Report No. 0006004.404
Revision 0
Project No. 0006004
January 2009

Oyster Creek Drywell Sandbed Region Wall Thinning Sensitivity Analyses Summary Report

Prepared for:

Exelon Nuclear
Contract # 01002562, Release # 0016
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REVISION CONTROL SHEET

Document Number: 0006004.404

Title: Oyster Creek Drywell Sandbed Region Wall Thinning Sensitivity Analyses Summary Report

Client: Exelon Nuclear

SI Project Number: 0006004 Quality Program: ☒ Nuclear ☐ Commercial

Section	Pages	Revision	Date	Comments
	i - viii	0	01/09/09	Initial Issue
1.0	1-1 - 1-2			
2.0	2-1 - 2-1			
3.0	3-1 - 3-1			
4.0	4-1 - 4-19			
5.0	5-1 – 5-95			
6.0	6-1 - 6-1			
7.0	7-1 - 7-1			

Table of Contents

Section Page

EXECUTIVE SUMMARY ..... **viii**

1.0 INTRODUCTION **1-1**

2.0 DEFINITION OF SENSITIVITY CASES **2-1**

3.0 EVALUATION APPROACH **3-1**

4.0 ASME CODE EVALUATION **4-1**

5.0 BUCKLING EVALUATION **5-1**

5.1 Sensitivity Case 1 5-1

5.1.1 Refueling Case *5-1*

5.1.2 Post-Accident Flooding Case *5-1*

5.2 Sensitivity Case 2 5-2

5.2.1 Refueling Case *5-2*

5.2.2 Post-Accident Flooding Case *5-3*

5.3 Comparison of Buckling Sensitivity Study Results 5-3

6.0 CONCLUSIONS AND DISCUSSIONS **6-1**

7.0 REFERENCES **7-1**

List of Tables

Section Page

Table 4-1: Code Evaluation, Load Combination LC5, Sensitivity Case 1 4-3
Table 4-2: Code Evaluation, Load Combination LC6, Sensitivity Case 1 4-4
Table 4-3: Code Evaluation, Load Combination LC9, Post-Accident Flooding, Sensitivity Case 1 4-5
Table 4-4: Code Evaluation, Load Combination LC10, Post-Accident Flooding, Sensitivity Case 1 4-6
Table 4-5: Code Evaluation, Load Combination LC5, Sensitivity Case 2 4-7
Table 4-6: Code Evaluation, Load Combination LC6, Sensitivity Case 2 4-8
Table 4-7: Code Evaluation, Load Combination LC9, Post-Accident Flooding, Sensitivity Case 2 4-9
Table 4-8: Code Evaluation, Load Combination LC10, Sensitivity Case 2 4-10
Table 4-9: Comparison of Stress Intensities (ksi) 4-11
Table 5-1: Capacity Reduction Factor, Sensitivity Case 1 5-6
Table 5-2: Capacity Reduction Factor, Sensitivity Case 2 5-7
Table 5-3: Refueling Case Load Factors and Maximum Displacements(1), Sensitivity Case 1 5-8
Table 5-4: Flooding Case Load Factors and Maximum Displacements(1), Sensitivity Case 1 5-12
Table 5-5: Refueling Case Load Factors and Maximum Displacements(1), Sensitivity Case 2 5-16
Table 5-6: Flooding Case Load Factors and Maximum Displacements(1), Sensitivity Case 2 5-20
Table 5-7: Buckling Load Factors 5-24
Table 5-8: Refueling Buckling Evaluation, Sensitivity Case 1 5-25
Table 5-9: Flooding Buckling Evaluation, Sensitivity Case 1 5-26
Table 5-10: Refueling Buckling Evaluation, Sensitivity Case 2 5-27
Table 5-11: Flooding Buckling Evaluation, Sensitivity Case 2 5-28
Table 5-12: Refueling Buckling Evaluation, Sandbed Region, Sensitivity Case 1 5-29
Table 5-13: Flooding Buckling Evaluation, Sandbed Region, Sensitivity Case 1 5-30
Table 5-14: Refueling Buckling Evaluation, Sandbed Region, Sensitivity Case 2 5-31
Table 5-15: Flooding Buckling Evaluation, Sandbed Region, Sensitivity Case 2 5-32
Table 5-16: Comparison of Load Factors 5-33
Table 5-17: Comparison of Sandbed Region Buckling Safety Factors, Refueling 5-34
Table 5-18: Comparison of Sandbed Region Buckling Safety Factors, Flooding 5-35

List of Figures

Section Page

Figure 4-1. Bay 1, LC 5 Refueling Stress, Sensitivity Case 1 4-12
Figure 4-2. Bay 1, LC 6 Refueling Stress, Sensitivity Case 1 4-13
Figure 4-3. Bay 1, LC 9 Flooding Stress, Sensitivity Case 1 4-14
Figure 4-4. Bay 1, LC 10 Flooding Stress, Sensitivity Case 1 4-15
Figure 4-5. Bay 19, LC 5 Refueling Stress, Sensitivity Case 2 4-16
Figure 4-6. Bay 19, LC 6 Refueling Stress, Sensitivity Case 2 4-17
Figure 4-7. Bay 19, LC 9 Flooding Stress, Sensitivity Case 2 4-18
Figure 4-8. Bay 19, Stress LC 10 Flooding Stress, Sensitivity Case 2 4-19
Figure 5-1: Refueling Buckling Stress, Cylindrical Region, Sensitivity Case 1 5-36
Figure 5-2: Refueling Buckling Stress, Upper Spherical Region, Sensitivity Case 1 5-37
Figure 5-3: Refueling Buckling Stress, Middle Spherical Region, Sensitivity Case 1 5-38
Figure 5-4: Refueling Buckling Stress, Lower Spherical Region, Sensitivity Case 1 5-39
Figure 5-5: Refueling Buckling Stress, Sandbed Region, Sensitivity Case 1 5-40
Figure 5-6: Refueling Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 1 5-41
Figure 5-7: Refueling Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 1 5-42
Figure 5-8: Refueling Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 1 5-43
Figure 5-9: Refueling Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 1 5-44
Figure 5-10: Refueling Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 1 5-45
Figure 5-11: Refueling Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 1 5-46
Figure 5-12: Refueling Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 1 5-47
Figure 5-13: Refueling Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 1 5-48
Figure 5-14: Refueling Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 1 5-49
Figure 5-15: Refueling Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 1 5-50
Figure 5-16: Flooding Buckling Stress, Cylindrical Region, Sensitivity Case 1 5-51
Figure 5-17: Flooding Buckling Stress, Upper Spherical Region, Sensitivity Case 1 5-52
Figure 5-18: Flooding Buckling Stress, Middle Spherical Region, Sensitivity Case 1 5-53
Figure 5-19: Flooding Buckling Stress, Lower Spherical Region, Sensitivity Case 1 5-54
Figure 5-20: Flooding Buckling Stress, Sandbed Region, Sensitivity Case 1 5-55

Figure 5-21: Flooding Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 1 5-56
Figure 5-22: Flooding Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 1 5-57
Figure 5-23: Flooding Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 1 5-58
Figure 5-24: Flooding Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 1 5-59
Figure 5-25: Flooding Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 1 5-60
Figure 5-26: Flooding Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 1 5-61
Figure 5-27: Flooding Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 1 5-62
Figure 5-28: Flooding Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 1 5-63
Figure 5-29: Flooding Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 1 5-64
Figure 5-30: Flooding Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 1 5-65
Figure 5-31: Refueling Buckling Stress, Cylindrical Region, Sensitivity Case 2 5-66
Figure 5-32: Refueling Buckling Stress, Upper Spherical Region, Sensitivity Case 2 5-67
Figure 5-33: Refueling Buckling Stress, Middle Spherical Region, Sensitivity Case 2 5-68
Figure 5-34: Refueling Buckling Stress, Lower Spherical Region, Sensitivity Case 2 5-69
Figure 5-35: Refueling Buckling Stress, Sandbed Region, Sensitivity Case 2 5-70
Figure 5-36: Refueling Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 2 5-71
Figure 5-37: Refueling Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 2 5-72
Figure 5-38: Refueling Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 2 5-73
Figure 5-39: Refueling Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 2 5-74
Figure 5-40: Refueling Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 2 5-75
Figure 5-41: Refueling Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 2 5-76
Figure 5-42: Refueling Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 2 5-77
Figure 5-43: Refueling Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 2 5-78
Figure 5-44: Refueling Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 2 5-79
Figure 5-45: Refueling Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 2 5-80
Figure 5-46: Flooding Buckling Stress, Cylindrical Region, Sensitivity Case 2 5-81
Figure 5-47: Flooding Buckling Stress, Upper Spherical Region, Sensitivity Case 2 5-82
Figure 5-48: Flooding Buckling Stress, Middle Spherical Region, Sensitivity Case 2 5-83
Figure 5-49: Flooding Buckling Stress, Lower Spherical Region, Sensitivity Case 2 5-84
Figure 5-50: Flooding Buckling Stress, Sandbed Region, Sensitivity Case 2 5-85
Figure 5-51: Flooding Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 2 5-86

Figure 5-52: Flooding Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 2 5-87
Figure 5-53: Flooding Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 2 5-88
Figure 5-54: Flooding Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 2 5-89
Figure 5-55: Flooding Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 2 5-90
Figure 5-56: Flooding Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 2..... 5-91
Figure 5-57: Flooding Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 2..... 5-92
Figure 5-58: Flooding Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 2..... 5-93
Figure 5-59: Flooding Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 2..... 5-94
Figure 5-60: Flooding Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 2..... 5-95

EXECUTIVE SUMMARY

This summary report presents a Sensitivity Study structural analysis of the Oyster Creek Nuclear Generating Station (Oyster Creek) primary containment drywell shell. Similar to the Base Case structural analysis (see SIA Report No. 0006004.403), this analysis uses detailed three-dimensional (3-D) finite element modeling techniques and modern updated methods to better quantify the margin that exists above the required minimum safety factors for buckling under the ASME Code.

In this Sensitivity Study, variations in the general and local area shell thicknesses are made in order to identify the resulting sensitivity of the drywell buckling and stress capability to these changes. Two cases were considered in this Sensitivity Study focusing on the effects of variations in the following areas:

- Case 1: Locally thinned area thickness reduction in one bay in the sandbed region.
- Case 2: General area thickness reduction in another bay in the sandbed region.

The purpose of the Sensitivity Study is to address potential questions regarding uncertainties in the existing condition of the shell by determining how sensitive the margins quantified in the Base Case analysis are to prescribed thickness variations.

The results of this Sensitivity Study show that, even with the postulated additional thinning, the drywell shell satisfies the required stress and buckling requirements.

In summary, the minimum sandbed region buckling safety factors (SF) are:

- Refueling: SF = 3.21 (Case 1), 3.46 (Case 2), both exceed Level A/B required SF of 2.00.
- Flooding: SF = 2.01 (Case 1), 1.98 (Case 2), both exceed Level C required SF of 1.67 (and the Level D required SF of 1.34).

1.0 INTRODUCTION

This summary report presents the analysis and results of the structural analysis sensitivity study of the Oyster Creek Nuclear Generating Station (Oyster Creek) primary containment drywell shell. Reference 1 presents the results of the detailed three-dimensional (3-D) finite element structural analysis of the drywell. The analysis in Reference 1 uses modern updated methods and current drywell shell thickness data to better quantify the margin that exists above the required minimum shell thickness for buckling under the ASME Boiler and Pressure Vessel Code (ASME Code).

The sensitivity study was performed with the use of the same detailed three-dimensional finite element model used in the Reference 1 analysis. In this sensitivity study, variations in the general and local area thicknesses in this model are made in order to identify the resulting sensitivity of the drywell buckling and stress capability to these changes. All other conditions remained the same except for those identified in Section 2.0 of this report. Two cases were considered in this sensitivity study focusing on the effect of variations in the thickness of a locally thinned area in one bay and in the thickness of the general area in another bay.

The purpose of the sensitivity study is to address uncertainties in the existing condition of the shell by determining how sensitive the margins quantified in the Base Case Analysis (Reference 1) are to certain parameters. These cases extrapolated measured wall thinning to a bounding future condition that would not only provide acceptance criteria for engineering evaluations of future ultrasonic measurement results but would also account for potential uncertainties in (1) the sizes of locally thinned areas, (2) the shell thickness between measured points and (3) the location of the thinnest points. By performing a bounding analysis, small changes in local or general area wall thicknesses will not affect the results of the analyses.

The results of these sensitivity cases show that, even considering the additional thinning postulated, the drywell shell would continue to satisfy the required stress and buckling requirements.

2.0 DEFINITION OF SENSITIVITY CASES

Two Sensitivity Cases were performed as part of this study. The two cases were:

Case 1: Reduce the wall thickness of the defined locally thinned area in Bay 1 from 696 mils (as in Reference 1) to 596 mils, keeping the general area of the thickness in Bay 1 constant (826 mils) (as in Reference 1) with all other inputs the same as the Base Case [1].

Case 2: Reduce the wall thickness of the general area in Bay 19 from 826 mils (as in Reference 1) to 776 mils, keeping the thickness of the locally thinned area constant (720 mils) [as in Reference 1] and all other input the same as the Base Case [1].

All other conditions were the same as that in the Reference 1 analysis.

3.0 EVALUATION APPROACH

The stress analyses and buckling evaluation for the two Sensitivity Cases follow the same methodology used in the Base Case evaluation documented in Reference 1. The load combinations and ASME Code evaluation are performed in the same manner as those in Reference 1. The loading input, analysis procedures, finite element model and the acceptance criteria for this sensitivity study are the same as those used in Reference 1. The only differences are those identified in Section 2.0 where different wall thicknesses in a locally thinned area and one sandbed region bay are used in the finite element model.

The buckling results from these two Sensitivity Cases are compared to the results obtained in Reference 1. The results of the evaluation performed in Reference 1 are identified as 'Base Case', while the two Sensitivity Cases are noted as 'Sensitivity Case 1' and 'Sensitivity Case 2'.

All analyses were performed using the ANSYS [2] finite element program as was the case for the analysis documented in Reference 1.

4.0 ASME CODE EVALUATION

This section describes the ASME Code evaluation for the two cases in this sensitivity study. The Sensitivity Case results are presented in Table 4-1 through Table 4-4 for Sensitivity Case 1 and Table 4-5 through Table 4-8 for Sensitivity Case 2. The load combination cases LC5, LC6, LC9, and LC10 are defined and determined to be the bounding load combinations in Reference 1. These load combination cases were the only ones evaluated for the sensitivity cases. These results can be directly compared with the results from the Base Case presented in Reference 1.

Based on the results of the evaluation, the high stress components for the two Sensitivity Cases are the same as those in the Base Case [1]. The high stress components are the stiffeners/gussets, star truss, sandbed region and penetrations X3A and X3B.

Examination of Table 4-1 through Table 4-8 in comparison with the results for the Base Case given in Reference 1 illustrates that the stresses in all components are essentially the same for all the load combinations, except those in the sandbed regions. This is expected since the only difference is the thinner wall in the sandbed regions among these three cases (2 sensitivity cases and the base case). Therefore, under the same loading conditions, it is expected that the differences in the resulting stresses should be limited to the areas in close proximity to the sandbed region. All of the other components, especially those in the cylindrical shell or in the upper portion of the spherical shell, far away from the concerned areas, should not be affected by the hypothetical reduction in wall thickness at the bottom of the drywell. The results of these analyses are consistent with these expectations.

The stress distributions in Bay 1 for the Sensitivity Case 1 are shown in Figure 4-1 through Figure 4-4. The stress distributions in Bay 19 for Sensitivity Case 2 are shown in Figure 4-5 through Figure 4-8.

Since the Sensitivity Cases involved a change in the shell thickness in sandbed Bay 1 or Bay 19, the results from the three different cases (2 sensitivity cases and base case) for these bays are summarized in Table 4-9. For Sensitivity Case 1, the wall thickness variation is limited to the circular locally thinned area with a diameter of 51" in Bay 1. The results show a slight increase

in stress compared to the Base Case. For the refueling condition (LC5 and LC6), the largest increase in stress is less than 1 ksi. For the post-accident flooding condition (LC9 and LC10), the largest increase in stress is about 3 ksi. This small increase is due to the very localized thickness variation in Bay 1. This localized effect is supported by the results in Bay 19 where the stresses between the Base Case and the Sensitivity Case 1 are essentially the same.

For Sensitivity Case 2, the results show a similar increase in the stress intensity. For the refueling condition (LC5 and LC6), the increase in stress is typically less than 1 ksi. For the post-accident flooding condition (LC9 and LC10), the largest increase is in the bending stress P_l+P_b bottom, approximately 2 ksi. This smaller increase compared to the increase in Sensitivity Case 1 is due to the more general reduced thickness in Bay 19.

It should be noted that the stress results in the other components in the Sensitivity Cases are essentially the same as those in the Base Case. Therefore, for the high stress components such as stiffeners/gussets, star truss, Penetrations X3A and X3B, the stresses are below the ASME Code allowables per Section MC, Subarticle NE-3213.9 and NE-3220 shown in Table 4-1 to Table 4-8, using a linearized stress through a rectangular section, along with the observation of stress reduction from a solid submodel for the male lug in the star truss component. These components are shown to be within the allowable stresses as described in detail in Reference 1.

Table 4-1: Code Evaluation, Load Combination LC5, Sensitivity Case 1

Component	P_m (ksi)	S_{mc} (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) (Note 1)	$1.5S_{mc}$ (ksi)	P_L+P_b+Q (ksi)		$3S_{mc}$ (ksi)
				Top	Bot			Top	Bot	
Top Head Shell	--	19.3	--	--	--	--	28.95	--	--	57.9
Top Hd Stfnrs/Gsts	--	19.3	--	--	--	--	28.95	--	--	57.9
Cylindrical Shell	--	19.3	16.1	28.62	28.56	--	28.95	26.76	27.84	57.9
Stiffeners/Gussets(2)	25.55	19.3	37.82	36.89	38.81	37.82	28.95	33.15	36.30	57.9
Star Truss/Stiffener	3.28	19.3	26.42	27.48	25.40	--	28.95	26.72	24.68	57.9
Knuckle	--	19.3	4.17	6.99	4.90	--	28.95	6.75	4.71	57.9
Spherical Shell	--	19.3	9.96	16.18	11.69	--	28.95	17.48	11.30	57.9
Upper Beam Seat	--	16.5	7.43	8.98	7.45	--	24.75	8.77	7.30	49.5
Lower Beam Seat	--	19.3	9.88	14.74	15.38	--	28.95	14.88	15.36	57.9
Vent Pipe	--	19.3	8.93	9.61	9.18	--	28.95	9.63	9.01	57.9
Sandbed – Bay 1	--	19.3	10.76	17.07	12.36	--	28.95	28.73	19.24	57.9
Sandbed – Bay 3	--	19.3	9.94	17.65	12.23	--	28.95	30.15	19.82	57.9
Sandbed – Bay 5	--	19.3	9.96	15.67	10.48	--	28.95	29.07	23.15	57.9
Sandbed – Bay 7	--	19.3	10.08	12.67	10.30	--	28.95	25.50	18.09	57.9
Sandbed – Bay 9	--	19.3	9.20	10.32	10.37	--	28.95	22.94	16.51	57.9
Sandbed – Bay 11	--	19.3	9.75	9.12	10.89	--	28.95	20.16	14.76	57.9
Sandbed – Bay 13	--	19.3	10.03	9.74	10.66	--	28.95	20.79	15.16	57.9
Sandbed – Bay 15	--	19.3	9.71	11.43	10.04	--	28.95	23.44	16.74	57.9
Sandbed – Bay 17	--	19.3	12.40	14.56	12.40	--	28.95	26.88	18.46	57.9
Sandbed – Bay 19	--	19.3	11.38	16.27	11.67	--	28.95	26.72	17.06	57.9
Pen X2A & X2B	--	19.3	6.75	8.97	7.60	--	28.95	14.66	9.80	57.9
Pen X3A & X3B	--	19.3	9.79	39.33	36.49	9.79	28.95	34.98	36.61	57.9
Pen X4A & X4B	--	19.3	5.13	4.98	5.97	--	28.95	6.82	9.67	57.9
Pen X5A & X5B	--	19.3	10.24	12.01	16.46	--	28.95	13.46	16.45	57.9
Pen X7	--	19.3	1.90	4.69	5.33	--	28.95	4.07	4.15	57.9
Pen X8	--	19.3	3.34	5.77	4.59	--	28.95	8.01	5.43	57.9
Pen X9 & X10	--	19.3	4.19	4.73	4.50	--	28.95	15.78	11.87	57.9
Pen X12B	--	19.3	4.71	4.93	4.49	--	28.95	11.10	9.88	57.9
Pen X18	--	19.3	2.72	9.05	6.26	--	28.95	20.19	13.71	57.9
Pen X63	--	19.3	1.20	2.10	2.54	--	28.95	18.75	9.61	57.9
Pen X66	--	19.3	4.19	10.15	8.27	--	28.95	9.99	7.99	57.9
Pen X70	--	19.3	7.12	13.92	9.96	--	28.95	17.87	12.79	57.9
18" Penetrations	--	19.3	3.59	9.05	6.26	--	28.95	20.19	13.71	57.9
14" Penetrations	--	19.3	3.45	3.62	3.29	--	28.95	3.67	3.37	57.9
10" Penetrations	--	19.3	3.82	3.17	4.64	--	28.95	3.52	4.64	57.9
8" Penetrations	--	19.3	5.25	5.41	6.30	--	28.95	5.29	6.23	57.9
6" Penetrations	--	19.3	4.79	4.59	5.88	--	28.95	4.58	5.88	57.9
3" Penetrations	--	19.3	4.36	7.22	6.97	--	28.95	8.02	7.54	57.9

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].
2: meets stress allowables after linearization of stress through a section as shown in Reference 1.

Table 4-2: Code Evaluation, Load Combination LC6, Sensitivity Case 1

Component	P_m (ksi)	S_{mc} (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) (Note 1)	$1.5S_{mc}$ (ksi)	P_L+P_b+Q (ksi)		$3S_{mc}$ (ksi)
				Top	Bot			Top	Bot	
Top Head Shell	--	19.3	--	--	--	--	28.95	--	--	57.9
Top Hd Stfnrs/Gsts	--	19.3	--	--	--	--	28.95	--	--	57.9
Cylindrical Shell	--	19.3	14.28	44.00	32.54	14.28	28.95	53.34	41.59	57.9
Stiffeners/Gussets(2)	5.12	19.3	30.50	44.00	32.54	30.50	28.95	53.34	41.59	57.9
Star Truss/Stiffener(3)	4.50	19.3	31.83	33.26	30.41	31.83	28.95	33.29	30.48	57.9
Knuckle	--	19.3	4.43	7.14	5.20	--	28.95	6.90	5.01	57.9
Spherical Shell	--	19.3	11.98	11.78	13.27	--	28.95	17.81	13.03	57.9
Upper Beam Seat	--	16.5	7.34	8.82	7.42	--	24.75	8.61	7.27	49.5
Lower Beam Seat	--	19.3	8.83	15.10	14.28	--	28.95	15.23	14.11	57.9
Vent Pipe	--	19.3	9.91	10.38	10.24	--	28.95	10.16	10.17	57.9
Sandbed – Bay 1	--	19.3	9.17	15.24	10.68	--	28.95	25.69	17.65	57.9
Sandbed – Bay 3	--	19.3	8.04	14.25	10.05	--	28.95	26.75	17.87	57.9
Sandbed – Bay 5	--	19.3	8.24	11.87	8.12	--	28.95	25.64	20.29	57.9
Sandbed – Bay 7	--	19.3	9.34	10.74	9.81	--	28.95	23.89	16.74	57.9
Sandbed – Bay 9	--	19.3	10.23	12.01	11.25	--	28.95	25.00	17.28	57.9
Sandbed – Bay 11	--	19.3	11.86	12.79	13.03	--	28.95	24.60	15.81	57.9
Sandbed – Bay 13	--	19.3	12.49	14.15	13.41	--	28.95	26.14	16.81	57.9
Sandbed – Bay 15	--	19.3	11.37	15.04	12.11	--	28.95	27.17	17.69	57.9
Sandbed – Bay 17	--	19.3	12.50	15.60	13.1	--	28.95	28.03	18.43	57.9
Sandbed – Bay 19	--	19.3	9.77	15.29	11.01	--	28.95	26.89	16.86	57.9
Pen X2A & X2B	--	19.3	6.78	9.07	7.79	--	28.95	14.77	9.98	57.9
Pen X3A & X3B	--	19.3	8.62	39.41	34.56	8.62	28.95	45.24	42.60	57.9
Pen X4A & X4B	--	19.3	5.91	5.59	6.46	--	28.95	6.45	9.45	57.9
Pen X5A & X5B	--	19.3	7.03	7.60	10.00	--	28.95	12.11	10.51	57.9
Pen X7	--	19.3	1.60	4.96	5.28	--	28.95	10.33	9.98	57.9
Pen X8	--	19.3	2.26	3.27	2.38	--	28.95	10.26	6.43	57.9
Pen X9 & X10	--	19.3	5.61	9.09	8.58	--	28.95	10.76	8.39	57.9
Pen X12B	--	19.3	5.96	6.48	5.85	--	28.95	6.84	5.64	57.9
Pen X18	--	19.3	3.47	8.87	8.02	--	28.95	7.61	4.98	57.9
Pen X63	--	19.3	3.09	11.53	7.11	--	28.95	28.68	15.32	57.9
Pen X66	--	19.3	3.25	5.85	5.18	--	28.95	4.83	4.61	57.9
Pen X70	--	19.3	6.02	7.34	7.69	--	28.95	11.34	9.58	57.9
18" Penetrations	--	19.3	3.47	8.87	8.02	--	28.95	7.61	6.28	57.9
14" Penetrations	--	19.3	3.63	3.86	3.52	--	28.95	3.86	3.58	57.9
10" Penetrations	--	19.3	2.59	2.42	2.96	--	28.95	2.59	3.57	57.9
8" Penetrations	--	19.3	5.66	7.00	6.71	--	28.95	6.88	6.65	57.9
6" Penetrations	--	19.3	4.70	4.63	5.86	--	28.95	4.64	5.86	57.9
3" Penetrations	--	19.3	4.80	4.79	5.04	--	28.95	5.39	5.17	57.9

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].

2: meets stress allowables after linearization of stress through a section as shown in Reference 1.

3: meets stress allowables after use of solid submodel as shown in Reference 1.

Table 4-3: Code Evaluation, Load Combination LC9, Post-Accident Flooding, Sensitivity Case 1

Comp	P_m (ksi)	S_y (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) Note 1	$1.5S_y$ (ksi)
				Top	Bottom		
Top Head	--	36.3	1.08	1.05	1.17	--	54.45
Cylindrical Shell	--	36.3	23.83	71.64	57.73	23.83	54.45
Stiffeners/Gussets	27.64	36.3	49.80	71.64	54.06	49.80	54.45
Star Truss/Stiffener(2)	8.30	36.3	73.23	91.42	85.33	73.23	54.45
Knuckle	--	36.3	12.01	11.42	12.62	--	54.45
Spherical Shell	--	36.3	37.54	40.25	37.10	--	54.45
Upper Beam Seat	--	30.6	13.22	18.50	10.57	--	45.90
Lower Beam Seat	--	36.3	22.16	32.67	27.36	--	54.45
Vent Pipe	--	36.3	35.11	37.38	32.75	--	54.45
Sandbed – Bay 1	35.99	36.3	43.10	45.80	49.01	--	54.45
Sandbed – Bay 3	31.15	36.3	38.73	42.75	40.82	--	54.45
Sandbed – Bay 5	28.23	36.3	38.43	40.13	43.29	--	54.45
Sandbed – Bay 7	27.95	36.3	38.84	40.01	37.74	--	54.45
Sandbed – Bay 9	27.81	36.3	39.00	39.58	38.25	--	54.45
Sandbed – Bay 11	30.28	36.3	44.61	45.16	44.02	--	54.45
Sandbed – Bay 13	29.79	36.3	44.06	44.53	43.64	--	54.45
Sandbed – Bay 15	32.92	36.3	39.64	40.48	38.87	--	54.45
Sandbed – Bay 17	22.88	36.3	49.19	50.68	50.31	--	54.45
Sandbed – Bay 19	30.66	36.3	48.40	50.01	47.18	--	54.45
Pen X2A & X2B	--	36.3	22.26	21.65	22.97	--	54.45
Pen X3A & X3B	--	36.3	12.62	78.74	71.34	12.62	54.45
Pen X4A & X4B	--	36.3	16.95	17.02	16.94	--	54.45
Pen X5A & X5B	--	36.3	7.36	10.91	11.99	--	54.45
Pen X7	--	36.3	7.13	10.39	14.21	--	54.45
Pen X8	--	36.3	10.12	10.28	10.79	--	54.45
Pen X9 & X10	--	36.3	11.70	12.04	11.68	--	54.45
Pen X12B	--	36.3	8.83	10.76	13.22	--	54.45
Pen X18	--	36.3	3.96	12.21	9.79	--	54.45
Pen X63	--	36.3	5.87	8.45	6.34	--	54.45
Pen X66	--	36.3	13.38	15.44	22.09	--	54.45
Pen X70	--	36.3	9.78	16.59	16.83	--	54.45
18" Penetrations	--	36.3	16.14	14.63	19.69	--	54.45
14" Penetrations	--	36.3	11.88	12.42	11.34	--	54.45
10" Penetrations	--	36.3	15.41	14.69	16.75	--	54.45
8" Penetrations	--	36.3	14.51	12.92	17.95	--	54.45
6" Penetrations	--	36.3	9.91	9.95	13.10	--	54.45
3" Penetrations	--	36.3	16.92	16.49	17.42	--	54.45

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].
2: meets allowables after use of solid submodel as shown in Reference 1.

Table 4-4: Code Evaluation, Load Combination LC10, Post-Accident Flooding, Sensitivity Case 1

Comp	P_m (ksi)	S_y (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) Note 1	$1.5S_y$ (ksi)
				Top	Bottom		
Top Head	--	36.3	0.88	1.31	1.20	--	54.45
Cylindrical Shell	--	36.3	23.71	65.04	58.47	23.71	54.45
Stiffeners/Gussets	21.48	36.3	49.21	65.04	55.25	49.21	54.45
Star Truss/Stiffener(2)	6.55	36.3	90.26	101.35	93.72	90.26	54.45
Knuckle	--	36.3	11.22	13.51	11.91	--	54.45
Spherical Shell	--	36.3	39.92	40.20	41.85	--	54.45
Upper Beam Seat	--	30.6	11.49	12.92	14.11	--	45.90
Lower Beam Seat	--	36.3	20.60	31.67	26.11	--	54.45
Vent Pipe	--	36.3	35.83	37.81	34.44	--	54.45
Sandbed – Bay 1	31.72	36.3	43.86	66.91	48.14	43.86	54.45
Sandbed – Bay 3	--	36.3	35.32	64.36	39.51	35.32	54.45
Sandbed – Bay 5	25.29	36.3	36.67	57.57	35.63	36.67	54.45
Sandbed – Bay 7	26.61	36.3	39.66	57.74	39.11	39.66	54.45
Sandbed – Bay 9	28.21	36.3	42.27	63.92	42.03	42.27	54.45
Sandbed – Bay 11	32.77	36.3	48.57	63.92	48.12	48.57	54.45
Sandbed – Bay 13	32.78	36.3	47.35	65.46	46.66	47.35	54.45
Sandbed – Bay 15	29.52	36.3	41.01	66.29	42.58	41.08	54.45
Sandbed – Bay 17	35.44	36.3	50.09	66.02	52.66	50.09	54.45
Sandbed – Bay 19	33.84	36.3	42.44	64.03	43.01	42.44	54.45
Pen X2A & X2B	--	36.3	20.86	19.72	22.42	--	54.45
Pen X3A & X3B	--	36.3	13.64	76.06	71.86	13.64	54.45
Pen X4A & X4B	--	36.3	18.64	17.95	19.31	--	54.45
Pen X5A & X5B	--	36.3	6.72	9.93	14.61	--	54.45
Pen X7	--	36.3	7.42	9.93	9.41	--	54.45
Pen X8	--	36.3	8.07	9.04	8.84	--	54.45
Pen X9 & X10	--	36.3	9.00	13.78	10.68	--	54.45
Pen X12B	--	36.3	11.27	15.57	11.50	--	54.45
Pen X18	--	36.3	4.50	13.30	11.82	--	54.45
Pen X63	--	36.3	7.05	18.20	10.14	--	54.45
Pen X66	--	36.3	9.21	11.29	13.55	--	54.45
Pen X70	--	36.3	7.98	9.19	11.20	--	54.45
18" Penetrations	--	36.3	15.63	16.58	19.07	--	54.45
14" Penetrations	--	36.3	12.36	12.87	11.89	--	54.45
10" Penetrations	--	36.3	10.45	9.42	11.98	--	54.45
8" Penetrations	--	36.3	10.98	13.62	14.05	--	54.45
6" Penetrations	--	36.3	10.43	10.67	10.35	--	54.45
3" Penetrations	--	36.3	16.54	15.82	17.58	--	54.45

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].
2: meets allowables after use of solid submodel as shown in Reference 1.

Table 4-5: Code Evaluation, Load Combination LC5, Sensitivity Case 2

Component	P_m (ksi)	S_{mc} (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) (Note 1)	$1.5S_{mc}$ (ksi)	P_L+P_b+Q (ksi)		$3S_{mc}$ (ksi)
				Top	Bot			Top	Bot	
Top Head Shell	--	19.3	--	--	--	--	28.95	--	--	57.9
Cylindrical Shell	--	19.3	16.10	28.62	28.56	--	28.95	26.76	27.84	57.9
Stiffeners/Gussets(2)	25.55	19.3	37.82	36.89	38.81	37.82	28.95	33.15	36.30	57.9
Star Truss/Stiffener	3.28	19.3	26.44	27.51	25.42	--	28.95	26.75	24.71	57.9
Knuckle	--	19.3	4.17	6.99	4.90	--	28.95	6.75	4.72	57.9
Spherical Shell	--	19.3	9.97	16.18	11.69	--	28.95	17.48	11.30	57.9
Upper Beam Seat	--	16.5	7.44	8.98	7.46	--	24.75	8.77	7.30	49.5
Lower Beam Seat	--	19.3	9.88	14.75	15.38	--	28.95	14.88	15.36	57.9
Vent Pipe	--	19.3	8.93	9.61	9.18	--	28.95	9.64	9.02	57.9
Sandbed – Bay 1	--	19.3	10.38	17.03	12.36	--	28.95	28.71	19.63	57.9
Sandbed – Bay 3	--	19.3	9.95	17.63	12.23	--	28.95	30.13	19.82	57.9
Sandbed – Bay 5	--	19.3	9.97	15.67	10.49	--	28.95	29.08	23.15	57.9
Sandbed – Bay 7	--	19.3	10.08	12.68	10.31	--	28.95	25.50	18.09	57.9
Sandbed – Bay 9	--	19.3	9.21	10.33	10.38	--	28.95	22.95	16.52	57.9
Sandbed – Bay 11	--	19.3	9.76	9.12	10.89	--	28.95	20.16	14.76	57.9
Sandbed – Bay 13	--	19.3	10.03	9.74	10.66	--	28.95	20.81	15.17	57.9
Sandbed – Bay 15	--	19.3	9.71	11.46	10.04	--	28.95	23.48	16.75	57.9
Sandbed – Bay 17	--	19.3	12.40	15.02	12.40	--	28.95	27.45	18.86	57.9
Sandbed – Bay 19	--	19.3	11.79	16.10	11.83	--	28.95	26.42	16.91	57.9
Pen X2A & X2B	--	19.3	6.76	8.97	7.60	--	28.95	14.66	9.80	57.9
Pen X3A & X3B	--	19.3	9.79	39.33	36.49	9.79	28.95	34.98	36.61	57.9
Pen X4A & X4B	--	19.3	5.13	4.98	5.97	--	28.95	6.82	9.67	57.9
Pen X5A & X5B	--	19.3	10.24	12.01	16.47	--	28.95	13.46	16.46	57.9
Pen X7	--	19.3	1.90	4.69	5.33	--	28.95	4.07	4.15	57.9
Pen X8	--	19.3	3.34	5.77	4.59	--	28.95	8.01	5.43	57.9
Pen X9 & X10	--	19.3	4.19	4.73	4.50	--	28.95	15.78	11.87	57.9
Pen X12B	--	19.3	4.71	4.93	4.49	--	28.95	11.10	9.88	57.9
Pen X18	--	19.3	2.72	9.05	6.26	--	28.95	20.19	13.71	57.9
Pen X63	--	19.3	1.20	2.10	2.54	--	28.95	18.74	9.62	57.9
Pen X66	--	19.3	4.69	10.15	8.27	--	28.95	9.99	7.99	57.9
Pen X70	--	19.3	7.12	13.91	9.96	--	28.95	17.87	12.79	57.9
18" Penetrations	--	19.3	3.57	9.05	6.26	--	28.95	20.19	13.71	57.9
14" Penetrations	--	19.3	3.45	3.63	3.29	--	28.95	3.67	3.37	57.9
10" Penetrations	--	19.3	3.82	3.17	4.64	--	28.95	3.53	4.64	57.9
8" Penetrations	--	19.3	5.25	5.41	6.30	--	28.95	5.29	6.23	57.9
6" Penetrations	--	19.3	4.79	4.59	5.88	--	28.95	4.58	5.88	57.9
3" Penetrations	--	19.3	4.36	7.22	6.97	--	28.95	8.02	7.54	57.9

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].

2: meets stress allowables after linearization of stress through a section as shown in Reference 1.

Table 4-6: Code Evaluation, Load Combination LC6, Sensitivity Case 2

Component	P_m (ksi)	S_{mc} (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) (Note 1)	$1.5S_{mc}$ (ksi)	P_L+P_b+Q (ksi)		$3S_{mc}$ (ksi)
				Top	Bot			Top	Bot	
Top Head Shell	--	19.3	--	--	--	--	28.95	--	--	57.9
Cylindrical Shell	--	19.3	14.28	44.00	32.54	14.28	28.95	53.34	41.59	57.9
Stiffeners/Gussets(2)	5.12	19.3	30.50	44.00	32.54	30.50	28.95	53.34	41.59	57.9
Star Truss/Stiffener(3)	4.50	19.3	31.83	33.26	30.41	31.82	28.95	33.29	30.48	57.9
Knuckle	--	19.3	4.43	7.14	5.20	--	28.95	6.91	5.01	57.9
Spherical Shell	--	19.3	11.98	11.78	13.28	--	28.95	17.81	13.03	57.9
Upper Beam Seat	--	16.5	7.34	8.82	7.42	--	24.75	8.61	7.27	49.5
Lower Beam Seat	--	19.3	8.83	15.10	14.28	--	28.95	15.24	14.12	57.9
Vent Pipe	--	19.3	9.91	10.38	10.24	--	28.95	10.17	10.18	57.9
Sandbed – Bay 1	--	19.3	8.86	15.38	10.85	--	28.95	26.09	18.14	57.9
Sandbed – Bay 3	--	19.3	8.04	14.23	10.04	--	28.95	26.73	17.87	57.9
Sandbed – Bay 5	--	19.3	8.24	11.88	8.13	--	28.95	25.65	20.30	57.9
Sandbed – Bay 7	--	19.3	9.35	10.75	9.81	--	28.95	23.89	16.74	57.9
Sandbed – Bay 9	--	19.3	10.24	12.01	11.26	--	28.95	25.01	17.28	57.9
Sandbed – Bay 11	--	19.3	11.87	12.80	13.03	--	28.95	24.61	15.81	57.9
Sandbed – Bay 13	--	19.3	12.49	14.17	13.41	--	28.95	26.16	16.81	57.9
Sandbed – Bay 15	--	19.3	11.37	15.08	12.11	--	28.95	27.21	17.70	57.9
Sandbed – Bay 17	--	19.3	12.50	16.01	13.10	--	28.95	28.52	18.81	57.9
Sandbed – Bay 19	--	19.3	10.04	15.49	11.39	--	28.95	26.95	16.63	57.9
Pen X2A & X2B	--	19.3	6.78	9.07	7.79	--	28.95	14.77	9.99	57.9
Pen X3A & X3B	--	19.3	8.62	39.41	34.56	8.62	28.95	45.24	42.60	57.9
Pen X4A & X4B	--	19.3	5.92	5.59	6.46	--	28.95	6.45	9.45	57.9
Pen X5A & X5B	--	19.3	7.03	7.60	10.00	--	28.95	12.11	10.51	57.9
Pen X7	--	19.3	1.60	4.96	5.28	--	28.95	10.33	9.98	57.9
Pen X8	--	19.3	2.26	3.27	2.38	--	28.95	10.25	6.43	57.9
Pen X9 & X10	--	19.3	5.61	9.09	8.58	--	28.95	10.76	8.39	57.9
Pen X12B	--	19.3	5.95	6.48	5.85	--	28.95	6.83	5.64	57.9
Pen X18	--	19.3	3.46	8.88	8.02	--	28.95	7.61	4.98	57.9
Pen X63	--	19.3	3.10	11.53	7.11	--	28.95	28.68	15.32	57.9
Pen X66	--	19.3	3.25	5.86	5.18	--	28.95	4.83	4.61	57.9
Pen X70	--	19.3	6.03	7.34	7.69	--	28.95	11.34	9.58	57.9
18" Penetrations	--	19.3	3.46	8.88	8.02	--	28.95	7.61	6.26	57.9
14" Penetrations	--	19.3	3.63	3.86	3.52	--	28.95	3.86	3.58	57.9
10" Penetrations	--	19.3	2.59	2.42	2.96	--	28.95	2.60	3.57	57.9
8" Penetrations	--	19.3	5.66	7.00	6.71	--	28.95	6.88	6.65	57.9
6" Penetrations	--	19.3	4.70	4.63	5.86	--	28.95	4.64	5.86	57.9
3" Penetrations	--	19.3	4.80	4.79	5.04	--	28.95	5.39	5.17	57.9

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].
2: meets stress allowables after linearization of stress through a section as shown in Reference 1.
3: meets stress allowables after use of solid submodel as shown in Reference 1.

Table 4-7: Code Evaluation, Load Combination LC9, Post-Accident Flooding, Sensitivity Case 2

Comp	P_m (ksi)	S_y (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) Note 1	$1.5S_y$ (ksi)
				Top	Bottom		
Top Head	--	36.3	1.08	1.05	1.17	--	54.45
Cylindrical Shell	--	36.3	23.83	71.64	57.73	23.83	54.45
Stiffeners/Gussets	27.64	36.3	49.80	71.64	54.06	49.80	54.45
Star Truss/Stiffener(2)	10.97	36.3	73.44	91.60	85.49	73.44	54.45
Knuckle	--	36.3	12.05	11.46	12.66	--	54.45
Spherical Shell		36.3	37.58	40.41	37.14	--	54.45
Upper Beam Seat	--	30.6	13.22	18.51	10.55	--	45.90
Lower Beam Seat	--	36.3	22.17	32.66	27.38	--	54.45
Vent Pipe	--	36.3	35.35	37.95	33.02	--	54.45
Sandbed – Bay 1	29.47	36.3	44.14	45.99	46.89	--	54.45
Sandbed – Bay 3	31.17	36.3	38.78	42.67	40.77	--	54.45
Sandbed – Bay 5	28.25	36.3	38.47	40.19	43.33	--	54.45
Sandbed – Bay 7	27.97	36.3	38.89	40.05	37.78	--	54.45
Sandbed – Bay 9	27.81	36.3	39.03	39.60	38.28	--	54.45
Sandbed – Bay 11	30.28	36.3	44.63	45.17	44.04	--	54.45
Sandbed – Bay 13	27.82	36.3	44.08	44.55	43.65	--	54.45
Sandbed – Bay 15	32.61	36.3	39.66	40.50	38.88	--	54.45
Sandbed – Bay 17	22.92	36.3	49.16	50.65	50.35	--	54.45
Sandbed – Bay 19	32.56	36.3	50.00	51.63	48.79	--	54.45
Pen X2A & X2B		36.3	22.28	21.66	22.98	--	54.45
Pen X3A & X3B	--	36.3	12.62	78.74	71.34	12.62	54.45
Pen X4A & X4B	--	36.3	16.96	17.03	16.96	--	54.45
Pen X5A & X5B	--	36.3	7.36	10.91	11.99	--	54.45
Pen X7	--	36.3	7.13	10.38	14.21	--	54.45
Pen X8	--	36.3	10.13	10.30	10.80	--	54.45
Pen X9 & X10	--	36.3	11.73	12.08	11.72	--	54.45
Pen X12B	--	36.3	8.82	10.79	13.20	--	54.45
Pen X18	--	36.3	3.97	12.21	9.79	--	54.45
Pen X63	--	36.3	5.86	8.44	6.33	--	54.45
Pen X66	--	36.3	13.39	15.45	22.10	--	54.45
Pen X70	--	36.3	9.80	16.59	16.83	--	54.45
18" Penetrations	--	36.3	16.07	14.55	19.62	--	54.45
14" Penetrations	--	36.3	11.89	12.43	11.35	--	54.45
10" Penetrations	--	36.3	15.42	14.70	16.76	--	54.45
8" Penetrations	--	36.3	14.53	12.93	17.97	--	54.45
6" Penetrations	--	36.3	9.92	9.95	13.10	--	54.45
3" Penetrations	--	36.3	16.93	16.51	17.43	--	54.45

Notes 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].
2: meets allowables after use of solid submodel as shown in Reference 1.

