Base Load Power Hub (BLPH)

BLPH Platform Load-out Analysis

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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.

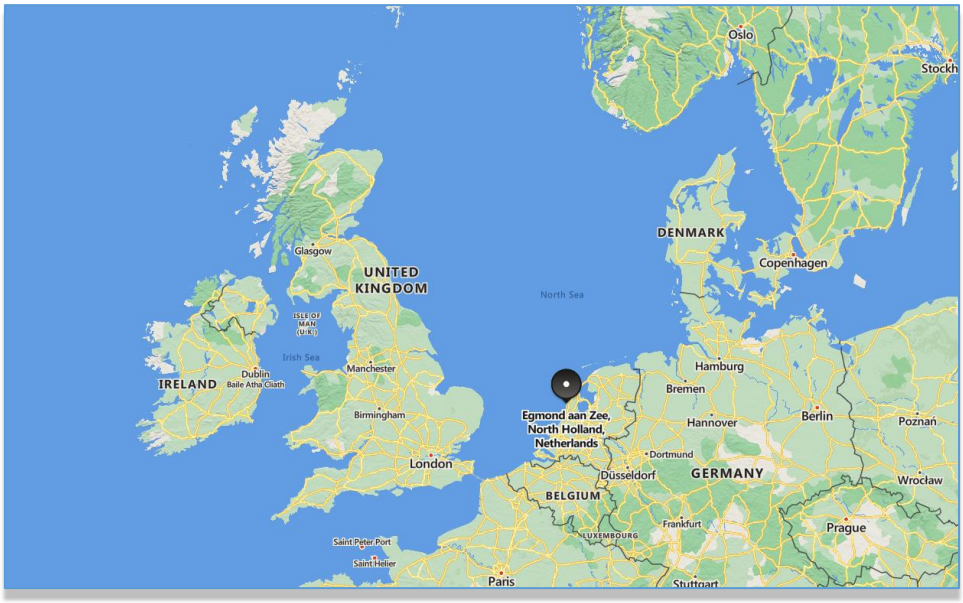


Figure 1.1 - HOLLANDSE KUST NOORD WIND PARK Location Map

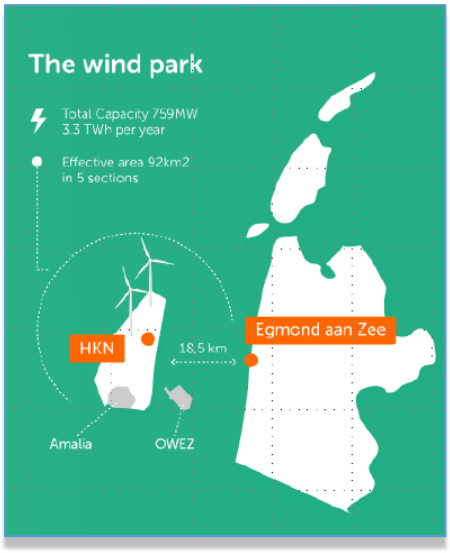


Figure 1.2 - Wind Park Details

The wind farm 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.

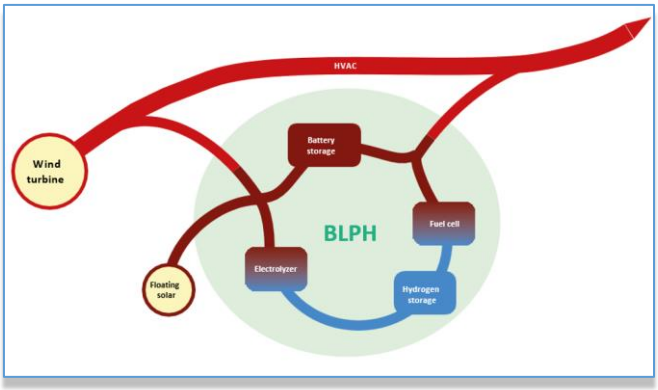


Figure 1.3 – BLPH Concept

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

The objective of this report is to present the results of the structural analysis performed on the BLPH Topside structure for the load out condition.

The analysis has been performed in compliance with the requirements, criteria and parameters reported in the Structural Design Premises, Ref./17/.

Loadout analysis is performed in accordance with DNV-ST-N001, Ref. /10/.

Structural Code checks are performed according to EN ISO 19902 for tubular members and tubular joints, Ref./6/, and according to Eurocode 3 for non-tubular structural elements, Ref./8/.

All structural analyses have been carried out using the structural analysis program SACS, the proprietary software developed by Bentley, Ref. /32/.

The International System of Units (SI) has been used in all engineering assessments and calculations.

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3 REFERENCES

3.1 CODES AND STANDARDS

Doc. No.	Description
/1/ BS EN ISO 19900	General requirements for offshore structures – 2019
/2/ BS EN ISO 19901-1	Specific requirements for offshore structures - Part 1: Metocean design and operating considerations - 2015
/3/ BS EN ISO 19901-3	Specific requirements for offshore structures – Part 3: Topsides structure - 2014
/4/ BS EN ISO 19901-5	Specific requirements for offshore structures – Part 5: Weight Management - 2021
/5/ BS EN ISO 19901-6	Specific requirements for offshore structures – Part 6: Marine Operations – 2009
/6/ BS EN ISO 19902	Petroleum and natural gas industries - Fixed steel offshore structures – 2020
/7/ ISO 19906:2019	Petroleum and natural gas industries – Arctic offshore structures
/8/ UNI EN 1993-1-1	Design of steel structures - Part 1-1: General rules and rules for buildings
/9/ UNI EN 1993-1-5	Design of Steel Structures – Part 1-5: Plated structural elements
/10/ DNV-ST-N001	DNV - Marine operation and marine warranty - 2021
/11/ DNV-ST-0145	DNV, Offshore substations
/12/ DNV-ST-0126	Support structures for wind turbine, 2018
/13/ DNV-RP-C201	DNV, Buckling Strength of Plated Structures, October 2010.

3.2 COMPANY SPECIFICATIONS

Doc. No.	Description
/14/ DEP 37.19.00.12	Gen - Offshore Topsides Structures
/15/ DEP 37.19.00.30	Gen - Fixed Steel Offshore Structures (Adoption of IOGP S-631-11, Amendments / Supplements to ISO 19902:2020).
/16/ DEP 37.81.10.19	Gen - Marine Operations Requirements – Loadout, Transportation and Installation of Offshore Structures (Amendments / Supplements to ISO 19901-6)

3.3 PROJECT DOCUMENTS

Doc. No.	Description
/17/ 123A90-DDL-ST-SP-90017	Structural Design Basis
/18/ 123A90-DDL-MD-RE-01006	Monthly Weight Report – Rev.03
/19/ 123A90-DDL-PP-DS-70070	Plot Plans
/20/ 123A90-DDL-ST-SP-90018	Structural Material Specification for Topside and TP
/21/ 123A90-DDL-ST-RE-90000	BLPH Platform – In service Analysis
/22/ 123A90-DDL-ST-RE-90002	BLPH Platform – Transportation analysis Report
/23/ 123A90-DDL-ST-RE-90005	BLPH Platform – Topside Joint Check Design Report
/24/ 123A90-DDL-TI-RE-99002	Loadout manual including ballast Sequence
/25/ 123A90-DDL-TI-SP-99014	Specification for TP, Topside and Caissons Transportation and Installation
/26/ 123A90-DDL-ST-TN-90119	Evaluating ISO and DNV approaches
/27/ 123A90-DDL-ST-DD-99021	Topside - BLPH Lower Grillage – Assembly
/28/ 123A90-DDL-ST-DD-99022	Topside - BLPH Lower Grillage – Type A2 and A4
/29/ 123A90-DDL-ST-DD-99023	Topside - BLPH Lower Grillage – Type C2 and C4
/30/ 123A90-DDL-ST-DD-99024	Topside - BLPH Lower Grillage - Details
/31/ 123A90-DDL-ST-DD-99025	Topside - BLPH Sea Fastening Drawings

3.4 SOFTWARE

Doc. No.	Description
/32/ SACS	Structural Analysis Computer System – BENTLEY Inc- v15

4 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY)	Crosswind
CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
PROJECT	HOLLANDSE KUST NOORD WIND PARK Project
T&I CONTRACTOR	DEME
ALS	Accidental Limit State
BLPH	Base Load Power Hub
CL	Concentrated Load
CoG	Centre of Gravity
CW	CrossWind
DAF	Dynamic Amplification Factor
DLB	Ductility Level Blast
DNV	Det Norske Veritas
DP	Dynamic Positioning
El.	Elevation
EPCI	Engineering Procurement Construction and Installation
FEED	Front End Engineering Design
HAT	Highest Astronomical Tide
HKN	Hollandse Kust Noord
ICCP	Impressed Current Corrosion Protection
LAT	Lowest Astronomical Tide
LRFD	Load and Resistance Factor Design
MSL	Mean Sea Level
NTE	Not-to-Exceed
PAU	Pre-Assembled Unit (H2 Vessels)
PG	Plate Girder
SHL	Static Hook Load
T&I	Transport & Installation
ToS	Top of Steel

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UC	Unity Check
UDL	Uniformly Distributed Load
WTG	Wind Turbine Generator
W2W	Walk to Work
SPMT	Self-propelled modular Trailer

Table 4.1 - Definitions and Abbreviations

5 SUMMARY AND CONCLUSIONS

The analyses performed show that the Topside, as configured, can withstand all possible combinations of imposed load out loads. The loadout is assumed to be performed by means of SPMT; the SPMT arrangement is considered to be isostatic (3 hydraulic circuits).

The software SACS™, ref./32/, is used for all global analyses of the structures in the SOW. Structural model of the Topside is the same used for transportation analysis, ref. /22/ with the following modifications:

- added Spacers Beams (no inertia) to properly transfer the load from SPMT to the structure.
- Ly of the PG at lower deck, Row B, modified according to the span of the SPMT supports.

5.1 WEIGHT RESULTANTS

The topside weight considered in the analysis is presented here below and then it is compared with the weight defined in the WCR, ref. /18/. COG location comparison between SACS structural model for Loadout Analysis and WCR is reported in following tables.

- The topside weight during LO was 1850 ton according to WCR rev.2 dated 06/05/2024 and decreased to 1802 ton in rev. 03, dated 23/07/2024.

SACS-WCR – Weight Comparison		
Load Comb.	**Fz [kN]**	**Fz [t]**
SACS (lcomb STAT)	-18540	-1890
WCR	-17678	-1802
Δ	862	88
Δ (%)	+4.8%	

COG NOMINAL POSITION			
CASE	**x [m]**	**y [m]**	**z [m]**
COG_SACS (lcomb STAT)	0.02	0.00	29.21
COG_WCR	-0.10	-0.30	29.30
Δ	-0.08	-0.30	-0.09
Topside Main Dimension	16.00	40.00	17.66
Δ (%)	0.5%	0.8%	0.5%

Table 5.1 – SACS-WCR CoG comparison in SACS ref. system (ref to section 9.1)

BLPH - TOPSIDE (NO LIVE LOAD AND SNOW) - Summary by Phase

Phase Code	Phase Description	Base Wt. (t)	Center of Gravity			Factored Wt. (t)	Center of Gravity			Design Net Wt. (t)	Center of Gravity			Design Gross (Expected) Wt. (t)	Center of Gravity		
			Northing (m)	Easting (m)	Elevation (m)		Northing (m)	Easting (m)	Elevation (m)		Northing (m)	Easting (m)	Elevation (m)		Northing (m)	Easting (m)	Elevation (m)
LO	Loadout	1612	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3
ST	Sea Transport	1612	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3
OP	Operating weight (Dry + Contents)	1655	19,6	8,0	29,3	1851	19,6	8,0	29,3	1851	19,6	8,0	29,3	1851	19,6	8,0	29,3
L	Lifting	1612	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3	1802	19,7	7,9	29,3

Table 5.2 – WCR weight and CoG during LO and transportation. X measured towards NORTH, Y measured towards EAST from C1 (WCR ref. system)

.

5.2 MAXIMUM HYDRAULIC CIRCUIT LOADS

In the table below are reported the max hydraulic circuit loads for the base case (gravity only). The loadout operation is planned to be performed using 88 axles of SPMTs located below the module using spacer beams to perform the transfer operation with bottom flange of primary steel at +2450mm (+/-300mm of SPMTs stroke) from the ground.

LOAD COMB	Hydraulic circuit A [t]	Hydraulic circuit B [t]	Hydraulic circuit C/D [t]
TEST	747	706.3	376.9
SPMT's self-weight (including PPU's)	151.5	151.5	89.1
Spacers weight	33	33	20
TOT	**931.5**	**891**	**486**
N° AXLES	34	34	20
TOT/axle	*27.4*	*26.2*	*24.3*

Table 5.3 – SPMT's hydraulic circuit loads – ground loads / axles << 40 t/axle

5.3 MEMBER CHECKS

Structural members with maximum Unity Check (UC) are detailed in the following table.

MEMBER	GROUP	DESCRIPTION	SECTION	COMBINATION	UC
L241-L055	B04	Plate Girder Lower Deck	PG04	LOD1	0.95
L000-L248	B02	Plate Girder Lower Deck	PG02	LOD1	0.94
L001-U001	D16	Column Row 2	323.9 x 19.05	LOD1	0.93
L202-L000	B02	Plate Girder Lower Deck	PG02	LOD1	0.92
L198-L027	B10	Plate Girder Lower Deck	PG10	LOD1	0.87
L191-L000	B10	Plate Girder Lower Deck	PG10	LOD1	0.85
L000-L198	B10	Plate Girder Lower Deck	PG10	LOD1	0.85
L027-L246	B10	Plate Girder Lower Deck	PG10	LOD1	0.80

Table 5.4 – Member UC Summary

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5.4 TUBULAR JOINT CHECKS

Structural tubular joints with maximum Unity Checks (UC) for punching shear are detailed in the following table.

JOINT	DESCRIPTION	CHORD	BRACE	COMBINATION	UC
D006	Bracing – Main Diagonal Row A	550 x 20	323.9 x 12.7	LOD1	0.249
D003	Bracing – Main Diagonal Row C	550 x 20	323.9 x 12.7	LOD1	0.236
D004	Bracing – Main Diagonal Row C	550 x 20	323.9 x 12.7	LOD1	0.224

Table 5.5 – Tubular joint UC summary

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6 BLPH TOPSIDE DESCRIPTION

The BLPH Topside comprises of two main deck levels with overall deck plan dimensions of 40 m x 16 m, excluding external walkways, laydown areas and stairs, with an overall deck height of 7 m between decks. There are currently 6 hydrogen storage vessels which lie horizontally, aligned north – south, within the PAU structure located above the upper deck. The Topsides layout is shown in Figure 6.1.

Main Deck elevations are:

- Lower Deck, El. + 23.310 m ToS;
- Upper Deck, El. + 30.310 m ToS.

The PAU steel module 12m x 9m for the storage of N.6 H2 Vessel 60t each is located on top of Topside Upper Deck. PAU height is 9m and on top roof it acts as rigging platform with lifting slings.

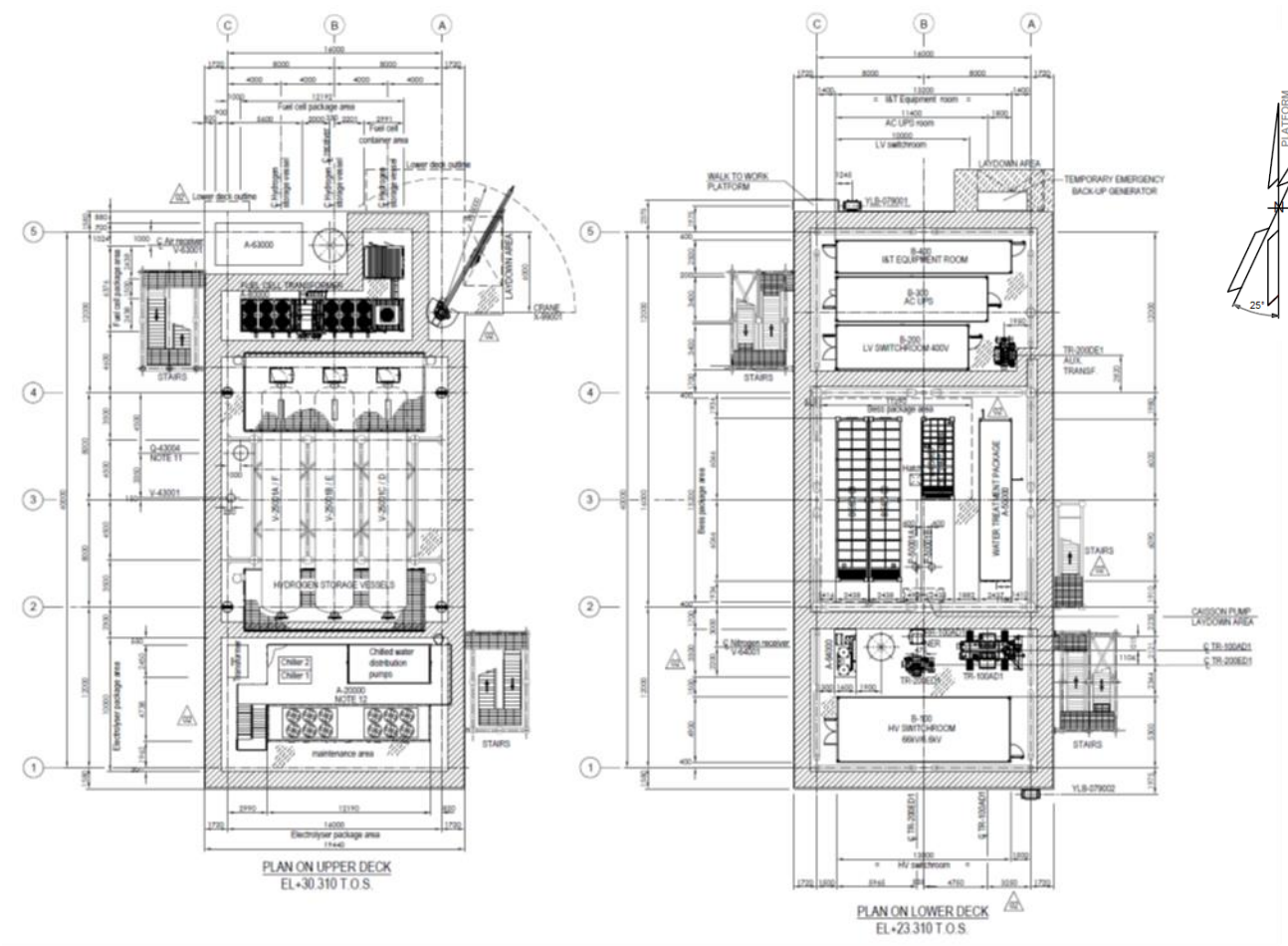


Figure 6.1 – Base Load Power Hub Plot Plan

7 MATERIALS

7.1 STRUCTURAL STEEL PROPERTIES

For the structural analyses, steel types and grades to be used for the platform structures are summarised in Table 7.1 and specified in Ref. /20/. The material selection criteria are based on the requirements of ISO 19906:2019, ISO 19902:2020 and ISO 19901-3:2014. The materials are in accordance with the EN standard 10225:2019 and 10025:2019 and are suitable for plates, rolled sections and welded / seamless tubulars.

			EN10025-3	ISO EN 19902:2020						
Design Class	**Complexity**	**SQL**	**Hot rolled bar**	**Plates and Welded Tubular**	**Sections**	**SMLS pipes**	**THK**	**CVN inpact test**	**Material Designation**	**List of Options (EN10225-1 to -4) & EN10025-3**
DC1 TP to monopile flange connection	High	**I (Z properties)**	EN 10025 S420 NL	NA	NA	NA	t > 50	-40	DC1-I-420-40_Z	1, 2, 3, 4, 6, 12, 18, 24, 30
DC1 Complex lift-nodes and element connection to topside, Lift points, main complex joints	High	**I (Z properties)**	NA	EN 10225 S420 QLO / ML	NA	NA	25 < t <= 50	-40	DC1-I-420-40_Z DC1-I-460-40_Z	2, 7, 8, 11, 12, 17, 18
							t > 50	-40		
DC2 simple joints, primary deck girders and beams of Topside and TP, column and diagonal to lift points, main columns, Davit crane support, Bolts	Low	**II**	NA	EN 10225 S420 QLO / MLO	NA	NA	t < = 12	0	NA	-
							12 < t <= 25	-20	DC2-II-420-20 / DC2-II-460-20	2, 7, 8, 11 17 for t > 40mm
							25 < t <= 50	-40	DC2-II-420-40 DC2-II-460-40	
							t > 50	-40		
DC3 all other columns and diagonals, stiffeners, Secondary deck beams, Grillage and sea fastening	High	**II**	NA	EN 10225 S355 NLO / MLO	EN 10025 S355 MLO	EN 10225 S355 NLHHO / QLHHO API 5L X52	t < = 12	0	DC3-II-355-0 / DC3-II-X52-0	2, 7, 8 11 for plate 17 for t > 40mm
							12 < t <= 25	-20	DC3-II-355-20 / DC3-II-X52-20	
							25 < t <= 50	-40	DC3-II-355-40 / DC3-II-X52-40	
							t > 50	-40		
DC4 Equipment and vessel supports, modules supports, equipment fixing bolts	Low	**III**	NA	EN 10025 S355 J2	EN 10025 S355 J2	API 5L X52 EN 10210 S355 J2H	t < = 12	0	DC4-III-355-0 / DC4-III-X52-0 / DC4-III-X60-0	-
							12 < t <= 25	0		
DC5 floor plating, grating, Walkways, stairs, handrails	Any	**IV**	NA	EN 10025 S235 JR EN 10025 S275 J0 EN 10025 S355 J0	EN 10025 S235 JR EN 10025 S275 J0 EN 10025 S355 J0	API 5L Gr.B EN 10210 S235 JRH / EN 10210 S275 J0H / EN 10210 S355 J0H	t < = 12	10	DC5-IV-235-10 / DC5-IV-275-10 / DC5-IV-355-10 / DC5-IV-GRB-10	-
							12 < t <= 25	10		

Table 7.1 - Material Selection, Ref /20/

Mechanical properties for structural materials are presented in Table 8-2, Table 8-3 and Table 8-4.

- Young's Modulus = 205,000 N/mm^2
- Density = 7850 kg/m^3
- Poisson's Ratio = 0.3

Thickness (mm)	Min. Tensile Strength (N/mm^2)	Min. Yield Strength (N/mm2)	Steel Type (1)
t ≤ 16	500	420	I & II
16 < t ≤ 40	500	400	I & II
40 < t ≤ 63	480	390	I & II
63 < t ≤ 100	480	380	I & II
Note: 1) Type I steel has Z (through the thickness) properties.			

Table 7.2 – Mechanical properties of Plates

Thickness (mm)	Min. Tensile Strength (N/mm²)	Min. Yield Strength (N/mm2)	Steel Type
t ≤ 20	460	355	III
20 < t ≤ 40	460	345	III

Table 7.3 – Mechanical properties of Structural Seamless Tubulars

Thickness (mm)	Min. Tensile Strength (N/mm2)	Min. Yield Strength (N/mm2)	Steel Type
t ≤ 16	460/360	355/275	IV
16 < t ≤ 40	460	345	IV

Table 7.4 – Mechanical properties for Structural Sections

7.2 PLATING

Plate thicknesses for primary structural steel starts at a minimum of 10 mm and increase in 5 mm steps Secondary steel lower and upper deck plates are 8 mm thick and 10mm for laydown areas for Dropped Object Protection (DOP).

Blast walls are not to be provided on a hydrogen processing facility, as free ventilation and free explosion venting is more important, and supportable, than obstruction walls.

7.3 GRATING

Gratings are characterized by bearing bars 30 mm x 5 mm and mesh 30 mm x 50 mm.

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8 DESIGN CRITERIA AND REQUIREMENTS

8.1 GENERAL

Structures in SOW are designed in accordance with limit states approach of ISO codes 19901 and 19902, Refs./2/, /3/ and /6/. For non-tubular sections, Eurocode, Ref./8/, is adopted.
Member forces and moments derived from the global analyses are used for checking member strength and stability, and joint strength.

8.2 PARTIAL RESISTANCE FACTORS

8.2.1 Partial Resistance Factors for Tubular Sections:

The partial resistance factors for tubular sections from ISO 19902, Ref./6/, are listed below.

Resistance factor	Value	Definition
$\gamma_{R,t}$	1.05	Partial resistance factor for axial tensile strength
$\gamma_{R,c}$	1.18	Partial resistance factor for axial compressive strength
$\gamma_{R,b}$	1.05	Partial resistance factor for bending strength
$\gamma_{R,v}$	1.05	Partial resistance factor for shear strength
$\gamma_{R,h}$	1.25	Partial resistance factor for hoop buckling strength

Table 8.1- Resistance Factors for Tubular Sections

8.2.2 Partial Resistance Factors for Non-tubular Sections

The partial resistance factors for non-tubular sections from Eurocode 3, Ref./8/, are listed below.

Resistance factor	Value	Definition
Resistance of members and cross sections		
γ_{M0}	1.10	Cross-section resistance to excessive yield strain including local buckling
γ_{M1}	1.10	Resistance of unstable elements measured during element inspection
γ_{M2}	1.25	Tensile cross-section resistance to mechanical breakdown
Resistance of connections		
γ_{M2}	1.25	Bolts, rivets, pins, welds and slabs on supporting surface
γ_{M3}	1.25	Sliding resistance at Ultimate Limit State Category C

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$\gamma_{M3,SER}$	1.10	Sliding resistance at Serviceability Limit State
γ_{M4}	1.10	Injection bolt collapse resistance
γ_{M5}	1.10	Resistance of connections in open lattice trusses
$\gamma_{M6,SER}$	1.00	Resistance of pins at Serviceability Limit State
γ_{M7}	1.10	Preload of high strength bolts

Table 8.2- Resistance for Non Tubular Section

8.2.3 Partial Resistance Factors for Tubular Joints Check

The partial resistance factors for tubular joints checks are provided in following table.

Resistance factor	Value	Definition
$\gamma_{R,j}$	1.05	Partial resistance factor for joints
$\gamma_{z,j}$	1.17	Additional partial resistance factor for members during joint pre-strain collapse

Table 8.3 - Resistance Factors for Tubular Joints

8.3 LOAD CLASSIFICATIONS

Design loads are classified as either global or local within ISO 19901-3, Ref. /3/ and ISO 19902, Ref./6/ and summarized in Table 8.4.

Load Type	ISO Designation	Description
Permanent (Dead)	G1	Structure self-weight; Equipment & piping dry weight;
Permanent (Dead)	G2	permanent action imposed on the topsides structure by self-weight of equipment and other objects, bulk loads
Variable (Live)	Q1	Equipment & piping contents weight
Transient	T	Transient Loads for Pre-Service Analyses

Table 8.4 - ISO Loads Classification

8.4 PARTIAL ACTION FACTORS

8.4.1 Partial Action Factors for Pre-Service Analyses

Partial Action Factors for Pre-Service analysis (e.g. Lifting, Transportation, Load-out) conditions are shown in Table 8.5 with reference to three design situations, where:

- G_T are the permanent actions during the transient situation.
- Q_T are the variable actions during the transient situation.
- T represents the actions from the transient situation being considered.

SITUATION	ACTION		
	Permanent (GT)	Variable (QT)	Transient (T)
1	1.3	1.3	1.0
2	1.1	1.1	1.35
3	0.95	0.9	1.35

Table 8.5 – Partial action factors for Pre-service Analyses

8.5 ACCEPTANCE CRITERIA

The maximum member Unity Check (UC) will be less than unity.

9 STRUCTURAL ANALYSIS

9.1 STRUCTURAL MODEL

The software SACS™, ref./32/, is used for all global analyses of the structures in the SoW. The structural model of the Topside for Lifting analysis is derived from the model of Transport analysis, ref./22/.

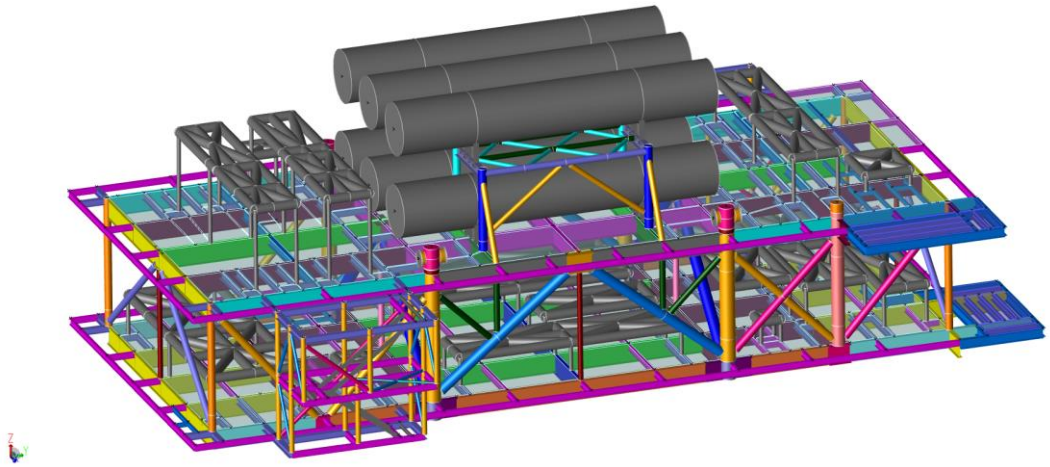


Figure 9.1 - Topside structural model

9.1.1 Coordinate System

The model geometry is referred to a right-handed orthogonal Cartesian coordinate system with the origin located at the centre of the foundation structure at level +0.0 m at barge deck. The X-axis is positive toward East, the Y-axis is positive toward North and the Z-axis is positive upward.

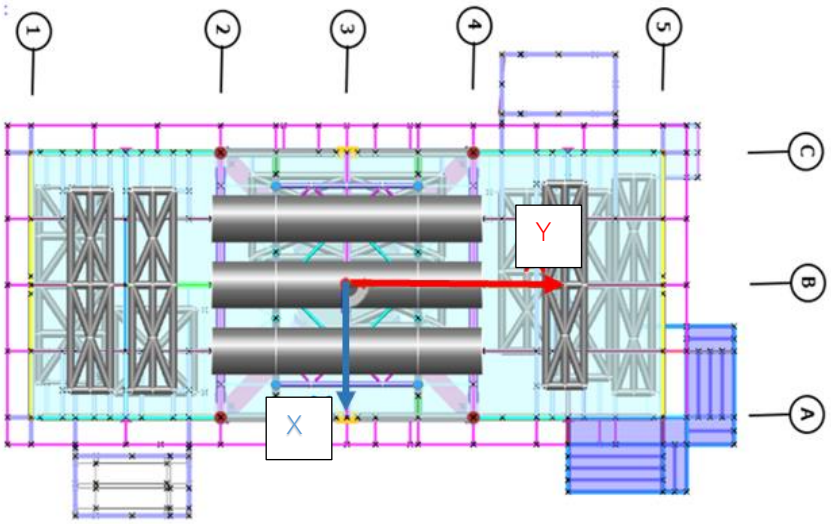


Figure 9.2 - BLPH Topsides Structural Model - Top View

9.1.2 Boundary Conditions

Having assigned vertical gravitational loads and upward reactions of SPMTs, the computational model presents instability in the Z direction. to remedy this, were assigned in vertical direction only, n.4 soft springs (k=1 kN/m) at the bottom of the 4 main legs.
Horizontal (isostatic) restrains have been applied to avoid numerical instability too.

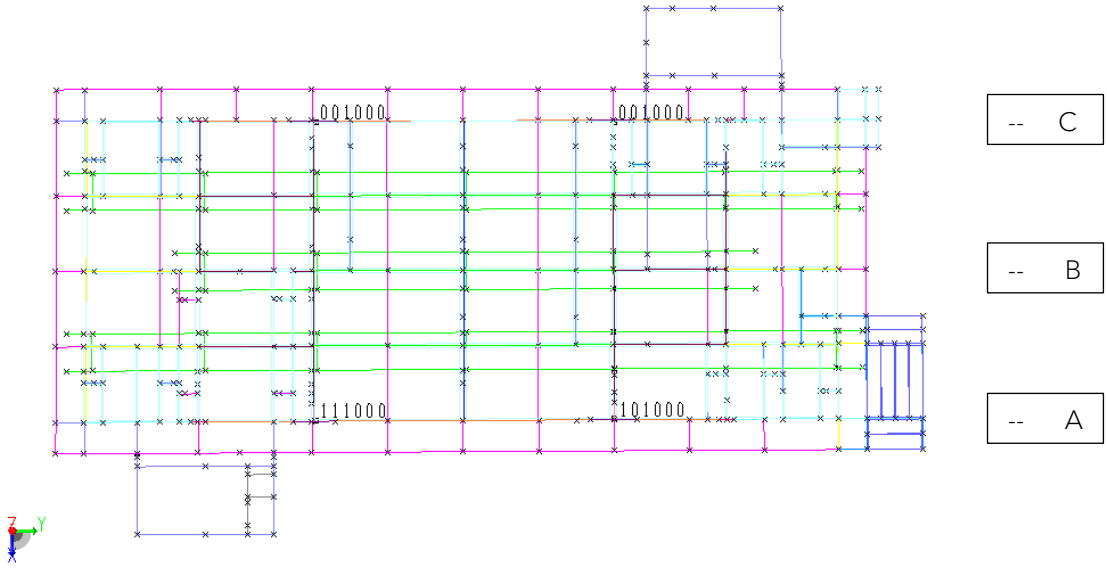


Figure 9.3 - Topside fixity/restraints

JOINT ID	Fixity	Comment
TU02	111000	Fixed in X and Y, vertical spring Z-dir k=1 kN/m
TU03	101000	Fixed in X , vertical spring Z-dir k=1 kN/m
TU01	001000	vertical spring Z-dir k=1 kN/m
TU04	001000	vertical spring Z-dir k=1 kN/m

Table 9.1 - Topside restraints

10 BASIC LOAD CASES

All the design loads have defined according to the Weight Control Report and Plot Plans, Ref./18/ and /19/, in terms of weights, CoG position and contingency factors. The datum for weight reporting is different to that for the SACS structural analysis. The origin for the weight reporting is at gridline intersection C1 at LAT.

The below load cases were taken from in-service analyses, where values and contingencies were validated by comparison with WCR.

10.1 PERMANENT ACTIONS

10.1.1 Modelled structural dead weights

Dead weights of the modelled structures have been automatically evaluated by SACS and included in following basic load conditions: DEAZ = DZTO + DZPU.

