Base Load Power Hub (BLPH)

BLPH Platform Caisson Frame Loadout Analysis

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APPENDIX A – MEMBER GROUPS AND SECTION PROPERTIES

APPENDIX B - WIREFRAME SCHEMES

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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.

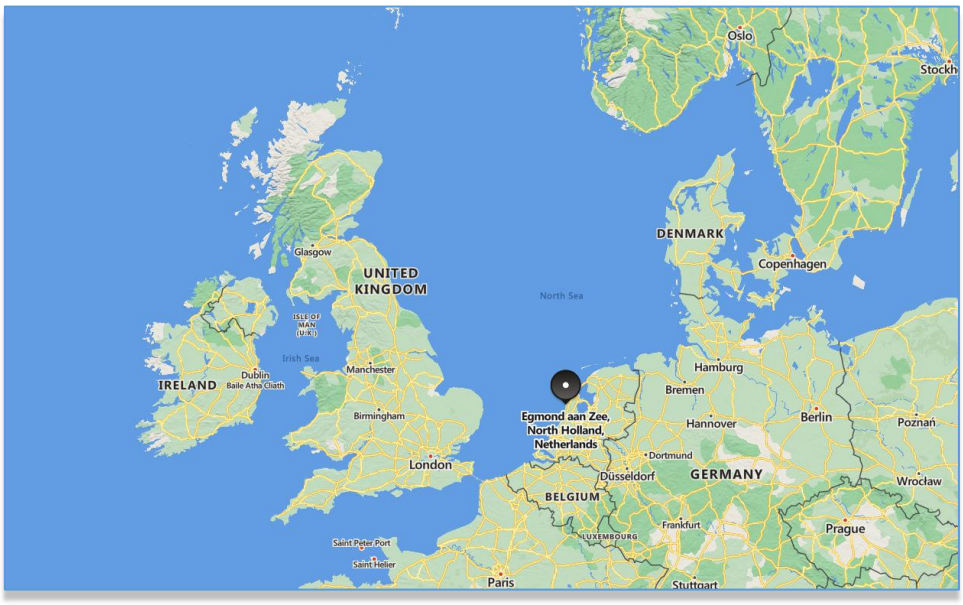


Figure 1.1 - HOLLANDSE KUST NOORD WIND PARK Location Map

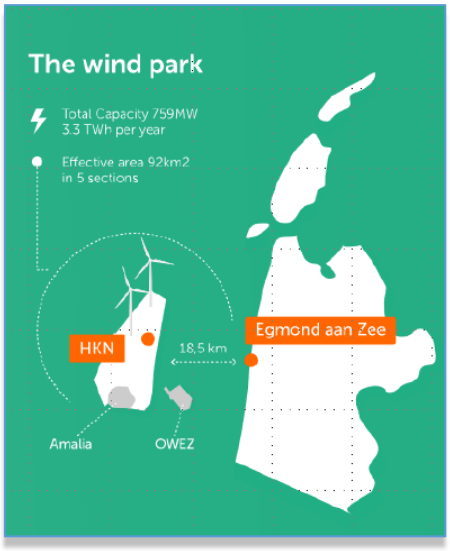


Figure 1.2 - Wind Park Details

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.

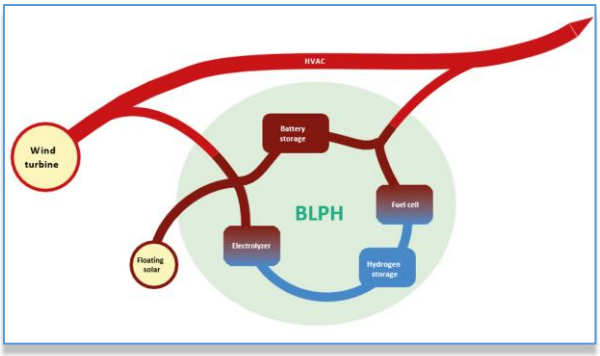


Figure 1.3 – BLPH Concept

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.

2 DOCUMENT SCOPE

The objective of this report is to present the results of the structural analysis performed on the BLPH Caisson Frame structure during the loadout phase.

Loadout is planned to be performed by lifting using yard crane, thus report covers the lifting analysis.

Lifting slings design and selection is presented in the yard instruction and is covered in a separate document.

The analysis has been performed in compliance with the requirements, criteria and parameters reported in the Structural Design Premises, Ref./16/. Lifting analysis is performed in accordance with DNV-ST-N001, Ref./9/.

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

All structural analyses have been carried out using the structural analysis program SACS, the proprietary software developed by Bentley, Ref. /29/.

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/ DNV-ST-N001	DNV - Marine operation and marine warranty - 2021
/10/ DNV-RP-C201	DNV, Buckling Strength of Plated Structures, October 2010.
/11/ DNV-ST-0145	DNV, Offshore substations
/12/ DNV-ST-0126	Support structures for wind turbine, 2018

3.2 COMPANY SPECIFICATIONS

Doc. No.	Description
/13/ DEP 37.19.00.12	Gen - Offshore Topsides Structures
/14/ DEP 37.19.00.30	Gen - Fixed Steel Offshore Structures (Adoption of IOGP S-631-11, Amendments / Supplements to ISO 19902:2020).
/15/ DEP 37.81.10.19	Gen - Marine Operations Requirements – Lifting, Transportation and Installation of Offshore Structures (Amendments / Supplements to ISO 19901-6)

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3.3 PROJECT DOCUMENTS

Doc. No.	Description
/16/ 123A90-DDL-ST-SP-90017	Structural Design Basis
/17/ 123A90-DDL-MD-RE-01006	Monthly Weight Report – Rev.03
/18/ 123A90-DDL-PP-DS-70070	Plot Plans
/19/ 123A90-DDL-ST-SP-90018	Structural Material Specification for Topside and TP
/20/ 123A90-DDL-TI-SP-99014	Specification for TP, Topside and Caissons Transportation and Installation
/21/ 123A90-DDL-ST-TN-90119	Evaluating ISO and DNV approaches
/22/ 123A90-DDL-ST-RE-90015	CF – In service, lifting and Transportation Design Report
/23/ 123A90-DDL-ST-DD-90094	Caisson frame – Elevations
/24/ 123A90-DDL-ST-DD-90095	Caisson frame - Details
/25/ 123A90-DDL-ST-DD-90096	Caisson frame - Details
/26/ 123A90-DDL-TI-DD-99015	BLPH Platform – Barge Layout
/27/ 123A90-DDL-TI-DD-99047	CF – Grillage drawing
/28/ 123A90-DDL-TI-DD-99048	CF – Sea Fastening drawing

3.4 SOFTWARE

Doc. No.	Description
/29/ 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
BLPH	Base Load Power Hub
CL	Concentrated Load
CF	Caisson Frame
CoG	Centre of Gravity
CW	CrossWind
DAF	Dynamic Amplification Factor
El.	Elevation
EPCI	Engineering Procurement Construction and Installation
HAT	Highest Astronomical Tide
HKN	Hollandse Kust Noord
LAT	Lowest Astronomical Tide
LRFD	Load and Resistance Factor Design
MSL	Mean Sea Level
NTE	Not-to-Exceed
PG	Plate Girder
SHL	Static Hook Load
T&I	Transport & Installation
ToS	Top of Steel
CsF	Consequence Factor
UC	Unity Check
UDL	Uniformly Distributed Load
UG	Upper grillage

Table 4.1 - Definitions and Abbreviations

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5 SUMMARY AND CONCLUSIONS

The analyses performed show that the CF can withstand the maximum loads can be experienced during loadout by lifting. The software SACS™, ref./29/, is used for all global analyses of the structures in the SOW.

Structural model of CF is the same used for transportation analysis, Ref. /22/.

Lifting sling will be used folded around tubular members.

5.1 MEMBER CHECKS

Structural members with maximum Unity Check (UC) are detailed in the following table. The maximum UC of CF results 0.42, including Consequence Factor = 0.42.

MEMBER	GROUP	DESCRIPTION	SECTION	COMBINATION	UC
700 - 702	TR3	Bracket – TR3 support	168.3X14.27	2001	0.42
900 - 902	TR1	Brine Caisson	323.9x28.58	2001	0.37

Table 5.1 – Member UC Summary

5.2 TUBULAR JOINT CHECKS

Structural tubular joints with maximum Unity Checks (UC) for punching shear are all lower than 0.2.

