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

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1 Social & economical background

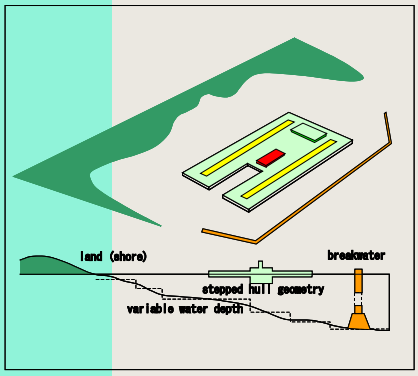
・Limitation of further use of land in urban areas (population, houses, plants, airports, etc.)

・Use of ocean space by stationing VLFS several km long and wide as floating social bases (seismic isolation, environment preservation, etc.)

Requirement:Versatile design by analysis tools based on large-scale hydroelastic simulation to realistic VLFS in protected sea

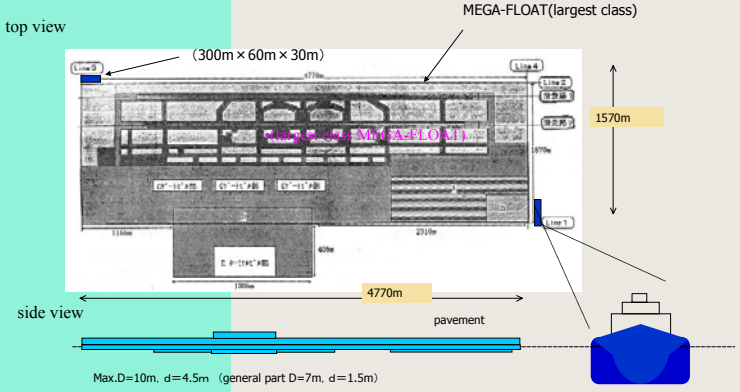
- **Validation & verification of various structural models to VLFS**
- **New FE formulation for large-scale water wave analysis and fast algorithms**
- **Large-scale modal structure-water wave interactions analysis on EWS/PC**

2 Conception of VLFS



Artist's conception of a MEGA-FLOAT

3 Difficulties in VLFS

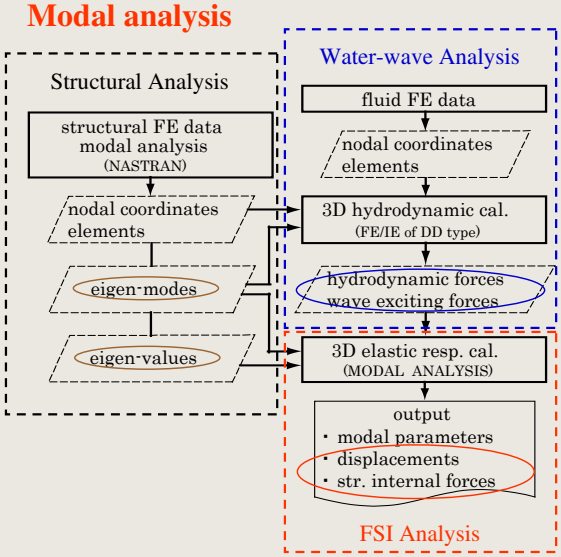


- **Shallow draft VLFS in protected water area**
- **Limitation to experimental facilities & models**
- **Few experiences in VLFS design & construction**

4 Structure water wave interactions

3D hydroelastic response analysis for detail design

- Structural analysis
  Finite element method (NASTRAN)
- **Water-wave analysis**
  Hybrid finite/infinite element method of domain decomposition type
- **Structure water wave interaction analysis**
  Modal analysis

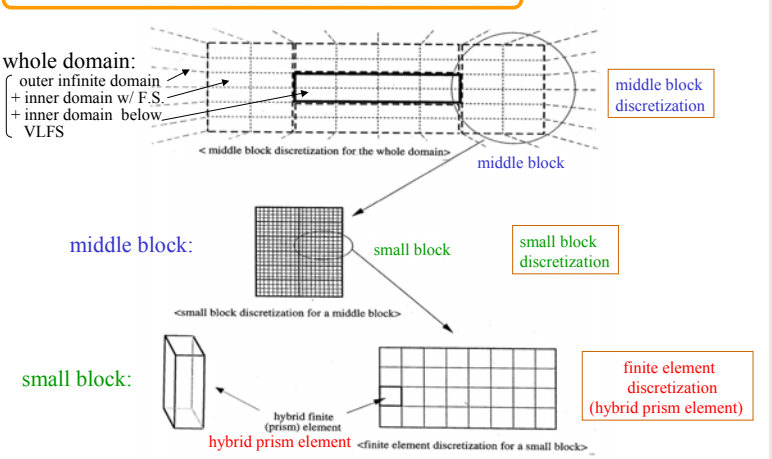


Flow chart of the present analysis

5 Innovation on water wave analysis

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

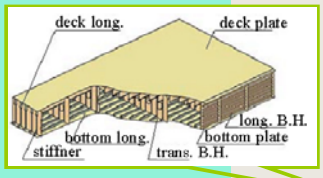
Condensation by hierarchical FEM



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

Before 583,200 d.o.f. ⇒ after 21,960 d.o.f.