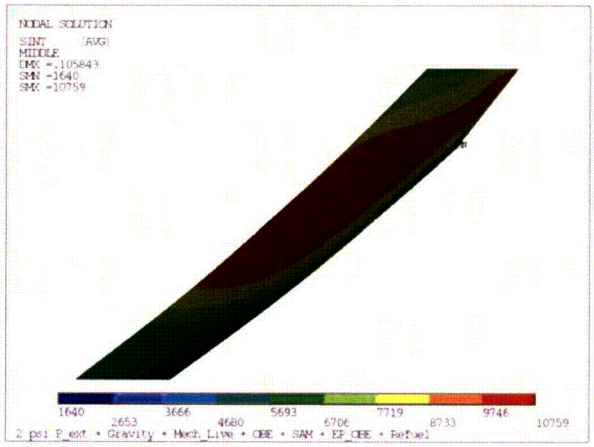
Table 4-8: Code Evaluation, Load Combination LC10, Sensitivity Case 2

Comp	P_m (ksi)	S_y (ksi)	P_L (ksi)	P_L+P_b (ksi)		P_L+P_b (ksi) Note 1	$1.5S_y$ (ksi)
				Top	Bottom		
Top Head	--	36.3	0.88	1.31	1.20	--	54.45
Cylindrical Shell	--	36.3	23.71	65.04	58.47	23.71	54.45
Stiffeners/Gussets	21.48	36.3	49.21	65.04	55.25	49.21	54.45
Star Truss / Stiffener	6.57	36.3	90.38	101.68	94.02	--	54.45
Knuckle	--	36.3	11.26	13.52	11.93	--	54.45
Spherical Shell	--	36.3	39.94	40.22	41.88	--	54.45
Upper Beam Seat	--	30.6	11.49	12.92	14.11	--	45.90
Lower Beam Seat	--	36.3	20.60	31.69	26.11	--	54.45
Vent Pipe	--	36.3	35.85	37.83	34.47	--	54.45
Sandbed – Bay 1	31.76	36.3	43.97	64.85	45.49	--	54.45
Sandbed – Bay 3	--	36.3	35.35	64.30	39.51	--	54.45
Sandbed – Bay 5	25.31	36.3	39.71	57.62	35.68	--	54.45
Sandbed – Bay 7	26.62	36.3	33.69	57.79	39.15	--	54.45
Sandbed – Bay 9	28.22	36.3	42.30	63.95	42.05	--	54.45
Sandbed – Bay 11	32.79	36.3	48.60	63.97	48.15	--	54.45
Sandbed – Bay 13	32.81	36.3	47.41	65.51	46.71	--	54.45
Sandbed – Bay 15	29.58	36.3	41.09	66.37	42.59	--	54.45
Sandbed – Bay 17	35.47	36.3	50.09	67.82	52.65	--	54.45
Sandbed – Bay 19	33.74	36.3	43.63	64.64	44.50	--	54.45
Pen X2A & X2B	--	36.3	20.88	19.73	22.44	--	54.45
Pen X3A & X3B	--	36.3	13.65	76.06	71.86	13.64	54.45
Pen X4A & X4B	--	36.3	18.65	17.96	19.32	--	54.45
Pen X5A & X5B	--	36.3	6.72	9.93	14.60	--	54.45
Pen X7	--	36.3	7.41	9.92	9.40	--	54.45
Pen X8	--	36.3	8.07	9.04	8.84	--	54.45
Pen X9 & X10	--	36.3	9.02	13.79	10.70	--	54.45
Pen X12B	--	36.3	11.25	15.58	11.49	--	54.45
Pen X18	--	36.3	4.50	13.30	11.82	--	54.45
Pen X63	--	36.3	7.06	18.20	10.15	--	54.45
Pen X66	--	36.3	9.21	11.30	13.55	--	54.45
Pen X70	--	36.3	8.00	9.21	11.22	--	54.45
18" Penetrations	--	36.3	15.55	16.51	19.01	--	54.45
14" Penetrations	--	36.3	12.36	12.88	11.89	--	54.45
10" Penetrations	--	36.3	10.45	9.42	11.98	--	54.45
8" Penetrations	--	36.3	10.99	13.64	14.07	--	54.45
6" Penetrations	--	36.3	10.44	10.68	10.36	--	54.45
3" Penetrations	--	36.3	16.54	15.82	17.58	--	54.45

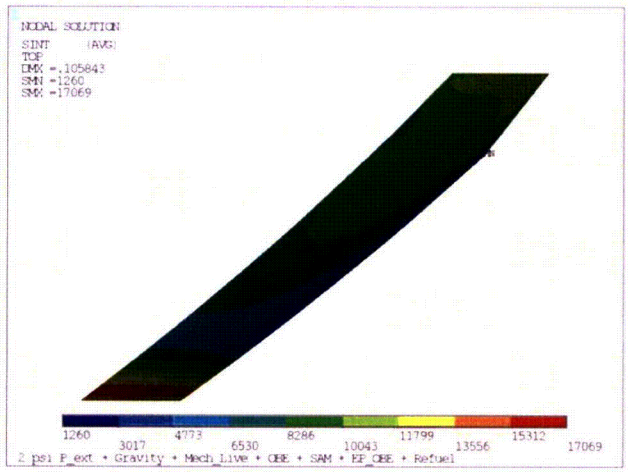
Note 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].

Table 4-9: Comparison of Stress Intensities (ksi)

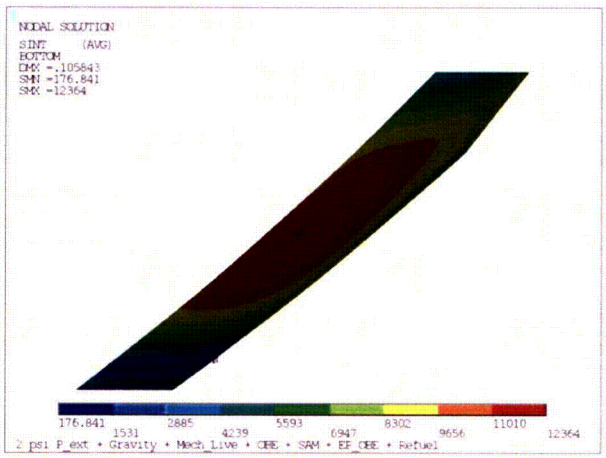
Bay	Load Case	Base Case					Sensitivity Case 1					Sensitivity Case 2				
		P_l	P_l+P_b		P_l+P_b+Q		P_l	P_l+P_b		P_l+P_b+Q		P_l	P_l+P_b		P_l+P_b+Q	
			Top	Bot	Top	Bot		Top	Bot	Top	Bot		Top	Bot	Top	Bot
1	LC5	10.38	16.99	12.35	28.67	19.59	10.76	17.07	12.36	28.73	19.24	10.38	17.03	12.36	28.71	19.63
	LC6	8.68	14.93	10.60	25.51	18.10	9.17	15.24	10.68	25.69	17.65	8.86	15.38	10.85	26.09	18.14
	LC9	44.03	45.93	46.68	--	--	43.10	45.80	49.01	--	--	44.14	45.99	46.89	--	--
	LC10	43.99	63.96	45.12			43.86	66.91	48.14	--	--	43.97	64.85	45.49	--	--
19	LC5	11.37	15.98	11.57	26.50	17.03	11.38	16.27	11.67	26.72	17.06	11.79	16.10	11.83	26.42	16.91
	LC6	9.77	15.26	11.00	26.87	16.85	9.77	15.29	11.01	26.89	16.86	10.04	15.49	11.39	26.95	16.63
	LC9	48.34	49.95	47.13	--	--	48.40	50.01	47.18	--	--	50.00	51.63	48.79	--	--
	LC10	42.35	63.92	42.95	--	--	42.44	64.03	43.01	--	--	43.63	64.64	44.50	--	--



(a) Membrane

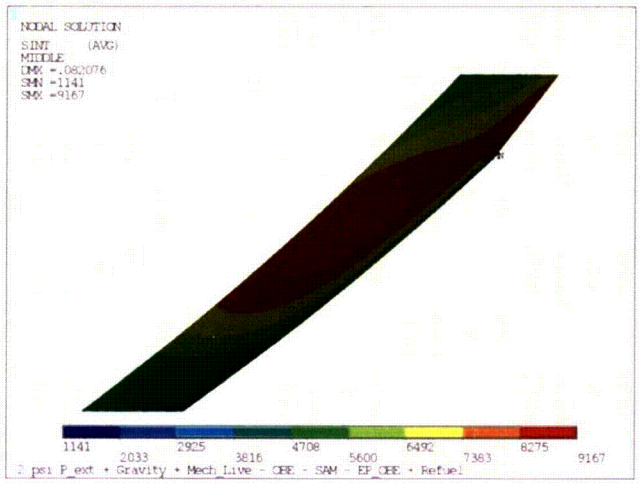


(b) Membrane + Bending, Top Surface

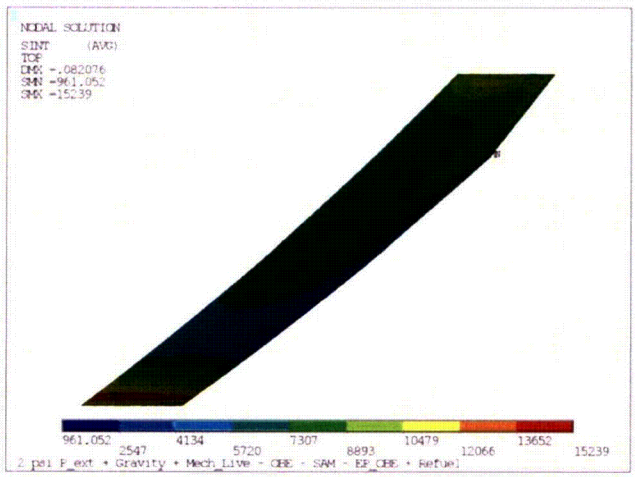


(c) Membrane + Bending, Bottom Surface

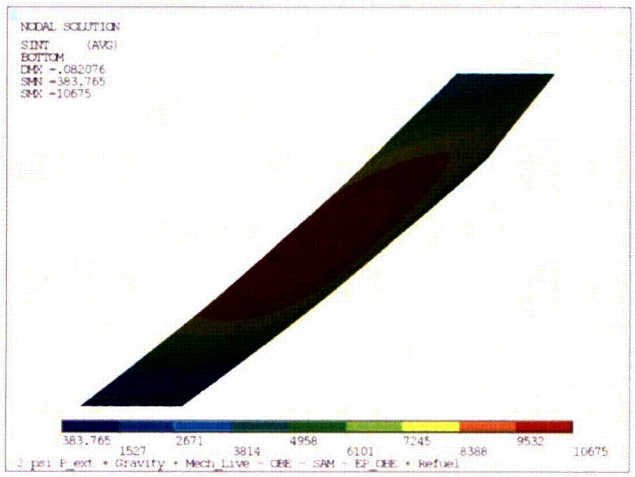
Figure 4-1. Bay 1, LC 5 Refueling Stress, Sensitivity Case 1



(a) Membrane

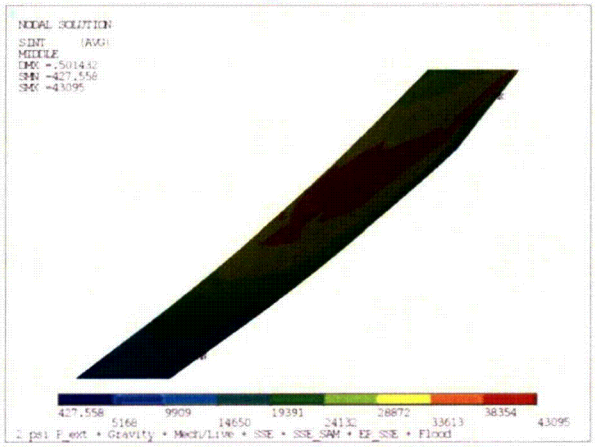


(b) Membrane + Bending, Top Surface

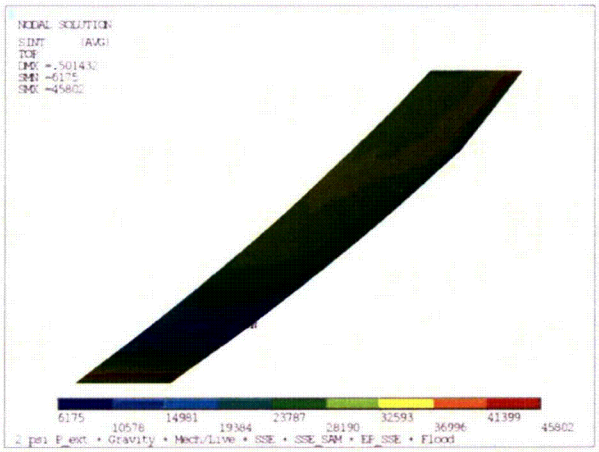


(c) Membrane + Bending, Bottom Surface

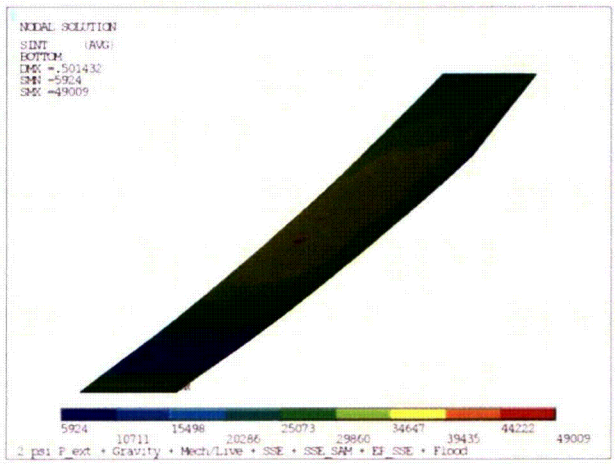
Figure 4-2. Bay 1, LC 6 Refueling Stress, Sensitivity Case 1



(a) Membrane

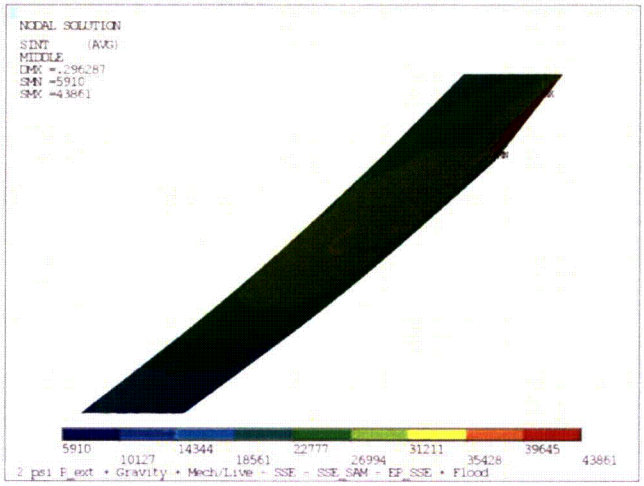


(b) Membrane + Bending, Top Surface

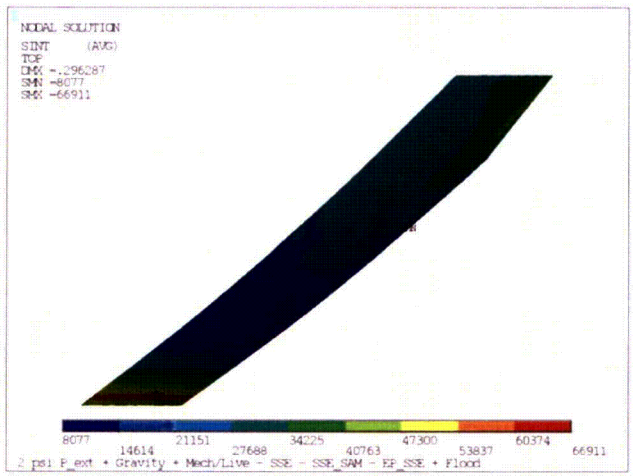


(c) Membrane + Bending, Bottom Surface

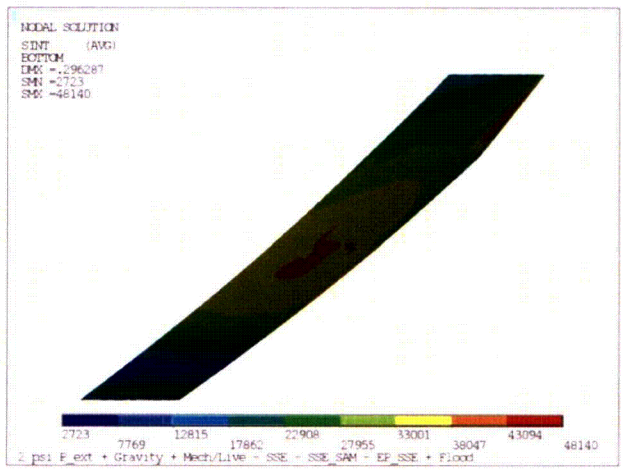
Figure 4-3. Bay 1, LC 9 Flooding Stress, Sensitivity Case 1



(a) Membrane

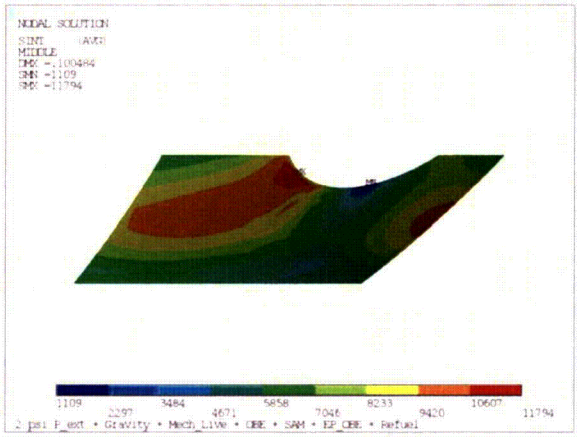


(b) Membrane + Bending, Top Surface

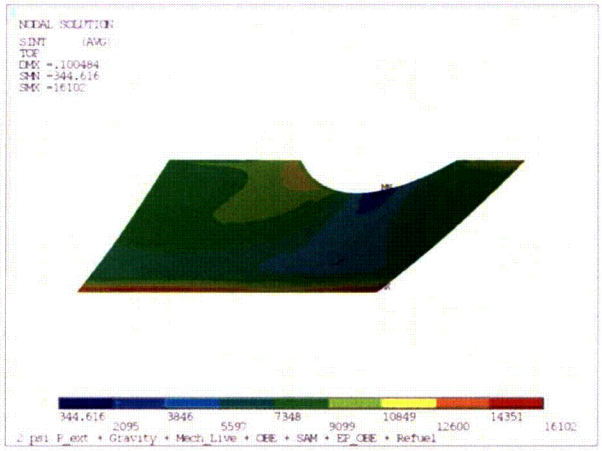


(c) Membrane + Bending, Bottom Surface

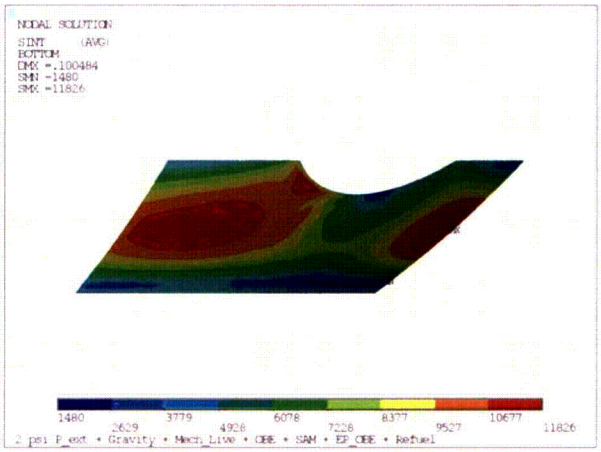
Figure 4-4. Bay 1, LC 10 Flooding Stress, Sensitivity Case 1



(a) Membrane

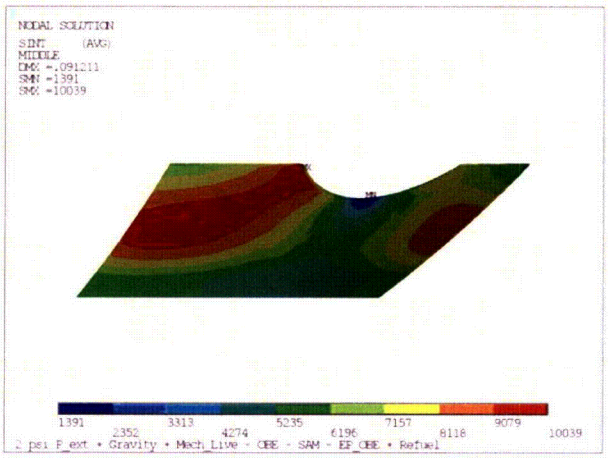


(b) Membrane + Bending, Top Surface

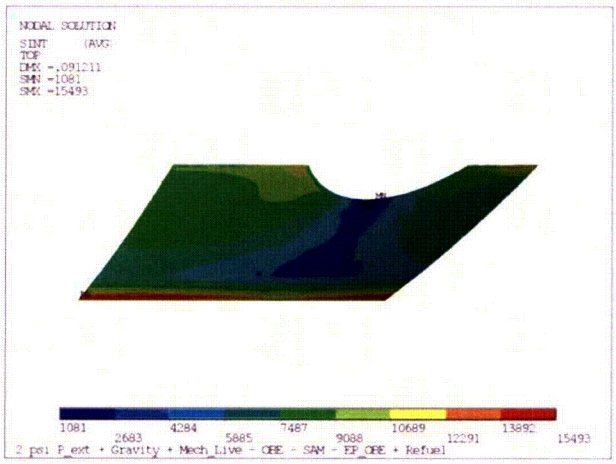


(c) Membrane + Bending, Bottom Surface

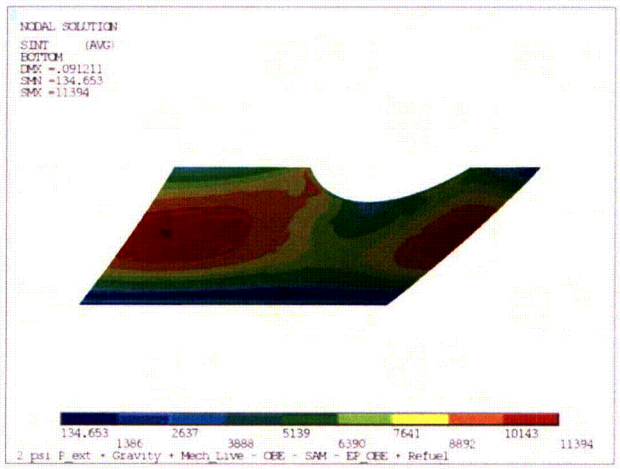
Figure 4-5. Bay 19, LC 5 Refueling Stress, Sensitivity Case 2



(a) Membrane

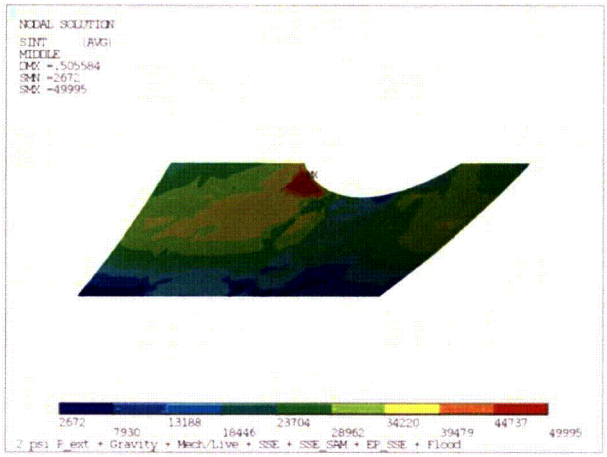


(b) Membrane + Bending, Top Surface

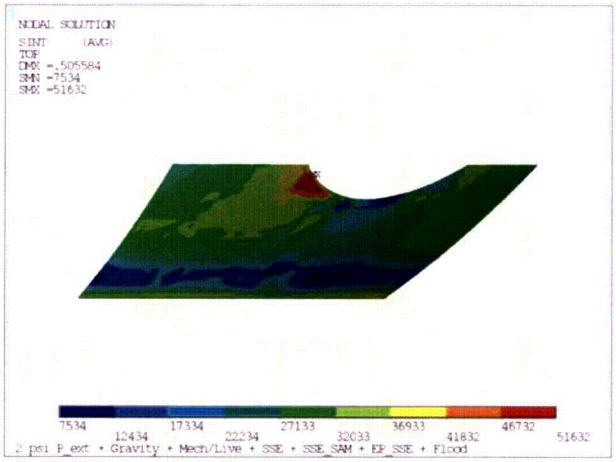


(c) Membrane + Bending, Bottom Surface

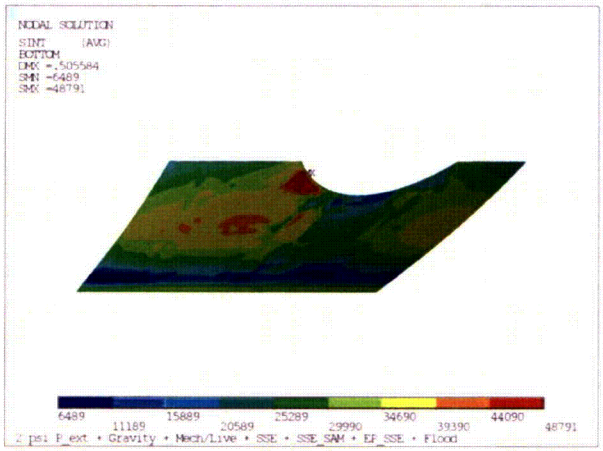
Figure 4-6. Bay 19, LC 6 Refueling Stress, Sensitivity Case 2



(a) Membrane

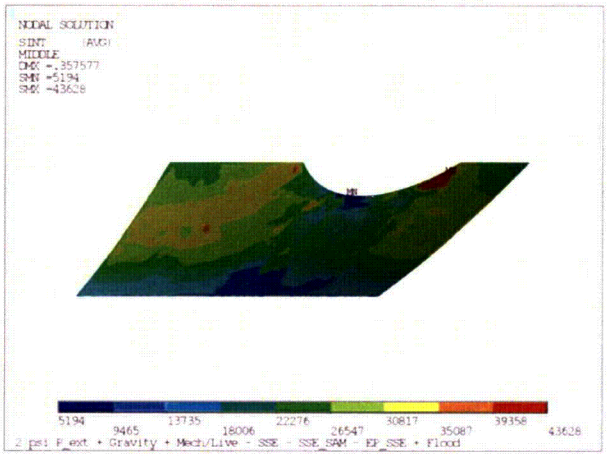


(b) Membrane + Bending, Top Surface

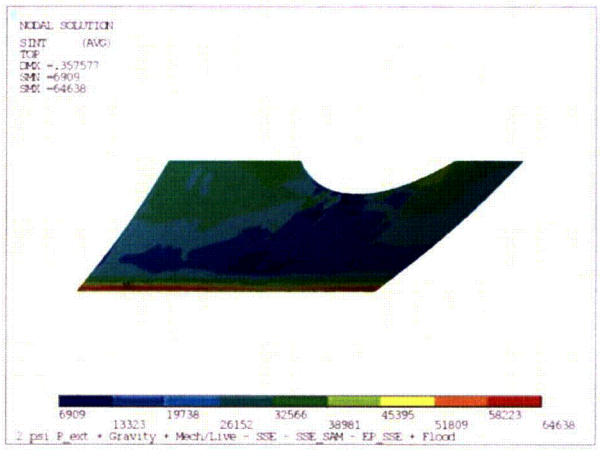


(c) Membrane + Bending, Bottom Surface

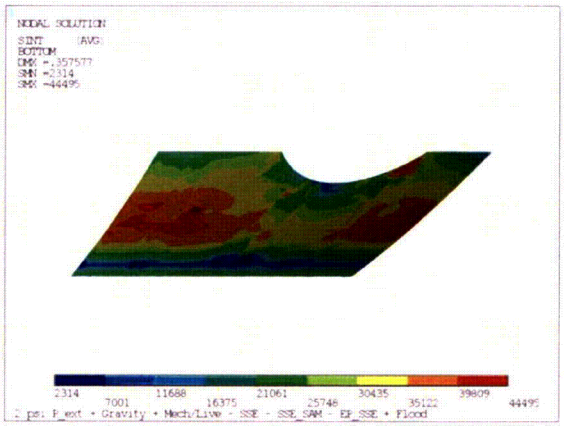
Figure 4-7. Bay 19, LC 9 Flooding Stress, Sensitivity Case 2



(a) Membrane



(b) Membrane+Bending, Top Surface



(c) Membrane + Bending, Bottom Surface

Figure 4-8. Bay 19, Stress LC 10 Flooding Stress, Sensitivity Case 2

5.0 BUCKLING EVALUATION

This section presents the results of the buckling evaluation for the two Sensitivity Cases.

5.1 Sensitivity Case 1

5.1.1 Refueling Case

The capacity reduction factors are presented in Table 5-1. The detail load factors and displacements are summarized in Table 5-3. The load factors for the cylindrical shell, spherical shell (upper, middle, lower) and sandbed are 7.227, 9.798, 10.651, 10.506, and 10.506, respectively, as shown in Table 5-7. The buckling results of the refueling case, Sensitivity Case 1 are summarized in Table 5-8. The safety factors are 3.34 (minimum required SF of 2.0) and 3.39 (minimum required SF of 2.0) for the cylindrical shell and spherical shell respectively, as shown in Table 5-8. The minimum safety factor in the sandbed region is 3.21 (minimum required SF of 2.0) for Bay 3 as shown in Table 5-12. The buckling stress results are illustrated in Figure 5-1 through Figure 5-5.

The bay-by-bay evaluation for the buckling is presented in Table 5-12. In this evaluation of individual bays, the capacity reduction factor was calculated using the minimum wall thickness in each bay. If the bay has a locally thinned area, the capacity reduction factor is calculated using the thickness of the locally thinned region. Using the thickness of locally thinned wall is conservative because a thinner wall thickness computes lower capacity reduction factor, and a lower capacity reduction results in lower buckling safety factor. The meridional and hoop stresses in each bay are obtained from Figure 5-6 to Figure 5-15.

5.1.2 Post-Accident Flooding Case

The buckling results of the post-accident flooding case for the Sensitivity Case 1 are summarized in Table 5-9. The first buckling mode in the cylindrical shell has a load factor of 9.139. The first mode in the sandbed region has a load factor of 7.054. It shows a deformed buckling mode

shape in Bays 1 and 19. This mode also shows some buckling displacement in the lower part of the spherical shell. As a result, this mode and its load factor are also identified with the buckling of the lower spherical shell. Since no mode has been identified with the buckling of the upper and middle spherical shell, the highest mode (number 200) and its load factor are being conservatively used for the upper and middle spherical shell. The detail load factors and displacements are summarized in Table 5-4.

In Table 5-9, the buckling safety factor for the cylindrical shell is 3.45 (minimum required SF of 1.67). The safety factor for the spherical shell is 2.19 (minimum required SF of 1.67), which is associated with the lower spherical shell. The minimum safety factor in the sandbed region for the post-accident flooding case is 2.01 (minimum required SF of 1.67) in Bay 19. The buckling stresses are presented in Figure 5-16 through Figure 5-30. Evaluation of individual sandbed bays is presented in Table 5-13.

5.2 Sensitivity Case 2

5.2.1 Refueling Case

The load factors for the cylindrical shell, spherical shell (upper, middle, lower) and sandbed are 7.224, 9.795, 10.649, 11.146 and 11.345, respectively. The detail load factors and displacements are summarized in Table 5-5. For the refueling case, the capacity reduction factors are presented in Table 5-2. The buckling results for the Refueling Case are summarized in Table 5-10. The safety factors are 3.34 (minimum required SF of 2.0) and 3.60 (minimum required SF of 2.0) for the cylindrical shell and spherical shell respectively. The minimum safety factor for the Sandbed Region is 3.46 (minimum required SF of 2.0) in Bay 3 as shown in Table 5-14.

The bay-by-bay buckling evaluation for the refueling load case, Sensitivity Case 2, is presented in Table 5-14. In this evaluation of individual bays, it follows what was performed in the Sensitivity Case 1 for individual bays. The buckling stresses are presented in Figure 5-31 through Figure 5-45.

5.2.2 Post-Accident Flooding Case

The buckling safety factor for the post-accident flooding case for the Sensitivity Case 2 is summarized in Table 5-11. The load factors for the cylinder, the spherical shell, and the sandbed region are 9.127, 6.992, and 6.965, respectively. The detailed load factors and displacements are summarized in Table 5-6. Since no mode has been identified with the buckling of the upper and middle spherical shell, the highest mode number 200 and its load factor are being conservatively used for the upper and middle spherical shell.

As summarized in Table 5-11, the cylindrical shell has a safety factor of 3.45 (minimum required SF of 1.67), the spherical shell has a safety factor of 2.19 (minimum required SF of 1.67), and the minimum safety factor in the sandbed region is 1.98 (minimum required SF of 1.67) in Bay 19. The bay by bay buckling evaluation is presented in Table 5-15. The buckling stresses are presented in Figure 5-46 through Figure 5-60.

5.3 Comparison of Buckling Sensitivity Study Results

To compare the sensitivity study results, the load factors and the safety factors were summarized in Table 5-16 through Table 5-18. The results of the load factors for the Base Case and the two Sensitivity Cases are presented in Table 5-16. The comparisons examine the refueling and post-accident flooding conditions for the three major drywell components: the cylindrical shell, the spherical shell, which is separated into the upper, middle, and lower sections with different thicknesses, and the sandbed region.

The load factors in the cylindrical shell do not change significantly among the three different cases for both refueling and post-accident flooding conditions. For the refueling condition, the load factors are from 7.229 for the Base Case to 7.224 for the Sensitivity Case 2. For the post-accident flooding condition, the load factors are from 9.148 for the Base Case to 9.127 for the Sensitivity Case 2. The load factor does not change significantly because the differences among these three cases are the thicknesses at the bottom of the drywell, far away from the cylindrical shell which is located at the top of the drywell. Also, the load factors in the cylindrical shell for

the refueling condition are lower than those for the flooding condition because the refueling loads are concentrated at the top of the cylindrical shell with the top head removed in the refueling condition whereas there is no refueling loading at the top of the cylindrical shell in the post-accident flooding condition.

The load factors in the sandbed region show more complexity in differences among the different study cases and loading conditions. For the refueling condition, the Base Case has a load factor of 11.584 while Sensitivity Case 1 has the lowest load factor of 10.506, with Sensitivity Case 2 at 11.345. The Sensitivity Cases have a lower load factor compared to the base case which has an overall thicker sandbed region.

In general, the sandbed region for the post-accident flooding condition shows lower load factors than those for the refueling condition. This is mainly due to a larger hydrostatic load at the bottom of the drywell, which is filled with water up to an elevation of 74'-6". The load factors for the two Sensitivity Cases are lower than the base case because of the reduced shell thickness in the sandbed region.

Table 5-17 and Table 5-18 present the comparison of buckling safety factors for the refueling and post-accident flooding conditions, respectively. Safety factors for individual bays for all three cases are also provided for comparison. For the refueling condition, Sensitivity Case 1 has the lowest safety factor of 3.21 (minimum required SF of 2.0) in Bay 3 compared to 3.54 (minimum required SF of 2.0) for the Base Case and 3.46 (minimum required SF of 2.0) for the Sensitivity Case 2, as shown in Table 5-17. They behave very similar to the load factor results presented in Table 5-16.

For the flooding case, Sensitivity Case 2 has the lowest safety factor of 1.98 (minimum required SF of 1.67) in Bay 19 compared to 2.02 (minimum required SF of 1.67) for the Base Case and 2.01 (minimum required SF of 1.67) for the Sensitivity Case 1, as shown in Table 5-18. This trend is similar to that of the refueling case, and the explanation for this trend has been presented in the previous section.

In all cases, the buckling safety factors satisfy the ASME requirements which are 2.0 for Levels A and B safety factor, 1.67 for Levels C safety factor and 1.34 for Level D safety factor.

Table 5-1: Capacity Reduction Factor, Sensitivity Case 1

Region		R (in)	t (in)	l (in)	M	R/t	α/α_{1L}
Cylindrical		198	0.604	96	8.78	327.81	0.330
Spherical	Upper	420	0.676	156	9.26	---	0.362
	Middle	420	0.678	396	23.47	---	0.207
	Lower	420	1.160	396	17.94	---	0.244
Bay 1	Above 11'	420	0.826	396	21.26	---	0.220
	Below 11'	420	0.826	396	21.26	---	0.220
Bay 3	Above 11'	420	1.180	396	17.79	---	0.245
	Below 11'	420	0.950	396	19.82	---	0.229
Bay 5	Above 11'	420	1.185	396	17.75	---	0.245
	Below 11'	420	1.074	396	18.65	---	0.238
Bay 7	Above 11'	420	1.133	396	18.15	---	0.242
	Below 11'	420	1.034	396	19.00	---	0.235
Bay 9	Above 11'	420	1.074	396	18.65	---	0.238
	Below 11'	420	0.993	396	19.39	---	0.232
Bay 11	Above 11'	420	0.860	396	20.84	---	0.223
	Below 11'	420	0.860	396	20.84	---	0.223
Bay 13	Above 11'	420	0.907	396	20.29	---	0.226
	Below 11'	420	0.907	396	20.29	---	0.226
Bay 15	Above 11'	420	1.062	396	18.75	---	0.237
	Below 11'	420	0.935	396	19.98	---	0.228
Bay 17	Above 11'	420	0.863	396	20.80	---	0.223
	Below 11'	420	0.963	396	19.69	---	0.230
Bay 19	Above 11'	420	0.826	396	21.26	---	0.220
	Below 11'	420	0.826	396	21.26	---	0.220
Bay 1	Local (1)	420	0.596	396	25.03	---	0.207
Bay 13	Local (1)	420	0.658	396	23.82	---	0.207
Bay 15	Local (1)	420	0.711	396	22.92	---	0.210
Bay 17	Local (1)	420	0.663	396	23.73	---	0.207
	Local (1)	420	0.850	396	20.96	---	0.222
Bay 19	Local (1)	420	0.720	396	22.77	---	0.211

Note: (1) The local regions refer to the locally thinned areas within the individual bays, as described in Reference 1.

Table 5-2: Capacity Reduction Factor, Sensitivity Case 2

Region		R (in)	t (in)	l (in)	M	R/t	α/α_{1L}
Cylindrical		198	0.604	96	8.78	327.81	0.330
Spherical	Upper	420	0.676	156	9.26	---	0.362
	Middle	420	0.678	396	23.47	---	0.207
	Lower	420	1.160	396	17.94	---	0.244
Bay 1	Above 11'	420	0.826	396	21.26	---	0.220
	Below 11'	420	0.826	396	21.26	---	0.220
Bay 3	Above 11'	420	1.180	396	17.79	---	0.245
	Below 11'	420	0.950	396	19.82	---	0.229
Bay 5	Above 11'	420	1.185	396	17.75	---	0.245
	Below 11'	420	1.074	396	18.65	---	0.238
Bay 7	Above 11'	420	1.133	396	18.15	---	0.242
	Below 11'	420	1.034	396	19.00	---	0.235
Bay 9	Above 11'	420	1.074	396	18.65	---	0.238
	Below 11'	420	0.993	396	19.39	---	0.232
Bay 11	Above 11'	420	0.860	396	20.84	---	0.223
	Below 11'	420	0.860	396	20.84	---	0.223
Bay 13	Above 11'	420	0.907	396	20.29	---	0.226
	Below 11'	420	0.907	396	20.29	---	0.226
Bay 15	Above 11'	420	1.062	396	18.75	---	0.237
	Below 11'	420	0.935	396	19.98	---	0.228
Bay 17	Above 11'	420	0.863	396	20.80	---	0.223
	Below 11'	420	0.963	396	19.69	---	0.230
Bay 19	Above 11'	420	0.776	396	21.94	---	0.216
	Below 11'	420	0.776	396	21.94	---	0.216
Bay 1	Local (1)	420	0.696	396	23.16	---	0.209
Bay 13	Local (1)	420	0.658	396	23.82	---	0.207
Bay 15	Local (1)	420	0.711	396	22.92	---	0.210
Bay 17	Local (1)	420	0.663	396	23.73	---	0.207
	Local (1)	420	0.850	396	20.96	---	0.222
Bay 19	Local (1)	420	0.720	396	22.77	---	0.211

Note: (1) The local regions refer to the locally thinned areas within the individual bays as described in Reference 1.

Table 5-3: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 1

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
1	7.227	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	7.456	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	7.459	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	7.462	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	7.941	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	7.988	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	8.075	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	8.092	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	8.676	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	8.826	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	9.227	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	9.288	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	9.588	1.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	9.734	1.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	9.798	0.03	1.39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	10.002	0.03	1.34	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	10.094	0.06	1.39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	10.269	0.06	1.34	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	10.281	1.29	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	10.341	1.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	10.369	1.20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	10.385	0.12	1.39	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	10.397	1.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	10.506	0.00	0.00	0.00	0.05	1.26	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.23
25	10.541	0.04	1.39	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	10.651	0.00	0.02	1.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	10.726	0.08	1.39	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	10.838	0.00	0.05	1.32	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	10.859	0.07	1.39	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	10.920	1.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	10.958	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	11.077	0.04	1.42	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	11.148	0.00	0.01	1.30	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	11.179	0.04	1.37	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	11.184	0.00	0.04	1.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	11.377	1.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	11.380	0.01	0.07	1.24	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	11.381	1.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	11.449	0.00	0.03	1.04	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	11.467	0.03	1.39	0.06	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
41	11.473	0.00	0.01	1.05	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	11.501	0.01	0.01	0.01	0.26	1.29	0.08	0.01	0.00	0.00	0.00	0.00	0.01	0.05	0.59
43	11.526	0.00	0.03	1.08	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	11.534	0.00	0.04	1.12	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	11.550	0.03	1.44	0.35	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
46	11.582	0.05	1.44	1.09	0.11	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
47	11.583	0.01	0.37	1.11	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	11.657	0.01	0.20	1.26	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	11.678	1.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	11.696	0.00	0.11	1.31	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of the buckling mode shapes.

Table 5-3: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
51	11.714	0.07	1.59	0.32	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	11.718	1.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	11.723	0.00	0.06	1.04	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	11.786	0.00	0.04	1.30	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	11.796	0.00	0.06	1.05	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
56	11.796	0.00	0.06	1.32	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	11.884	1.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	11.901	0.04	1.29	0.36	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	11.916	0.01	0.22	1.16	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	11.933	0.07	1.38	0.19	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	11.985	0.04	1.36	0.21	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
62	11.992	0.00	0.09	1.09	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	12.048	0.00	0.04	1.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
64	12.068	0.01	0.21	1.13	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	12.072	0.01	0.34	1.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	12.077	0.07	1.34	0.58	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	12.108	0.06	1.31	0.25	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	12.166	0.00	0.05	1.05	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
69	12.174	0.01	0.15	1.11	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	12.183	0.00	0.03	1.05	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	12.195	0.01	0.25	1.30	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	12.234	0.30	1.29	0.30	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	12.239	1.21	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	12.243	0.11	0.19	1.11	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	12.314	0.02	0.21	1.27	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76	12.321	0.10	1.36	0.51	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
77	12.347	0.01	0.14	1.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	12.386	0.08	1.02	1.01	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	12.390	0.14	1.43	0.89	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	12.414	1.08	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	12.418	0.06	0.17	1.05	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
82	12.433	0.07	0.29	1.03	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	12.437	0.66	1.34	0.29	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
84	12.439	1.05	0.15	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	12.460	0.02	0.30	0.89	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	12.490	1.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
87	12.496	0.01	0.01	0.01	0.26	0.32	0.04	0.00	0.00	0.00	0.00	0.01	0.02	0.73	1.27
88	12.498	0.12	1.27	0.82	0.13	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08
89	12.515	0.03	0.59	1.04	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
90	12.527	0.03	0.58	1.15	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
91	12.540	0.02	0.29	1.14	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
92	12.576	0.01	0.23	1.15	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	12.592	0.23	0.37	1.13	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	12.594	1.00	0.02	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95	12.605	0.01	0.12	1.13	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	12.643	0.08	1.37	0.75	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	12.719	0.07	1.30	0.56	0.08	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
98	12.769	0.01	0.08	1.08	0.51	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
99	12.775	1.04	0.03	0.01	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
100	12.778	0.02	0.09	1.06	0.25	0.11	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-3: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
101	12.780	0.02	0.01	0.04	0.20	1.27	0.53	0.01	0.00	0.00	0.00	0.00	0.01	0.22	0.98
102	12.799	1.07	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
103	12.801	0.03	0.10	1.05	0.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
104	12.808	0.01	0.26	1.13	0.52	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
105	12.836	1.14	0.18	0.13	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106	12.838	0.35	1.52	1.07	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	12.863	1.07	0.09	0.10	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
108	12.865	0.53	0.88	1.07	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
109	12.879	0.04	0.43	1.11	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110	12.881	0.08	1.12	1.12	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	12.907	0.02	0.62	1.04	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112	12.926	0.04	1.38	0.61	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
113	12.936	0.02	0.48	1.07	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	12.964	0.07	1.37	0.83	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	12.968	0.01	0.23	1.13	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	12.974	0.01	0.27	1.05	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
117	13.021	0.02	0.53	1.08	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118	13.026	0.02	0.47	1.02	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
119	13.031	0.02	0.62	1.08	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	13.040	0.05	1.28	1.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
121	13.066	1.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122	13.084	0.01	0.37	1.10	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
123	13.107	1.04	0.73	0.45	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
124	13.108	1.04	0.20	0.12	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	13.183	0.01	0.30	1.08	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
126	13.191	0.01	0.42	0.92	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
127	13.223	0.02	0.45	1.13	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
128	13.248	0.01	0.23	1.08	0.27	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
129	13.252	0.00	0.00	0.01	0.20	1.27	0.72	0.01	0.00	0.00	0.00	0.00	0.00	0.20	0.78
130	13.275	0.01	0.24	1.28	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
131	13.287	0.01	0.29	1.01	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
132	13.295	0.04	1.35	0.57	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
133	13.330	0.05	0.77	1.13	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
134	13.340	0.01	0.25	1.07	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135	13.362	1.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
136	13.373	0.05	0.52	1.02	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
137	13.380	0.03	0.27	1.08	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
138	13.400	0.03	0.22	1.19	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
139	13.409	1.12	0.15	0.24	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	13.411	1.12	0.62	0.94	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	13.429	0.14	1.23	0.80	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03
142	13.440	0.01	0.29	1.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
143	13.461	0.13	1.29	0.65	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
144	13.476	0.00	0.01	0.01	0.57	0.24	0.09	0.00	0.00	0.00	0.01	0.01	0.05	0.96	1.31
145	13.486	0.04	1.23	0.71	0.07	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05
146	13.497	0.02	0.55	1.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
147	13.546	0.03	0.44	1.11	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
148	13.562	0.06	1.32	0.87	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
149	13.595	0.01	0.54	1.13	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150	13.602	0.02	0.57	1.15	0.38	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-3: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (concluded)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
151	13.639	0.03	1.28	0.86	0.31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
152	13.667	0.00	0.13	1.12	0.42	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
153	13.676	0.00	0.01	0.01	0.61	1.27	0.06	0.01	0.00	0.00	0.01	0.01	0.02	0.25	1.30
154	13.694	0.01	0.22	1.01	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
155	13.702	0.01	0.27	1.11	0.42	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
156	13.718	0.06	1.19	0.61	0.26	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
157	13.729	0.09	1.13	0.99	0.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
158	13.748	0.01	0.28	1.05	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
159	13.755	0.06	1.30	0.99	0.37	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
160	13.765	0.03	0.47	1.06	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
161	13.793	0.05	0.70	1.08	0.27	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
162	13.805	0.32	1.44	0.95	0.25	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
163	13.829	1.03	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
164	13.843	0.32	0.82	1.02	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
165	13.856	1.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
166	13.870	0.14	0.80	1.10	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
167	13.882	0.05	1.08	1.08	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
168	13.892	0.03	0.51	1.19	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
169	13.935	0.05	1.18	0.62	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
170	13.940	0.06	0.63	1.02	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
171	13.968	0.02	0.20	1.01	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
172	13.974	0.08	1.07	1.17	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
173	13.981	0.01	0.19	1.01	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
174	14.019	0.05	0.70	1.05	0.41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
175	14.042	0.03	0.66	1.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
176	14.062	0.05	1.42	0.81	0.24	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
177	14.106	0.03	0.55	0.89	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00
178	14.115	0.02	0.39	0.86	0.25	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
179	14.127	0.00	0.01	0.01	0.31	0.06	0.04	0.00	0.00	0.00	0.02	0.02	0.65	1.27	0.07
180	14.141	0.03	0.72	1.13	0.47	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
181	14.151	0.05	1.34	0.83	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00
182	14.154	0.05	0.89	0.98	0.41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
183	14.198	0.03	0.29	1.05	0.36	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
184	14.213	0.07	0.35	1.03	0.30	0.29	0.20	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.05
185	14.216	0.03	0.21	1.02	0.32	0.70	0.47	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.12
186	14.217	0.01	0.02	0.09	0.50	1.30	0.88	0.03	0.01	0.00	0.02	0.02	0.03	0.05	0.22
187	14.229	0.48	0.60	1.19	0.34	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
188	14.233	1.07	0.05	0.08	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
189	14.251	0.07	0.51	1.08	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
190	14.269	0.04	0.67	1.02	0.26	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
191	14.276	0.06	0.51	1.02	0.26	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
192	14.332	1.02	0.07	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
193	14.341	0.53	1.16	0.81	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
194	14.350	0.07	0.51	1.08	0.33	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
195	14.378	0.07	0.39	1.00	0.27	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
196	14.388	1.00	0.03	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
197	14.393	0.16	0.83	0.87	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
198	14.412	0.13	0.93	1.05	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
199	14.442	0.34	1.14	1.07	0.39	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00
200	14.449	1.01	0.05	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-4: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 1

