

Very Large Floating Structures for the Future
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Overview of Mega-float: Concept, Design Criteria and Analysis and Design

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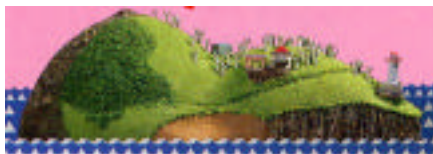
Outline of Presentation

1. Activities before Mega-float Project
2. Technological Research Association of Mega-float
3. Activities after Mega-float Project
(Ship Research Center and the Shipbuilders' Association of Japan)

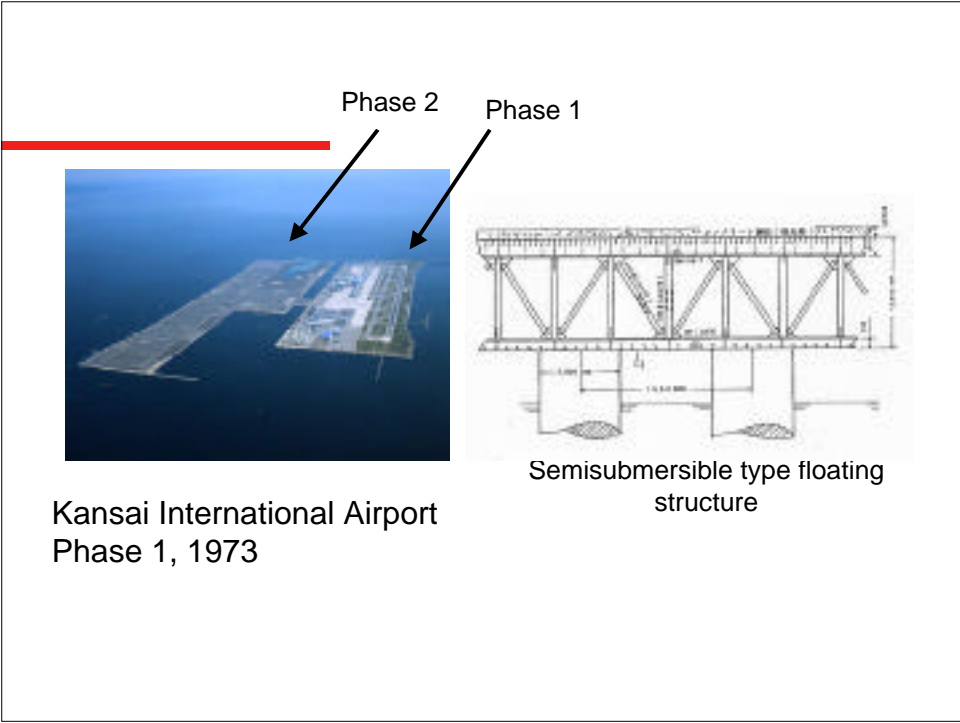
History of Very Large Floating Structure in Japan

1960's	Puppet drama "Hykkori Hyouta Jima"
1973-1974	Proposal of Floating Airport for Kansai international Airport Phase 1 (semisubmersible type)
1975	Okinawa International Ocean Exhibition
1988	Kamigoto Oil Stock Pile 390m x 97m x 27.6m x 5Units
1996	Shirashima Oil Stock Pile 397m x 82m x 25.1m x 8Unit
1994	Proposal of Floating Runway for Kansai international Airport Phase 2 (pontoon type)
1995/5	Technological Research Association of Mega-float
1995-1996	Phse1 Experiment 300m x 60m
1997-	Phase 2 Experiment 1000m x 60-120m, Landing & Takeoff Experiment

"Hyokkori HyoutannJima"



Puppet Drama





Floating Oil Stock Pile

Kamigoto 1988 (27.7Million bbl)
Shirashima 1996 (35.2Million bbl)

National Oil Stock Pile
(296.0Million bbl)

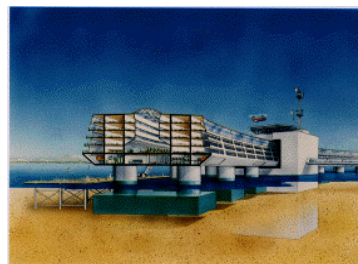
Land	7 bases
Sea	2 bases
Underground	1 base

