January 2024

Dear Colleagues,

Invitation to

Comparative Study on Wave Interaction with Twin Floating Vessels in Beam Sea

ISOPE PACOMS-2024 Chennai, India, October 13 - 16, 2024

On behalf of ISOPE PACOMS-2024 LOC, we invite you to join 'Comparative Study on Wave Interaction with Twin Floating Vessels in Beam Sea' organized by Local Organizing Committee (LOC) of ISOPE PACOMS-2024.

The purpose of this comparative study is to share the state-of-the-art numerical analysis capability on wave interactions with twin floating vessels in close proximity. In this comparative study, sets of experimental data, including the wavemaker motion, wave elevation, motion response of the vessel models, and horizontal forces acting on them, will be provided beforehand. Participants should provide results of the time histories of the wave elevation, heave and roll motions as well as the horizontal force acting on the vessels. Details of the model test are described below.
Please find an enclosed participation form as well as technical details of the test cases for the comparative study.

***Participation form due*: March 04, 2024** or earlier	*Numerical results deadline*: **June 03, 2024**
	Circulation of preliminary report: **September 01, 2024**
Release of the data: **March 11, 2024**	***Final report*: September 15, 2024**

How to join the Comparative Study

(a) **E-mail** your participation form to vsriram@doe.iitm.ac.in or shaswat.saincher@gmail.com if you'd like to submit a full paper to be included in the Conference Proceedings. Please attach a one-page abstract when submitting the participation form.
(b) Experimental data and submission format shall be communicated to the participants no later than **March 11, 2024.**
(c) **Email** your numerical results in the submission format to vsriram@doe.iitm.ac.in or shaswat.saincher@gmail.com

We look forward to hosting you in Chennai, India this October!

Sincerely yours,
Dr. V. Sriram, Session Organizer, Indian Institute of Technology Madras, Chennai, India.
Dr. Shaswat Saincher, Session Co-organizer, Indian Institute of Technology Madras, Chennai, India.
Dr. Vineesh P., Session Co-organizer, Indian Institute of Technology Madras, Chennai, India.

Application form for participation of ISOPE PACOMS-2024 LOC

Comparative Study on Wave Interaction with Twin Floating Vessels in Beam Sea

Dear ISOPE PACOMS-2024 LOC,

We are willing to participate in the Comparative Study on Comparative Study on Wave Interaction with Twin Floating Vessels in Beam Sea organized by ISOPE PACOMS-2024 LOC for the following topic (please mark with 'x'):

- **Category A.** Shallow-draught vessel on the weather side (SW configuration): (   )
- **Category B.** Deep-draught vessel on the weather side (DW configuration): (   )

We hope to receive the experiment details and probe reading on the subject of comparative studies through the following email address,____.

Name of Institute:

Address:

Contact Person:

-Name:

-Email:

Comparative Study on Wave Interaction with Twin

Floating Vessels in Beam Sea

General Description

Wave structure interaction during the side-by-side offloading of LNG (Liquefied Natural Gas) from an FLNG (Floating Liquefied Natural Gas) platform to an LNG carrier is of paramount importance for researchers all around the globe. Laboratory experiments that present the motion response of vessels and wave amplification in the gap between the vessels are extremely rare in the literature. In the present study, two adjacent floating vessel models, which are free to move in heave and roll, are subjected to regular waves in beam sea conditions. The two models have unequal draughts, with the model having a deeper draught representing the FLNG platform and the model having a shallow draught representing the LNG carrier. Two different configurations are considered here: one having the shallow draught on the weather side (SW configuration) and the other in which the deep draught vessel come on the weather side (DW configuration). The wave elevations in the gap, heave (along y) and roll (about z) motion of the models and the horizontal force (along x) acting on the vessels are measured during the experiment.

Data corresponding to incident regular waves having a time period of **1.1s** propagating in **0.6m** deep water with a wave height of **3.45cm** shall be provided. Experimental data include (piston-type) wave maker motion, wave elevation at five different locations, heave (along y) and roll (about z) motions of both vessels and sway force (along x) acting on the vessels.

Experimental Setup

The experiments are conducted in the glass flume facility of IIT Madras. The flume has a length of 21m (measured along x) and a width of 0.6m (measured along z). Even though the flume has a total depth of 0.8m (measured along y), the water depth is chosen as 0.6m for this study. One end of the glass flume is fitted with a piston-type wave maker, and the other end with a parabolic beach. Two vessel models of length 0.58m (along z) and 0.3m breadth (along x) are placed in beam sea position, such that the centre of the gap between the vessels is at 6.5m from the wave paddle. A schematic representation of the experimental setup is illustrated in Figure 1. The length of the vessels is made to 0.58m so that the gap between the side wall of the flume and the model will be 1cm. Thus, the chance of water flowing into the gap between the vessels from the side of the vessels is less, making it a two-dimensional flow problem.

