RESULTS OF 6 YEARS RESEARCH PROJECT OF MEGA-FLOAT

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1. Introduction

Technological Research Association of Mega-Float (hereinafter referred to as "TRAM") was established in April 1995 and has carried out "Research and Development of an Ultra Large Floating Structure" (hereinafter referred to as "phase Ⅰ") for a three-year program. This research was successfully completed with results anticipated in March 1998. In phase 1, a large floating model was built by assembling modules on sea for corroborative experiments, and then investigations and the corroborative experiments solved many subjects using the model that had been constructed. An object of this project was to research and develop the elemental technologies to be used for various purposes to realize The Ultra Large Floating Structure, so-called "Mega-Float", in near future. Detailed contents of phase 1 have been presented in "The 20th Joint Meeting UJNR/MFP" as "Outline of New Research Project for an Ultra Large Floating Platform". The large floating model of the experiment was shown in Fig.-1.

The research on the Mega-Float was scheduled to be finalized in fiscal year 1997; but it was decided to continue with a second stage, so called "phaseⅡ"from April 1998 to March 2001.
After phaseⅡ、TRAM was terminated and the technologies are succeeded to Shipbuilding Reserch Centre of Japan(Referred to as SRCJ).
This article introduces outline of phaseⅡresearch and summary of phase Ⅰ and phaseⅡ.

2. Outline of Phase 2 Research

Phase Ⅱ research was studies of the unresolved questions proposed by the Airport Utilization Survey Investigating Meeting, which was organized in Ministry of Transport .

This research was supposed to be composed of corroborative experiments, requiring a large-scale model on which aircraft can take-off and land. However, due to the limited budget of phase Ⅱ they finally decided to perform an experiment using a model which is substantially the same size as the existing small commuter airport.

Dimensions of the airport model are;

Length	about 1,000 m	
Breadth	60 m	(partially 121 m)
Depth	3 m	
Draft	about 1 m	
Total area	about 8.4 ha	
Runway	900 m x 25 m	

FIG-1 :View of the experimental model in Phase-Ⅱ(joining of unit on sea)

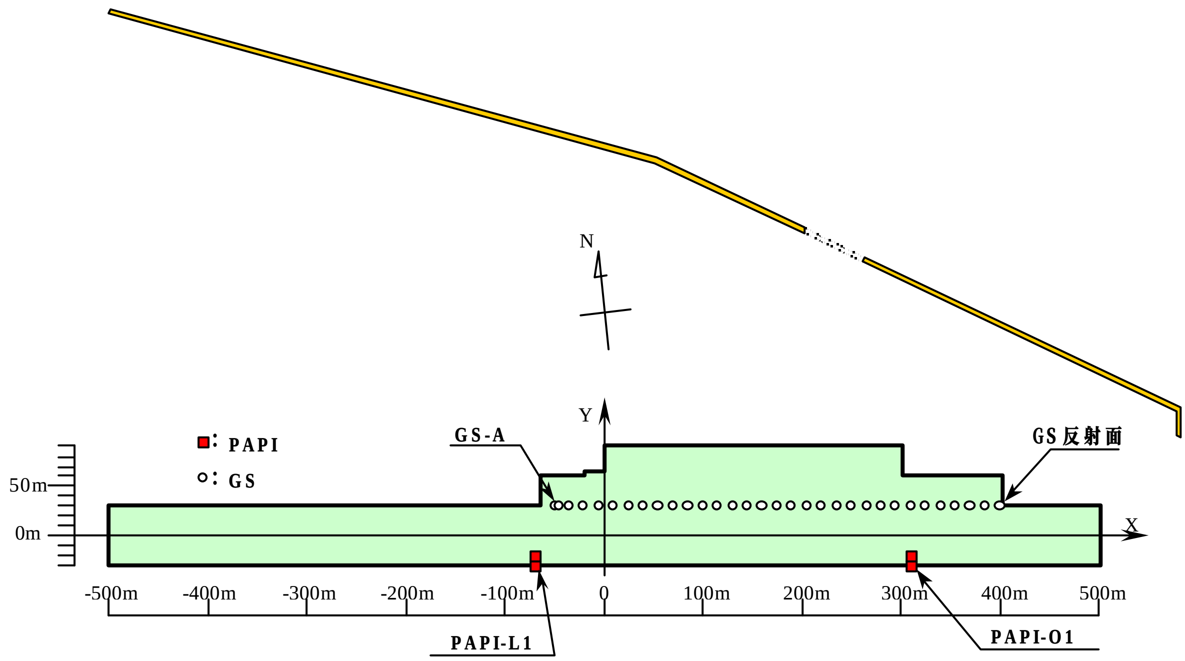

FIG-2: Rough general arrangement of phaseⅡmodel

Rough general arrangement is shown in FIG-2.

