COMPASS
www.compassis.com

SeaFEM - Validation Case 4

Floating cylinder

SeaFEM

Version
15.1.0

Compass Ingeniería y Sistemas http://www.compassis.com
Tel.: +34 932 181 989 - Fax.: +34 933 969 746 - E: info@compassis.com - C/ Tuset 8, 7o 2a, Barcelona 08006 (Spain)

http://www.compassis.com
info@compassis.com
November 2018

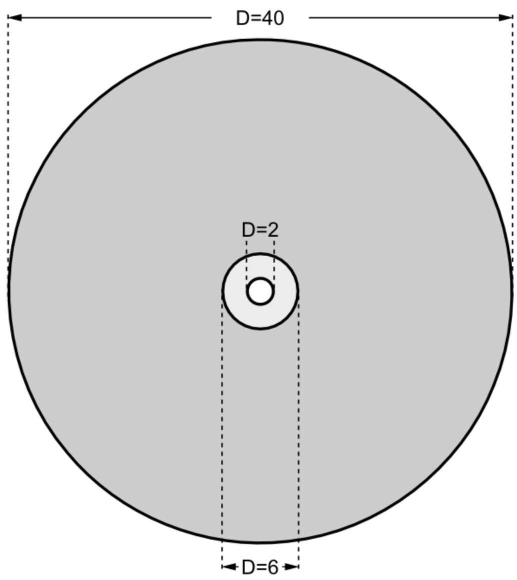
Table of Contents

1 Validation Case 4 - Floating cylinder

The present test case analyzes the seakeeping behaviour of a freely floating cylinder subject to the action of monochromatic waves. The cylinder characteristics are given in the following table.

Cylinder characteristics	
Radius "R" (m)	1
Draft "D" (m)	0.5
XG (m)	0
YG (m)	0
ZG (m)	0
Ixx/Mass (m2)	1
Iyy/Mass (m2)	1

The GiD geometry below shows the whole computational domain with the floating cylinder located at the center:



The mass of the body is calculated internally in order to equal the mass of the water displaced by the cylinder. The gravity used is $g=9.80665 m/s^2$, the water density used is $\rho=1025 kg/m^3$, and water depth is H=20m.

In the present analysis we are interested to know how the body moves when excited by a regular wave. In this specific case, where the only excitation is the wave, the cylinder is expected to respond harmonically with the same frequency of the incident wave. However, since the computational method used herein solves the problem in the time domain, initial conditions will be important. In order to attain faster the harmonic steady state, the incident potential is introduced smoothly by means of a cosine function along an initialization time. Moreover, the body is supposed to be initially at the equilibrium position with zero velocity. During the initialization period a dissipation term proportional to the body velocity is introduced. This dissipation term is smoothly decreased down to zero so that it disappears after the initialization period.

Problem description

- Geometry

Floating cylinder of radius Rc=1m and height H = 0.5m centered in a cylindrical domain of depth 5 meters and radius Rd=20m.

- Domain

Seakeeping analysis dealing with an spectrum waves of period ranging from 1 to 5 seconds.

- 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: 1 s

Largest period: 5 s

Wave direction: 0.0 deg

- Time data and solver parameters

Time step: 0.05 s

Simulation time: 200 s

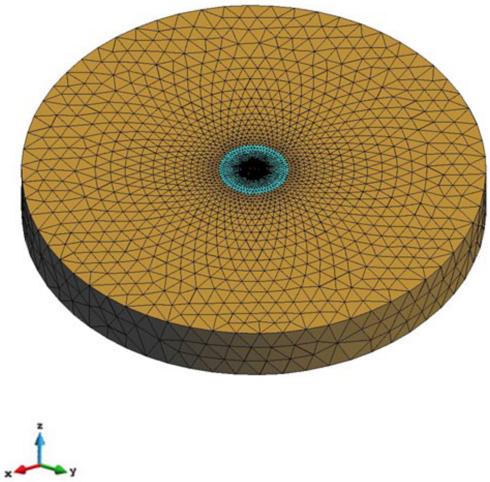
Symmetric solver: Deflated conjugate gradient (tolerance = 1.0E-7) with and ILU preconditioner

