Base Load Power Hub (BLPH)

BLPH Platform Lifting 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.

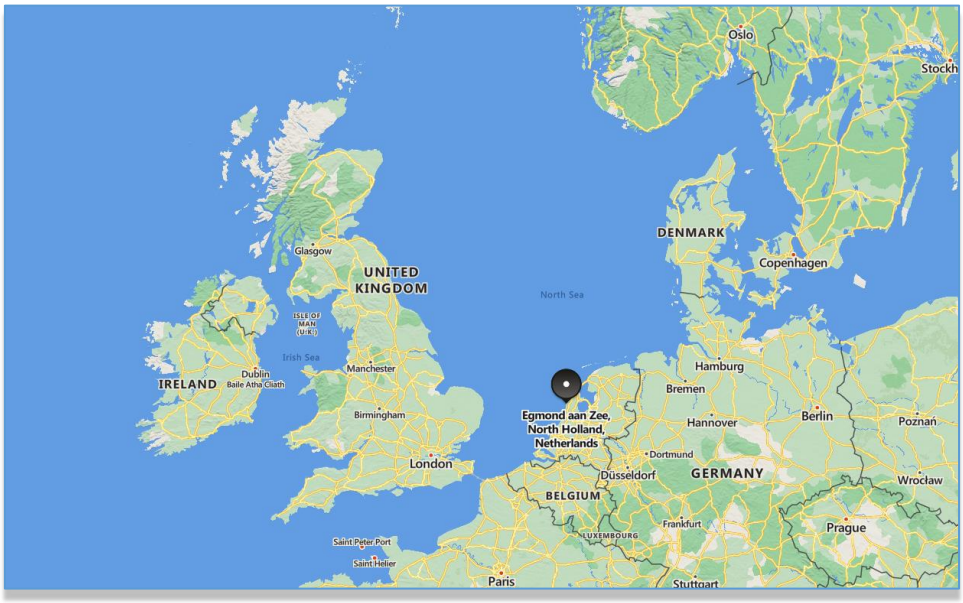


Figure 1.1 - HOLLANDSE KUST NOORD WIND PARK Location Map

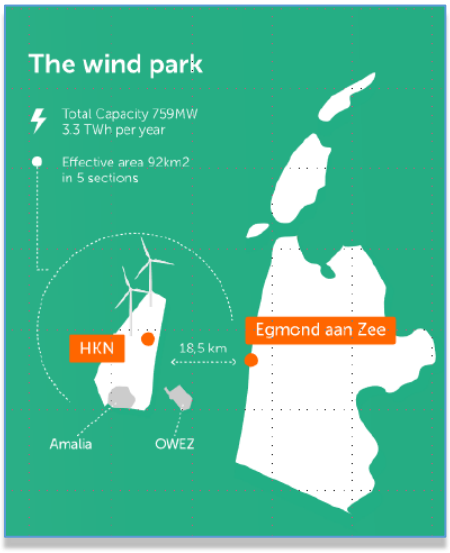


Figure 1.2 - Wind Park Details

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.

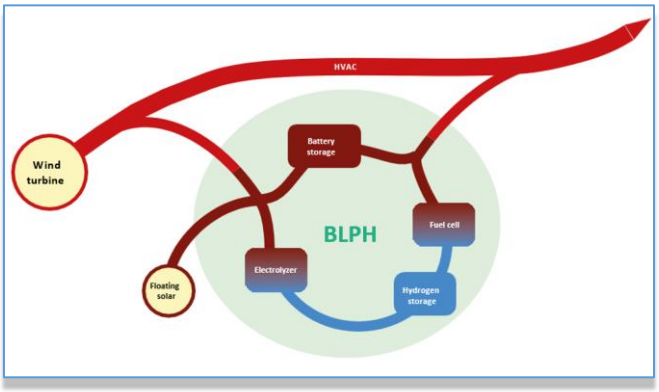


Figure 1.3 – BLPH Concept

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 lifting conditions.

The analysis has been performed in compliance with the requirements, criteria and parameters reported in the Structural Design Premises, Ref./18/.

Lifting analysis is executed according to what prescribed in DNV-ST-N001, Ref./11/.

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/.

Trunnion joints were checked for lifting conditions in dedicated calculation report named *BLPH Platform – Joint Check Design Report* Ref./24/.

All structural analyses have been carried out using the structural analysis program SACS, the proprietary software developed by Bentley, Ref. /28/.

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/ API RP 2A-WSD	Recommended practice for planning, designing and constructing fixed offshore platforms – Working stress design – 22nd edition – 2014
/10/ UNI EN 1993-1-5	Design of Steel Structures – Part 1-5: Plated structural elements
/11/ DNV-ST-N001	DNV GL - Marine operation and marine warranty - 2021
/12/ DNV-ST-0145	DNV, Offshore substations
/13/ DNV-RP-C201	DNV, Buckling Strength of Plated Structures, October 2010.
/14/ DNV-ST-0126	Support structures for wind turbine, 2018

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3.2 COMPANY SPECIFICATIONS

Doc. No.	Description
/15/ DEP 37.19.00.12	Gen - Offshore Topsides Structures
/16/ DEP 37.19.00.30	Gen - Fixed Steel Offshore Structures (Adoption of IOGP S-631-11, Amendments / Supplements to ISO 19902:2020).
/17/ 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
/18/ 123A90-DDL-ST-SP-90017	Structural Design Basis
/19/ 123A90-DDL-MD-RE-01006	Monthly Weight Report – rev 03
/20/ 123A90-DDL-PP-DS-70070	Plot Plans
/21/ 123A90-DDL-ST-SP-90018	Structural Material Specification for Topside and TP
/22/ 123A90-DDL-ST-RE-90000	BLPH Platform – In service Analysis
/23/ 123A90-DDL-ST-RE-90002	BLPH Platform – Topside Transportation analysis Report
/24/ 123A90-DDL-ST-RE-90005	BLPH Platform – Topside Joint Check Design Report
/25/ 123A90-DDL-ST-TN-90119	Evaluating ISO and DNV approaches
/26/ 123A90-DDL-ST-DD-90055	BLPH Platform – Lifting Points General Arrangement
/27/ 123A90-DDL-ST-DD-90056	BLPH Platform – Lifting Points Details

3.4 SOFTWARE

Doc. No.	Description
/28/ SACS	Structural Analysis Computer System – BENTLEY Inc- v15

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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
BESS	BATTERY ENERGY STORAGE SYSTEM
BG	Box Girder
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
HLV	Heavy Lift Vessel
ICCP	Impressed Current Corrosion Protection
LAT	Lowest Astronomical Tide
LRFD	Load and Resistance Factor Design
MSL	Mean Sea Level
NTE	Not-to-Exceed
OD	Outside Diameter
PAU	Pre-Assembled Unit (H2 Vessels)
PG	Plate Girder

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SHL	Static Hook Load
T&I	Transport & Installation
ToS	Top of Steel
UC	Unity Check
UDL	Uniformly Distributed Load
WTG	Wind Turbine Generator
W2W	Walk to Work

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 lifting loads.

The Topside weight considered in the analysis is presented here below and then it is compared with the weight defined in the WCR, ref. /19/.

5.1 WEIGHT RESULTANTS

COG location comparison between SACS structural model for Lifting Analysis and WCR is reported in following tables. The Topside weight during lifting operations is 1802 t (ref WCR rev 03), assumed 1890t in calculation.

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

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 Topside weight and CoG – WCR ref. system

5.2 MEMBER CHECKS

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

Members verified with CF 1.30					
MEMBER	**GROUP**	**DESCRIPTION**	**SECTION**	**COMBINATION**	**UC**
L005-U005	C20	Main column - Row C2	800x40 / 800x20 / 800x30	LC11	0.50
U001-U072	B21	Plate girder - Lower deck	PG21	LA11	0.49
L015-U015	C20	Main column - Row C4	800x40 / 800x20 / 800x30	LC51	0.49

Table 5.3 – Member UC Summary (CF=1.30)

Members verified with CF 1.15					
MEMBER	**GROUP**	**DESCRIPTION**	**SECTION**	**COMBINATION**	**UC**
L033-U003	D05	Diagonal Brace - Row A	406.4 x 12.7	LA12	0.79
L110-U005	D05	Diagonal Brace - Row C	406.4 x 12.7	LC12	0.75
L113-U015	D05	Diagonal Brace - Row C	406.4 x 12.7	LC52	0.75

Table 5.4 – Member UC Summary (CF=1.15)

Members verified with CF 1.00					
MEMBER	**GROUP**	**DESCRIPTION**	**SECTION**	**COMBINATION**	**UC**
L181-L011	B02	Plate girder - Lower Deck - Row B	PG02	LC53	0.89
L050-U170	D05	Diagona Brace - row C	406.4 x 12.7	LC13	0.85
L00B-Y000	IP3	secondary beam - stair south	IPE330	LA13	0.81
L234-L133	B04	Plate girder - Lower Deck - Row B	PG04	LA13	0.80

Table 5.5 – Member UC Summary (CF=1.00)

5.3 TUBULAR JOINT CHECKS

Structural tubular joints with maximum Unity Checks (UC) > 0.7 for punching shear are detailed in the following table.

All the joints have been verified using CF = 1.30

JOINT	DESCRIPTION	CHORD	BRACE	COMBINATION	UC
0002	X Bracing Row A (crane)	406.4 x 20.62	406.4 x 15.88	LA51	0.954
U003	Upper Deck - Rows A-2	800 x 30	406.4 x 12.7	LA11	0.829

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U005	Upper Deck - Rows C-2	800 x 30	406.4 x 12.7	LC11	0.798
U015	Upper Deck - Rows C-4	800 x 30	406.4 x 12.7	LC51	0.791
D004	K-bracing diagonal row C	550 x 20	323.9 x 12.7	LC51	0.726

Table 5.6 – Tubular joint UC summary (CF = 1.30)

5.4 TRUNNION JOINT CHECKS

Trunnion joints were checked for lifting conditions according to ISO 19902 Ref./6/ and UNI EN 1993 refs. /8/ and /10/.

Checks are reported in dedicated calculation report *BLPH Platform – Joint Check Design Report* Ref./24/.

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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's Upper Deck. PAU height is 9m and on top roof it acts as rigging platform with lifting slings.

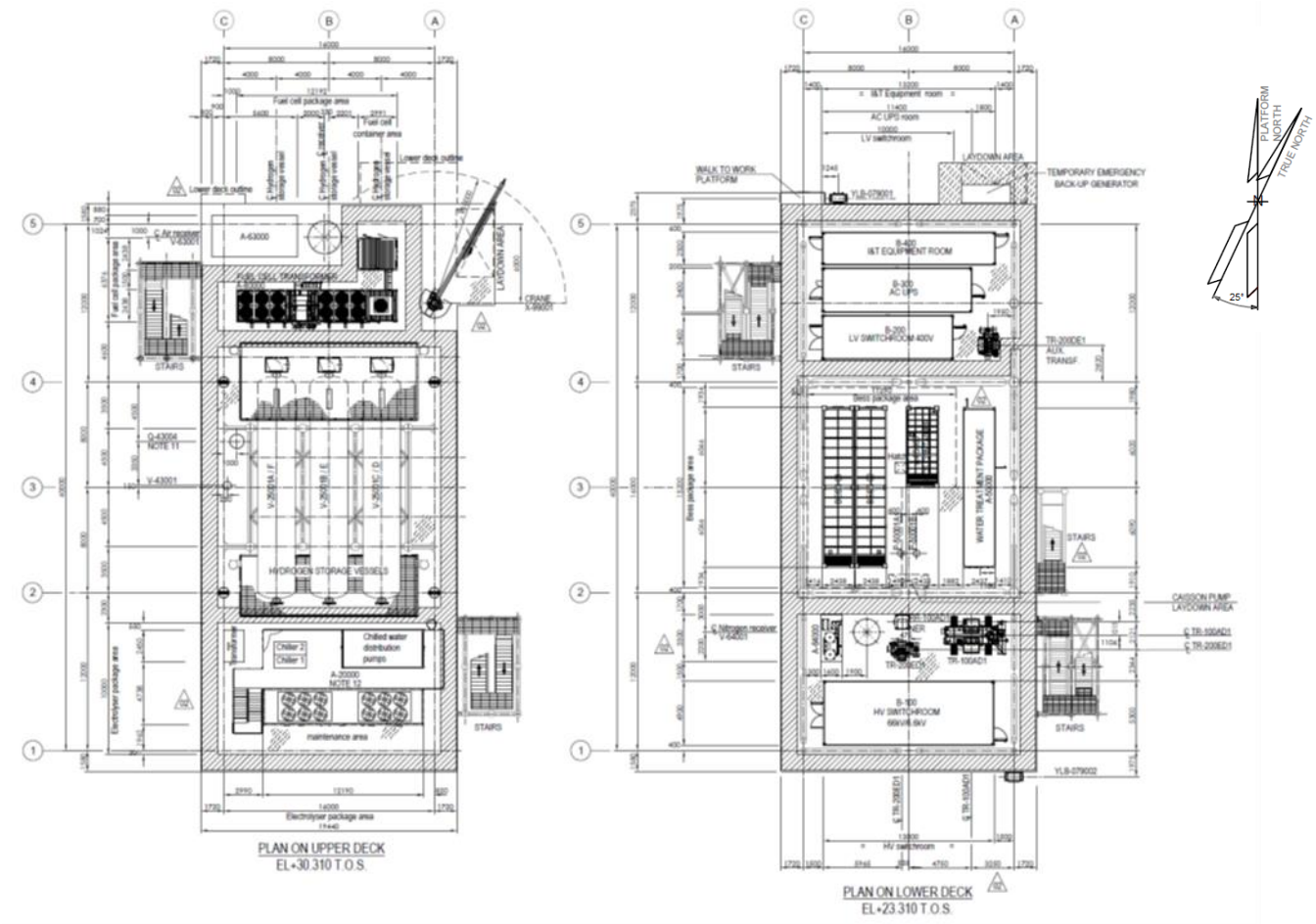


Figure 6.1 - Base Load Power Hub Plot Plan

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./21/. 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.

			STEEL NAME						DNV-ST-0145, 2021			
Design Class	Complexity	SQL	Plates and Welded tubular	Sections	SMLS pipes	THK	CVN inpact test	Material designation	Classification of Structural members (DNV-OS-C101)	Plates and Welded tubular	Sections	SMLS pipes
DC1 Complex lift-nodes and element connection to topside, Lift points, main complex joints, TP to monopile flange connection and TP cans	High	I (Z properties)	EN 10225 S420 QLO / MLO EN 10225 S460 QLO / MLO	NA	NA	t <= 12	-	-	Special cat. "S"	NA NV F420 / NV F460 (3)(4)	NA	NA
						12 < t <= 25	-	-				
						25 < t <= 50	-40	DC1-I-420-40_Z DC1-I-460-40_Z				
						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	Low	II	EN 10225 S420 QLO / MLO EN 10225 S460 QLO / MLO	NA	NA	t <= 12	-		Primary category members "1"	NV F420 / NV F460 (3)(4)	NA	NA
						12 < t <= 25	-20	DC2-II-420-20 / DC2-II-460-20				
						25 < t <= 50	-40	DC2-II-420-40 DC2-II-460-40				
						t > 50	-40					
		I (Z properties)	NA	NA	NA	t <= 12	-	-	Special cat. "S"	NA	NA	NA
						12 < t <= 25	-	-				
						25 < t <= 50	-	-				
						t > 50	-	-				
DC3 all other columns and diagonals, stiffeners, Secondary deck beams, Grillage and sea fastening	High	II	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	Primary category members "1"	NV F36 (4)	NV F36 (4)	NV F36 (4)
						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, bolts	Low	III	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	Secondary category members "2"	NV A36 / AW 36	NV A36 / AW 36	NV A36 / AW 36
						12 < t <= 25	0					
						25 < t <= 50	-	-				
						t > 50	-	-				
DC5 floor plating, grating, Walkways, stairs, handrails	Any	IV	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 / S275 J0H / S355 J0H	t <= 12	10	DC5-IV-235-10 / DC5-IV-275-10 / DC5-IV-355-10 / DC5-IV-GRB-10	Non structural members (NS)	NV A NV A27S	NV A NV A27S	NV A27S
						12 < t <= 25	10					
						25 < t <= 50	-	-				
						t > 50	-	-				

Table 7.1 - Material Selection, Ref /21/

Mechanical properties for structural materials are presented in Table 7.2, Table 7.3 and Table 7.4.

- 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

Grating 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 is 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
$\gamma_{M3,SER}$	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

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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; Any actions due to misalignment of structures such as between the topside and TP
Permanent (Dead)	G2	permanent action imposed on the topsides structure by self-weight of equipment and other objects that remain constant for long periods of time, but which can change from one mode of operation to another, or during a mode of operation, bulk loads
Variable (Live)	Q1	Equipment & piping contents weight; Superimposed area loads
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 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

For Lifting Analyses, situation 1 only is considered since it is the most critical for the Topside structural checks.

8.5 ACCEPTANCE CRITERIA

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

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9 STRUCTURAL ANALYSIS

9.1 STRUCTURAL MODEL

The software SACS™, ref./28/, 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 in-service analysis, ref. /22/.

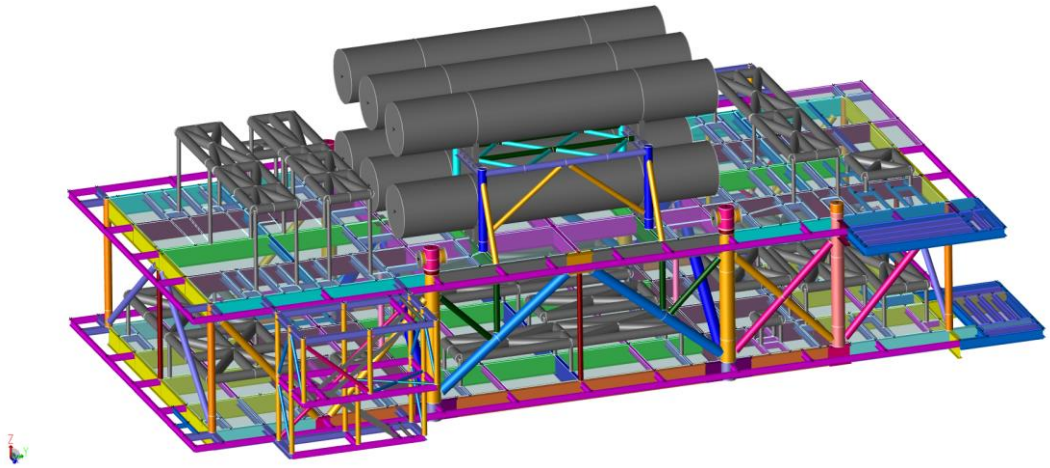


Figure 9.1 - Topside structural model

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 relative to LAT. The X-axis is positive toward East, the Y-axis is positive toward North and the Z-axis is positive upward.

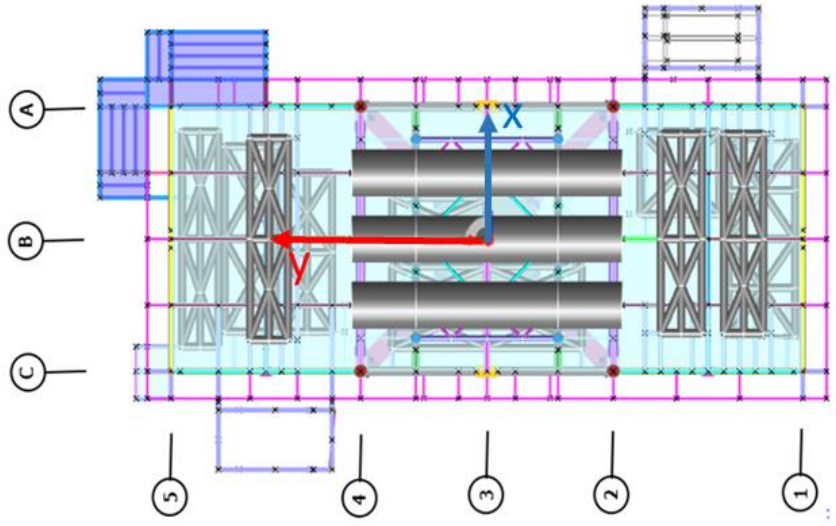


Figure 9.2 - BLPH Topsides Structural Model - Top View

9.1.2 Methodology

The Topside structure is assumed to be lifted in air with two cranes in a single vessel using one spreader beam for each hook (two spreader beam in total). The topside is lifted at four points localized on the main deck columns A2, A4, C2 and C4. Since the lifting is statically determinate, slings are not modelled.

Lifting analysis is executed according to what prescribed in DNV-ST-N001, Ref./11/.

The analysis includes the following steps:

- Topside model generation starting from in-service analysis model;
- input of the proper design loads;
- execution of the analysis for the different load conditions;
- evaluation of maximum reactions;
- Strength checks of structural members and joints for the design load combinations.

9.1.3 Boundary Conditions

The Topside is vertically suspended to the trunnion joints (PHA2, PHC2, PHA4, PHC4 at el.+31.21) and it is also horizontally restrained (in X and Y direction, statically determined) at joints U010 and U020 at el.31.21 (UD elevation) to avoid numerical instability, Figure 9.3.

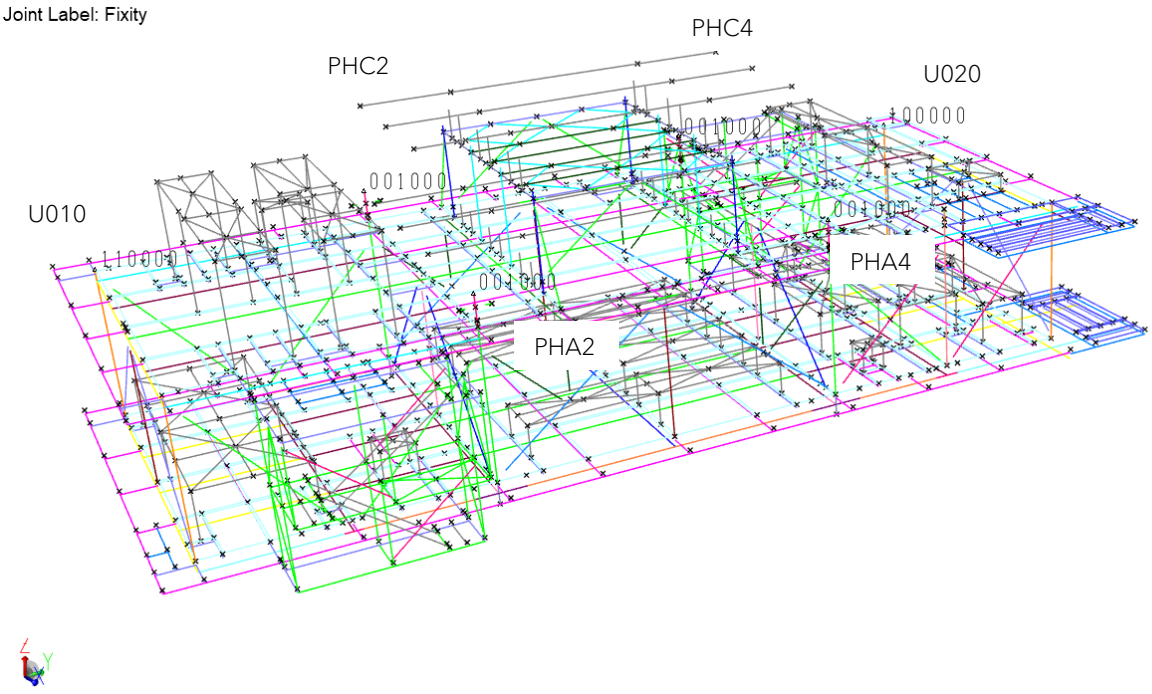


Figure 9.3 - BLPH Topsides Structural Model – Boundary Conditions

10 BASIC LOAD CASES

All the design loads have defined according to the Weight Control Report and Plot Plans, Ref./19/ and /20/, 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.

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

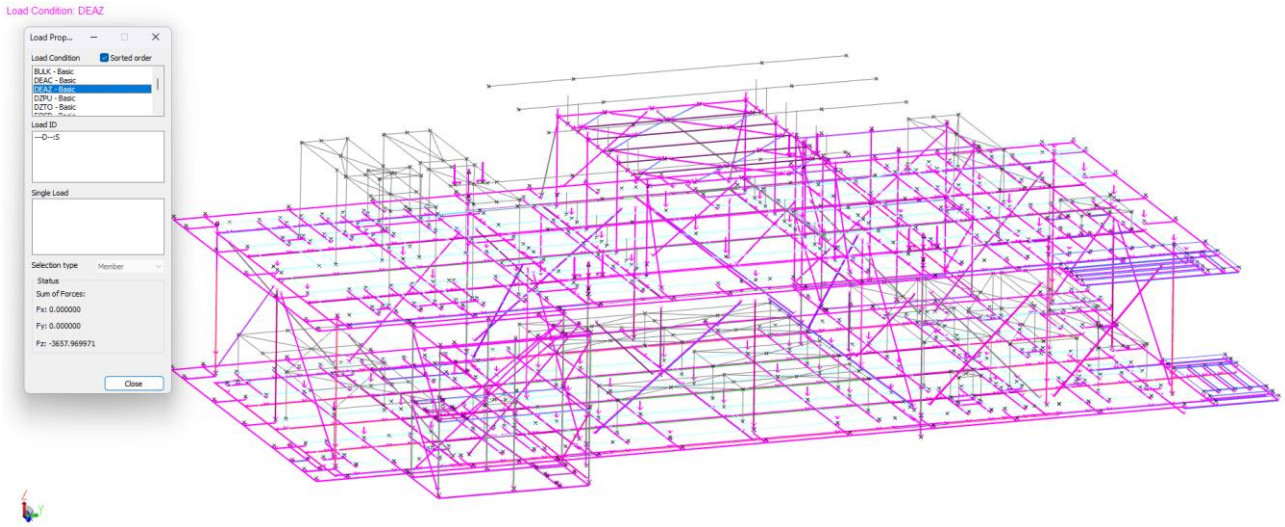


Figure 10.1 – Topside Load condition DEAZ

- Load condition DZTO: TOPSIDE MODELLED WEIGHT

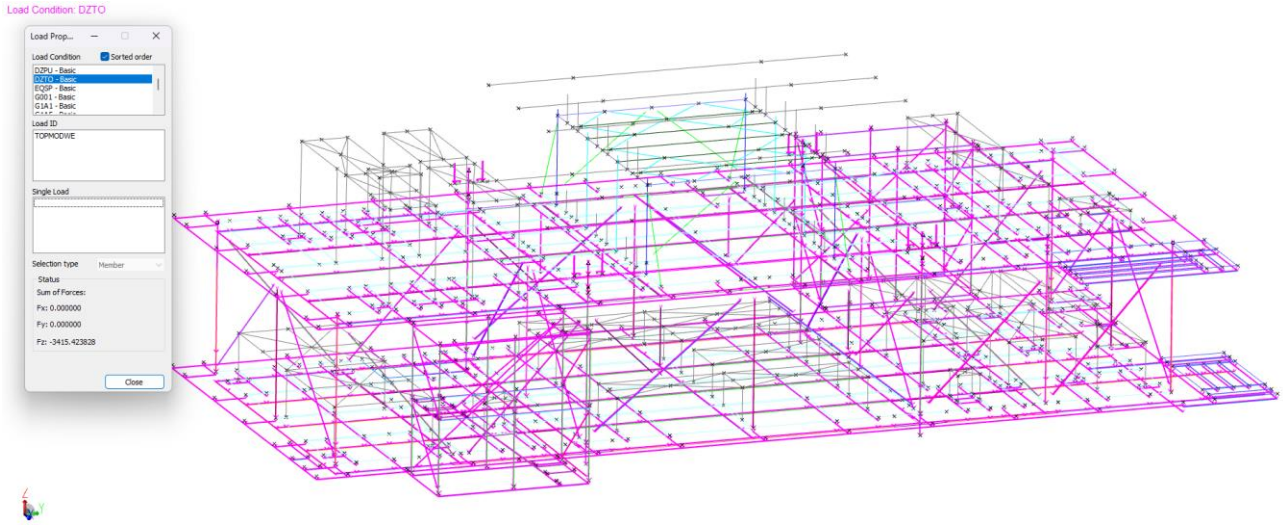


Figure 10.2 – Topside basic load conditions forming DEAZ

- Load condition DZPU: PAU MODELLED WEIGHT

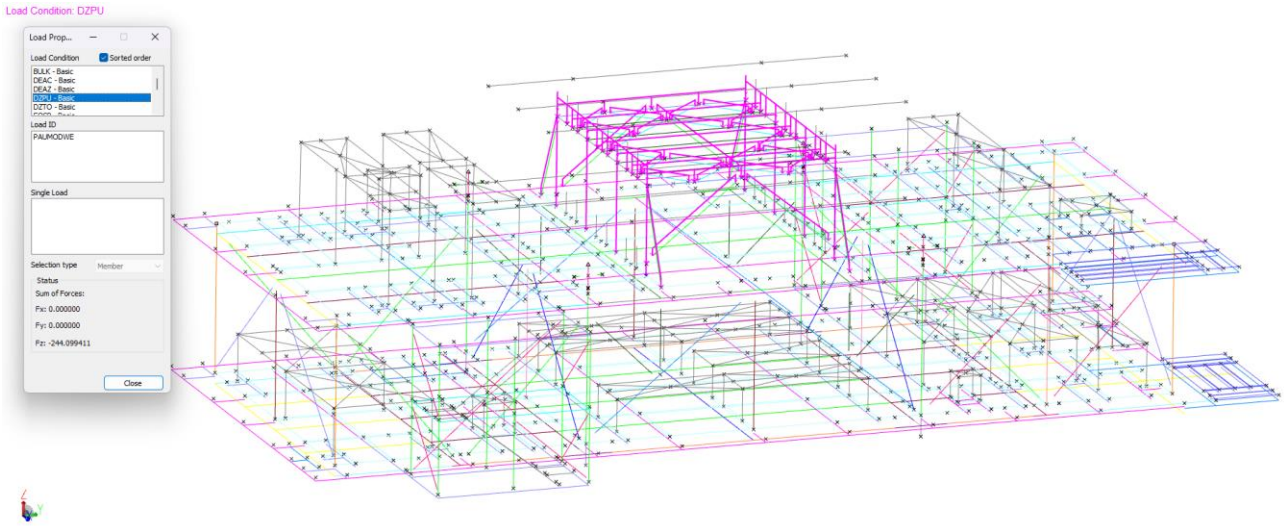


Figure 10.3 – Topside basic load conditions forming DEAZ

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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.

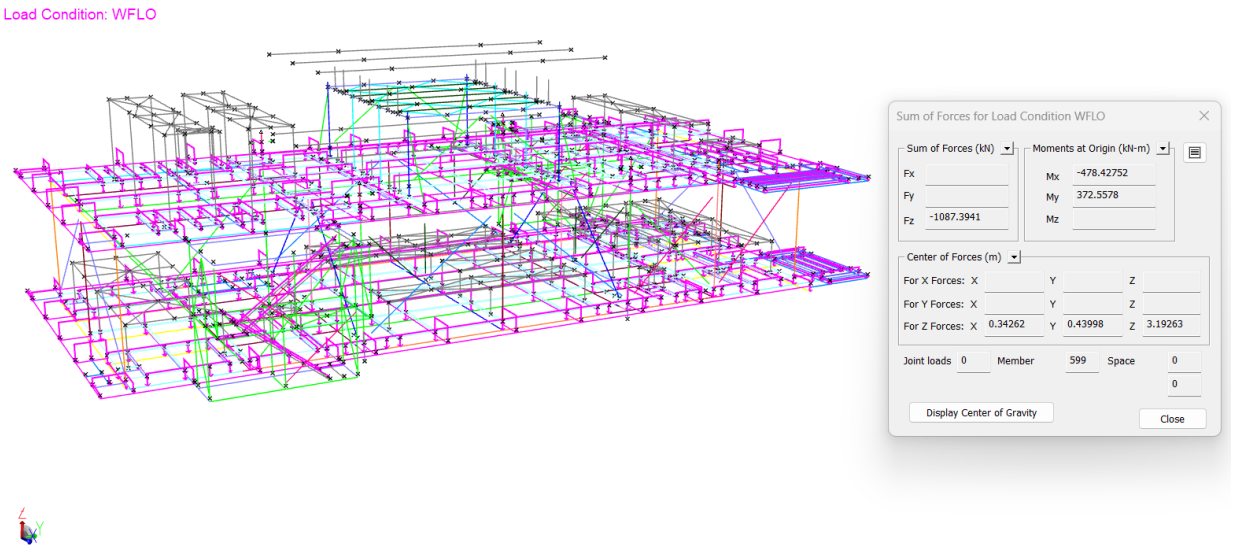


Figure 10.4 – Topside basic load conditions WFLO

- 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./19/.

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

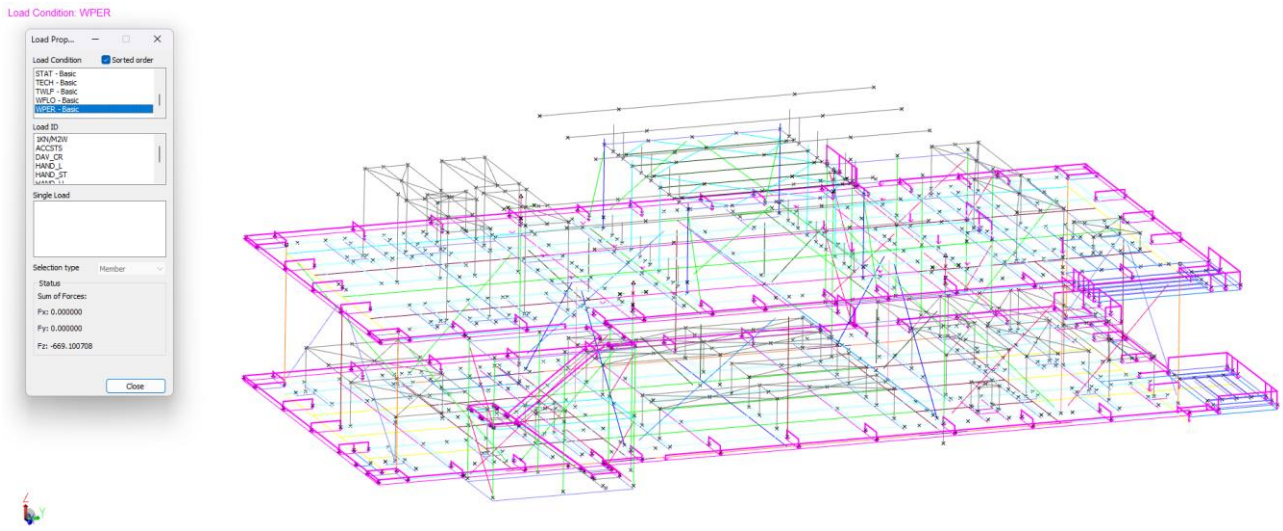


Figure 10.5 – Topside basic load conditions WPER

- 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).