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6 CAISSON FRAME DESCRIPTION

The caisson frame is designed to structurally connect n.2 seawater lift caissons and n.1 brine discharge caisson to the Monopile CW70.

The monopile is supplied with N. 6 stubs for support of the caisson frame. These are arranged in pairs at N. 3 elevations (El. +14.5m LAT, El. +7m LAT and El. 0.00m LAT) and cannot be modified or moved as monopile CW70 is already installed in the wind farm. All the supports will be surveyed offshore prior to proceed with caisson loadout.

The support concept is that the CF form a structure similar to the boat landing frame, which has been successfully installed by Van Oord on monopile.

The brine caisson is "piggy-backed" off the CF. it is positioned on the outside of the CF and terminates 6m above the inlet to the seawater lift pump caissons. This to avoid, as far as possible, cross-contamination of waste brine water being dumped overboard with fresh seawater drawn for electrolysis.

The seawater lift caissons contain submersible pumps, so the caissons must be vertical.

6.1 CF LIFTING ARRANGEMENT

The lifting is assumed to be performed by means of 4-slings converging to Crane main hook.

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. /19/. The material selection criteria are based on the requirements of ISO 19906:2019, ISO 19902:2020 and ISO 19901-3:2014. The materials are in accordance with the EN standard 10225:2019 and 10025:2019 and are suitable for plates, rolled sections and welded / seamless tubulars.

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

Table 7.1 - Material Selection, Ref /19/

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

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

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

Table 7.2 – Mechanical properties of Plates

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

Table 7.3 – Mechanical properties of Structural Seamless Tubulars

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

Table 7.4 – Mechanical properties for Structural Sections

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8 DESIGN CRITERIA AND REQUIREMENTS

8.1 GENERAL

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

8.2 PARTIAL RESISTANCE FACTORS

8.2.1 Partial Resistance Factors for Tubular Sections:

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

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

Table 8.1- Resistance Factors for Tubular Sections

8.2.2 Partial Resistance Factors for 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 8.2 - Resistance Factors for Tubular Joints

8.3 PARTIAL ACTION FACTORS

8.3.1 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 8.3 with reference to three design situations, where:

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

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

Table 8.3 – Partial action factors for Pre-service Analyses

8.4 ACCEPTANCE CRITERIA

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

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9 BASIC LOAD CASES

All the design loads have defined according to the Weight Control Report and Plot Plans, respectively Ref./17/ and /18/, 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.

9.1 PERMANENT ACTIONS

Caisson frame self-weight as modelled and an additional 20% of not modeled weights (e.g. pins and polyurethane guide). The weights of the inner 6" string and pump are not insisting on CF.

9.2 TRANSIENT LOADS

9.2.1 Wind loads

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

10 STRUCTURAL ANALYSIS

10.1 STRUCTURAL MODEL

The software SACS™, ref./29/, is used for the lifting analysis of CF. The structural model of the CF is shown here below, and it is based on ref. to /22/.

CF is assumed to be loaded out using single hook and 2slings folded around the piggy-backed brine discharge pipe (323.9x28.58)

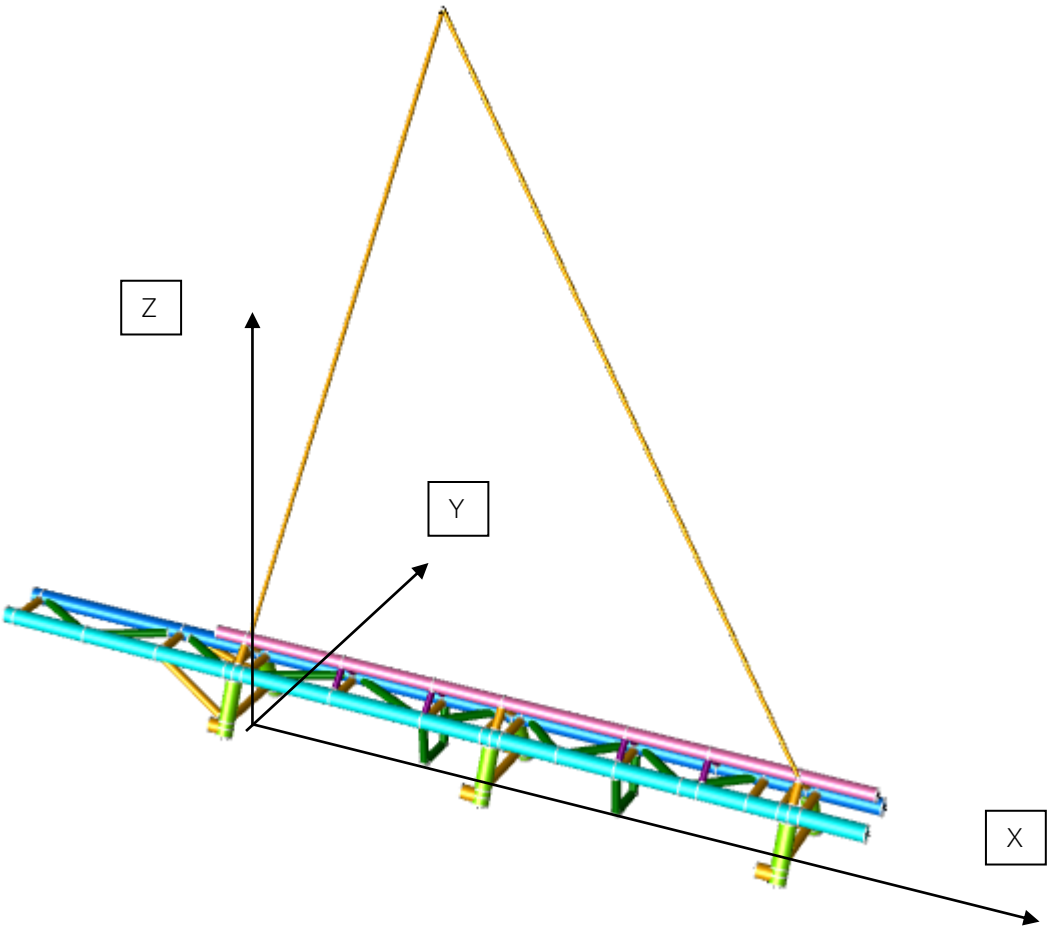


Figure 10.1 - CF structural model

The SACS reference system is in the center of the CF with X dir along CF length, Y-dir transversal and Z positive vertical measured from barge elevation (bottom of CF).

10.1.1 Boundary Conditions

The CF is vertically suspended from the Brine discharge pipe with 2 slings to hook point, being Its structure perfectly symmetrical.

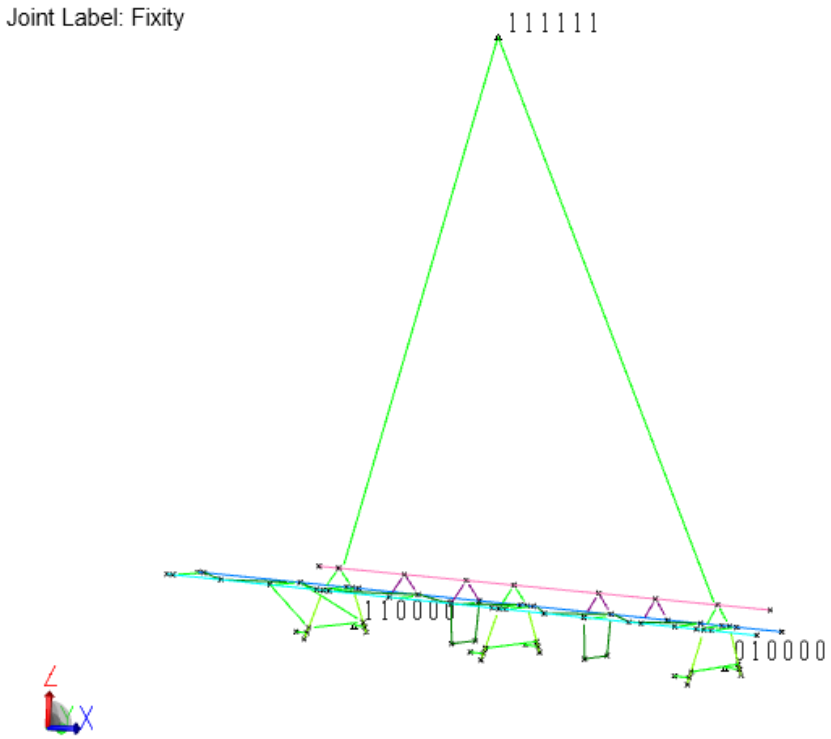


Figure 10.2 – CF fixities

Horizontal (isostatic) restrains have been applied to avoid numerical instability.