Stock of Private Sector
(296.0Million bbl)

Technological Research Association of Mega-float

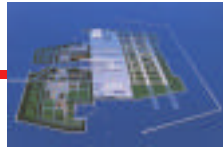
1993
Transport Technological Council
recommended to promote Very Large
Floating Structure (Ministry of Land ,
Infrastructure and Transportation)

1995
Technological Research Association of
Mega-float



Floating City

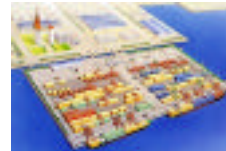
Concepts of Mega-float



Floating Airport



Offshore Container Terminal



Sports Facility



Leisure Facility



Waste Process Facility



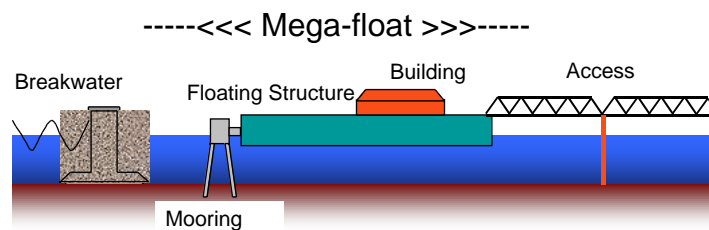
Floating Emergency Rescue Base

Budget and Schedule of the Association

	Phase1 (1995-1997)	Phse2 (1998-2000)
Objective	Establish basic technology	Establish airport construction technology
Experiment	300m long model Joining of unit at sea	1000m long model Joining of unit at sea
Research	<ul style="list-style-type: none"> • Design • Fabrication and joining at sea • Operational requiemment • Environmental impact 	<ul style="list-style-type: none"> • ILS test • Landing and take off of airplane • Concept study • Legal aspect
Budget	\$68.2million	\$103.6million

Objective of the Association

1. Develop technology for Ocean Space Utilization of calm sea in large bay
(pontoon type, cost reduction)
2. Prove and demonstrate soundness of the technology



Target Project

General Target

Ocean space utilization of calm sea in large bay
Floating airport, ocean city, emergency rescue base,
leisure facilities, etc.

Focused Target

Tokyo Metropolitan Third Airport
New Runway of Haneda International Airport



Floating Airport

Shortage of Air Transportation Capacity

Annual Number of Passenger

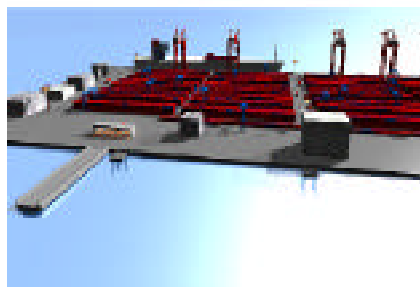
Category 1 Airport

Haneda 56.4million (Tokyo, domestic)

Narita 27.4million (Tokyo, international)

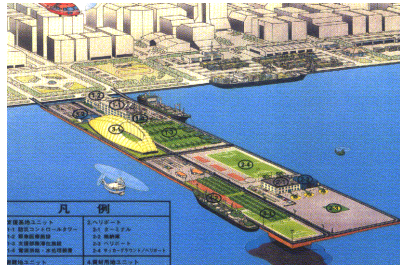
Kansai 20.5million (Kansai, international)

Itami 16.3million (Kansai, domestic)



