A New Concept of Ocean Nuclear Power Plant (ONPP)

Kang-Heon Lee[*], Ki-Hwan Lee[*], Phill-Seung Lee[**], Yong Hoon Jeong[***], Jin Kook Kim[****]
[*,**]*Division of Ocean Systems Engineering, Korea Advanced Institute of Science and Technology*
[***]*Department of Nuclear & Quantum Engineering, Korea Advanced Institute of Science and Technology*
[****]*Civil Engineering Research Department, Research Institute of Industrial Science and Technology*
[**]*Corresponding author: phillseung@kaist.edu*

1. Introduction

Since 1950s, studies on floating type Nuclear Power Plant (NPP) have been attempted. Recently, Russia's first floating NPP has been completed and will be operated in 2012. However, the floating type only can mount relatively small size NPP and easily affected by ocean waves or Tsunami. In this study, we adopt the Gravity Based Structures (GBS), one of widely used ocean structures, to implement the concept of large scale ONPP with Advanced Power Reactor 1400 (APR1400) model [1] which is the latest model developed by KOREA. Actually, the GBS type ONPP system has never been researched.

In this paper, we present a new concept of nuclear power plant based on ocean environment to overcome the safety limitation of conventional land-based NPP and social problems, called NIMBY (Not In My Back Yard) or BANANA (Build Absolutely Nothing Anywhere Near Anybody). We also present the safety features of our concept and future works.

2. Concept of ONPP

In this section, the key idea and concept design with major considerations will be described briefly.

2.1 Key Idea

First, several modules of GBS concrete caissons fabricated in dry dock and NPP is constructed on it. Then the floatable and moveable ONPP system is towed by tug boats and settled on a place nearby shores. After loading and testing the fuel that system can be operated and supply electricity. These whole procedures are presented in Fig. 1.

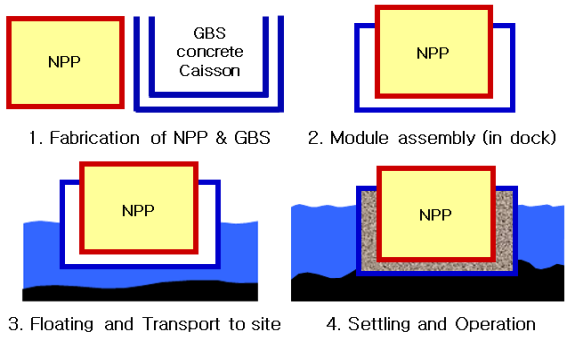


Fig.1. GBS type ONPP

2.2 Design Considerations

Considering the characteristics of KOREA's latest developed NPP model which has been constructed in Shin-Kori #3/4 and Shin-Ulchin #1/2, some important specifications of NPP are listed in table 1.

Table 1: Specifications of APR1400

Building	Area (m^2)	Volume (m^3)	Weight (ton)
Reactor	3,200	265,000	240,000
Aux.	7,100	509,000	540,000
Compound	13,500	90,300	76,000
Turbine	13,600	540,000	220,000
Others	32,000	630,000	-

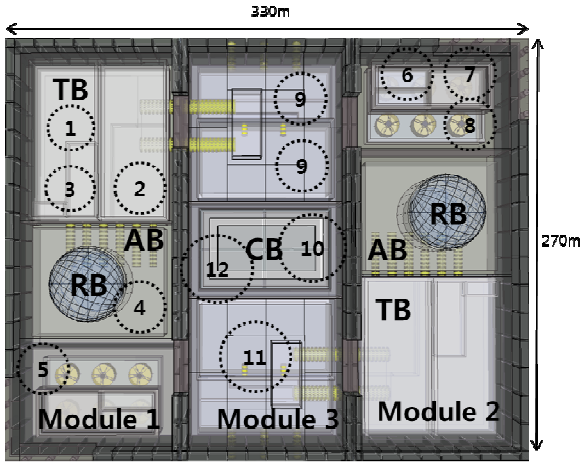
Even if there are a lot of design parameters of NPP should be considered, only layout, functional relationships between buildings, foundation, pipelines, weight balance, separations of hot and cold site and area, volume and weight of buildings are taken into account in this study.