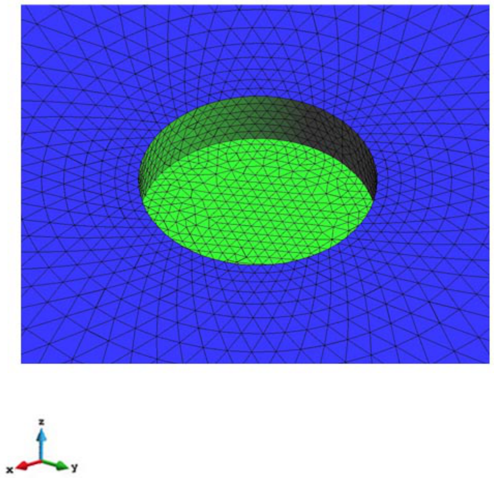
Mesh

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

Mesh properties	
Min. element size	0.1
Max element size	5
Mesh size transition	0.3
Number of elements	82,307
Number of nodes	14,246

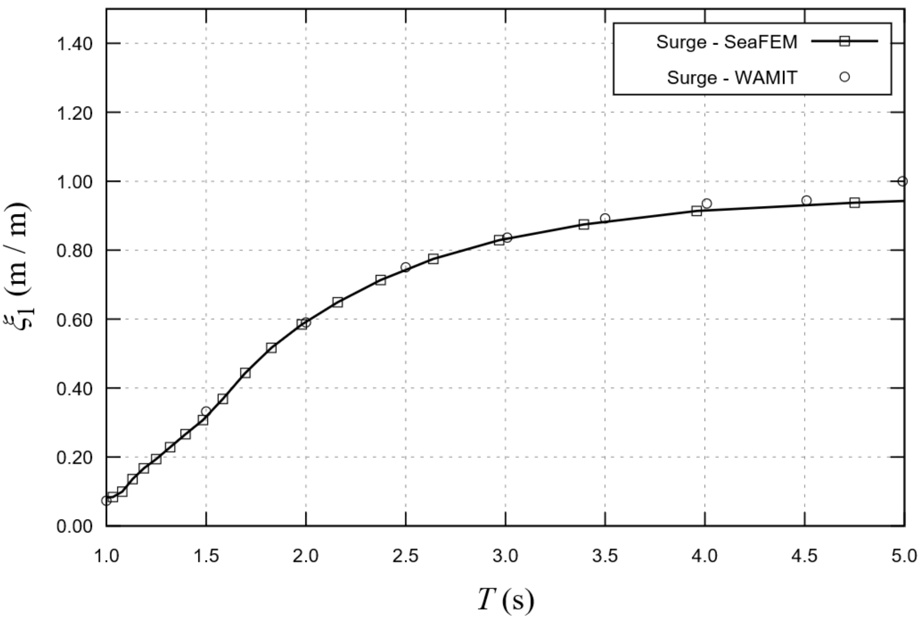
The following figures show the mesh used for the present analysis. First a global view is presented, while the second picture focuses on the detail of the mesh in the free surface region close to the floating cylinder.

