X-SEA VERIFICATION REPORT 1

Oil/Gas Offshore Steel Jacket Structures

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01	16/12/2019	Oil/gas offshore jacket structure subjected to self-weight, Airy's wave, and Stoke's 5th order wave.	Van Nguyen Dinh	Ki-Du Kim

Summary:

This document reports the verification of X-SEA software using the static analysis of an oil/gas offshore jacket structure subjected to self-weight, Airy's wave, and Stoke's 5^{th} order wave and comparing with the SACS software results. The jacket structure has 102.413 meters height and four fixed supports in the bottom of the legs. Jacket member type 1 has four elements. The reaction at supports, displacement of main legs and internal member forces calculated in X-SEA and SACS are in good agreement.

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Oil/Gas Offshore Steel Jacket Structures

1 Introduction

For the verification of X-SEA software, the static analysis of an oil/gas offshore jacket structure subjected to self-weight, Airy's wave, and Stoke's 5th order wave is carried out using X-SEA and SACS software. The jacket structure has 102.413 meters height and four fixed supports in the bottom of the legs. Jacket member type 1 has four elements.

In order to compare the X-SEA results with those of SACS, the reaction at supports, displacement of main legs and internal member forces in both X-SEA and SACS were calculated as shown in the form of tables and plots. The reaction force is taken from the four fixed supports of the bottom of the structure. Displacement and internal forces are compared in each node on all four main legs. All the node positions calculated from the X-SEA and SACS are illustrated in **Figure 1** and **Figure 2**, respectively. The four elements (4 meshes) are used for every single members.

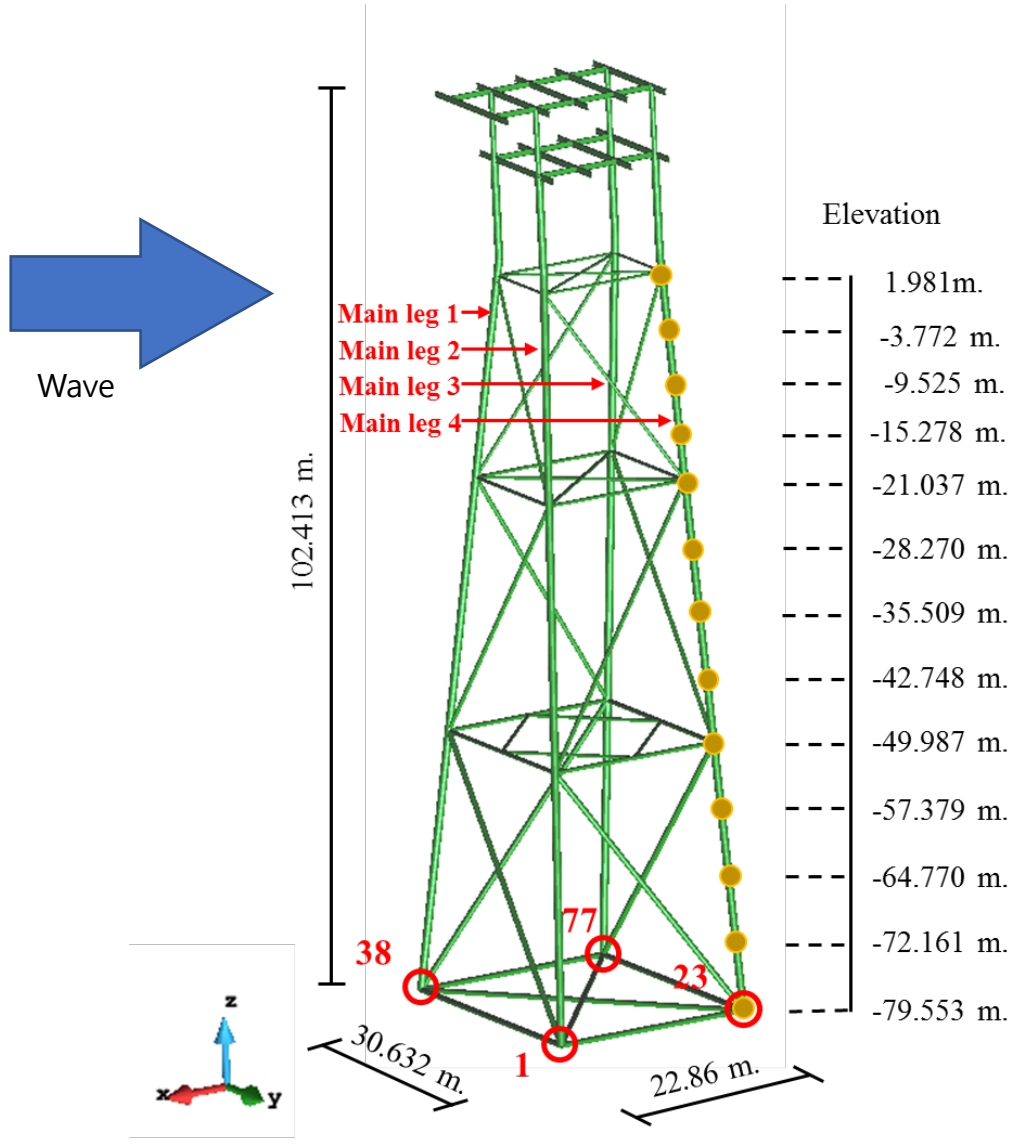

Figure 1. Model of the oil/gas jacket platform in X-SEA.

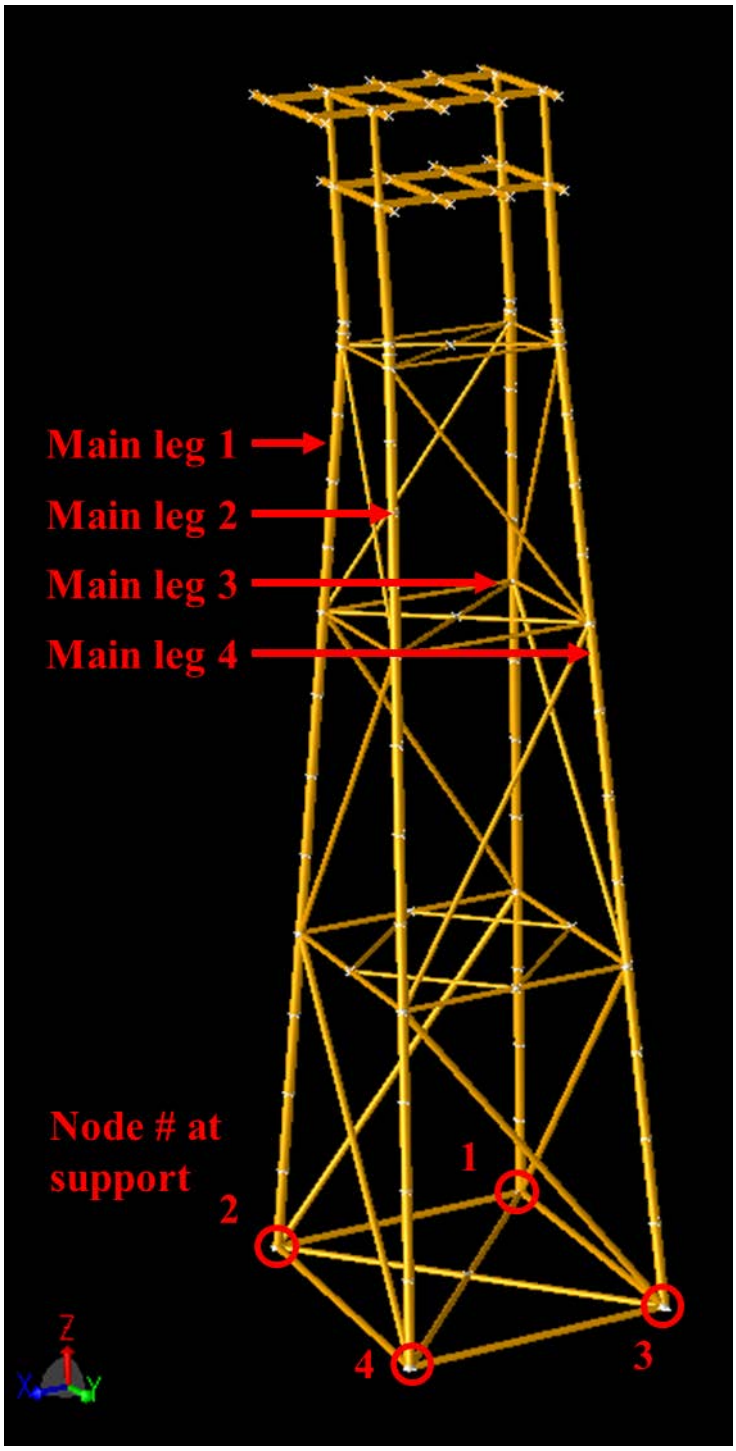

Figure 2. Model of the oil/gas jacket platform in SACS.

2 Geometric and Material Properties of Offshore Oil/gas Jacket Structure

The jacket height is 102.67 m and base dimensions are 22.98 x 30.632 m. The legs and bracings of the jacket are in circular section as presented in **Figure 4**, where their section properties are listed in **Table 1**. The topside of the jacket structure are in I – sections as in **Figure 5** with dimensions listed in **Table 2**.

Table 1. Section details of the oil/gas jacket structure legs and bracings

Section (Circular)	Diameter (m)	Thickness (m)
Main Leg Type 1	0.9114	0.0254
Main Leg Type 2	0.9114	0.01905
Main Leg Type 3	0.6604	0.01905
Bracing 1	0.2032	0.1873
Bracing 2	0.2540	0.2350
Bracing 3	0.1619	0.1492
Bracing 4	0.3048	0.2858
Bracing 5	0.3302	0.3048

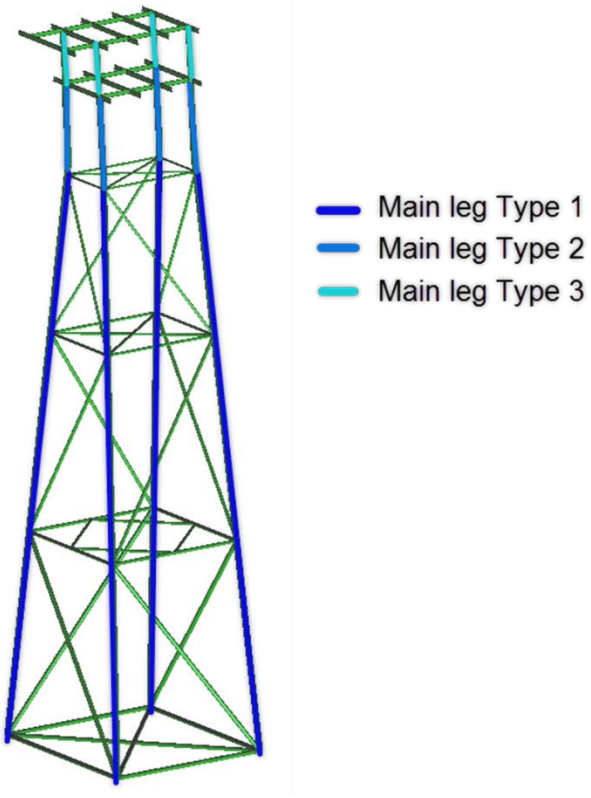

Figure 3. Sections and leg types of the oil/gas jacket structure

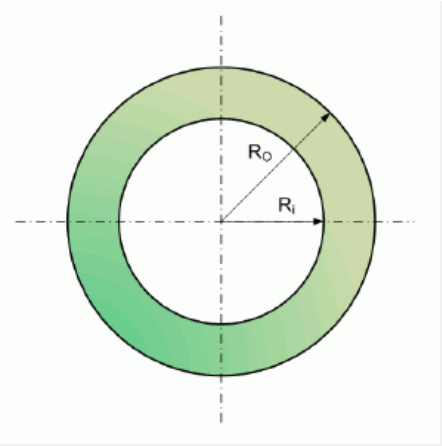

Figure 4. Circular section

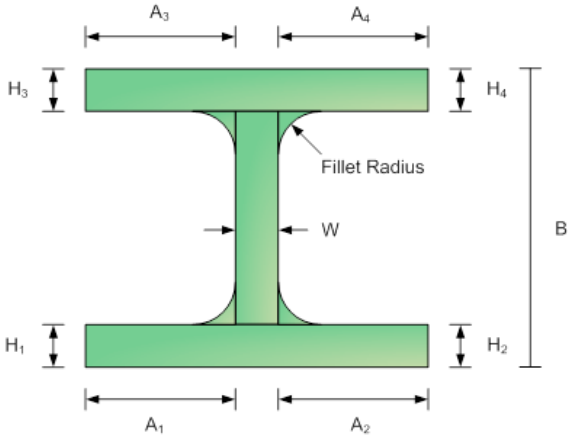

Figure 5. I section

Table 2. Section detail of jacket structure topside.

