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Upgraded Features of Newly Constructed Fuel Assembly Mechanical Characterization Test Facility in KAERI

Kang-Hee Lee [a*], Heung-Seok Kang[a], Kyung-Ho Yoon[a], Hyung-Kyu Kim[a],
Young-Ho Lee[a], Soo-Ho Kim [a] and Jae-Ho Yang[a]

[a]*LWR Fuel Technology Development Division, KAERI, 989bungil-111, Deaduk-dero, Yusung, Deajon, Korea*
[*]*Corresponding author: leekh@kaeri.re.kr*

1. Introduction

Fuel assembly mechanical characterization test facility (FAMeCT) in KAERI is newly constructed with upgraded functional features such as increased loading capacity, under-water vibration testing and severe earthquake simulation for extended fuel design guideline[1]. This facility is designed and developed to provide out-pile fuel data for accident analysis model and fuel licensing. Full scale fuel assembly with equivalent mass simulated pellet is commonly used as a specimen in case of LWR plant. Necessity of upgrade and movement of the test facility to accommodate different types of fuel and cover up under-water and seismic simulation test has been raised recently.

The facility building is compactly designed in the scale of 3rd floor building and has regions for assembly-wise mechanical test equipment, dynamic load (seismic) simulating test system, small scale hydraulic loop and component wise test equipment. Figure 1 shows schematic regional layout of the facility building. Mechanical test platform and system is designed to increase loading capacity for axial compression test. Structural stability of the support system of new upper core plate simulator is validated through a limit case functional test. New test system can carry out under-water vibration and mechanical test using a segmented and cylindrical type water reservoir. Excitation system deliver controlled external force, to test structure inside water through flexible diaphragm, with constant magnitude and variable frequency.

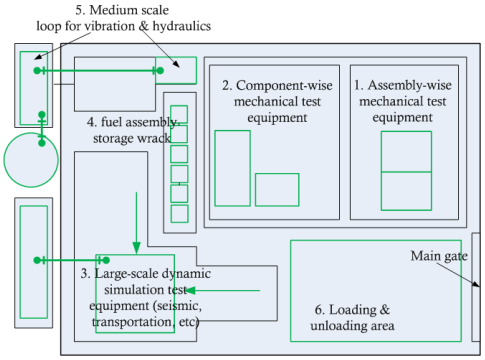

Fig. 1. Schematic regional layout of the facility building.

Dynamic load and seismic accident simulation system is designed to be installed at 2 meter underground from the floor, for the use of that region for the other purpose, such as unloading/loading area, when the system is not used. Thus thick plate cover and frame support is applied to cover the region of the test system. Shaking table is designed and fabricated by domestic company and the hydraulic actuation system will be supplied by the foreign vendor. Figure 2 shows internal configurations of the facility.

Fig. 2. Internal configurations of the FAMeCT facility

Table 1. List of FAMeCT-Mechanical Characterization Test.

Types of test	Boundary condition	Test results	Environment	Remarks
1. Lateral vibration	BOL/EOL axial loading, tilted*	natural frequency, damping, mode shape	Dry, Wet	PWR,SFR, SMART, Research-Rx fuels
2. Lateral bending	BOL/EOL axial loading, tilted*	strain, bending stiffness	Dry	PWR,SFR, SMART, Research-Rx
3. Lateral impact	BOL/EOL axial loading	impact force, restitution coeff.	Dry	Side-by-side two FAs
4. Axial compression	BOL/EOL axial loading, tilted*	strain, compressive stiffness, limit case test	Dry	
5. Axial drop	Free fall by self weight	impact force, restitution coeff.	Dry	Pull and release drop mech.
6. Seismic integrity	BOL/EOL axial loading, tilted*	strain, acceleration, impact force	Dry, Wet (still water)	Side-by-side two FAs

*tilted : free standing without UCPS compression

This paper briefly introduce the test facility construction and scope of the test and is focused on the upgraded design features. Authors hope to facilitate the facility more in the future and collaborate with the industry. Table 1 lists up test scope of KAERI-FAMeCT.

