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SeaFEM - Validation Case 3

ISSC Tension Leg Platform

SeaFEM

Version
15.1.0

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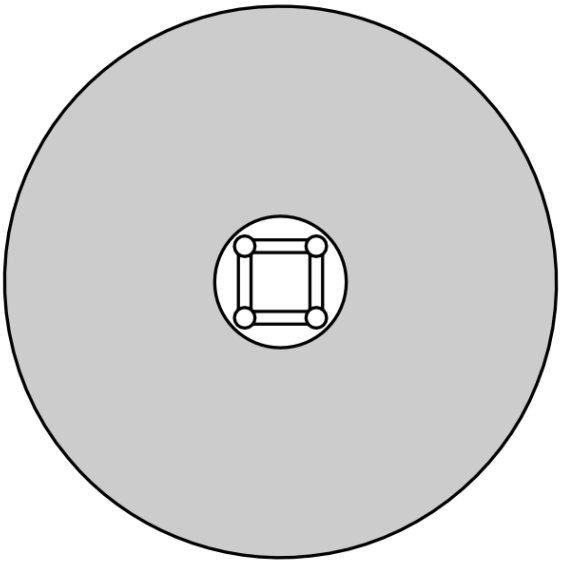
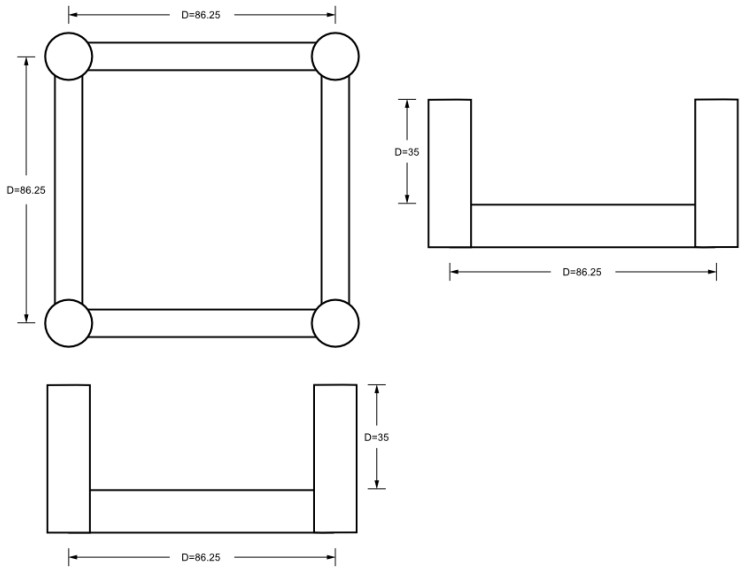
1 Validation Case 3 - ISSC_TLP_structure

In this section we analyze the seakeeping behaviour of a freely floating tension leg platform. The platform used is the ISSC TLP (Eatock Taylor, R. and Jefferys, ER., Variability of Hydrodynamic Load Predictions for a Tension Leg Plattform, cean Eng. 1986, Vol 13; 5, 449-490). The geometry of the TLP and the computational domain enclosing it are shown in the following figures. First, a general view of the computational domain is shown.



Next, a detailed view of the platform geometry is presented indicating its main dimensions (units in meters).



The mass is obtained internally to equal the displacement of the platform. The gravity centre position and radii of inertia are provided in the table below.

Structure properties	
XG (m)	0
YG (m)	0
ZG (m)	3
Rxx (m)	38.876
Ryy (m)	38.876
Rzz (m)	42.420

Problem description

- Geometry

Squared-shape tension leg platform (TLP). Side length and heigth of the TLP are about 86.25 and 35 meters respectively.

- Domain

Seakeeping analysis dealing with waves.

- Fluid Properties

Seakeeping analysis undertaken using SeaFEM always consider that the fluid medium is sea water. Nevertheless, water density can be adjusted to match the actual fluid properties variation. For the present analsyis, water density was taken to be $\rho = 1025\ kg/m^3$.

- Fluid Models

Seakeeping analysis undertaken using SeaFEM always deal with incompressible fluids.

