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Study on IHA Vibration Characteristics with TM-ICI

Jung-Dae Son [a*], Sung-ho Chung [a], Yu-Sung Kim [a], In-Geun Jo [a]
[a]*Doosan Heavy Industries & Construction Co., LTD. Nuclear Power Analysis Team*
[*]*Corresponding author: jungdae.son2@doosan.com*

1. Introduction

As the importance of coping with serious accidents becomes more important after the Fukushima Nuclear Power Plant accident, it is expected that the regulation requirements will be strengthened in the direction of applying TM-ICI technology. For in-core instrument (ICI) designs, there is a "top-mounted pattern type (Fig. 1.1)" where the ICI nozzle is attached to the top of the reactor and a "bottom-mounted pattern type (Fig.1.2)" that is attached to the bottom of the reactor.

Globally, competitor-supplied reactor vessel models are equipped with an in-core instrument (ICI) that measures the power distribution of the reactor core, which is inserted into the nuclear fuel assembly through the upper head of the reactor vessel. This is to exclude the risk of out-of-core release of the core melt through the lower ICI nozzle. Also, it is possible to effectively perform the cooling of the outer wall of the reactor or the cooling of the core melt with the core melting. The structure and shape of the reactor vessel is simple and does not require the installation of complex structures to guide and support the ICI.

In this paper, IHA structure is changed as TM-ICI technology is applied. The ICI Cable from the RV Head will pass through the IHA. The reason for confirming the vibration characteristics of IHA was initial analysis for CEDM cooling fan and seismic design. In particular, the CEDM cooling fan should be designed to avoid the natural frequency of the IHA as a rotating device. Fig. 1.3 shows the conceptual model of TM-ICI

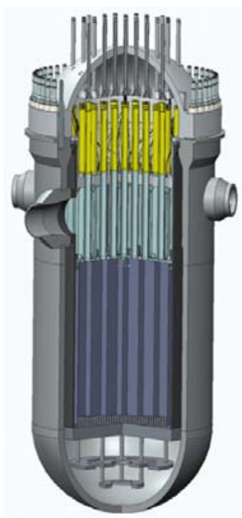


Fig. 1.1 TM-ICI Type New RPV

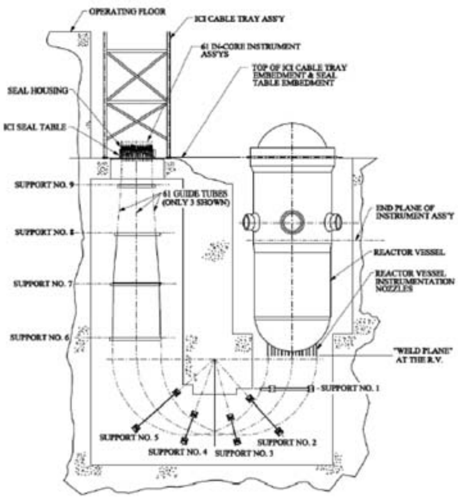


Fig. 1.2 System 80 Type Nuclear Reactor Layout

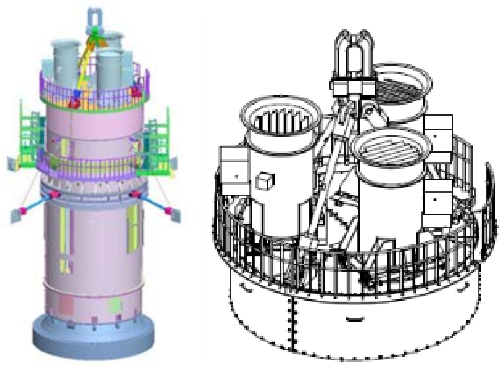


Fig. 1.3 IHA for TM-ICI Type

2. Finite Element Model

IHA consists of Cooling System, Seismic System, Lifting System, Air Plenum System and others. The analytical model is based on the Air Plenum Assembly of the IHA components that are directly affected by the vibration of the CEDM cooling fan. IHA Air Plenum Plate consists of Shell and Beam elements, CEDM Cooling Fan, Tripod Assembly and Main Column are used as mass elements.

2.1 Analysis Method

Two methods of analysis were applied. In the first case, the vibration characteristics were analyzed in the absence of the CEDM cooling fan, and in the second case, the vibration characteristics of the CEDM cooling fan using the isolation were analyzed. The analytical model is shown in Fig.2.1 and Fig.2.2.

