Base Load Power Hub (BLPH)

INSTRUMENT AIR PACKAGE A-63000
PACKAGE STRUCTURAL CALCULATION REPORT
INCLUDING FIXING POINTS and LIFTING POINTS

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Document Class: 3

ROSETTI MARINO

1	NO COMMENTS - APPROVED - WORK MAY PROCEED
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3	MAJOR COMMENTS – REJECTED – DO NOT PROCEED
4	APPROVAL NOT REQUIRED

NOTE: Approval doesn't relieve the supplier from mandatory compliance with contractual documents and specifications. Comments made do not imply acceptance of any cost or delivery impact.

Sign	Date
Giuseppe Cavallo	07/07/24

Rev.	Date	Description	Prepared	Reviewed	Approved
01	21/06/2024	Issue for Information (IFI)	GT	MC	TM
00	30/04/2024	Issue for Information (IFI)	GT	MC	TM

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Rev.	Description
00	Issue for Information (IFI)
01	Issue for Information (IFI)

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

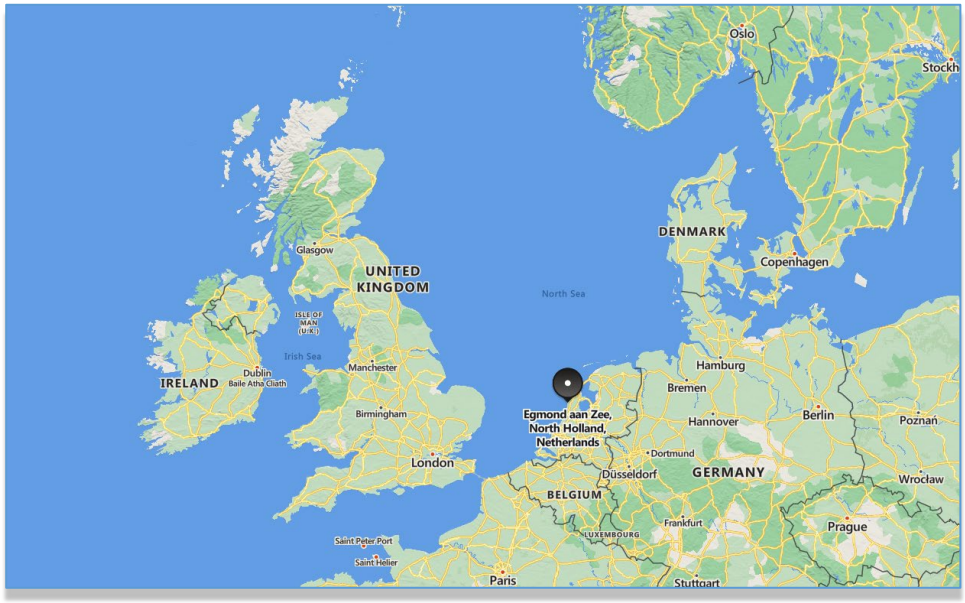


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map



Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

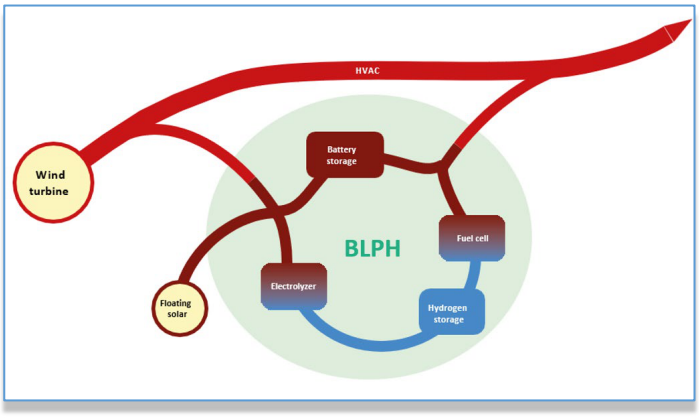


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

This document identifies any electrical equipment to be fed with its main characteristics.

2.1 REFERENCES

Doc. No.	Description
1724000428-PR-PID-00019	PACKAGE P&ID
1724000428-MAC-DA-00005	CERTIFIED PACKAGE GENERAL ARRANGEMENT AND DIMENSIONAL OUTLINE DRAWINGS (INCLUDING : NAMEPLATE, BASEFRAME, FOUNDATION LOADS, NOZZLES LOADS, NOZZLES LIST, BATTERY LIMITS, CoG)

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project

Table 2 - Definitions and Abbreviations

3 STRUCTURAL CALCULATION

This report deals with the structural design of the instrument air package (see Figure 1) in the following conditions:

- Lifting conditions
- Operating conditions: static + action of wind
- Transportation conditions, including wind action

3.1 CODES AND STANDARDS

The design of the structure is carried out in accordance with the following Codes and Standards:

- UNI EN 1990 “EUROCODE 0 – Basis of Structural Design”
- UNI EN 1991 "EUROCODE 1 – Actions on structures”
- UNI EN 1993 “EUROCODE 3 – Design of steel structures”

3.2 MATERIALS OF CONSTRUCTION

According with Bill of Material contained in technical drawings, the material of construction for the main structure elements is S 355 J2 (EN 10025-2), having the following mechanical properties:

MATERIAL	**Steel S355 J2** (EN 10025-2)	
Elastic modulus	E	210000 [MPa]
Poisson	ν	0.29
Density	Ro	7870 [Kg/m3]
Yield strength	Fty	350 [MPa]
Ultimate strength	Ftu	420 [MPa]

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3.3 LIFTING ANALYSIS

Is considered as the load of the materials forming a permanent part of the structure unit. It is defined as the load of structures and equipment on operating conditions:

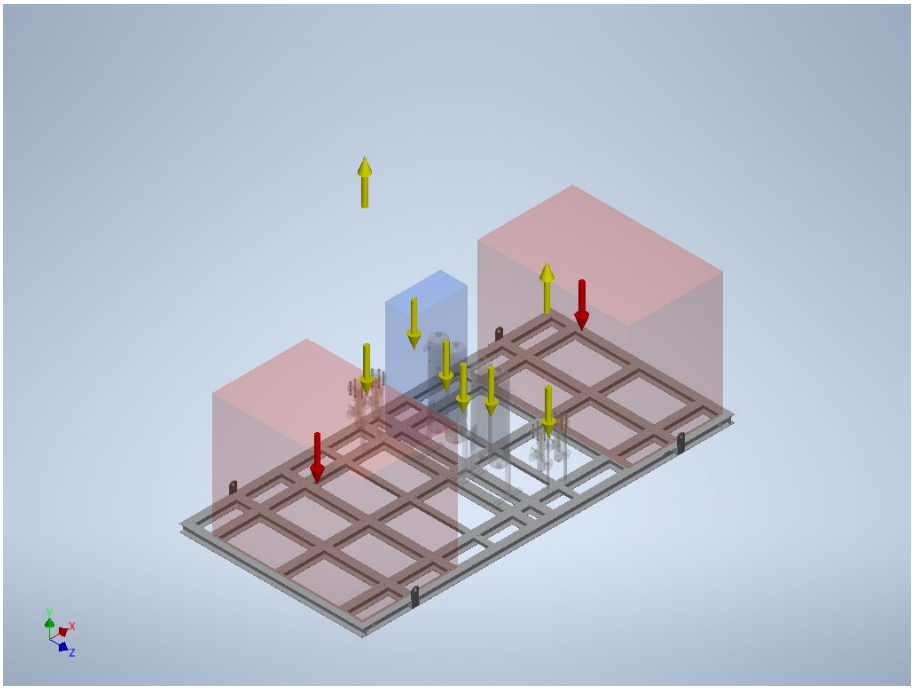
Item	Weight (kg)	Weight (N)
Compressor_1	2775	27222,75
Compressor_2	2775	27222,75
Dryer_1	500	4905
Dryer_2	500	4905
Pre-filter group	250	2452,5
Post-filter group	250	2452,5
Control Panel (UCP)	350	3433,5
Baseframe	2000	19620
TOTAL (including piping and valves)	11000	107910

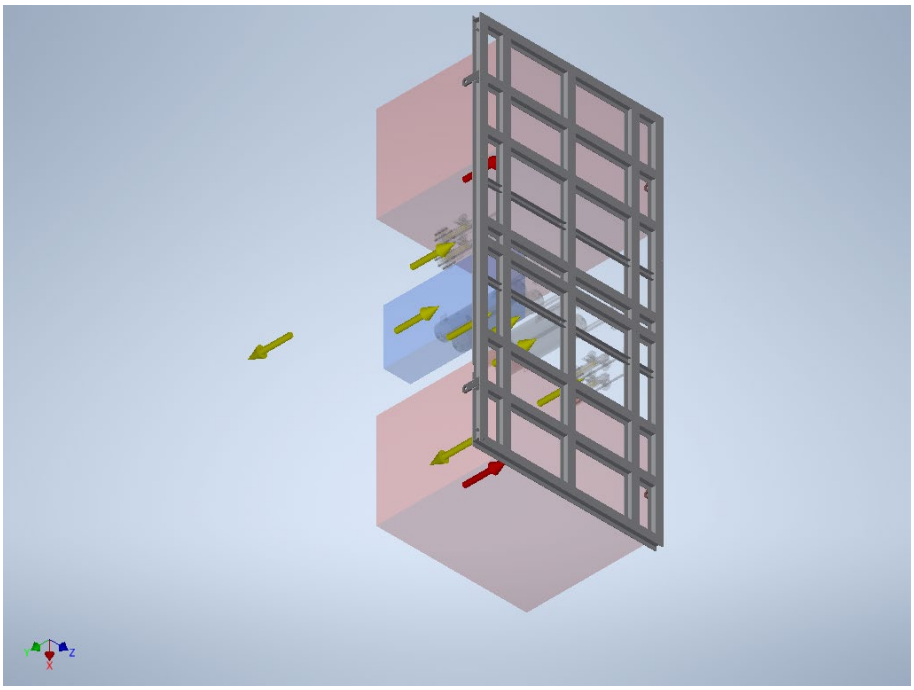
Each load has been applied as concentrated in each center of gravity.

The padeye has been also calculated, as shown in section 3.4.

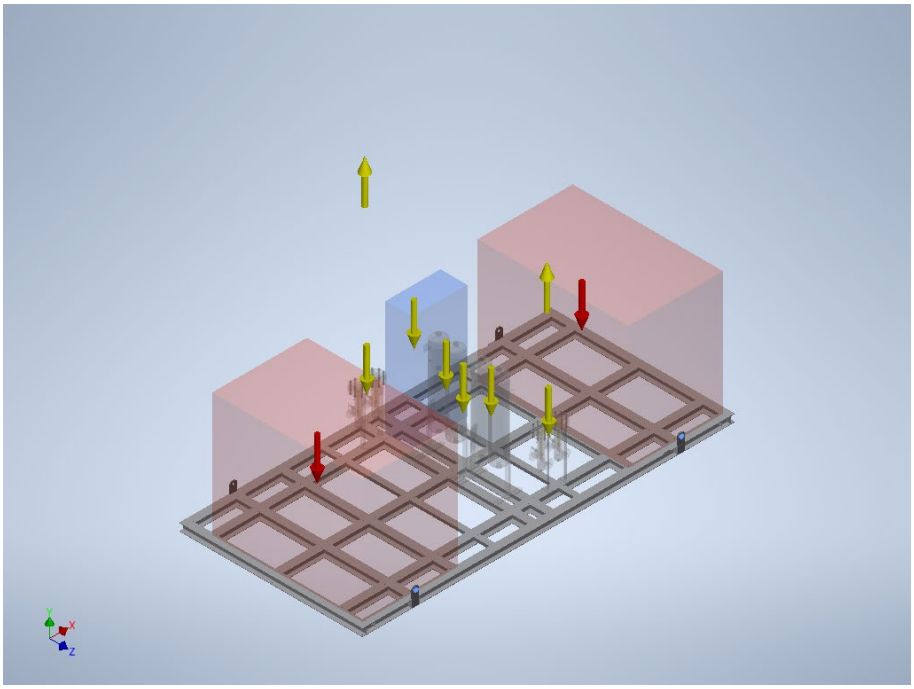
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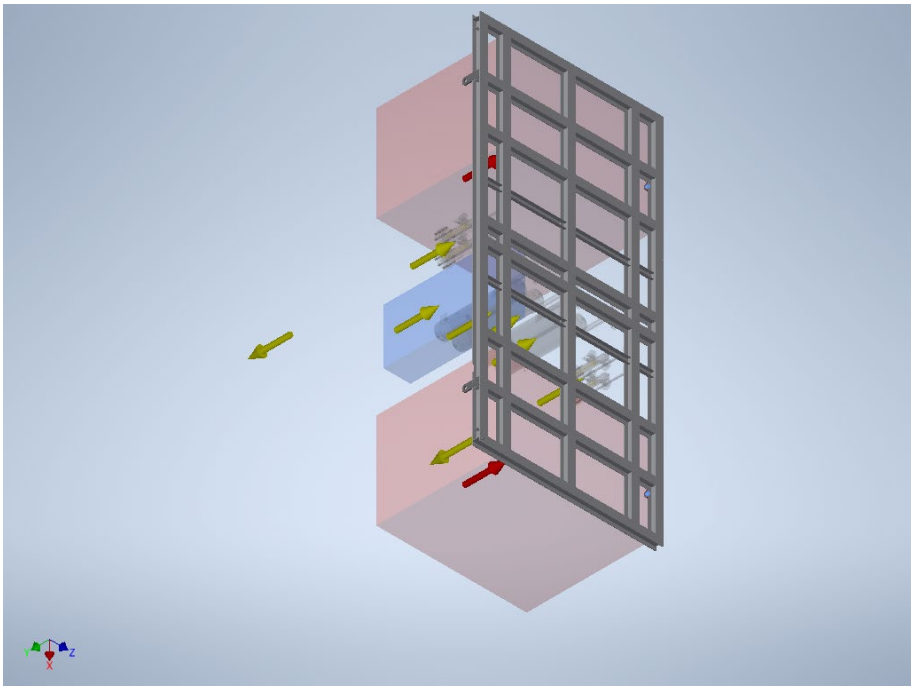
Gravity



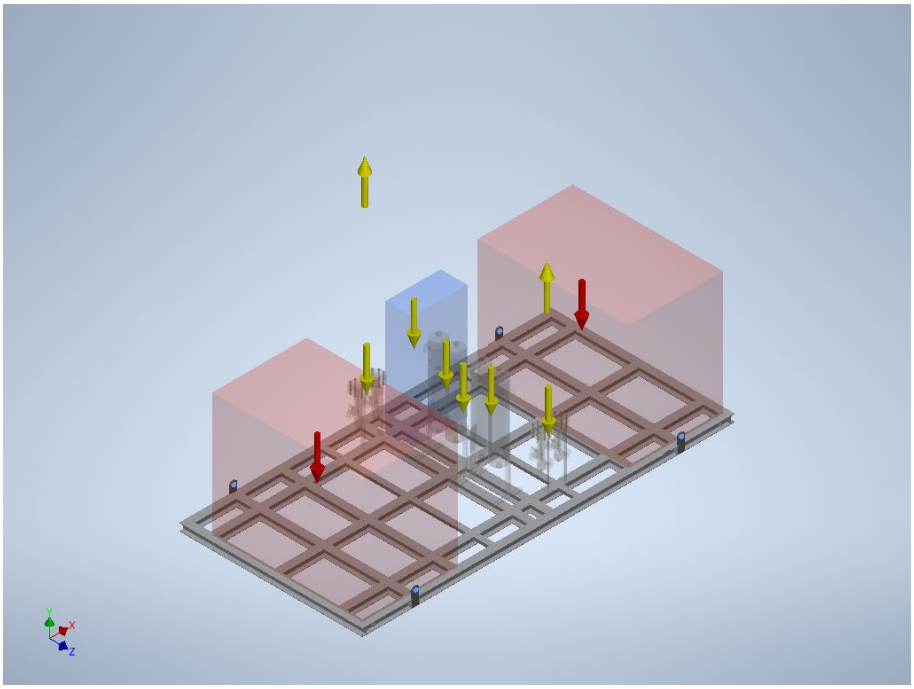


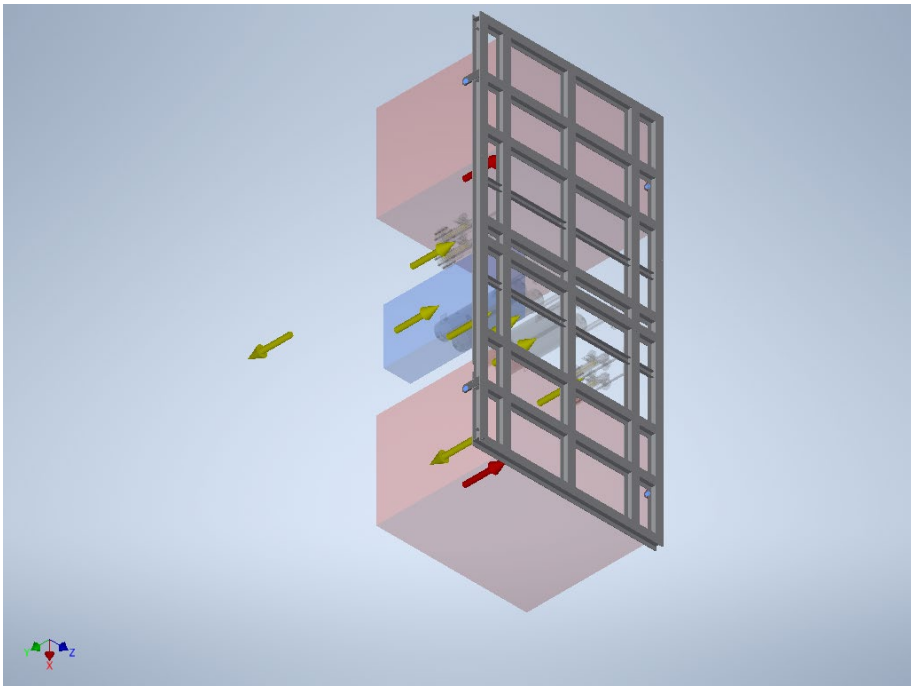
Lifting load_1 (applied according to the lifting sketch)



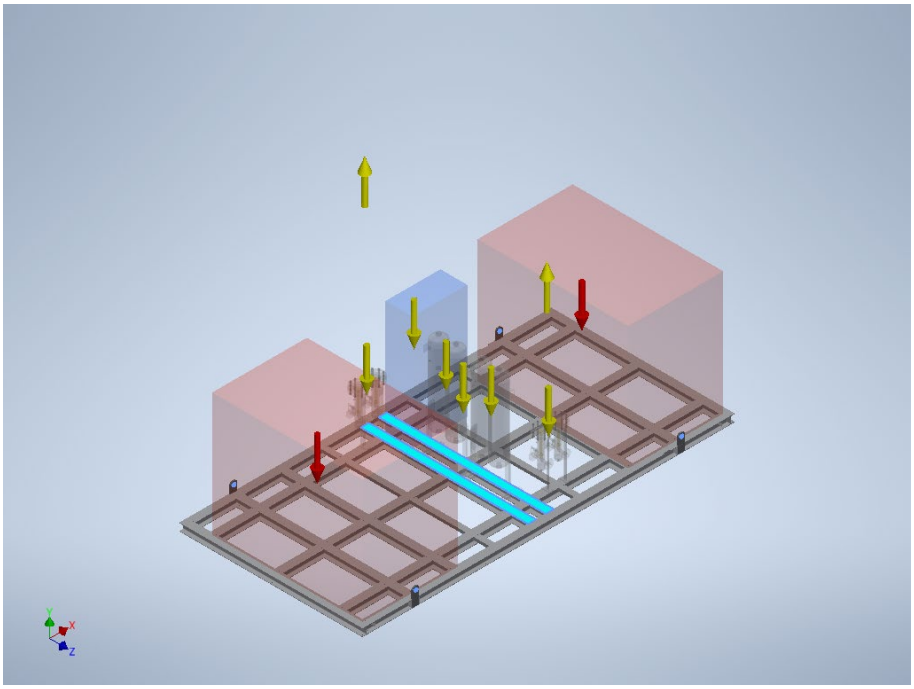


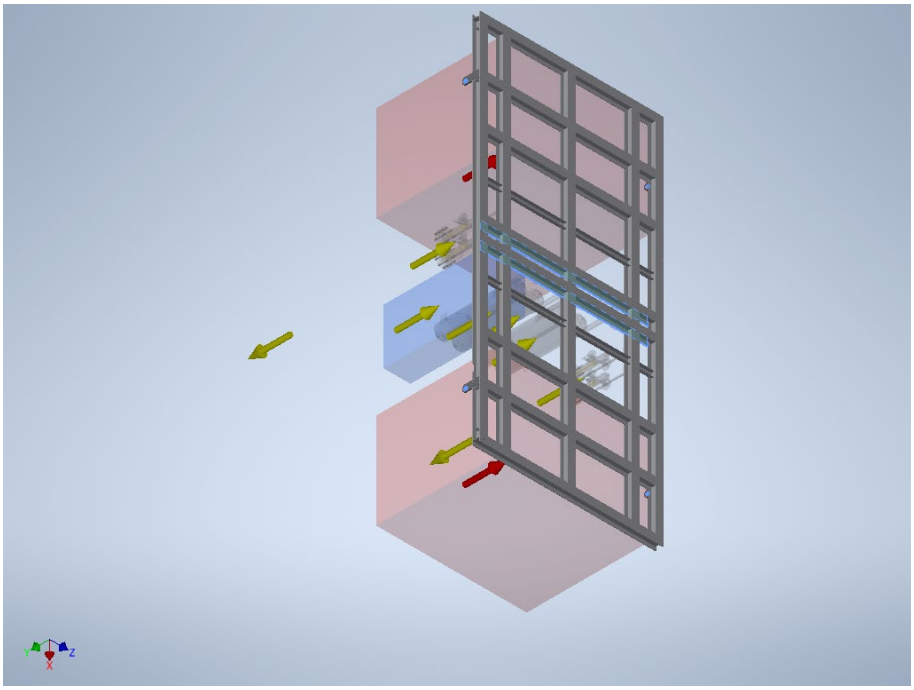
Lifting load_2 (applied according to the lifting sketch)