2.3 Concept Design

In this section, all important buildings and other facilities of NPP, listed in table 2, are rearranged with 3 GBS concrete caisson modules based on the considerations explained in 2.2. Basically, the system consists of 3 modules of GBS concrete caisson. It has an overall dimension of 270m (L), 330m (W) and 65m (H) with the symmetric layout in Fig.2. ONPP is positioned in ocean at water level of 20~30m shown in Fig.3.

Table 2: Buildings and facilities of NPP

#	Building	#	Building
1	Turbine, Generator	7	AAC, D/G
2	Fire pump and water Waste water Cooling water tower	8	Boiler fuel oil
3	Wastewater treatment	9	Intake / Discharge
4	Reactor, Auxiliary	10	Compound
5	Storage tank	11	Transmission
6	Aux. boiler	12	Main control center



RB : Reactor Building, TB : Turbine Building
CB : Compound Building, AB : Auxiliary Building
Fig.2. ONPP layout

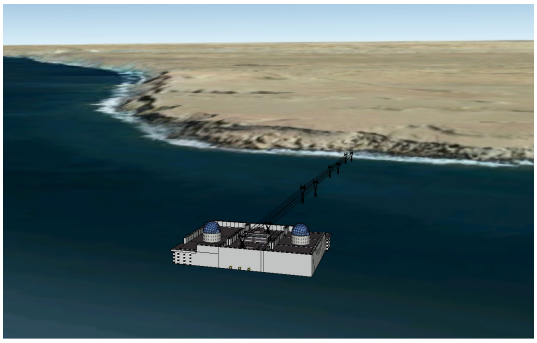


Fig.3. Bird's eye view

3. Safety Features

3.1 Seismic effect

Since GBS can be isolated from foundation at seabed in this concept, sliding phenomenon may reduce the motion of whole structures. Furthermore, kinematic energy of structures caused by earthquake can be absorbed by surrounding seawater which is acting as a natural damper.

3.2 Tsunami

In deep sea areas, Tsunami has a small wave height of less than 1m and a very long wavelength. However, its wave height rapidly grows up to 20m when it reaches shallow water areas. This phenomenon made Fukushima NPP malfunctioned. Since ONPP is located in onshore at the water depth of 20~30m, the effect of Tsunami is inherently reduced (about 60~70%).

3.3 Double barrier

In this concept, we considered the impact load cases such as explosion, marine collision and terrorism. In addition, ballasting system and connecting systems between GBS modules are considered as well.

The proposed ONPP model has double barrier shown in Fig.4 with dashed-lines which is very similar to double hull in modern ships.

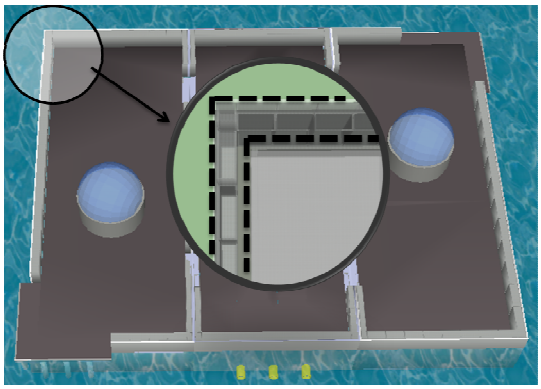


Fig.4. ONPP layout

4. Conclusions

In this study, we introduced the new concept of GBS type ONPP to overcome the limitations of land-based NPP's safety margin and to meet the increasing demand of the world NPP market. In the future, the detailed design of ONPP should be developed and various feasibility studies need to be carried out focusing various safety features described in section 3 to improve the design.

REFERENCES

[1] Korea Hydro & Nuclear Power Co., LTD, PSAR, Revised Vol.1, 2008.

Acknowledgements

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