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# Oyster Creek Drywell Sandbed Region Wall Thinning Sensitivity Analyses Summary Report

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## 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.

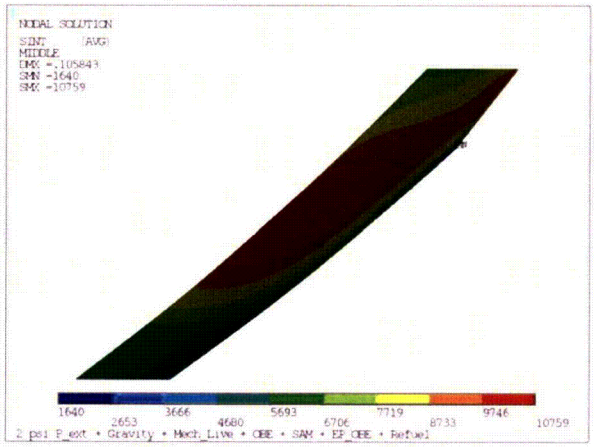
**Table 4-8: Code Evaluation, Load Combination LC10, Sensitivity Case 2**

| 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 |

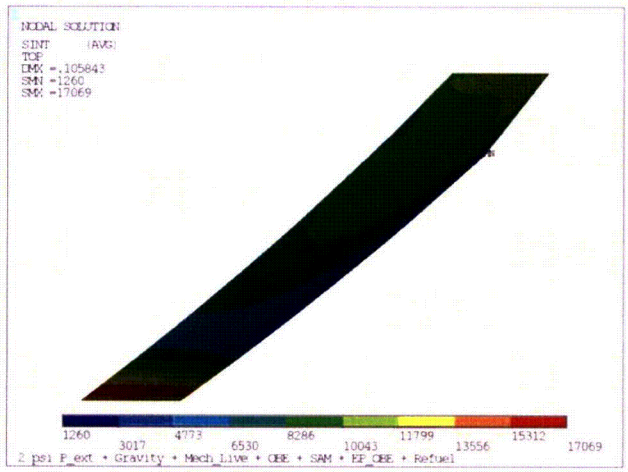
Note 1: without bending stress at gross structural discontinuity per Section MC, NE-3213.9 [3].

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

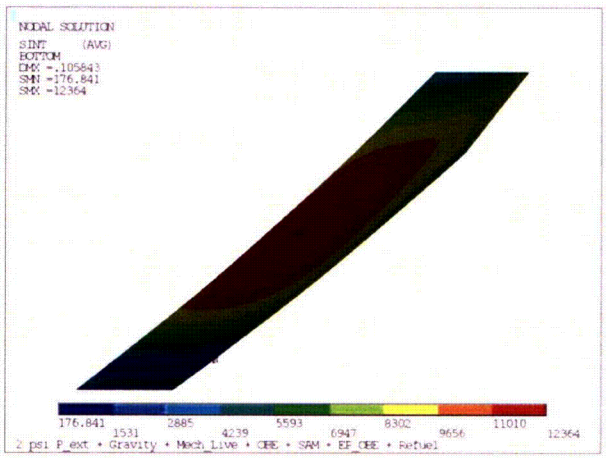
| Bay | Load Case | Base Case | | | | | Sensitivity Case 1 | | | | | Sensitivity Case 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $P_l$ | $P_l+P_b$ | | $P_l+P_b+Q$ | | $P_l$ | $P_l+P_b$ | | $P_l+P_b+Q$ | | $P_l$ | $P_l+P_b$ | | $P_l+P_b+Q$ | |
| | | | Top | 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

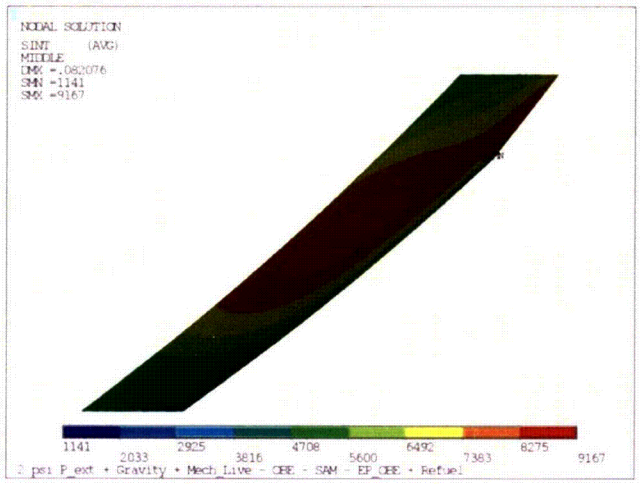



(b) Membrane + Bending, Top Surface

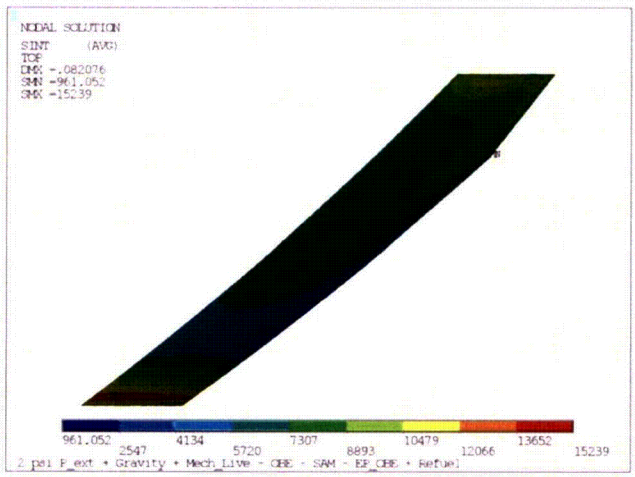



(c) Membrane + Bending, Bottom Surface

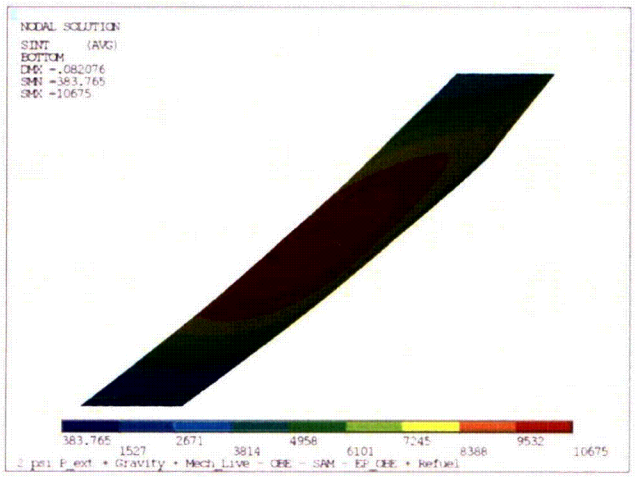
**Figure 4-1. Bay 1, LC 5 Refueling Stress, Sensitivity Case 1**




(a) Membrane

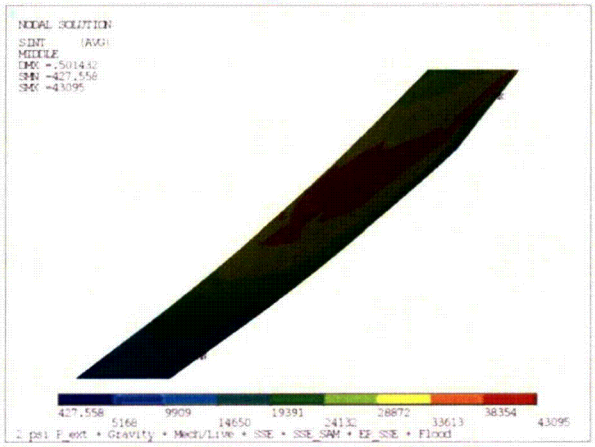



(b) Membrane + Bending, Top Surface

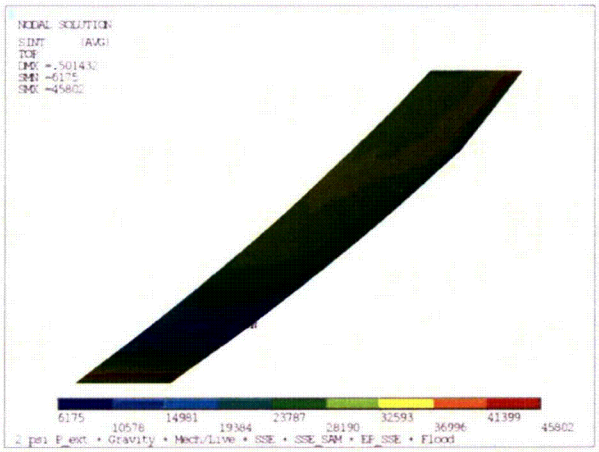



(c) Membrane + Bending, Bottom Surface

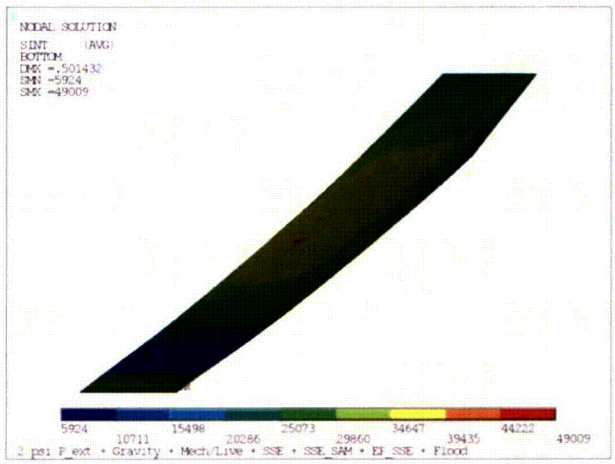
**Figure 4-2. Bay 1, LC 6 Refueling Stress, Sensitivity Case 1**




(a) Membrane

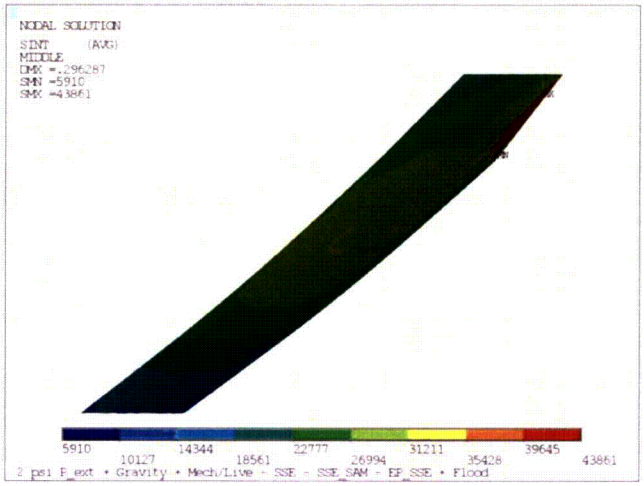



(b) Membrane + Bending, Top Surface

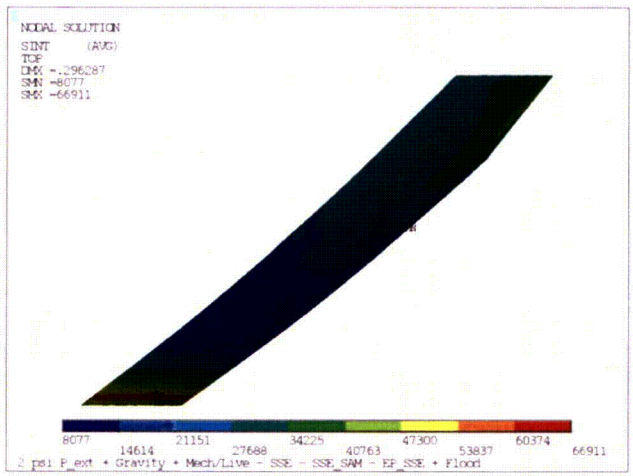



(c) Membrane + Bending, Bottom Surface

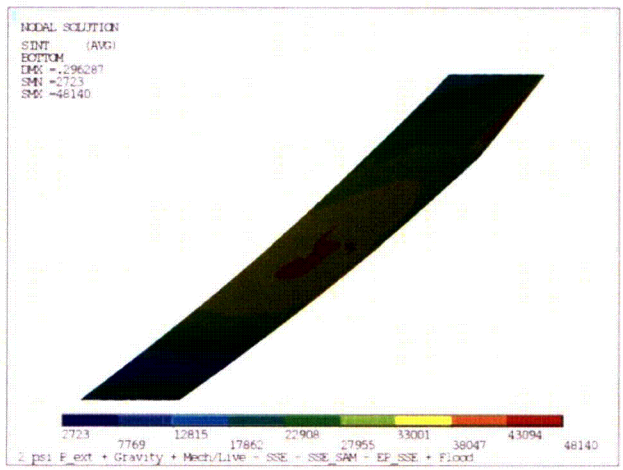
**Figure 4-3. Bay 1, LC 9 Flooding Stress, Sensitivity Case 1**




(a) Membrane

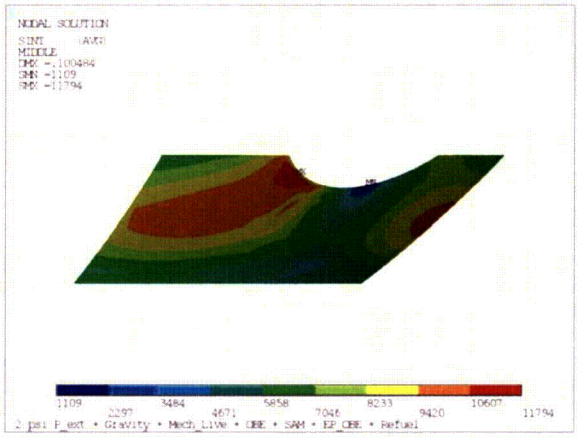



(b) Membrane + Bending, Top Surface

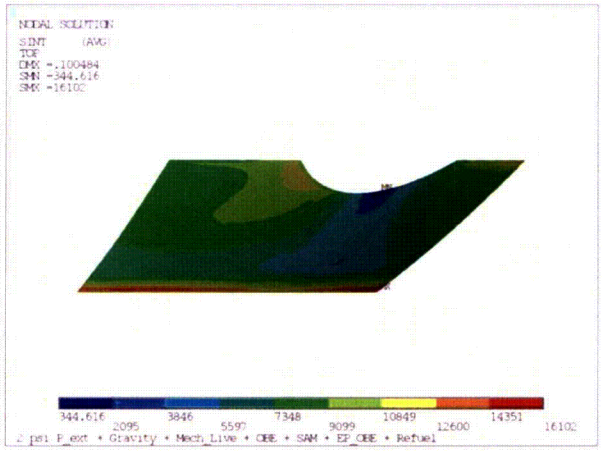



(c) Membrane + Bending, Bottom Surface

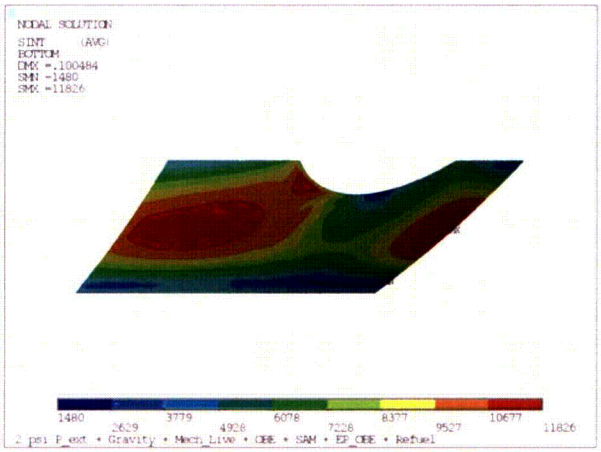
**Figure 4-4. Bay 1, LC 10 Flooding Stress, Sensitivity Case 1**




(a) Membrane

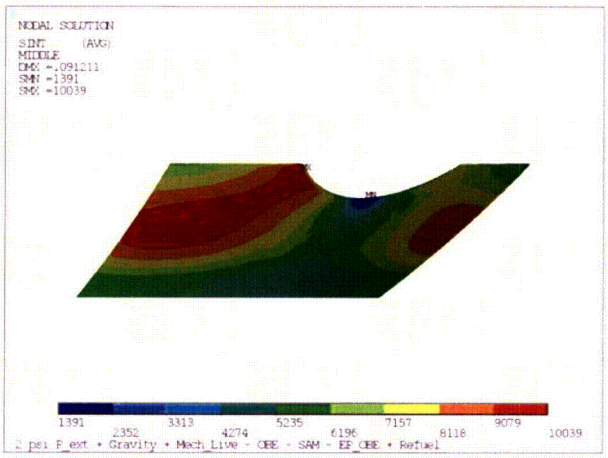



(b) Membrane + Bending, Top Surface

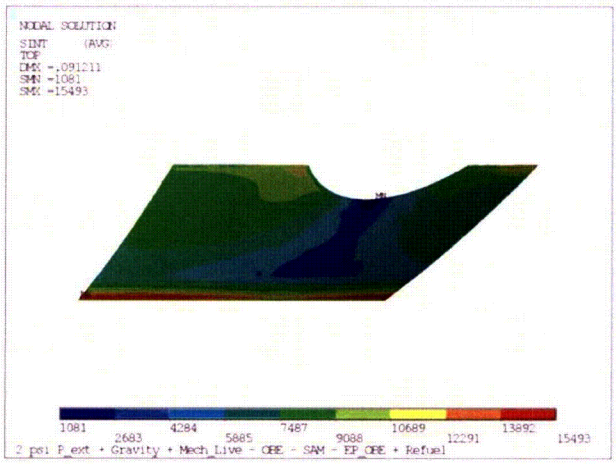



(c) Membrane + Bending, Bottom Surface

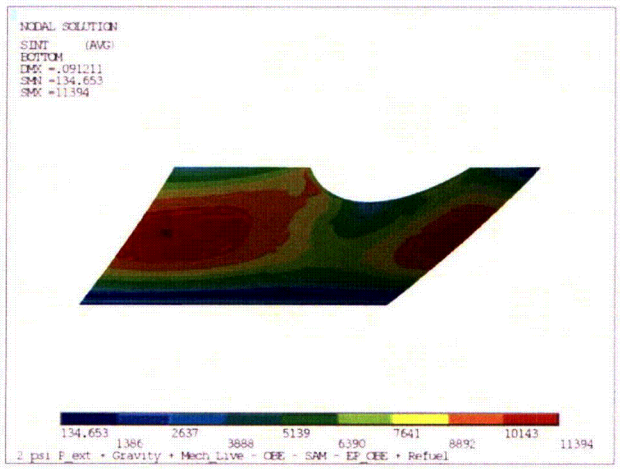
**Figure 4-5. Bay 19, LC 5 Refueling Stress, Sensitivity Case 2**




(a) Membrane

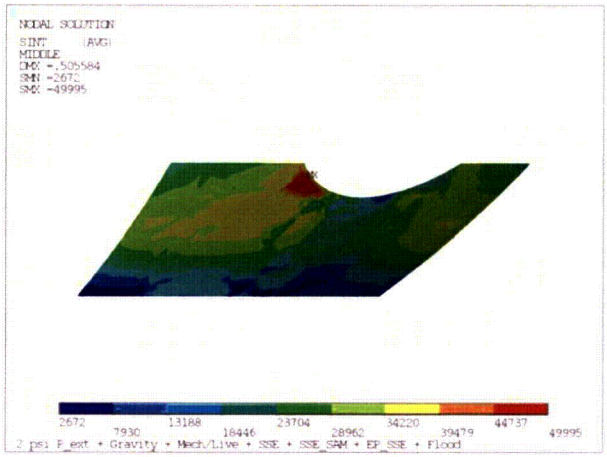



(b) Membrane + Bending, Top Surface

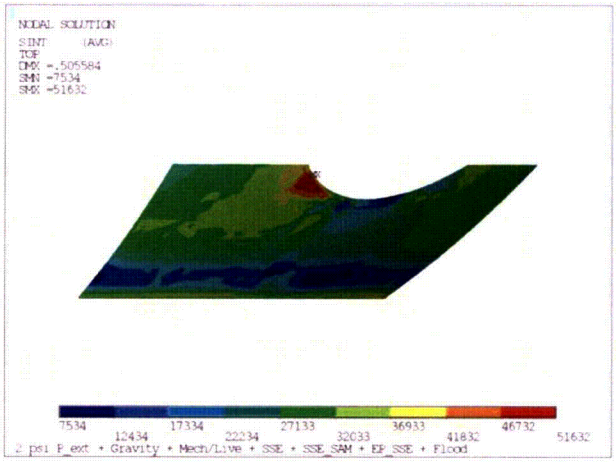



(c) Membrane + Bending, Bottom Surface

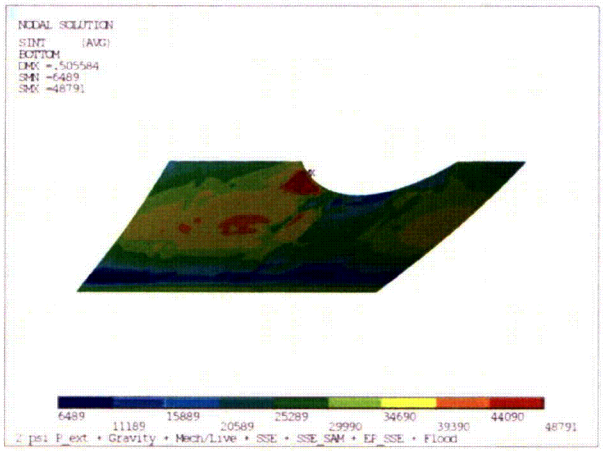
**Figure 4-6. Bay 19, LC 6 Refueling Stress, Sensitivity Case 2**




(a) Membrane

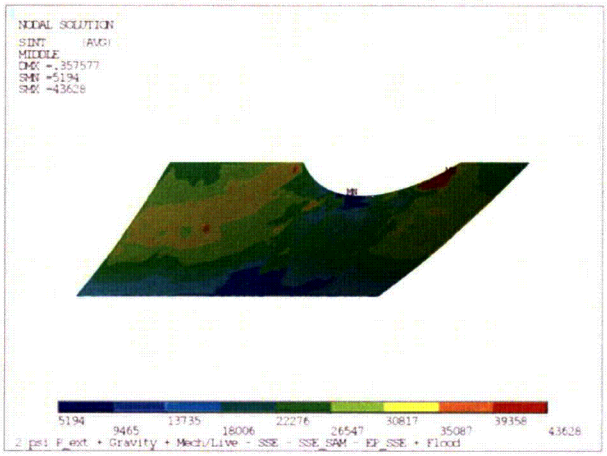



(b) Membrane + Bending, Top Surface

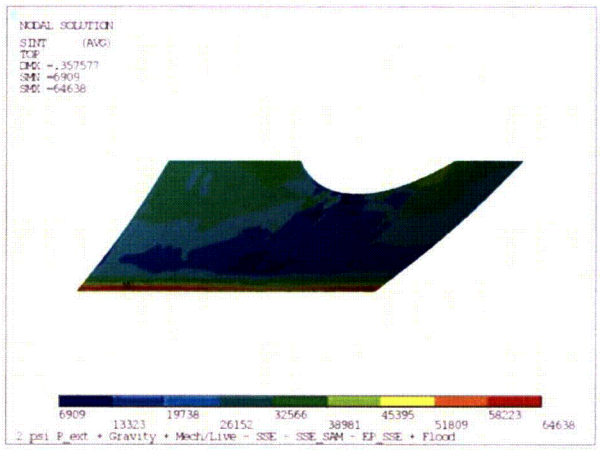



(c) Membrane + Bending, Bottom Surface

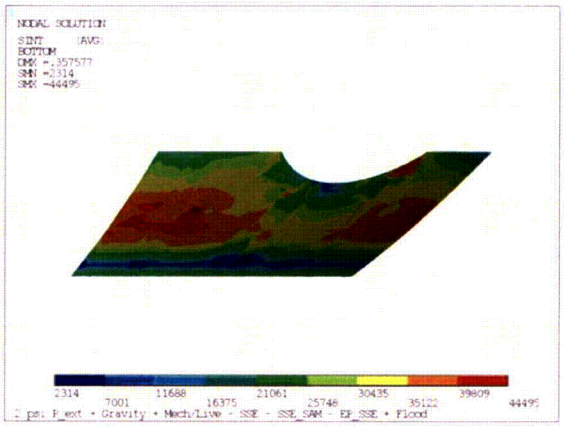
**Figure 4-7. Bay 19, LC 9 Flooding Stress, Sensitivity Case 2**




