# Experimental Dynamic Compatibility Testing for Simulated Test Fuel Plate

Kang-Hee Lee [a*], Heung-Seok Kang [a], Yong-Jin Jeong [b], Jeong-Sik Yim [c]

[a] *LWR Fuel Tech. Div., KAERI, Deaduk-dero 989bun-gil,111, Yusung, Daejeon, Korea*
[b] *Research Reactor Fuel Development Div., KAERI*
[c] *JRTR Fuel Develop. Div., KAERI*
[*] *Corresponding author:leekh@kaeri.re.kr*

## 1. Introduction

Many research reactors use thin fuel plate as a fuel element. Longer-side edges of each fuel element are firmly fixed and swaged at corresponding side plates when assembling. JRTR fuel is a box shaped, mechanical assembly of fuel plates which are located each other with a fine coolant fluid gap. They provide proper power distribution and neutron source to target test object in the core and vibrate due to the downward coolant flow under normal reactor operation.

Fast coolant flow in a research reactor can make the fuel element dynamically unstable at a certain flow condition or at relatively low flow velocity. To assess the structural integrity of this fuel element, a flow test using a prototype fuel element and assembly should be performed under normal operational or transient accident condition. But, there are many restrictions for use of a real uranium fuel plate as a hydraulic test specimen. Thus, we fabricated mass-equivalent, simulated test fuel plate (STFP) using a compact mixture of tungsten and aluminum powder instead of real uranium powder. We want to show the dynamic compatibility of the STFP, using conventional vibration test method and frequency comparison. This paper will scope fuel plate fabrication, vibration compatibility testing and test results.

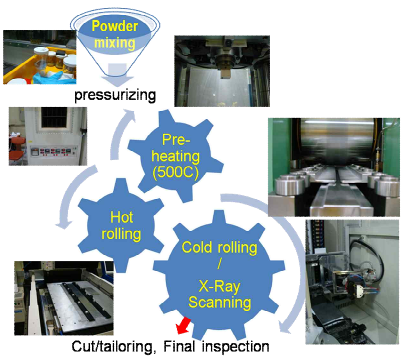


Fig. 1 Schematic fabrication process

## 2. Test Fuel Plate Fabrication

The STFP was fabricated by the research reactor fuel development team in KAERI. The schematic fabrication process of the test fuel plate was shown in Fig. 1. Processing temperature, initial size of the plate and the number of rolling step are the key manufacturing parameters. Fig. 2 show the typical result of the X-ray penetration scanning and uniform distribution of a tungsten powder for STFP. Minor difference in distribution of the tungsten power has little effect on dynamics of the fuel plate.

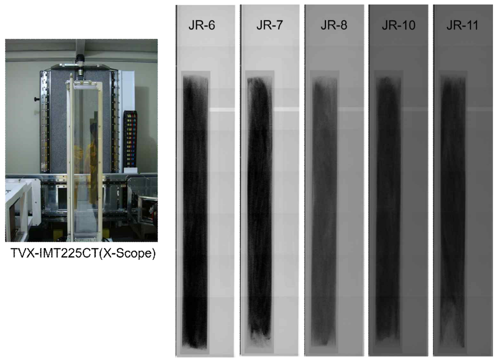


Fig. 2 X-Ray Scanning Results

## 3. Vibration Testing

Free-free boundary condition was planned to apply the test fuel plate because elastic plate with free-free boundary has same eigenvalue to clamped one. We support a fuel plate with plastic wire through the pin hole located at the upper center of the plate. Fig. 3 shows the overall configuration of the test setup. We use a conventional modal vibration testing method with impulse force hammer and miniature accelerometers [1-3]. Accelerometer mounted at mid/quarter/ a third quarter positions with bee wax.

During the vibration characterization test, external excitation force is applied to the test fuel plate by the impact hammer. Force transducer, installed at hammer tip measures excitation force applied to the test object. Accelerometers measure all responses of the test structure at multiple measurement locations. Frequency response function (FRF) at each measurement position can be deduced from the post signal processing using the measured forces and measured response accelerations. Modal analysis using FRFs produces the final dynamic characters using a specific modal parameters estimation algorithm.

Fig. 3 Vibration test configuration

All measured signal was monitored in testing system during the test and saved using a dynamic data acquisition system. Test data analysis software or spectrum analyzer processes all measured signal to produce frequency response function which is the input-output relationship between force and response of the structure.

During the test, we award that the tension in support plastic wire can make the natural frequency lowered. This un-intuitive understanding is from the principle that transverse vibration of the simple beam has same eigenvalue for both free-free and clamped-clamped boundary condition. This means that tension in the support wire can have much role in changing free boundary to pined one.

## 4. Test Results

Fig. 4 shows the comparison of the FRF from STFP and real uranium fuel plate. Peak frequency in the measured FRF indicates corresponding natural frequencies. Their imaginary parts represent magnitude of the modal vector. The natural frequency of STFP is quite close to those of real uranium fuel plate. Thus, test results show good dynamic compatibility of the STFP. We also expect that STFP can simulate dynamic behavior of real uranium fuel plate in the reactor coolant flowing environment.

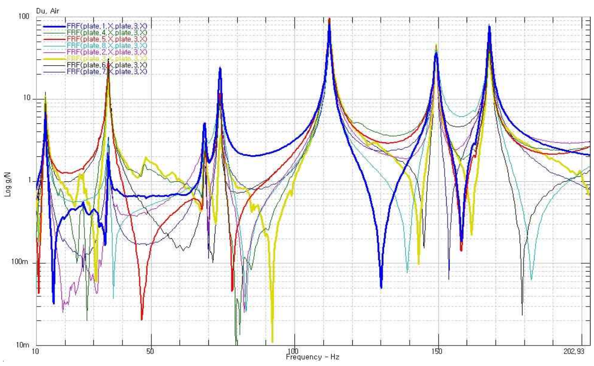

Fig. 4 FRF comparison from vibration test

## 5. Conclusion

Test results show that the simulated test fuel plate with equivalent mass distribution (having tungsten and aluminum powder mixture) can compatibly simulate dynamic behaviors of the real fuel plate; we also expect that they do in the coolant flowing environment.

During vibration testing, we understand that the tension in support plastic wire can make the natural frequency lowered. This un-intuitive understanding is from the principle that transverse vibration of the simple beam has same eigenvalue for both free-free and clamped-clamped boundary condition. This means that tension in the show vibration test method and results from comparing natural frequency of the real uranium fuel plate.

## Acknowledgement

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