Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2009

Assessment of Structural Integrity after the Small Improvement of Reactor Coolant Pump

Jung woo Lee*, Min su Park, Sang hoon Choi, Gyung sub Kim, Sung ho Park
Technology Research & Development Institute, Korea Plant Service & Engineering
Migeum road 1, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-726, ljw1974@kps.co.kr

1. Introduction

Vibration is one of physical phenomena to affect capability and life cycles in turbo machinery. Vibration of most turbo machinery is caused by unbalanced mass, which leads turbo machinery to be damaged or failed before design life

This research tried to optimize the effect on operation of Reactor Coolant Pump(RCP) due to the improvement of structure.

2. Methods and Results

The method of examination for stability could be experiment and the field survey before and after modifying RCP design, but there is a lot of limitation such as dose which is about 10,000mR during operation. Therefore, numerical method applied to industry frequently is used.

The analysis program applied to numerical method makes use of Workbench Ver.12 of ANSYS Co.

2.1 Geometry and Finite Element Model

Reactor Coolant Pump consists of Casing, Impeller, Diffuser, Shaft, seals, accessories and bolts.

This estimate of geometric model, which just eliminates unessential factor such as fillet and chamber, is similar to real RCP.

Figure 1 shows finite element model of Reactor Coolant Pump

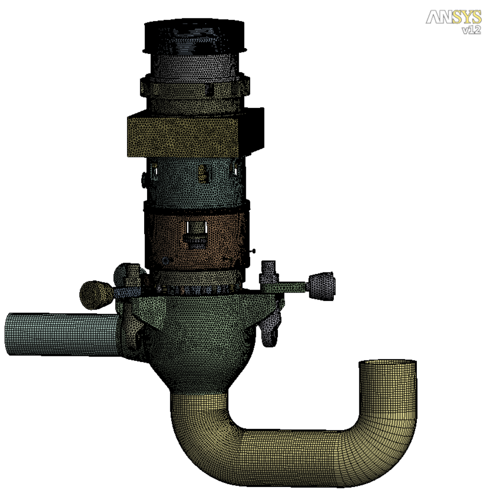


Fig.1 Finite Element Model of RCP

2.2 Material Properties

Generally, most material of RCP is made of stainless steel to prevent corrosion. Therefore, Material property mentioned by SA-182 F304L, part A, Section II of ASME code 2007 is applied.

Table 1 presents material properties of Reactor Coolant Pump.

Table 1 Material Properties of SA-182 F304L

Modulus of Elasticity	Yield Strength	Tensile Strength	Maximum Allowable Stress	Poisson's Ratio
195GPa	170Mpa	485MPa	115MPa	0.29

2.3 Modal Analysis

Modal analysis was performed to analyze structural characteristics of the machinery on dynamic behavior

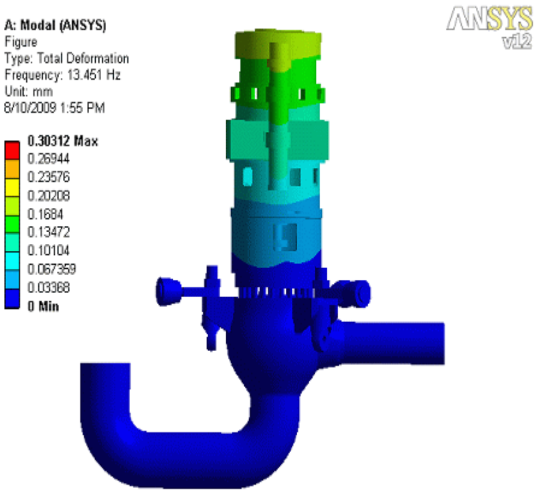
Usually, the mode-extractor method to search natural frequency is used orthonormalization method. The effect on natural frequencies of structure according to the modified mass of RCP is estimated by Block-Lanczos

Table 2 presents natural frequencies of before and after modifying of RCP.

