

Modal Analysis of Nuclear Fuel Assembly Using the Model **Reduction Method**

Muhammad Subhan, Ihn Namgung KEPCO International Nuclear Graduate School (KINGS) Ulsan, Republic of Korea

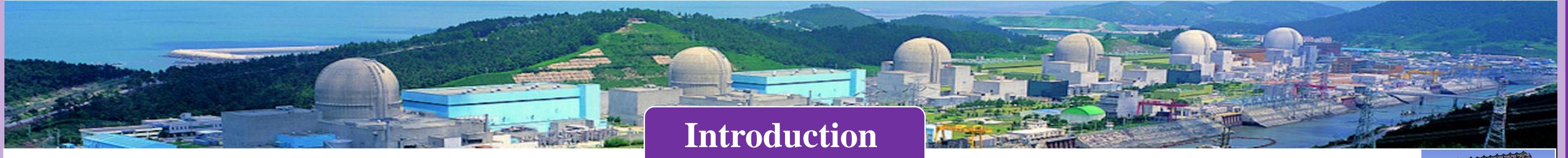


Element Size

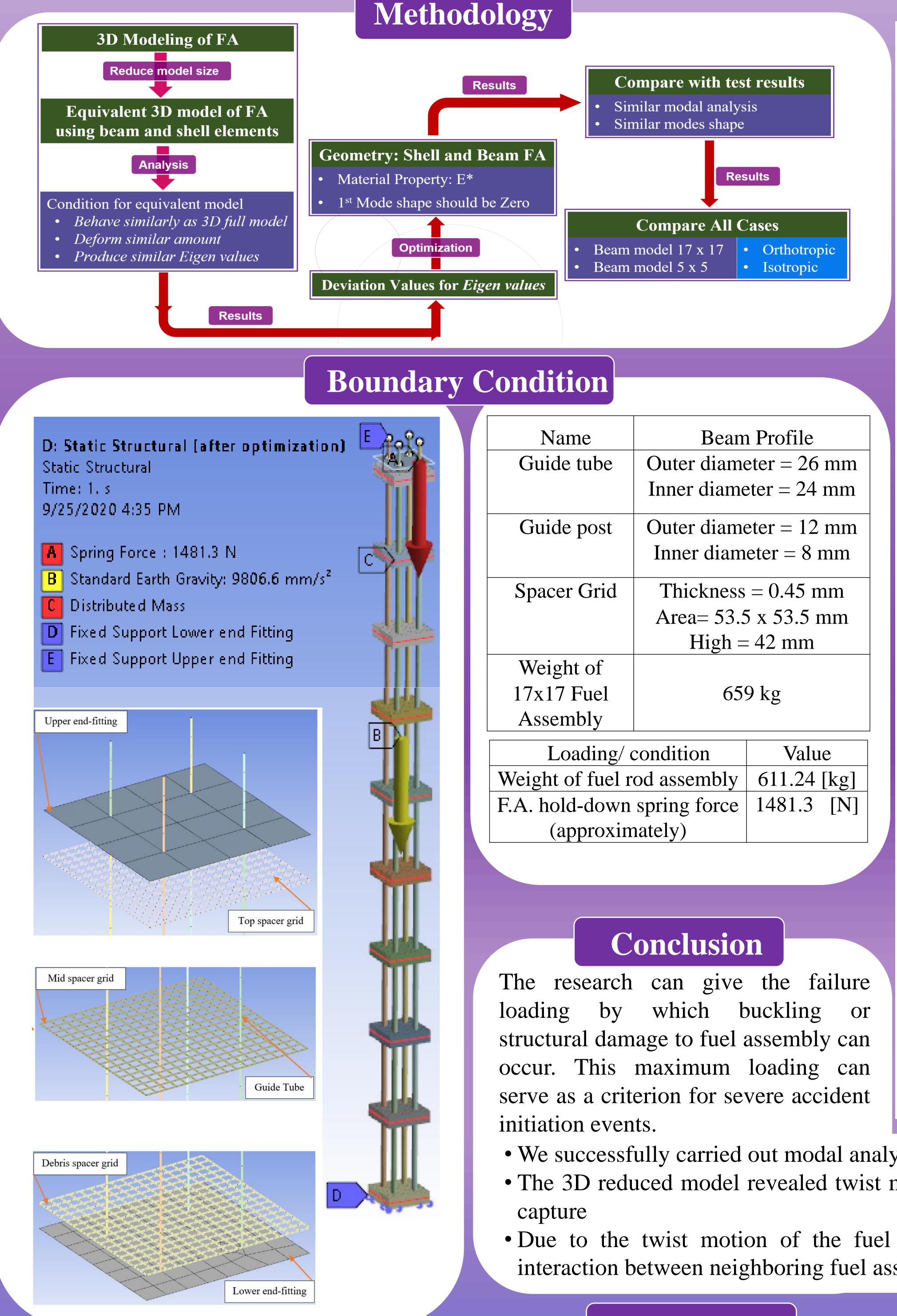
Inflation

Advanced

10.0 mm



- The structure of fuel assemblies should have the capability to withstand lateral static and dynamic loads from external forces such as an earthquake.
- Currently, a lot of research has been the put in development of nuclear fuel assembly using 1D or 2D modeling and avoid the complexities of 3D modeling fuel assembly. But, in the 1D or 2D model, interaction between CEA guide tubes and twist motion of fuel assembly can not be assessed. 3D Dynamic analysis on the other hand, in the case of time history analysis, requires a lot of computing time.
- In this research, a 3D modeling approach will be introduced and proposed the method and will carry out a simple case of dynamic analysis. Beam and shell elements are used to construct fuel assembly and reduced model size using ANSYS software.
- The modal analysis of this fuel assembly gives Mode shapes and Modal values. This presents for the first time each fuel rod behavior and interaction between them, and will also show which position of the spacer grid will experience more dynamic-behavior.



