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Validation case 19

Frequency domain analysis of two ships in side-by-side configuration

SeaFEM

Version
15.1.0

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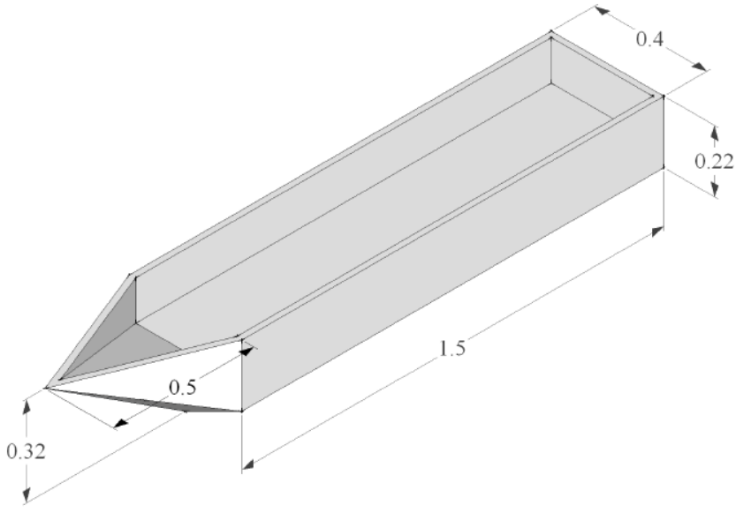
1 Frequency domain analysis of two ships in side-by-side configuration

Problem description

This validation model concerns a multibody system comprised by two bodies of canonical geometries, namely a barge and a geosim, arranged in a side-by-side configuration. The tests were conducted at the CEHINAV-Technical University of Madrid (UPM), which has a towing tank of 100m of length, 3.8m wide and a water depth of 2.5m. Two cases were analysed corresponding to two different gaps between the barge and the geosim (see ref. [1]). Case 1 was set up with a gap of 0.05 meters, while case 2 was prepared with a gap of 0.1 meter. In both cases, the results correspond to a heading direction equal to 180º.



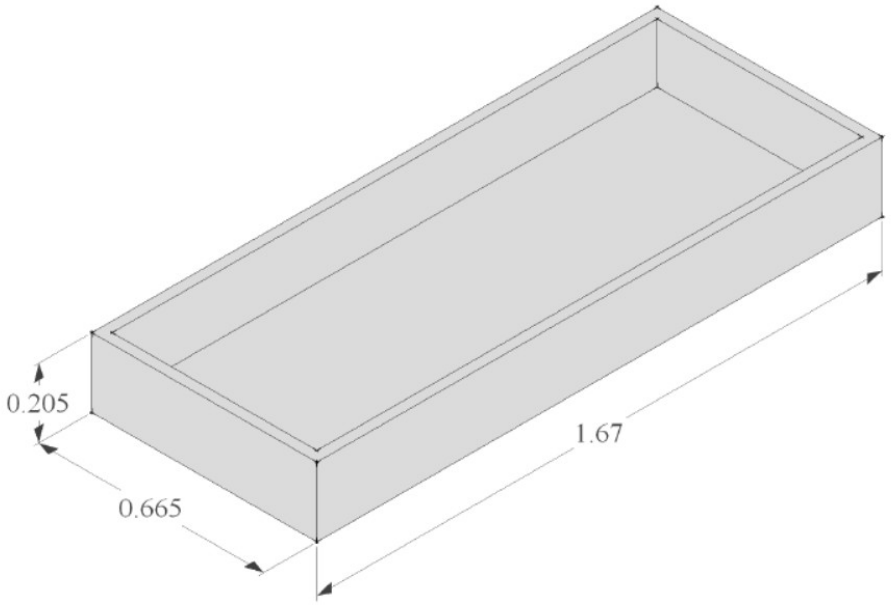
Geosim geometry and main dimensions in meters (source: ref. [1])

The characteristics of the barge and geosim models are summarized in the following table.

Parameter	Barge	Geosim
Length overall (m)	1.67	2.0
Breadth (m)	0.665	0.40
Depth (m)	0.205	0.32
Draft [m]	0.12	0.18
Displacement Weight [kg]	133.26	83.30
CoG above baseline [m] (Exp)	-	0.181
GMt [m]	-	0.035
GMl [m]	-	1.87

CoG from the stern [m]	0.835	0.802
Pitch radius of gyration [m]	-	0.56

The cases of study reproduce the conditions of the experiments, considering three degrees of freedom (surge, heave and pitch) for the geosim model dynamics, while the barge is kept fixed.