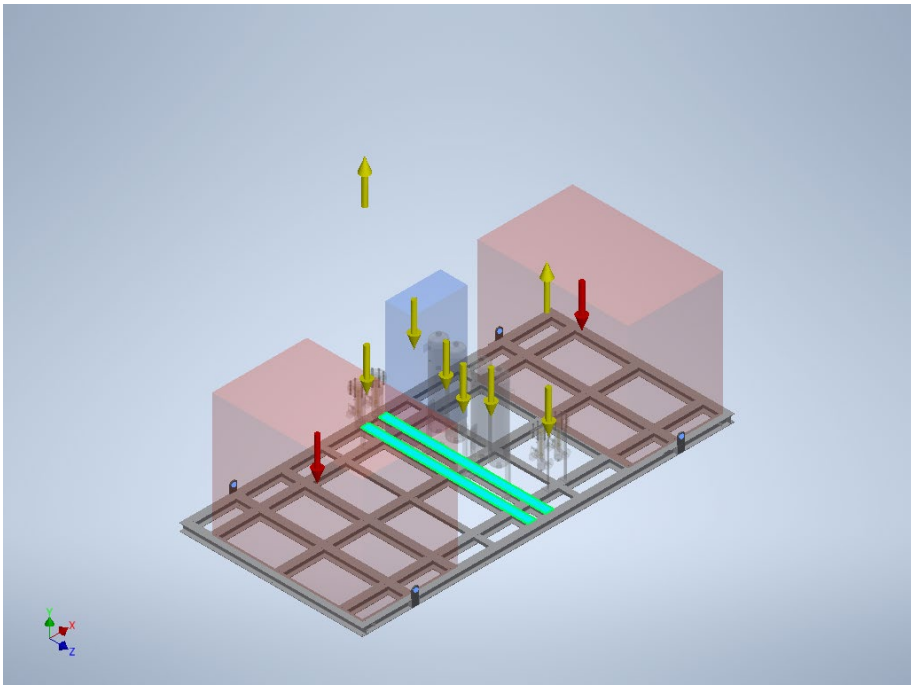


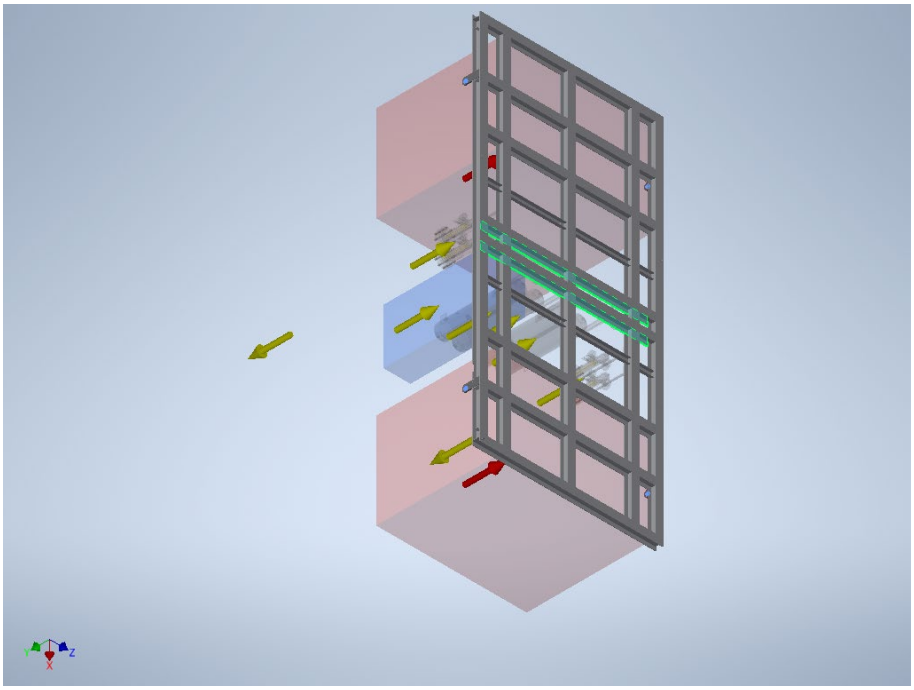
Dryer_1



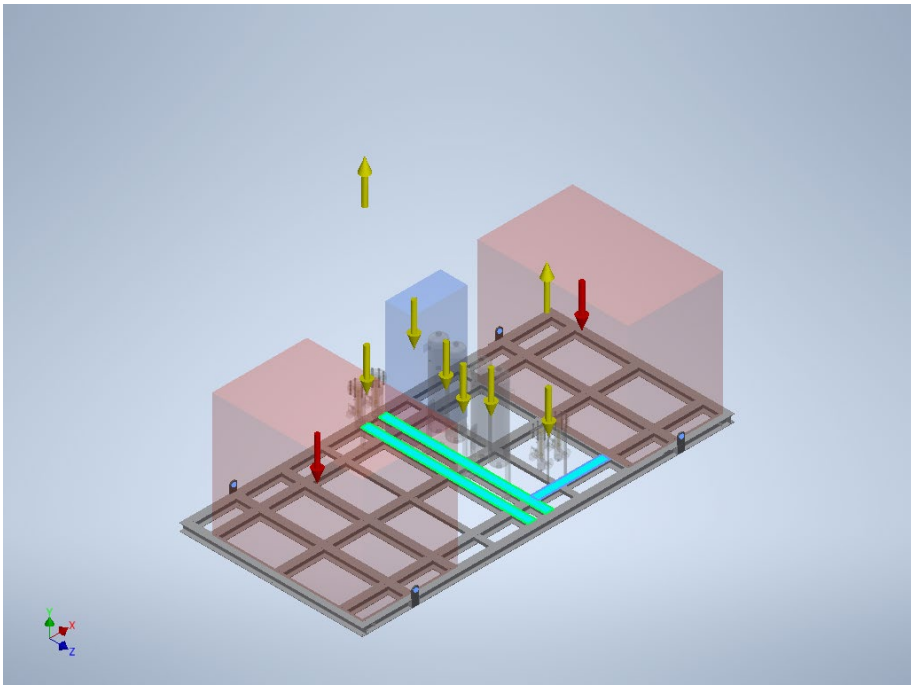


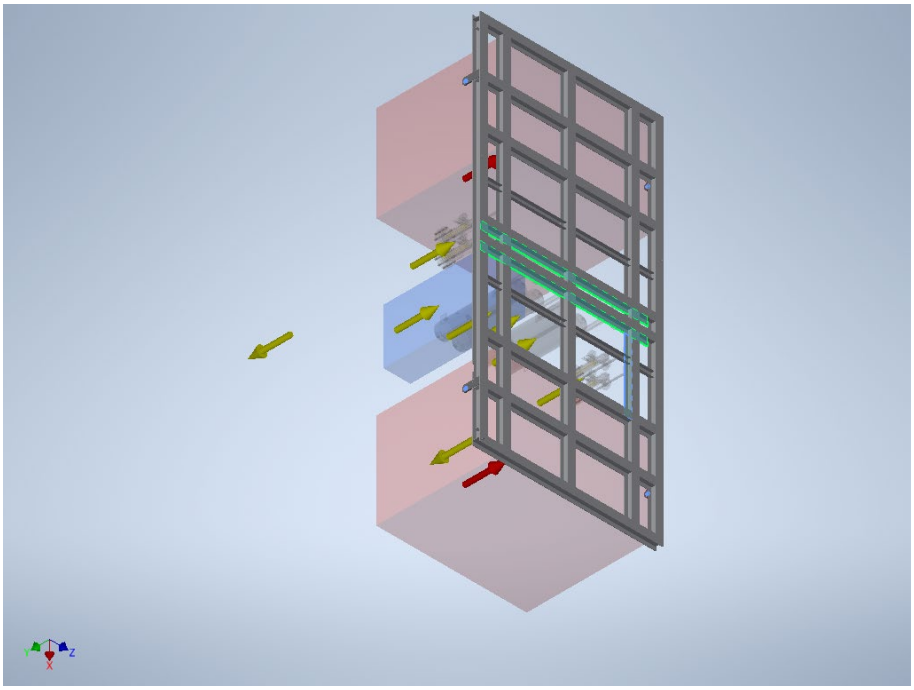
Dryer_2



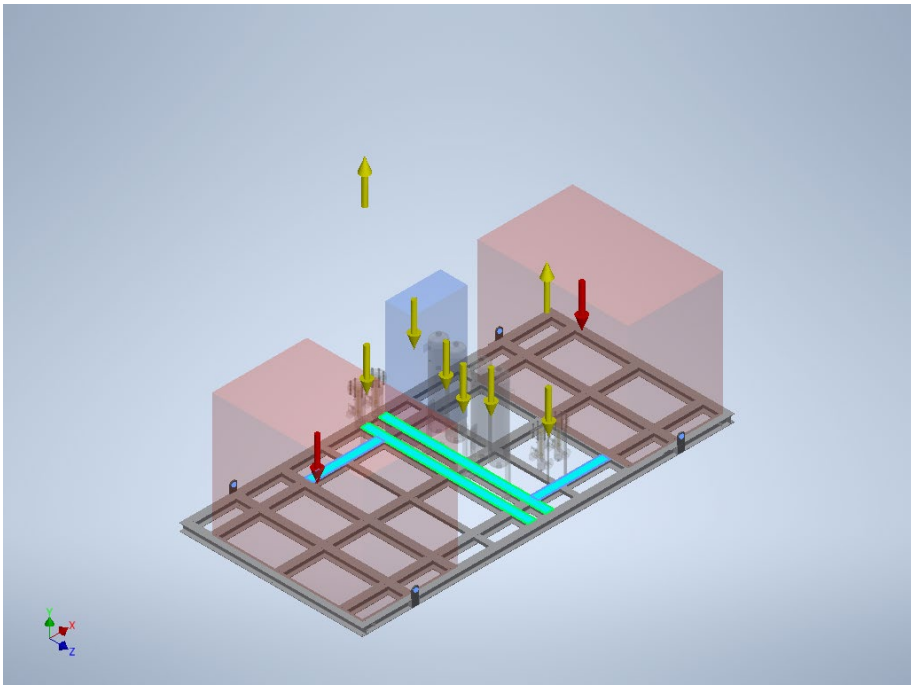


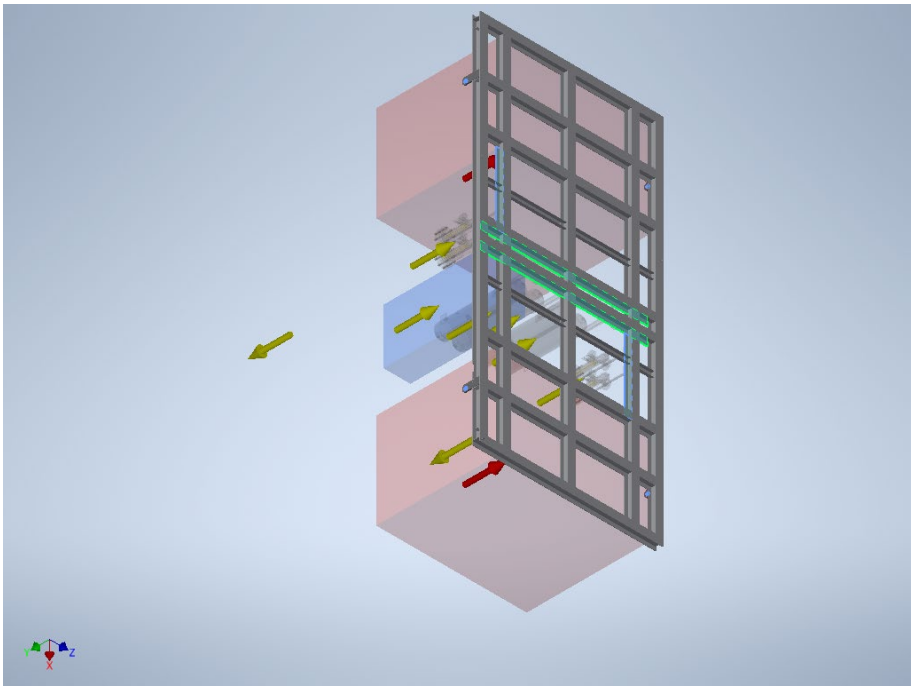
Post-filter group



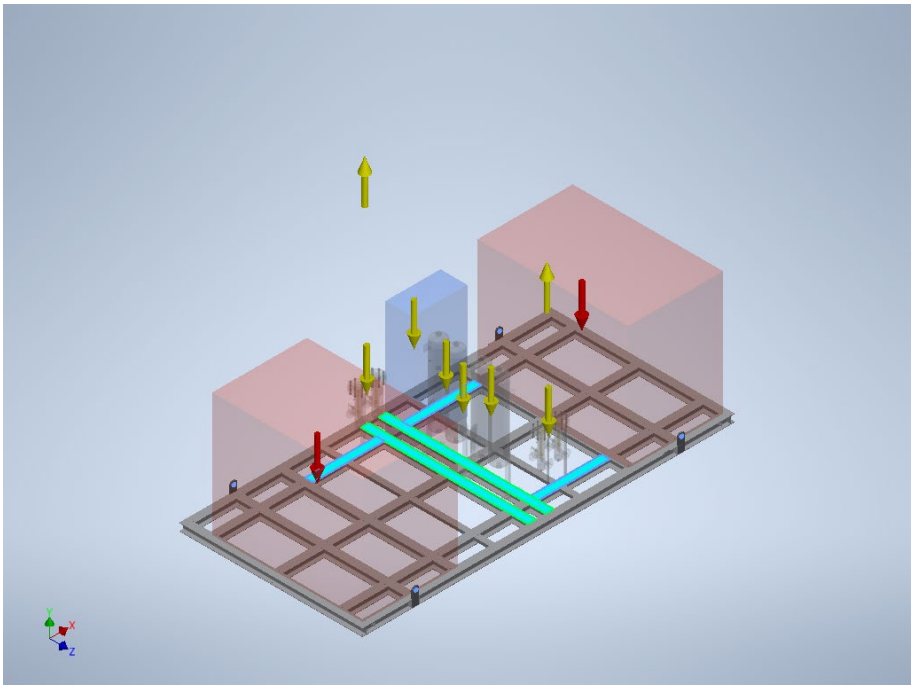


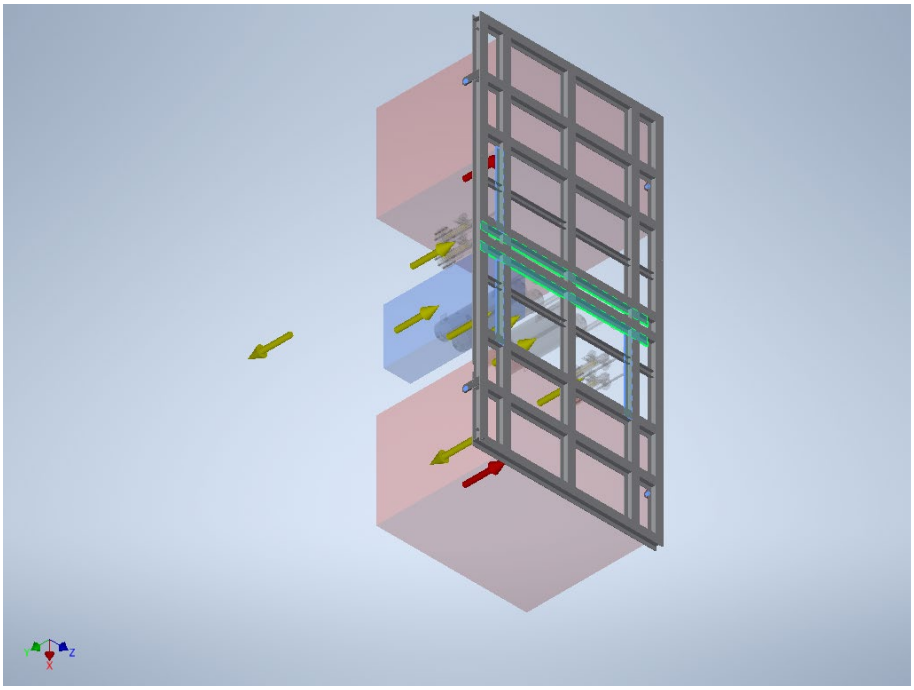
Pre-filter group



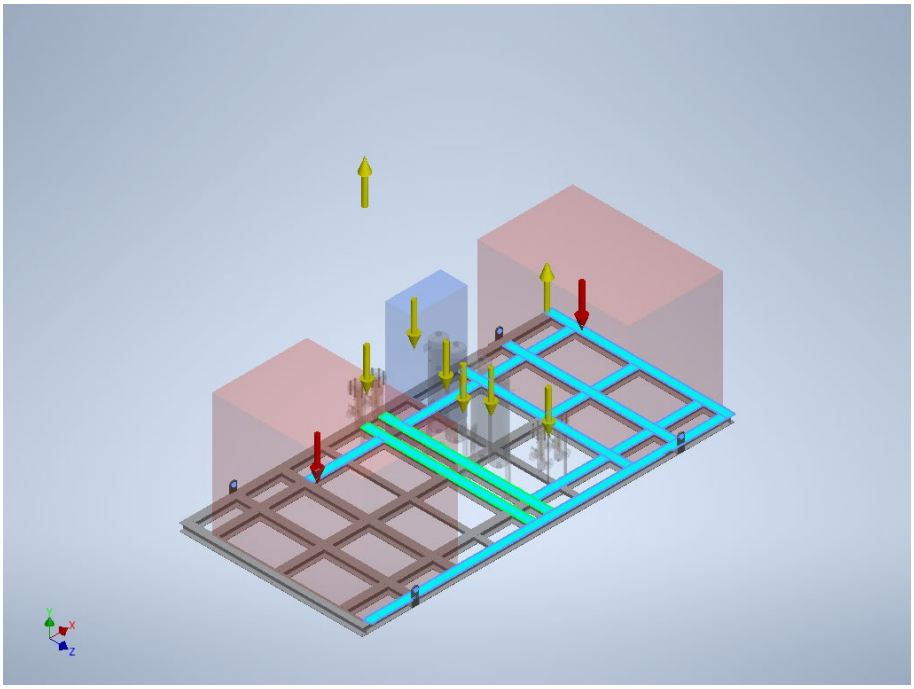


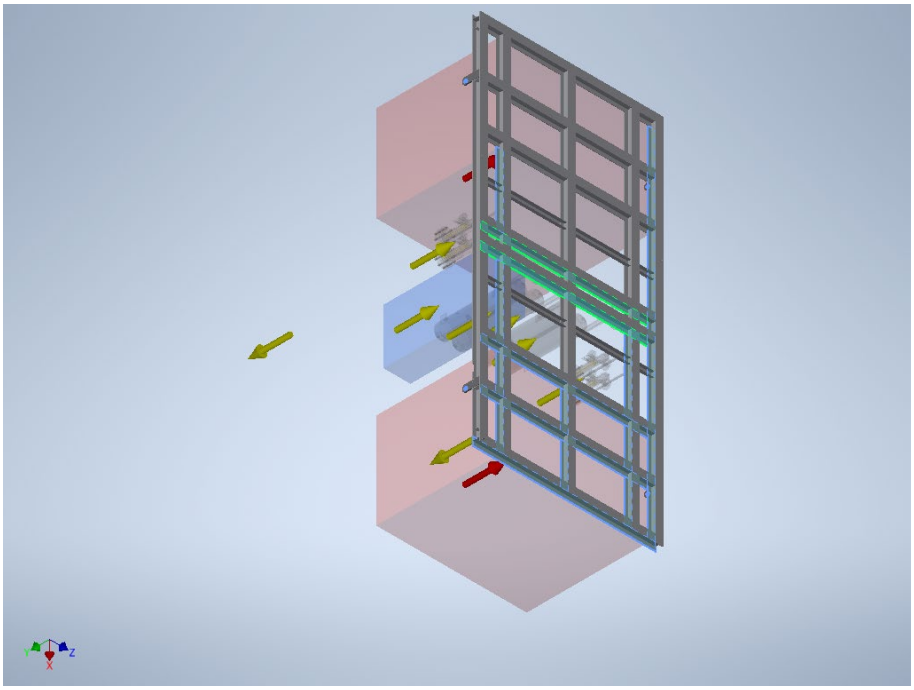
Local Control Panel (LCP)