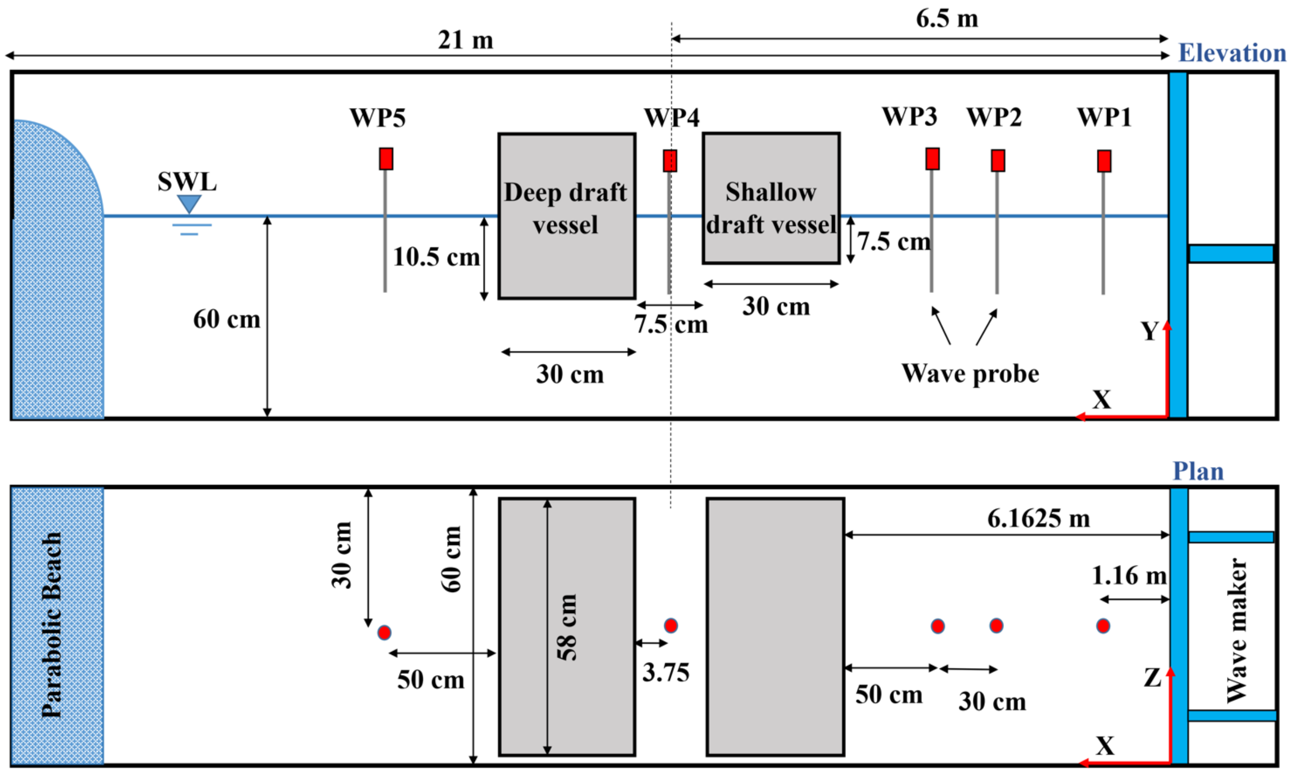

Figure 1. Schematic representation of experimental setup: x-axis points in the direction of wave propagation, y-axis points along the water depth (vertically) and z-axis points along the spanwise direction.

Both the vessels are allowed to move in the heave (along y) and roll (about z) direction, but motion in the sway (along x) direction (here along the direction of the wave propagation) is arrested. This is made possible using a couple of roller and linear bearing arrangements. The arrangements of roller and linear bearings are depicted in Figure 2. Roller bearings are attached to either side of the vessels at the centre of gravity, making roll motion possible. Vessels are attached to two linear bearings on either side. Each linear bearing can move vertically through a rigid rod extended downward from a fixed frame. These rigid rods prevent the vessels from moving in surge and sway directions. Since these fixed rods are provided at either end of the vessel, the yaw motion and pitch motions are also arrested. The rigid rods are connected to a fixed frame through a S-type load cell. These load cells record the sway force (along x) acting on the models.