- Load condition DEAZ: Modelled structures total weight

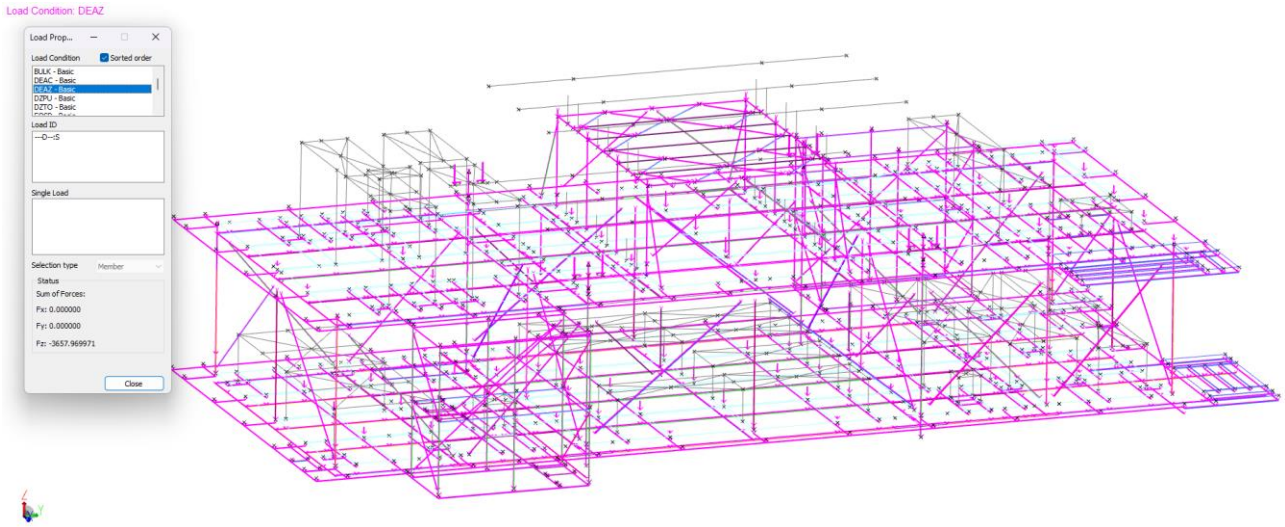


Figure 10.1 – Topside Load condition DEAZ

- Load condition DZTO: TOPSIDE MODELLED WEIGHT

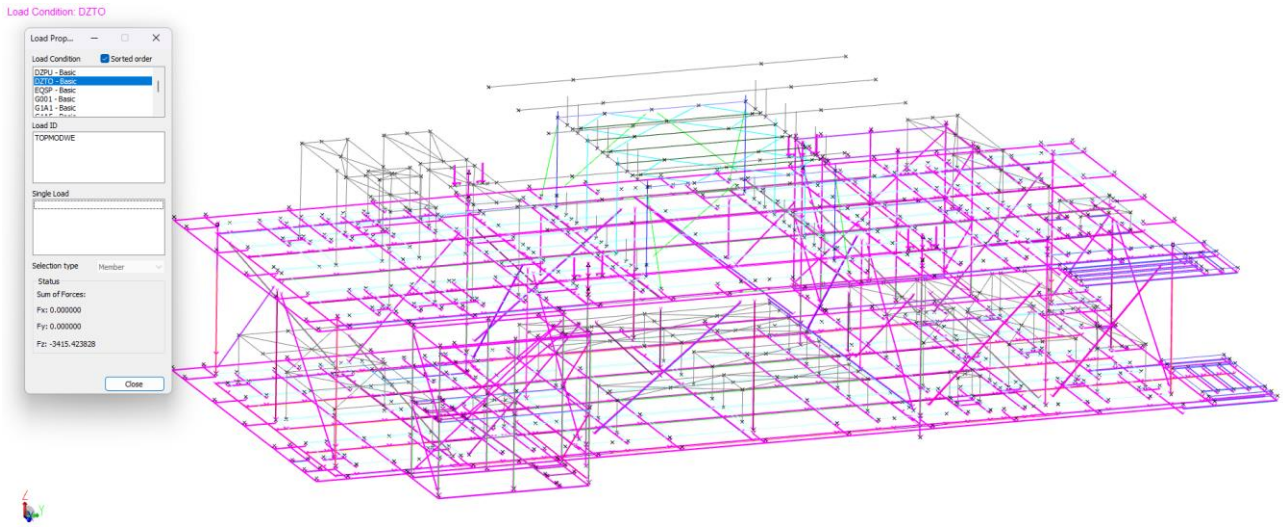


Figure 10.2 – Topside basic load conditions forming DEAZ

- Load condition DZPU: PAU MODELLED WEIGHT

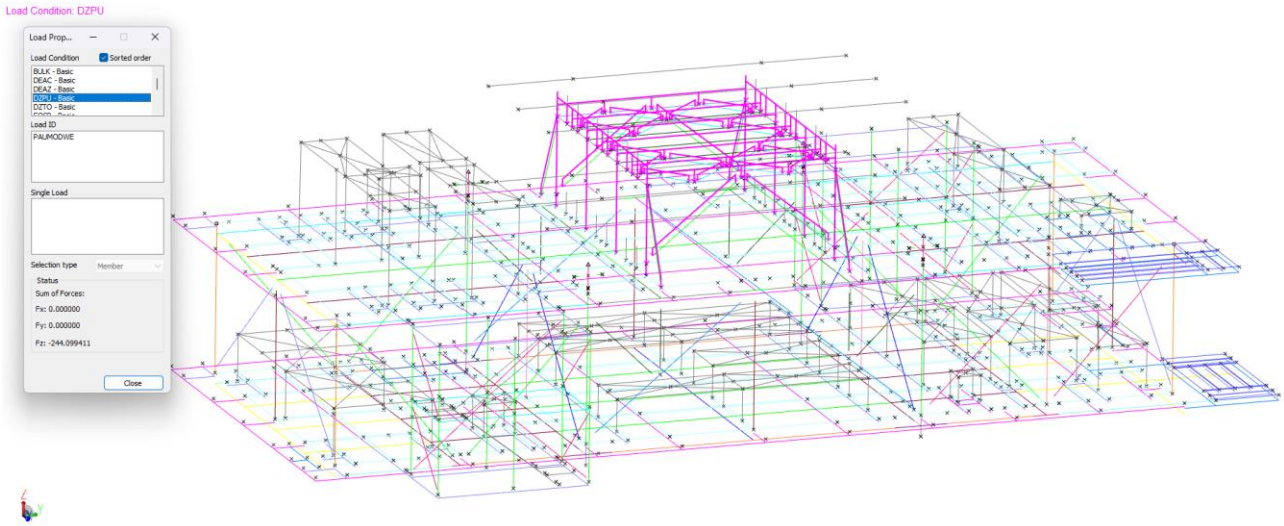


Figure 10.3 – Topside basic load conditions forming DEAZ

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10.1.2 Not modelled structural dead weights

Following basic Load conditions have been defined for not modelled structural dead weights.

- Load condition WFLO: FLOORING AND GRATING PERMANENT LOADS

Flooring and grating weights have been defined in SACS load combination WFLO according to calculations reported in following table.

PLATING & GRATING GRAVITY WEIGHTS - WFLO							
g_grat =	0.500	kN/m2	GRATING 30X50 - 30X5				
g_plat 8mm =	0.650	kN/m2	PLATING THK=8mm				
g_plat 10mm =	0.800	kN/m2	PLATING THK=10mm				
LOAD ID	**Dim.**		**EL.**	**W**	**W tot**	**Description**	**TEKLA**
	x	**y**	**z**				
[-]	**[m]**	**[m]**	**[m]**	**[kN]**	**[kN]**		**[kN]**
L_GR_0.5	1.640	42.250	23.310	69.3	92.2	Lower deck grating	88.3
L_GR_0.5	15.300	1.500	23.310	23.0			
U_GR_0.5	1.640	43.000	30.310	35.3	88.4	Upper Deck grating	73.6
U_GR_0.5	1.640	35.500	30.310	29.1			
U_GR_0.5	16.000	1.500	30.310	24.0			
L_P10	7.000	3.000	23.310	16.8	16.8	Lower Deck flooring 10mm	17.6
U_P10	4.500	7.500	30.310	27.0	27.0	Upper Deck flooring 10mm	29.4
L_P8	12.900	4.700	23.310	39.4	416.0	Lower Deck Plating 8mm in Equipment area	400.0
	5.000	4.300	23.310	14.0			
	4.950	12.200	23.310	39.3			
	2.450	6.100	23.310	9.7			
	11.200	9.540	23.310	69.5			
	16.000	40.000	23.310	244.2		Lower Deck Plating 8mm	
U_P8	12.200	2.440	30.310	19.3	431.0	Upper Deck Plating 8mm in Equipment area	400.0
	12.000	4.820	30.310	37.6			
	16.000	40.000	30.310	359.1		Upper Deck Plating 8mm	
STGR_0.5				27.1	27.1	tower stairs grating	26.5
SACS LOAD CONDITION				**WFLO**	**1098.5**	**Total Flooring & grating structural weight**	**1035.4**

Table 10.1 – Load Condition WFLO: Plating and grating weights' calculation.

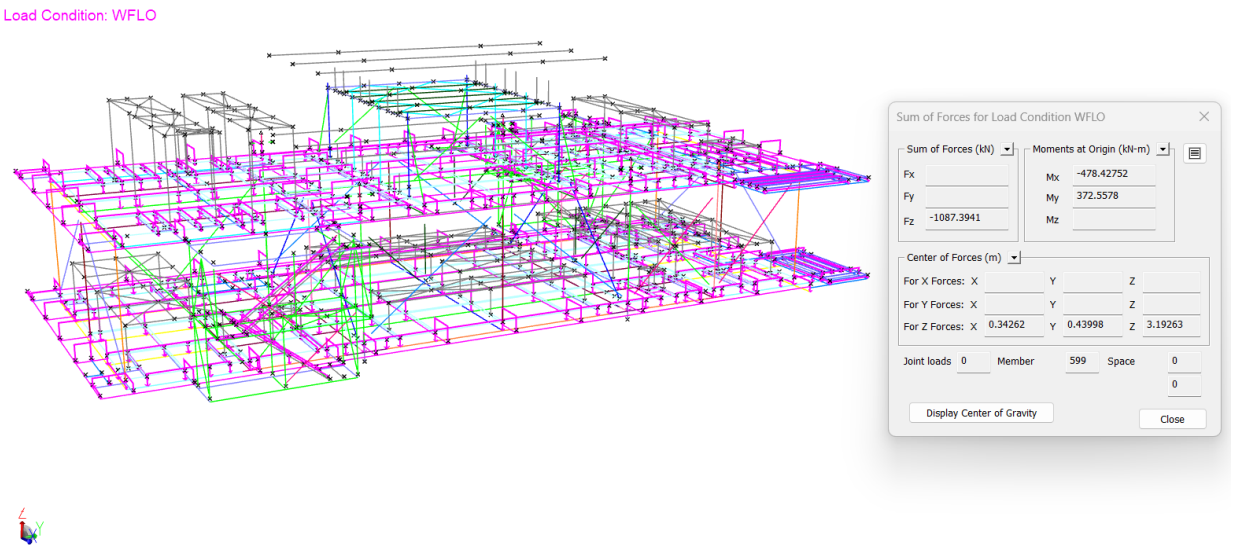


Figure 10.4 – Topside basic load conditions WFLO

- Load condition WPER: SECONDARY STRUCTURES PERMANENT LOADS

Not modelled structural weights have been defined in SACS load condition WPER as per following table, based on WCR, ref./18/.

PERMANENT STRUCTURAL WEIGHTS - WPER						
LOAD ID	Dim.		EL.	W	W tot	Description
	x	y	z			
[-]	[m]	[m]	[m]	[kN]	[kN]	
DAV_CR	8	14	31.1	60	60	DAVIT Crane
ACCSTS			30.31	360	360	PAU Access Stairs
HAND_L			23.31	43.2	43.2	Handrail Lower deck
HAND_U			30.31	45	45.0	Handrail Upper deck
HANDHD			23.31 / 30.31	51.5	51.1	Heavy Duty Handrail U&LD
HAND_ST			23.31 / 30.310	33.9	33.9	Tower Stairs Handrail
1 kN/m2W			23.31	37.8	37.8	not-modelled walkways sec. beams LD
U1kN/m2W			30.31	37.8	37.8	not-modelled walkways sec. beams UD
SACS LOAD CONDITION				WPER	668.8	Not Modelled Permanent Structural Weights

Table 10.2 – Load Condition WPER

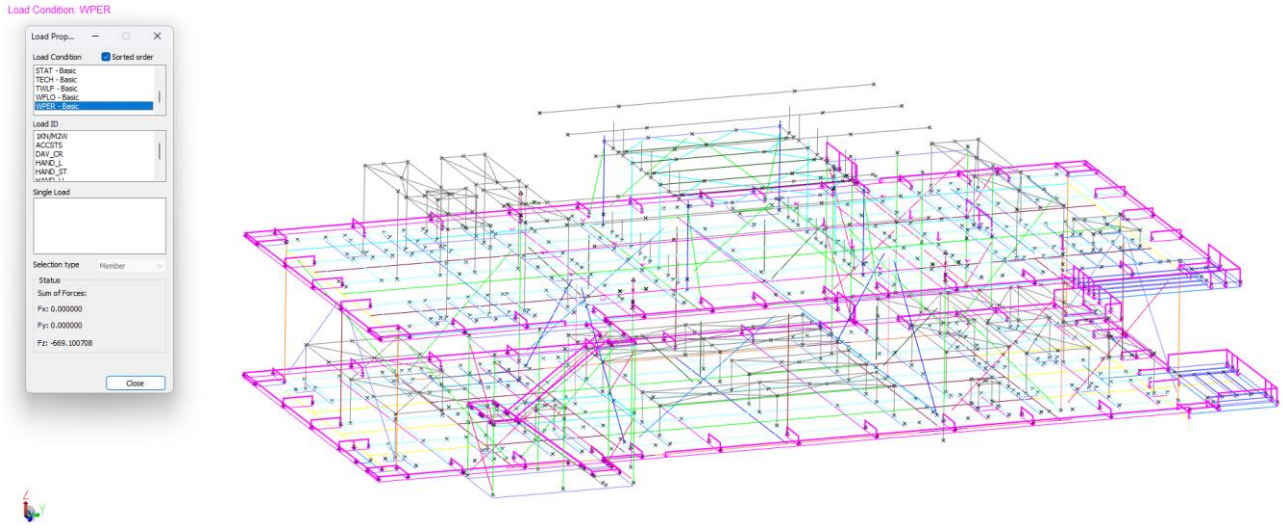


Figure 10.5 – Topside basic load conditions WPER

- Load condition EQSP: EQUIPMENT SUPPORTS WEIGHT

Equipment supports weights have been included in load condition EQSP. As per current WCR estimate, equipment's support weights are assumed as 15% of equipment gross weights (including dry and content weights).

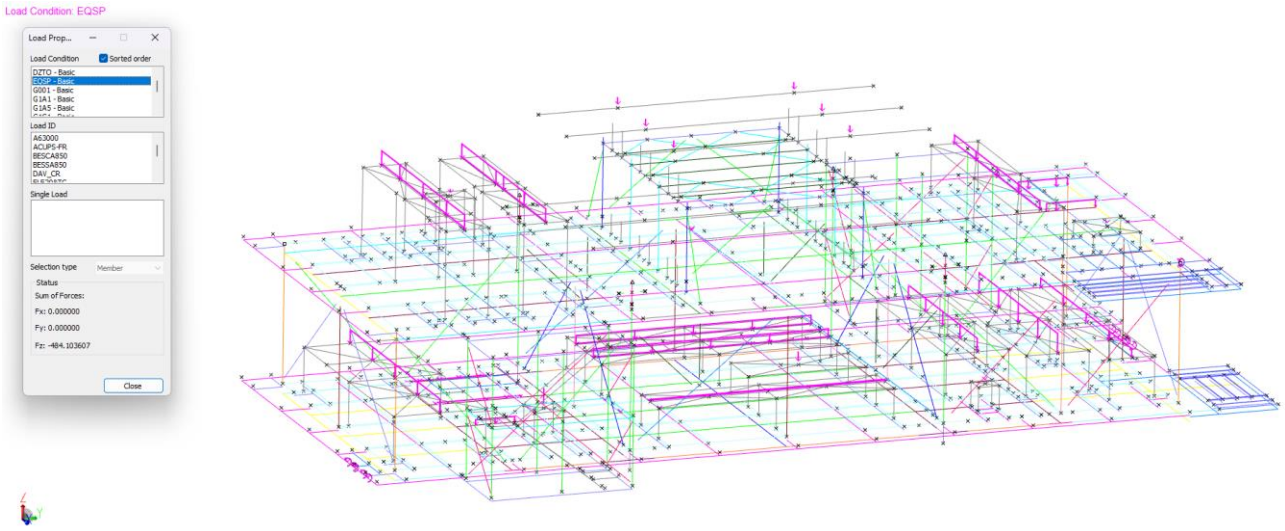


Figure 10.6 – Topside basic load conditions EQSP

10.1.3 Equipment Dry weights and other disciplines' bulk loads

These loads include dry weight of all platform process/utility equipment and electrical & instrumentation equipment and other objects permanently mounted on the structure that do not change with the mode of operation. Equipment loads have been modelled in SACS as uniform or concentrated loads at proper location. For main equipment, dummy structural elements have been included in the global model to account for equipment's CoG location as per WCR and Plot Plans.

EQUIPMENT WEIGHTS										
Loc.	DISC	DESCRIPTION	TAG	Wdry [t]	Wdry [kN]	Wcontent [t]	Wcontent [kN]	contingency [%]	Wdry [kN]	Wcontent [kN]
UD	MEC	H2 STORAGE VESSEL	V-25001A/F	352.20	3455.08	1.50	14.72	12%	3869.69	16.48
UD	MEC	ELECTROLYSER	A-20000	135.30	1327.29	11.50	112.82	12%	1486.57	126.35
UD	MEC	TRANSFORMER	A-20000-T	8.20	80.44	1.00	9.81	12%	90.10	10.99
UD	MEC	FUEL CELL	A-80000A+B	34.02	333.73	5.00	49.05	12%	373.77	54.94
UD	MEC	FUEL CELL TRANSF	A-80000-C	7.14	70.02	1.00	9.81	12%	78.43	10.99
UD	MEC	AIR SYSTEM	A-63000	10.80	105.95			12%	118.66	
UD	MEC	AIR RECEIVER	V-63001	7.42	72.79			12%	81.53	
UD	MEC	HYDROGEN VENT KO DRUM	V-43001	0.78	7.65	0.50	4.91	12%	8.57	5.49
UD	MEC	HYDROGEN VENT HEATER	H-43002	1.30	12.75	0.75	7.36	12%	14.28	8.24
UD	MEC	HYDROGEN VENT	Q-43004	3.40	33.35	1.00	9.81	12%	37.36	10.99
			TOT UD	560.56	5499.06	22.25	218.27		6158.95	244.47
LD	MEC	Nitrogen package	A-64000	7.50	73.58	1.00	9.81	12%	82.40	10.99
LD	MEC	N2 RECEIVER	V-64001	4.00	39.24			12%	43.95	
LD	MEC	BESS (PCS CONTAINER)	A-85000	15.00	147.15	3.00	29.43	12%	164.81	32.96
LD	MEC	BESS (BC1)	A-85001	35.00	343.35	5.00	49.05	12%	384.55	54.94
LD	MEC	BESS (BC2)	A-85002	35.00	343.35	5.00	49.05	12%	384.55	54.94
LD	MEC	WATER treatment package	A-50000	10.50	103.01	5.50	53.96	12%	115.37	60.43
LD	MEC	seawater lift pump A / B	P-50001 A/B	3.25	31.88	10.00	98.10	12%	35.71	109.87
LD	MEC	LIFE RAFT	YLB-079002	5.50	53.96			12%	60.43	
LD	MEC	NER	RR-100AD1	0.38	3.73			12%	4.18	
LD	MEC	Solar TRAFO	TR-200ED1	3.34	32.77	1.00	9.81	15%	37.68	11.28
LD	MEC	TRANSFORMER AUX 6.6/0.4kV	TR-200DE1	5.05	49.54	1.50	14.72	15%	56.97	16.92
LD	MEC	MAIN TRANSFORMER 66kV/6.6kV	TR-100AD1	22.75	223.18	3.00	29.43	15%	256.65	33.84
			TOT LD	147.27	1444.72	35.00	343.35		1627.25	386.17
			TOT MECD	**6943.8**			561.6		7786.2	

Table 10.3 - WCR Equipment dry and content weights

- Load condition MECD: EQUIPMENT DRY WEIGHTS (contingency included)

Equipment dry weights at Upper and Lower Deck, already including 12% contingency for mechanical discipline and 15% contingency for others) have been included in load condition MECD which provide a resultant conservatively larger than WCR values (Table 10.3).

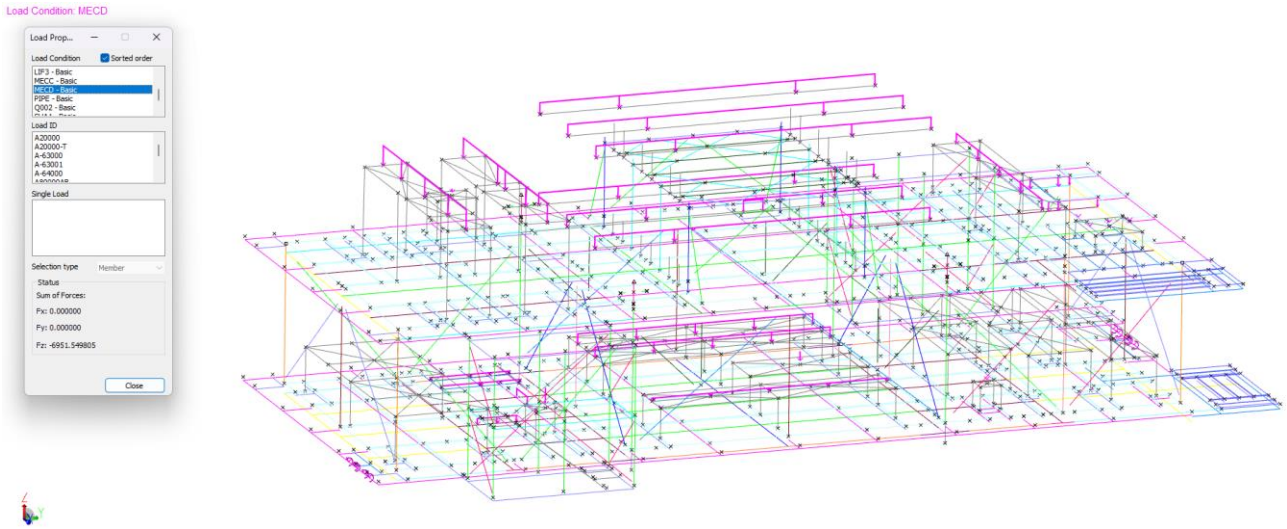


Figure 10.7 – Topside basic load conditions MECD

10.1.4 Other disciplines' bulk loads

Following basic load conditions have been included in the structural model to account for bulk loads:

- Load condition TECH: Technical Room Weight

Considers the weights of the four technical rooms, including architectural, structure, safety etc.

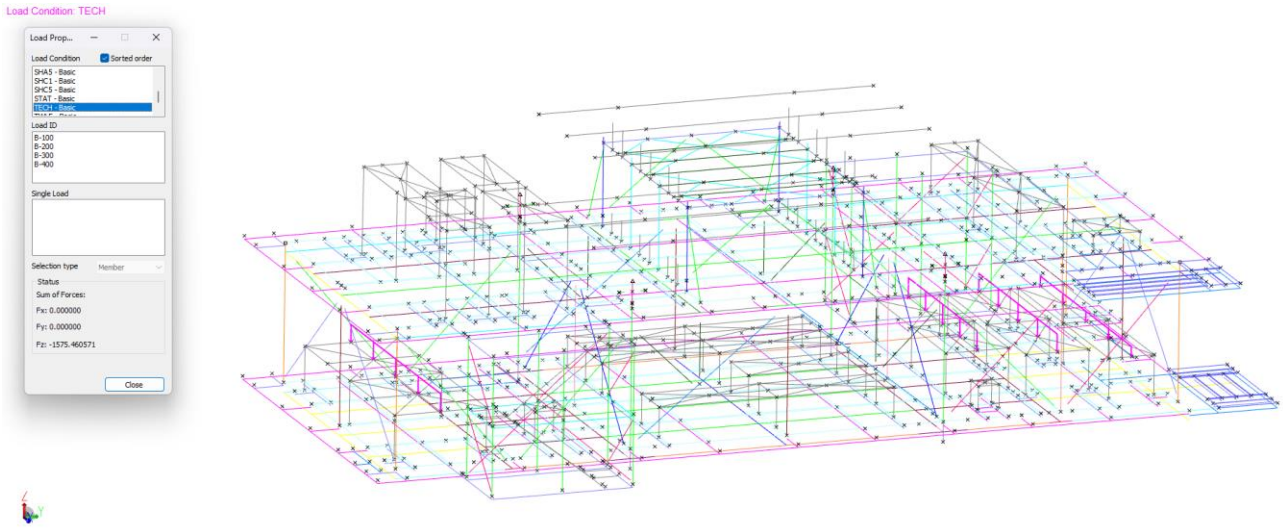


Figure 10.8 – Topside basic load conditions ARCH

- Load condition BULK: Electrical and Instrumental Bulk Weights

Load condition BULK includes weights resulting from a uniform distributed load of 1 kN/m2 at BLPH Upper and Lower Deck, excluding external walkways.

This auxiliary load condition has been defined to account for all disciplines' bulk load (structural, architectural, electrical, instrumentation, HVAC, piping, mechanical, fire and safety).

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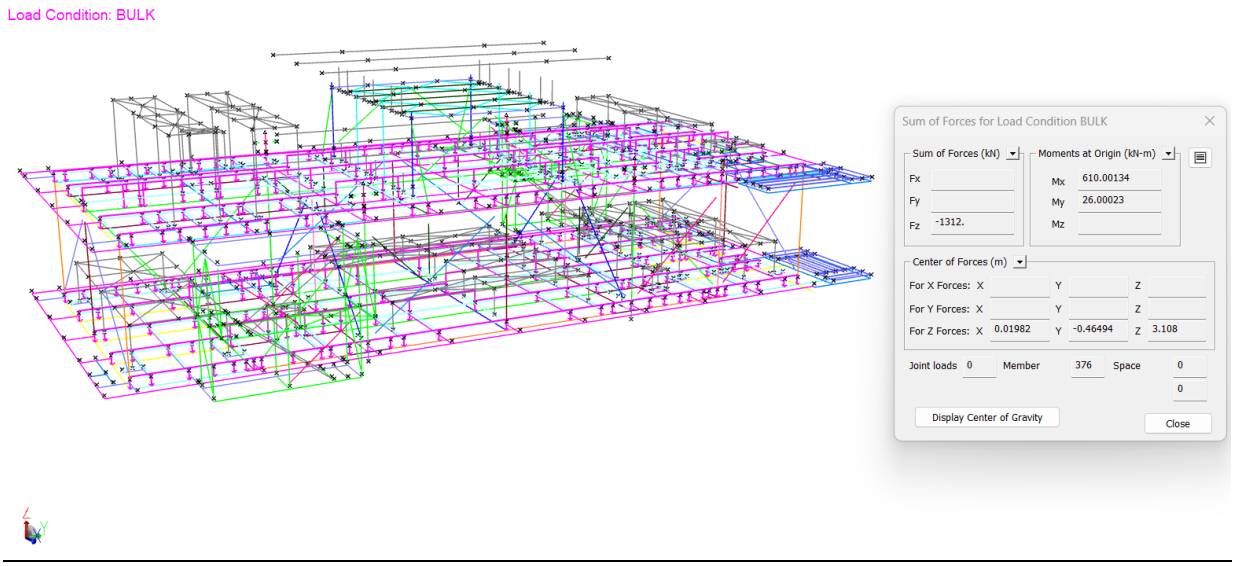


Figure 10.9 – Topside basic load conditions BULK

- Load condition PIPE: Piping Weights

PIPING WEIGHS										
LD	PIP	Distributed LD		1.76	17.3		0.0	12%	19.4	0.00
UD	PIP	Distributed UD		0.35	3.4		0.0	12%	3.8	0.00
LD-UD	PIP	BULK LOAD		17.20	168.7		0.0	12%	189.0	0.00
			TOT	19.31	189.4		0.0		212.2	0

Table 10.4 - Load Condition PIPE: Piping weights

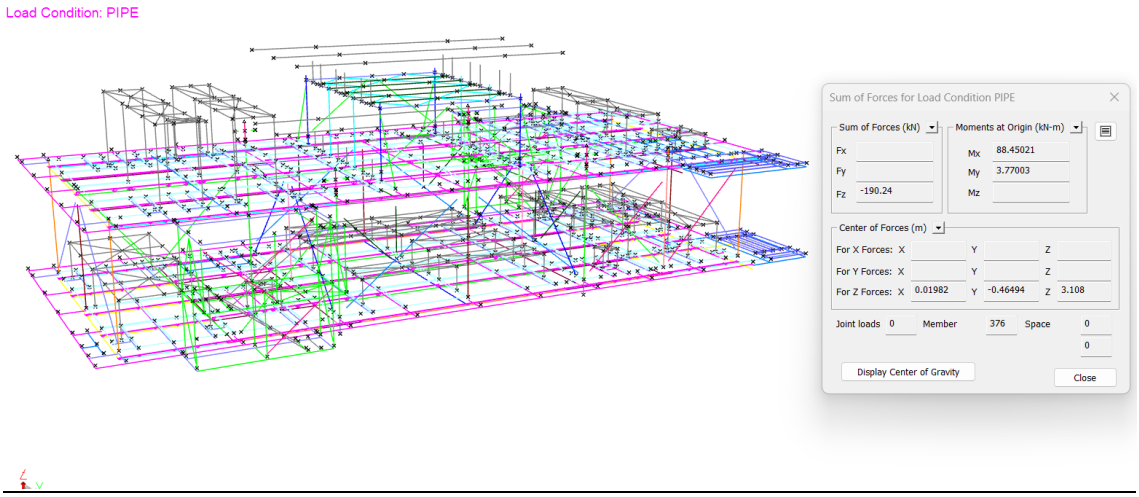


Figure 10.10 – Topside basic load conditions PIPE

10.1.5 Permanent Actions Basic Load Combination

Auxiliar load combination DEAC has been defined to account for different contingencies of modelled structure (Topside, Pau).

Permanent actions basic load cases have been combined in load combination G001 accounting for different weight contingencies of basic load conditions (the same used in WCR). Refer to in-service analysis for comparison of WCR values and modelled ones.

Auxiliar Basic Load Combination DEAC		
Basic Load cases	Description	Load Factors
DZTO	TOPSIDE MODELED WEIGHT	0.145
DZPU	PAU MODELLED WEIGHT	0.030

Permanent Basic Load combination G001		
Basic Load case	Description	Load Factor
DEAZ	Modelled structural Element weight	1.10
DEAC	Modelled structural Element CONTINGENCY weight	1.00
WFLO	Flooring & grating permanent loads	1.12
WPER	Permanent not modelled loads	1.12
MECD	Equipment dry weight (+ contingency)	1.12
TECH	Technical rooms dry weight (incl. safety/ele and + contingency)	1.15
EQSP	Equipment support weight	1.00
PIPE	Piping Loads	1.12
BULK	Bulk loads contingency (1 kN/m2 no ext walkways)	1.00

Table 10.5 - Permanent Actions - Basic Load Combination

Following SACS excerpt details the basic load conditions and load combination G001 resultant, accounting for gross permanent weights.

```
                                    ************* SEASTATE LOAD CASE CENTER REPORT *************
                                                    RELATIVE TO STRUCTURAL ORIGIN
LOAD  LOAD       ********* X - DIRECTION *********      ********* Y - DIRECTION *********      ********* Z - DIRECTION *********
CASE  LABEL      FORCE      X         Y         Z        FORCE      X         Y         Z        FORCE      X         Y         Z
                   (KN)     (M)       (M)       (M)        (KN)     (M)       (M)       (M)        (KN)     (M)       (M)       (M)

  1   BULK       0.00                                    0.00                                  -1312.00     0.02     -0.46     26.42
  2   DEAZ       0.00                                    0.00                                  -3657.95     0.45      1.07     27.21
  3   DZPU       0.00                                    0.00                                   -244.10     0.00      0.00     33.74
  4   DZTO       0.00                                    0.00                                  -3415.42     0.41      1.12     27.24
  5   EQSP       0.00                                    0.00                                   -484.10    -0.37      0.03     29.26
  7   MECD       0.00                                    0.00                                  -6951.55    -0.21     -1.92     32.22
 12   TECH       0.00                                    0.00                                  -1575.46    -0.65      5.00     25.37
 13   WFLO       0.00                                    0.00                                  -1087.39     0.34      0.44     26.51
 14   WPER       0.00                                    0.00                                   -670.33     1.11      4.05     28.99
 15   DEAC       0.00                                    0.00                                   -502.56     0.49      1.11     26.86
 16   PIPE       0.00                                    0.00                                   -190.24     0.02     -0.46     26.42

 17   G001       0.00                                    0.00                                 -18112.90     0.02      0.10     29.20
```

10.2 VARIABLE ACTIONS

10.2.1 Equipment content weights

Equipment mechanical content weights at Upper and Lower Deck, not including 12% contingency foreseen by WCR, have been included in load condition MECC.

- Load condition MECC: EQUIPMENT CONTENT WEIGHTS (contingency not included)

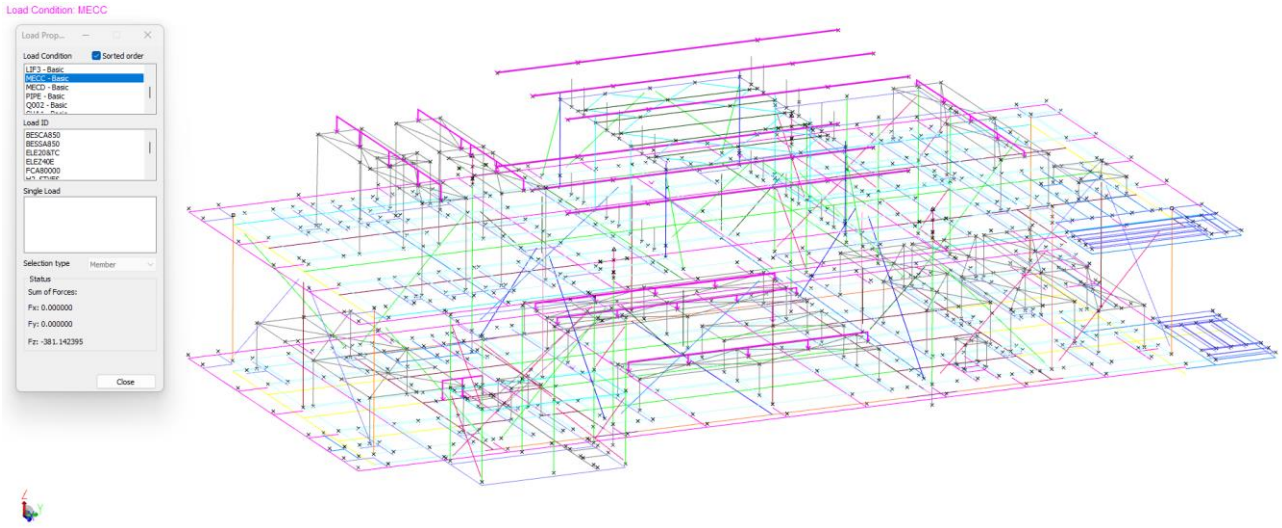


Figure 10.11 – Topside basic load conditions MECC

10.2.2 Variable Actions Basic Load Combination

Variable actions basic load cases have been combined in load combination.