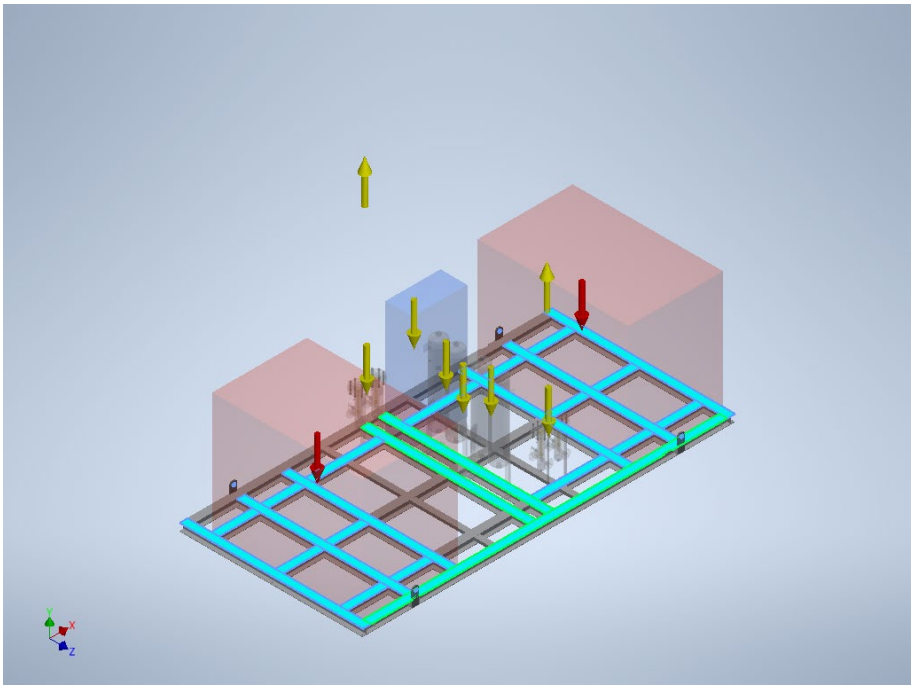


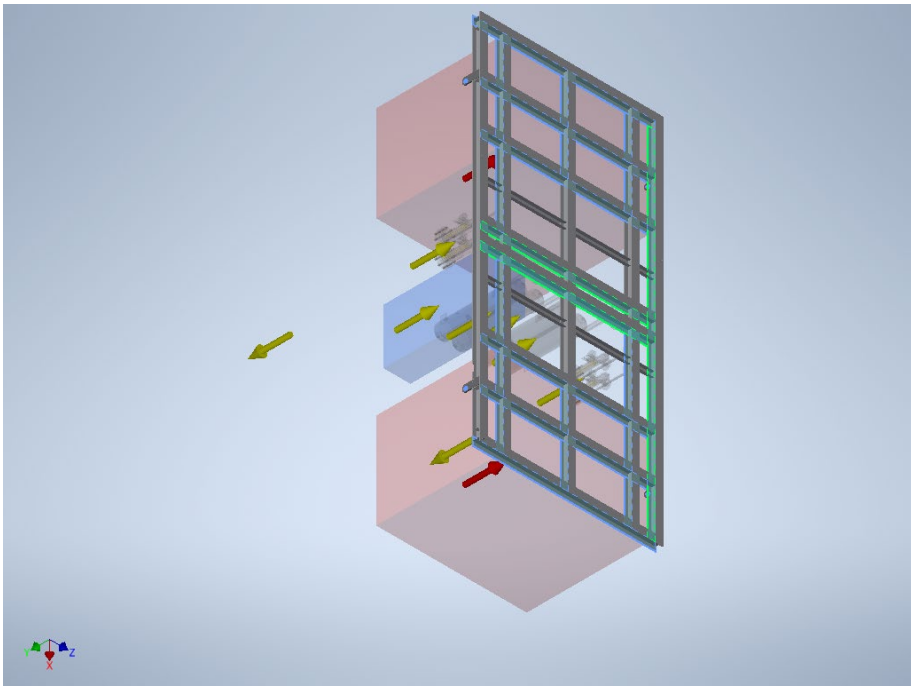
Air Compressor_1



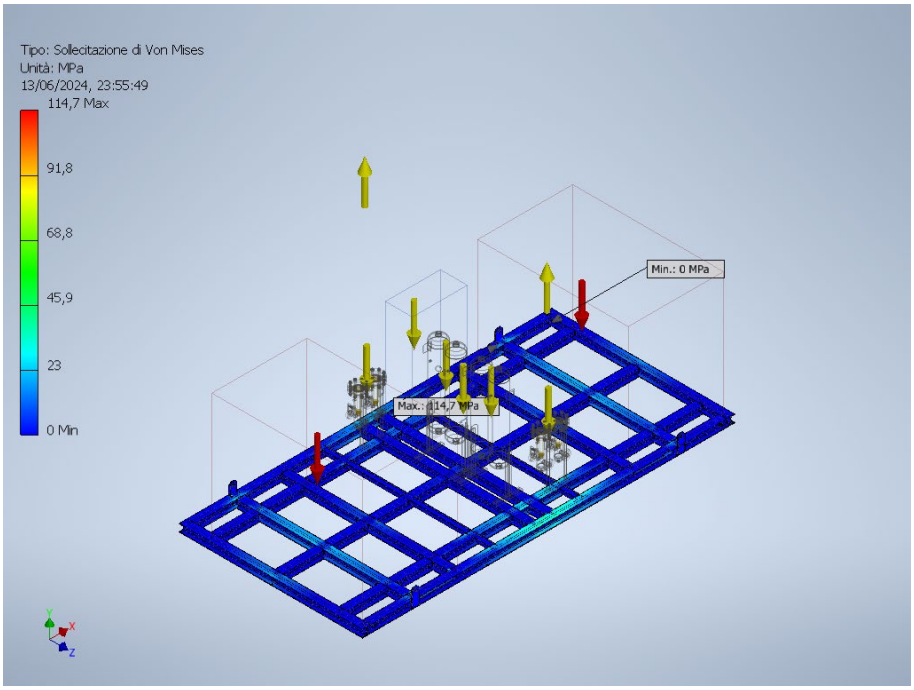


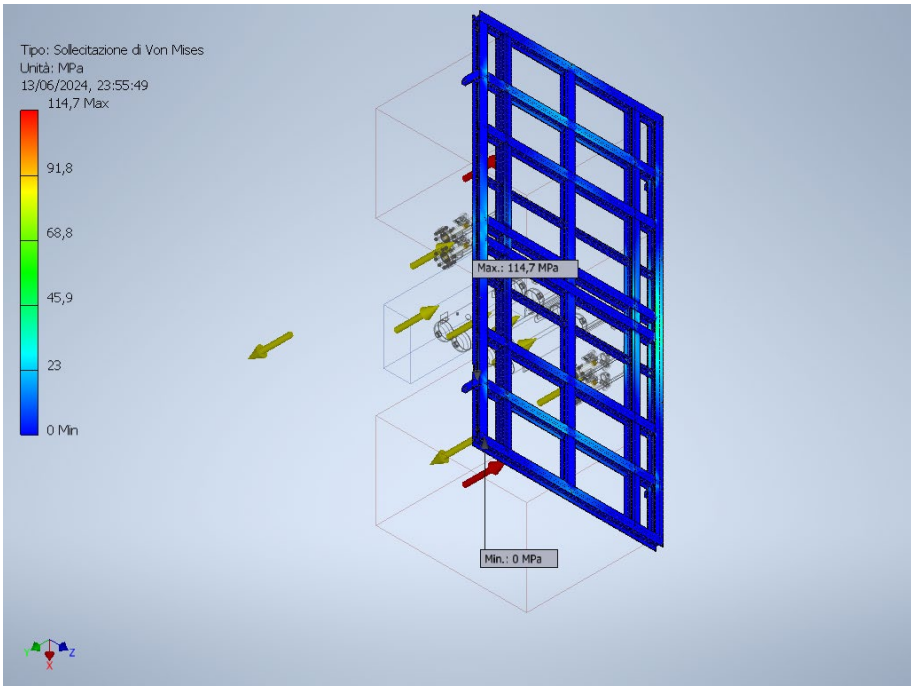
Air Compressor_2



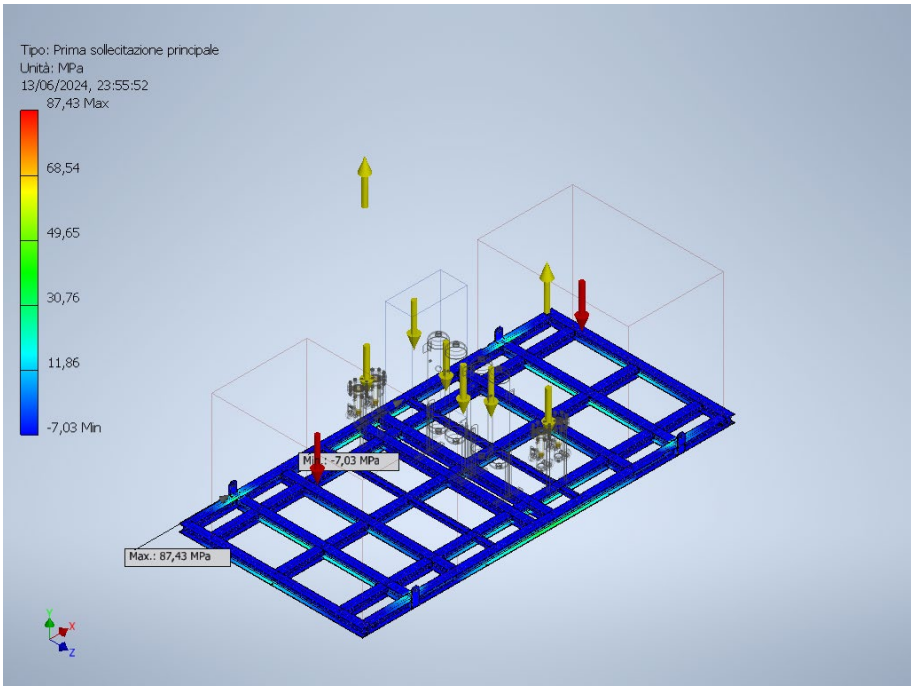


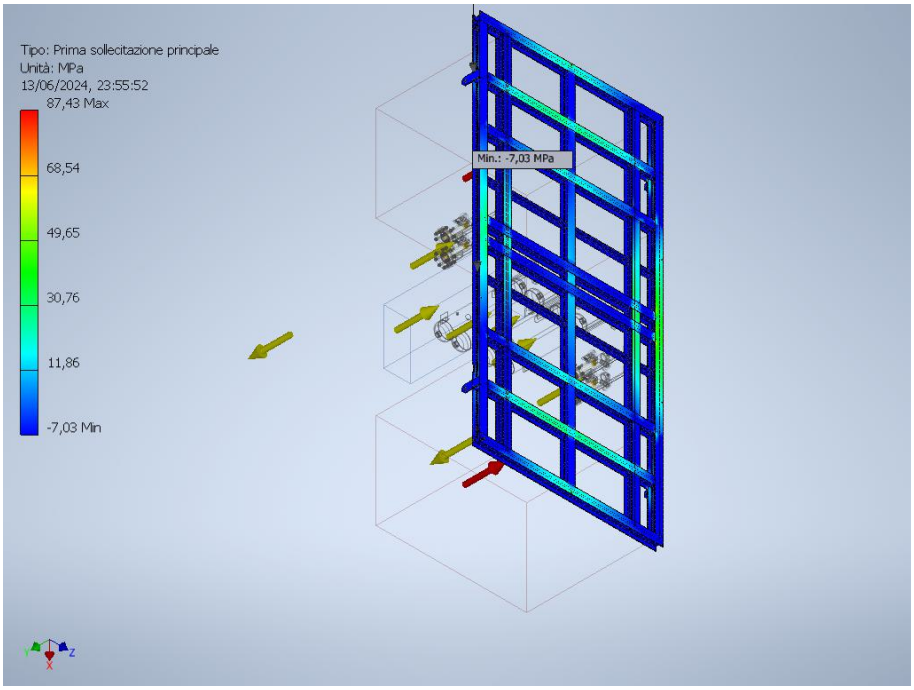
Von Mises stress



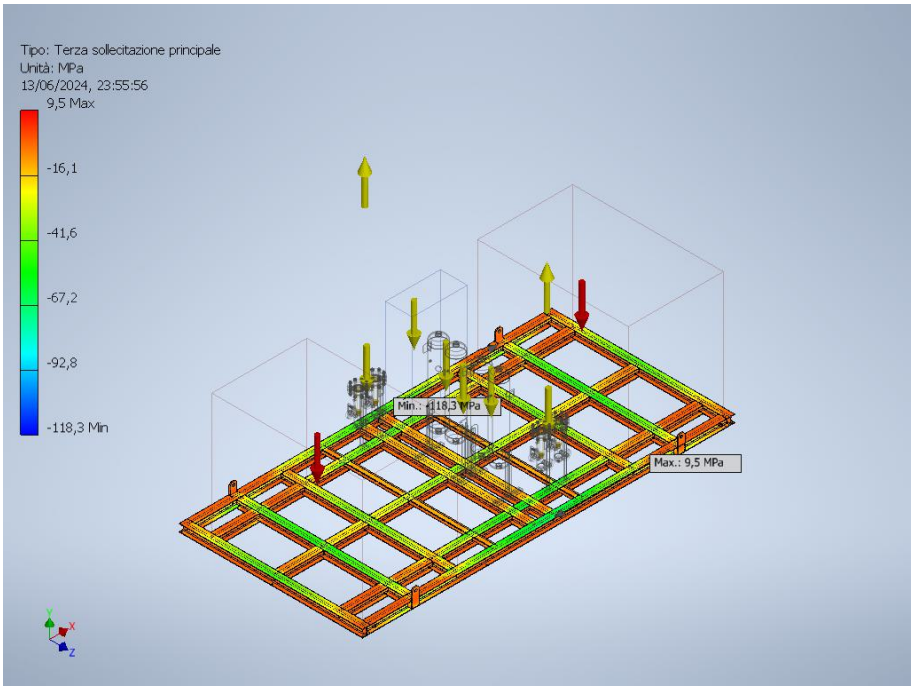


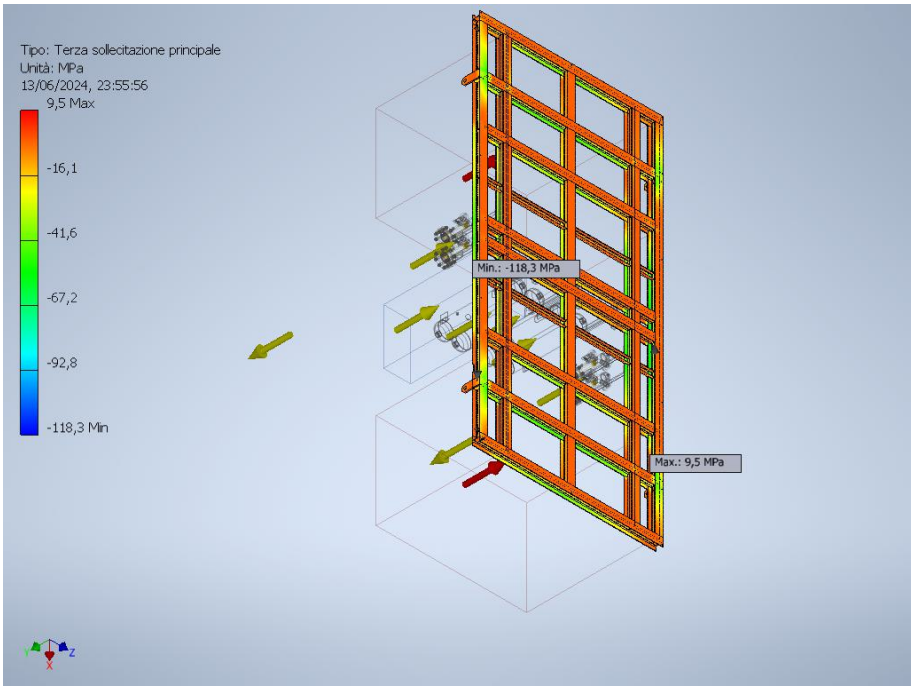
First principal stress



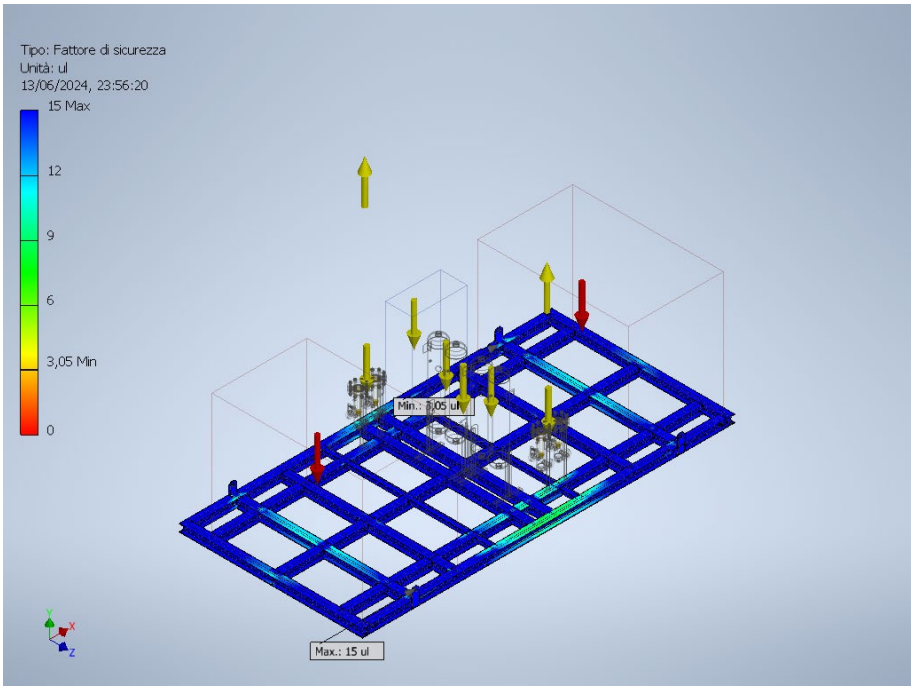


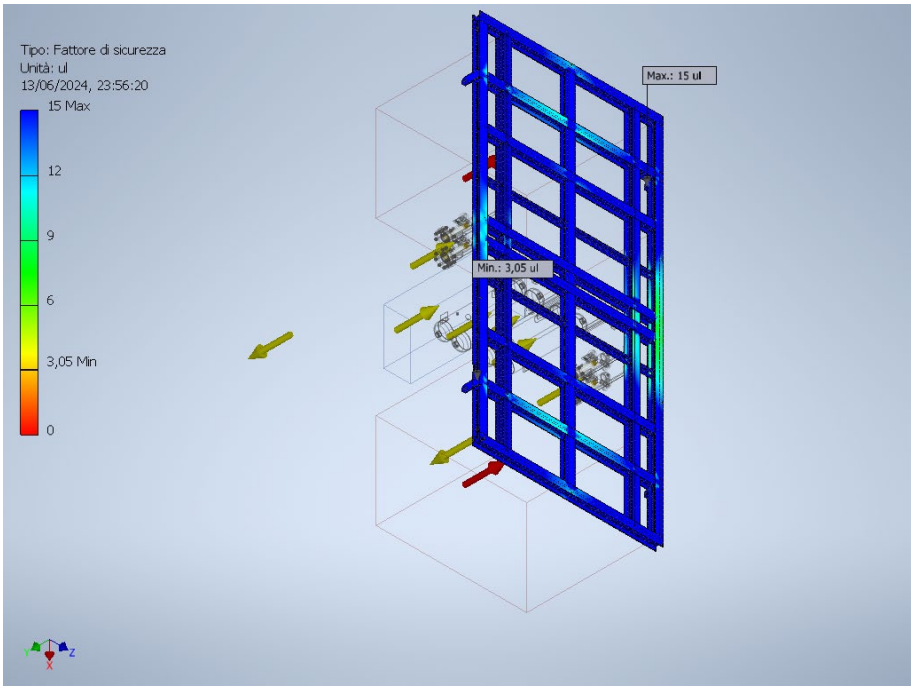
Third principal stress





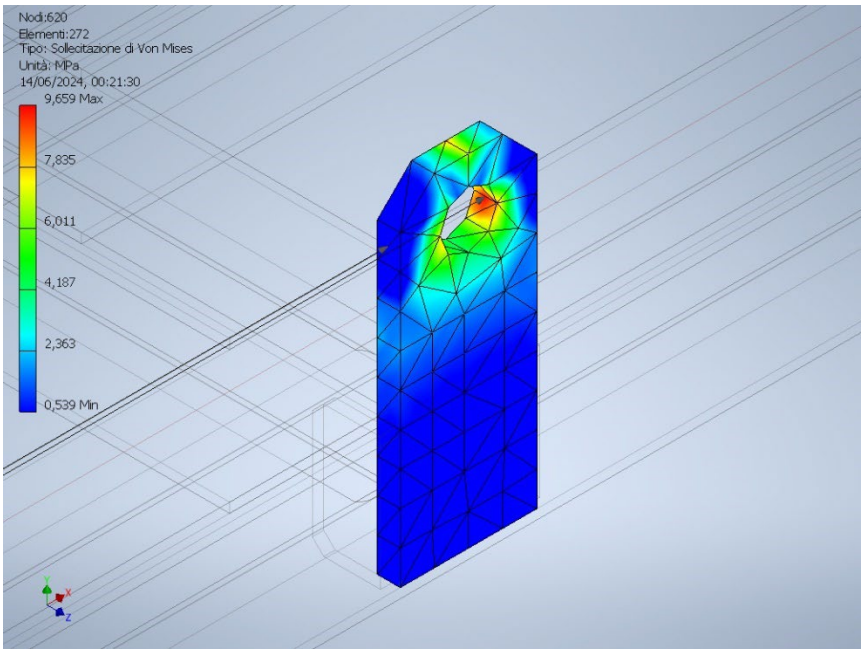
Safety factor

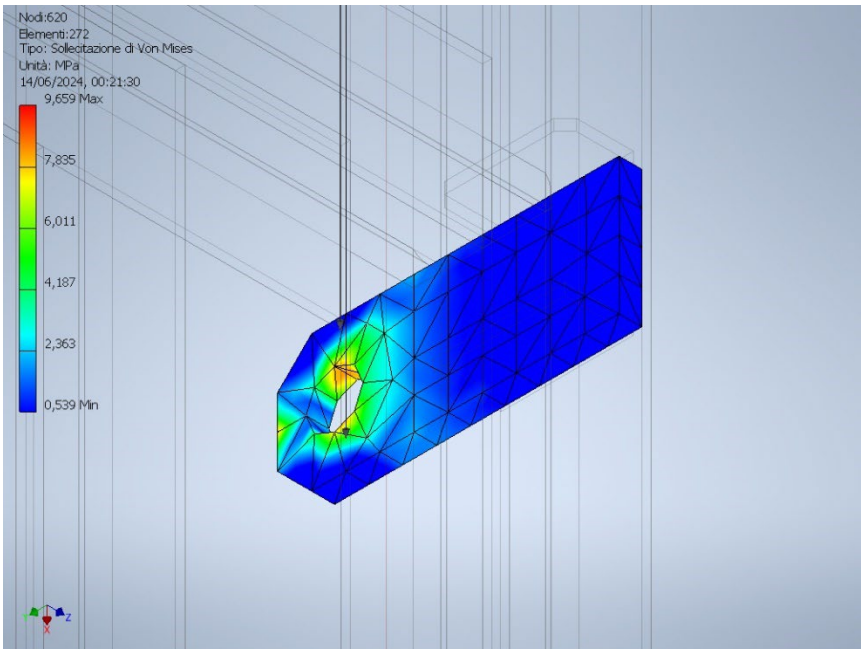




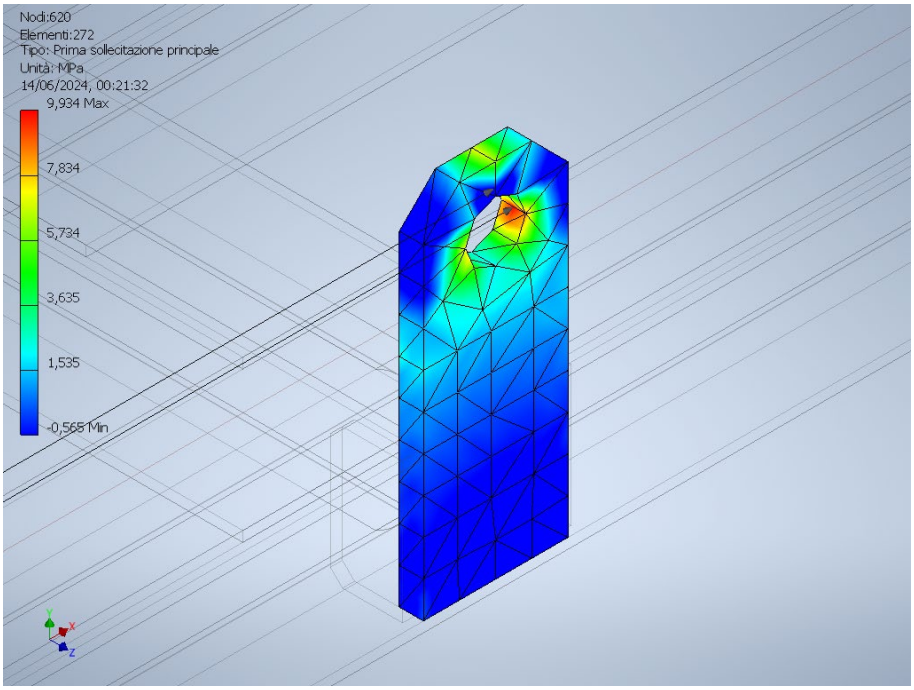
3.4 PADEYE ANALYSIS

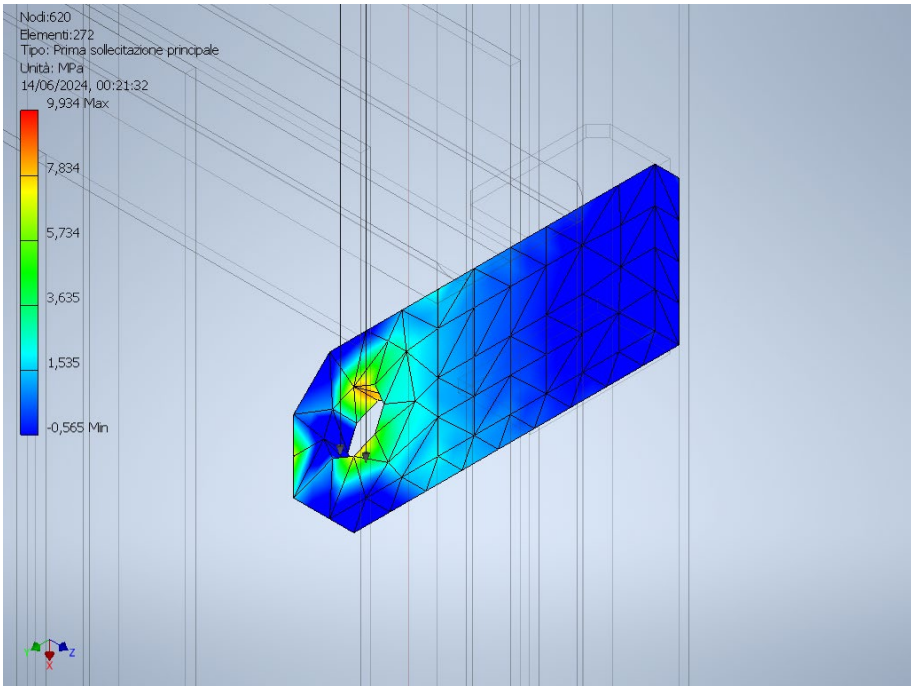
Von Mises stress



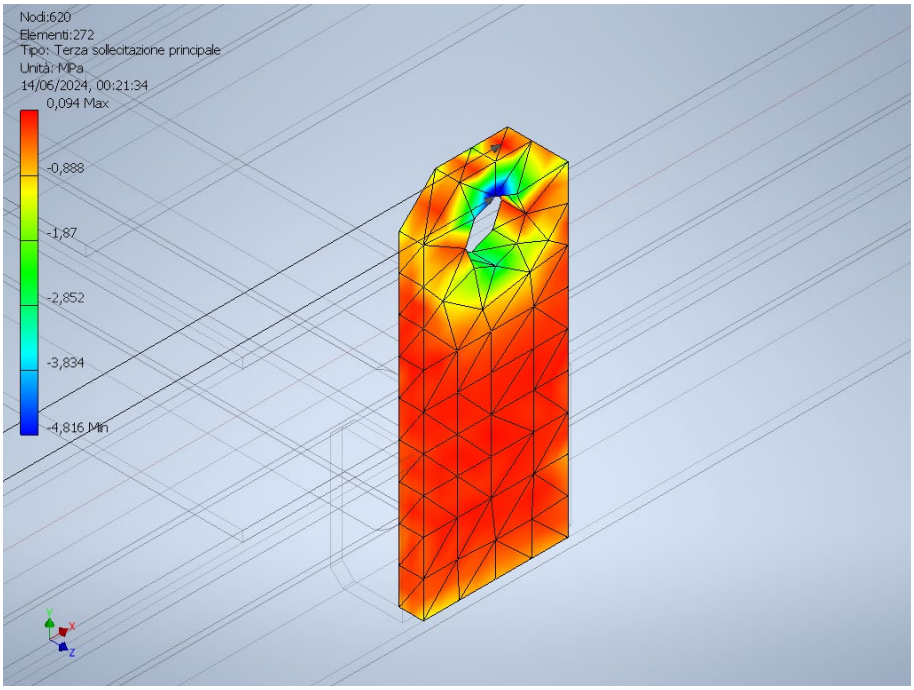


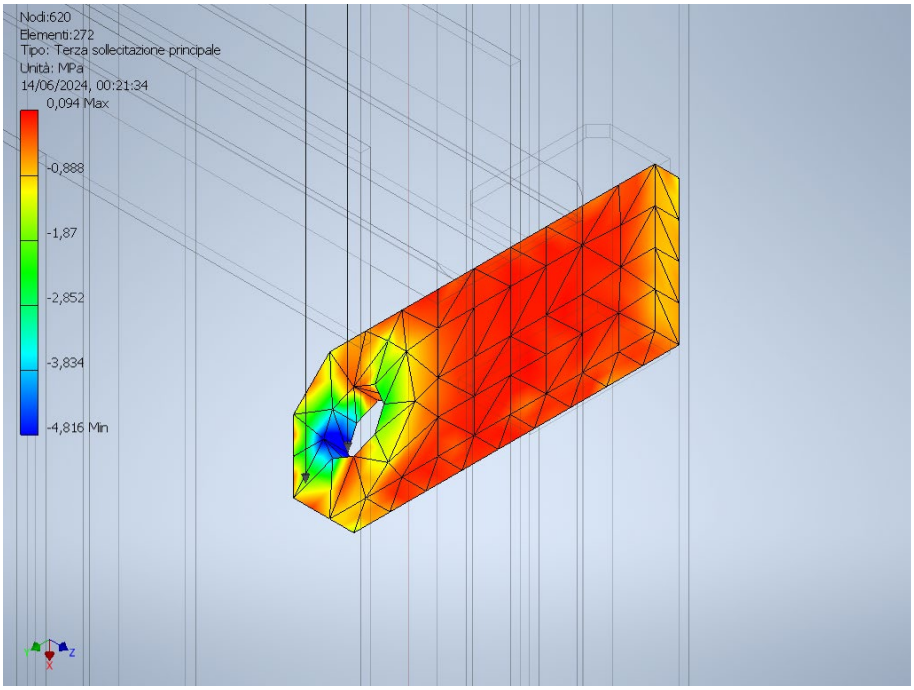
First principal stress



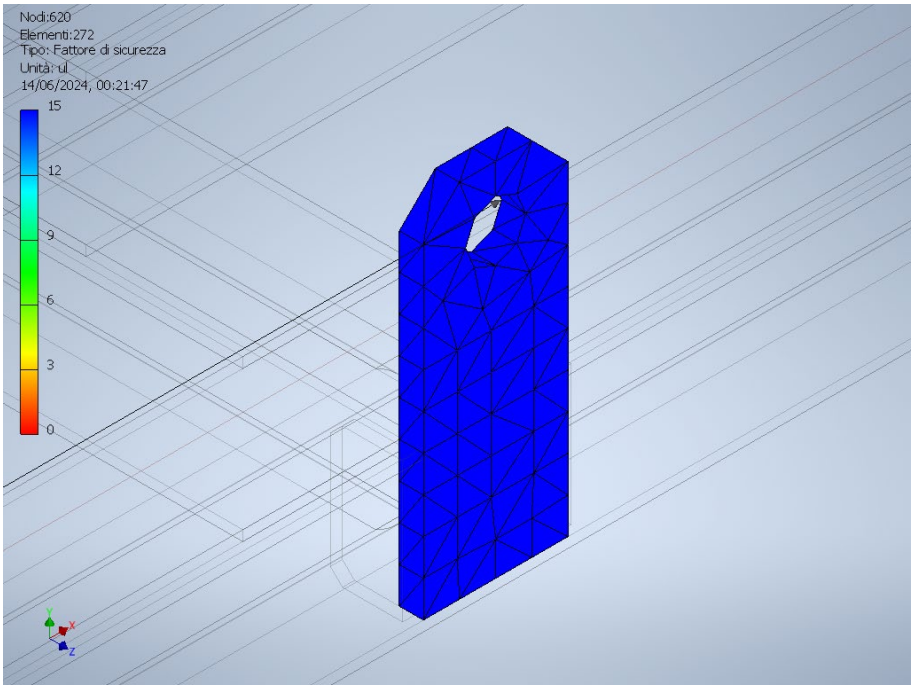


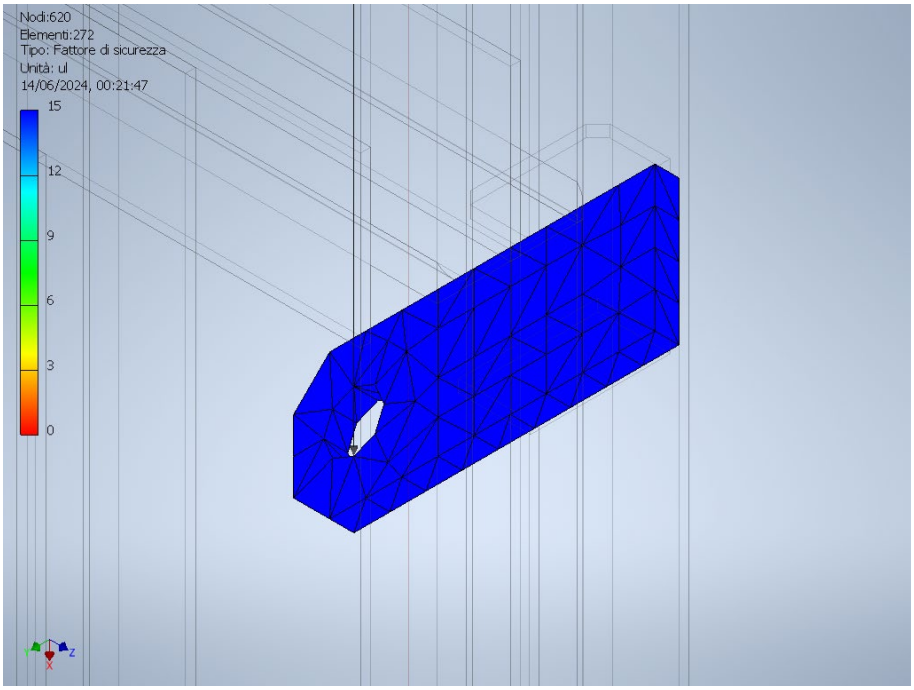
Third principal stress





Safety factor





3.5 STATIC ANALYSIS

Is considered as the load of the materials forming a permanent part of the structure unit. It is defined as the load of structures and equipment on operating conditions:

Item	Weight (kg)	Weight (N)
Compressor_1	2775	27222,75
Compressor_2	2775	27222,75
Dryer_1	500	4905
Dryer_2	500	4905
Pre-filter group	250	2452,5
Post-filter group	250	2452,5
Control Panel (UCP)	350	3433,5
Baseframe	2000	19620
TOTAL (including piping and valves)	11000	107910

Action of wind is considered for this calculation.

Wind Loads are defined in project specification "STRUCTURAL DESIGN BASIS" document No. 123A90-DDL-ST-SP-90017 Rev.0

Design Wind Speed: 40 m/s – 50ys return period.

Peak velocity pressure:

$q_p(z)=[1+7\cdot l_v(z)]\cdot 1/2\cdot\rho\cdot v_m^2(z)=c_e(z)\cdot q_b$

where:

ρ = 1.25 kg/m^3 (air density)

$c_e(z) = q_p(z)/ q_b$ (exposure factor)

$q_b = 1/2\cdot\rho\cdot v_b^2$ = 1.0 kPa (basic velocity pressure)

According to EN 1991, Figure 4.2 Paragraph 4.5

$c_e(z)$ = 3.8

$q_p(z)$ **= 3.8 kPa (peak velocity pressure)**

Wind Force

According to EN 1991, Section 5.3 Expression (5.3), wind force F_w may be determined as:

$F_w = c_s c_d \cdot c_f \cdot q_p(z) \cdot A_{ref}$

where

$c_s c_d = 1$ (structural factor defined in Section 6)

$c_f = 1.26$ (force coefficient, given in Section 7, formula 7.11)

$q_p(z) = 3.8$ kPa (peak velocity pressure)

$A_{ref\text{-}X}$ = (Reference area, X-Direction)

$A_{ref\text{-}Z}$ = (Reference area, Z-Direction)

$F_{w\text{-}X} = 27086$ N

$F_{w\text{-}Z} = 17096$ N

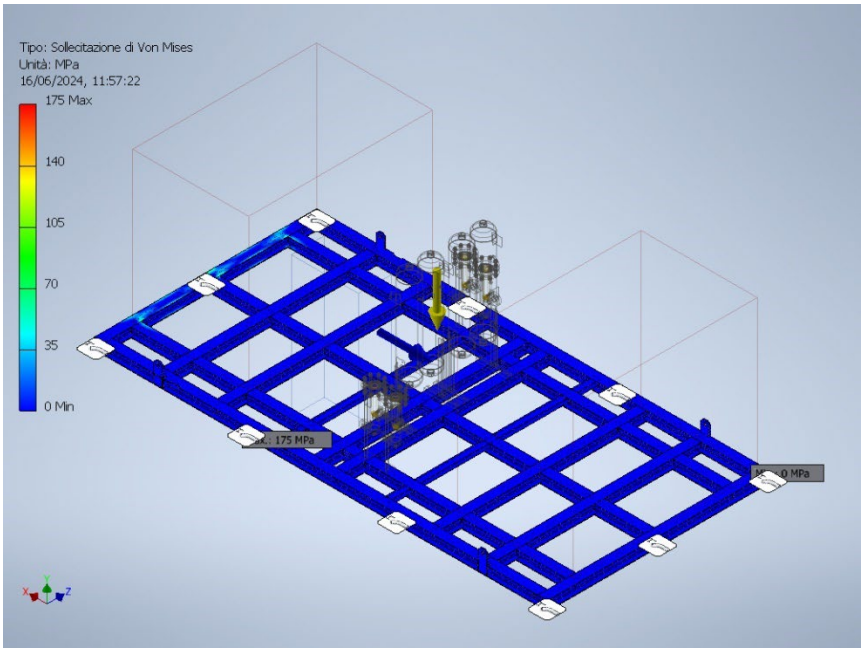
Calculation cases are:

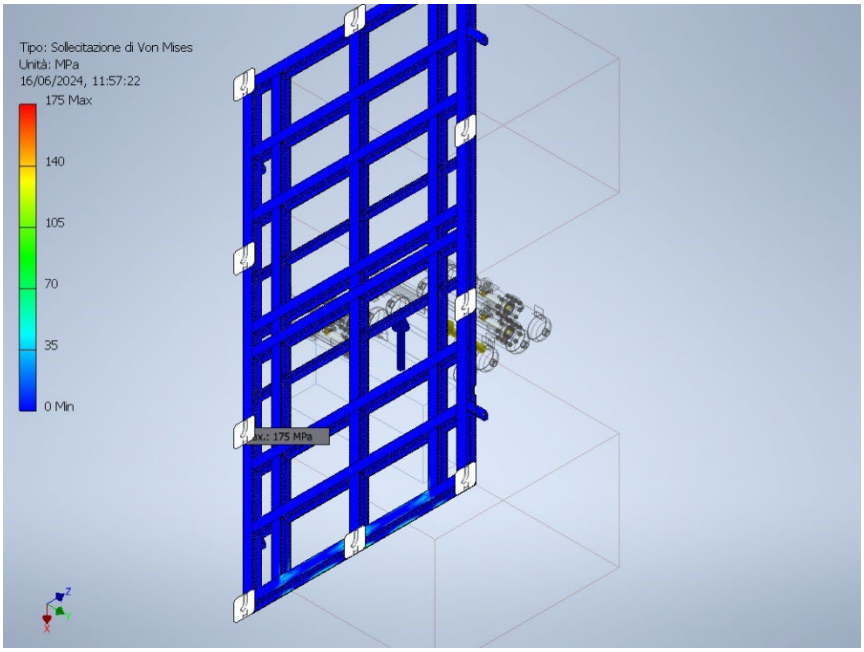
- Permanent load + Wind action along X- direction
- Permanent load + Wind action along X+ direction
- Permanent load + Wind action along Z- direction
- Permanent load + Wind action along Z+ direction

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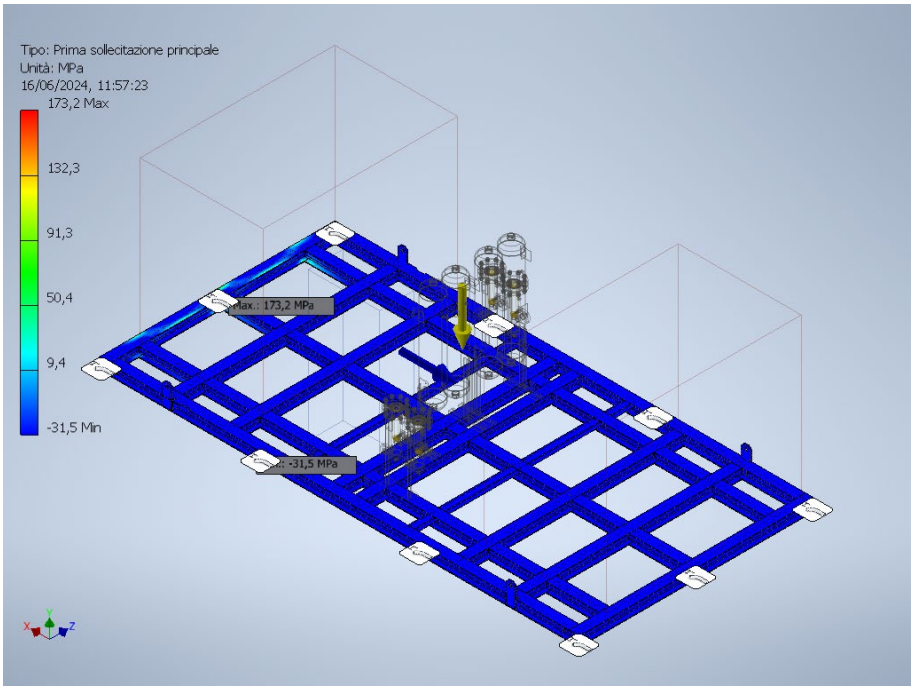
3.5.1 PERMANENT LOAD + WIND (X- DIRECTION)