Barge geometry and main dimensions in meters (source: ref. [1])

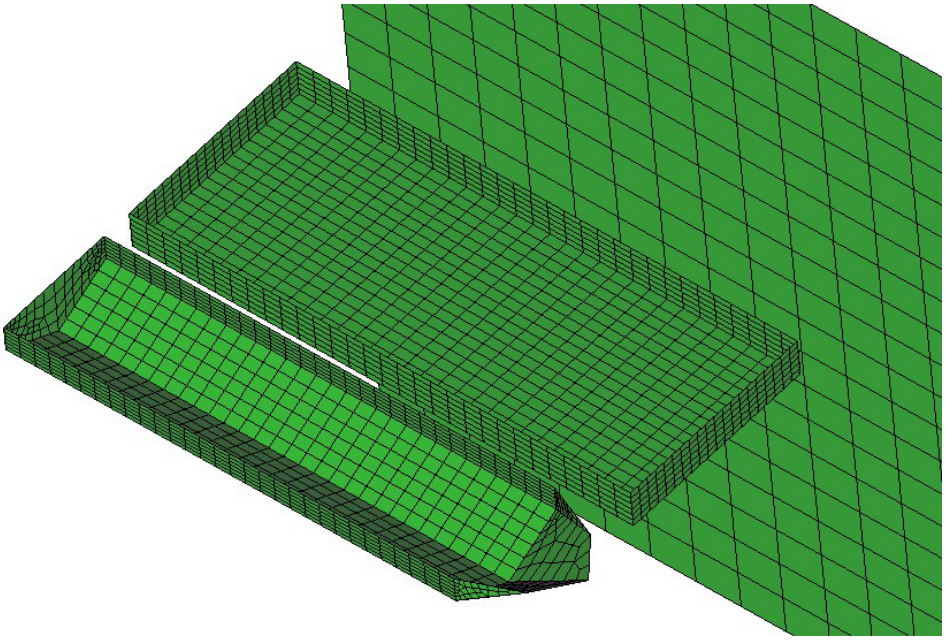
Mesh

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

Mesh properties	No model basin walls	With model basin walls
Elements in length (geosim)	30	30
Elements in beam (geosim)	20	20
Elements in draft (barge)	6	6
Elements in length (barge)	30	30
Elements in walls sides	20	20

A global view of the resulting mesh is shown in the following figure. The image corresponds to

test case number 2 with a gap equal to 0.1 meters.

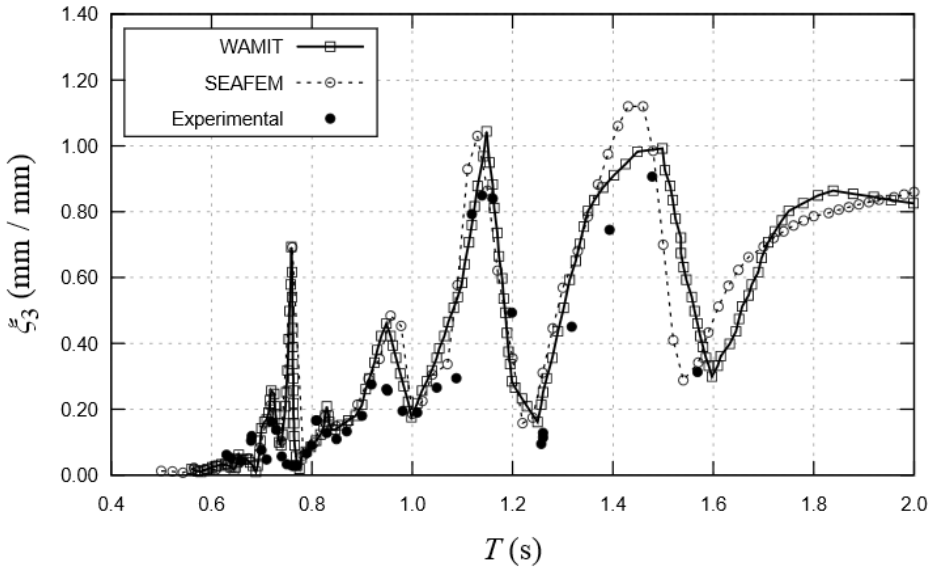


Results

In this section, RAOs results obtained with the frequency module of SeaFEM are compared with those obtained experimentally and with the solver WAMIT in reference [1]. In particular, heave and pitch RAOs responses of the geosim model are plotted. Two different configurations were analysed; one including the walls of the model basin in the model and the other with open boundary conditions. Both configurations were also analyzed using two different gaps between the barge and the geosim (namely 0.05 meters and 0.1 meters respectively).

