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SeaFEM - Validation Case 15

Diffraction of second-order surface waves by a semi-submerged horizontal rectangular cylinder

SeaFEM

Version
15.1.0

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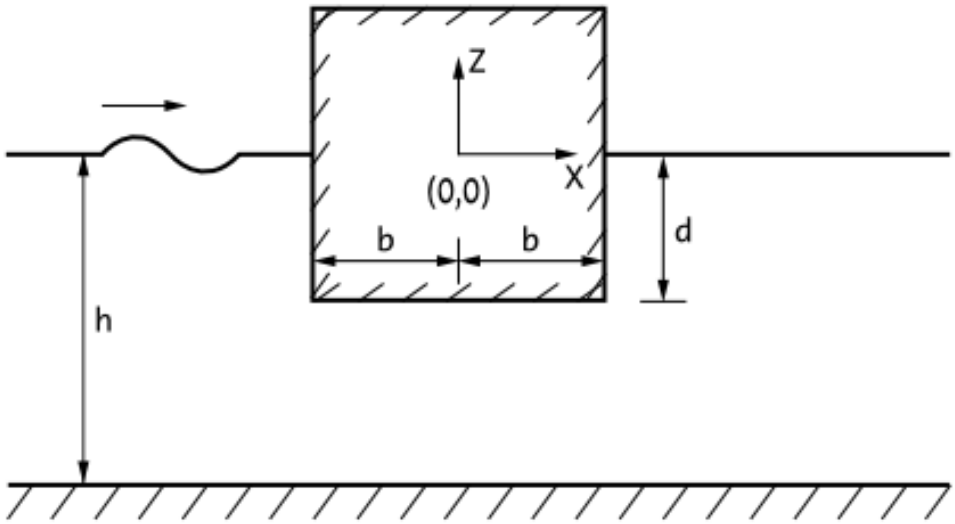
1 Validation Case 15 - Second order wave diffraction

This test case deals with the solution to the diffraction problem for second-order surface waves by a semisubmerged horizontal cylinder of rectangular cross section. The boundary-value problem is solved with SeaFEM and the results are compared against the analytical solution obtained by the method of matched eigenfunction expansions presented in reference [1].

Horizontal and vertical forces and the moment about the heel of the prismatic cylinder are analyzed for different monochromatic waves. An schema of the problem under analysis is shown in the figure below.



Relevant geometry parameters read as follows:

- h = 1 m
- b = 1 m
- d = 0.2 m

Problem description

The situation considered for analysis is the diffraction of waves by a completely fixed horizontal cylinder of rectangular cross section. The analysis is undertaken with the following assumptions:

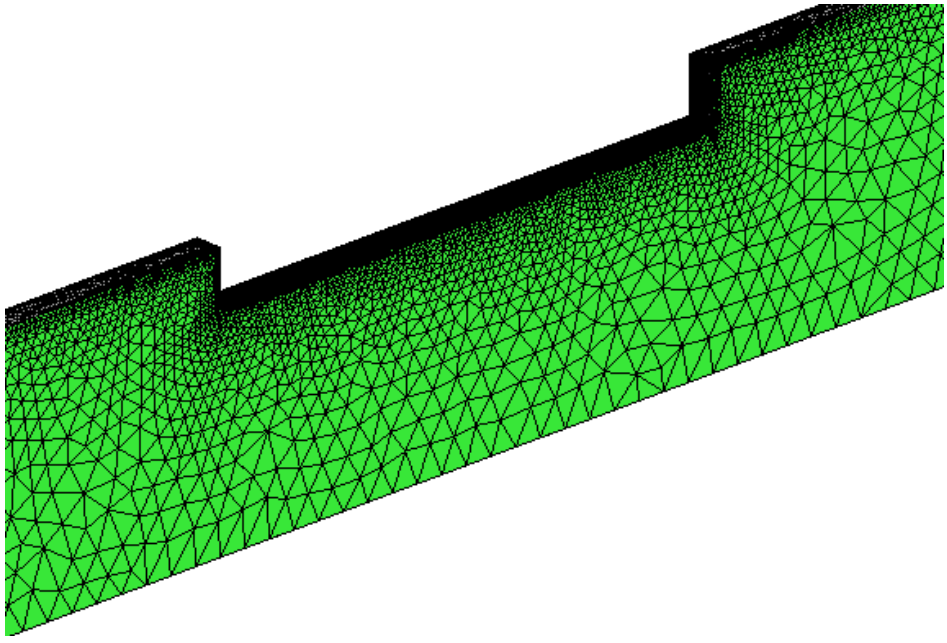
- The fluid is inviscid and incompressible
- The sea bottom and the cylinder are impervious
- The excitation is provided by normally incident plane waves of small amplitude and frequency.
- Several cases are run for different wave periods (T = 0.897, 1.003, 1.07, 1.16, 1.445, 2.299, 4.17, 6.37 s.)
- The simulation time is about 15 s. with and initialization time of 5 s.
- All degrees of freedom are restrained so that the body is completely fixed. Hence, only wave's diffraction occurs but not radiation.