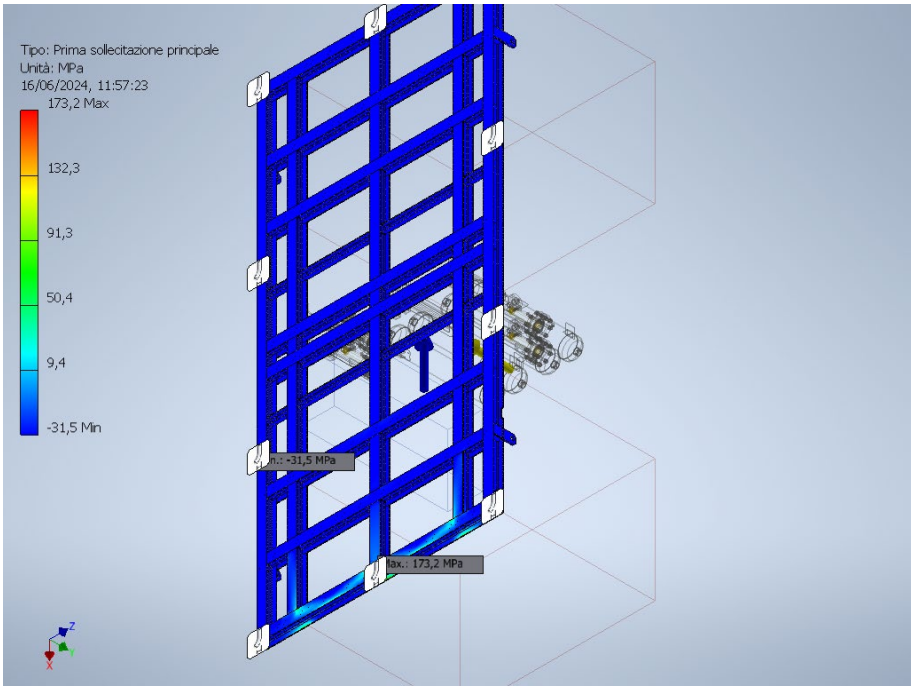
Von Mises stress



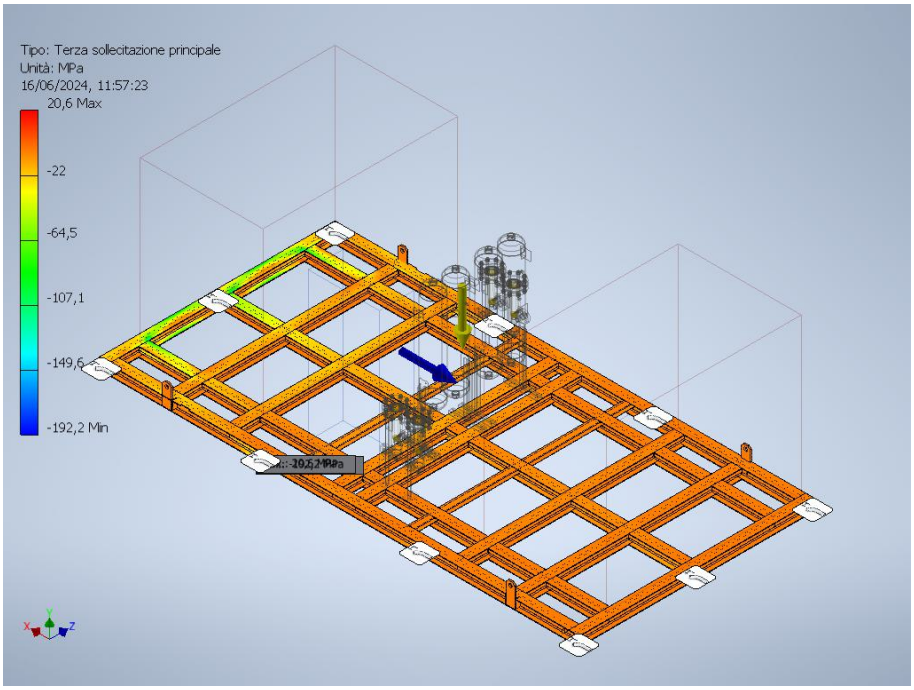


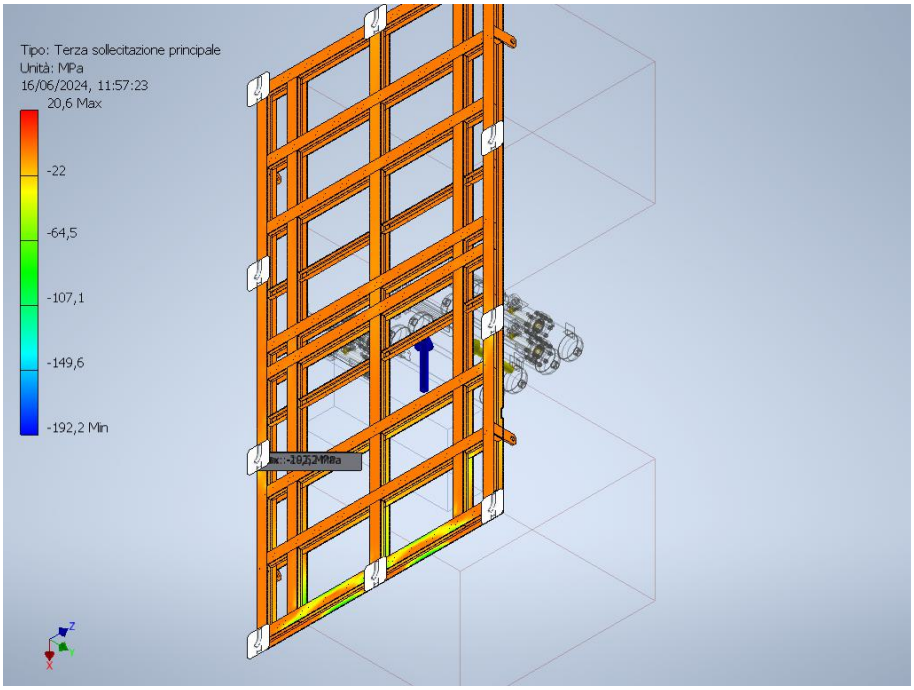
First principal stress



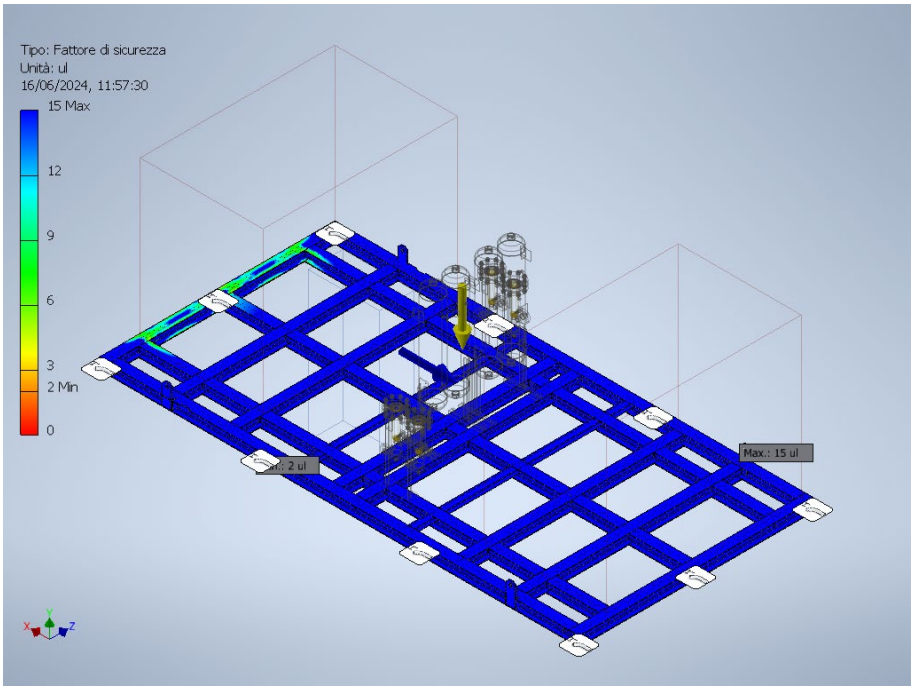


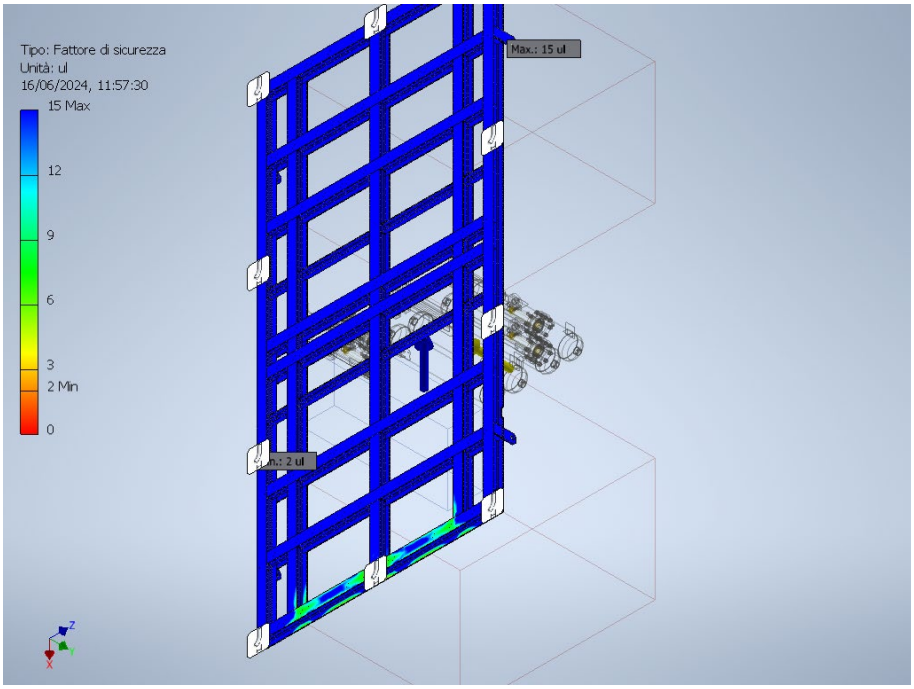
Third principal stress





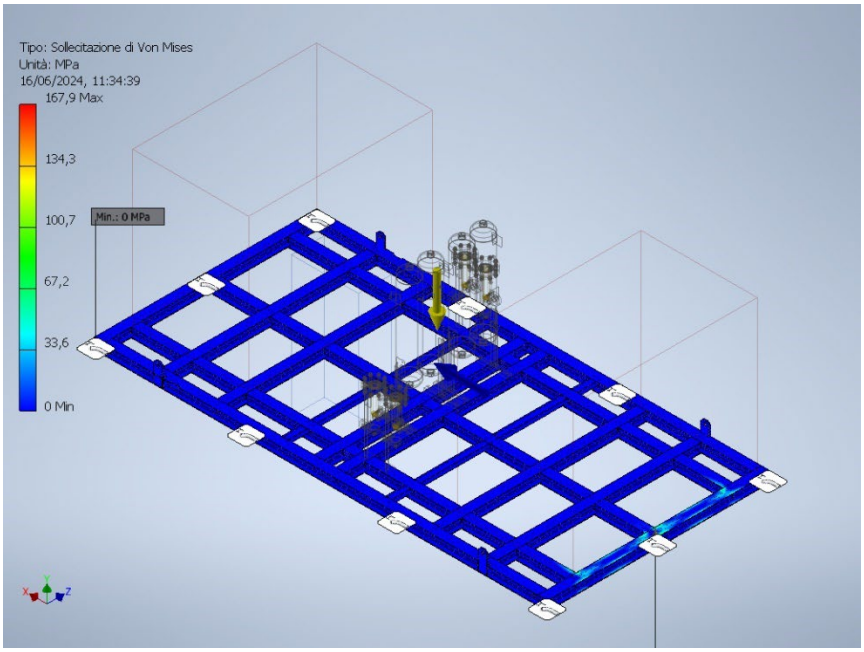
Safety factor

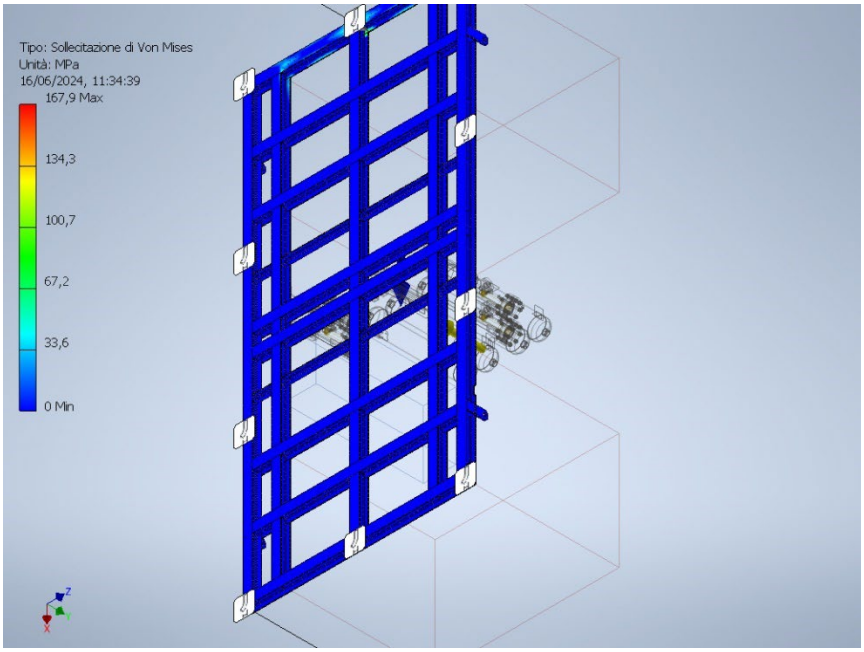




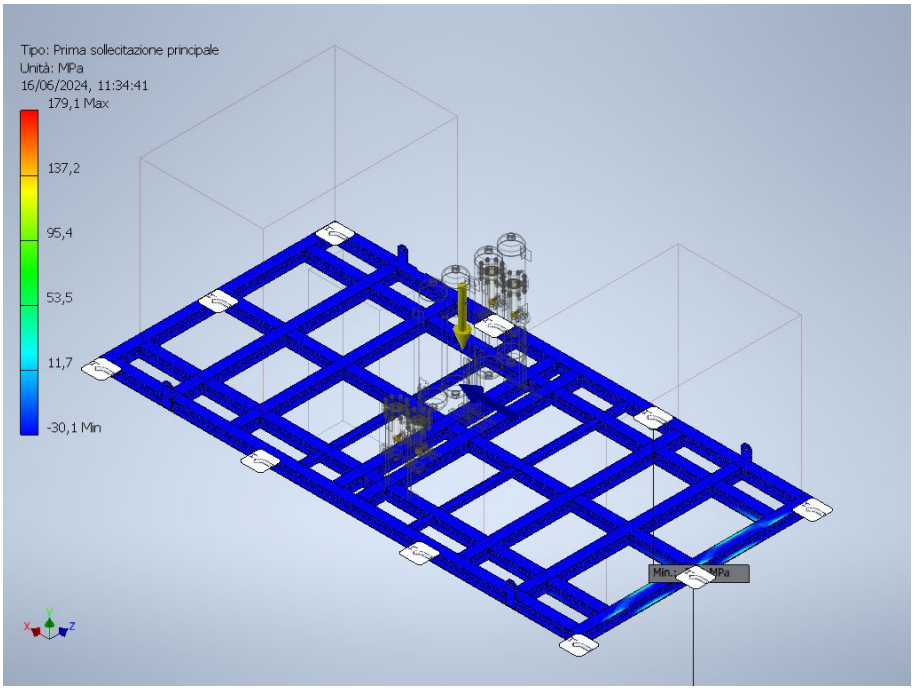
3.5.2 PERMANENT LOAD + WIND (X+ DIRECTION)

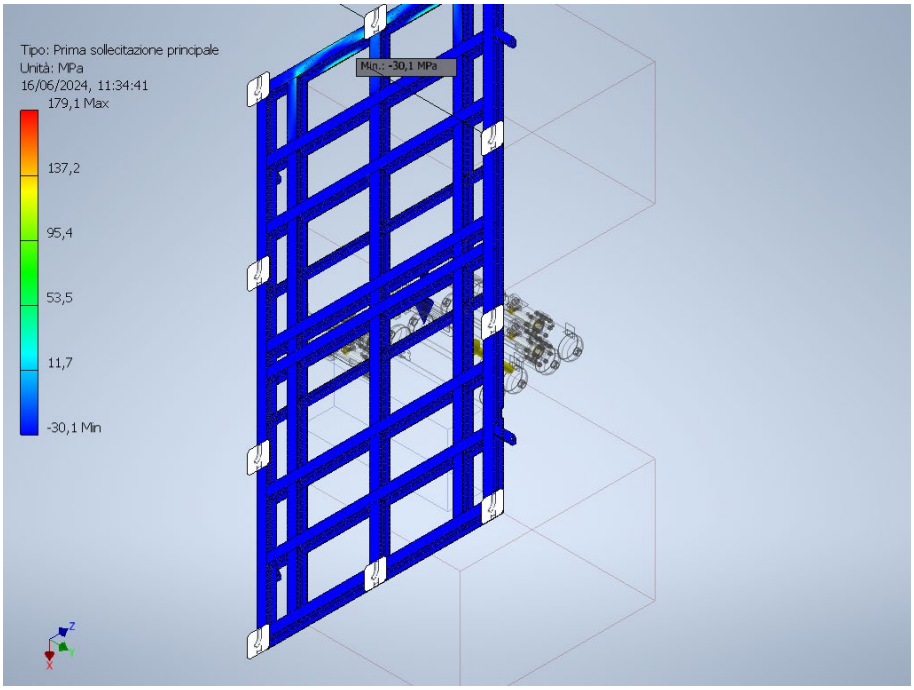
Von Mises stress



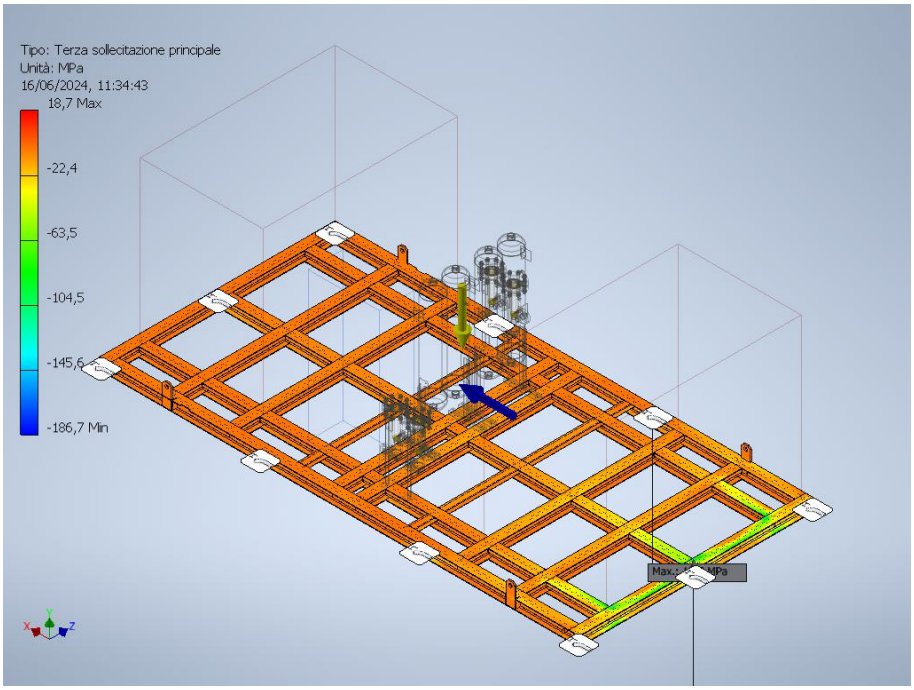


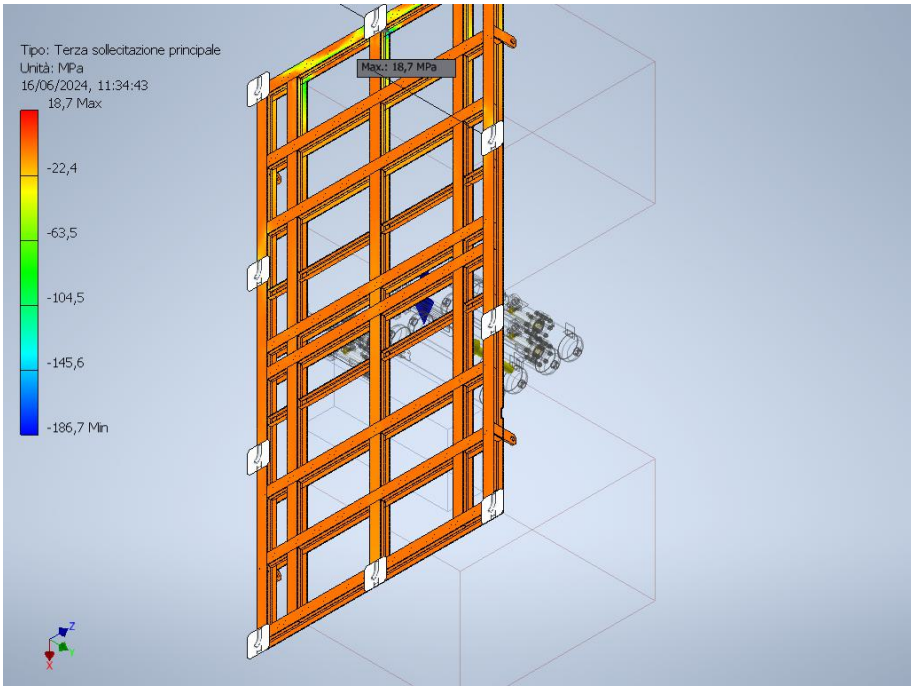
First principal stress



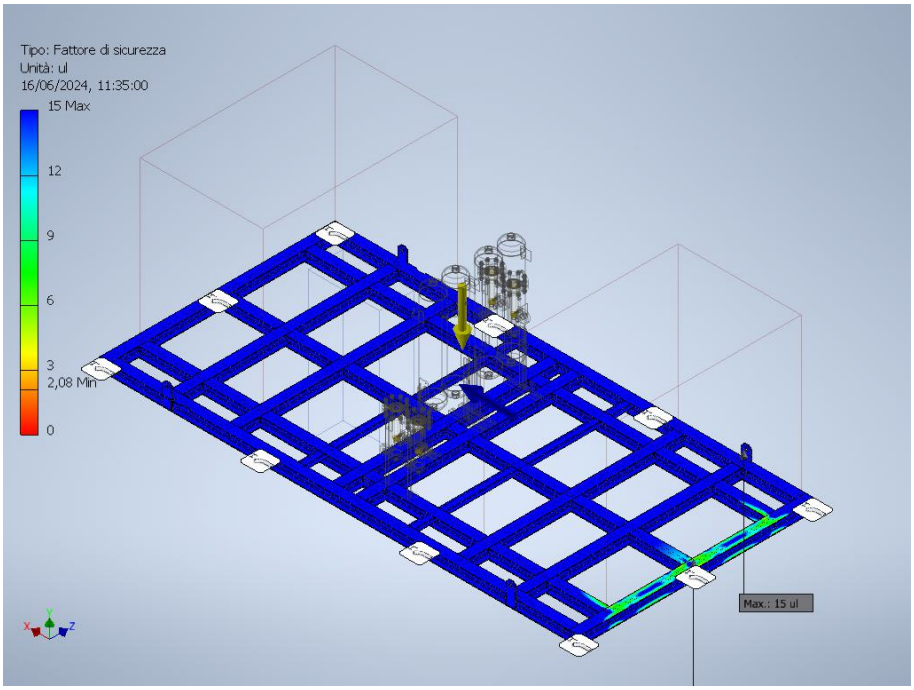


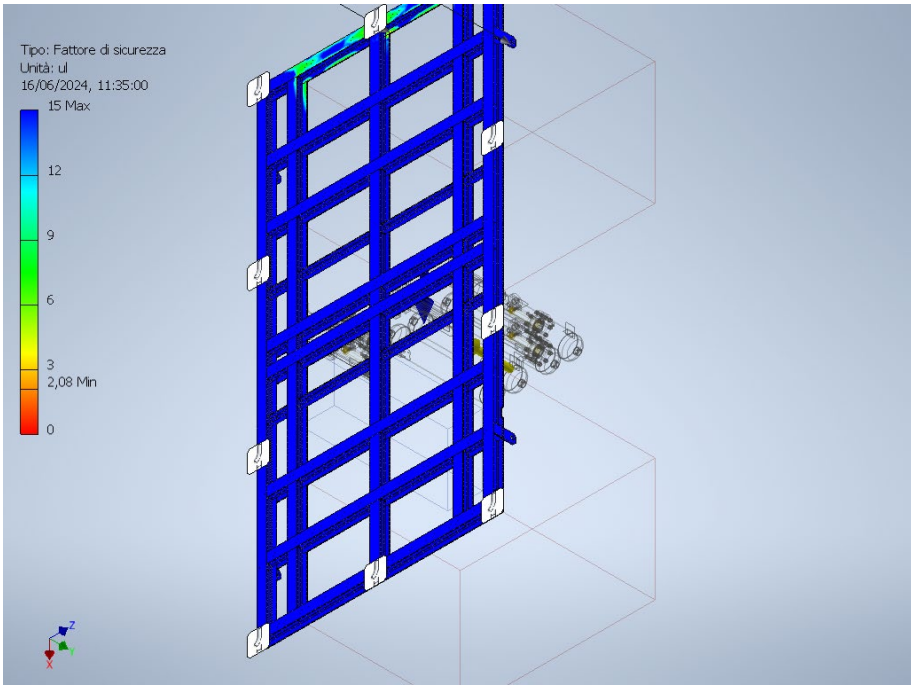
Third principal stress





Safety factor

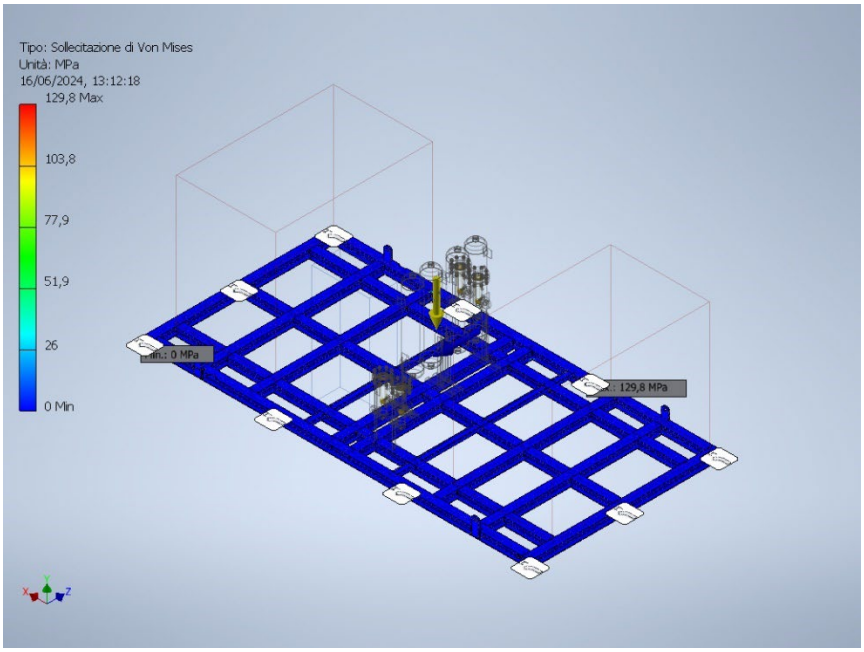


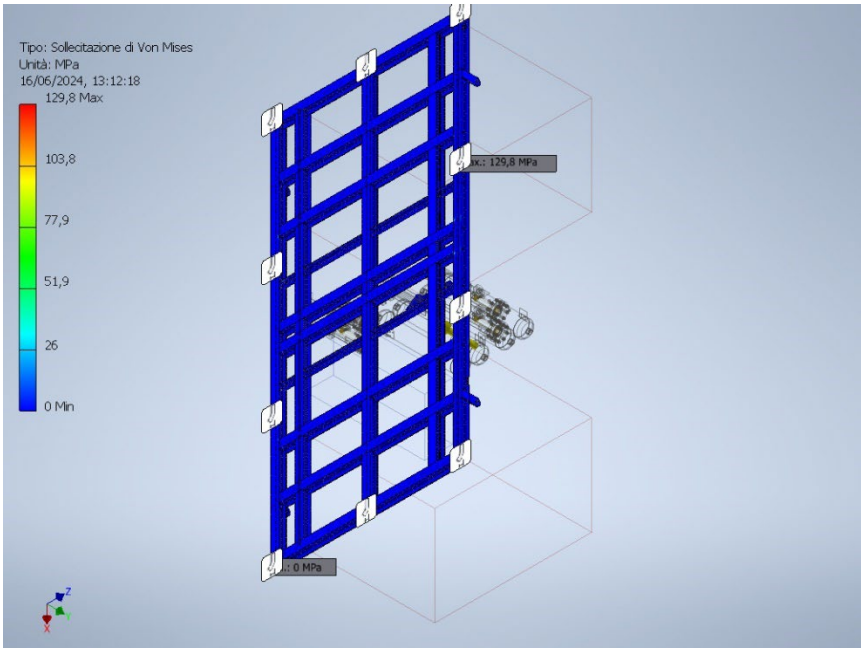


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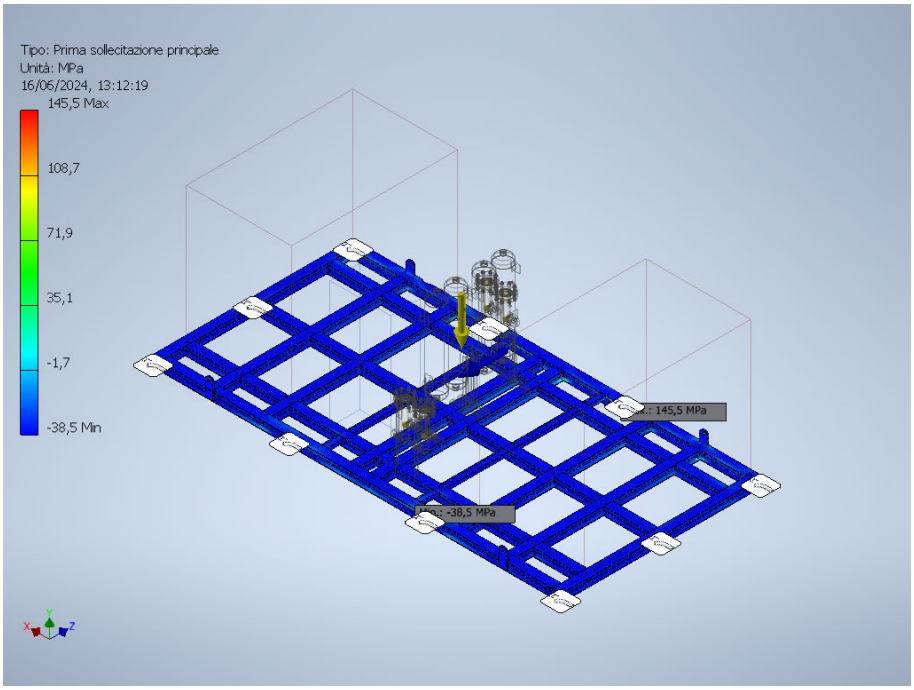
3.5.3 PERMANENT LOAD + WIND (Z- DIRECTION)

