PROJECT OFFICE

INFRAPROJEKT s.c.
www.infraprojekt.pl

INFRAPROJEKT s.c.
41-500 Chorzów
ul. Dworcowa 1/7
T/F: +48 32 241 56 62
E: biuro@infraprojekt.pl

NAME OF PROJECT	**STATIC COUNTINGS OF AN ALUMINUM PROFILE FOR BALUSTRADES/HAND-RAILS FOR HORIZONTAL LOAD: 1 kN/m (1,5 kN/m) ANCHOR IN THE PROFILE SIDE (SIDE ANCHORING)**
INVESTOR	UMAKOW Sp. zo.o. 41-800 Zabrze ul. Alojzego Pawliczka 27A
LEVEL	STATIC CALCULATIONS

Major, function	**Name and surname** **No. of qualifications**	**Signature**
CONSTRUCTION GROUP Architect	Mgr. Ing. Marek Sikora SLK/5654/PWOK/14	Mgr.Ing. Marek Sikora Qualifications for planning as well as managing constructions works without restrictions in expertise: construct.-build. nr SLK/5654/PWOK/14 bridge/SLK/2775/PWOM/09

PLACE AND DATE OF ISSUE	Chorzów, October 2014

Content

1. Basic documents

Command/Order
- Orders by the company UMAKOW s.r.o. with the domicile in Zabrzu prze, Alojzego Pawliczka 27A str.

Norms
[1] PN-EN 1991-1-1 Actions on structures. General actions.
[2] PN-EN 1999-1-1 Design of aluminium constructions. General conditions.

Other
- Systems for attaching glass hand-rail into an aluminium profile together with inserts and seals submitted by the company UMAKOW s.r.o.

2. Assumptions admitted into the calculations

Profile material data:	
EN-AW alloy:	6063
Product type:	Embossed profile EP;
Version:	T6;
Minimal required characteristic stress:	f_0 = 160 MPa (6063);
Partial coefficient of material safety:	γ_M = 1,10
Elasticity model:	E = 70 GPa

Assumptions of the calculation model:
- Height of the hand-rail/balustrade equal to the height of glass table exiting the profile amounts to 1.10 m;
- Load from the glass balustrade is transferred to the profile walls through plastic inserts placed in accordance with the norms of the producer – draft of the norms for insert placement is stated in the point 5.2;
- Anchor placement in the profile side at 25 cm;
- Static calculations have been made on a model body by the method of finished elements in the elastic area;
- Density of the profile is checked by comparing the maximal stress with the allowed one – general case.

These static calculations do not check the attachment of the glass table in the profile nor the effectiveness of the table itself. The only thing checked is the carrying capacity of the aluminium profile, which is affected by the load caused by pressure on the handle.
The wind pressure has not been considered into the calculations – balustrades will be situated inside the building.

3. Specification of powers loading the profile walls

Load compilation

	Load description	Load charact. kN/m	γ_f
1.	Glass table pressure [25,0 kN/m^3·0,02 m·1,20 m]	0,60	1,35
	Load on insert [0,60 kN/m·1,0 m/4/0,1 m]	1,50	1,35
	Load on 1 edge of insert 1,50 kN/m / 2	0,75	1,35
2.	Horizontal load (Usage category C3) [1,000 kN/m]	1,00	1,50

SCHEME

Specification of powers acting on the inserts transferring the load on the profile walls (characteristic loads):

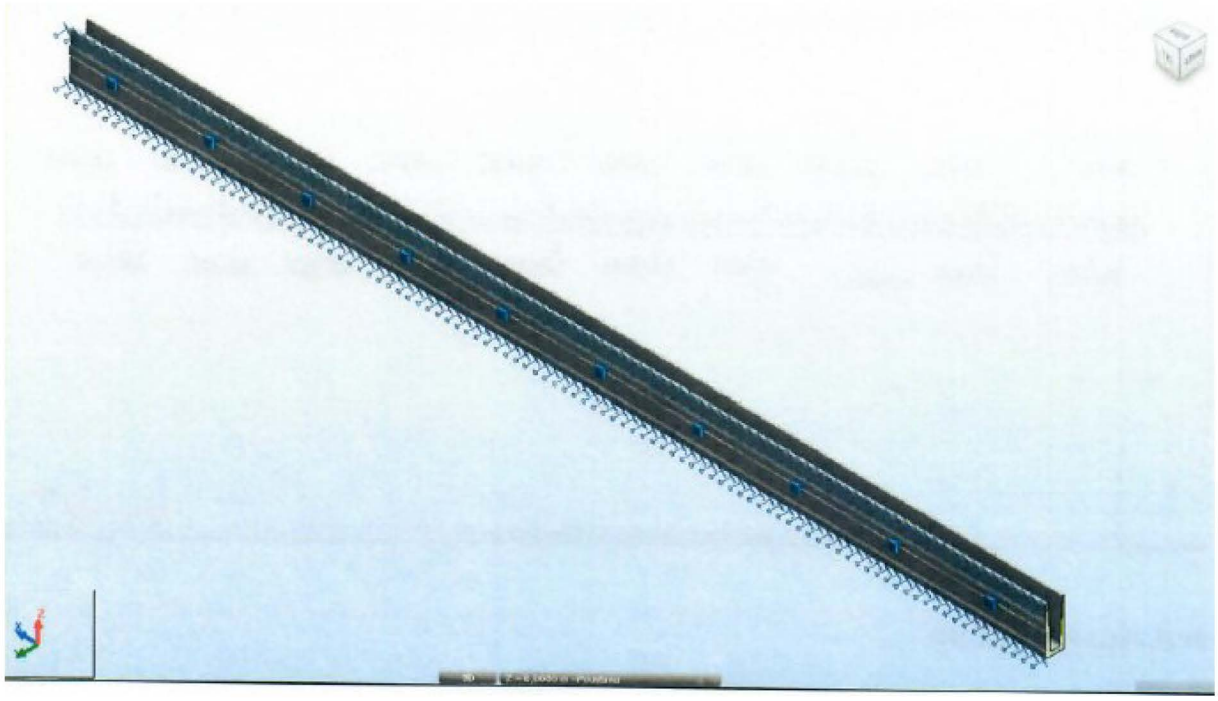
- white insert (width 100 mm):
$P_2 = H_2 \times 2,5 / (0,1 \times n) = 19,5 \times 2,5 / (0,1 \times 10) = 48,75$ kN/m – load by a pressure on balustrade, where:
n – number of inserts at length 2,5 m – 10pcs accepted

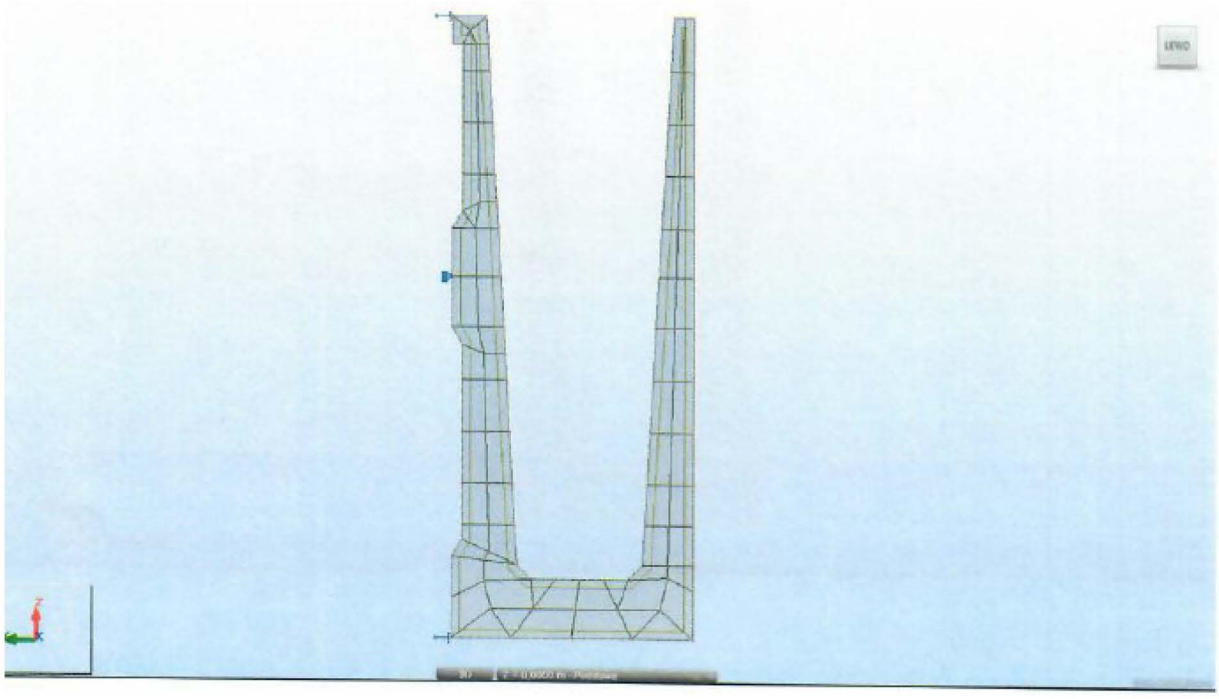
- green insert (width 65 mm):
$P_1 = H_1 \times 2,5 / (0,1 \times n) = 18,5 \times 2,5 / (0,065 \times 10) = 71,15$ kN/m – load by pressure on balustrade, where:
n – number of inserts at 2,5 mb – 10pcs accepted

4. Static – capacity calculations

4.1. Calculation model

Profile has been designed in a calculation program as a volume construction comprised of finished unit elements. The construction is anchored into the ceiling with the help of anchor bolts situated in the side of the profile. Coarsenings of the profile are fitted in with the construction into which is attached the profile – line supports have been considered for this, transferring only pressure.