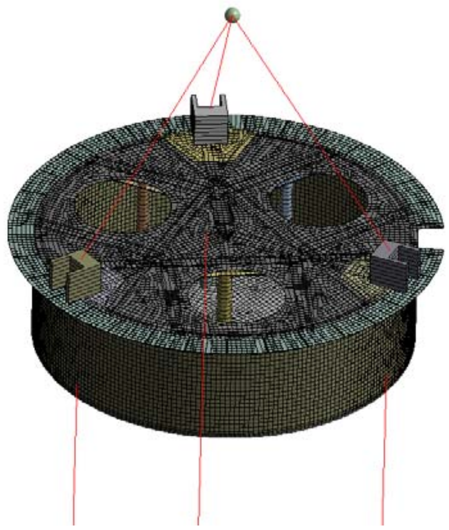


Fig. 2.1 Model without CEDM Cooling Fan (Case 1)

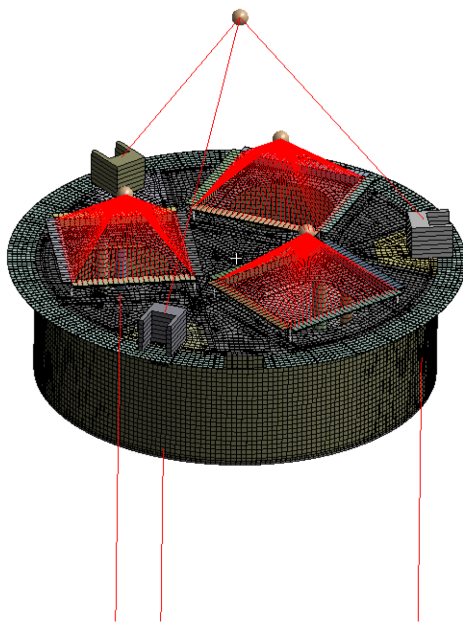


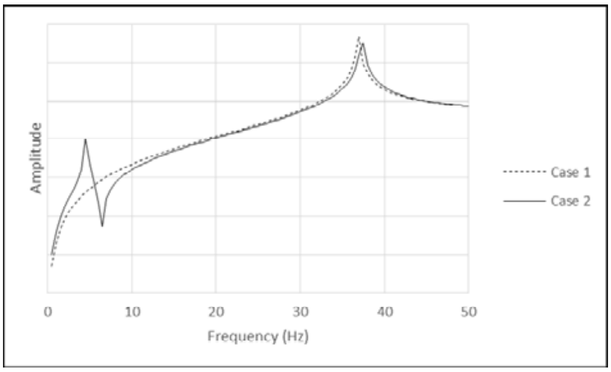
Fig. 2.2 Model with CEDM Cooling Fan (Case 2)

2.2 Analysis results

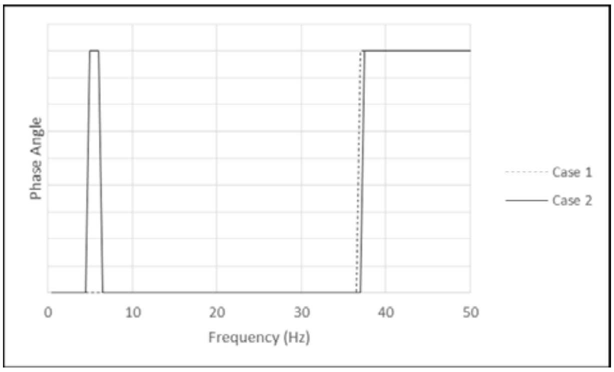
The analysis results of the natural frequency are shown in Table 2.1 below. And resonant frequency analysis is shown in Graph 2.1 and Graph 2.2.

Table 2.1 Natural Frequency Results

Case		1	2	
Mode			1	2
Frequency (Hz)	X-direction	43.90	5.08	43.20
	Y-direction	43.51	5.08	42.81
	Z-direction	36.89	4.59	37.33



Graph 2.1 Amplitude at Z-direction



Graph 2.2 Phase Angle at Z-direction

3. Conclusions

The natural frequencies up to 100 Hz were analyzed. The peak value in Case 1 was 44 Hz in the horizontal direction and 37 Hz in the vertical direction. The peak value in Case 2 was calculated for two frequencies. Peak values at low frequencies are near 5 Hz in the horizontal and vertical directions. This is expected due to the isolation effect of the CEDM cooling fan. Peak values occurring at high frequency are issued at 43 Hz in the horizontal direction and 37 Hz in the vertical direction and are analyzed as natural frequencies of the IHA Air Plenum Assembly. As a result, the excitation frequency provided by the CEDM cooling fan is expected to have no influence on the IHA by isolation.

REFERENCES

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[3] ASTM Annual Book of Standard Specification for Structure Steel Structure Steel

[4] William T. Thomson, Marie Dillon Dahleh, Prentice-Hall, "Theory of Vibration with Applications"