(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 | $\alpha/\alpha_{1L}$ |
|---|---|---|---|---|---|---|---|
| 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 | $\alpha/\alpha_{1L}$ |
|---|---|---|---|---|---|---|---|
| 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 |
| $\sigma_y$, Yield Strength (ksi) | 36.3 | 36.3 | 36.3 | 36.3 |
| E, Young's Modulus (ksi) | 29,000 | 29,000 | 29,000 | 29,000 |
| $\lambda$, Load Factor (1) | 7.227 | 9.798 | 10.651 | 10.506 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.330 | 0.362 | 0.207 | 0.244 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 3.41 | 3.91 | 4.78 | 4.52 |
| $\sigma_2$, Hoop Tension Stress (ksi) | 8.86 | 2.29 | 4.61 | 4.22 |
| Pbar | 0.100 | 0.049 | 0.098 | 0.053 |
| $\alpha_p$, Capacity Reduction Factor (due to tensile effect) | 0.133 | 0.074 | 0.131 | 0.079 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.463 | 0.436 | 0.338 | 0.323 |
| $\Delta$ , Parameter ( $= \alpha_m \lambda \sigma_1 / \sigma_y$ ) | 0.314 | 0.460 | 0.474 | 0.422 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 1.000 | 1.000 | 1.000 |
| $\sigma_{ic}$, 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 |
| $\sigma_y$, Yield Strength (ksi) | 36.3 | 36.3 | 36.3 | 36.3 |
| E, Young's Modulus (ksi) | 29,000 | 29,000 | 29,000 | 29,000 |
| $\lambda$, Load Factor (1) | 9.139 | 14.664 | 14.664 | 7.054 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.330 | 0.362 | 0.207 | 0.244 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 2.61 | 2.65 | 4.73 | 10.50 |
| $\sigma_2$, Hoop Tension Stress (ksi) | 2.66 | 6.66 | 16.15 | 22.61 |
| Pbar | 0.030 | 0.143 | 0.345 | 0.282 |
| $\alpha_p$, Capacity Reduction Factor (due to tensile effect) | 0.048 | 0.171 | 0.285 | 0.258 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.378 | 0.533 | 0.492 | 0.502 |
| $\Delta$ , Parameter ( $= \alpha_m \lambda \sigma_1 / \sigma_y$ ) | 0.248 | 0.570 | 0.941 | 1.025 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 0.970 | 0.658 | 0.619 |
| $\sigma_{ic}$, 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 |
| $\sigma_y$, Yield Strength (ksi) | 36.3 | 36.3 | 36.3 | 36.3 |
| E, Young's Modulus (ksi) | 29,000 | 29,000 | 29,000 | 29,000 |
| $\lambda$, Load Factor (1) | 7.224 | 9.795 | 10.649 | 11.146 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.330 | 0.362 | 0.207 | 0.244 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 3.41 | 3.91 | 4.79 | 4.56 |
| $\sigma_2$, Hoop Tension Stress (ksi) | 8.86 | 2.29 | 4.61 | 4.23 |
| Pbar | 0.100 | 0.049 | 0.098 | 0.053 |
| $\alpha_p$, Capacity Reduction Factor (due to tensile effect) | 0.133 | 0.074 | 0.131 | 0.079 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.463 | 0.436 | 0.338 | 0.323 |
| $\Delta$, Parameter ( $= \alpha_m \lambda \sigma_1 / \sigma_y$) | 0.314 | 0.461 | 0.474 | 0.452 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 1.000 | 1.000 | 1.000 |
| $\sigma_{ic}$, 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 |
| $\sigma_y$, Yield Strength (ksi) | 36.3 | 36.3 | 36.3 | 36.3 |
| E, Young's Modulus (ksi) | 29,000 | 29,000 | 29,000 | 29,000 |
| $\lambda$, Load Factor (1) | 9.127 | 14.617 | 14.617 | 6.992 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.330 | 0.362 | 0.207 | 0.244 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 2.61 | 2.65 | 4.73 | 10.46 |
| $\sigma_2$, Hoop Tension Stress (ksi) | 2.66 | 6.66 | 16.15 | 22.62 |
| Pbar | 0.030 | 0.143 | 0.345 | 0.282 |
| $\alpha_p$, Capacity Reduction Factor (due to tensile effect) | 0.048 | 0.171 | 0.285 | 0.258 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.378 | 0.533 | 0.492 | 0.502 |
| $\Delta$ , Parameter ( $= \alpha_m \lambda \sigma_1 / \sigma_y$ ) | 0.248 | 0.569 | 0.938 | 1.012 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 0.970 | 0.660 | 0.625 |
| $\sigma_{ic}$, 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 |
| $\sigma_y$, 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 |
| $\lambda$, Load Factor[2] | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 | 10.506 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.207 | 0.229 | 0.238 | 0.235 | 0.232 | 0.223 | 0.207 | 0.210 | 0.207 | 0.211 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 5.20 | 4.76 | 4.38 | 4.37 | 4.13 | 4.42 | 4.73 | 4.76 | 5.51 | 5.24 |
| $\sigma_2$, 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 |
| $\alpha_p$, 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 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.331 | 0.305 | 0.308 | 0.308 | 0.308 | 0.319 | 0.326 | 0.319 | 0.340 | 0.323 |
| $\Delta$ , 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 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $\sigma_{ie}$, 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 |
| $\sigma_y$, 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 |
| $\lambda$, Load Factor (2) | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 | 7.054 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.207 | 0.229 | 0.238 | 0.235 | 0.232 | 0.223 | 0.207 | 0.210 | 0.207 | 0.211 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 11.80 | 9.45 | 9.95 | 10.04 | 10.20 | 11.18 | 11.34 | 10.13 | 11.44 | 12.25 |
| $\sigma_2$, 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 |
| $\alpha_p$, 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 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.571 | 0.492 | 0.473 | 0.479 | 0.487 | 0.514 | 0.530 | 0.525 | 0.555 | 0.529 |
| $\Delta$ , 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 |
| $\eta$, Plasticity Reduction Factor | 0.524 | 0.678 | 0.672 | 0.661 | 0.647 | 0.583 | 0.565 | 0.615 | 0.545 | 0.537 |
| $\sigma_{ic}$, 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 |
| $\sigma_y$, 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 |
| $\lambda$, Load Factor [2] | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 | 11.345 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.209 | 0.229 | 0.238 | 0.235 | 0.232 | 0.223 | 0.207 | 0.210 | 0.207 | 0.211 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 5.03 | 4.75 | 4.38 | 4.37 | 4.14 | 4.42 | 4.73 | 4.77 | 5.51 | 5.42 |
| $\sigma_2$, 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 |
| $\alpha_p$, 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 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.320 | 0.305 | 0.308 | 0.308 | 0.308 | 0.319 | 0.326 | 0.319 | 0.340 | 0.326 |
| $\Delta$ , 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 |
| $\eta$, Plasticity Reduction Factor | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.949 | 0.995 |
| $\sigma_{ie}$, 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 |
| $\sigma_y$, 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 |
| $\lambda$, Load Factor[2] | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 | 6.965 |
| $\alpha/\alpha_{1L}$, Capacity Reduction Factor | 0.209 | 0.229 | 0.238 | 0.235 | 0.232 | 0.223 | 0.207 | 0.210 | 0.207 | 0.211 |
| $\sigma_1$, Meridional Compressive Stress (ksi) | 11.79 | 9.46 | 9.96 | 10.05 | 10.21 | 11.19 | 11.34 | 10.14 | 11.44 | 12.52 |
| $\sigma_2$, 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 |
| $\alpha_p$, 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 |
| $\alpha_m$, Modified Capacity Reduction Factor | 0.540 | 0.492 | 0.473 | 0.479 | 0.487 | 0.514 | 0.530 | 0.525 | 0.555 | 0.536 |
| $\Delta$ , 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 |
| $\eta$, Plasticity Reduction Factor | 0.549 | 0.684 | 0.678 | 0.667 | 0.652 | 0.588 | 0.570 | 0.621 | 0.549 | 0.529 |
| $\sigma_{ie}$, 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**

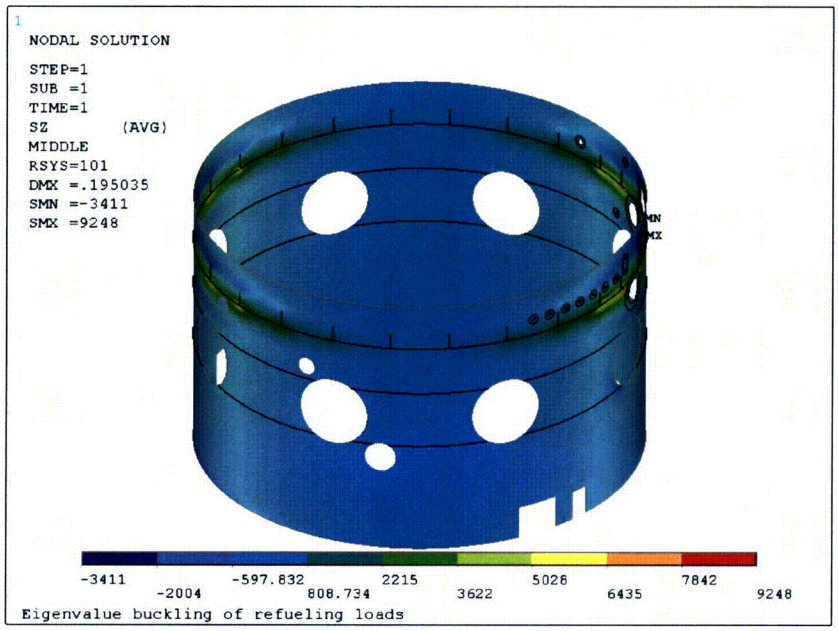
| Load Case | Region | Base Case | Sensitivity Case 1 | Sensitivity Case 2 |
|---|---|---|---|---|
| Refueling | Cylindrical Shell | 7.229 | 7.227 | 7.224 |
| | Upper Spherical Shell | 9.800 | 9.798 | 9.795 |
| | Middle Spherical Shell | 10.652 | 10.651 | 10.649 |
| | Lower Spherical Shell | 11.150 | 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**

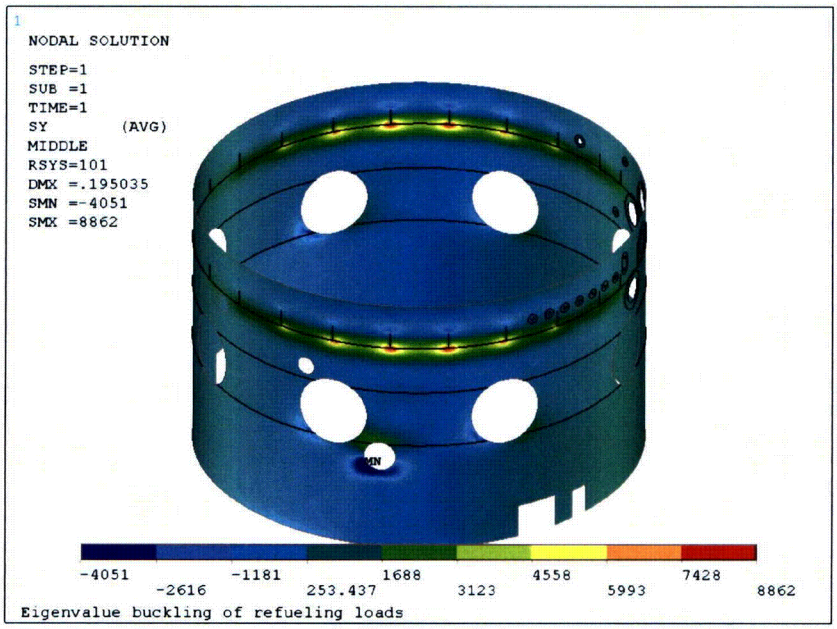
| Region | Base Case | Sensitivity Case 1 | Sensitivity Case 2 | Level A/B Allowable |
|---|---|---|---|---|
| Bay 1 | 3.70 | 3.48 | 3.63 | 2.00 |
| Bay 3 | 3.54 | 3.21 | 3.46 | 2.00 |
| Bay 5 | 3.56 | 3.23 | 3.49 | 2.00 |
| Bay 7 | 3.57 | 3.24 | 3.50 | 2.00 |
| Bay 9 | 3.56 | 3.23 | 3.49 | 2.00 |
| 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 |

