16X16

A Study on the Buckling Characteristic of the Spacer Grid in the Improved 16X16 Fuel Assembly



Abstract

The new 16X16 fuel assembly design has been developed to improve the nuclear, thermal-hydraulic, and mechanical performance of the current 16X16 fuel assembly design in Kori 2. This study contains the static buckling analysis for the plate and cell models to evaluate the buckling characteristic of spacer grid. The static buckling strength of 16X16 mid grid design was estimated using the static buckling analysis result with cell models and the estimated static buckling strength was compared with the static buckling test result. The dynamic buckling strength of 16X16 mid grid design was estimated using previous test result for similar design. The estimated static buckling strength are well coincident with the test result of the improved 16X16 spacer grid.

2004

2 16X16

16X16 16X16 . 가 , 6 $\mathsf{ZIRLO}^{\mathsf{TM}}$ ZIRLO[™] 3 ,

[1]. 16X16

1.

, $\mathsf{ZIRLO}^{\mathsf{TM}}$ 3 . , I 가 가 (Transverse Direction)

1 16X16 .

,

1

Earthquake) Accident)

[2].

가

가

가

16X16 가

.

가

16X16

(Cell) (Plate)

.

, 16X16

.

.

가

,

,

(SSE, Safe Shutdown

(LOCA, Loss Of Coolant

가 16X16 - , 가 .

2.

(Plate) (Cell) 가 (Window) (Height) (Width) 가 (Slot) , 가 가 . , 가 가 가 16X16 1 . 2 2 0.0, 0.1, 0.2, 가 0.3, 0.4, 0.5 in. 0.0, 0.1, 0.2, 0.3, 0.4 in. 2 가 1 , , 2 4 , 6 , 8 , 10 가 2 5가 ANSYS 8.0[3] (Plate) (Cell) 2 3 . (Plate) 2 3 (Cell) 4 (SHELL63) (Plate) 1,930 1,810 , 1,910 2,040 - , (Cell) Flat Formed 3,195 , Flat 2,875 3,195 Formed 2,875 가

, ,

4 , 5 6 . 7 Flat Formed . , 8

3.

4.

,

9 16X16 (without tubes) (with tubes) 2,050 lbs 1,450 lbs

5,250 lbs 1,450 lbs . 16X16 9 .

가 9 . 가 .

5,612 lbs 2,276 lbs .

. 가 .

4.1 가

(Plate) (Window) 4 (Height) (Width) • 가가

.

가

.

5	가		(Slot)		
가 가					
	(Cell) 6		가 가		
7	,	6(a)	(Flat) 1	8 (Formed	
1 2 Formed	Formed 3		Flat 8	1 Formed	
		가.	가 2	3	
Formed		가 1	. 6(b) Formed 2 3	Flat Formed	
	Flat 가			2	
	. 2		2 3 S		
6(c) Formed 2	Formed 3 Flat 1	Flat	가	2	
	Formed	가 . Flat	1 3		
4.2 16X16					
16X16		20	1	가	
			가	8	
2 Cell 2 Cell	3 Cell 1 3 Cell	1		8 4,880 lbs	

2,570 lbs . 가 가 [4], 가 . 2 Cell (15%) 1 8 3 Cell 4,150 lbs 2,180 lbs 1 16X16 2,050 lbs 16X16 17X17 OFA 17X17 OFA . 16X16 , 가 17X17 STD 16X16 17X17 16X16 STD 16X16 16X16 STD 가 . 4,373 lbs 4,434 lbs 17X17 OFA 16X16 • 17X17 16X16 . 17X17 OFA 16X16 [5] 5,525 lbs , 16X16 [1] 5,692 lbs 가 가 가 . 5.

16X16 (Plate) (Window) (Height) (Width), (Slot) 가, (Cell) 가 . 가 가

> 가 가 . , 가 가



- [1] 16x16 Nest Generation Fuel (16NGF) Final Design Closeout Package, INB/ KNFC/Westinghouse, November 2004
- [2] USNRC Standard Review Plan Section 4.2 Appendix A, " Evaluation of Fuel Assembly Structural Response to Externally Applied Forces", USNRC, 1981
- [3] ANSYS Rev. 8.0, Swanson Analysis System Inc.
- [4] S. Y. Jeon, K. L. Jeon, K. T. Kim, "Experimental and Numerical Test for Buckling Characteristics of Spacer Grids in PWR Fuel Assembly", Proc. Of the 16th International Conference on STRUCTURAL MECHANICS in REACTOR TECHNOLOGY, 2001
- [5] 16x16 Nest Generation Fuel (16NGF) Design and Manufacturability Review Package, INB/KNFC/Westinghouse, November 2002

1.	16X16

(inc	:h)	159.975	
(inc	:h)	152.80	
(inc	:h)	0.485	
(inc	:h)	0.360	
		1	
		1	
()		6	
		3	
		1	
	(inch)	2.25	
(inch)		7.755	

2.

Young's Modulus (at 70°F, psi)	14.3 X 10 ⁶
Posion Ratio	0.3
Yield Strength, 0.2% (Minimum, psi)	43,000
Ultimate Tensile Strength (Minimum, psi)	55,000





1. 16X16 /





B: Ux=Uy=Uz=0,

D:Uy=Uz=Rx=Ry=Rz=0, F:Uy=Uz=Rx=Ry=Rz=0,



A:Ux=Uy=Uz=Rx=Ry=Rz=0, $C: Ux{=}Uy{=}Uz{=}Rx{=}Ry{=}Rz{=}0,$ E: Uy=Uz=0,

G : Displacement Coupling with Ux

2. (Plate)

 \rightarrow

0.29

 \checkmark 0.20 \wedge

 $\frac{1}{1}$

0.02

3.

2.25

0.89







(Cell)

B: Ux=Uy=Uz=0,D:Uy=Uz=Rx=Ry=Rz=0, F:Uy=Uz=Rx=Ry=Rz=0,



4.

가







(c) 3 셀(Cell) 모델

1

□ with Flat Spring/Dimple

그림 6. 스프링과 딤플의 성형 여부에 따른 좌굴강도 영향

2

Mode

3

B with Formed Spring/Dimple



7.

	Mode 1		Mode 2		Mode 3	
	Flat	Formed	Flat	Formed	Flat	Formed
1 Cell	N I I I I I I I I I I I I I I I I I I I	X	×			
2 Cell						
3 Cell						