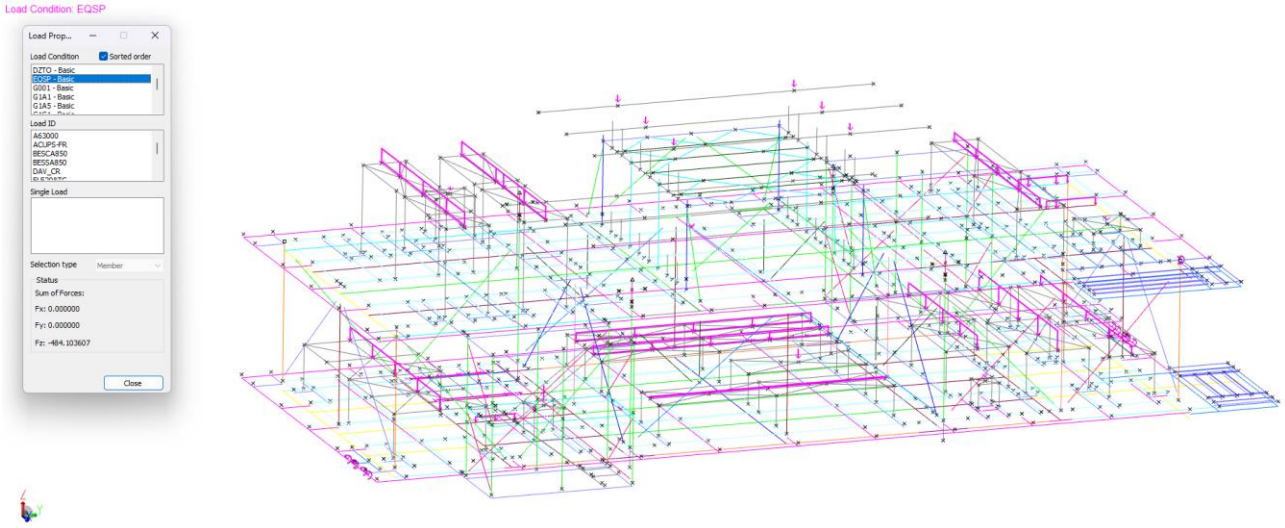


Figure 10.6 – Topside basic load conditions EQSP

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).

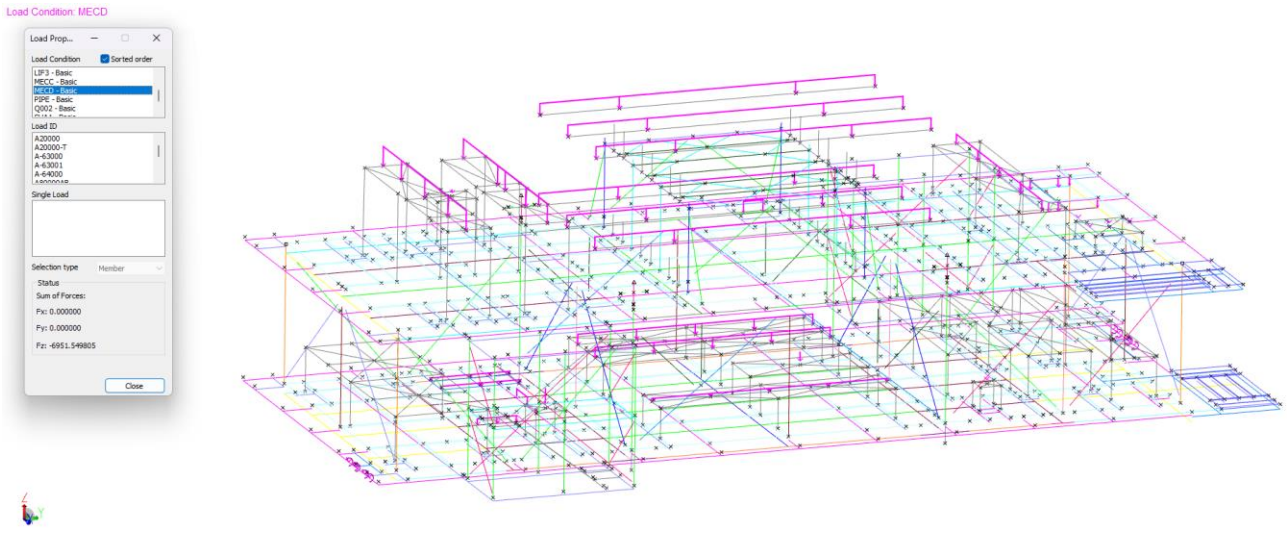


Figure 10.7 – Topside basic load conditions MECD

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.

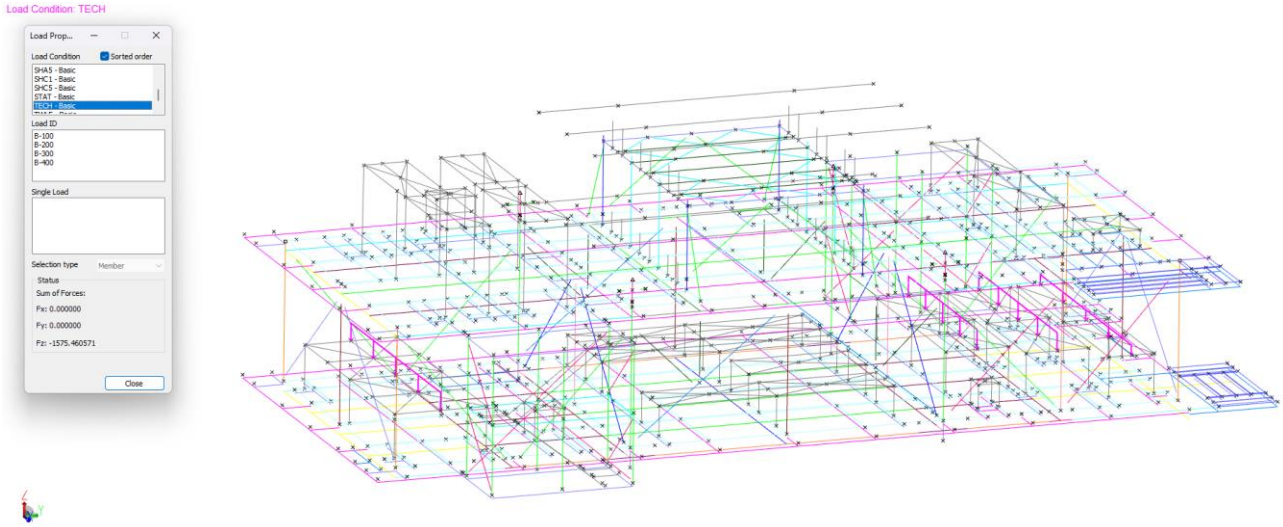


Figure 10.8 – Topside basic load conditions ARCH

- 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).

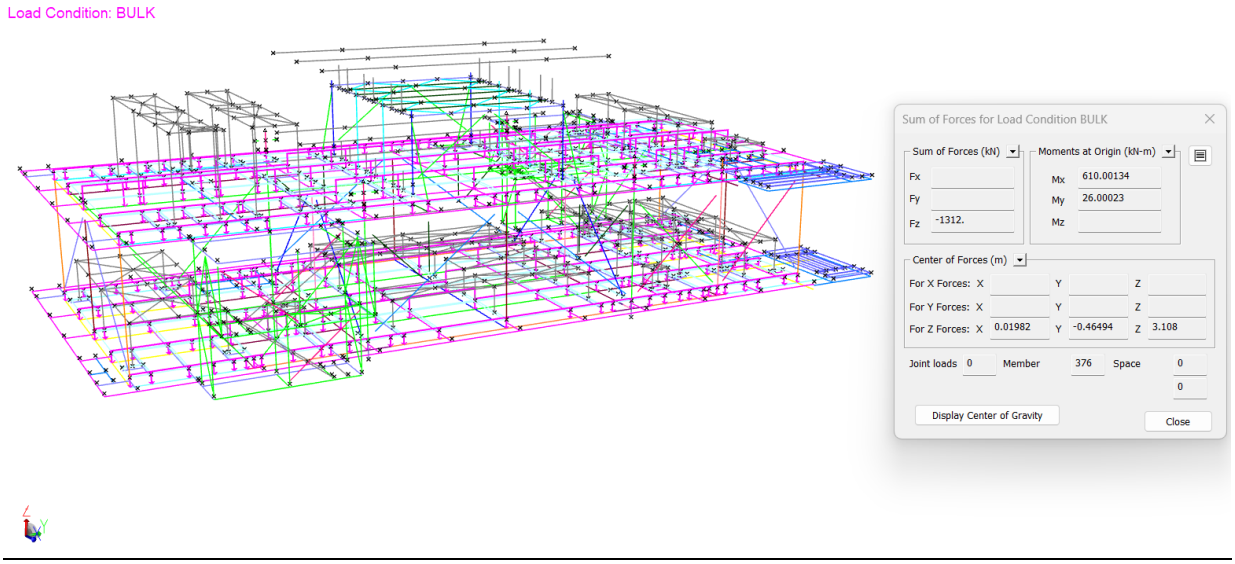


Figure 10.9 – Topside basic load conditions BULK

- <u>Load condition PIPE: Piping Weights</u>

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

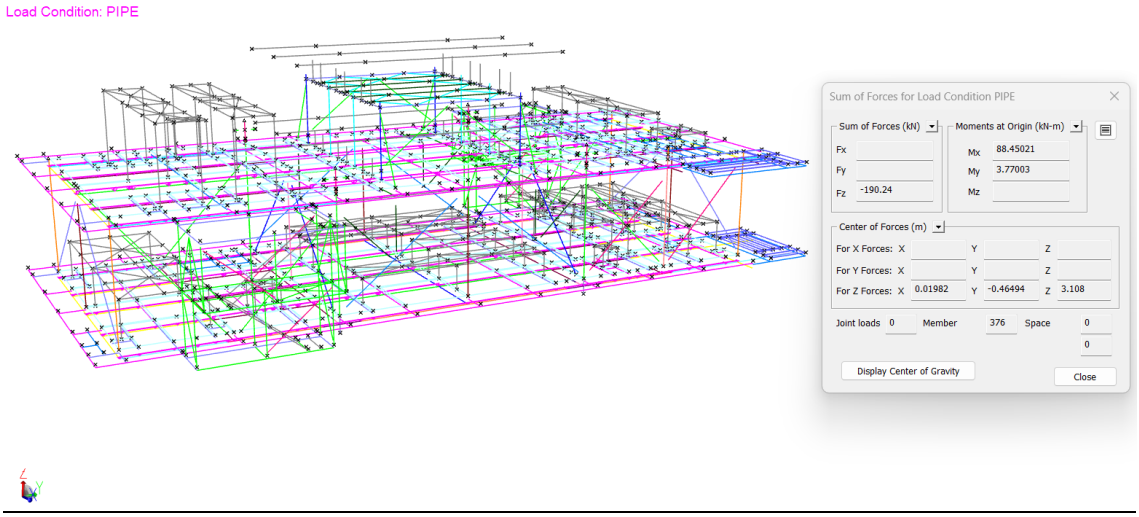


Figure 10.10 – Topside basic load conditions PIPE

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.

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
```

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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)

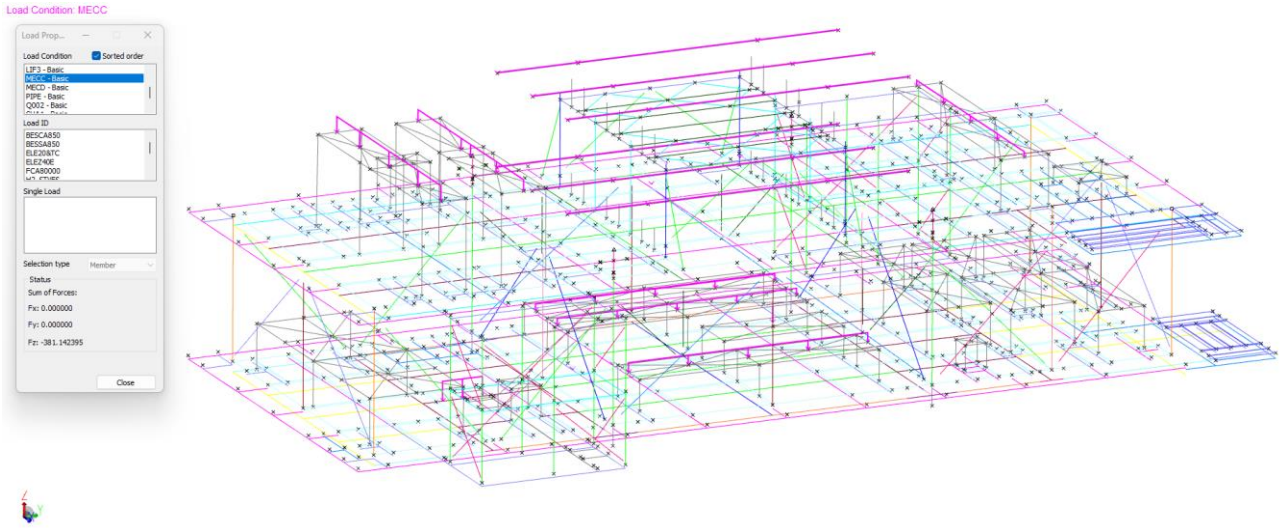


Figure 10.11 – Topside basic load conditions MECC

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
```

10.3 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

10.4 COG SHIFT LOAD CONDITIONS

For the purpose of Topside detail design lifting analyses, the topsides CoG location is considered to be within a CoG tolerance envelope of 5% the distance between the structure length and breadth:

- Longitudinal Cog shift envelope (along global X axis; E-W direction) = 5% x 16 m = 0.8 m (±0.4m);
- Transversal Cog shift envelope (along global Y axis; N-S direction) = 5% x 40 m = 2 m (±1.0m).

CoG shift (from WCR position) is obtained by applying suitable couples made by vertical upward and downward forces applied at the upper deck corner joints of the structural model (joints U010, U008, U020, U018).

Four load cases with 0kN vertical resultant have been defined, one for each CoG shifted position, to produce the shifting of CoG in combination with load combination STAT (load combination comprehensive of total BLPH permanent loads) without increasing the global weight resultant:

- POS. 1 - Cog shift toward intersection between rows A and 5: load condition SHA5;
- POS. 2 - Cog shift toward intersection between rows A and 1: load condition SHA1;
- POS. 3 - Cog shift toward intersection between rows C and 5: load condition SHC5;
- POS. 4 - Cog shift toward intersection between rows C and 1: load condition SHC1.

Vertical forces are applied to the joints at the intersection of row A and 5, row A and 1, row C and 5 and row C and 1 at upper deck elevation.

The original CoG position from WCR and the four shifted positions are reported in following tables and figure, with the indication of the vertical forces at corner joints for each load condition.

To check the correct execution of CoG shifting the following four load cases have been defined:

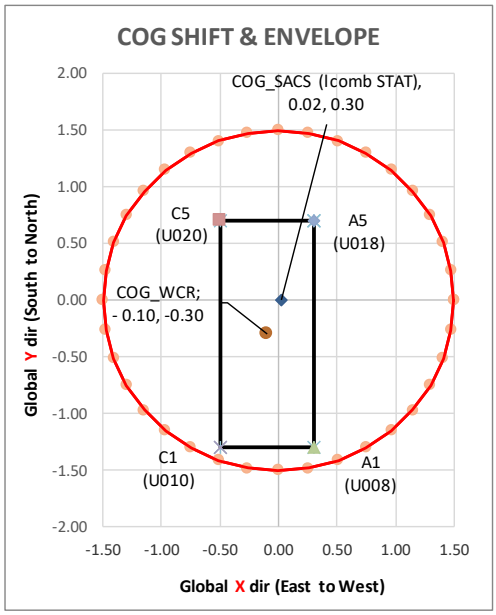
- G1A5 = SHA5 + STAT
- G1A1 = SHA1+ STAT
- G1C5 = SHC5 + STAT
- G1C1 = SHC1 + STAT

Following excerpt from SACS output provide the CoG shifting as per Figure 10.12.

```
                                    ************* 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)

   8  SHA5         0.00                                     0.00                                    COUPLE
   9  SHA1         0.00                                     0.00                                      0.00
  10  SHC5         0.00                                     0.00                                      0.00
  11  SHC1         0.00                                     0.00                                    COUPLE

  20  G1A1         0.00                                     0.00                                -18539.78      0.30     -1.30     29.21
  21  G1A5         0.00                                     0.00                                -18539.78      0.30      0.70     29.21
  22  G1C1         0.00                                     0.00                                -18539.78     -0.50     -1.30     29.21
  23  G1C5         0.00                                     0.00                                -18539.78     -0.50      0.70     29.21
```



W = -18540 kN

X and Y = SACS ref. system

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
COG shift Values			
Shift toward	x [m]	y [m]	POS
A5	0.40	1.00	1
A1	0.40	-1.00	2
C5	-0.40	1.00	3
C1	-0.40	-1.00	4

COG SHIFT FROM WCR VALUE			
Shift toward	x [m]	y [m]	POS
A5	0.30	0.70	1
A1	0.30	-1.30	2
C5	-0.50	0.70	3
C1	-0.50	-1.30	4

SACS FORCES for COG shifting				
COG Position	1	2	3	4
COG SHIFT toward	A5	A1	C5	C1
Fz [kN] @ joint U008	0.00	-463.50	463.50	0.00
Fz [kN] @ joint U010	324.45	-139.05	-139.05	-602.55
Fz [kN] @ joint U020	0.00	463.50	-463.50	0.00
Fz [kN] @ joint U018	-324.45	139.05	139.05	602.55
Load condition	SHA5	SHA1	SHC5	SHC1

Figure 10.12 - CoG shifting - Forces and Positions

11 LOAD COMBINATIONS

11.1 BASIC LOAD COMBINATIONS

Basic Load cases and load combinations detailed in chapter 10, have been combined together to define the final Load Combinations to be used in the lifting global analysis, according to Partial Action Factor as per sec. 8.4.1 for all the five positions of CoG.

11.1.1 Lift Coefficients

The following lift factors will be applied following the DNV code, Ref./11/, and in accordance with Structural Design basis, Ref./18/:

Description		Coefficient Lifting points	Coefficient Other elements	Coefficient Other elements
Weight contingency factor as Ref./11/, sec. 16.2.2.1		1.05	1.05	1.05
(3)Cog shift contingency factor as Ref./11/, sec. 16.2.2.1		1.00	1.00	1.00
DAF for the gross weight 1000<W<2500 T, Ref./11/		1.15	1.15	1.15
(1)Tilt factor as per Ref./11/, Appendix P		1.02	1.02	1.02
(2)Yaw factor as Ref./11/, sec. 16.2.4.5		1.00	1.00	1.00
Skew Factor as Ref./11/, section 16.2.6.9		1.10	1.10	1.10
TOTAL		1.35	1.35	1.35
Consequence Factors as per Ref./11/, section 16.2.2.1	For lift points, spreader bars and rigging.	1.30		
	For non-redundant members framing into the lift point.			
	For load transferring redundant members framing directly into the lift point.		1.15	
	For all other members of the lifted structure			1.00
TOTAL		1.76	1.56	1.35
Load Factor as per DNV-ST-N001		1.30	1.30	1.30
TOTAL ULS		2.29	2.03	1.76

Table 11.1: Lift total factors for ULS lifting analyses

Note:

(1) According to Ref./18/ Tilt effect is to be computed for the more onerous condition of a tilt of 1.5° and a hook elevation difference of ±0.5m. On the safe side, tilt is computed for a tilt of 3° and a hook elevation difference of ±1.0m and it results in 1.014 for the WCR Cog position and 1.017 for the SACS CoG Position. Conservatively, Tilt factor is set to 1.02.

(2) According to Ref./18/ Yaw factor shall be 1.00.

(3) CoG shift contingency factor is set to 1.00 since the 5% shift envelope is considered as per section 10.4.

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11.2 LIFTING LOAD COMBINATIONS

LOAD COMB	LOAD CASE	
	STAT	LIF0
LIF0	1.00	
LIF1		2.29
LIF2		2.03
LIF3		1.76

Table 11.2: Load Combinations with CoG in Nominal Position

LOAD COMB	LOAD CASE	
	G1A1	LA10
LA10	1.00	
LA11		2.29
LA12		2.03
LA13		1.76

Table 11.3: Load Combinations SHIFT A1

LOAD COMB	LOAD CASE	
	G1A5	LA50
LA50	1.00	
LA51		2.29
LA52		2.03
LA53		1.76

Table 11.4: Load Combinations SHIFT A5

LOAD COMB	LOAD CASE	
	G1C1	LC10
LC10	1.00	
LC11		2.29
LC12		2.03
LC13		1.76

Table 11.5: Load Combinations SHIFT C1

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LOAD COMB	LOAD CASE	
	G1C5	LC50
LC50	1.00	
LC51		2.29
LC52		2.03
LC53		1.76

Table 11.6: Load Combinations SHIFT C5

Following excerpt from SACS output provide the Load Combinations resultants.

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

LOAD CASE	LOAD LABEL	********* X - DIRECTION ********* FORCE (KN)	X (M)	Y (M)	Z (M)	********* Y - DIRECTION ********* FORCE (KN)	X (M)	Y (M)	Z (M)	********* Z - DIRECTION ********* FORCE (KN)	X (M)	Y (M)	Z (M)
41	LIF0	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-18546.81	0.02	0.00	29.22
42	LIF1	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-42472.19	0.02	0.00	29.22
43	LIF2	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-37650.02	0.02	0.00	29.22
44	LIF3	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-32642.38	0.02	0.00	29.22
25	LA10	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-18546.81	0.30	-1.30	29.22
26	LA11	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-42472.19	0.30	-1.30	29.22
27	LA12	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-37650.02	0.30	-1.30	29.22
28	LA13	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-32642.38	0.30	-1.30	29.22
29	LA50	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-18546.81	0.30	0.70	29.22
30	LA51	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-42472.19	0.30	0.70	29.22
31	LA52	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-37650.02	0.30	0.70	29.22
32	LA53	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-32642.38	0.30	0.70	29.22
33	LC10	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-18546.81	-0.50	-1.30	29.22
34	LC11	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-42472.19	-0.50	-1.30	29.22
35	LC12	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-37650.02	-0.50	-1.30	29.22
36	LC13	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-32642.38	-0.50	-1.30	29.22
37	LC50	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-18546.81	-0.50	0.70	29.22
38	LC51	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-42472.19	-0.50	0.70	29.22
39	LC52	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-37650.02	-0.50	0.70	29.22
40	LC53	0.00	-77.81	-62.87	27.32	-0.00	-19.05	140.79	31.89	-32642.38	-0.50	0.70	29.22

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12 ANALYSIS RESULTS

This section presents the results of the performed Lifting analysis in terms of:

- Reactions at fixed points
- 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.

FIXED JOINTS REACTION FORCES AND MOMENTS REPORT

JOINT	LOAD COND	FORCE(X) kN	FORCE(Y) kN	FORCE(Z) kN	MOMENT(X) kN-m	MOMENT(Y) kN-m	MOMENT(Z) kN-m

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
PHA2	LA10	0.000	0.000	5675.800	0.000	0.000	0.000
	LA11	0.000	0.000	12997.626	0.000	0.000	0.000
	LA12	0.000	0.000	11521.845	0.000	0.000	0.000
	LA13	0.000	0.000	9989.366	0.000	0.000	0.000
	LA50	0.000	0.000	4508.643	0.000	0.000	0.000
	LA51	0.000	0.000	10324.859	0.000	0.000	0.000
	LA52	0.000	0.000	9152.510	0.000	0.000	0.000
	LA53	0.000	0.000	7935.170	0.000	0.000	0.000
	LC10	0.000	0.000	5216.438	0.000	0.000	0.000
	LC11	0.000	0.000	11945.693	0.000	0.000	0.000
	LC12	0.000	0.000	10589.345	0.000	0.000	0.000
	LC13	0.000	0.000	9180.896	0.000	0.000	0.000
	LC50	0.000	0.000	4049.282	0.000	0.000	0.000
	LC51	0.000	0.000	9272.923	0.000	0.000	0.000
	LC52	0.000	0.000	8220.004	0.000	0.000	0.000
	LC53	0.000	0.000	7126.695	0.000	0.000	0.000
	LIF0	0.000	0.000	4756.372	0.000	0.000	0.000
	LIF1	0.000	0.000	10892.159	0.000	0.000	0.000
	LIF2	0.000	0.000	9655.398	0.000	0.000	0.000
	LIF3	0.000	0.000	8371.171	0.000	0.000	0.000
PHA4	LA10	0.000	0.000	3935.987	0.000	0.000	0.000
	LA11	0.000	0.000	9013.460	0.000	0.000	0.000
	LA12	0.000	0.000	7990.092	0.000	0.000	0.000
	LA13	0.000	0.000	6927.373	0.000	0.000	0.000
	LA50	0.000	0.000	5103.144	0.000	0.000	0.000
	LA51	0.000	0.000	11686.245	0.000	0.000	0.000
	LA52	0.000	0.000	10359.422	0.000	0.000	0.000
	LA53	0.000	0.000	8981.566	0.000	0.000	0.000
	LC10	0.000	0.000	3468.349	0.000	0.000	0.000
	LC11	0.000	0.000	7942.581	0.000	0.000	0.000
	LC12	0.000	0.000	7040.777	0.000	0.000	0.000
	LC13	0.000	0.000	6104.321	0.000	0.000	0.000
	LC50	0.000	0.000	4635.505	0.000	0.000	0.000
	LC51	0.000	0.000	10615.344	0.000	0.000	0.000
	LC52	0.000	0.000	9410.117	0.000	0.000	0.000
	LC53	0.000	0.000	8158.524	0.000	0.000	0.000
	LIF0	0.000	0.000	4530.966	0.000	0.000	0.000
	LIF1	0.000	0.000	10375.951	0.000	0.000	0.000
	LIF2	0.000	0.000	9197.898	0.000	0.000	0.000
	LIF3	0.000	0.000	7974.536	0.000	0.000	0.000

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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
PHC2	LA10	0.000	0.000	5095.047	0.000	0.000	0.000
	LA11	0.000	0.000	11667.698	0.000	0.000	0.000
	LA12	0.000	0.000	10342.913	0.000	0.000	0.000
	LA13	0.000	0.000	8967.251	0.000	0.000	0.000
	LA50	0.000	0.000	3944.704	0.000	0.000	0.000
	LA51	0.000	0.000	9033.423	0.000	0.000	0.000
	LA52	0.000	0.000	8007.715	0.000	0.000	0.000
	LA53	0.000	0.000	6942.644	0.000	0.000	0.000
	LC10	0.000	0.000	5554.408	0.000	0.000	0.000
	LC11	0.000	0.000	12719.596	0.000	0.000	0.000
	LC12	0.000	0.000	11275.444	0.000	0.000	0.000
	LC13	0.000	0.000	9775.739	0.000	0.000	0.000
	LC50	0.000	0.000	4404.064	0.000	0.000	0.000
	LC51	0.000	0.000	10085.359	0.000	0.000	0.000
	LC52	0.000	0.000	8940.214	0.000	0.000	0.000
	LC53	0.000	0.000	7751.121	0.000	0.000	0.000
	LIF0	0.000	0.000	4508.100	0.000	0.000	0.000
	LIF1	0.000	0.000	10323.604	0.000	0.000	0.000
	LIF2	0.000	0.000	9151.410	0.000	0.000	0.000
	LIF3	0.000	0.000	7934.221	0.000	0.000	0.000
PHC4	LA10	0.000	0.000	3839.898	0.000	0.000	0.000
	LA11	0.000	0.000	8793.410	0.000	0.000	0.000
	LA12	0.000	0.000	7795.032	0.000	0.000	0.000
	LA13	0.000	0.000	6758.257	0.000	0.000	0.000
	LA50	0.000	0.000	4990.242	0.000	0.000	0.000
	LA51	0.000	0.000	11427.685	0.000	0.000	0.000
	LA52	0.000	0.000	10130.232	0.000	0.000	0.000
	LA53	0.000	0.000	8782.861	0.000	0.000	0.000
	LC10	0.000	0.000	4307.537	0.000	0.000	0.000
	LC11	0.000	0.000	9864.305	0.000	0.000	0.000
	LC12	0.000	0.000	8744.334	0.000	0.000	0.000
	LC13	0.000	0.000	7581.298	0.000	0.000	0.000
	LC50	0.000	0.000	5457.880	0.000	0.000	0.000
	LC51	0.000	0.000	12498.560	0.000	0.000	0.000
	LC52	0.000	0.000	11079.546	0.000	0.000	0.000
	LC53	0.000	0.000	9605.907	0.000	0.000	0.000
	LIF0	0.000	0.000	4751.295	0.000	0.000	0.000
	LIF1	0.000	0.000	10880.496	0.000	0.000	0.000
	LIF2	0.000	0.000	9645.170	0.000	0.000	0.000
	LIF3	0.000	0.000	8362.316	0.000	0.000	0.000

Maximum ULS vertical reactions at trunnion is 12997.63 kN = 1325 tons for LCOMB LA11 at lifting point A2. The structural check of the Trunnion (and connected elements), presented in ref. /24/, is performed using 1282 ton calculated in previous Rev. 0, hence the new load is 3% greater than the old one.

The checks carried out in report ref. /24/ using FE model are still considered valid, as the new load is calculated with approximately 5% more topside weight compared to WCR.

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
U010	LA10	-0.000	0.000	0.000	0.000	0.000	0.000
	LA11	-0.000	0.000	0.000	0.000	0.000	0.000
	LA12	-0.000	0.000	0.000	0.000	0.000	0.000
	LA13	-0.000	0.000	0.000	0.000	0.000	0.000
	LA50	-0.000	0.000	0.000	0.000	0.000	0.000
	LA51	-0.000	0.000	0.000	0.000	0.000	0.000
	LA52	-0.000	0.000	0.000	0.000	0.000	0.000
	LA53	-0.000	0.000	0.000	0.000	0.000	0.000
	LC10	-0.000	0.000	0.000	0.000	0.000	0.000
	LC11	-0.000	0.000	0.000	0.000	0.000	0.000
	LC12	-0.000	0.000	0.000	0.000	0.000	0.000
	LC13	-0.000	0.000	0.000	0.000	0.000	0.000
	LC50	-0.000	0.000	0.000	0.000	0.000	0.000
	LC51	-0.000	0.000	0.000	0.000	0.000	0.000

	LC52	-0.000	0.000	0.000	0.000	0.000	0.000
	LC53	-0.000	0.000	0.000	0.000	0.000	0.000
	LIF0	-0.000	0.000	0.000	0.000	0.000	0.000
	LIF1	-0.000	0.000	0.000	0.000	0.000	0.000
	LIF2	-0.000	0.000	0.000	0.000	0.000	0.000
	LIF3	-0.000	0.000	0.000	0.000	0.000	0.000
U020	LA10	0.000	0.000	0.000	0.000	0.000	0.000
	LA11	0.000	0.000	0.000	0.000	0.000	0.000
	LA12	0.000	0.000	0.000	0.000	0.000	0.000
	LA13	0.000	0.000	0.000	0.000	0.000	0.000
	LA50	0.000	0.000	0.000	0.000	0.000	0.000
	LA51	0.000	0.000	0.000	0.000	0.000	0.000
	LA52	0.000	0.000	0.000	0.000	0.000	0.000
	LA53	0.000	0.000	0.000	0.000	0.000	0.000
	LC10	0.000	0.000	0.000	0.000	0.000	0.000
	LC11	0.000	0.000	0.000	0.000	0.000	0.000
	LC12	0.000	0.000	0.000	0.000	0.000	0.000
	LC13	0.000	0.000	0.000	0.000	0.000	0.000
	LC50	0.000	0.000	0.000	0.000	0.000	0.000
	LC51	0.000	0.000	0.000	0.000	0.000	0.000
	LC52	0.000	0.000	0.000	0.000	0.000	0.000
	LC53	0.000	0.000	0.000	0.000	0.000	0.000
	LIF0	0.000	0.000	0.000	0.000	0.000	0.000
	LIF1	0.000	0.000	0.000	0.000	0.000	0.000
	LIF2	0.000	0.000	0.000	0.000	0.000	0.000
	LIF3	0.000	0.000	0.000	0.000	0.000	0.000

12.1.1 Trunnion check

Trunnion joints were checked for lifting conditions according to ISO 19902 Ref./6/ and UNI EN 1993 refs. /8/,/10/. Checks are reported in dedicated calculation report *BLPH Platform – Joint Check Design Report* Ref./24/.