Results

Type: Total Deformation Type: Total Deformation Frequency: 3.7 Hz Unit: mm 11/15/2020 10:24 PM Internet interne	armation 3 al Deformation 4 ryse: Total Deformation 4 Type: Total Deformation 5 Type: Total Deformation 5 Type: Total Deformation 5 Type: Total Deformation 5 Type: Total Deformation 1 Type: Total Deformation 5 Type: Total Deforeforeforeforeforeforeforeforeforefor	Deformation 6 Total Deformation 7 Total Deformation 7 Type: Total Deformation 7 Frequency: 12.175 Hz Total Deformation 7 Juit mm 1/15/2020 10:30 PM 3.1308 Max 2.8239 2.7829 2.4351 2.0872 2.179 1.7333 1.4119 1.0436 0.65689 0.69573 0.35298 0.34766 0.35298 0.Min Min
Type: Total Deformation Type: Total Deformation Frequency: 12:577 Hz Interminant 11/15/2020 10:33 PM Interminant 1.712 Interminant 1.284 Interminant Interminant Interminant	formation 11 tal Deformation cy: 17.256 Hz D20 10:34 PM Total Deformation 12 Type: Total Deformation Frequency: 17.256 Hz Unit: mm Total Deformation 13 Type: Total Deformation Frequency: 17.256 Hz Unit: mm Total Deformation Frequency: 18.248 Hz Unit: mm Total Deformation Frequency: 18.248 Hz Unit: mm 757 149 1.8965 Max 3.3035 Max 1.1715/ 2.9365 1.1751 1.2643 1.0536 0.84289 0.63217 0.42145 0.36706 D Min 1.1012 0.0 0.0734121 0.036706 D Min Min 0.0 0 Min 0.0 0 Min	Deformation 14 Total Deformation 15 Total Deformation 15 Type: Total Deformation 15 Type: Total Deformation trop: 21.735 Hz Frequency: 21.833 Hz
Type: Total Deformation Frequency: 24.245 Hz Unit: mm 11/15/2020 10:38 PM	iormation 19 Total Deformation 20 ial Deformation Type: Total Deformation y: 25.827 Hz Frequency: 26.143 Hz 20 10:39 PM Unit: mm 11/15/2020 10:39 PM 3.0916 2.7052 2.3187 7 1.9323 957 1.5458 217 1.594 0.38645 0.38645	
Mode	Results	Remarks
1	3.7	Beam mode
2	3.7001	Beam mode
3	5.0208	Twist mode
4 5	7.8718 7.872	Beam mode Beam mode
6	8.5931	Twist mode
	12.175	Twist mode
8	12.577	Beam mode
8 9	12.577 12.577	Beam mode Beam mode
ð		
8 9 10 11	<i>12.577</i> 15.684 17.256	<i>Beam mode</i> Twist mode <i>Beam mode</i>
8 9 10 11 12	12.577 15.684 17.256 17.256	Beam modeTwist modeBeam modeBeam mode
8 9 10 11 12 13	12.577 15.684 17.256 17.256 18.948	Beam modeTwist modeBeam modeBeam modeTwist mode
8 9 10 11 12 13 14	12.577 15.684 17.256 17.256 18.948 21.735	Beam modeTwist modeBeam modeBeam modeTwist modeBeam mode
8 9 10 11 12 13	12.577 15.684 17.256 17.256 18.948	Beam modeTwist modeBeam modeBeam modeTwist mode

Guide post	Outer diameter = 12 mm						
	Inner diameter = 8 mm						
Spacer Grid	Grid Thickness = 0.45 mm						
	Area= 53.5 x 53.5 mm						
	High = 42 mm						
Weight of							
17x17 Fuel	659 kg						
Assembly							
Loading/	Loading/ condition						
Weight of fuel a	Weight of fuel rod assembly						
F.A. hold-down	F.A. hold-down spring force						
(approximately)							
Conclusion							
The research can give the failure							
Č ľ	loading by which buckling or						
structural dan	structural damage to fuel assembly can						

17	24.245	Twist mode
18	25.827	Beam mode

- We successfully carried out modal analysis of single fuel assembly
- The 3D reduced model revealed twist modes that the lumped mass spring model cannot
- Due to the twist motion of the fuel assembly we can assume that there could be interaction between neighboring fuel assemblies.

Future Work

This research is first step to full core modeling using 3D reduced model of Fuel Assembly to investigate the seismic response of the full-core and interaction between Fuel Assemblies and Fuel Assemblies and reactor internals.

This research was supported by the 2020 Research Fund of the KEPCO International Nuclear Graduate School (KINGS), the Republic of Korea.