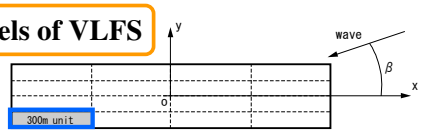
6 Innovation on structural analysis



3D structure

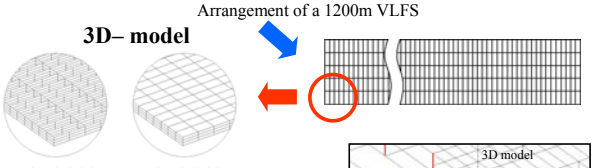
Mega-Float Phase-II model
(1000m × 60~120m × 3m/1m)

Structure models of VLFS



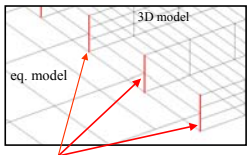
Arrangement of a 1200m VLFS

3D– model



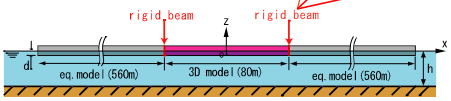
Mesh subdivision of bulkheads

Mesh subdivision of a deck & side shells



3D-hybrid model

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

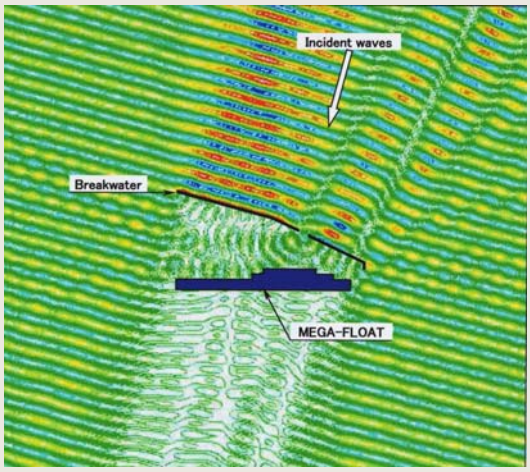


Estimated computation size(d.o.f.)

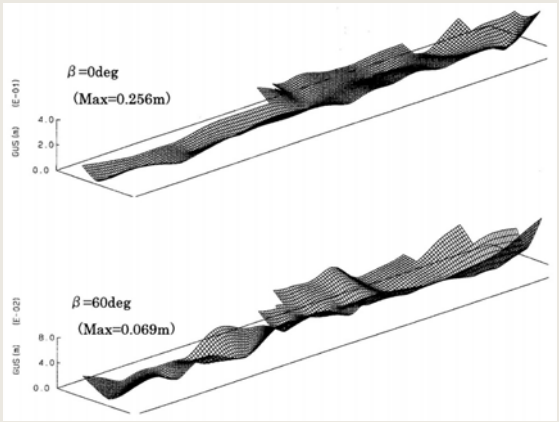
VLFS size

Structural models	Model property	Element size	300*60m (1 unit)	1200*240m (16 units)	4800*1600m (434 units)
2D-model	Plate -orthotropic -sandwich	@10m	600	9,000	240,000
3D-simpl. model	w/o openings	@1m	20,000	220,000	8,000,000
3D-detail model	w/ openings, rough mesh	@10cm	200,000	3,000,000	80,000,000
Hybrid model-s	3D-simpl. +2D model		—	120,000 (3D /1 unit)	320,000 (3D /1 unit)
Hybrid model-d	3D-detail +2D model		—	360,000 (3D /1 unit)	600,000 (3D /1 unit)
3D-local model	w/ openings, fine mesh	@1cm	20,000,000	300,000,000	8000,000,000

7 Elastic response of Phase-II model (orthotropic plate approximation)

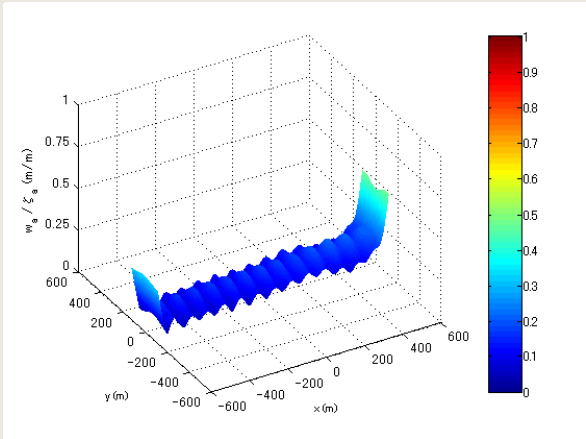


Wave Height Distribution



Bird-eye view of displacement amplitude

8 Elastic resp. of 3D structure model (1200m VLFS)



Bird-eye view of displacement amplitude

[wave period 7.0s (λ /L=0.06) , incident angle β =0°]