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

12.2.1.1 Members framing into lifting points: consequence factor of 1.30

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 0.40 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
U005-U236	B06	0.472	LC11	0.0	-8.09	-116.97	-24.41	72.60	1024.46	18.7	41.4	0.443	LA11	0.441	LC51
U015-U033	B06	0.418	LC51	0.0	-7.58	-108.93	6.40	-4.56	903.15	18.7	41.4	0.396	LA51	0.395	LIF1
U037-U004	B06	0.423	LC11	0.0	0.85	-7.90	16.34	-44.65	1000.33	18.7	41.4	0.405	LC51	0.402	LA11
U236-U037	B06	0.425	LC11	0.0	0.85	-37.92	26.80	-44.65	1005.31	18.7	41.4	0.407	LC51	0.404	LA11
U242-U003	B06	0.452	LA11	1.5	-7.08	-110.13	-29.55	-76.52	-929.34	18.7	41.4	0.427	LA51	0.426	LIF1
U001-U072	B21	0.494	LA11	0.7	-36.35	-36.28	-9.31	63.16	-2863.85	18.4	20.2	0.482	LA51	0.462	LIF1
U070-U011	B21	0.435	LC51	0.0	-27.70	-27.91	0.96	-11.74	2521.07	18.4	20.2	0.415	LC11	0.385	LIF1
U071-U001	B21	0.463	LC11	0.0	-36.13	-32.94	-8.94	-64.28	2685.54	18.4	20.2	0.448	LC51	0.408	LIF1

PEA2-PFA2 C06	0.469	LA11	0.0	178.56	0.00	0.00	-0.00	0.00	10.3	10.3	0.431	LC11	0.393	LIF1
PEA4-PFA4 C06	0.421	LA51	0.0	160.49	0.00	0.00	-0.00	0.00	10.3	10.3	0.383	LC51	0.374	LIF1
PEC2-PFC2 C06	0.459	LC11	0.0	174.73	0.00	0.00	0.00	0.00	10.3	10.3	0.421	LA11	0.372	LIF1
PEC4-PFC4 C06	0.451	LC51	0.0	171.68	0.00	0.00	0.00	0.00	10.3	10.3	0.412	LA51	0.392	LIF1
U003-PEA2 C06	0.469	LA11	0.2	178.55	0.00	0.00	0.00	0.00	10.3	10.3	0.431	LC11	0.393	LIF1
U005-PEC2 C06	0.459	LC11	0.2	174.72	0.00	0.00	0.00	-0.00	10.3	10.3	0.421	LA11	0.372	LIF1
U013-PEA4 C06	0.421	LA51	0.2	160.48	0.00	0.00	0.00	0.00	10.3	10.3	0.383	LC51	0.374	LIF1
U015-PEC4 C06	0.451	LC51	0.2	171.67	0.00	0.00	0.00	-0.00	10.3	10.3	0.412	LA51	0.392	LIF1
L003-U003 C20	0.472	LA11	1.2	125.42	51.58	148.84	-539.68	-118.42	24.6	24.6	0.430	LC11	0.402	LIF1
L005-U005 C20	0.504	LC11	1.2	130.94	42.08	-161.62	588.62	-52.63	24.6	24.6	0.462	LA11	0.423	LIF1
L013-U013 C20	0.404	LA51	1.2	136.37	-13.45	114.60	-419.34	-15.80	24.6	24.6	0.360	LC51	0.358	LIF1
L015-U015 C20	0.487	LC51	1.2	122.55	-44.27	-161.33	560.19	66.92	24.6	24.6	0.447	LA51	0.432	LIF1

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

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

** NO UNITY CHECKS IN THIS GROUP **

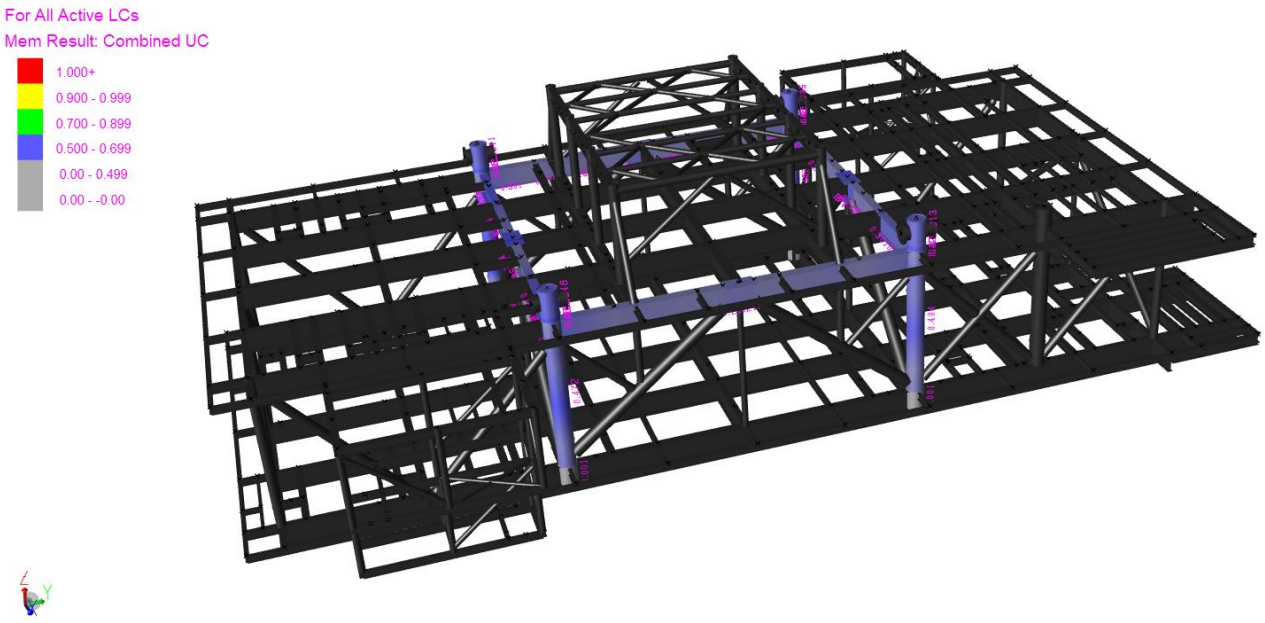


Figure 12.1 - Topside Structural Model for members framing to lifting points- 3D view

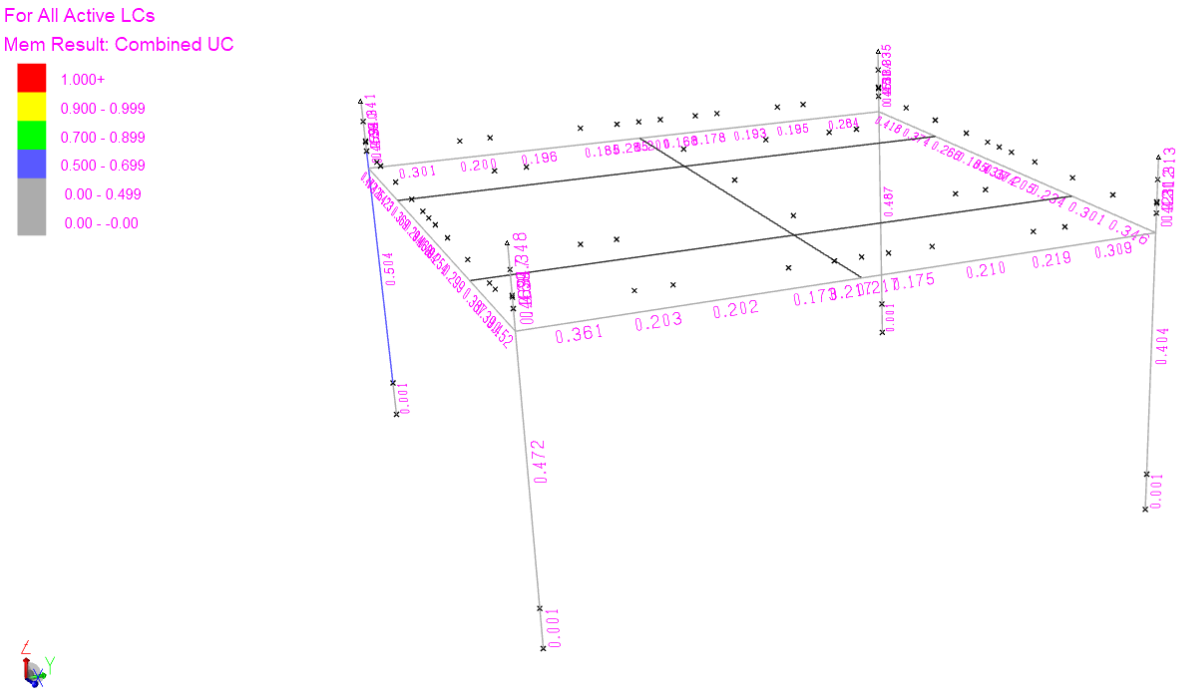


Figure 12.2 - Topside Structural Model for members framing to lifting points- UC

Maximum UC per member's group is 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 / EC3:2005

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
B06	U005-U236	LC11	0.47	0.0	-8.1	-117.0	-24.4	240.7	1178.8	286.4	823.7	BN+COM	8.00	4.00	0.69	0.40
B07	U003-U247	LA11	0.36	0.0	55.9	-80.7	-3.9	363.6	2358.6	405.0	555.1	BN+AX	8.00	3.50	0.00	0.00
B20	U076-U078	LA11	0.29	0.0	12.8	-19.1	2.1	363.6	3585.1	397.0	549.8	SHEAR	8.00	4.50	0.00	0.00
B21	U001-U072	LA11	0.49	0.7	-36.3	-36.3	-9.3	363.6	4963.0	399.8	551.4	SHEAR	8.00	4.00	0.40	0.86
C06	PEA2-PFA2	LA11	0.47	0.0	178.6	0.0	0.0	.4E+03	.2E+05	.5E+03	.5E+03	TEN	2.80	2.80	0.85	0.85
C20	L005-U005	LC11	0.50	1.2	130.9	42.1	-161.6	381.0	3330.5	461.8	461.8	TN+BN	7.00	7.00	0.85	0.85
CT7	PGA2-PHA2	LA11	0.35	0.5	132.6	0.0	0.0	.4E+03	.2E+05	.5E+03	.5E+03	TEN	2.80	2.80	0.85	0.85
TS1	TU04-L015	LA11	0.00	1.0	0.2	0.0	0.0	.4E+03	.1E+06	.5E+03	.5E+03	TEN	1.00	1.00	0.85	0.85

12.2.1.2 Members not directly framing into lifting points: consequence factor of 1.15

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

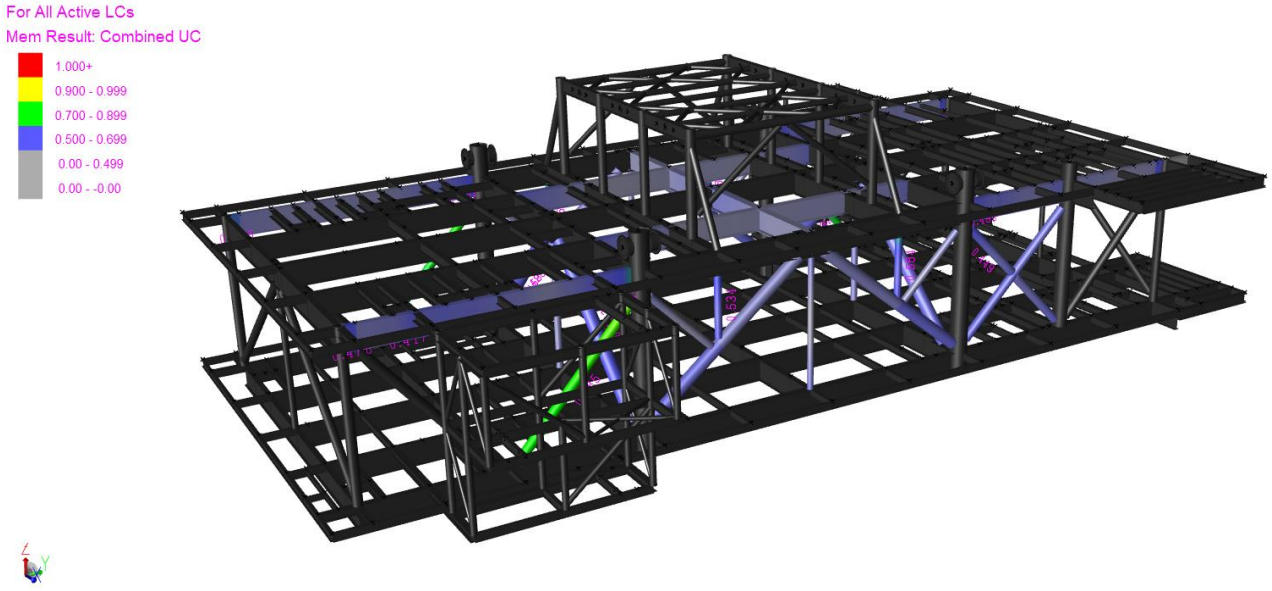
GROUP II - UNITY CHECKS GREATER THAN 0.60 AND LESS THAN 0.90

HIGHEST 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
U015-U064	B15	0.671	LC52	0.0	12.38	-202.09	2.55	1.27	631.07	31.3	104.0	0.605	LA52	0.594	LIF2
U116-U003	B15	0.685	LA12	2.0	12.86	-264.54	19.04	17.47	-850.21	31.3	104.0	0.642	LC12	0.593	LIF2
D004-U023	D03	0.624	LC52	2.7	-101.33	-56.75	129.47	68.45	-39.04	24.6	24.6	0.599	LA52	0.581	LIF2
L033-U003	D05	0.785	LA12	7.6	268.89	-36.27	25.43	6.98	-13.30	54.9	54.9	0.586	LC12	0.510	LIF2
L110-U005	D05	0.748	LC12	7.6	255.82	-45.51	-27.30	-7.10	-15.74	54.9	54.9	0.548	LA12	0.432	LC52
L113-U015	D05	0.746	LC52	7.6	257.31	-43.26	23.86	7.44	-15.20	54.9	54.9	0.547	LA52	0.510	LIF2

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

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

** NO UNITY CHECKS IN THIS GROUP **



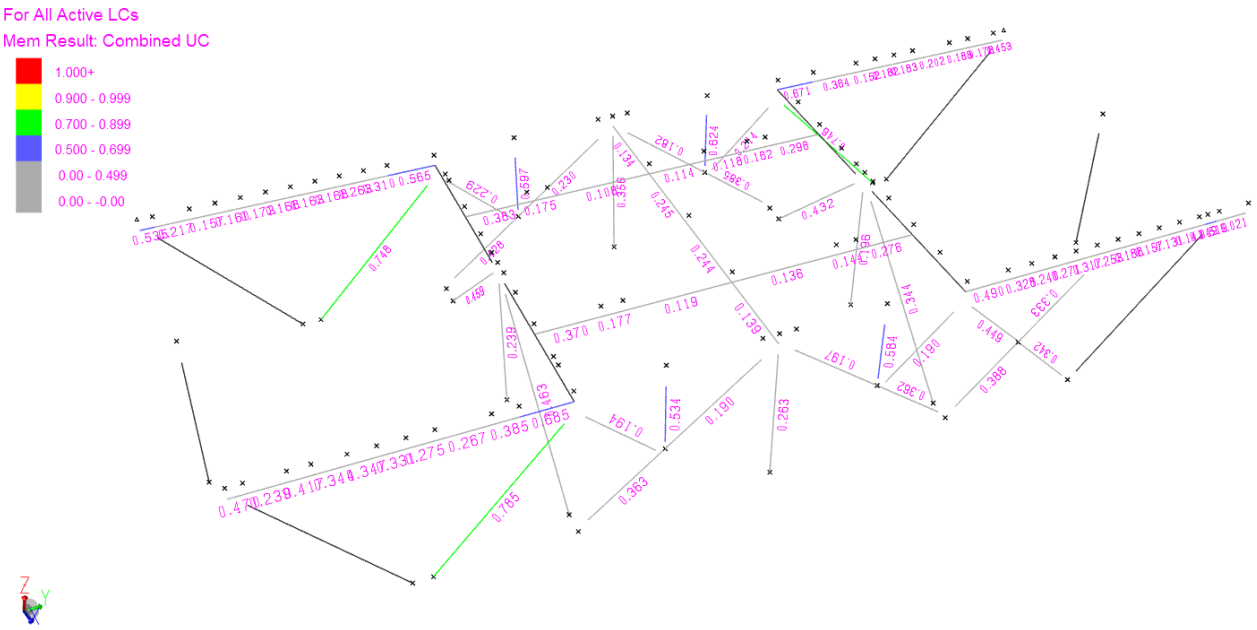


Figure 12.3 - Topside Structural Model for members not directly framing to lifting points - 3D view

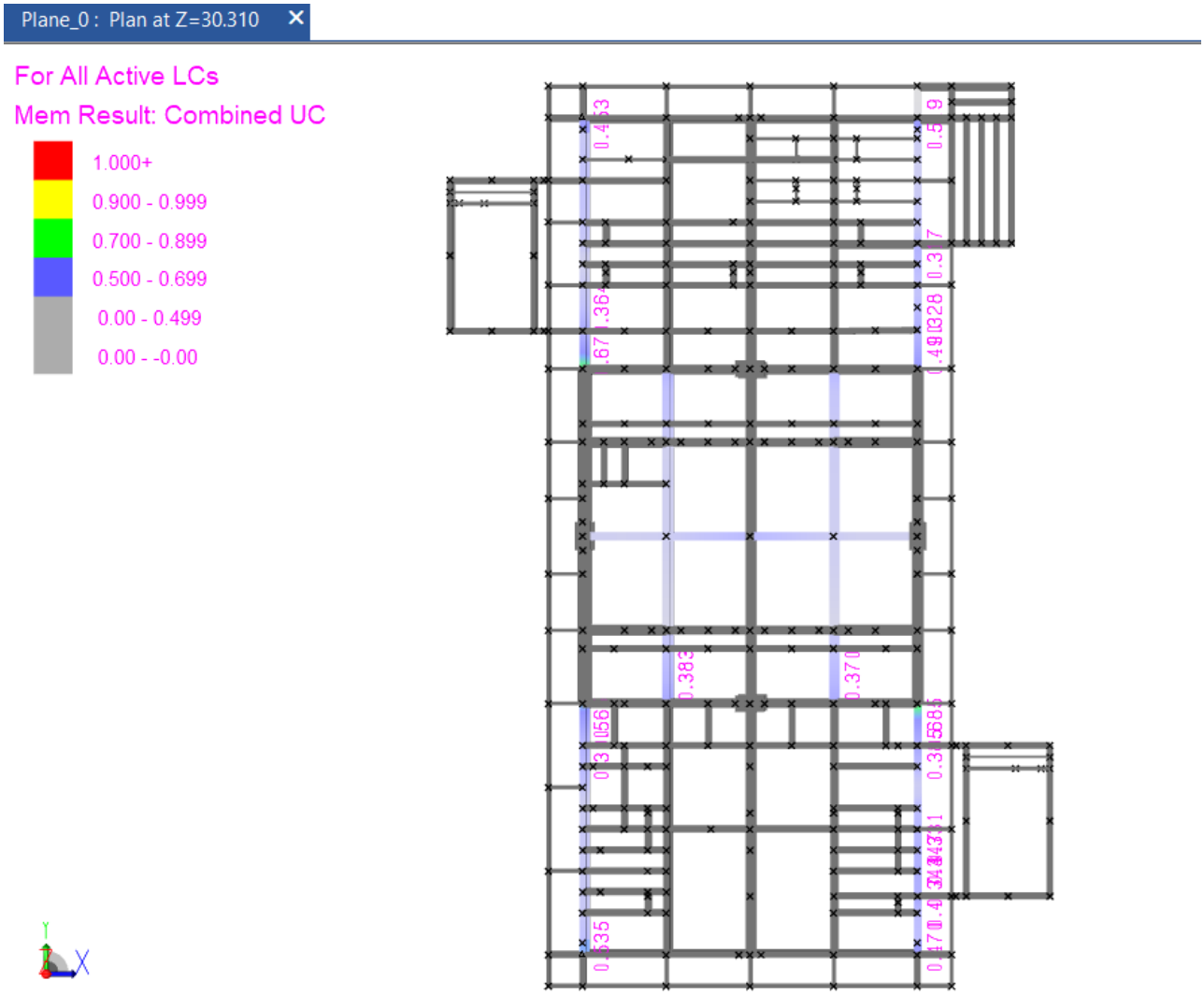


Figure 12.4 - Topside Structural Model for members not directly framing to lifting points- UC>0.3 – Upper deck

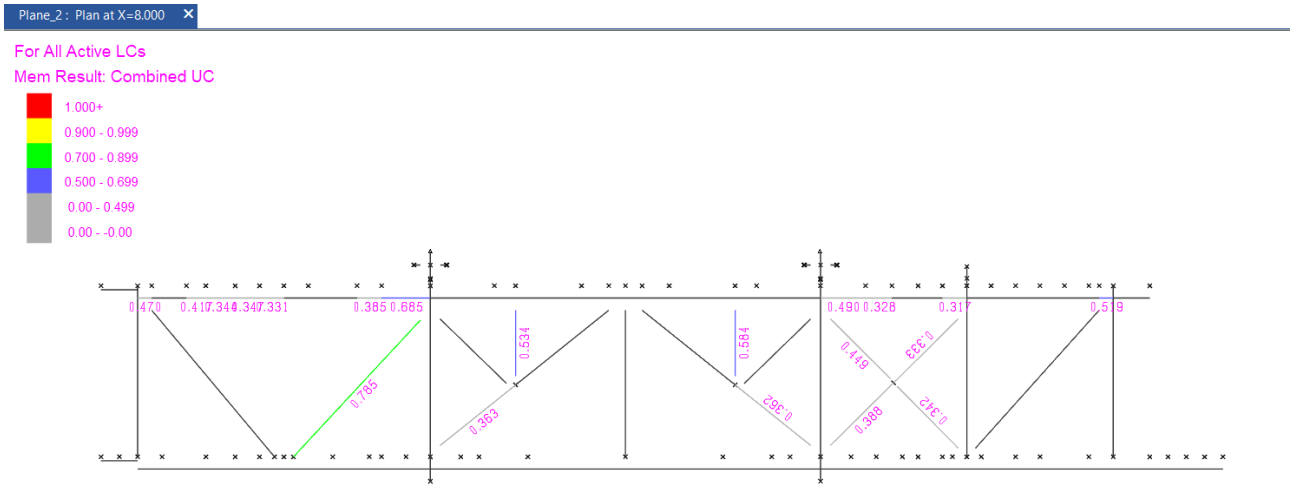


Figure 12.5 - Topside Structural Model for members not directly framing to lifting points- UC>0.3 – Row A

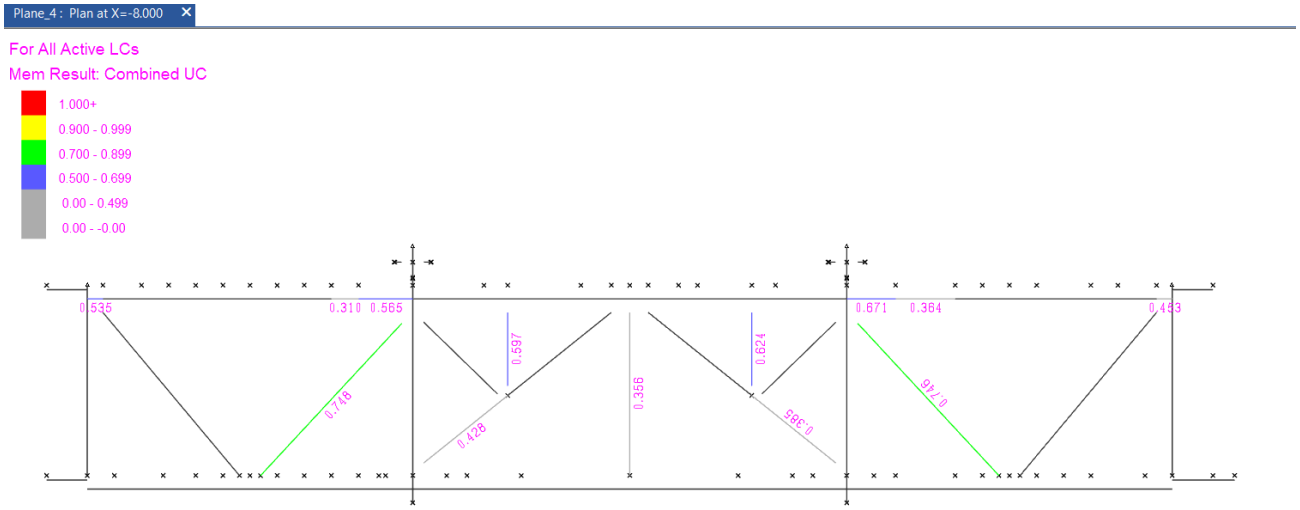


Figure 12.6 - Topside Structural Model for members not directly framing to lifting points- UC>0.3 – Row C

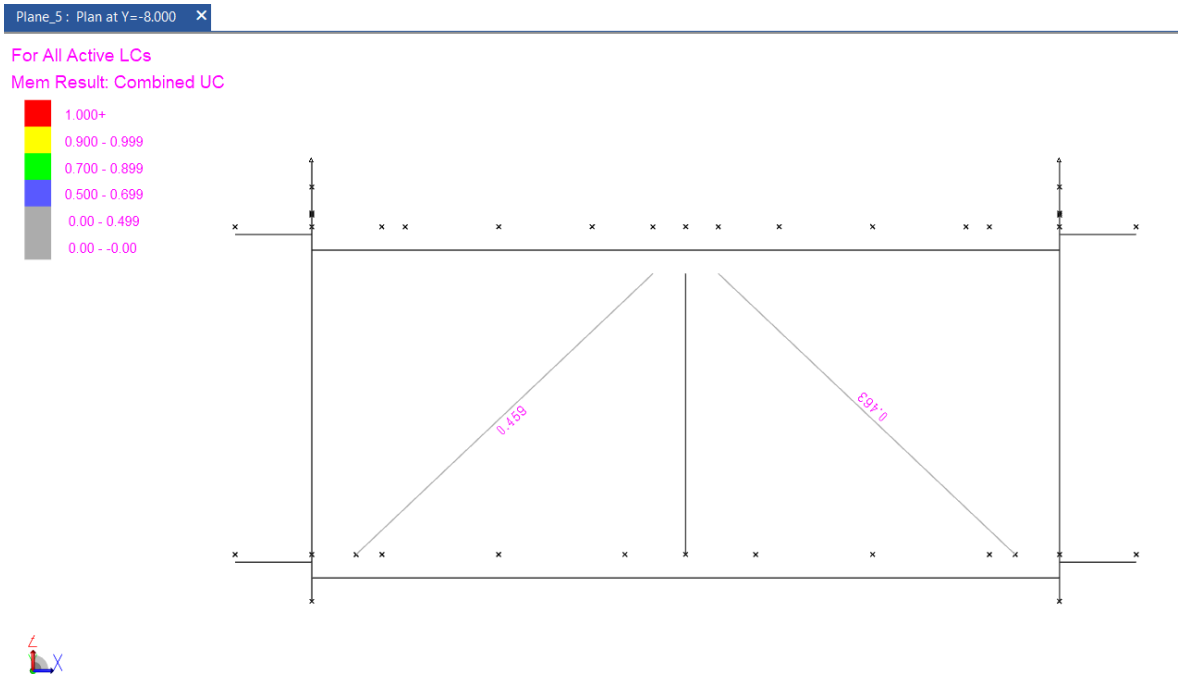


Figure 12.7 - Topside Structural Model for members not directly framing to lifting points- UC>0.3 – Row 2

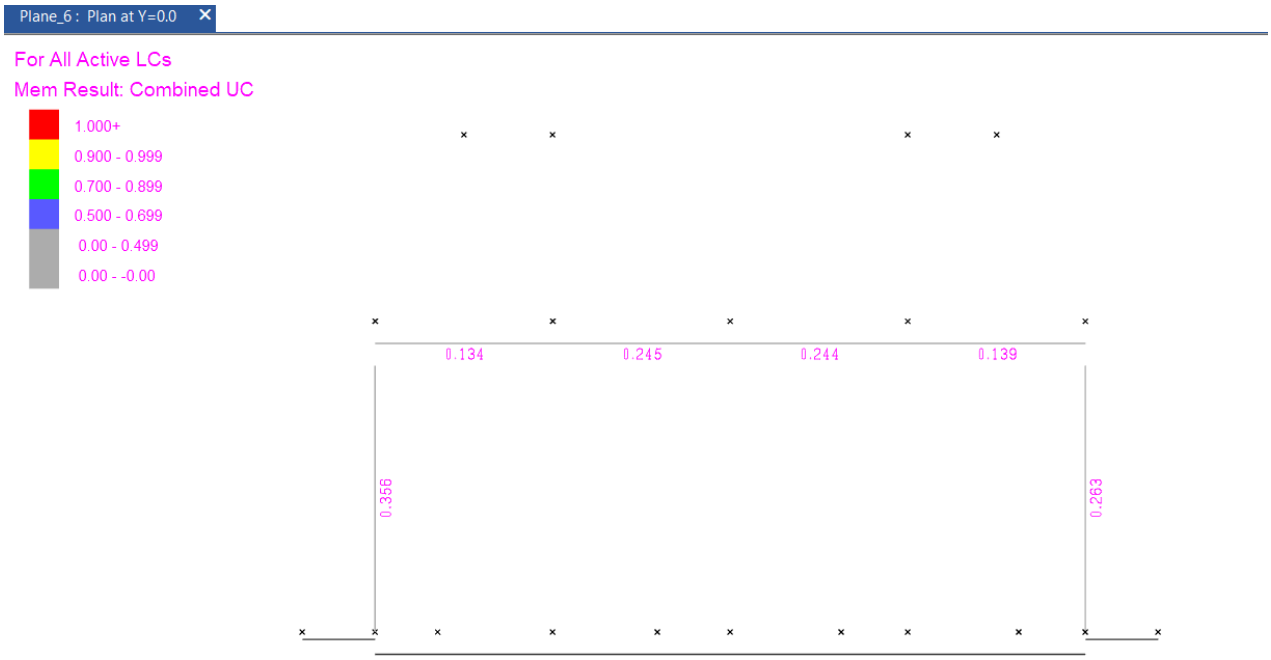


Figure 12.8 - Topside Structural Model for members not directly framing to lifting points- UC>0 – Row 3

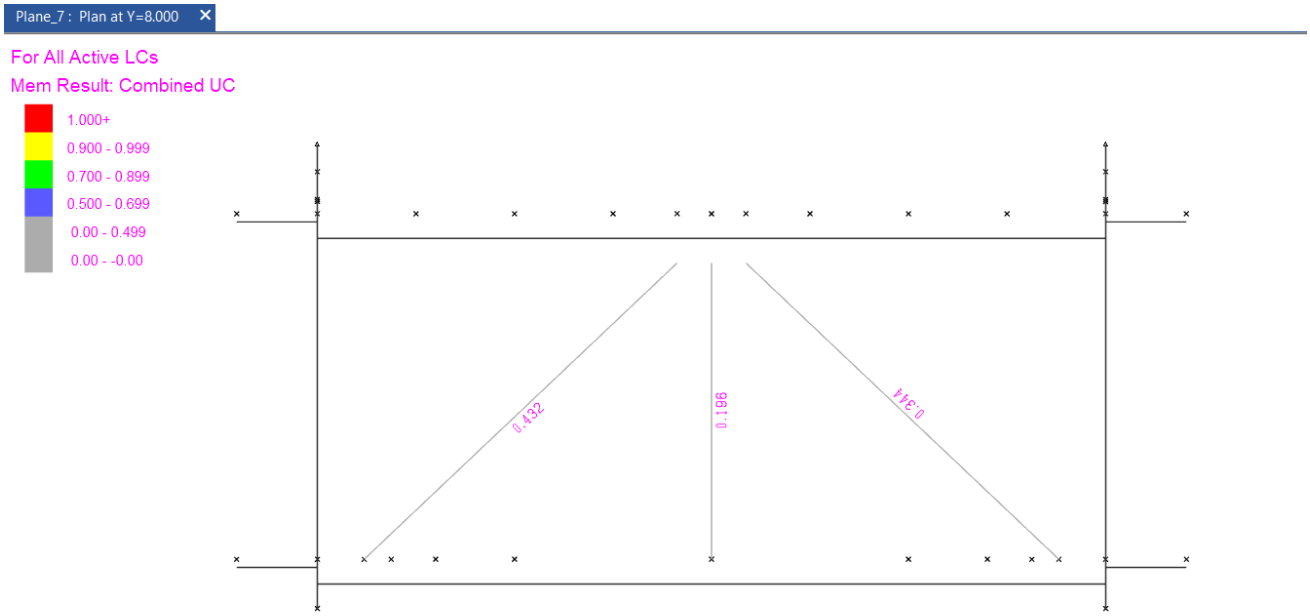


Figure 12.9 - Topside Structural Model for members not directly framing to lifting points- UC>0 – Row 4

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 / EC3:2005

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
B06	U004-U244	LC12	0.38	0.0	20.6	-123.3	10.9	363.6	1441.0	403.6	553.9	BN+AX	16.00	3.50	0.00	0.00
B15	U116-U003	LA12	0.68	2.0	12.9	-264.5	19.0	363.6	187.0	430.5	588.2	BN+AX	12.00	6.00	0.00	0.00
C03	L021-U078	LC12	0.36	0.0	46.3	-21.9	-147.6	338.1	482.6	448.2	448.2	TN+BN	6.00	6.00	0.85	0.85
D01	L005-D003	LC12	0.43	0.0	-85.3	-27.6	68.9	296.1	878.3	498.6	498.6	ACBI	9.00	9.00	0.85	0.85
D03	D004-U023	LC52	0.62	2.7	-101.3	-56.7	129.5	292.0	3352.8	447.5	447.5	ACBI	2.71	2.71	0.85	0.85
D04	L203-U072	LA12	0.46	0.0	-114.6	44.6	-9.0	305.2	1116.1	490.8	490.8	ACBI	8.74	8.74	0.85	0.85
D05	L033-U003	LA12	0.79	7.6	268.9	-36.3	25.4	338.1	670.8	438.3	438.3	TN+BN	7.65	7.65	0.85	0.85
D06	U013-0002	LA52	0.45	0.0	141.7	-92.7	53.9	338.1	3176.4	447.5	447.5	TN+BN	3.49	3.49	0.85	0.85
D16	L001-U001	LA12	0.24	6.0	104.3	-55.5	-10.0	338.1	655.4	456.2	456.2	TN+BN	6.00	6.00	0.85	0.85
D36	L013-0002	LA52	0.39	0.0	-76.1	-33.8	56.0	290.4	2829.5	452.6	452.6	ACBI	3.65	3.65	0.85	0.85

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12.2.1.3 Other members: consequence factor of 1.00

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 or equal to 1.0.

