# Simplified Geometric Model Development to Evaluate Spent Fuel Integrity of Representative in Long-Term Dry Storage

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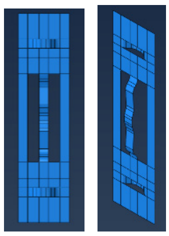
## 1. Introduction

The research about dry storage for interim storage of low burn-up Spent Nuclear Fuels (SNFs) is still a work in progress because PWR spent fuel pools will be saturated with SNF in 2024 [1]. The Korea Atomic Energy Research Institute (KAERI) has conducted various kinds of tests and analyses to obtain useful data for predicting the integrity and retrievability of SNFs after transportation and long-term dry storage. Among several fuel assembly (FA) components, spacer grids (SGs) protect the fuel rods from external impact loads issued by transportation, earthquake and abnormal events during handling. Before buckling of SGs, they sustains the external impact load. The dynamic buckling strength of a SG is important characteristics to determine whether it is possible to handle SNFs experienced external loads or not. FE model of a kind of SGs, 14 KNF-OFA, has been developed to predict dynamic buckling strength. But its shape is so complicated that it takes a lot of time and efforts to generate a geometric model. In this paper, a simplified geometric model, KAERI model, to replace a SNF representative SG, a 14 KNF-OFA SG, is suggested and validated by comparing predicted reaction forces versus time with those of a detail geometric model.

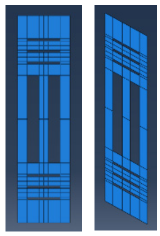
## 2. KAERI Model

### 2.1 KAERI model development

PNNL suggested simplified finite element model [2]. They used a plate shape model with suitable shell thickness which was decided by the equivalent slot study to produce similar lateral response to a finely-meshed grid slot that included the springs and dimples. But KAERI model is decided by using same cross-sectional area and volume as a detail geometric model shown in Fig. 1.



(a) detail



(b) KAERI

Fig. 1. Geometric models of 14 KNF-OFA.

### 2.2 Spring and dimple stiffness

Because the KAERI model has flat springs and dimples, we apply a connector element [3] having the characteristics of an axial spring to replace curved springs and dimples in a detail model. To input spring and dimple stiffness, spring characteristic analyses of a spring and a dimple in a detail model are performed.

## 3. Validation of KAERI model

### 3.1 Load and boundary conditions

Since the development objective of the FE model is to predict the dynamic buckling strength, dynamic impact analyses were performed to validate KAERI model. The rotational degree of freedom of the cladding tube was constrained. The degree of freedom in all directions of the center point on the upper surface was constrained. Reaction forces in y-direction (RF2) were calculated on this point. The mass of a hammer was 48.85 kg and it collided with a 1x1 spacer grid in upper direction at a speed of 256.322 mm/s. The speed for a 3x3 spacer grid was 443.963 mm/s [4].

*3.2 Analyses results*

Three kinds of geometric models were used such as a detail, PNNL and KAERI. Same mesh size, load, constraints and boundary conditions were applied. To confirm the size effect, several arrays of SGs were analyzed. Fig. 2 shows that RF2 obtained by the KAERI model is similar to the result of the detail model in the case of 1x1 and 3x3 SGs. It means that the KAERI model is useful.

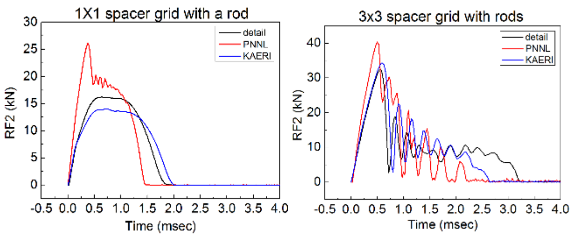



Fig. 2. Analyses results in the case of 1×1 and 3×3 SGs.

## 4. Conclusions

KAERI suggested a simplified geometric model with the same cross-sectional area and volume as a detail model. A connector element was used to simulate the spring and dimple of the detailed model. In order to confirm the validity of the KAERI model, dynamic impact analyses were performed on the detail, PNNL and KAERI model and the results were compared. Through the analyses results, it is confirmed that the KAERI model are valid. It could reduce the time to generate a geometric model. The KAERI model will be used for a full-size 14 KNF-OFA SG dynamic impact analyses and for a 14 KNF-OFA fuel assembly to evaluate the mechanical integrity during transportation.

## ACKNOWLEDGEMENT

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