JOINT ID	Fixity	Comment
FX00	110000	Fixed in X and Y
FX20	100000	Fixed in X
HK00	111111	Hook point

Table 10.1 – CF restraints

The model includes a hook joint aligned with CoG position and elevation defined to have a minimum sling angle of 60 deg.

The slings are modeled with elements having axial stiffness only and are considered of Sling type and modelled according to section 16.2.6.11 of Ref. /9/.

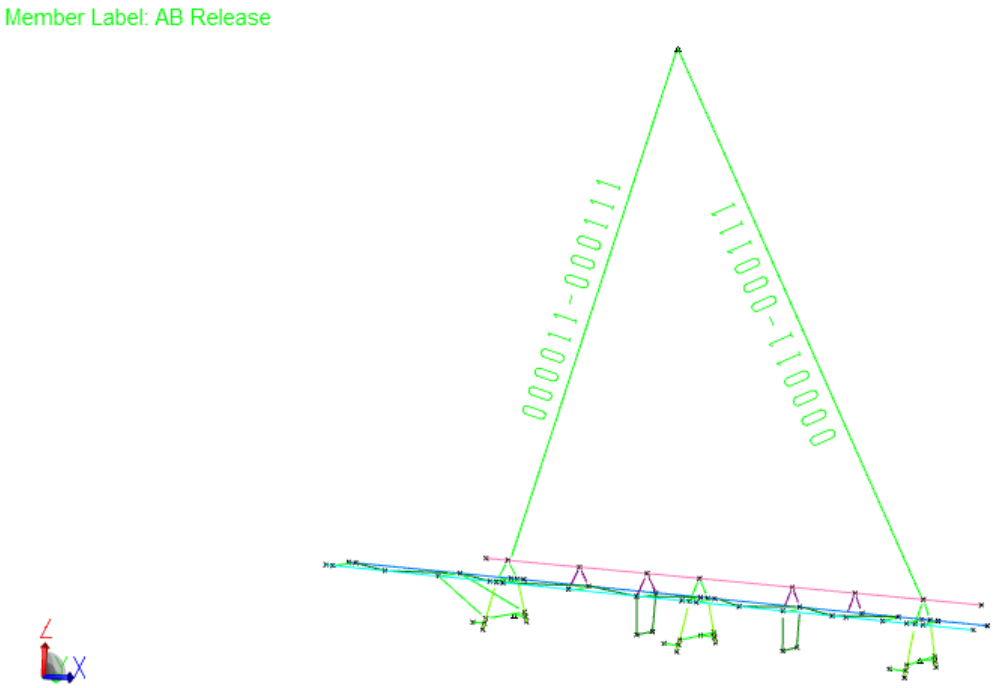


Figure 10.3 - Lifting Analysis – SACS Model – Sling Release

10.1.2 Cog Shift Load Conditions

For the purpose of CF lifting analyses for loadout operation, a factor 1.05 is considered to account for CoG shift resulting in an increased sling force.

11 LOAD COMBINATIONS

11.1 BASIC LOAD COMBINATIONS

Basic Load cases and load combinations detailed in chapter 9, 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. 8.3.1 for all the five positions of CoG.

11.1.1 Lift Coefficients

The following lift factors will be applied following the DNV code, Ref./9/, and in accordance with Structural Design basis, Ref./16/:

Weight contingency factor as Ref./9/, sec. 16.2.2.1	1.10
CoG shift Factor	1.05
DAF for the gross weight 300<W<1000 T, Ref./9/, Sect 16.2.5 for yard operation (onshore)	1.10

11.1.2 SKL Factor

The SKL factor is 1.00.

11.1.3 Consequence Factor: CsF

Consequence factor		Coefficients		
Description		**Lifting points**	**Other elements**	**Other elements**
Consequence Factors as per Ref./9/, section 16.2.2.1	Lift points, spreader bars	1.30		
	Non-redundant members framing into the lift point.			
	Load transferring redundant members framing directly into the lift point.		1.15	
	All other members of the lifted structure			1.00

Table 11.1 - Lift total factors for ULS lifting analyses

11.2 LOAD COMBINATIONS

The lifting combination 1001 is generated by applying the lift coefficients listed in section 11.1 to the C000 combination. On top of that, the dead load factor 1.30 as per ISO 19902 and ISO 19901-6 is applied.

Note, structure is all checked considering CsF = 1.30.

LOAD COMB	LOAD CASE	notes
	C000	
1001	1.30*(1.10*1.05*1.10) = 1.65	SLU combination
2001	1.30*(1.10*1.05*1.10)*1.30 = 2.15	With CsF

Table 11.2 - Load Combinations

Following excerpt from SACS output provide the Load Combinations resultants, with contingency, DAF, SKL and ULS factor included:

```
                                  ************* 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   DEAZ         0.00                                  0.00                                -288.22     6.28      0.00      5.60
  2   DEAC         0.00                                  0.00                                 -57.64     6.28      0.00      5.60
  3   C000         0.00                                  0.00                                -345.87     6.28      0.00      5.60
  4   1001         0.00                                  0.00                                -570.69     6.28      0.00      5.60
  5   2001         0.00                                  0.00                                -743.62     6.28      0.00      5.60
```

And also including the CsF = 1.30:

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

  5   2001         0.00                                  0.00                                -743.62     6.28      0.00      5.60
```

Table 11.3 - Load Combinations center report

12 ANALYSIS RESULTS

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

- Joints reactions;
- Structural checks of structural members;
- Structural checks of tubular connections;
- Definition of the lifting slings loads;

12.1 JOINTS REACTIONS

The Hooks joint reactions are detailed in the next tables:

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)
HK00	C000	8.599	-1.177	328.385	0.000	0.000	0.000
	1001	14.189	-1.941	541.834	0.000	0.000	0.000
	2001	18.489	-2.530	706.032	0.000	0.000	0.000

Table 12.1 – Fixed hooks Joint reactions

And the reactions at the restrained joints (used to delete numerical instability):

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)
FX00	C000	-8.599	1.401	0.000	0.000	0.000	0.000
	1001	-14.189	2.311	0.000	0.000	0.000	0.000
	2001	-18.489	3.012	0.000	0.000	0.000	0.000
FX20	C000	0.000	-0.224	0.000	0.000	0.000	0.000
	1001	0.000	-0.370	0.000	0.000	0.000	0.000
	2001	0.000	-0.482	0.000	0.000	0.000	0.000

Table 12.2 – Restrains reactions

12.2 STRUCTURAL CHECKS

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

12.2.1 Member checks

All members were checked according to ISO 19902 and Eurocode 3, Ref./6/and /8/, respectively for tubular and non-tubular elements.

12.2.1.1 Members framing into lifting points: CsF = 1.30

Members' code checks are reported in the following and show that the structure can withstand all load combinations, with utilization factors below 1.0.