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

GROUP II - UNITY CHECKS GREATER THAN 0.60 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
L033-L238	B01	0.609	LA13	0.0	-94.60	-9.59	0.55	7.04	87.41	15.1	72.5	0.570	LC13	0.488	LIF3
L048-L210	B01	0.652	LA13	0.0	-72.23	-36.94	-48.00	66.11	-206.35	15.1	72.5	0.566	LC13	0.492	LIF3
L110-L555	B01	0.626	LC13	0.0	-84.61	-18.67	7.13	1.34	48.22	15.1	72.5	0.537	LA13	0.443	LIF3
L168-LD06	B01	0.660	LC13	0.7	-69.76	-48.36	3.86	11.88	-87.62	15.1	72.5	0.554	LA13	0.465	LIF3
L183-LD02	B01	0.643	LA53	0.7	-35.60	-54.78	11.07	41.96	-194.96	20.1	96.6	0.556	LC53	0.543	LIF3
L184-LD01	B01	0.699	LC53	0.7	-21.03	-81.22	-16.96	-41.45	-286.79	20.1	96.6	0.595	LA53	0.559	LIF3
L190-L077	B01	0.627	LA13	0.0	-36.28	-54.79	-12.41	8.13	193.26	20.1	96.6	0.539	LC13	0.489	LIF3
L238-L262	B01	0.637	LA13	1.5	-85.00	-14.86	-28.48	-33.77	-9.00	15.1	72.5	0.542	LC13	0.482	LIF3
L262-L048	B01	0.693	LA13	0.0	-79.60	-23.37	-28.47	13.65	-45.24	15.1	72.5	0.595	LC13	0.538	LIF3
L519-L168	B01	0.615	LC13	1.0	-84.44	-20.21	-4.09	-5.88	-48.59	15.1	72.5	0.518	LA13	0.429	LIF3
L555-L199	B01	0.622	LC13	0.0	-84.60	-16.51	7.74	-2.11	16.81	15.1	72.5	0.535	LA13	0.440	LIF3
LD04-L190	B01	0.758	LA13	0.0	-31.68	-75.99	21.00	-60.84	234.71	20.1	96.6	0.657	LC13	0.583	LIF3
LD05-L185	B01	0.723	LC13	0.0	-20.20	-87.21	-13.69	50.39	291.88	20.1	96.6	0.622	LA13	0.508	LIF3
L001-L187	B02	0.759	LC13	0.0	-25.97	-114.70	-9.76	11.95	478.09	38.8	90.6	0.750	LA13	0.683	LIF3
L002-L178	B02	0.657	LA13	0.4	-28.12	-75.33	-8.88	6.84	266.32	38.8	90.6	0.628	LC13	0.593	LIF3
L004-L186	B02	0.637	LC13	0.0	-25.17	-95.15	6.59	-3.83	477.36	38.8	90.6	0.588	LA13	0.545	LIF3
L180-L014	B02	0.722	LC53	2.0	-24.47	-109.46	12.55	9.19	-488.46	38.8	90.6	0.673	LA53	0.649	LIF3
L181-L011	B02	0.892	LC53	2.0	-26.49	-140.79	-11.30	-9.54	-582.46	38.8	90.6	0.882	LA53	0.848	LIF3
L011-L040	B03	0.757	LC53	0.0	-26.84	-183.50	-27.27	18.56	676.35	30.1	96.6	0.746	LA53	0.721	LIF3
L014-L059	B03	0.637	LC53	0.0	-28.75	-135.97	-3.91	1.26	445.26	30.1	96.6	0.579	LA53	0.563	LIF3
L216-L001	B03	0.685	LC13	1.0	-27.10	-152.99	-11.41	-6.74	-467.86	30.1	96.6	0.680	LA13	0.625	LIF3
L522-L004	B03	0.608	LC13	1.0	-30.41	-116.78	-9.98	-3.81	-343.38	30.1	96.6	0.555	LA13	0.506	LIF3
L045-L255	B04	0.649	LC13	2.0	9.74	99.25	14.58	10.07	166.71	31.7	129.5	0.632	LC53	0.625	LA13
L230-L234	B04	0.792	LA53	0.4	9.65	104.44	-14.76	-7.43	70.90	31.7	129.5	0.791	LA13	0.784	LIF3
L234-L133	B04	0.796	LA13	0.0	7.08	113.60	-16.51	20.73	-256.50	31.7	129.5	0.785	LA53	0.782	LIF3
L255-L230	B04	0.756	LA13	0.6	11.50	102.56	-6.50	-4.63	62.25	31.7	129.5	0.748	LA53	0.744	LIF3
U001-U245	B12	0.768	LC13	0.0	6.84	-258.25	-0.26	0.17	1040.88	38.8	39.6	0.768	LA13	0.740	LIF3
U081-U127	B12	0.705	LA53	2.2	13.80	166.95	1.57	0.58	84.57	29.1	68.0	0.703	LC53	0.689	LIF3
U127-U130	B12	0.692	LA53	0.0	13.79	166.98	1.57	0.48	-331.92	29.1	68.0	0.690	LC53	0.675	LIF3
U233-U001	B12	0.711	LC13	2.0	3.97	-266.63	-8.14	-9.62	-1240.92	29.1	22.7	0.711	LA13	0.687	LIF3
U014-U087	B13	0.635	LC53	0.0	22.07	-136.59	8.81	-3.98	307.40	30.1	96.6	0.614	LA53	0.592	LIF3
U006-U069	B14	0.746	LC13	0.5	-57.05	-61.70	-6.81	0.05	-680.32	21.1	86.4	0.702	LC53	0.671	LA13
U068-U006	B14	0.756	LA13	0.0	-58.52	-58.92	-10.87	-1.60	668.08	21.1	86.4	0.712	LA53	0.700	LIF3
L003-LD04	B31	0.713	LA13	0.0	-24.51	-71.75	48.73	-60.84	253.56	19.3	86.9	0.623	LC13	0.572	LIF3
L005-LD05	B31	0.677	LC13	0.0	-15.63	-83.87	-38.05	50.39	310.73	19.3	86.9	0.586	LA13	0.503	LIF3

LD01-L015 B31	0.652	LC53	1.2	-16.27	-79.23	-34.86	-41.45	-305.65	19.3	86.9	0.560	LA53	0.536	LIF3
L126-L033 B32	0.612	LA13	0.4	-24.32	-79.09	-4.69	13.09	-2581.40	14.3	43.4	0.502	LC13	0.465	LIF3
L049-U169 D05	0.744	LA13	1.6	-179.14	14.81	2.06	-1.28	0.15	56.2	56.2	0.577	LC13	0.531	LIF3
L050-U170 D05	0.851	LC13	7.8	-180.24	-52.98	-0.38	0.86	-24.40	56.2	56.2	0.639	LA13	0.540	LC53
L154-U152 D05	0.732	LC53	7.8	-162.40	-35.92	-2.66	-0.98	-19.45	56.2	56.2	0.528	LA53	0.502	LIF3
L00B-Y000 IP3	0.814	LA13	0.0	-0.67	-0.46	260.20	-74.96	54.57	26.3	12.7	0.674	LA53	0.671	LIF3
L305-L070 S03	0.679	LA53	0.0	1.38	24.55	2.72	-1.14	-9.73	29.2	45.1	0.677	LA13	0.675	LIF3

SACS-IV MEMBER UNITY CHECK RANGE SUMMARY

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

** NO UNITY CHECKS IN THIS GROUP **

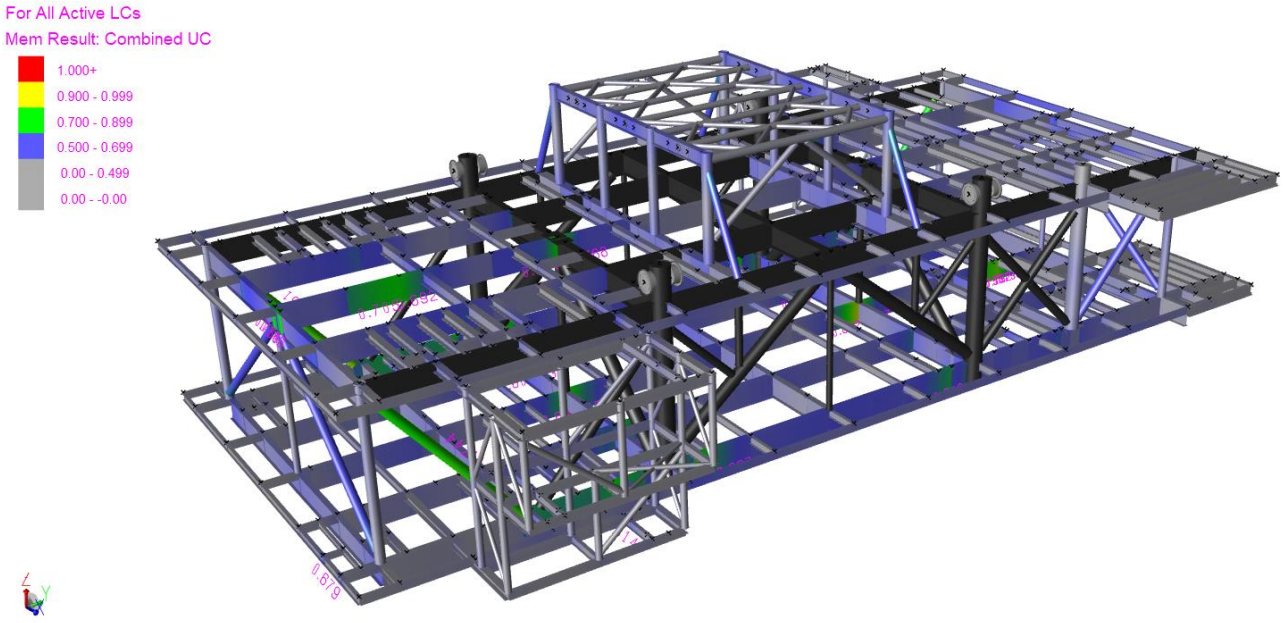


Figure 12.10 - Topside Structural Model for other members - 3D view

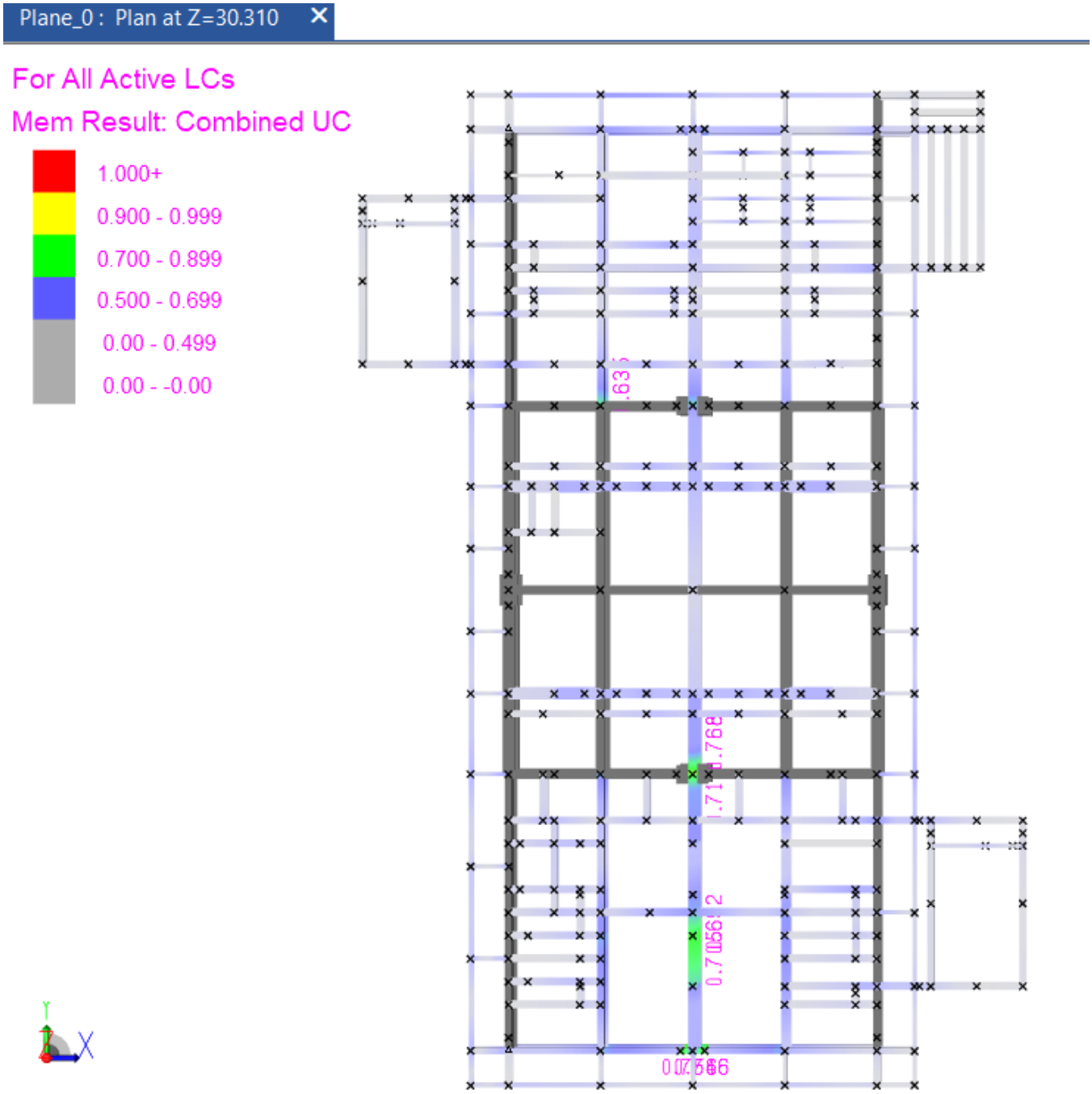


Figure 12.11 - Topside Structural Model for members framing to lifting points- UC>0.6 – Upper deck

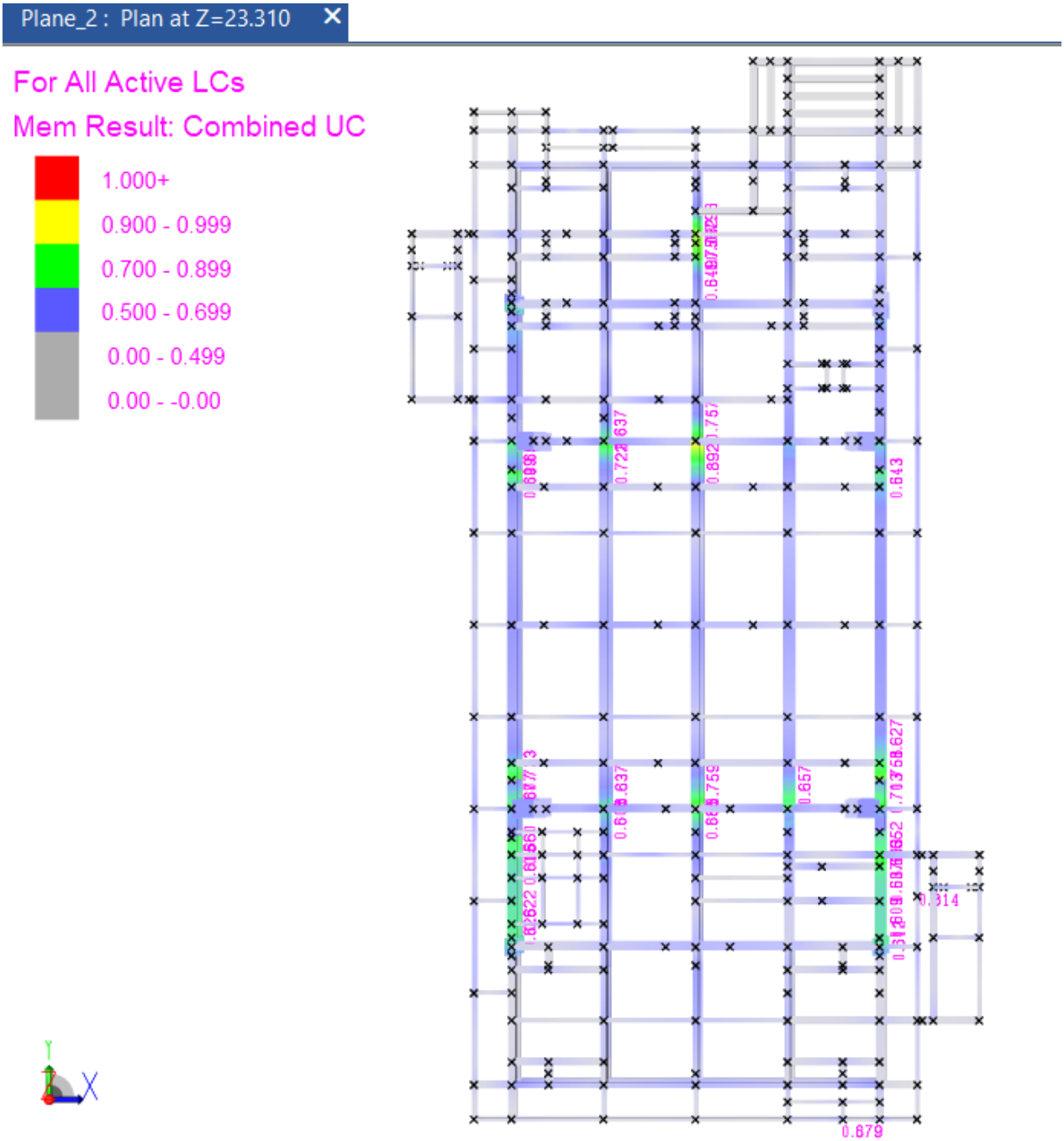


Figure 12.12 - Topside Structural Model for other members - UC>0.6 – Lower deck

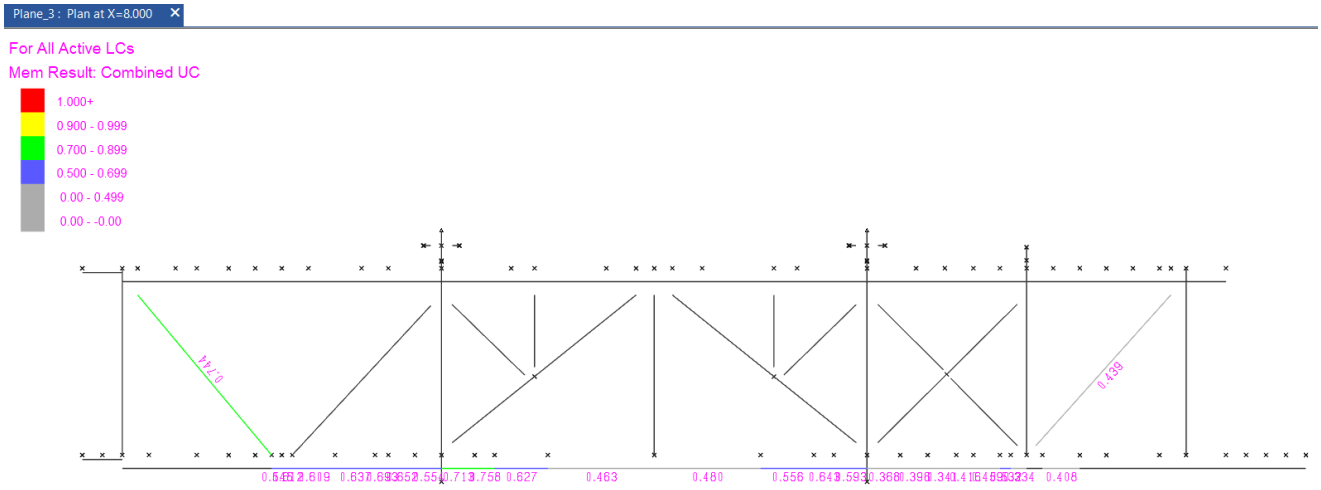


Figure 12.13 - Topside Structural Model for other members - UC>0.4 – Row A

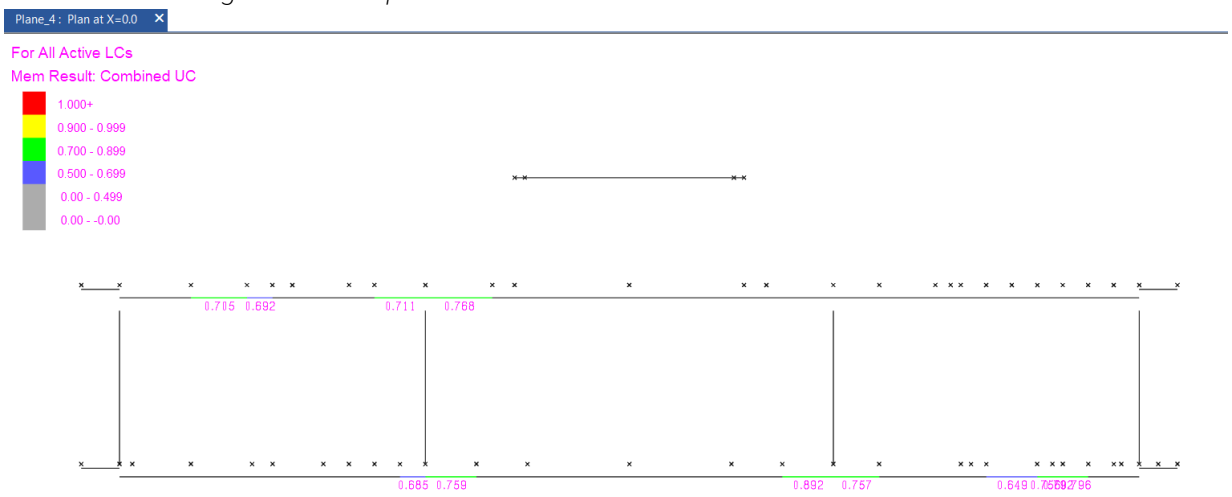


Figure 12.14 - Topside Structural Model for other members - UC>0.6 – Row B

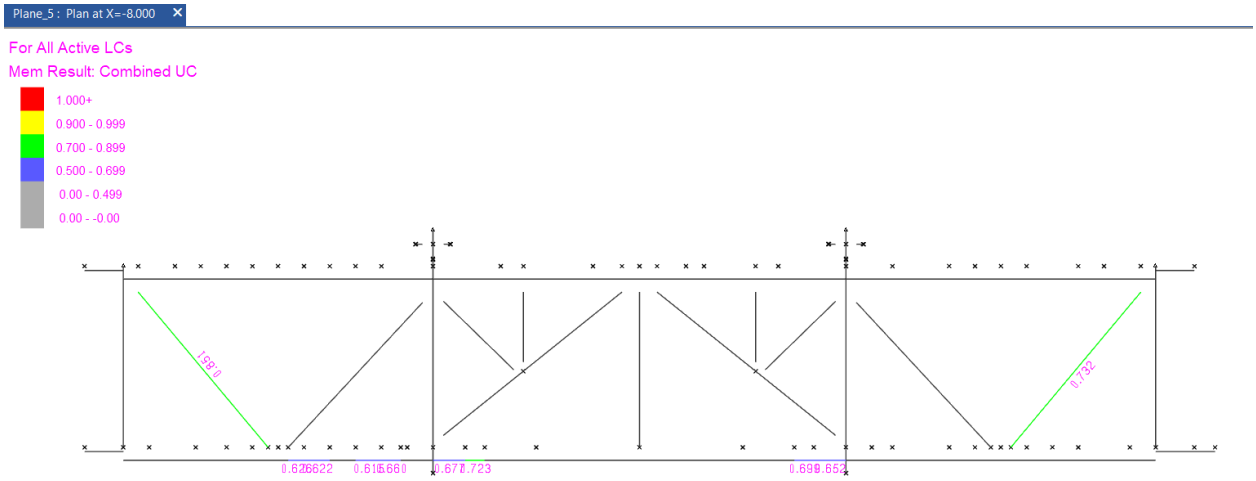


Figure 12.15 - Topside Structural Model for other members - UC>0.6 – Row C

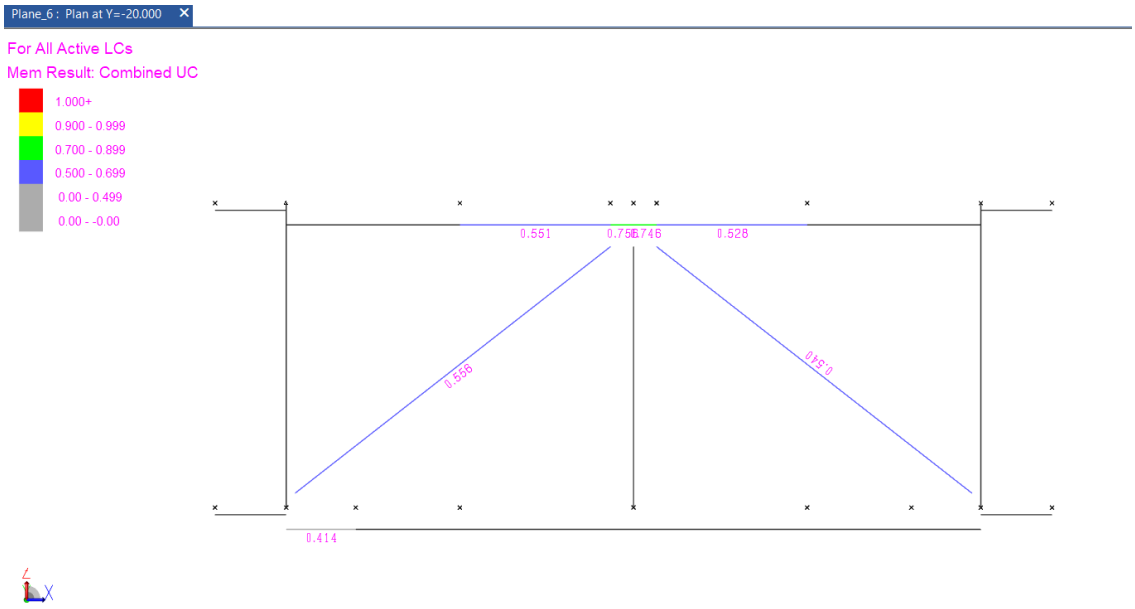


Figure 12.16 - Topside Structural Model for other members - UC>0.4 – Row 1

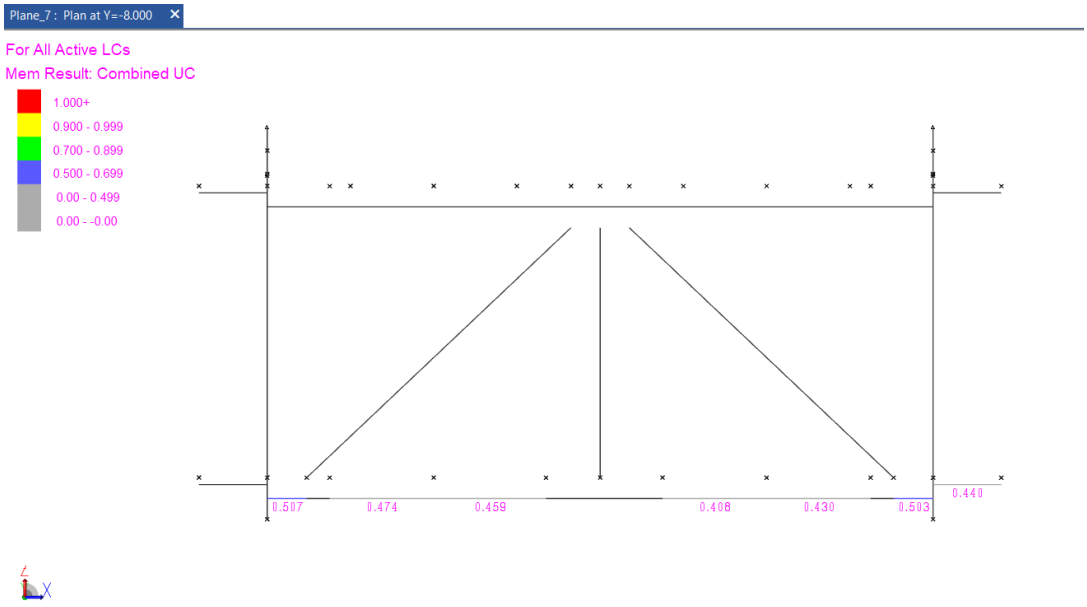


Figure 12.17 - Topside Structural Model for other members - UC>0.4 – Row 2

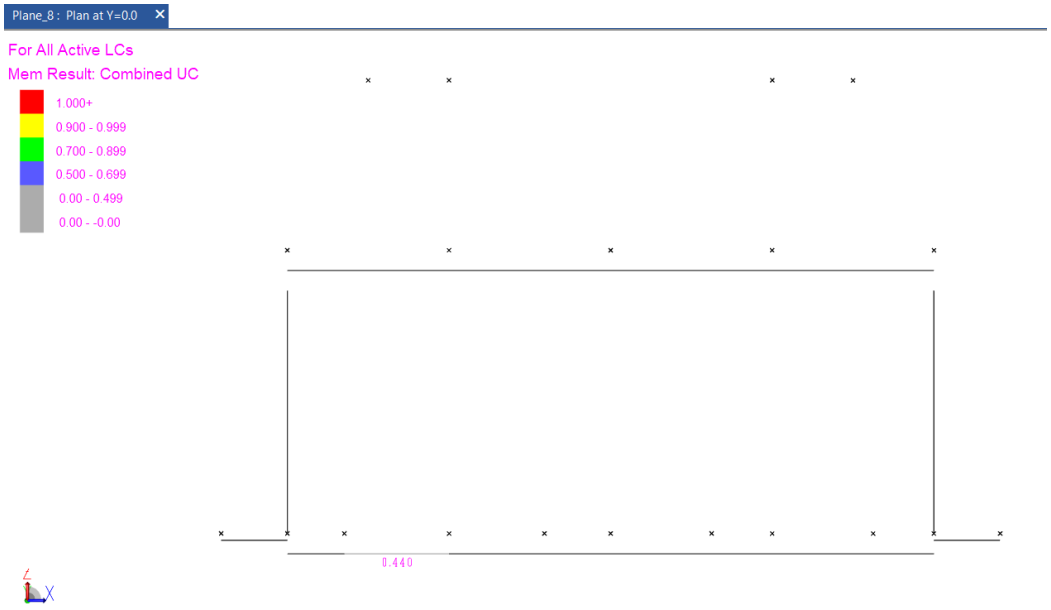


Figure 12.18 - Topside Structural Model for other members - UC>0.4 – Row 3

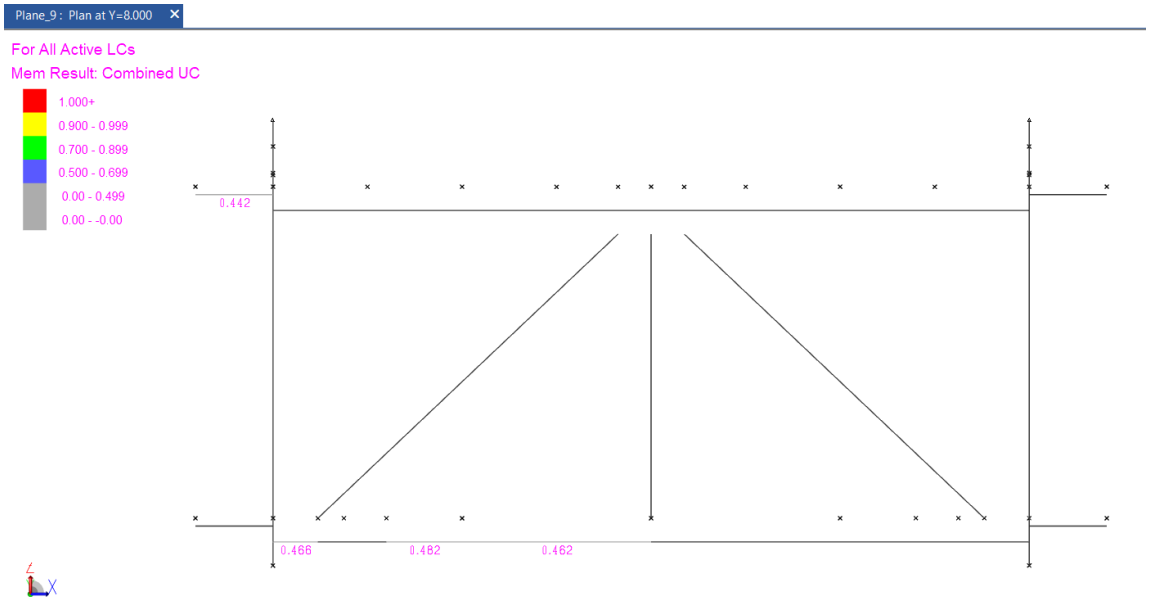


Figure 12.19 - Topside Structural Model for other members - UC>0.4 – Row 4

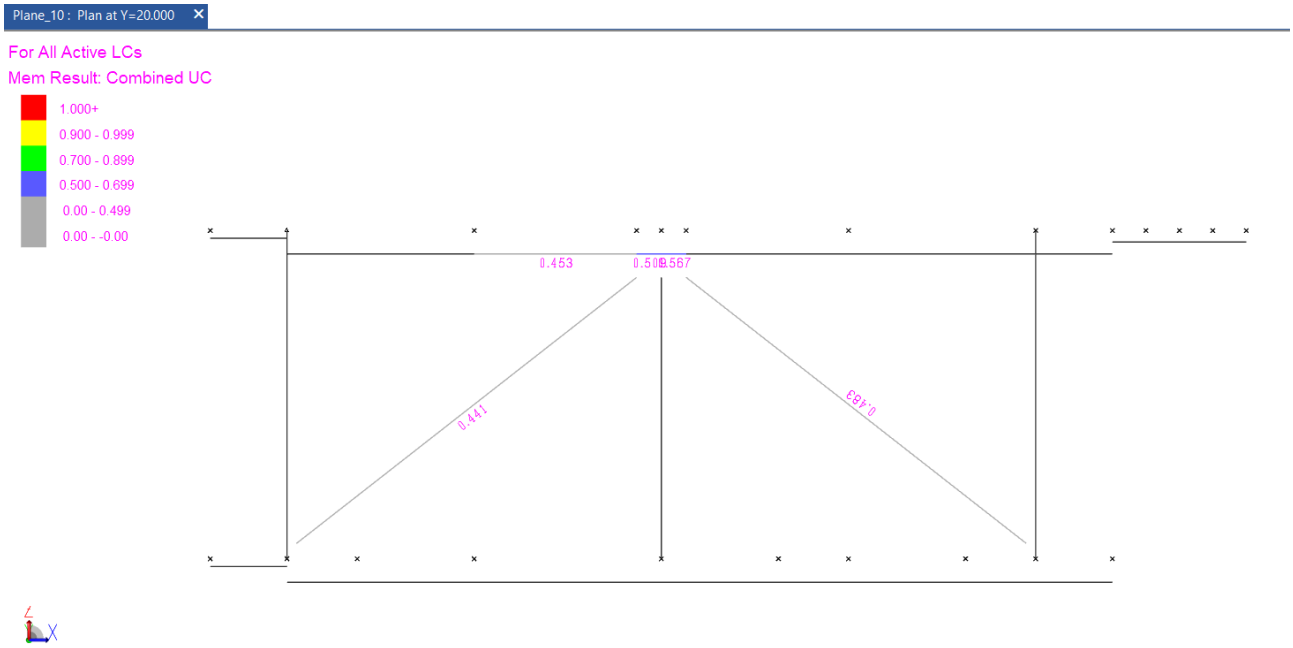


Figure 12.20 - Topside Structural Model for other members - UC>0.4 – Row 5

Maximum UC per member's group is 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 / EC3:2005