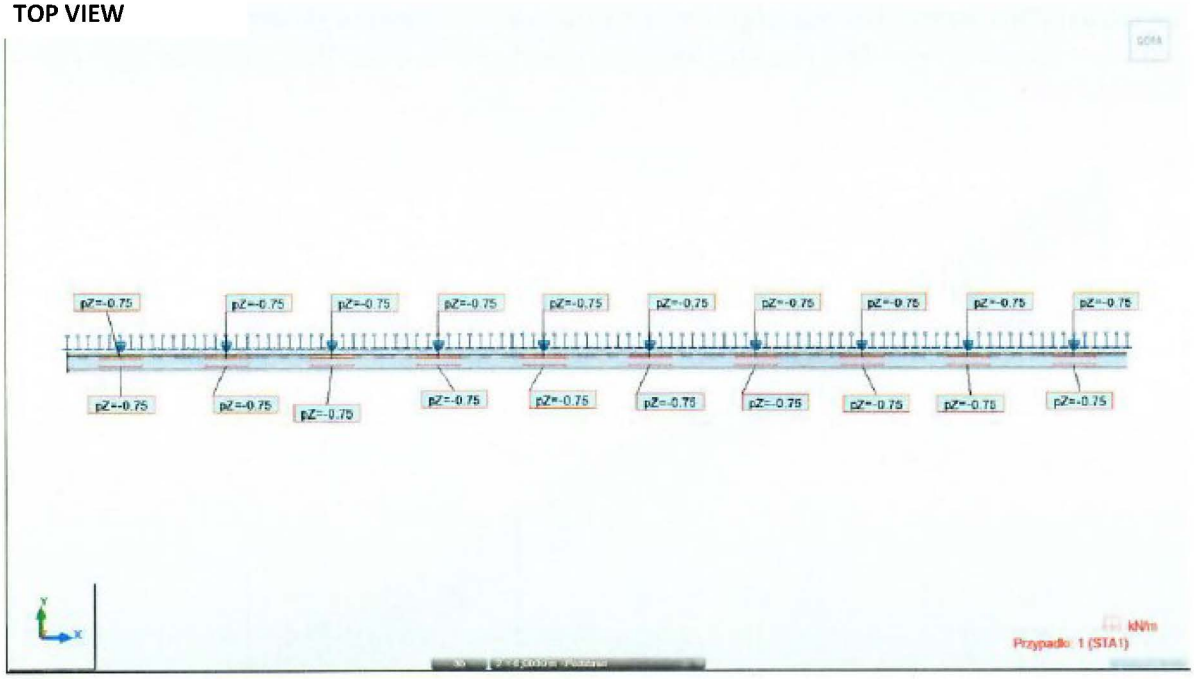




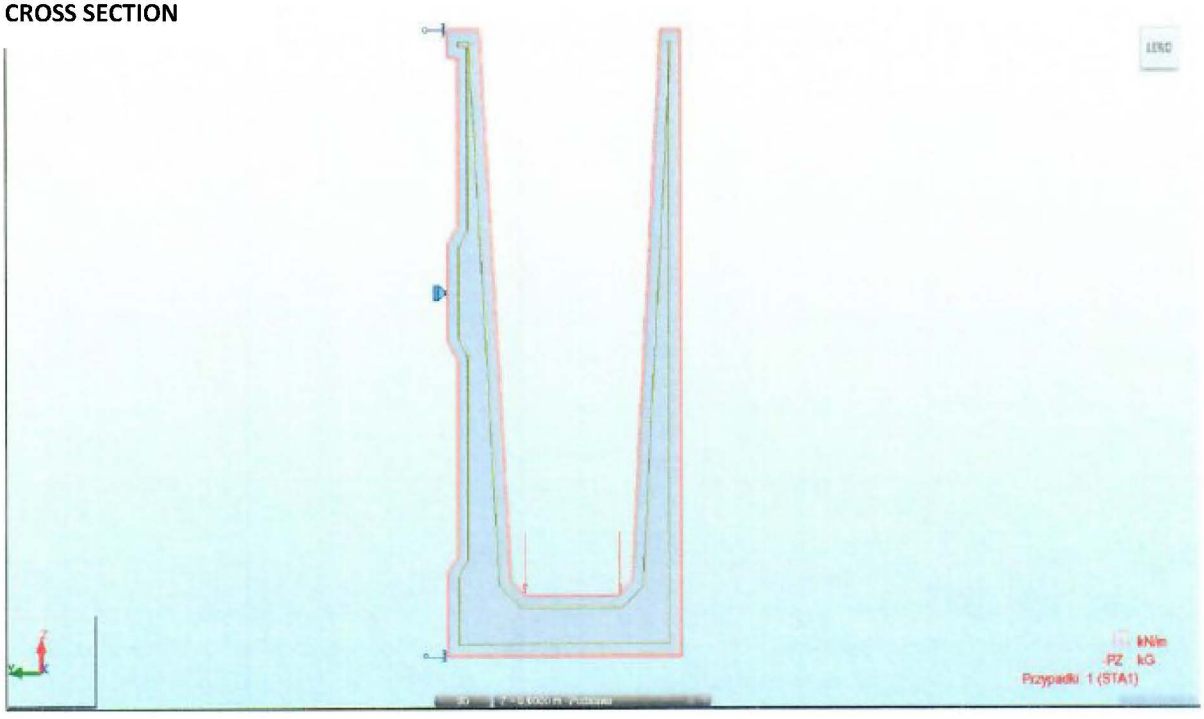
4.2. Loads

- Permanent loads (inherent profile load + glass balustrade/hand-rail load)