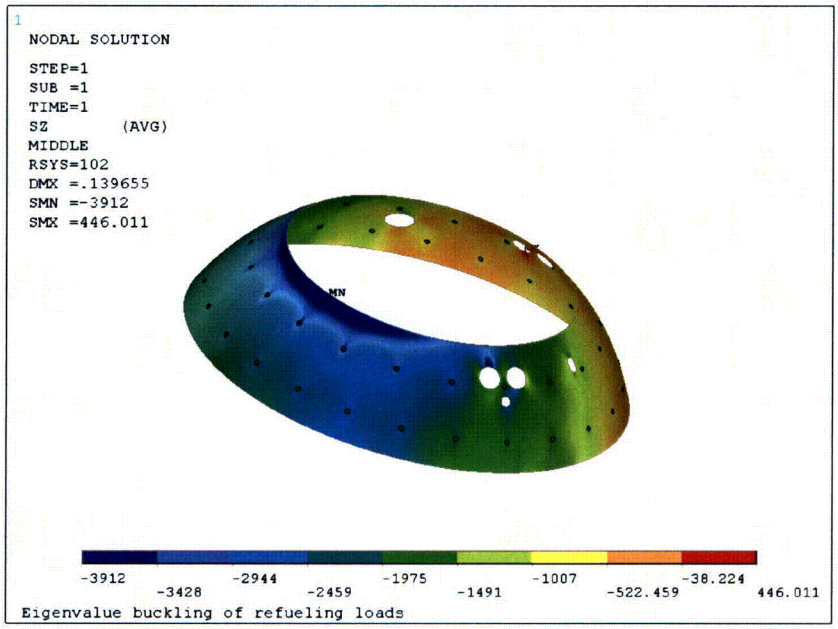



(a) Axial Stress

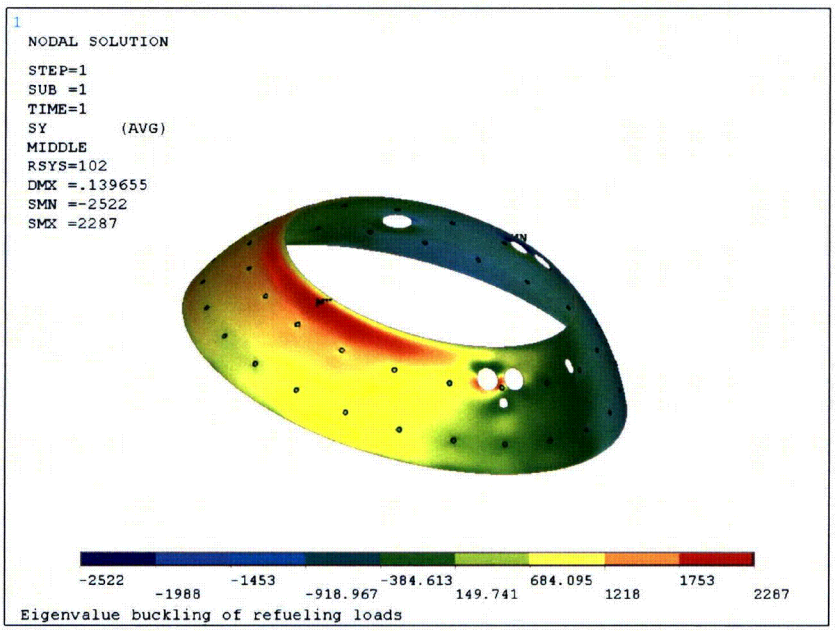



(b) Hoop Stress

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

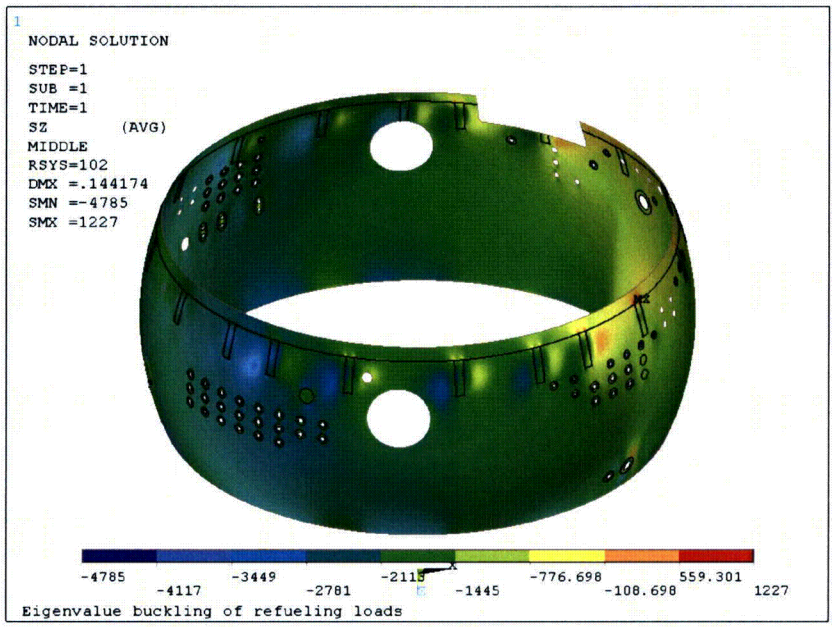



(a) Meridional Stress

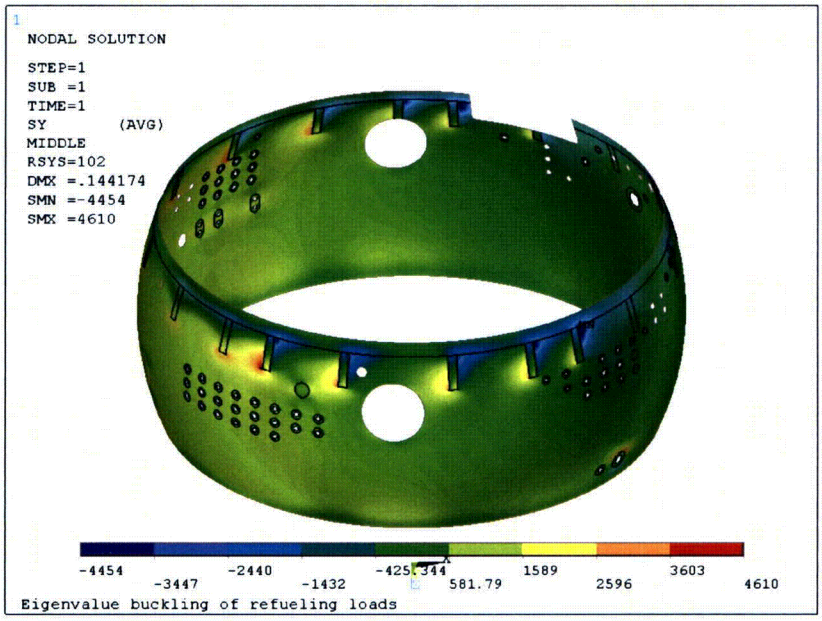



(b) Hoop Stress

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

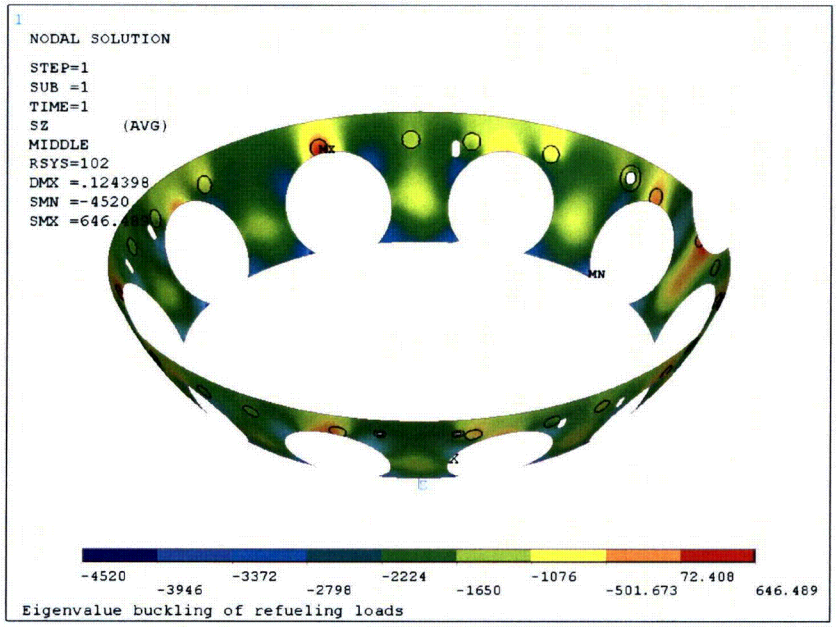



(a) Meridional Stress

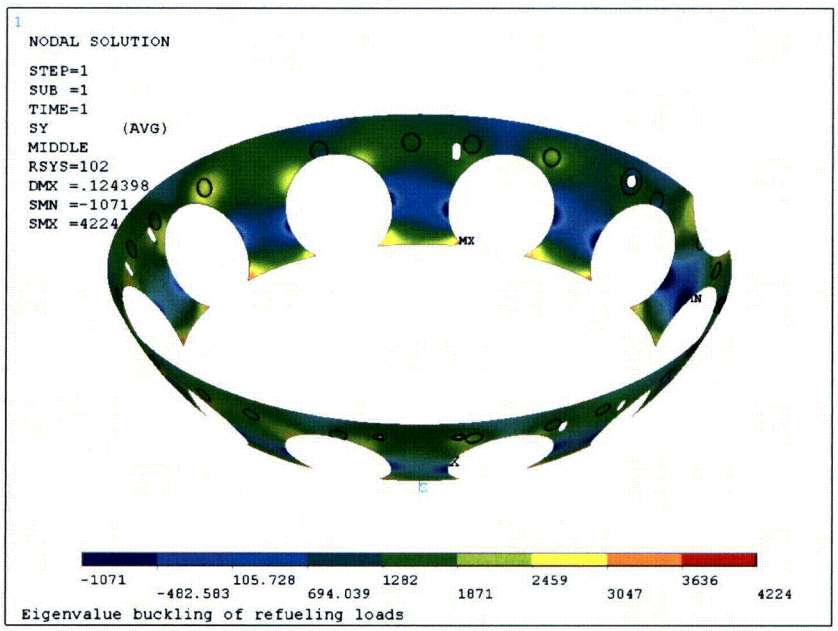



(b) Hoop Stress

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

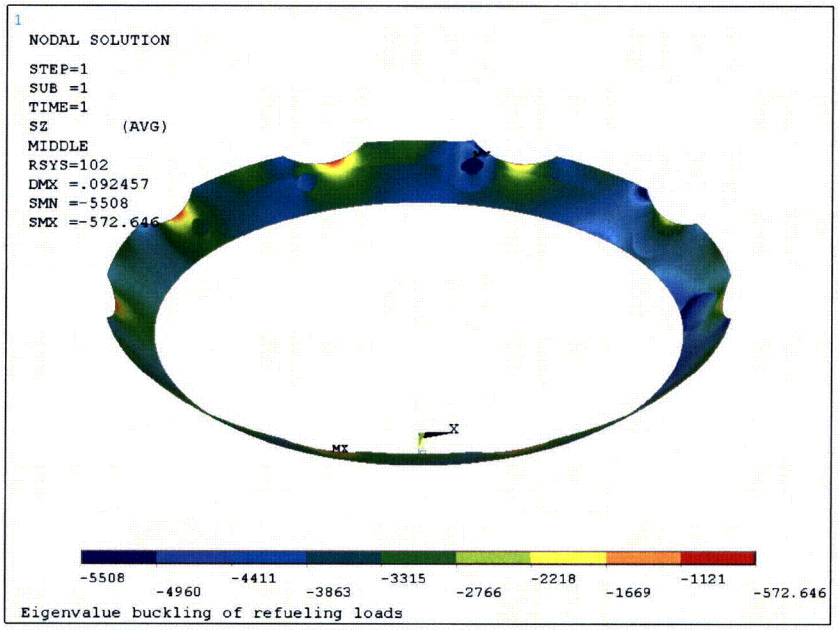



(a) Meridional Stress

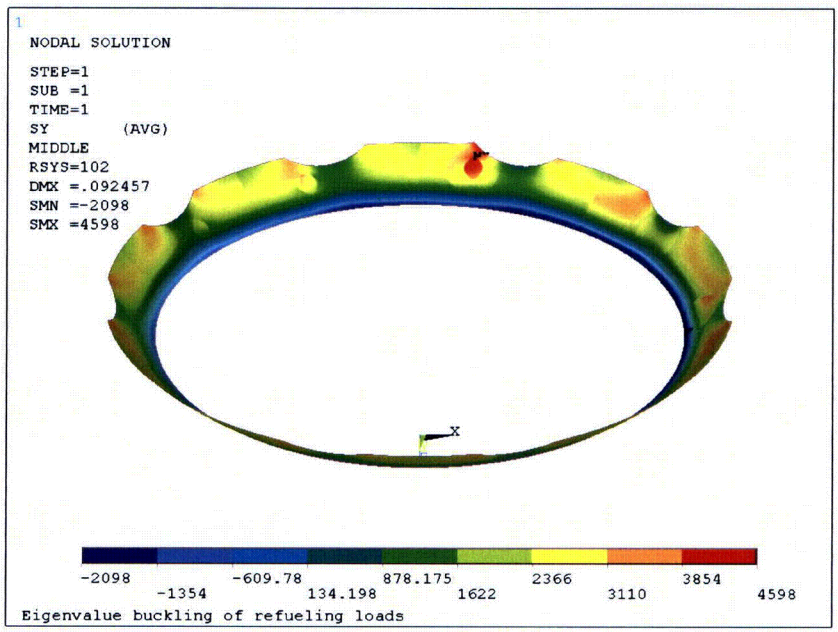



(b) Hoop Stress

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

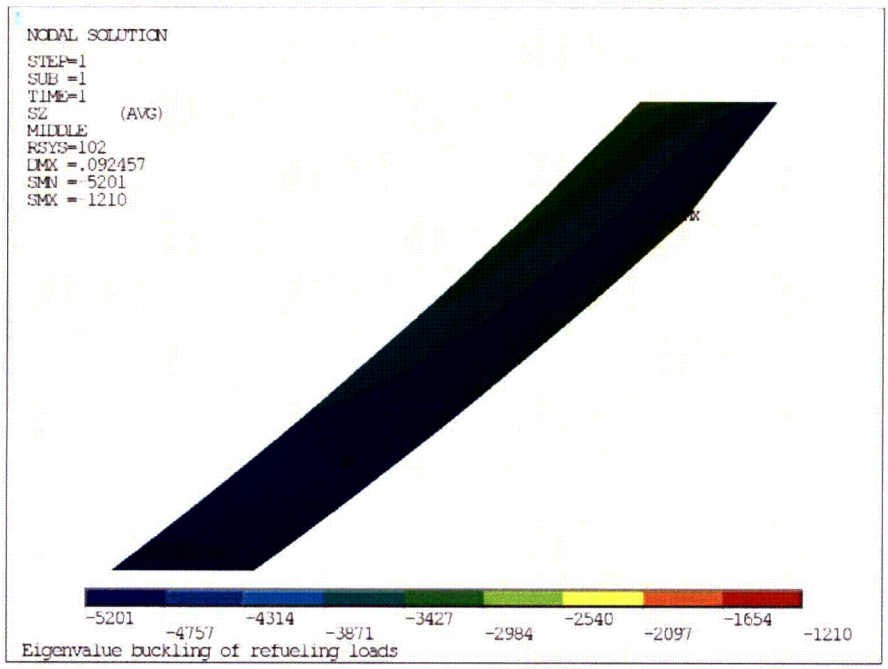



(a) Meridional

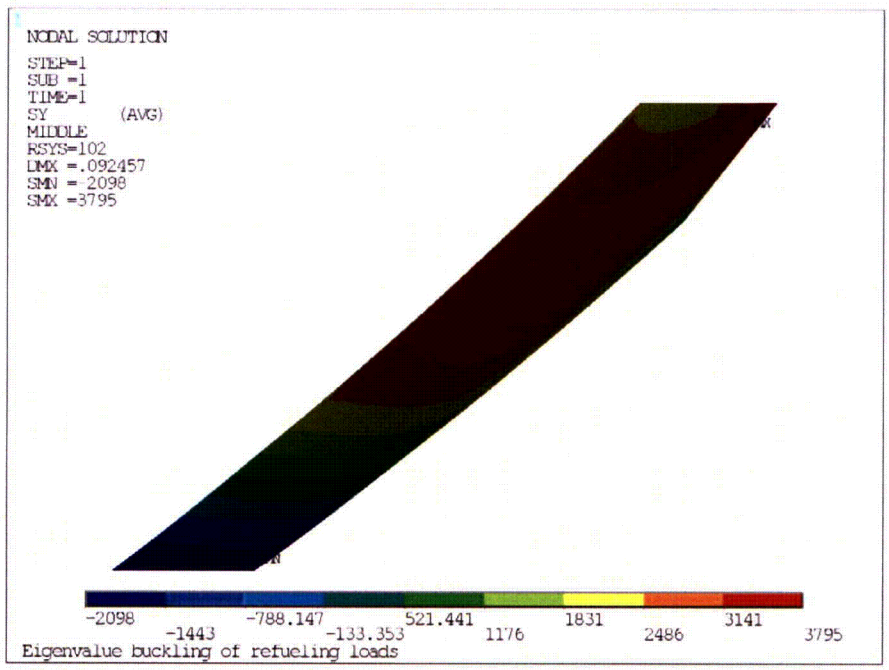



(b) Hoop Stress

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

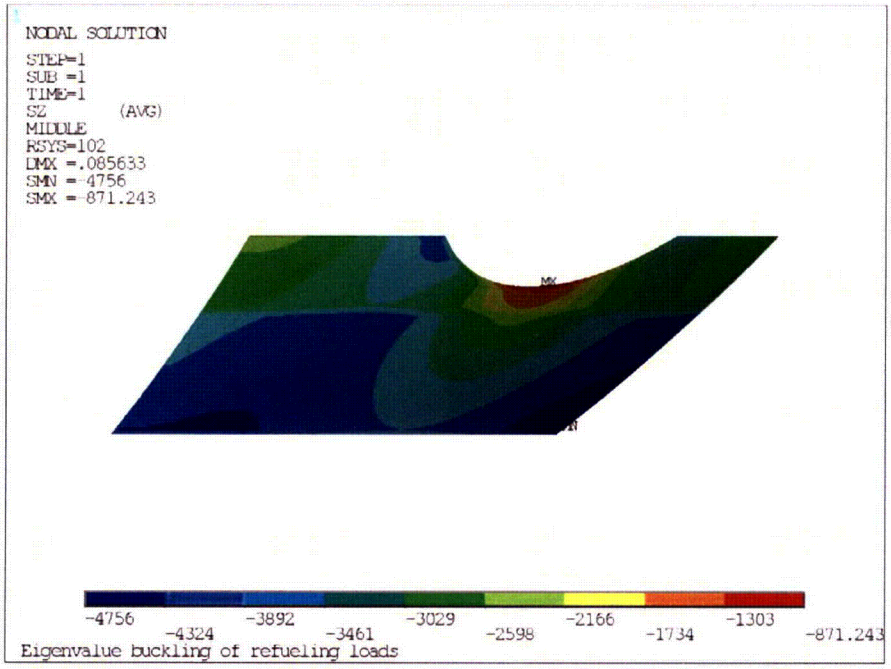



(a) Meridional Stress

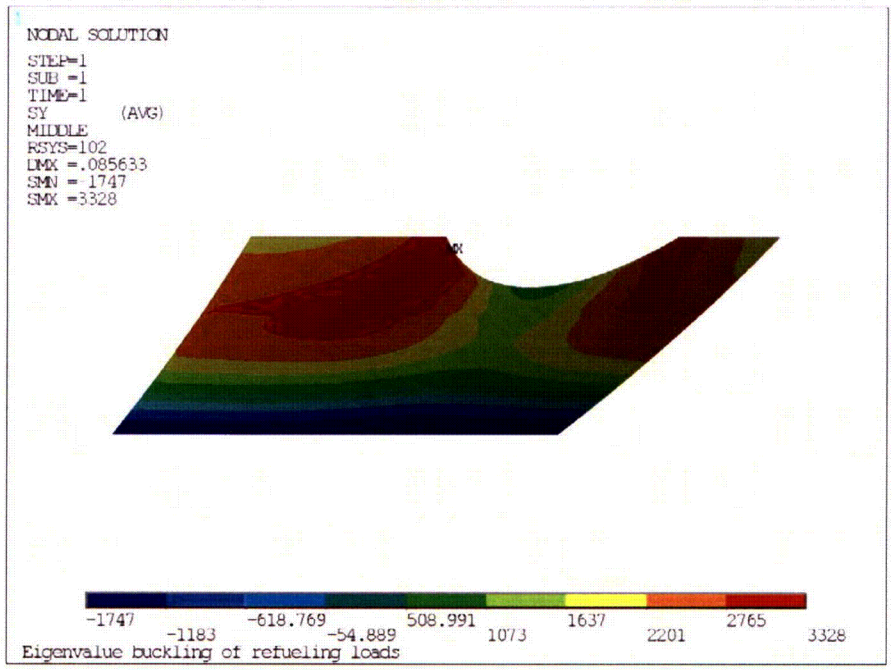



(b) Hoop Stress

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

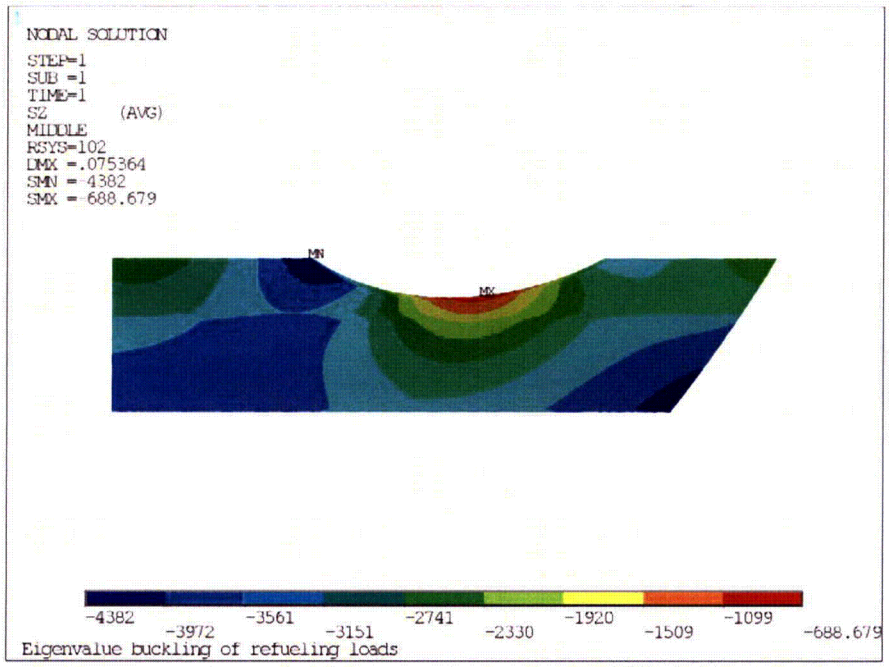



(a) Meridional Stress

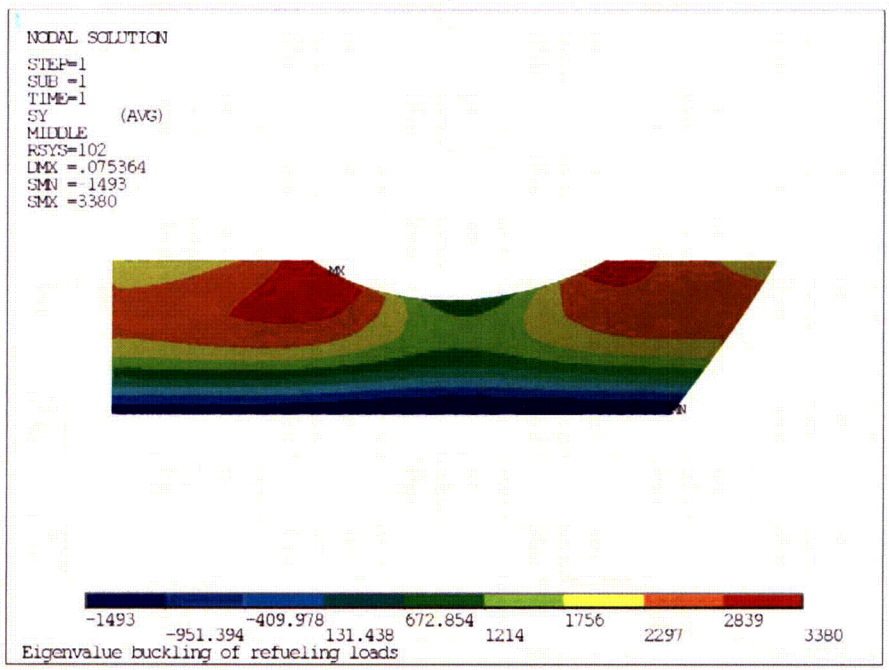



(b) Hoop Stress

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