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
1	6.516	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6.650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	6.699	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	6.761	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.782	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6.790	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	6.852	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	6.942	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	6.967	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	7.054	0.01	0.01	0.01	0.16	1.26	0.25	0.02	0.01	0.01	0.01	0.01	0.02	0.19	0.89
11	7.106	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	7.161	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
13	7.174	0.00	0.00	0.00	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
14	7.278	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	7.283	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	7.353	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	7.356	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	7.360	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	7.426	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	7.491	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
21	7.596	0.00	0.01	0.01	0.22	0.56	0.16	0.00	0.00	0.01	0.01	0.02	0.07	0.90	1.26
22	7.611	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	7.668	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	7.754	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
25	7.793	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
26	7.803	0.00	0.00	0.00	0.01	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
27	7.805	0.01	0.01	0.02	0.20	1.26	0.88	0.04	0.01	0.01	0.02	0.02	0.02	0.08	0.71
28	7.963	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
29	8.080	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
30	8.103	0.00	0.01	0.01	0.34	1.30	0.61	0.01	0.00	0.01	0.03	0.03	0.02	0.50	1.13
31	8.140	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00
32	8.175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	8.216	0.01	0.01	0.02	0.30	0.04	0.01	0.01	0.02	0.25	1.26	1.24	0.23	0.07	0.04
34	8.221	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.02	0.09	0.09	0.02	0.00	0.01
35	8.313	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00
36	8.342	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
37	8.362	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	8.404	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
39	8.458	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.03
40	8.501	0.01	0.01	0.01	0.31	0.25	0.11	0.00	0.00	0.01	0.06	0.07	0.31	0.77	1.03
41	8.504	0.00	0.00	0.00	0.06	0.04	0.02	0.00	0.00	0.00	0.01	0.01	0.06	0.14	0.19
42	8.600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	8.605	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	8.685	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.02
45	8.714	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.01
46	8.738	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.01
47	8.746	0.01	0.01	0.01	0.28	0.36	0.25	0.02	0.00	0.03	0.11	0.34	1.03	1.26	0.54
48	8.812	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
49	8.859	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
50	8.911	0.00	0.01	0.01	0.36	1.30	0.95	0.07	0.01	0.07	0.08	0.15	0.19	0.28	0.52

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-4: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
51	8.942	0.00	0.00	0.01	0.20	1.27	0.66	0.05	0.01	0.01	0.02	0.05	0.05	0.46	1.15
52	8.989	0.00	0.01	0.01	0.29	0.13	0.09	0.01	0.06	1.07	1.26	0.90	0.90	0.32	0.08
53	9.027	0.01	0.02	0.02	0.33	0.08	0.03	0.02	0.07	0.92	1.07	1.26	1.26	0.42	0.07
54	9.047	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.07	0.02	0.00
55	9.115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00
56	9.133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
57	9.139	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	9.166	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	9.190	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	9.222	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	9.232	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
62	9.294	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	9.329	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
64	9.391	0.01	0.01	0.01	0.46	0.01	0.00	0.00	0.01	0.43	1.30	1.26	0.18	0.02	0.01
65	9.537	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	9.544	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
67	9.618	0.00	0.00	0.00	0.02	0.05	0.02	0.01	0.00	0.00	0.00	0.01	0.04	0.05	0.05
68	9.623	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03
69	9.643	0.00	0.01	0.01	0.39	0.05	0.03	0.00	0.00	0.01	0.03	0.19	0.91	1.31	0.06
70	9.726	0.00	0.00	0.00	0.04	0.12	0.05	0.01	0.00	0.00	0.00	0.00	0.02	0.10	0.15
71	9.766	0.00	0.00	0.01	0.11	0.42	0.21	0.07	0.01	0.01	0.01	0.02	0.08	0.30	0.50
72	9.809	0.00	0.00	0.00	0.02	0.06	0.04	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.07
73	9.889	0.00	0.00	0.00	0.01	0.05	0.04	0.03	0.00	0.00	0.00	0.00	0.01	0.02	0.07
74	9.972	0.00	0.00	0.00	0.02	0.03	0.03	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.01
75	10.067	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
76	10.072	0.03	0.01	0.01	0.29	0.01	0.02	0.01	0.01	0.14	0.30	0.94	0.93	0.03	0.02
77	10.082	0.00	0.00	0.00	0.03	0.01	0.01	0.00	0.00	0.02	0.03	0.08	0.08	0.03	0.01
78	10.154	0.04	0.01	0.01	0.42	0.03	0.06	0.05	0.13	1.09	1.31	0.22	0.15	0.03	0.03
79	10.164	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
80	10.187	0.00	0.00	0.00	0.04	0.24	0.22	0.14	0.02	0.03	0.04	0.01	0.03	0.17	0.25
81	10.236	0.00	0.00	0.00	0.02	0.13	0.11	0.07	0.00	0.01	0.01	0.00	0.01	0.08	0.11
82	10.283	0.00	0.00	0.00	0.03	0.24	0.18	0.06	0.01	0.00	0.00	0.00	0.02	0.15	0.20
83	10.398	0.00	0.00	0.00	0.01	0.06	0.04	0.02	0.01	0.01	0.01	0.00	0.02	0.03	0.05
84	10.483	0.01	0.01	0.02	0.27	0.45	1.26	1.01	0.13	0.07	0.05	0.02	0.03	0.32	0.39
85	10.501	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.01
86	10.563	0.00	0.00	0.00	0.01	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03
87	10.614	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	10.691	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	10.783	0.00	0.00	0.01	0.18	0.16	0.11	0.07	0.35	0.35	0.93	1.02	0.56	0.20	0.18
90	10.806	0.00	0.00	0.00	0.02	0.03	0.02	0.01	0.03	0.03	0.05	0.06	0.03	0.04	0.03
91	10.815	0.04	0.00	0.00	0.09	0.40	0.28	0.07	0.02	0.07	0.23	0.25	0.17	0.46	0.44
92	10.818	1.26	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
93	10.867	0.00	0.00	0.00	0.02	0.08	0.06	0.02	0.06	0.06	0.03	0.03	0.02	0.08	0.09
94	10.933	0.01	0.01	0.01	0.22	0.04	0.05	0.19	0.70	0.70	0.15	0.15	0.10	0.06	0.06
95	10.966	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	11.053	0.00	0.00	0.00	0.04	0.01	0.01	0.03	0.14	0.14	0.02	0.03	0.02	0.01	0.01
97	11.080	0.00	0.01	0.01	0.51	0.87	1.08	0.56	0.15	0.15	0.15	0.19	0.68	1.29	1.09
98	11.088	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.03	0.02
99	11.156	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00
100	11.262	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-4: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
101	11.294	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.02	0.02	0.04	0.04	0.02	0.02
102	11.442	0.00	0.00	0.00	0.05	0.20	0.21	0.11	0.11	0.09	0.17	0.42	0.51	0.32	0.15
103	11.458	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
104	11.503	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	11.511	0.00	0.00	0.00	0.02	0.06	0.07	0.04	0.04	0.02	0.02	0.10	0.12	0.09	0.04
106	11.517	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	11.586	0.01	0.02	0.02	0.41	0.14	1.12	1.26	1.25	0.40	0.10	0.11	0.14	0.12	0.09
108	11.602	0.00	0.00	0.00	0.01	0.01	0.04	0.04	0.04	0.01	0.01	0.01	0.01	0.01	0.00
109	11.697	0.00	0.00	0.00	0.13	0.43	0.55	0.21	0.05	0.12	0.13	0.35	0.41	0.36	0.28
110	11.703	0.00	0.00	0.00	0.04	0.11	0.16	0.07	0.01	0.01	0.04	0.10	0.12	0.10	0.08
111	11.739	0.00	0.00	0.00	0.02	0.01	0.05	0.05	0.03	0.05	0.05	0.05	0.01	0.01	0.01
112	11.887	0.00	0.01	0.01	0.36	0.20	1.31	1.13	1.07	0.23	0.20	0.13	0.26	0.21	0.14
113	12.003	0.00	0.00	0.01	0.23	0.45	0.61	0.45	0.37	0.55	0.53	0.56	1.26	0.98	0.62
114	12.095	0.00	0.00	0.01	0.26	0.18	0.22	0.16	0.39	1.27	1.15	1.12	0.58	0.45	0.23
115	12.183	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	12.247	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
117	12.337	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118	12.384	0.00	0.00	0.00	0.10	0.35	0.39	0.12	0.04	0.06	0.08	0.09	0.09	0.28	0.34
119	12.392	1.04	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
120	12.392	0.01	0.00	0.00	0.09	0.29	0.33	0.10	0.04	0.07	0.09	0.10	0.08	0.23	0.28
121	12.407	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122	12.425	0.01	0.00	0.01	0.24	0.35	0.37	0.13	0.73	0.91	1.19	1.30	0.69	0.28	0.33
123	12.453	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
124	12.505	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	12.521	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
126	12.552	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
127	12.579	0.01	0.01	0.02	0.37	0.06	0.03	0.12	1.30	1.31	0.47	0.28	0.25	0.05	0.07
128	12.648	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
129	12.732	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	12.741	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
131	12.818	0.00	0.00	0.00	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.02	0.04	0.04	0.07
132	12.826	0.01	0.01	0.02	0.24	0.96	0.52	0.23	0.09	0.09	0.10	0.35	0.86	0.77	1.29
133	12.854	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02
134	12.916	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.03	0.00
135	12.946	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00
136	12.956	0.00	0.01	0.01	0.37	0.49	0.22	0.06	0.06	0.19	0.36	0.70	1.29	0.88	0.54
137	12.973	0.00	0.00	0.00	0.03	0.06	0.03	0.01	0.01	0.02	0.03	0.06	0.09	0.06	0.07
138	12.994	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.03	0.01
139	13.004	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.05	0.03	0.01
140	13.032	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	13.039	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
142	13.093	1.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
143	13.108	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01
144	13.127	0.01	0.00	0.01	0.22	0.24	0.11	0.14	0.16	0.41	0.64	1.22	1.20	0.49	0.26
145	13.149	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.01	0.03	0.05	0.09	0.09	0.03	0.02
146	13.194	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.01
147	13.233	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
148	13.291	1.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
149	13.306	0.01	0.01	0.02	0.37	0.10	0.09	1.31	1.31	0.29	0.12	0.10	0.10	0.05	0.05
150	13.317	0.00	0.00	0.00	0.02	0.00	0.00	0.09	0.09	0.02	0.01	0.01	0.01	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-4: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 1 (concluded)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
151	13.366	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
152	13.417	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
153	13.419	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
154	13.488	0.00	0.00	0.01	0.28	1.26	0.91	0.26	0.12	0.02	0.02	0.09	0.27	0.92	1.26
155	13.508	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
156	13.533	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
157	13.560	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
158	13.596	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
159	13.610	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
160	13.641	1.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
161	13.672	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
162	13.699	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
163	13.717	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
164	13.725	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
165	13.758	0.00	0.00	0.00	0.05	0.11	0.07	0.04	0.01	0.02	0.01	0.01	0.00	0.01	0.08
166	13.766	0.01	0.01	0.01	0.34	0.80	0.47	0.31	0.07	0.11	0.07	0.03	0.03	0.10	0.58
167	13.781	0.00	0.00	0.00	0.03	0.07	0.04	0.03	0.01	0.02	0.02	0.01	0.00	0.01	0.05
168	13.825	0.00	0.01	0.01	0.39	0.12	0.06	0.18	0.39	1.29	0.92	0.23	0.12	0.05	0.09
169	13.835	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.03	0.08	0.06	0.02	0.01	0.01	0.01
170	13.853	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
171	13.867	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
172	13.890	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
173	13.911	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01
174	14.003	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
175	14.024	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
176	14.063	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
177	14.072	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
178	14.148	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
179	14.211	0.00	0.00	0.00	0.02	0.03	0.05	0.03	0.01	0.00	0.00	0.00	0.01	0.03	0.04
180	14.231	0.01	0.02	0.02	0.43	0.90	1.27	0.94	0.14	0.02	0.04	0.06	0.23	0.66	1.04
181	14.240	0.00	0.00	0.00	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02
182	14.260	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
183	14.305	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01
184	14.314	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
185	14.332	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
186	14.371	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
187	14.384	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
188	14.410	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
189	14.411	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.03	0.03	0.01	0.01	0.01	0.01	0.01
190	14.419	1.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
191	14.438	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.04	0.04	0.02	0.01	0.01	0.00	0.01
192	14.461	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
193	14.483	0.01	0.00	0.00	0.16	0.30	0.36	0.31	0.35	0.34	0.19	0.15	0.09	0.26	0.34
194	14.490	0.00	0.00	0.00	0.02	0.04	0.04	0.04	0.04	0.04	0.03	0.02	0.01	0.03	0.04
195	14.512	0.00	0.00	0.00	0.05	0.09	0.10	0.08	0.04	0.04	0.01	0.01	0.02	0.07	0.10
196	14.538	0.01	0.01	0.01	0.27	0.50	0.53	0.44	1.10	1.06	0.62	0.47	0.31	0.40	0.51
197	14.574	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01
198	14.620	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
199	14.658	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
200	14.664	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-5: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 2

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
1	7.224	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	7.454	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	7.456	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	7.460	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	7.939	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	7.986	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	8.072	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	8.090	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	8.672	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	8.822	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	9.224	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	9.286	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	9.585	1.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	9.730	1.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	9.795	0.03	1.39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	9.999	0.03	1.34	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	10.091	0.06	1.39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	10.267	0.06	1.34	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	10.277	1.29	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	10.337	1.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	10.365	1.20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	10.383	0.12	1.39	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	10.394	1.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	10.538	0.04	1.39	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	10.649	0.00	0.02	1.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	10.724	0.08	1.39	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	10.836	0.00	0.05	1.32	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	10.857	0.07	1.39	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	10.914	1.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	10.952	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	11.074	0.04	1.42	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	11.146	0.00	0.01	1.30	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	11.176	0.04	1.37	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	11.182	0.00	0.04	1.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	11.345	0.01	0.01	0.01	0.25	0.92	0.05	0.01	0.00	0.00	0.00	0.01	0.02	0.58	1.26
36	11.373	1.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	11.377	1.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	11.378	0.01	0.07	1.24	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	11.447	0.00	0.03	1.04	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	11.465	0.03	1.39	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	11.471	0.00	0.02	1.05	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	11.508	0.00	0.00	0.01	0.28	1.17	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.63	1.27
43	11.525	0.00	0.03	1.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	11.535	0.00	0.04	1.12	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	11.548	0.03	1.44	0.37	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
46	11.579	0.05	1.42	0.47	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
47	11.583	0.00	0.06	1.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	11.654	0.01	0.21	1.26	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	11.674	1.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	11.695	0.00	0.11	1.31	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-5: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
51	11.710	0.07	1.59	0.33	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	11.715	1.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	11.720	0.00	0.05	1.04	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	11.785	0.00	0.04	1.30	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	11.794	0.00	0.06	1.05	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
56	11.796	0.00	0.06	1.32	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	11.881	1.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	11.898	0.04	1.29	0.37	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
59	11.913	0.01	0.22	1.16	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	11.930	0.07	1.38	0.19	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
61	11.982	0.04	1.36	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
62	11.989	0.00	0.08	1.09	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	12.046	0.00	0.04	1.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
64	12.066	0.01	0.22	1.13	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	12.070	0.01	0.39	1.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	12.075	0.07	1.34	0.65	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	12.105	0.06	1.31	0.25	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	12.168	0.00	0.06	1.05	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
69	12.172	0.01	0.14	1.11	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	12.186	0.00	0.03	1.05	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	12.193	0.01	0.25	1.30	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
72	12.231	0.27	1.29	0.30	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
73	12.237	1.21	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	12.240	0.12	0.19	1.12	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
75	12.257	0.01	0.01	0.01	0.52	0.24	0.03	0.00	0.00	0.00	0.00	0.01	0.02	0.83	1.30
76	12.311	0.02	0.22	1.27	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
77	12.319	0.10	1.36	0.51	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	12.344	0.01	0.14	1.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	12.384	0.09	1.10	1.01	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	12.388	0.14	1.43	0.97	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	12.411	1.08	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	12.415	0.04	0.17	1.05	0.45	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
83	12.430	0.07	0.32	1.03	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	12.434	0.92	1.34	0.32	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
85	12.435	1.05	0.21	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	12.457	0.02	0.29	0.91	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	12.487	1.01	0.02	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
88	12.492	0.02	0.01	0.01	0.59	1.27	0.11	0.01	0.00	0.00	0.00	0.00	0.01	0.26	1.30
89	12.496	0.10	1.27	0.79	0.13	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06
90	12.512	0.03	0.58	1.04	0.37	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
91	12.525	0.03	0.53	1.12	0.49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
92	12.538	0.02	0.32	1.16	0.48	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
93	12.576	0.02	0.24	1.14	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	12.589	1.00	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95	12.592	0.15	0.35	1.13	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	12.603	0.01	0.13	1.13	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	12.641	0.08	1.37	0.76	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	12.716	0.07	1.30	0.56	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
99	12.766	0.01	0.08	1.08	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	12.771	1.04	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-5: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
101	12.780	0.01	0.09	1.08	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	12.795	1.07	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
103	12.802	0.02	0.15	1.05	0.31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104	12.806	0.01	0.27	1.13	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	12.831	1.14	0.14	0.10	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106	12.834	0.27	1.52	1.07	0.15	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
107	12.847	0.01	0.01	0.01	0.15	1.27	0.46	0.01	0.00	0.00	0.00	0.00	0.00	0.13	0.84
108	12.858	1.07	0.05	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
109	12.862	0.30	0.90	1.07	0.49	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
110	12.876	0.04	0.45	1.11	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	12.878	0.07	1.05	1.12	0.28	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
112	12.905	0.03	0.69	1.04	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
113	12.923	0.04	1.38	0.66	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	12.935	0.02	0.45	1.04	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	12.961	0.07	1.37	0.84	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	12.966	0.01	0.23	1.13	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
117	12.971	0.01	0.27	1.05	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118	13.020	0.02	0.59	1.06	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
119	13.024	0.03	0.71	1.14	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	13.029	0.02	0.60	1.08	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
121	13.037	0.05	1.11	1.10	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122	13.063	1.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
123	13.082	0.02	0.39	1.11	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
124	13.105	1.04	0.85	0.53	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	13.105	1.04	0.17	0.10	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
126	13.182	0.01	0.31	1.08	0.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
127	13.190	0.01	0.40	0.91	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
128	13.204	0.00	0.00	0.01	0.20	1.27	0.71	0.01	0.00	0.00	0.00	0.00	0.01	0.10	0.62
129	13.222	0.02	0.45	1.13	0.44	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	13.250	0.01	0.23	1.09	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
131	13.272	0.01	0.24	1.27	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
132	13.284	0.01	0.30	1.01	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
133	13.292	0.04	1.35	0.57	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
134	13.328	0.05	0.79	1.13	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135	13.337	0.01	0.24	1.07	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
136	13.359	1.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
137	13.372	0.05	0.48	1.10	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
138	13.379	0.04	0.28	1.02	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
139	13.399	0.03	0.25	1.20	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	13.406	1.12	0.09	0.15	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	13.408	0.77	0.70	1.08	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
142	13.425	0.14	1.23	0.80	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
143	13.441	0.01	0.27	1.27	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
144	13.458	0.13	1.29	0.65	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
145	13.484	0.04	1.24	0.71	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
146	13.495	0.02	0.54	1.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147	13.543	0.03	0.43	1.11	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
148	13.558	0.06	1.32	0.87	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
149	13.593	0.01	0.55	1.13	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150	13.599	0.02	0.57	1.15	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-5: Refueling Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (concluded)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
151	13.636	0.03	1.28	0.88	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
152	13.667	0.00	0.14	1.12	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
153	13.692	0.01	0.22	1.01	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
154	13.702	0.01	0.29	1.11	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
155	13.717	0.06	1.19	0.65	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
156	13.726	0.08	1.13	1.05	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157	13.750	0.01	0.29	1.05	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
158	13.753	0.06	1.30	0.92	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
159	13.767	0.03	0.38	1.06	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	13.791	0.06	0.73	1.08	0.27	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
161	13.803	0.34	1.43	0.95	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
162	13.825	1.03	0.04	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
163	13.841	0.30	0.83	1.04	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
164	13.851	1.01	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
165	13.867	0.12	0.79	1.10	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
166	13.880	0.05	1.10	1.08	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
167	13.890	0.03	0.50	1.18	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
168	13.932	0.05	1.18	0.62	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
169	13.937	0.06	0.62	1.02	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
170	13.970	0.08	0.96	1.02	0.26	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
171	13.974	0.03	0.39	1.01	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
172	13.984	0.01	0.15	1.01	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
173	14.017	0.04	0.72	1.04	0.41	0.34	0.07	0.00	0.00	0.00	0.01	0.01	0.07	0.20	0.45
174	14.020	0.01	0.04	0.05	0.21	0.98	0.22	0.00	0.00	0.00	0.01	0.02	0.17	0.57	1.28
175	14.041	0.03	0.67	1.02	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
176	14.059	0.05	1.42	0.85	0.25	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
177	14.104	0.03	0.62	0.90	0.31	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.01
178	14.113	0.02	0.39	0.87	0.25	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.01
179	14.114	0.00	0.01	0.01	0.31	0.20	0.10	0.00	0.00	0.00	0.02	0.02	0.65	1.27	0.20
180	14.138	0.03	0.70	1.13	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
181	14.148	0.05	1.34	0.81	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
182	14.152	0.05	0.82	0.91	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
183	14.196	0.03	0.29	1.05	0.36	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
184	14.211	0.07	0.31	1.03	0.30	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
185	14.217	0.05	0.25	1.01	0.27	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
186	14.228	1.06	0.28	0.73	0.19	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
187	14.230	1.08	0.16	0.35	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
188	14.249	0.06	0.52	1.08	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
189	14.268	0.09	1.20	1.09	0.35	0.22	0.15	0.01	0.00	0.00	0.00	0.00	0.01	0.03	0.07
190	14.278	0.03	0.25	1.02	0.27	0.11	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03
191	14.281	0.01	0.02	0.02	0.50	1.31	0.88	0.03	0.01	0.01	0.02	0.02	0.05	0.20	0.39
192	14.328	1.02	0.06	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
193	14.338	0.46	1.16	0.79	0.21	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
194	14.347	0.06	0.50	1.08	0.33	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
195	14.378	0.12	0.50	1.00	0.28	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
196	14.384	1.00	0.02	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
197	14.391	0.11	0.75	0.89	0.19	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
198	14.410	0.12	0.87	1.05	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
199	14.439	0.38	1.16	1.07	0.39	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
200	14.445	1.01	0.05	0.07	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-6: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 2

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
1	6.534	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6.634	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	6.667	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	6.749	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.782	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6.805	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	6.843	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	6.934	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
9	6.965	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
10	6.992	0.01	0.01	0.02	0.18	1.00	0.16	0.02	0.01	0.01	0.01	0.02	0.05	0.78	1.26
11	7.052	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	7.154	0.00	0.00	0.00	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
13	7.167	0.00	0.00	0.00	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
14	7.275	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	7.281	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	7.335	0.00	0.00	0.01	0.15	1.17	0.28	0.02	0.00	0.00	0.00	0.00	0.03	0.87	1.26
17	7.351	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
18	7.353	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	7.356	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	7.423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	7.516	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
22	7.609	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	7.656	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	7.733	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	7.791	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	7.802	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	7.830	0.01	0.02	0.02	0.33	1.23	0.86	0.05	0.01	0.02	0.05	0.04	0.10	0.86	1.30
28	7.925	0.00	0.00	0.00	0.13	0.43	0.30	0.01	0.00	0.00	0.01	0.01	0.03	0.31	0.47
29	7.941	0.00	0.00	0.00	0.03	0.12	0.09	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.09
30	8.071	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	8.134	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00
32	8.172	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	8.208	0.01	0.01	0.02	0.30	0.03	0.01	0.01	0.02	0.25	1.26	1.24	0.23	0.06	0.03
34	8.242	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.02
35	8.304	0.00	0.01	0.01	0.41	1.29	0.33	0.01	0.00	0.01	0.02	0.02	0.14	0.68	1.29
36	8.309	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
37	8.359	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	8.365	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
39	8.382	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
40	8.445	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01
41	8.469	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	8.589	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	8.602	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	8.669	0.00	0.00	0.00	0.03	0.02	0.01	0.00	0.00	0.00	0.01	0.03	0.09	0.11	0.03
45	8.678	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.03	0.09	0.11	0.02
46	8.697	0.00	0.01	0.01	0.19	0.12	0.08	0.01	0.00	0.02	0.08	0.23	0.72	0.89	0.20
47	8.705	0.00	0.00	0.00	0.04	0.02	0.02	0.00	0.00	0.00	0.01	0.03	0.13	0.17	0.04
48	8.809	0.00	0.00	0.00	0.03	0.20	0.10	0.01	0.00	0.00	0.00	0.01	0.01	0.06	0.18
49	8.809	0.00	0.00	0.00	0.09	0.68	0.34	0.03	0.00	0.00	0.01	0.03	0.03	0.19	0.60
50	8.856	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-6: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
51	8.932	0.00	0.01	0.01	0.36	1.31	0.96	0.07	0.01	0.09	0.11	0.15	0.15	0.23	0.53
52	8.979	0.00	0.00	0.01	0.30	0.21	0.15	0.01	0.06	1.06	1.26	1.08	1.08	0.35	0.10
53	9.017	0.01	0.02	0.02	0.32	0.07	0.02	0.02	0.08	1.09	1.26	1.23	1.23	0.41	0.06
54	9.040	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.05	0.02	0.00
55	9.109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00
56	9.127	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	9.130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
58	9.164	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	9.175	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	9.207	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	9.229	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
62	9.292	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	9.326	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
64	9.382	0.01	0.01	0.01	0.46	0.01	0.00	0.00	0.01	0.43	1.30	1.26	0.18	0.02	0.01
65	9.522	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	9.542	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
67	9.618	0.00	0.00	0.00	0.13	0.01	0.01	0.00	0.00	0.01	0.01	0.06	0.30	0.43	0.02
68	9.620	0.00	0.00	0.01	0.15	0.01	0.01	0.00	0.00	0.01	0.01	0.07	0.35	0.51	0.02
69	9.645	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.01
70	9.709	0.00	0.00	0.00	0.02	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.06
71	9.797	0.00	0.00	0.00	0.02	0.11	0.04	0.03	0.00	0.00	0.00	0.00	0.02	0.11	0.12
72	9.817	0.00	0.00	0.00	0.06	0.47	0.20	0.05	0.01	0.01	0.01	0.02	0.10	0.39	0.45
73	9.886	0.00	0.00	0.00	0.02	0.07	0.05	0.03	0.00	0.00	0.00	0.01	0.02	0.05	0.08
74	9.965	0.00	0.00	0.00	0.02	0.03	0.04	0.02	0.01	0.00	0.00	0.01	0.02	0.03	0.03
75	10.051	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
76	10.058	0.02	0.01	0.01	0.20	0.03	0.01	0.01	0.01	0.09	0.20	0.64	0.64	0.04	0.05
77	10.066	0.00	0.00	0.00	0.04	0.03	0.02	0.00	0.00	0.02	0.04	0.13	0.13	0.03	0.04
78	10.108	0.00	0.00	0.00	0.12	0.64	0.51	0.25	0.03	0.05	0.05	0.01	0.06	0.48	0.63
79	10.147	0.12	0.01	0.01	0.42	0.04	0.02	0.03	0.13	1.09	1.31	0.22	0.14	0.03	0.03
80	10.151	1.08	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.00	0.00	0.00
81	10.216	0.00	0.00	0.00	0.02	0.11	0.07	0.02	0.01	0.00	0.00	0.00	0.01	0.07	0.09
82	10.262	0.00	0.00	0.00	0.02	0.09	0.05	0.02	0.00	0.01	0.01	0.01	0.01	0.06	0.07
83	10.384	0.00	0.00	0.00	0.02	0.03	0.05	0.04	0.01	0.01	0.00	0.00	0.03	0.04	0.06
84	10.453	0.01	0.01	0.02	0.26	0.34	1.23	0.97	0.13	0.07	0.05	0.03	0.07	0.31	0.31
85	10.488	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.02	0.02	0.01	0.01	0.01
86	10.558	0.00	0.00	0.00	0.01	0.03	0.03	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.03
87	10.599	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	10.676	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	10.740	0.00	0.00	0.01	0.24	0.49	0.26	0.22	0.06	0.08	0.26	0.29	0.38	0.80	0.53
90	10.778	0.01	0.00	0.01	0.21	0.21	0.09	0.08	0.39	0.39	1.13	1.24	0.65	0.37	0.25
91	10.794	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	10.804	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.04	0.04	0.06	0.06	0.03	0.01	0.00
93	10.855	0.00	0.00	0.00	0.02	0.03	0.02	0.02	0.06	0.06	0.03	0.03	0.02	0.07	0.05
94	10.919	0.01	0.01	0.01	0.22	0.47	0.44	0.22	0.71	0.71	0.16	0.15	0.10	0.26	0.35
95	10.940	1.28	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
96	10.943	0.04	0.01	0.01	0.20	0.62	0.58	0.29	0.64	0.64	0.14	0.14	0.08	0.37	0.40
97	11.049	0.00	0.00	0.00	0.04	0.01	0.01	0.03	0.14	0.14	0.02	0.03	0.01	0.01	0.01
98	11.082	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
99	11.149	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
100	11.258	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.02	0.01	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-6: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (continued)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
101	11.285	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.05	0.03	0.01
102	11.419	0.00	0.00	0.00	0.06	0.14	0.13	0.08	0.08	0.09	0.18	0.44	0.54	0.35	0.15
103	11.423	0.00	0.00	0.00	0.01	0.03	0.03	0.02	0.02	0.01	0.03	0.09	0.11	0.07	0.03
104	11.482	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	11.495	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106	11.502	0.00	0.00	0.00	0.02	0.03	0.03	0.05	0.05	0.02	0.02	0.08	0.10	0.07	0.03
107	11.579	0.01	0.02	0.02	0.41	0.20	1.11	1.26	1.25	0.40	0.10	0.09	0.11	0.14	0.14
108	11.648	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
109	11.680	0.00	0.01	0.01	0.33	1.09	1.27	0.48	0.07	0.20	0.23	0.66	0.79	0.85	0.87
110	11.693	0.00	0.00	0.00	0.02	0.06	0.07	0.05	0.02	0.02	0.02	0.04	0.05	0.05	0.04
111	11.732	0.00	0.00	0.00	0.02	0.01	0.05	0.05	0.03	0.05	0.05	0.05	0.01	0.01	0.01
112	11.877	0.01	0.01	0.01	0.36	0.16	1.31	1.13	1.06	0.25	0.23	0.20	0.37	0.30	0.15
113	11.937	0.00	0.00	0.01	0.22	0.44	0.52	0.50	0.46	0.35	0.35	0.66	1.26	1.02	0.47
114	12.080	0.00	0.00	0.01	0.25	0.08	0.11	0.19	0.40	1.27	1.15	1.12	0.48	0.31	0.13
115	12.161	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	12.237	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
117	12.303	0.01	0.01	0.01	0.36	0.88	1.30	0.49	0.15	0.07	0.08	0.09	0.23	0.83	1.06
118	12.319	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
119	12.369	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	12.387	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
121	12.390	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122	12.411	0.01	0.00	0.01	0.24	0.09	0.11	0.07	0.70	0.93	1.19	1.30	0.72	0.15	0.10
123	12.423	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
124	12.462	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	12.517	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
126	12.528	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
127	12.571	0.01	0.01	0.02	0.37	0.07	0.04	0.11	1.30	1.31	0.46	0.28	0.24	0.05	0.09
128	12.599	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
129	12.712	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	12.758	0.01	0.02	0.02	0.45	0.93	0.46	0.15	0.11	0.11	0.06	0.25	0.58	0.59	1.28
131	12.784	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.04
132	12.805	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
133	12.889	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.04	0.03	0.01
134	12.906	0.00	0.00	0.00	0.04	0.04	0.03	0.00	0.00	0.02	0.03	0.07	0.15	0.11	0.03
135	12.911	0.00	0.00	0.00	0.12	0.12	0.07	0.01	0.01	0.05	0.10	0.19	0.41	0.28	0.10
136	12.917	0.00	0.00	0.00	0.08	0.10	0.06	0.01	0.01	0.04	0.07	0.14	0.28	0.19	0.09
137	12.983	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.01	0.02	0.03	0.05	0.05	0.04	0.03
138	12.991	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01
139	13.009	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
140	13.023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	13.069	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.01	0.01
142	13.070	1.20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
143	13.079	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
144	13.102	0.01	0.00	0.01	0.20	0.20	0.13	0.13	0.17	0.44	0.68	1.29	1.28	0.44	0.25
145	13.132	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.06	0.07	0.02	0.01
146	13.184	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01
147	13.228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
148	13.273	1.30	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
149	13.297	0.01	0.01	0.02	0.37	0.15	0.10	1.31	1.31	0.29	0.12	0.08	0.08	0.11	0.15
150	13.312	0.00	0.00	0.00	0.02	0.00	0.00	0.06	0.06	0.01	0.01	0.00	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-6: Flooding Case Load Factors and Maximum Displacements[1], Sensitivity Case 2 (concluded)

Mode #	Load Factor	Cylinder	Sphere			Sandbed Region									
			Upper	Middle	Lower	Bay 1	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13	Bay 15	Bay 17	Bay 19
151	13.319	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
152	13.319	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01
153	13.372	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
154	13.400	0.00	0.00	0.01	0.24	1.19	0.86	0.31	0.27	0.05	0.05	0.15	0.35	0.92	1.27
155	13.504	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
156	13.511	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157	13.552	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
158	13.577	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
159	13.590	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.02
160	13.622	1.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
161	13.665	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01
162	13.692	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
163	13.717	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
164	13.740	0.01	0.01	0.01	0.73	1.26	0.47	0.22	0.04	0.05	0.05	0.06	0.17	0.85	1.26
165	13.751	0.00	0.00	0.00	0.03	0.06	0.02	0.01	0.01	0.02	0.01	0.00	0.01	0.04	0.06
166	13.763	0.00	0.00	0.00	0.02	0.03	0.01	0.01	0.01	0.03	0.02	0.01	0.00	0.02	0.03
167	13.780	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.03	0.02	0.01	0.00	0.00	0.01
168	13.794	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
169	13.814	0.00	0.00	0.01	0.24	0.02	0.02	0.10	0.25	0.81	0.58	0.15	0.07	0.03	0.01
170	13.819	0.00	0.00	0.00	0.04	0.00	0.00	0.02	0.05	0.15	0.10	0.03	0.01	0.01	0.01
171	13.857	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
172	13.866	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
173	13.868	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.00	0.01	0.00	0.01
174	13.965	0.01	0.01	0.02	0.57	1.07	0.33	0.24	0.05	0.02	0.04	0.07	0.25	0.94	1.26
175	13.989	0.00	0.00	0.00	0.02	0.04	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.03	0.05
176	14.016	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
177	14.059	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
178	14.070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
179	14.083	0.00	0.01	0.01	0.25	1.15	1.27	0.88	0.13	0.07	0.09	0.12	0.40	0.98	0.93
180	14.129	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
181	14.151	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
182	14.225	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00
183	14.252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
184	14.257	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
185	14.301	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
186	14.308	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
187	14.315	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
188	14.367	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
189	14.386	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
190	14.390	1.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
191	14.404	0.01	0.00	0.00	0.07	0.13	0.15	0.13	0.11	0.11	0.05	0.04	0.03	0.08	0.10
192	14.418	0.01	0.00	0.01	0.46	0.85	1.10	0.93	0.28	0.26	0.14	0.11	0.16	0.50	0.65
193	14.430	0.01	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.05	0.02	0.02	0.01	0.00	0.01
194	14.434	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
195	14.503	0.00	0.00	0.00	0.01	0.03	0.03	0.04	0.10	0.09	0.05	0.03	0.02	0.02	0.02
196	14.516	0.00	0.00	0.00	0.06	0.07	0.07	0.13	0.31	0.30	0.18	0.14	0.09	0.04	0.05
197	14.527	0.00	0.00	0.00	0.02	0.01	0.02	0.04	0.10	0.10	0.06	0.05	0.03	0.01	0.01
198	14.560	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00
199	14.571	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
200	14.617	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

Note: (1) The displacement represents the vector sum of buckling mode shapes.

Table 5-7: Buckling Load Factors

Region		Sensitivity Case 1				Sensitivity Case 2			
		Refueling Case		Flooding Case		Refueling Case		Flooding Case	
		Buckling Mode	Load Factor	Buckling Mode	Load Factor	Buckling Mode	Load Factor	Buckling Mode	Load Factor
Cylindrical		1	7.227	57	9.139	1	7.224	56	9.127
Spherical	Upper	15	9.798	200 (1)	14.664	15	9.795	200 (1)	14.617
	Middle	26	10.651	200 (1)	14.664	25	10.649	200 (1)	14.617
	Lower	24	10.506	10	7.054	32	11.146	10	6.992
Bay 1		24	10.506	10	7.054	35	11.345	9	6.965
Bay 3		24	10.506	10	7.054	35	11.345	9	6.965
Bay 5		24	10.506	10	7.054	35	11.345	9	6.965
Bay 7		24	10.506	10	7.054	35	11.345	9	6.965
Bay 9		24	10.506	10	7.054	35	11.345	9	6.965
Bay 11		24	10.506	10	7.054	35	11.345	9	6.965
Bay 13		24	10.506	10	7.054	35	11.345	9	6.965
Bay 15		24	10.506	10	7.054	35	11.345	9	6.965
Bay 17		24	10.506	10	7.054	35	11.345	9	6.965
Bay 19		24	10.506	10	7.054	35	11.345	9	6.965

Note: (1) With reference to Table 5-4 and Table 5-6, no significant mode (up to 200) is identified for these regions. Conservatively, the load factor for mode 200 is used.

Table 5-8: Refueling Buckling Evaluation, Sensitivity Case 1

Region	Cylindrical	Spherical		
		Upper	Middle	Lower
R, Shell Radius (in)	198	420	420	420
t, Wall Thickness (in)	0.604	0.676	0.678	1.160
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000
λ, Load Factor (1)	7.227	9.798	10.651	10.506
α/α_{1L}, Capacity Reduction Factor	0.330	0.362	0.207	0.244
σ_1, Meridional Compressive Stress (ksi)	3.41	3.91	4.78	4.52
σ_2, Hoop Tension Stress (ksi)	8.86	2.29	4.61	4.22
Pbar	0.100	0.049	0.098	0.053
α_p, Capacity Reduction Factor (due to tensile effect)	0.133	0.074	0.131	0.079
α_m, Modified Capacity Reduction Factor	0.463	0.436	0.338	0.323
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.314	0.460	0.474	0.422
η, Plasticity Reduction Factor	1.000	1.000	1.000	1.000
σ_{ic}, Theoretical Buckling Stress (ksi)	11.40	16.72	17.22	15.33
SF, Safety Factor	3.34	4.27	3.60	3.39

Notes: (1) The load factor is taken from Table 5-7.

Table 5-9: Flooding Buckling Evaluation, Sensitivity Case 1

Region	Cylindrical	Spherical		
		Upper	Middle	Lower
R, Shell Radius (in)	198	420	420	420
t, Wall Thickness (in)	0.604	0.676	0.678	1.160
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000
λ, Load Factor (1)	9.139	14.664	14.664	7.054
α/α_{1L}, Capacity Reduction Factor	0.330	0.362	0.207	0.244
σ_1, Meridional Compressive Stress (ksi)	2.61	2.65	4.73	10.50
σ_2, Hoop Tension Stress (ksi)	2.66	6.66	16.15	22.61
Pbar	0.030	0.143	0.345	0.282
α_p, Capacity Reduction Factor (due to tensile effect)	0.048	0.171	0.285	0.258
α_m, Modified Capacity Reduction Factor	0.378	0.533	0.492	0.502
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.248	0.570	0.941	1.025
η, Plasticity Reduction Factor	1.000	0.970	0.658	0.619
σ_{ic}, Theoretical Buckling Stress (ksi)	9.02	20.06	22.48	23.03
SF, Safety Factor	3.45	7.58	4.75	2.19

Notes: (1) The load factor is taken from Table 5-7.

Table 5-10: Refueling Buckling Evaluation, Sensitivity Case 2

Region	Cylindrical	Spherical		
		Upper	Middle	Lower
R, Shell Radius (in)	198	420	420	420
t, Wall Thickness (in)	0.604	0.676	0.678	1.160
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000
λ, Load Factor (1)	7.224	9.795	10.649	11.146
α/α_{1L}, Capacity Reduction Factor	0.330	0.362	0.207	0.244
σ_1, Meridional Compressive Stress (ksi)	3.41	3.91	4.79	4.56
σ_2, Hoop Tension Stress (ksi)	8.86	2.29	4.61	4.23
Pbar	0.100	0.049	0.098	0.053
α_p, Capacity Reduction Factor (due to tensile effect)	0.133	0.074	0.131	0.079
α_m, Modified Capacity Reduction Factor	0.463	0.436	0.338	0.323
Δ, Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.314	0.461	0.474	0.452
η, Plasticity Reduction Factor	1.000	1.000	1.000	1.000
σ_{ic}, Theoretical Buckling Stress (ksi)	11.40	16.72	17.22	16.42
SF, Safety Factor	3.34	4.27	3.60	3.60

Notes: (1) The load factor is taken from Table 5-7.

Table 5-11: Flooding Buckling Evaluation, Sensitivity Case 2

Region	Cylindrical	Spherical		
		Upper	Middle	Lower
R, Shell Radius (in)	198	420	420	420
t, Wall Thickness (in)	0.604	0.676	0.678	1.160
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000
λ, Load Factor (1)	9.127	14.617	14.617	6.992
α/α_{1L}, Capacity Reduction Factor	0.330	0.362	0.207	0.244
σ_1, Meridional Compressive Stress (ksi)	2.61	2.65	4.73	10.46
σ_2, Hoop Tension Stress (ksi)	2.66	6.66	16.15	22.62
Pbar	0.030	0.143	0.345	0.282
α_p, Capacity Reduction Factor (due to tensile effect)	0.048	0.171	0.285	0.258
α_m, Modified Capacity Reduction Factor	0.378	0.533	0.492	0.502
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.248	0.569	0.938	1.012
η, Plasticity Reduction Factor	1.000	0.970	0.660	0.625
σ_{ic}, Theoretical Buckling Stress (ksi)	9.00	20.06	22.47	22.95
SF, Safety Factor	3.45	7.56	4.75	2.19

Notes: (1) The load factor is taken from Table 5-7.

Table 5-12: Refueling Buckling Evaluation, Sandbed Region, Sensitivity Case 1

	Bay 1[1]	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13[1]	Bay 15[1]	Bay 17[1]	Bay 19[1]
R, Shell Radius (in)	420	420	420	420	420	420	420	420	420	420
t, Wall Thickness (in)	0.596	0.950	1.074	1.034	0.993	0.860	0.658	0.711	0.663	0.720
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000
λ, Load Factor[2]	10.506	10.506	10.506	10.506	10.506	10.506	10.506	10.506	10.506	10.506
α/α_{1L}, Capacity Reduction Factor	0.207	0.229	0.238	0.235	0.232	0.223	0.207	0.210	0.207	0.211
σ_1, Meridional Compressive Stress (ksi)	5.20	4.76	4.38	4.37	4.13	4.42	4.73	4.76	5.51	5.24
σ_2, Hoop Tension Stress (ksi)	3.80	3.33	3.38	3.45	3.44	3.93	3.96	3.82	4.60	4.03
Pbar	0.092	0.051	0.046	0.048	0.050	0.066	0.087	0.078	0.100	0.081
α_p, Capacity Reduction Factor (due to tensile effect)	0.124	0.076	0.070	0.073	0.076	0.096	0.119	0.109	0.133	0.112
α_m, Modified Capacity Reduction Factor	0.331	0.305	0.308	0.308	0.308	0.319	0.326	0.319	0.340	0.323
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.499	0.420	0.390	0.390	0.368	0.408	0.446	0.440	0.542	0.490
η, Plasticity Reduction Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
σ_{ie}, Theoretical Buckling Stress (ksi)	18.11	15.26	14.16	14.15	13.36	14.80	16.19	15.96	19.66	17.80
SF, Safety Factor	3.48	3.21	3.23	3.24	3.23	3.35	3.43	3.35	3.57	3.40

Notes: (1) The thickness for these bays corresponds to the locally thinned area.

(2) The load factor is taken from Table 5-7.

Table 5-13: Flooding Buckling Evaluation, Sandbed Region, Sensitivity Case 1

	Bay 1(1)	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13(1)	Bay 15(1)	Bay 17(1)	Bay 19(1)
R, Shell Radius (in)	420	420	420	420	420	420	420	420	420	420
t, Wall Thickness (in)	0.596	0.950	1.074	1.034	0.993	0.860	0.658	0.711	0.663	0.720
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000
λ, Load Factor (2)	7.054	7.054	7.054	7.054	7.054	7.054	7.054	7.054	7.054	7.054
α/α_{1L}, Capacity Reduction Factor	0.207	0.229	0.238	0.235	0.232	0.223	0.207	0.210	0.207	0.211
σ_1, Meridional Compressive Stress (ksi)	11.80	9.45	9.95	10.04	10.20	11.18	11.34	10.13	11.44	12.25
σ_2, Hoop Tension Stress (ksi)	26.08	19.18	17.55	18.10	18.82	21.38	20.85	21.10	25.52	21.96
Pbar	0.634	0.292	0.237	0.253	0.274	0.360	0.459	0.430	0.557	0.442
α_p, Capacity Reduction Factor (due to tensile effect)	0.364	0.263	0.235	0.244	0.255	0.291	0.323	0.315	0.348	0.318
α_m, Modified Capacity Reduction Factor	0.571	0.492	0.473	0.479	0.487	0.514	0.530	0.525	0.555	0.529
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	1.309	0.904	0.914	0.935	0.964	1.117	1.168	1.033	1.234	1.260
η, Plasticity Reduction Factor	0.524	0.678	0.672	0.661	0.647	0.583	0.565	0.615	0.545	0.537
σ_{ic}, Theoretical Buckling Stress (ksi)	24.89	22.24	22.31	22.44	22.64	23.63	23.97	23.09	24.40	24.57
SF, Safety Factor	2.11	2.35	2.24	2.23	2.22	2.11	2.11	2.28	2.13	2.01

Notes: (1) The thickness for these bays corresponds to the locally thinned area.

(2) The load factor is taken from Table 5-7.