This research was scheduled to start design work of an airport model in April 1998 to construct and complete the model some time in the summer of 1999, and to start experiments using aircraft from the autumn. Further, it was scheduled to experiment with aircraft taking-off and landing in fiscal year 2000, to finalize all the research by March 2001, and to remove the airport model by end of the year.

The total research budget was about 9.9 billion yen for the three years, of which about 5.3 billion yen was to be subsidized by the Nippon Foundation. Besides, the Ministry of Transport was to give direct assistance for the research, and to lease special airport equipment. The contents of the research are as follows and are illustrated in FIG-3.

(1) Research on airport facilities

The facilities used on the floating airport require the functions as airport. To satisfy the requirements, some new facilities were required to be developed. This research aimed to develop these facilities and then to confirm their functions with the airport model or a laboratory model.

□Low-headed dolphin for mooring:

For the purposes of safe operation, the airport should not have protrusions above an inclination line extending at a predetermined angle from the end of the runway (This is called an Obstacle limitation surface). Also, it is not preferable for the runway to drift from side to side. Therefore, this research developed a mooring dolphin to satisfy above-mentioned functions.

□Approach light supporting device:

On the floating airport, approach lights arranged on an extension line off the floating body are attached on top of piles on the seabed, in which the arrangement of the approach lights requires linearity of a certain accuracy, even if the floating body moves up and down due to the tide. This research develops a connecting mechanism to prevent the linearity at the border from deteriorating.

□Research on specification of pavement on steel

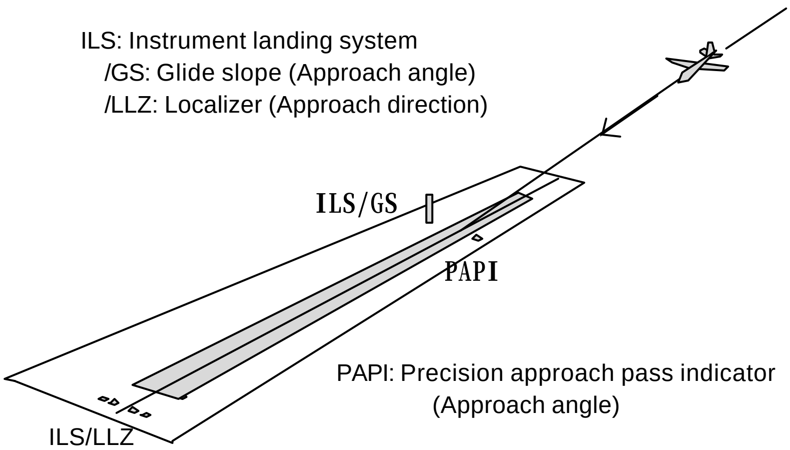

FIG-3:Location of equipment for landing

structure showing hydro-elastic motion:

Although phase Ⅰ includes research pavement on a steel-plate, this research includes corroborative experiments on large-scale execution, and control and maintenance during actual execution of works.

(2) Research on simulation program:

This research developed computer program capable of simulating movements of the area with landing devices accurately and verified that it can correctly simulate airport model of 1000m in length.

(3) Experiment on navigation equipment for landing:

□Function verification experiment of instrumental landing system (ILS):

ILS is a device for guiding an aircraft to an approach pass using radio waves. This research verified how the device installed on the model could guide the aircraft.

□Function verification experiment of precision approach pass indicator (PAPI):

PAPI is a device for informing the approach angle with signal light to the aircraft. This research verified how the device installed in the airport model could be viewed from aircraft on air.

□Applicability research of future air navigation system (FANS):

FANS is a control system for accurately informing position including attitude to an aircraft according to information obtained from artificial satellites, which are now being developed. In the case of a floating airport, this system needs correspond to the vertical movement of the floating body caused by tides. This research is study of FANS fundamental functions.