Variable Loads Basic Load Combination Q002		
Basic Load cases	Description	Load Factors
MECC	EQUIPMENT CONTENT LOADS (CONT EXCL)	1.120

Following excerpt of SACS output details the basic load cases and combinations accounting for variable loads.

```
                              ************* SEASTATE LOAD CASE CENTER REPORT *************
                                            RELATIVE TO STRUCTURAL ORIGIN
LOAD  LOAD      ********* X - DIRECTION ******  ********* Y - DIRECTION *********   ********* Z - DIRECTION *********
CASE  LABEL     FORCE      X       Y       Z    FORCE      X       Y       Z        FORCE      X       Y       Z
                  (KN)     (M)     (M)     (M)    (KN)     (M)     (M)     (M)        (KN)     (M)     (M)     (M)

  6   MECC        0.00                            0.00                               -381.14    0.20   -4.61   30.19
 18   Q002        0.00                            0.00                               -426.88    0.20   -4.61   30.19
```

10.2.1 Wind loads

Loadout will be performed in good environmental conditions, with limited wind speed. This will be reflected in loadout manual.

10.3 WCR – STRUCTURAL MODEL COMPARISON

Load combination STAT includes permanent and maximum variable loads and is defined as per following table and SACS excerpt for WCR cross check.

WCR Comparison - Load Combination STAT		
Basic Load cases	Description	Load Factors
G001	BLPH TOPSIDES PERMANENT LOADS	1.000
Q002	BLPH TOPSIDES VARIABLE LOADS	1.000

```
                                        ************* SEASTATE LOAD CASE CENTER REPORT *************
                                                        RELATIVE TO STRUCTURAL ORIGIN
LOAD  LOAD       ********* X - DIRECTION *********      ********* Y - DIRECTION *********      ********* Z - DIRECTION *********
CASE  LABEL      FORCE      X        Y        Z         FORCE      X        Y        Z         FORCE      X        Y        Z
                   (KN)     (M)      (M)      (M)         (KN)     (M)      (M)      (M)         (KN)     (M)      (M)      (M)

  19  STAT         0.00                                   0.00                                -18539.78     0.02     0.00    29.21
```

COG location comparison between current structural model for Lifting Analysis and WCR is reported in following tables.

SACS-WCR - Permanent & Variable Loads Comparison		
Load Comb.	**Fz [kN]**	**Fz [t]**
SACS (lcomb STAT)	-18540	-1890
WCR	-17678	-1802
Δ	862	88
Δ (%)	4.8%	

COG NOMINAL POSITION			
CASE	**x [m]**	**y [m]**	**z [m]**
COG_SACS (lcomb STAT)	0.02	0.00	29.21
COG_WCR	-0.10	-0.30	29.30
Δ	-0.08	-0.30	-0.09
Topside Main Dimension	16.00	40.00	17.66
Δ (%)	0.5%	0.8%	0.5%

Table 10.6 – SACS-WCR CoG comparison

After this comparison the modelled structure has been shifted from the Z elevation of the platform in service, to the elevation of topside on barge, e.g. LD from +23.310m LAT to +3.50m from barge deck.

10.3.1 CoG shift

Starting from Combination STAT was created load combination TWLO (topside weight in loadout) after shifting the structure in Z-dir. and shifting the CoG to match the SPMT centre of force (see section 10.4).

TWLO = STAT*1.00+SWCR*1.00

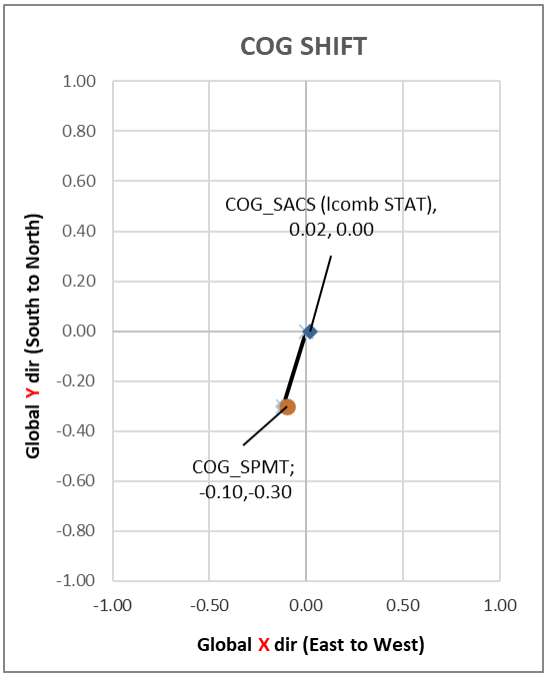


Figure 10.12 - Load out Arrangement

```
                                                ************* SEASTATE LOAD CASE CENTER REPORT *************
                                                  RELATIVE TO STRUCTURAL ORIGIN
LOAD  LOAD       ********* X - DIRECTION *********      ********* Y - DIRECTION *********      ********* Z - DIRECTION *********
CASE  LABEL      FORCE      X        Y        Z         FORCE      X        Y        Z         FORCE      X        Y        Z
                   (KN)     (M)      (M)      (M)         (KN)     (M)      (M)      (M)         (KN)     (M)      (M)      (M)

  16  SWCR         0.00                                   0.00                                  COUPLE
  25  TWLO        -0.00                                   0.00     0.49    -8.40    12.27   -18543.74    -0.11    -0.29     9.41
```

10.4 SPMT'S LOADS

Dedicated load cases, one each hydraulic system, were defined to proper consider the behaviour of the topsides on the SPMTs. For each hydraulic circuit the total amount of load was uniformly distributed along spacers (beams were modelled with inertia null – as spacers); consequently, it is transferred to topside structure at connection points.

An overview of the loadout layout is shown in the following figure, the RED circles represent the centre of the hydraulic circuits, and the red square represent the location of the contact between the topside and the SPMTs spacer beams.

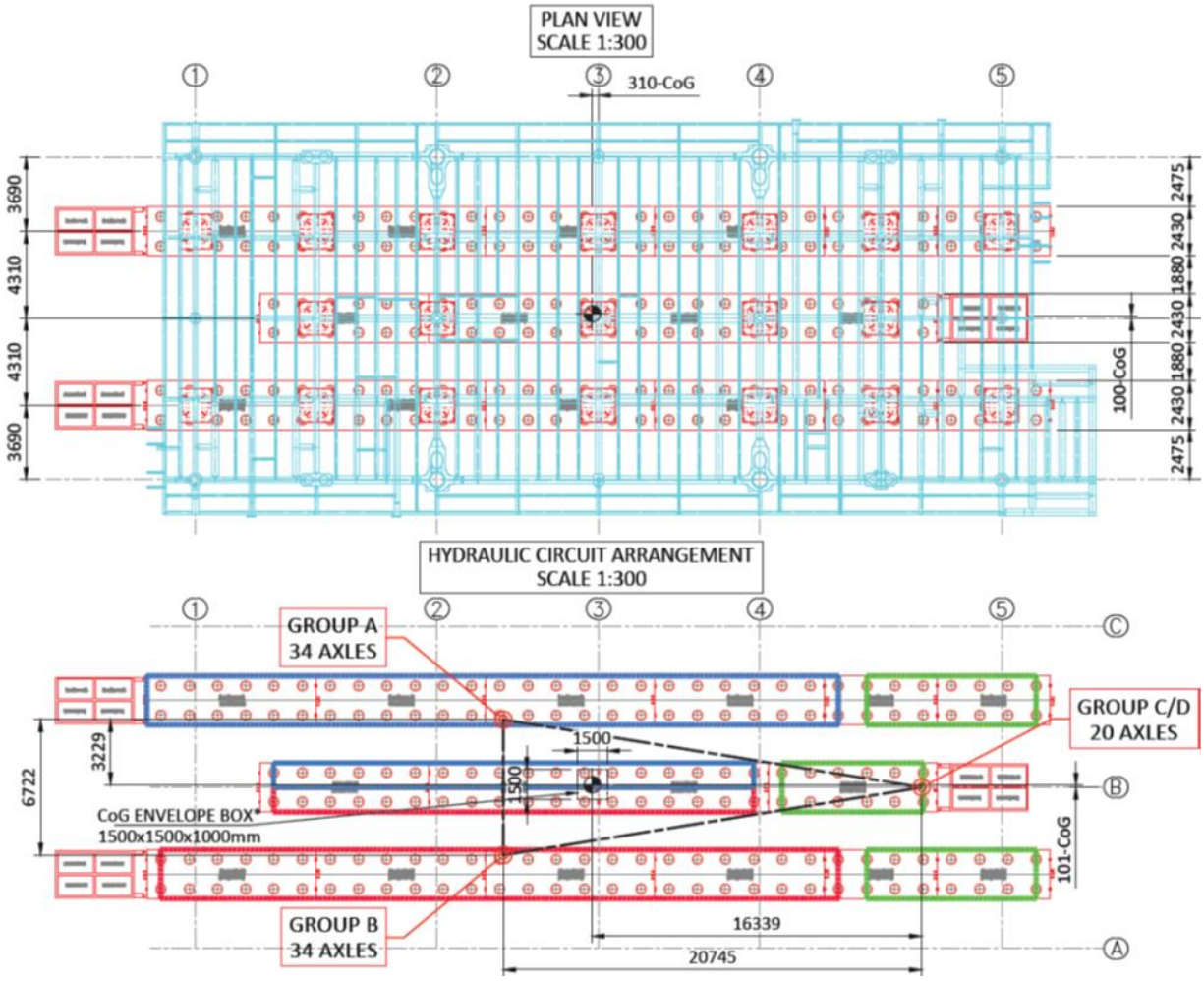


Figure 10.13 – Load out Arrangement

LOAD COMB	Hydraulic circuit A [t]	Hydraulic circuit B [t]	Hydraulic circuit C/D [t]
SPMT	747	706.3	376.9
Spacer beam length	*2 x 33.6 + 23 m*	*2 x 33.6 + 23 m*	*2 x (2 x 8.4) + 2 x 7 m*
Load t/m	*8.281*	*7.830*	*7.918*

Table 10.7 – Applied load to spacer beams

```
************* SEASTATE LOAD CASE CENTER REPORT ************
                RELATIVE TO STRUCTURAL ORIGIN

LOAD      ******** X - DIRECTION *********      ********* Y - DIRECTION *********      ********* Z - DIRECTION *******
LABEL     FORCE      X          Y          Z      FORCE      X          Y          Z      FORCE      X          Y          Z
           (KN)     (M)        (M)        (M)      (KN)     (M)        (M)        (M)      (KN)     (M)        (M)        (M)

6  HCG1       0.00                              0.00                              7469.46    -3.24      -4.72      2.00
7  HCG2       0.00                              0.00                              7062.66     3.24      -4.72      2.00
8  HCG3       0.00                              0.00                              3768.97    -0.00      15.94      2.00
```

- Load condition HCG1: HYDRAULIC CIRCUIT GROUP 1

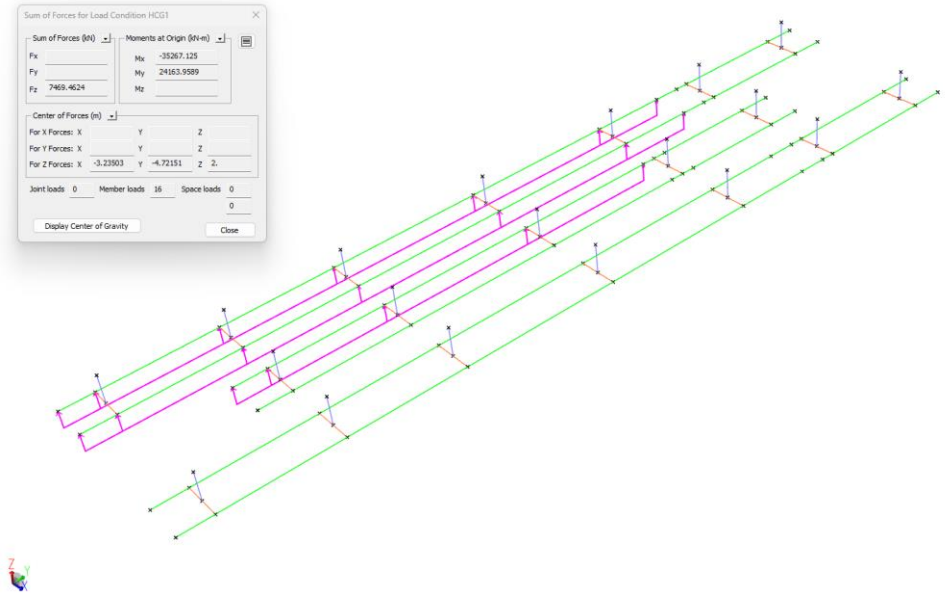


Figure 10.14 – HCG1 load case

- Load condition HCG2: HYDRAULIC CIRCUIT GROUP 2

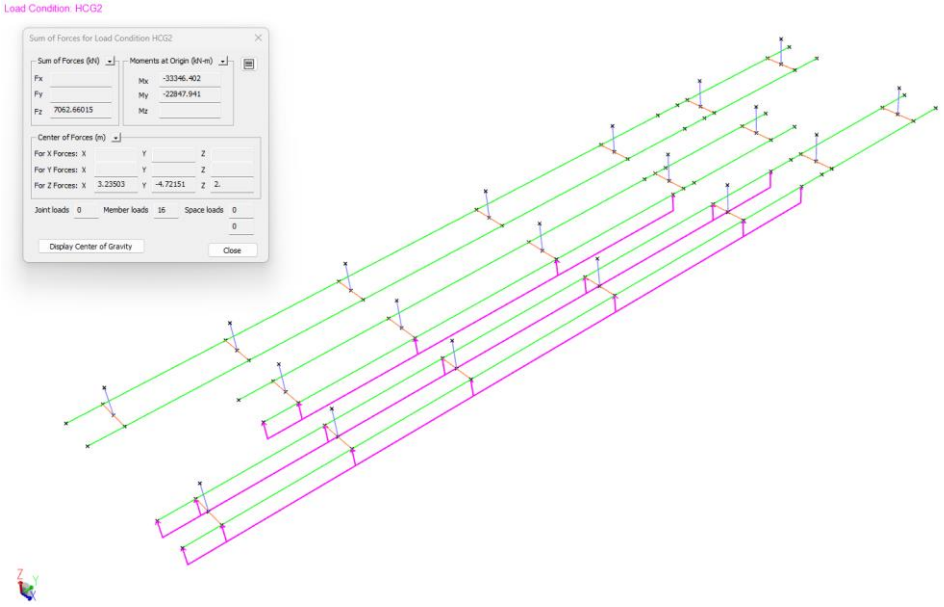


Figure 10.15 – HCG2 load case

- Load condition HCG3: HYDRAULIC CIRCUIT GROUP 3

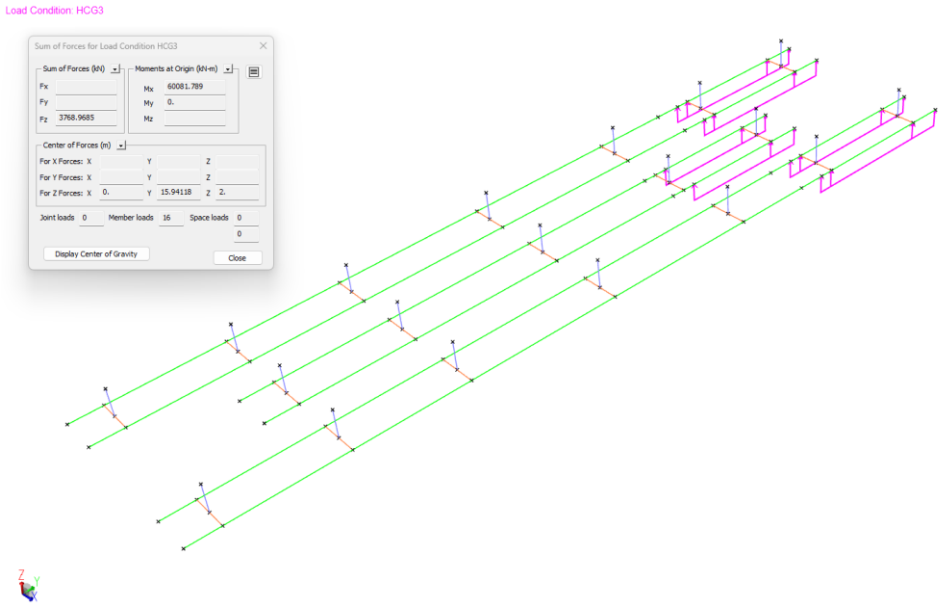


Figure 10.16 – HCG3 load case

11 LOAD COMBINATIONS

11.1 BASIC LOAD COMBINATIONS

The Topside Weight Load Out combination (TWLO) accounts for all the vertical load to be moved out to the transportation barge.

Comb	G001	Q002	HCG1	HCG2	HCG3
TWLO	1.000	1.000	-	-	-
SPMT	-	-	1.000	1.000	1.000
TEST	1.000	1.000	1.000	1.000	1.000

Following excerpt of SACS output provides the basic load combinations resultants.

```
************* SEASTATE LOAD CASE CENTER REPORT ************
                RELATIVE TO STRUCTURAL ORIGIN

LOAD     ******** X - DIRECTION *********     ********* Y - DIRECTION *********      ********** Z - DIRECTION *******
LABEL    FORCE      X         Y         Z      FORCE      X         Y         Z        FORCE       X         Y         Z
           (KN)     (M)       (M)       (M)      (KN)     (M)       (M)       (M)        (KN)      (M)       (M)       (M)

TWLO      -0.00                                 0.00     0.49     -8.40     12.27   -18543.74    -0.11     -0.29      9.41
SPMT       0.00                                 0.00                                 18543.26    -0.13     -0.29      2.00
TEST      -0.00                                 0.00     0.49     -8.40     12.27      COUPLE
```

11.2 LOAD OUT COMBINATIONS

The load out combinations were defined according to section 8.4.

Comb	TWLO	SPMT	
LOD1	1.300	1.300	Load out situation 1
LOD2	1.100	1.100	Load out situation 2
LOD3	0.900	0.900	Load out situation 3

Following excerpt from SACS output provide the Load out Combinations resultants.

```
************* SEASTATE LOAD CASE CENTER REPORT ************
                RELATIVE TO STRUCTURAL ORIGIN

 LOAD     ******** X - DIRECTION *********     ********* Y - DIRECTION *********      ********* Z - DIRECTION *******
 LABEL    FORCE      X         Y         Z      FORCE      X         Y         Z        FORCE      X         Y         Z
            (KN)     (M)       (M)       (M)      (KN)     (M)       (M)       (M)        (KN)     (M)       (M)       (M)

LOD1      -0.00                                 0.00     0.49     -8.40     12.27      COUPLE
LOD2      -0.00                                 0.00     0.49     -8.40     12.27      COUPLE
LOD3      -0.00                                 0.00     0.49     -8.40     12.27      COUPLE
```

Following excerpt from SACS output provide the horizontal restraints reactions and springs vertical reactions:

SACS-IV SYSTEM SPRING FORCES AND MOMENTS

JOINT	LOAD CASE	COORD. SYS.	FORCES X (KN)	FORCES Y (KN)	FORCES Z (KN)	MOMENTS X (KN-M)	MOMENTS Y (KN-M)	MOMENTS Z (KN-M)
TU02	LOD1	GLOB	0.000	0.000	-20.790	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	-17.605	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	-14.388	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	-15.993	0.000	0.000	0.000
TU01	LOD1	GLOB	0.000	0.000	14.618	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	12.337	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	10.122	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	11.233	0.000	0.000	0.000
TU04	LOD1	GLOB	0.000	0.000	20.472	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	17.310	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	14.189	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	15.766	0.000	0.000	0.000
TU03	LOD1	GLOB	0.000	0.000	-14.934	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	-12.630	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	-10.320	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	-11.458	0.000	0.000	0.000

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12 ANALYSIS RESULTS

This section presents the results of the performed Load Out analysis in terms of:

- Reactions at restrained joints
- Structural checks of structural members.
- Structural checks of tubular connections.

12.1 REACTIONS AT FIXED POINTS

Vertical reactions at fixed points are reported in the following SACS excerpt for all the examined load combinations.

SACS-IV SYSTEM SPRING FORCES AND MOMENTS

JOINT	LOAD CASE	COORD. SYS.	FORCES X (KN)	FORCES Y (KN)	FORCES Z (KN)	MOMENTS X (KN-M)	MOMENTS Y (KN-M)	MOMENTS Z (KN-M)
TU02	LOD1	GLOB	0.000	0.000	-20.790	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	-17.605	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	-14.388	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	-15.993	0.000	0.000	0.000
TU01	LOD1	GLOB	0.000	0.000	14.618	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	12.337	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	10.122	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	11.233	0.000	0.000	0.000
TU04	LOD1	GLOB	0.000	0.000	20.472	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	17.310	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	14.189	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	15.766	0.000	0.000	0.000
TU03	LOD1	GLOB	0.000	0.000	-14.934	0.000	0.000	0.000
	LOD2	GLOB	0.000	0.000	-12.630	0.000	0.000	0.000
	LOD3	GLOB	0.000	0.000	-10.320	0.000	0.000	0.000
	TEST	GLOB	0.000	0.000	-11.458	0.000	0.000	0.000

Reactions at horizontal restraints are null.

SACS-IV SYSTEM FIXED JOINTS REACTION FORCES AND MOMENTS

JOINT NUMBER	LOAD CASE	FORCE(X) KN	FORCE(Y) KN	FORCE(Z) KN	MOMENT(X) KN-M	MOMENT(Y) KN-M	MOMENT(Z) KN-M
TU01	LOD1	0.001	-0.000	0.000	0.000	0.000	0.000
	LOD2	0.001	-0.000	0.000	0.000	0.000	0.000
	LOD3	0.001	-0.000	0.000	0.000	0.000	0.000
	TEST	0.001	-0.000	0.000	0.000	0.000	0.000
TU04	LOD1	-0.001	0.000	0.000	0.000	0.000	0.000
	LOD2	-0.001	0.000	0.000	0.000	0.000	0.000
	LOD3	-0.001	0.000	0.000	0.000	0.000	0.000
	TEST	-0.001	0.000	0.000	0.000	0.000	0.000

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12.2 STRUCTURAL CHECKS

The results of the performed analysis in terms of members' Unity Check (UC) and Joints' Punching Shear Unity Checks are detailed in the following.

12.2.1 Member checks

All members were checked according to ISO 19902 and Eurocode 3, Ref./6/and /8/, respectively for tubular and non-tubular elements. Members' code checks are reported in the following and show that the structure can withstand all load combinations, with utilization factors below 1.0.

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

GROUP II - UNITY CHECKS GREATER THAN 0.70 AND LESS THAN 0.90

MEMBER	GROUP ID	MAXIMUM COMBINED UNITY CK	LOAD COND NO.	DIST FROM END	AXIAL STRESS N/MM2	BENDING STRESS Y N/MM2	BENDING STRESS Z N/MM2	SHEAR FORCE FY KN	SHEAR FORCE FZ KN	KLY/RY	KLZ/RZ	SECOND-HIGHEST UNITY CHECK	SECOND-HIGHEST LOAD COND	THIRD-HIGHEST UNITY CHECK	THIRD-HIGHEST LOAD COND
L055-L267	B03	0.713	LOD1	0.0	0.39	-188.98	-2.56	1.35	797.38	15.1	96.6	0.603	LOD2	0.548	TEST
L207-L004	B03	0.729	LOD1	2.5	-16.81	-188.63	-22.07	-15.06	-941.84	20.1	64.4	0.618	LOD2	0.562	TEST
L164-L009	B04	0.763	LOD1	2.4	-9.33	-180.51	-4.93	-2.65	-414.76	21.1	86.4	0.647	LOD2	0.588	TEST
L242-L241	B04	0.778	LOD1	2.4	-18.48	-166.92	0.24	0.34	-319.48	15.8	129.5	0.662	LOD2	0.604	TEST
L000-L198	B10	0.849	LOD1	2.5	-60.89	-133.81	3.53	1.43	-3.34	40.2	64.4	0.718	LOD2	0.653	TEST
L022-L191	B10	0.738	LOD1	2.4	-58.17	-114.14	-0.34	-0.76	-23.29	40.2	64.4	0.625	LOD2	0.568	TEST
L027-L246	B10	0.801	LOD1	0.0	-24.83	-203.58	0.10	-0.12	608.37	40.2	64.4	0.679	LOD2	0.617	TEST
L191-L000	B10	0.853	LOD1	1.6	-58.17	-147.07	-1.99	-0.75	-189.16	40.2	64.4	0.722	LOD2	0.656	TEST
L198-L027	B10	0.869	LOD1	1.5	-60.94	-145.27	-4.67	-4.11	-73.98	40.2	64.4	0.735	LOD2	0.668	TEST
L011-U011	D16	0.766	LOD1	0.0	-190.61	-26.48	3.57	-1.41	2.34	55.6	55.6	0.644	LOD2	0.584	TEST

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

GROUP III - UNITY CHECKS GREATER THAN 0.90 AND LESS THAN 999.00

MEMBER	GROUP ID	MAXIMUM COMBINED UNITY CK	LOAD COND NO.	DIST FROM END	AXIAL STRESS N/MM2	BENDING STRESS Y N/MM2	BENDING STRESS Z N/MM2	SHEAR FORCE FY KN	SHEAR FORCE FZ KN	KLY/RY	KLZ/RZ	SECOND-HIGHEST UNITY CHECK	SECOND-HIGHEST LOAD COND	THIRD-HIGHEST UNITY CHECK	THIRD-HIGHEST LOAD COND
L000-L248	B02	0.936	LOD1	0.0	-4.03	-229.99	-1.03	0.81	679.56	19.4	90.6	0.792	LOD2	0.721	TEST
L202-L000	B02	0.917	LOD1	4.0	-3.26	-231.23	-0.83	-0.38	-737.09	19.4	90.6	0.776	LOD2	0.706	TEST
L241-L055	B04	0.949	LOD1	0.8	-18.48	-230.28	0.90	0.34	-560.67	15.8	69.1	0.803	LOD2	0.730	TEST
L001-U001	D16	0.934	LOD1	0.0	-237.74	22.56	-3.52	1.01	-6.31	55.6	55.6	0.786	LOD2	0.713	TEST

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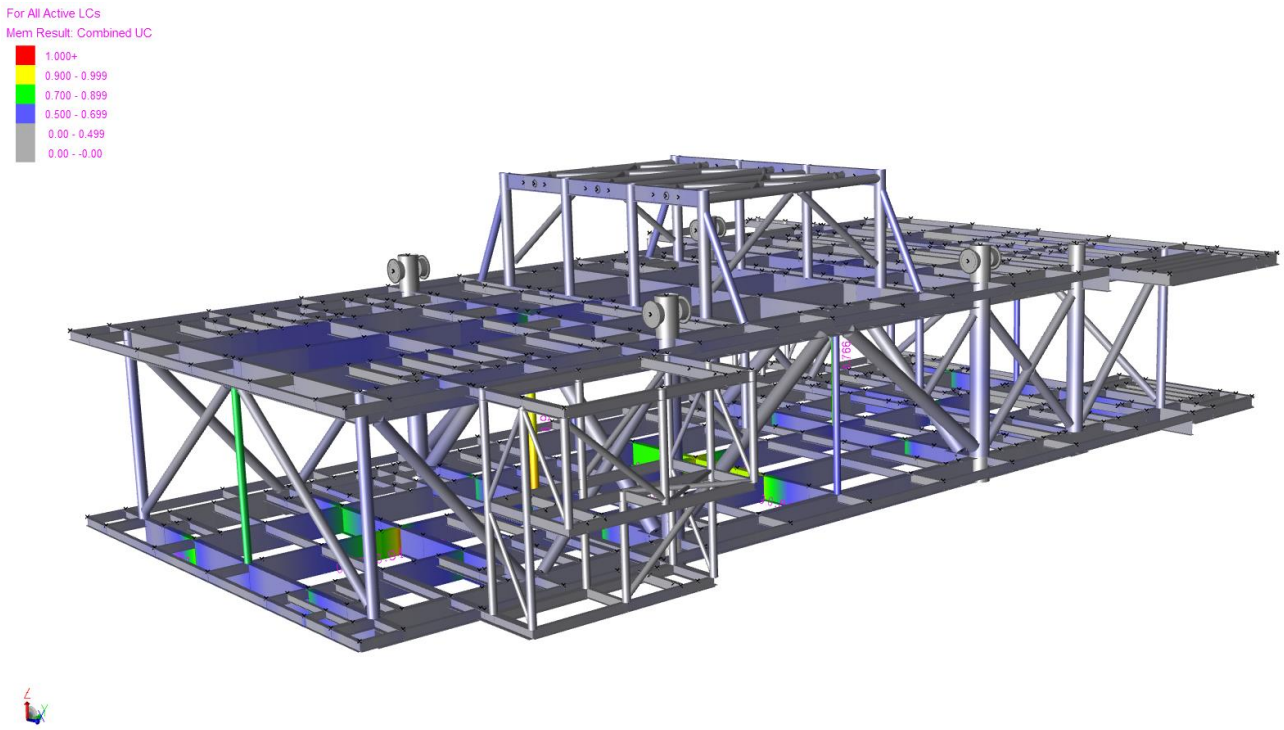