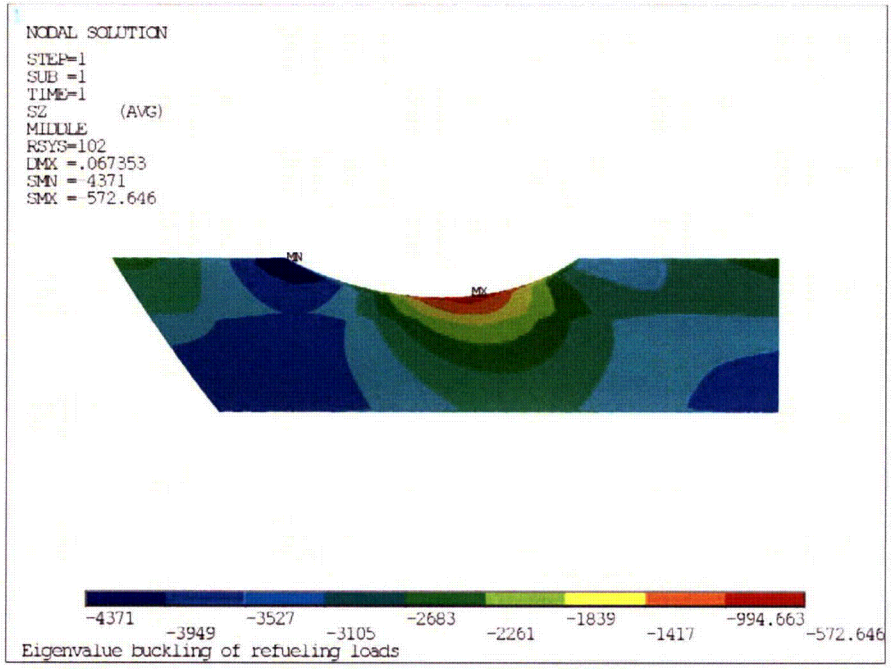



(a) Meridional Stress

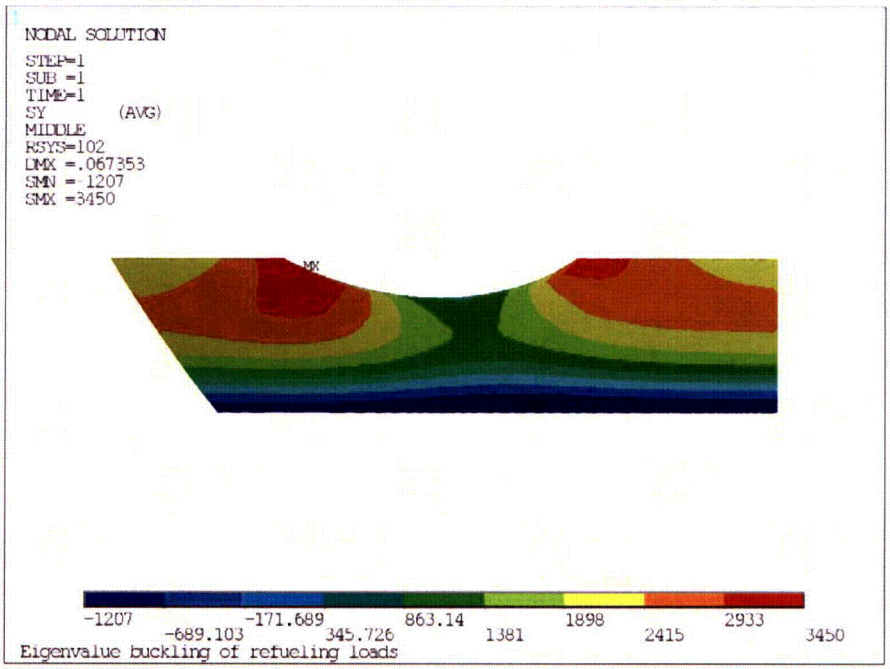



(b) Hoop Stress

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

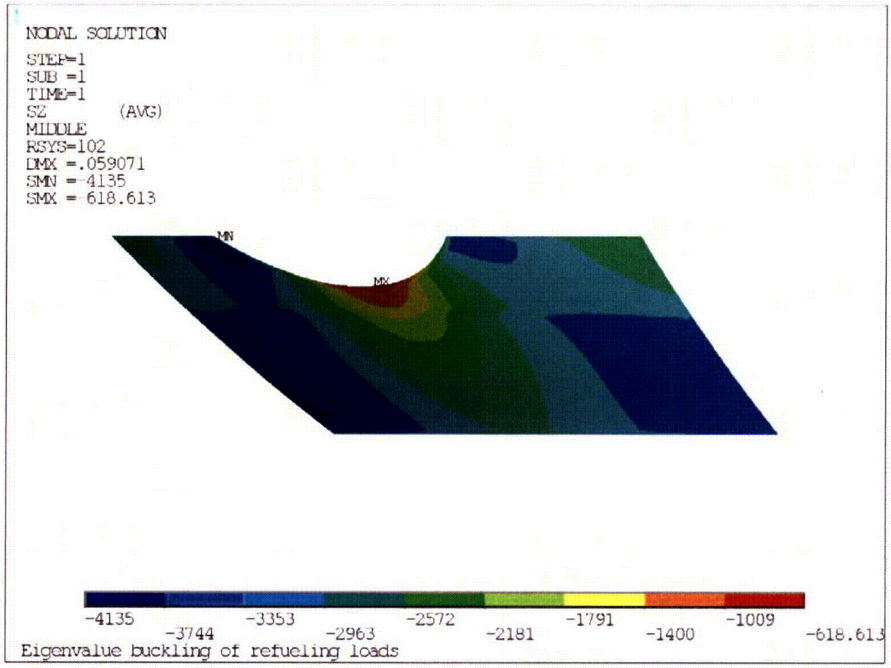



(a) Meridional Stress

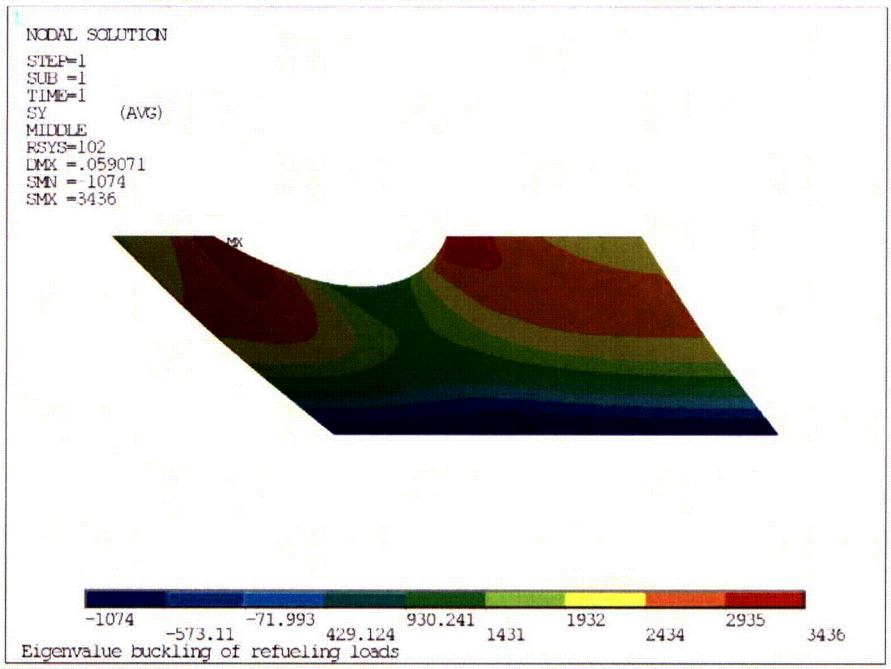



(b) Hoop Stress

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

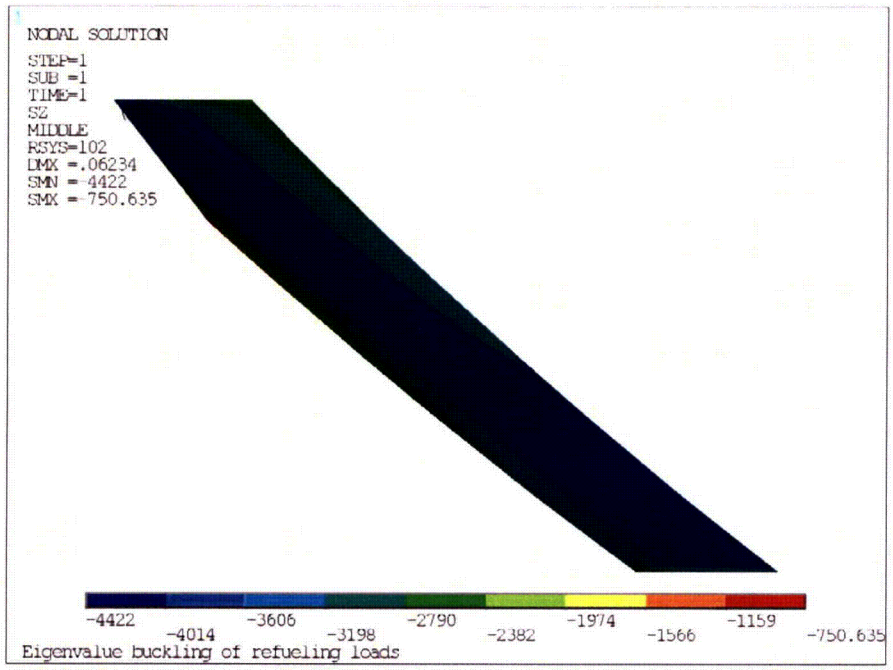



(a) Meridional Stress

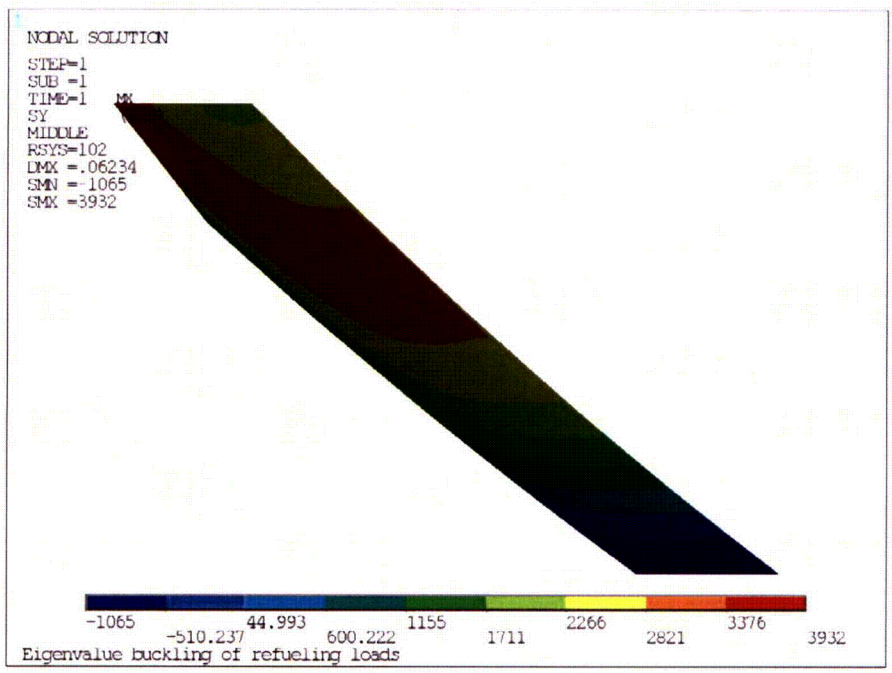



(b) Hoop Stress

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

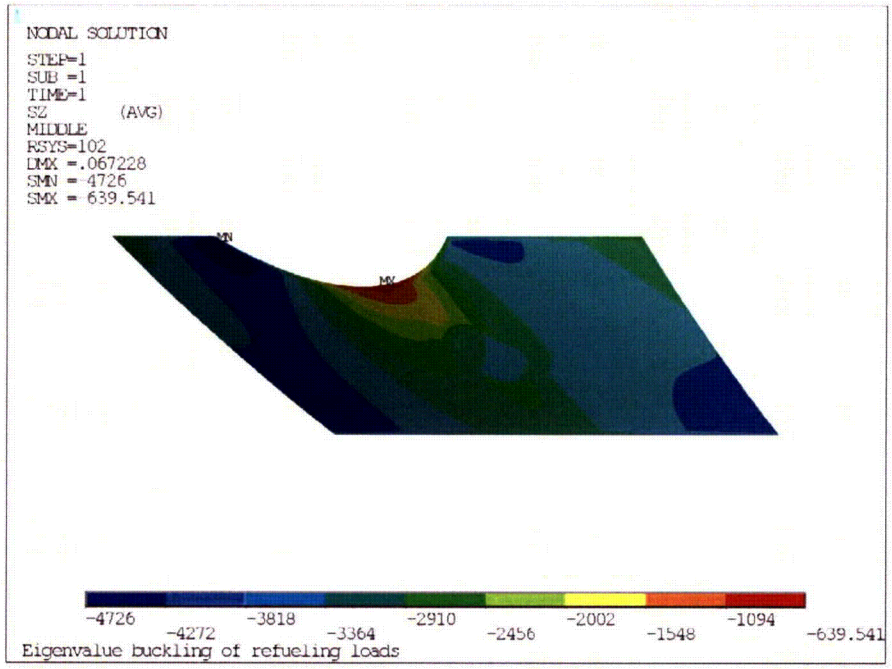



(a) Meridional Stress

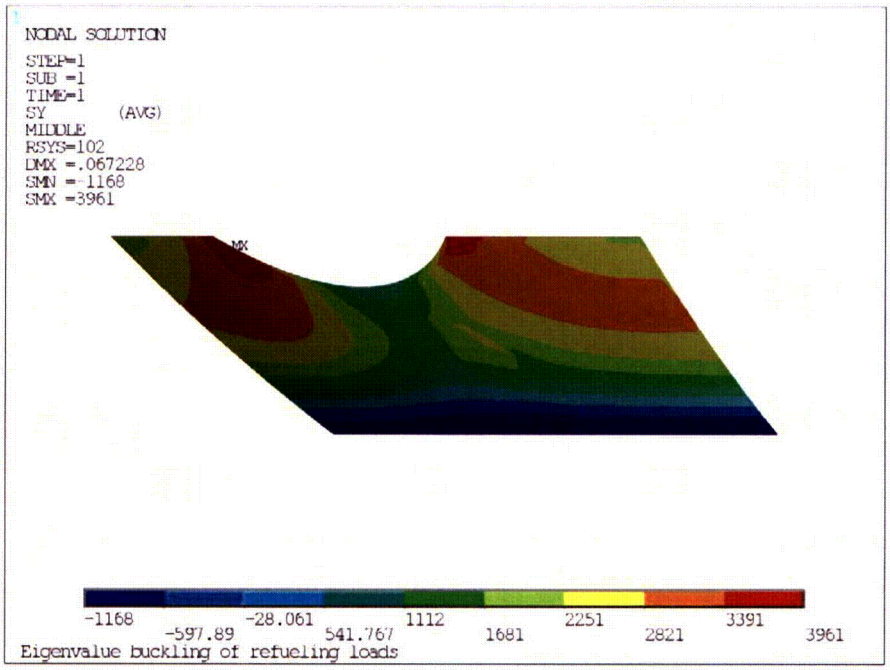



(b) Hoop Stress

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

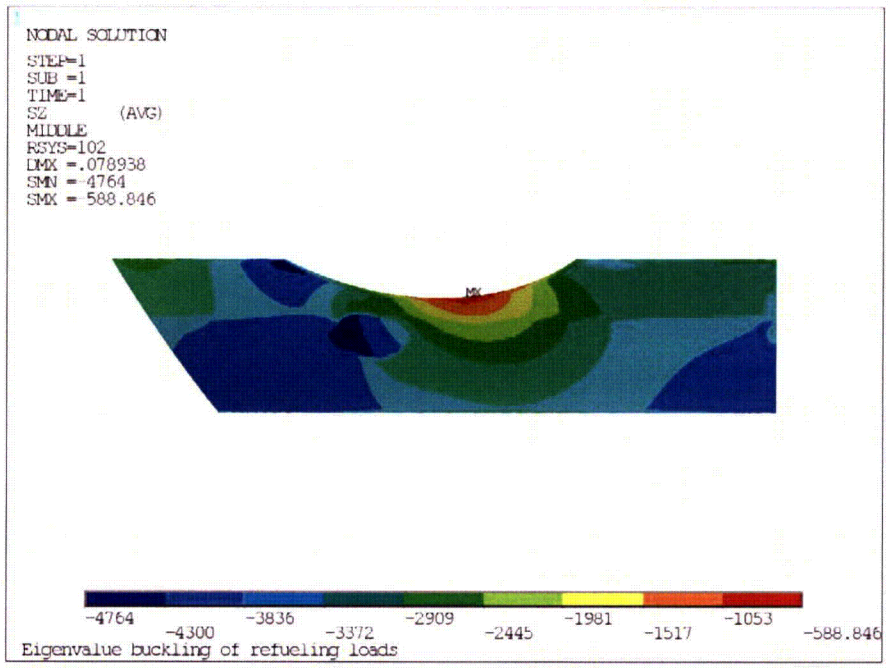



(a) Meridional Stress

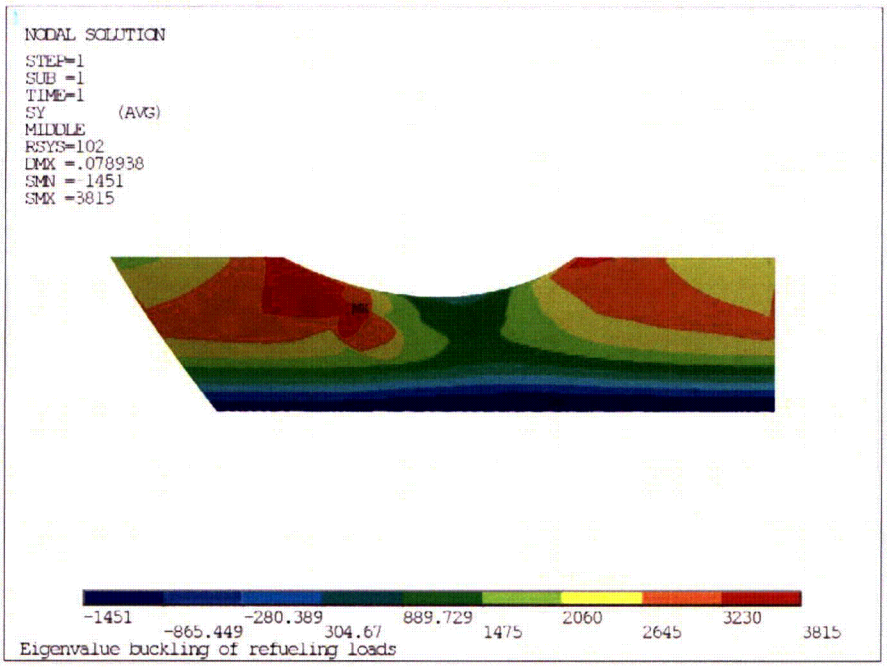



(b) Hoop Stress

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

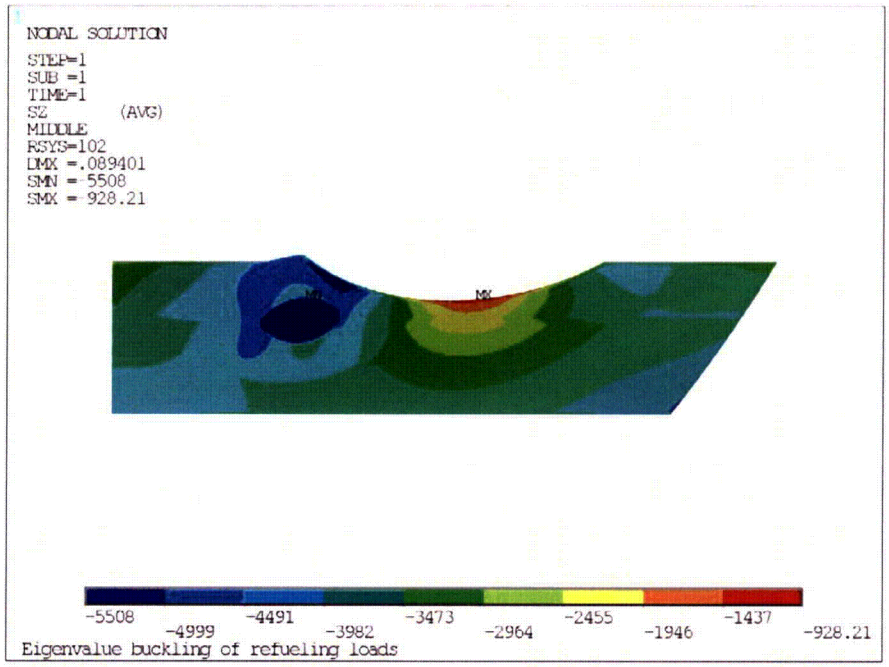



(a) Meridional Stress

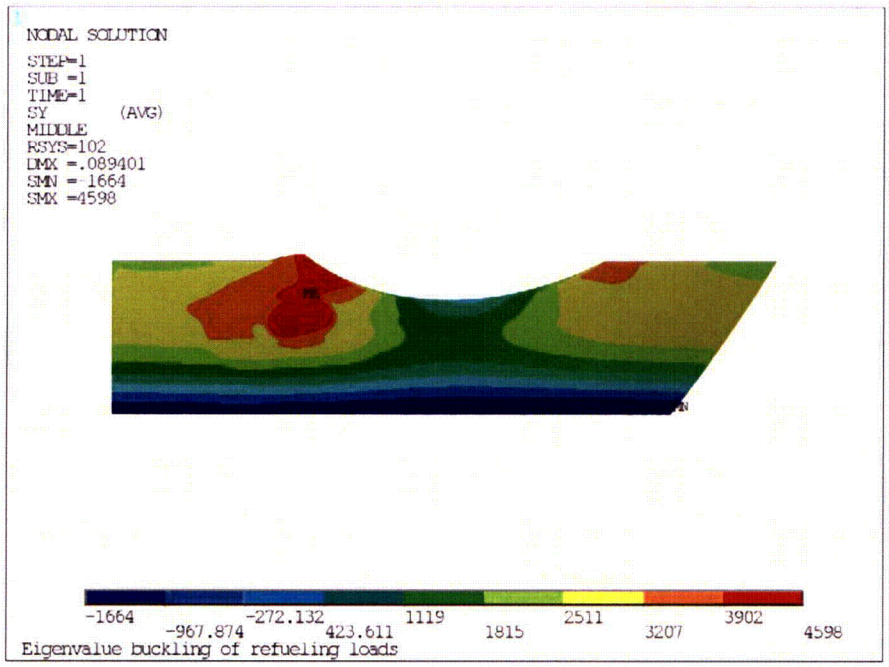



(b) Hoop Stress

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

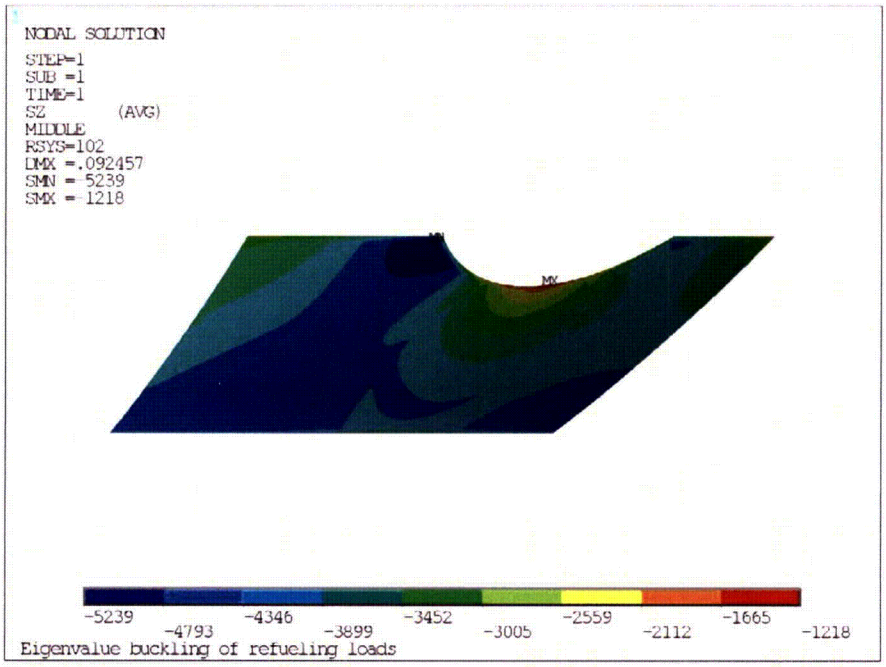



(a) Meridional Stress

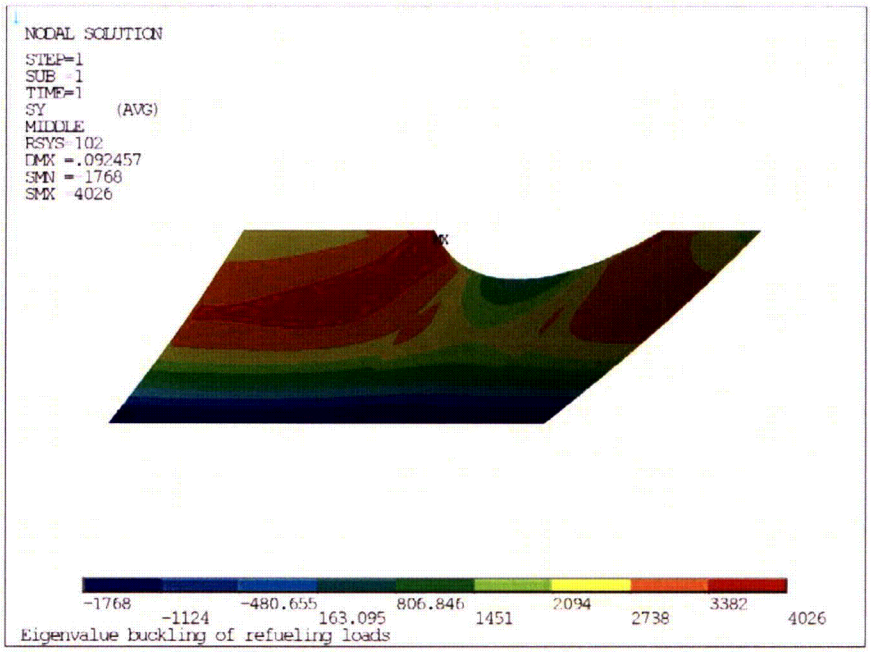



(b) Hoop Stress

