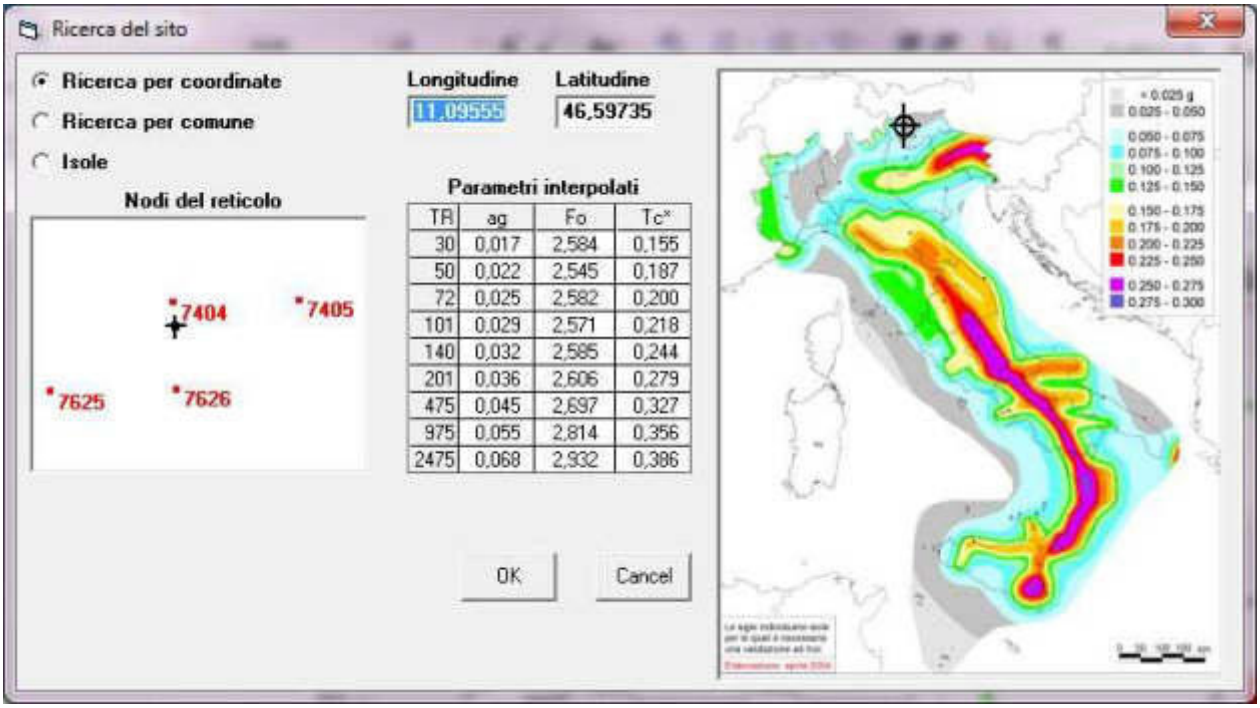


2.33 Lastfall 128 bis 221: Verkehrslasten LM1 (SLS häufige Kombination)

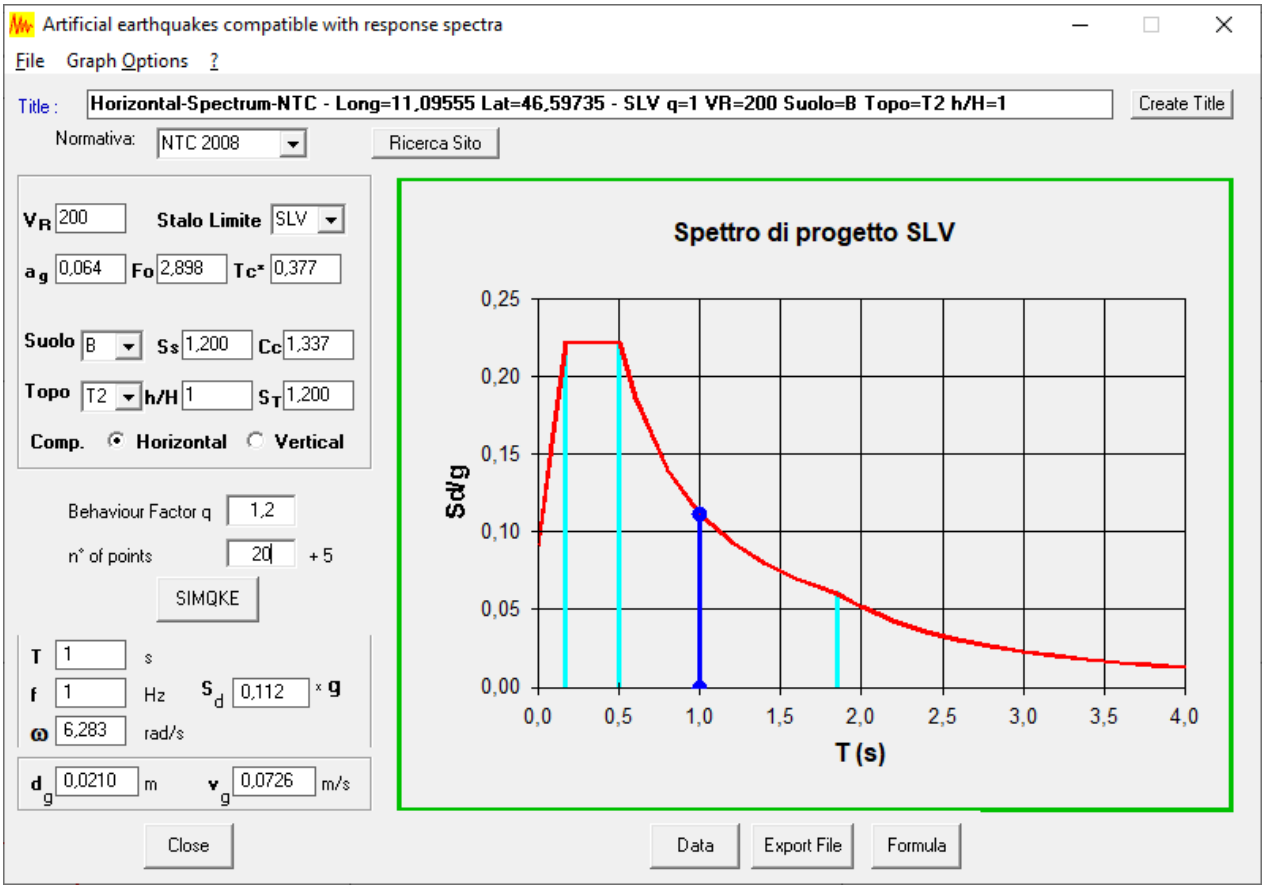
Lastmodell 1 mit auf 40% reduzierte Flächenlasten und auf 75% reduzierte Punktlasten. Siehe Lastfälle 30 bis 123.

2.34 Lastfall Erdbeben in X und Z

Koordinaten WGS 84 des Standortes: 46,59735 e 11,09555



Antwortspektrum:



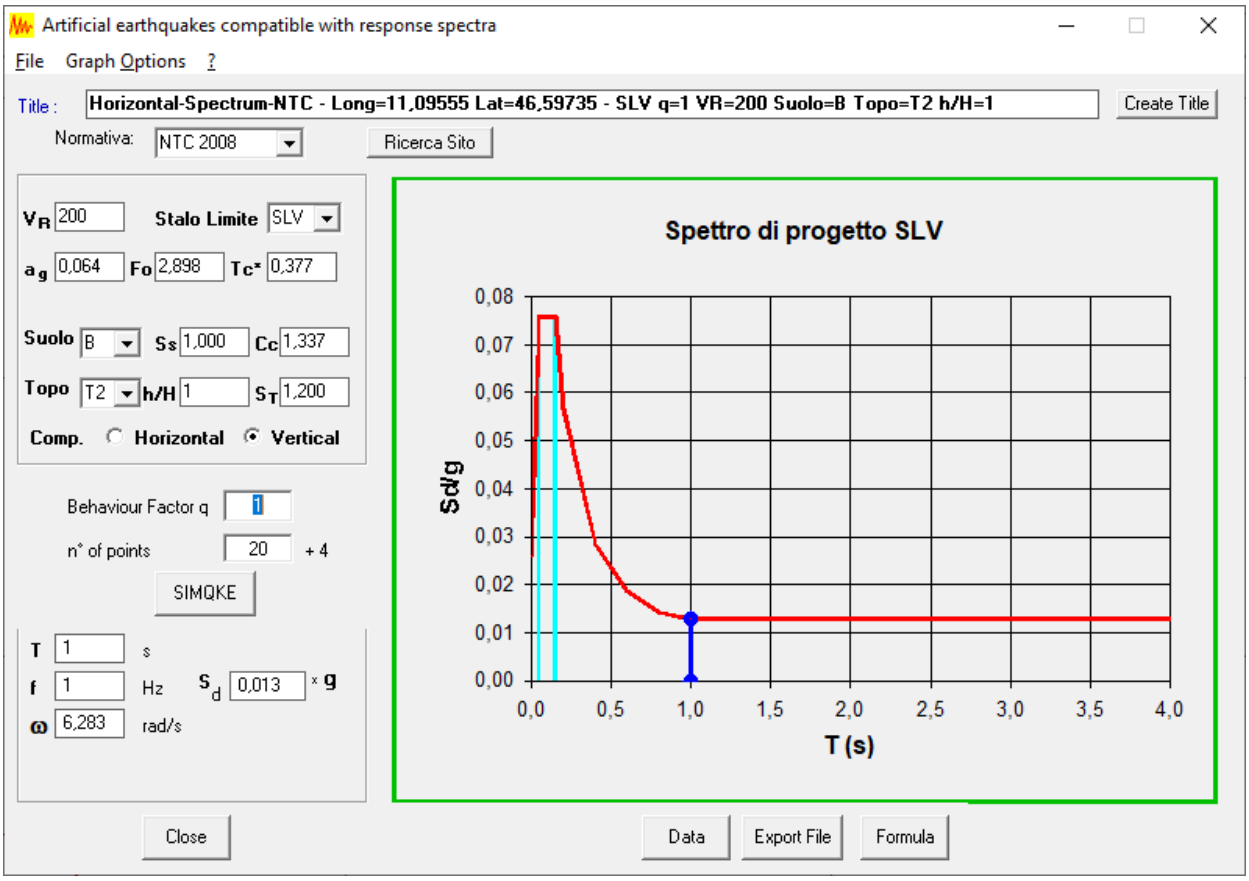
Der angesetzte Faktor q0=1,20. Dies ist laut NTC2018 zulässig:

Tipologia strutturale	q_0 CD"A"	CD"B"
Ponti (§ 7.9.2.1)		
Pile in calcestruzzo armato		
Pile verticali inflesse	3,5 λ	1,5
Elementi di sostegno inclinati inflessi	2,1 λ	1,2

Alle Vorgaben für Bauwerke mit Duktilitätsklasse „B“, siehe Kapitel 7.9.6 vom NTC2018 wurden eingehalten.

2.35 Lastfall Erdbeben in Y

Antwortspektrum:



2.36 Lastkombinationen

Es werden folgende Teilsicherheitsbeiwerte angesetzt:

Für ständige Einwirkungen (Eigengewicht) bei ungünstiger Auswirkung:	1,35
Für ständige Einwirkungen (Permanente Auflast) bei ungünstiger Auswirkung:	1,50
Für ständige Einwirkungen bei günstiger Auswirkung:	1,00
Verkehrslasten bei ungünstiger Auswirkung:	1,35
Verkehrslasten bei günstiger Auswirkung:	0,00
Alle anderen veränderlichen Einwirkungen bei ungünstiger Auswirkung:	1,50
Alle anderen veränderlichen Einwirkungen bei günstiger Auswirkung:	0,00

Einwirkungen aus Erdbeben und Eigengewicht sind außergewöhnliche Lastkombinationen

mit Teilsicherheit 1,0.

Temperatur und Windlastfälle werden nicht gleichzeitig angesetzt.

Kombinationsbeiwert für Temperatur und Windlastfälle $\psi 0 = 0,6$.

Bei den Lastkombinationen mit Temperatur oder Wind als Haupteinwirkung werden reduzierte Verkehrslasten (begleitende Einwirkung) angesetzt. Die Flächenlasten werden auf 40% reduziert, die Punktlasten auf 75%.

Folgende Envelopes wurden für die automatische Bemessung generiert:

ULS_LM1 (leitend)	Min
ULS_LM1 (leitend)	Max
ULS_Temp/Wind (leitend)	Min
ULS_Temp/Wind (leitend)	Max

ULS_LM1(leitend):

	Case	Factor 1	Factor 2	Set
1	1: Eigengewicht Struktur	1,0	1,35	<None>
2	2: Permanente Auflast	1,0	1,5	<None>
3	3: Temperatur +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
4	4: Temperatur -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
5	5: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
6	6: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
7	7: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
8	8: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
9	9: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
10	10: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer)	0,0	0,9	OR {Set 1} : GRP {1}
11	11: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
12	12: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
13	13: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
14	14: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
15	15: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
16	16: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Kont. Temp. +24,5K	0,0	0,9	OR {Set 1} : GRP {1}
17	17: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
18	18: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
19	19: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
20	20: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
21	21: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
22	22: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Kont. Temp. -24,5K	0,0	0,9	OR {Set 1} : GRP {1}
23	23: Schwinden -15°C	0,0	0,9	OR {Set 1} : GRP {1}
24	24: Wind in +X	0,0	0,9	OR {Set 1} : GRP {1}
25	25: Wind in -X	0,0	0,9	OR {Set 1} : GRP {1}
26	26: Wind in +Z	0,0	0,9	OR {Set 1} : GRP {1}
27	27: Wind in -Z	0,0	0,9	OR {Set 1} : GRP {1}
28	28: Bremsen in X	0,0	1,35	OR {Set 2} : GRP {2}
29	29: Bremsen in -X	0,0	1,35	OR {Set 2} : GRP {2}
30	30: LM1_M_+Z_1_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
31	31: LM1_M_+Z_2_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
32	32: LM1_M_+Z_3_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
33	33: LM1_M_+Z_4_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
34	34: LM1_M_MITTE_1_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
35	35: LM1_M_MITTE_2_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
36	36: LM1_M_MITTE_3_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
37	37: LM1_M_MITTE_4_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
38	38: LM1_M_-Z_1_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
39	39: LM1_M_-Z_2_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
40	40: LM1_M_-Z_3_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
41	41: LM1_M_-Z_4_Feldmoment	0,0	1,35	OR {Set 2} : GRP {2}
42	42: LM1_M_+Z_1_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
43	43: LM1_M_+Z_2_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}

44	44: LM1_M_+Z_3_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
45	45: LM1_M_+Z_4_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
46	47: LM1_M_+Z_5_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
47	46: LM1_M_+Z_6_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
48	48: LM1_M_MITTE_1_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
49	49: LM1_M_MITTE_2_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
50	50: LM1_M_MITTE_3_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
51	51: LM1_M_MITTE_4_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
52	52: LM1_M_MITTE_5_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
53	53: LM1_M_MITTE_6_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
54	54: LM1_M_-Z_1_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
55	55: LM1_M_-Z_2_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
56	56: LM1_M_-Z_3_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
57	57: LM1_M_-Z_4_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
58	58: LM1_M_-Z_5_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
59	59: LM1_M_-Z_6_Stützmoment	0,0	1,35	OR {Set 2} : GRP {2}
60	60: LM1_Q_+Z_1	0,0	1,35	OR {Set 2} : GRP {2}
61	61: LM1_Q_+Z_2	0,0	1,35	OR {Set 2} : GRP {2}
62	62: LM1_Q_MITTE_1	0,0	1,35	OR {Set 2} : GRP {2}
63	63: LM1_Q_MITTE_2	0,0	1,35	OR {Set 2} : GRP {2}
64	64: LM1_Q_-Z_1	0,0	1,35	OR {Set 2} : GRP {2}
65	65: LM1_Q_-Z_2	0,0	1,35	OR {Set 2} : GRP {2}
66	66: LM1_AchseA1,A2,1,2,3,11,12,13,B_+Z	0,0	1,35	OR {Set 2} : GRP {2}
67	67: LM1_AchseA1,A2,1,2,3,11,12,13,B_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
68	68: LM1_AchseA1,A2,1,2,3,11,12,13,B_-Z	0,0	1,35	OR {Set 2} : GRP {2}
69	69: LM1_Ganze Bogen+Achse4_+Z	0,0	1,35	OR {Set 2} : GRP {2}
70	70: LM1_Ganze Bogen+Achse5_+Z	0,0	1,35	OR {Set 2} : GRP {2}
71	71: LM1_Ganze Bogen+Achse6_+Z	0,0	1,35	OR {Set 2} : GRP {2}
72	72: LM1_Ganze Bogen+Achse7_+Z	0,0	1,35	OR {Set 2} : GRP {2}
73	73: LM1_Ganze Bogen+Achse8_+Z	0,0	1,35	OR {Set 2} : GRP {2}
74	74: LM1_Ganze Bogen+Achse9_+Z	0,0	1,35	OR {Set 2} : GRP {2}
75	75: LM1_Ganze Bogen+Achse10_+Z	0,0	1,35	OR {Set 2} : GRP {2}
76	76: LM1_Ganze Bogen+Achse4_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
77	77: LM1_Ganze Bogen+Achse5_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
78	78: LM1_Ganze Bogen+Achse6_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
79	79: LM1_Ganze Bogen+Achse7_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
80	80: LM1_Ganze Bogen+Achse8_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
81	81: LM1_Ganze Bogen+Achse9_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
82	82: LM1_Ganze Bogen+Achse10_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
83	83: LM1_Ganze Bogen+Achse4_-Z	0,0	1,35	OR {Set 2} : GRP {2}
84	84: LM1_Ganze Bogen+Achse5_-Z	0,0	1,35	OR {Set 2} : GRP {2}
85	85: LM1_Ganze Bogen+Achse6_-Z	0,0	1,35	OR {Set 2} : GRP {2}
86	86: LM1_Ganze Bogen+Achse7_-Z	0,0	1,35	OR {Set 2} : GRP {2}
87	87: LM1_Ganze Bogen+Achse8_-Z	0,0	1,35	OR {Set 2} : GRP {2}

88	88: LM1_Ganze Bogen+Achse9_-Z	0,0	1,35	OR {Set 2} : GRP {2}
89	89: LM1_Ganze Bogen+Achse10_-Z	0,0	1,35	OR {Set 2} : GRP {2}
90	90: LM1_Halbe Bogen (Lana)+Achse4_+Z	0,0	1,35	OR {Set 2} : GRP {2}
91	91: LM1_Halbe Bogen (Lana)+Achse5_+Z	0,0	1,35	OR {Set 2} : GRP {2}
92	92: LM1_Halbe Bogen (Lana)+Achse6_+Z	0,0	1,35	OR {Set 2} : GRP {2}
93	93: LM1_Halbe Bogen (Lana)+Achse4_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
94	94: LM1_Halbe Bogen (Lana)+Achse5_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
95	95: LM1_Halbe Bogen (Lana)+Achse6_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
96	96: LM1_Halbe Bogen (Lana)+Achse4_-Z	0,0	1,35	OR {Set 2} : GRP {2}
97	97: LM1_Halbe Bogen (Lana)+Achse5_-Z	0,0	1,35	OR {Set 2} : GRP {2}
98	98: LM1_Halbe Bogen (Lana)+Achse6_-Z	0,0	1,35	OR {Set 2} : GRP {2}
99	99: LM1_Halbe Bogen (St.Pankratz)+Achse8_+Z	0,0	1,35	OR {Set 2} : GRP {2}
100	100: LM1_Halbe Bogen (St.Pankratz)+Achse9_+Z	0,0	1,35	OR {Set 2} : GRP {2}
101	101: LM1_Halbe Bogen (St.Pankratz)+Achse10_+Z	0,0	1,35	OR {Set 2} : GRP {2}
102	102: LM1_Halbe Bogen (St.Pankratz)+Achse8_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
103	103: LM1_Halbe Bogen (St.Pankratz)+Achse9_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
104	104: LM1_Halbe Bogen (St.Pankratz)+Achse10_MITTE	0,0	1,35	OR {Set 2} : GRP {2}
105	105: LM1_Halbe Bogen (St.Pankratz)+Achse8_-Z	0,0	1,35	OR {Set 2} : GRP {2}
106	106: LM1_Halbe Bogen (St.Pankratz)+Achse9_-Z	0,0	1,35	OR {Set 2} : GRP {2}
107	107: LM1_Halbe Bogen (St.Pankratz)+Achse10_-Z	0,0	1,35	OR {Set 2} : GRP {2}
108	108: LM1_nur 1 Spur_Achse A1,A2,1,2,3,11,12,13,B_+Z	0,0	1,35	OR {Set 2} : GRP {2}
109	109: LM1_nur 1 Spur_Achse A1,A2,1,2,3,11,12,13,B_-Z	0,0	1,35	OR {Set 2} : GRP {2}
110	110: LM1_nur 1 Spur_Achse 4_+Z	0,0	1,35	OR {Set 2} : GRP {2}
111	111: LM1_nur 1 Spur_Achse 5_+Z	0,0	1,35	OR {Set 2} : GRP {2}
112	112: LM1_nur 1 Spur_Achse 6_+Z	0,0	1,35	OR {Set 2} : GRP {2}
113	113: LM1_nur 1 Spur_Achse 7_+Z	0,0	1,35	OR {Set 2} : GRP {2}
114	114: LM1_nur 1 Spur_Achse 8_+Z	0,0	1,35	OR {Set 2} : GRP {2}
115	115: LM1_nur 1 Spur_Achse 9_+Z	0,0	1,35	OR {Set 2} : GRP {2}
116	116: LM1_nur 1 Spur_Achse 10_+Z	0,0	1,35	OR {Set 2} : GRP {2}
117	117: LM1_nur 1 Spur_Achse 4_-Z	0,0	1,35	OR {Set 2} : GRP {2}
118	118: LM1_nur 1 Spur_Achse 5_-Z	0,0	1,35	OR {Set 2} : GRP {2}
119	119: LM1_nur 1 Spur_Achse 6_-Z	0,0	1,35	OR {Set 2} : GRP {2}
120	120: LM1_nur 1 Spur_Achse 7_-Z	0,0	1,35	OR {Set 2} : GRP {2}
121	121: LM1_nur 1 Spur_Achse 8_-Z	0,0	1,35	OR {Set 2} : GRP {2}
122	122: LM1_nur 1 Spur_Achse 9_-Z	0,0	1,35	OR {Set 2} : GRP {2}
123	123: LM1_nur 1 Spur_Achse 10_-Z	0,0	1,35	OR {Set 2} : GRP {2}
124	126: Ersatzlast Imperfekt.Pfeiler +X	0,0	1,0	<None>
125	127: Ersatzlast Imperfekt.Pfeiler in -X	0,0	1,0	<None>

ULS_Temp/Wind(leitend):

	Case	Factor 1	Factor 2	Set
1	1: Eigengewicht Struktur	1,0	1,35	<None>
2	2: Permanente Auflast	1,0	1,5	<None>
3	3: Temperatur +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
4	4: Temperatur -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
5	5: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
6	6: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
7	7: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
8	8: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
9	9: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
10	10: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer)	0,0	1,5	OR {Set 1} : GRP {1}
11	11: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
12	12: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
13	13: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
14	14: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
15	15: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
16	16: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Kont. Temp. +24,5K	0,0	1,5	OR {Set 1} : GRP {1}
17	17: Temperaturdifferenz oben/unten FBPL (oben 10°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
18	18: Temperaturdifferenz oben/unten FBPL (unten 8°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
19	19: Temperaturdifferenz oben/unten Bogen (oben 5°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
20	20: Temperaturdifferenz oben/unten Bogen (unten 5°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
21	21: Temperaturdifferenz vorne/hinten Pfeiler (in +X 5°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
22	22: Temperaturdifferenz vorne/hinten Pfeiler (in -X 5°C wärmer) + Kont. Temp. -24,5K	0,0	1,5	OR {Set 1} : GRP {1}
23	23: Schwinden -15°C	0,0	1,5	OR {Set 1} : GRP {1}
24	24: Wind in +X	0,0	1,5	OR {Set 1} : GRP {1}
25	25: Wind in -X	0,0	1,5	OR {Set 1} : GRP {1}
26	26: Wind in +Z	0,0	1,5	OR {Set 1} : GRP {1}
27	27: Wind in -Z	0,0	1,5	OR {Set 1} : GRP {1}
28	128: LM1_M_+Z_1_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
29	129: LM1_M_+Z_2_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
30	130: LM1_M_+Z_3_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
31	131: LM1_M_+Z_4_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
32	132: LM1_M_MITTE_1_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
33	133: LM1_M_MITTE_2_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
34	134: LM1_M_MITTE_3_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
35	135: LM1_M_MITTE_4_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
36	136: LM1_M_-Z_1_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
37	137: LM1_M_-Z_2_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
38	138: LM1_M_-Z_3_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
39	139: LM1_M_-Z_4_Feldmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
40	140: LM1_M_+Z_1_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
41	141: LM1_M_+Z_2_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
42	142: LM1_M_+Z_3_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
43	143: LM1_M_+Z_4_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
44	144: LM1_M_+Z_5_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}

45	145: LM1_M_+Z_6_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
46	146: LM1_M_MITTE_1_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
47	147: LM1_M_MITTE_2_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
48	148: LM1_M_MITTE_3_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
49	149: LM1_M_MITTE_4_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
50	150: LM1_M_MITTE_5_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
51	151: LM1_M_MITTE_6_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
52	152: LM1_M_-Z_1_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
53	153: LM1_M_-Z_2_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
54	154: LM1_M_-Z_3_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
55	155: LM1_M_-Z_4_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
56	156: LM1_M_-Z_5_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
57	157: LM1_M_-Z_6_Stützmoment_häufig	0,0	1,35	OR {Set 2} : GRP {2}
58	158: LM1_Q_+Z_1_häufig	0,0	1,35	OR {Set 2} : GRP {2}
59	159: LM1_Q_+Z_2_häufig	0,0	1,35	OR {Set 2} : GRP {2}
60	160: LM1_Q_MITTE_1_häufig	0,0	1,35	OR {Set 2} : GRP {2}
61	161: LM1_Q_MITTE_2_häufig	0,0	1,35	OR {Set 2} : GRP {2}
62	162: LM1_Q_-Z_1_häufig	0,0	1,35	OR {Set 2} : GRP {2}
63	163: LM1_Q_-Z_2_häufig	0,0	1,35	OR {Set 2} : GRP {2}
64	164: LM1_AchseA1,A2,1,2,3,11,12,13,B_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
65	165: LM1_AchseA1,A2,1,2,3,11,12,13,B_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
66	166: LM1_AchseA1,A2,1,2,3,11,12,13,B_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
67	167: LM1_Ganze Bogen+Achse4_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
68	168: LM1_Ganze Bogen+Achse5_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
69	169: LM1_Ganze Bogen+Achse6_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
70	170: LM1_Ganze Bogen+Achse7_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
71	171: LM1_Ganze Bogen+Achse8_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
72	172: LM1_Ganze Bogen+Achse9_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
73	173: LM1_Ganze Bogen+Achse10_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
74	174: LM1_Ganze Bogen+Achse4_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
75	175: LM1_Ganze Bogen+Achse5_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
76	176: LM1_Ganze Bogen+Achse6_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
77	177: LM1_Ganze Bogen+Achse7_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
78	178: LM1_Ganze Bogen+Achse8_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
79	179: LM1_Ganze Bogen+Achse9_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
80	180: LM1_Ganze Bogen+Achse10_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
81	181: LM1_Ganze Bogen+Achse4_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
82	182: LM1_Ganze Bogen+Achse5_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
83	183: LM1_Ganze Bogen+Achse6_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
84	184: LM1_Ganze Bogen+Achse7_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
85	185: LM1_Ganze Bogen+Achse8_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
86	186: LM1_Ganze Bogen+Achse9_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
87	187: LM1_Ganze Bogen+Achse10_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
88	188: LM1_Halbe Bogen (Lana)+Achse4_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}

89	189: LM1_Halbe Bogen (Lana)+Achse5_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
90	190: LM1_Halbe Bogen (Lana)+Achse6_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
91	191: LM1_Halbe Bogen (Lana)+Achse4_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
92	192: LM1_Halbe Bogen (Lana)+Achse5_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
93	193: LM1_Halbe Bogen (Lana)+Achse6_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
94	194: LM1_Halbe Bogen (Lana)+Achse4_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
95	195: LM1_Halbe Bogen (Lana)+Achse5_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
96	196: LM1_Halbe Bogen (Lana)+Achse6_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
97	197: LM1_Halbe Bogen (St.Pankratz)+Achse8_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
98	198: LM1_Halbe Bogen (St.Pankratz)+Achse9_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
99	199: LM1_Halbe Bogen (St.Pankratz)+Achse10_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
100	200: LM1_Halbe Bogen (St.Pankratz)+Achse8_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
101	201: LM1_Halbe Bogen (St.Pankratz)+Achse9_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
102	202: LM1_Halbe Bogen (St.Pankratz)+Achse10_MITTE_häufig	0,0	1,35	OR {Set 2} : GRP {2}
103	203: LM1_Halbe Bogen (St.Pankratz)+Achse8_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
104	204: LM1_Halbe Bogen (St.Pankratz)+Achse9_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
105	205: LM1_Halbe Bogen (St.Pankratz)+Achse10_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
106	206: LM1_nur 1 Spur_Achse A1,A2,1,2,3,11,12,13,B_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
107	207: LM1_nur 1 Spur_Achse A1,A2,1,2,3,11,12,13,B_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
108	208: LM1_nur 1 Spur_Achse 4_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
109	209: LM1_nur 1 Spur_Achse 5_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
110	210: LM1_nur 1 Spur_Achse 6_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
111	211: LM1_nur 1 Spur_Achse 7_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
112	212: LM1_nur 1 Spur_Achse 8_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
113	213: LM1_nur 1 Spur_Achse 9_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
114	214: LM1_nur 1 Spur_Achse 10_+Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
115	215: LM1_nur 1 Spur_Achse 4_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
116	216: LM1_nur 1 Spur_Achse 5_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
117	217: LM1_nur 1 Spur_Achse 6_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
118	218: LM1_nur 1 Spur_Achse 7_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
119	219: LM1_nur 1 Spur_Achse 8_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
120	220: LM1_nur 1 Spur_Achse 9_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
121	221: LM1_nur 1 Spur_Achse 10_-Z_häufig	0,0	1,35	OR {Set 2} : GRP {2}
122	126: Ersatzlast Imperfekt.Pfeiler +X	0,0	1,0	<None>
123	127: Ersatzlast Imperfekt.Pfeiler in -X	0,0	1,0	<None>

3. Nachweise im Grenzzustand der Tragsicherheit

3.1 Fahrbahnplatte

3.1.1 Bewehrung und längs und Querrichtung

Die Bemessung erfolgt automatisch, siehe Isolinien in Anlage.

3.1.2 Querkraft im Bereich mit reduzierter Stärke in Längsrichtung

Querkraftbewehrung im Stützbereich: 16Bügel d16/15 + 2 nach oben gebogene Bewehrungseisen d16/15

as = 455,7cm²/9,4m = 48,5cm²/m

Bemessung auf Querkraft								
d	bw	Nsd	Asw(Bügel)	Asl(logitud.)	fck	fyk	alpha	phi
[m]	[m]	[MN]	[m2]	[m2]	[MPa]	[MPa]	[°]	[°]
0,30	1,00	0,000	0,00485	0,00471	30,00	450,00	90,00	45,00
fyd	fcd	cot(phi)	k	sigma_cp	rho1	alpha_c		
[MPa]	[MPa]	[]	[]	[]	[]	[]		
391,30	20,00	1,00080	1,81650	0,00000	0,01570	1,00000		
		OK				OK		
		OK						
V_Rd_1_ ohne Querkraftbewehrung			**V_Rsd_mit Querkraftbewehrung**			**V_Rcd_ Beton**		
[MN]			**[MN]**			**[MN]**		
0,236			**0,513**			**1,352**		

Siehe Isolinien in Anlage.

3.1.3 Querkraft Bereiche mit voller Stärke in Längsrichtung

Querkraftbewehrung im Stützbereich: 16Bügel d16/15 + 2 nach oben gebogene Bewehrungseisen d16/15

as = 455,7cm²/9,4m = 48,5cm²/m

Bemessung auf Querkraft								
d	bw	Nsd	Asw(Bügel)	Asl(logitud.)	fck	fyk	alpha	phi
[m]	[m]	[MN]	[m2]	[m2]	[MPa]	[MPa]	[°]	[°]
0,45	1,00	0,000	0,00485	0,00471	30,00	450,00	90,00	45,00
fyd	fcd	cot(phi)	k	sigma_cp	rho1	alpha_c		
[MPa]	[MPa]	[]	[]	[]	[]	[]		
391,30	20,00	1,00080	1,66667	0,00000	0,01047	1,00000		
		OK				OK		
		OK						
V_Rd_1_ ohne Querkraftbewehrung			**V_Rsd_mit Querkraftbewehrung**			**V_Rcd_ Beton**		
[MN]			**[MN]**			**[MN]**		
0,284			**0,770**			**2,028**		

Siehe Isolinien in Anlage.

3.1.4 Querkraft im Bereich mit reduzierter Stärke in Querrichtung

Querkraftbewehrung im Stützbereich: 16Bügel d16/15 + 2 nach oben gebogene Bewehrungseisen d16/15

as = 455,7cm²/9,4m = 48,5cm²/m

Bemessung auf Querkraft								
d	bw	Nsd	Asw(Bügel)	Asl(logitud.)	fck	fyk	alpha	phi
[m]	[m]	[MN]	[m2]	[m2]	[MPa]	[MPa]	[°]	[°]
0,30	1,00	0,000	0,00485	0,00134	30,00	450,00	90,00	45,00
fyd	fcd	cot(phi)	k	sigma_cp	rho1	alpha_c		
[MPa]	[MPa]	[]	[]	[]	[]	[]		
391,30	20,00	1,00080	1,81650	0,00000	0,00447	1,00000		
		OK				OK		
		OK						
V_Rd_1_ ohne Querkraftbewehrung			**V_Rsd_mit Querkraftbewehrung**			**V_Rcd_ Beton**		
[MN]			**[MN]**			**[MN]**		
0,155			**0,513**			**1,352**		

Siehe Isolinien in Anlage.

3.1.5 Querkraft Bereiche mit voller Stärke in Querrichtung

Querkraftbewehrung im Stützbereich: 16Bügel d16/15 + 2 nach oben gebogene Bewehrungseisen d16/15

as = 455,7cm²/9,4m = 48,5cm²/m

Bemessung auf Querkraft								
d	bw	Nsd	Asw(Bügel)	Asl(logitud.)	fck	fyk	alpha	phi
[m]	[m]	[MN]	[m2]	[m2]	[MPa]	[MPa]	[°]	[°]
0,45	1,00	0,000	0,00485	0,00134	30,00	450,00	90,00	45,00
fyd	fcd	cot(phi)	k	sigma_cp	rho1	alpha_c		
[MPa]	[MPa]	[]	[]	[]	[]	[]		
391,30	20,00	1,00080	1,66667	0,00000	0,00298	1,00000		
		OK				OK		
		OK						
V_Rd_1_ ohne Querkraftbewehrung			**V_Rsd_mit Querkraftbewehrung**			**V_Rcd_ Beton**		
[MN]			**[MN]**			**[MN]**		
0,187			**0,770**			**2,028**		

Siehe Isolinien in Anlage.

3.1.6 Konzentrierte Krafteinleitung ober Lager im Bereich mit reduzierter Stärke

Größte Druckkraft Lager N_sd = 1240,0kN

Querzugkräfte: T= 0,25*Nsd = 310,0kN -> As, erf = 310,0kN/39,13kN/cm² = 7,9cm² -> Wähle 4d20 = 12,6cm²

3.1.7 Konzentrierte Krafteinleitung ober Lager im Bereich mit voller Stärke

Größte Druckkraft Lager N_sd = 1851,0kN

Querzugkräfte: T= 0,25*Nsd = 463,0kN -> As, erf = 463,0kN/39,13kN/cm² = 11,8cm² -> Wähle 4d20 = 12,6cm²

3.2 Lager

3.2.1 Lager Achse A1 und B

Beschreibung	ULS	Erdbeben	Gewählt
N_sd,max (Größter Druck)	1180,0kN	373,0kN	1400,0kN
N_sd,min (Kleinster Druck)	6,0kN	126,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 84,0kN/(1,5mm/kN) = 56,0mm	=Q_sd/K=Msd/(E*I)*h = 21,0kN/(1,5mm/kN) = 14,0mm	+/-60,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 4,0kN/(1,5mm/kN) = 2,7mm	= Q_sd/K = 1,0kN/(1,5mm/kN) = 0,7mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,029MNm/(188,1MPa*0,0009m4)*0,072m =0,012rad	=Msd/(E*I)*h =0,01MNm/(188,1MPa*0,0009m4)*0,072m =0,004rad	0,020rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,007MNm/(188,1MPa*0,0016m4)*0,072m =0,002rad	=Msd/(E*I)*h =0,002MNm/(188,1MPa*0,0016m4)*0,072m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,5kN/mm
F_z,sd (nur mittleres querfestes Lager)	213,0kN	752,0kN	+/-1000kN

Wähle 12 Stück (2 sind querfest) bewehrte Neoprenlager 400x300x128, Elastomerdicke 72mm.

3.2.2 Lager Achse A2

Beschreibung	**ULS**	**Erdbeben**	**Gewählt**
N_sd,max (Größter Druck)	1765,0kN	513,0kN	1900,0kN
N_sd,min (Kleinster Druck)	0,0kN	378,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 76,0kN/(1,5mm/kN) = 51,0mm	=Q_sd/K=Msd/(E*I)*h = 19,0kN/(1,5mm/kN) = 12,7mm	+/-55,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 8,0kN/(1,5mm/kN) = 5,3mm	= Q_sd/K = 9,0kN/(1,5mm/kN) = 6,0mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,014MNm/(188,1MPa*0,0009m4) *0,072m =0,006rad	=Msd/(E*I)*h =0,003MNm/(188,1MPa*0,0009m4)*0, 072m =0,001rad	0,010rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,008MNm/(188,1MPa*0,0016m4) *0,072m =0,002rad	=Msd/(E*I)*h =0,002MNm/(188,1MPa*0,0016m4)*0, 072m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,5kN/mm
F_z,sd (nur mittleres querfestes Lager)	20,0kN	39,0kN	+/-100kN

Wähle 6 Stück (1 ist querfest) bewehrte Neoprenlager 400x300x128, Elastomerdicke 72mm.

3.2.3 Lager Achse 1,2,12 und 13

Beschreibung	**ULS**	**Erdbeben**	**Gewählt**
N_sd,max (Größter Druck)	1662,0kN	593,0kN	1700,0kN
N_sd,min (Kleinster Druck)	99,0kN	233,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 71,0kN/(1,8mm/kN) = 39,0mm	=Q_sd/K=Msd/(E*I)*h = 32,0kN/(1,8mm/kN) = 18,0mm	+/-50,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 2,0kN/(1,8mm/kN) = 1,1mm	= Q_sd/K = 1,0kN/(1,8mm/kN) = 0,6mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,023MNm/(188,1MPa*0,0009m4) *0,06m =0,008rad	=Msd/(E*I)*h =0,006MNm/(188,1MPa*0,0009m4)*0, 06m =0,002rad	0,01rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,007MNm/(188,1MPa*0,0016m4) *0,06m =0,001rad	=Msd/(E*I)*h =0,002MNm/(188,1MPa*0,0016m4)*0, 06m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,8kN/mm
F_z,sd (nur mittleres querfestes Lager)	393,0kN	1077,0kN	+/-1200kN

Wähle 24 Stück (4 sind querfest) bewehrte Neoprenlager 400x300x112, Elastomerdicke 60mm.

3.2.4 Lager Achse 3,4,5,6,8,9,10,11

Beschreibung	**ULS**	**Erdbeben**	**Gewählt**
N_sd,max (Größter Druck)	1240,0kN	407,0kN	1400,0kN
N_sd,min (Kleinster Druck)	18,0kN	151,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 35,0kN/(1,4mm/kN) = 25,0mm	=Q_sd/K=Msd/(E*I)*h = 19,0kN/(1,4mm/kN) = 14,0mm	+/-25,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 2,0kN/(1,4mm/kN) = 1,4mm	= Q_sd/K = 1,0kN/(1,4mm/kN) = 0,7mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,012MNm/(251,3MPa*0,00039m4)*0,048m =0,006rad	=Msd/(E*I)*h =0,002MNm/(251,3MPa*0,00039m4)*0,048m =0,001rad	0,01rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,05MNm/(251,3MPa*0,00056m4)*0,048m =0,0017rad	=Msd/(E*I)*h =0,002MNm/(251,3MPa*0,00056m4)*0,048m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,4kN/mm
F_z,sd (nur mittleres querfestes Lager)	247,0kN	348,0kN	+/-500kN

Wähle 48 Stück (8 sind querfest) bewehrte Neoprenlager 300x250x93, Elastomerdicke 48mm.

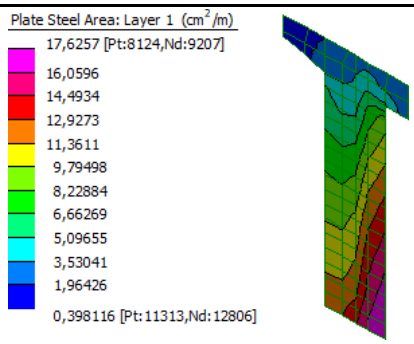
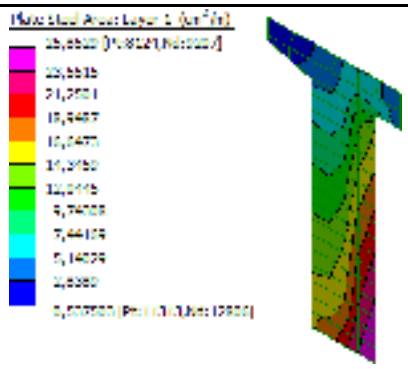
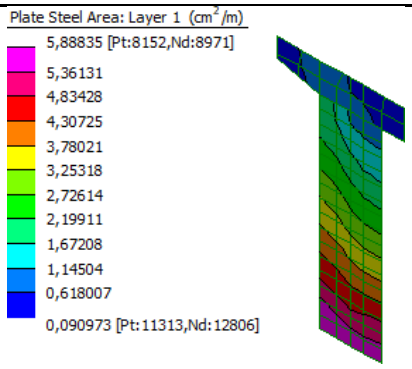
3.3 Pfeiler und Stiele Bogen

3.3.1 Pfeiler Achse A2

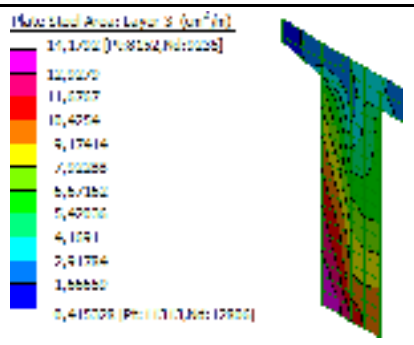
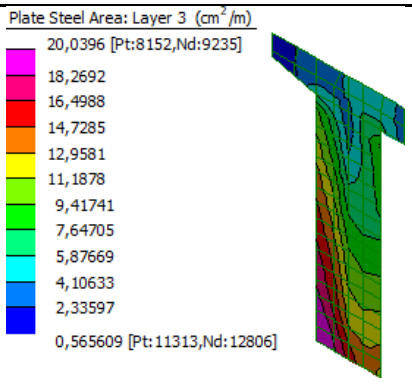
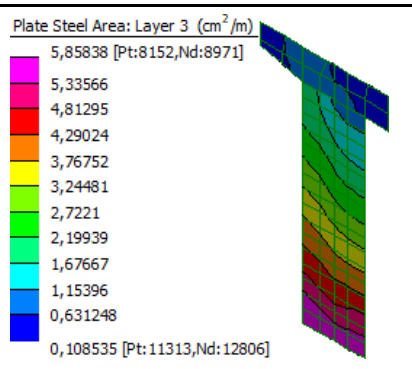
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

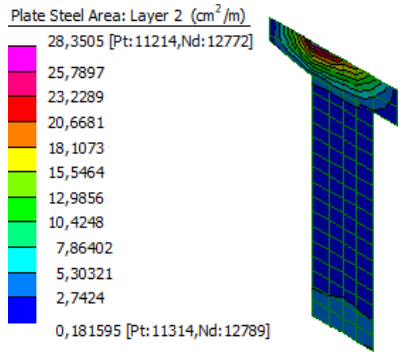
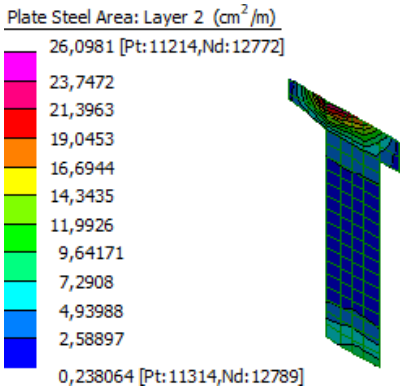
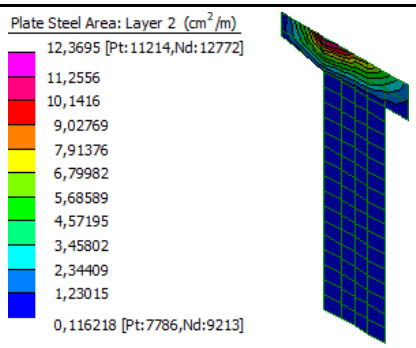
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

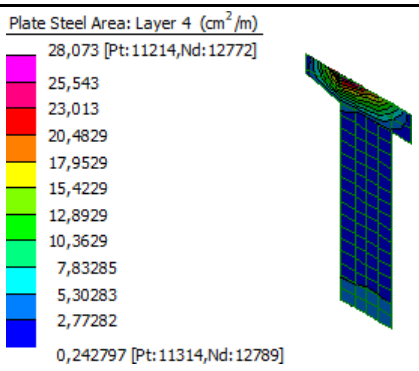
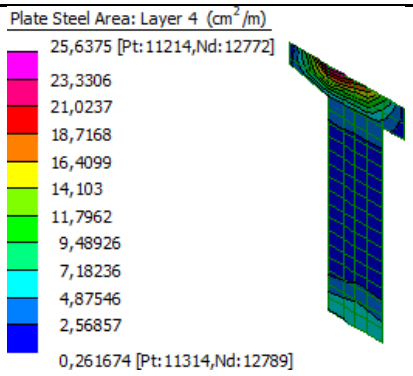
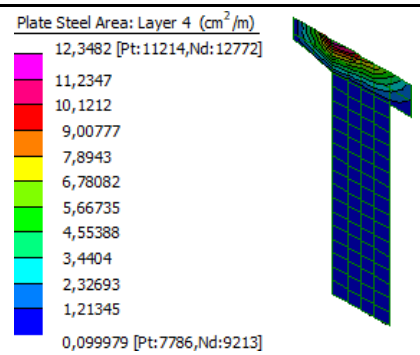
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

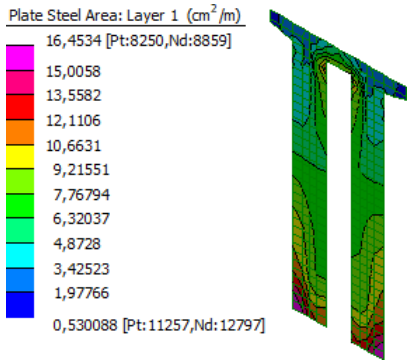
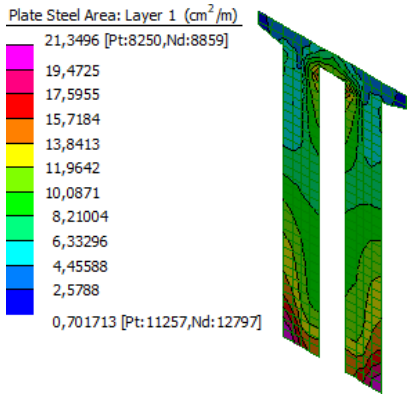
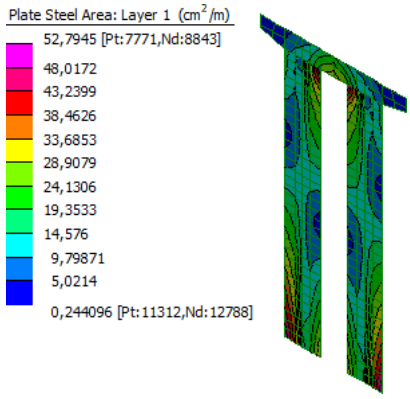
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 4,7MN / (2,26m*0,76m) = 2,7MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.2 Pfeiler Achse 1

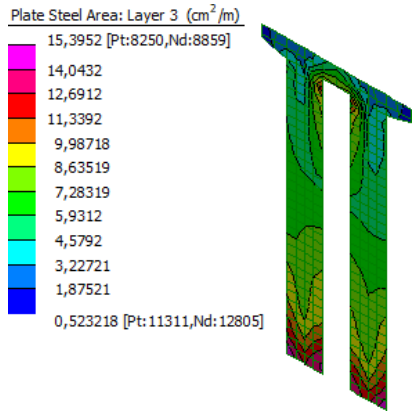
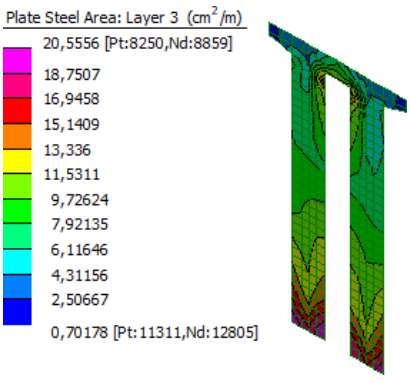
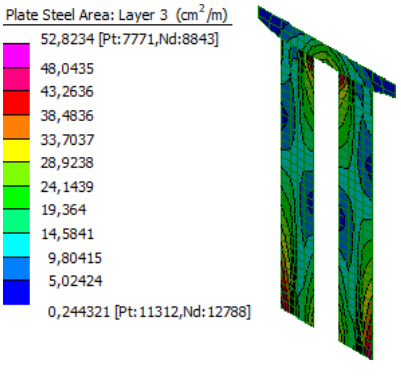
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

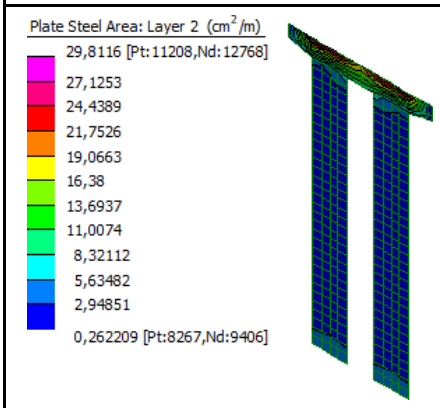
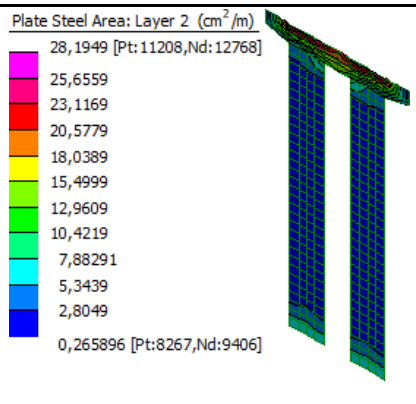
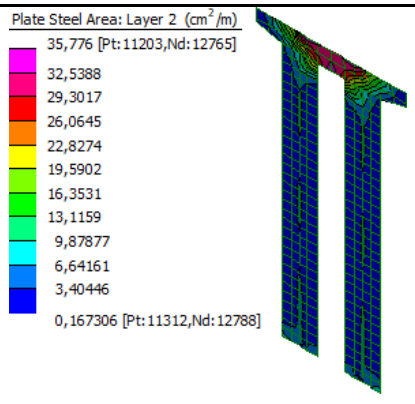
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

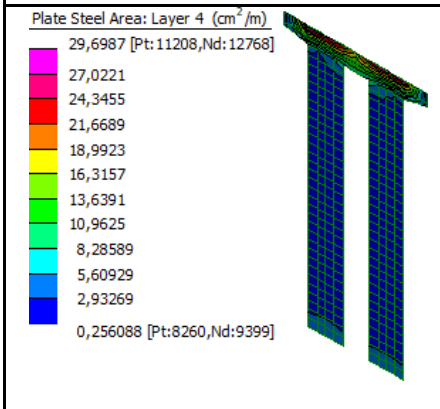
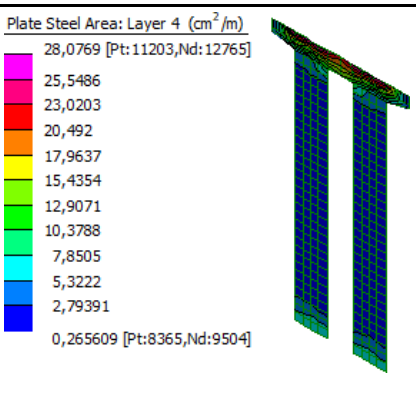
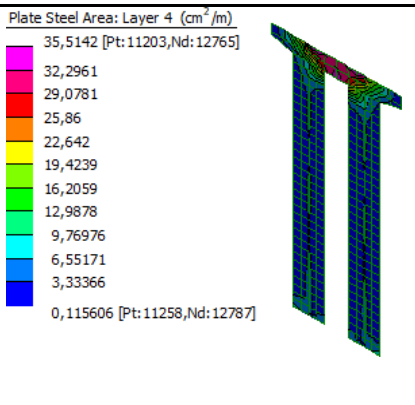
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

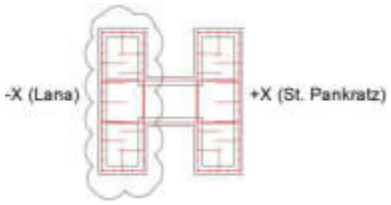
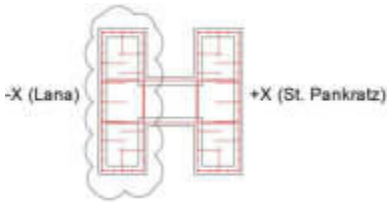
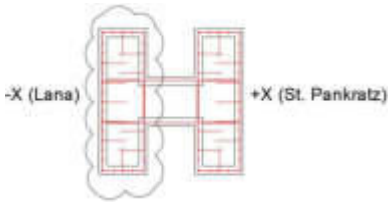
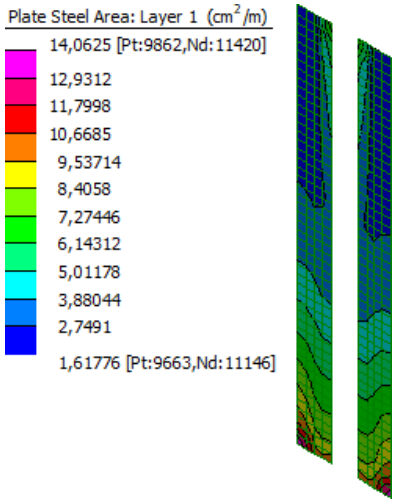
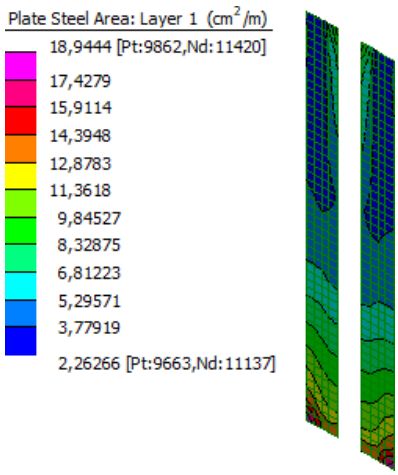
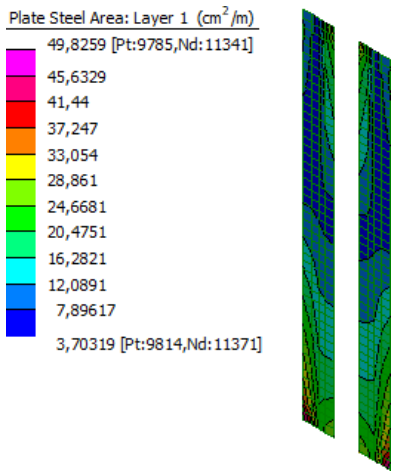
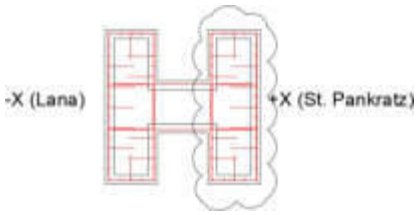
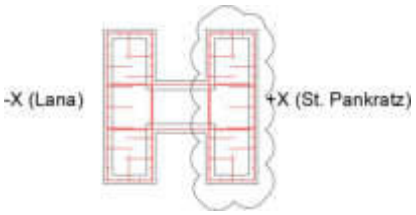
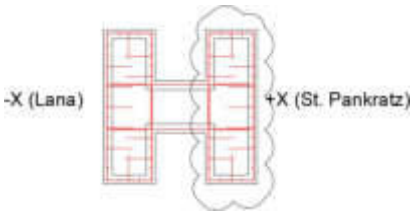
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

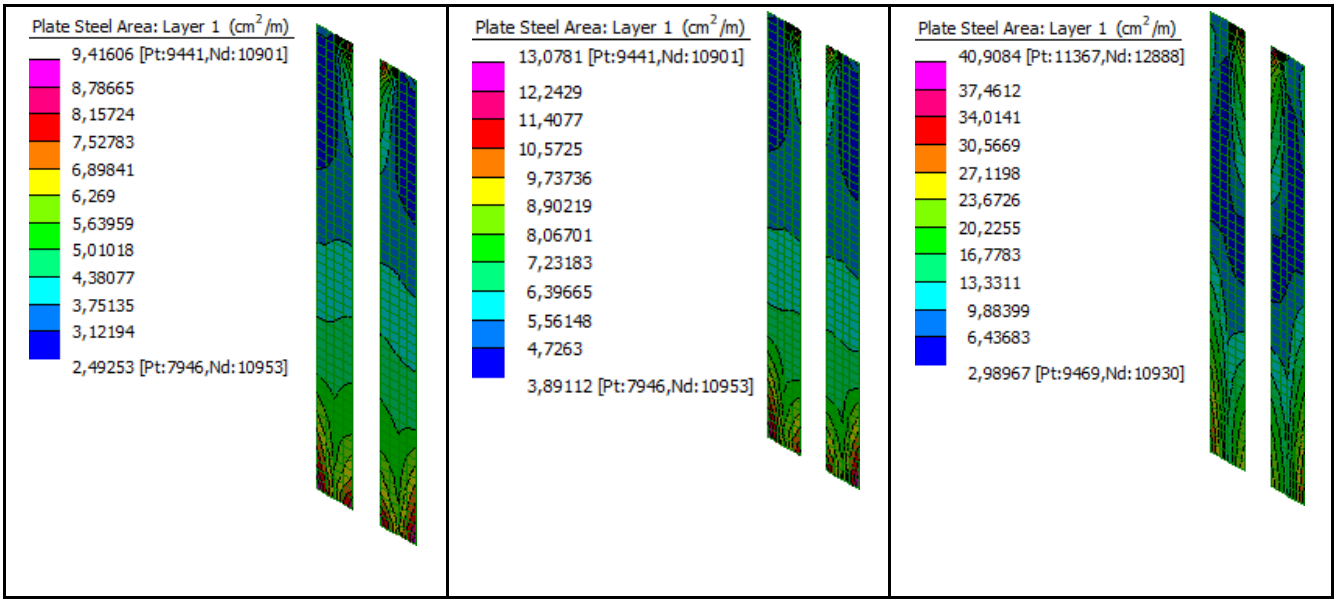
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 5,5MN / (2,26m*0,76m) = 3,2MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.3 Pfeiler Achse 2

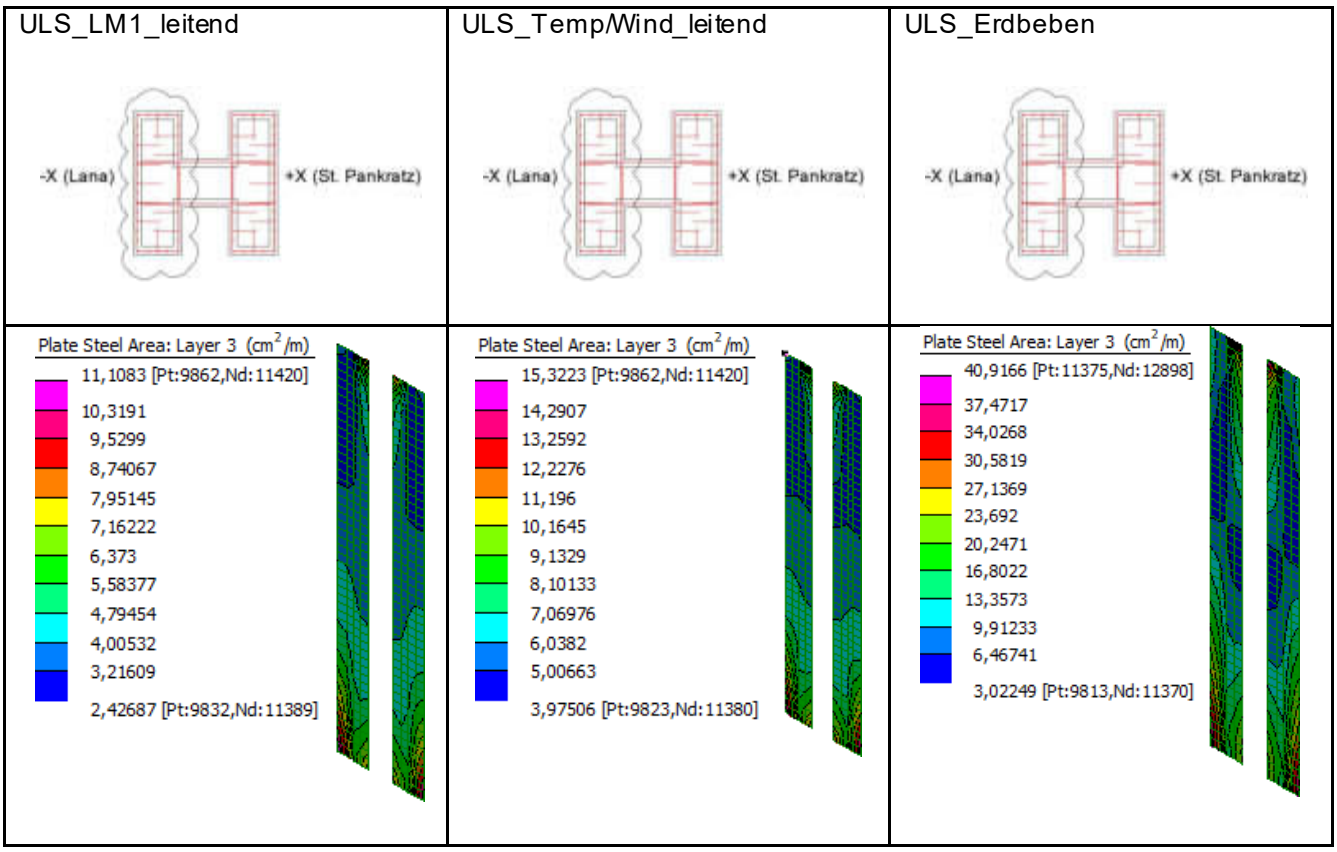
Automatische Berechnung der erforderlichen Bewehrung (ULS):

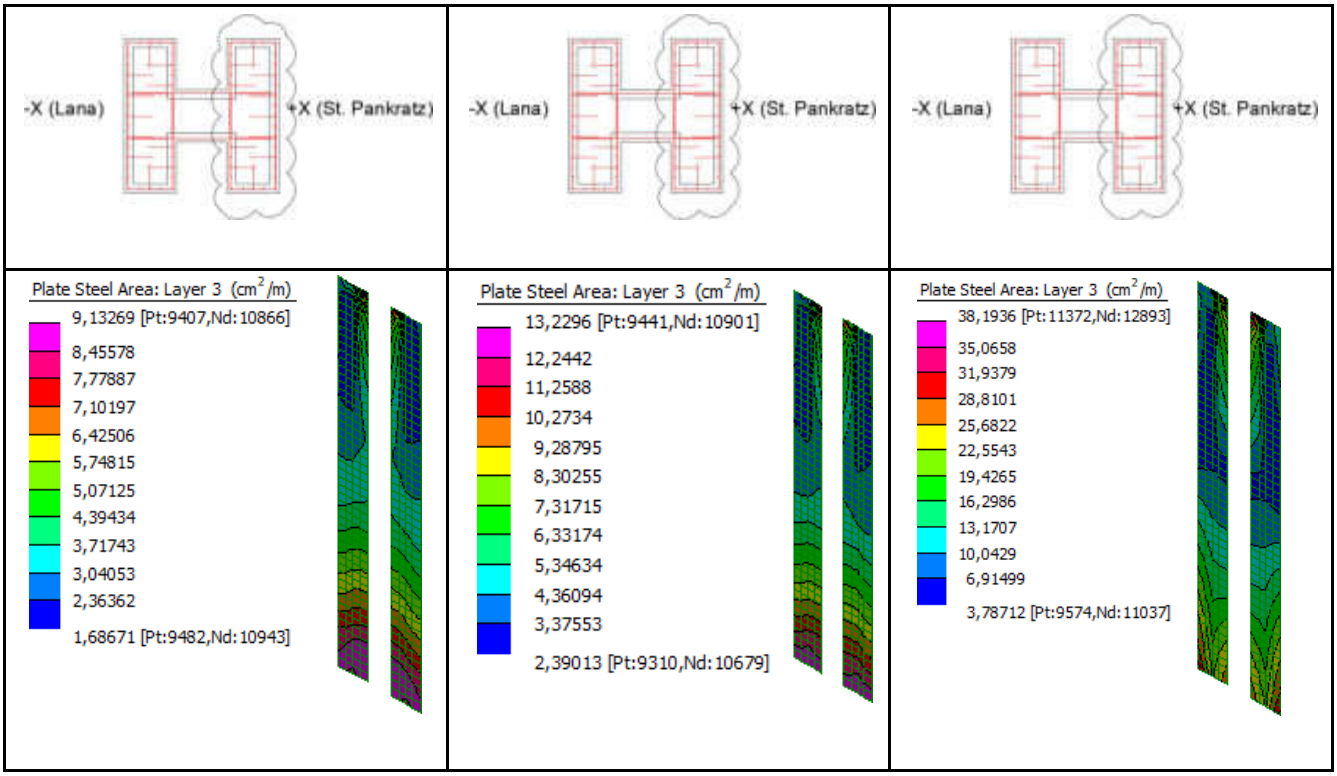
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		
		
		

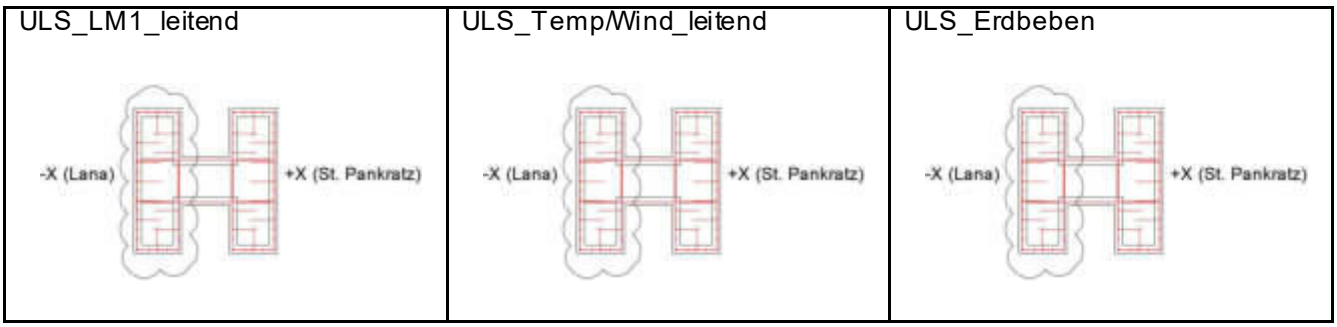


Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:





Erforderliche horizontale Bewehrung ULS auf der Seite Lana:



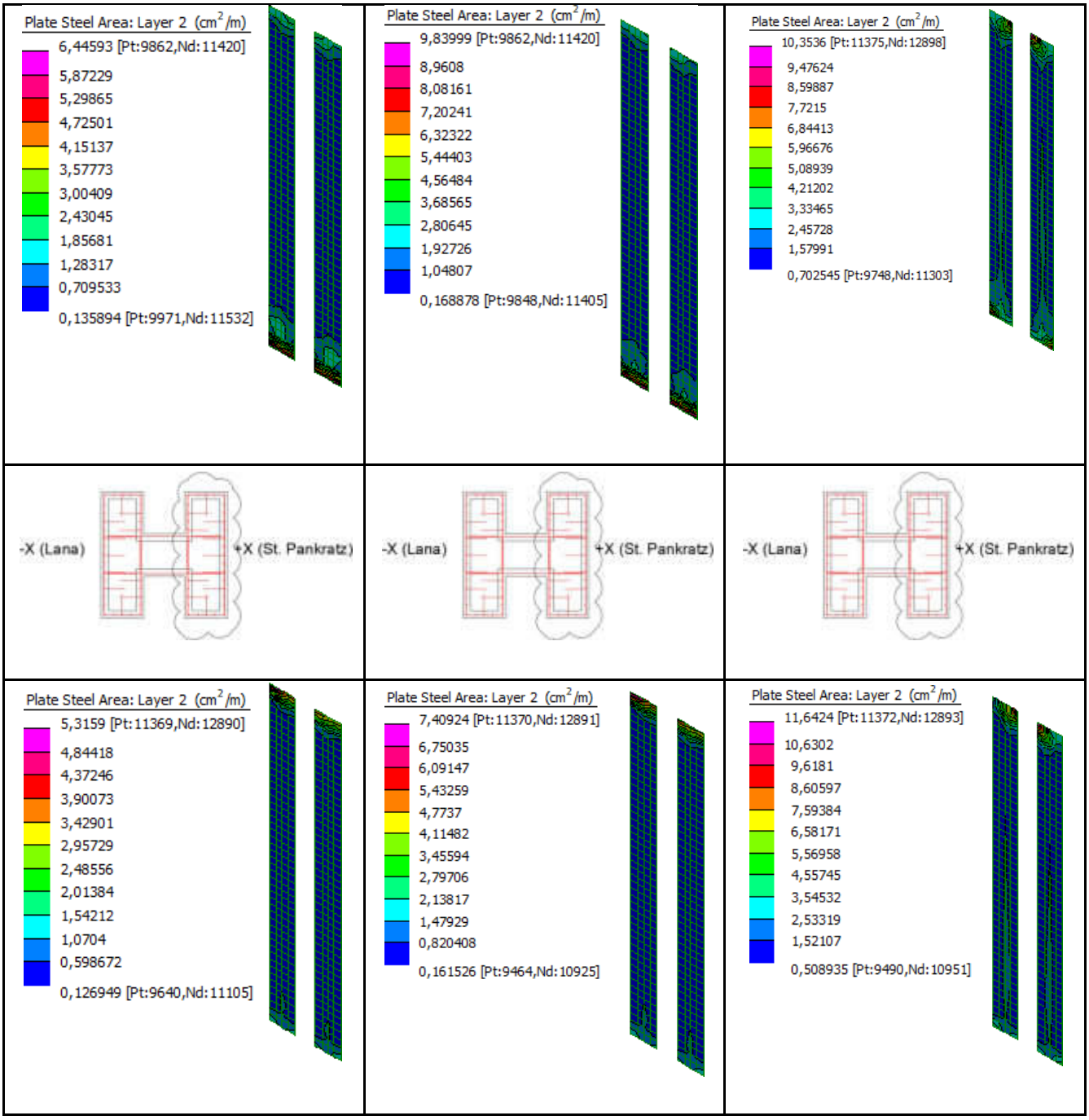
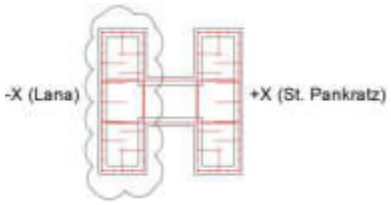
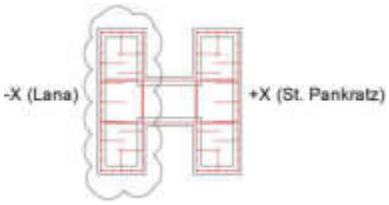
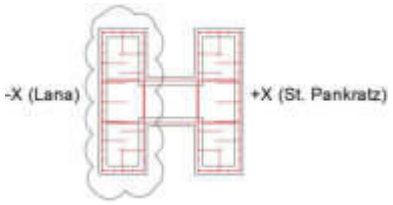
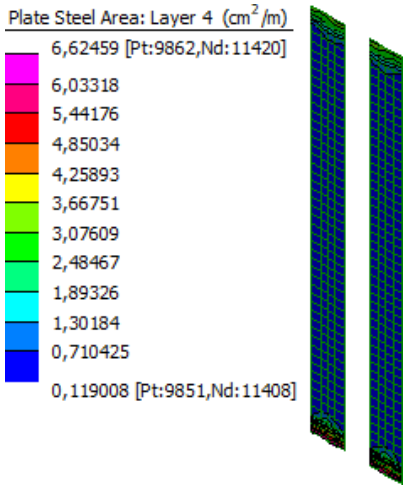
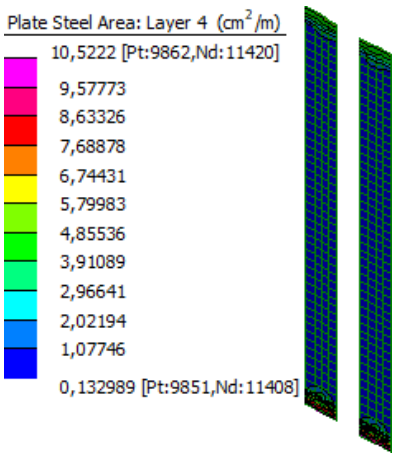
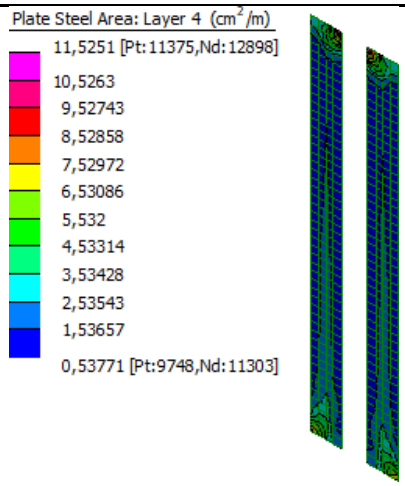
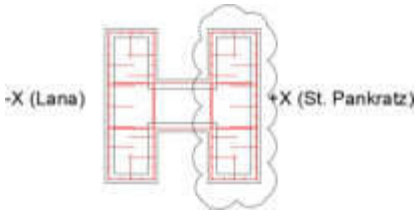
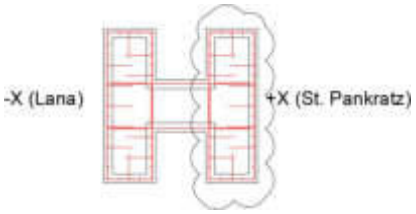
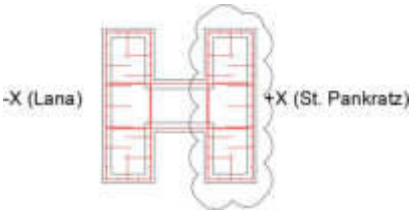
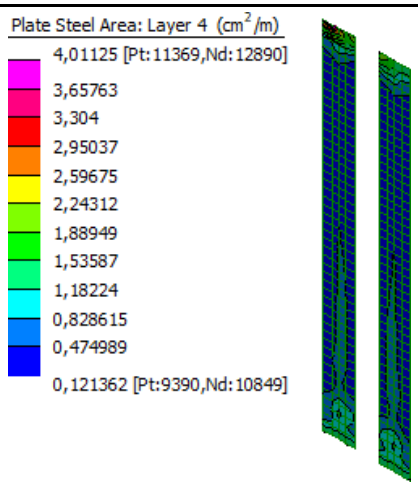
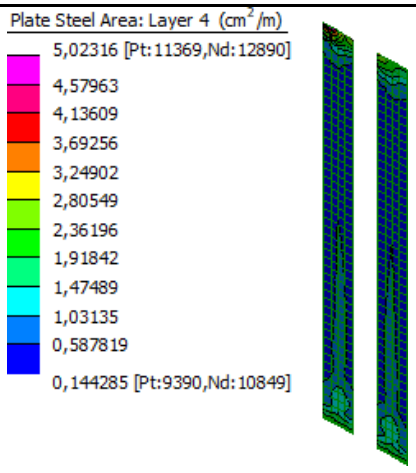
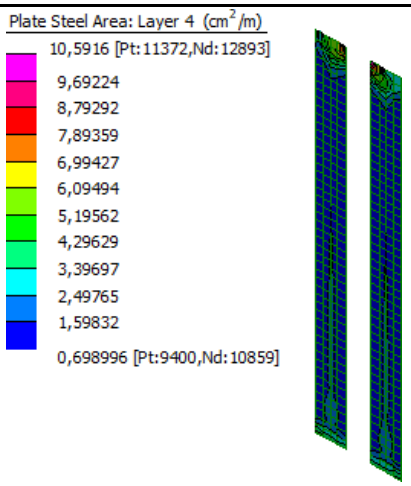
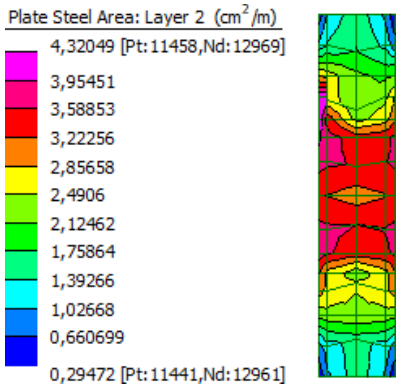
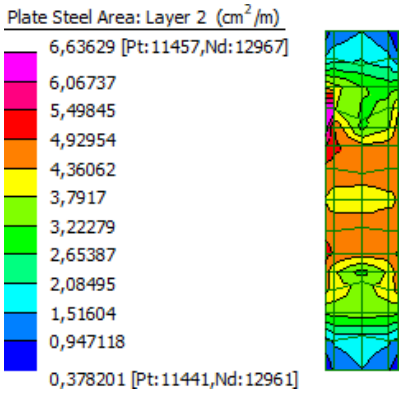
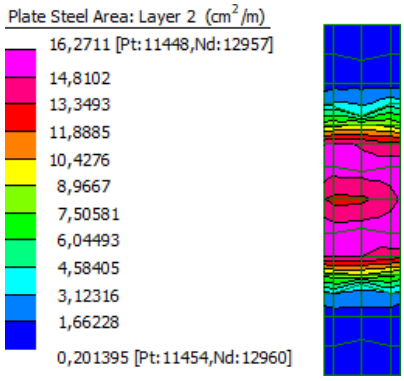


Plate Steel Area: Layer 2 (cm²/m)
6,44593 [Pt:9862,Nd:11420]
5,87229
5,29865
4,72501
4,15137
3,57773
3,00409
2,43045
1,85681
1,28317
0,709533
0,135894 [Pt:9971,Nd:11532]
Plate Steel Area: Layer 2 (cm²/m)
9,83999 [Pt:9862,Nd:11420]
8,9608
8,08161
7,20241
6,32322
5,44403
4,56484
3,68565
2,80645
1,92726
1,04807
0,168878 [Pt:9848,Nd:11405]
Plate Steel Area: Layer 2 (cm²/m)
10,3536 [Pt:11375,Nd:12898]
9,47624
8,59887
7,7215
6,84413
5,96676
5,08939
4,21202
3,33465
2,45728
1,57991
0,702545 [Pt:9748,Nd:11303]
-X (Lana)
+X (St. Pankratz)
-X (Lana)
+X (St. Pankratz)
-X (Lana)
+X (St. Pankratz)
Plate Steel Area: Layer 2 (cm²/m)
5,3159 [Pt:11369,Nd:12890]
4,84418
4,37246
3,90073
3,42901
2,95729
2,48556
2,01384
1,54212
1,0704
0,598672
0,126949 [Pt:9640,Nd:11105]
Plate Steel Area: Layer 2 (cm²/m)
7,40924 [Pt:11370,Nd:12891]
6,75035
6,09147
5,43259
4,7737
4,11482
3,45594
2,79706
2,13817
1,47929
0,820408
0,161526 [Pt:9464,Nd:10925]
Plate Steel Area: Layer 2 (cm²/m)
11,6424 [Pt:11372,Nd:12893]
10,6302
9,6181
8,60597
7,59384
6,58171
5,56958
4,55745
3,54532
2,53319
1,52107
0,508935 [Pt:9490,Nd:10951]

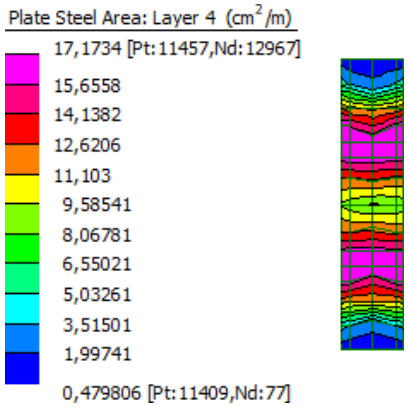
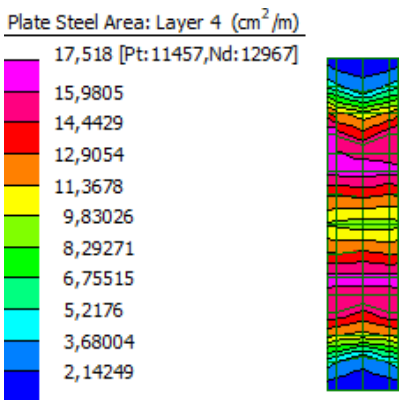
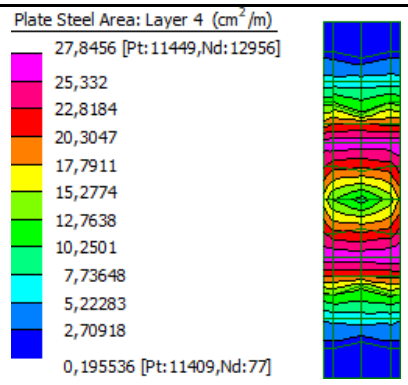
Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		
		
		
		

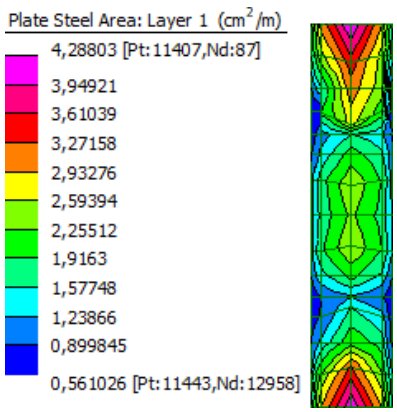
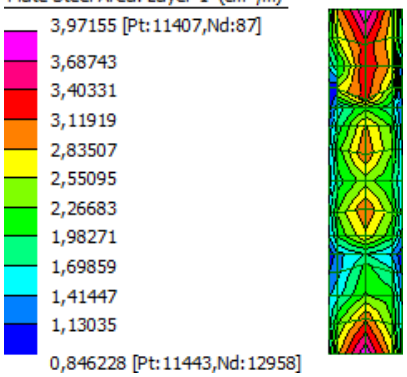
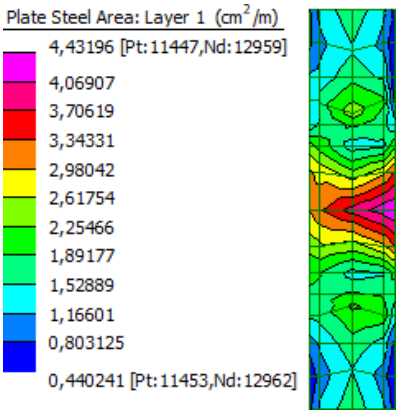
Erforderliche untere Bewehrung in Brückenquerrichtung Pfeilerkopf Achse 2

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

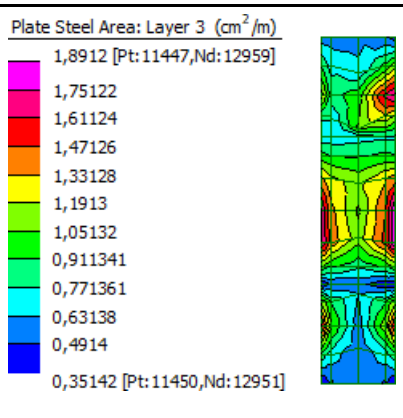
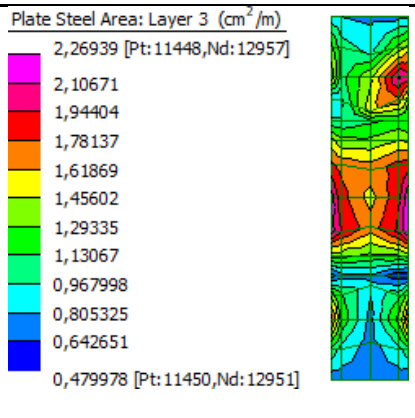
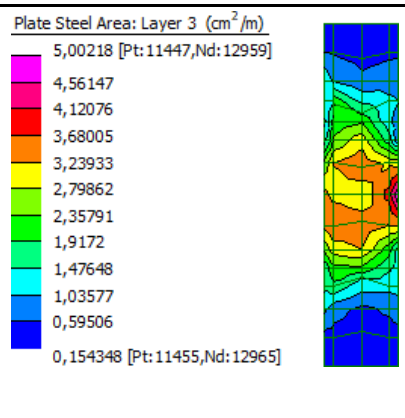
Erforderliche obere Bewehrung in Brückenquerrichtung Pfeilerkopf Achse 2

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche untere Bewehrung in Brückenlängsrichtung Pfeilerkopf Achse 2

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche obere Bewehrung in Brückenlängsrichtung Pfeilerkopf Achse 2

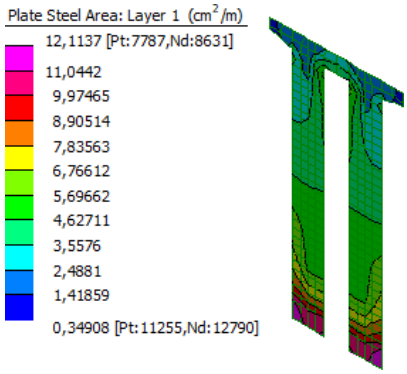
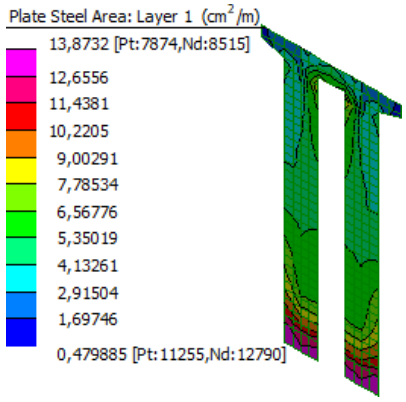
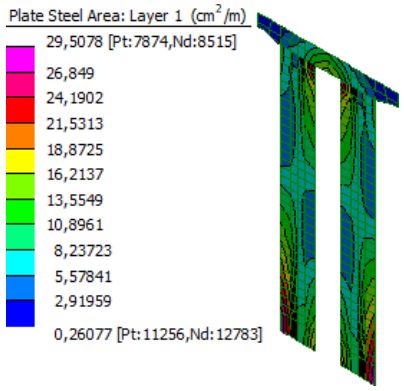
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

3.3.4 Pfeiler Achse 3

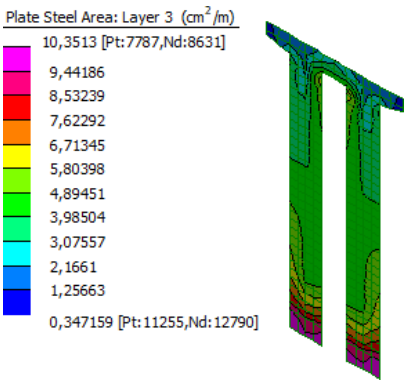
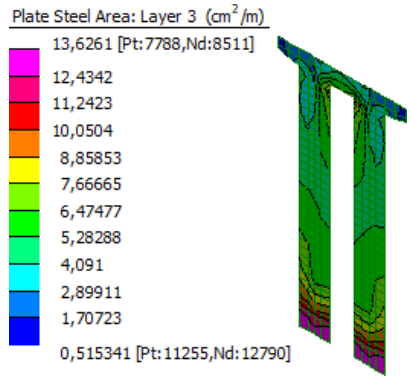
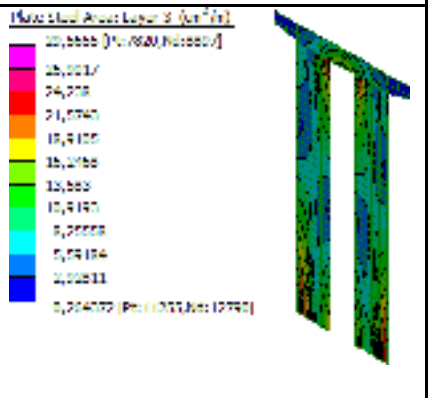
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

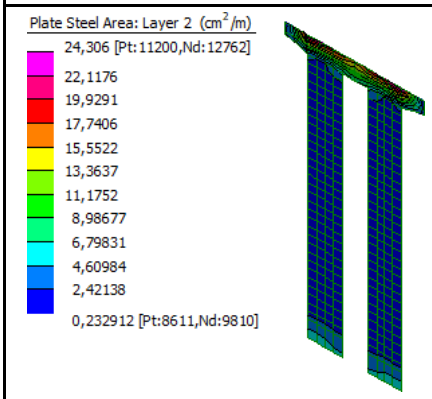
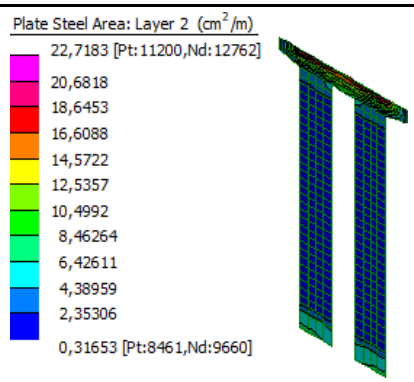
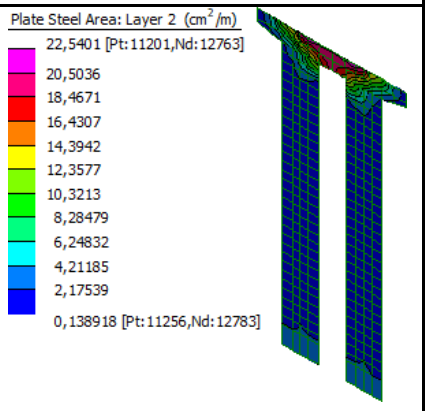
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

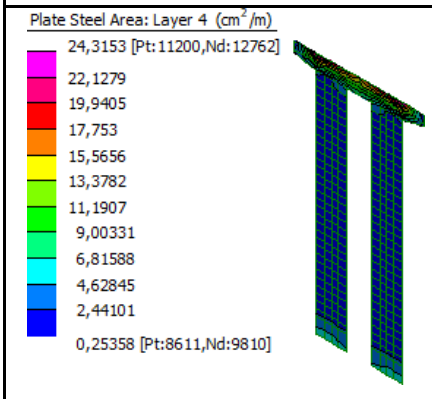
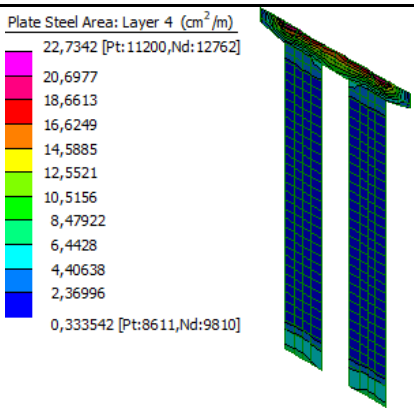
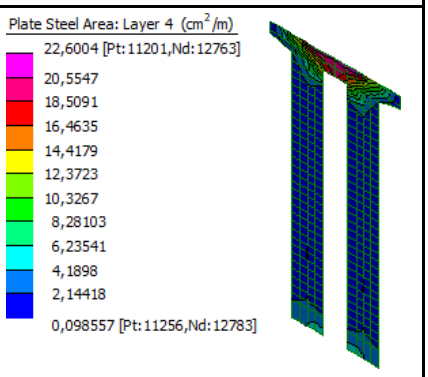
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

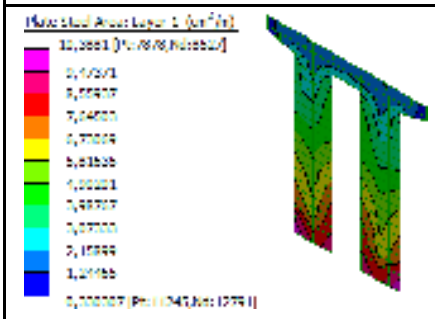
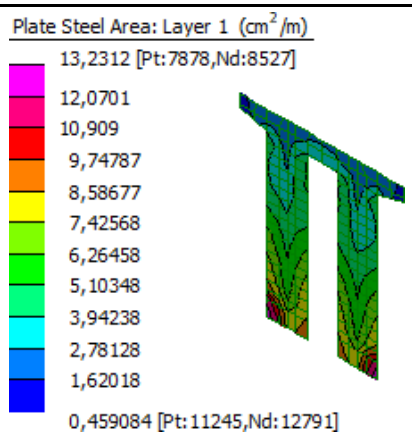
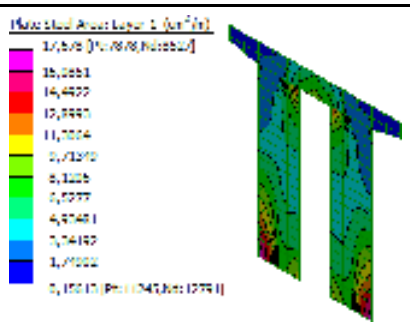
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 4,1MN / (2,26m*0,76m) = 2,4MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.5 Pfeiler Achse 4

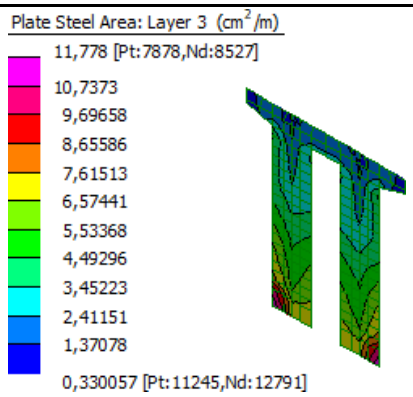
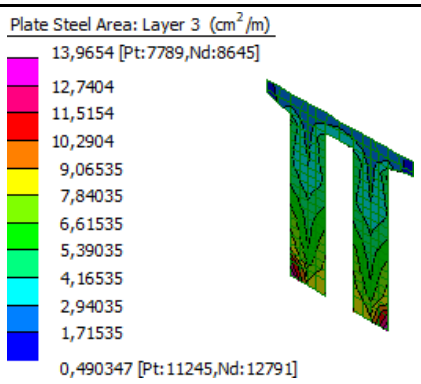
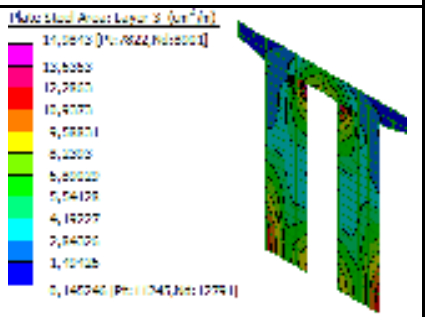
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

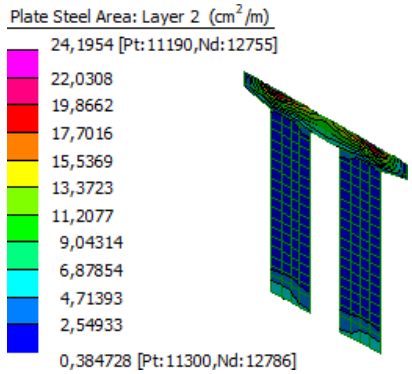
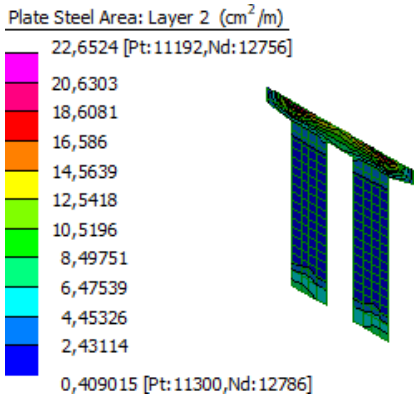
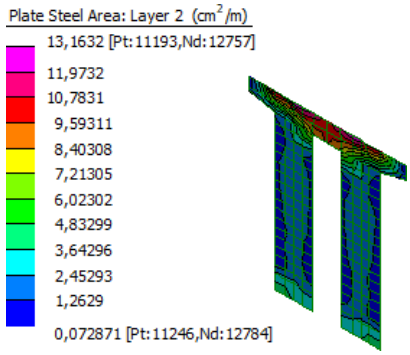
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

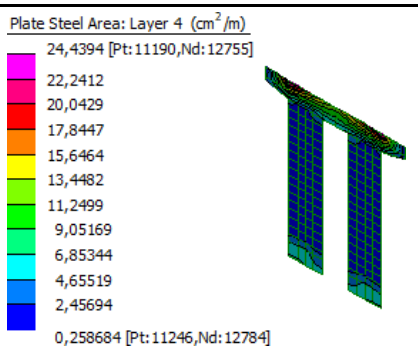
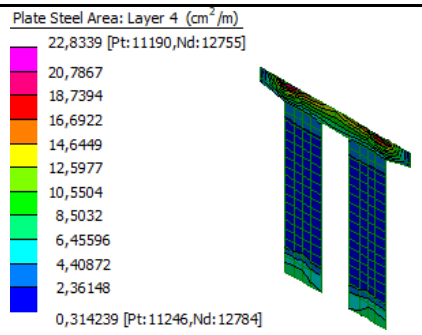
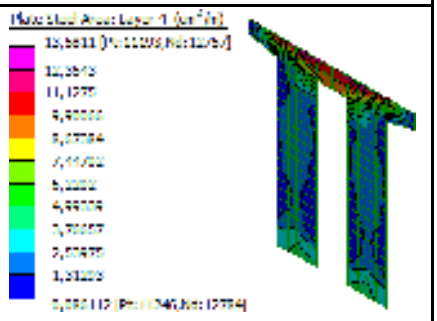
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

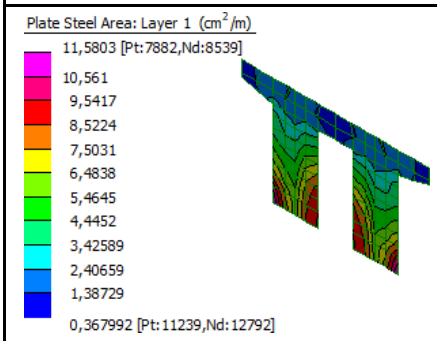
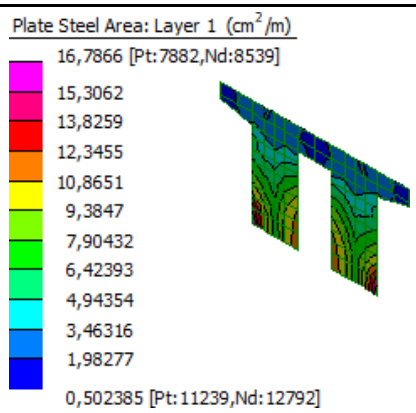
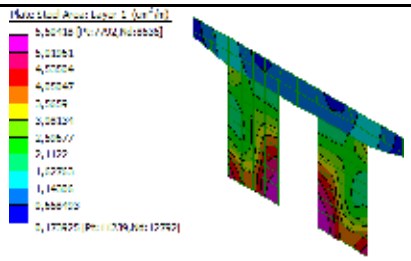
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,6MN / (2,26m*0,76m) = 2,1MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.6 Pfeiler Achse 5

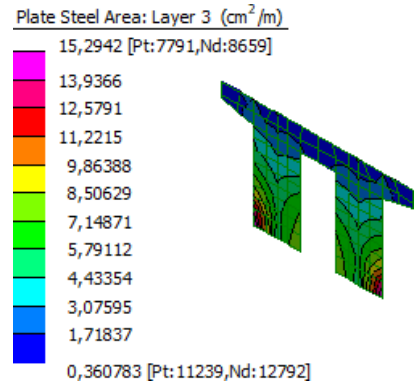
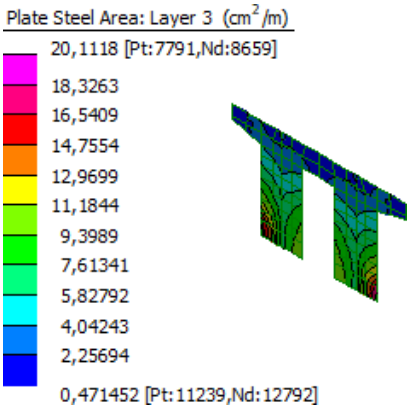
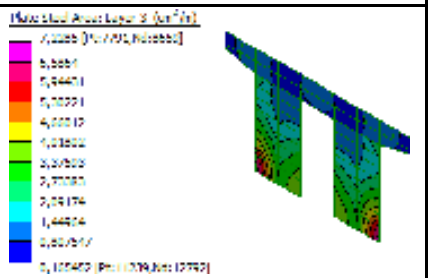
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

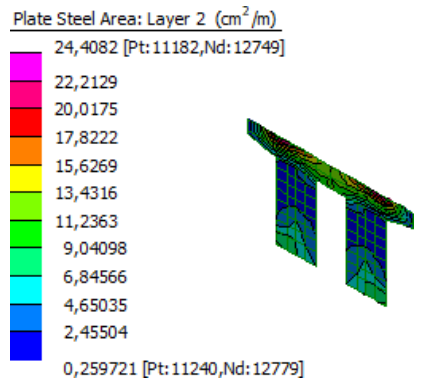
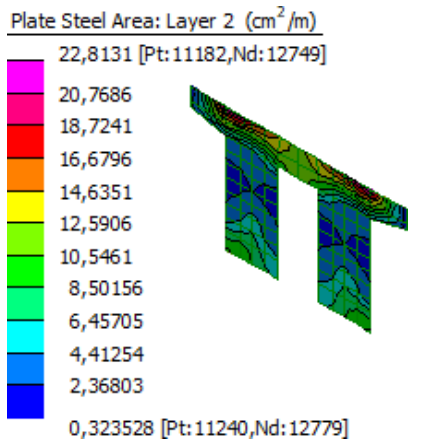
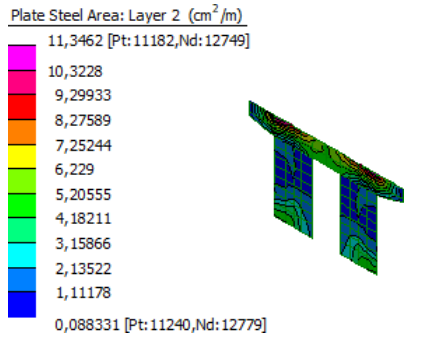
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

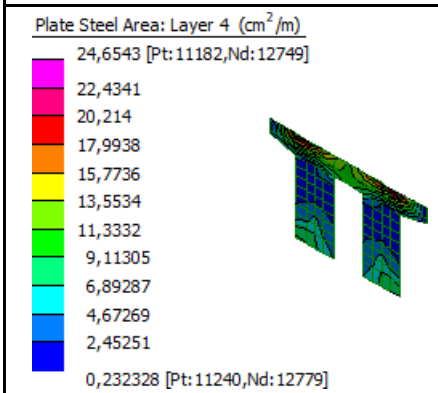
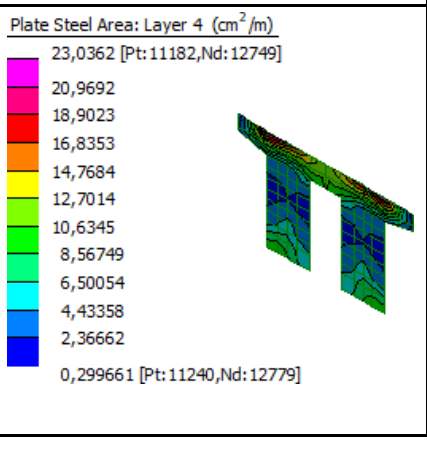
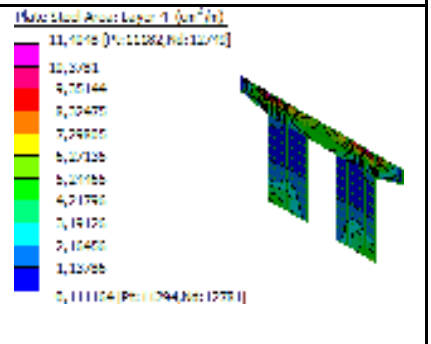
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

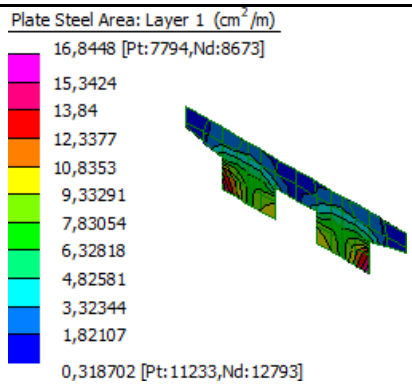
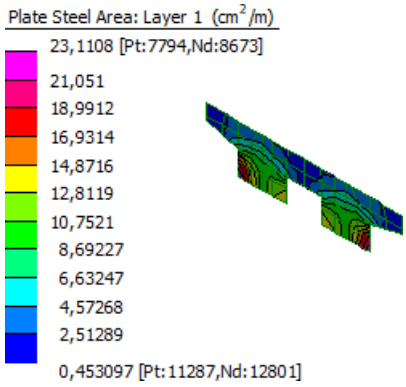
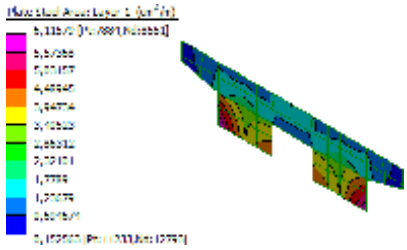
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,6MN / (2,26m*0,76m) = 2,1MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.7 Pfeiler Achse 6

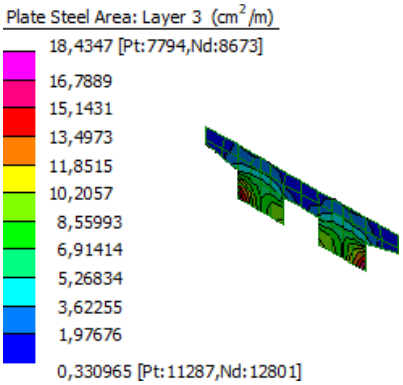
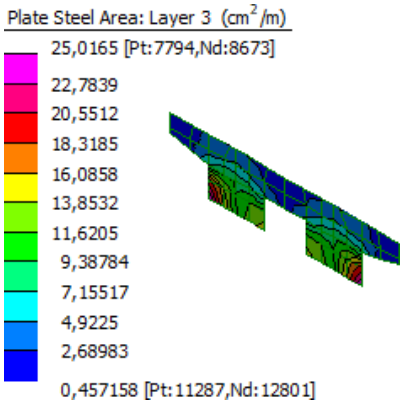
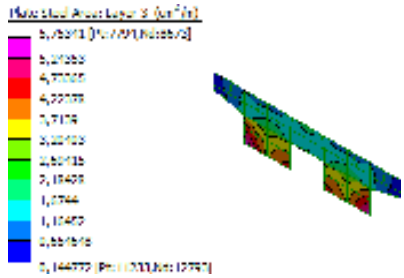
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

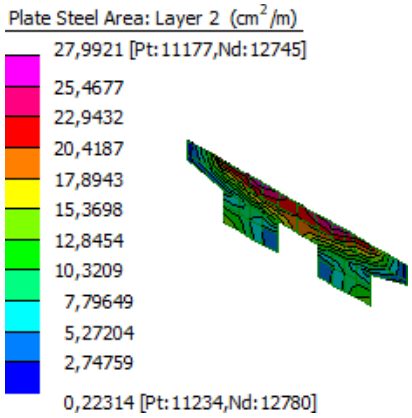
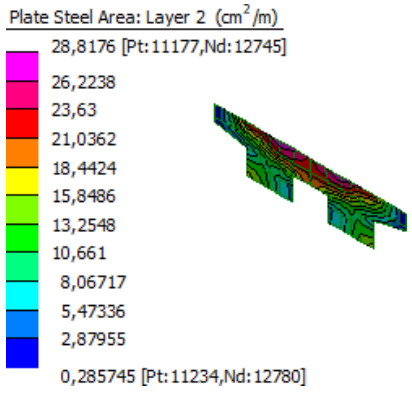
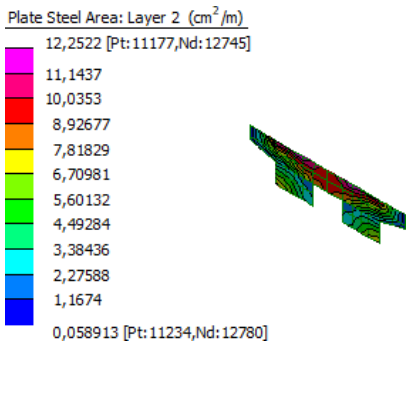
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

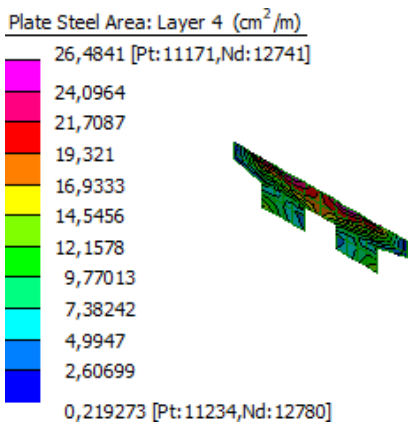
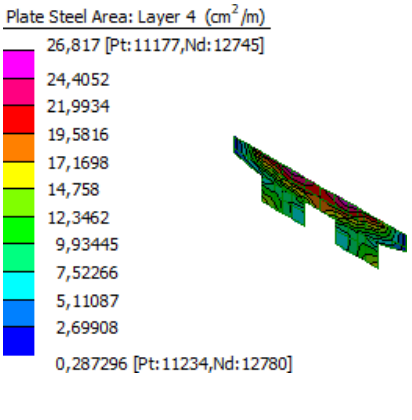
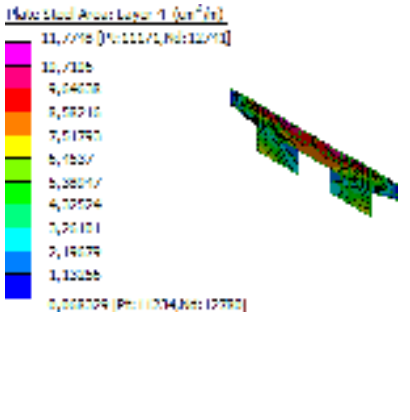
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

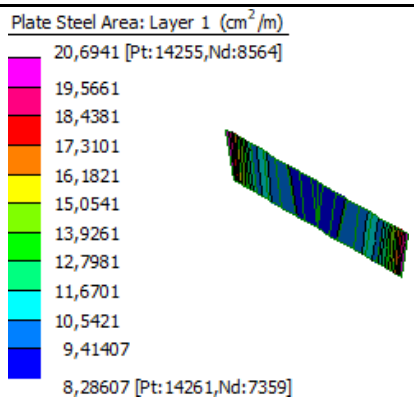
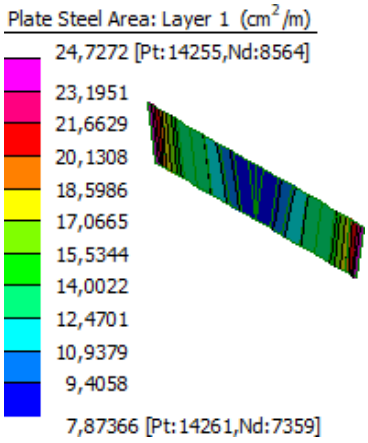
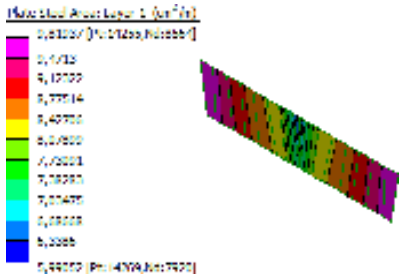
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,7MN / (2,26m*0,76m) = 2,2MPa < f_cd=11,8MPa -> Nachweis erfüllt

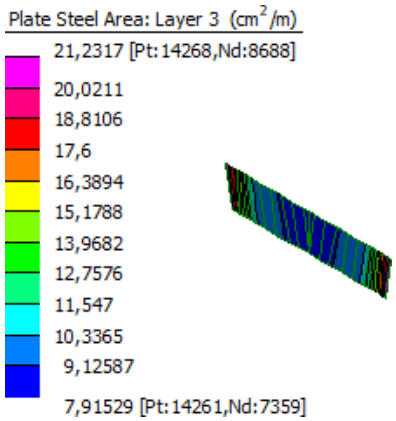
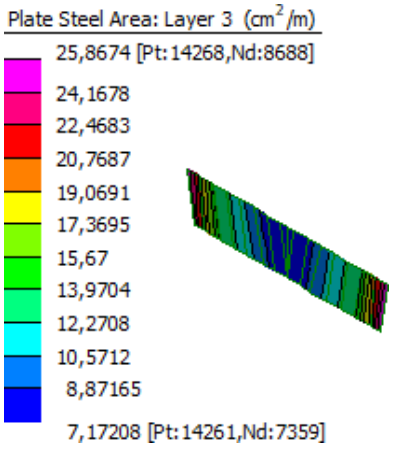
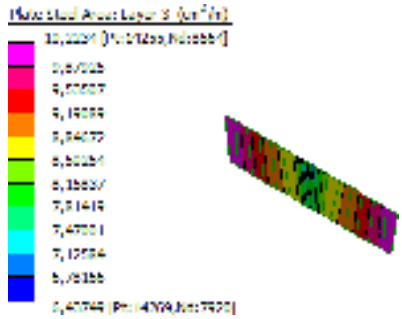
3.3.8 Pfeiler Achse 7

Automatische Berechnung der erforderlichen Bewehrung (ULS):

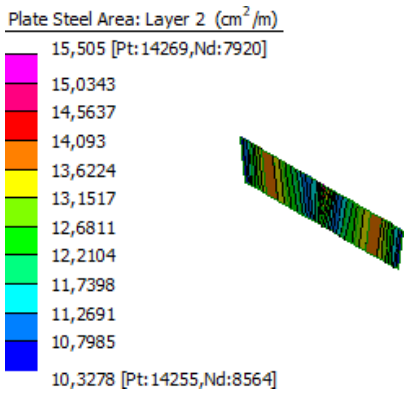
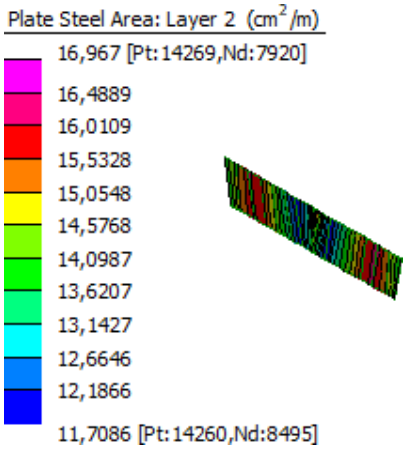
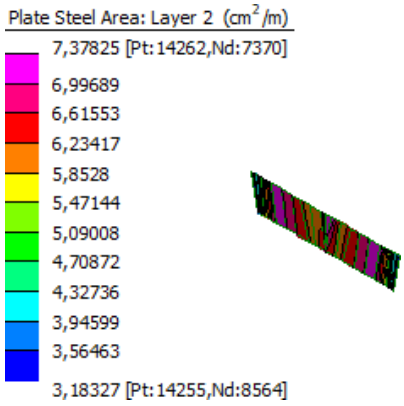
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

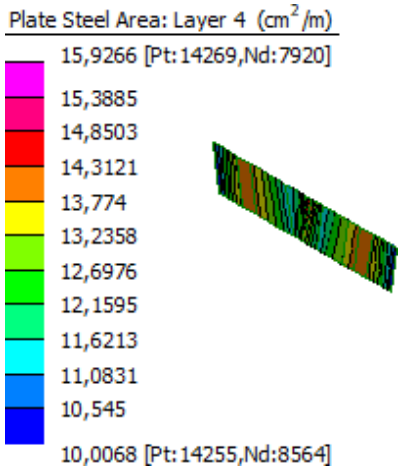
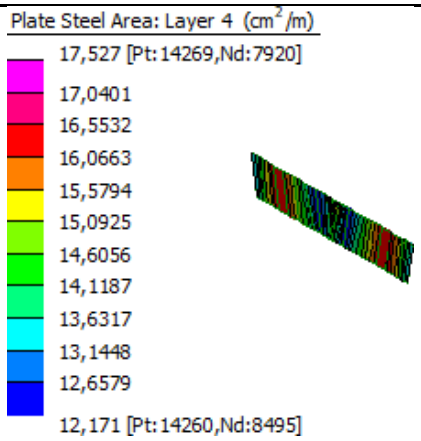
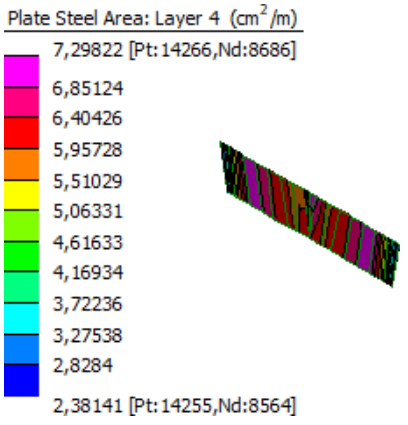
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

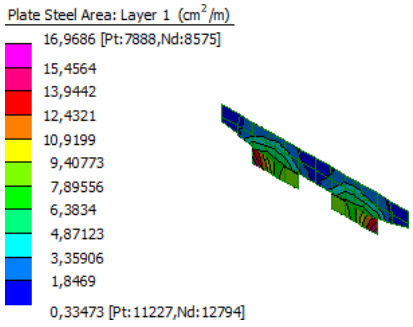
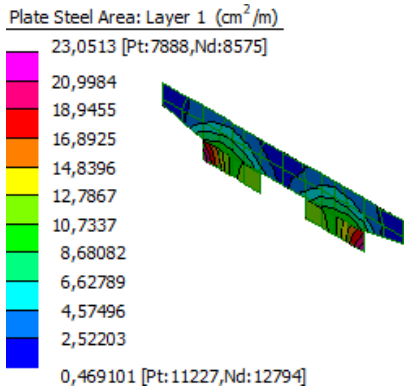
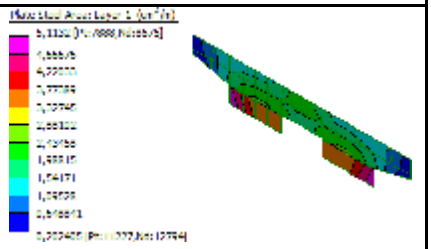
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

3.3.9 Pfeiler Achse 8

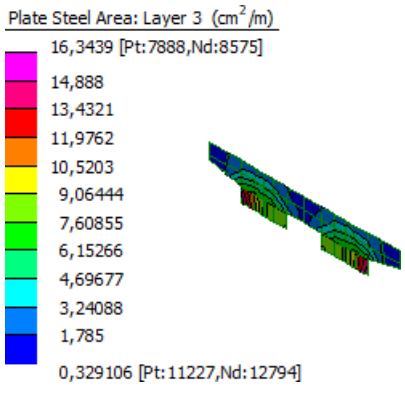
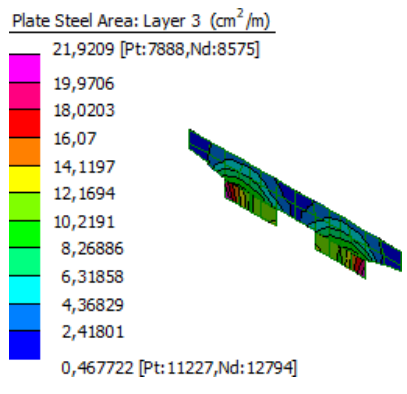
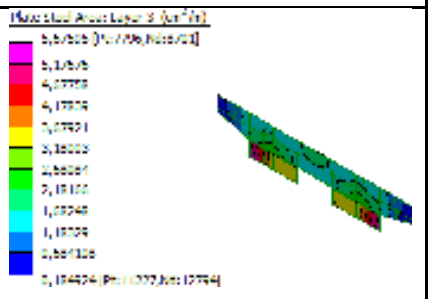
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

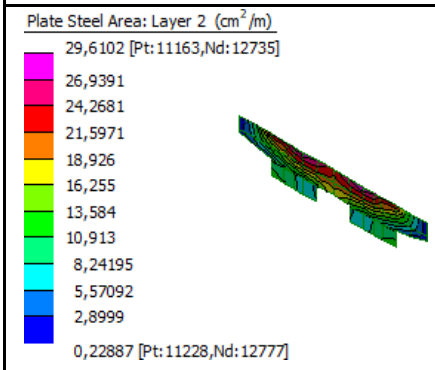
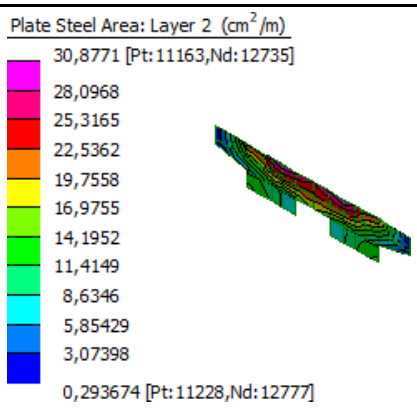
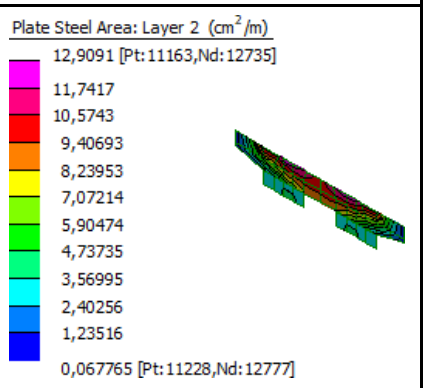
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

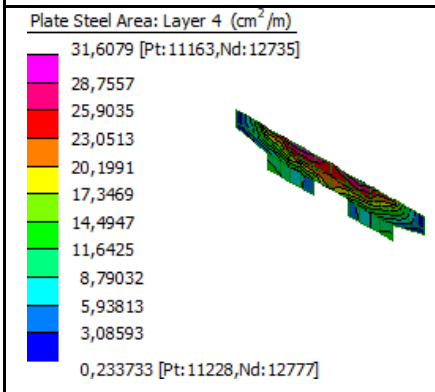
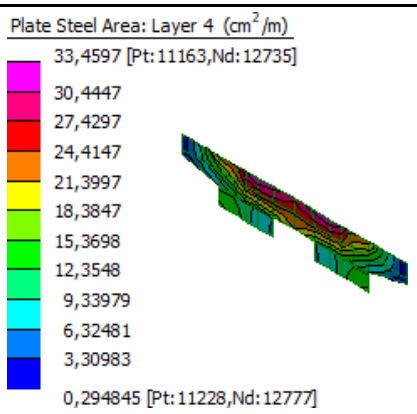
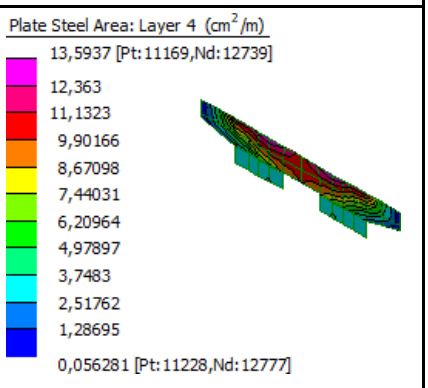
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

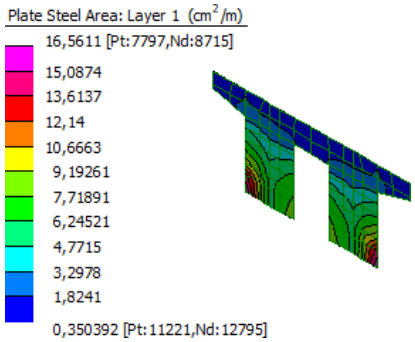
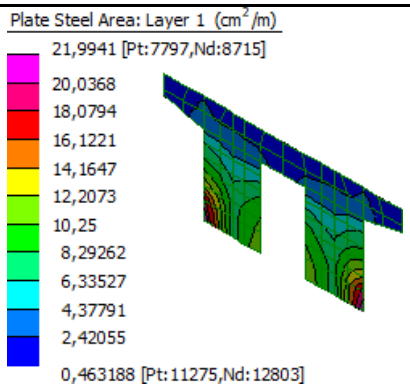
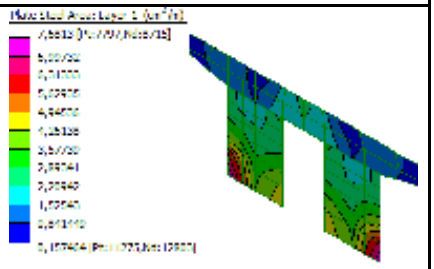
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,5MN / (2,26m*0,76m) = 2,03MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.10 Pfeiler Achse 9

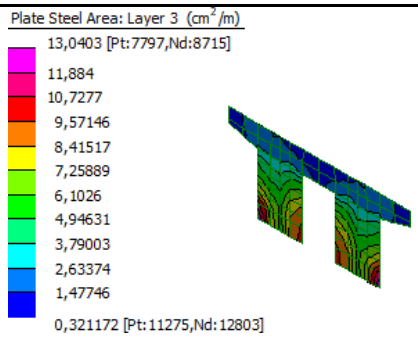
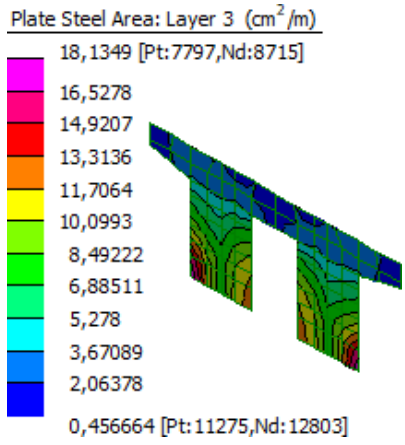
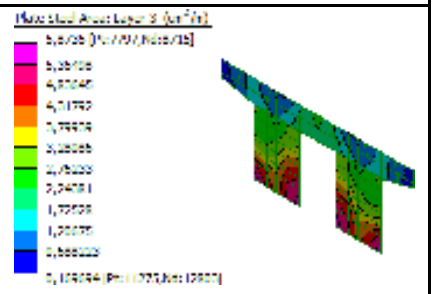
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

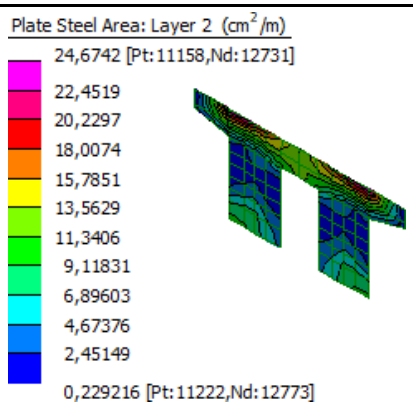
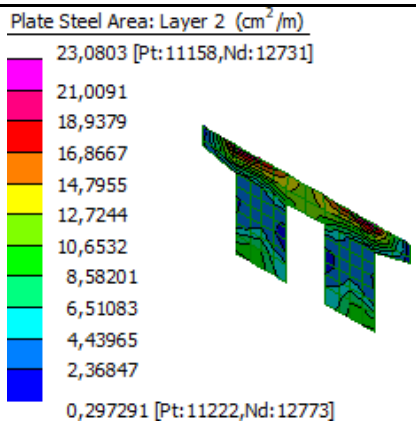
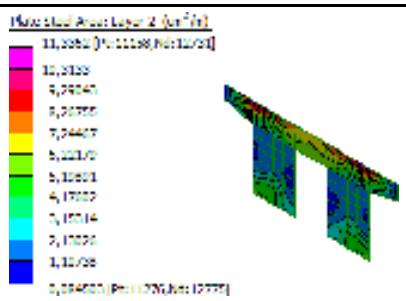
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

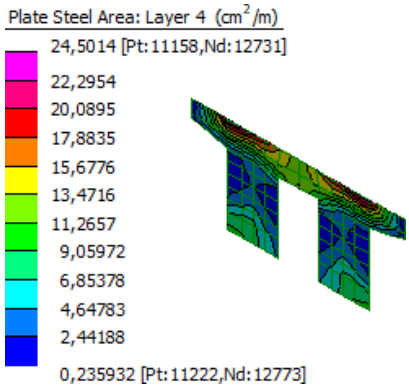
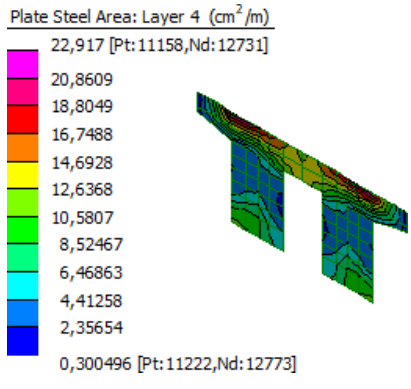
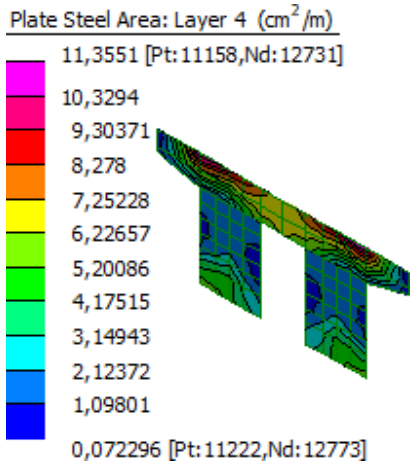
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

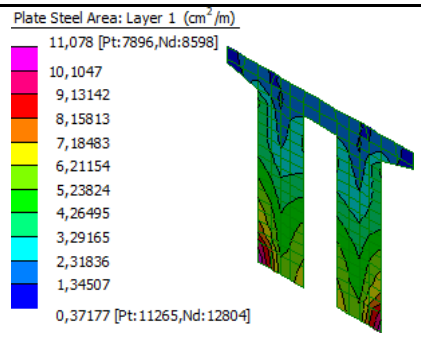
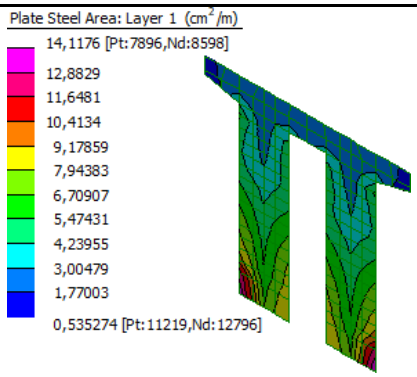
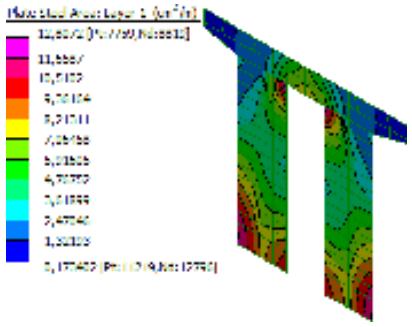
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,6MN / (2,26m*0,76m) = 2,1MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.11 Pfeiler Achse 10

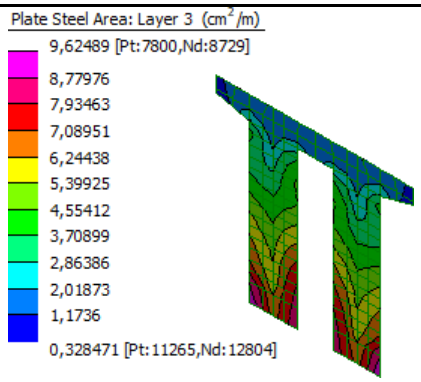
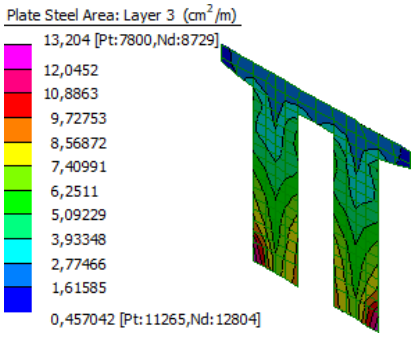
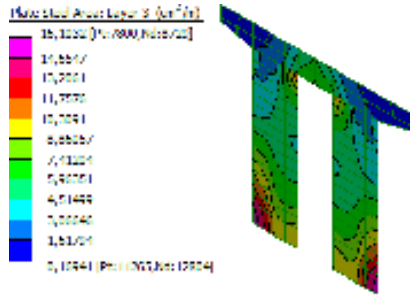
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

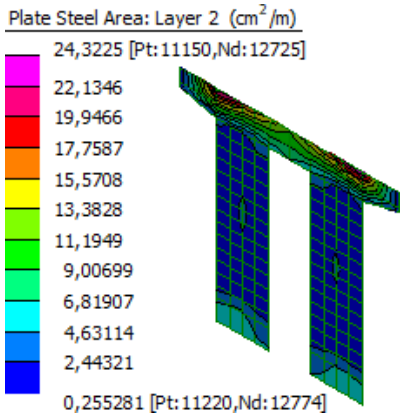
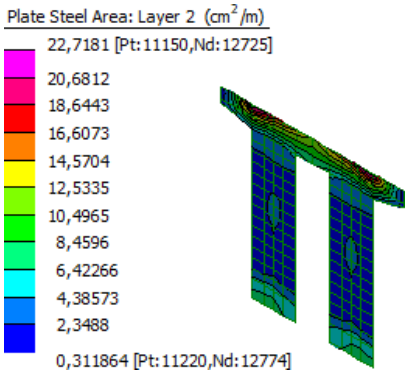
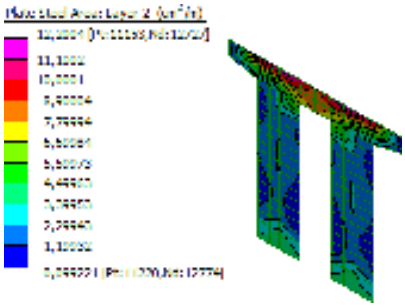
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

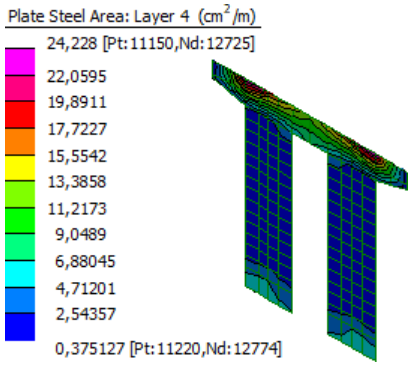
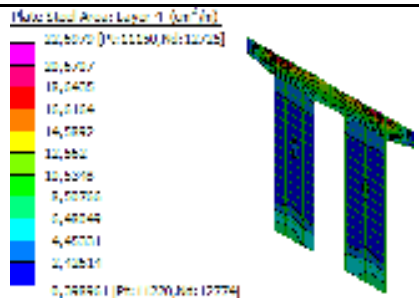
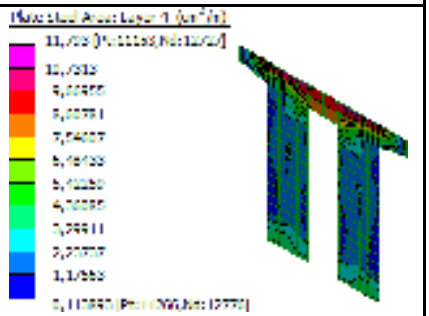
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

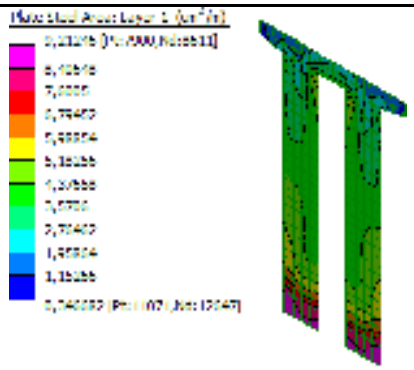
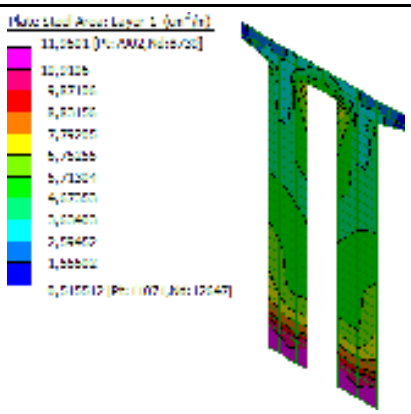
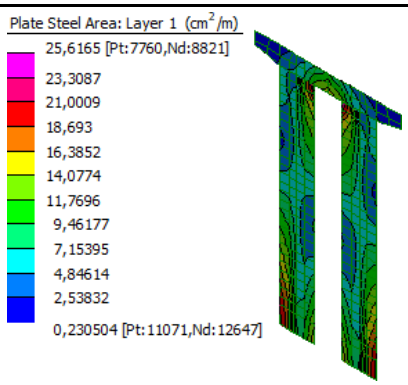
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,5MN / (2,26m*0,76m) = 2,0MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.12 Pfeiler Achse 11

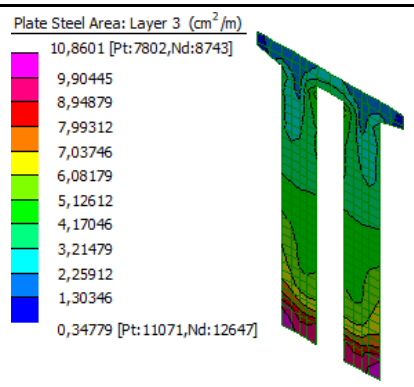
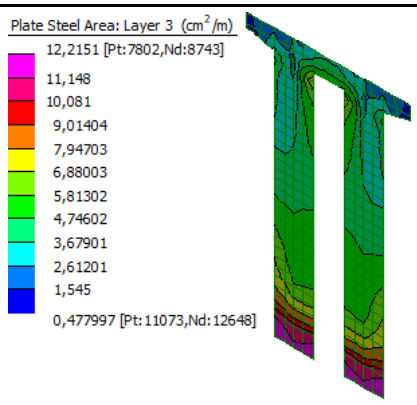
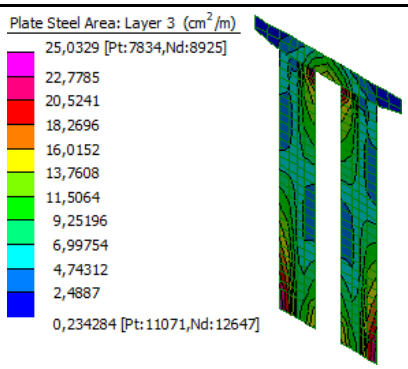
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

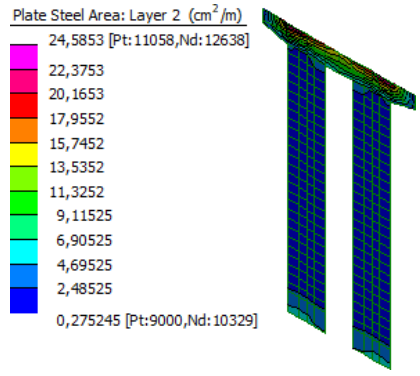
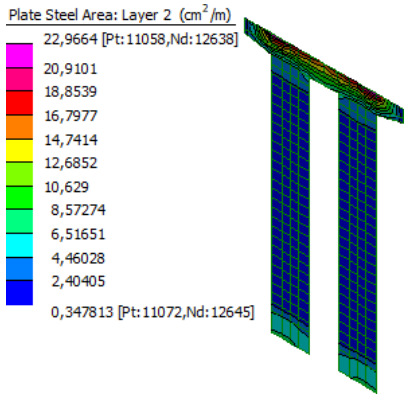
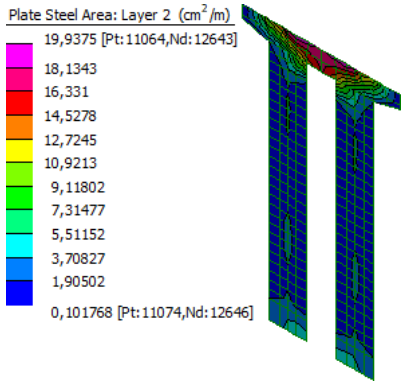
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

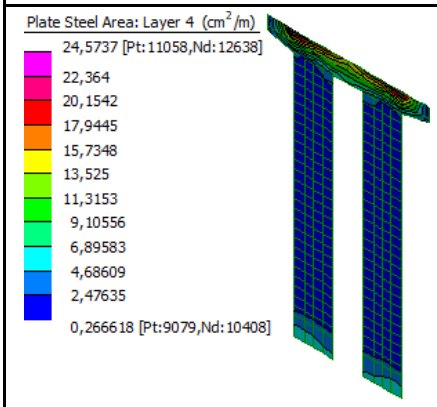
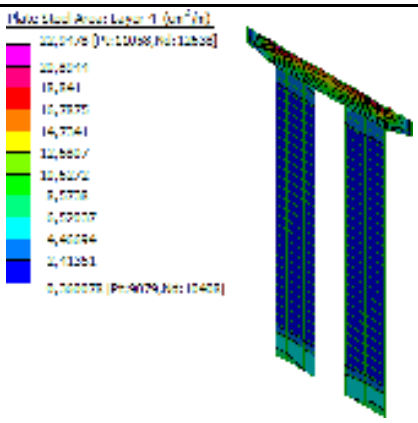
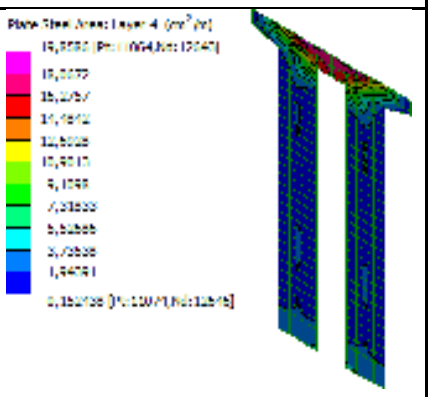
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

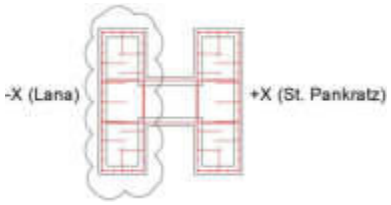
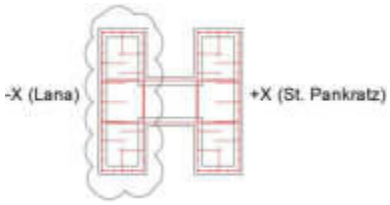
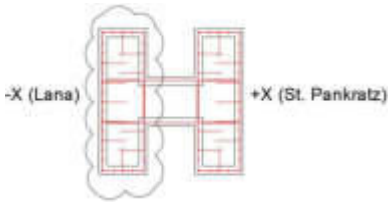
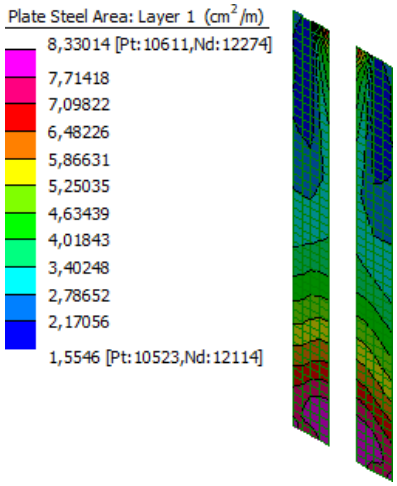
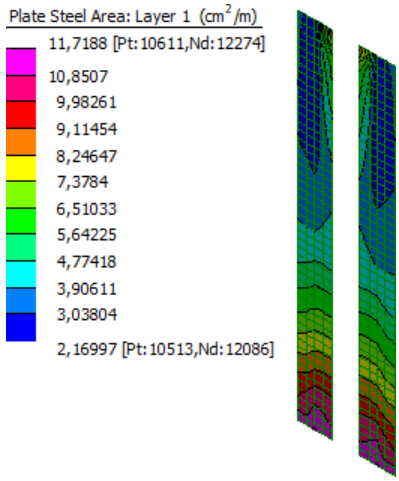
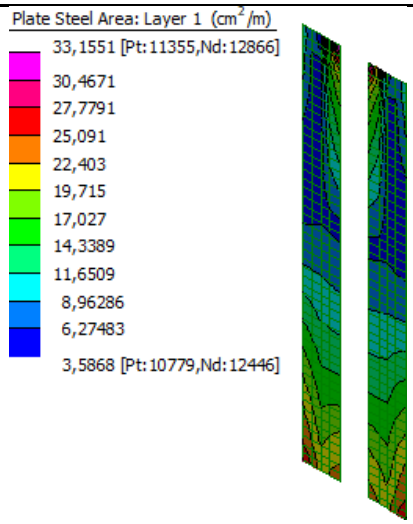
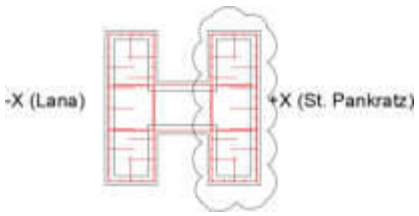
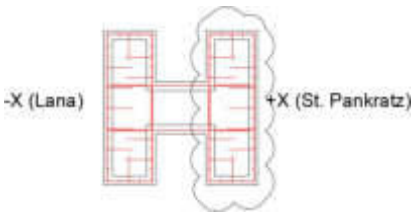
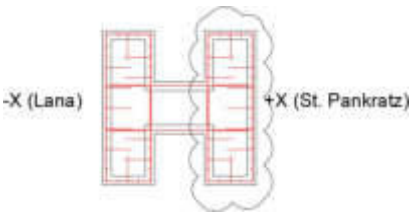
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

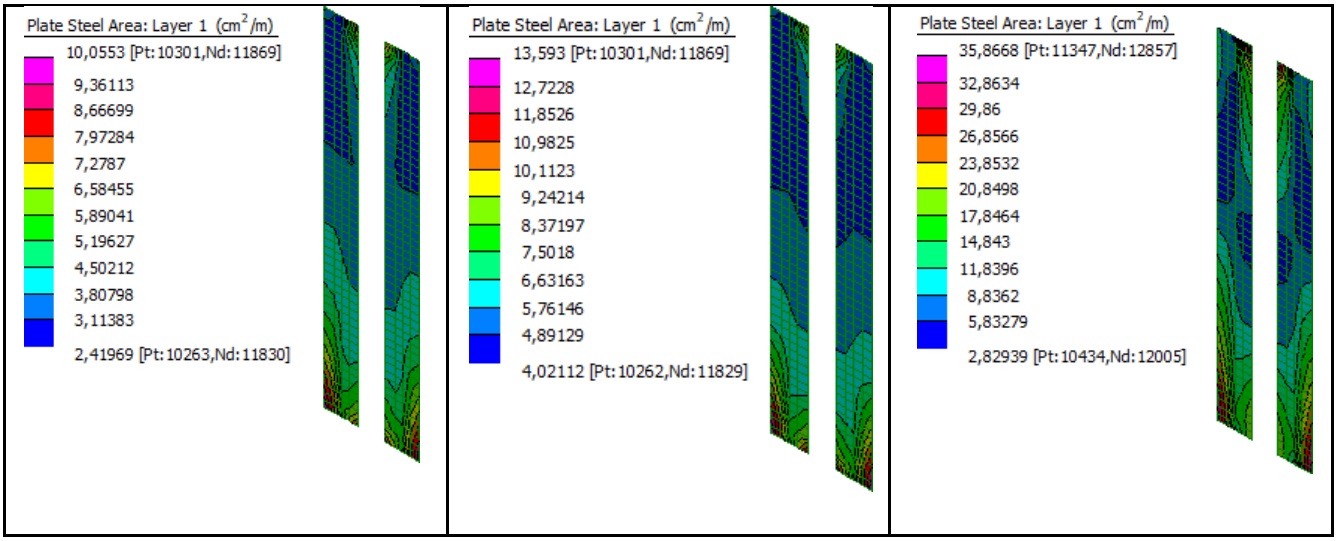
Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 3,9MN / (2,26m*0,76m) = 2,3MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.3.13 Pfeiler Achse 12

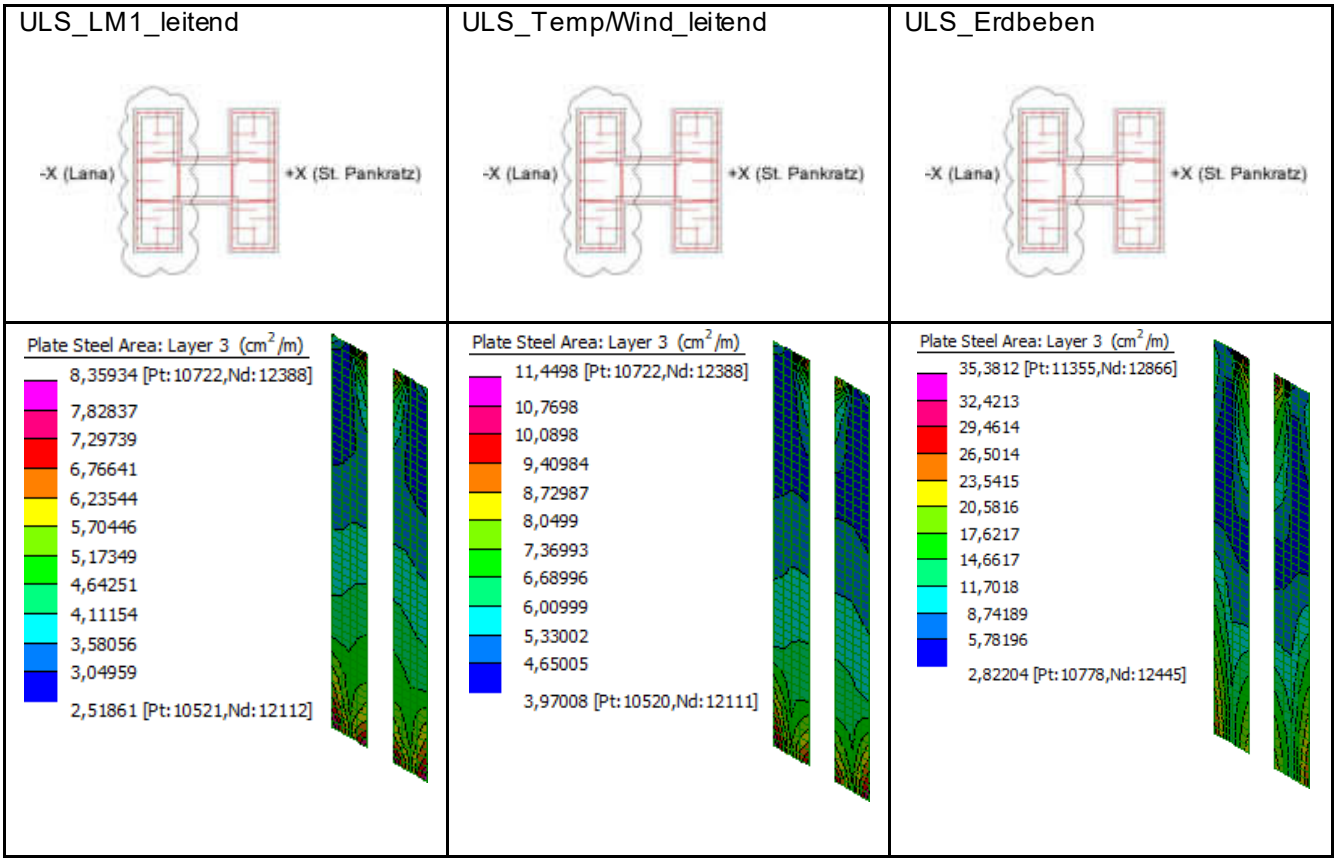
Automatische Berechnung der erforderlichen Bewehrung (ULS):

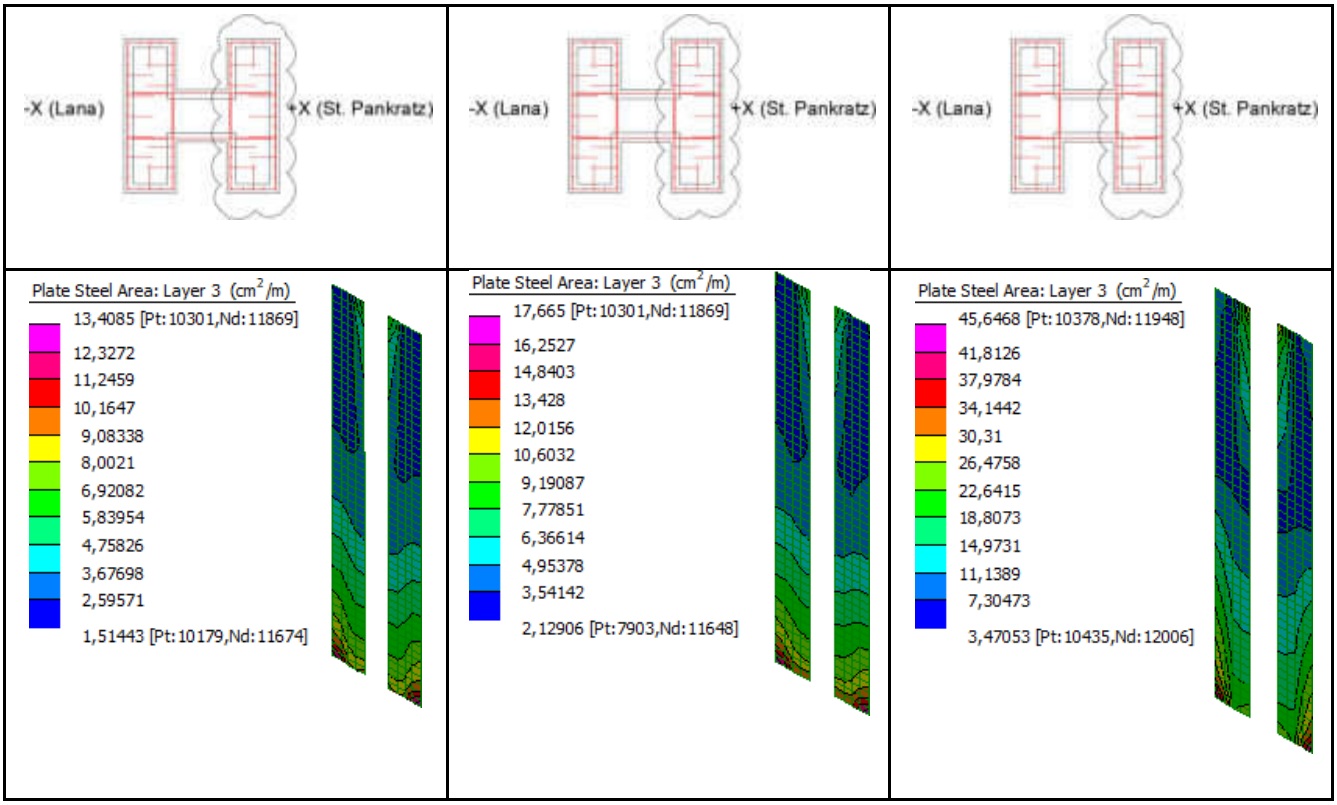
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		
		
		

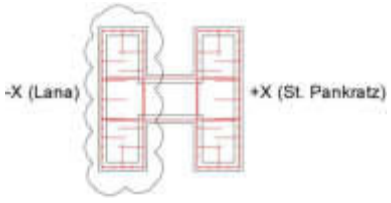
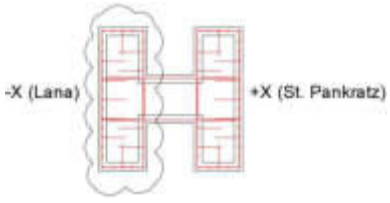
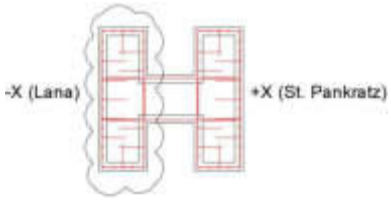


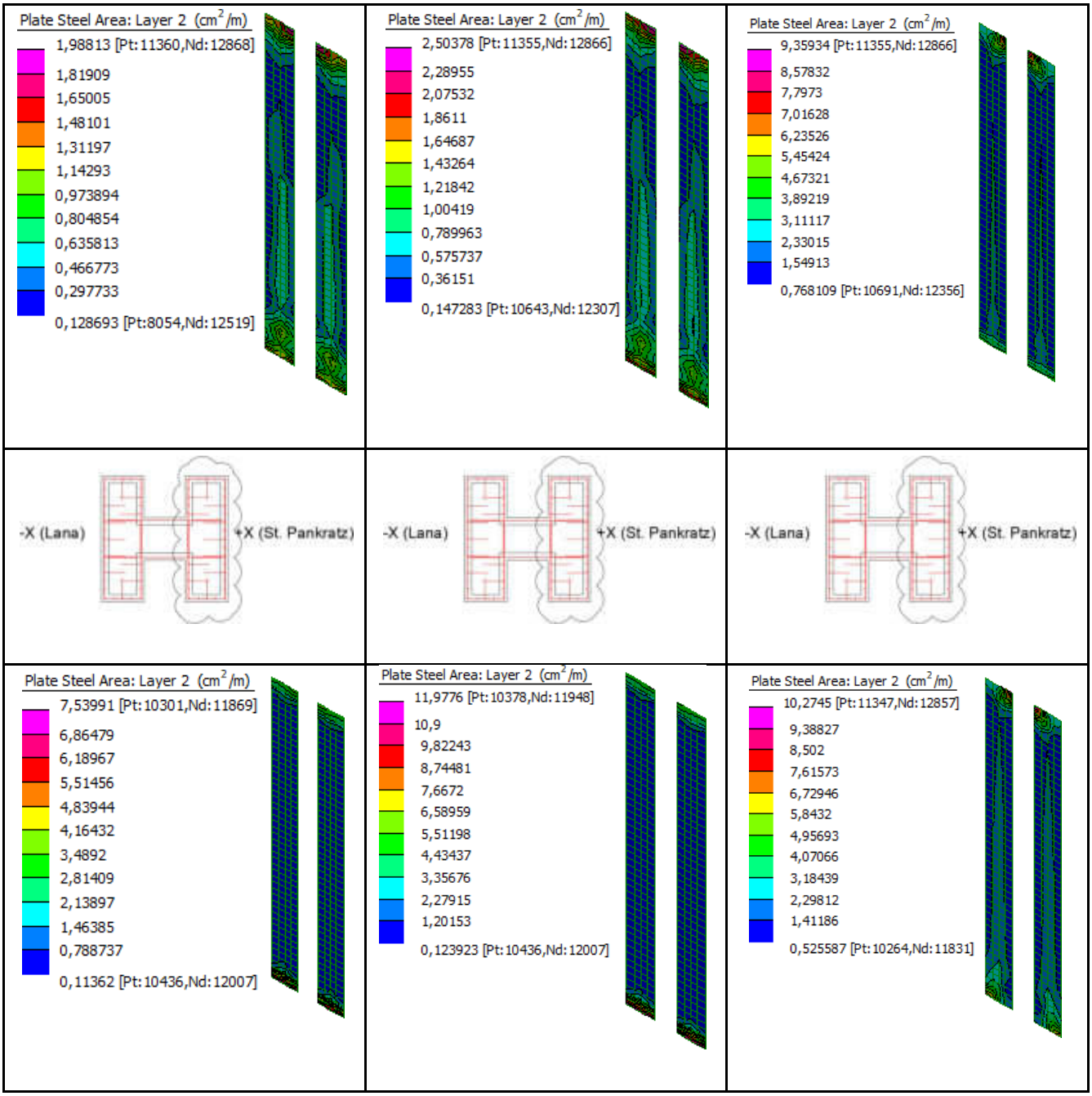
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:





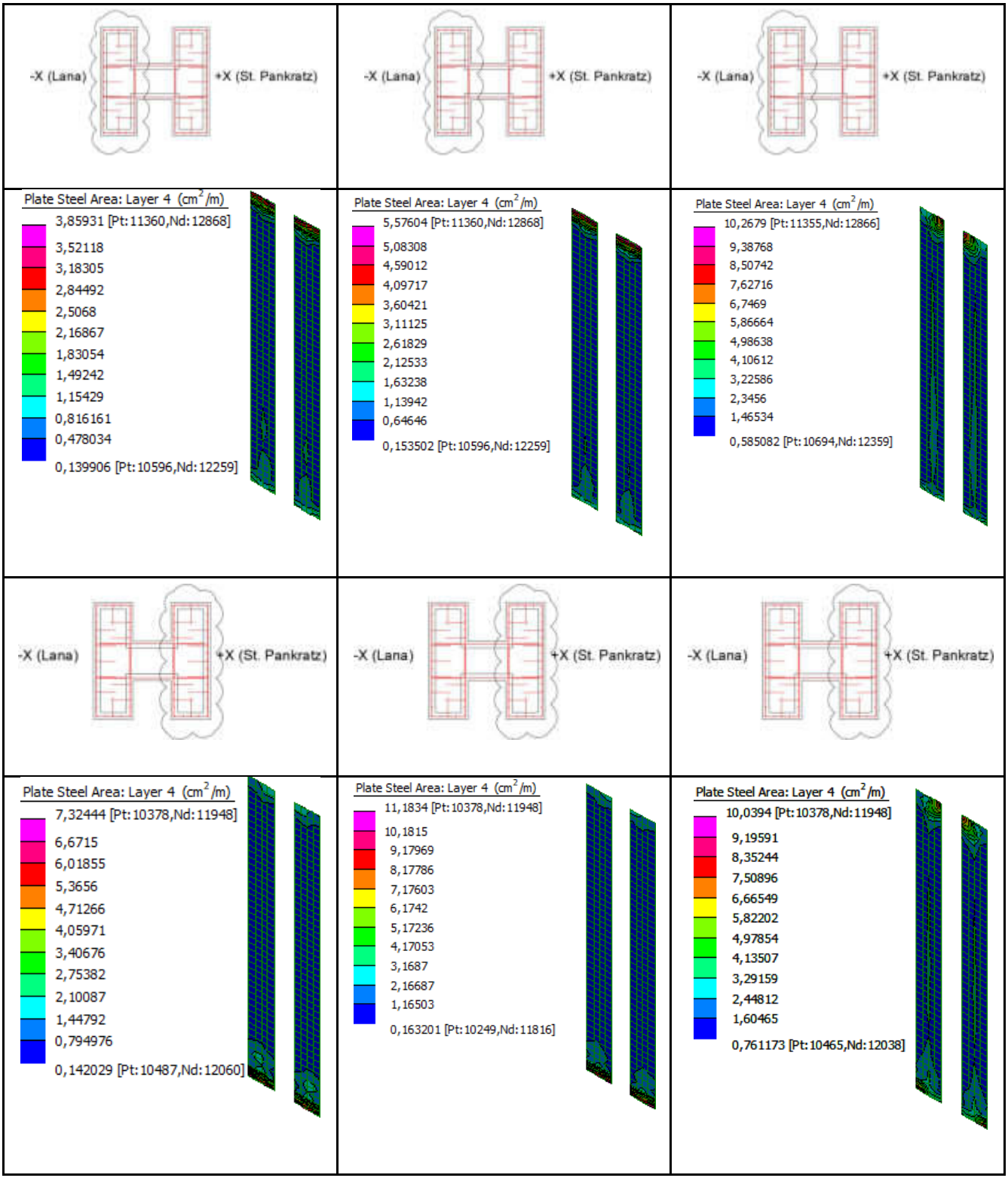
Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

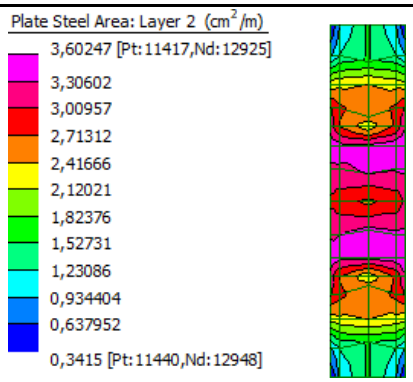
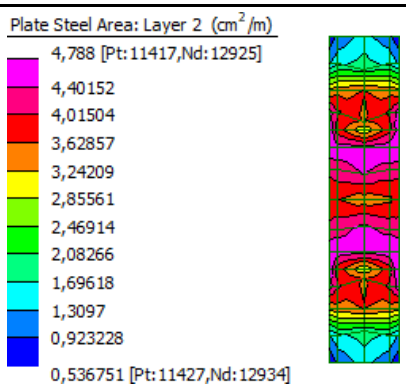
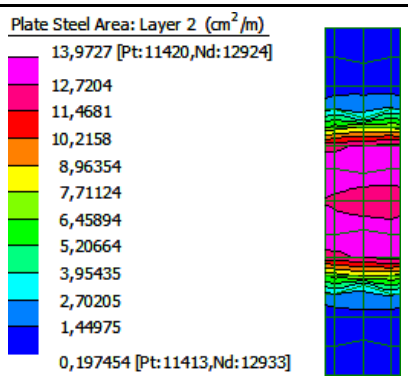


Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

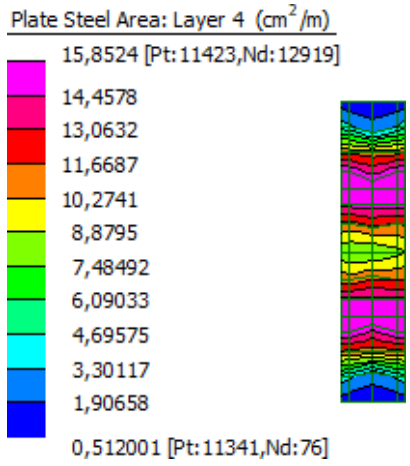
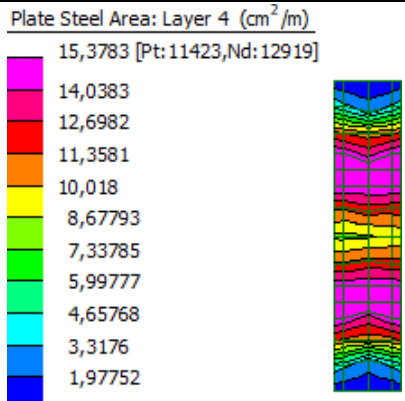
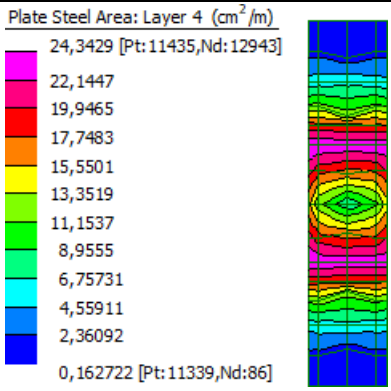
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben


-X (Lana)
+X (St. Pankratz)
Plate Steel Area: Layer 4 (cm²/m)
3,85931 [Pt:11360,Nd:12868]
3,52118
3,18305
2,84492
2,5068
2,16867
1,83054
1,49242
1,15429
0,816161
0,478034
0,139906 [Pt:10596,Nd:12259]
Plate Steel Area: Layer 4 (cm²/m)
5,57604 [Pt:11360,Nd:12868]
5,08308
4,59012
4,09717
3,60421
3,11125
2,61829
2,12533
1,63238
1,13942
0,64646
0,153502 [Pt:10596,Nd:12259]
Plate Steel Area: Layer 4 (cm²/m)
10,2679 [Pt:11355,Nd:12866]
9,38768
8,50742
7,62716
6,7469
5,86664
4,98638
4,10612
3,22586
2,3456
1,46534
0,585082 [Pt:10694,Nd:12359]
-X (Lana)
+X (St. Pankratz)
Plate Steel Area: Layer 4 (cm²/m)
7,32444 [Pt:10378,Nd:11948]
6,6715
6,01855
5,3656
4,71266
4,05971
3,40676
2,75382
2,10087
1,44792
0,794976
0,142029 [Pt:10487,Nd:12060]
Plate Steel Area: Layer 4 (cm²/m)
11,1834 [Pt:10378,Nd:11948]
10,1815
9,17969
8,17786
7,17603
6,1742
5,17236
4,17053
3,1687
2,16687
1,16503
0,163201 [Pt:10249,Nd:11816]
Plate Steel Area: Layer 4 (cm²/m)
10,0394 [Pt:10378,Nd:11948]
9,19591
8,35244
7,50896
6,66549
5,82202
4,97854
4,13507
3,29159
2,44812
1,60465
0,761173 [Pt:10465,Nd:12038]

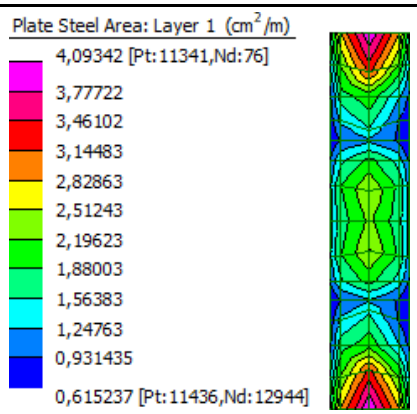
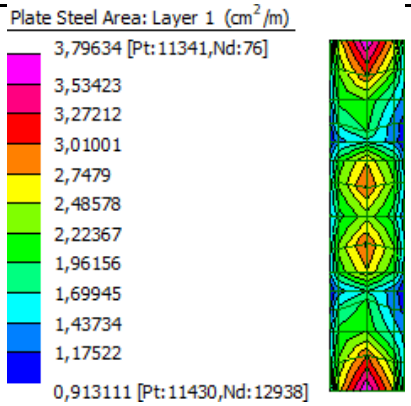
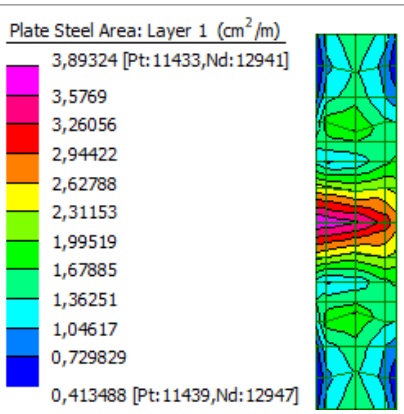
Erforderliche untere Bewehrung in Brückenquerrichtung Pfeilerkopf Achse 12

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

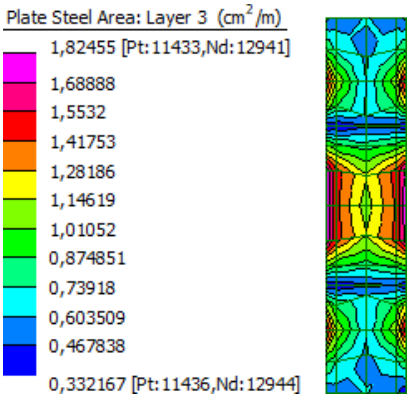
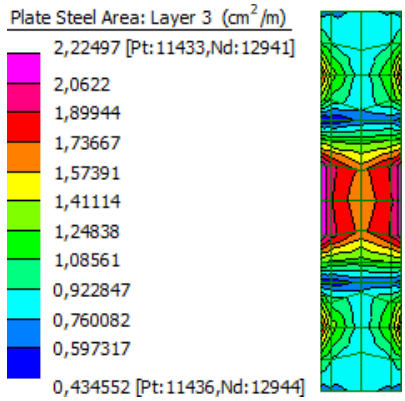
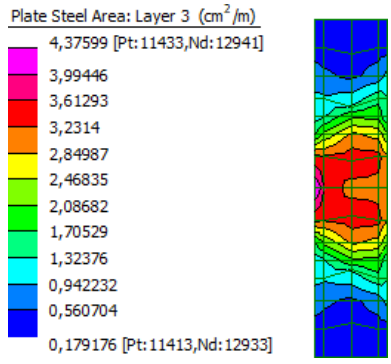
Erforderliche obere Bewehrung in Brückenquerrichtung Pfeilerkopf Achse 12

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche untere Bewehrung in Brückenlängsrichtung Pfeilerkopf Achse 12

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche obere Bewehrung in Brückenlängsrichtung Pfeilerkopf Achse 12

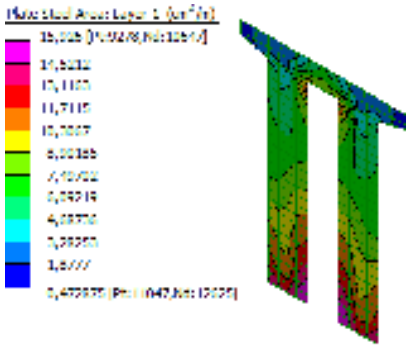
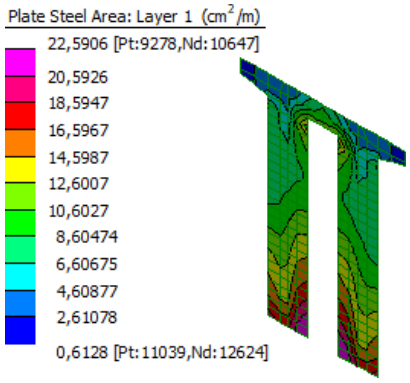
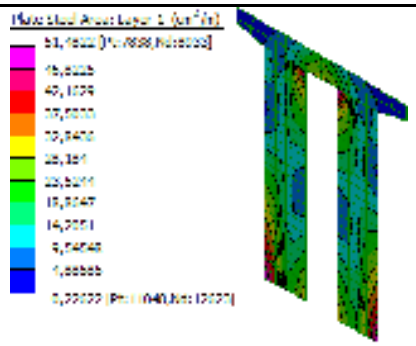
ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

3.3.14 Pfeiler Achse 13

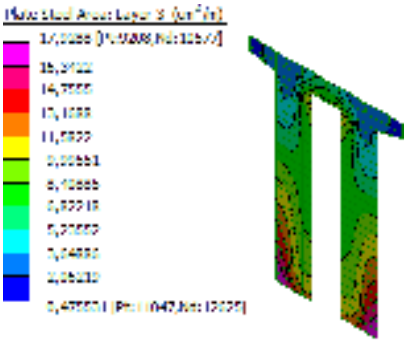
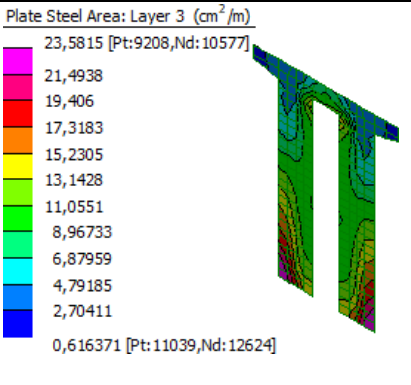
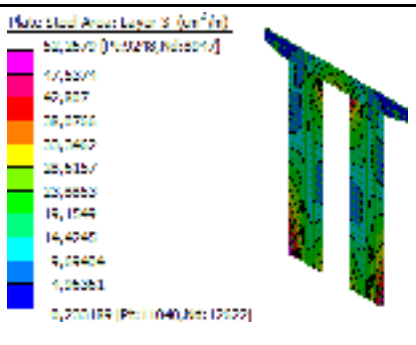
Siehe auch Kapitel „Stabilitätsnachweise Pfeiler und Stiele“ in Anlage.