Figure 12.1 - Topside Structural Model 3D view - UC>0.7

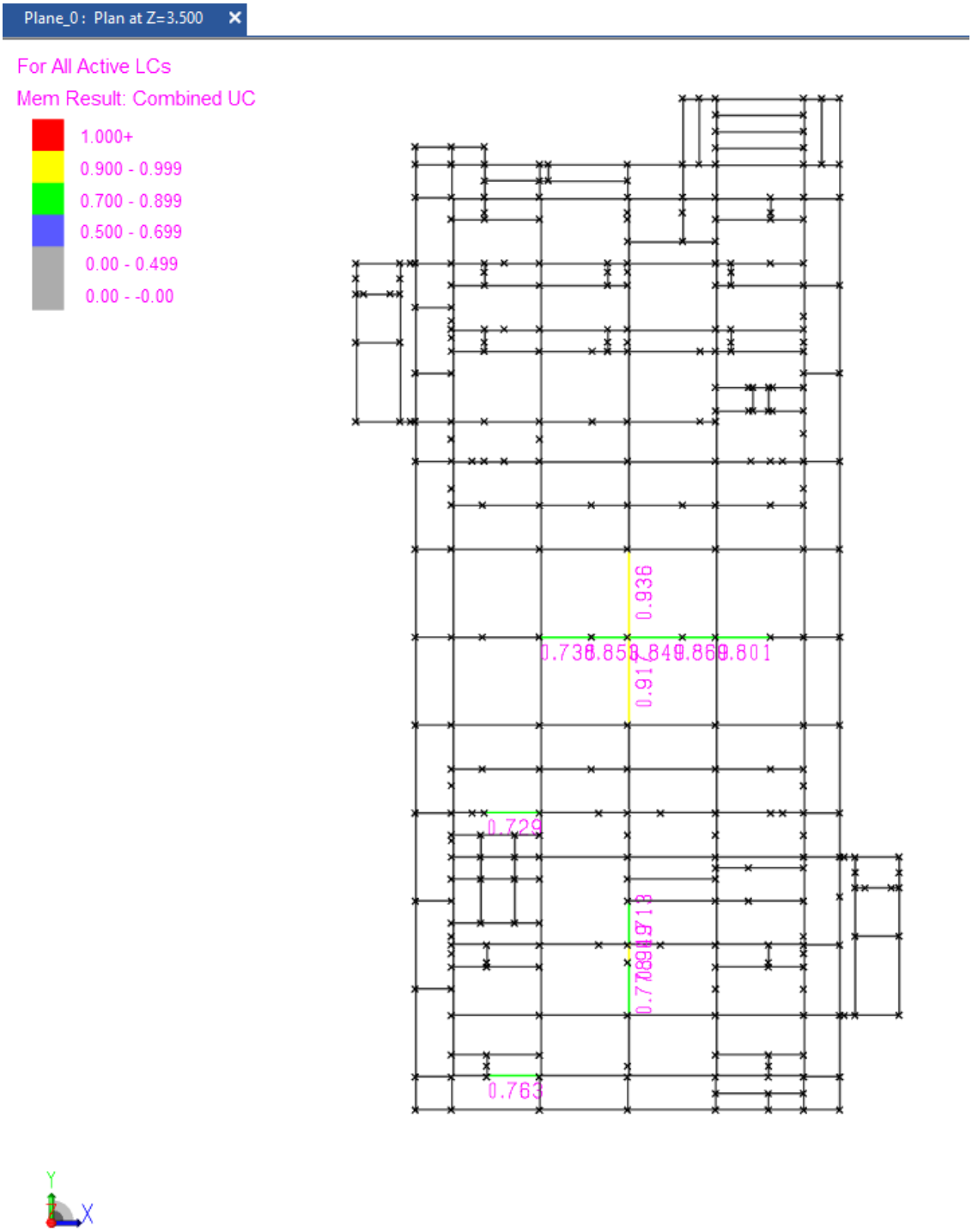


Figure 12.2 - Lower Deck - Member UC>0.7

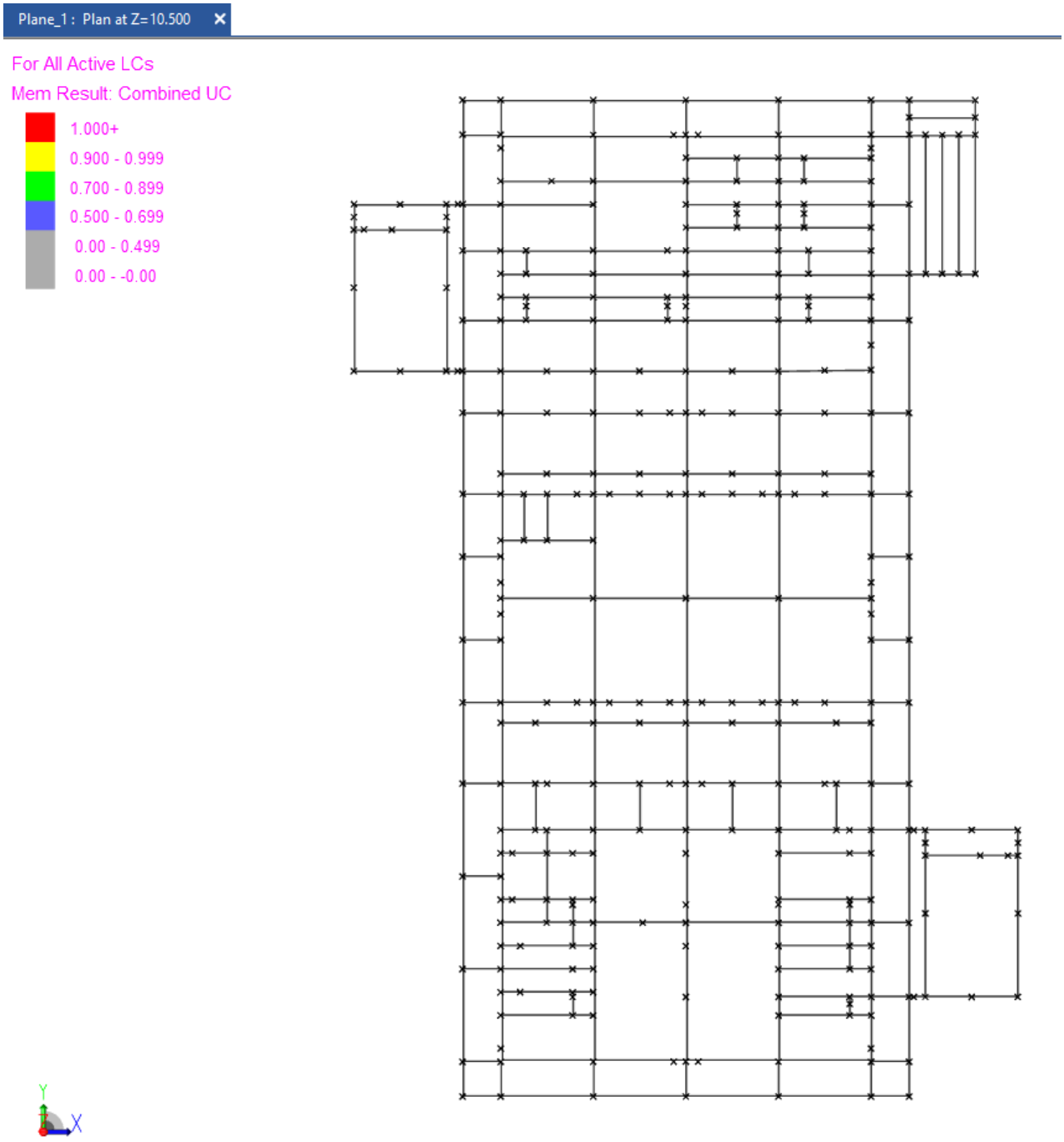


Figure 12.3 - Upper Deck - Member UC>0.7

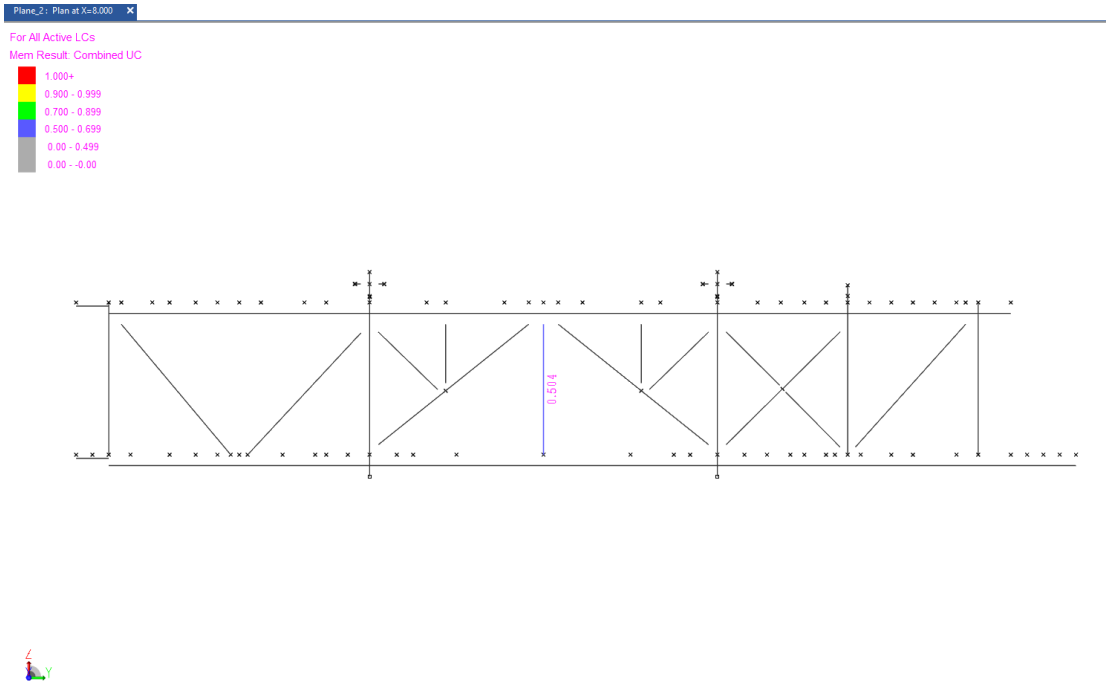


Figure 12.4 - Row A - UC>0.4

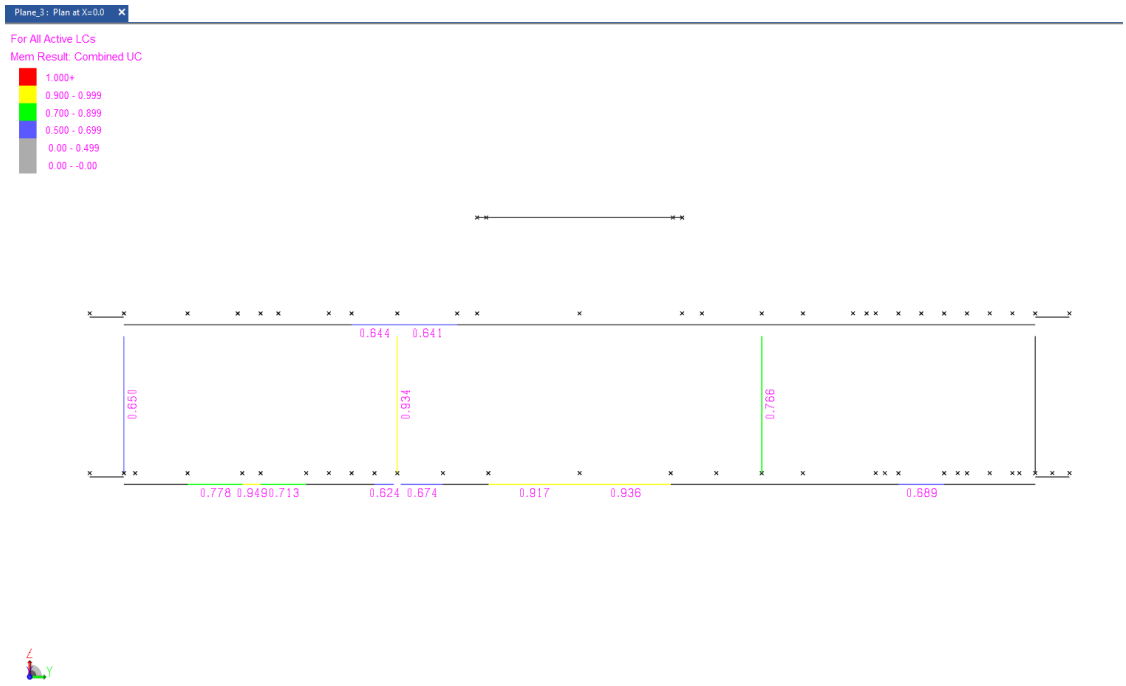


Figure 12.5 - Row B - UC>0.6

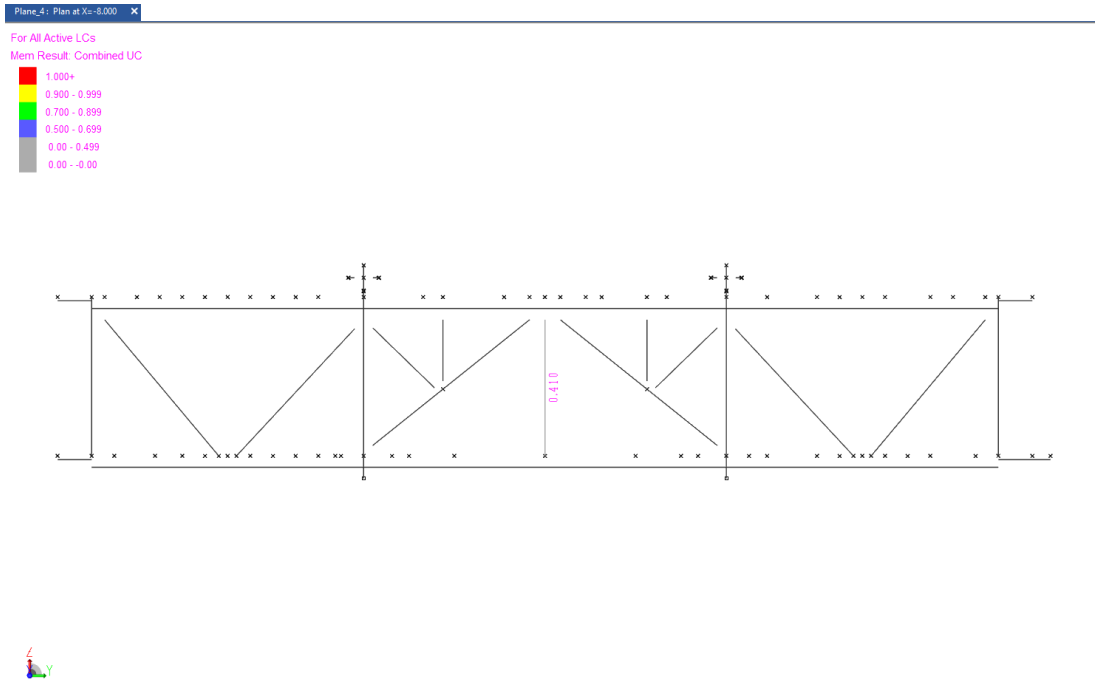


Figure 12.6 - Row C - UC>0.4

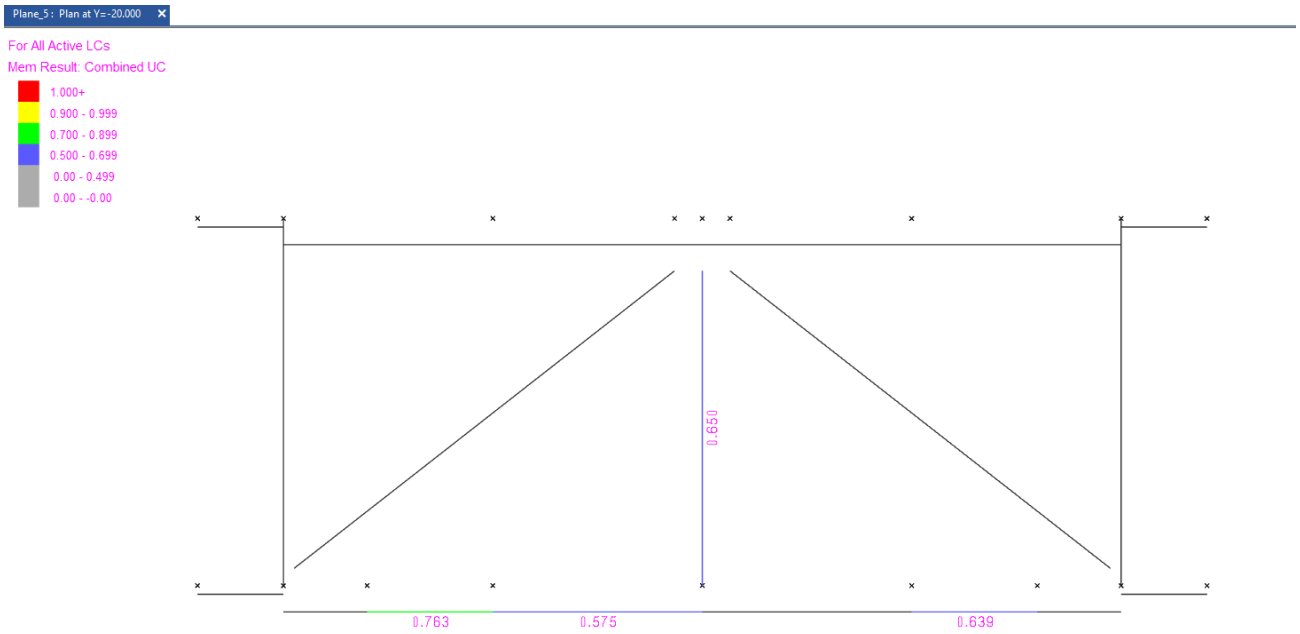


Figure 12.7 - Row 1- UC>0.5

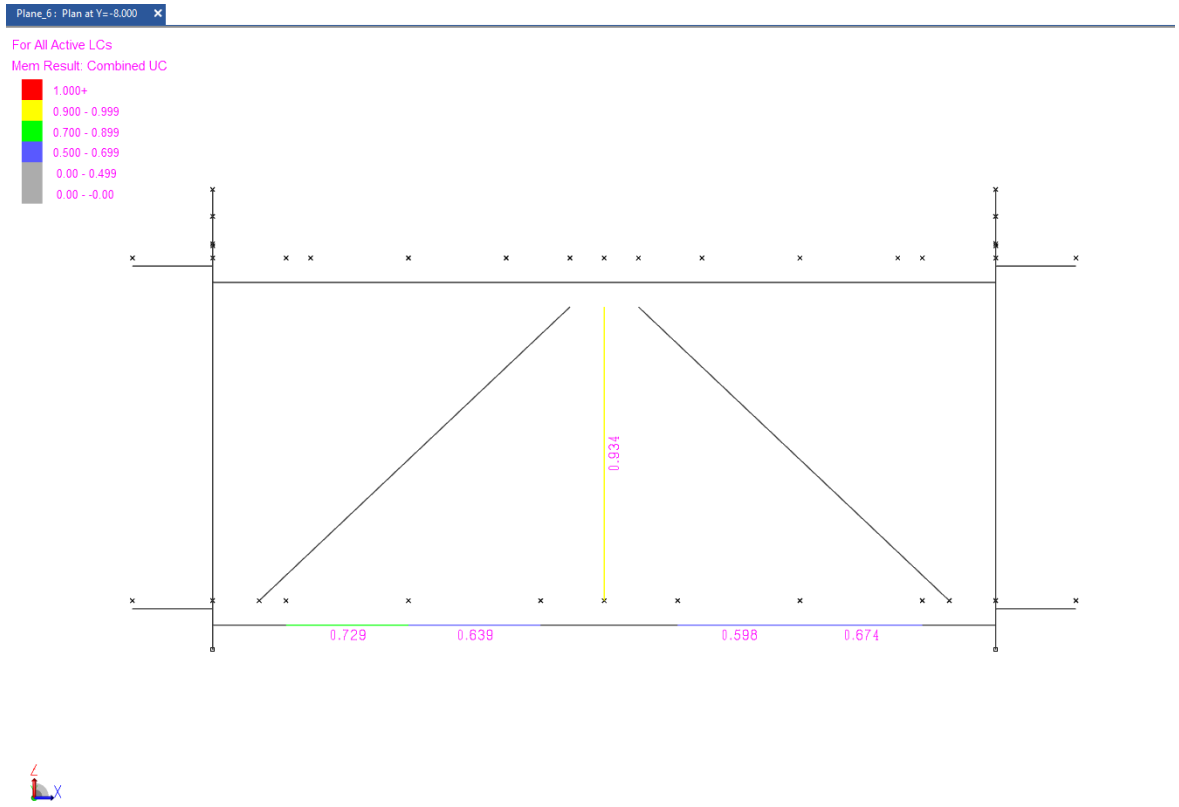


Figure 12.8 - Row 2 – UC>0.5

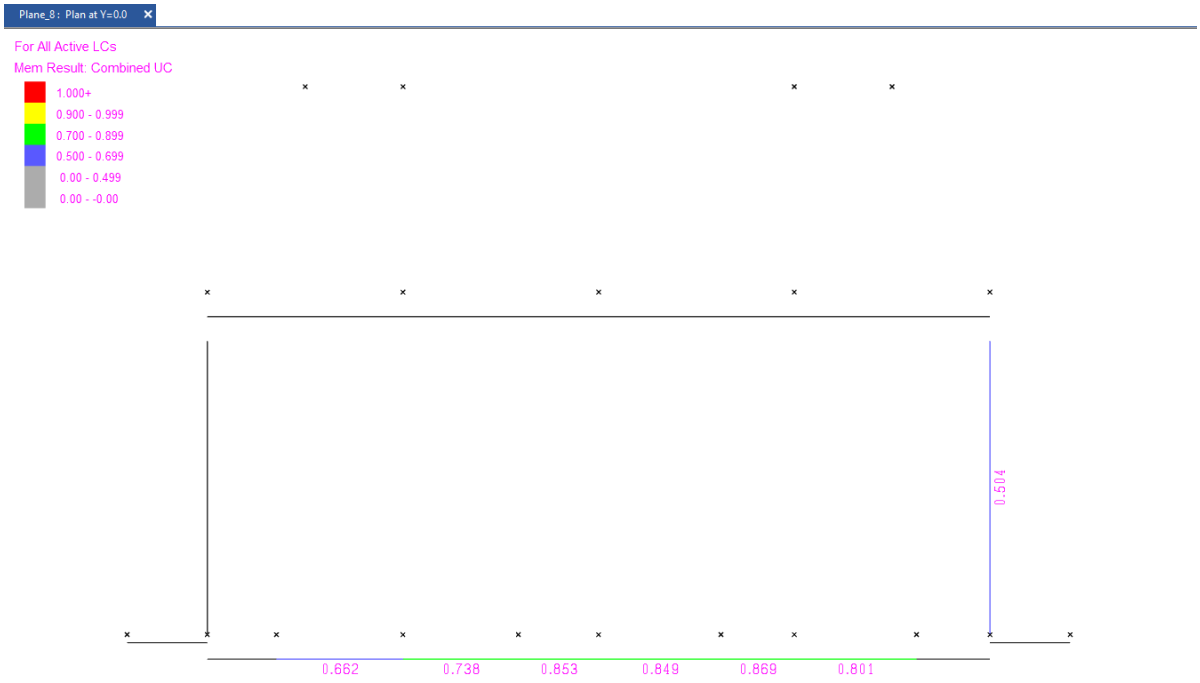


Figure 12.9 - Row 3 - UC>0.5

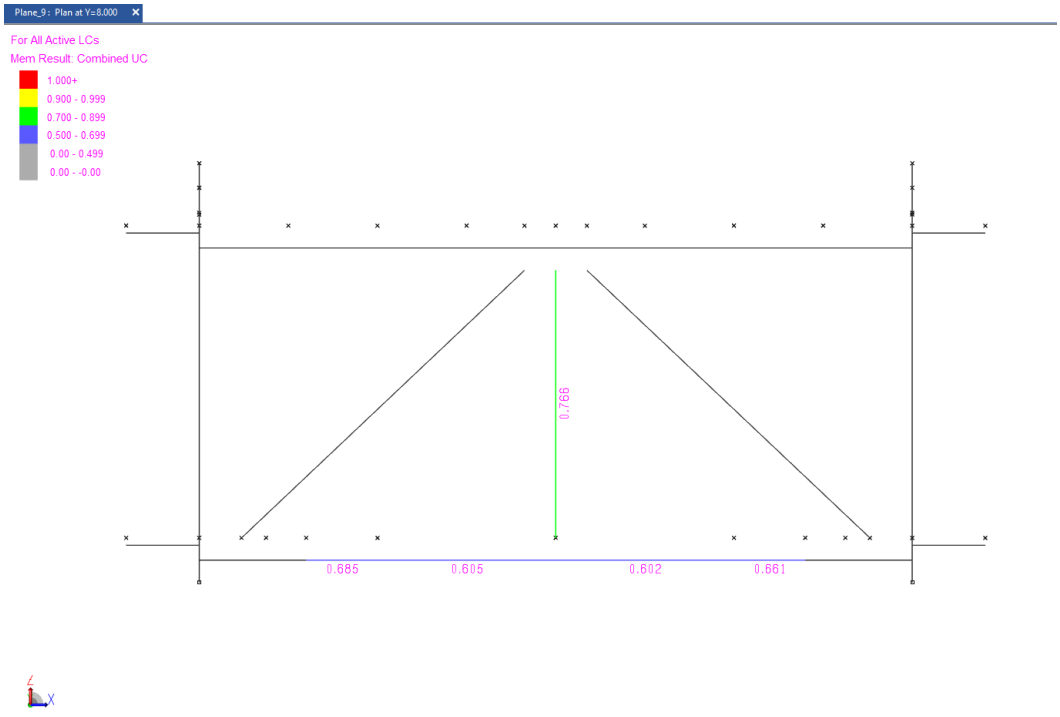


Figure 12.10 – Row 4 – UC>0.5

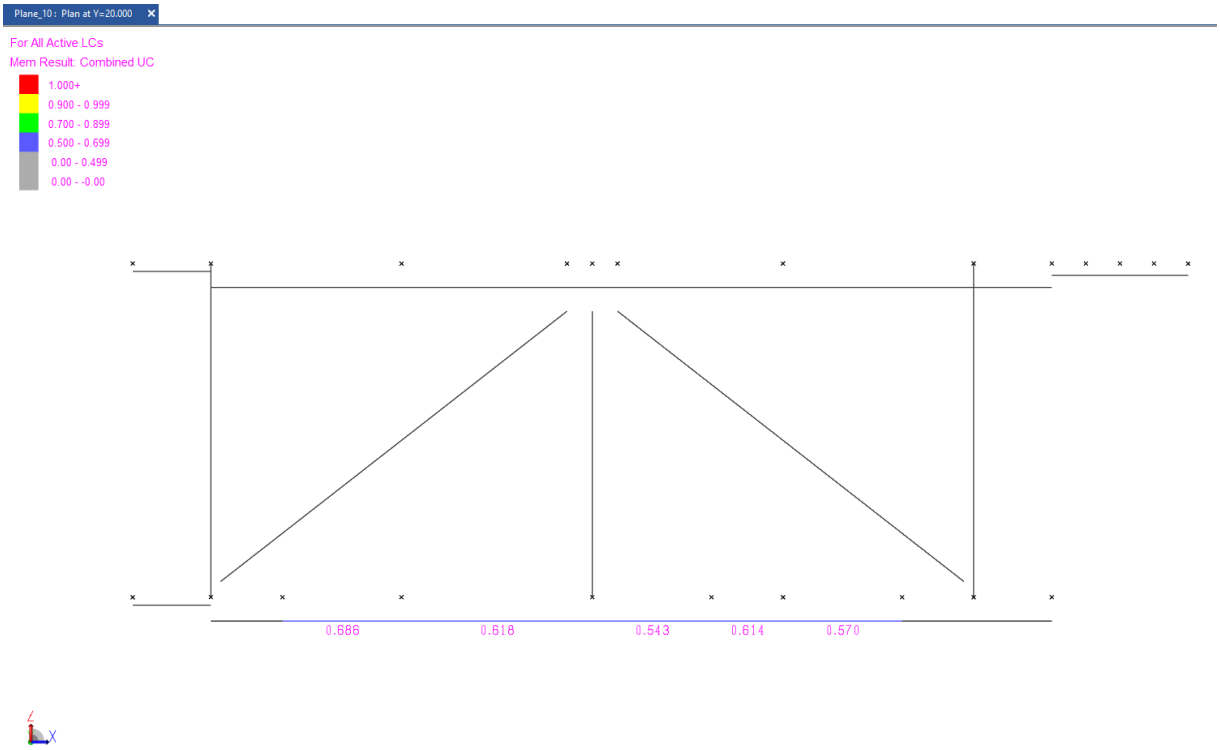


Figure 12.11 - Row 5 - UC>0.5

Maximum UC per member's group are reported in following SACS excerpt.

* * * M E M B E R G R O U P S U M M A R Y * * *
ISO 19902:2020 / EC3:1992

GRUP ID	CRITICAL MEMBER	LOAD COND	MAX. UNITY CHECK	DIST FROM END M	* APPLIED STRESSES * AXIAL N/MM2	BEND-Y N/MM2	BEND-Z N/MM2	*** ALLOWABLE STRESSES *** AXIAL N/MM2	EULER N/MM2	BEND-Y N/MM2	BEND-Z N/MM2	CRIT COND	EFFECTIVE LENGTHS KLY M	KLZ M	CM * VALUES * Y	Z
B01	L028-L121	LOD1	0.14	4.0	32.2	-11.8	-10.9	363.6	216.7	419.4	570.0	BN+AX	8.00	8.00	-1.70	-1.58
B02	L000-L248	LOD1	0.94	0.0	-4.0	-230.0	-1.0	145.4	246.4	254.1	371.2	LATBUC	8.00	8.00	-33.36	0.20
B03	L207-L004	LOD1	0.73	2.5	-16.8	-188.6	-22.1	216.8	487.5	318.0	380.7	LATBUC	8.00	4.00	-27.36	4.06
B04	L241-L055	LOD1	0.95	0.8	-18.5	-230.3	0.9	202.4	423.9	269.4	342.2	LATBUC	6.00	3.20	-33.40	0.13
B05	L225-L018	LOD1	0.11	1.0	0.3	-25.4	8.0	363.6	187.0	230.3	588.2	LATBUC	6.00	6.00	-3.69	1.15
B06	U072-U241	LOD1	0.25	0.0	-10.5	-72.1	-4.2	262.5	1178.8	361.7	369.3	BN+COM	8.00	4.00	-10.45	0.76
B07	U003-U247	LOD1	0.14	0.0	-4.5	-41.5	-5.0	306.1	2358.6	363.1	363.5	BN+COM	8.00	3.50	-6.03	-0.72
B09	H228-UP03	LOD1	0.13	1.3	8.2	-21.1	8.3	363.6	1497.6	399.0	550.9	SHEAR	16.00	4.00	-3.05	1.21
B10	L198-L027	LOD1	0.87	1.5	-60.9	-145.3	-4.7	237.2	487.5	264.0	363.6	LATBUC	16.00	4.00	-21.07	-0.68
B12	U233-U001	LOD1	0.64	2.0	-15.8	-213.6	0.6	335.4	2390.0	358.9	365.7	BN+COM	12.00	2.00	-30.98	-0.16
B13	U128-U131	LOD1	0.39	1.0	-6.9	59.7	-9.0	132.7	216.7	189.9	336.5	LATBUC	12.00	6.00	8.66	-1.30
B14	U017-U018	LOD1	0.15	4.0	-0.6	-38.0	4.6	155.3	271.3	289.8	364.7	LATBUC	8.00	4.00	-5.51	0.67

B15	U116-U003	LOD1	0.28	2.0	-0.8	-101.0	21.4	118.9	187.0	430.4	591.4	BN+COM	12.00	6.00	-14.65	3.10
B20	U076-U078	LOD1	0.07	0.0	-9.7	-9.0	3.7	326.7	3585.1	360.1	358.6	BN+COM	8.00	4.50	-1.30	0.64
B21	U001-U072	LOD1	0.23	0.0	1.4	-46.1	-1.8	363.6	4963.0	363.6	363.6	SHEAR	8.00	4.00	-6.68	-0.26
B22	L203-L003	LOD1	0.22	0.0	0.5	8.4	2.5	363.6	5763.9	363.6	363.6	SHEAR	8.00	4.00	6.54	0.50
B23	L204-L207	LOD1	0.31	0.5	-6.3	18.9	2.5	344.4	5548.4	361.9	361.4	SHEAR	8.00	4.00	5.10	0.50
B31	L521-L005	LOD1	0.08	1.0	3.4	9.5	-27.9	363.6	476.5	410.6	560.3	BN+AX	6.00	6.00	1.66	-4.04
B32	L152-L110	LOD1	0.09	0.0	4.7	-3.6	-0.8	363.6	1074.5	406.0	556.2	SHEAR	6.00	6.00	0.76	-0.12
C03	L006-U006	LOD1	0.65	6.0	-138.8	41.0	2.7	256.7	482.6	448.2	448.2	ACBI	6.00	6.00	0.85	0.85
C05	L010-U010	LOD1	0.23	0.9	-27.5	-10.8	65.7	283.3	808.7	438.3	438.3	ACBI	7.00	7.00	0.85	0.85
C06	U015-PEC4	LOD1	0.00	0.0	-0.3	0.0	0.0	.4E+03	.2E+05	.5E+03	.5E+03	ACBI	2.80	2.80	0.85	0.85
C07	U045-CR01	LOD1	0.00	0.0	-1.5	0.0	0.0	.4E+03	.4E+05	.5E+03	.5E+03	ACBI	1.60	1.60	0.85	0.85
C08	CR01-CR03	LOD1	0.01	0.0	-2.1	0.0	0.0	.3E+03	.5E+05	.4E+03	.4E+03	ACBI	1.60	1.60	0.85	0.85
C11	L156-U045	LOD1	0.14	1.1	-7.4	2.8	-68.6	363.6	2518.1	476.0	476.0	ACBI	7.00	7.00	0.85	0.85
C20	L003-U003	LOD1	0.27	1.2	-19.0	6.4	-114.6	351.5	3330.5	461.8	461.8	ACBI	7.00	7.00	0.85	0.85
CT7	PFC4-PGC4	LOD1	0.00	0.0	-0.2	0.0	0.0	.4E+03	.2E+05	.5E+03	.5E+03	ACBI	2.80	2.80	0.85	0.85
CT8	PSC4-PGC4	LOD1	0.00	0.2	0.0	-0.1	0.0	.4E+03	.6E+05	.5E+03	.5E+03	SHEAR	1.37	1.37	0.85	0.85
CT9	SSC4-PSC4	LOD1	0.00	0.0	0.0	-0.0	0.0	.4E+03	.6E+05	.6E+03	.6E+03	SHEAR	1.37	1.37	0.85	0.85
D01	L005-D003	LOD1	0.15	0.0	-21.4	-12.0	-45.5	317.6	878.3	498.6	498.6	ACBI	9.00	9.00	0.85	0.85
D02	L010-U068	LOD1	0.14	0.0	21.3	-61.3	1.2	338.1	350.5	446.0	446.0	TN+BN	9.22	9.22	0.85	0.85
D03	D006-U022	LOD1	0.21	0.0	-43.7	28.0	-24.6	313.2	3352.8	447.5	447.5	ACBI	2.71	2.71	0.85	0.85
D04	L204-U071	LOD1	0.20	0.0	16.8	-95.1	2.9	381.0	1116.1	490.8	490.8	TN+BN	8.74	8.74	0.85	0.85
D05	L049-U169	LOD1	0.13	7.8	0.1	57.8	0.1	338.1	639.6	438.3	438.3	TN+BN	7.83	7.83	0.85	0.85
D06	L156-0002	LOD1	0.09	0.0	-11.4	0.5	-29.9	312.2	3038.3	447.5	447.5	ACBI	3.57	3.57	0.85	0.85
D16	L001-U001	LOD1	0.93	0.0	-237.7	22.6	-3.5	274.1	655.4	456.2	456.2	ACBI	6.00	6.00	0.85	0.85
D36	L013-0002	LOD1	0.10	0.0	-0.8	-6.6	-44.0	322.7	2829.5	452.6	452.6	ACBI	3.65	3.65	0.85	0.85
IP3	N012-N018	LOD1	0.08	0.0	-1.6	9.0	-6.0	40.4	50.5	272.8	513.0	LATBUC	3.55	7.10	1.30	-0.86
PB1	H232-P103	LOD1	0.23	1.3	-18.0	-54.9	4.4	294.3	2535.2	346.5	490.9	BN+COM	4.00	2.00	-7.96	0.63
PC2	U00F-U00K	LOD1	0.14	4.5	-19.5	36.1	-12.6	294.0	1109.9	447.5	447.5	ACBI	5.90	5.90	0.85	0.85
PC3	P003-P103	LOD1	0.15	3.9	17.5	-2.8	-65.4	338.1	1397.4	448.6	448.6	TN+BN	5.90	5.90	0.85	0.85
PD1	U00J-P140	LOD1	0.06	0.0	-0.3	-27.3	3.0	322.7	207.4	455.9	455.9	ACBI	9.00	2.25	0.85	0.85
PD2	P145-P137	LOD1	0.05	0.0	-6.8	16.4	-3.8	306.4	1954.3	455.8	455.8	ACBI	2.35	2.35	0.85	0.85
PD3	P003-P112	LOD1	0.05	5.0	-4.2	-4.1	-20.5	276.3	685.6	450.8	450.8	ACBI	5.01	5.01	0.85	0.85
PL1	P112-P123	LOD1	0.03	0.0	2.0	-7.6	-3.6	338.1	1439.5	450.0	450.0	SHEAR	4.50	4.50	0.85	0.85
S01	U130-U131	LOD1	0.19	4.0	8.7	-53.0	-1.6	313.6	348.0	337.0	476.8	BN+AX	16.00	4.00	-7.68	-0.23
S02	U283-U284	LOD1	0.30	2.2	0.0	91.0	-0.5	322.7	303.1	305.0	496.2	LATBUC	4.00	2.20	13.20	-0.07
S03	L305-L070	LOD1	0.48	0.0	3.4	8.3	3.1	322.7	994.9	345.1	496.3	BN+AX	4.00	1.60	1.20	-1.71
S04	L257-L173	LOD1	0.43	0.9	14.3	-66.5	56.1	322.7	704.5	322.7	322.7	BN+AX	4.00	4.00	-9.64	8.13
S07	US04-US05	LOD1	0.02	2.0	-0.5	3.1	-0.1	49.3	66.6	236.9	695.4	LATBUC	4.00	4.00	0.45	0.04
SF1	U022-P103	LOD1	0.30	4.4	-72.4	-28.6	4.3	297.9	1285.0	447.5	447.5	ACBI	4.37	4.37	0.85	0.85
ST1	N038-U00M	LOD1	0.10	3.2	15.6	19.3	-40.0	338.1	1721.3	445.2	445.2	TN+BN	3.20	3.20	0.85	0.85

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ST2	M00P-U13B	LOD1	0.04	4.5	3.2	-1.9	-15.5	338.1	567.9	446.7	446.7	TN+BN	4.45	4.45	0.85	0.85
ST6	L11D-US06	LOD1	0.08	0.0	-11.5	-6.5	-1.3	191.0	451.1	313.6	313.6	ACBI	3.77	3.77	0.85	0.85
ST7	M200-M204	LOD1	0.02	0.0	-0.0	-6.4	1.3	225.5	1059.2	314.8	314.8	BEND	2.06	2.06	0.85	0.85
TS1	TU04-L015	LOD1	0.00	0.5	0.3	0.0	0.0	.4E+03	.1E+06	.5E+03	.5E+03	TEN	1.00	1.00	0.85	0.85
VHE	0003-0004	LOD1	0.04	1.0	-0.4	15.0	0.0	294.4	1883.0	358.8	491.5	BN+COM	2.00	2.00	2.17	0.00

12.2.2 ULS Joint checks

All tubular joints punching shear checks and strength checks are detailed in following SACS excerpt and provide utilization factors lower than 1.0, according to ISO19902, ref./6/.