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

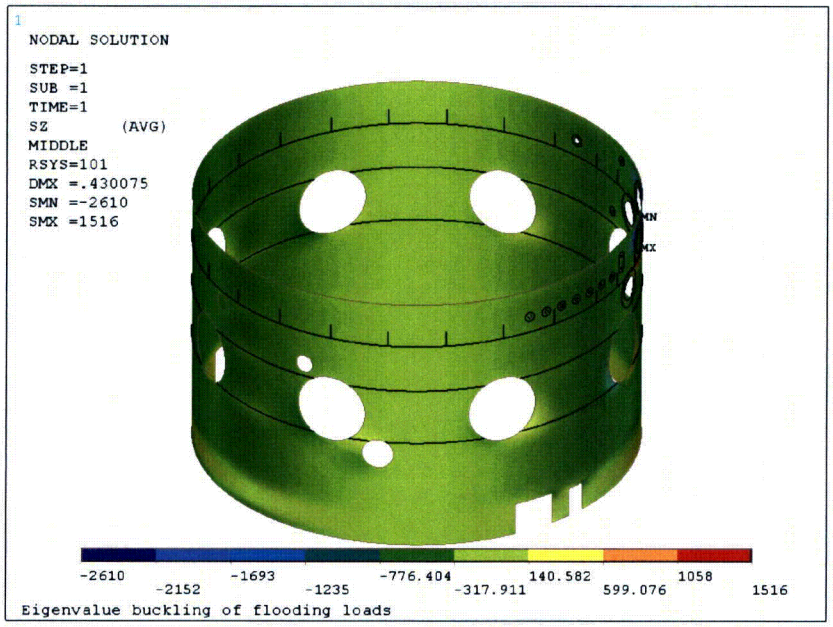



(a) Meridional Stress

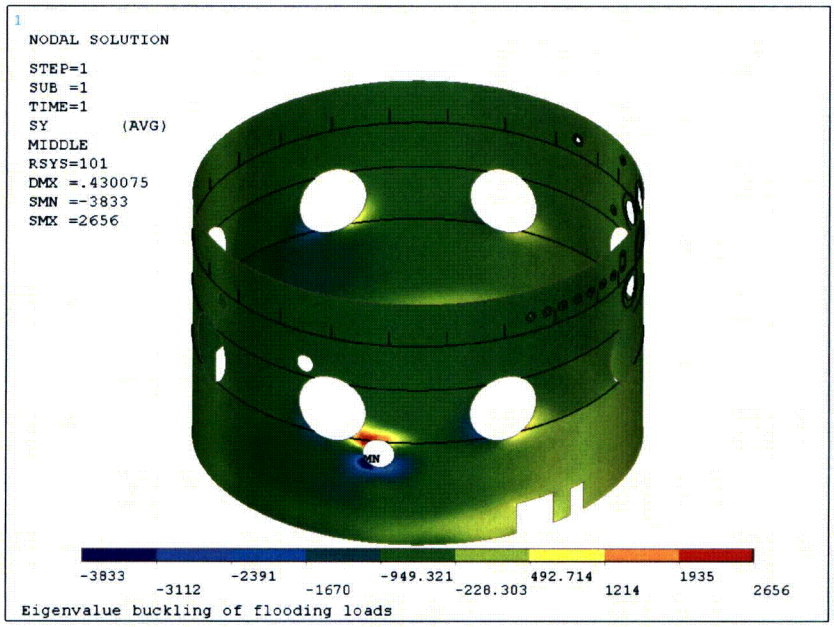



(b) Hoop Stress

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

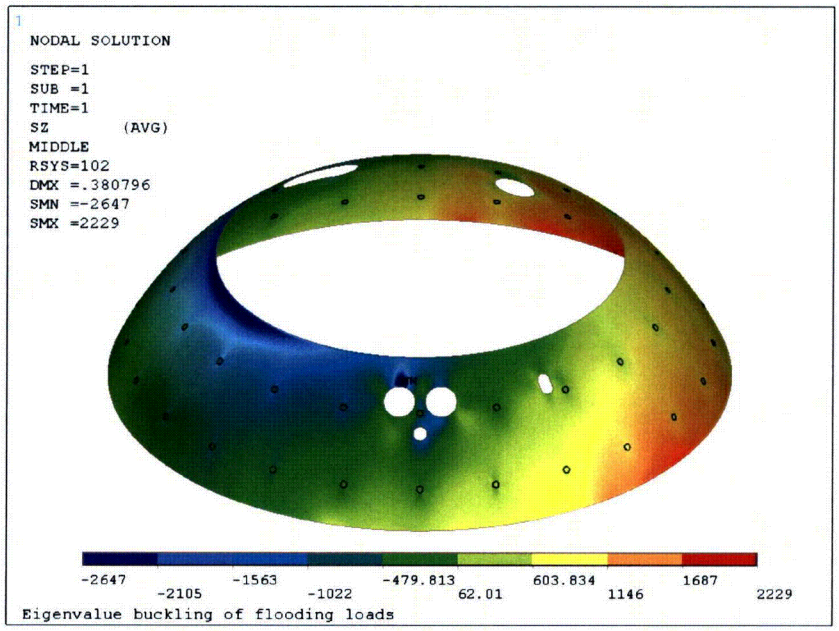



(a) Axial Stress

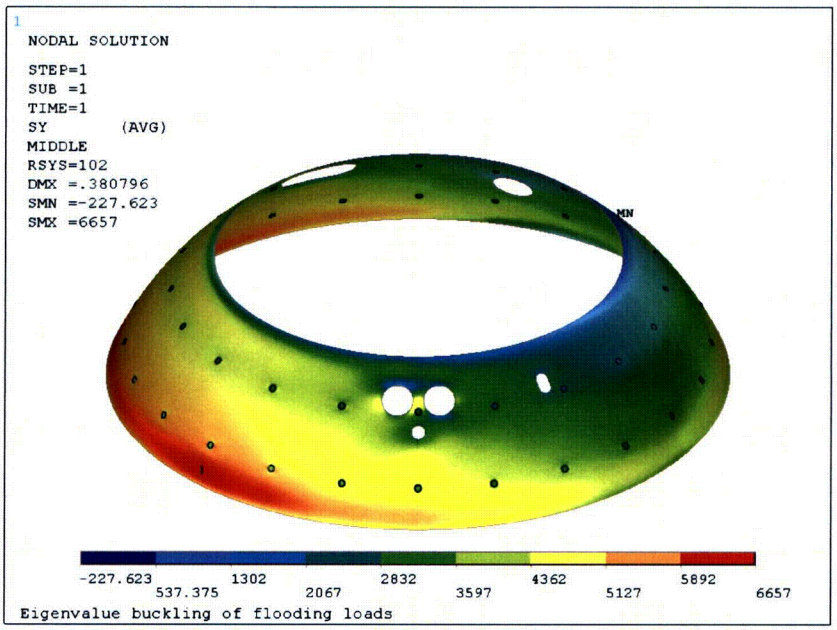



(b) Hoop Stress

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

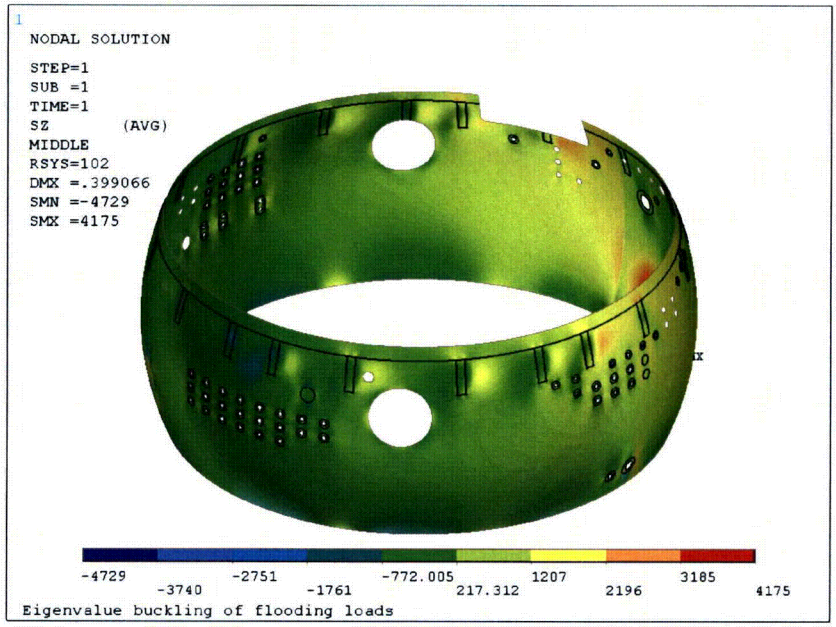



(a) Meridional Stress

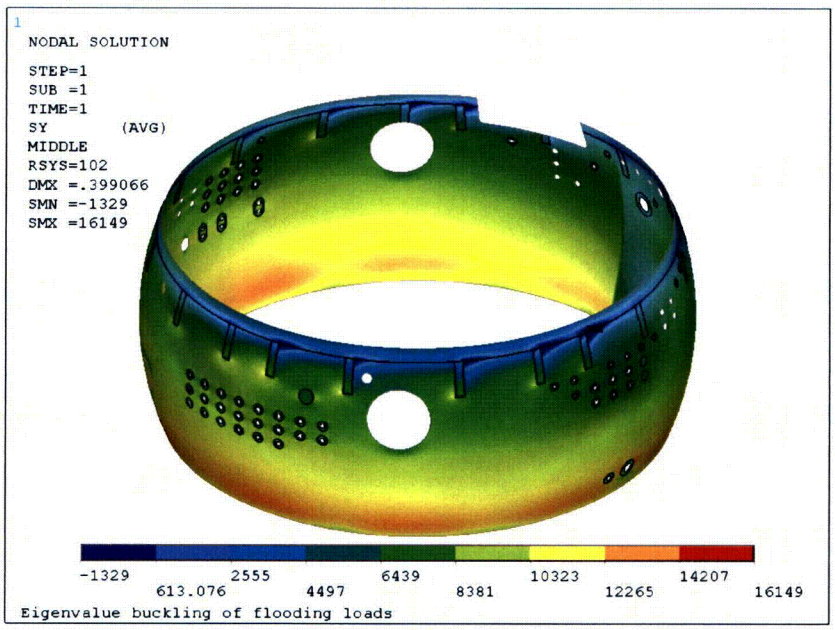



(b) Hoop Stress

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

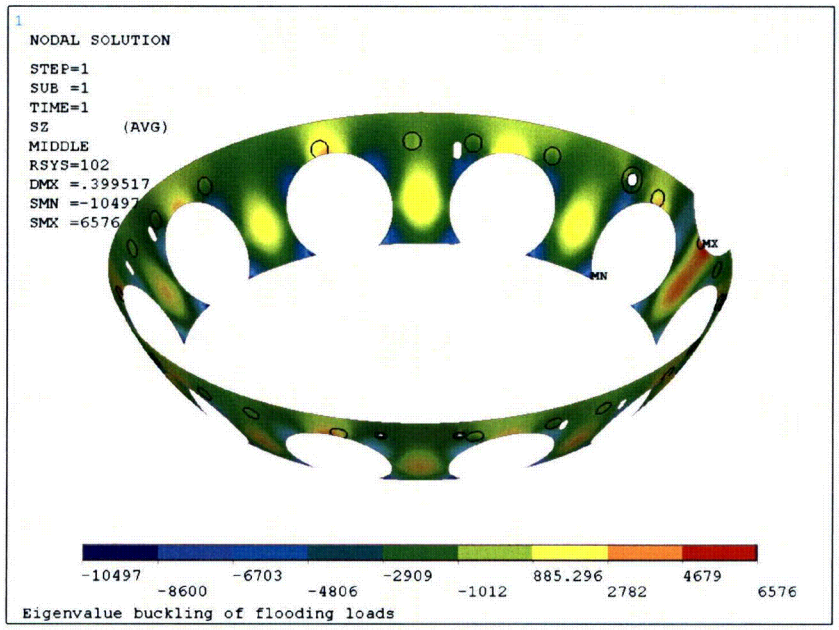



(a) Meridional Stress

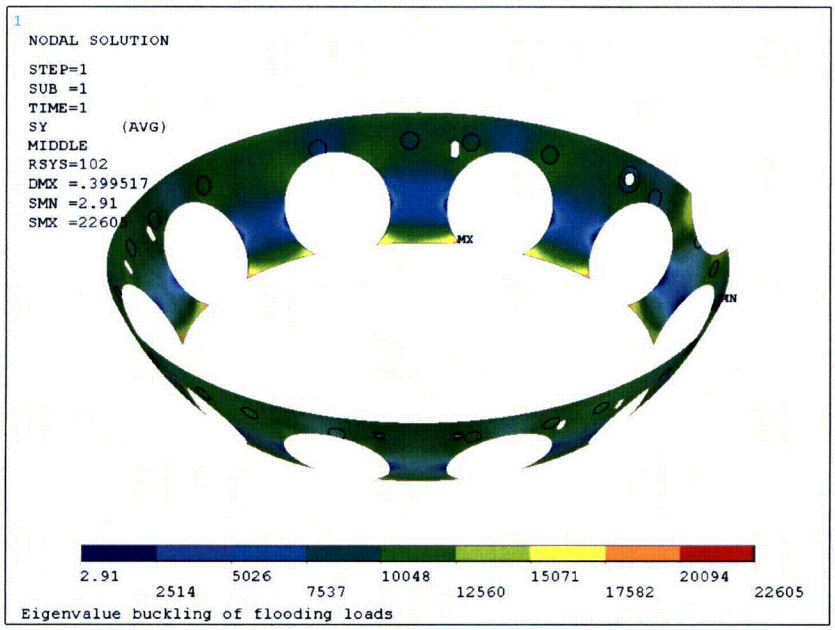



(b) Hoop Stress

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

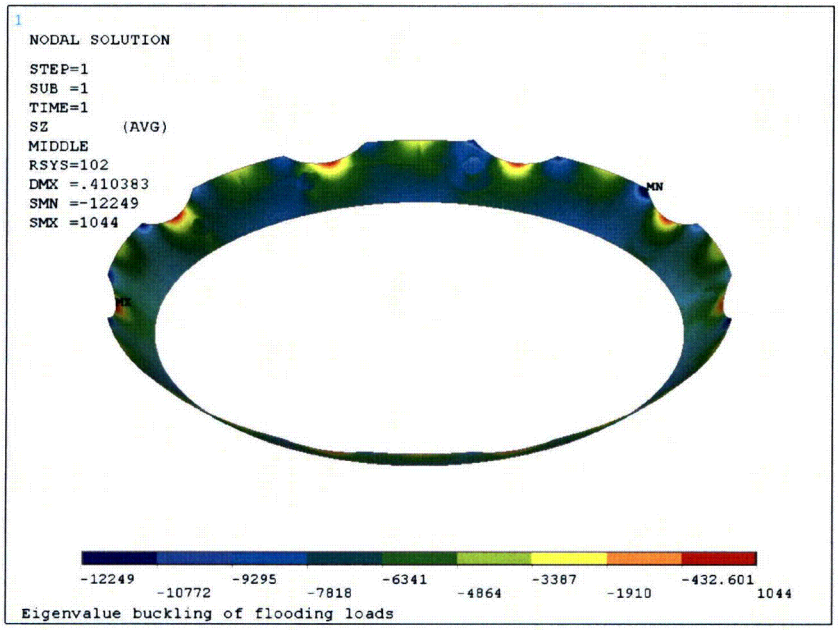



(a) Meridional Stress

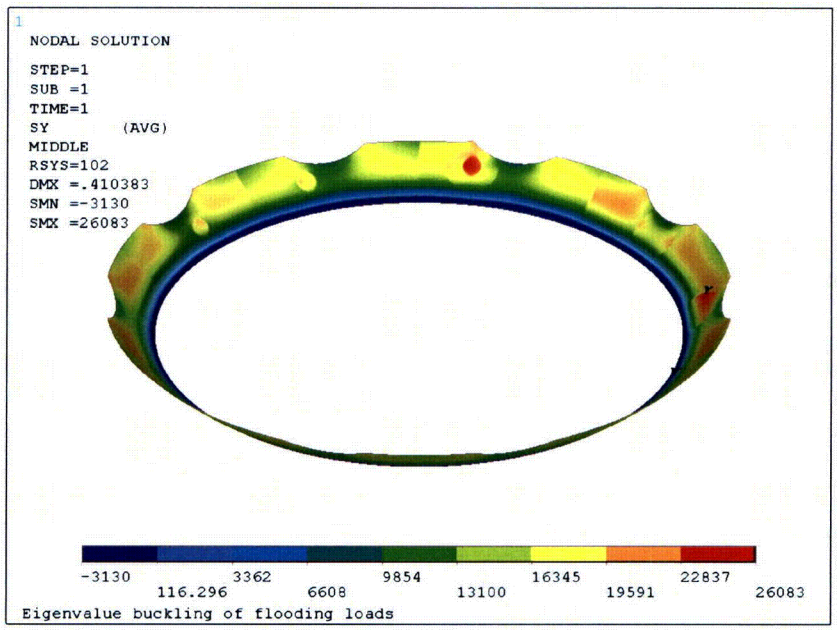



(b) Hoop Stress

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

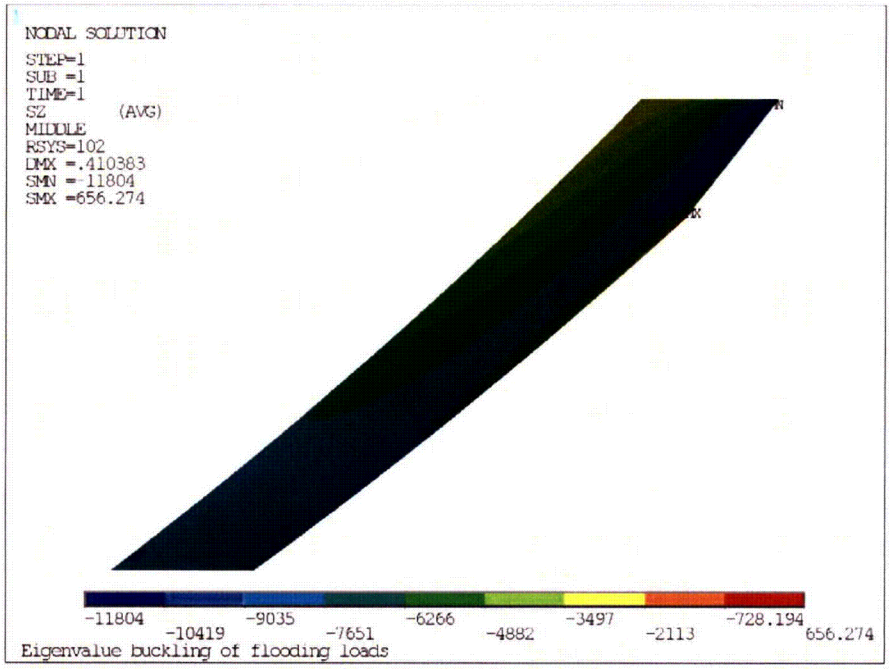



(a) Meridional

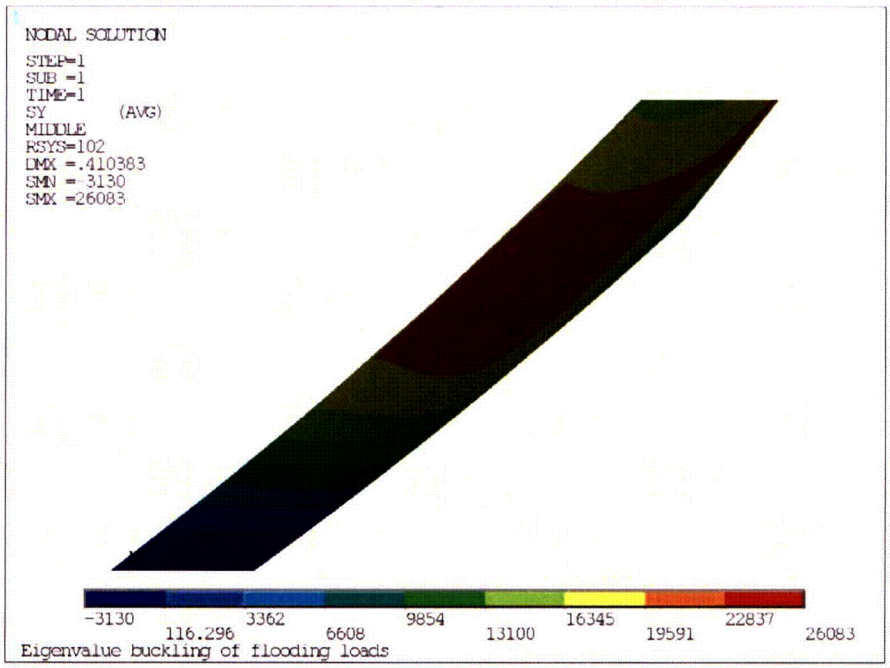



(b) Hoop Stress

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

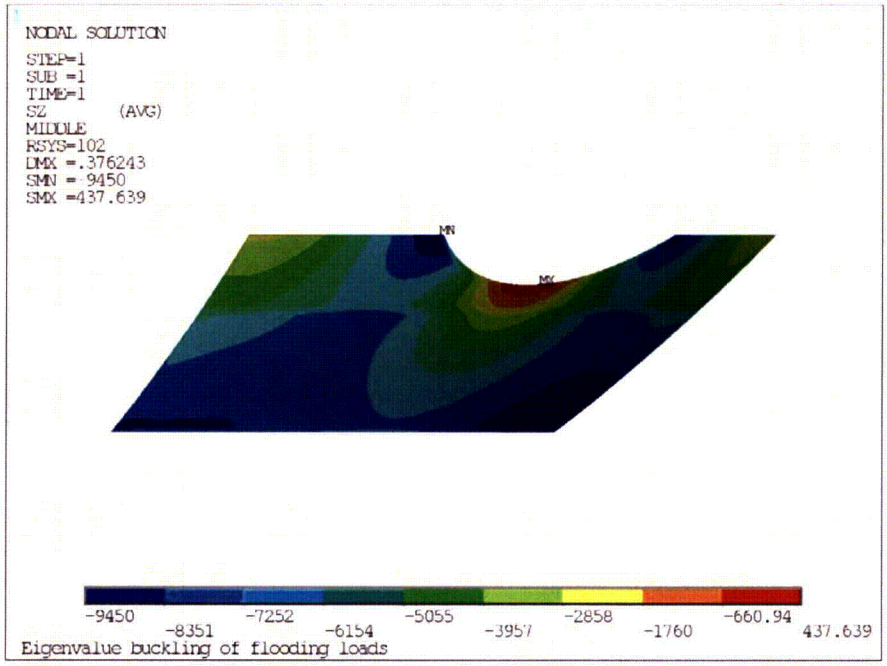



(a) Meridional Stress

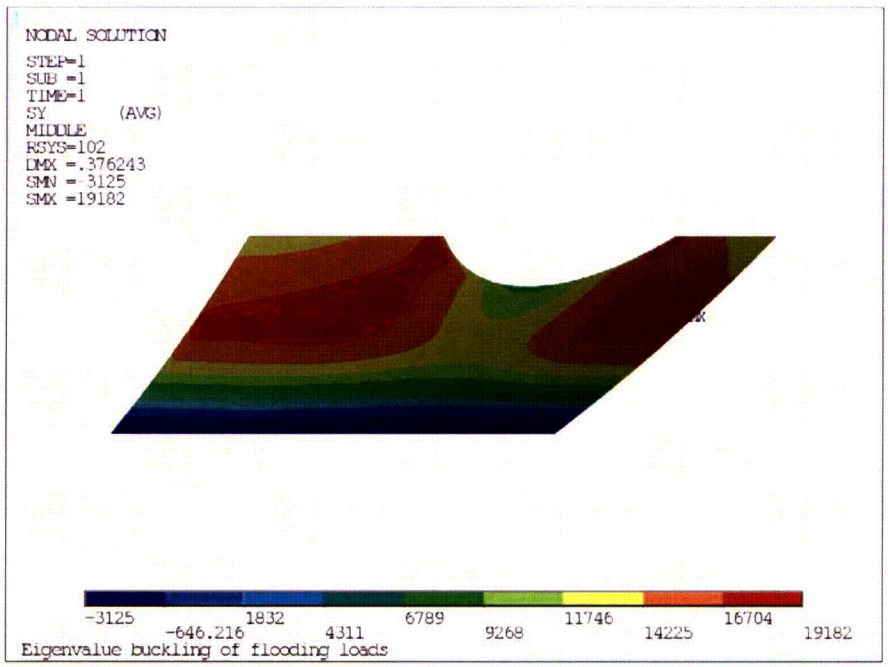



(b) Hoop Stress