Mesh

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

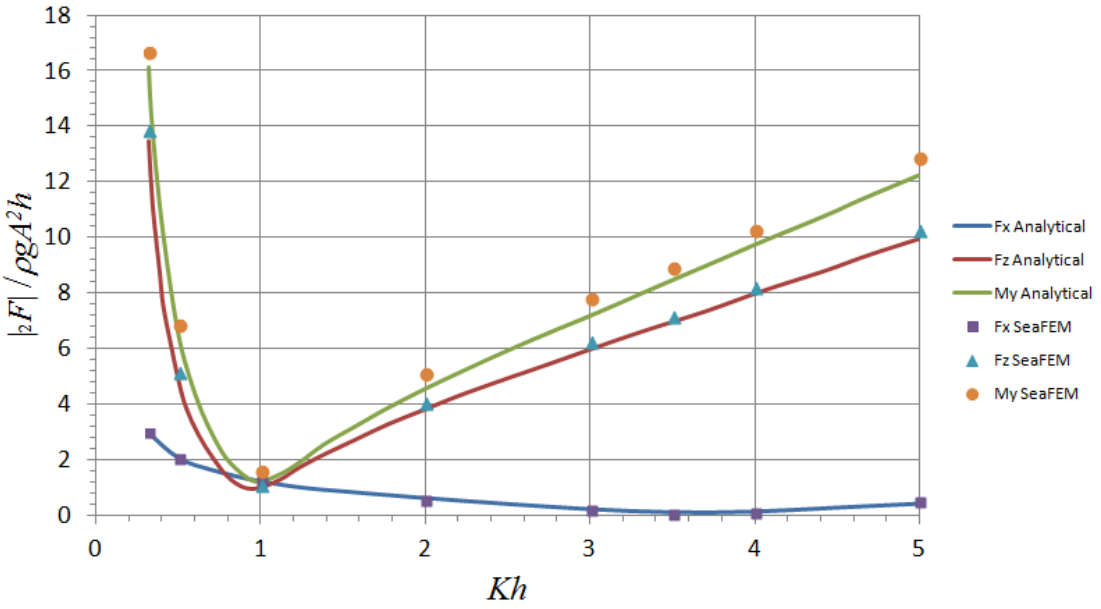
Mesh properties	
Min. element size	0.01
Max element size	0.1
Mesh size transition	0.3
Number of elements	121687
Number of nodes	22940

Next picture shows an isometric view of the mesh used for the present analysis at the region close to the surface of the semisibmerged body.



Results

The following figure shows the amplitude of the second-order horizontal and vertical forces, and the moment about y axis for both, the analytical results in [1] and the results obtained using SeaFEM. The second-order components of the forces (and moments) are normalized relative to the density of the fluid, the gravity, the square of the wave amplitude and the depth of the computational domain. Results are plotted against the dimensionless wave number (kh). As it can be observed, a good agreement is obtained within the entire range of analyzed wave numbers.



References

[1] Wojciech S., Diffraction of second-order surface waves by semisubmerged horizontal rectangular cylinder, J. Waterway, Port, Coastal, Ocean eng. 1993. Vol 119, 160-171

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