* * J O I N T C A N S U M M A R Y * *
(UNITY CHECK ORDER)

JOINT	ORIGINAL DIAMETER (CM)	ORIGINAL THICKNESS (CM)	ORIGINAL YLD STRS (N/MM2)	ORIGINAL UC	DESIGN DIAMETER (CM)	DESIGN THICKNESS (CM)	DESIGN YLD STRS (N/MM2)	DESIGN UC
D006	55.000	2.000	400.000	0.249	55.000	2.000	400.000	0.249
D003	55.000	2.000	400.000	0.236	55.000	2.000	400.000	0.236
D004	55.000	2.000	400.000	0.224	55.000	2.000	400.000	0.224
D005	55.000	2.000	400.000	0.190	55.000	2.000	400.000	0.190
U013	80.000	3.000	400.000	0.113	80.000	3.000	400.000	0.113
U005	80.000	3.000	400.000	0.109	80.000	3.000	400.000	0.109
U015	80.000	3.000	400.000	0.096	80.000	3.000	400.000	0.096
L020	40.640	2.144	355.000	0.094	40.640	2.144	355.000	0.094
L008	40.640	2.144	355.000	0.086	40.640	2.144	355.000	0.086
P003	45.720	1.905	355.000	0.077	45.720	1.905	355.000	0.077
P001	45.720	1.905	355.000	0.075	45.720	1.905	355.000	0.075
U003	80.000	3.000	400.000	0.074	80.000	3.000	400.000	0.074
P120	35.500	1.588	355.000	0.073	35.500	1.588	355.000	0.073
P112	35.500	1.588	355.000	0.072	35.500	1.588	355.000	0.072
P123	35.500	1.588	355.000	0.072	35.500	1.588	355.000	0.072
P111	35.500	1.588	355.000	0.071	35.500	1.588	355.000	0.071
L018	40.640	2.144	355.000	0.067	40.640	2.144	355.000	0.067
L010	40.640	2.144	355.000	0.067	40.640	2.144	355.000	0.067
P122	35.500	1.588	355.000	0.062	35.500	1.588	355.000	0.062
P121	35.500	1.588	355.000	0.061	35.500	1.588	355.000	0.061
P004	45.720	1.905	355.000	0.049	45.720	1.905	355.000	0.049
P002	45.720	1.905	355.000	0.048	45.720	1.905	355.000	0.048
P118	27.310	1.588	355.000	0.045	27.310	1.588	355.000	0.045
P119	27.310	1.588	355.000	0.043	27.310	1.588	355.000	0.043

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APPENDIX A – MEMBER GROUPS AND SECTION PROPERTIES

Member Group Report

Name	Section	OD (cm)	WT (cm)	E (kN/cm2)	G (kN/cm2)	Fy (kN/cm2)	Ky	Kz	SPC	SAM	F	Density (tonne/m3)	Length (m)	Section
B01	PG01			20500.000	7885.000	40.000	1.00	1.00				7.850		
B02	PG02			20500.000	7885.000	40.000	1.00	1.00				7.850		
B03	PG03			20500.000	7885.000	40.000	1.00	1.00				7.850		
B04	PG04			20500.000	7885.000	40.000	1.00	1.00				7.850		
B05	PG05			20500.000	7885.000	40.000	1.00	1.00				7.850		
B06	PG06			20500.000	7885.000	40.000	1.00	1.00				7.850		
B07	PG07			20500.000	7885.000	40.000	1.00	1.00				7.850		
B09	PG09			20500.000	7885.000	40.000	1.00	1.00				7.850		
B10	PG10			20500.000	7885.000	40.000	1.00	1.00				7.850		
B12	PG02			20500.000	7885.000	40.000	1.00	1.00				7.850		
B13	PG03			20500.000	7885.000	40.000	1.00	1.00				7.850		
B14	PG04			20500.000	7885.000	40.000	1.00	1.00				7.850		
B15	PG05			20500.000	7885.000	40.000	1.00	1.00				7.850		
B20	PG20			20500.000	7885.000	40.000	1.00	1.00				7.850		
B21	PG21			20500.000	7885.000	40.000	1.00	1.00				7.850		
B22	PG22			20500.000	7885.000	40.000	1.00	1.00				7.850		
B23	PG23			20500.000	7885.000	40.000	1.00	1.00				7.850		
B31	PG31			20500.000	7885.000	40.000	1.00	1.00				7.850		
B32	PG32			20500.000	7885.000	40.000	1.00	1.00				7.850		
C03		27.300	1.113	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
C05		40.640	2.144	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850	0.90	
C05		40.640	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
C06		80.000	3.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
C07		70.000	3.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
C08		70.000	2.000	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
C11		70.000	3.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850	1.10	
C11		70.000	2.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
C11		70.000	3.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850	2.10	
C20		80.000	4.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850	1.21	
C20		80.000	2.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
C20		80.000	3.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850	2.05	
CT7		82.000	4.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
CT8		70.000	3.500	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
CT9		95.000	47.400	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
D01		55.000	2.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
D02		35.560	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
D03		32.390	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
D04		60.000	2.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
D05		40.640	1.270	20500.000	7886.000	35.500	1.00	1.00		0.50		7.850		
D06		40.640	1.588	20500.000	7886.000	35.500	1.00	1.00		0.50		7.850		
D16		32.390	1.905	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
D36		40.640	2.062	20500.000	7886.000	35.500	1.00	1.00		0.50		7.850		
DU1	HEA800			20500.000	7885.000	40.000	1.00	1.00				9.99999905-6		
DU2		284.000	2.000	20500.000	7885.000	40.000	1.00	1.00		0.50		9.99999905-6		
DU3		21.910	1.000	205.000	79.000	40.000	1.00	1.00		0.50		9.99999905-6		
DU4		50.800	2.540	205.000	79.000	40.000	1.00	1.00		0.50		9.99999905-6		
PB1	HE600B			20500.000	7885.000	34.500	1.00	1.00				7.850		
PC2		40.640	1.588	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
PC3		45.720	1.905	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
PD1		27.310	1.588	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
PD2		21.910	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
PD3		27.310	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
PL1		35.500	1.588	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
S01	HE500A			20500.000	7885.000	34.500	1.00	1.00				7.850		
S02	IPE240			20500.000	7885.000	35.500	1.00	1.00				7.850		
S03	IPE330			20500.000	7885.000	35.500	1.00	1.00				7.850		
S04	HE340A			20500.000	7885.000	35.500	1.00	1.00				7.850		
S06	HEA220			20500.000	7885.000	35.500	1.00	1.00				7.850		
S07	UPN220			20500.000	7885.000	35.500	1.00	1.00				7.850		
SF1		32.390	1.270	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
ST1		27.310	0.927	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
ST2		21.910	0.818	20500.000	7885.000	35.500	1.00	1.00		0.50		7.850		
TS1		80.000	4.000	20500.000	7885.000	40.000	1.00	1.00		0.50		7.850		
VHE	VHESEC			20500.000	7885.000	35.500	1.00	1.00				7.850		

TUBULAR MEMBER PROPERTIES

GRP	M/S	JOINT THICK M	WALL THICK CM	OUTSIDE DIAM. CM	E 1000 KN/CM2	G 1000 KN/CM2	AXIAL AREA CM**2	***** MOMENTS OF INERTIA **** X-X CM**4	Y-Y CM**4	Z-Z CM**4	YIELD STRESS KN/CM2	KY	KZ	SHEAR AREA CM**2	RING SPACE M	SECT TAPER LENG M
DM1	9	0.00	5.000	20.00	20.0	7.7	235.62	14726.	7363.2	7363.2	24.8	2.0	2.0	117.81	0.00	0.00

Member Section Report

Section	Type	AX(cm2)	J(cm4)	IY(cm4)	IZ(cm4)	A(cm)	B(cm)	C(cm)	D(cm)	E(cm)	F(cm)
HE500A	WF	197.500	309.300	86970.000	10370.000	30.000	2.300	49.000	1.200	2.700	
PG01	PLG *	390.000	551.140	618312.50	26730.001	40.000	2.500	100.000	2.000		
PG02	PLG *	342.500	452.849	582588.50	26693.384	40.000	2.500	100.000	1.500		
PG03	PLG *	292.500	348.683	463734.37	11276.719	30.000	2.500	100.000	1.500		
PG04	PLG *	244.000	198.460	350725.34	5235.333	25.000	2.000	100.000	1.500		
PG05	PLG *	340.000	446.973	499458.31	11313.334	30.000	2.500	100.000	2.000		
PG06	PLG *	458.000	1550.254	835042.68	42692.539	40.000	4.000	100.000	1.500		
PG07	PLG *	584.000	2022.513	1051914.7	83394.671	50.000	4.000	100.000	2.000		
PG09	PLG *	538.000	1976.921	1019469.4	83359.210	50.000	4.000	100.000	1.500		
PG10	PLG *	292.500	348.683	463734.37	11276.719	30.000	2.500	100.000	1.500		
PG20	PLG *	784.000	3089.179	1512981.3	281311.34	75.000	4.000	100.000	2.000		
PG21	PLG *	870.000	3397.574	1637640.1	341453.12	80.000	4.000	100.000	2.500		
PG22	PGD *	916.000	606003.37	1670085.3	524390.31	80.000	4.000	100.000	1.500		51.500
PG23	PLG *	778.000	3256.920	1572749.5	341359.18	80.000	4.000	100.000	1.500		1.000
PG31	PLG *	504.000	1595.846	867488.00	42728.000	40.000	4.000	100.000	2.000		
PG32	PLG *	495.000	769.890	867906.25	94638.757	61.000	2.500	100.000	2.000		
VHESEC	WF *	105.000	55.327	20868.748	3908.750	25.000	1.500	33.000	1.000		

An * indicates that AX, J, IY and IZ are computed values, not user defined.

WIDE FLANGE/WIDE FLANGE COMPACT,MEMBER PROPERTIES

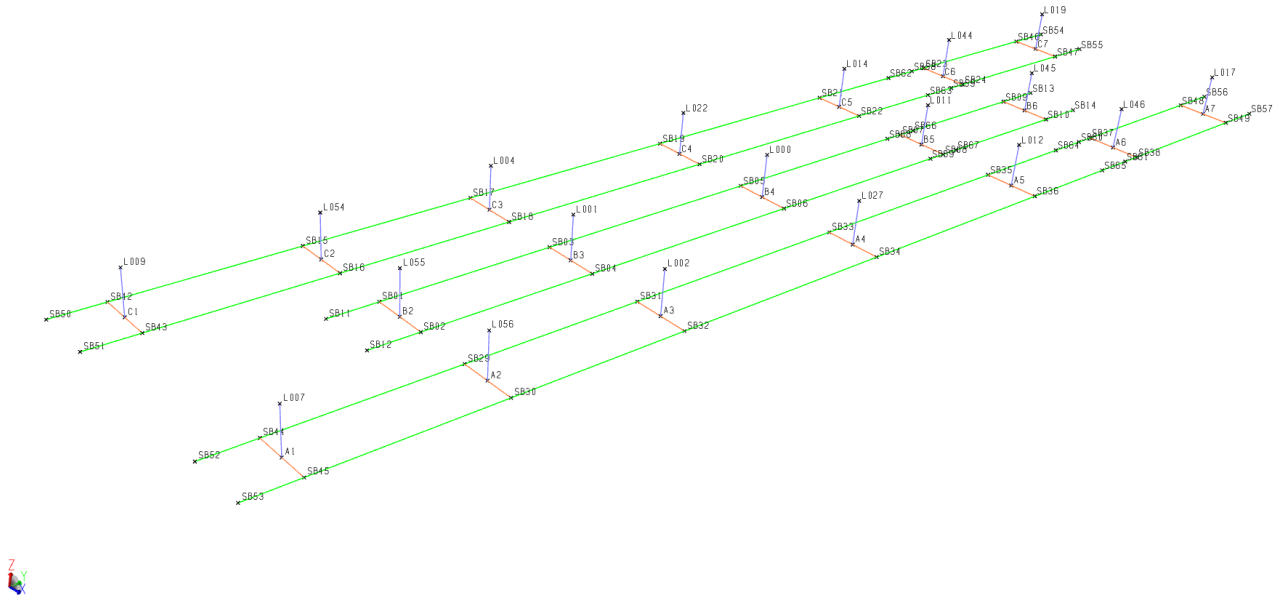
GRP	M/S	** FLANGE ** THICK	WIDTH	WEB THICK	FILET RAD.	DEPTH	E 1000	G 1000	AXIAL AREA	**** MOMENTS OF INERTIA **** X-X	Y-Y	Z-Z	YIELD STRESS	KY	KZ	FLANGE-BRC TOP	BOT	SECT TPR LEN
		CM	CM	CM	CM	CM	KN/CM2	KN/CM2	CM**2	CM**4	CM**4	CM**4	KN/CM2			M	M	M
DM2	9	3.00	30.00	1.750	3.000	80.00	20.5	7.9	334.2	946.0	0.3591E+06	0.1490E+05	35.5	1.0	1.0	0.0	0.0	0.00
SB1	9	3.00	30.00	1.000	3.000	80.00	20.5	7.9	334.0	946.0	1.000	0.1490E+05	35.5	1.0	1.0	0.0	0.0	0.00

Plate Group Report

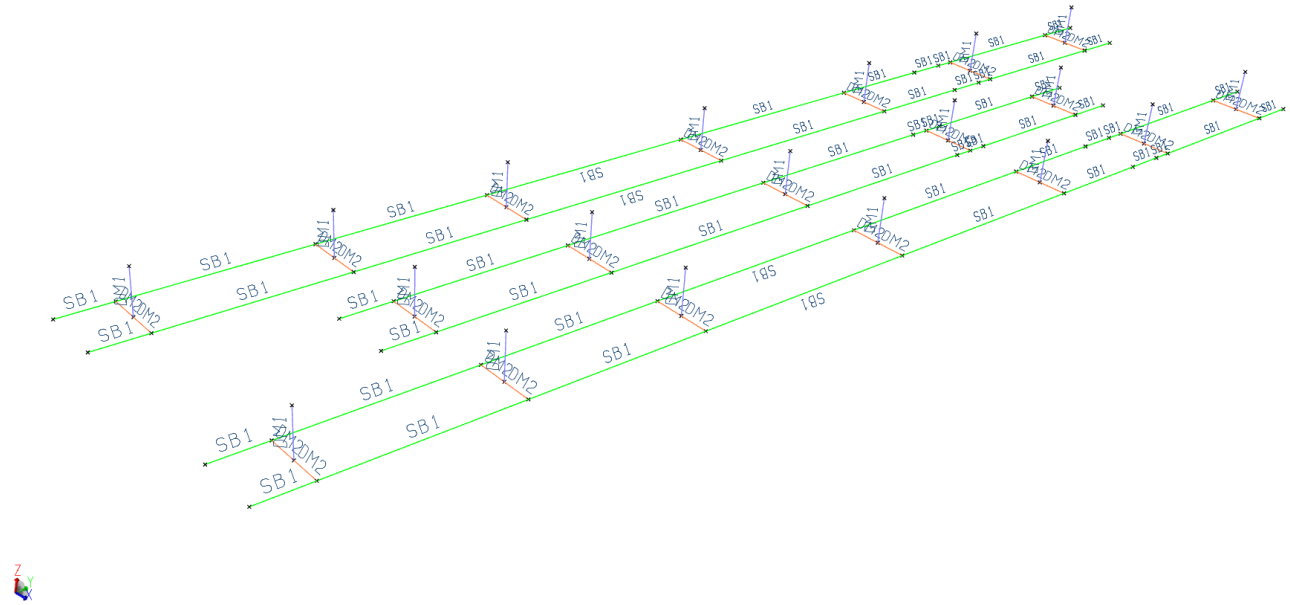
Name	Z	Thickness (cm)	M	E (kN/cm2)	U	Fy (kN/cm2)	Z Offset (cm)	Section	Spacing (cm)	L	T	Density (tonne/m3)
P08		0.800	S	20500.000	0.300	35.500						10.0000029-5
P10		1.000	S	20500.000	0.300	35.500						10.0000029-5

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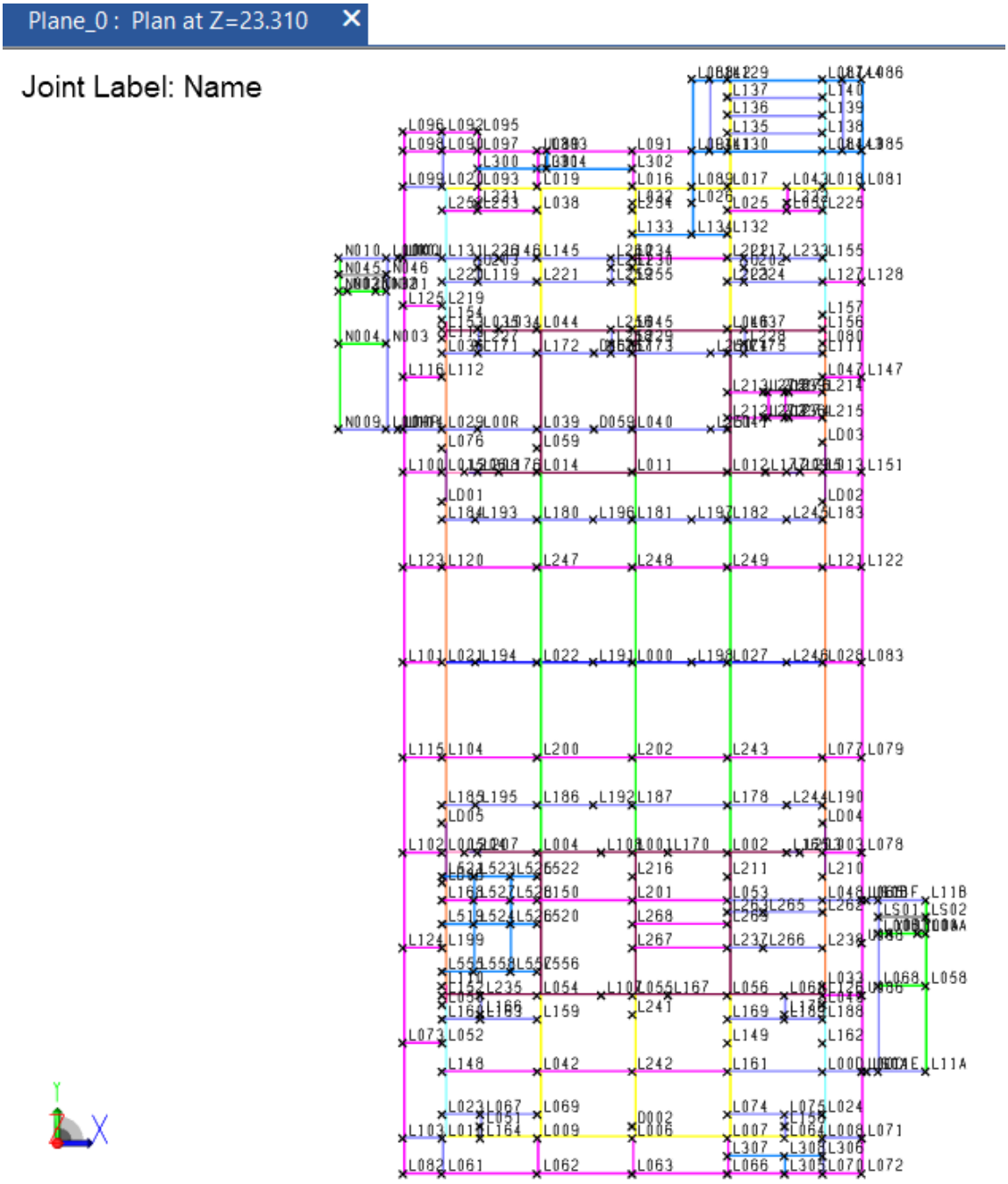
APPENDIX B - WIREFRAME SCHEMES