Automatische Berechnung der erforderlichen Bewehrung (ULS):

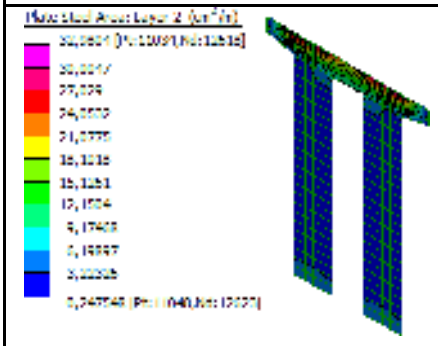
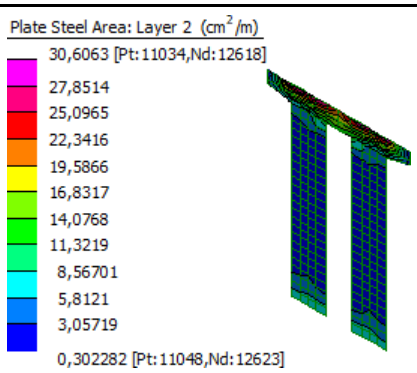
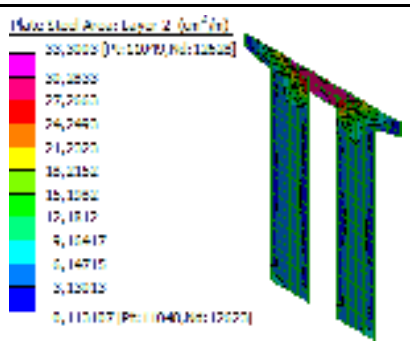
Erforderliche vertikale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

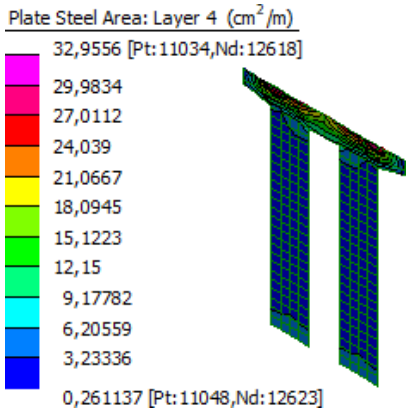
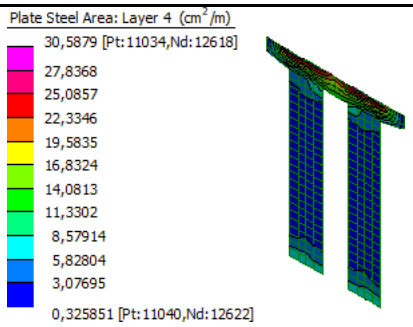
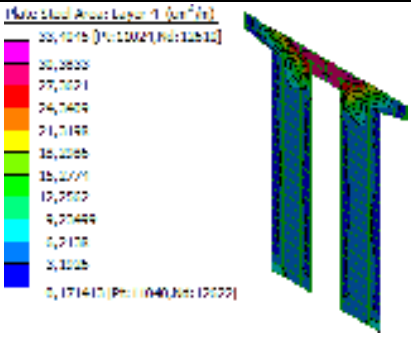
Erforderliche vertikale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite Lana:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Erforderliche horizontale Bewehrung ULS auf der Seite St. Pankraz:

ULS_LM1_leitend	ULS_Temp/Wind_leitend	ULS_Erdbeben
		

Maximaler Druck der auf den Bestandsquerschnitt wirkt: σ = Nsd_ges/A_ges = 5,7MN / (2,26m*0,76m) = 3,3MPa < f_cd=11,8MPa -> Nachweis erfüllt

3.4 Bogen

3.4.1 Bewehrung und Längs- und Querrichtung

Die Bemessung erfolgt automatisch, siehe Isolinien in Anlage.

3.4.2 Querkraft

Der geringste Druck (ULS) im Scheitelbereich beträgt ca. 1,33MPa.

Die Querschnittshöhe beträgt ca. 1,5m.

Bemessung auf Querkraft				
d	bw	Nsd	Asl (logitud.)	fck
[m]	[m]	[MN]	[m2]	[MPa]
1,40	1,00	2,000	0,00300	30,00
k	sigma_cp	rho1		
[]	[]	[]		
1,37796	1,42857	0,00214		
V_Rd_1_ senza armatura a taglio				
[MN]				
0,734				

In allen Bereichen wo die Schubspannung 0,734MN/1,5m = 0,49MPa nicht überschreitet ist keine Querkraftbewehrung erforderlich.

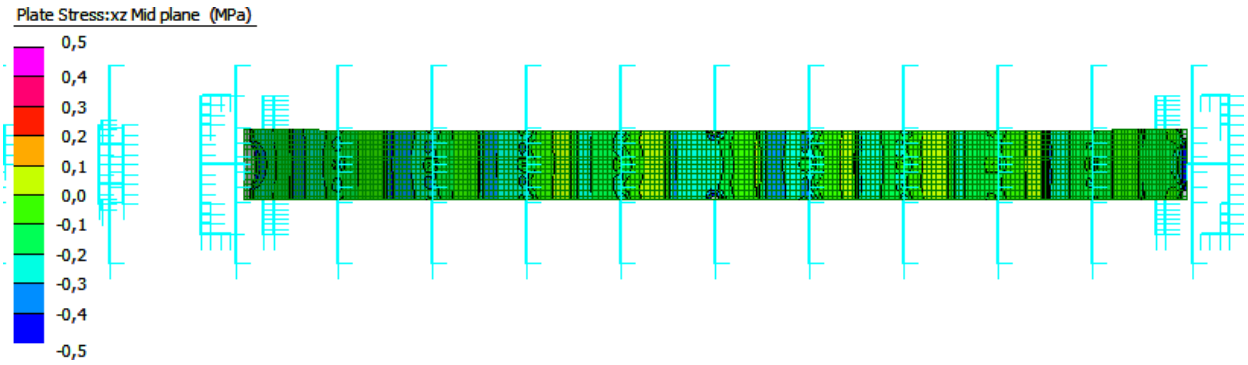
Der geringste Druck (ULS) im Kämpferbereich beträgt ca. 1,74MPa.

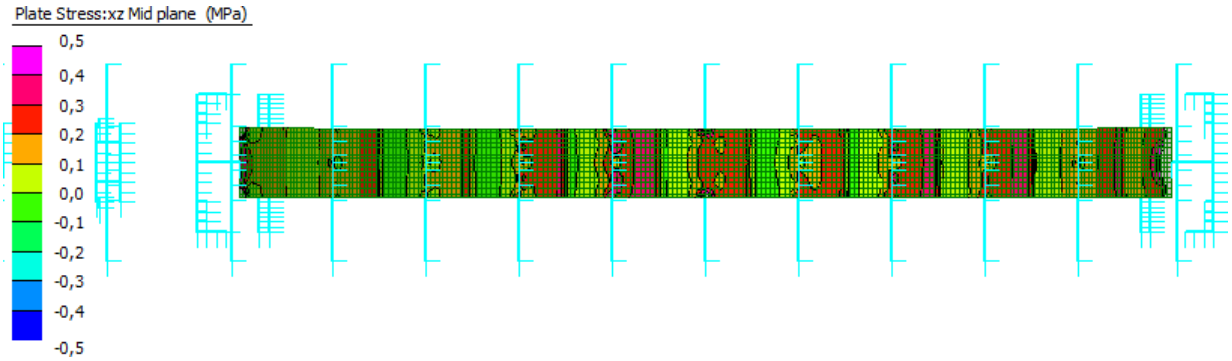
Die Querschnittshöhe beträgt ca. 2,3m.

Bemessung auf Querkraft				
d	bw	Nsd	Asl (logitud.)	fck
[m]	[m]	[MN]	[m2]	[MPa]
2,20	1,00	4,000	0,00300	30,00
k	sigma_cp	rho1		
[]	[]	[]		
1,30151	1,81818	0,00136		
V_Rd_1_ senza armatura a taglio				
[MN]				
1,226				

In allen Bereichen wo die Schubspannung 1,226MN/2,3m = 0,53MPa nicht überschreitet ist keine Querkraftbewehrung erforderlich.

Isolinien min/max. Envelope Schubspannungen (ULS):





3.4.3 Erforderliche Rückhängebewehrung Aufgrund Umlenkkraft Längsbewehrung bzw. Zug im Beton

Vorhandene Längsbewehrung Bogenverstärkung Untersicht: ca. 40d30 mit A_s = 282,7cm²

Maximale Längskraft in der Bewehrung F_max1 = A_s*fyd = 282,7cm²*39,13kN/cm² = 11.062,1kN

Maximale Längskraft Aufgrund Schwinden Ergänzungsbeton. Es wird die mittlere Betonzugfestigkeit angesetzt:

F_max2 = 2,9MPa*0,2m*7,4m*1000 = 4.292,0kN < F_max1

Berechnung der Umlenkkraft: u_sd=1/r*F = 1/60m*11.062,1kN = 184,4kN/m

Vorhandene Rückhängebewehrung: 12d20/60+2d16/15 mit a_s = 89,6cm²/m

Aufgrund des reduzierten Übergriffs wird übertragbare Kraft auf 50% reduziert.

Umlenkwiderstand u_rd = 89,6cm²/m*50%*39,13kN/cm² = 1753,0kN

Nachweis u_rd > u_sd erfüllt.

3.5 Randbalken

3.5.1 Bemessung Randbalken

Leitplanke H3

Steher HEA 100 im Abstand von 1,33m

Mitte Band in 0,60m Höhe ober OK Fahrbahn

Mitte Band in 0,45m Höhe ober OK Randbalken

Plastisches Moment am Steherfuß M_pl = f_yk*W_pl = 35,5kN/cm²*83,0cm³*1/100 = 29,5kNm -> m = 22,2kNm/m

Horizontale Kraft F = 29,5kNm/0,45m = 65,5kN -> f = 49,3kN/m

<u>Innere Reihe Einzeldübel:</u>

Innere Hebelarm: 1,15m

Dübelkraft F_sd = (22,2kNm/m+49,3kN/m*0,30m)/1,15m = 32,2kN/m = 9,66kN/Dübel bei Dübelabstand 30cm -> OK

<u>Äußere Reihe Einzeldübel:</u>

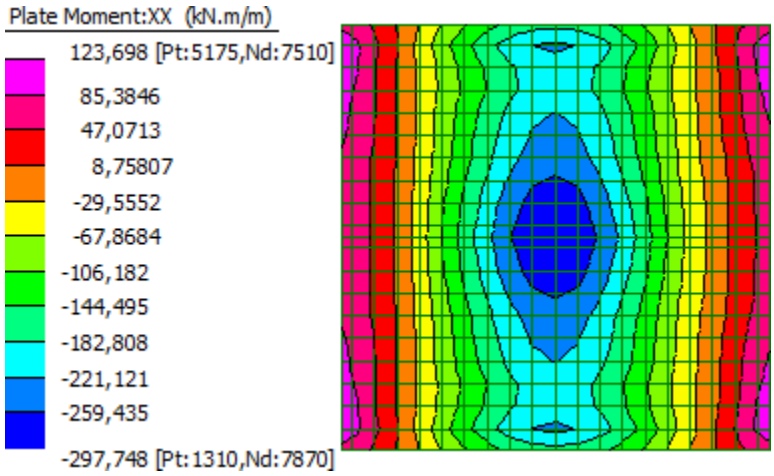
Gewählter Dübelabstand 60cm

4. Nachweise im Grenzzustand der Gebrauchstauglichkeit

4.1 Fahrbahnplatte

4.1.1 Rissbreite in Feldmitte im Bereich mit reduzierter Querschnittshöhe

Feld im Bogenbereich mit 9,5m Spannweite, Größtes Feldmoment in Feldmitte SLS - Häufige Kombination:



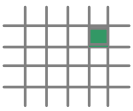
Innerer Hebelarm im Bereich des größten Biegemoments ca. 0,35m.

Vorhandene Bewehrung: 2d30/30 -> a_s = 47,1cm²/m

Spannung in der Bewehrung: 297,7kNm / (0,35m*47,1cm²/m)*10 = 180,6MPa

Berechnung der Rissbreite nach EN 1992-1-1 (D) (Ausgabe 01.11.2005)
Kapitel 7.3.4

Charakteristische Rissbreite w_k	
w_k = s_r,max*(ε_sm-ε_cm) =	0,00023 m
Maximale Rissabstand s_r,max	
s_r,max = k3*c+k1*k2*k4*ϕ/ρ_p,eff	0,4004 m
(ε_sm-ε_cm) =(σ_s - kt*f_ct,eff/ρ_p,eff*(1+α_e*ρ_p,eff))/E_s	0,0006
oder (e_sm-e_cm) = 0,6*σ_s/E_s =	0,0005
	0,0006
Landesspezifischer Wert k3 =	3,4000

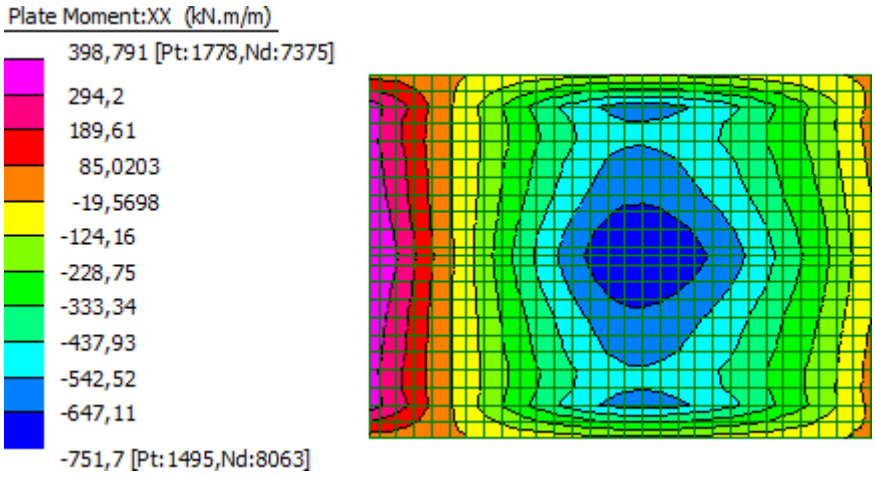


Betondeckung bezonden auf die Längsbewehrung c=	0,0700	m
Beiwert zur Brücksichtigung der Verbundeigenschaften der Bewehrung k1 =	0,8000	
Beiwert zur Berücksichtigung der Dehnungsverteilung k2 =	0,5000	
Landesspezifischer Wert k4 =	0,4250	
Stabdurchmesser ϕ	0,0300	m
$\rho\_p,eff = A\_s / A\_c,eff$	0,0314	
Querschnittsfläche des Betonstahls A_s =	0,004710	m²
Wirkungsbereich der Bewehrung Ac,eff =	0,1500	m²
Spannung in der Zugbewehrung σs =	180,6000	MPa
Faktor der von der Dauer der Lasteinwirkung abhängt kt =	0,6000	
Mittelwert der wirksamen Zugfestigkeit fct,eff (Meistens =fctm)	2,9000	MPa
Verhältnis αe = E_s/E_cm	6,0606	
E-Modul Bewehrung E_s=	200000,0000	MPa
E-Modul Beton E_cm =	33000,0000	MPa

Die Rissbreite beträgt 0,23mm < 0,3mm -> Nachweis erfüllt

4.1.2 Rissbreite in Feldmitte im Bereich mit nicht reduzierter Querschnittshöhe

Endfeld Seite St. Pankraz mit 14,25m Spannweite, Größtes Feldmoment in Feldmitte SLS - Häufige Kombination:



Innerer Hebelarm im Bereich des größten Biegemoments ca. 0,50m.

Vorhandene Bewehrung: 3d30/30 -> $a_s = 70{,}7 cm^2/m$

Spannung in der Bewehrung: 751,7kNm / (0,50m*70,7cm²/m)*10 = 212,6MPa

Berechnung der Rissbreite nach EN 1992-1-1 (D) (Ausgabe 01.11.2005)
Kapitel 7.3.4

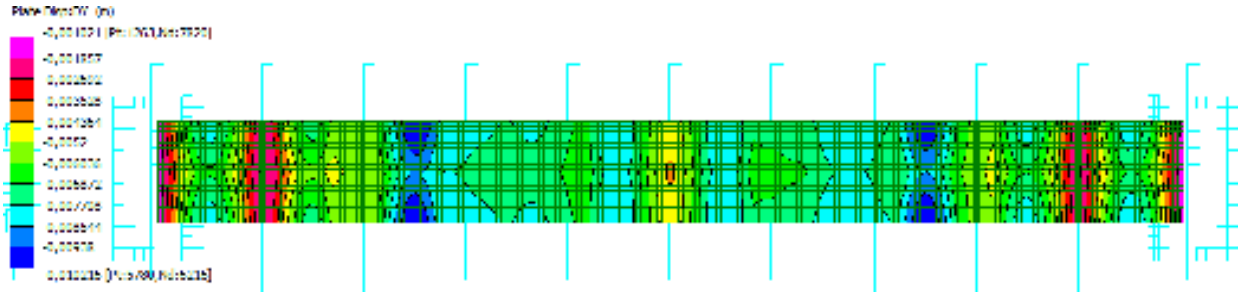
Charakteristische Rissbreite w_k		
$w_k = s_{r,max}*(\varepsilon_{sm}-\varepsilon_{cm}) =$	0,00029	m
Maximale Rissabstand $s_{r,max}$		
$s_{r,max} = k3*c+k1*k2*k4*\phi/\rho_{p,eff}$	0,3462	m
$(\varepsilon_{sm}-\varepsilon_{cm}) =(\sigma_s - kt*f_{ct,eff}/\rho_{p,eff}*(1+\alpha_e*\rho_{p,eff}))/E_s$	0,0008	
oder $(e_{sm}-e_{cm}) = 0{,}6*\sigma_s/E_s =$	0,0006	
	0,0008	
Landesspezifischer Wert k3 =	3,4000	
Betondeckung bezonden auf die Längsbewehrung c=	0,0700	m
Beiwert zur Brücksichtigung der Verbundeigenschaften der Bewehrung k1 =	0,8000	

Beiwert zur Berücksichtigung der Dehnungsverteilung k2 =	0,5000	
Landesspezifischer Wert k4 =	0,4250	
Stabdurchmesser ϕ	0,0300	m
ρ_p,eff = A_s /A_c,eff	0,0471	
Querschnittsfläche des Betonstahls A_s =	0,007070	m²
Wirkungsbereich der Bewehrung Ac,eff =	0,1500	m²
Spannung in der Zugbewehrung σs =	212,6000	MPa
Faktor der von der Dauer der Lasteinwirkung abhängt kt =	0,6000	
Mittelwert der wirksamen Zugfestigkeit fct,eff (Meistens =fctm)	2,9000	MPa
Verhältnis αe = E_s/E_cm	6,0606	
E-Modul Bewehrung E_s=	200000,0000	MPa
E-Modul Beton E_cm =	33000,0000	MPa

Die Rissbreite beträgt 0,29mm < 0,3mm -> Nachweis erfüllt

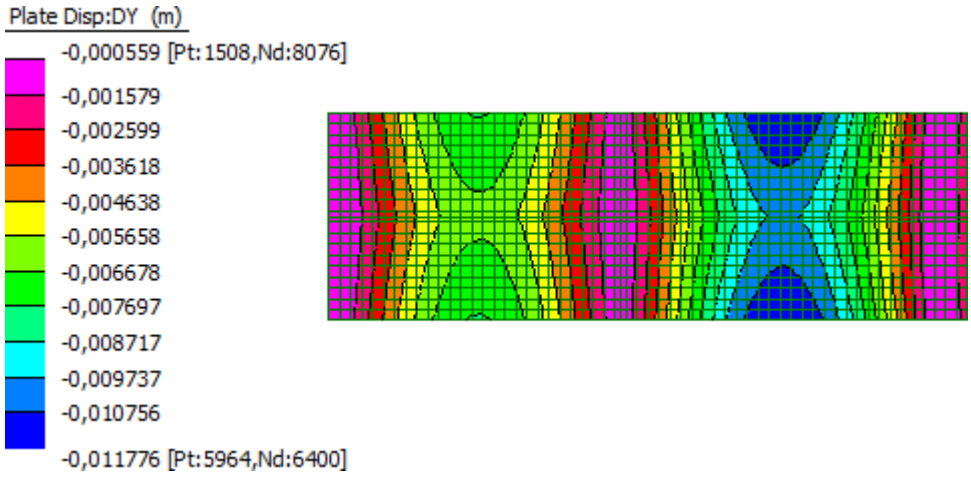
4.1.3 Durchbiegung im Bereich mit reduzierter Querschnittshöhe

Feld 4 bis 13: Die maximale Kurzzeitdurchbiegung aus Verkehrslasten (Häufige Kombination mit E*I im Zustand 1) beträgt 0,0102m -> Entspricht l(=9,5m)/931

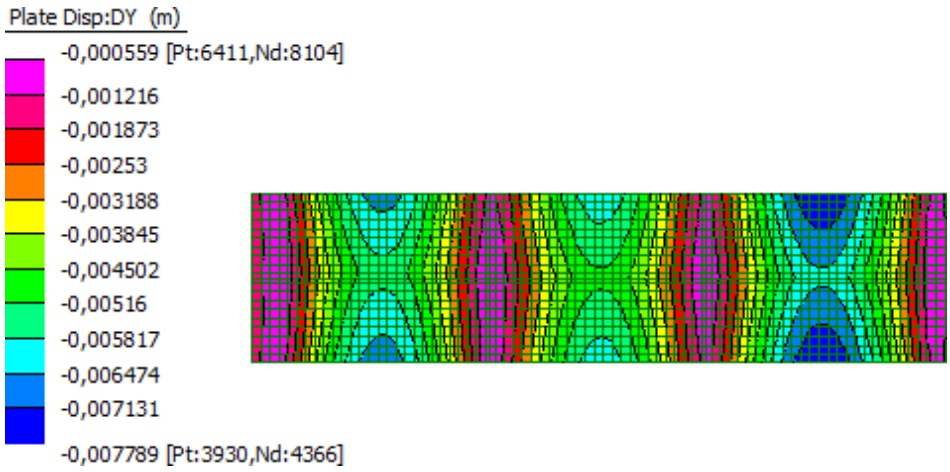


4.1.4 Durchbiegung im Bereich mit nicht reduzierter Querschnittshöhe

Feld 14 und 15: Die maximale Kurzzeitdurchbiegung aus Verkehrslasten (Häufige Kombination mit E*I im Zustand 1) beträgt 0,0118m -> Entspricht l(=14,25m)/1208



Feld 1,2,3: Die maximale Kurzzeitdurchbiegung aus Verkehrslasten (Häufige Kombination mit E*I im Zustand 1) beträgt 0,0078m -> Entspricht l(=12,75m)/1634



4.2 Pfeiler - Schwinden

Der Ergänzungsbeton der Pfeiler schwindet. Durch Kriechen baut sich ein Teil der Schwindspannungen ab. Vereinfachend kann die Schwindverkürzung mit ca. -15K angenommen werden.

Durch das Schwinden verkürzt sich auch der Querschnitt der Bestandspfeiler. Somit reduziert sich die Zugspannung im Ergänzungsbeton um ca. 42% (Verhältnis Querschnittsfläche Ergänzungsbeton zu Gesamtquerschnittsfläche = 0,71mq/1,71mq).

Durch die Auflast (Eigengewicht Fahrbahnplatte und permanente Auflast) des neuen Tragwerks erhält der Gesamtquerschnitt einen Druck. Die mittlere Druckspannung beträgt bei den Stielen im Bogenbereich (100,5kN/m+78,0kN/m)*9,5m / (2*2,26m*0,76m) *1/1000 = 0,49MPa

Die mittlere Zugspannung im Ergänzungsbeton beträgt 15K*(100%-42%)*30.000MPa*0,00001-0,49MPa = 2,12MPa. Dieser Wert ist kleiner als die mittlere Zugfestigkeit des Betons.

Die mittlere Zugkraft im Ergänzungsbeton beträgt: F_V,sd = 2,12MPa*0,71mq = 1,51MN = 1510kN

Diese Kraft wird über Verdübelung, Anschlussbewehrung und Rauigkeit der Fuge Alt/Neu übertragen.

Nachweis laut Eurocode 1992-1-1:2004 Kapitel 6.2.5:

Eingeklebte Anschlussbewehrung im 60cm breiten Streifen im Beriech Stützenfuß und am oberen Ende 4*13d16 -> A_s = 104,6cm²

F_V,rd = A_s*f_yd*μ*sin(α)+cos(α) = 104,6cm²*45,0kN/cm²*0,5 (Verhältnis Einklebelänge/Verankerugnslänge)*0,7*sin(90°)+cos(90°) = 1647,5kN

Nachweis: F_V,sd < F_V,rd -> Nachweis erfüllt.

4.3 Bogen - Schwinden

Der Ergänzungsbeton des Bogens schwindet. Durch Kriechen baut sich ein Teil der Schwindspannungen ab. Vereinfachend kann die Schwindverkürzung mit ca. -15K angenommen werden.

Durch das Schwinden verkürzt sich auch der Querschnitt des Bestandsbogens. Somit reduziert sich die Zugspannung im Ergänzungsbeton um ca. 75% (Dies entspricht dem Verhältnis der Querschnittsfläche des Ergänzungsbetons zur Gesamtquerschnittsfläche).

Durch die Mehrauflast aus der schwereren Fahrbahnplatte und den größeren permanenten Auflasten des neuen Tragwerks erhält der Gesamtquerschnitt eine größere Druckkraft, bzw. Erhöhung der Druckspannung um ca. 0,4MPa.

Die mittlere Zugspannung im Ergänzungsbeton beträgt 15K*(100%-75%)*30.000MPa*0,00001-0,4MPa = 0,72MPa. Dieser Wert ist viel kleiner als die mittlere Zugfestigkeit des Betons.

Die mittlere Zugkraft im Ergänzungsbeton auf der Unterseite des Bognes beträgt: F_sd = 0,72MPa*0,2m*7,4m = 1,07MN = 1070kN

Diese Kraft wird über Anschlussbewehrung zum neuen Fundament übertragen.

Erforderliche Anschlussbewehrung Unterseite Bogen: A_s,erf = F_sd/fyd = 1070,0kN/39,13kN/cm² = 27,3cm².

Vorhandene Anschlussbewehrung Unterseite Bogen: 64d30 -> A_s,vorh = 452,4cm²

Nachweis: A_s,vorh > A_s,erf -> Nachweis erfüllt.

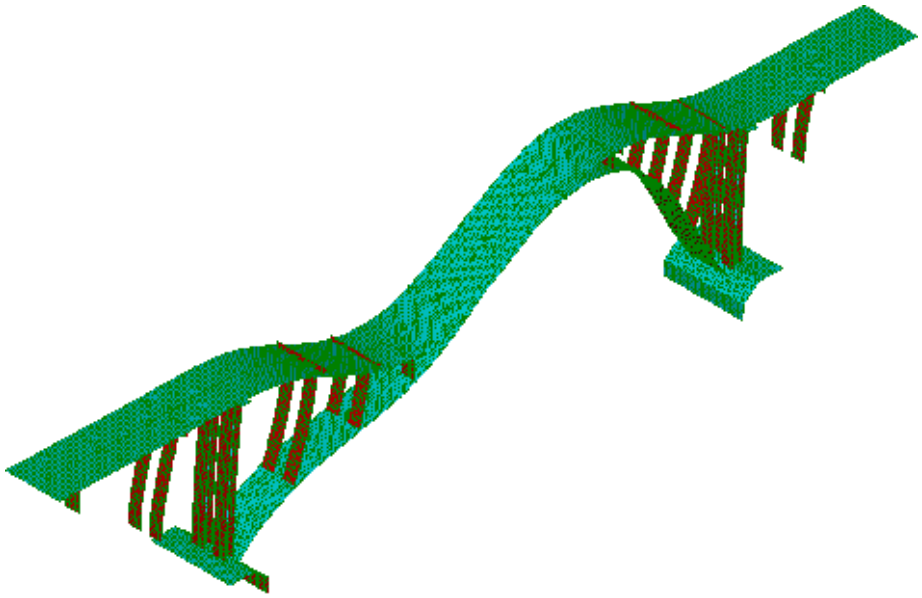
Aufgrund der Ähnlichkeit sind die weitern Bereiche (Ergänzungsbeton Oberseite Bogen, Hohlzellen, usw.) ebenfalls nachgewiesen.

4.4 Eigenfrequenzen

Es werden nur Eigenfrequenzen mit mehr als 5% Massenbeteiligung aufgelistet.

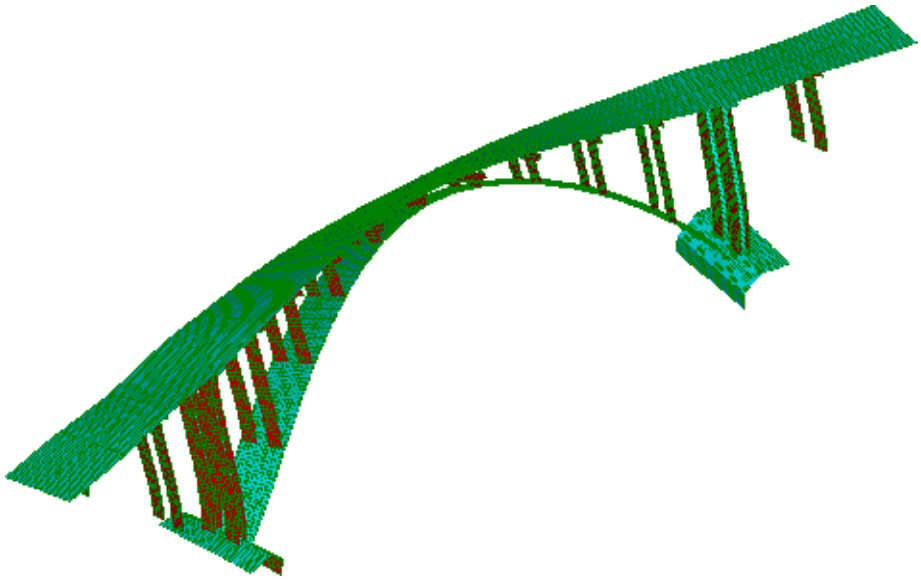
4.4.1 Eigenfrequenz 1,07Hz

Massenbeteiligung: 32,9% in X 0,0% in Y 0,0% in Z



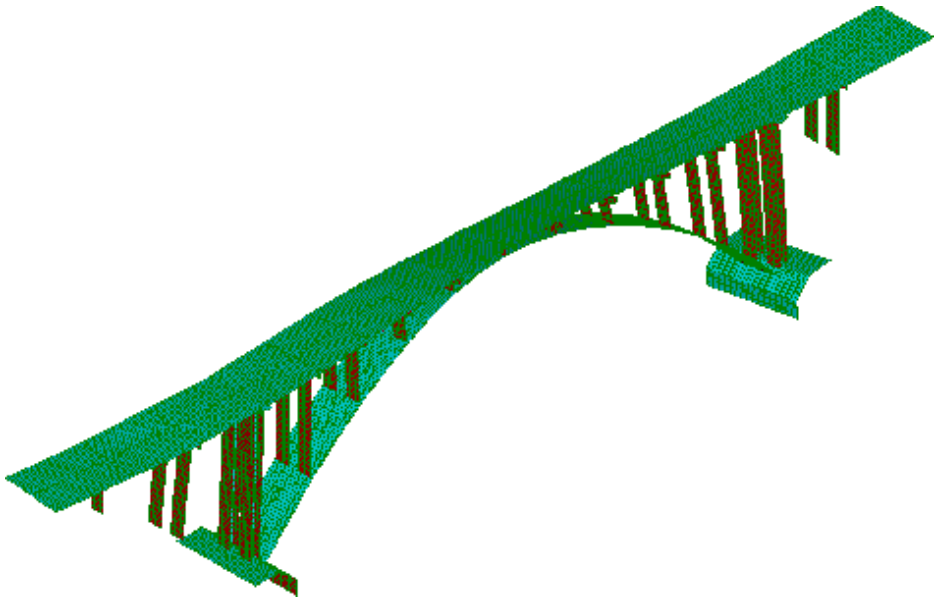
4.4.2 Eigenfrequenz 1,10Hz

Massenbeteiligung: 0,0% in X 0,0% in Y 68,1% in Z



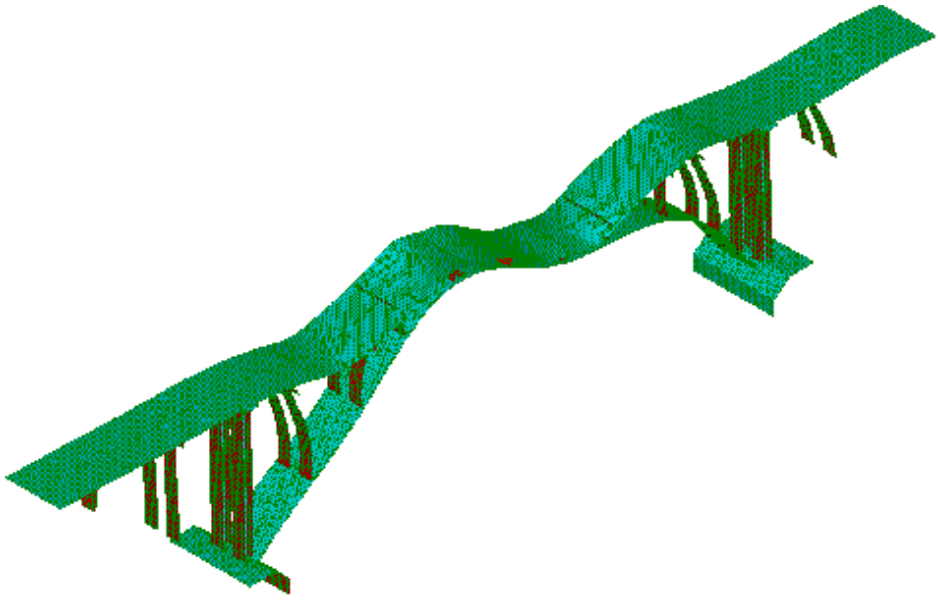
4.4.3 Eigenfrequenz 3,42Hz

Massenbeteiligung: 0,0% in X 0,0% in Y 19,5% in Z



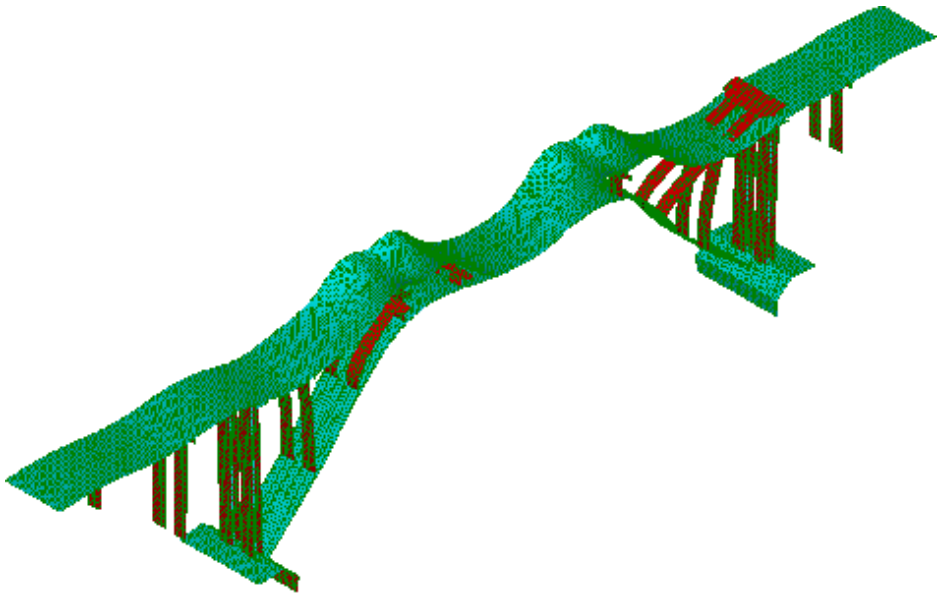
4.4.4 Eigenfrequenz 3,50Hz

Massenbeteiligung: 10,6% in X 0,0% in Y 0,0% in Z



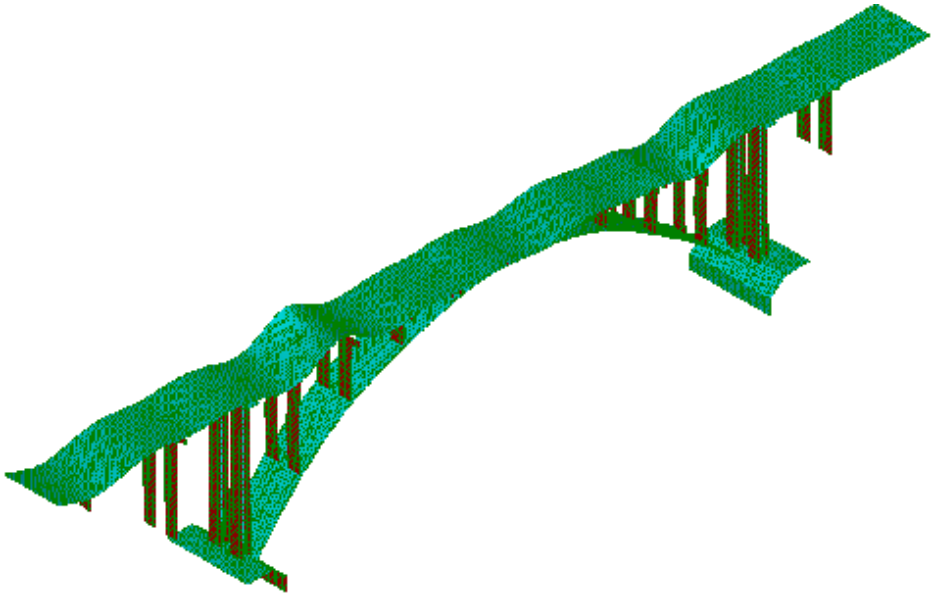
4.4.5 Eigenfrequenz 4,45Hz

Massenbeteiligung: 0,0% in X 11,2% in Y 0,0% in Z



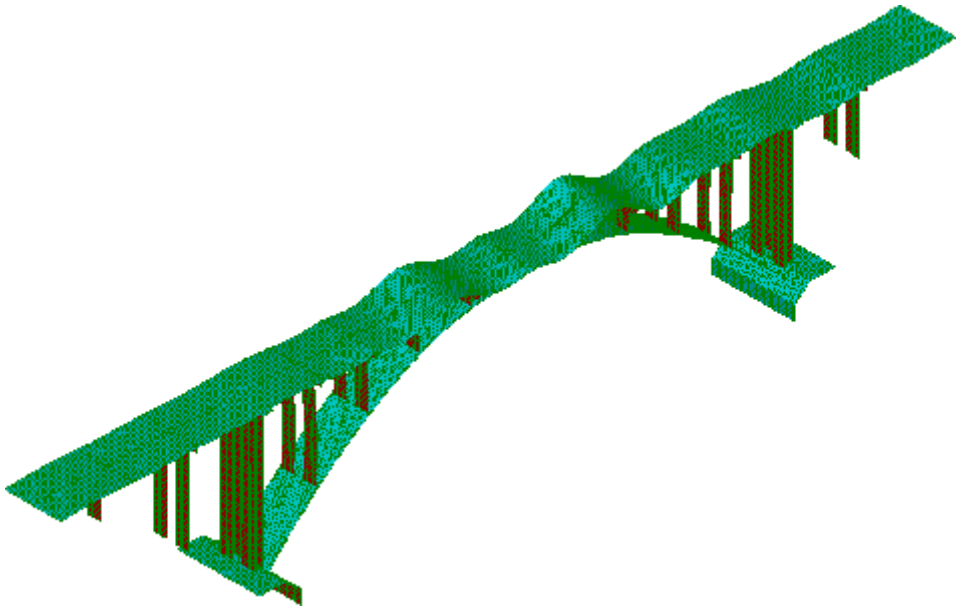
4.4.6 Eigenfrequenz 5,46Hz

Massenbeteiligung: 11,2% in X 0,0% in Y 0,0% in Z



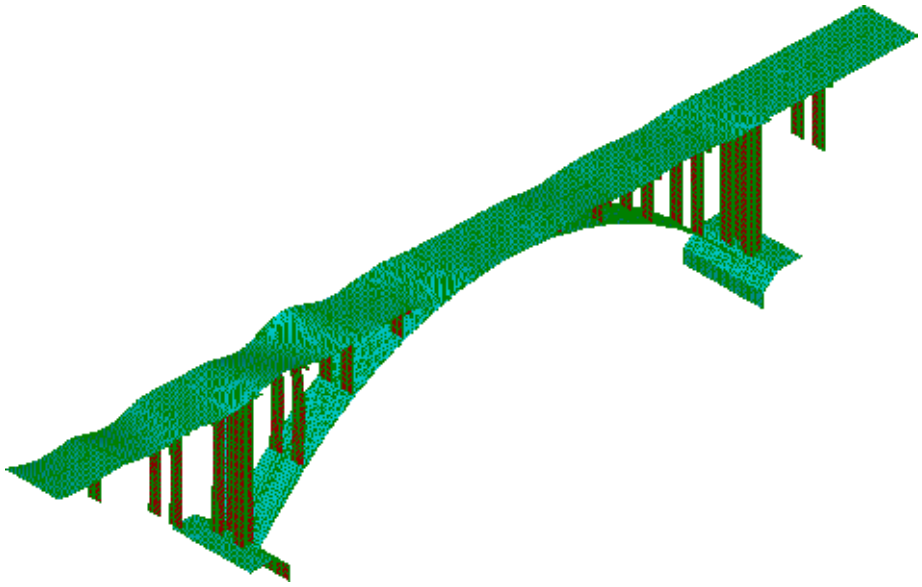
4.4.7 Eigenfrequenz 5,76Hz

Massenbeteiligung: 0,1% in X 10,4% in Y 0,0% in Z



4.4.8 Eigenfrequenz 7,41Hz

Massenbeteiligung: 0,3% in X 5,5% in Y 0,0% in Z



5. Anlagen

5.1 Erforderliche Bewehrung und Schnittgrößen Bogen

5.2 Erforderliche Bewehrung und Schnittgrößen Fahrbahnplatte

5.3 Erforderliche Bewehrung und Schnittgrößen Kämpferfundament

5.4 Weitere Schnittgrößen bei Pfeiler und Stiele

5.5 Pfahlkräfte Mikropfähle

5.6 Geotechnische Nachweise

5.7 Nachweise Widerlager St. Pankraz

5.8 Nachweise Widerlager Lana

5.9 Parameter Studie

5.10 Stabilitätsnachweise Pfeiler und Stiele

5.11 Materialprüfungen Bestandsbauwerk

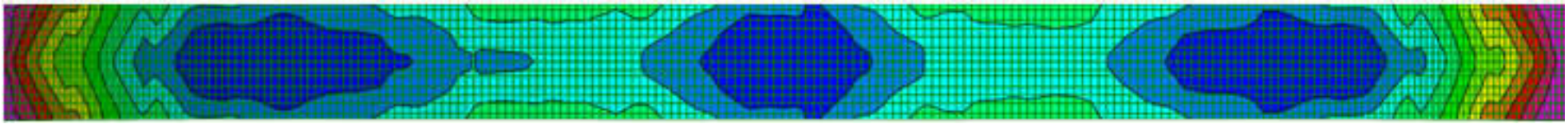
5.12 Validierung Software

5.1 Erforderliche Bewehrung und Schnittgrößen Bogen

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

48,0873 [Pt:11754,Nd:13303]
44,8869
41,6866
38,4862
35,2859
32,0855
28,8852
25,6849
22,4845
19,2842
16,0838
12,8835 [Pt:13044,Nd:14724]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

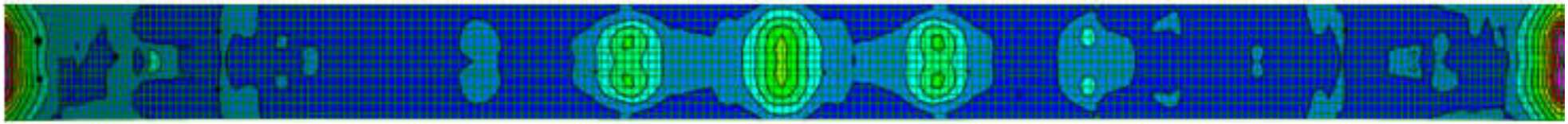
ULS_LM1 leitend_Erforderliche obere Bewehrung in Längsrichtung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 8:31 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

16,3481 [Pt:11730,Nd:13279]
15,0548
13,7616
12,4683
11,1751
9,8818
8,58855
7,2953
6,00205
4,7088
3,41554
2,12229 [Pt:12995,Nd:14630]



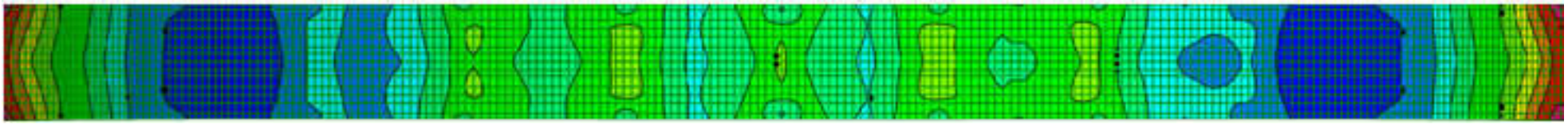
17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Erforderliche obere Bewehrung in Querrichtung Bogen

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

56,8897 [Pt:11547,Nd:13088]
52,7768
48,664
44,5512
40,4383
36,3255
32,2126
28,0998
23,987
19,8741
15,7613
11,6485 [Pt:12476,Nd:14091]



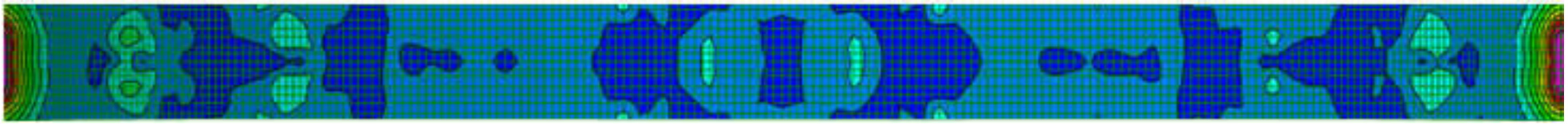
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Erforderliche untere Bewehrung in Längsrichtung Bogen

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

15,5388 [Pt:11730,Nd:13279]
14,2426
12,9465
11,6503
10,3542
9,058
7,76185
6,4657
5,16955
3,8734
2,57725
1,2811 [Pt:12143,Nd:13727]



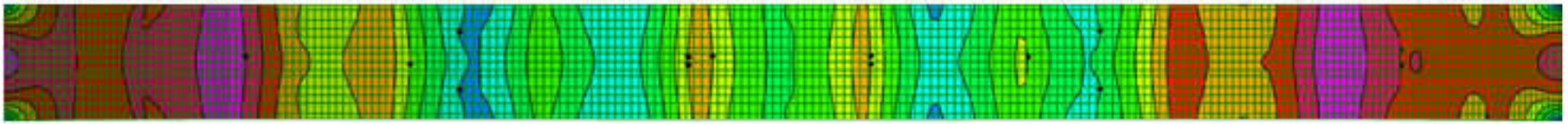
17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Erforderliche untere Bewehrung in Querrichtung Bogen

Title:	
Project:	
Author:	Reference:

Plate Stress:xx +z surface (MPa)

-3,71637 [Pt:12138,Nd:13722]
-4,44188
-5,16738
-5,89289
-6,61839
-7,3439
-8,0694
-8,79491
-9,52041
-10,2459
-10,9714 [Pt:11629,Nd:13171]



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

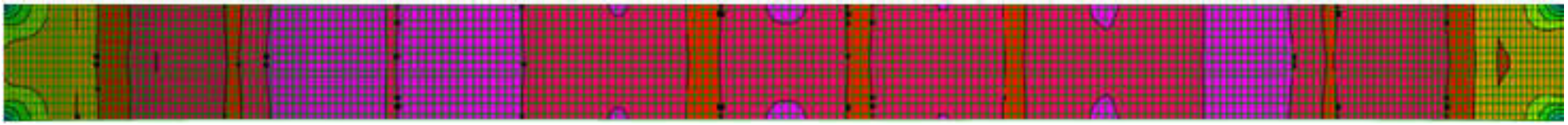
ULS_LM1 leitend_Größter Druck Oberseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:56 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx -z surface (MPa)

-4,66391 [Pt:7491,Nd:14863]
-5,7784
-6,89289
-8,00739
-9,12188
-10,2364
-11,3509
-12,4654
-13,5799
-14,6943
-15,8088 [Pt:11547,Nd:13088]

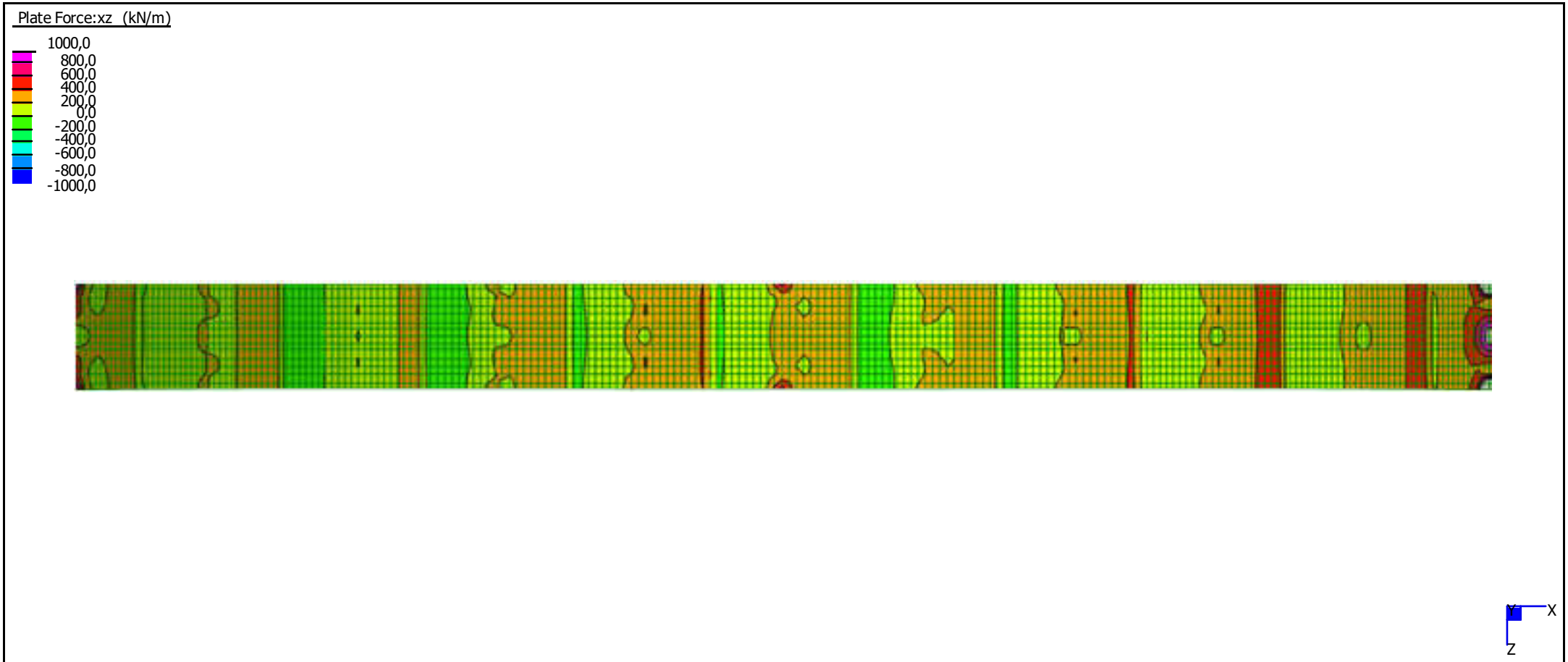


17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Größter Druck Unterseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:54 am

Title:	
Project:	
Author:	Reference:

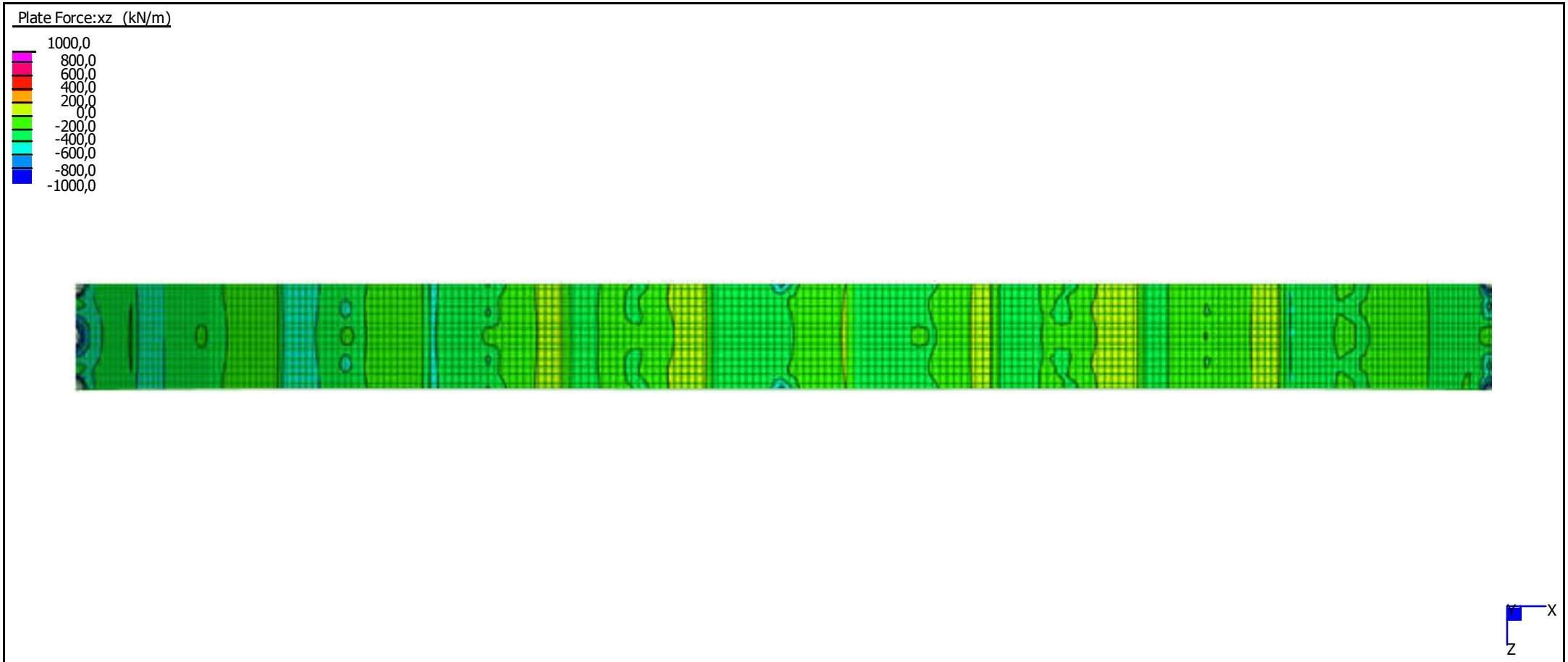


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 10:00 am

Title:	
Project:	
Author:	Reference:



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

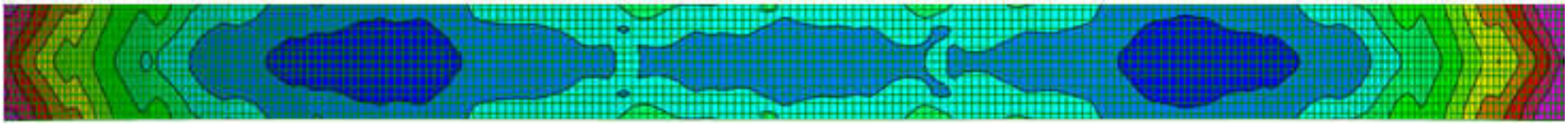
ULS_LM1 leitend_Minimale Querkraft Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:59 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

56,13 [Pt:11547,Nd:13088]
52,309
48,488
44,667
40,846
37,0249
33,2039
29,3829
25,5619
21,7409
17,9199
14,0989 [Pt:12725,Nd:14350]



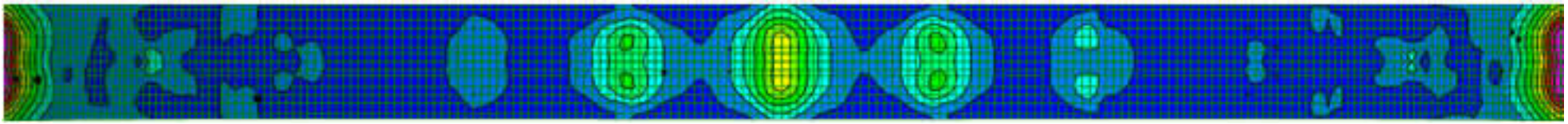
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Erforderliche obere Bewehrung in Längsrichtung Bogen

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

21,9246 [Pt:11730,Nd:13279]
20,0874
18,2502
16,4129
14,5757
12,7385
10,9012
9,06398
7,22674
5,38951
3,55227
1,71504 [Pt:12995,Nd:14630]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

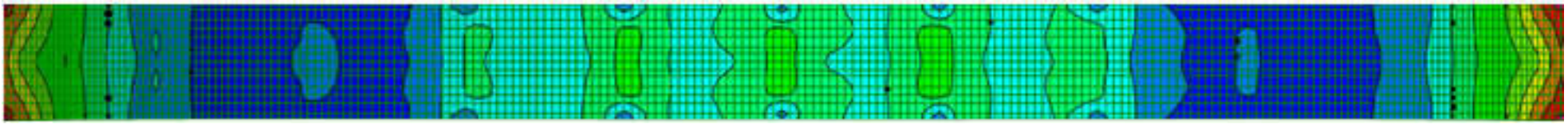
ULS_Wind oder Temperatur leitend_Erforderliche obere Bewehrung in Querrichtung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 8:56 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

64,9162 [Pt:11547,Nd:13088]
60,4873
56,0584
51,6296
47,2007
42,7719
38,343
33,9142
29,4853
25,0564
20,6276
16,1987 [Pt:7545,Nd:8599]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

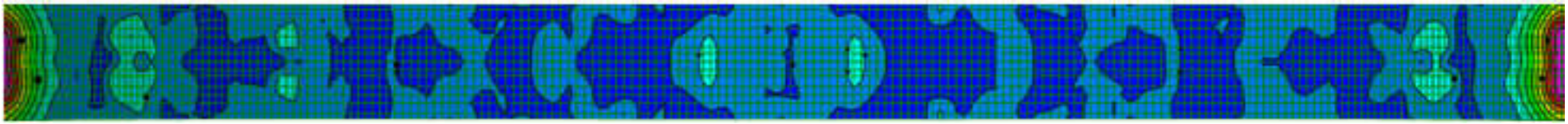
ULS_Wind oder Temperatur leitend_Erforderliche untere Bewehrung in Längsrichtung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:25 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

20,4904 [Pt:11730,Nd:13279]
18,714
16,9376
15,1612
13,3848
11,6084
9,83197
8,05556
6,27914
4,50273
2,72632
0,949902 [Pt:12143,Nd:13727]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

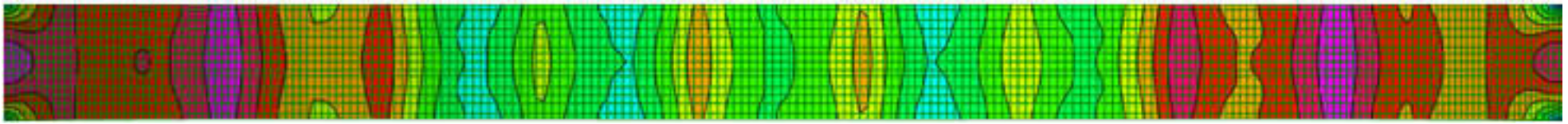
ULS_Wind oder Temperatur leitend_Erforderliche untere Bewehrung in Querrichtung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:04 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx +z surface (MPa)

-4,19309 [Pt:11469,Nd:12980]
-4,83451
-5,47592
-6,11733
-6,75874
-7,40015
-8,04156
-8,68297
-9,32438
-9,96579
-10,6072 [Pt:11629,Nd:13171]



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

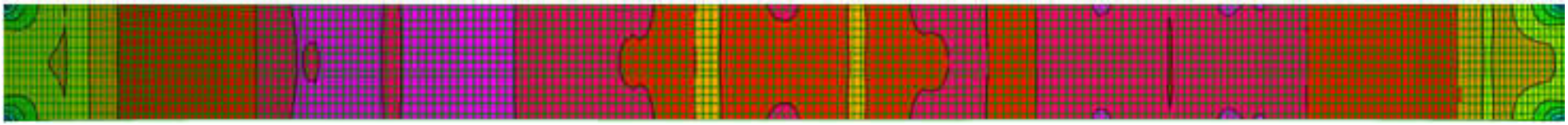
ULS_Wind oder Temperatur leitend_Größter Druck Oberseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:51 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx -z surface (MPa)

-4,15065 [Pt:7491,Nd:8540]
-5,25663
-6,36262
-7,4686
-8,57459
-9,68058
-10,7866
-11,8925
-12,9985
-14,1045
-15,2105 [Pt:11547,Nd:13088]

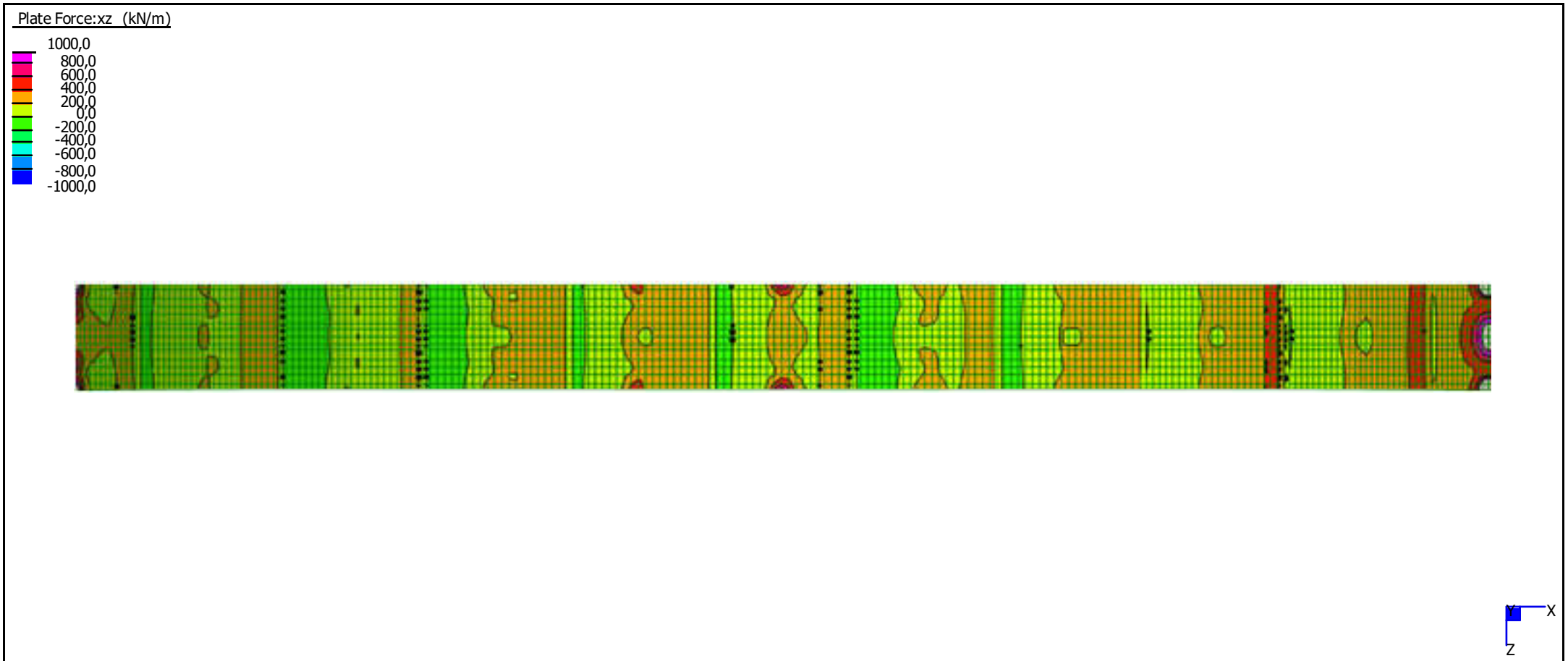


17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Größter Druck Unterseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 9:52 am

Title:	
Project:	
Author:	Reference:

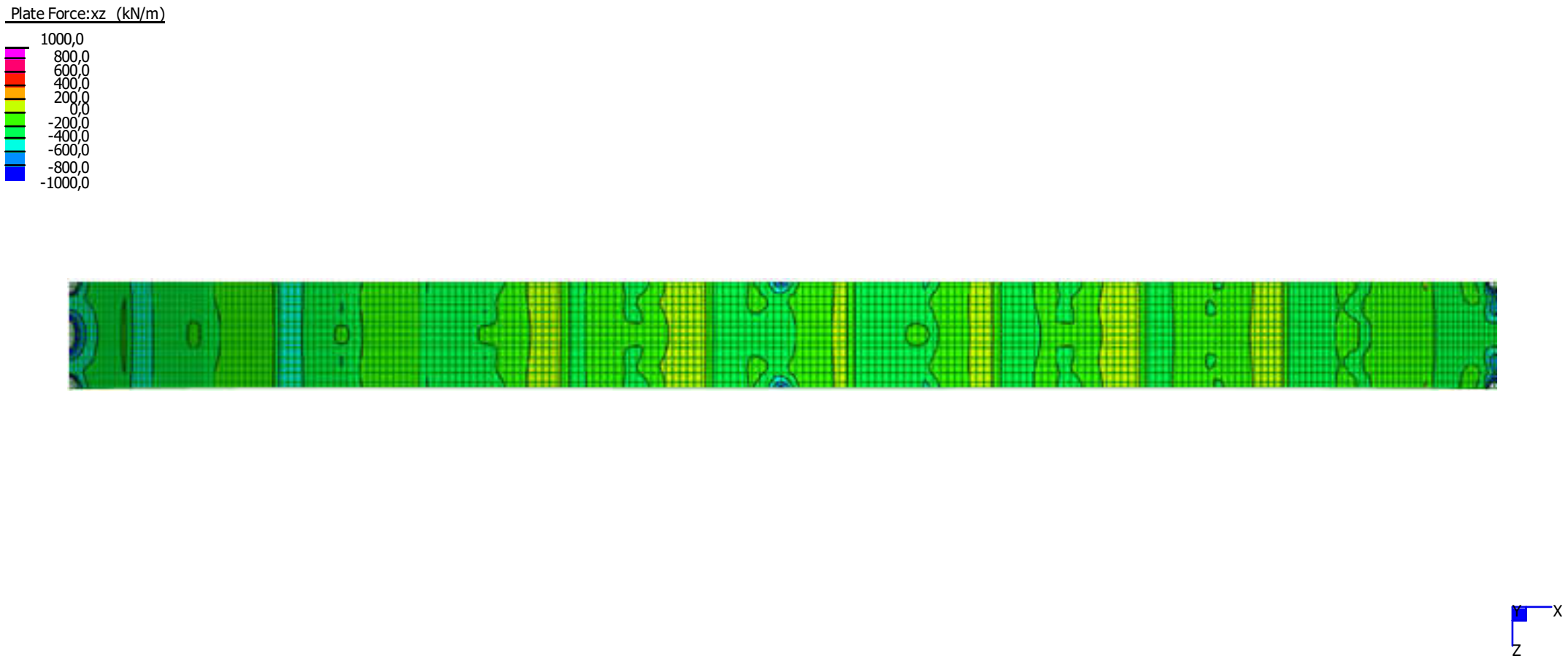


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 10:03 am

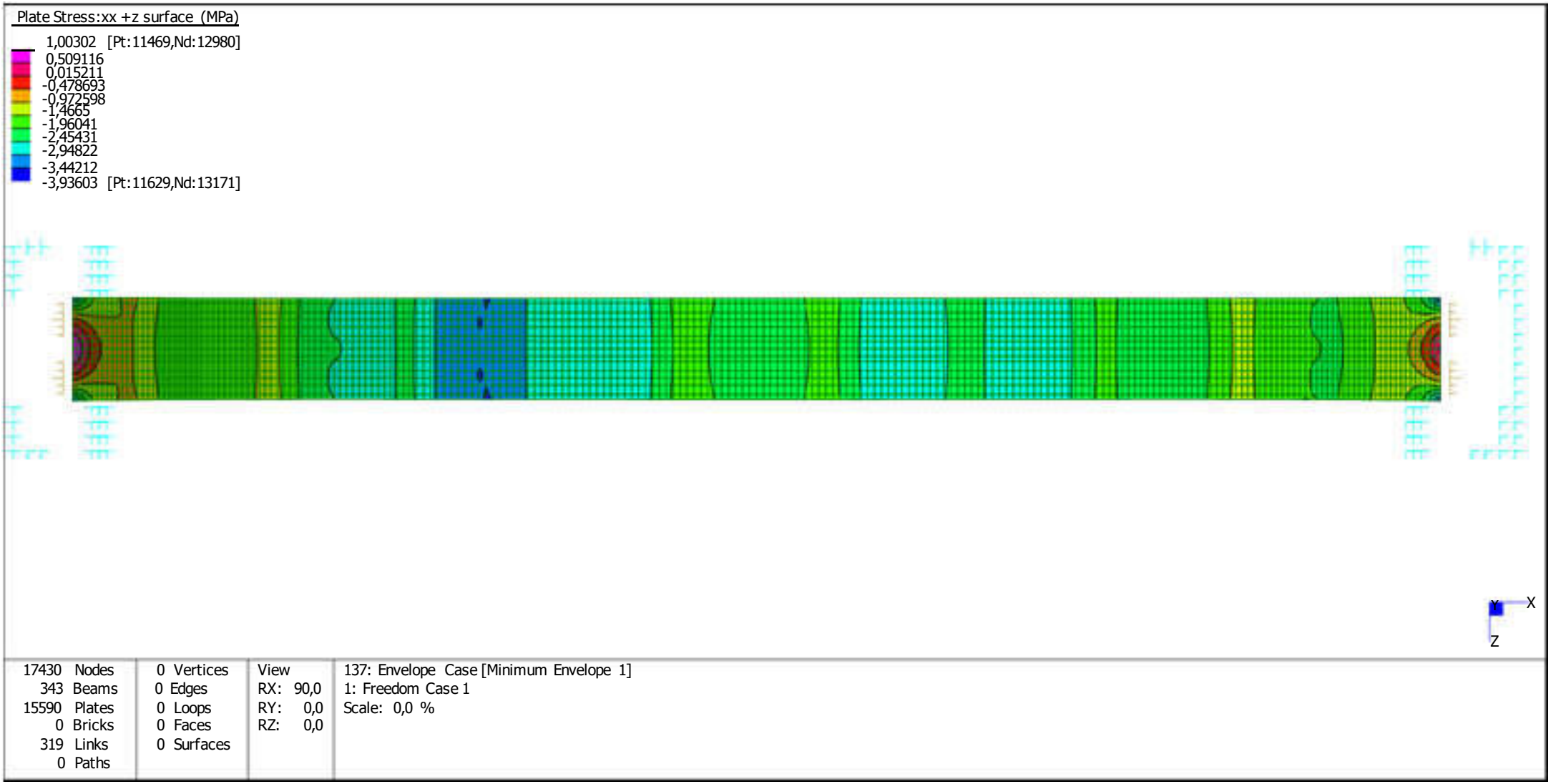
Title:	
Project:	
Author:	Reference:



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Querkraft Bogen in Längsrichtung

Title:	
Project:	
Author:	Reference:

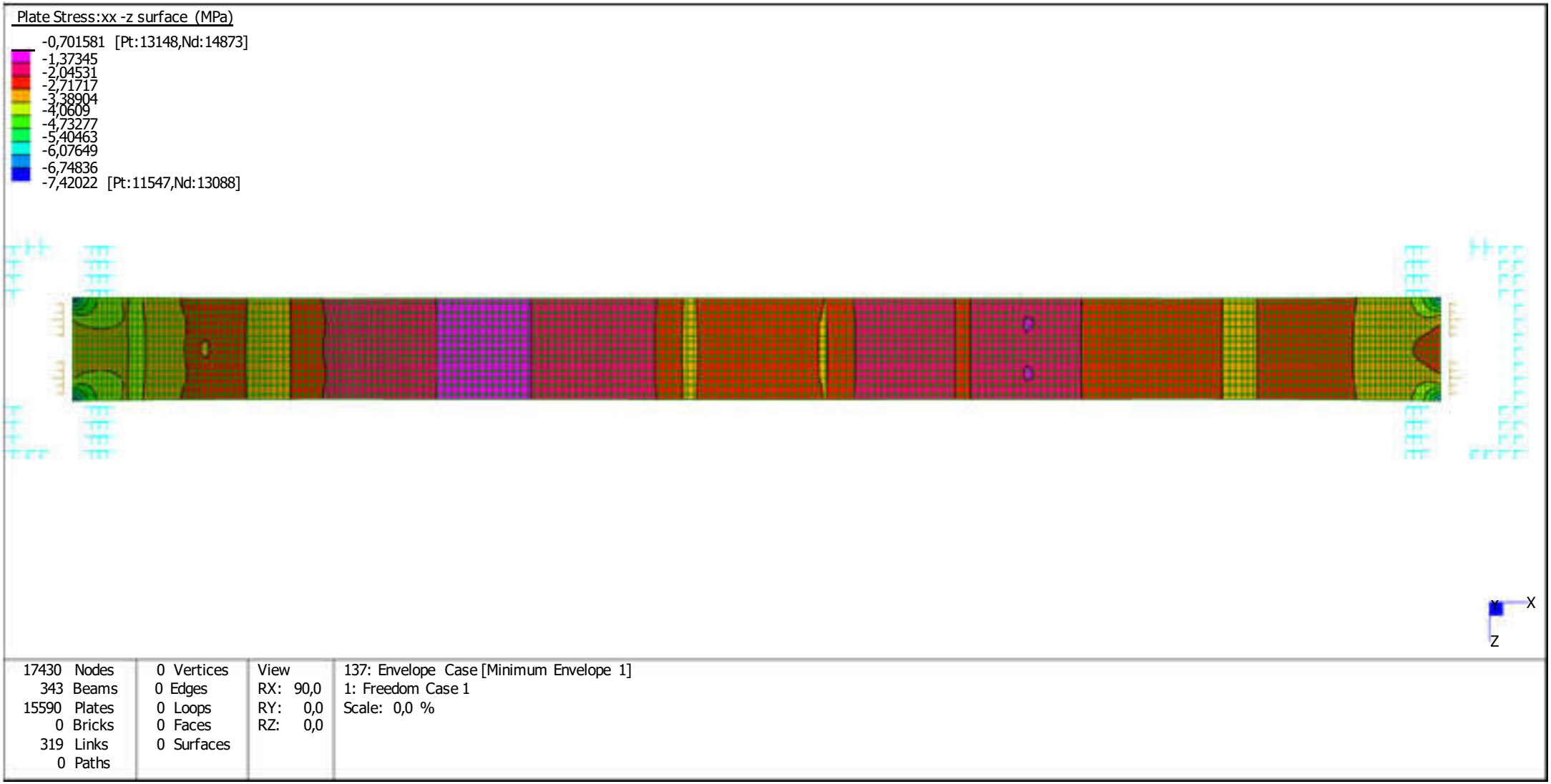


17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Größter Druck Oberseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:48 am

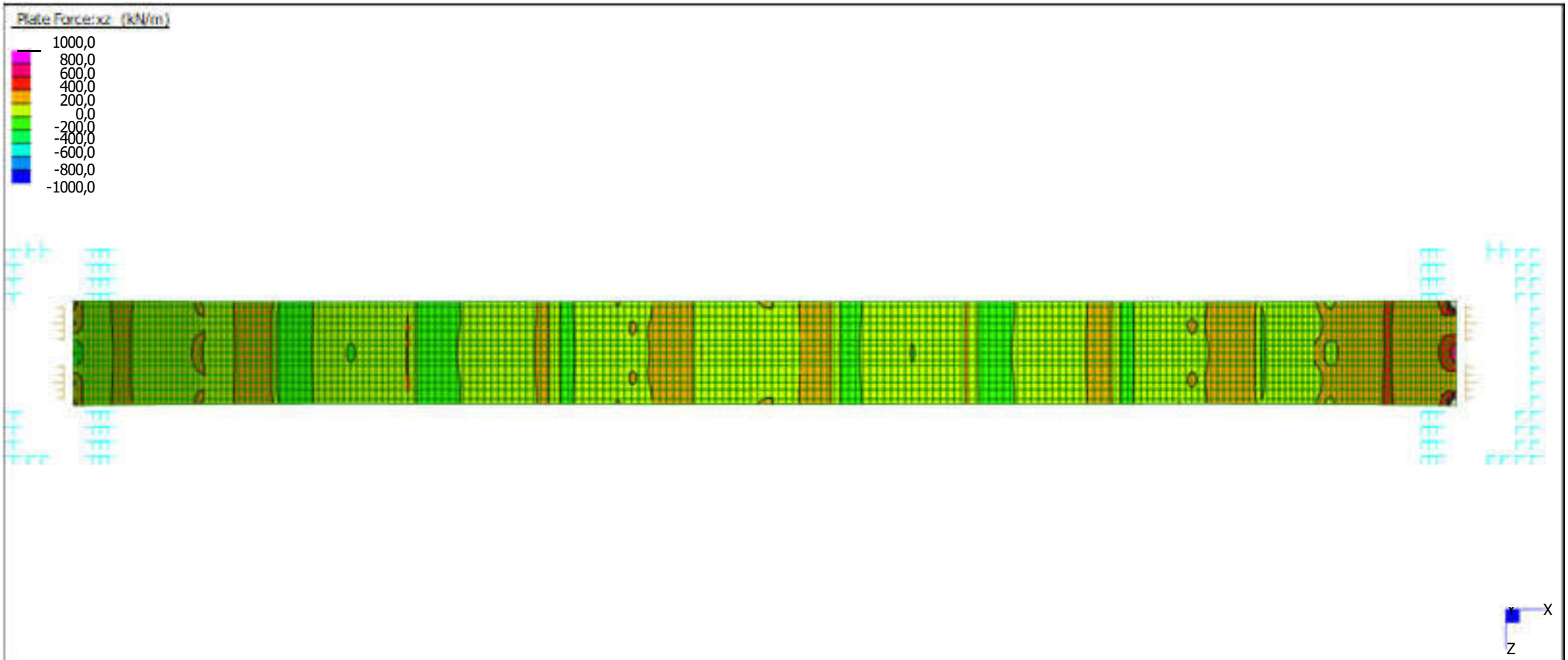
Title:	
Project:	
Author:	Reference:



ULS_Erdbeben_Größter Druck Unterseite Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:47 am

Title:	
Project:	
Author:	Reference:

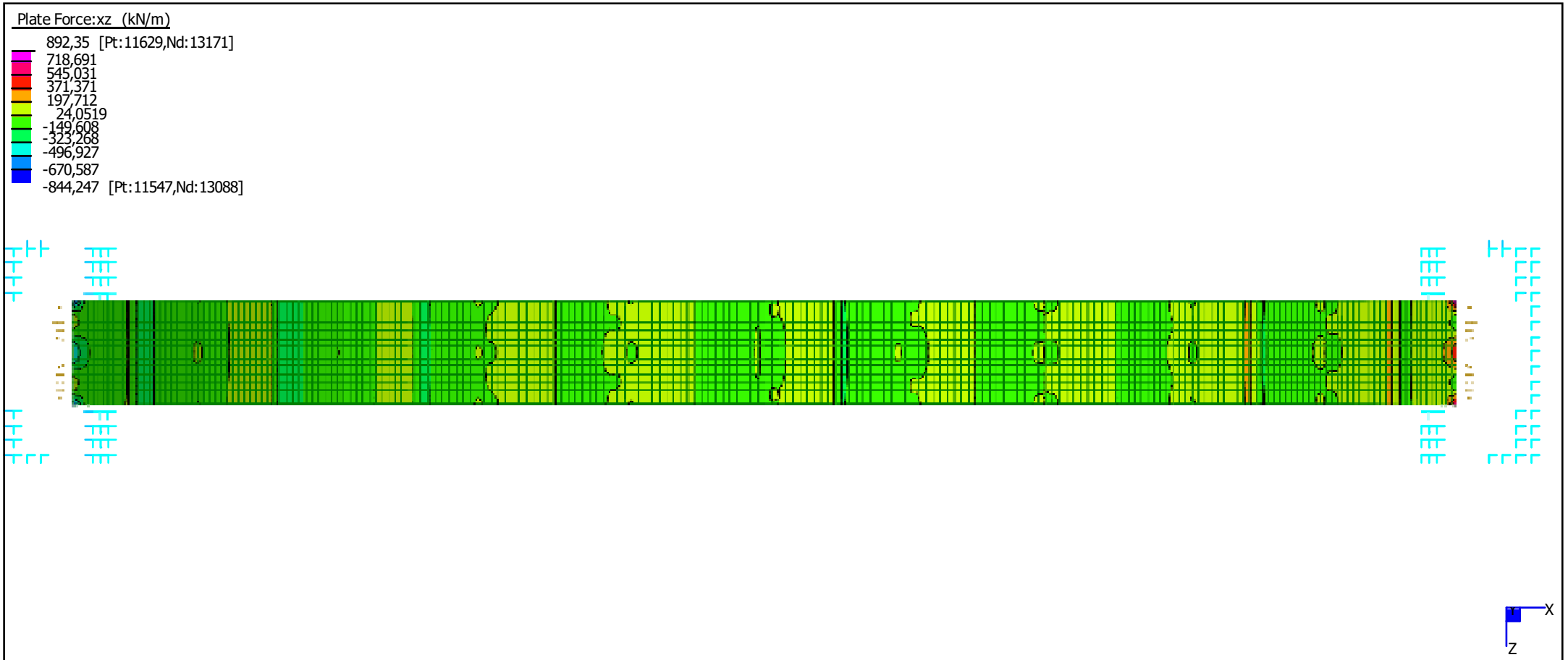


17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Maximale Querkraft Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:52 am

Title:	
Project:	
Author:	Reference:

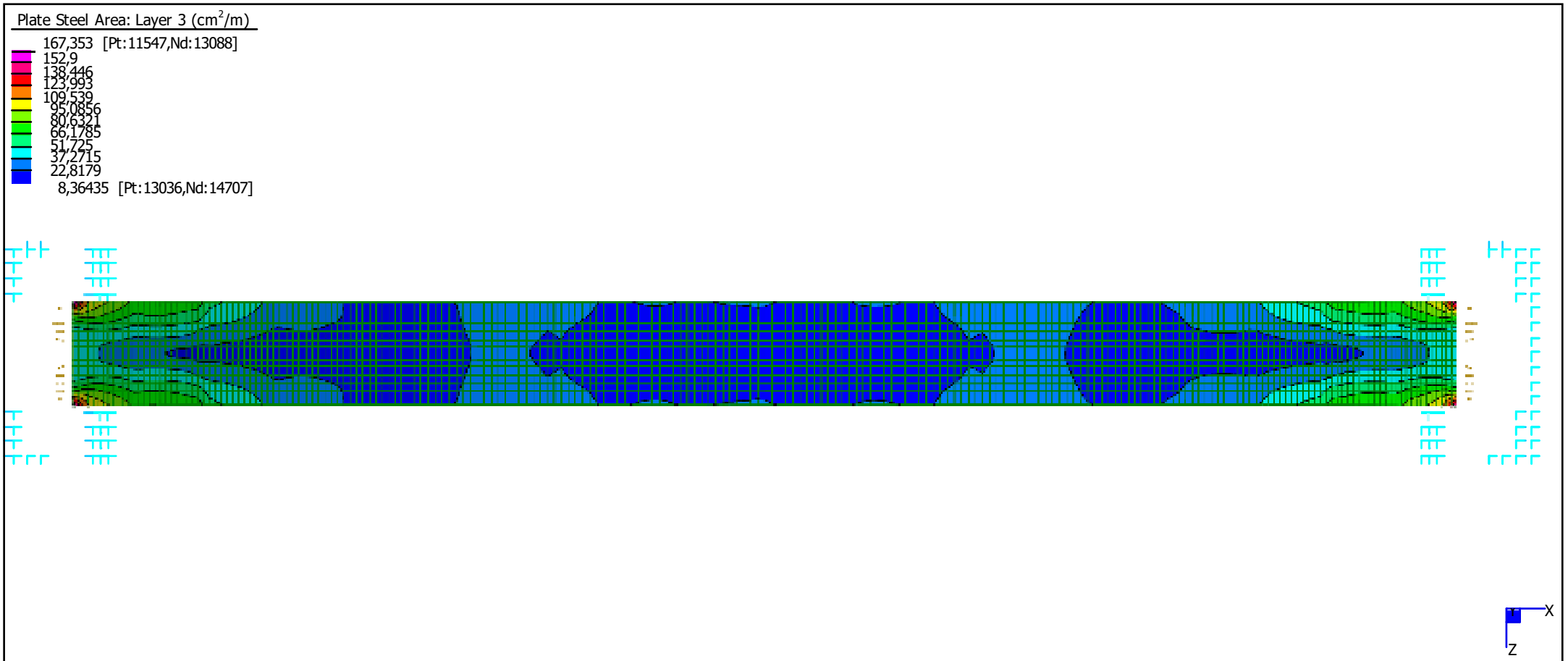


17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Querkraft Bogen in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:49 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

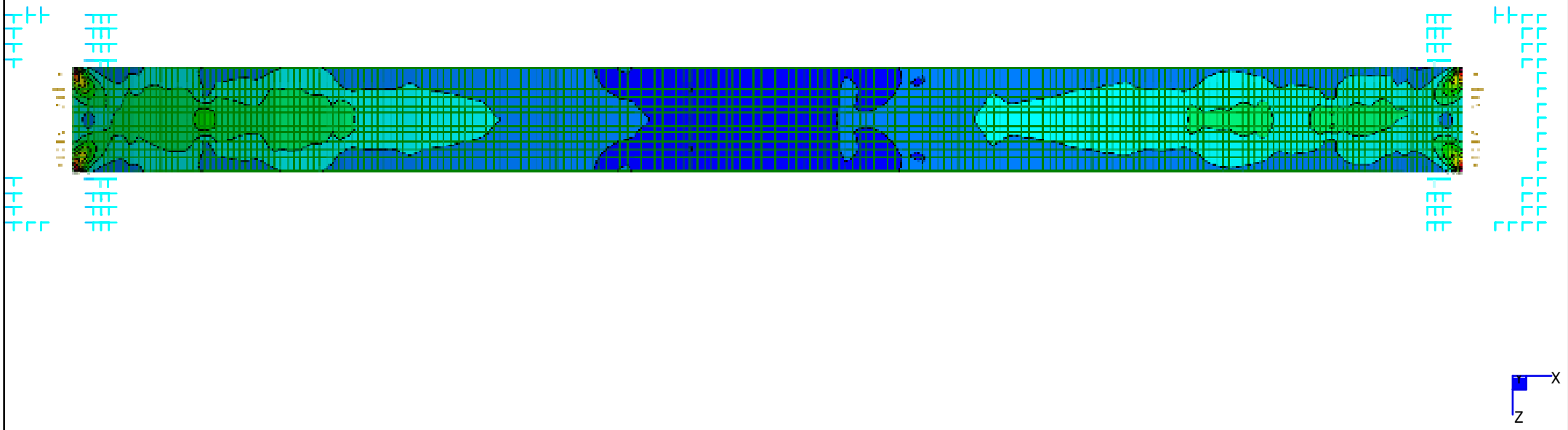
ULS_Erdbeben_Obere Längsbewehrung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:09 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

38,4625 [Pt:11547,Nd:13088]
35,0939
31,7253
28,3567
24,9881
21,6196
18,251
14,8824
11,5138
8,14522
4,77663
1,40805 [Pt:13353,Nd:15078]

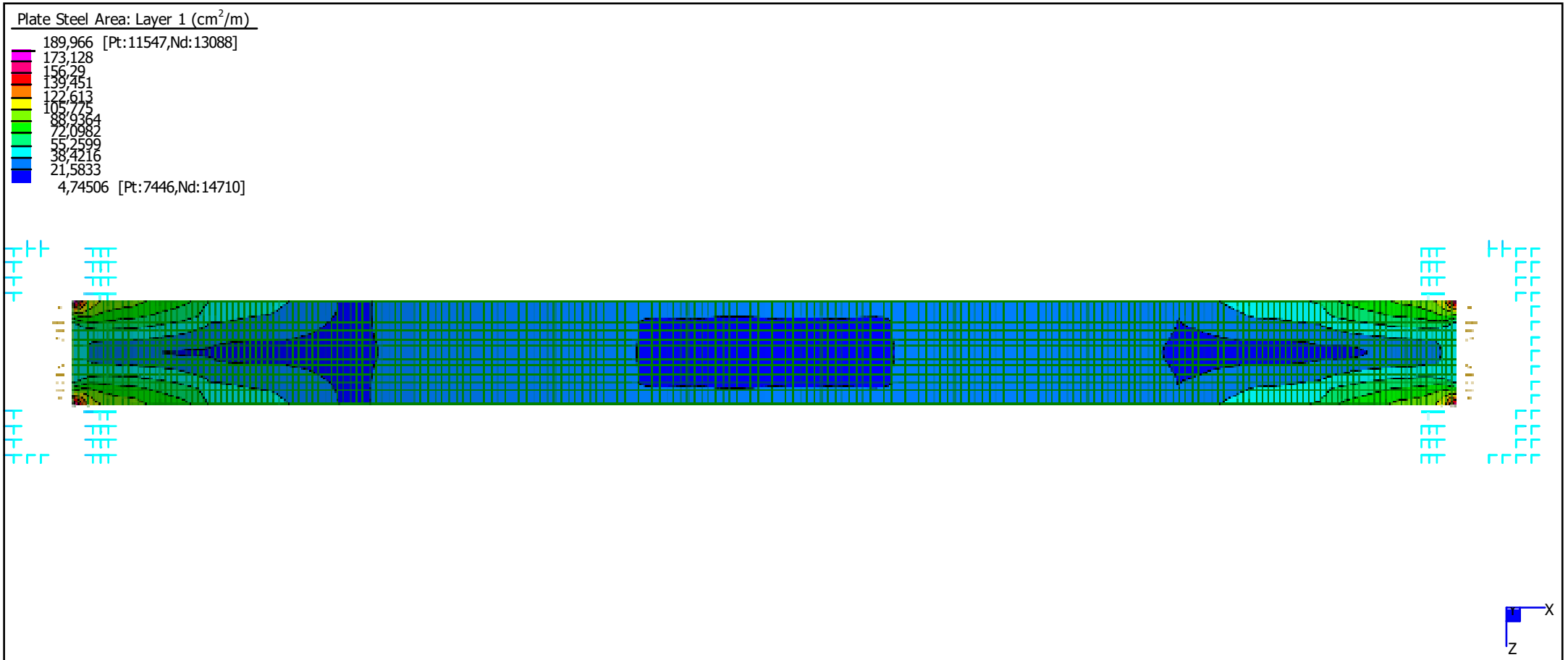


17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Obere Querbewehrung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:37 am

Title:	
Project:	
Author:	Reference:

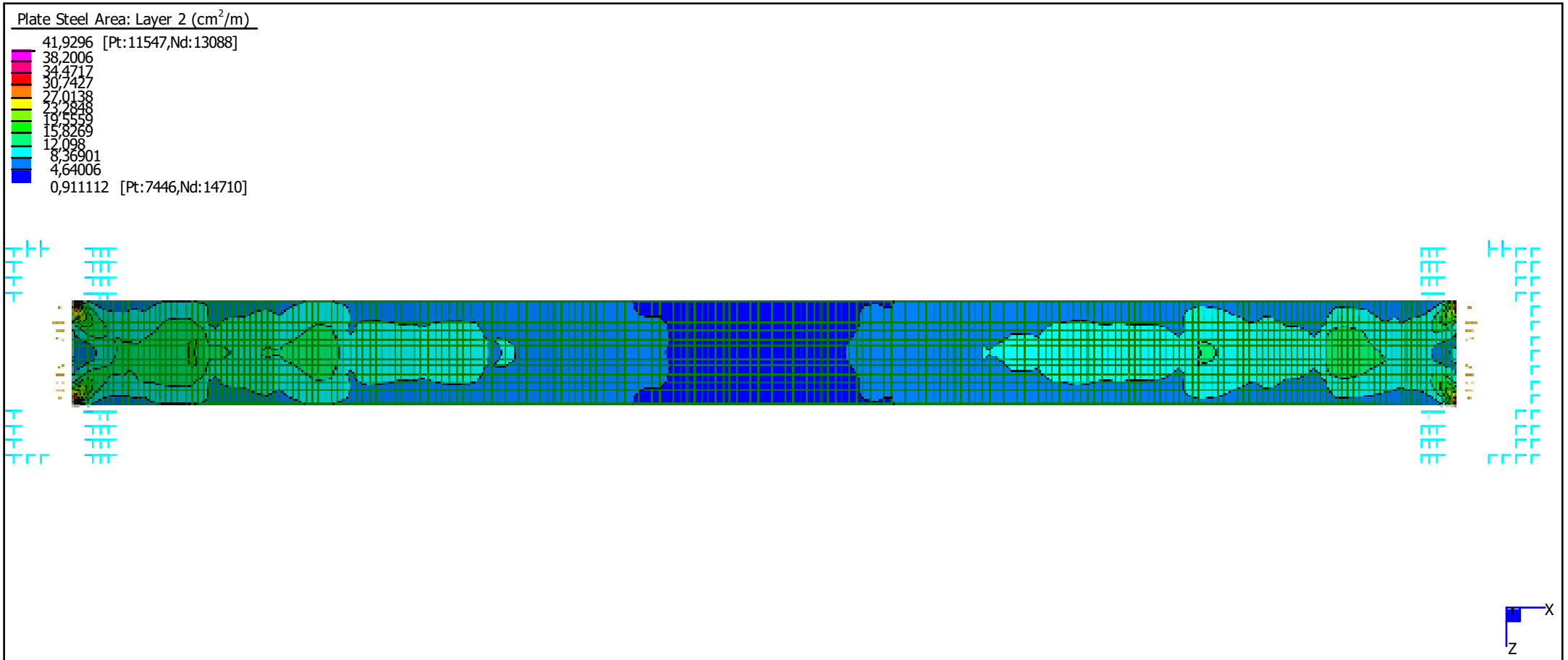


17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Untere Längsbewehrung Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 9:54 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Untere Querbewehrung Bogen

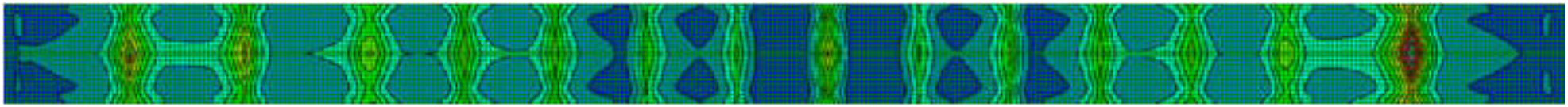
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 10:17 am

5.2 Erforderliche Bewehrung und Schnittgrößen Fahrbahnplatte

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

69,8354 [Pt:1182,Nd:7364]
63,6382
57,441
51,2437
45,0465
38,8493
32,652
26,4548
20,2576
14,0603
7,8631
1,66586 [Pt:6684,Nd:7147]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

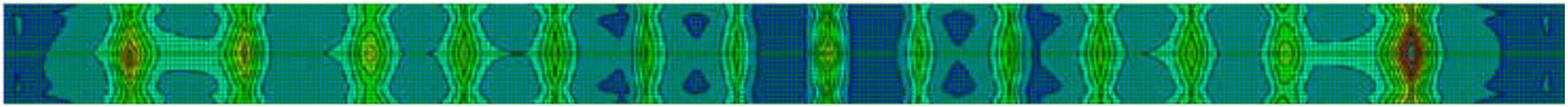
ULS_LM1 leitend_Erforderliche obere Bewehrung in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 3:54 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

65,0654 [Pt:1182,Nd:7364]
59,2854
53,5053
47,7252
41,9451
36,1651
30,385
24,6049
18,8248
13,0448
7,26468
1,4846 [Pt:6279,Nd:6715]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

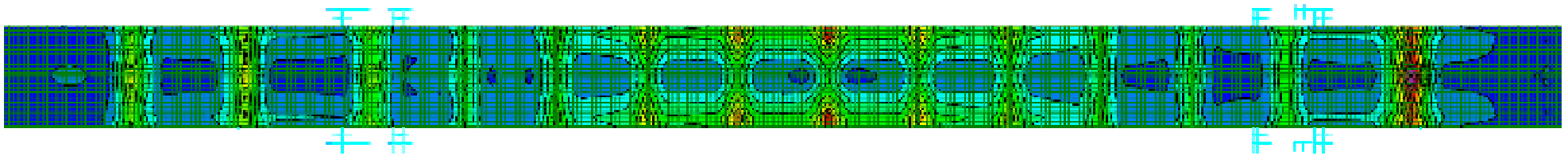
ULS_Wind oder Temperatur leitend_Erforderliche obere Bewehrung in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 5:16 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

35,417 [Pt:1778,Nd:7386]
32,2142
29,0115
25,8088
22,6061
19,4034
16,2007
12,998
9,79529
6,59258
3,38987
0,187167 [Pt:6441,Nd:6904]



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Erforderliche obere Bewehrung in Längsrichtung

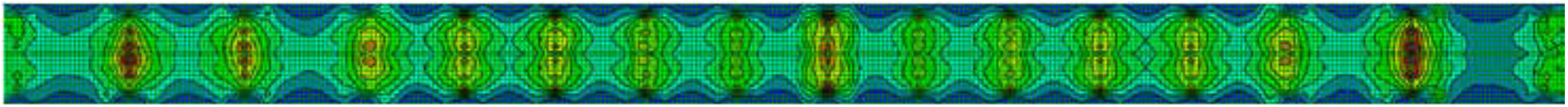
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

15 November 2018 3:35 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

19,0324 [Pt:884,Nd:7353]
17,3434
15,6544
13,9654
12,2764
10,5874
8,89838
7,20939
5,52039
3,83139
2,14239
0,453389 [Pt:4347,Nd:4783]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

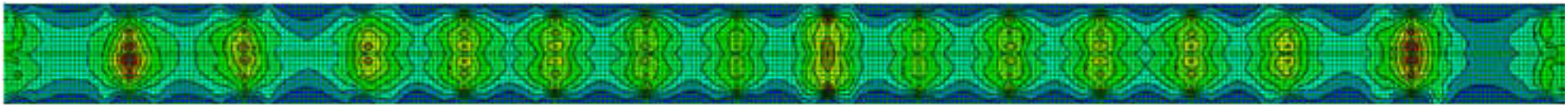
ULS_LM1 leitend_Erforderliche obere Bewehrung in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 4:16 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

20,4924 [Pt:6415,Nd:7558]
18,6648
16,8371
15,0094
13,1818
11,3541
9,52646
7,6988
5,87114
4,04348
2,21582
0,388164 [Pt:6659,Nd:7121]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

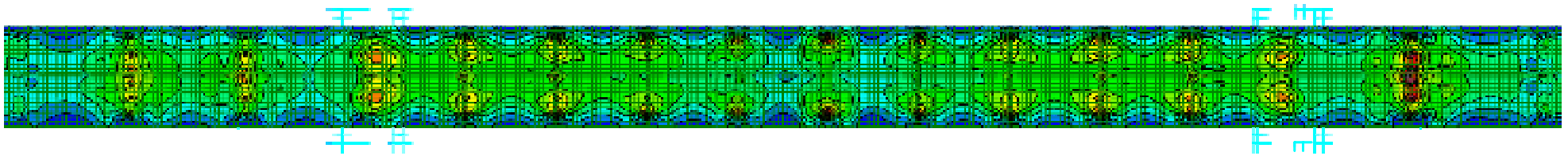
ULS_Wind oder Temperatur leitend_Erforderliche obere Bewehrung in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 4:45 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

10,0
9,09091
8,18182
7,27273
6,36364
5,45455
4,54545
3,63636
2,72727
1,81818
0,909091
0,0



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Erforderliche obere Bewehrung in Querrichtung

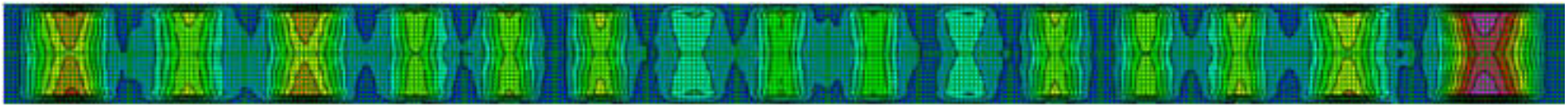
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

15 November 2018 4:18 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

65,2257 [Pt:3878,Nd:4314]
59,4202
53,6146
47,8091
42,0036
36,198
30,3925
24,587
18,7814
12,9759
7,17035
1,36482 [Pt:3597,Nd:4033]



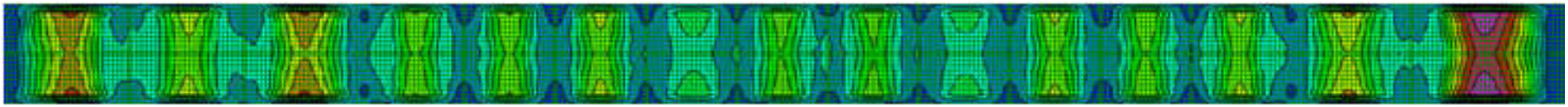
17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Erforderliche untere Bewehrung in Längsrichtung

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

55,9646 [Pt:3878,Nd:4314]
50,9826
46,0006
41,0186
36,0366
31,0546
26,0726
21,0906
16,1086
11,1266
6,14457
1,16256 [Pt:3597,Nd:4033]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

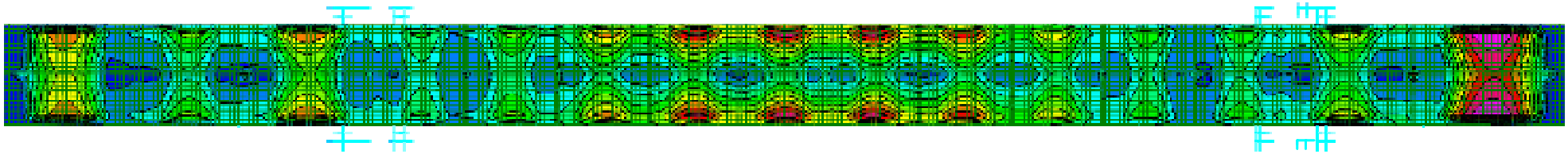
ULS_Wind oder Temperatur leitend_Erforderliche untere Bewehrung in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 5:07 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

24,9203 [Pt:3879,Nd:4315]
22,6579
20,3956
18,1332
15,8708
13,6085
11,3461
9,08374
6,82137
4,55901
2,29664
0,034271 [Pt:4491,Nd:4927]



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Erforderliche untere Bewehrung in Längsrichtung

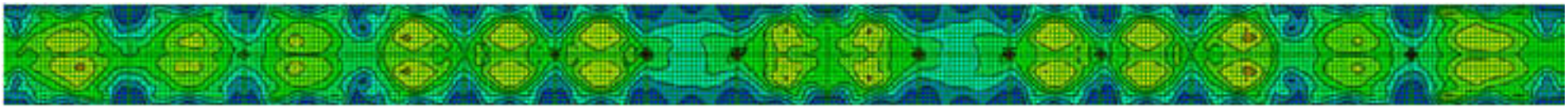
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

15 November 2018 3:06 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

14,1737 [Pt:1339,Nd:7900]
12,898
11,6224
10,3468
9,07121
7,79559
6,51998
5,24436
3,96875
2,69313
1,41752
0,141903 [Pt:6248,Nd:7551]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

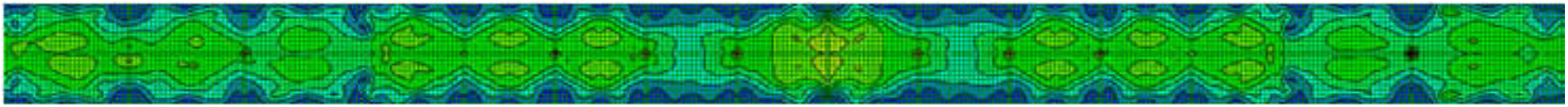
ULS_LM1 leitend_Erforderliche untere Bewehrung in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 4:08 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

16,0669 [Pt:1480,Nd:8047]
14,6222
13,1774
11,7326
10,2879
8,84309
7,39832
5,95355
4,50878
3,06402
1,61925
0,17448 [Pt:6820,Nd:7573]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

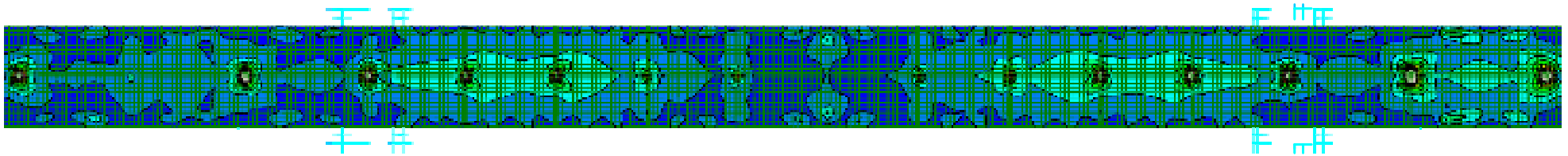
ULS_Wind oder Temperatur leitend_Erforderliche untere Bewehrung in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 4:53 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

10,0
9,09091
8,18182
7,27273
6,36364
5,45455
4,54545
3,63636
2,72727
1,81818
0,909091
0,0



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Erforderliche untere Bewehrung in Querrichtung

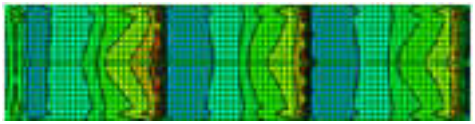
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

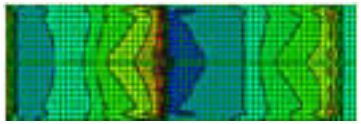
15 November 2018 3:56 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

657,801 [Pt:6416,Nd:6878]
571,371
484,941
398,511
312,081
225,651
139,221
52,7912
-33,6388
-120,069
-206,499 [Pt:288,Nd:724]





17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

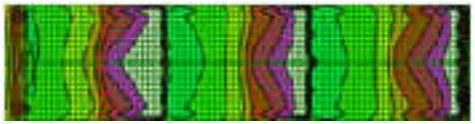
ULS_LM1 leitend_Maximale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

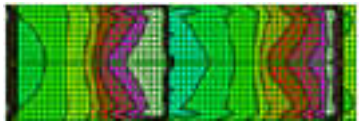
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:51 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

284,0
227,2
170,4
113,6
56,8
0,0
-56,8
-113,6
-170,4
-227,2
-284,0





17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

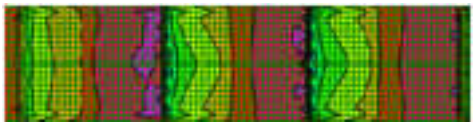
ULS_LM1 leitend_Maximale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

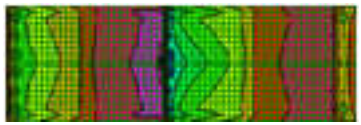
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:52 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

181,658 [Pt:287,Nd:723]
95,7116
9,76533
-76,1809
-162,127
-248,073
-334,02
-419,966
-505,912
-591,859
-677,805 [Pt:1480,Nd:8047]





17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

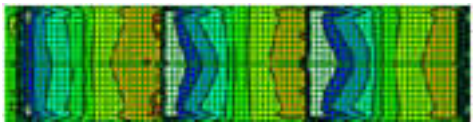
ULS_LM1 leitend_Minimale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

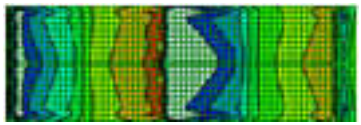
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:47 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

284,0
227,2
170,4
113,6
56,8
0,0
-56,8
-113,6
-170,4
-227,2
-284,0





17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Minimale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

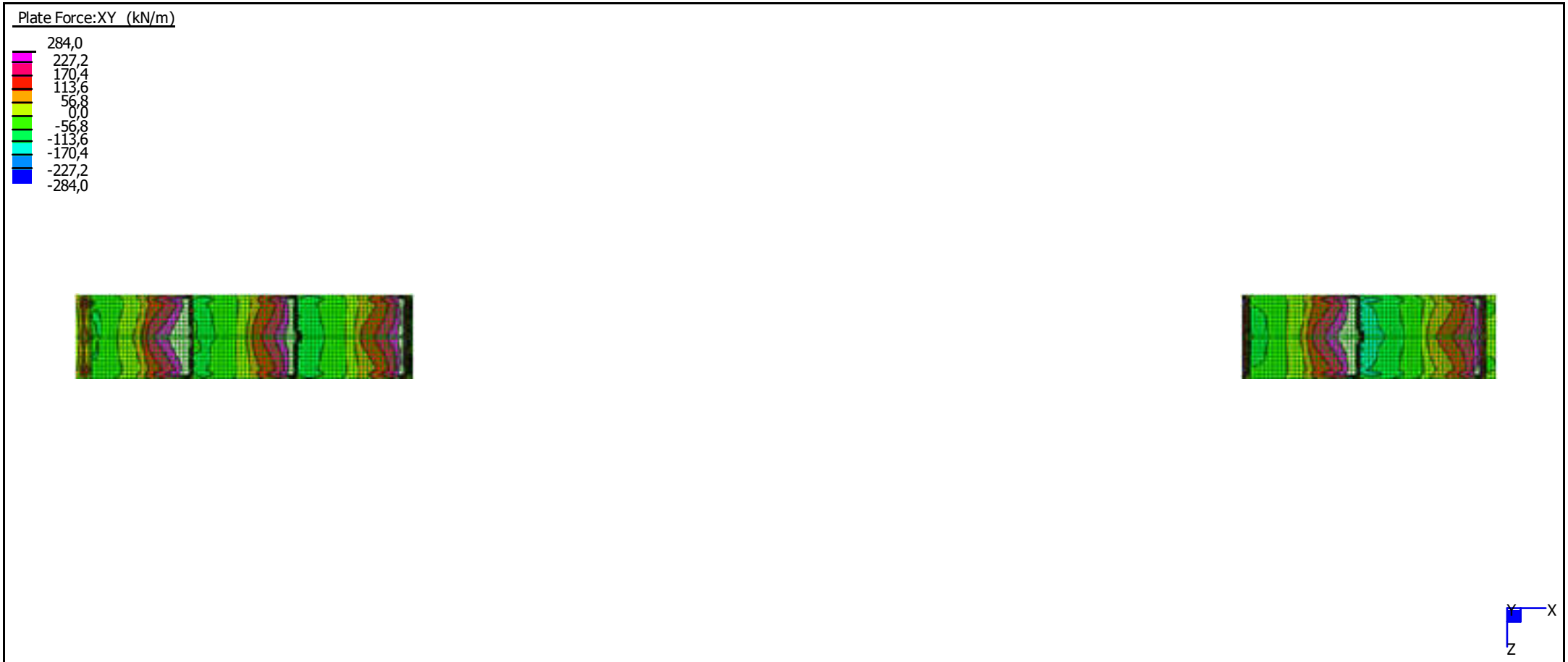
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:48 pm

Title:	
Project:	
Author:	Reference:

17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Maximale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Title:	
Project:	
Author:	Reference:

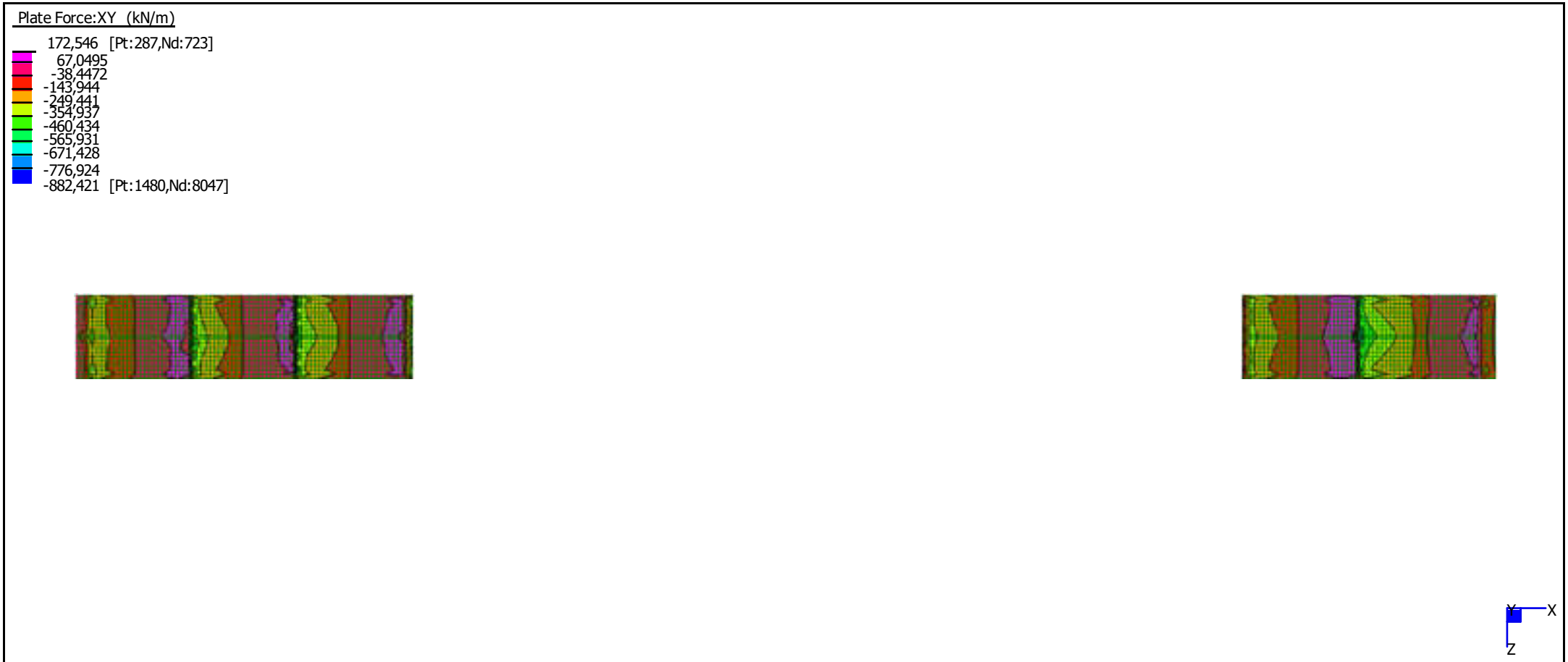


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:58 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

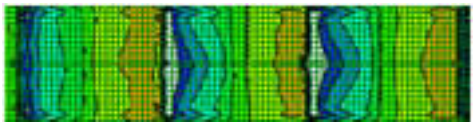
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

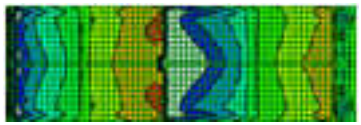
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:55 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

284,0
227,2
170,4
113,6
56,8
0,0
-56,8
-113,6
-170,4
-227,2
-284,0





17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

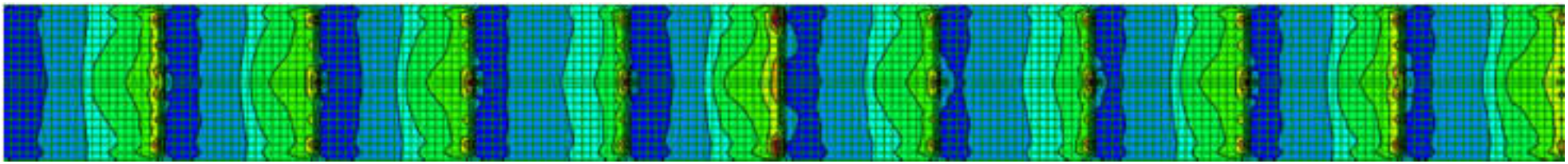
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Längsrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:56 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

627,534 [Pt:1320,Nd:7880]
554,444
481,354
408,264
335,174
262,083
188,993
115,903
42,8132
-30,2768
-103,367 [Pt:3406,Nd:3842]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

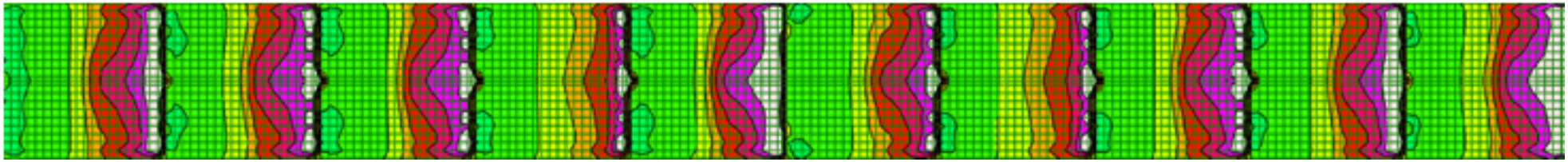
ULS_LM1 leitend_Maximale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:13 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

236,0
188,8
141,6
94,4
47,2
0,0
-47,2
-94,4
-141,6
-188,8
-236,0



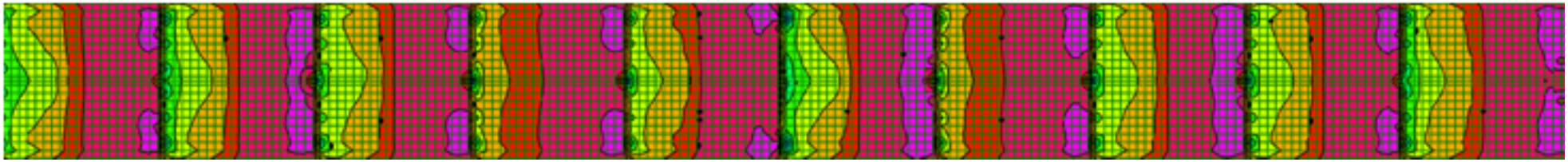
17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Maximale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

112,612 [Pt:5250,Nd:5686]
40,3456
-31,9205
-104,187
-176,453
-248,719
-320,985
-393,251
-465,517
-537,783
-610,049 [Pt:1396,Nd:7960]



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

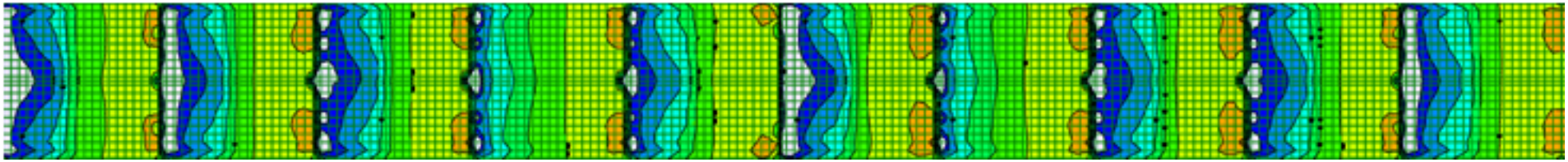
ULS_LM1 leitend_Minimale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:10 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

236,0
188,8
141,6
94,4
47,2
0,0
-47,2
-94,4
-141,6
-188,8
-236,0



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

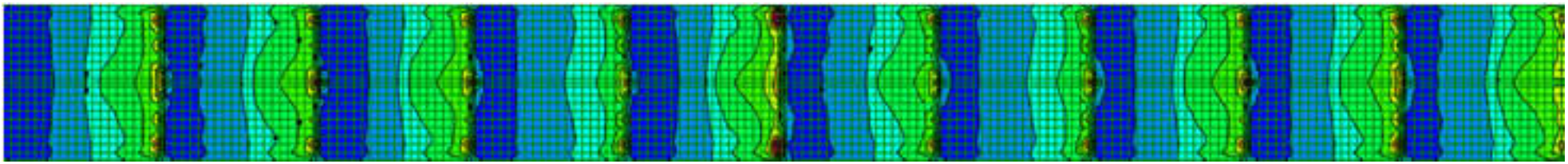
ULS_LM1 leitend_Minimale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:11 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

569,337 [Pt:1415,Nd:7980]
503,645
437,954
372,262
306,57
240,879
175,187
109,495
43,8039
-21,8878
-87,5794 [Pt:5175,Nd:5611]

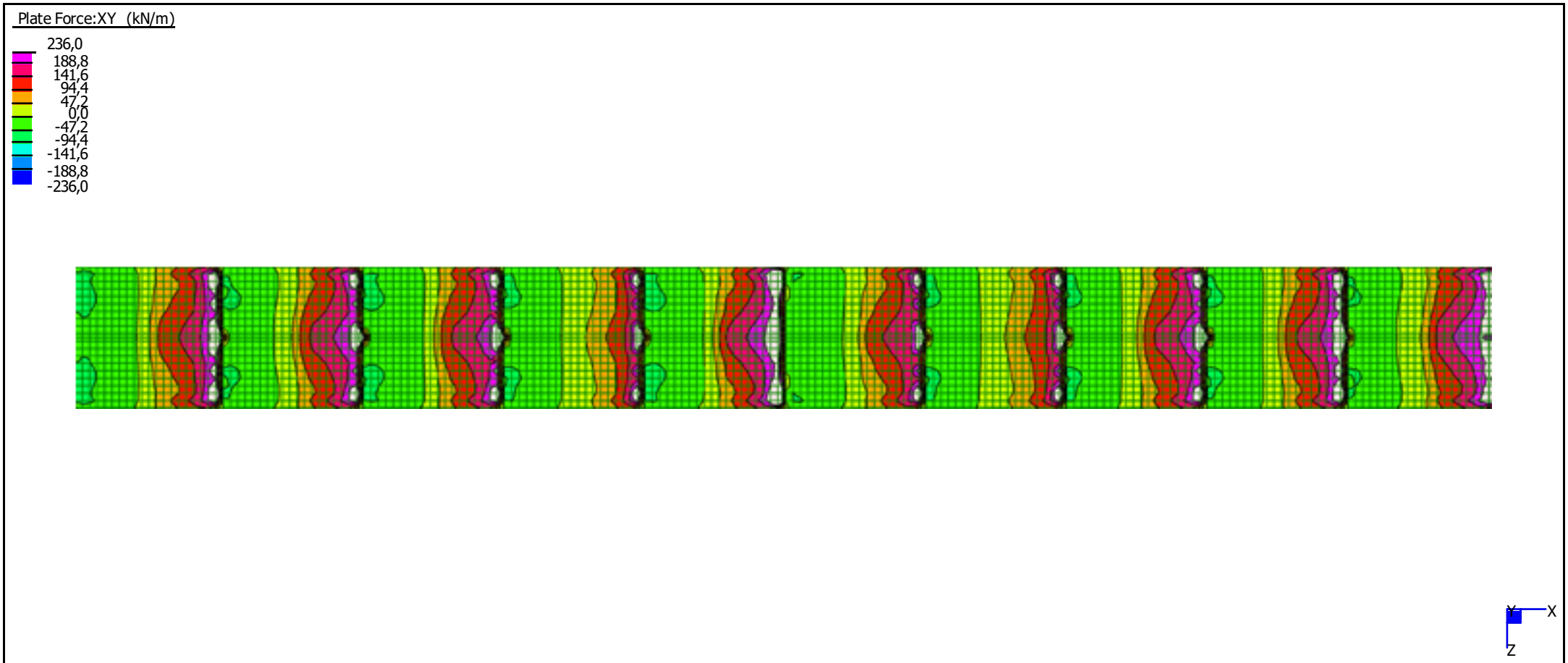


17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Maximale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:19 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

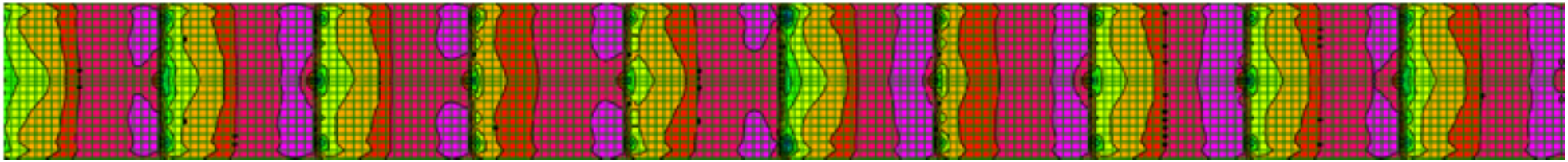
ULS_Wind oder Temperatur leitend_Maximale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:19 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

95,2898 [Pt:3500,Nd:3936]
28,9485
-37,3928
-103,734
-170,075
-236,417
-302,758
-369,099
-435,441
-501,782
-568,123 [Pt:1415,Nd:7980]



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

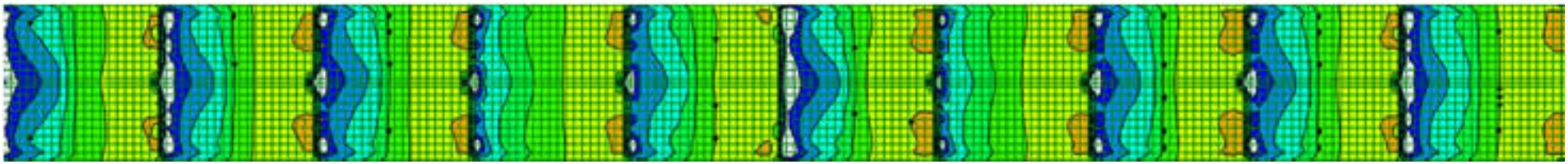
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:16 pm

Title:	
Project:	
Author:	Reference:

Plate Force:XY (kN/m)

236,0
188,8
141,6
94,4
47,2
0,0
-47,2
-94,4
-141,6
-188,8
-236,0



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

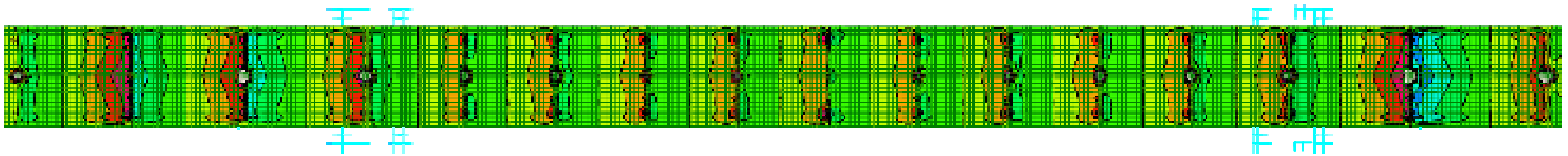
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Längsrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:17 pm

Title:	
Project:	
Author:	Reference:

Plate Force:xz (kN/m)

250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
-200,0
-250,0



17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

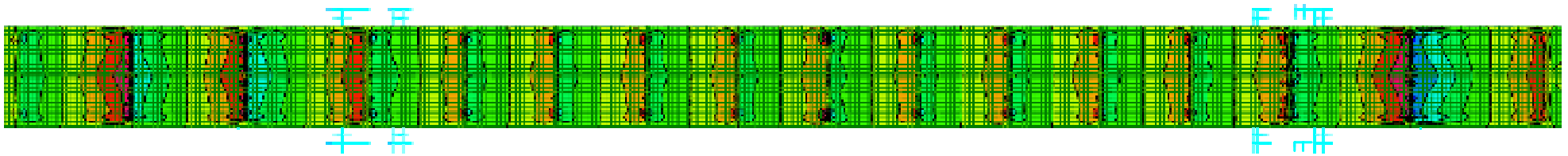
ULS_Erdbeben_Maximale Querkraft in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
15 November 2018 4:26 pm

Title:	
Project:	
Author:	Reference:

Plate Force:xz (kN/m)

231,444 [Pt:3565,Nd:4001]
184,732
138,021
91,3098
44,5985
-2,11278
-48,8241
-95,5354
-142,247
-188,958
-235,669 [Pt:5354,Nd:5790]



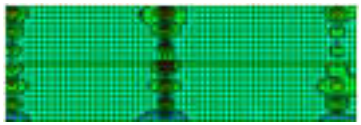
17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Querkraft in Längsrichtung

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

573,593 [Pt:1778,Nd:7375]
500,7
427,806
354,913
282,02
209,126
136,233
63,3393
-9,55417
-82,4476
-155,341 [Pt:3864,Nd:7463]

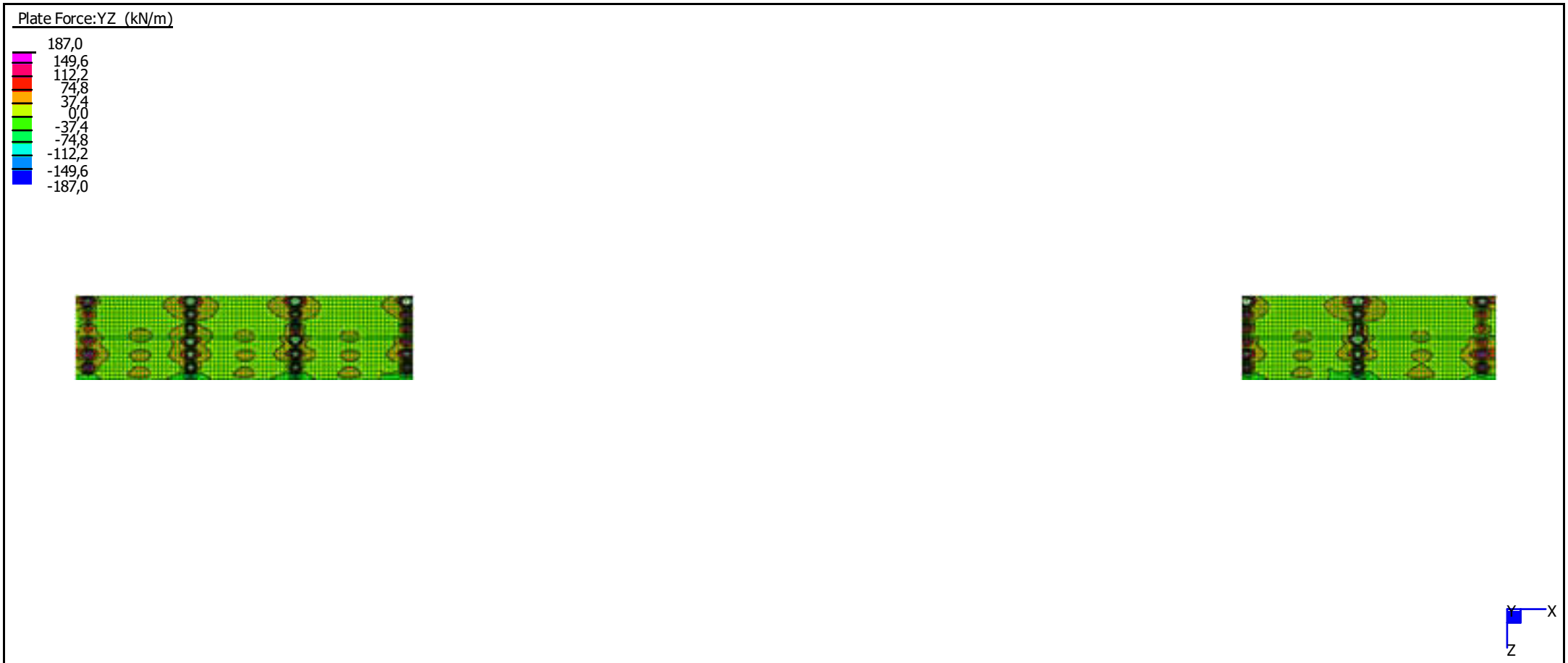


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 3:50 pm

Title:	
Project:	
Author:	Reference:

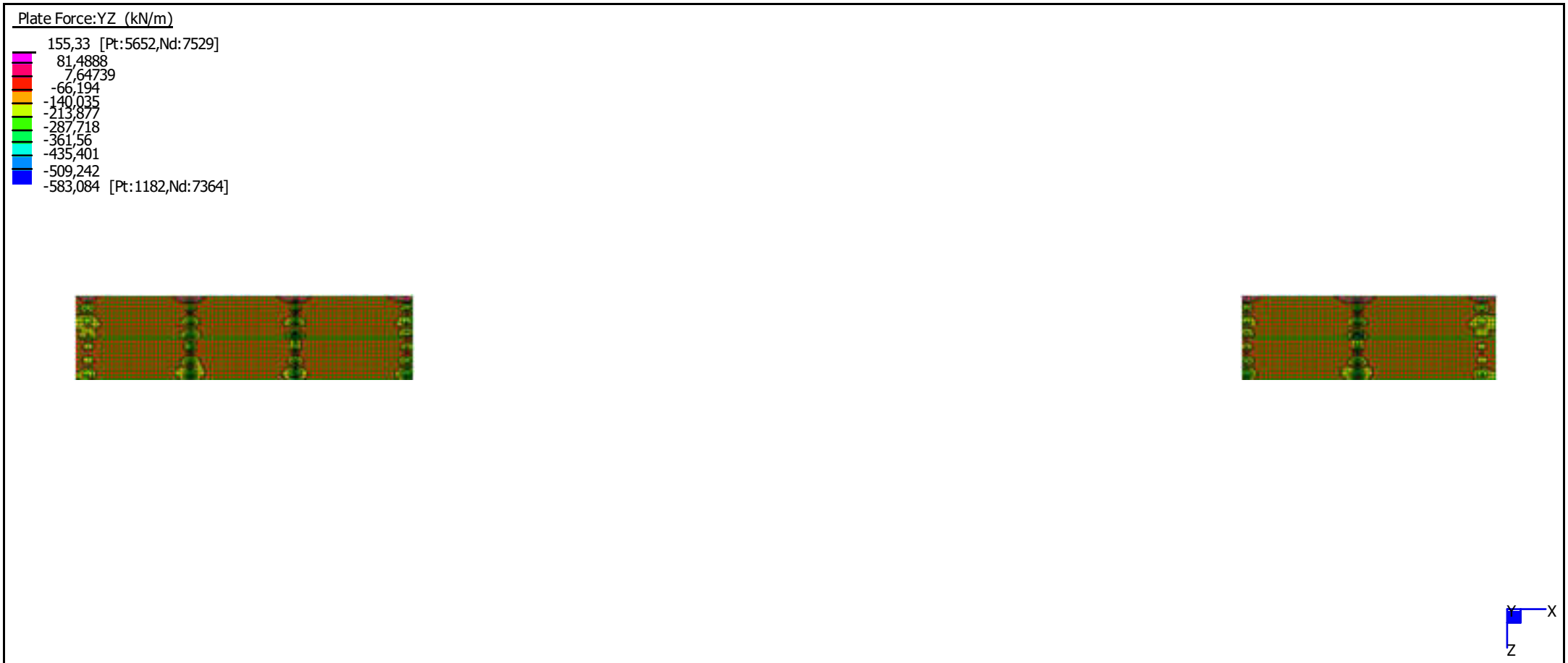


17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Maximale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 3:51 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

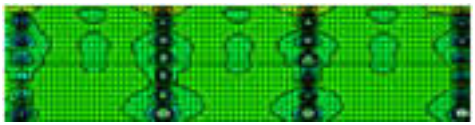
ULS_LM1 leitend_Minimale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 3:45 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

187,0
149,6
112,2
74,8
37,4
0,0
-37,4
-74,8
-112,2
-149,6
-187,0



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

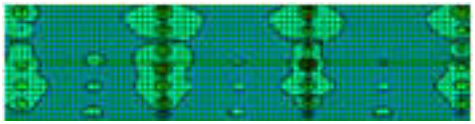
ULS_LM1 leitend_Minimale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

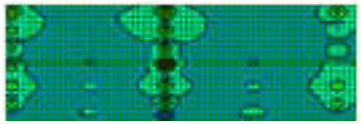
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 3:48 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

739,119 [Pt:1480,Nd:8047]
651,321
563,524
475,726
387,929
300,131
212,333
124,536
36,7379
-51,0597
-138,857 [Pt:3864,Nd:7463]

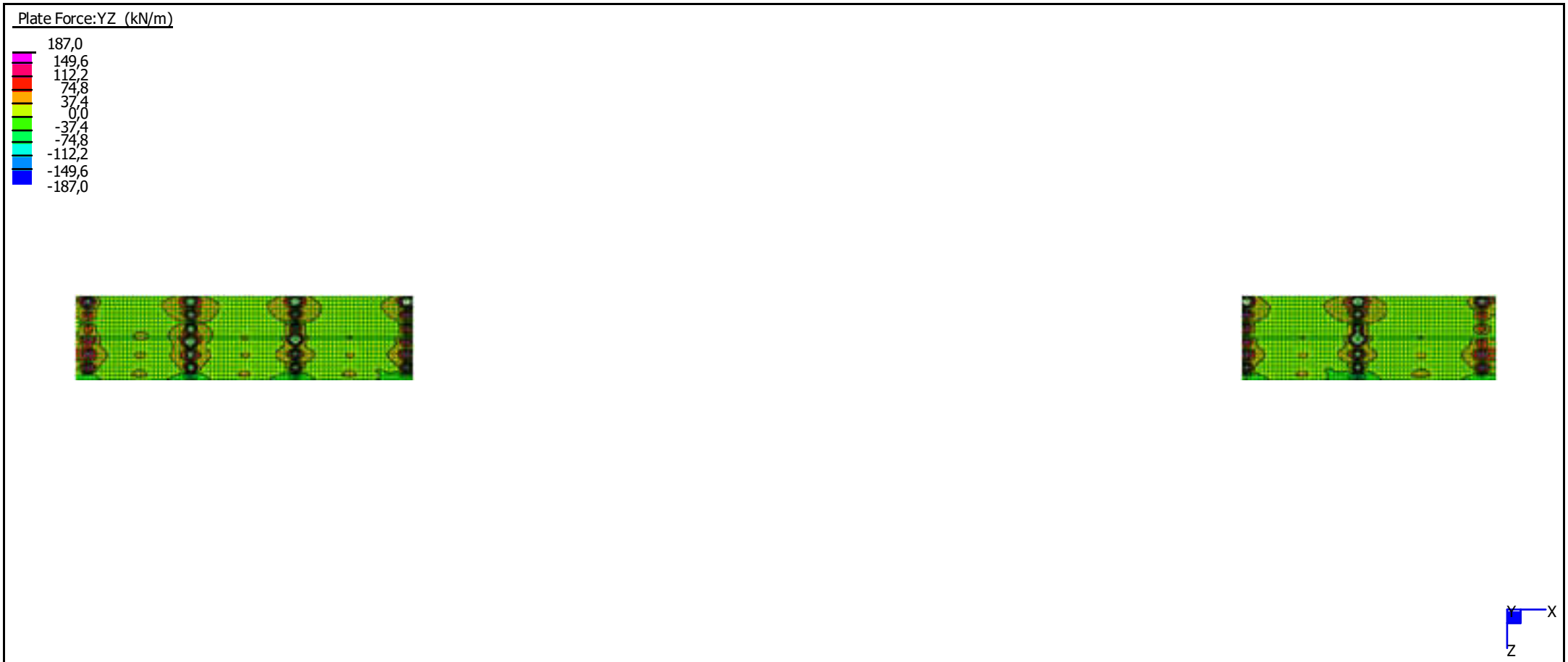




17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Title:	
Project:	
Author:	Reference:



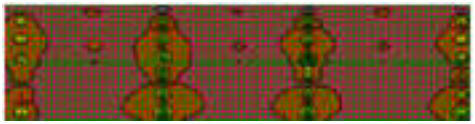
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

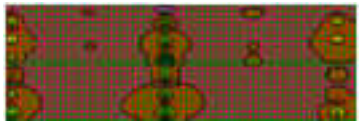
ULS_Wind oder Temperatur leitend_Maximale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

138,847 [Pt:5652,Nd:7529]
49,7068
-39,4335
-128,574
-217,714
-306,854
-395,995
-485,135
-574,275
-663,416
-752,556 [Pt:1480,Nd:8047]



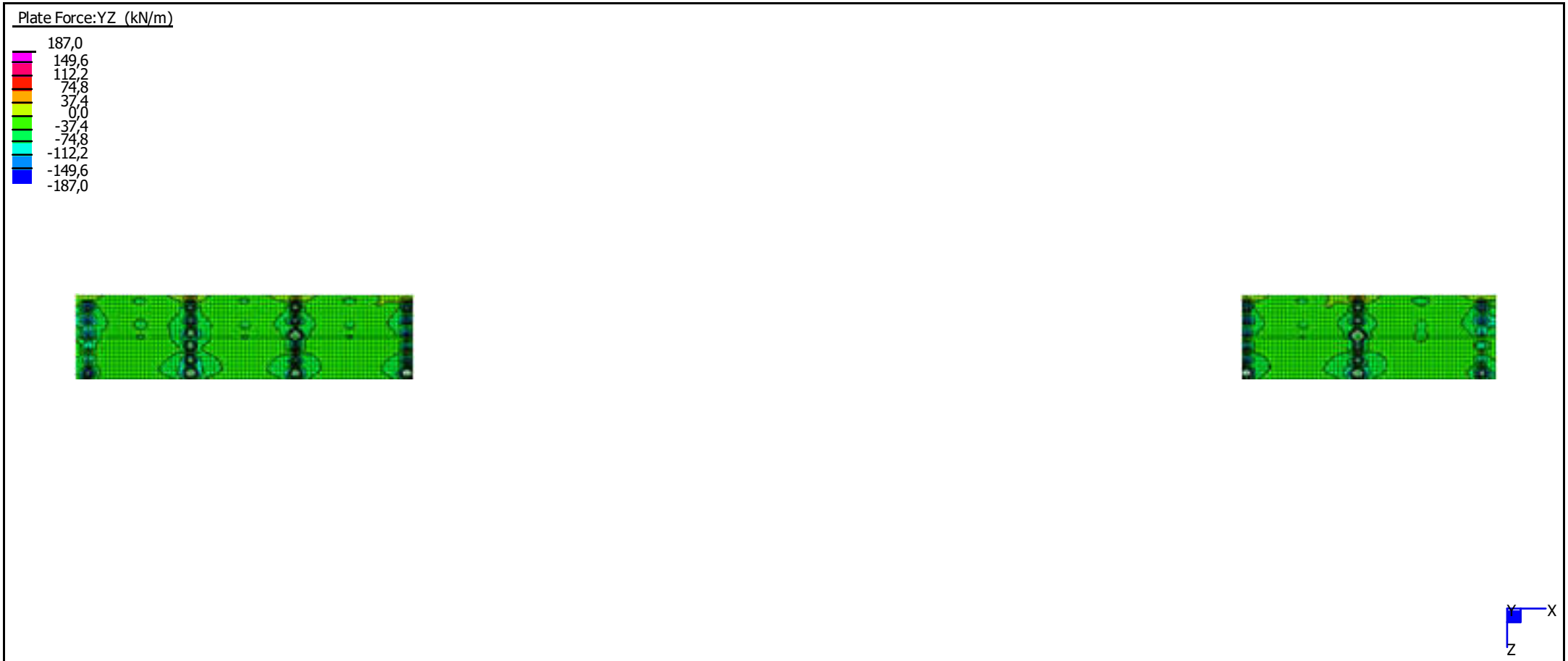


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 4:39 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

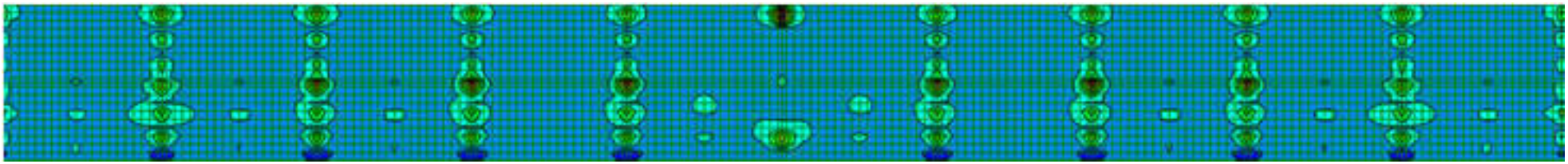
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Querrichtung - Bereiche mit nicht reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 3:54 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

646,675 [Pt:5530,Nd:7524]
571,785
496,895
422,005
347,115
272,225
197,335
122,445
47,5554
-27,3346
-102,225 [Pt:3723,Nd:7457]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

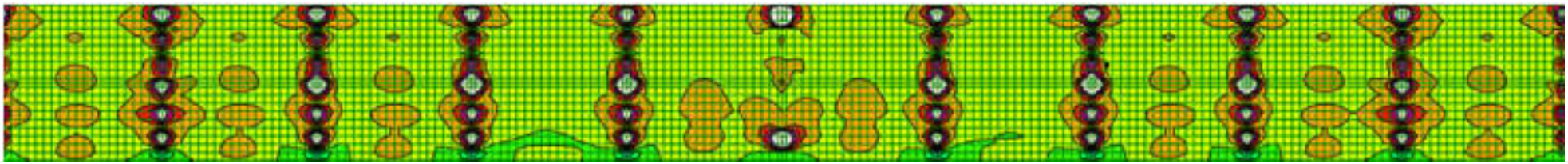
ULS_LM1 leitend_Maximale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:27 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

155,0
124,0
93,0
62,0
31,0
0,0
-31,0
-62,0
-93,0
-124,0
-155,0



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

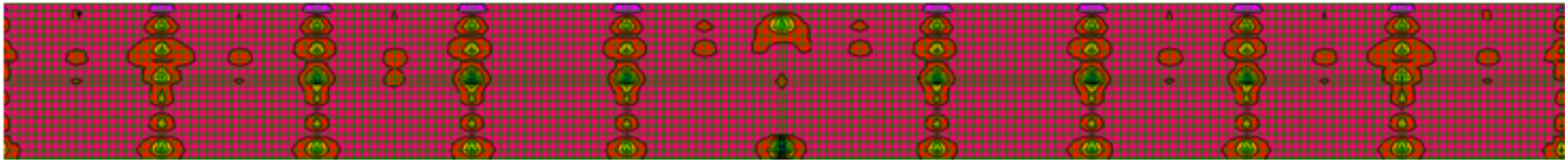
ULS_LM1 leitend_Maximale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:26 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

102,168 [Pt:5511,Nd:7523]
27,2817
-47,6042
-122,49
-197,376
-272,262
-347,148
-422,034
-496,92
-571,806
-646,692 [Pt:3742,Nd:7458]



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

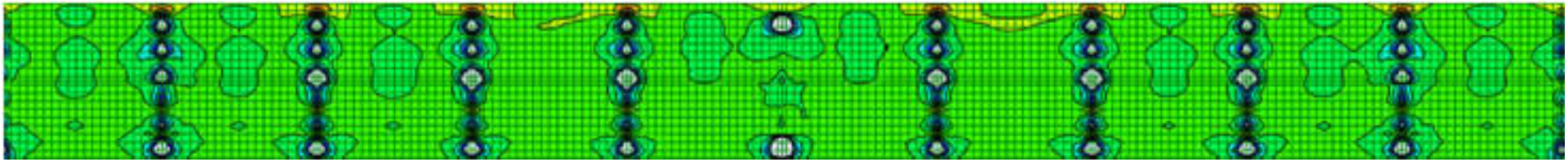
ULS_LM1 leitend_Minimale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:23 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

155,0
124,0
93,0
62,0
31,0
0,0
-31,0
-62,0
-93,0
-124,0
-155,0



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

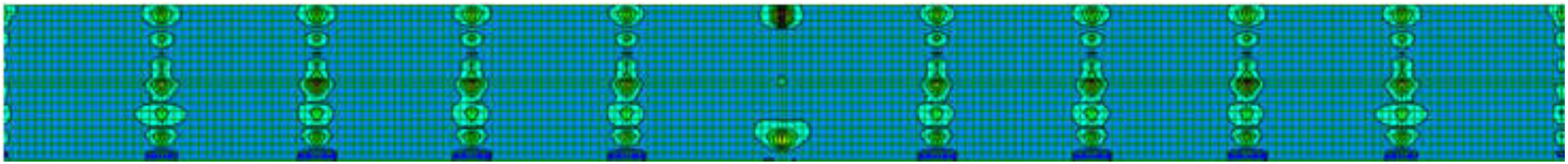
ULS_LM1 leitend_Minimale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:24 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

631,221 [Pt:5530,Nd:7524]
559,266
487,311
415,355
343,4
271,444
199,489
127,533
55,5777
-16,3778
-88,3333 [Pt:3723,Nd:7457]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

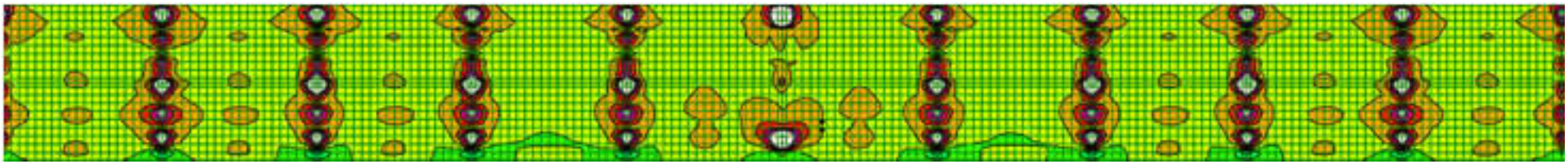
ULS_Wind oder Temperatur leitend_Maximale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:37 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

155,0
124,0
93,0
62,0
31,0
0,0
-31,0
-62,0
-93,0
-124,0
-155,0



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

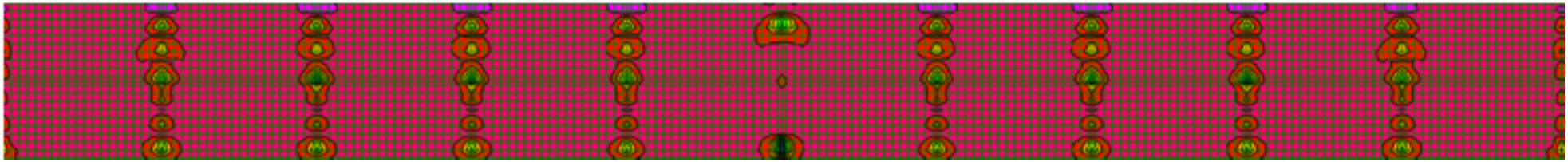
ULS_Wind oder Temperatur leitend_Maximale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:36 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

88,3267 [Pt:5511,Nd:7523]
16,3701
-55,5864
-127,543
-199,5
-271,456
-343,413
-415,369
-487,326
-559,283
-631,239 [Pt:3742,Nd:7458]



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

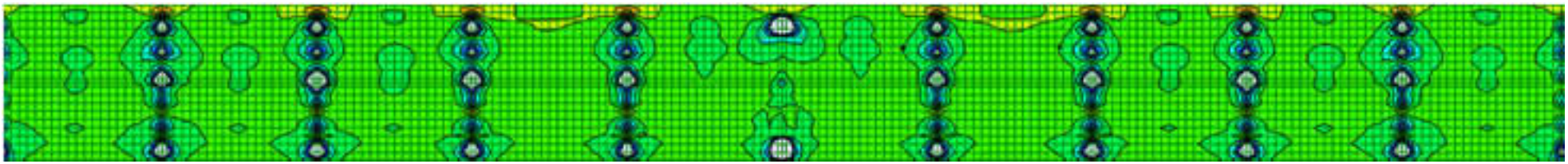
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:29 pm

Title:	
Project:	
Author:	Reference:

Plate Force:YZ (kN/m)

155,0
124,0
93,0
62,0
31,0
0,0
-31,0
-62,0
-93,0
-124,0
-155,0



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

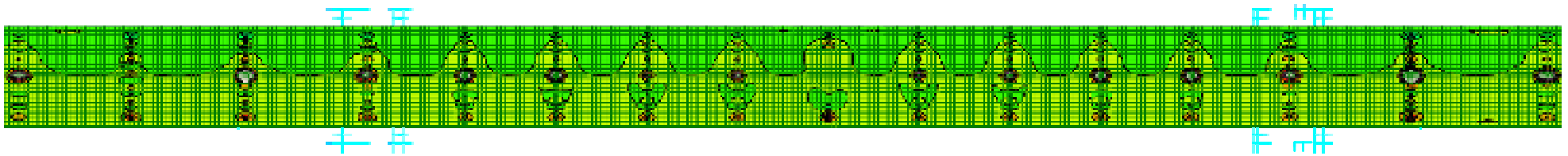
ULS_Wind oder Temperatur leitend_Minimale Querkraft in Querrichtung - Bereiche mit reduzierter Plattenstaerke

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
28 November 2018 5:35 pm

Title:	
Project:	
Author:	Reference:

Plate Force:yz (kN/m)

250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
-200,0
-250,0



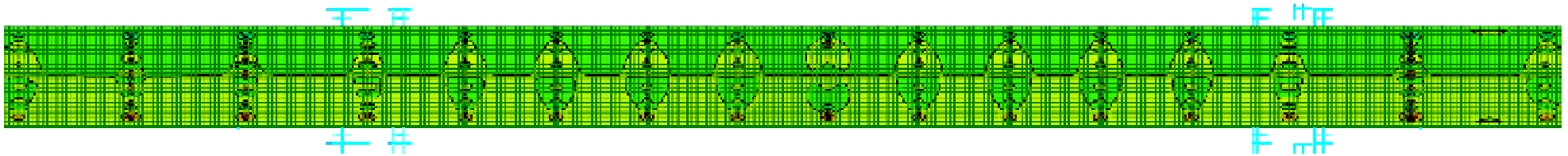
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 90,0 RY: 0,0 RZ: 0,0	138: Envelope Case [Maximum Envelope 2] 1: Freedom Case 1 Scale: 0,0 %

ULS_Erdbeben_Maximale Querkraft in Querrichtung

Title:	
Project:	
Author:	Reference:

Plate Force:yz (kN/m)

250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
-200,0
-250,0



17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 90,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Querkraft in Querrichtung

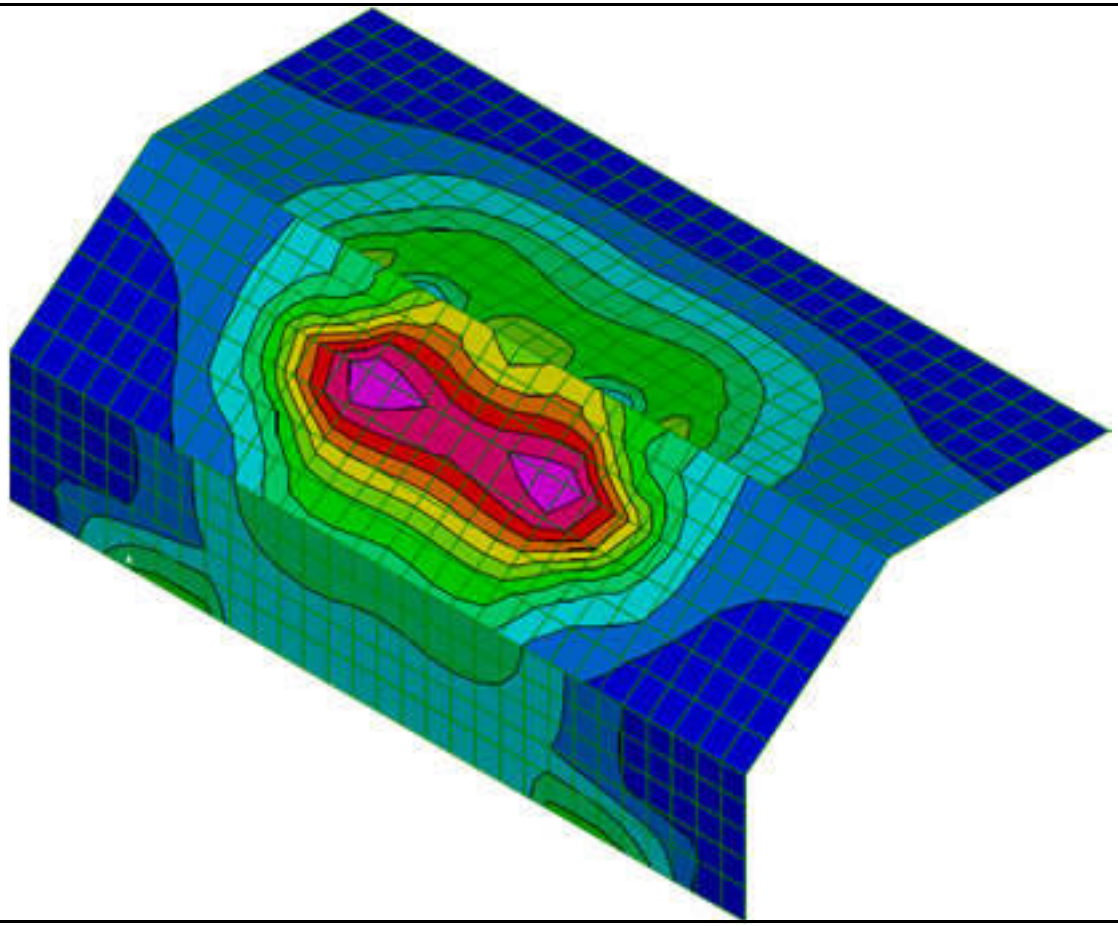
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
15 November 2018 4:51 pm

5.3 Erforderliche Bewehrung und Schnittgrößen Kämpferfundament

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

29,4171 [Pt:14859,Nd:13135]
26,8017
24,1863
21,5709
18,9555
16,34
13,7246
11,1092
8,49379
5,87838
3,26296
0,647539 [Pt:14786,Nd:16629]

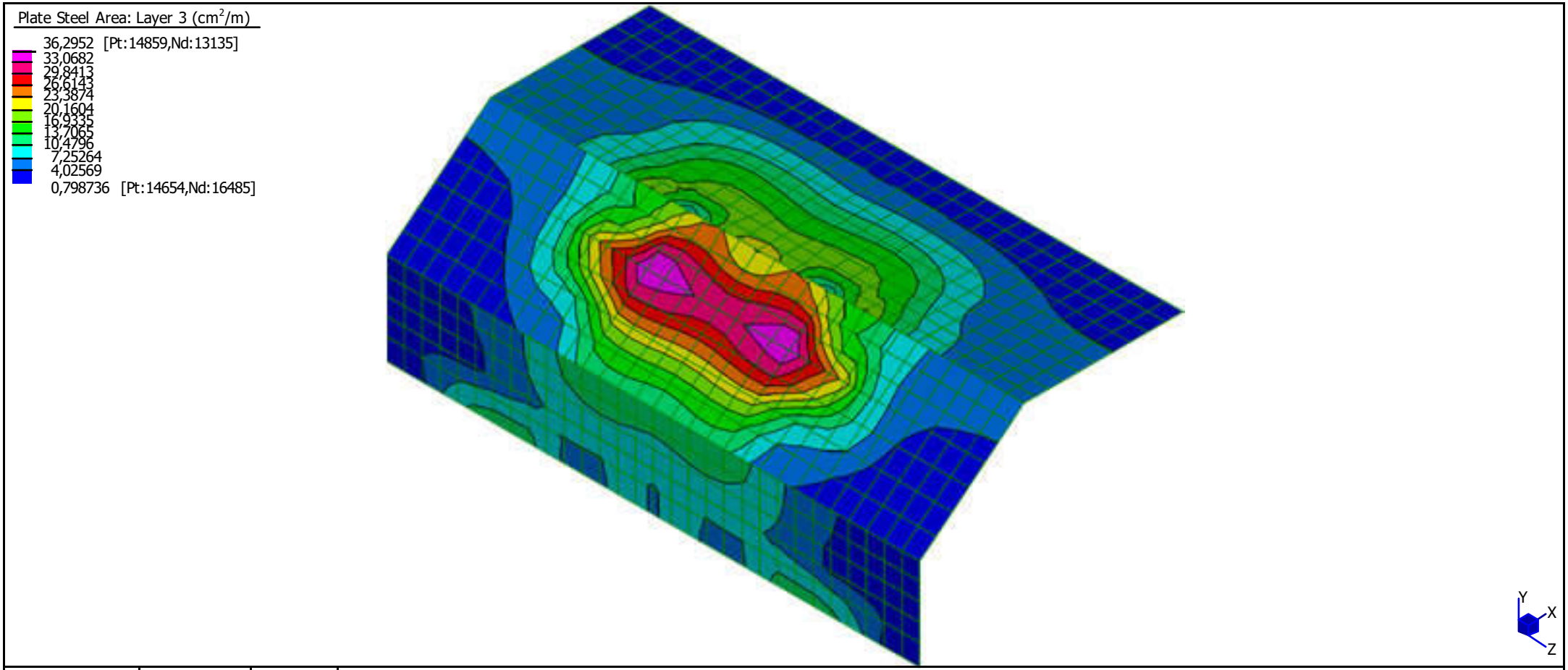


17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Obere Längsbewehrung Kämpferfundament

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 11:50 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

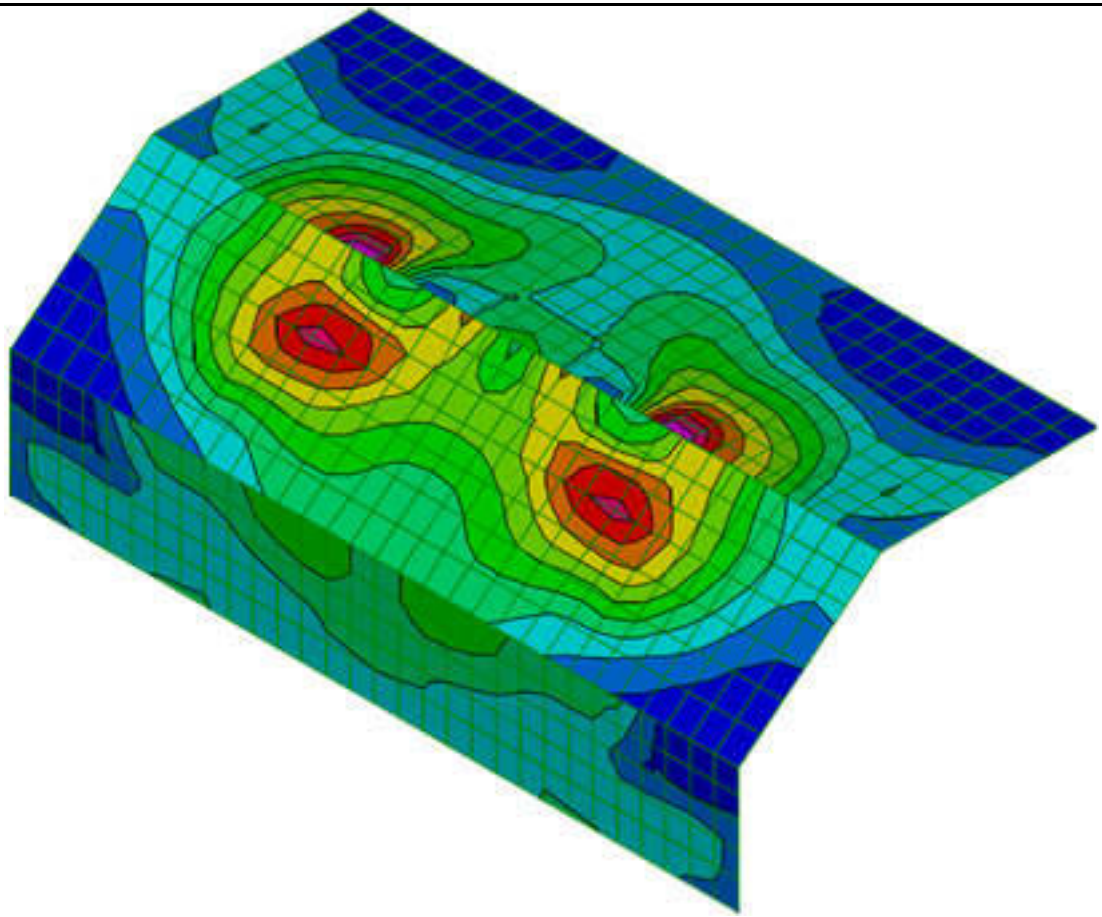
ULS_Wind oder Temperatur leitend_Obere Längsbewehrung Kämpferfundament

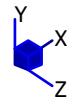
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:32 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 3 (cm^2/m)

54,2301 [Pt:14741,Nd:16558]
49,4581
44,686
39,9139
35,1419
30,3698
25,5978
20,8257
16,0537
11,2816
6,50955
1,73749 [Pt:14624,Nd:16365]





17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Obere Längsbewehrung Kämpferfundament

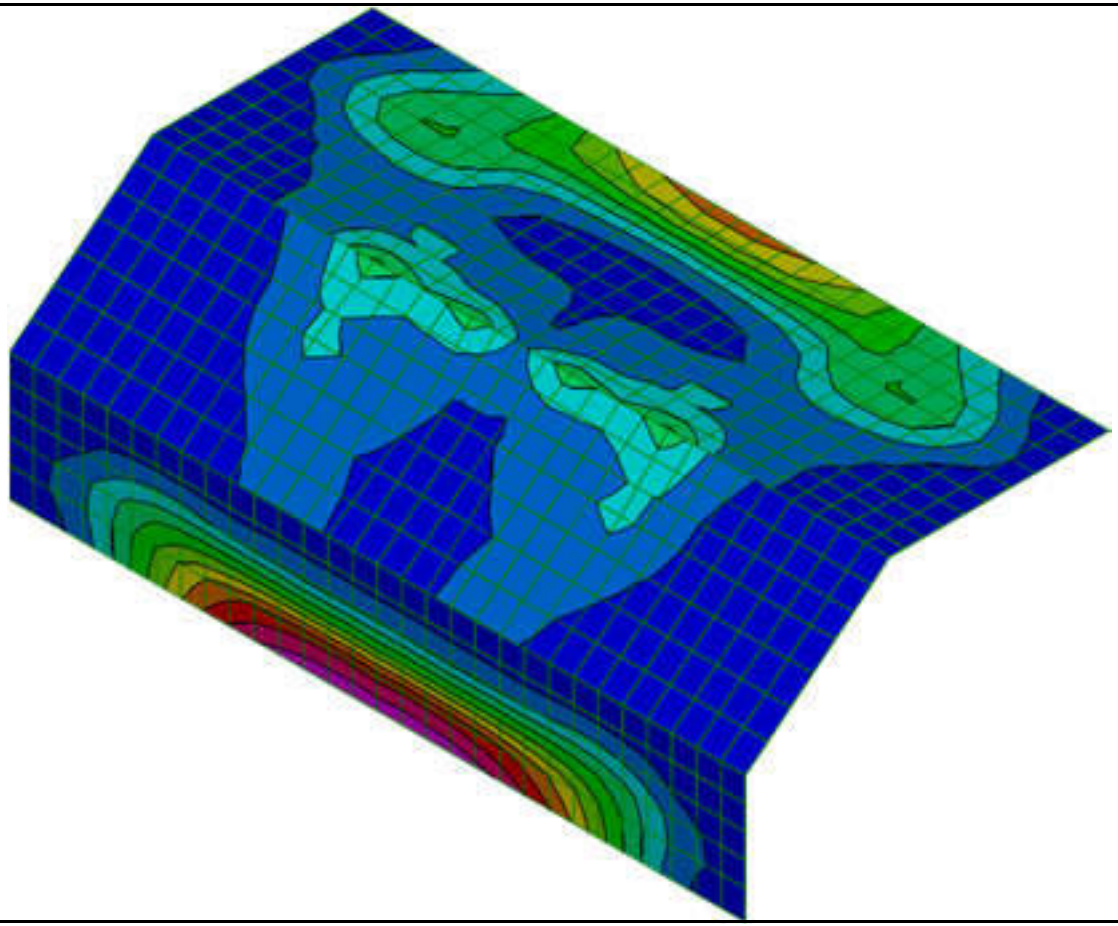
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

14 November 2018 11:18 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

61,8114 [Pt:14802,Nd:16646]
56,2293
50,6473
45,0652
39,4831
33,9011
28,319
22,7369
17,1549
11,5728
5,99073
0,408667 [Pt:14816,Nd:16660]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

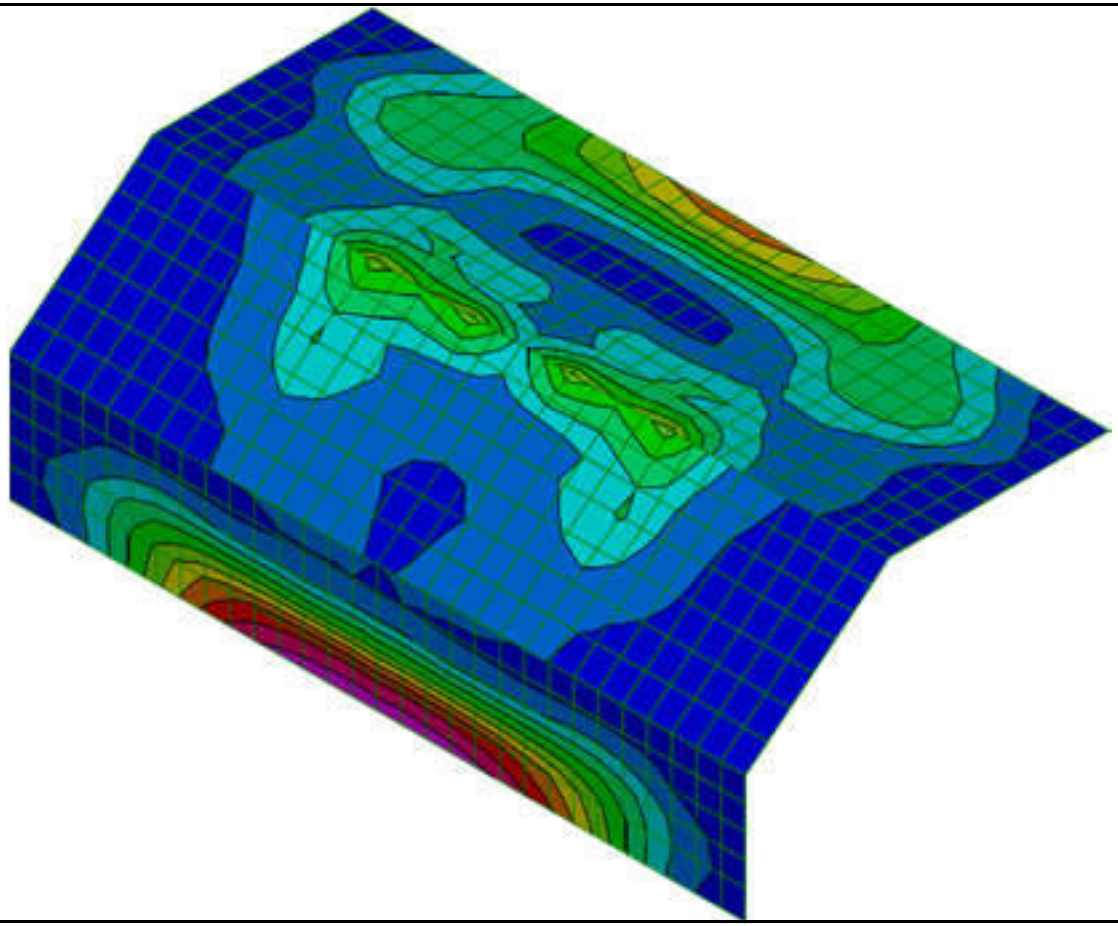
ULS_LM1 leitend_Obere Querbewehrung Kämpferfundament

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 12:32 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

61,8434 [Pt:14802,Nd:16646]
56,2666
50,6897
45,1129
39,536
33,9592
28,3823
22,8055
17,2287
11,6518
6,07498
0,498135 [Pt:14598,Nd:16422]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

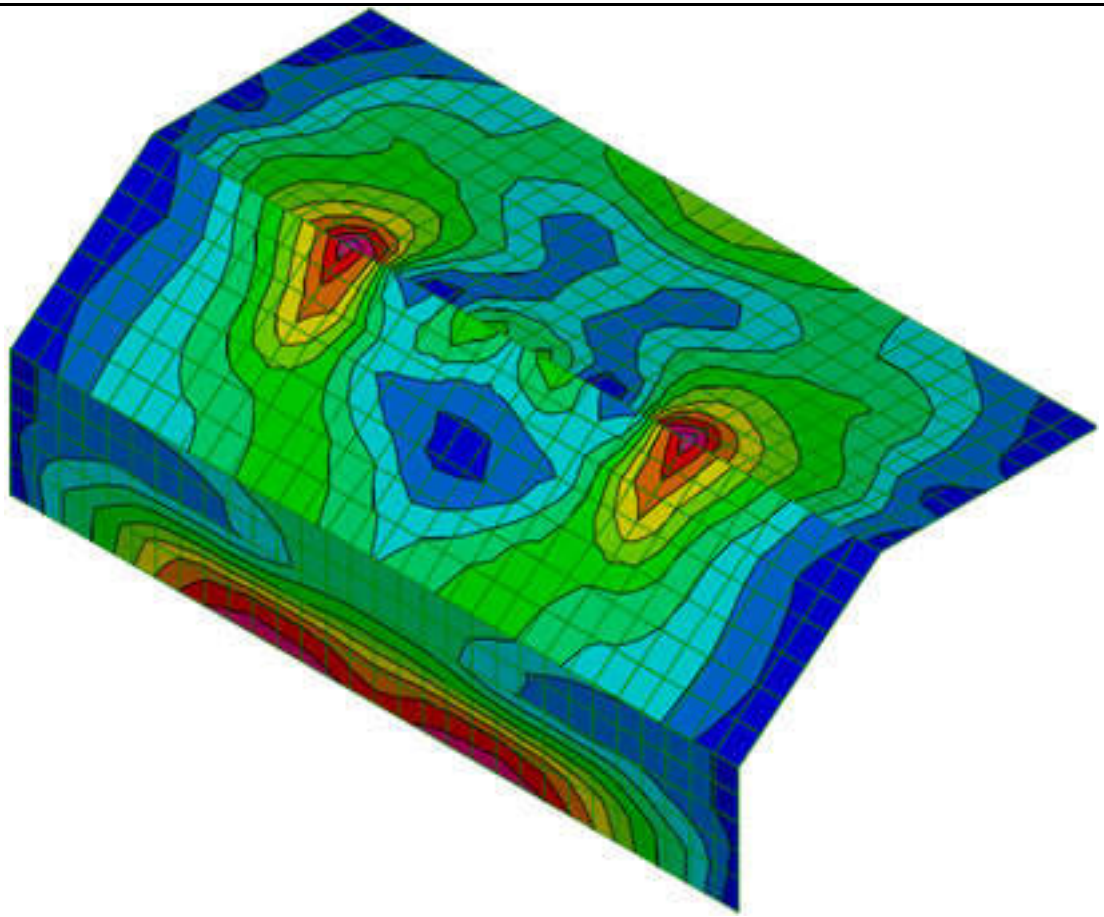
ULS_Wind oder Temperatur leitend_Obere Querbewehrung Kämpferfundament

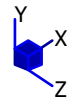
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:15 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 4 (cm^2/m)

65,3791 [Pt:14754,Nd:16571]
59,528
53,6768
47,8257
41,9746
36,1235
30,2723
24,4212
18,5701
12,719
6,86783
1,0167 [Pt:14598,Nd:16422]





17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Obere Querbewehrung Kämpferfundament