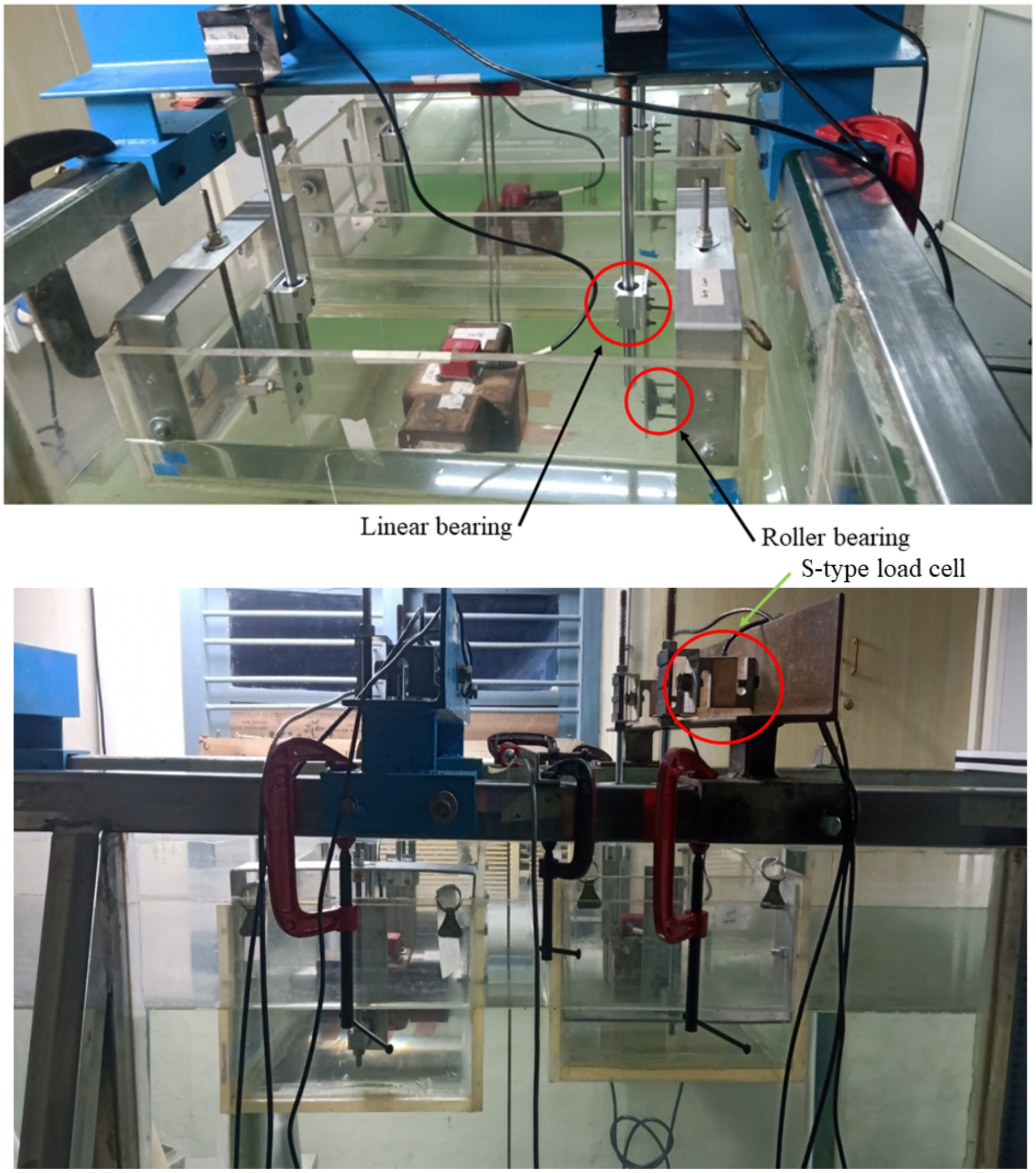

Figure 2. Photos of the experimental setup: (top) perspective-view facing the wavemaker, (bottom) side-view.

Heave and roll motions of floating vessels are captured by Ellipse-A version of inertial measurement units (IMU) by SBG system. The IMU is capable of measuring three translator motions (surge (z), sway (x), heave (y)) and three rotatory motions (pitch ($\circlearrowleft$x), roll ($\circlearrowleft$z), yaw ($\circlearrowleft$y)). The IMU has a dimension of 46 x 45 x 24mm and a weight of 45g. Since the weight and size of the IMU are negligible, it will not change the location of the center of gravity of the vessel models used for the present study. S-type load cells are used to measure the horizontal force acting on the vessels. The load cells can measure the tensile and compressive force acting only in the sway (x) direction. A total of four load cells are used for the experiment. All the load cells are calibrated using standard weights, and the calibration constant is the same in compression and tension. The outputs from the load cells are recorded at a sampling rate of 300 Hz with the help of a data acquisition system.