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	LD04-L190	LA13	0.76	0.0	-31.7	-76.0	21.0	121.6	216.7	162.3	720.7	BN+COM	8.00	8.00	0.93	0.40
B02	L181-L011	LC53	0.89	2.0	-26.5	-140.8	-11.3	133.3	246.4	207.3	812.2	BN+COM	16.00	8.00	0.73	0.49
B03	L011-L040	LC53	0.76	0.0	-26.8	-183.5	-27.3	121.6	216.7	361.1	998.0	BN+COM	12.00	6.00	0.72	0.40
B04	L234-L133	LA13	0.80	0.0	7.1	113.6	-16.5	363.6	120.6	133.8	589.5	LATBUC	12.00	6.00	0.00	0.00
B05	L157-L127	LA53	0.41	0.0	10.2	-80.9	-3.4	363.6	187.0	173.5	588.2	LATBUC	6.00	6.00	0.00	0.00
B09	H228-UP03	LA53	0.32	1.3	11.3	-49.4	10.1	363.6	1497.6	399.0	550.9	WSHBUC	16.00	4.00	0.00	0.00
B10	L194-L022	LA13	0.44	2.6	15.0	131.1	-1.8	363.6	487.5	264.0	570.0	LATBUC	16.00	4.00	0.00	0.00
B12	U001-U245	LC13	0.77	0.0	6.8	-258.3	-0.3	363.6	1287.2	327.3	559.5	LATBUC	16.00	3.50	0.00	0.00
B13	U014-U087	LC53	0.63	0.0	22.1	-136.6	8.8	363.6	216.7	180.4	570.0	LATBUC	12.00	6.00	0.00	0.00
B14	U068-U006	LA13	0.76	0.0	-58.5	-58.9	-10.9	128.9	271.3	228.7	279.5	BN+COM	8.00	4.00	0.66	0.94
B22	L005-L204	LC13	0.51	0.0	-4.1	-55.6	-2.5	363.6	5763.9	401.3	552.2	WSHBUC	8.00	4.00	0.41	0.86
B23	L206-L208	LA53	0.23	0.0	22.0	-22.1	5.2	363.6	5548.4	391.8	547.6	WSHBUC	8.00	4.00	0.00	0.00
B31	L003-LD04	LA13	0.71	0.0	-24.5	-71.8	48.7	122.5	268.0	181.0	420.5	BN+COM	8.00	8.00	0.90	0.71
B32	L126-L033	LA13	0.61	0.4	-24.3	-79.1	-4.7	362.8	1074.5	405.4	556.2	WSHBUC	6.00	6.00	0.71	0.90
C03	L006-U006	LA53	0.22	6.0	36.9	91.6	4.8	338.1	482.6	448.2	448.2	TN+BN	6.00	6.00	0.85	0.85
C05	L010-U010	LC13	0.24	7.0	57.3	-77.5	46.5	338.1	808.7	438.3	438.3	TN+BN	7.00	7.00	0.85	0.85
C07	U045-CR01	LA13	0.01	0.0	-2.0	0.0	0.0	.3E+03	.4E+05	.5E+03	.5E+03	ACBI	1.60	1.60	0.85	0.85
C08	CR01-CR03	LA13	0.01	0.0	-2.9	0.0	0.0	.3E+03	.5E+05	.4E+03	.4E+03	ACBI	1.60	1.60	0.85	0.85
C11	L156-U045	LA53	0.15	1.1	17.1	0.6	71.6	381.0	2518.1	476.0	476.0	TN+BN	7.00	7.00	0.85	0.85
CT8	PSC4-PGC4	LA13	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	LA13	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
D02	L010-U068	LA53	0.56	0.0	-101.8	-31.0	6.0	216.1	350.5	446.0	446.0	ACBI	9.22	9.22	0.85	0.85
D05	L050-U170	LC13	0.85	7.8	-180.2	-53.0	-0.4	254.4	639.6	438.3	438.3	ACBI	7.83	7.83	0.85	0.85
D36	L156-U153	LA53	0.44	0.0	-98.8	-14.1	-19.1	255.5	654.4	452.6	452.6	ACBI	7.59	7.59	0.85	0.85
IP3	L00B-Y000	LA13	0.81	0.0	-0.7	-0.5	260.2	322.7	2934.8	322.7	322.7	BN+AX	3.60	0.45	0.59	0.47
PB1	H232-P103	LA53	0.46	1.3	-32.8	-100.8	8.6	244.0	2535.2	323.0	690.6	BN+COM	4.00	2.00	0.54	0.63
PC2	U00F-U00K	LA13	0.24	4.5	-23.3	78.3	-13.6	274.1	1109.9	447.5	447.5	ACBI	5.90	5.90	0.85	0.85
PC3	UP03-P003	LA53	0.29	0.0	32.6	5.3	124.5	338.1	1397.4	448.6	448.6	TN+BN	5.90	5.90	0.85	0.85
PD1	U00J-P140	LC53	0.07	0.0	0.1	-30.4	2.2	338.1	207.4	455.9	455.9	TN+BN	9.00	2.25	0.85	0.85
PD2	P145-P137	LA53	0.08	0.0	-9.2	25.9	6.1	285.7	1954.3	455.8	455.8	ACBI	2.35	2.35	0.85	0.85
PD3	P003-P112	LA53	0.08	5.0	-2.6	-1.6	-37.4	300.8	685.6	450.8	450.8	ACBI	5.01	5.01	0.85	0.85
PL1	P112-P123	LC53	0.04	0.0	2.0	-4.1	-6.4	338.1	1439.5	450.0	450.0	SHEAR	4.50	4.50	0.85	0.85
S01	U130-U131	LC13	0.43	0.0	14.2	126.4	4.3	313.6	348.0	337.0	476.8	BN+AX	16.00	4.00	0.00	0.00
S02	U283-U284	LA53	0.45	2.2	-0.4	124.5	1.8	161.5	303.1	281.0	755.3	BN+COM	4.00	2.20	0.62	0.60
S03	L305-L070	LA53	0.68	0.0	1.4	24.5	2.7	322.7	994.9	345.1	496.3	BN+AX	4.00	1.60	0.00	0.00
S04	D060-L257	LA53	0.47	0.0	-3.7	131.9	-2.8	212.6	704.5	294.3	555.3	BN+COM	4.00	4.00	0.85	0.79
S07	N048-N049	LC53	0.06	0.0	-1.3	-1.9	10.0	45.2	66.6	111.2	548.5	LATBUC	4.00	4.00	0.92	0.40
SF1	U022-P103	LA53	0.58	4.4	-129.7	-51.0	5.7	277.7	1285.0	447.5	447.5	ACBI	4.37	4.37	0.85	0.85

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ST1 N038-U00M LC53	0.19	3.2	20.5	67.7	-48.2	338.1	1721.3	445.2	445.2	TN+BN	3.20	3.20	0.85	0.85
ST2 M00P-U13B LA13	0.10	4.5	27.5	-11.5	-40.2	338.1	567.9	446.7	446.7	TN+BN	4.45	4.45	0.85	0.85
ST6 L11D-US06 LA13	0.16	0.0	-20.8	-9.6	-10.6	178.0	451.1	313.6	313.6	ACBI	3.77	3.77	0.85	0.85
ST7 M200-M204 LA13	0.04	0.0	0.6	-11.1	2.9	236.2	1059.2	314.8	314.8	TN+BN	2.06	2.06	0.85	0.85
VHE 0003-0004 LA13	0.06	1.0	-0.2	20.3	0.0	295.8	1883.0	328.9	750.8	BN+COM	2.00	2.00	1.00	1.00

12.2.2 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/. Joints' checks are reported for all the exanimated load combinations. All joint checks have been performed considering consequence factor CF = 1.30, on the safe side.

* * 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
0002	40.640	2.062	355.000	0.910	40.640	2.062	355.000	0.910
U003	80.000	3.000	400.000	0.780	80.000	3.000	400.000	0.780
U005	80.000	3.000	400.000	0.762	80.000	3.000	400.000	0.762
U015	80.000	3.000	400.000	0.742	80.000	3.000	400.000	0.742
D004	55.000	2.000	400.000	0.685	55.000	2.000	400.000	0.685
D003	55.000	2.000	400.000	0.661	55.000	2.000	400.000	0.661
U013	80.000	3.000	400.000	0.643	80.000	3.000	400.000	0.643
D006	55.000	2.000	400.000	0.620	55.000	2.000	400.000	0.620
U13B	27.310	0.927	355.000	0.587	27.310	0.927	355.000	0.587
D005	55.000	2.000	400.000	0.576	55.000	2.000	400.000	0.576
U00M	27.310	0.927	355.000	0.518	27.310	0.927	355.000	0.518
L156	70.000	3.000	400.000	0.512	70.000	3.000	400.000	0.512
M00P	27.310	0.927	355.000	0.495	27.310	0.927	355.000	0.495
U200	27.310	0.927	355.000	0.431	27.310	0.927	355.000	0.431
U045	70.000	3.000	400.000	0.416	70.000	3.000	400.000	0.416
P103	45.720	1.905	355.000	0.415	45.720	1.905	355.000	0.415
P104	45.720	1.905	355.000	0.412	45.720	1.905	355.000	0.412
L005	80.000	4.000	400.000	0.411	80.000	4.000	400.000	0.411
P101	45.720	1.905	355.000	0.399	45.720	1.905	355.000	0.399
P102	45.720	1.905	355.000	0.395	45.720	1.905	355.000	0.395
L008	40.640	2.144	355.000	0.384	40.640	2.144	355.000	0.384
L010	40.640	2.144	355.000	0.374	40.640	2.144	355.000	0.374
L015	80.000	4.000	400.000	0.367	80.000	4.000	400.000	0.367
L018	40.640	2.144	355.000	0.365	40.640	2.144	355.000	0.365
L013	80.000	4.000	400.000	0.351	80.000	4.000	400.000	0.351
L11E	27.310	0.927	355.000	0.348	27.310	0.927	355.000	0.348
L003	80.000	4.000	400.000	0.343	80.000	4.000	400.000	0.343
L00K	27.310	0.927	355.000	0.308	27.310	0.927	355.000	0.308
L020	40.640	2.144	355.000	0.297	40.640	2.144	355.000	0.297
L11F	27.310	0.927	355.000	0.167	27.310	0.927	355.000	0.167
P003	45.720	1.905	355.000	0.152	45.720	1.905	355.000	0.152
L00H	27.310	0.927	355.000	0.148	27.310	0.927	355.000	0.148
P004	45.720	1.905	355.000	0.146	45.720	1.905	355.000	0.146
P001	45.720	1.905	355.000	0.146	45.720	1.905	355.000	0.146
U118	27.310	0.927	355.000	0.144	27.310	0.927	355.000	0.144
P112	35.500	1.588	355.000	0.143	35.500	1.588	355.000	0.143
P111	35.500	1.588	355.000	0.143	35.500	1.588	355.000	0.143
P002	45.720	1.905	355.000	0.142	45.720	1.905	355.000	0.142
P123	35.500	1.588	355.000	0.136	35.500	1.588	355.000	0.136
M00C	27.310	0.927	355.000	0.134	27.310	0.927	355.000	0.134
P121	35.500	1.588	355.000	0.133	35.500	1.588	355.000	0.133
P120	35.500	1.588	355.000	0.133	35.500	1.588	355.000	0.133
P122	35.500	1.588	355.000	0.131	35.500	1.588	355.000	0.131
U066	27.310	0.927	355.000	0.123	27.310	0.927	355.000	0.123
L11D	27.310	0.927	355.000	0.122	27.310	0.927	355.000	0.122
P145	27.310	1.588	355.000	0.118	27.310	1.588	355.000	0.118
P148	27.310	1.588	355.000	0.117	27.310	1.588	355.000	0.117
L11C	27.310	0.927	355.000	0.108	27.310	0.927	355.000	0.108
M118	27.310	0.927	355.000	0.108	27.310	0.927	355.000	0.108

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U00N	27.310	0.927	355.000	0.101	27.310	0.927	355.000	0.101
M00A	27.310	0.927	355.000	0.099	27.310	0.927	355.000	0.099
L11A	27.310	0.927	355.000	0.098	27.310	0.927	355.000	0.098
U13A	27.310	0.927	355.000	0.095	27.310	0.927	355.000	0.095
U119	27.310	0.927	355.000	0.077	27.310	0.927	355.000	0.077
M119	27.310	0.927	355.000	0.076	27.310	0.927	355.000	0.076
P137	27.310	1.588	355.000	0.075	27.310	1.588	355.000	0.075
P139	27.310	1.588	355.000	0.074	27.310	1.588	355.000	0.074
P118	27.310	1.588	355.000	0.072	27.310	1.588	355.000	0.072
P138	27.310	1.588	355.000	0.071	27.310	1.588	355.000	0.071
P140	27.310	1.588	355.000	0.071	27.310	1.588	355.000	0.071
P119	27.310	1.588	355.000	0.070	27.310	1.588	355.000	0.070
M001	27.310	0.927	355.000	0.062	27.310	0.927	355.000	0.062
M00B	27.310	0.927	355.000	0.061	27.310	0.927	355.000	0.061
L00L	27.310	0.927	355.000	0.059	27.310	0.927	355.000	0.059
M00Q	27.310	0.927	355.000	0.055	27.310	0.927	355.000	0.055
P147	27.310	1.588	355.000	0.053	27.310	1.588	355.000	0.053
P146	27.310	1.588	355.000	0.053	27.310	1.588	355.000	0.053
P144	27.310	1.588	355.000	0.052	27.310	1.588	355.000	0.052
P149	27.310	1.588	355.000	0.051	27.310	1.588	355.000	0.051
U062	27.310	0.927	355.000	0.040	27.310	0.927	355.000	0.040
U198	27.310	0.927	355.000	0.028	27.310	0.927	355.000	0.028
L11B	27.310	0.927	355.000	0.027	27.310	0.927	355.000	0.027
L118	27.310	0.927	355.000	0.015	27.310	0.927	355.000	0.015

The maximum UC for punching shear check is UC = 0.91 at joint 0002.

12.2.3 Plate checks

All plates checks have been performed considering consequence factor CF = 1.30, on the safe side.

***** PLATE STRESS GROUP SUMMARY *****
N/MM2

GRUP	CRIT. PLATE	TYPE	MAX UNITY CHECK	LOAD COND NO.	**** MEMBRANE **** SX	SY	TXY	BENDING-UPPER SURF. SX	SY	TXY	** MAX ** VM	X-STIFFENER S-TOP	S-BOT	Y-STIFFENER S-TOP	S-BOT
P08	A176	SHR	0.243	LC51	0.0	0.0	45.3	0.0	0.0	0.0	78.4				
P10	A067	SHR	0.033	LA51	0.0	0.0	6.1	0.0	0.0	0.0	10.5				

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		

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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		

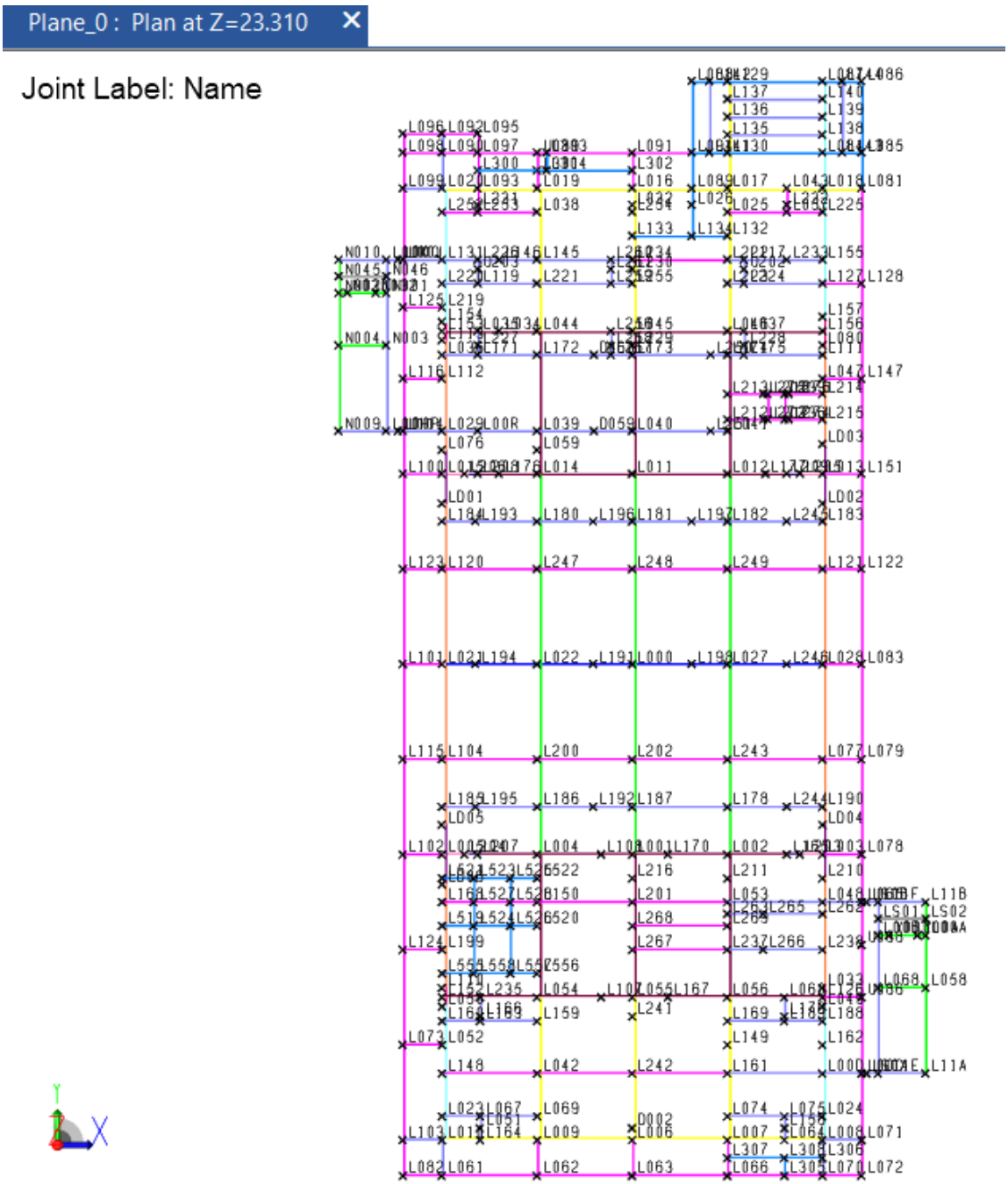
An * indicates that AX, J, IY and IZ are computed values, not user defined.

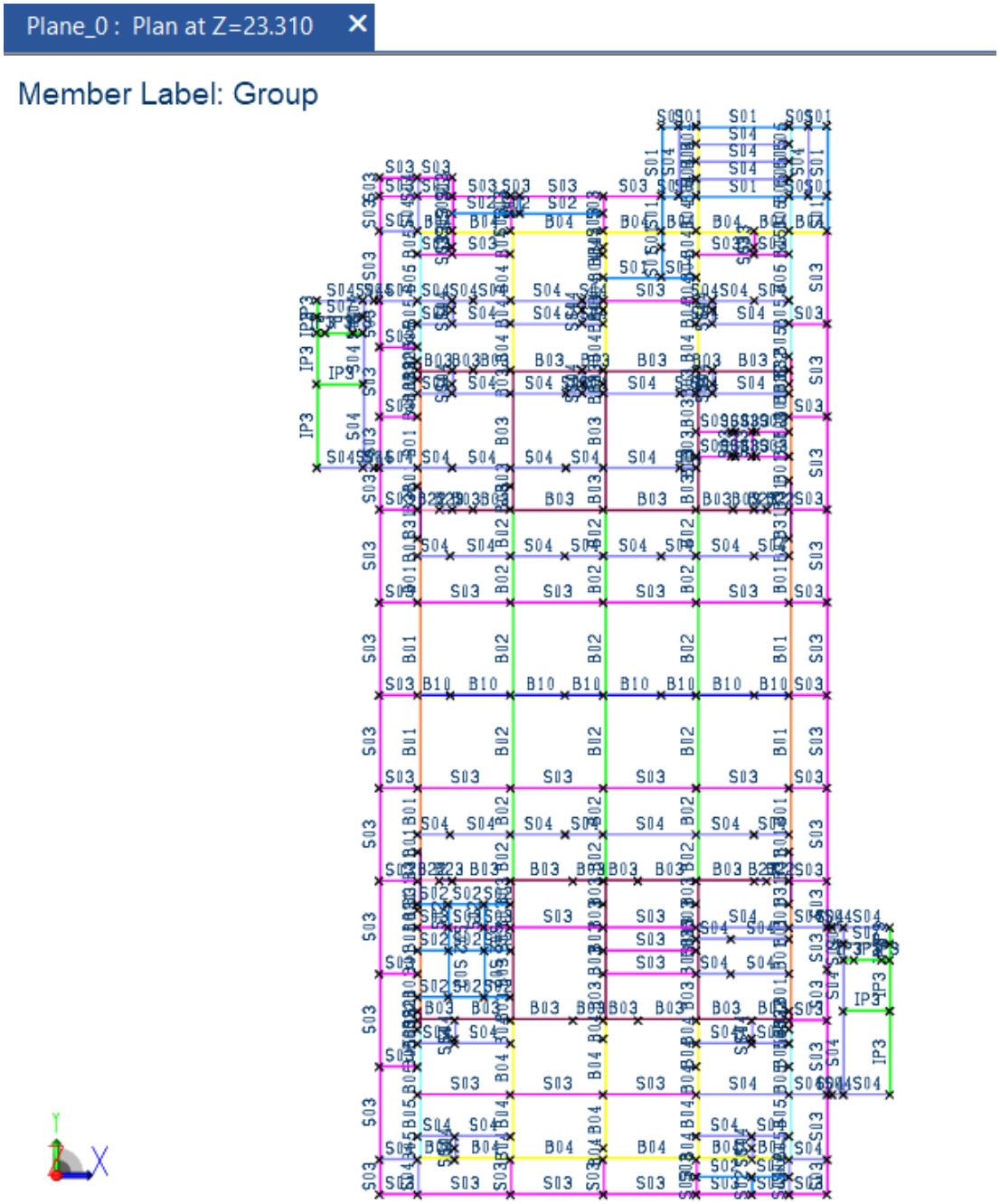
Plate Group Report

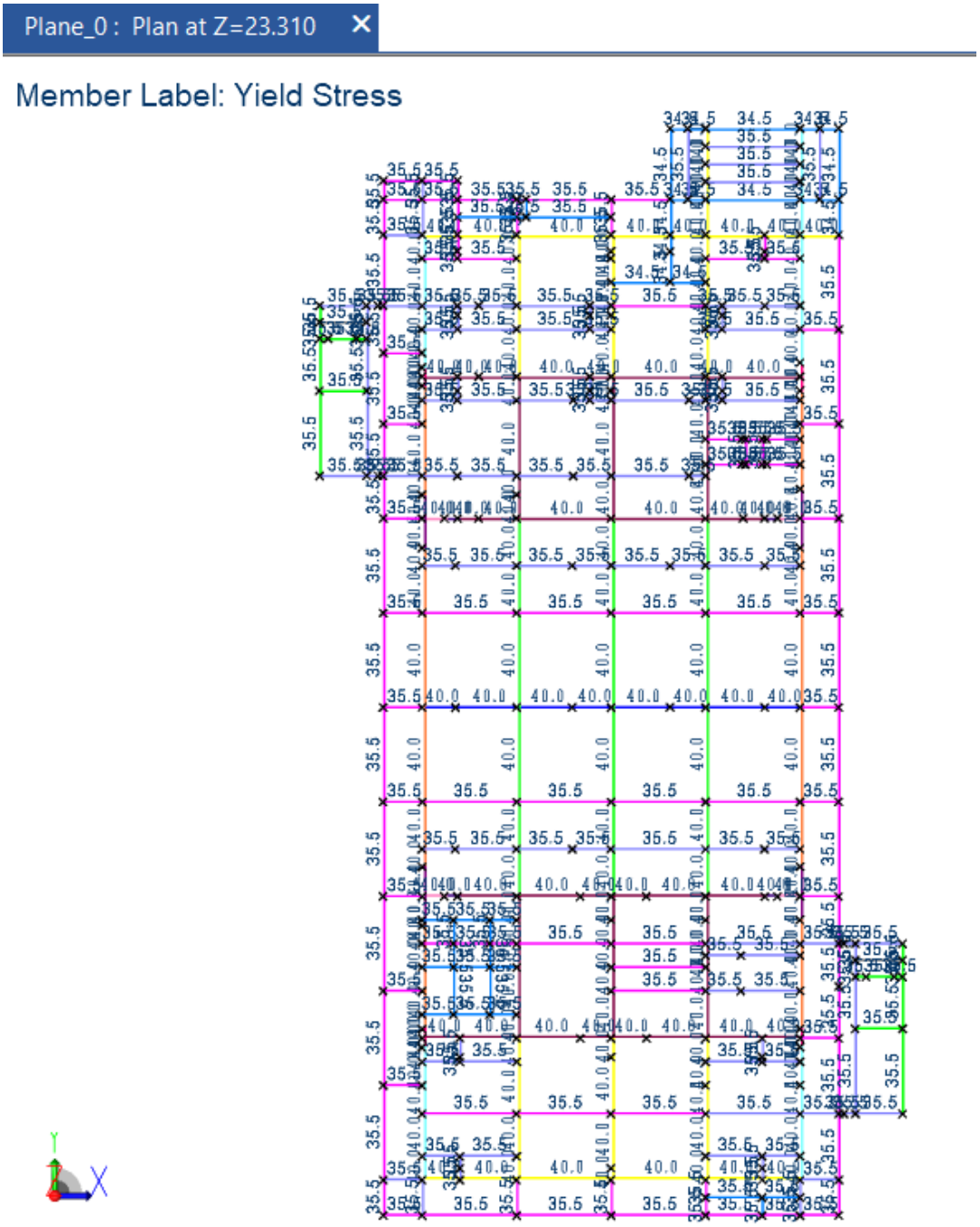
Name	Z	Thickness (cm)	M	E (kN/cm2)	U	Fy (kN/cm2)	Z Offset (cm)	Section	Spacing (cm)	L	T	Density (tonne/m3)
P08		0.800	S	20500.000	0.300	35.500						10.0000029-5
P10		1.000	S	20500.000	0.300	35.500						10.0000029-5

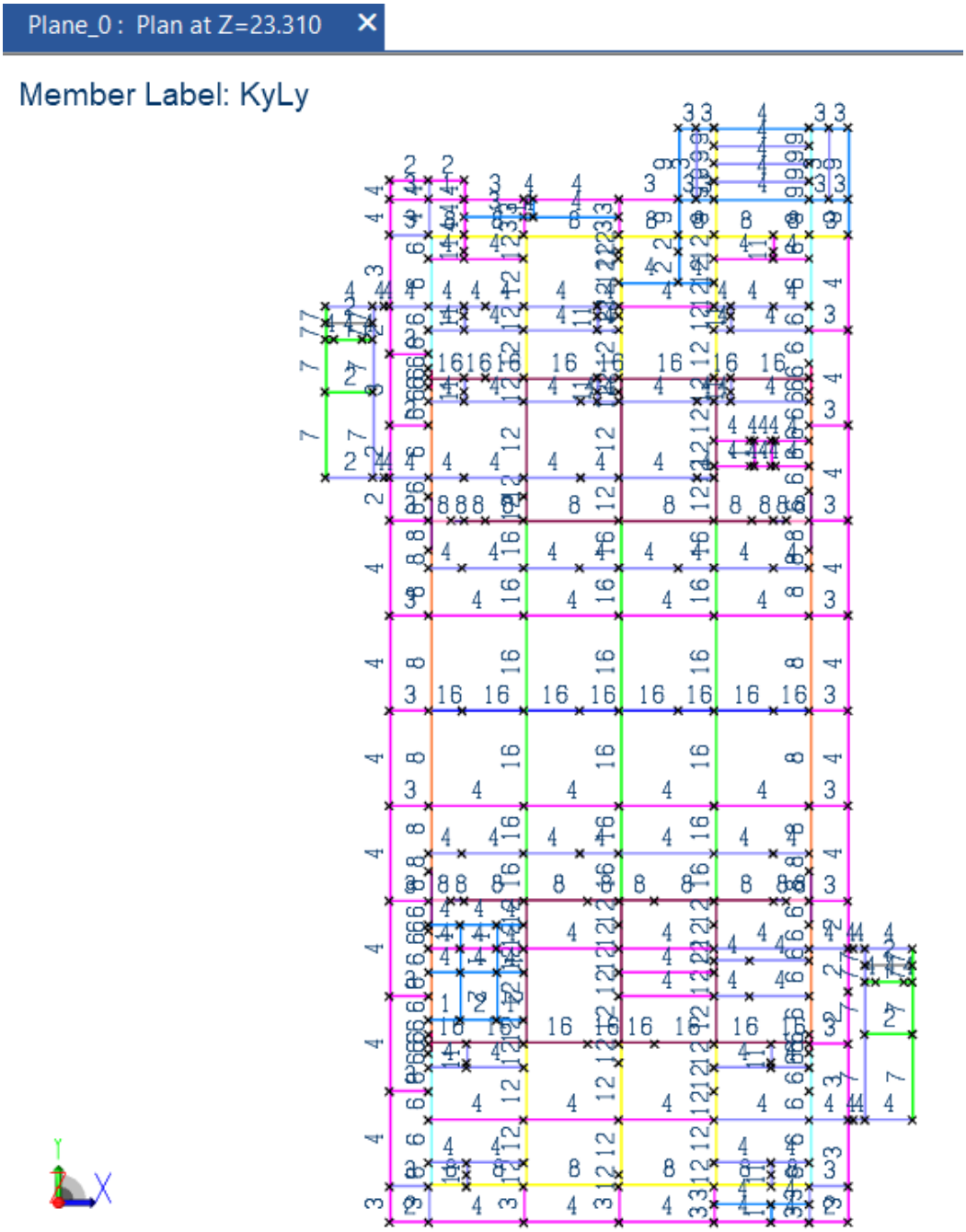
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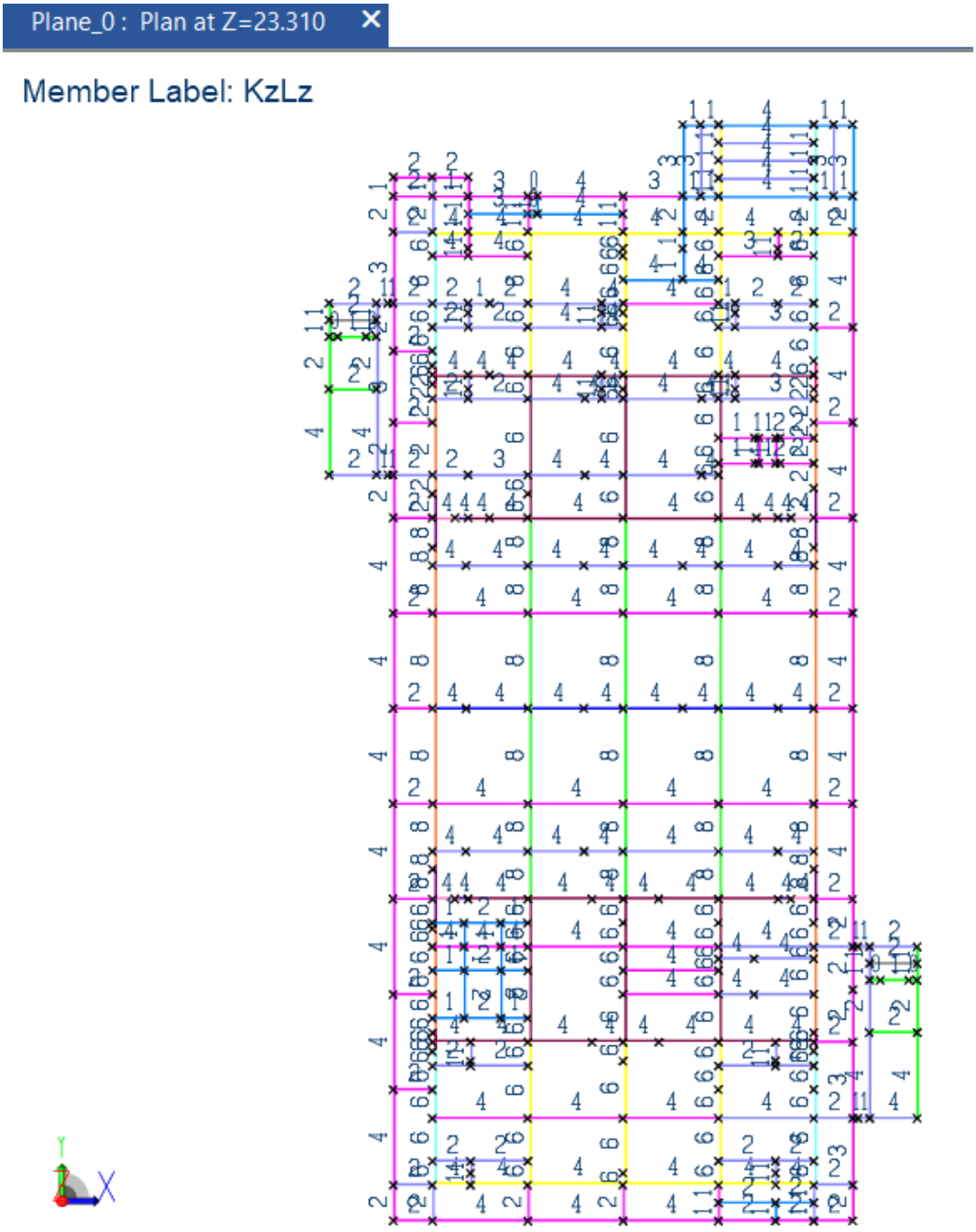
APPENDIX B - WIREFRAME SCHEMES