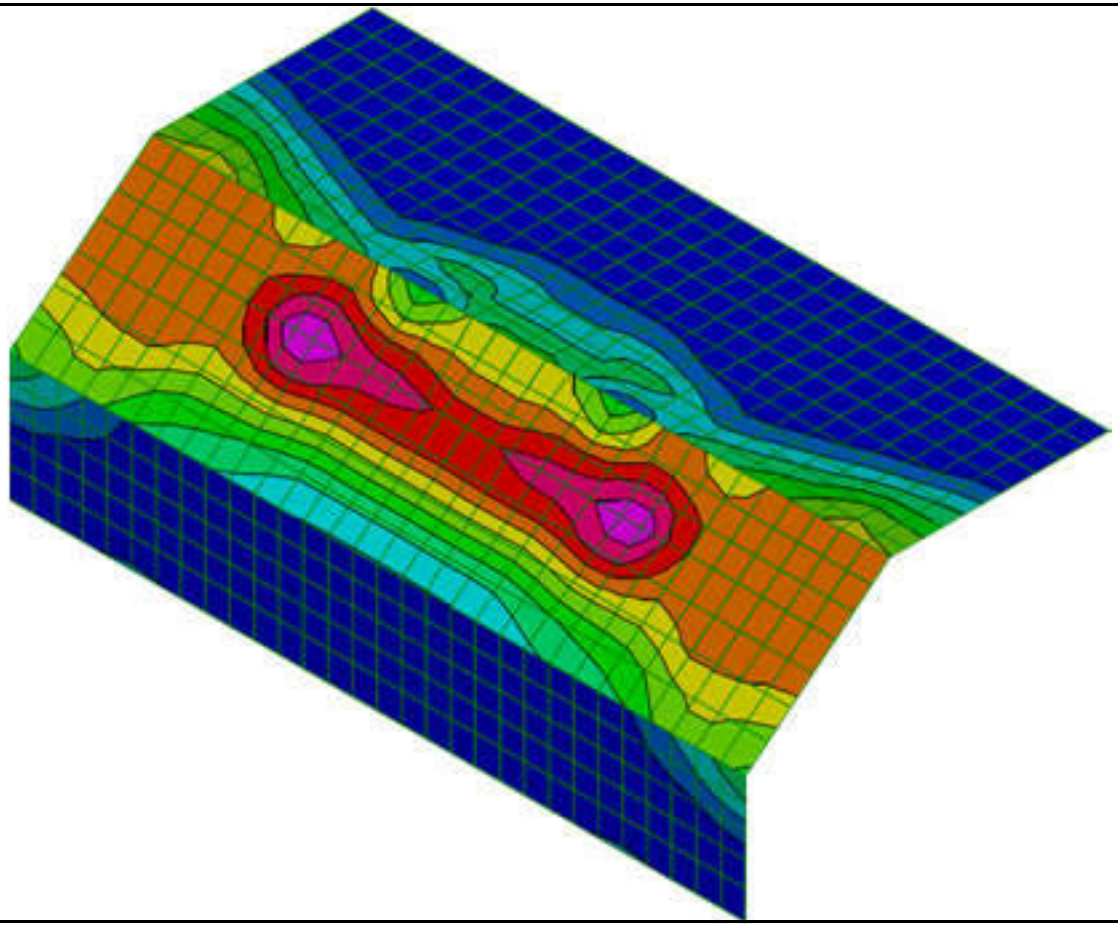
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

14 November 2018 11:27 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

130,336 [Pt:14861,Nd:13159]
118,626
106,916
95,206
83,4959
71,7857
60,0756
48,3654
36,6553
24,9452
13,235
1,52486 [Pt:14582,Nd:16386]

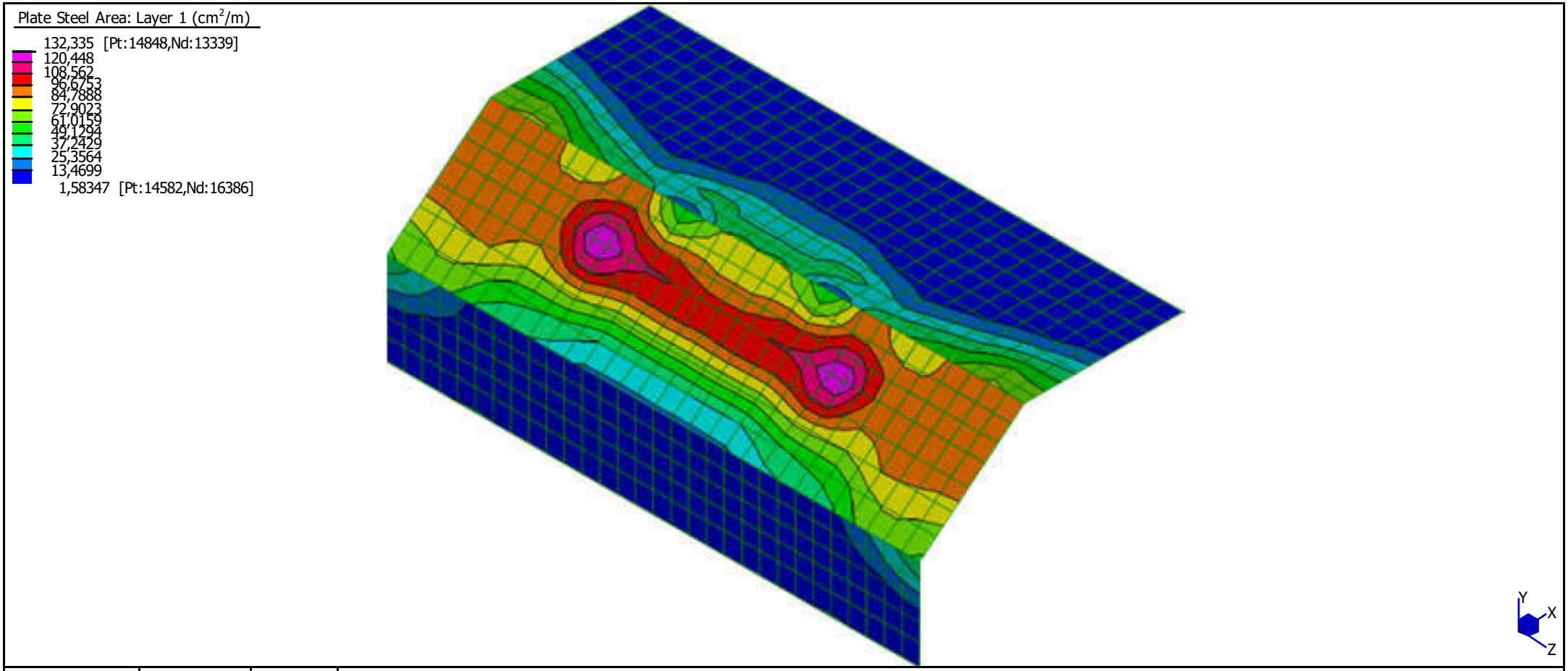


17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Untere Längsbewehrung Kämpferfundament

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 12:18 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

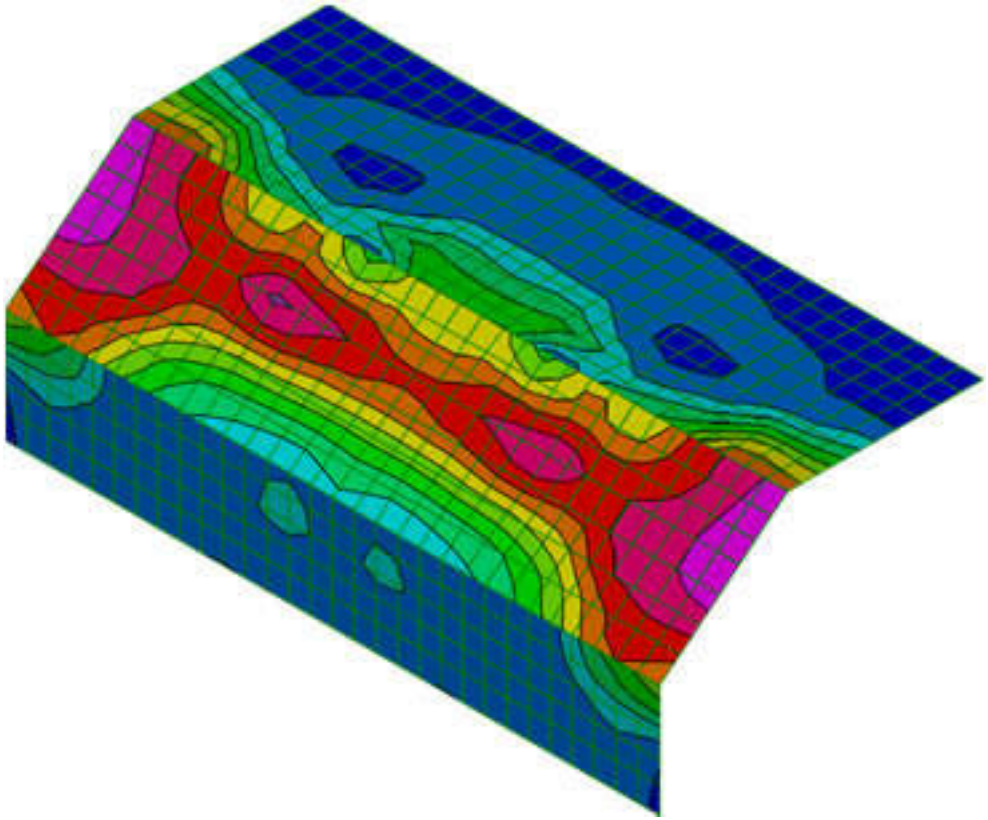
ULS_Wind oder Temperatur leitend_Untere Längsbewehrung Kämpferfundament

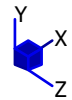
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:22 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 1 (cm^2/m)

103,835 [Pt:15415,Nd:17251]
94,5435
85,2516
75,9598
66,6679
57,376
48,0842
38,7923
29,5004
20,2086
10,9167
1,62484 [Pt:14653,Nd:16484]





17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Untere Längsbewehrung Kämpferfundament

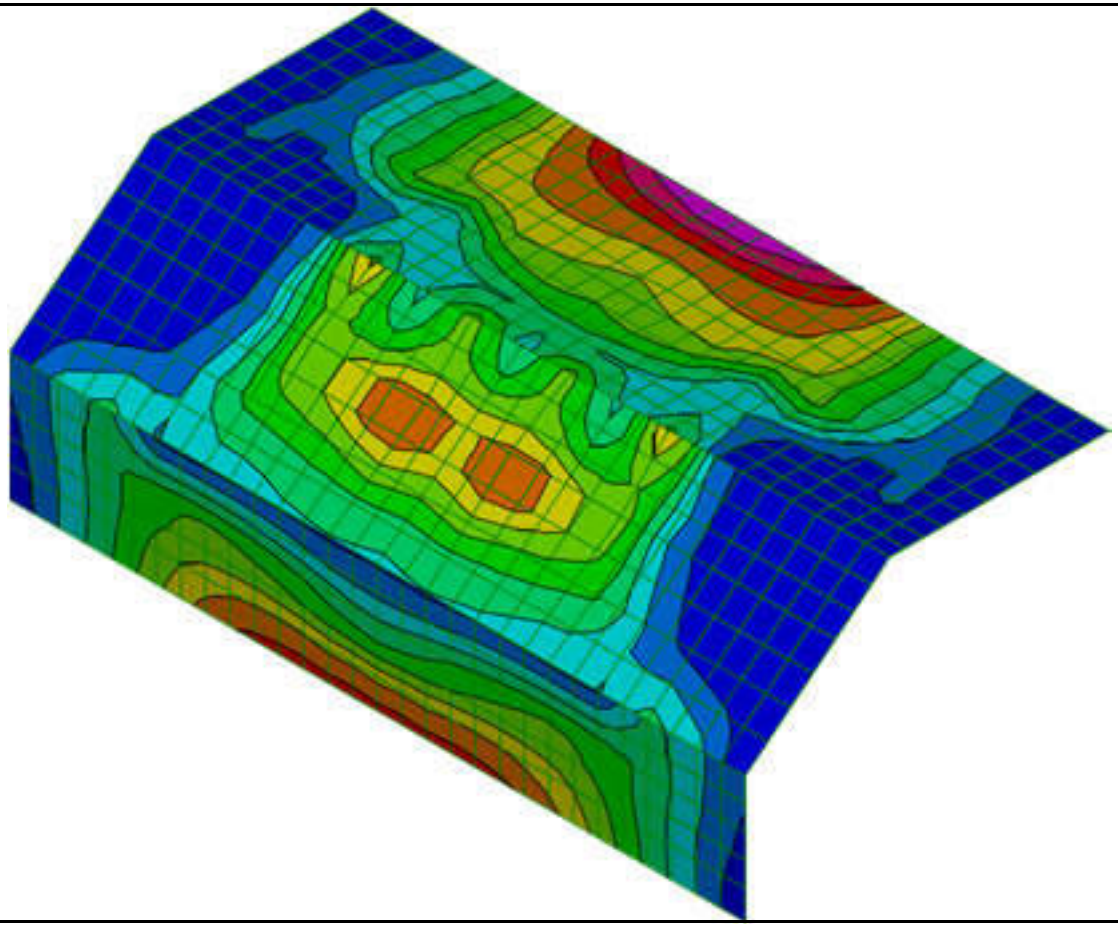
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

14 November 2018 11:14 am

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

76,5719 [Pt:14640,Nd:16471]
69,6588
62,7458
55,8327
48,9197
42,0066
35,0936
28,1806
21,2675
14,3545
7,44142
0,528373 [Pt:14627,Nd:16457]



17430 Nodes	0 Vertices	View	225: ULS_LM1 (leitend) [Factors Max Envelope 4]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

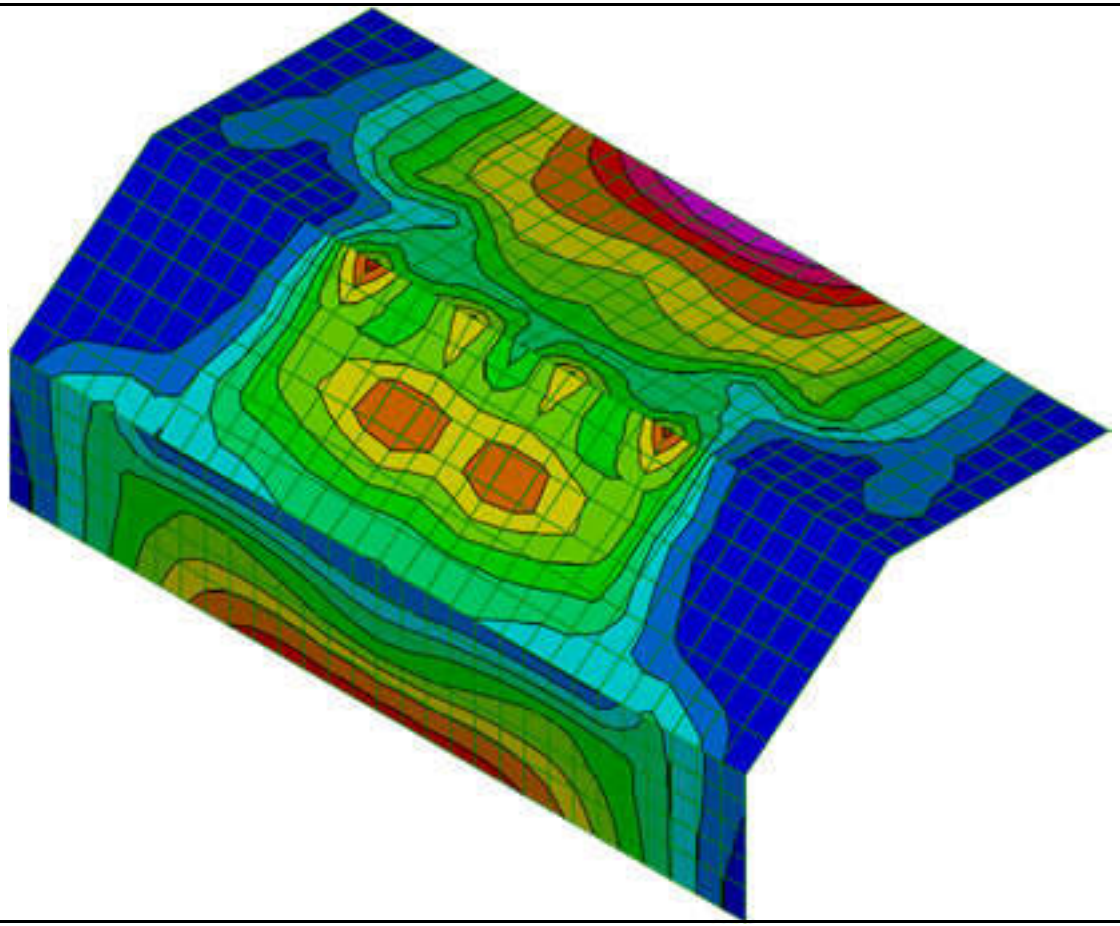
ULS_LM1 leitend_Untere Querbewehrung Kämpferfundament

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 12:28 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

75,3113 [Pt:14640,Nd:16471]
68,5179
61,7246
54,9312
48,1379
41,3446
34,5512
27,7579
20,9645
14,1712
7,37785
0,584508 [Pt:14627,Nd:17349]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

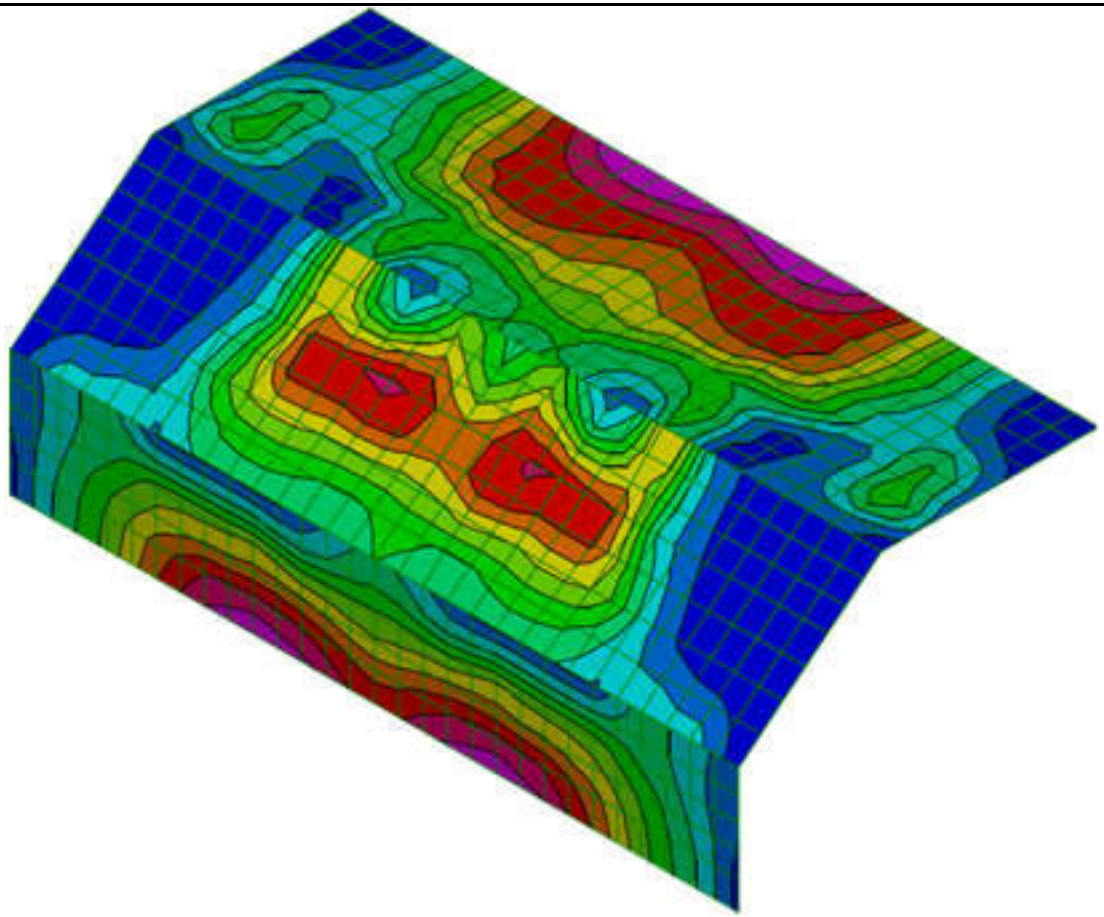
ULS_Wind oder Temperatur leitend_Untere Querbewehrung Kämpferfundament

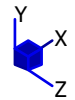
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:18 pm

Title:	
Project:	
Author:	Reference:

Plate Steel Area: Layer 2 (cm^2/m)

61,7398 [Pt:14642,Nd:16473]
56,2395
50,7391
45,2387
39,7384
34,238
28,7376
23,2373
17,7369
12,2365
6,73615
1,23578 [Pt:14627,Nd:16457]





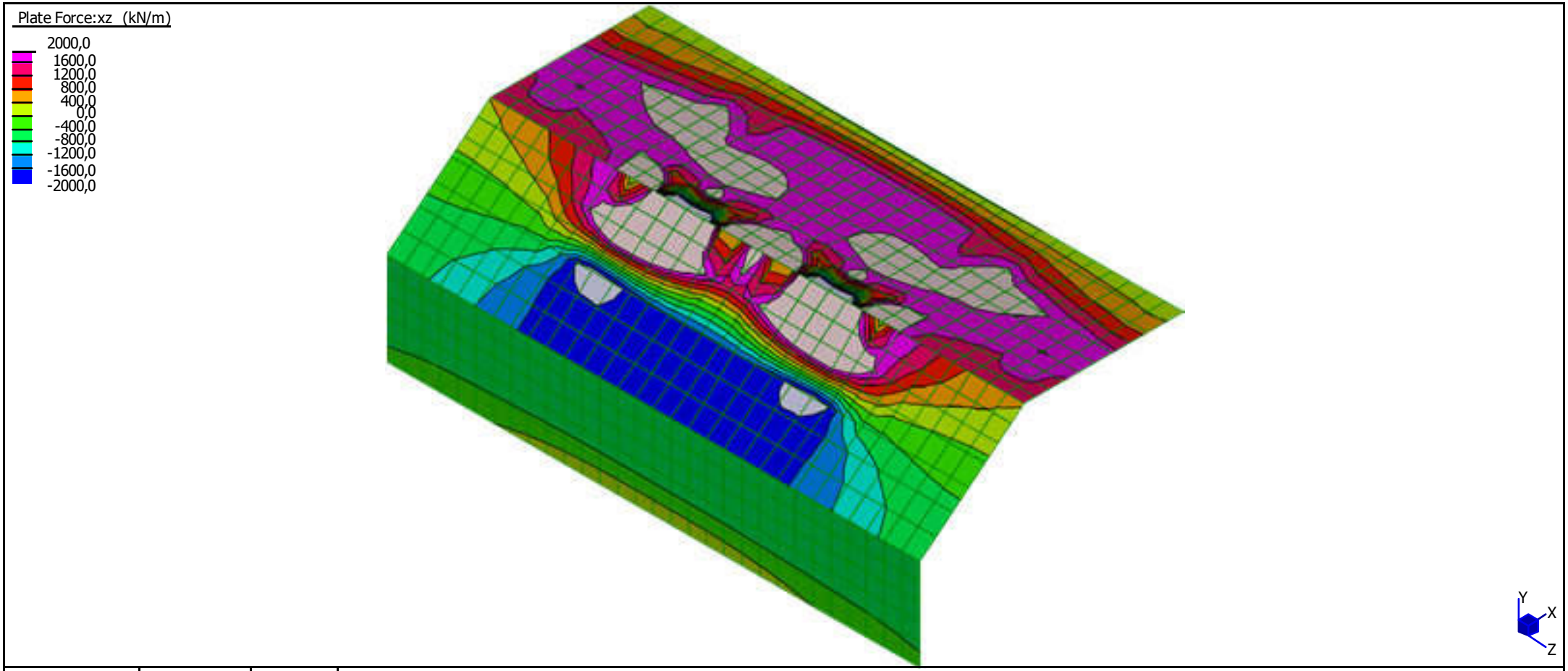
17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Untere Querbewehrung Kämpferfundament

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA

14 November 2018 11:22 am

Title:	
Project:	
Author:	Reference:

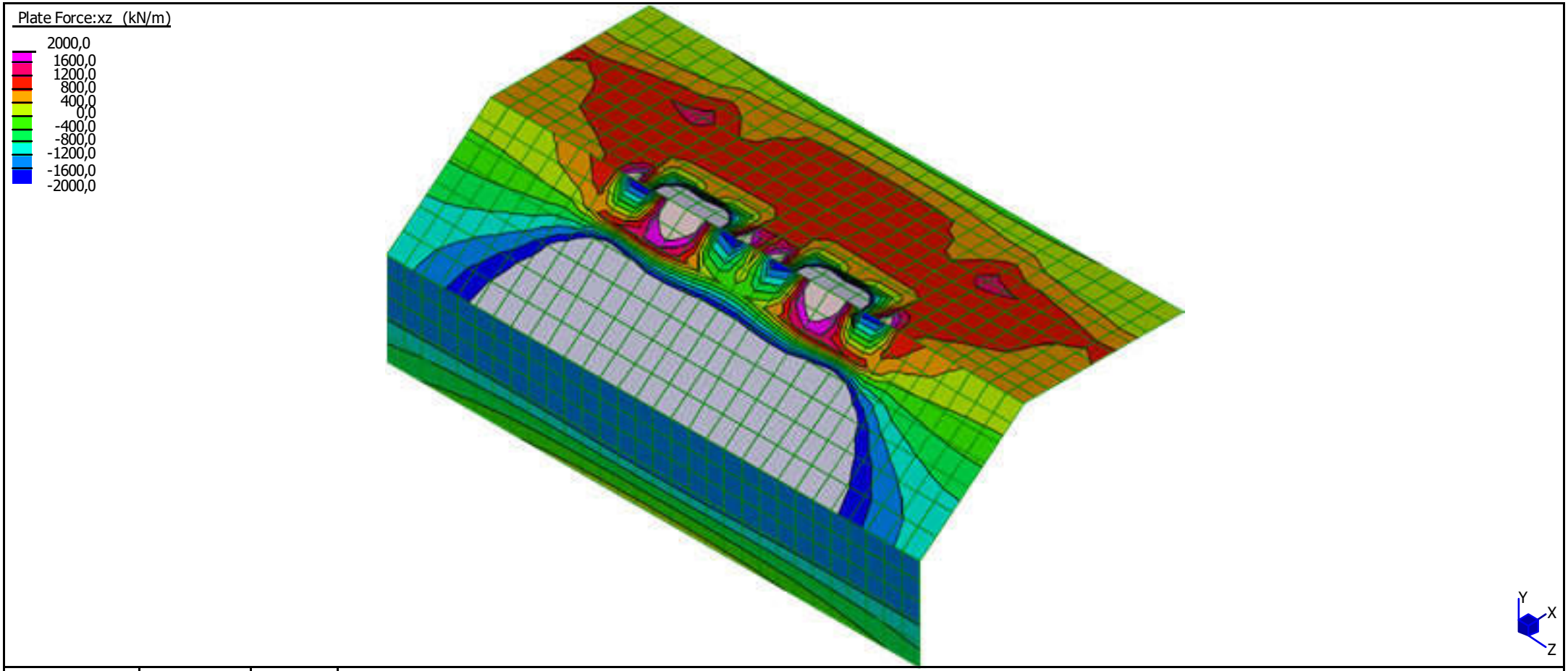


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:45 pm

Title:	
Project:	
Author:	Reference:

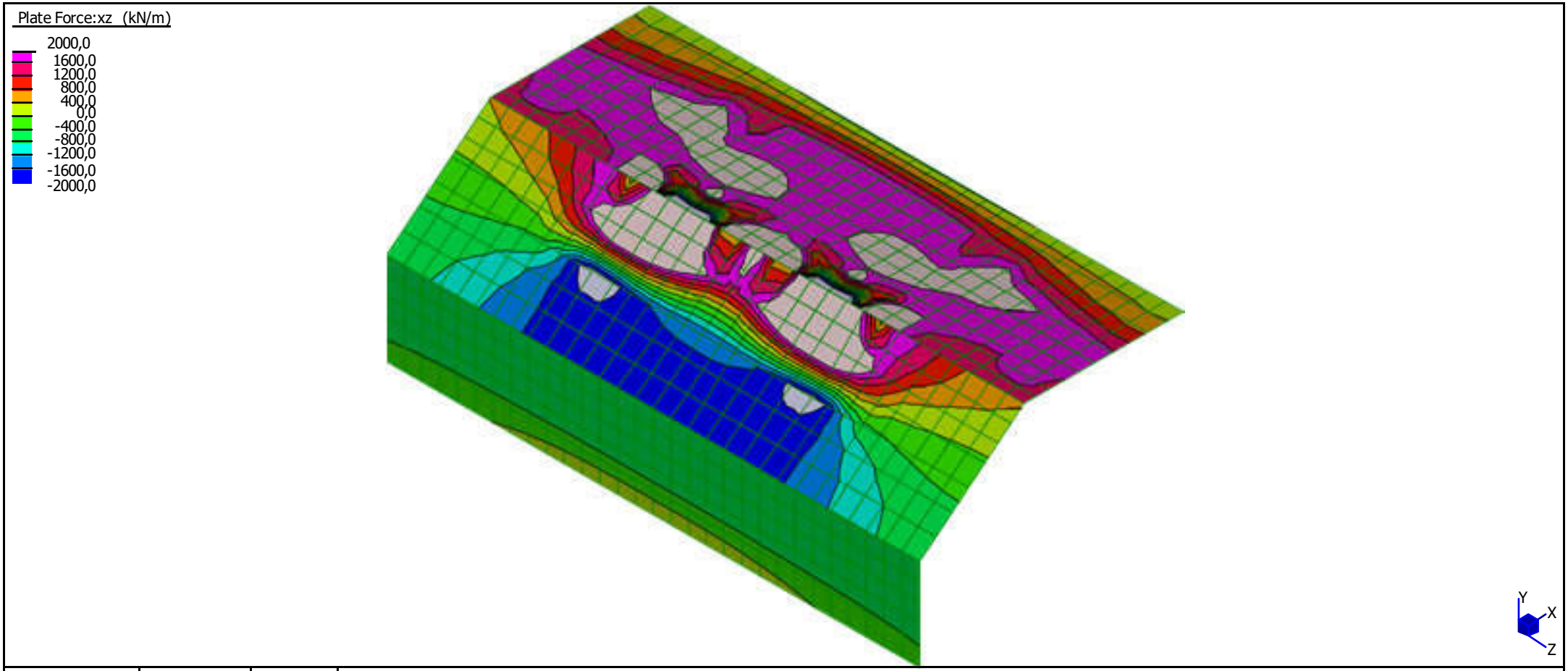


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Minimale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:44 pm

Title:	
Project:	
Author:	Reference:

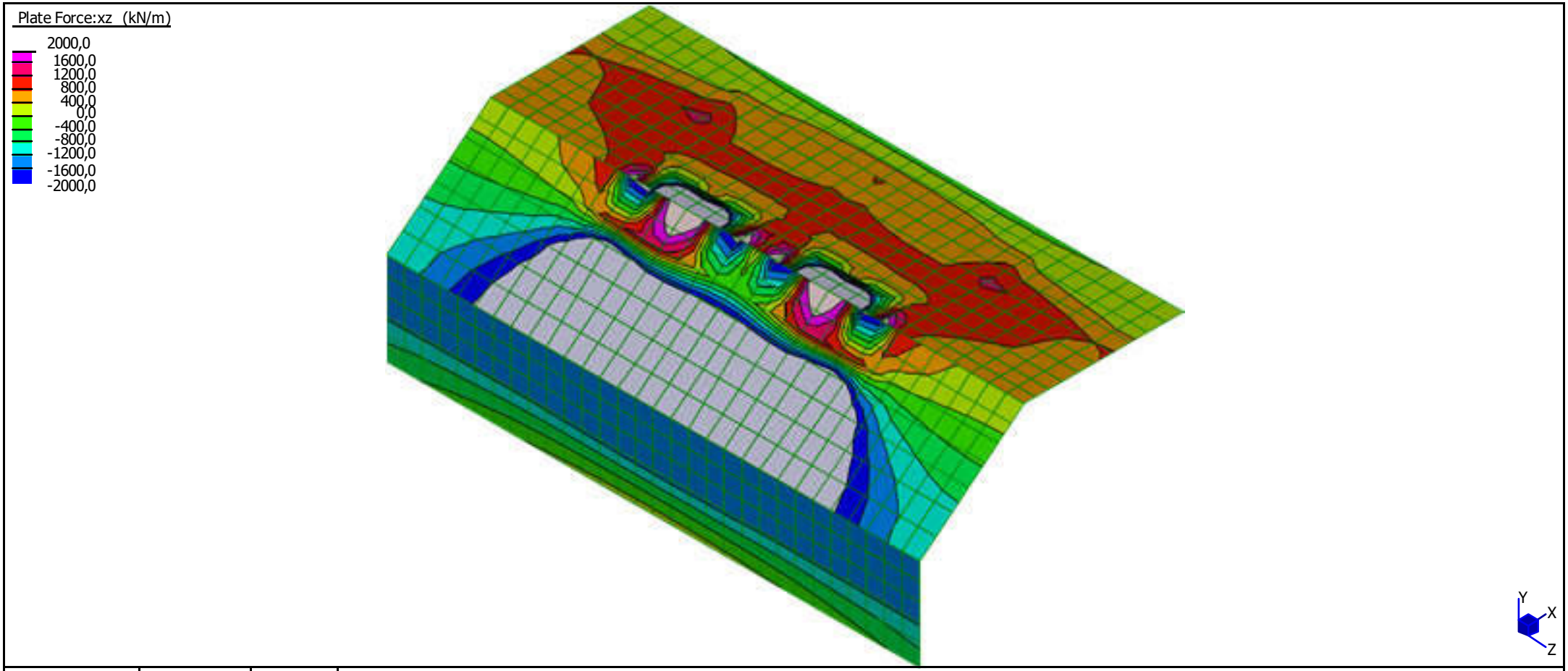


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:57 pm

Title:	
Project:	
Author:	Reference:

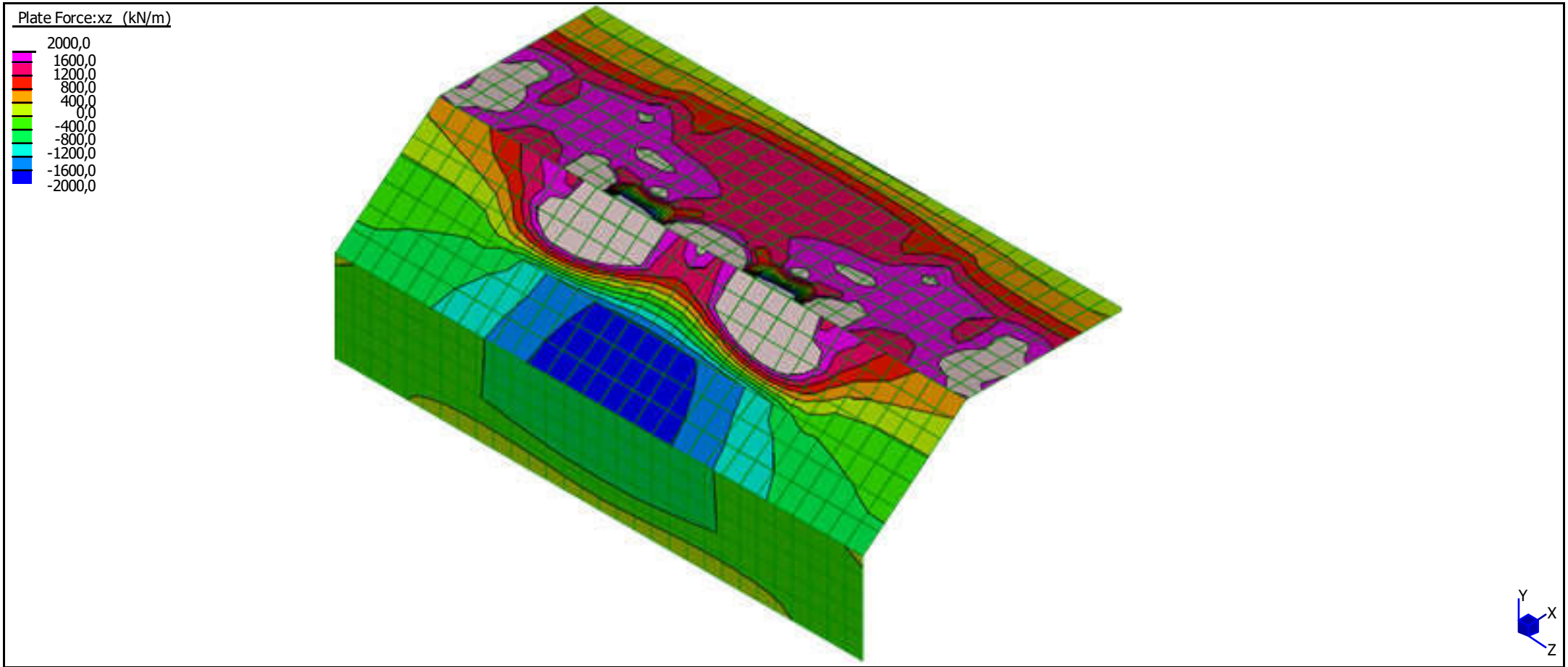


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:58 pm

Title:	
Project:	
Author:	Reference:

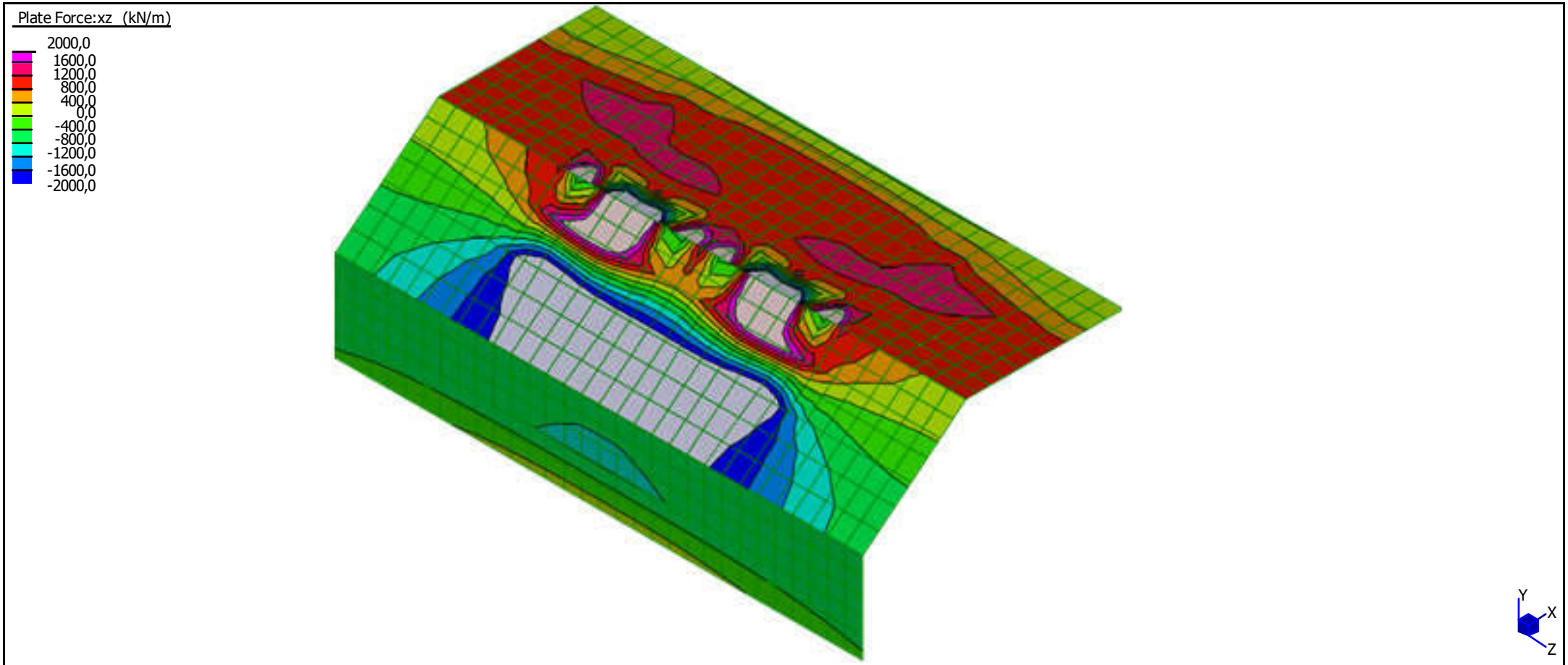


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	138: Envelope Case [Maximum Envelope 2] 1: Freedom Case 1 Scale: 0,0 %

ULS_Erdbeben_Maximale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 11:30 am

Title:	
Project:	
Author:	Reference:

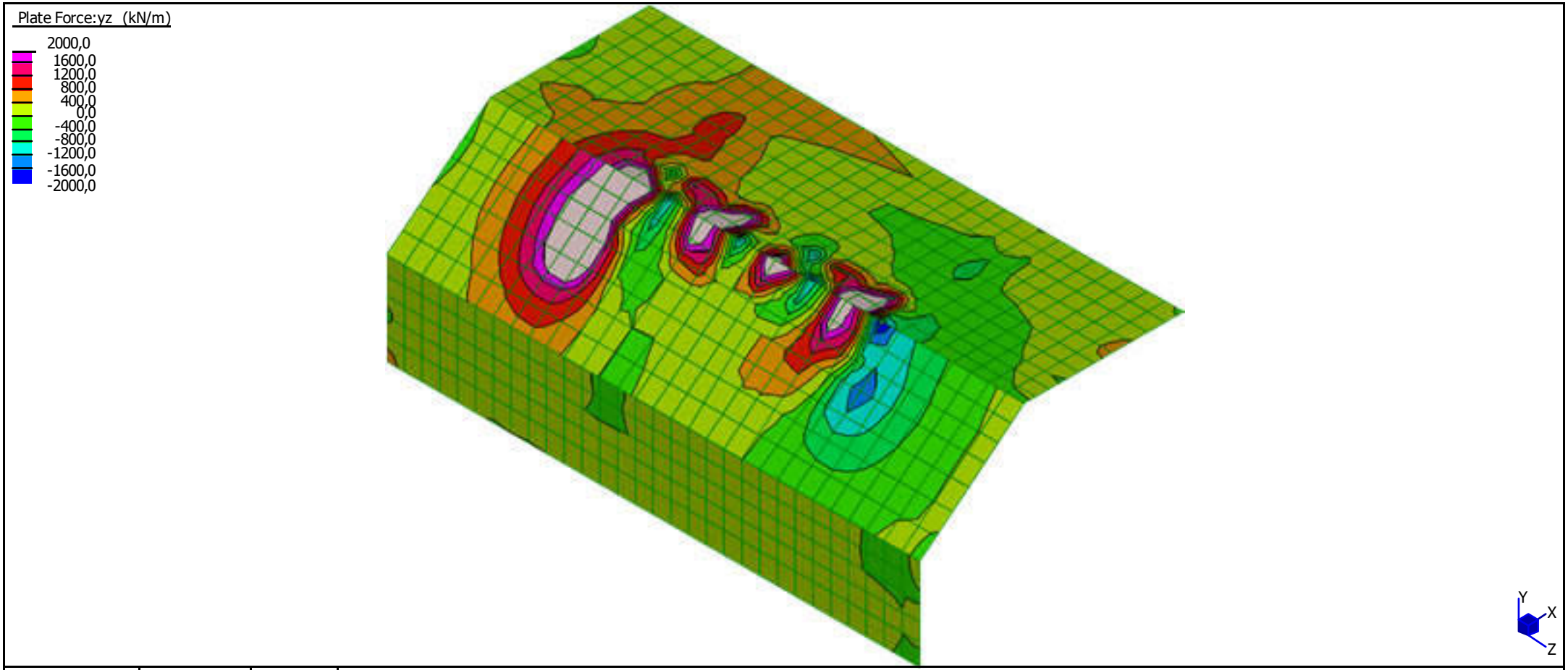


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	137: Envelope Case [Minimum Envelope 1] 1: Freedom Case 1 Scale: 0,0 %

ULS_Erdbeben_Minimale Querkraft Kämpferfundament in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 11:29 am

Title:	
Project:	
Author:	Reference:

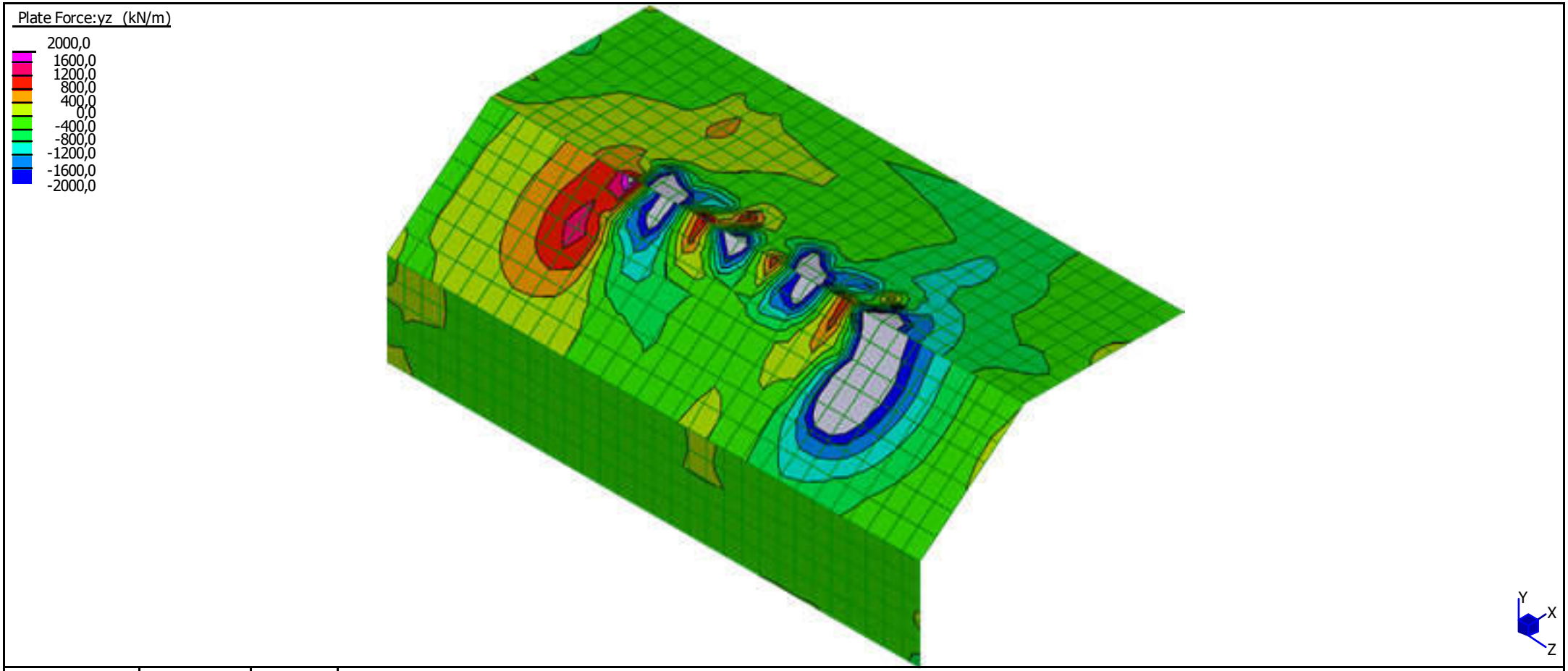


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft Kämpferfundament in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:50 pm

Title:	
Project:	
Author:	Reference:

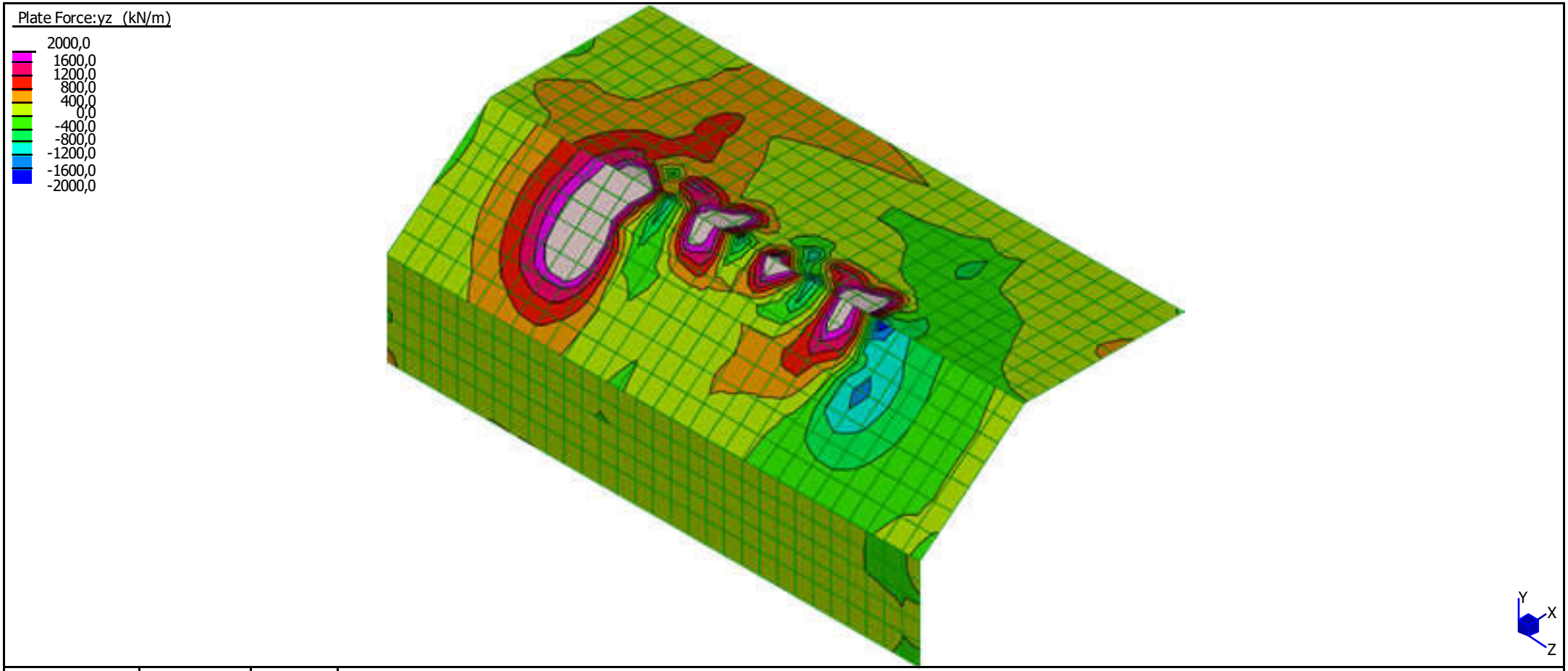


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Minimale Querkraft Kämpferfundament in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:51 pm

Title:	
Project:	
Author:	Reference:

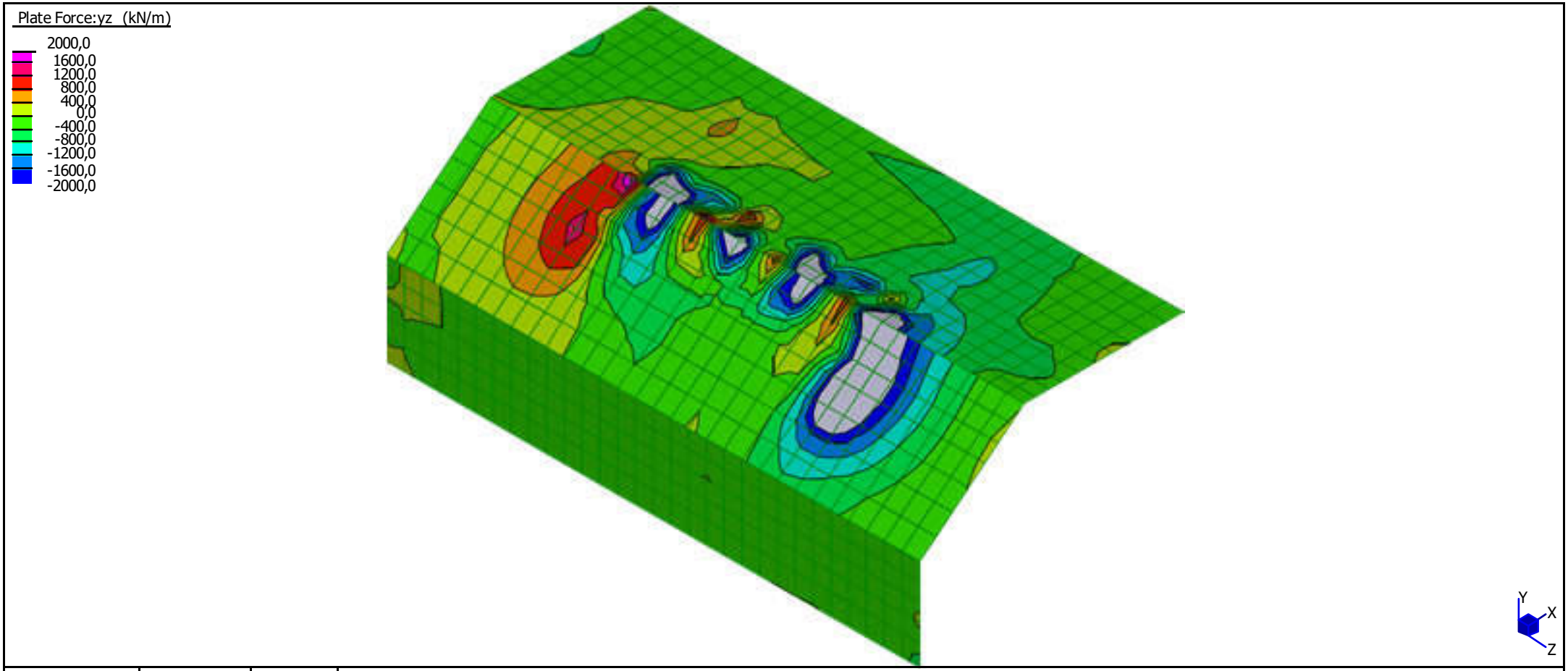


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft Kämpferfundament in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:56 pm

Title:	
Project:	
Author:	Reference:

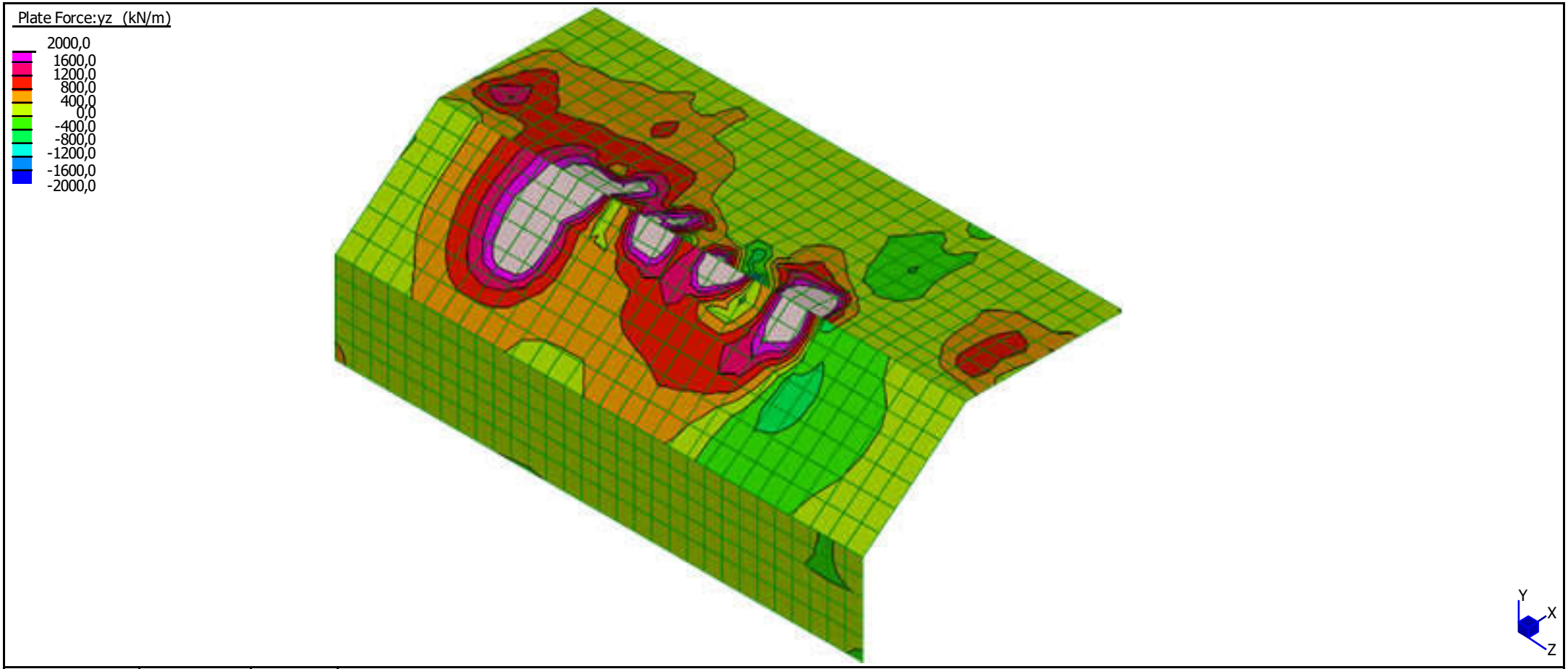


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Querkraft Kämpferfundament in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 2:54 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	138: Envelope Case [Maximum Envelope 2] 1: Freedom Case 1 Scale: 0,0 %

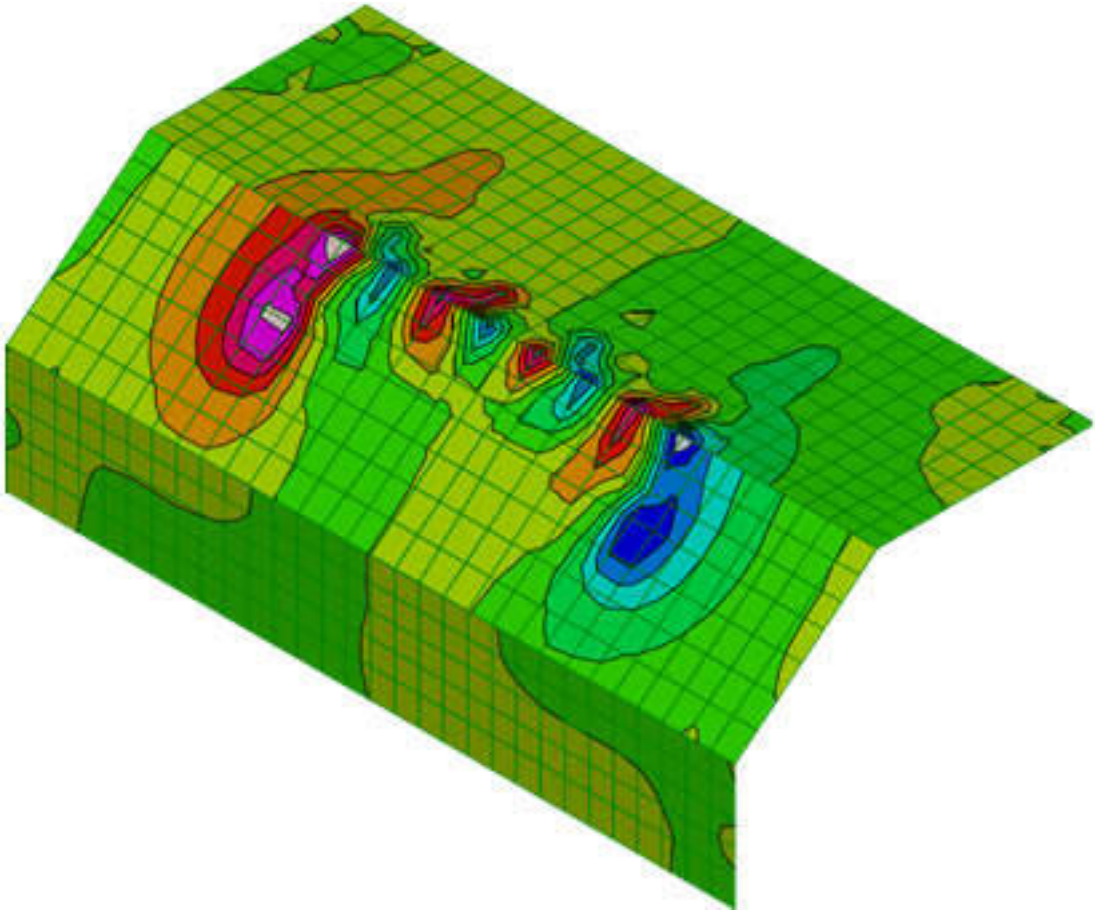
ULS_Erdbeben_Maximale Querkraft Kämpferfundament in Querrichtung

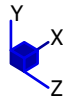
Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 11:33 am

Title:	
Project:	
Author:	Reference:

Plate Force:yz (kN/m)

2000,0
1600,0
1200,0
800,0
400,0
0,0
-400,0
-800,0
-1200,0
-1600,0
-2000,0





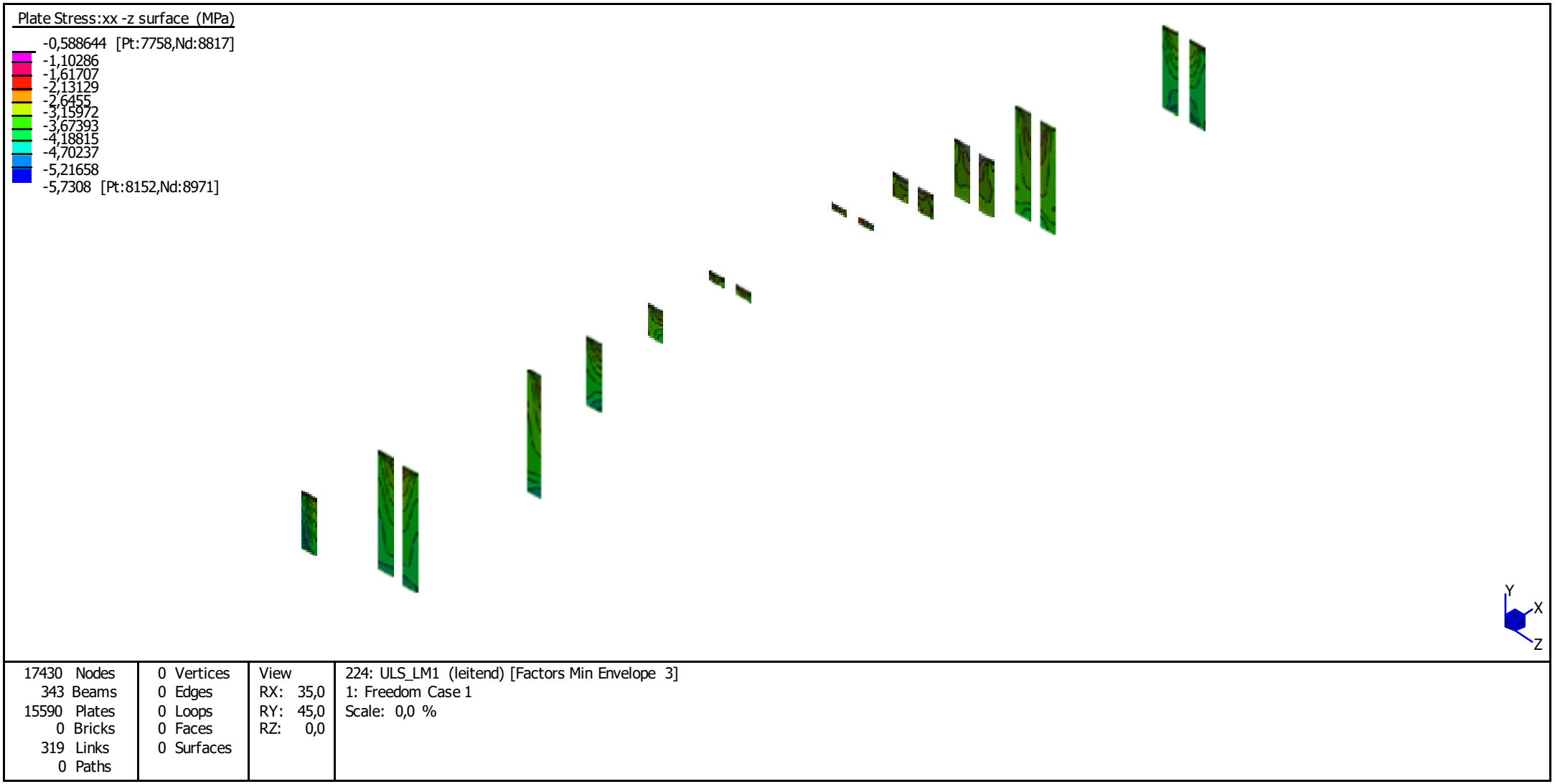
17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Maximale Querkraft Kämpferfundament in Querrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 11:32 am

5.4 Weitere Schnittgrößen bei Pfeiler und Stiele

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

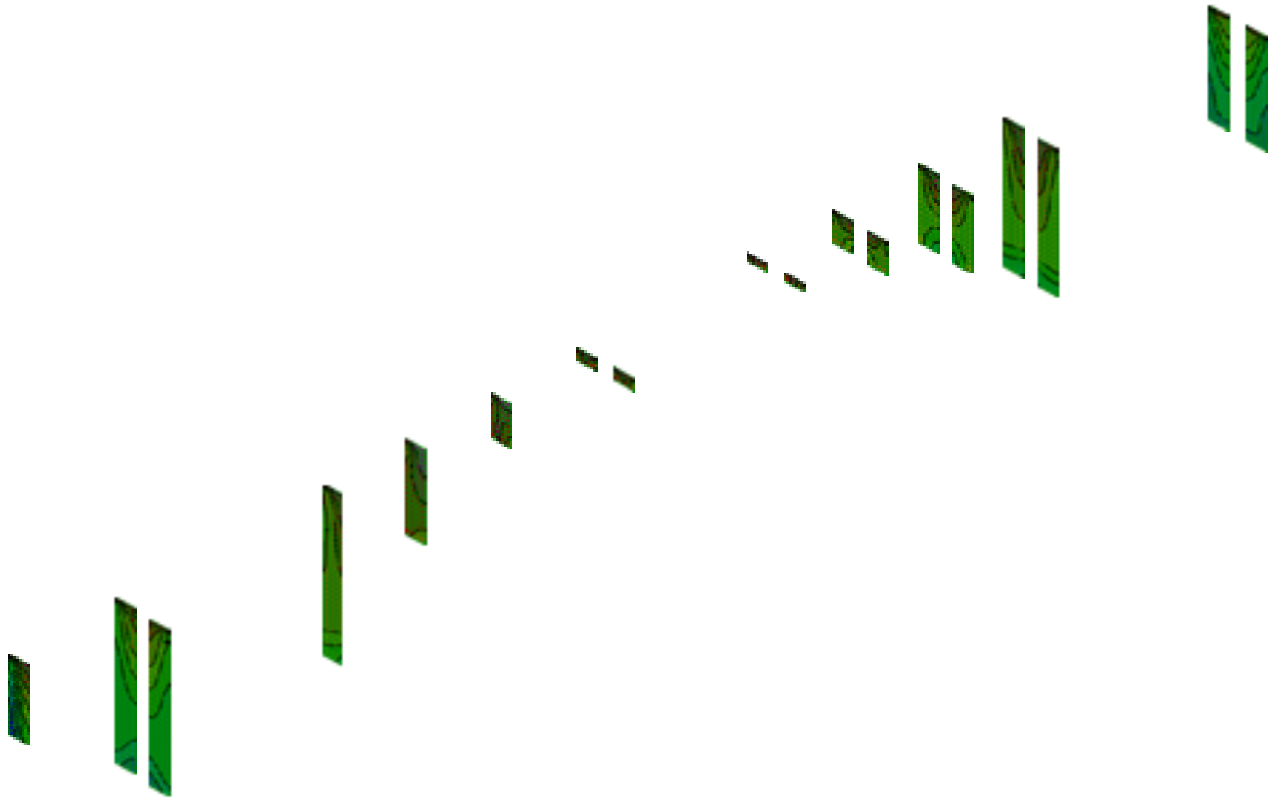
ULS_LM1 leitend_Größter Druck Pfeiler Seite Lana

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:42 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx +z surface (MPa)

-0,555934 [Pt:7755,Nd:8811]
-1,12274
-1,68955
-2,25636
-2,82317
-3,38998
-3,95678
-4,52359
-5,0904
-5,65721
-6,22402 [Pt:8152,Nd:8971]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

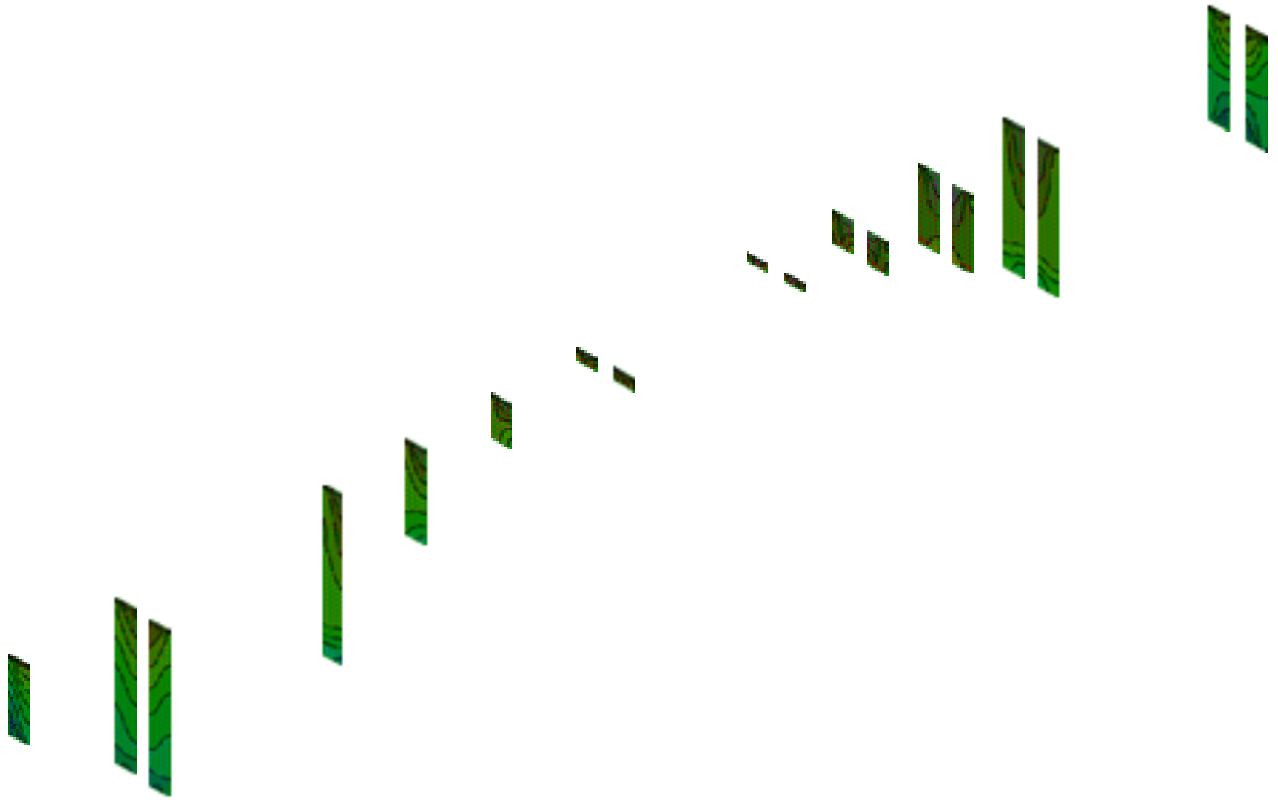
ULS_LM1 leitend_Größter Druck Pfeiler Seite St Pankraz

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:42 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx -z surface (MPa)

-0,552289 [Pt:7758,Nd:8817]
-1,1664
-1,78052
-2,39463
-3,00875
-3,62286
-4,23698
-4,85109
-5,46521
-6,07932
-6,69343 [Pt:9153,Nd:8794]



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

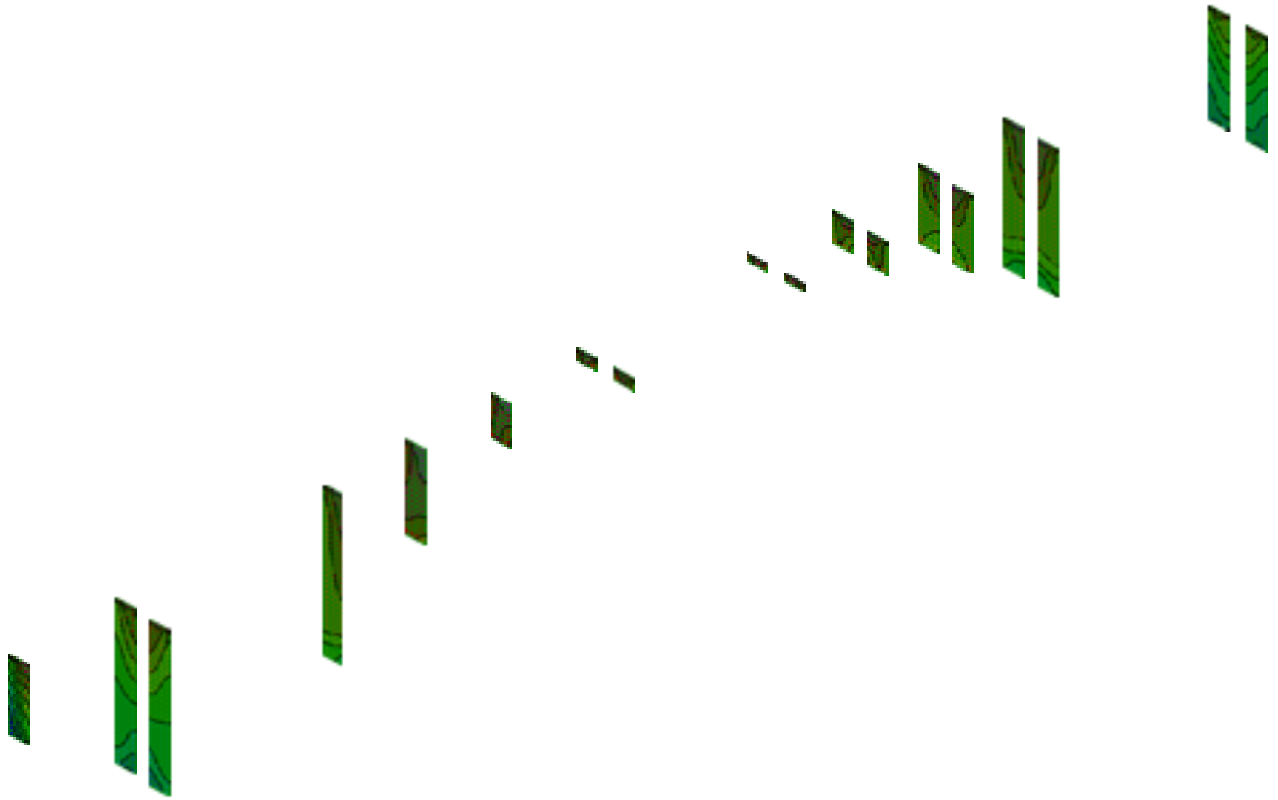
ULS_Wind oder Temperatur leitend_Größter Druck Pfeiler Seite Lana

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:40 am

Title:	
Project:	
Author:	Reference:

Plate Stress:xx +z surface (MPa)

-0,526998 [Pt:7755,Nd:8811]
-1,19865
-1,87031
-2,54196
-3,21362
-3,88527
-4,55692
-5,22858
-5,90023
-6,57189
-7,24354 [Pt:8152,Nd:8971]

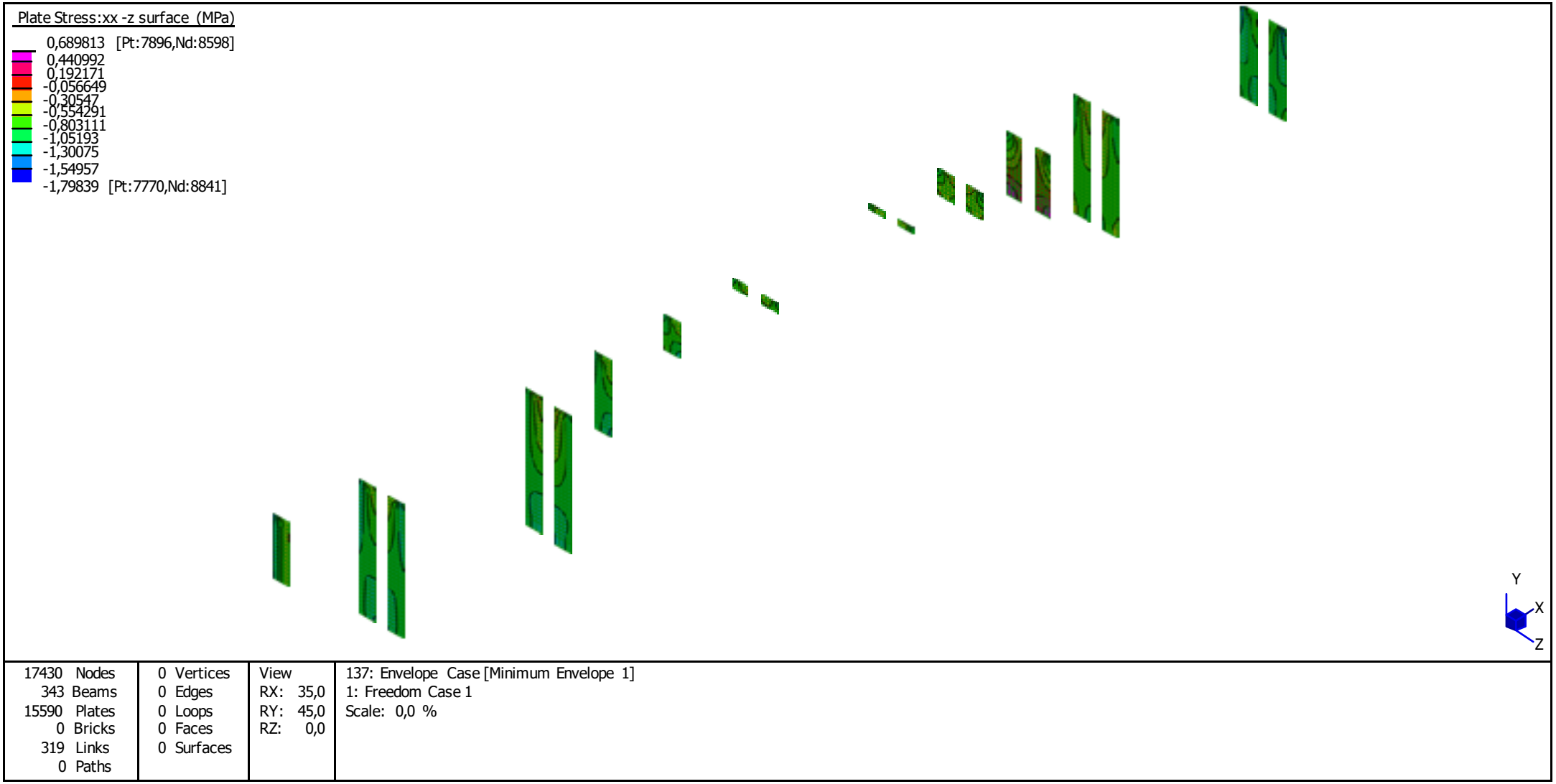


17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Größter Druck Pfeiler Seite St Pankraz

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:41 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

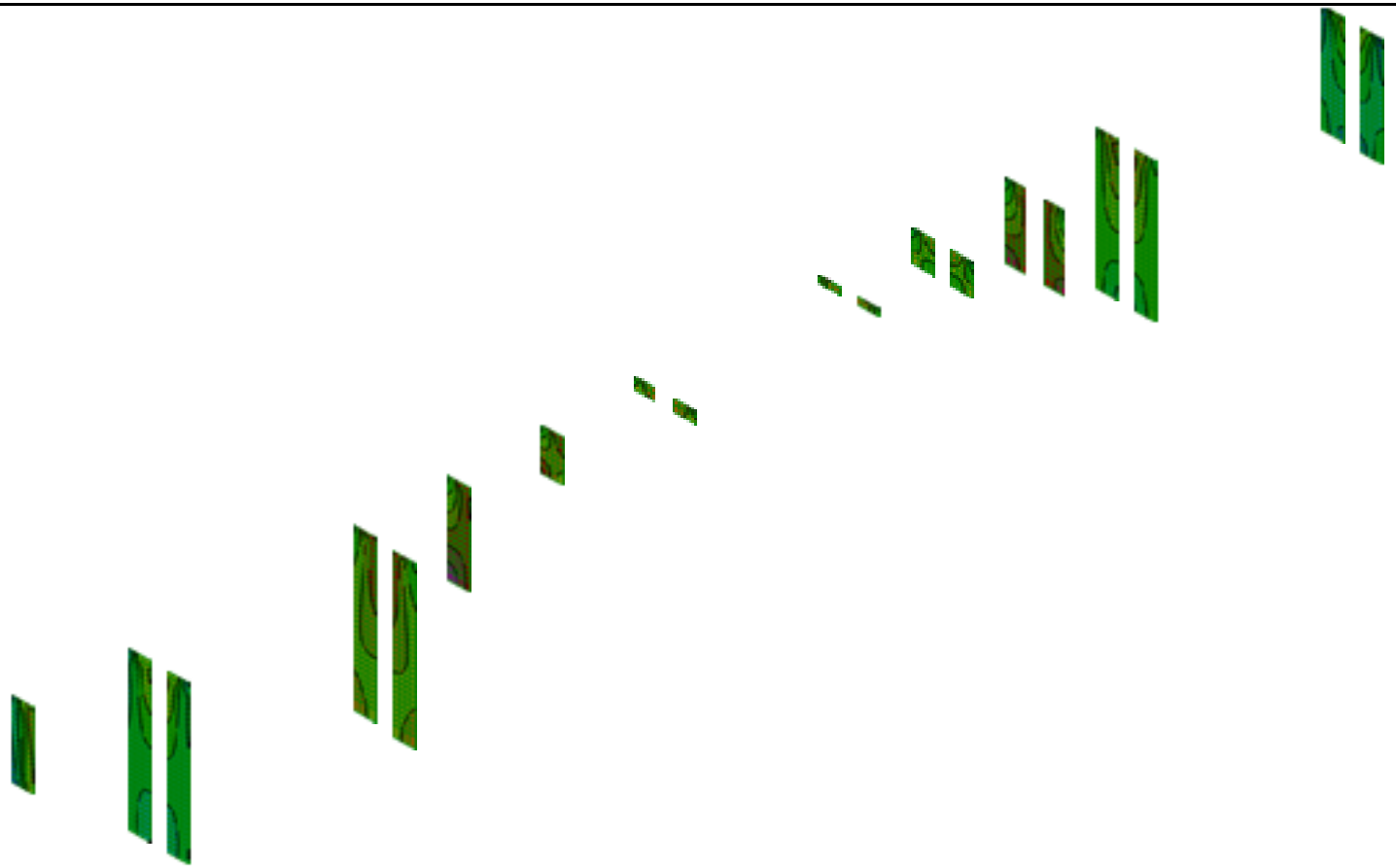
ULS_Erdbeben_Größter Druck Pfeiler Seite Lana

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:34 pm

Title:	
Project:	
Author:	Reference:

Plate Stress:xx +z surface (MPa)

0,409908 [Pt:7878,Nd:8527]
0,179142
-0,051624
-0,28239
-0,513157
-0,743923
-0,974689
-1,20546
-1,43622
-1,66699
-1,89775 [Pt:7770,Nd:8841]

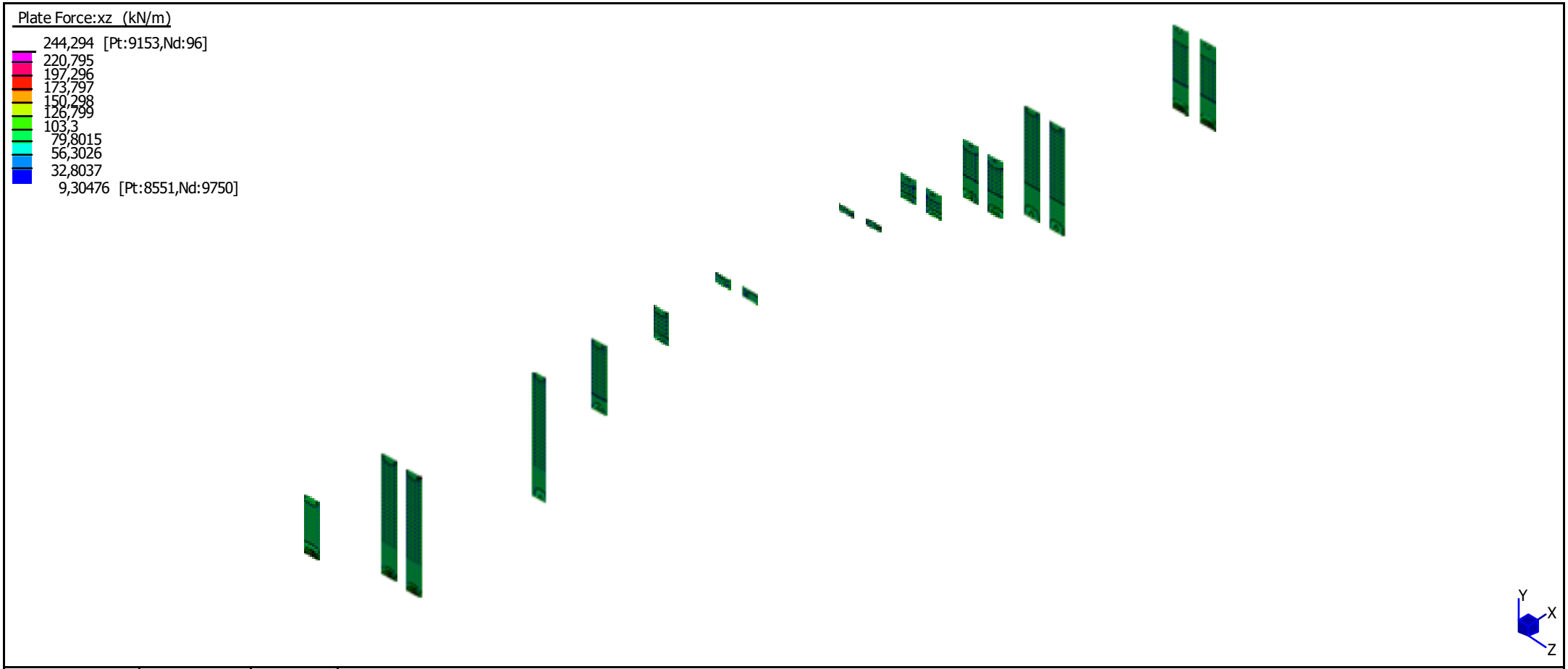


17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Größter Druck Pfeiler Seite St. Pankratz

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:33 pm

Title:	
Project:	
Author:	Reference:

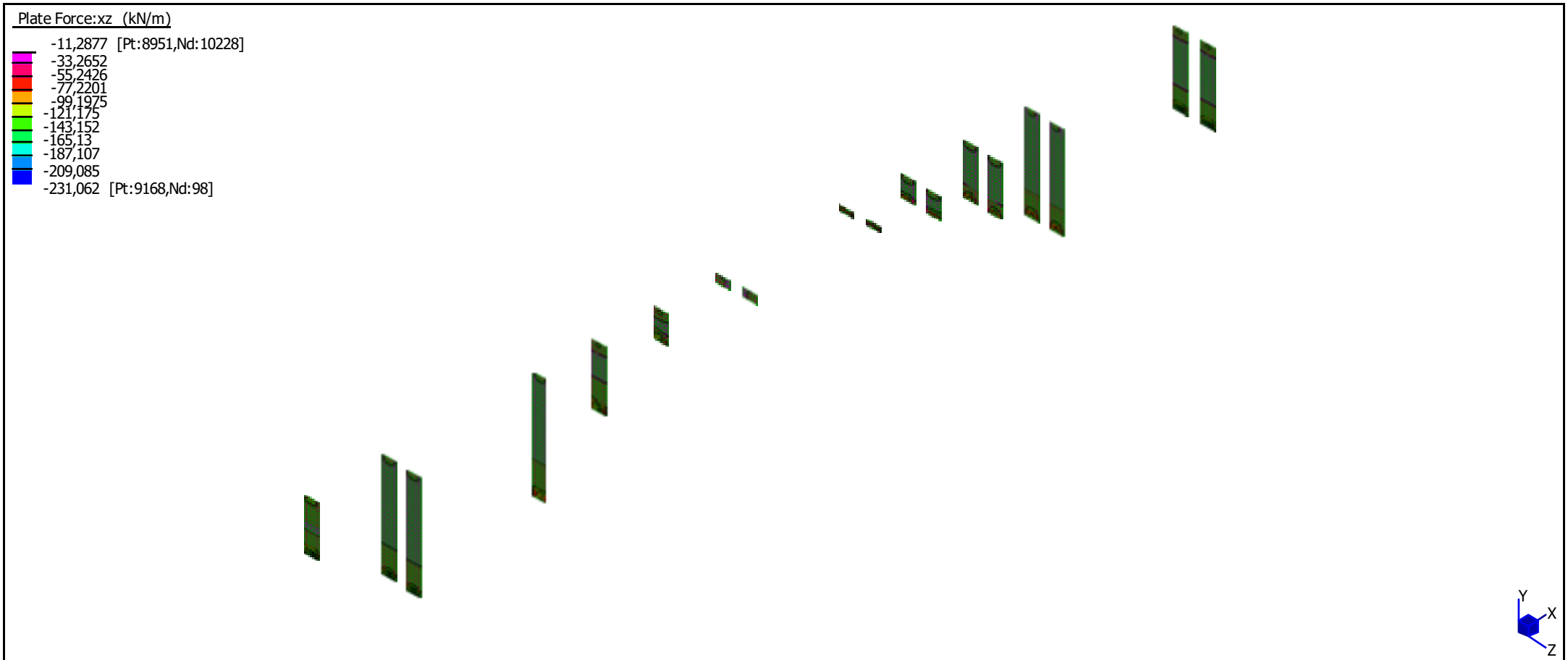


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:45 am

Title:	
Project:	
Author:	Reference:

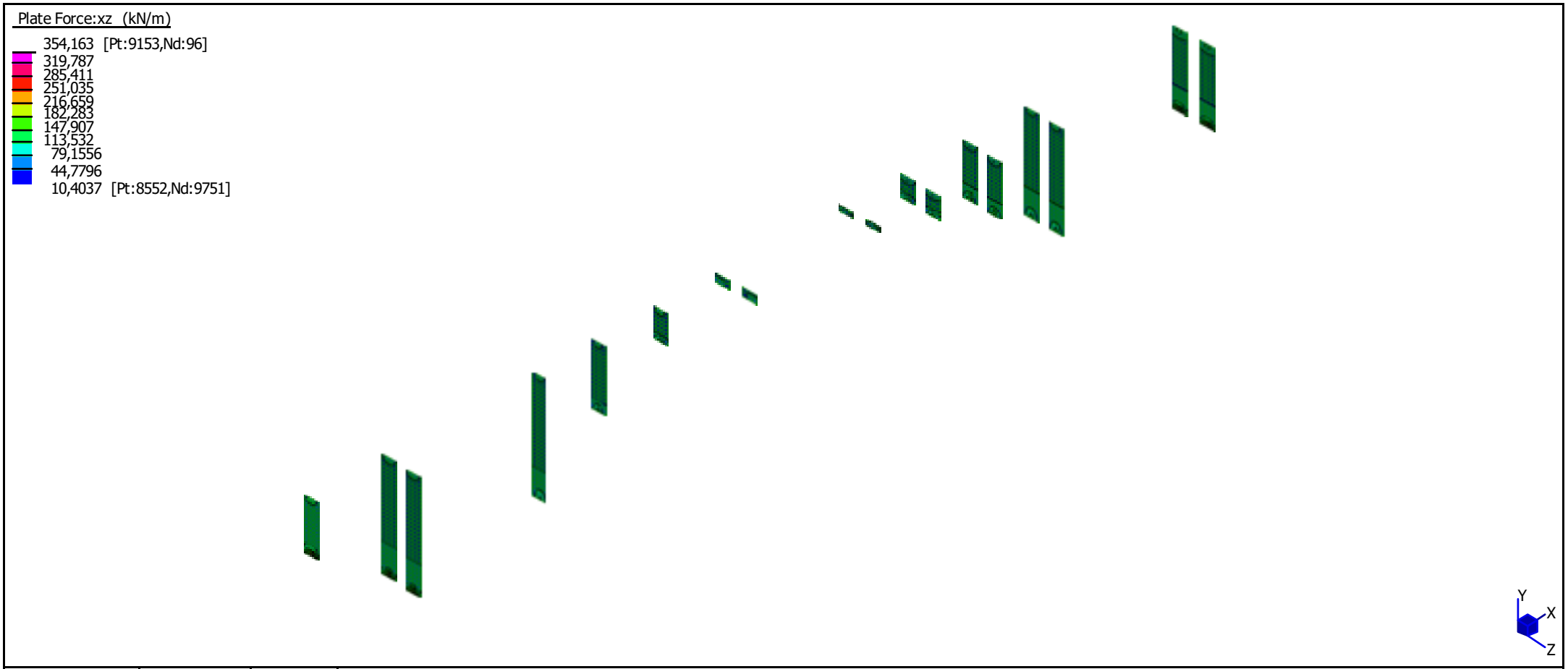


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	224: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Minimale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:44 am

Title:	
Project:	
Author:	Reference:

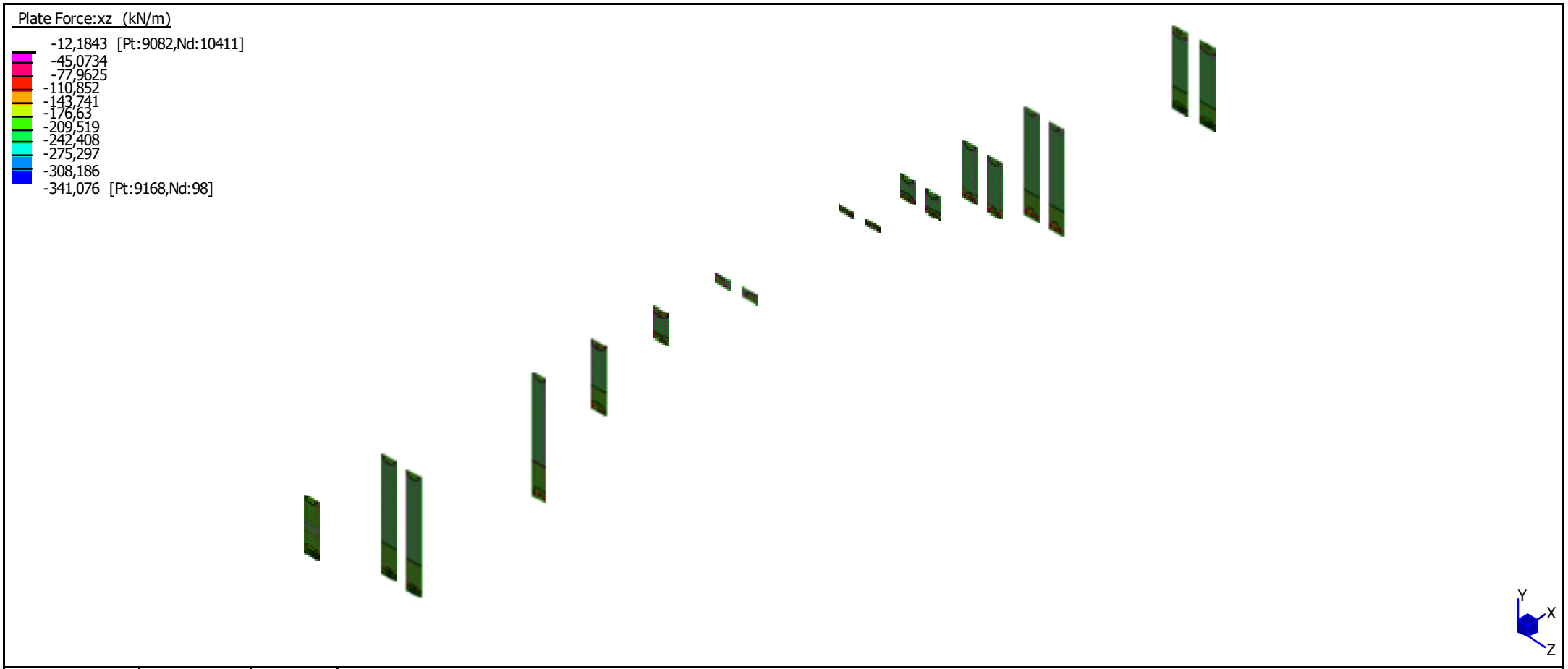


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:47 am

Title:	
Project:	
Author:	Reference:

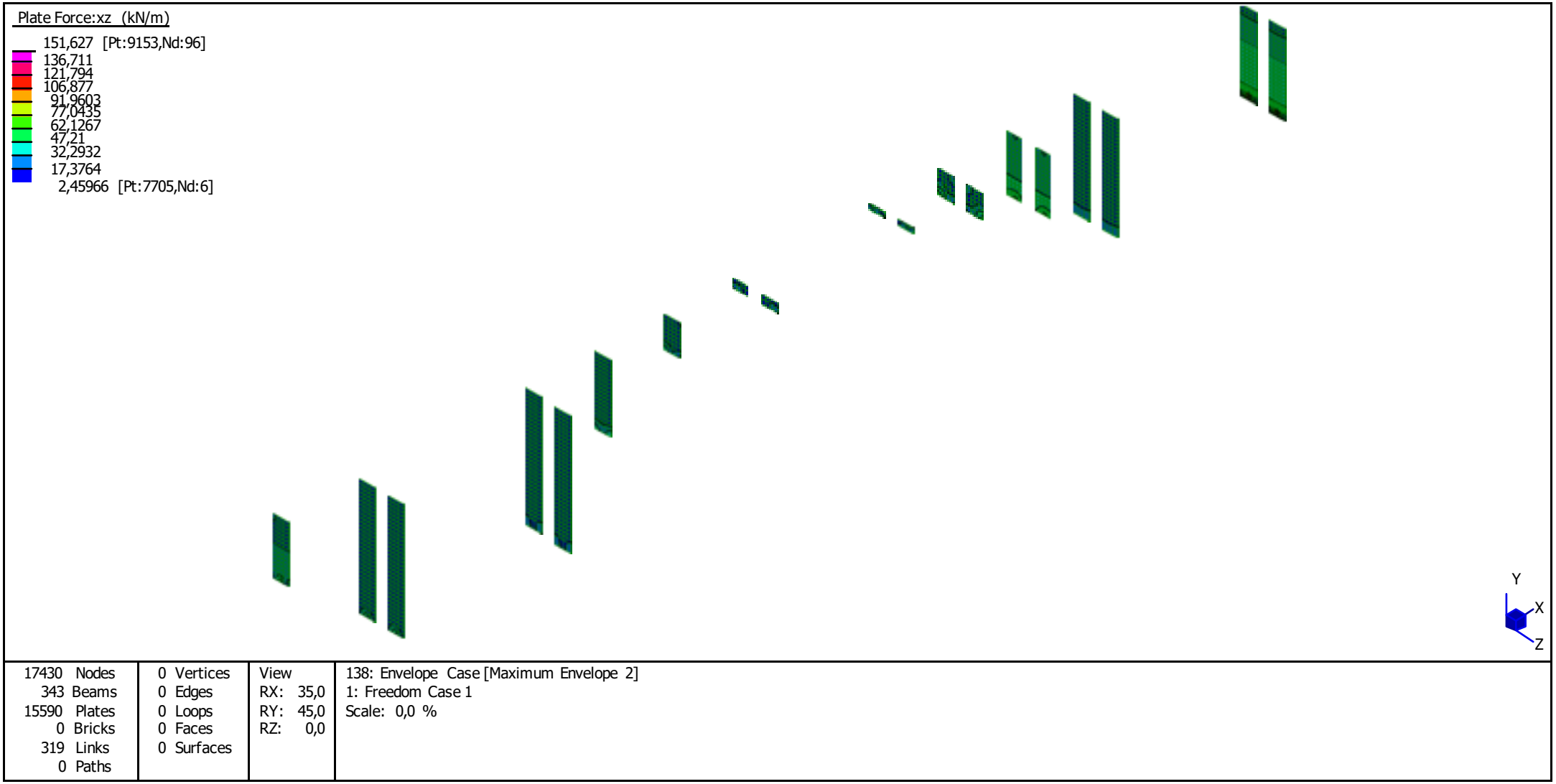


17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Minimale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:48 am

Title:	
Project:	
Author:	Reference:

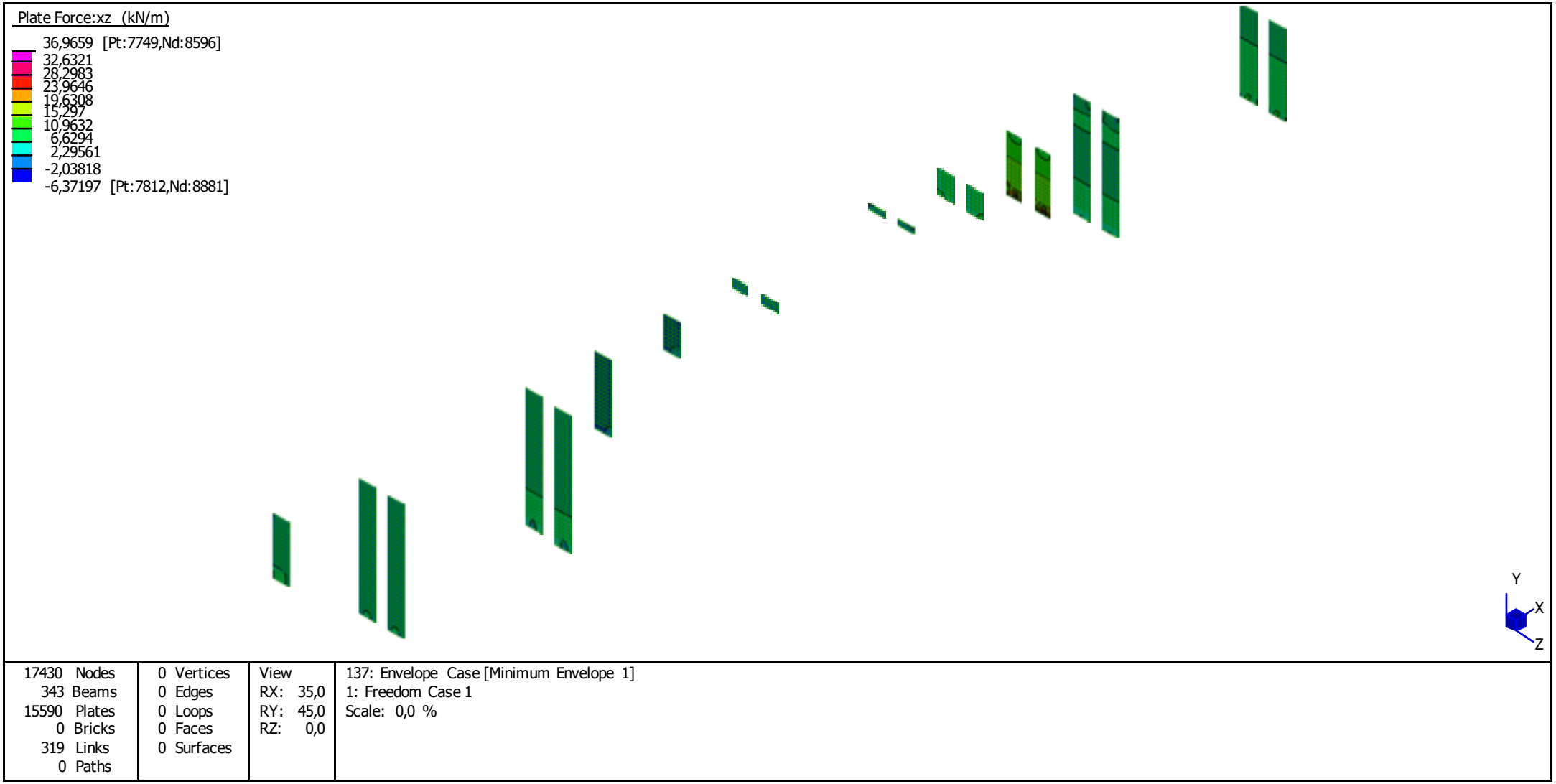


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	138: Envelope Case [Maximum Envelope 2] 1: Freedom Case 1 Scale: 0,0 %

ULS_Erdbeben_Maximale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:23 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

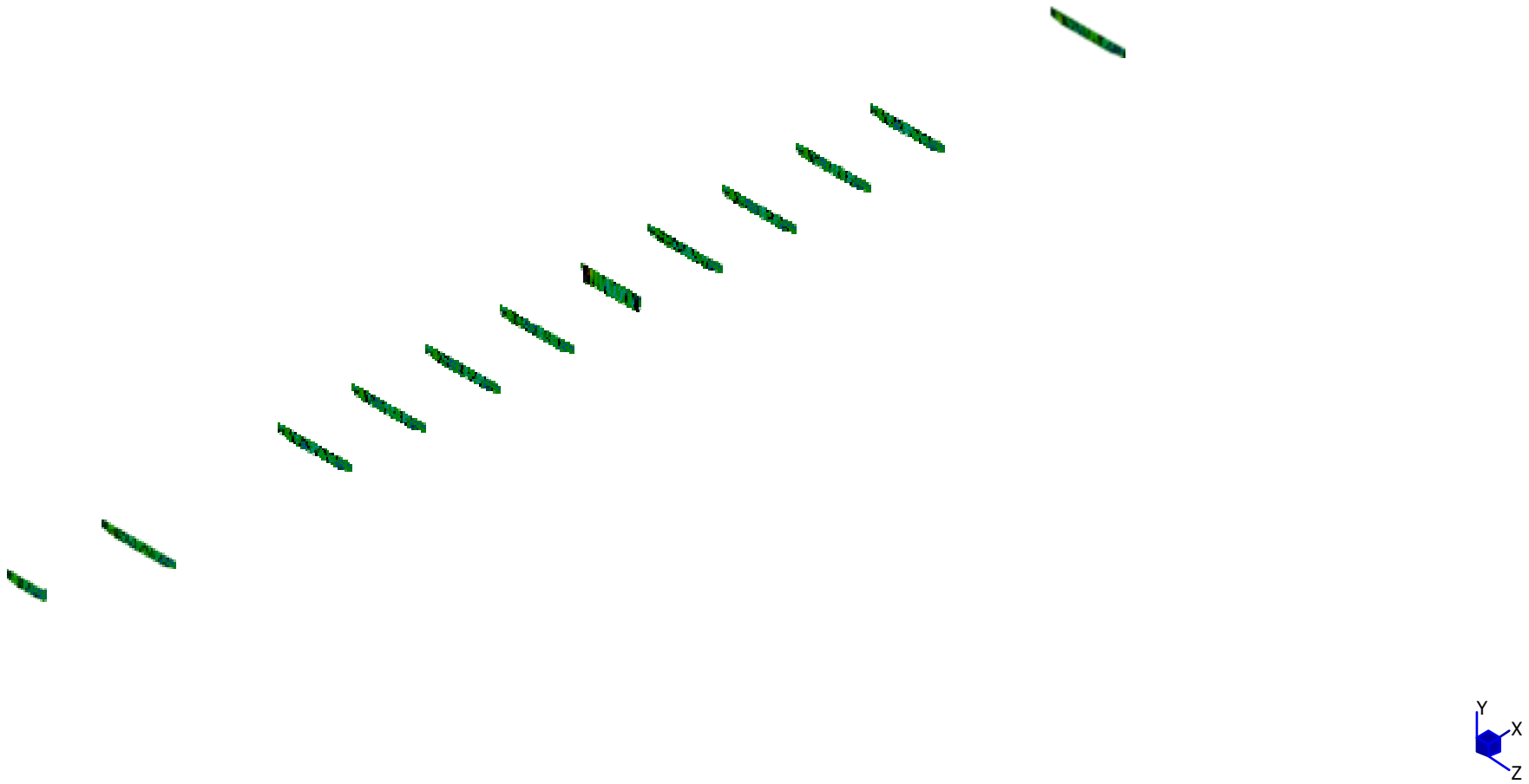
ULS_Erdbeben_Minimale Querkraft Pfeiler in Längsrichtung

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:23 pm

Title:	
Project:	
Author:	Reference:

Plate Force:xy (kN/m)

1636,35 [Pt:14255,Nd:8564]
1440,99
1245,63
1050,27
854,903
659,541
464,179
268,817
73,4554
-121,907
-317,268 [Pt:14268,Nd:8688]

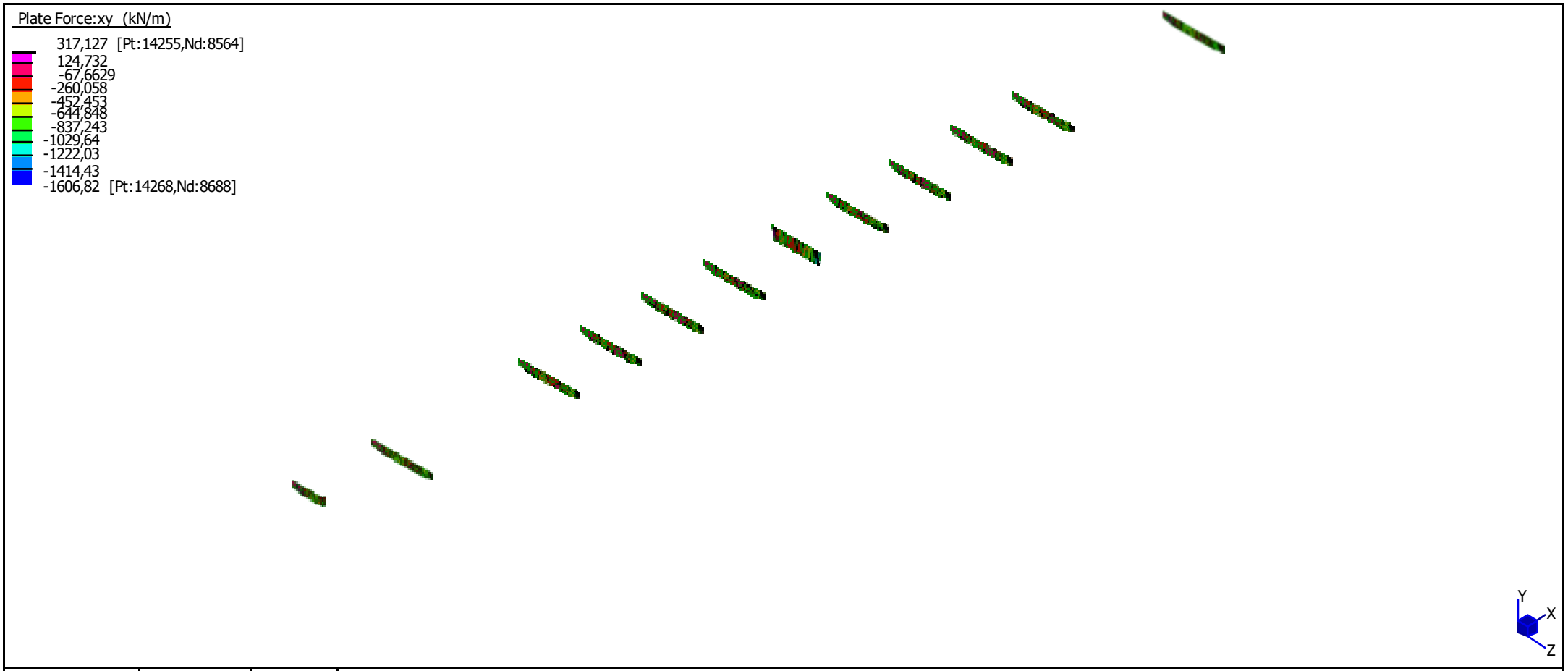


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:55 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

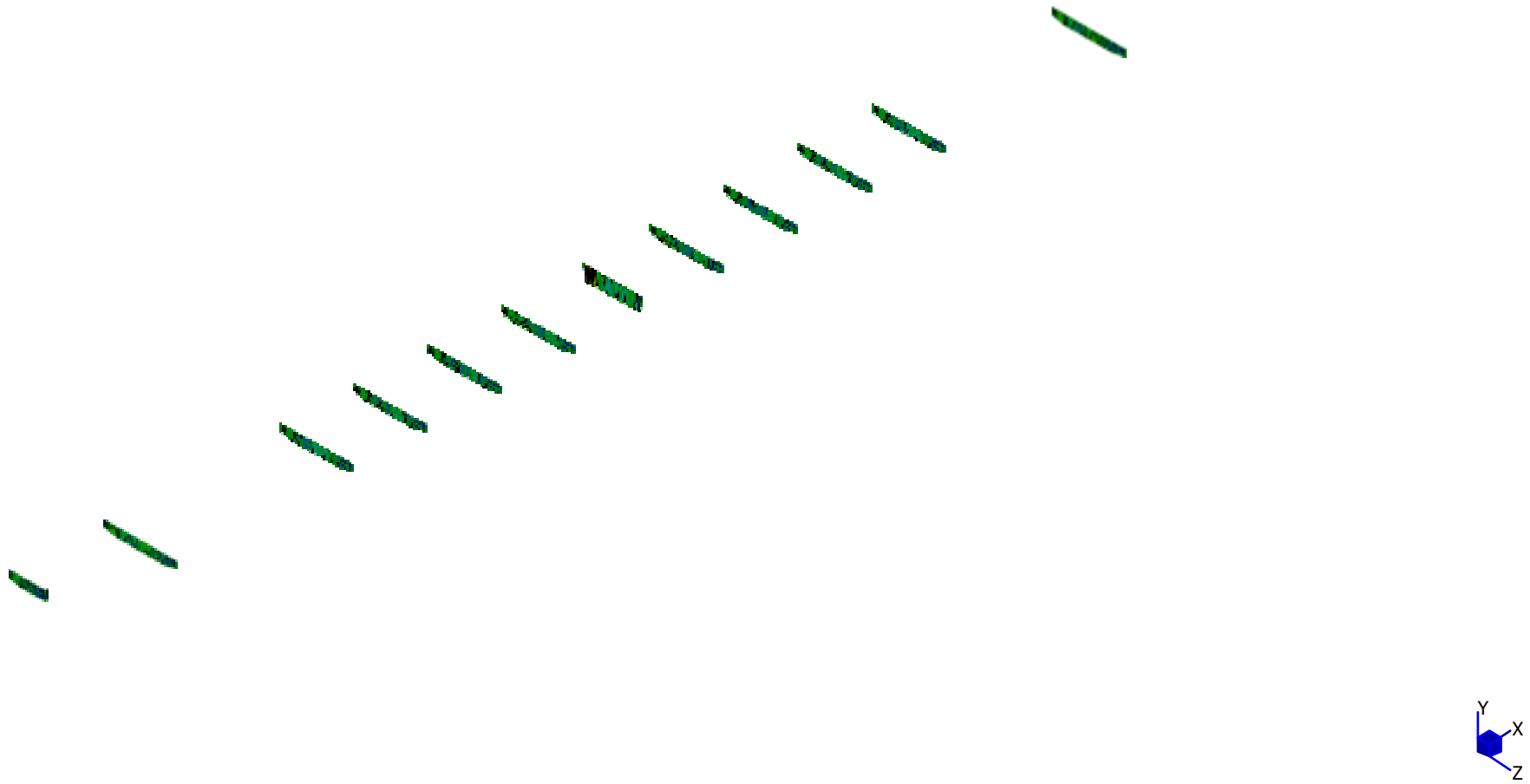
ULS_LM1 leitend_Minimale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:54 am

Title:	
Project:	
Author:	Reference:

Plate Force:xy (kN/m)

1760,14 [Pt:14255,Nd:8564]
1564,13
1368,13
1172,12
976,118
780,113
584,108
388,103
192,098
-3,90739
-199,912 [Pt:11029,Nd:8841]

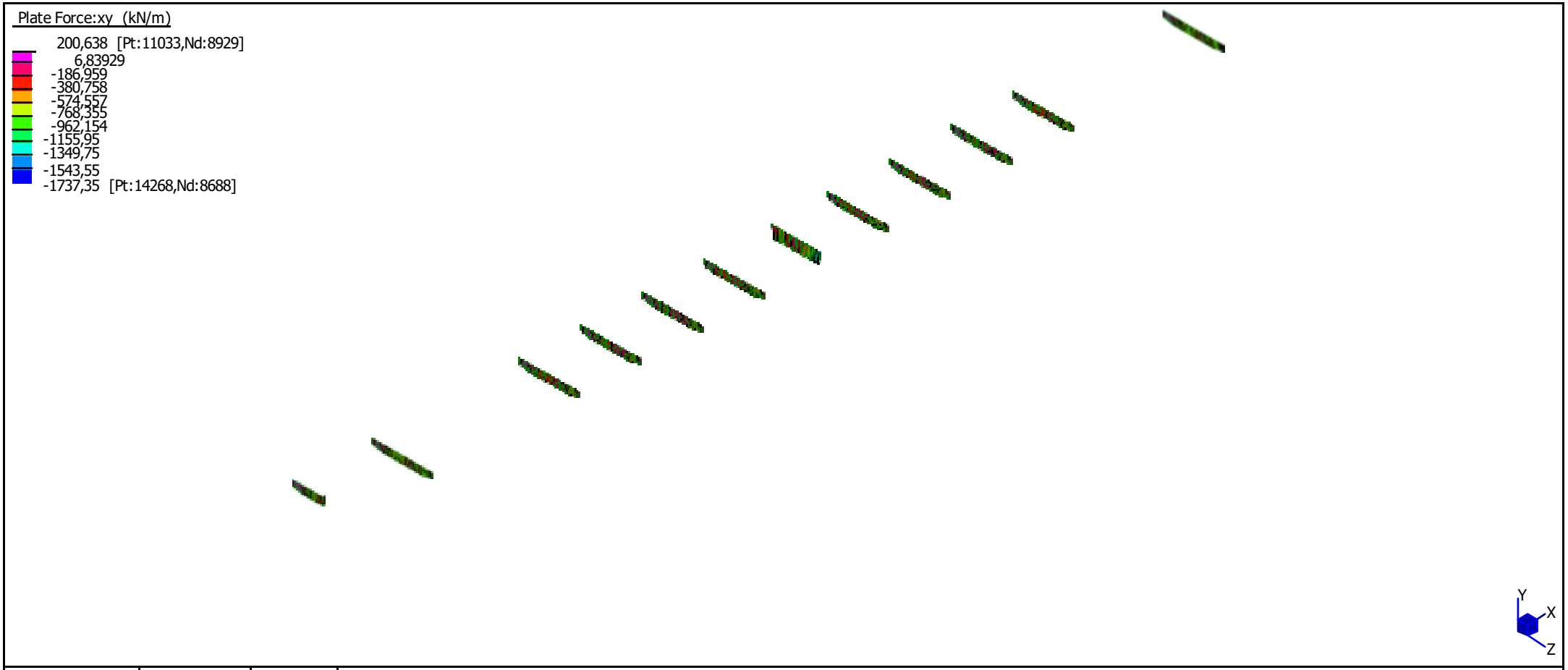


17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Maximale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:51 am

Title:	
Project:	
Author:	Reference:

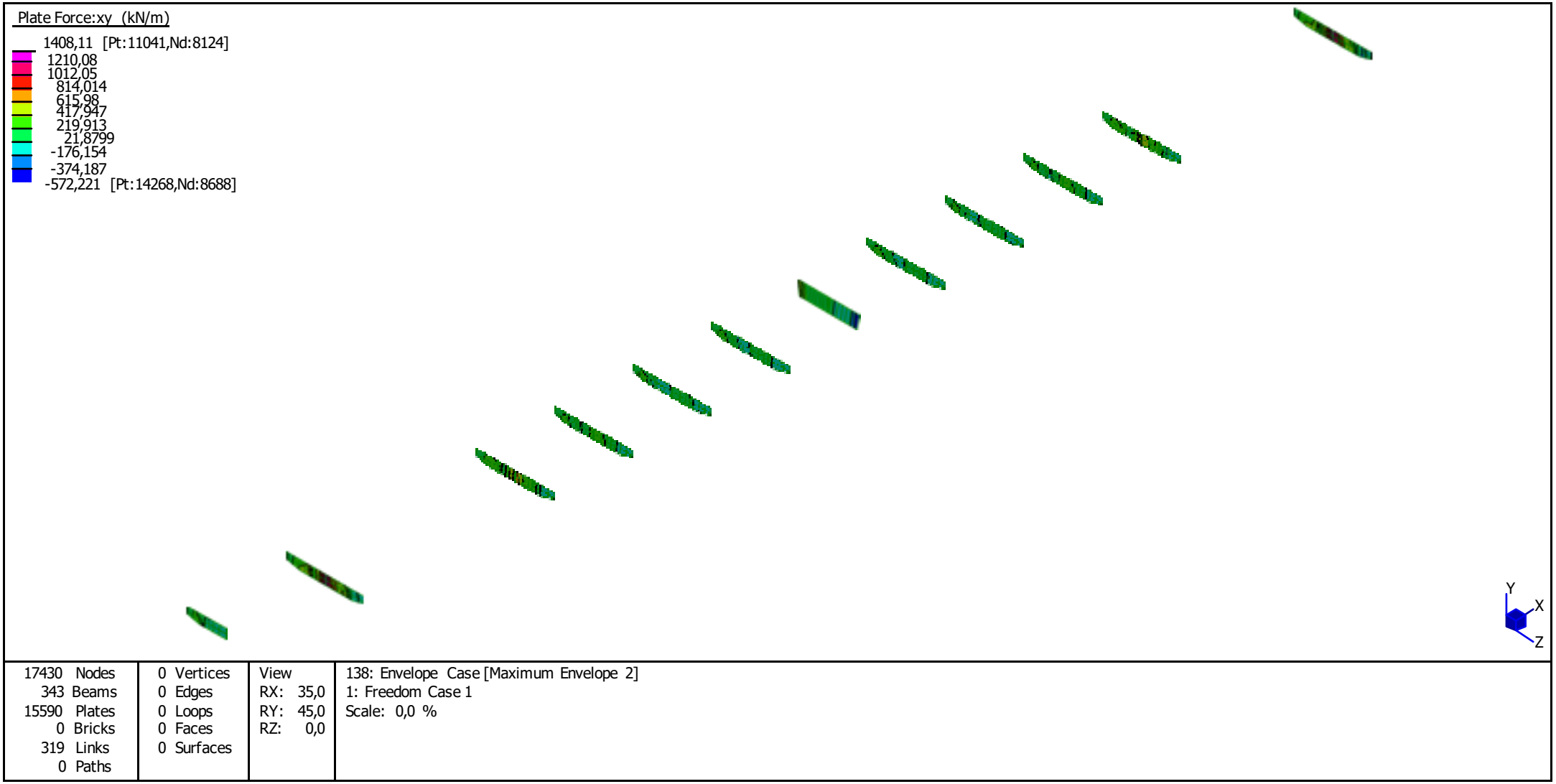


17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Minimale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
19 Dezember 2018 10:53 am

Title:	
Project:	
Author:	Reference:

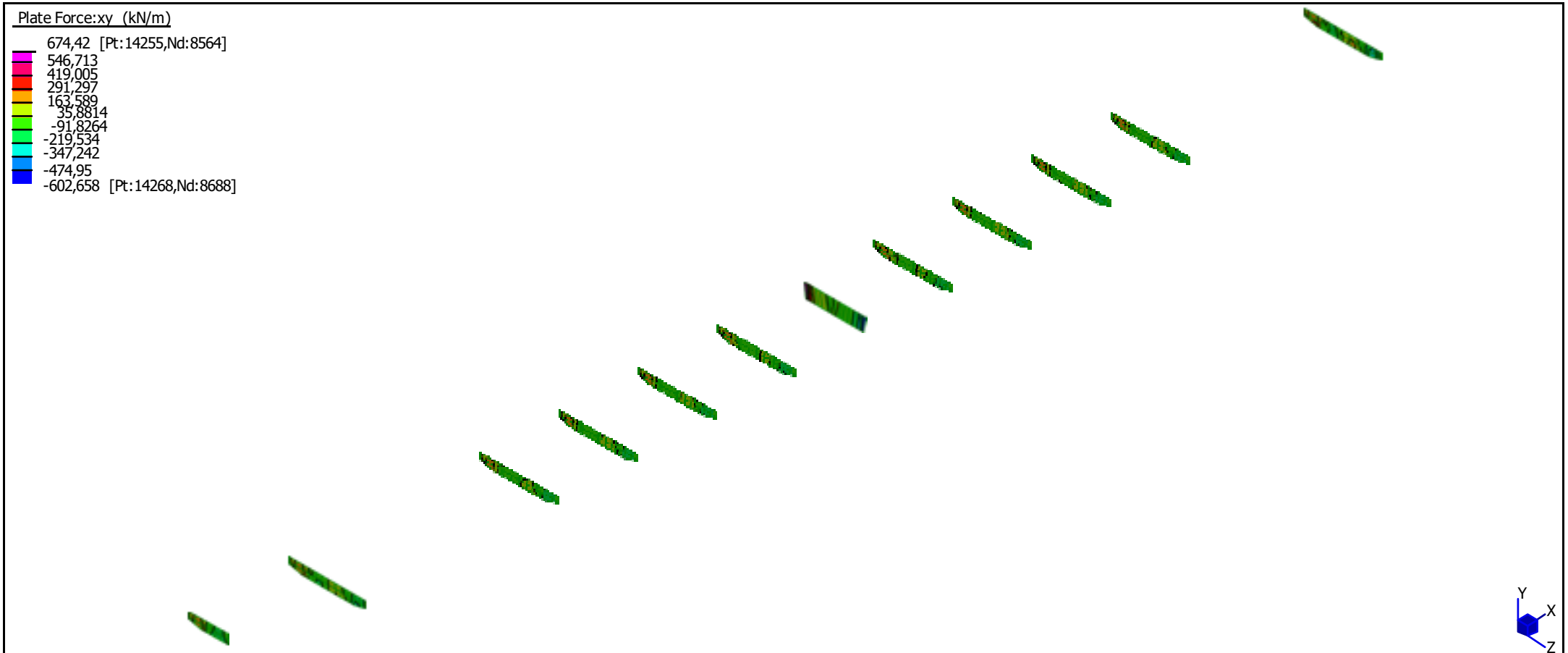


17430 Nodes	0 Vertices	View	138: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Maximale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:27 pm

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	137: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

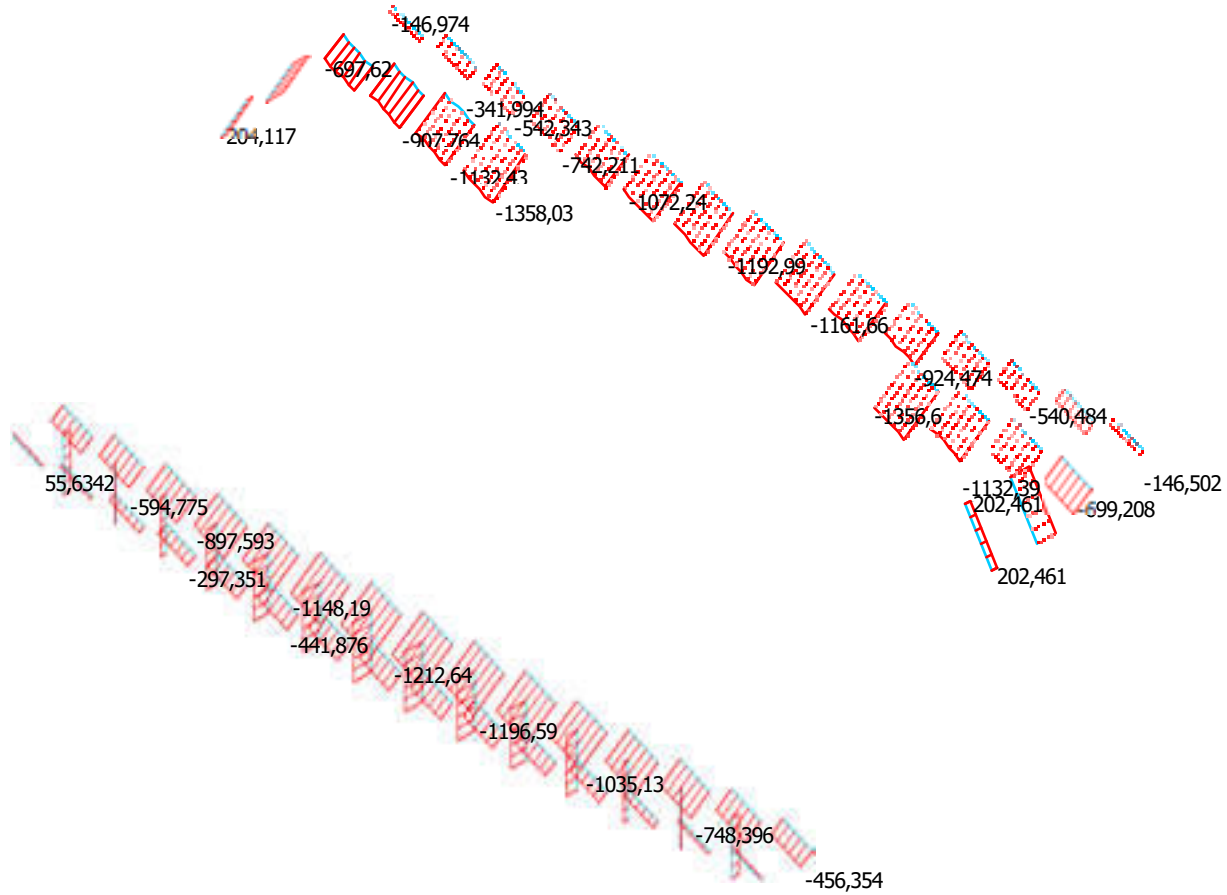
ULS_Erdbeben_Minimale Querkraft Pfeilerkopf

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_12_FeC_Endstand.LSA
14 November 2018 5:25 pm

5.5 Pfahlkräfte Mikropfähle

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-1358,03	576,409
	[Bm:221]	[Bm:125]



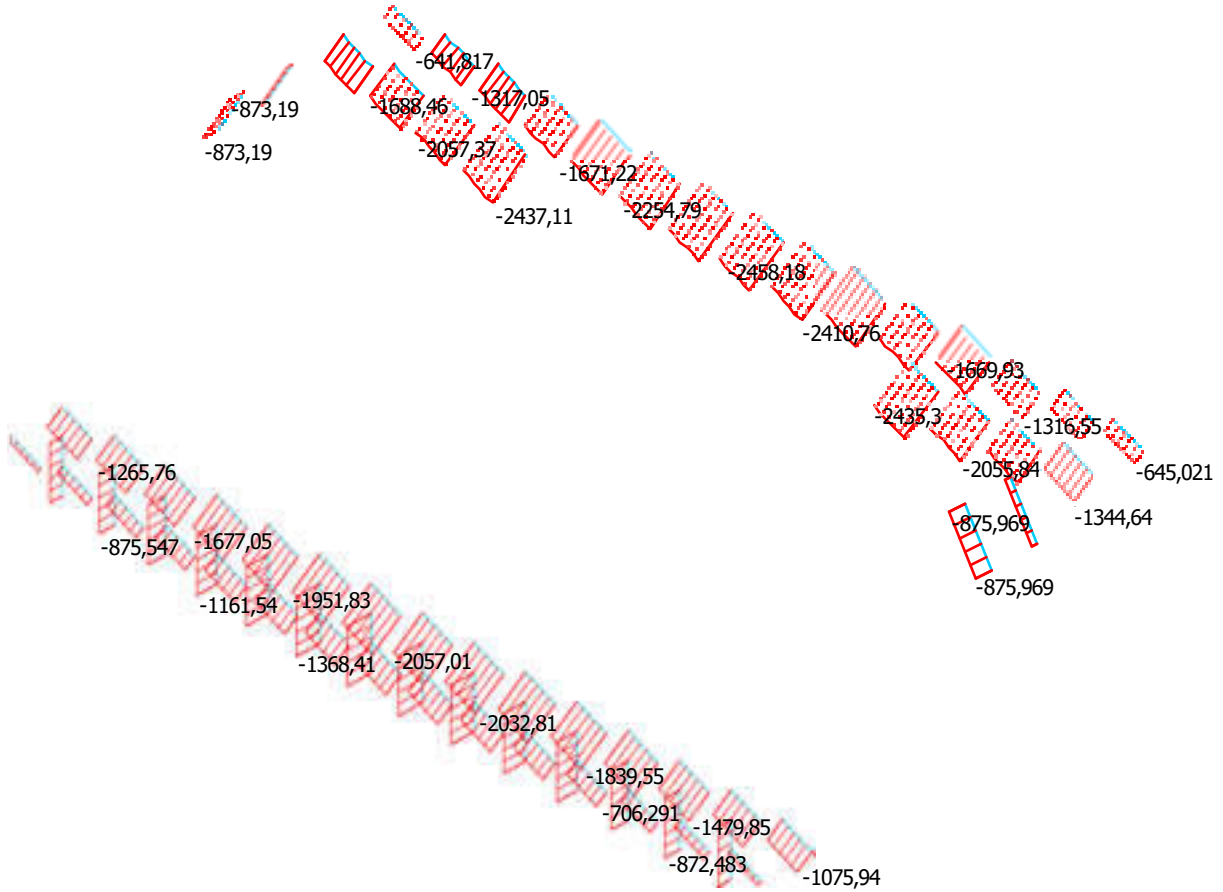
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	225: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 12:27 pm

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-2458,18	-190,901
	[Bm:91]	[Bm:205]



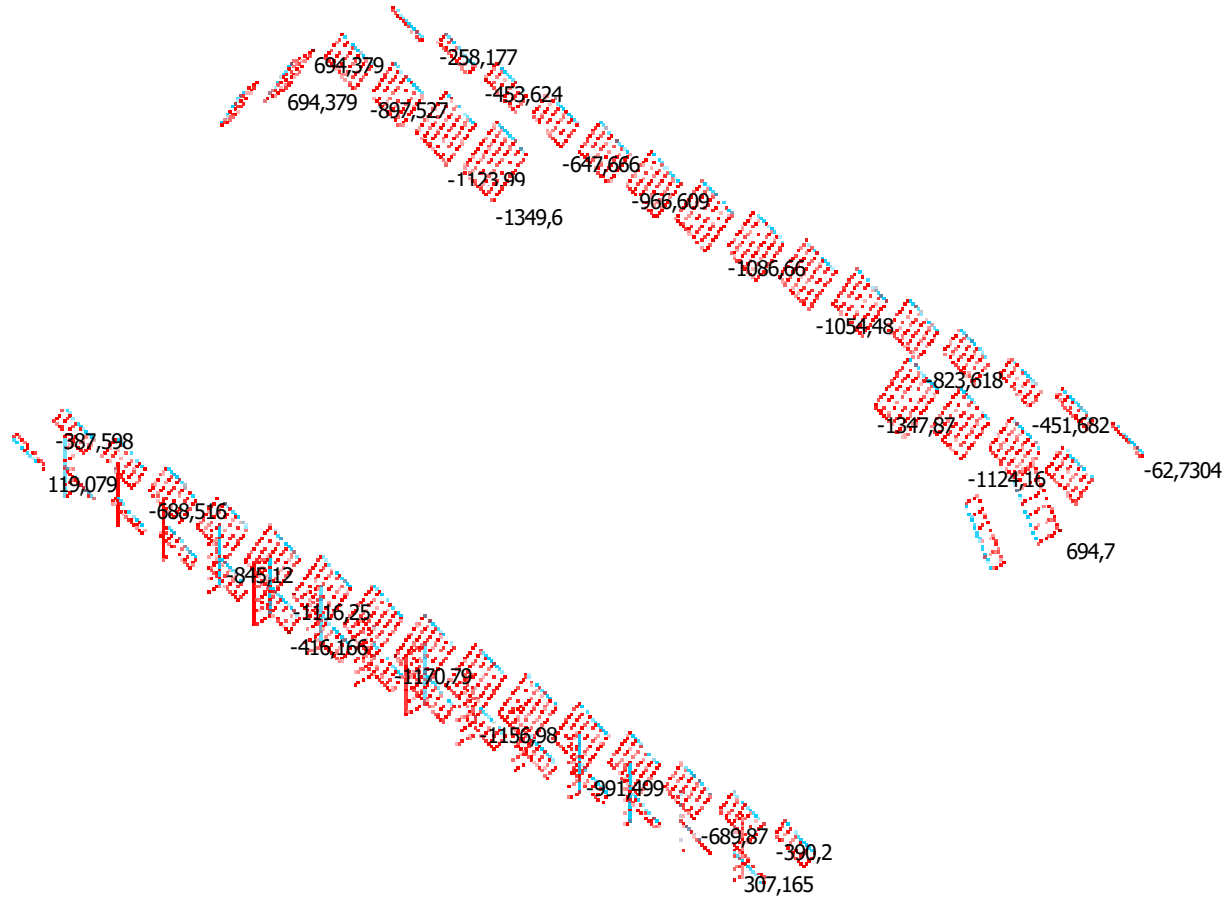
17430 Nodes	0 Vertices	View	224: ULS_LM1 (leitend) [Factors Min Envelope 3]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Minimale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 12:26 pm

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-1349,6	694,7
	[Bm:221]	[Bm:125]



17430 Nodes	0 Vertices	View	227: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
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15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Maximale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 12:24 pm

Title:	
Project:	
Author:	Reference:

	MIN	MAX
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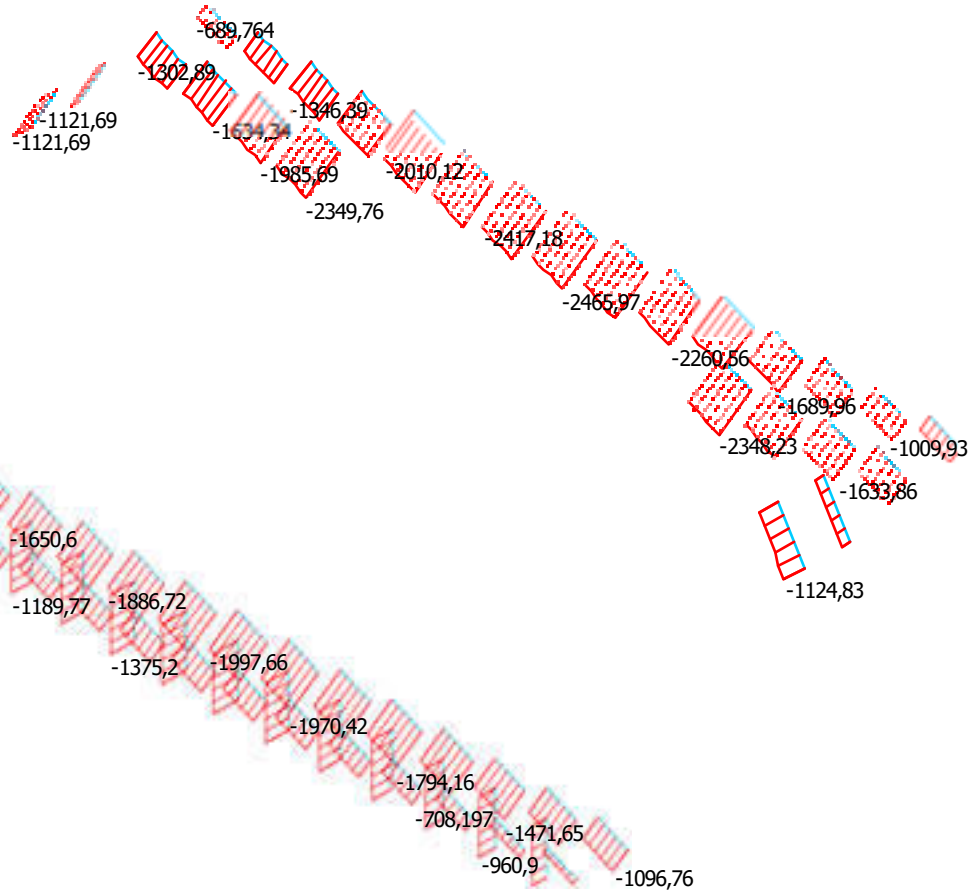
	[Bm:91]	[Bm:205]



17430 Nodes	0 Vertices	View	226: ULS_Temp/Wind (leitend) [Factors Min Envelope 5]
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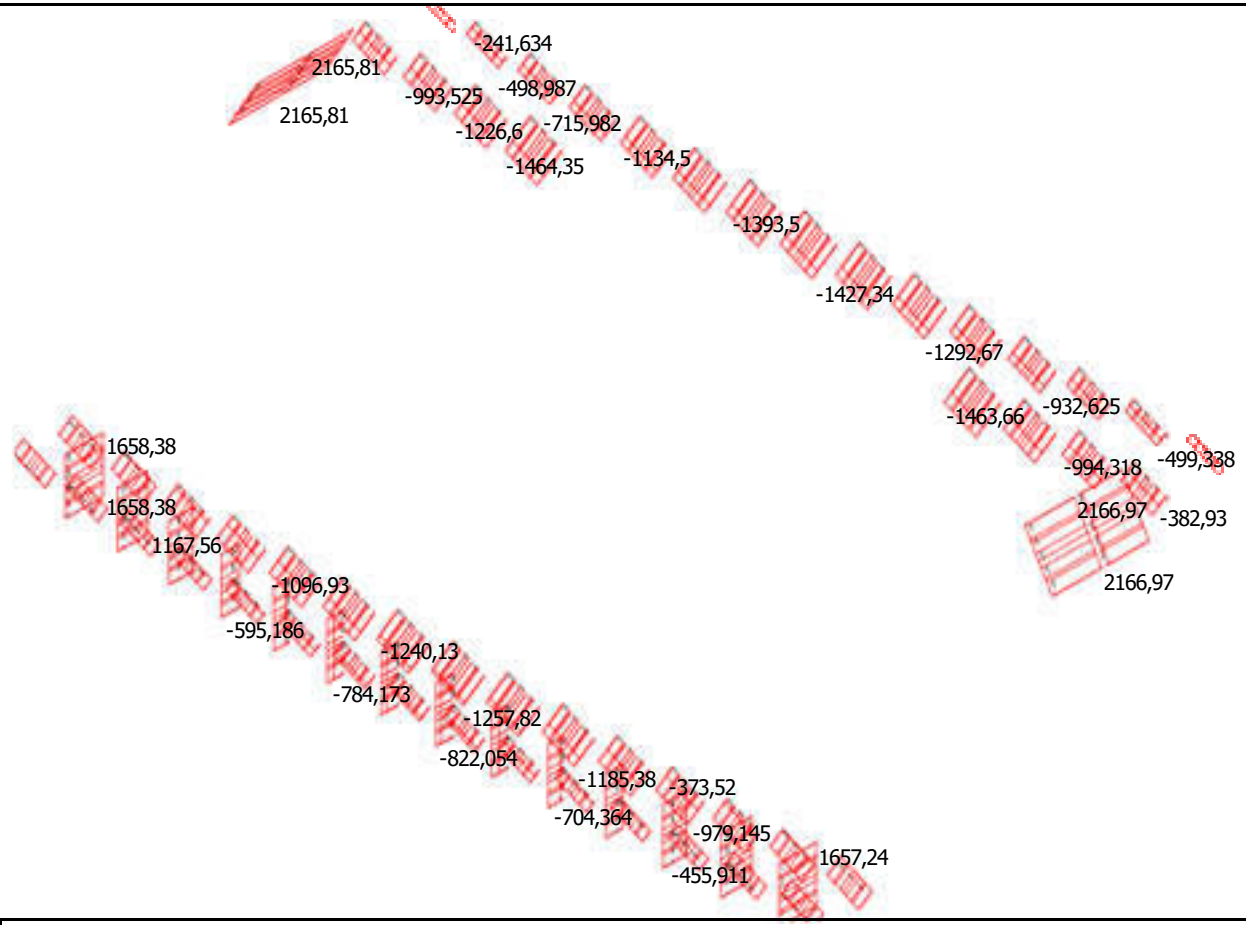
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Minimale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
23 November 2018 12:23 pm

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-1464,35	2166,97
	[Bm:221]	[Bm:12



17430 Nodes	0 Vertices	View	226: Envelope Case [Maximum Envelope 2]
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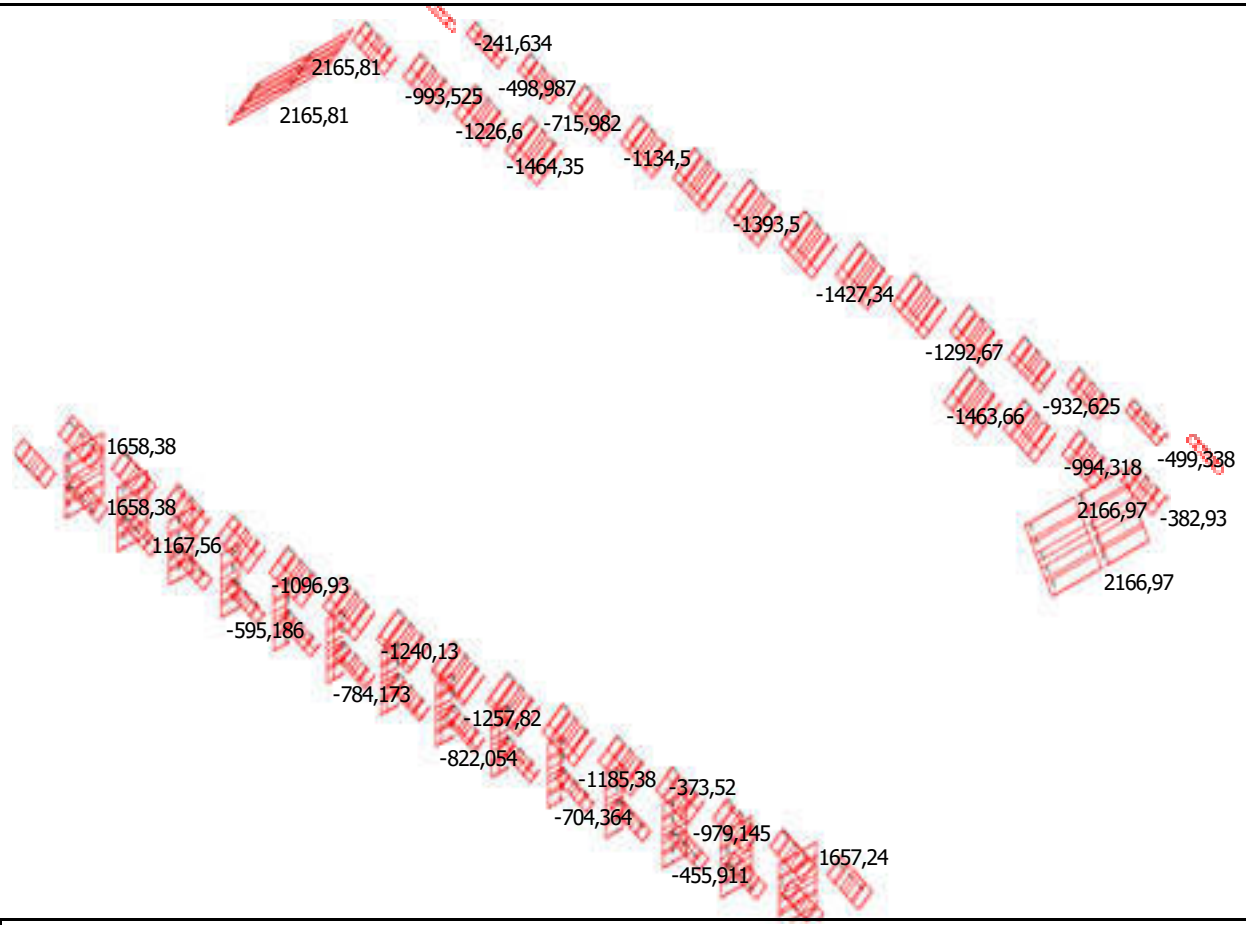
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Maximale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 8:35 am

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-1464,35	2166,97
	[Bm:221]	[Bm:12



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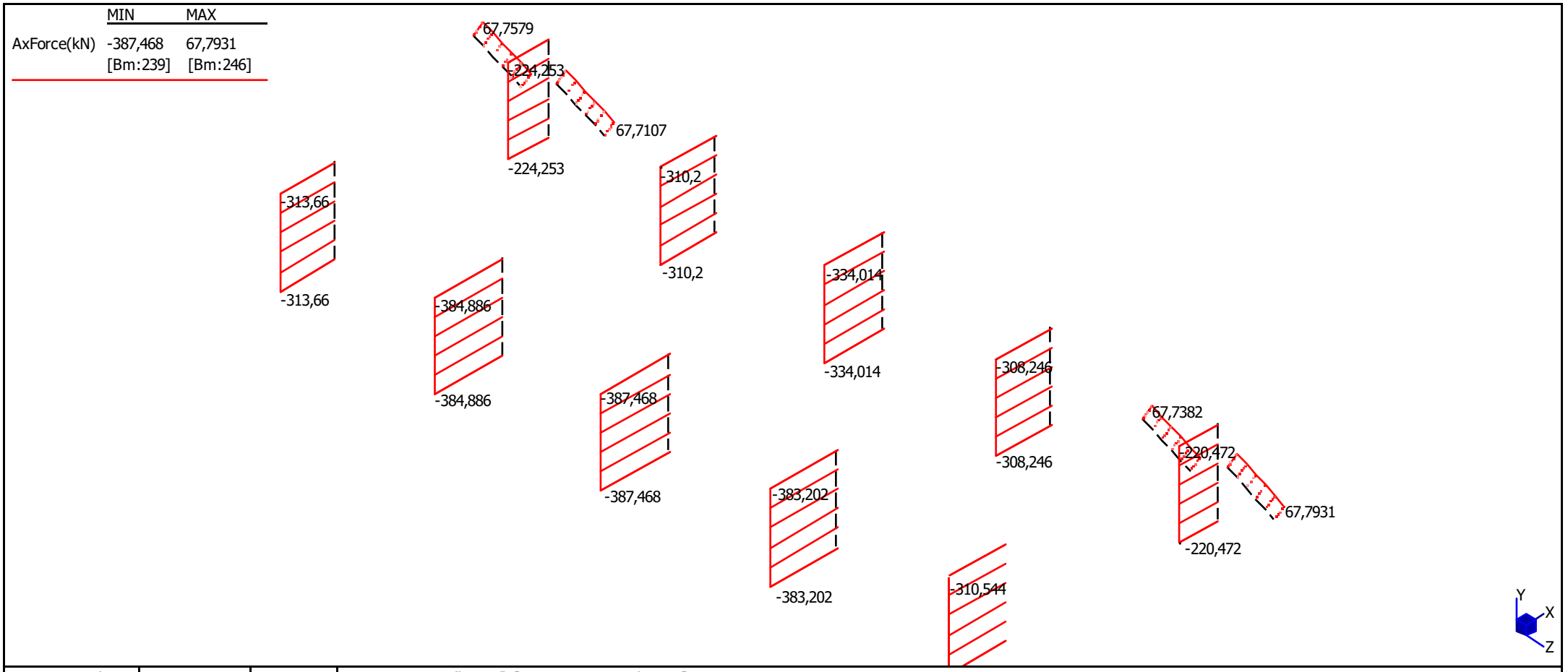
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Pfahlkraft Kämpferfundament Bogen

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 8:34 am

Title:	
Project:	
Author:	Reference:

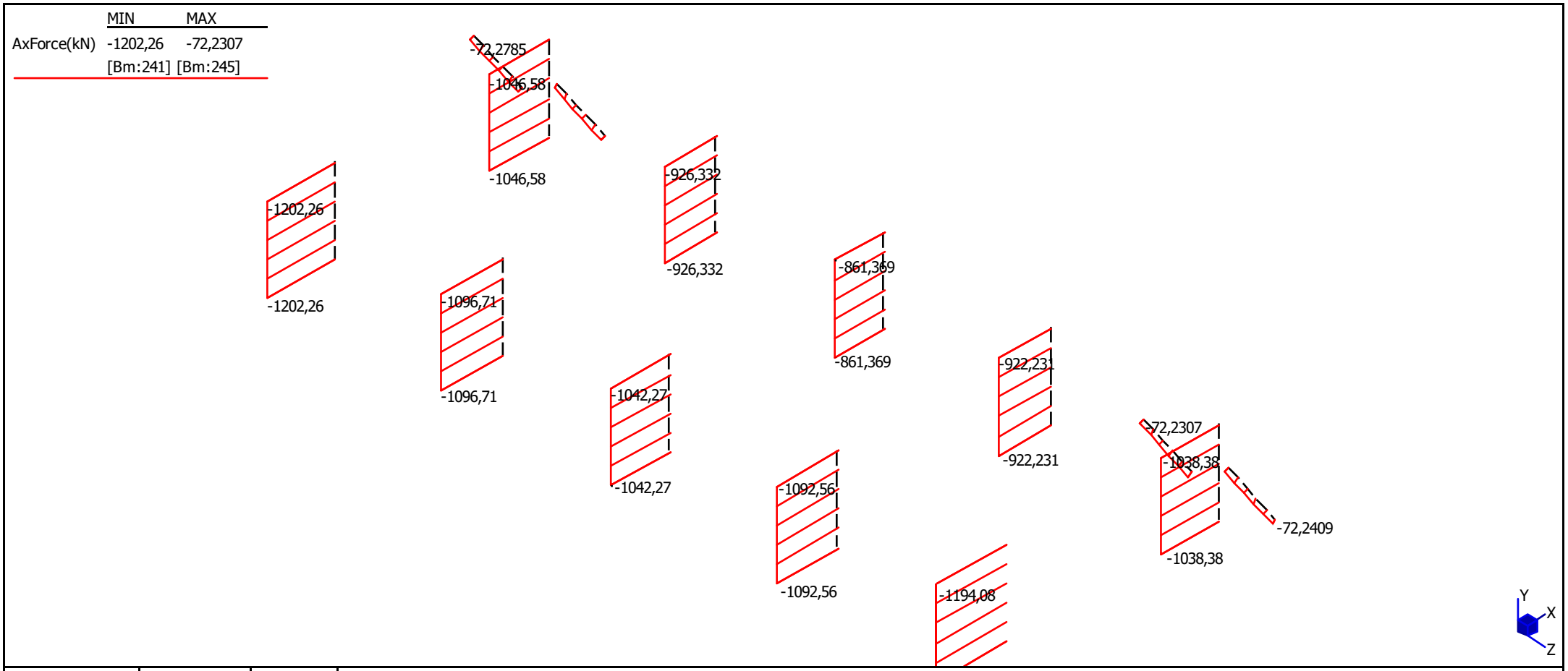


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	228: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Pfahlkraft Pfeilerfundamente Achse 13

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 9:34 am

Title:	
Project:	
Author:	Reference:



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319 Links	0 Surfaces		
0 Paths			

ULS_LM1 leitend_Minimale Pfahlkraft Pfeilerfundamente Achse 13

Title:	
Project:	
Author:	Reference:

	MIN	MAX
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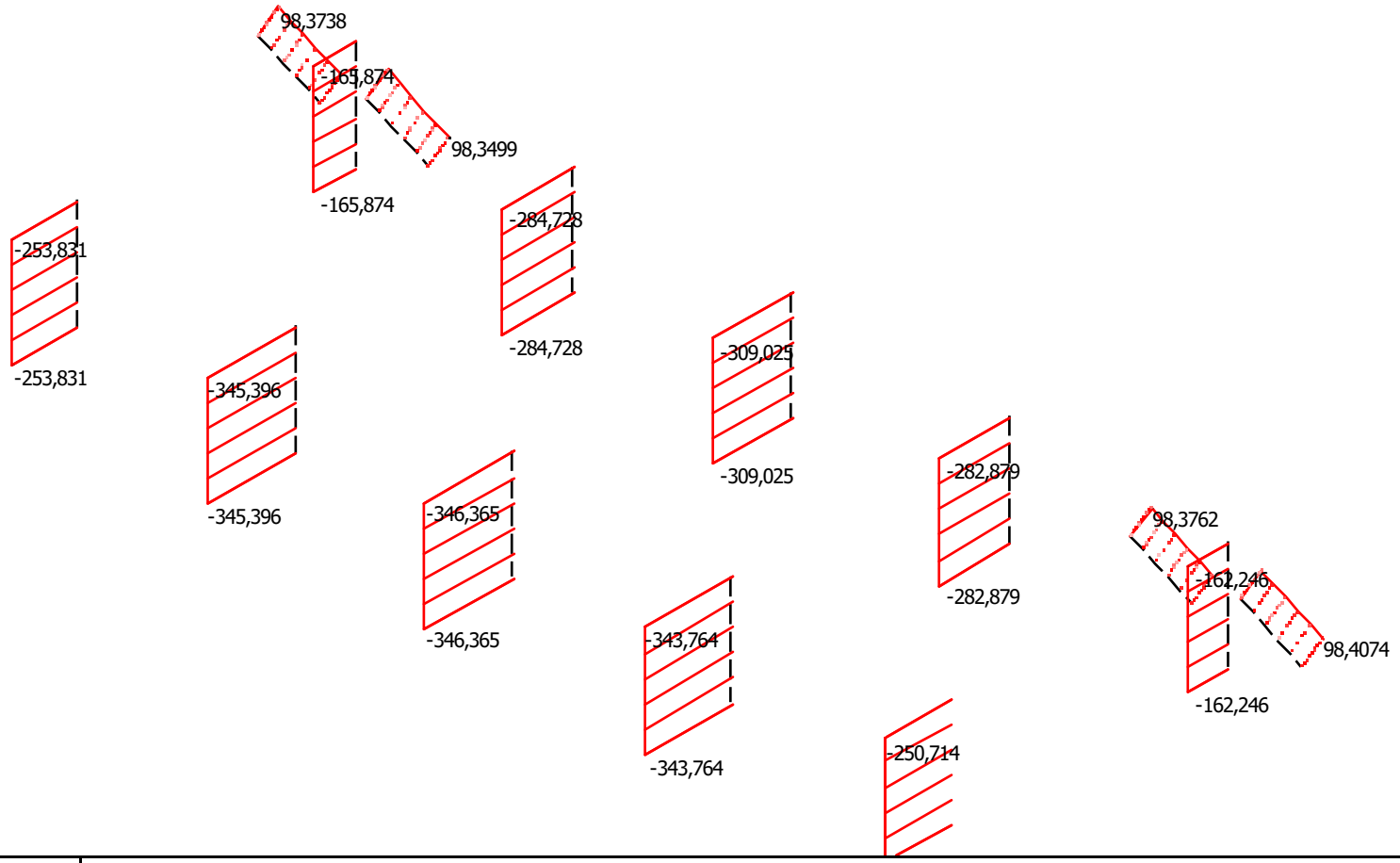

17430 Nodes	0 Vertices	View	230: ULS_Temp/Wind (leitend) [Factors Max Envelope 6]
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15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Wind oder Temperatur leitend_Maximale Pfahlkraft Pfeilerfundamente Achse 13

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
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26 November 2018 9:37 am

Title:	
Project:	
Author:	Reference:

	MIN	MAX
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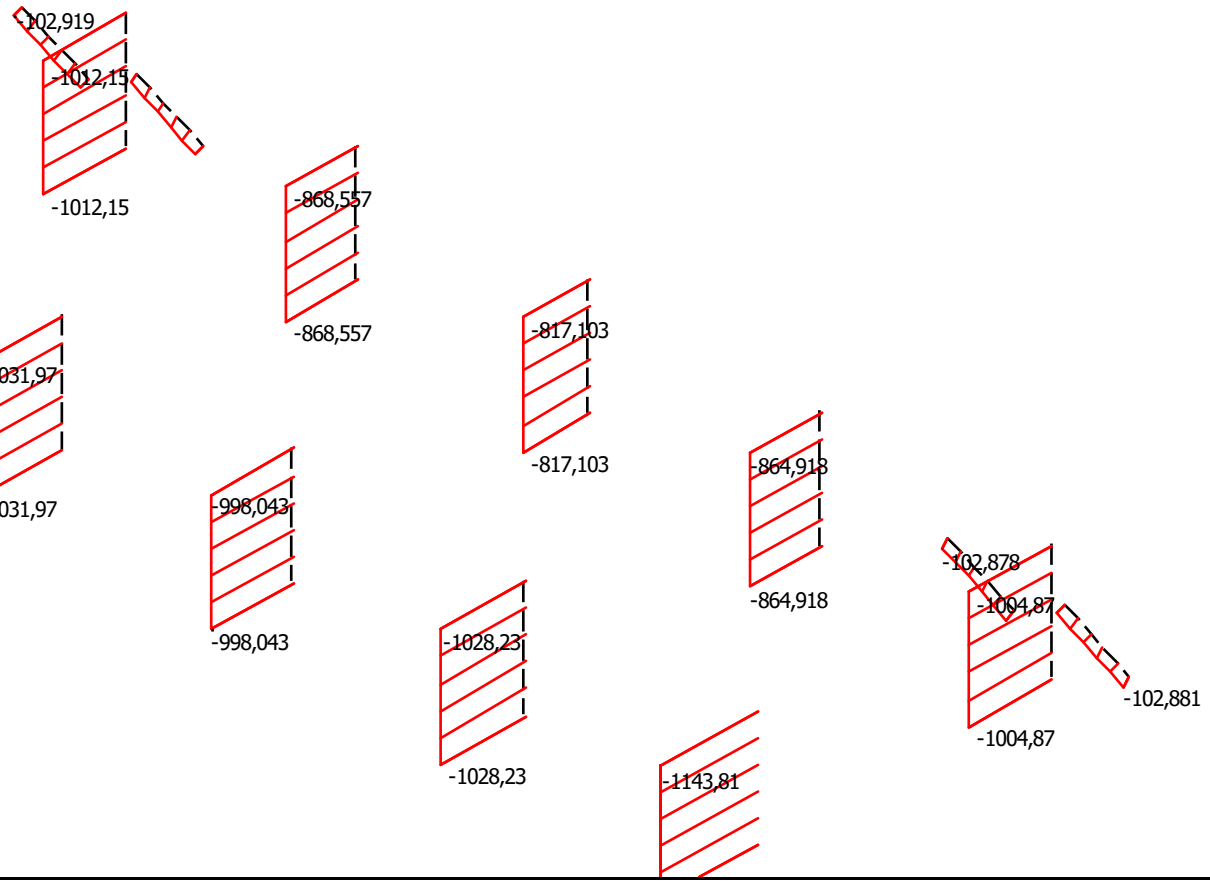
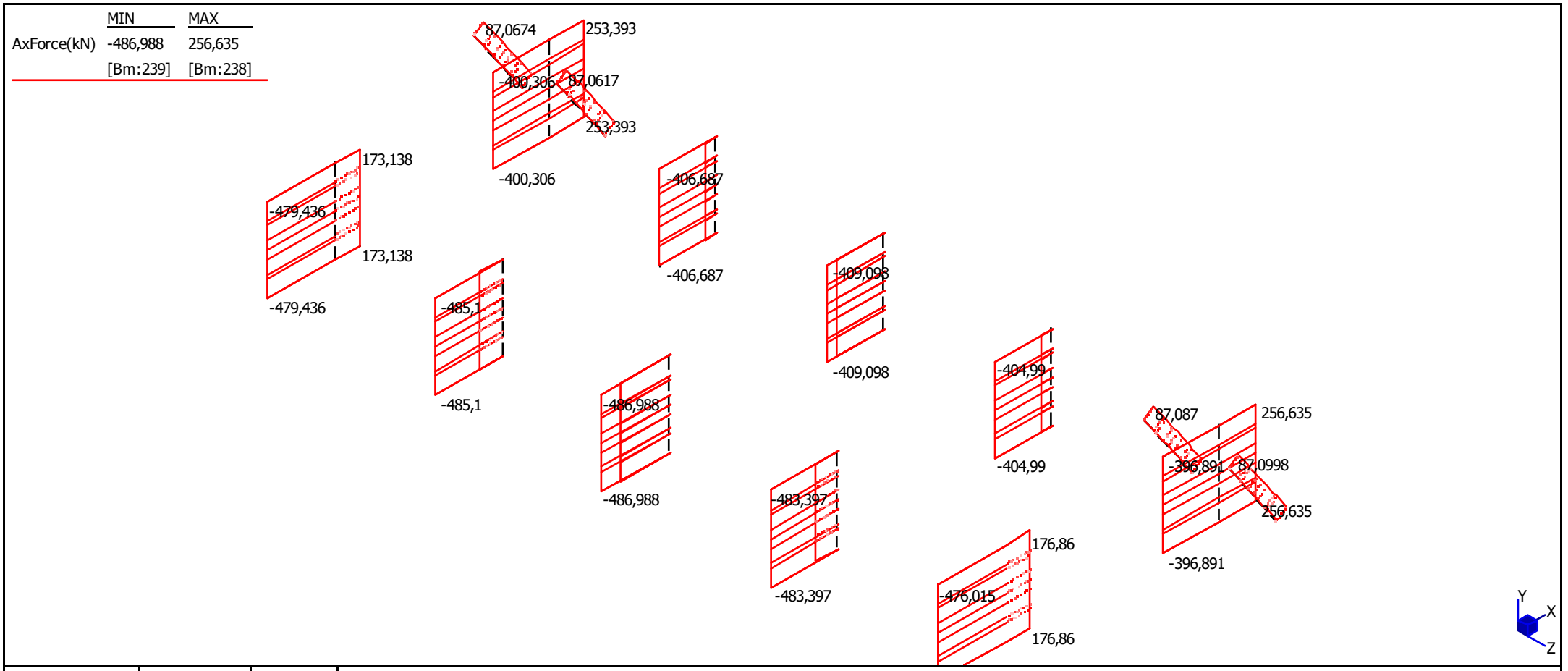


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	229: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Pfahlkraft Pfeilerfundamente Achse 13

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 9:35 am

Title:	
Project:	
Author:	Reference:

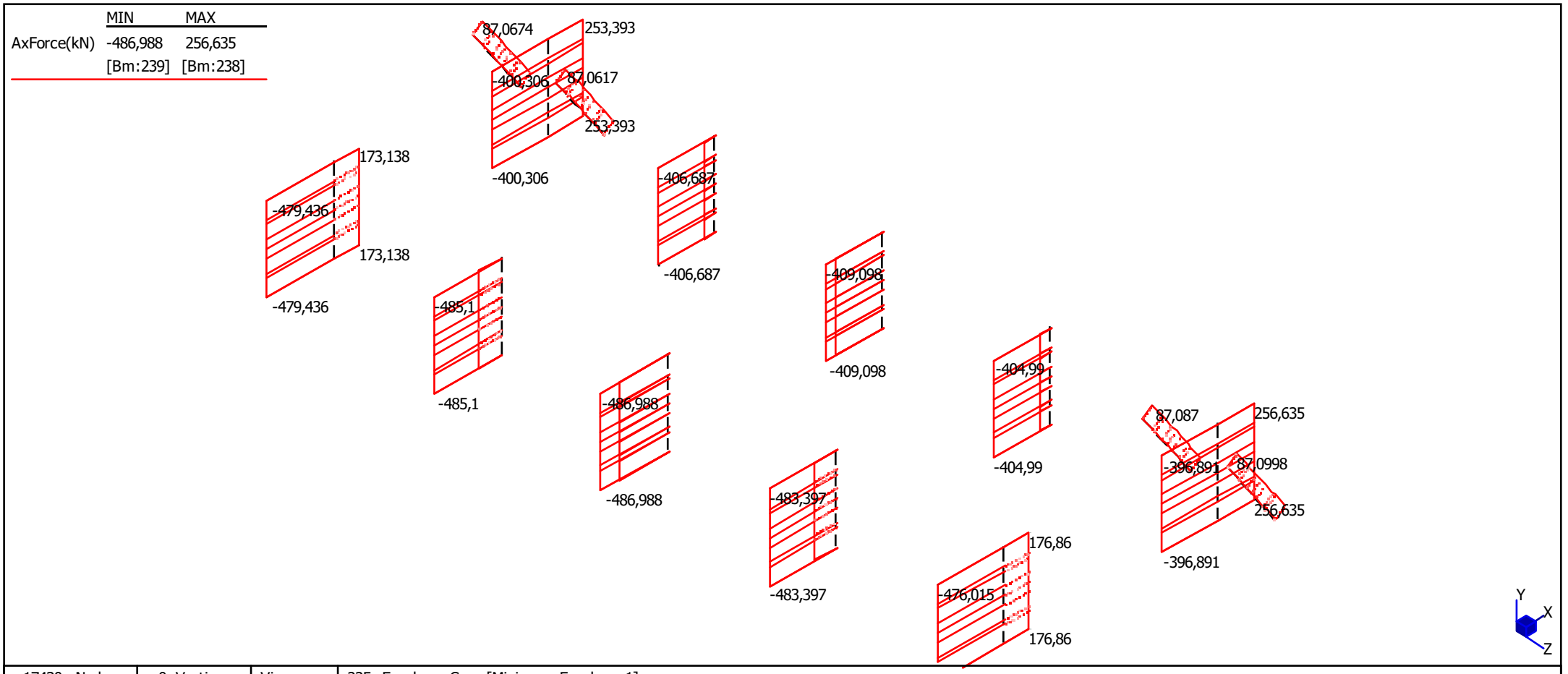


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	226: Envelope Case [Maximum Envelope 2] 1: Freedom Case 1 Scale: 0,0 %

ULS_Erdbeben_Maximale Pfahlkraft Pfeilerfundamente Achse 13

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 9:31 am

Title:	
Project:	
Author:	Reference:



17430 Nodes	0 Vertices	View	225: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Pfahlkraft Pfeilerfundamente Achse 13

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
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26 November 2018 9:31 am

Title:	
Project:	
Author:	Reference:

	MIN	MAX
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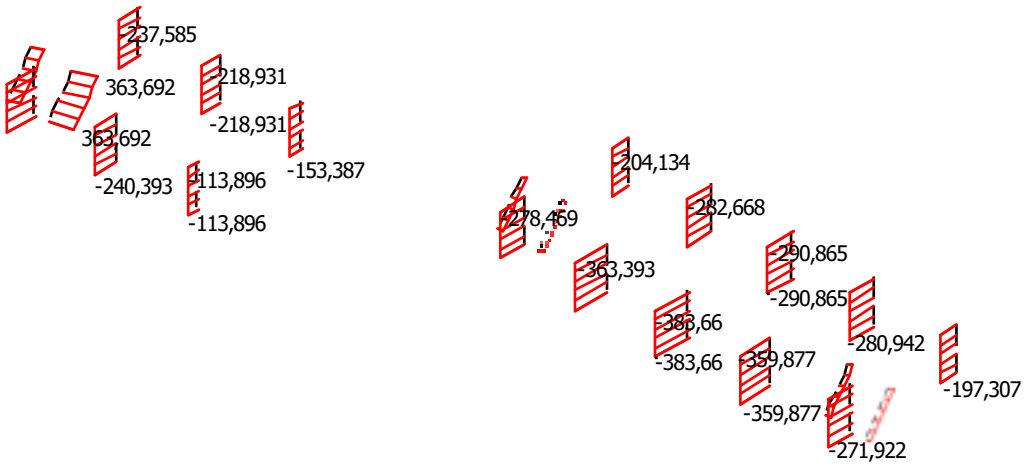
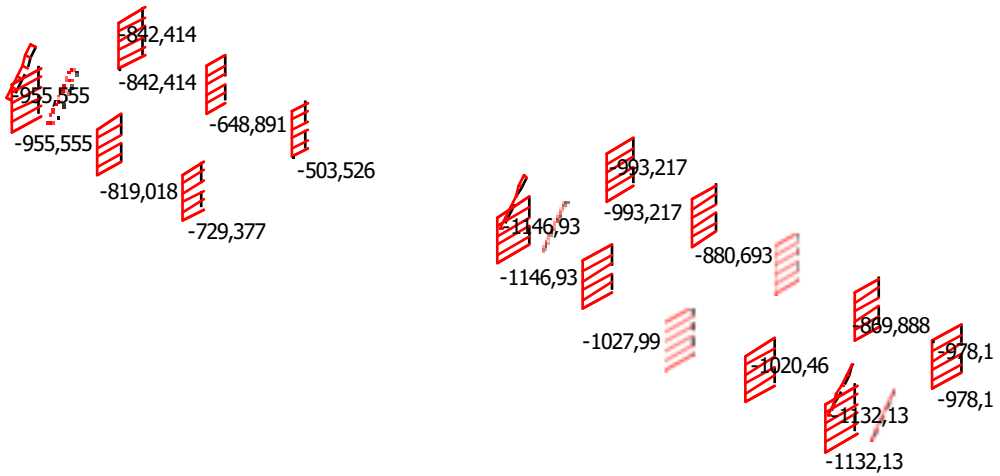


17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	228: ULS_LM1 (leitend) [Factors Max Envelope 4] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Maximale Pfahlkraft Pfeilerfundamente Achse A 2 und 1

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-1146,93	-74,2713
	[Bm:255]	[Bm:258]



17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	227: ULS_LM1 (leitend) [Factors Min Envelope 3] 1: Freedom Case 1 Scale: 0,0 %

ULS_LM1 leitend_Minimale Pfahlkraft Pfeilerfundamente Achse A 2 und 1

Title:	
Project:	
Author:	Reference:

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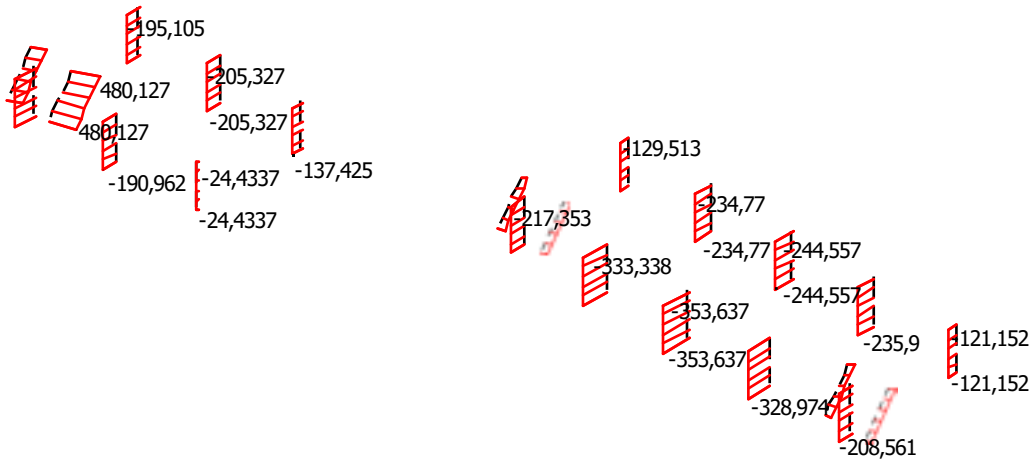

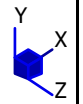

17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	230: ULS_Temp/Wind (leitend) [Factors Max Envelope 6] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Maximale Pfahlkraft Pfeilerfundamente Achse A 2 und 1

Title:	
Project:	
Author:	Reference:

	MIN	MAX
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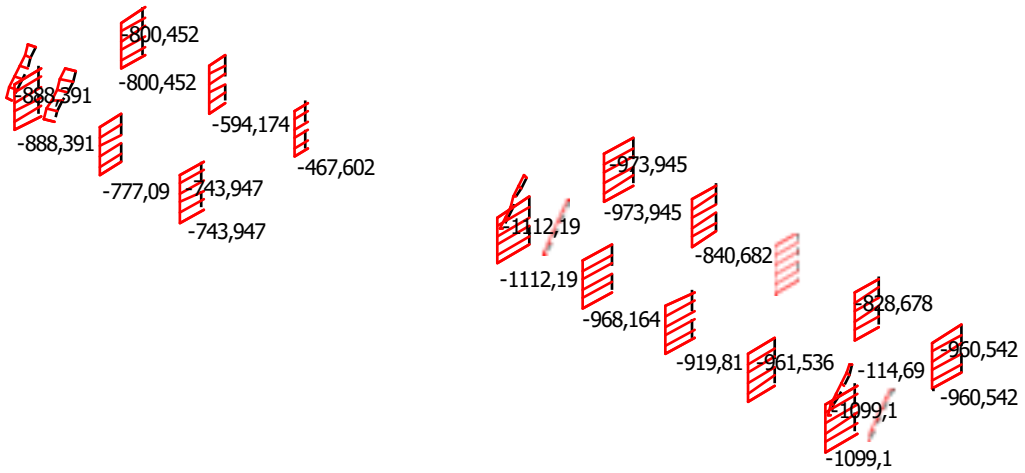
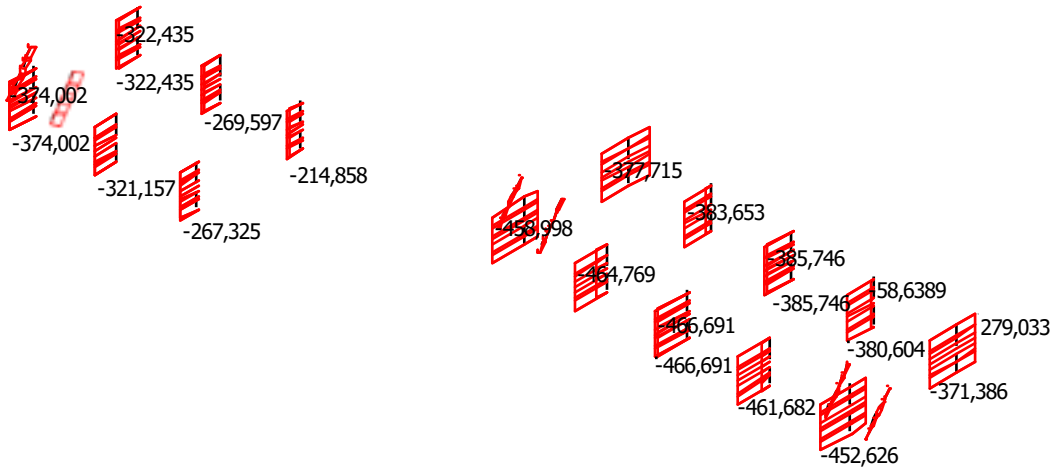


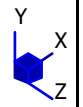
17430 Nodes 343 Beams 15590 Plates 0 Bricks 319 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 35,0 RY: 45,0 RZ: 0,0	229: ULS_Temp/Wind (leitend) [Factors Min Envelope 5] 1: Freedom Case 1 Scale: 0,0 %

ULS_Wind oder Temperatur leitend_Minimale Pfahlkraft Pfeilerfundamente Achse A2 und 1

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-466,691	279,033
	[Bm:253]	[Bm:252]





17430 Nodes	0 Vertices	View	226: Envelope Case [Maximum Envelope 2]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Maximale Pfahlkraft Pfeilerfundamente Achse A 2 und 1

Title:	
Project:	
Author:	Reference:

	MIN	MAX
AxForce(kN)	-466,691	279,033
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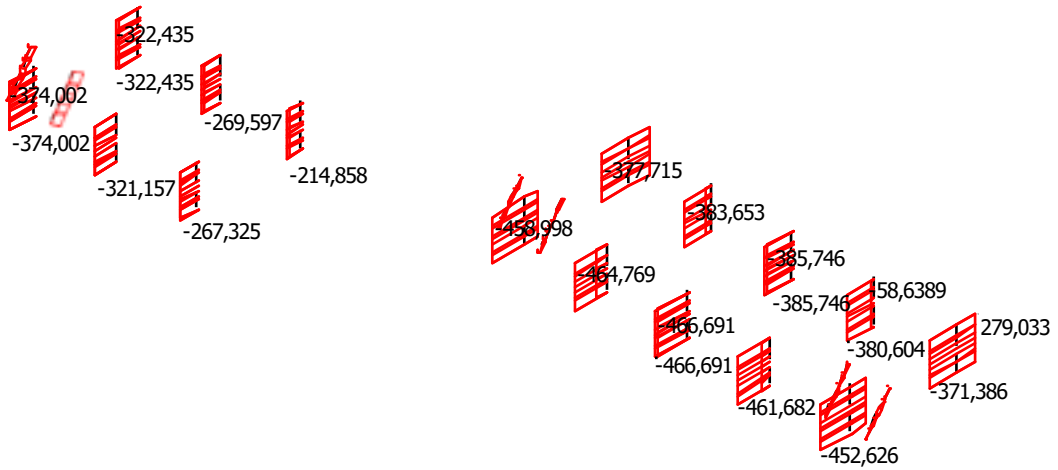

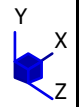

17430 Nodes	0 Vertices	View	225: Envelope Case [Minimum Envelope 1]
343 Beams	0 Edges	RX: 35,0	1: Freedom Case 1
15590 Plates	0 Loops	RY: 45,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
319 Links	0 Surfaces		
0 Paths			

ULS_Erdbeben_Minimale Pfahlkraft Pfeilerfundamente Achse A 2 und 1

Straus7 R2.4.6 [Licenced to:INGENIEURTEAM BERGMEISTER VARNA]
Model file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.st7
Result file: W:\2017\17-W054_P Sanierung Brücke Eschenlohe_\K06 AP\Statik\Straus7\Endstand\2018_11_22_FeC_Endstand.LSA
26 November 2018 9:27 am

5.6 Geotechnische Nachweise

17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Allegato relazione: Verifiche fondazioni di micropali

17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Allegato relazione: Verifiche fondazioni di micropali

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1 Parametrizzazione geotecnica

1.1 GE1 cachirite

unitá geotecnica GE1 cachirite avente le seguenti proprietá riportate nella relazione Jesacher 2016:

γ=20 kN/m^3 φk´=34° ck´=3 kPa

Un valore di τlim viene assunto pari a:

τlim=200 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

5.3.1. GE 1 – Kakirit **5.3.1. GE 1 – Cachirite**

Geotechnische Einheit **Unità geotecnica**	**GE 1** ***GE 1***
Korngrößenzusammensetzung, Textur, Gefüge *Composizione granulometrica, tessitura, struttura*	Sand, kiesig bis schwach kiesig, schluffig bis schwach schluffig, mit einzelnen Steinen und Blöcken, abschnittsweise reliktisches Felsgefüge (Kakirit). *Sabbia, da ghiaiosa a debolmente ghiaiosa, da limosa a debolmente limosa, con rari ciottoli e blocchi, a tratti struttura rocciosa relitta (cachirite)*
Kurzbezeichnung gem. DIN 4021 / *denominazione sec.* DIN 4021	S, g', u', x''
Bodenart gem. DIN 18196 / *tipo di terreno sec.* DIN 18196	SU - SW
Durchlässigkeitskoeffizient ***k*** *Coefficiente di permeabilità* ***k***	10^{-6} – 10^{-7} m/s (durchlässig bis schwach durchlässig) *(da permeabile a poco permeabile)*

Geotechnische Bodenkennwerte ***Parametri geotecnici del terreno***	
Wichte feucht γ / *peso del terreno* **γ** [kN/m³]	19,5 – 20,5
Reibungswinkel / *angolo di attrito* **φ'** [°]	34 – 38
Kohäsion / *coesione* **c'** [kPa]	5 – 3
Steifemodul / *modulo edometrico* $\mathbf{E_s}$ [MPa]	30 – 45

1.2 GE2 Cataclasite

Unitá geotecnica GE2 cataclasite avente le seguenti proprietá riportate nella relazione Jesacher 2016:

γ=26 kN/m^3 φk´=27° ck´=100 kPa

Un valore di τlim viene assunto pari a:

τlim=350 kPa

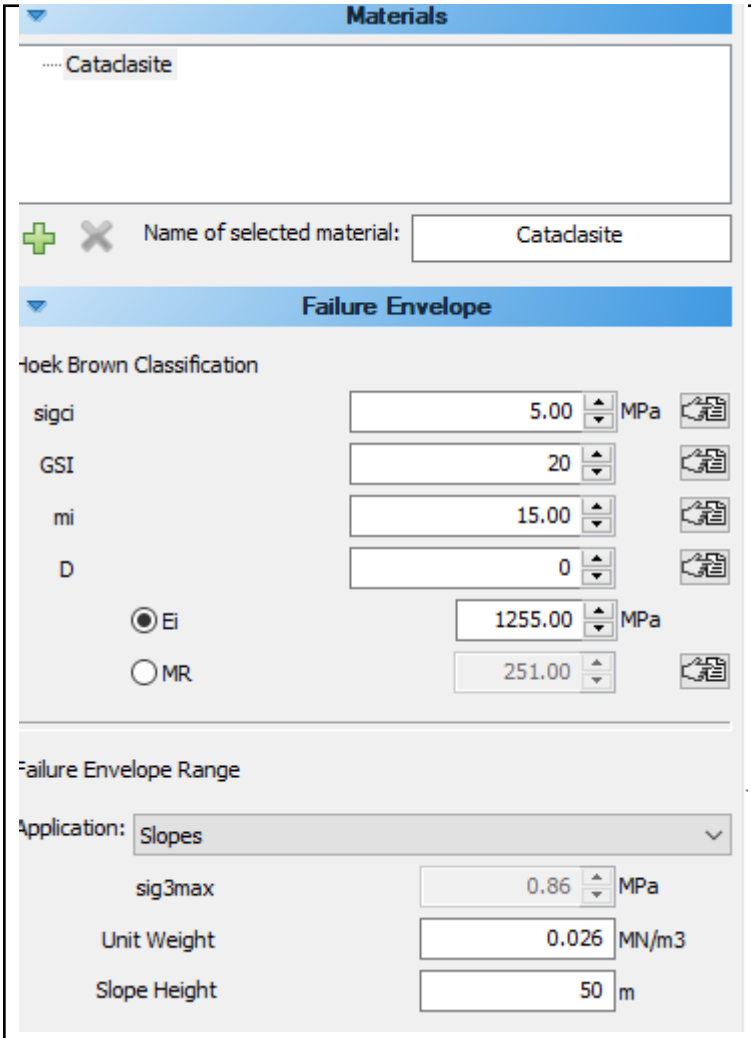
Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

5.3.2. GE 2 – Kataklasit **5.3.2. GE 2 – Cataclasite**

Geotechnische Einheit **Unità geotecnica**	**GE 2** ***GE 2***		
Lithologie *Litologia, composizione mineralogica*	Grüngrauer bis beiger, feinkörniger Hornfels, rostbraun verwittert, häufig Spiegelharnische; meist komplett zerbrochen (= X, G, y), *Cornubianite a grana fine da grigio verdastro a beige, alterazione di colore ocra, frequenti specchi di faglia, per lo più completamente fratturato a sassi e ghiaia con singoli blocchi*		
Schieferung / *Scistosità*	305/52 – 323/48		
Trennflächenorientierung *Orientamento della discontinuità*	*K_1 315/57 – 327/41* *K_4 033/54 – 043/56*	*K_2 150/50 – 157/53* *K_5 103/55*	*K_3 113/16*

Gesteinskennwerte ***Parametri della roccia***	
Dichte ρ / peso specifico ρ [t/m³]	2,65 – 2,75
Einaxiale Gesteinsdruckfestigkeit UCS / resistenza alla compr. monoassiale [MPa]	5 – 45, charakt. Wert / *valore caratt.* 25
m_i [-] (Hoek & Brown)	15 – 20, charakt. Wert / *valore caratt.*19
CAI Index / indice [-]	3,0 – 4, charakt. Wert / *valore caratt.* 4,5

Gebirgskennwerte ***Parametri dell'ammasso roccioso***	
RQD [%]	0 – 40, charakt. Wert / *valore caratt.* 15
GSI [-] (Hoek)	20 - 40, charakt. Wert / *valore caratt.* 30
E-Modul / *modulo elastico* [MPa]	1.255 – 2511, charakt. Wert / *valore caratt.* 1.500



Cataclasite	
Hoek Brown Classification	
intact uniaxial compressive strength	5 MPa
GSI	20
mi	15
disturbance factor	0
intact modulus	1255 MPa
Hoek Brown Criterion	
mb	0.861
s	1.379e-004
a	0.544
Failure Envelope Range	
application	slopes
sig3max	0.86 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.125 MPa
friction angle	27.445 deg
Rock Mass Parameters	
tensile strength	-8.004e-004 MPa
uniaxial compressive strength	0.04 MPa
global strength	0.506 MPa
modulus of deformation	57.318 MPa

1.3 GE3 Roccia moderatamente disgregata

Unitá geotecnica GE3 cataclasite avente le seguenti proprietá riportate nella relazione Jesacher 2016:

γ=26 kN/m^3 φk´=50 ck´=500 kPa

Un valore di τlim viene assunto pari a:

τlim=500 kPa

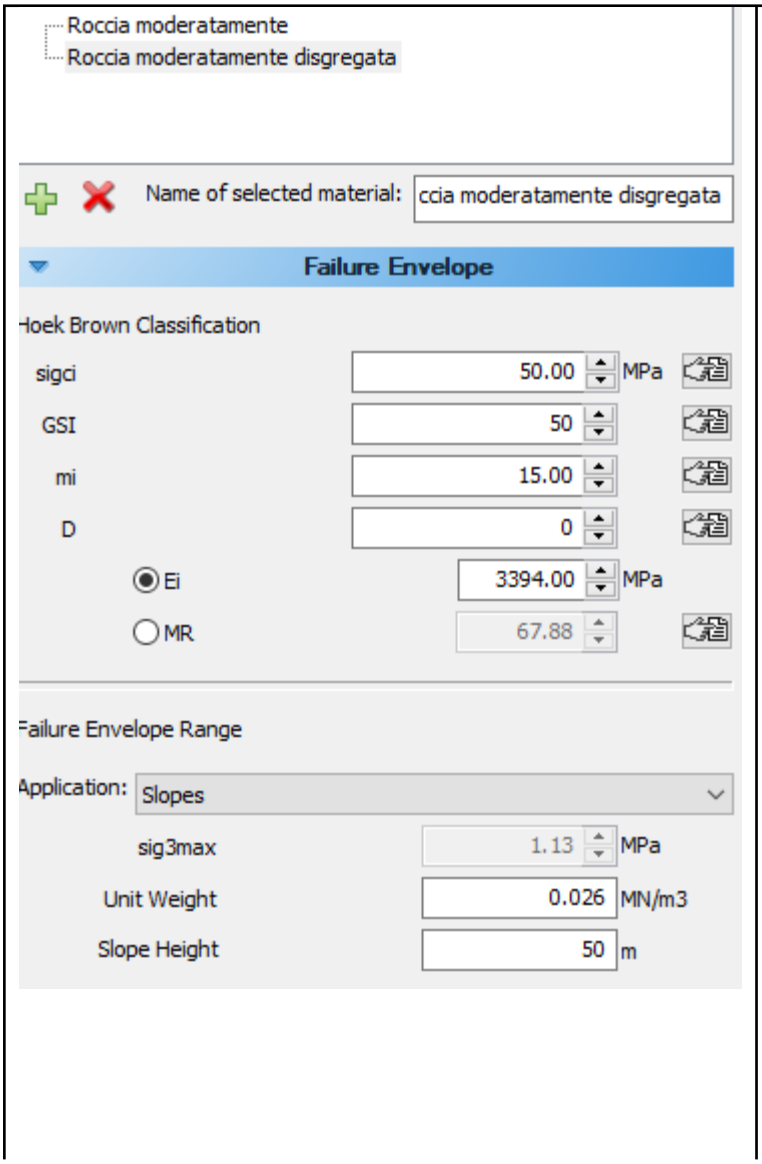
Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

5.3.3. GE 3 – Fels mäßig zerlegt **5.3.3. GE 3 – Roccia modestamente disgregata**

Geotechnische Einheit **Unità geotecnica**	**GE 3** ***GE 3***		
Lithologie *Litologia, composizione mineralogica*	grüngrauer bis beiger Hornfels bis Quarzit, mit Quarzlagen, häufig Spiegelharnische sowie deutliche Striemung, einzelne dünne Kakirit-Lagen, Trennflächen z.T. rostbraun angewittert *Cornubianite a quarzite da grigio verdastro a beige, a luogo con livelli quarzosi, abbondanti specchi di faglia e striature, rari livelli di fault gouge, singole fratture con alterazione di colore ocra*		
Schieferung / *Scistosità*	305/52 – 323/48		
Trennflächenorientierung *Orientamento della discontinuità*	K_1 *315/57 – 327/41* K_4 *033/54 – 043/56*	K_2 *150/50 – 157/53* K_5 *103/55*	K_3 *113/16*

Gesteinskennwerte ***Parametri della roccia***	
Dichte ρ / peso specifico ρ [t/m³]	2,65 – 2,75
Einaxiale Gesteinsdruckfestigkeit UCS / resistenza alla compr. monoassiale [MPa]	50 – 70, charakt. Wert / *valore caratt.* 55
m_i *[-] (Hoek & Brown)*	15 – 20, charakt. Wert / *valore caratt.*19
CAI Index / indice [-]	3,0 – 4,5, charakt. Wert / *valore caratt.* 4,5

Gebirgskennwerte ***Parametri dell'ammasso roccioso***	
RQD [%]	20 – 65, charakt. Wert / *valore caratt.* 35
GSI [-] (Hoek)	50 - 70, charakt. Wert / *valore caratt.* 60
E-Modul / *modulo elastico* [MPa]	3.394 – 8.235, charakt. Wert / *valore caratt.* 4.000



cia moderatamente disgreg	
Hoek Brown Classification	
intact uniaxial compressive strength	50 MPa
GSI	50
mi	15
disturbance factor	0
intact modulus	3394 MPa
Hoek Brown Criterion	
mb	2.515
s	0.004
a	0.506
Failure Envelope Range	
application	slopes
sig3max	1.13 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.63 MPa
friction angle	53.277 deg
Rock Mass Parameters	
tensile strength	-0.077 MPa
uniaxial compressive strength	3.011 MPa
global strength	10.587 MPa
modulus of deformation	1042.589 MPa

1.4 Materiale di riempimento

Materiale di riempimento avente le seguenti proprietá riportate nella mail dello studio Jesacher:
Il materiale di riempimento ha i seguenti parametri:

γ=20 kN/m^3 φk´=34 ck´=0 kPa

Un valore di τlim viene assunto pari a:

τlim=150 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

1.5 Materiale di deposito fondo valle

Materiale di riempimento avente le seguenti proprietá riportate nella mail dello studio Jesacher:
Il materiale di riempimento ha i seguenti parametri:

γ=20 kN/m^3 φk´=36 ck´=0 kPa

Un valore di τlim viene assunto pari a:

τlim=200 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

From: Michael Jesacher - Geologiebüro Jesacher [michael@jesacher.bz]
Received: Dienstag, 14 Apr. 2020, 12:06
To: Walter Weis [Walter.Weis@bergmeister.eu]
CC: Cristian Ferraro [Cristian.Ferraro@bergmeister.eu]; Umberto Capozzi [Umberto.Capozzi@bergmeister.eu]
Subject: AW: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Walter,

bestätige hiermit endgültig die u.a. Parameter.