Offshore Container Terminal

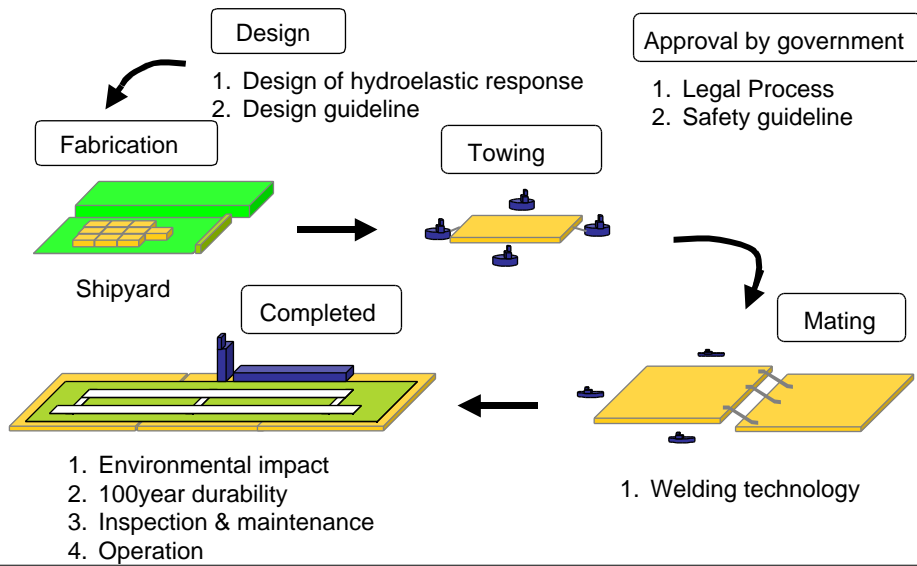
Larger container ship



Installed in three major bay
 Tokyo Bay
 Ise Bay
 Osaka Bay

Floating Emergency Rescue Base

Area of Research



Research of Mega-float

Design Technology

- (1) A group of analysis programs developed in various complexities and level of modeling.
- (2) Functional and safety requirement studies.
- (3) Design Guideline including recommendation of risk based evaluation of safety.

Demonstration of soundness of technology

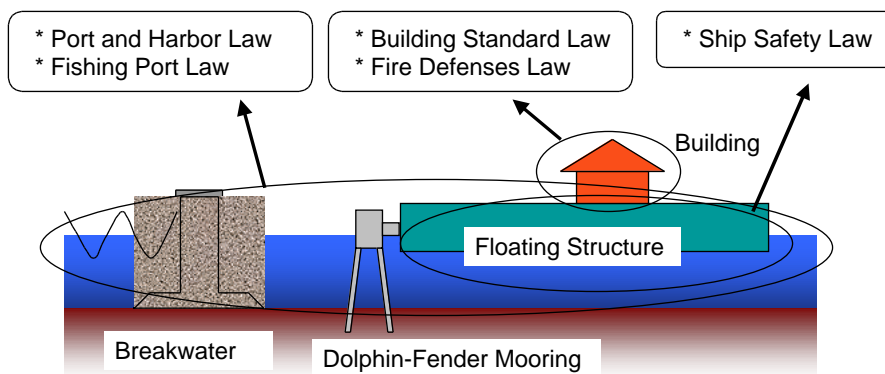
- (1) On site experiments with 1000m long floater to demonstrate the soundness of technology for public and decision makers.
- (2) Fabrication technology.

Others

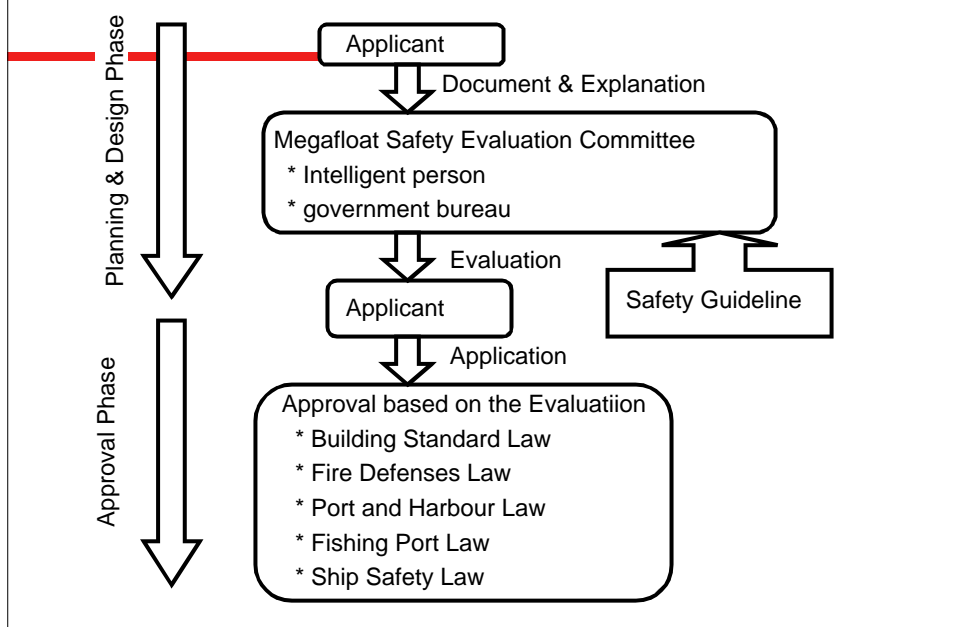
- (1) Legal process of approval in government.
- (2) Inspection and maintenance technology for long term service.
- (3) Environmental impact study
- (4) Other related researches such as semi-submersible type Mega-float, Eco-float and so forth.