From the resulting graphs, it can be observed that the results provided by the two computational models are in good agreement. Furthermore SeaFEM results compare well with the experimental data available. Only relevant differences are found for the heave results for periods about 0.8s, where both computational models show spurious peaks of heave and pitch motions RAOs [1]. It is noticeable that the amplitude of those spurious peaks is smaller in the results obtained by SeaFEM that in the case of WAMIT. Experimental results are compared against the model configuration that includes the walls of the model basin since such a configuration appears to be more representative when compared to the experiments [1].

Case 1: Gap = 0.05 m. - Heave RAO with model basin walls



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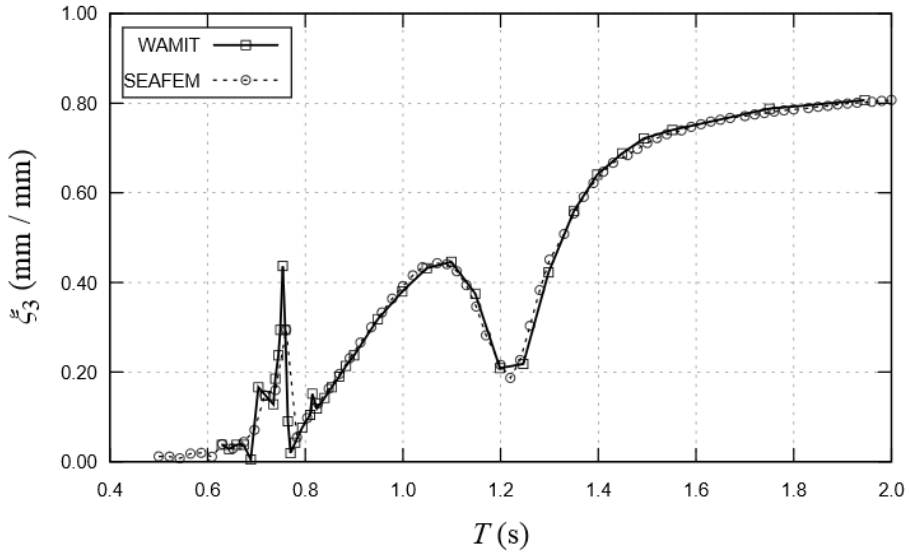
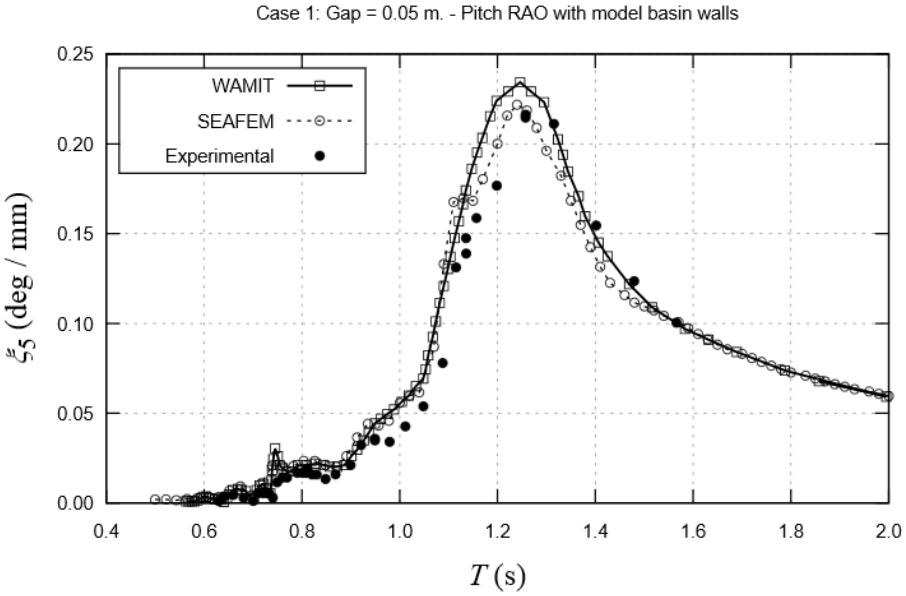
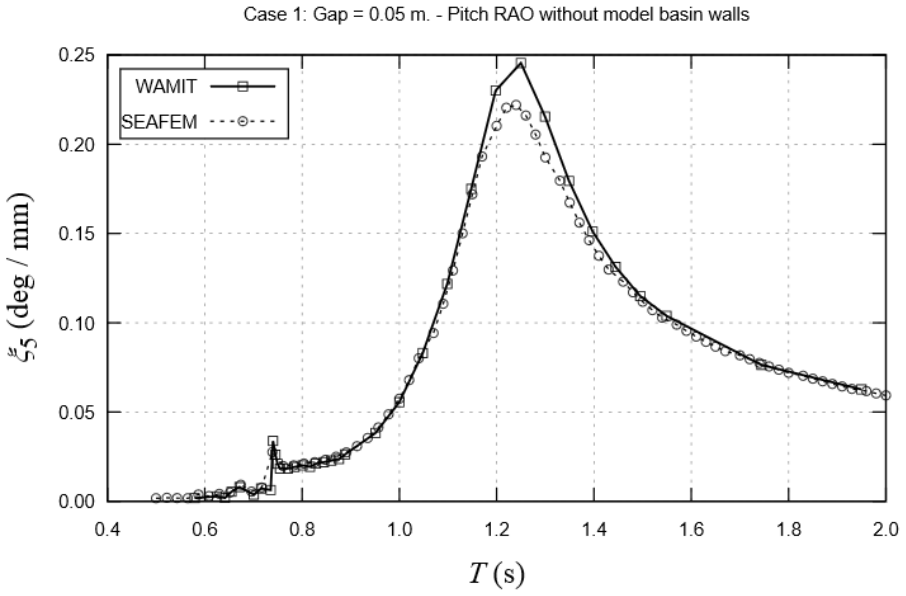