Section - I section	Height (B) (m.)	Web (W) (m.)	Flange length (A) (m.)	Flange height (H) (m.)	Fillet radius (Radius)
W1	0.6350	0.0179	0.1561	0.0309	0.0127
W2	0.6223	0.0154	0.1561	0.0244	0.0127

The material properties of steel to be used in the analysis are elastic modulus E = 2.0x1011N/m2; Poisson's ratio (ν) = 0.30 and mass density = 7850 kg/m3.

3 Analysis Results of X-SEA and SACS

3.1 Offshore jacket structure subjected to self-weight loads

The reactions of the jacket subjected to self-weight loads by X-SEA model and SACS model are in **Table 3** and **Table 4**, respectively. The normalized reactions by X-SEA/SACS results in **Table 5** show good agreement in the results from the two software.

Table 3. Reaction of the jacket subjected to self-weight load by X-SEA model.

	CASE – Self weight ---- Reaction by X-SEA					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
38	-22.25	104.55	1035.31	528.26	734.72	-23.83
1	-77.17	-88.36	978.32	-997.33	343.93	-23.38
77	12.58	137.54	1368.85	1004.48	-238.52	-32.87
23	86.83	-153.74	1420.19	-517.84	-632.46	4.05

Table 4. Reaction of the jacket using self-weight loading by SACS model.

	CASE – Self weight ---- Reaction by SACS					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
2	-22.31	104.82	1037.01	527.58	735.02	-23.88
4	-77.37	-88.58	979.90	-997.39	343.40	-23.42
1	12.62	138.04	1372.55	1004.87	-237.84	-32.85
3	87.07	-154.27	1423.97	-516.84	-632.49	4.14

Table 5. Normalized reactions of the jacket subjected to self-weight loads by X-SEA/SACS results.

		CASE – Self weight ---- Nominal Solution					
Node		F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
X-SEA	SACS						
38	2	1.00	1.00	1.00	1.00	1.00	1.00
1	4	1.00	1.00	1.00	1.00	1.00	1.00
77	1	1.00	1.00	1.00	1.00	1.00	1.00
23	3	1.00	1.00	1.00	1.00	1.00	0.98

3.2 Offshore jacket structure subjected to Airy's wave

Table 6. Environment condition and Airy's wave parameters

Environment condition	Wave parameter
Water depth = 78.553 m. Sea bed level = -79.553 m. Water density = 1025 kg/m^3 Air Density = 1.25 kg/m^3	Wave theory = Airy wave theory Water density = 1025 kg/m^3 Wave height = 12.04 m Wave period = 10 seconds Drag coefficient (C_d) = 0.69 Mass coefficient (C_m) = 1.42

3.2.1 Wave force

Table 7. Wave force due to Airy's wave

Wave Force						
	X-SEA			SACS		
Elevation (m)	F_X(kN)	F_Y(kN)	F_Z(kN)	F_X(kN)	F_Y(kN)	F_Z(kN)
-15.278	6.942	0.105	0.681	7.000	0.038	0.500
-21.031	4.483	0.106	0.435	4.520	0.045	0.446
-28.27	2.640	0.097	0.252	2.660	0.063	0.258
-35.509	1.604	0.083	0.150	1.618	0.064	0.154
-42.748	1.016	0.067	0.093	1.028	0.056	0.096
-49.987	0.680	0.051	0.062	0.687	0.046	0.063
-57.379	0.485	0.037	0.044	0.491	0.034	0.045
-64.77	0.379	0.025	0.035	0.383	0.023	0.035
-72.161	0.329	0.014	0.031	0.331	0.013	0.031
-79.553	0.322	0.004	0.032	0.032	0.004	0.032

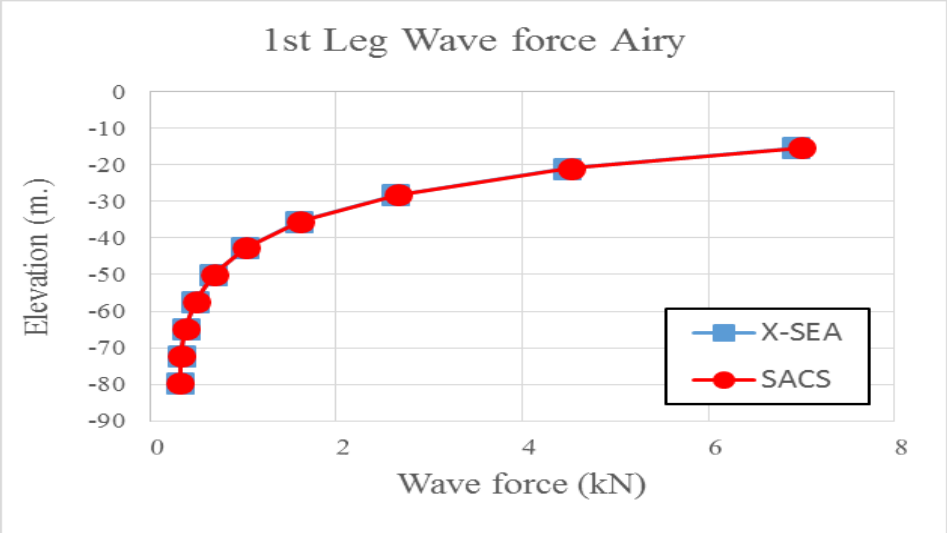

Figure 6. Comparison of wave forces in X-direction according to the height of the 1st leg between X-SEA and SACS results using Airy's wave theory

3.2.2 Reaction

Table 8. Reactions of the jacket structure by X-SEA using Airy's wave theory

	Case 1 : Airy ----- Wave Reaction by X-SEA					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
38	-315.089	88.697	701.647	-12.748	-24.278	33.073
1	-83.373	-94.981	706.633	-14.335	-58.242	-51.218
77	-1.017	-76.385	-670.357	2.636	-11.196	8.697
23	-243.422	85.768	-681.108	-2.591	-17.581	-8.061

Table 9. Reaction of the jacket structure by SACS using Airy's wave theory

	Case 1 : Airy ----- Wave Reaction by SACS					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
2	-318.429	88.996	705.107	-12.172	-24.340	33.693
4	-83.742	-94.912	708.786	-13.103	-58.943	-52.227
1	-1.149	-77.582	-681.371	1.688	-12.785	9.659
3	-246.825	87.478	-694.470	-3.318	-14.438	-8.460

Table 10. Nominal solution (X-SEA/SACS) of jacket reactions by using Airy's wave theory

	Case 1 : Airy ----- Nominal Solution of Reaction						
Node		F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
X-SEA	SACS						
38	2	0.990	0.997	0.995	1.047	0.997	0.982
1	4	0.996	1.001	0.997	1.094	0.988	0.981
77	1	0.885	0.985	0.984	1.561	0.876	0.900
23	3	0.986	0.980	0.981	0.781	1.218	0.953

3.2.3 Displacement

Table 11. Displacement of the jacket structure (1st leg) by X-SEA using Airy's wave

	Case 1 : Airy ----- Displacement from X-SEA (1st Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.710	0.271	-0.070	0.000	0.000	0.000
-3.7719	14.496	0.306	-0.097	0.000	0.000	0.000
-9.525	13.969	0.354	-0.158	0.000	0.000	0.000
-15.278	13.075	0.377	-0.252	0.000	0.000	0.000
-21.031	12.305	0.348	-0.327	0.000	0.000	-0.001
-28.27	13.607	0.314	-0.005	0.000	0.000	0.000
-35.509	13.085	0.146	0.151	0.000	0.000	-0.001
-42.748	9.411	-0.215	0.015	0.000	0.001	-0.001
-49.987	4.715	-0.670	-0.211	0.000	0.000	0.000
-57.379	2.127	-0.793	-0.263	0.000	0.000	0.000
-64.77	1.001	-0.529	-0.217	0.000	0.000	0.000
-72.161	0.337	-0.182	-0.135	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 12. Displacement of the jacket structure (1st leg) by SACS using Airy's wave theory.

	Case 1 : Airy ----- Displacement from SACS (1st Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.829	0.272	-0.051	0.000	0.000	0.000
-3.7719	14.610	0.286	-0.076	0.000	0.000	0.000
-9.525	14.087	0.305	-0.133	0.000	0.000	0.000
-15.278	13.196	0.324	-0.226	0.000	0.000	0.000
-21.031	12.419	0.336	-0.308	0.000	0.000	-0.001
-28.27	13.606	0.311	0.000	0.000	0.000	0.000
-35.509	13.134	0.108	0.165	0.000	0.000	-0.001
-42.748	9.505	-0.264	0.034	0.000	0.001	-0.001
-49.987	4.787	-0.670	-0.200	0.000	0.000	0.000
-57.379	2.119	-0.749	-0.267	0.000	0.000	0.000
-64.77	0.979	-0.490	-0.222	0.000	0.000	0.000
-72.161	0.325	-0.167	-0.137	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

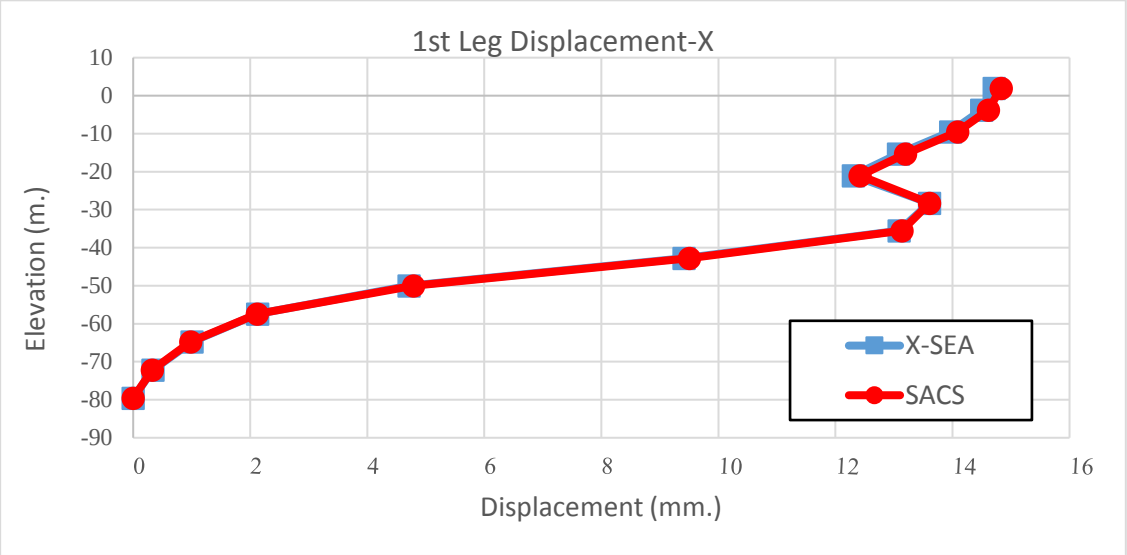

Figure 7. Comparison of X-displacement according to the height of the 1st leg between X-SEA and SACS results using Airy's wave theory.

