Creation of Very Large Floating Structures (VLFS) &
Very Large-scale Applied/computational Mechanics

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1 Social & economical background
• Limitation of further use of land in urban areas (population, houses, plants, airports, etc.)
• Use of ocean space by stationing VLFS several km long and wide as floating social bases (seismic isolation, environment preservation, etc.)

2 Conception of VLFS

3 Difficulties in VLFS

4 Structure water wave interactions

3D hydroelastic response analysis for detail design

Modal analysis

Structural Analysis

Water-wave Analysis

Fluid FE data

Hydrodynamic forces

Wave exciting forces

Output

FSI Analysis

Flow chart of the present analysis
Innovation on water wave analysis

BEM-like FEM (hybrid prism element + Domain Decomp.)

Condensation by hierarchical FEM

whole domain:
- outer infinite domain
- inner domain below VLFS
middle block: middle block discretization
small block: small block discretization

Tokyo Bay model: [Domain (5400m x 2400m)]

Before: 583,200 d.o.f. → after: 21,960 d.o.f.

Innovation on structural analysis

3D structure

Structure models of VLFS

3D-model

Mega-Float Phase-II model (1000m x 60-120m x 3m/1m)

Bird's-eye view of displacement amplitude

3D-hybrid model

(3D-model + 2D-equiv. Model with rigid beam interfaces)

Estimated computation size (d.o.f.)

<table>
<thead>
<tr>
<th>Structural property</th>
<th>Model property</th>
<th>Element size</th>
<th>100*90m (1 unit)</th>
<th>1200*240m (16 units)</th>
<th>4800*1600m (434 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D-model</td>
<td>Plate-orthotropic-sandwich</td>
<td>@ 10m</td>
<td>600</td>
<td>9,000</td>
<td>240,000</td>
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<tr>
<td>3D-simpl. model</td>
<td>w/o openings</td>
<td>@ 1m</td>
<td>20,000</td>
<td>220,000</td>
<td>8,000,000</td>
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<tr>
<td>3D-detail model</td>
<td>w/ openings, rough mesh</td>
<td>@ 10cm</td>
<td>200,000</td>
<td>30,000,000</td>
<td>80,000,000</td>
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<tr>
<td>Hybrid model-s</td>
<td>3D-simpl. +2D model</td>
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<td>120,000</td>
<td>(3D/3 unit)</td>
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<tr>
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<td>3D-detail +2D model</td>
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<td>(3D/1 unit)</td>
<td>600,000</td>
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<tr>
<td>3D-local model</td>
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<td>500,000,000</td>
<td>8000,000,000</td>
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</tbody>
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Elastic response of Phase-II model (orthotropic plate approximation)

Wave Height Distribution

Before: 80,000,000

Bird's-eye view of displacement amplitude

[wave period 7.0s (\(\lambda/L=0.06\)), incident angle \(\beta=0^\circ\)]