Safety Guideline for VLFS

Laws related to Mega-float



Approval Procedure in Government



Contents of Safety Guide Line for VLFS

Volume 1 General Rules	Chapter 5-4 Preventive Measures against Material Deterioration
Chapter 1-1 General	Volume 6 Station Keeping Facility
Chapter 1-2 Fundamental concept for safety of VLFS	Chapter 6-1 General
Volume 2 Environmental Impact Assessment	Chapter 6-2 Configuration, Arrangement and Structural Strength of Station keeping Facility
Chapter 2-1 General Rules	Volume 7 Wave Control Facility
Chapter 2-2 Environmental Impact Assessment	Chapter 7-1 General
Chapter 2-3 Environmental Monitoring	Volume 8 Disaster Prevention Measures
Volume 3 Materials	Chapter 8-1 General
Chapter 3-1 General	Chapter 8-2 Disaster Prevention Control
Chapter 3-2 Steel Materials	Chapter 8-3 Disaster Prevention Planning of VLFS
Chapter 3-3 Concrete etc.	Volume 9 Quality Control for Construction Works
Chapter 3-4 Non-ferrous Metals	Chapter 9-1 General
Chapter 3-5 Non-metal materials	Chapter 9-2 Survey and Inspection
Volume 4 Design Load	Volume 10 Maintenance and Inspection
Chapter 4-1 General Rule	Chapter 10-1 General
Chapter 4-2 Dead Load	Chapter 10-2 Management, Maintenance and Inspection
Chapter 4-3 Live Load	Volume 11 Overall Safety Evaluation
Chapter 4-4 Environmental Load	Chapter 11-1 General
Chapter 4-5 Accidental Load	Chapter 11-2 Evaluation of Safety
Volume 5 Hull Structures	
Chapter 5-1 General Rules	
Chapter 5-2 Water-tightness and Compartments	

Development of Dynamic Response Analysis Program

A group of analysis programs were developed in various complexities and level of modeling.

- 1) Global hydroelastic response
- 2) Analysis program for structural response
 - One step method
 - Two step method

1. Global hydroelastic response

Program	A	B	C	D	E
Fluid domain	2-D DD	3-D DD	3-D DD	3-D BEM+FEM	3-D DD+FEM
Water depth	uniform	uniform	uniform	uniform	variable
Draft	uniform	uniform	uniform	uniform	variable
Structure	beam	plate	plate	FEM	FEM
Shape		rectangular	combination of rectangular	arbitrary	arbitrary
Stiffness	uniform	uniform	uniform	variable	variable
Mass	uniform	uniform	uniform	variable	variable
Beakwater			considered		consider

2. Structural analysis

DD: domain decomposition

One step method

global response & structural response

Two step method

global response



structural response

Research on Design Criteria

1. Safety

Technical Guideline based on existing knowledge

2. Functionability

1) Investigation of existing standard and code

2) Influence of elastic response on ILS

Series of experiments using flight simulator of airline company

Functionability criteria of runway

Facility	Criteria	Rule
Runway	slope longitudinal < 1.0 deg. transverse < 1.5 deg. radius of curvature > 30000m	Airport facility design standard
Taxiway	slope longitudinal < 1.5 deg. transverse < 1.5 deg. radius of curvature > 3000m	
ILS/GS	misalignment < 0.144 deg.	Civil aeronautics law
PAPI	misalignment < 0.1 deg.	

