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SeaFEM - Validation Case 1

Bottom mounted cylinder

SeaFEM

Version
15.1.0

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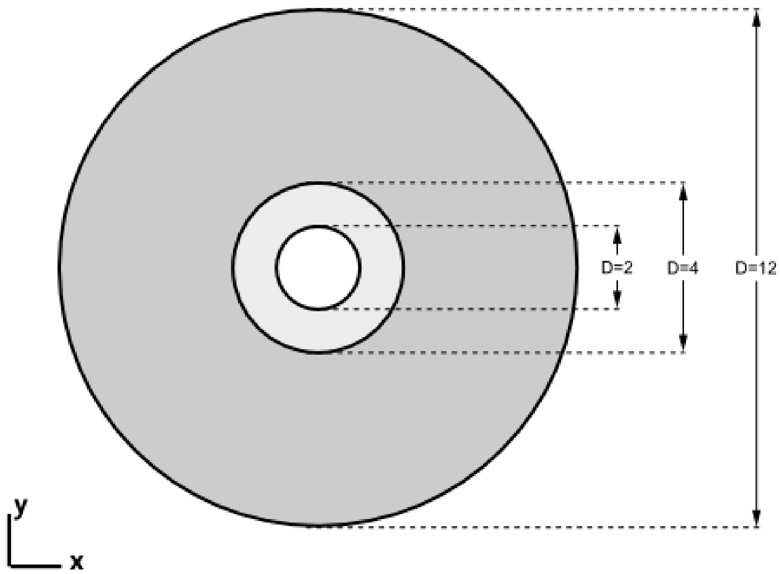
1 Validation Case 1 - Bottom mounted cylinder

This validation case analyses the diffraction problem of a bottom mounted cylinder of radius R=1m and height H=1m. The analysis is carried out for a monochromatic wave of amplitude A=0.1m and wave length L=2m propagating in a domain of 1 meter depth.

Since water depth (d) is exactly one half of the wave length (λ) considered here, the corresponding wave period can be evaluated from a deep water approximation, this being generally valid for d/λ > 0.5. Under this assumption, wave length and wave period are correlated by the following expression.

$$\lambda = \frac{g \cdot T^2}{2\pi} = 1.56 \cdot T^2$$

The following image shows a top view of the computational domain. The intermediate zone centered at the origin and with diameter D=4m corresponds to the analysis area where no artificial dissipation is introduced. The boundary of this area, located at a distance of 2 meters from the center of the scattering cylinder, indicates where the free surface absorption area (beach) starts. Such an absoprtion area is introduced in order to damp those waves refracted and radiated by the body.



For this case, an analythical solution is used to verify the results. The analytical solution is taken from the work "R. McCamy and R. Fuchs, Wave forces on piles: a diffraction theory. Tech. Memo No. 69, U.S. Army Corps of Engrs, 1954".

Problem description

- Geometry

Bottom mounted cylinder of radius R_c=1m and height H=1m centered in a cylindrical domain of depth equal to the height of the cylinder and radius R_d = 6m.

- Domain

Seakeeping analysis dealing with monochromatic 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 ρ = 1025 kg/m^3.

- Fluid Models

Seakeeping analysis undertaken using SeaFEM always deal with incompressible fluids.

- Boundary Conditions and seakeeping environment

Wave spectrum type: monochromatic

Wave amplitude: 0.1 m

Wave period: 1.1339 s

Wave direction: 0.0 deg

- Time data and solver parameters

Time step: internally evaluated based on stability criteria

Simulation time: 25 s

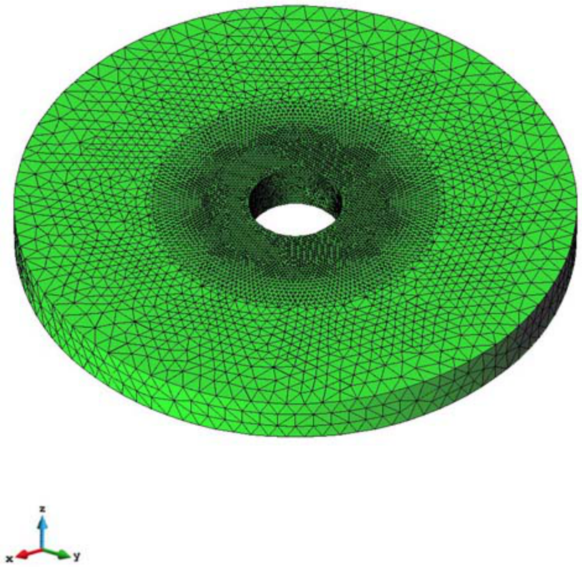
Symmetric solver: Stabilized bi-conjugate gradient (tolerance = 1.0E-7) with and ILU preconditioner

Mesh

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

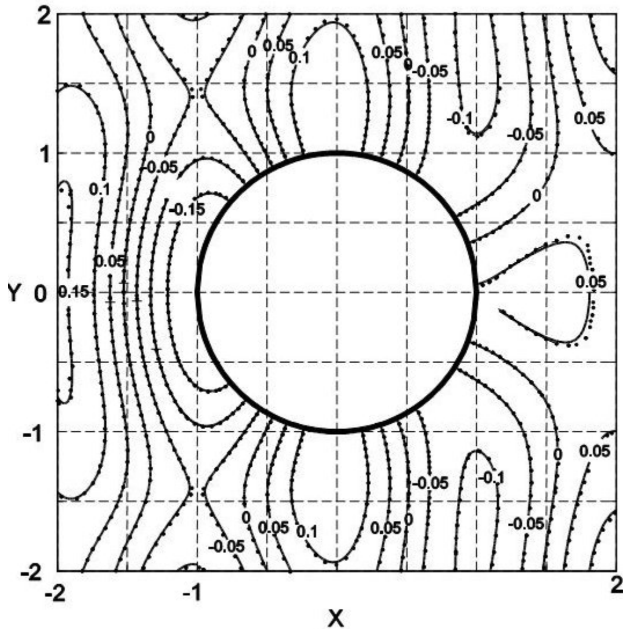
Mesh properties	
Min. element size	0.1
Max element size	0.5
Mesh size transition	0.1
Number of elements	208,087
Number of nodes	35,914

Next picture shows an isometric view of the whole domain mesh used for the present analysis. It can be appreciated how the mesh is gradually refined when approaching the surface of the mounted cylinder.