- Boundary Conditions and seakeeping environment

Wave spectrum type: white noise

Wave amplitude: 1.0 m

Shortest period: 8 s

Largest period: 15 s

Wave direction: 0.0 deg

- Time data and solver parameters

Time step: 0.5 s

Simulation time: 300 s

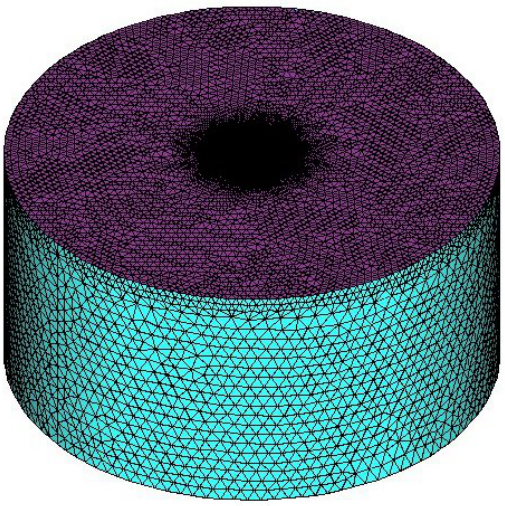
Symmetric solver: Deflated conjugate gradient (tolerance = 1.0E-7) with and ILU preconditioner

Mesh

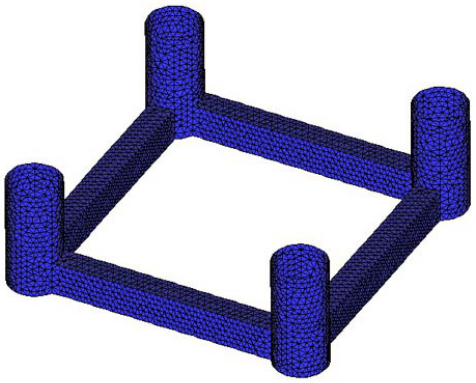
Mesh properties for the present analysis are summarized in the following table:

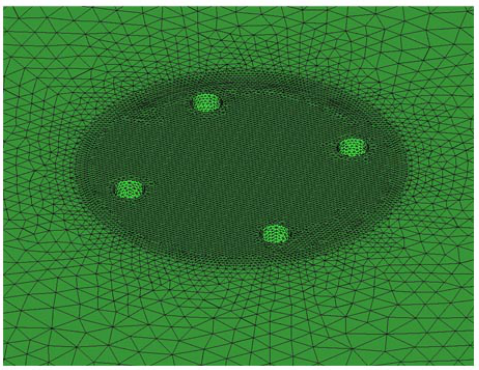
Mesh properties	
Min. element size	2
Max element size	25
Mesh size transition	0.3
Number of elements	475,613
Number of nodes	83,047

Next picture shows an isometric view of the whole domain mesh used for the present analysis.



Next, a detail of the mesh close to the surface of the TLP structure is shown. The surface mesh of the TLP structure is shown as well as the free surface mesh around the structure.