Table 13. X-SEA displacement of the jacket model (2nd leg) using Airy's wave theory

	Case 1 : Airy ----- Displacement from X-SEA (2nd Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.741	0.283	-0.016	0.000	0.000	0.000
-3.7719	14.741	0.414	0.006	0.000	0.000	0.001
-9.525	14.467	0.471	-0.010	0.000	0.000	0.001
-15.278	13.733	0.459	-0.080	0.000	0.000	0.001
-21.031	12.901	0.372	-0.168	0.000	0.000	0.001
-28.27	13.762	0.009	-0.128	0.000	0.000	0.001
-35.509	12.685	-0.435	-0.292	0.000	0.000	0.001
-42.748	8.709	-0.689	-0.722	0.000	0.001	0.001
-49.987	4.337	-0.641	-1.155	0.000	0.000	0.000
-57.379	2.228	-0.466	-0.967	0.000	0.000	0.000
-64.77	1.193	-0.255	-0.667	0.000	0.000	0.000
-72.161	0.428	-0.064	-0.342	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 14. SACS Displacement of Jacket model (2nd leg) using Airy's wave theory

	Case 1 : Airy ----- Displacement from SACS (2nd Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.854	0.285	0.005	0.000	0.000	0.000
-3.7719	14.752	0.484	0.024	0.000	0.000	0.001
-9.525	14.395	0.594	0.007	0.000	0.000	0.001
-15.278	13.675	0.570	-0.064	0.000	0.000	0.001
-21.031	13.032	0.365	-0.149	0.000	0.000	0.001
-28.27	14.005	-0.099	-0.114	0.000	0.000	0.001
-35.509	12.945	-0.522	-0.277	0.000	0.000	0.001
-42.748	8.874	-0.721	-0.713	0.000	0.001	0.001
-49.987	4.382	-0.641	-1.156	0.000	0.000	0.000
-57.379	2.180	-0.459	-0.975	0.000	0.000	0.000
-64.77	1.142	-0.249	-0.674	0.000	0.000	0.000
-72.161	0.405	-0.061	-0.346	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

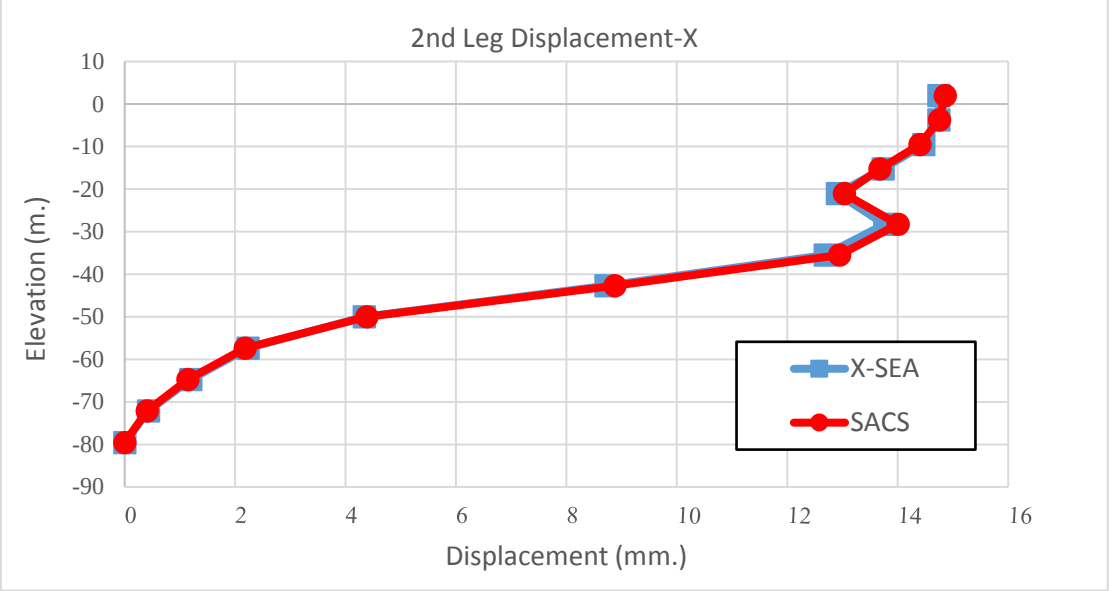

Figure 8. Comparison of X-displacement according to the height of the 2nd leg between X-SEA and SACS results using Airy's wave theory

Table 15. Displacement of X-SEA jacket model (3rd leg) using Airy's wave theory

	Case 1 : Airy ----- Displacement from X-SEA (3rd leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.697	0.376	1.380	0.000	0.000	0.000
-3.7719	14.879	0.837	1.321	0.000	0.000	0.000
-9.525	14.818	1.200	1.274	0.000	0.000	-0.001
-15.278	14.116	1.149	1.279	0.000	0.000	-0.001
-21.031	12.793	0.411	1.369	0.000	0.000	-0.001
-28.27	12.367	-0.340	1.472	0.000	0.000	-0.001
-35.509	11.187	-0.467	1.496	0.000	0.000	0.000
-42.748	8.286	-0.536	1.513	0.000	0.000	0.000
-49.987	4.572	-0.744	1.548	0.000	0.000	0.000
-57.379	1.883	-0.767	1.187	0.000	0.000	0.000
-64.77	0.559	-0.459	0.785	0.000	0.000	0.000
-72.161	0.073	-0.126	0.379	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 16. Displacement of SACS jacket model (3rd leg) using Airy's wave theory.

	Case 1 : Airy ----- Displacement from SACS (3rd leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.816	0.369	1.409	0.000	0.000	0.000
-3.7719	14.909	0.779	1.356	0.000	0.000	0.000
-9.525	14.758	1.106	1.314	0.000	0.000	-0.001
-15.278	14.051	1.065	1.318	0.000	0.000	-0.001
-21.031	12.915	0.411	1.398	0.000	0.000	-0.001
-28.27	12.633	-0.292	1.493	0.000	0.000	-0.001
-35.509	11.433	-0.451	1.520	0.000	0.000	0.000
-42.748	8.417	-0.557	1.541	0.000	0.000	0.000
-49.987	4.638	-0.762	1.574	0.000	0.000	0.000
-57.379	1.937	-0.770	1.205	0.000	0.000	0.000
-64.77	0.594	-0.457	0.796	0.000	0.000	0.000
-72.161	0.087	-0.124	0.385	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

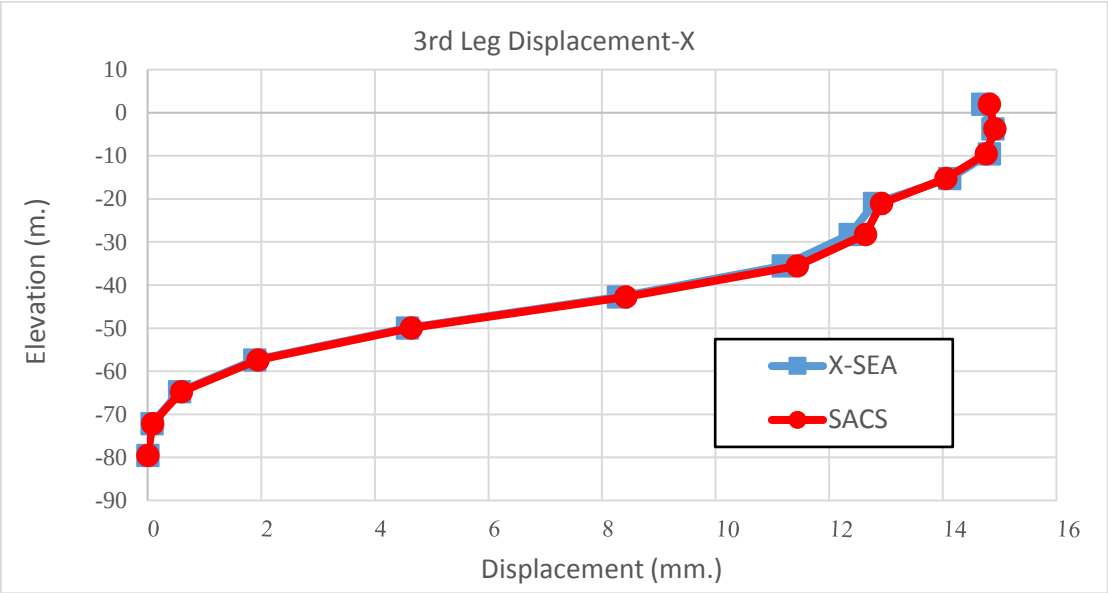

Figure 9. Comparison of X-displacement according to the height of the 3rd leg between X-SEA and SACS results using Airy's wave theory.

Table 17. X-SEA displacement of the jacket model (4th leg) using Airy's wave theory

	Case 1 : Airy ----- Displacement from X-SEA (4th leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.773	0.362	1.414	0.000	0.000	0.000
-3.7719	15.024	0.432	1.424	0.000	0.000	0.000
-9.525	14.909	0.406	1.422	0.000	0.000	0.000
-15.278	14.009	0.365	1.418	0.000	0.000	0.000
-21.031	12.326	0.345	1.416	0.000	0.000	0.000
-28.27	11.582	-0.213	1.177	0.000	0.000	0.000
-35.509	10.460	-1.001	0.909	0.000	0.000	0.000
-42.748	7.830	-1.294	0.702	0.000	0.000	0.000
-49.987	4.434	-0.745	0.601	0.000	0.000	0.000
-57.379	1.929	-0.083	0.510	0.000	0.000	0.000
-64.77	0.635	0.084	0.358	0.000	0.000	0.000
-72.161	0.107	0.041	0.179	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 18. SACS displacement of jacket model (4th leg) using Airy's wave theory

	Case 1 : Airy ----- Displacement from SACS (4th leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.885	0.356	1.442	0.000	0.000	0.000
-3.7719	15.053	0.450	1.455	0.000	0.000	0.000
-9.525	14.878	0.450	1.456	0.000	0.000	0.000
-15.278	13.986	0.410	1.452	0.000	0.000	0.000
-21.031	12.447	0.347	1.445	0.000	0.000	0.000
-28.27	11.807	-0.211	1.203	0.000	0.000	0.000
-35.509	10.708	-0.970	0.935	0.000	0.000	0.000
-42.748	8.001	-1.263	0.725	0.000	0.000	0.000
-49.987	4.484	-0.762	0.615	0.000	0.000	0.000
-57.379	1.896	-0.135	0.516	0.000	0.000	0.000
-64.77	0.596	0.042	0.360	0.000	0.000	0.000
-72.161	0.092	0.025	0.181	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