Two different vessel models are fabricated for the laboratory test. They are a shallow draught vessel with a draught of 7.5cm and a deep draught vessel with a draught of 10.5 cm (Figure 3). The properties of these models are listed in Table 1. Each vessel's center of gravity (CG) is located in the middle of its length (z) and breadth (x) dimensions. The elevation of CG from the bottom of the vessels (along y) is provided in the table.

Table 1. Properties of the vessel models

Property	**Shallow draught vessel**	**Deep draught vessel**
Breadth along x (cm)	30	30
Height along y (cm)	20	20
Length along z (cm)	58	58
Draught along y (cm)	7.5	10.5
Height of the CG from the bottom of the vessel (cm)	6.5	6.3
Mass (kg)	13.048	18.265
Roll moment of inertia (⟳z) about CG (kg.m^2)	0.13335	0.16733

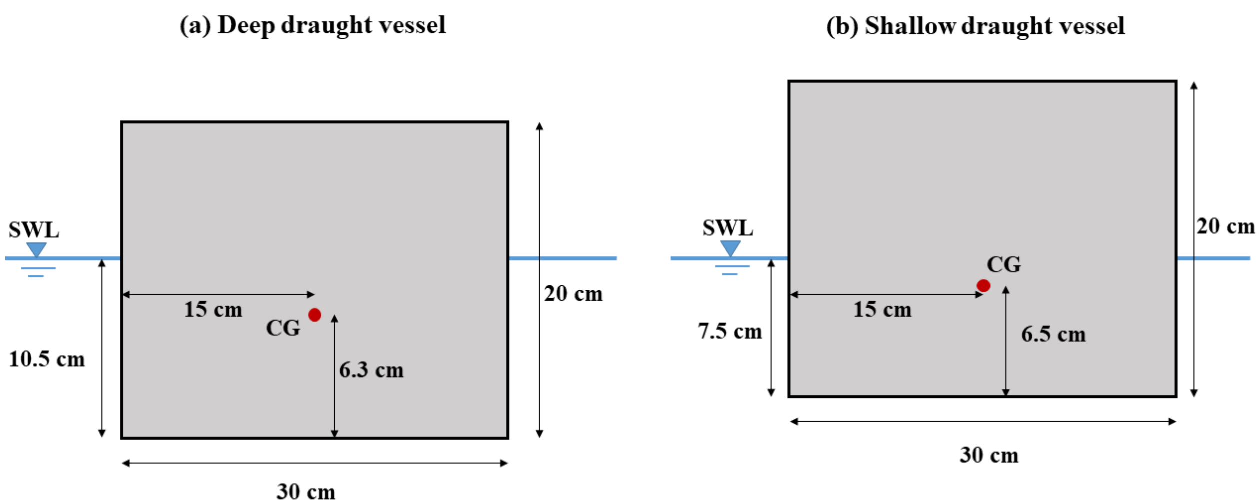

Figure 3 Positioning of the vessels with respect to the waterline along with CG locations.

The present investigation analyses two vessel configurations (Table 2). In the SW configuration (as shown in Figure 1), a shallow draught vessel is placed at the weather side. Meanwhile, in DW configuration, the deep draught vessel comes at the weather side. In both configurations, the separation between the vessels is 7.5 cm.

Table 2. Different vessel configurations

Configuration	**Vessel on the weather-side**	**Vessel on the leeward-side**
SW	Shallow draught vessel	Deep draught vessel
DW	Deep draught vessel	Shallow draught vessel

The locations of the wave-probes corresponding to Figure 1 are listed in Table 3; wavemaker is at x=0m.

Table 3. Locations of the wave-probes with respect to the wavemaker (same for both configurations)

Wave-probe	**Position**
WP1 (near the wavemaker)	x=1.16m
WP2 (before weather-side vessel)	x=5.3625m
WP3 (before weather-side vessel)	x=5.6625m
WP4 (gap)	x=6.5m
WP5 (after leeward-side vessel)	x=7.3375m

References

Vineesh P., Sriram V., 2023. Numerical investigation of wave interaction with two closely spaced floating boxes using particle method, *Ocean Engineering* **268**, 113465.