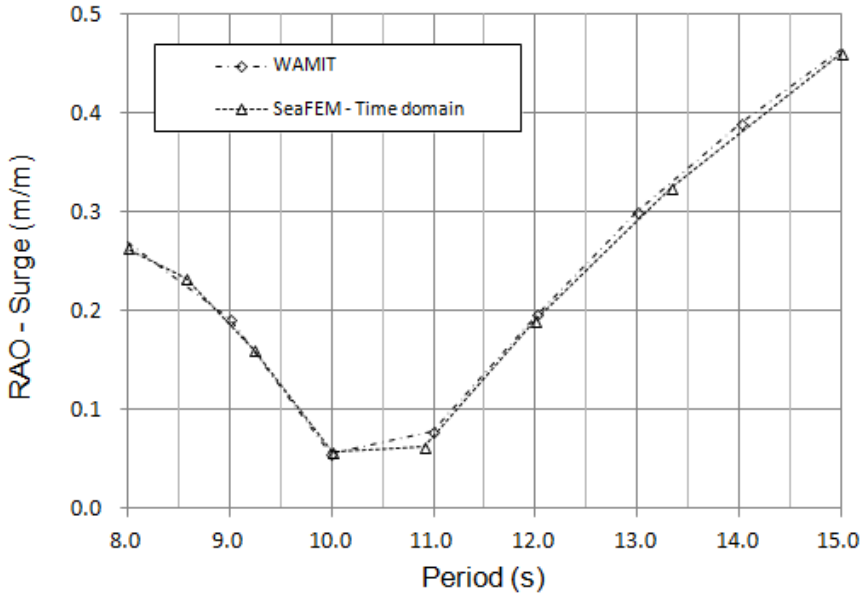


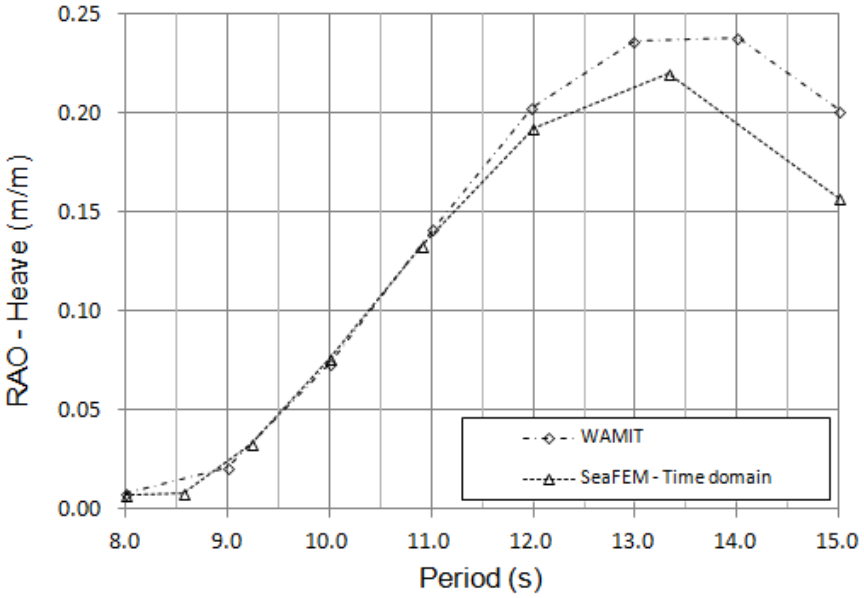


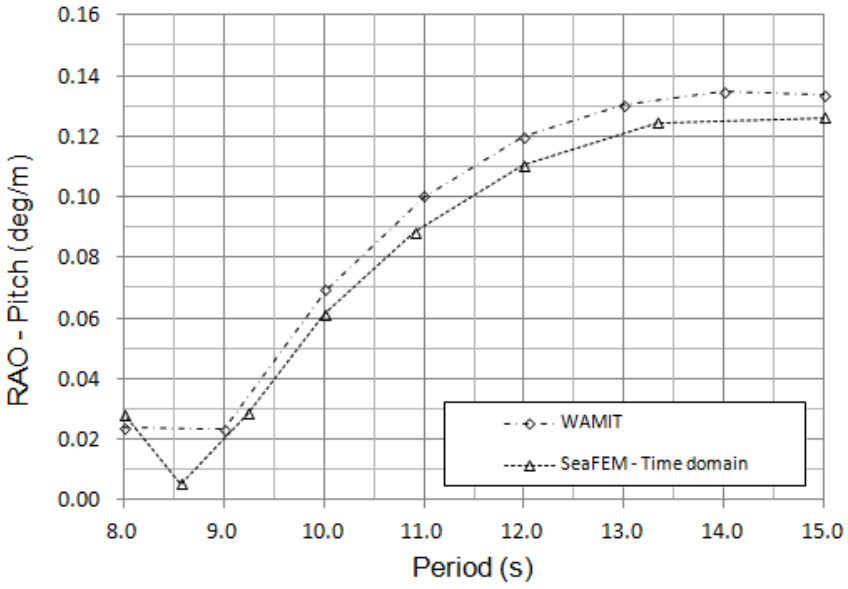
Results

Simulations were carried out for periods ranging between eight and fifteen seconds for three different wave heading. Figures below compare the response amplitude operators (RAOs) obtained by the present FEM model and RAOs obtained by the well known program WAMIT, which is based on the boundary element method (BEM). For propper comparison, SeaFEM RAOs results concerning rotational degrees of freedom must be multiplied by the characteristic length of the model. This is so because WAMIT results are provided in, while the output of SeaFEM is not. In this case, the characteristic length of the model is half the distance between the legs of the TLP structure L = 43.125 m.

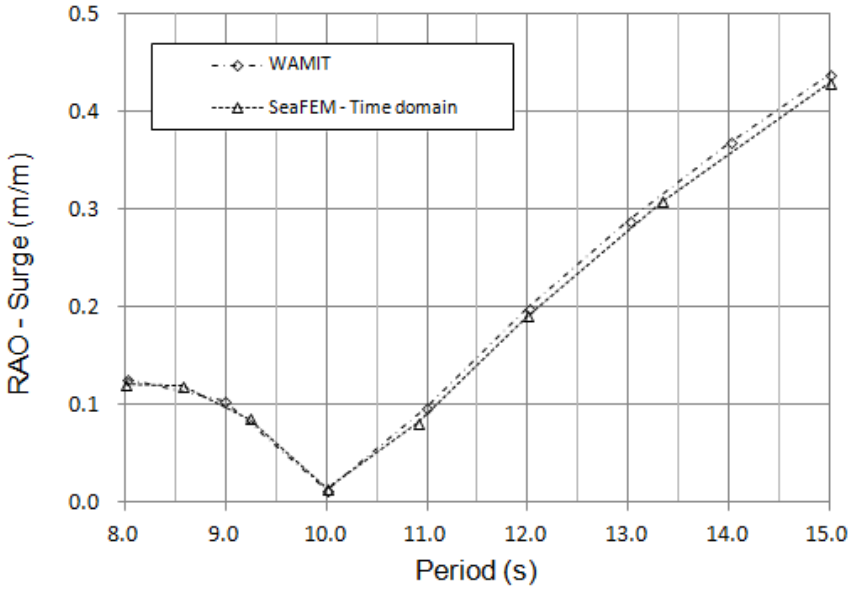
SeaFEM vs. Wamit raos results for 0º heading:

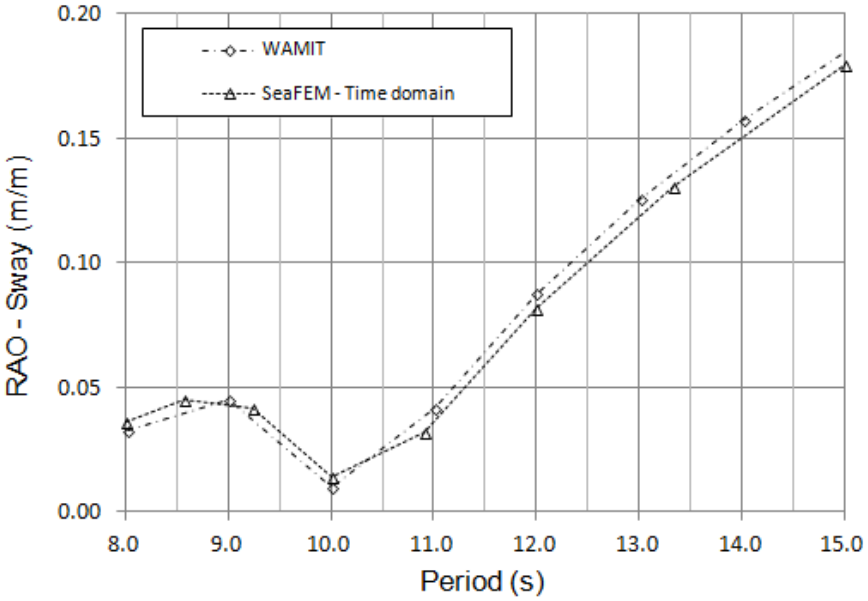


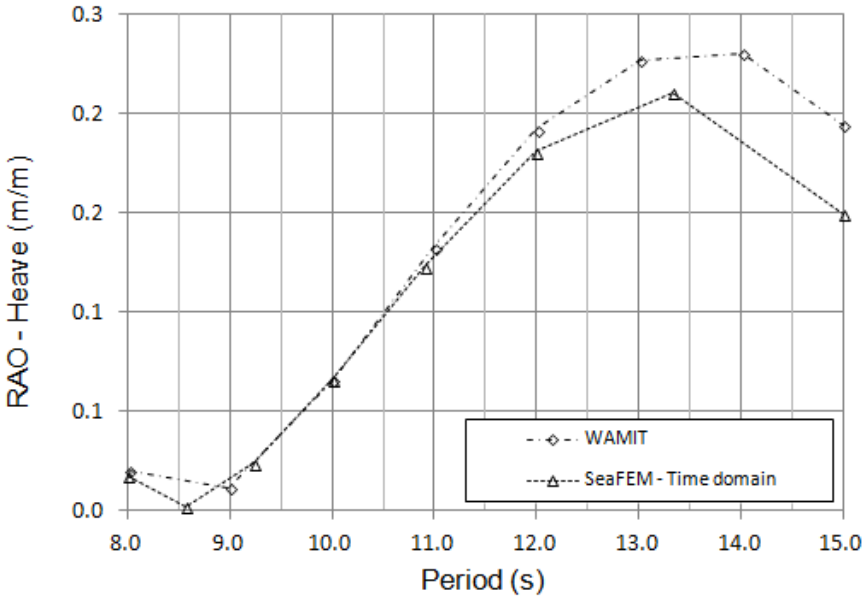


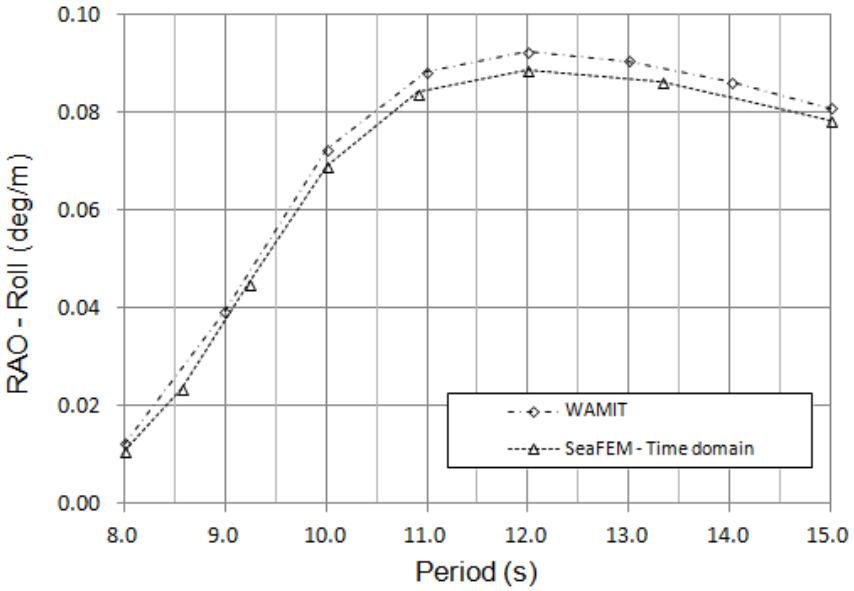


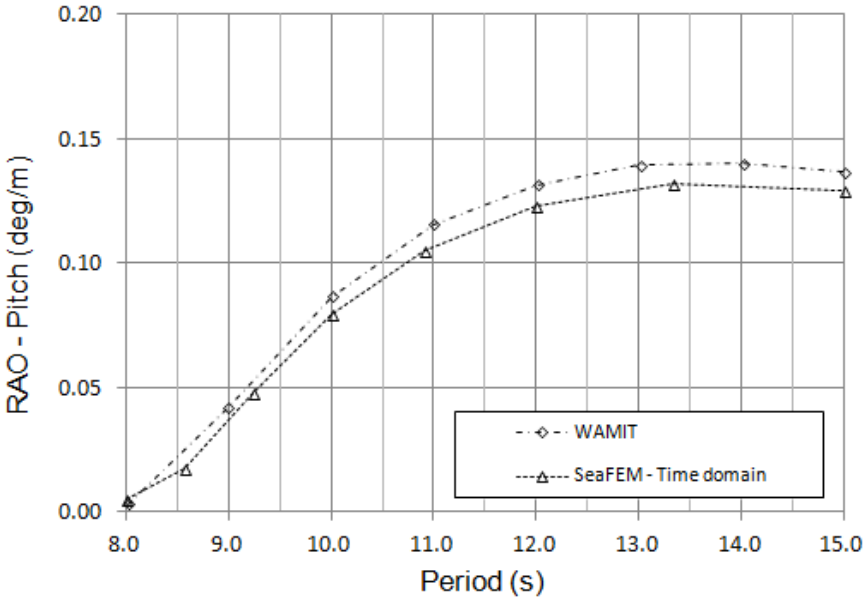
SeaFEM vs. Wamit raos results for 22.5º heading:

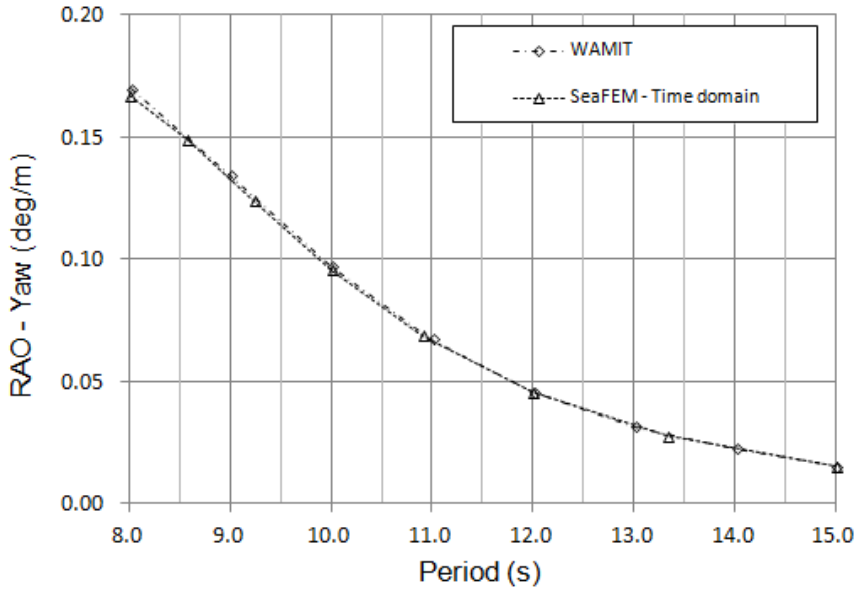

WAMIT
SeaFEM - Time domain
RAO - Surge (m/m)
Period (s)
0.0
0.1
0.2
0.3
0.4
0.5
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0