TOP VIEW

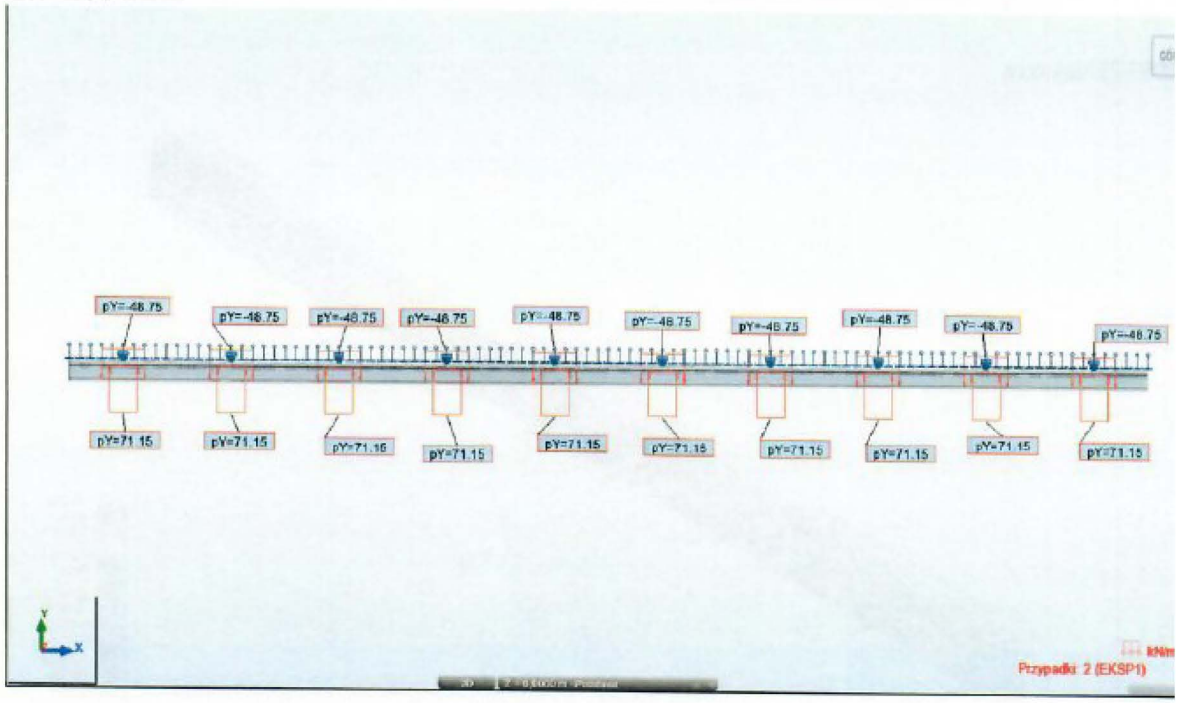


CROSS SECTION

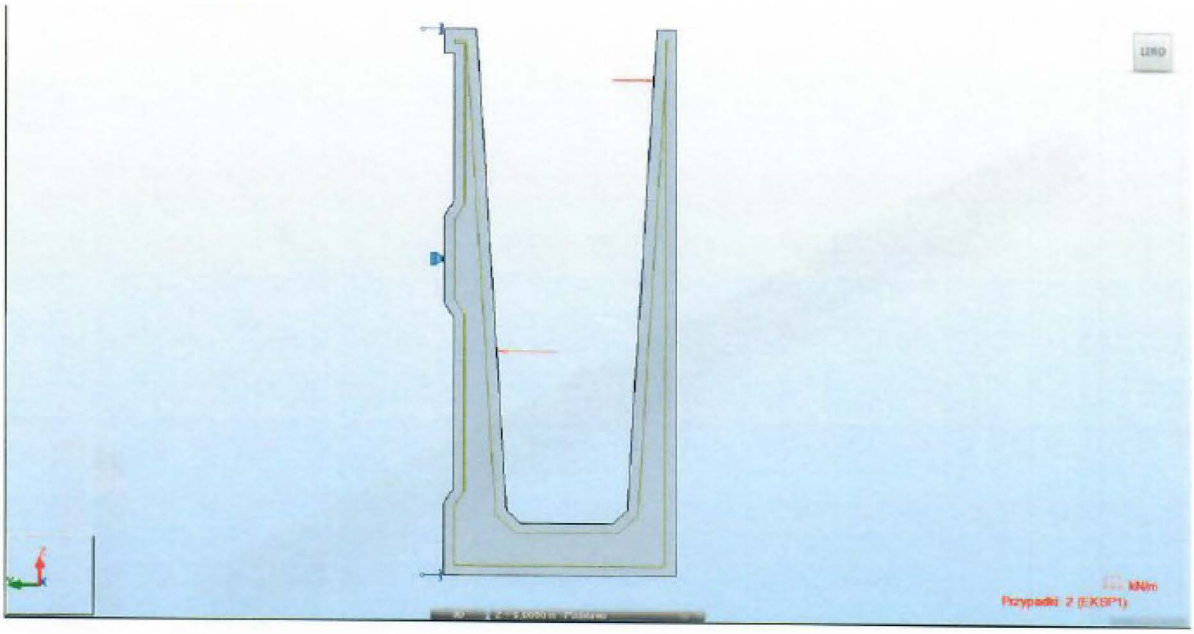


- Useful pressure load on the balustrade (transferred through white and green inserts)

TOP VIEW



CROSS SECTION



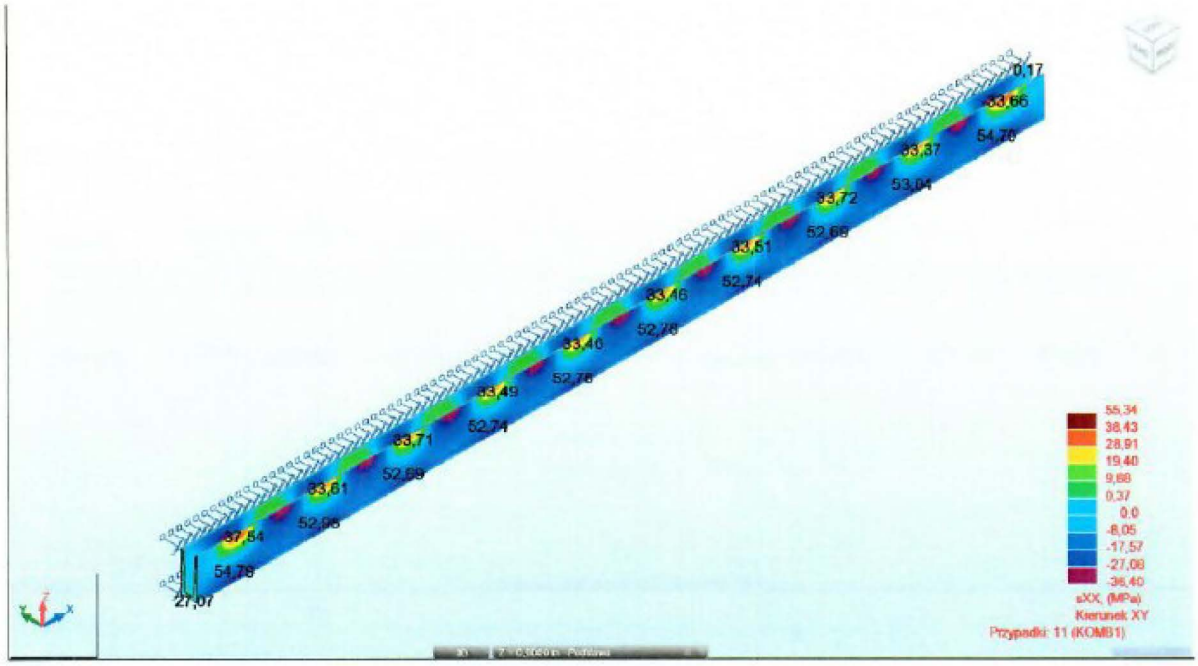
Combination of loads:

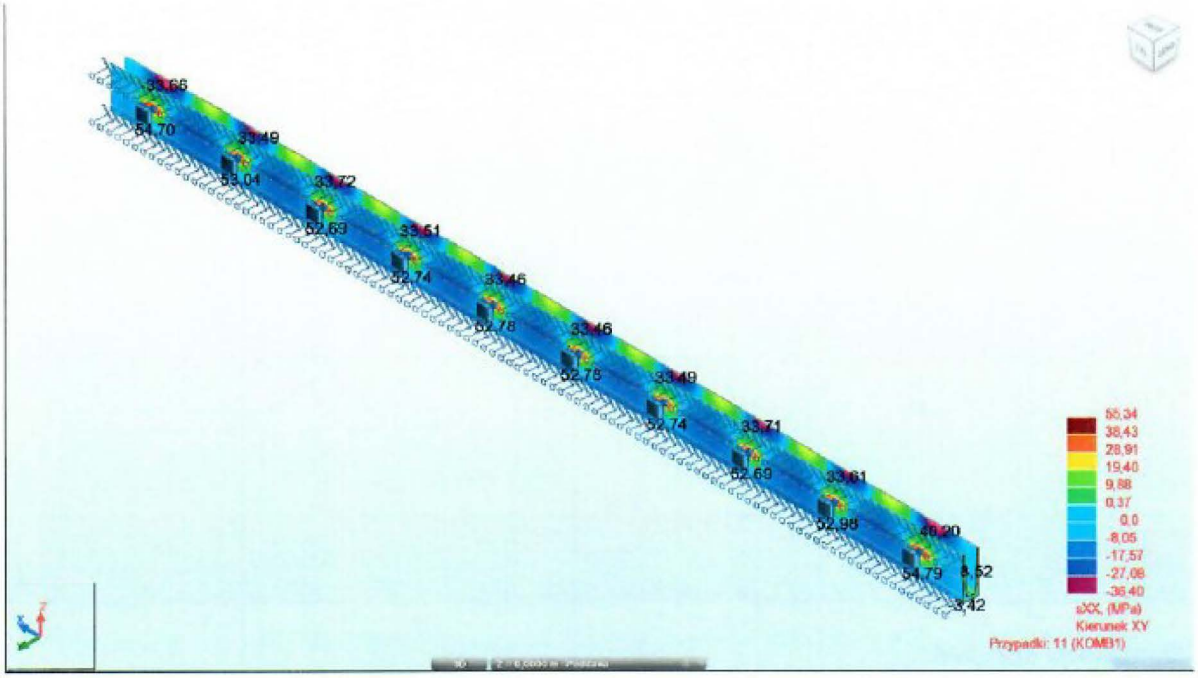
Calculation combination:	KOMB1: 1,35xSTA1 + 1,50xEKSP1
Characteristic combination:	KOMB2: 1,00xSTA1 + 1,00xEKSP1