Table 5-14: Refueling Buckling Evaluation, Sandbed Region, Sensitivity Case 2

	Bay 1[1]	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13[1]	Bay 15[1]	Bay 17[1]	Bay 19[1]
R, Shell Radius (in)	420	420	420	420	420	420	420	420	420	420
t, Wall Thickness (in)	0.696	0.950	1.074	1.034	0.993	0.860	0.658	0.711	0.663	0.720
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000
λ, Load Factor [2]	11.345	11.345	11.345	11.345	11.345	11.345	11.345	11.345	11.345	11.345
α/α_{1L}, Capacity Reduction Factor	0.209	0.229	0.238	0.235	0.232	0.223	0.207	0.210	0.207	0.211
σ_1, Meridional Compressive Stress (ksi)	5.03	4.75	4.38	4.37	4.14	4.42	4.73	4.77	5.51	5.42
σ_2, Hoop Tension Stress (ksi)	3.82	3.33	3.38	3.45	3.44	3.93	3.96	3.82	4.60	4.13
Pbar	0.079	0.051	0.046	0.048	0.050	0.066	0.087	0.078	0.101	0.083
α_p, Capacity Reduction Factor (due to tensile effect)	0.111	0.076	0.070	0.073	0.076	0.096	0.119	0.109	0.133	0.115
α_m, Modified Capacity Reduction Factor	0.320	0.305	0.308	0.308	0.308	0.319	0.326	0.319	0.340	0.326
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	0.502	0.453	0.421	0.421	0.398	0.440	0.482	0.475	0.585	0.552
η, Plasticity Reduction Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.949	0.995
σ_{ie}, Theoretical Buckling Stress (ksi)	18.23	16.45	15.30	15.29	14.43	15.99	17.49	17.24	20.16	19.94
SF, Safety Factor	3.63	3.46	3.49	3.50	3.49	3.61	3.70	3.62	3.66	3.68

Notes: (1) The thickness for these bays corresponds to the locally thinned area.

(2) The load factor is taken from Table 5-7.

Table 5-15: Flooding Buckling Evaluation, Sandbed Region, Sensitivity Case 2

	Bay 1[1]	Bay 3	Bay 5	Bay 7	Bay 9	Bay 11	Bay 13[1]	Bay 15[1]	Bay 17[1]	Bay 19[1]
R, Shell Radius (in)	420	420	420	420	420	420	420	420	420	420
t, Wall Thickness (in)	0.696	0.950	1.074	1.034	0.993	0.860	0.658	0.711	0.663	0.720
σ_y, Yield Strength (ksi)	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
E, Young's Modulus (ksi)	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000
λ, Load Factor[2]	6.965	6.965	6.965	6.965	6.965	6.965	6.965	6.965	6.965	6.965
α/α_{1L}, Capacity Reduction Factor	0.209	0.229	0.238	0.235	0.232	0.223	0.207	0.210	0.207	0.211
σ_1, Meridional Compressive Stress (ksi)	11.79	9.46	9.96	10.05	10.21	11.19	11.34	10.14	11.44	12.52
σ_2, Hoop Tension Stress (ksi)	23.33	19.18	17.55	18.10	18.82	21.38	20.86	21.10	25.53	23.15
Pbar	0.485	0.292	0.237	0.254	0.275	0.360	0.459	0.430	0.558	0.466
α_p, Capacity Reduction Factor (due to tensile effect)	0.331	0.263	0.235	0.244	0.255	0.291	0.323	0.315	0.348	0.325
α_m, Modified Capacity Reduction Factor	0.540	0.492	0.473	0.479	0.487	0.514	0.530	0.525	0.555	0.536
Δ , Parameter ($= \alpha_m \lambda \sigma_1 / \sigma_y$)	1.220	0.893	0.903	0.923	0.953	1.104	1.154	1.021	1.219	1.288
η, Plasticity Reduction Factor	0.549	0.684	0.678	0.667	0.652	0.588	0.570	0.621	0.549	0.529
σ_{ie}, Theoretical Buckling Stress (ksi)	24.31	22.17	22.24	22.37	22.56	23.55	23.88	23.00	24.30	24.75
SF, Safety Factor	2.06	2.34	2.23	2.23	2.21	2.10	2.11	2.27	2.12	1.98

Notes: (1) The thickness for these bays corresponds to the locally thinned area.

(2) The load factor is taken from Table 5-7.

Table 5-16: Comparison of Load Factors

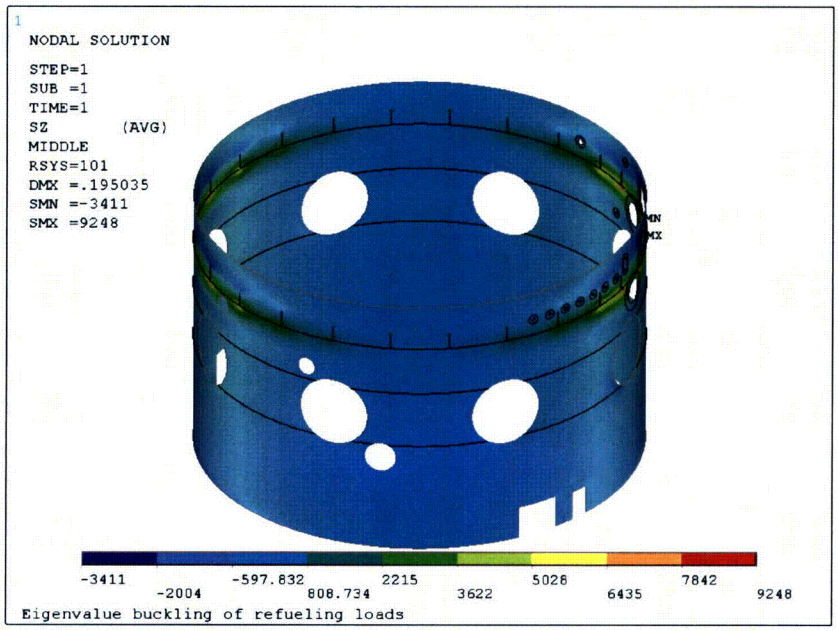
Load Case	Region	Base Case	Sensitivity Case 1	Sensitivity Case 2
Refueling	Cylindrical Shell	7.229	7.227	7.224
	Upper Spherical Shell	9.800	9.798	9.795
	Middle Spherical Shell	10.652	10.651	10.649
	Lower Spherical Shell	11.150	10.506	11.146
	Sandbed	11.584	10.506	11.345
Flooding	Cylindrical Shell	9.148	9.139	9.127
	Upper Spherical Shell	14.704	14.664	14.617
	Middle Spherical Shell	14.704	14.664	14.617
	Lower Spherical Shell	7.344	7.054	6.992
	Sandbed	7.162	7.054	6.965

Table 5-17: Comparison of Sandbed Region Buckling Safety Factors, Refueling

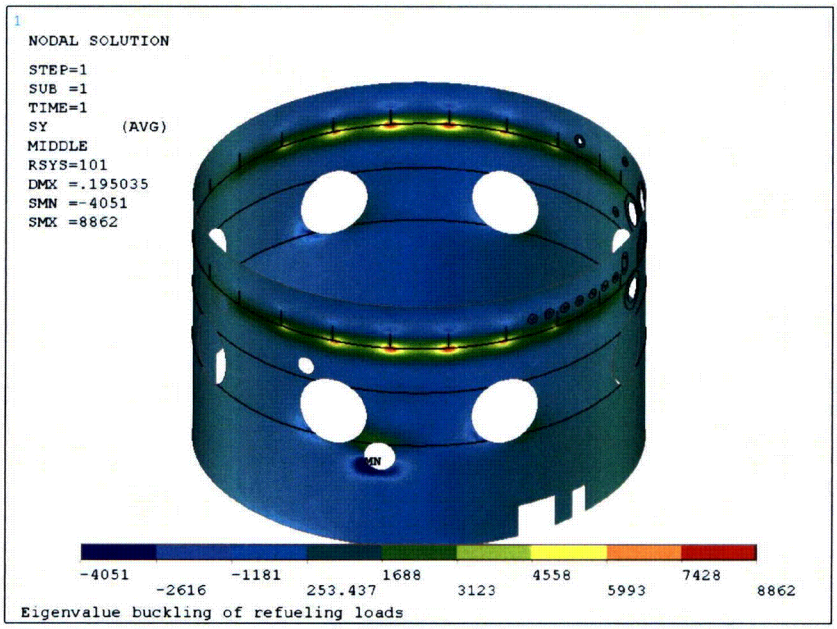
Region	Base Case	Sensitivity Case 1	Sensitivity Case 2	Level A/B Allowable
Bay 1	3.70	3.48	3.63	2.00
Bay 3	3.54	3.21	3.46	2.00
Bay 5	3.56	3.23	3.49	2.00
Bay 7	3.57	3.24	3.50	2.00
Bay 9	3.56	3.23	3.49	2.00
Bay 11	3.69	3.35	3.61	2.00
Bay 13	3.78	3.43	3.70	2.00
Bay 15	3.69	3.35	3.62	2.00
Bay 17	3.67	3.57	3.66	2.00
Bay 19	3.74	3.40	3.68	2.00

Table 5-18: Comparison of Sandbed Region Buckling Safety Factors, Flooding

Region	Base Case	Sensitivity Case 1	Sensitivity Case 2	Level C Allowable
Bay 1	2.08	2.11	2.06	1.67
Bay 3	2.36	2.35	2.34	1.67
Bay 5	2.25	2.24	2.23	1.67
Bay 7	2.24	2.23	2.23	1.67
Bay 9	2.23	2.22	2.21	1.67
Bay 11	2.12	2.11	2.10	1.67
Bay 13	2.13	2.11	2.11	1.67
Bay 15	2.29	2.28	2.27	1.67
Bay 17	2.14	2.13	2.12	1.67
Bay 19	2.02	2.01	1.98	1.67

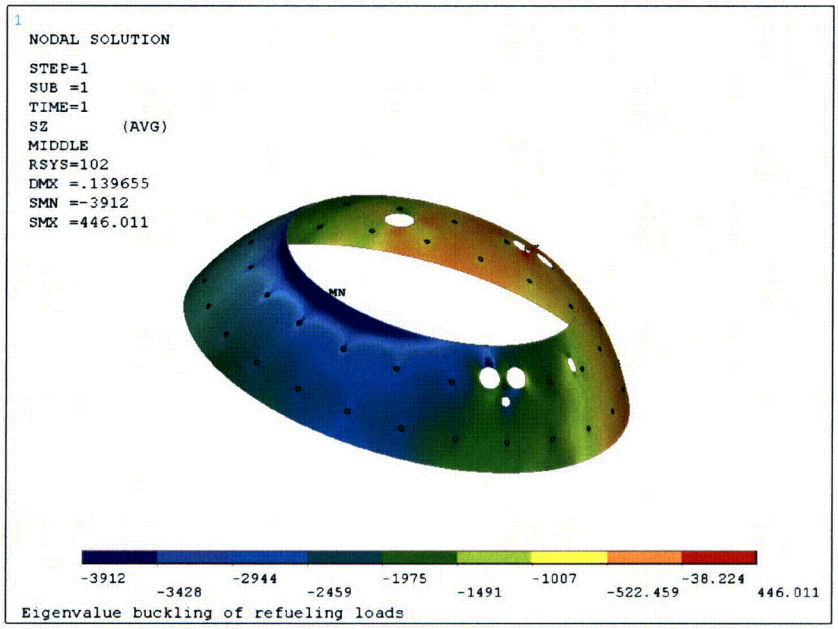


(a) Axial Stress

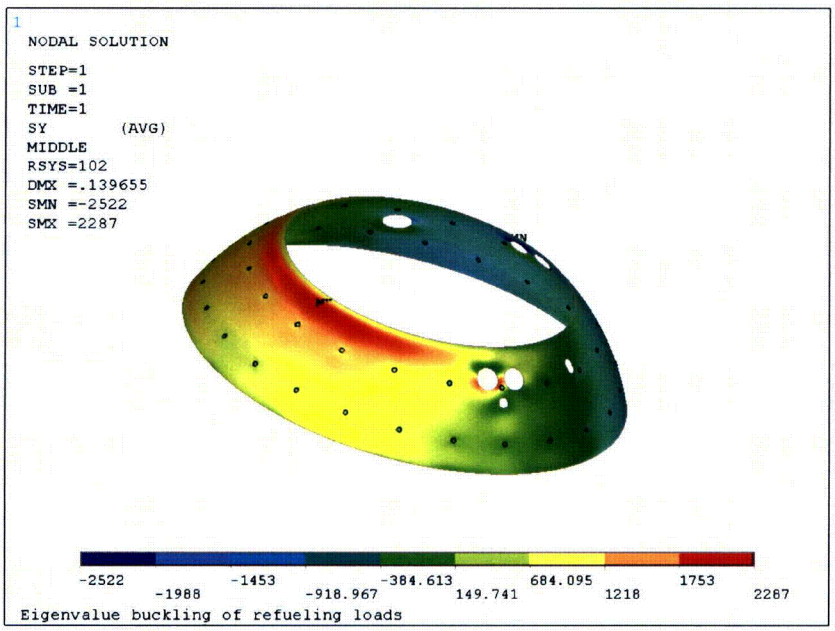


(b) Hoop Stress

Figure 5-1: Refueling Buckling Stress, Cylindrical Region, Sensitivity Case 1

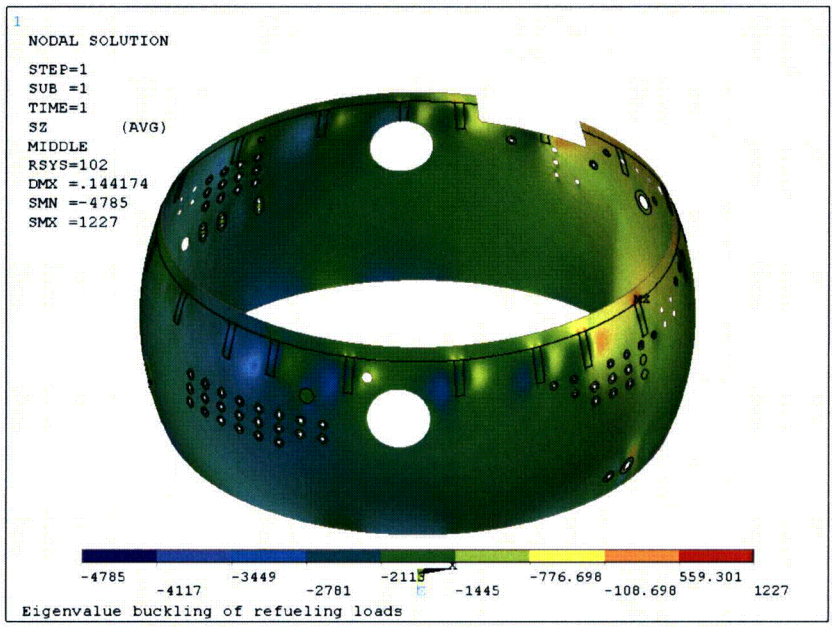


(a) Meridional Stress

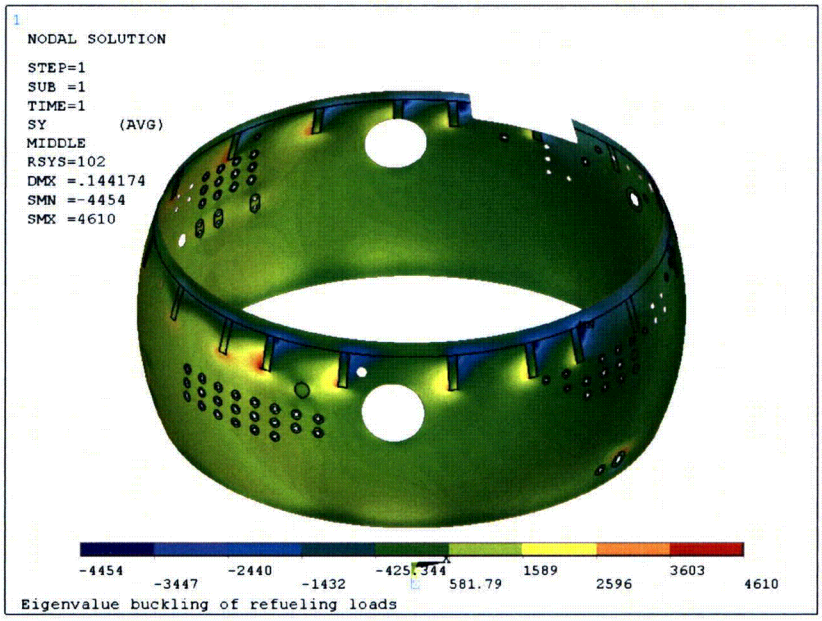


(b) Hoop Stress

Figure 5-2: Refueling Buckling Stress, Upper Spherical Region, Sensitivity Case 1

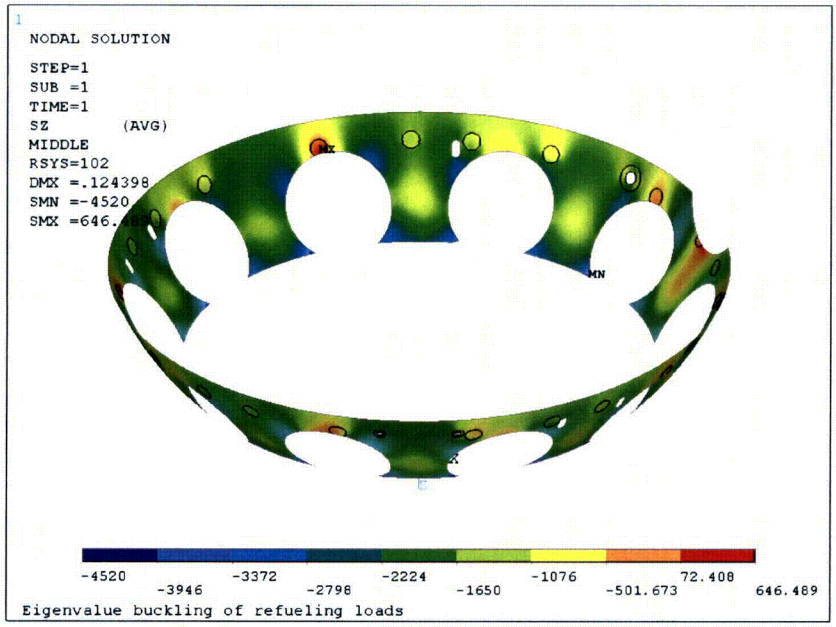


(a) Meridional Stress

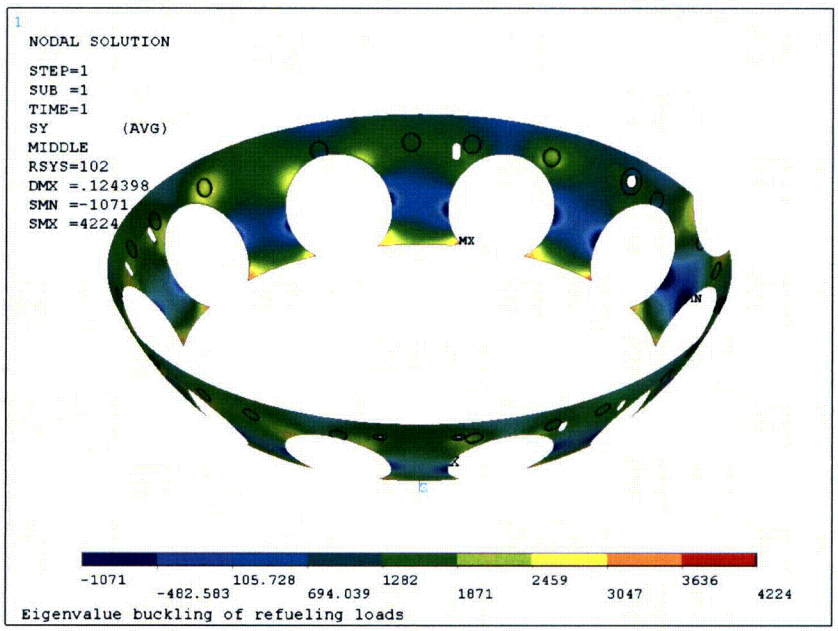


(b) Hoop Stress

Figure 5-3: Refueling Buckling Stress, Middle Spherical Region, Sensitivity Case 1

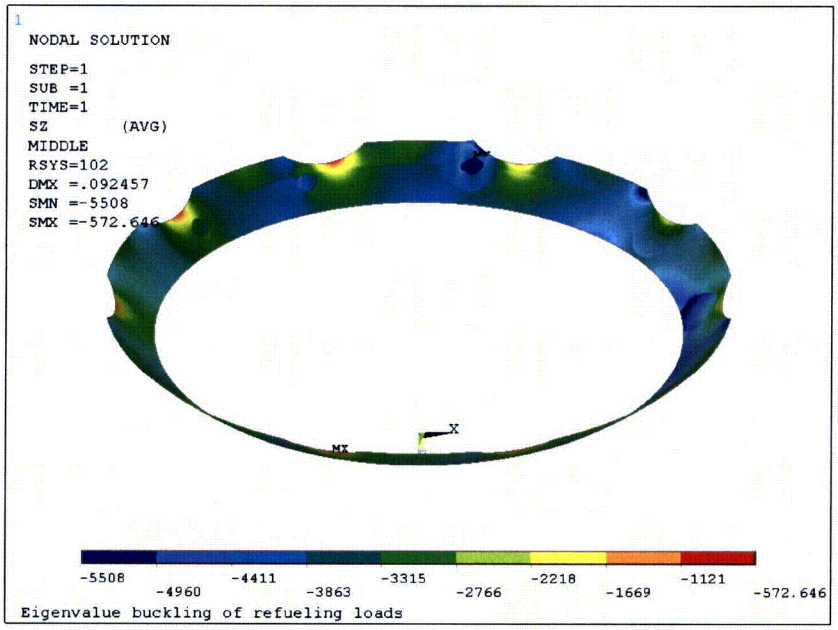


(a) Meridional Stress

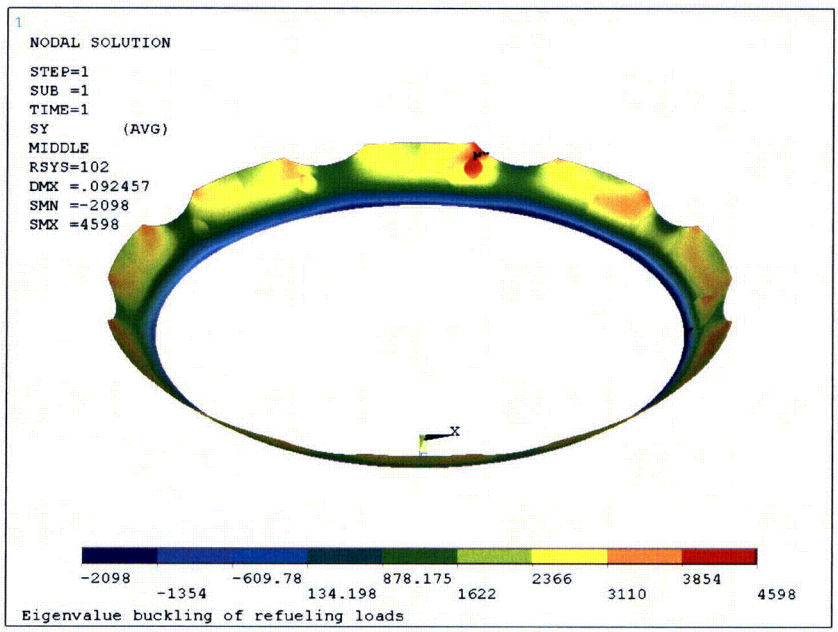


(b) Hoop Stress

Figure 5-4: Refueling Buckling Stress, Lower Spherical Region, Sensitivity Case 1

