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Validation of a Computacional Model of a Nuclear Fuel Assembly Bottom Nozzle

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1. Introduction

In this paper, the methodology for validating a computational model of a bottom nozzle of a PWR reactor fuel assembly is described. A prototype was manufactured with the same dimensions as the model and equal compressive loads were applied at the same points on the model and on the prototype. Finally, the stress and strain data in the model and in the prototype obtained at each point are compared.

2. Methodology

The methodology established for the validation of the model was based on criteria established in the North American standards NUREG-0800 and RG 1.70, which require that stress, strain or loading limits be established and evaluated, and that the structural design be considered in relation to the performance from a security perspective.
A computational model of a bottom nozzle of a fuel assembly of a PWR reactor was developed. Figure 1 shows the model. Then the model was analyzed using the finite elements method. A load of 3000N was applied to the central hole in the model and the nozzle responses were analyzed considering stress and deformation.

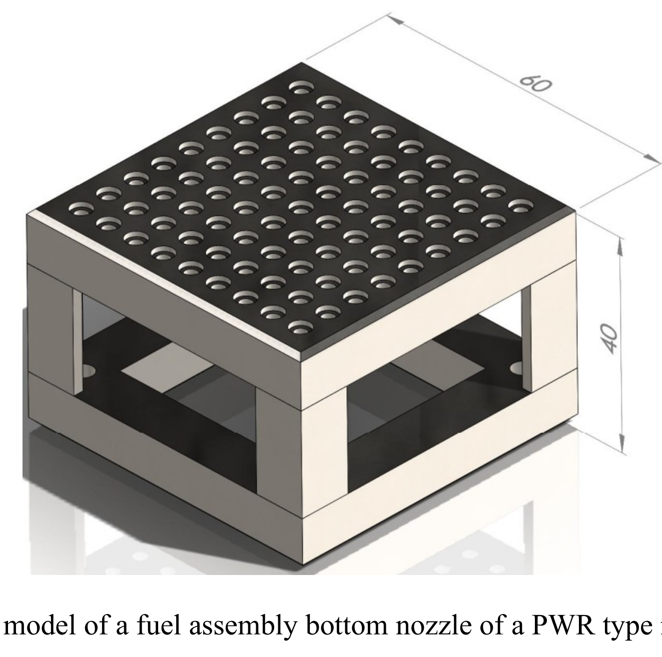

Figure 1: Computational model of a fuel assembly bottom nozzle of a PWR type nuclear reactor in reduced and simplified size.

Figure 2 shows the results obtained for stress and Figure 3 shows the results for deformations.