Gute Arbeit, Michl

jesacher
geologiebüro | studio di geologia

Von: Walter Weis [mailto:Walter.Weis@bergmeister.eu]
Gesendet: Dienstag, 14. April 2020 09:51
An: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Cc: Cristian Ferraro <Cristian.Ferraro@bergmeister.eu>; Umberto Capozzi <Umberto.Capozzi@bergmeister.eu>
Betreff: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Michael, bitte um dringende endgültige Abstimmung der Scherparameter. Ich habe die Parameter wie folgt laut heutiger Telefonnotiz mit dir zusammengestellt. Bitte um Bestätigung.

Charakteristische Scherparameter und charakteristische **Mantelreibungen:**

Künstlichen Auffüllung: 34 Grad c = 0
Mantelreibung char. 150 KPa

GE1: Kakirit:
phi 34 Grad und c = 3KPA
Mantelreibung char. 200KPa

GE2: Kataklase:
Mantelreibung char. 350KPa

GE3: Fels verwittert:
Mantelreibung char. 500 KPa

Lockergesteinsauflage im Talboden:
phi = 36 Grad
c = 0
Mantelreibung char.: 200 KPa

Danke Walter

Von: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Gesendet: Freitag, 10. April 2020 09:08
An: Walter Weis <Walter.Weis@bergmeister.eu>
Betreff: AW: Eschenlohe: Kämpferfundamente

Hallo Walter siehe unten!

Grüße Micht

jesacher
geologisches studio di geologia

Von: Walter Weis [mailto:Walter.Weis@bergmeister.eu]
Gesendet: Freitag, 10. April 2020 08:57
An: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Betreff: Eschenlohe: Kämpferfundamente

Hallo Michael, anbei 2 paar Fragen

1.) Böschungssicherheit Kämpferfundament Lana und Pankraz. Problem bei Lana. Stimmt der Schichtverlauf?...Ja

Jesacher 2008:
c' = 52 kPa, f' = 38°.....das war das Modell vor den Bohrungen!

Jesacher 2018
GE1: Kalkrit slide Lana c' = 3 kPa e f' = 34°.....OK
GE2: Kalkfaxe slide Lana c' = 100 kPa e f' = 27°.....OK
GE3: Fels verwitert slide Lana c' = 500 kPa e f' = 50°.
Weitere Angaben zu den Scherparametern der Klüfte
C = 0-30 KPA, f = 33-36 Grad

2.) Sind diese Mantelreibungen für diese Mikropfähle vertretbar
Mantelreibungen:
Künstlichen Auffüllung: 32 Grad c = 0
Mantelreibung char.: 100 KPa
GE1: Kalkrit:
pH 34 Grad und c = 3KPA
Mantelreibung char.: 200KPa
GE2: Kalkfaxe:
Mantelreibung char.: 350KPa
GE3: Fels verwitert:
Mantelreibung char.: 500 KPa

Pfähle im Projekt vorgesehen zur Info:

- Micropali Fundament Widerlager Lana: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 12m (Bohrloch 240mm) und verdilen
- Micropali Fundament Widerlager Pankraz: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 12m (Bohrloch 240mm) und verdilen
- Micropali Fundament Pfeiler: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 16m (Bohrloch 240mm) und verdilen
- Micropali Kämpfer: Pfahl 139/20mm S355J2 mit Manschettenrohr lg = 16m (Bohrloch 240mm) und verdilen

Mikropfähle Kämpfer: machbar und notwendig, die quergeneigten können alle 4 Stück auf der Westseite ausgeführt werden. Die längsgeneigten Pfähle können zwischen den 11 Stützen ausgeführt werden.
Bohrgerät: Comacchio MC800 G = 4500 ku mit Ausbauen von oben eingehoben.

2 Vita utile micropali

Il diametro del micropalo in trazione subisce una riduzione pari a 1,20mm in quanto si ipotizza lo strato di boiacca fessurato. Il micropalo a compressione si ipotizza protetto dalla boiacca. Si assume una vita utile di 100 anni.

Table F.1 Loss of thickness [mm] due to corrosion for piles and sheet piles in soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undisturbed natural soils (sand, silt, clay, schist, ….)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial grounds	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, …)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt, ….)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag, ….)	0,50	2,00	3,25	4,50	5,75

Notes:

1) Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two.

2) The values given are only for guidance. Local conditions should be considered because they might affect the actual corrosion rate, which can be lower or higher than the average value given in the table.

3) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

3 Verifiche geotecniche fondazioni asse A2

3.1 Inviluppi SISMA/SLU da Straus7

Angolo di attrito a favore di sicurezza di calcolo=35°

Fondazione pila asse A2		X_A	Y_A	Z	M_x trsv	Mz_long	e long	e trasv	η long	η trasv
Combinazione	Straus7	[kN]	[kN]	[kN]	[kNm]	[kNm]	[m]	[m]	-	-
SISMA	A	33,5302	1926,14	47,3001	864,358	335,029	0,17	0,45	40,22	28,51
SISMA	B	-2,46048	1927,32	-68,6679	-28,2327	36,5855	0,02	0,01	548,48	19,65
SISMA	C	7,97273	2036,62	347,768	3158,86	123,413	0,06	**1,55**	178,87	4,10
SLU MIN LM1	FX	-94,3898	2333	-232,414	-823,285	749,518	0,32	0,35	17,31	7,03
SLU MIN LM1	FY	-50,496	1557,98	-256,801	-954,273	500,527	0,32	0,61	21,60	4,25
SLU MIN LM1	FZ	-63,7236	3473,98	-300,853	-713,375	473,234	0,14	0,21	38,17	8,09
SLU MIN LM1	MX	-15,7669	2664,61	-221,266	-1160,18	65,2735	0,02	0,44	118,34	8,43
SLU MIN LM1	MY	66,187	2099,8	17,7586	406,269	-644,621	0,31	0,19	22,21	82,79
SLU MIN LM1	MZ	85,7624	2099,47	17,8931	407,269	-682,805	0,33	0,19	17,14	82,16
SLU MAX LM1	FX	85,7624	2099,47	17,8931	407,269	-682,805	0,33	0,19	17,14	82,16
SLU MAX LM1	FY	38,3032	4314,92	-14,8318	572,701	-402,17	0,09	0,13	78,88	203,71
SLU MAX LM1	FZ	54,6132	2150,5	84,8583	704,142	-411,397	0,19	0,33	27,57	17,74
SLU MAX LM1	MX	6,85124	3105,51	-23,257	800,329	2,00286	0,00	0,26	317,39	93,50
SLU MAX LM1	MY	-74,8144	2332,67	-232,28	-822,286	711,334	0,30	0,35	21,83	7,03
SLU MAX LM1	MZ	-94,3898	2333	-232,414	-823,285	749,518	0,32	0,35	17,31	7,03
SLU MIN TEMP/WIND	FX	-125,887	2166,3	-287,396	-1089,12	1024,32	0,47	0,50	12,05	5,28
SLU MIN TEMP/WIND	FY	-86,5152	1348,58	-328,601	-1180,44	812,074	**0,60**	0,88	**10,91**	**2,87**
SLU MIN TEMP/WIND	FZ	-99,6919	2804,28	-376,484	-1108,69	787,567	0,28	0,40	19,70	5,22
SLU MIN TEMP/WIND	MX	-15,7456	2602,67	-271,936	-1436,97	65,4877	0,03	0,55	115,74	6,70
SLU MIN TEMP/WIND	MY	97,7659	2265,96	80,4067	730,071	-920,208	0,41	0,32	16,23	19,73
SLU MIN TEMP/WIND	MZ	117,341	2265,63	80,5412	731,07	-958,392	0,42	0,32	13,52	19,70
SLU MAX TEMP/WIND	FX	117,341	2265,63	80,5412	731,07	-958,392	0,42	0,32	13,52	19,70
SLU MAX TEMP/WIND	FY	73,1558	3972,05	83,9067	865,843	-704,318	0,18	0,22	38,02	33,15
SLU MAX TEMP/WIND	FZ	90,3742	2327,57	155,14	940,984	-721,632	0,31	0,40	18,03	10,51
SLU MAX TEMP/WIND	MX	7,15205	2665,78	45,7808	1104,68	-0,121374	0,00	0,41	260,99	40,77
SLU MAX TEMP/WIND	MY	-106,312	2165,97	-287,262	-1088,12	986,136	0,46	0,50	14,27	5,28
SLU MAX TEMP/WIND	MZ	-125,887	2166,3	-287,396	-1089,12	1024,32	0,47	0,50	12,05	5,28
							e long MAX	e trasv MAX	η long MIN	η trasv MIN
							0,60	**1,55**	**10,91**	**2,87**

3.2 Verifica a scivolamento fondazione priva di micropali

Reazione verticale Nsd=2000 kN

Reazione massima orizzontale Hsd(trasversale da sisma C)=350 kN

η=0,90*Nsd*tanϕ′/(1,10*Hsd)= 0,90*2000*tan35/(1,10*350)=3,0>1,10 Verificato

3.3 Verifica a taglio fondazione con micropali

Micropali 139,7x12,5mm S355

Area di taglio=24,92 cm^2

Vrd=fyd*Av//$\sqrt{3}$=355 MPa/1,05*24,92/(100)^2 m^2*1000/$\sqrt{3}$=486,43 kN

Nr di micropali presenti 16

Vrd totale=Nr*Vrd=16*486,43 kN=7782,88 kN>Ved=350 kN Verificato

3.4 Verifica tensionale

Verifica tensionale fondazioni		
Luogo	Fondazioni pila	
asse	A2	
L_long	3,45	m
B_trasv	10,2	m
σlim	3000	[kPa]
Verifica tensionale longitudinale		
Combinazione	SLU MIN TEMP/WIND	
Nsd	1340	kN
Msd_long	820	kNm
e_long	0,61	m
σmax	78,69	[kPa]
σmin	0,00	[kPa]
Verifica tensionale trasversale		
Combinazione	Sisma C	
Nsd	2000	kN
Msd_trasv	3200	kNm
e_long	1,60	m
σmax	110,33	[kPa]
σmin	3,34	[kPa]
Verifica		
σmax<σlim	**Verificato**	

3.5 Verifica strutturale micropalo assi A2

Nsd compressione micropalo 139x12,5mm=1150 kN

Nsd trazione micropalo 139x12,5mm=500 kN

Verifica sezione metallica micropalo		
Micropalo	139,7mmx12,5mm	
d esterno	139,70	mm
Spessore	12,50	mm
d interno	114,70	mm
Area micropalo	4995,13	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	1688,83	kN
Spessore corrosione	2,40	mm
diametro esterno corroso	137,30	mm
diametro interno	114,70	mm
Area micropalo con corrosione	4473,00	mm2
Nrd con corrosione	**1512,30**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	

3.6 Verifica a sfilamento micropalo assi A2

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	

4 Verifiche geotecniche fondazioni asse 1

4.1 Inviluppi SISMA/SLU da Straus7

Angolo di attrito a favore di sicurezza di calcolo=35°

Fondazione pila asse 1		X_A	Y_A	Z	M_x trsv	Mz_long	e long	e trasv	η long	η trasv
Combinazione	Straus7	[kN]	[kN]	[kN]	[kNm]	[kNm]	[m]	[m]	-	-
SISMA	A	41,0809	4433,75	211,597	3634,06	577,298	0,13	0,82	75,57	14,67
SISMA	B	0,496055	4481,54	28,7284	523,612	40,8117	0,01	0,12	6325,93	109,23
SISMA	C	11,4475	4472,11	680,091	11589,8	189,911	0,04	**2,59**	273,54	**4,60**
SLU MIN LM1	FX	-172,72	5487,52	43,6145	792,027	1308,73	0,24	0,14	22,25	88,10
SLU MIN LM1	FY	-23,5723	4263,77	3,49765	38,4619	302,553	0,07	0,01	126,65	853,58
SLU MIN LM1	FZ	2,72765	4330,86	-183,259	-2787,8	-131,328	0,03	0,64	1111,76	16,55
SLU MIN LM1	MX	6,04051	5658,58	-121,723	-4745,39	-185,411	0,03	0,84	655,93	32,55
SLU MIN LM1	MY	-0,251834	7193,56	156,791	3556,25	141,186	0,02	0,49	20001,21	32,13
SLU MIN LM1	MZ	73,8501	4398,01	9,54427	9,62344	-1330,61	0,30	0,00	41,70	322,66
SLU MAX LM1	FX	169,88	4871,24	19,2495	378,608	-1247,09	0,26	0,08	20,08	177,19
SLU MAX LM1	FY	25,3368	8178,29	9,00684	2159,07	-316,119	0,04	0,26	226,02	635,79
SLU MAX LM1	FZ	-11,9215	6008,28	209,427	3330,6	298,006	0,05	0,55	352,90	20,09
SLU MAX LM1	MX	-8,62455	7337,99	153,348	5411,25	244,071	0,03	0,74	595,75	33,51
SLU MAX LM1	MY	14,4368	5506,41	-126,804	-2923,93	-288,517	0,05	0,53	267,07	30,41
SLU MAX LM1	MZ	-76,6896	5960,76	53,3197	1161,01	1392,25	0,23	0,19	54,42	78,28
SLU MIN TEMP/WIND	FX	-265,583	5518,27	29,175	547,508	1746,46	0,32	0,10	14,55	132,44
SLU MIN TEMP/WIND	FY	-46,3009	4157,82	18,794	616,265	685,331	0,16	0,15	62,88	154,91
SLU MIN TEMP/WIND	FZ	3,55746	4350,23	-247,057	-3677,79	-144,574	0,03	0,85	856,25	12,33
SLU MIN TEMP/WIND	MX	6,01571	5172,72	-209,747	-4891,91	-185,427	0,04	0,95	602,09	17,27
SLU MIN TEMP/WIND	MY	-2,63017	6774	246,048	4481,19	168,566	0,02	0,66	1803,38	19,28
SLU MIN TEMP/WIND	MZ	102,891	4407,53	2,04517	-250,6	-1825,82	**0,41**	0,06	29,99	1509,01
SLU MAX TEMP/WIND	FX	262,899	4868,71	16,499	330,378	-1686,62	0,35	0,07	**12,97**	206,63
SLU MAX TEMP/WIND	FY	47,0123	7422,06	-3,59939	1051,47	-679,987	0,09	0,14	110,55	1443,85
SLU MAX TEMP/WIND	FZ	-11,093	6027,68	273,131	4218,86	284,769	0,05	0,70	380,48	15,45
SLU MAX TEMP/WIND	MX	-8,64463	6851,41	239,139	5508,27	244,008	0,04	0,80	554,96	20,06
SLU MAX TEMP/WIND	MY	12,0496	5089,24	-217,664	-3885,16	-261,052	0,06	0,76	295,73	16,37
SLU MAX TEMP/WIND	MZ	-105,575	5979,46	43,6288	1128,48	1885,65	0,32	0,19	39,66	95,97
							e long MAX	e trasv MAX	η long MIN	η trasv MIN
							0,41	**2,59**	**12,97**	**4,60**

4.2 Verifica a scivolamento fondazione priva di micropali

Reazione verticale Nsd=4400 kN

Reazione massima orizzontale Hsd(questo caso trasversale da Sisma C)=700 kN

η=0,90*Nsd*tanϕ′/(1,10*Hsd)= 0,90*4400*tan35/(1,10*700)=3,60>1,10 Verificato

4.3 Verifica a taglio fondazione con micropali

Micropali 139,7x12,5mm S355

Area di taglio=24,92 cm^2

Vrd=fyd*Av//$\sqrt{3}$=355 MPa/1,05*24,92/(100)^2 m^2*1000/$\sqrt{3}$=486,43 kN

Nr di micropali presenti 14

Vrd totale=Nr*Vrd=14*486,43 kN=6810,02 kN>Ved=700 kN Verificato

4.4 Verifica tensionale

Verifica tensionale fondazioni		
Luogo	Fondazioni pila	
asse	1	
L_long	3,45	m
B_trasv	10,2	m
σlim	3000	[kPa]
Verifica tensionale longitudinale		
Combinazione	SLU MIN TEMP/WIND	
Nsd	4400	kN
Msd_long	1800	kNm
e_long	0,41	m
σmax	213,99	[kPa]
σmin	36,08	[kPa]
Verifica tensionale trasversale		
Combinazione	Sisma C	
Nsd	4400	kN
Msd_trasv	11600	kNm
e_long	2,64	m
σmax	181,25	[kPa]
σmin	0,00	[kPa]
Verifica		
σmax<σlim	**Verificato**	

4.5 Verifica strutturale micropalo asse 1

Nsd compressione micropalo 139x12,5mm=1150 kN

Nsd trazione micropalo 139x12,5mm=500 kN

Verifica sezione metallica micropalo		
Micropalo	139,7mmx12,5mm	
d esterno	139,70	mm
Spessore	12,50	mm
d interno	114,70	mm
Area micropalo	4995,13	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	1688,83	kN
Spessore corrosione	2,40	mm
diametro esterno corroso	137,30	mm
diametro interno	114,70	mm
Area micropalo con corrosione	4473,00	mm2
Nrd con corrosione	**1512,30**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	

4.6 Verifica a sfilamento micropalo asse 1

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	

5 Verifiche geotecniche fondazioni imposta arco asse 2 lato Lana

5.1 Inviluppi SISMA/SLU da Straus7

Angolo di attrito a favore di sicurezza di calcolo=35°

Imposta arco Lana asse 2		X_A	Y_A	Z	M_x trsv	Mz_long	Fondazione inclinata di 30°					
Combinazione	Straus7	[kN]	[kN]	[kN]	[kNm]	[kNm]	F perpendicolare A	Forza parallela A	e long	e trasv	η long	η trasv
SISMA	A	27500	47500	1200	30600	34600	54886,21	65,70	0,63	0,56	584,97	32,03
SISMA	B	25820	46600	100	2900	-1900	53266,78	-939,22	0,04	0,05	39,71	372,98
SISMA	C	26200	46800	3910	101128	8154	53629,99	-710,13	0,15	**1,89**	52,88	**9,60**
SLU MIN LM1	FX	23688,5	45569,6	15,1288	424,723	13174,3	51308,68	-2269,96	0,26	0,01	15,83	2374,72
SLU MIN LM1	FY	23688,5	45569,6	15,1288	424,723	13174,3	51308,68	-2269,96	0,26	0,01	15,83	2374,72
SLU MIN LM1	FZ	27213,1	48670,3	-728,715	-9321,45	716,318	55756,27	-767,91	0,01	0,17	50,84	53,58
SLU MIN LM1	MX	27062,5	49790,5	-655,391	-23137,1	-436,991	56651,09	-1458,44	0,01	0,41	27,20	60,52
SLU MIN LM1	MY	30680,7	66617,3	701,879	24390,2	-5047,48	76032,62	-1542,23	0,07	0,32	34,52	75,85
SLU MIN LM1	MZ	30243,2	49054,4	7,78574	1185,65	-48130,9	57603,96	1664,18	0,84	0,02	24,24	5180,59
SLU MAX LM1	FX	39864,9	69685,9	38,4435	-5563,2	-21313,5	80282,21	-318,93	0,27	0,07	176,26	1462,26
SLU MAX LM1	FY	39864,9	69685,9	38,4435	-5563,2	-21313,5	80282,21	-318,93	0,27	0,07	176,26	1462,26
SLU MAX LM1	FZ	36831	65498	765,873	10306,4	-3889,35	75138,43	-852,42	0,05	0,14	61,72	68,70
SLU MAX LM1	MX	36680,7	66617,3	701,879	24390,2	-5047,48	76032,62	-1542,23	0,07	0,32	34,52	75,85
SLU MAX LM1	MY	27062,5	49790,5	-655,391	-23137,1	-436,991	56651,09	-1458,44	0,01	0,41	27,20	60,52
SLU MAX LM1	MZ	33885,2	64276,8	78,0169	-1451,39	34291	72607,94	-2792,96	0,47	0,02	18,20	651,66
SLU MIN TEMP/WIND	FX	23730,1	45715,2	14,842	390,849	14783,2	51455,57	-2306,73	0,29	0,01	**15,62**	2427,54
SLU MIN TEMP/WIND	FY	23730,1	45715,2	14,842	390,849	14783,2	51455,57	-2306,73	0,29	0,01	15,62	2427,54
SLU MIN TEMP/WIND	FZ	26007,3	47301,9	-1167,03	-21933,3	1395,03	53968,30	-1127,97	0,03	0,41	33,50	32,38
SLU MIN TEMP/WIND	MX	25892,3	48071,6	-1127,57	-29123,4	535,533	54577,38	-1612,41	0,01	0,53	23,70	33,89
SLU MIN TEMP/WIND	MY	35510,5	64898,7	1170,47	30273,5	-4074,7	73959,17	-1696,35	0,06	0,41	30,53	44,24
SLU MIN TEMP/WIND	MZ	29557,4	48641,8	-9,54683	276,917	-48614,8	56903,73	1276,56	**0,85**	0,00	31,21	4173,58
SLU MAX TEMP/WIND	FX	38310,1	66954,5	30,6833	-3072,78	-24925	77139,35	-299,73	0,32	0,04	180,21	1760,36
SLU MAX TEMP/WIND	FY	38310,1	66954,5	30,6833	-3072,78	-24925	77139,35	-299,73	0,32	0,04	180,21	1760,36
SLU MAX TEMP/WIND	FZ	35625,3	64129,5	1204,22	22919,3	-3212,82	73350,43	-1212,34	0,04	0,31	42,36	42,65
SLU MAX TEMP/WIND	MX	35510,5	64898,7	1170,47	30273,5	-4074,7	73959,17	-1696,35	0,06	0,41	30,53	44,24
SLU MAX TEMP/WIND	MY	25892,3	48071,6	-1127,57	-29123,4	535,533	54577,38	-1612,41	0,01	0,53	23,70	33,89
SLU MAX TEMP/WIND	MZ	32496	62517,6	73,5232	116,884	37917,1	70389,83	-3116,44	0,54	0,00	15,82	670,37
									e long MAX	e trasv MAX	η long MIN	η trasv MIN
									0,85	**1,89**	**15,62**	**9,60**

5.2 Verifica a scivolamento fondazione priva di micropali

Reazione verticale Nsd=46800 kN

Reazione massima orizzontale Hsd(questo caso trasversale Sisma C)=4000 kN

η=0,90*Nsd*tanϕ'/(1,10*Hsd)=0,90*46800*tan35/(1,10*4000)=8,20>1,10 Verificato

5.3 Verifica a taglio fondazione con micropali

Micropali 139,7x20mm S355

Area di taglio=37,99 cm^2

Vrd=fyd*Av//$\sqrt{3}$=355 MPa/1,05*37,99/(100)^2 m^2*1000/$\sqrt{3}$=741,56 kN

Nr di micropali presenti 71

Vrd totale=Nr*Vrd=71*741,56 kN=52650,80 kN>Ved=4000 kN Verificato

5.4 Verifica tensionale

Verifica tensionale fondazioni		
Luogo	imposta arco	
asse	2	
L_long	8,5	m
B_trasv	15	m
σlim	3000	[kPa]
Verifica tensionale longitudinale		
Combinazione	SLU MIN TEMP/WIND	
Nsd	56900	kN
Msd_long	48700	kNm
e_long	0,86	m
σmax	715,89	[kPa]
σmin	176,66	[kPa]
Verifica tensionale trasversale		
Combinazione	Sisma C	
Nsd	53600	kN
Msd_trasv	101200	kNm
e_long	1,89	m
σmax	737,88	[kPa]
σmin	102,90	[kPa]
Verifica		
σmax<σlim	**Verificato**	

5.5 Verifica strutturale micropalo imposta arco asse 2

Nsd compressione micropalo 139x20mm=2458 kN

Nsd trazione micropalo 139x20mm=2166 kN

Verifica sezione metallica micropalo		
Micropalo	139,7mmx20mm	
d esterno	139,70	mm
Spessore	20,00	mm
d interno	99,70	mm
Area micropalo	7520,97	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	2542,81	kN
Ned in compressione	**2458,00**	kN
Verifica	**Verificato**	
Spessore corrosione	2,40	mm
diametro esterno corroso	137,30	mm
diametro interno	99,70	mm
Area micropalo con corrosione	6998,84	mm2
Nrd con corrosione	**2366,27**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	

5.6 Verifica a sfilamento micropalo imposta arco asse 2

Verifica geostatica compressione micropalo imposta arco		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	12,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**2585,08**	**kN**
Ned	**2458,00**	kN
Verifica	**Verificato**	

Verifica geostatica a trazione micropalo		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	12,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**2585,08**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	

6 Verifiche geotecniche fondazioni imposta arco asse 12 lato S.Pancrazio

6.1 Inviluppi SISMA/SLU da Straus7

Angolo di attrito a favore di sicurezza di calcolo=35°

Imposta arco San Pancrazio asse 12		X_A	Y_A	Z	M_x trsv	Mz_long	Fondazione inclinata di 30°					
Combinazione	Straus7	[kN]	[kN]	[kN]	[kNm]	[kNm]	F perpendicolare A	Forza parallela A	e long	e trasv	η long	η trasv
SISMA	A	22650	46370	1150	28300	44574	51482,60	-3569,52	**0,87**	0,55	**10,10**	31,35
SISMA	B	24500	45500	100	2400	8200	51654,16	-1532,38	0,16	0,05	23,60	361,69
SISMA	C	24200	45700	3800	94300	18300	51677,36	-1892,19	0,35	**1,82**	19,12	**9,52**
SLU MIN LM1	FX	-39816,1	68135,5	15,0307	-6174,03	24901	78915,12	414,00	0,32	0,08	133,47	3676,27
SLU MIN LM1	FY	-23619,6	44408,6	-0,021318	6,33343	-9120,12	50268,78	-1749,13	0,18	0,00	20,12	1651119,98
SLU MIN LM1	FZ	-34977,5	61803,6	-727,638	-8763,96	6066,05	71012,24	-610,40	0,09	0,12	81,46	68,34
SLU MIN LM1	MX	-34809,9	62915	-658,622	-22703,2	7009,01	71890,94	-1311,24	0,10	0,32	38,39	76,43
SLU MIN LM1	MY	-34809,9	62915	-658,622	-22703,2	7009,01	71890,94	-1311,24	0,10	0,32	38,39	76,43
SLU MIN LM1	MZ	-26236,3	48486,8	41,3425	-2503,14	-29782,7	55108,95	-1522,10	0,54	0,05	25,35	933,37
SLU MAX LM1	FX	-23619,6	44408,6	-0,021318	6,33343	-9120,12	50268,78	-1749,13	0,18	0,00	20,12	1651119,98
SLU MAX LM1	FY	-39816,1	68135,5	15,0307	-6174,03	24901	78915,12	414,00	0,32	0,08	133,47	3676,27
SLU MAX LM1	FZ	-29023,6	49650,6	727,894	8727,88	6613,06	57510,48	309,87	0,11	0,15	129,95	55,32
SLU MAX LM1	MX	-28856	50761,9	659,262	22687,6	7558,74	58389,09	-390,92	0,13	0,39	104,59	62,02
SLU MAX LM1	MY	-28856	50761,9	659,262	22687,6	7558,74	58389,09	-390,92	0,13	0,39	104,59	62,02
SLU MAX LM1	MZ	-37822,1	62115,3	-14,6878	-1322,7	53093,8	72704,48	1697,25	0,73	0,02	29,99	3466,02
SLU MIN TEMP/WIND	FX	-38255,9	65417,9	9,24931	-3655,17	28545,5	75781,51	421,63	0,38	0,05	125,85	5736,95
SLU MIN TEMP/WIND	FY	-23710,3	44563,2	0,293573	-10,3229	-10074,6	50448,01	-1747,88	0,20	0,00	20,21	120324,69
SLU MIN TEMP/WIND	FZ	-33768,6	60436,2	-1163,43	-20908,8	5374,17	69223,58	-973,63	0,08	0,30	49,78	41,66
SLU MIN TEMP/WIND	MX	-33640,8	61209,1	-1122,55	-28117,3	6091,88	69829,04	-1470,76	0,09	0,40	33,24	43,56
SLU MIN TEMP/WIND	MY	-33640,8	61209,1	-1122,55	-28117,3	6091,88	69829,04	-1470,76	0,09	0,40	33,24	43,56
SLU MIN TEMP/WIND	MZ	-24752,2	46684,5	24,7706	-1247,53	-34092,2	52806,06	-1906,22	0,65	0,02	19,40	1492,71
SLU MAX TEMP/WIND	FX	-23710,3	44563,2	0,293573	-10,3229	-10074,6	50448,01	-1747,88	0,20	0,00	20,21	120324,69
SLU MAX TEMP/WIND	FY	-38255,9	65417,9	9,24931	-3655,17	28545,5	75781,51	421,63	0,38	0,05	125,85	5736,95
SLU MAX TEMP/WIND	FZ	-27814,6	48283,2	1163,73	20874,2	5920,87	55721,78	-53,45	0,11	0,37	729,97	33,53
SLU MAX TEMP/WIND	MX	-27686,7	49056	1123,08	28095,2	6640,04	56327,09	-550,61	0,12	0,50	71,63	35,12
SLU MAX TEMP/WIND	MY	-27686,7	49056	1123,08	28095,2	6640,04	56327,09	-550,61	0,12	0,50	71,63	35,12
SLU MAX TEMP/WIND	MZ	-37230,8	61751,1	-8,90061	-806,208	54234,1	72093,42	1367,27	0,75	0,01	36,92	5671,56
									e long MAX	e trasv MAX	η long MIN	η trasv MIN
									0,87	**1,82**	**10,10**	**9,52**

6.2 Verifica a scivolamento fondazione priva di micropali

Reazione verticale Nsd=45700 kN

Reazione massima orizzontale Hsd(questo caso trasversale Sisma C)=4000 kN

η=0,90*Nsd*tanϕ′/(1,10*Hsd)=0,90*46800*tan35/(1,10*4000)=6,54>1,10 Verificato

6.3 Verifica a taglio fondazione con micropali

Micropali 139,7x20mm S355

Area di taglio=37,99 cm^2

Vrd=fyd*Av//$\sqrt{3}$=355 MPa/1,05*37,99/(100)^2 m^2*1000/$\sqrt{3}$=741,56 kN

Nr di micropali presenti 71

Vrd totale=Nr*Vrd=71*741,56 kN=52650,80 kN>Ved=4000 kN Verificato

6.4 Verifica tensionale

Verifica tensionale fondazioni		
Luogo	imposta arco	
asse	12	
L_long	8,5	m
B_trasv	15	m
σlim	3000	[kPa]
Verifica tensionale longitudinale		
Combinazione	Sisma A	
Nsd	51400	kN
Msd_long	44600	kNm
e_long	0,87	m
σmax	650,06	[kPa]
σmin	156,22	[kPa]
Verifica tensionale trasversale		
Combinazione	Sisma C	
Nsd	51600	kN
Msd_trasv	94300	kNm
e_long	1,83	m
σmax	700,58	[kPa]
σmin	108,86	[kPa]
Verifica		
σmax<σlim	**Verificato**	

6.5 Verifica strutturale micropalo imposta arco 12

Nsd compressione micropalo 139x20mm=2458 kN

Nsd trazione micropalo 139x20mm=2166 kN

Verifica sezione metallica micropalo		
Micropalo	139,7mmx20mm	
d esterno	139,70	mm
Spessore	20,00	mm
d interno	99,70	mm
Area micropalo	7520,97	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	2542,81	kN
Ned in compressione	**2458,00**	kN
Verifica	**Verificato**	
Spessore corrosione	2,40	mm
diametro esterno corroso	137,30	mm
diametro interno	99,70	mm
Area micropalo con corrosione	6998,84	mm2
Nrd con corrosione	**2366,27**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	

6.6 Verifica a sfilamento micropalo imposta arco 12

Verifica geostatica compressione micropalo imposta arco		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	8,00	m
τ limite in GE2	350,00	kN/m2
L micropalo bulbo in GE2	4,00	m
γt	1,15	-
ξ	1,40	-
Nrd	**2528,88**	**kN**
Ned	**2458,00**	kN
Verifica	**Verificato**	

Verifica geostatica a trazione micropalo		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	12,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**2585,08**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	

7 Verifiche geotecniche fondazioni asse 13

7.1 Inviluppi SISMA/SLU da Straus7

Angolo di attrito a favore di sicurezza di calcolo=35°

Fondazione pila asse 13		X_A	Y_A	Z	M_x trsv	Mz_long	e long	e trasv	η long	η trasv
Combinazione	Straus7	[kN]	[kN]	[kN]	[kNm]	[kNm]	[m]	[m]	-	-
SISMA	A	69,5684	4717,14	291,846	3597,59	737,323	0,16	0,76	47,48	11,32
SISMA	B	1,95983	4682,25	29,9248	367,243	44,3614	0,01	0,08	1672,87	109,56
SISMA	C	20,4607	4692,56	968,551	11938,9	235,634	0,05	**2,54**	160,59	**3,39**
SLU MIN LM1	FX	-156,119	5825,56	11,9015	148,395	936,761	0,16	0,03	25,80	342,74
SLU MIN LM1	FY	-37,2022	4475,66	57,1101	695,326	346,228	0,08	0,16	84,24	54,87
SLU MIN LM1	FZ	4,1817	4596,62	-282,906	-3289,89	-145,568	0,03	0,72	769,68	11,38
SLU MIN LM1	MX	-2,01288	6066,28	-196,618	-5432,14	-71,1869	0,01	0,90	2110,24	21,60
SLU MIN LM1	MY	-1,36739	5798,18	-199,651	-3403,96	-111,163	0,02	0,59	2969,11	20,34
SLU MIN LM1	MZ	109,946	5196,77	54,1444	658,935	-1408,03	0,27	0,13	33,10	67,21
SLU MAX LM1	FX	157,153	5195,13	54,8425	667,534	-884,047	0,17	0,13	23,15	66,33
SLU MAX LM1	FY	63,8149	8849,89	-7,92339	-2282,93	-618,539	0,07	0,26	97,11	782,08
SLU MAX LM1	FZ	8,08507	6402,01	287,448	3346,28	42,3727	0,01	0,52	554,45	15,59
SLU MAX LM1	MX	1,89013	7871,67	201,19	5488,93	116,758	0,01	0,70	2916,10	27,40
SLU MAX LM1	MY	2,53567	7603,57	204,254	3461,12	76,7806	0,01	0,46	2099,67	26,07
SLU MAX LM1	MZ	-110,911	5823,92	12,5996	156,993	1460,75	0,25	0,03	36,77	323,66
SLU MIN TEMP/WIND	FX	-228,985	5821,56	7,22694	90,0747	1214,95	0,21	0,02	17,80	564,04
SLU MIN TEMP/WIND	FY	-90,8201	4439,44	32,6333	399,203	980,745	0,22	0,09	34,23	95,26
SLU MIN TEMP/WIND	FZ	2,69676	4614,33	-360,65	-4133,69	-128,619	0,03	0,90	1198,10	8,96
SLU MIN TEMP/WIND	MX	-2,30341	5498,51	-309,81	-5451,54	-69,4651	0,01	0,99	1671,48	12,43
SLU MIN TEMP/WIND	MY	-1,37565	5385,34	-316,739	-4329,89	-101,366	0,02	0,80	2741,14	11,91
SLU MIN TEMP/WIND	MZ	152,014	5226,84	29,1372	356,232	-1916,49	**0,37**	0,07	24,08	125,61
SLU MAX TEMP/WIND	FX	228,083	5224,1	30,2926	370,461	-1163,88	0,22	0,07	**16,04**	120,75
SLU MAX TEMP/WIND	FY	104,753	8007,5	-0,348896	-1394,05	-1105,4	0,14	0,17	53,53	1607,35
SLU MAX TEMP/WIND	FZ	6,60065	6419,71	365,032	4188,09	59,315	0,01	0,65	681,01	12,31
SLU MAX TEMP/WIND	MX	1,6002	7303,9	314,206	5506,13	118,472	0,02	0,75	3196,00	16,28
SLU MAX TEMP/WIND	MY	2,52811	7190,72	321,171	4384,92	86,57	0,01	0,61	1991,60	15,68
SLU MAX TEMP/WIND	MZ	-152,917	5818,82	8,3823	104,304	1967,57	0,34	0,02	26,64	486,07
							e long MAX	e trasv MAX	η long MIN	η trasv MIN
							0,37	**2,54**	**16,04**	**3,39**

7.2 Verifica a scivolamento fondazione priva di micropali

Reazione verticale Nsd=4600 kN

Reazione massima orizzontale Hsd(questo caso trasversale sisma C)=1000 kN

η=0,90*Nsd*tanϕ´/(1,10*Hsd)= 0,90*4600*tan35/(1,10*1000)=2,65>1,10 Verificato

7.3 Verifica a taglio fondazione con micropali

Micropali 139,7x12,5mm S355

Area di taglio=24,92 cm^2

Vrd=fyd*Av//$\sqrt{3}$=355 MPa/1,05*24,92/$(100)^2$ m^2*1000/$\sqrt{3}$=486,43 kN

Nr di micropali presenti 14

Vrd totale=Nr*Vrd=14*486,43 kN=6810,02 kN>Ved=1000 kN Verificato

7.4 Verifica tensionale

Verifica tensionale fondazioni		
Luogo	Fondazioni pila	
asse	13	
L_long	3,65	m
B_trasv	10,2	m
σlim	3000	[kPa]
Verifica tensionale longitudinale		
Combinazione	SLU MIN TEMP/WIND	
Nsd	5200	kN
Msd_long	2000	kNm
e_long	0,38	m
σmax	227,98	[kPa]
σmin	51,37	[kPa]
Verifica tensionale trasversale		
Combinazione	Sisma C	
Nsd	4700	kN
Msd_trasv	12000	kNm
e_long	2,55	m
σmax	182,05	[kPa]
σmin	0,00	[kPa]
Verifica		
σmax<σlim	**Verificato**	

7.5 Verifica strutturale micropalo asse 13

Nsd compressione micropalo 139x12,5mm=1200 kN

Nsd trazione micropalo 139x12,5mm=300 kN

Verifica sezione metallica micropalo		
Micropalo	139,7mmx12,5mm	
d esterno	139,70	mm
Spessore	12,50	mm
d interno	114,70	mm
Area micropalo	4995,13	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	1688,83	kN
Spessore corrosione	2,40	mm
diametro esterno corroso	137,30	mm
diametro interno	114,70	mm
Area micropalo con corrosione	4473,00	mm2
Nrd con corrosione	**1512,30**	**kN**
Ned	**1200,00**	kN
Verifica	**Verificato**	

7.6 Verifica a sfilamento micropalo asse 13

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**1200,00**	kN
Verifica	**Verificato**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	6,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**300,00**	kN
Verifica	**Verificato**	

8 Verifica slide

8.1 Carichi per combinazione A2+M2+R2

IMPOSTA ARCO LATO LANA			
LC	X_A	Y_A	M_A
	[kN]	[kN]	[kNm]
G1	21500	41650	-3670
G2	3650	4300	6820
Temp	-550	50	-13000
Acc	1450	2800	-13640
A2	27415	50945	-29436
SUPERFICIE DI APPOGGIO (l=9,08m) IMPOSTA INCLINATA 30,0 GRADI			
forza ortogonale alla supeficie in A	57827,1642		
forza parallela alla superficie in A	-1730,41356		
momento in A	-29436		
carico trapezoidale distribuito su 9,08m punto f1	567,466831		
carico trapezoidale distribuito su 9,08m punto f2	281,683891		
carico lineare parallelo alla superficie su 9,08m f3	-12,7049453		

IMPOSTA ARCO LATO SAN PANCRAZIO			
LC	X_B	Y_B	M_B
	[kN]	[kN]	[kNm]
G1	21500	40550	440
G2	3660	4270	6650
Temp	-690	-30	-14000
Acc	1460	2770	-13460
A2	27259	49663	-26613
SUPERFICIE DI APPOGGIO (l=9,08m) IMPOSTA INCLINATA 30,0 GRADI			
forza ortogonale alla supeficie in A	56638,9196		
forza parallela alla superficie in A	-1224,51352		
momento in A	-26613		
carico trapezoidale distribuito su 9,08m punto f1	545,038851		
carico trapezoidale distribuito su 9,08m punto f2	286,663346		
carico lineare parallelo alla superficie su 9,08m f3	-8,99055447		

8.2 Parametri geotecnici per verifica slide

Tabella parametrizzazione terreno						
Unitá	Descrizione	γ [kN/m3]	ϕk´ [°]	ck´ [kPa]	Es´ [MPa]	τlim [kPa]
GE1	Cachirite	20	34	3	30	200
GE2	Catacalsite	26	27	100	50	350
GE3	Roccia debolmente disgregata	26	50	500	1000	500
-	Materiale di riporto	20	34	0	-	150
-	Materiali di deposito	20	36	0	-	-

$\phi' d = \tan^{-1}(\tan \phi' / 1{,}25)$

$c' d = c' k / 1{,}25$

Tabella parametrizzazione terreno per Slide combo A2+M2+R2				
Unitá	Descrizione	γ [kN/m3]	ϕd´ [°]	cd´ [kPa]
GE1	Cachirite	20	28	2,4
GE2	Catacalsite	26	22	80
GE3	Roccia debolmente disgregata	26	43	400
-	Materiale di riporto	20	28	0
-	Materiali di deposito	20	30	0

8.3 Verifica SLIDE lato LANA senza micropali (Combinazione A2+M2+R2)

Material Properties

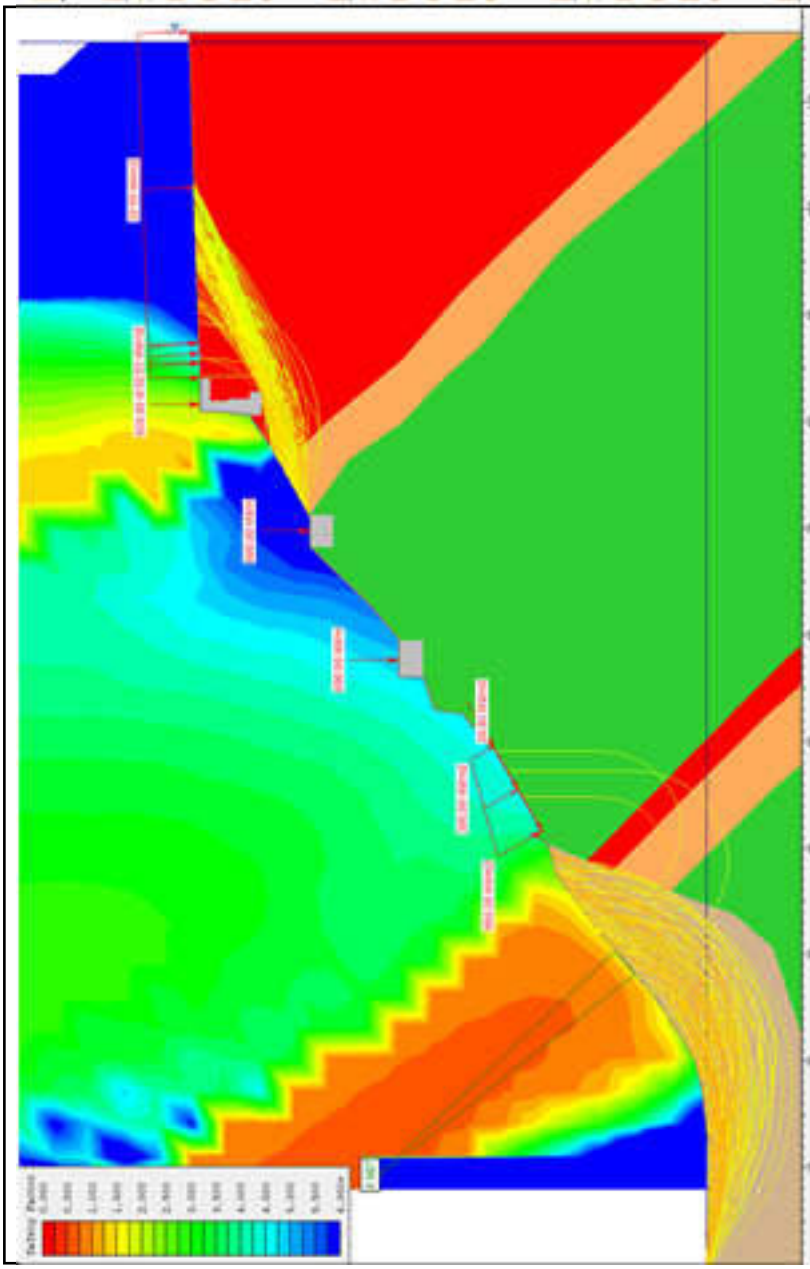
Material: GE1 Cachirite
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 2.4 kPa
Friction Angle: 28 degrees
Water Surface: None

Material: GE2 Cataclastica
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 80 kPa
Friction Angle: 22 degrees
Water Surface: None

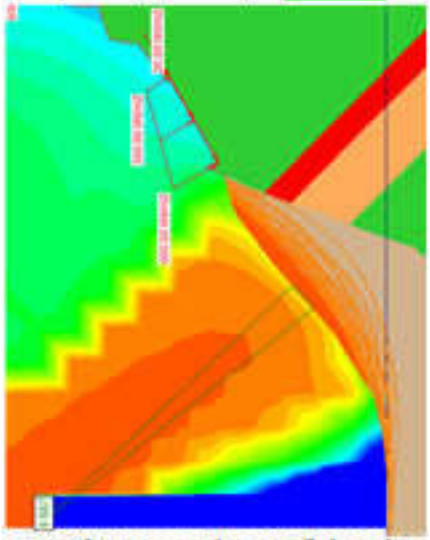
Material: GE3
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 400 kPa
Friction Angle: 43 degrees
Water Surface: None

Material: CLS
Strength Type: Mohr-Coulomb
Unit Weight: 25 kN/m3
Cohesion: 100000 kPa
Friction Angle: 89 degrees
Water Surface: None

Material: Depositi
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 30 degrees
Water Surface: None



1) Imposta arco Fs >1,45 verificato
2) Imposta spalla Fs>1,10 verificato



Fs<1,1 interessano la zona di deposito come sopra riportato

Pendenza max scavo fronte spalla lato Lana a lungo termine 2/3.

8.4 Verifica SLIDE lato LANA con micropali (Combinazione A2+M2+R2)

Material Properties

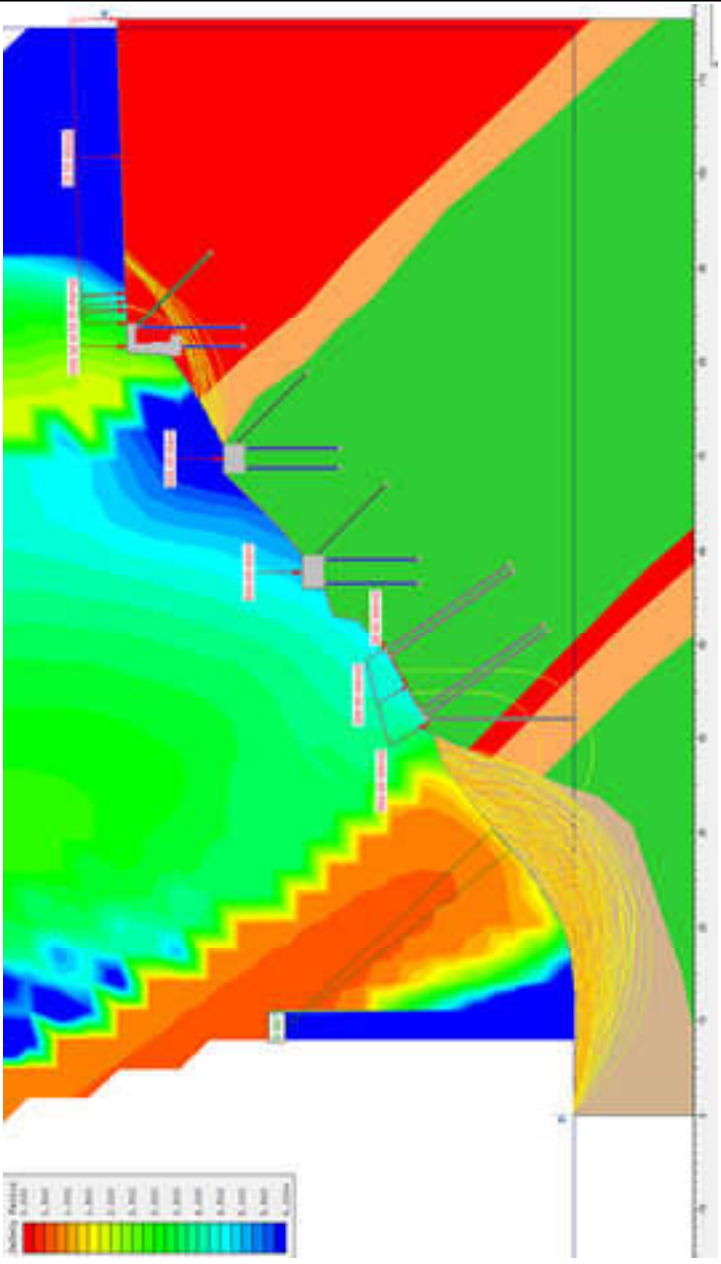
Material: GE1 Cachinite
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 2.4 kPa
Friction Angle: 28 degrees
Water Surface: None

Material: GE2 Cataclastica
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 80 kPa
Friction Angle: 22 degrees
Water Surface: None

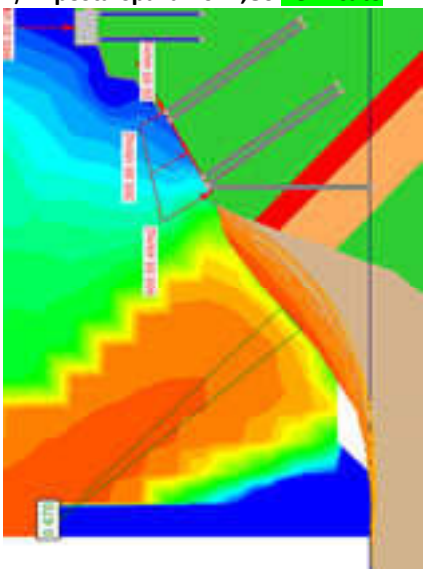
Material: GE3
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 400 kPa
Friction Angle: 43 degrees
Water Surface: None

Material: CLS
Strength Type: Mohr-Coulomb
Unit Weight: 25 kN/m3
Cohesion: 100000 kPa
Friction Angle: 89 degrees
Water Surface: None

Material: Depositi
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 30 degrees
Water Surface: None



1) **Imposta arco Fs >1,55 verificato**
2) **Imposta spalla Fs>1,80 verificato**



Fs<1,1 interessano la zona di deposito come sopra riportato

Pendenza max scavo fronte spalla lato Lana a lungo termine 2/3.

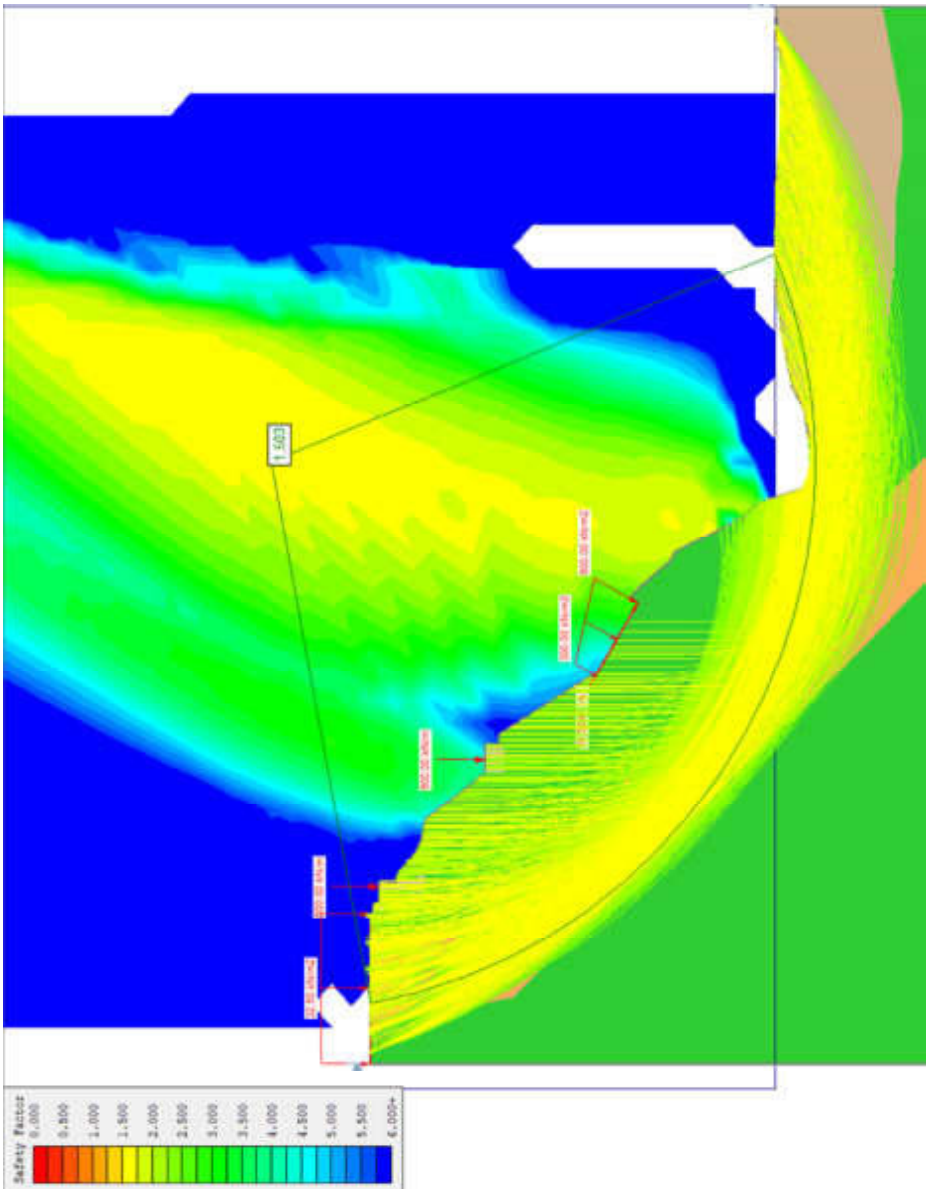
Support Properties

Support: 139.7x10mm i=1m
139.7x10mm i=1m
Support Type: Micro-Pile
Force Application: Passive
Out-of-Plane Spacing: 1 m
Pile Shear Strength: 200 kN

Support: 139.7x10mm i=2m
139.7x10mm i=2m
Support Type: Micro-Pile
Force Application: Passive
Out-of-Plane Spacing: 2 m
Pile Shear Strength: 200 kN

Support: 139.7x20mm i=1.00m
139.7x20mm i=1.00m
Support Type: Micro-Pile
Force Application: Passive
Out-of-Plane Spacing: 1 m
Pile Shear Strength: 300 kN

8.5 Verifica SLIDE lato San pancrazio senza micropali (Combinazione A2+M2+R2)



1) **Imposta arco Fs >1,50**
verificato
2) **Imposta spalla Fs>1,50**
verificato

Material Properties

Material: GE1 Cachirite
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 2.4 kPa
Friction Angle: 28 degrees
Water Surface: None

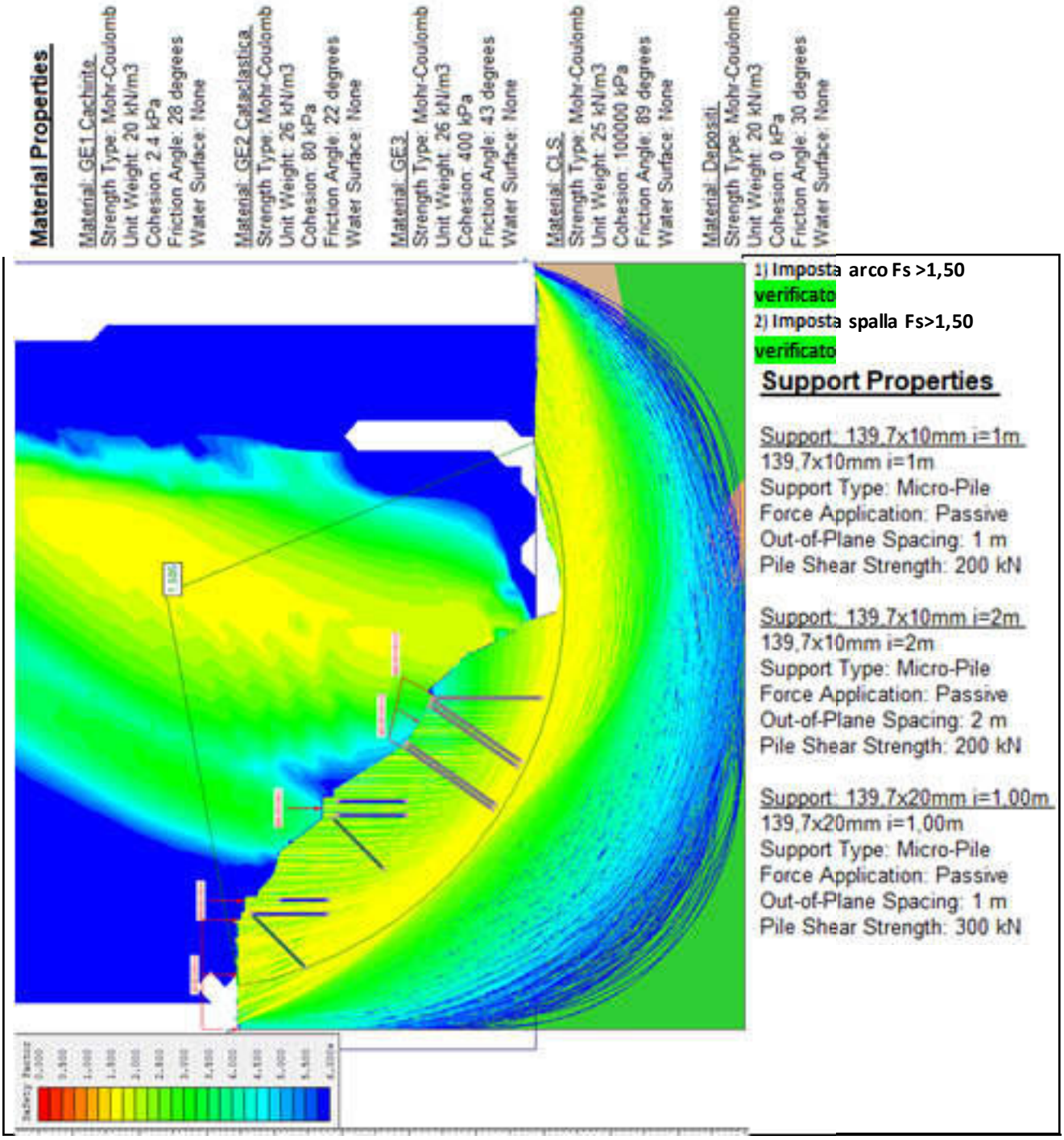
Material: GE2 Cataclastica
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 80 kPa
Friction Angle: 22 degrees
Water Surface: None

Material: GE3
Strength Type: Mohr-Coulomb
Unit Weight: 26 kN/m3
Cohesion: 400 kPa
Friction Angle: 43 degrees
Water Surface: None

Material: CLS
Strength Type: Mohr-Coulomb
Unit Weight: 25 kN/m3
Cohesion: 100000 kPa
Friction Angle: 89 degrees
Water Surface: None

Material: Depositi
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 30 degrees
Water Surface: None

8.6 Verifica SLIDE lato San pancrazio con micropali (Combinazione A2+M2+R2)



5.7 Nachweise Widerlager St. Pankraz

17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Verifiche della spalla lato San Pancrazio

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1. Premesse generali

1.1. Descrizione generale

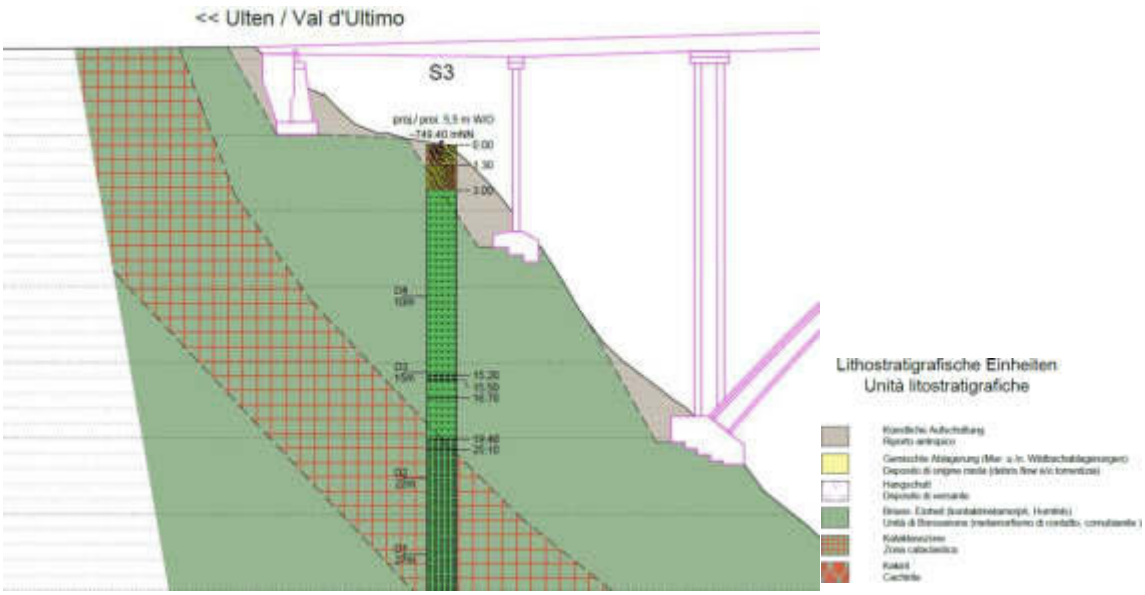
Il ponte Eschenlohe si trova in corrispondenza del km 7,750 della strada provinciale n°9 della Val d'Ultimo.
Il ponte attraversa in vicinanza del castello prestanome Eschenlohe una valle in direzione NW-SE, che ad est del ponte citato sfocia nel Rio Valsura.

Nella presente relazione si presentano i calcoli e le verifiche del cavalletto di micropali per il rinforzo della spalla asse B in direzione San Pancrazio del ponte "Eschenlohe".

1.2. Descrizione geologica e parametrizzazione geotecnica

Le spalle del ponte sono fondate su roccia debolmente disgregata. Nei settori in questione il substrato roccioso è coperto soltanto localmente da detrito di versante.

Fonte: relazione geologica e sismica del geologo Jesacher.
Di seguito si riporta una sezione longitudinale geologica che individua la posizione della spalla oggetto di relazione e la conformazione geologica:



La spalla, come sopra evidenziato, poggia su unitá litologica GE3 roccia debolmente disgregata avente le seguenti proprietá calcolate con Rocdata:

γ=26 kN/m^3 φk´=50 ck´=500 kPa

Un valore di τlim viene assunto pari a:

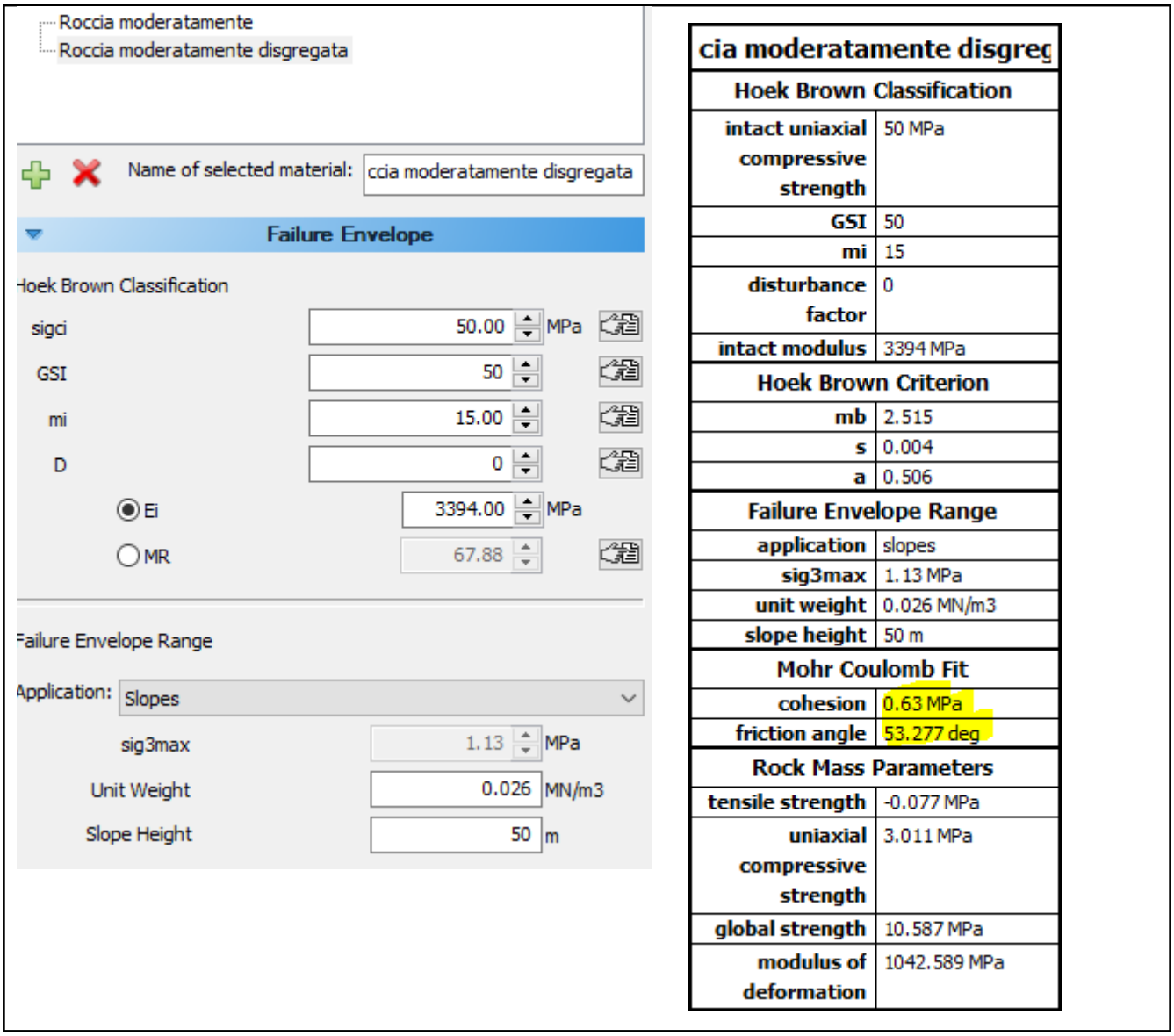
τlim=500 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

Geotechnische Einheit **Unità geotecnica**	**GE 3** ***GE 3***		
Lithologie	grüngrauer bis beiger Hornfels bis Quarzit, mit Quarzlagen, häufig Spiegelharnische sowie deutliche Striemung, einzelne dünne Kakirit-Lagen, Trennflächen z.T. rostbraun angewittert		
Litologia, composizione mineralogica	*Cornubianite a quarzite da grigio verdastro a beige, a luogo con livelli quarzosi, abbondanti specchi di faglia e striature, rari livelli di fault gouge, singole fratture con alterazione di colore ocra*		
Schieferung / *Scistosità*	305/52 – 323/48		
Trennflächenorientierung *Orientamento della discontinuità*	*K_1 315/57 – 327/41* *K_4 033/54 – 043/56*	*K_2 150/50 – 157/53* *K_5 103/55*	*K_3 113/16*

Gesteinskennwerte ***Parametri della roccia***	
Dichte ρ / peso specifico ρ [t/m³]	2,65 – 2,75
Einaxiale Gesteinsdruckfestigkeit UCS / resistenza alla compr. monoassiale [MPa]	50 – 70, charakt. Wert / *valore caratt.* 55
m_i [-] (Hoek & Brown)	15 – 20, charakt. Wert / *valore caratt.*19
CAI Index / indice [-]	3,0 – 4,5, charakt. Wert / *valore caratt.* 4,5

Gebirgskennwerte ***Parametri dell'ammasso roccioso***	
RQD [%]	20 – 65, charakt. Wert / *valore caratt.* 35
GSI [-] (Hoek)	50 - 70, charakt. Wert / *valore caratt.* 60
E-Modul / *modulo elastico* [MPa]	3.394 – 8.235, charakt. Wert / *valore caratt.* 4.000



cia moderatamente disgreg	
Hoek Brown Classification	
intact uniaxial compressive strength	50 MPa
GSI	50
mi	15
disturbance factor	0
intact modulus	3394 MPa
Hoek Brown Criterion	
mb	2.515
s	0.004
a	0.506
Failure Envelope Range	
application	slopes
sig3max	1.13 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.63 MPa
friction angle	53.277 deg
Rock Mass Parameters	
tensile strength	-0.077 MPa
uniaxial compressive strength	3.011 MPa
global strength	10.587 MPa
modulus of deformation	1042.589 MPa

Il materiale di riempimento ha i seguenti parametri:

γ=20 kN/m^3 φk´=34 ck´=0 kPa

Un valore di τlim viene assunto pari a:

τlim=150 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

Lo strato di roccia moderatamente disgregata GE3 poggia su circa 10m di Cataclasite GE2 per poi ripresentarsi (vedi sezione longitudinale).

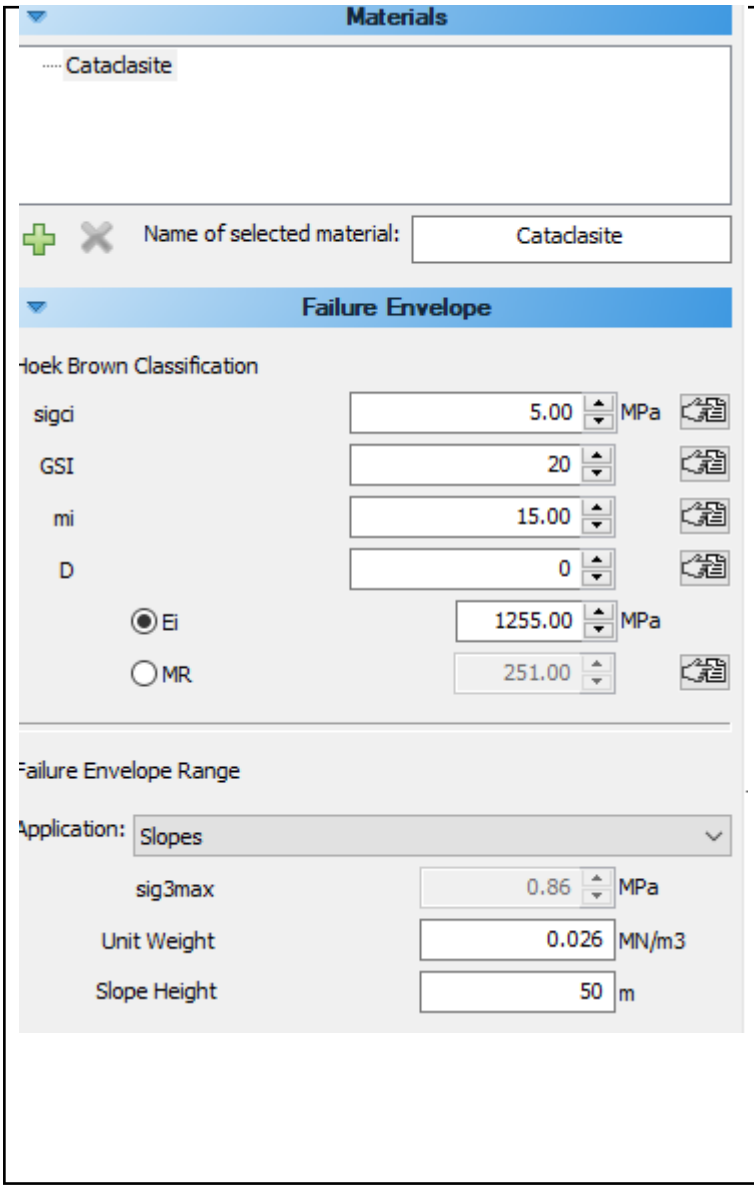
I parametri dello strato di zona di cataclasite sono stati valutati con il programma Rocdata:

γ=26 kN/m3 φk´=27° ck´=100 kPa

Un valore di τlim viene assunto pari a:

τlim=350 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.



Cataclasite	
Hoek Brown Classification	
intact uniaxial compressive strength	5 MPa
GSI	20
mi	15
disturbance factor	0
intact modulus	1255 MPa
Hoek Brown Criterion	
mb	0.861
s	1.379e-004
a	0.544
Failure Envelope Range	
application	slopes
sig3max	0.86 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.125 MPa
friction angle	27.445 deg
Rock Mass Parameters	
tensile strength	-8.004e-004 MPa
uniaxial compressive strength	0.04 MPa
global strength	0.506 MPa
modulus of deformation	57.318 MPa

2. Materiali costruttivi

calcestruzzo

- C30/37 f_{ck} = 30 N/mm²

Acciaio per c.emento armato:

- B 450 C: f_{yk} = 450 N/mm²

Acciaio per micropali:

- S355 f_{yk} = 355 N/mm²

3. Fattori di sicurezza

fattori di sicurezza per materiale

combinazione base:

-calcestruzzo	$\gamma_C = 1.50$
-acciaio armatura	$\gamma_S = 1.15$
- acciaio	$\gamma_S = 1.05$

combinazioni straordinarie:

- calcestruzzo	$\gamma_C = 1,00$
-acciaio armatura	$\gamma_S = 1.00$
-acciaio	$\gamma_{St} = 1.00$

fattori di sicurezza per carichi perdita dell'equilibrio statico

$\gamma_{G,sup}$	= 1.1	carichi permanenti e carichi propri, svantaggiose
$\gamma_{G,inf}$	= 0.9	carichi permanenti e carichi propri, svantaggiose
γ_Q	= 1.5	carichi accidentali, sfavorevoli
γ_A	= 1.0	carichi straordinari

Rottura della struttura

$\gamma_{G,sup}$	= 1.3	carichi propri, svantaggiose
$\gamma_{G,inf}$	= 1.0	carichi propri, vantaggiose
$\gamma_{G,sup}$	= 1.5	carichi permanenti non stutturali, svantaggiose
$\gamma_{G,inf}$	= 0.0	carichi permanenti non stutturali, vantaggiose
γ_Q	= 1.5	carichi permanenti e carichi propri, svantaggiose
γ_P	= 1.0	precompressione, effetto della temperatura, deformazione del terreno, viscosità, ritiro
γ_A	= 1.0	carichi straordinari

$\gamma_A = \gamma_G = \gamma_Q$

Rottura del suolo

$\gamma_{G,inf}$	= 1.0	carichi propri
$\gamma_{G,sup}$	= 1.3	carichi permanenti non stutturali, svantaggiose
$\gamma_{G,inf}$	= 0.0	carichi permanenti non stutturali, vantaggiose
γ_Q	= 1.3	carichi accidentali, sfavorevoli
γ_A	= 1.0	carichi straordinari

4. Copriferro

Il copriferro é stato stabilito secondo il Circolare 2019 e D.M. 2018.

La struttura può essere classificata come una struttura in classe di esposizione XF2 secondo la UNI EN 206-1 in quanto può essere sottoposta direttamente all´azione dei Sali antigelo.

Tabella 4.1.III – *Descrizione delle condizioni ambientali*

CONDIZIONI AMBIENTALI	CLASSE DI ESPOSIZIONE
Ordinarie	X0, XC1, XC2, XC3, XF1
Aggressive	XC4, XD1, XS1, XA1, XA2, XF2, XF3
Molto aggressive	XD2, XD3, XS2, XS3, XA3, XF4

Tabella C4.1.IV *Copriferri minimi in mm*

			barre da c.a. elementi a piastra		barre da c.a. altri elementi		cavi da c.a.p. elementi a piastra		cavi da c.a.p. altri elementi	
C_{min}	C_o	ambiente	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$
C25/30	C35/45	ordinario	15	20	20	25	25	30	30	35
C28/35	C40/50	aggressivo	25	30	30	35	35	40	40	45
C35/45	C45/55	molto ag.	35	40	40	45	45	50	50	50

In funzione della classificazione secondo le indicazioni delle NTC2018 la struttura è presente in condizioni ambientali “Molto aggressive.”

Si adotta un calcestruzzo C30/37 come indicato alla Tabella C4.1.IV della NTC18, per il quale è necessario prevedere un copriferro pari a 50mm.

5. Normative

Norme Tecniche per le Costruzioni di cui al DM 17 gennaio 2018, con le istruzioni applicative emanate con la Circolare Ministeriale n. 617 del 2 febbraio 2009. Coerentemente con quanto previsto ai cap. 1 e 12 delle suddette norme tecniche, per quanto non espressamente nelle stesse si fa riferimento ai Eurocodici strutturali.

Eurocodice 0 - Criteri generali di progettazione strutturale
2006 UNI EN 1990:2006

Eurocodice 2 – Progettazione delle strutture in calcestruzzo
UNI EN 1992-1-1:

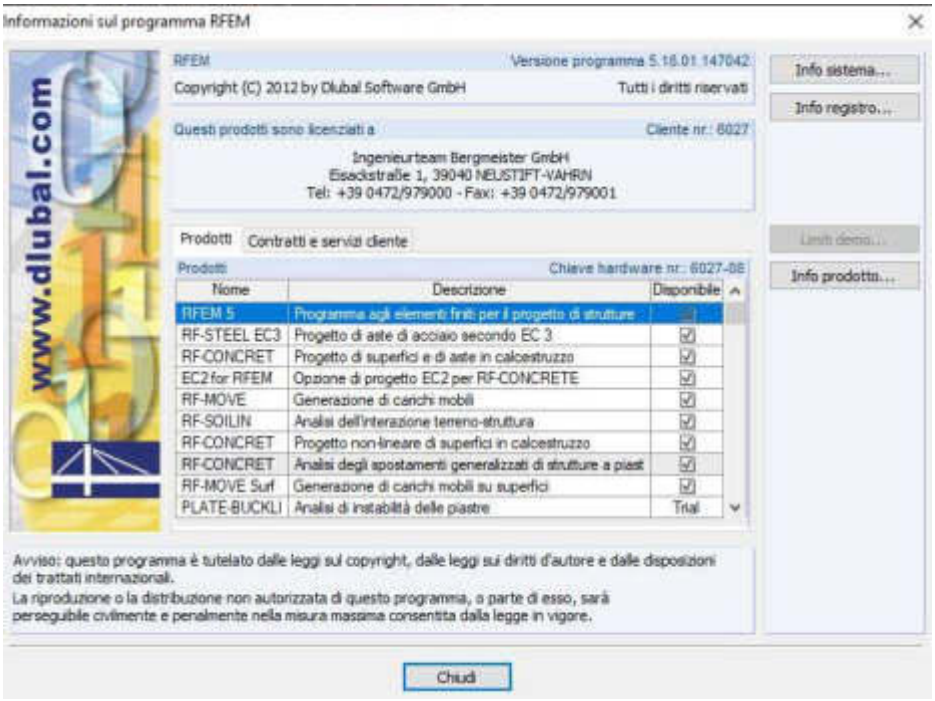
2005 Parte 1-1: Regole generali e regole per gli edifici

Eurocodice 7 – Progettazione geotecnica
UNI EN 1997-1:

2005 Parte 1: Regole generali

6. Software utilizzato per il calcolo

[1] RFEM 5.18.01.147042



7. Descrizione della struttura, del modello di calcolo e dei carichi

La struttura oggetto di calcolo si compone di un cavalletto di micropali composto da:

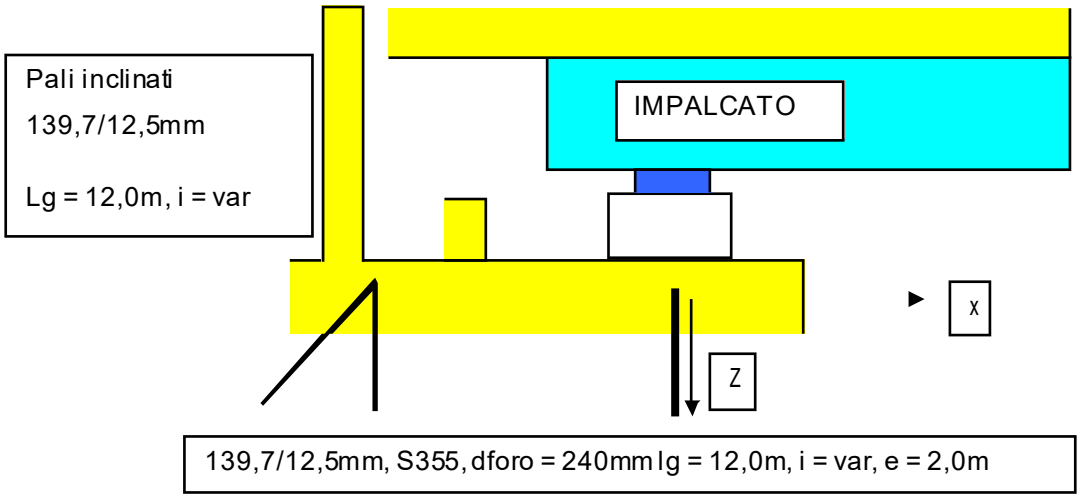
- Fondazione di collegamento composta da una parte di spessore pari a 80 cm e una di 40 cm;
- Micropali valvolati in acciaio zincato S355 139,7mmx12,5mm di lunghezza pari a 12m.
- 6 Baggioli in calcestruzzo di dimensioni 70cmx70cmx15cm con interasse di 1,60m ove poggiano gli elastomeri

Tale cavalletto è composto da due file di micropali con interasse longitudinale rispetto l´asse del ponte variabile tra 1,65m e 2m.

I micropali hanno un interesse trasversale rispetto l´asse del ponte di variabile tra 0,6m e 1m.

I micropali e la struttura di collegamento rinforzano le spalle esistenti alte circa 6m composte da muri con spessore variabile con l´altezza.

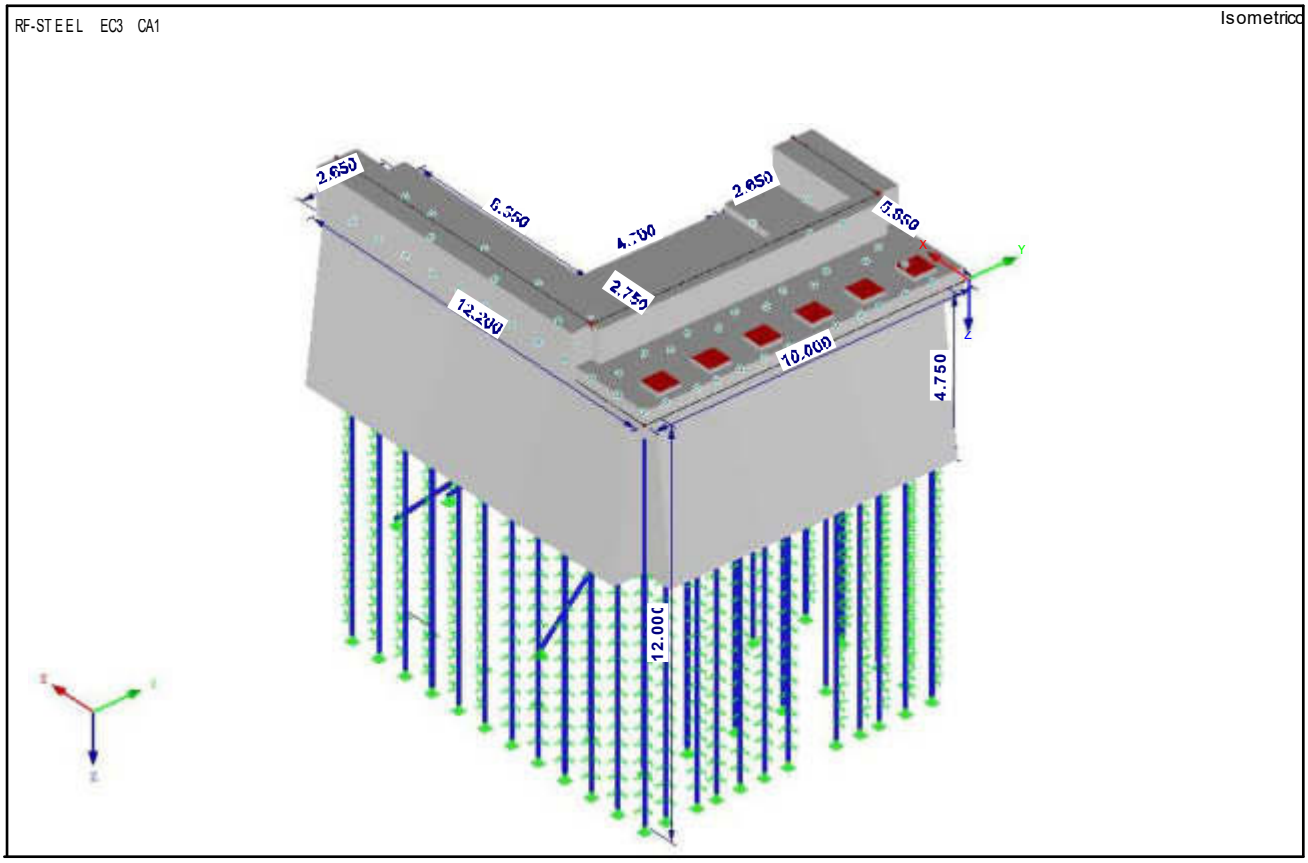
Sono presenti 38 micropali verticali e 12 inclinati.

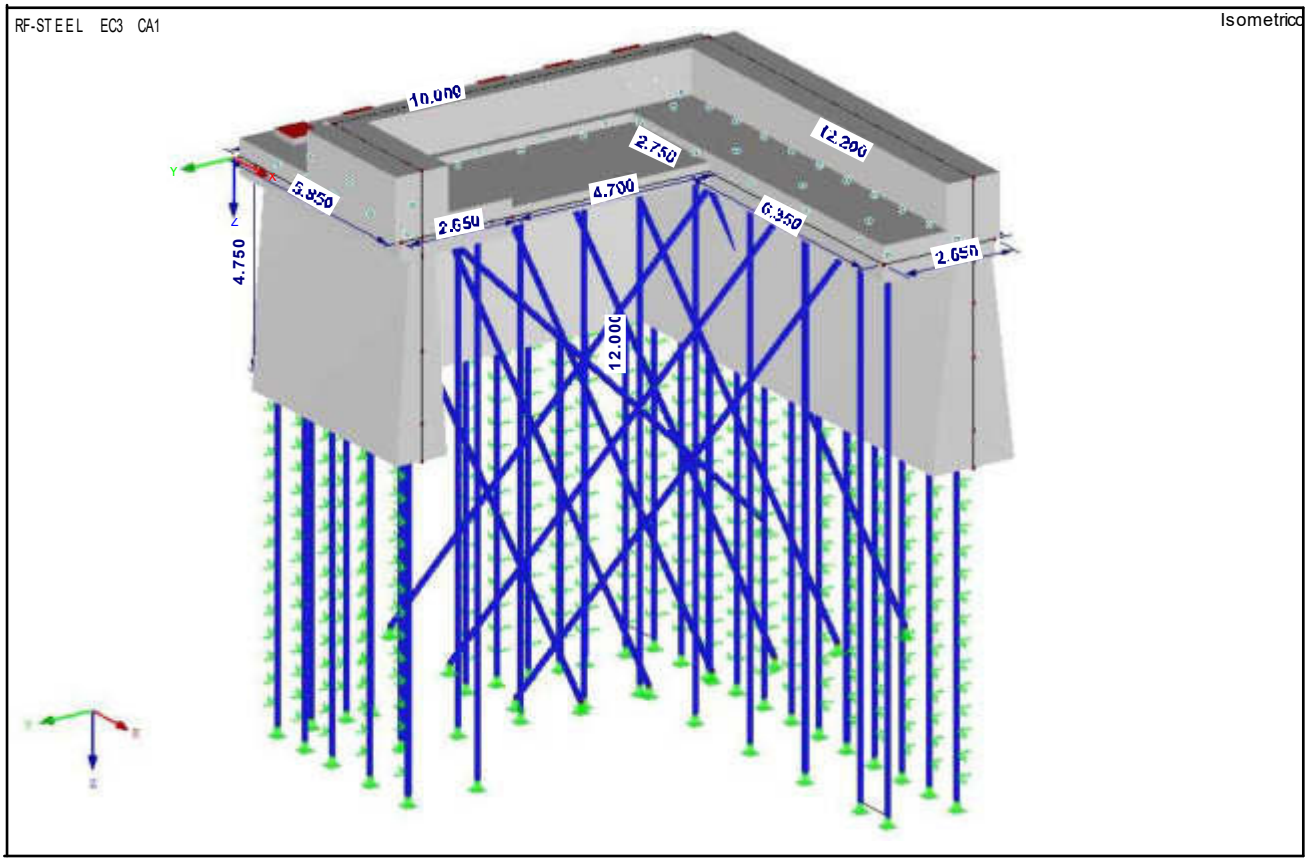


Nel modello di calcolo la struttura di collegamento in calcestruzzo armato è composta da elementi shell mentre i micropali e i baggioli da elementi beam.

7.1. Geometria del modello

Di seguito si riporta la geometria del modello:





7.2. Vincoli del modello

I micropali sono stati vincolati con cerniere in corrispondenza della testa e del piede dello stesso. per i micropali della prima fila sono state inserite ogni 0,50m molle alla Winkler orizzontali kh=15000 kN/m. i micropali sono innestati in roccia con buone qualitá meccaniche.

7.3. Carichi del modello

Di seguito si riportano la lista dei carichi applicati al modello di calcolo:

CC1:Peso proprio

CC2:SLU massima compressione appoggio ponte

CC3: SLU minima compressione appoggio ponte

CC4: SLU Forza longitudinale orizzontale massima appoggio multidirezionale ponte

CC5: SLU Forza trasversale orizzontale massima appoggio multidirezionale ponte

CC6: SLU Forza momento longitudinale massimo appoggio multidirezionale ponte

CC7: SLU Forza momento trasversale massimo appoggio multidirezionale ponte

CC8: SLU Forza orizzontale massimo appoggio vincolato trasversalmente ponte

CC9:SISMA massima compressione appoggio ponte

CC10: SISMA minima compressione appoggio ponte

CC11: SISMA Forza longitudinale orizzontale massima appoggio multidirezionale ponte

CC12: SISMA Forza trasversale orizzontale massima appoggio multidirezionale ponte

CC13: SISMA Forza momento longitudinale massimo appoggio multidirezionale ponte

CC14: SISMA Forza momento trasversale massimo appoggio multidirezionale ponte

CC15: SISMA Forza orizzontale massimo appoggio vincolato trasversalmente ponte

CC16:Spinta a riposo da riempimento

CC17:Spinta a riposo da traffico

CC18:Sovraspinta sismica terreno direzione +x

CC19: Sovraspinta sismica terreno direzione +y

CC20:Sovraspinta sismica terreno direzione –y

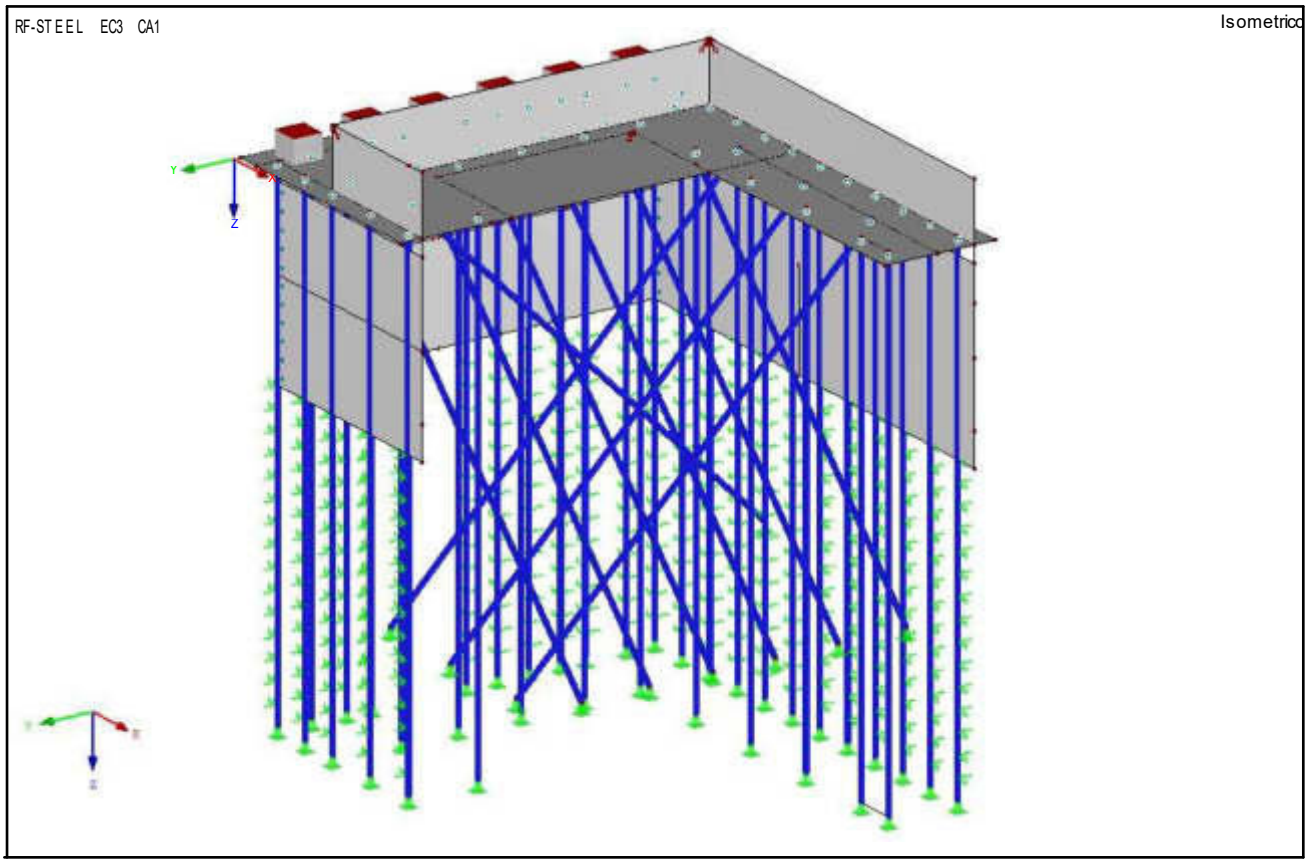
CC21:Sisma strutture in direzione longitudinale

CC22: Sisma strutture in direzione trasversale

CC23:Riempimento

CC24:traffico

7.3.1. CC1:Peso proprio



E´ stato assegnato un peso specifico per il calcestruzzo pari a 25 kN/m^3.

E´ stato assegnato un peso specifico per l´acciaio die micropali pari a 78,50 kN/m^3.

Il programma RFEM calcola in automatico il peso proprio degli elementi strutturali.

7.3.2. da CC2 a CC15: Carichi SLU e sismici provenienti dal ponte

I carichi dal CC2 al CC15 sono stati ricavati dalla tabella al punto 3.2.1 Lager Achse A1 und B della relazione di calcolo "Verifiche della struttura rinforzata" del 19.12.2018:

3.2 Lager

3.2.1 Lager Achse A1 und B

Beschreibung	ULS	Erdbeben	Gewählt
N_sd,max (Größter Druck)	1180,0kN	373,0kN	1400,0kN
N_sd,min (Kleinster Druck)	6,0kN	126,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 84,0kN/(1,5mm/kN) = 56,0mm	=Q_sd/K=Msd/(E*I)*h = 21,0kN/(1,5mm/kN) = 14,0mm	+/-60,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 4,0kN/(1,5mm/kN) = 2,7mm	= Q_sd/K = 1,0kN/(1,5mm/kN) = 0,7mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,029MNm/(188,1MPa*0,0009m4) *0,072m =0,012rad	=Msd/(E*I)*h =0,01MNm/(188,1MPa*0,0009m4)*0,072m =0,004rad	0,020rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,007MNm/(188,1MPa*0,0016m4) *0,072m =0,002rad	=Msd/(E*I)*h =0,002MNm/(188,1MPa*0,0016m4)*0,072m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,5kN/mm
F_z,sd (nur mittleres querfestes Lager)	213,0kN	752,0kN	+/-1000kN

Wähle 12 Stück (2 sind querfest) bewehrte Neoprenlager 400x300x128, Elastomerdicke 72mm.

Tali carichi sono stati applicati in corrispondenza della sommitá dei baggioli.

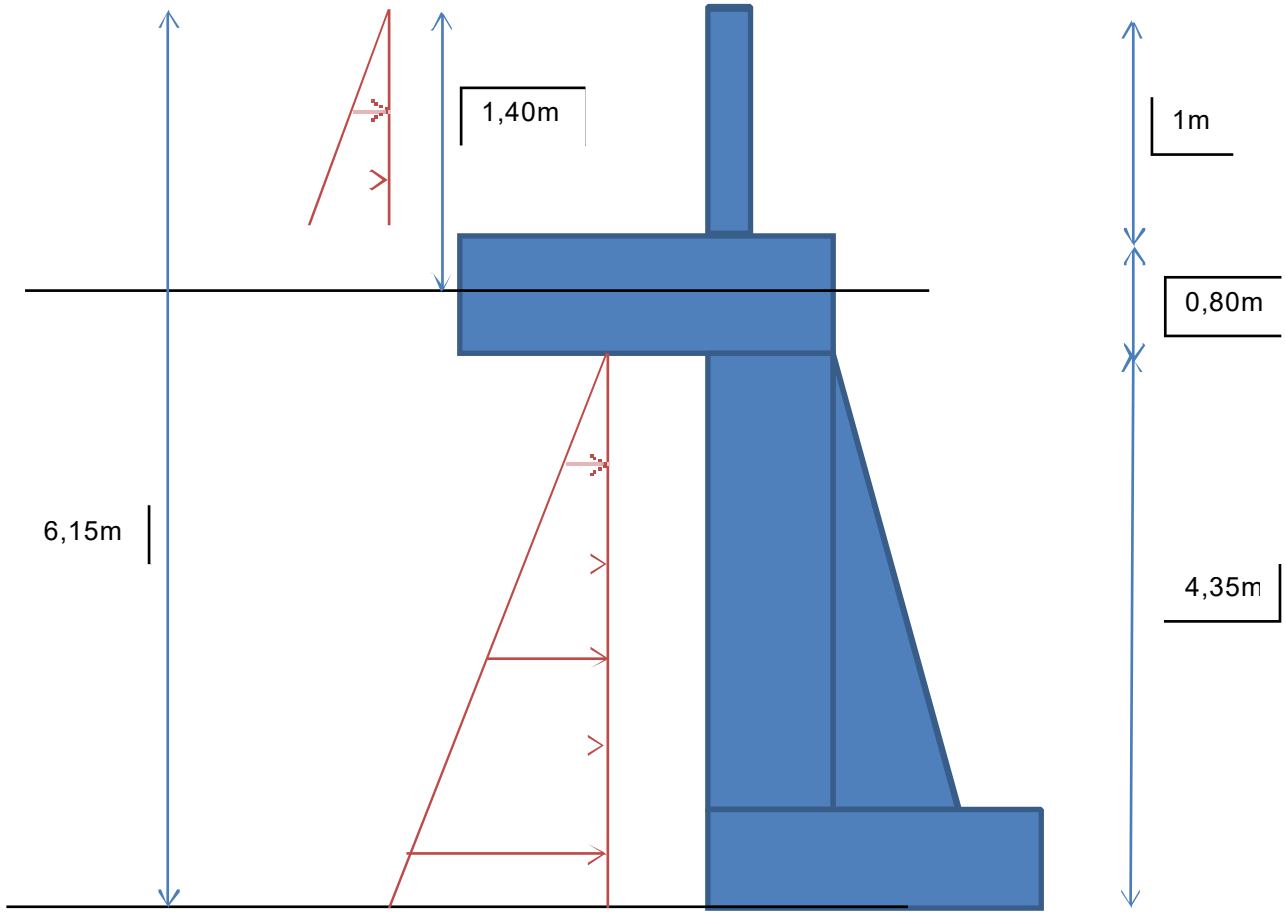
7.3.3. CC16: Spinta maggiorata da riempimento

E´ stato assunto un materiale di riempimento standard con angolo di attrito pari a 34° e peso specifico di 20 kN/m^3.

Il coefficiente di spinta a riposo è pari a k0=1-sinϕ´=1-sin 34°=0,44

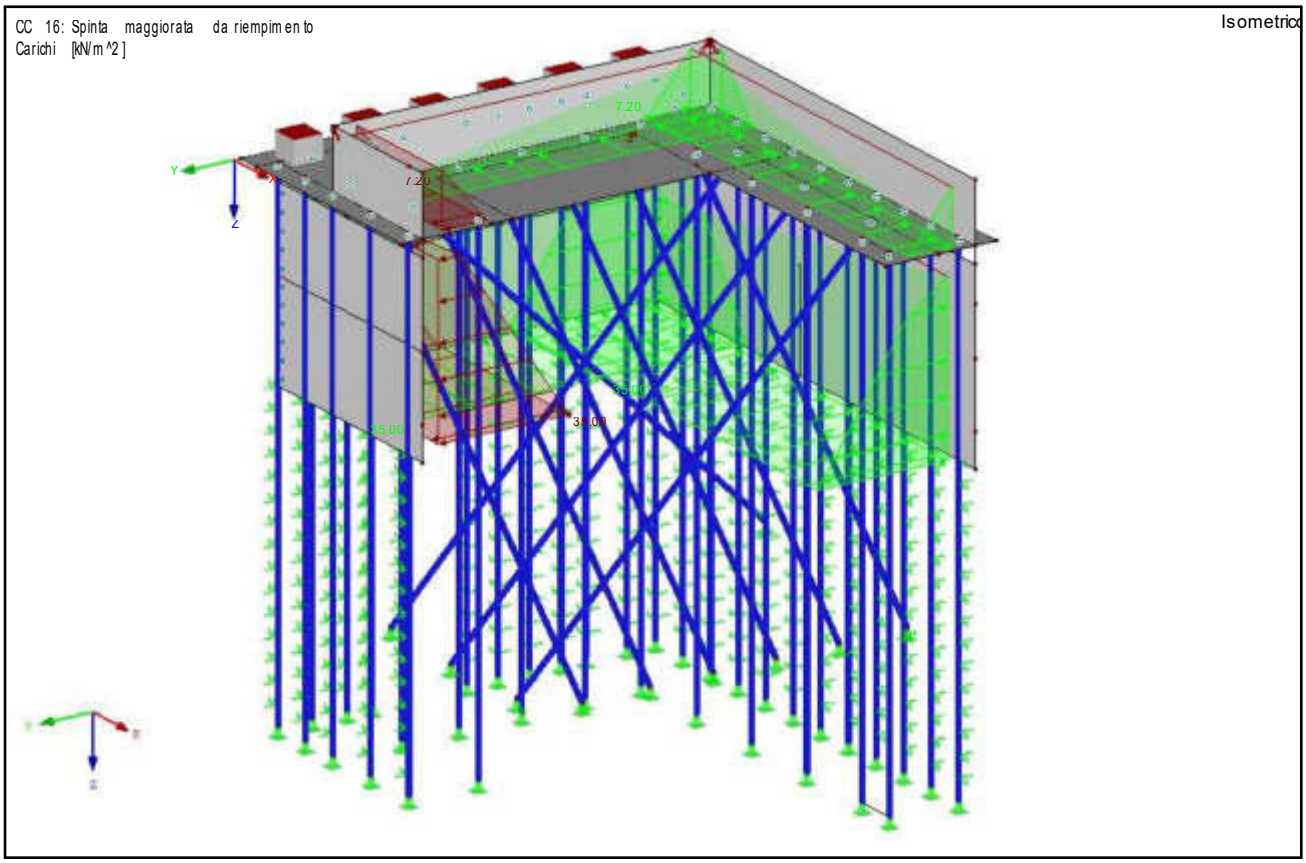
Il coefficiente di spinta attiva è pari a ka=tan(45°-34°/2)^2=0,28

Il coefficiente di spinta maggiorato è pari a k=(ka+k0)/2=(0,44+0,28)/2=0,36

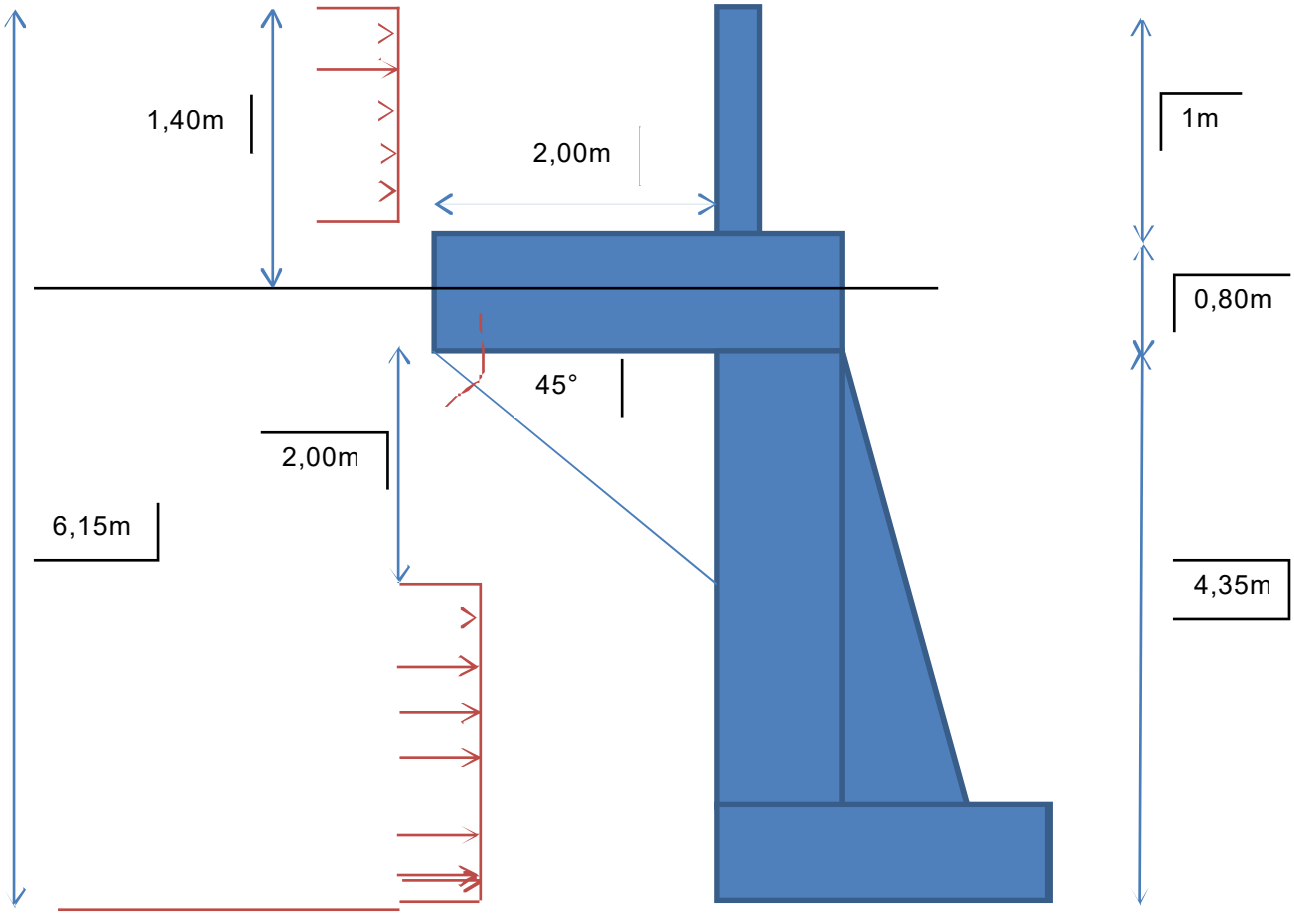


σRFEM(z=1,00m)=γ*z*k0=20 kN/m3*1,00m*0,36=7,20 kPa

σRFEM(z=6,15m)=γ*z*k0=20 kN/m3*4,75m*0,36=34,20 kPa

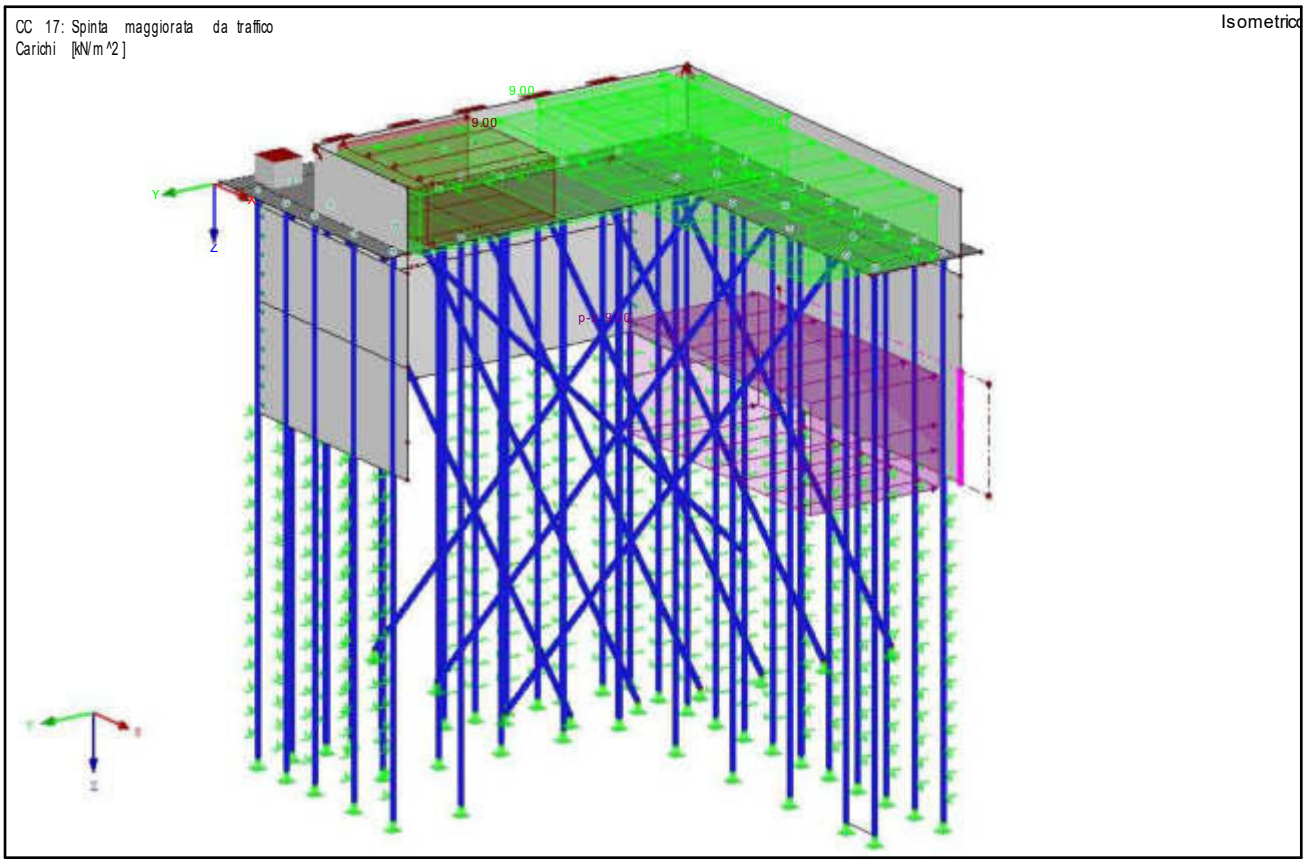

CC 16: Spinta maggiorata da riempimento
Carichi [kN/m^2]
Isometrico
7.20
7.20
35.00
35.00
Y
X
Z

7.3.4. CC17: Spinta maggiorata da traffico



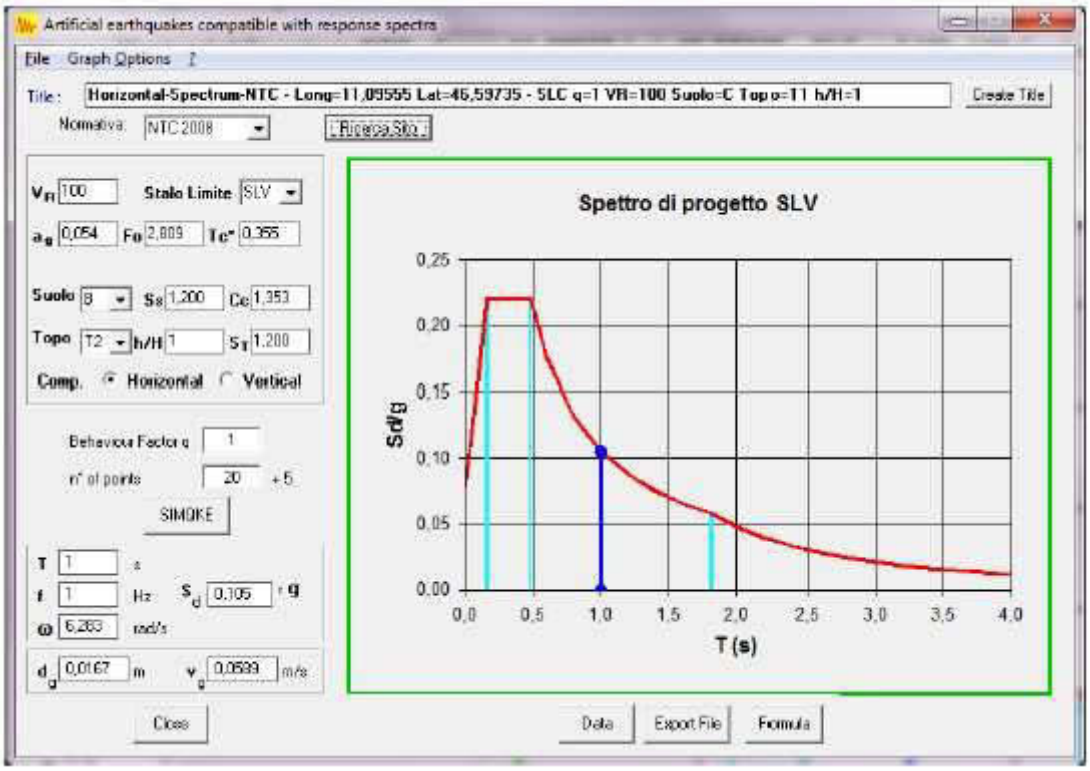
q traffico=25 kPa

σq RFEM=q*k0=25 kN/m2*0,36=9 kPa


CC 17: Spinta maggiorata da traffico
Carichi [kN/m^2]
Isometrico
9.00
9.00
9.00
Y
Z
p=-9.00

7.3.5. CC18:Sovraspinta sismica terreno direzione +x

Parametri dalla tabella al punto 2.34 Erdbeben in X und Z della relazione di calcolo "Verifiche della struttura rinforzata" del 19.12.2018:



- α=ag/g(SLV)=0,054
- SS=1,20
- ST=1,20

La sovraspinta sismica viene calcolata come al punto E.9 dell´eurocodice 1998 parte 5 del 2005:

E.9 *Forze causate dalla spinta del terreno per strutture rigide*

Nel caso di strutture rigide che sono completamente vincolate, in modo tale che non può svilupparsi nel terreno uno stato di spinta attiva, e per un muro verticale con terrapieno a superficie orizzontale, la forza dinamica dovuta all'incremento di spinta del terreno può essere preso uguale a:

$$\Delta P_d = \alpha \cdot S \cdot \gamma \cdot H^2 \qquad \text{(E.19)}$$

dove:

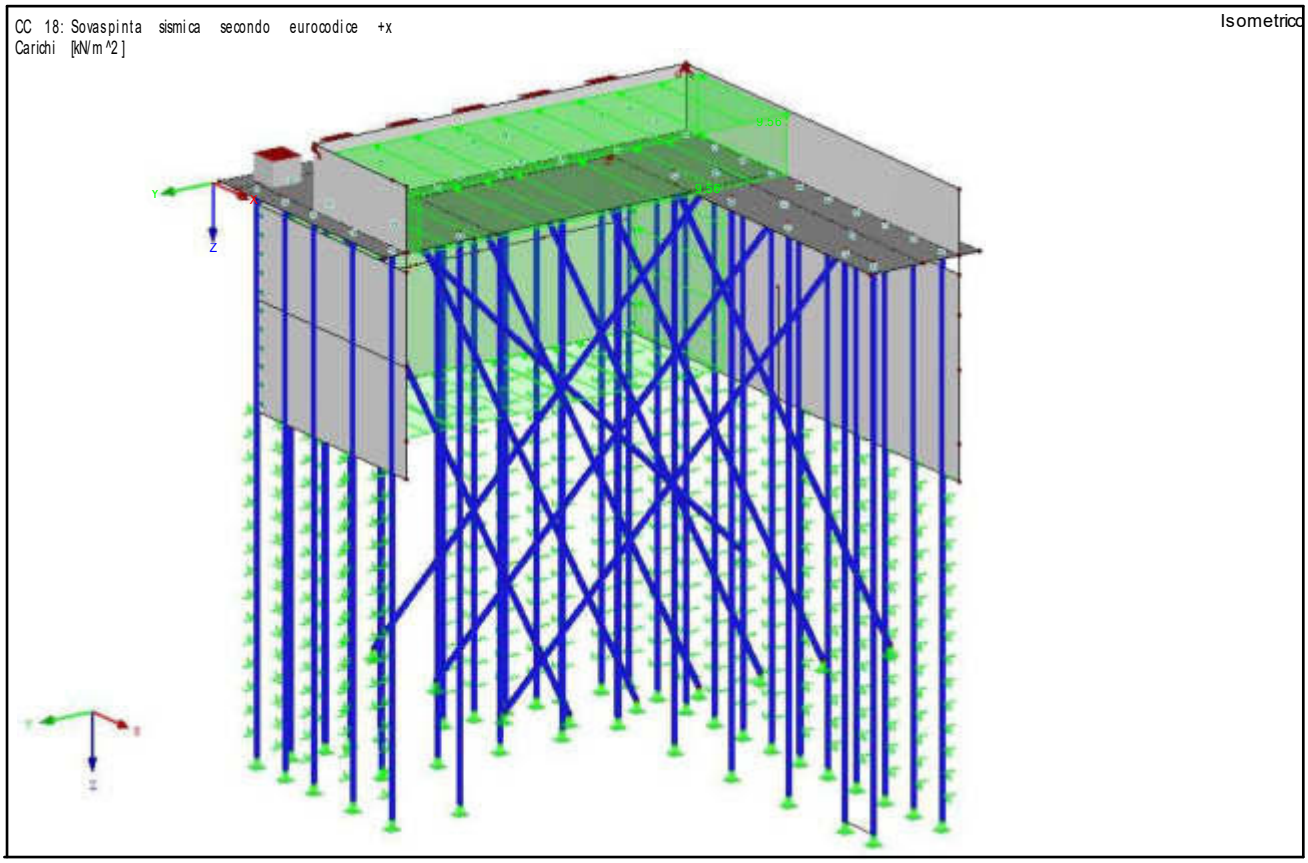
H è l'altezza del muro.

Il punto di applicazione può essere preso a metà dell'altezza.

$\Delta Pd\ spalla = \alpha * S * \gamma * H^2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m^3 * (6{,}15m)^2 = 58{,}82\ kN/m$

In RFEM le sovraspinte causate dalla spinta del terreno per strutture rigide viene applicato tramite un carico distribuito:

ΔPd spalla RFEM= α*S*γ*H2=0,054*1,20*1,20*20kN/m3*6,15m=9,56 kPa

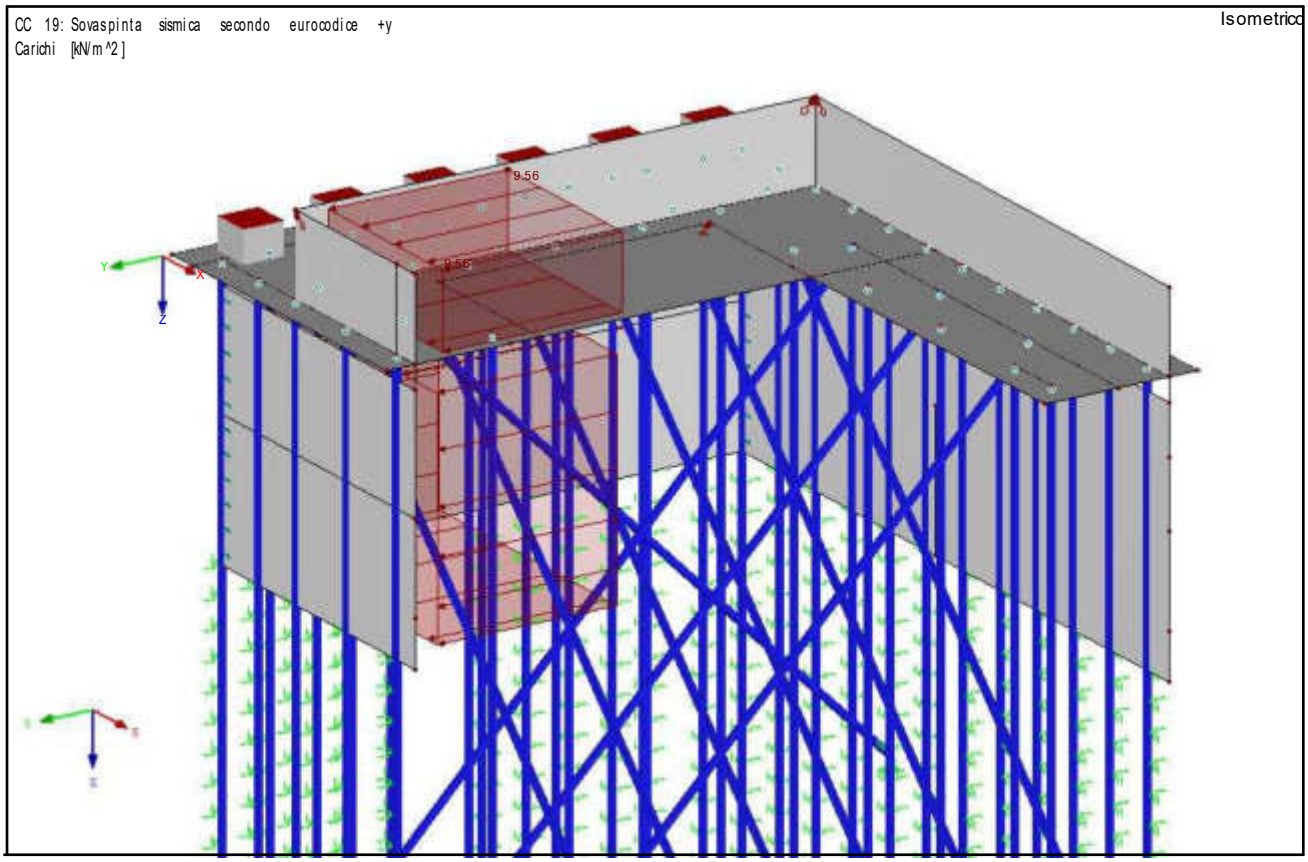


7.3.6. CC18:Sovraspinta sismica terreno direzione +y

$\Delta Pd\ spalla = \alpha * S * \gamma * H^2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m^3 * (6{,}15m)^2 = 58{,}82\ kN/m$

In RFEM le sovraspinte causate dalla spinta del terreno per strutture rigide viene applicato tramite un carico distribuito:

$\Delta Pd\ spalla\ RFEM = \alpha * S * \gamma * H2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m3 * 6{,}15m = 9{,}56\ kPa$

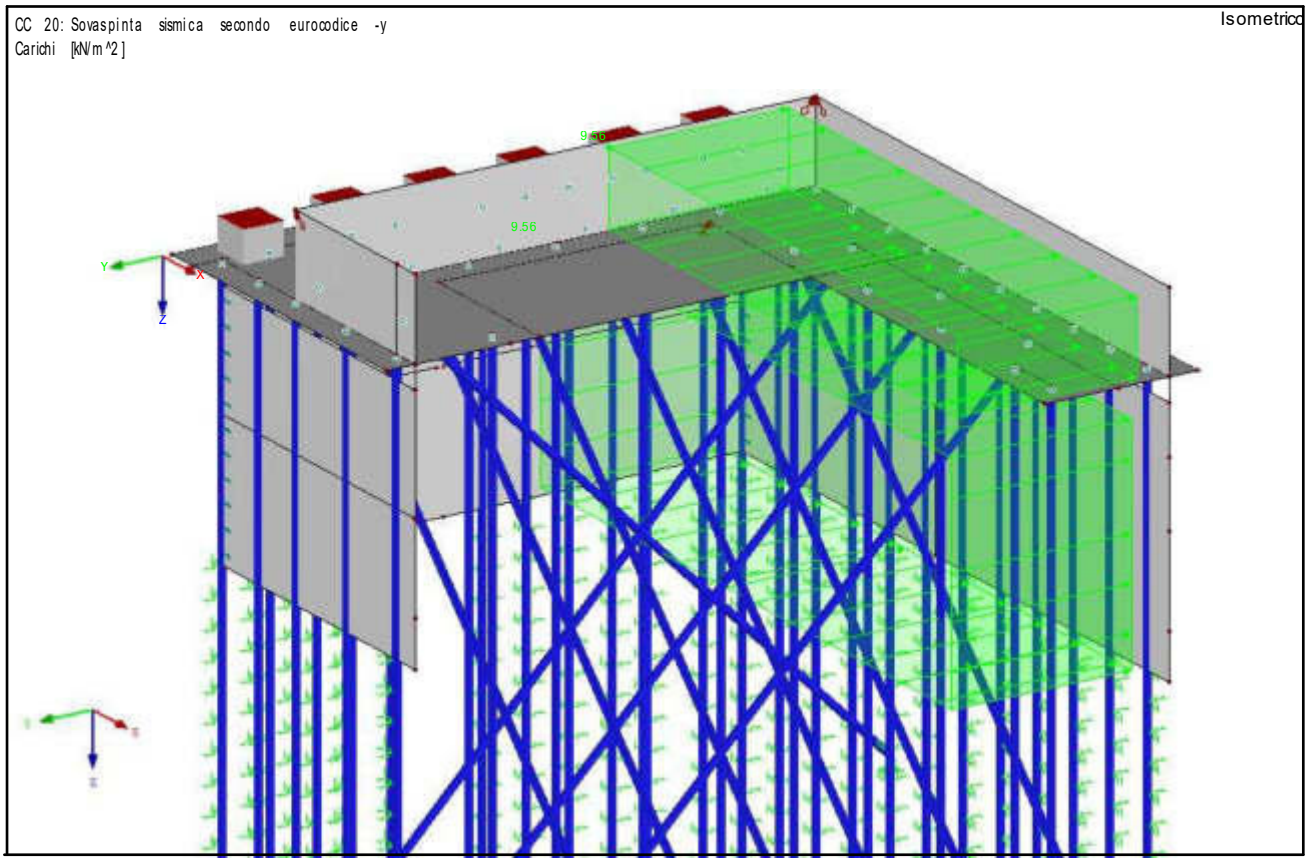


7.3.7. CC18:Sovraspinta sismica terreno direzione -y

$\Delta Pd\ spalla = \alpha * S * \gamma * H^2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m^3 * (6{,}15m)^2 = 58{,}82\ kN/m$

In RFEM le sovraspinte causate dalla spinta del terreno per strutture rigide viene applicato tramite un carico distribuito:

$\Delta Pd\ spalla\ RFEM = \alpha * S * \gamma * H2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m3 * 6{,}15m = 9{,}56\ kPa$



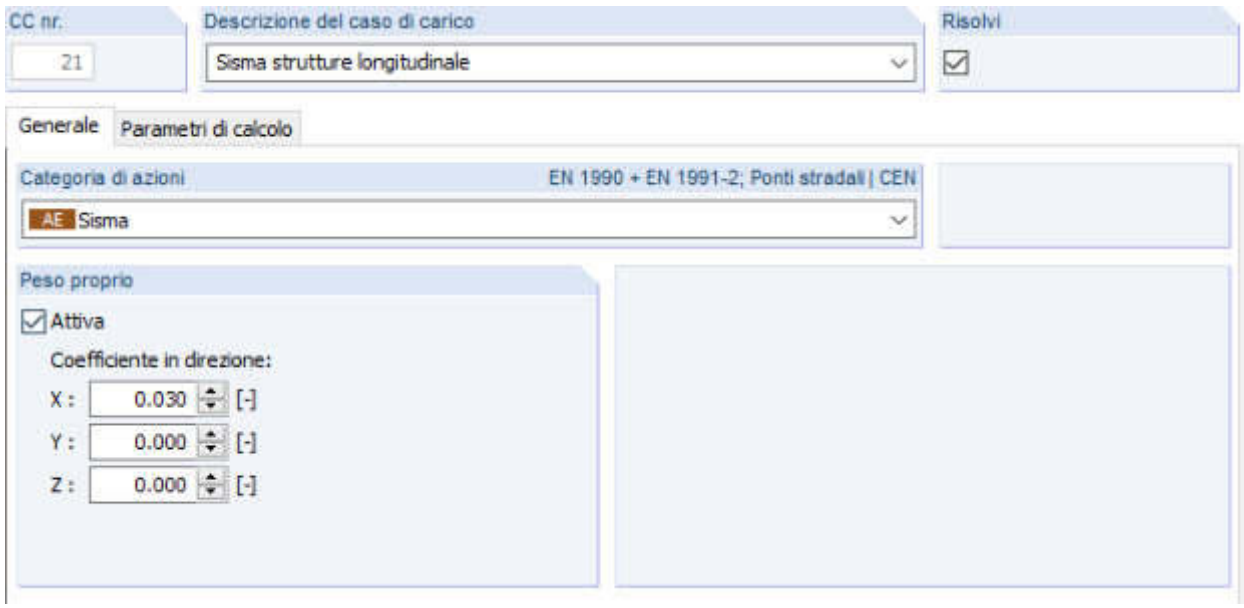
7.3.8. da CC21 a CC22: Sisma strutture longitudinali

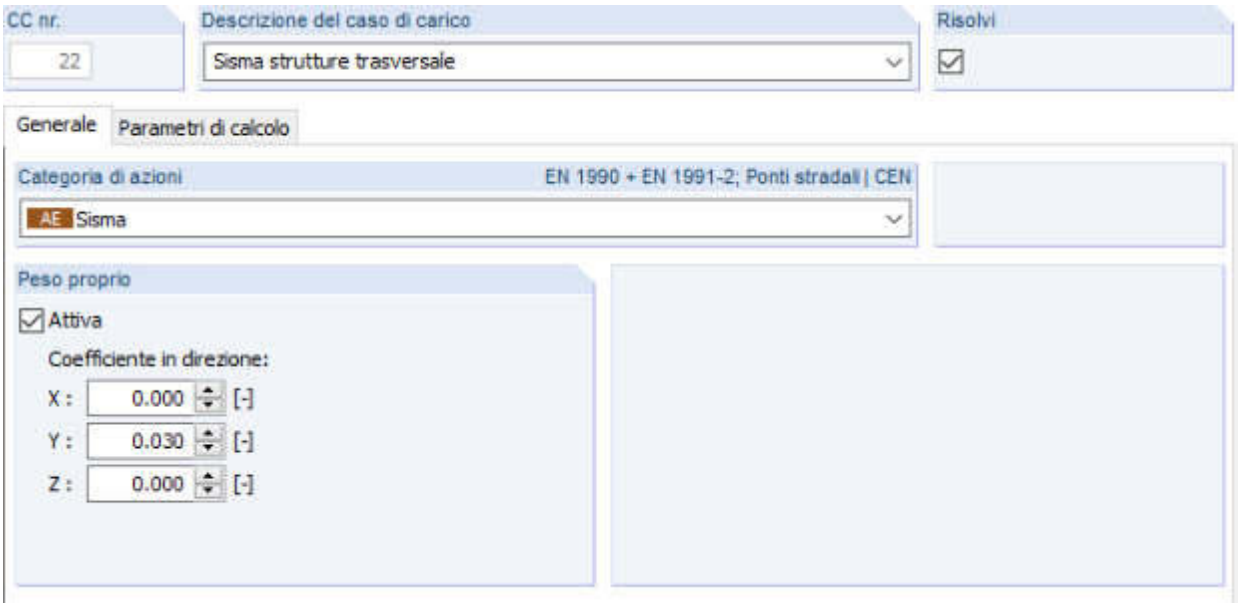
Dalle NTC 2018:muri di sostegno sismica si determina kh:

kh(SLV)=βm*S*ag/g=0,38*0,054*1,20*1,20=0,029

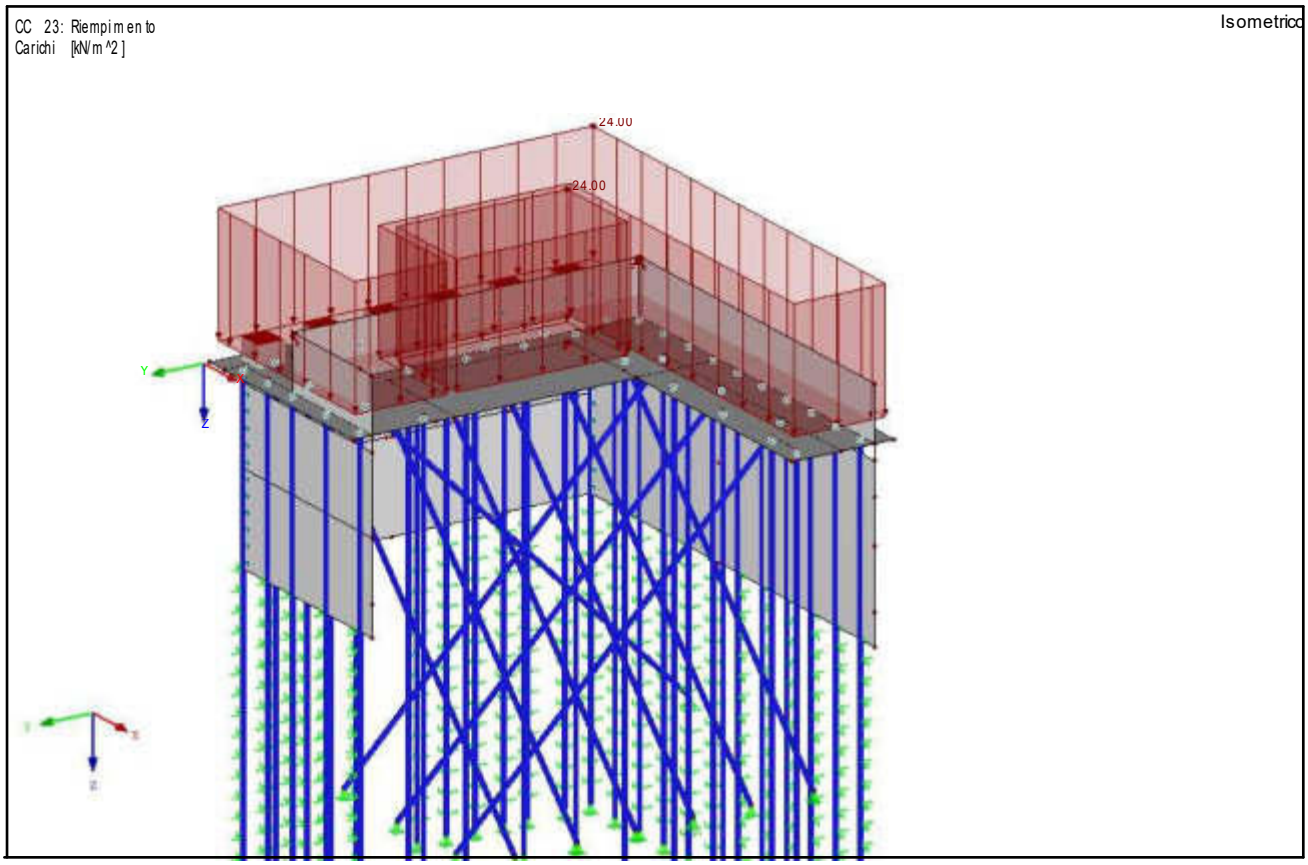
kv(SLV)±kh*0,50=±0,0147

In RFEM diventa:



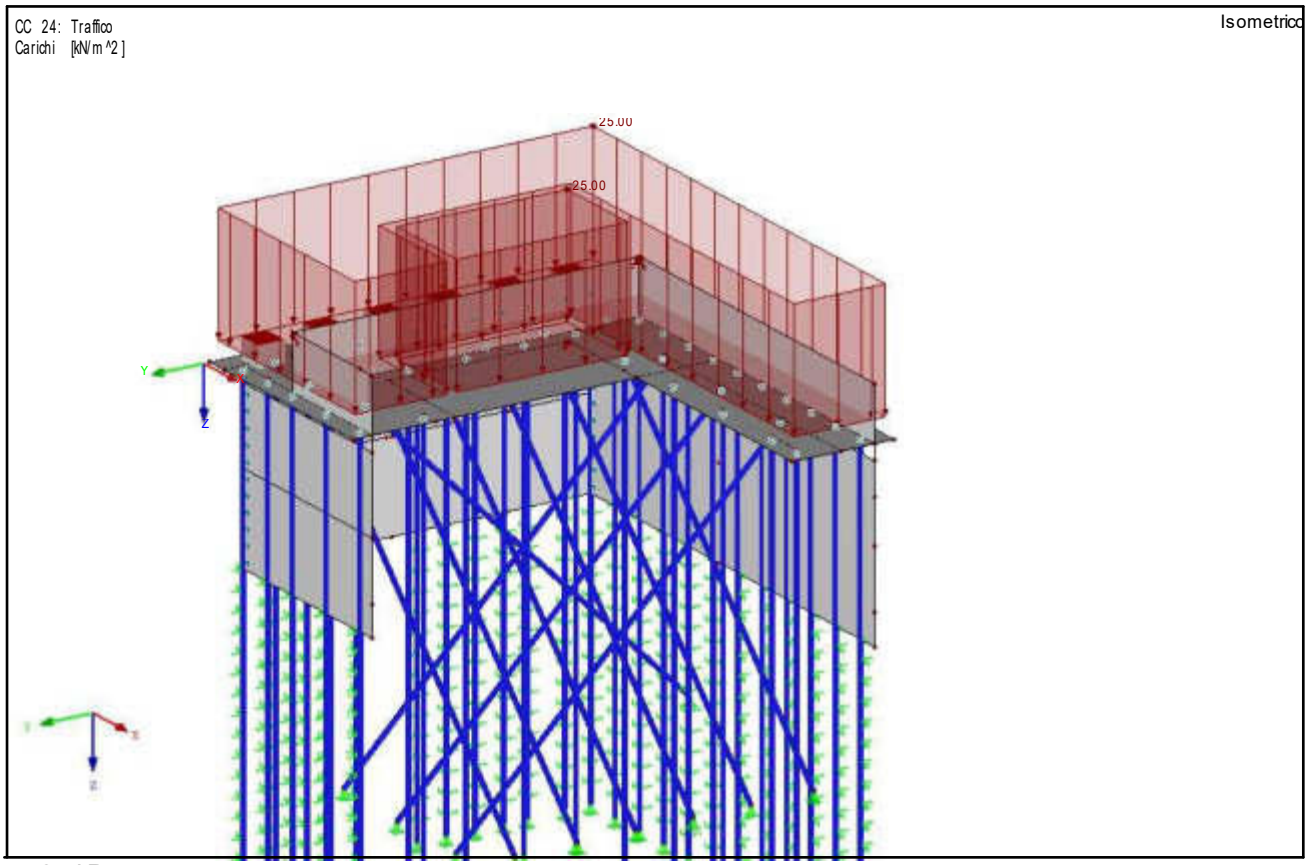


7.3.9. CC23:Riempimento



g2=γg2*h=24 kN/m^3*1,00m=24,00 kPa

7.3.10. CC24:Traffico



q=25 kPa

8. Combinazione di carico

CR1:Stati limite ultimi SLU

CC1/p o 1.35*CC1/p + CC2 o CC3 + CC4 o -1*CC4 + CC5 o -1*CC5 + CC6 o -1*CC6 + CC7 o -1*CC7 + CC8 o -1*CC8 + 1.35*CC16/p o CC16/p + 1.35*CC17 + 1.35*CC23/p o CC23/p + 1.35*CC24

CR2:Sisma

1.02*CC1/p o 0.99*CC1/p + CC9 o CC10 + CC11 o -1*CC11 + CC12 o -1*CC12 + CC13 o -1*CC13 + CC14 o -1*CC14 + CC15 o -1*CC15 + CC16/p + CC18 o 0.3*CC18 + CC19 o 0.3*CC19 o CC20 o 0.3*CC20 + CC21 o 0.3*CC21 o -1*CC21 o -0.3*CC21 + CC22 o 0.3*CC22 o -1*CC22 o -0.3*CC22 + CC23/p

CR: Inviluppo SLU/Sisma

CR1/p o CR2/p

9. Vita utile micropali

Il diametro del micropalo subisce una riduzione pari a 3,00mm in quanto si ipotizza lo strato di boiacca fessurato. Si assume una vita utile di 100 anni.

Table F.1 Loss of thickness [mm] due to corrosion for piles and sheet piles in soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undisturbed natural soils (sand, silt, clay, schist, ...)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial grounds	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, ...)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt, ...)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag, ...)	0,50	2,00	3,25	4,50	5,75

Notes:

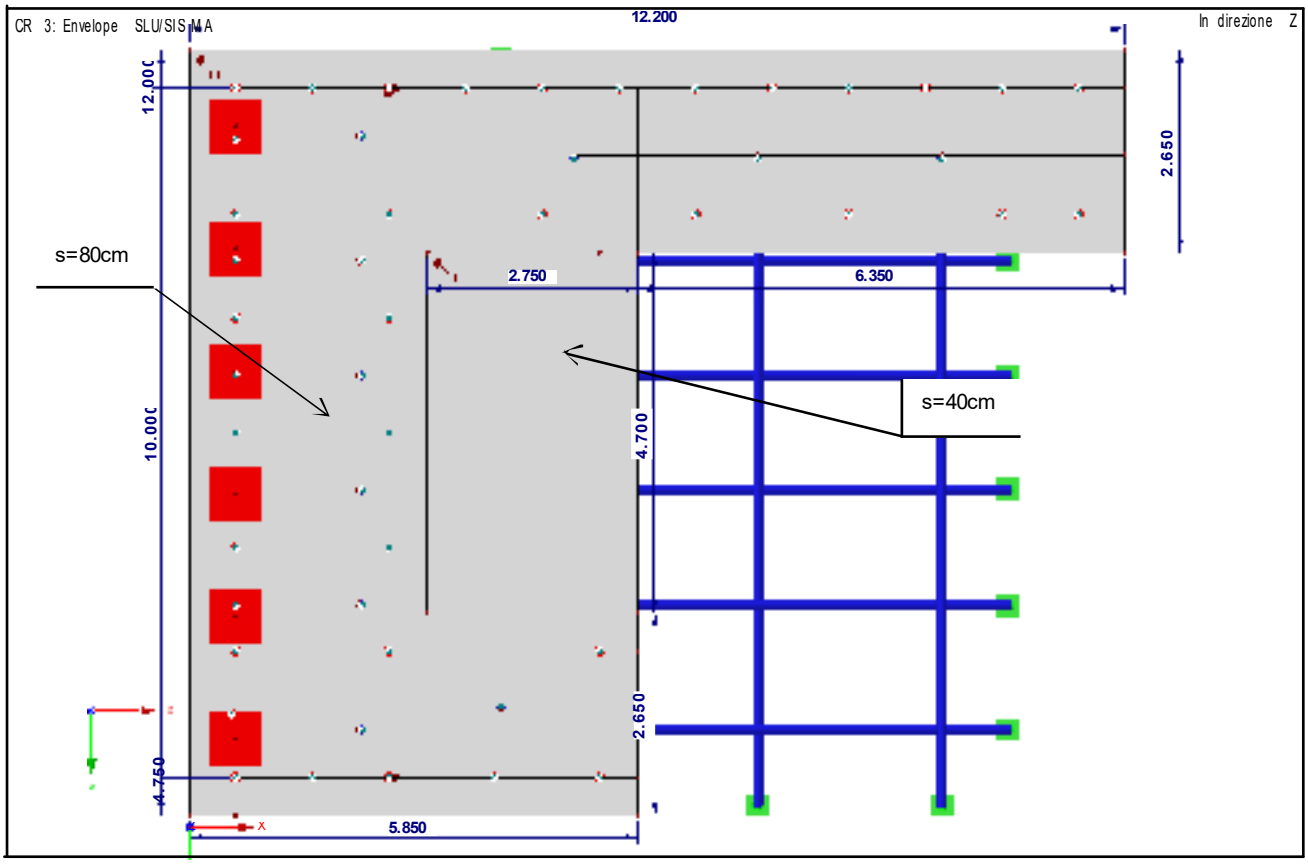
1) Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two.

2) The values given are only for guidance. Local conditions should be considered because they might affect the actual corrosion rate, which can be lower or higher than the average value given in the table.

3) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

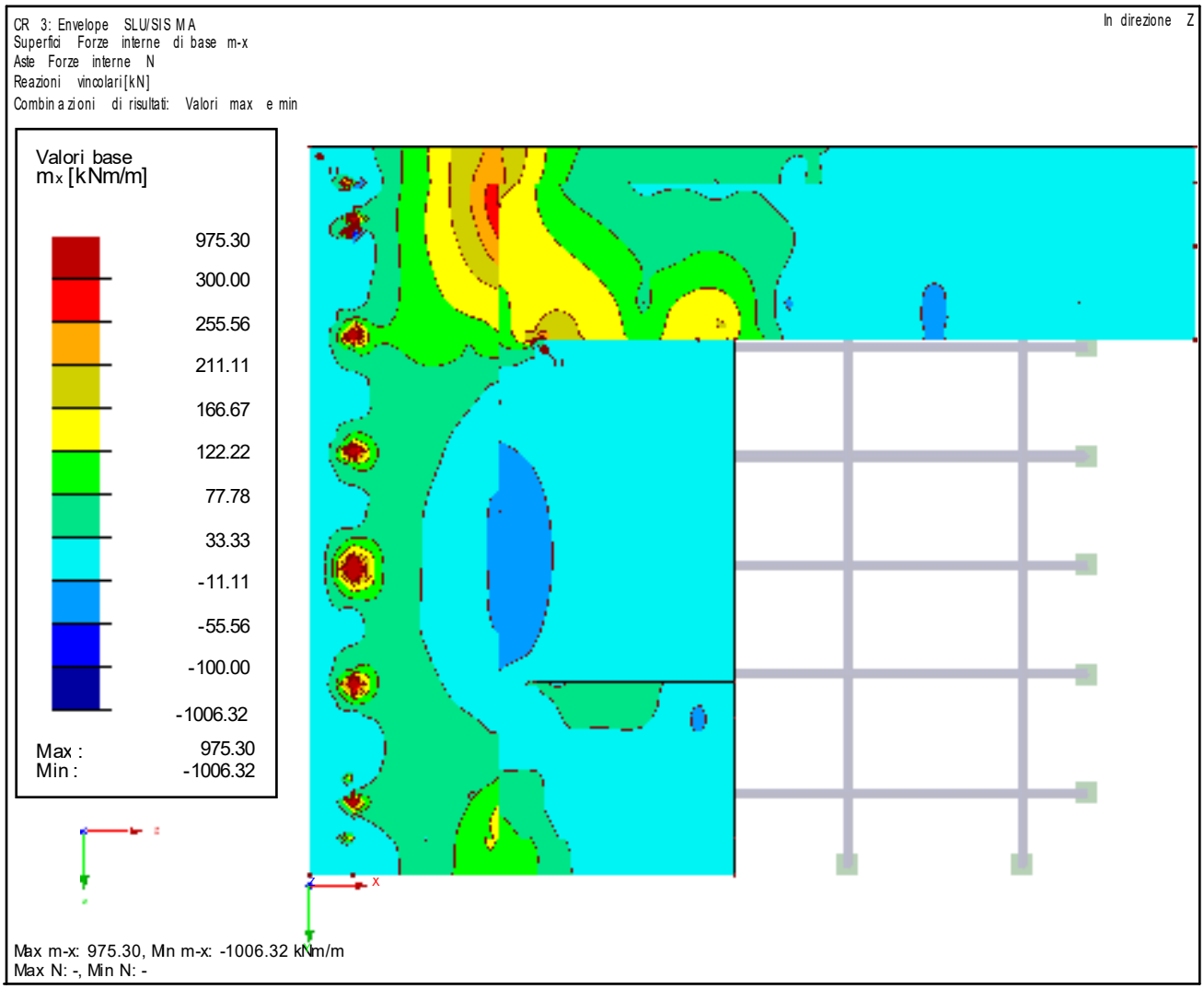
10. Fondazione di collegamento

10.1. Geometria

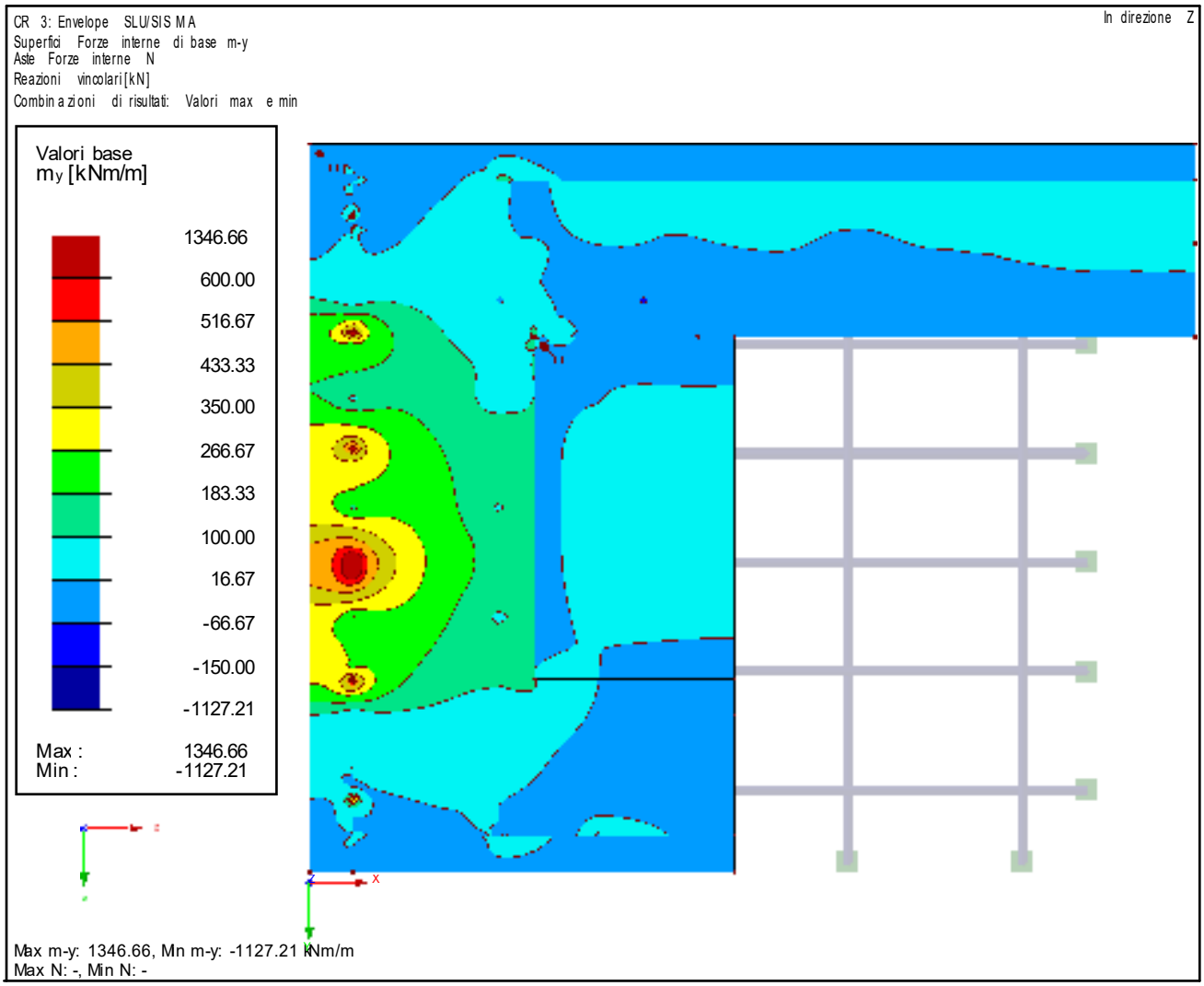


10.2. Inviluppo sollecitazioni SLU/SISMA

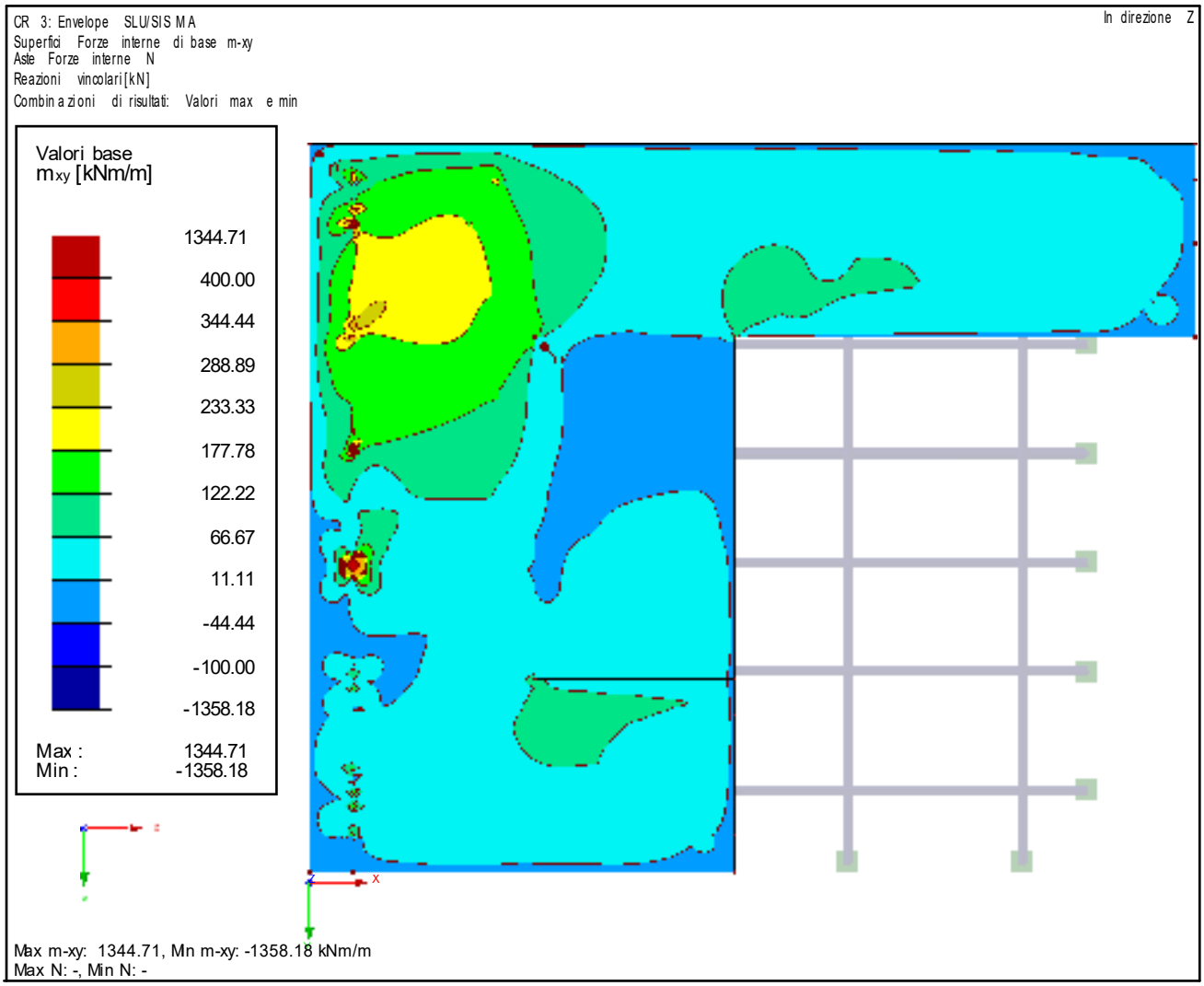
10.2.1. Inviluppo SLU/SISMA Valori momento mx



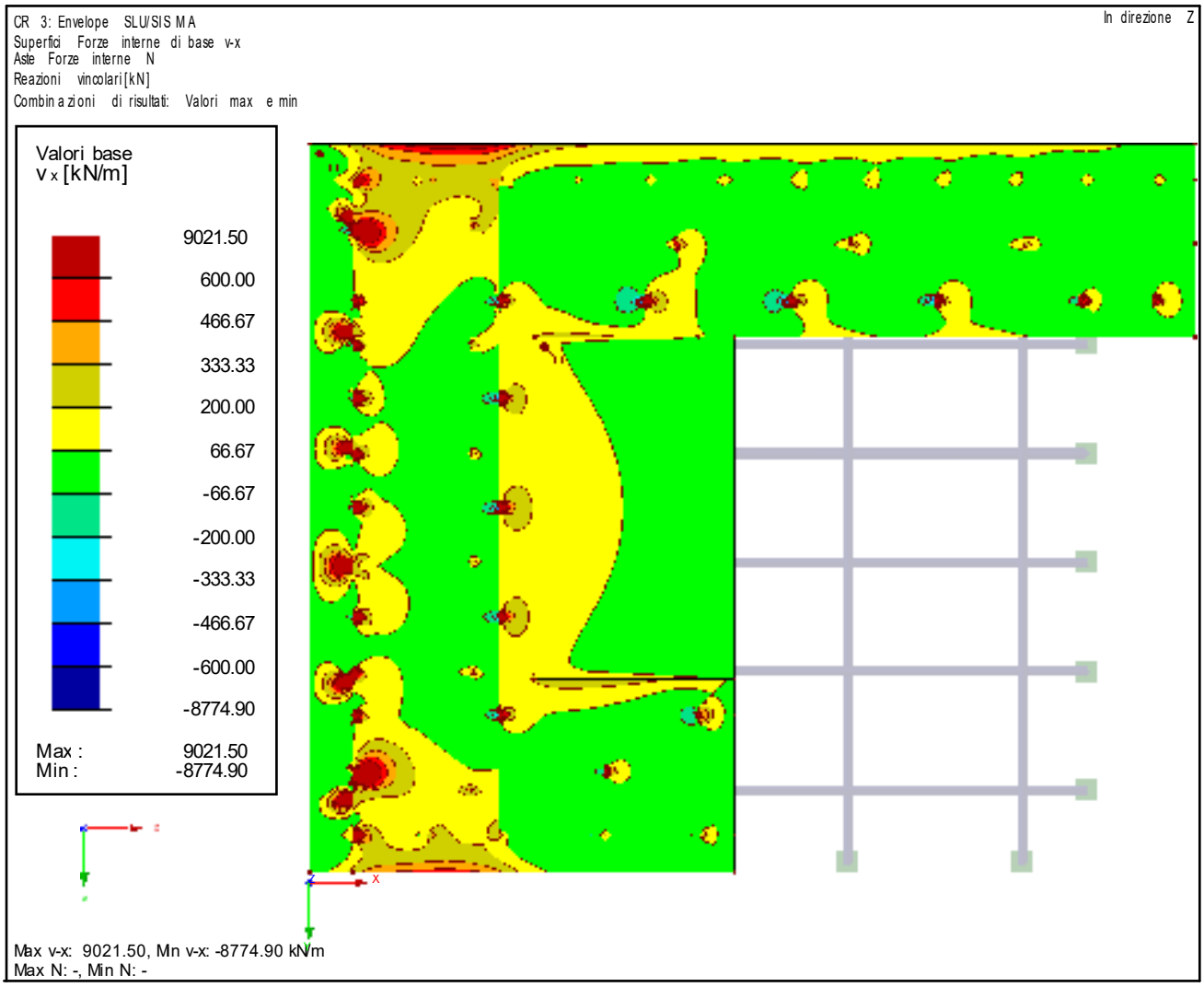
10.2.2. Inviluppo SLU/SISMA Valori momento my



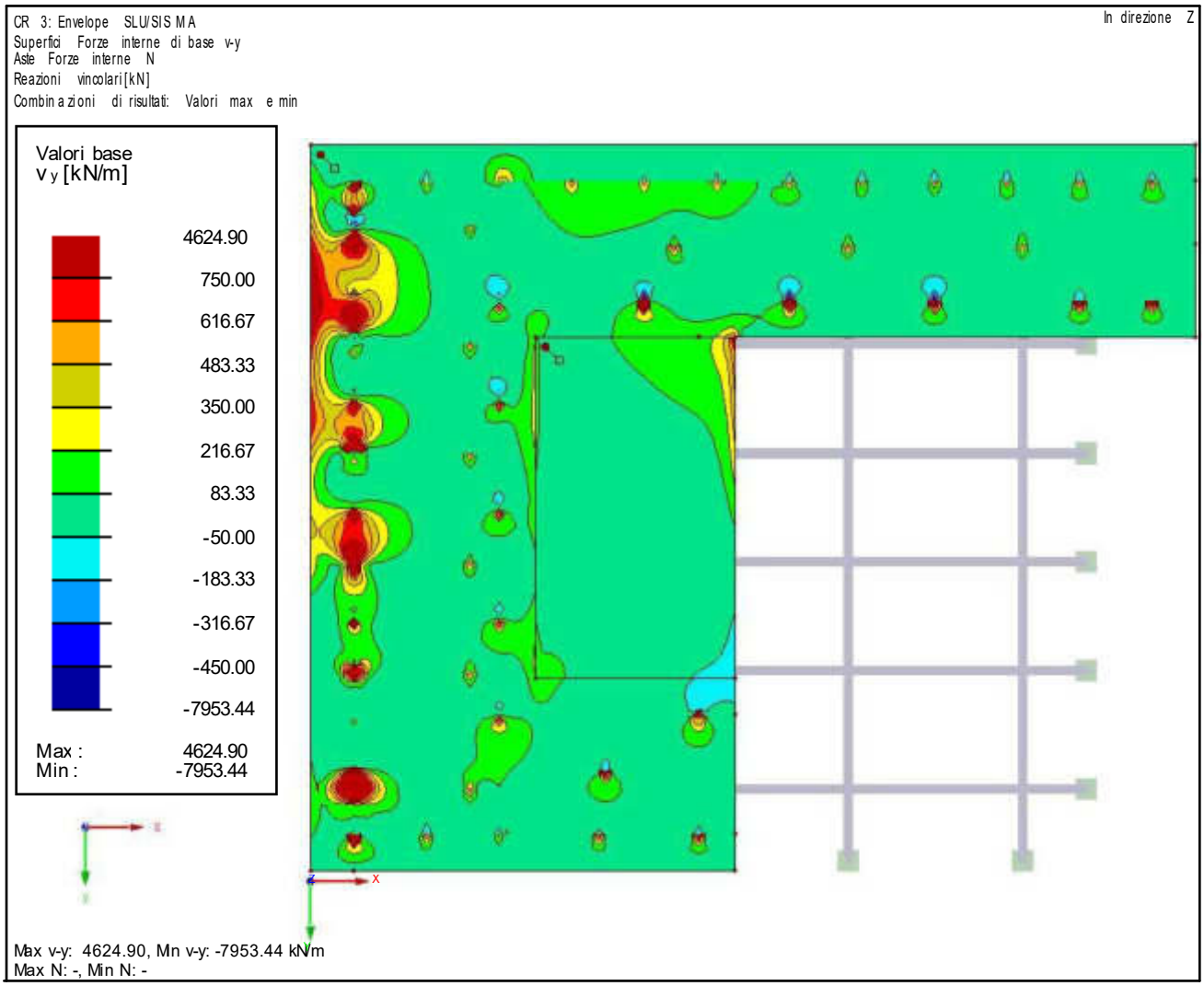
10.2.3. Inviluppo SLU/SISMA Valori momento torcente mxy



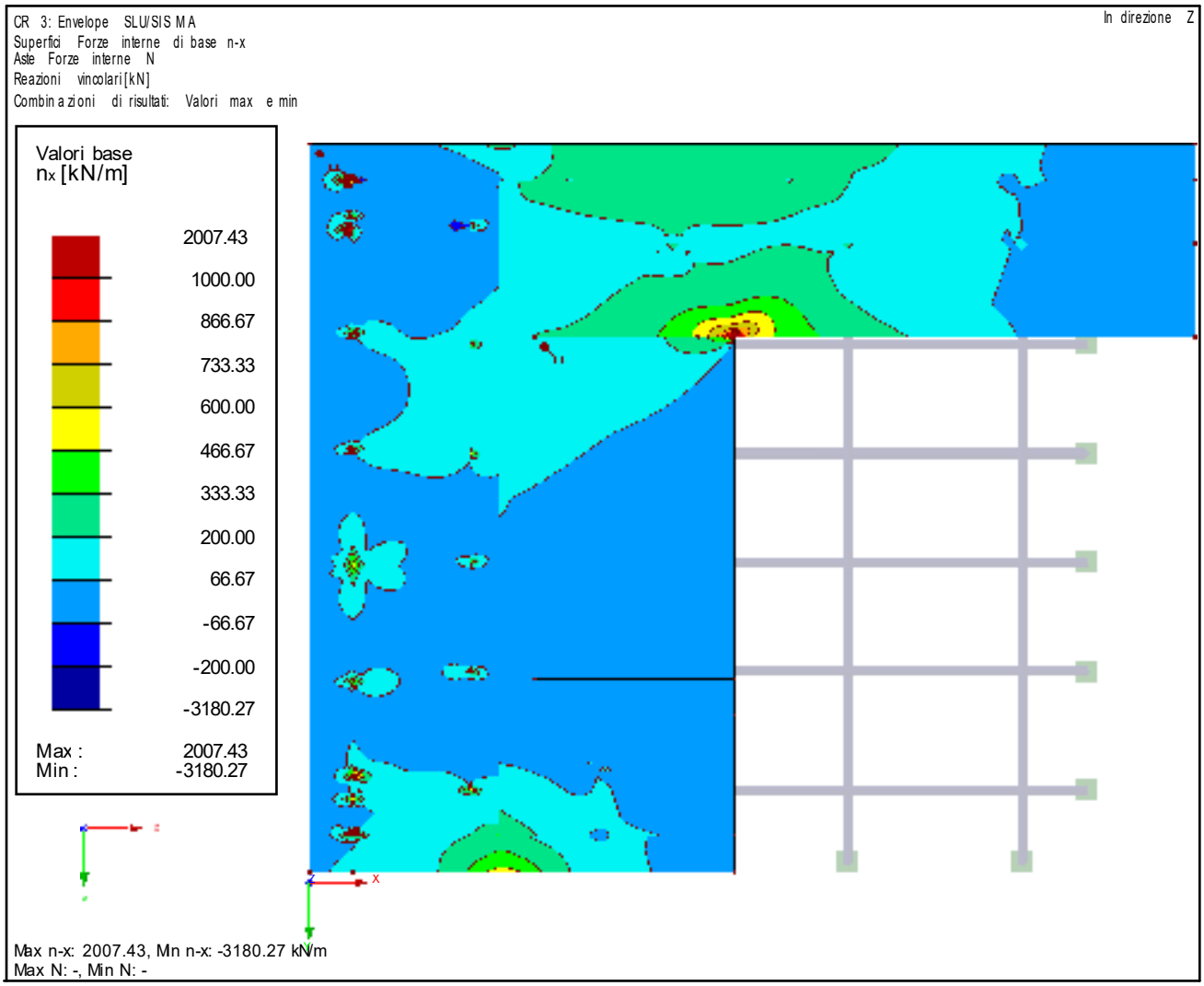
10.2.4. Inviluppo SLU/SISMA Valori forze di taglio vx



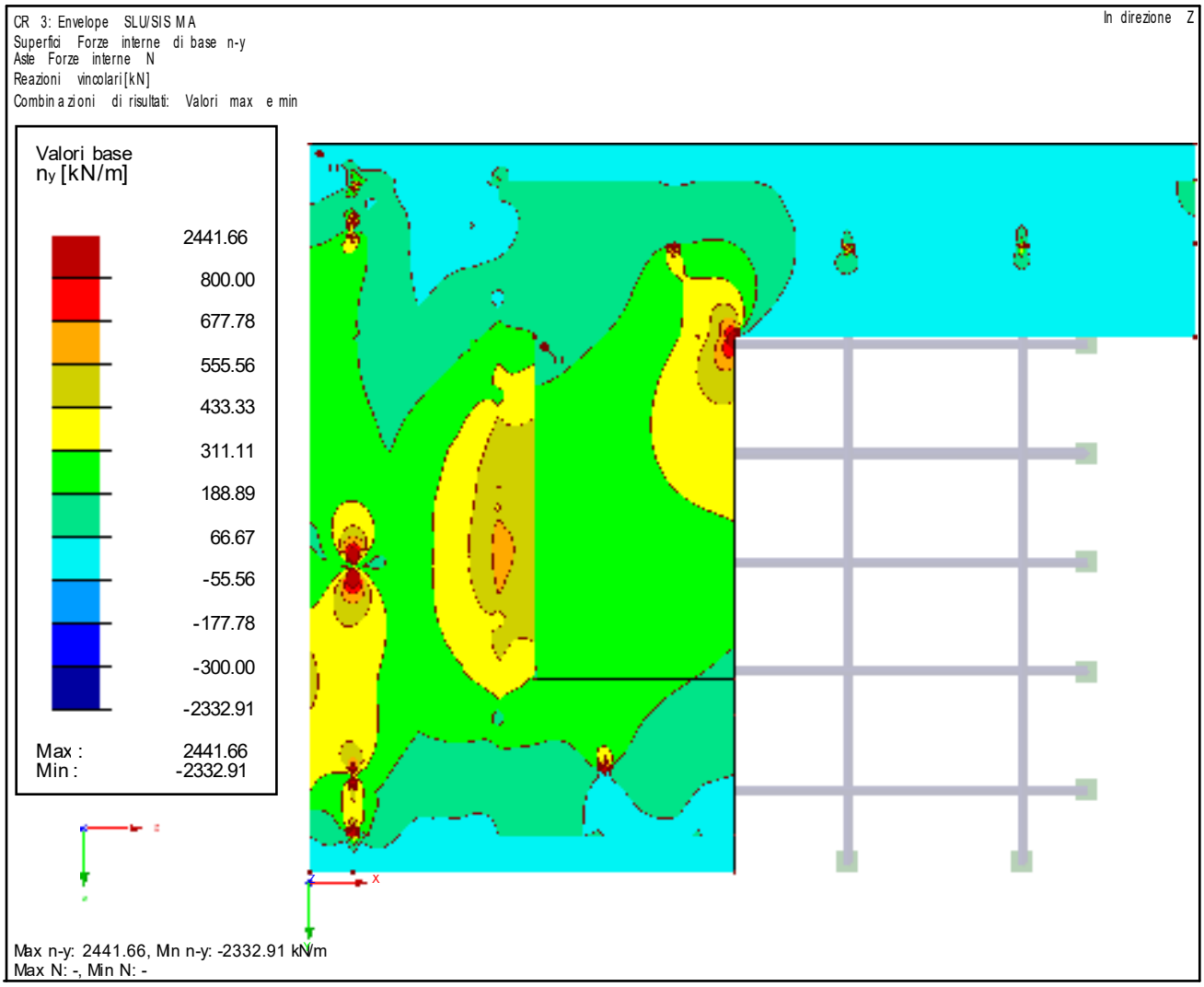
10.2.5. Inviluppo SLU/SISMA Valori forze di taglio vy



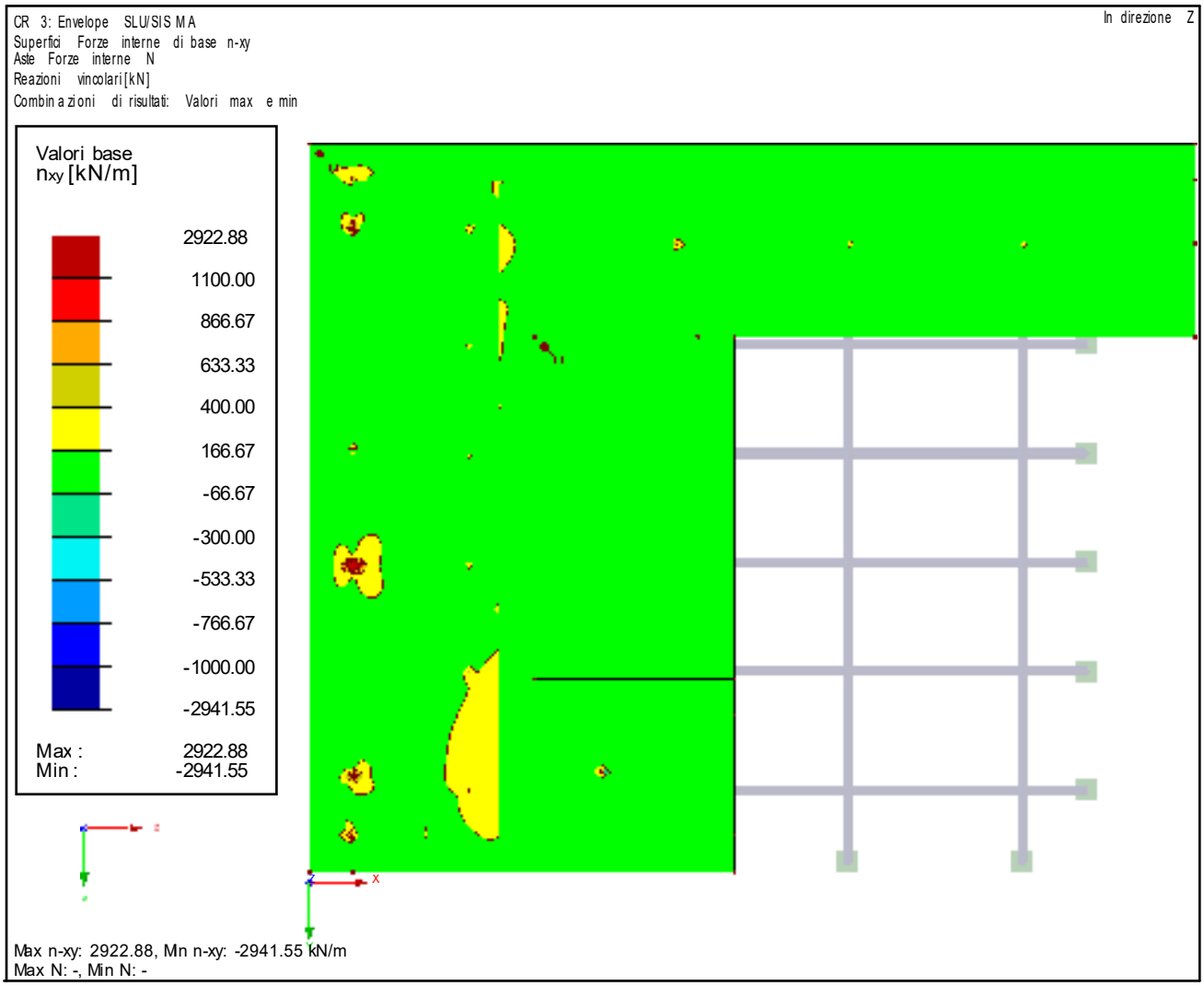
10.2.6. Inviluppo SLU/SISMA Valori forze membranali nx



10.2.7. Inviluppo SLU/SISMA Valori massimi membranali ny

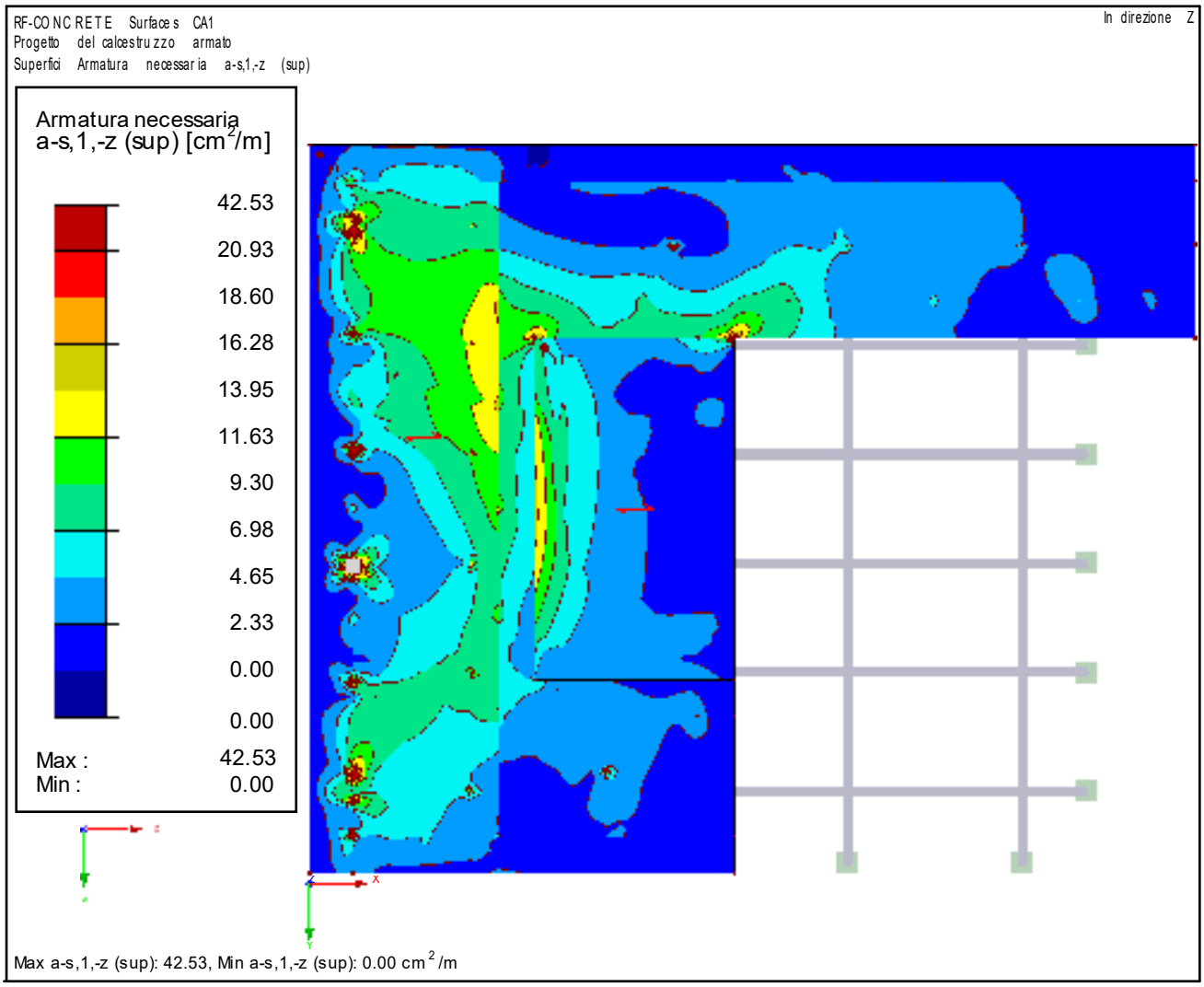


10.2.8. Inviluppo SLU/SISMA Valori massimi membranali nxy



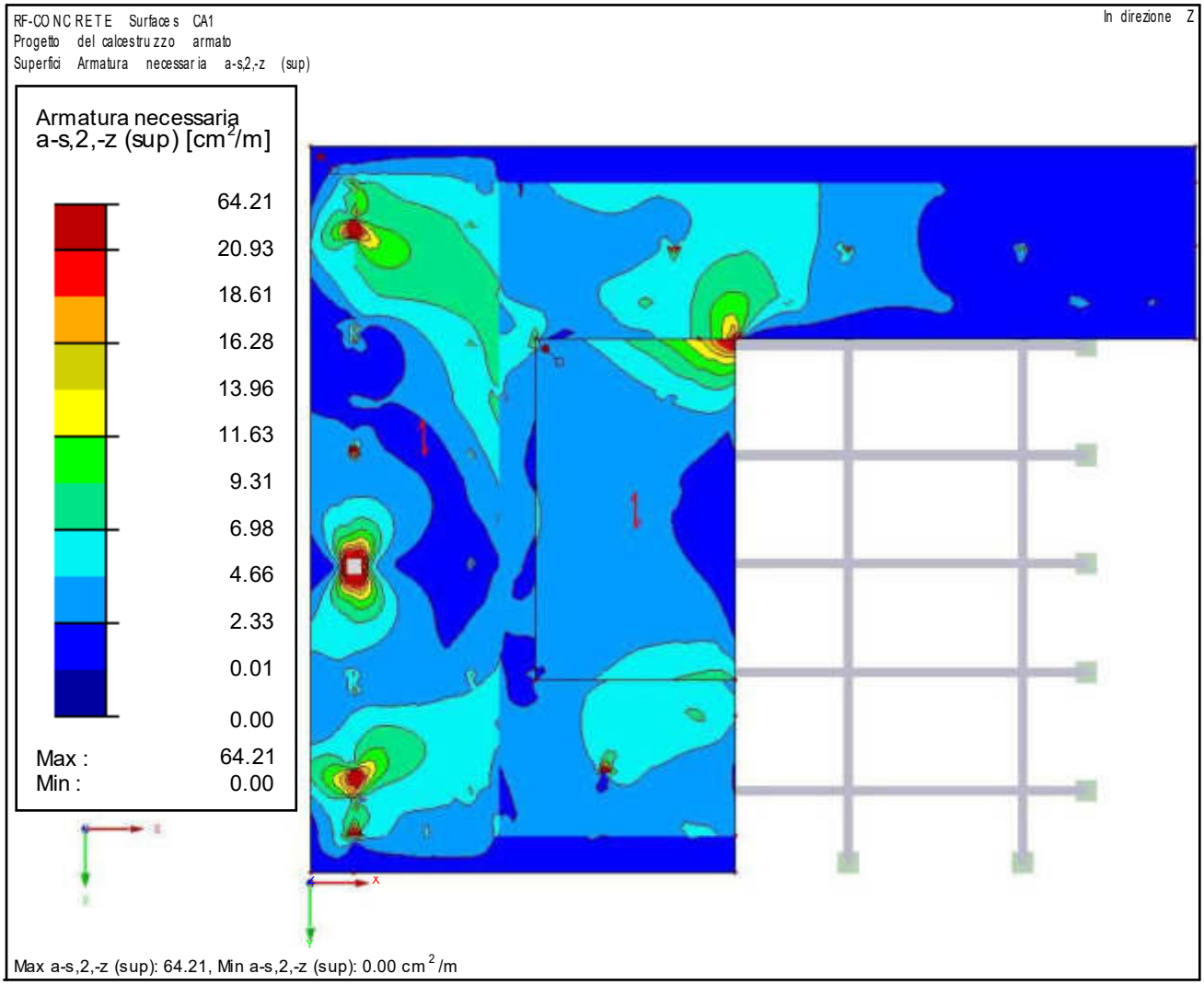
10.3. Isolinee di armatura estradosso in direzione longitudinale alla direzione del ponte

Si prevede di disporre come armatura base ϕ20/15=20,93 cm^2/m



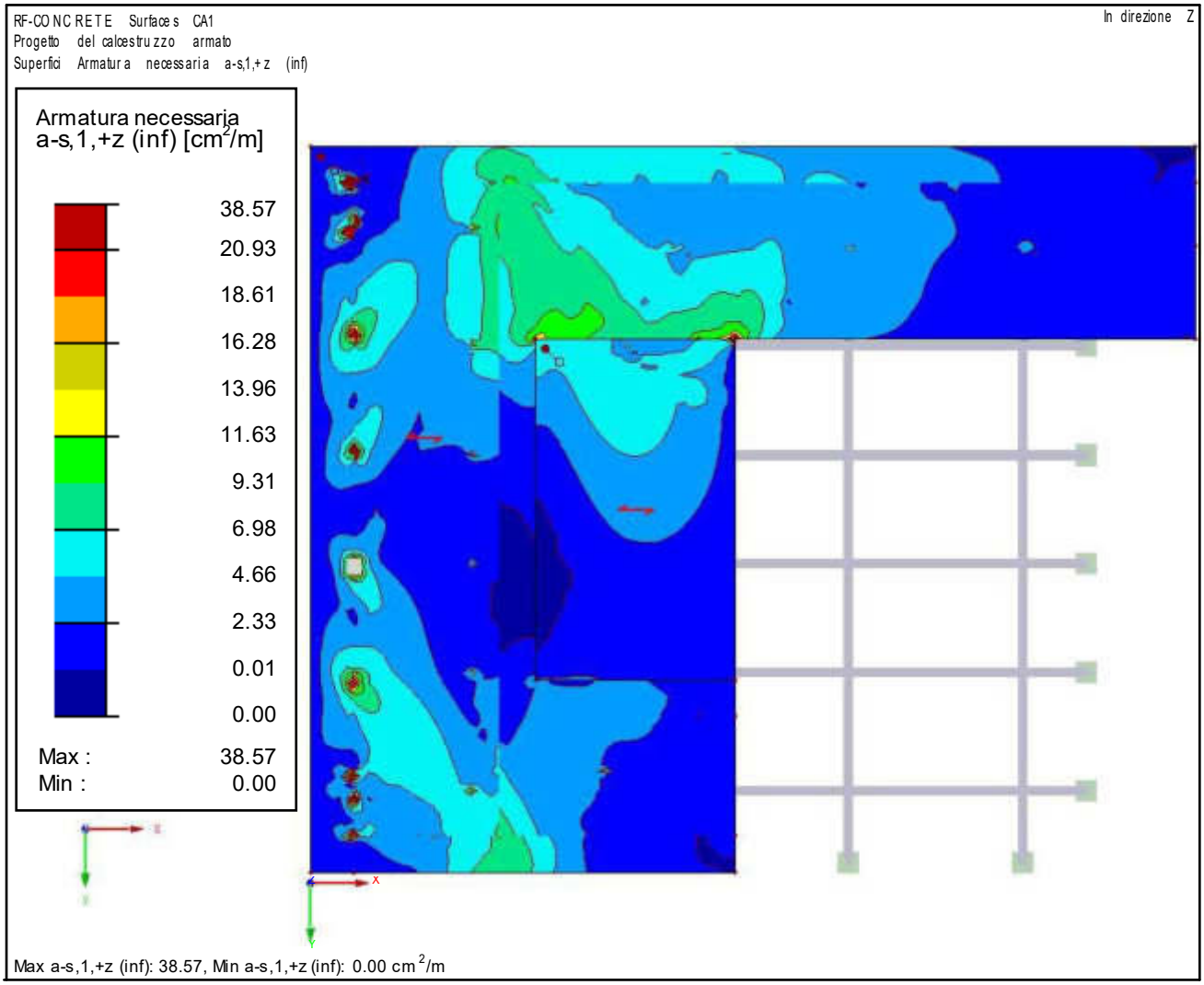
10.4. Isolinee di armatura estradosso in direzione trasversale alla direzione del ponte

Si prevede di disporre come armatura base ϕ20/15=20,93 cm^2/m



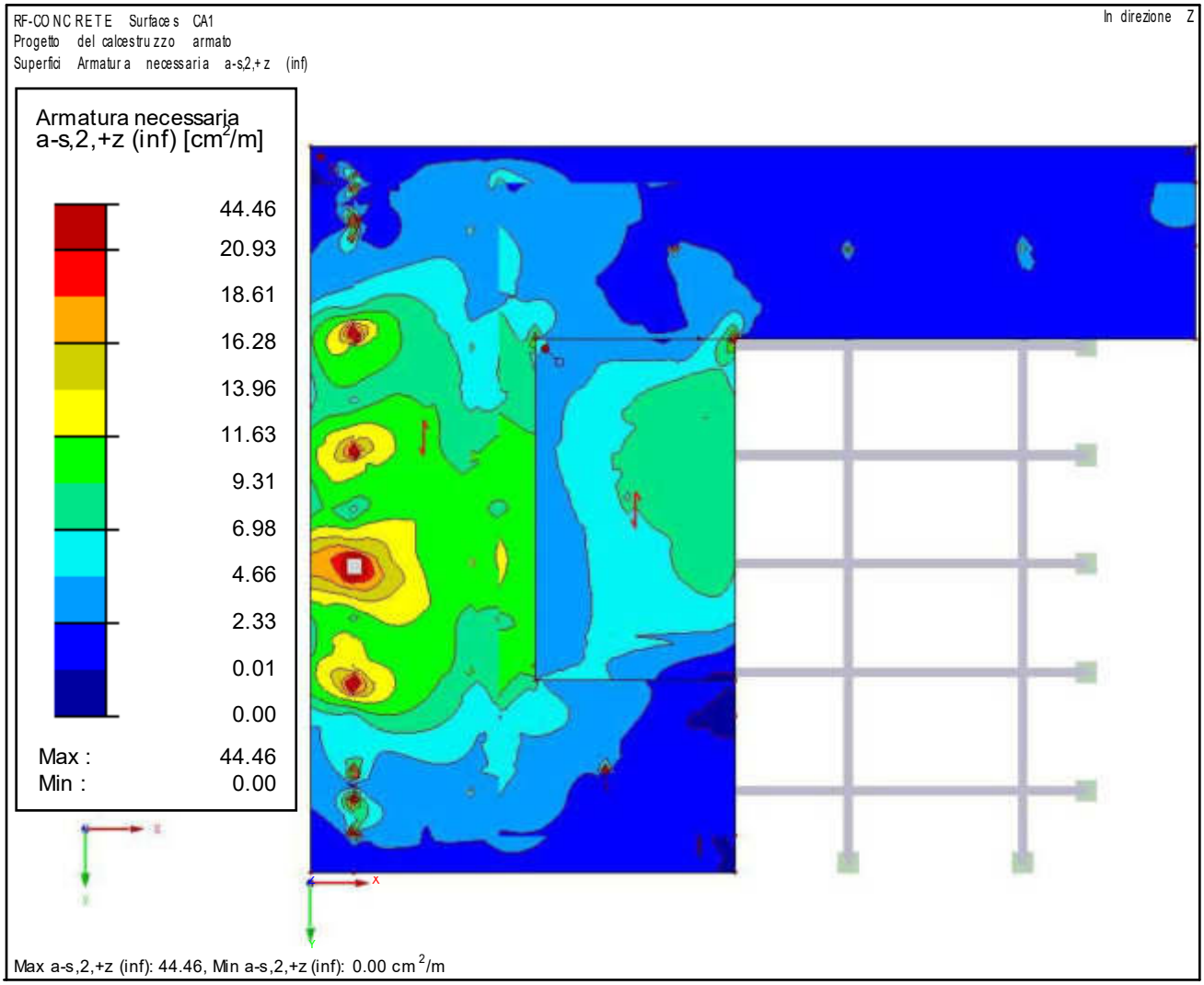
10.5. Isolinee di armatura intradosso in direzione longitudinale alla direzione del ponte

Si prevede di disporre come armatura base ϕ20/15=20,93 cm^2/m



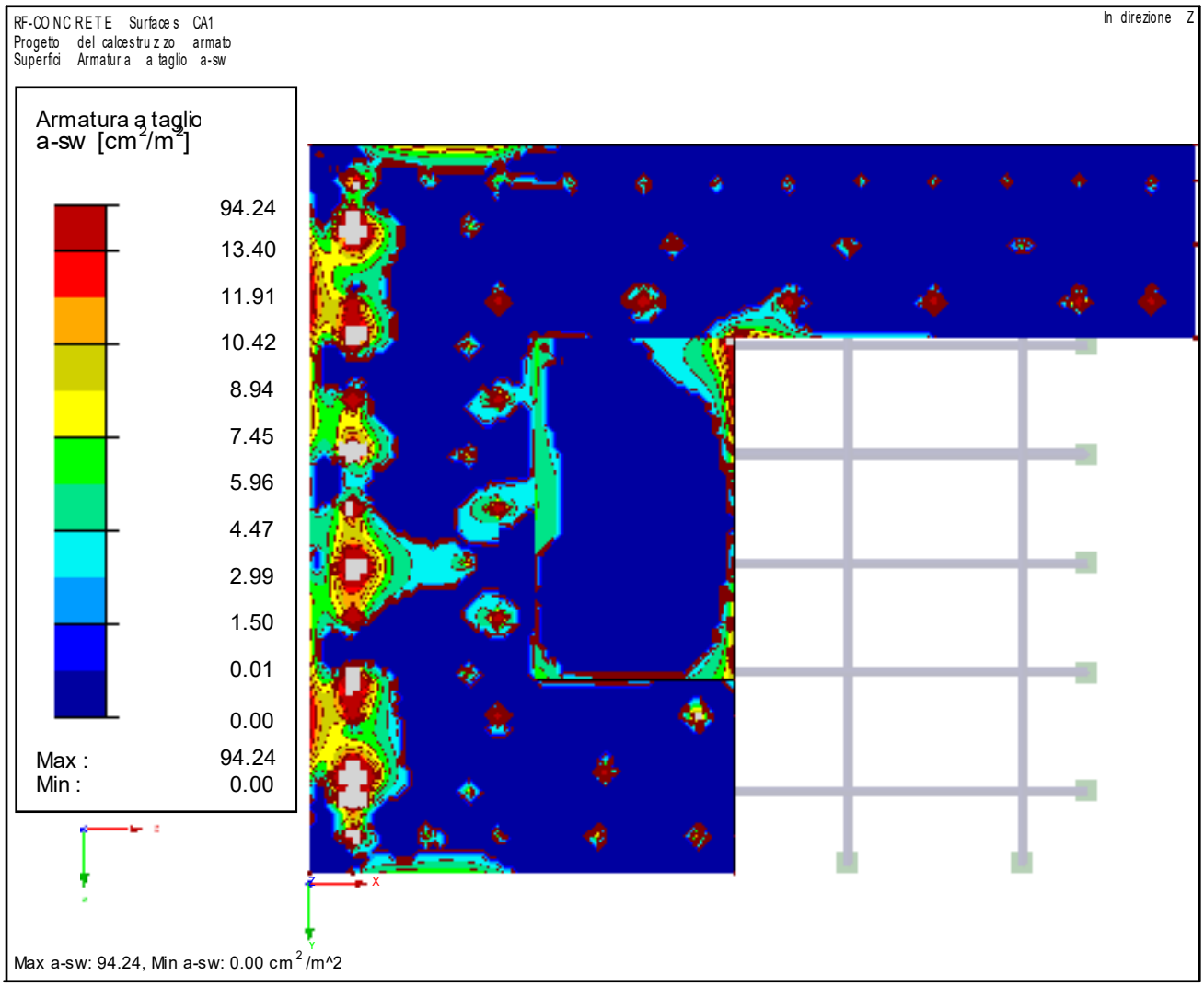
10.6. Isolinee di armatura intradosso in direzione trasversale alla direzione del ponte

Si prevede di disporre come armatura base ϕ20/15=20,93 cm^2/m



10.7. Isolinee di armatura a taglio

Si prevede di disporre come armatura base 2ϕ16/30=13,40 cm^2/m^2

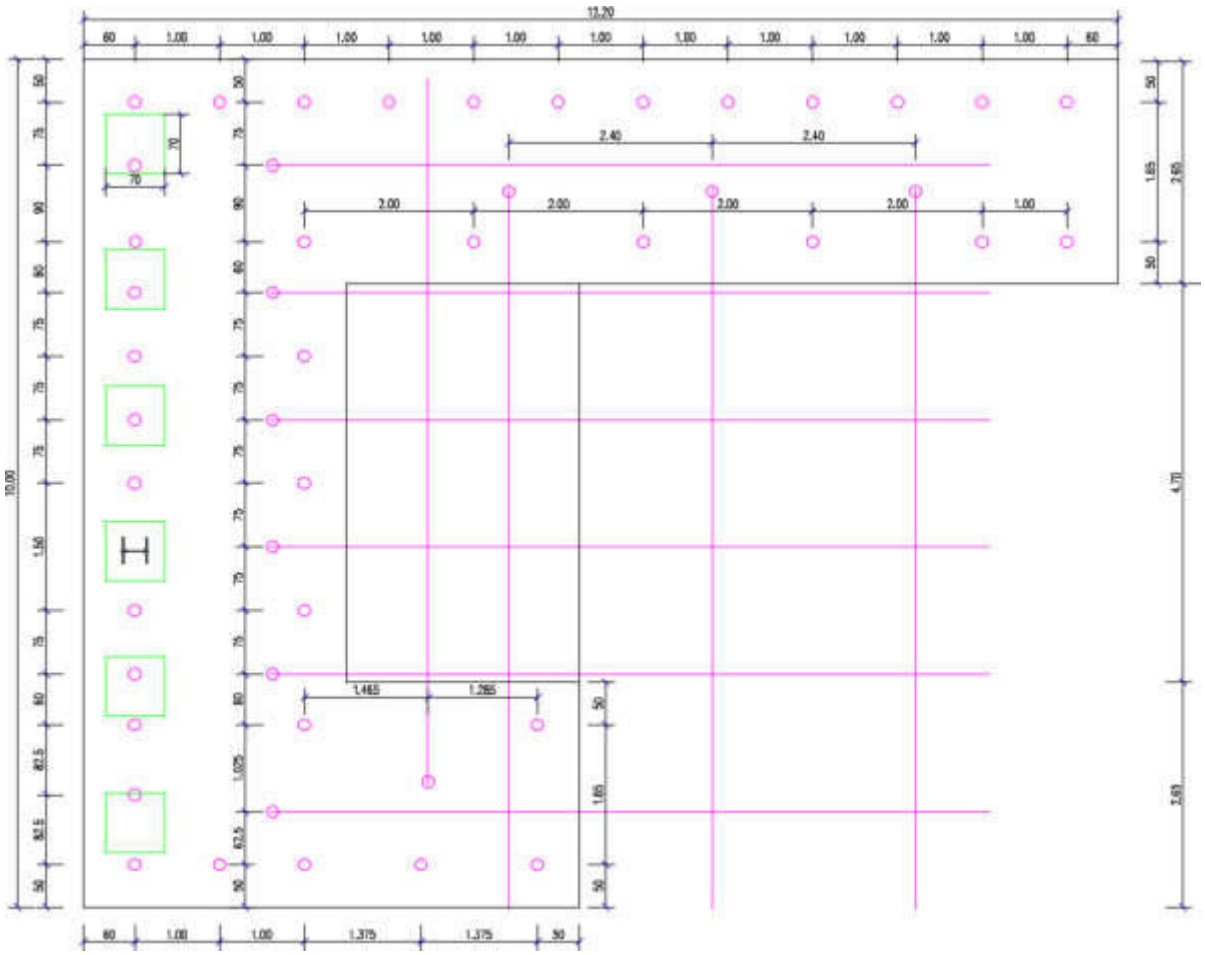


10.8. Verifica a punzonamento

Vedi allegato A

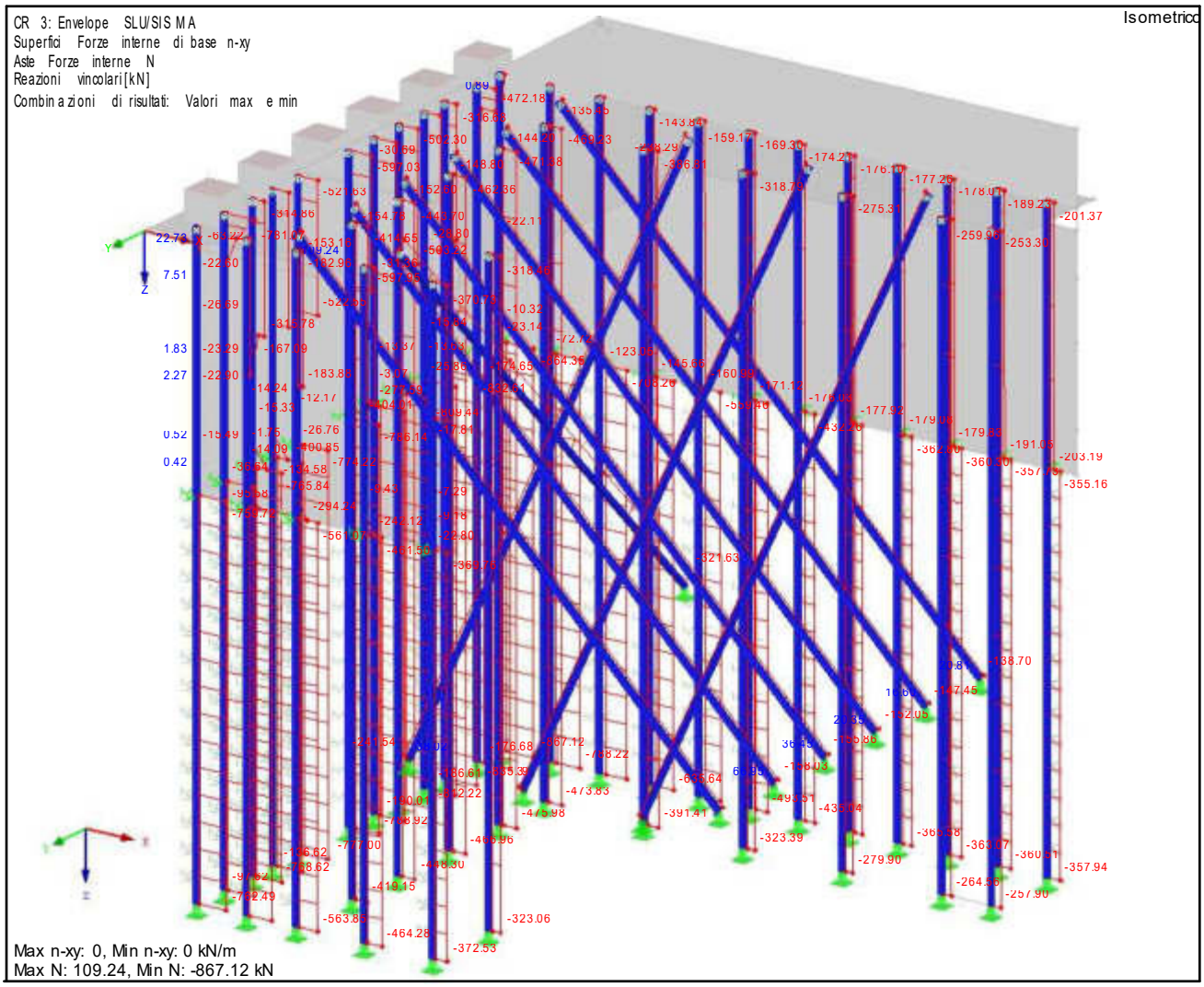
11. Micropali

11.1. Geometria



11.2. Inviluppo sforzo normale di progetto SLU/SISMA e verifica sezione metallica

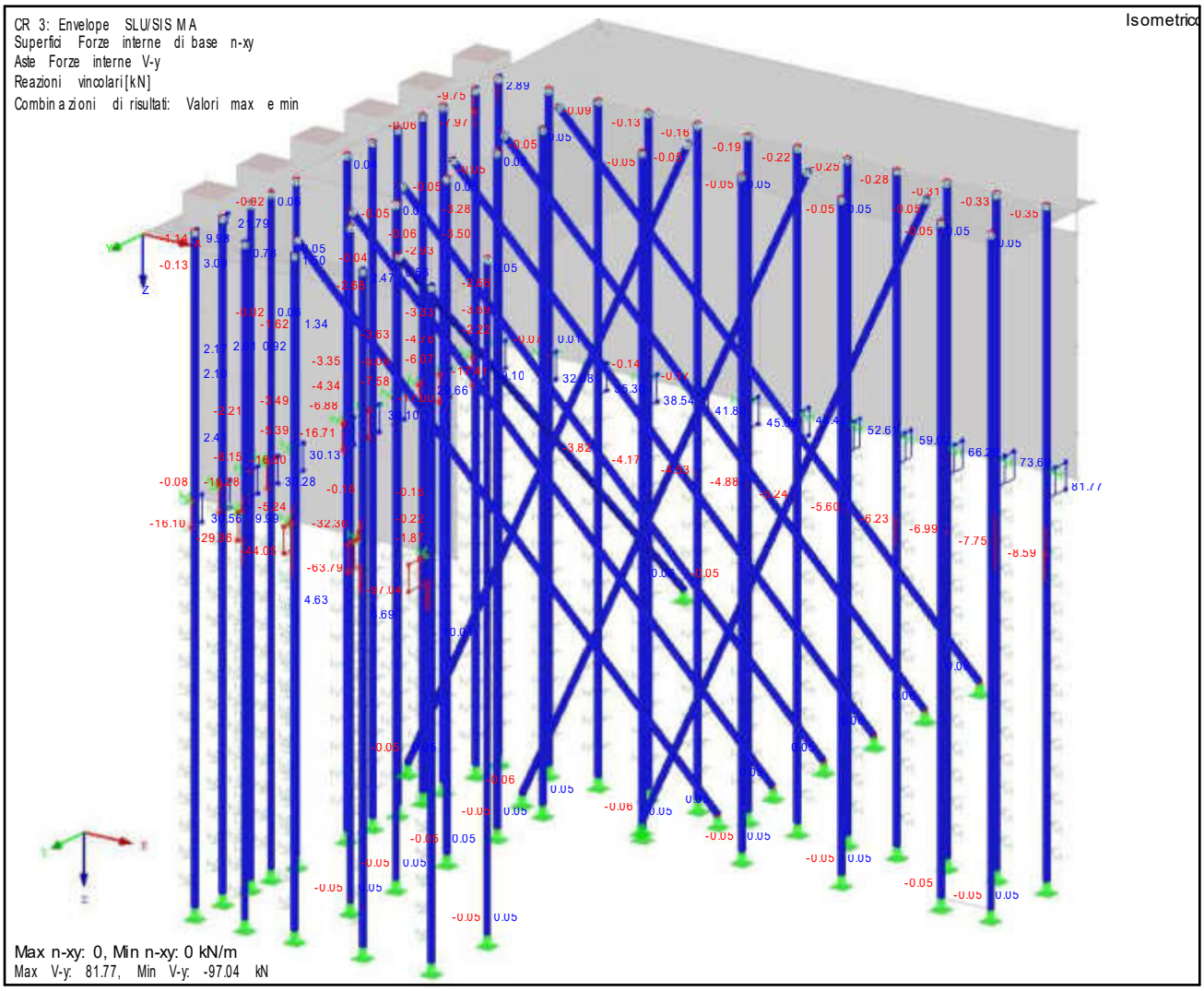
11.2.1. Inviluppo sforzo normale di progetto SLU/SISMA



Azioni di progetto

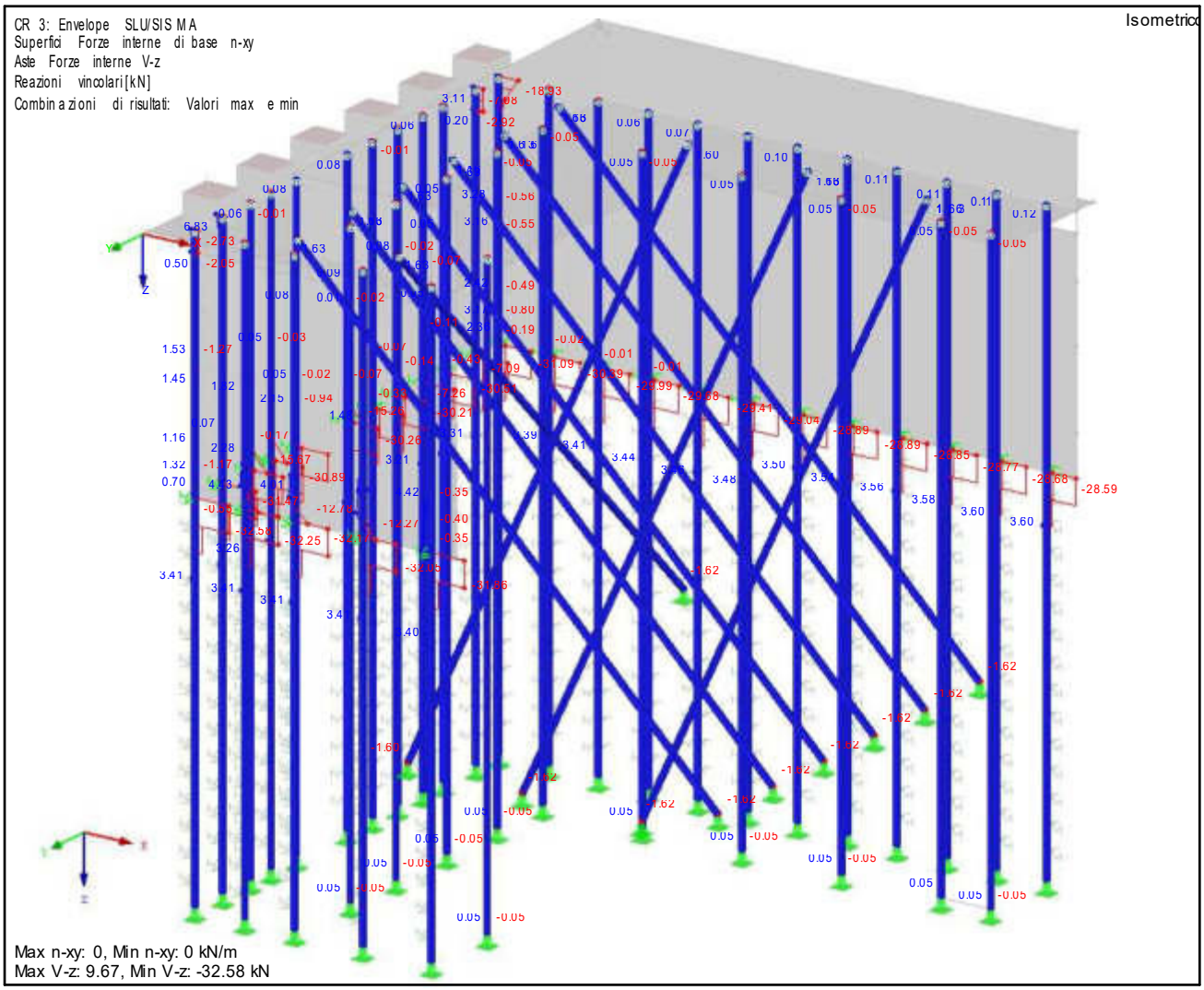
Nedmax di trazione=900,00 kN

Nedmax di compressione=150,00 kN



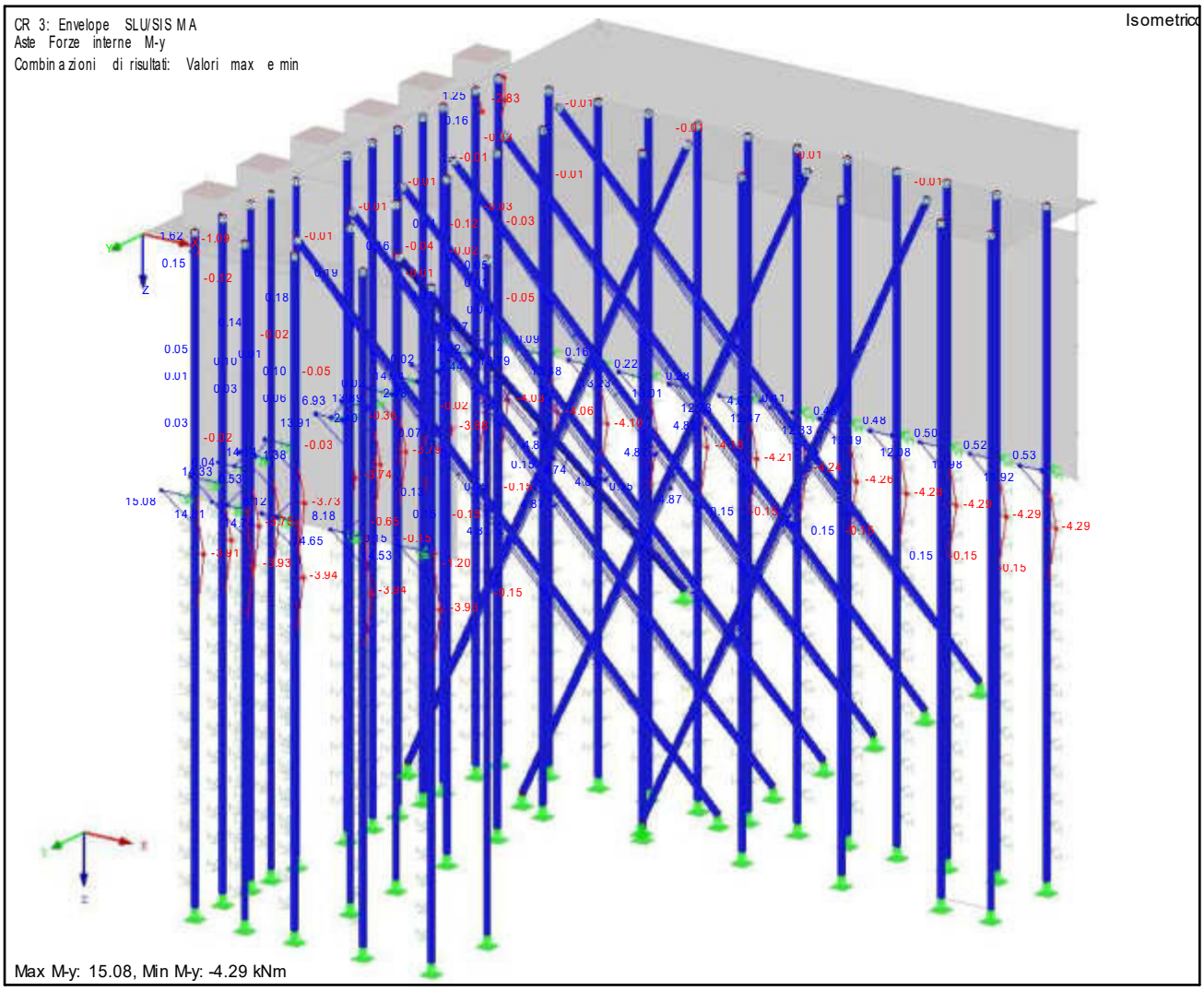
Azioni di progetto

Ved-y=85,00 kN



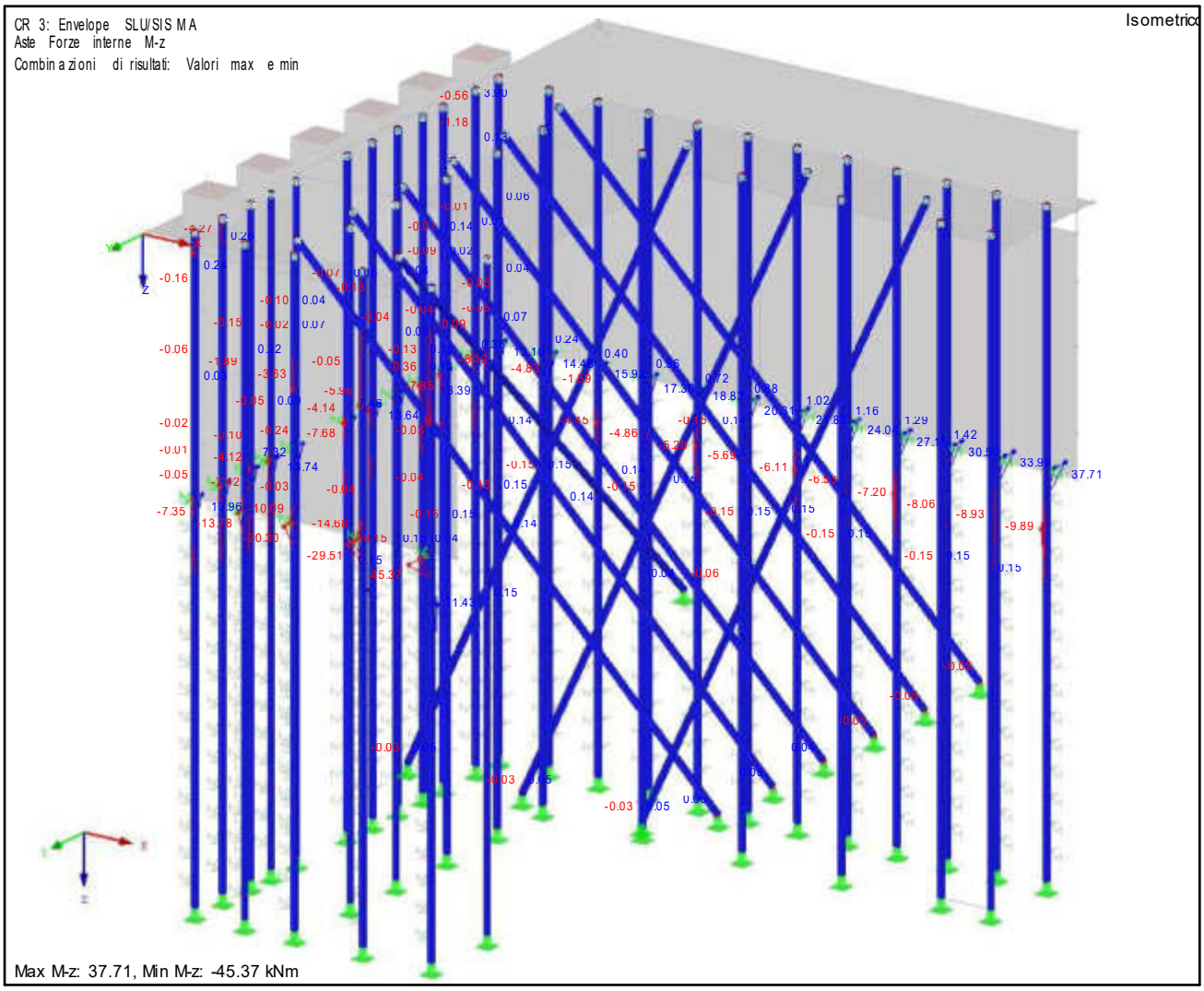
Azioni di progetto

Ved-y=35,00 kN



Azioni di progetto

Med-y=15,00 kN



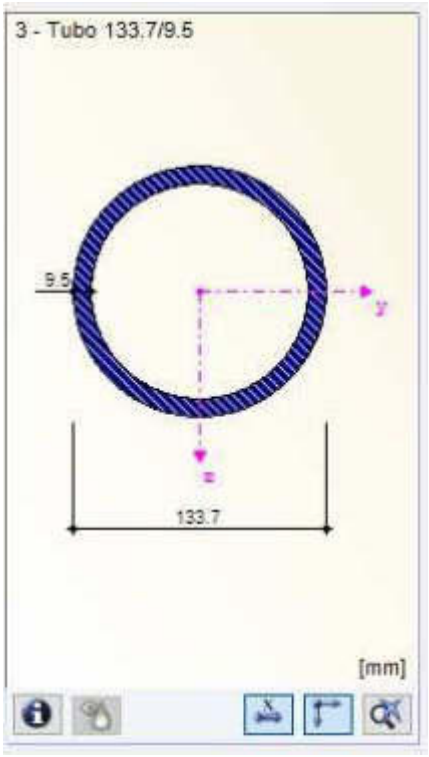
Azioni di progetto

Med-y=40,00 kN

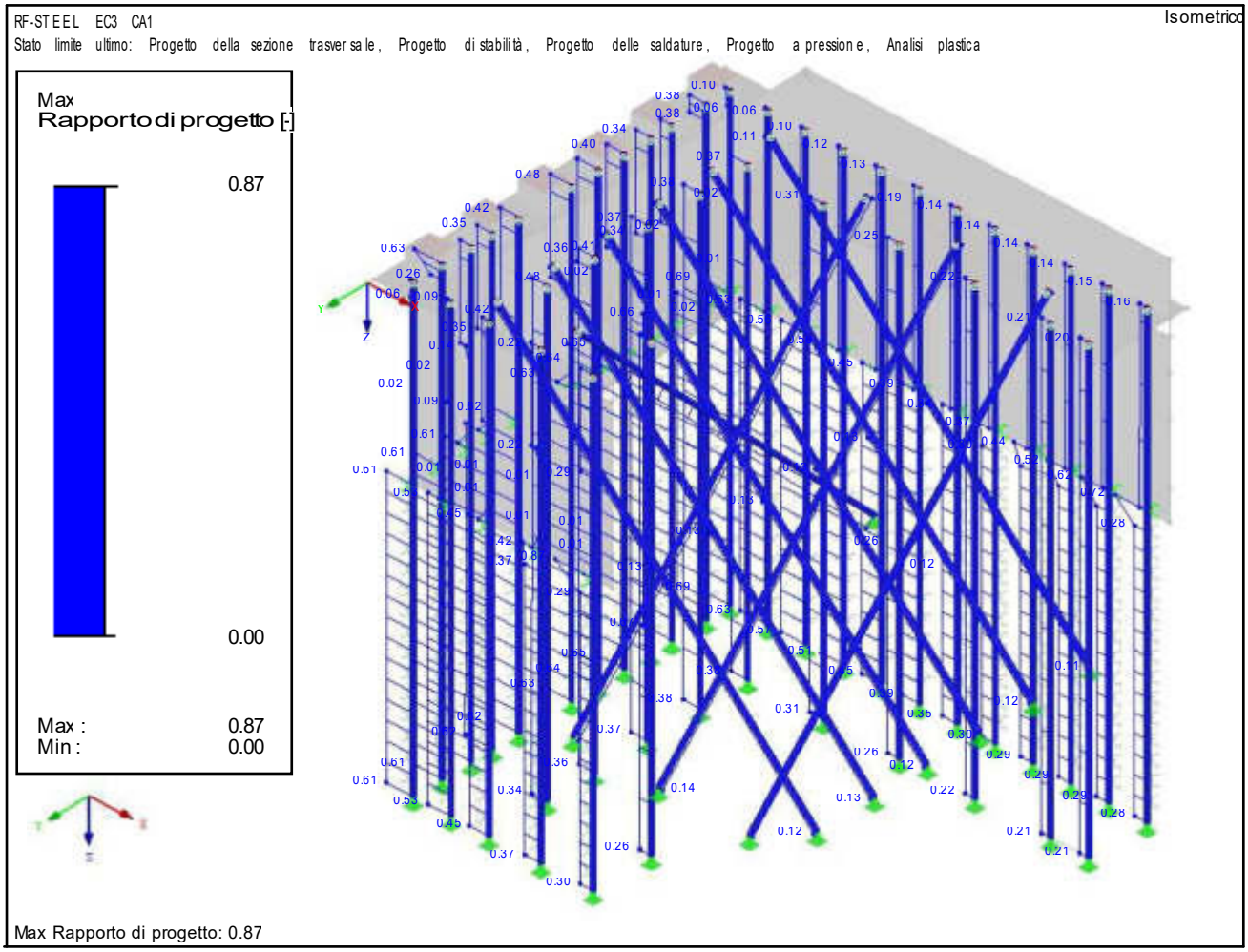
11.2.2. Verifica sezione metallica micropalo

Verifica sezione metallica micropalo compressione		
Micropalo	139,7mmx12,5mm	
d esterno	139,70	mm
Spessore	12,50	mm
d interno	114,70	mm
Area micropalo	4995,13	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	1688,83	kN
Riduzione diametro esterno corroso	6,00	mm
diametro esterno corroso	133,70	mm
diametro interno	114,70	mm
Area micropalo con corrosione	3706,77	mm2
Nrd con corrosione	**1253,24**	**kN**
Ned di trazione	**900,00**	kN
Verifica	**Verificato**	

Il diametro del micropalo in trazione subisce una riduzione pari a 3,00mm in quanto si ipotizza lo strato di boiacca fessurato. Si assume una vita utile di 100 anni.



Di seguito l´output di verifica di tutti i micropali con sezione ridotta. Micropalo di dimensioni 113,70x9,50mm.



Carico	A Descrizione	B Asta nr.	C Posizione x [m]	D Rapporto di progetto	E	F Formula di progetto	G SP
	Progetto allo stato limite ultimo						
CR1	SLU	78	0.000	0.79	≤ 1	CS221) Verifica della sezione trasversale - Flessione biassiale, forza assiale e di taglio sec. I	PT
CR2	SISMA	78	0.000	0.87	≤ 1	CS221) Verifica della sezione trasversale - Flessione biassiale, forza assiale e di taglio sec. I	EC
			Max:	0.87	≤ 1		

Dettagli - Asta 78 - x: 0.000 m - CR1

- ⊞ Proprietà del materiale - Acciaio S 355 1 | UNI EN 10025-2:2004-11
- ⊞ Proprietà della sezione trasversale - Tubo 133.7/9.5
- ⊞ Forze interne di progetto
- ⊞ Classificazione della sezione trasversale - Classe 1

Forze interne di progetto					
	N_{Ed}	-254.33	kN		
Forza di taglio	$V_{y,Ed}$	-82.18	kN		
Forza di taglio	$V_{z,Ed}$	-31.56	kN		
Momento torcente	T_{Ed}	-0.27	kNm		
Momento	$M_{y,Ed}$	14.46	kNm		
Momento	$M_{z,Ed}$	-38.62	kNm		

Rapporto di progetto				
Momento	$M_{y,Ed}$	14.46	kNm	
Modulo di resistenza plastico	$W_{pl,y}$	146.83	cm^3	
Tensione di snervamento	f_y	35.50	kN/cm^2	
Coefficiente parziale	γ_{M0}	1.050		
Momento resistente	$M_{pl,y,Rd}$	49.64	kNm	
Forza di taglio	$V_{z,Ed}$	31.56	kN	
Area di taglio efficace	$A_{v,z}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,z,Rd}$	460.63	kN	
Criterio $V_{z,Ed} / V_{pl,z,Rd}$	v_z	0.069		≤ 0.5
Forza assiale	N_{Ed}	-254.33	kN	
Area della sezione trasversale	A	37.07	cm^2	
Resistenza plastica di progetto alle forze normali	$N_{pl,Rd}$	1253.24	kN	
Momento resistente	$M_{N,pl,y,Rd}$	46.34	kNm	
Momento	$M_{z,Ed}$	38.62	kNm	
Modulo di resistenza plastico	$W_{pl,z}$	146.83	cm^3	
Momento resistente	$M_{pl,z,Rd}$	49.64	kNm	
Forza di taglio	$V_{y,Ed}$	82.18	kN	
Area di taglio efficace	$A_{v,y}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,y,Rd}$	460.63	kN	
Criterio $V_{y,Ed} / V_{pl,y,Rd}$	v_y	0.178		≤ 0.5
Momento resistente	$M_{N,pl,z,Rd}$	46.34	kNm	
Costante di interazione	α	2.000		
Costante di interazione	β	2.000		
Componente di progetto per M_y	η_{My}	0.10		≤ 1
Componente di progetto per M_z	η_{Mz}	0.69		≤ 1
Componente di progetto per M	η_M	0.79		≤ 1

Formula di progetto

$$(M_{y,Ed} / M_{N,y,Rd})^{\alpha} + (M_{z,Ed} / M_{N,z,Rd})^{\beta} = 0.79 \leq 1 \quad (6.41)$$

Forze interne di progetto					
Forza assiale	N_{Ed}	-105.61	kN		
Forza di taglio	$V_{y,Ed}$	-97.25	kN		
Forza di taglio	$V_{z,Ed}$	-31.78	kN		
Momento torcente	T_{Ed}	-0.32	kNm		
Momento	$M_{y,Ed}$	14.53	kNm		
Momento	$M_{z,Ed}$	-45.63	kNm		

Dettagli - Asta 78 - x: 0.000 m - CR2

⊞ Proprietà del materiale - Acciaio S 355 1 | UNI EN 10025-2:2004-11

⊞ Proprietà della sezione trasversale - Tubo 133.7/9.5

⊞ Forze interne di progetto

⊞ Classificazione della sezione trasversale - Classe 1

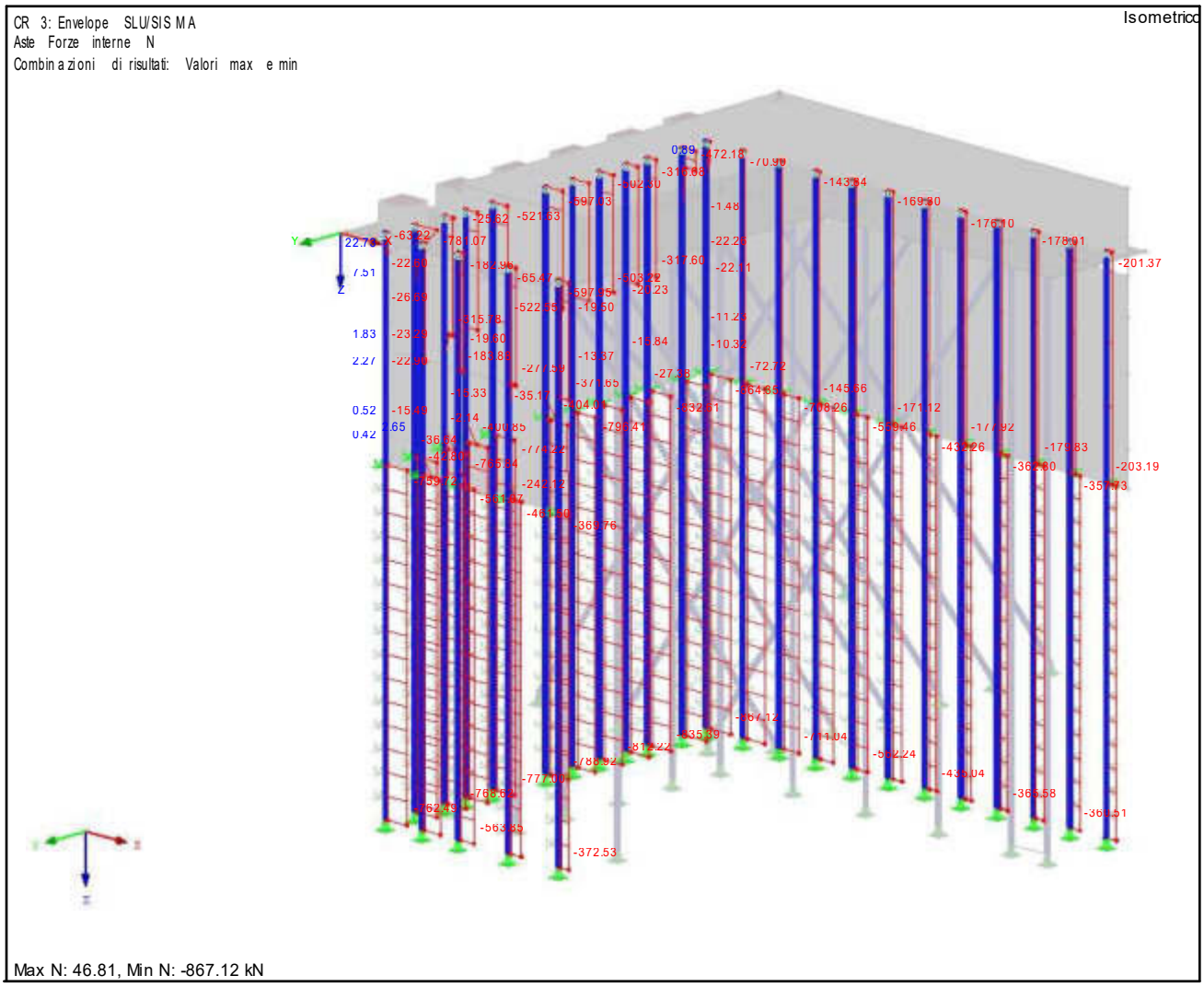
⊟ Rapporto di progetto				
Momento	$M_{y,Ed}$	14.53	kNm	
Modulo di resistenza plastico	$W_{pl,y}$	146.83	cm^3	
Tensione di snervamento	f_y	35.50	kN/cm^2	
Coefficiente parziale	γ_{M0}	1.000		
Momento resistente	$M_{pl,y,Rd}$	52.12	kNm	
Forza di taglio	$V_{z,Ed}$	31.78	kN	
Area di taglio efficace	$A_{v,z}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,z,Rd}$	483.66	kN	
Criterio $V_{z,Ed} / V_{pl,z,Rd}$	v_z	0.066		≤ 0.5
Forza assiale	N_{Ed}	-105.61	kN	
Area della sezione trasversale	A	37.07	cm^2	
Resistenza plastica di progetto alle forze normali	$N_{pl,Rd}$	1315.90	kN	
Momento resistente	$M_{N,pl,y,Rd}$	51.41	kNm	
Momento	$M_{z,Ed}$	45.63	kNm	
Modulo di resistenza plastico	$W_{pl,z}$	146.83	cm^3	
Momento resistente	$M_{pl,z,Rd}$	52.12	kNm	
Forza di taglio	$V_{y,Ed}$	97.25	kN	
Area di taglio efficace	$A_{v,y}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,y,Rd}$		kN	
Criterio $V_{y,Ed} / V_{pl,y,Rd}$	v_y	0.201		≤ 0.5
Momento resistente	$M_{N,pl,z,Rd}$	51.41	kNm	
Costante di interazione	α	2.000		
Costante di interazione	β	2.000		
Componente di progetto per M_y	η_{My}	0.08		≤ 1
Componente di progetto per M_z	η_{Mz}	0.79		≤ 1
Componente di progetto per M	η_M	0.87		≤ 1

⊟ Formula di progetto

$(M_{y,Ed} / M_{N,y,Rd})^{\alpha} + (M_{z,Ed} / M_{N,z,Rd})^{\beta} = 0.87 \leq 1$ (6.41)

11.3. Inviluppo sollecitazioni SLU/SISMA micropali verticali prima fila e verifica geostatica

11.3.1. Inviluppo sollecitazioni SLU/SISMA micropali verticali prima fila



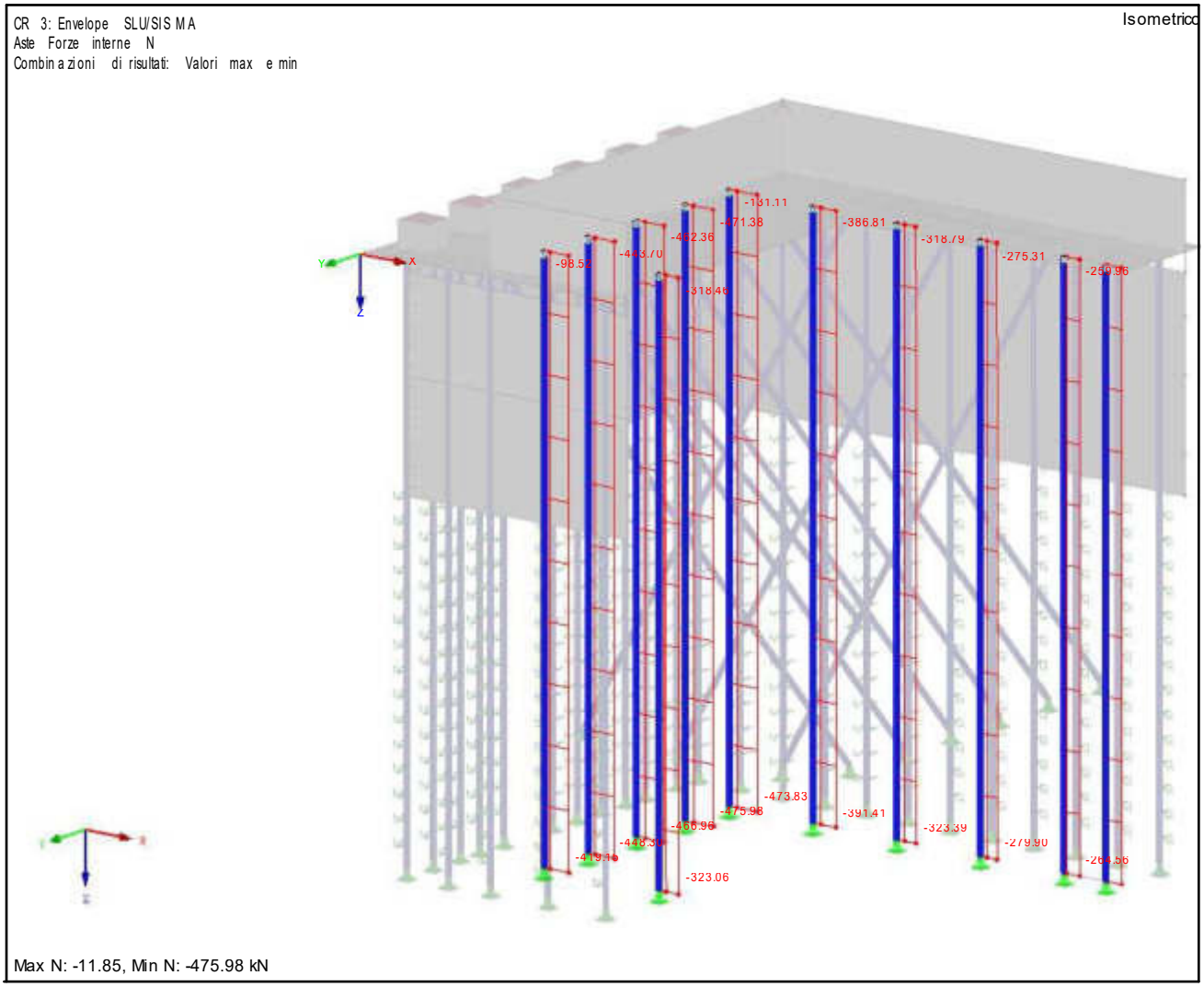
11.3.2. Verifica geostatica micropali verticali prima fila

Verifica geostatica micropalo verticale a compressione I fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd	**1697,63**	**kN**
Ned	**900,00**	kN
Verifica	**Verificato**	
α	**0,53**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

11.4. Inviluppo sollecitazioni SLU/SISMA micropali verticali seconda fila e verifica geostatica

11.4.1. Inviluppo sollecitazioni SLU/SISMA micropali verticali seconda fila



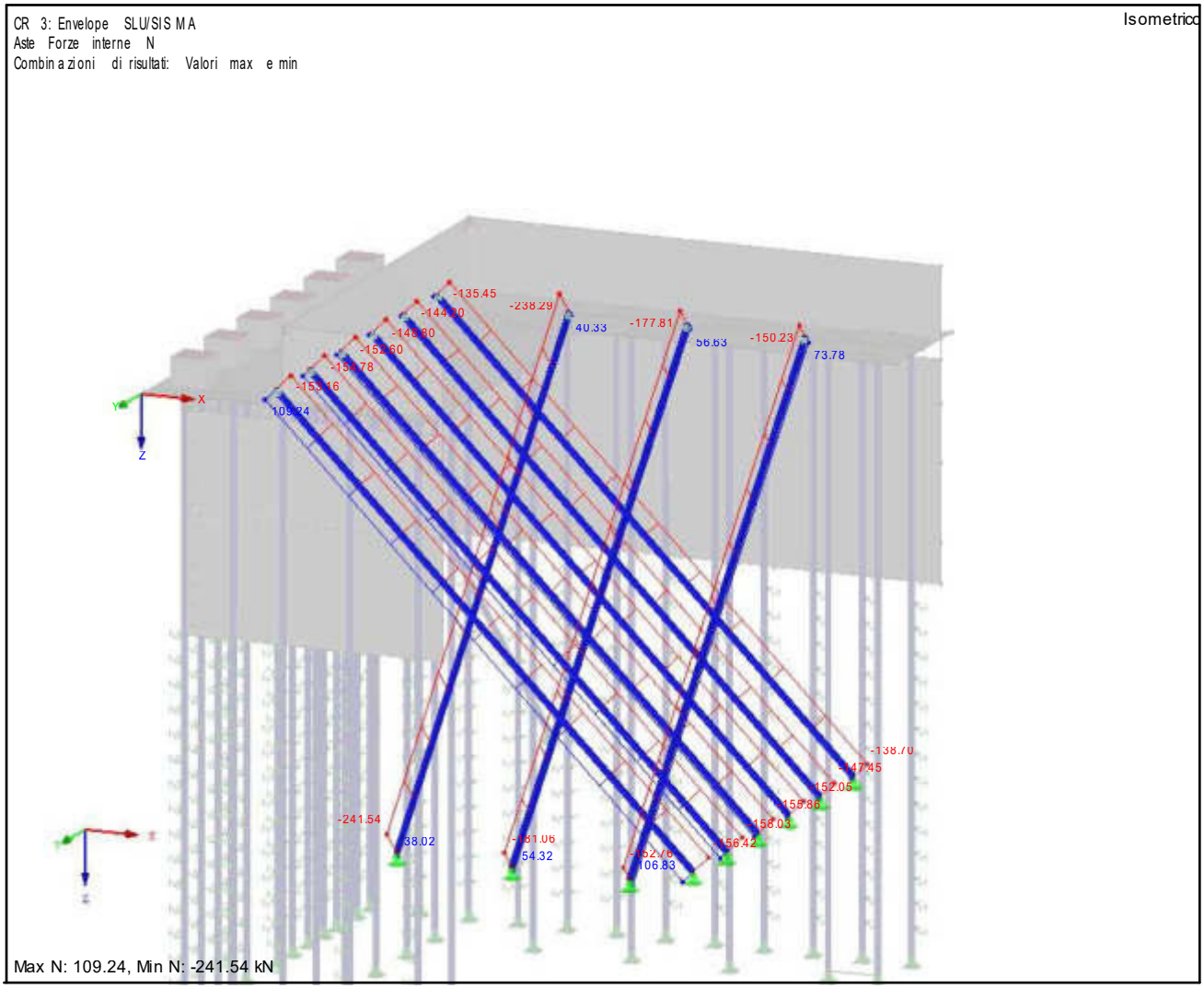
11.4.2. Verifica geostatica micropali verticali seconda fila

Verifica geostatica micropalo verticale a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd	**1697,63**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,29**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

11.5. Inviluppo sollecitazioni SLU/SISMA micropali inclinati seconda fila e verifica geostatica

11.5.1. Inviluppo sollecitazioni SLU/SISMA micropali inclinati seconda fila



11.5.2. Verifica geostatica micropali inclinati seconda fila

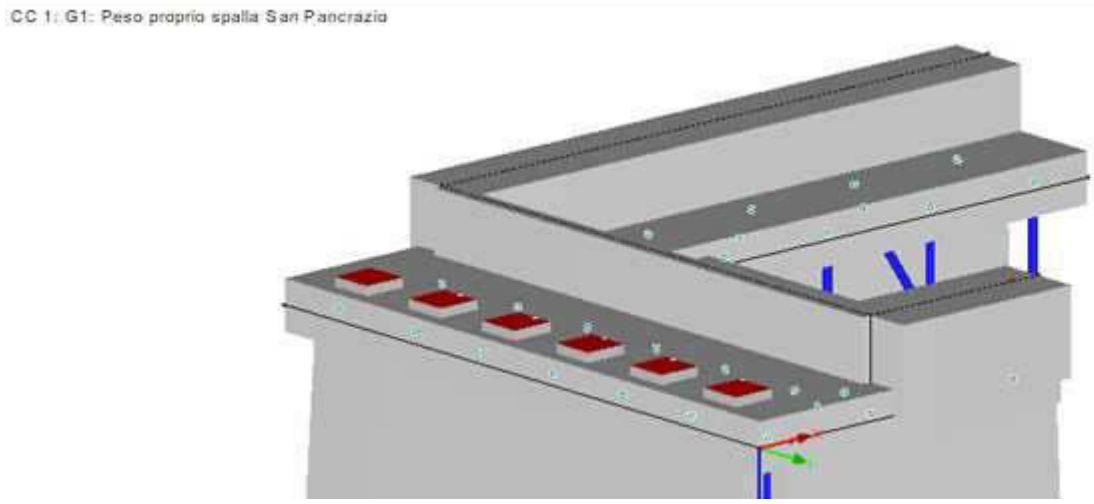
Verifica geostatica micropalo inclinato a trazione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in GE2	350,00	kN/m2
L micropalo bulbo in GE2	6,00	m
τ limite in GE3	500,00	kN/m
L micropalo bulbo in GE3	2,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1335,63**	**kN**
Ned	**200,00**	kN
Verifica	**Verificato**	
α	**0,15**	

Verifica geostatica micropalo inclinato a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in GE2	350,00	kN/m2
L micropalo bulbo in GE2	6,00	m
τ limite in GE3	500,00	kN/m
L micropalo bulbo in GE3	2,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1451,77**	**kN**
Ned	**250,00**	kN
Verifica	**Verificato**	
α	**0,17**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

12. Baggioli

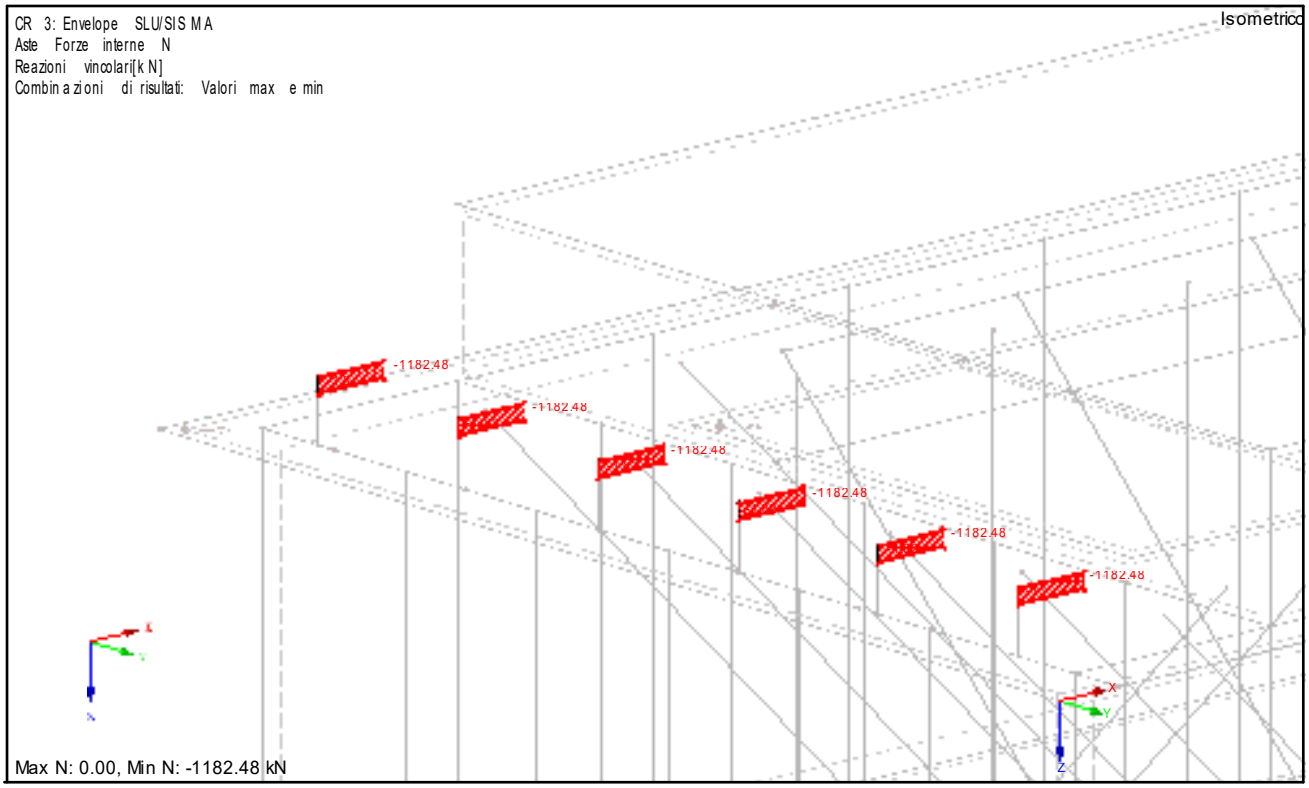
12.1. Geometria



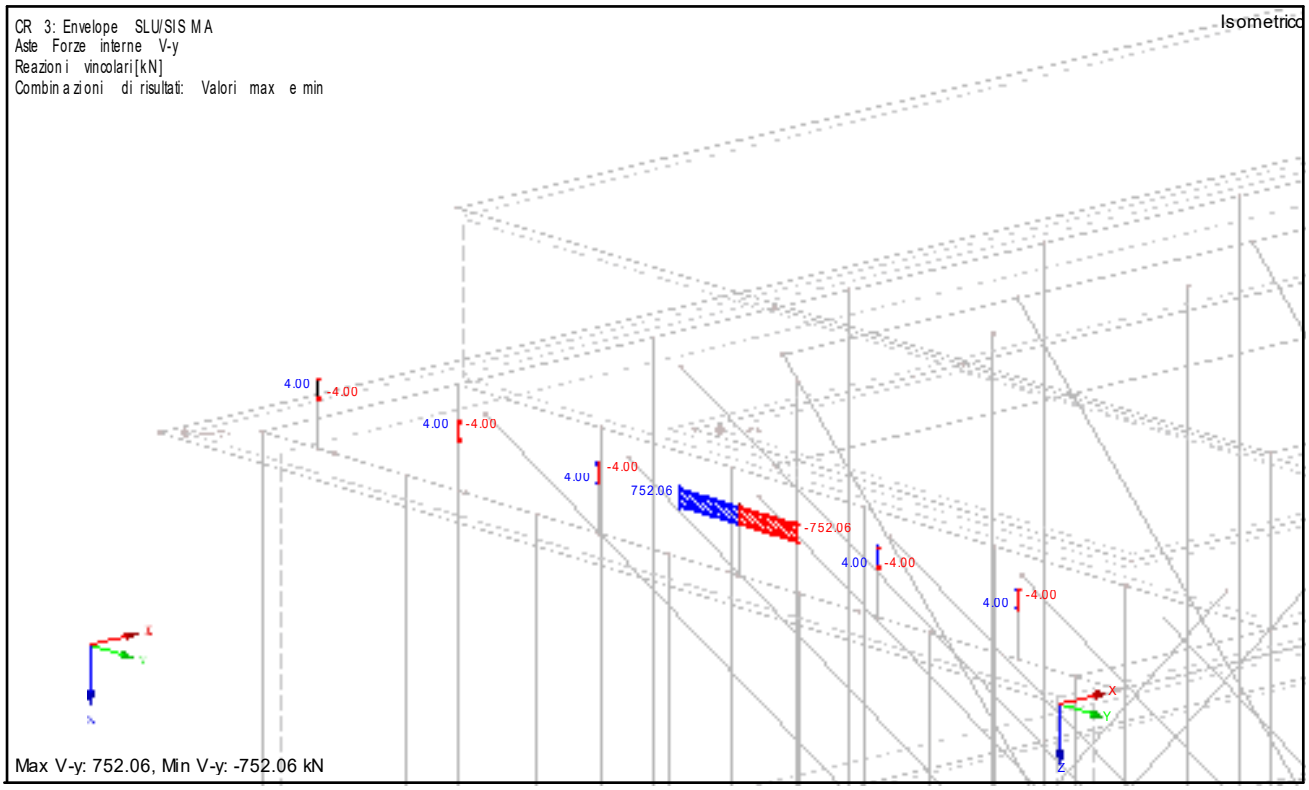
I baggioli dove poggiano gli elastomeri hanno dimensioni 70cmx70cmx15cm

12.2. Inviluppo sollecitazioni SLU/SISMA

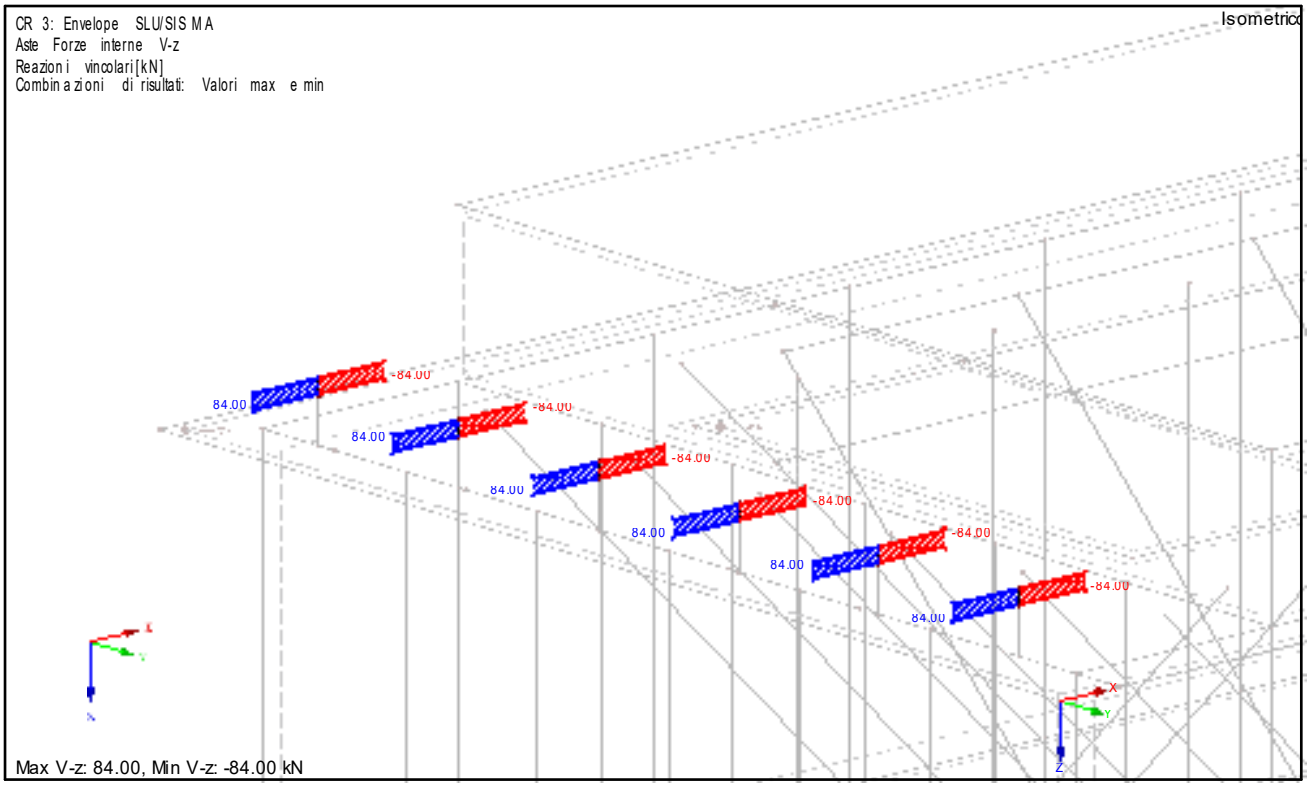
12.2.1. Inviluppo SLU/SISMA Valori sforzo normale N



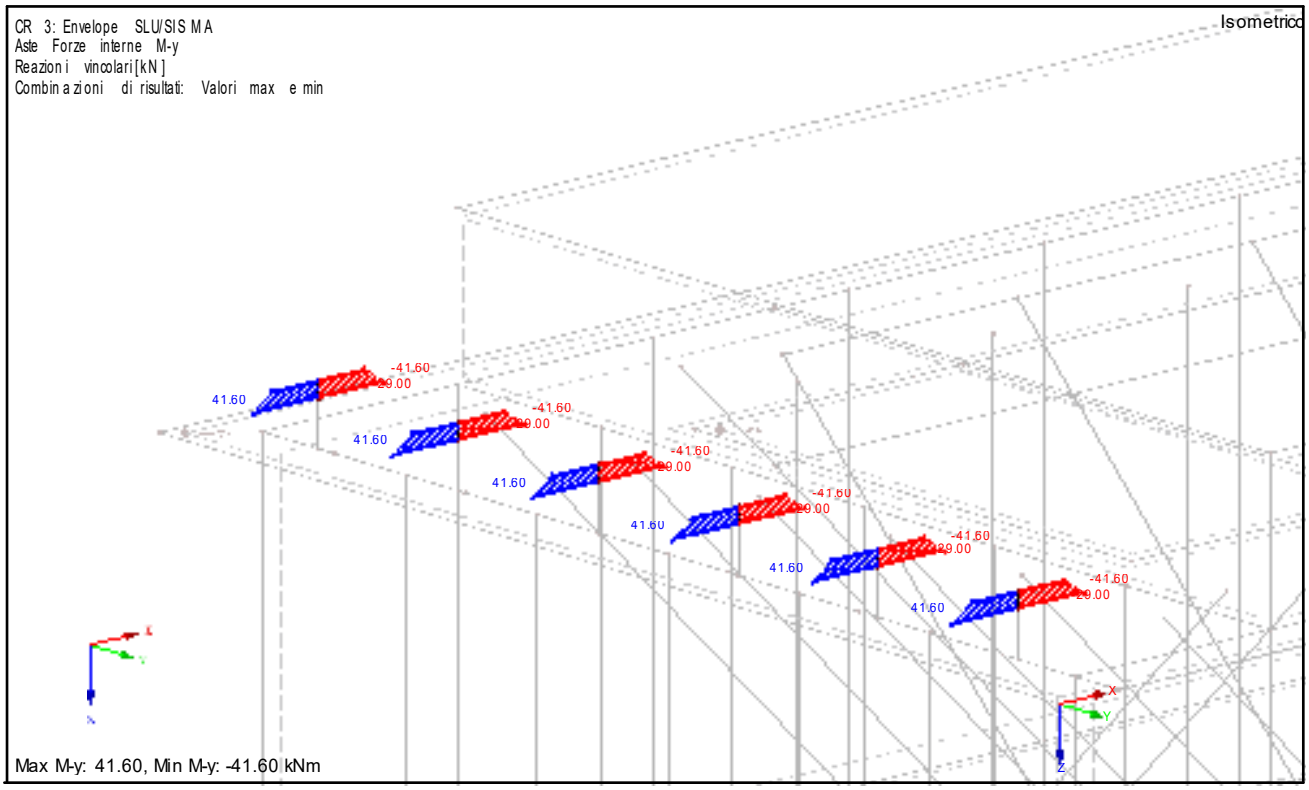
12.2.2. Inviluppo SLU/SISMA Valori taglio trasversale



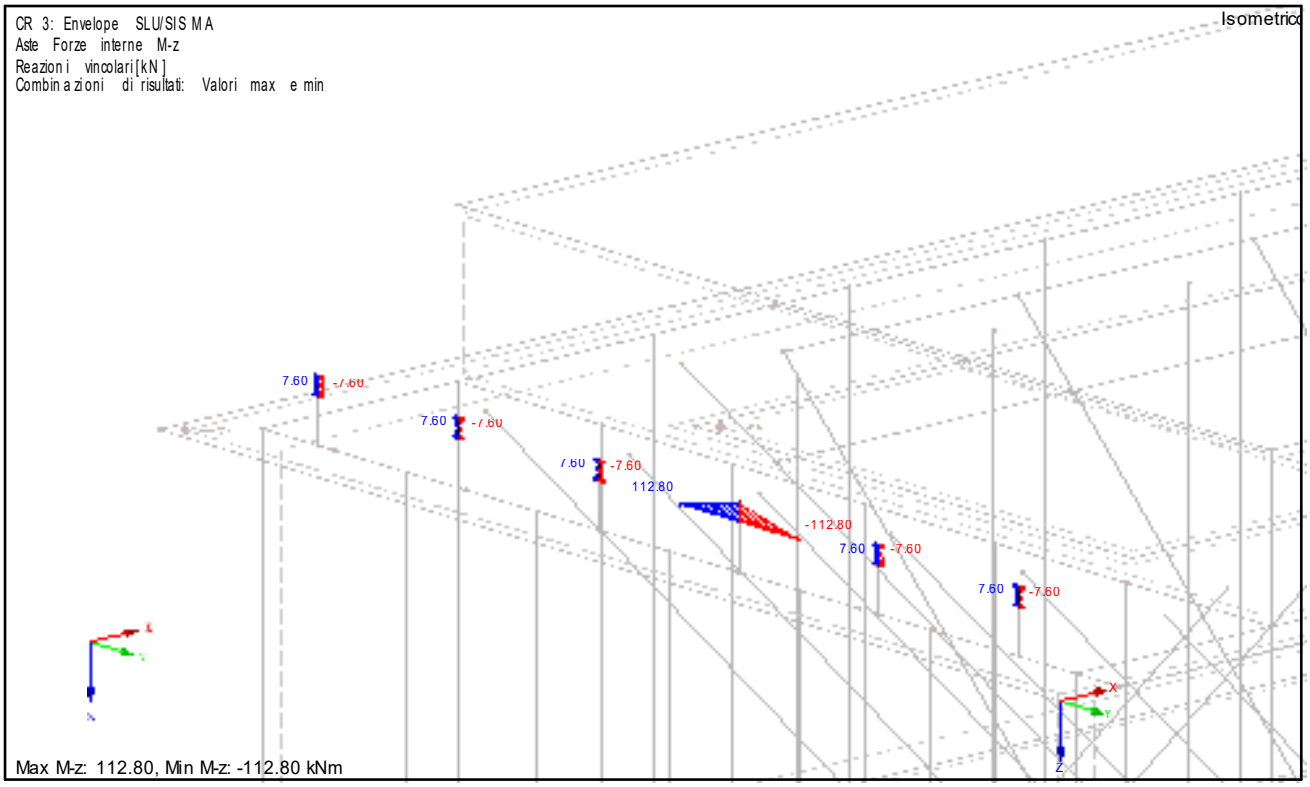
12.2.3. Inviluppo SLU/SISMA Valori taglio longitudinale



12.2.4. Inviluppo SLU/SISMA Valori momento flettente longitudinale



12.2.5. Inviluppo SLU/SISMA Valori momento flettente trasversale



12.3. Verifiche baggioli

12.3.1. Verifica a pressoflessione

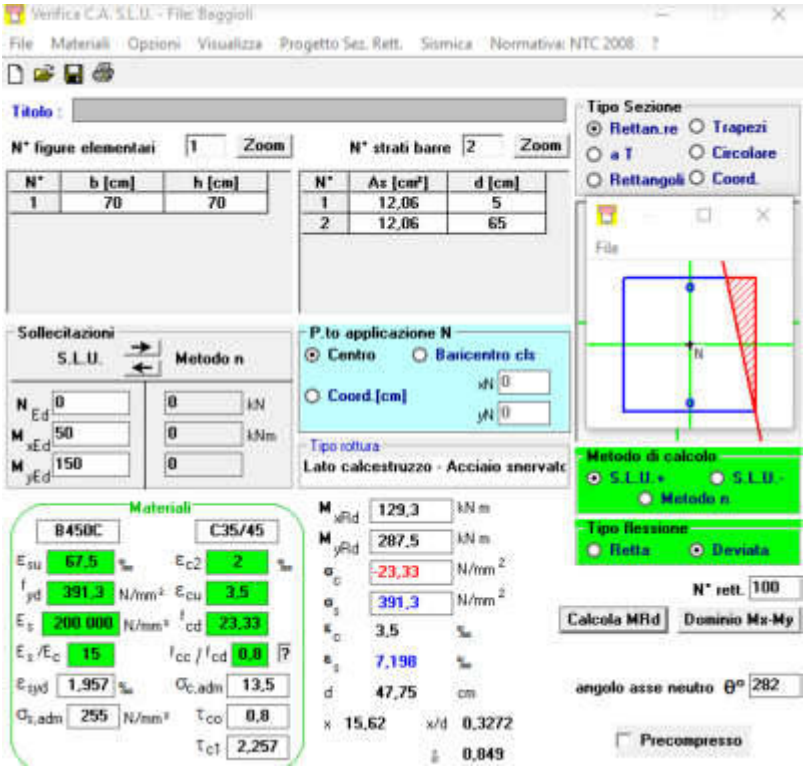
Azioni di progetto

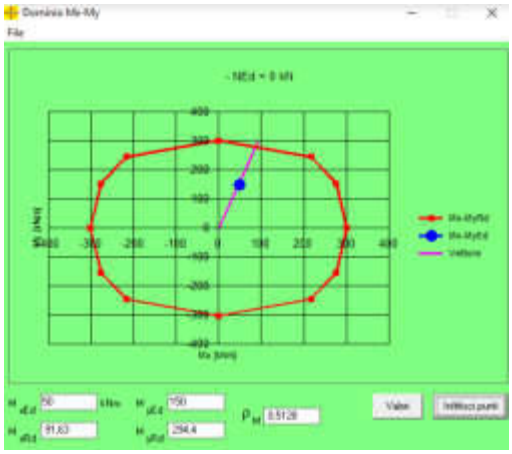
Nsd=0,00 kN

Msd_longitudinale=50,00 kNm

Msd_trasversale=150,00 kNm

Si dispongono al minimo 6ϕ16=12,06 cm^2





12.3.2. Verifica a taglio

- **Azioni di progetto baggioli per baggioli con appoggio multidirezionale**

Nsd=0,00 kN Vsd=100,00 kN

Tabella per calcolo resistenza senza armatura a taglio

Valore di calcolo del taglio resistente				
d	bw	Nsd	Asl(logitud.)	fck
[m]	[m]	[MN]	[m2]	[MPa]
0,65	0,70	0,000	0,00120	35,00
k	sigma_cp	rho1		
[]	[]	[]		
1,55470	0,00000	0,00264		
V_Rd_1_ senza armatura a taglio				
[MN]				
0,183				

Ved=100,00 kN<Vrd=183,00 kN verificato

- **Azioni di progetto baggioli per baggioli con appoggio fisso trasversale**

Nsd=0,00 kN Vsd_Sisma=800,00 kN

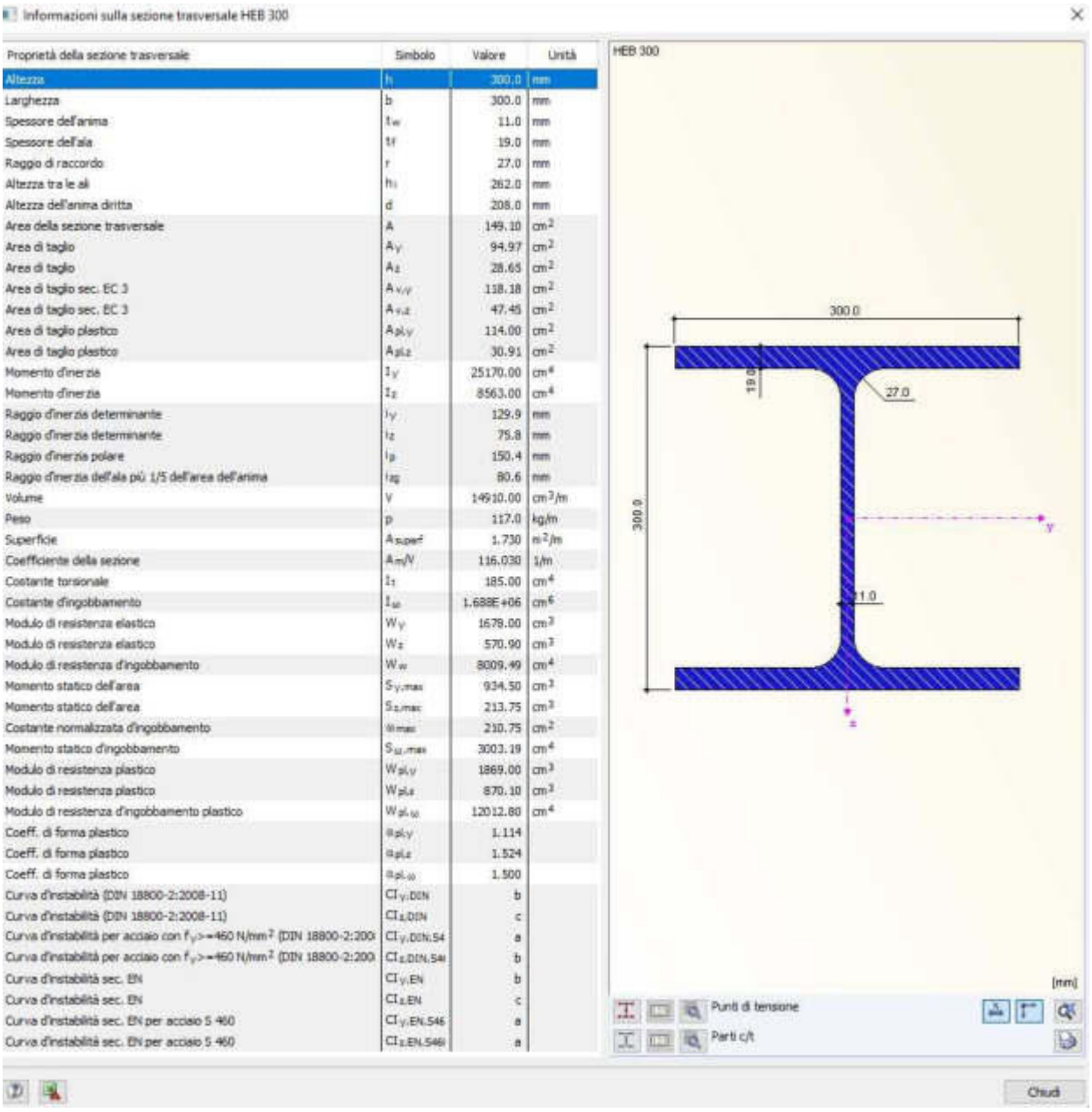
Si prevede l´inserimento di un profilo HEB 300 S355 per l´assorbimento della forza sismica di lunghezza pari a 75 cm.

Av=95,00 cm^2

fyd=fyk/γs=355 MPa/1,05=338,10 MPa

Vrd=fyd*Av//$\sqrt{3}$=338,10 MPa*95/$(100)^2$ m^2*1000/$\sqrt{3}$=1854,40 kN

Ved=800,00 kN<Vrd=1854,40 kN Verificato



Proprietà della sezione trasversale	Simbolo	Valore	Unità
Altezza	h	300.0	mm
Larghezza	b	300.0	mm
Spessore dell'anima	t_w	11.0	mm
Spessore dell'ala	tf	19.0	mm
Raggio di raccordo	r	27.0	mm
Altezza tra le ali	h_i	262.0	mm
Altezza dell'anima diritta	d	208.0	mm
Area della sezione trasversale	A	149.10	cm^2
Area di taglio	A_y	94.97	cm^2
Area di taglio	A_z	28.65	cm^2
Area di taglio sec. EC 3	$A_{v,y}$	118.18	cm^2
Area di taglio sec. EC 3	$A_{v,z}$	47.45	cm^2
Area di taglio plastico	$A_{pl,y}$	114.00	cm^2
Area di taglio plastico	$A_{pl,z}$	30.91	cm^2
Momento d'inerzia	I_y	25170.00	cm^4
Momento d'inerzia	I_z	8563.00	cm^4
Raggio d'inerzia determinante	i_y	129.9	mm
Raggio d'inerzia determinante	i_z	75.8	mm
Raggio d'inerzia polare	i_p	150.4	mm
Raggio d'inerzia dell'ala più 1/5 dell'area dell'anima	i_{ag}	80.6	mm
Volume	V	14910.00	cm^3/m
Peso	p	117.0	kg/m
Superficie	A_{surf}	1.730	m^2/m
Coefficiente della sezione	A_m/V	116.030	1/m
Costante torsionale	I_t	185.00	cm^4
Costante d'ingobbamento	I_ω	1.688E+06	cm^6
Modulo di resistenza elastico	W_y	1678.00	cm^3
Modulo di resistenza elastico	W_z	570.90	cm^3
Modulo di resistenza d'ingobbamento	W_ω	8009.49	cm^4
Momento statico dell'area	$S_{y,max}$	934.50	cm^3
Momento statico dell'area	$S_{z,max}$	213.75	cm^3
Costante normalizzata d'ingobbamento	ω_{max}	210.75	cm^2
Momento statico d'ingobbamento	$S_{\omega,max}$	3003.19	cm^4
Modulo di resistenza plastico	$W_{pl,y}$	1869.00	cm^3
Modulo di resistenza plastico	$W_{pl,z}$	870.10	cm^3
Modulo di resistenza d'ingobbamento plastico	$W_{pl,\omega}$	12012.80	cm^4
Coeff. di forma plastico	$\alpha_{pl,y}$	1.114	
Coeff. di forma plastico	$\alpha_{pl,z}$	1.524	
Coeff. di forma plastico	$\alpha_{pl,\omega}$	1.500	
Curva d'instabilità (DIN 18800-2:2008-11)	$CI_{y,DIN}$	b	
Curva d'instabilità (DIN 18800-2:2008-11)	$CI_{z,DIN}$	c	
Curva d'instabilità per acciaio con f_y>=460 N/mm² (DIN 18800-2:200	$CI_{y,DIN,54}$	a	
Curva d'instabilità per acciaio con f_y>=460 N/mm² (DIN 18800-2:200	$CI_{z,DIN,54}$	b	
Curva d'instabilità sec. EN	$CI_{y,EN}$	b	
Curva d'instabilità sec. EN	$CI_{z,EN}$	c	
Curva d'instabilità sec. EN per acciaio S 460	$CI_{y,EN,546}$	a	
Curva d'instabilità sec. EN per acciaio S 460	$CI_{z,EN,546}$	a	

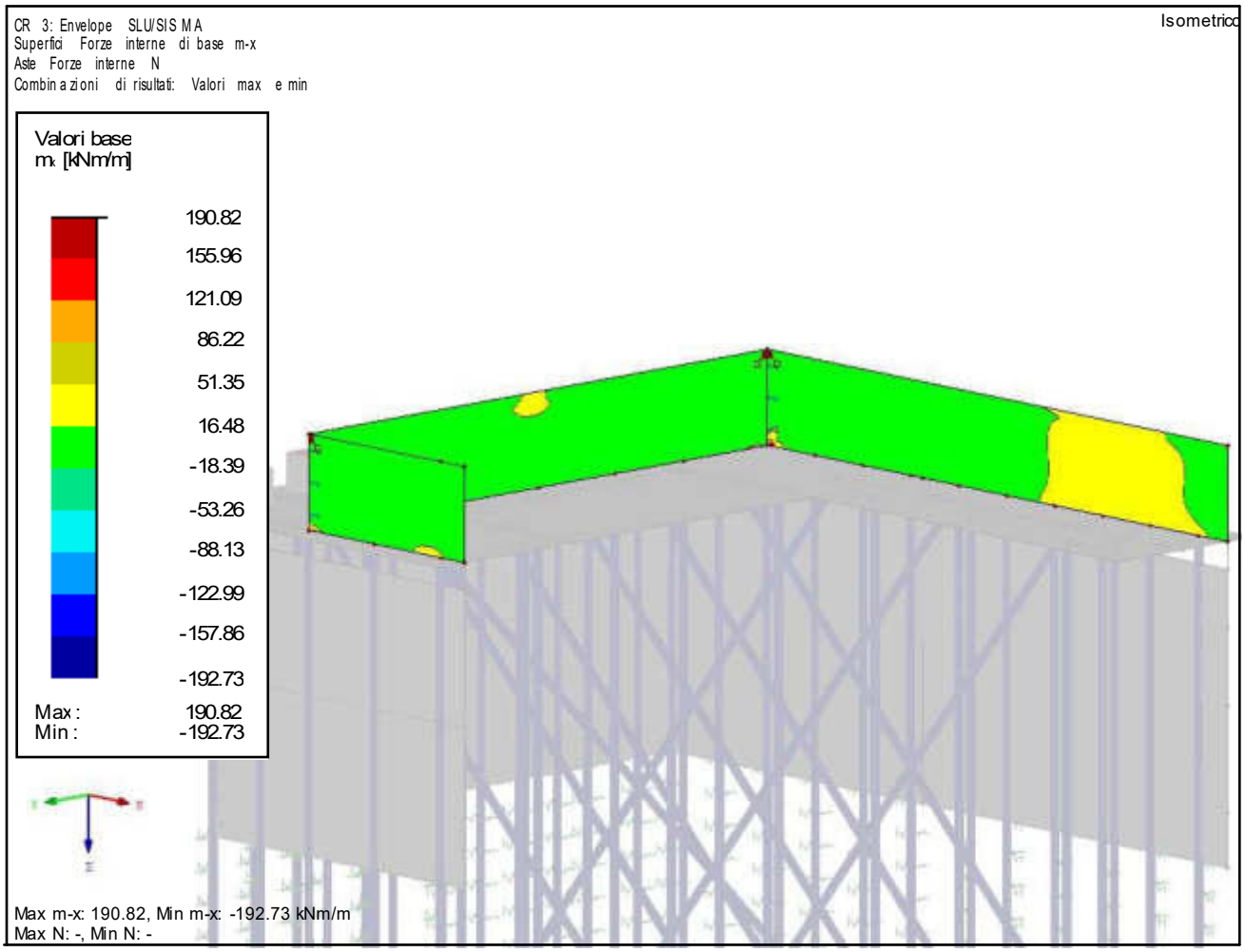
13. Muro paraghiaia

13.1. Geometria

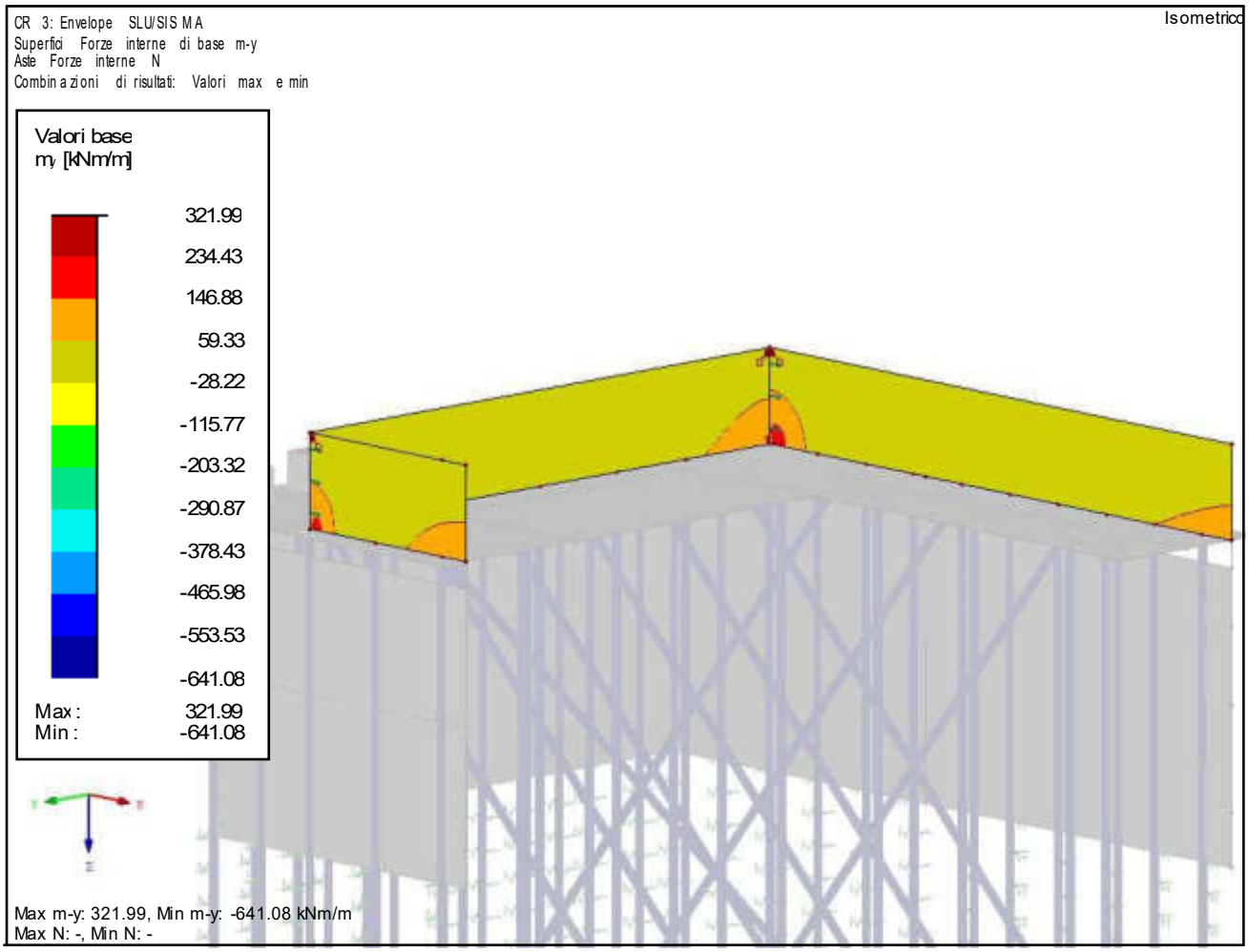
I muri paraghiaia hanno uno spessore pari a 60cm nel ponte e pari a 125cm nei muri d´ala.

13.2. Inviluppo sollecitazioni SLU/SISMA

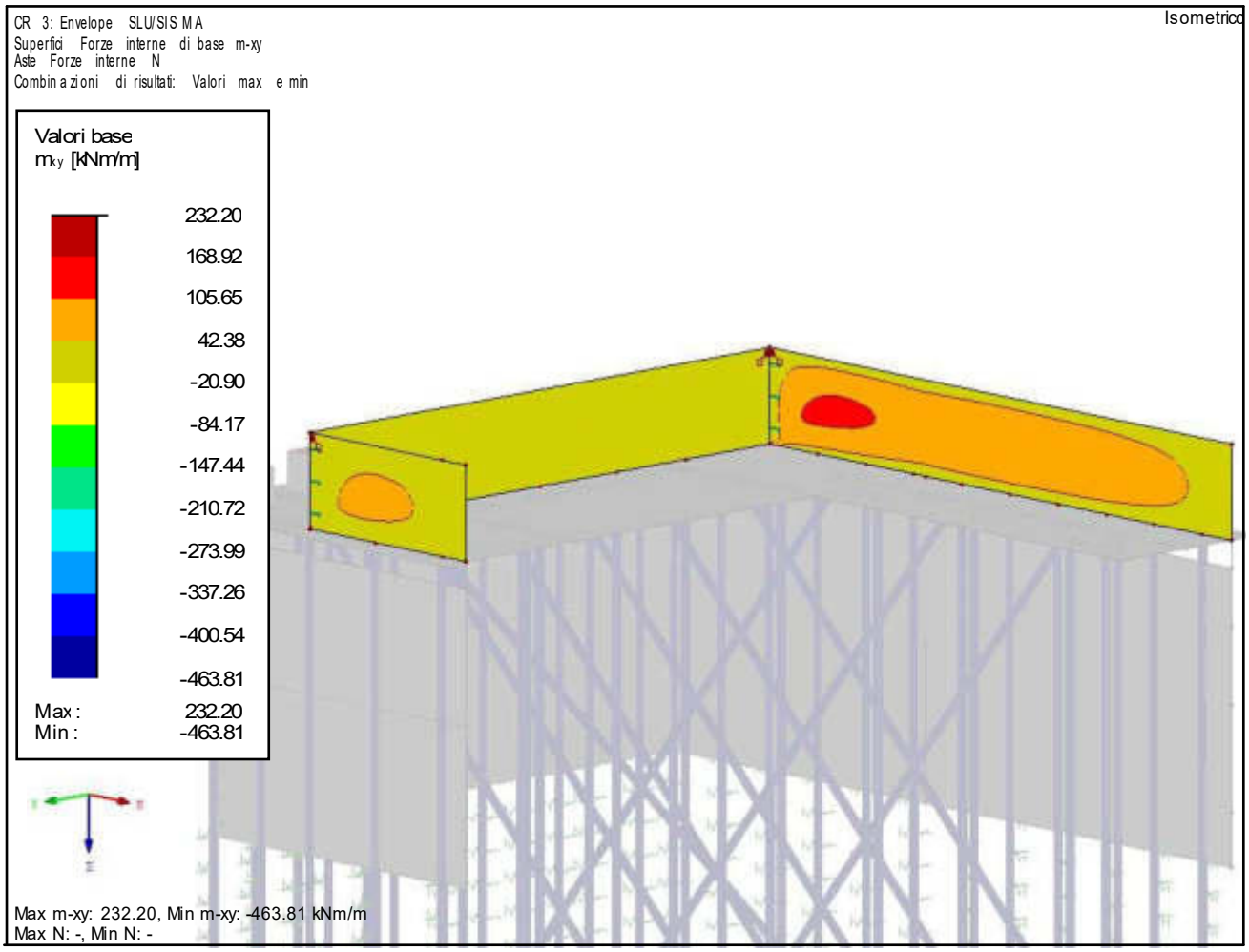
13.2.1. Inviluppo SLU/SISMA Valori momento orizzontale mx



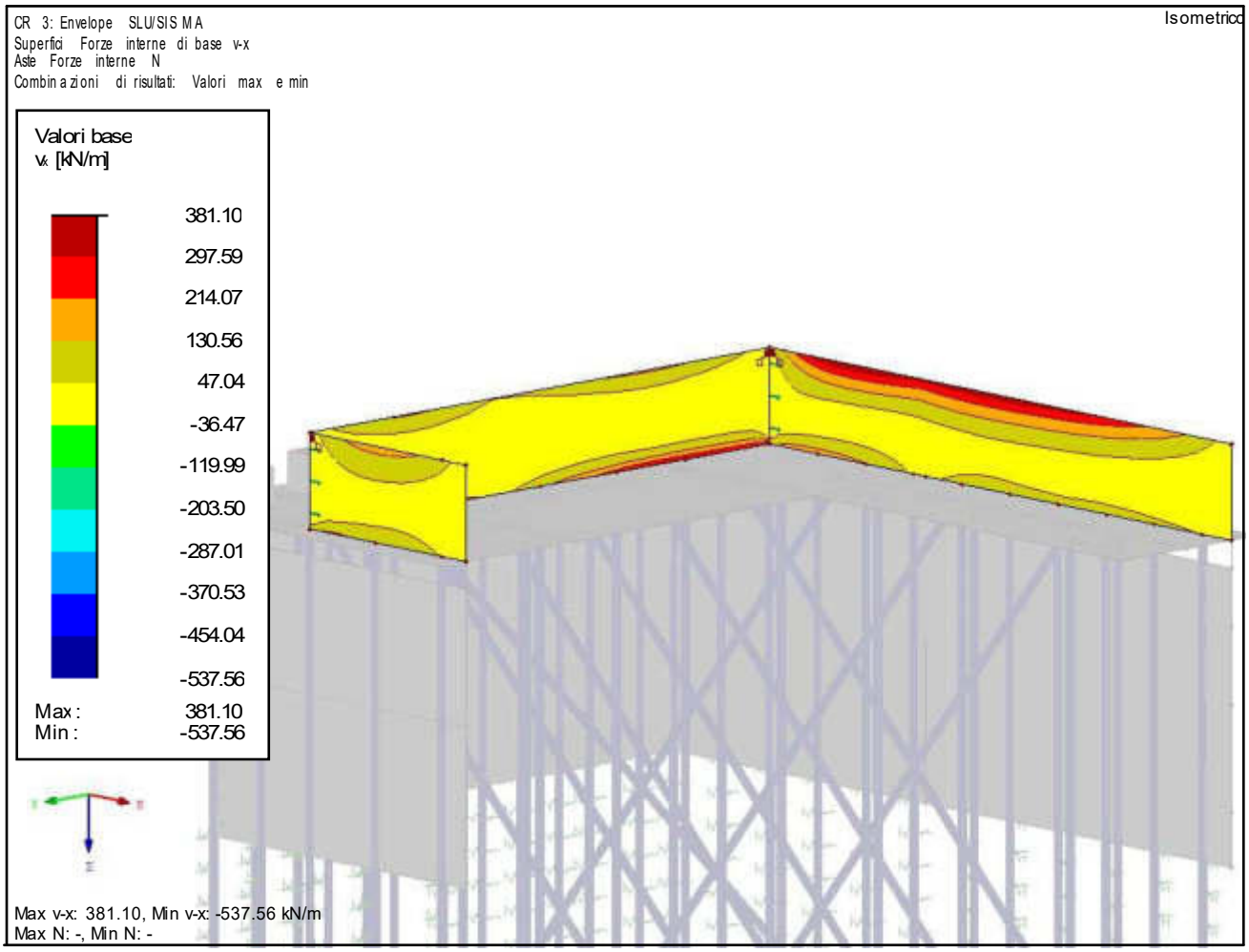
13.2.2. Inviluppo SLU/SISMA Valori momento verticale my



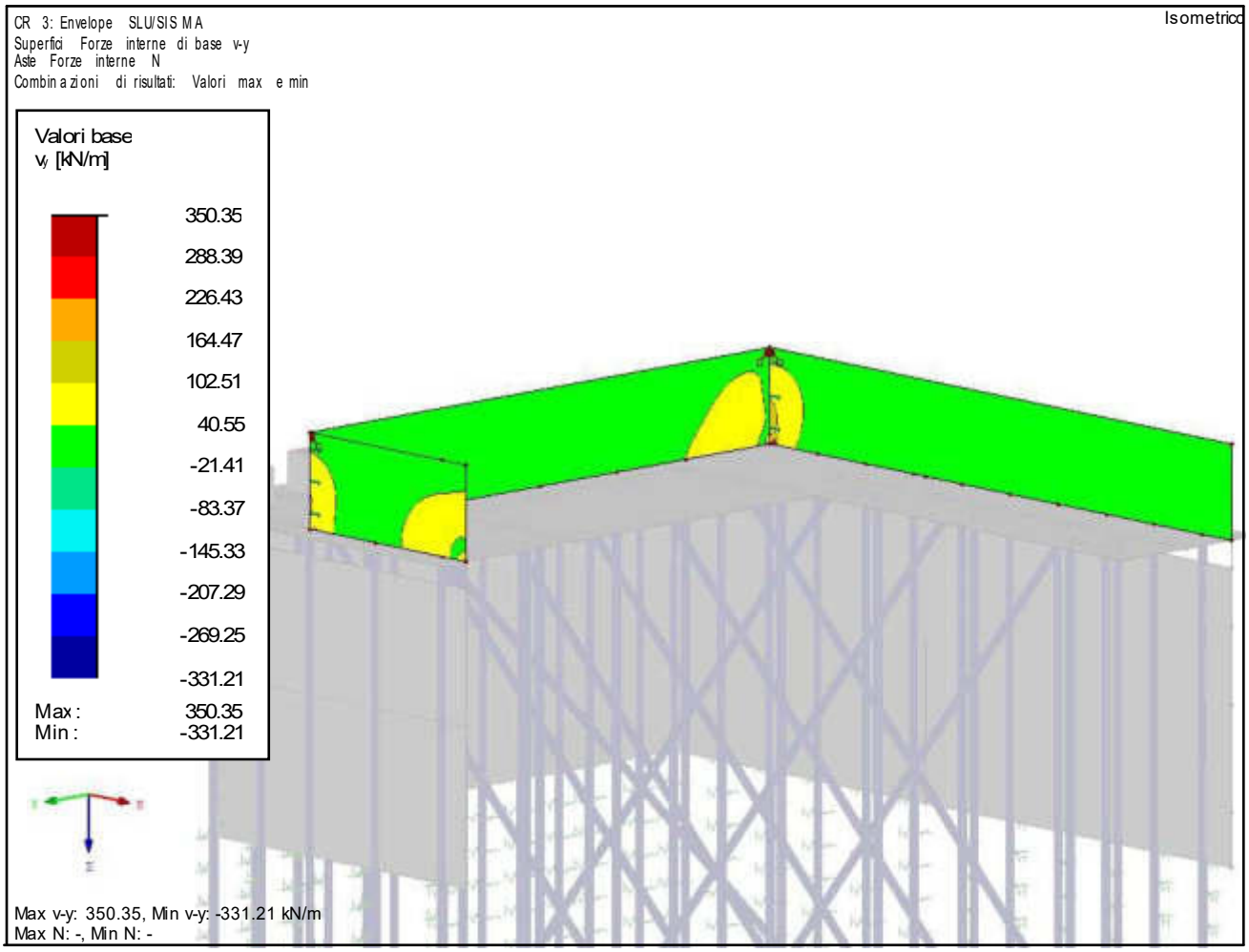
13.2.3. Inviluppo SLU/SISMA Valori momento torcente mxy



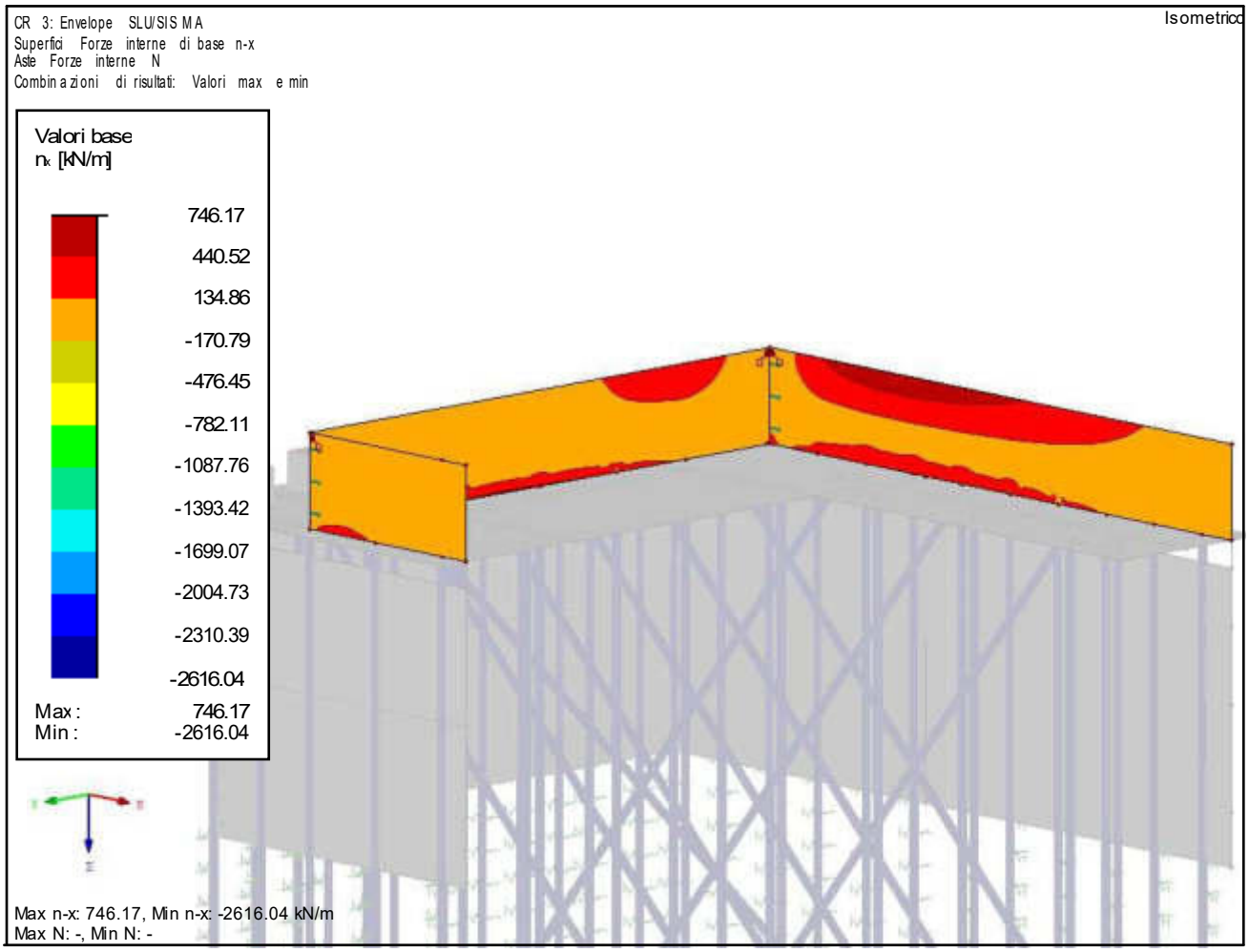
13.2.4. Inviluppo SLU/SISMA Valori taglio orizzontale vx



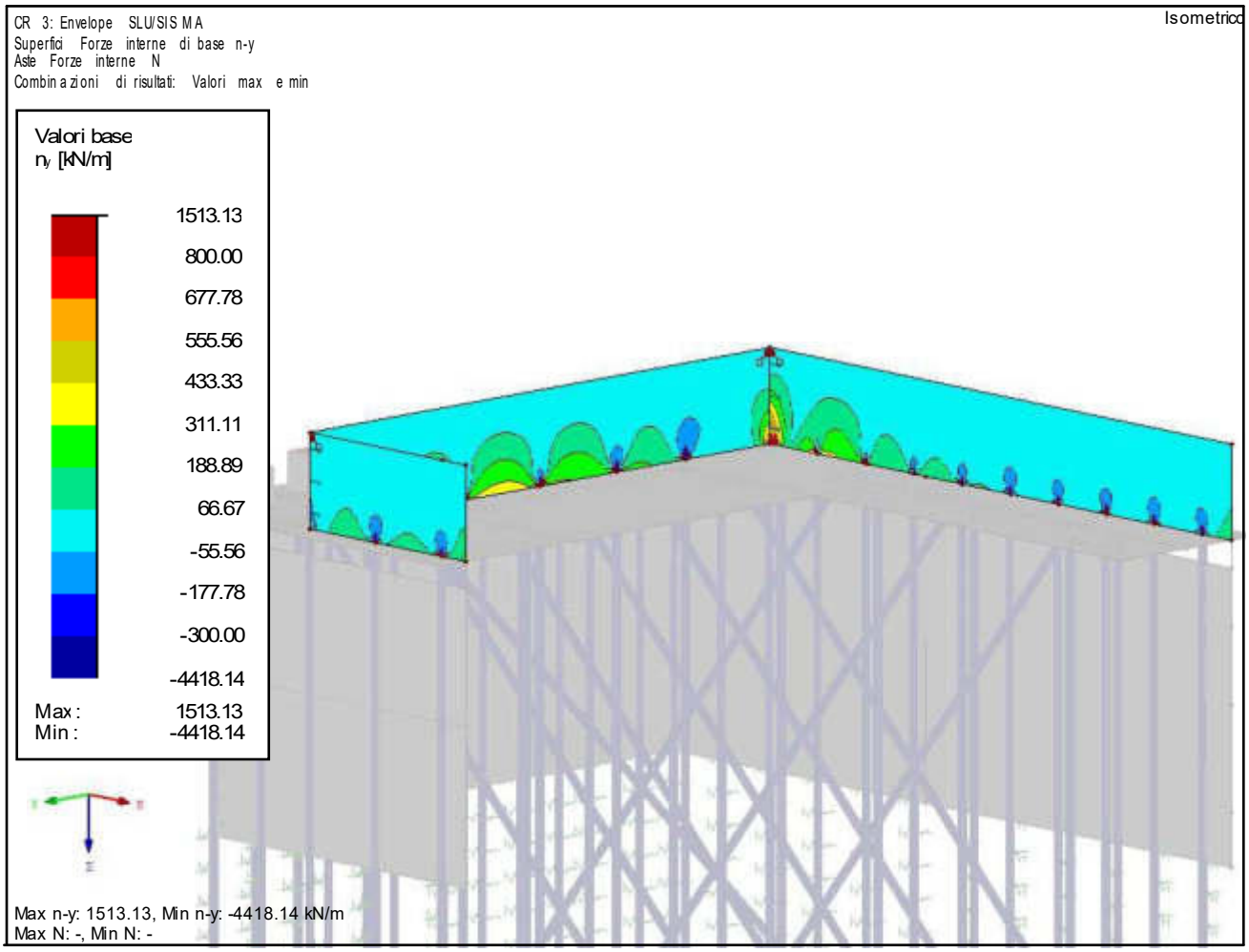
13.2.5. Inviluppo SLU/SISMA Valori taglio verticale vy



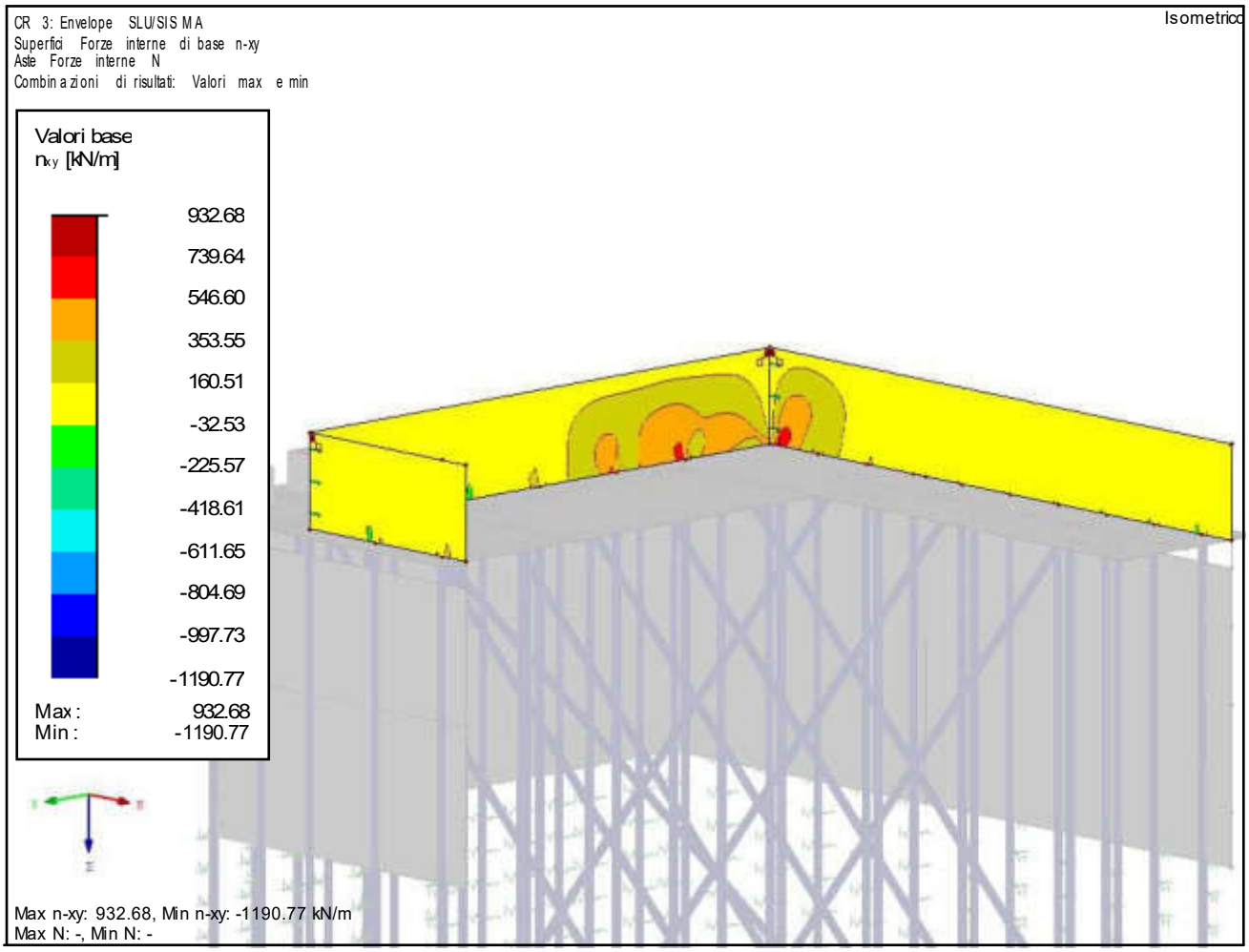
13.2.6. Inviluppo SLU/SISMA Valori forza membranale orizzontale nx



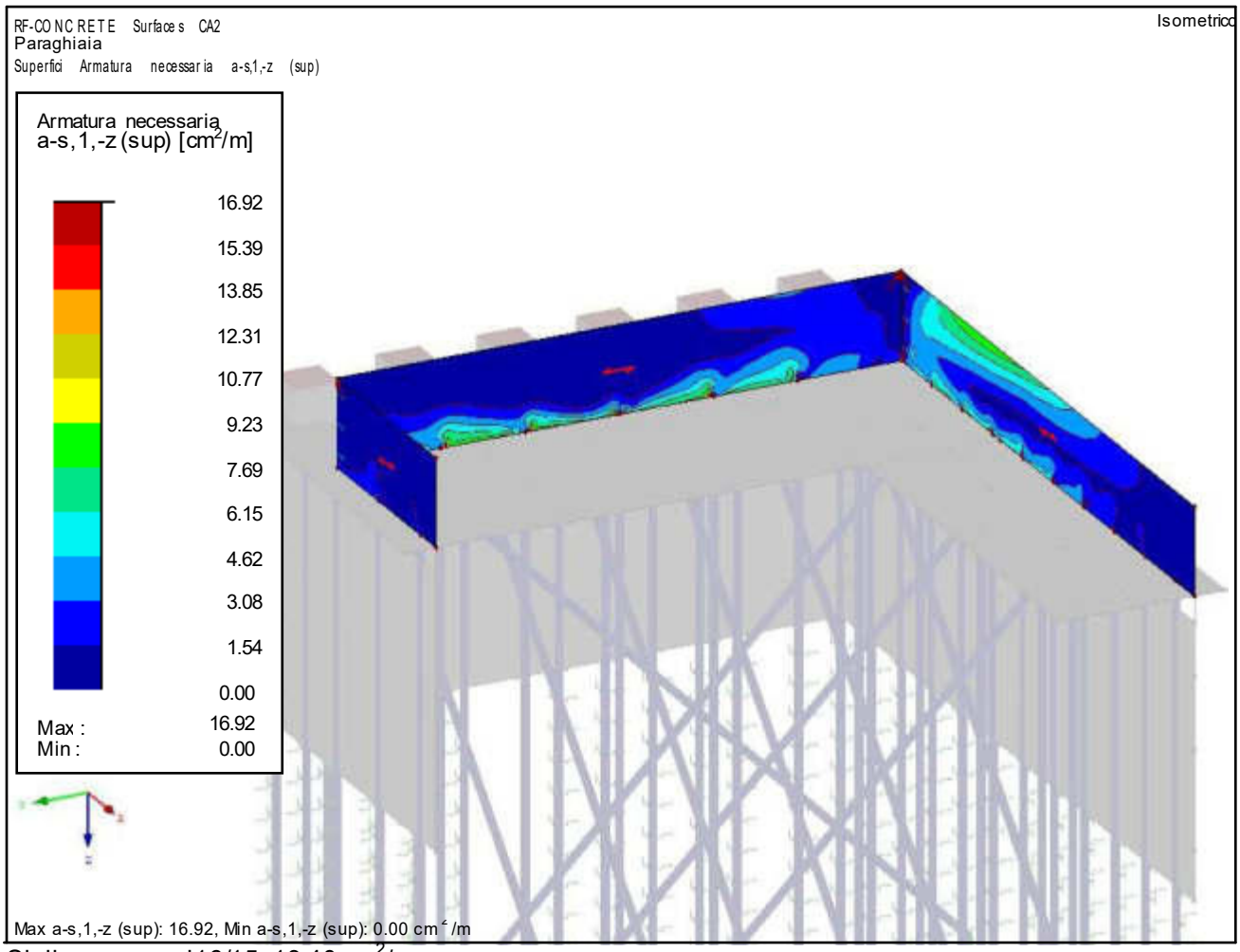
13.2.7. Inviluppo SLU/SISMA Valori forza membranale verticale ny



13.2.8. Inviluppo SLU/SISMA Valori forza membranale nxy

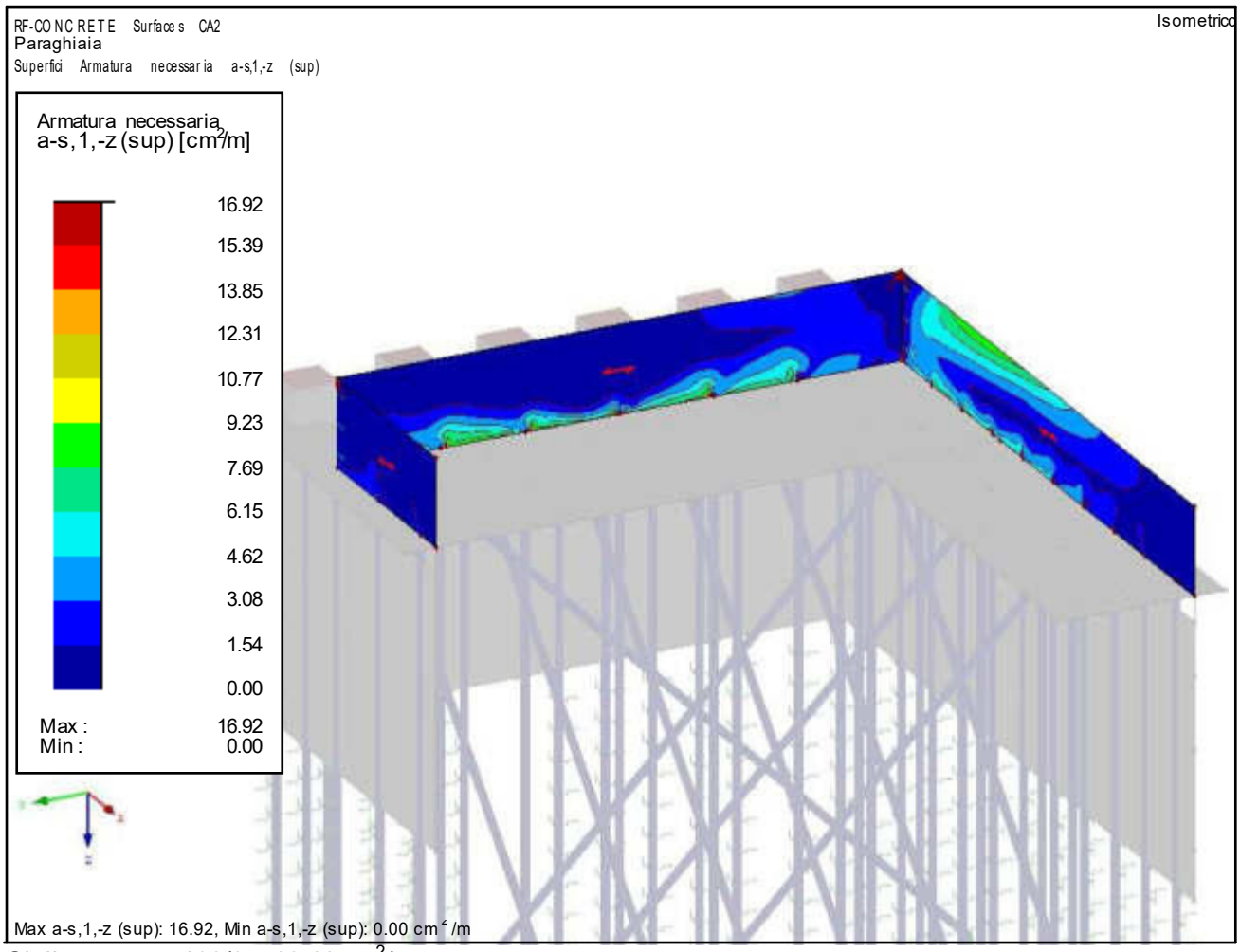


13.3. Isolinee di armatura orizzontali –z locale



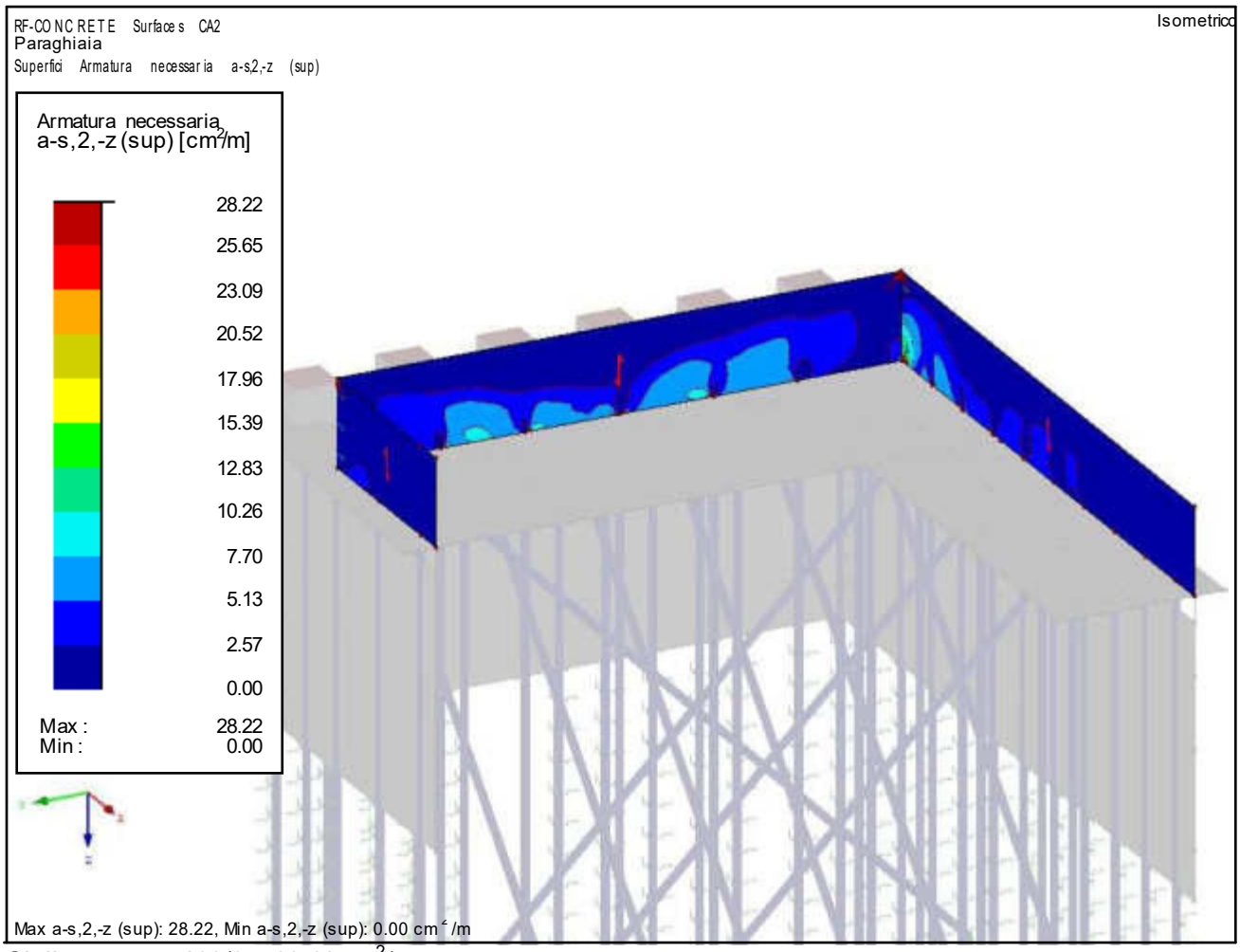
Si dispongono d16/15=13,40 cm^2/m

13.4. Isolinee di armatura verticale –z locale



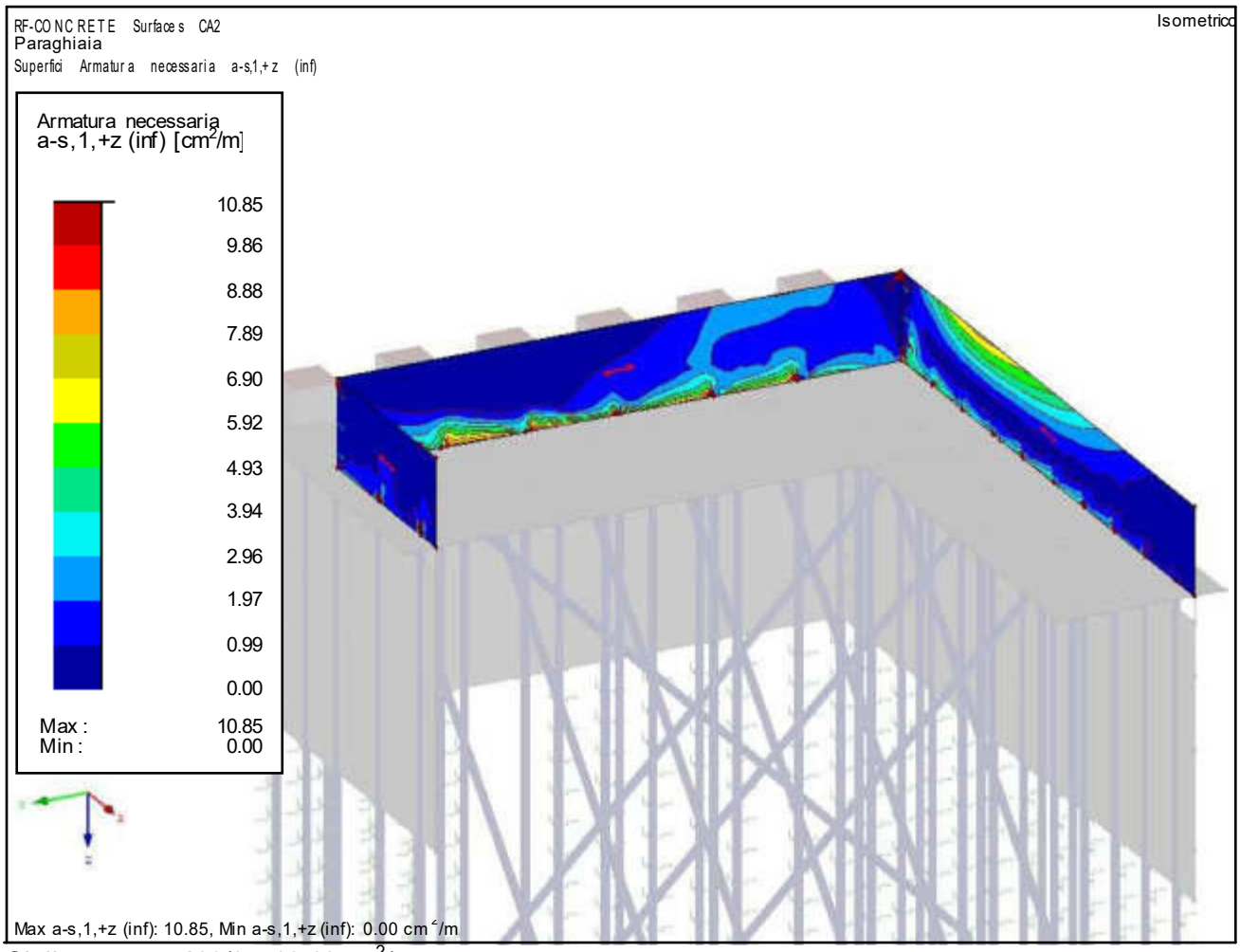
Si dispongono d16/15=13,40 cm^2/m

13.5. Isolinee di armatura orizzontali +z locale



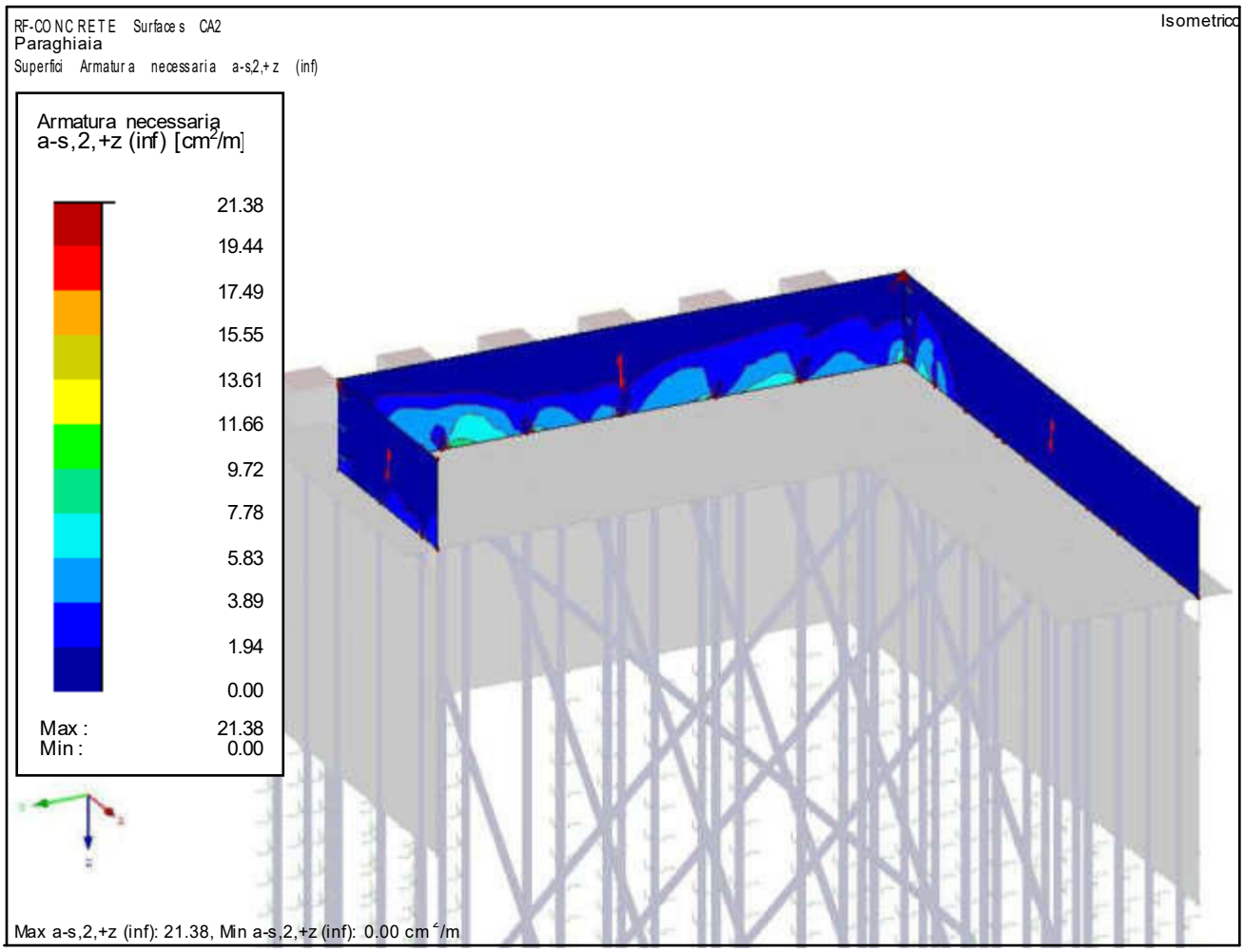
Si dispongono d16/15=13,40 cm^2/m

13.6. Isolinee di armatura verticali +z locale



Si dispongono d16/15=13,40 cm^2/m

13.7. Isolinee di armatura a taglio



Non si dispone armatura a taglio

14. Allegato A: Verifica a punzonamento

HALFEN HDB Armatura di punzonamento, ETA-12/0454 (Europe, EN 1992-1-1:2004 + AC:2010 + A1:2014)

HALFEN Programma di calcolo HDB, version 13.40

Il dimensionamento - inclusi i valori statici - vale solo per il prodotto HALFEN esposto. Le capacità portanti di prodotti concorrenti apparentemente identici possono variare. L'editore del programma declina ogni responsabilità per prodotti alternativi.

Verifica di punzonamento per pilastro rotondo di bordo (**Calcestruzzo gettato in opera**)

Carico di punzonamento	V_{Ed}	= 1000,0 kN
Aumento del carico	β	= 1,40
Spessore soletta	h	= 80 cm
Altezza statica	d	= 73,9 cm
Diametro pilastro	Ø	= 24 cm
Distanza dal bordo / Inclination	e / α	= 50 cm / 0 °
Distanza dal bordo	e	= 50 cm
Profondità di penetrazione pilastro	h_a	= 0 cm
Copriferro alto / parte inferiore	$c_{nom,o}$ / $c_{nom,u}$	= 4,5 cm / 4,5 cm
Beton / Acciaio d'armatura / HDB		= C30/37 / f_{yk}=500 N/mm² / B500
Diametro / Interasse		= Ø20 / 150 mm (ρ_x = 0,28 %)
Diametro / Interasse		= Ø20 / 150 mm (ρ_y = 0,28 %)
Tasso d'armatura	ρ_l	= 0,28 % < 2,00 %

Nella sezione di verifica critica. u_1

Sezione di verifica analoga al pilastro interno

specific column perimeter	u_0 / d	= 1
u_1		= 626 cm
$k = min\ \{1 + \sqrt{200/d[mm]}\ ; 2\}$		= 1,52
Pre-factor for $v_{Rd,c,1}$	$C_{Rd,c}$	= 0,10
$v_{Rd,c,1} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3}$		= 310,13 kN/m²
$v_{Rd,c,2} = v_{min} = 0{,}0421/\gamma_C \cdot k^{3/2} \cdot f_{ck}^{1/2}$		= 287,98 kN/m²

$V_{Rd,c} = max\ \{v_{Rd,c,1}; v_{Rd,c,2}\} \cdot u_1 \cdot d$ = 1434,8 kN > 1400,0 kN = V_{Ed} ·

Maximum allowed punching shear (web-crushing limit) at the periphery of the column (EN 1992-1-1, section 6.4.3(2)):

$V_{Rd,max,u0} = 0{,}4 \cdot \nu \cdot f_{cd} \cdot u_0 \cdot d$ = 1991,8 kN

Non è necessaria nessuna armatura di punzonamento

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HALFEN HDB Armatura di punzonamento, ETA-12/0454 (Europe, EN 1992-1-1:2004 + AC:2010 + A1:2014)

HALFEN Programma di calcolo HDB, version 13.40

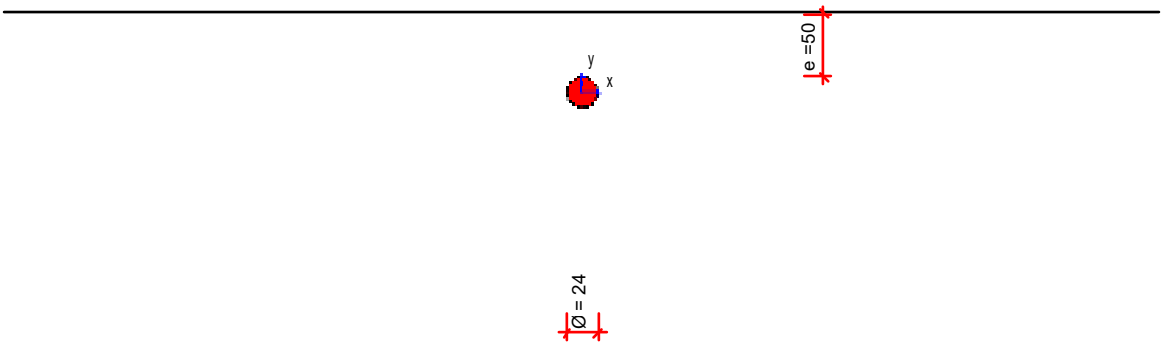
Il dimensionamento - inclusi i valori statici - vale solo per il prodotto HALFEN esposto. Le capacità portanti di prodotti concorrenti apparentemente identici possono variare. L'editore del programma declina ogni responsabilità per prodotti alternativi.

Area di posa

Sezione Scale 1:35

[cm]

Pianta Scale 1:59



Minimum bar length: $l_{bar,min,x}$ = 467,4 cm + 2 · l_{bd}; $l_{bar,min,y}$ = 295,7 cm + l_{bd}; l_{bd} is the anchorage length
Note: Due to other verifications, different minimum bar length can be decisive.

Bar length calculated without the required design anchorage length at the free edge. The anchorage length at the free edge has to be determined separately.

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15. Allegato B: Parametri geotecnici

From: Michael Jesacher - Geologiebüro Jesacher [michael@jesacher.bz]
Received: Dienstag, 14 Apr. 2020, 12:06
To: Walter Weis [Walter.Weis@bergmeister.eu]
CC: Cristian Ferraro [Cristian.Ferraro@bergmeister.eu]; Umberto Capozzi [Umberto.Capozzi@bergmeister.eu]
Subject: AW: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Walter,

bestätige hiermit endgültig die u.a. Parameter.

Gute Arbeit, Michl

jesacher
geologiebüro | studio di geologia

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Tel. 0474 409 376 | Fax 0474 831 093 | Mobil 348 364 76 29
info@jesacher.bz | direkt: michael@jesacher.bz | www.jesacher.bz
PEC: m.jesacher@geotecpec.it

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Von: Walter Weis [mailto:Walter.Weis@bergmeister.eu]
Gesendet: Dienstag, 14. April 2020 09:51
An: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Cc: Cristian Ferraro <Cristian.Ferraro@bergmeister.eu>; Umberto Capozzi <Umberto.Capozzi@bergmeister.eu>
Betreff: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Michael, bitte um dringende endgültige Abstimmung der Scherparameter. Ich habe die Parameter wie folgt laut heutiger Telefonnotiz mit dir zusammengestellt. Bitte um Bestätigung.

Charakteristische Scherparameter und charakteristische **Mantelreibungen:**

Künstlichen Auffüllung: 34 Grad c = 0
Mantelreibung char. 150 KPa

GE1: Kakirit:
phi 34 Grad und c = 3KPA
Mantelreibung char. 200KPa

GE2: Kataklase:
Mantelreibung char. 350KPa

GE3: Fels verwittert:
Mantelreibung char. 500 KPa

Lockergesteinsauflage im Talboden:
phi = 36 Grad
c = 0
Mantelreibung char.: 200 KPa

Danke Walter

5.8 Nachweise Widerlager Lana

17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Verifiche della spalla lato Lana

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1. Premesse generali

1.1. Descrizione generale

Il ponte Eschenlohe si trova in corrispondenza del km 7,750 della strada provinciale n°9 della Val d'Ultimo. Il ponte attraversa in vicinanza del castello prestanome Eschenlohe una valle in direzione NW-SE, che ad est del ponte citato sfocia nel Rio Valsura.

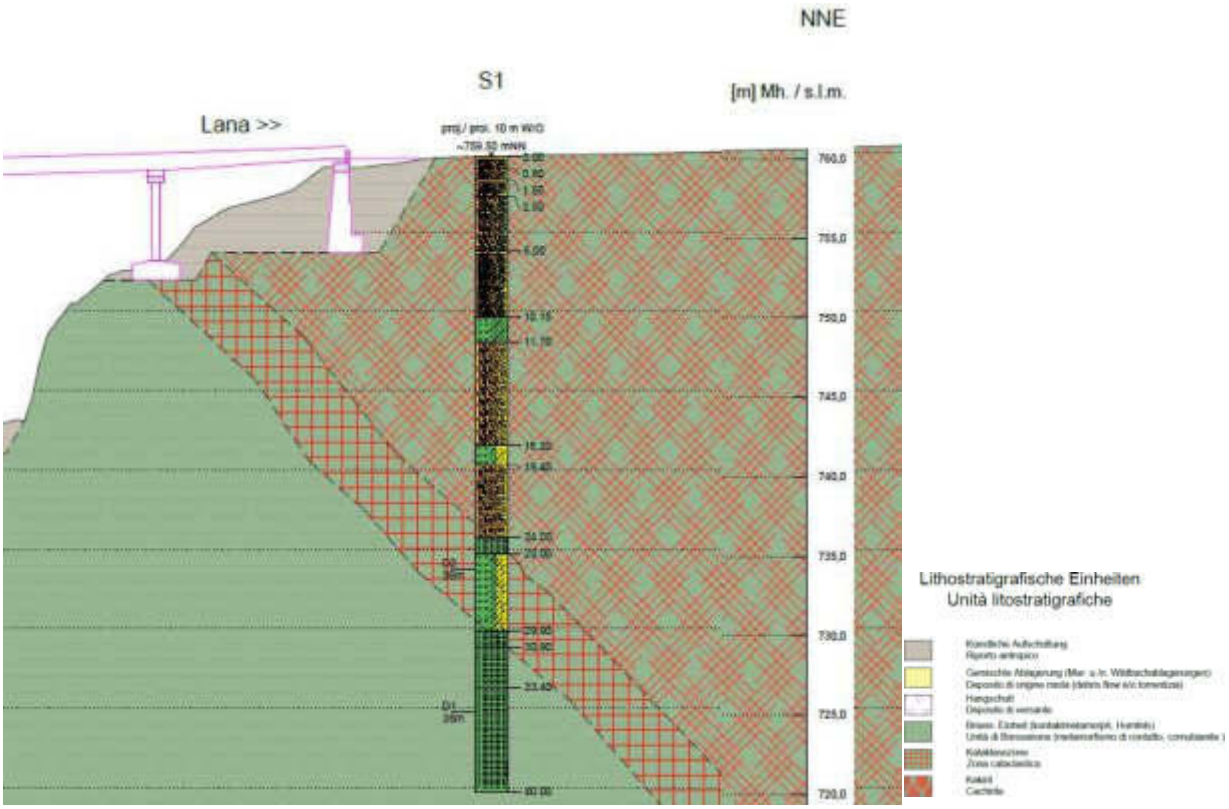
Nella presente relazione si presentano i calcoli e le verifiche del cavalletto di micropali per il rinforzo della spalla asse A1 in direzione Lana del ponte "Eschenlohe" .

1.2. Descrizione geologica e parametrizzazione geotecnica

Le spalle del ponte sono fondate su cachirite. La cachirite è composta a livello di composizione granulometrica da sabbia, da ghiaiosa a debolmente ghiaiosa, da limosa a debolmente limosa, con rari ciottoli e blocchi.

Fonte: relazione geologica e sismica del geologo Jesacher 2016.

Di seguito si riporta una sezione longitudinale geologica che individua la posizione della spalla oggetto di relazione e la conformazione geologica:



La spalla, come sopra evidenziato, poggia su unitá litologica GE1 cachirite avente le seguenti proprietá riportate nella relazione Jesacher 2016:

γ=20 kN/m^3 φk´=34° ck´=3 kPa

Un valore di τlim viene assunto pari a:

τlim=200 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

5.3.1. GE 1 – Kakirit

5.3.1. GE 1 – Cachirite

Geotechnische Einheit **Unità geotecnica**	**GE 1** ***GE 1***
Korngrößenzusammensetzung, Textur, Gefüge *Composizione granulometrica, tessitura, struttura*	Sand, kiesig bis schwach kiesig, schluffig bis schwach schluffig, mit einzelnen Steinen und Blöcken, abschnittsweise reliktisches Felsgefüge (Kakirit). *Sabbia, da ghiaiosa a debolmente ghiaiosa, da limosa a debolmente limosa, con rari ciottoli e blocchi, a tratti struttura rocciosa relitta (cachirite)*
Kurzbezeichnung gem. DIN 4021 / *denominazione sec.* DIN 4021	S, g', u', x''
Bodenart gem. DIN 18196 / *tipo di terreno sec.* DIN 18196	SU - SW
Durchlässigkeitskoeffizient ***k*** *Coefficiente di permeabilità* ***k***	10^{-5} – 10^{-7} m/s (durchlässig bis schwach durchlässig) *(da permeabile a poco permeabile)*

Geotechnische Bodenkennwerte ***Parametri geotecnici del terreno***	
Wichte feucht γ / *peso del terreno* ***γ*** [kN/m³]	19,5 – 20,5
Reibungswinkel / *angolo di attrito* **φ'** [°]	34 – 38
Kohäsion / *coesione* **c'** [kPa]	5 – 3
Steifemodul / *modulo edometrico* $\mathbf{E_S}$ [MPa]	30 – 45

Lo strato di cachirite GE1 é attraversato da una zona di cataclasite GE2 per uno spessore di circa 5m.