WAMIT
SeaFEM - Time domain
RAO - Sway (m/m)
Period (s)
0.00
0.05
0.10
0.15
0.20
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0

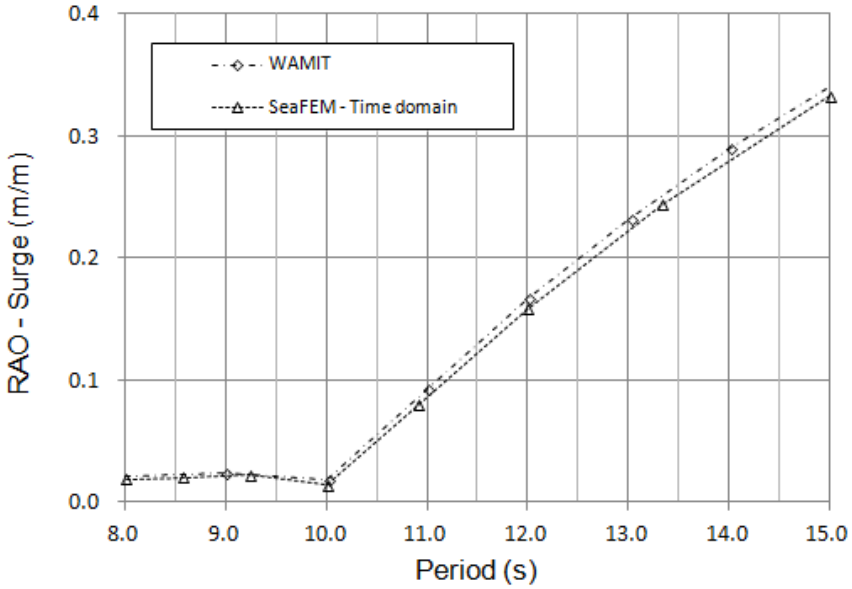

RAO - Heave (m/m)
0.3
0.2
0.2
0.1
0.1
0.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
Period (s)
WAMIT
SeaFEM - Time domain

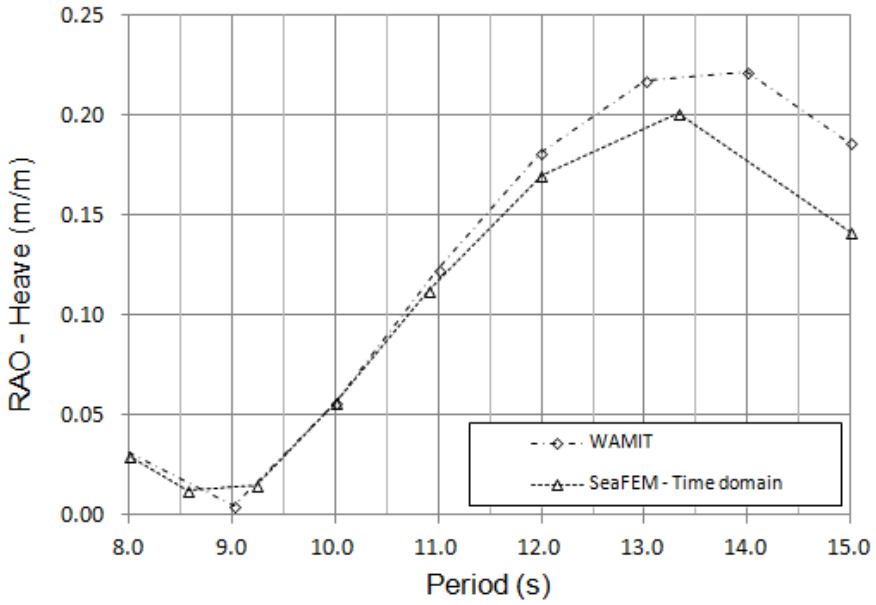

RAO - Roll (deg/m)
0.10
0.08
0.06
0.04
0.02
0.00
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
Period (s)
WAMIT
SeaFEM - Time domain