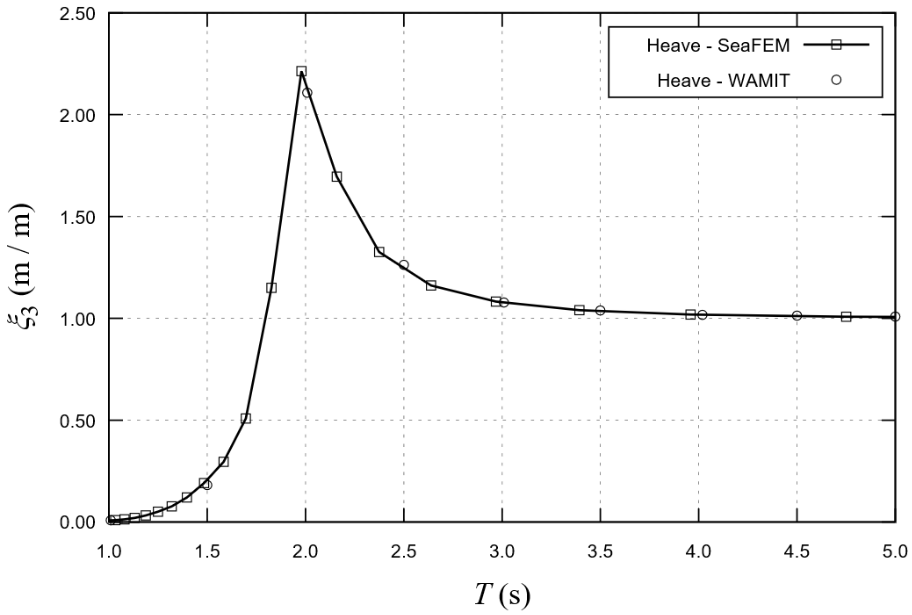


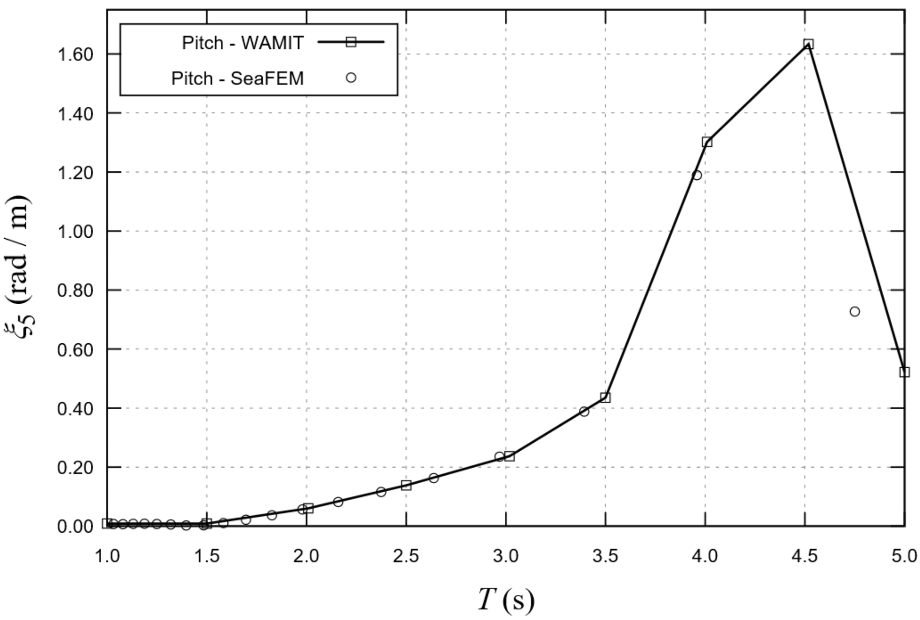


Results

In the present SeaFEM simulations the RAOs are calculated using a white noise spectrum. Using this type of spectrum, a number of waves is introduced with frequencies uniformly distributed across a given interval but with the same amplitude and direction. In the present case, wave periods range between 1 and 5 seconds. Figures below compare the response amplitude operators (RAOs) obtained by the present SeaFEM model and RAOs obtained by the well known program WAMIT, which is based on the boundary element method (BEM). Both results agree well and only some small differences are observed in the resonance area for the pitch movement. Such a deviation is probably due to the different numerical dissipation added in BEM and FEM formulations respectively.




Heave - SeaFEM
Heave - WAMIT
2.50
2.00
1.50
1.00
0.50
0.00
ξ_3 (m / m)
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
T (s)


Pitch - WAMIT
Pitch - SeaFEM
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
ξ_5 (rad / m)
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
T (s)

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