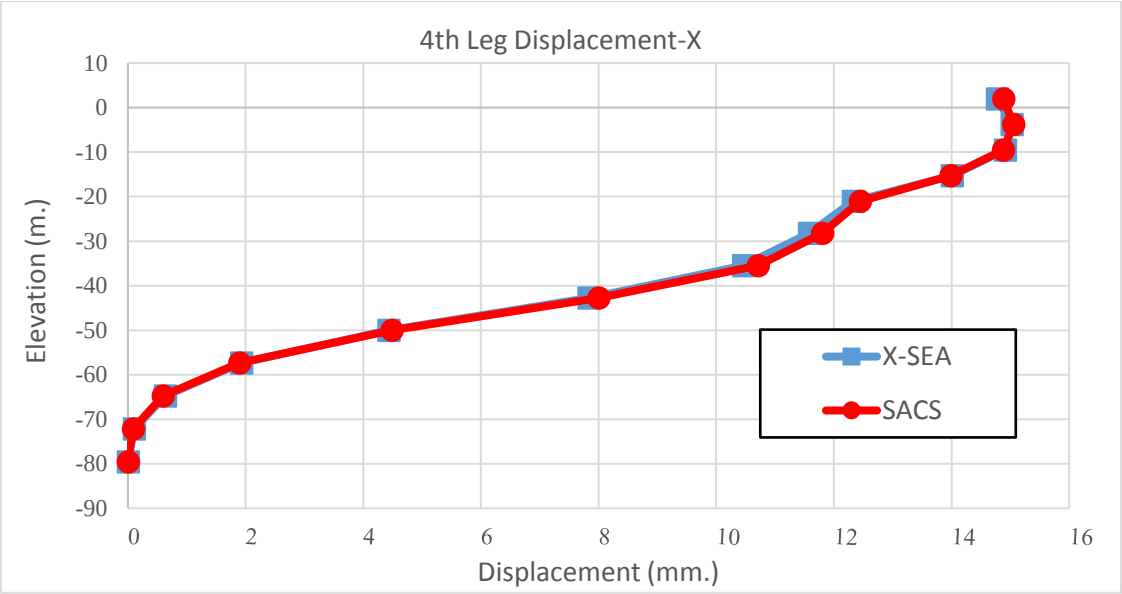

Figure 10. Comparison of X-displacement according to the height of the 4th leg between X-SEA and SACS results using Airy's wave theory.

3.2.4 Member Force

Table 19. X-SEA member forces of the jacket model (1st leg) using Airy's wave theory

	Case 1 : Airy ----- Member force from X-SEA (1st leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	4.438	-0.029	-0.476	11.552	9.725	-8.615
-9.525	4.438	-0.029	-0.476	11.552	12.501	-8.784
-15.278	5.502	1.327	0.088	11.755	12.402	-7.201
-21.031	5.934	20.050	22.579	12.060	-111.701	90.077
-28.27	-355.570	-12.699	-19.162	-4.405	58.160	-42.806
-35.509	-356.024	-1.385	-3.281	-4.611	78.868	-57.199
-42.748	-356.281	5.370	6.459	-4.724	29.613	-20.567
-49.987	-356.429	9.581	12.685	-4.785	-64.477	47.781
-57.379	-357.983	-3.120	-6.236	-14.330	-31.097	12.881
-64.77	-358.033	-1.076	-3.187	-14.346	-7.633	3.595
-72.161	-358.058	0.563	-0.840	-14.353	-1.554	6.660
-79.553	-358.067	2.052	1.170	-14.352	-10.400	20.813

Table 20. SACS member force of the jacket model (1st leg) using Airy's wave theory

	Case 1 : Airy ----- Member force from SACS (1st leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	4.835	0.253	-0.389	11.529	9.655	-8.162
-9.525	4.835	0.253	-0.389	11.529	11.924	-9.634
-15.278	4.835	-6.018	7.353	11.529	8.904	-6.821
-21.031	4.835	-26.922	33.412	11.529	-115.380	93.759
-28.27	-355.660	24.493	-31.199	-3.651	-99.586	83.071
-35.509	-355.660	-1.393	2.135	-3.650	73.100	-53.132
-42.748	-355.660	-1.392	2.135	-3.651	73.101	-53.132
-49.987	-355.660	-10.867	15.130	-3.651	-66.702	47.030
-57.379	-356.980	4.993	-8.272	-15.132	-80.837	43.470
-64.77	-356.980	2.437	-4.641	-15.132	-33.255	16.194
-72.161	-356.980	0.537	-1.953	-15.132	-9.002	5.344
-79.553	-356.980	-2.542	2.164	-15.132	-11.701	20.800

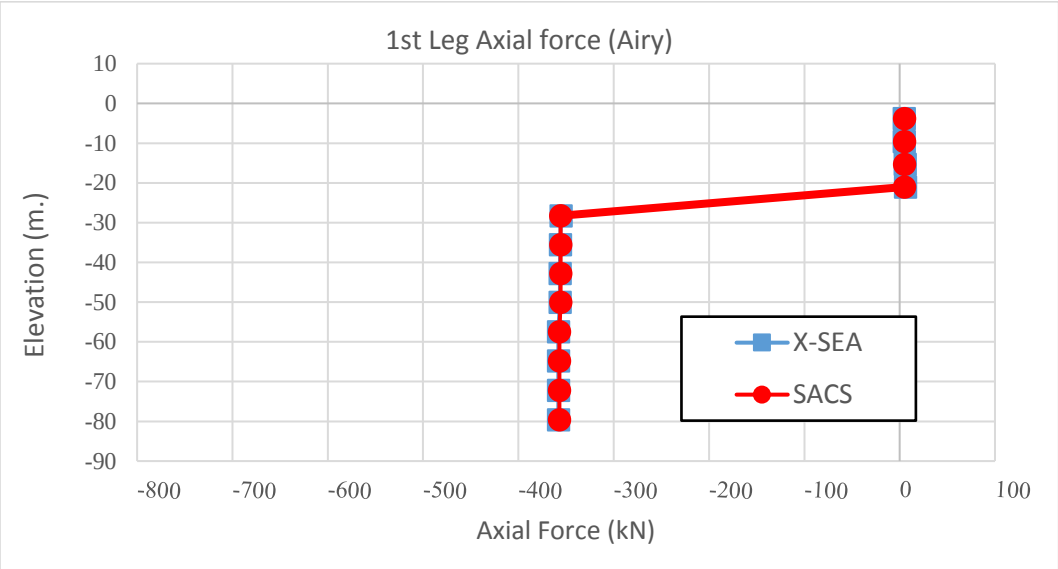

Figure 11. Comparison of axial force according to the height of the 1st leg between X-SEA and SACS results using Airy's wave theory

Table 21. Member force of the jacket (2nd leg) modelled by X-SEA using Airy's wave theory

	Case 1 : Airy ----- Member force from X-SEA (2nd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-11.795	-0.796	1.049	-29.151	-6.942	-9.633
-9.525	-11.795	-0.796	1.049	-29.151	-13.055	-14.271
-15.278	-10.781	-1.283	0.484	-27.438	-17.488	-17.158
-21.031	-10.390	14.745	-22.006	-24.867	101.487	75.651
-28.27	3.390	-14.737	18.604	34.595	-59.907	-49.156
-35.509	2.949	-1.990	2.724	32.935	-75.383	-53.057
-42.748	2.708	5.564	-7.016	31.993	-21.387	-5.936
-49.987	2.578	10.222	-13.240	31.454	77.158	72.912
-57.379	-705.536	-4.192	4.968	9.231	16.348	15.058
-64.77	-705.571	-2.015	1.917	9.044	2.527	1.855
-72.161	-705.583	-0.310	-0.423	8.947	5.980	1.007
-79.553	-705.580	1.196	-2.437	8.911	24.341	11.270

Table 22. Member forces of the jacket (2nd leg) modelled by SACS using Airy's wave theory

	Case 1 : Airy ----- Member force from SACS (2nd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-10.817	-0.741	0.392	-30.390	3.695	-5.252
-9.525	-10.817	-0.741	0.392	-30.390	5.979	-9.572
-15.278	-10.817	5.530	-7.350	-30.390	5.259	-13.925
-21.031	-10.817	26.433	-33.409	-30.390	-119.010	83.808
-28.27	7.585	-22.783	30.175	31.853	-86.671	61.558
-35.509	7.585	3.102	-3.159	31.853	71.006	-49.583
-42.748	7.585	3.102	-3.159	31.853	71.006	-49.583
-49.987	7.585	12.576	-16.154	31.853	-83.807	75.641
-57.379	-708.430	-5.465	7.112	8.661	-59.260	48.465
-64.77	-708.430	-2.909	3.482	8.661	-20.360	17.658
-72.161	-708.430	0.575	-1.378	8.661	-7.194	1.775

-79.553	-708.430	2.071	-3.324	8.661	-24.848	11.676

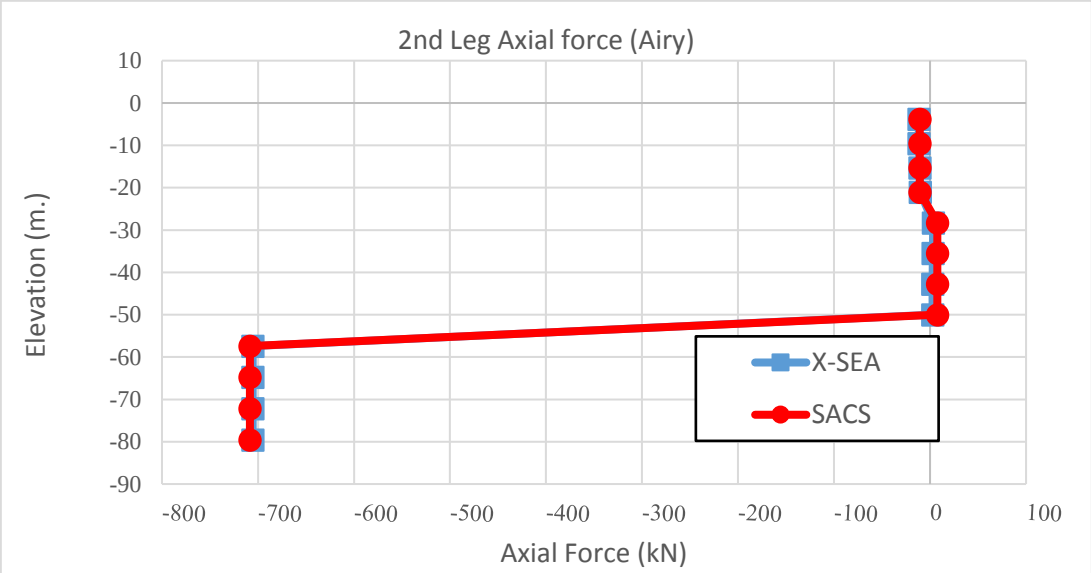

Figure 12. Comparison of axial forces according to the height of the 2nd leg between X-SEA and SACS results using Airy's wave theory

Table 23. Member forces of the jacket (3rd leg) modelled by X-SEA using Airy's wave theory

	Case 1 : Airy ----- Member force from X-SEA (3rd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	3.894	2.291	-2.863	21.107	10.164	4.130
-9.525	3.894	2.291	-2.863	21.107	26.763	17.410
-15.278	3.894	2.118	-2.303	21.107	40.527	30.468
-21.031	3.894	-0.356	19.368	21.107	-64.977	31.105
-28.27	-16.491	3.719	-15.620	-26.565	35.181	-14.147
-35.509	-16.491	1.829	-2.950	-26.565	53.287	0.170
-42.748	-16.491	0.543	3.573	-26.565	25.410	4.804
-49.987	-16.491	-0.337	6.851	-26.565	-25.521	2.808
-57.379	687.400	1.389	-2.504	-0.984	-33.592	-7.907
-64.77	687.400	1.000	-1.755	-0.983	-20.774	-0.268
-72.161	687.400	0.754	-1.429	-0.983	-10.249	5.431