Plane_0 : Plan at Z=23.310
Member Label: Group

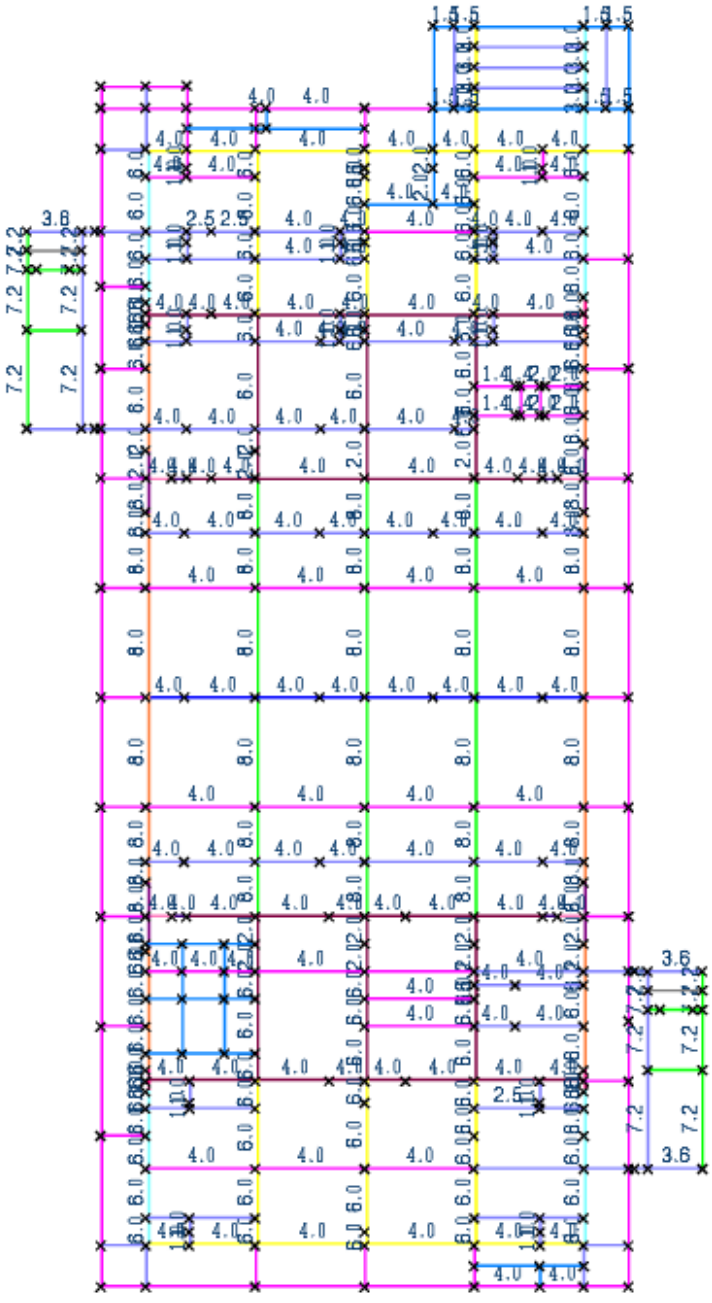

Plane_0 : Plan at Z=23.310
Member Label: Yield Stress

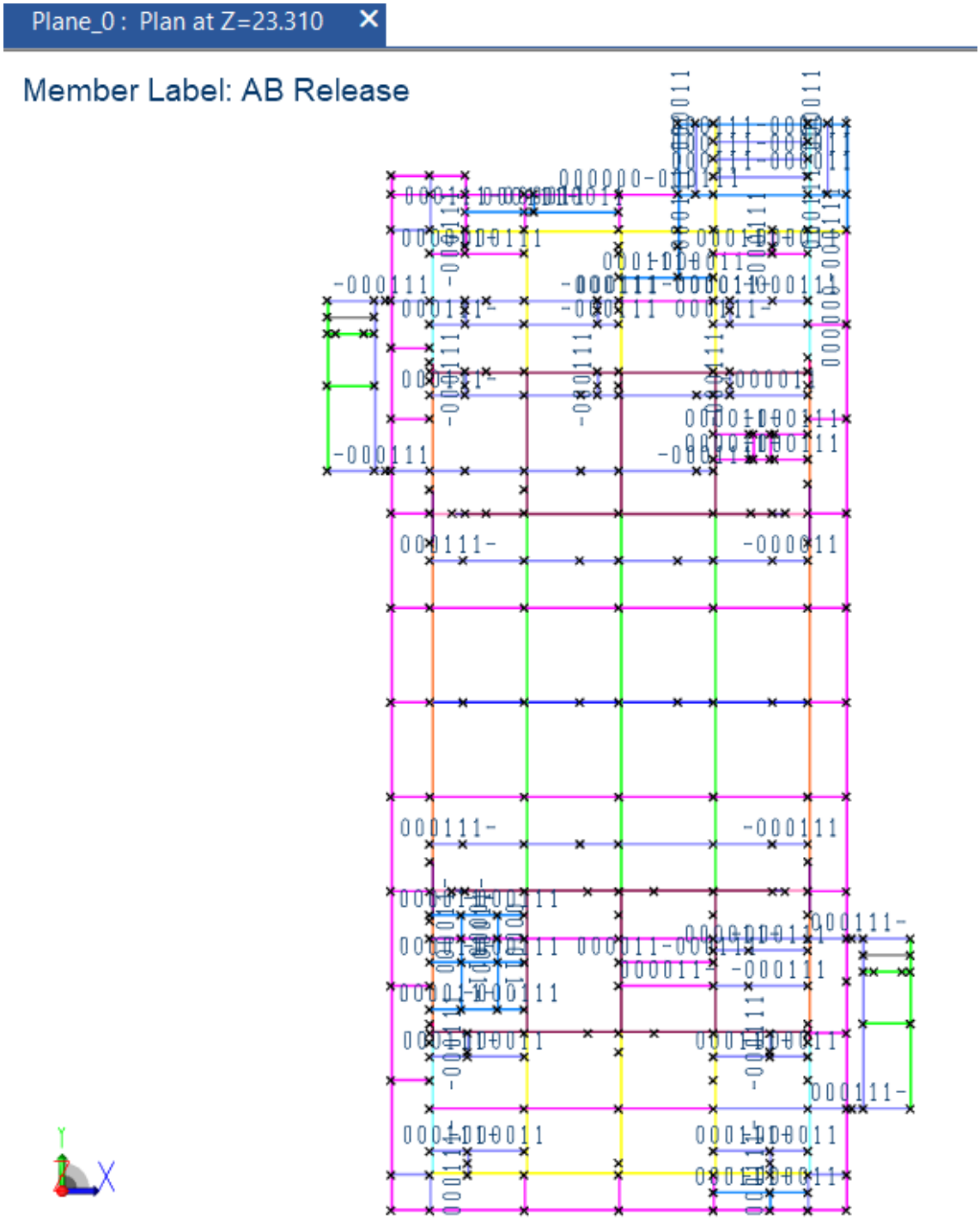

Plane_0 : Plan at Z=23.310
Member Label: KyLy

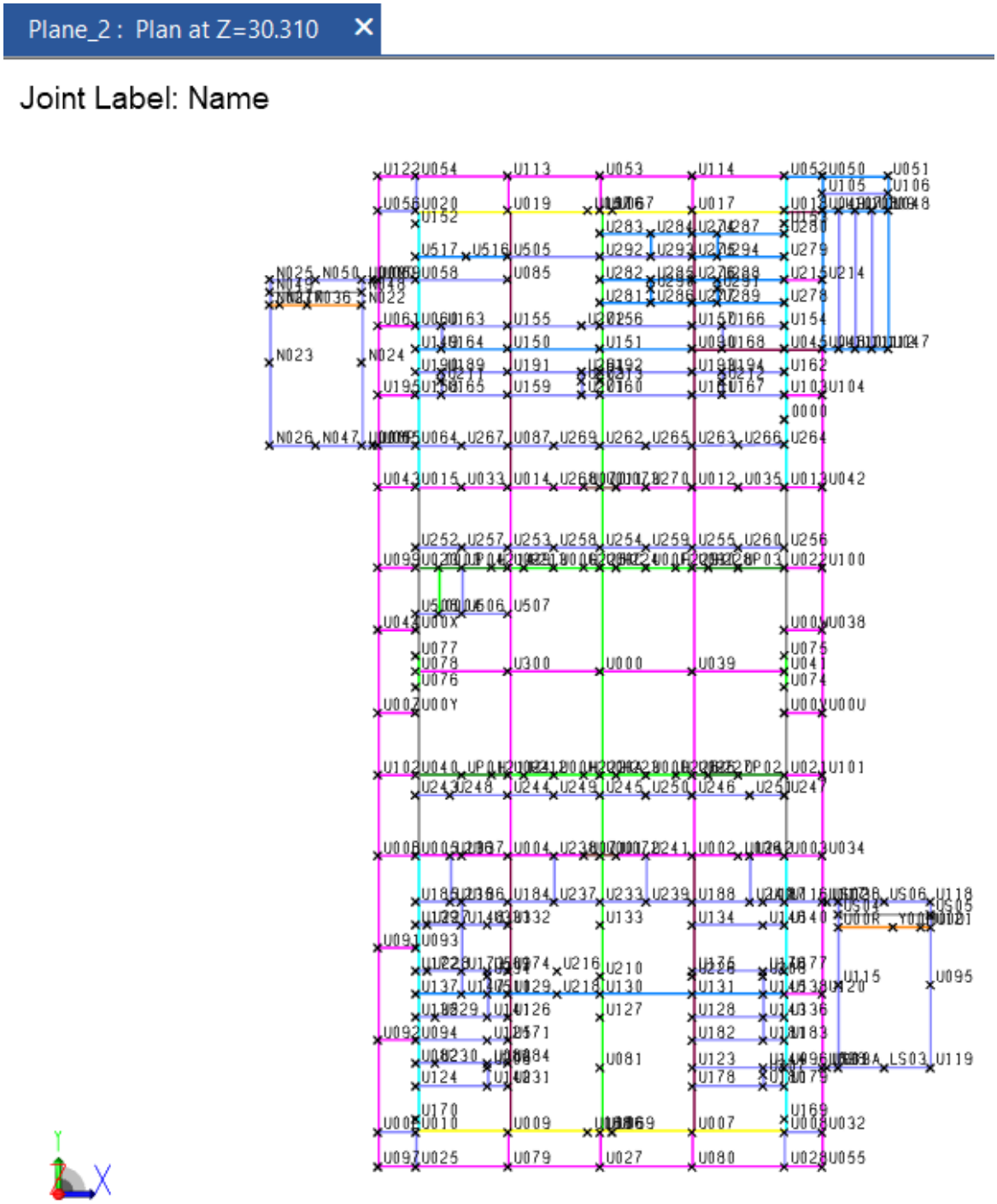

Plane_0 : Plan at Z=23.310
Member Label: KzLz

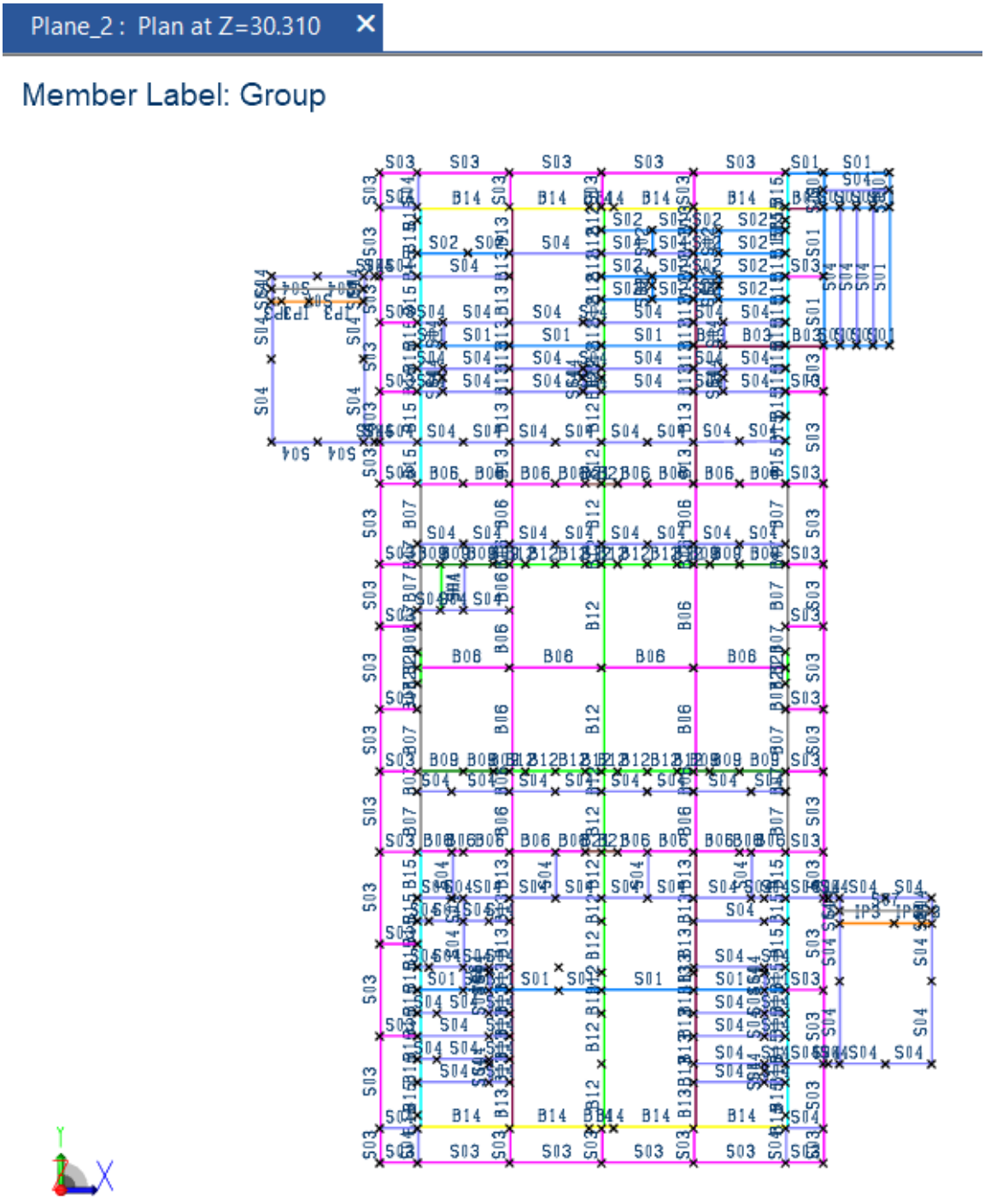
Plane_0 : Plan at Z=23.310

Member Label: Lb

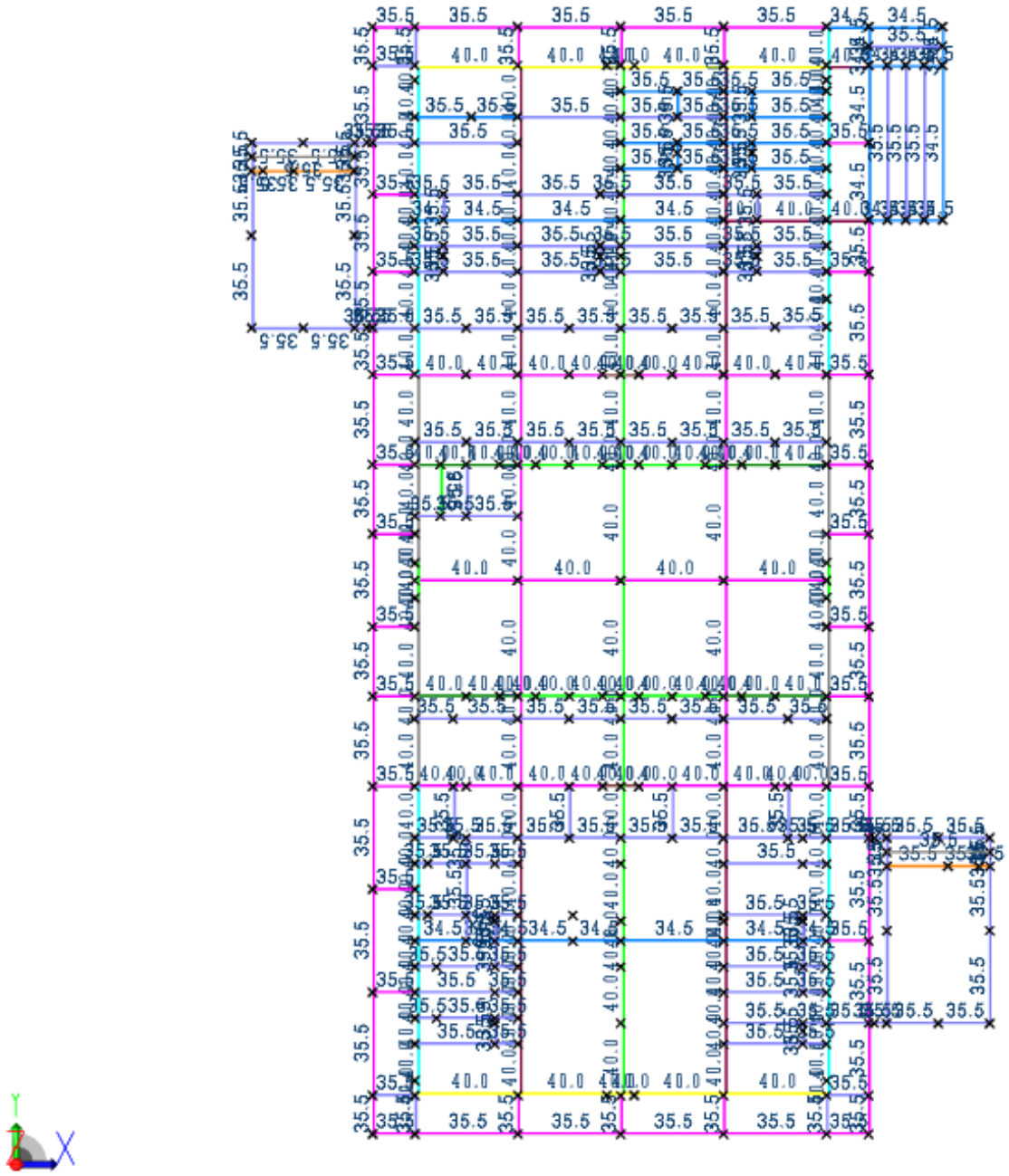


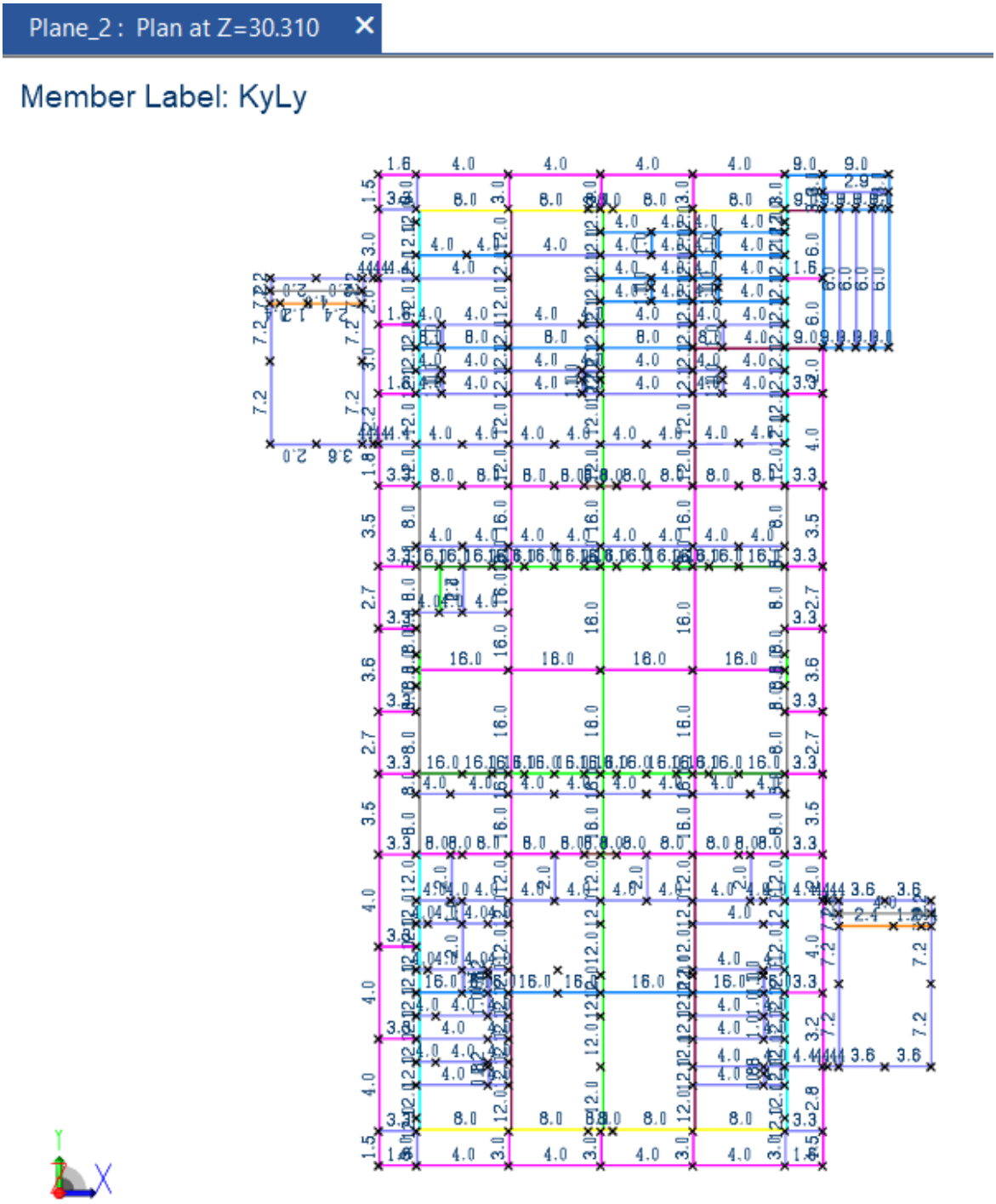

Plane_0 : Plan at Z=23.310
Member Label: AB Release

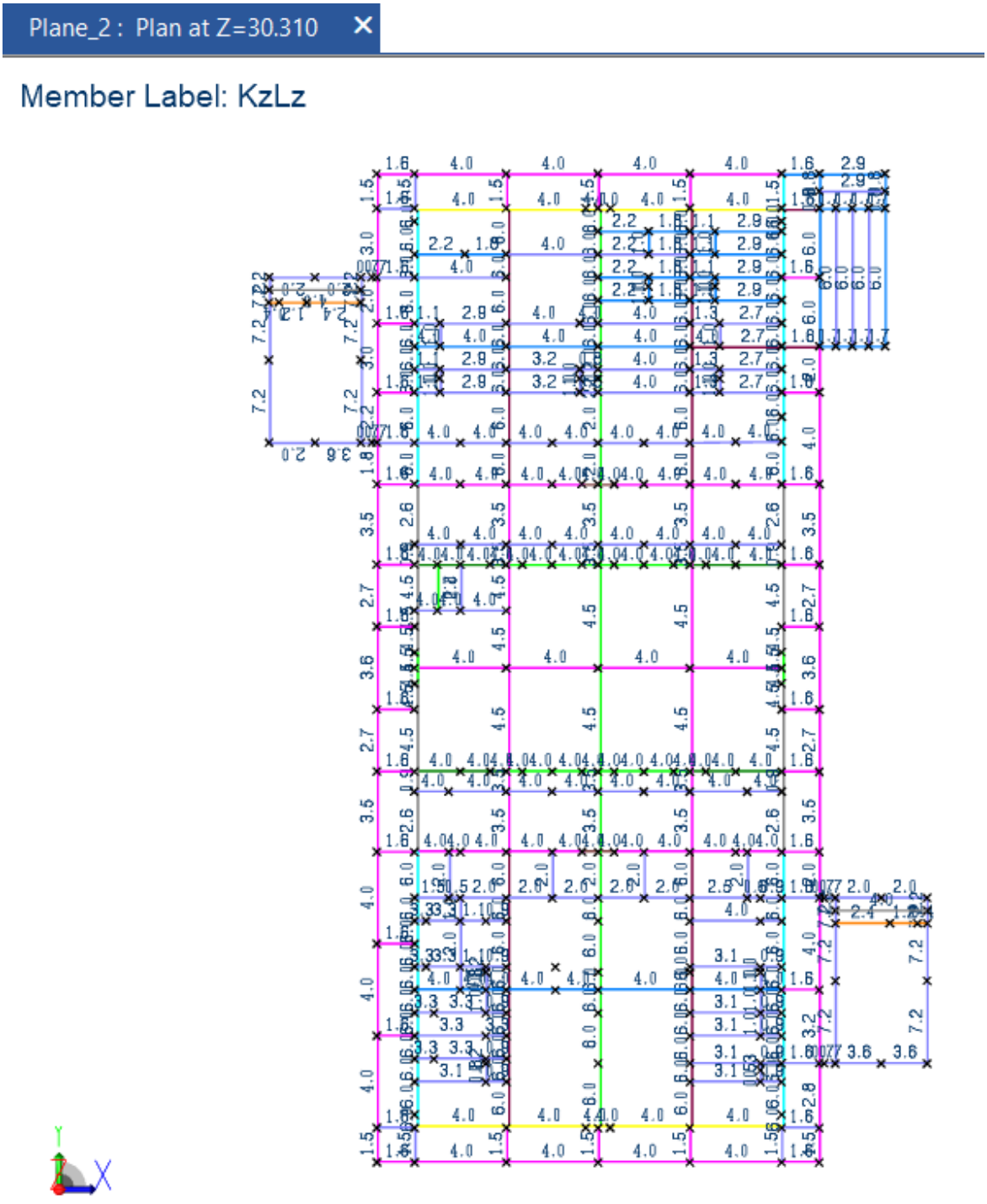

Plane_2 : Plan at Z=30.310
Joint Label: Name
Y
X


Plane_2 : Plan at Z=30.310
Member Label: Group

Member Label: Yield Stress

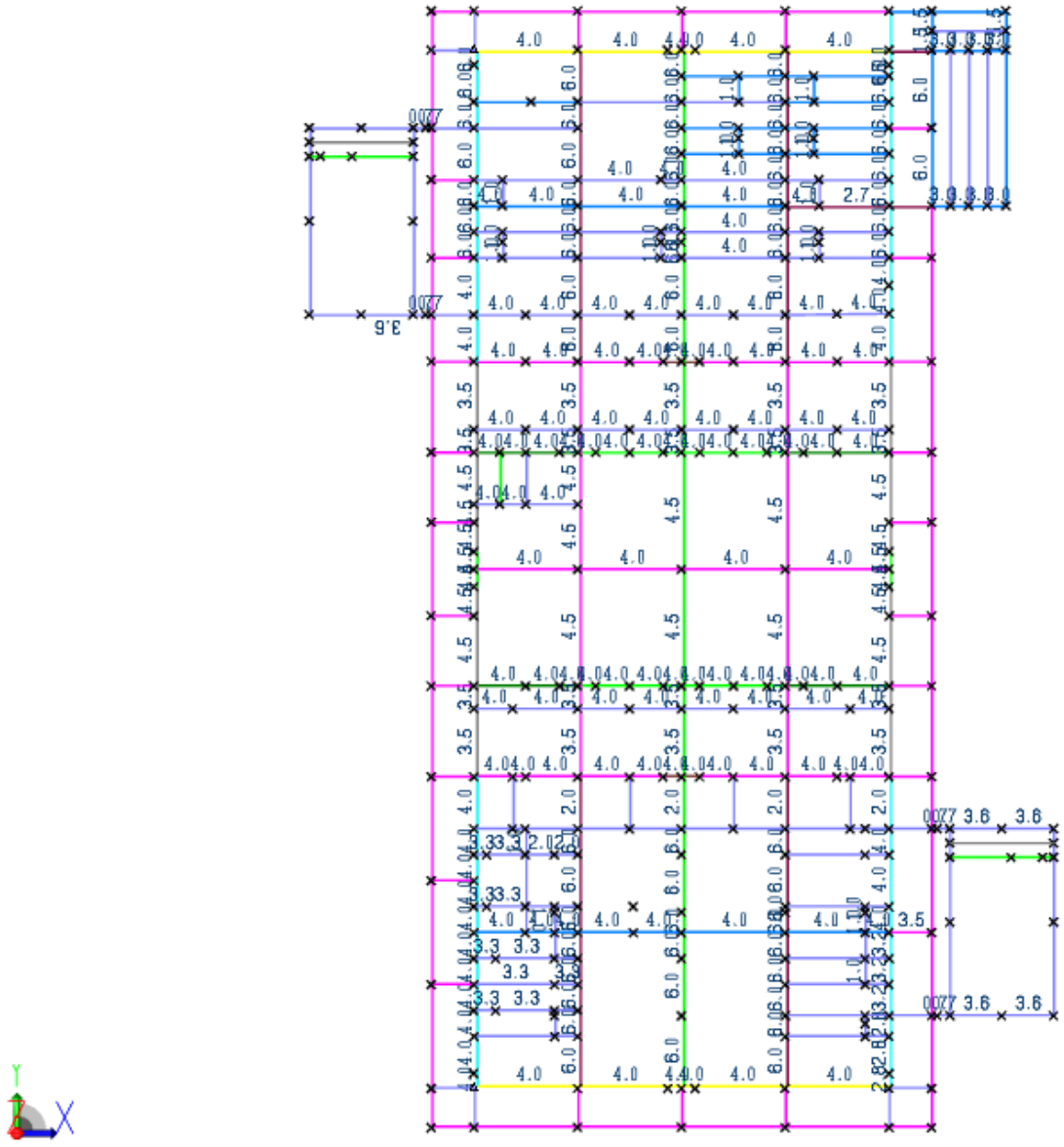


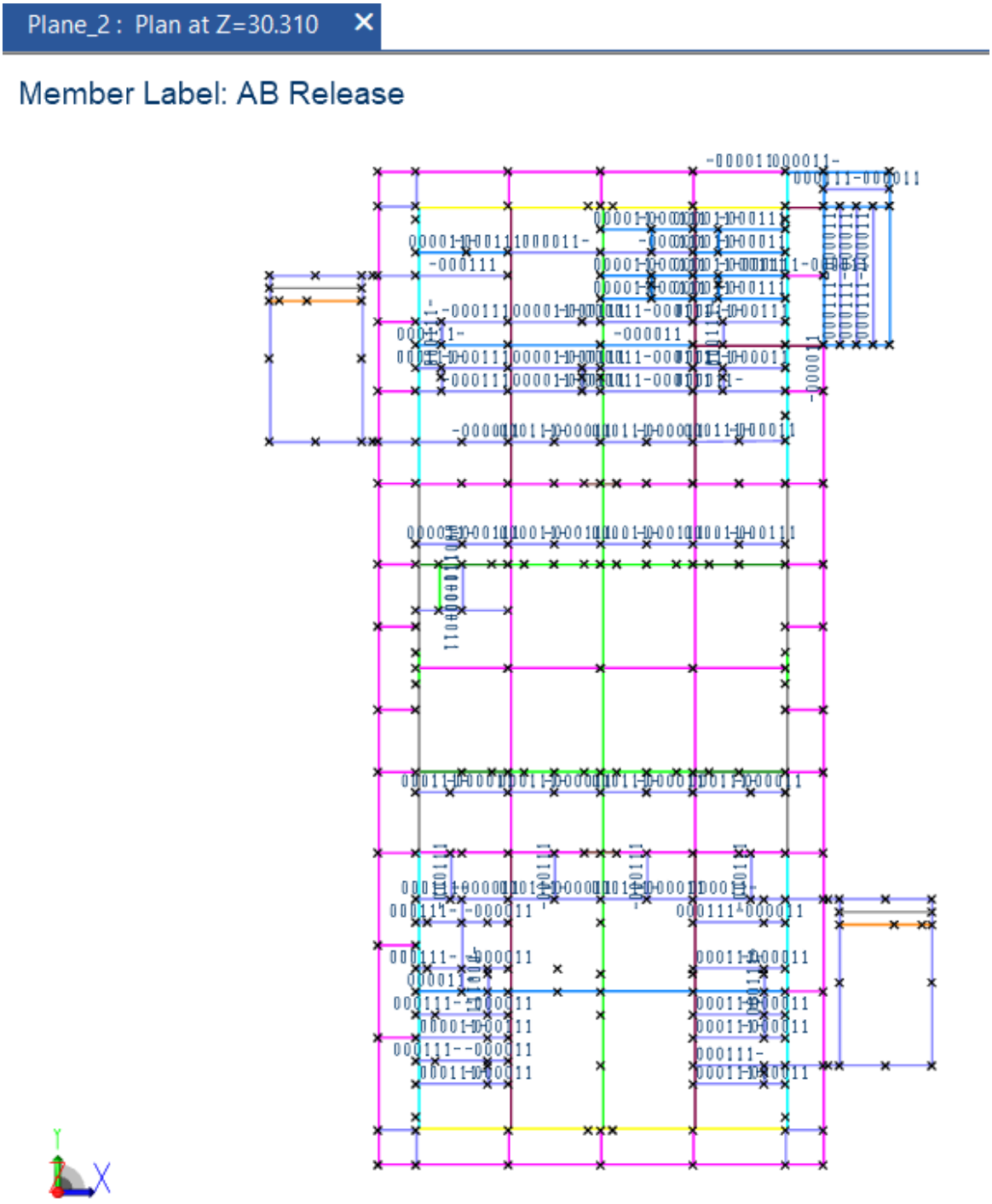

Plane_2 : Plan at Z=30.310
Member Label: KyLy


Plane_2 : Plan at Z=30.310
Member Label: KzLz

Plane_1 : Plan at Z=30.310

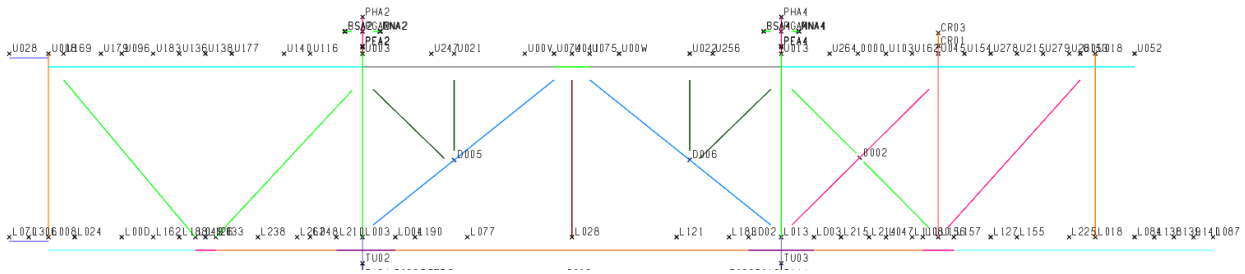
Member Label: Lb




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

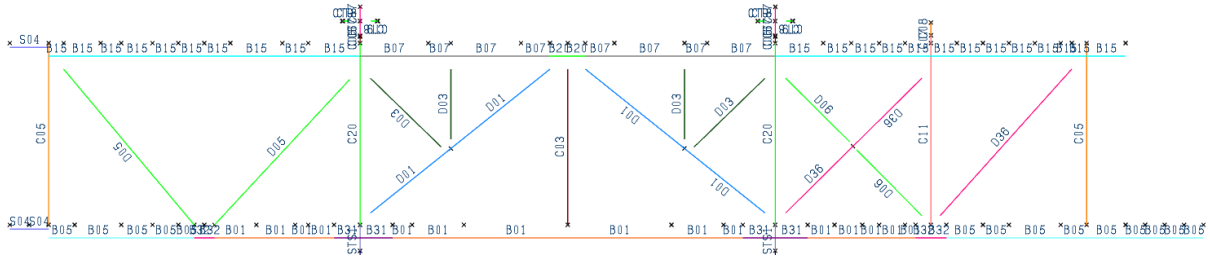
Plane_3 : Plan at X=8.000

Joint Label: Name



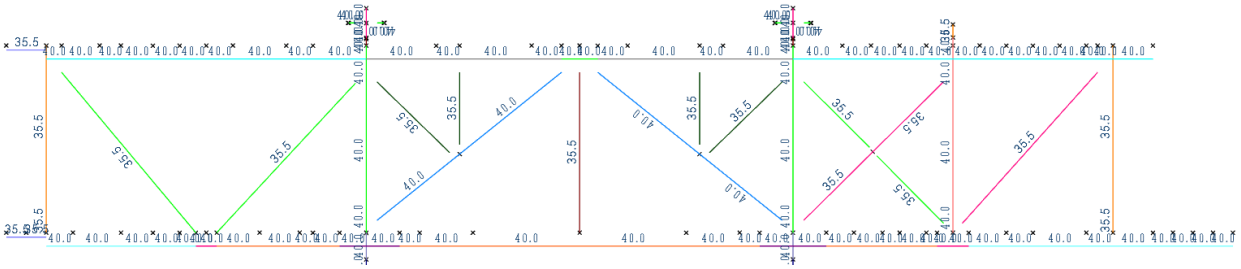
Plane_3 : Plan at X=8.000

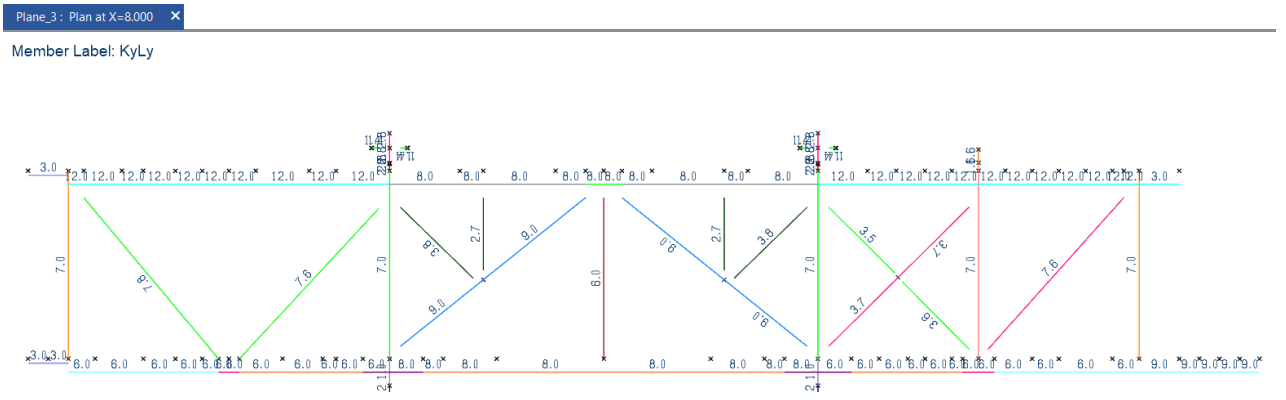
Member Label: Group

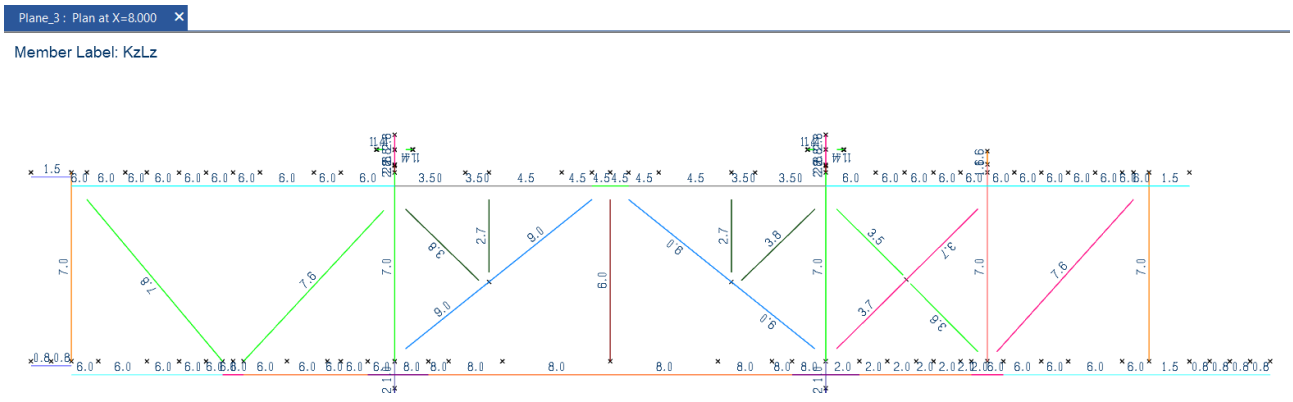


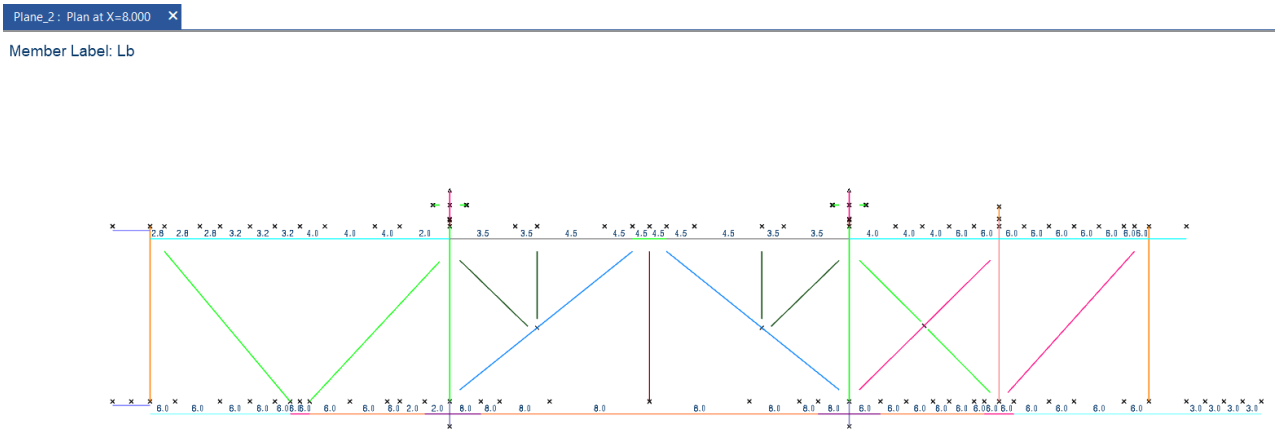
Plane_3 : Plan at X=8.000

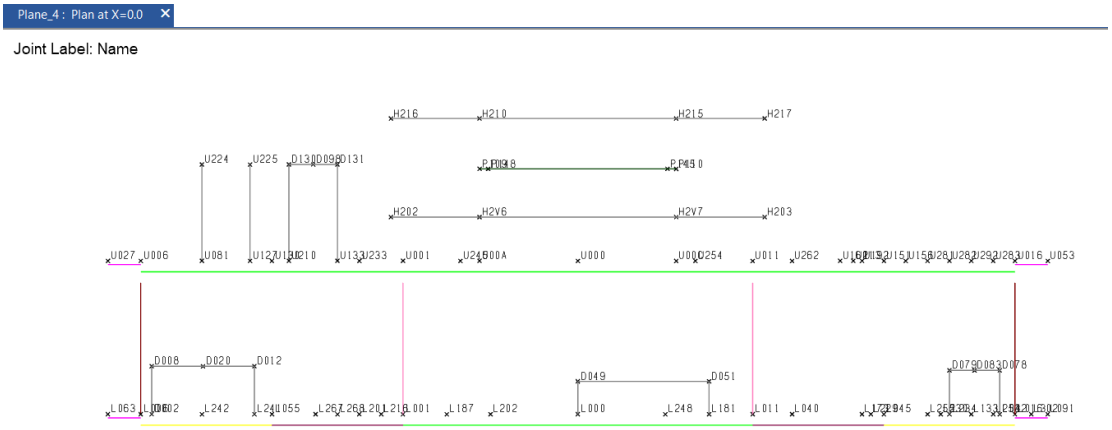
Member Label: Yield Stress

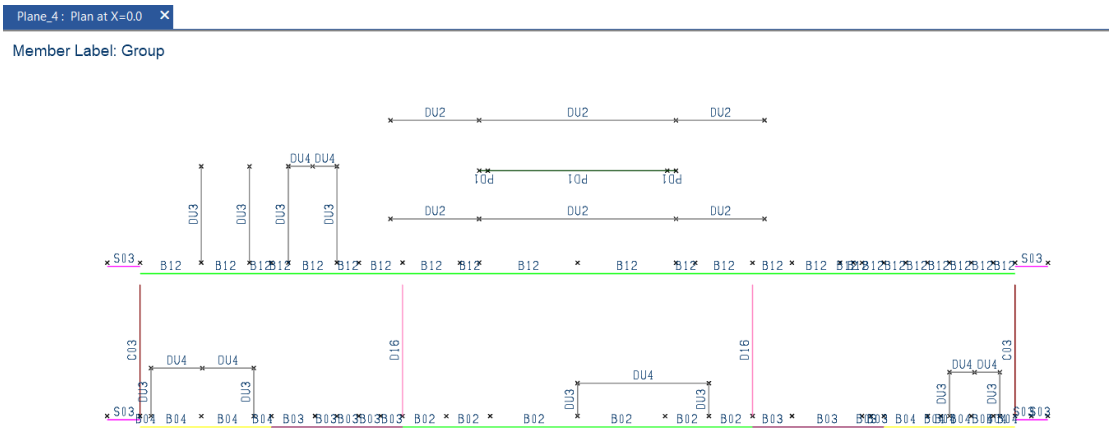


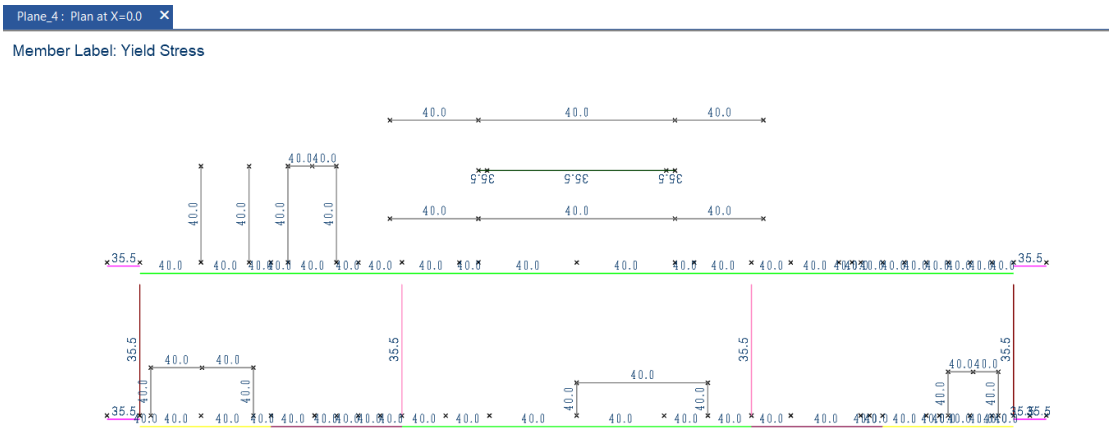

Plane_3 : Plan at X=8.000
Member Label: KyLy


Plane_3 : Plan at X=8.000
Member Label: KzLz


Plane_2 : Plan at X=8.000
Member Label: Lb

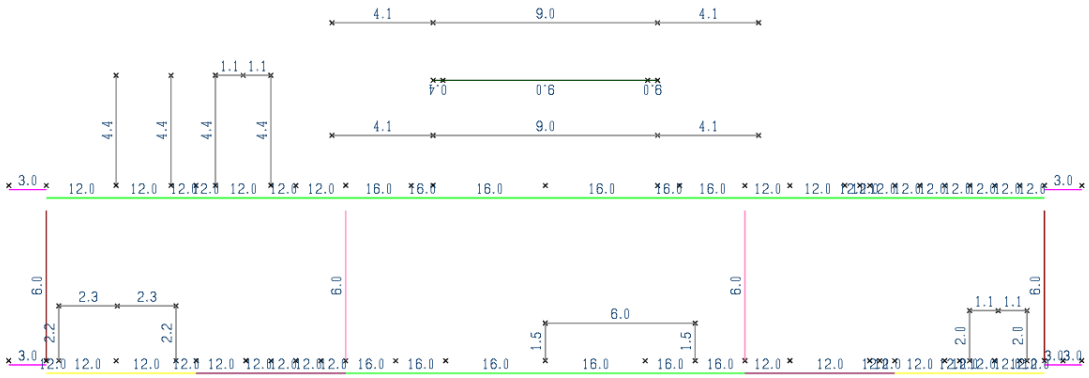

Plane_4 : Plan at X=0.0