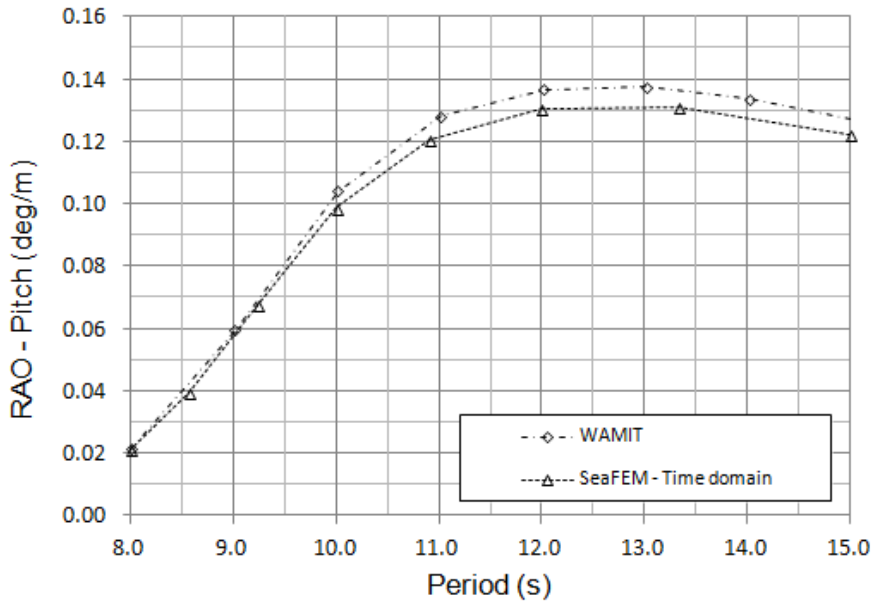




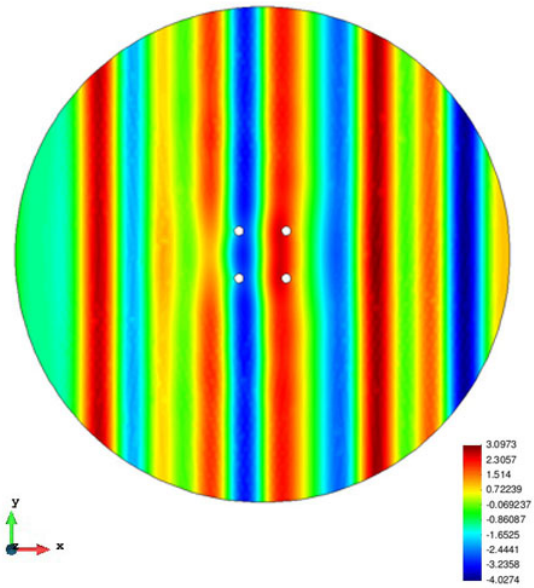
SeaFEM vs. Wamit raos results for 45º heading:

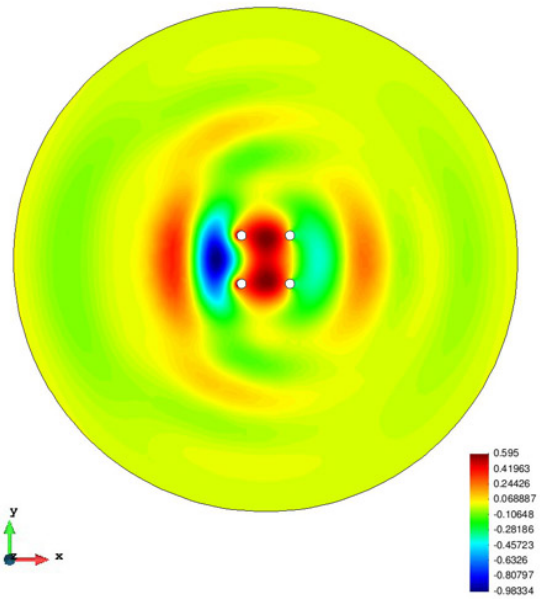

0.4
0.3
0.2
0.1
0.0
RAO - Surge (m/m)
WAMIT
SeaFEM - Time domain
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
Period (s)

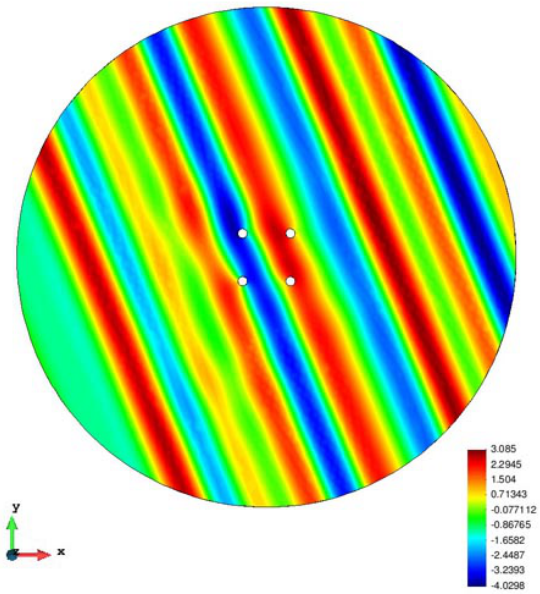

0.25
0.20
0.15
0.10
0.05
0.00
RAO - Heave (m/m)
WAMIT
SeaFEM - Time domain
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
Period (s)