-79.553	687.400	0.648	-1.288	-0.983	-0.704	10.245

Table 24. Member forces of the jacket (3rd leg) modelled by SACS using Airy's wave theory

	Case 1 : Airy ----- Member force from SACS (3rd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	3.795	-2.057	-2.262	22.496	10.164	3.525
-9.525	3.795	-2.057	-2.262	22.496	23.281	15.450
-15.278	3.795	-1.362	6.105	22.496	30.096	26.856
-21.031	3.795	0.911	30.535	22.496	-82.114	27.831
-28.27	-14.125	-4.579	-25.743	-28.062	-83.819	-38.790
-35.509	-14.125	-1.063	1.436	-28.062	51.857	-0.694
-42.748	-14.125	-1.063	1.436	-28.062	51.857	-0.694
-49.987	-14.125	0.651	8.553	-28.062	-32.663	0.825
-57.379	698.550	-1.676	-3.185	-1.417	-52.794	-18.450
-64.77	698.550	-1.185	-2.037	-1.417	-33.868	-7.914
-72.161	698.550	-0.869	-1.515	-1.417	-20.894	-0.362
-79.553	698.550	-0.692	-1.290	-1.417	-10.560	5.378

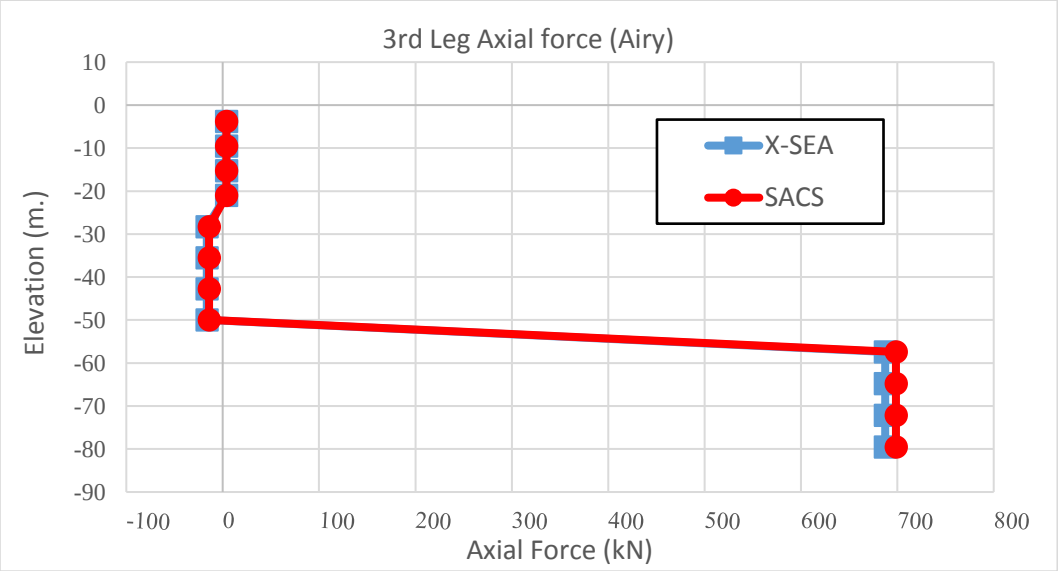

Figure 13. Comparison of axial forces according to the height of the 3rd leg between X-SEA and SACS results using Airy's wave theory

Table 25. Member forces of the jacket (4th leg) modelled by X-SEA using Airy's wave theory

	Case 1 : Airy ----- Member force from X-SEA (4th leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-3.077	0.573	3.002	-5.180	-15.331	-3.984
-9.525	-3.077	0.573	3.002	-5.180	-32.735	-0.660
-15.278	-3.283	0.635	2.442	-4.016	-48.477	2.442
-21.031	-3.391	-1.442	-19.229	-2.440	54.634	-6.878
-28.27	327.347	4.832	16.216	8.062	-27.675	-3.618
-35.509	327.435	2.762	3.546	6.900	-48.957	14.789
-42.748	327.493	1.357	-2.976	6.283	-24.807	23.506
-49.987	327.533	0.399	-6.255	5.961	22.099	25.610
-57.379	327.914	1.443	2.224	4.571	29.513	-12.112
-64.77	327.936	1.006	1.475	4.485	18.867	-4.993
-72.161	327.953	0.731	1.149	4.447	10.468	0.223
-79.553	327.968	0.596	1.007	4.432	3.024	4.553

Table 26. Member forces of the jacket (4th leg) modelled by SACS using Airy's wave theory

	Case 1 : Airy ----- Member force from SACS (4th leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-2.724	0.398	2.698	-5.647	14.294	-3.980
-9.525	-2.724	0.398	2.698	-5.647	29.938	-1.669
-15.278	-2.724	-0.296	-5.669	-5.647	39.281	0.122
-21.031	-2.724	-2.570	-30.099	-5.647	-70.402	-8.518
-28.27	333.700	5.217	26.658	5.242	-102.610	-34.313
-35.509	333.700	1.701	-0.521	5.242	46.408	13.093
-42.748	333.700	1.702	-0.521	5.242	46.408	13.093
-49.987	333.700	-0.013	-7.638	5.242	-24.768	23.922
-57.379	335.610	1.527	3.082	5.192	-50.261	-20.653
-64.77	335.610	1.036	1.934	5.192	-32.102	-11.225

-72.161	335.610	0.721	1.412	5.192	-19.896	-4.778
-79.553	335.610	0.544	1.187	5.192	-10.330	-0.146

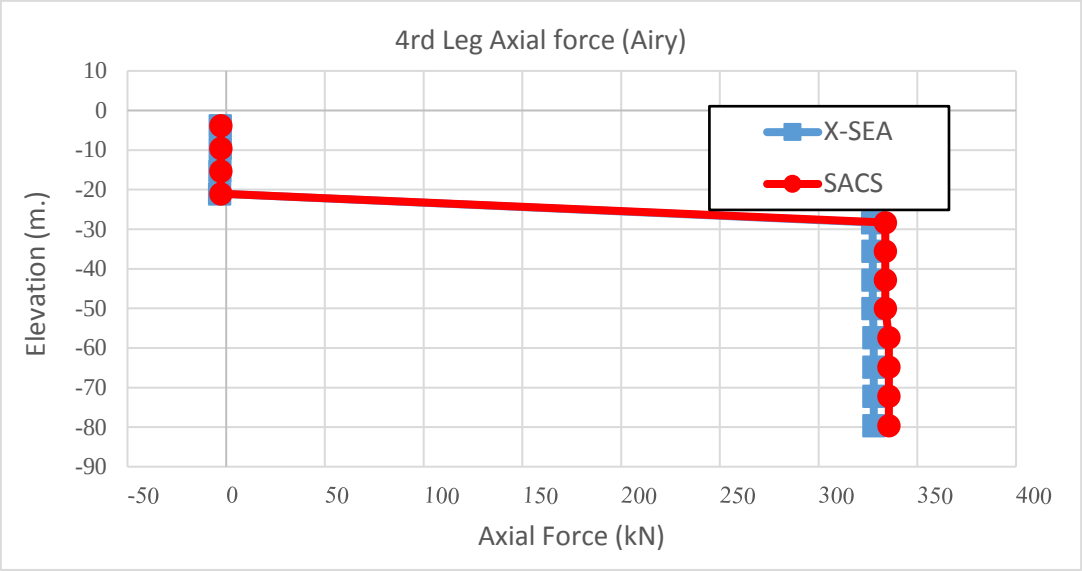

Figure 14. Comparison of axial forces according to the height of the 4th leg between X-SEA and SACS results using Airy's wave theory.

3.3 Jacket structure subjected to Stoke's wave

Table 27. Environment condition and wave parameters

Environment condition	Wave parameter
Water depth = 78.553 m. Sea bed level = -79.553 m. Water density = 1025 kg/m^3 Air Density = 1.25 kg/m^3	Wave theory = Stoke wave theory Water density = 1025 kg/m^3 Wave height = 12.04 m Wave period = 10 seconds Drag coefficient (C_d) = 0.69 Mass coefficient (C_m) = 1.42

3.3.1 Wave force

Table 28. Wave forces due to Stoke's wave

Wave Force						
	X-SEA			SACS		
Elevation (m)	F_X(kN)	F_Y(kN)	F_Z(kN)	F_X(kN)	F_Y(kN)	F_Z(kN)
-15.278	6.478	0.123	0.632	6.552	0.038	0.500
-21.031	4.240	0.117	0.409	4.275	0.045	0.446
-28.27	2.545	0.103	0.242	2.562	0.063	0.258
-35.509	1.579	0.086	0.147	1.587	0.064	0.154
-42.748	1.021	0.069	0.094	1.027	0.056	0.096
-49.987	0.697	0.053	0.063	0.697	0.046	0.063
-57.379	0.506	0.038	0.046	0.508	0.034	0.045
-64.77	0.401	0.025	0.037	0.399	0.023	0.035
-72.161	0.352	0.014	0.033	0.347	0.013	0.031
-79.553	0.344	0.004	0.034	0.337	0.004	0.032

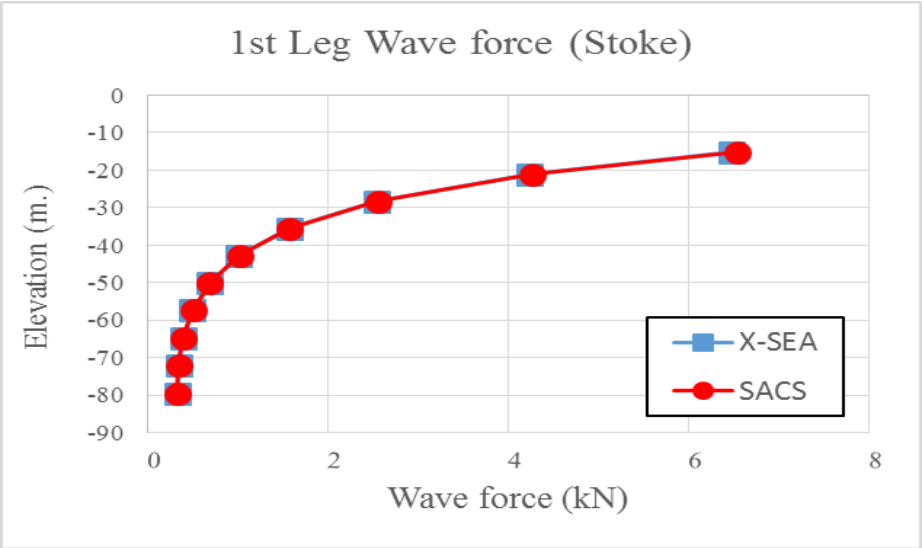

Figure 15. Comparison of wave force in X-direction according to the height of the 1st leg between X-SEA and SACS results using Stoke's wave theory

3.3.2 Reaction

Table 29. Reactions of the jacket structure modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Wave Reaction by X-SEA (1st leg)					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
38	-313.549	88.151	696.828	-12.940	-29.041	35.087
1	-84.302	-94.796	704.160	-14.615	-63.052	-54.522
77	-2.014	-76.384	-667.224	2.969	-15.416	11.637
23	-242.219	85.139	-675.635	-2.650	-22.235	-9.835

