§9. Lower Cryostat

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Lower cryostat is a component of LHD that consists of a base plate, lower electromagnetic support structure and thermal shields for the base plate. This component was fabricated since 1990 and assembling was completed in 1994. The base plate and lower electromagnetic support structure were processed in a factory of the fabricator. They were made as 10 fan-shaped divided sectors because of their limit of transportation. After those parts were transported to experimental hall in Toki site, they were jointed each other by welding method. We succeeded to keep assembling accuracy of key points of electromagnetic support structure and the base plate within ± 2 mm in.

Figure 1 shows a photograph of the base plate and the electromagnetic structure when they were joined by the agency of the cryogenic support post. Weight of lower electromagnetic support structure is 180 ton and it was hanged by 250 ton crane to set to the cryogenic support post put on the base plate.

Superconducting magnets and the electromagnetic support structure have 850 tons refrigerating mass and are supported by 10 cryogenic support posts. This support post was designed as combination of CFRP plates and stainless steel plates for thermal insulator and thermal anchor, respectively, to take an adiabatic distance from the base plate to the support structure of cryogenic temperature.

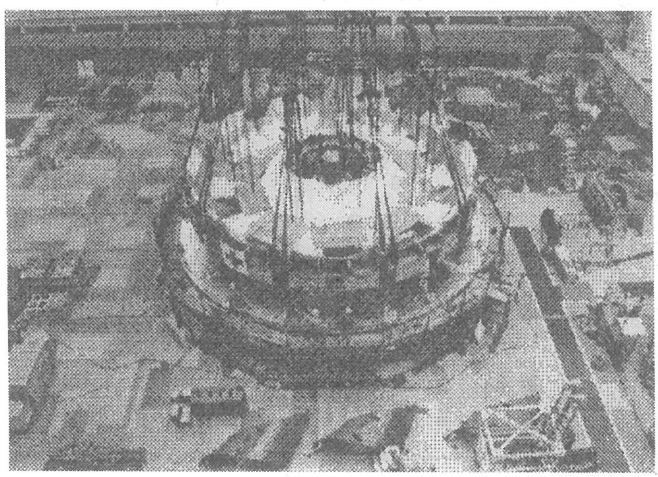

Fig. 1. Construction of base plate and electromagnetic support structure of lower cryostat.

We estimated characteristic vibration of support post and electromagnetic support structure by finite element method analysis. From the results of modal analysis, value of the first mode natural frequency was 13.5 Hz and it was needed to confirm a dynamic response when such an earthquake wave subjected to these structures because the first natural vibration mode might resonate to earthquake. We reduced a total element number to reduce a calculation time and memory space.

Figure 2 shows an input wave form and dynamic response of support post for EL-CENTRO earth quake. Appeared displacements from dynamic analyses were three times larger than that of static analyses for 0.3 G transverse loading. Maximum stress imposed on this support post was about 440 MPa. We also estimated a natural frequency and dumping coefficient by hammered the cryogenic support post. The value of natural frequency was 12 Hz and dumping coefficient was 0.5 % to 1.0 %. These values showed good agreements with analytical values.

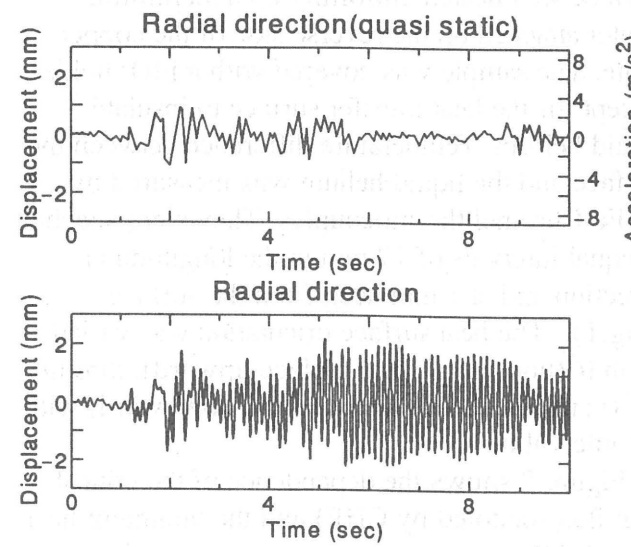

Fig. 2. Input wave form and dynamic response of cryogenic support post with electromagnetic support structure for EL-CENTRO earthquake.