```
                    SACS-IV   MEMBER UNITY CHECK RANGE SUMMARY

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

                  ** NO UNITY CHECKS IN THIS GROUP **

                    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 **
```

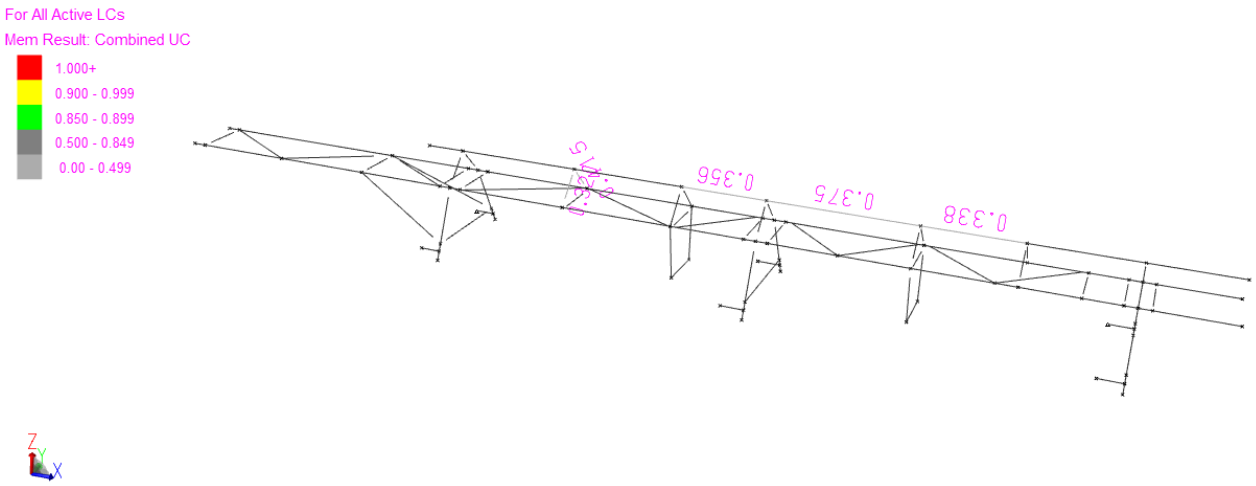


Figure 12.1 - CF Structural Model 3D view – U C> 0.30

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 19902:2007 / EC3:2005
                                  (EN 1993-1-1:2005/NA NONE)
                                                                                                                  EFFECTIVE      CM
GRUP CRITICAL LOAD  MAX.  DIST  * APPLIED STRESSES *    *** ALLOWABLE STRESSES ***   CRIT      LENGTHS    * VALUES *
 ID   MEMBER  COND UNITY FROM   AXIAL BEND-Y BEND-Z    AXIAL  EULER BEND-Y BEND-Z   COND     KLY    KLZ    Y      Z
      CHECK  END                                                                             M      M
                     M    N/MM2  N/MM2  N/MM2    N/MM2  N/MM2  N/MM2  N/MM2

CFA FX00- S00 2001  0.00  0.4     0.6    0.6    0.2   .3E+03 .4E+05 .4E+03 .4E+03   TN+BN    0.87   0.87   0.85   0.85
CFB  900- T00 2001  0.11  0.0     2.8   42.8    3.4    319.0 4578.0  437.7  437.7   TN+BN    2.80   1.22   0.85   0.85
CS1  800- 900 2001  0.15  0.2     0.8   11.4  -65.3    319.0  713.0  443.5  443.5   TN+BN    7.00   7.00   0.85   0.85
CS2  801- 901 2001  0.13  0.2     0.6  -13.1  -54.7    319.0  713.0  443.5  443.5   TN+BN    7.00   7.00   0.85   0.85
CS3  502- 602 2001  0.37  2.8   -27.4    4.3   17.6     83.0  108.9  456.0  456.0   ACBI    14.30  14.30   0.85   0.85
TR1  900- 902 2001  0.20  0.5    20.5   29.7   55.1   .3E+03 .4E+05 .5E+03 .5E+03   TN+BN    0.52   0.52   0.85   0.85
TR2  801- 700 2001  0.06  0.0    -0.8    0.2  -27.7    292.4 1467.4  453.9  453.9   ACBI     2.65   2.65   0.85   0.85
TR3  700- 702 2001  0.42  0.0    -2.7 -184.5    3.1   .3E+03 .2E+05 .5E+03 .5E+03   ACBI     0.55   0.55   0.85   0.85
```

12.2.1.2 Members not directly framing into lifting points: CsF 1.15

All the elements have been verified with CsF 1.30.

12.2.1.3 Other members: CsF 1.00

All the elements have been verified with CsF 1.30.

12.2.2 ULS Joint checks

All tubular joints punching shear checks and strength checks are detailed in following SACS excerpt and provide utilization factors lower than 1.0, according to ISO19902, ref./6/. All the verifications were performed against combination with CsF = 1.3.

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

	ORIGINAL					LOAD DESIGN						
JOINT	DIAMETER (CM)	THICKNESS (CM)	YLD STRS (N/MM2)	LOAD UC	STRN UC	DIAMETER (CM)	THICKNESS (CM)	YLD STRS (N/MM2)	LOAD UC	STRN UC	BRACE JOINT	LOAD CASE
902	32.390	2.858	345.000	0.180	0.211	32.390	2.858	345.000	0.180	0.211	900	2001
202	32.390	2.858	345.000	0.091	0.107	32.390	2.858	345.000	0.091	0.107	HK00	2001

12.3 LIFTING SLINGS INTERNAL ACTIONS

The lifting slings internal actions are presented in the following tables:

- Table 12.3 shows the results for all the load combinations.
- Table 12.4 shows the above actions without CsF and ULS factors, for the definition of slings MBL.

SACS-IV SYSTEM MEMBER FORCES AND MOMENTS

MEMBER NUMBER	MEMBER END	GROUP ID	LOAD CASE	FORCE(X) KN	FORCE(Y) KN	FORCE(Z) KN	MOMENT(X) KN-M	MOMENT(Y) KN-M	MOMENT(Z) KN-M
202-HK00	202	SL0	C000	119.59	-0.00	3.20	0.00	0.00	0.00
			1001	197.32	-0.00	5.28	0.00	0.00	0.00
			2001	257.12	-0.00	6.88	0.00	0.00	0.00
	HK00		C000	131.26	-0.00	-3.20	0.00	0.00	0.00
			1001	216.58	-0.00	-5.28	0.00	0.00	0.00
			2001	282.21	-0.00	-6.88	0.00	0.00	0.00
902-HK00	902	SL0	C000	210.99	0.00	1.96	0.00	0.00	0.00
			1001	348.13	0.00	3.23	0.00	0.00	0.00
			2001	453.63	0.00	4.21	0.00	0.00	0.00
	HK00		C000	222.66	0.00	-1.96	0.00	0.00	0.00
			1001	367.39	0.00	-3.23	0.00	0.00	0.00
			2001	478.72	0.00	-4.21	0.00	0.00	0.00

Table 12.3 – Slings internal actions

MEMBER NUMBER	MEMBER END	GROUP ID	LOAD CASE	FORCE(X) KN	FORCE(Y) KN	FORCE(Z) KN	MOMENT(X) KN-M	MOMENT(Y) KN-M	MOMENT(Z) KN-M
202-HK00	202	SL0	1001	197.32	-0.00	5.28	0.00	0.00	0.00
902-HK00	902	SL0	1001	348.13	0.00	3.23	0.00	0.00	0.00

Table 12.4 – Slings internal actions: sling selection

APPENDIX A – MEMBER GROUP AND SECTION PROPERTIES

****** SEASTATE INITIAL GROUP DESCRIPTION ******

GROUP LABEL	SECTION LABEL	***** AREAS **** CONST.	DISPL. (CM**2)	** DIAMETERS ** Y (CM)	Z	* SECTION * TYPE	* MATL. * LENGTH	* DENSITY (TONNE/M**3)	* JOINT * THICK (M.)	FLOOD	** DRAG AND INERTIA COEFFICIENTS ** CDY	CDZ	CMY	CMZ	CDT	CMT
CFA		285.67	989.80	35.50	35.50	TUB		7.849	0.000	NO	0.62	0.62	1.39	1.39	0.00	0.00
CFB		365.17	1297.17	40.64	40.64	TUB		7.849	0.000	NO	0.63	0.63	1.39	1.39	0.00	0.00
CS1		424.47	1297.17	40.64	40.64	TUB		7.849	0.000	YES	0.63	0.63	1.39	1.39	0.00	0.00
CS2		424.47	1297.17	40.64	40.64	TUB		7.849	0.000	YES	0.63	0.63	1.39	1.39	0.00	0.00
CS3		265.16	823.97	32.39	32.39	TUB		7.849	0.000	YES	0.61	0.61	1.39	1.39	0.00	0.00
SL0		77.75	78.54	10.00	10.00	TUB		7.849	0.000	NO	0.61	0.61	1.39	1.39	0.00	0.00
TR1		141.75	377.03	21.91	21.91	TUB		7.849	0.000	NO	0.61	0.61	1.39	1.39	0.00	0.00
TR2		115.21	377.03	21.91	21.91	TUB		7.849	0.000	NO	0.61	0.61	1.39	1.39	0.00	0.00
TR3		69.05	222.46	16.83	16.83	TUB		7.849	0.000	NO	0.61	0.61	1.39	1.39	0.00	0.00