(4) Take-off/landing experiment

The behavior of the floating body can be grasped by simulation calculations. According to the calculation results for the floating airport, no problem will arise. Therefore, this research included general landing corroborative experiments and obtained various data.

□Taking-off and landing corroboration on floating body:

This research verifies whether or not instruments installed on the aircraft such as a magnetic compass are operating normally.

□Verification of inertial navigation system (INS):

INS is a device for locating position by integrating the direction and acceleration of the aircraft. This device is required to be zero-adjusted on the airport at standstill before take-off; therefore, this research verifies that the device can be zero-adjusted even on the floating airport model.

(5) Research on environmental assessment

□Collection of environmental data:

This research measured quality of bottom material, water organisms, benthos, etc., and then obtained related data before and after airport model was installed.

□Investigation on relationship between sound on airport and fishes.

The relationship between the sound of airport and fish was studied in phase 1; however, this research surveys the relationship especially when the aircraft take off and land.

□Research on removing organisms:

Organisms adhering to floating body have a fish-attracting effect, which does not adversely affect the Mega-Float as distinct from the ship. However, excessive organisms should be prevented from fouling the Mega-Float. Since it was verified in phase 1 that forming a air layer on the bottom surface prevented organisms from fouling the bottom surface, this research studied practical application to Mega-Float.

(6) Research related to airport in phase Ⅰ

□Research of pavement specification on runway

This research investigated three types of runway specification to clarify the appropriate construction and pavement method when a runway is built on steel plates, conducted a durability test by the Port and Harbor Research Institute, and verified that the all three types were practically feasible.

□Research on landing simulation:

This research incorporated a rolling landing beam, which considered how the floating body rolls, into the existing flight simulator of an aircraft, got experienced pilots operate the simulator in the beam, and then verified that there were no problems for the pilots except if there was a typhoon.

□Investigation of airport traffic control tower structure on floating airport:

This research trial-designed the structure of the traffic control tower which has severe accuracy requirements due to rolling, and provided a shape that reduced rolling.

□Development of partial behavior control device:

This research developed a device for preventing the PAPI from rolling. That is, developed new device reduced the vibration of the PAPI fitting bed to a degree at which the function of the PAPI is not affected.

□Taking off and landing experiment using a helicopter:

This research verified that there was no influence on the magnetic compass of the aircraft when the helicopter flew on the approach route of the aircraft, and measured noise, vibration, etc., upon taking-off and landing.

3.Summary

To emphasize the result and conclusions of Mega-Float research project, additional briefing are shown in FIG-4 and FIG-5.
And also results of case study regarding 4000m long floating airport are shown in FIG-6and FIG-7

The present objects of the SRCJ are to realize the Mega-Float. People in the SRCJ and the SRCJ related companies will make every effort to achieve these objects.

References:

1)Isobe E : New research project of Mega-Float, Proceedings of UJNR MFP,22th

2)Kikutake T : A mega-float airport, the state of the art, Proceedings of OMAE'98

During 3 years from fiscal 1995 to 1998, Tecnological Research Association of Mega-Float made R&D for ultra large floating structures more than several kilometers long with lifetimes of over 100 years using a large experimental model of 300m long, 60m wide and 2m deep and obtained following results.

1. Established on-sea unit joining tecnology through actual on-sea joining experiment.

2. Developed design procedures of Mega-Float and Proposed how to evaluate safety of Mega-Float.

3. Established 100 years duration tecnology through developments of application method of anticorrosive materials and maintenance system.

4. Developed estimating programs of hydro-elastic motion, affection by temperature, noise, vibration, etc., which are characteristics of steel made floating structure , and also developed coutermeasures to guarantee operational functions in case required.

5. Confirmed that floating structure has less environmental impact through the measured data of actual experiment site , and supplied methods and actual data for environmental assessment of floating structure.

FIG-4:Result of phase I research project

Corroborative Experiment to Use Mega-Float as Airports

Basing on the result of PhaseⅠ、Floating Airport Model of 1000 meters long was constructed off Yokosuka Bay and the following researches were conducted through actual takeoffs and landings of aircraft.