Joint Label: Name


Plane_4 : Plan at X=0.0
Member Label: Group


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

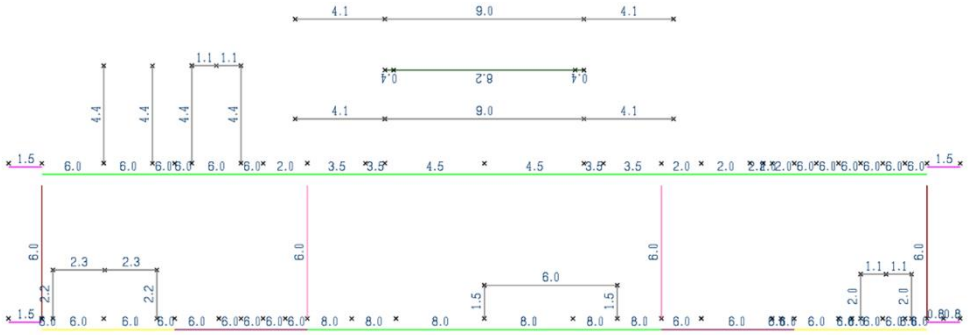
Plane_4 : Plan at X=0.0

Member Label: KyLy



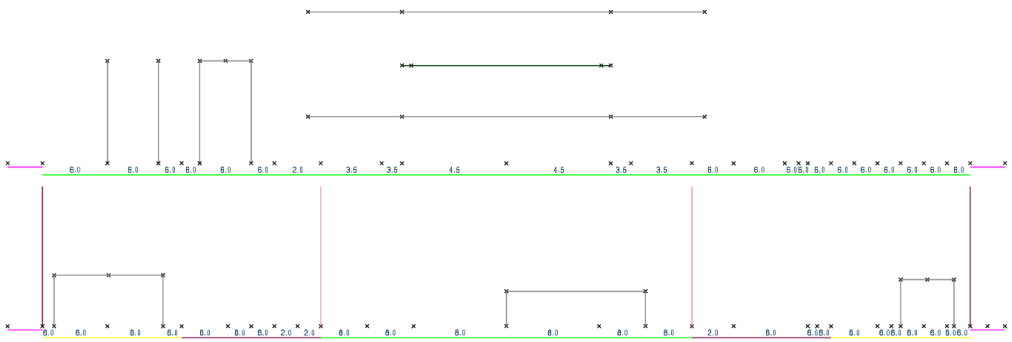
Plane_4 : Plan at X=0.0

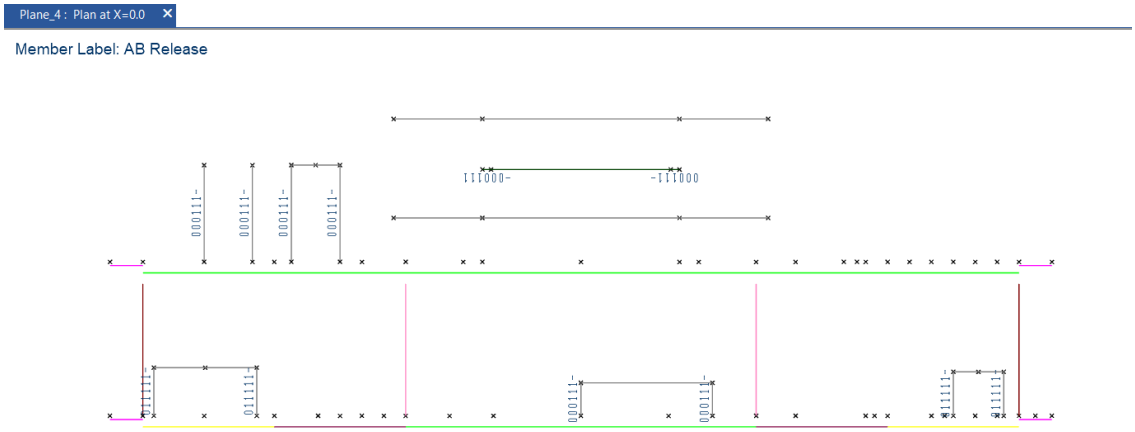
Member Label: KzLz

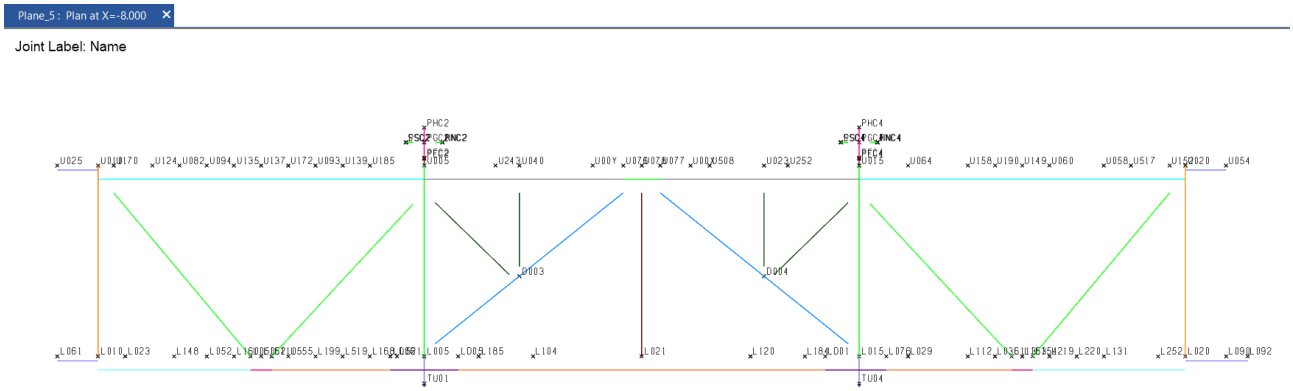


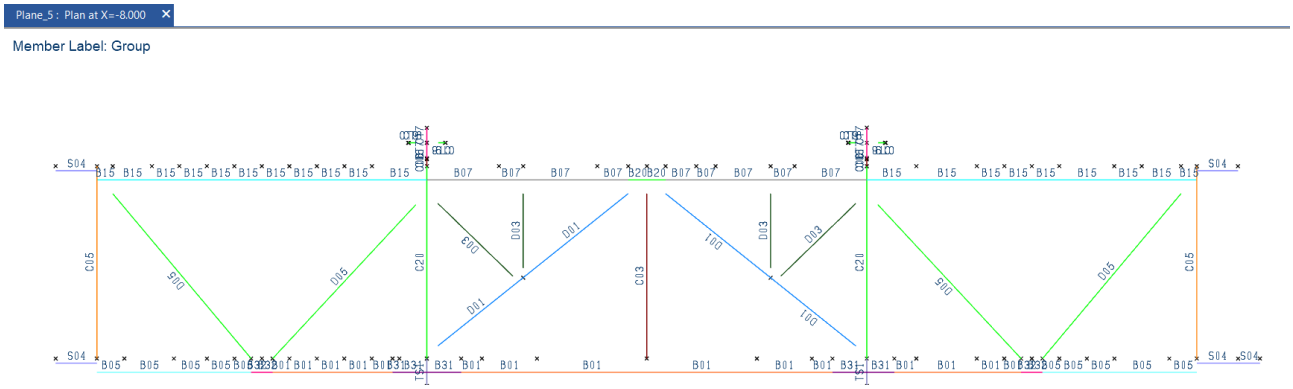
Plane_3 : Plan at X=0.0

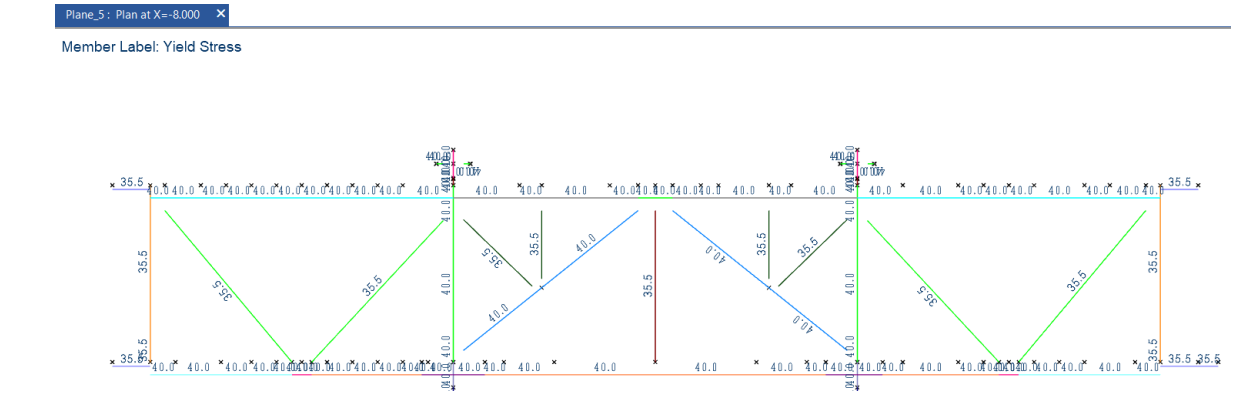
Member Label: Lb



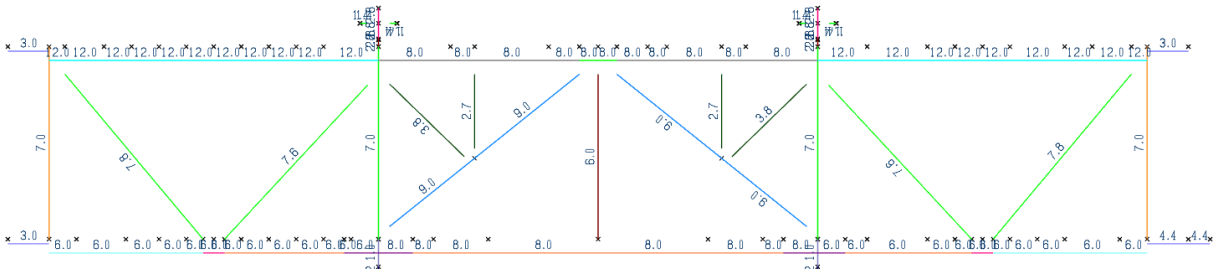

Plane_4 : Plan at X=0.0
Member Label: AB Release

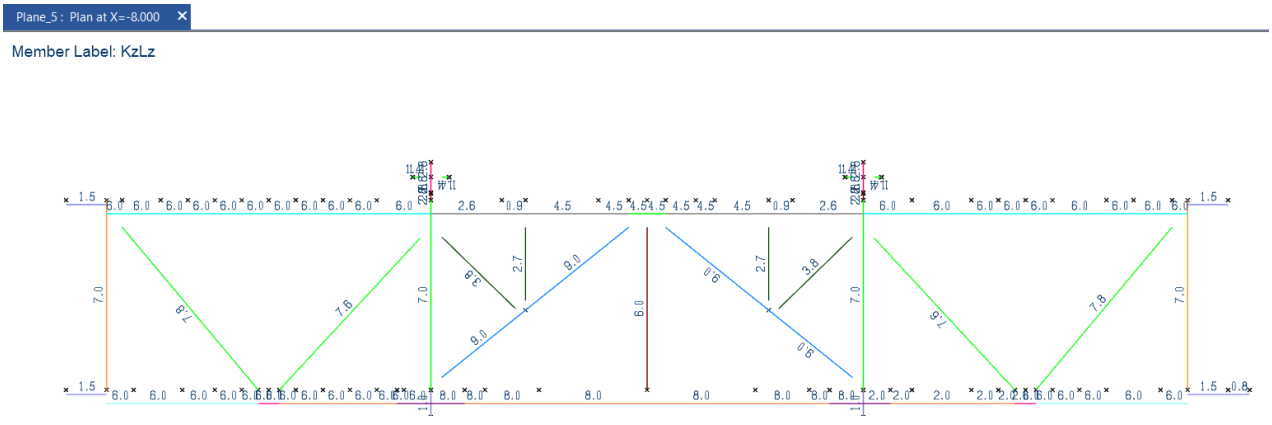

Plane_5 : Plan at X=-8.000
Joint Label: Name

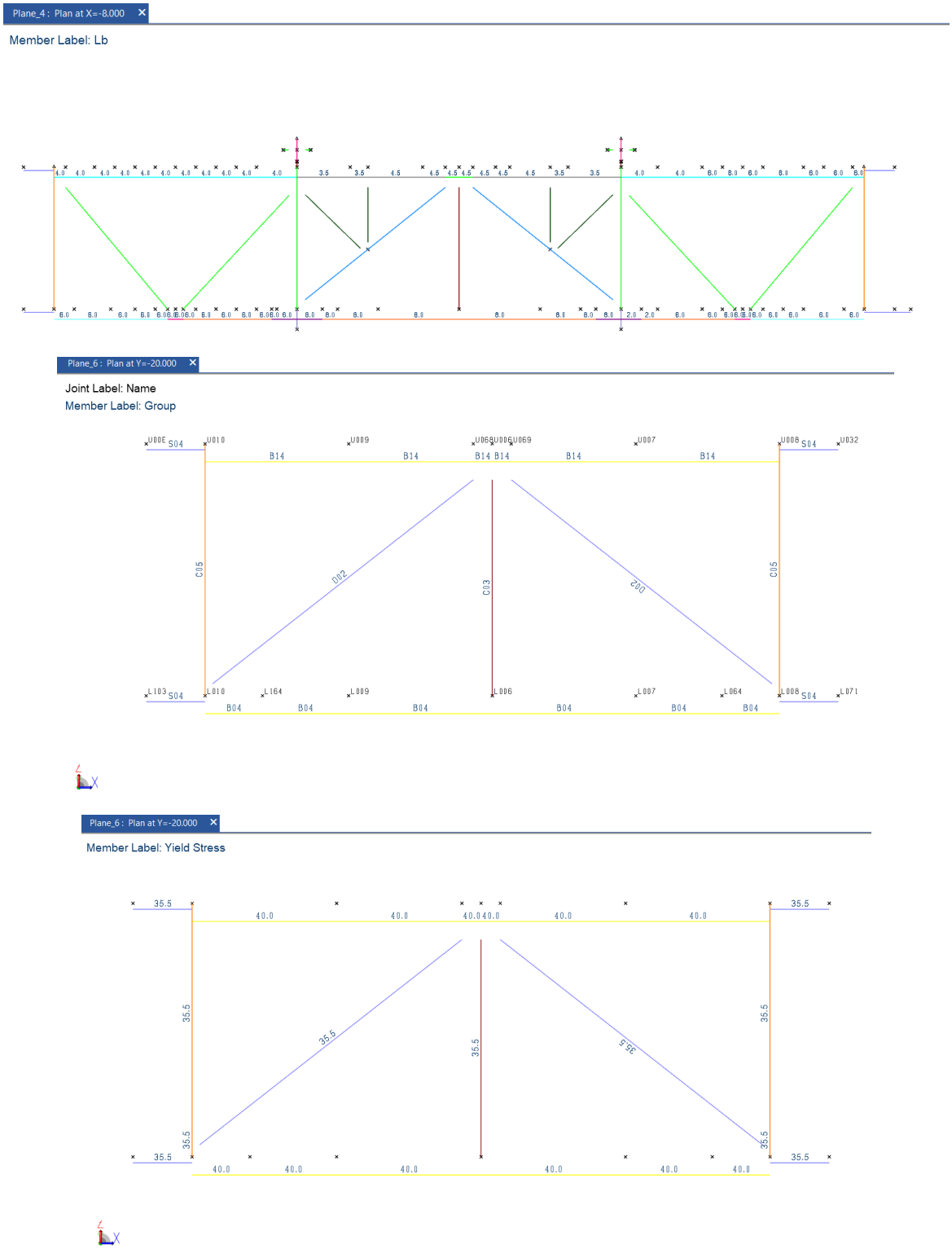

Plane_5 : Plan at X=-8.000
Member Label: Group

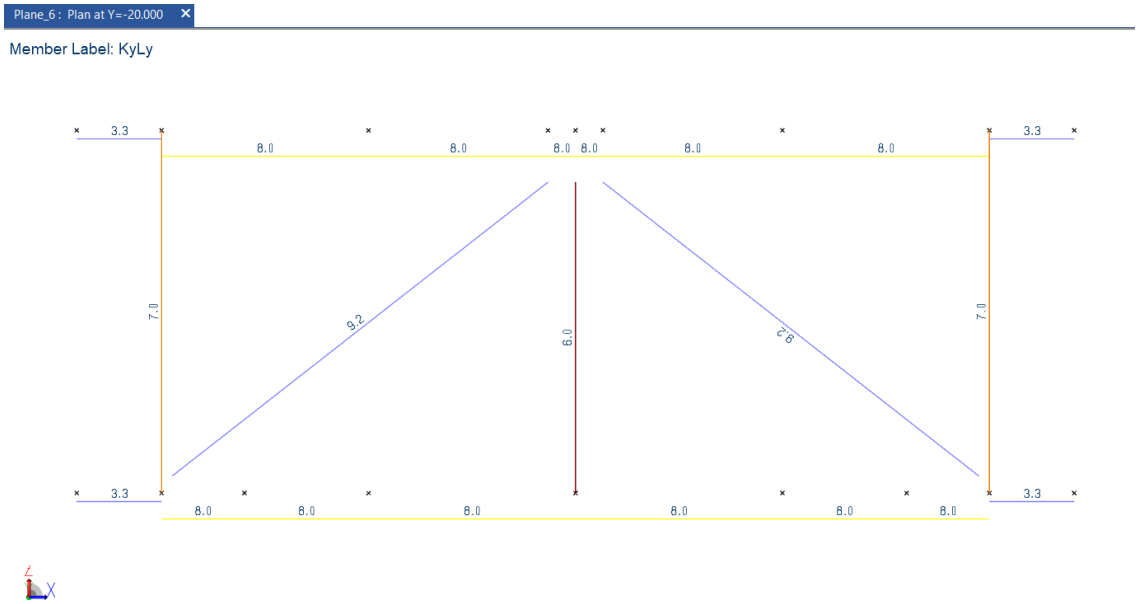


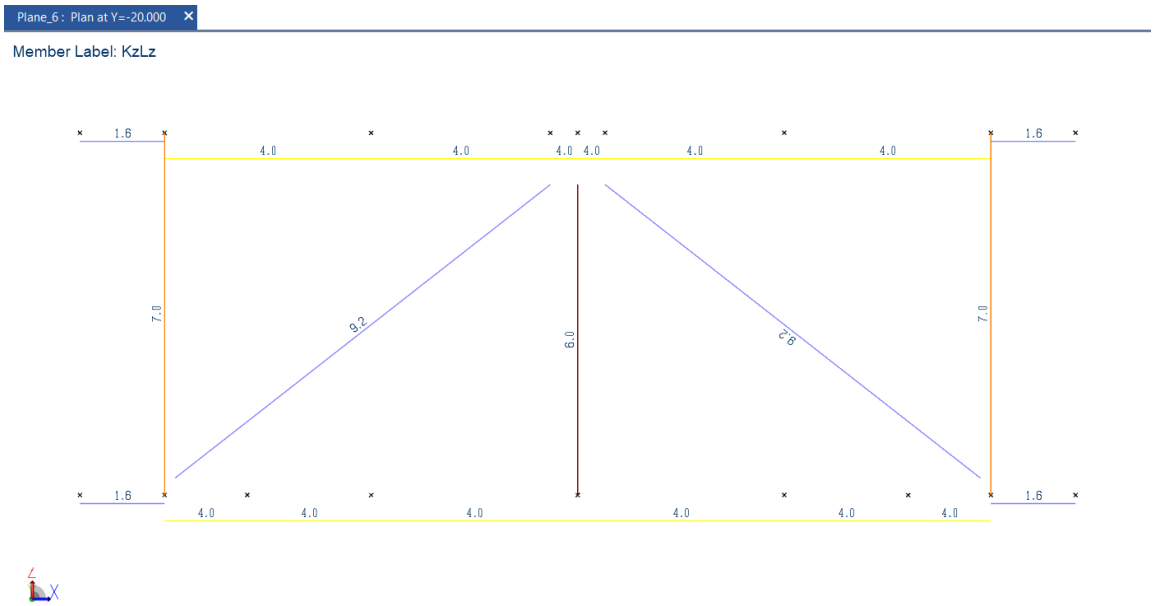
Member Label: KyLy

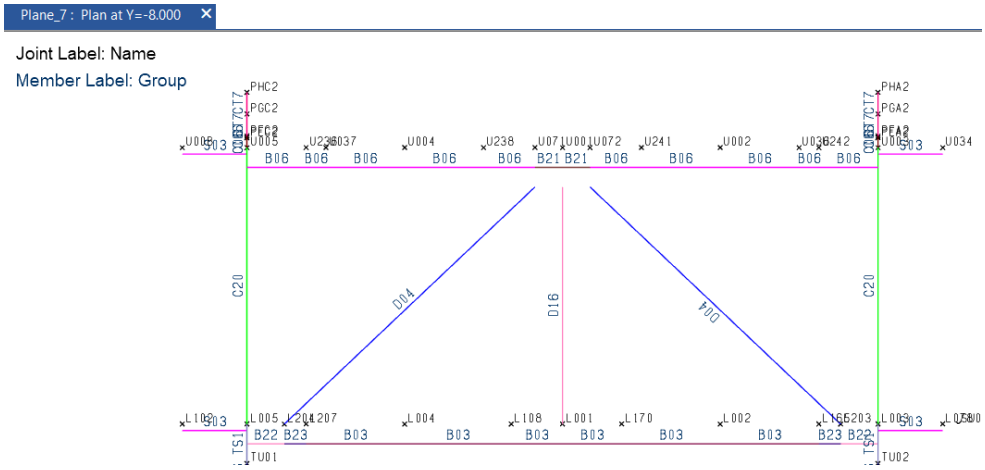


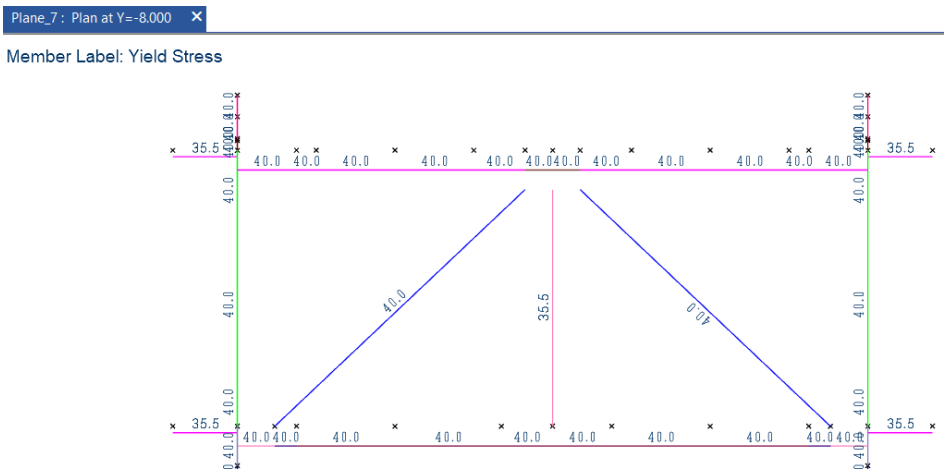


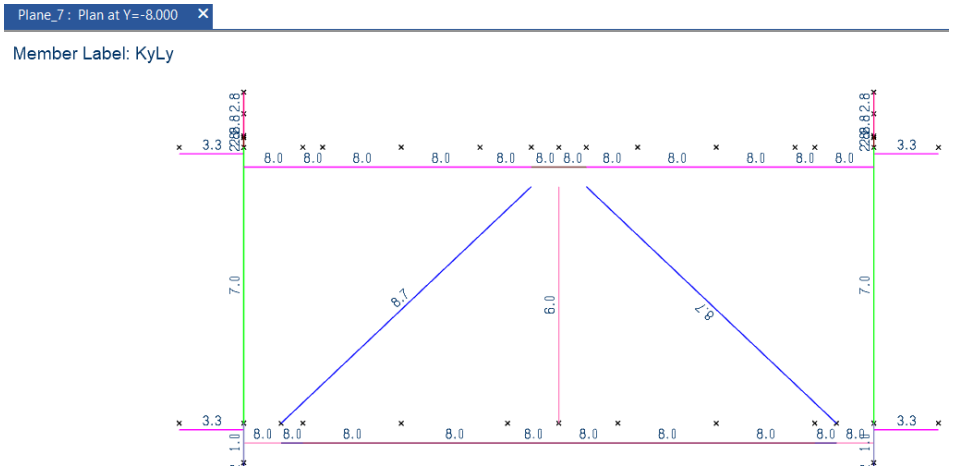

Plane_4 : Plan at X=-8.000
Member Label: Lb
Plane_6 : Plan at Y=-20.000
Joint Label: Name
Member Label: Group
Plane_6 : Plan at Y=-20.000
Member Label: Yield Stress

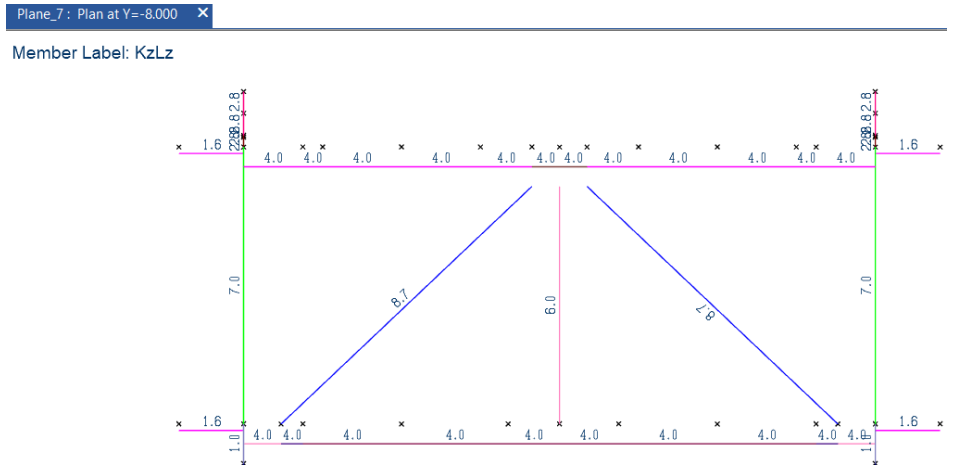

Plane_6 : Plan at Y=-20.000
Member Label: KyLy
3.3
8.0
7.0
9.2
6.0

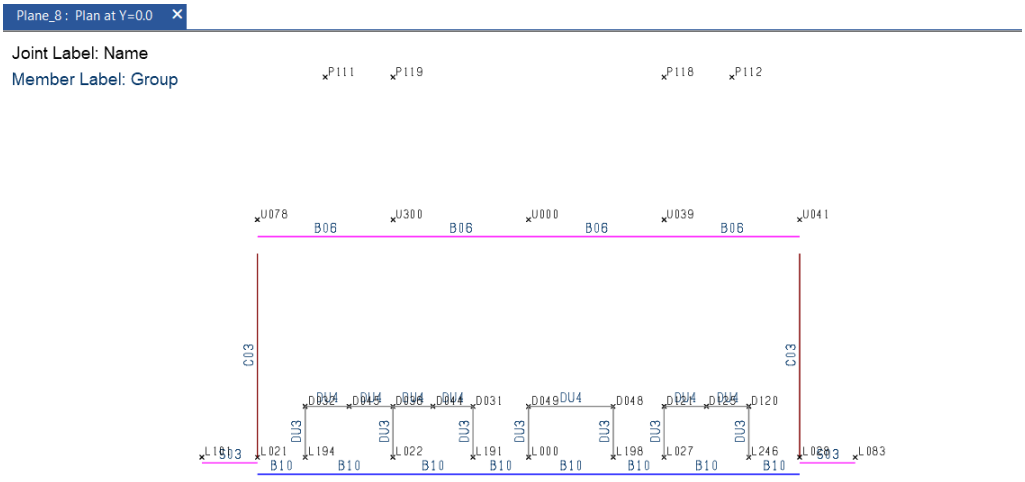

Plane_6 : Plan at Y=-20.000
Member Label: KzLz
1.6
4.0
7.0
9.2
6.0

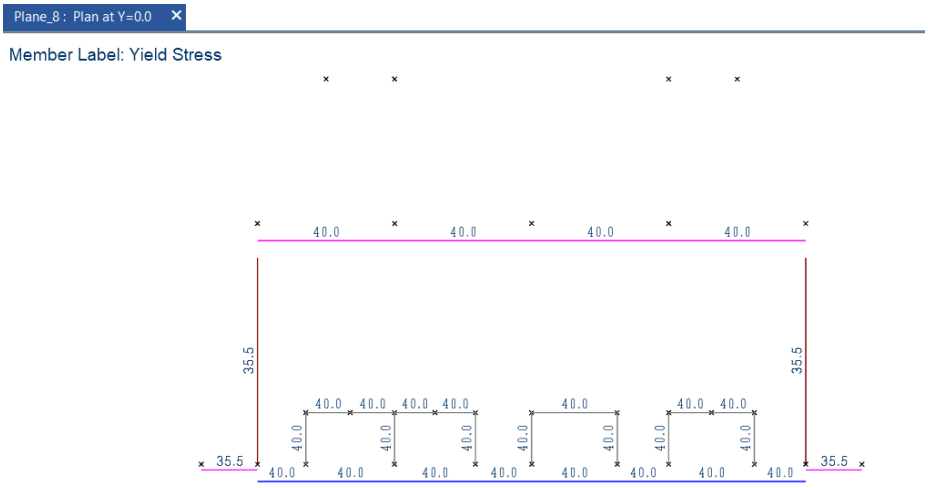

Plane_7 : Plan at Y=-8.000
Joint Label: Name
Member Label: Group
PHC2
PGC2
PHA2
PGA2
C20
D04
D16
TS1
TS2
TU01
TU02

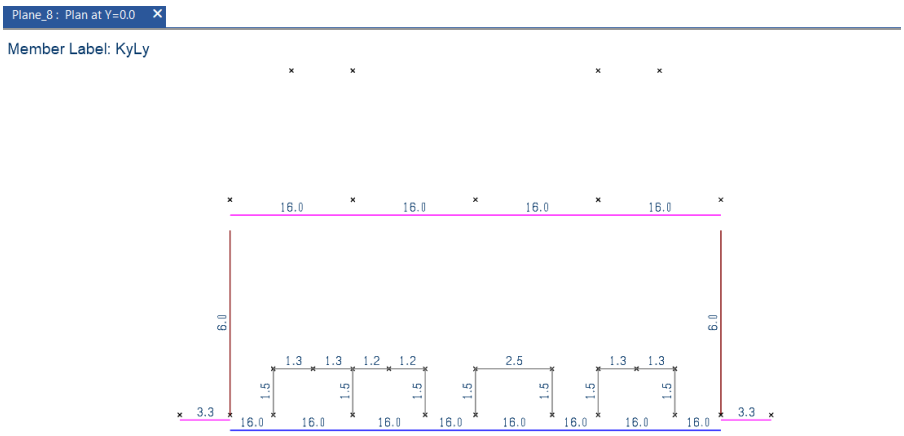

Plane_7 : Plan at Y=-8.000
Member Label: Yield Stress
35.5
40.0

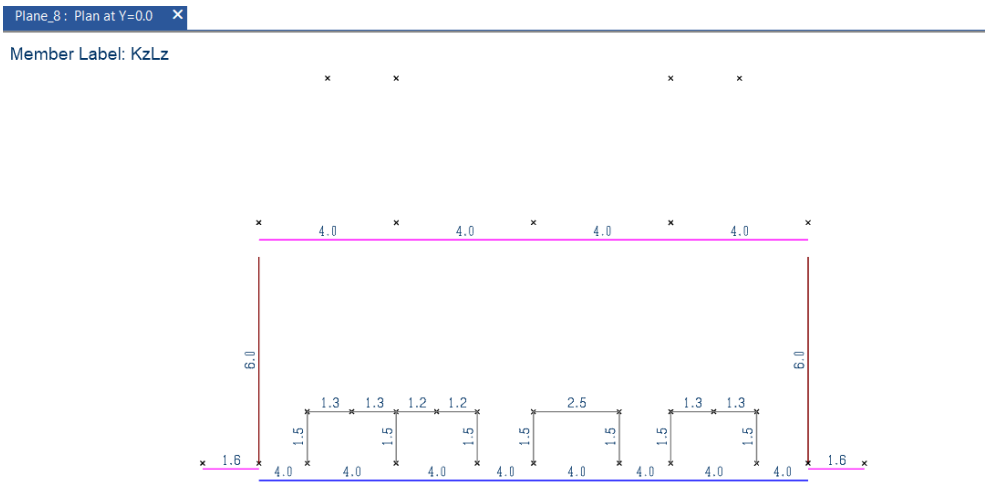