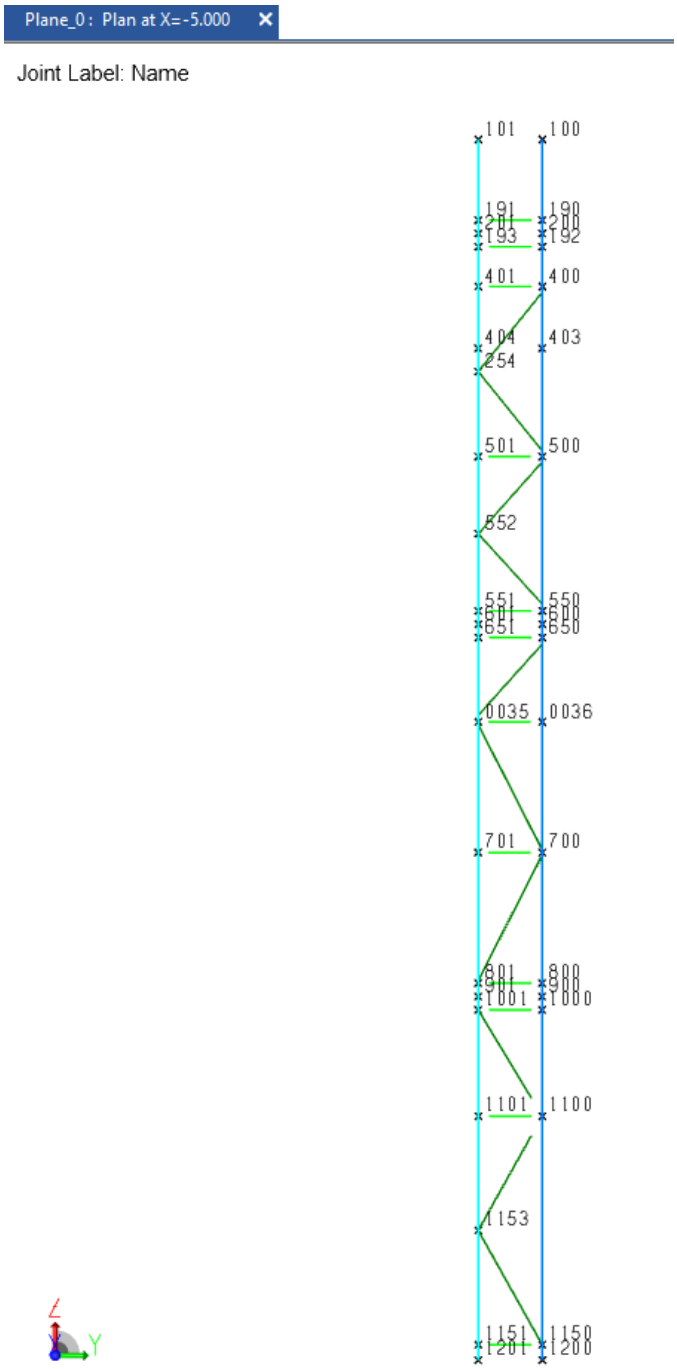
TECON - BLPH CAISSON FRAME LOADOUT (by LIFTING)

TUBULAR MEMBER PROPERTIES

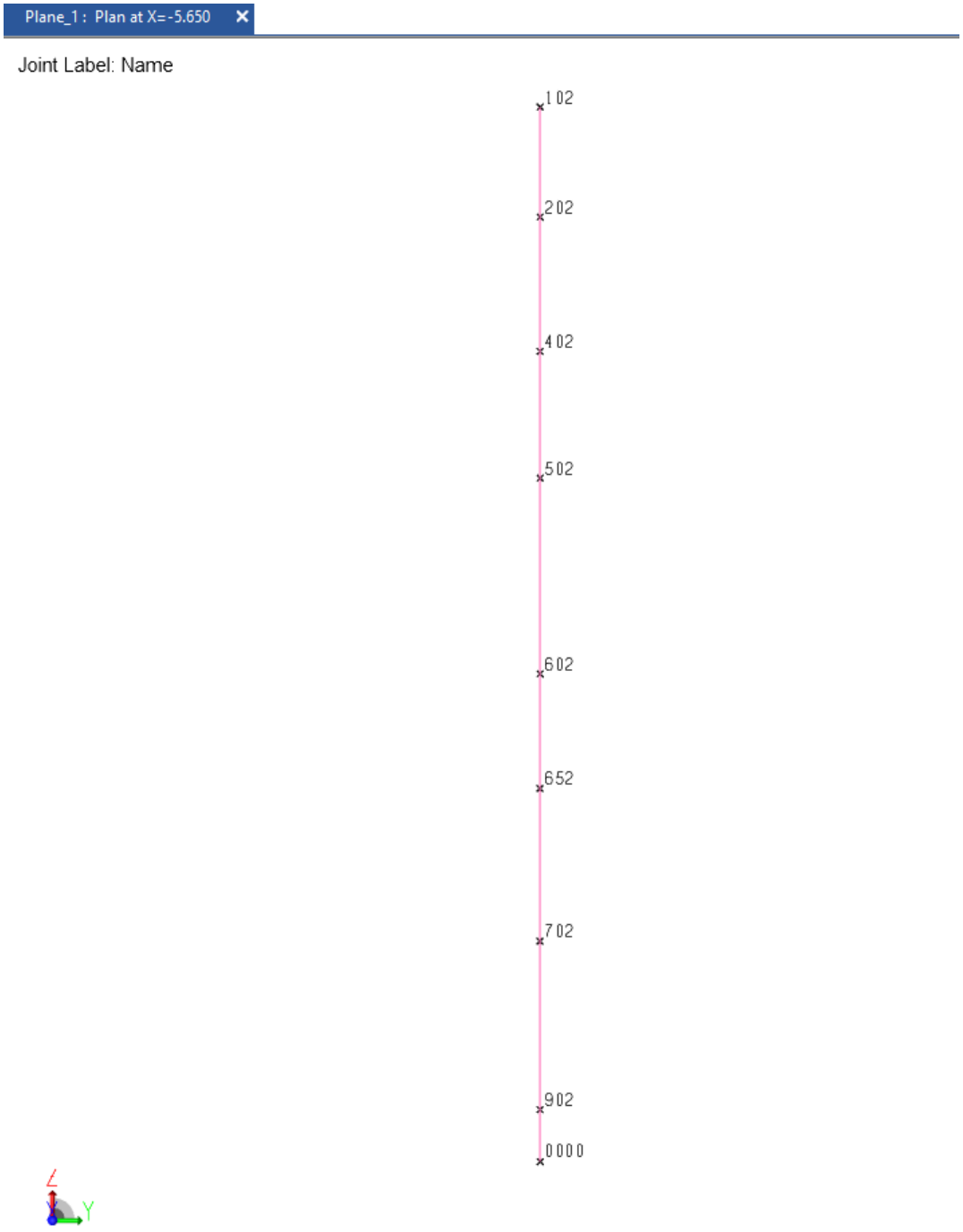
JOINT GRP	M/S	WALL THICK M	OUTSIDE THICK CM	E DIAM. CM	G 1000 KN/CM2	AXIAL 1000 KN/CM2	AREA CM**2	***** MOMENTS OF INERTIA **** X-X CM**4	Y-Y CM**4	Z-Z CM**4	YIELD STRESS KN/CM2	KY	KZ	SHEAR	RING AREA CM**2	SECT SPACE M	TAPER LENG M
CFA	1	0.00	2.779	35.50	20.5	7.7	285.67	77016.	38508.	38508.	33.5	1.0	1.0		142.84	0.00	0.00
CFB	1	0.00	3.096	40.64	20.5	7.7	365.17	0.12956E+06	64778.	64778.	33.5	1.0	1.0		182.58	0.00	0.00
CS1	1	0.00	3.653	40.64	20.5	7.7	424.47	0.14659E+06	73295.	73295.	33.5	1.0	1.0		212.24	0.00	0.00
CS2	1	0.00	3.653	40.64	20.5	7.7	424.47	0.14659E+06	73295.	73295.	33.5	1.0	1.0		212.24	0.00	0.00
CS3	1	0.00	2.858	32.39	20.5	7.7	265.16	58356.	29178.	29178.	34.5	1.0	1.0		132.58	0.00	0.00
SL0	1	0.00	4.500	10.00	25.0	8.0	77.755	981.66	490.83	490.83	50.0	1.0	1.0		77.75	0.00	0.00
TR1	1	0.00	2.301	21.91	20.5	7.7	141.75	13814.	6906.9	6906.9	34.5	1.0	1.0		70.88	0.00	0.00
TR2	1	0.00	1.826	21.91	20.5	7.7	115.21	11714.	5857.2	5857.2	34.5	1.0	1.0		57.61	0.00	0.00
TR3	1	0.00	1.427	16.83	20.5	7.7	69.053	4130.9	2065.4	2065.4	34.5	1.0	1.0		34.53	0.00	0.00

