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Magnetic Actuation Connector Between Extension Shaft and Armature for Bottom Mounted Control Rod Drive Mechanism

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1. Introduction

A bottom mounted control rod drive mechanism (BMCRDM) in a research reactor is composed of an electromagnet, stepping motor, ball screw, guide tube, armature and extension shaft assembly, and damping mechanism as shown in Fig. 1. The stepping motor directly drives the ball screw, and the nut of the ball screw makes the electromagnet move up and down along the guide tube. Therefore, the electromagnet and armature inside the guide tube interact and produce magnetism, thus making the armature, connecting extension shaft and control rod move up and down to control the power of reactor. During the overhaul, the control absorber rod (CAR), extension shaft, and armature of BMCRDM are lifted together for closing a seal valve. But total length of CAR assembly is so long that it cannot be lifted due to exposure above the water level of pool which is strictly controlled. In addition to this, it is difficult to calibrate a position indicator and lifting force of electromagnet without armature assembly as a seal valve is closed. For this reason, it is necessary to install a disconnecting system between armature and extension shaft.

Therefore, KAERI has developed magnetic actuation connector using plunger between armature and extension shaft for the bottom mounted control rod drive mechanism in research reactor. [1][2][3]

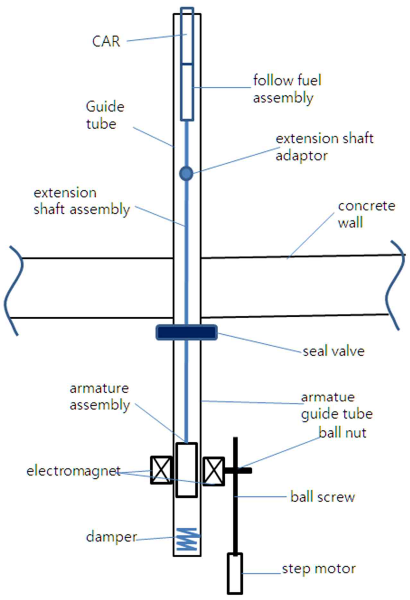

Fig. 1. Schematic of BMCRDM.

2. Automatic Connection System between Armature and Extension Shaft Neutron

The magnetic actuation connector system consists of a ball lock, spring, electromagnet, plunger armature, and plunger stator in the guide tube.

Fig. 2 shows disconnecting mechanism of a newly developed technique of magnetic actuation connector.

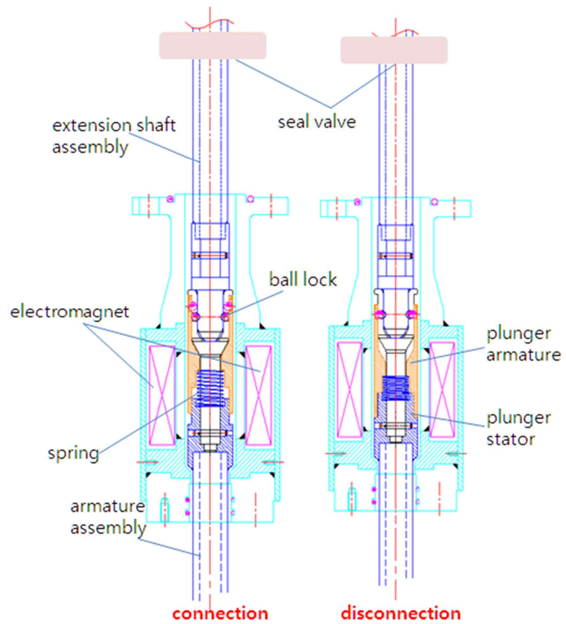

Fig. 2. A detailed view of disconnecting mechanism of magnetic actuation connector.

3. Methods and Results

In this section the numerical magnetic field calculation with finite element method is described as well as the details of configuration and function for the magnetic actuation connector which is operated in the guide tube.

3.1 Electromagnetic FEM Analysis Results

In recent year, the FEM has become widely accepted by the engineering professions as an extremely valuable method of analysis. Its application has enabled satisfactory solutions to be obtained for many problems which had been regarded as insoluble, and the amount of research effort currently being devoted to the FEM ensures a rapidly widening field of application.

A newly developed technique of the connector for such a computation is given in Fig. 3, where the exact course of the magnetic equi-flux of electromagnet is shown.

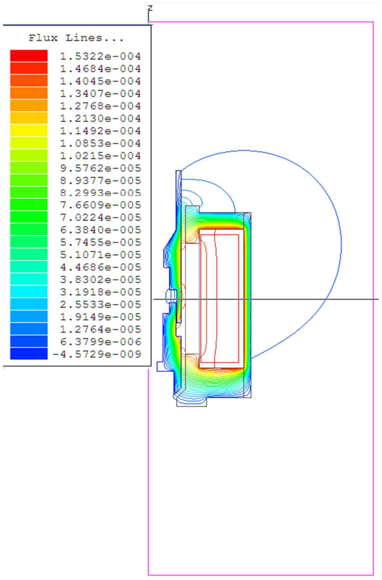

Fig. 3. Equi-flux distribution lines FEM results of magnetic actuation connector.

3.2 Experimental Results

Fig 4 shows a newly developed technique of prototype connector which is designed by FEM analysis result. The lifting force of prototype automatic connector is measured. As a result, it is shown that the lifting force of the prototype automatic connector have a good agreement with the result of the FEM.

Fig. 4. A prototype magnetic actuation connector.

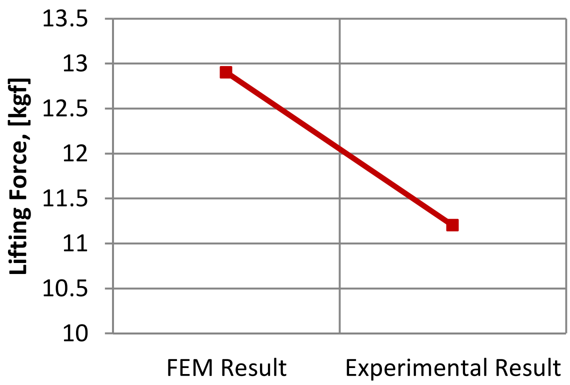

Fig. 5. Comparison of calculated and measured lifting force of magnetic actuation connector.

3. Conclusion

The results of a FEM and the experiments in this work lead to the following conclusions:

(1) The FEM result for the design of the magnetic actuation connector is compared with the measured lifting force of prototype production. As a result, it is shown that the lifting force of the prototype connector has a good agreement with the result of the FEM.

(2) A newly developed technique of prototype magnetic actuation connector which is designed by FEM analysis result is proposed.

REFERENCES

[1]Hyung Huh et al., “Analysis on Electromagnet Characteristics of Research Reactor CRDM for Thrust Force Improvement,” Transaction of the KNS Autumn Meeting, 2010

[2]Hyung Huh et al., “A Study on the Electromagnet Thrust Force Characteristics of Newly Proposed Hybrid Bottom-mounted CRDM for Research Reactor,” Transaction of the KNS Spring Meeting, 2007

[3]Hyung Huh et al., “The Design, Fabrication, and Characteristic Experiment of the Electromagnet of Bottom-mounted CRDM for Research Reactor,”