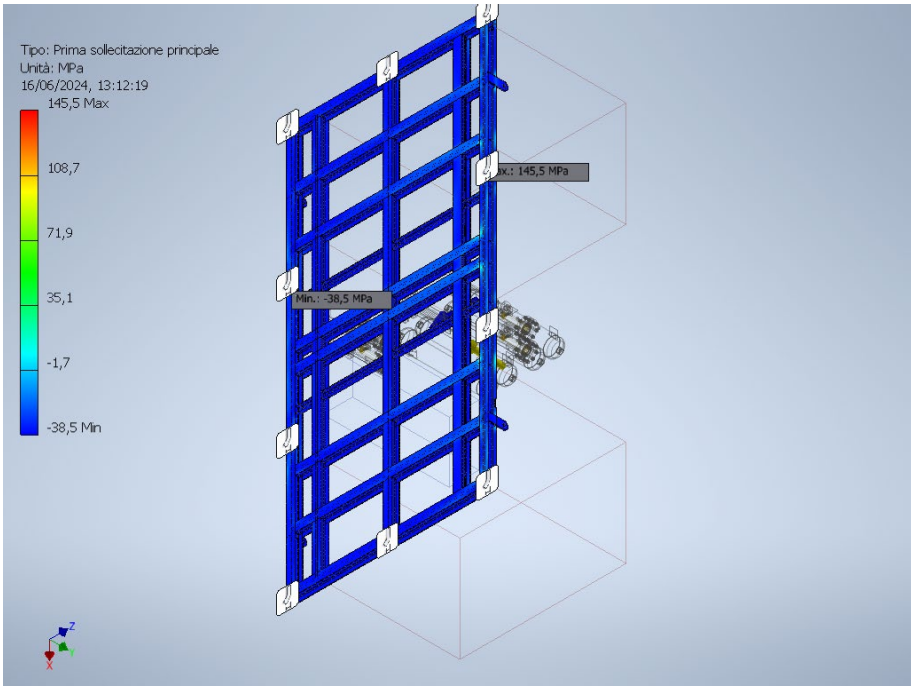
Von Mises stress



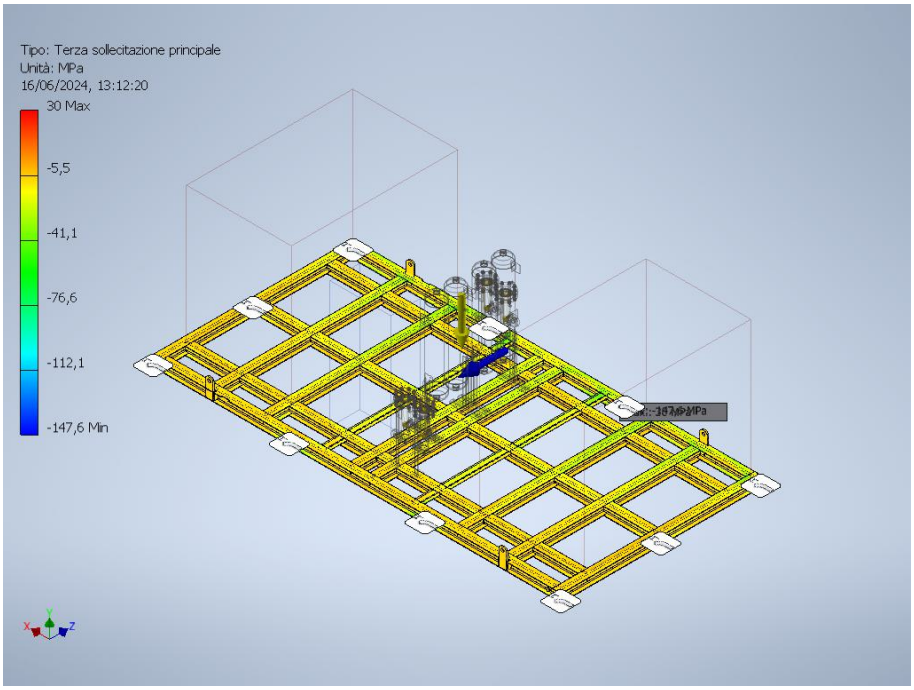


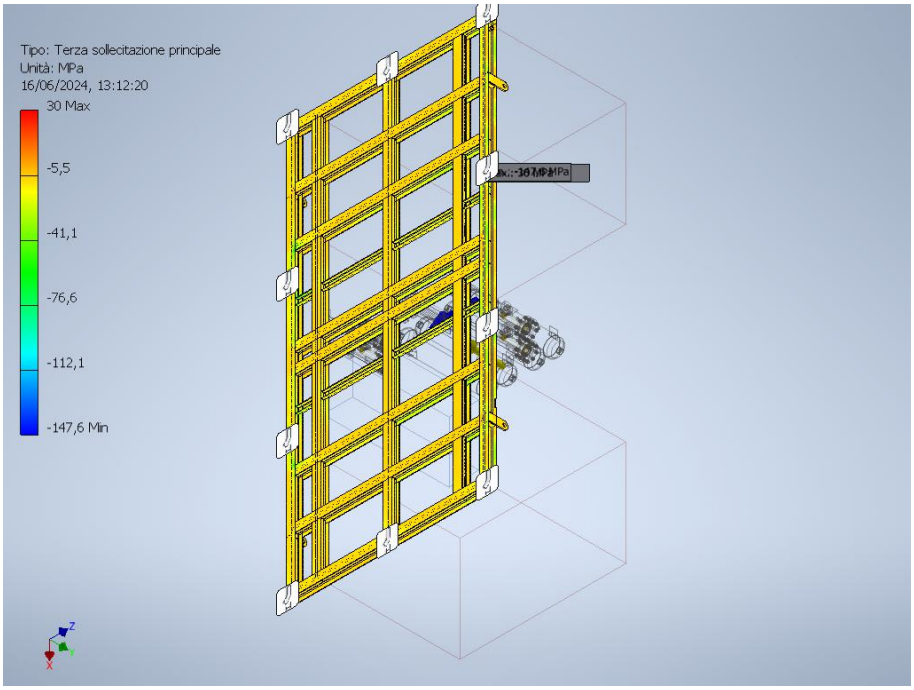
First principal stress



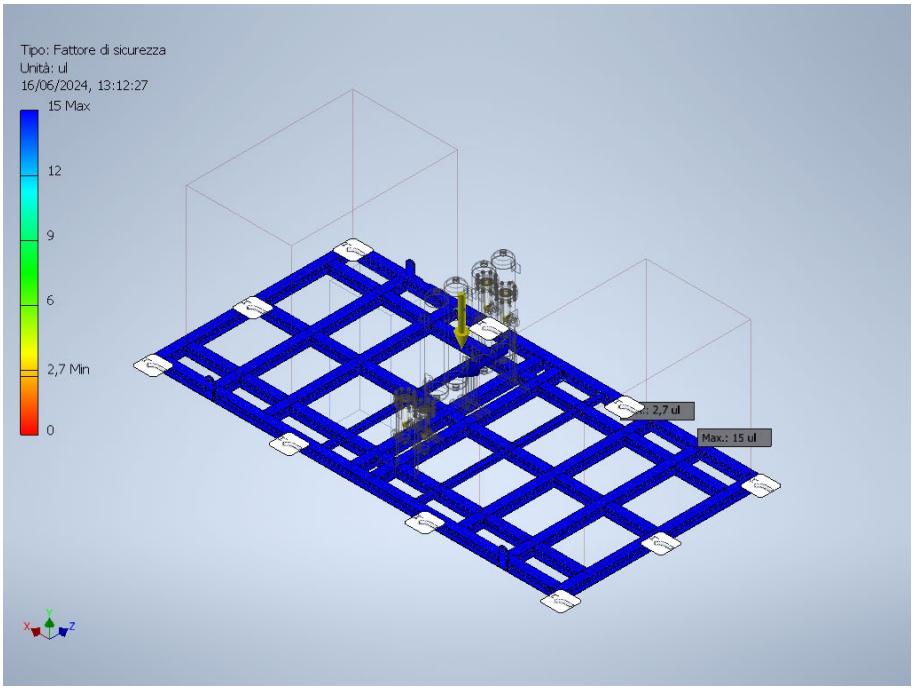


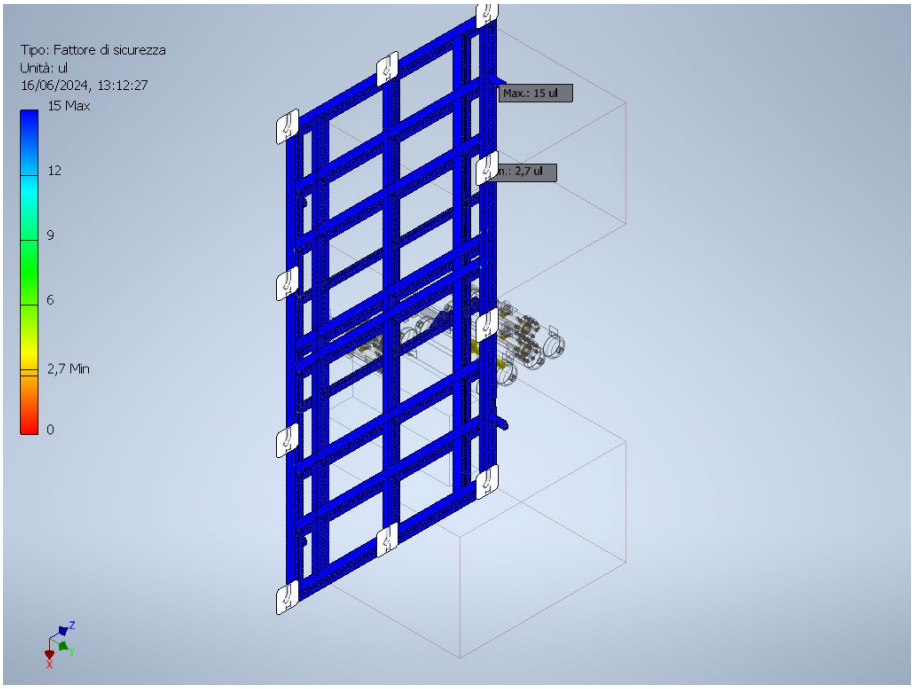
Third principal stress





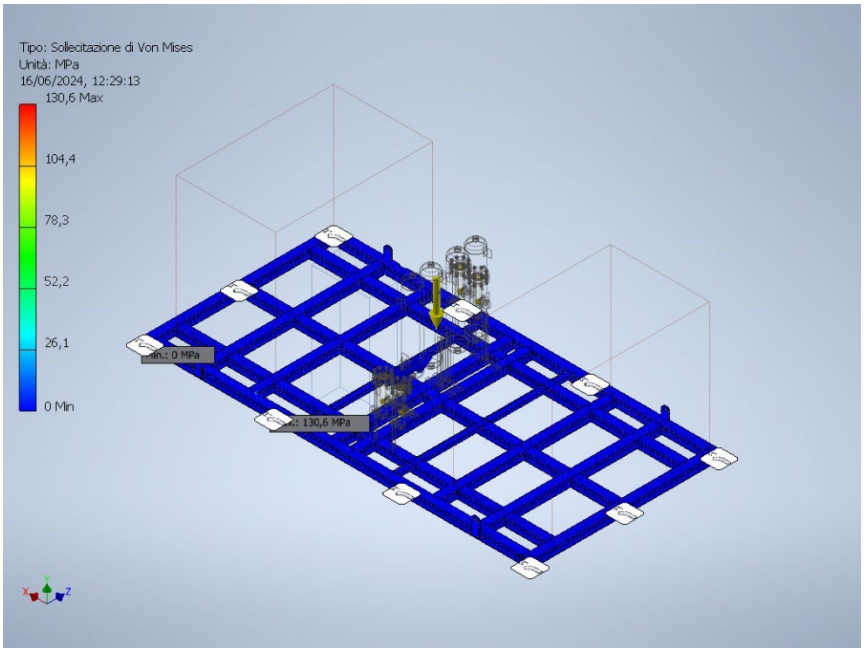
Safety factor

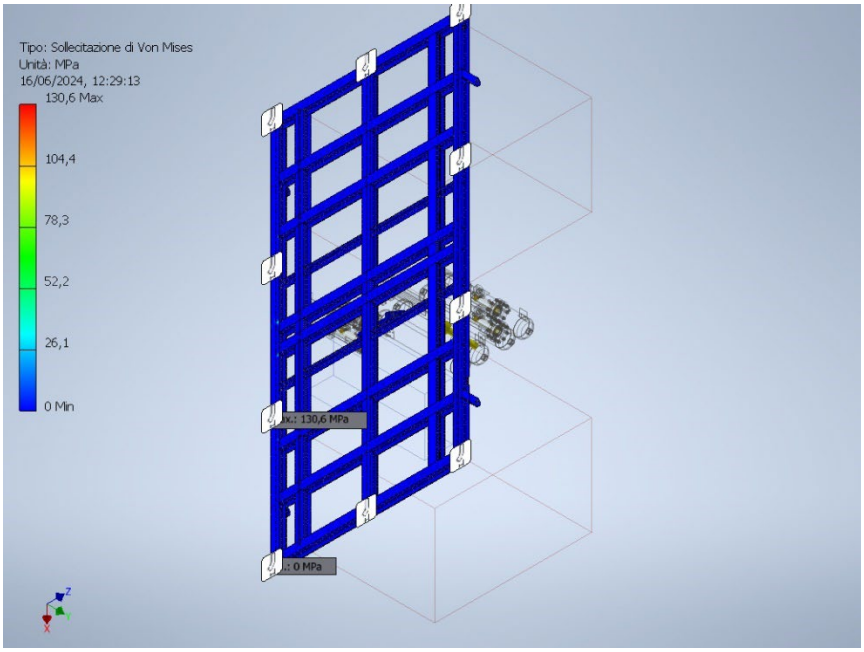




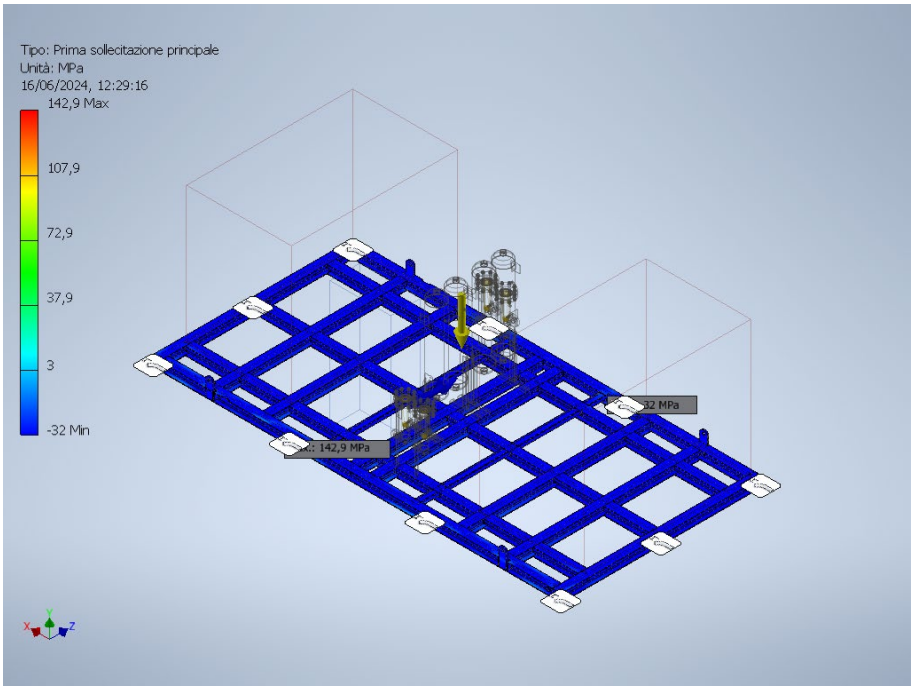
3.5.4 PERMANENT LOAD + WIND (Z+ DIRECTION)

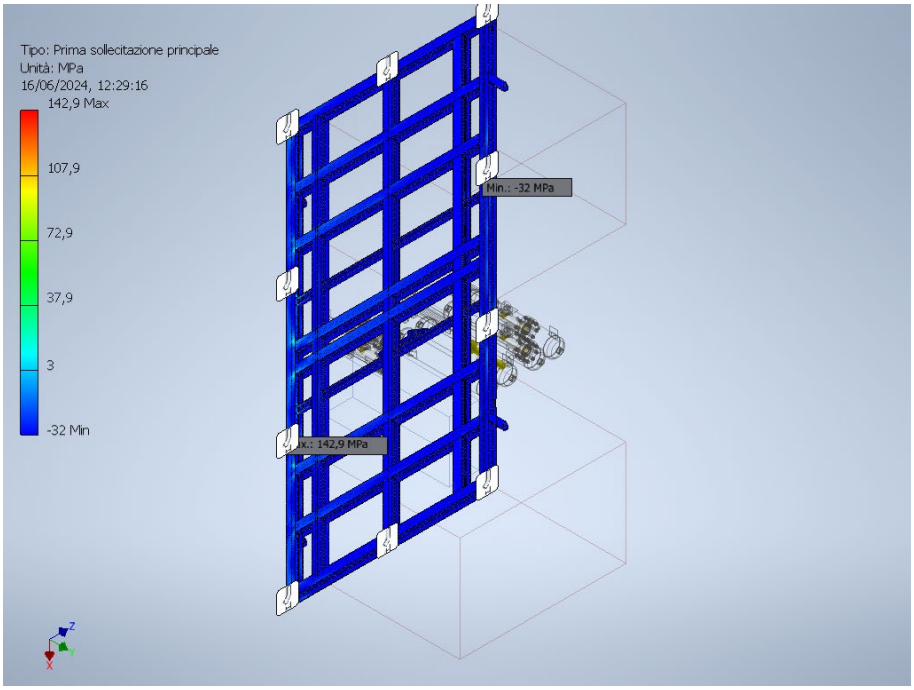
Von Mises stress





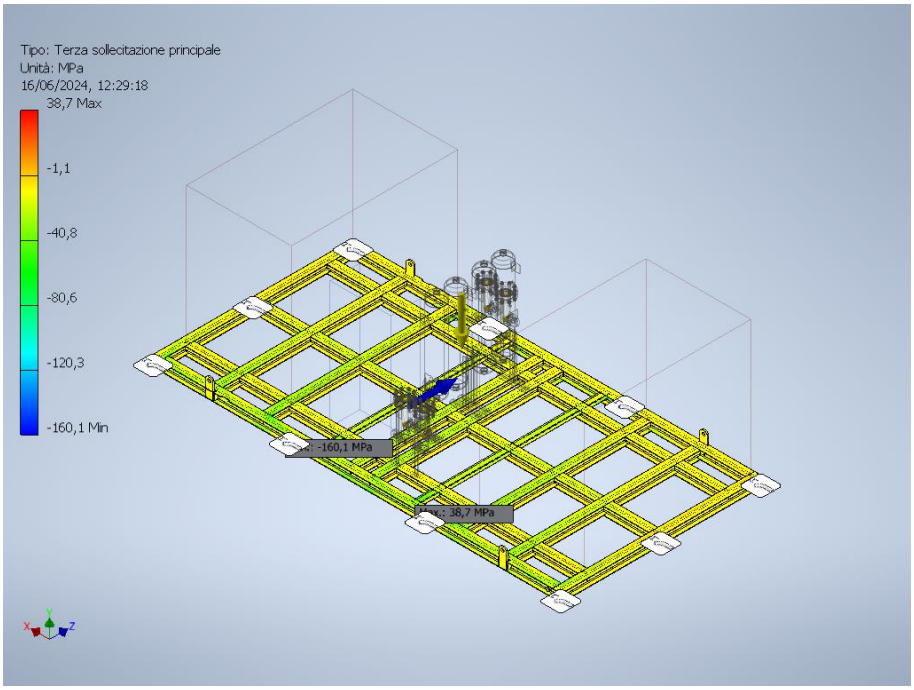
First principal stress

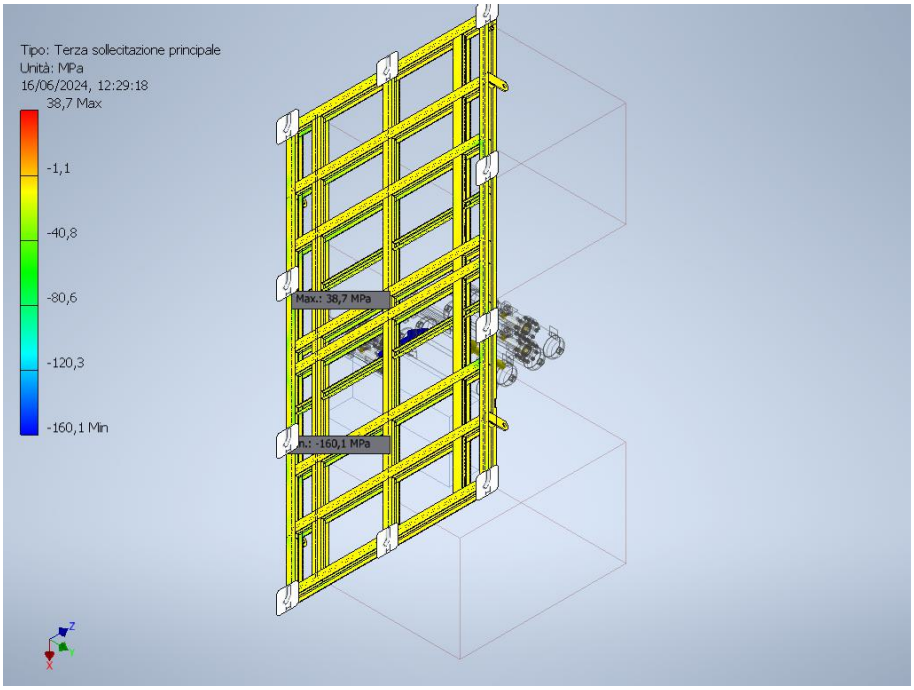




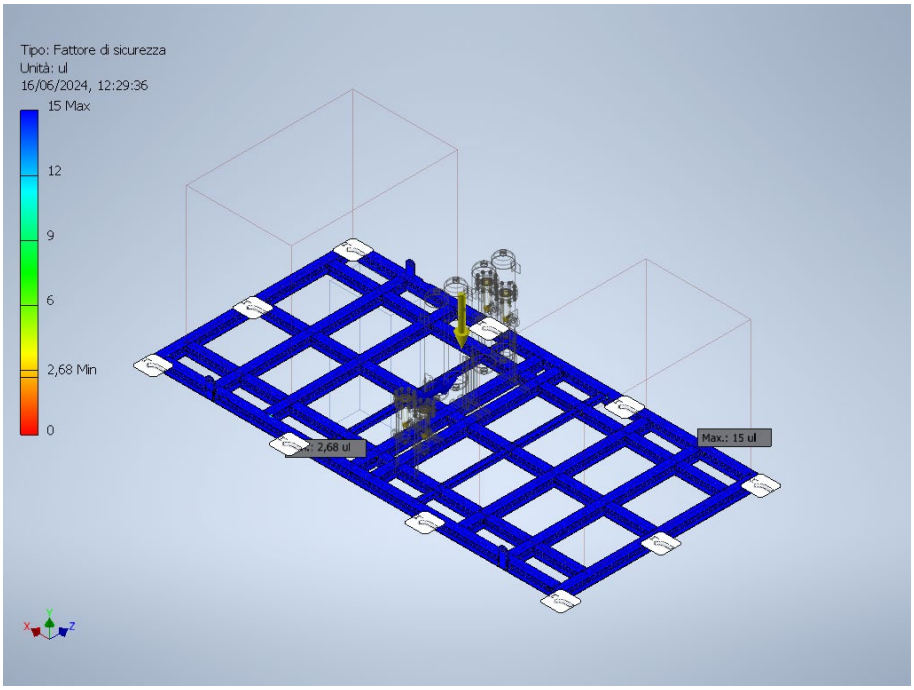
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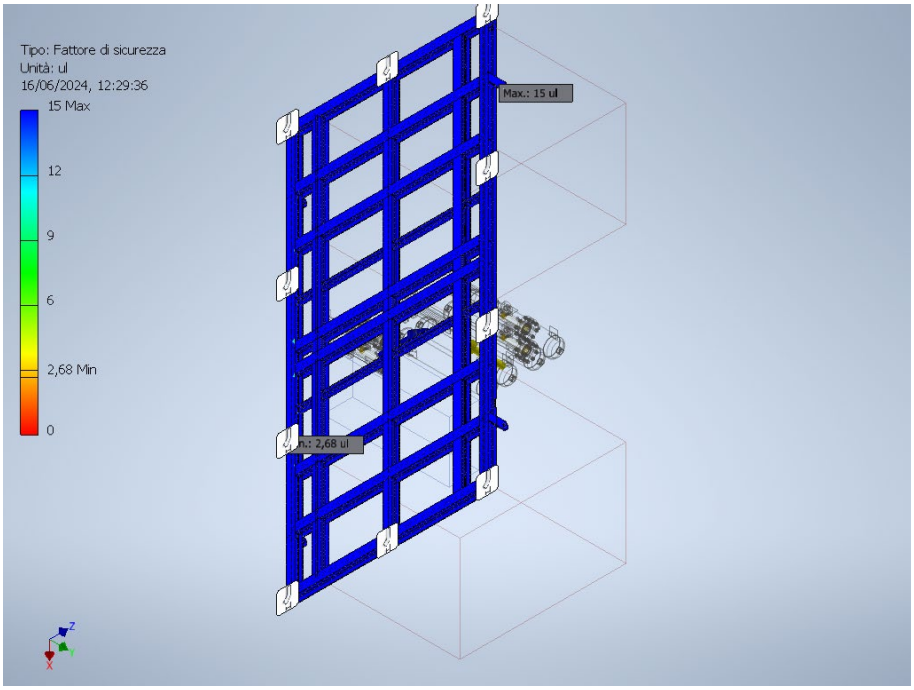
Third principal stress





Safety factor





3.6 TRANSPORTATION ANALYSIS

Transportation load has been considered as an horizontal acceleration equal to 0.7g.