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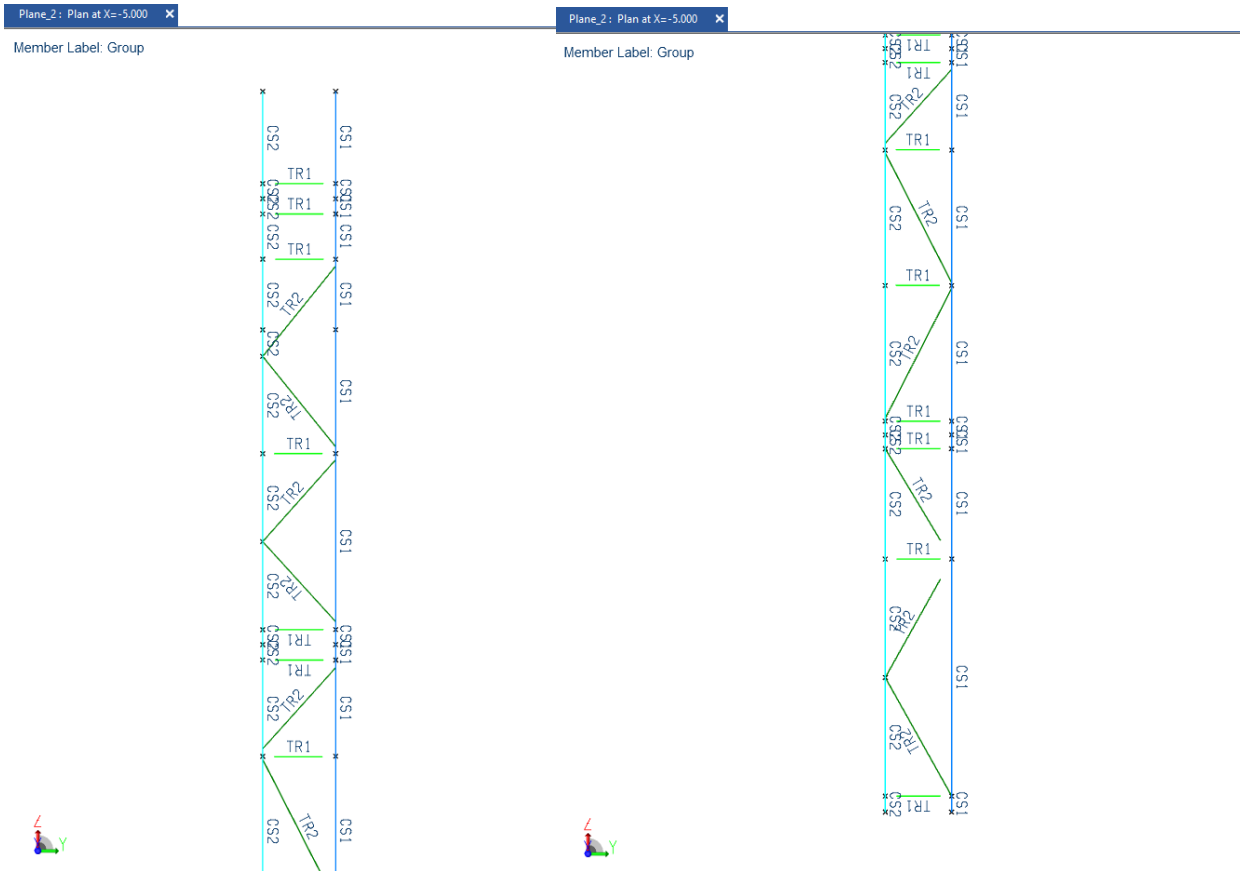
APPENDIX B – WIREFRAME SCHEMES