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

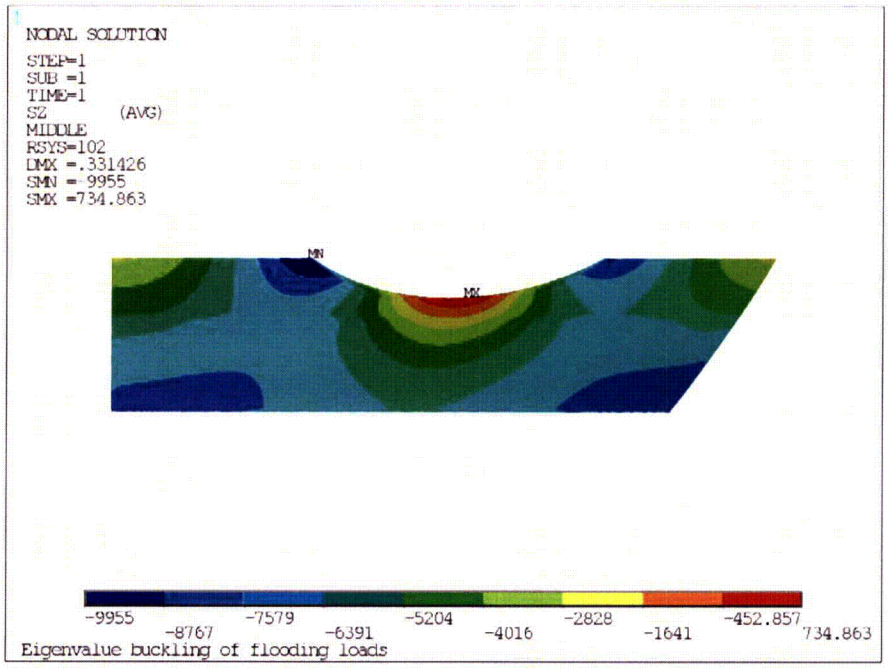



(a) Meridional Stress

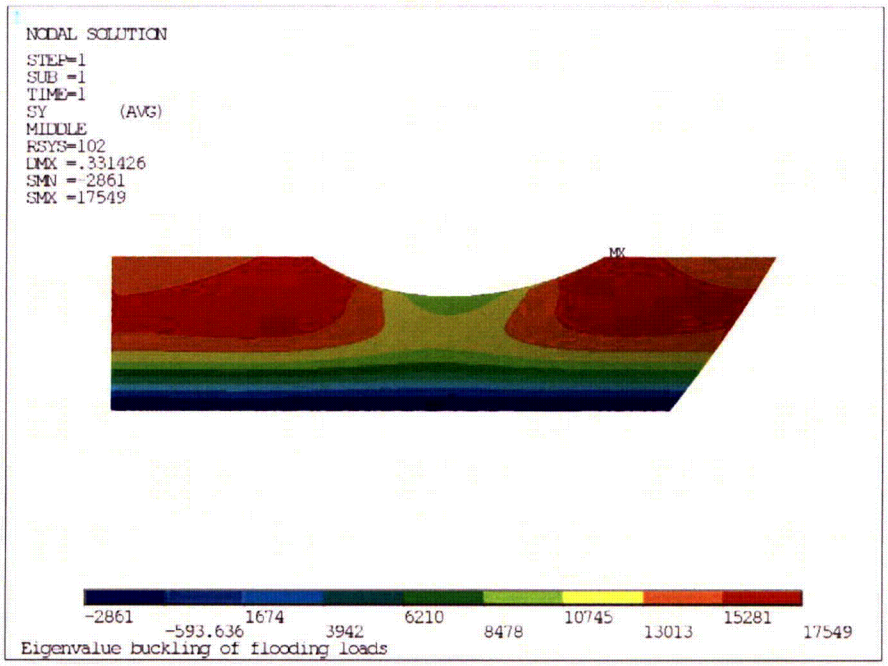



(b) Hoop Stress

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

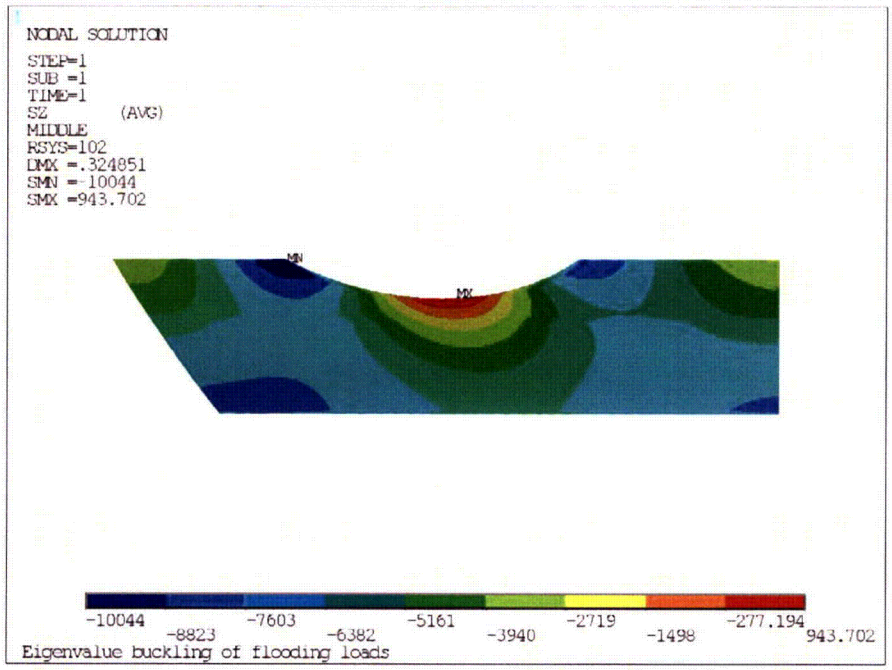



(a) Meridional Stress

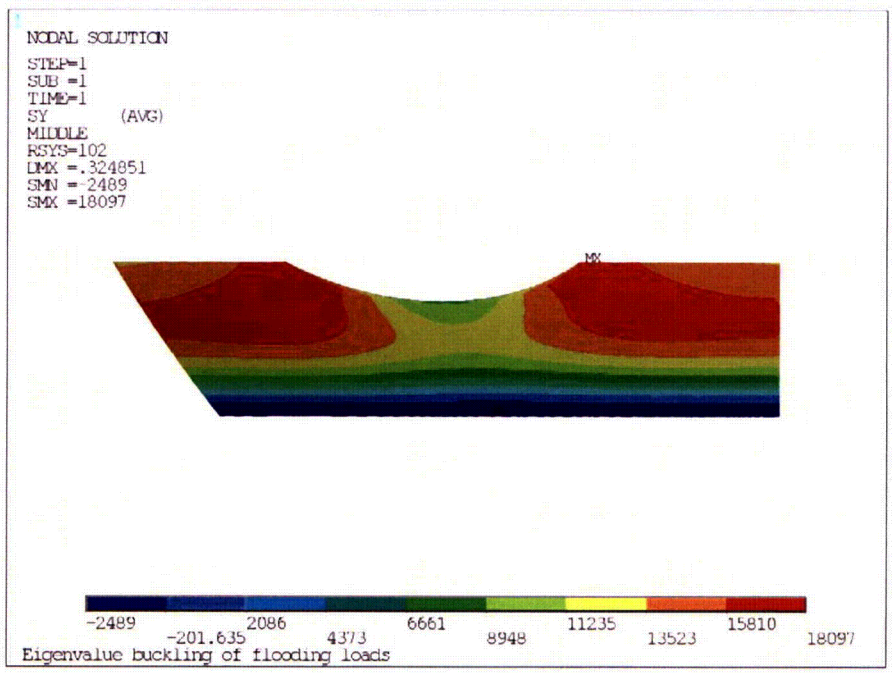



(b) Hoop Stress

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

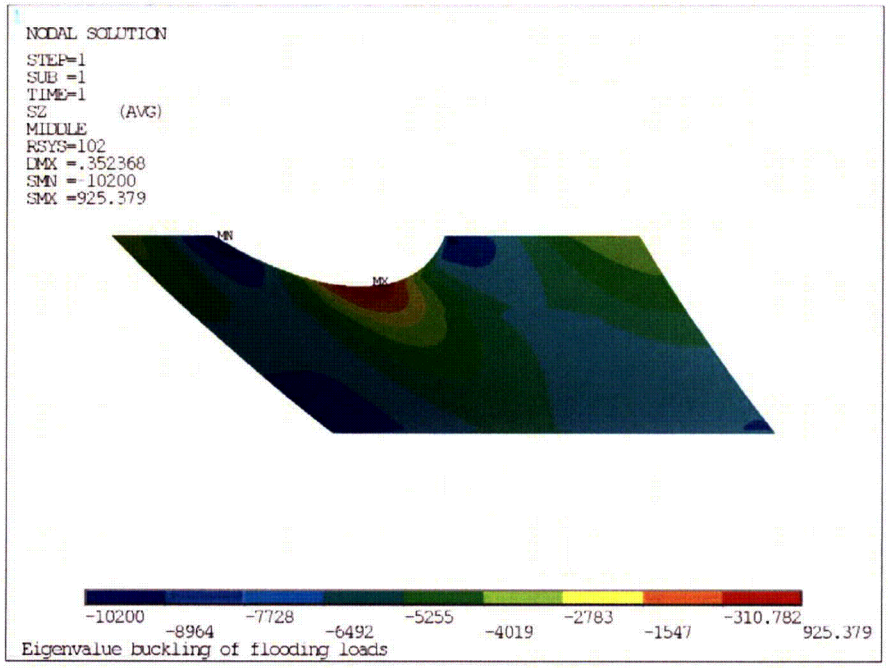



(a) Meridional Stress

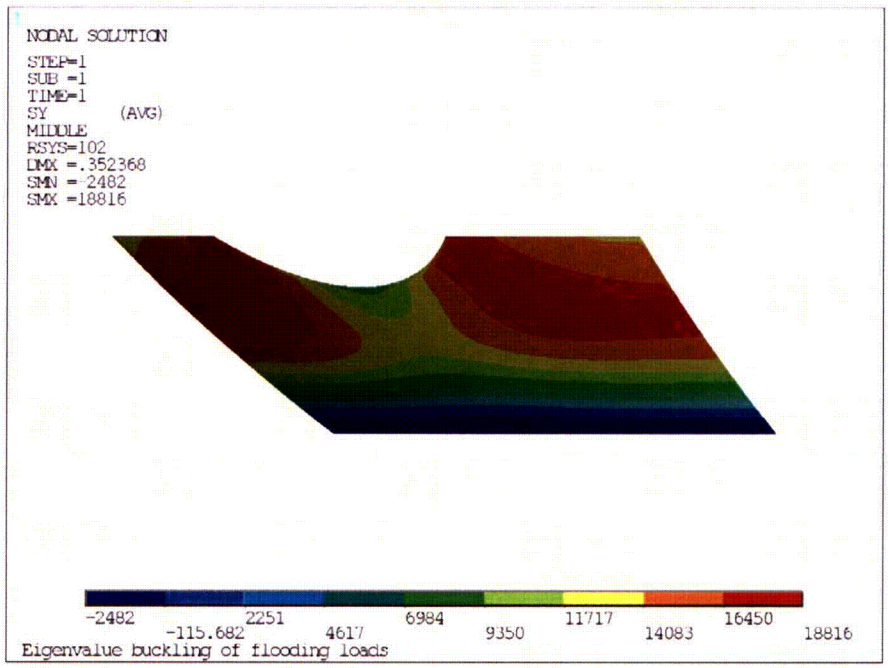



(b) Hoop Stress

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

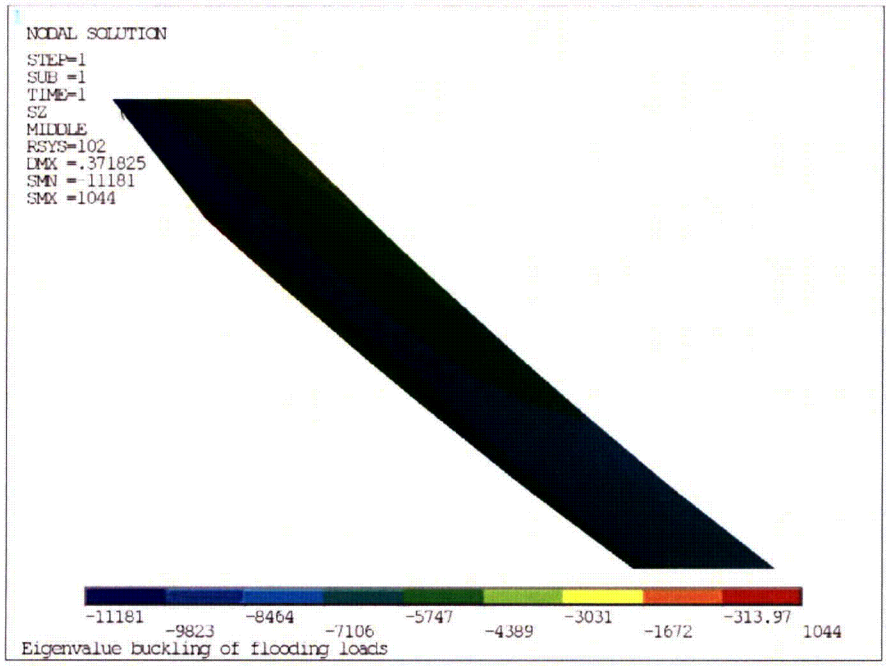



(a) Meridional Stress

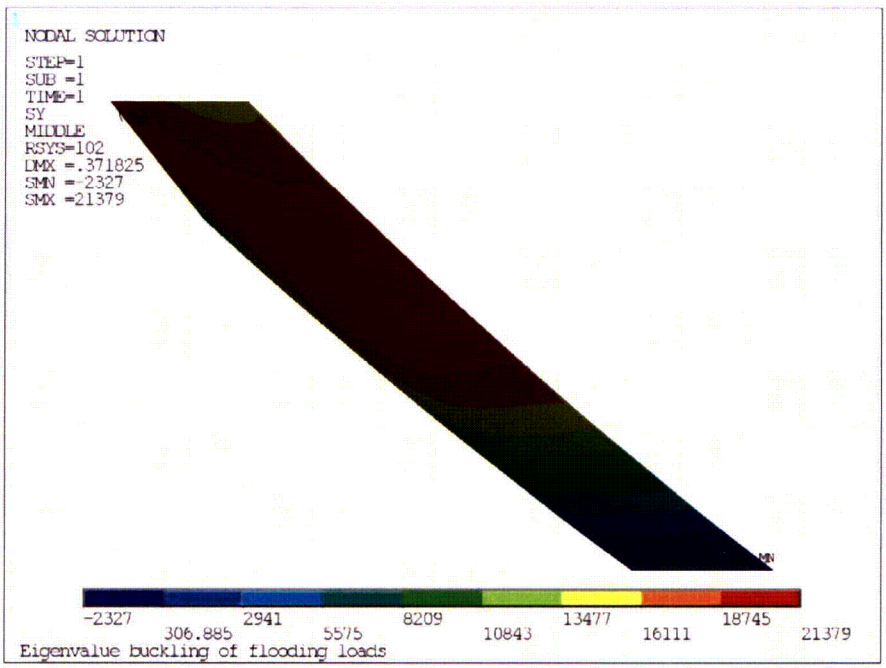



(b) Hoop Stress

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

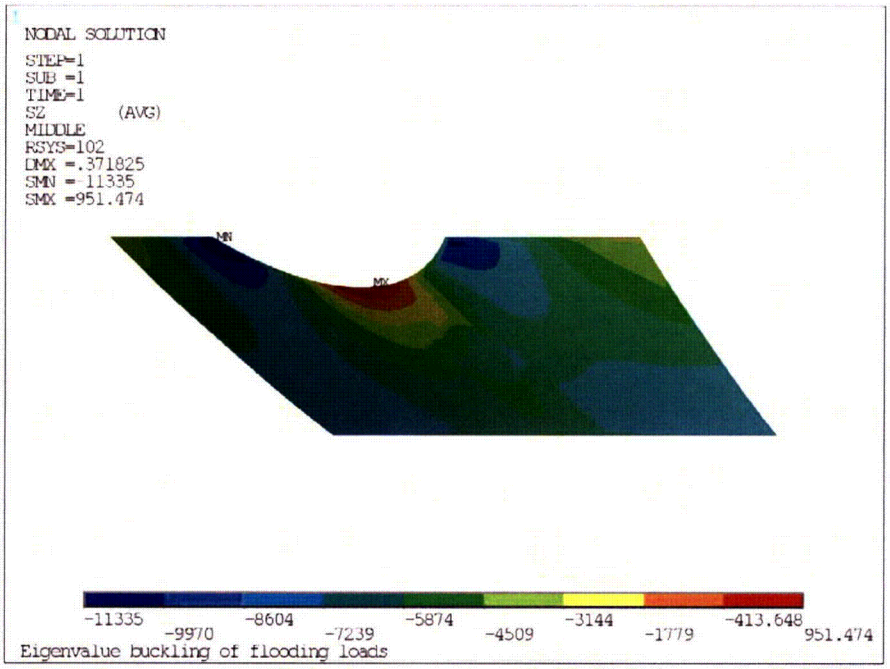



(a) Meridional Stress

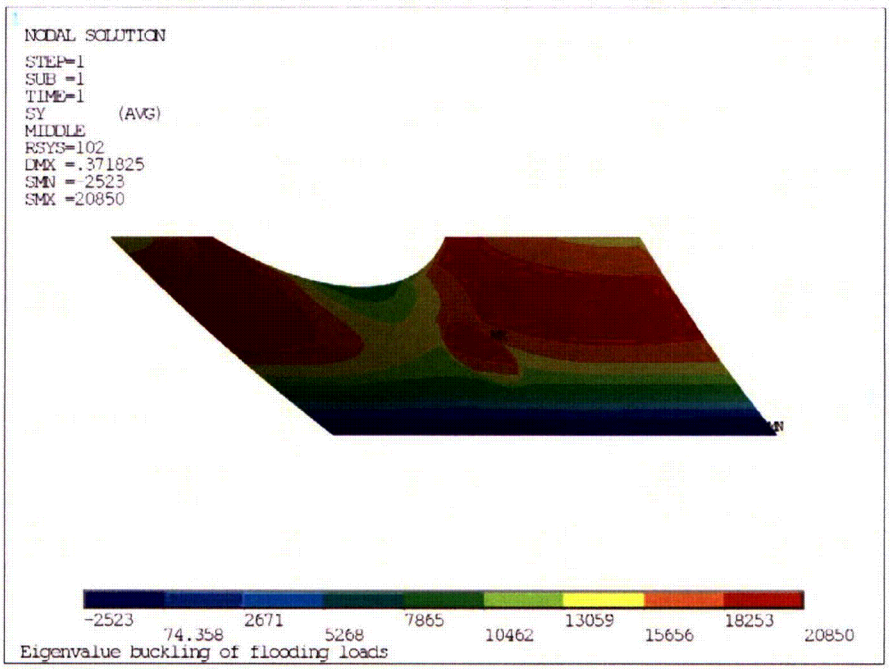



(b) Hoop Stress

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

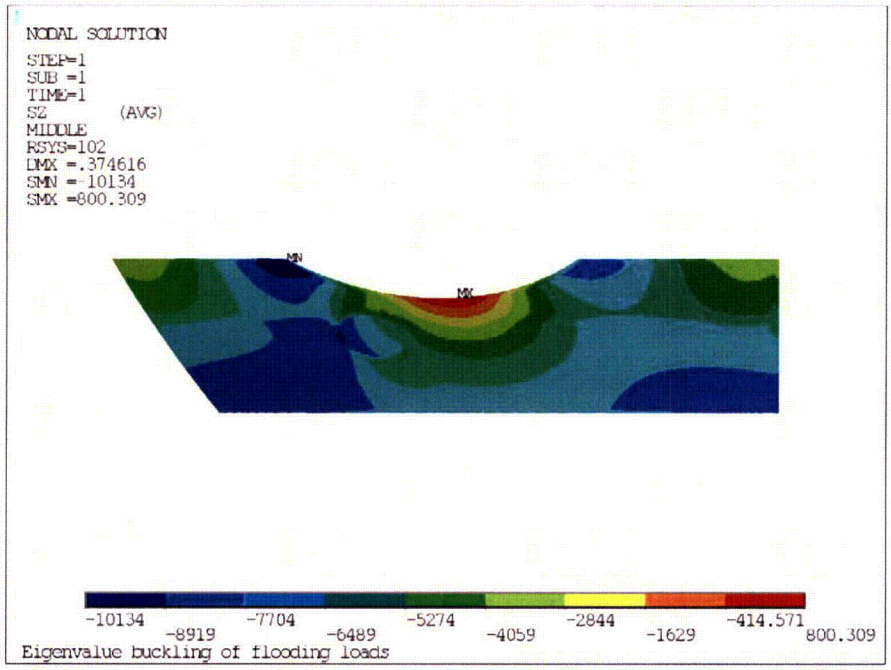



(a) Meridional Stress

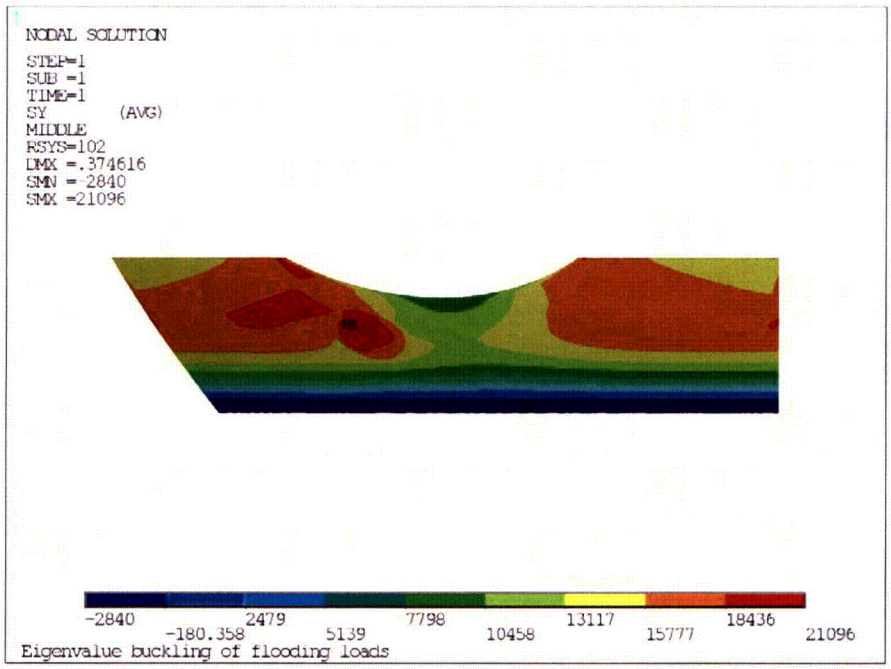



(b) Hoop Stress

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

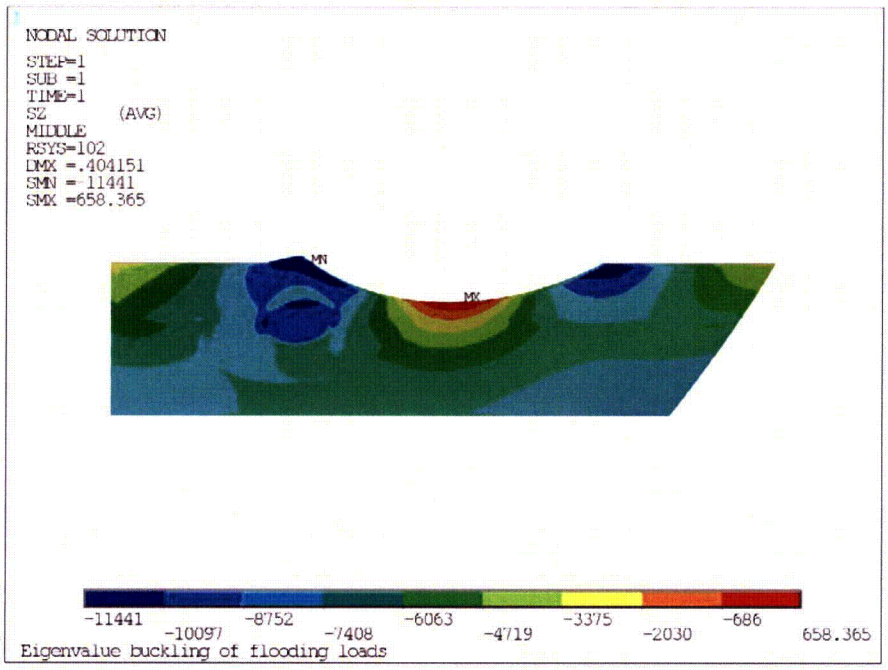



(a) Meridional Stress

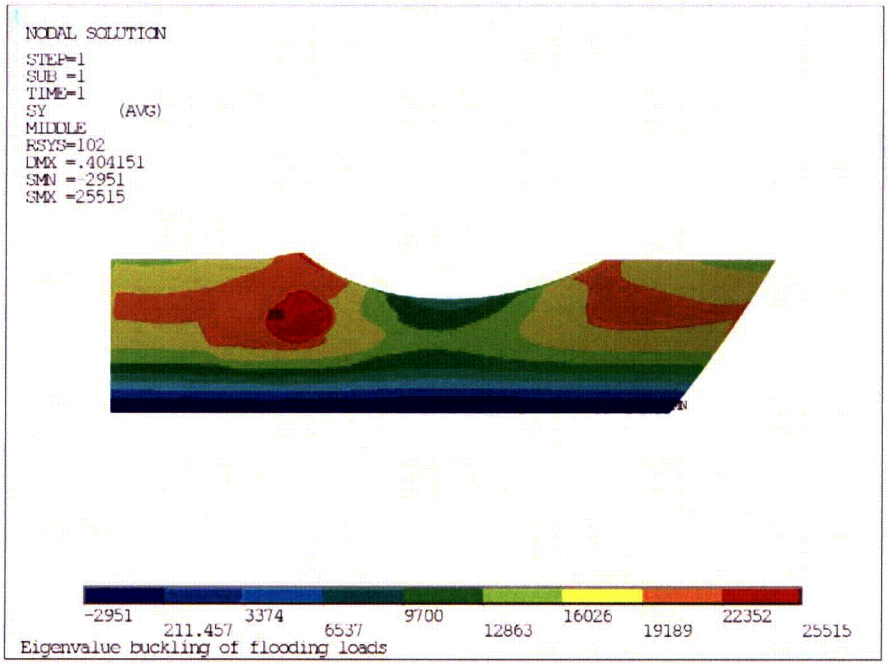