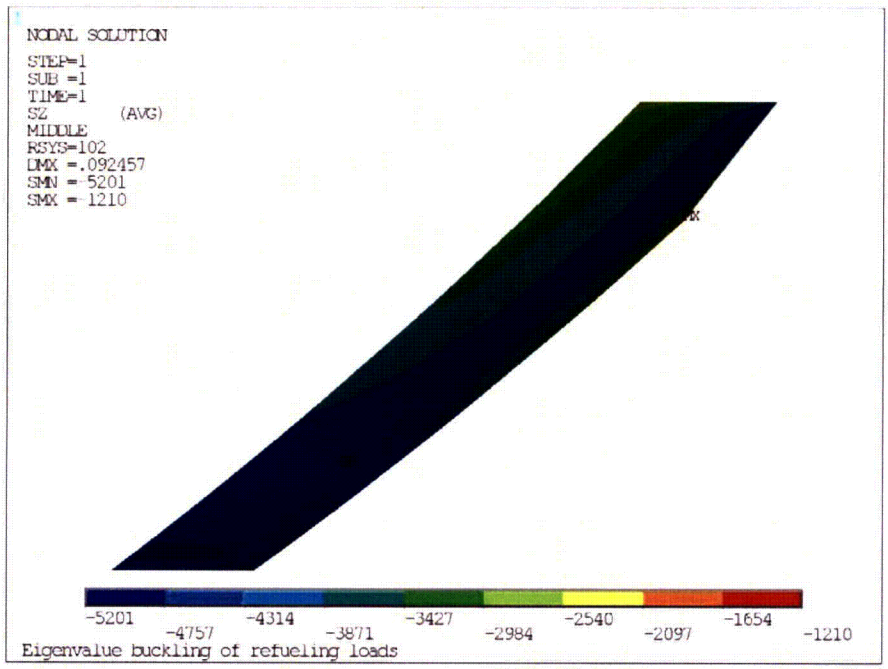


(a) Meridional

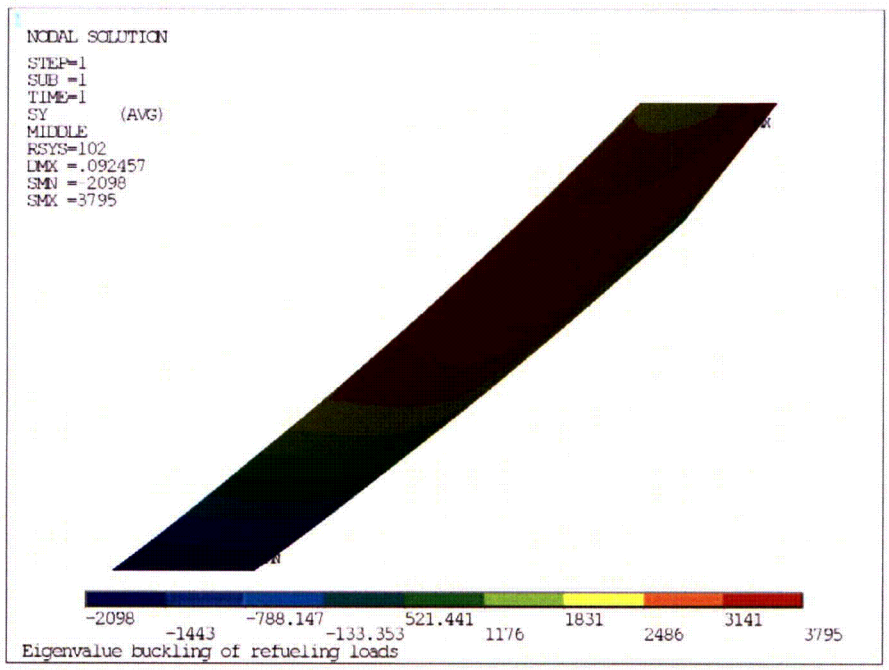


(b) Hoop Stress

Figure 5-5: Refueling Buckling Stress, Sandbed Region, Sensitivity Case 1

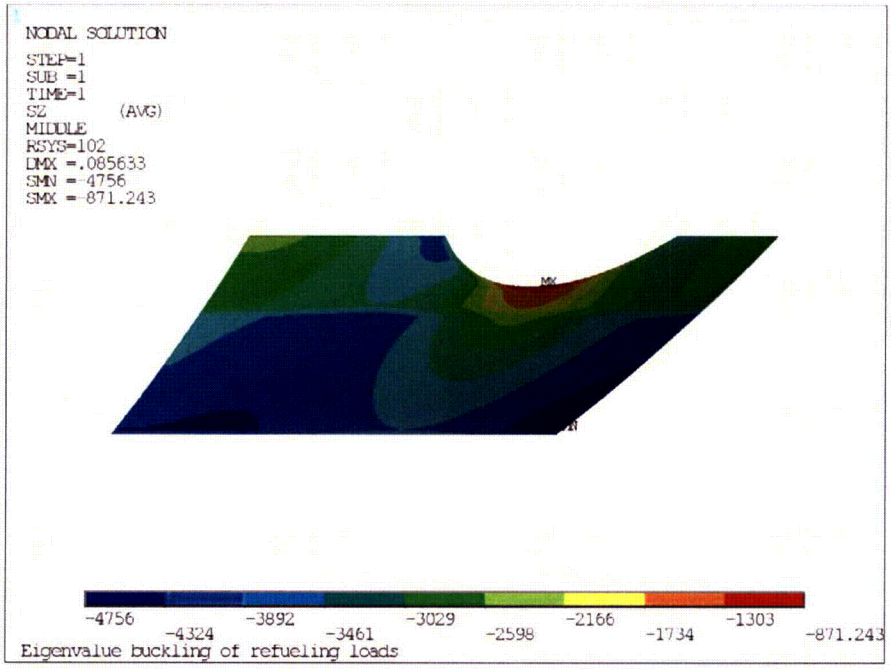


(a) Meridional Stress

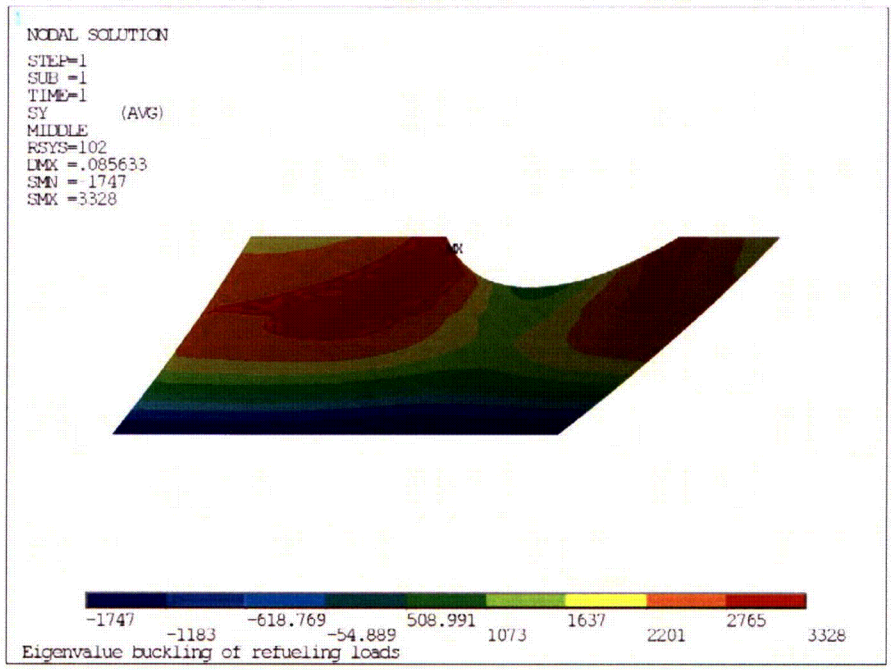


(b) Hoop Stress

Figure 5-6: Refueling Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 1

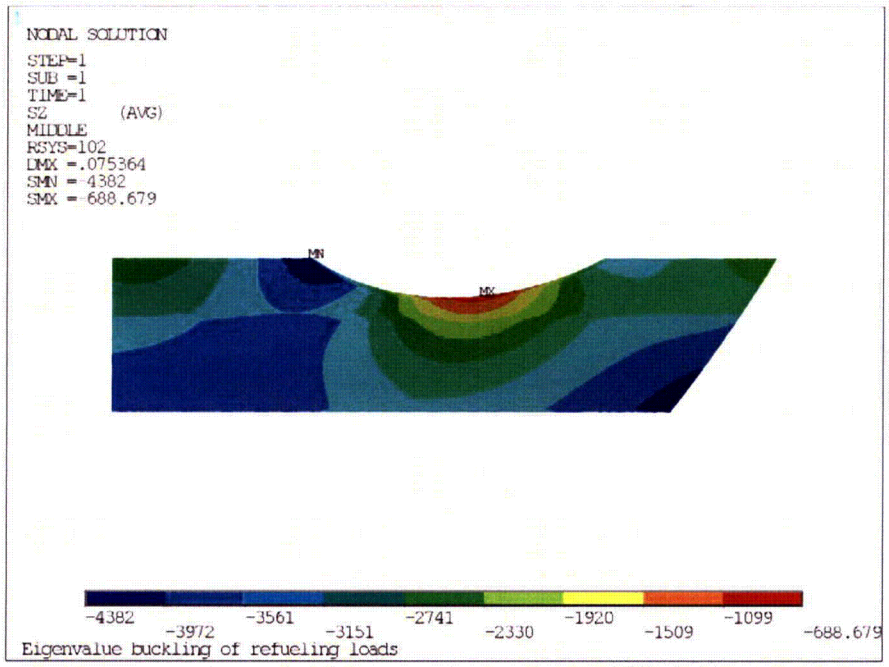


(a) Meridional Stress

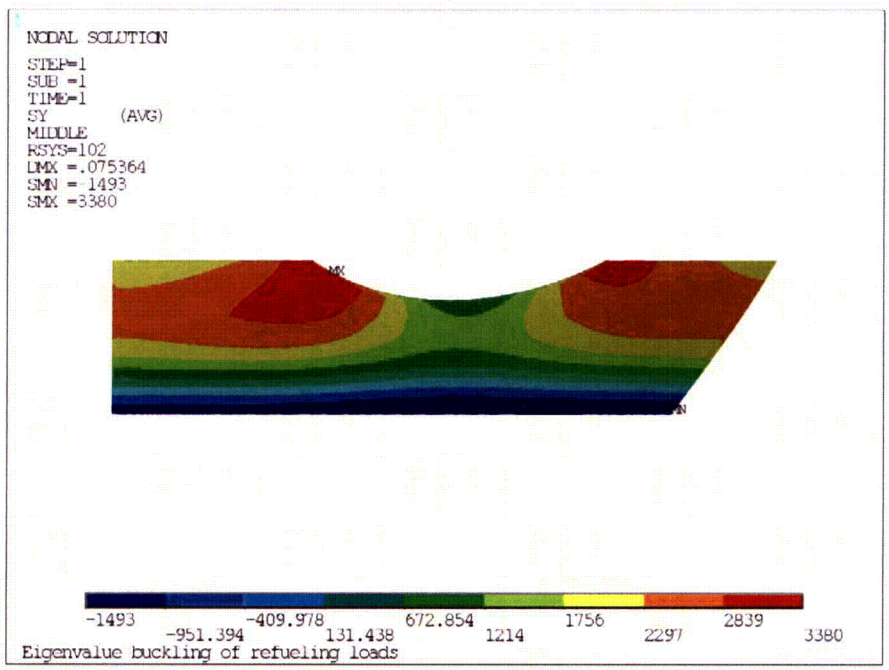


(b) Hoop Stress

Figure 5-7: Refueling Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 1

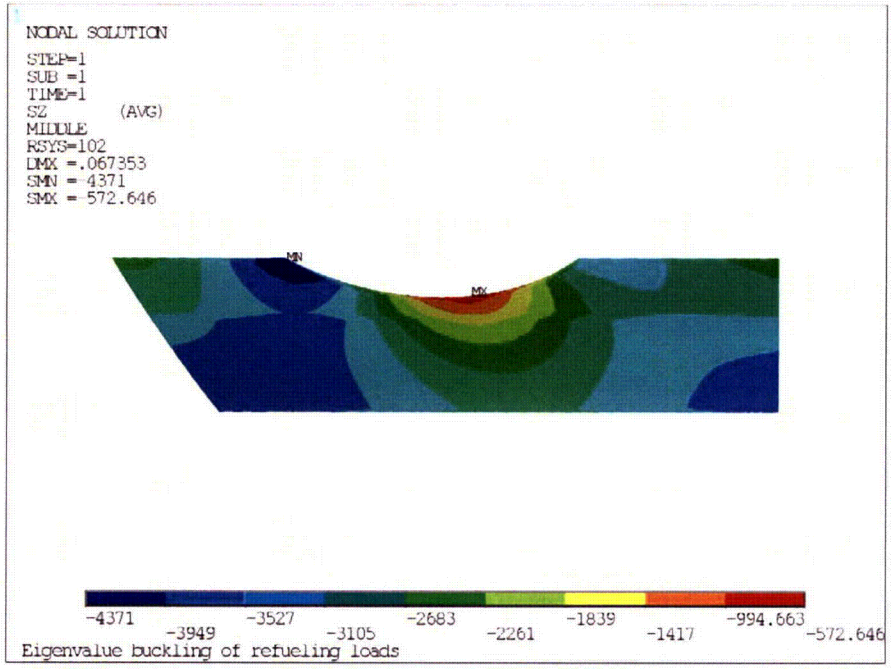


(a) Meridional Stress

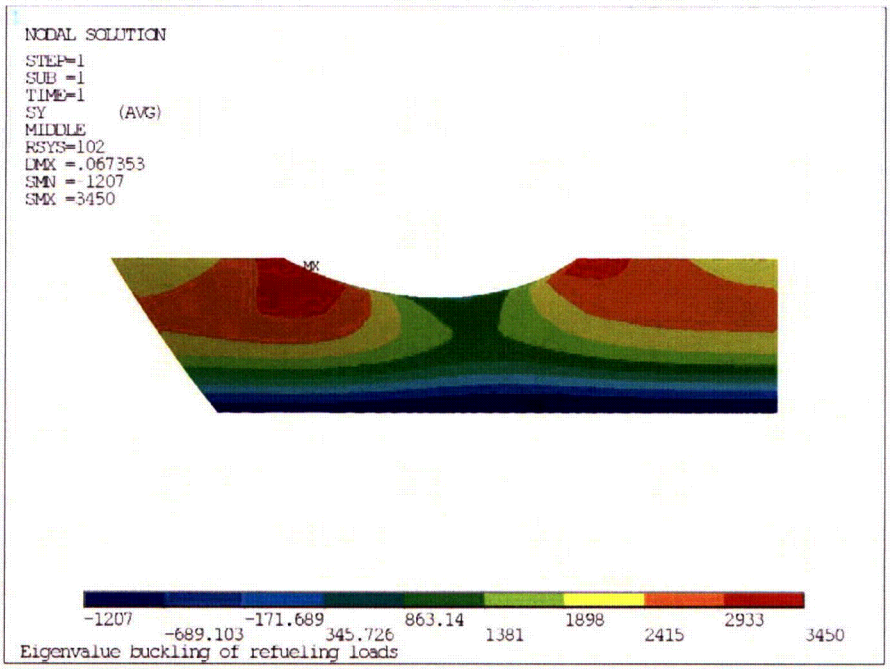


(b) Hoop Stress

Figure 5-8: Refueling Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 1

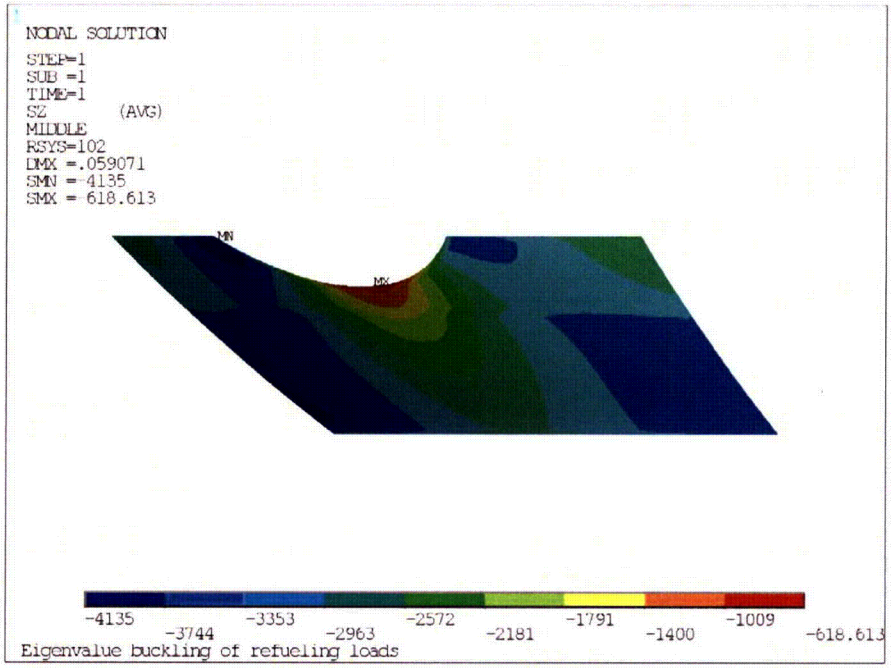


(a) Meridional Stress

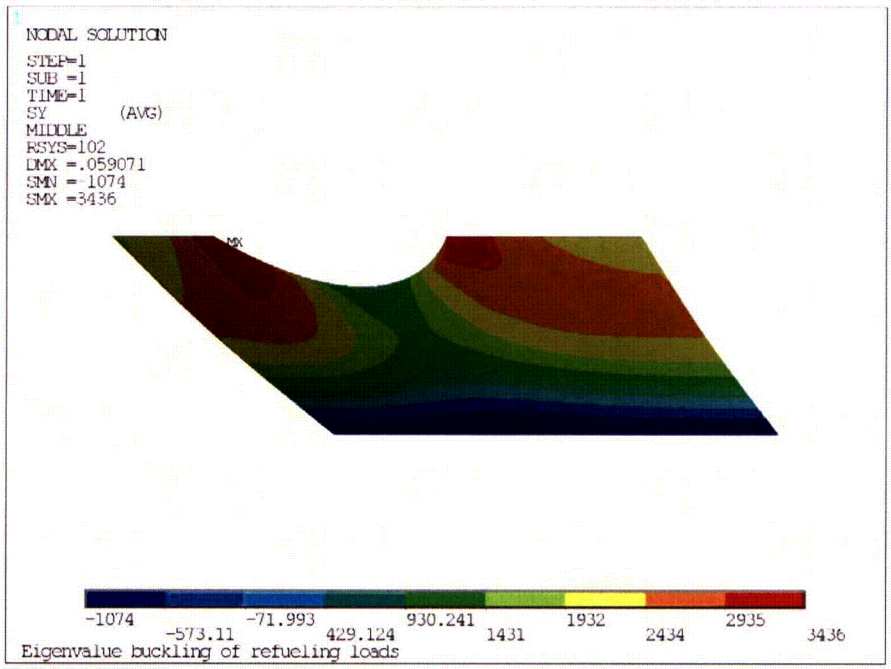


(b) Hoop Stress

Figure 5-9: Refueling Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 1

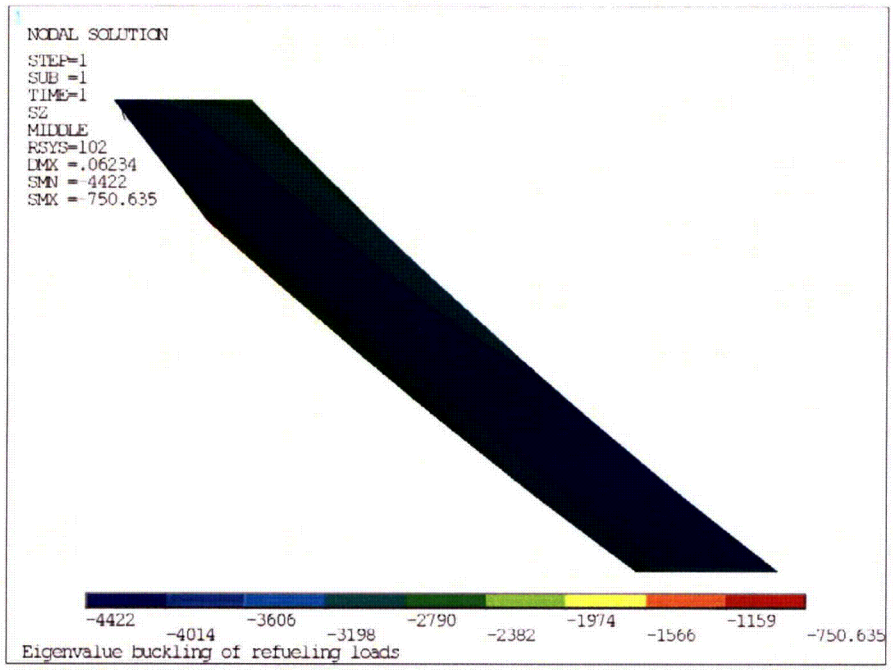


(a) Meridional Stress

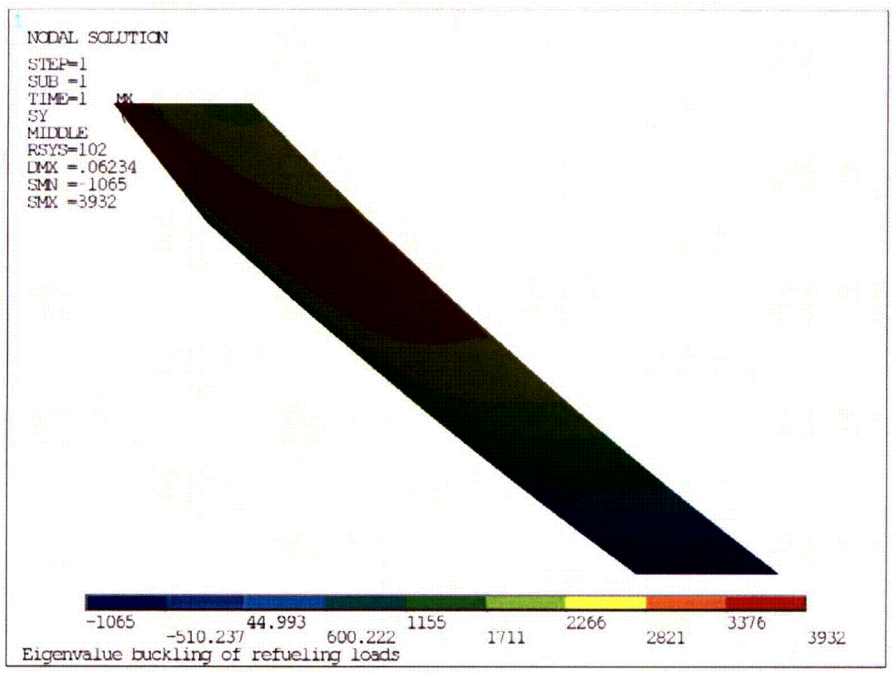


(b) Hoop Stress

Figure 5-10: Refueling Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 1

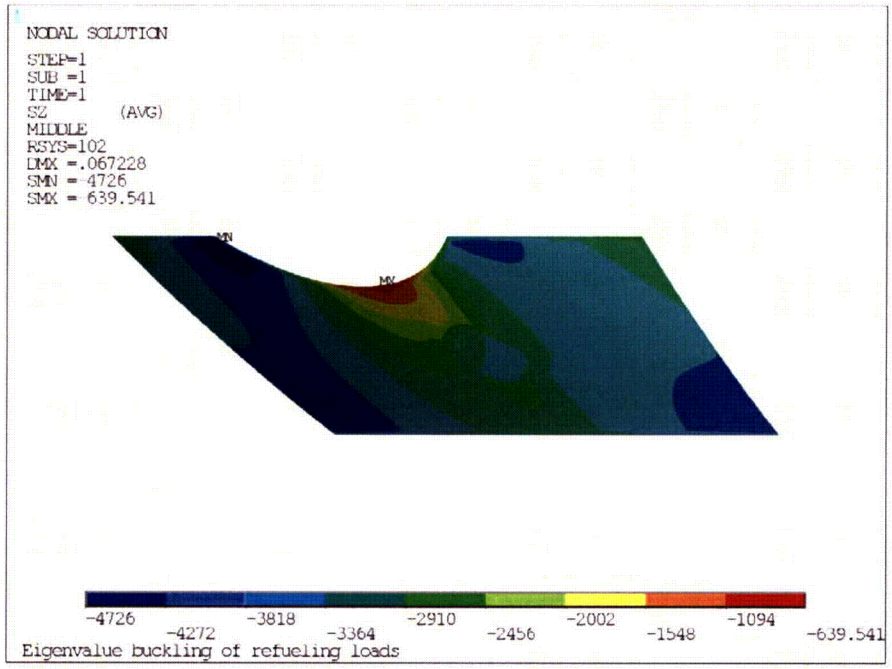


(a) Meridional Stress

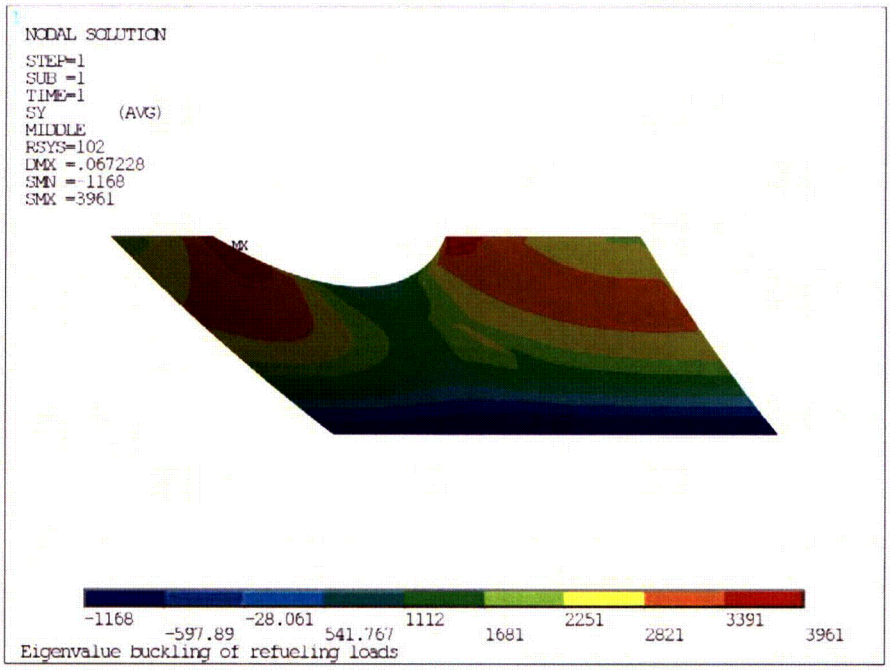


(b) Hoop Stress

Figure 5-11: Refueling Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 1

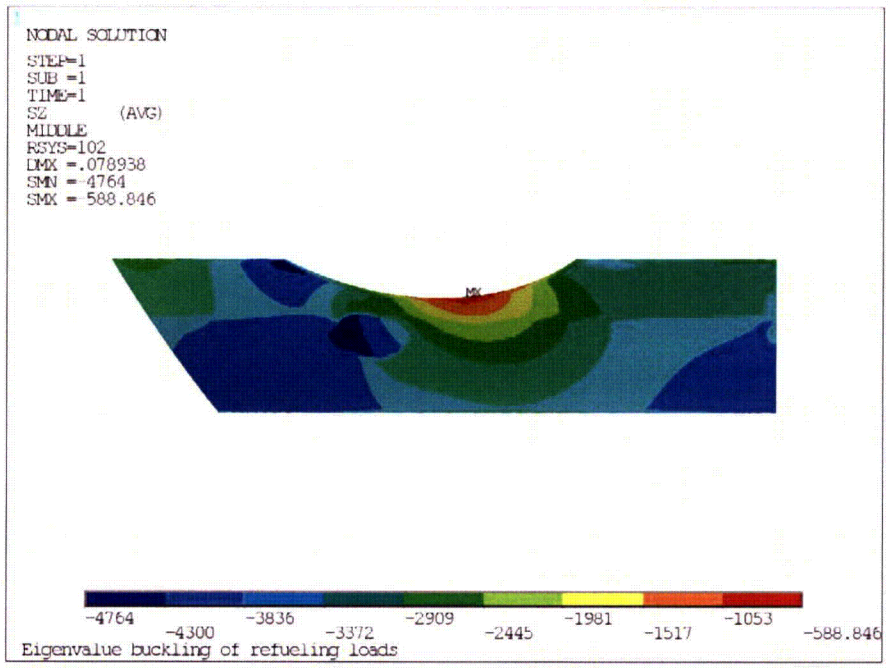


(a) Meridional Stress

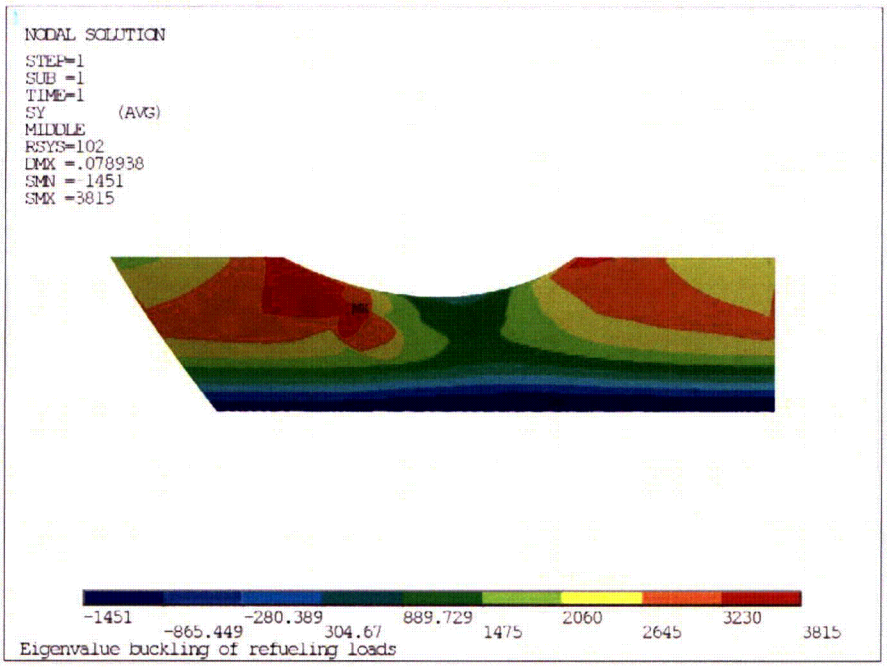


(b) Hoop Stress

Figure 5-12: Refueling Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 1

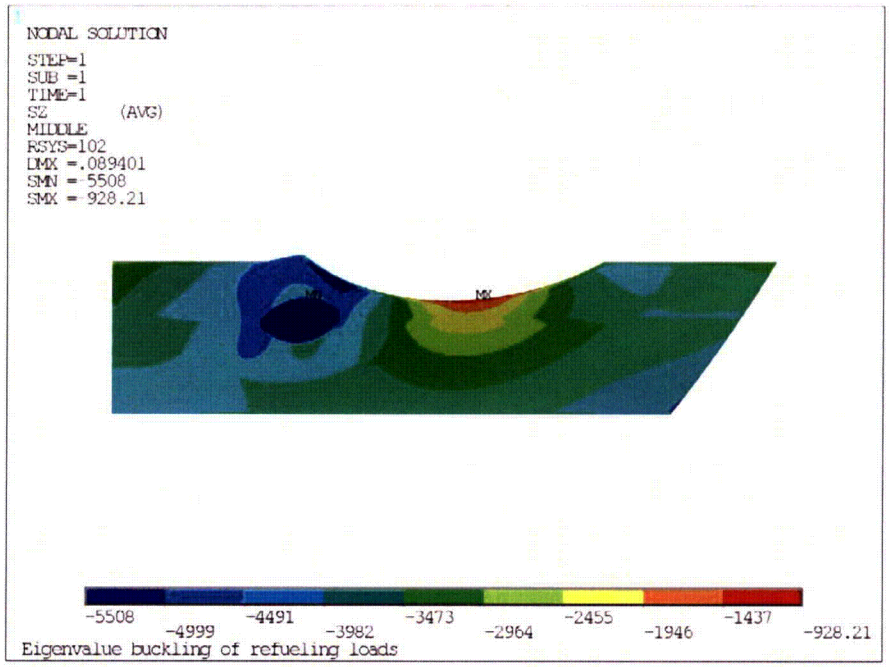


(a) Meridional Stress

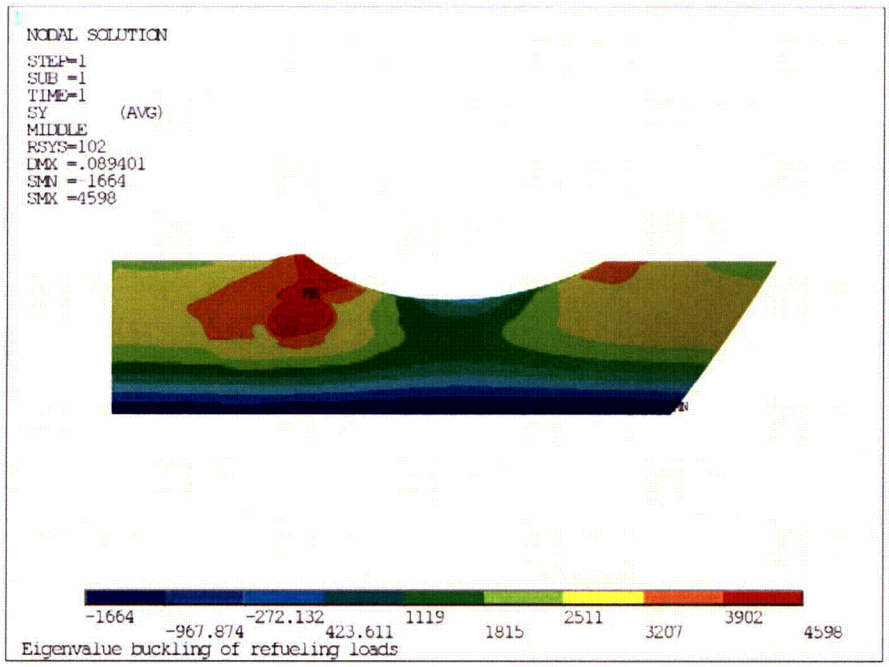


(b) Hoop Stress

Figure 5-13: Refueling Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 1

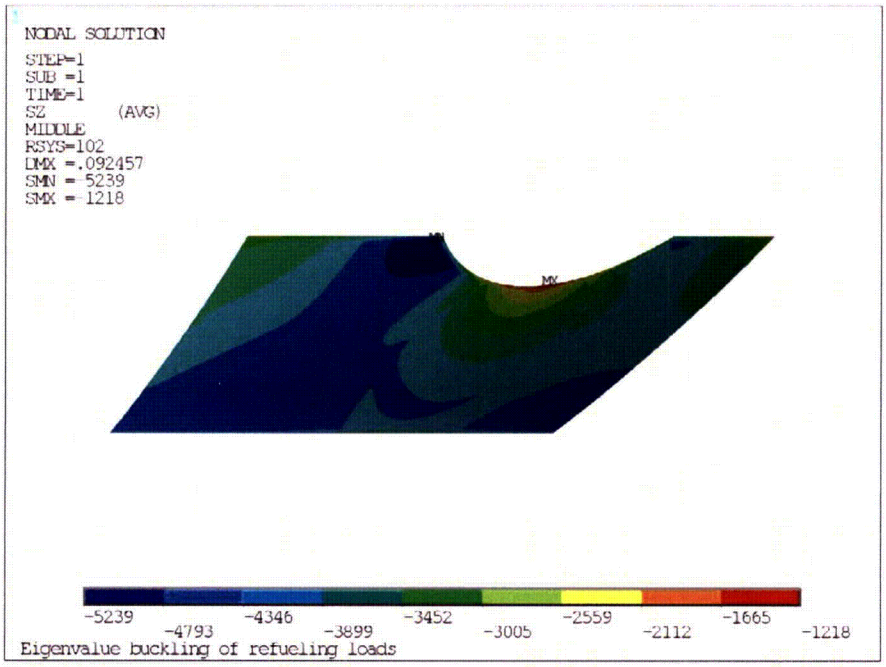


(a) Meridional Stress

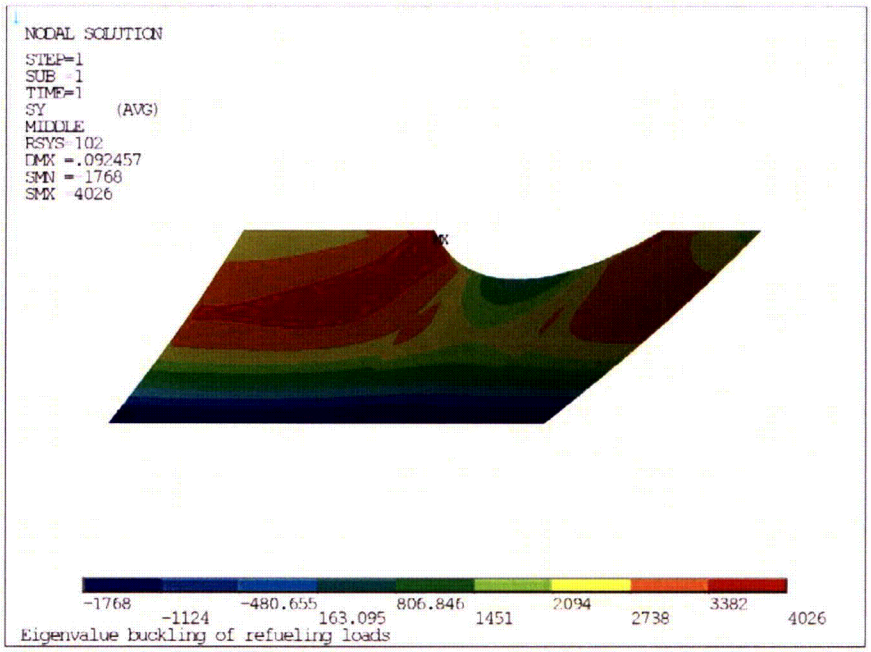


(b) Hoop Stress

Figure 5-14: Refueling Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 1

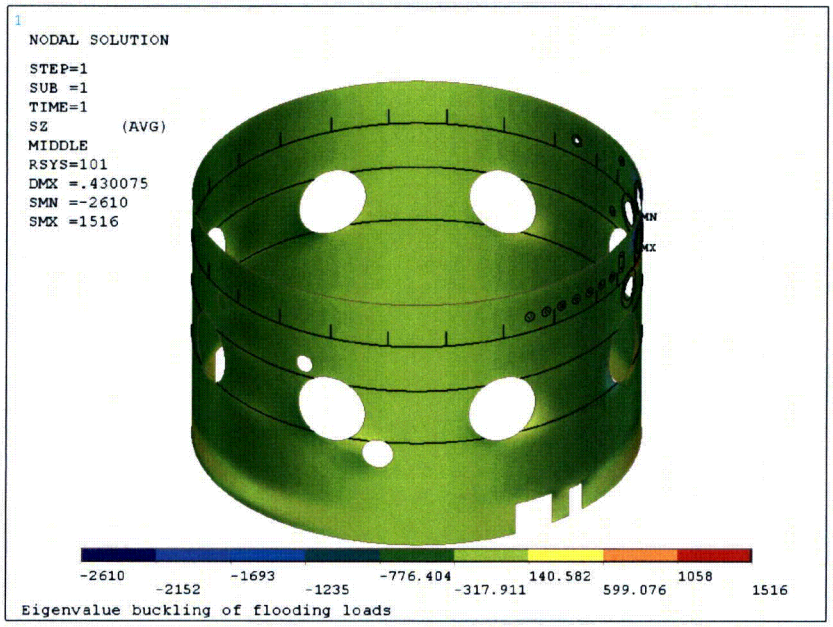


(a) Meridional Stress

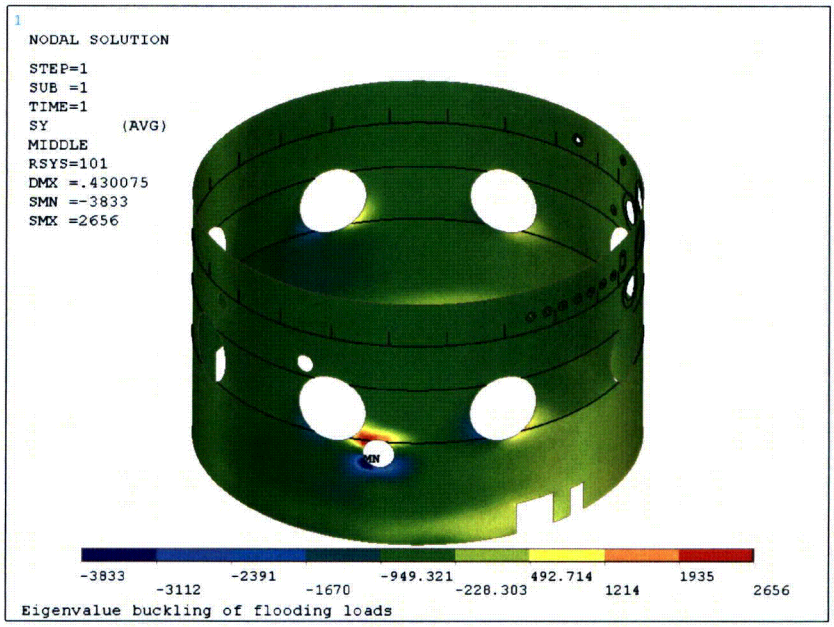


(b) Hoop Stress

Figure 5-15: Refueling Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 1

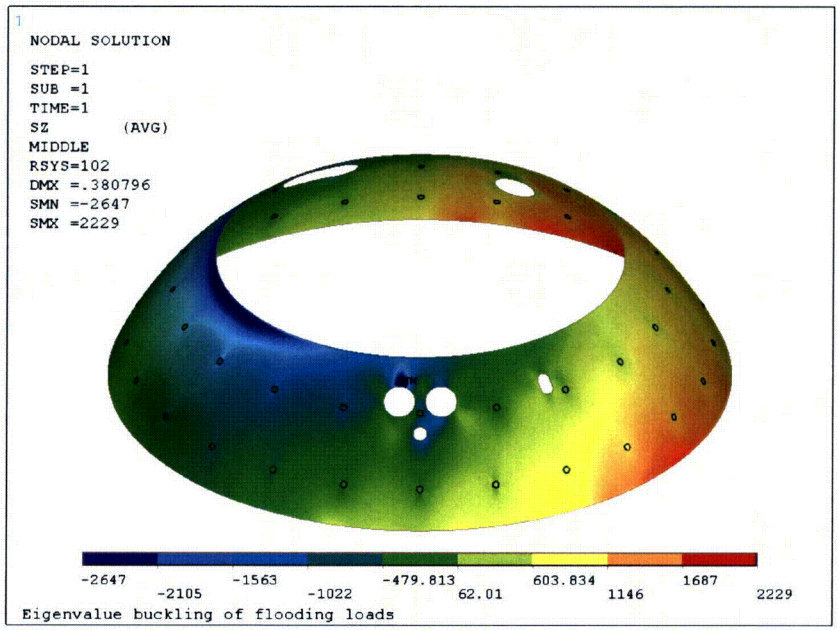


(a) Axial Stress

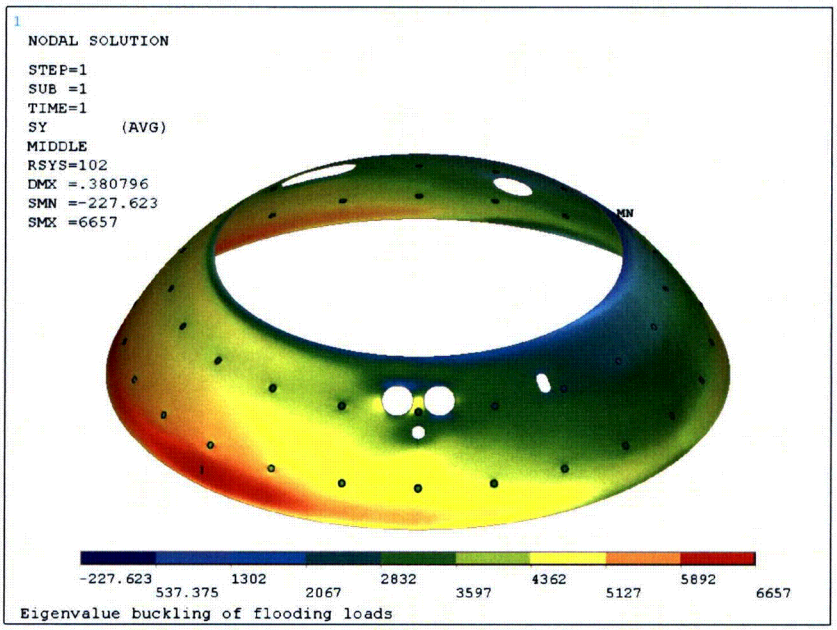


(b) Hoop Stress

Figure 5-16: Flooding Buckling Stress, Cylindrical Region, Sensitivity Case 1

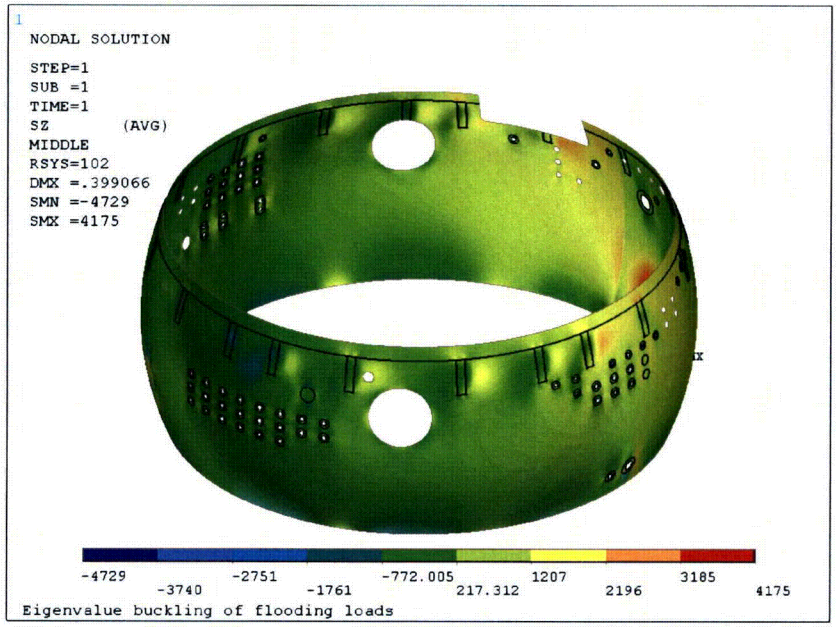


(a) Meridional Stress

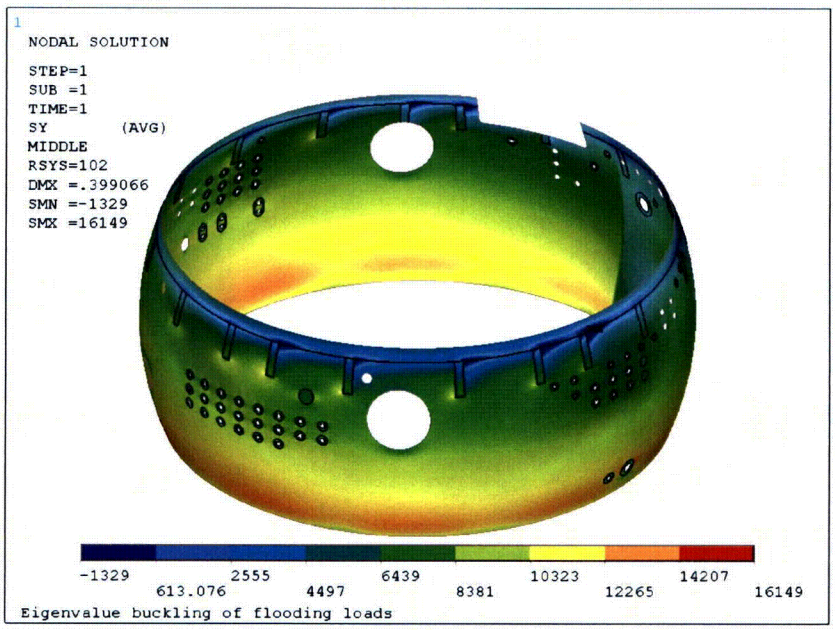


(b) Hoop Stress

Figure 5-17: Flooding Buckling Stress, Upper Spherical Region, Sensitivity Case 1

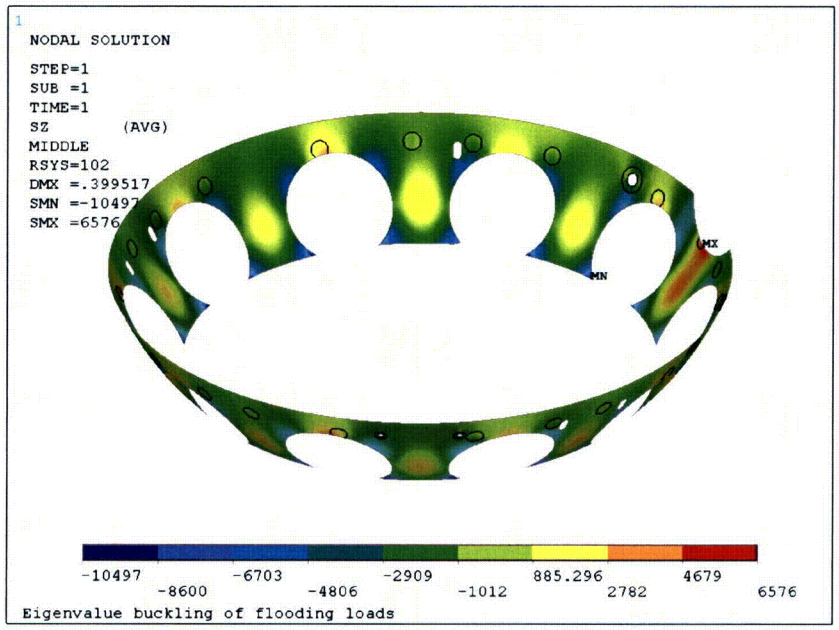


(a) Meridional Stress

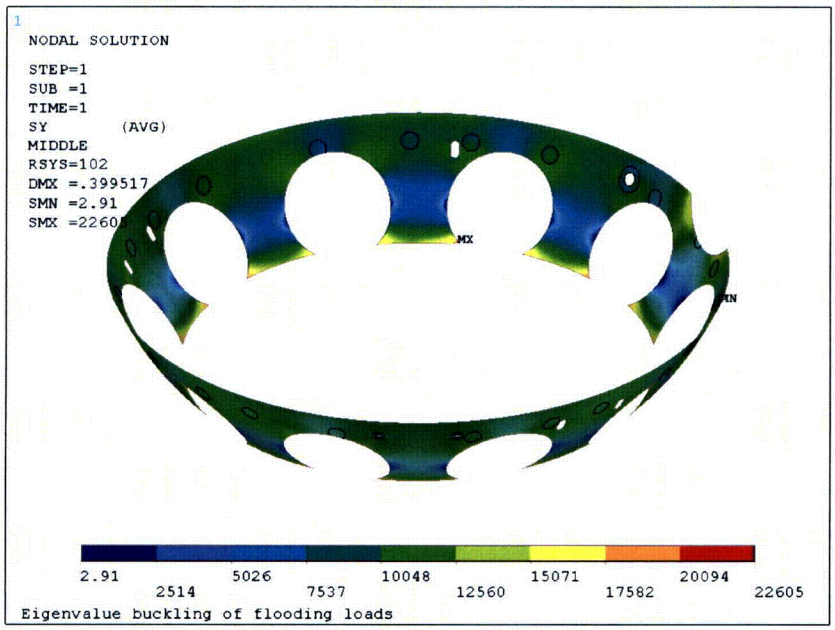


(b) Hoop Stress

Figure 5-18: Flooding Buckling Stress, Middle Spherical Region, Sensitivity Case 1

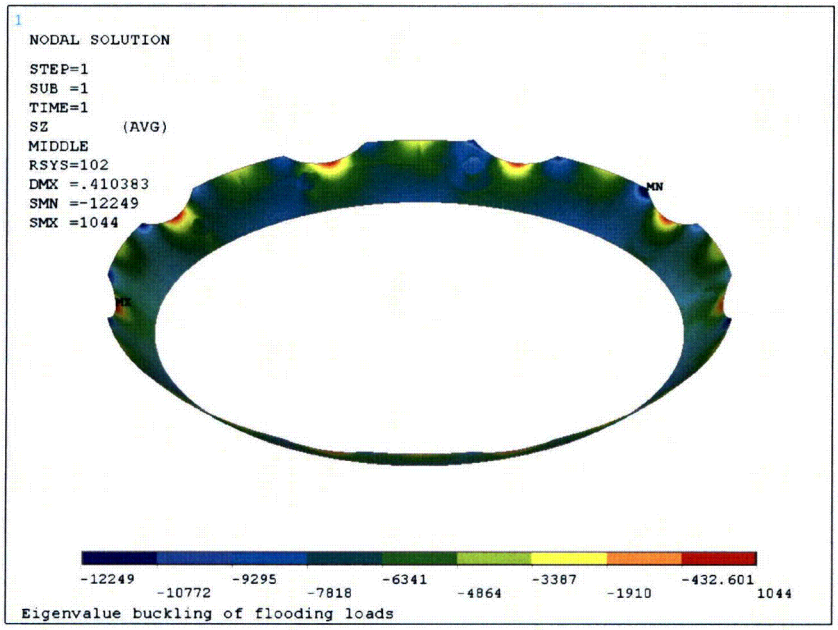


(a) Meridional Stress

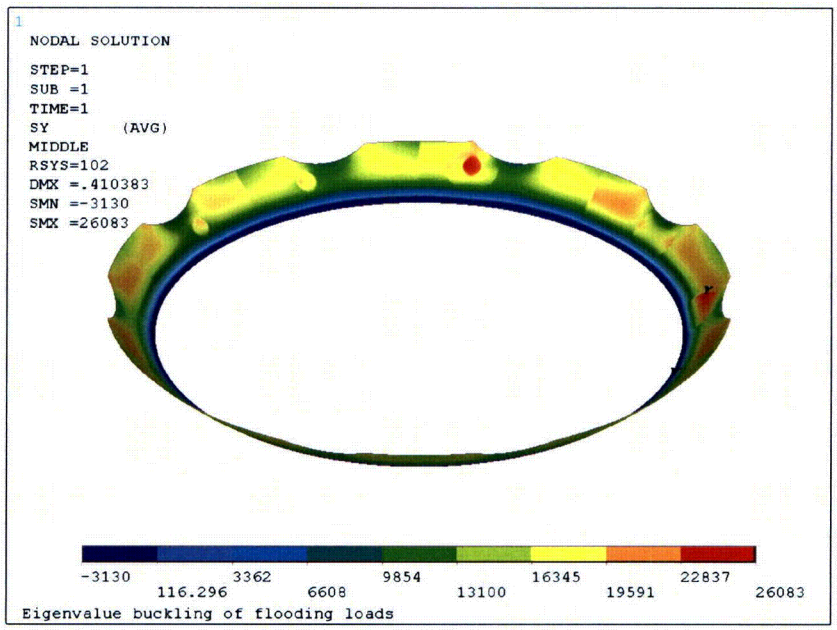


(b) Hoop Stress

Figure 5-19: Flooding Buckling Stress, Lower Spherical Region, Sensitivity Case 1