5.3.2. GE 2 – Kataklasit **5.3.2. GE 2 – Cataclasite**

Geotechnische Einheit **Unità geotecnica**	**GE 2** ***GE 2***		
Lithologie *Litologia, composizione mineralogica*	Grüngrauer bis beiger, feinkörniger Hornfels, rostbraun verwittert, häufig Spiegelharnische; meist komplett zerbrochen (= X, G, y), *Cornubianite a grana fine da grigio verdastro a beige, alterazione di colore ocra, frequenti specchi di faglia, per lo più completamente fratturato a sassi e ghiaia con singoli blocchi*		
Schieferung / *Scistosità*	305/52 – 323/48		
Trennflächenorientierung *Orientamento della discontinuità*	K_1 *315/57 – 327/41* K_4 *033/54 – 043/56*	K_2 *150/50 – 157/53* K_5 *103/55*	K_3 *113/16*

Gesteinskennwerte ***Parametri della roccia***	
Dichte ρ / peso specifico ρ [t/m³]	2,65 – 2,75
Einaxiale Gesteinsdruckfestigkeit UCS / resistenza alla compr. monoassiale [MPa]	5 – 45, charakt. Wert / *valore caratt.* 25
m, [-] (Hoek & Brown)	15 – 20, charakt. Wert / *valore caratt.*19
CAI Index / indice [-]	3,0 – 4, charakt. Wert / *valore caratt.* 4,5

Gebirgskennwerte ***Parametri dell'ammasso roccioso***	
RQD [%]	0 – 40, charakt. Wert / *valore caratt.* 15
GSI [-] (Hoek)	20 - 40, charakt. Wert / *valore caratt.* 30
E-Modul / *modulo elastico* [MPa]	1.255 – 2511, charakt. Wert / *valore caratt.* 1.500

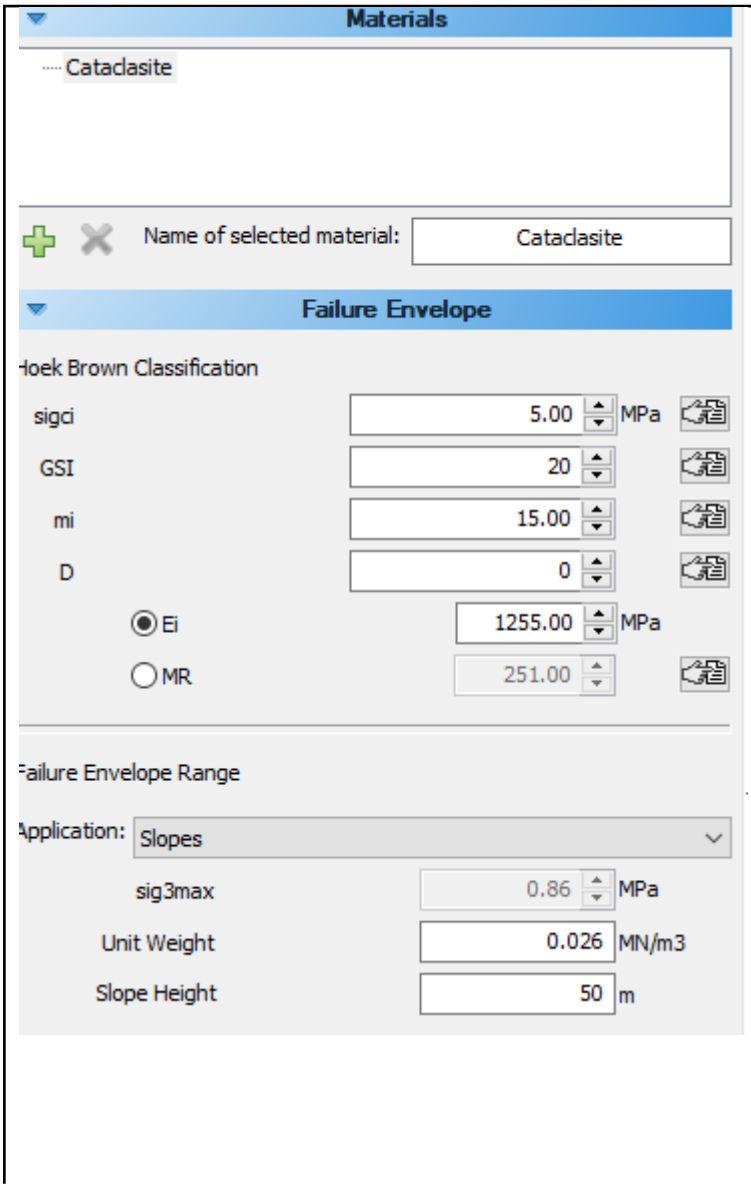
I parametri dello strato di zona di cataclasite sono stati valutati con il programma Rocdata:

γ=26 kN/m^3 $\varphi k'$=27° ck'=100 kPa

Un valore di τlim viene assunto pari a:

τlim=350 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.



Cataclasite	
Hoek Brown Classification	
intact uniaxial compressive strength	5 MPa
GSI	20
mi	15
disturbance factor	0
intact modulus	1255 MPa
Hoek Brown Criterion	
mb	0.861
s	1.379e-004
a	0.544
Failure Envelope Range	
application	slopes
sig3max	0.86 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.125 MPa
friction angle	27.445 deg
Rock Mass Parameters	
tensile strength	-8.004e-004 MPa
uniaxial compressive strength	0.04 MPa
global strength	0.506 MPa
modulus of deformation	57.318 MPa

Infine come da sezione longitudinale, gli strati di cachirite e cataclasite poggiano su GE3 roccia moderatamente disgregata aventi i seguenti parametri geotecnici calcolati come di seguito con Rocdata:

γ=26 kN/m^3 φk´=50 ck´=500 kPa

Un valore di τlim viene assunto pari a:

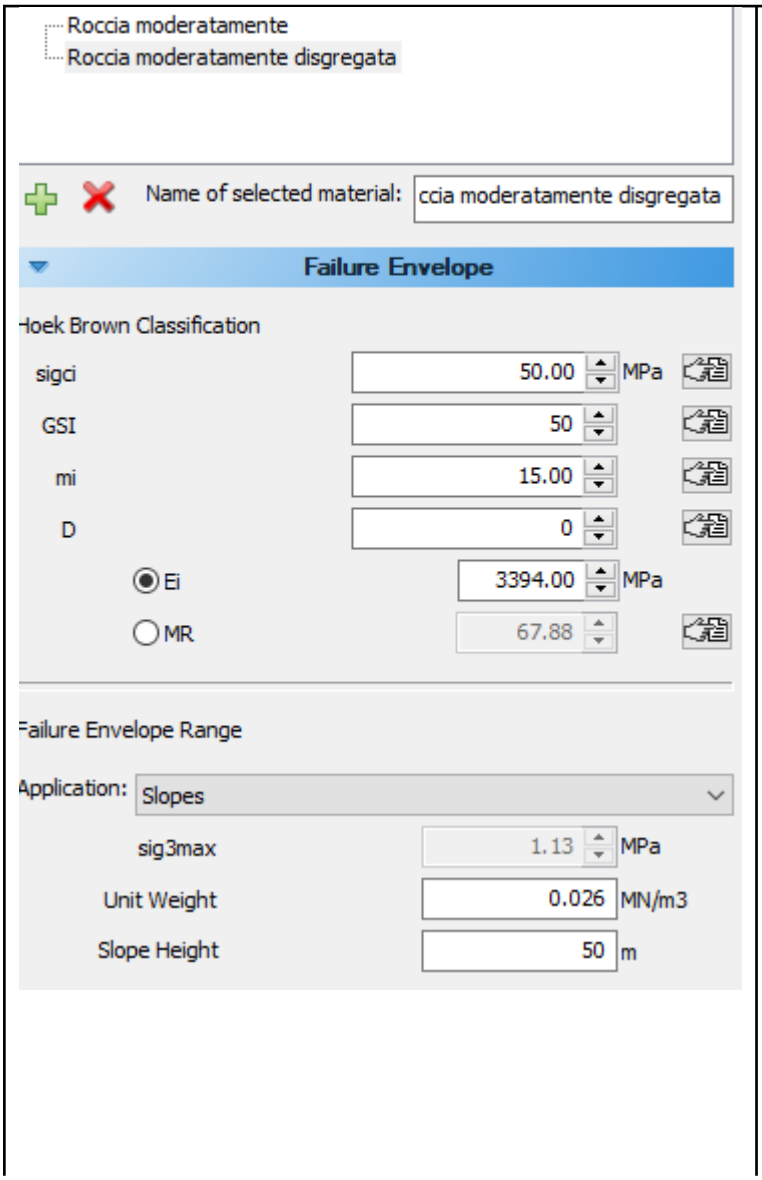
τlim=500 kPa

Il valore di τlim deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

Geotechnische Einheit **Unità geotecnica**	**GE 3** ***GE 3***		
Lithologie	grüngrauer bis beiger Hornfels bis Quarzit, mit Quarzlagen, häufig Spiegelharnische sowie deutliche Striemung, einzelne dünne Kakirit-Lagen, Trennflächen z.T. rostbraun angewittert		
Litologia, composizione mineralogica	*Cornubianite a quarzite da grigio verdastro a beige, a luogo con livelli quarzosi, abbondanti specchi di faglia e striature, rari livelli di fault gouge, singole fratture con alterazione di colore ocra*		
Schieferung / *Scistosità*	305/52 – 323/48		
Trennflächenorientierung *Orientamento della discontinuità*	K_1 315/57 – 327/41 K_4 033/54 – 043/56	K_2 150/50 – 157/53 K_5 103/55	K_3 113/16

Gesteinskennwerte ***Parametri della roccia***	
Dichte ρ / peso specifico ρ [t/m³]	2,65 – 2,75
Einaxiale Gesteinsdruckfestigkeit UCS / resistenza alla compr. monoassiale [MPa]	50 – 70, charakt. Wert / *valore caratt.* 55
m_i [-] (Hoek & Brown)	15 – 20, charakt. Wert / *valore caratt.*19
CAI Index / indice [-]	3,0 – 4,5, charakt. Wert / *valore caratt.* 4,5

Gebirgskennwerte ***Parametri dell'ammasso roccioso***	
RQD [%]	20 – 65, charakt. Wert / *valore caratt.* 35
GSI [-] (Hoek)	50 - 70, charakt. Wert / *valore caratt.* 60
E-Modul / *modulo elastico* [MPa]	3.394 – 8.235, charakt. Wert / *valore caratt.* 4.000



cia moderatamente disgreg	
Hoek Brown Classification	
intact uniaxial compressive strength	50 MPa
GSI	50
mi	15
disturbance factor	0
intact modulus	3394 MPa
Hoek Brown Criterion	
mb	2.515
s	0.004
a	0.506
Failure Envelope Range	
application	slopes
sig3max	1.13 MPa
unit weight	0.026 MN/m3
slope height	50 m
Mohr Coulomb Fit	
cohesion	0.63 MPa
friction angle	53.277 deg
Rock Mass Parameters	
tensile strength	-0.077 MPa
uniaxial compressive strength	3.011 MPa
global strength	10.587 MPa
modulus of deformation	1042.589 MPa

Il materiale di riempimento ha i seguenti parametri:

γ=20 kN/m^3 φ_k´=34 c_k´=0 kPa

Un valore di τ_{lim} viene assunto pari a:

τ_{lim}=150 kPa

Il valore di τ_{lim} deve essere verificato in fase di realizzazione dell´opera mediante prove di carico su micropalo pilota.

2. Materiali costruttivi

calcestruzzo

- C30/37 f_{ck} = 30 N/mm²

Acciaio per c.emento armato:

- B 450 C: f_{yk} = 450 N/mm²

Acciaio per micropali:

- S355 f_{yk} = 355 N/mm²

3. Fattori di sicurezza

fattori di sicurezza per materiale

combinazione base:

-calcestruzzo	$\gamma_C = 1.50$
-acciaio armatura	$\gamma_S = 1.15$
- acciaio	$\gamma_S = 1.05$

combinazioni straordinarie:

- calcestruzzo	$\gamma_C = 1{,}00$
-acciaio armatura	$\gamma_S = 1.00$
-acciaio	$\gamma_{St} = 1.00$

fattori di sicurezza per carichi perdita dell'equilibrio statico

$\gamma_{G,sup}$	= 1.1	carichi permanenti e carichi propri, svantaggiose
$\gamma_{G,inf}$	= 0.9	carichi permanenti e carichi propri, svantaggiose
γ_Q	= 1.5	carichi accidentali, sfavorevoli
γ_A	= 1.0	carichi straordinari

Rottura della struttura

$\gamma_{G,sup}$	= 1.3	carichi propri, svantaggiose
$\gamma_{G,inf}$	= 1.0	carichi propri, vantaggiose
$\gamma_{G,sup}$	= 1.5	carichi permanenti non stutturali, svantaggiose
$\gamma_{G,inf}$	= 0.0	carichi permanenti non stutturali, vantaggiose
γ_Q	= 1.5	carichi permanenti e carichi propri, svantaggiose
γ_P	= 1.0	precompressione, effetto della temperatura, deformazione del terreno, viscosità, ritiro
γ_A	= 1.0	carichi straordinari

$\gamma_A = \gamma_G = \gamma_Q$

Rottura del suolo

$\gamma_{G,inf}$	= 1.0	carichi propri
$\gamma_{G,sup}$	= 1.3	carichi permanenti non stutturali, svantaggiose
$\gamma_{G,inf}$	= 0.0	carichi permanenti non stutturali, vantaggiose
γ_Q	= 1.3	carichi accidentali, sfavorevoli
γ_A	= 1.0	carichi straordinari

4. Copriferro

Il copriferro é stato stabilito secondo il Circolare 2019 e D.M. 2018.

La struttura può essere classificata come una struttura in classe di esposizione XF2 secondo la UNI EN 206-1 in quanto può essere sottoposta direttamente all´azione dei Sali antigelo.

Tabella 4.1.III – *Descrizione delle condizioni ambientali*

CONDIZIONI AMBIENTALI	CLASSE DI ESPOSIZIONE
Ordinarie	X0, XC1, XC2, XC3, XF1
Aggressive	XC4, XD1, XS1, XA1, XA2, XF2, XF3
Molto aggressive	XD2, XD3, XS2, XS3, XA3, XF4

Tabella C4.1.IV *Copriferri minimi in mm*

			barre da c.a. elementi a piastra		barre da c.a. altri elementi		cavi da c.a.p. elementi a piastra		cavi da c.a.p. altri elementi	
C_{min}	C_o	ambiente	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$	$C \geq C_o$	$C_{min} \leq C < C_o$
C25/30	C35/45	ordinario	15	20	20	25	25	30	30	35
C28/35	C40/50	aggressivo	25	30	30	35	35	40	40	45
C35/45	C45/55	molto ag.	35	40	40	45	45	50	50	50

In funzione della classificazione secondo le indicazioni delle NTC2018 la struttura è presente in condizioni ambientali “Molto aggressive.”

Si adotta un calcestruzzo C30/37 come indicato alla Tabella C4.1.IV della NTC18, per il quale è necessario prevedere un copriferro pari a 50mm.

5. Normative

Norme Tecniche per le Costruzioni di cui al DM 17 gennaio 2018, con le istruzioni applicative emanate con la Circolare Ministeriale n. 617 del 2 febbraio 2009. Coerentemente con quanto previsto ai cap. 1 e 12 delle suddette norme tecniche, per quanto non espressamente nelle stesse si fa riferimento ai Eurocodici strutturali.

Eurocodice 0 - Criteri generali di progettazione strutturale
2006 UNI EN 1990:2006

Eurocodice 2 – Progettazione delle strutture in calcestruzzo
UNI EN 1992-1-1:

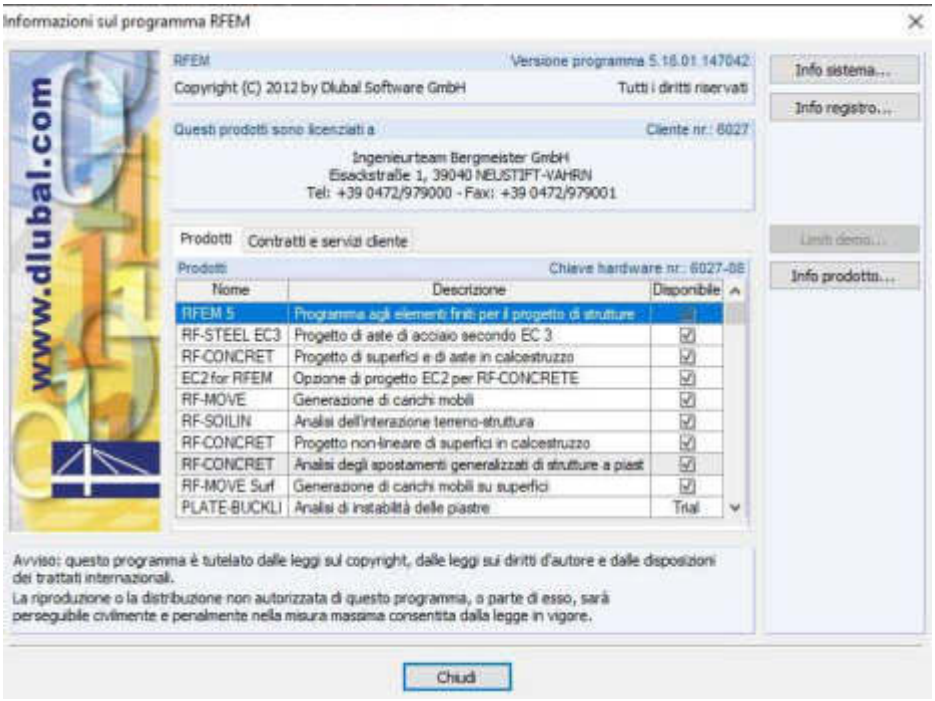
2005 Parte 1-1: Regole generali e regole per gli edifici

Eurocodice 7 – Progettazione geotecnica
UNI EN 1997-1:

2005 Parte 1: Regole generali

6. Software utilizzato per il calcolo

[1] RFEM 5.18.01.147042



7. Descrizione della struttura, del modello di calcolo e dei carichi

La struttura oggetto di calcolo si compone di un cavalletto di micropali composto da:

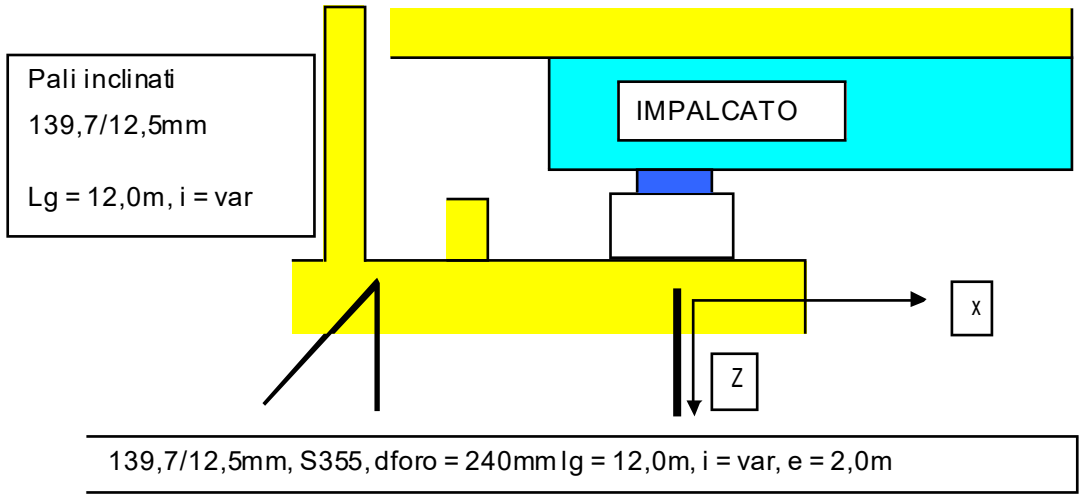
- Fondazione di collegamento composta da una parte di spessore pari a 80 cm;
- Micropali valvolati in acciaio S355 139,7mmx12,5mm di lunghezza pari a 12m e 14m.
- 6 Baggioli in calcestruzzo di dimensioni 70cmx70cmx15cm con interasse di 1,60m ove poggiano gli elastomeri

Tale cavalletto è composto due file di micropali con interasse longitudinale rispetto l´asse del ponte variabile tra 1,50m e 2m.

I micropali hanno un interesse trasversale rispetto l´asse del ponte di variabile tra 0,5m e 0,85m.

I micropali e la struttura di collegamento rinforzano le spalle esistenti alte circa 6m composte da muri con spessore variabile con l´altezza.

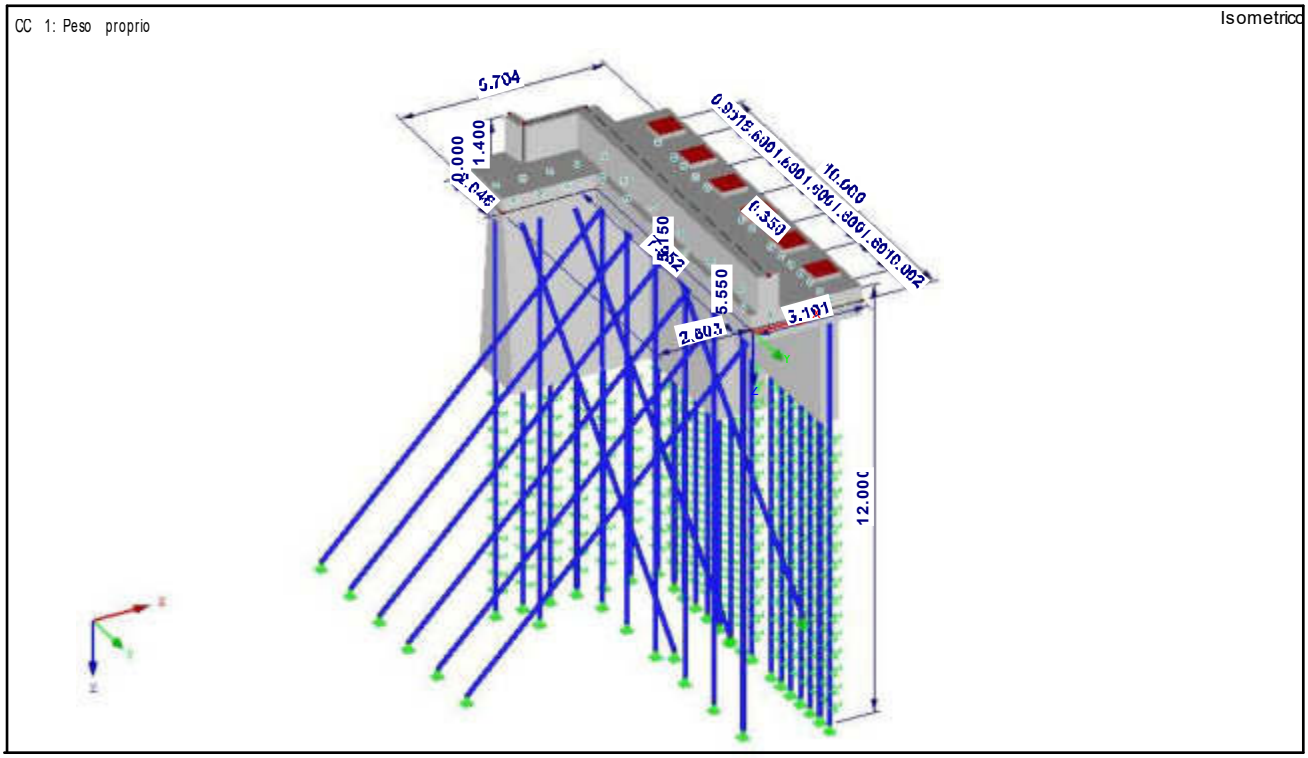
Sono presenti 29 micropali verticali e 9 inclinati.

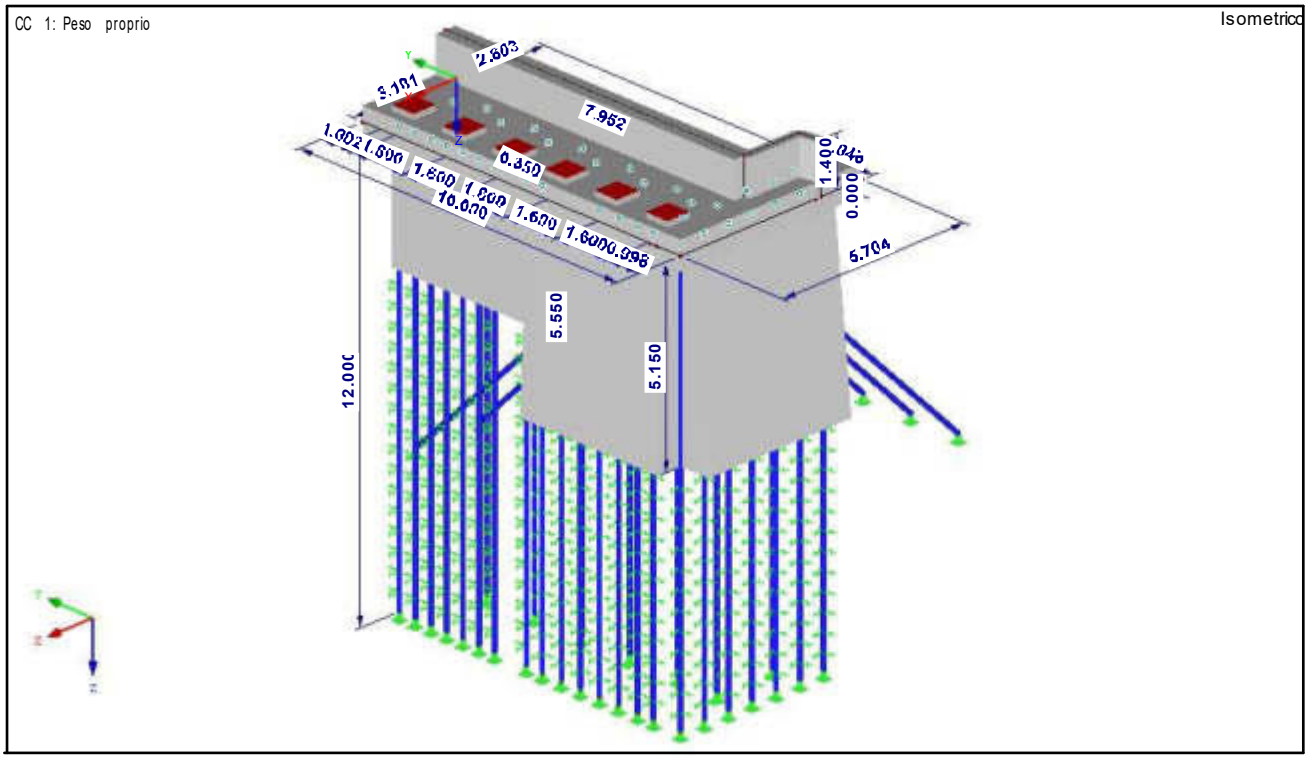


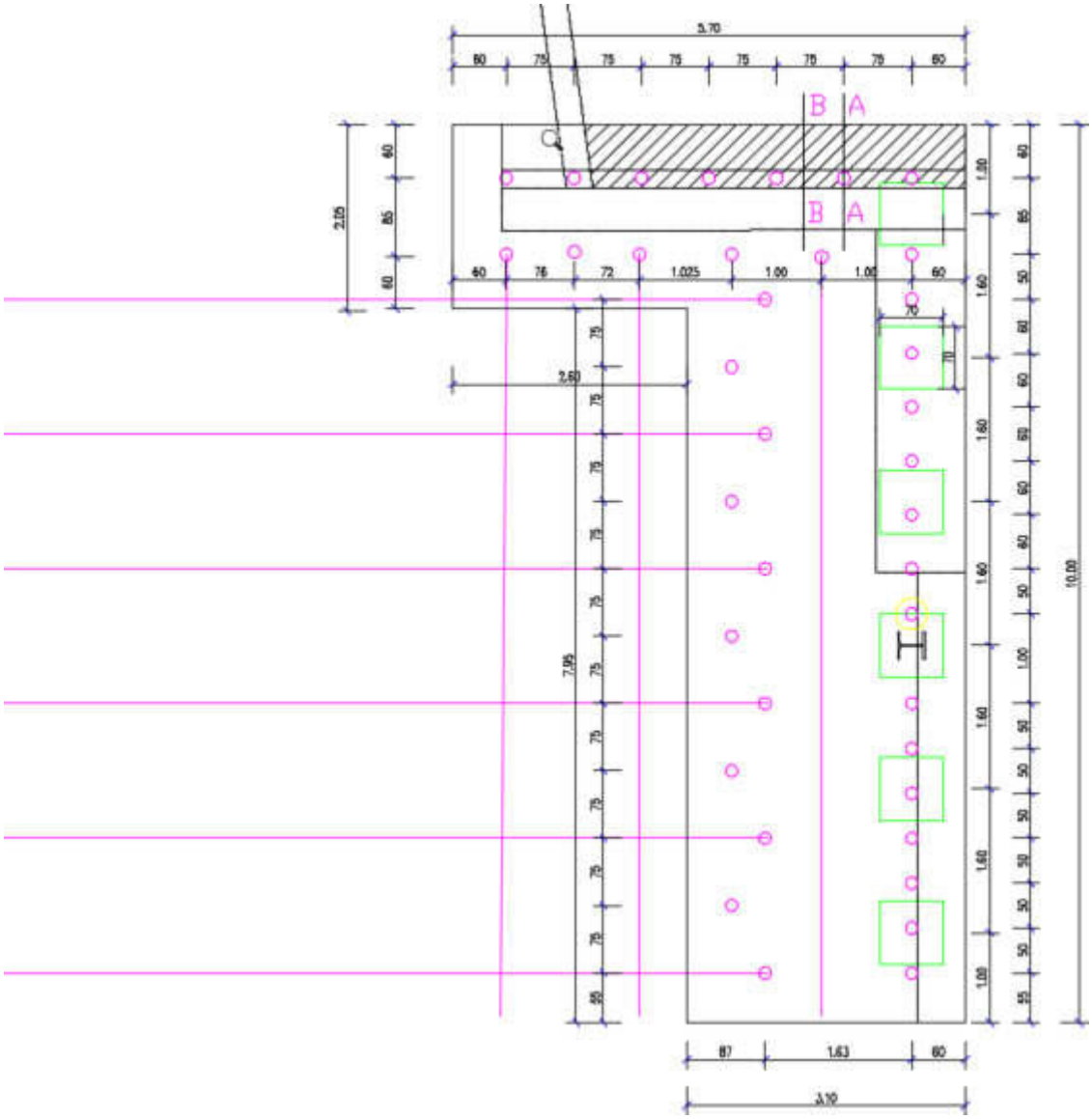
Nel modello di calcolo la struttura di collegamento in calcestruzzo armato è composta da elementi shell mentre i micropali e i baggioli da elementi beam.

7.1. Geometria del modello

Di seguito si riporta la geometria del modello:







7.2. Vincoli del modello

I micropali sono stati vincolati con cerniere in corrispondenza di:

-testa del micropalo.

-piede del micropalo.

Vincoli con molle alla Winkler orizzontali sono state applicate ogni mezzo metro nella prima fila di micropali.

-Lato muro nuovo strutturale kh=500 kN/m da z=3,50m a 5,15m

Lato muro esistente

- z=5,65m kh=900 kN/m
- z=6,15m kh=1500 kN/m
- z=6,65m kh=2500 kN/m
- z=7,15m kh=3300 kN/m

- Da z=7,65 a z=12m kh=5000 kN/m

7.3. Carichi del modello

Di seguito si riportano la lista dei carichi applicati al modello di calcolo:

CC1:Peso proprio

CC2:SLU massima compressione appoggio ponte

CC3: SLU minima compressione appoggio ponte

CC4: SLU Forza longitudinale orizzontale massima appoggio multidirezionale ponte

CC5: SLU Forza trasversale orizzontale massima appoggio multidirezionale ponte

CC6: SLU Forza momento longitudinale massimo appoggio multidirezionale ponte

CC7: SLU Forza momento trasversale massimo appoggio multidirezionale ponte

CC8: SLU Forza orizzontale massimo appoggio vincolato trasversalmente ponte

CC9:SISMA massima compressione appoggio ponte

CC10: SISMA minima compressione appoggio ponte

CC11: SISMA Forza longitudinale orizzontale massima appoggio multidirezionale ponte

CC12: SISMA Forza trasversale orizzontale massima appoggio multidirezionale ponte

CC13: SISMA Forza momento longitudinale massimo appoggio multidirezionale ponte

CC14: SISMA Forza momento trasversale massimo appoggio multidirezionale ponte

CC15: SISMA Forza orizzontale massimo appoggio vincolato trasversalmente ponte

CC16:Spinta a riposo da riempimento

CC17:Spinta a riposo da traffico

CC18:Sovraspinta sismica terreno direzione +x

CC19: Sovraspinta sismica terreno direzione +y

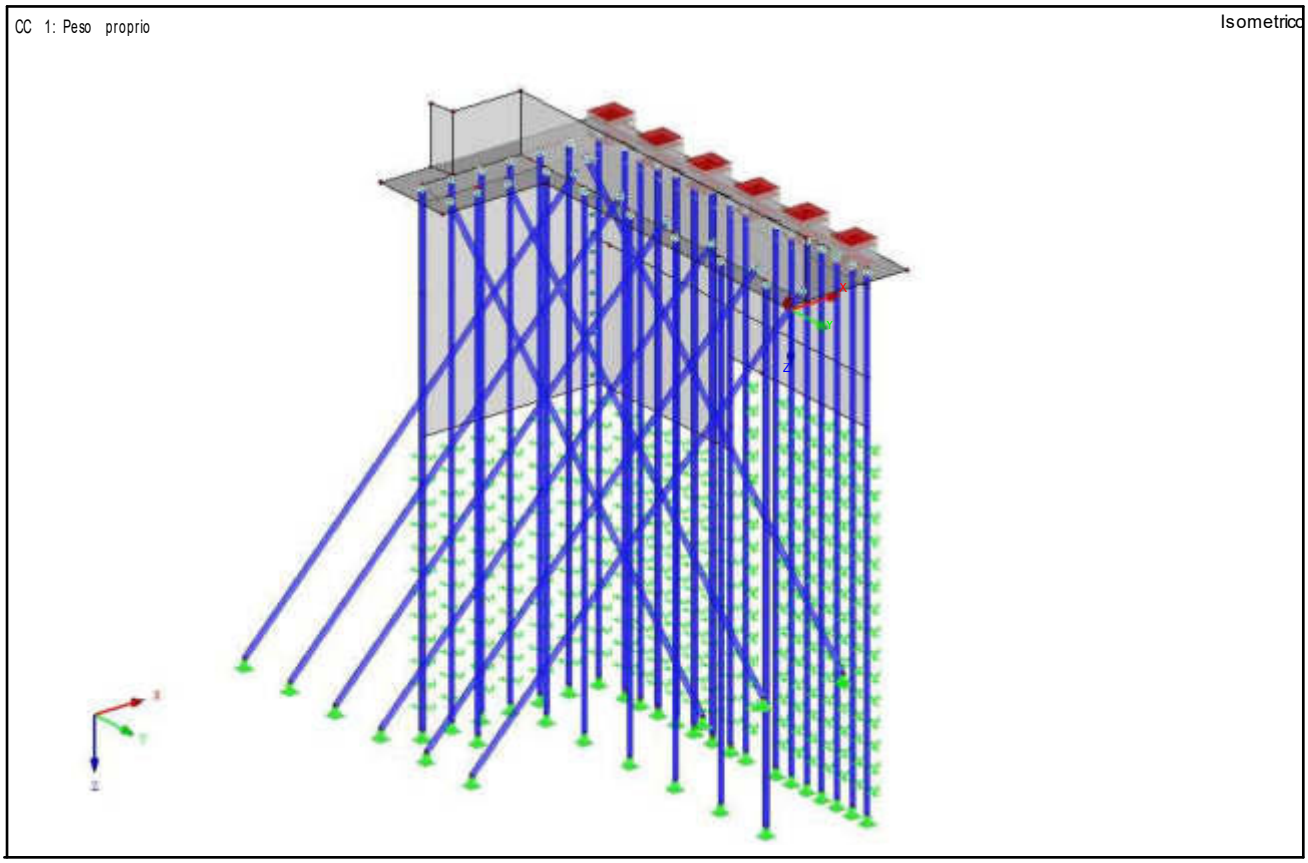
CC20:Sisma strutture in direzione longitudinale

CC21: Sisma strutture in direzione trasversale

CC22:Riempimento

CC23:traffico

7.3.1. CC1:Peso proprio



E´ stato assegnato un peso specifico per il calcestruzzo pari a 25 kN/m^3.

E´ stato assegnato un peso specifico per l´acciaio dei micropali pari a 78,50 kN/m^3.

Il programma RFEM calcola in automatico il peso proprio degli elementi strutturali.

7.3.2. da CC2 a CC15: Carichi SLU e sismici provenienti dal ponte

I carichi dal CC2 al CC15 sono stati ricavati dalla tabella al punto 3.2.1 Lager Achse A1 und B della relazione di calcolo "Verifiche della struttura rinforzata" del 19.12.2018:

3.2 Lager

3.2.1 Lager Achse A1 und B

Beschreibung	ULS	Erdbeben	Gewählt
N_sd,max (Größter Druck)	1180,0kN	373,0kN	1400,0kN
N_sd,min (Kleinster Druck)	6,0kN	126,0kN	0,0kN
u_x,sd (Verschiebung in Längsrichtung)	= Q_sd/K=Msd/(E*I)*h = 84,0kN/(1,5mm/kN) = 56,0mm	=Q_sd/K=Msd/(E*I)*h = 21,0kN/(1,5mm/kN) = 14,0mm	+/-60,0mm
u_z,sd (Verschiebung in Querrichtung)	= Q_sd/K = 4,0kN/(1,5mm/kN) = 2,7mm	= Q_sd/K = 1,0kN/(1,5mm/kN) = 0,7mm	+/-10,0mm
φ_sd, längs (Rotation um die Querachse)	=Msd/(E*I)*h =0,029MNm/(188,1MPa*0,0009m4) *0,072m =0,012rad	=Msd/(E*I)*h =0,01MNm/(188,1MPa*0,0009m4)*0,0 72m =0,004rad	0,020rad
φ_sd, quer (Rotation um die Längsachse)	=Msd/(E*I)*h =0,007MNm/(188,1MPa*0,0016m4) *0,072m =0,002rad	=Msd/(E*I)*h =0,002MNm/(188,1MPa*0,0016m4)*0, 072m =0,001rad	0,005rad
Erforderliche horizontale Steifigkeit Lager			1,5kN/mm
F_z,sd (nur mittleres querfestes Lager)	213,0kN	752,0kN	+/-1000kN

Wähle 12 Stück (2 sind querfest) bewehrte Neoprenlager 400x300x128, Elastomerdicke 72mm.

Tali carichi sono stati applicati in corrispondenza della sommitá dei baggioli.

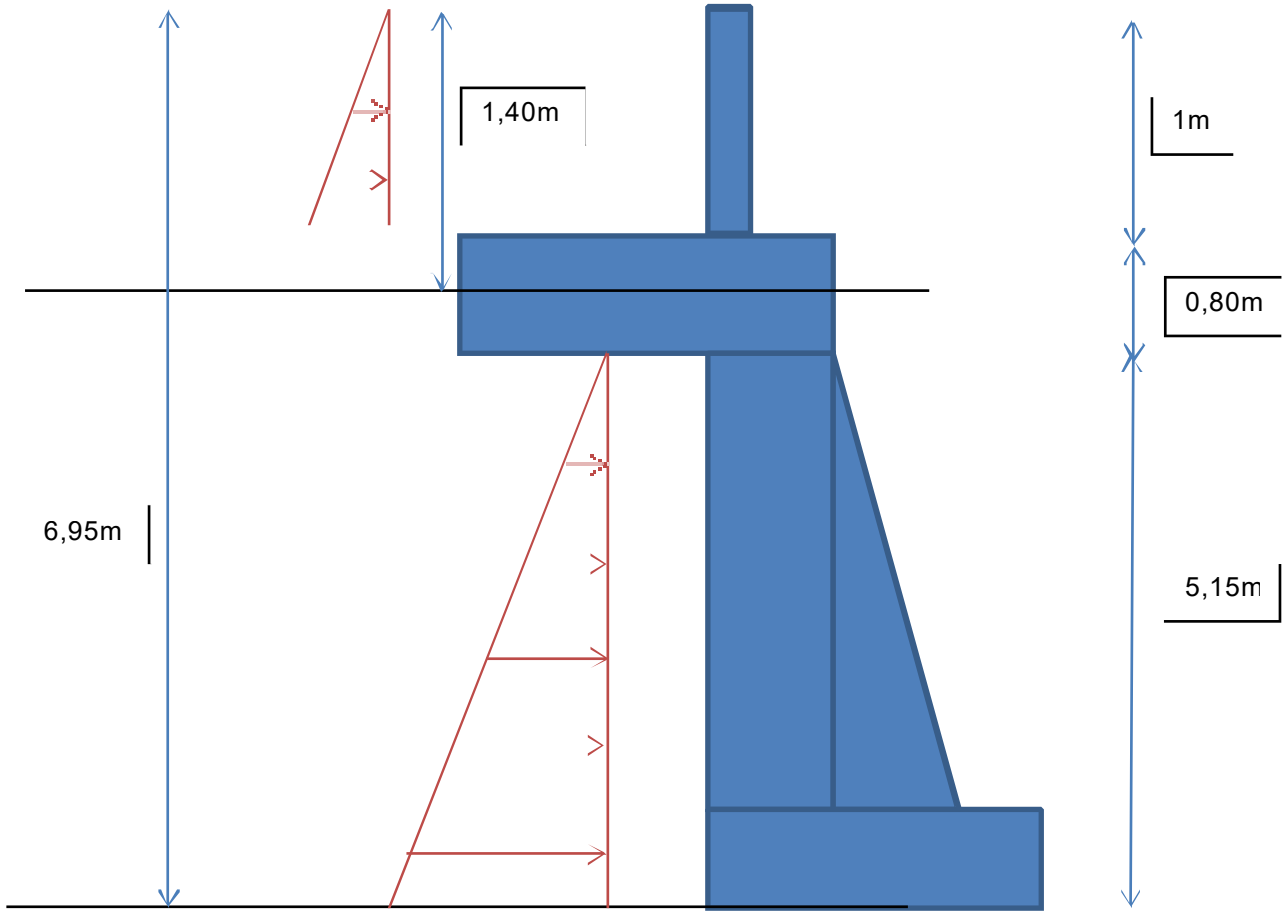
7.3.3. CC16: Spinta maggiorata da riempimento

E´ stato assunto un materiale di riempimento standard con angolo di attrito pari a 34° e peso specifico di 20 kN/m^3.

Il coefficiente di spinta a riposo è pari a k0=1-sinϕ´=1-sin 34°=0,44

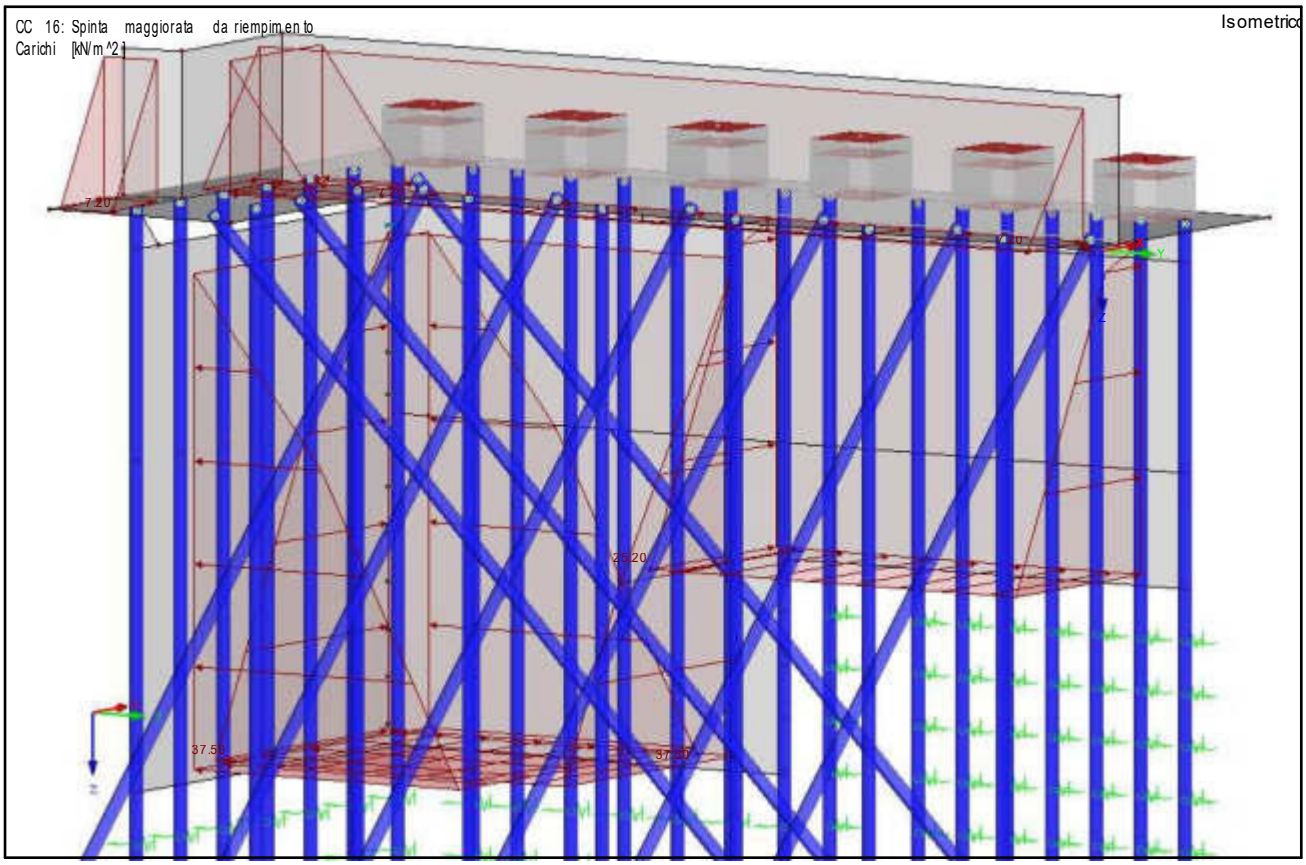
Il coefficiente di spinta attiva è pari a ka=tan(45°-34°/2)^2=0,28

Il coefficiente di spinta maggiorato è pari a k=(ka+k0)/2=(0,44+0,28)/2=0,36

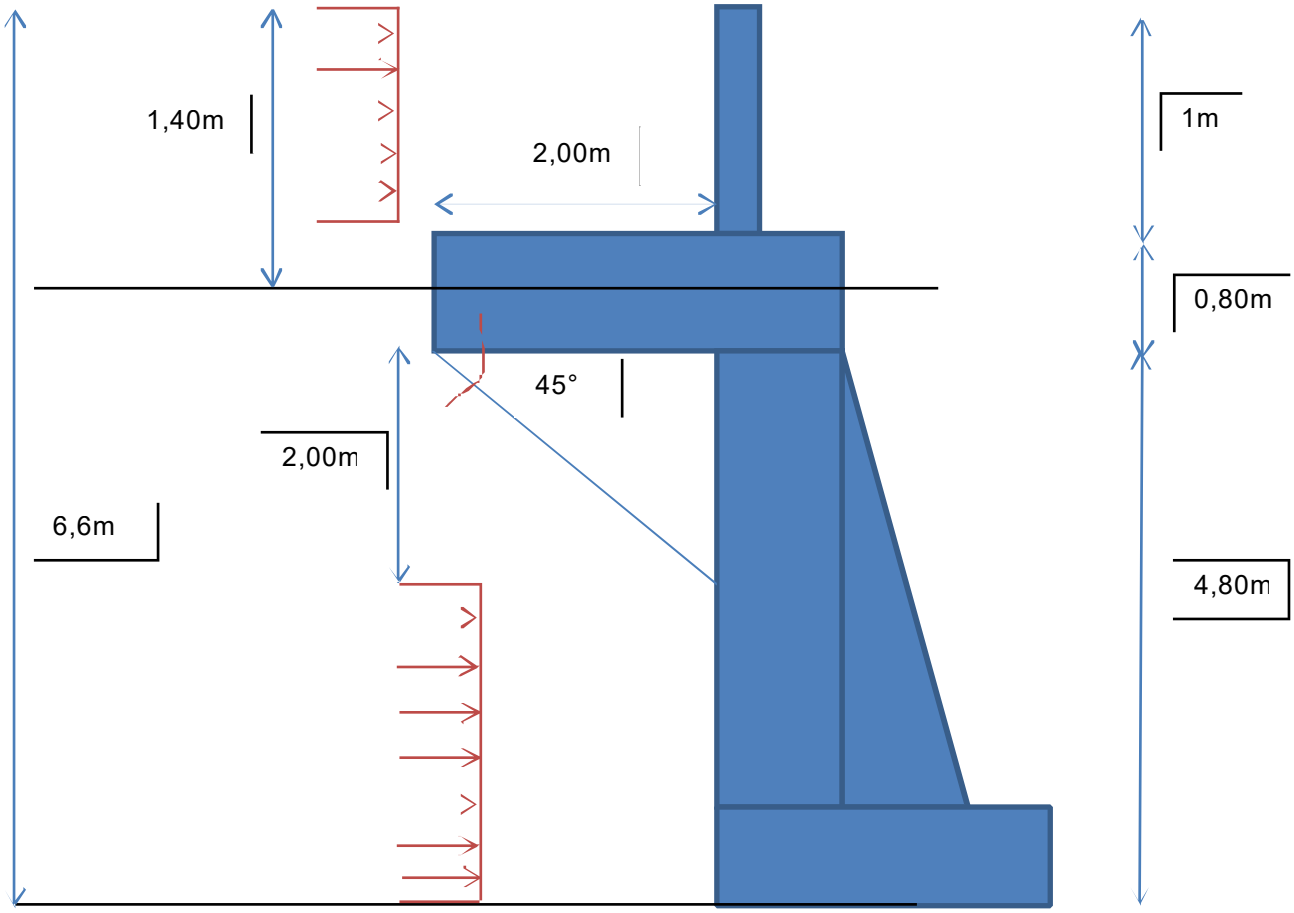


σRFEM(z=1,00m)=γ*z*k0=20 kN/m3*1,00m*0,36=7,20 kPa

σRFEM(z=5,20m)=γ*z*k0=20 kN/m3*5,20m*0,36=37,44 kPa

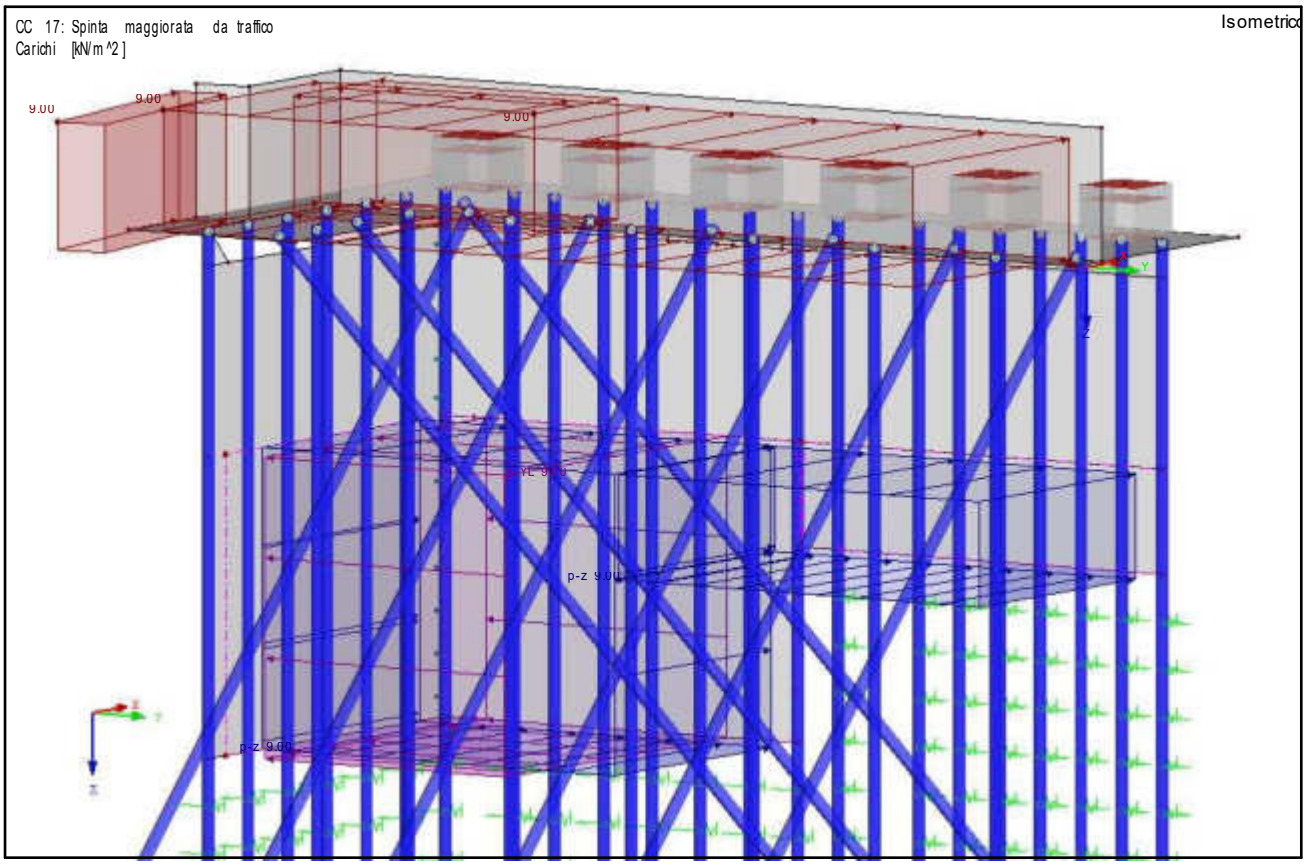

CC 16: Spinta maggiorata da riempimento
Carichi [kN/m^2]
Isometrico
7.20
7.20
7.20
25.20
37.50
37.50

7.3.4. CC17: Spinta maggiorata da traffico



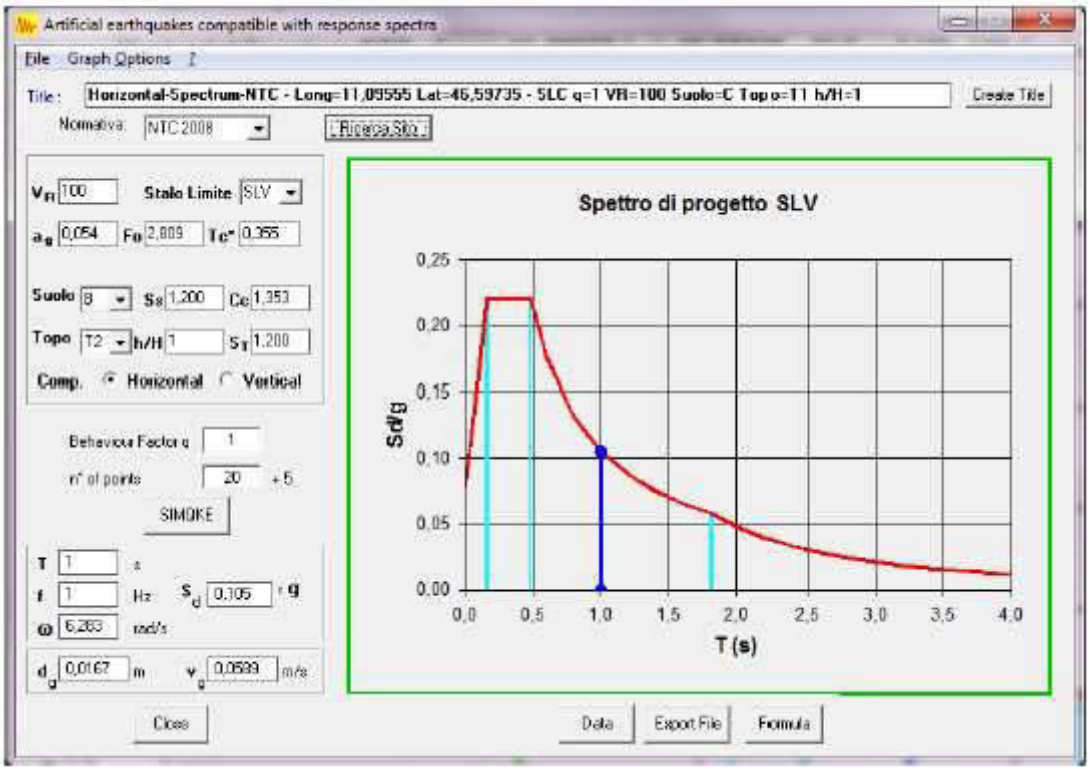
q traffico=25 kPa

σq RFEM=q*k0=25 kN/m2*0,36=9 kPa


CC 17: Spinta maggiorata da traffico
Carichi [kN/m^2]
Isometrico
9.00
9.00
9.00
p-z 9.00
p-z 9.00

7.3.5. CC18:Sovraspinta sismica terreno direzione -x

Parametri dalla tabella al punto 2.34 Erdbeben in X und Z della relazione di calcolo "Verifiche della struttura rinforzata" del 19.12.2018:



- α=ag/g(SLV)=0,054
- SS=1,20
- ST=1,20

La sovraspinta sismica viene calcolata come al punto E.9 dell´eurocodice 1998 parte 5 del 2005:

E.9 *Forze causate dalla spinta del terreno per strutture rigide*

Nel caso di strutture rigide che sono completamente vincolate, in modo tale che non può svilupparsi nel terreno uno stato di spinta attiva, e per un muro verticale con terrapieno a superficie orizzontale, la forza dinamica dovuta all'incremento di spinta del terreno può essere preso uguale a:

$$\Delta P_d = \alpha \cdot S \cdot \gamma \cdot H^2 \qquad \text{(E.19)}$$

dove:

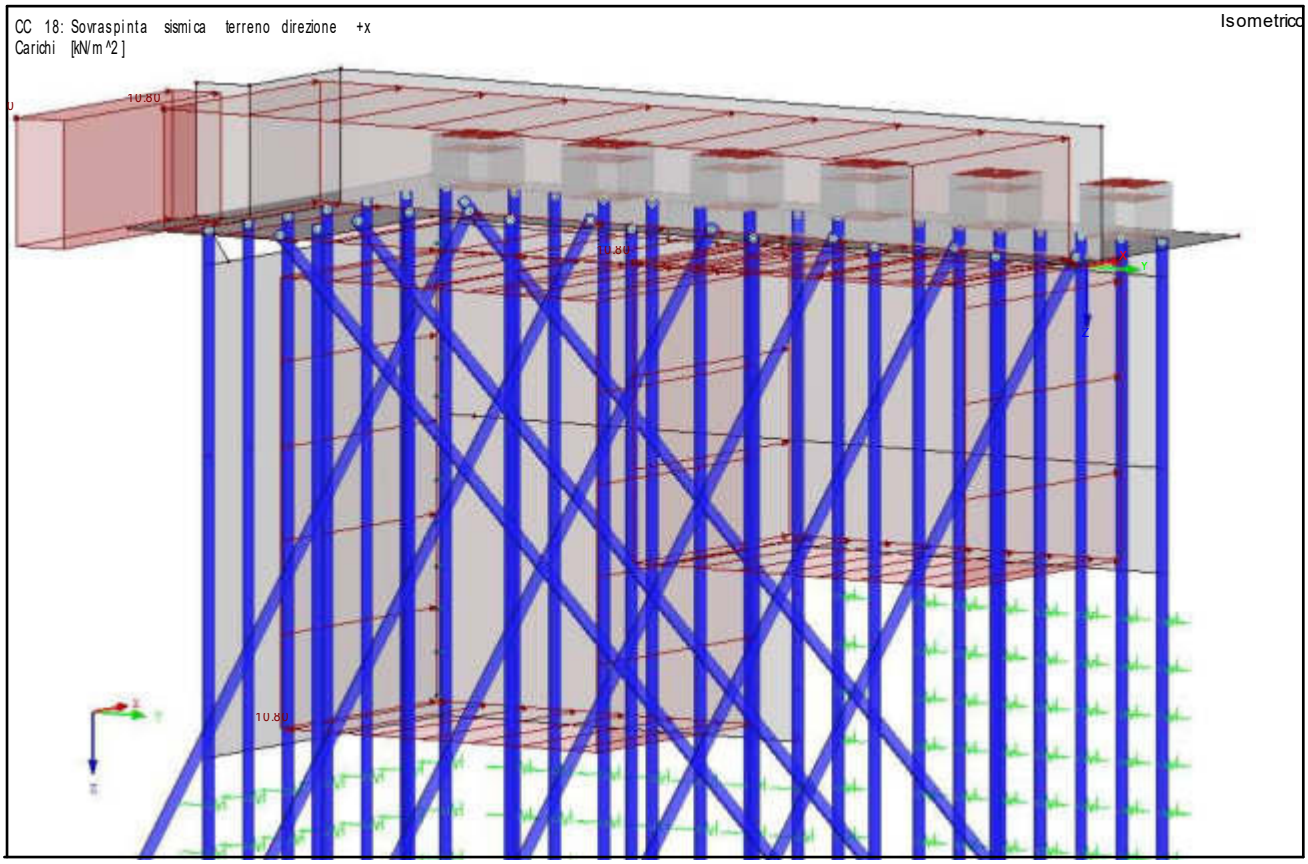
H è l'altezza del muro.

Il punto di applicazione può essere preso a metà dell'altezza.

$\Delta Pd\ spalla = \alpha * S * \gamma * H^2 = 0{,}054 * 1{,}20 * 1{,}20 * 20 kN/m^3 * (6{,}95m)^2 = 75{,}12\ kN/m$

In RFEM le sovraspinte causate dalla spinta del terreno per strutture rigide viene applicato tramite un carico distribuito:

ΔPd spalla RFEM= α*S*γ*H2=0,054*1,20*1,20*20kN/m3*6,95m=10,80 kPa

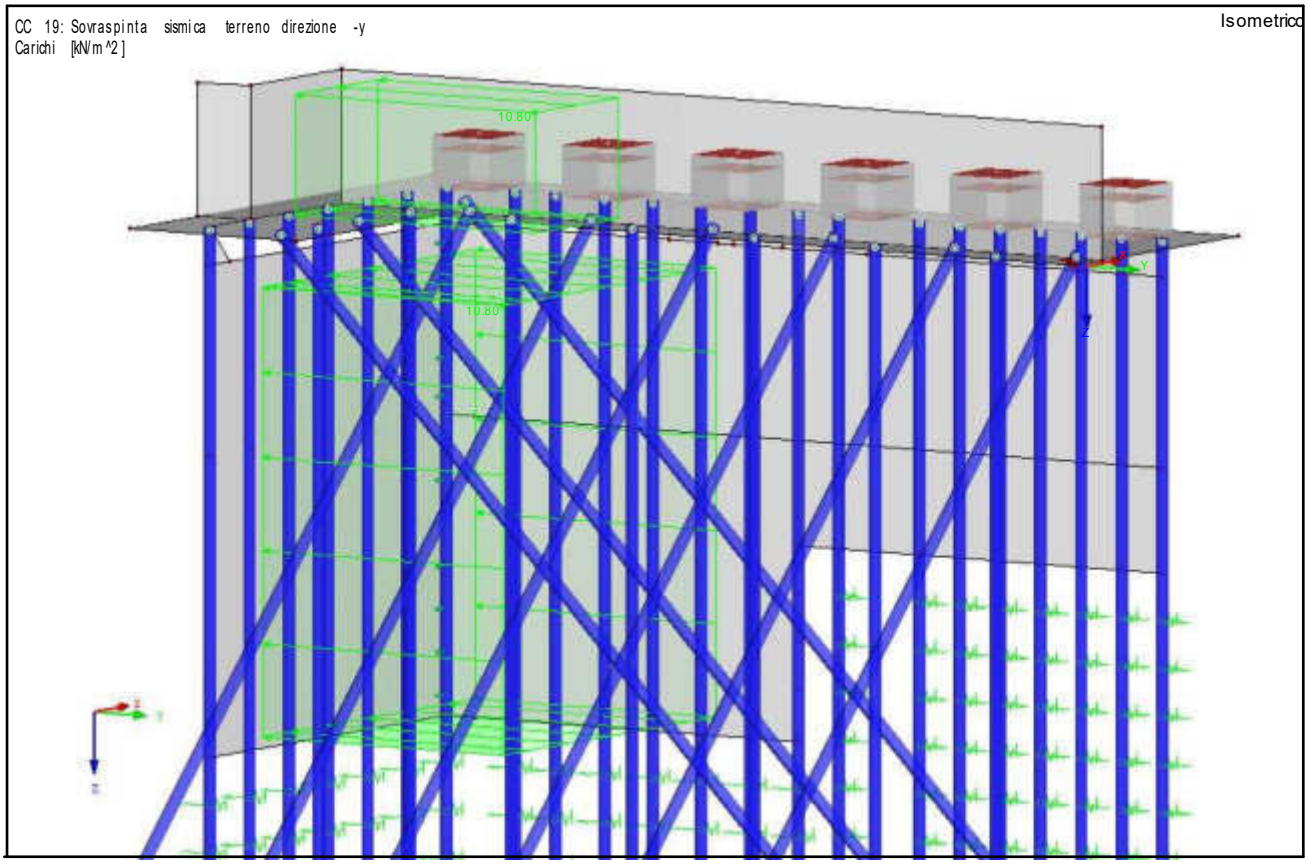


7.3.6. CC18:Sovraspinta sismica terreno direzione +y

ΔPd spalla=α*S*γ*H2=0,054*1,20*1,20*20kN/m3*(6,50m)2=65,70 kN/m

In RFEM le sovraspinte causate dalla spinta del terreno per strutture rigide viene applicato tramite un carico distribuito:

ΔPd spalla RFEM= α*S*γ*H2=0,054*1,20*1,20*20kN/m3*6,50m=10,80 kPa



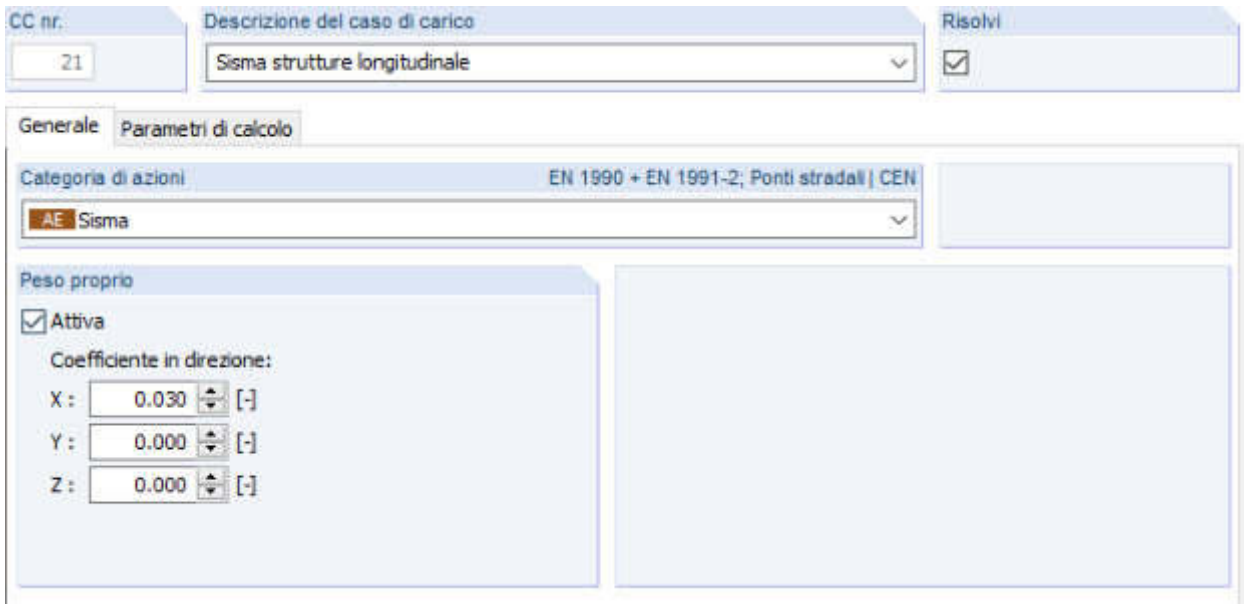
7.3.7. da CC21 a CC22: Sisma strutture longitudinali

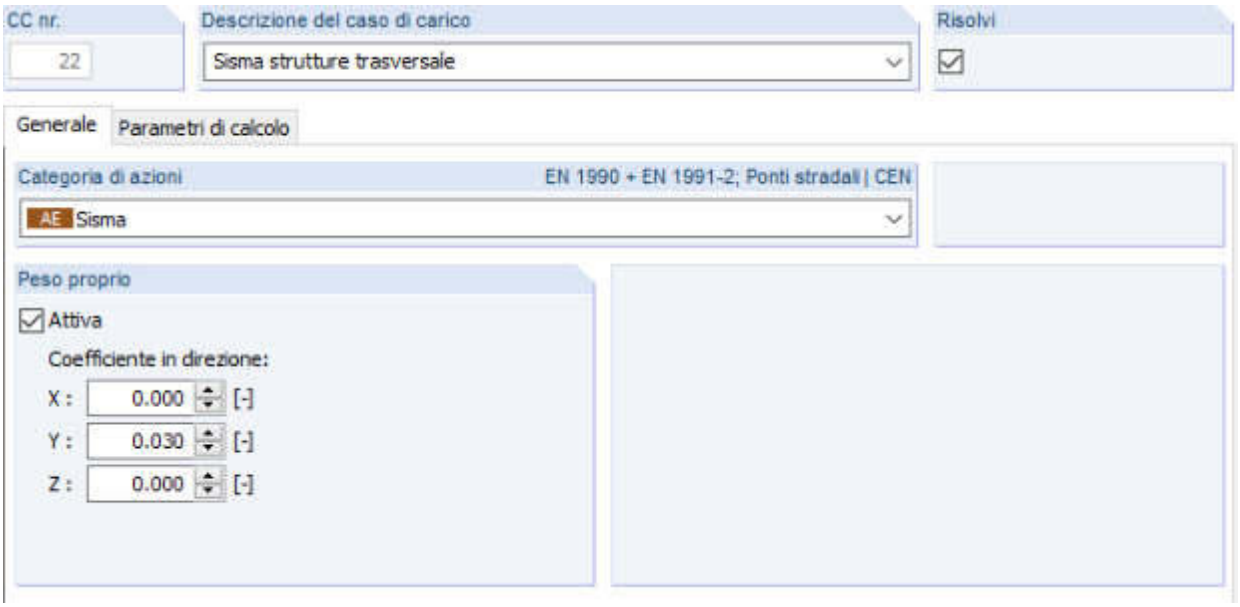
Dalle NTC 2018: muri di sostegno sismica si determina kh:

kh(SLV)=βm*S*ag/g=0,38*0,054*1,20*1,20=0,029

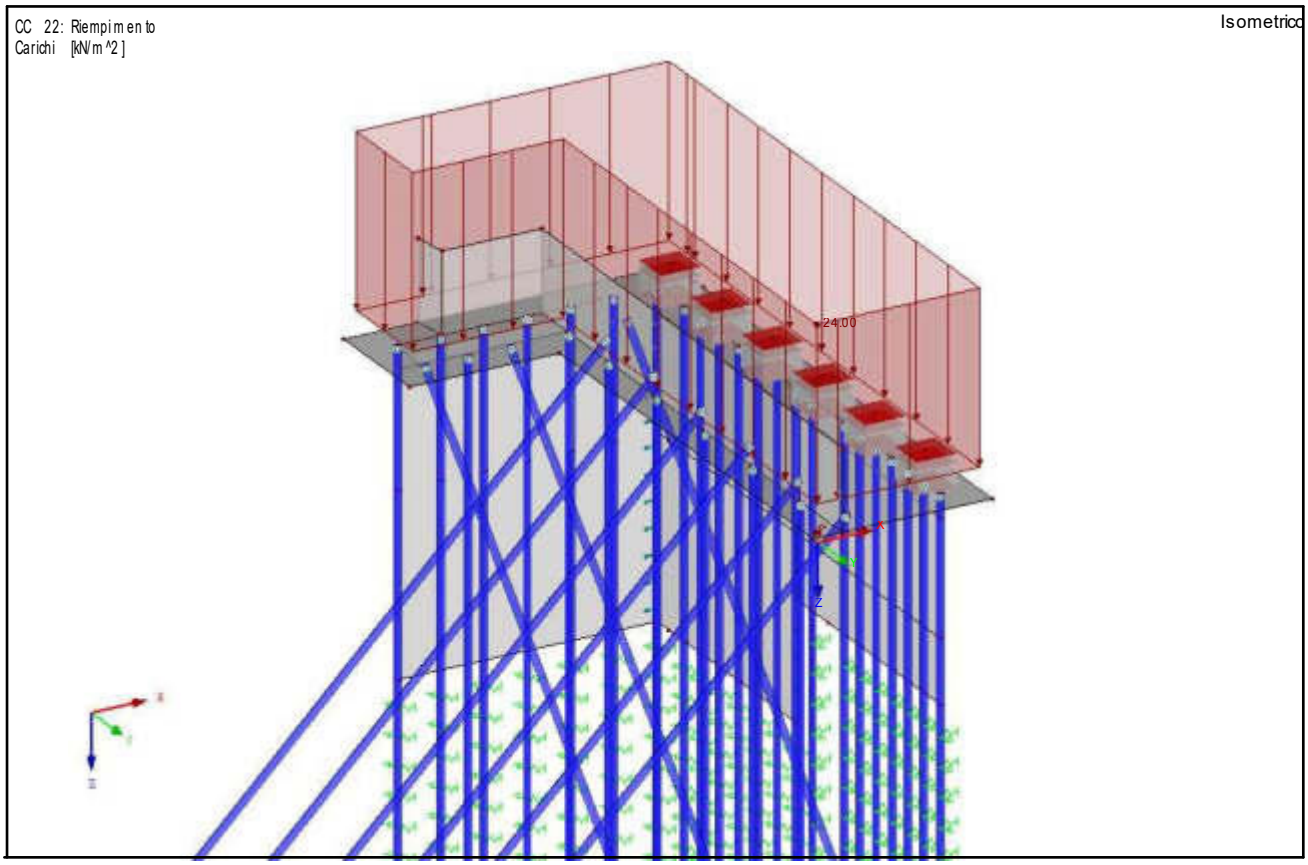
kv(SLV)±kh*0,50=±0,0147

In RFEM diventa:



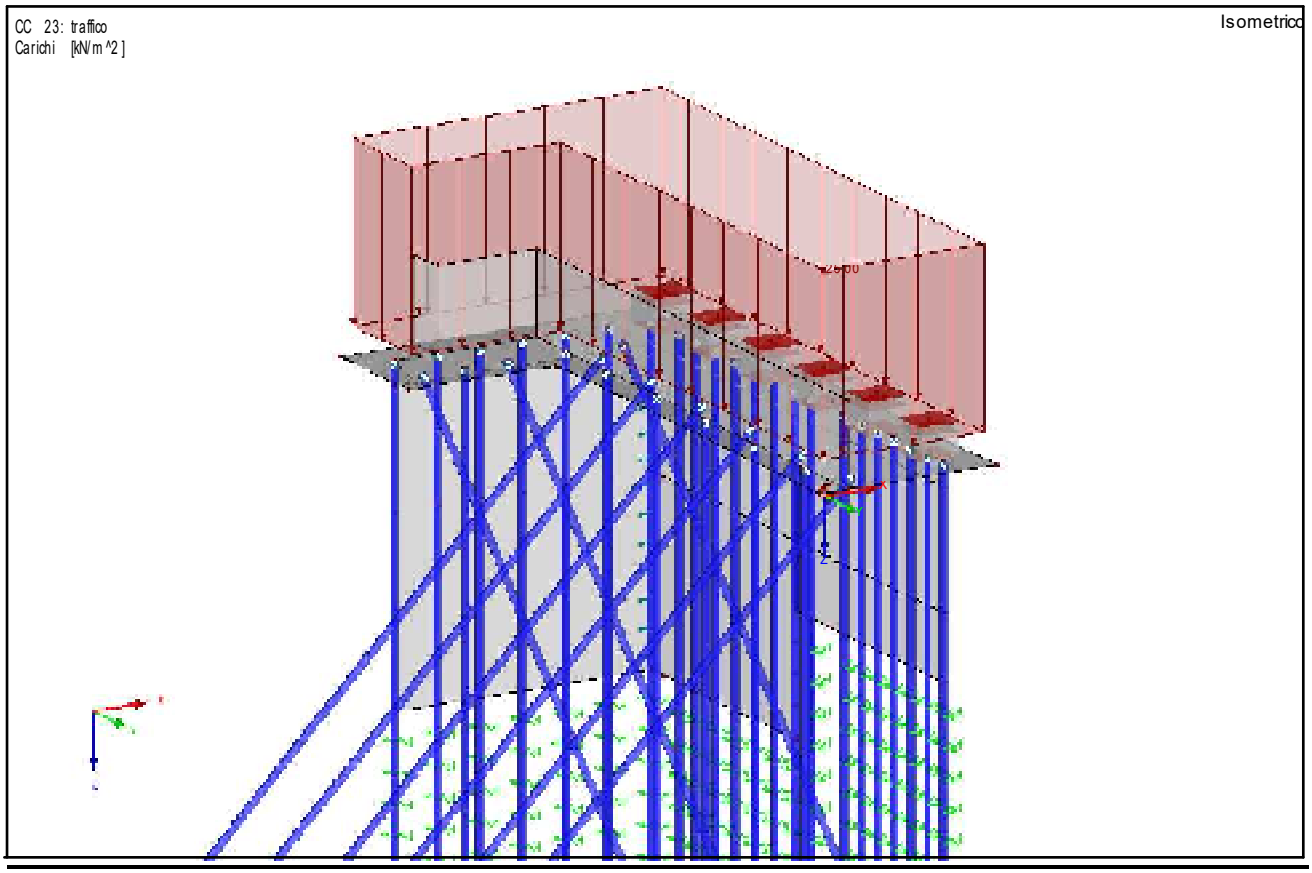


7.3.8. CC23:Riempimento



g2=γg2*h=24 kN/m^3*1,00m=24,00 kPa

7.3.9. CC24:Traffico



q=25 kPa

8. Combinazione di carico

CR1:Stati limite ultimi SLU

CC1/p o 1.35*CC1/p + CC2 o CC3 + CC4 o -1*CC4 + CC5 o -1*CC5 + CC6 o -1*CC6 + CC7 o -1*CC7 + CC8 o -1*CC8 + CC16/p o 1.35*CC16/p + 1.35*CC17 + 1.35*CC22/p o CC22/p + 1.35*CC23

CR2:Sisma

1.02*CC1/p o 0.98*CC1/p + CC9 o CC10 + CC11 o -1*CC11 + CC12 o -1*CC12 + CC13 o -1*CC13 + CC14 o -1*CC14 + CC15 o -1*CC15 + CC16/p + CC18 o 0.3*CC18 + CC19 o 0.3*CC19 + CC20 o 0.3*CC20 o -1*CC20 o -0.3*CC20 + CC21 o 0.3*CC21 o -1*CC21 o -0.3*CC21 + CC22/p

CR3: Inviluppo SLU/Sisma

CR1/p o CR2/p

9. Vita utile micropali

Il diametro del micropalo subisce una riduzione pari a 3,00mm in quanto si ipotizza lo strato di boiacca fessurato. Si assume una vita utile di 100 anni.

Table F.1 Loss of thickness [mm] due to corrosion for piles and sheet piles in soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undisturbed natural soils (sand, silt, clay, schist, ...)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial grounds	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, ...)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt, ...)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag, ...)	0,50	2,00	3,25	4,50	5,75

Notes:

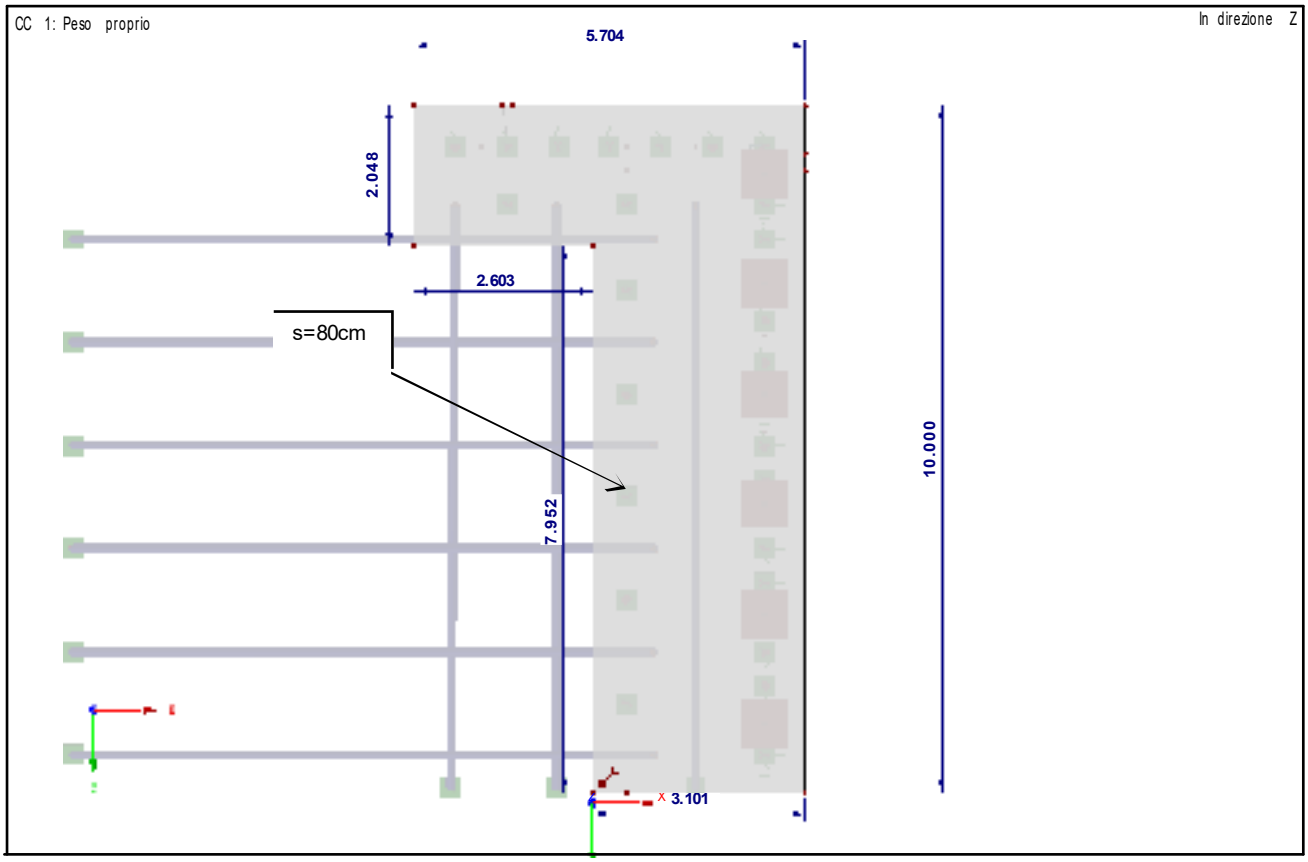
1) Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two.

2) The values given are only for guidance. Local conditions should be considered because they might affect the actual corrosion rate, which can be lower or higher than the average value given in the table.

3) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

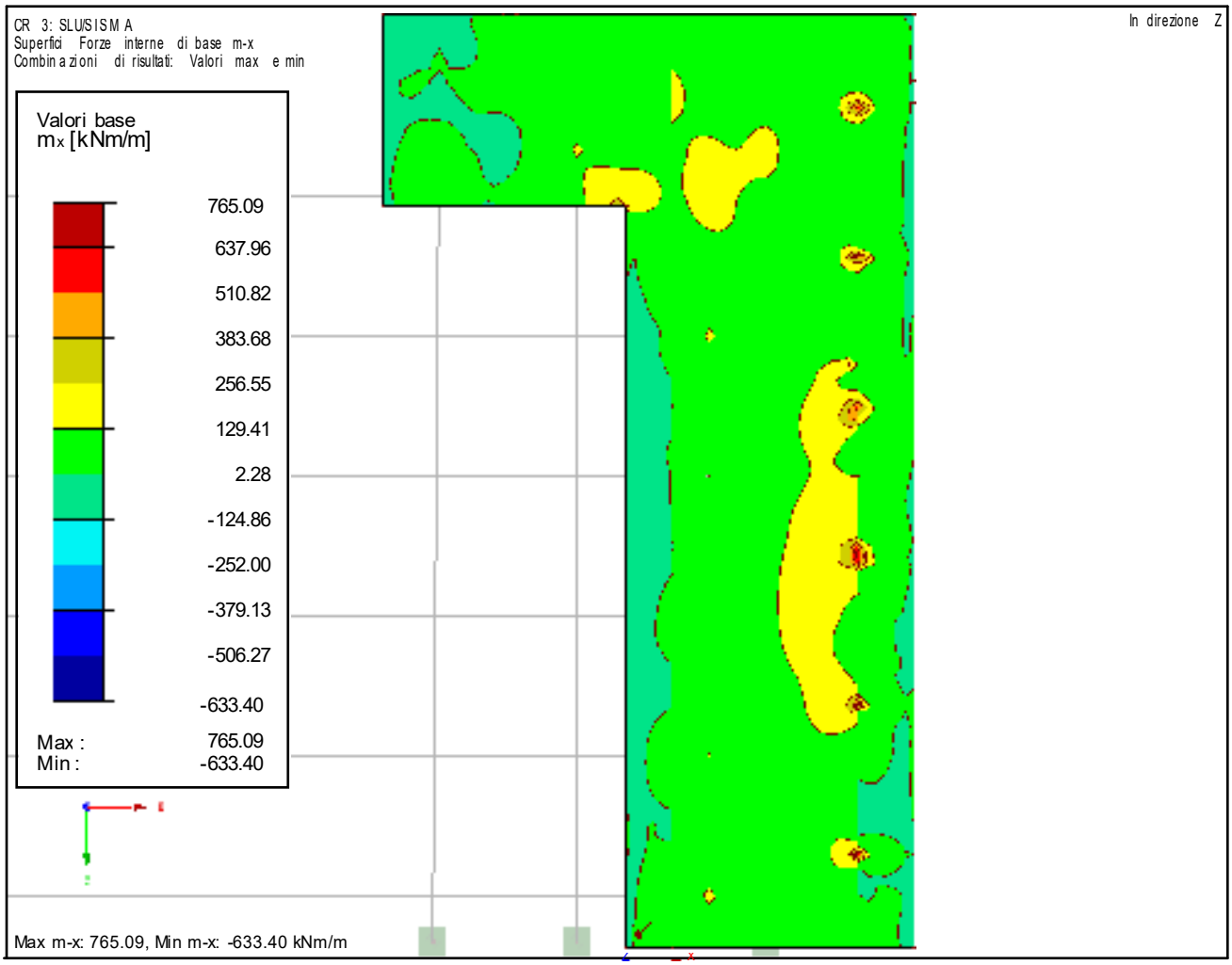
10. Fondazione di collegamento

10.1. Geometria

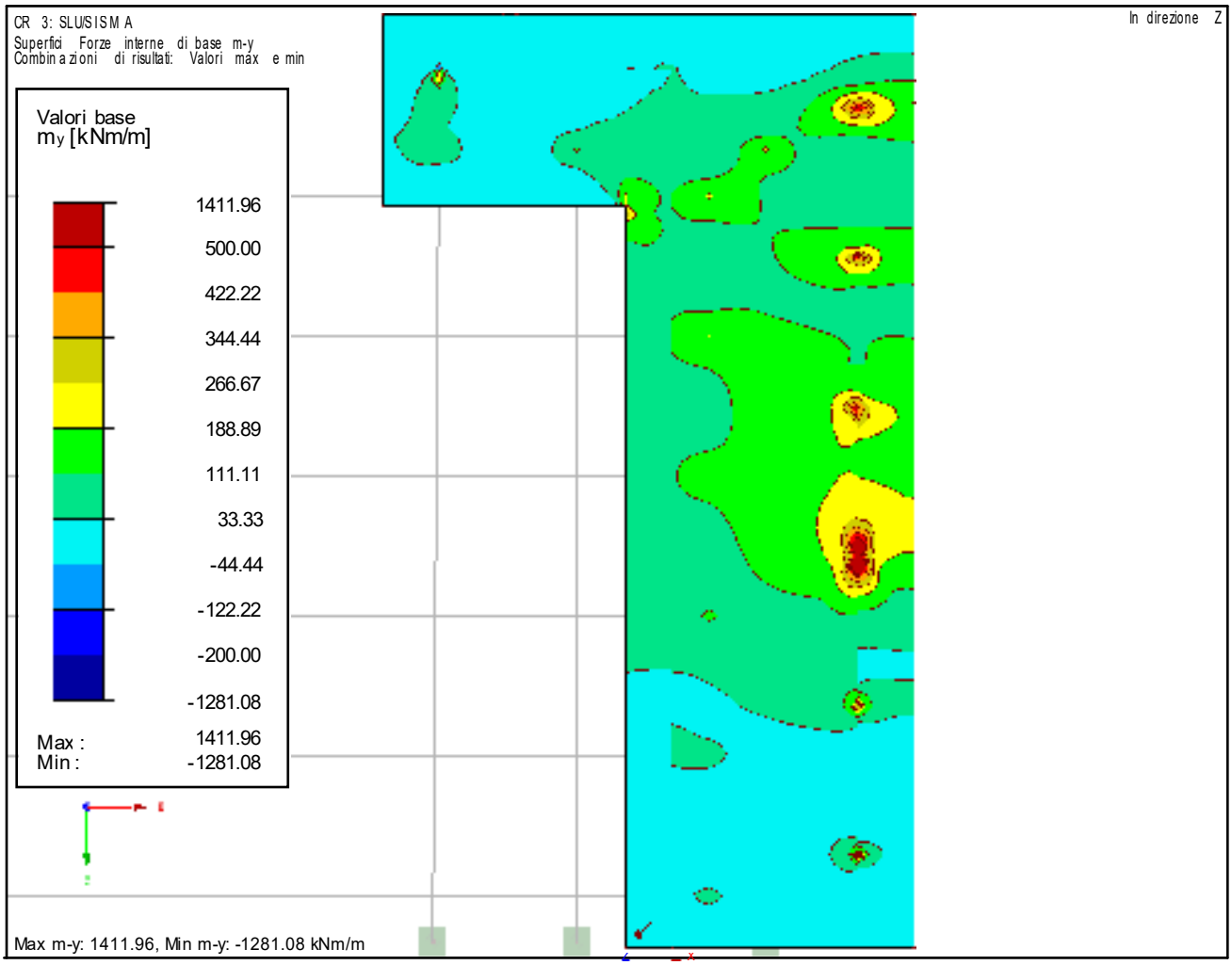


10.2. Inviluppo sollecitazioni SLU/SISMA

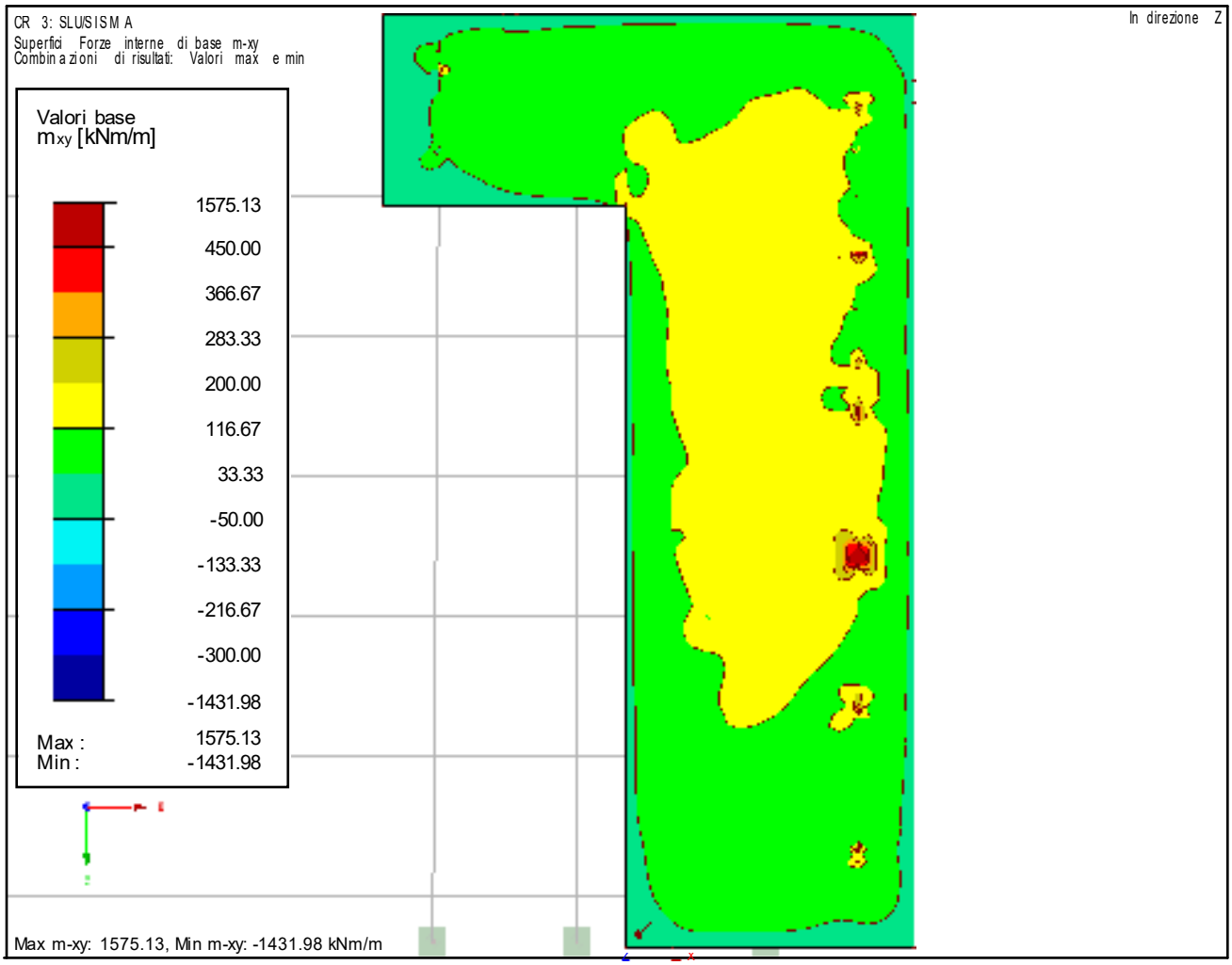
10.2.1. Inviluppo SLU/SISMA Valori momento mx



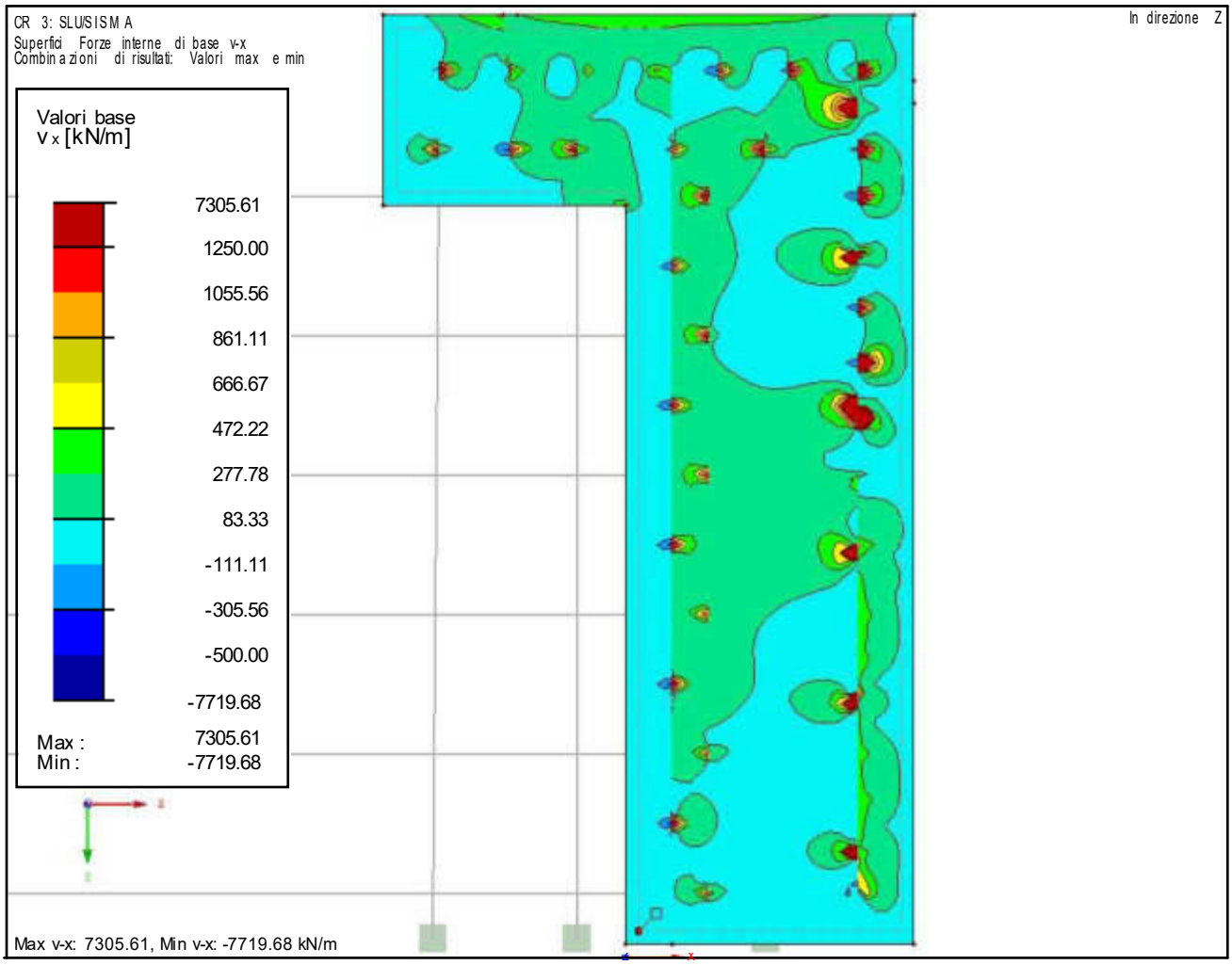
10.2.2. Inviluppo SLU/SISMA Valori momento my



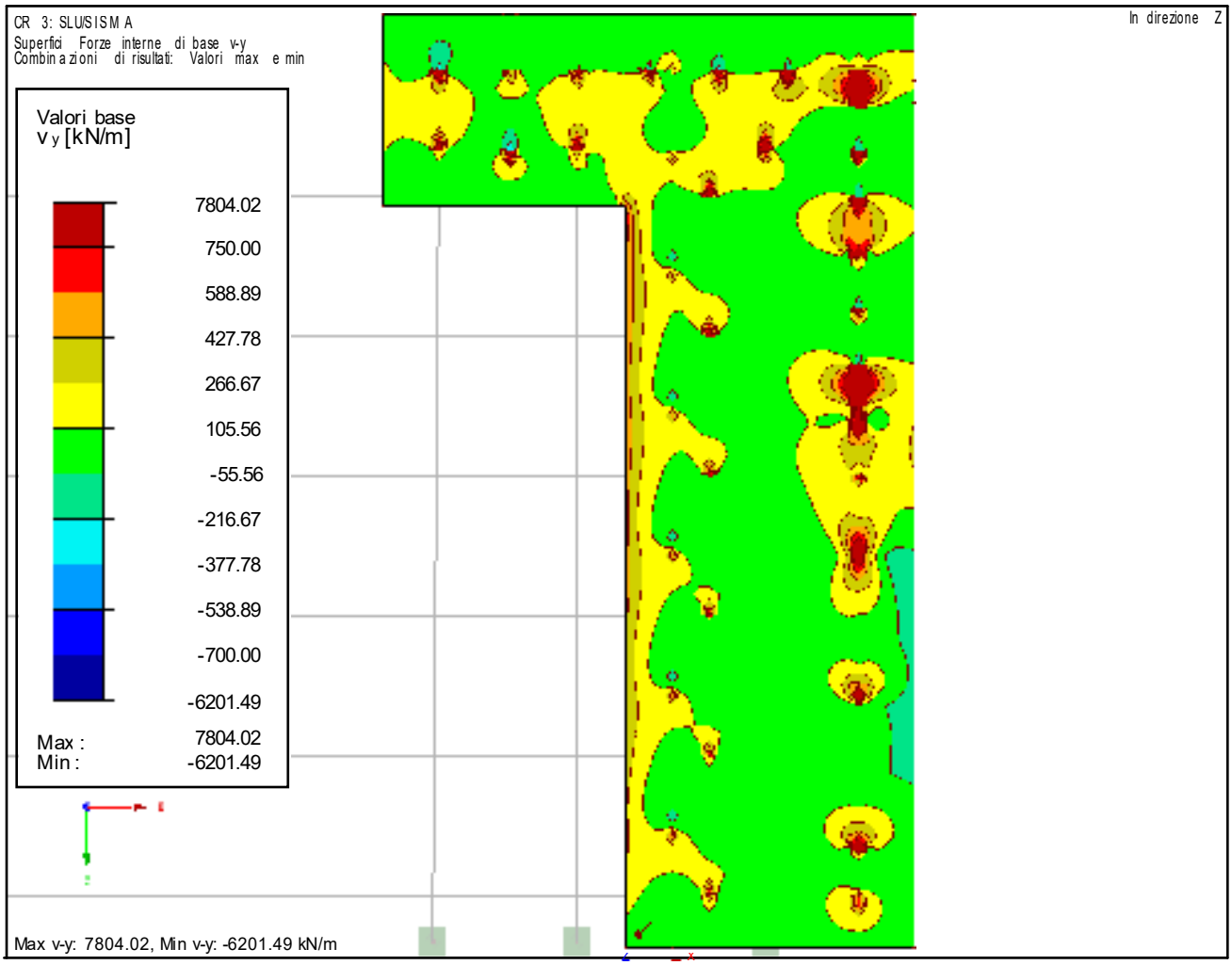
10.2.3. Inviluppo SLU/SISMA Valori momento torcente mxy



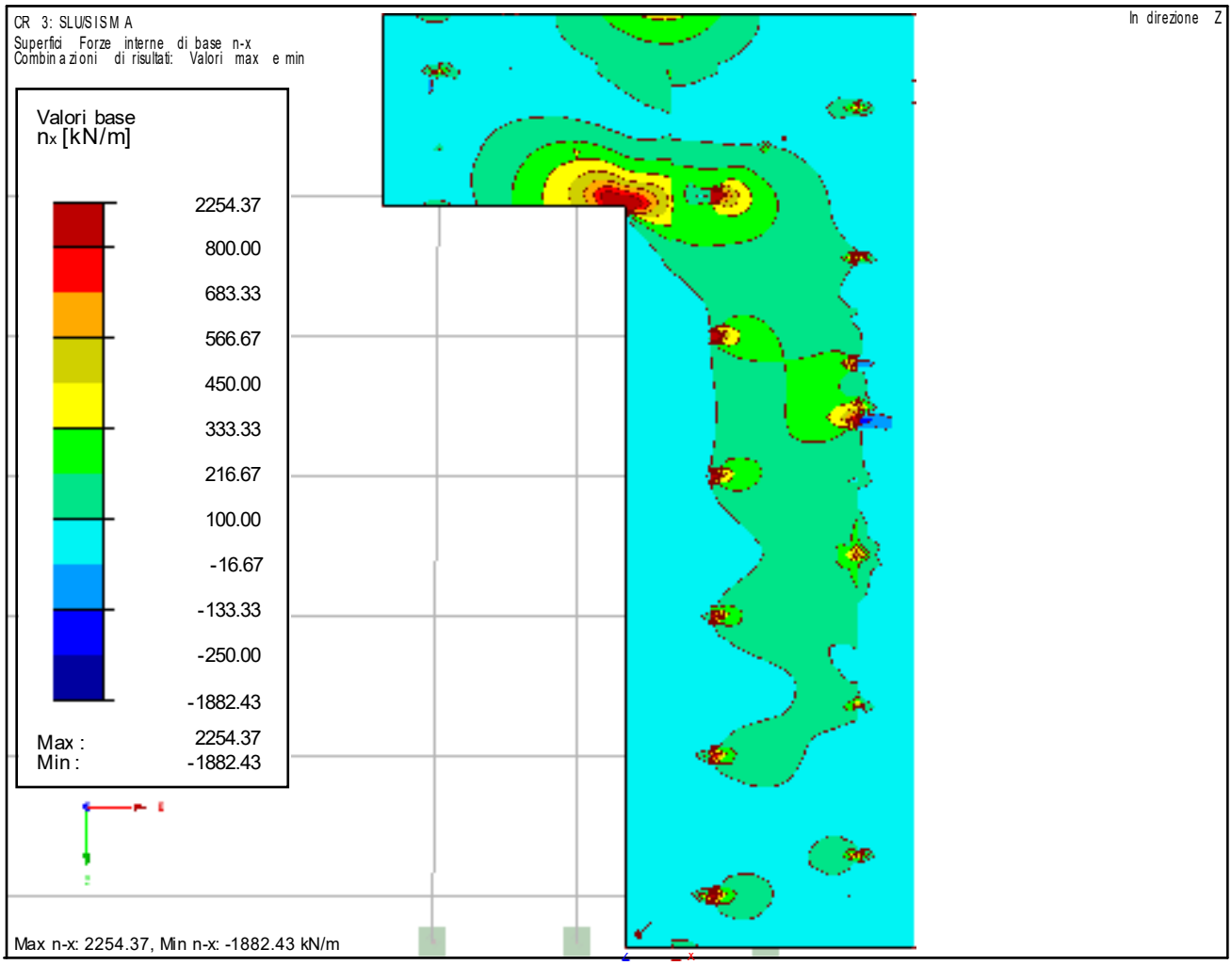
10.2.4. Inviluppo SLU/SISMA Valori forze di taglio vx



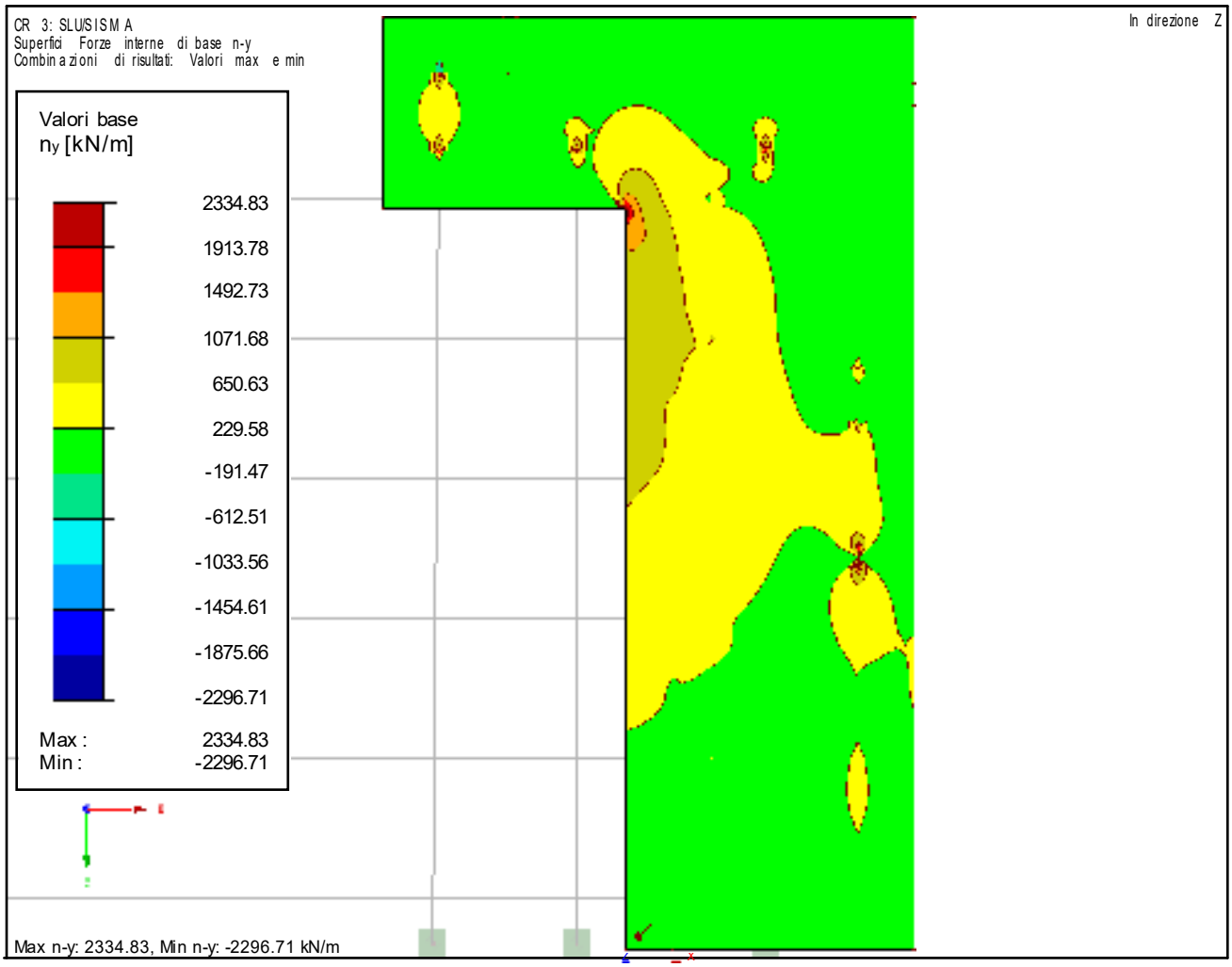
10.2.5. Inviluppo SLU/SISMA Valori forze di taglio vy



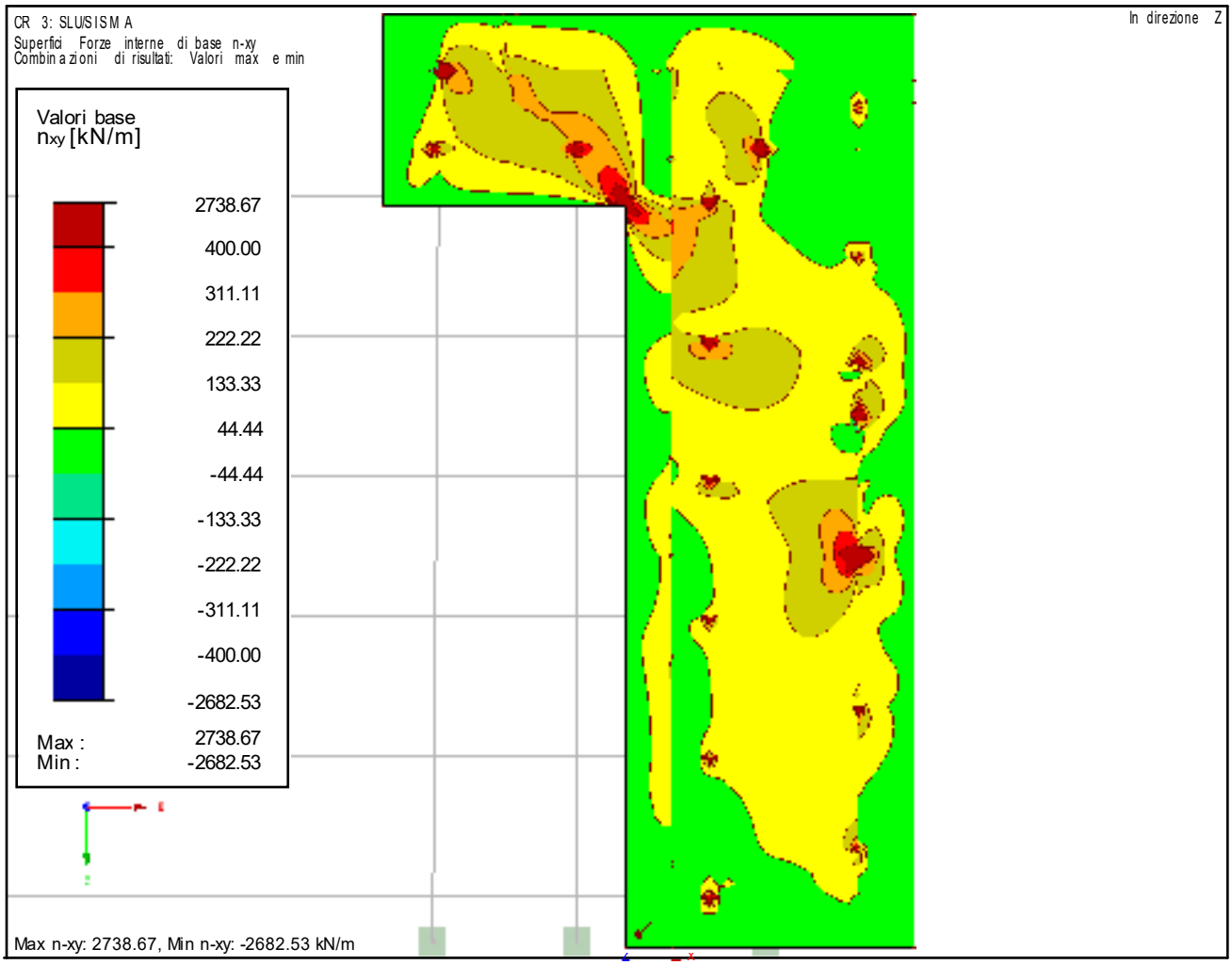
10.2.6. Inviluppo SLU/SISMA Valori forze membranali nx



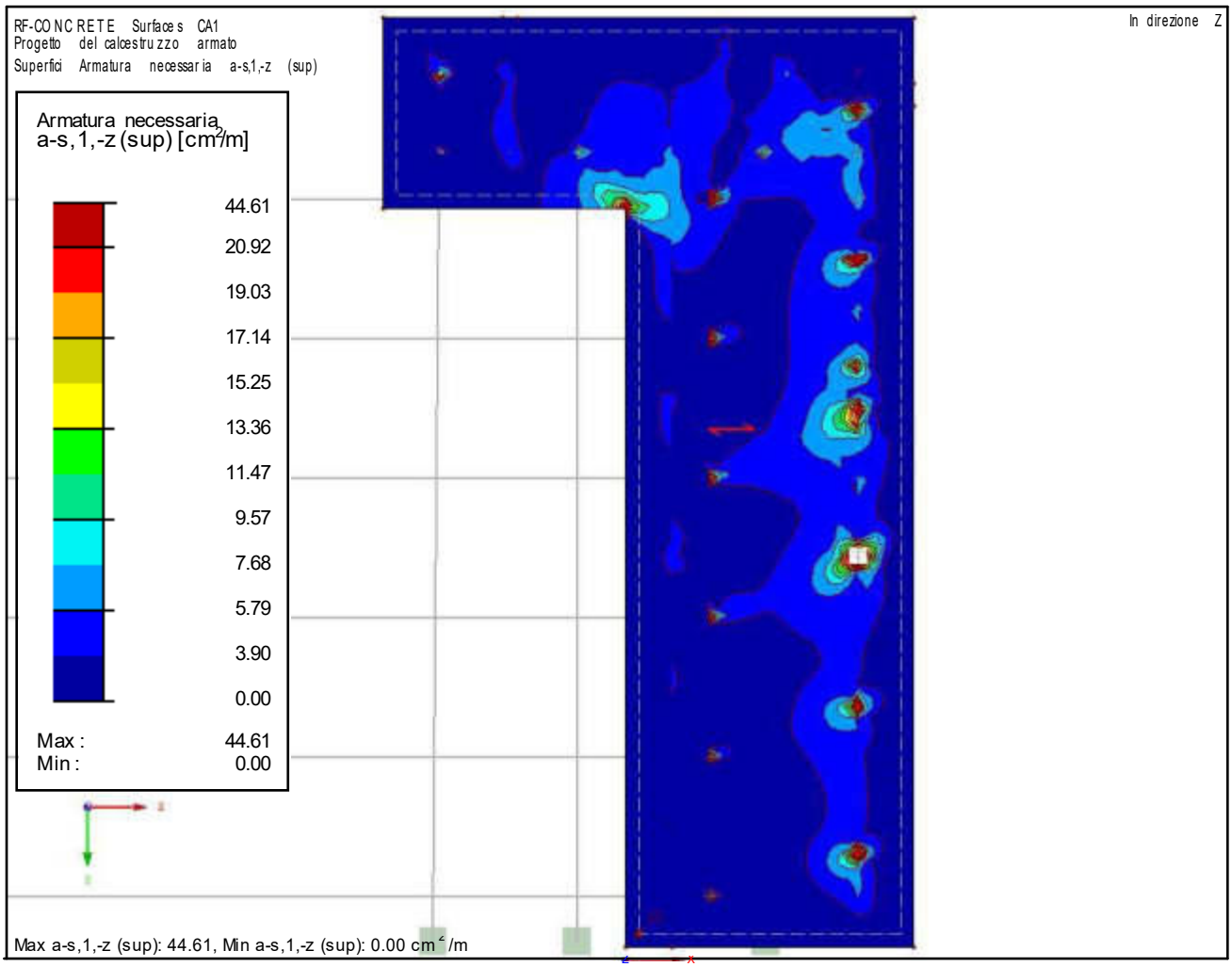
10.2.7. Inviluppo SLU/SISMA Valori massimi membranali ny



10.2.8. Inviluppo SLU/SISMA Valori massimi membranali nxy

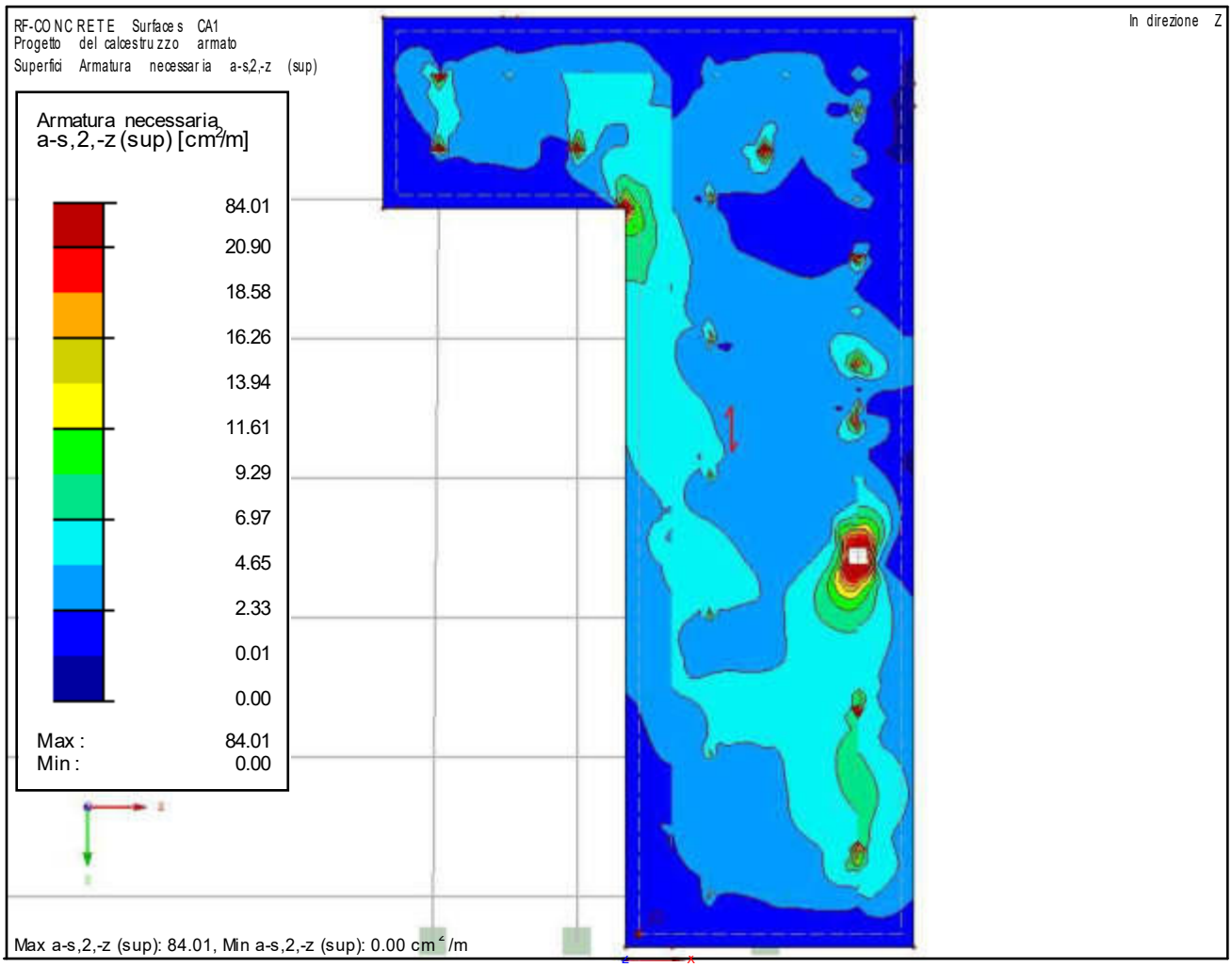


10.3. Isolinee di armatura estradosso in direzione longitudinale alla direzione del ponte



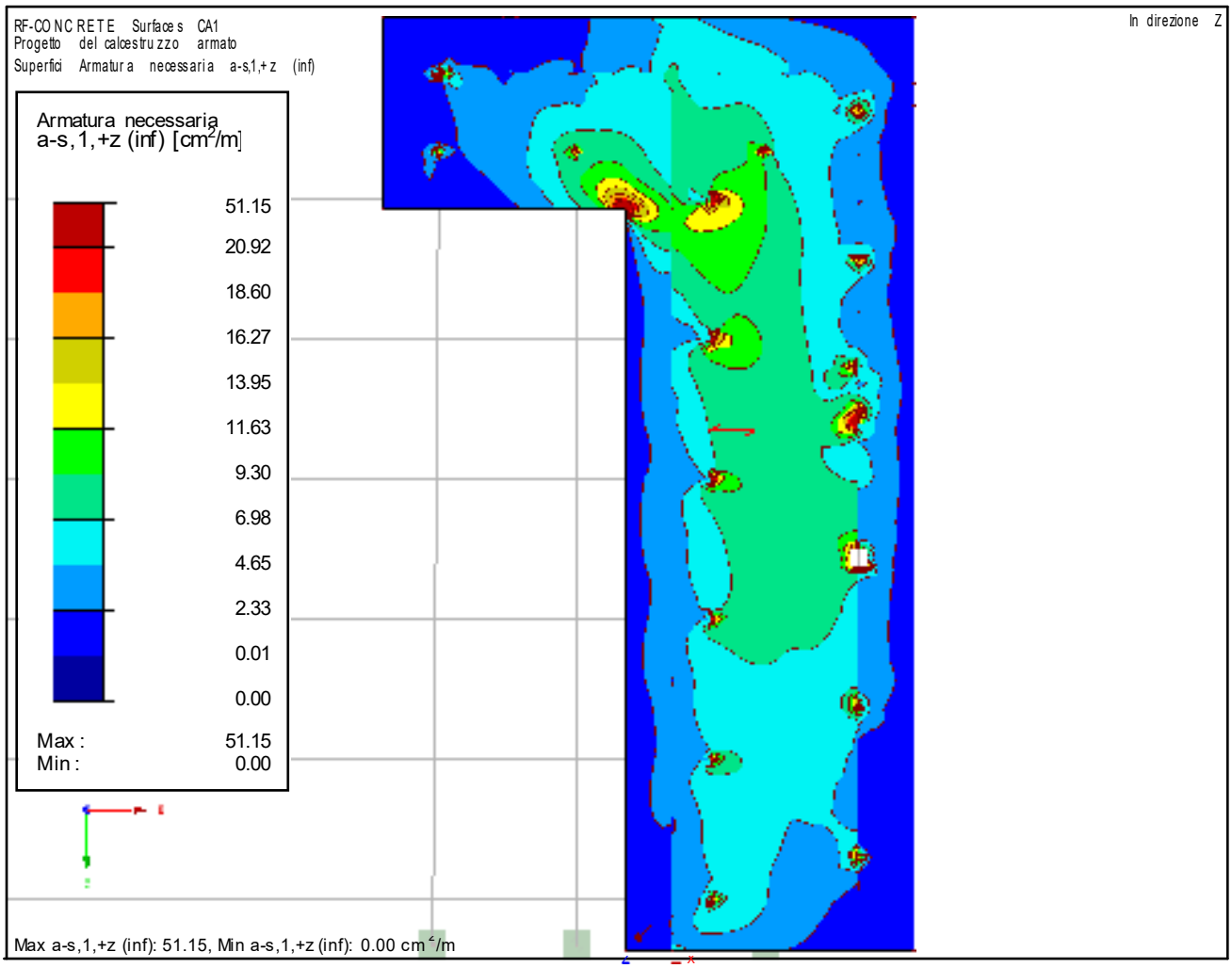
A meno di singolaritá di calcolo si dispone un armatura al minimo pari a ϕ20/15=20,93 cm2/m

10.4. Isolinee di armatura estradosso in direzione trasversale alla direzione del ponte



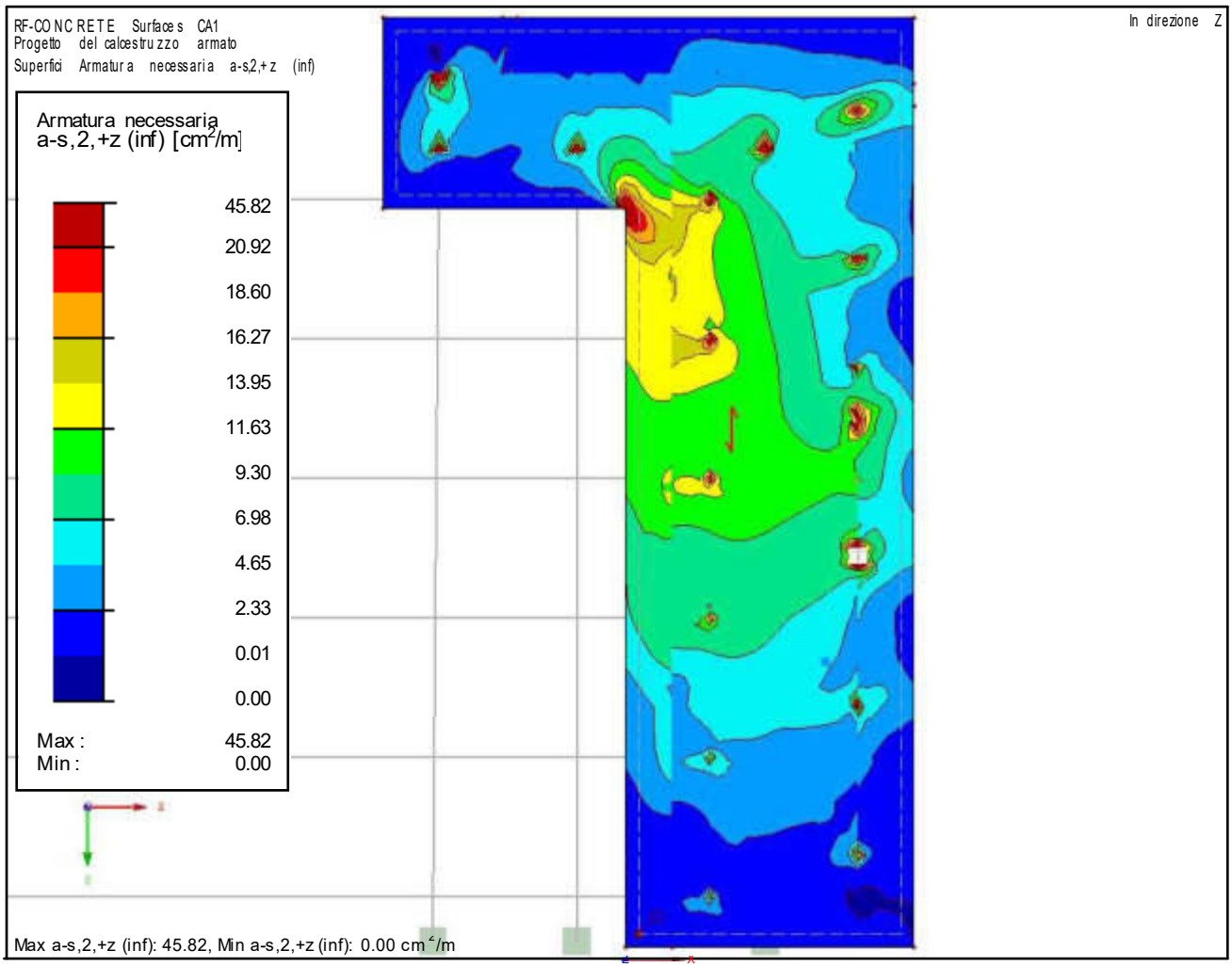
A meno di singolaritá di calcolo si dispone un armatura pari a ϕ20/15=20,93 cm2/m

10.5. Isolinee di armatura intradosso in direzione longitudinale alla direzione del ponte



A meno di singolaritá di calcolo si dispone un armatura pari a ϕ20/15=20,93 cm^2/m

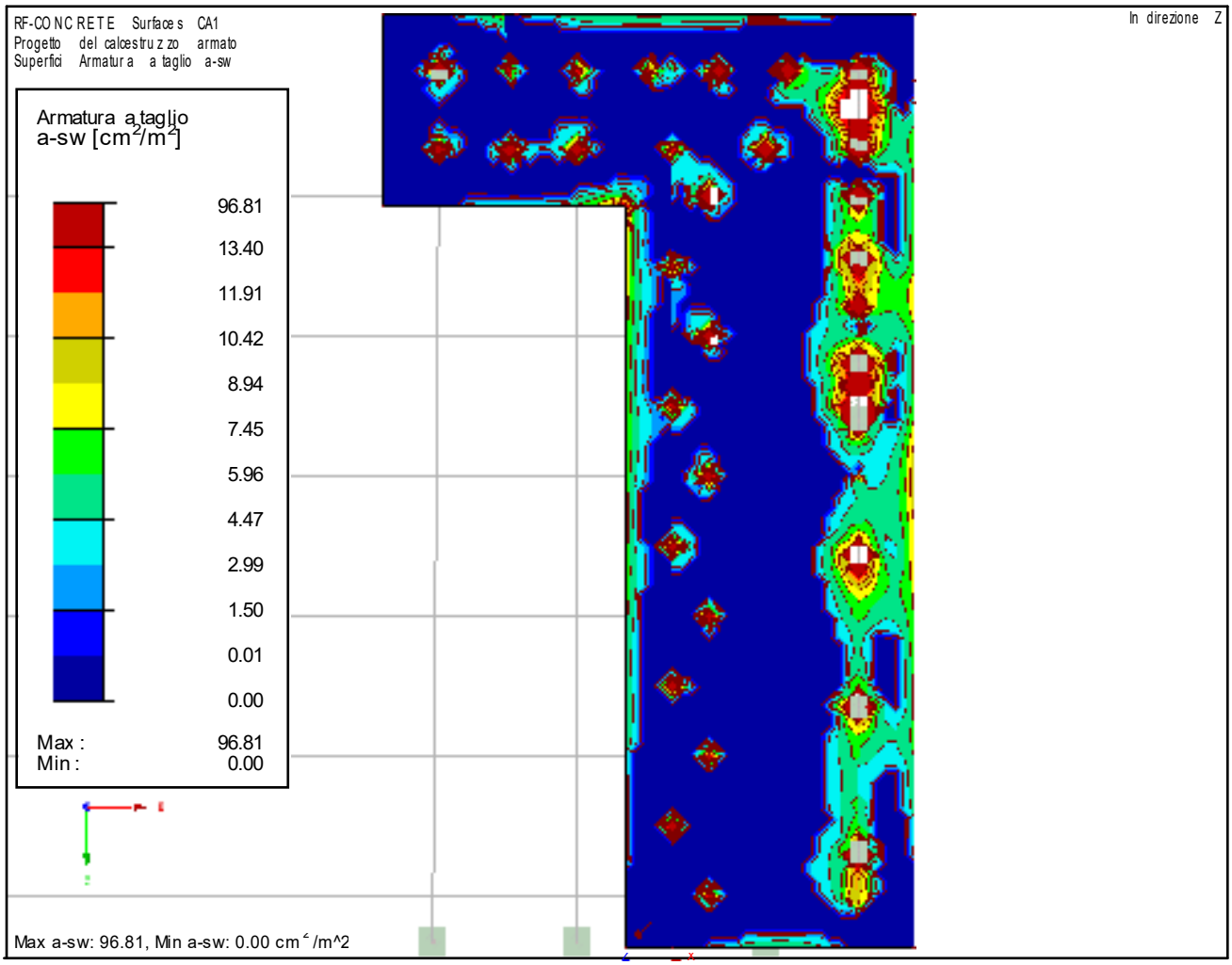
10.6. Isolinee di armatura intradosso in direzione trasversale alla direzione del ponte



A meno di singolaritá di calcolo si dispone un armatura pari a ϕ20/15=20,93 cm^2/m

10.7. Isolinee di armatura a taglio

Si prevede di disporre come armatura base 2ϕ16/30=13,40 cm^2/m^2

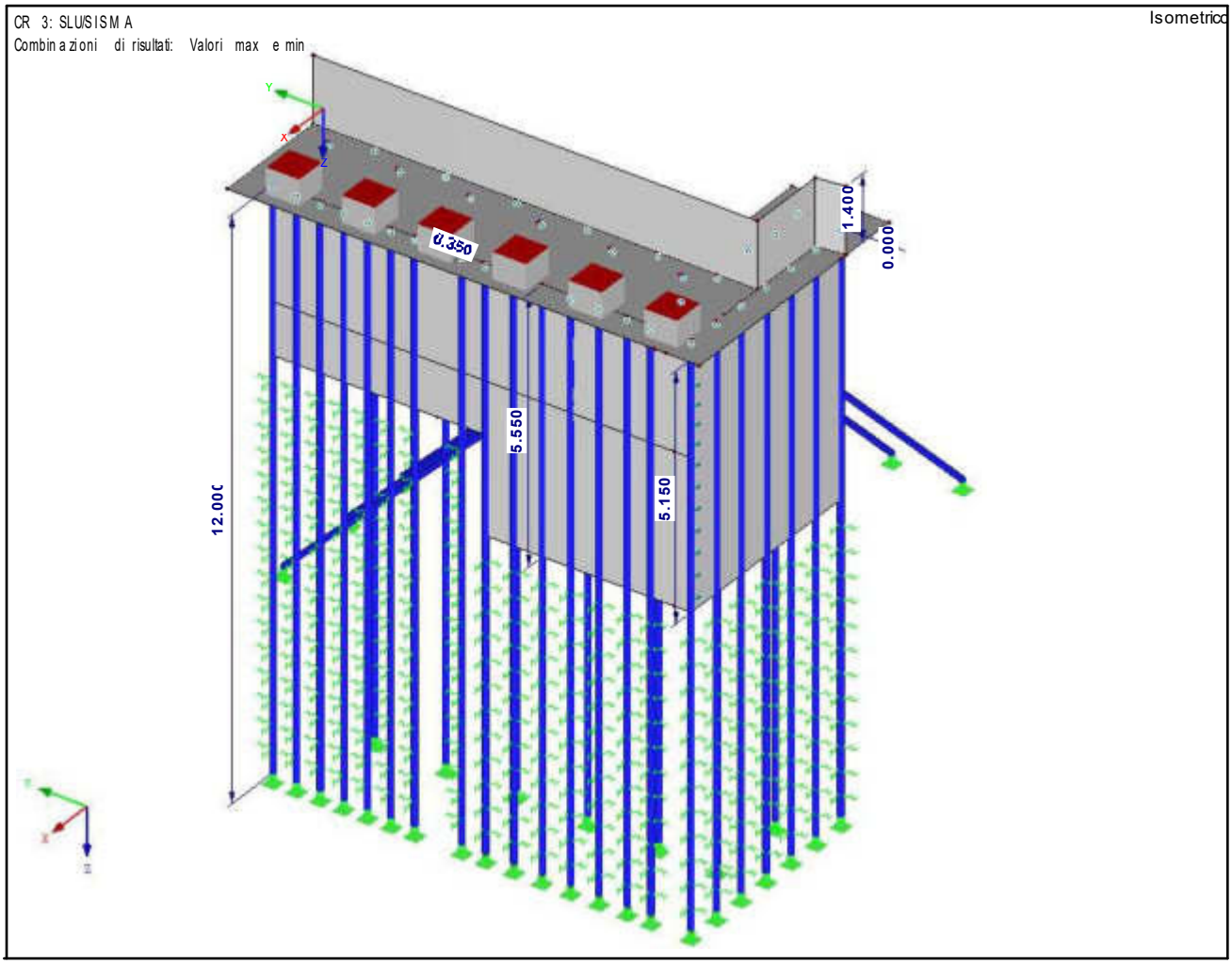


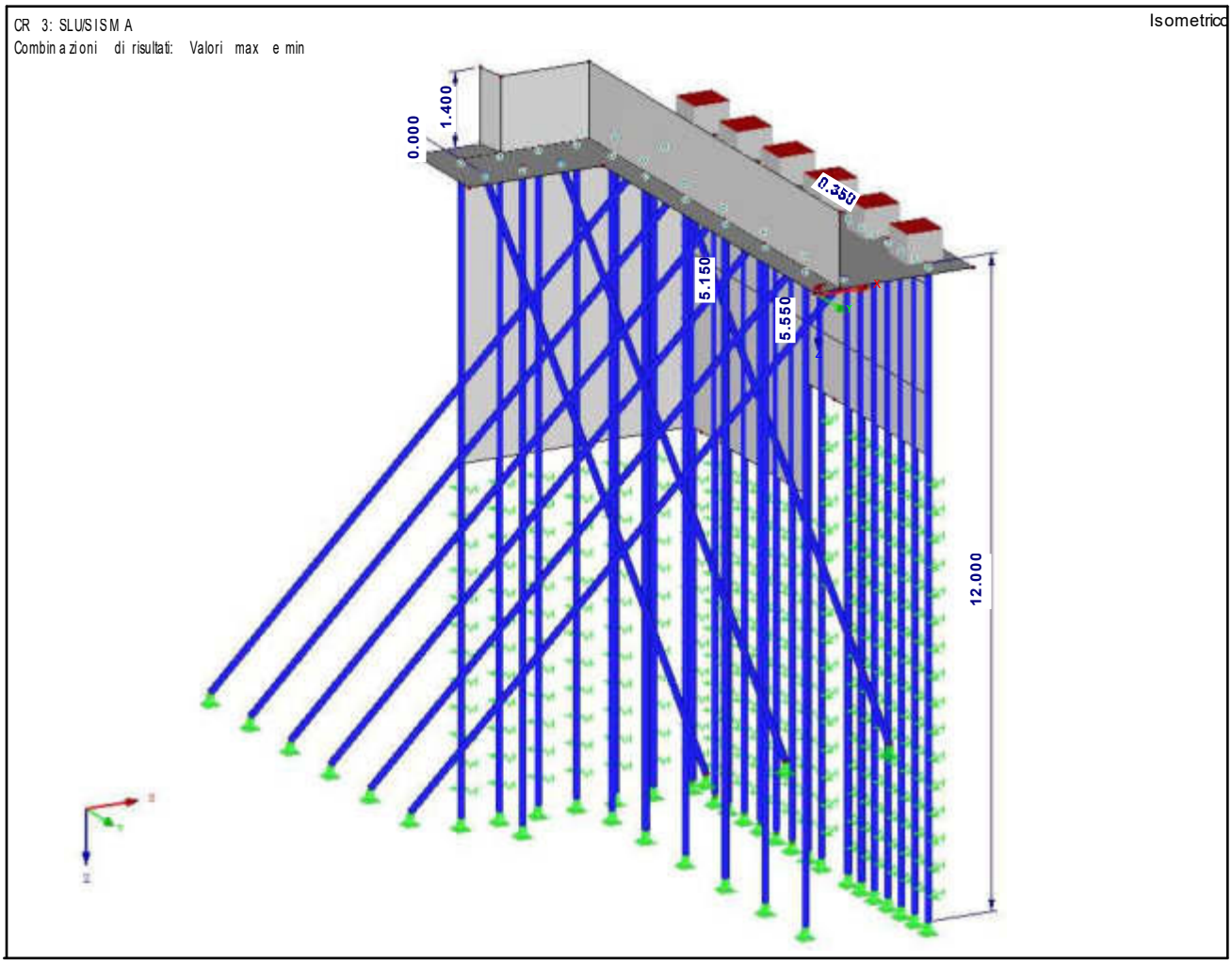
10.8. Verifica a punzonamento

Vedi allegato A

11. Micropali

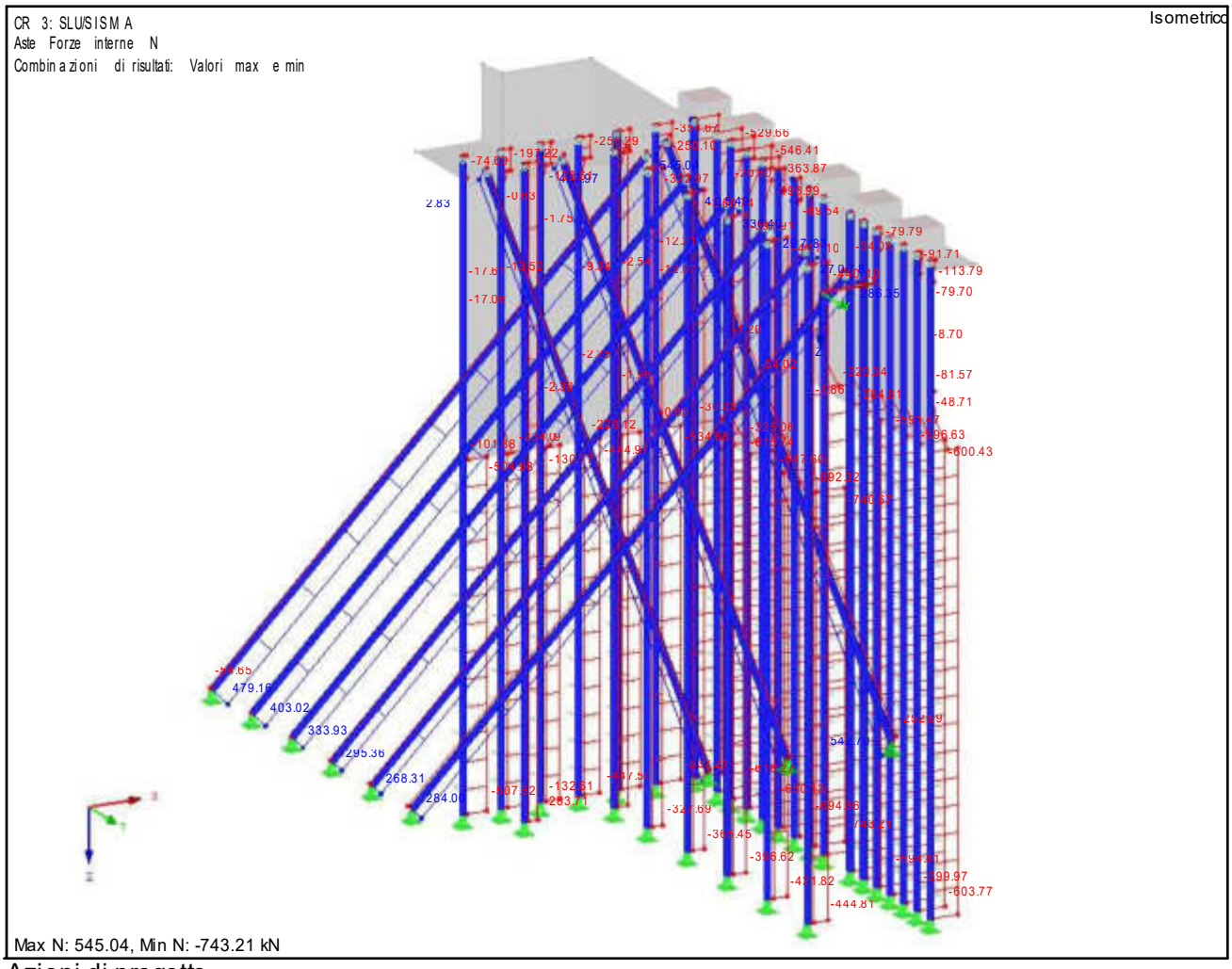
11.1. Geometria




CR 3: SLU/SISM A
Combinazioni di risultati: Valori max e min
Isometrico
0.000
1.400
0.350
5.150
5.550
12.000

11.2. Inviluppo sforzo normale di progetto SLU/SISMA e verifica sezione metallica

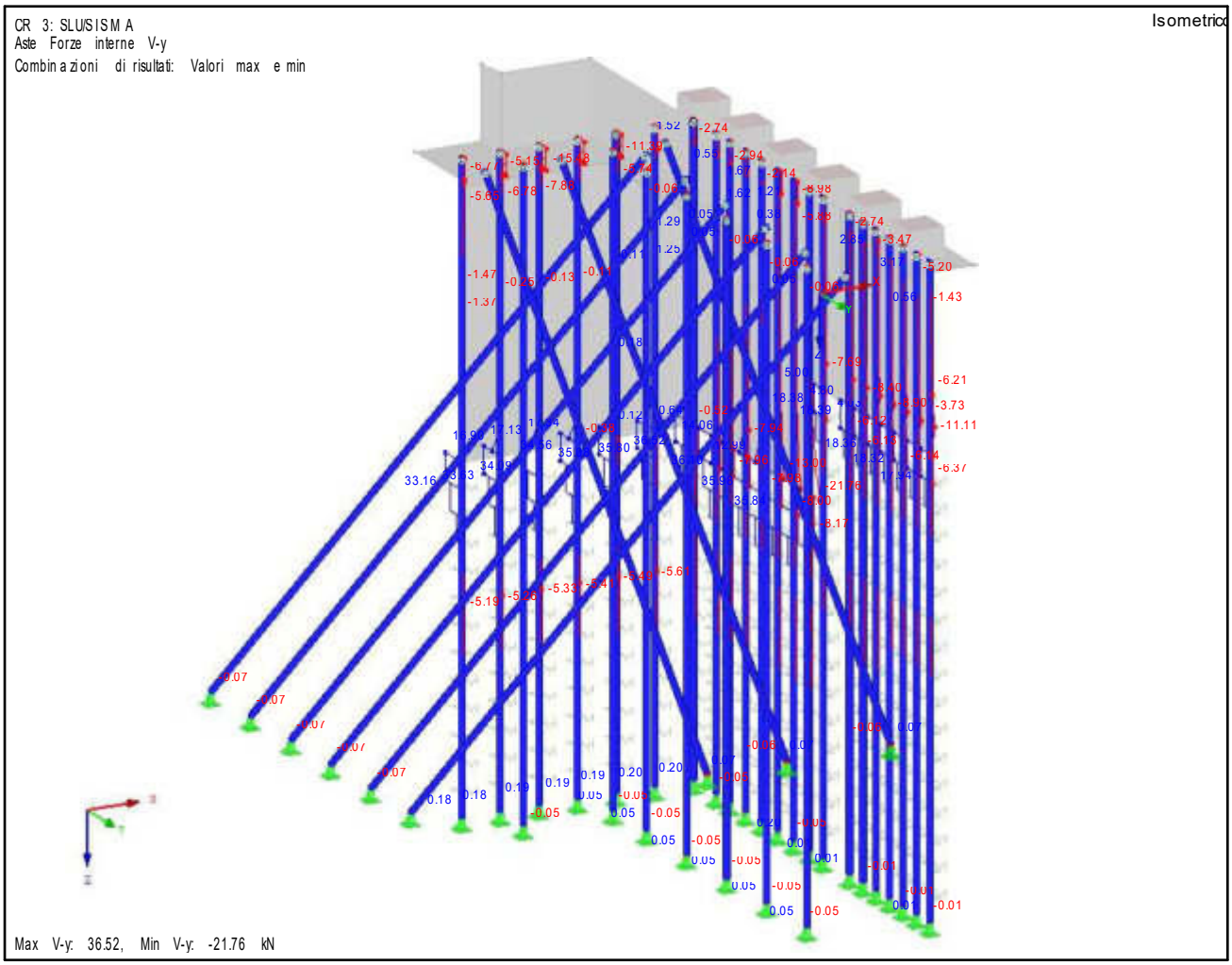
11.2.1. Inviluppo sforzo normale di progetto SLU/SISMA



Azioni di progetto

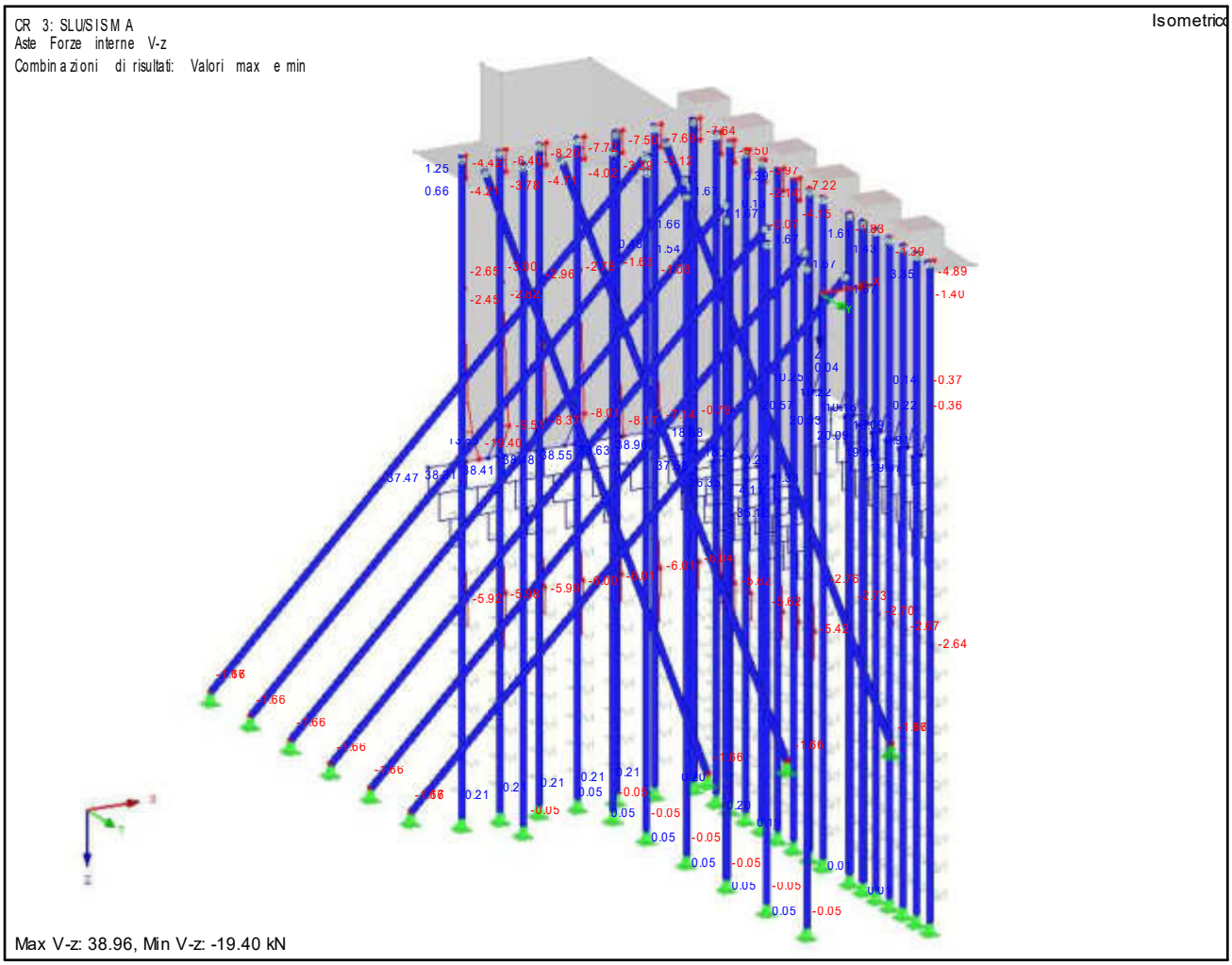
Nedmax di trazione=550,00 kN

Nedmax di compressione=750,00 kN



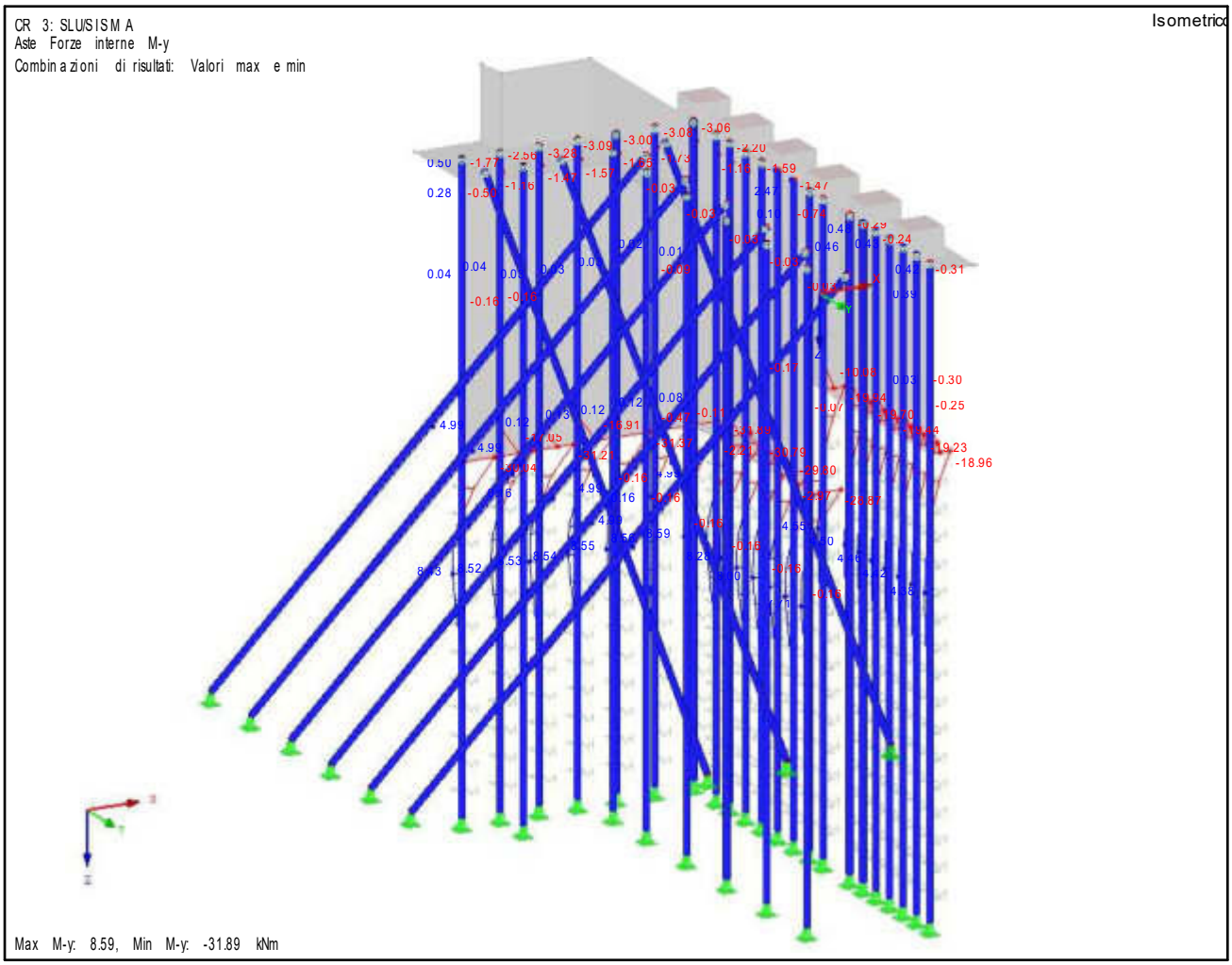
Azioni di progetto

Vedmax in direzione y=40,00 kN



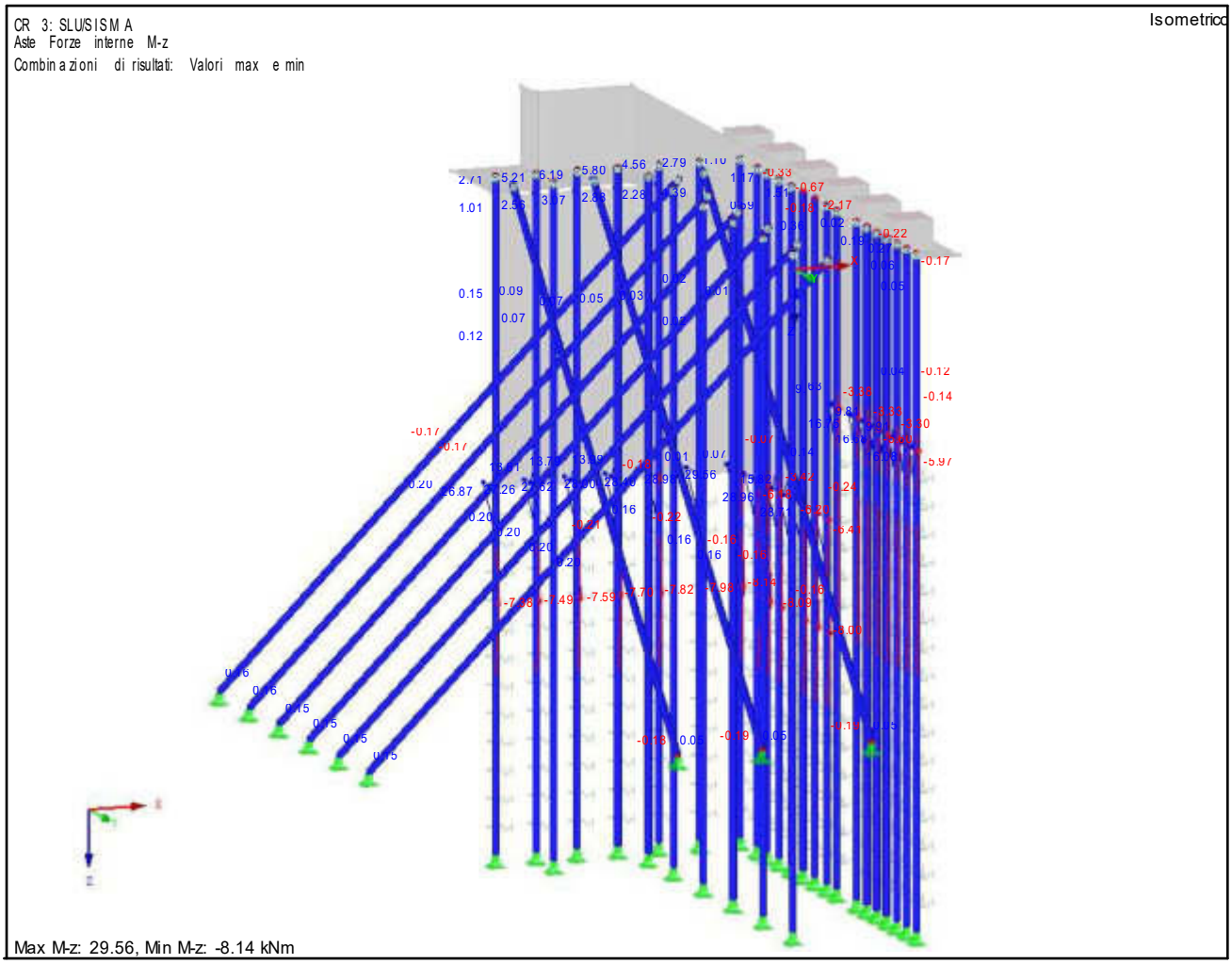
Azioni di progetto

Vedmax in direzione z=40,00 kN



Azioni di progetto

Med_y max=35 kNm



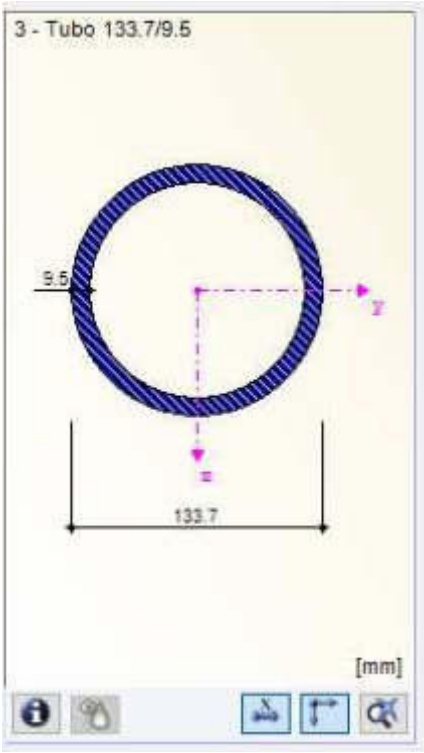
Azioni di progetto

Med_z max=30 kNm

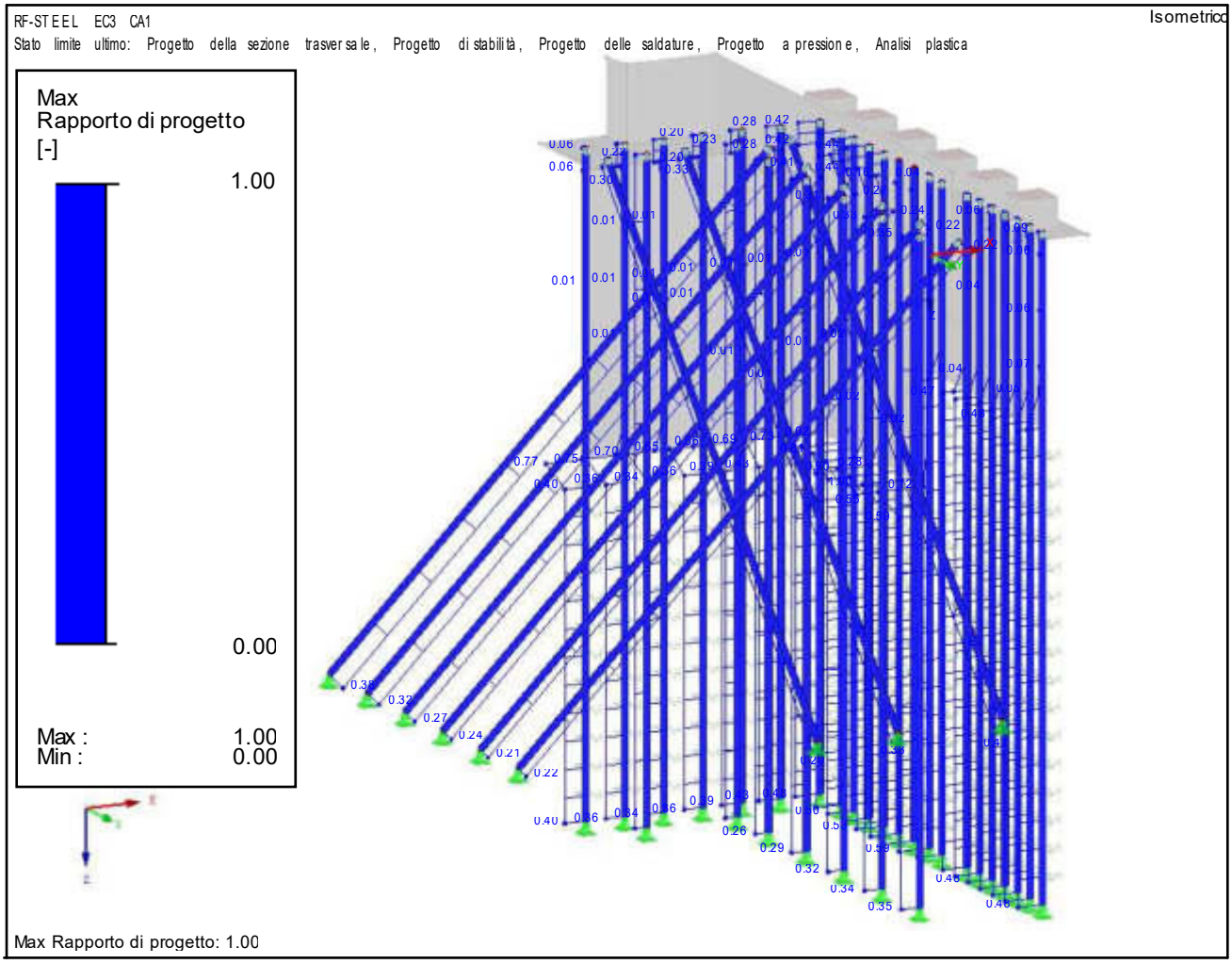
11.2.2. Verifica sezione metallica micropalo

Verifica sezione metallica micropalo		
Micropalo	139,7mmx12,5mm	
d esterno	139,70	mm
Spessore	12,50	mm
d interno	114,70	mm
Area micropalo	4995,13	mm2
Tipo acciaio	355,00	MPA
γs	1,05	-
fyd	338,10	MPA
Nrd senza corrosione	1688,83	kN
Riduzione diametro esterno corros	6,00	mm
diametro esterno corroso	133,70	mm
diametro interno	114,70	mm
Area micropalo con corrosione	3706,77	mm2
Nrd con corrosione	**1253,24**	**kN**
Ned	**750,00**	kN
Verifica	**Verificato**	

Il diametro del micropalo in trazione subisce una riduzione pari a 3,00mm in quanto si ipotizza lo strato di boiacca fessurato. Si assume una vita utile di 100 anni.



Di seguito l´output di verifica di tutti i micropali con sezione ridotta. Micropalo di dimensioni 113,70x9,50mm.