Technical Guideline

Technical Guide Line of Mega-float

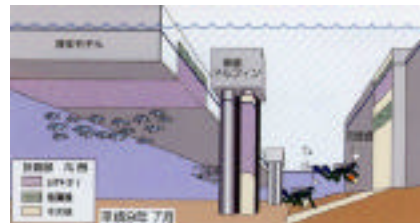
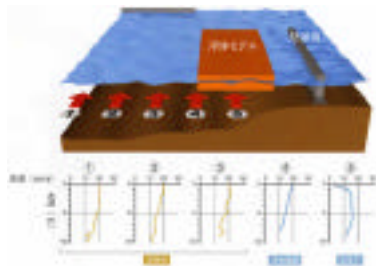
- Volume 1 General Rules
- Volume 2 Environmental Impact Assessment
- Volume 3 Materials
- Volume 4 Design Load
- Volume 5 Hull Structures
- Volume 6 Station Keeping Facility
- Volume 7 Wave Control Facility
- Volume 8 Disaster Prevention Measures
- Volume 9 Quality Control for Construction Works
- Volume 10 Maintenance and Inspection
- Volume 11 Overall Safety Evaluation

Environmental Impact Research

1. Flow around and below Megafloat
2. Water Quality
3. Bottom Materials
4. Oceanographic Conditions
5. Aquatic Organisms



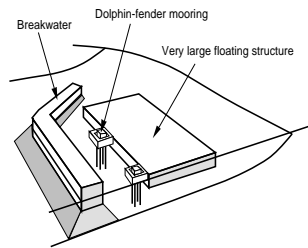
- Fish under experiment float



Overall Safety Evaluation

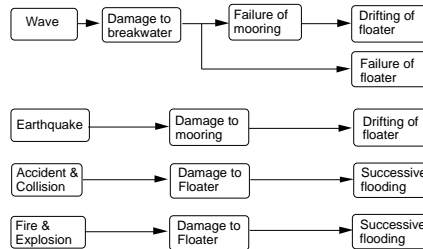
Risk based safety analysis of Mega-float system

System



- Pontoon type floater
- Dolphin-fender mooring system
- Breakwater

Scenario

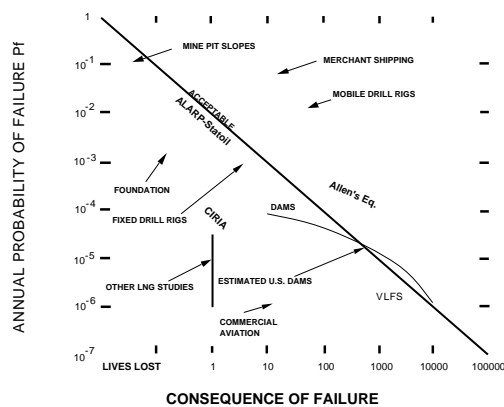


Criteria

Investigation of safety of activities in Japan

Activities	FAR
Automobile	43.5
Civil Aviation	46.3
Railway (total)	4.3
Railway (passengers)	2.6
Shipping	6.3
Fire	0.20
Disease	74.9
Industries	0.64
Natural Disaster	0.016