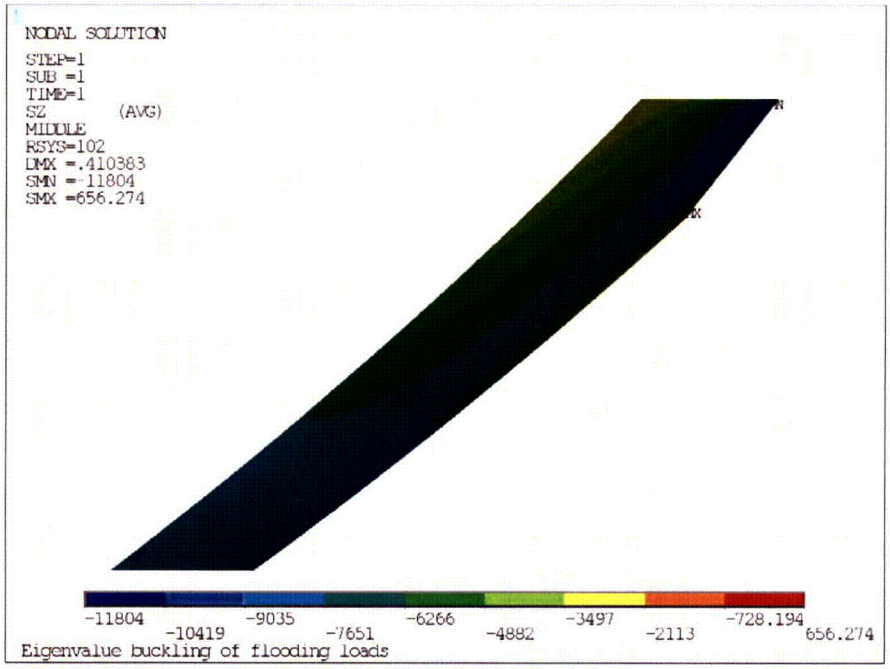


(a) Meridional

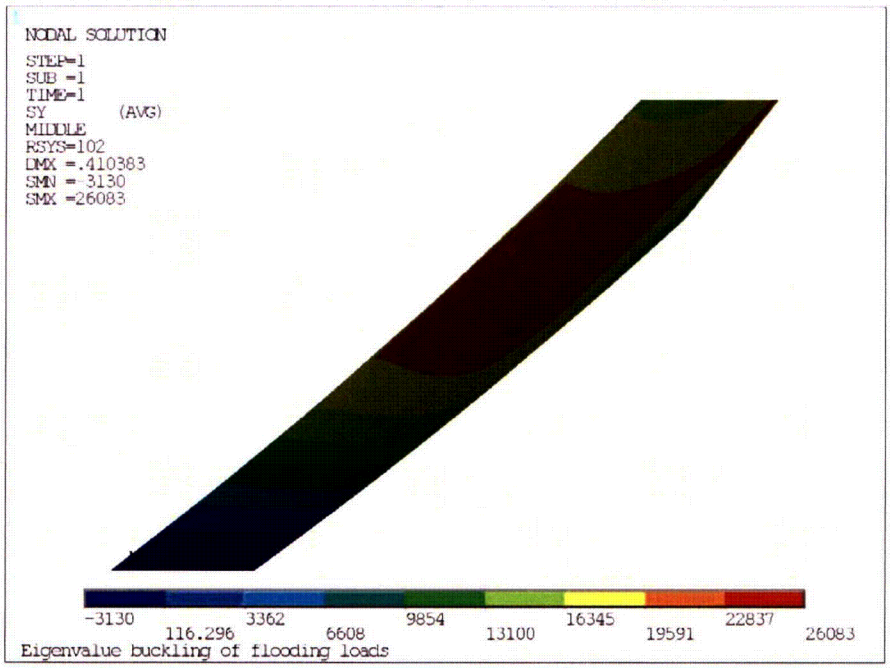


(b) Hoop Stress

Figure 5-20: Flooding Buckling Stress, Sandbed Region, Sensitivity Case 1

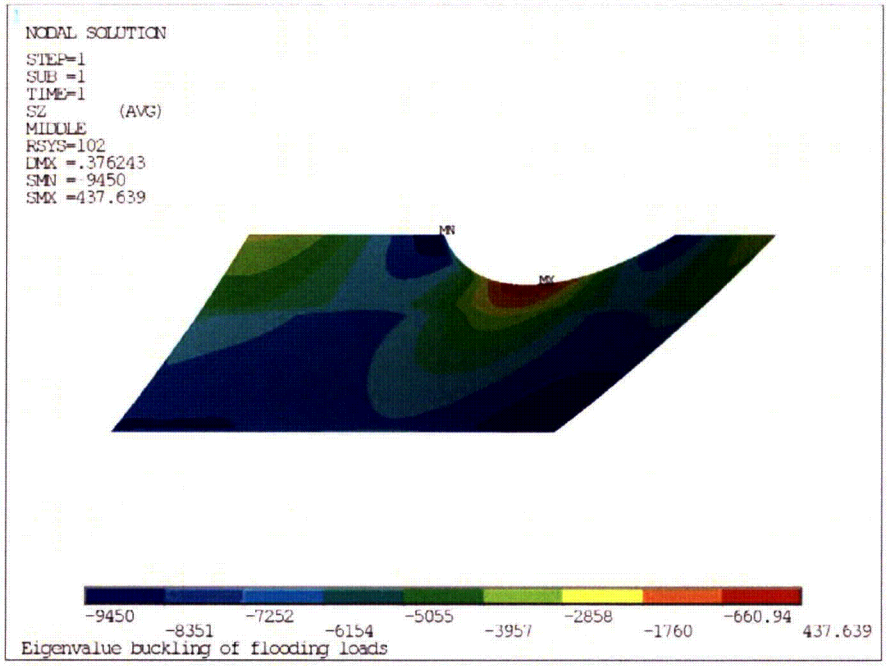


(a) Meridional Stress

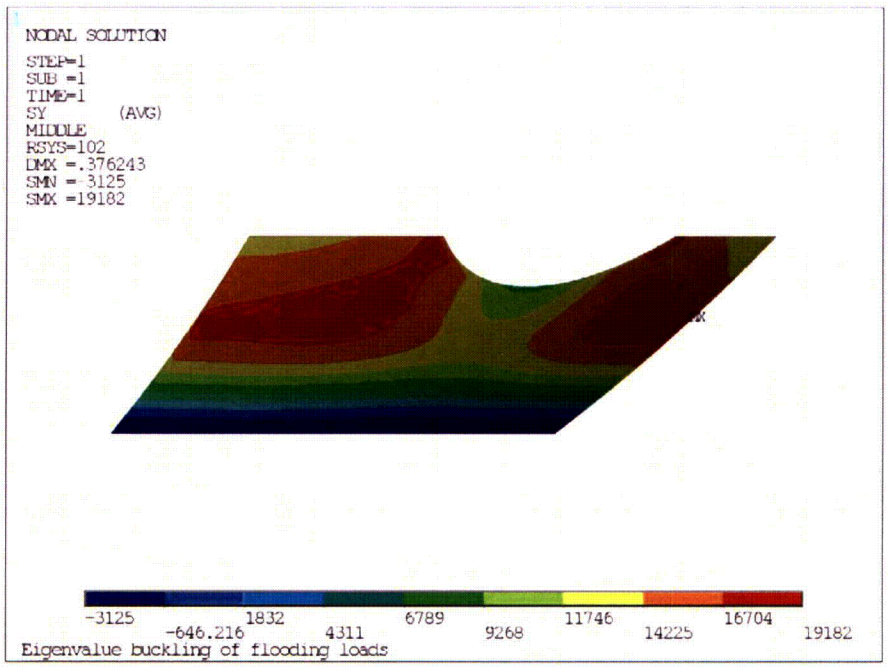


(b) Hoop Stress

Figure 5-21: Flooding Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 1

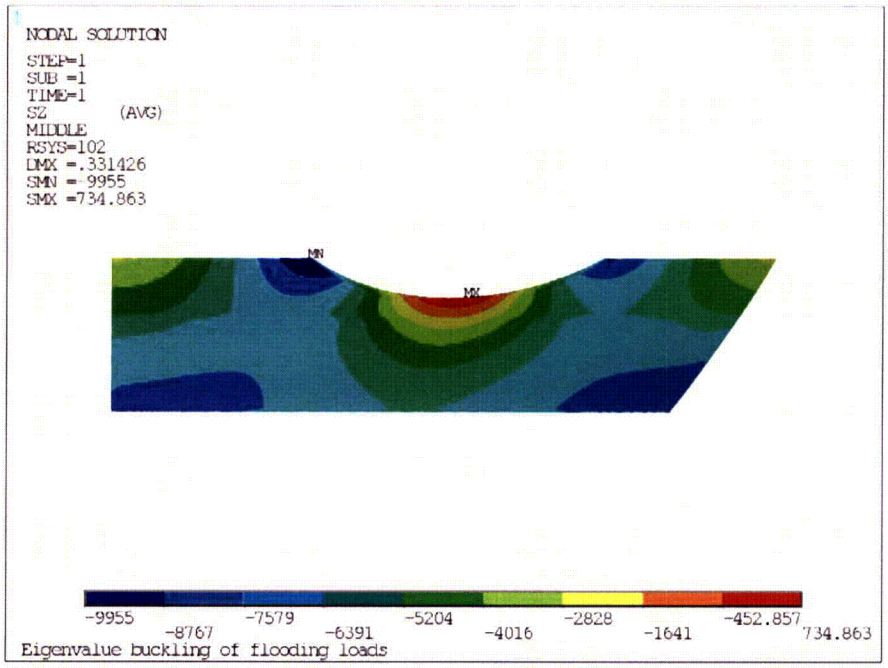


(a) Meridional Stress

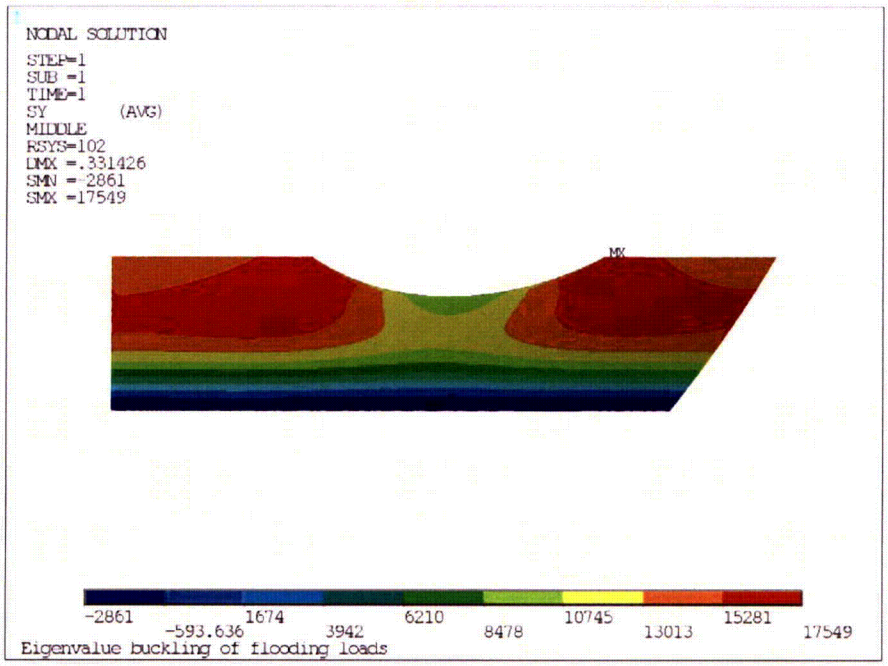


(b) Hoop Stress

Figure 5-22: Flooding Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 1

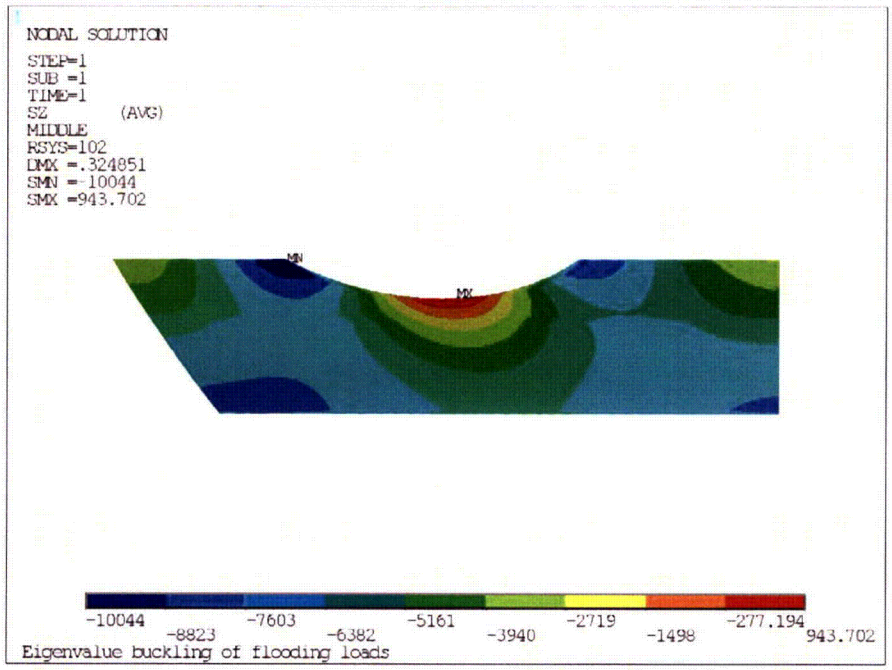


(a) Meridional Stress

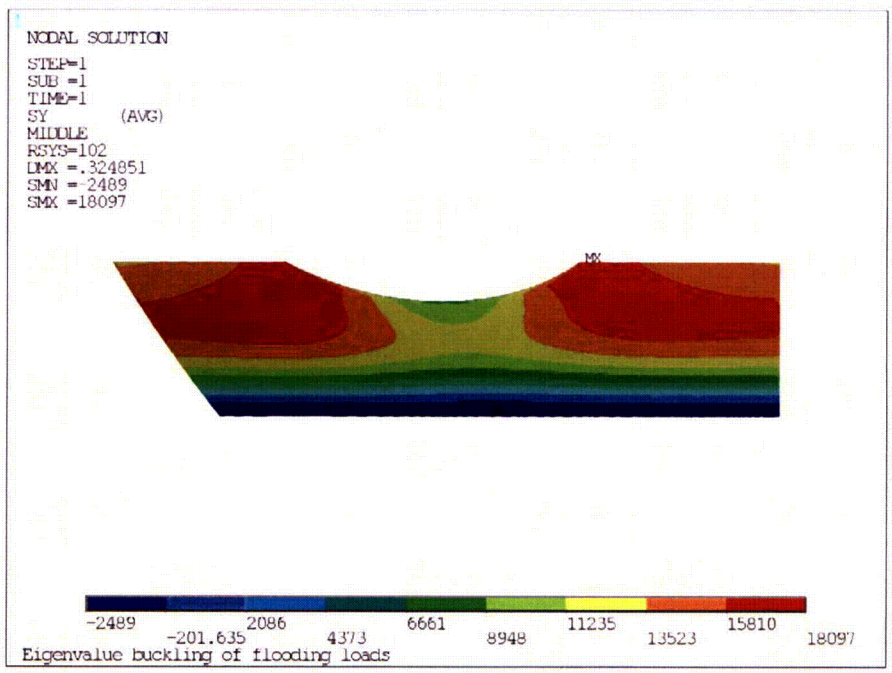


(b) Hoop Stress

Figure 5-23: Flooding Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 1

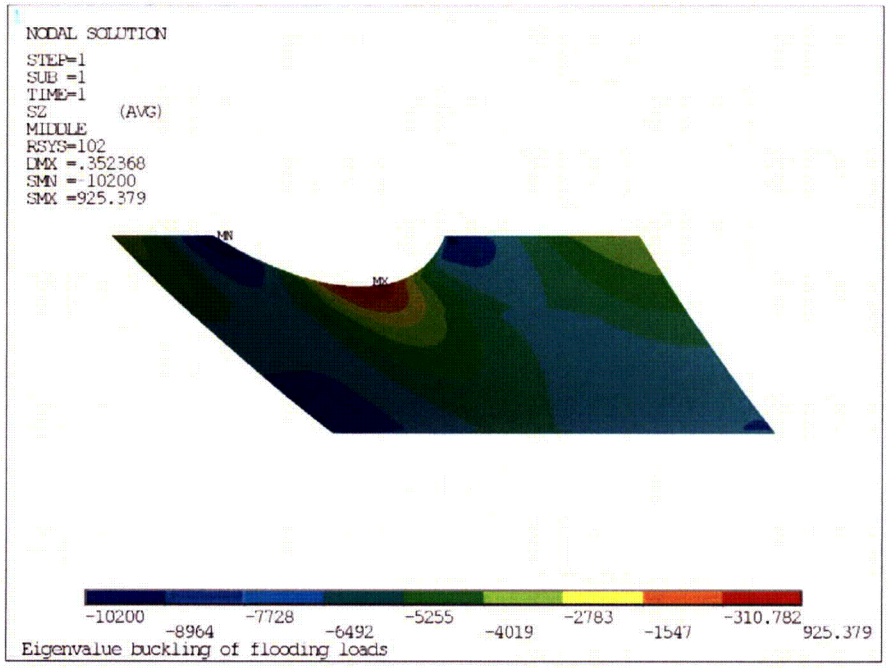


(a) Meridional Stress

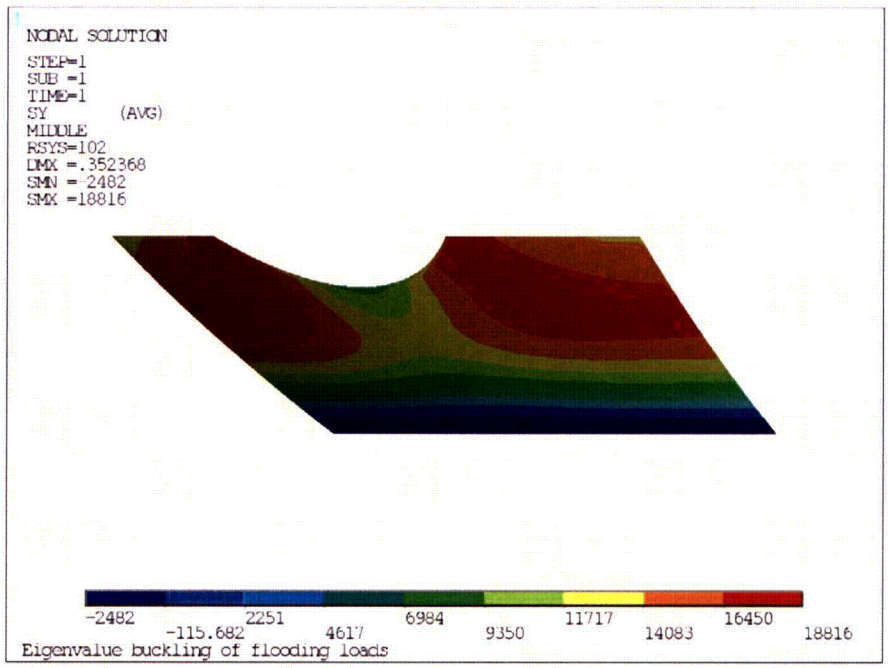


(b) Hoop Stress

Figure 5-24: Flooding Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 1

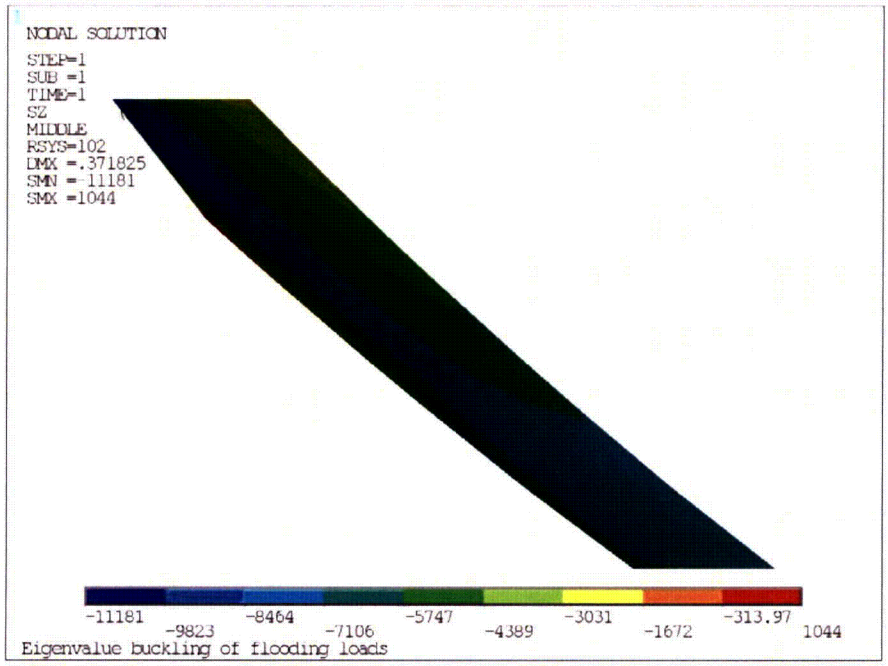


(a) Meridional Stress

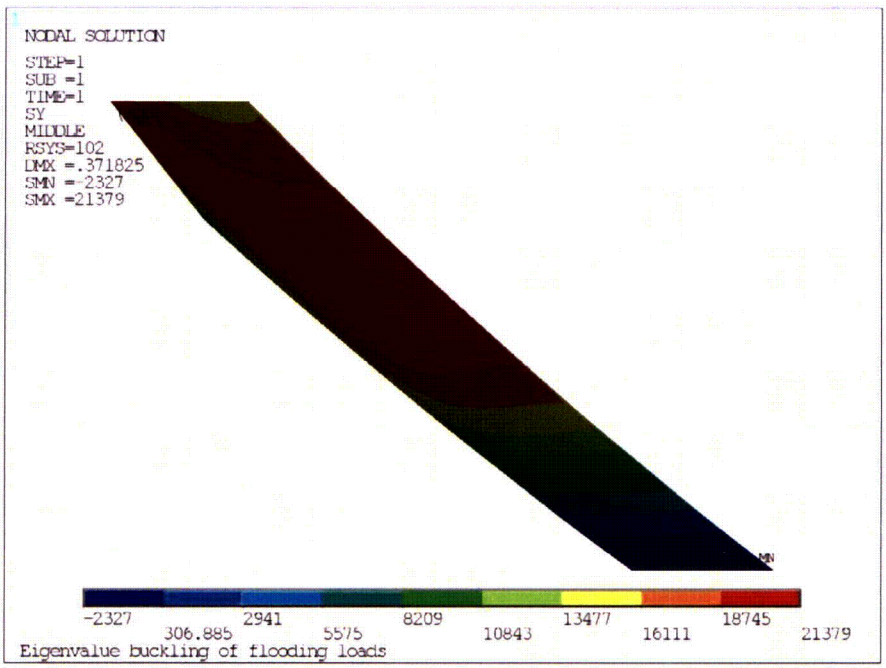


(b) Hoop Stress

Figure 5-25: Flooding Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 1

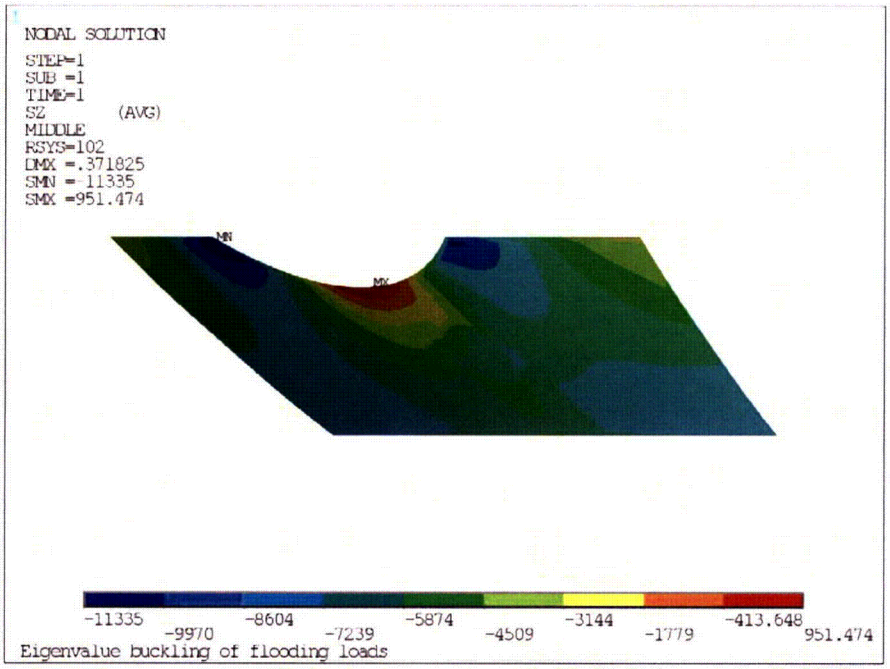


(a) Meridional Stress

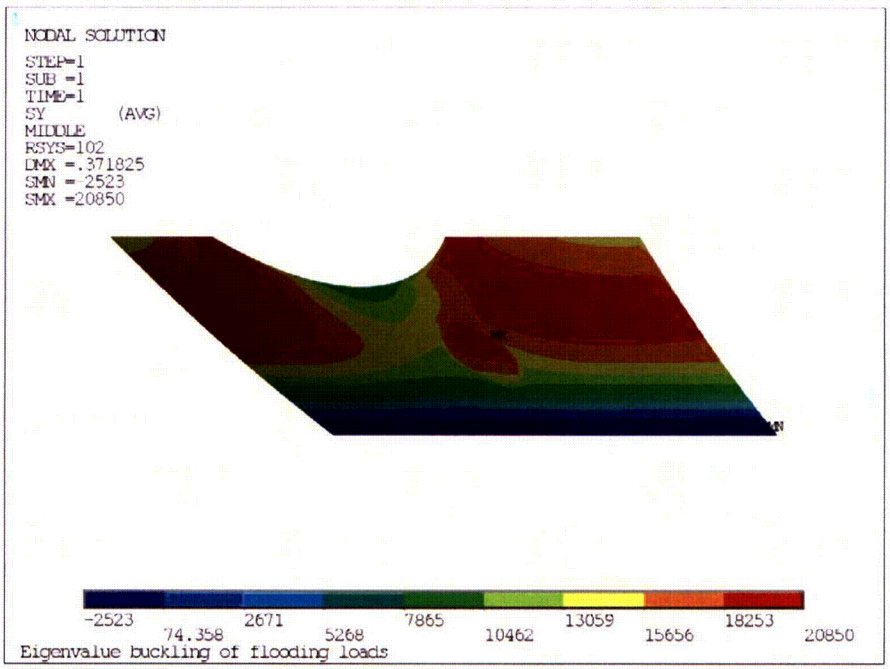


(b) Hoop Stress

Figure 5-26: Flooding Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 1

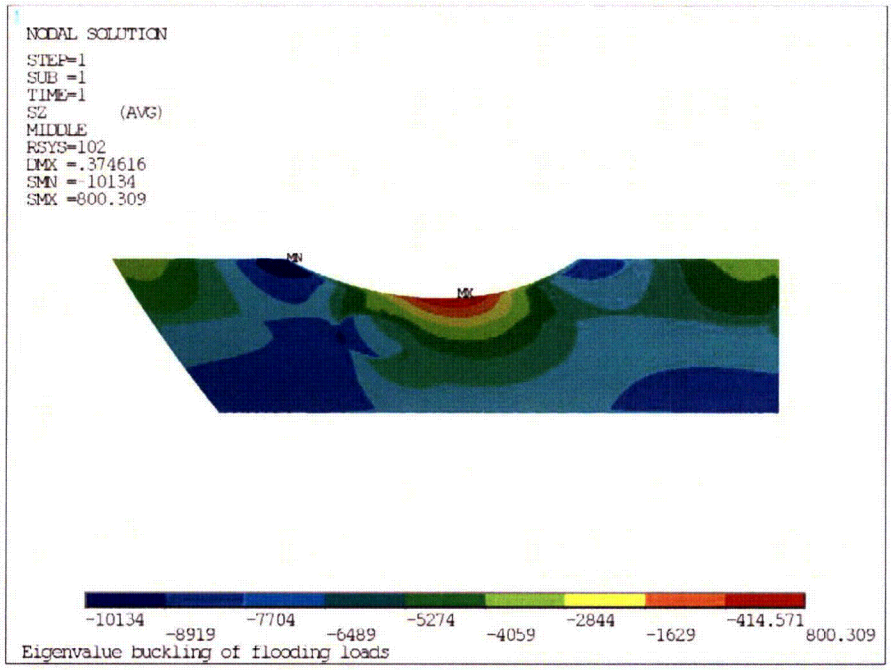


(a) Meridional Stress

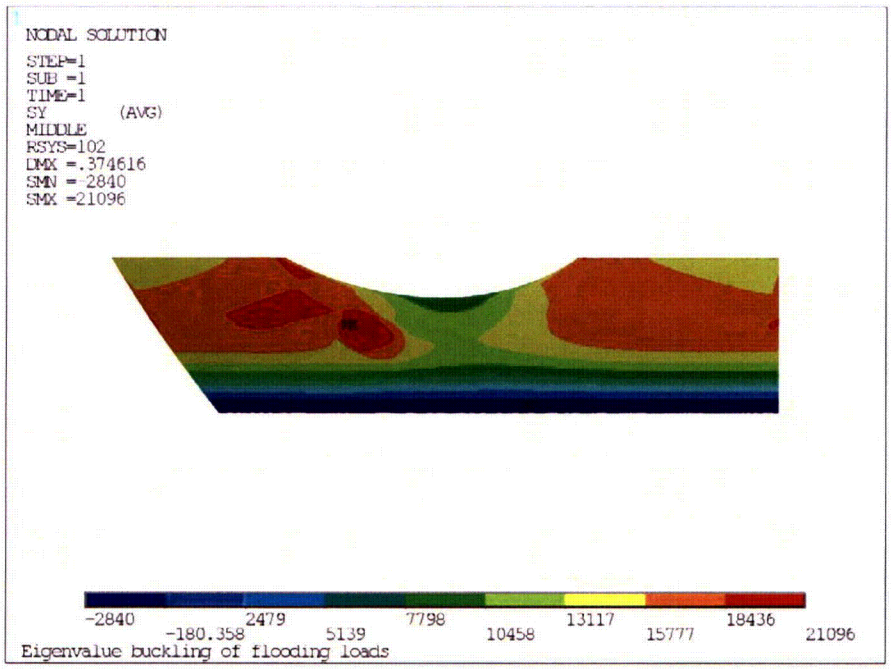


(b) Hoop Stress

Figure 5-27: Flooding Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 1

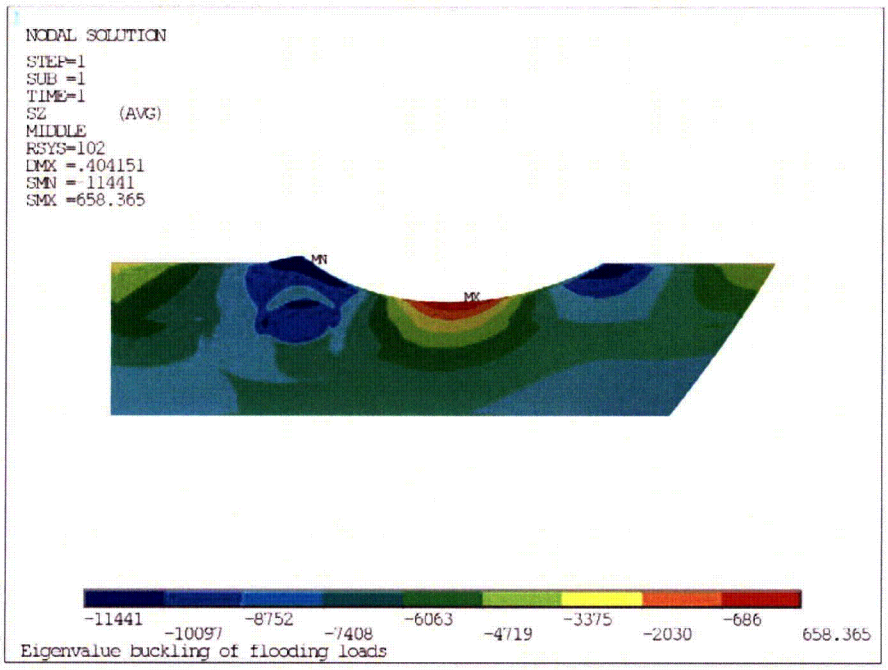


(a) Meridional Stress

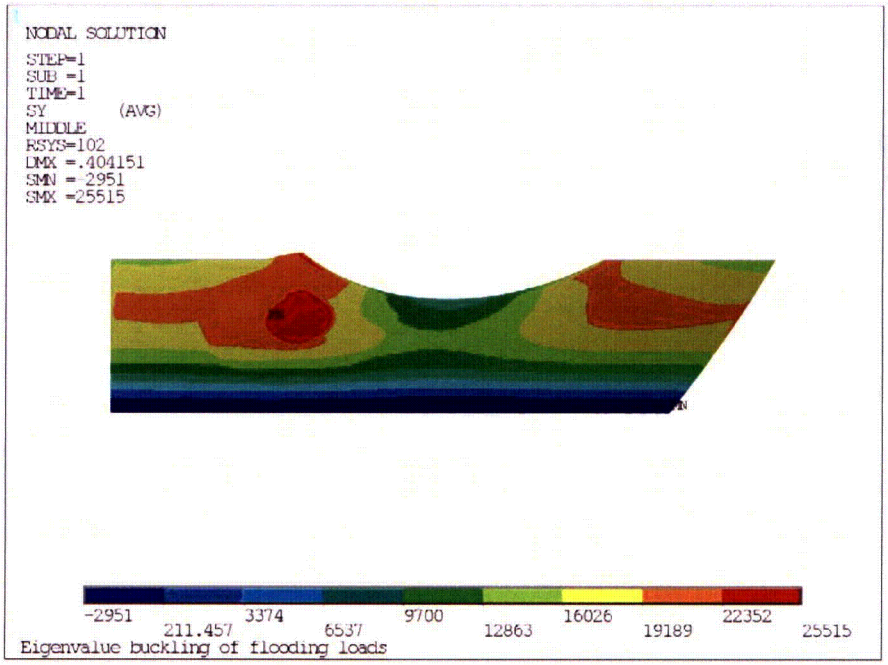


(b) Hoop Stress

Figure 5-28: Flooding Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 1

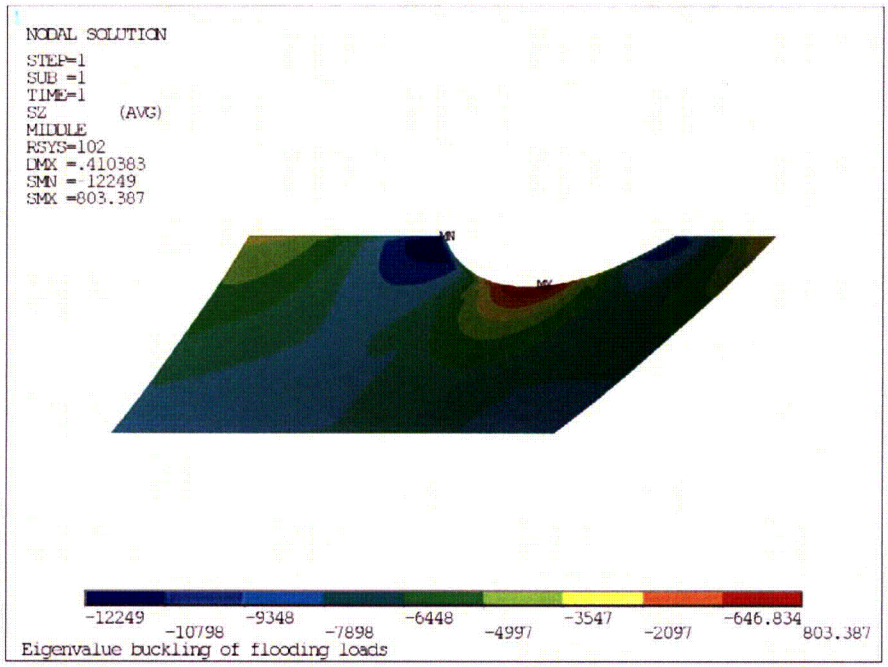


(a) Meridional Stress

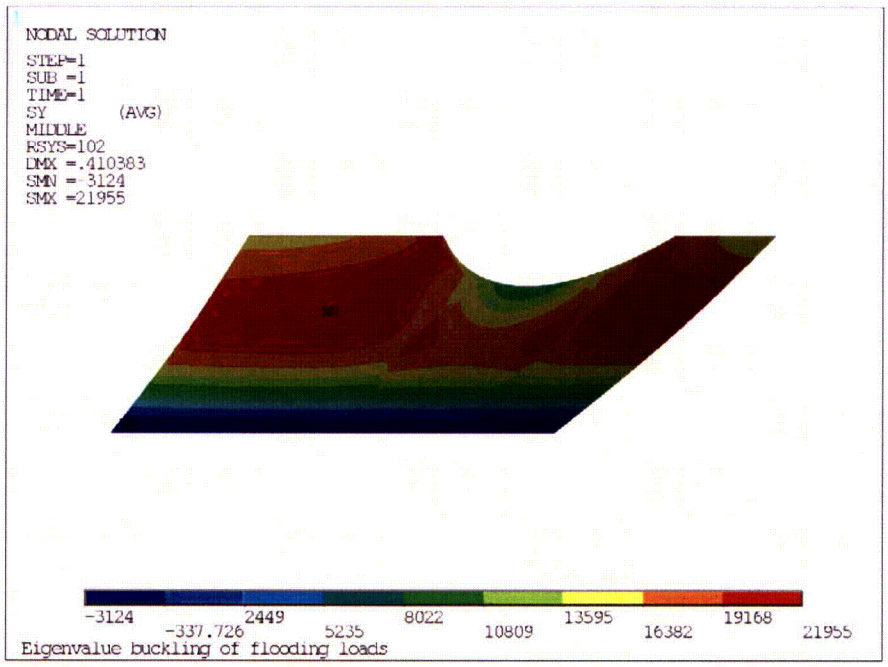


(b) Hoop Stress

Figure 5-29: Flooding Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 1

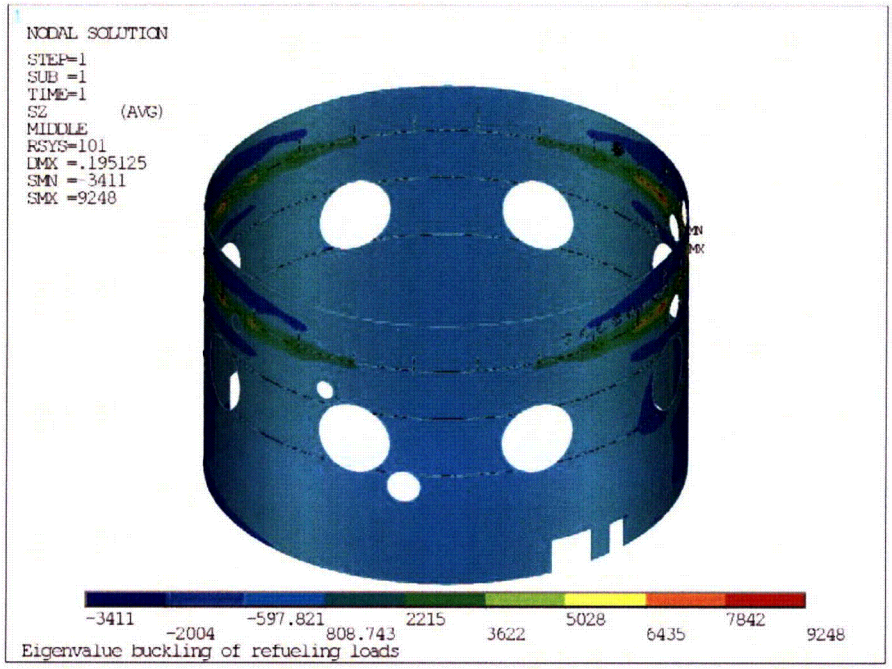


(a) Meridional Stress

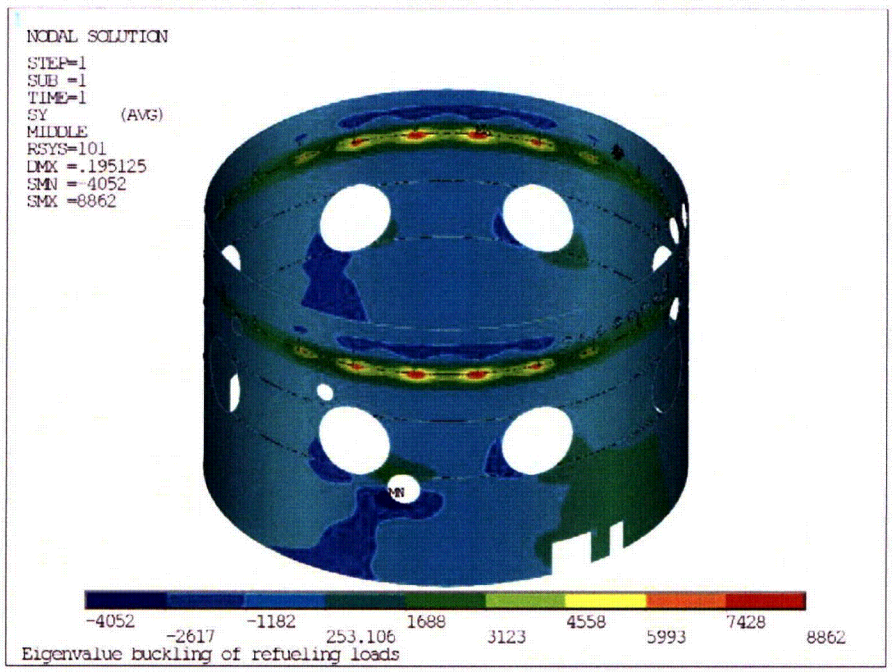


(b) Hoop Stress

Figure 5-30: Flooding Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 1

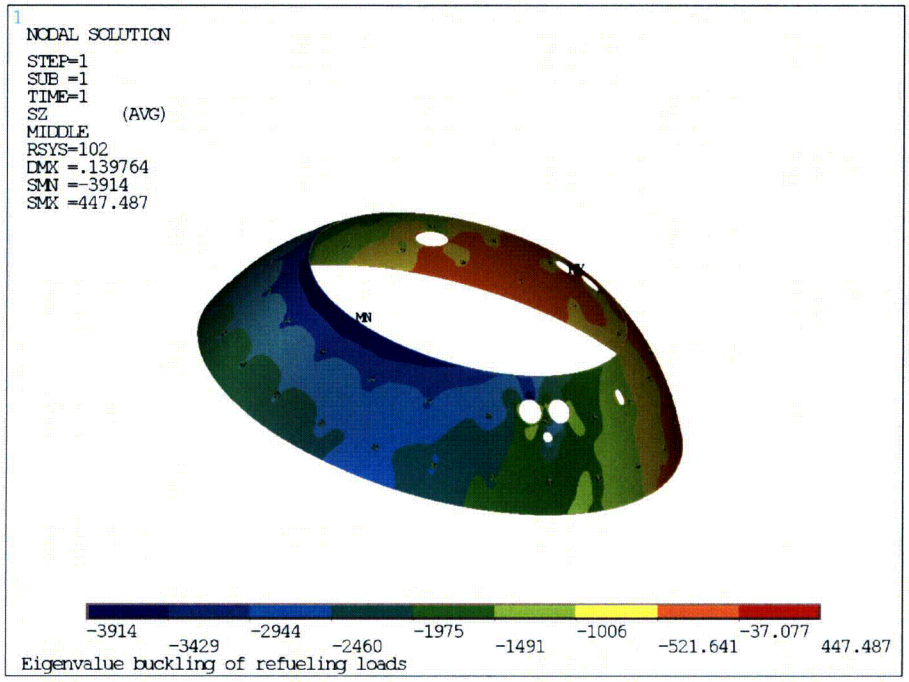


(a) Axial Stress

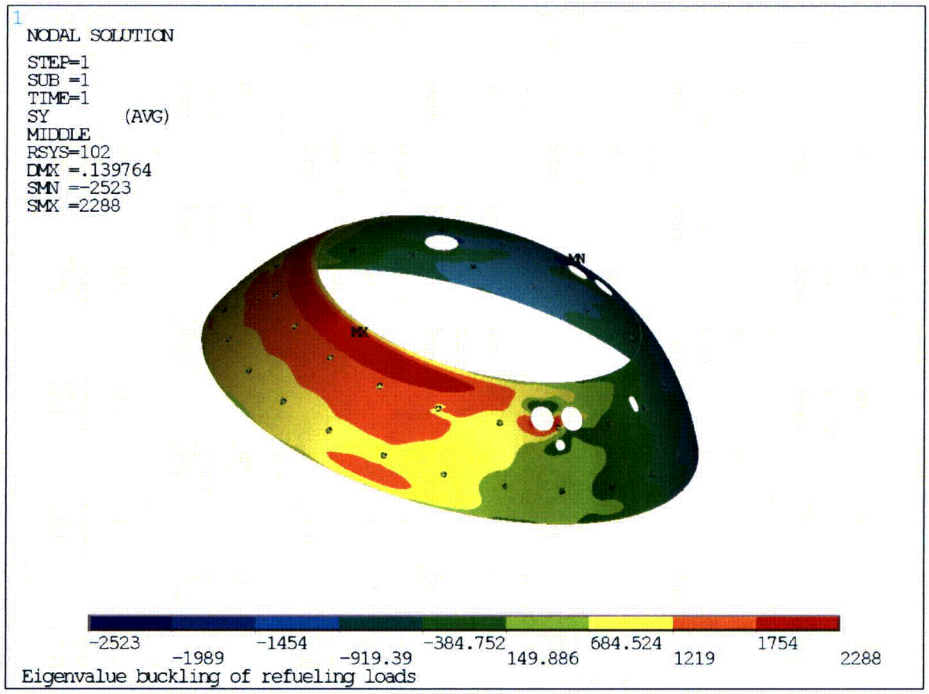


(b) Hoop Stress

Figure 5-31: Refueling Buckling Stress, Cylindrical Region, Sensitivity Case 2

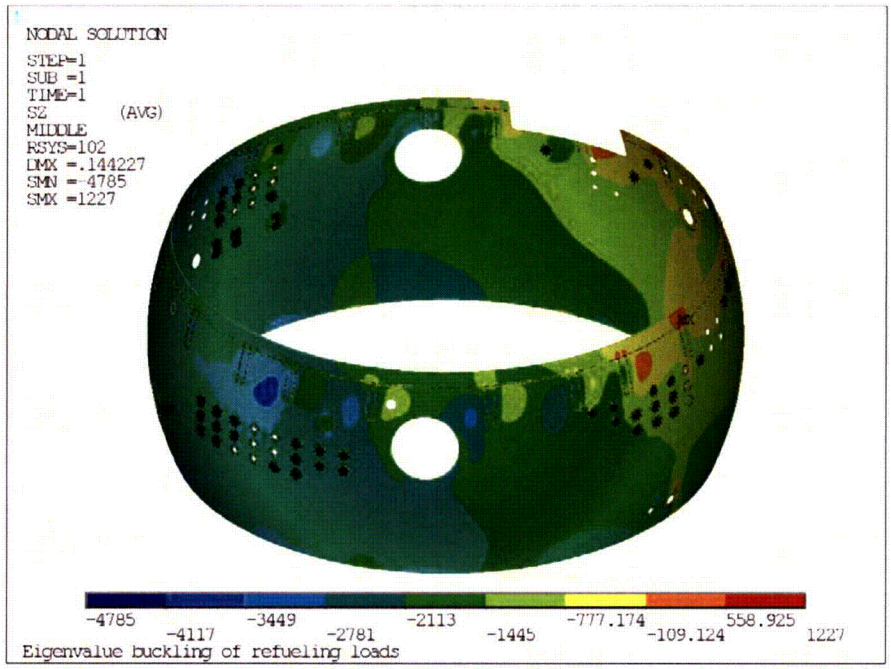


(a) Meridional Stress

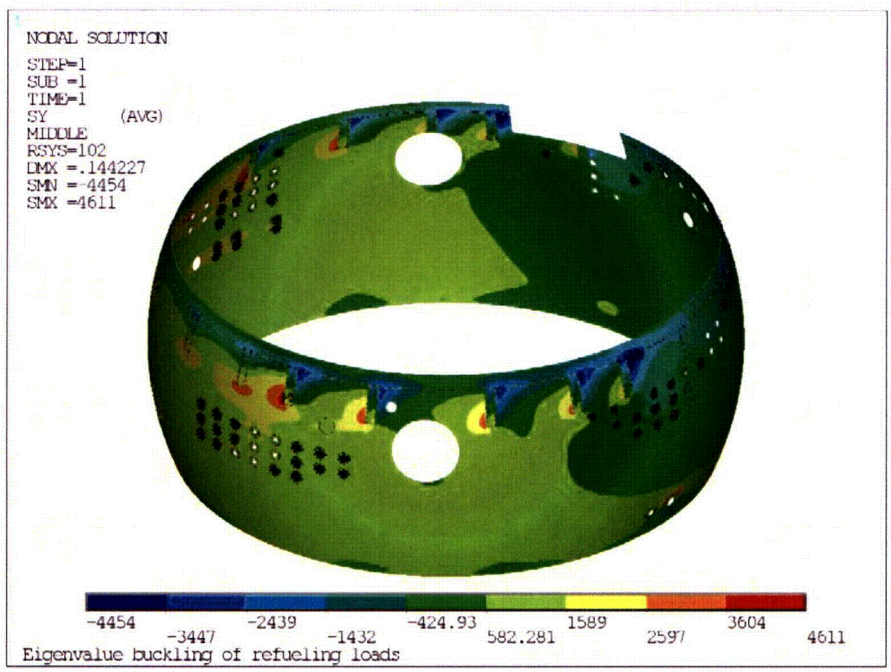


(b) Hoop Stress

Figure 5-32: Refueling Buckling Stress, Upper Spherical Region, Sensitivity Case 2

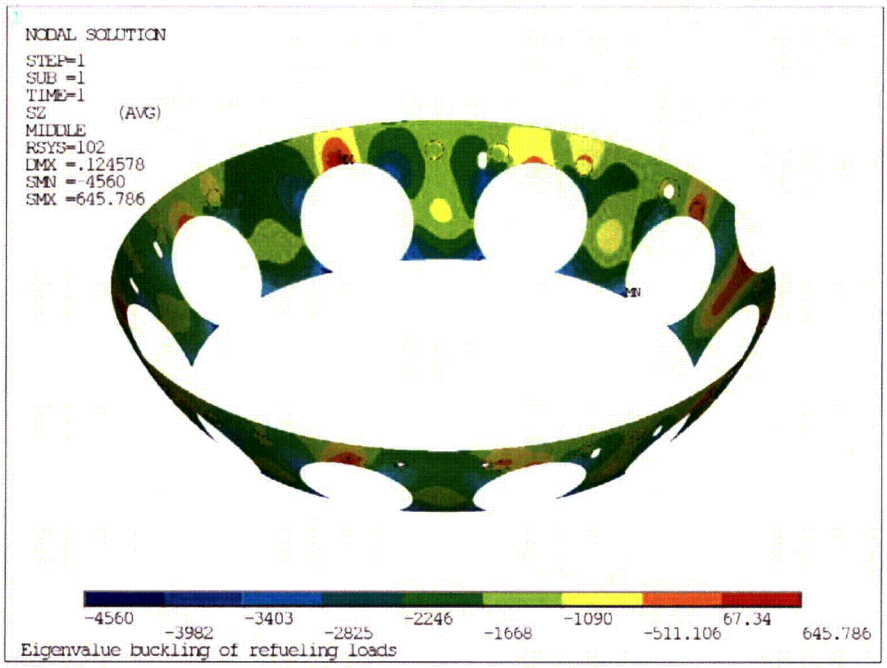


(a) Meridional Stress

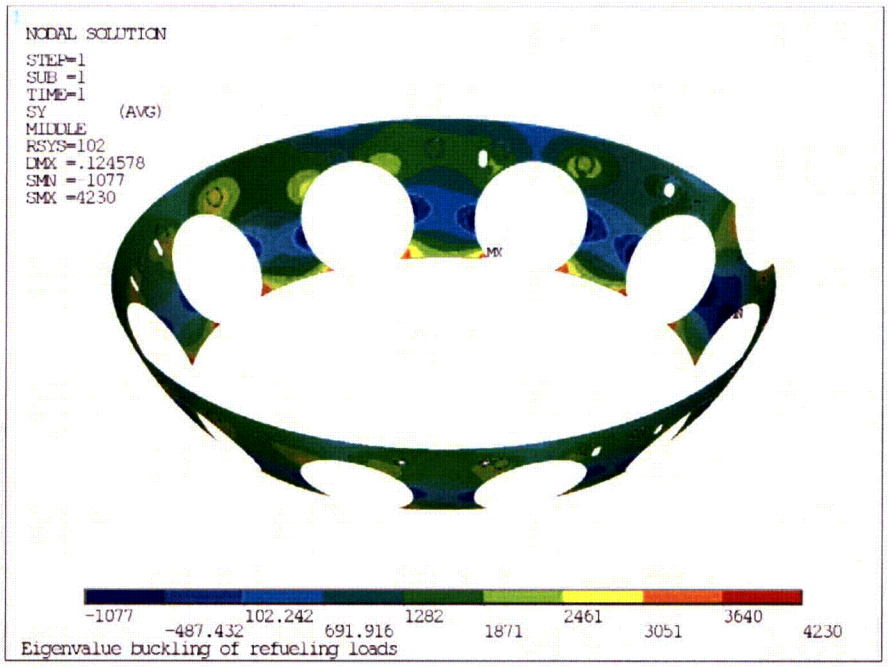


(b) Hoop Stress

Figure 5-33: Refueling Buckling Stress, Middle Spherical Region, Sensitivity Case 2

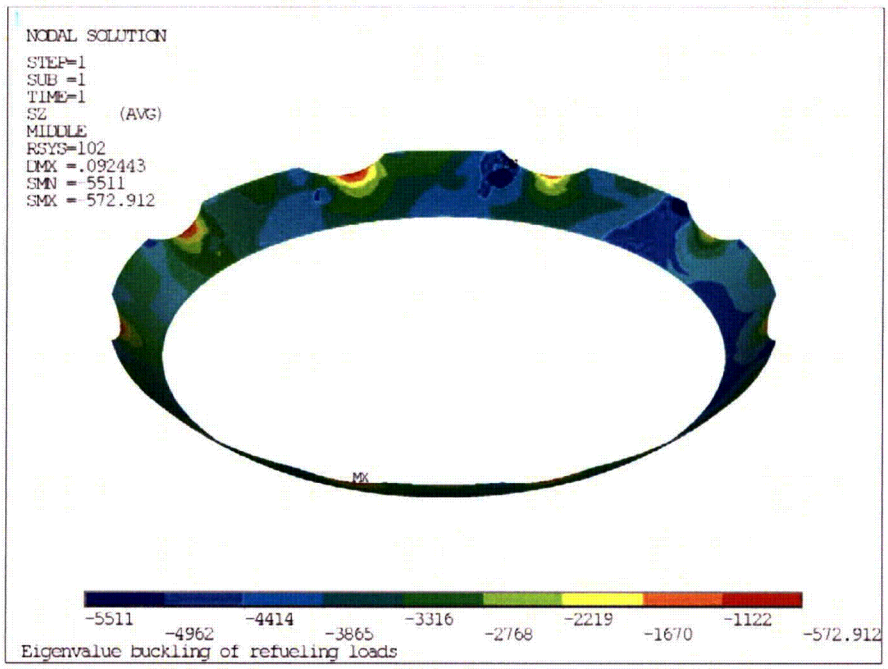


(a) Meridional Stress

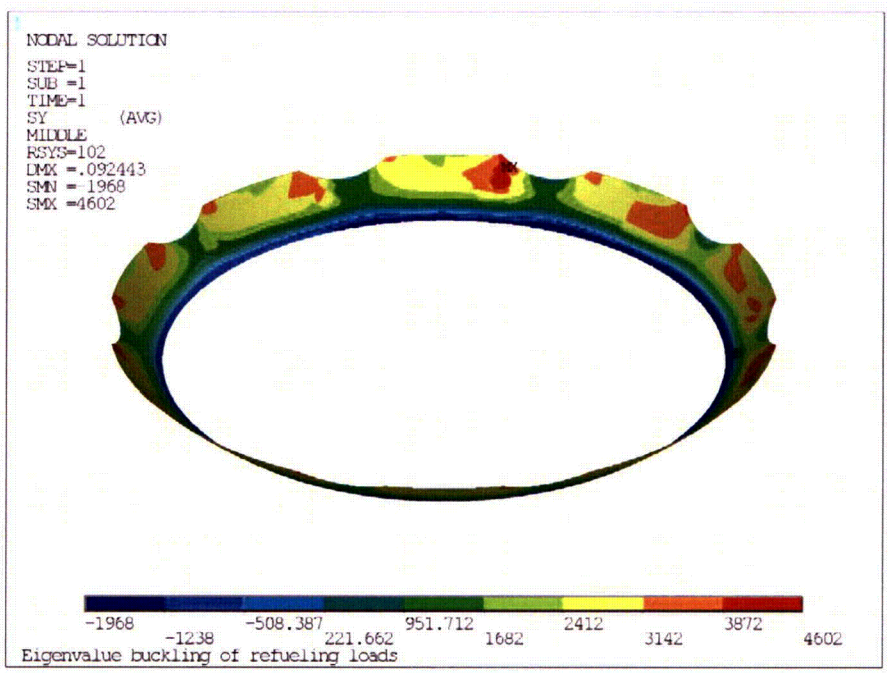


(b) Hoop Stress

Figure 5-34: Refueling Buckling Stress, Lower Spherical Region, Sensitivity Case 2