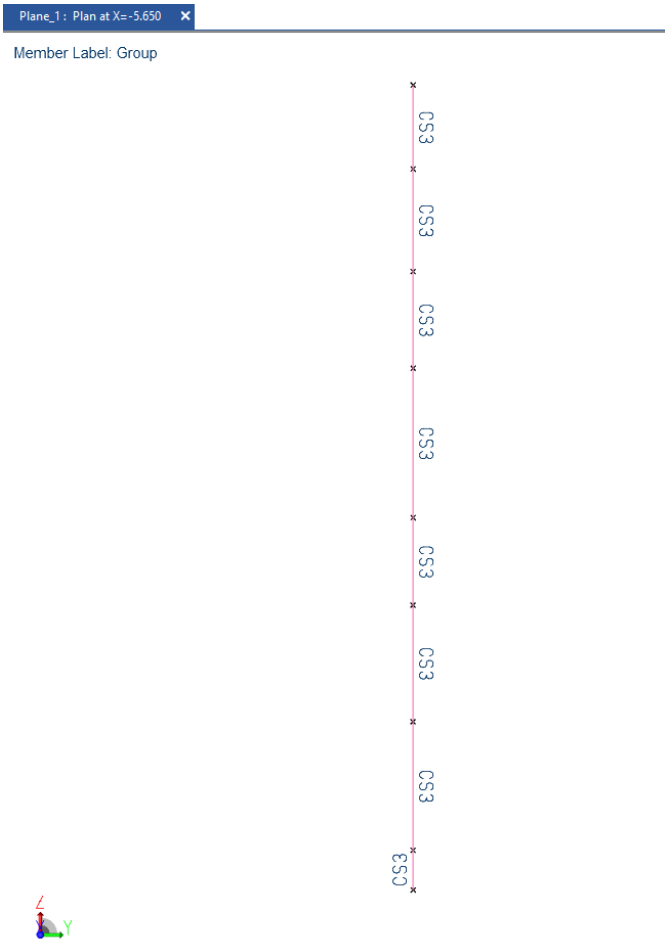
Seawater caissons frame – joints name



Brine discharge caisson – joints name

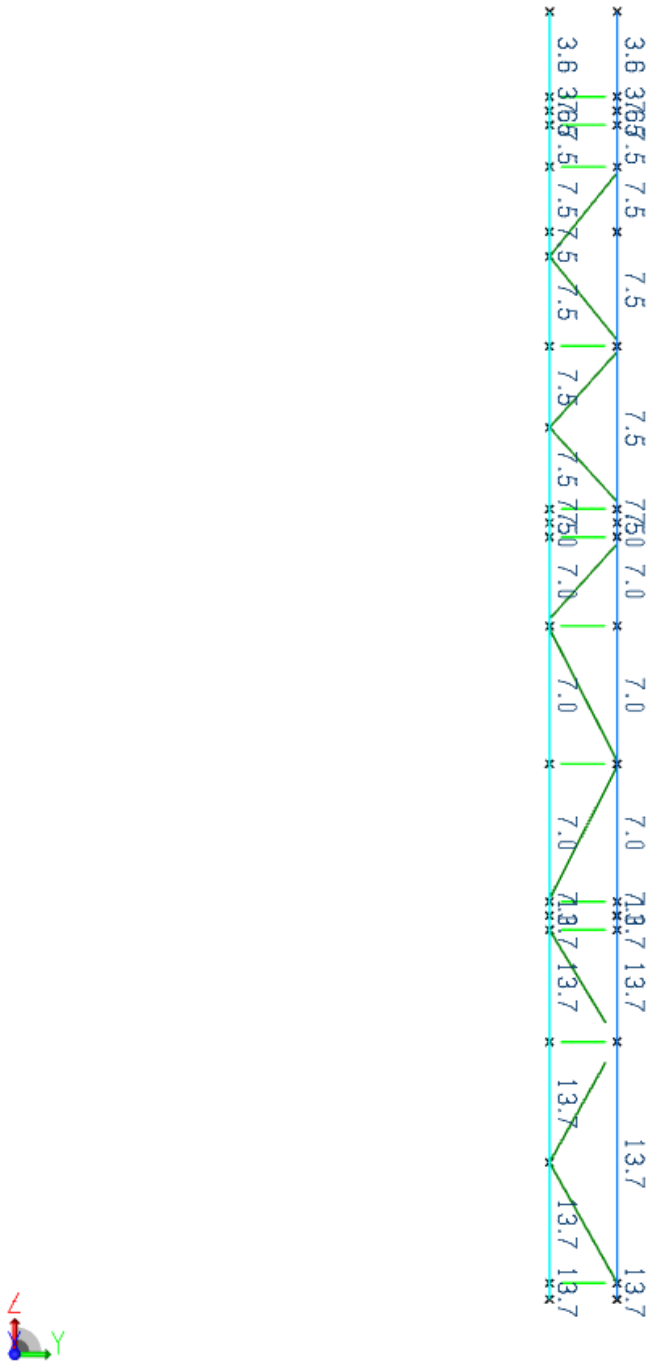


Seawater caissons frame – groups



Brine discharge caisson – groups

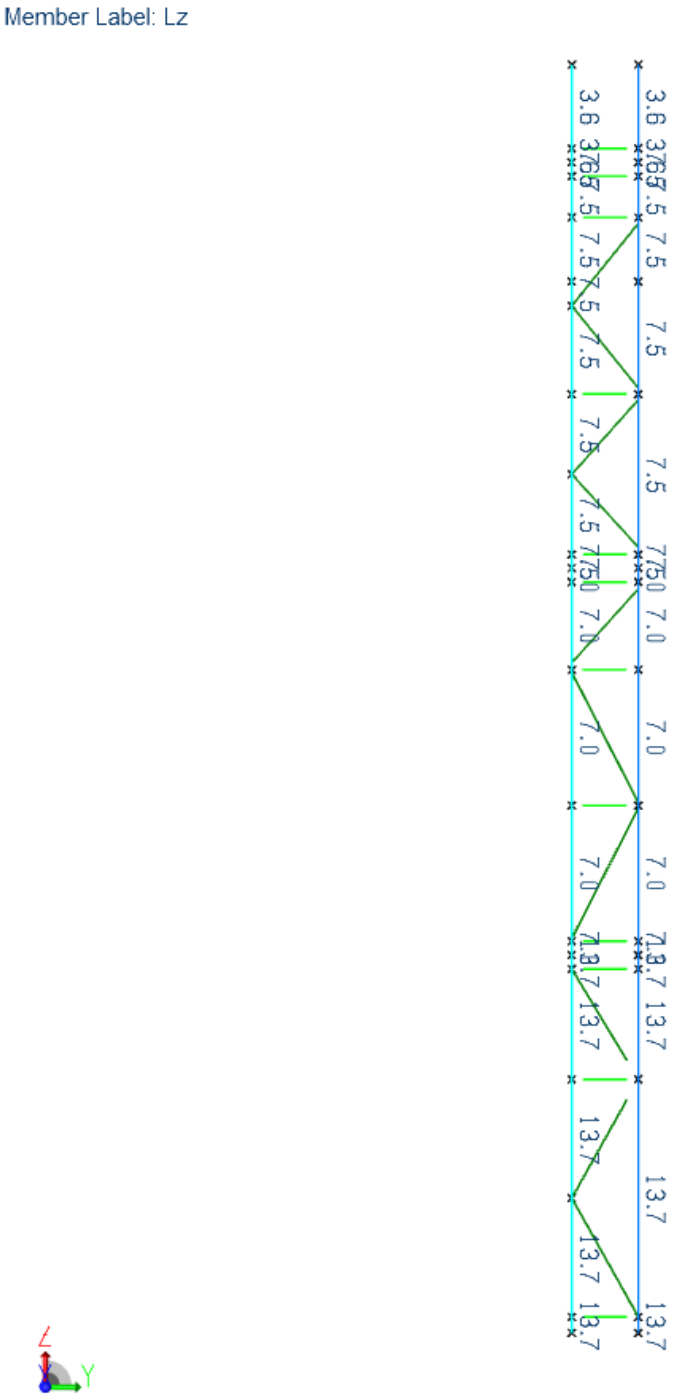
Member Label: Ly



Seawater caissons frame – Ly



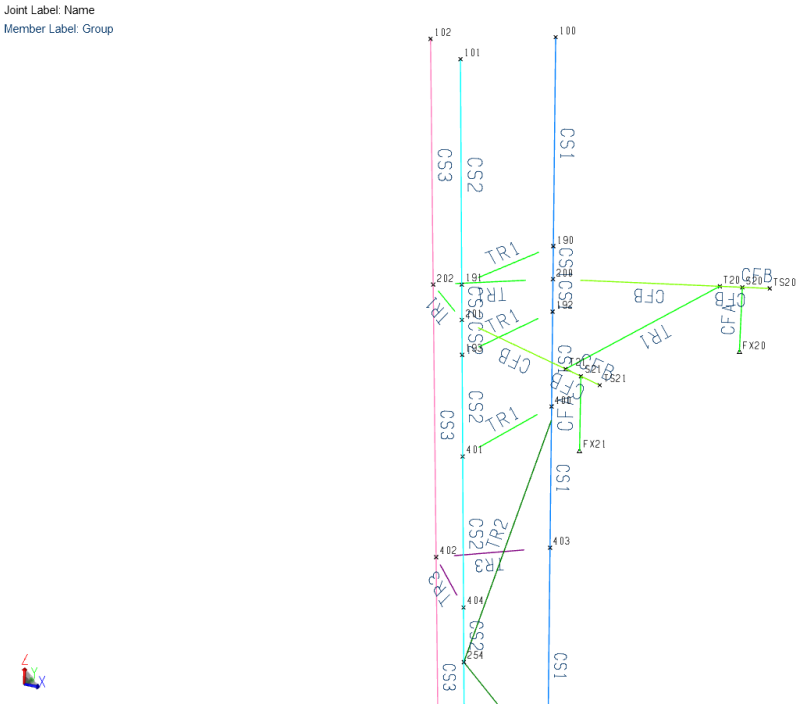
Brine discharge caisson – Ly



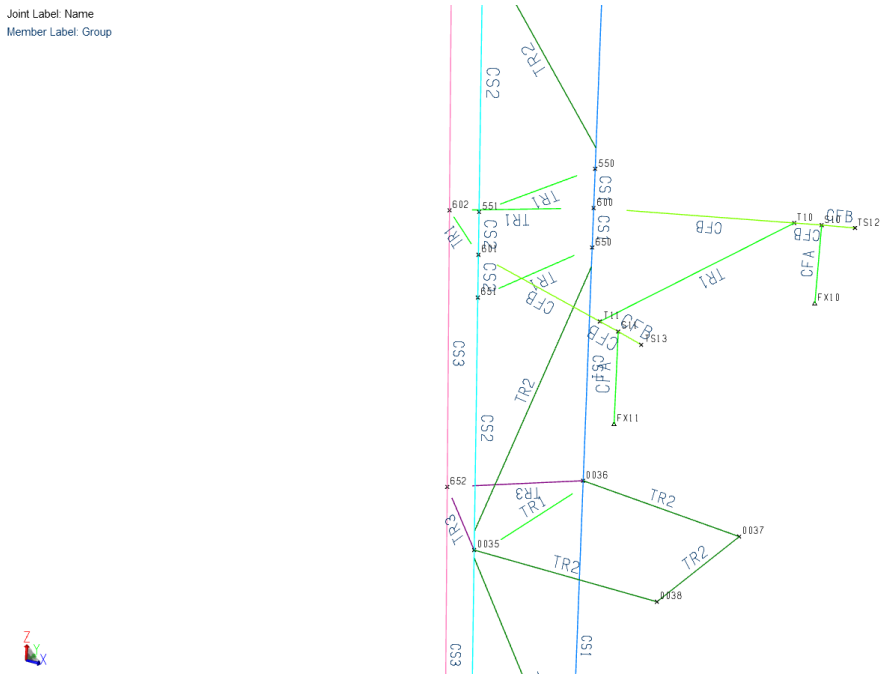