4.3. Stress in the profile

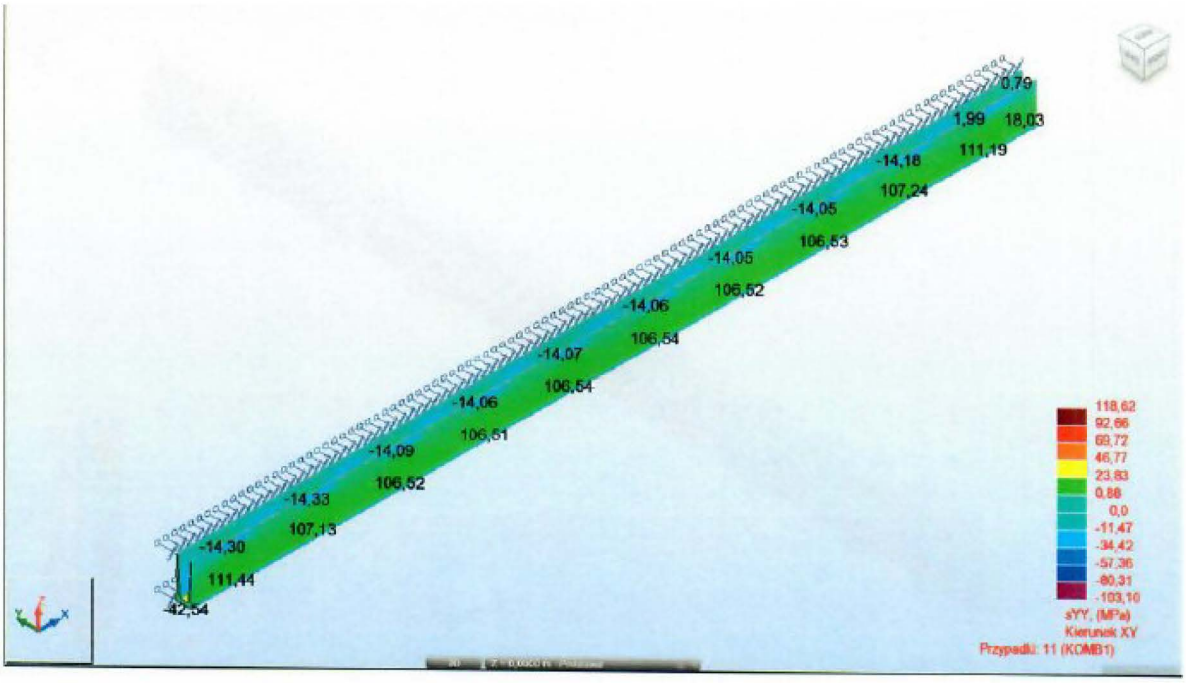
4.3.1. Normal stress

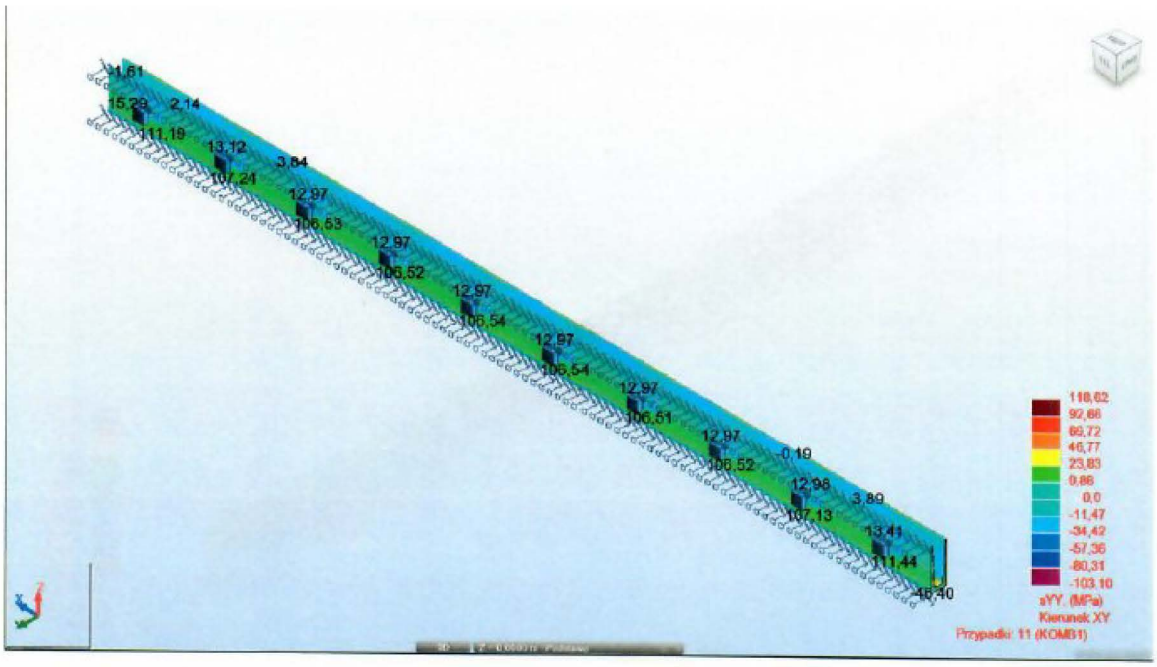
STRESSES σxx



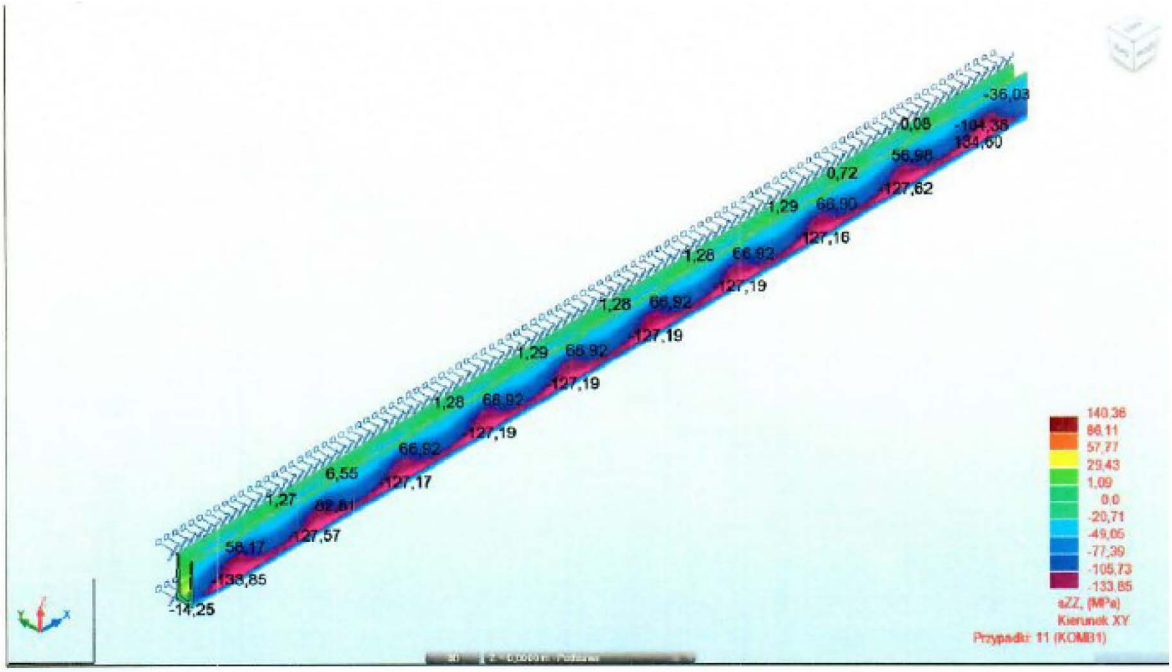


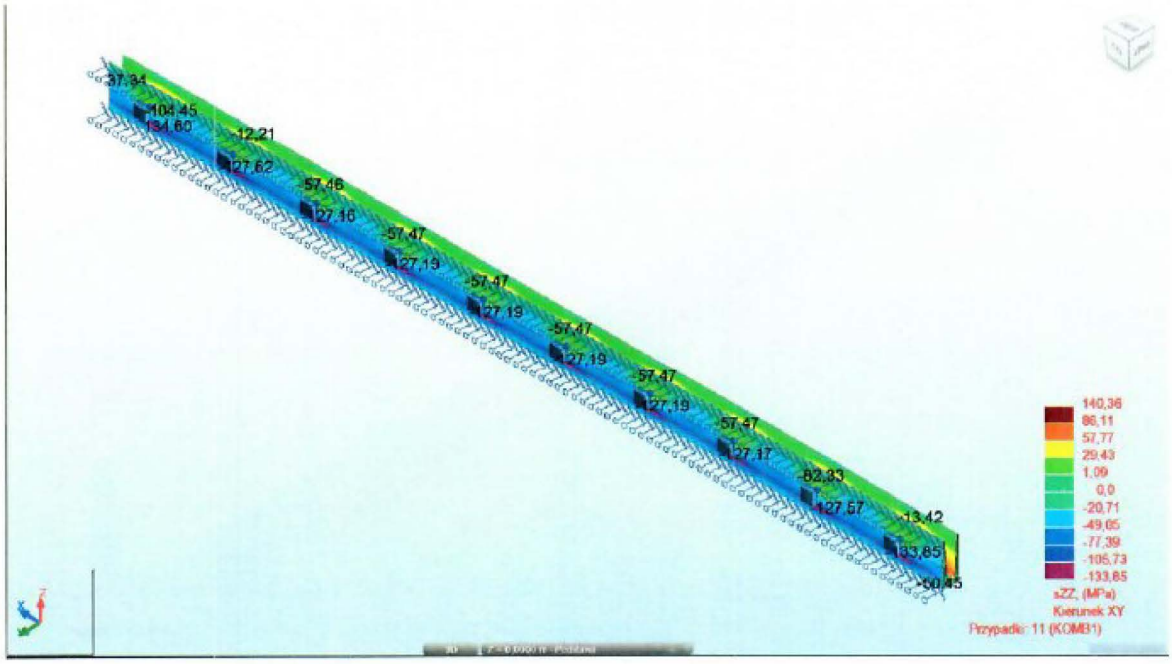
STRESSES σyy





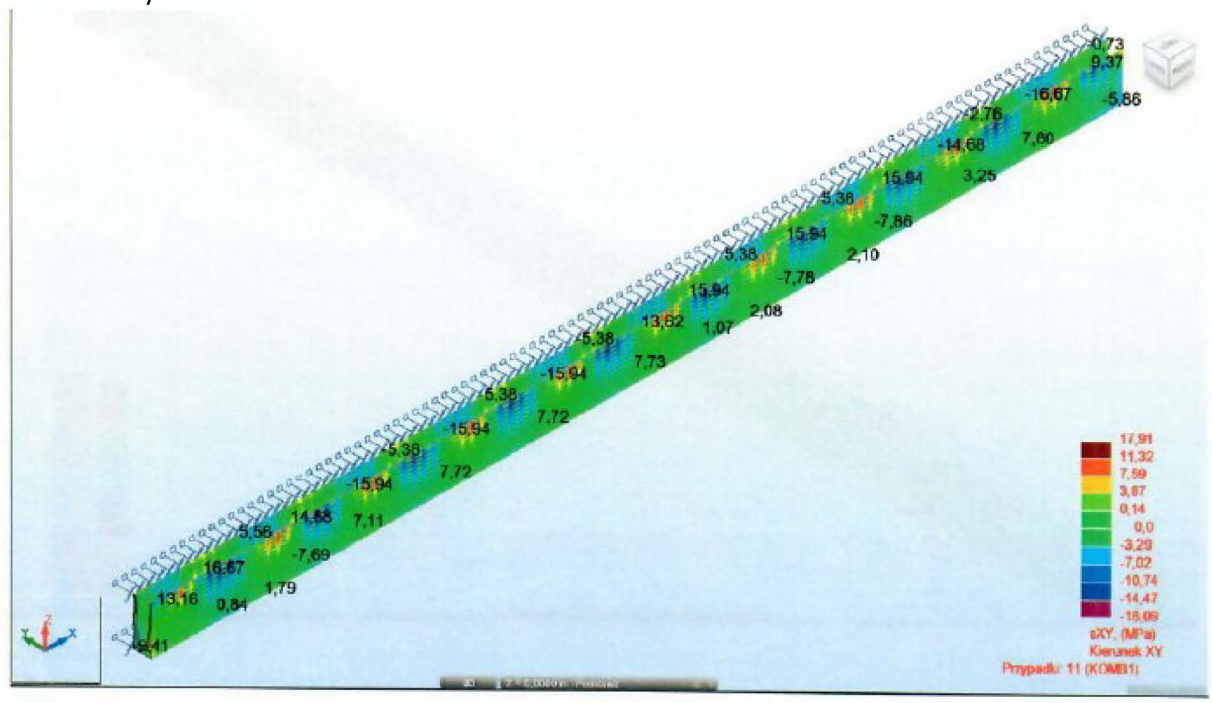
STRESSES σzz



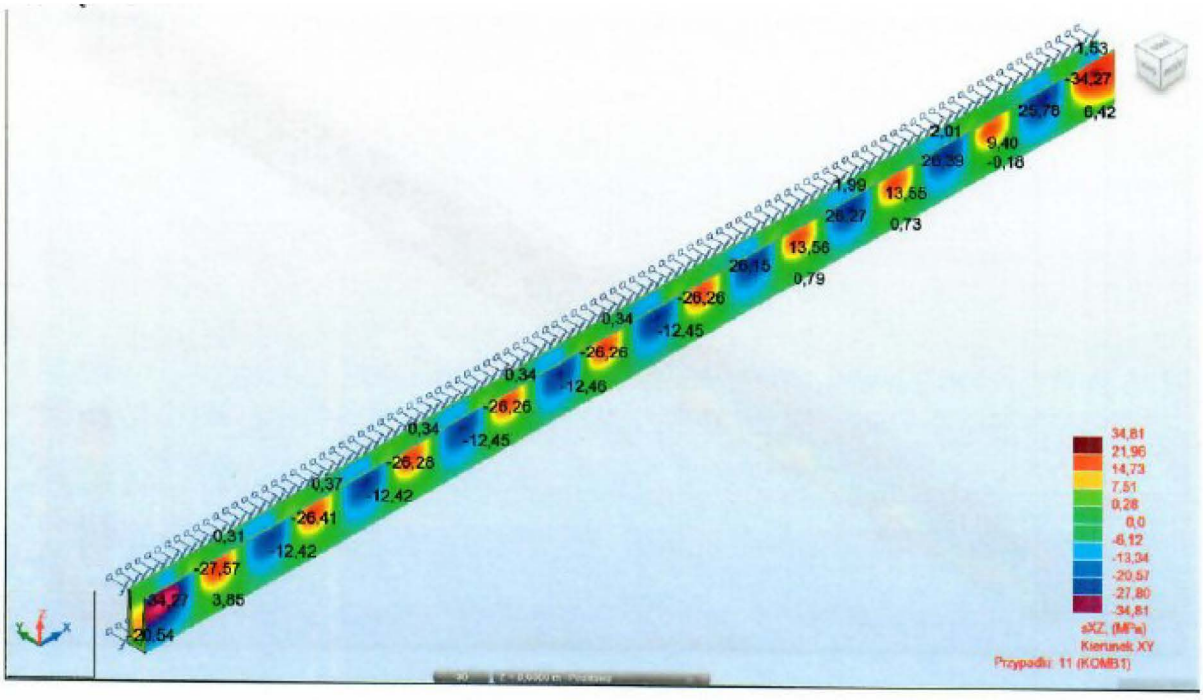


4.3.2. Junction/tangent stresses

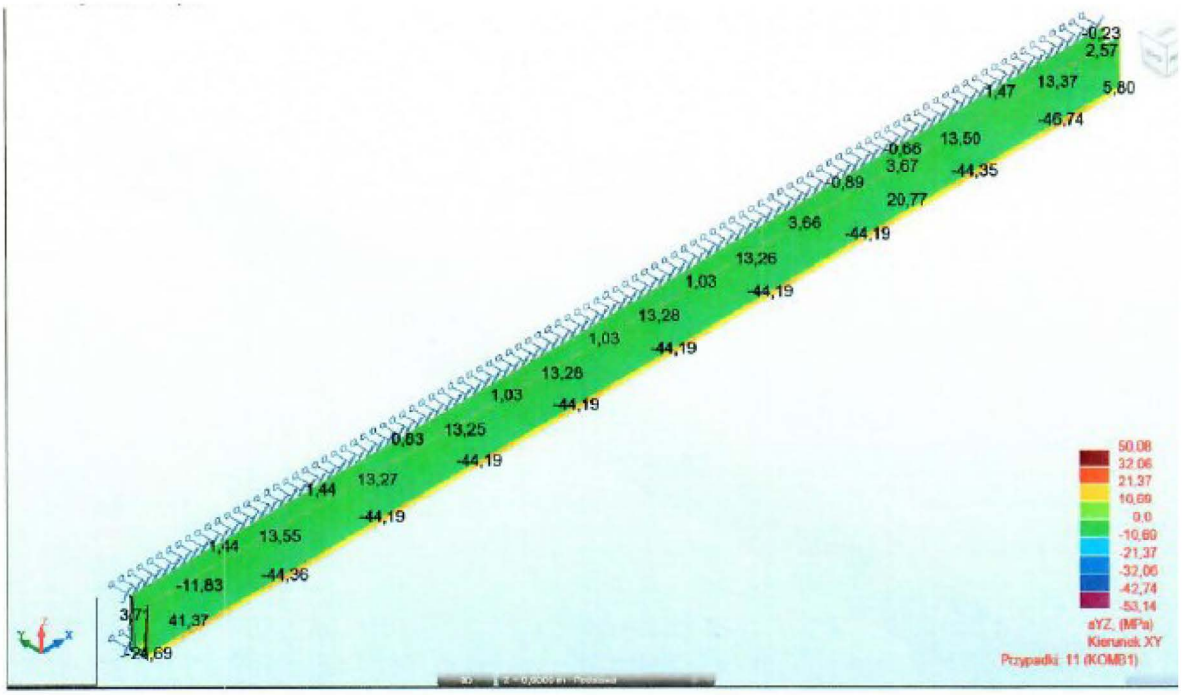
STRESSES τxy



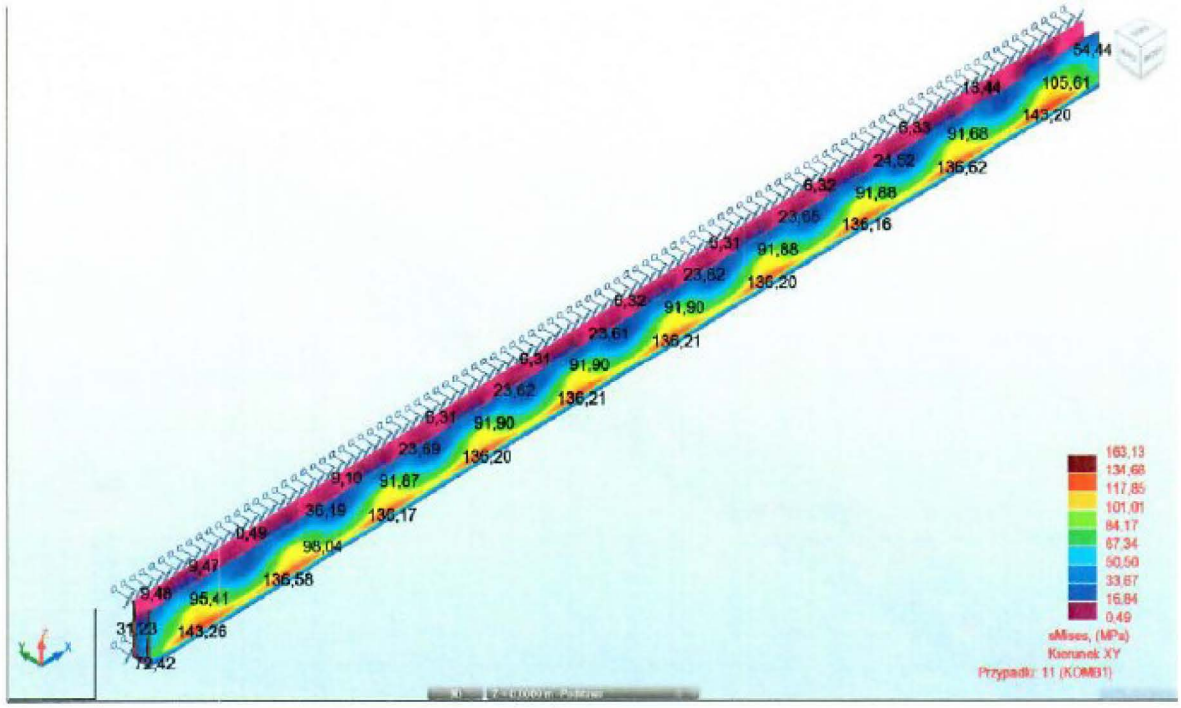
STRESSES τXZ

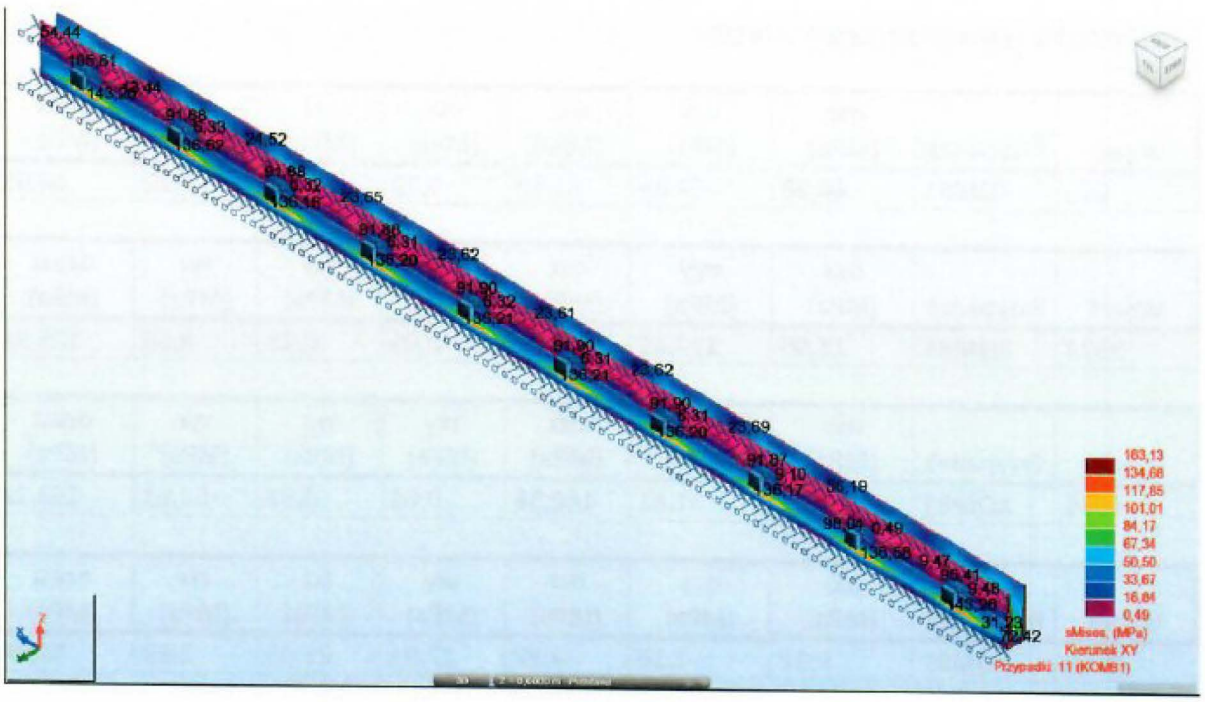


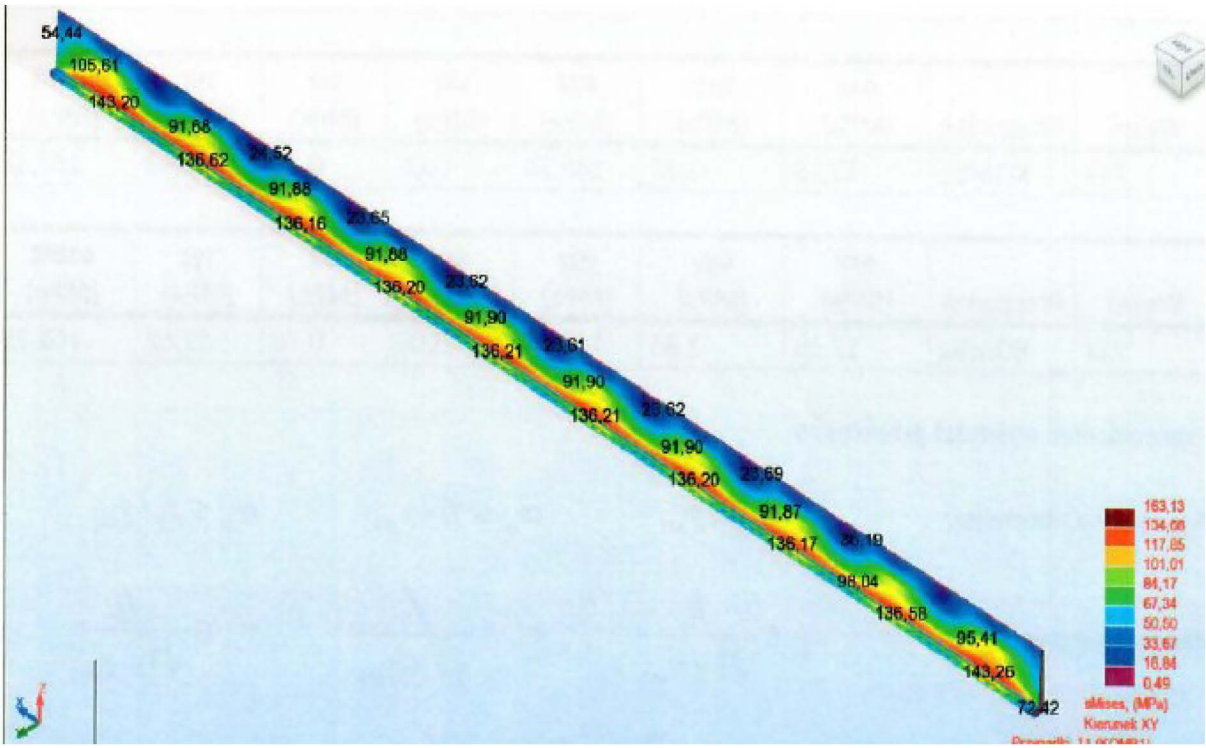
STRESSES τyz



4.3.3. Additional stresses




54,44
105,61
143,20
91,68
136,62
91,88
136,16
91,88
136,20
91,90
136,21
91,90
136,21
91,90
136,20
91,87
136,17
98,04