Case 1: Gap = 0.05 m. - Pitch RAO with model basin walls
WAMIT
SEAFEM
Experimental
0.25
0.20
0.15
0.10
0.05
0.00
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
ξ5 (deg / mm)
T (s)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0.25
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0.10
0.05
0.00
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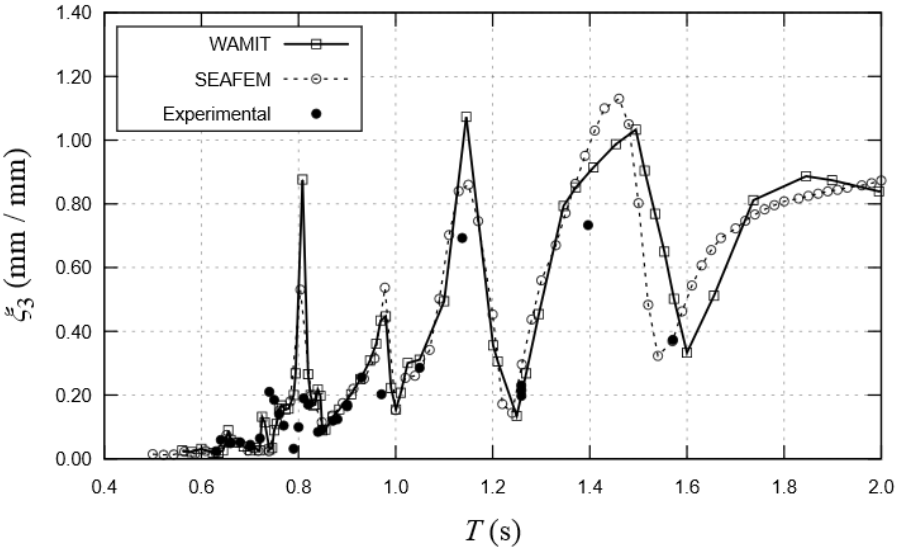
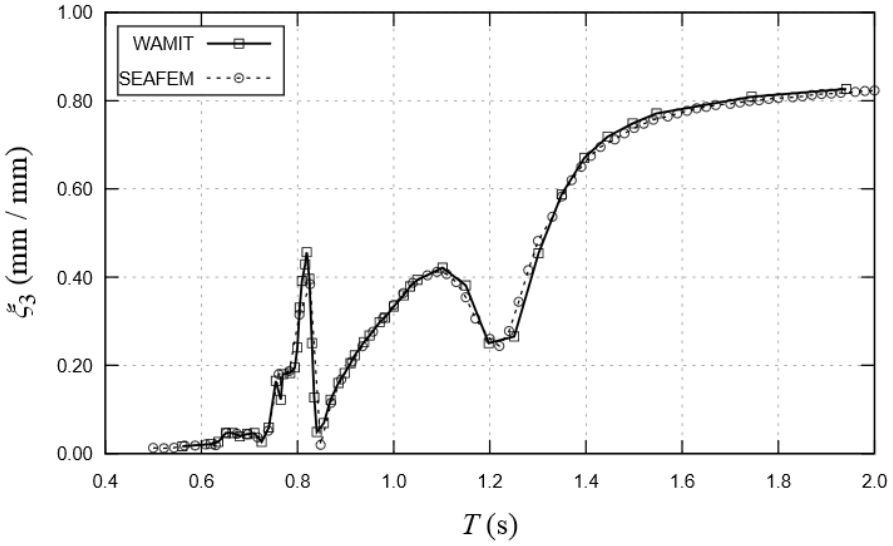
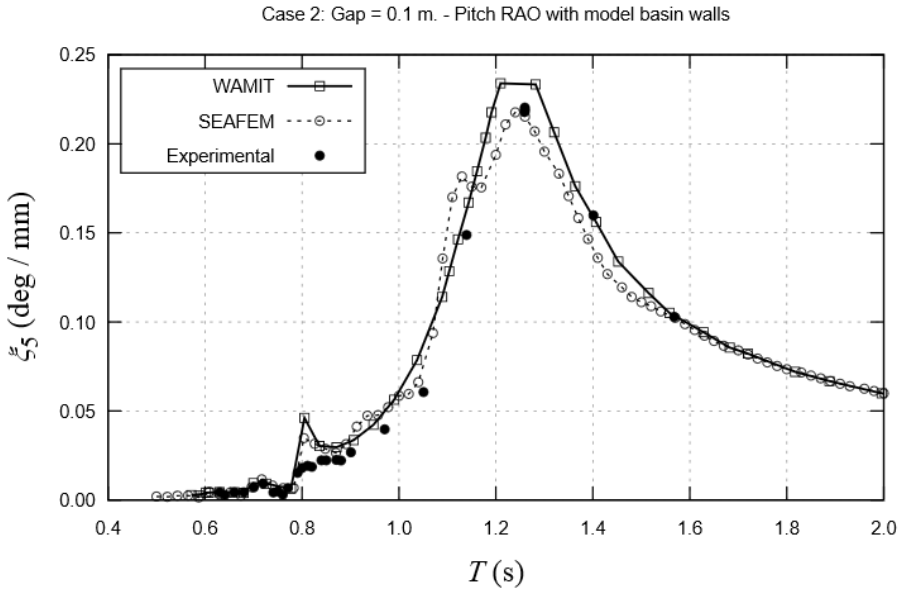
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
ξ5 (deg / mm)
T (s)