Table 30. Reactions of the jacket structure modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Wave Reaction by SACS (1st leg)					
Node	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
2	-313.099	88.649	703.271	-12.462	-28.988	16.560
4	-80.295	-94.899	709.250	-13.469	-63.469	-36.350
1	-0.728	-77.339	-680.765	1.908	-17.716	8.325
3	-244.770	86.512	-691.288	-3.351	-19.742	-5.765

Table 31. Nominal solution (X-SEA/SACS) of reaction of jacket structure using Stoke's wave theory

		Case 2 : Stoke ------- Nominal Solution of Reaction					
Node		F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
X-SEA	SACS						
38	2	1.001	0.994	0.991	1.038	1.002	2.119
1	4	1.050	0.999	0.993	1.085	0.993	1.500
77	1	2.767	0.988	0.980	1.556	0.870	1.398
23	3	0.990	0.984	0.977	0.791	1.126	1.706

3.3.3 Displacement

Table 32. Displacement of the jacket (1st leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from X-SEA (1st Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.673	0.295	-0.070	0.000	0.000	0.000
-3.7719	14.601	0.335	-0.085	0.000	0.000	0.000
-9.525	14.143	0.390	-0.139	0.000	0.000	0.000
-15.278	13.172	0.412	-0.241	0.000	0.000	0.000
-21.031	12.207	0.366	-0.333	0.000	0.000	-0.001
-28.27	13.296	0.323	-0.032	0.000	0.000	0.000
-35.509	12.751	0.161	0.120	0.000	0.000	0.000
-42.748	9.205	-0.198	-0.004	0.000	0.001	-0.001
-49.987	4.682	-0.666	-0.211	0.000	0.000	0.000
-57.379	2.208	-0.802	-0.251	0.000	0.000	0.000
-64.77	1.099	-0.538	-0.204	0.000	0.000	0.000
-72.161	0.381	-0.185	-0.129	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

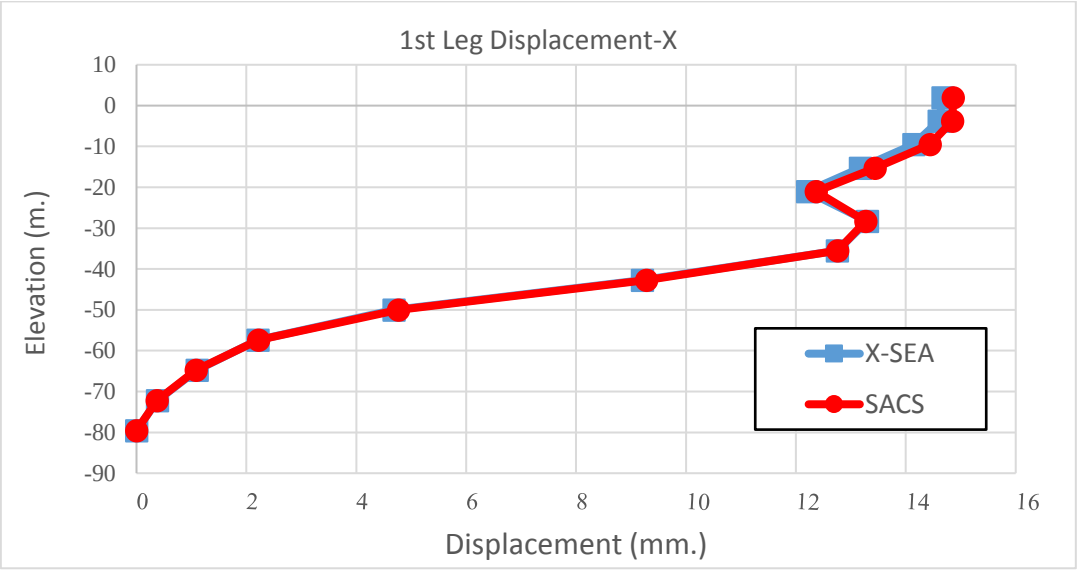

Figure 16. Comparison of X-displacement according to the height of the 1st leg between X-SEA and SACS results using Stoke's wave theory

Table 33. Displacement of the jacket (1st leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from SACS (1st Leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.828	0.272	-0.051	0.000	0.000	0.000
-3.7719	14.860	0.294	-0.052	0.000	0.000	0.000
-9.525	14.849	0.314	-0.058	0.000	0.000	0.000
-15.278	14.439	0.342	-0.105	0.000	0.000	0.000
-21.031	13.437	0.360	-0.210	0.000	0.000	0.000
-28.27	12.369	0.354	-0.318	0.000	0.000	0.000
-35.509	13.270	0.317	-0.036	0.000	0.000	0.000
-42.748	12.757	0.122	0.123	0.000	0.000	0.000
-49.987	9.277	-0.248	0.008	0.000	0.001	-0.001
-57.379	4.765	-0.671	-0.204	0.000	0.000	0.000
-64.77	2.219	-0.765	-0.256	0.000	0.000	0.000
-72.161	1.086	-0.504	-0.211	0.000	0.000	0.000
-79.553	0.370	-0.172	-0.133	0.000	0.000	0.000

Table 34. Displacement of the jacket (2nd leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from X-SEA (2nd)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.699	0.306	-0.026	0.000	0.000	0.000
-3.7719	14.853	0.412	0.009	0.000	0.000	0.001
-9.525	14.635	0.451	-0.002	0.000	0.000	0.001
-15.278	13.810	0.443	-0.079	0.000	0.000	0.001
-21.031	12.789	0.389	-0.181	0.000	0.000	0.001
-28.27	13.459	0.054	-0.154	0.000	0.000	0.001
-35.509	12.367	-0.398	-0.318	0.000	0.000	0.001
-42.748	8.517	-0.671	-0.736	0.000	0.001	0.001
-49.987	4.309	-0.637	-1.152	0.000	0.000	0.000
-57.379	2.308	-0.467	-0.955	0.000	0.000	0.000
-64.77	1.287	-0.257	-0.655	0.000	0.000	0.000

-72.161	0.471	-0.065	-0.337	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 35. Displacement of the jacket (2nd leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from SACS (2nd leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.881	0.306	-0.006	0.000	0.000	0.000
-3.7719	15.011	0.478	0.034	0.000	0.000	0.001
-9.525	14.775	0.569	0.028	0.000	0.000	0.001
-15.278	13.937	0.548	-0.053	0.000	0.000	0.001
-21.031	12.976	0.380	-0.164	0.000	0.000	0.001
-28.27	13.641	-0.051	-0.153	0.000	0.000	0.001
-35.509	12.549	-0.484	-0.318	0.000	0.000	0.001
-42.748	8.648	-0.706	-0.737	0.000	0.001	0.001
-49.987	4.368	-0.641	-1.158	0.000	0.000	0.000
-57.379	2.283	-0.464	-0.966	0.000	0.000	0.000
-64.77	1.248	-0.253	-0.664	0.000	0.000	0.000
-72.161	0.450	-0.063	-0.341	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

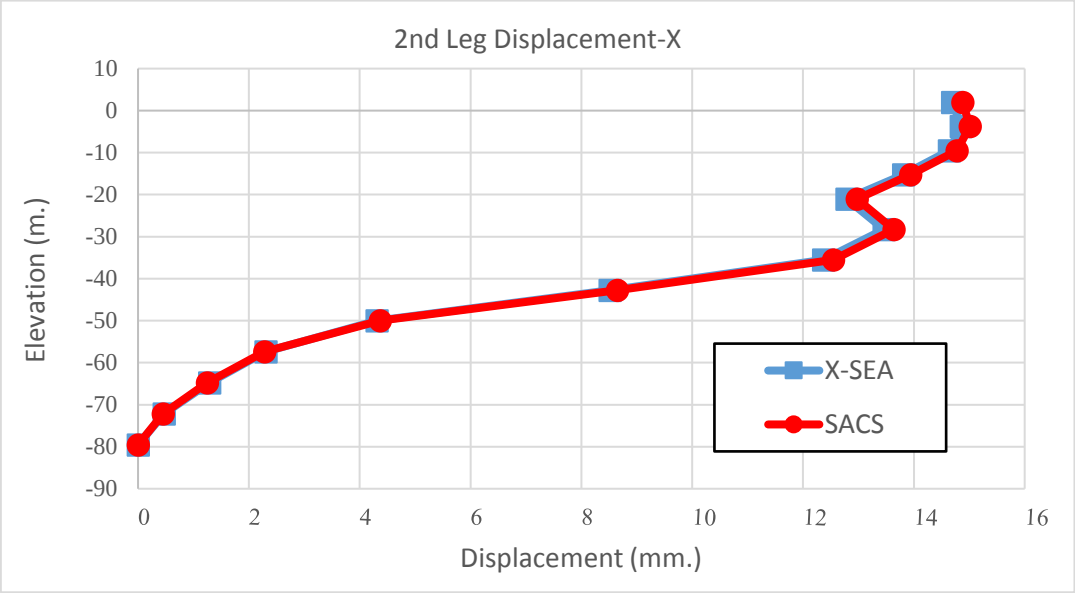

Figure 17. Comparison of X-displacement according to the height of the 2nd leg between X-SEA and SACS results using Stoke's wave theory

Table 36. Displacement of the jacket (3rd leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from X-SEA (3rd leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.655	0.401	1.382	0.000	0.000	0.000
-3.7719	15.059	0.871	1.321	0.000	0.000	0.000
-9.525	15.120	1.240	1.272	0.000	0.000	-0.001
-15.278	14.304	1.180	1.277	0.000	0.000	-0.001
-21.031	12.686	0.427	1.368	0.000	0.000	-0.001
-28.27	12.010	-0.334	1.470	0.000	0.000	-0.001
-35.509	10.829	-0.466	1.493	0.000	0.000	0.000
-42.748	8.080	-0.534	1.508	0.000	0.000	0.000
-49.987	4.538	-0.737	1.539	0.000	0.000	0.000
-57.379	1.952	-0.758	1.180	0.000	0.000	0.000
-64.77	0.643	-0.452	0.780	0.000	0.000	0.000
-72.161	0.111	-0.124	0.377	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

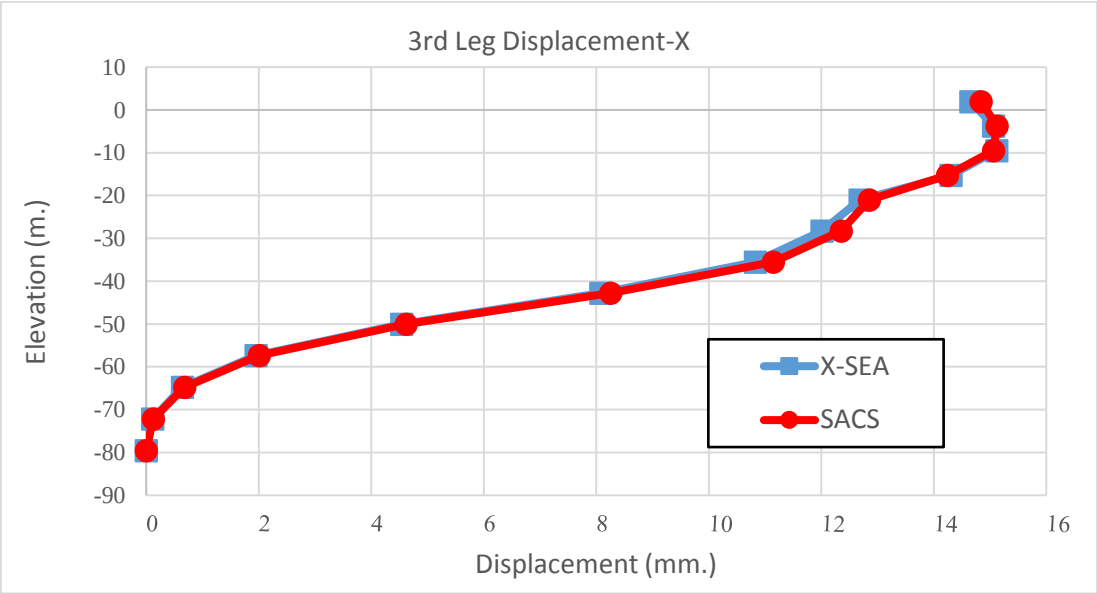

Figure 18. Comparison of X-displacement according to the height of the 3rd leg between X-SEA and SACS results using Stoke's wave theory