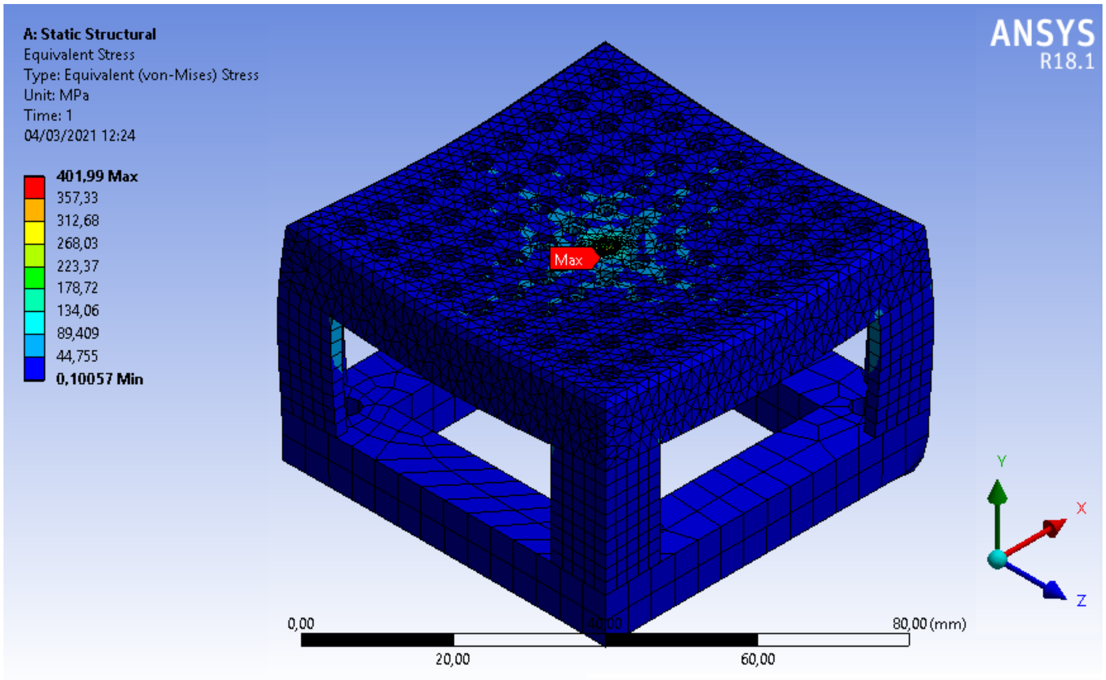

Figure 2: Stress results from finite elements analysis of the bottom nozzle computational model. The point of maximum stress (402 MPa) is pointed at the central hole, which is where the load is applied in the analysis.

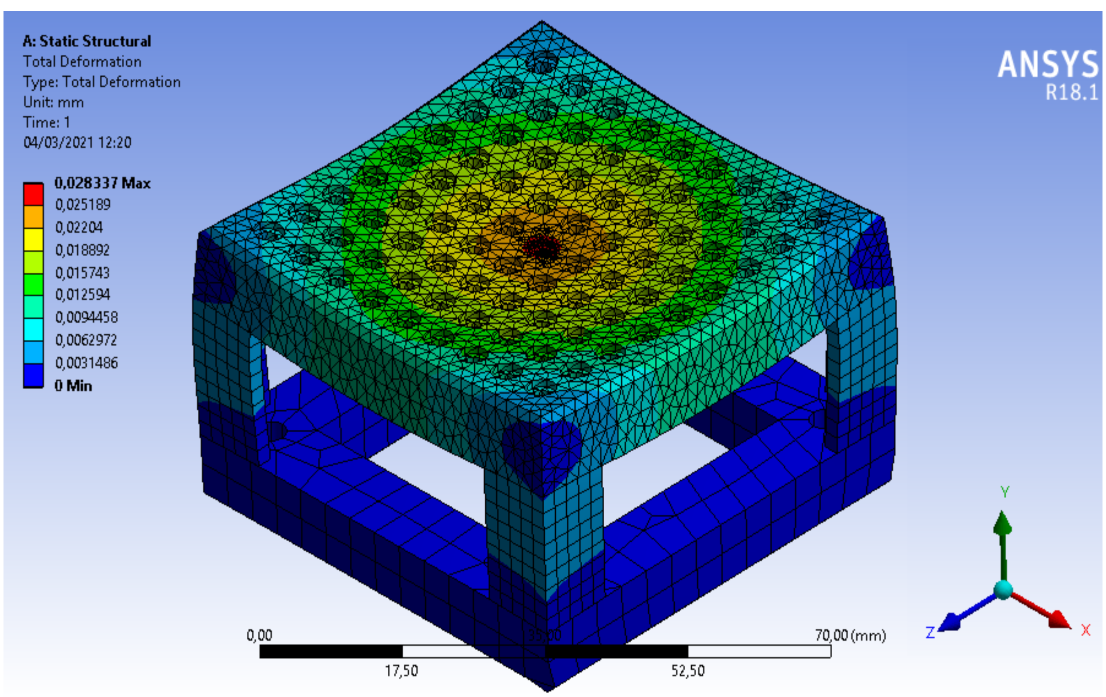

Figure 3: Deformation results of finite elements analysis of the bottom nozzle computational model. The maximum deformation point (0.028) is pointed at the central hole, which is where the load is applied in the analysis.

A metallic prototype with dimensions equal to the model will be built and this will be tested with a compressive load in a universal mechanical testing machine. The same load used in the finite elements analysis will be applied in the prototype and in the same places. Deformations and stresses generated will be registered by sensors throughout the test.

3. Results and Discussion

The finite elements analysis and prototype test data will be compared and their percentage variation will be raised, considering the errors embedded in both. The meshes will still be refined in finite elements analysis in order to obtain more reliable results.

4. Conclusions

Steps for validation of the computational model of a bottom nozzle of a fuel assembly of a PWR nuclear reactor used in the evaluation of design limits for safety were presented. The methodology basically consisted of validating by mechanical tests a finite elements analysis of a computational model and a prototype dimensionally equal.

Acknowledgements

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References

[1] U.S. Nuclear Regulatory Commission, "Standart Review Plan, NUREG 0800, Section 4.2 Fuel System Design", (2007).
[2] U. S. Regulatory Commission, "Regulatory Guide 1.70, Section 4.2 Fuel System Design", rev 3, (1978).