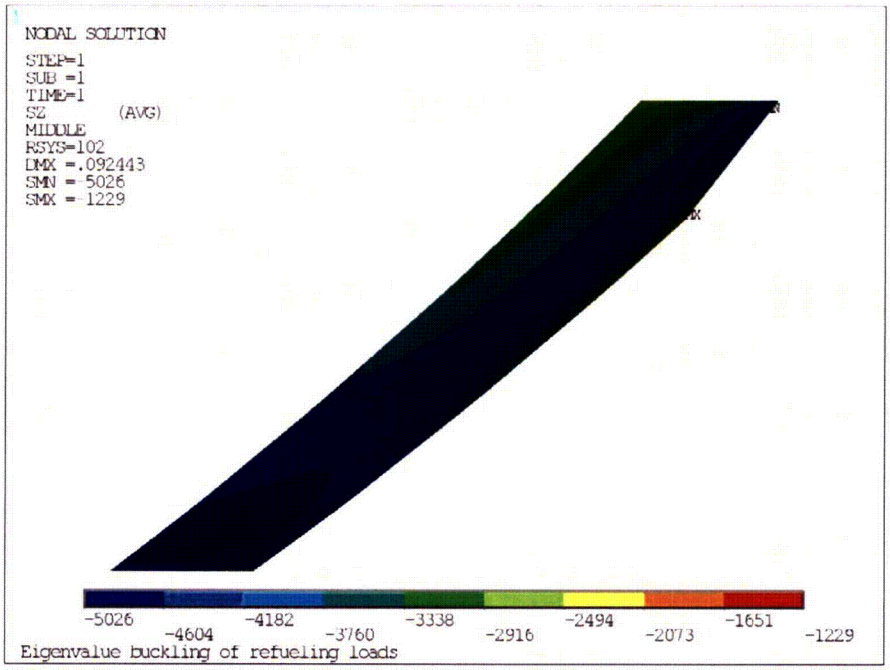


(a) Meridional

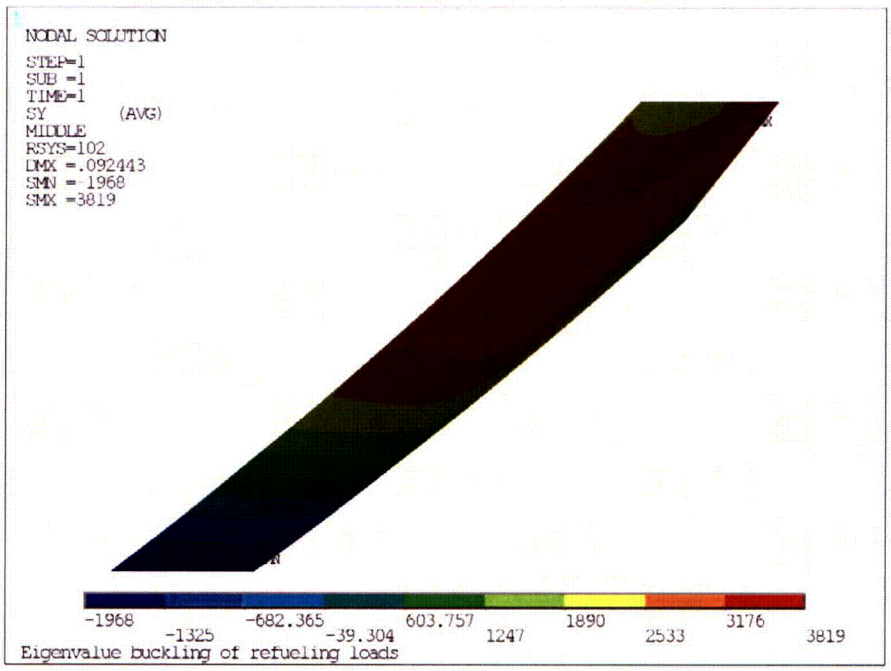


(b) Hoop Stress

Figure 5-35: Refueling Buckling Stress, Sandbed Region, Sensitivity Case 2

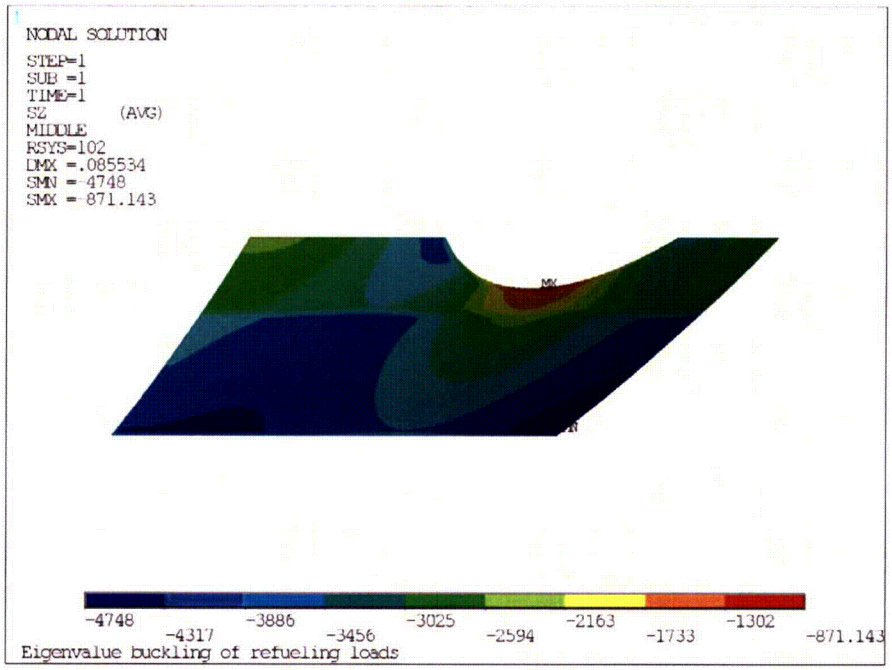


(a) Meridional Stress

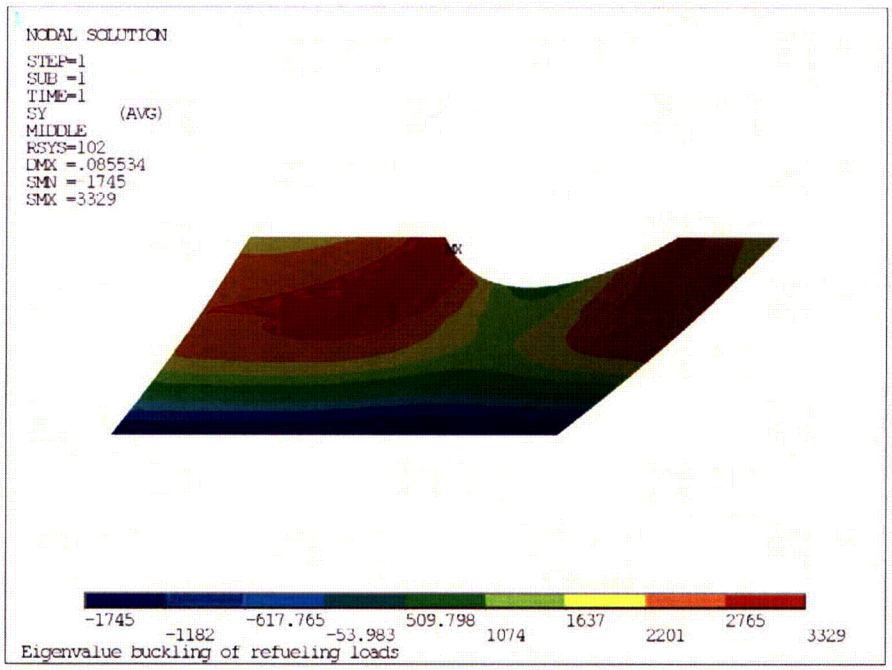


(b) Hoop Stress

Figure 5-36: Refueling Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 2

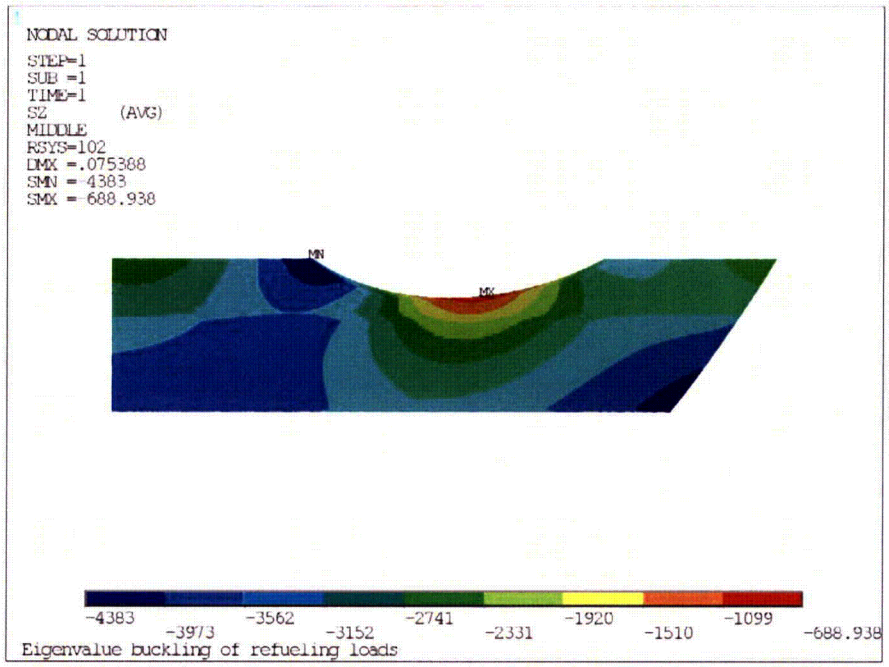


(a) Meridional Stress

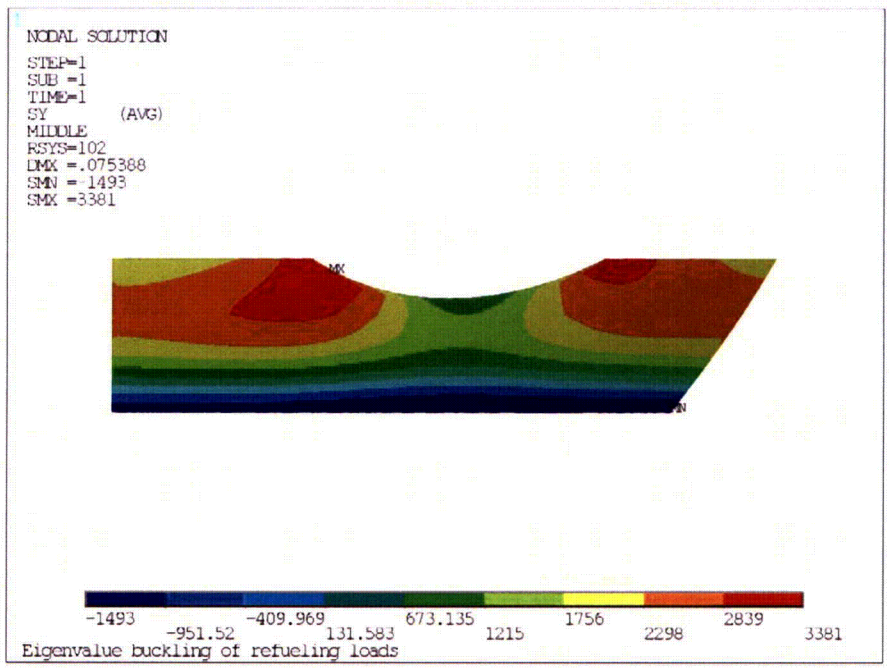


(b) Hoop Stress

Figure 5-37: Refueling Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 2

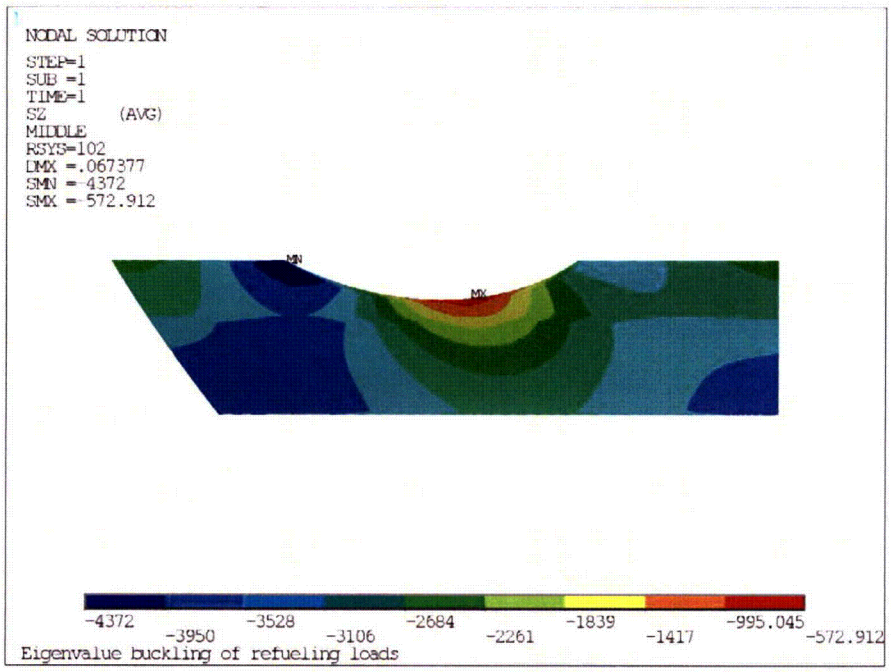


(a) Meridional Stress

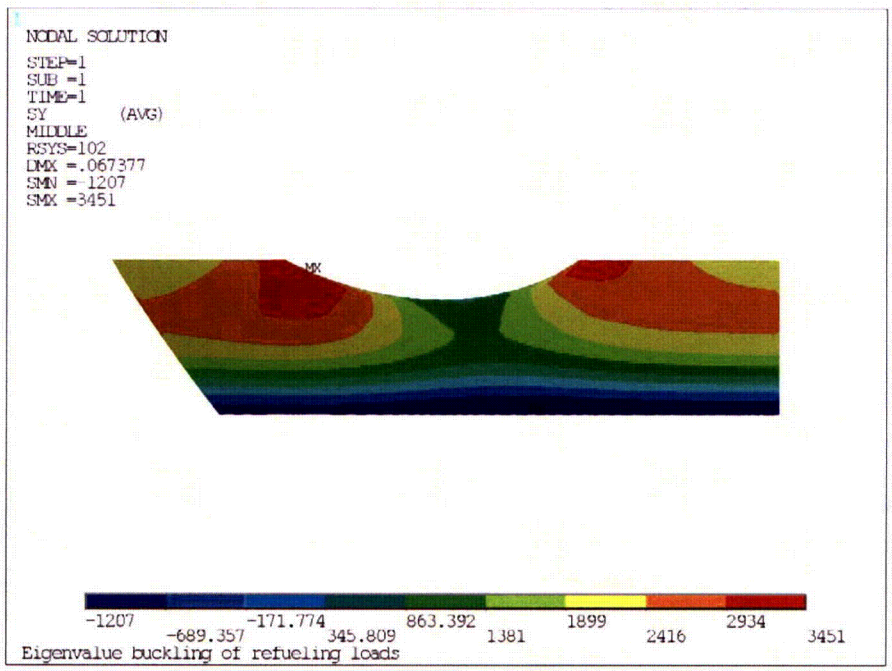


(b) Hoop Stress

Figure 5-38: Refueling Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 2

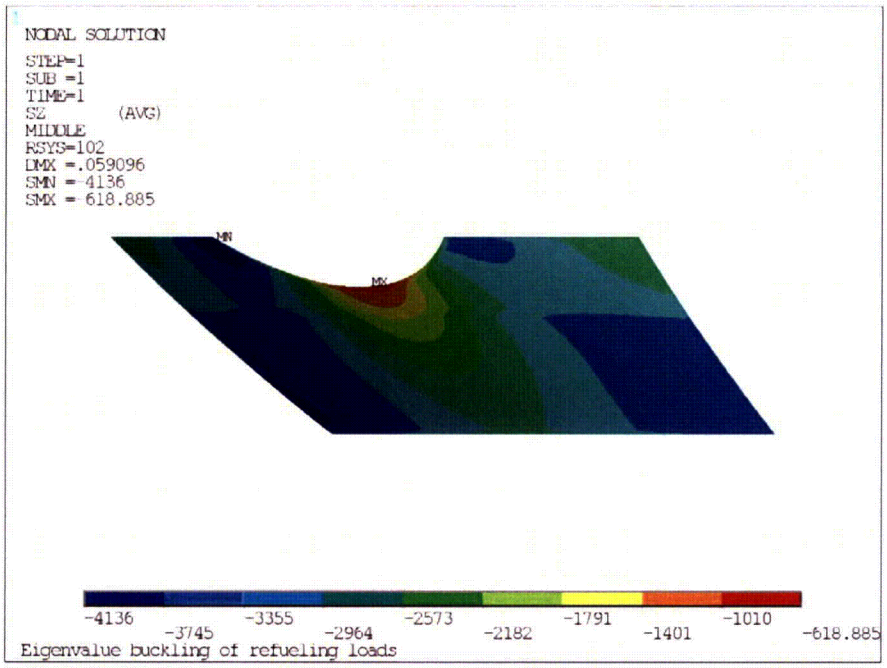


(a) Meridional Stress

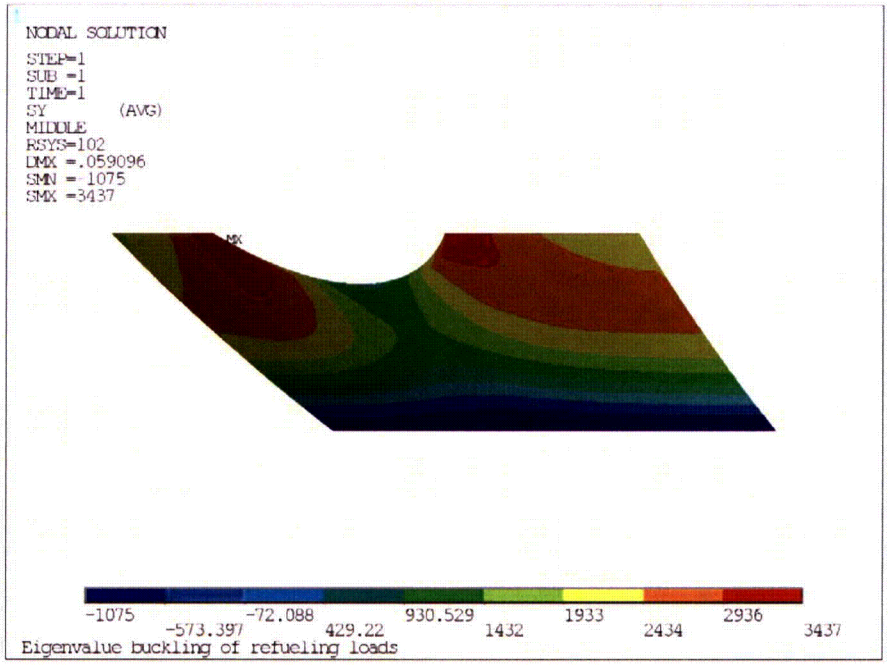


(b) Hoop Stress

Figure 5-39: Refueling Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 2

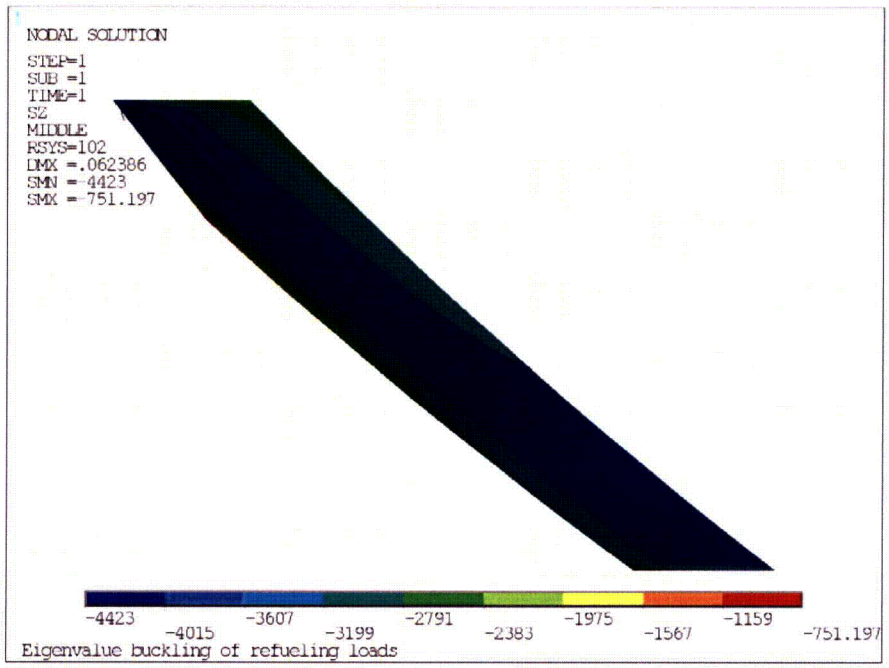


(a) Meridional Stress

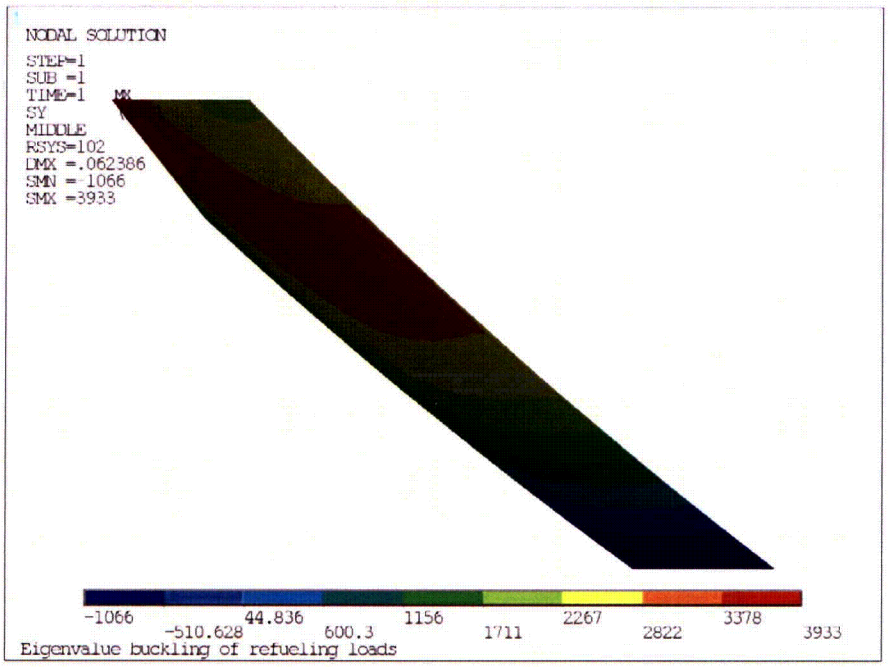


(b) Hoop Stress

Figure 5-40: Refueling Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 2

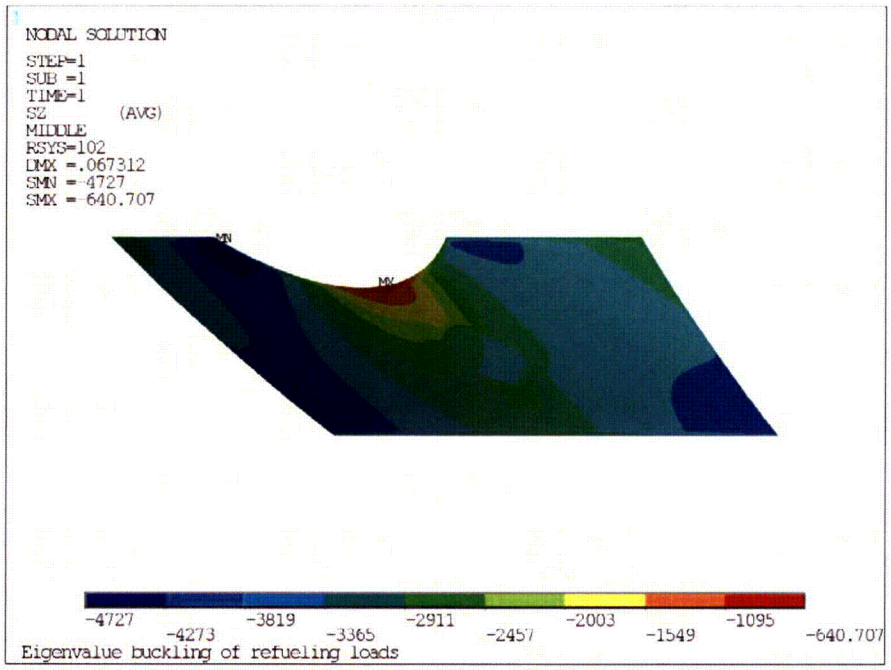


(a) Meridional Stress

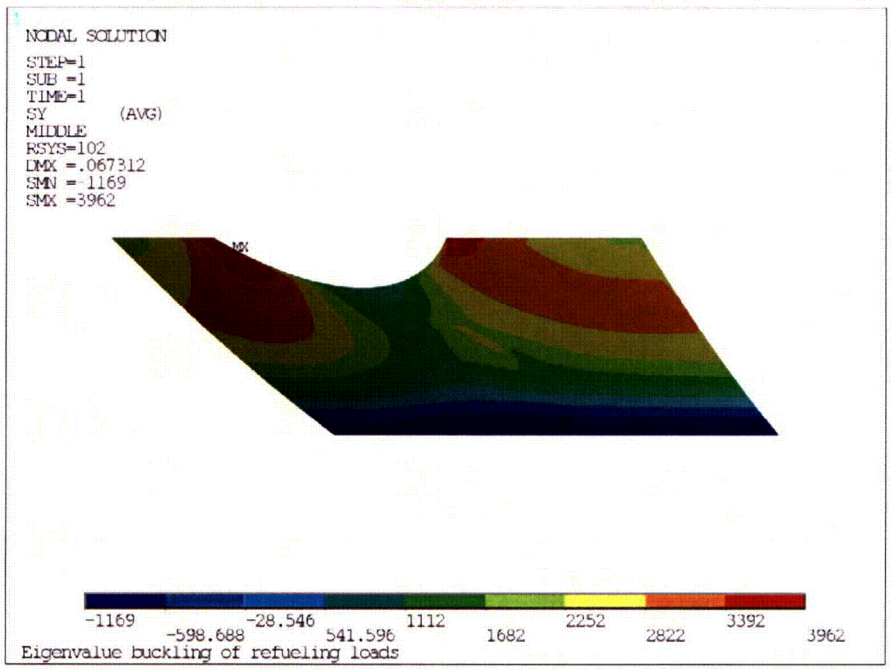


(b) Hoop Stress

Figure 5-41: Refueling Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 2

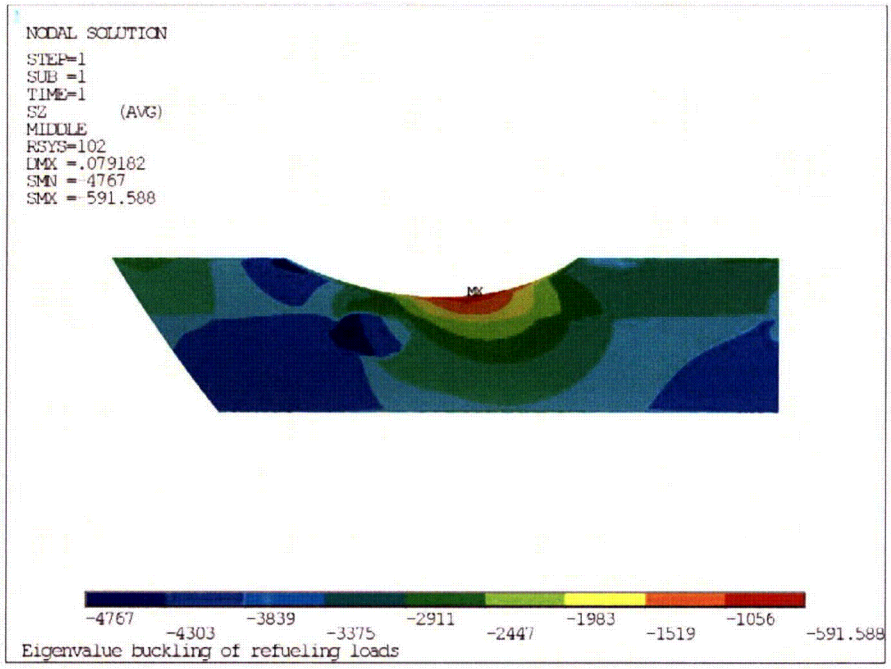


(a) Meridional Stress

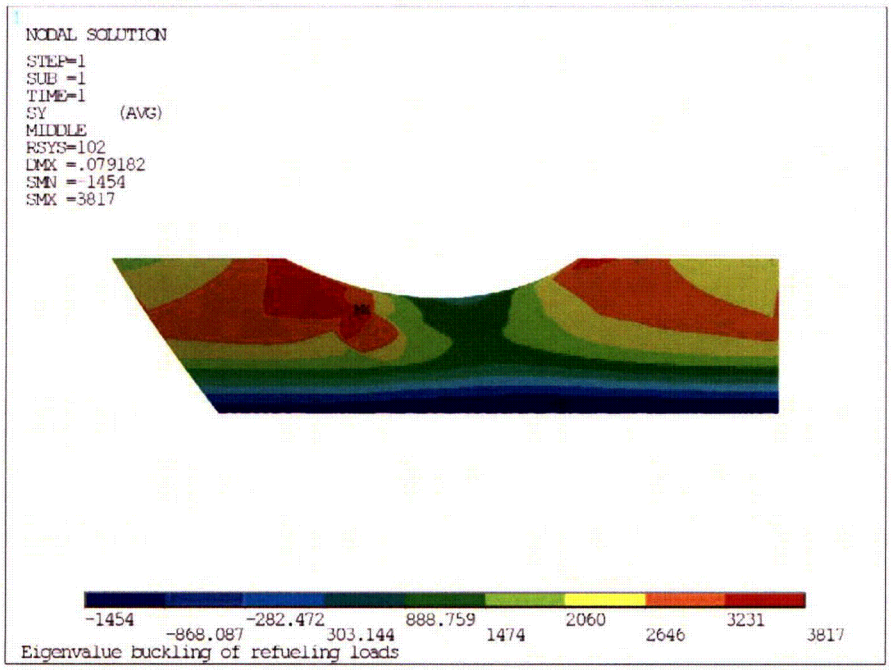


(b) Hoop Stress

Figure 5-42: Refueling Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 2

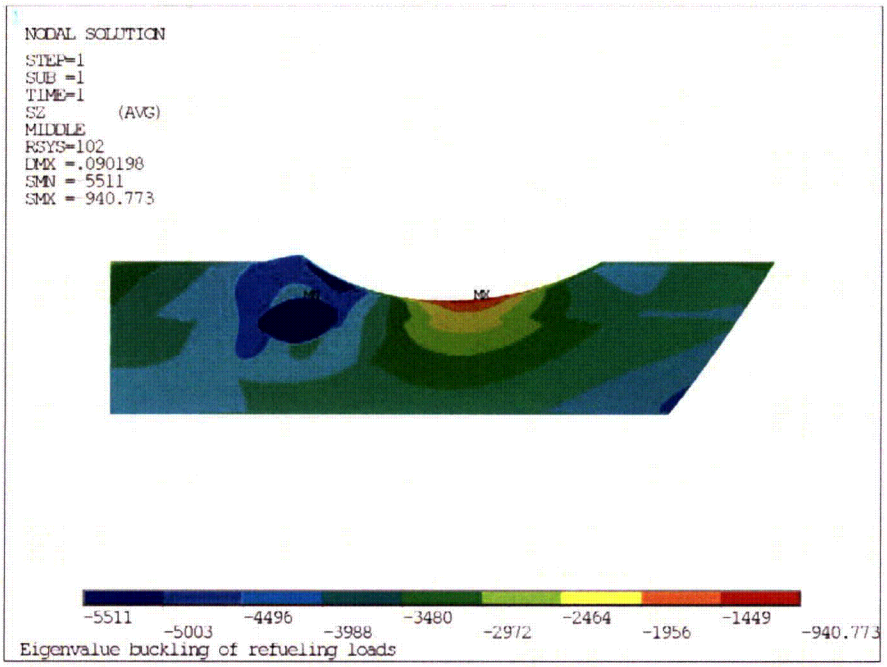


(a) Meridional Stress

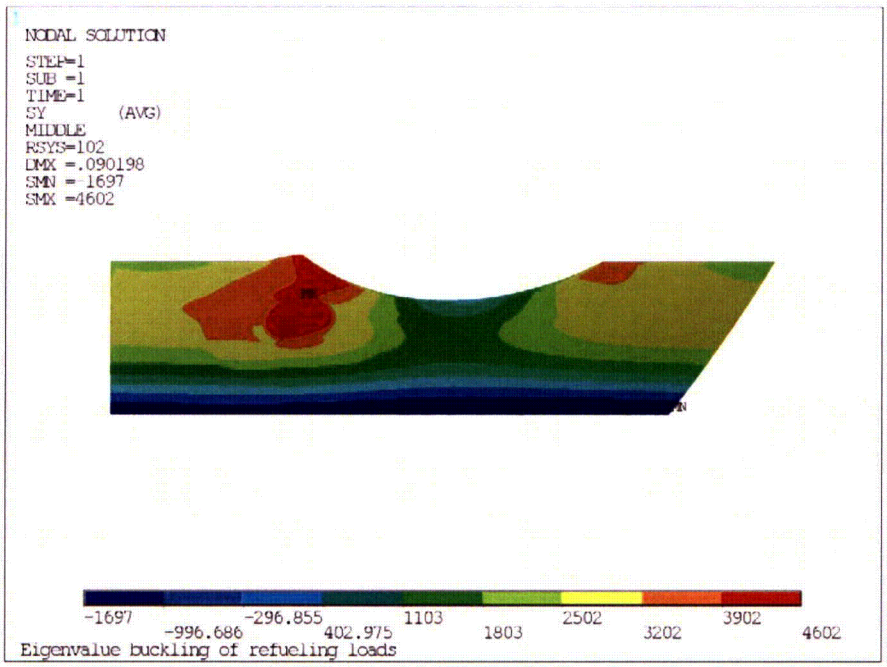


(b) Hoop Stress

Figure 5-43: Refueling Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 2

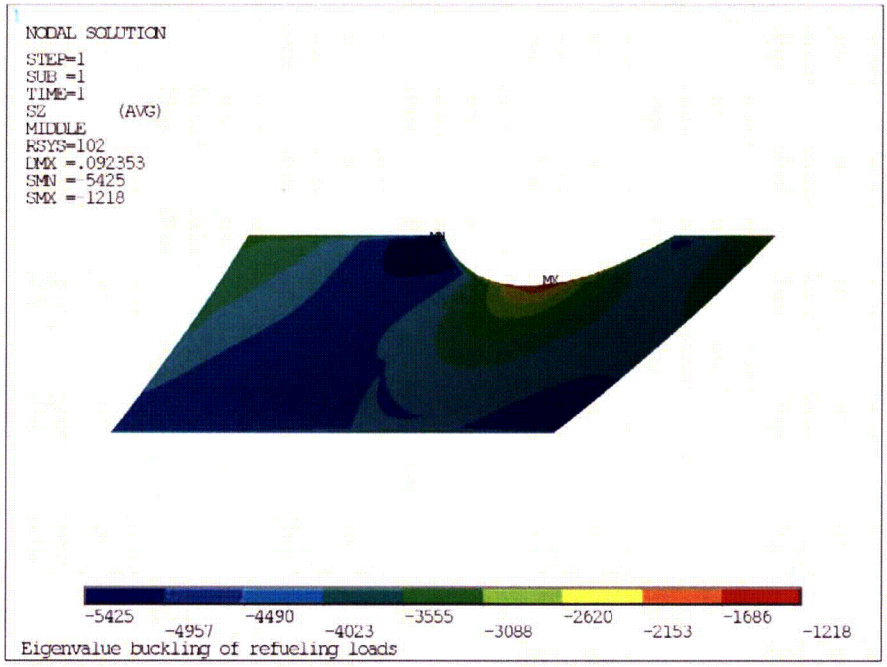


(a) Meridional Stress

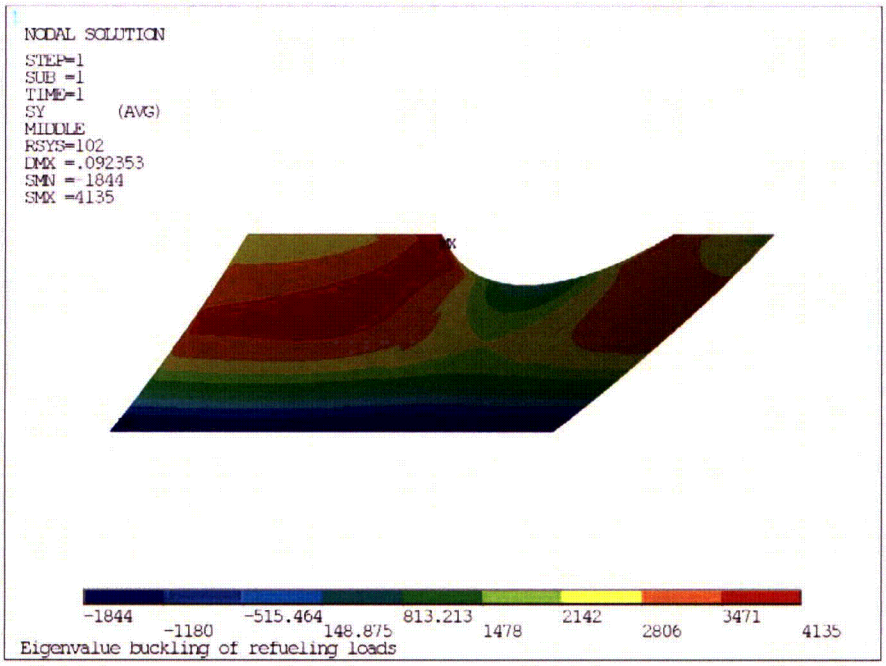


(b) Hoop Stress

Figure 5-44: Refueling Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 2

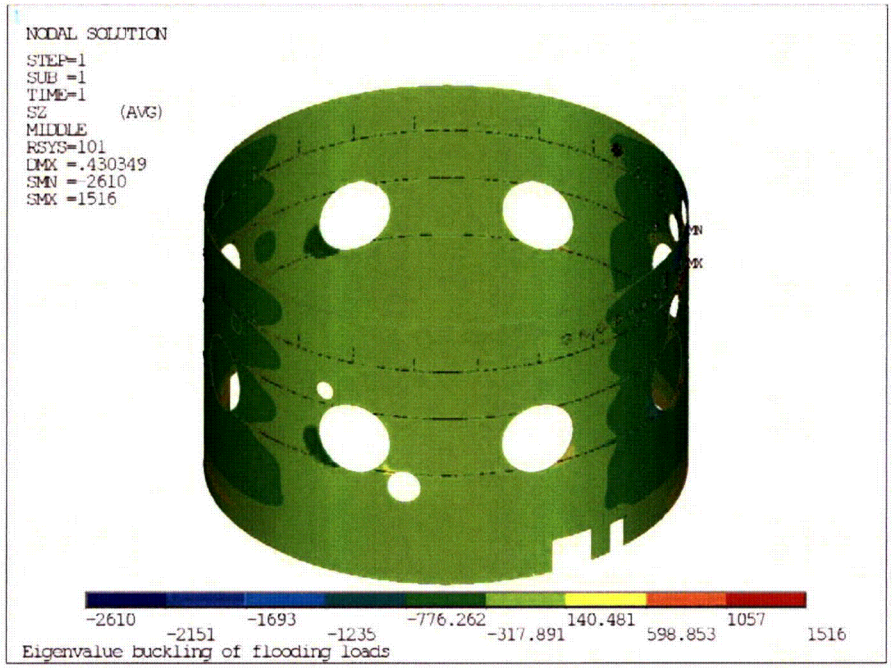


(a) Meridional Stress

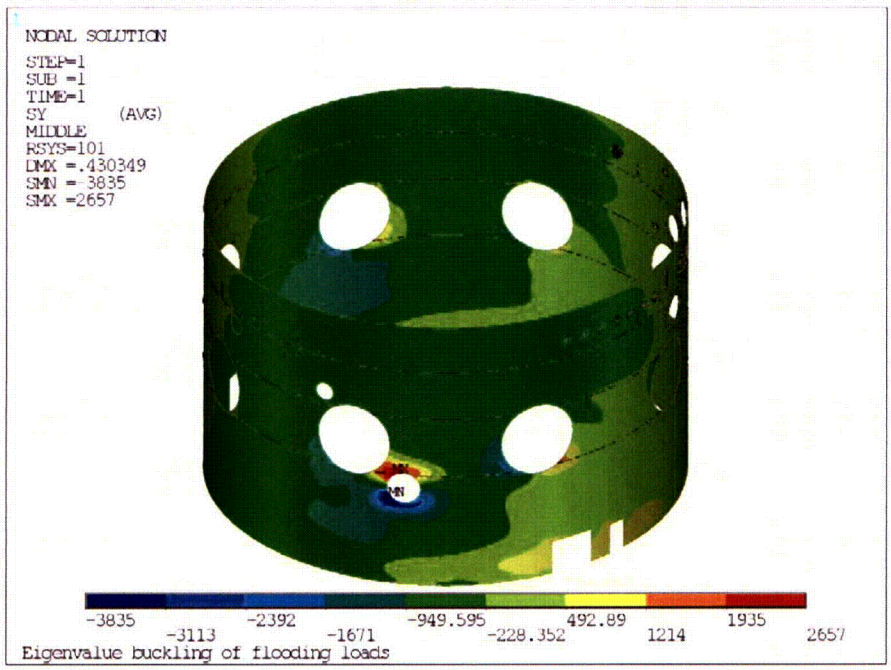


(b) Hoop Stress

Figure 5-45: Refueling Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 2

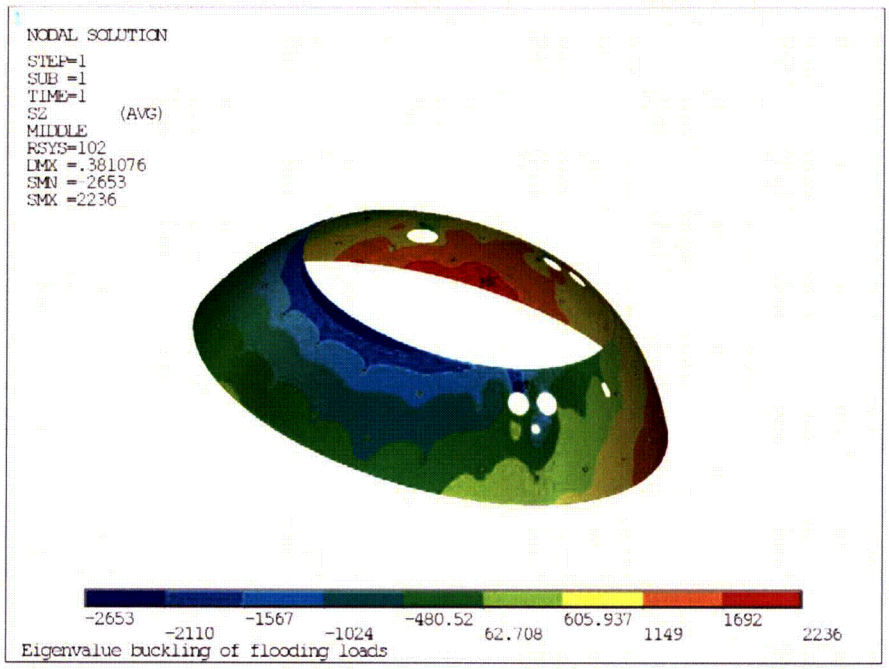


(a) Axial Stress

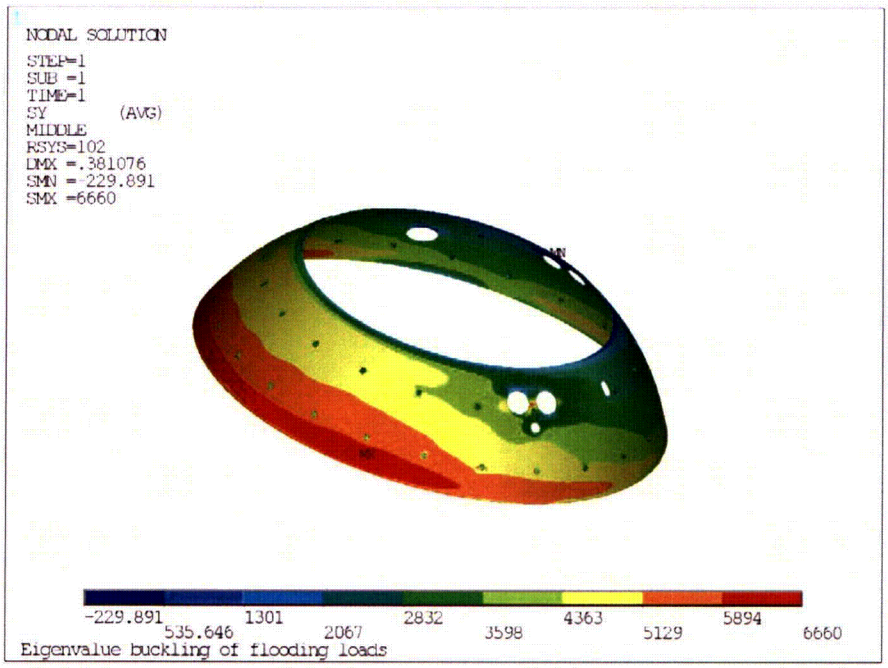


(b) Hoop Stress

Figure 5-46: Flooding Buckling Stress, Cylindrical Region, Sensitivity Case 2

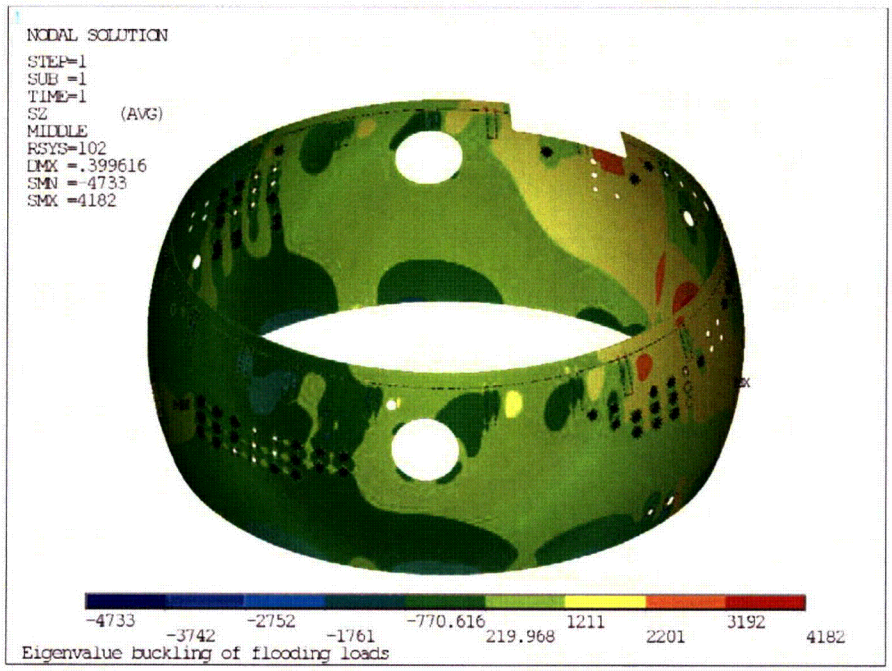


(a) Meridional Stress

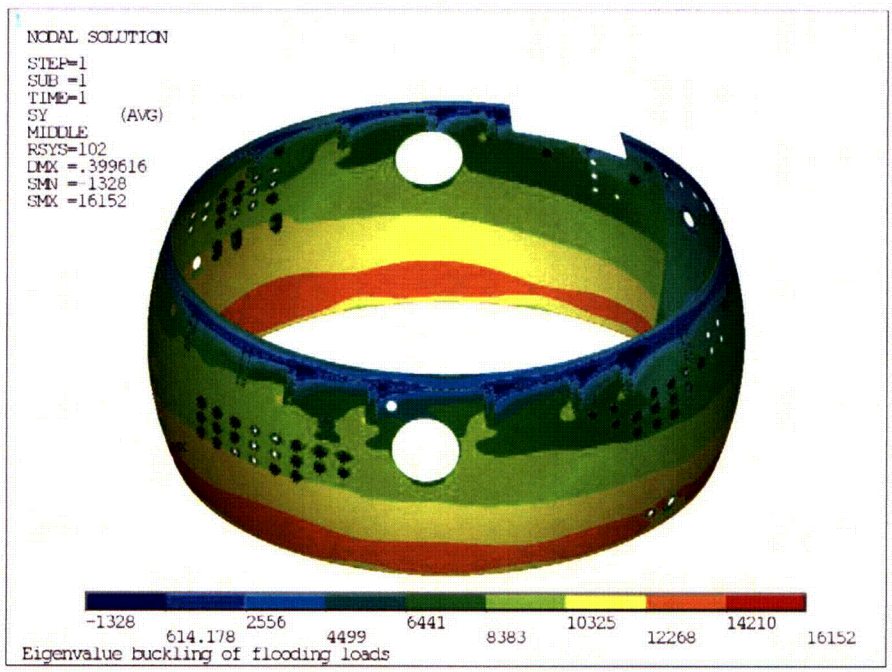


(b) Hoop Stress

Figure 5-47: Flooding Buckling Stress, Upper Spherical Region, Sensitivity Case 2

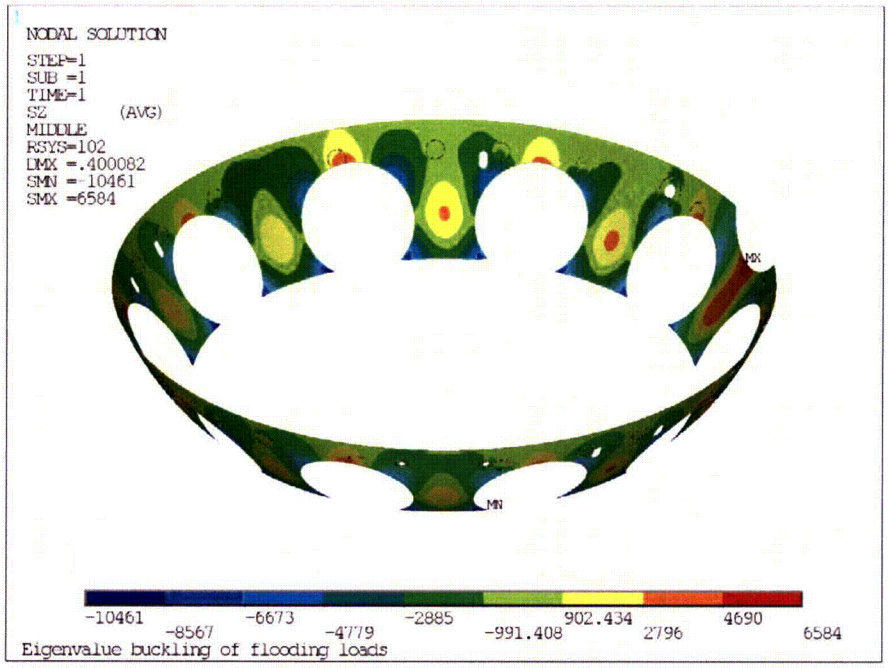


(a) Meridional Stress

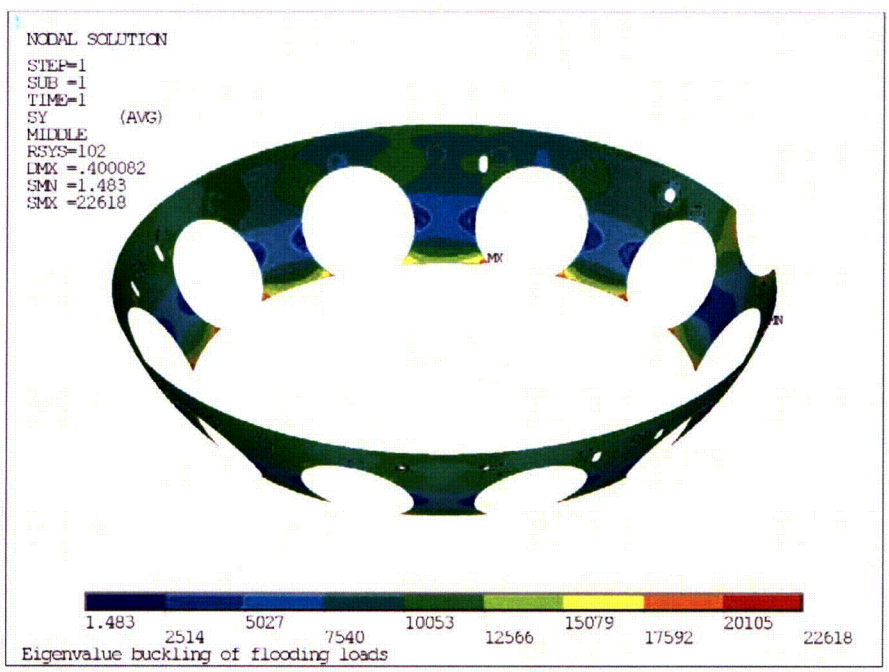


(b) Hoop Stress

Figure 5-48: Flooding Buckling Stress, Middle Spherical Region, Sensitivity Case 2