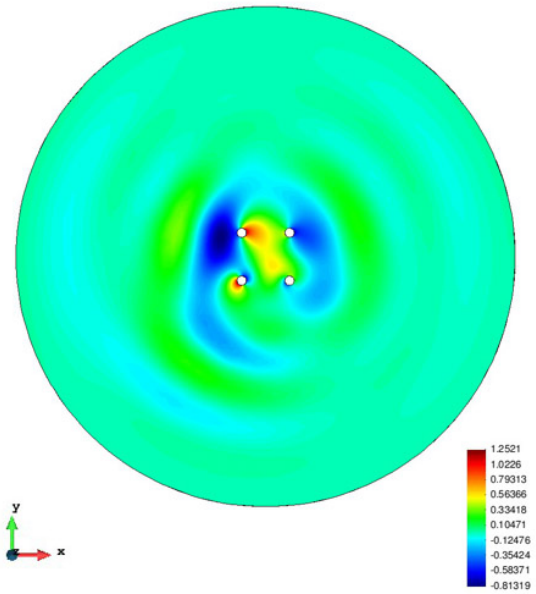


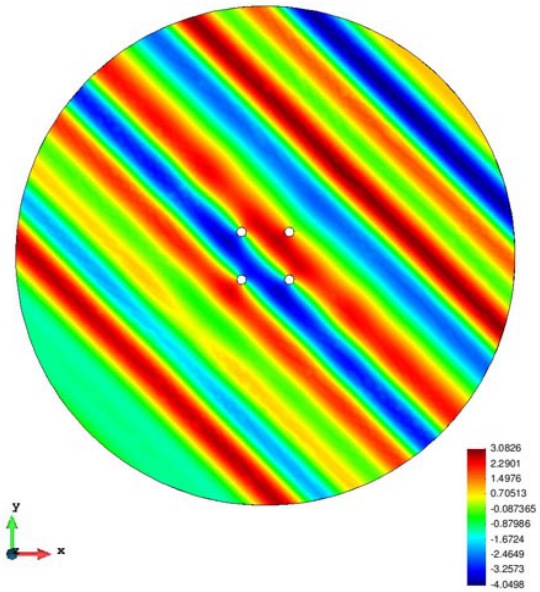
The figures below show the total elevation and the scattered waves for the three different heading values under analysis. For the sake of comparison, all captions correspond to the last time step of the simulation.

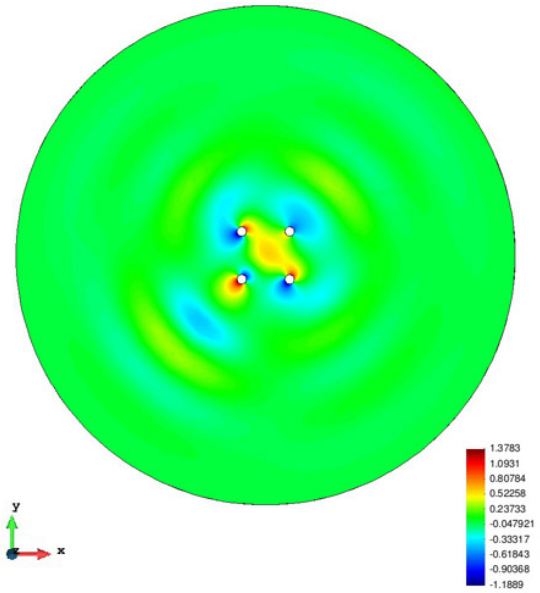





3.085
2.2945
1.504
0.71343
-0.077112
-0.86765
-1.6582
-2.4487
-3.2393
-4.0298
y
x


1.2521
1.0226
0.79313
0.56366
0.33418
0.10471
-0.12476
-0.35424
-0.58371
-0.81319
y
x


3.0826
2.2901
1.4976
0.70513
-0.087365
-0.87986
-1.6724
-2.4649
-3.2573
-4.0498
y
x


1.3783
1.0931
0.80784
0.52258
0.23733
-0.047921
-0.33317
-0.61843
-0.90368
-1.1889
y
x

References

[1] Eatock Taylor, R. and Jefferys, ER., Variability of Hydrodynamic Load Predictions for a Tension Leg Plattform, ocean Eng. 1986, Vol 13; 5, 449-490

Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018