The transportation load has been combined with the action of wind as calculated in the previous section. Calculation cases are:

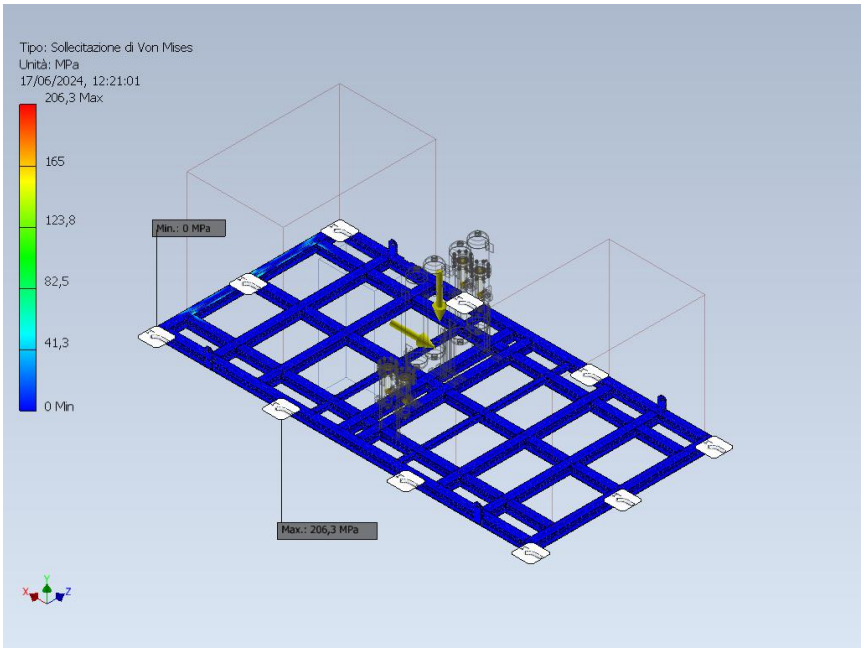
- Transportation load + Wind action along X- direction
- Transportation load + Wind action along X+ direction
- Transportation load + Wind action along Z- direction
- Transportation load + Wind action along Z+ direction

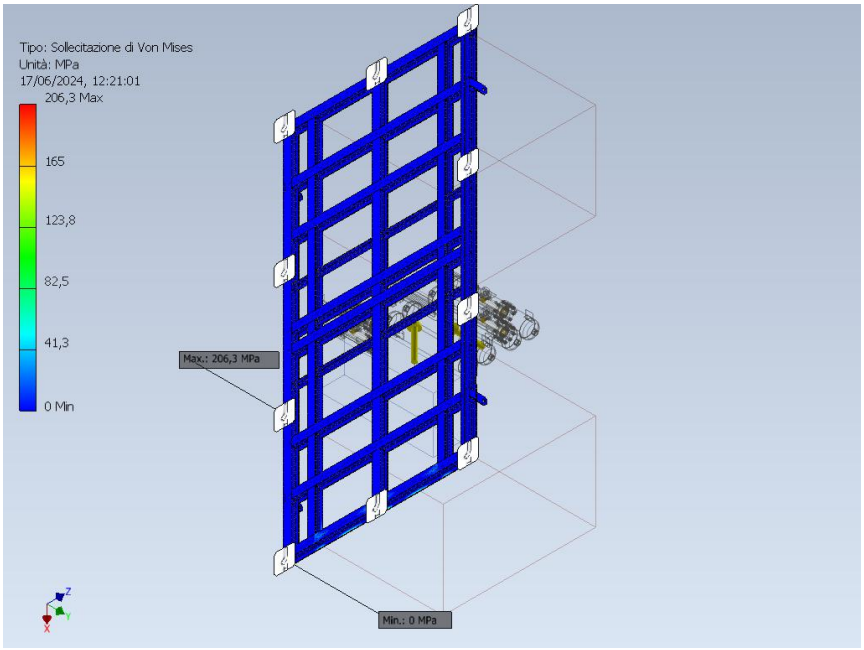
To be more conservative, transportation load and wind actions have been considered acting in the same direction for each calculation case.

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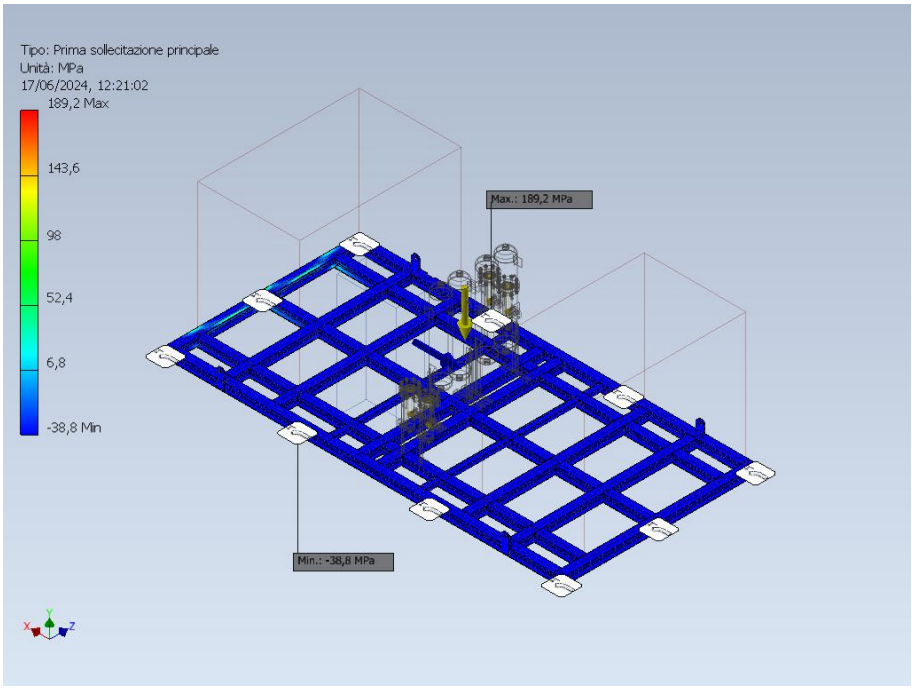
3.6.1 TRANSPORTATION LOAD + WIND (X- DIRECTION)

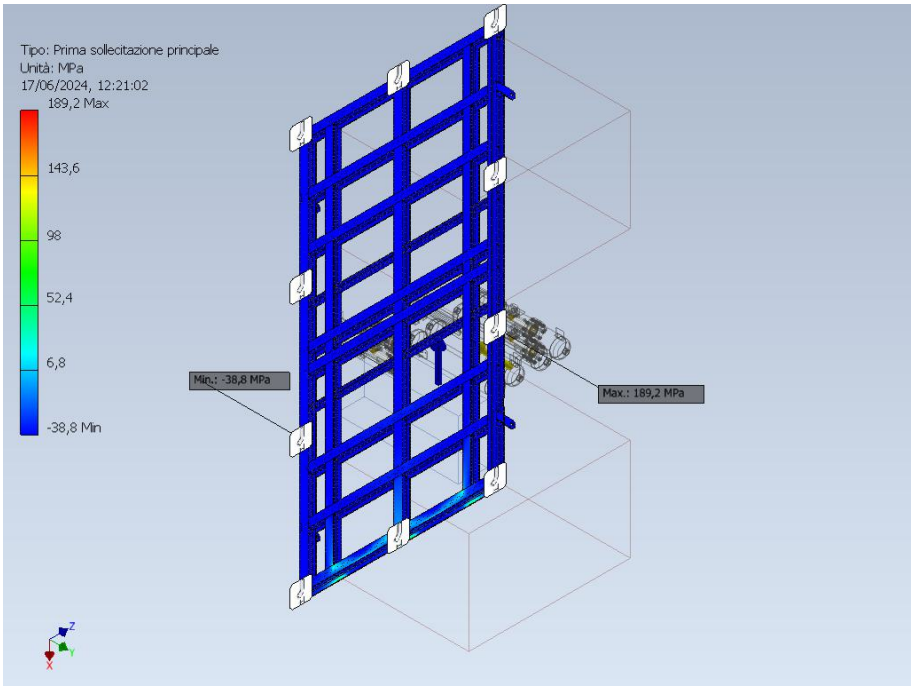
Von Mises stress



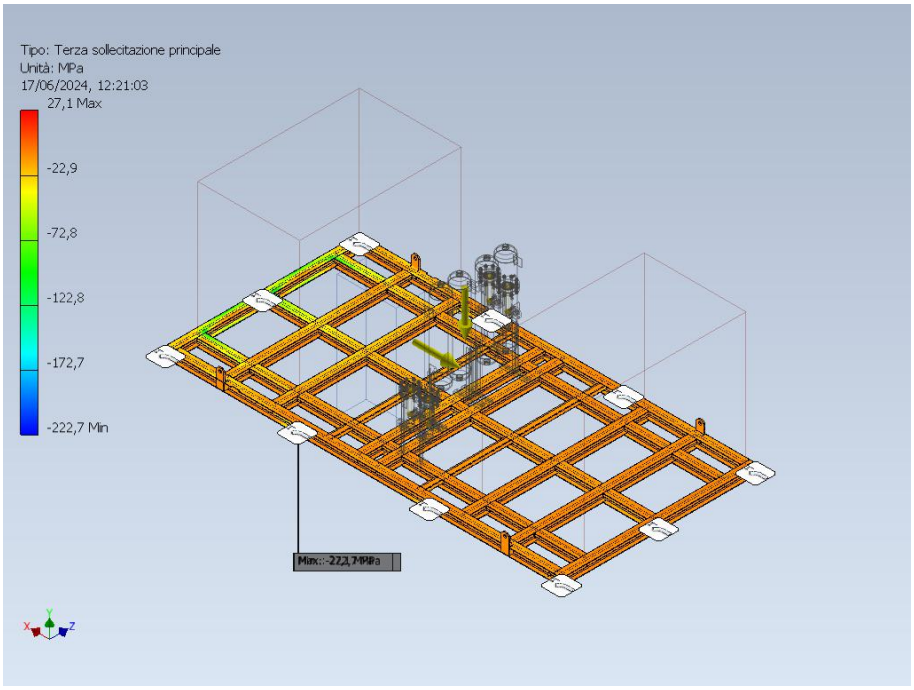


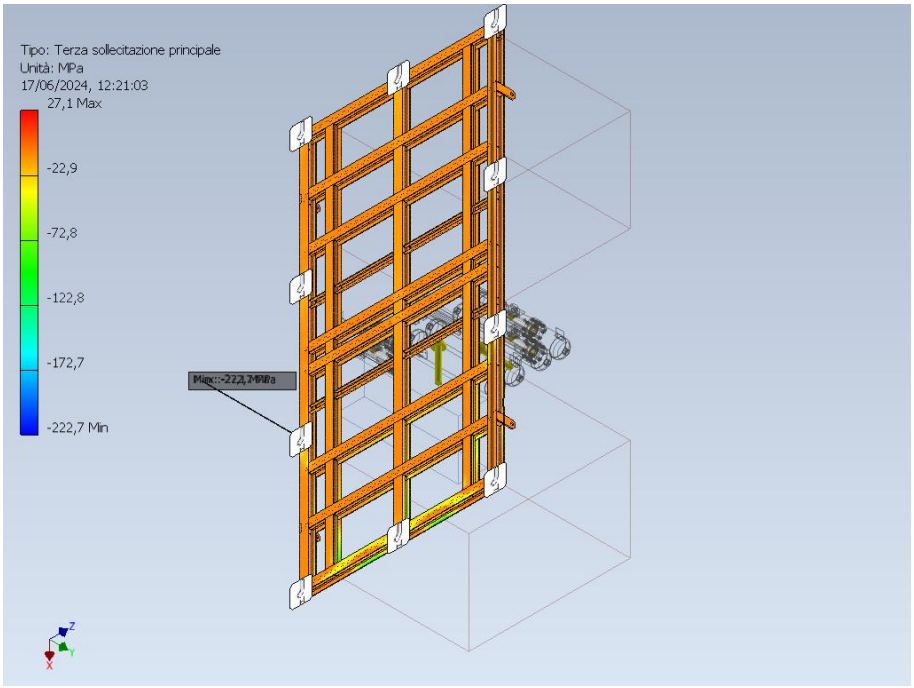
First principal stress



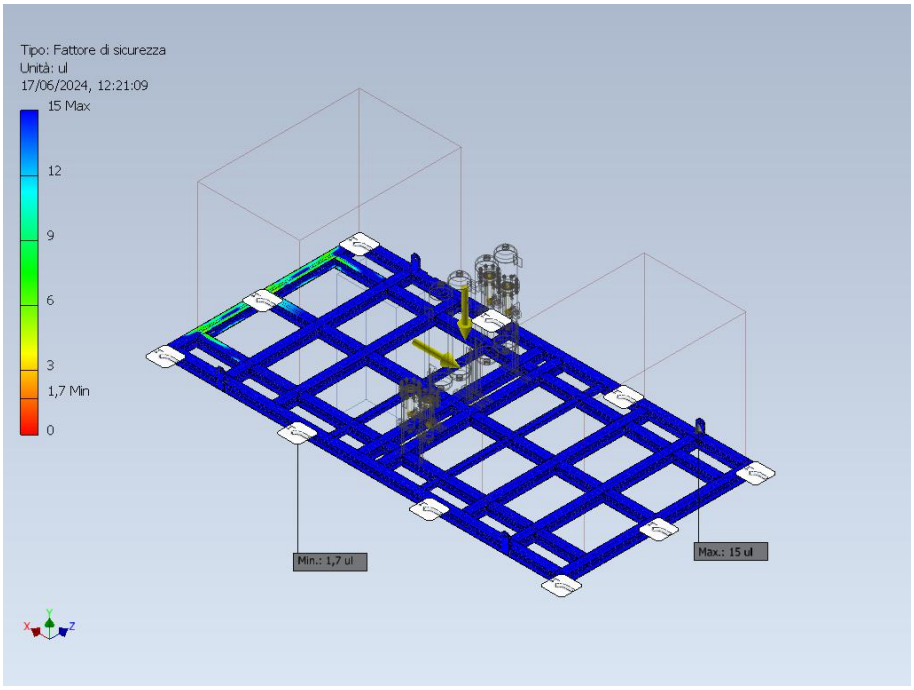


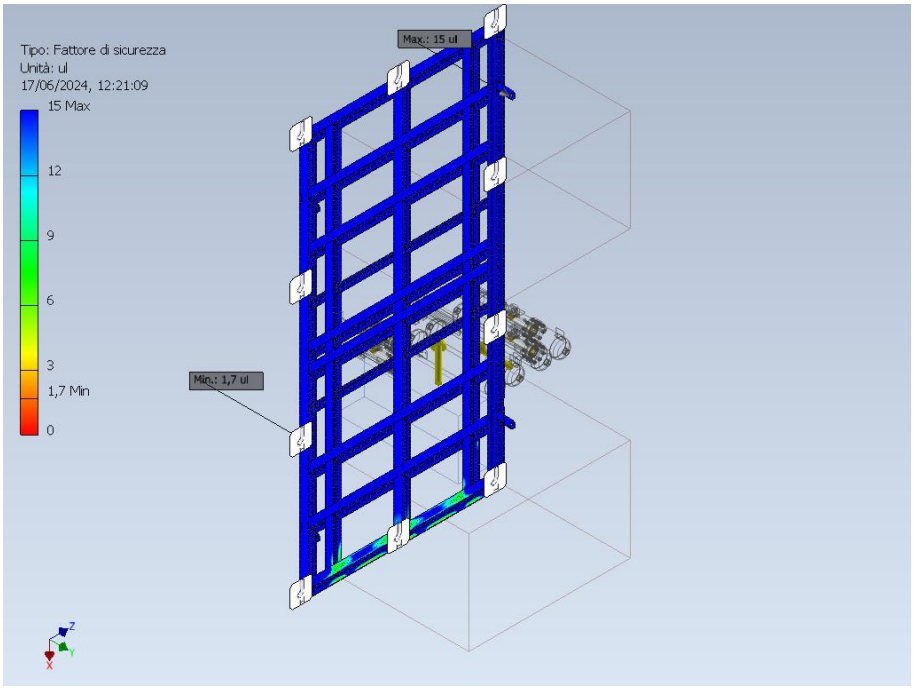
Third principal stress





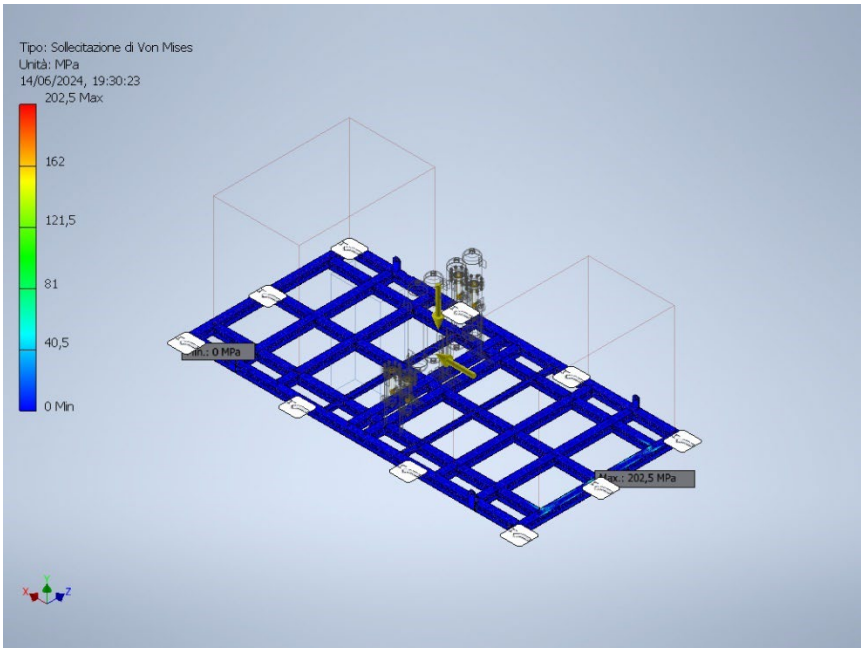
Safety factor

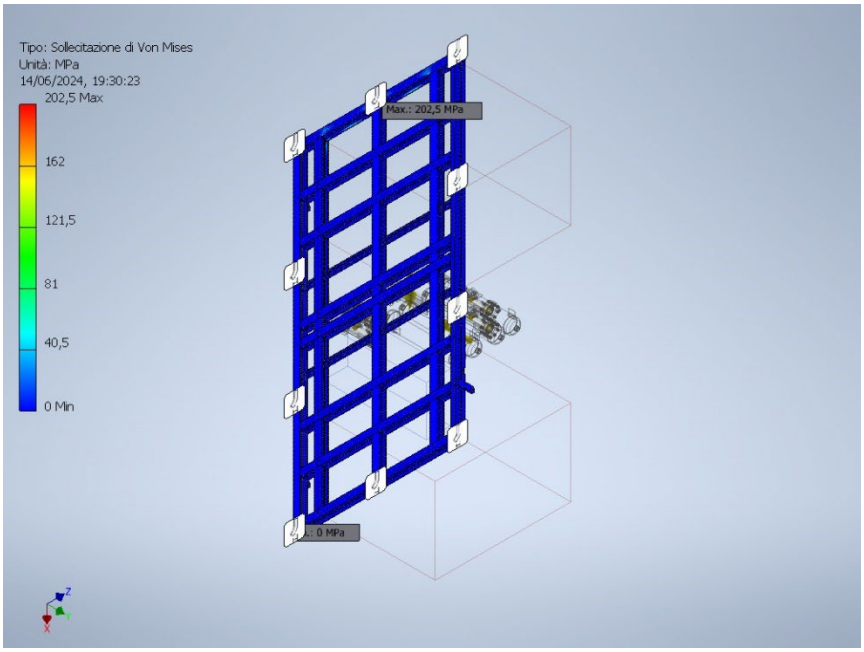




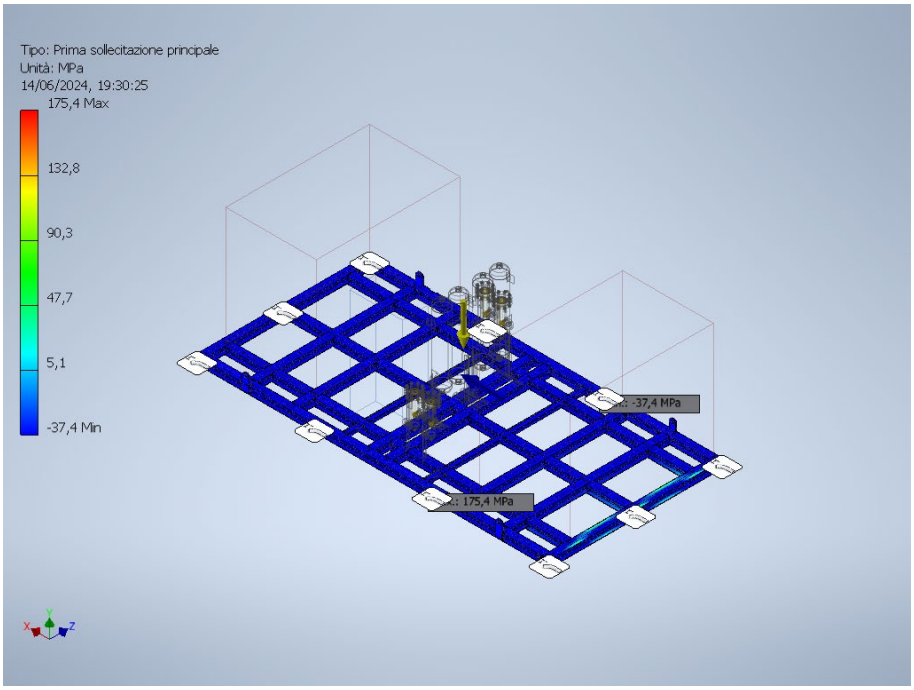
3.6.2 TRANSPORTATION LOAD + WIND (X+ DIRECTION)