Case 2: Gap = 0.1 m. - Heave RAO with model basin walls



Case 2: Gap = 0.1 m. - Heave RAO without model basin walls




Case 2: Gap = 0.1 m. - Pitch RAO with model basin walls
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SEAFEM
Experimental
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0.15
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0.05
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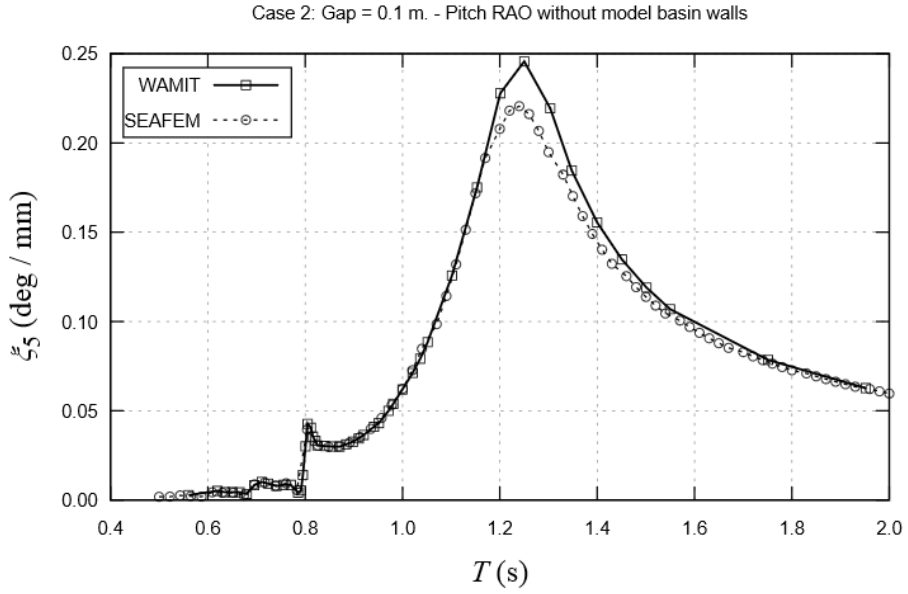
2.0
ξ5 (deg / mm)
T (s)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1.2
1.4
1.6
1.8
2.0
ξ5 (deg / mm)
T (s)

References

[1] R.A. Watai, P. Dinoi, F. Ruggeri, A. Souto-Iglesias, A.N. Simos. (2015). Rankine Time-Domain Method with Application to Side-by-Side Gap Flow Modeling. Applied Ocean Research, 50, 69-90.

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