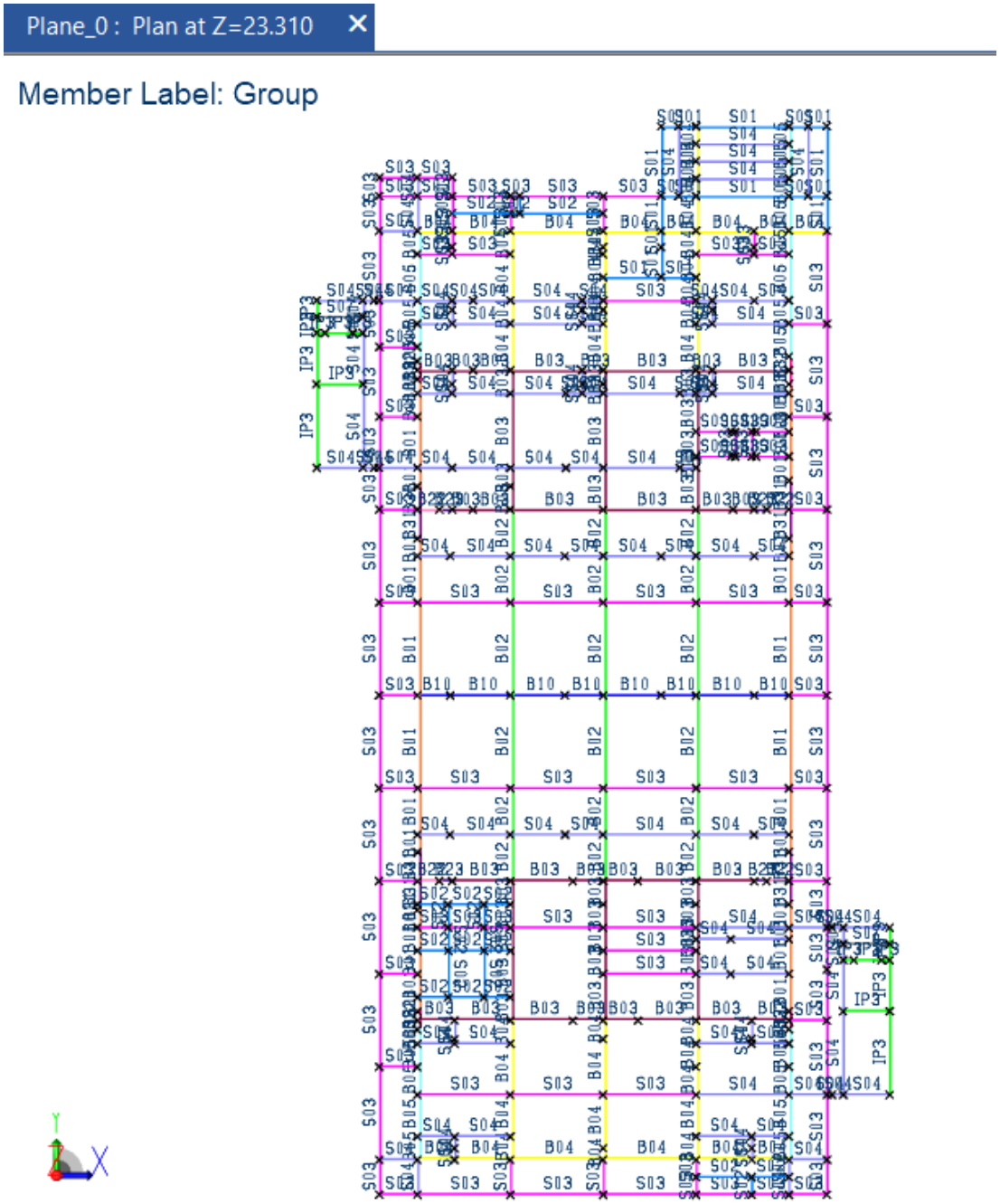


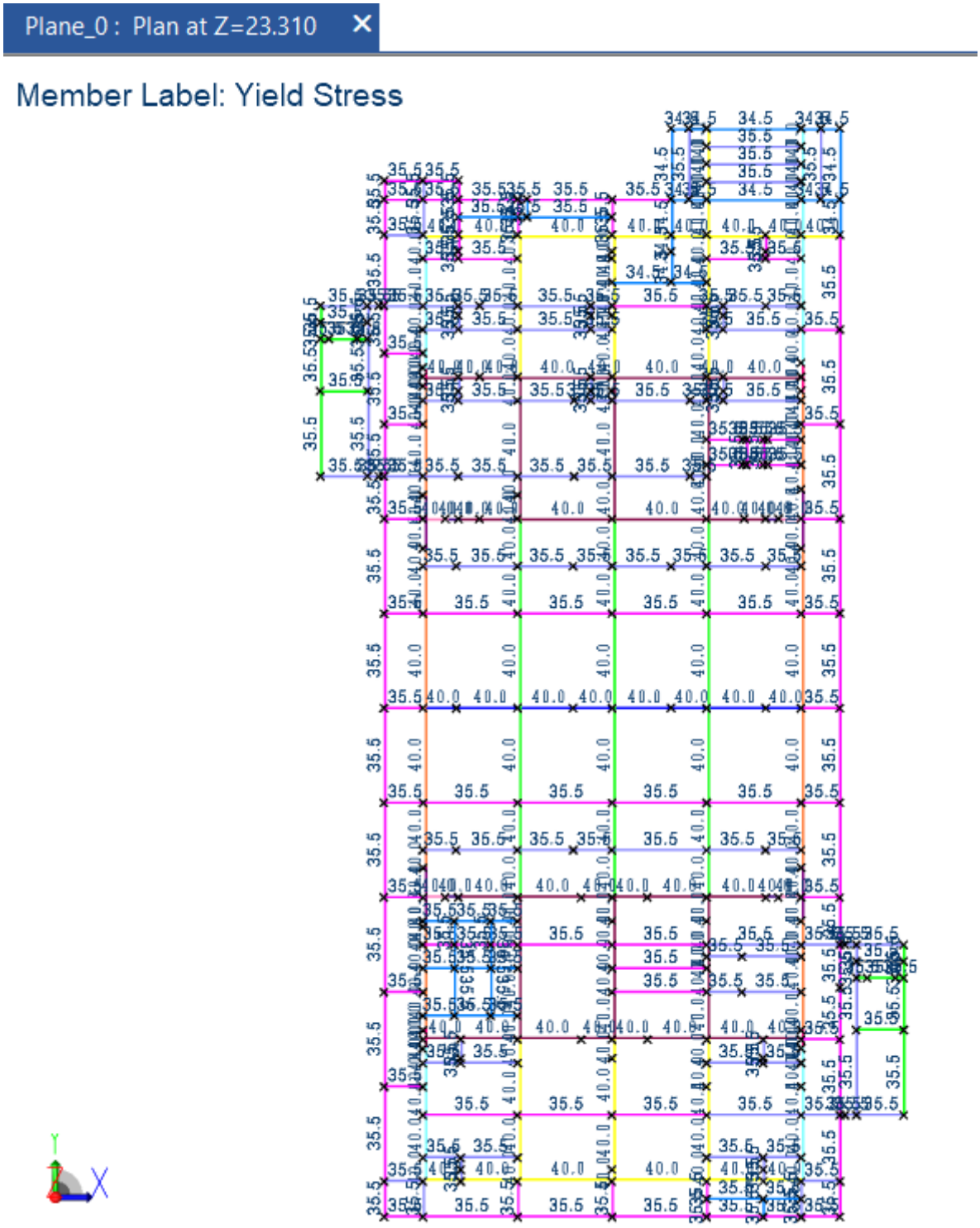
Spacer beams joints

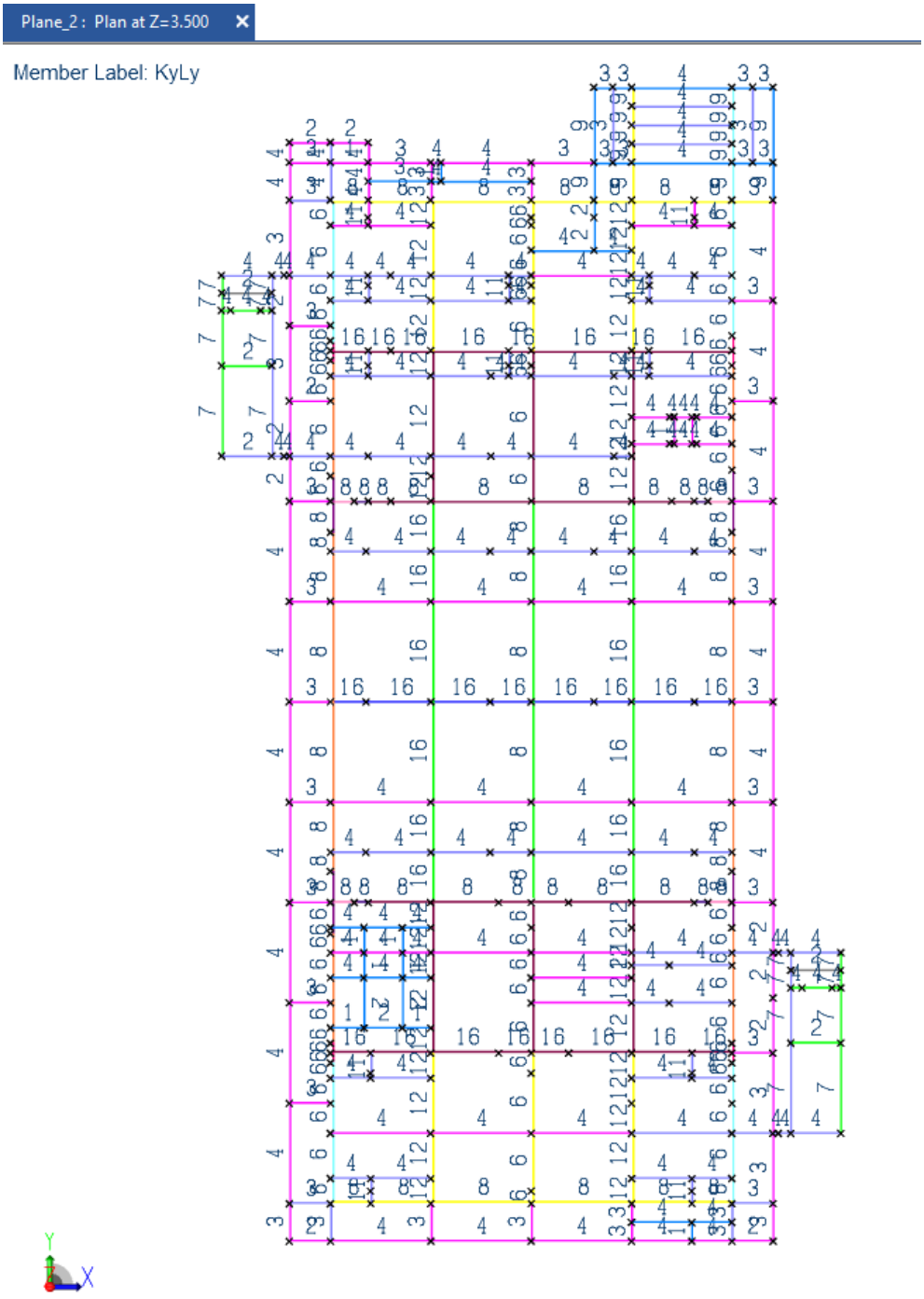


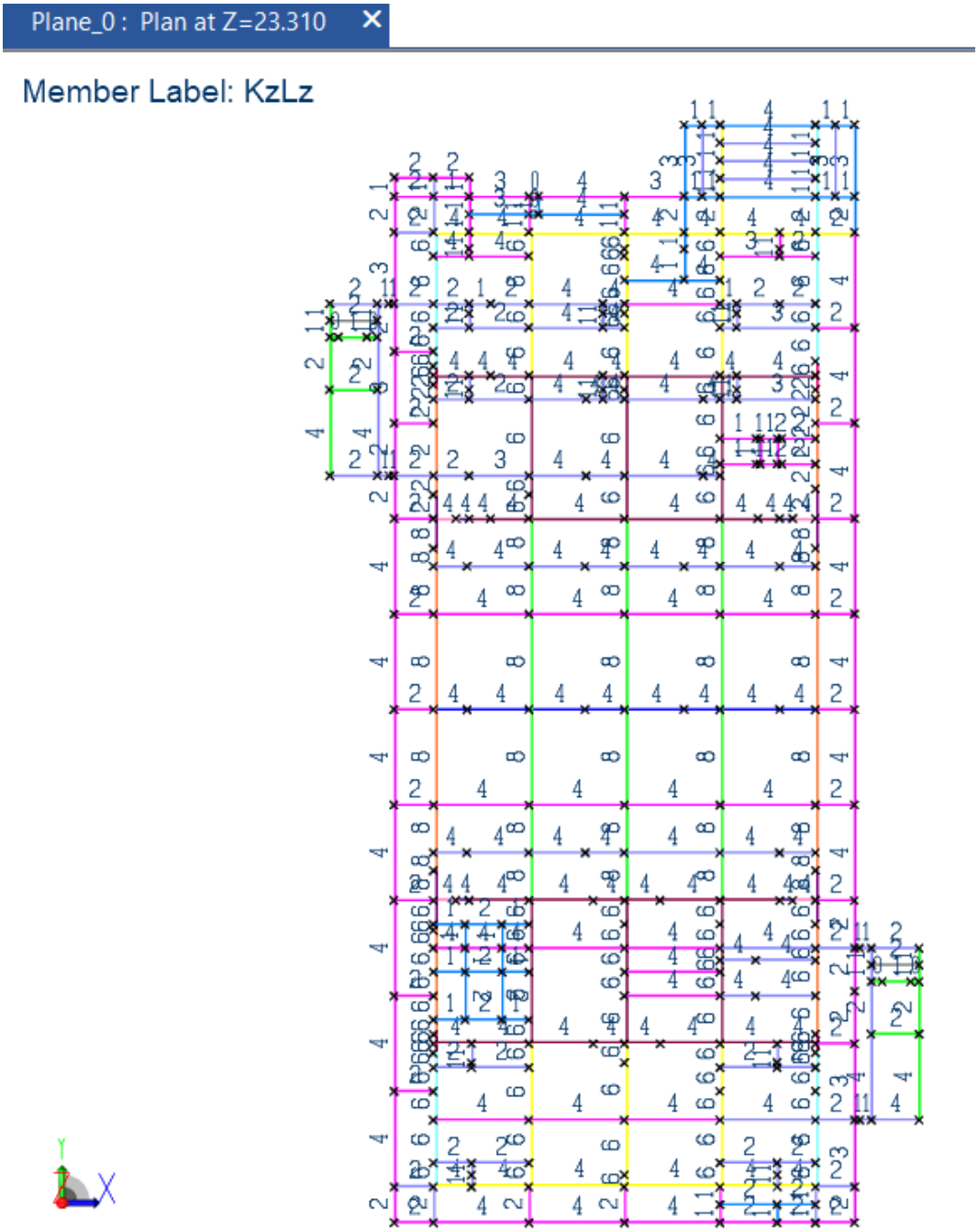
Spacer beams member group


Plane_0 : Plan at Z=23.310
Joint Label: Name


Plane_0 : Plan at Z=23.310
Member Label: Group

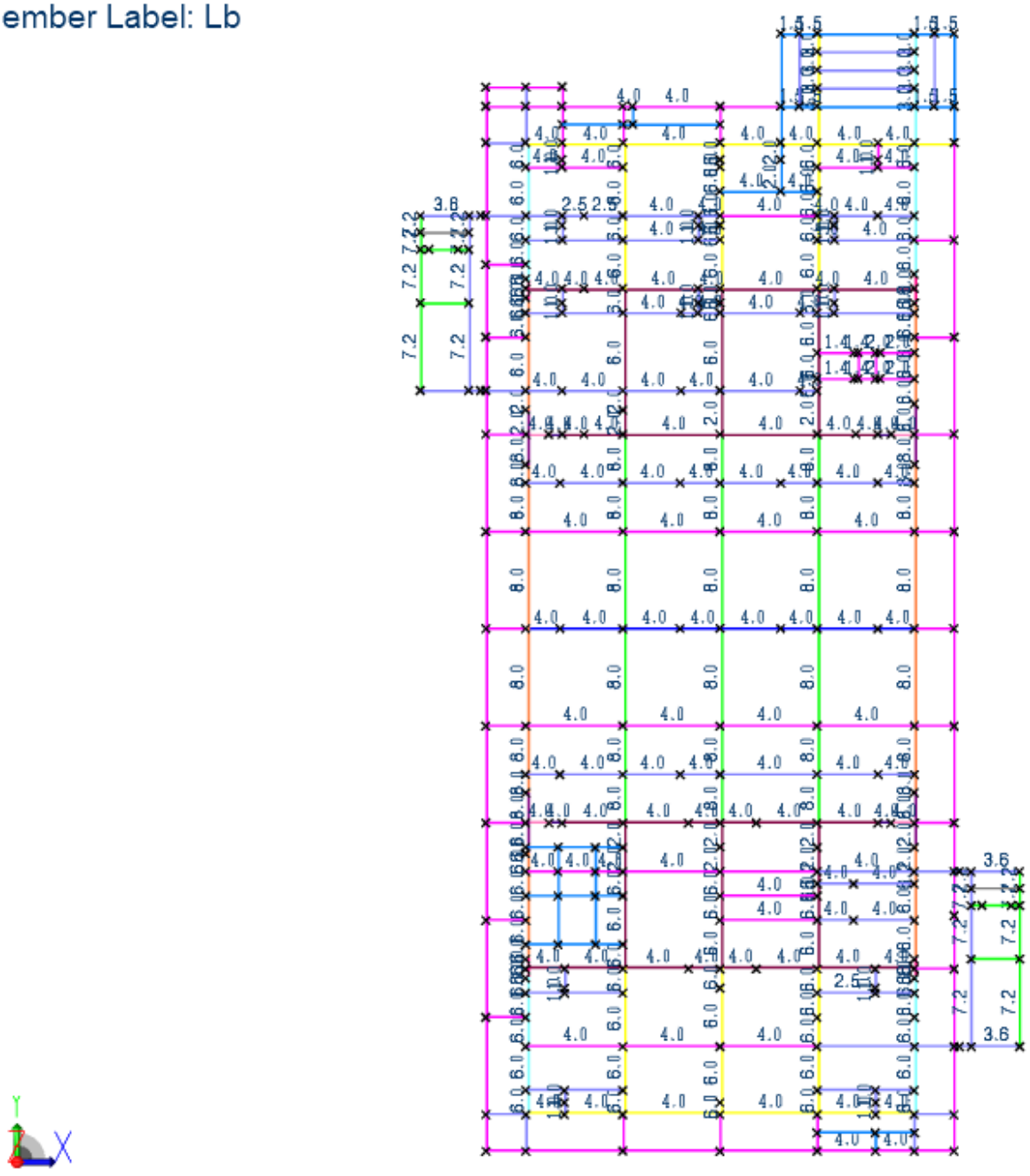

Plane_0 : Plan at Z=23.310
Member Label: Yield Stress

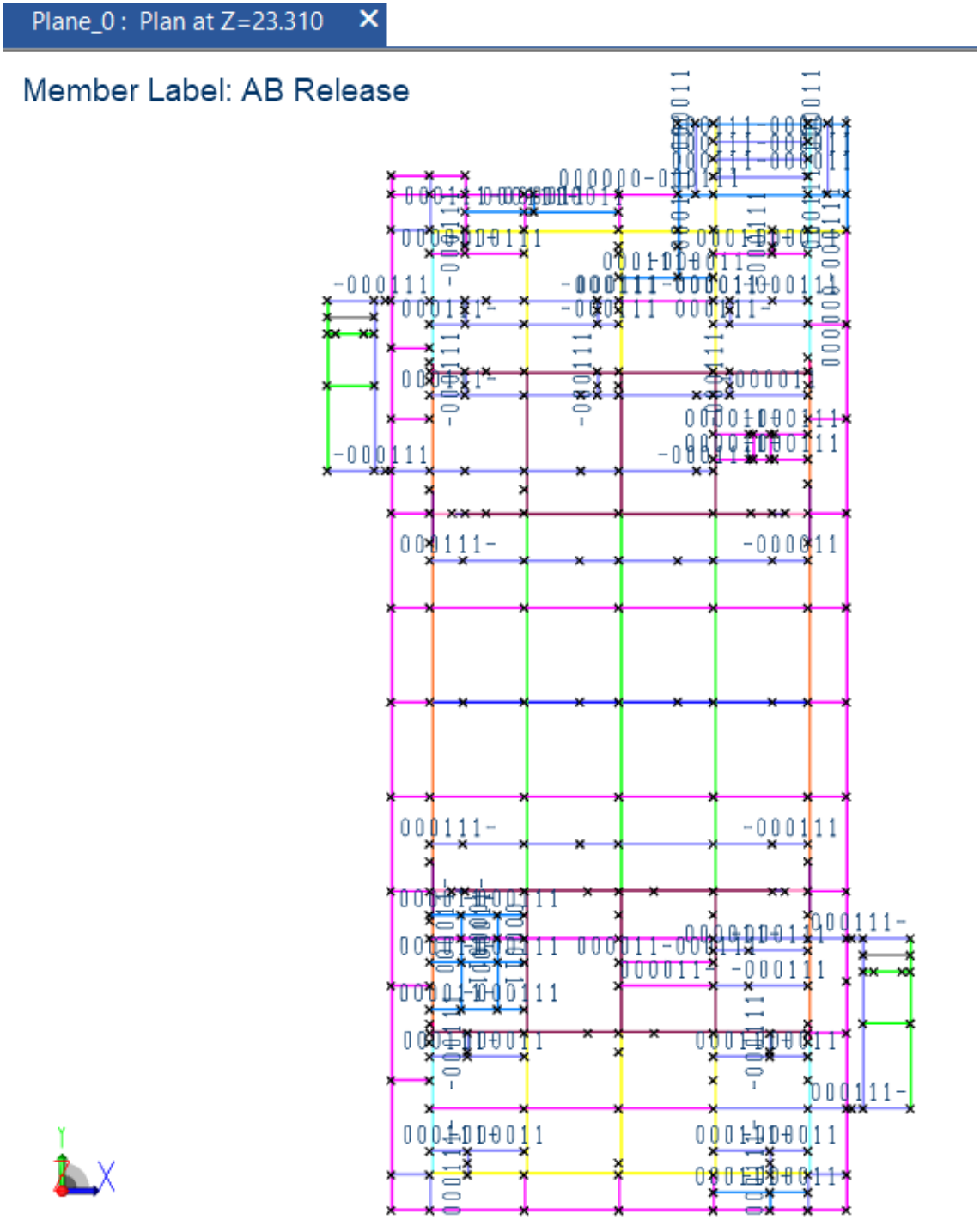

Plane_2 : Plan at Z=3.500
Member Label: KyLy
Y
X

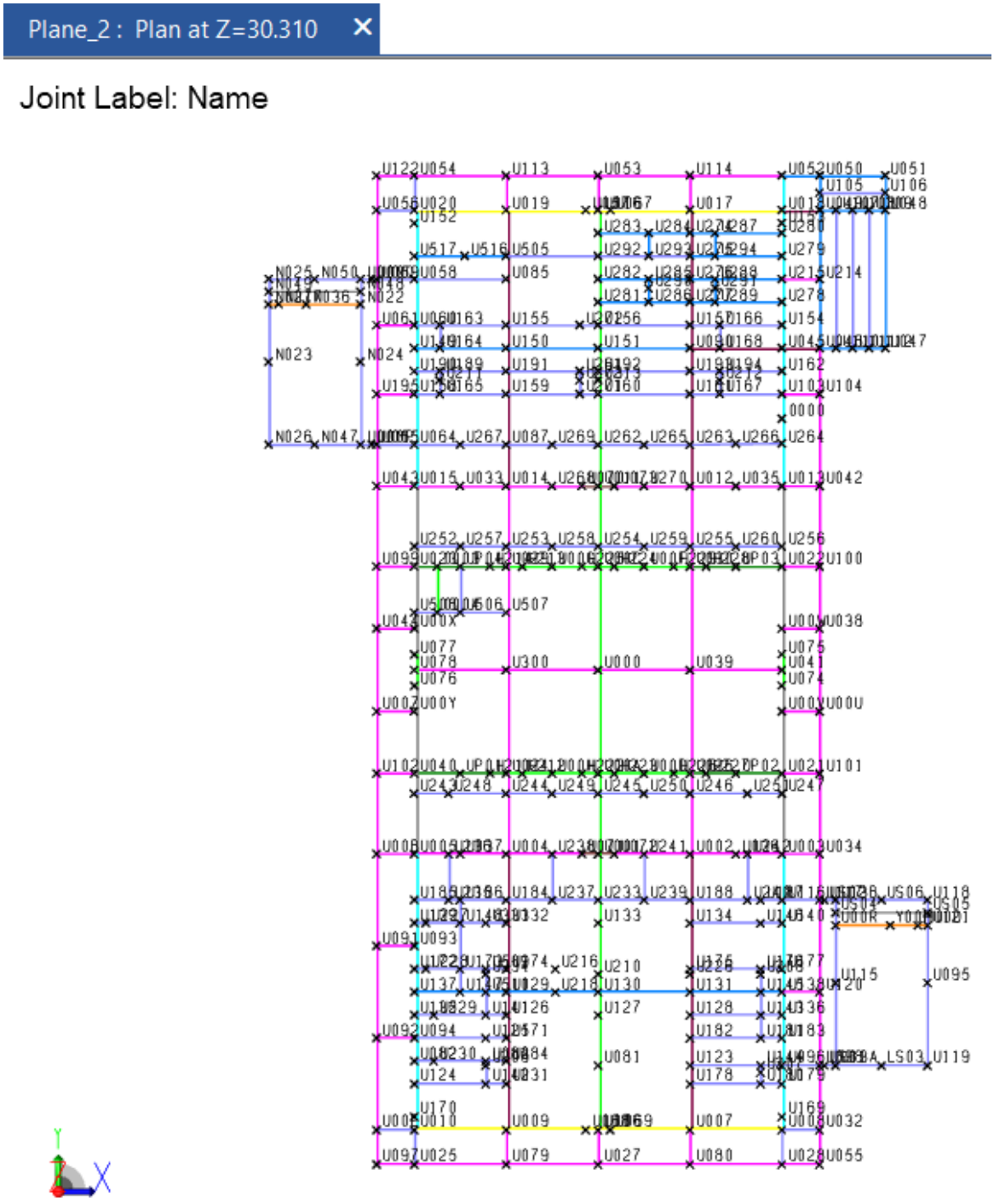

Plane_0 : Plan at Z=23.310
Member Label: KzLz

Plane_0 : Plan at Z=23.310

Member Label: Lb

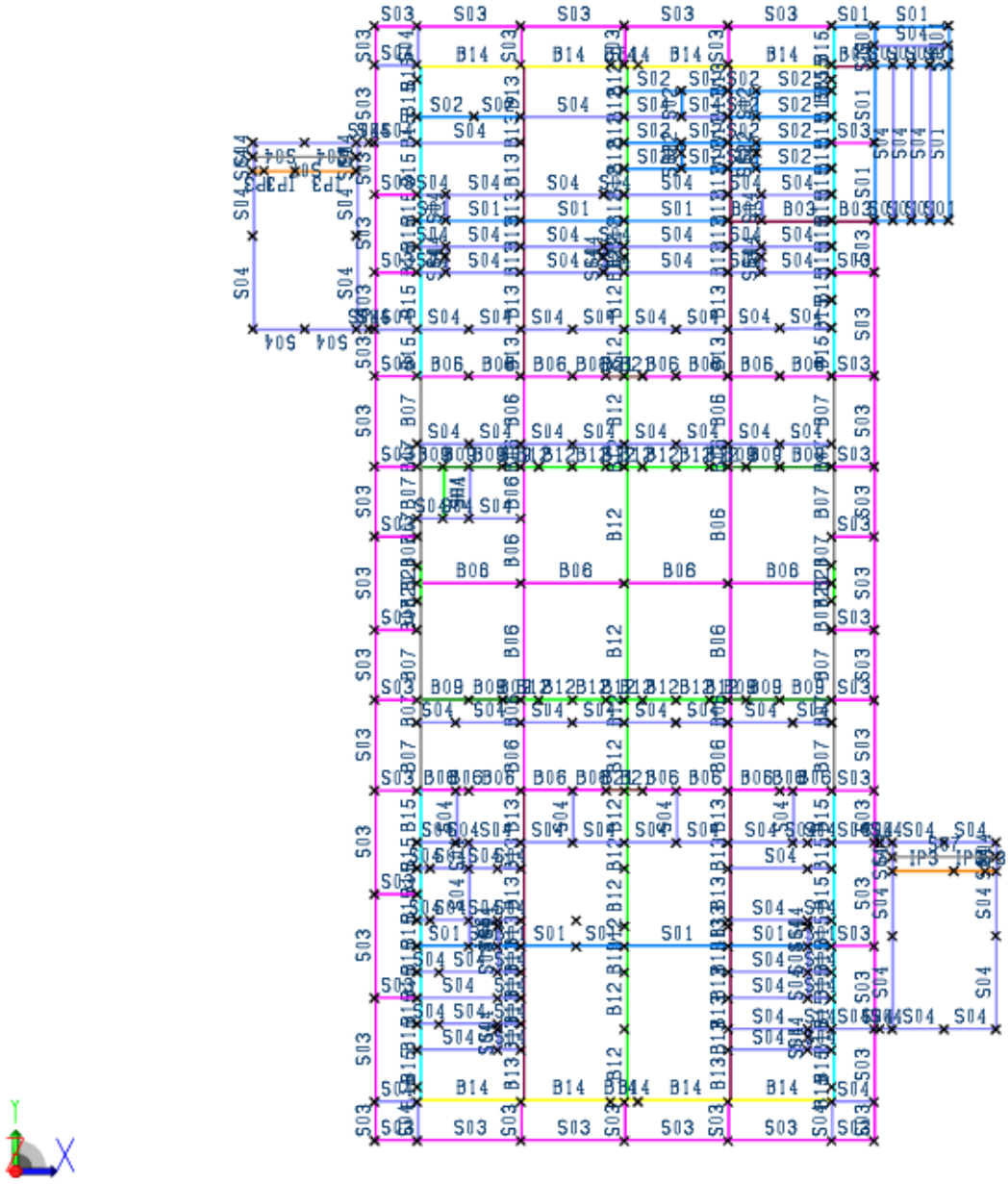



Plane_0 : Plan at Z=23.310
Member Label: AB Release

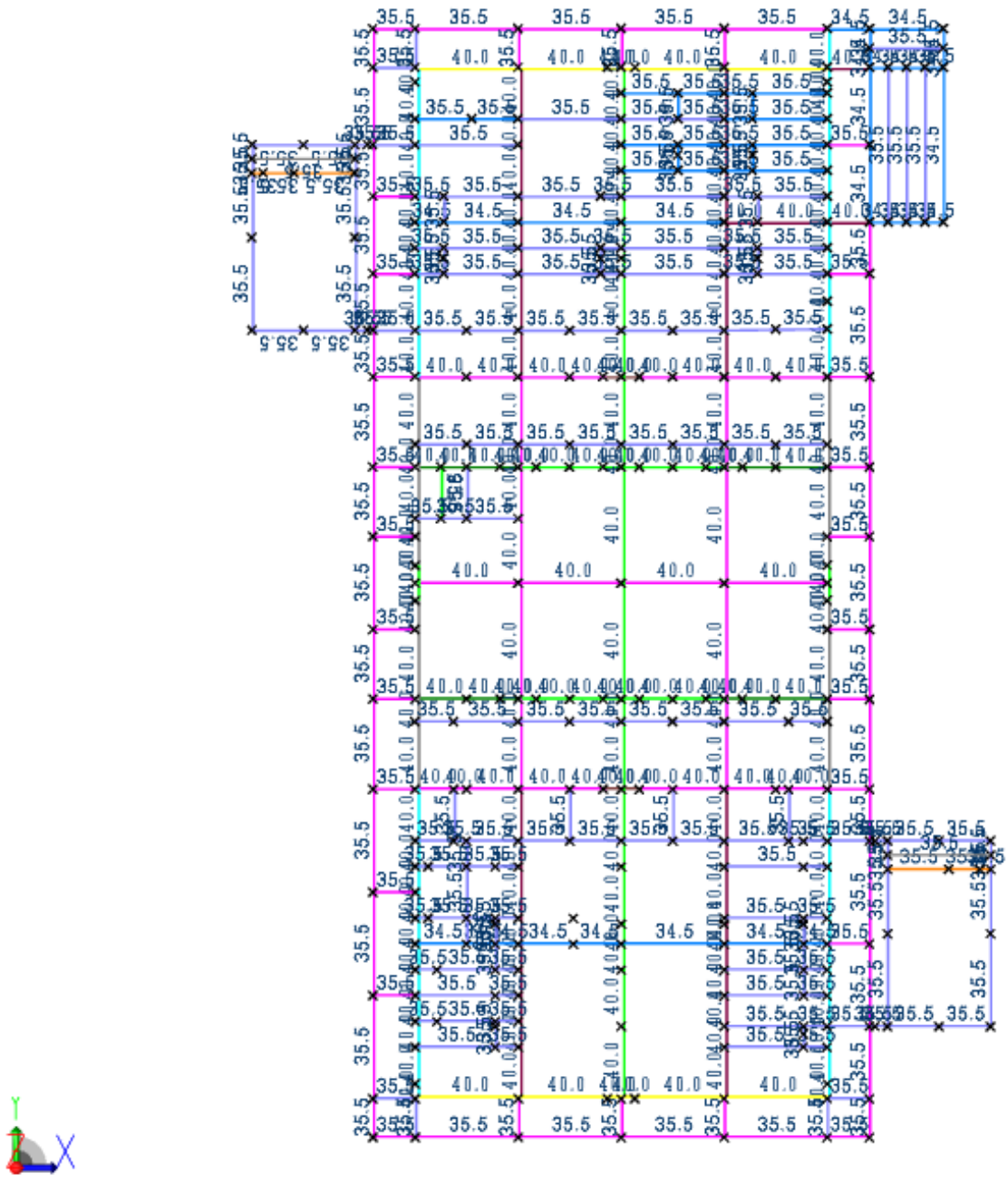

Plane_2 : Plan at Z=30.310
Joint Label: Name

Plane_2 : Plan at Z=30.310

Member Label: Group

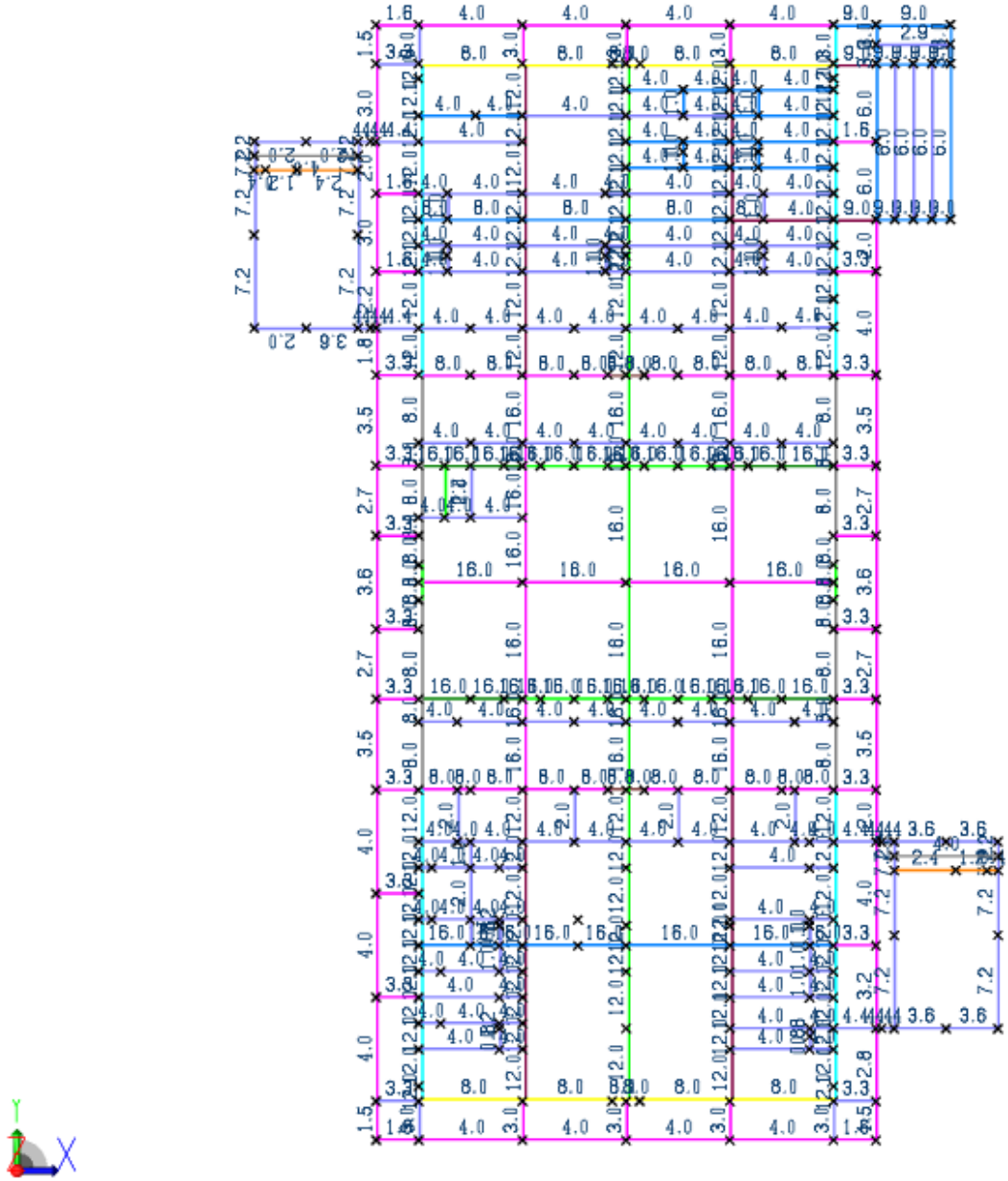


Member Label: Yield Stress



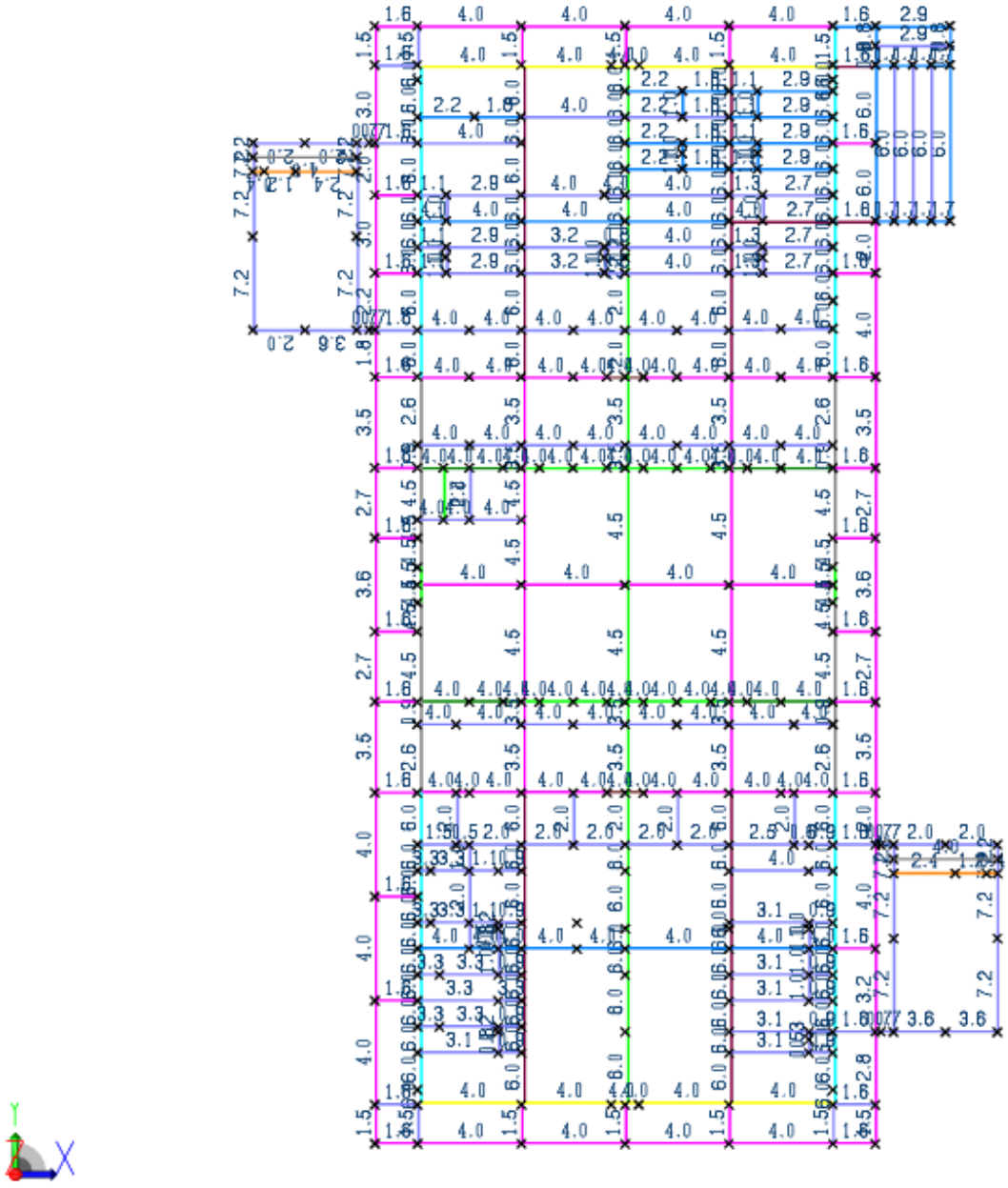
Plane_2 : Plan at Z=30.310

Member Label: KyLy



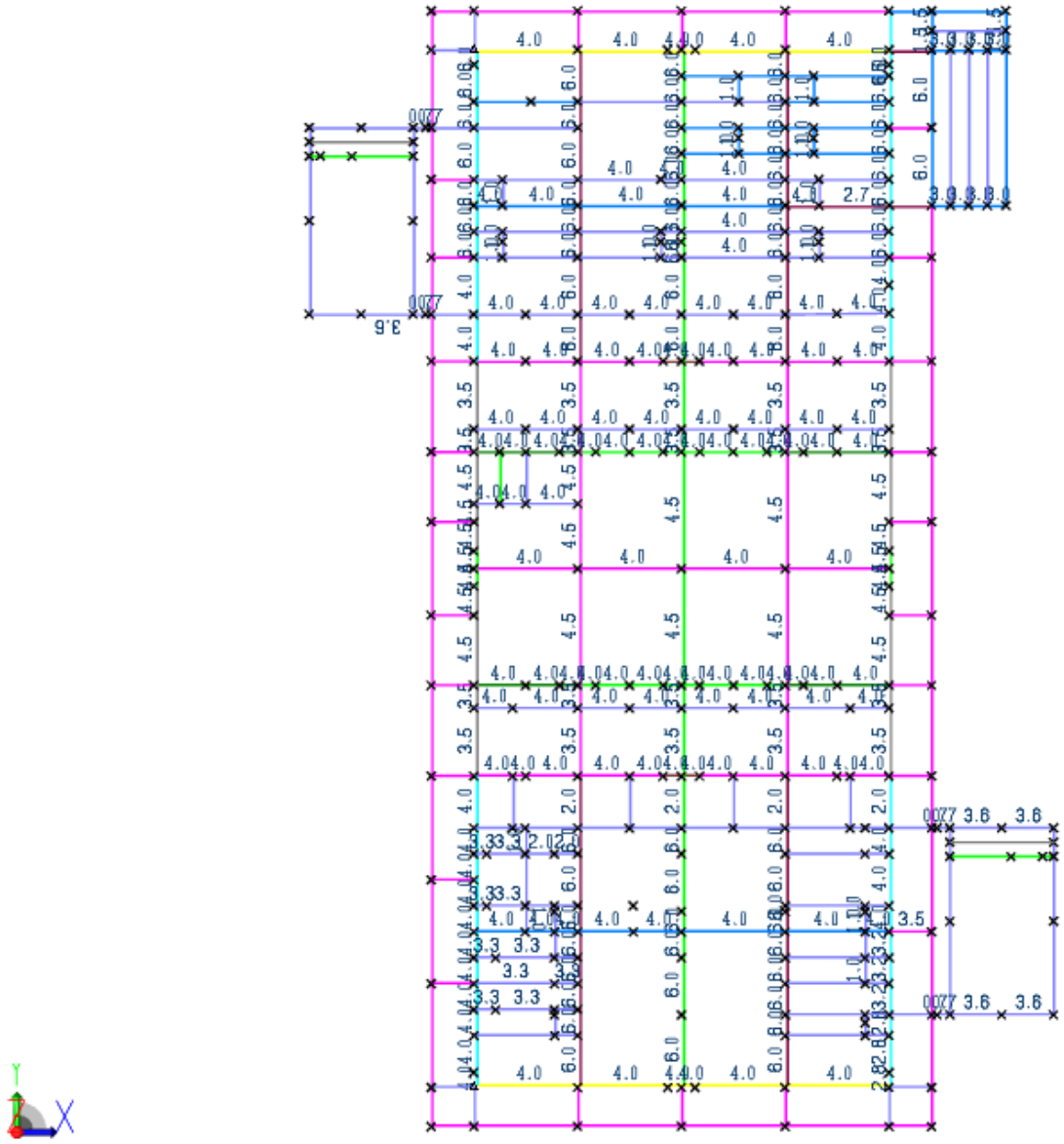
Plane_2 : Plan at Z=30.310

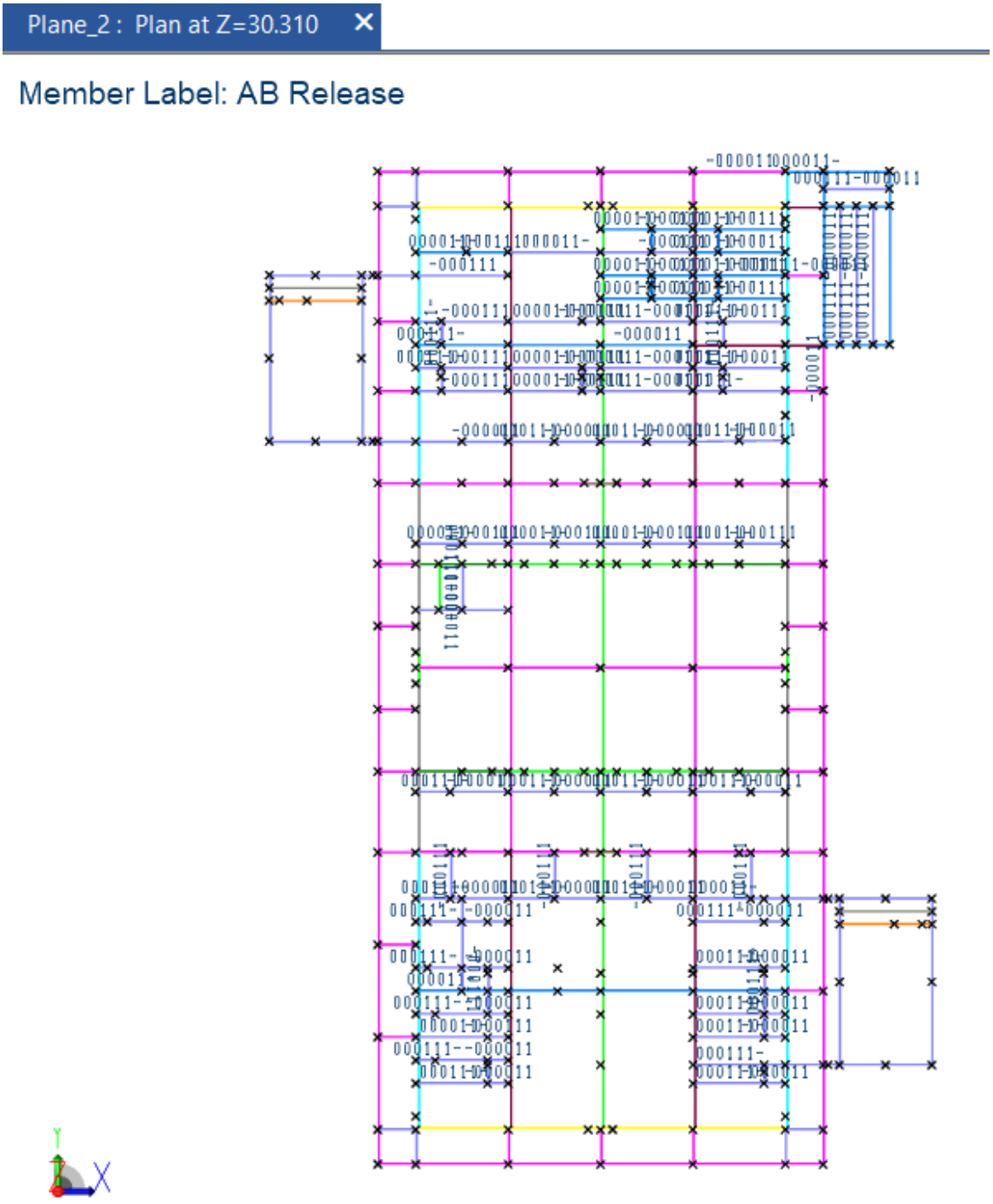
Member Label: KzLz



Plane_1 : Plan at Z=30.310

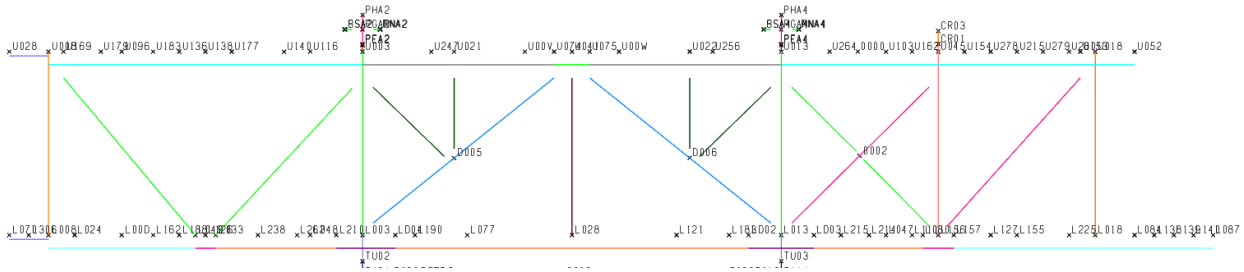
Member Label: Lb




Plane_2 : Plan at Z=30.310
Member Label: AB Release

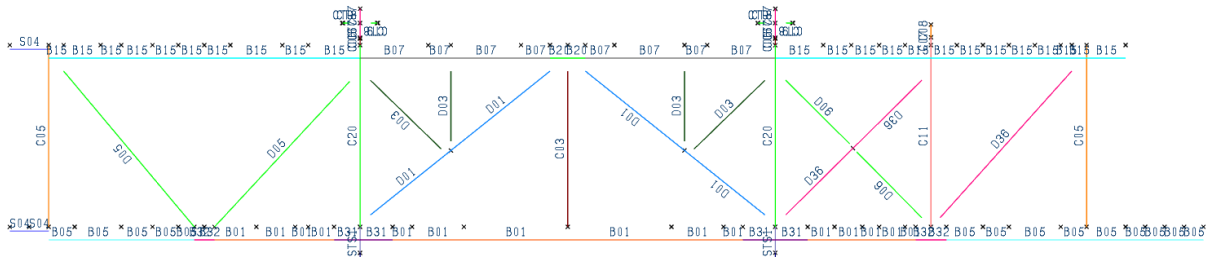
Plane_3 : Plan at X=8.000

Joint Label: Name



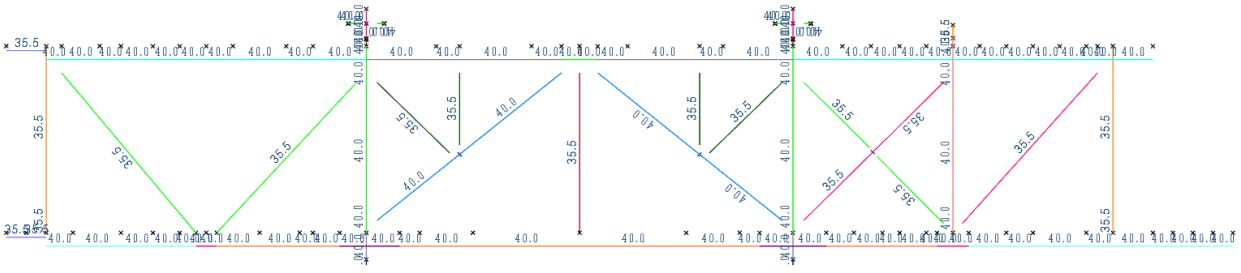
Plane_3 : Plan at X=8.000

Member Label: Group



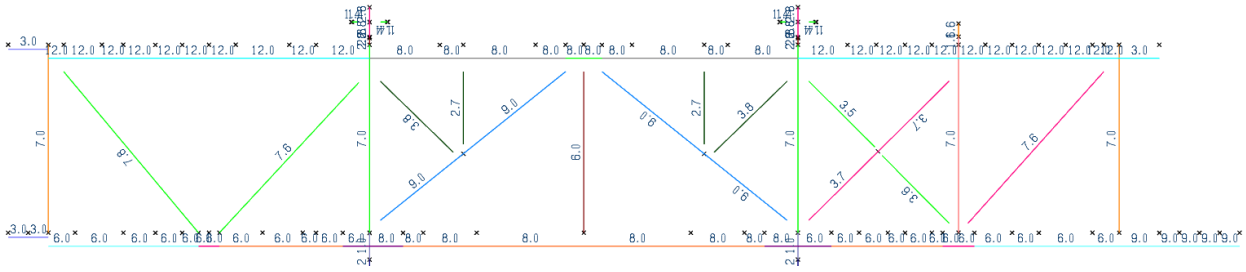
Plane_3 : Plan at X=8.000

Member Label: Yield Stress