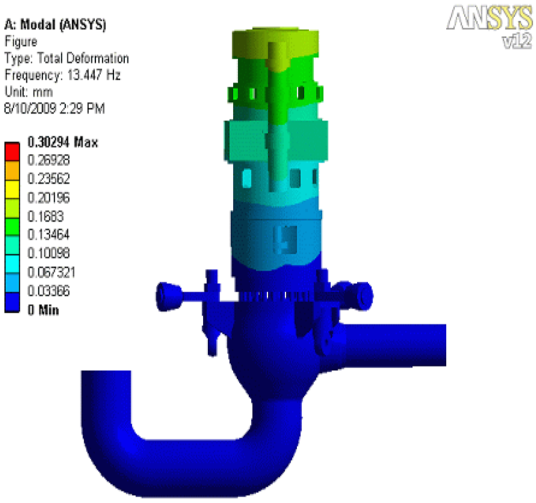
Table 2 Natural Frequencies of before and after modifying of RCP

Natural Frequencies	Before (Hz)	After (Hz)
1	13.451	13.447
2	15.183	15.18
3	25.888	25.884
4	26.328	26.323
5	31.736	31.735
6	54.186	54.169
7	55.626	55.601
8	61.12	61.099
9	72.225	72.206
10	74.789	74.781

Figure 2 shows 1st mode shape of before and after modified structure, natural frequencies are calculated to 13.451 and 13.447 Hz.



(a) Before



(b) After

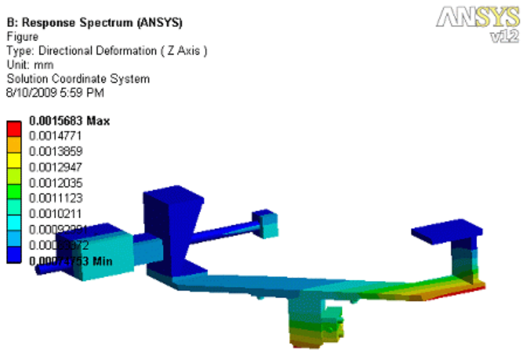
Fig.2 1st Mode Shape

2.4 Spectrum Analysis

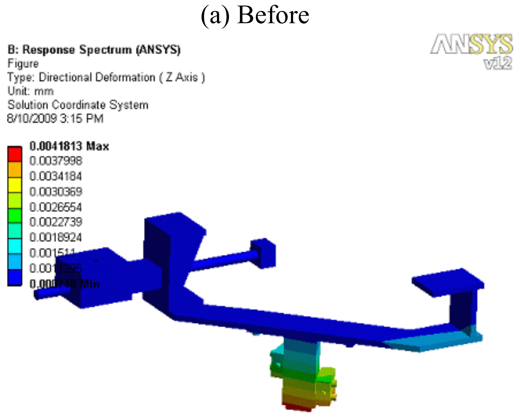
Spectrum analysis estimated to validate distribution of displacement of the structure.

ANSYS uses single-point method to conduct spectrum analysis, and mode combination method applies to SRSS(square root of sum of squares).

Figure 3 shows distribution of displacement before and after modifying of structure.



(a) Before



(b) After

Fig. 3 The distribution of displacement

3. Conclusions

The result of modal analysis of Reactor Coolant Pump shows that natural frequencies are different with 0.001~0.025Hz due to modified structure.

A consequence of analysis of response spectrum as shown in Figure 3 is rarely affected by modified structure.

Therefore, operation condition of RCP is not much different with previous condition despite the design modification of tiny structure, and RCP could be being operated stably

REFERENCES

[1] L. Meirovitch, Fundamentals of Vibrations, Mc Graw Hill, 2001

[2] Simon G. Braun, David J. Ewins, Singiresu S. Rao, Encyclopedia of Vibration, Academic press, 2002

[3] Singiresu S. Rao, Mechanical Vibration, Addison Wesley, 1990

[4] American Society of Civil Engineers, Seismic Analysis of Safety-related Nuclear Structures and Commentary, ASCE Standard, 2000