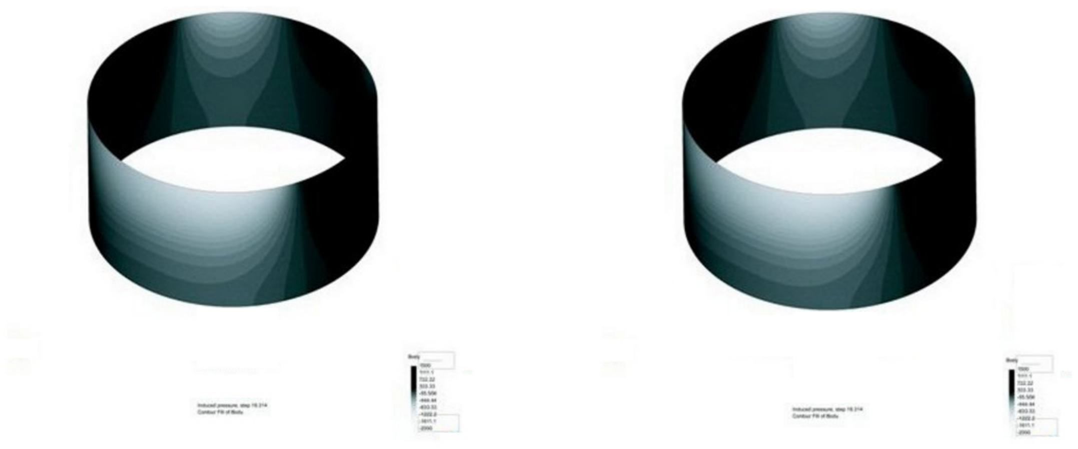


Results

First, wave elevation results obtained using SeaFEM are compared against the analytical solution. In the figure below wave elevation iscontours are shown in the free surface region close to the mounted cylinder. Solid lines correspond to the analytical solution in [1], while dashed lines correspond to the solution computed using SeaFEM. Note that both solutions are in very good agreement.

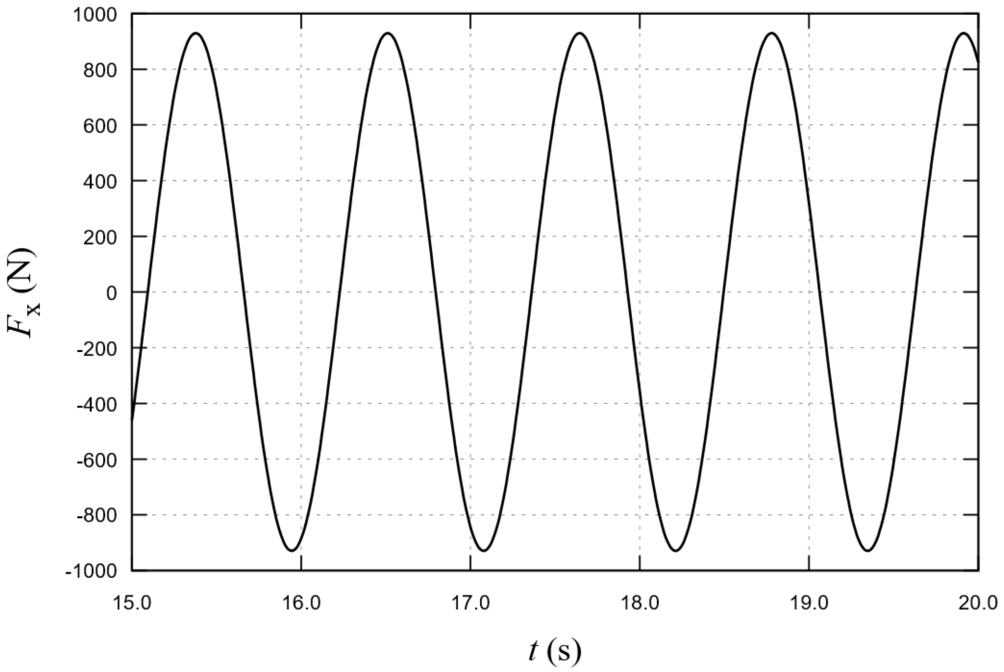


The following figure shows the pressure distribution at the cylinder surface. First picture corresponds to SeaFEM while the second one was obtained by evaluating the analytical solution in [1] in locations coincident with the body mesh points extracted from SeaFEM model. The computed analytical solution was further exported in GiD file format for the sake of visualization. As can be seen, both pressure distributions are visualy identical.



Finally, the force exherted by the incident waves over the body was recorded during a significant time period. The resulting oscillating force in the X direction (incidence direction) is compared herein with the corresponding analytical solution in [1].

As in the case of previous verification data, the two signals are in good agreement in terms of booth, amplitude and oscillation period.



References

[1] R. McCamy and R. Fuchs, Wave forces on piles: a diffraction theory. Tech. Memo No. 69, U.S. Army Corps of Engrs, 1954

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