Table 37. Displacement of the jacket (3rd leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from SACS (3rd leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.839	0.394	1.417	0.000	0.000	0.000
-3.7719	15.121	0.807	1.363	0.000	0.000	0.000
-9.525	15.058	1.136	1.319	0.000	0.000	-0.001
-15.278	14.243	1.091	1.322	0.000	0.000	-0.001
-21.031	12.855	0.430	1.402	0.000	0.000	-0.001
-28.27	12.351	-0.276	1.495	0.000	0.000	-0.001
-35.509	11.145	-0.441	1.521	0.000	0.000	0.000
-42.748	8.253	-0.550	1.540	0.000	0.000	0.000
-49.987	4.618	-0.757	1.571	0.000	0.000	0.000
-57.379	2.011	-0.766	1.203	0.000	0.000	0.000
-64.77	0.683	-0.454	0.795	0.000	0.000	0.000
-72.161	0.127	-0.123	0.384	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 38. Displacement of the jacket (4th leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from X-SEA (4th leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.739	0.388	1.408	0.000	0.000	0.000
-3.7719	15.217	0.452	1.418	0.000	0.000	0.000
-9.525	15.227	0.416	1.415	0.000	0.000	0.000
-15.278	14.214	0.375	1.411	0.000	0.000	0.000
-21.031	12.229	0.362	1.411	0.000	0.000	0.000
-28.27	11.222	-0.190	1.173	0.000	0.000	0.000
-35.509	10.096	-0.975	0.906	0.000	0.000	0.000
-42.748	7.620	-1.274	0.699	0.000	0.000	0.000
-49.987	4.406	-0.738	0.597	0.000	0.000	0.000
-57.379	2.010	-0.085	0.507	0.000	0.000	0.000
-64.77	0.728	0.080	0.355	0.000	0.000	0.000

-72.161	0.148	0.039	0.177	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

Table 39. Displacement of the jacket (4th leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Displacement from SACS (4th leg)					
Elevation (m)	Dx (mm.)	Dy (mm.)	Dz (mm.)	Rx (rad)	Ry (rad)	Rz (rad)
1.9812	14.918	0.381	1.443	0.000	0.000	0.000
-3.7719	15.275	0.474	1.456	0.000	0.000	0.000
-9.525	15.194	0.467	1.457	0.000	0.000	0.000
-15.278	14.200	0.427	1.453	0.000	0.000	0.000
-21.031	12.400	0.368	1.447	0.000	0.000	0.000
-28.27	11.521	-0.190	1.204	0.000	0.000	0.000
-35.509	10.408	-0.949	0.936	0.000	0.000	0.000
-42.748	7.829	-1.249	0.726	0.000	0.000	0.000
-49.987	4.472	-0.757	0.614	0.000	0.000	0.000
-57.379	1.990	-0.137	0.514	0.000	0.000	0.000
-64.77	0.701	0.039	0.359	0.000	0.000	0.000
-72.161	0.138	0.024	0.180	0.000	0.000	0.000
-79.553	0.000	0.000	0.000	0.000	0.000	0.000

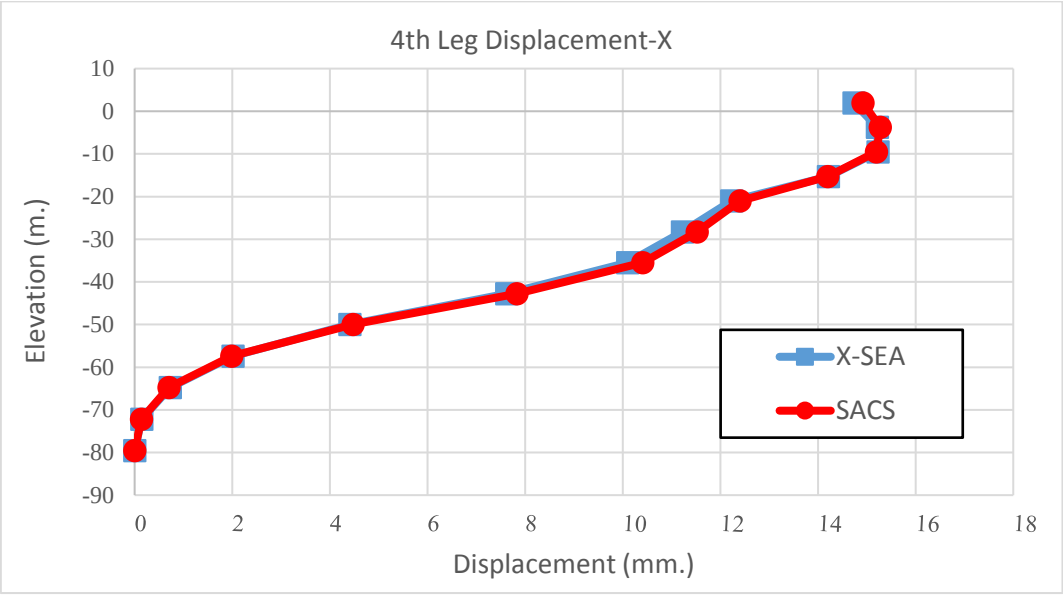

Figure 19. Comparison of X-displacement according to the height of the 4th leg between X-SEA and SACS results using Stoke's wave theory

3.3.4 Member forces

Table 40. Member force of the jacket (1st leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Member force from X-SEA (1st leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	4.744	-0.301	-0.925	10.694	12.079	-10.581
-9.525	4.744	-0.301	-0.925	10.694	17.471	-12.336
-15.278	5.961	1.555	0.090	10.962	17.924	-10.932
-21.031	6.154	20.161	22.961	11.166	-110.526	89.753
-28.27	-354.532	-12.343	-18.806	-3.726	53.317	-39.302
-35.509	-354.954	-1.478	-3.470	-3.915	75.653	-54.403
-42.748	-355.197	5.149	6.124	-4.019	28.963	-19.462
-49.987	-355.339	9.372	12.378	-4.078	-62.832	47.274
-57.379	-356.433	-3.113	-6.303	-14.306	-29.259	10.924
-64.77	-356.483	-0.978	-3.130	-14.322	-6.218	2.284
-72.161	-356.508	0.759	-0.652	-14.328	-1.547	6.731
-79.553	-356.516	2.350	1.490	-14.328	-12.790	23.027

Table 41. Member force of the jacket (1st leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Member force from SACS (1st leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	5.296	0.776	-1.153	10.469	12.731	-10.701
-9.525	5.296	0.776	-1.153	10.469	19.447	-15.223
-15.278	5.296	0.776	-1.153	10.469	19.447	-15.223
-21.031	5.296	-27.328	34.087	10.469	-116.430	95.240
-28.27	-356.470	23.503	-30.305	-3.212	-102.510	83.404
-35.509	-356.470	-1.174	1.767	-3.212	69.172	-49.736
-42.748	-356.470	-1.174	1.767	-3.212	69.173	-49.736

-49.987	-356.470	-10.554	14.712	-3.212	-64.331	46.033
-57.379	-357.570	4.947	-8.302	-14.956	-78.747	40.710
-64.77	-357.570	2.340	-4.591	-14.956	-31.218	13.950
-72.161	-357.570	0.368	-1.803	-14.956	-7.716	4.098
-79.553	-357.570	-2.855	2.503	-14.956	-14.097	23.161

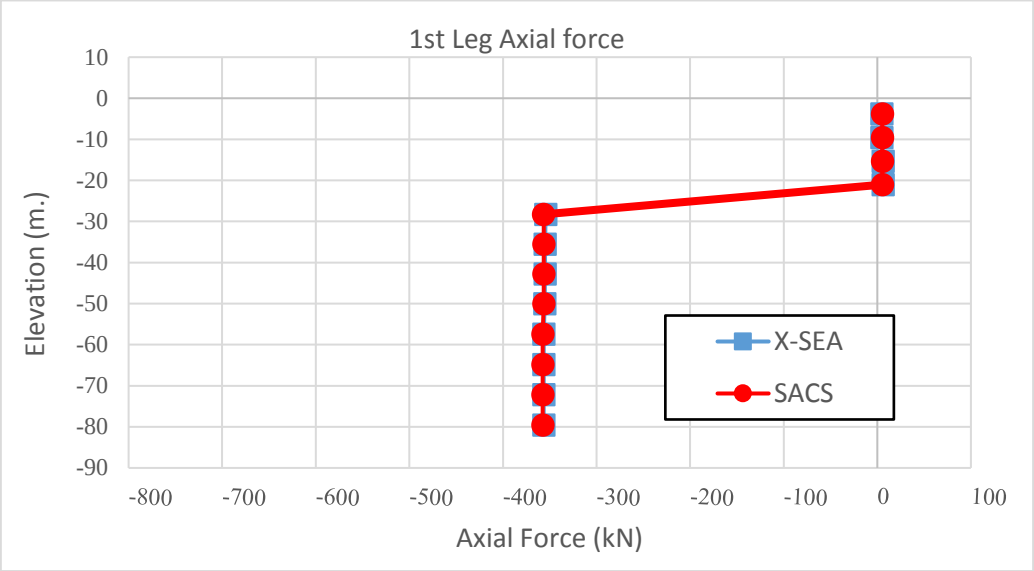

Figure 20. Comparison of axial forces according to the height of the 1st leg between X-SEA and SACS results using Stoke's wave theory

Table 42. Member force of the jacket (2nd leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Member force from X-SEA (2nd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-14.658	-0.957	1.388	-28.181	-10.297	-11.900
-9.525	-14.658	-0.957	1.388	-28.181	-18.386	-17.473
-15.278	-13.512	-1.263	0.373	-25.897	-23.132	-19.886
-21.031	-13.351	15.266	-22.498	-24.149	101.400	76.980
-28.27	-1.239	-14.185	18.248	33.355	-54.901	-46.298
-35.509	-1.644	-1.999	2.913	31.814	-72.087	-50.744
-42.748	-1.868	5.376	-6.681	30.926	-20.691	-5.154
-49.987	-1.992	10.025	-12.934	30.408	75.544	72.243
-57.379	-702.911	-4.237	5.023	9.066	14.324	13.542

-64.77	-702.945	-1.972	1.846	8.882	1.021	0.739
-72.161	-702.956	-0.170	-0.625	8.785	5.980	1.029
-79.553	-702.953	1.438	-2.770	8.749	26.837	13.189