2.1 Progetto per caso di carico

Carico	A Descrizione	B Asta nr.	C Posizione x [m]	D Rapporto di progetto	E	F Formula di progetto	G SP
	Progetto allo stato limite ultimo						
CR1	SLU	63	0.000	1.00	≤ 1	CS221) Verifica della sezione trasversale - Flessione biassiale, forza assiale e di taglio sec. I	PT
CR2	SISMA	63	0.000	0.53	≤ 1	CS221) Verifica della sezione trasversale - Flessione biassiale, forza assiale e di taglio sec. I	EC
			Max:	1.00	≤ 1		

Forze interne di progetto					
Forza assiale	N_{Ed}	-703.99	kN		
Forza di taglio	$V_{y,Ed}$	27.13	kN		
Forza di taglio	$V_{z,Ed}$	27.66	kN		
Momento torcente	T_{Ed}	-0.01	kNm		
Momento	$M_{y,Ed}$	-21.99	kNm		
Momento	$M_{z,Ed}$	21.98	kNm		

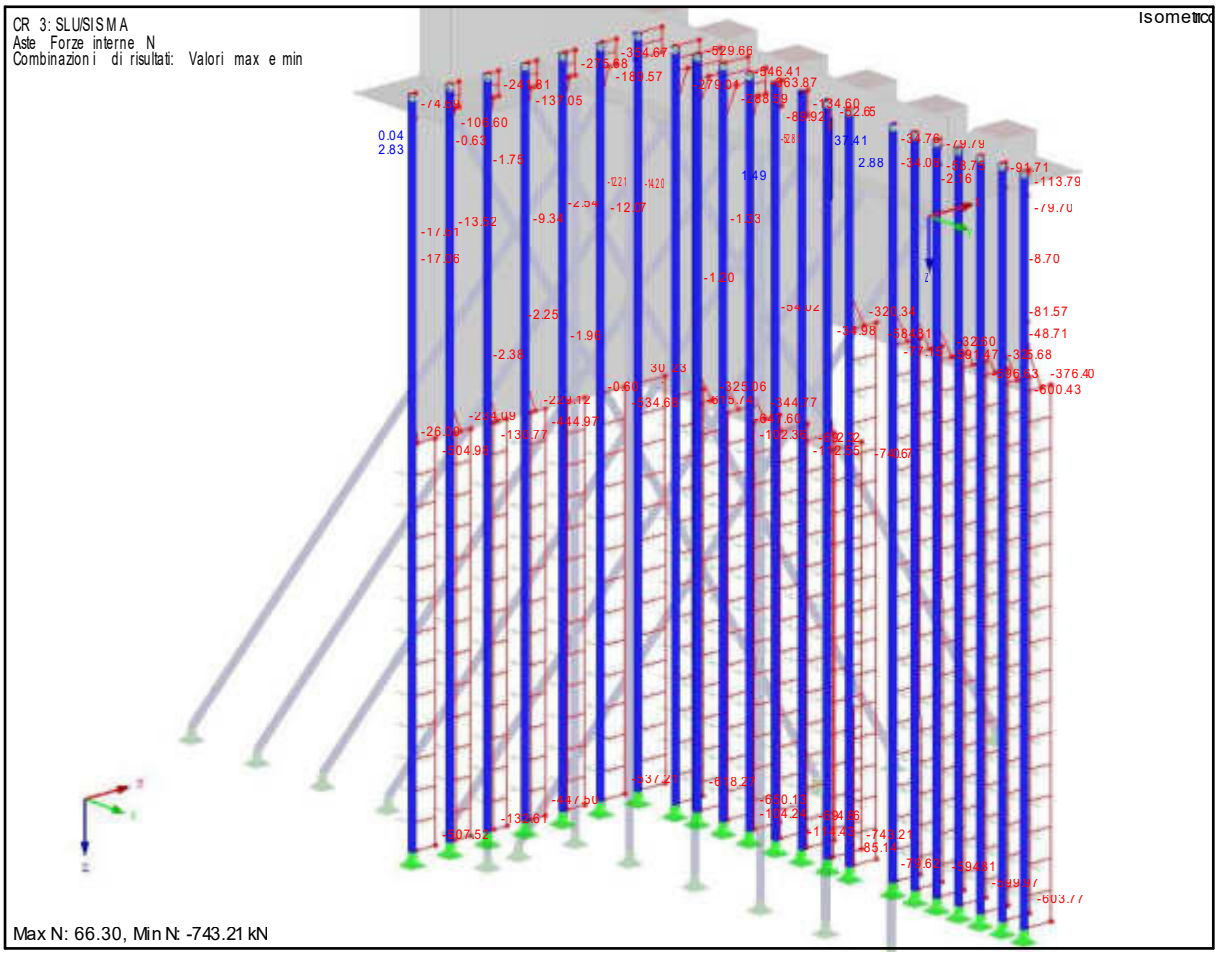
Dettagli - Asta 63 - x: 0.000 m - CR1

Proprietà del materiale - Acciaio S 355 | UNI EN 10025-2:2004-11					
Proprietà della sezione trasversale - Tubo 133.7/9.5					
Forze interne di progetto					
Forza assiale	N_{Ed}	-703.90	kN		
Forza di taglio	$V_{y,Ed}$	27.12	kN		
Forza di taglio	$V_{z,Ed}$	27.67	kN		
Momento torcente	T_{Ed}	-0.01	kNm		
Momento	$M_{y,Ed}$	-22.00	kNm		
Momento	$M_{z,Ed}$	21.97	kNm		
Classificazione della sezione trasversale - Classe 1					

Rapporto di progetto				
Momento	$M_{y,Ed}$	22.00	kNm	
Modulo di resistenza plastico	$W_{pl,y}$	146.83	cm^3	
Tensione di snervamento	f_y	35.50	kN/cm^2	
Coefficiente parziale	γ_{M0}	1.050		
Momento resistente	$M_{pl,y,Rd}$	49.64	kNm	
Forza di taglio	$V_{z,Ed}$	27.67	kN	
Area di taglio efficace	$A_{v,z}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,z,Rd}$	460.63	kN	
Criterio $V_{z,Ed} / V_{pl,z,Rd}$	v_z	0.060		≤ 0.5
Forza assiale	N_{Ed}	-703.90	kN	
Area della sezione trasversale	A	37.07	cm^2	
Resistenza plastica di progetto alle forze normali	$N_{pl,Rd}$	1253.24	kN	
Momento resistente	$M_{N,pl,y,Rd}$	31.02	kNm	
Momento	$M_{z,Ed}$	21.97	kNm	
Modulo di resistenza plastico	$W_{pl,z}$	146.83	cm^3	
Momento resistente	$M_{pl,z,Rd}$	49.64	kNm	
Forza di taglio	$V_{y,Ed}$	27.12	kN	
Area di taglio efficace	$A_{v,y}$	23.60	cm^2	
Resistenza alla forza di taglio	$V_{pl,y,Rd}$	460.63	kN	
Criterio $V_{y,Ed} / V_{pl,y,Rd}$	v_y	0.059		≤ 0.5
Momento resistente	$M_{N,pl,z,Rd}$	31.02	kNm	
Costante di interazione	α	2.000		
Costante di interazione	β	2.000		
Componente di progetto per M_y	η_{My}	0.50		≤ 1
Componente di progetto per M_z	η_{Mz}	0.50		≤ 1
Componente di progetto per M	η_M	1.00		≤ 1
Formula di progetto				
$(M_{y,Ed} / M_{N,y,Rd})^{\alpha} + (M_{z,Ed} / M_{N,z,Rd})^{\beta} = 1.00 \le 1$ (6.41)				

11.3. Inviluppo sollecitazioni SLU/SISMA micropali verticali prima fila e verifica geostatica

11.3.1. Inviluppo sollecitazioni SLU/SISMA micropali verticali prima fila



11.3.2. Verifica geostatica micropali verticali L=14m prima fila presso l´appoggio nel muro esistente e del nuovo

Verifica geostatica micropalo verticale compressione I fila L=14m		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in cachirite	200,00	kN/m2
L micropalo bulbo in cachirite	8,50	m
τ limite in rilevato	0,00	kN/m
L micropalo bulbo in rilevato	0,00	m
γc	1,15	-
ξ3	1,40	-
Nrd sfilamento	**796,13**	**kN**
Nrd base	**119,42**	**kN**
Nrd	**915,55**	**kN**
Ned	**750,00**	kN
Verifica	**Verificato**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

Nrd base=0,15*Nrd sfilamento

I pali in asse al ponte sotto il muro esistente e al nuovo muro strutturale vengono allungati a 14m

11.3.3. Verifica geostatica micropali verticali L=12m prima fila presso muri d´ala esistenti

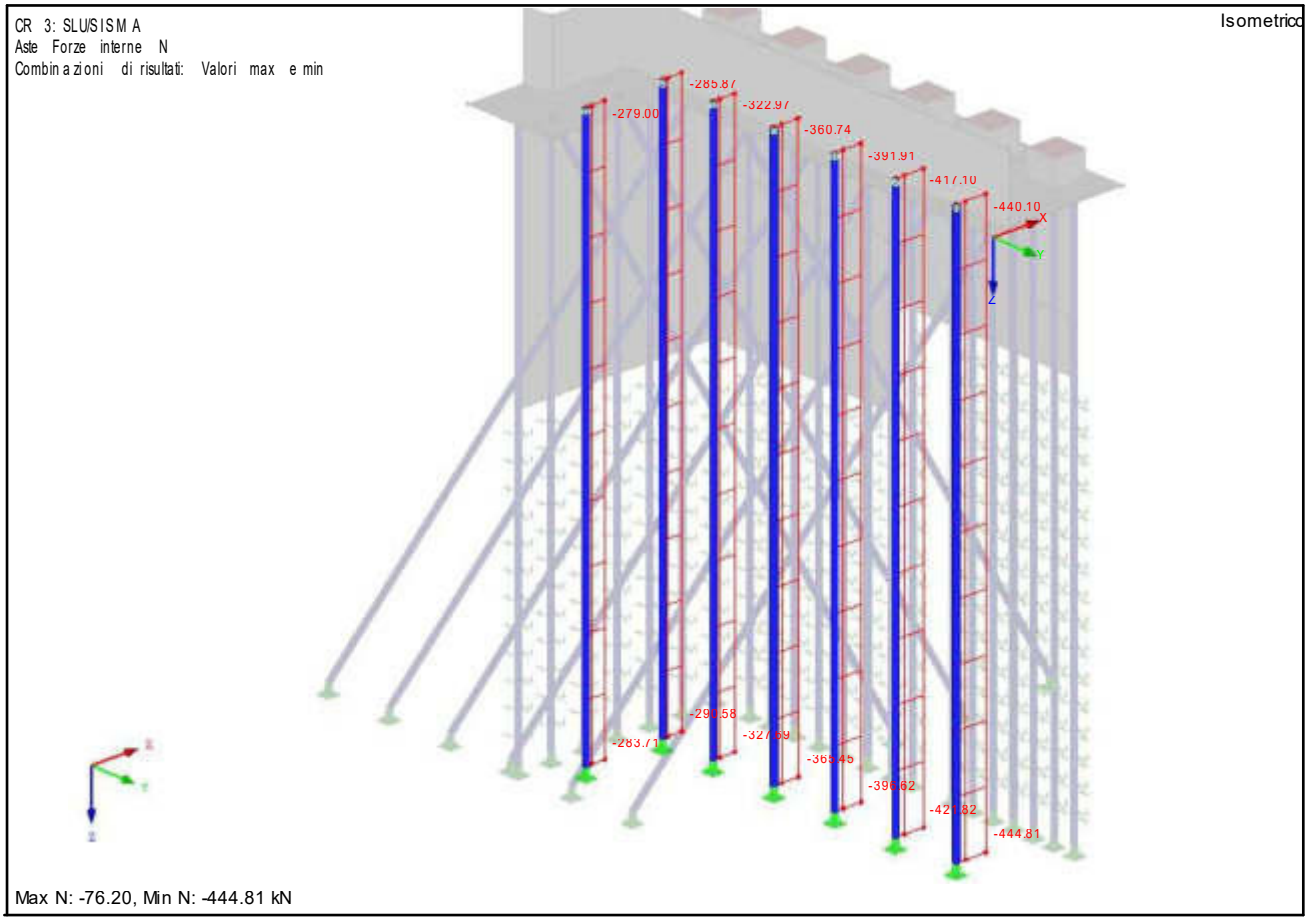
Verifica geostatica micropalo verticale compressione I fila L=12m muro d´ala		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in cachirite	200,00	kN/m2
L micropalo bulbo in cachirite	6,50	m
τ limite in rilevato	0,00	kN/m
L micropalo bulbo in rilevato	0,00	m
γc	1,15	-
ξ3	1,40	-
Nrd sfilamento	**608,81**	**kN**
Nrd base	**91,32**	**kN**
Nrd	**700,13**	**kN**
Ned	**600,00**	kN
Verifica	**Verificato**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

Nrd base=0,15*Nrd sfilamento

11.4. Inviluppo sollecitazioni SLU/SISMA micropali verticali seconda fila e verifica geostatica

11.4.1. Inviluppo sollecitazioni SLU/SISMA micropali verticali seconda fila



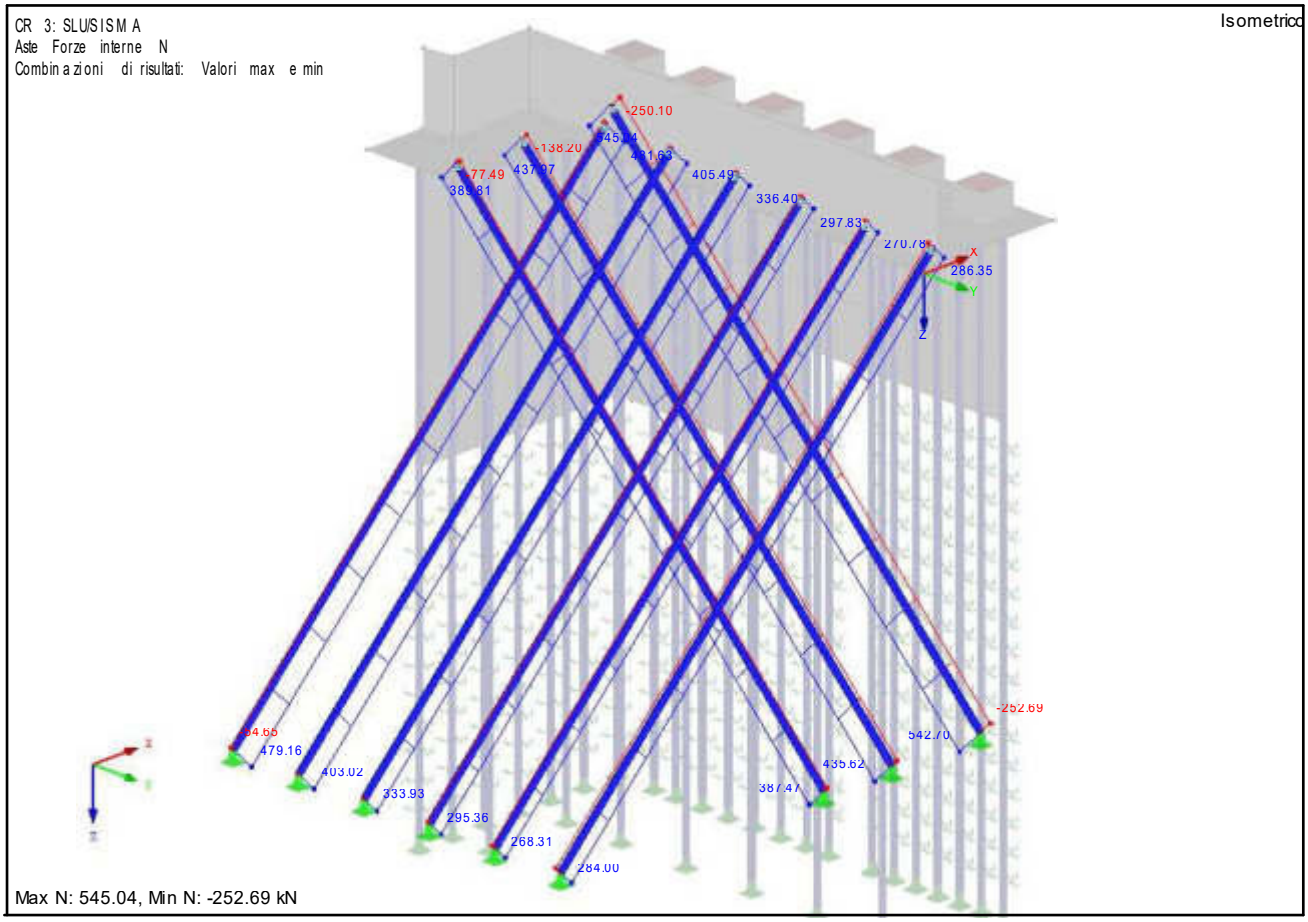
11.4.2. Verifica geostatica micropali verticali seconda fila

Verifica geostatica micropalo verticale a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in cachirite	200,00	kN/m2
L micropalo bulbo in cachirite	6,50	m
τ limite in rilevato	150,00	kN/m2
L micropalo bulbo in rilevato	1,50	m
γc	1,15	-
ξ3	1,40	-
Nrd sfilamento	**714,18**	**kN**
Nrd base	**107,13**	**kN**
Nrd	**821,30**	**kN**
Ned	**450,00**	kN
Verifica	**Verificato**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)
Nrd base=0,15*Nrd sfilamento

11.5. Inviluppo sollecitazioni SLU/SISMA micropali inclinati seconda fila e verifica geostatica

11.5.1. Inviluppo sollecitazioni SLU/SISMA micropali inclinati seconda fila



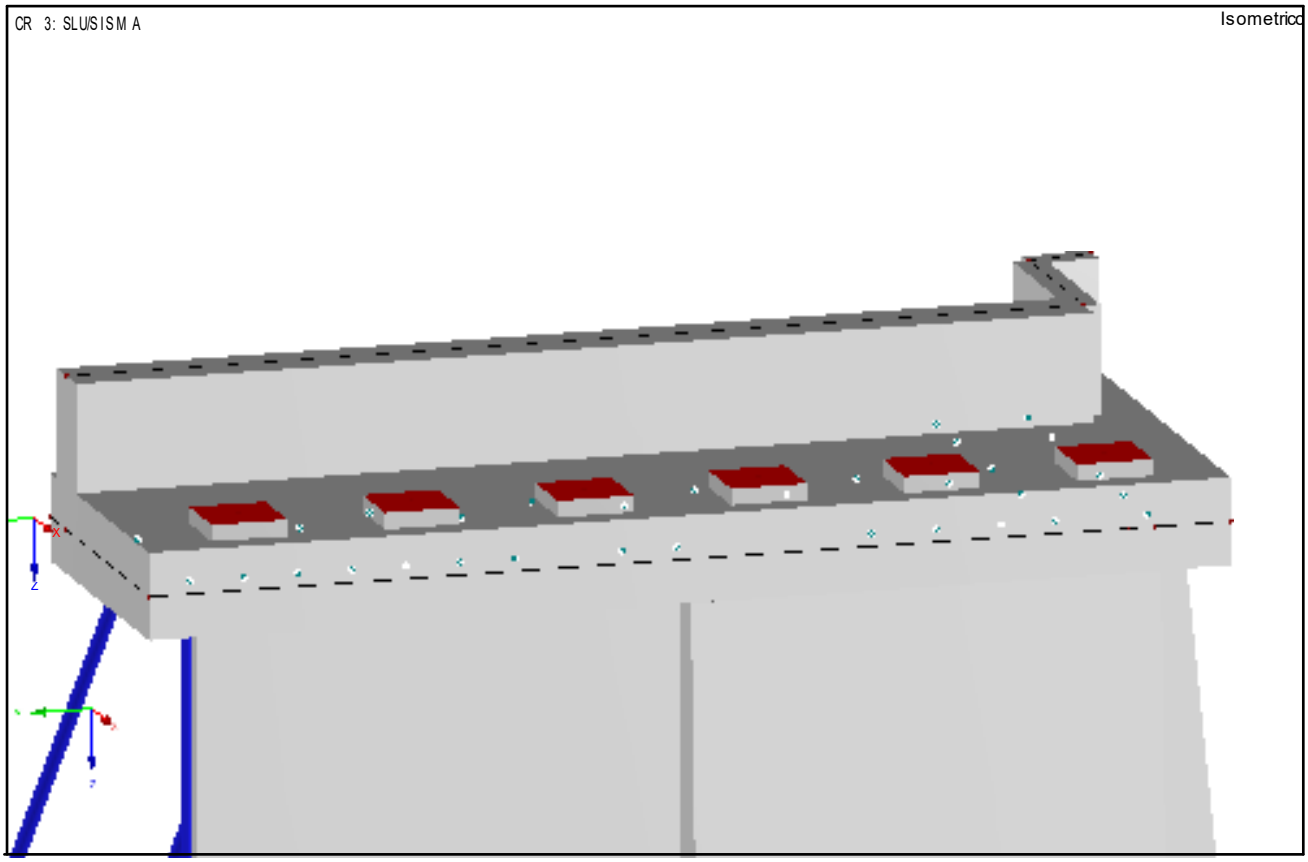
11.5.2. Verifica geostatica micropali inclinati seconda fila

Verifica geostatica micropalo 12m inclinato a trazione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in cachirite	200,00	kN/m2
L micropalo bulbo in cachirite	6,00	m
τ limite in cachirite	150,00	kN/m2
L micropalo bulbo in cachirite	2,00	m
γt	1,25	-
ξ3	1,40	-
Nrd	**646,27**	**kN**
Ned	**600,00**	kN
Verifica	**Verificato**	

Nrd sfilamento=d*Π*L*τlim/(γ*ξ)

12. Baggioli

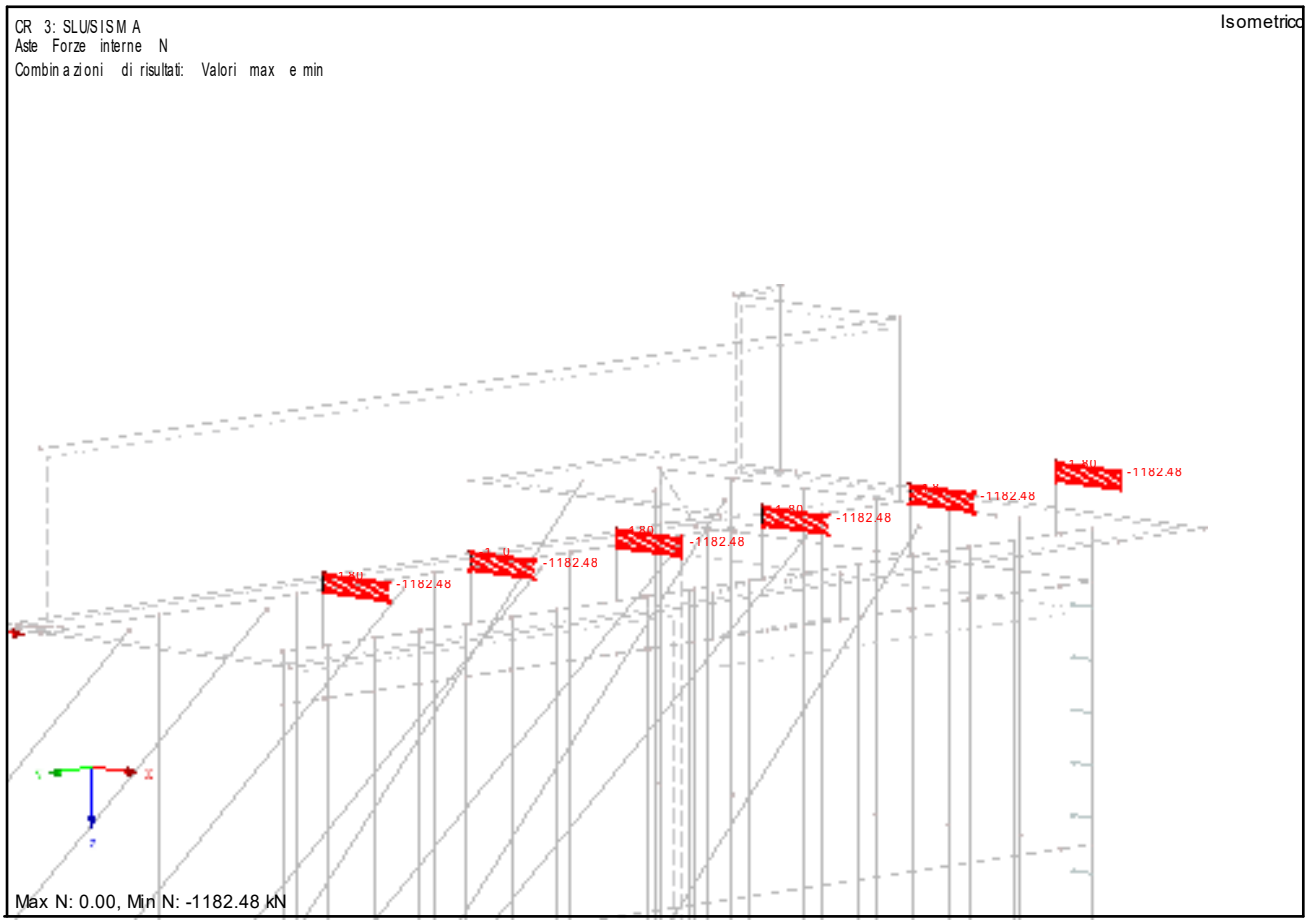
12.1. Geometria



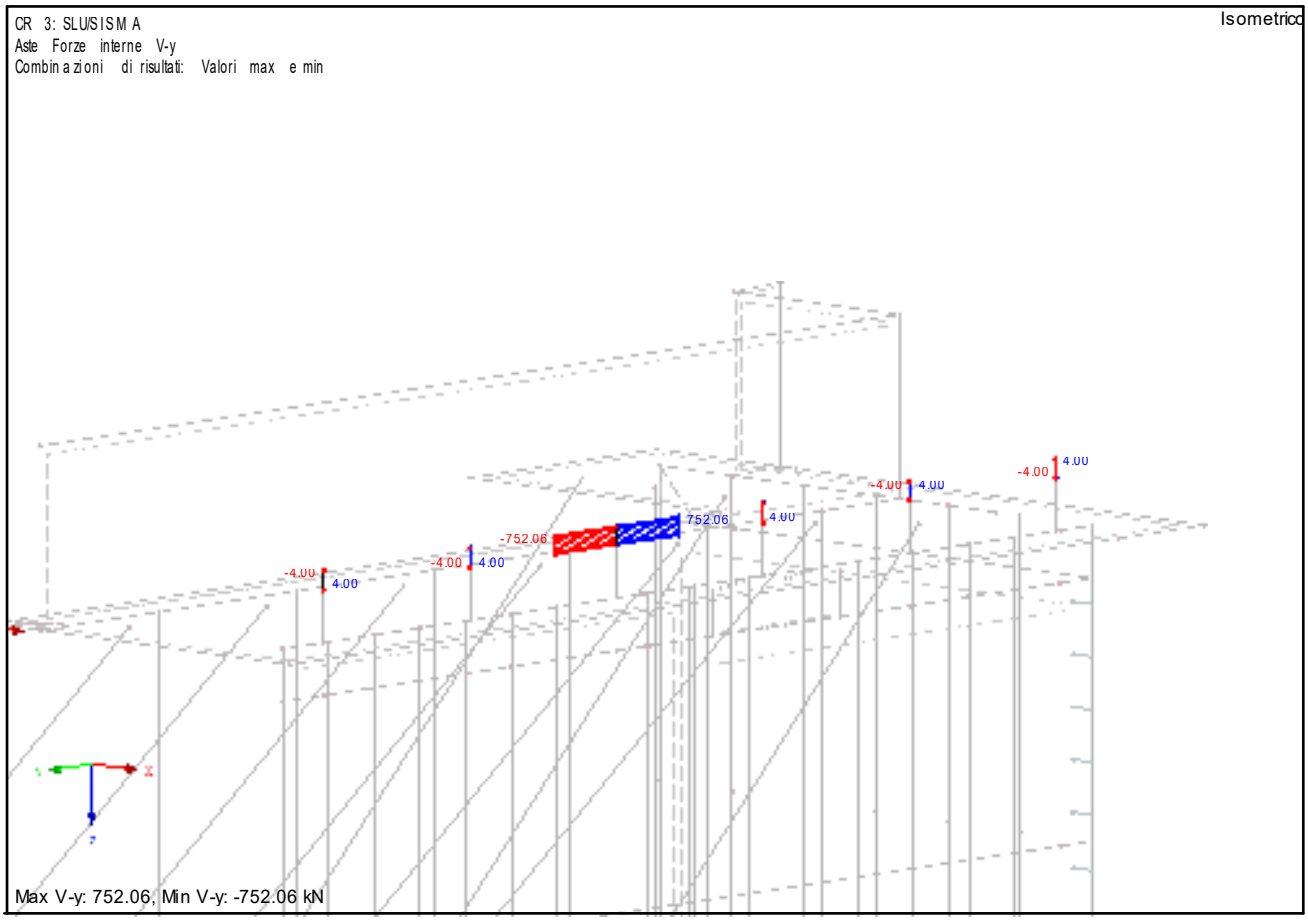
I baggioli dove poggiano gli elastomeri hanno dimensioni 70cmx70cmx15cm

12.2. Inviluppo sollecitazioni SLU/SISMA

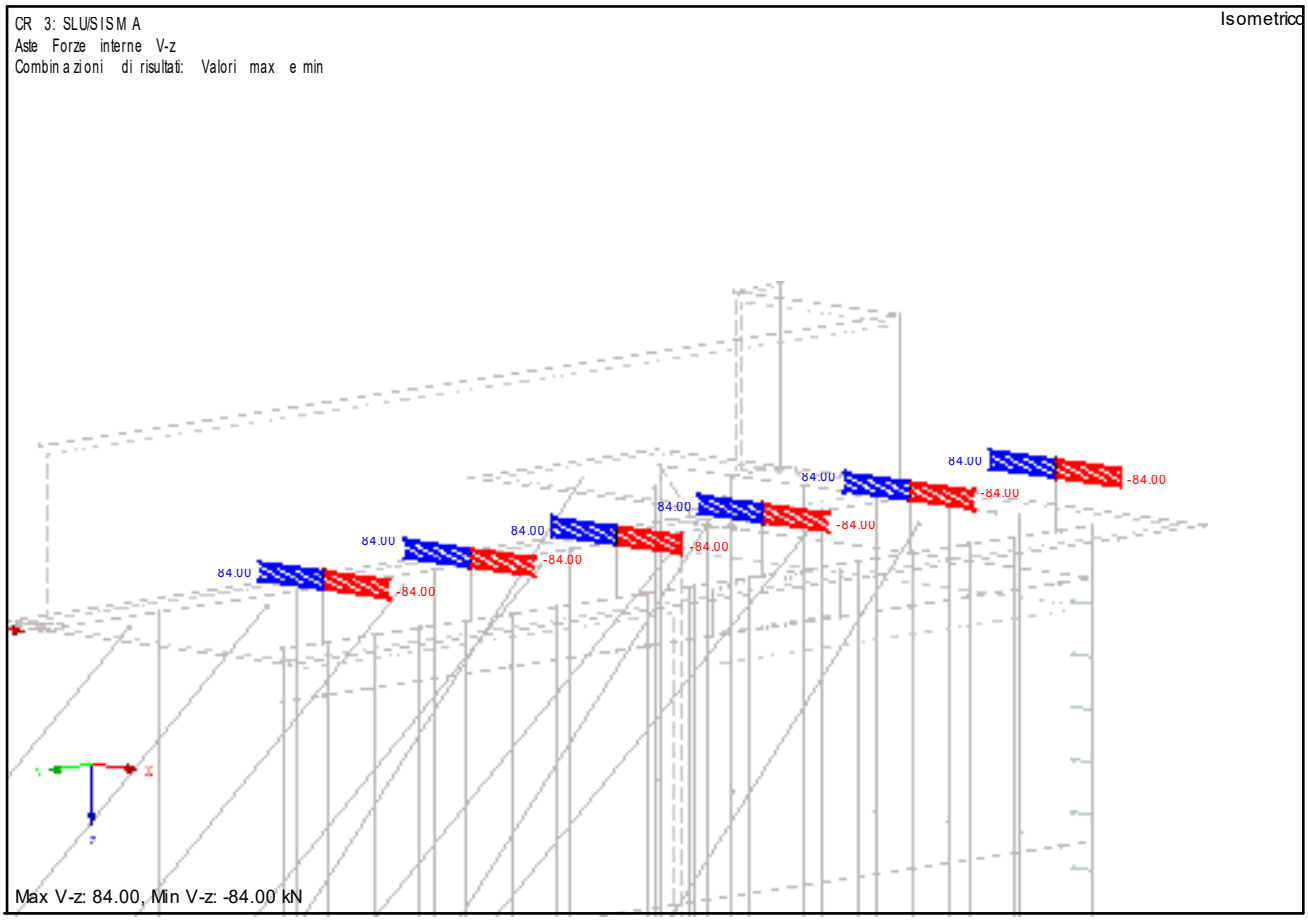
12.2.1. Inviluppo SLU/SISMA Valori sforzo normale N



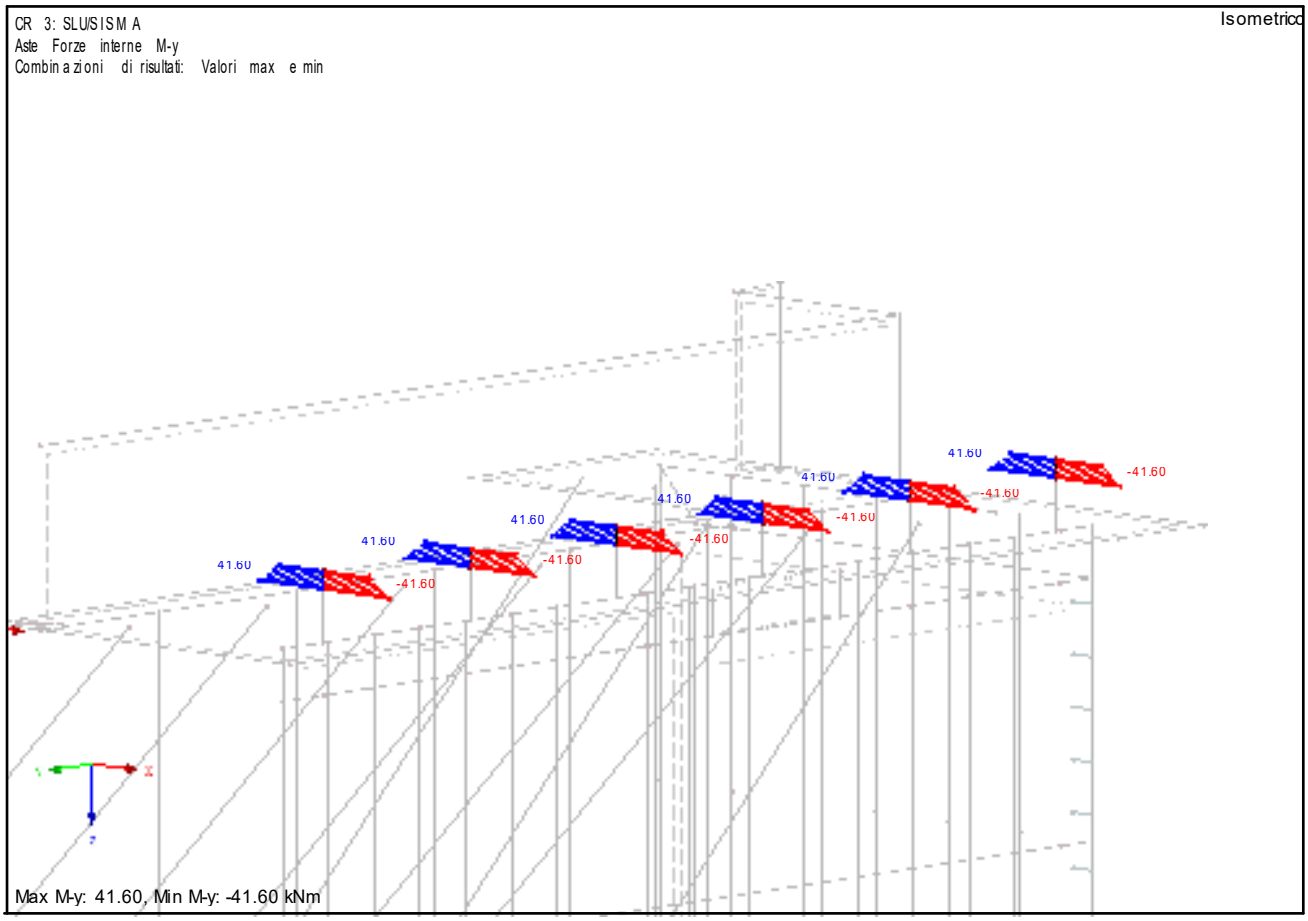
12.2.2. Inviluppo SLU/SISMA Valori taglio trasversale



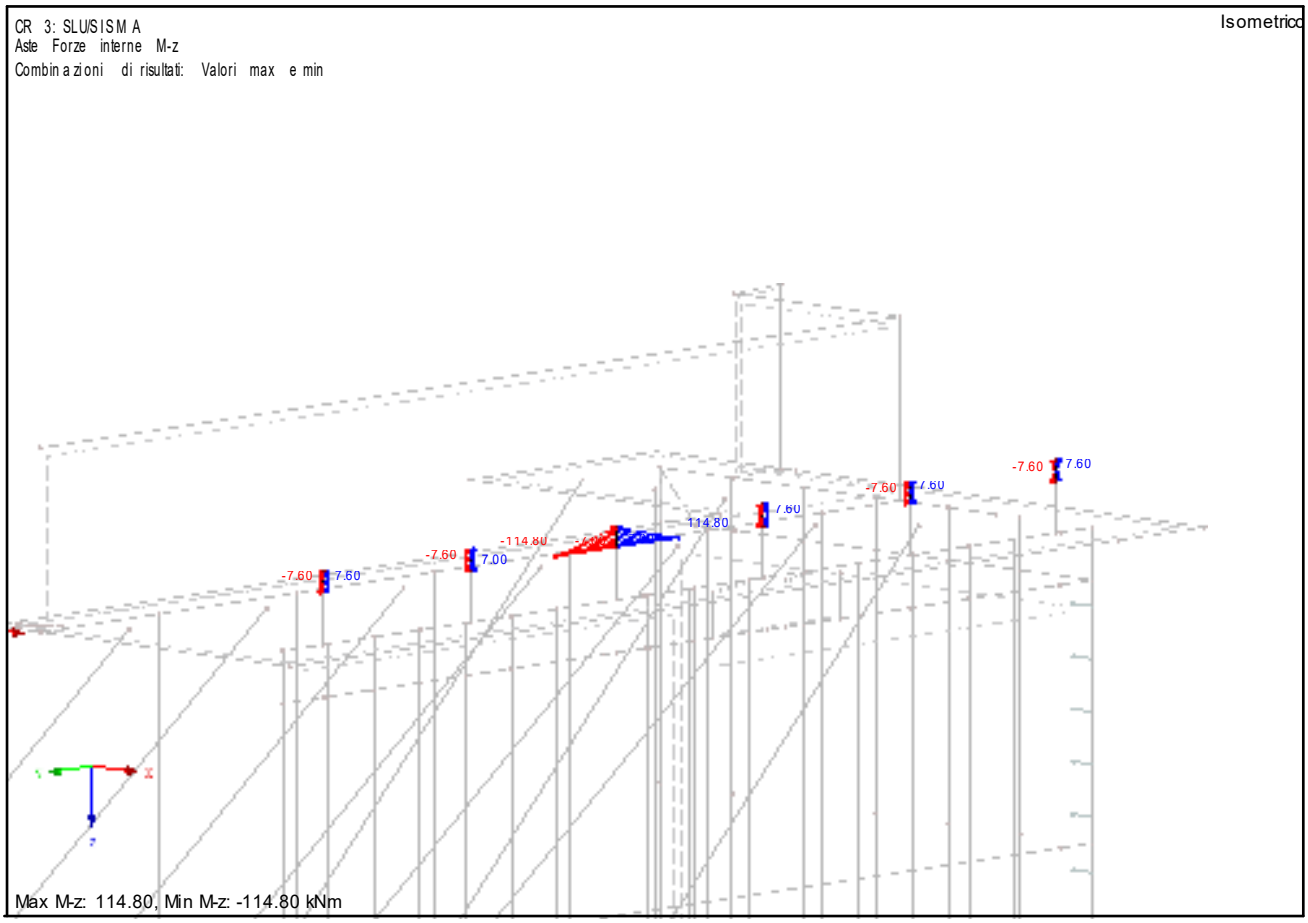
12.2.3. Inviluppo SLU/SISMA Valori taglio longitudinale



12.2.4. Inviluppo SLU/SISMA Valori momento flettente longitudinale



12.2.5. Inviluppo SLU/SISMA Valori momento flettente trasversale



12.3. Verifiche baggioli

12.3.1. Verifica a pressoflessione

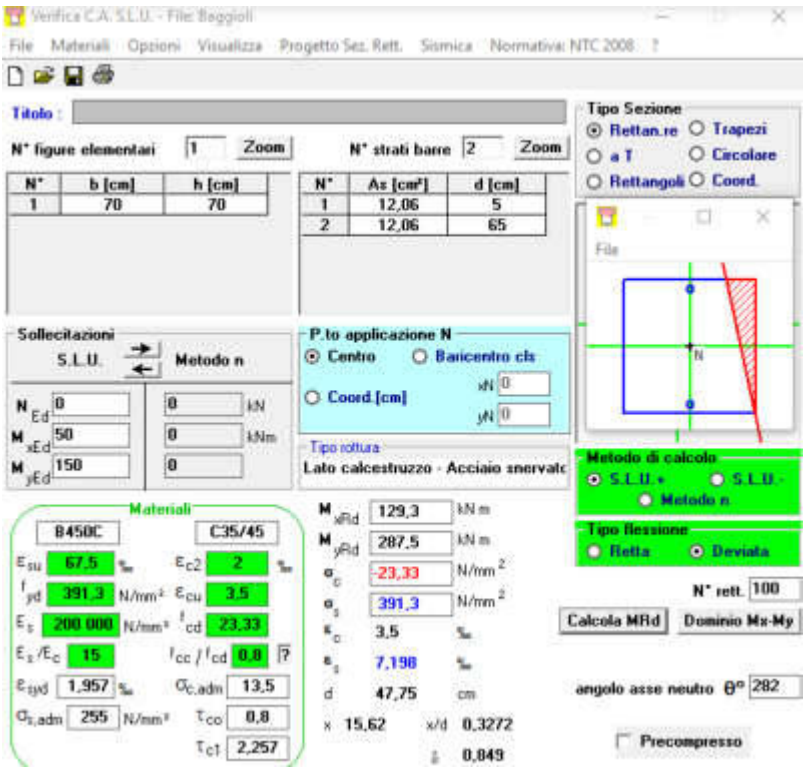
Azioni di progetto

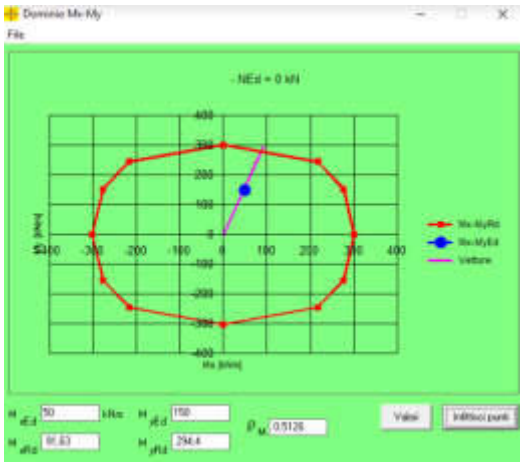
Nsd=0,00 kN

Msd_longitudinale=50,00 kNm

Msd_trasversale=150,00 kNm

Si dispongono al minimo 6ϕ16=12,06 cm^2





12.3.2. Verifica a taglio

- **Azioni di progetto baggioli per baggioli con appoggio multidirezionale**

Nsd=0,00 kN Vsd=100,00 kN

Tabella per calcolo resistenza senza armatura a taglio

Valore di calcolo del taglio resistente				
d	bw	Nsd	Asl(logitud.)	fck
[m]	[m]	[MN]	[m2]	[MPa]
0,65	0,70	0,000	0,00120	35,00
k	sigma_cp	rho1		
[]	[]	[]		
1,55470	0,00000	0,00264		
V_Rd_1_ senza armatura a taglio				
[MN]				
0,183				

Ved=100,00 kN<Vrd=183,00 kN verificato

- **Azioni di progetto baggioli per baggioli con appoggio fisso trasversale**

Nsd=0,00 kN Vsd_Sisma=800,00 kN

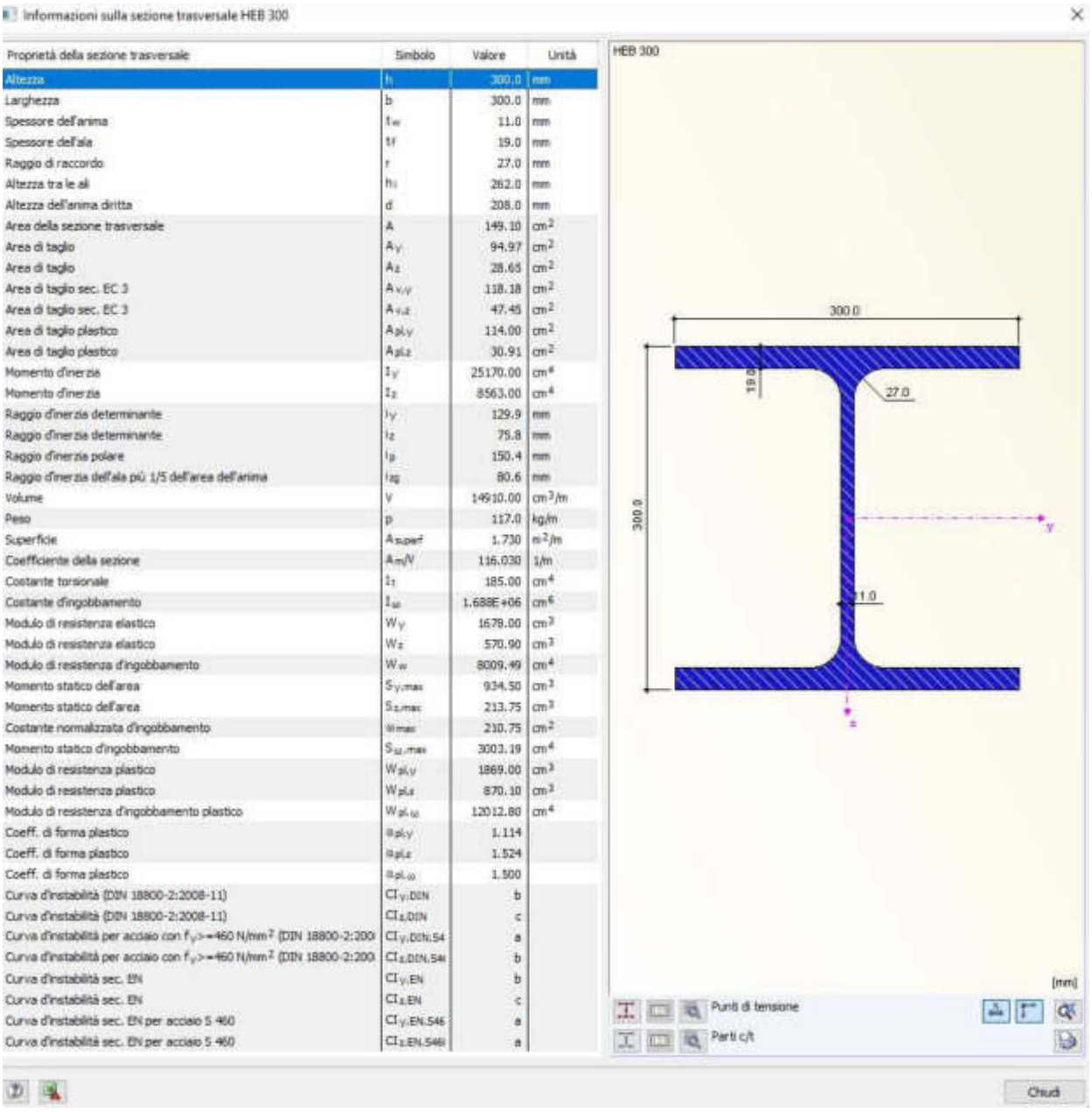
Si prevede l´inserimento di un profilo HEB 300 S355 per l´assorbimento della forza sismica di lunghezza pari a 75 cm.

Av=95,00 cm^2

fyd=fyk/γs=355 MPa/1,05=338,10 MPa

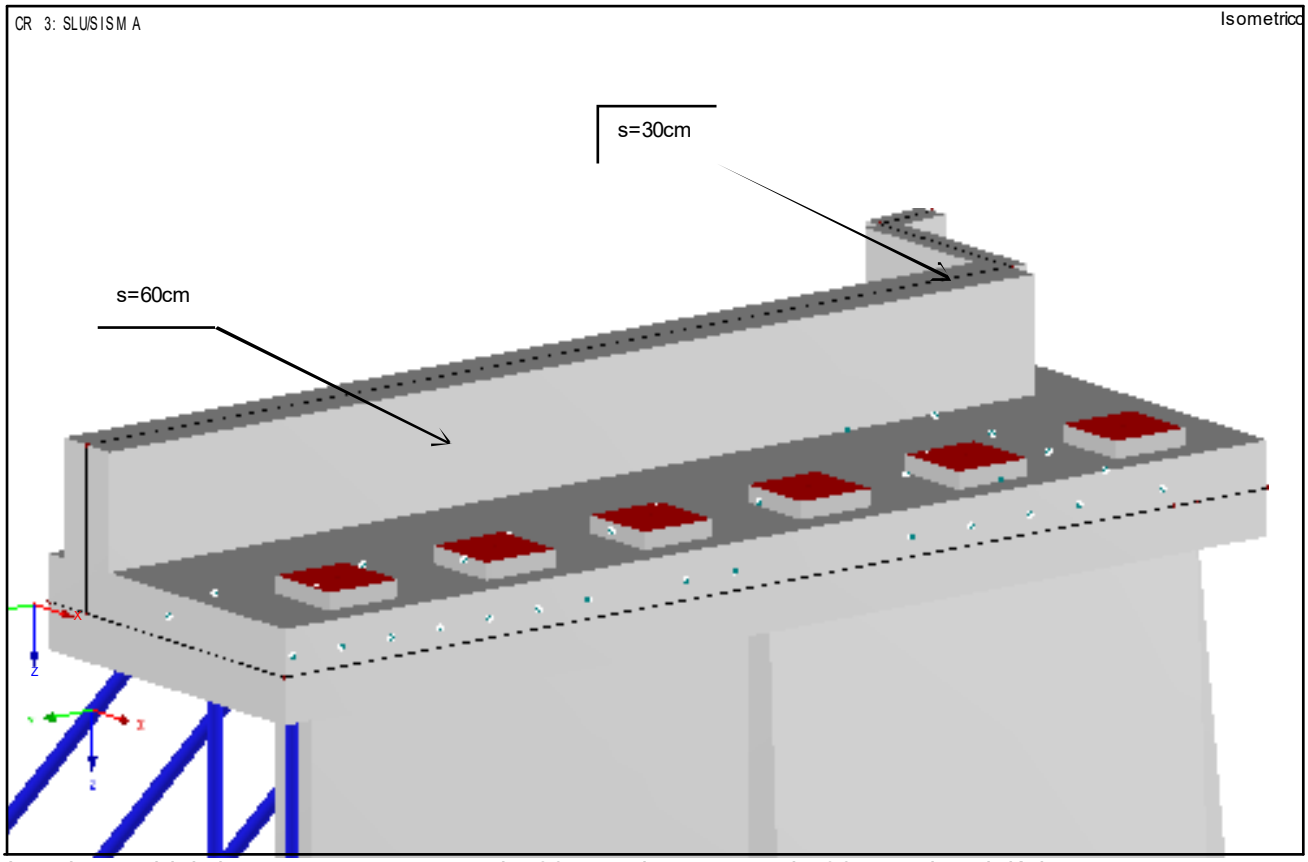
Vrd=fyd*Av//$\sqrt{3}$=338,10 MPa*95/$(100)^2$ m^2*1000/$\sqrt{3}$=1854,40 kN

Ved=800,00 kN<Vrd=1854,40 kN Verificato


Informazioni sulla sezione trasversale HEB 300
Proprietà della sezione trasversale | Simbolo | Valore | Unità
Altezza | h | 300.0 | mm
Larghezza | b | 300.0 | mm
Spessore dell'anima | tw | 11.0 | mm
Spessore dell'ala | tf | 19.0 | mm
Raggio di raccordo | r | 27.0 | mm
Altezza tra le ali | hi | 262.0 | mm
Altezza dell'anima diritta | d | 208.0 | mm
Area della sezione trasversale | A | 149.10 | cm²
Area di taglio | Ay | 94.97 | cm²
Area di taglio | Az | 28.65 | cm²
Area di taglio sec. EC 3 | Av,y | 118.18 | cm²
Area di taglio sec. EC 3 | Av,z | 47.45 | cm²
Area di taglio plastico | Apl,y | 114.00 | cm²
Area di taglio plastico | Apl,z | 30.91 | cm²
Momento d'inerzia | Iy | 25170.00 | cm⁴
Momento d'inerzia | Iz | 8563.00 | cm⁴
Raggio d'inerzia determinante | iy | 129.9 | mm
Raggio d'inerzia determinante | iz | 75.8 | mm
Raggio d'inerzia polare | ip | 150.4 | mm
Raggio d'inerzia dell'ala più 1/5 dell'area dell'anima | irg | 80.6 | mm
Volume | V | 1491.0.00 | cm³/m
Peso | p | 117.0 | kg/m
Superficie | Asuperf | 1.730 | m²/m
Coefficiente della sezione | Am/V | 116.030 | 1/m
Costante torsionale | It | 185.00 | cm⁴
Costante d'ingobbamento | Iω | 1.688E+06 | cm⁶
Modulo di resistenza elastico | Wy | 1678.00 | cm³
Modulo di resistenza elastico | Wz | 570.90 | cm³
Modulo di resistenza d'ingobbamento | Wω | 8009.49 | cm⁴
Momento statico dell'area | Sy,max | 934.50 | cm³
Momento statico dell'area | Sz,max | 213.75 | cm³
Costante normalizzata d'ingobbamento | ωmax | 210.75 | cm²
Momento statico d'ingobbamento | Sω,max | 3003.19 | cm⁴
Modulo di resistenza plastico | Wpl,y | 1869.00 | cm³
Modulo di resistenza plastico | Wpl,z | 870.10 | cm³
Modulo di resistenza d'ingobbamento plastico | Wpl,ω | 12012.80 | cm⁴
Coeff. di forma plastico | αpl,y | 1.114 |
Coeff. di forma plastico | αpl,z | 1.524 |
Coeff. di forma plastico | αpl,ω | 1.500 |
Curva d'instabilità (DIN 18800-2:2008-11) | CIy,DIN | b |
Curva d'instabilità (DIN 18800-2:2008-11) | CIz,DIN | c |
Curva d'instabilità per acciaio con fy>=460 N/mm² (DIN 18800-2:200 | CIy,DIN,54 | a |
Curva d'instabilità per acciaio con fy>=460 N/mm² (DIN 18800-2:200 | CIz,DIN,54 | b |
Curva d'instabilità sec. EN | CIy,EN | b |
Curva d'instabilità sec. EN | CIz,EN | c |
Curva d'instabilità sec. EN per acciaio S 460 | CIy,EN,546 | a |
Curva d'instabilità sec. EN per acciaio S 460 | CIz,EN,546 | a
HEB 300
300.0
19.0
27.0
300.0
21.0
y
z
[mm]
Punti di tensione
Parti c/t
Chiudi

13. Muro paraghiaia

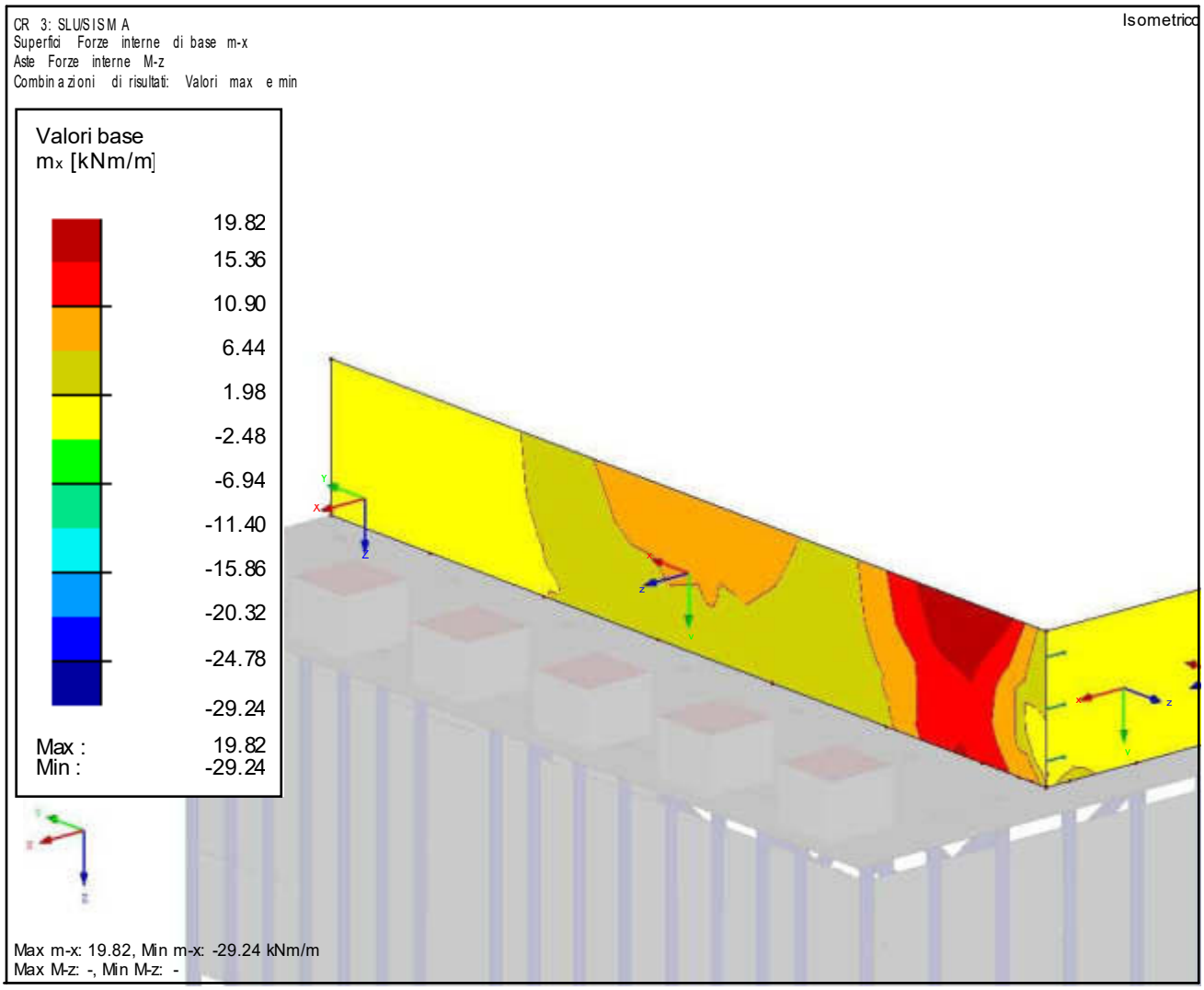
13.1. Geometria



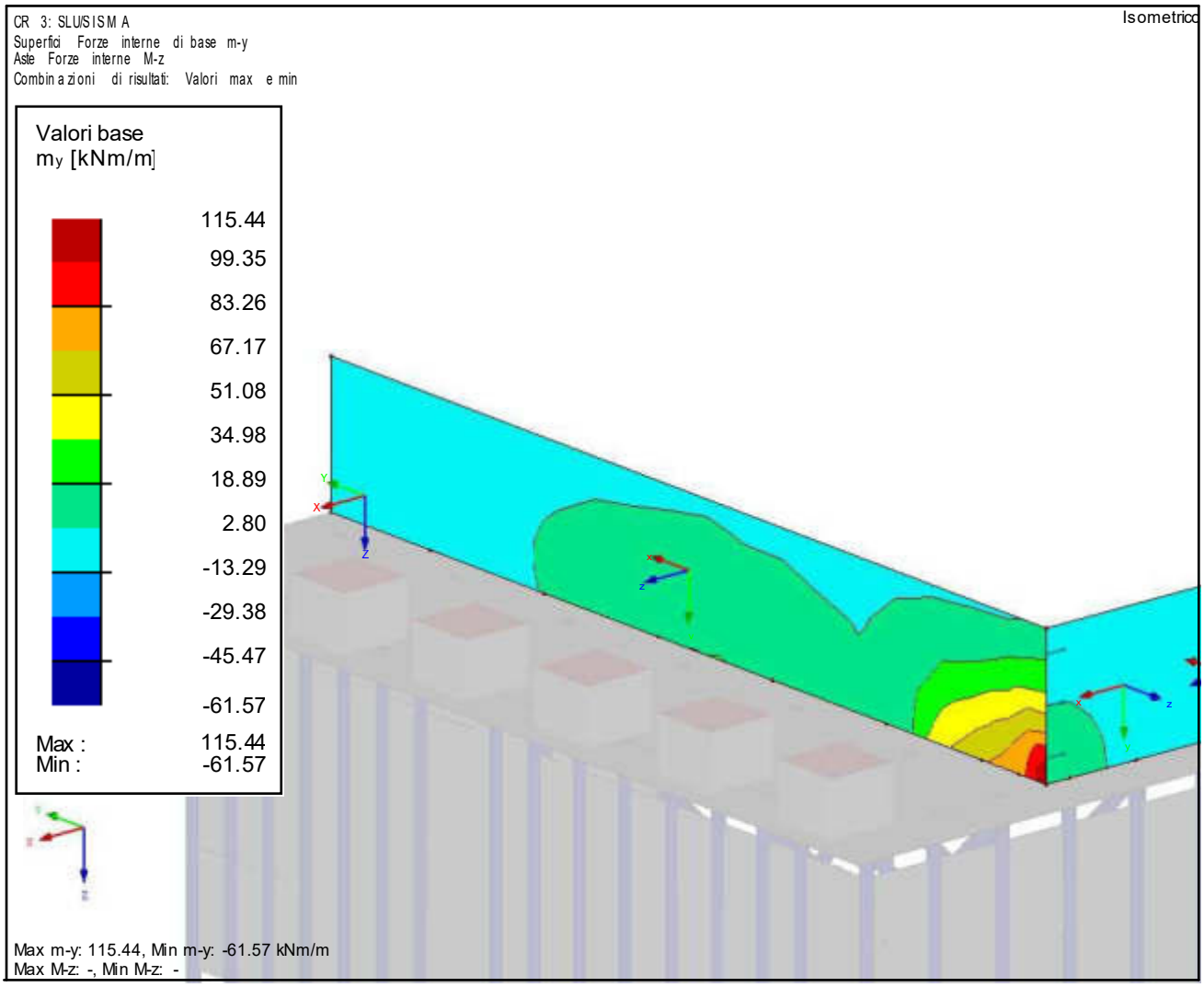
I muri paraghiaia hanno uno spessore pari a 60cm nel ponte e pari a 30cm nei muri d´ala.

13.2. Inviluppo sollecitazioni SLU/SISMA

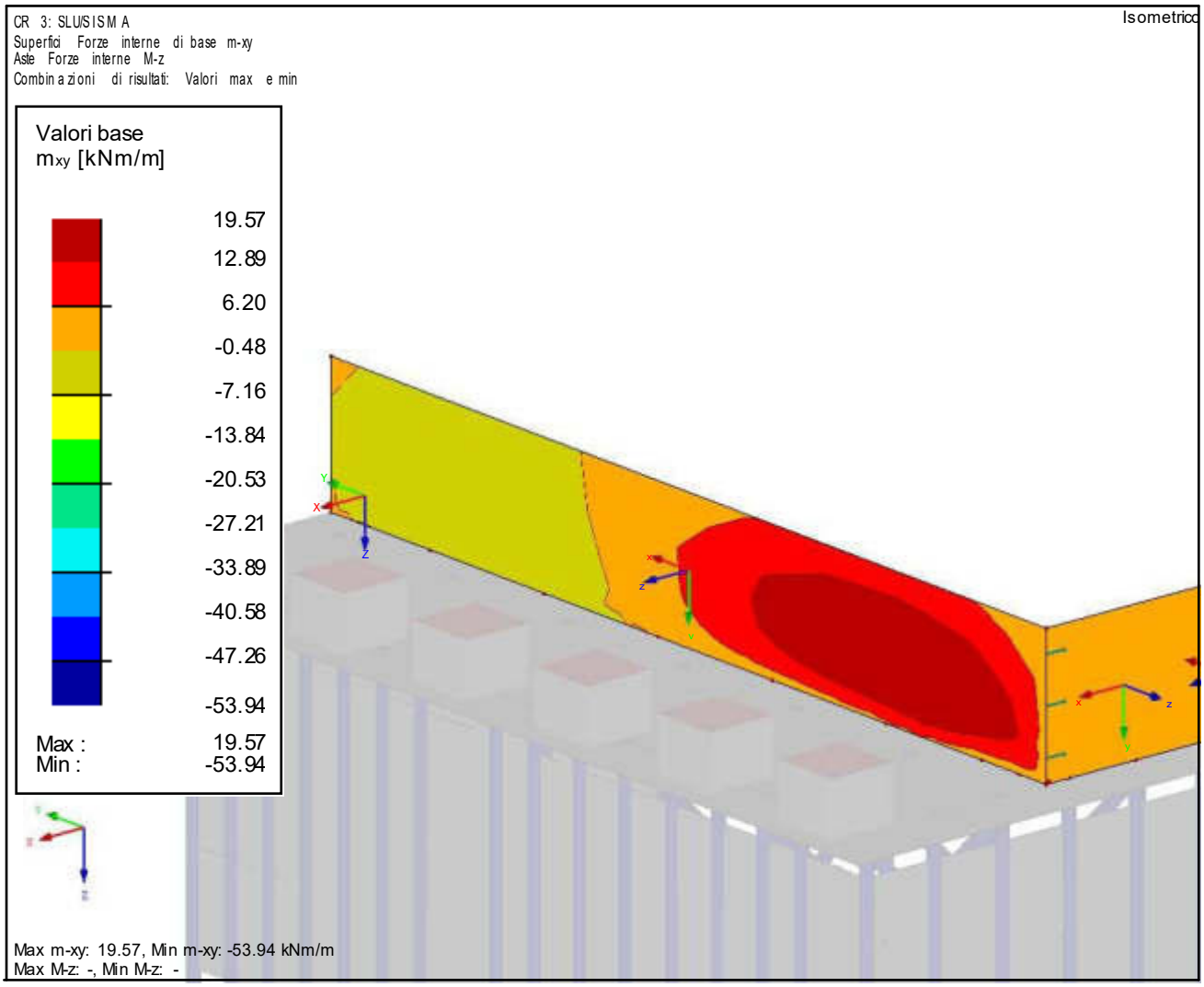
13.2.1. Inviluppo SLU/SISMA Valori momento orizzontale mx



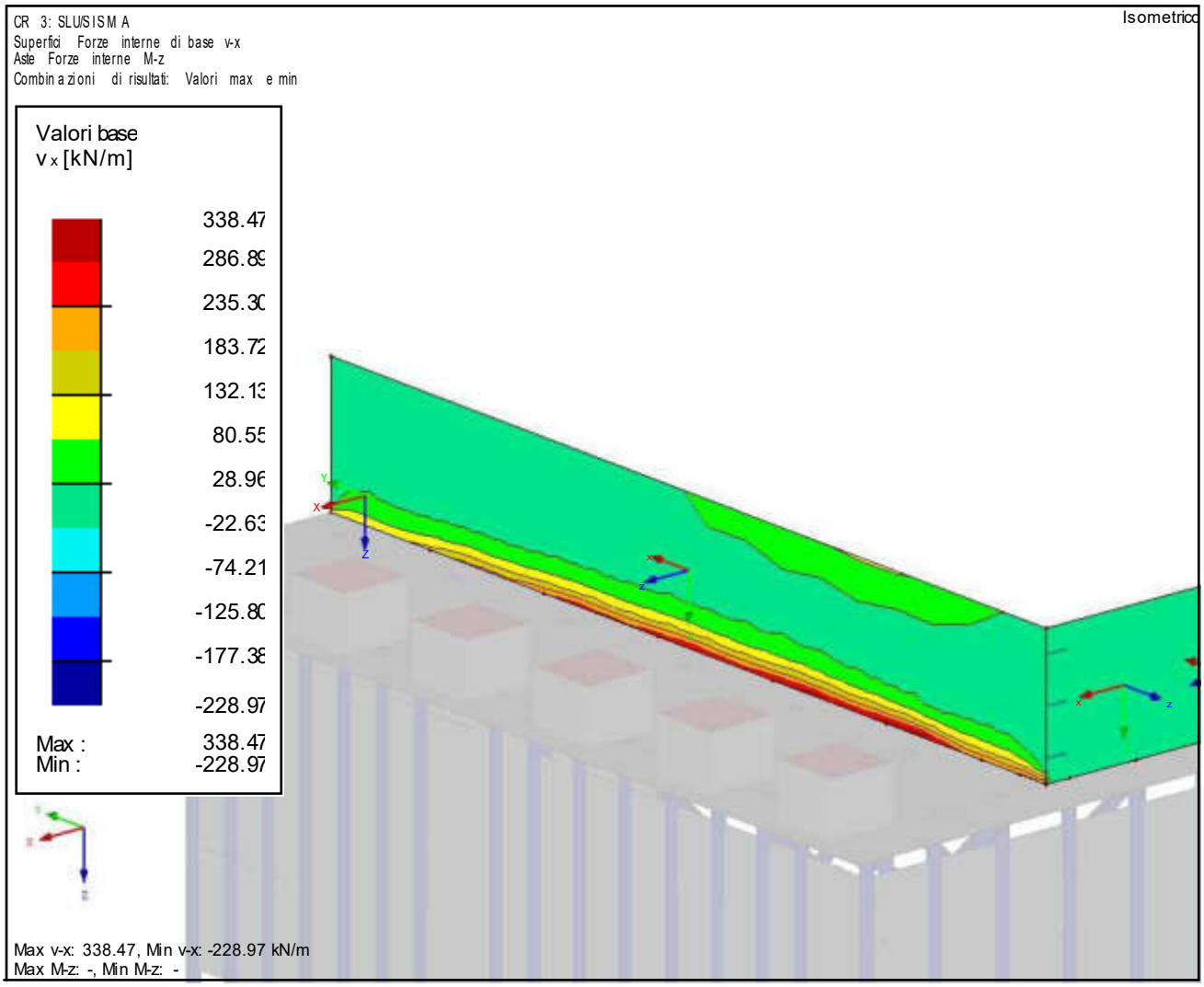
13.2.2. Inviluppo SLU/SISMA Valori momento verticale my



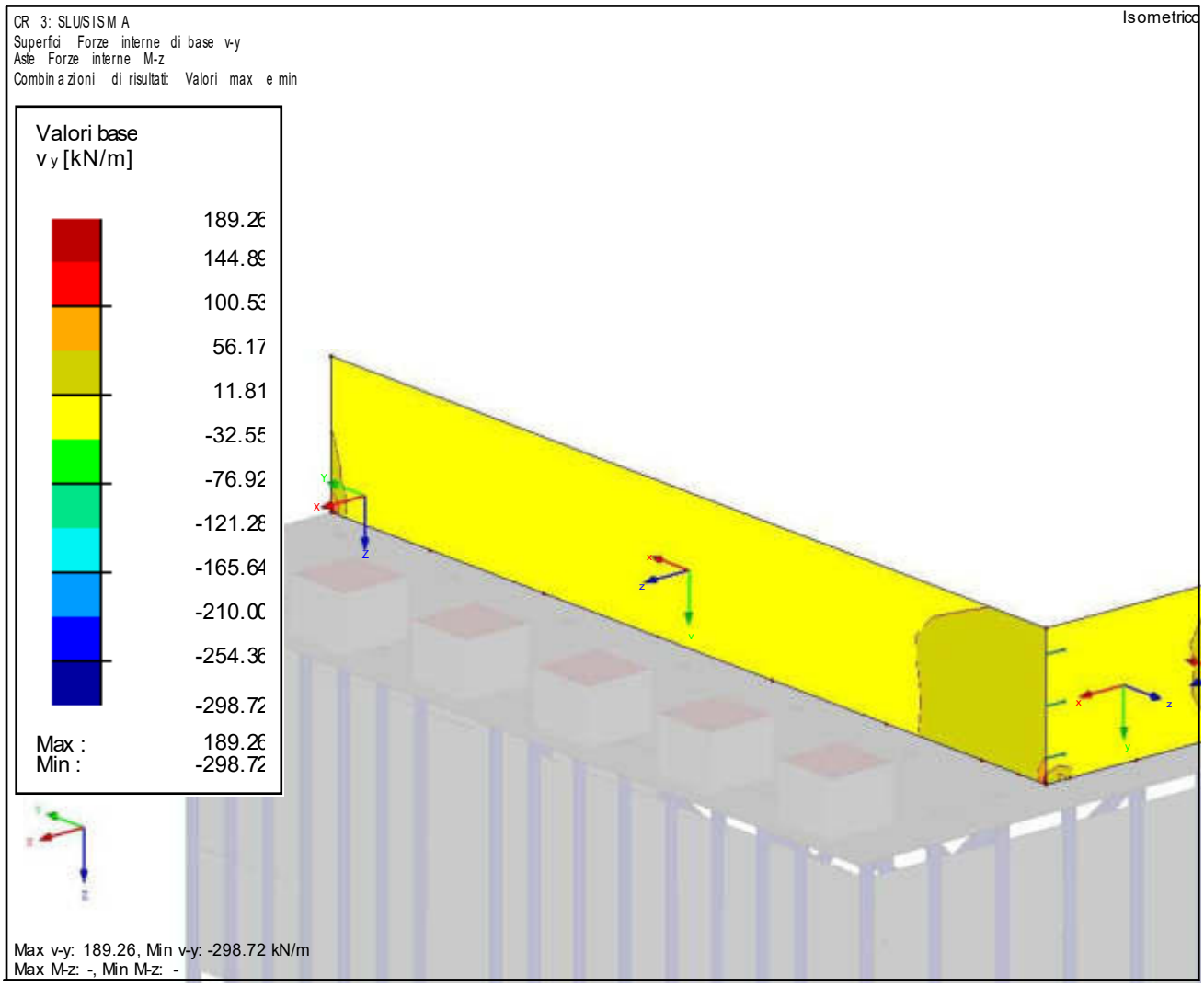
13.2.3. Inviluppo SLU/SISMA Valori momento torcente mxy



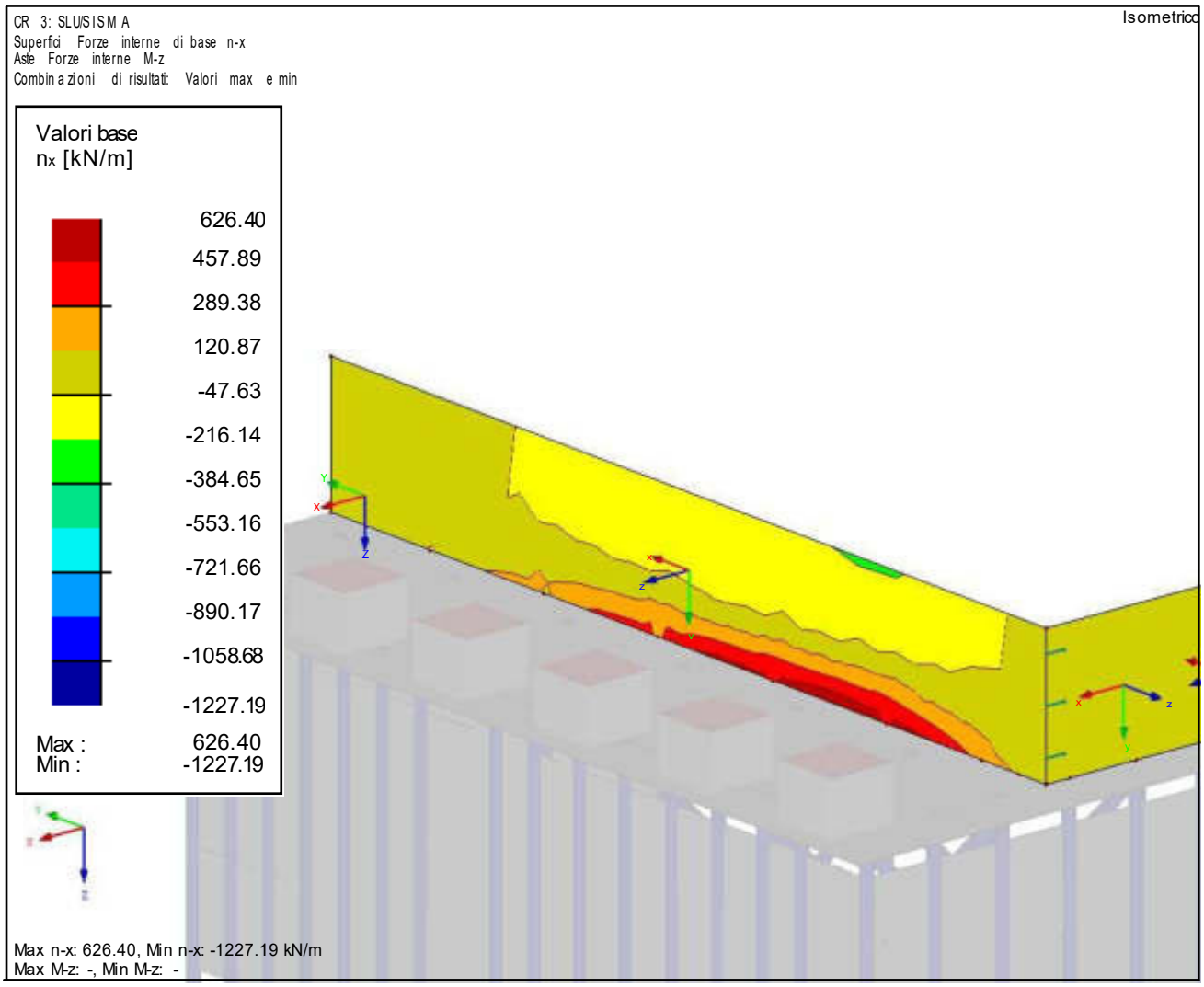
13.2.4. Inviluppo SLU/SISMA Valori taglio orizzontale vx



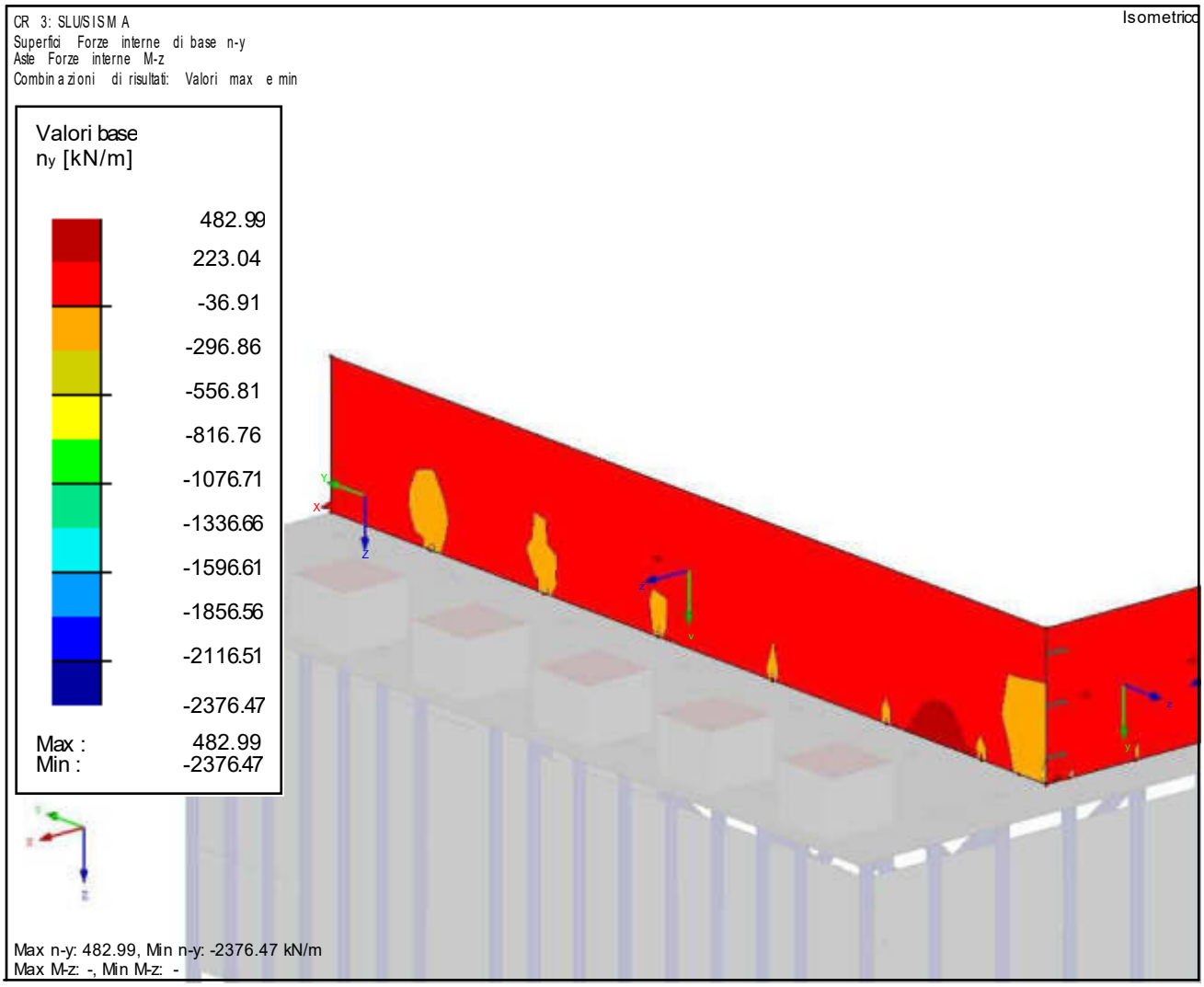
13.2.5. Inviluppo SLU/SISMA Valori taglio verticale vy



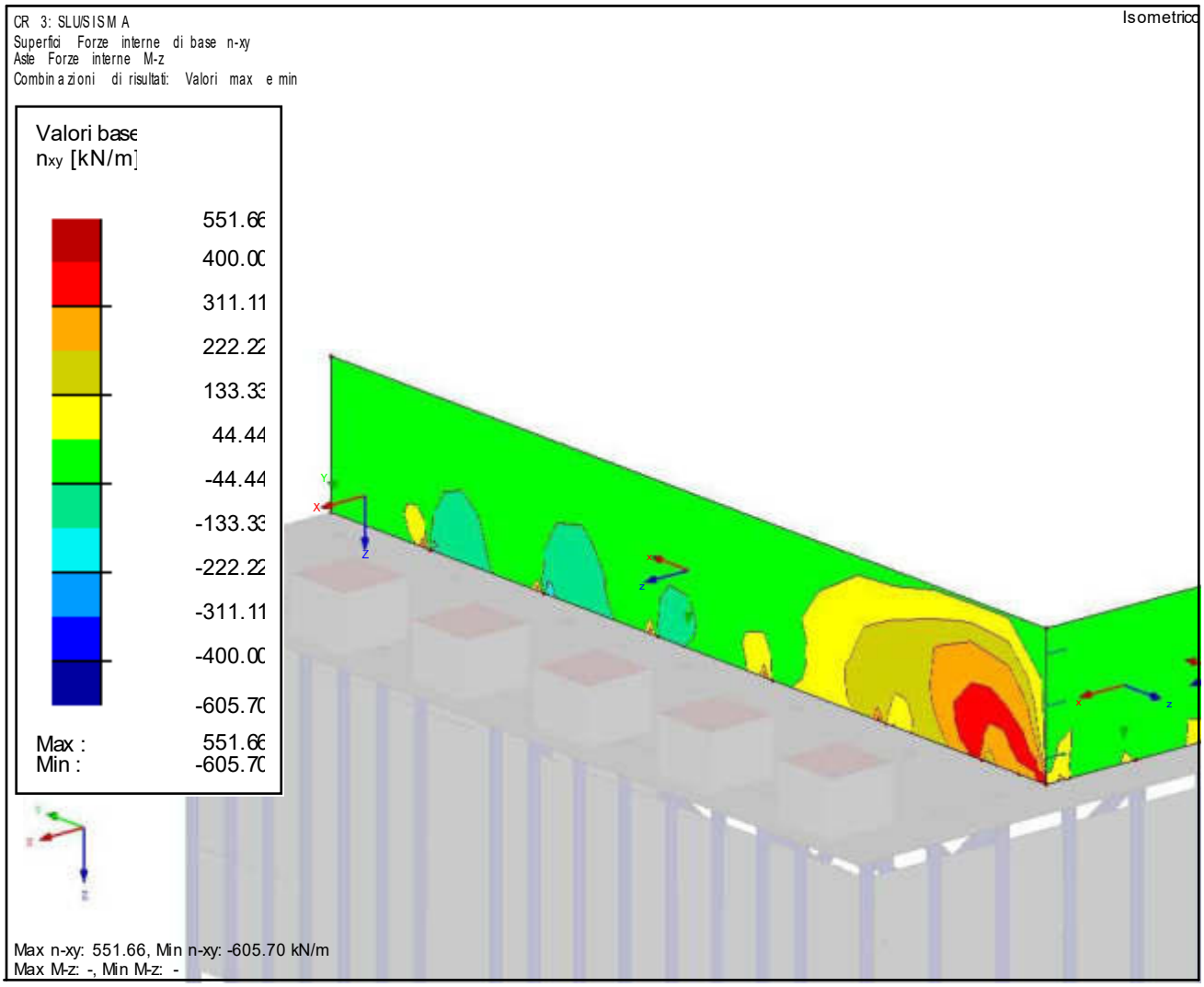
13.2.6. Inviluppo SLU/SISMA Valori forza membranale orizzontale nx



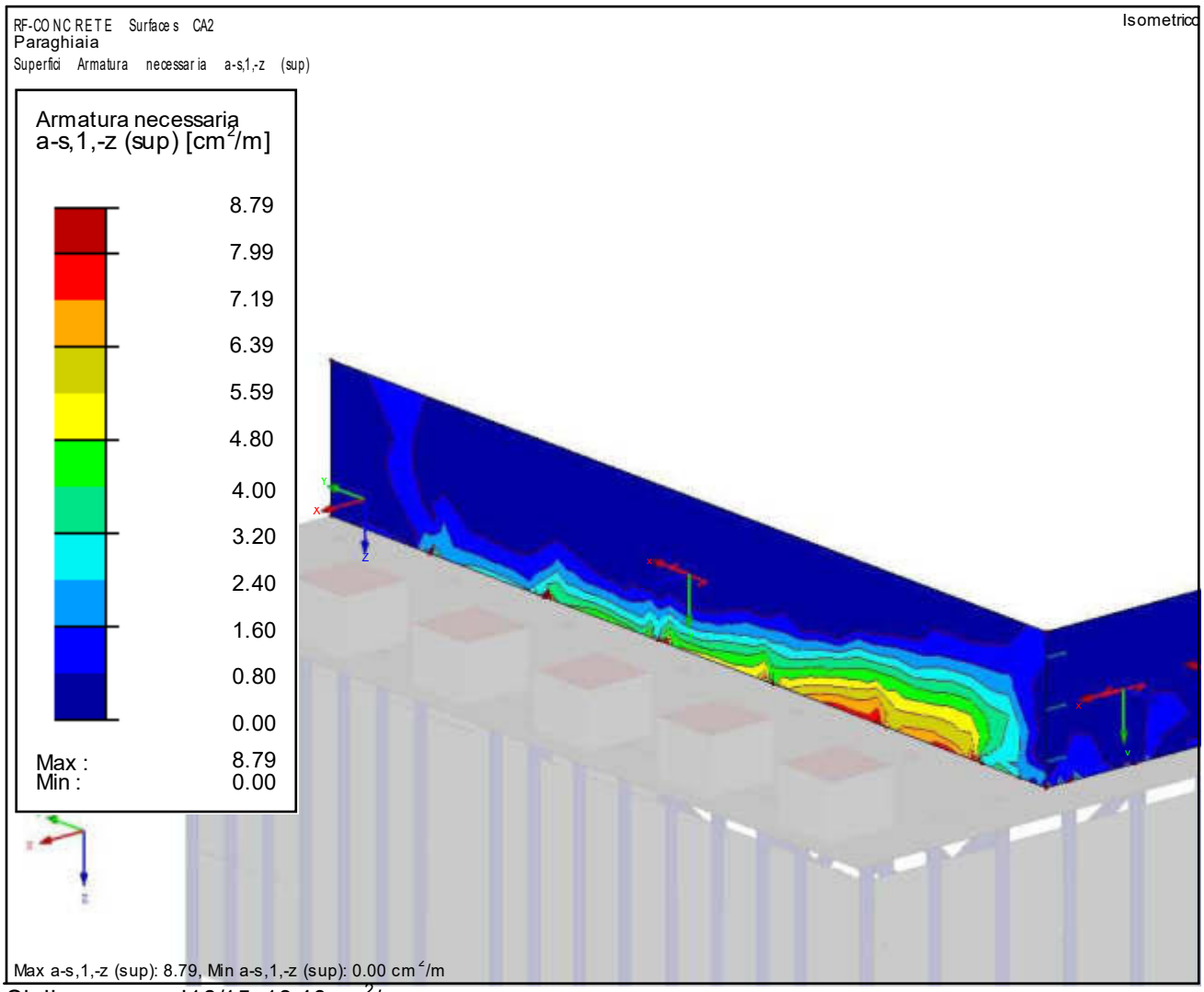
13.2.7. Inviluppo SLU/SISMA Valori forza membranale verticale ny



13.2.8. Inviluppo SLU/SISMA Valori forza membranale nxy

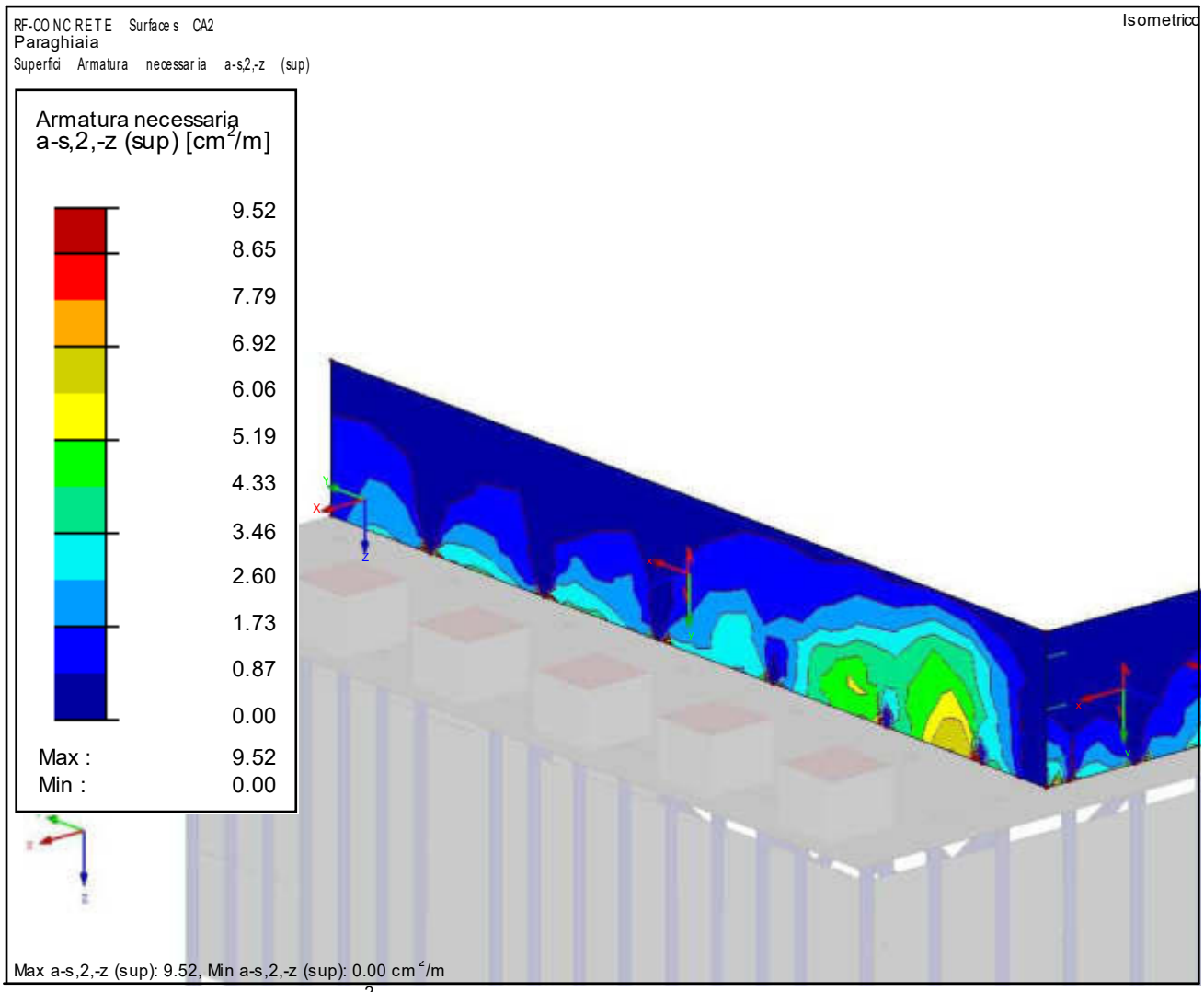


13.3. Isolinee di armatura orizzontali lato Lana



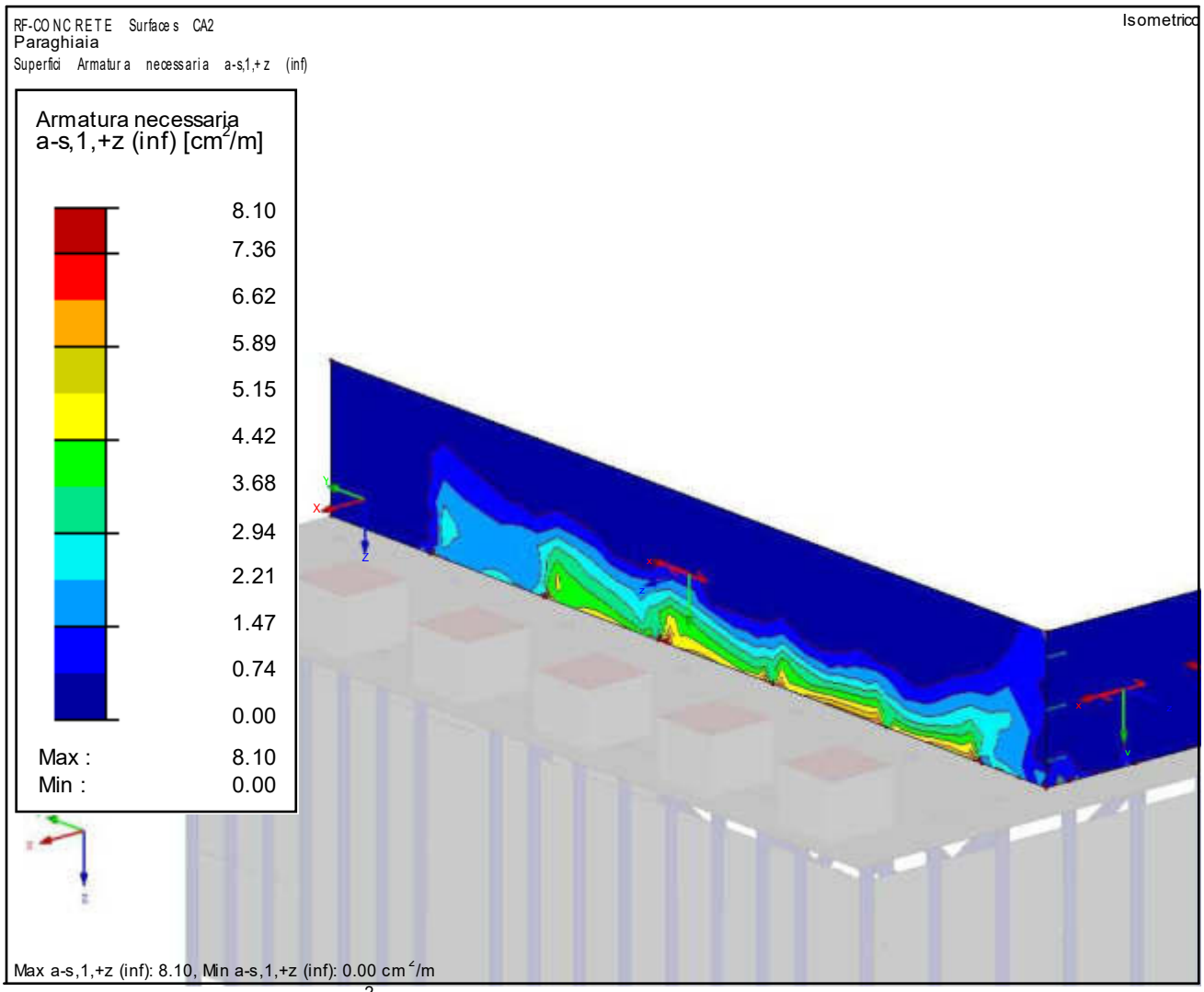
Si dispongono d16/15=13,40 cm^2/m

13.4. Isolinee di armatura verticale lato Lana



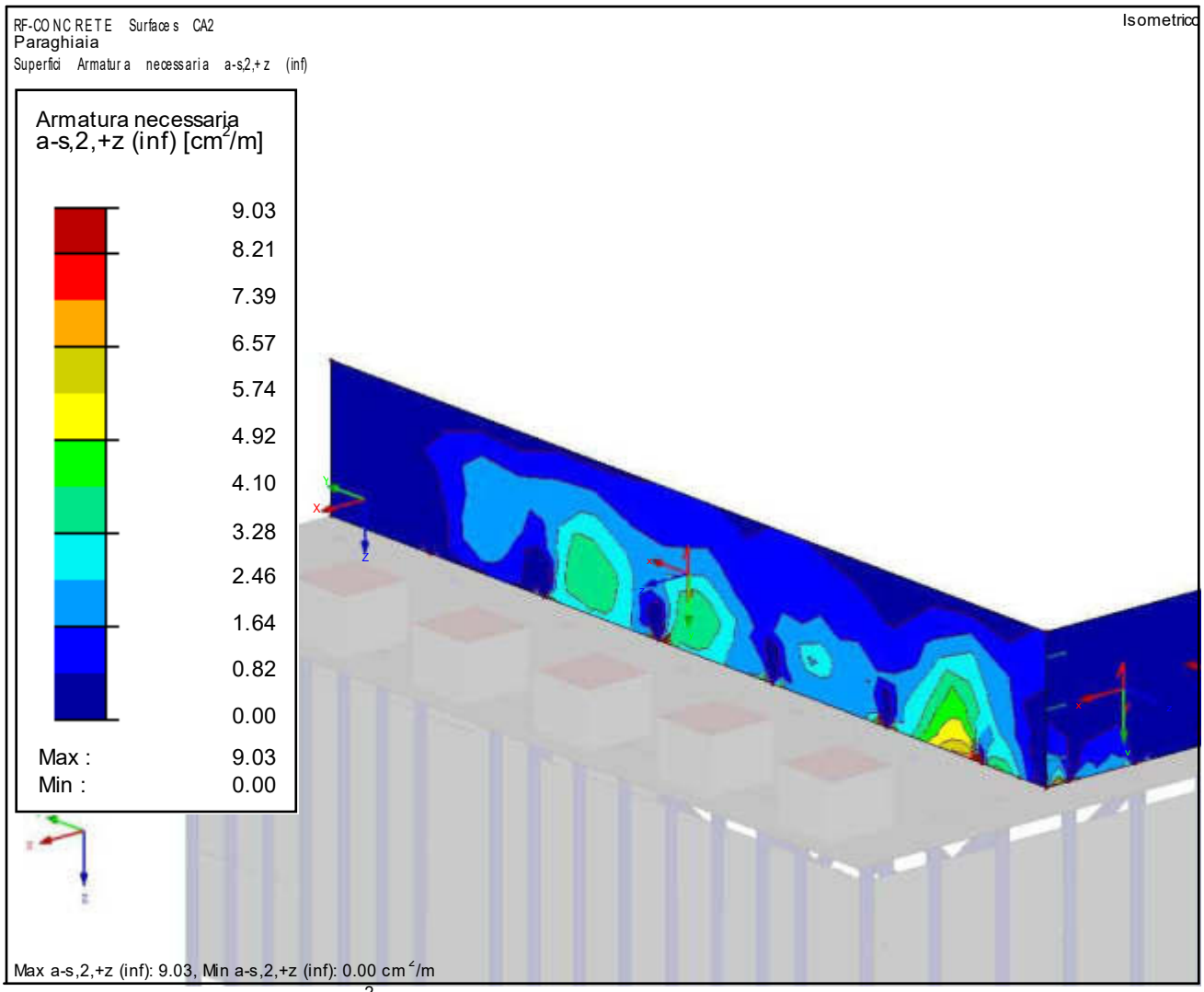
Si dispongono d16/15=13,40 cm^2/m

13.5. Isolinee di armatura orizzontali lato ponte



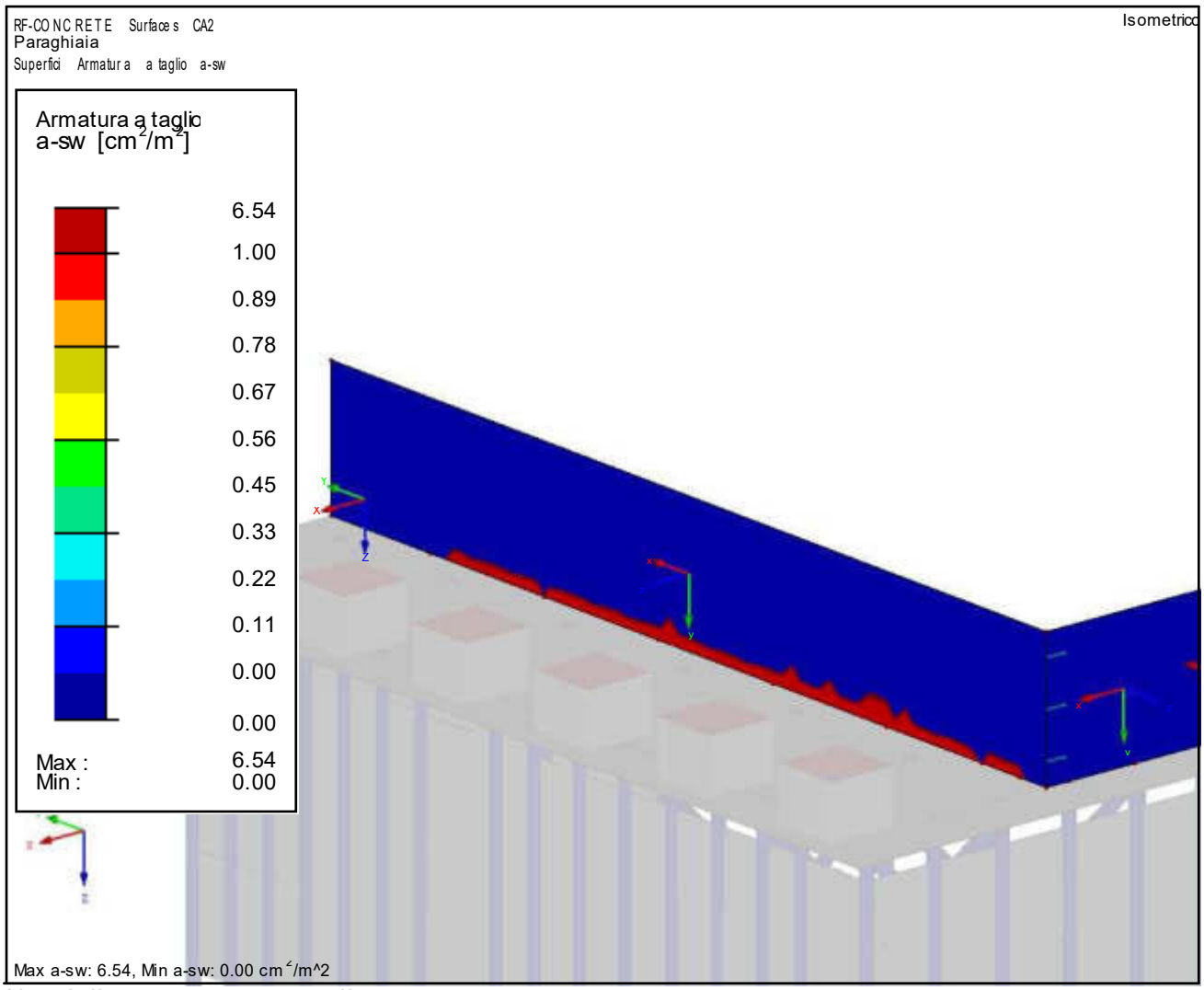
Si dispongono d16/15=13,40 cm^2/m

13.6. Isolinee di armatura verticali lato ponte



Si dispongono d16/15=13,40 cm^2/m

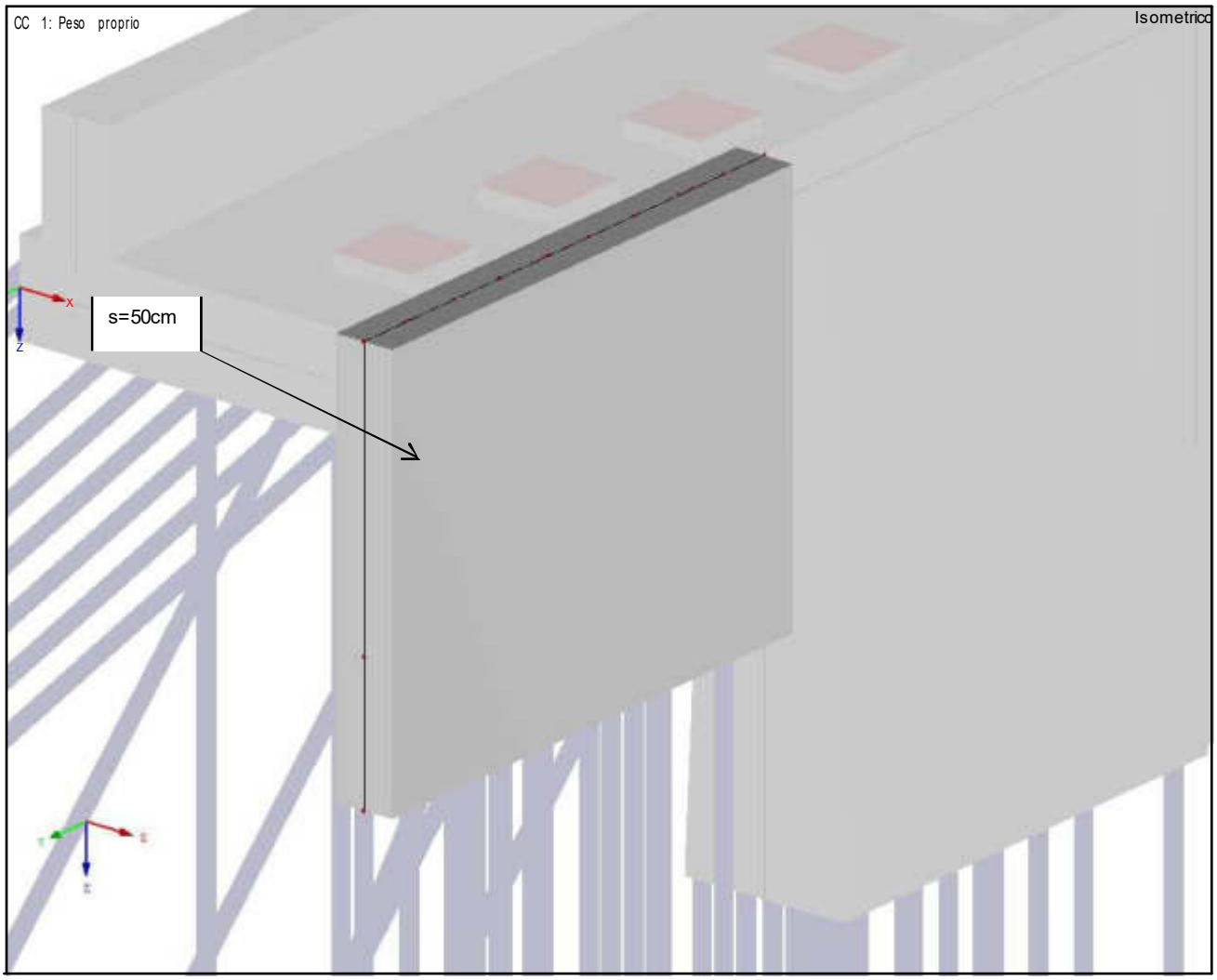
13.7. Isolinee di armatura a taglio



Non si dispone armatura a taglio

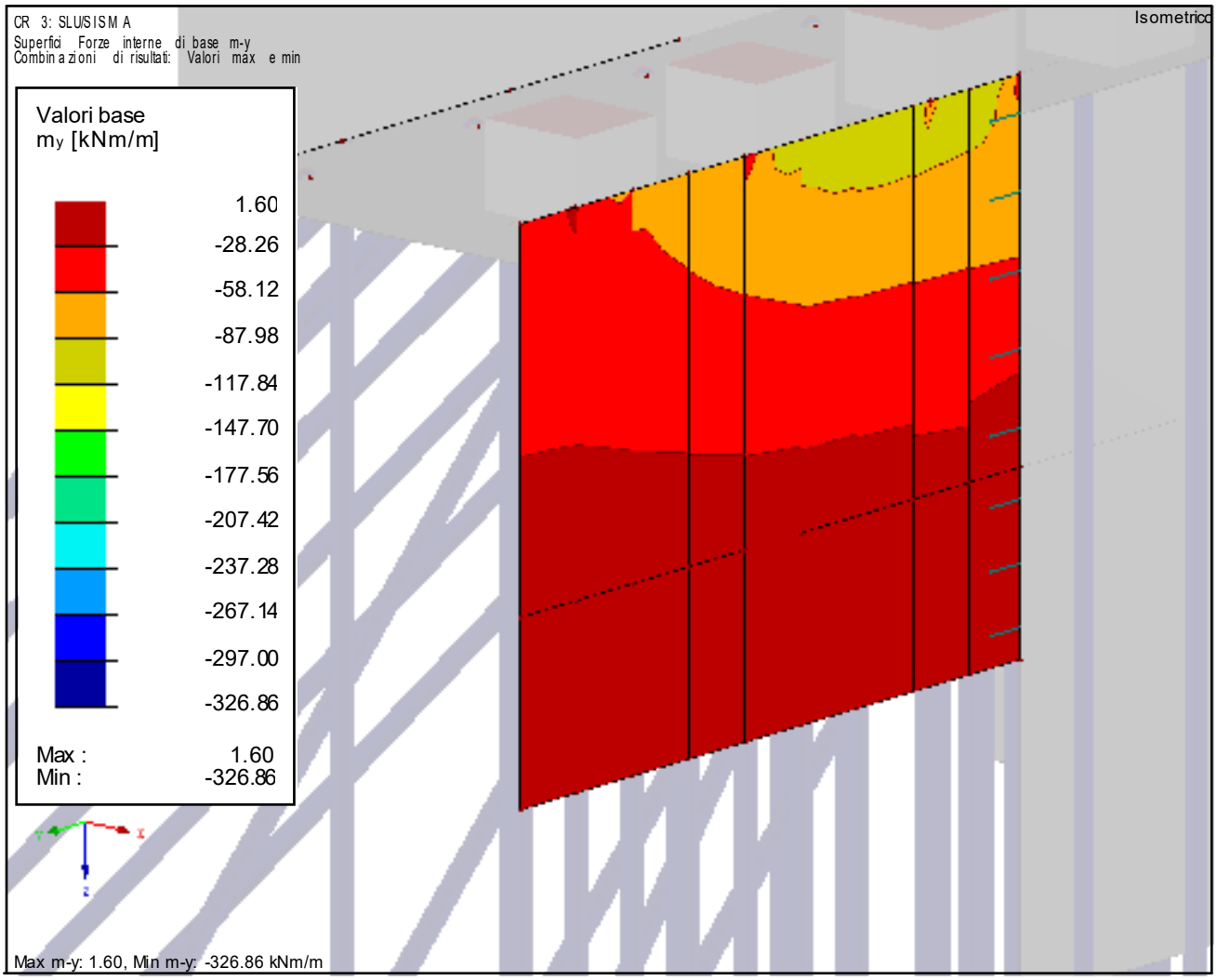
14. Muro strutturale adiacente muro esistente in appoggio

14.1. Geometria

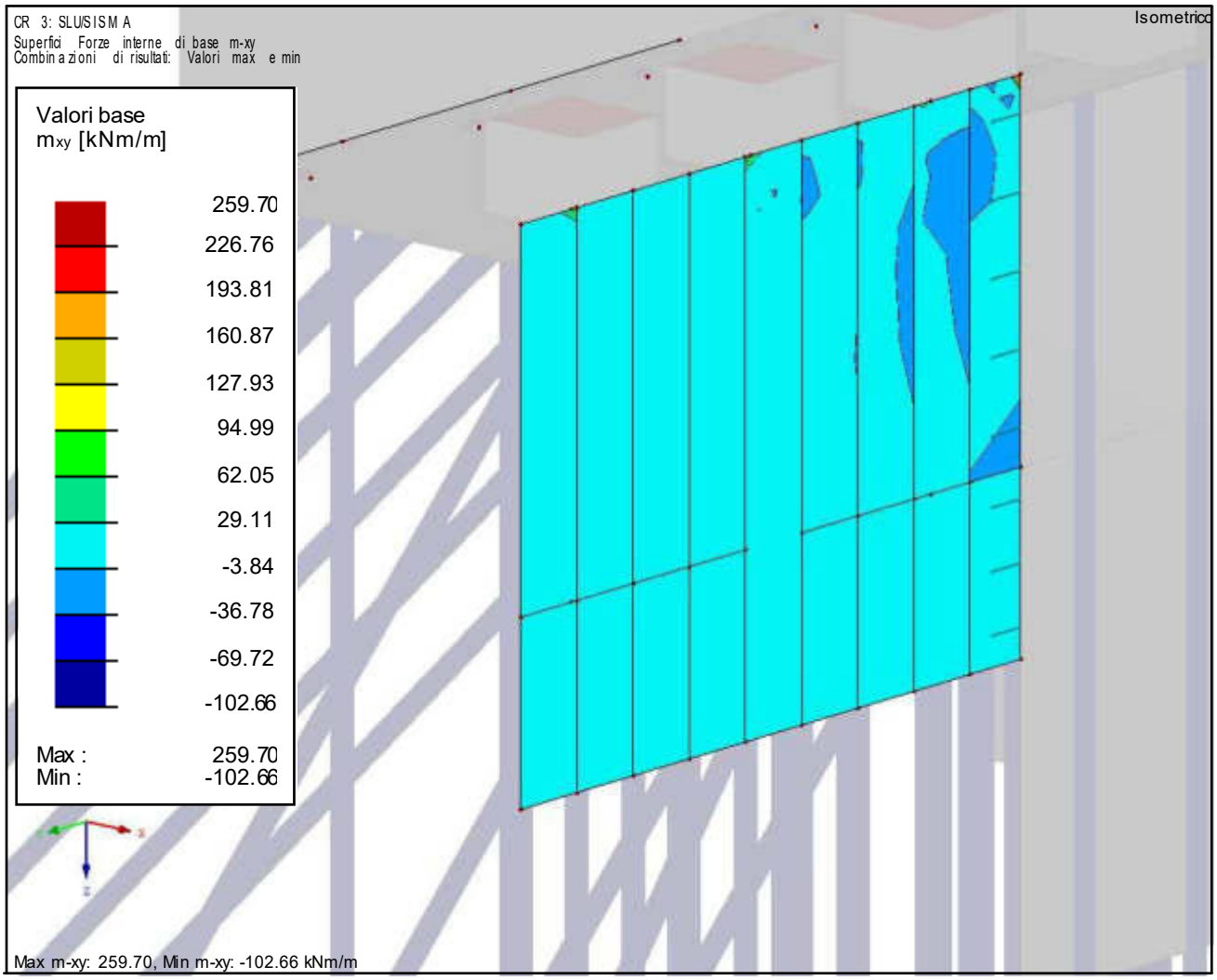


14.1.1. Inviluppo SLU/SISMA Valori momento orizzontale mx

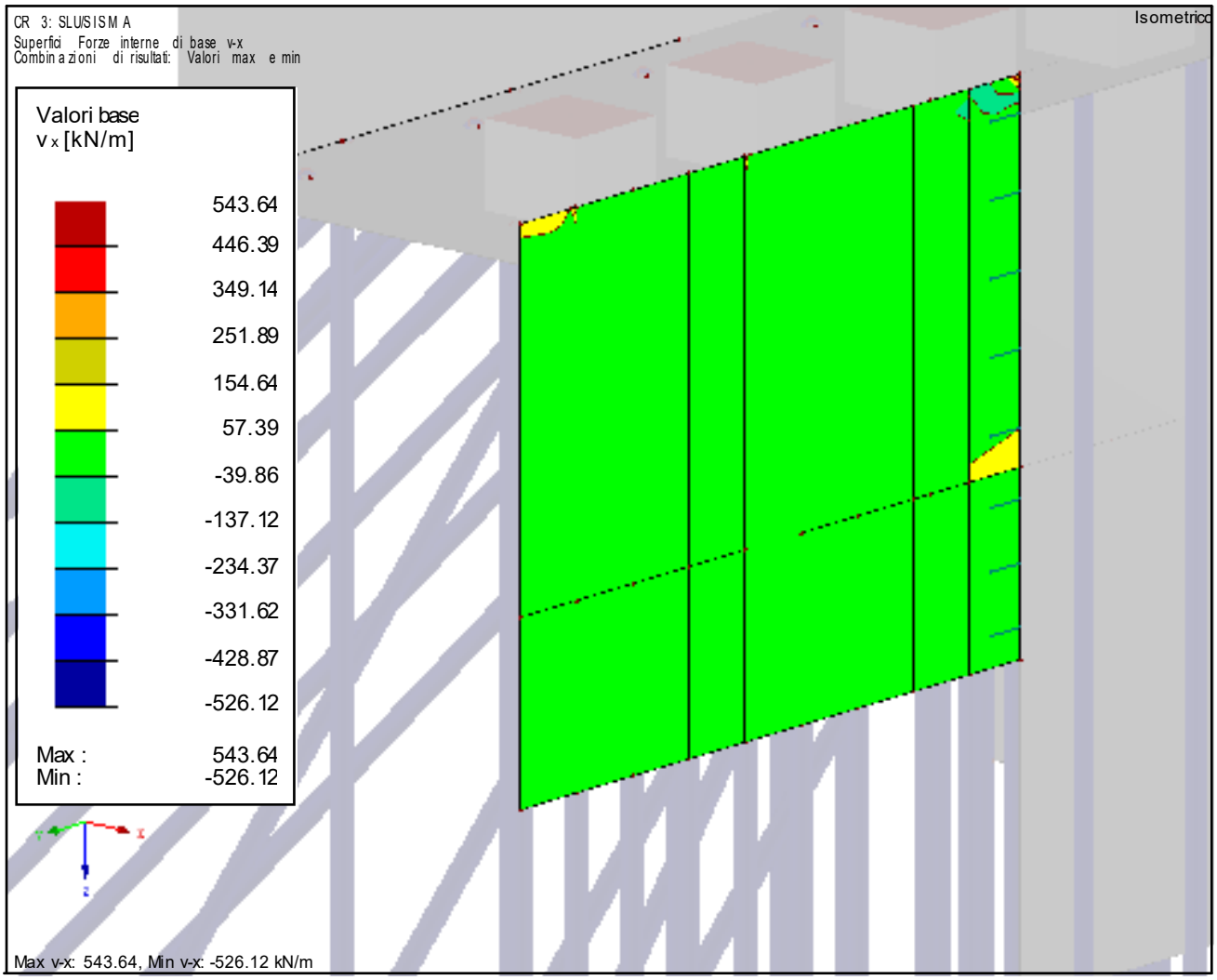
14.1.2. Inviluppo SLU/SISMA Valori momento verticale my



14.1.3. Inviluppo SLU/SISMA Valori momento torcente mxy

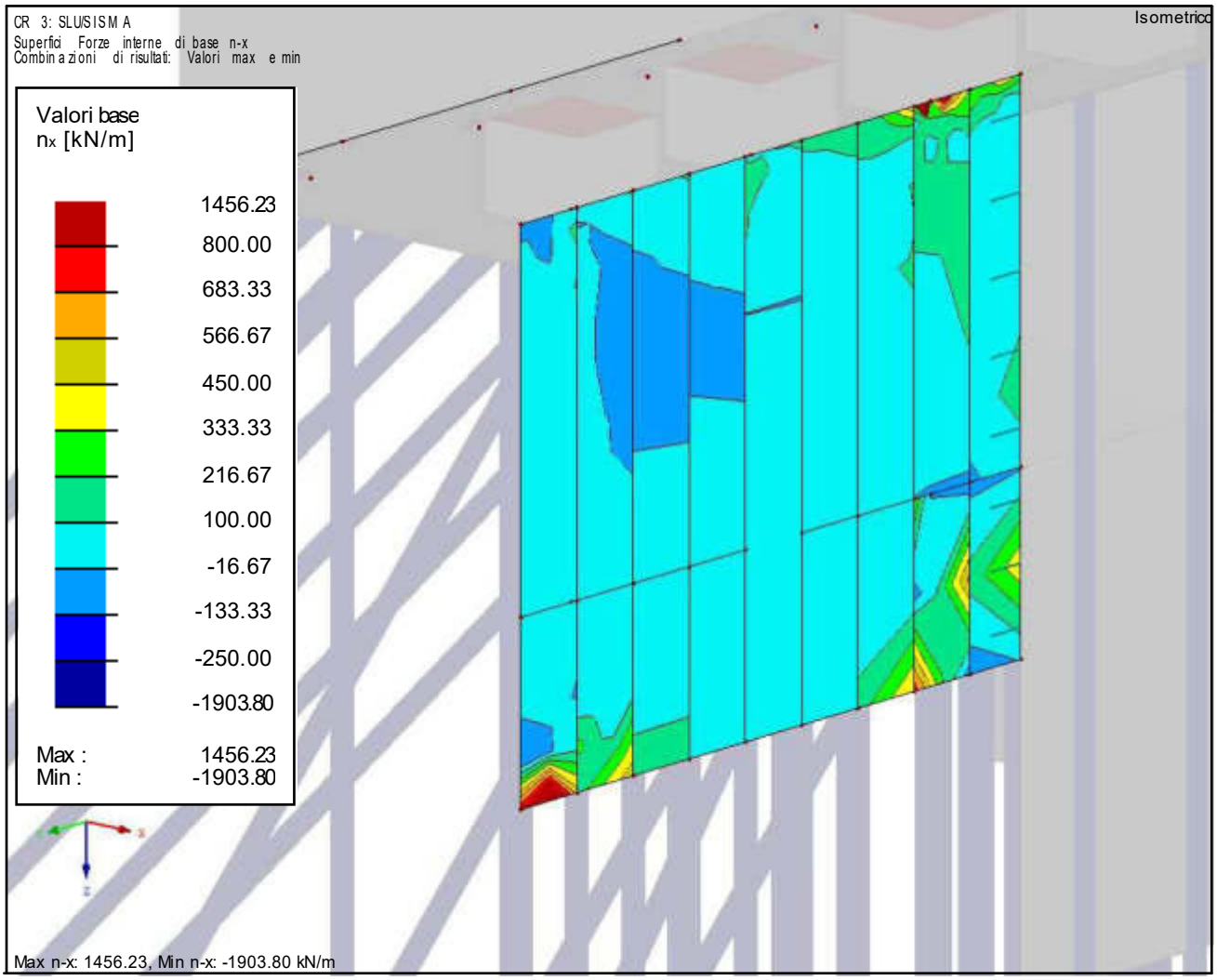


14.1.4. Inviluppo SLU/SISMA Valori taglio orizzontale vx

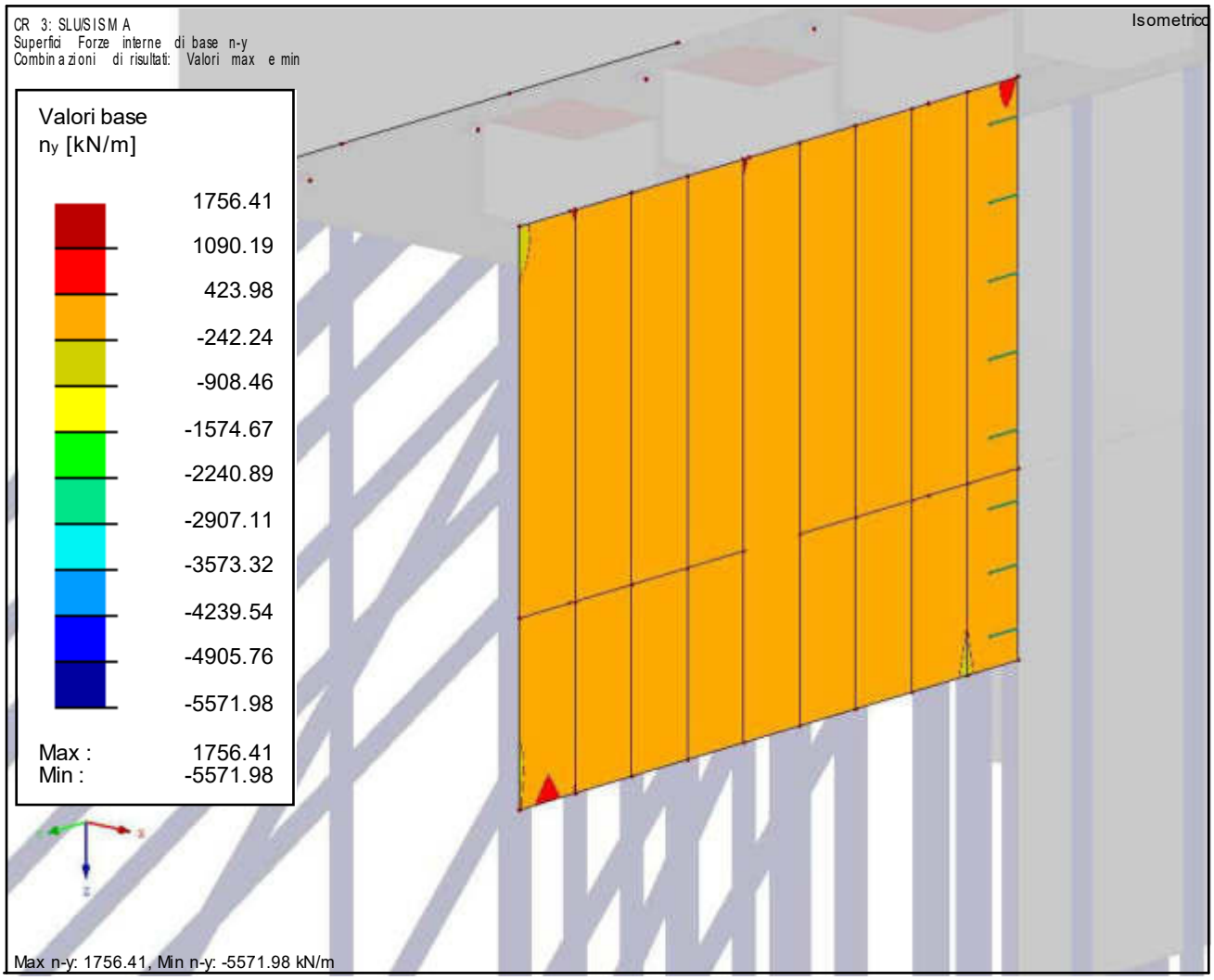


14.1.5. Inviluppo SLU/SISMA Valori taglio verticale vy

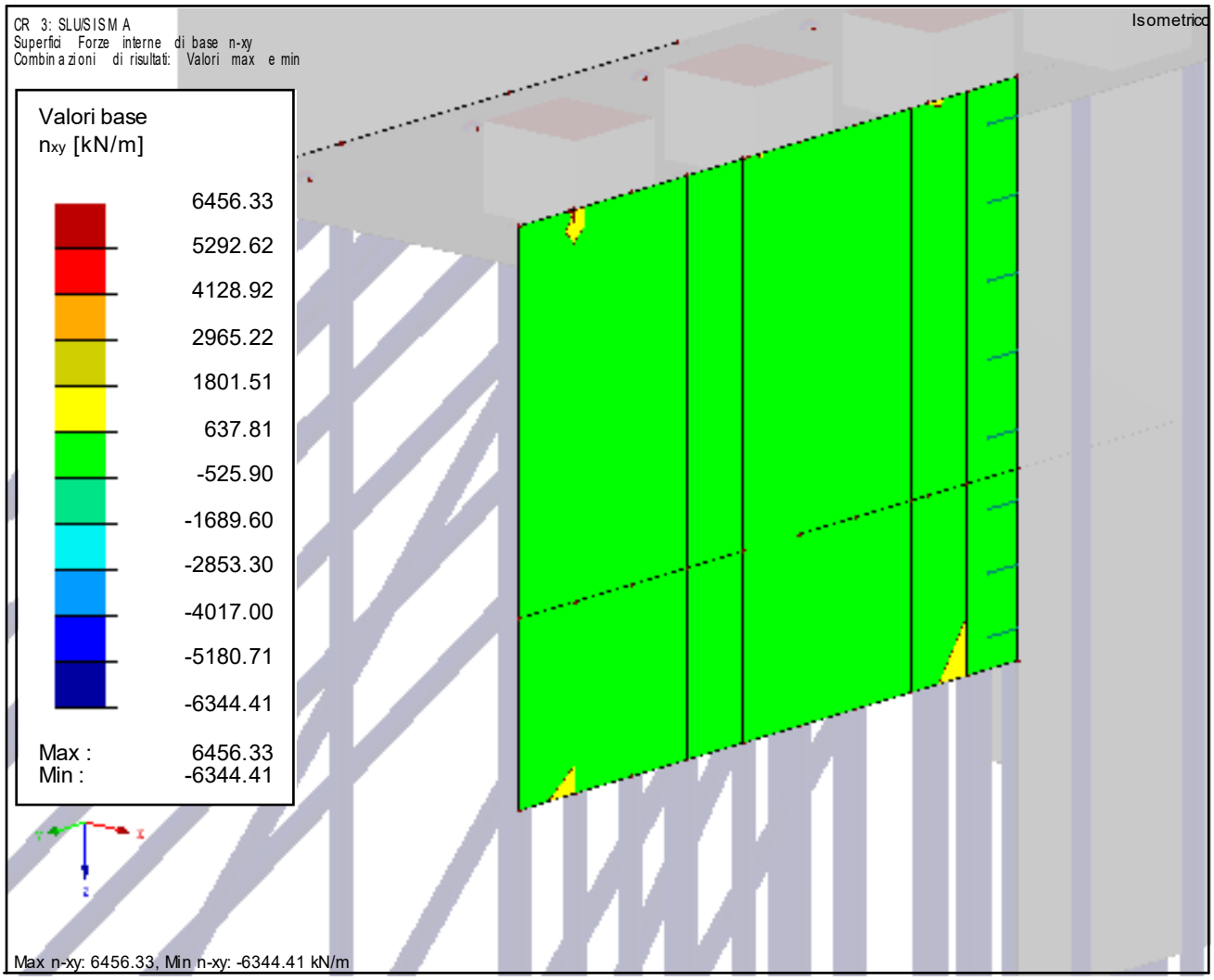
14.1.6. Inviluppo SLU/SISMA Valori forza membranale orizzontale nx



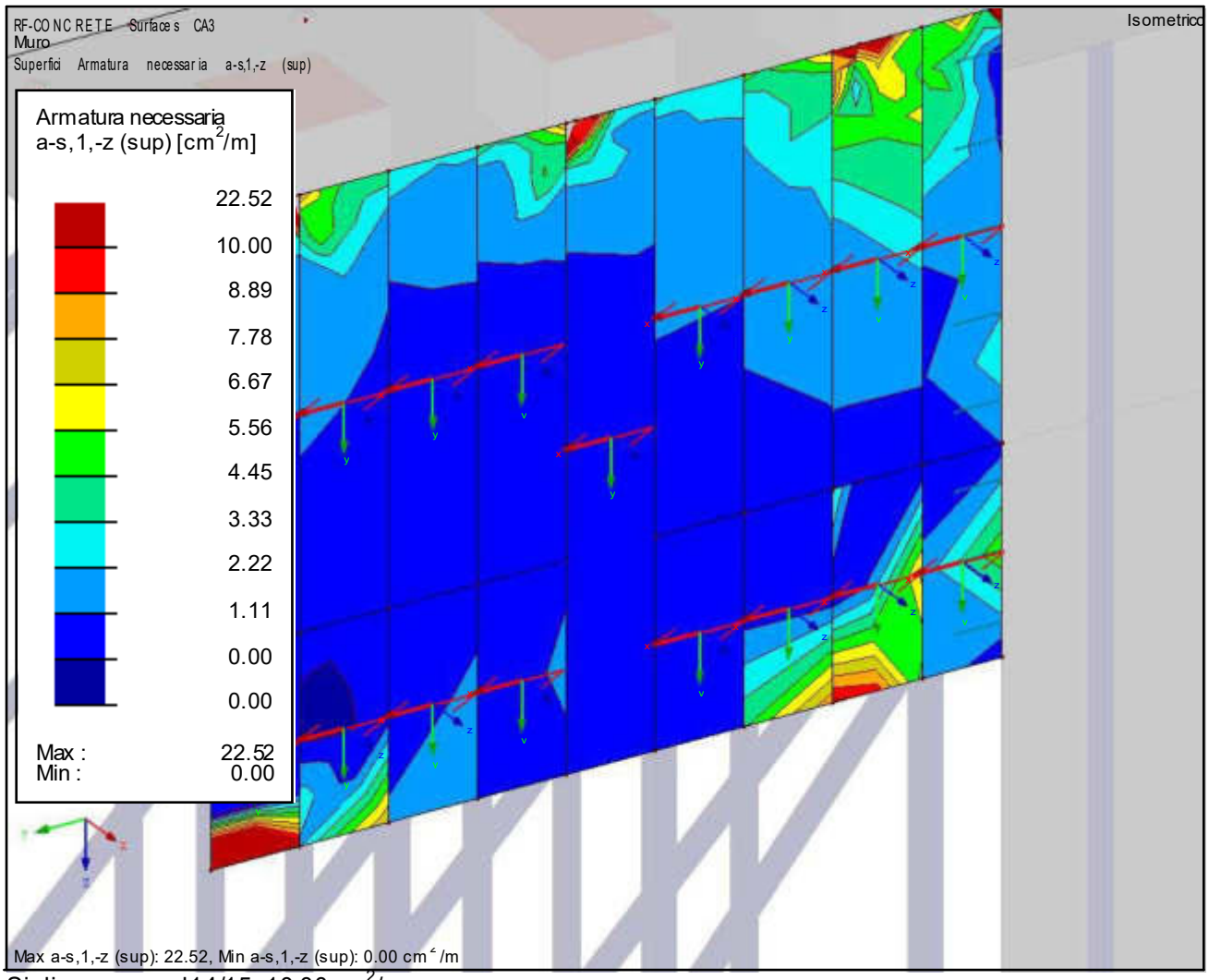
14.1.7. Inviluppo SLU/SISMA Valori forza membranale verticale ny



14.1.8. Inviluppo SLU/SISMA Valori forza membranale nxy

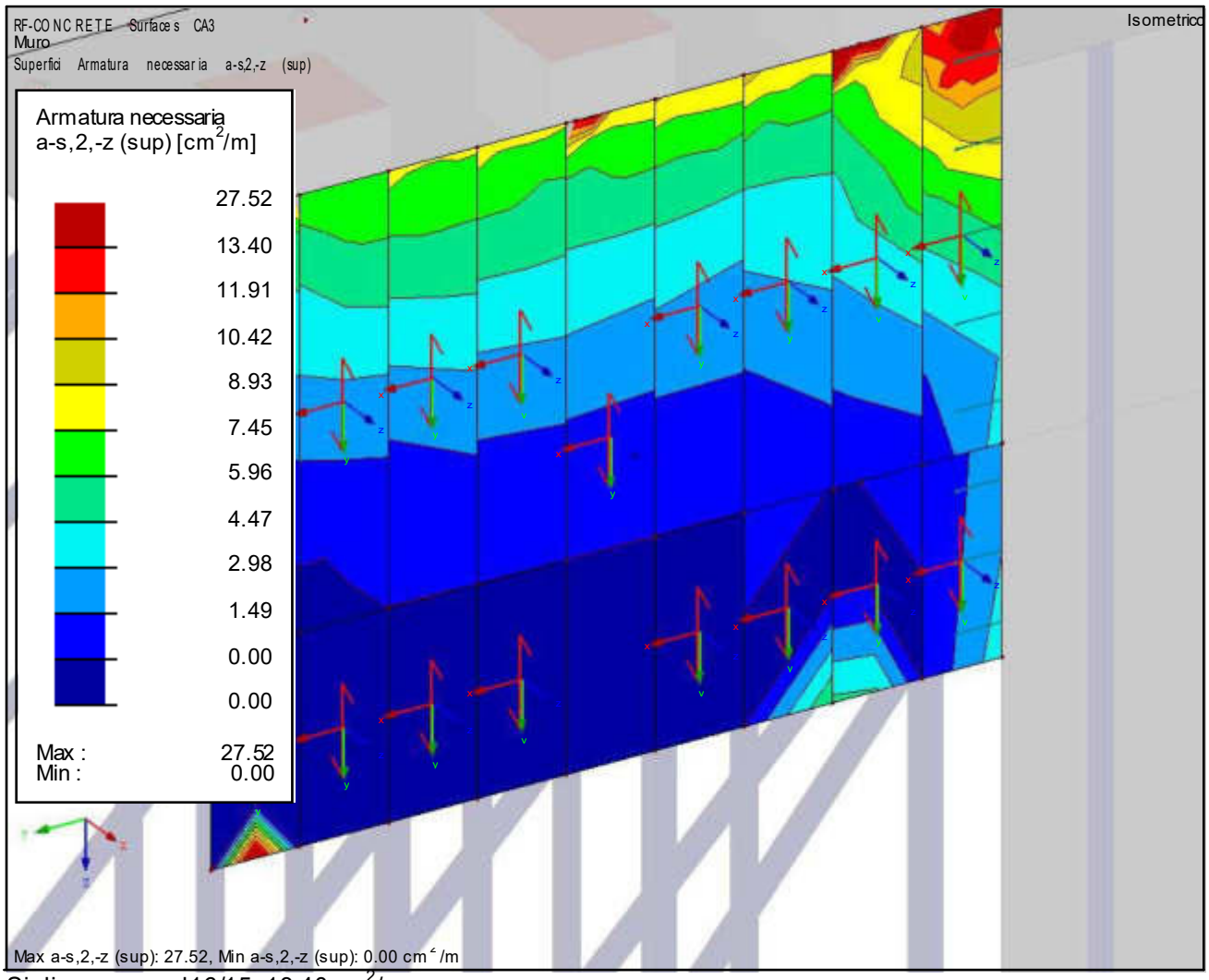


14.2. Isolinee di armatura orizzontali lato Lana



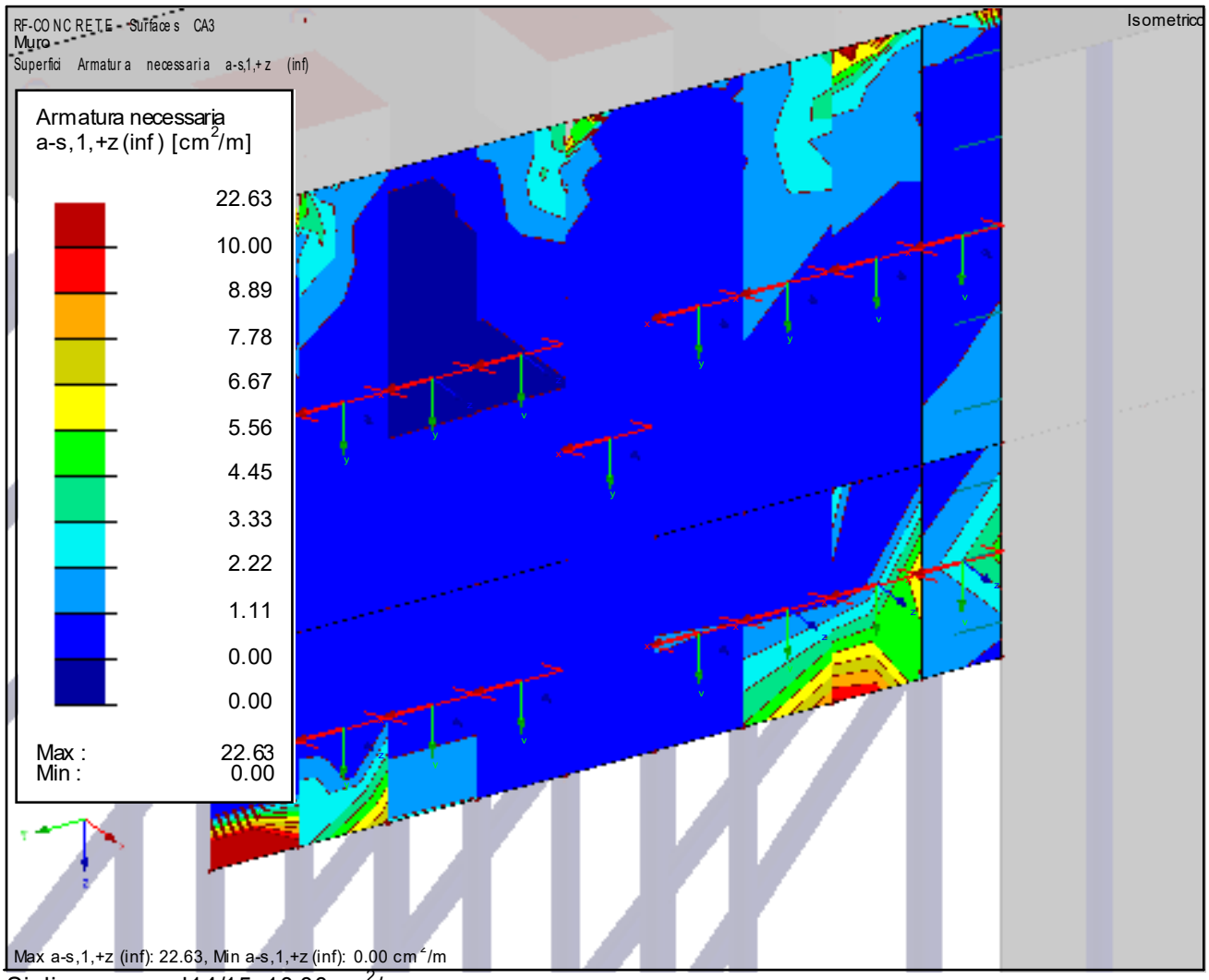
Si dispongono d14/15=10,00 cm^2/m

14.3. Isolinee di armatura verticale lato Lana



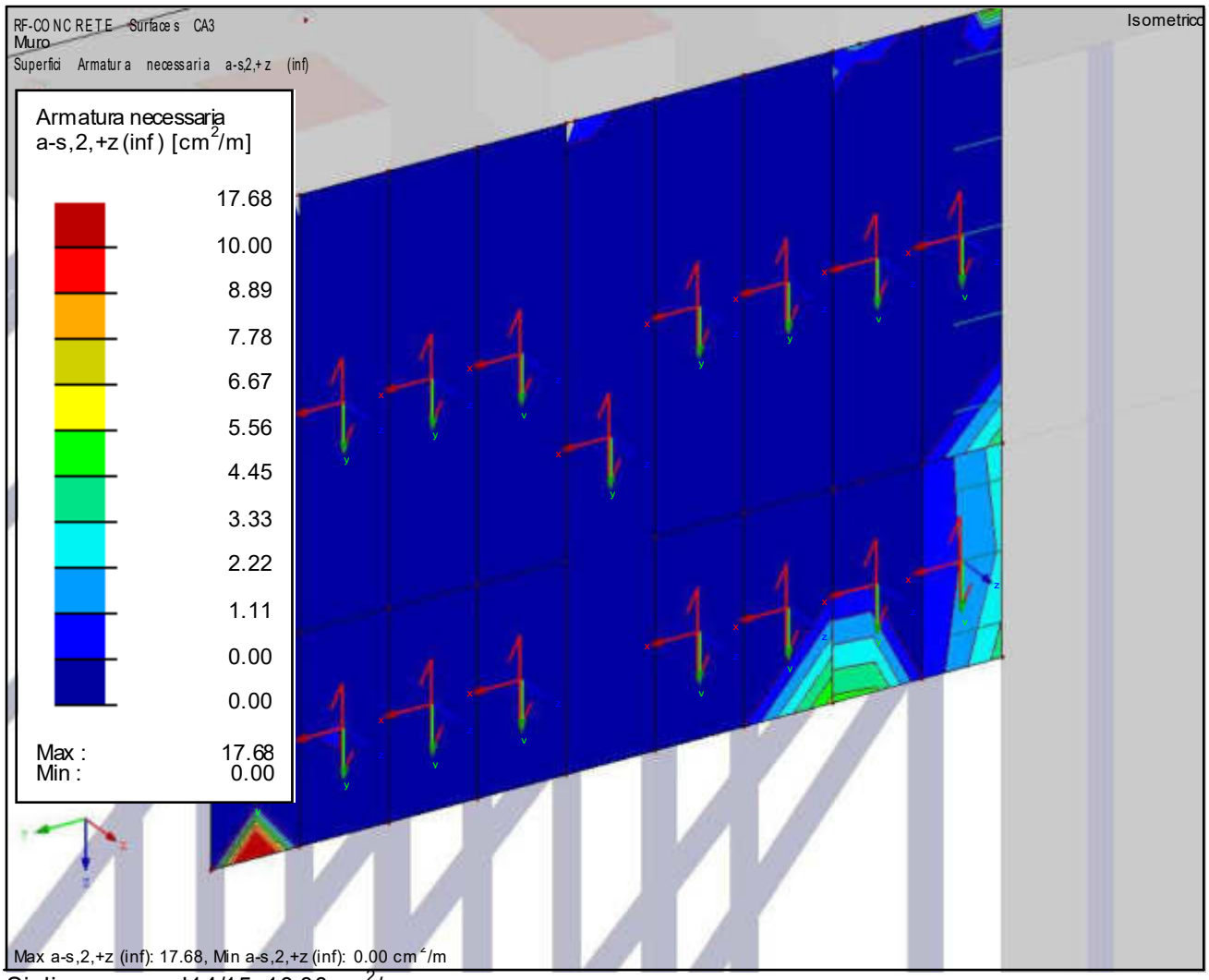
Si dispongono d16/15=13,40 cm^2/m

14.4. Isolinee di armatura orizzontali lato ponte



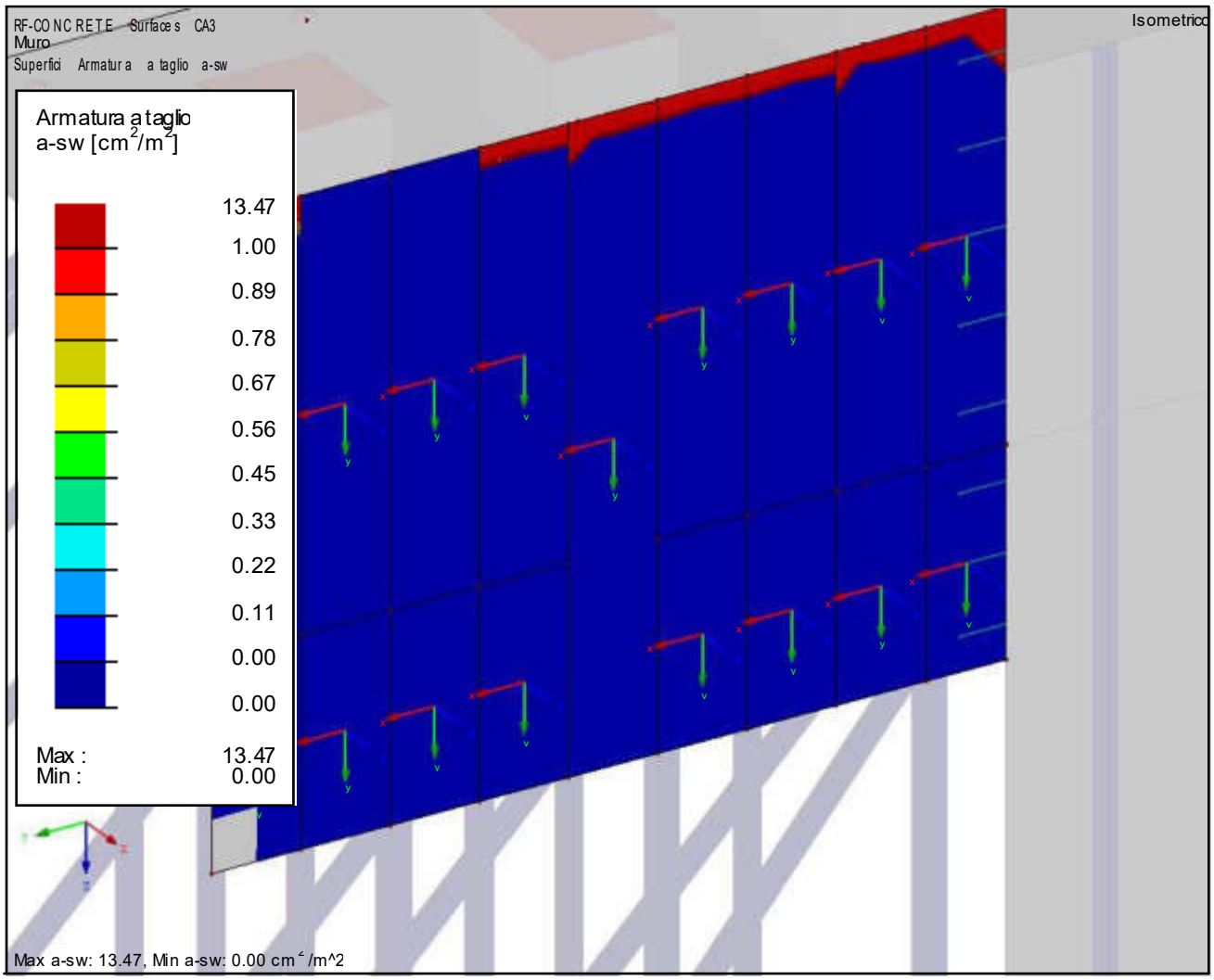
Si dispongono d14/15=10,00 cm^2/m

14.5. Isolinee di armatura verticali lato ponte



Si dispongono d14/15=10,00 cm^2/m

14.6. Isolinee di armatura a taglio



Non si dispone armatura a taglio

15. Allegato A: Verifica a punzonamento

HALFEN HDB Armatura di punzonamento, ETA-12/0454 (Europe, EN 1992-1-1:2004 + AC:2010 + A1:2014)

HALFEN Programma di calcolo HDB, version 13.40

Il dimensionamento - inclusi i valori statici - vale solo per il prodotto HALFEN esposto. Le capacità portanti di prodotti concorrenti apparentemente identici possono variare. L'editore del programma declina ogni responsabilità per prodotti alternativi.

Verifica di punzonamento per pilastro rotondo di bordo (**Calcestruzzo gettato in opera**)

Carico di punzonamento	V_{Ed}	= 1000,0 kN
Aumento del carico	β	= 1,40
Spessore soletta	h	= 80 cm
Altezza statica	d	= 73,9 cm
Diametro pilastro	Ø	= 24 cm
Distanza dal bordo / Inclination	e / α	= 50 cm / 0 °
Distanza dal bordo	e	= 50 cm
Profondità di penetrazione pilastro	h_a	= 0 cm
Copriferro alto / parte inferiore	$c_{nom,o}$ / $c_{nom,u}$	= 4,5 cm / 4,5 cm
Beton / Acciaio d'armatura / HDB		= C30/37 / f_{yk}=500 N/mm² / B500
Diametro / Interasse		= Ø20 / 150 mm (ρ_x = 0,28 %)
Diametro / Interasse		= Ø20 / 150 mm (ρ_y = 0,28 %)
Tasso d'armatura	ρ_l	= 0,28 % < 2,00 %

Nella sezione di verifica critica. u_1

Sezione di verifica analoga al pilastro interno

specific column perimeter	u_0 / d	= 1
u_1		= 626 cm
$k = min\ \{1 + \sqrt{200/d[mm]}\ ; 2\}$		= 1,52
Pre-factor for $v_{Rd,c,1}$	$C_{Rd,c}$	= 0,10
$v_{Rd,c,1} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3}$		= 310,13 kN/m²
$v_{Rd,c,2} = v_{min} = 0{,}0421/\gamma_C \cdot k^{3/2} \cdot f_{ck}^{1/2}$		= 287,98 kN/m²

$V_{Rd,c} = max\ \{v_{Rd,c,1}; v_{Rd,c,2}\} \cdot u_1 \cdot d$ = 1434,8 kN > 1400,0 kN = V_{Ed} ·

Maximum allowed punching shear (web-crushing limit) at the periphery of the column (EN 1992-1-1, section 6.4.3(2)):

$V_{Rd,max,u0} = 0{,}4 \cdot \nu \cdot f_{cd} \cdot u_0 \cdot d$ = 1991,8 kN

Non è necessaria nessuna armatura di punzonamento

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HALFEN HDB Armatura di punzonamento, ETA-12/0454 (Europe, EN 1992-1-1:2004 + AC:2010 + A1:2014)

HALFEN Programma di calcolo HDB, version 13.40

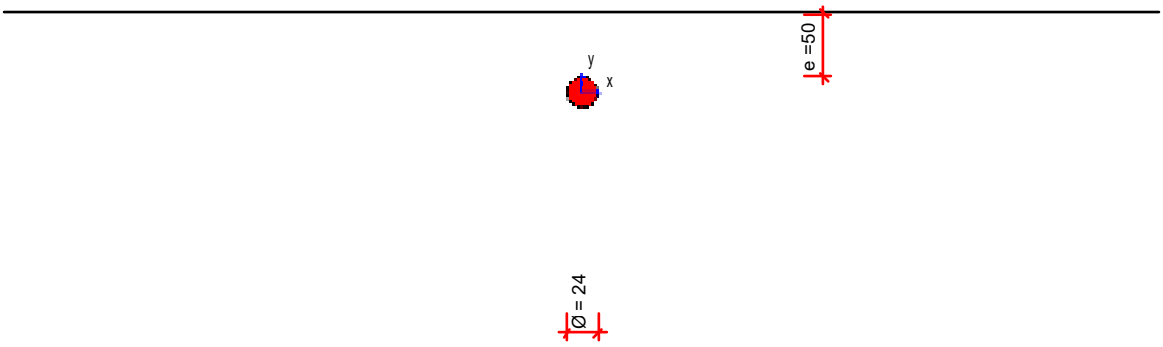
Il dimensionamento - inclusi i valori statici - vale solo per il prodotto HALFEN esposto. Le capacità portanti di prodotti concorrenti apparentemente identici possono variare. L'editore del programma declina ogni responsabilità per prodotti alternativi.

Area di posa

Sezione Scale 1:35

[cm]

Pianta Scale 1:59



Minimum bar length: $l_{bar,min,x}$ = 467,4 cm + 2 · l_{bd}; $l_{bar,min,y}$ = 295,7 cm + l_{bd}; l_{bd} is the anchorage length
Note: Due to other verifications, different minimum bar length can be decisive.

Bar length calculated without the required design anchorage length at the free edge. The anchorage length at the free edge has to be determined separately.

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16. Allegato B: Parametri geotecnici

From: Michael Jesacher - Geologiebüro Jesacher [michael@jesacher.bz]
Received: Dienstag, 14 Apr. 2020, 12:06
To: Walter Weis [Walter.Weis@bergmeister.eu]
CC: Cristian Ferraro [Cristian.Ferraro@bergmeister.eu]; Umberto Capozzi [Umberto.Capozzi@bergmeister.eu]
Subject: AW: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Walter,

bestätige hiermit endgültig die u.a. Parameter.

Guta Arbeit, Michi

jesacher
geologiebüro | studio di geologia

Von: Walter Weis [mailto:Walter.Weis@bergmeister.eu]
Gesendet: Dienstag, 14. April 2020 09:51
An: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Cc: Cristian Ferraro <Cristian.Ferraro@bergmeister.eu>; Umberto Capozzi <Umberto.Capozzi@bergmeister.eu>
Betreff: Eschenlohe: Kämpferfundamente und Mikropfähle

Hallo Michael, bitte um dringende endgültige Abstimmung der Scherparameter. Ich habe die Parameter wie folgt laut heutiger Telefonnotiz mit dir zusammengestellt. Bitte um Bestätigung.

Charakteristische Scherparameter und charakteristische **Mantelreibungen:**

Künstlichen Auffüllung: 34 Grad c = 0
Mantelreibung char. 150 KPa

GE1: Kakint:
phi 34 Grad und c = 3KPA
Mantelreibung char. 200KPa

GE2: Kataklase:
Mantelreibung char. 350KPa

GE3: Fels verwittert:
Mantelreibung char. 500 KPa

Lockergesteinsauflage im Talboden:
phi = 36 Grad
c = 0
Mantelreibung char.: 200 KPa

Danke Walter

Von: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Gesendet: Freitag, 10. April 2020 09:08
An: Walter Weis <Walter.Weis@bergmeister.eu>
Betreff: AW: Eschenlohe: Kämpferfundamente

Hallo Walter siehe unten!

Grüße Michi

jesacher
geologiebüro | studio di geologia

Von: Walter Weis [mailto:Walter.Weis@bergmeister.eu]
Gesendet: Freitag, 10. April 2020 08:57
An: Michael Jesacher - Geologiebüro Jesacher <michael@jesacher.bz>
Betreff: Eschenlohe: Kämpferfundamente

Hallo Michael, anbei 2 paar Fragen:

1.) Böschungssicherheit Kämpferfundament Lana und Parkraz, Problem bei Lana, Stimmt der Schichtverlauf?...ja

Jesacher 2008:
c = 52 kPa, f' = 38°.....das war das Modell vor den Bohrungen!

Jesacher 2010:
GE1: Kakint: alide Lana c' = 3 kPa e f' = 34°.....OK
GE2: Kataklase: alide Lana c' = 100 kPa e f' = 27°.....OK
GE3: Fels verwittert: alide Lana c' = 500 kPa e f' = 50°.
Weitere Angaben zu den Scherparametern der Klüfte:
C = 0-30 KPA, f = 33-38 Grad

2.) Sind diese Mantelreibungen für diese Mikropfähle vertretbar:
Mantelreibungen:
Künstlichen Auffüllung: 32 Grad c = 0
Mantelreibung char.: 150 KPa
GE1: Kakint:
phi 34 Grad und c = 3KPA
Mantelreibung char.: 200KPa
GE2: Kataklase:
Mantelreibung char.: 350KPa
GE3: Fels verwittert:
Mantelreibung char.: 500 KPa

Pfähle im Projekt vorgesehen zur Info:

- Micropali Fundament Widerlager Lana: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 12m (Bohrloch 240mm) und verdüen
- Micropali Fundament Widerlager Parkraz: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 12m (Bohrloch 240mm) und verdüen
- Micropali Fundament Pfeiler: Pfahl 139/12,5mm S355J2 mit Manschettenrohr lg = 18m (Bohrloch 240mm) und verdüen
- Micropali Kämpfer: Pfahl 139/20mm S355J2 mit Manschettenrohr lg = 18m (Bohrloch 240mm) und verdüen

Mikropfähle Kämpfer: machbar und notwendig, die quergeneigten können alle 4 Stück auf der Westseite ausgeführt werden. Die längsgeneigten Pfähle können zwischen den 11 Stützen ausgeführt werden.
Bohrgerät: Comacchio MC600 G = 4500 kg mit Autokran von oben eingehoben.

5.9 Parameter Studie

17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Allegato relazione: Studio parametrico

Der Planer | il progettista
dott. dott. ing. Walter Weis

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Tel. 0472/979000

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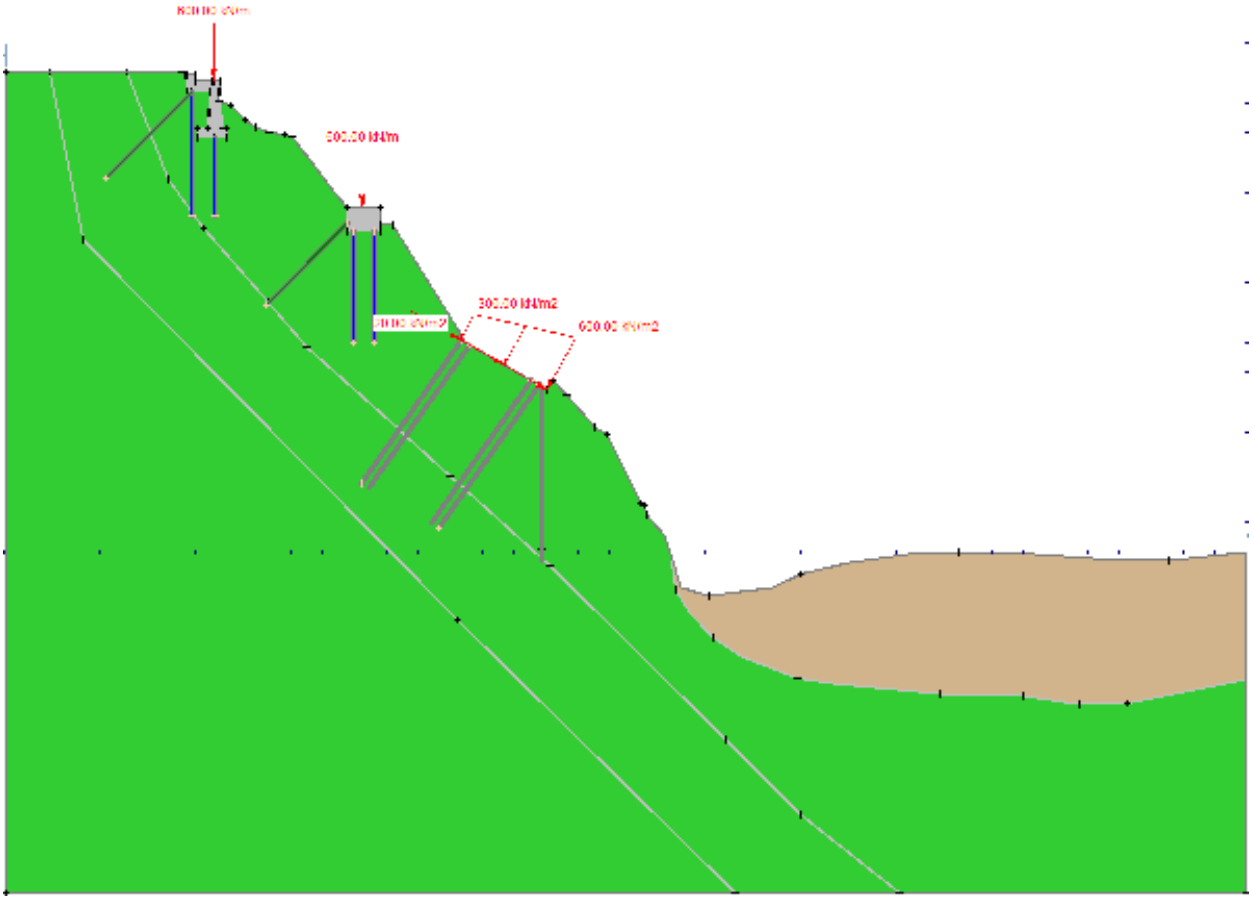
1 Premessa

A causa delle incertezze sulla reale stratigrafia presente in sito si eseguono delle analisi parametriche sulle verifiche stabilitá globale SLIDE e delle resistenze a sfilamento die micropali.

2 Analisi parametrica coesione e verifiche stabilitá globale SLIDE

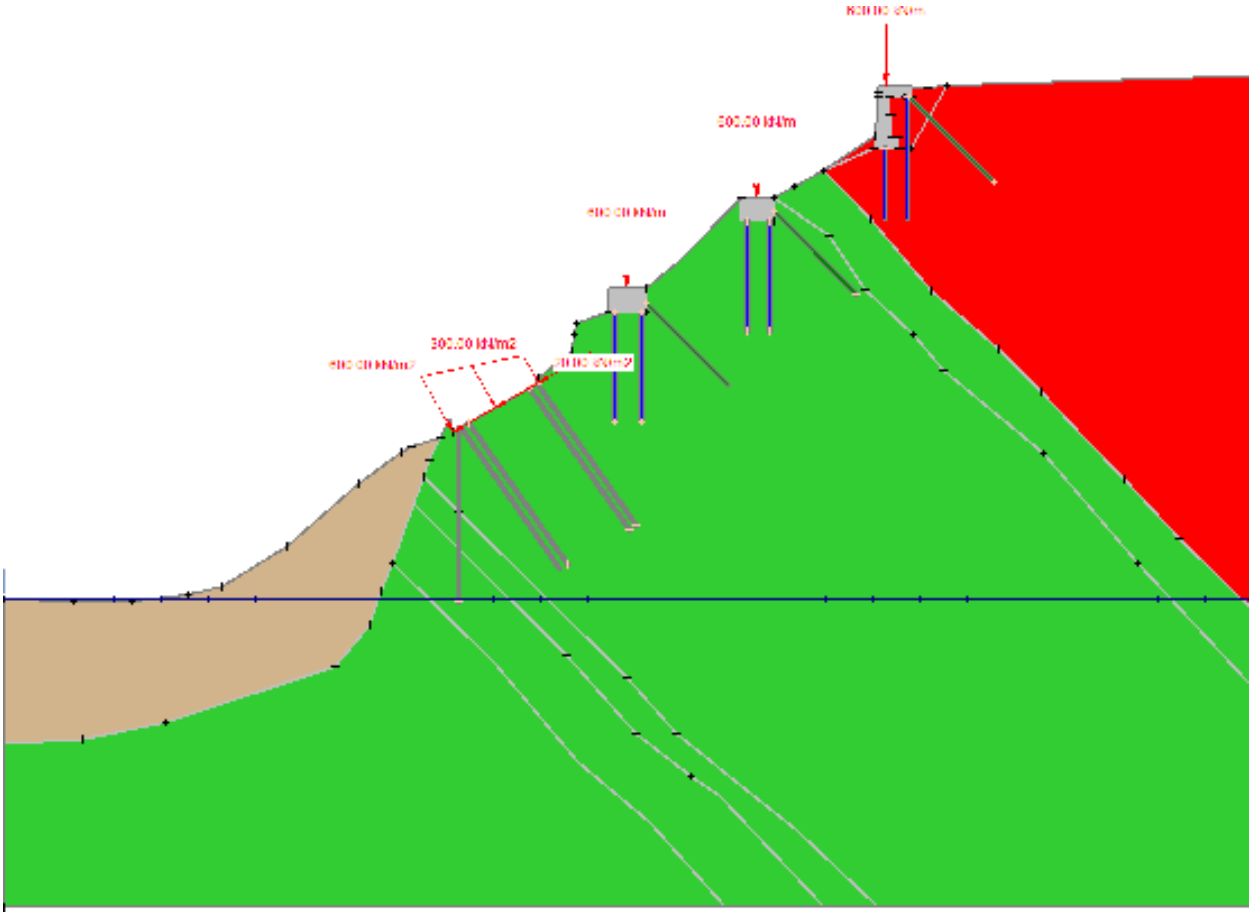
2.1 Ipotesi di calcolo, geometria e carichi di calcolo

Per la verifica di stabilitá globale con SLIDE si è assunto un angolo di attrito standard fisso pari a ϕ´(M2)=30°(M2) e si è valutato il range dei fattori di sicurezza facendo variare la coesione. Sia per il pendio verso Lana che di San Pancrazio sono state eseguite analisi con e senza micropali.
Per il pendio lato San Pancrazio la stratigrafia è la seguente:



In marrone si evidenziano i materiali di deposito di fondo valle con parametri fissi pari a ϕ´(M2)=30° e c´=0 kPa
In verde si evidenzia l´unitá geologica soggetta a variazione del parametro della coesione con angolo di attrito fisso a ϕ´(M2)=30°.

Per il pendio lato Lana la geometria con carichi di calcolo è la seguente:



In rosso si evidenzia l´unitá GE1 Cachirite con parametri fissi pari a ϕ´(M2)=28° e c´(M2)=2,4 kPa
In marrone si evidenziano i materiali di deposito di fondo valle con parametri fissi pari a ϕ´(M2)=30° e c´=0 kPa
In verde si evidenzia l´unitá geologica soggetta a variazione del parametro della coesione con angolo di attrito fisso a ϕ´(M2)=30°.

2.2 Tabella riassuntiva dei risultati e commento

Pendio lato San Pancrazio																							
Caso	Fondazioni senza micropali									Caso	Fondazioni con micropali												
ϕ´(M2) [°]	30									ϕ´(M2) [°]	30												
Ubicazione	Imposta arco			Fondazioni fuori arco						Ubicazione	Imposta arco			Fondazioni fuori arco									
Coefficiente di sicurezza	Fs			Ordinary/Fellenius						Coefficiente di sicurezza	Ordinary/Fellenius			Fs									
c´(M2)[kPa]	10	20	30	40	50	60	70	100	250	500	c´(M2)[kPa]	10	20	30	40	50	60	70	100	250	500		
0,50<Fs<1,00	0,75<Fs<1,00	0,50<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,75<Fs<2,00	2,75<Fs<3,00	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	2,00<Fs<2,25	2,75<Fs<3,50	
0,75<Fs<1,00	1,00<Fs<1,25	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,50<Fs<1,75	2,25<Fs<2,75	3,50<Fs<4,00	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,50<Fs<1,75	2,25<Fs<2,75	3,50<Fs<4,00	

Pendio lato San Pancrazio																							
Caso	Fondazioni senza micropali									Caso	Fondazioni con micropali												
ϕ´(M2) [°]	30									ϕ´(M2) [°]	30												
Ubicazione	Imposta arco			Fondazioni fuori arco						Ubicazione	Imposta arco			Fondazioni fuori arco									
Coefficiente di sicurezza	Fs			Ordinary/Fellenius						Coefficiente di sicurezza	Ordinary/Fellenius			Fs									
c´(M2)[kPa]	10	20	30	40	50	60	70	100	250	500	c´(M2)[kPa]	10	20	30	40	50	60	70	100	250	500		
0,50<Fs<1,00	0,75<Fs<1,00	0,50<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	2,00<Fs<2,25	3,25<Fs<3,50	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,75<Fs<2,00	2,75<Fs<3,00	
0,75<Fs<1,00	1,00<Fs<1,25	0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,50<Fs<1,75	2,25<Fs<2,75	3,50<Fs<4,00	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,50<Fs<1,75	2,25<Fs<2,75	3,50<Fs<4,00	

Pendio lato Lana																							
Caso	Fondazioni senza micropali									Caso	Fondazioni con micropali												
ϕ´(M2) [°]	30									ϕ´(M2) [°]	30												
Ubicazione	Imposta arco			Fondazioni fuori arco						Ubicazione	Imposta arco			Fondazioni fuori arco									
Coefficiente di sicurezza	Fs			Fs						Coefficiente di sicurezza	Fs			Fs									
c´(M2)[kPa]	5	10	20	30	40	50	100	250	500	c´(M2)[kPa]	5	10	20	30	40	50	100	250	500				
0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,50<Fs<0,75 Solo Spalla Imposta Fs>1,0	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	0,50<Fs<0,75	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	2,50<Fs<2,75	2,75<Fs<3,00	
0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	0,75<Fs<1,00	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	2,50<Fs<2,75	2,75<Fs<3,00	3,00<Fs<3,25	

Pendio lato Lana																							
Caso	Fondazioni senza micropali									Caso	Fondazioni con micropali												
ϕ´(M2) [°]	30									ϕ´(M2) [°]	30												
Ubicazione	Imposta arco			Fondazioni fuori arco						Ubicazione	Imposta arco			Fondazioni fuori arco									
Coefficiente di sicurezza	Fs			Fs						Coefficiente di sicurezza	Fs			Fs									
c´(M2)[kPa]	5	10	20	30	40	50	100	250	500	c´(M2)[kPa]	5	10	20	30	40	50	100	250	500				
0,75<Fs<1,00	0,75<Fs<1,00	0,75<Fs<1,00	0,50<Fs<0,75 Solo Spalla Imposta Fs>1,0	1,00<Fs<1,25	1,00<Fs<1,25	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	0,50<Fs<0,75	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	2,50<Fs<2,75	2,75<Fs<3,00	
0,75<Fs<1,00	1,00<Fs<1,25	1,00<Fs<1,25	0,75<Fs<1,00	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,50<Fs<1,75	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	1,00<Fs<1,25	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,25<Fs<1,50	1,75<Fs<2,00	2,00<Fs<2,25	2,25<Fs<2,50	2,50<Fs<2,75	2,75<Fs<3,00	3,00<Fs<3,25	

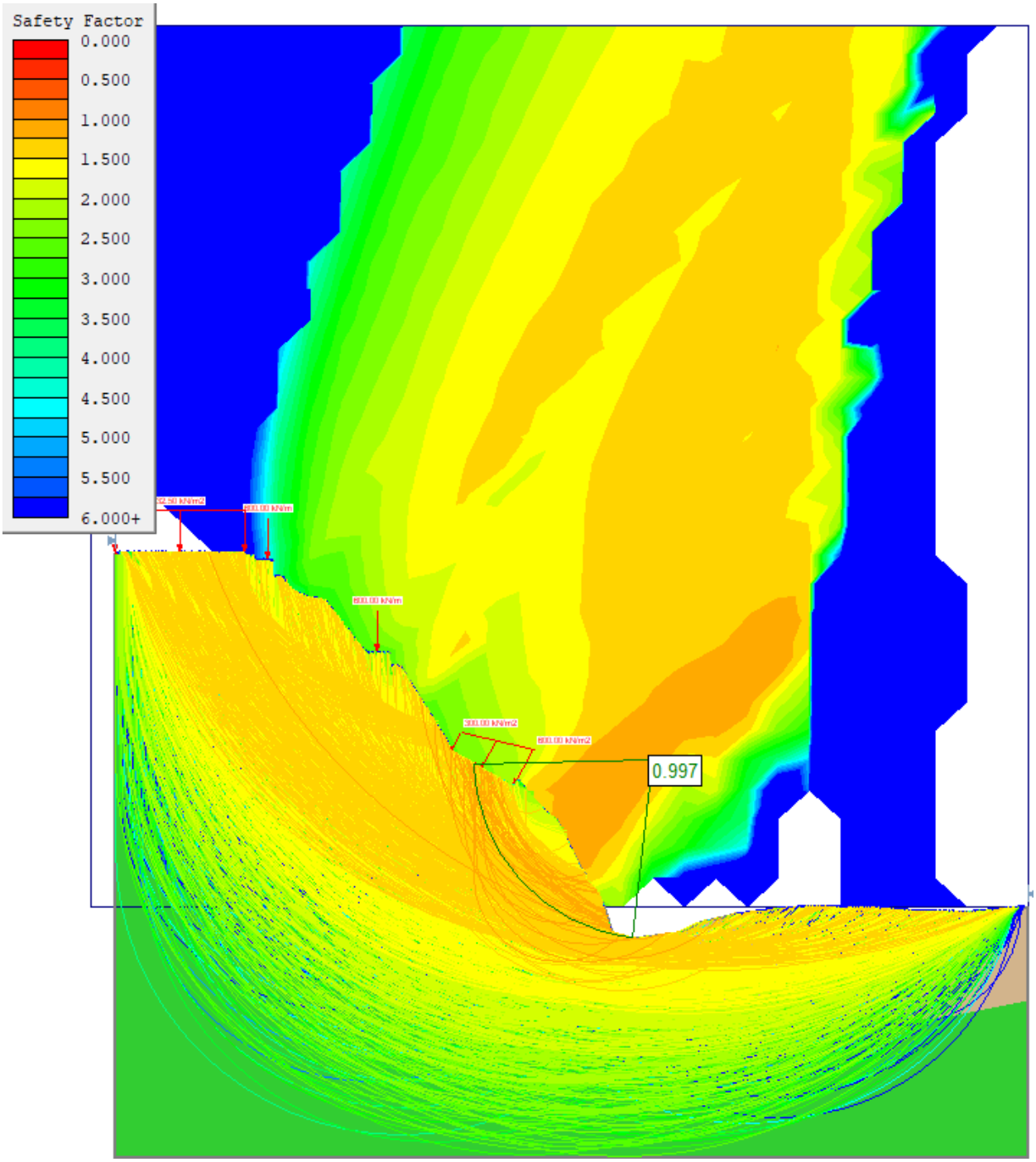
Per il lato San Pancrazio il coefficiente di sicurezza assume valori pari ad 1 per:
-coesione (M2) pari a 60 kPa nel caso senza micropali;

- coesione (M2) pari a 50 kPa nel caso con fondazione con micropali.

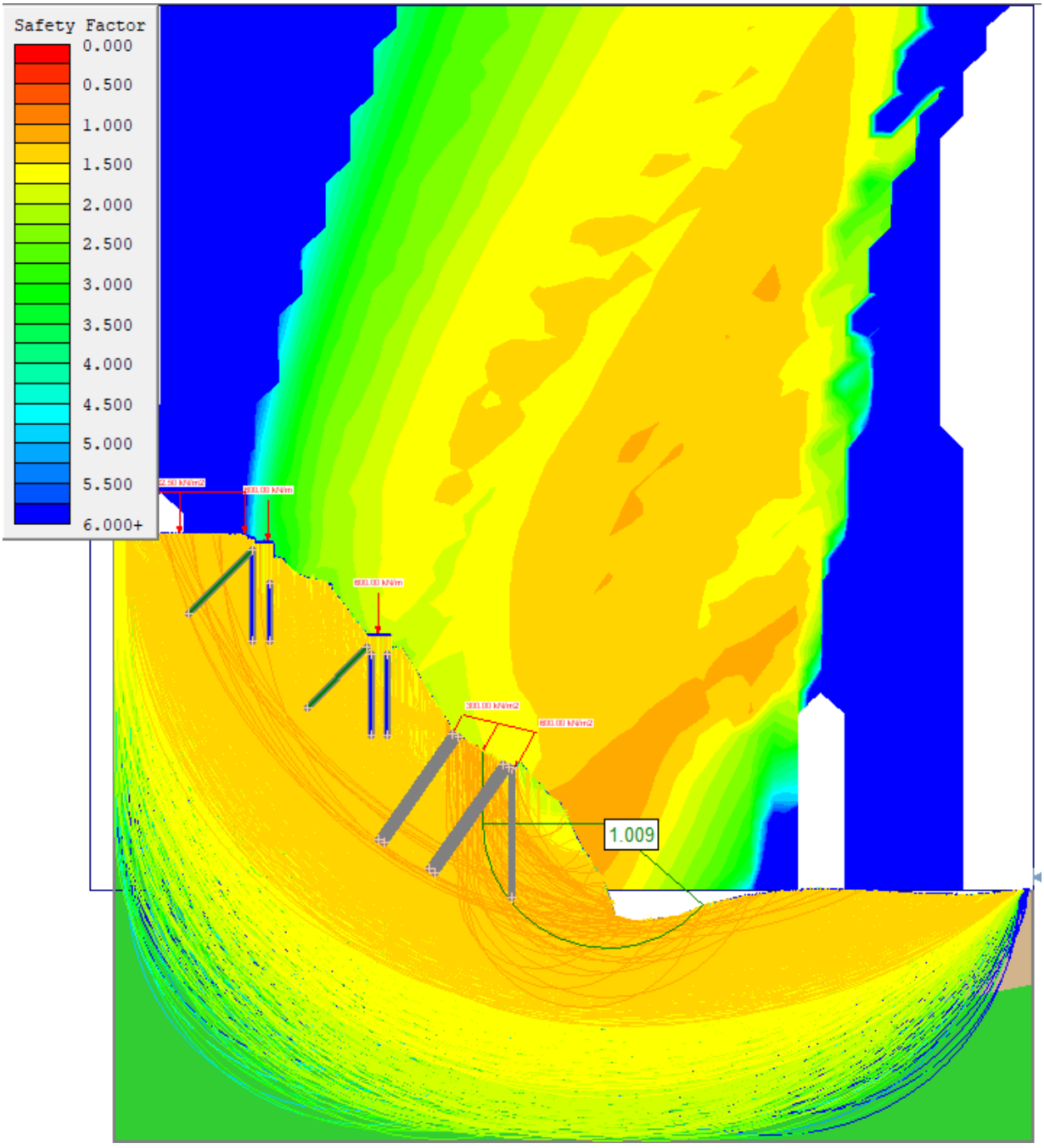
Per il lato Lana il coefficiente di sicurezza assume valori pari ad 1 per:

- coesione (M2) pari a 30 kPa nel caso senza micropali;
- coesione (M2) pari a 10 kPa nel caso con fondazione con micropali.

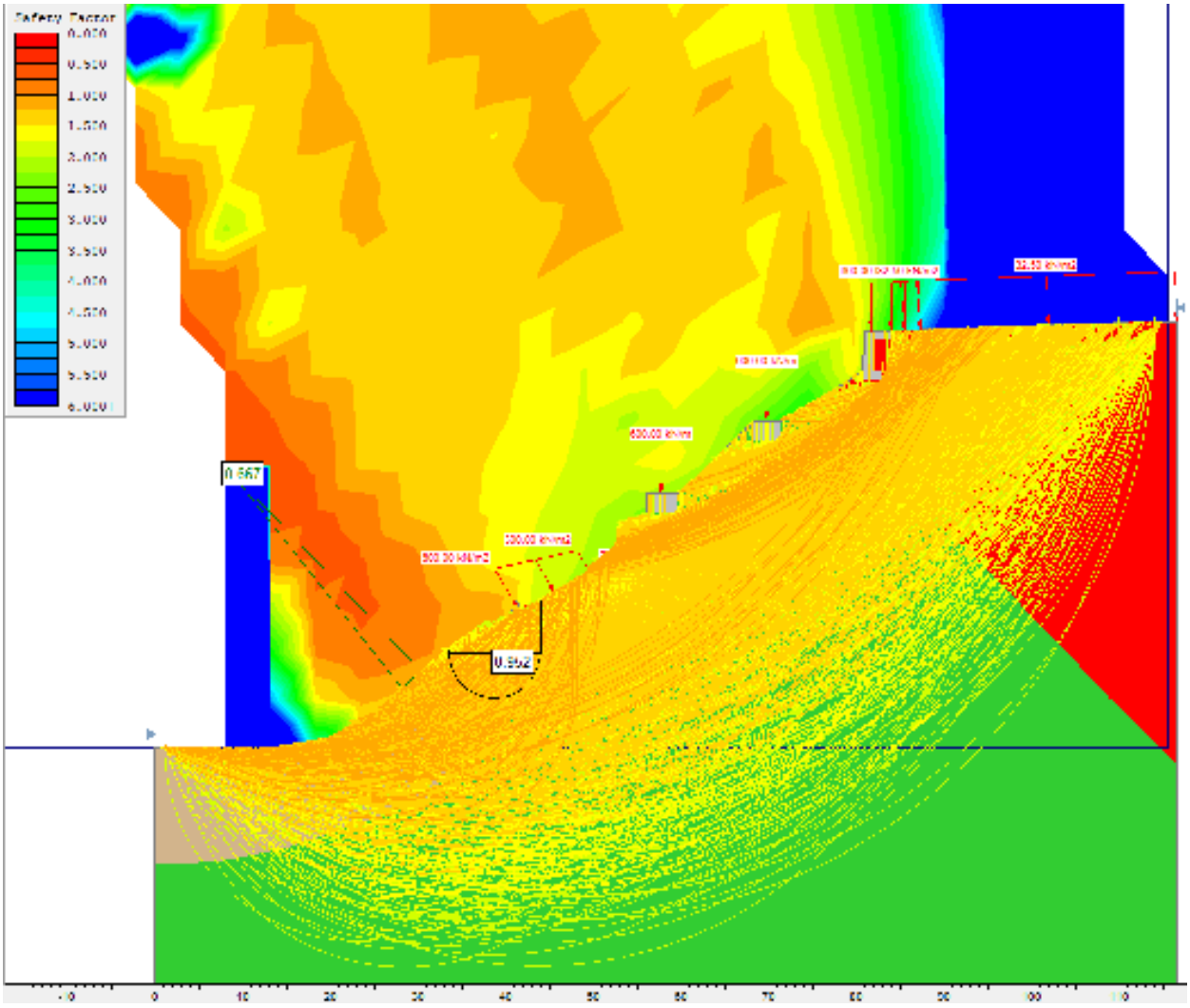
2.2.1 Output Fs=1,00 Lato San Pancrazio senza micropali c´(M2)=60 kPa ϕ´(M2)=30°



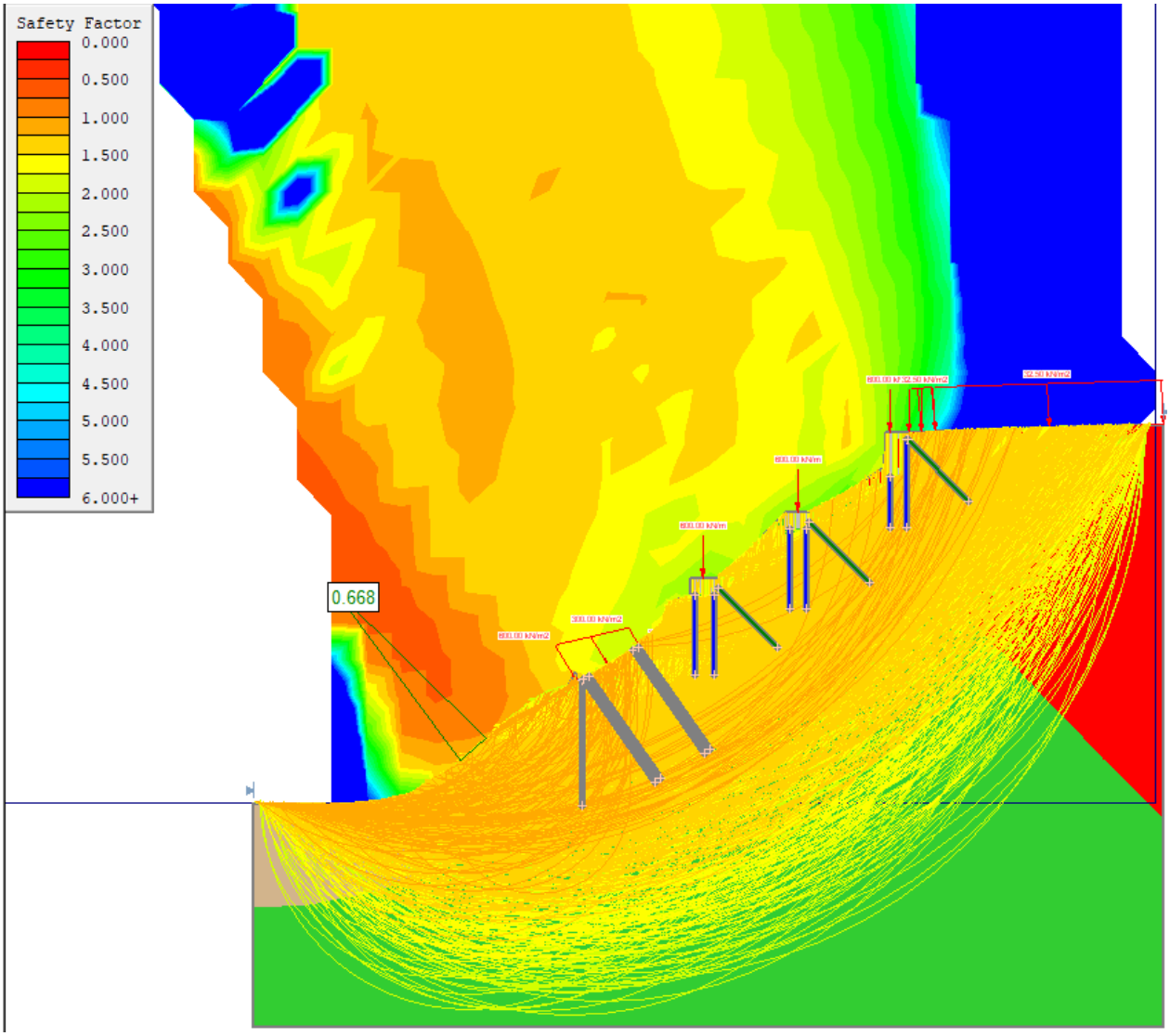
2.2.2 Output Fs=1,00 Lato San Pancrazio con micropali c´(M2)=50 kPa ϕ´(M2)=30°



2.2.3 Output Fs=0,96 ≅ 1,00 Lato Lana senza micropali c´(M2)=30 kPa ϕ´(M2)=30°



2.2.4 Output Fs=1,00 Lato Lana con micropali c´(M2)=10 kPa ϕ´(M2)=30°



3 Analisi parametrica τlim micropali e verifiche sfilamento micropali

A causa dell´incertezza sulla reale stratigrafia si esegue un´analisi parametrica sulla τlim a sfilamento die micropali.