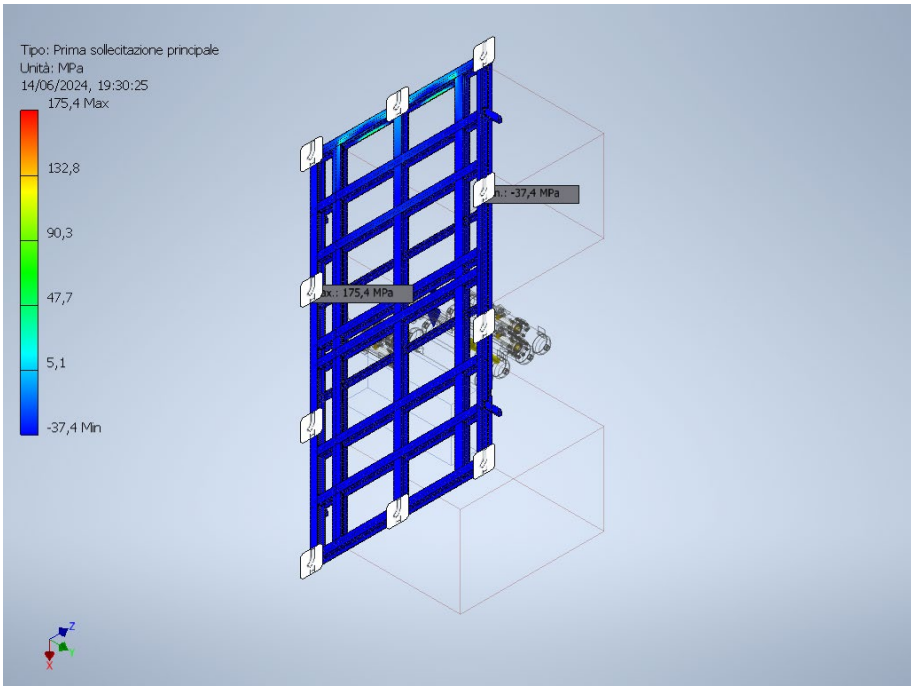
Von Mises stress



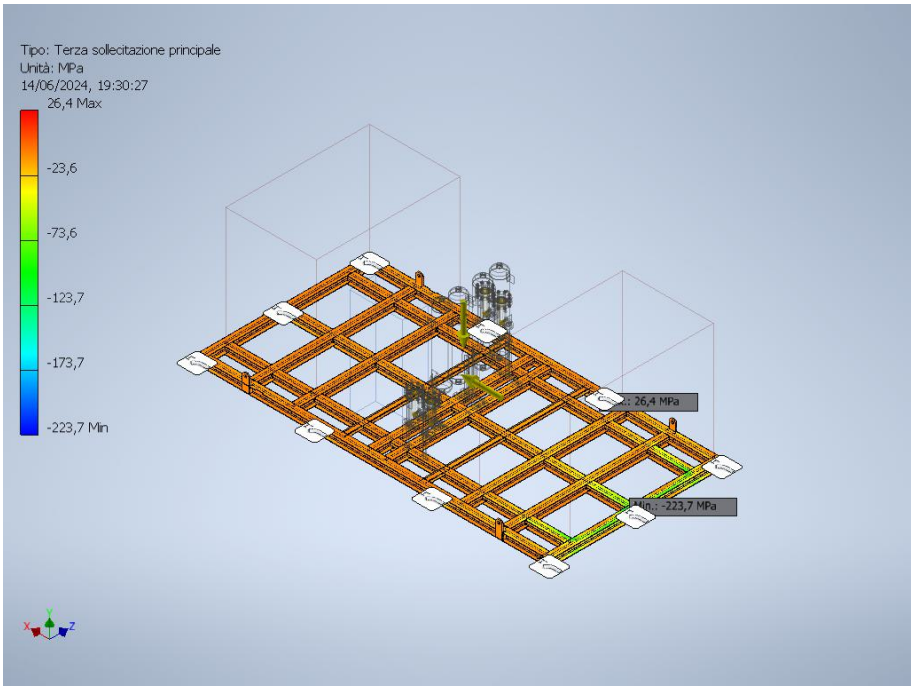


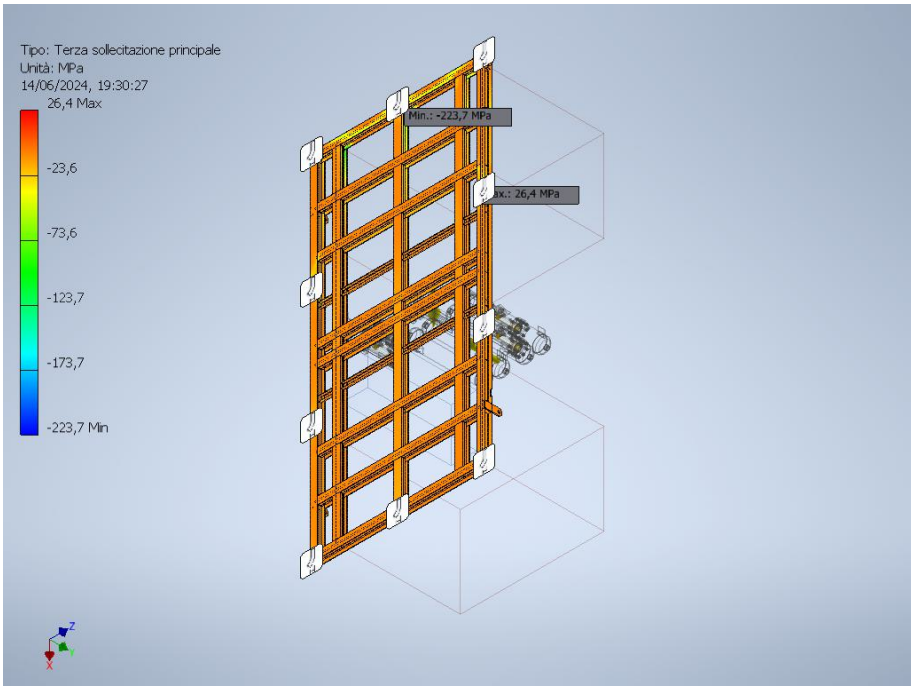
First principal stress



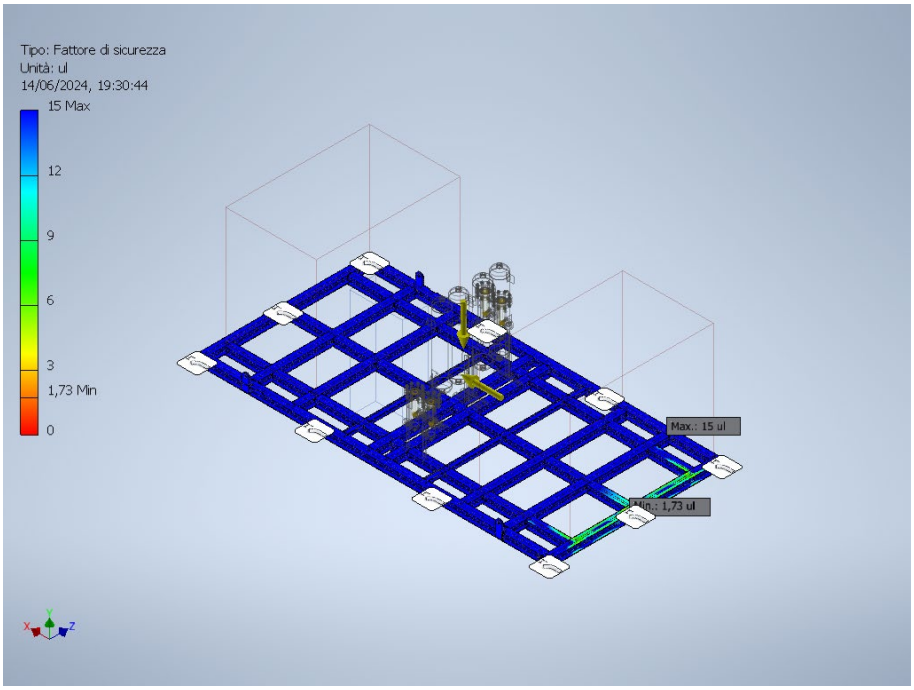


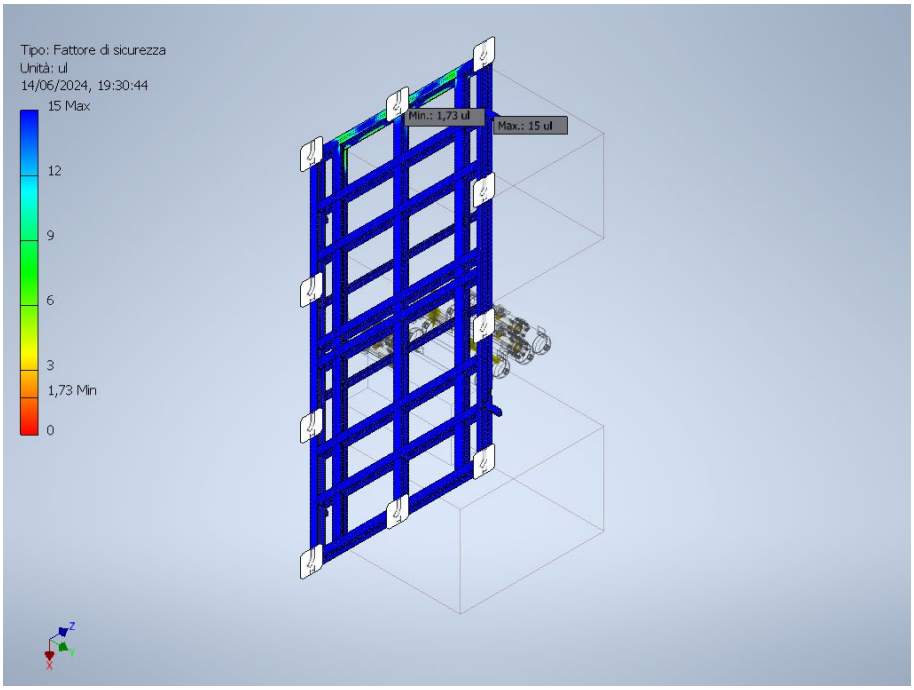
Third principal stress





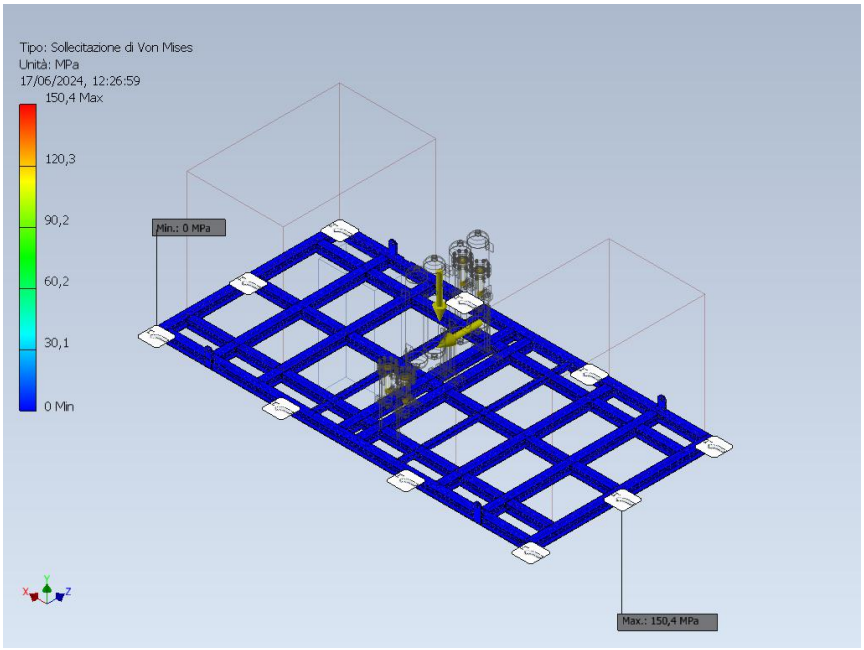
Safety factor

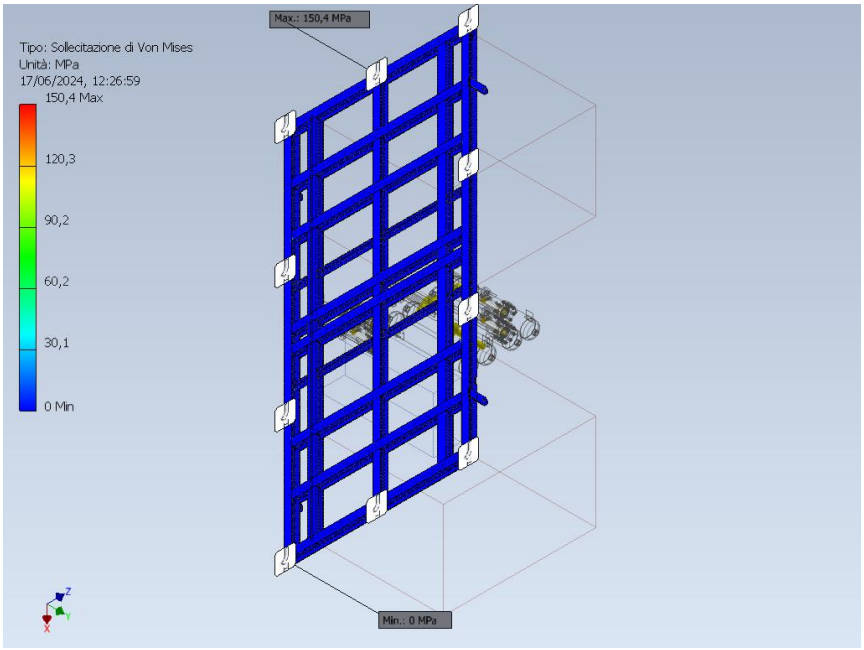




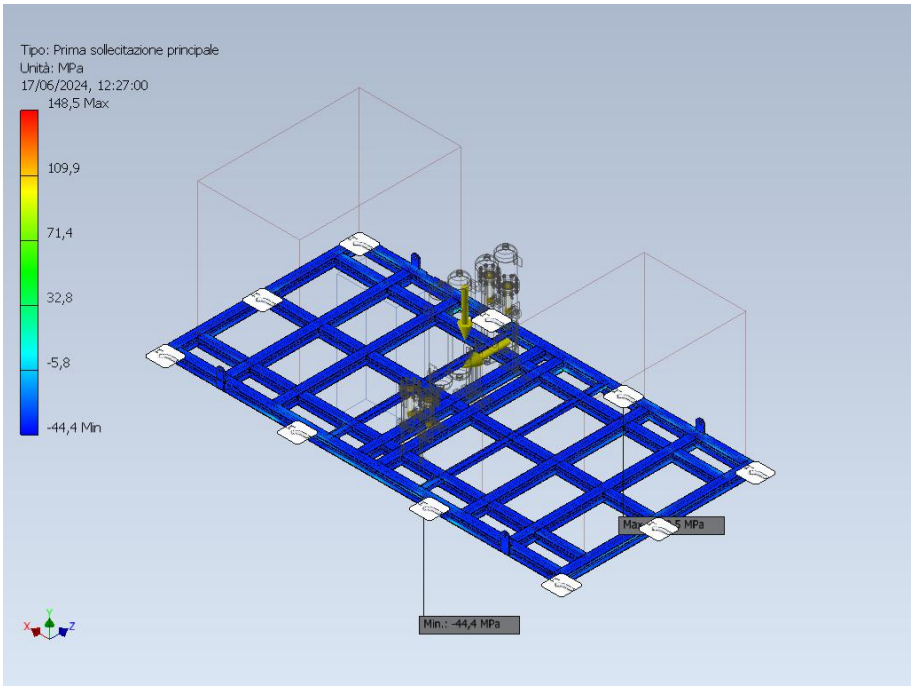
3.6.3 TRANSPORTATION LOAD + WIND (Z- DIRECTION)

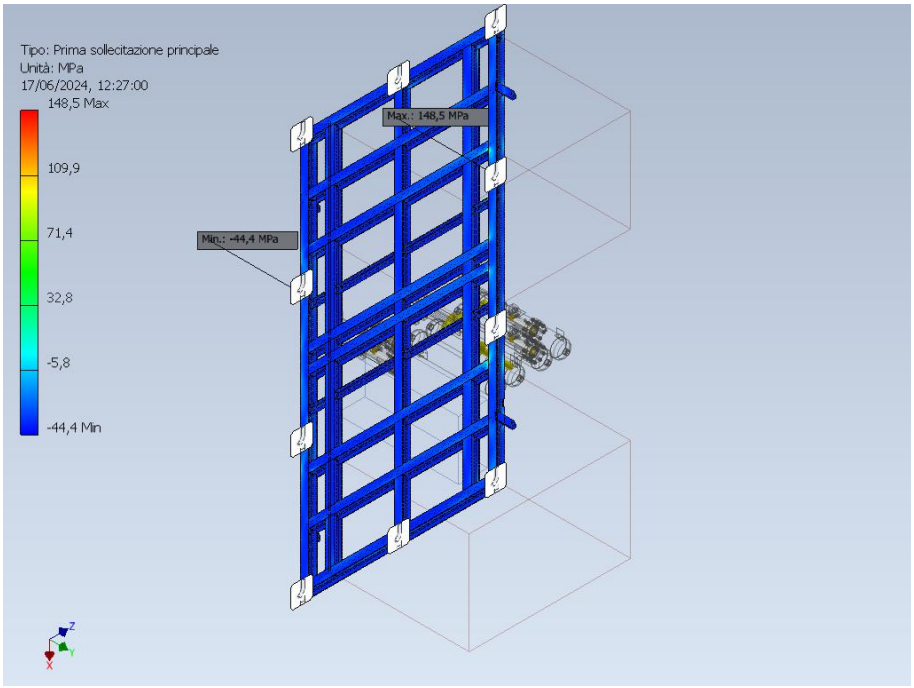
Von Mises stress



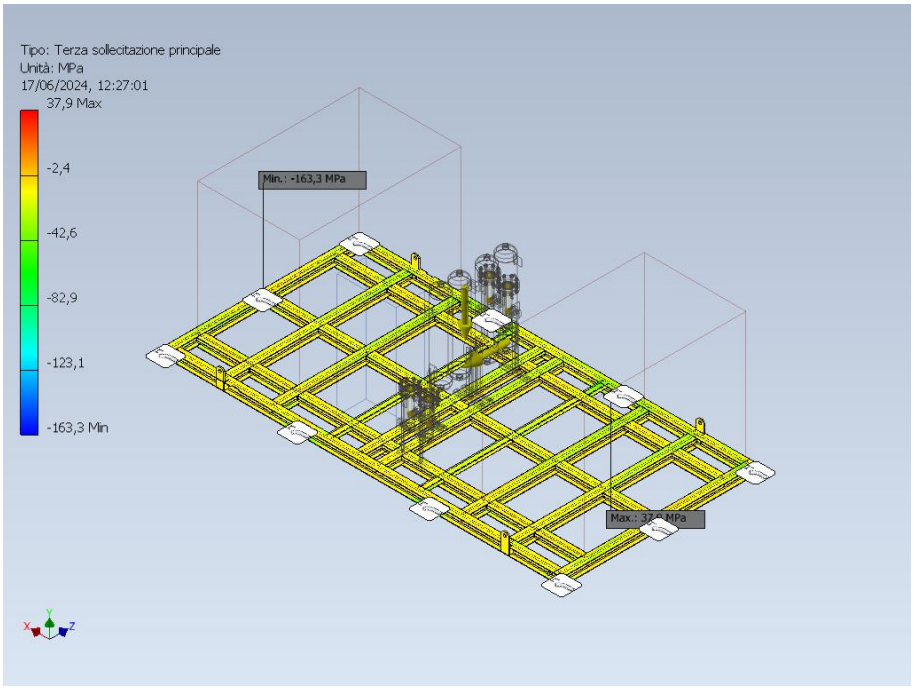


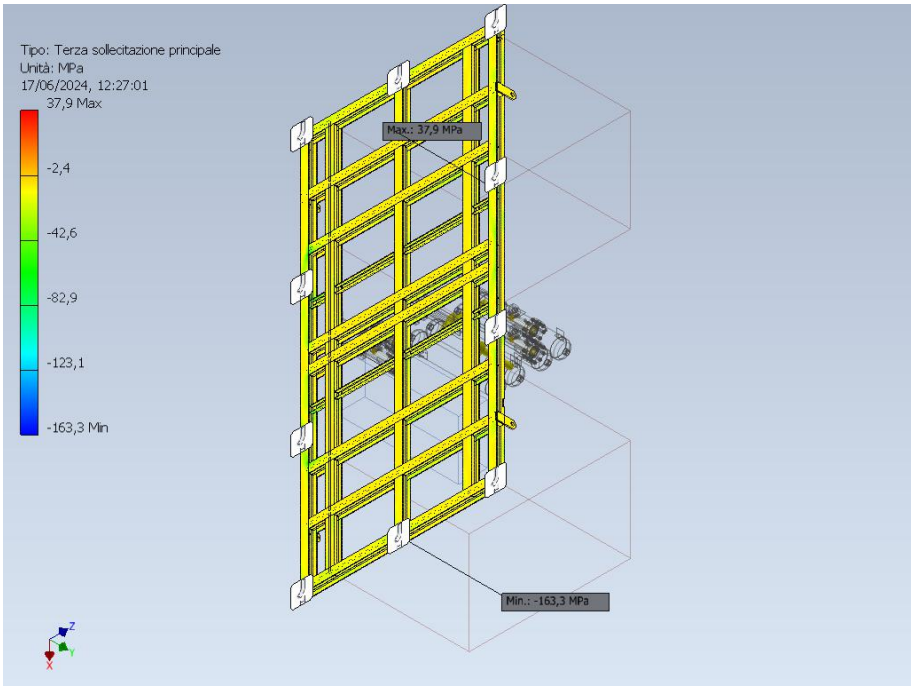
First principal stress



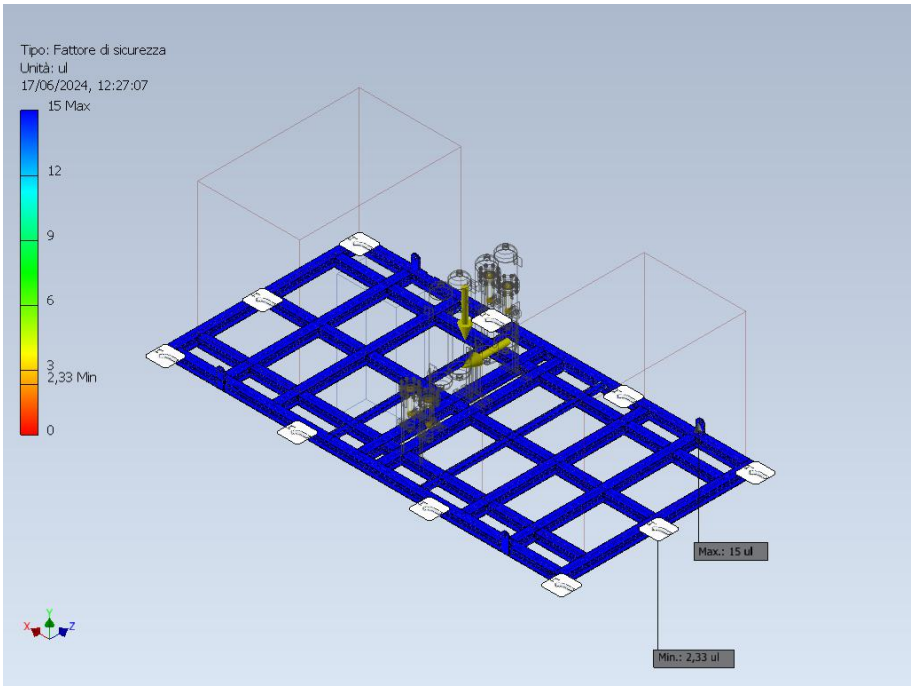


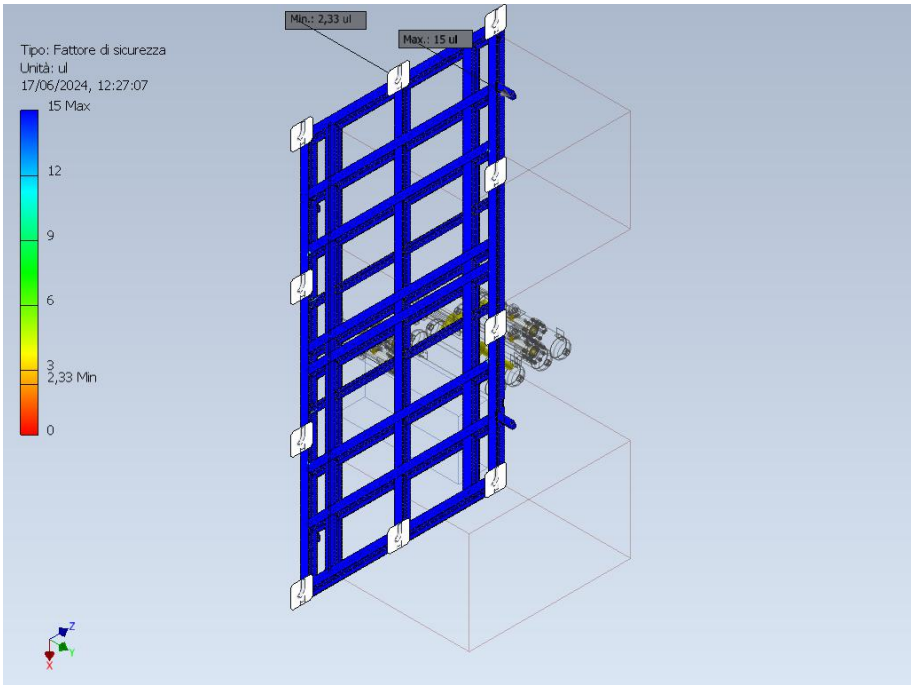
Third principal stress





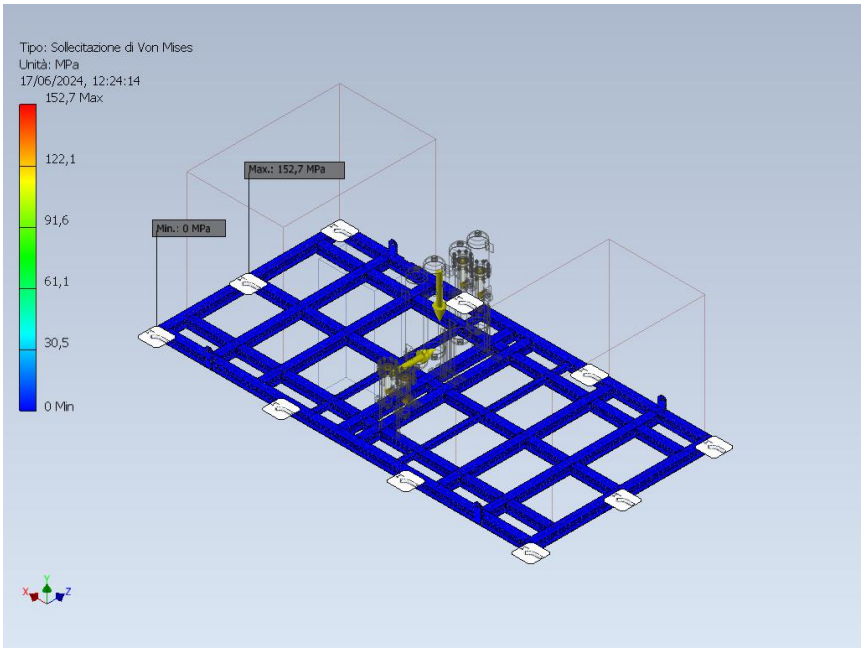
Safety factor

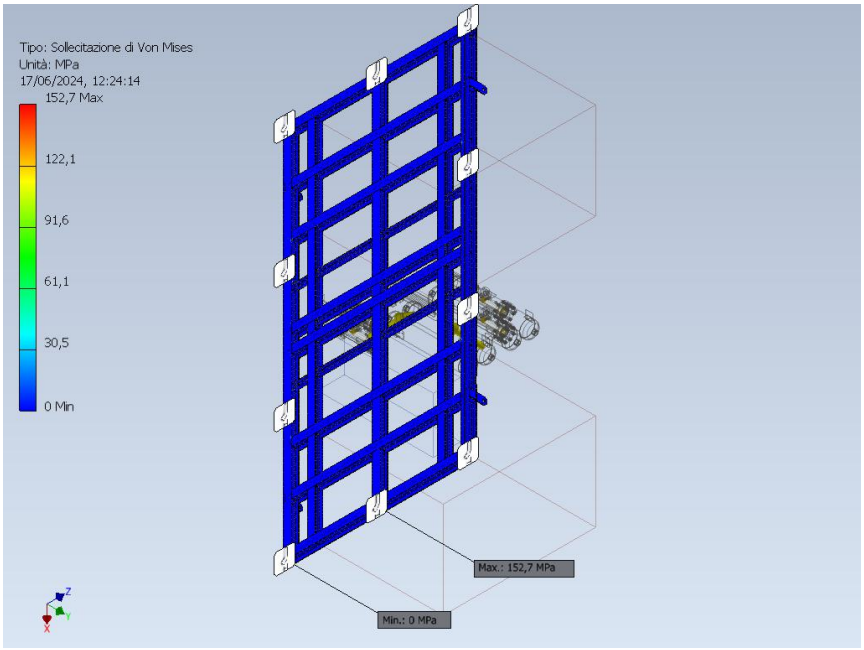




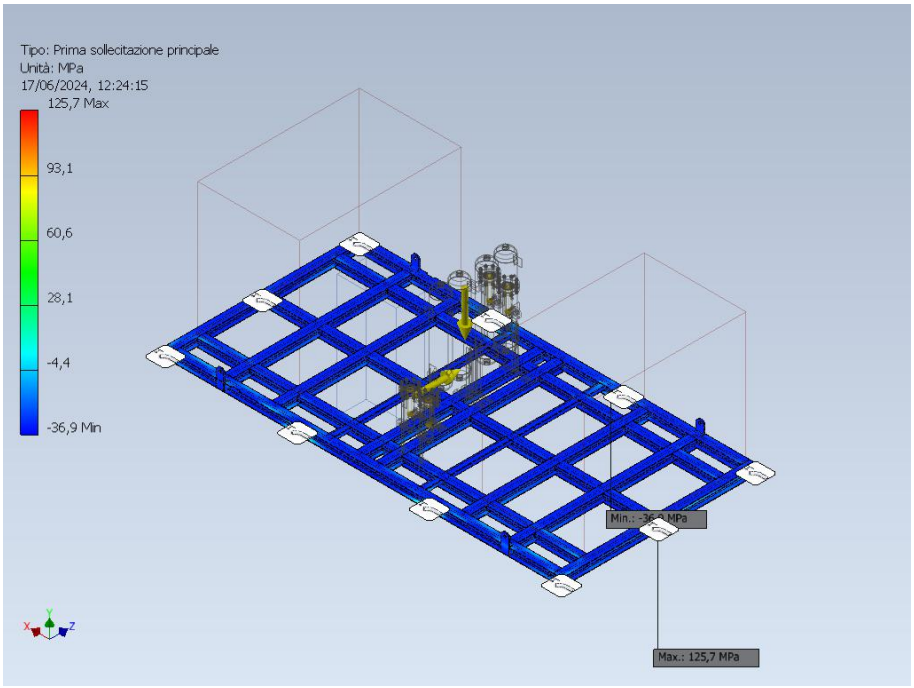
3.6.4 TRANSPORTATION LOAD + WIND (Z+ DIRECTION)