Table 43. Member force of the jacket (2nd leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Member force from SACS (2nd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-13.986	-1.247	1.185	-29.601	2.847	-4.973
-9.525	-13.986	-1.247	1.185	-29.601	16.660	-19.499
-15.278	-13.986	7.319	-9.473	-29.601	13.053	-18.306
-21.031	-13.986	26.858	-34.054	-29.601	-118.840	85.481
-28.27	2.563	-21.825	29.359	30.927	-91.220	62.144
-35.509	2.563	2.851	-2.713	30.927	66.588	-46.403
-42.748	2.563	2.851	-2.713	30.927	66.588	-46.403
-49.987	2.563	12.232	-15.658	30.927	-80.787	73.960
-57.379	-708.780	-5.458	7.117	8.458	-56.694	46.494
-64.77	-708.780	-2.850	3.407	8.458	-18.033	15.913
-72.161	-708.780	0.778	-1.649	8.458	-7.478	1.982
-79.553	-708.780	2.344	-3.687	8.458	-27.512	13.664

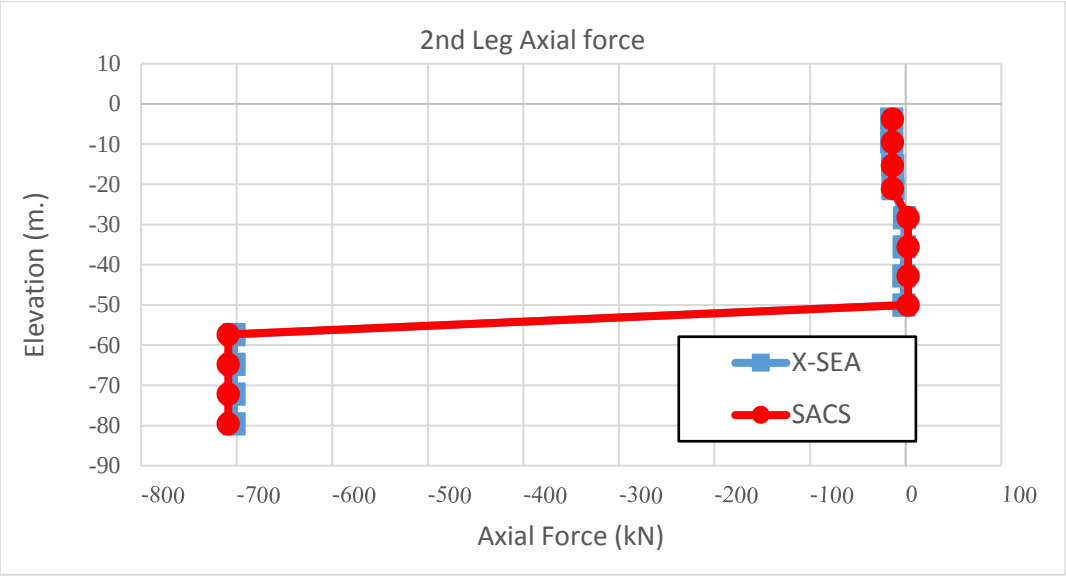

Figure 21. Comparison of axial forces according to the height of the 2nd leg between X-SEA and SACS results using Stoke's wave theory

Table 44. Member force of the jacket (3rd leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Member force from X-SEA (3rd leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	6.526	2.377	-3.857	20.727	14.321	4.260
-9.525	6.526	2.377	-3.857	20.727	36.682	18.039
-15.278	6.526	2.038	-2.183	20.727	51.160	31.123
-21.031	6.526	-0.597	20.996	20.728	-67.605	29.857
-28.27	-12.400	3.658	-15.424	-25.948	27.804	-14.341
-35.509	-12.400	1.824	-3.346	-25.948	49.102	-0.067
-42.748	-12.400	0.562	3.078	-25.947	24.958	4.707
-49.987	-12.400	-0.311	6.452	-25.947	-23.016	2.902
-57.379	683.852	1.384	-2.564	-0.939	-31.185	-7.783
-64.77	683.852	0.990	-1.659	-0.939	-19.085	-0.213
-72.161	683.852	0.740	-1.193	-0.939	-10.319	5.382
-79.553	683.852	0.631	-0.927	-0.939	-3.467	10.071

Table 45. Member force of the jacket (3rd leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Member force from SACS (3rd leg)

Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	6.698	-2.108	-2.948	21.851	14.415	3.553
-9.525	6.698	-2.108	-2.948	21.851	31.507	15.774
-15.278	6.698	-1.137	8.344	21.851	36.357	26.954
-21.031	6.698	1.056	30.971	21.851	-83.004	26.874
-28.27	-9.871	-4.491	-24.925	-27.188	-88.220	-38.346
-35.509	-9.871	-1.061	0.996	-27.188	48.405	-0.757
-42.748	-9.871	-1.061	0.996	-27.189	48.405	-0.757
-49.987	-9.871	0.646	8.367	-27.188	-31.003	0.826
-57.379	697.440	-1.684	-3.435	-1.350	-51.742	-18.485
-64.77	697.440	-1.188	-2.079	-1.350	-31.735	-7.904
-72.161	697.440	-0.867	-1.362	-1.350	-19.187	-0.349
-79.553	697.440	-0.686	-0.961	-1.350	-10.655	5.359

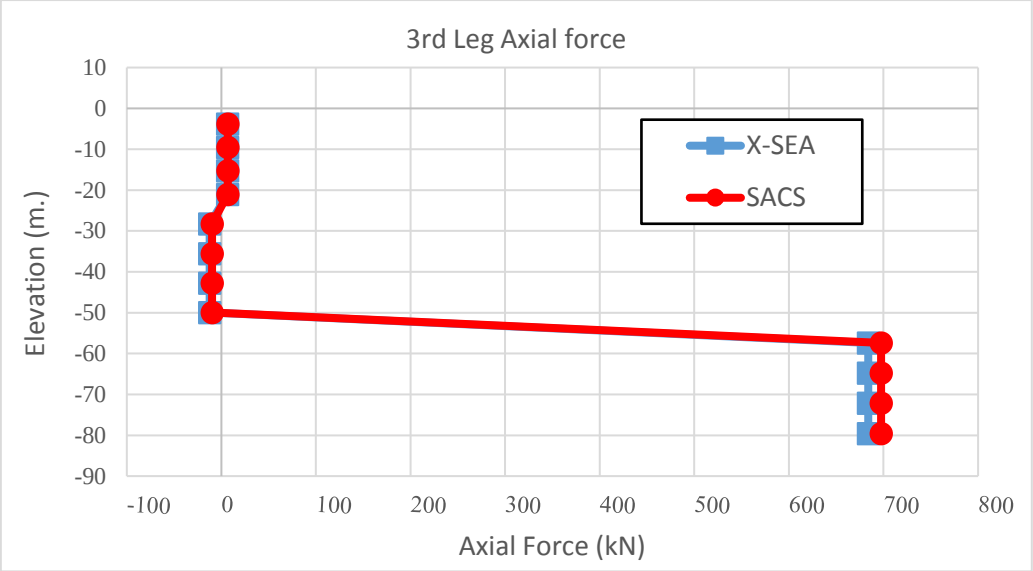

Figure 22. Comparison of axial forces according to the height of the 3rd leg between X-SEA and SACS results using Stoke's wave theory

Table 46. Member force of the jacket (4th leg) modelled in X-SEA using Stoke's wave theory

	Case 2 : Stoke ----- Member force from X-SEA (4th leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)

-3.7719	-3.629	0.700	4.024	-3.995	-19.487	-4.245
-9.525	-3.629	0.700	4.024	-3.995	-42.817	-0.184
-15.278	-3.908	0.700	2.350	-2.000	-60.275	3.181
-21.031	-3.930	-1.671	-20.829	-1.462	56.980	-7.804
-28.27	326.046	4.744	16.021	7.332	-19.962	-3.792
-35.509	326.129	2.742	3.944	6.270	-44.549	14.525
-42.748	326.184	1.366	-2.481	5.695	-24.185	23.336
-49.987	326.223	0.418	-5.854	5.387	19.739	25.584
-57.379	325.710	1.437	2.264	4.642	26.851	-11.918
-64.77	325.732	0.996	1.359	4.554	17.074	-4.881
-72.161	325.749	0.716	0.893	4.513	10.585	0.217
-79.553	325.765	0.578	0.627	4.497	5.984	4.410

Table 47. Member force of the jacket (4th leg) modelled in SACS using Stoke's wave theory

	Case 2 : Stoke ----- Member force from SACS (4th leg)					
Elevation (m)	Axial (kN)	Shear-S (kN)	Shear-T (kN)	Torsion (kN)	Moment-S (kN-m)	Moment-T (kN-m)
-3.7719	-3.240	0.476	3.455	-4.592	18.241	-4.152
-9.525	-3.240	0.476	3.455	-4.592	38.274	-1.394
-15.278	-3.240	-0.495	-7.837	-4.592	46.065	0.323
-21.031	-3.240	-2.688	-30.464	-4.592	-70.354	-9.220
-28.27	334.100	5.134	25.833	4.552	-107.210	-34.018
-35.509	334.100	1.704	-0.088	4.552	42.657	12.955
-42.748	334.100	1.704	-0.088	4.552	42.657	12.955
-49.987	334.100	-0.003	-7.459	4.552	-23.504	23.921
-57.379	334.800	1.528	3.296	5.299	-48.526	-20.499
-64.77	334.800	1.032	1.940	5.299	-29.552	-11.085
-72.161	334.800	0.711	1.224	5.299	-18.037	-4.693
-79.553	334.800	0.530	0.823	5.299	-10.538	-0.151

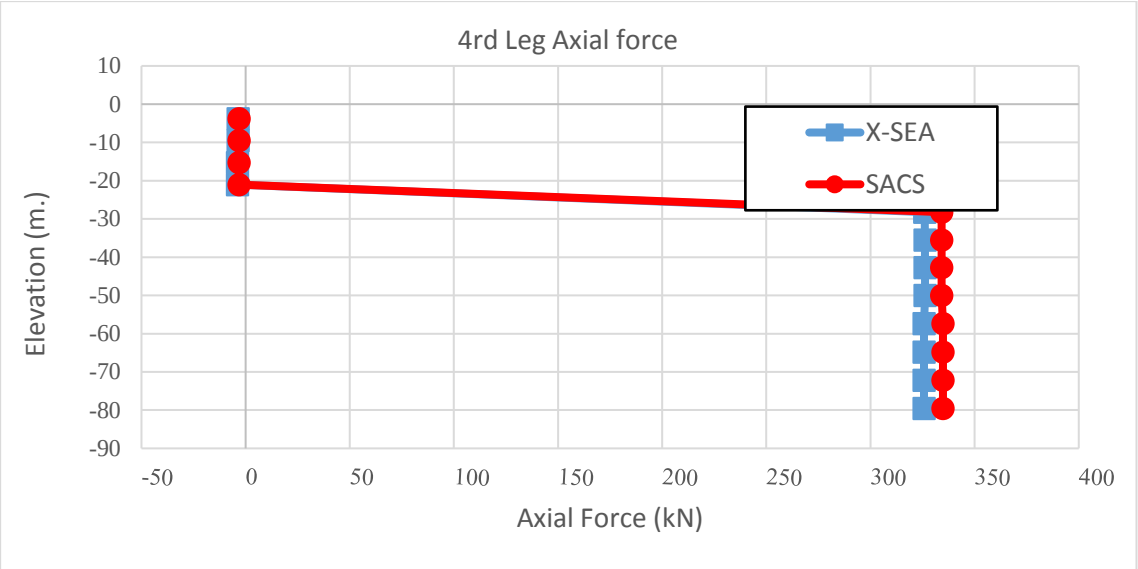

Figure 23. Comparison of axial forces according to the height of the 4th leg between X-SEA and SACS results using Stoke's wave theory