136,58
95,41
143,26
72,42
163,13
134,68
117,85
101,01
84,17
67,34
50,50
33,67
16,84
0,49
sMises, (MPa)
Kierunek XY
Przypadki: 11 (KOMB1)


54,44
105,61
143,20
91,68
136,62
91,88
136,16
91,88
136,20
91,90
136,21
91,90
136,21
91,90
136,20
91,87
136,17
98,04
136,58
95,41
143,26
72,42
163,13
134,68
117,85
101,01
84,17
67,34
50,50
33,67
16,84
0,49
sMises, (MPa)
Kierunek XY

- maximal stress values in the profile

Knot	Case	**σxx (MPa)**	σyy (MPa)	σzz (MPa)	τxy (MPa)	τxz (MPa)	τyz (MPa)	σaddit. (MPa)
645	KOMB1	**44,20**	-23,89	31,80	0,22	-1,25	7,12	64,05

Knot	Case	σxx (MPa)	**σyy (MPa)**	σzz (MPa)	τxy (MPa)	τxz (MPa)	τyz (MPa)	σaddit. (MPa)
9973	KOMB1	11,00	**117,45**	-20,09	-0,09	0,11	8,56	125,81

Knot	Case	σxx (MPa)	σyy (MPa)	**σzz (MPa)**	τxy (MPa)	τxz (MPa)	τyz (MPa)	σaddit. (MPa)
9981	KOMB1	13,19	-1,81	**140,36**	0,04	-0,32	-52,61	163,12

Knot	Case	σxx (MPa)	σyy (MPa)	σzz (MPa)	**τxy (MPa)**	τxz (MPa)	τyz (MPa)	σaddit. (MPa)
9760	KOMB1	9,17	-2,16	-4,57	**17,91**	-23,03	2,89	52,34

Knot	Case	σxx (MPa)	σyy (MPa)	σzz (MPa)	τxy (MPa)	**τxz (MPa)**	τyz (MPa)	σaddit. (MPa)
266	KOMB1	-2,55	-3,42	31,32	3,77	**34,46**	1,16	69,19

Knot	Case	σxx (MPa)	σyy (MPa)	σzz (MPa)	τxy (MPa)	τxz (MPa)	**τyz (MPa)**	σaddit. (MPa)
711	KOMB1	13,13	-1,81	140,34	-0,06	0,38	**-52,62**	163,13

Knot	Case	σxx (MPa)	σyy (MPa)	σzz (MPa)	τxy (MPa)	τxz (MPa)	τyz (MPa)	**σaddit. (MPa)**
711	KOMB1	13,13	-1,81	140,34	-0,06	0,38	-52,62	**163,13**

- cross-section carrying capacity check