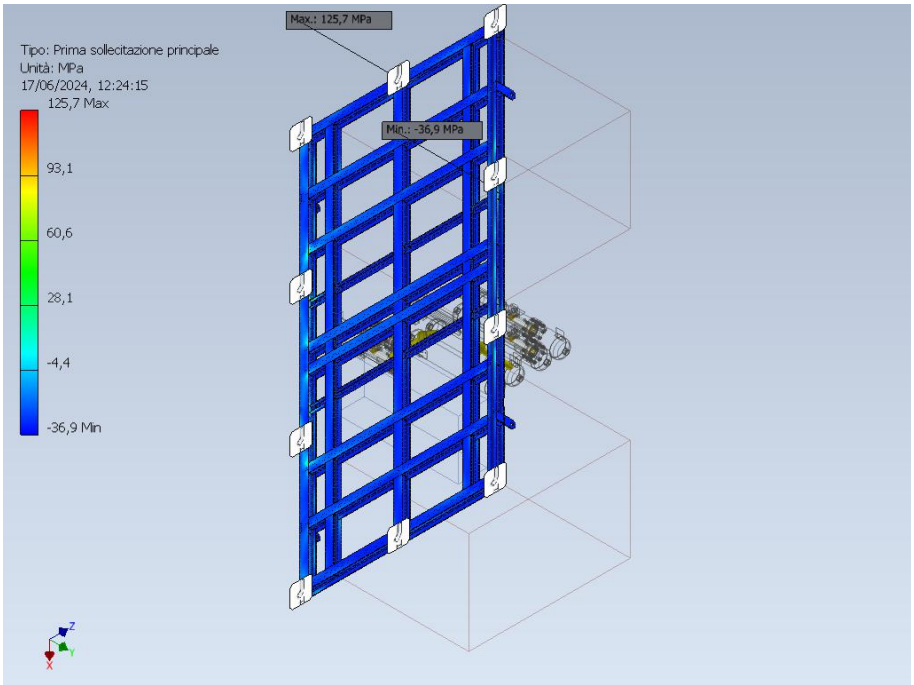
Von Mises stress



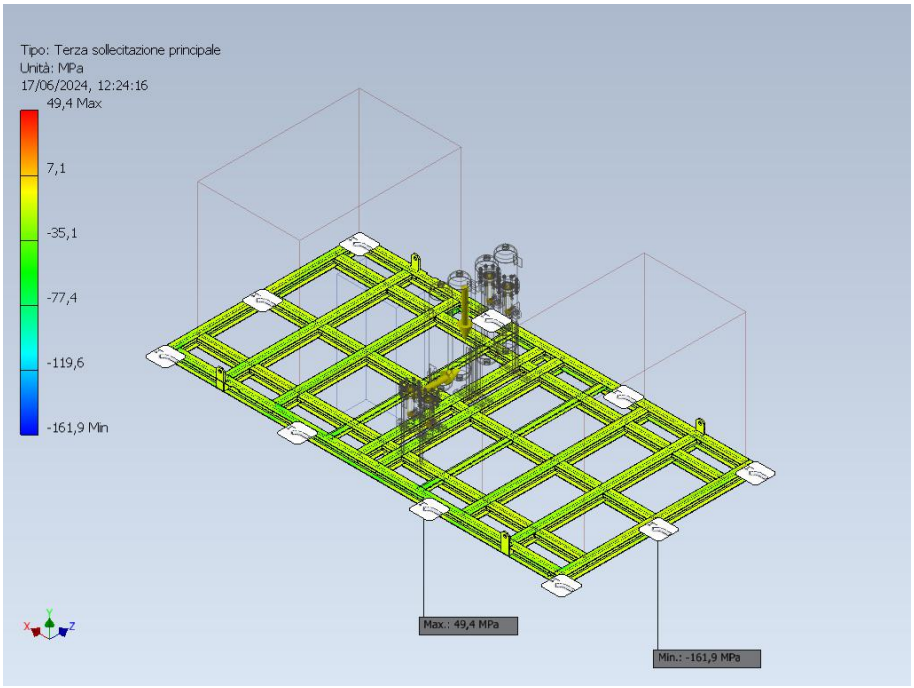


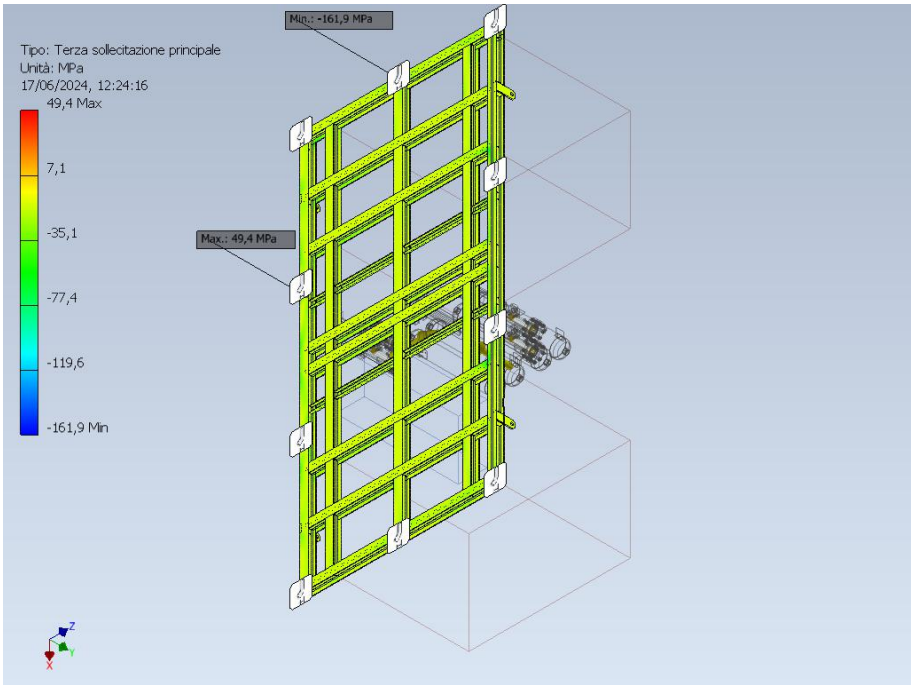
First principal stress



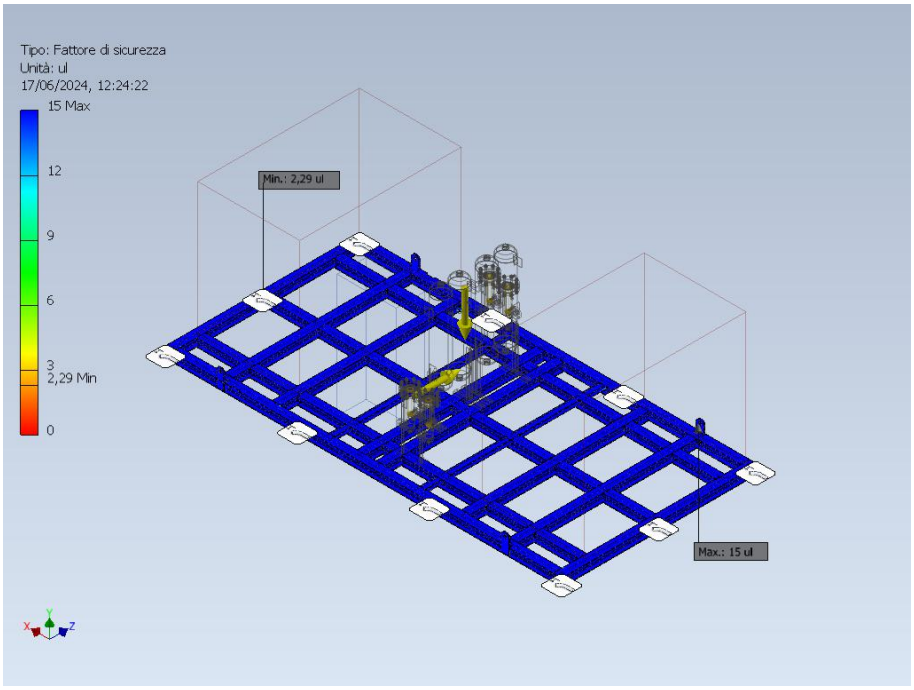


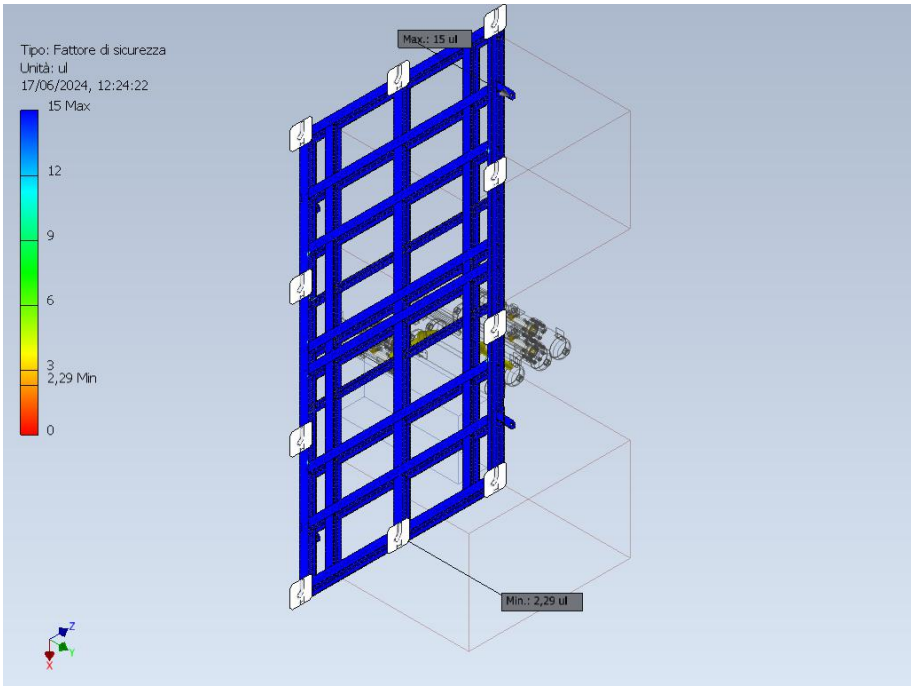
Third principal stress





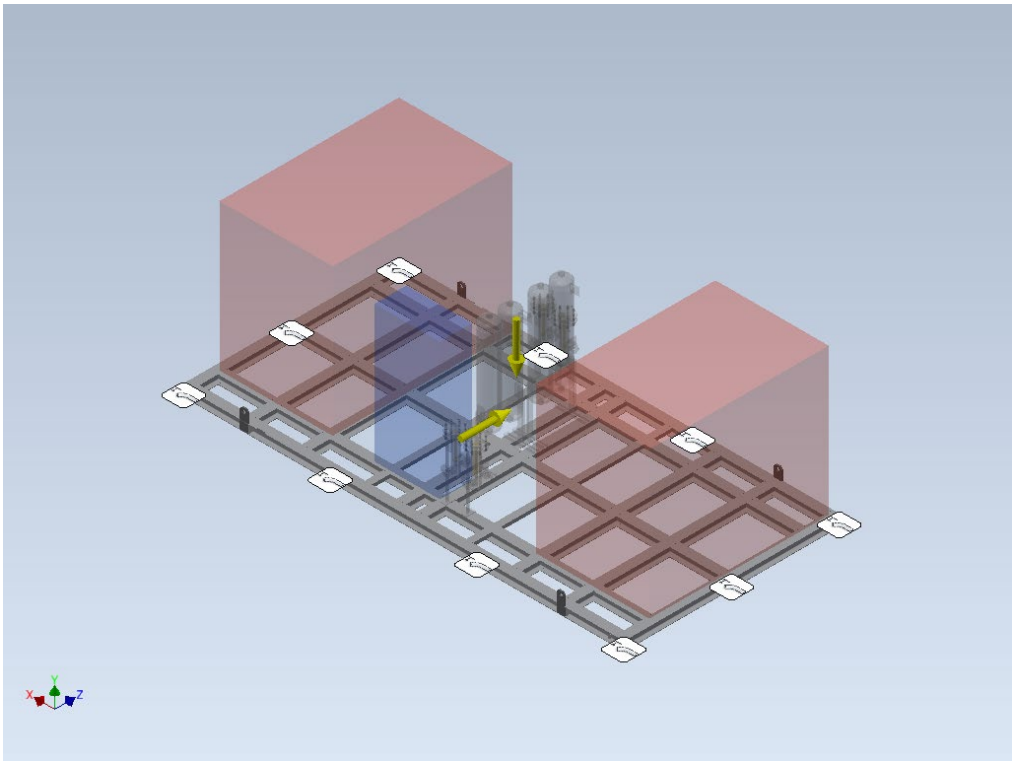
Safety factor





3.7 ANCHOR BOLTS CHECK

The skid is constrained to the main structure in no.10 points, by mean of M12 x 80 mm screws, in ASTM A 320 Gr. L7 steel.



The following tables show the valueas of the support reactions for each constraint in the Static + Wind load combination case and in the Transportation + Wind load combination case.

STATIC + WIND X+ DIRECTION				
Nome vincolo	Forza di reazione [N]		Momento di reazione [Nm]	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	4949,250	4757,380	60,994	-28,840
		-655,639		-36,985
		1196,910		38,996
Vincolo di fissaggio:2	13991,200	-11341,300	181,661	180,866
		6671,800		16,956
		-4755,790		-0,733
Vincolo di fissaggio:3	2899,660	-1730,870	64,379	64,293
		2149,980		-3,296
		-888,649		-0,466
Vincolo di fissaggio:4	1916,650	-1528,140	17,192	4,607
		628,246		8,698
		-971,424		-14,096
Vincolo di fissaggio:5	10503,400	-10424,800	20,309	0,542
		1282,690		-0,966
		0,000		-20,279
Vincolo di fissaggio:6	1907,020	-1512,500	18,162	-4,237
		630,081		-9,872
		975,730		-14,644
Vincolo di fissaggio:7	3027,210	-1885,820	64,231	-63,945
		2166,980		-2,865
		954,930		-5,336
Vincolo di fissaggio:8	14376,900	-11828,200	188,898	-185,329
		6677,420		-34,094
		4711,770		-13,164
Vincolo di fissaggio:9	4877,170	4615,520	55,942	26,237
		-675,540		37,945
		-1423,850		31,642
Vincolo di fissaggio:10	6890,600	3957,950	75,623	-0,663
		-5636,940		8,835
		199,719		75,102

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	4,76	X	0,18
Y	6,68	Y	0,04
Z	4,71	Z	0,08

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-11,83	X	-0,19
Y	-5,64	Y	-0,04
Z	-4,76	Z	-0,02

STATIC + WIND X- DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	1694,230	1306,830	17,087	4,237
		605,484		-8,415
		-892,188		14,254
Vincolo di fissaggio:2	3247,940	1891,640	60,067	59,521
		2281,940		-1,260
		-1328,000		7,985
Vincolo di fissaggio:3	14030,100	11825,000	203,171	199,768
		6545,650		-29,833
		-3763,880		21,941
Vincolo di fissaggio:4	5182,310	-5013,880	61,622	-27,814
		-646,018		41,178
		1140,160		-36,443
Vincolo di fissaggio:5	6970,480	-4144,800	77,861	2,820
		-5604,300		4,180
		0,000		-77,697
Vincolo di fissaggio:6	4854,550	-4655,030	58,551	29,854
		-658,940		-35,960
		-1209,610		-35,269
Vincolo di fissaggio:7	14169,700	11956,100	200,965	-200,452
		6560,910		12,802
		3845,270		6,489
Vincolo di fissaggio:8	3287,690	2003,800	61,235	-60,965
		2271,300		-3,860
		1278,610		4,257
Vincolo di fissaggio:9	1812,240	1430,970	16,456	-4,350
		611,817		8,006
		928,551		13,703
Vincolo di fissaggio:10	10396,200	10318,800	19,851	-0,324
		1266,490		-0,650
		0,000		19,838

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	11,96	X	0,20
Y	6,56	Y	0,04
Z	3,85	Z	0,02

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-5,01	X	-0,20
Y	-5,60	Y	-0,04
Z	-3,76	Z	-0,08

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STATIC + WIND Z+ DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	4243,93	3523,13	19,69	6,47
		852,01		8,63
		-2207,38		16,48
Vincolo di fissaggio:2	13945,50	182,17	55,77	-26,76
		4277,29		-20,98
		-13272,10		44,20
Vincolo di fissaggio:3	11360,80	1141,69	50,63	24,10
		3819,92		29,27
		-10638,20		-33,56
Vincolo di fissaggio:4	4916,70	-4204,56	19,40	7,17
		918,67		-3,58
		-2377,33		-17,67
Vincolo di fissaggio:5	8127,90	-6164,71	90,47	6,67
		2935,14		-32,25
		-4409,55		-84,27
Vincolo di fissaggio:6	1606,29	1377,87	50,37	-15,47
		324,61		47,50
		759,13		-6,48
Vincolo di fissaggio:7	6361,49	-3812,44	206,35	-180,29
		-1350,11		92,62
		4910,30		38,68
Vincolo di fissaggio:8	6035,97	3803,36	192,11	-154,43
		-1668,83		-101,32
		4379,77		-52,84
Vincolo di fissaggio:9	1891,63	-1793,52	49,46	-14,86
		172,32		-46,98
		576,09		4,30
Vincolo di fissaggio:10	8003,82	5945,88	86,61	6,44
		2892,79		27,63
		-4509,93		81,83

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	5,95	X	0,02
Y	4,28	Y	0,09
Z	4,91	Z	0,08

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-6,16	X	-0,18
Y	-1,67	Y	-0,10
Z	-13,27	Z	-0,08

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STATIC + WIND Z- DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	1718,850	-1596,250	47,538	15,438
		205,977		44,751
		-603,325		4,342
Vincolo di fissaggio:2	5572,190	3620,300	200,141	175,914
		-1704,920		86,304
		-3877,610		-40,773
Vincolo di fissaggio:3	6771,460	-4091,990	210,426	171,794
		-1332,830		-110,001
		-5227,980		51,633
Vincolo di fissaggio:4	1760,270	1578,480	50,984	14,802
		281,633		-48,336
		-726,376		-6,627
Vincolo di fissaggio:5	8051,320	-6118,360	88,046	-6,545
		2923,570		26,554
		4340,760		-83,691
Vincolo di fissaggio:6	4738,160	-4014,390	19,626	-6,156
		903,778		3,687
		2349,040		-18,267
Vincolo di fissaggio:7	11596,100	904,238	46,016	-17,514
		3875,360		-28,879
		10891,900		-31,252
Vincolo di fissaggio:8	13477,400	-51,752	58,133	6,632
		4214,900		23,844
		12801,300		52,602
Vincolo di fissaggio:9	4453,900	3748,990	19,987	-6,693
		872,450		-8,404
		2240,790		16,854
Vincolo di fissaggio:10	8084,300	6018,690	88,641	-6,285
		2904,480		-31,684
		4549,220		82,546

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	6,02	X	0,18
Y	4,21	Y	0,09
Z	12,80	Z	0,08

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-6,12	X	-0,02
Y	-1,70	Y	-0,11
Z	-5,23	Z	-0,08

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TRANSPORTATION + WIND X+ DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	6699,080	-2659,620	55,082	-54,696
		-3261,280		2,685
		5212,310		-5,924
Vincolo di fissaggio:2	22744,800	-20711,000	209,280	204,727
		7543,060		42,482
		-5610,780		8,951
Vincolo di fissaggio:3	9394,000	-7736,280	142,781	141,971
		5243,880		11,469
		-948,113		9,958
Vincolo di fissaggio:4	8095,720	-7429,950	65,512	15,405
		2255,900		39,220
		-2290,730		-50,163
Vincolo di fissaggio:5	13265,900	-13181,400	22,406	0,665
		1493,600		-1,672
		-60,844		-22,334
Vincolo di fissaggio:6	7993,760	-7351,920	70,490	-14,228
		2252,810		-45,349
		2185,040		-52,056
Vincolo di fissaggio:7	9769,780	-8183,080	145,102	-142,870
		5270,000		-25,334
		844,291		-0,962
Vincolo di fissaggio:8	23392,900	-21452,400	217,533	-208,646
		7536,120		-61,318
		5497,910		-5,238
Vincolo di fissaggio:9	6791,900	-2848,390	52,717	51,053
		-3273,390		1,471
		-5225,080		-13,056
Vincolo di fissaggio:10	15965,600	-10763,600	14,628	0,882
		-11785,200		12,448
		391,223		-7,632

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-2,66	X	0,20
Y	7,54	Y	0,04
Z	5,50	Z	0,01

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-21,45	X	-0,21
Y	-11,79	Y	-0,06
Z	-5,61	Z	-0,05

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TRANSPORTATION + WIND X- DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	7803,940	7151,210	67,964	14,595
		2232,540		-41,592
		-2185,700		51,732
Vincolo di fissaggio:2	9831,320	8054,730	133,894	131,919
		5397,730		-22,466
		-1625,040		4,492
Vincolo di fissaggio:3	22915,400	21202,500	230,017	222,493
		7391,700		-56,540
		-4575,230		14,421
Vincolo di fissaggio:4	6490,930	2313,180	54,596	-53,684
		-3239,900		6,845
		5126,830		7,204
Vincolo di fissaggio:5	15817,300	10582,400	11,491	0,964
		-11753,700		10,178
		227,301		5,245
Vincolo di fissaggio:6	6588,810	2796,170	56,731	55,491
		-3243,800		6,430
		-5007,150		9,888
Vincolo di fissaggio:7	23275,100	21576,400	227,655	-224,489
		7406,530		37,742
		4618,620		-2,653
Vincolo di fissaggio:8	9973,080	8284,330	136,738	-136,308
		5387,650		9,862
		1343,650		-4,494
Vincolo di fissaggio:9	7935,240	7306,910	65,384	-14,557
		2233,820		40,082
		2141,750		49,564
Vincolo di fissaggio:10	13131,700	13049,400	21,472	-0,410
		1466,810		-0,247
		-62,622		21,467

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	21,58	X	0,22
Y	7,41	Y	0,04
Z	5,13	Z	0,05

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	2,31	X	-0,22
Y	-11,75	Y	-0,06
Z	-5,01	Z	0,00

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TRANSPORTATION + WIND Z+ DIRECTION				
Nome vincolo	Forza di reazione		Momento di reazione	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)
Vincolo di fissaggio:1	13883,500	6453,080	126,358	58,952
		5752,580		54,751
		-10863,500		97,434
Vincolo di fissaggio:2	17457,900	-1544,810	99,318	-84,267
		3856,120		-24,649
		-16956,400		46,427
Vincolo di fissaggio:3	14858,100	2907,540	66,228	-27,866
		3406,230		43,345
		-14167,100		-41,603
Vincolo di fissaggio:4	14370,700	-7318,380	127,968	61,847
		5828,200		-57,780
		-10908,300		-95,980
Vincolo di fissaggio:5	10525,400	-4873,780	169,644	-14,530
		8495,030		-46,376
		-3855,380		-162,534
Vincolo di fissaggio:6	10889,000	8427,610	62,175	1,310
		-2678,740		-4,779
		-6353,730		61,977
Vincolo di fissaggio:7	13231,500	-5826,380	75,024	-12,838
		-8235,110		63,320
		-8562,040		38,135
Vincolo di fissaggio:8	14079,900	5690,480	71,236	-1,386
		-8554,510		-49,256
		-9627,180		-51,444
Vincolo di fissaggio:9	11158,100	-8522,300	61,205	4,661
		-2768,530		9,644
		-6648,980		-60,260
Vincolo di fissaggio:10	10539,900	4607,480	164,298	-17,410
		8470,170		33,026
		-4256,380		160,000

MAX			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	8,43	X	0,06
Y	8,50	Y	0,06
Z	-3,86	Z	0,16

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-8,52	X	-0,08
Y	-8,55	Y	-0,06
Z	-16,96	Z	-0,16

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TRANSPORTATION + WIND Z- DIRECTION					MAX			
Nome vincolo	Forza di reazione		Momento di reazione		Forza di reazione [kN]		Momento di reazione [kNm]	
	Intensità	Componente (X,Y,Z)	Intensità	Componente (X,Y,Z)		Componente (X,Y,Z)		Componente (X,Y,Z)
Vincolo di fissaggio:1	10845,000	-8188,600	63,143	-2,352	X	8,75	X	0,06
		-2738,080		-8,180	Y	8,49	Y	0,05
		6562,220		-62,567	Z	16,31	Z	0,16
Vincolo di fissaggio:2	14501,800	5323,580	69,511	27,864				
		-8624,450		46,969				
		10372,100		-43,004				
Vincolo di fissaggio:3	13092,900	-6201,440	78,799	3,979				
		-8177,300		-65,558				
		8130,000		43,539				
Vincolo di fissaggio:4	11172,000	8746,000	59,448	-5,691				
		-2714,230		4,337				
		6399,520		59,016				
Vincolo di fissaggio:5	10469,500	-4814,140	165,599	17,294				
		8488,660		30,534				
		3791,630		-161,838				
Vincolo di fissaggio:6	14240,800	-7107,780	127,704	-58,323				
		5809,460		52,173				
		10887,100		-100,919				
Vincolo di fissaggio:7	15136,600	2652,550	62,604	37,084				
		3467,010		-37,355				
		14493,500		-33,891				
Vincolo di fissaggio:8	16834,800	-1782,720	90,580	58,605				
		3785,420		33,132				
		16306,600		60,601				
Vincolo di fissaggio:9	14009,200	6658,210	131,162	-59,149				
		5777,160		-64,046				
		10888,100		97,995				
Vincolo di fissaggio:10	10628,000	4712,820	168,349	14,953				
		8485,690		-45,626				
		4328,570		161,357				

min			
Forza di reazione [kN]		Momento di reazione [kNm]	
	Componente (X,Y,Z)		Componente (X,Y,Z)
X	-8,19	X	-0,06
Y	-8,62	Y	-0,07
Z	3,79	Z	-0,16

The bolt strength has been verified with respect to the combined tension and shear effects, according to Eurocode EC3.

	Bolt Class	Bolt diameter	Fx [kN]	Fy [kN]	Fz [kN]
Static + wind Max	8.8	M12	11,96	6,68	12,80
Transportation + wind Max	8.8	M12	21,58	8,50	16,31
Static + wind min	8.8	M12	-11,83	-5,64	-13,27
Transportation + wind min	8.8	M12	-21,45	-11,79	-16,96

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Bolt verification Procedure (according to EC3)

Type	Bolt						Nominal Tensile Strength	Yield strength	Resistance factor	Partial Safety factor
	Bolt Class	Bolt diameter	A_{bolt}	A_{res}	A_{res}/A_{bolt}	k2 for normal bolts	f_{tb}	f_{yb}	α_v	γ_{M2}
		[mm]	[mm2]	[mm2]			[MPa]	[MPa]		
Static + wind Max	8.8	M12	113	84,3	0,746	0,9	895	585	0,6	1,25
Transportation + wind Max	8.8	M12	113	84,3	0,746	0,9	895	585	0,6	1,25
Static + wind min	8.8	M12	113	84,3	0,746	0,9	895	585	0,6	1,25
Transportation + wind min	8.8	M12	113	84,3	0,746	0,9	895	585	0,6	1,25

Bolt verification Procedure (according to EC3)

Type	Bolt Class	Bolt diameter	Tension demand $F_{t,Ed}$	Shear demand $F_{v,Ed}$	Tension resistance $F_{t,Rd}$	Shear resistance $F_{v,Rd}$
		[mm]	[kN]	[kN]	[kN]	[kN]
Static + wind Max	8.8	M12	6,68	12,80	54,32	36,22
Transportation + wind Max	8.8	M12	8,50	21,58	54,32	36,22
Static + wind min	8.8	M12	5,64	11,83	54,32	36,22
Transportation + wind min	8.8	M12	11,79	16,96	54,32	36,22

Bolt verification Procedure (according to EC3)

Type	Bolt Class	Bolt diameter	Tension check $F_{t,Ed}/F_{t,Rd} < 1$	Shear check $F_{v,Ed}/F_{v,Rd} < 1$	Combined Shear and tension check $F_{v,Ed}/F_{v,Rd} + F_{t,Ed}/1,4\,F_{t,Rd} \leq 1,0$
		[mm]			
Static + wind Max	8.8	M12	Ok	Ok	Ok
Transportation + wind Max	8.8	M12	Ok	Ok	Ok
Static + wind min	8.8	M12	Ok	Ok	Ok
Transportation + wind min	8.8	M12	Ok	Ok	Ok

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3.8 CONCLUSIONS

The analysis shown that the stresses are below the allowable ones, in each of the load combination cases.

- the maximum calculated Von Mises Stress is equal to 206,296 MPa

- the maximum calculated First Principal Stress is equal to 189,243 MPa

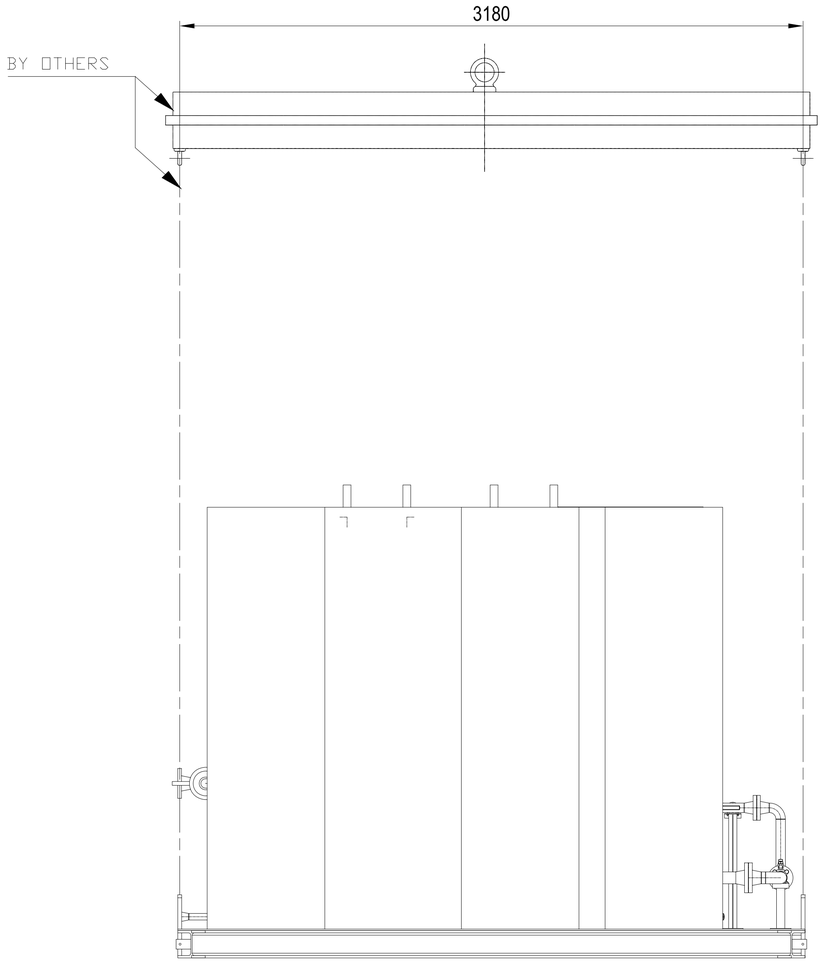
- the maximum calculated Third Principal Stress is equal to 49,3885 MPa

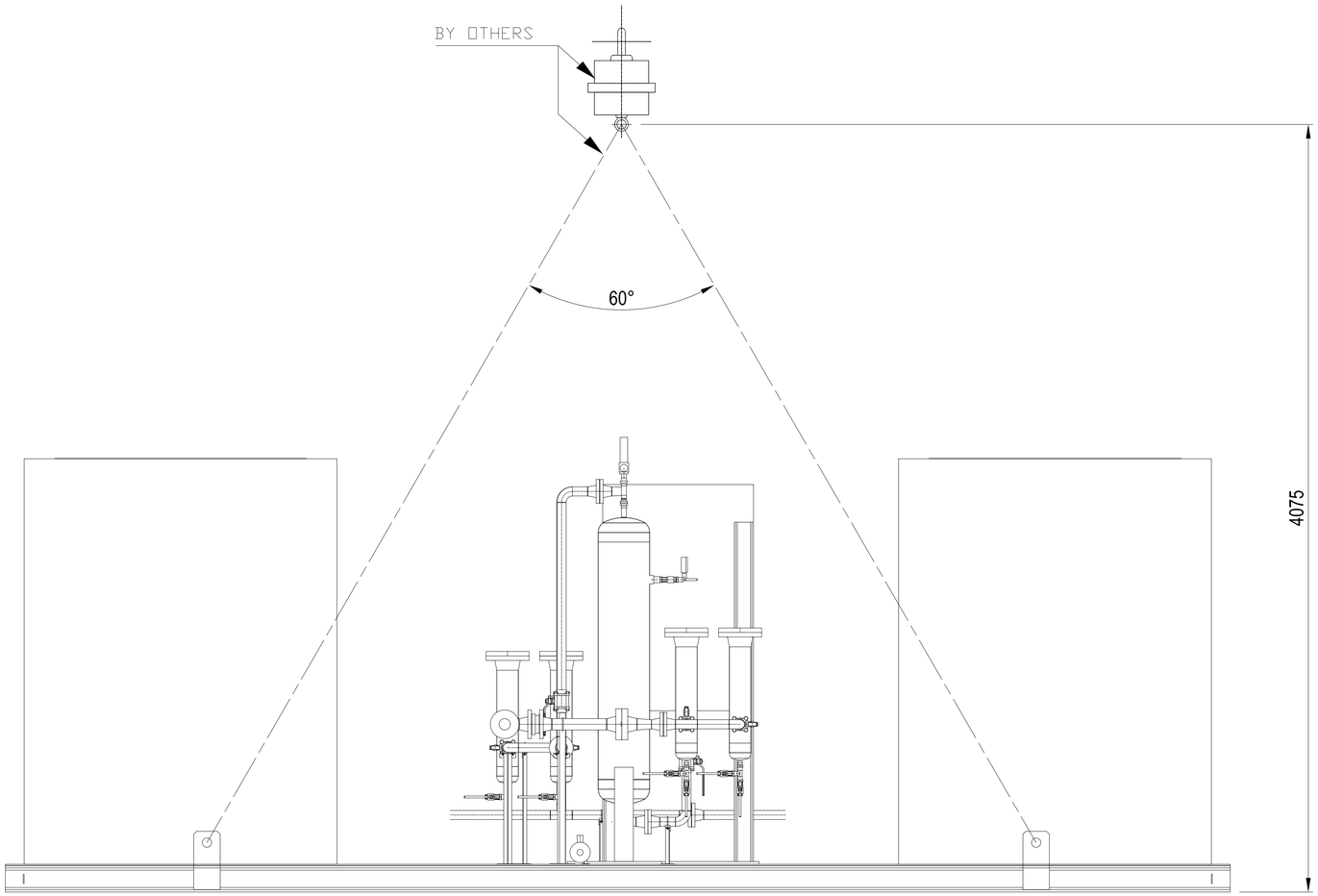
The displacement can be considered negligible.

Safety factor is 1,69.

The actual design of the structure can be considered acceptable.

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0	30/04/2024	FIRST ISSUE	GT	TM
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COMMESSA N° / JOB N° 166/24 | SERIAL N° | FORMATO / SIZE A1 | SCALA / SCALE 1 : 20

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SKID ARIA BLPH NETHERLAND
LIFTING SKETCH

DISEGNO N° / DRAWING N° CVV52815.1

FOGLIO / SHEET 1 | DI / OF 1

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