(b) Hoop Stress

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

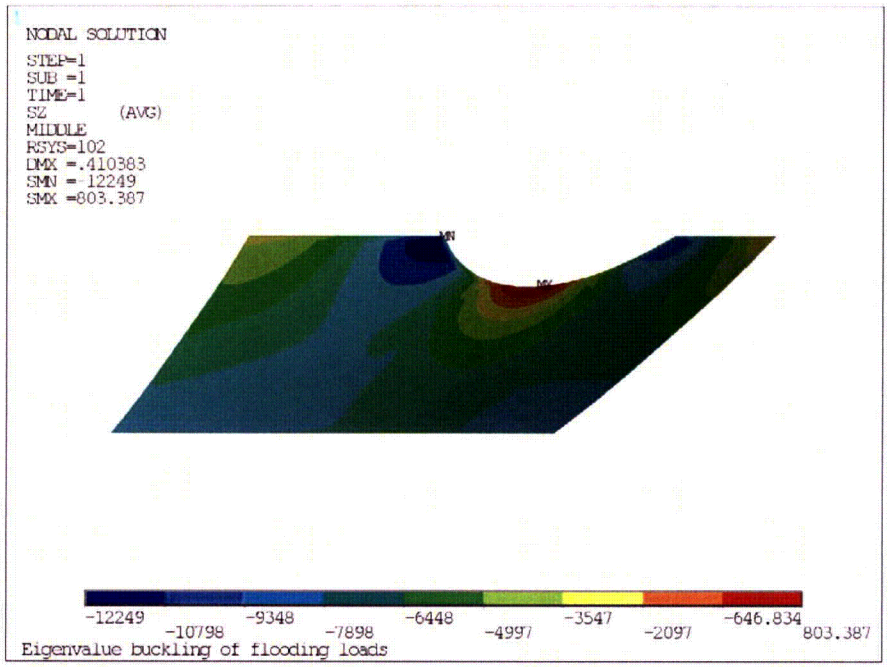



(a) Meridional Stress

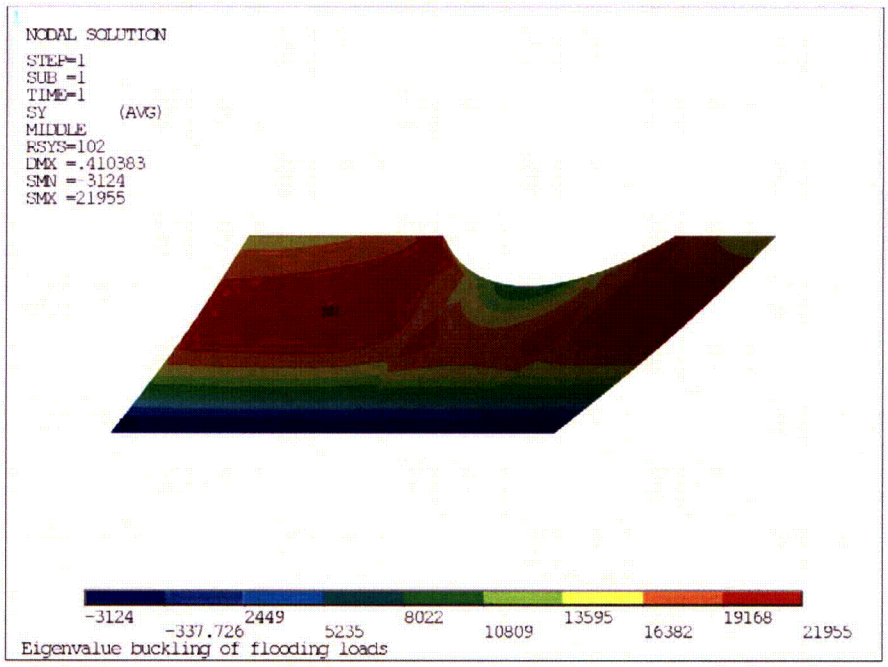



(b) Hoop Stress

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

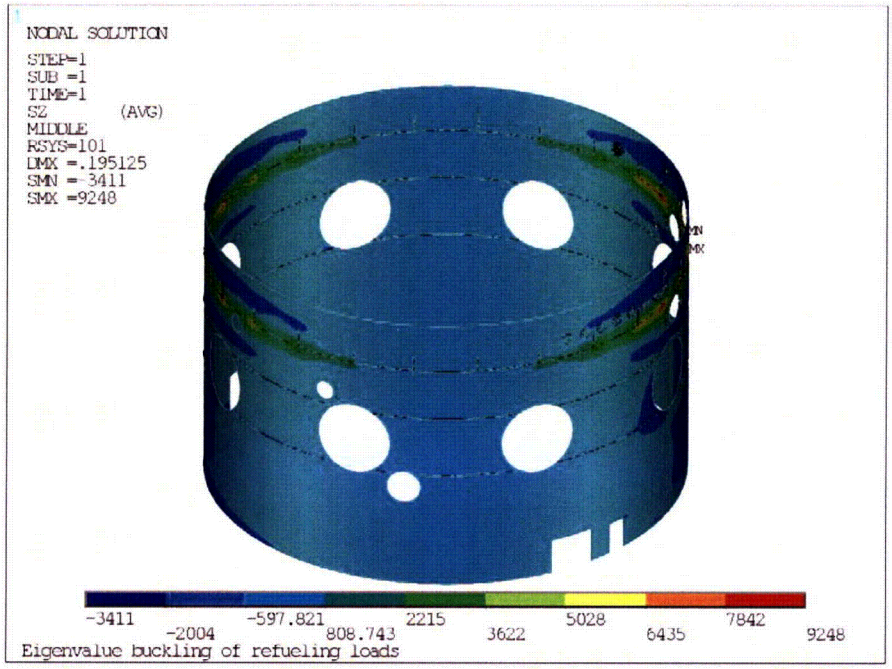



(a) Meridional Stress

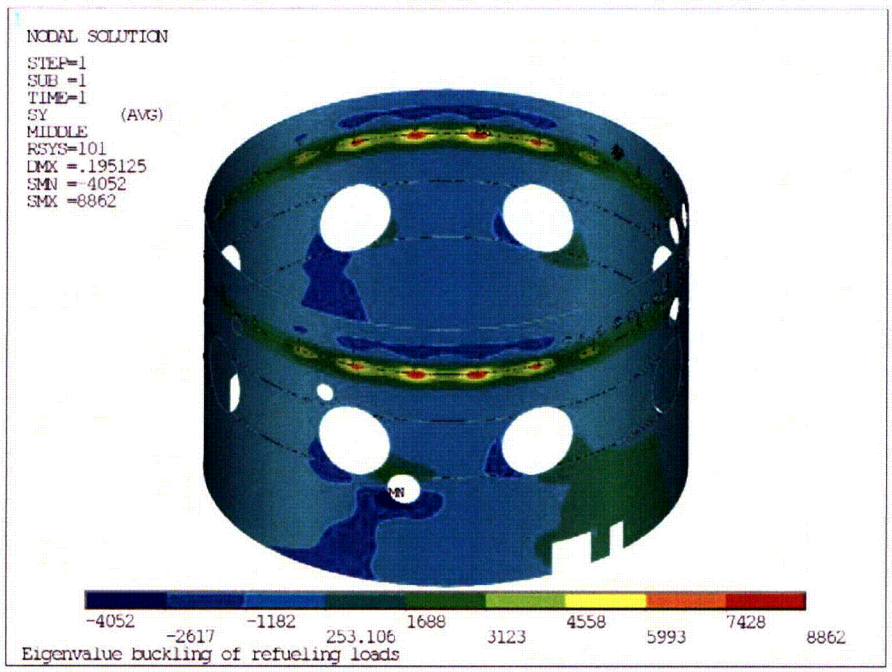



(b) Hoop Stress

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

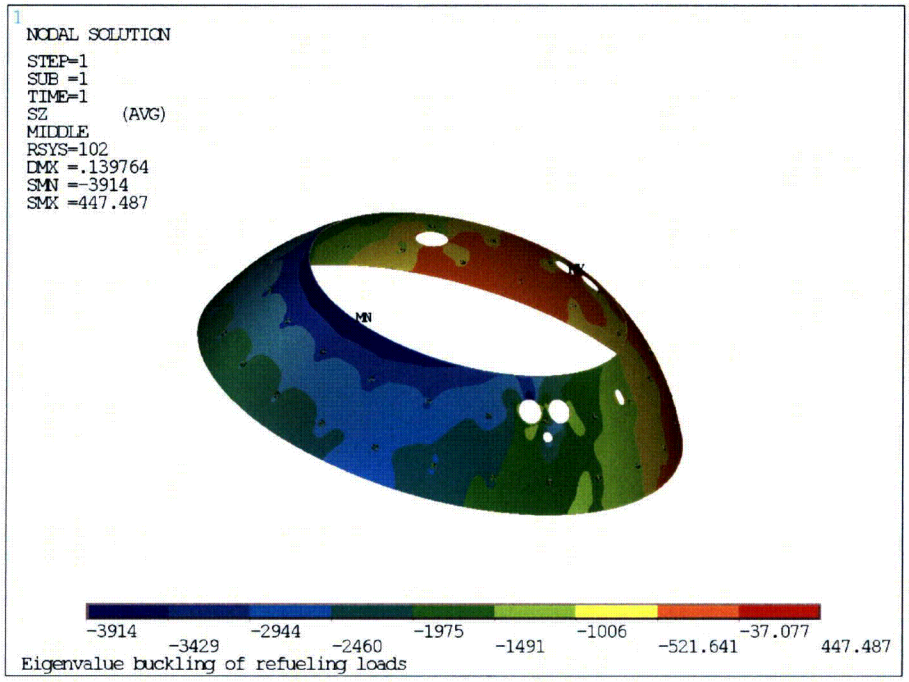



(a) Axial Stress

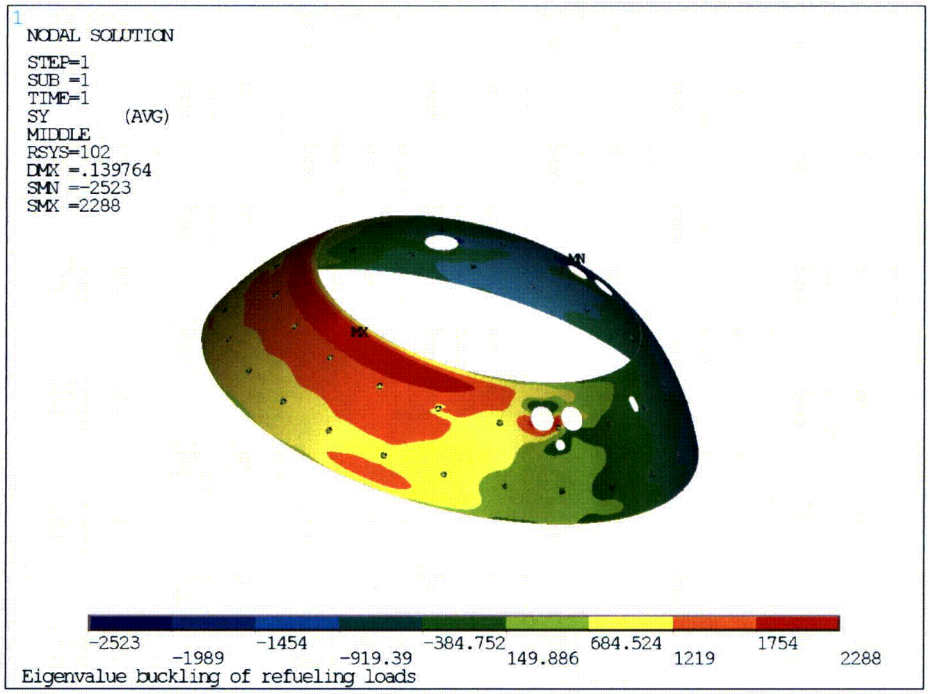



(b) Hoop Stress

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

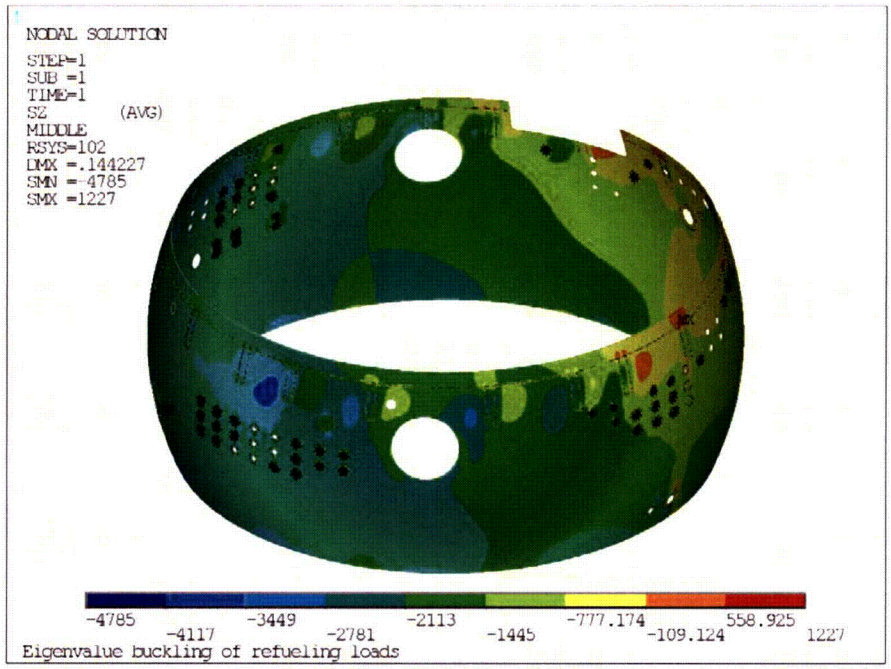



(a) Meridional Stress

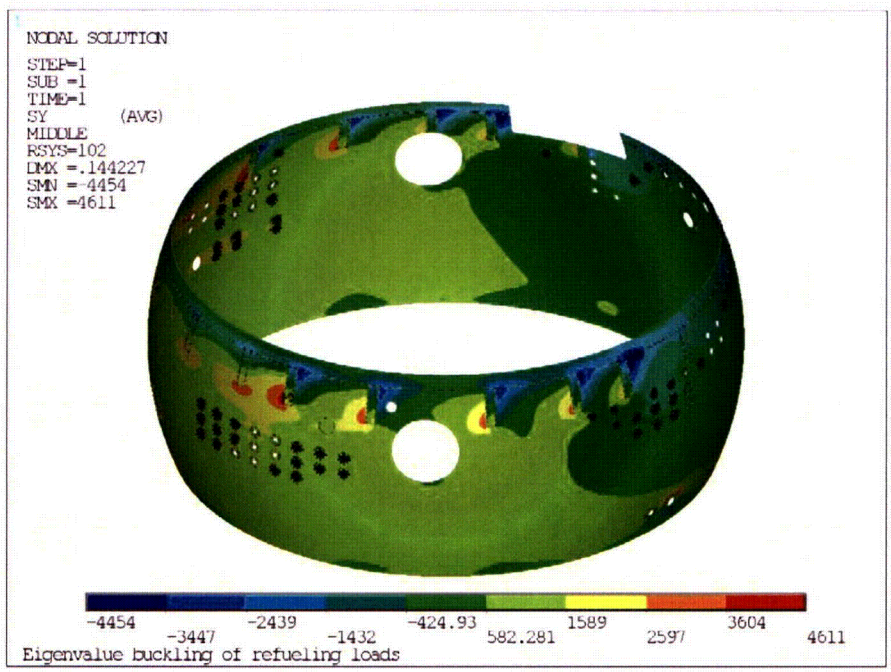



(b) Hoop Stress

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

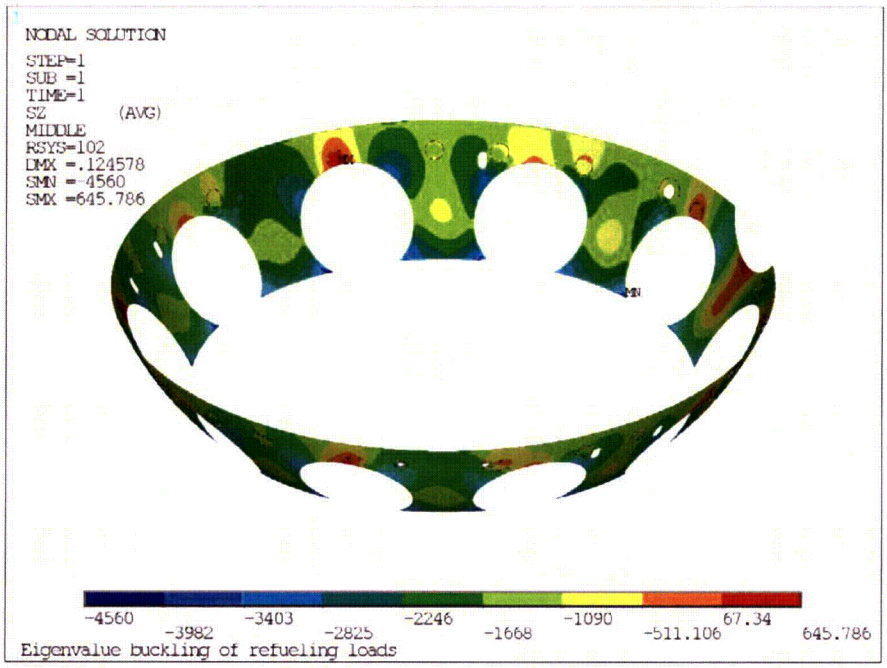



(a) Meridional Stress

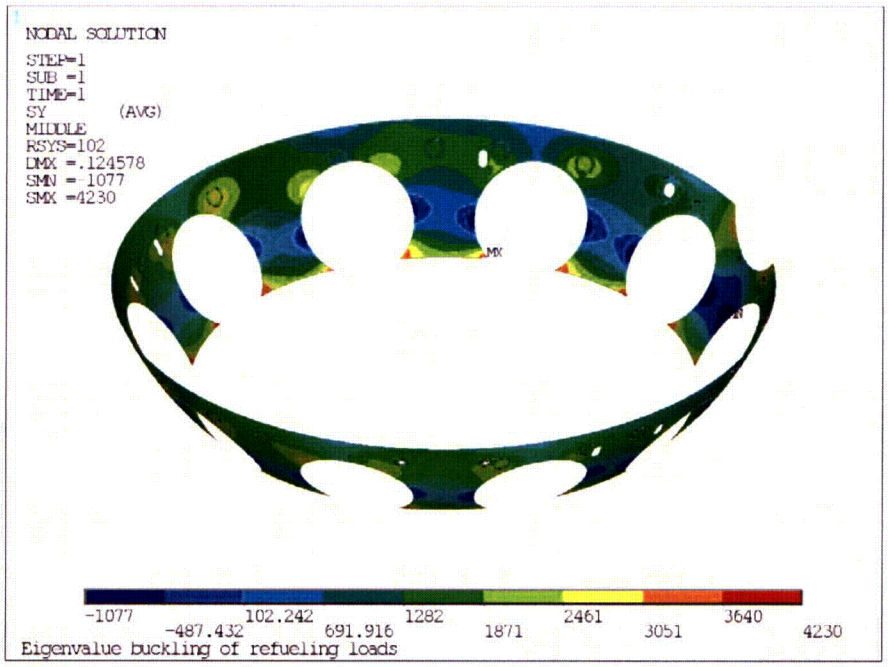



(b) Hoop Stress

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

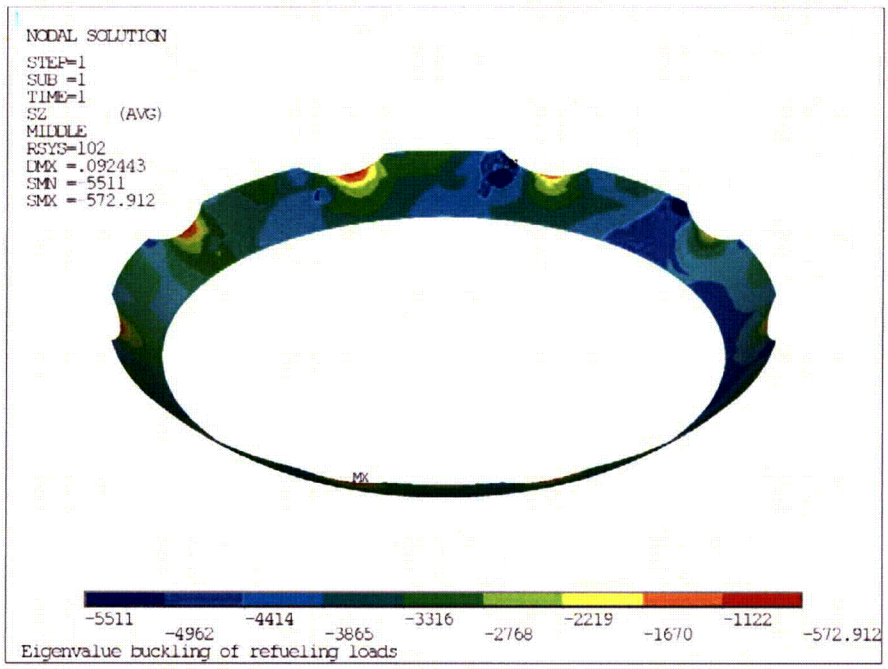



(a) Meridional Stress

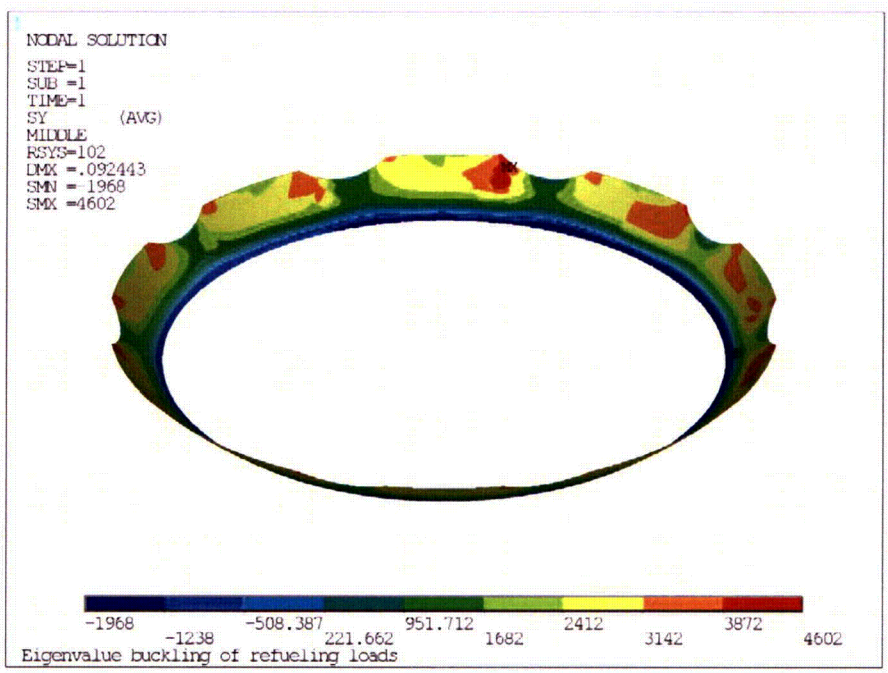



(b) Hoop Stress

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

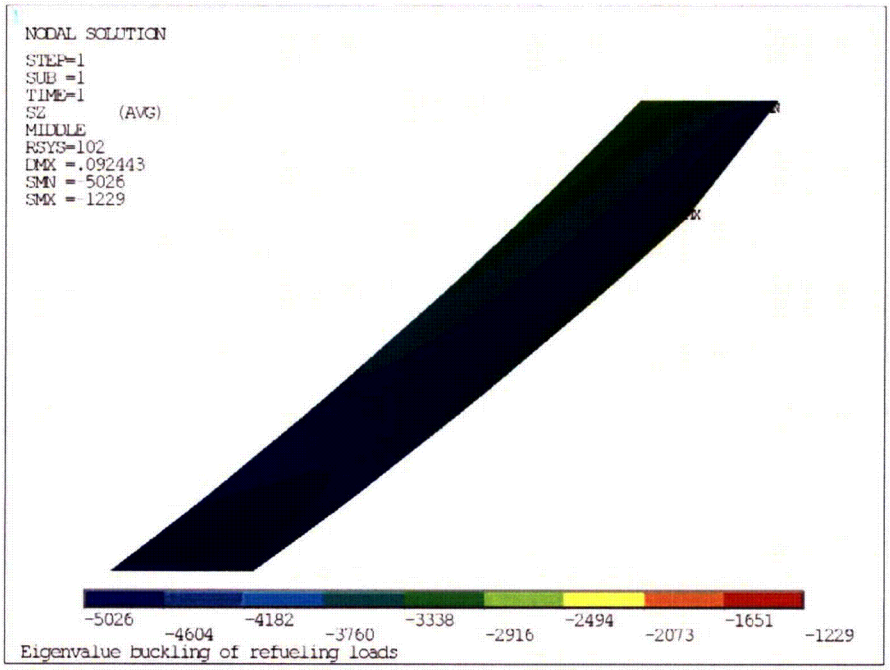



(a) Meridional

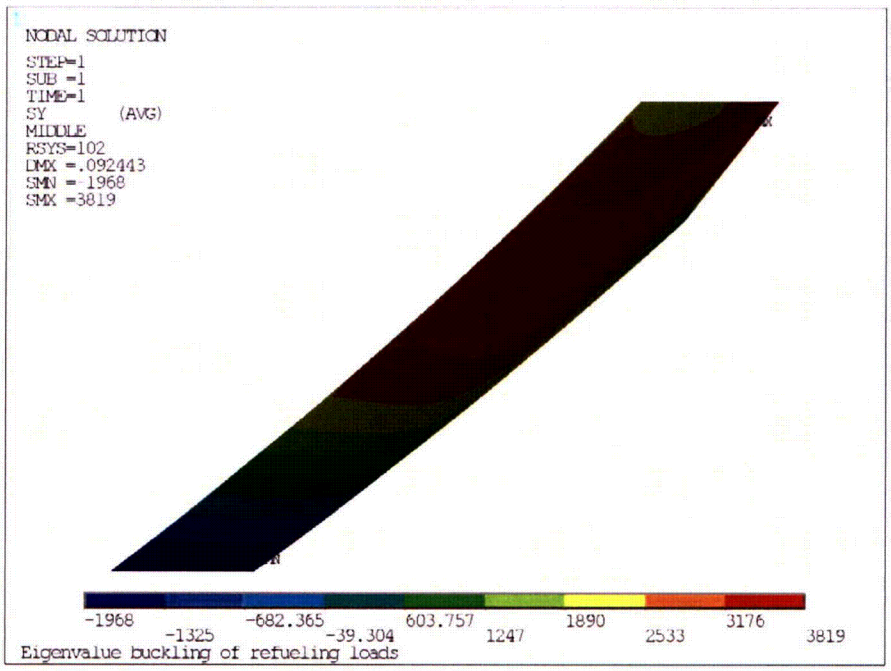