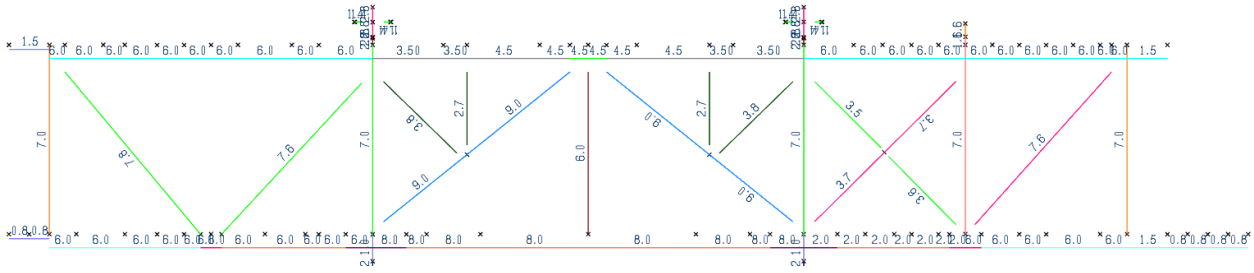
Plane_3 : Plan at X=8.000

Member Label: KyLy



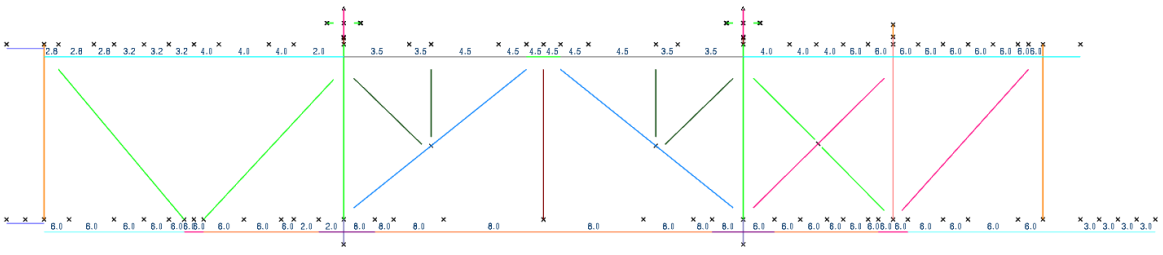
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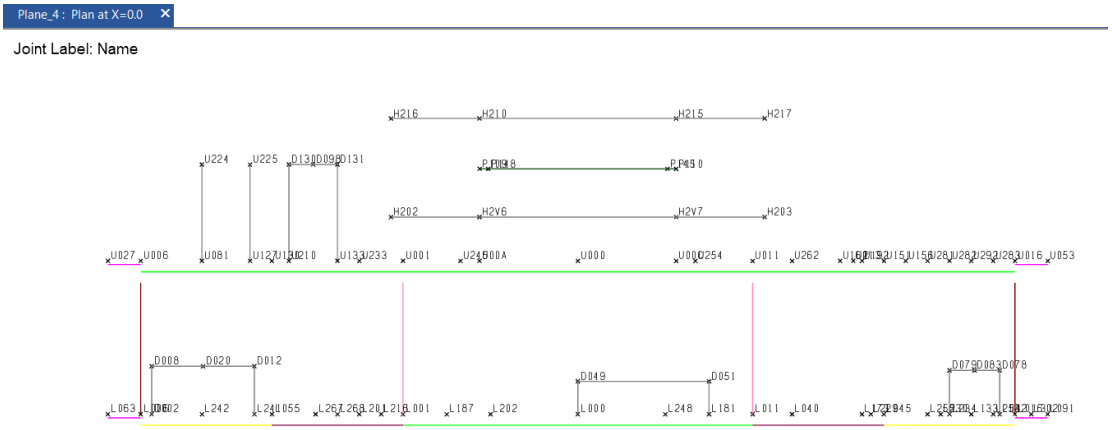
Member Label: KzLz

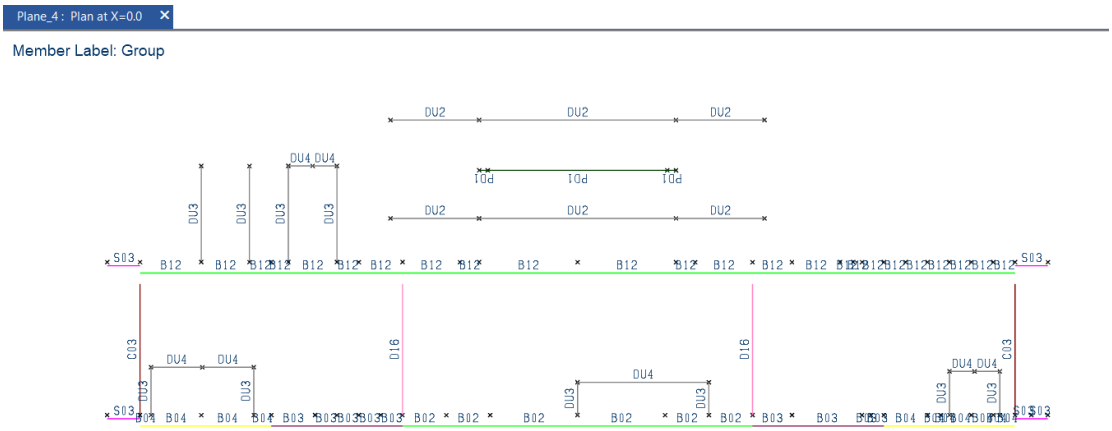


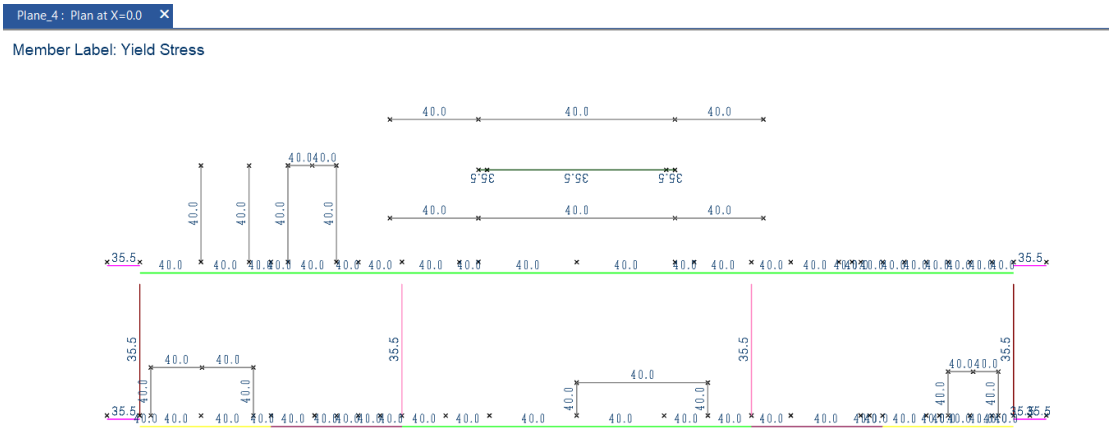
Plane_2 : Plan at X=8.000

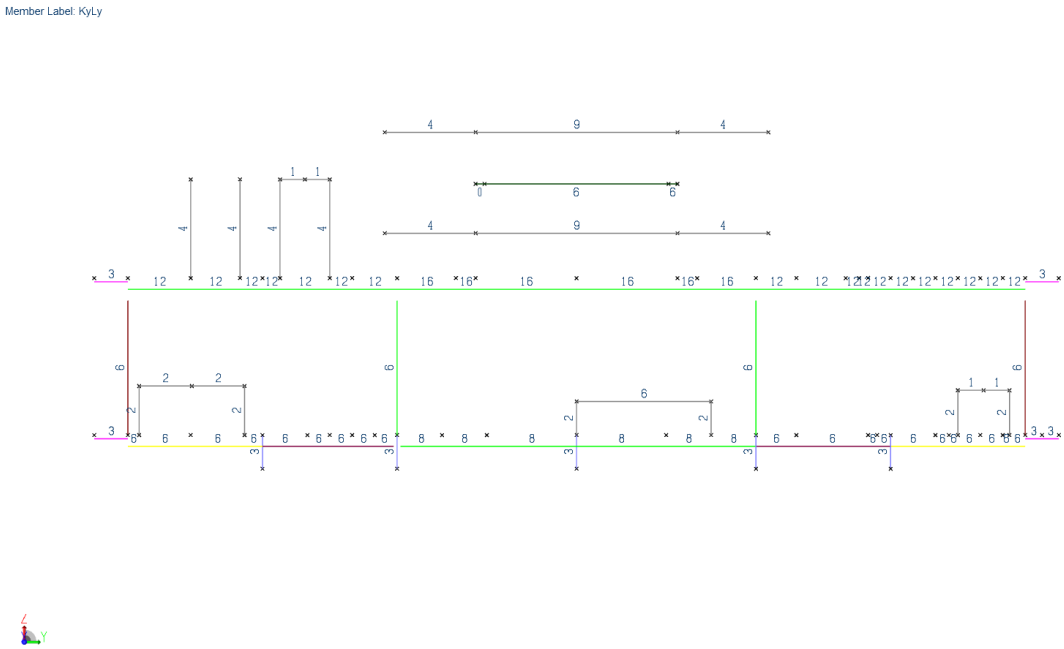
Member Label: Lb

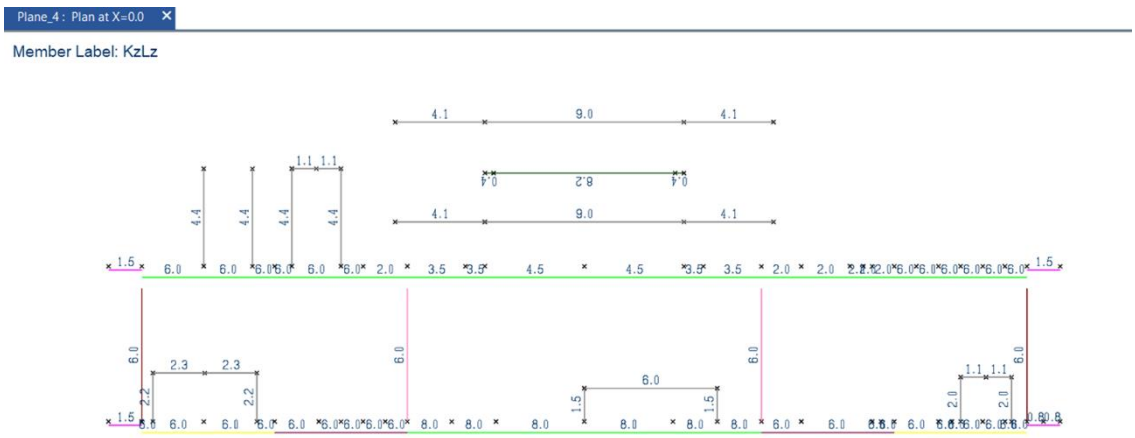


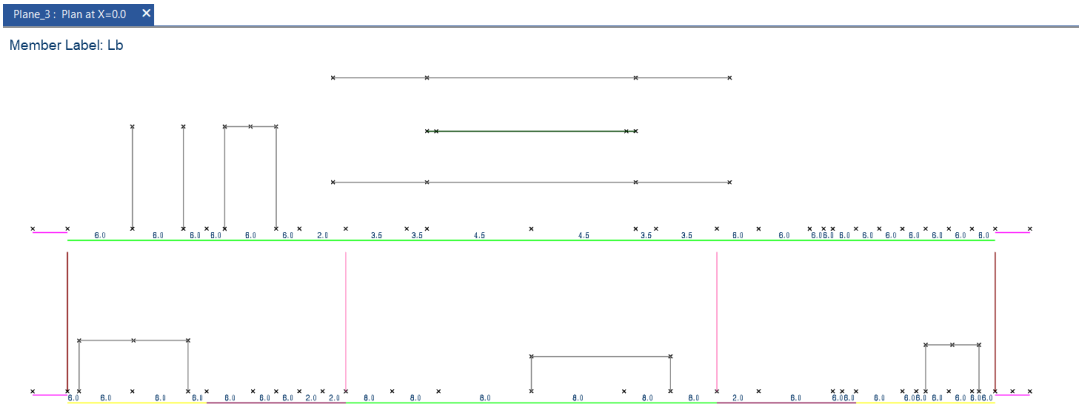

Plane_4 : Plan at X=0.0
Joint Label: Name

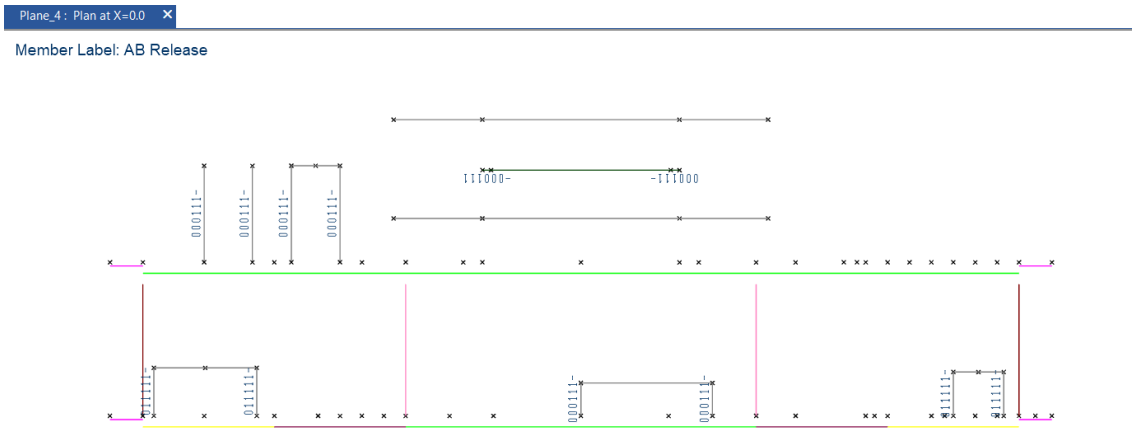

Plane_4 : Plan at X=0.0
Member Label: Group

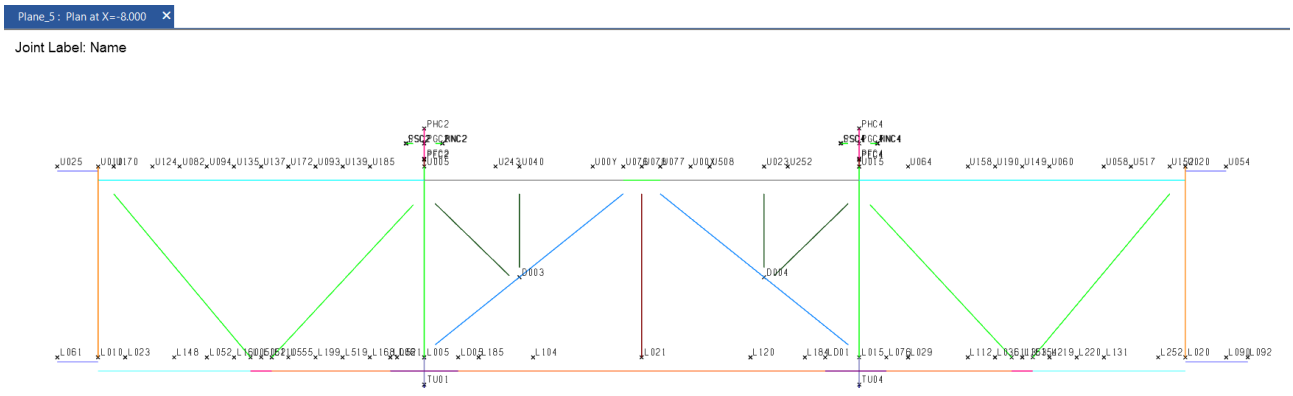

Plane_4 : Plan at X=0.0
Member Label: Yield Stress

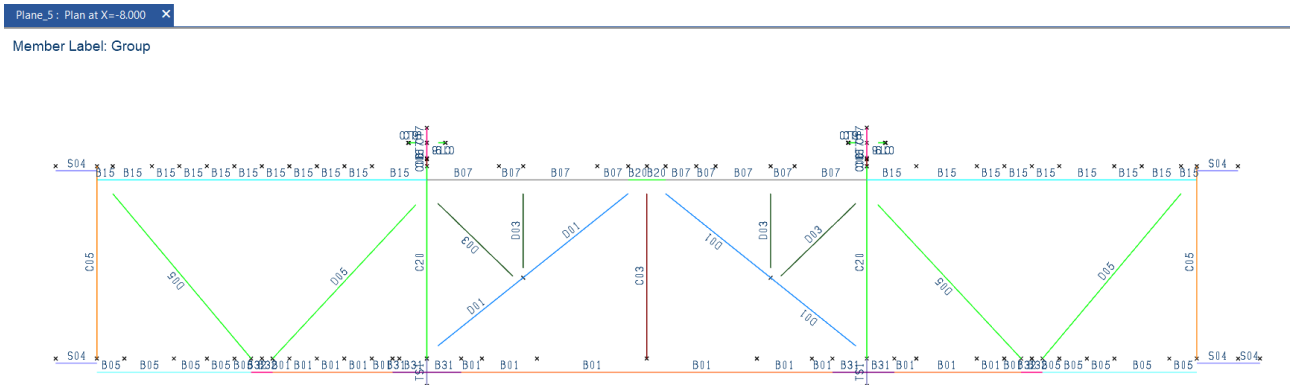

Member Label: KyLy

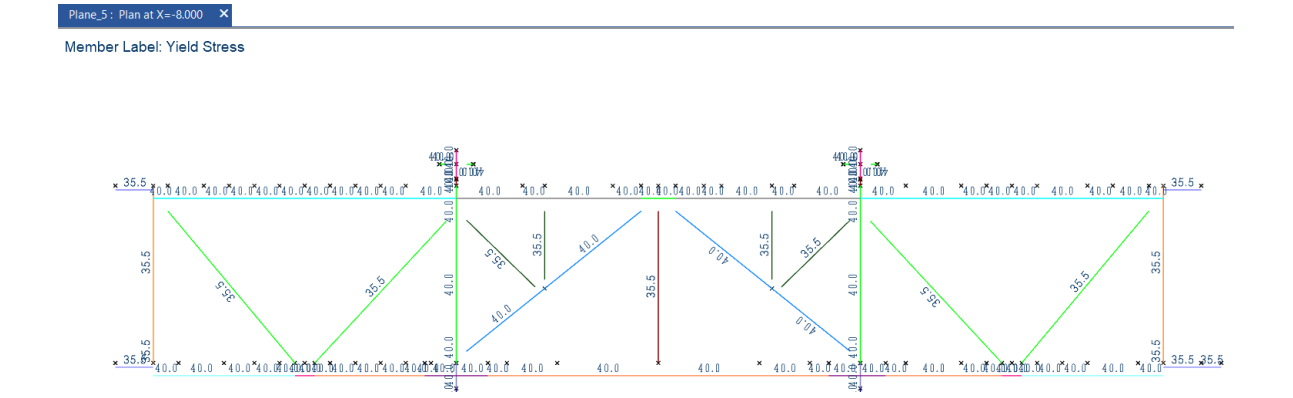

Plane_4 : Plan at X=0.0
Member Label: KzLz

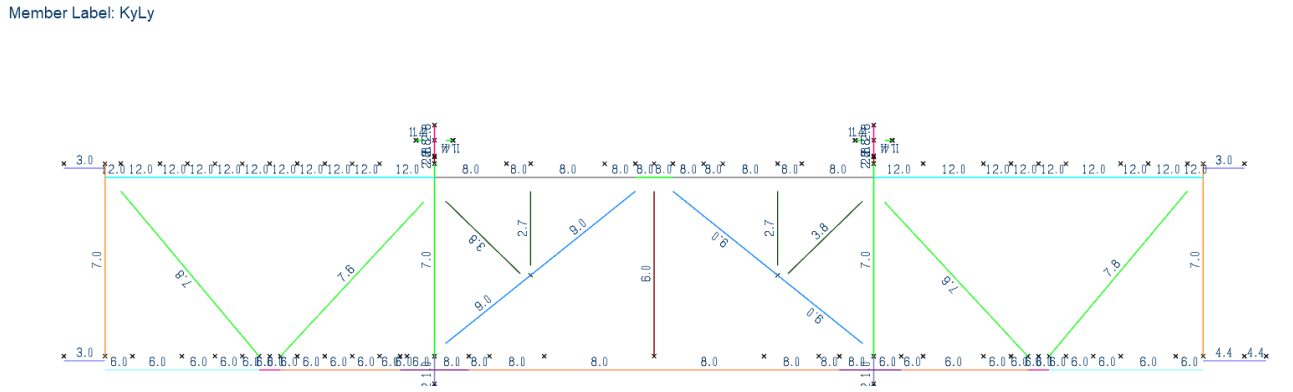

Plane_3 : Plan at X=0.0
Member Label: Lb

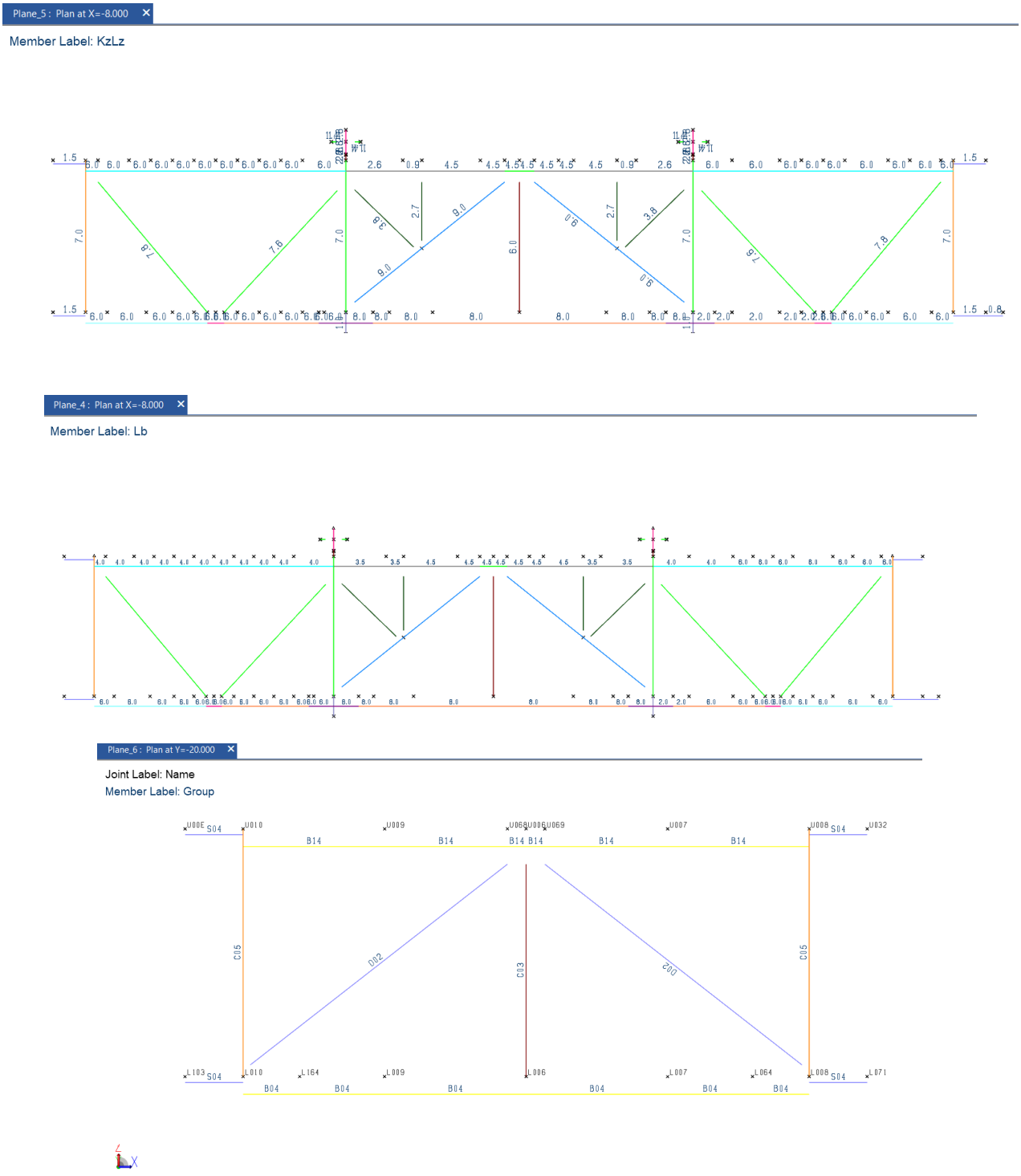

Plane_4 : Plan at X=0.0
Member Label: AB Release

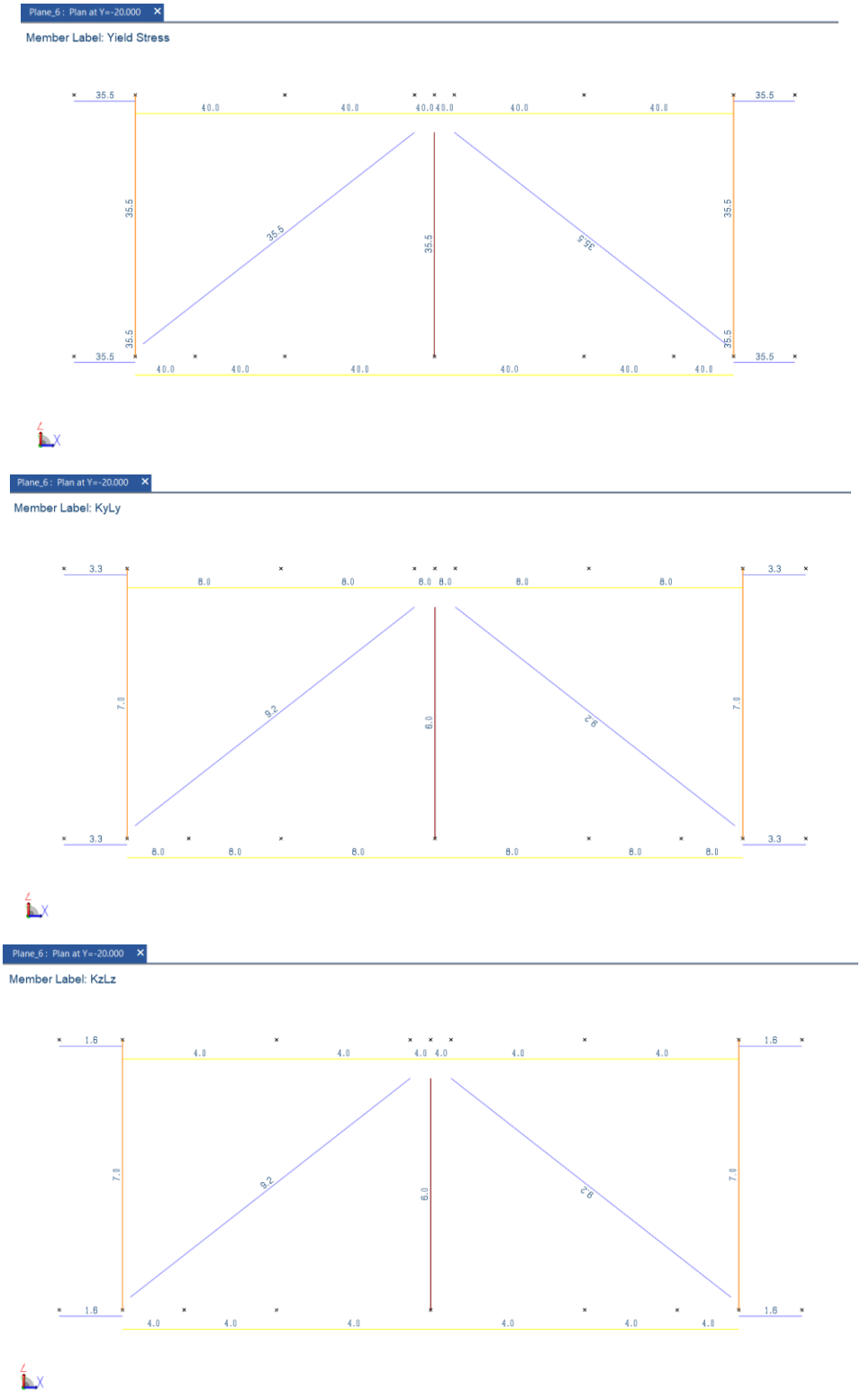

Plane_5 : Plan at X=-8.000
Joint Label: Name

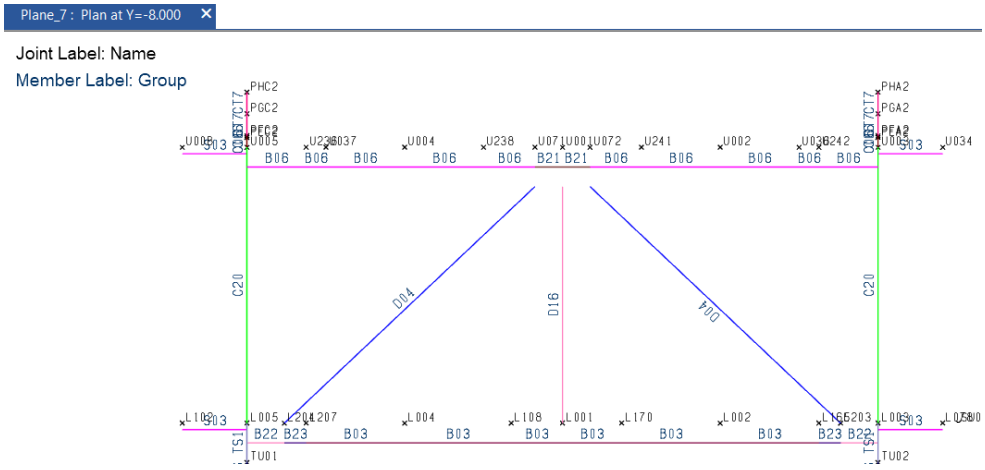

Plane_5 : Plan at X=-8.000
Member Label: Group

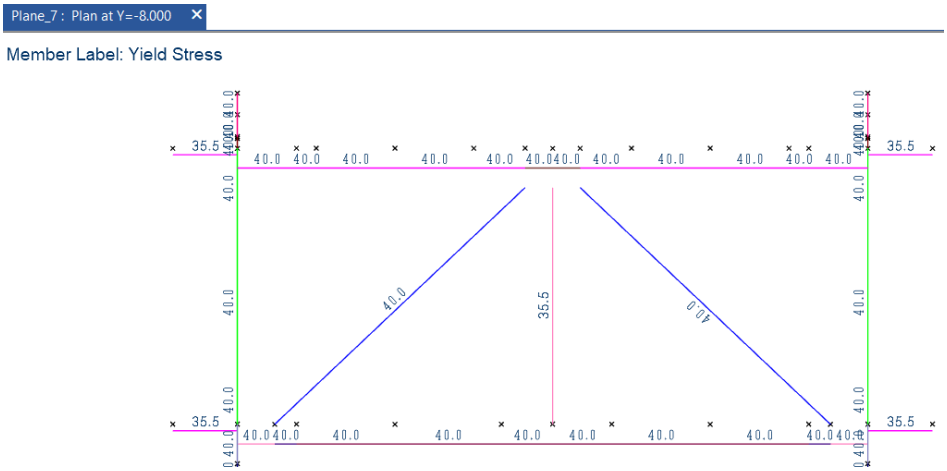

Plane_5 : Plan at X=-8.000
Member Label: Yield Stress

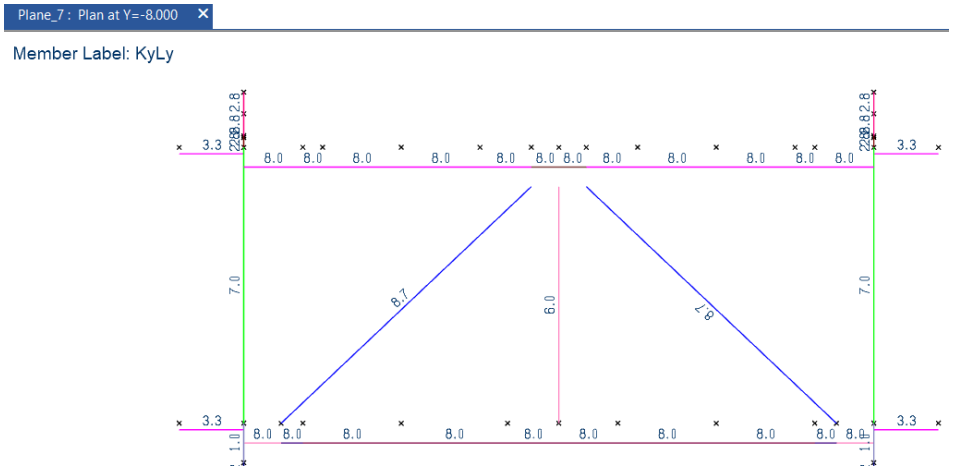

Member Label: KyLy

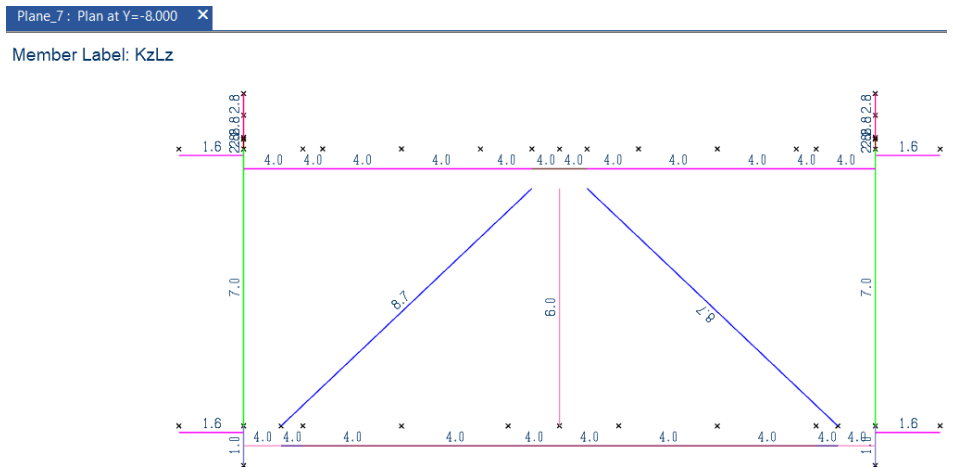

Plane_5 : Plan at X=-8.000
Member Label: KzLz
Plane_4 : Plan at X=-8.000
Member Label: Lb
Plane_6 : Plan at Y=-20.000
Joint Label: Name
Member Label: Group