2. Upgraded Features of New FAMeCT

2.1 Any Reactor Types of Fuel Specimen

The FAMeCT can carry out various mechanical characterization tests for any types of fuel design using a movable UCPS and multi-purpose use of fuel positioning (including changeable lower support system) and alignment system. The test system can accommodate any type of reactor fuel of PWR, SFR, SMART, and even a research reactor fuel with box shape and short length compared to commercial one.

2.2 Increased loading Capacity

Loading capacity of mechanical test system of FAMeCT has increased up to 35kN for axial compression test. Renovation of UCPS support design is primarily done for this purpose. Figure 3 shows the results (axial forces and strain deformed) of limit-case-loading functional test for the test facility undertaken[2].

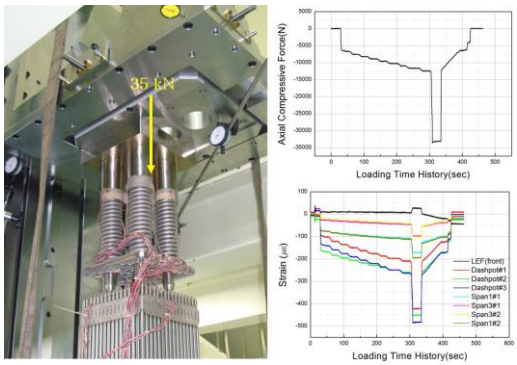

Fig. 3. Results of limit-case functional test of the facility

2.3 Under-Water Testing and Water Reservoir

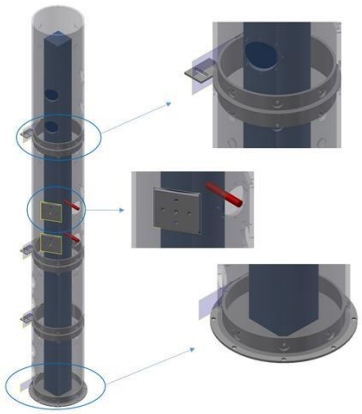

Fig. 4. Shematic drawing of the water reservoir for under water mechanical testing

Figure 4 shows the schematic drawing of the water reservoir for the under-water mechanical test. The system can deliver dynamic controlled force through the transparent water wall through flexible diaphragm using thin metal stinger. The shaking system will located at the outside of the wall. There are many ports over the wall for installation of devices and signal line extraction.

2.4 Seisimc simulation test system for severe earthquake event and anticipated dynamic events.

Seismic accident (including anticipated dynamic events for power plant) simulation test system will be installed underground at FAMeCT facility, until end of May, 2016. The system is composed of shaking table, two perpendicular hydraulic actuators and their control system units imported from MTS cooperation (US). Shaking table is designed and fabricated by the indigenous technology and domestic company. Figure 5 shows anticipated setup of seismic simulation test system.

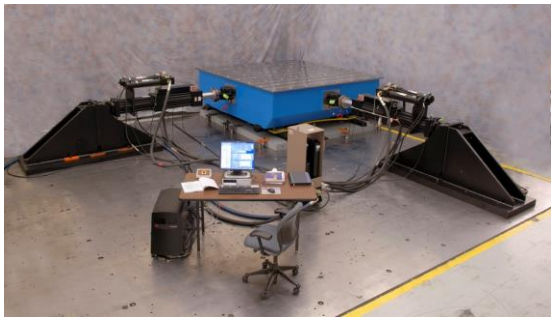

Fig. 5. Anticipated setup of seismic simulation test system for the fuel assembly and partial core.

3. Conclusions

Fuel assembly mechanical characterization test facility in KAERI is newly constructed and upgraded with advanced functional features such as uprated loading capacity, under-water vibration testing and severe earthquake simulation for extended fuel design guideline. This paper briefly introduce the test facility construction and scope of the facility and is focused on the upgraded design features of the facility. Authors hope to facilitate the facility more in the future and collaborate with the industry.

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