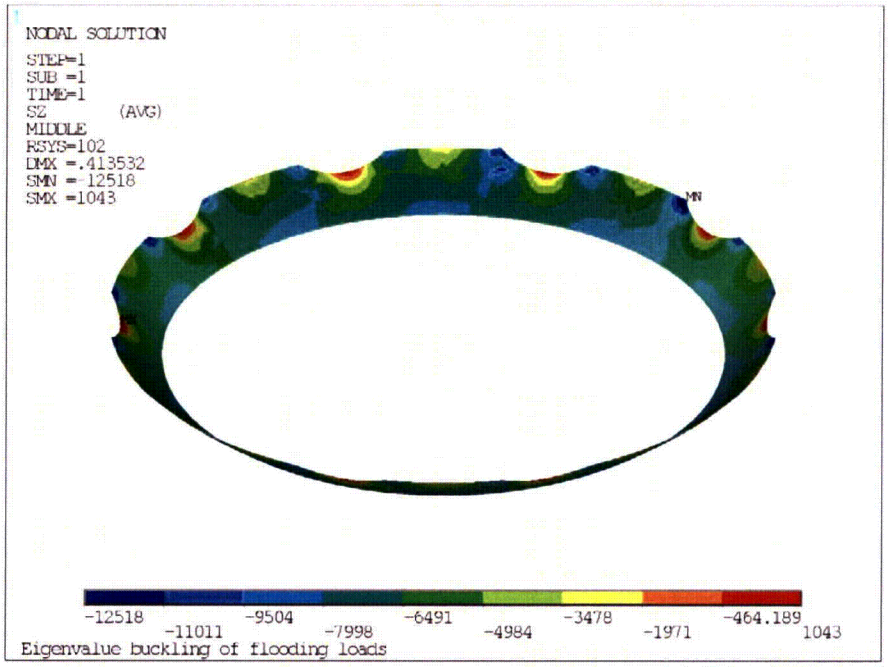


(a) Meridional Stress

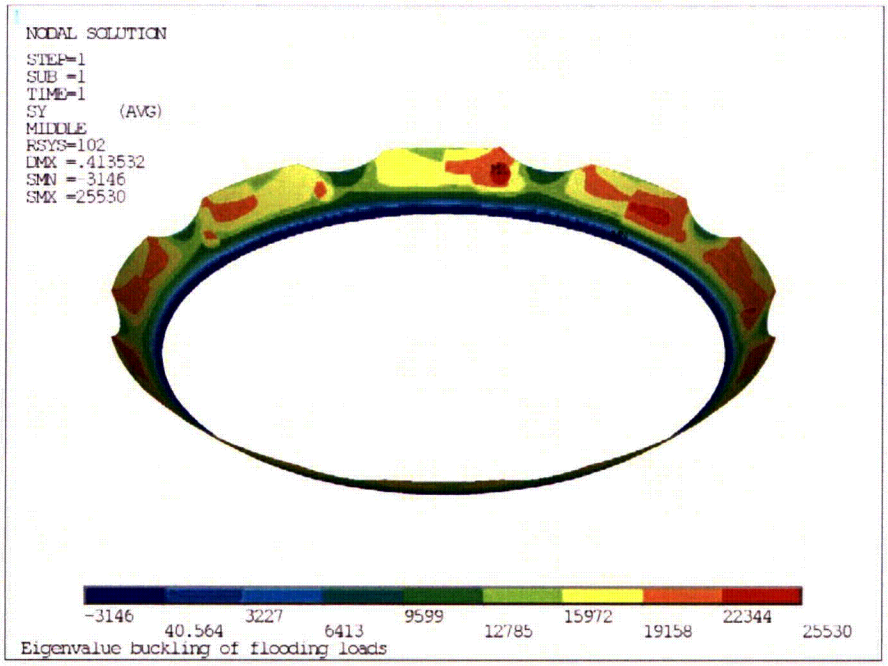


(b) Hoop Stress

Figure 5-49: Flooding Buckling Stress, Lower Spherical Region, Sensitivity Case 2

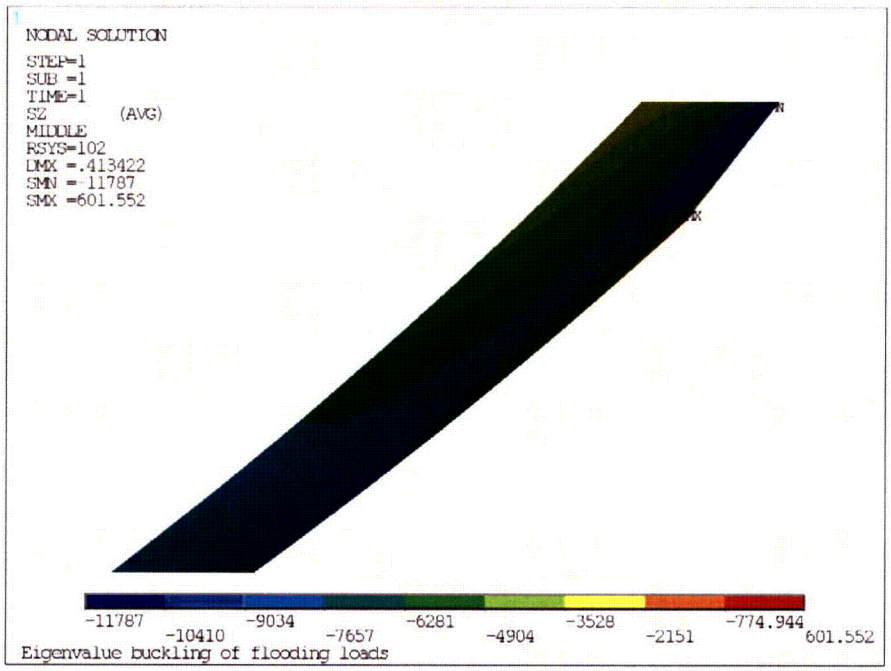


(a) Meridional

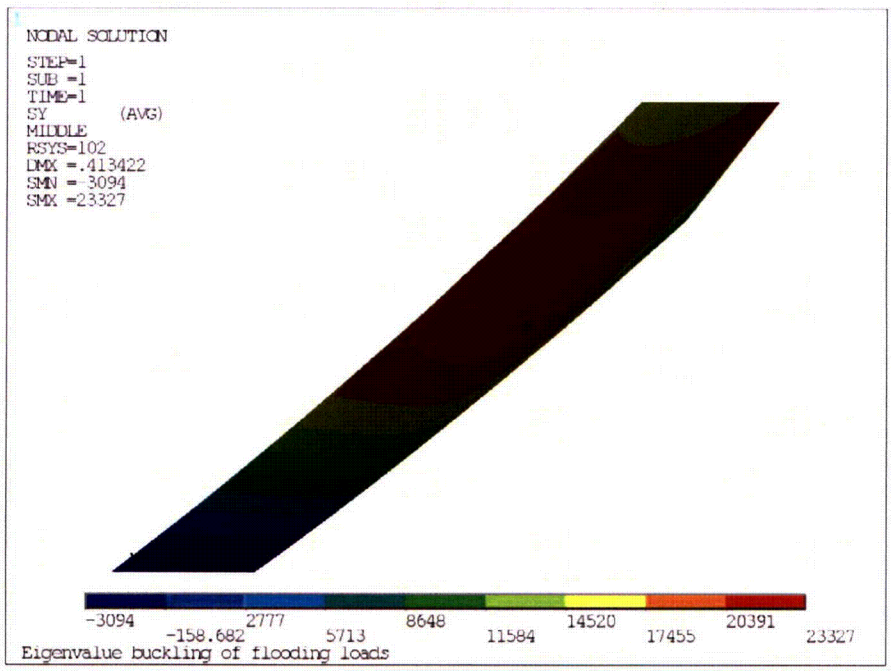


(b) Hoop Stress

Figure 5-50: Flooding Buckling Stress, Sandbed Region, Sensitivity Case 2

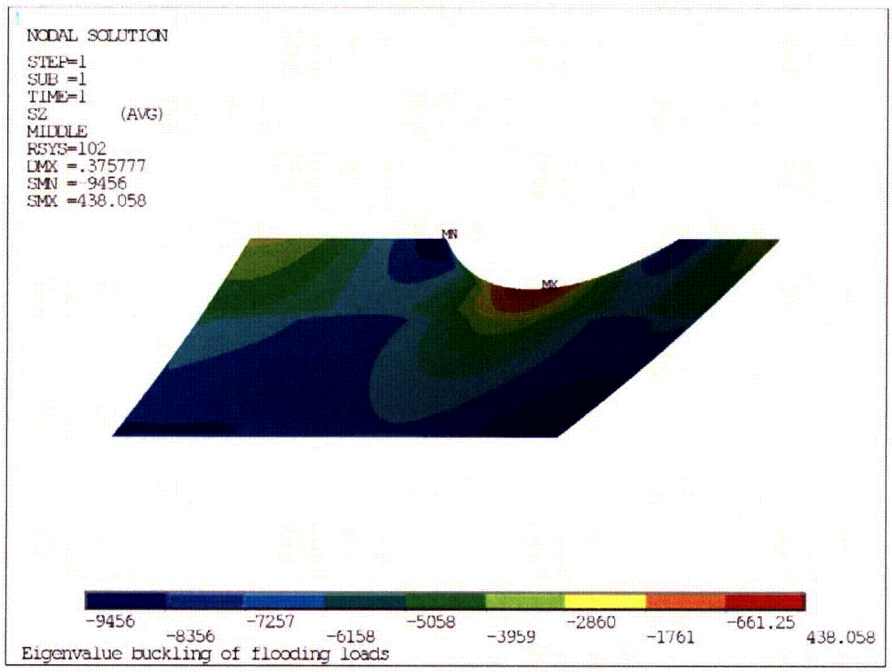


(a) Meridional Stress

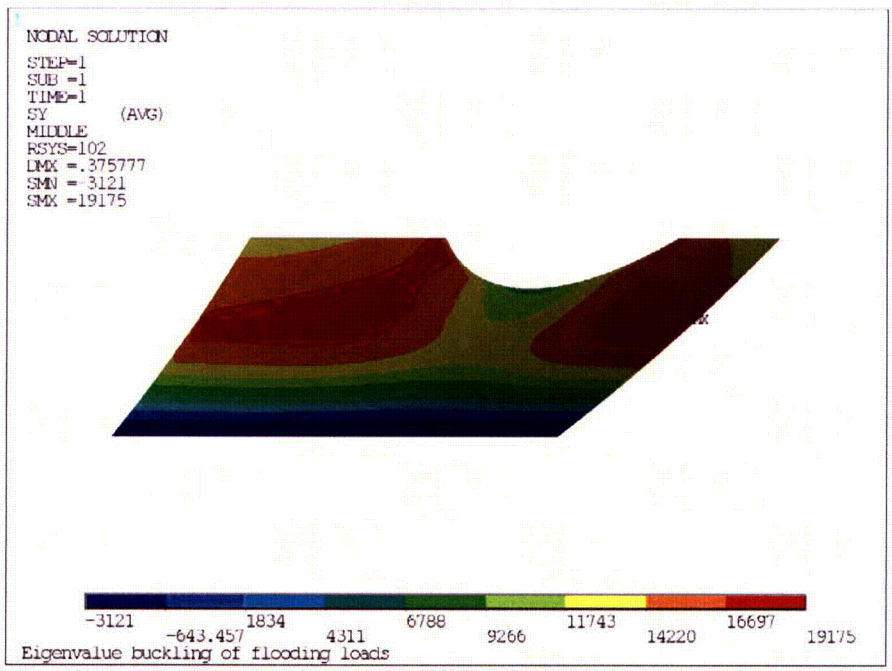


(b) Hoop Stress

Figure 5-51: Flooding Buckling Stress, Bay 1 Sandbed Region, Sensitivity Case 2

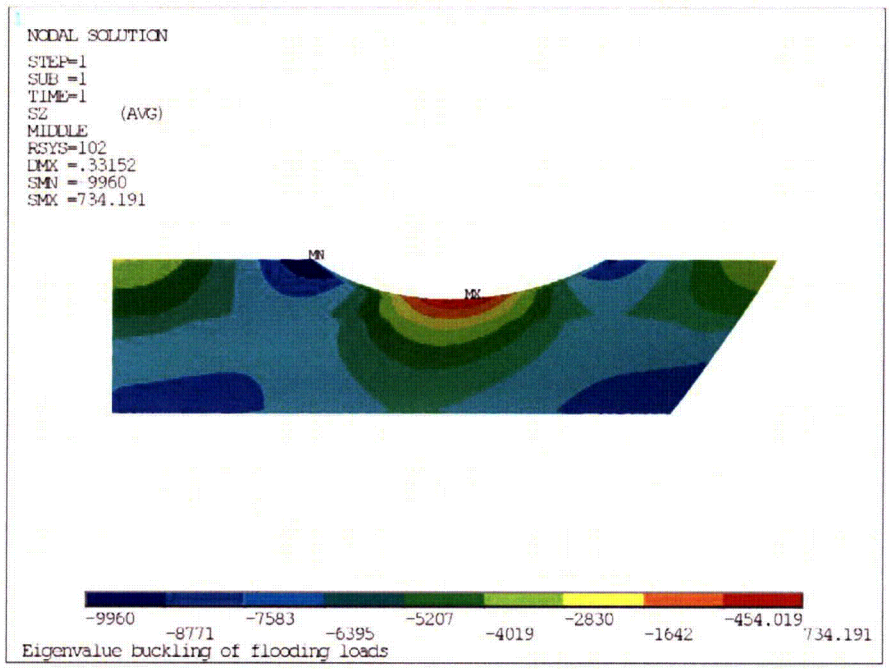


(a) Meridional Stress

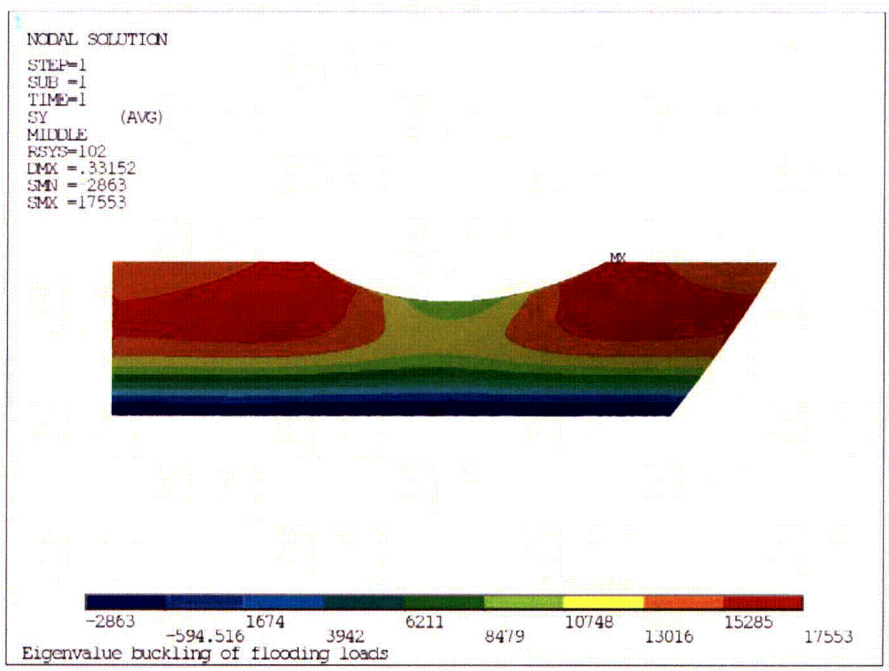


(b) Hoop Stress

Figure 5-52: Flooding Buckling Stress, Bay 3 Sandbed Region, Sensitivity Case 2

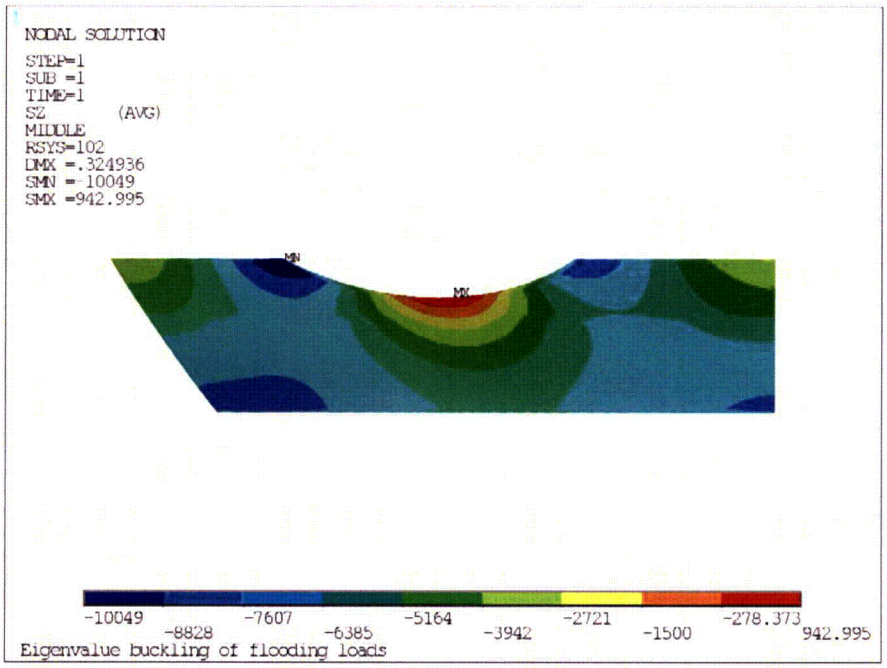


(a) Meridional Stress

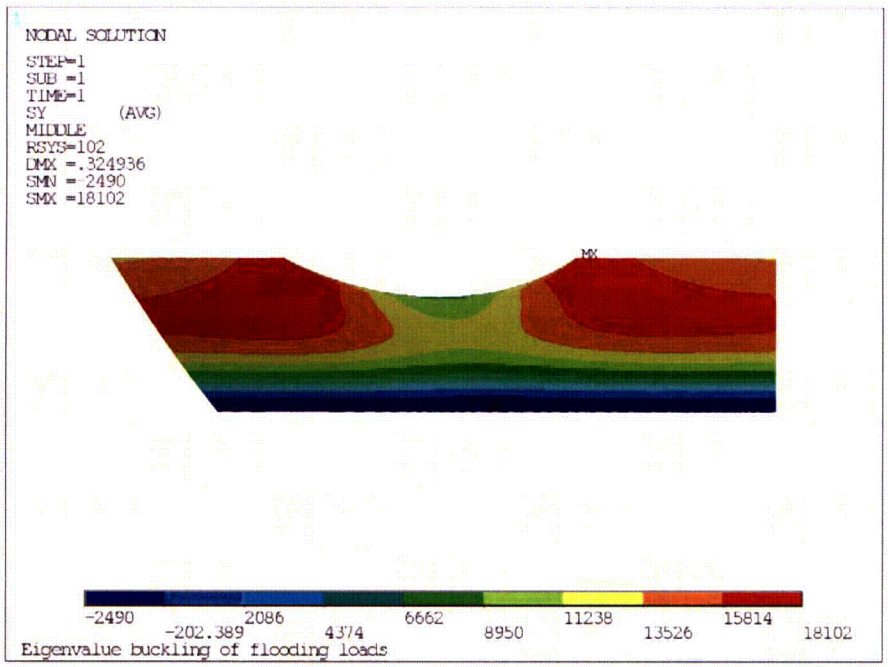


(b) Hoop Stress

Figure 5-53: Flooding Buckling Stress, Bay 5 Sandbed Region, Sensitivity Case 2

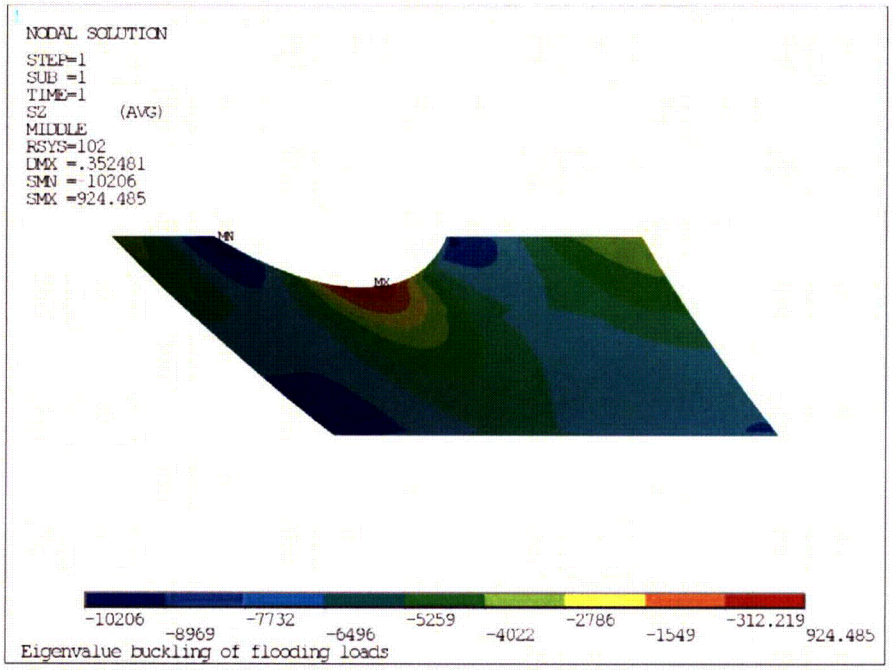


(a) Meridional Stress

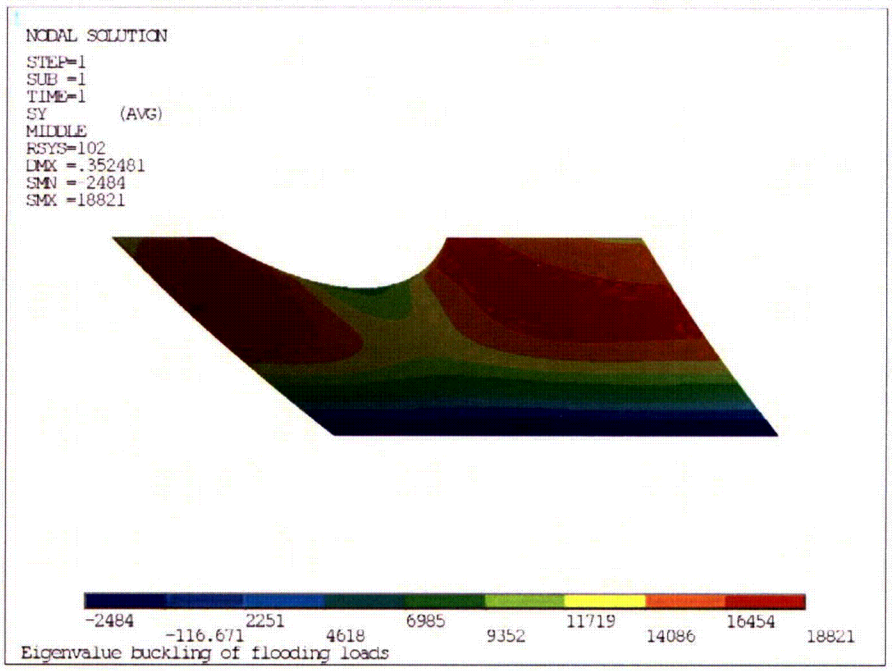


(b) Hoop Stress

Figure 5-54: Flooding Buckling Stress, Bay 7 Sandbed Region, Sensitivity Case 2

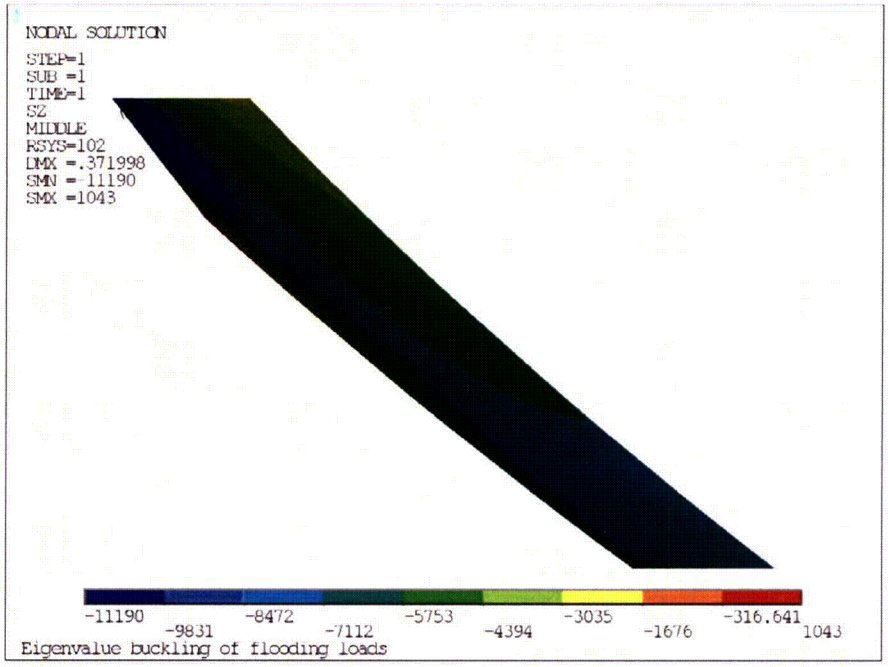


(a) Meridional Stress

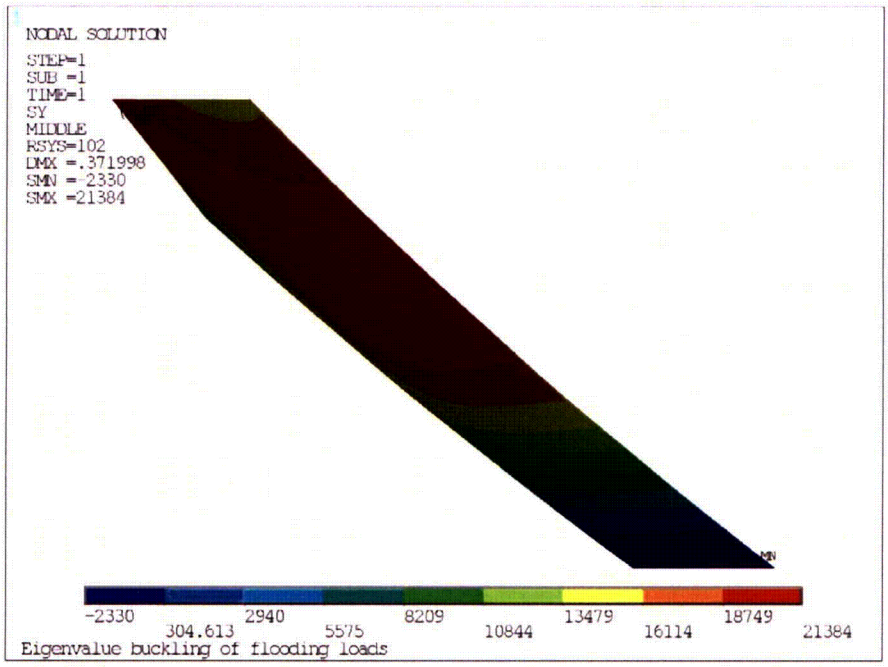


(b) Hoop Stress

Figure 5-55: Flooding Buckling Stress, Bay 9 Sandbed Region, Sensitivity Case 2

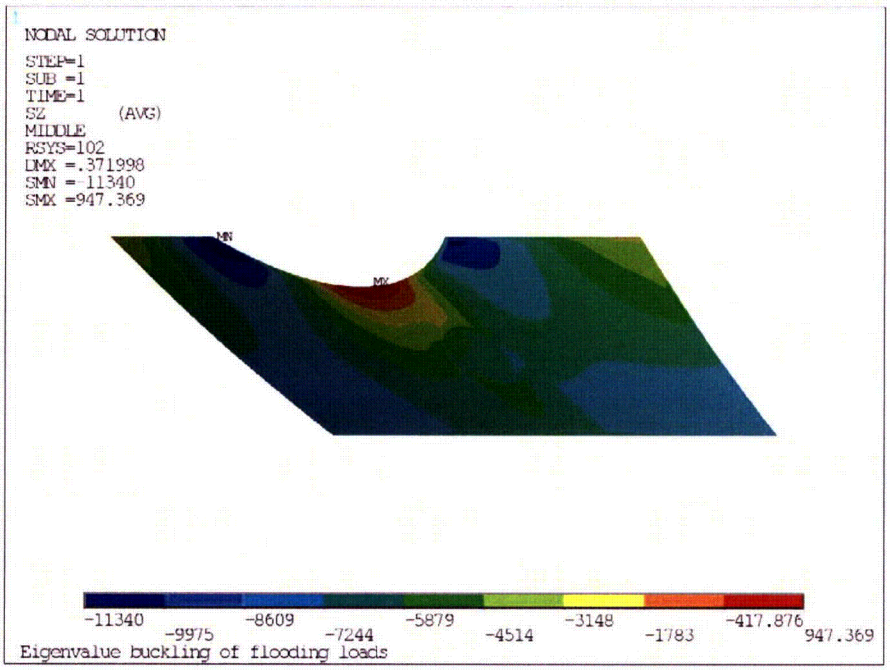


(a) Meridional Stress

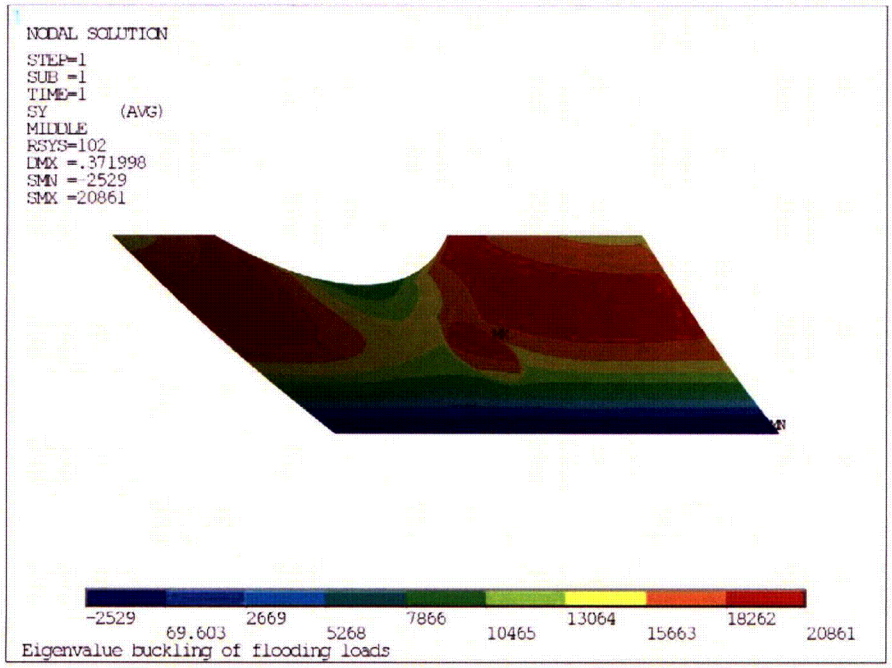


(b) Hoop Stress

Figure 5-56: Flooding Buckling Stress, Bay 11 Sandbed Region, Sensitivity Case 2

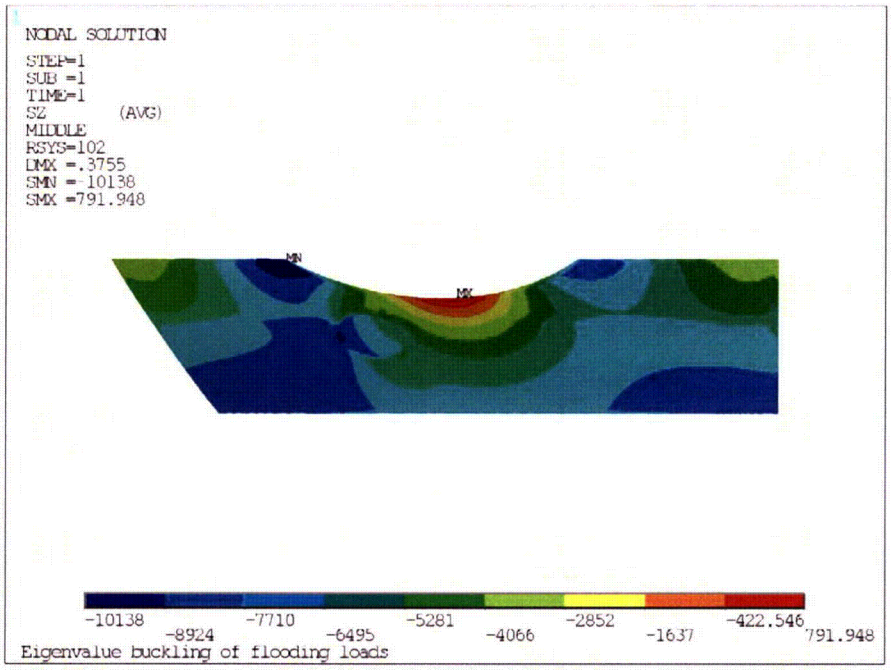


(a) Meridional Stress

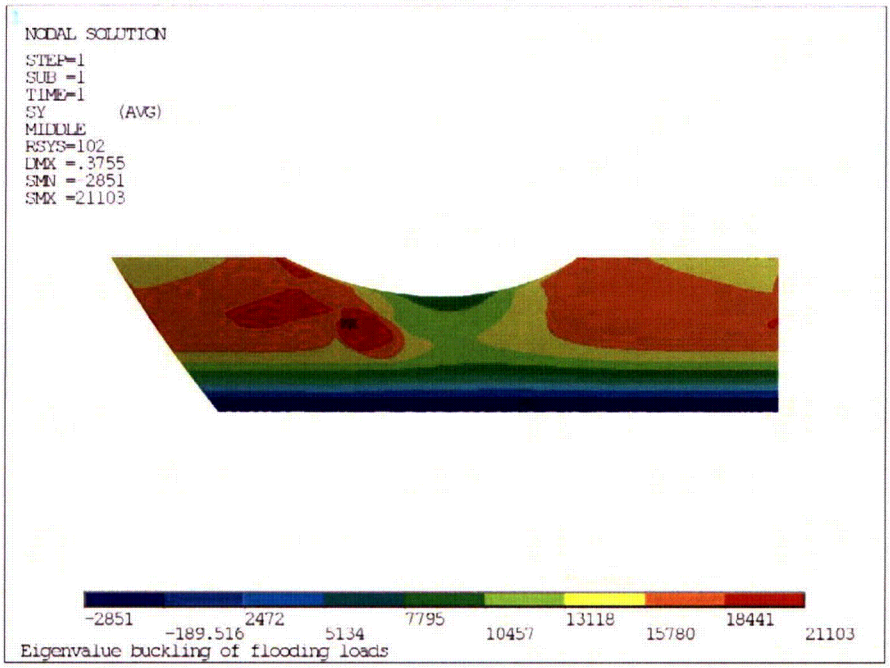


(b) Hoop Stress

Figure 5-57: Flooding Buckling Stress, Bay 13 Sandbed Region, Sensitivity Case 2

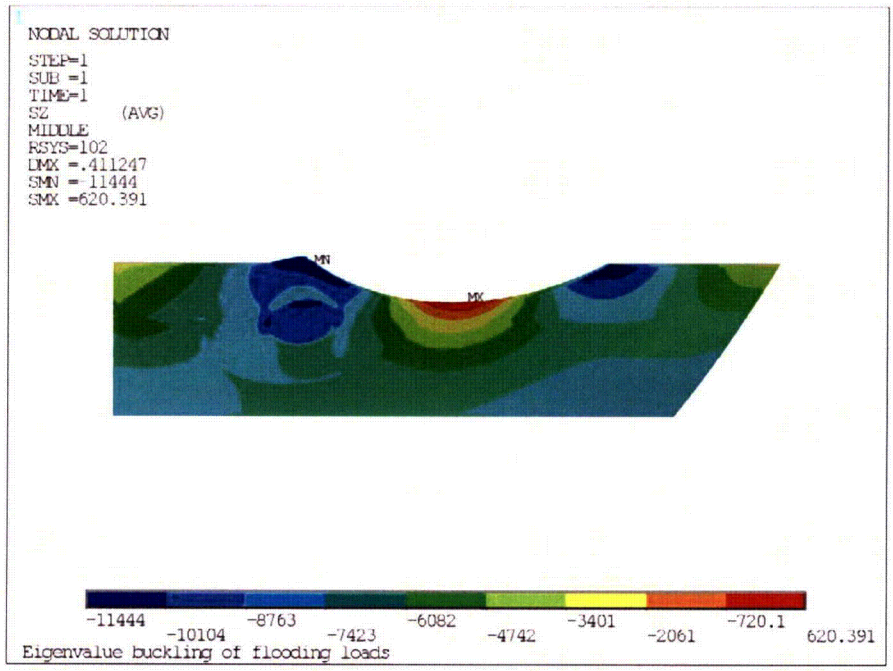


(a) Meridional Stress

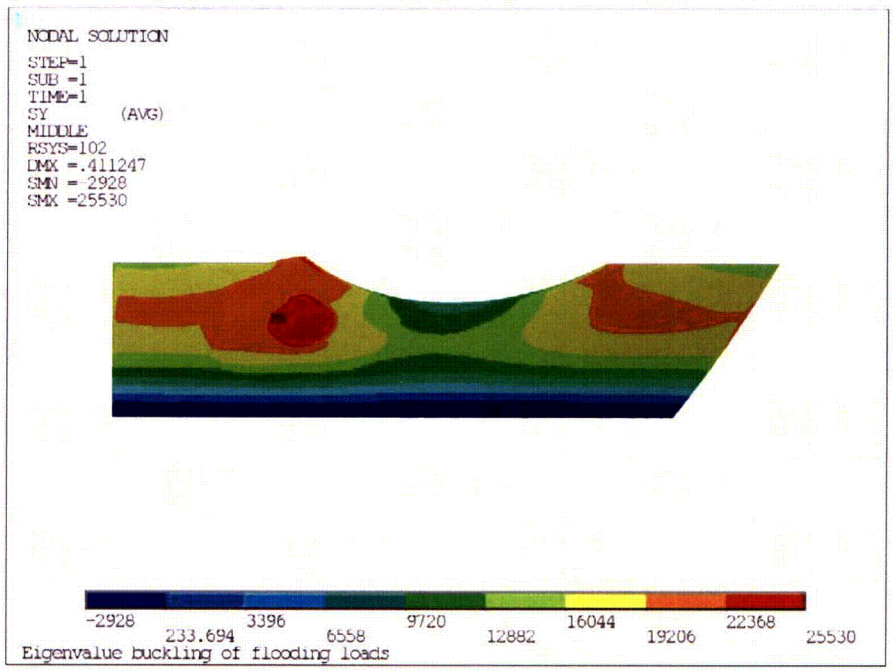


(b) Hoop Stress

Figure 5-58: Flooding Buckling Stress, Bay 15 Sandbed Region, Sensitivity Case 2

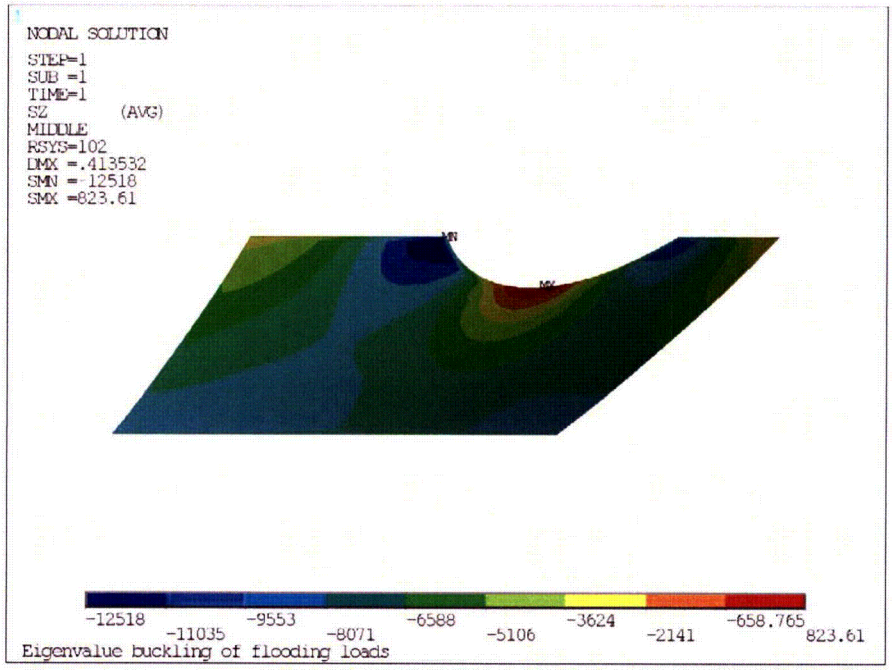


(a) Meridional Stress

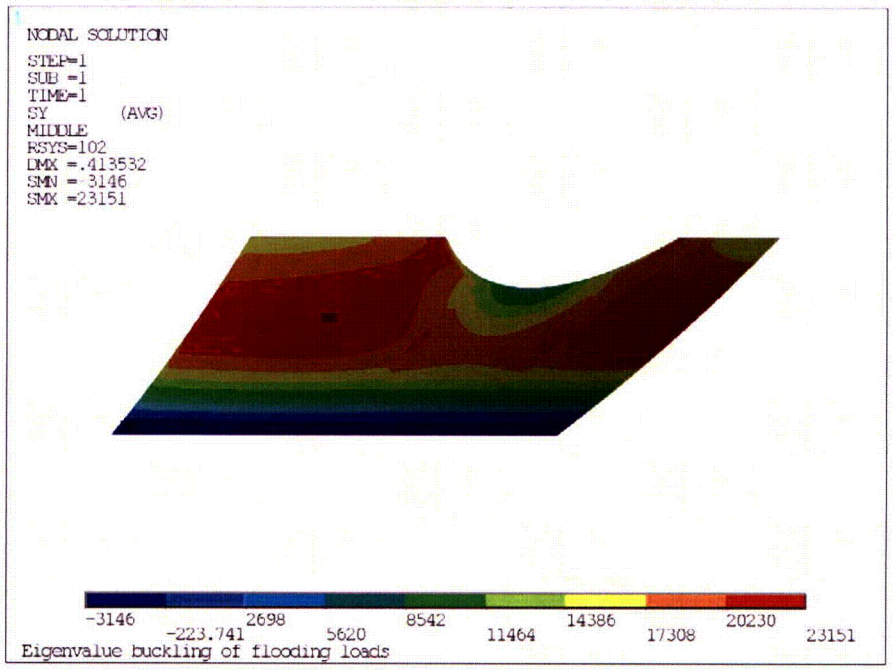


(b) Hoop Stress

Figure 5-59: Flooding Buckling Stress, Bay 17 Sandbed Region, Sensitivity Case 2



(a) Meridional Stress



(b) Hoop Stress

Figure 5-60: Flooding Buckling Stress, Bay 19 Sandbed Region, Sensitivity Case 2

6.0 CONCLUSIONS AND DISCUSSIONS

A sensitivity study was performed to determine the degree to which uncertainties in the size of modeled thinned areas in the sand bed region of the Oyster Creek drywell shell affect ASME Code margins. Sensitivity Case 1 assesses the sensitivity of the base case discussed in Reference 1 to uncertainties in the thicknesses of locally thinned areas. Sensitivity Case 2 assesses the sensitivity of the base case to uncertainties in the thickness of an entire bay that has relatively thin bays on either side. For the analyzed sensitivity cases, the stress changes in the sand bed region were not significant. Therefore, uncertainties in the size of thinned areas analyzed in this Sensitivity Study do not significantly affect ASME Code margins.

For the load cases examined, the changes in wall thicknesses have only a minimal effect on the resulting buckling safety factors. For Sensitivity Case 1, a 14.4% reduction (696 mils to 596 mils) in the thickness of the locally thinned area resulted in a 9.3% reduction (Bay 3 – max reduction) in the safety factor for the refueling case, from 3.54 to 3.21, and only a 0.9% reduction (Bay 13 – max reduction) in the safety factor for the post-accident case, from 2.13 to 2.11. Similarly, for Sensitivity Case 2, a 6.1% reduction in thickness of the general area resulted in a 2.3% reduction (Bay 3 – max reduction) in safety factor for the refueling case, from 3.54 to 3.46, and only a 2.0% reduction (Bay 19 – max reduction) in the safety factor for the post accident case, from 2.02 to 1.98. The reason for the biggest drop in the buckling safety factor in Sensitivity Case 1 refueling condition is due to a combination of load factor, capacity reduction factor, and the tensile hoop stress effects. All these factors are dependent on the wall thickness, which has a larger decrease for Sensitivity Case 1. Similar reduction is not observed in the post accident flooding condition is because of the presence of the significant tensile hoop stress, which is beneficial for the buckling condition.

Thus this Sensitivity Study clearly demonstrates that, considering the assumptions identified in Reference 1, even under additional significant changes in local and general area thicknesses, the calculated margin to the specified ASME Code safety factor is not significantly reduced.

7.0 REFERENCES

1. SI Report 0006004.403, Revision 0, "Structural Evaluation of the Oyster Creek Drywell Summary Report," January 2009, SI File No. 0006004.403.
2. ANSYS/Mechanical, Release 11.1 (w/Service Pack 1), ANSYS, January 2007.
3. ASME Boiler and Pressure Vessel Code, Section III, Class MC, 1989 Edition with Addenda to Winter 1991.