Normal stresses: $\sigma_{xx} \le f_0 / \gamma_{M1}$ $\sigma_{yy} \le f_0 / \gamma_{M1}$ $\sigma_{zz} \le f_0 / \gamma_{M1}$

Tangent stresses: $\tau_{xy} \le \frac{f_0}{\sqrt{3} \times \gamma_{M1}}$ $\tau_{xz} \le \frac{f_0}{\sqrt{3} \times \gamma_{M1}}$ $\tau_{yz} \le \frac{f_0}{\sqrt{3} \times \gamma_{M1}}$

Additional stresses:

$$\sigma_{zast} = \sqrt{0,5 \times [(\sigma_{xx} - \sigma_{yy})^2 + (\sigma_{yy} - \sigma_{zz})^2 + (\sigma_{xx} - \sigma_{zz})^2 + 6 \times (\tau_{xy}^{\ 2} + \tau_{xz}^{\ 2} + \tau_{yz}^{\ 2})]} \le 1,2 \times \frac{f_0}{\gamma_{M1}}$$

Accepted stress values:

f_0 / γ_{M1} = 160 MPa / 1,1 = **145,5MPa**

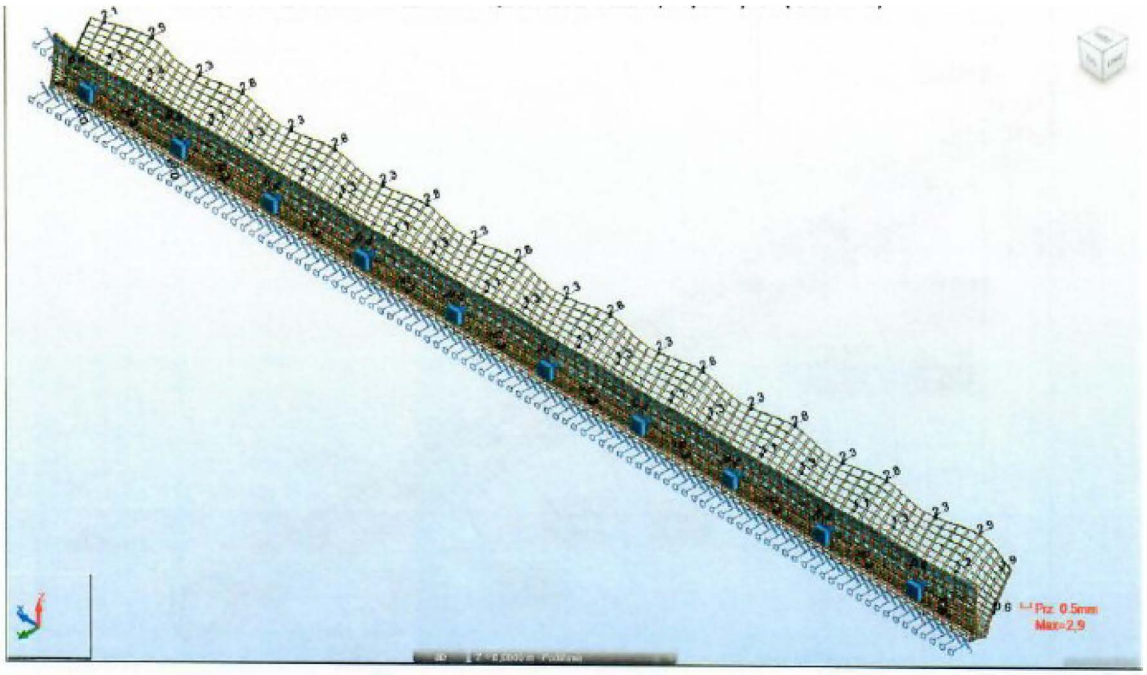
$f_0 / (\sqrt{3} \gamma_{M1})$ = 160 MPa / (1,73 x 1,10) = **84,0 MPa**