3.1 Verifica a sfilamento micropali presso Imposta arco

3.1.1 Verifica a sfilamento micropali con τlim=500 kPa

Verifica geostatica a trazione micropalo		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**3231,35**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	
α	0,67	

Verifica geostatica compressione micropalo imposta arco		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	500,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,15	-
ξ	1,40	-
Nrd	**3512,34**	**kN**
Ned	**2458,00**	kN
Verifica	**Verificato**	
α	0,70	

3.1.2 Verifica a sfilamento micropali con τlim=350 kPa

Verifica geostatica a trazione micropalo		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	350,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**2261,95**	**kN**
Ned	**2166,00**	kN
Verifica	**Verificato**	
α	0,96	

Verifica geostatica compressione micropalo imposta arco		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	350,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,15	-
ξ	1,40	-
Nrd	**2458,64**	**kN**
Ned	**2458,00**	kN
Verifica	**Verificato**	
α	1,00	

3.1.3 Verifica a sfilamento micropali con τlim=200 kPa

Verifica geostatica a trazione micropalo		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	200,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**2166,00**	kN
Verifica	**Non verificato**	
α	1,68	

Verifica geostatica compressione micropalo imposta arco		
Micropalo	139,7mmx20mm	
Diametro foro	0,24	m
τ limite in GE3	200,00	kN/m2
L micropalo bulbo in GE3	15,00	m
γt	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**2458,00**	kN
Verifica	**Non verificato**	
α	1,75	

Se dalle prove in sito dovesse risultare una τlim<350 kPa, i micropali devono essere allungati.

3.2 Verifica a sfilamento micropali presso assi A2 o 1

3.2.1 Verifica a sfilamento micropali con τlim=500 kPa

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	15,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**3512,34**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	
α	**0,33**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**3231,35**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,15**	

3.2.2 Verifica a sfilamento micropali con τlim=200 kPa

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	15,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**1150,00**	kN
Verifica	**Verificato**	
α	**0,82**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,39**	

Se dalle prove in sito dovesse risultare una τlim<200 kPa, i micropali devono essere allungati.

3.3 Verifica a sfilamento micropali presso asse 13

3.3.1 Verifica a sfilamento micropali con τlim=500 kPa

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	15,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**3512,34**	**kN**
Ned	**1200,00**	kN
Verifica	**Verificato**	
α	**0,34**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**3231,35**	**kN**
Ned	**300,00**	kN
Verifica	**Verificato**	
α	**0,09**	

3.3.2 Verifica a sfilamento micropali con τlim=200 kPa

Verifica geostatica micropalo verticale a compressione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	15,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1404,94**	**kN**
Ned	**1200,00**	kN
Verifica	**Verificato**	
α	**0,85**	

Verifica geostatica micropalo verticale a trazione		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	15,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1292,54**	**kN**
Ned	**300,00**	kN
Verifica	**Verificato**	
α	**0,23**	

Se dalle prove in sito dovesse risultare una τlim<200 kPa, i micropali devono essere allungati.

3.4 Verifica a sfilamento micropali presso spalla lato San Pancrazio

3.4.1 Verifica a sfilamento micropali con τlim=500 kPa

Verifica geostatica micropalo verticale a compressione I fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd	**1697,63**	**kN**
Ned	**900,00**	kN
Verifica	**Verificato**	
α	**0,53**	

Verifica geostatica micropalo verticale a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	500,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd	**1697,63**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,29**	

Verifica geostatica micropalo inclinato a trazione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in GE2	350,00	kN/m2
L micropalo bulbo in GE2	6,00	m
τ limite in GE3	500,00	kN/m
L micropalo bulbo in GE3	2,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**1335,63**	**kN**
Ned	**200,00**	kN
Verifica	**Verificato**	
α	**0,15**	

Verifica geostatica micropalo inclinato a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite in GE2	350,00	kN/m2
L micropalo bulbo in GE2	6,00	m
τ limite in GE3	500,00	kN/m
L micropalo bulbo in GE3	2,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1451,77**	**kN**
Ned	**250,00**	kN
Verifica	**Verificato**	
α	**0,17**	

3.4.2 Verifica a sfilamento micropali con τlim=350 kPa

Verifica geostatica micropalo verticale a compressione I fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	350,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd sfilamento	**1188,34**	**kN**
Nrd base	**178,25**	
Ned	**900,00**	kN
Verifica	**Verificato**	
α	**0,66**	

Verifica geostatica micropalo verticale a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	350,00	kN/m2
L micropalo bulbo	7,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**1147,36**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,44**	

Verifica geostatica micropalo inclinato a trazione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite bulbo	350,00	kN/m
L micropalo bulbo	6,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**904,78**	**kN**
Ned	**200,00**	kN
Verifica	**Verificato**	
α	0,22	

Verifica geostatica micropalo inclinato a compressione II fila		
Micropalo	9,7mmx12,5mm	
Diametro foro	0,24	m
τ limite bulbo	350,00	kN/m
L micropalo bulbo	6,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**983,46**	**kN**
Ned	**250,00**	kN
Verifica	**Verificato**	
α	0,25	

3.4.3 Verifica a sfilamento micropali con τlim=200 kPa

Verifica geostatica micropalo verticale a compressione I fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	7,25	m
γc	1,15	-
ξ	1,40	-
Nrd sfilamento	**679,05**	**kN**
Nrd base	**101,86**	
Ned	**900,00**	kN
Verifica	**Non verificato**	
α	**1,15**	

Verifica geostatica micropalo verticale a compressione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite	200,00	kN/m2
L micropalo bulbo	7,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**655,64**	**kN**
Ned	**500,00**	kN
Verifica	**Verificato**	
α	**0,76**	

Verifica geostatica micropalo inclinato a trazione II fila		
Micropalo	139,7mmx12,5mm	
Diametro foro	0,24	m
τ limite bulbo	200,00	kN/m
L micropalo bulbo	6,00	m
γt	1,25	-
ξ	1,40	-
Nrd	**517,02**	**kN**
Ned	**200,00**	kN
Verifica	**Verificato**	
α	**0,39**	

Verifica geostatica micropalo inclinato a compressione II fila		
Micropalo	9,7mmx12,5mm	
Diametro foro	0,24	m
τ limite bulbo	200,00	kN/m
L micropalo bulbo	6,00	m
γc	1,15	-
ξ	1,40	-
Nrd	**561,97**	**kN**
Ned	**250,00**	kN
Verifica	**Verificato**	
α	**0,44**	

Se dalle prove in sito dovesse risultare una τlim<350 kPa, i micropali devono essere allungati.

3.4.4 Tabella riassuntiva analisi parametrica sfruttamento micropali e commento

Analisi parametrica	τlim=500 kPa	τlim=350 kPa	τlim=200 kPa
Sfruttamento α	α=Ned/Nrd	α=Ned/Nrd	α=Ned/Nrd
Imposta arco	0,70	1,00	1,75
Asse A2 o 1	0,33	-	0,82
Asse 13	0,34	-	0,85
Spalla San Pancrazio	0,53	0,66	1,15

Se nel corso delle prove su micropalo pilota (10 verticali indagate), emergesse una τlim a sfilamento caratteristica inferiore a 350 kPa nei pressi dell´imposta dell´arco e della spalla lato San Pancrazio è assolutamente necessario allungare i micropali.
Se nel corso delle prove su micropalo pilota (10 verticali indagate), emergesse in generale una τlim a sfilamento caratteristica inferiore a 200 kPa, i micropali devono essere allungati anche per la spalla lato Lana e per le 3 fondazioni A2, 1 e 13.

4 Conclusioni

4.1 Stabilitá globale versante

Dall´analisi parametrica della stabilitá dei due versanti, lato Lana e San Pancrazio, emerge che l´utilizzo dei micropali incrementa la resistenza ed aumenta, a paritá di coesione il fattore di sicurezza. Questo fenomeno é piú accentuato nel pendio lato Lana.
I valori di coesione che generano un fattore di sicurezza unitario sono inferiori ai valori di coesione ricavabili dai parametri ricavabili dai dati geologici/geotecnici dell´ammasso GE3 consultabili nella relazione geologica.
Per il lato San Pancrazio il coefficiente di sicurezza assume valori pari ad 1 per:

- coesione (M2) pari a 60kPa nel caso senza micropali;

- coesione (M2) pari a 50kPa nel caso con fondazione con micropali.

Per il lato Lana il coefficiente di sicurezza assume valori pari ad 1 per:

- coesione (M2) pari a 30kPa nel caso senza micropali;

- coesione (M2) pari a 10kPa nel caso con fondazione con micropali.

Il pendio a lungo termine fronte la spalla lato Lana deve avere un´inclinazione massima pari a 2/3.

4.2 Verifica geostatica a sfilamento dei micropali

Se nel corso delle prove su micropalo pilota(10 verticali indagate) eseguite presso le 2 imposte dell`arco e presso la spalla San Pancrazio emerge una τlim a sfilamento caratteristica inferiore a 350kPa, è assolutamente necessario allungare i micropali.
Se nel corso delle prove su micropalo pilota (10 verticali indagate) eseguite presso la spalla lato Lana e presso le 3 fondazioni A2, 1 e 13, emerge in generale una τlim a sfilamento caratteristica inferiore a 200kPa, i micropali devono essere allungati.

5.10 Stabilitätsnachweise Pfeiler und Stiele

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse A2, Biegung um die schwache Achse

Nsd=Ned	4,7	MN
Msd	0,92	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0159	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	8,55	m
l0 (Knicklänge)	14,5	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa

Ac	1,7176	m²

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,684	[-]
θi =	0,0034	[-]
Exzentrizität ei =	0,0292	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	66,09141239

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,160963314
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	26,86923541

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,50	MN/m
δ = C*l^3/(E*J)	1,13	
Steifigkeit K der unteren Drehfeder	oo	MNm/rad
γ= K*l/(E*J)	oo	
β	1,7	
Knicklänge l0=β*l	14,5	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0292	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0150	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0643	MN

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	382,2062224	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,027372257	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,062578193	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00162816	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	17,92342673	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	1,0574298	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333	

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**1,366234172**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12	

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,006875098	

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,213076728	
n = Ned/(Ac*fcd) =	0,16	
nu = 1+ω =	1,213076728	
nbal =	0,4	

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	1,11	
β = 0.35 + fck/200 - λ/150 =	0,06	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,120457443	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,623579784**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,231	MN/m²
σN = Ned / Ac * (20/fcd) =	3,22	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,463	MN/m²
σN = Ned / Ac * (20/fcd) =	3,22	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 1, Biegung um die schwache Achse

Nsd=Ned	5,5	MN
Msd	0,86	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0159	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	16,9	m
l0 (Knicklänge)	16,9	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	5,40	MN/m
δ = C*l^3/(E*J)	10,51	
Steifigkeit K der unteren Drehfeder	oo	MNm/rad
γ= K*l/(E*J)	oo	
β	1	
Knicklänge l0=β*l	16,9	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0411	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0063	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0535	MN

Ac 1,7176 m²

Berücksichtigung der Imperfektionen

Grundwert Θ0 =	0,005	[-] = 1/200
αh =	0,487	[-]
Θi =	0,0024	[-]
Exzentrizität ei =	0,0411	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	77,03068065

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n

n=N_Ed/(Ac*fcd)	0,188361325

Grenzschlankheit λlim

λlim = 20*A*B*C/(n)^0,5

λlim = 20*0,7*1,1*0,7/(n)^0,5 =	24,83835858

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	402,7937604	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,037333108	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,085350595	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00162816	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	13,90492406	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	1,086102853	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**1,670055861**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,006059758

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000
ω = As*fyd/(Ac*fcd) =	0,213076728
n = Ned/(Ac*fcd) =	0,19
nu = 1+ω =	1,213076728
nbal =	0,4

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	0,98
β = 0.35 + fck/200 - λ/150 =	-0,01

1/r0 = εyd/(0.45*d) =	0,006211111
εyd = fyd/Es =	0,0019565

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,144227283	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,879352911**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,505	MN/m²
σN = Ned / Ac * (20/fcd) =	3,77	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,694	MN/m²
σN = Ned / Ac * (20/fcd) =	3,77	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 3, Biegung um die schwache Achse

Nsd=Ned	4,1	MN
Msd	0,75	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0159	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	16,4	m
l0 (Knicklänge)	18	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa
Ac	1,7176	m²

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	7,47	
Steifigkeit K der unteren Drehfeder	14300	MNm/rad
γ= K*l/(E*J)	94,56	
β	1,1	
Knicklänge l0=β*l	18,0	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0405	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0049	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0405	MN

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,494	[-]
θi =	0,0025	[-]
Exzentrizität ei =	0,0405	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	82,04451194

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,140414806
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	28,7681748

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	386,8965285	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,029641564	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,06776626	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00162816	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	11,77359572	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,916037345	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333	

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**1,318176325**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12	

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,00568606	

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,213076728	
n = Ned/(Ac*fcd) =	0,14	
nu = 1+ω =	1,213076728	
nbal =	0,4	

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	0,92	
β = 0.35 + fck/200 - λ/150 =	-0,05	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,153523624	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,545484204**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,188	MN/m²
σN = Ned / Ac * (20/fcd) =	2,81	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,393	MN/m²
σN = Ned / Ac * (20/fcd) =	2,81	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 4, Biegung um die schwache Achse

Nsd=Ned	3,6	MN
Msd	0,6	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0094	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	9,4	m
l0 (Knicklänge)	14,6	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa
Ac	1,7176	m²

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	1,41	
Steifigkeit K der unteren Drehfeder	12200	MNm/rad
γ= K*l/(E*J)	46,24	
β	1,55	
Knicklänge l0=β*l	14,6	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0307	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0100	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0470	MN

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,652	[-]
θi =	0,0033	[-]
Exzentrizität ei =	0,0307	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	66,54721524

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n

n=N_Ed/(Ac*fcd)	0,123291049

Grenzschlankheit λlim

λlim = 20*A*B*C/(n)^0,5

λlim = 20*0,7*1,1*0,7/(n)^0,5 =	30,70103289

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	236,1442983	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,021110577	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,0482628	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	10,92272623	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,71037391	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,997316329**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,006841125

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000
ω = As*fyd/(Ac*fcd) =	0,12596989
n = Ned/(Ac*fcd) =	0,12
nu = 1+ω =	1,12596989
nbal =	0,4

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	1,10
β = 0.35 + fck/200 - λ/150 =	0,06

1/r0 = εyd/(0.45*d) =	0,006211111
εyd = fyd/Es =	0,0019565

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,12152119	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,147850193**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,899	MN/m²
σN = Ned / Ac * (20/fcd) =	2,47	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,035	MN/m²
σN = Ned / Ac * (20/fcd) =	2,47	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 5, Biegung um die schwache Achse

Nsd=Ned	3,6	MN	**Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":**		
Msd	0,29	MNm	Tafel 5.4		
fcd	17	MPa	Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
b	2,26	m	δ = C*l^3/(E*J)	0,18	
h (Wobei h<b)	0,76	m	Steifigkeit K der unteren Drehfeder	9500	MNm/rad
As,tot	0,0094	m²	γ= K*l/(E*J)	18,00	
d1	0,06	m	β	2	
fyd	391,3	MPa	Knicklänge l0=β*l	9,4	m
l (Systemlänge)	4,7	m			
l0 (Knicklänge)	9,4	m			
Kriechzahl φef =	1,8		**Berechnung der Ersatzbelastung für die Imperfektion:**		
fck =	30	MPa	Exzentrizität aus Säbelkrümmung ei =	0,0217	m
Ec =	30000	MPa	Ersatzlast q = Nsd*e_ges*8/l²=	0,0283	MN/m
Es =	200000	MPa	Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0664	MN

Ac	1,7176	m²	
Berücksichtigung der Imperfektionen			
Grundwert θ0 =	0,005	[-] = 1/200	
αh =	0,923	[-]	
θi =	0,0046	[-]	
Exzentrizität ei =	0,0217	[m]	

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	42,84546735

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,123291049
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	30,70103289

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7		
c0 =	12	
Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2		
EI = Kc*Ecd*Ic+Ks*Es*Is	220,6040277	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,013591742	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,03107331	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4
Berechnung der Knicklast aus Nennsteifigkeit		
NB = Pi^2*EI/l0^2	24,6159741	MN
Berechnung von M0Ed		
M0Ed = Msd+Nsd*ei =	0,36804614	MNm
Momentenvergrößerung Kapitel 5.8.7.3		
Beiwert β = (Pi)^2/c0	0,821633333	
Bemessungsmoment Med		
Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,419846562**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)		
c =	12	
Krümmung nach Kap. 5.8.8.3		
1/r = Kr*Kφ*1/r0 =	0,008607696	
Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3		
Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,12596989	
n = Ned/(Ac*fcd) =	0,12	
nu = 1+ω =	1,12596989	
nbal =	0,4	
Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3		
Kφ = 1+β*φef =	1,39	
β = 0.35 + fck/200 - λ/150 =	0,21	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	
Ausmitte nach Theorie 2. Ordnung:		
e2 = 1/r * l0^2/c =	0,063381332	m
Bemessungsmoment Med		
Med = M0ed + M2 =	**0,596218935**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):			**Bemessung nach Bewehrungsatlas (Ausgabe März 2009):**		
σM = Med / (Ac*h) * (20/fcd) =	0,378	MN/m²	σM = Med / (Ac*h) * (20/fcd) =	0,537	MN/m²
σN = Ned / Ac * (20/fcd) =	2,47	MN/m²	σN = Ned / Ac * (20/fcd) =	2,47	MN/m²
d1/h =	0,079		d1/h =	0,079	
ρ0,tot =	0,2	%	ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²	As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²
As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt			**As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt**		

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 6, Biegung um die schwache Achse

Nsd=Ned	3,7	MN
Msd	0,09	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0094	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	1,7	m
l0 (Knicklänge)	3,4	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa
Ac	1,7176	m²

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	0,01	
Steifigkeit K der unteren Drehfeder	6800	MNm/rad
γ= K*l/(E*J)	4,66	
β	2	
Knicklänge l0=β*l	3,4	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0085	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0871	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0740	MN

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	1,000	[-]
θi =	0,0050	[-]
Exzentrizität ei =	0,0085	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	15,4972967

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,1267158
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	30,2833123

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	202,9551947	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,005052722	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,011551484	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	173,1018199	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,12145	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333	

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,123629512**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12	

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,010646046	

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,12596989	
n = Ned/(Ac*fcd) =	0,13	
nu = 1+ω =	1,12596989	
nbal =	0,4	

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	1,71	
β = 0.35 + fck/200 - λ/150 =	0,40	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,010255691	m

Bemessungsmoment Med

Med = M0ed + M2 =	**0,159396056**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,111	MN/m²
σN = Ned / Ac * (20/fcd) =	2,53	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,144	MN/m²
σN = Ned / Ac * (20/fcd) =	2,53	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 8, Biegung um die schwache Achse

Nsd=Ned	3,5	MN
Msd	0,08	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0094	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	1,2	m
l0 (Knicklänge)	2,4	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa

Ac 1,7176 m²

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	1,000	[-]
θi =	0,0050	[-]
Exzentrizität ei =	0,0060	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	10,93926826

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n

n=N_Ed/(Ac*fcd)	0,119866298

Grenzschlankheit λlim

λlim = 20*A*B*C/(n)^0,5

λlim = 20*0,7*1,1*0,7/(n)^0,5 =	31,13653028

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	0,00	
Steifigkeit K der unteren Drehfeder	6800	MNm/rad
γ= K*l/(E*J)	3,29	
β	2	
Knicklänge l0=β*l	2,4	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0060	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,1167	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0700	MN

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	199,4851984	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,003373837	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,007713233	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	341,4660177	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,101	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,101859398**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,010985771

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000
ω = As*fyd/(Ac*fcd) =	0,12596989
n = Ned/(Ac*fcd) =	0,12
nu = 1+ω =	1,12596989
nbal =	0,4

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	1,77
β = 0.35 + fck/200 - λ/150 =	0,43

1/r0 = εyd/(0.45*d) =	0,006211111
εyd = fyd/Es =	0,0019565

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,00527317	m

Bemessungsmoment Med

Med = M0ed + M2 =	**0,119456095**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,092	MN/m²
σN = Ned / Ac * (20/fcd) =	2,40	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,108	MN/m²
σN = Ned / Ac * (20/fcd) =	2,40	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 9, Biegung um die schwache Achse

Nsd=Ned	3,6	MN
Msd	0,11	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0159	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	3,6	m
l0 (Knicklänge)	7,2	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa
Ac	1,7176	m²

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	0,08	
Steifigkeit K der unteren Drehfeder	9500	MNm/rad
γ= K*l/(E*J)	13,79	
β	2	
Knicklänge l0=β*l	7,2	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0180	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0400	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0720	MN

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	1,000	[-]
θi =	0,0050	[-]
Exzentrizität ei =	0,0180	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	32,81780477

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,123291049
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	30,70103289

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	347,1492978	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,010410696	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,023800833	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00162816	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	66,02533211	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,1748	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,183082494**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,009355091

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000
ω = As*fyd/(Ac*fcd) =	0,213076728
n = Ned/(Ac*fcd) =	0,12
nu = 1+ω =	1,213076728
nbal =	0,4

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	1,51
β = 0.35 + fck/200 - λ/150 =	0,28
1/r0 = εyd/(0.45*d) =	0,006211111
εyd = fyd/Es =	0,0019565

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,040413992	m

Bemessungsmoment Med

Med = M0ed + M2 =	**0,320290371**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,165	MN/m²
σN = Ned / Ac * (20/fcd) =	2,47	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	0,289	MN/m²
σN = Ned / Ac * (20/fcd) =	2,47	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 10, Biegung um die schwache Achse

Nsd=Ned	3,5	MN	**Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":**		
Msd	0,42	MNm	Tafel 5.4		
fcd	17	MPa	Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
b	2,26	m	δ = C*l^3/(E*J)	0,80	
h (Wobei h<b)	0,76	m	Steifigkeit K der unteren Drehfeder	12200	MNm/rad
As,tot	0,0094	m²	γ= K*l/(E*J)	38,37	
d1	0,06	m	β	1,7	
fyd	391,3	MPa	Knicklänge l0=β*l	13,3	m
l (Systemlänge)	7,8	m			
l0 (Knicklänge)	13,3	m			
Kriechzahl φef =	1,8		**Berechnung der Ersatzbelastung für die Imperfektion:**		
fck =	30	MPa	Exzentrizität aus Säbelkrümmung ei =	0,0279	m
Ec =	30000	MPa	Ersatzlast q = Nsd*e_ges*8/l²=	0,0129	MN/m
Es =	200000	MPa	Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0501	MN

Ac	1,7176	m²
Berücksichtigung der Imperfektionen		
Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,716	[-]
θi =	0,0036	[-]
Exzentrizität ei =	0,0279	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	60,62177826

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,119866298
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	31,13653028

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7		
c0 =	12	
Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2		
EI = Kc*Ecd*Ic+Ks*Es*Is	231,1551409	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,018696678	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,042744165	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4
Berechnung der Knicklast aus Nennsteifigkeit		
NB = Pi^2*EI/l0^2	12,88426269	MN
Berechnung von M0Ed		
M0Ed = Msd+Nsd*ei =	0,51774968	MNm
Momentenvergrößerung Kapitel 5.8.7.3		
Beiwert β = (Pi)^2/c0	0,821633333	
Bemessungsmoment Med		
Med = M0Ed*(1+ β/((NB/Ned)-1))	**0,676409069**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)		
c =	12	
Krümmung nach Kap. 5.8.8.3		
1/r = Kr*Kφ*1/r0 =	0,007282768	
Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3		
Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,12596989	
n = Ned/(Ac*fcd) =	0,12	
nu = 1+ω =	1,12596989	
nbal =	0,4	
Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3		
Kφ = 1+β*φef =	1,17	
β = 0.35 + fck/200 - λ/150 =	0,10	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	
Ausmitte nach Theorie 2. Ordnung:		
e2 = 1/r * l0^2/c =	0,107354068	m
Bemessungsmoment Med		
Med = M0ed + M2 =	**0,893488918**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):			**Bemessung nach Bewehrungsatlas (Ausgabe März 2009):**		
σM = Med / (Ac*h) * (20/fcd) =	0,610	MN/m²	σM = Med / (Ac*h) * (20/fcd) =	0,805	MN/m²
σN = Ned / Ac * (20/fcd) =	2,40	MN/m²	σN = Ned / Ac * (20/fcd) =	2,40	MN/m²
d1/h =	0,079		d1/h =	0,079	
ρ0,tot =	0,2	%	ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²	As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²
As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt			**As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt**		

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 11, Biegung um die schwache Achse

Nsd=Ned	3,9	MN
Msd	0,62	MNm
fcd	17	MPa
b	2,26	m
h (Wobei h<b)	0,76	m
As,tot	0,0094	m²
d1	0,06	m
fyd	391,3	MPa
l (Systemlänge)	14,2	m
l0 (Knicklänge)	17	m
Kriechzahl φef =	1,8	
fck =	30	MPa
Ec =	30000	MPa
Es =	200000	MPa

Ac 1,7176 m²

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,531	[-]
θi =	0,0027	[-]
Exzentrizität ei =	0,0377	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	77,4864835

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,133565303
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	29,4965983

Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":

Tafel 5.4

Steifigkeit C der Wegfeder am oberene Ende:	4,20	MN/m
δ = C*l^3/(E*J)	4,85	
Steifigkeit K der unteren Drehfeder	14300	MNm/rad
γ= K*l/(E*J)	81,87	
β	1,2	
Knicklänge l0=β*l	17,0	m

Berechnung der Ersatzbelastung für die Imperfektion:

Exzentrizität aus Säbelkrümmung ei =	0,0377	m
Ersatzlast q = Nsd*e_ges*8/l²=	0,0058	MN/m
Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0414	MN

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	247,5504585	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,02662921	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,060879445	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00096256	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	8,445496542	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	0,766963261	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333	

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**1,307637759**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12	

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,006025785	

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,12596989	
n = Ned/(Ac*fcd) =	0,13	
nu = 1+ω =	1,12596989	
nbal =	0,4	

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	0,97	
β = 0.35 + fck/200 - λ/150 =	-0,02	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,145120994	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,332935136**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,179	MN/m²
σN = Ned / Ac * (20/fcd) =	2,67	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,201	MN/m²
σN = Ned / Ac * (20/fcd) =	2,67	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 94cm² (30d20) > As,tot -> Nachweis erfüllt

Stützen: Bemessung auf Druck und Biegemoment nach EN 1992-1-1: 2004 + AC:2010 (D)

Pfeiler Achse 13, Biegung um die schwache Achse

Nsd=Ned	5,7	MN	**Berechnung der Knicklänge laut Petersen "Statik und Stabilität der Baukonstruktionen":**		
Msd	0,88	MNm	Tafel 5.4		
fcd	17	MPa	Steifigkeit C der Wegfeder am oberene Ende:	5,40	MN/m
b	2,26	m	δ = C*l^3/(E*J)	3,67	
h (Wobei h<b)	0,76	m	Steifigkeit K der unteren Drehfeder	oo	MNm/rad
As,tot	0,0159	m²	γ= K*l/(E*J)	oo	
d1	0,06	m	β	1,4	
fyd	391,3	MPa	Knicklänge l0=β*l	16,7	m
l (Systemlänge)	11,9	m			
l0 (Knicklänge)	16,7	m			
Kriechzahl φef =	1,8		**Berechnung der Ersatzbelastung für die Imperfektion:**		
fck =	30	MPa	Exzentrizität aus Säbelkrümmung ei =	0,0345	m
Ec =	30000	MPa	Ersatzlast q = Nsd*e_ges*8/l²=	0,0111	MN/m
Es =	200000	MPa	Ersatzkräfte am oberen und am unteren Ende Q=Nsd*e_ges*4/l	0,0661	MN

Ac	1,7176	m²

Berücksichtigung der Imperfektionen

Grundwert θ0 =	0,005	[-] = 1/200
αh =	0,580	[-]
θi =	0,0029	[-]
Exzentrizität ei =	0,0345	[m]

Berücksichtigung der Theorie 2. Ordnung

Berechnung Schlankheit:

Trägheitsmoment Ic_min = b*h^3/12 =	0,082673813
Trägheitsradius i = (Imin/Ac)^0,5 =	0,219393102
Schlankheit λ= l0/i	76,11907496

Berechnung Grenzschlankheit (ob Zusatzmoment aus TH.2.O. berücksichtigt werden muss)

Bezogne Normalkraft n	
n=N_Ed/(Ac*fcd)	0,195210828
Grenzschlankheit λlim	
λlim = 20*A*B*C/(n)^0,5	
λlim = 20*0,7*1,1*0,7/(n)^0,5 =	24,39870687

Nennsteifigkeitsverfahren:

Beiwert zur Momentenvergrößerung_Kap. 5.8.7

c0 =	12	

Berechnung der Nenn-Steifigkeit Kapitel 5.8.7.2

EI = Kc*Ecd*Ic+Ks*Es*Is	404,65328	MNm²
Ks =	1	
Kc = k1*k2/(1+φef)	0,038232798	
k1 = (fck/20)^0,5	1,224744871	
k2 = n*λ/170<0,20	0,087407457	
Is = (As,tot/2)*(h/2-d1)^2*2	0,00162816	m4

Berechnung der Knicklast aus Nennsteifigkeit

NB = Pi^2*EI/l0^2	14,30571006	MN

Berechnung von M0Ed

M0Ed = Msd+Nsd*ei =	1,076629347	MNm

Momentenvergrößerung Kapitel 5.8.7.3

Beiwert β = (Pi)^2/c0	0,821633333	

Bemessungsmoment Med

Med = M0Ed*(1+ β/((NB/Ned)-1))	**1,662541369**	MNm

Nennkrümmungsverfahren:

Beiwert zum Krümmungsverlauf nach Kap. 5.8.8.2 (4)

c =	12	

Krümmung nach Kap. 5.8.8.3

1/r = Kr*Kφ*1/r0 =	0,006127703	

Beiwert in Abhängigkeit der Normalkraft Kapitel 5.8.8.3

Kr = (nu-n)/(nu-nbal)	1,000	
ω = As*fyd/(Ac*fcd) =	0,213076728	
n = Ned/(Ac*fcd) =	0,20	
nu = 1+ω =	1,213076728	
nbal =	0,4	

Beiwert zur Berücksichtigung des Kriechens Kapitel 5.8.8.3

Kφ = 1+β*φef =	0,99	
β = 0.35 + fck/200 - λ/150 =	-0,01	
1/r0 = εyd/(0.45*d) =	0,006211111	
εyd = fyd/Es =	0,0019565	

Ausmitte nach Theorie 2. Ordnung:

e2 = 1/r * l0^2/c =	0,142412918	m

Bemessungsmoment Med

Med = M0ed + M2 =	**1,888382978**	MNm

Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,498	MN/m²
σN = Ned / Ac * (20/fcd) =	3,90	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

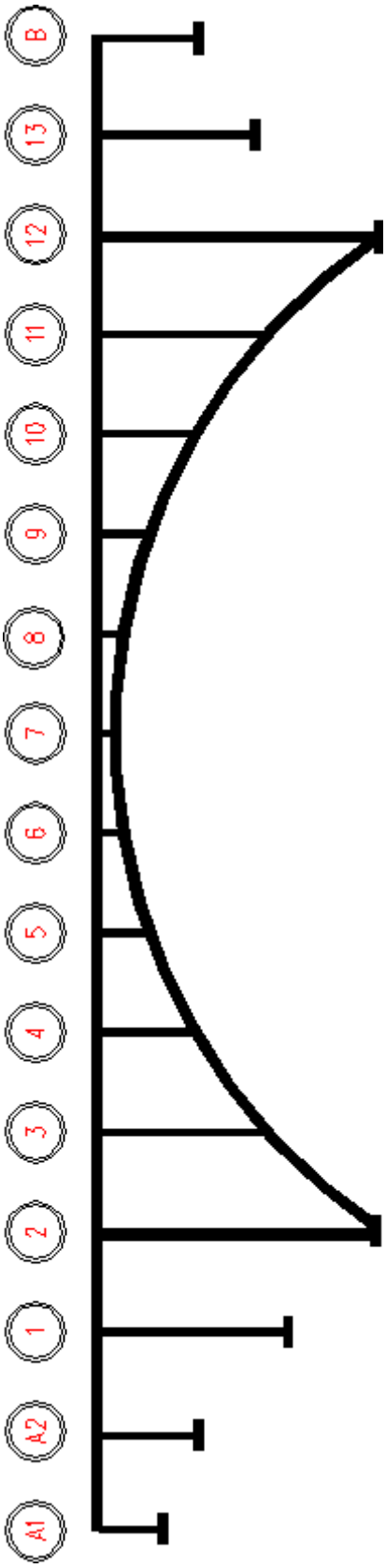
Bemessung nach Bewehrungsatlas (Ausgabe März 2009):

σM = Med / (Ac*h) * (20/fcd) =	1,702	MN/m²
σN = Ned / Ac * (20/fcd) =	3,90	MN/m²
d1/h =	0,079	
ρ0,tot =	0,2	%
As,tot = ρ0,tot/100 * fcd/20 * 478/fyd *Ac =	35,67	cm²

As, vorh = 159cm² (30d26) > As,tot -> Nachweis erfüllt

5.11 Materialprüfungen Bestandsbauwerk

Bezeichnung der Ständer:



PONTE AD ARCO ESCHENLOHE
BOGENBRÜCKE ESCHENLOHE

VALUTAZIONE STATO DI FATTO
ZUSTANDSBEURTEILUNG

BERGMEISTER

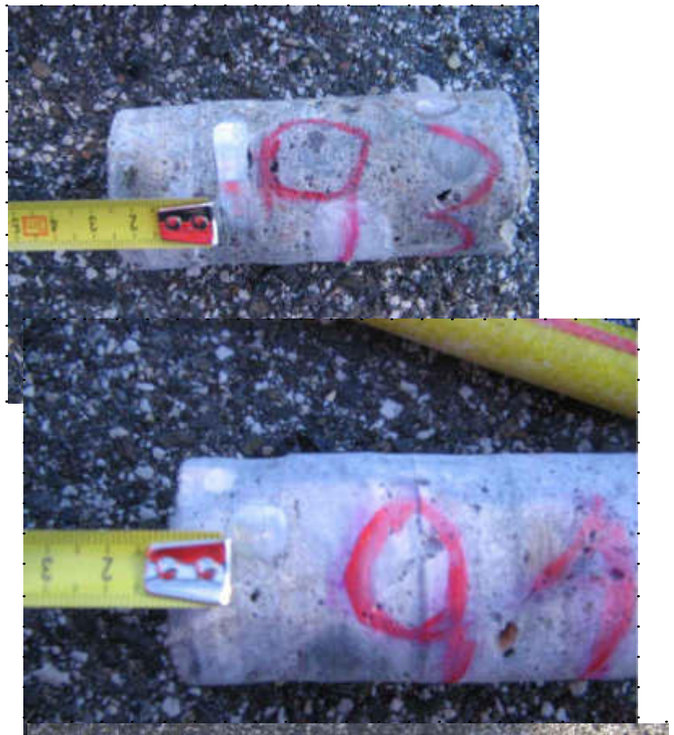
Dr. Ing. WALTER WEIS

Foto carotaggi

ASSE 10 lato S. Pancrazio

ASSE 6 Arco

ASSE 7-8 Arco



ARCO Lato LANA

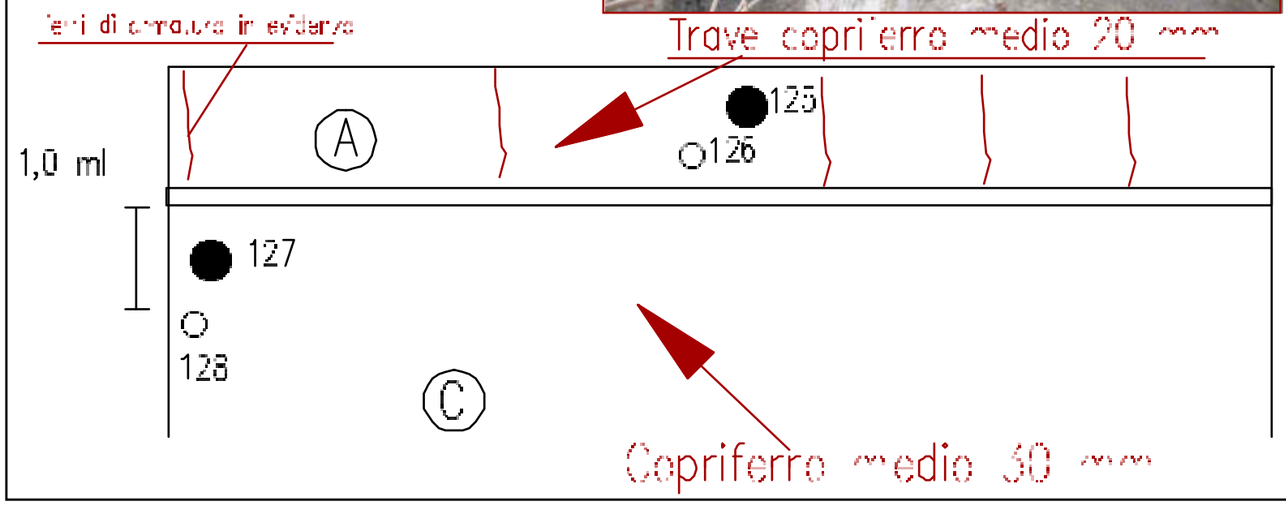
(A) Eseguita martellatura sulla base dell'arco il suono risulta pieno al di fuori di una fascia di larghezza 60 cm che parte dalla base e si estende fino al colmo. In questo tratto vi sono ferri in evidenza ed il copriferro si distacca (vedi foto).
Copriferro medio 1,5–2,0 cm

Copriferro medio
(A) MARTELLATURA
○ Carotaggio DN 50
● Carotaggio DN 100

ASSE B Lato LANA

(A) Eseguita martellatura sulla trave in senso longitudinale,il rumore risulta pieno, ma vi sono vari ferri di armatura in evidenza. Vi e' il distacco di parte del copriferro durante la martellatura

(C) Eseguita martellatura sul muro risulta suono pieno



Copriferro medio

(A) MARTELLATURA

○ Carotaggio DN 50

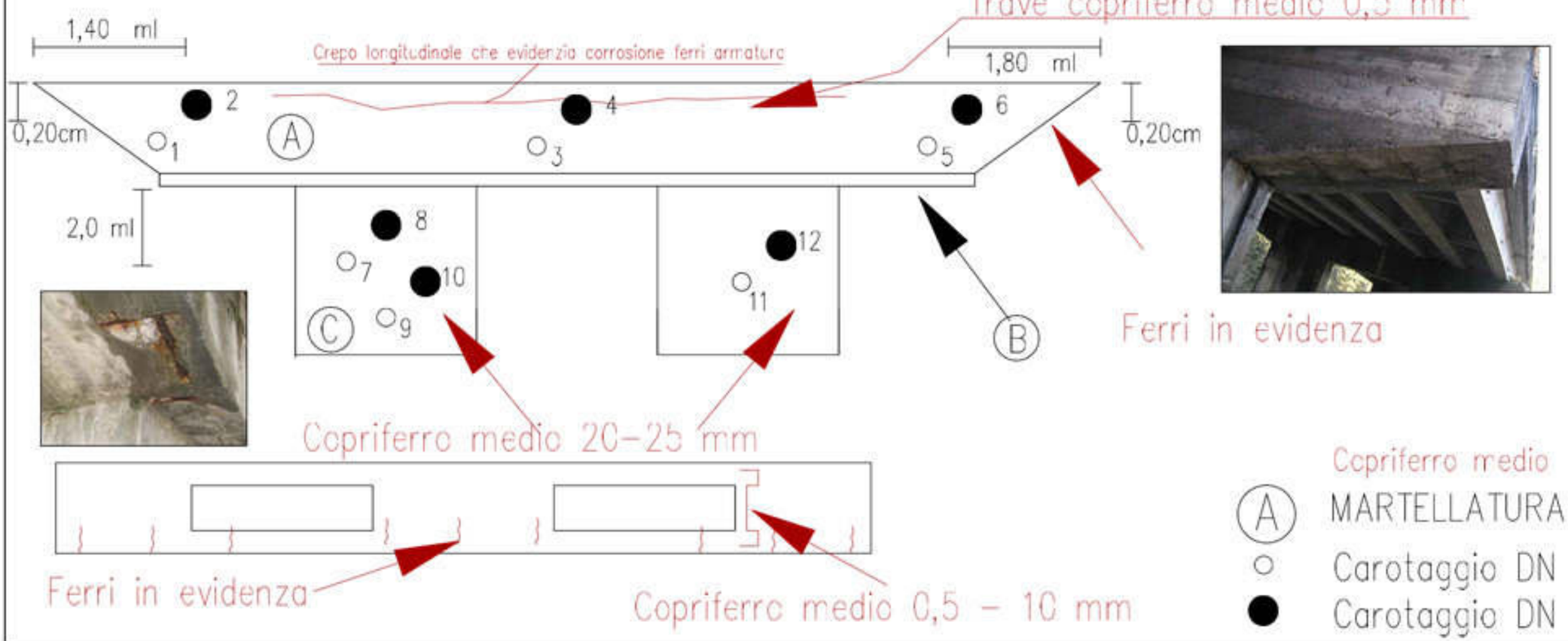
● Carotaggio DN 100

ASSE 13 Lato LANA

Ⓐ Eseguita martellatura su tutta la trave in senso longitudinale, distaccamento copriferro

Ⓑ Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno salvo alcuni tratti

Ⓒ Eseguita martellatura su entambi i pilastri risulta un suono pieno

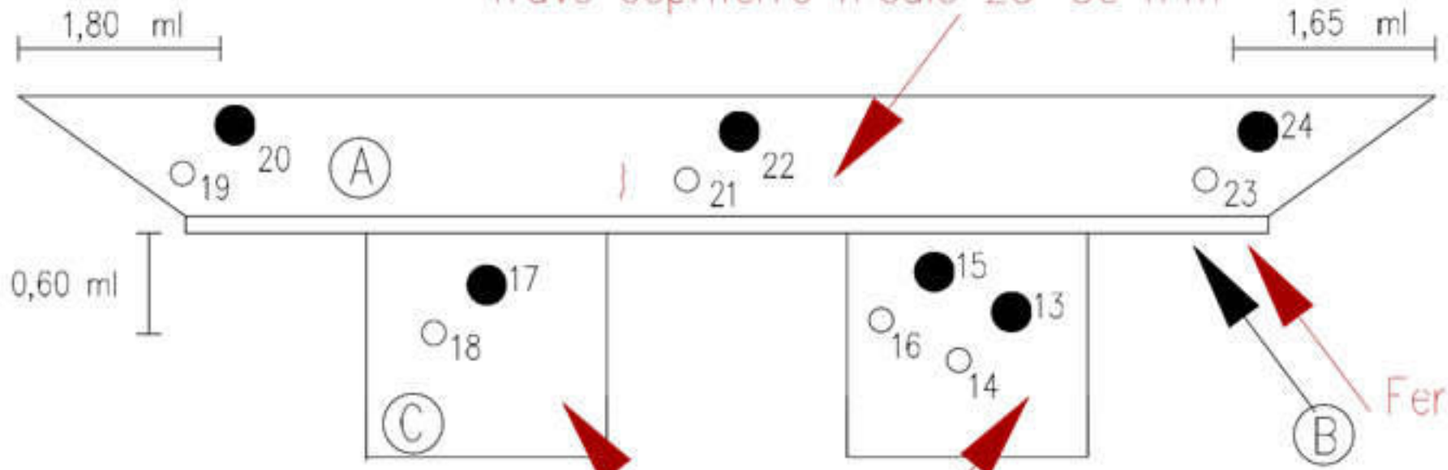


ASSE 12 Lato S. PANCRAZIO

Ⓐ Eseguita martellatura su tutta la trave in senso longitudinale,risulta un suono pieno

Ⓑ Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno, nonostante vi siano dei ferri di armatura in evidenza

Ⓒ Eseguita martellatura su entambi i pilastri risulta un suono pieno



Copriferro medio

Ⓐ MARTELLATURA

○ Carotaggio DN 50

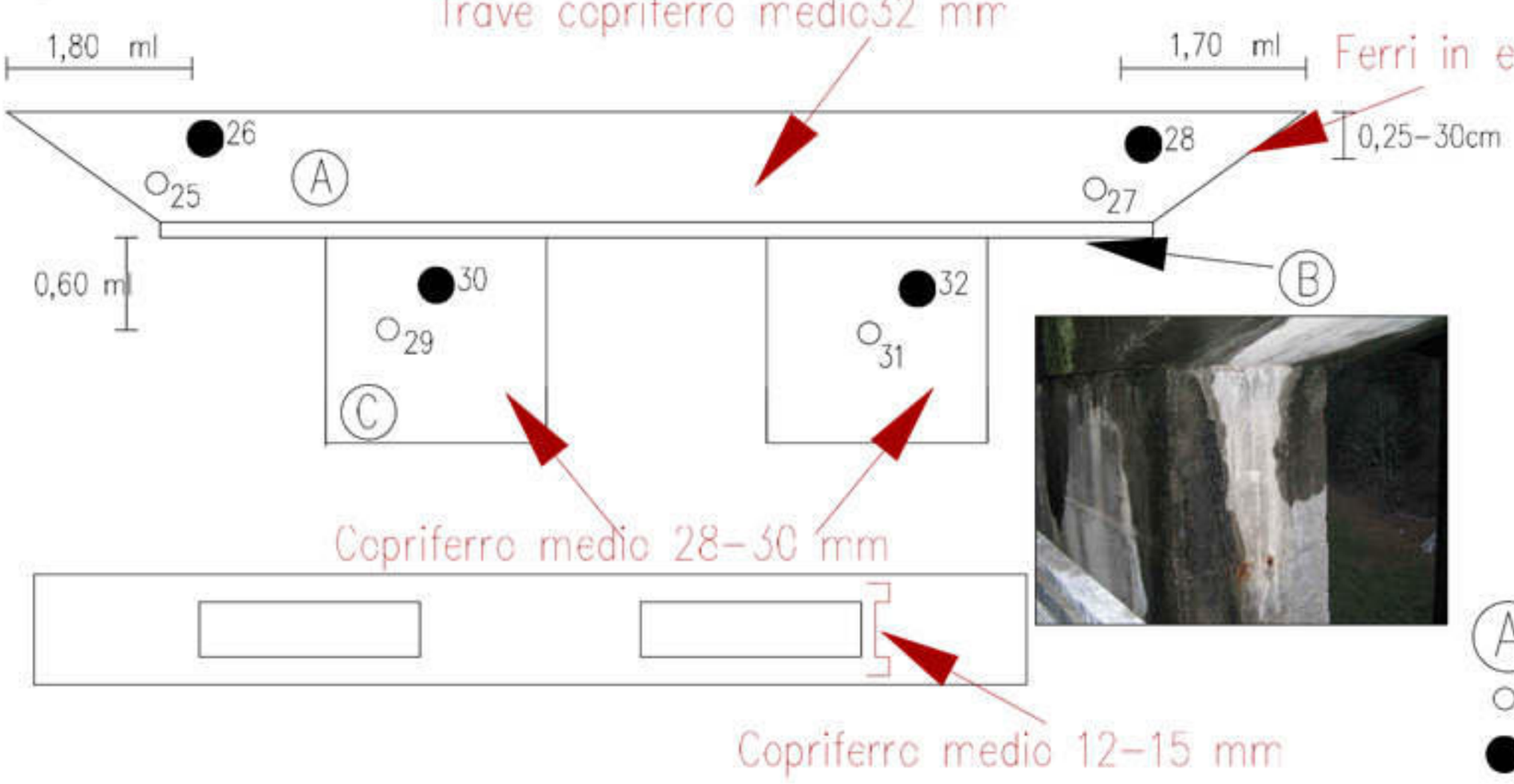
● Carotaggio DN 100

ASSE 11 Lato S. PANCRAZIO

Ⓐ Eseguita martellatura su tutta la trave in senso longitudinale,risulta un suono pieno

Ⓑ Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno, nonostante vi siano dei ferri di armatura in evidenza

Ⓒ Eseguita martellatura su entambi i pilastri risulta un suono pieno



Copriferro medio

Ⓐ MARTELLATURA

○ Carotaggio DN 50

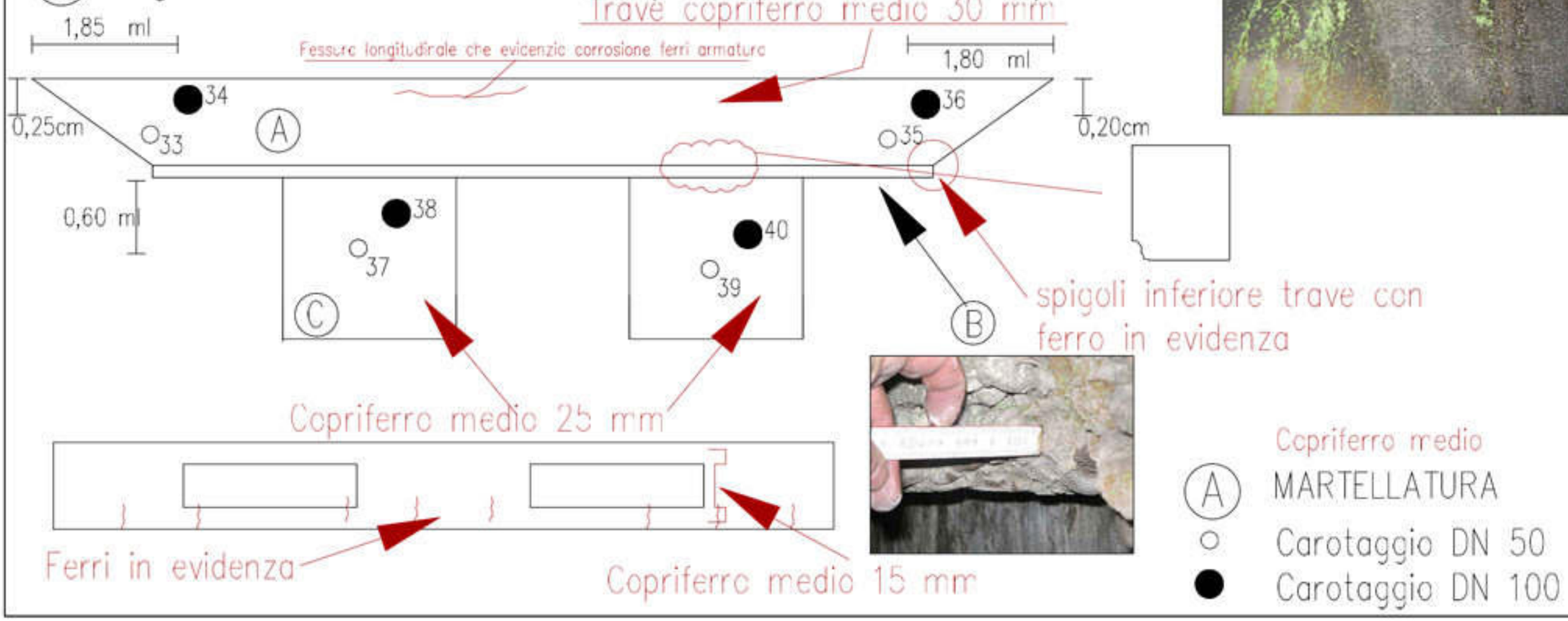
● Carotaggio DN 100

ASSE 10 Lato S. PANCRAZIO

(A) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno tranne che in due punti il primo sulla fessura in alto e il secondo punto dove vi e un distaccamento del cls di circa 4cm in profondita e 20 cm in lunghezza

(B) Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno salvo alcuni tratti dove vi e distacco del copriferro

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno

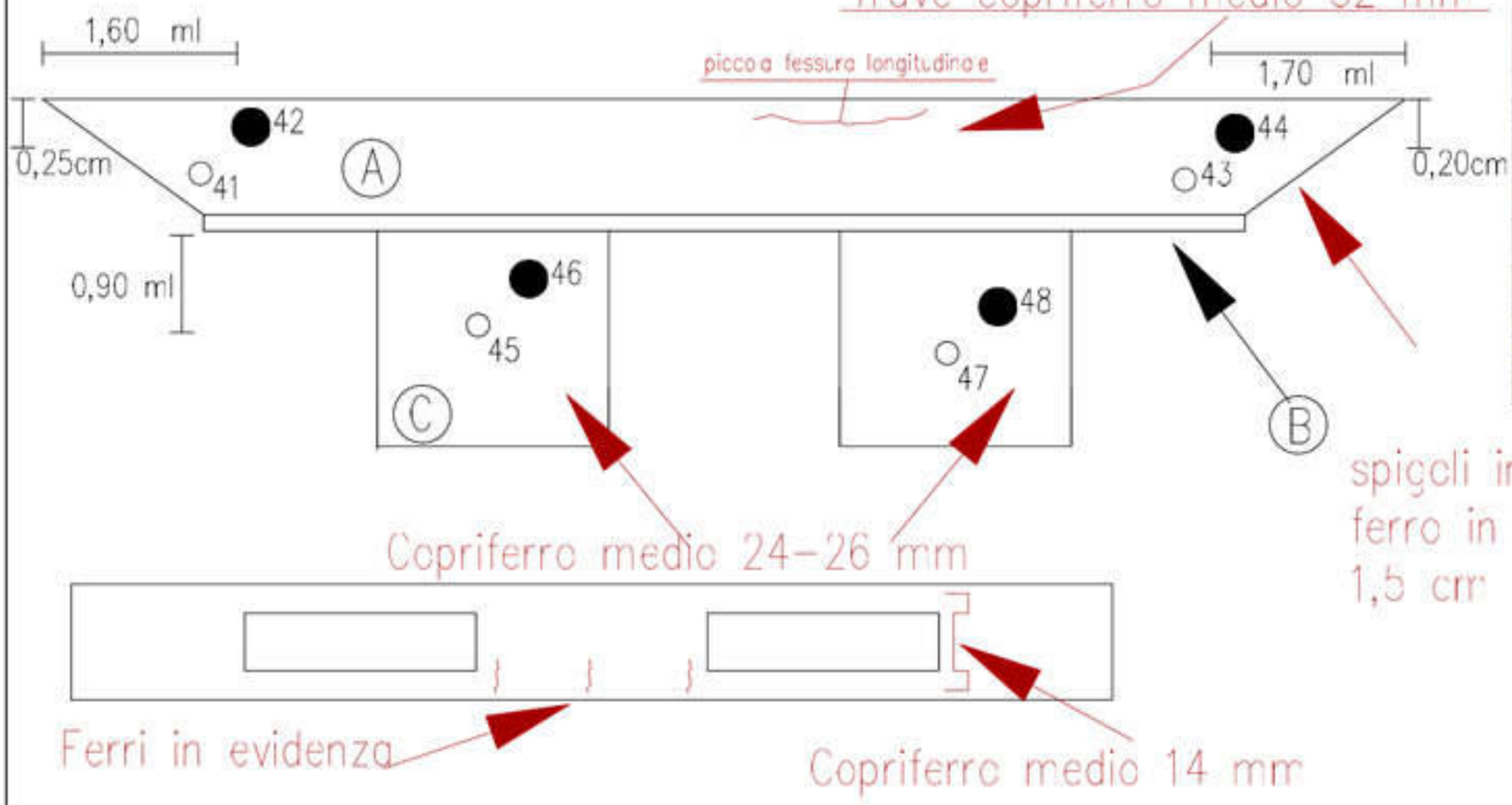


ASSE 9 Lato LANA

Ⓐ Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno

Ⓑ Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno, vi sono solo pochi ferri in evidenza

Ⓒ Eseguita martellatura su entambi i pilastri risulta un suono pieno



Copriferro medio

Ⓐ MARTELLATURA

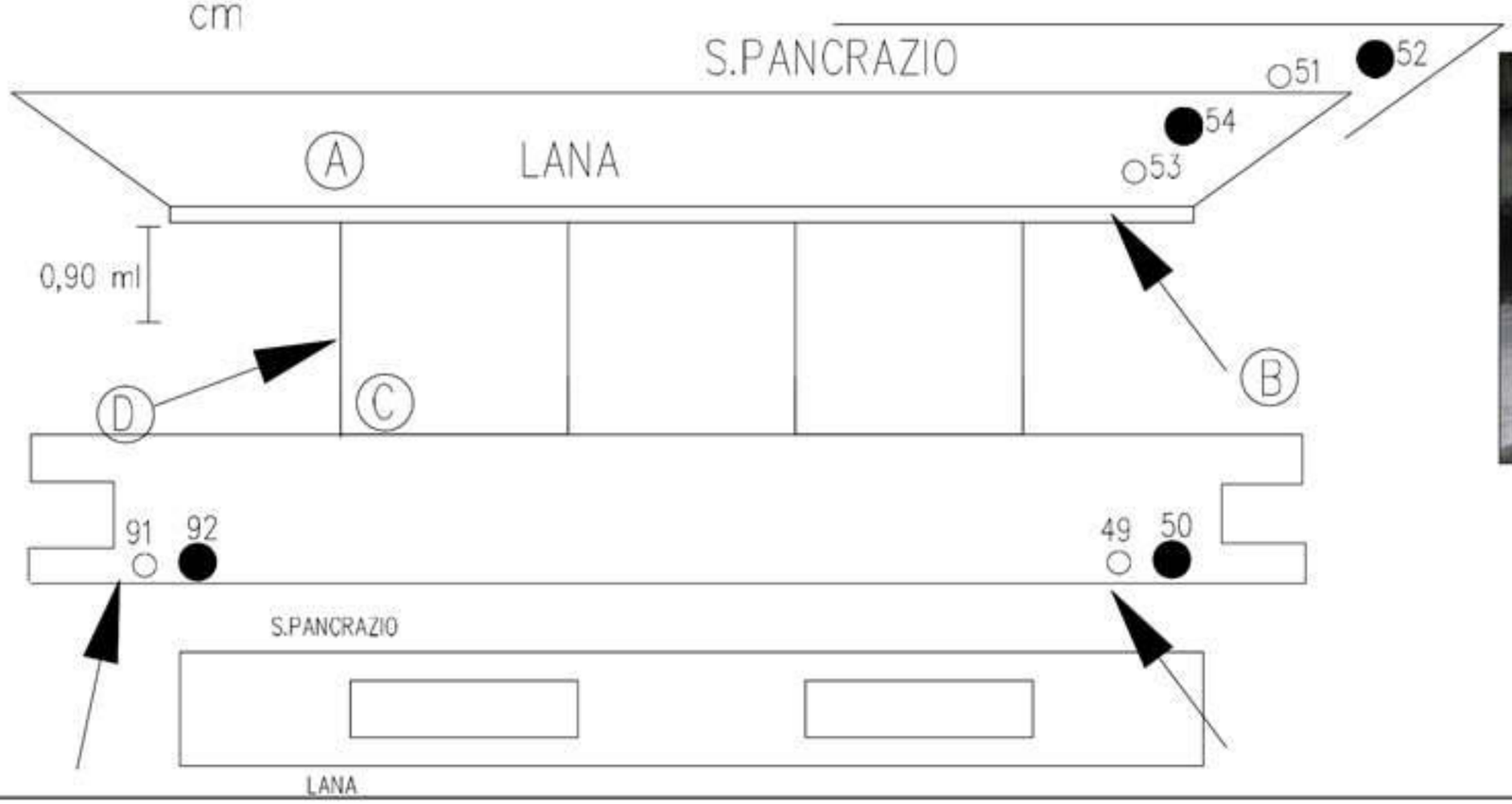
○ Carotaggio DN 50

● Carotaggio DN 100

ASSE 8 Lato LANA – S. PANCRAZIO

(A)(B) Eseguita martellatura sulla parte longitudinale della trave e nell'intradosso, il suono risulta ancora pieno, vi e un distacco evidente del copriferro su tutta la trave con ferri di armatura in evidenza (lato S. Pancrazio) Copriferro medio 1,5 cm

(C)(D) Eseguita martellatura su entambi i pilastri risulta un suono pieno ma risultano parecchi ferri in evidenza con copriferro di circa 1,5 cm



Copriferro medio

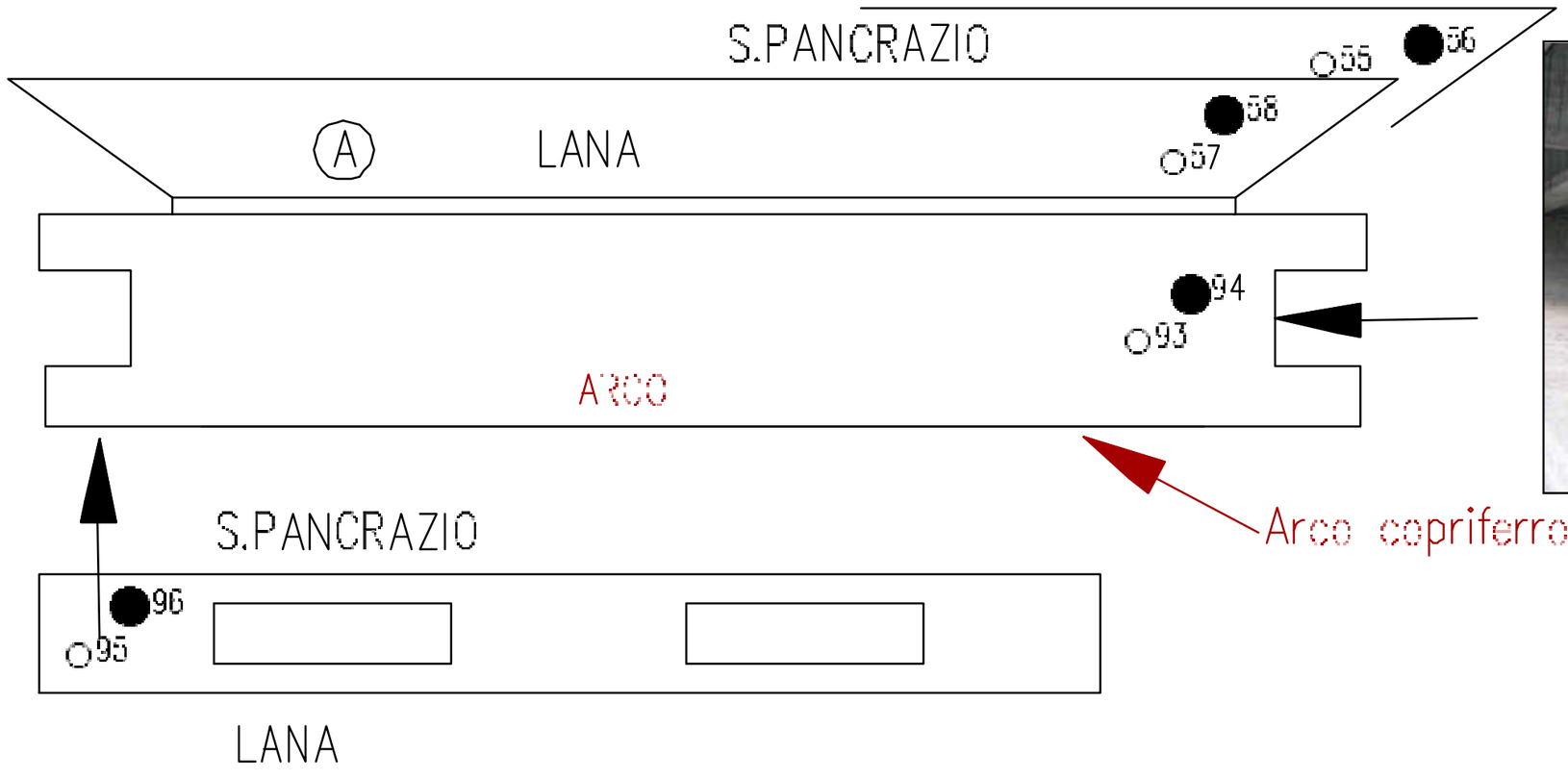
(A) MARTELLATURA

○ Carotaggio DN 50

● Carotaggio DN 100

ASSE 7 Lato LANA – S. PANCRAZIO

Ⓐ Non essendoci i pilastri viene eseguita la martellatura su trave ed arco. Su entrambi i lati della trave il suono risulta pieno. Ci sono solo alcuni ferri in evidenza con copriferro di circa 2 cm



Arco copriferro medio 25 mm

Copriferro medio

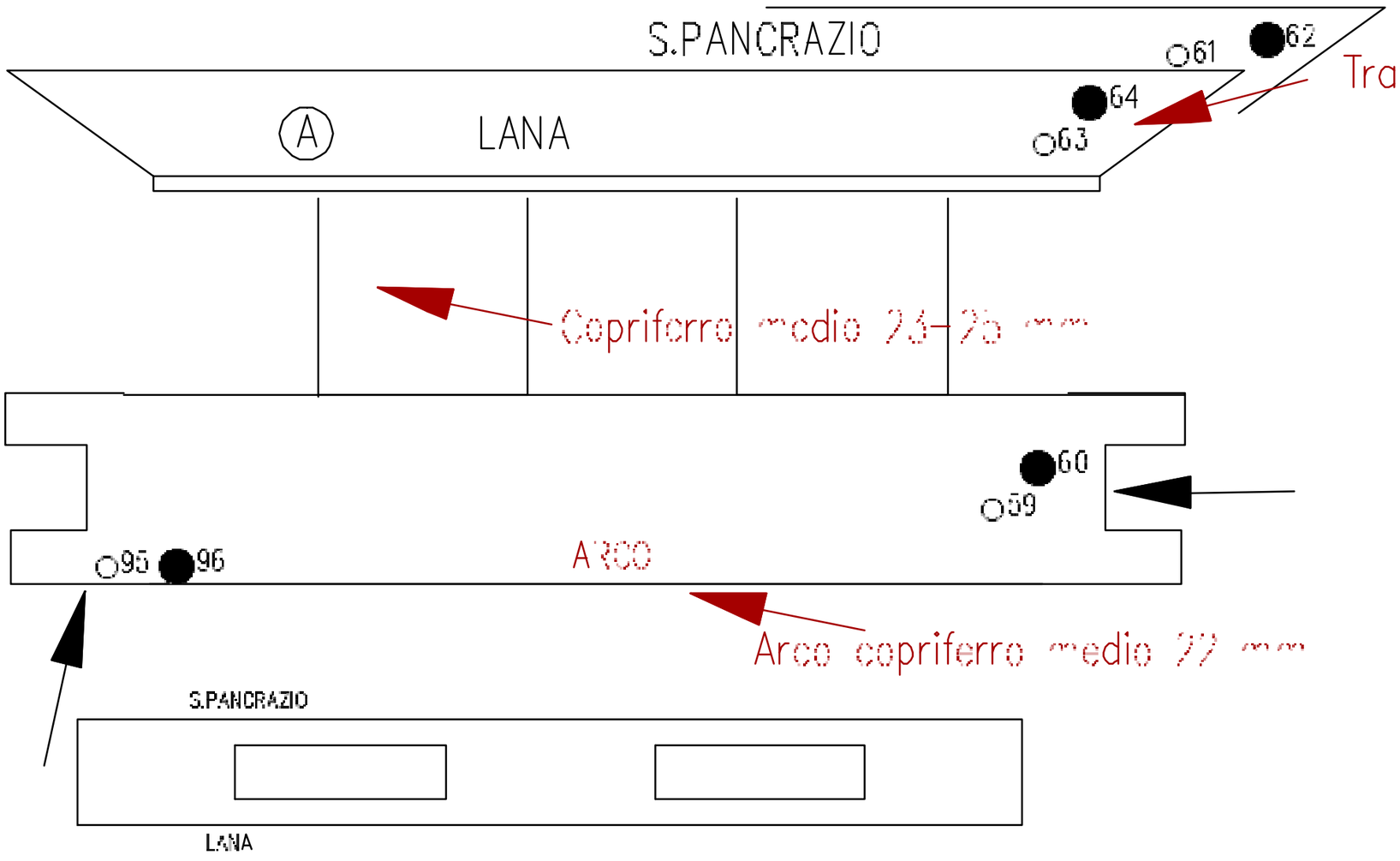
Ⓐ MARTELLATURA

○ Carotaggio DN 50

● Carotaggio DN 100

ASSE 6 Lato LANA – S. PANCRAZIO

Ⓐ Eseguita martellatura sulla trave e sui pilastri, il suono risulta pieno



Trave copriferro medio 32 mm

Copriferro medio

Ⓐ MARTELLATURA

○ Carotaggio DN 50

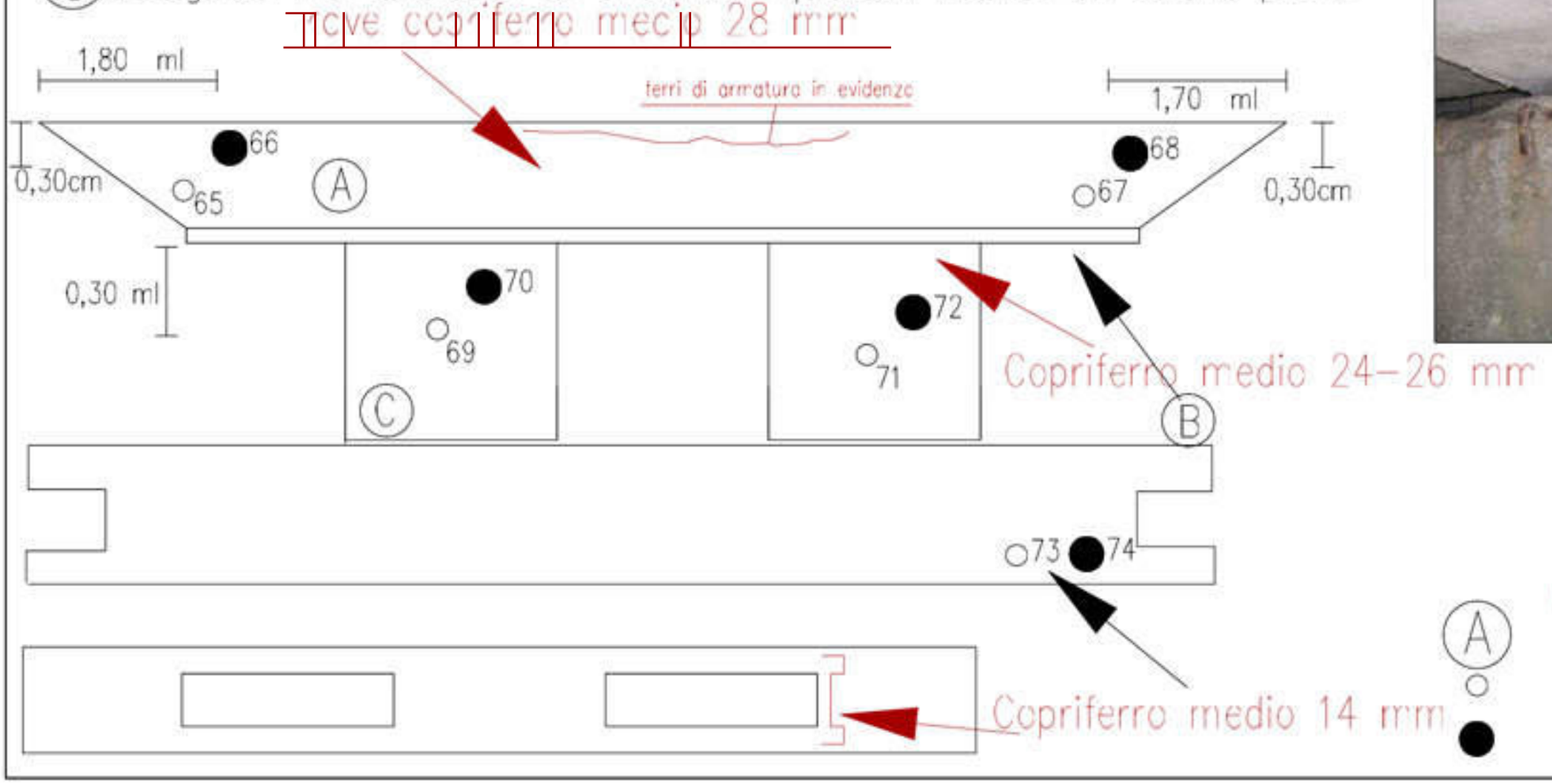
● Carotaggio DN 100

ASSE 5 Lato S. PANCRAZIO

(A) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Risultano esserci ferri di armatura scoperti tra estradosso trave e pulvino

(B) Eseguita martellatura sulla parte inferiore della trave, il suono risulta pieno

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno



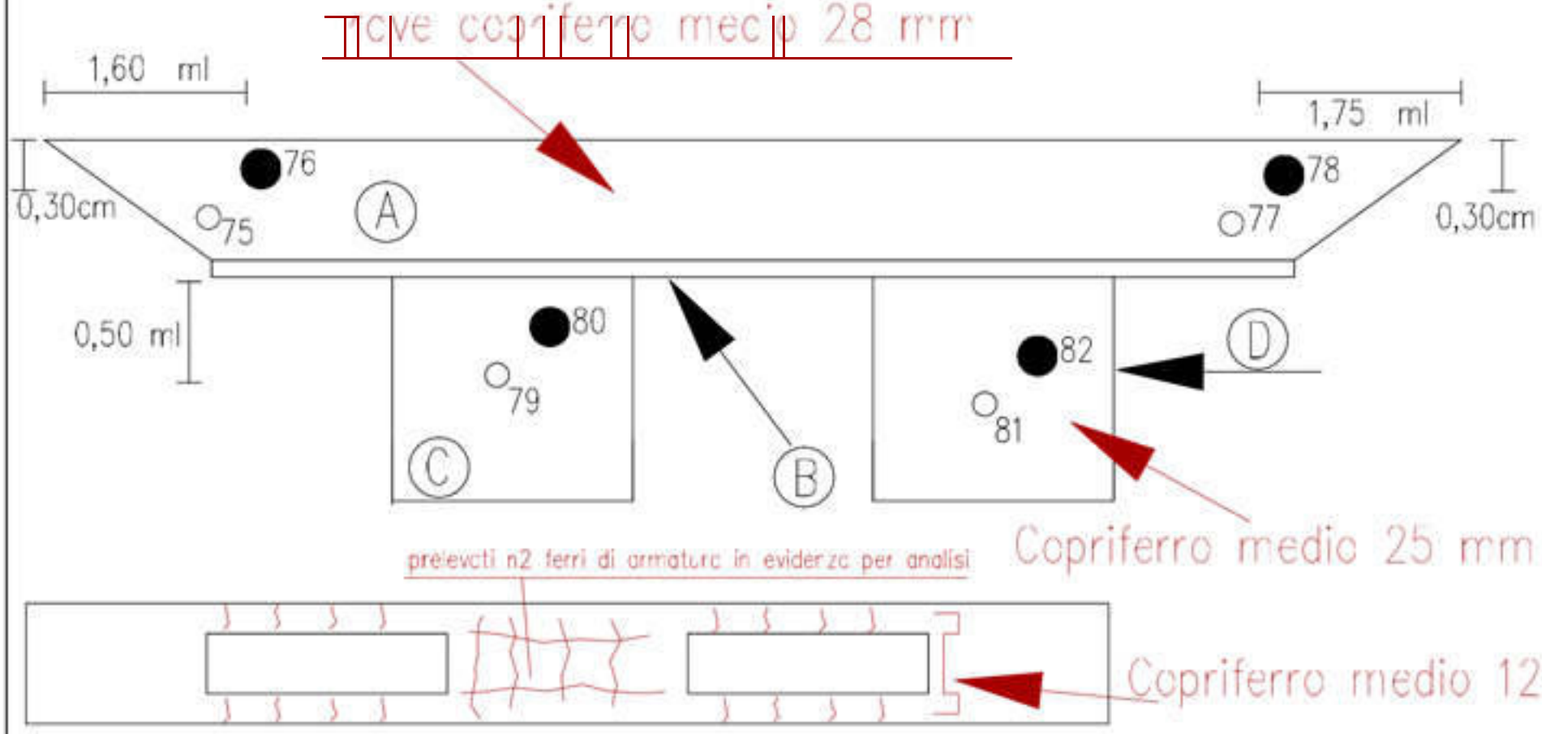
Copriferro medio
(A) MARTELLATURA
○ Carotaggio DN 50
● Carotaggio DN 100

ASSE 4 Lato S. PANCRAZIO

(A)(B) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Estradosso trave vi sono numerosi ferri senza copriferro che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno

(D) Come da foto vi sono numerosi ferri in evidenza, copriferro medio 1,5–2,0 cm



Copriferro medio
(A) MARTELLATURA
○ Carotaggio DN 50
● Carotaggio DN 100

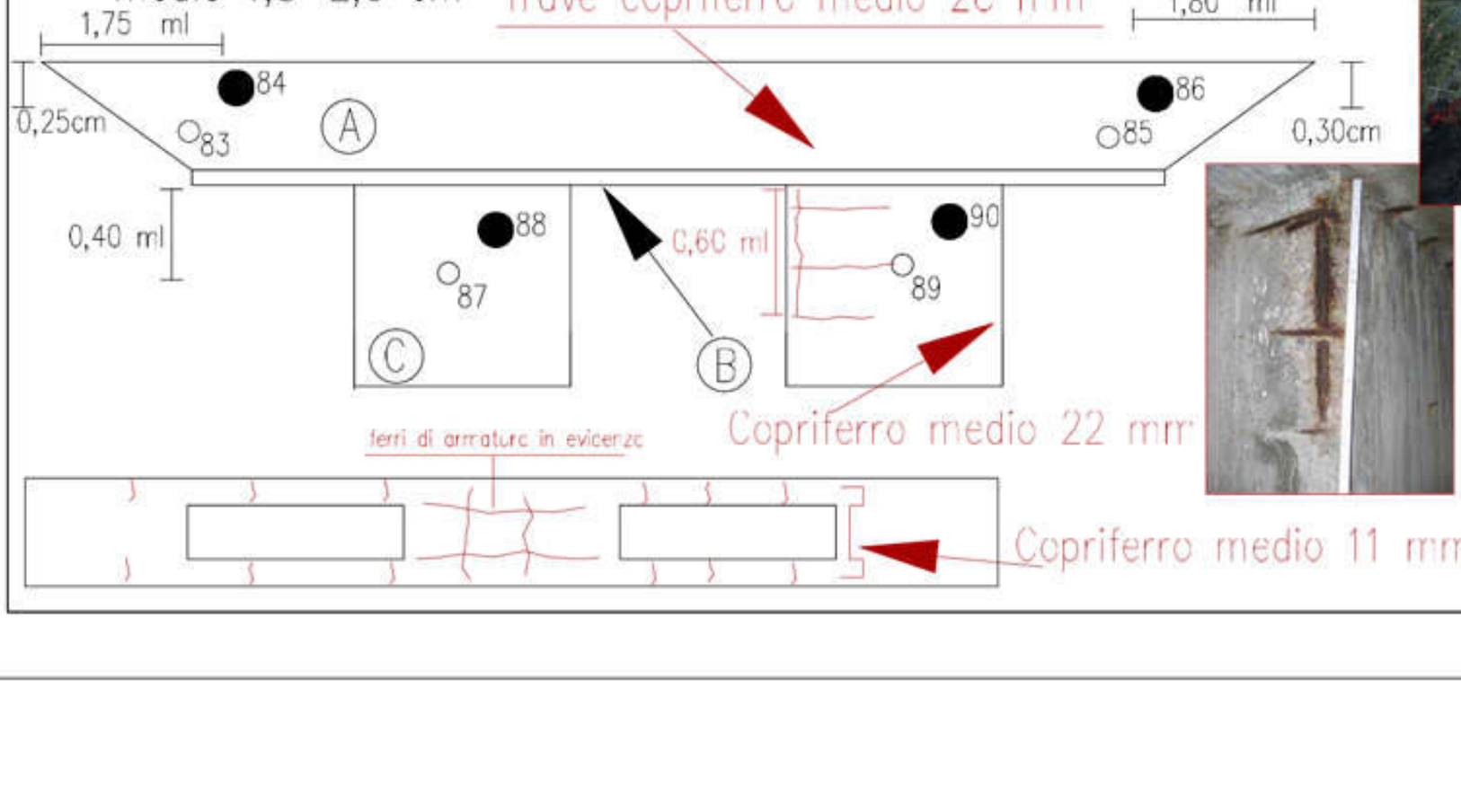
ASSE 3 Lato S. PANCRAZIO

Ⓐ Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Estradosso trave vi sono numerosi ferri senza copriferro

Ⓑ che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm. Sul pilastro(come da foto) ferro armatura in evidenza lunghezza 60 cm circa

Ⓒ Eseguita martellatura su entambi i pilastri risulta un suono pieno Sul pilastro(come da foto) ferro armatura in evidenza lunghezza 60 cm circa

Come da foto vi sono numerosi ferri in evidenza, copriferro medio 1,5–2,0 cm



Ⓐ Copriferro medio MARTELLATURA

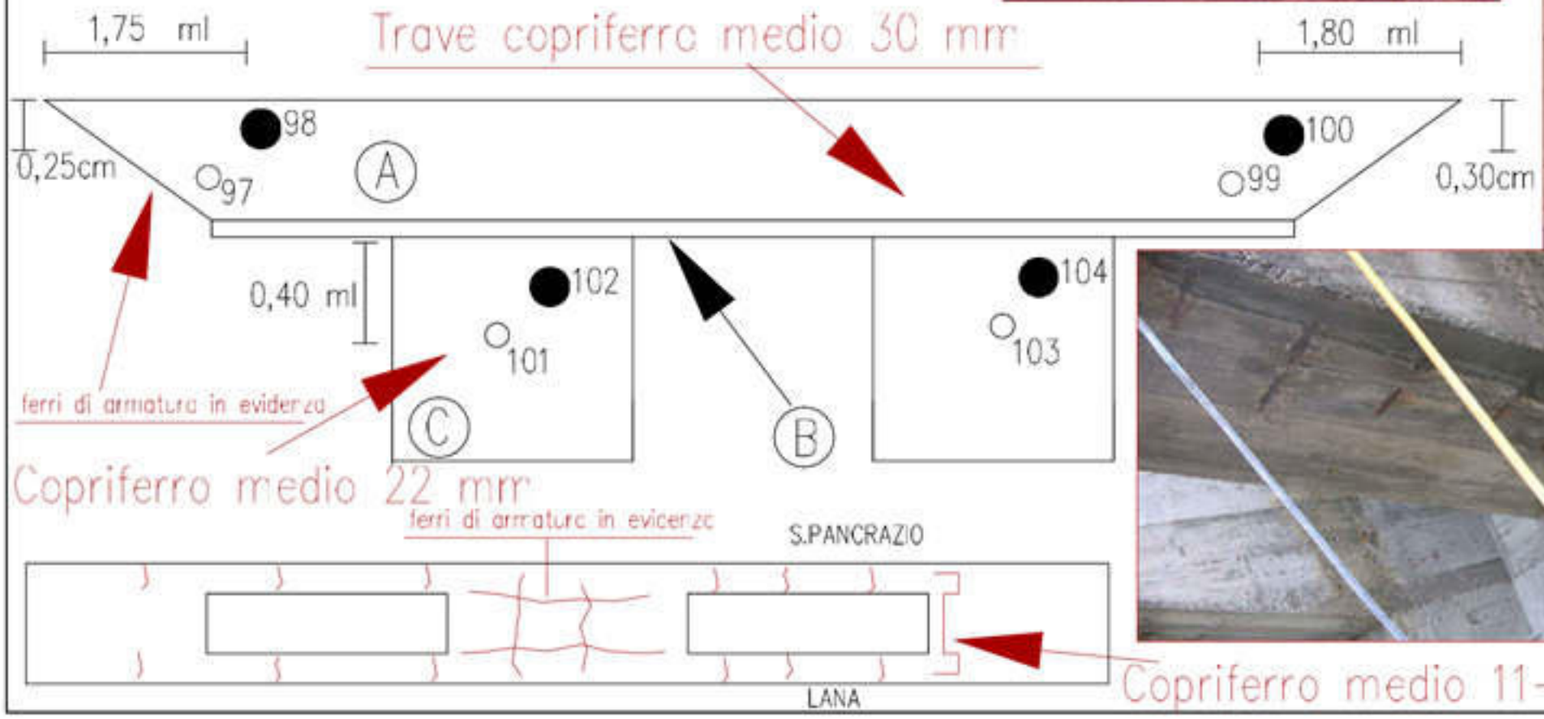
○ Carotaggio DN 50

● Carotaggio DN 100

ASSE 2 Lato LANA

(A) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Estradosso trave vi sono vari ferri senza copriferro che (B) cade eseguendo la martellatura. Copriferro 1,5–2,0 cm.

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno. Alla base tra pilastri e arco vi e' un grave distacco di cls su entrambi i pilastri internamente

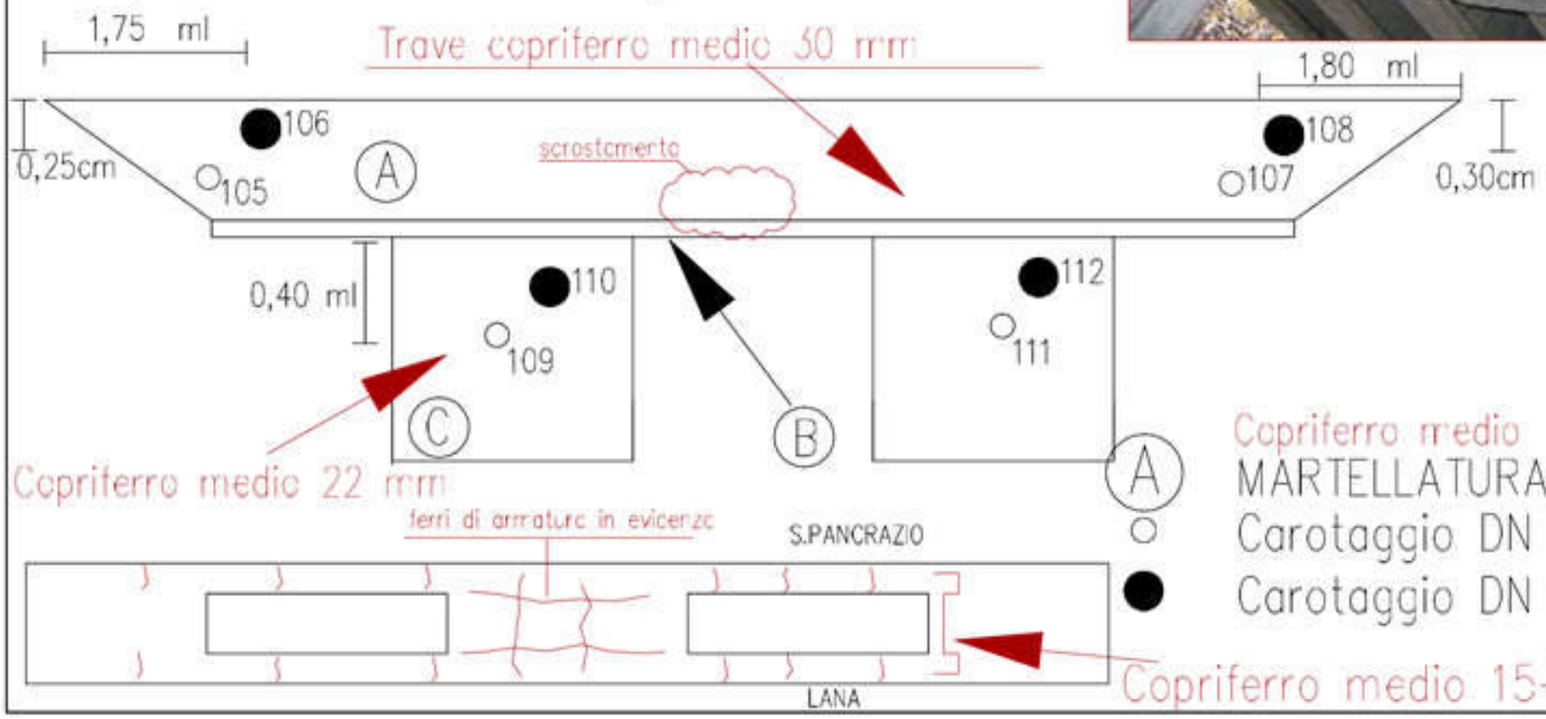


ASSE 1 Lato S. PANCRAZIO

(A) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Estradosso trave vi sono vari ferri senza copriferro che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm.

(B) Estradosso trave vi sono vari ferri senza copriferro che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm.

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno.

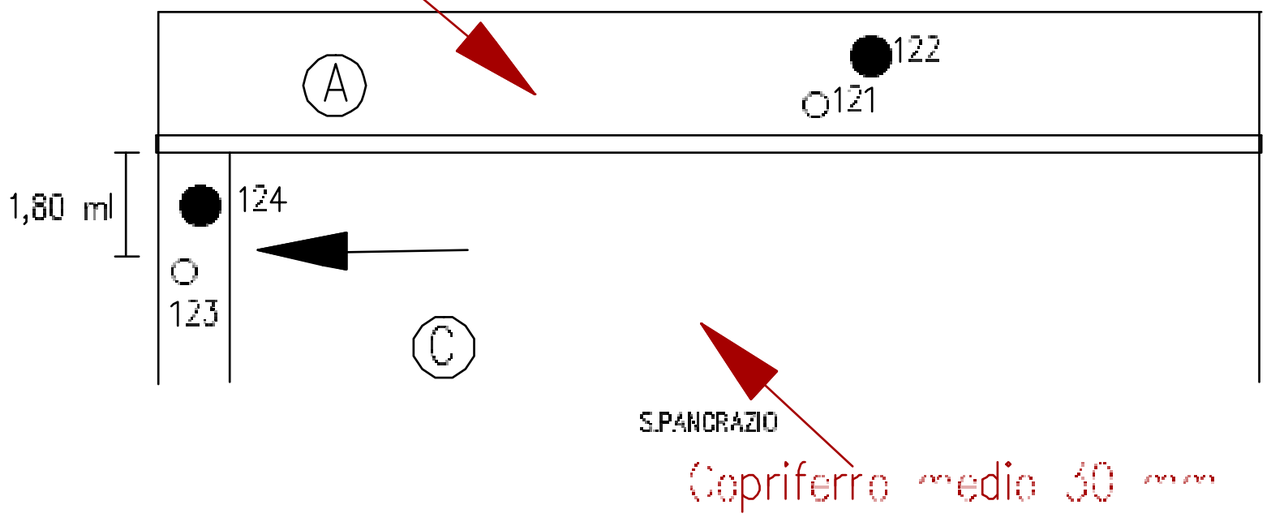


ASSE A1 Lato S. PANCRAZIO

Ⓐ Eseguita martellatura su tutta la trave in senso longitudina
rumore risulta pieno. .

Ⓒ Eseguita martellatura sul muro risulta
suono picno

Trave copriferro medio 28 mm



Copriferro medio 30 mm

Copriferro medio

Ⓐ MARTELLATURA

○ Carotaggio DN 50

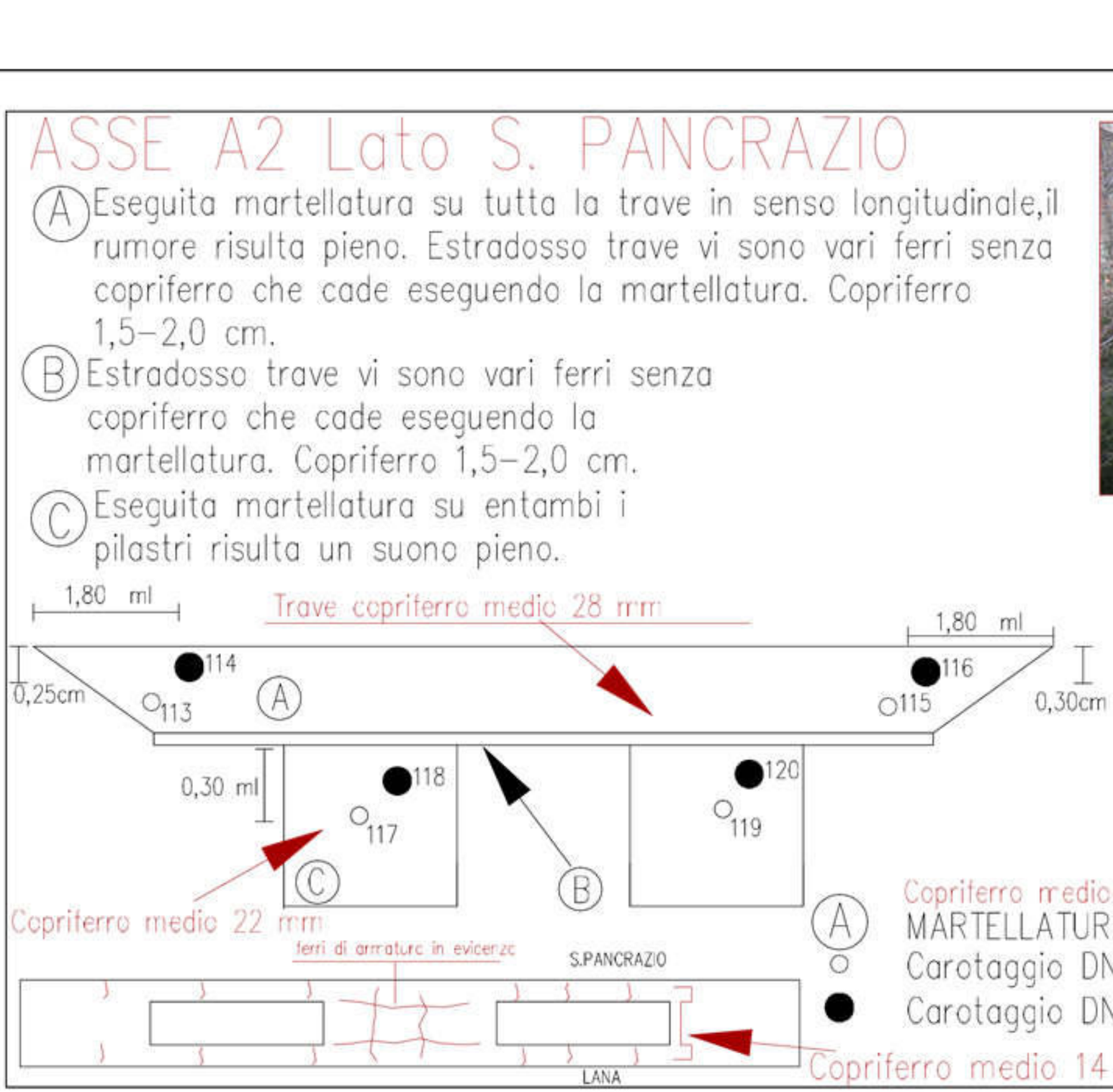
● Carotaggio DN 100

ASSE A2 Lato S. PANCRAZIO

(A) Eseguita martellatura su tutta la trave in senso longitudinale,il rumore risulta pieno. Estradosso trave vi sono vari ferri senza copriferro che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm.

(B) Estradosso trave vi sono vari ferri senza copriferro che cade eseguendo la martellatura. Copriferro 1,5–2,0 cm.

(C) Eseguita martellatura su entambi i pilastri risulta un suono pieno.



A MARTELLATURA

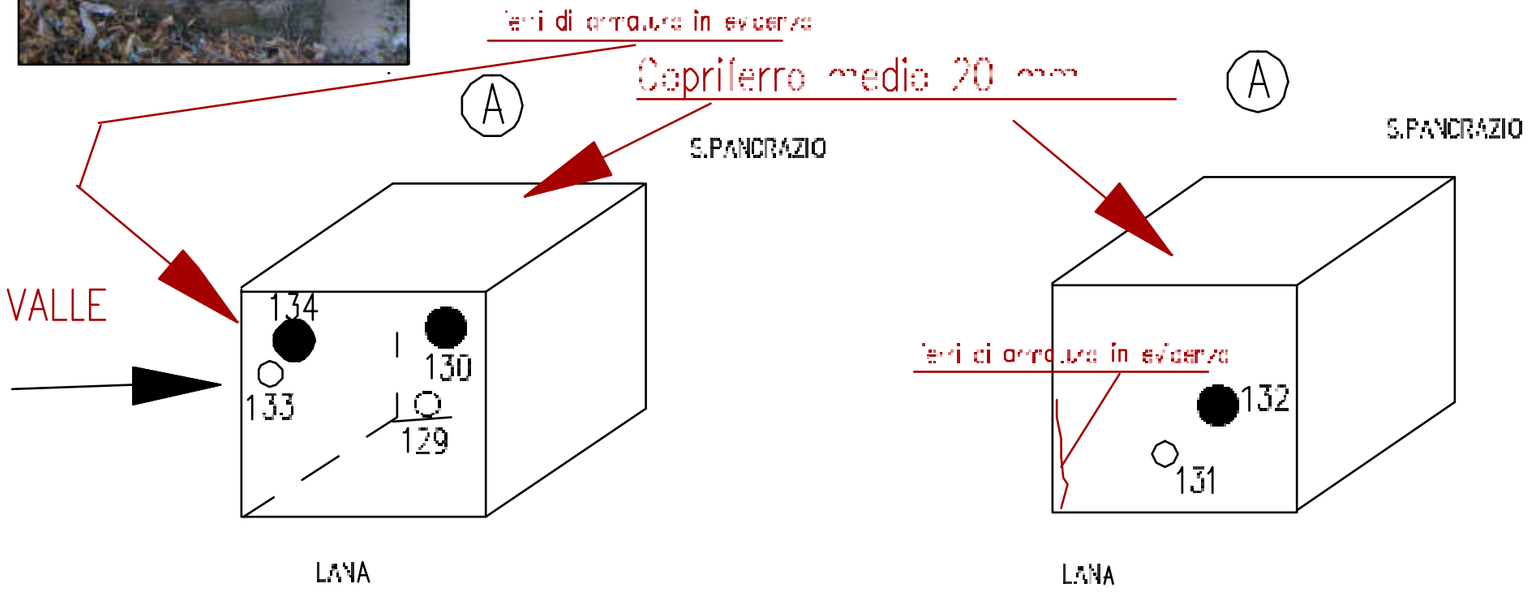
Carotaggio DN 50

Carotaggio DN 100

Copriferro medio

PLINTI FONDAZIONE Lato LANA

(A) Eseguita martellatura sui plinti di fondazione A–B il suono risulta pieno nonostante vi siano su entrambi i plinti ferri in evidenza(vedi foto). Copriferro medio 2,0 cm



MONTE

Copriferro medio

(A) MARTELLATURA

○ Carotaggio DN 50

● Carotaggio DN 100

LABOR TEST s.r.l.
Sede operativa / Operative Sitz
Via Aeroporto F. Baracca, 4 / F. Baracca Flughafenstr. 4
I - 39100 BOLZANO / BOZEN
Tel e Fax 0471/252090

MINUTA DI PROVA

Profilo Cloruri su CLS
Cloruri idrosolubili UNI 9944

N. 08/001

Foglio 1 di 3
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Data
Datum

Commessa: 08/001
data inizio: 11/01/2008 13-14/03/08
Riferimento n° protocollo 58228
Cliente:
Estrazione: Acido Nitrico

marchio Carota	N° carota	Strato analizzato	massa portacampione (g)	Massa port. + campione (g)	Massa campione (g)	AgNO3 (ml)	KSCN (ml)	KSCN (ml)corr	Cloruri (%)	Cloruri in cemento (%)
58228	1	1	1,2542	7,8287	6,5745	5	4,7	4,7	0,008	0,057
58228	3	1	1,2542	9,1935	7,9393	15	3,0	3,0	0,268	1,891
58229	3	2	1,2430	11,2388	9,9958	20	6,1	6,1	0,247	1,740
58228	5	1	1,2542	7,2768	6,0226	15	3,0	3,0	0,353	2,493
58228	5	2	1,2430	11,1293	9,8863	20	10,3	10,3	0,174	1,228
58228	7	1	1,2542	7,5304	6,2762	10	3,0	3,0	0,198	1,396
58228	7	2	1,2430	11,1903	9,9473	10	5,5	5,5	0,080	0,566
58228	9	1	1,2542	9,6001	8,3459	20	2,5	2,5	0,372	2,624
58228	9	2	1,2430	11,3576	10,1146	20	3,0	3,0	0,298	2,103
58228	11	1	1,2542	9,1456	7,8914	5	3,0	3,0	0,045	0,317
58228	13	1	1,2542	8,7542	7,5000	20	3,0	3,0	0,402	2,837
58228	13	2	1,2430	13,2933	12,0503	20	8,0	8,0	0,177	1,246
58228	15	1	1,2542	7,7641	6,5099	30	3,3	3,3	0,727	5,133
58228	15	2	1,2430	12,9205	11,6775	20	3,0	3,0	0,258	1,822
58228	17	1	1,2542	11,0526	9,7984	5	4,8	4,8	0,004	0,026
58228	19	1	1,2542	11,7661	10,5119	10	3,6	3,6	0,108	0,762
58228	19	2	1,2430	13,8688	12,6258	20	12,6	12,6	0,104	0,733
58228	21	1	1,2452	9,1531	7,9079	25	3,5	3,5	0,482	3,402
58228	21	2	1,2430	9,3752	8,1322	20	15,1	15,1	0,107	0,754
58228	23	1	1,2452	10,6971	9,4519	10	3,6	3,6	0,120	0,847
58228	23	2	1,2430	11,8427	10,5997	20	16,6	16,6	0,057	0,401
58228	25	1	1,2452	11,0010	9,7558	5	3,0	3,0	0,036	0,257
58228	27	1	1,2452	10,8276	9,5824	5	4,0	4,0	0,019	0,131
58228	29	1	1,2452	11,6790	10,4338	35	2,8	2,8	0,547	3,862
58228	29	2	1,2430	11,4268	10,1816	20	4,0	4,0	0,279	1,967
58228	31	1	1,2452	11,0025	9,7573	25	3,1	3,1	0,398	2,809
58228	31	2	1,2403	8,0042	6,7612	20	7,9	7,9	0,317	2,240
58228	33	1	1,2452	13,0477	11,8025	10	4,0	4,0	0,090	0,636
58228	33	2	1,2452	10,3874	9,1471	20	17,6	17,6	0,047	0,328
58228	35	1	1,2452	10,9506	9,7054	10	4,4	4,4	0,102	0,722

LABOR TEST s.r.l.
Sede operativa / Operative Sitz
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MINUTA DI PROVA

Profilo Cloruri su CLS
Cloruri idrosolubili UNI 9944

N. 08/001

Foglio 2 di 3
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58228	35	2	1,2407	7,9836	6,7384	20	17,5	17,5	0,066	0,464
58228	37	1	1,2452	10,3643	9,1191	5	4,0	4,0	0,019	0,137
58228	39	1	1,2452	14,0953	12,8501	20	3,2	3,2	0,232	1,636
58228	39	2	1,2407	8,9976	7,7524	20	8,5	8,5	0,263	1,856
58228	41	1	1,2458	13,1116	11,8658	30	2,4	2,4	0,412	2,911
58228	41	2	1,2407	10,9316	9,6909	20	2,7	2,7	0,316	2,234
58228	43	1	1,2458	11,5553	10,3095	5	2,8	2,8	0,038	0,267
58228	45	1	1,2458	10,5480	9,3022	10	3,0	3,0	0,133	0,942
58228	45	2	1,2403	8,4654	7,2251	20	16,1	16,1	0,096	0,675
58228	47	1	1,2458	11,0040	9,7582	50	3,1	3,1	0,852	6,015
58228	47	2	1,2403	16,4576	15,2173	40	1,5	1,5	0,449	3,166
58228	49	1	1,2458	8,4842	7,2384	15	3,6	3,6	0,279	1,971
58228	49	2	1,2403	12,0124	10,7721	20	5,1	5,1	0,245	1,731
58228	51	1	1,2458	9,0652	7,8194	5	4,0	4,0	0,023	0,160
58228	53	1	1,2458	12,2588	11,0130	50	3,0	3,0	0,757	5,341
58228	53	2	1,2403	9,6454	8,4051	20	15,1	15,1	0,103	0,730
58228	55	1	1,2458	8,5612	7,3154	30	2,9	2,9	0,657	4,636
58228	55	2	1,2403	11,3513	10,1110	20	16,6	16,6	0,060	0,421
58228	57	1	1,2458	10,1720	8,9262	5	3,5	3,5	0,030	0,210
58228	59	1	1,2458	9,0074	7,7616	25	2,7	2,7	0,509	3,595
58228	59	2	1,2440	10,6868	9,4428	20	18,9	18,9	0,021	0,146
58228	61	1	1,2448	7,2619	6,0171	5	2,8	2,8	0,065	0,458
58228	63	1	1,2448	10,8027	9,5579	5	3,2	3,2	0,033	0,236
58228	65	1	1,2448	9,2247	7,9799	5	2,5	2,5	0,056	0,392
58228	67	1	1,2448	9,5850	8,3402	30	3,6	3,6	0,561	3,961
58228	67	2	1,2440	10,7573	9,5133	20	4,0	4,0	0,298	2,105
58228	69	1	1,2448	8,8865	7,6417	5	3,6	3,6	0,032	0,229
58228	71	1	1,2448	12,3466	11,1018	5	3,0	3,0	0,032	0,225
58228	73	1	1,2448	10,7056	9,4608	5	4,2	4,2	0,015	0,106
58228	75	1	1,2448	10,3034	9,0586	5	4,2	4,2	0,016	0,111
58228	77	1	1,2448	11,3650	10,1202	5	3,0	3,0	0,035	0,247
58228	79	1	1,2448	11,2714	10,0266	20	3,2	3,2	0,297	2,097
58228	79	2	1,2440	9,4163	8,1723	20	4,0	4,0	0,347	2,450
58228	81	1	1,2447	12,2381	10,9934	10	2,8	2,8	0,116	0,820
58228	81	2	1,2440	8,2354	6,9914	20	19,0	19,0	0,025	0,179
58228	83	1	1,2447	9,8151	8,5704	50	3,1	3,1	0,970	6,848
58228	83	2	1,2440	10,6250	9,3810	20	15,2	15,2	0,091	0,640
58228	85	1	1,2447	9,2080	7,9633	10	4,0	4,0	0,134	0,943
58228	85	2	1,2431	9,7000	8,4569	20	15,8	15,8	0,088	0,621
58228	87	1	1,2447	10,4969	9,2522	70	3,0	3,0	1,284	9,062

LABOR TEST s.r.l.
Sede operativa / Operative Sitz
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MINUTA DI PROVA

Profilo Cloruri su CLS
Cloruri idrosolubili UNI 9944

N. 08/001

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58228	87	2	1,2431	10,2016	8,9585	60	3,2	3,2	1,124	7,934
58228	89	1	1,2447	12,3017	11,0570	70	3,0	3,0	1,074	7,583
58228	89	2	1,2431	11,4401	10,1970	60	3,5	3,5	0,982	6,934
58228	91	1	1,2447	13,9960	12,7513	5	4,5	4,5	0,007	0,049
58228	93	1	1,2447	8,6730	7,4283	5	3,0	3,0	0,048	0,337
58228	95	1	1,2447	11,4961	10,2514	5	4,8	4,8	0,003	0,024
58228	97	1	1,2447	13,1786	11,9339	5	2,5	2,5	0,037	0,262
58228	99	1	1,2447	10,3543	9,1096	10	4,0	4,0	0,117	0,824
58228	99	2	1,2431	11,1584	9,9153	20	18,5	18,5	0,027	0,189
58228	101	1	1,2383	12,5654	11,3271	5	4,0	4,0	0,016	0,110
58228	103	1	1,2383	13,1367	11,8984	25	3,1	3,1	0,326	2,303
58228	103	2	1,2431	13,7510	12,5079	20	14,9	14,9	0,072	0,510
58228	105	1	1,2383	11,0165	9,7782	5	2,6	2,6	0,044	0,307
58228	107	1	1,2383	9,3779	8,1396	5	2,7	2,7	0,050	0,354
58228	109	1	1,2383	9,0469	7,8086	20	16,4	16,4	0,082	0,577
58228	111	1	1,2383	8,5454	7,3071	5	3,1	3,1	0,046	0,325
58228	113	1	1,2383	10,7276	9,4893	5	2,7	2,7	0,043	0,303
58228	115	1	1,2383	11,1374	9,8991	15	3,0	3,0	0,215	1,517
58228	115	2	1,2431	13,7150	12,4719	20	15,2	15,2	0,068	0,482
58228	117	1	1,2383	10,0094	8,7711	25	3,5	3,5	0,435	3,068
58228	117	2	1,2431	8,6828	7,4397	20	15,4	15,4	0,110	0,774
58228	119	1	1,2383	14,5331	13,2948	30	3,2	3,2	0,357	2,523
58228	119	2	1,2431	10,3501	9,1070	20	18,5	18,5	0,029	0,206
58228	121	1	1,2680	9,7754	8,5074	30	3,0	3,0	0,563	3,972
58228	121	2	1,2431	15,2485	14,0054	20	14,0	14,0	0,076	0,536
58228	123	1	1,2680	7,5893	6,3213	5	3,5	3,5	0,042	0,297
58228	125	1	1,2680	8,6765	7,4085	5	4,2	4,2	0,019	0,135
58228	127	1	1,2680	7,4835	6,2155	10	3,0	3,0	0,200	1,409
58228	127	2	1,2431	10,9247	9,6816	20	12,1	12,1	0,145	1,021
58228	129	1	1,2680	9,8784	8,6104	5	3,9	3,9	0,023	0,160
58228	131	1	1,2680	8,4067	7,1387	5	3,0	3,0	0,050	0,351
58228	133	1	1,2680	9,4135	8,1455	5	3,6	3,6	0,030	0,215
58228	135	1	1,2680	8,6064	7,3384	5	3,4	3,4	0,039	0,273

Brücke Eschenlohe

Druckfestigkeitsprüfungen						fc = Rc*{0,65 + 0,7/[(1+d/20)*(h/d)^1,25]}	
						.... Resistenza arota	
Materialprüfanstalt Kardaun						Fc.... Resistenza cilindrica	
Lage:		**Ständerstiele**					
						Zylinderdruckfestigkeit	Würfeldruckfestigkeit
Brücke	Probe Nr	Datum:	d	h	G	fc	Rc
			[cm]	[cm]	[kg]	[MPa]	[MPa]
Eschenlohe	10	17.12.2007	9,30	18,60	3,09	22,52	26,47
Eschenlohe	12	17.12.2007	9,30	14,00	2,33	30,03	32,06
Eschenlohe	14	17.12.2007	9,30	18,60	3,23	27,97	32,87
Eschenlohe	16	17.12.2007	9,30	18,60	3,15	41,81	49,14
Eschenlohe	18	17.12.2007	9,30	18,60	3,18	37,10	43,60
Eschenlohe	32	17.12.2007	9,30	18,60	3,14	38,28	44,99
Eschenlohe	38	17.12.2007	9,30	18,60	3,08	25,91	30,45
Eschenlohe	40	17.12.2007	9,30	18,60	3,02	27,82	32,69
Eschenlohe	46	17.12.2007	9,30	18,60	3,12	22,67	26,64
Eschenlohe	48	17.12.2007	9,30	18,60	3,05	29,74	34,95
Eschenlohe	70	17.12.2007	9,30	18,60	3,02	21,35	25,09
Eschenlohe	72	17.12.2007	9,30	18,60	3,09	39,01	45,85
Eschenlohe	80	17.12.2007	9,30	18,60	3,08	39,75	46,72
Eschenlohe	82	17.12.2007	9,30	18,60	3,05	37,10	43,60
Eschenlohe	88	17.12.2007	9,30	18,60	3,08	45,64	53,64
Eschenlohe	90	17.12.2007	9,30	18,60	3,06	37,10	43,60
Eschenlohe	102	17.12.2007	9,30	18,60	3,13	33,86	39,79
Eschenlohe	104	17.12.2007	9,30	18,60	3,10	37,98	44,64
Eschenlohe	110	17.12.2007	9,30	18,60	3,02	25,61	30,10
Eschenlohe	112	17.12.2007	9,30	18,60	3,01	37,24	43,77
Eschenlohe	118	17.12.2007	9,30	14,00	2,32	41,81	44,64
Eschenlohe	120	17.12.2007	9,30	18,60	3,06	34,74	40,83
Mittelwert	[MPa]	μ = (Rc1 + Rc2 +...+ Rcn)/n					38,91
Anzahl n	[]						22
Standartabweichung	[MPa]	s = {[(Rc1-Rcm)^2+...+(Rcn-Rcm)^2]/(n-1)}^0,5					8,19
Charakteristische Würfeldruckfestigkeit						Rck	25,43

Brücke Eschenlohe

Druckfestigkeitsprüfungen

fc = Rc*{0,65 + 0,7/[(1+d/20)*(h/d)^1,25]}

c.... Resi ten a arota

Fc.... Resistenza cilindrica

Materialprüfanstalt Kardaun

Lage: Ständerquerriegel

						Zylinderdruckfestigkeit	Würfeldruckfestigkeit
Brücke	Probe Nr	Datum:	d	h	G	fc	Rc
			[cm]	[cm]	[kg]	[MPa]	[MPa]
Eschenlohe	2	17.12.2007	9,30	11,60	1,93	46,08	45,51
Eschenlohe	4	17.12.2007	9,30	18,60	3,11	37,10	43,60
Eschenlohe	6	17.12.2007	9,30	18,60	3,04	32,39	38,07
Eschenlohe	20	17.12.2007	9,30	18,60	3,14	41,22	48,44
Eschenlohe	22	17.12.2007	9,30	18,60	3,11	32,98	38,76
Eschenlohe	24	17.12.2007	9,30	18,60	3,16	52,41	61,59
Eschenlohe	26	17.12.2007	9,30	18,60	3,07	40,34	47,41
Eschenlohe	28	17.12.2007	9,30	18,60	3,00	46,81	55,01
Eschenlohe	34	17.12.2007	9,30	18,60	3,04	47,99	56,40
Eschenlohe	36	17.12.2007	9,30	14,00	2,35	47,40	50,61
Eschenlohe	42	17.12.2007	9,30	18,60	3,11	50,94	59,87
Eschenlohe	44	17.12.2007	9,30	16,30	2,83	40,34	45,48
Eschenlohe	52	17.12.2007	9,30	18,60	3,14	51,82	60,90
Eschenlohe	54	17.12.2007	9,30	18,60	3,00	32,68	38,41
Eschenlohe	56	17.12.2007	9,30	9,30	1,59	60,65	53,78
Eschenlohe	58	17.12.2007	9,30	18,60	3,12	46,81	55,01
Eschenlohe	62	17.12.2007	9,30	18,60	3,31	42,99	50,52
Eschenlohe	64	17.12.2007	9,30	18,60	3,13	46,81	55,01
Eschenlohe	66	17.12.2007	9,30	18,60	3,07	50,64	59,51
Eschenlohe	68	17.12.2007	9,30	18,60	3,01	45,05	52,94
Eschenlohe	76	17.12.2007	9,30	18,60	3,09	46,52	54,67
Eschenlohe	78	17.12.2007	9,30	18,60	3,09	47,55	55,88
Eschenlohe	84	17.12.2007	9,30	18,60	3,04	47,84	56,22
Eschenlohe	86	17.12.2007	9,30	18,60	3,04	33,71	39,62
Eschenlohe	98	17.12.2007	9,30	18,60	3,19	40,34	47,41
Eschenlohe	100	17.12.2007	9,30	18,60	3,16	48,29	56,75
Eschenlohe	106	17.12.2007	9,30	18,60	3,07	30,18	35,47
Eschenlohe	108	17.12.2007	9,30	18,60	3,15	36,51	42,91
Eschenlohe	114	17.12.2007	9,30	18,60	3,12	44,75	52,59
Eschenlohe	116	17.12.2007	9,30	18,60	3,01	34,74	40,83
Mittelwert	[MPa]	μ = (Rc1 + Rc2 +...+ Rcn)/n					49,97
Anzahl n	[]						30
Standartabweichung	[MPa]	s = {[(Rc1-Rcm)^2+...+(Rcn-Rcm)^2]/(n-1)}^0,5					7,62
Charakteristische Würfeldruckfestigkeit						Rck	37,44

Brücke Eschenlohe

Druckfestigkeitsprüfungen

fc = Rc*{0,65 + 0,7/[(1+d/20)*(h/d)^1,25]}

fc . Res stenza carota

Fc.... Resistenza cilindrica

Materialprüfanstalt Kardaun

Lage: Bogen

Brücke	Probe Nr.	Datum:	d	h	G	Zylinderdruckfestigkeit fc	Würfeldruckfestigkeit Rc
			[cm]	[cm]	[kg]	[MPa]	[MPa]
Eschenlohe	92	17.12.2007	9,30	18,60	2,96	27,53	32,35
Eschenlohe	60	17.12.2007	9,30	14,00	2,24	32,39	34,58
Eschenlohe	74	17.12.2007	9,30	16,30	2,62	29,74	33,53
Eschenlohe	94	17.12.2007	9,30	14,00	2,20	30,18	32,22
Eschenlohe	96	17.12.2007	9,30	18,60	2,93	31,80	37,37
Mittelwert	[MPa]	μ = (Rc1 + Rc2 +...+ Rcn)/n					34,01
Anzahl n	[]						5
Standartabweichung	[MPa]	s = {[(Rc1-Rcm)^2+...+(Rcn-Rcm)^2]/(n-1)}^0,5					2,11

Charakteristische Würfeldruckfestigkeit Rck 30,54

5.12 Validierung Software

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17-W054 Risanamento del ponte 15 Eschenlohe SP9 al km 7,750

PROGETTO ESECUTIVO

Allegato relazione: Validazione software

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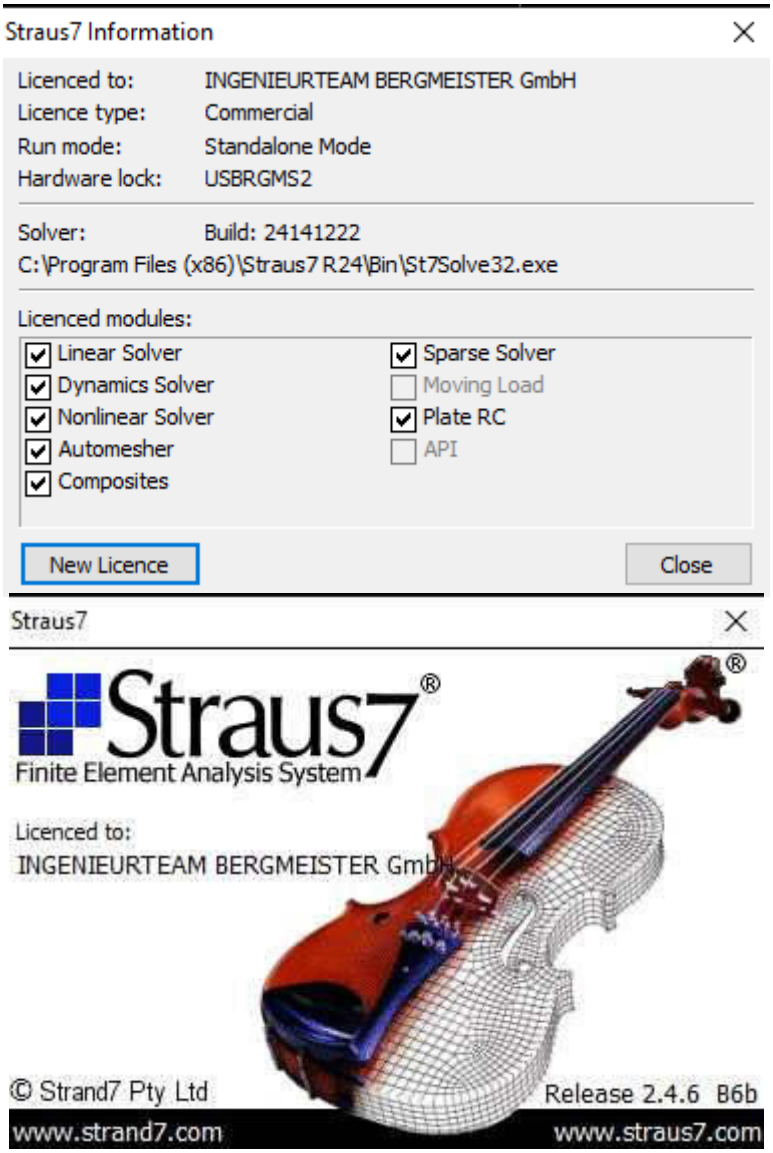
1 Descrizione del software

Straus7 è un codice di calcolo internazionalmente riconosciuto per l'analisi agli elementi finiti (FEA) di piastre, pareti, gusci, solidi e strutture intelaiate complesse (vedi figura 1), valido per diverse tipologie di materiali da costruzione.

Dati:



2 Riferimenti normativi

- Decreto 31/07/2012: "Approvazione degli Appendici nazionali recanti i parametri tecnici per l'applicazione degli Eurocodici"
- UNI EN 1993-1-1, 2005, Parte 1-1: Regole generali e regole per gli edifici

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3 Validazione

3.1 Introduzione

Nel presente documento, si considera un modello strutturale bidimensionale creato con una specifica geometria e condizioni di carico. Particolarmente, si valuta una struttura a un piano singolo calcolata con il software Straus7 e un calcolo analitico alternativo.
Il calcolo analitico è presentato con passaggi semplici e interpretabili (dal lettore), di verifica dei calcoli e dei risultati forniti dal software. Si applicano le regole generalmente applicate nel calcolo statico.

La verifica è condotta in due fasi 2:

a. Prima si conduce il calcolo analitico.
b. Successivamente, si valuta l'efficienza del modello statico risolto dal software STRAUS7. Quindi si valutano i dati di input e output.

Si noti che Straus7 fornisce le forze calcolate ai nodi mentre il calcolo analitico restituisce le reazioni vincolari (uguali in grandezza ma di segno opposto).

3.2 Modello strutturale e carichi

In questo capitolo si descrivono la struttura del telaio, la sua geometria, i carichi e le condizioni al contorno.

La struttura consiste di un telaio con due appoggi (vedi Figura 1). La luce del telaio è pari a 6m. La Colonna di sinistra è alta 5 m. Sul lato destro del telaio si pone una colonna alta 3 m. Il telaio è orizzontale ma con una diversa quota degli appoggi (2 m).

La struttura nel complesso si caratterizza per le seguenti dimensioni:

- Luce: 6,00 m
- Altezza: 5,00 m / 3,00 m (sinistra/destra).

Gli elementi strutturali principali (colonne e travi) sono modellati tramite elementi di trave, costituiti da profili standard (HEB 200).

L'appoggio del telaio è costituito da un carrello (appoggio più alto) e una cerniera. Il carrello è previsto mobile nella direzione trasversale a fine di evitare sforzi di taglio.
Le condizioni di carico sono riportate nella Figura 2.

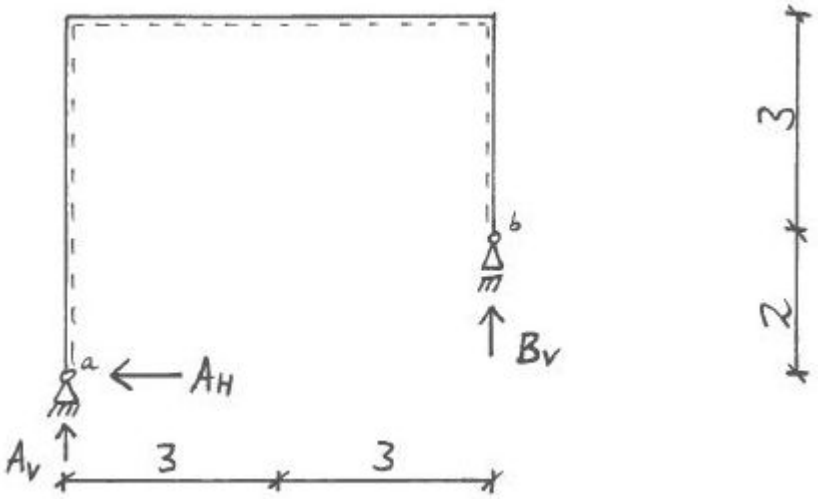

Figura 1 – Geometria del modello strutturale (tutti i dati sono in [m])

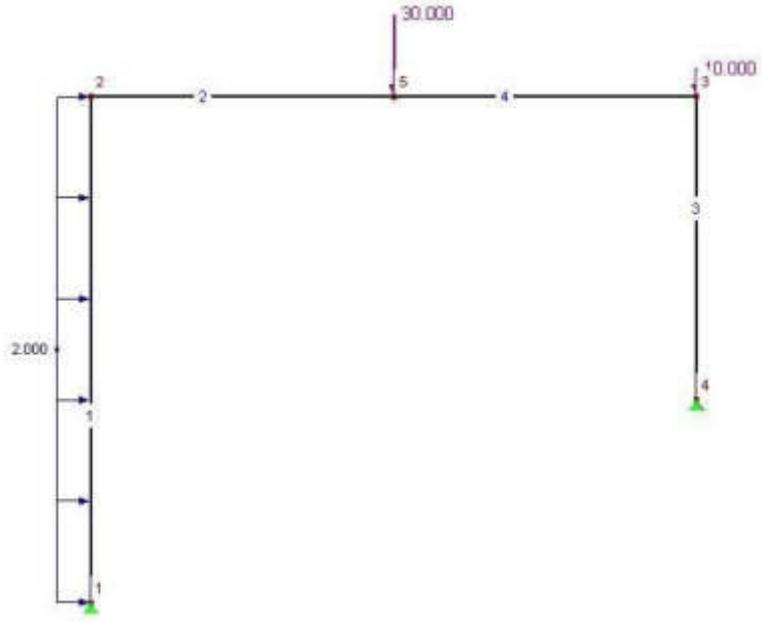

Figura 2 – Carichi applicati (il carico permanente non è rappresentato)

Tipologie di carico considerate:

- Carico permanente (peso proprio della struttura)
- Carichi variabili (forza concentrata, 30 kN)
- Azioni ambientali (vento, 2 kN/m)
- Carico permanente (strutturale) (colonna di supporto, 10 kN)

Successivamente si discutono le ipotesi di carico nel dettaglio.

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Caso di carico 1 (LC1) / peso proprio strutture metalliche

Il peso delle strutture metalliche è valutato dal software STRAUS7 con un peso specifico 78,5 kN/m³.

Caso di carico 2 (LC2) / azione del vento

L'azione del vento è modellata come un carico di 2 kN/m.

Azione vento	2,0kN/m

Caso di carico 3 (LC3) / azione concentrata

Azione concentrata (nodo [5])	30,0 kN - azione singola

Il carico verticale ha un'entità di 30 kN. Quest'azione variabile può essere considerate come una forza indotta da un tubolare di supporto.

Caso di carico 4 (LC4) / azione permanente

Azione permanente (nodo [3])	10,0 kN - azione singola

Il carico verticale ha un'entità di 10 kN. Questo è considerate un permanente strutturale.

3.3 Casi di carico e combinazioni di carico

Le combinazioni dei casi di carico (ossia i gruppi dei carichi) per la progettazione della struttura sono state definite secondo NTC 2018. Al fine di facilitare il calcolo delle combinazioni, i casi di carico sono stati raccolti in gruppi cui si applicano gli stessi coefficienti combinatori e di sicurezza secondo la Tabella 1.

Tabella 1 – Casi di carico e coefficienti di combinazione

Caso di carico	Definizione caso di carico	Assegnazione		Coefficienti carichi variabili		
				Ψ_0	Ψ_1	Ψ_2
1	Peso proprio	LC1	Permanenti			
2	Vento	LC2	Vento	0,6	0,2	0
3	Peso proprio	LC3	Variabili	1,0	0,9	0,8
4	Permanente	LC4	Permanenti			

Le principali combinazioni di progetto per il calcolo delle strutture sono state definite nel modo seguente (analogamente alla combinazione LC1 in Straus7):

I. ULS (STR)– azioni permanenti e variabili (combinazione agli stati limite ultimi per la verifica di resistenza e delle azioni temporanee)

combinazioni dei carichi:
ULS STR "vento dominante" = 1,3 * (LC1 + LC4) + 1,5 * LC2 + 1,5 * 1,0 * LC3
ULS STR „forza concentrate dominante" = 1,3 * (LC1 + LC4) + 1,5 * LC3 + 1,5 * 0,6 * LC2

Combinazione di verifica:
LC1 = LG1 oppure LG2

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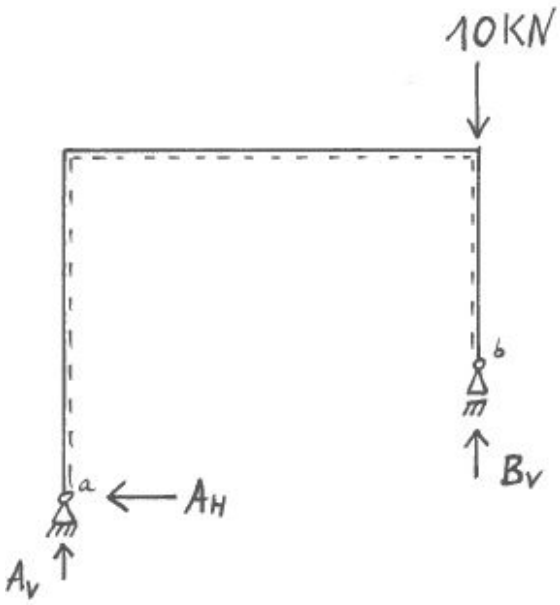
3.4 Reazioni vincolari. Calcolo analitico

LC1 + LC4: carichi permanenti e peso proprio



(carico permanente calcolato additivamente)

$$\circlearrowleft + \Sigma M_a = 0 = 6m * 10kN + 6m * 0{,}613 \frac{kN}{m} * 3m - 6m * B_V + 3m * 0{,}613 \frac{kN}{m} * 6m$$

$$0 = 60kNm + 11{,}03kNm + -6m * B_V + 11{,}03\ kNm$$

$$6m * B_V = 82{,}06\ kNm$$

$$\underline{B_V = 13{,}68\ kN}$$

$$t + \Sigma F_y = 0 = A_V + B_V - 10\ kN - 0{,}613 \frac{kN}{m} * 6m - 0{,}613 \frac{kN}{m} * 5m - 0{,}613 \frac{kN}{m} * 3m$$

$$t + \Sigma F_y = 0 = A_V + 13{,}68kN - 10\ kN - 3{,}68kN - 3{,}07kN - 1{,}84kN$$

$$0 = A_V - 4{,}91kN$$

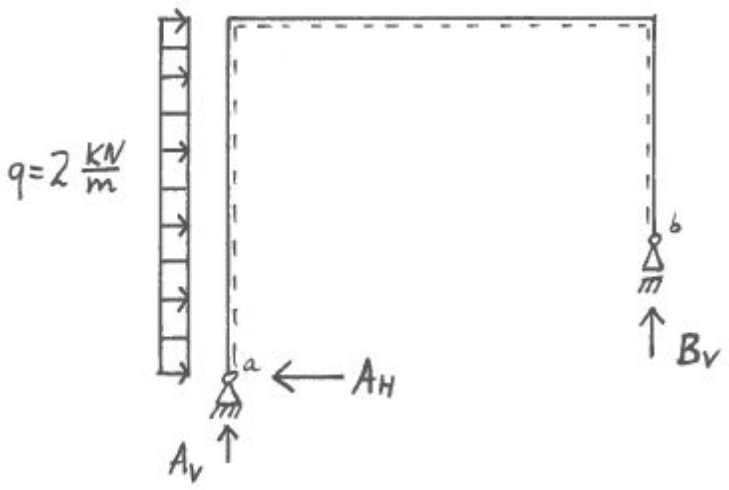
$$\underline{A_V = 4{,}91\ kN}$$

$$\rightarrow + \Sigma F_x = 0 = -A_H$$

$$\rightarrow + \Sigma F_x = 0 = -A_H$$

$$\underline{A_H = 0\ kN}$$

LC2: azione del vento



$R = q * l = 2kN/m * 5m = 10\ kN$

$\circlearrowright + \Sigma M_a = 0 = 2{,}5m * R - 6m * B_V$

$\circlearrowright + \Sigma M_a = 0 = 2{,}5m * 10kN - 6m * B_V$

$0 = 25kNm - 6m * B_V$

$6m * B_V = 25kNm$

$\underline{B_V = 4{,}17\ kN}$

$t + \Sigma F_y = 0 = A_V + B_V$

$t + \Sigma F_y = 0 = A_V + 4{,}17kN$

$0 = A_V + 4{,}17kN$

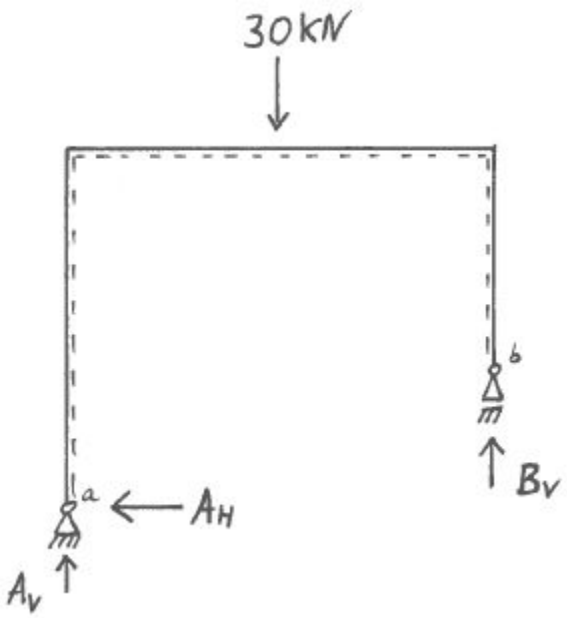
$\underline{A_V = -4{,}17\ kN}$

$\rightarrow + \Sigma F_x = 0 = R - A_H$

$\rightarrow + \Sigma F_x = 0 = 10kN - A_H$

$\underline{A_H = 10\ kN}$

LC3: azioni variabili



$$\circlearrowright + \Sigma M_a = 0 = 3m * 30kN - 6m * B_V$$

$$\circlearrowright + \Sigma M_a = 0 = 90kNm - 6m * B_V$$

$$6m * B_V = 90kNm$$

$$\underline{B_V = 15\ kN}$$

$$t + \Sigma F_y = 0 = A_V + B_V - 30kN$$

$$t + \Sigma F_y = 0 = A_V + 15kN - 30kN$$

$$0 = A_V - 15kN$$

$$\underline{A_V = 15\ kN}$$

$$\rightarrow + \Sigma F_x = 0 = -A_H$$

$$\rightarrow + \Sigma F_x = 0 = 0 - A_H$$

$$\underline{A_H = 0\ kN}$$

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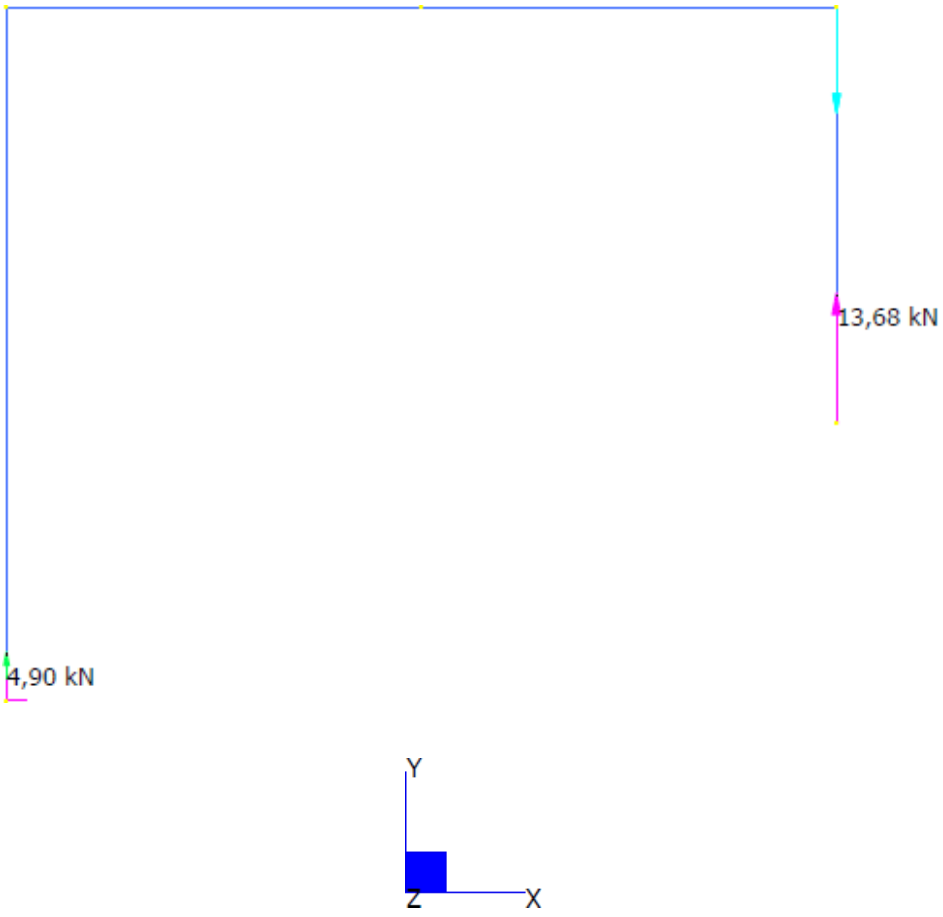
3.5 Reazioni vincolari. Calcolo Straus7

LC1 + LC4: permanenti + variabili

Reazioni:



6 Nodes 4 Beams 0 Plates 0 Bricks 0 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 0,0 RY: 0,0 RZ: 0,0	5: LC1+LC4 [Combination 1] 1: Freedom Case 1 Scale: 0,0 %

No.	Support Forces [kN] $P_{x'}$	$P_{y'}$	Support Moments $M_{y'}$ [kNm]
1	0,00	4,90	0,00
4	0,00	13,68	0,00
Σ Forces	0,00	18,58	
Σ Loads	0,00	18,58	

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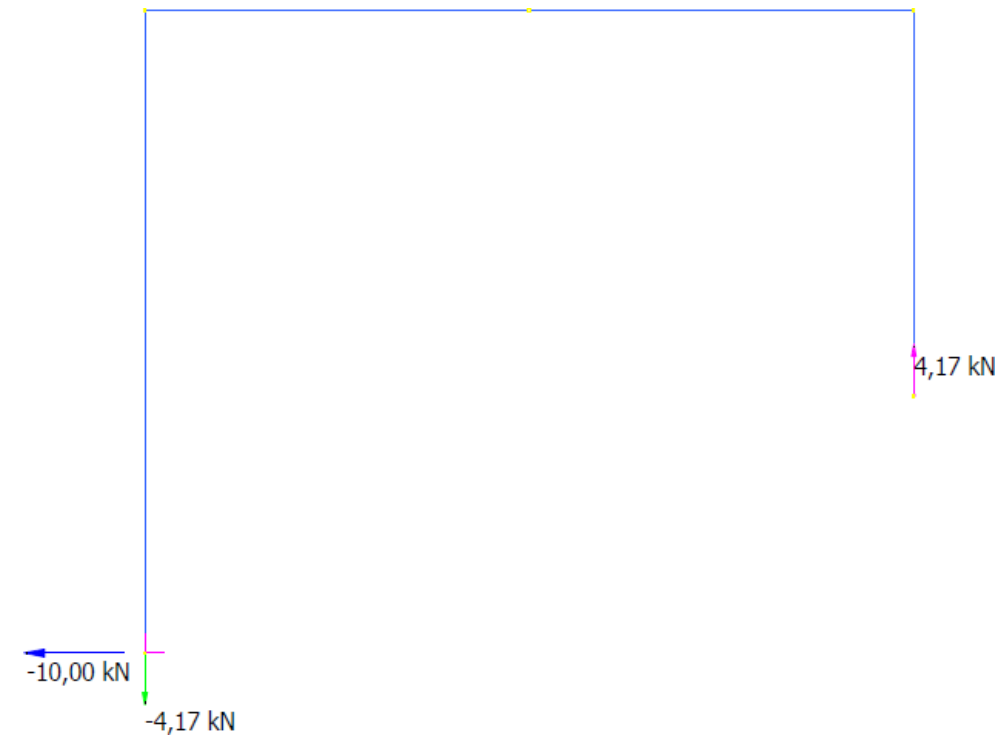
LC2: vento

Reazioni:



6 Nodes	0 Vertices	View	2: LC2/Azione del vento
4 Beams	0 Edges	RX: 0,0	1: Freedom Case 1
0 Plates	0 Loops	RY: 0,0	Scale: 0,0 %
0 Bricks	0 Faces	RZ: 0,0	
0 Links	0 Surfaces		
0 Paths			

Node No.	Support Forces [kN] $P_{X'}$	P_Y	Support Moments $M_{Y'}$ [kNm]
1	-10,00	-4,17	0,00
4	0,00	4,17	0,00
Σ Forces	-10,00	0,00	
Σ Loads	-10,00	0,00	

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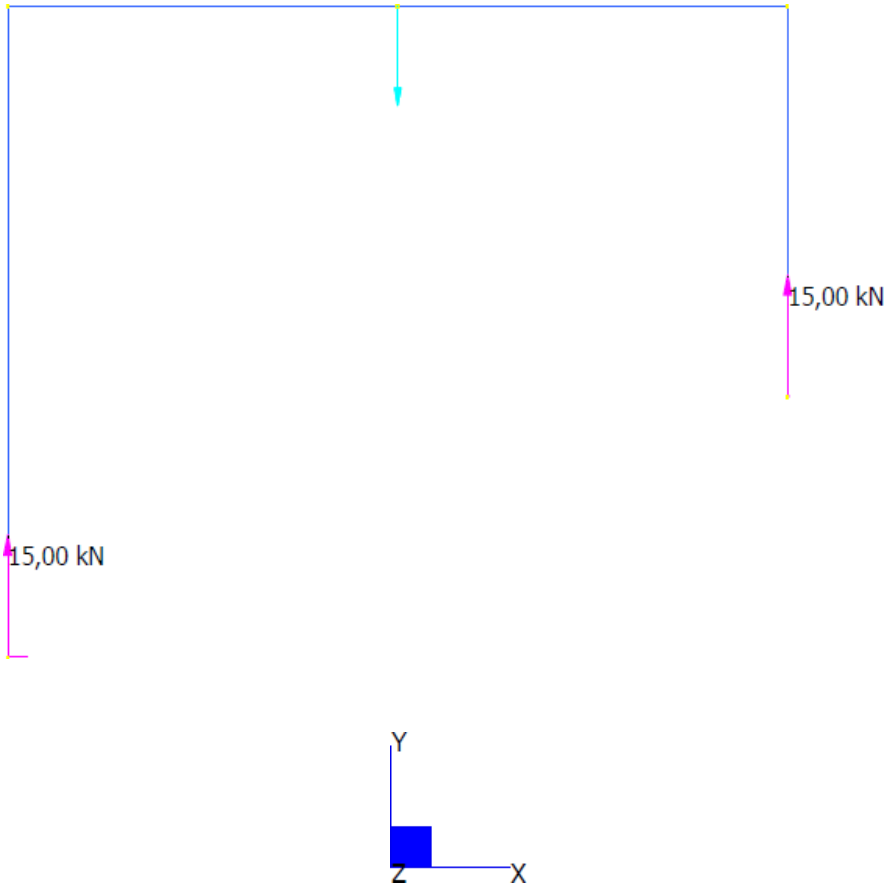
LC3: carichi variabili

Reazioni:



6 Nodes 4 Beams 0 Plates 0 Bricks 0 Links 0 Paths	0 Vertices 0 Edges 0 Loops 0 Faces 0 Surfaces	View RX: 0,0 RY: 0,0 RZ: 0,0	3: LC3/Azione concentrata 1: Freedom Case 1 Scale: 0,0 %

Node No.	Support Forces [kN] $P_{X'}$	P_y	Support Moments $M_{Y'}$ [kNm]
1	0,00	15,00	0,00
4	0,00	15,00	0,00
Σ Forces	0,00	30,00	
Σ Loads	0,00	30,00	

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3.6 Combinazioni. Calcolo analitico

Gruppo di carico 1:

→ reazioni agli appoggi

ULS STR "vento dominante"

ULS STR "lead wind" = 1,3 * (LC1 + LC4) + 1,5 * LC2 + 1,5 * 1,0 * LC3

$$A_V = 1{,}3 * (A_{VLC1} + A_{VLC4}) + 1{,}5 * A_{VLC2} + 1{,}5 * 1{,}0 * A_{VLC3}$$

$$A_V = 1{,}3 * 4{,}91\text{kN} + 1{,}5 * (-4{,}17)\text{kN} + 1{,}5 * 1{,}0 * 15\text{kN}$$

$$\underline{A_V = 22{,}63\text{ kN}}$$

$$B_V = 1{,}3 * (B_{VLC1} + B_{VLC4}) + 1{,}5 * B_{VLC2} + 1{,}5 * 1{,}0 * B_{VLC3}$$

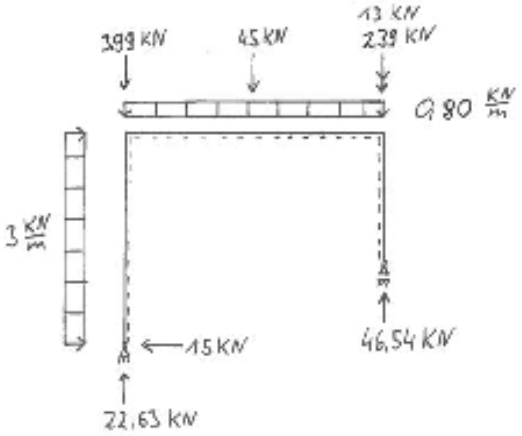
$$B_V = 1{,}3 * 13{,}68\text{kN} + 1{,}5 * 4{,}17\text{kN} + 1{,}5 * 1{,}0 * 15\text{kN}$$

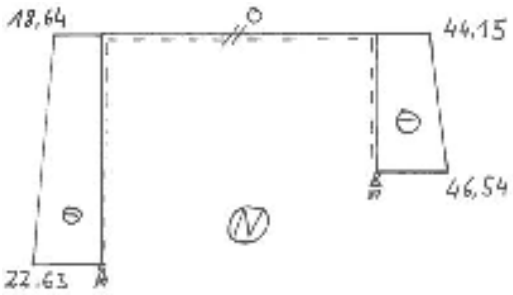
$$\underline{B_V = 46{,}54\text{ kN}}$$

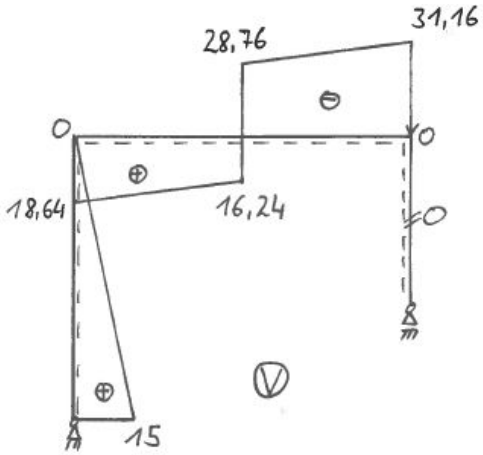
$$A_H = 1{,}3 * (A_{HLC1} + A_{VLC4}) + 1{,}5 * A_{HLC2} + 1{,}5 * 1{,}0 HA_{VLC3}$$

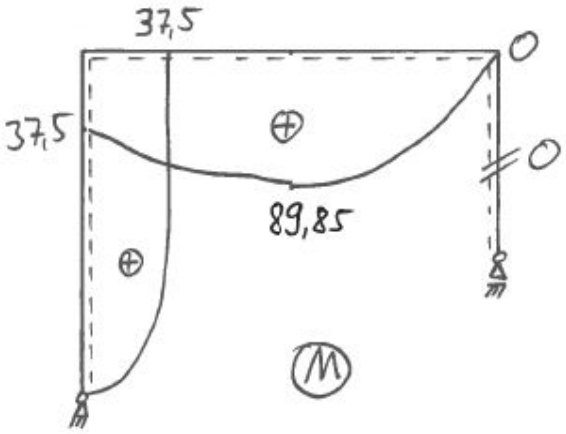
$$A_H = 1{,}3 * 0 + 1{,}5 * 10\text{kN} + 1{,}5 * 1{,}0 * 0$$

$$\underline{A_H = 15\text{ kN}}$$

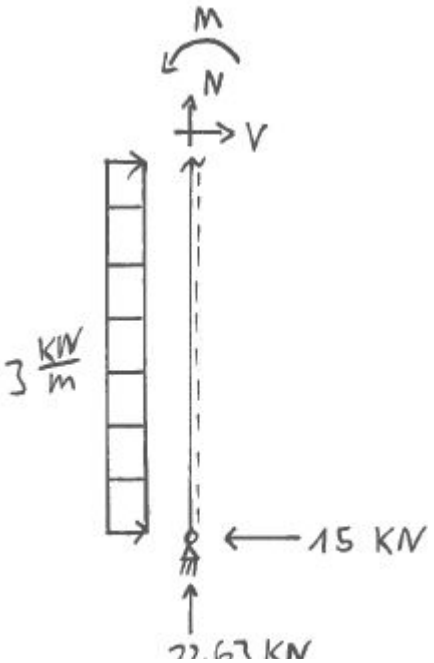








→ condizioni di equilibrio



$$\circlearrowright + \Sigma M_c = 0 = -2{,}5\text{m} * R + 5\text{m} * A_H - M_c$$

$$\circlearrowright + \Sigma M_c = 0 = -2{,}5\text{m} * 15\text{kN} + 5\text{m} * 15\text{kN} - M_c$$

$$M_c = -37{,}5\text{kNm} + 75\text{kNm}$$

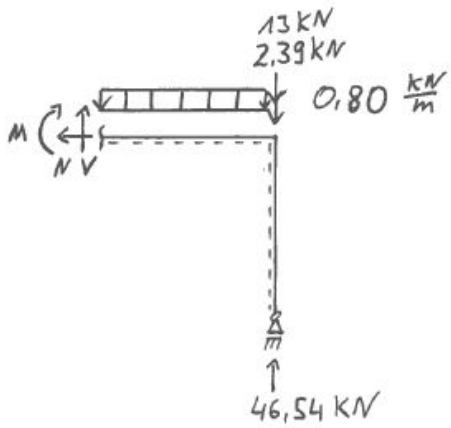
$$\underline{M_c = 37{,}5\text{kNm}}$$

$$\rightarrow + \Sigma F_x = 0 = N + 22{,}63\text{kN} - 0{,}80 \frac{\text{kN}}{\text{m}} * 5\text{m}$$

$$\rightarrow + \Sigma F_x = 0 = N + 22{,}63\text{kN} - 3{,}99\text{kN}$$

$$N = -22{,}63\text{kN} + 3{,}99\text{kN}$$

$$\underline{N = 18.64\text{ kN}}$$



$$\circlearrowright + \Sigma M_e = 0 = 3\text{m} * 13\text{kN} + 3\text{m} * 2{,}39\text{kN} - 3\text{m} * B_V + M_e + 0{,}8 \frac{\text{kN}}{\text{m}} * 3\text{m} * 1{,}5\text{m}$$

$$\circlearrowright + \Sigma M_e = 0 = 3\text{m} * 13\text{kN} + 3\text{m} * 2{,}39\text{kN} - 3\text{m} * 46{,}54\text{kN} + M_e + 1{,}5\text{m} * 2{,}4\text{kN}$$

$$M_e = -39\text{kNm} - 7{,}17\text{ kNm} + 139{,}62\text{kNm} - 3{,}6\text{kNm}$$

Gruppo di carico 2:

→ reazioni agli appoggi

ULS STR „lead pipe“ = 1,3 * (LC1 + LC4) + 1,5 * LC3 + 1,5 * 0,6 * LC2

$A_V = 1{,}3 * (A_{VLC1} + A_{VLC4}) + 1{,}5 * A_{VLC3} + 1{,}5 * 0{,}6 * A_{VLC2}$

$A_V = 1{,}3 * 4{,}91\text{kN} + 1{,}5 * 15\text{kN} + 1{,}5 * 0{,}6 * (-4{,}17)\text{kN}$

$\underline{A_V = 25{,}13\text{ kN}}$

$B_V = 1{,}3 * (B_{VLC1} + B_{VLC4}) + 1{,}5 * B_{VLC3} + 1{,}5 * 0{,}6 * B_{VLC2}$

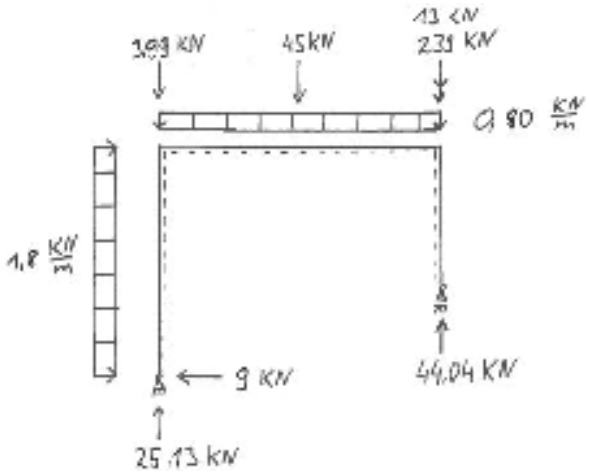
$B_V = 1{,}3 * 13{,}68\text{kN} + 1{,}5 * 15\text{kN} + 1{,}5 * 0{,}6 * 4{,}17\text{kN}$

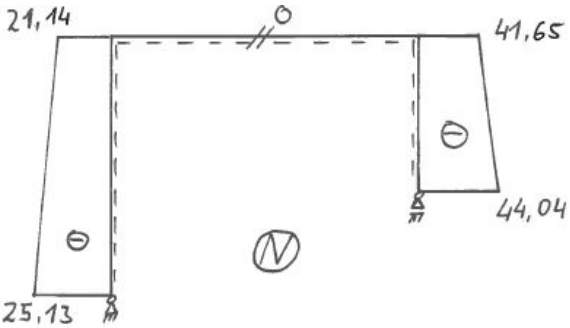
$\underline{B_V = 44{,}04\text{ kN}}$

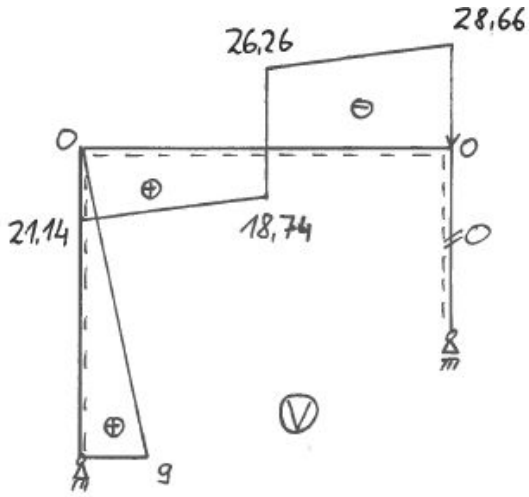
$A_H = 1{,}3 * (A_{HLC1} + A_{VLC4}) + 1{,}5 * A_{HLC3} + 1{,}5 * 1{,}0HA_{VLC2}$

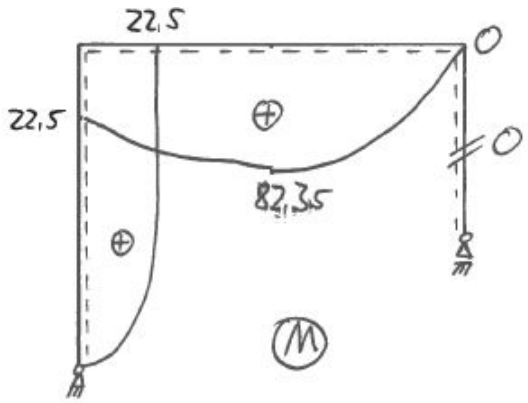
$A_H = 1{,}3 * 0 + 1{,}5 * 0 + 1{,}5 * 0{,}6 * 10\text{kN}$

$\underline{A_H = 9\text{ kN}}$

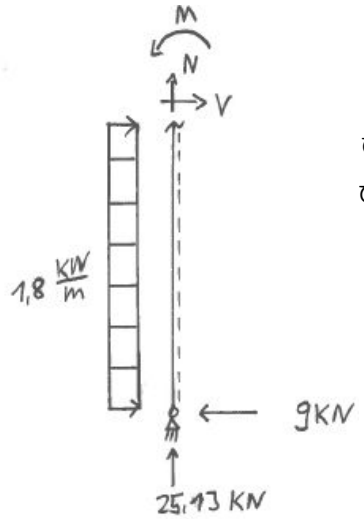








→ condizioni di equilibrio



$$\circlearrowright + \Sigma M_c = 0 = -2{,}5\text{m} * R + 5\text{m} * A_H - M_c$$

$$\circlearrowright + \Sigma M_c = 0 = -2{,}5\text{m} * 9\text{kN} + 5\text{m} * 9\text{kN} - M_c$$

$$M_c = -22{,}5\text{kNm} + 45\text{kNm}$$

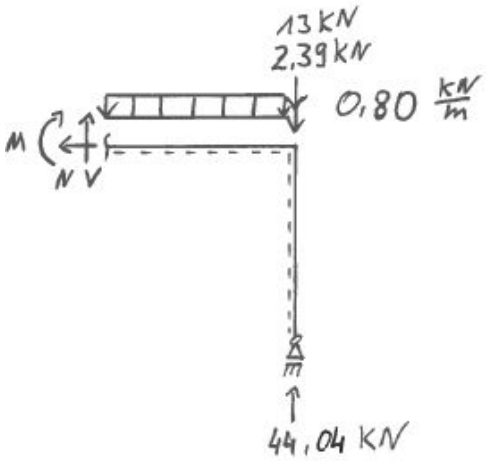
$$\underline{M_c = 22{,}5\text{kNm}}$$

$$\rightarrow + \Sigma F_x = 0 = N + 25{,}13\text{kN} - 0{,}80 \frac{\text{kN}}{\text{m}} * 5\text{m}$$

$$\rightarrow + \Sigma F_x = 0 = N + 25{,}13\text{kN} - 3.99\text{kN}$$

$$N = -25{,}13\text{kN} + 3{,}99\text{kN}$$

$$\underline{N = 21{,}14\text{ kN}}$$



$$\circlearrowright + \Sigma M_e = 0 = 3\text{m} * 13\text{kN} + 3\text{m} * 2{,}39\text{kN} - 3\text{m} * B_V + M_e$$

$$+ 0{,}8 \frac{\text{kN}}{\text{m}} * 3\text{m} * 1{,}5\text{m}$$

$$\circlearrowright + \Sigma M_e = 0 = 3\text{m} * 13\text{kN} + 3\text{m} * 2{,}39\text{kN} - 3\text{m} * 44{,}04\text{kN}$$

$$+ M_e + 1{,}5\text{m} * 2{,}4\text{kN}$$

$$M_e = -39\text{kNm} - 7{,}17\text{ kNm} + 132{,}12\text{kNm} - 3{,}6\text{kNm}$$

$$\underline{M_e = 82{,}35\text{ kNm}}$$

Combinazione di carico:

La combinazione associa I due gruppi di carico. Le reazioni massime agli appoggi ammontano a:

$$A_V = 22{,}63 \text{ kN}$$
$$B_V = 46{,}53 \text{ kN}$$
$$A_H = -15 \text{ kN}$$

Imponendo le condizioni di equilibrio statico si ottendono i seguenti risultati, utilizzate per le validazioni:

Azione assiale: 0 kN
Azione di taglio: -31,14 kN
Momento flettente: 89,84 kNm.

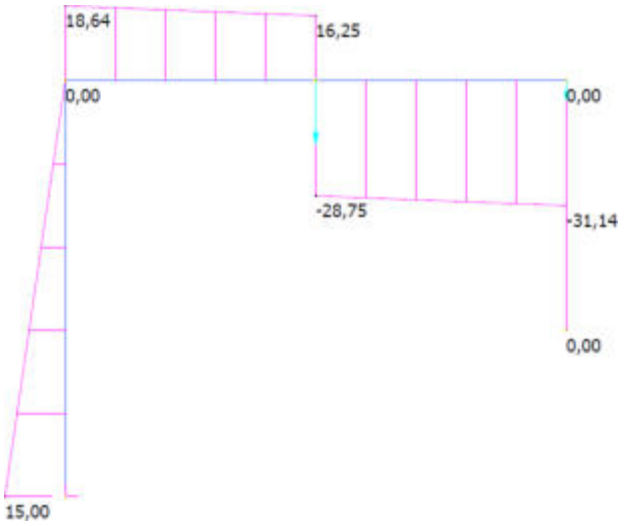
3.7 Combinazioni. Calcolo STRAUS7

Gruppo di carico:

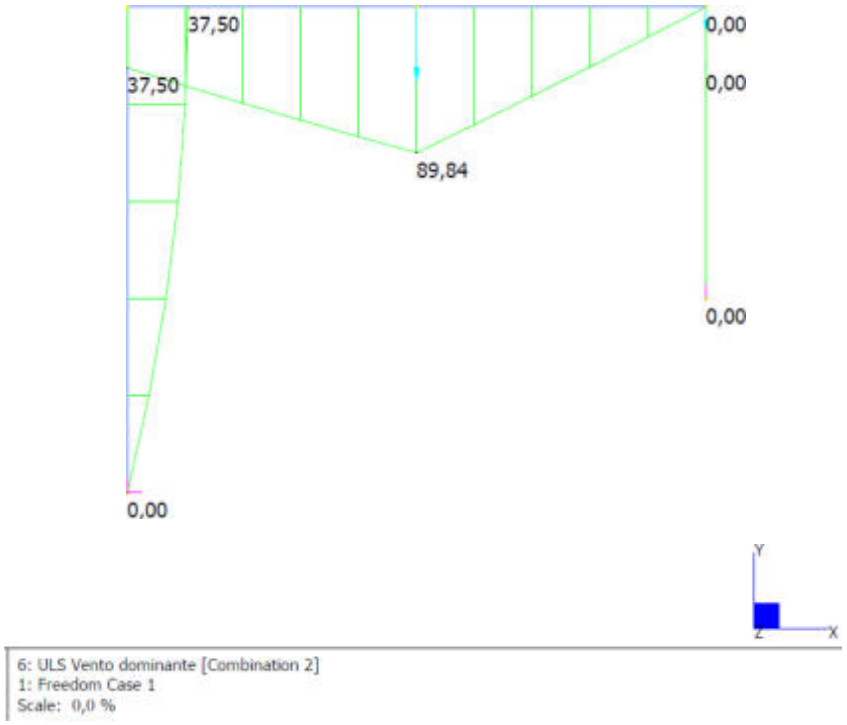
ULS STR "vento dominante" = 1,3 * (LC1 + LC4) + 1,5 * LC2 + 1,5 * 1,0 * LC

Azione assiale:

Azione di taglio:



Momento flettente:



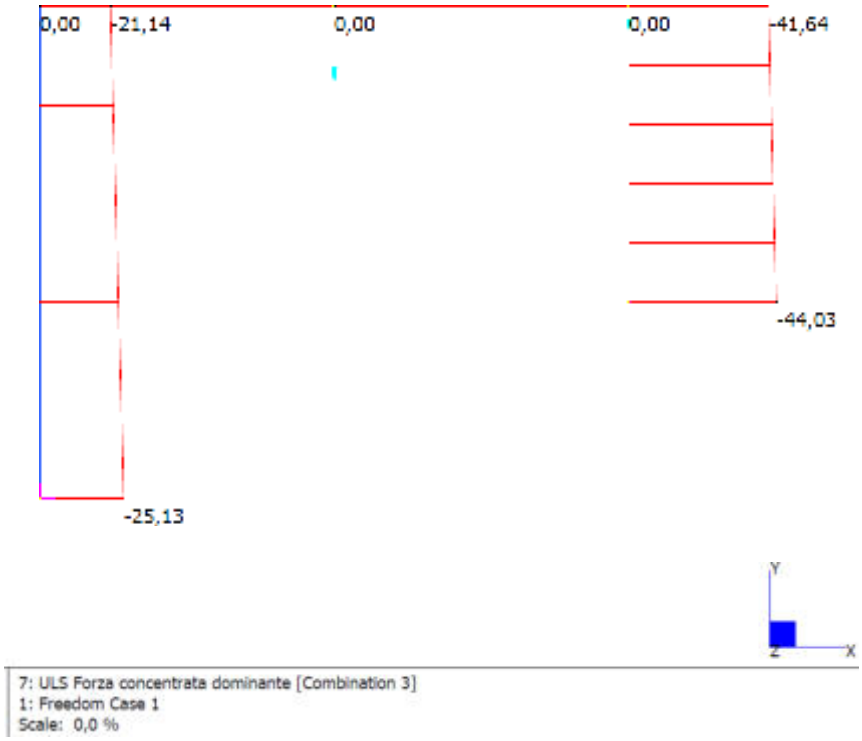
Condizioni di equilibrio:

Member	node	Location x [m]	N [kN]	Sf2 [kN]	BM [kN]
1	1	0,00	-22,63	-15,00	0,00
	2	5,00	-18,64	0,00	37,50
2	2	0,00	0,00	18,64	37,50
	5	3,00	0,00	16,25	89,84
3	4	0,00	-46,53	0,00	0,00
	3	3,00	-44,14	0,00	0,00
4	5	0,00	0,00	-28,75	89,84
	3	3,00	0,00	-31,14	0,00

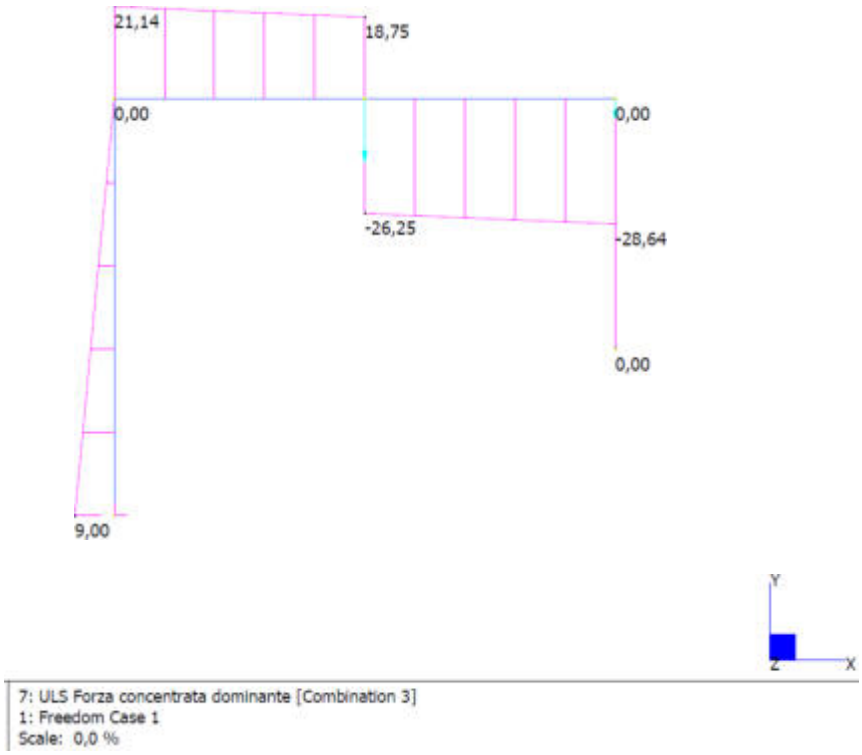
Gruppo di carico:

ULS STR „forza concentrata dominante“ = 1,3 * (LC1 + LC4) + 1,5 * LC3 + 1,5 * 0,6 * LC2

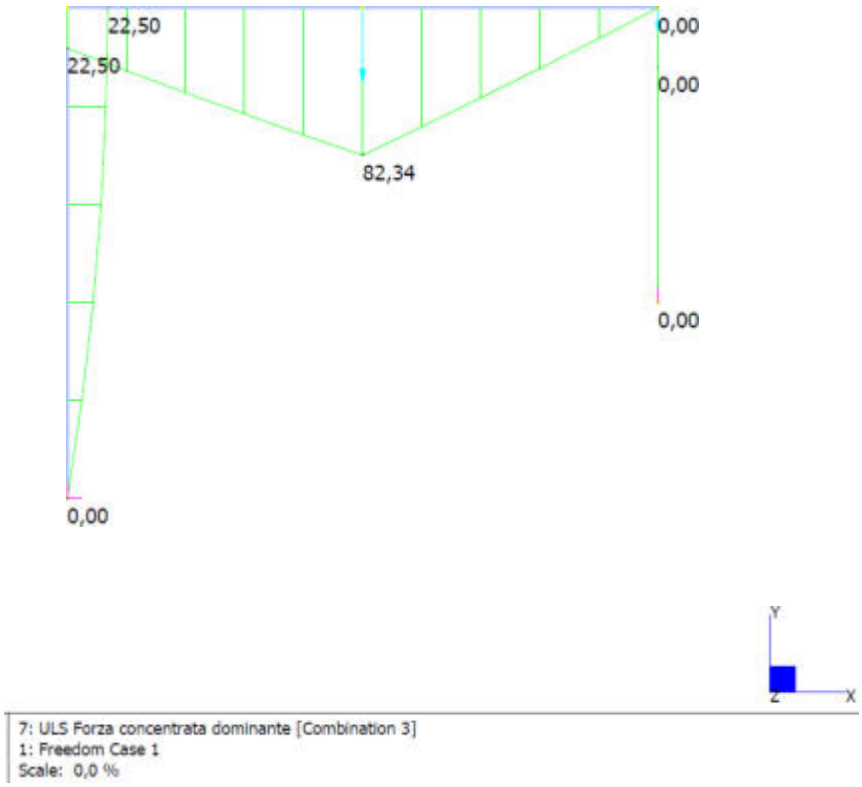
Azione assiale:



Azione tagliante:



Momento flettente:



Condizioni di equilibrio:

Member	node	Location x [m]	N [kN]	Sf2 [kN]	BM [kN]
1	1	0,00	-25,13	9,00	0,00
	2	5,00	-21,14	0,00	22,50
2	2	0,00	0,00	21,14	22,50
	5	3,00	0,00	18,75	82,34
3	4	0,00	-44,03	0,00	0,00
	3	3,00	-41,64	0,00	0,00
4	5	0,00	0,00	-26,25	82,34
	3	3,00	0,00	-28,64	0,00

Combinazione di carico:

La combinazione di carico determina le azioni agli appoggi per i due gruppi di carico.

Limit Envelopes | Combination Envelopes | Factors Envelopes

	Envelope Case	
	1: Minimum Envelope	2: Maximum Envelope
CASES	**Envelope Case**	**Envelope Case**
1: LC1/peso proprio strutture metalliche		
2: LC2/Azione del vento		
3: LC3/Azione concentrata		
4: LC4/Azione permanente		
5: LC1+LC4 [Combination 1]		
6: ULS Vento dominante [Combination 2]	✓	✓
7: ULS Forza concentrata dominante [Combination 3]	✓	✓

Envelope min

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Envelope max

Nel seguito si valuta l'accuratezza del software Straus 7, in riferimento ai valori ottenuti per le reazioni e le forze interne: δ indica l'errore relativo t (espresso in percentuale).

Quantità Quantity	Combinazione Combination	Unità Unit	Valore – value Calcolo analitico Hand calculation	 Straus7	δ [%]
A_V	1	kN	22,63	22,63	0,00%
A_H	1	kN	15	15	0,00%
B_V	1	kN	46,54	46,53	0,02%
N_{Sd} [1]	1	kN	22,63	22,63	0,00%
V_{Sd} [1]	1	kN	15	15	0,00%
M_{Sd} [1]	1	kN m	37,5	37,5	0,00%
N_{Sd} [2-4]	1	kN	0	0	-
V_{Sd} [2-4]	1	kN	31,16	31,14	0,06%
M_{Sd} [2-4]	1	kN m	89,85	89,84	0,01%
N_{Sd} [3]	1	kN	46,54	46,53	0,02%
V_{Sd} [3]	1	kN	0	0	-
M_{Sd} [3]	1	kN m	0	0	-
A_V	2	kN	25,13	25,13	0,00%
A_H	2	kN	9	9	0,00%
B_V	2	kN	44,04	44,03	0,02%
N_{Sd} [1]	2	kN	25,13	25,13	0,00%
V_{Sd} [1]	2	kN	9	9	0,00%
M_{Sd} [1]	2	kN m	22,5	22,5	0,00%
N_{Sd} [2-4]	2	kN	0	0	-
V_{Sd} [2-4]	2	kN	28,66	28,64	0,07%
M_{Sd} [2-4]	2	kN m	82,35	82,34	0,01%
N_{Sd} [3]	2	kN	44,04	44,03	0,02%
V_{Sd} [3]	2	kN	0	0	-
M_{Sd} [3]	2	kN m	0	0	-

M_{Sd}, N_{Sd}, V_{Sd}: momento flettente, azione assiale, azione tagliante

[1], [2-4], [3]: aste che compongono il sistema

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4 Conclusioni

Nel presente documento di è conseguita una validazione del software di calcolo strutturale (Straus7) adottato per il progetto strutturale, in riferimento alle reazioni, alle forze interne e all'analisi dello stato di sforzo nella struttura.
Si è eseguito un confronto tra il calcolo analitico e il calcolo automatico condotto con Straus7. Nella sezione precedente si è dimostrato che i risultati forniti dal programma corrispondono a quelli attesi. Un accordo perfetto tra i risultati del calcolo analitico per effetto dell'arrotondamento non è stato ottenuto. Tuttavia le deviazioni individuati erano contenute entro un limite accettabile.