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# Axial Impact Behavior of a Newly Developed Fuel Assembly using Fuel Assembly Mechanical Characterization Tester (FAMeCT)

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## 1. Introduction

The purposes of this work are two points. One is the verification of the fuel assembly mechanical characterization tester (FAMeCT), and the other is the comparison test results between the test data and those of the other institution to evaluate the mechanical performance of the newly developed fuel assembly.

The FAMeCT is a tester of versatile function for mechanical characterization of an actual size fuel assembly. The whole shape of the FAMeCT is shown in Figure 1.

Fig. 1. FAMeCT test facility

The available test of this as follows; lateral & tilt vibration, lateral & tile stiffness, axial & torsional stiffness, and lateral & axial impact test. In this paper, the axial impact behavior of a fuel assembly dealt. The fuel assembly was positioned vertically on a rigid plate with four insert pins, which was the typical reactor condition for pressurized water reactor power plant.

## 2. Axial impact test setup and procedure

The sensors which one load cell and one displacement transducer for axial impact test are mounted with FAMeCT. A 222 kN load cell is mounted the below of the lower core support structure simulator (LCPS). And one 50 mm displacement transducer is mounted on the adapter plate of the top end piece. These detail information of the sensors are shown in the Table 1. These sensors are connected the dynamic scanner for test. Because of the axial impact test is dynamic test, the sampling rate for test is set 500 points per second.

Table 1: Sensor configuration for the axial impact test

| id | Ch. | description | sensitivity |
|---|---|---|---|
| BOT-L | 26 | 222 kN load cell | -1.9856 |
| TOP-D1 | 27 | 50 mm displ. sensor | 3.374 |

The initial drop height of a fuel assembly was adjusted from top surface of LCPS to bottom surface of a fuel assembly. The fuel assembly was dropped from initial heights of 5 mm to 40 mm in 5 mm increments. The ball joint mechanism was quickly released for test by moving of the lever. And then the initial drop height, impact force, impact duration, rebound height, and restitution coefficient values were obtained from DAS. The schematic drawing for axial impact test was shown in Fig. 2.

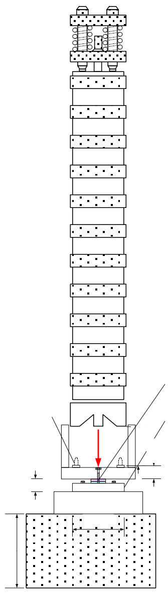

Fig. 2. Schematic drawing for the axial impact test

## 3. Test results

The initial drop height, impact force, impact duration, rebound height, and the restitution coefficient values as the drop height of a fuel assembly were summarized in the Table 2.

Table 2. Test results from the axial impact test

| $h_0$ (mm) | F (N) | t (s) | v (mm/s) | $h_1$ (mm) | c |
|---|---|---|---|---|---|
| 0 | | | | | |
| 10 | 62134 | 0.016 | 442.9 | 5.342 | 0.731 |
| 15 | 76680 | 0.012 | 542.4 | 7.083 | 0.687 |
| 20 | 84135 | 0.012 | 626.3 | 8.408 | 0.648 |
| 25 | 91590 | 0.012 | 700.2 | 10.796 | 0.657 |
| 30 | 95906 | 0.012 | 767.0 | 12.506 | 0.646 |
| 35 | 104874 | 0.014 | 828.5 | 12.979 | 0.609 |
| 40 | 113871 | 0.016 | 885.7 | 13.744 | 0.586 |
| | | 0.013 | | | 0.672 |

The typical trace of the fuel assembly at the 10 mm initial drop height was shown in Fig. 3. In this Figure, the negative displacements were caused the oscillation of the sensor bracket on the adapter plate.

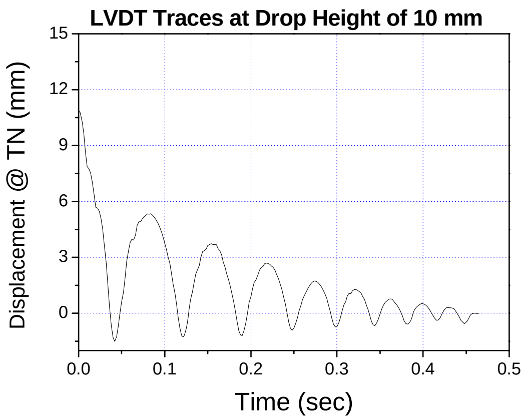


Fig. 3. Trace of the adapter plate for the axial impact test

The impact force at the initial drop height 10 mm was shown in Fig. 4. These impact forces were linearly decreased as the time history. The peak values were very sharply shape due to the elastic collision with the lower core support plate. And the 500 points per second sampling frequency was very suitable parameter for the axial impact test. And the maximum impact forces as the initial drop height were shown in Fig. 5. These maximum impact forces had the linear behavior as the drop height. As the results of this, the stiffness of the fuel assembly due to the axial impact was regarded the linear structure.

Synthetically, the average restitution coefficient (c) was much larger than Korean Standard Nuclear Power (KSNP) fuel assembly. That was why the total mass of a newly developed fuel assembly was smaller than previous fuel. And there were less clearance between the rods to grid supports.

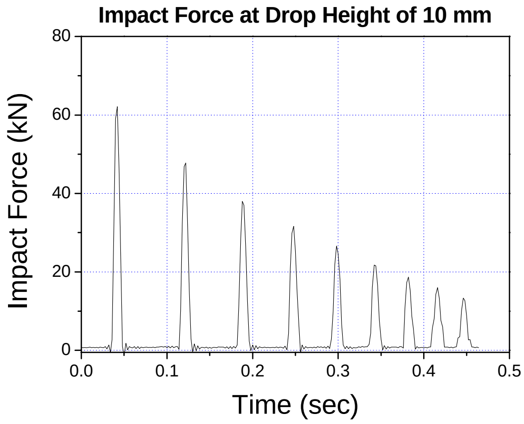


Fig. 4. Impact force history at the 10 mm initial drop height

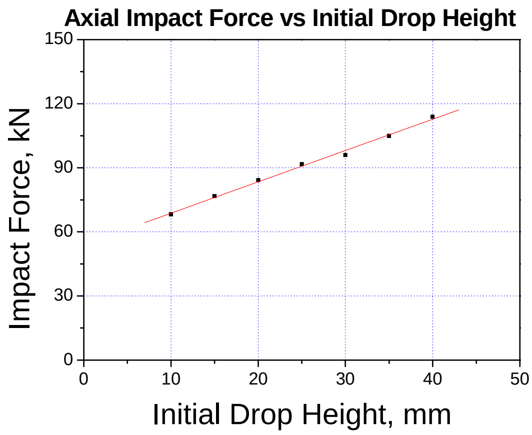


Fig. 5. Maximum impact force vs. initial drop height

## 4. Conclusion

The axial impact test was executed using the KAERI test facility, FAMeCT. Test setup and the test procedure were well established. The axial impact behavior of the newly developed fuel assembly was shown comparing with other fuel assembly. Nevertheless the displacement sensor setup needs to modify the sensor bracket for decreasing the oscillation of the adapter plate during axial impact.

## ACKNOWLEDGEMENTS

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