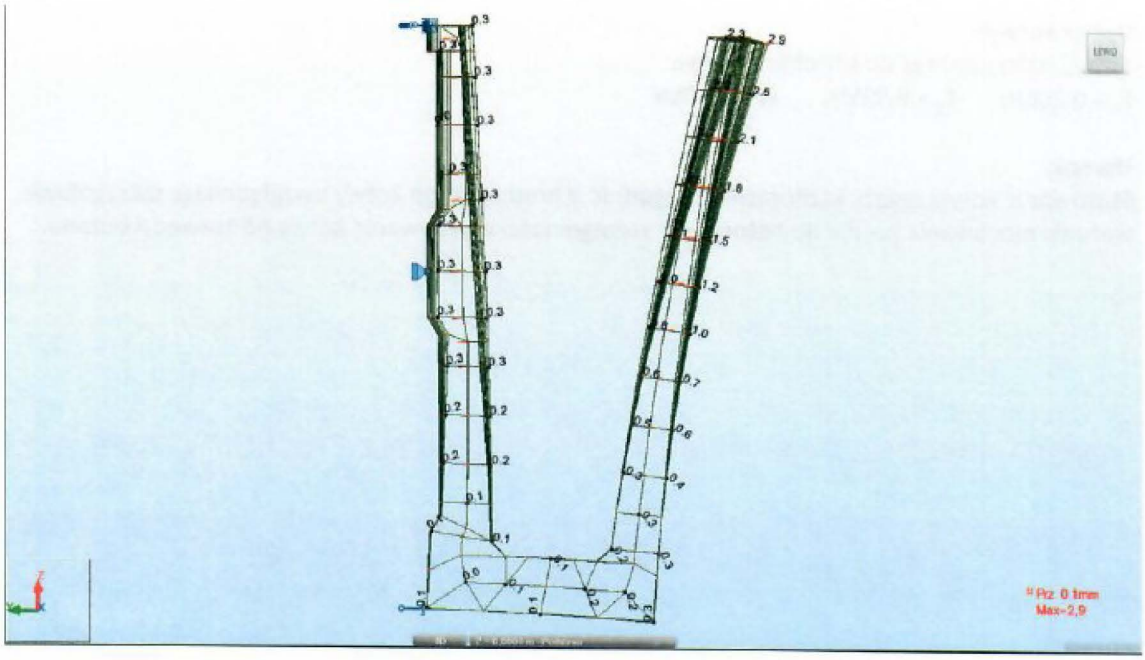
$1,2 x f_0/\gamma_{M1}$ = **174,5 MPa**

Profile fulfills carrying capacity conditions.

4.4. Deformations under load

Deformations introduced according to characteristic loads (KOMB2).

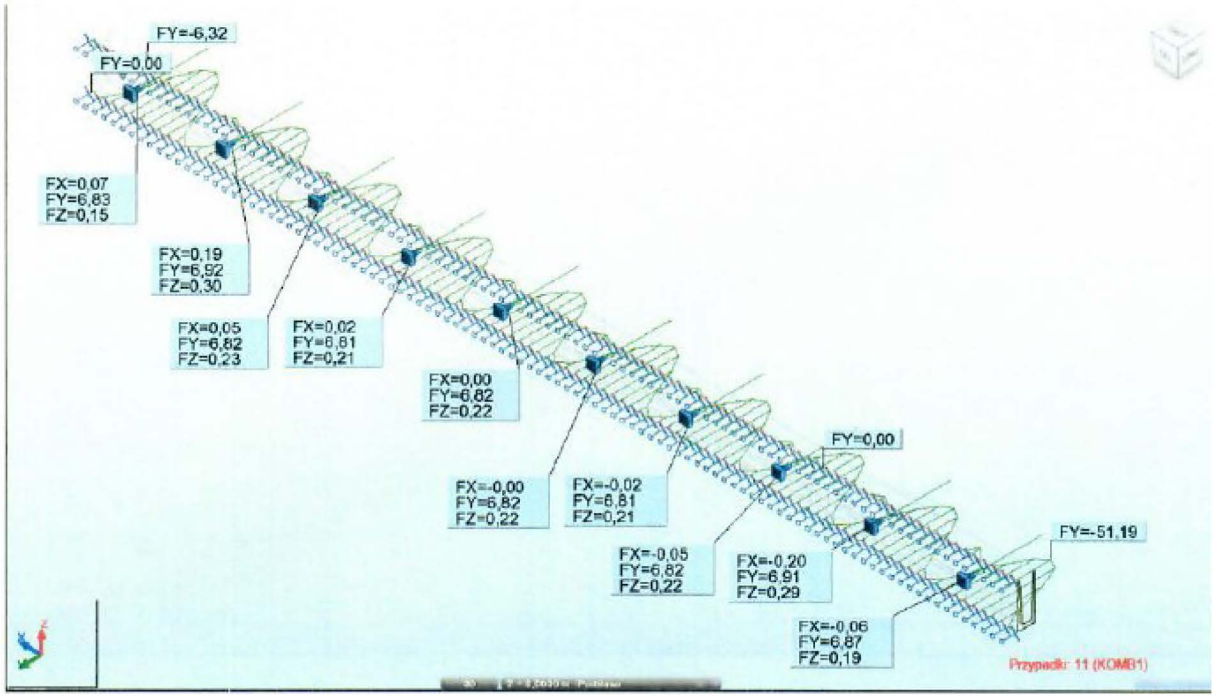




Maximal deflection of the vertical profile wall equals **2,8mm.**

4.5. Reactions and selection of anchor

Reactions in anchors as well as diagrams of pressure powers in the ceiling are represented below.

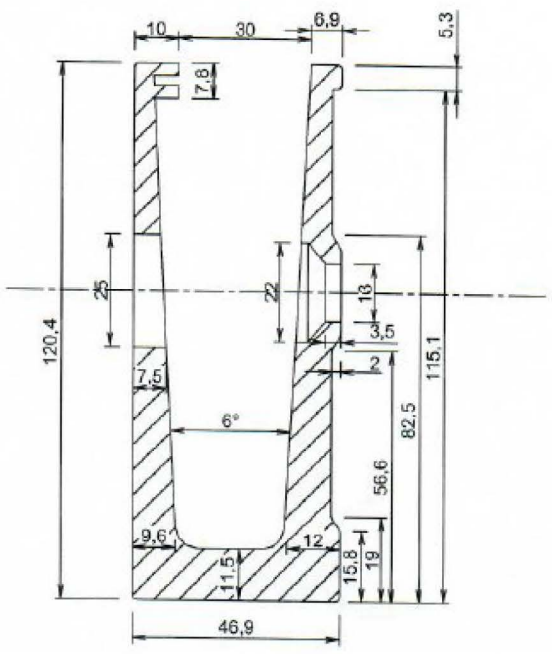


Anchor selection:
Anchors must be chosen according to the calculated power:
F_x = 0,20 kN; F_y = 6,92 kN; F_z = 0,30 kN

Warning:
Usage of an anchor must be approved by the producer of the anchor and detailed conditions must be considered for attaching the profile into concrete – anchor situated in detail from the edge of concrete.

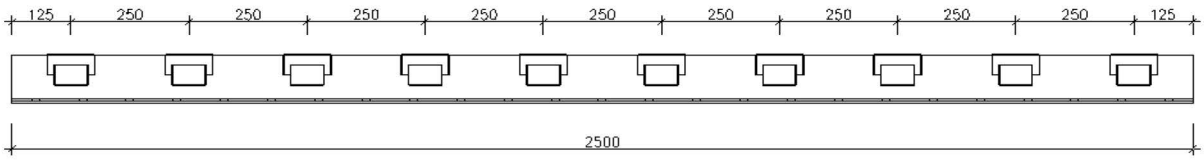
5. Norms for profile usage

5.1. Profile drawing

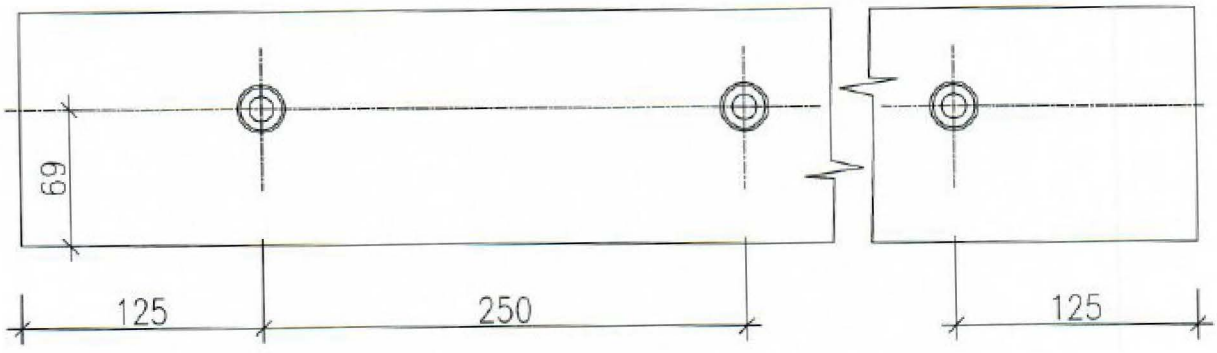


5.2. Initial data for placement of anchors or inserts (white and green), through which the load transfers to the profile walls

PLACEMENT OF INSERTS IN THE PROFILE



Anchor placement:



Drafted by:

mgr inż. Marek Sikora