Plane_7 : Plan at Y=-8.000
Member Label: KyLy
3.3
8.0
7.0
8.7
6.0
1.0

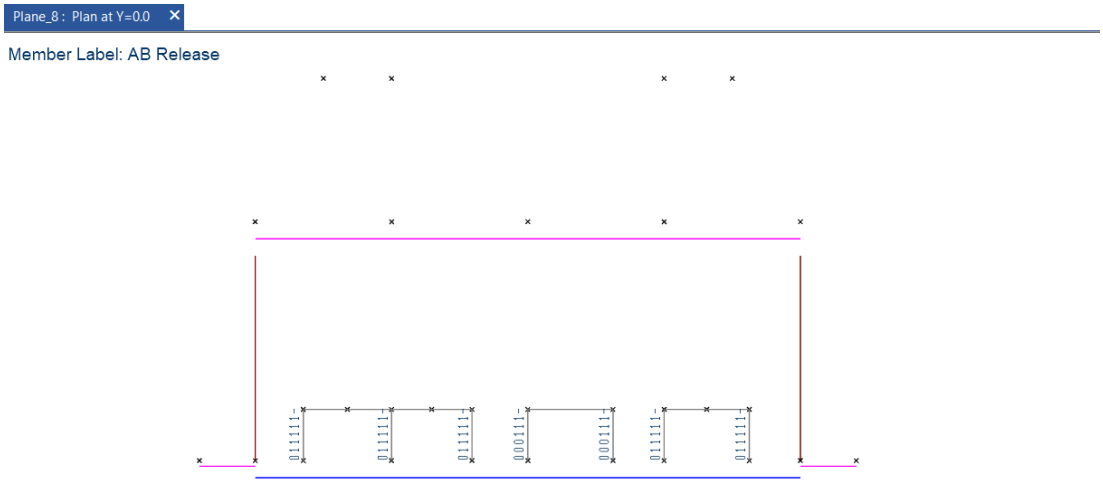

Plane_7 : Plan at Y=-8.000
Member Label: KzLz
1.6
4.0
7.0
8.7
6.0
1.0

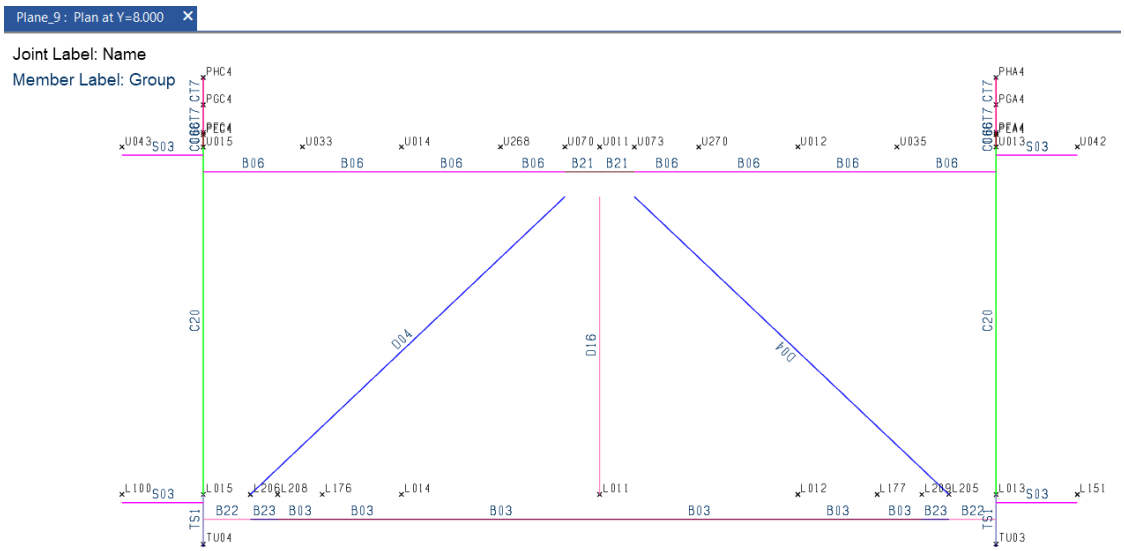

Plane_8 : Plan at Y=0.0
Joint Label: Name
Member Label: Group
P111
P119
P118
P112
U078
U300
U000
U039
U041
B06
C03
DU4
DU3
B10

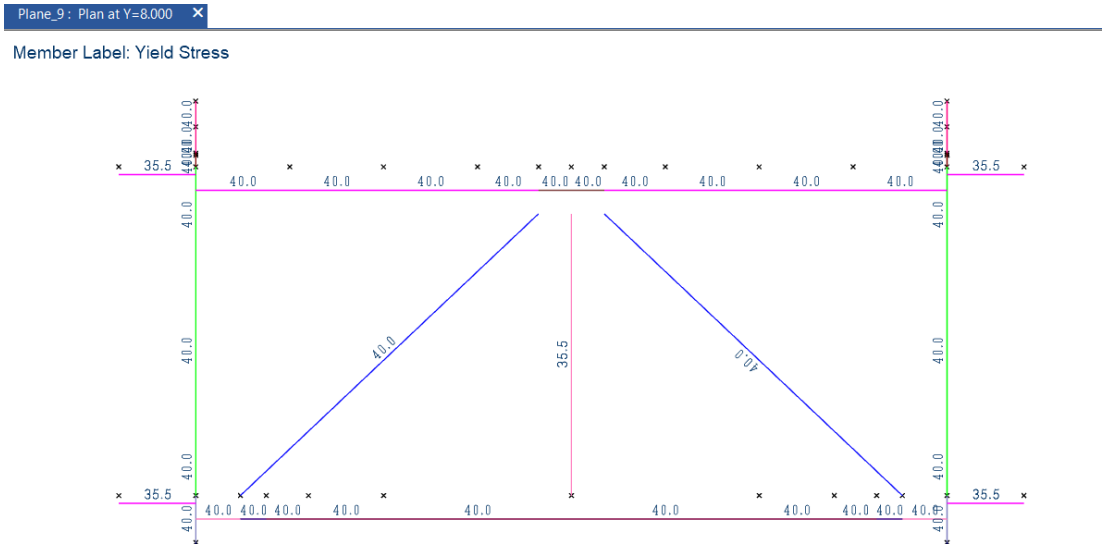

Plane_8 : Plan at Y=0.0
Member Label: Yield Stress
40.0
35.5

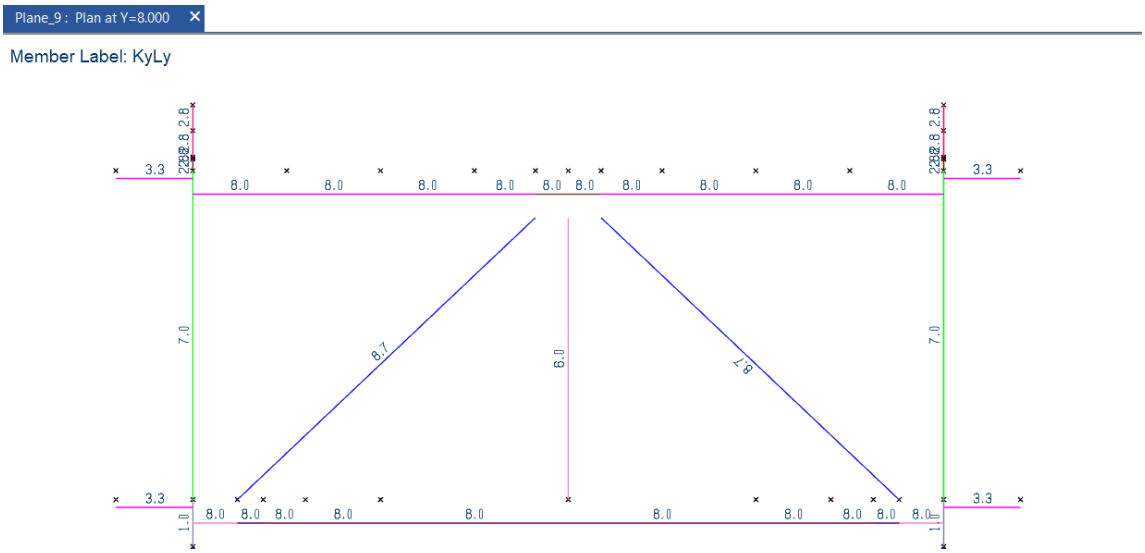

Plane_8 : Plan at Y=0.0
Member Label: KyLy
16.0
6.0
3.3
1.3
1.2
2.5
1.5

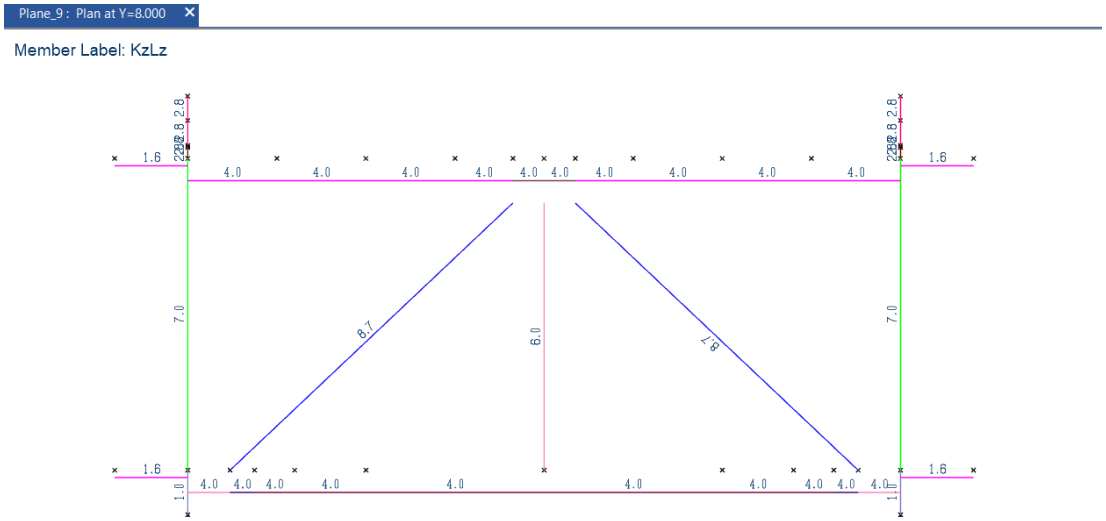

Plane_8 : Plan at Y=0.0
Member Label: KzLz
4.0
6.0
1.6
1.3
1.2
2.5
1.5

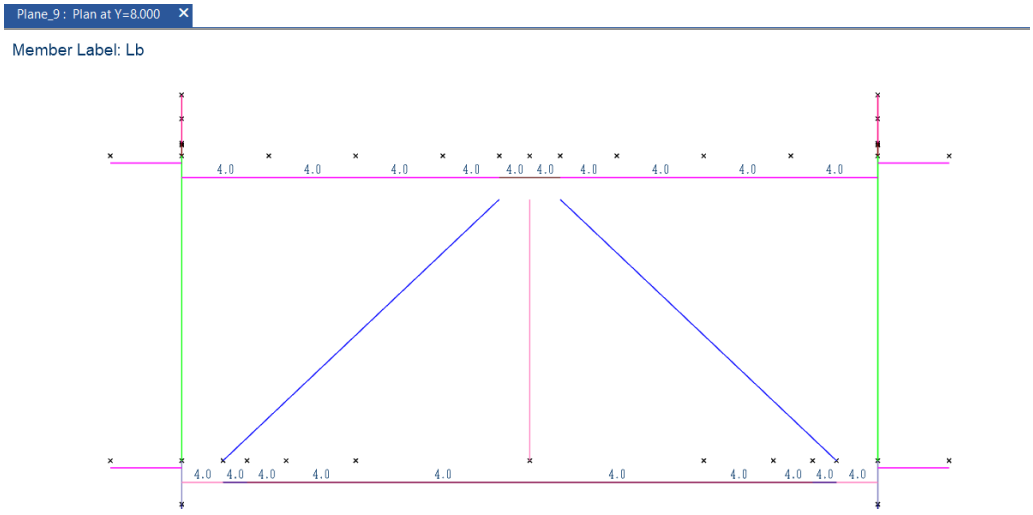

Plane_8 : Plan at Y=0.0
Member Label: AB Release

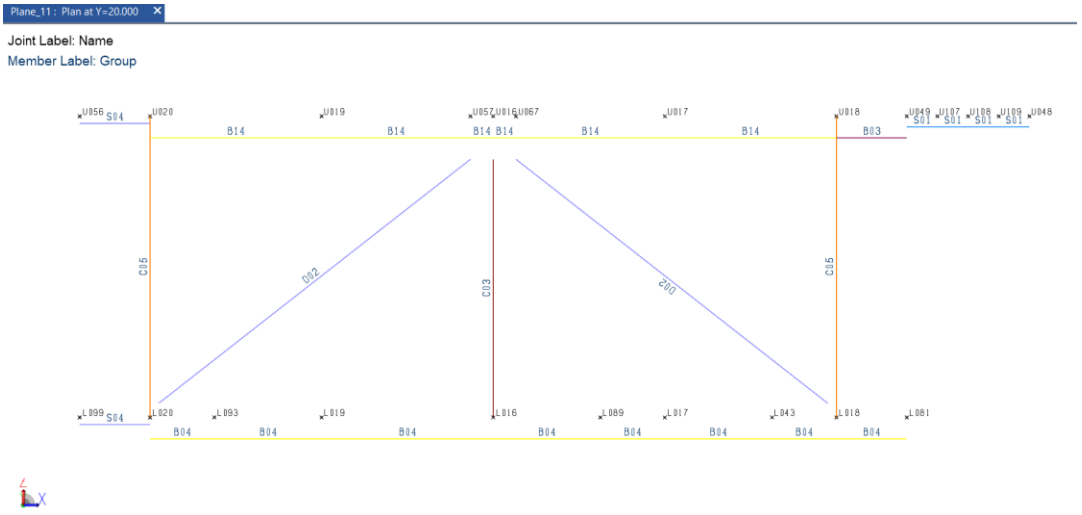

Plane_9 : Plan at Y=8.000
Joint Label: Name
Member Label: Group
PHC4
PGC4
PEC4
PHA4
PGA4
PEA4
C066T17 C17
U043
S03
U015
U033
U014
U268
U070
U011
U073
U270
U012
U035
U013
U042
B06
B21
C20
D04
D16
D00
L100
L015
L206
L208
L176
L014
L011
L012
L177
L209
L205
L013
L151
B22
B23
B03
TS1
TU04
TU03

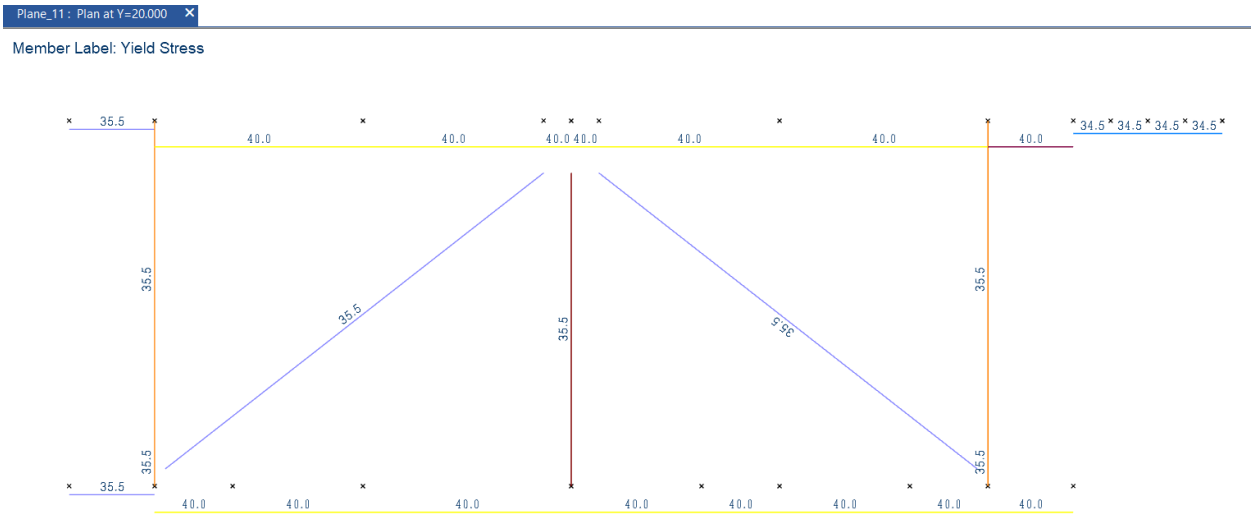

Plane_9 : Plan at Y=8.000
Member Label: Yield Stress
35.5
40.0
35.5


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

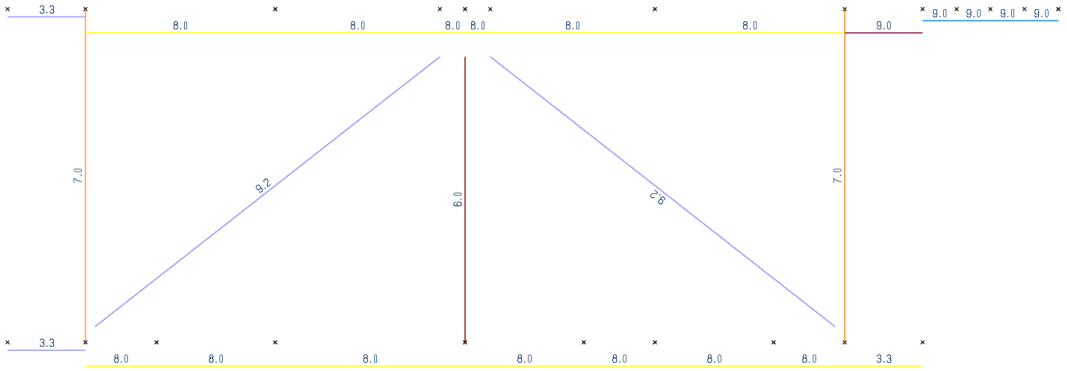

Plane_9 : Plan at Y=8.000
Member Label: KzLz
1.6
4.0
7.0
8.7
6.0
1.0


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

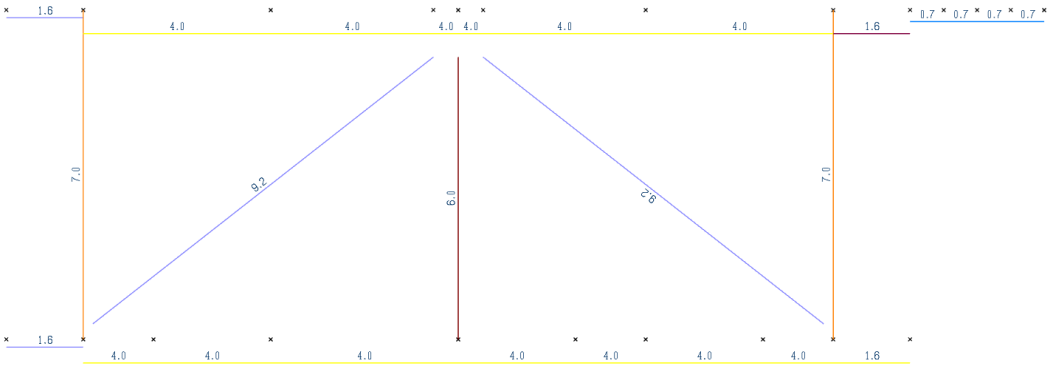
Member Label: KyLy



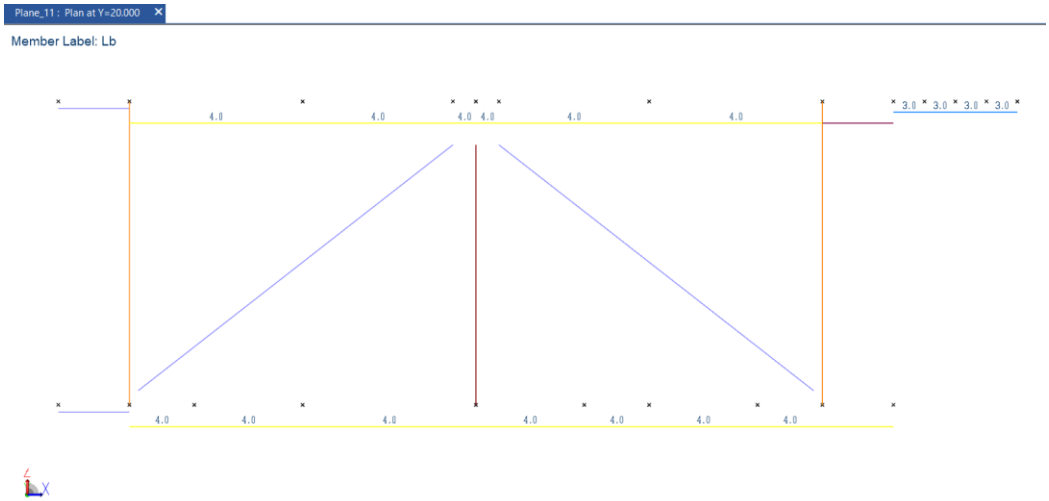


Plane_11 : Plan at Y=20.000

Member Label: KzLz






Plane_11 : Plan at Y=20.000
Member Label: Lb
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
4.0
3.0
3.0
3.0
3.0