Target Safety of Mega-float



Experiment

Phase 1



9 units
100m x 20m

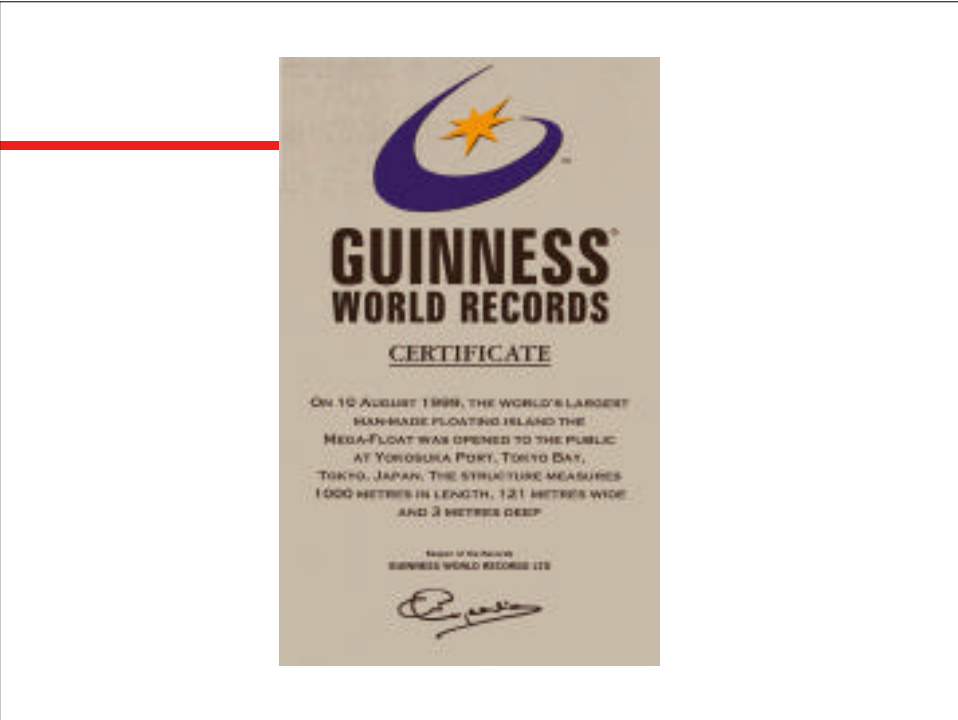
Megafloat Phase1 Experiment

Phase 2



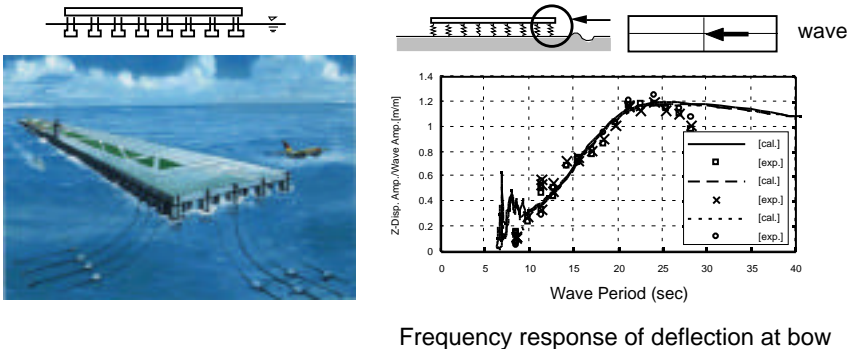
1000m x 60-140m

Megafloat Phase2 Experiment



Semisubmersible Type Mega-float (related research)

1. Development of hydroelastic response analysis program VODAC
2. Verification by model test

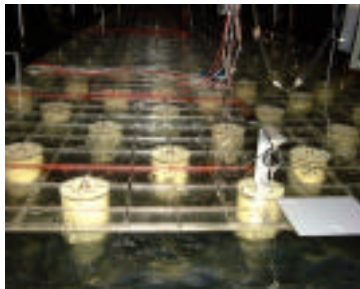




Wave tank experiment



Wind tunnel experiment



Projects after Technological Research Association of Mega-float



Megafloat Information Base
L200m x B100m x D2m



World Cup Mega-park
L200m x B100m x D2m



Marine Park Kumanonada
L120m x B60m x D3m



Uzushio Megafloat Nandan
L101m x B60m x D3m

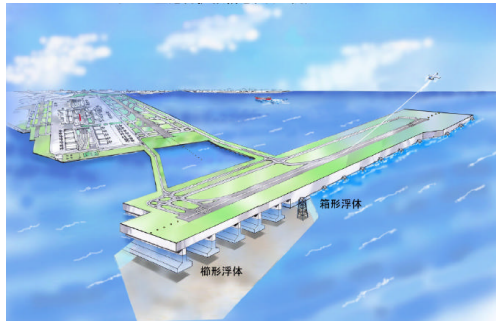


Ferry Pier
L143m x B20m x D3m

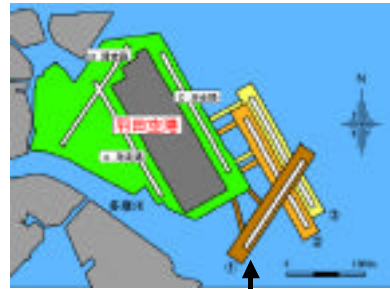


Shimizu Port Fishing Park
L143m x B20m x D3m

Haneda International Airport New Runway



Haneda International Airport



New Runway

Floating Wind Turbine