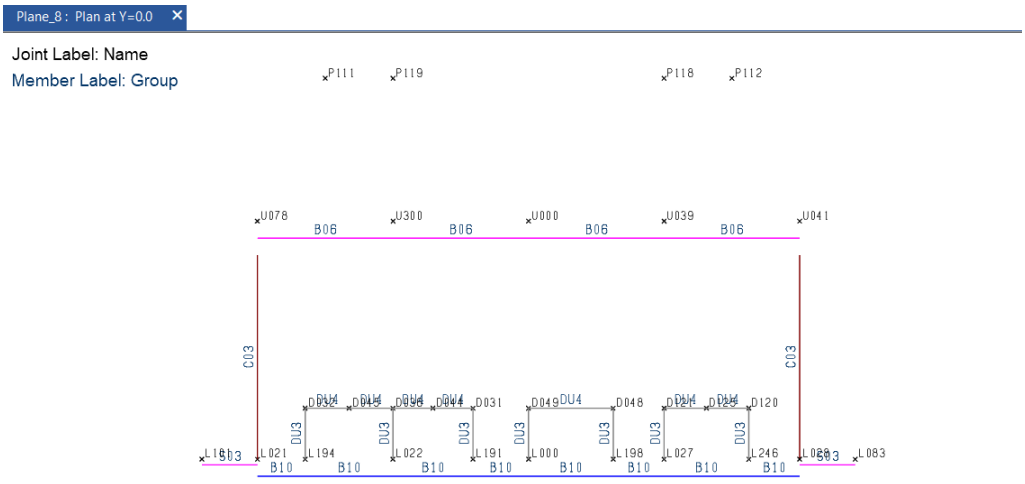

Plane_6 : Plan at Y=-20.000
Member Label: Yield Stress
Plane_6 : Plan at Y=-20.000
Member Label: KyLy
Plane_6 : Plan at Y=-20.000
Member Label: KzLz

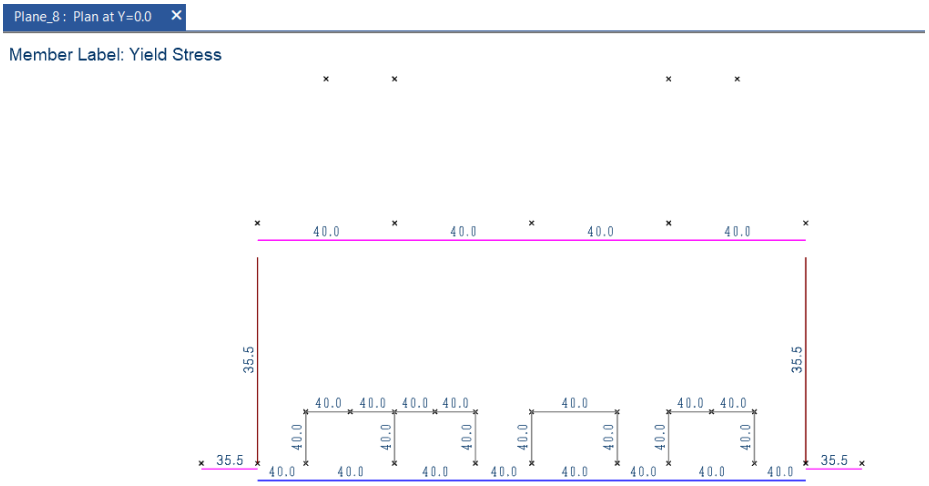

Plane_7 : Plan at Y=-8.000
Joint Label: Name
Member Label: Group
PHC2
PGC2
PHA2
PGA2
C20
D04
D16
B06
B21
B22
B23
B03
S03
TS1
TS2
TU01
TU02

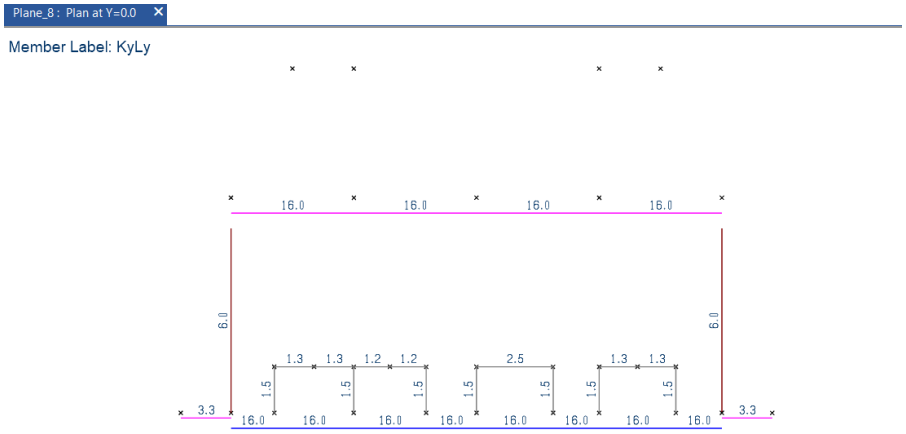

Plane_7 : Plan at Y=-8.000
Member Label: Yield Stress
35.5
40.0

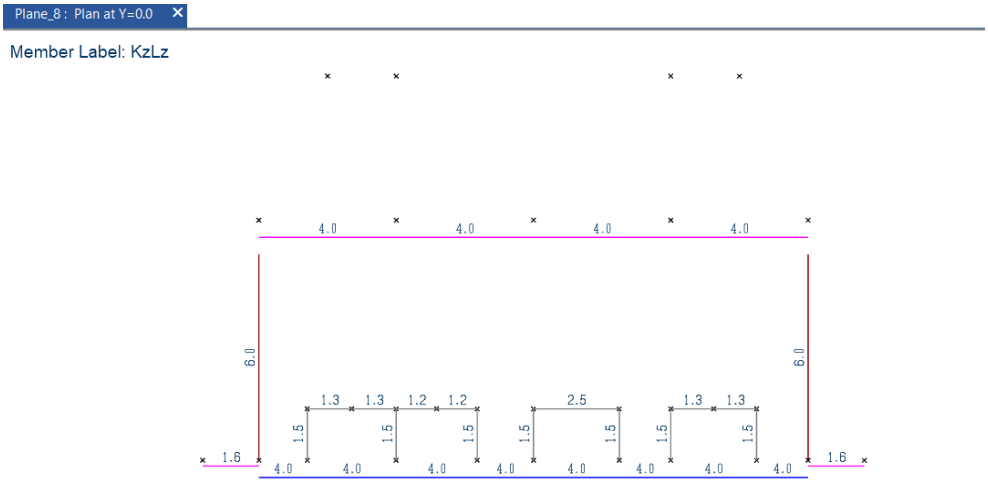

Plane_7 : Plan at Y=-8.000
Member Label: KyLy

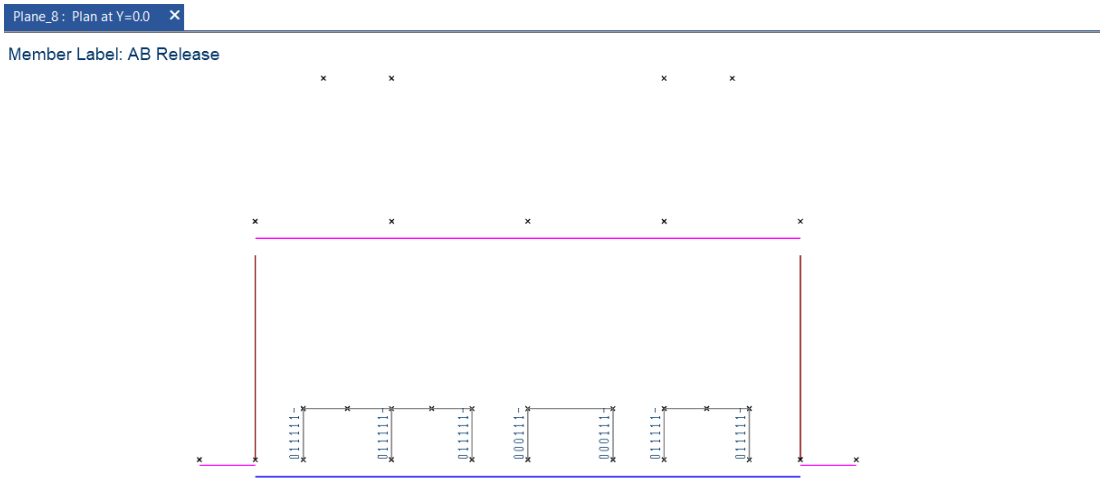

Plane_7 : Plan at Y=-8.000
Member Label: KzLz

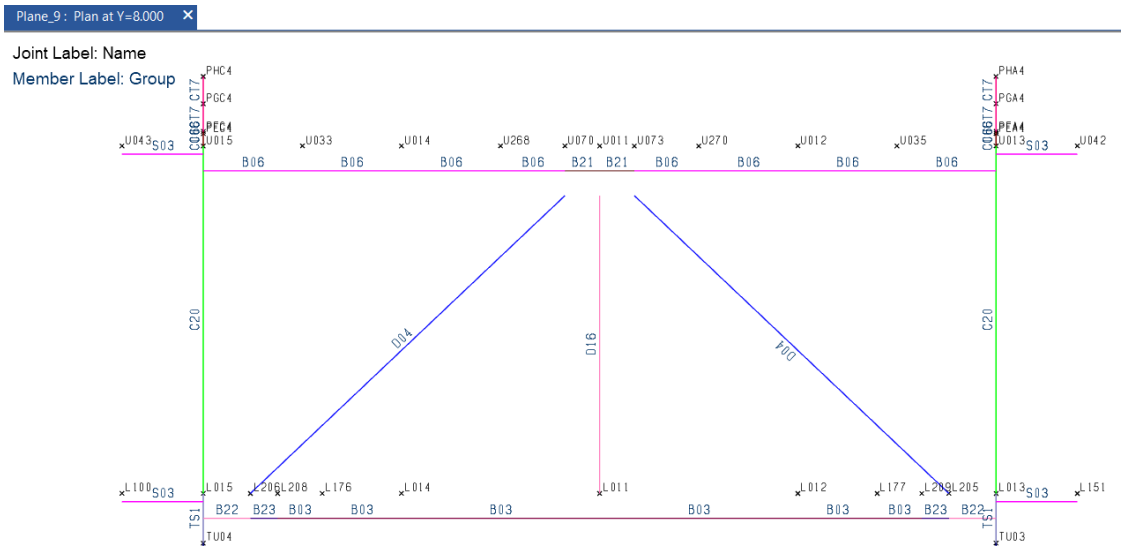

Plane_8 : Plan at Y=0.0
Joint Label: Name
Member Label: Group

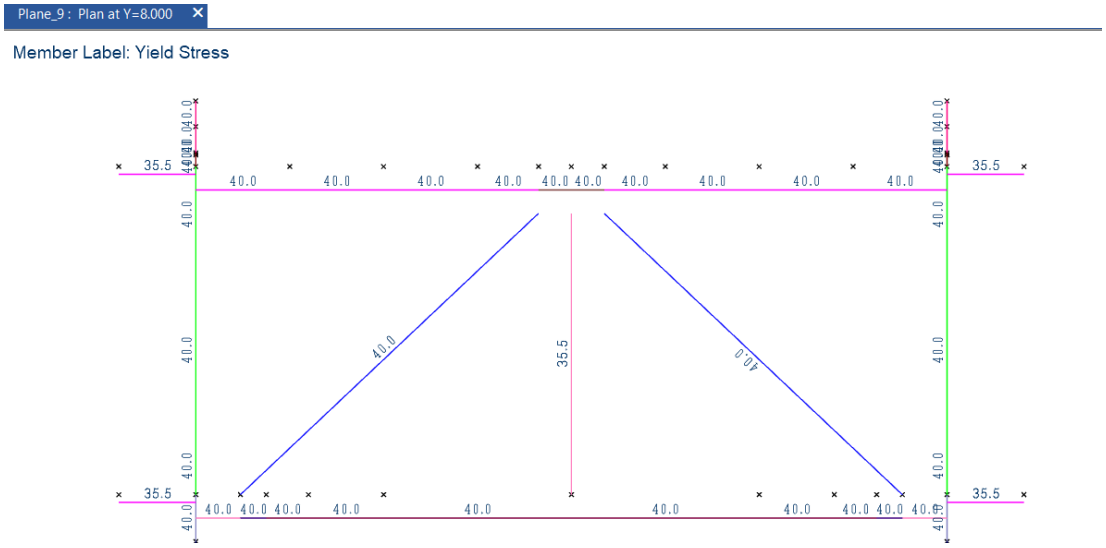

Plane_8 : Plan at Y=0.0
Member Label: Yield Stress
40.0
35.5

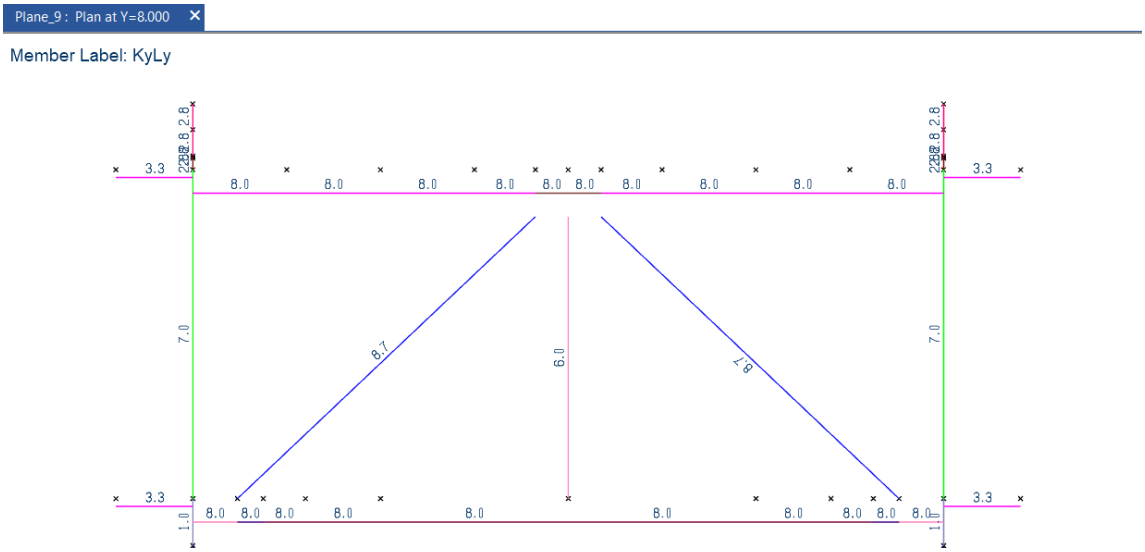

Plane_8 : Plan at Y=0.0
Member Label: KyLy
16.0
6.0
1.3
1.2
2.5
1.5
3.3

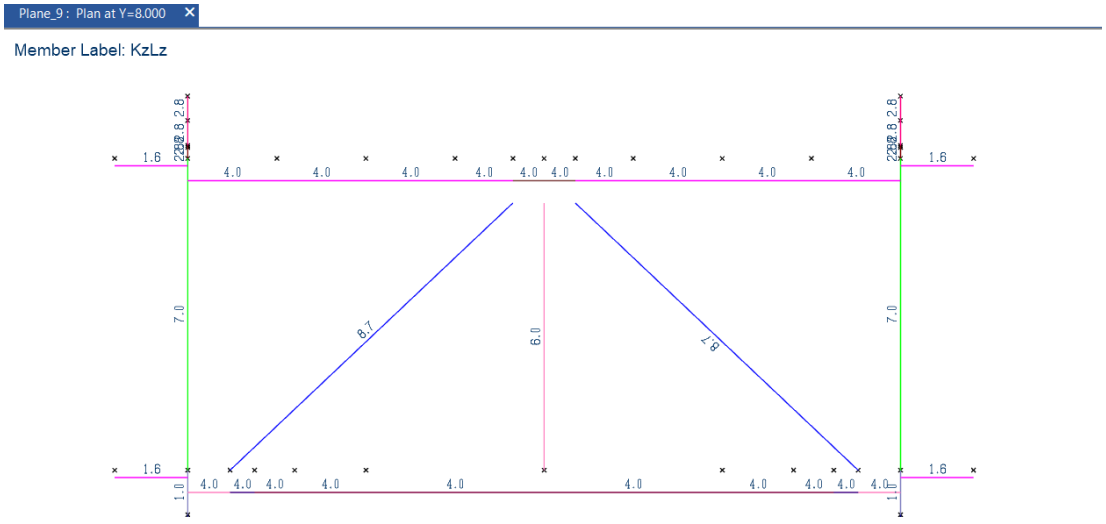

Plane_8 : Plan at Y=0.0
Member Label: KzLz
4.0
6.0
1.3
1.2
2.5
1.5
1.6

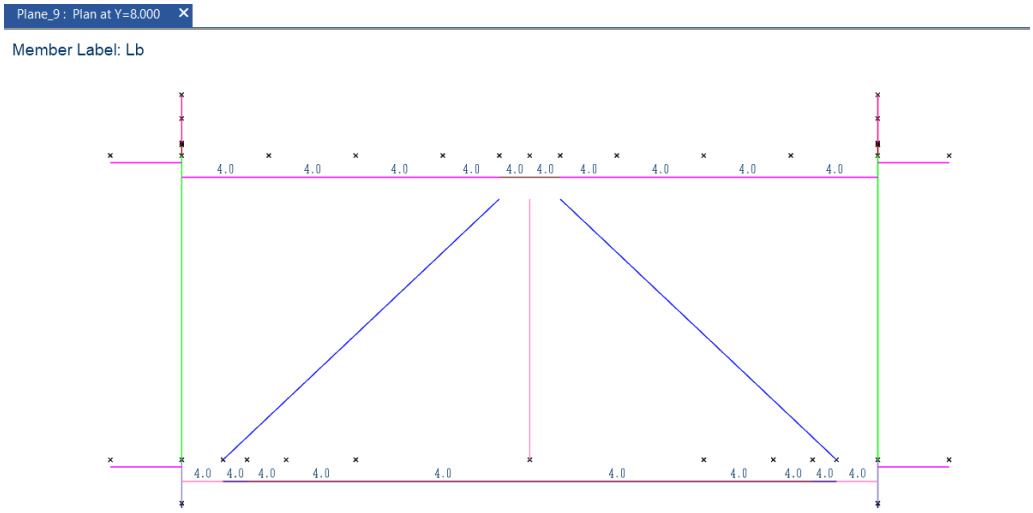

Plane_8 : Plan at Y=0.0
Member Label: AB Release

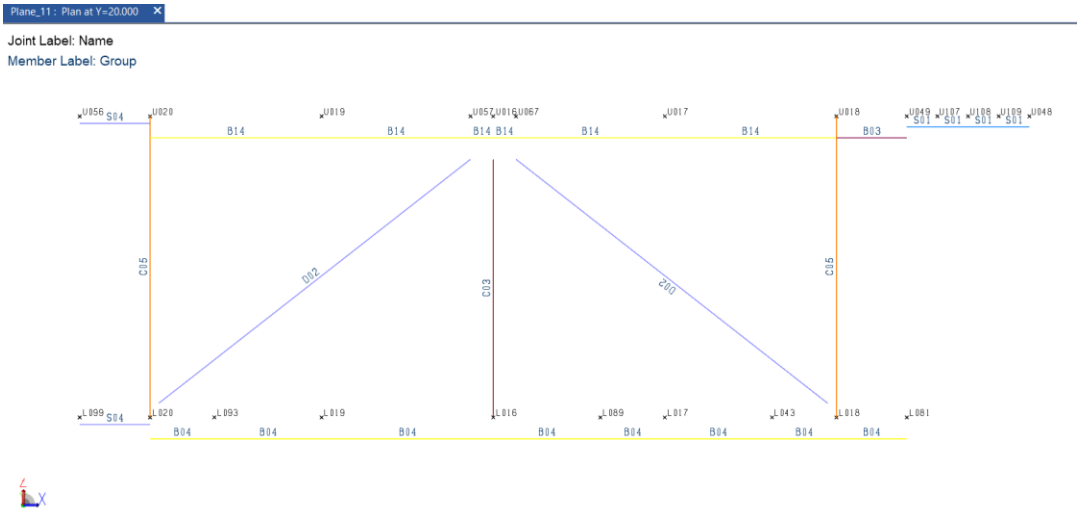

Plane_9 : Plan at Y=8.000
Joint Label: Name
Member Label: Group
B06
B21
B03
B22
B23
C20
D04
D16

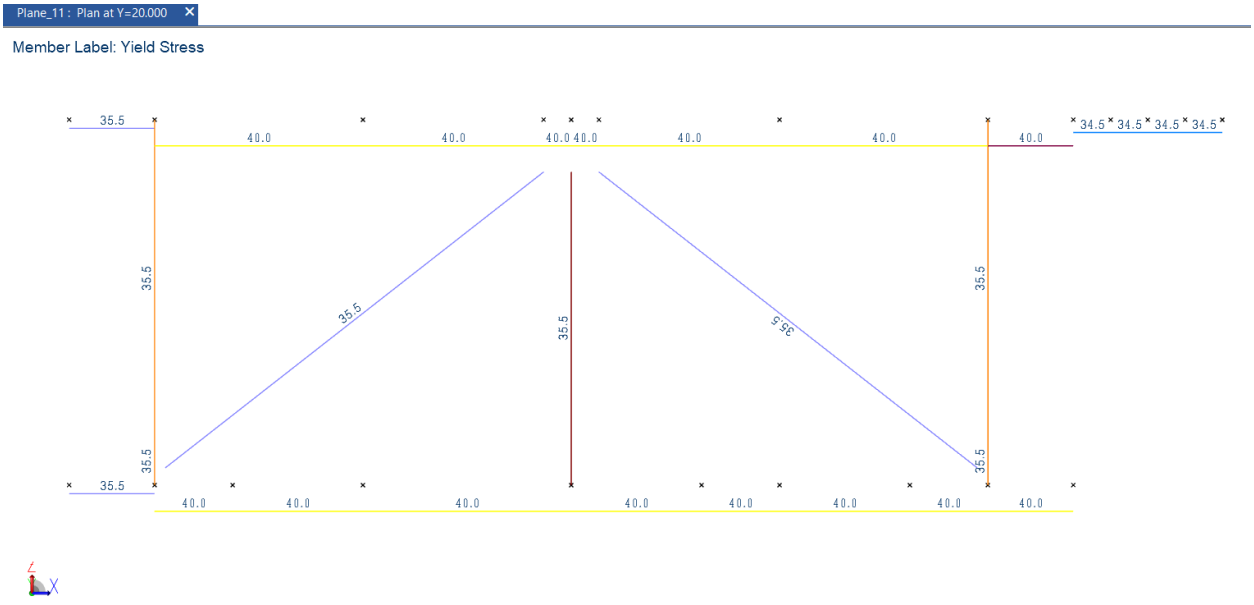

Plane_9 : Plan at Y=8.000
Member Label: Yield Stress
35.5
40.0
35.5

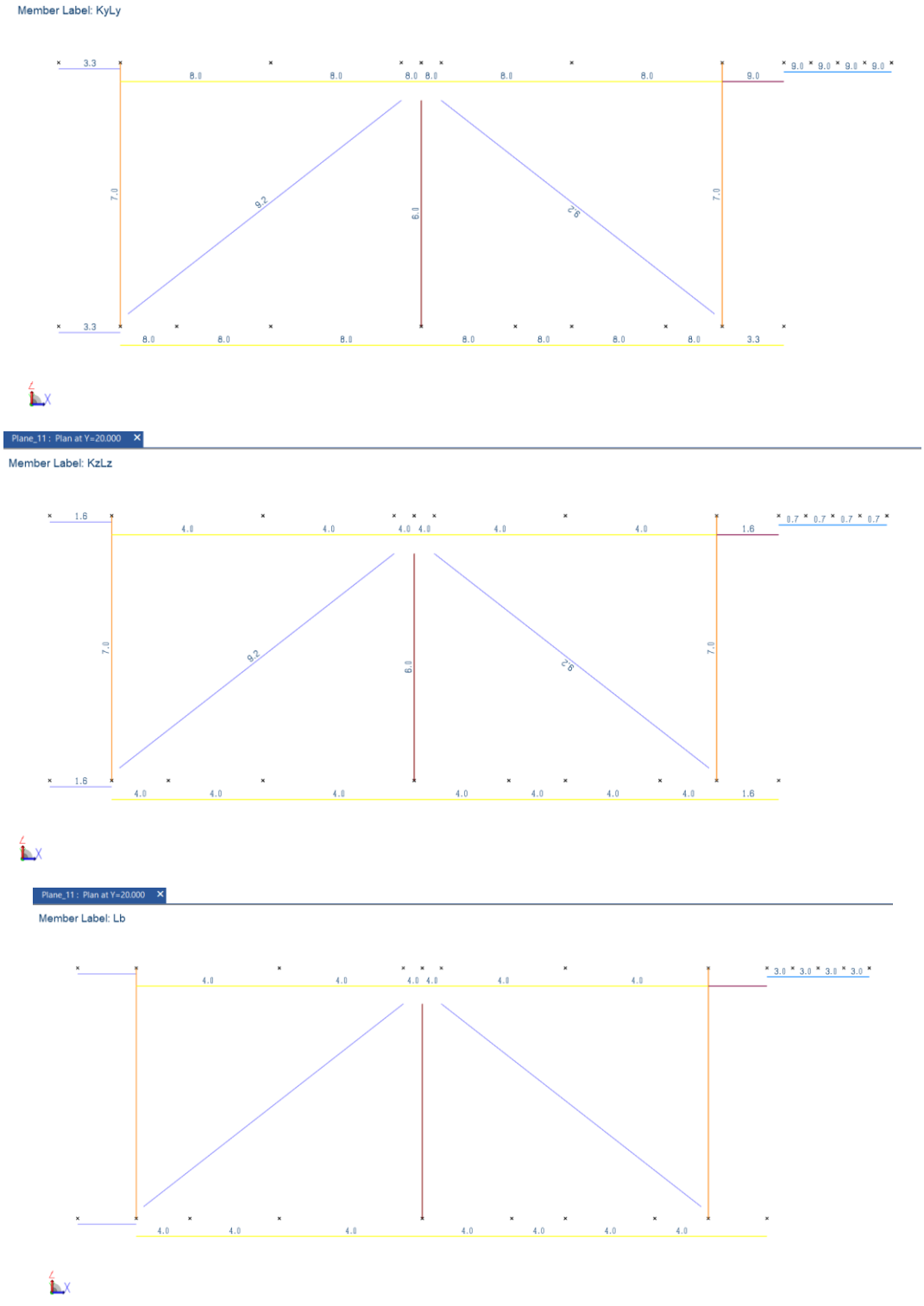

Plane_9 : Plan at Y=8.000
Member Label: KyLy
3.3
8.0
7.0
6.0
8.7
1.0


Plane_9 : Plan at Y=8.000
Member Label: KzLz
1.6
4.0
7.0
8.7
6.0
1.8
1.0


Plane_9 : Plan at Y=8.000
Member Label: Lb
4.0

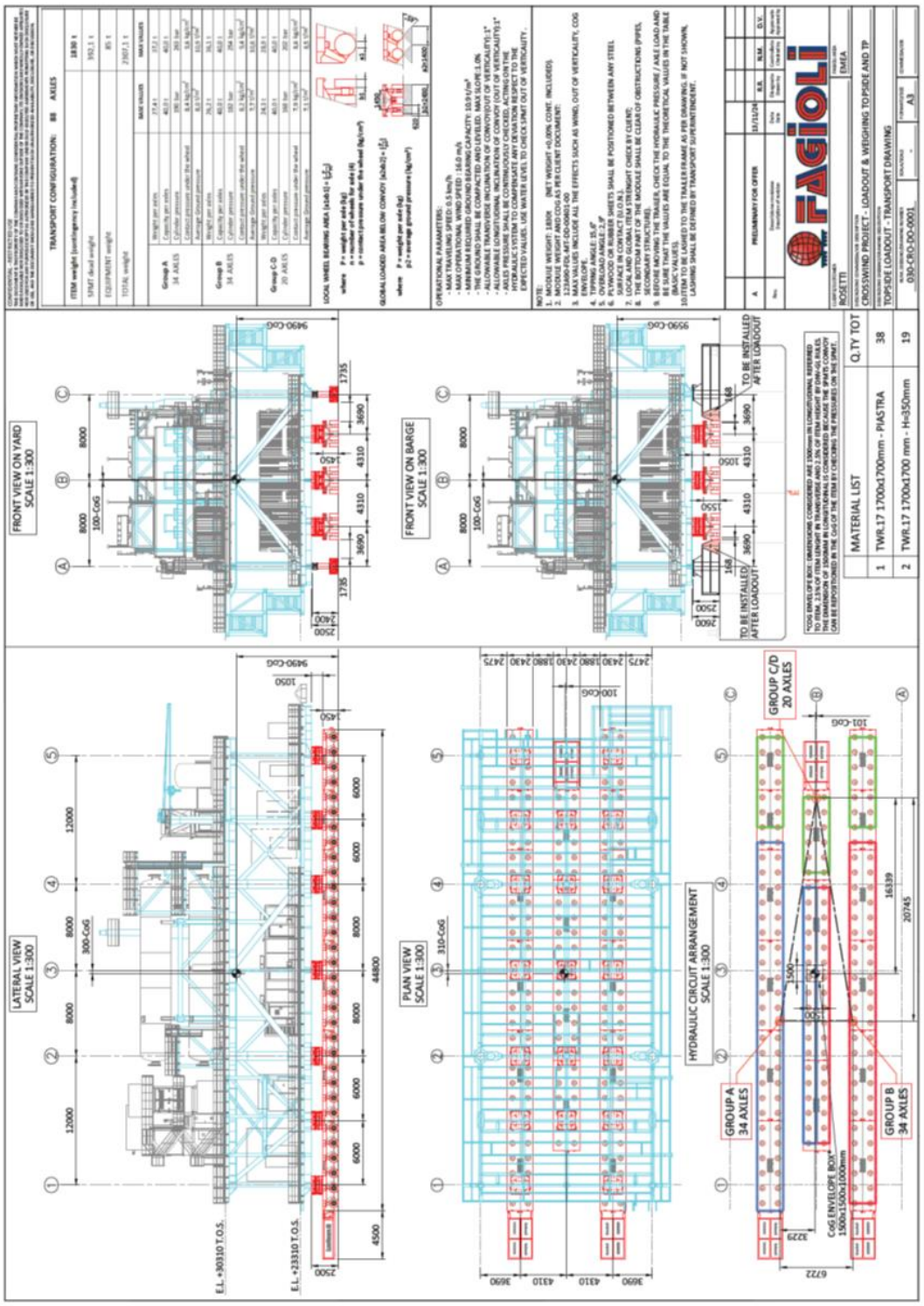

Plane_11 : Plan at Y=20.000
Joint Label: Name
Member Label: Group


Plane_11 : Plan at Y=20.000
Member Label: Yield Stress
35.5
40.0
34.5


Member Label: KyLy
Plane_11 : Plan at Y=20.000
Member Label: KzLz
Plane_11 : Plan at Y=20.000
Member Label: Lb

APPENDIX C – SPMT ARRANGEMENT

This document undergoes an issuance cycle within EDMS Fusionlive". Its distribution is electronically controlled. Once printed shall be considered as "NOT CONTROLLED" copy


FRONT VIEW ON YARD
SCALE 1:300
FRONT VIEW ON BARGE
SCALE 1:300
LATERAL VIEW
SCALE 1:300
PLAN VIEW
SCALE 1:300
HYDRAULIC CIRCUIT ARRANGEMENT
SCALE 1:300
GROUP A
34 AXLES
GROUP B
34 AXLES
GROUP C/D
20 AXLES
TO BE INSTALLED
AFTER LOADOUT
MATERIAL LIST
Q.TY TOT
1 TWR.17 1700x1700mm - PIASTRA 38
2 TWR.17 1700x1700 mm - H=350mm 19
CROSSWIND PROJECT - LOADOUT & WEIGHING TOPSIDE AND TP
TOPSIDE LOADOUT - TRANSPORT DRAWING
FAGIOLI
ROSETTI
EMEA
A3