1.Verification of applicability to develped design and construction technology and applicability to very large scale floating structure
 a)Simulation program of hydro-elastic vertical motion of the model
 b)Simulation program of horizontal movement and force for dolphin-fender mooring
 c)Summary and evaluation of construction technology

2.Development of airport function simyulation programs
 a)GS path simulation program for airplane approaching to runway affected by hydro-elastic motion of structure

3.Verification of Instrument Landing System Functions
 a)Flight navigation tests on the model by Japanese civil aviation bureau using flight checkers regarding ILS,GS, FANS,etc.

4.Experimental takeoffs and landings
 a)Confirmation of safe landing on the model runway
 b)Confirmation of affection on magnetic compass by steel structure

5.Study of environmental impact
 a)Measurement and evaluation of lifes under the model and sea bed , and quality of sea water
 b)Proposal how to make assessment of environmental condition aroud Mega- Float

FIG-５: Plan and results of phaseⅡresearch project

Challenge in design to future 4,000m length floating airport and its evaluation (Refer to FIG-7:Arrangement of Floating Airport)

1.Design conditions
 a)Airplane;LA-0 class for strucure b)Runway; 2 international and domestic
 c)Arrangement; separated terminal and gate buildings
 d)Environmental conditions;
 ・Water depth; 13~18m ・Wind;25m/s in operation, 35m/s in 200 years storm condition
 ・Operation length;100 years ・Sea wave;H1/3=2.3m ,T1/3=5sec in operation, H1/3=3.7m, T1/3=6.1sec in 200 years storm

2.Plannning and analysis
 a)Design and analysis of structure and mooring system
 b)Simulation of fluctuation of ILS/GS ,PAPI
 c)Evaluation by pilots using training flight simulator in every conditions analaized in b) and got good evaluation as same as land airport in view of airplane stability
 d)Miscellaneous analysis and evaluation regarding motion of conntrol tower, pavement of runway, access facility from land, etc,.

3.Conclusion
 a)4000m length floating air port is more stable than 1000m experimental model
 b)Fundamental technology is established
 c)Miscellaneous land-use facilities of airport are available on Mega-Float in view of design

4.Today's situation of Mega-Float project
 a)Proposal is being made for future expansion plan of Haneda airport in Tokyo Bay same as other conventional methods

FIG-６:Case study of 4000m class floating airport

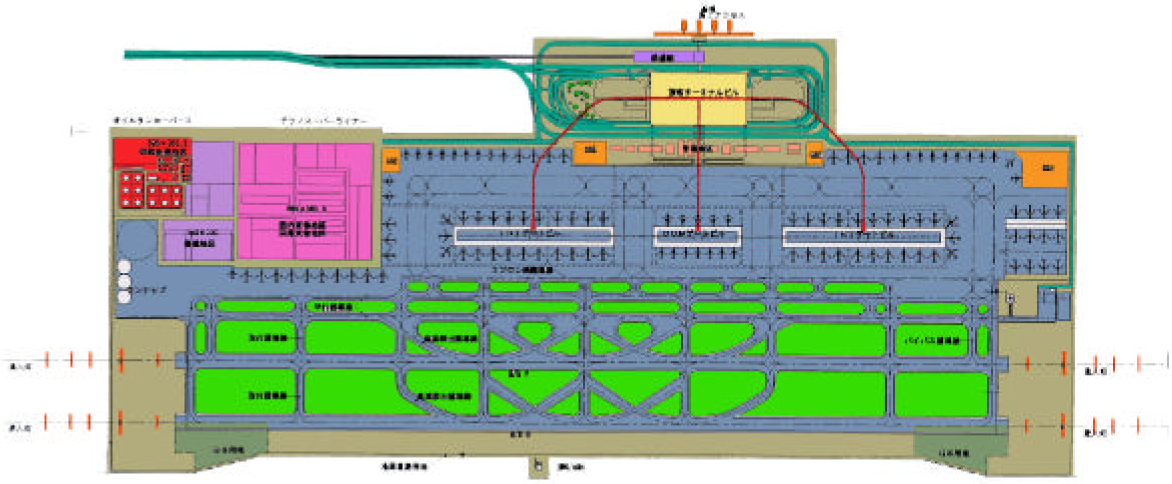

FIG-7: General Arrangement of Floating Airport(Sample)