Seawater caissons frame – Lz



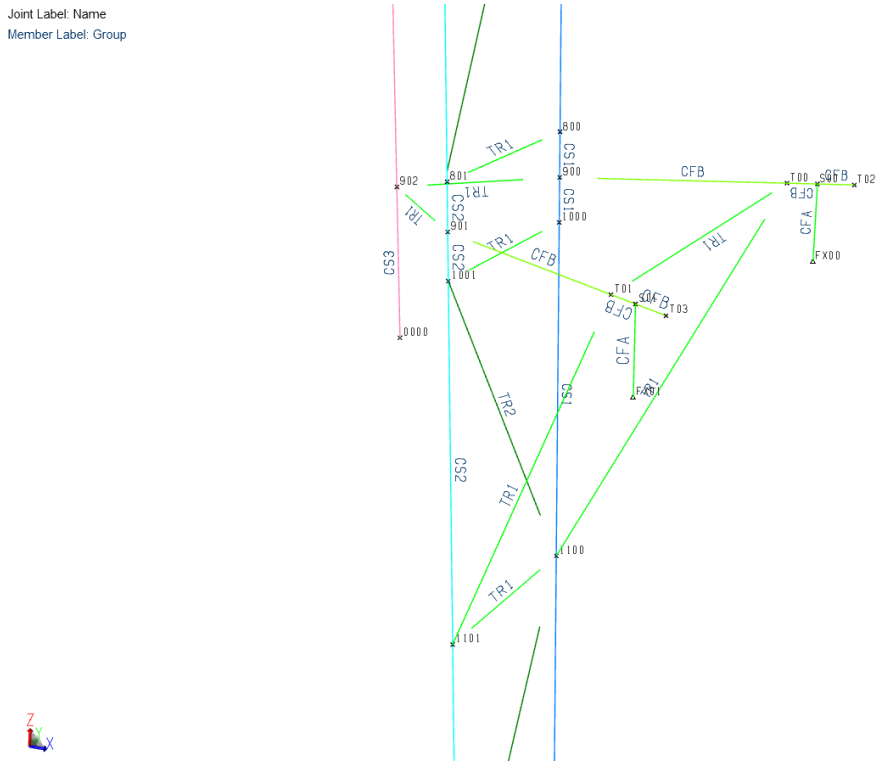
Brine discharge caisson – Lz



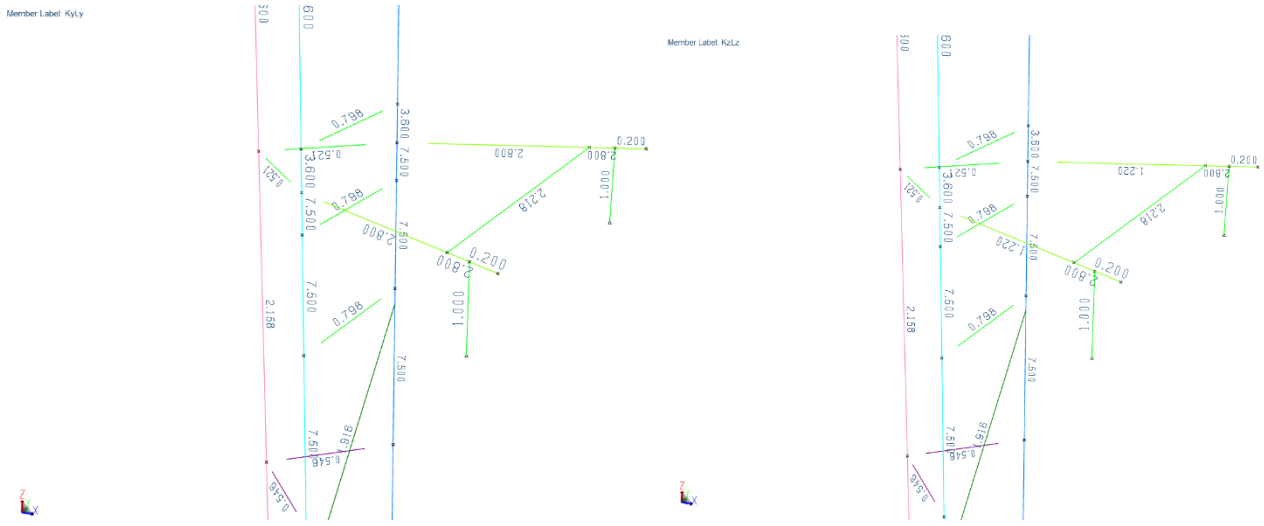
EL + 15.153m LAT – joins name and member groups



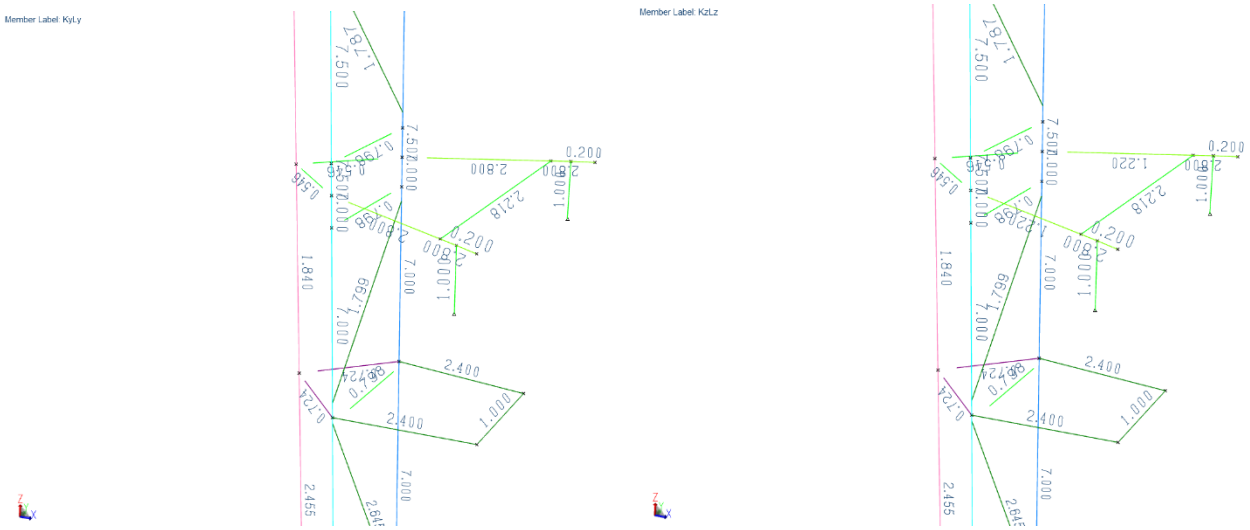
EL + 7.837m LAT – joins name and member groups



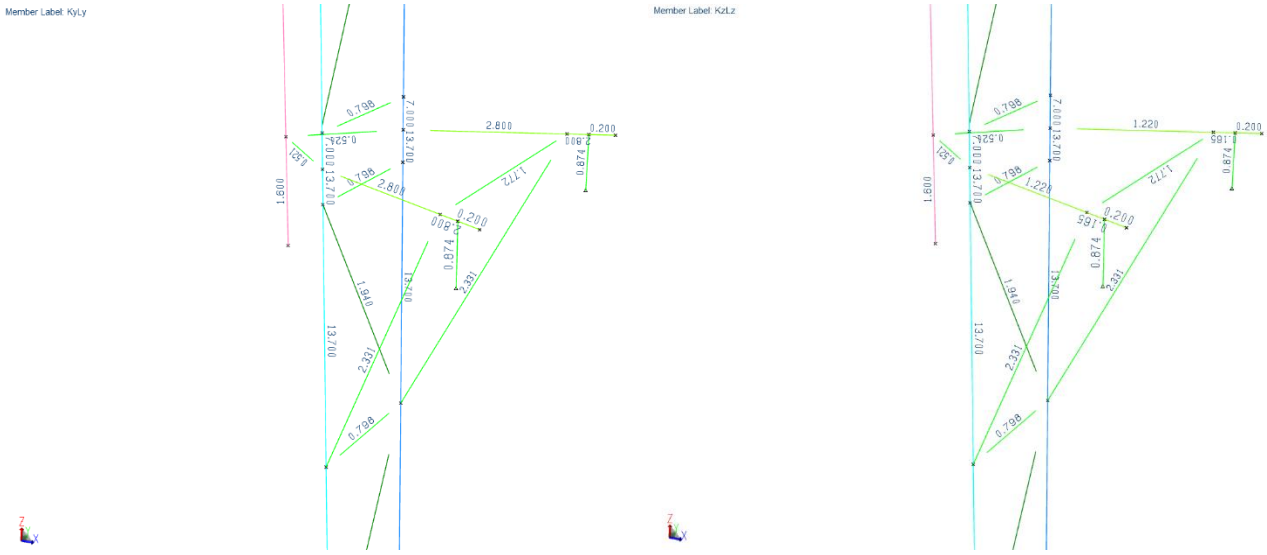
EL + 0.837m LAT – joins name and member groups



EL + 15.153m LAT – Ly & Lz



EL + 7.837m LAT – Ly & Lz



EL + 0.837m LAT – Ly & Lz