(b) Hoop Stress

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

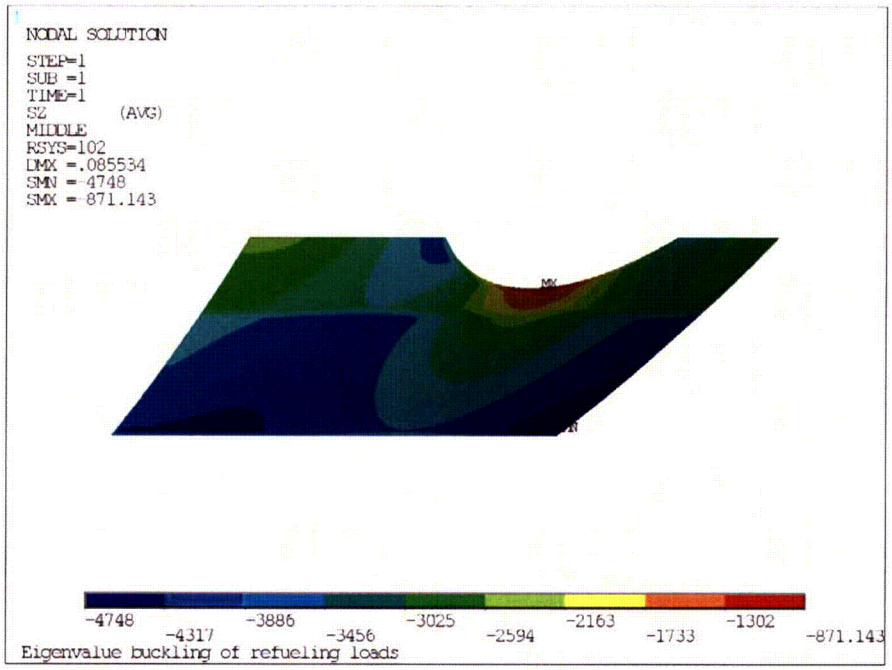



(a) Meridional Stress

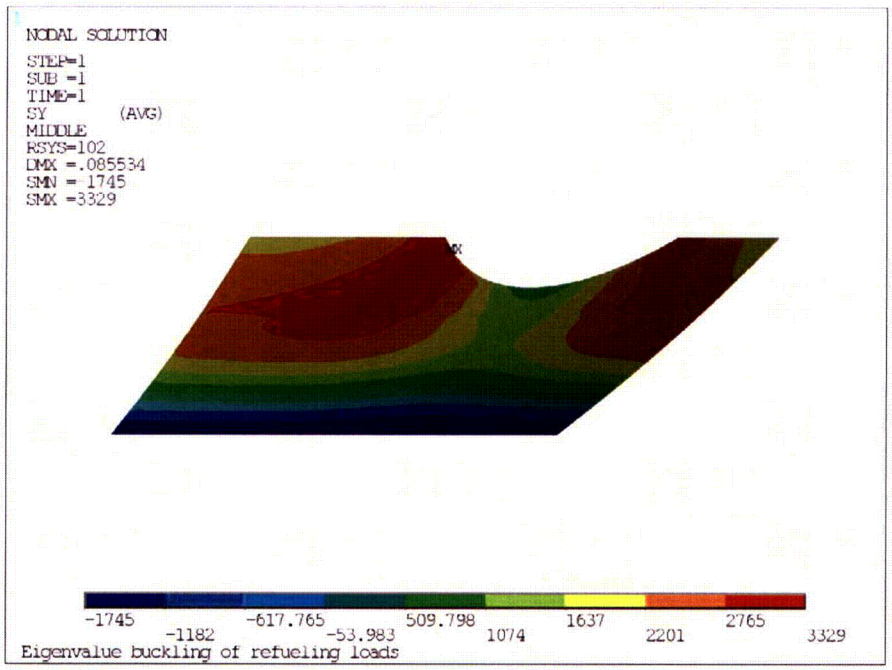



(b) Hoop Stress

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

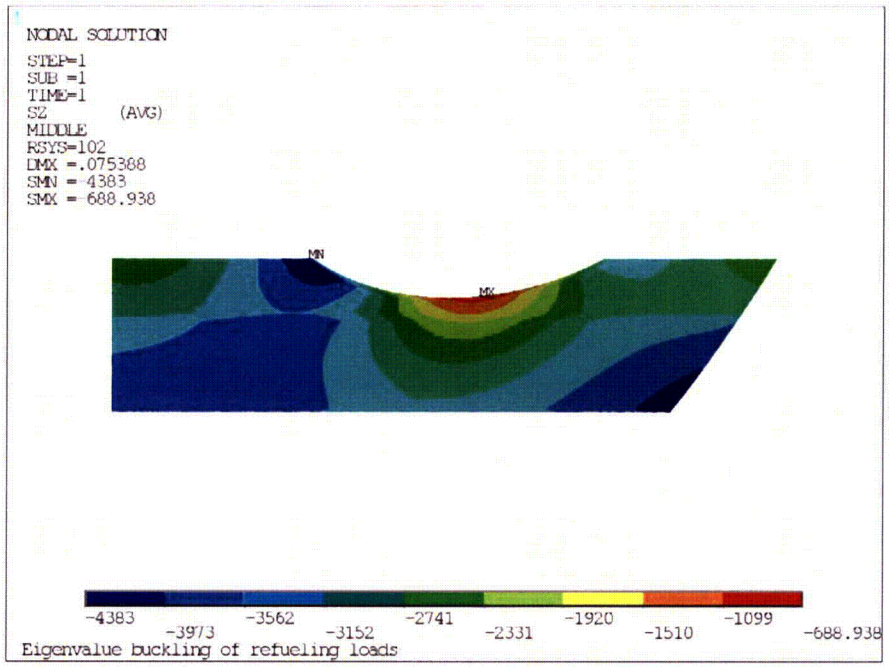



(a) Meridional Stress

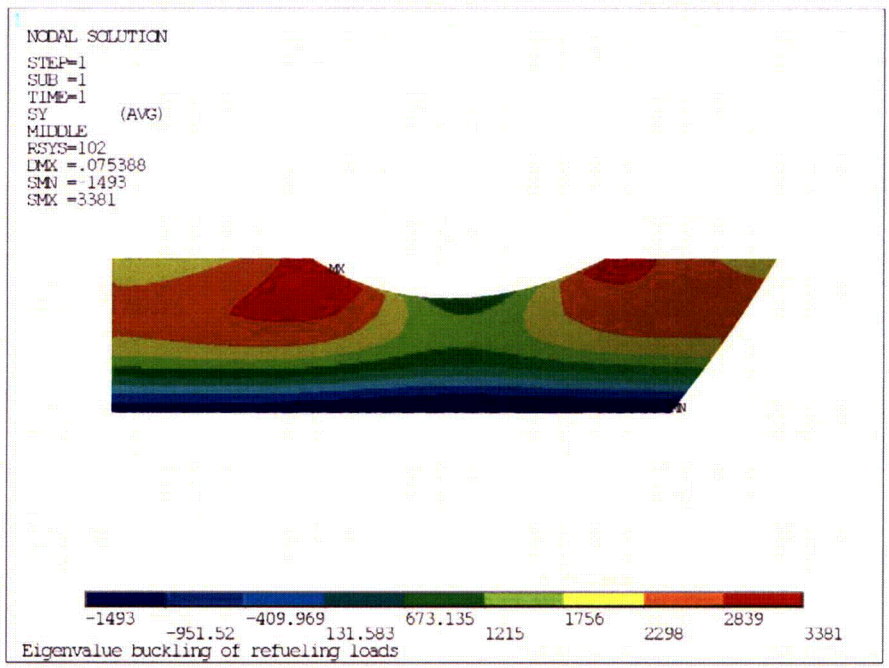



(b) Hoop Stress

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

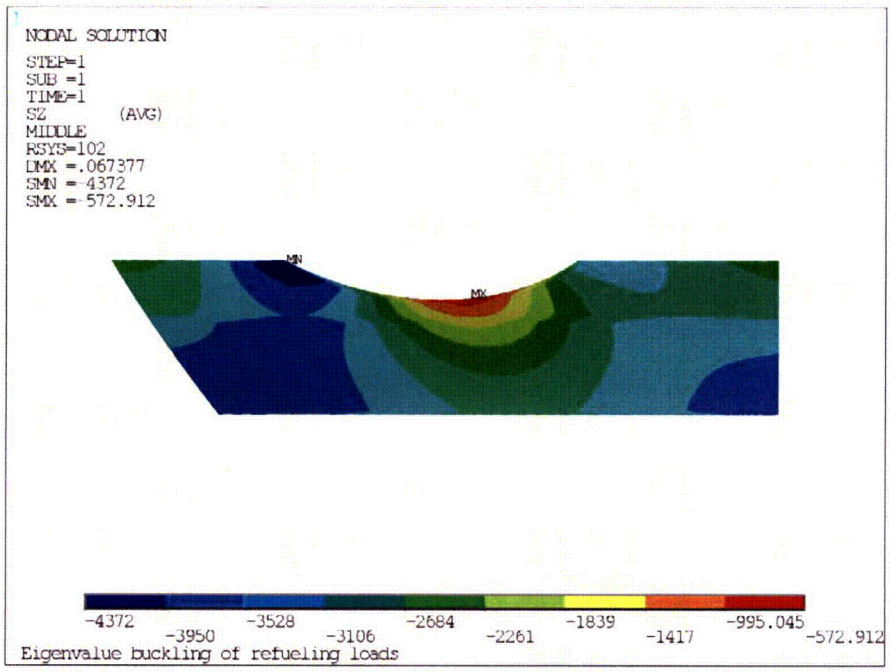



(a) Meridional Stress

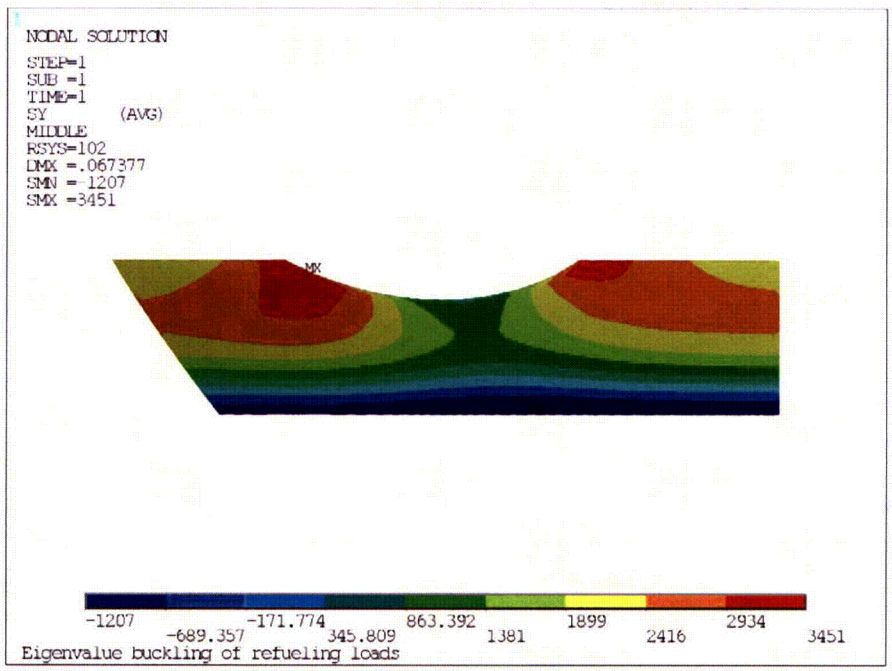



(b) Hoop Stress

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

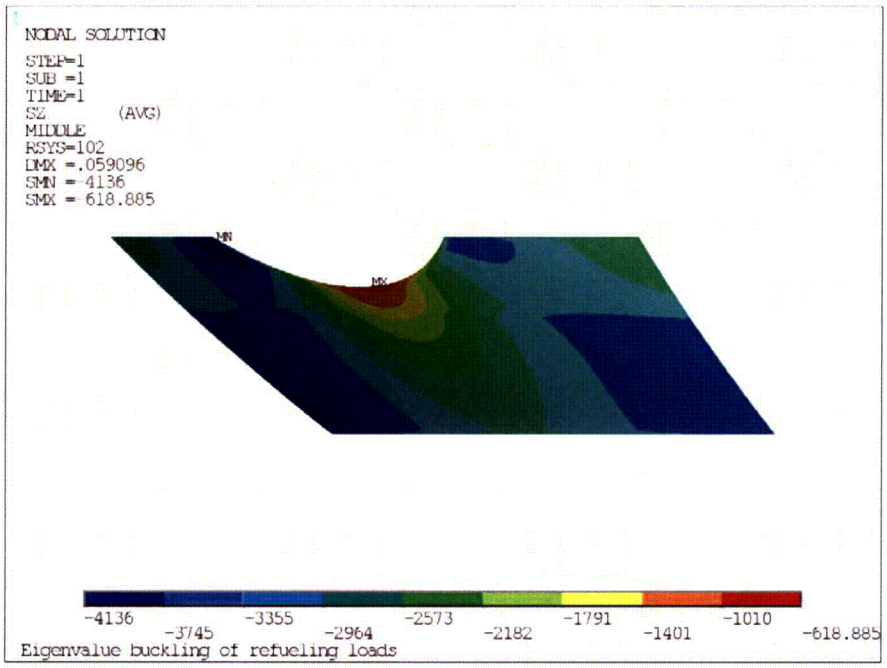



(a) Meridional Stress

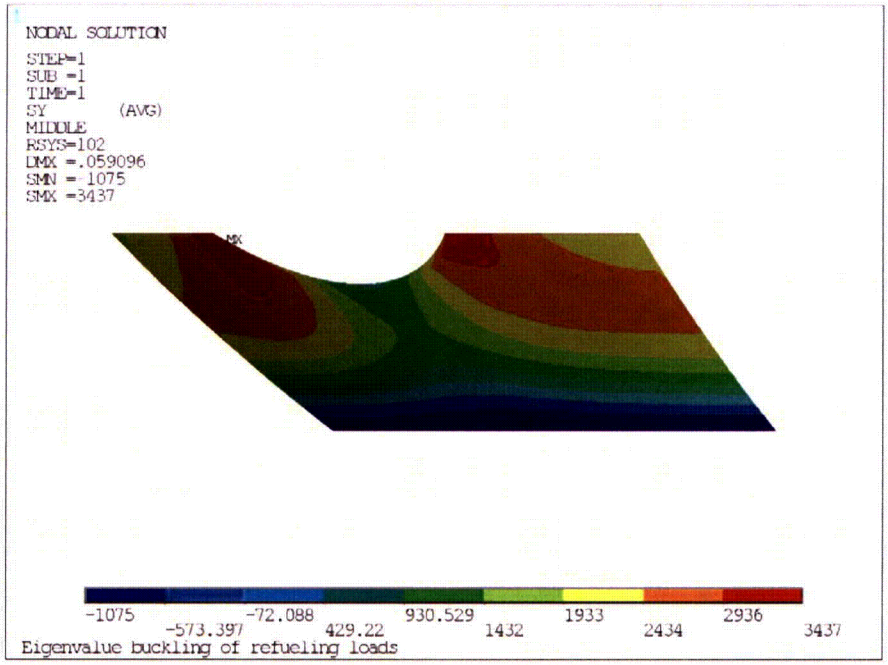



(b) Hoop Stress

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

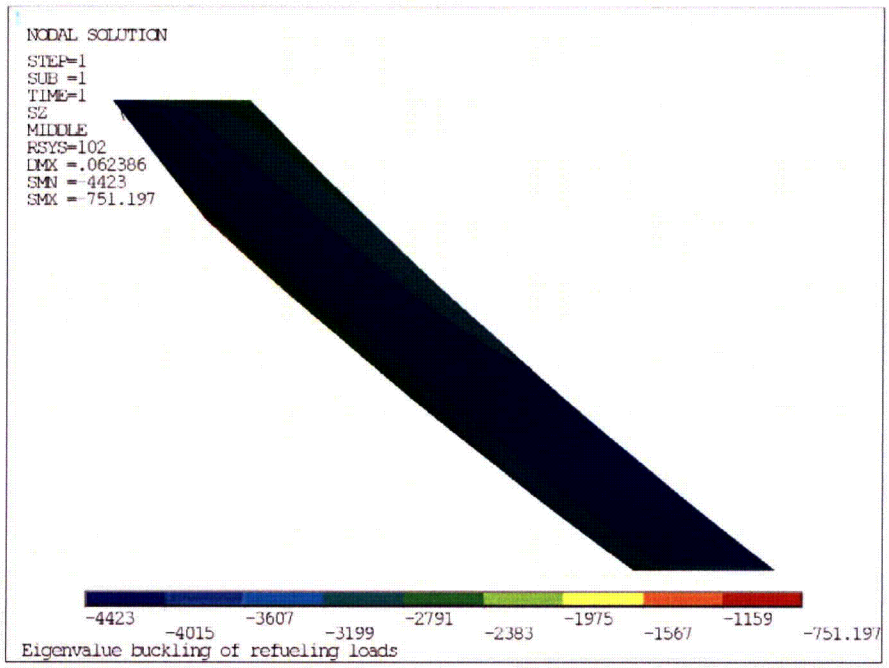



(a) Meridional Stress

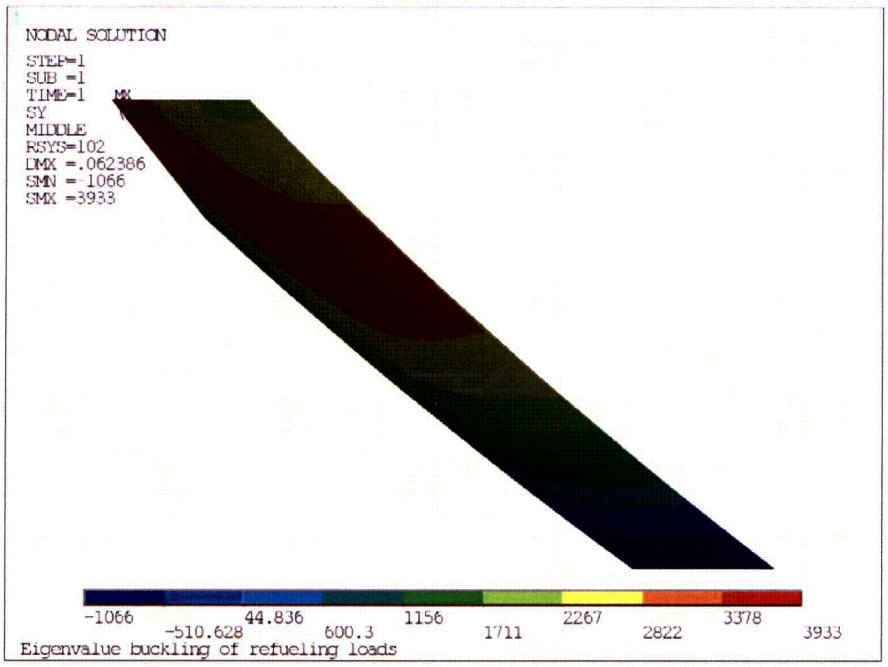



(b) Hoop Stress

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

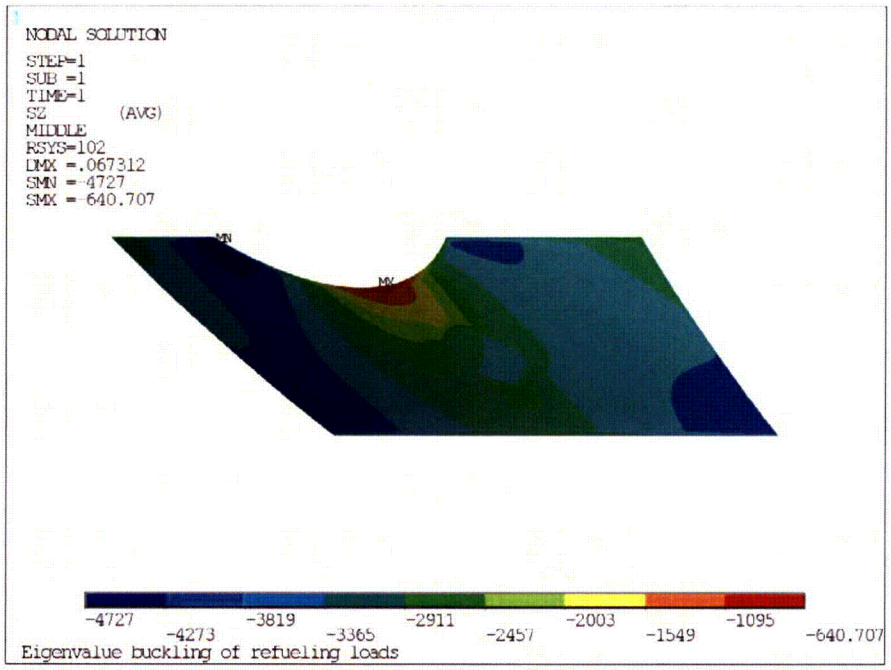



(a) Meridional Stress

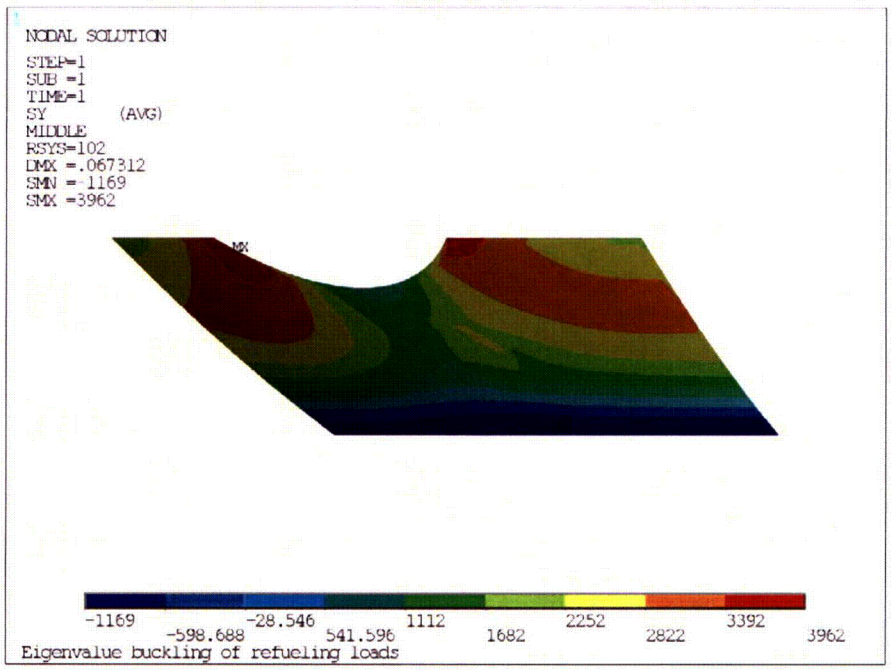



(b) Hoop Stress

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

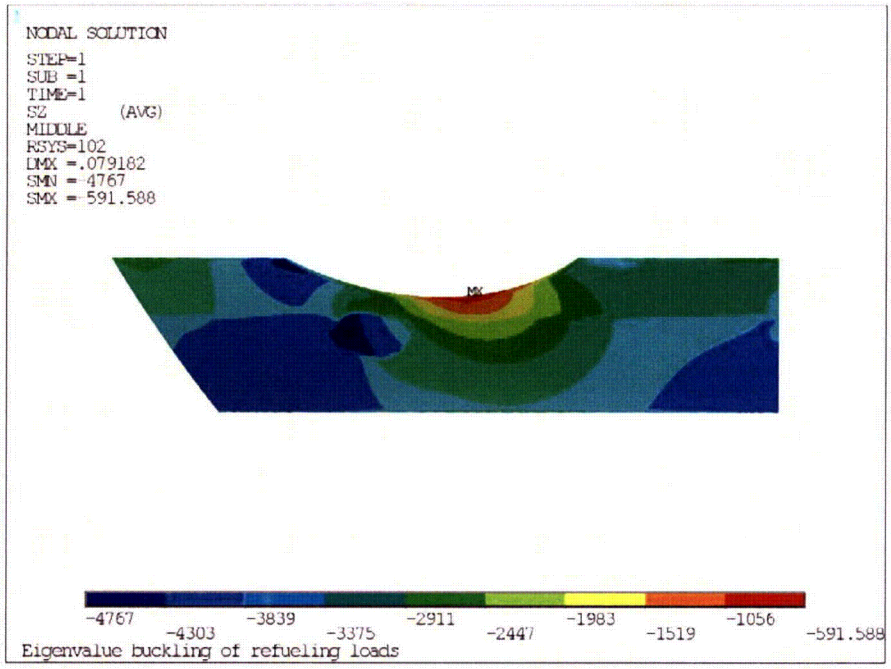



(a) Meridional Stress

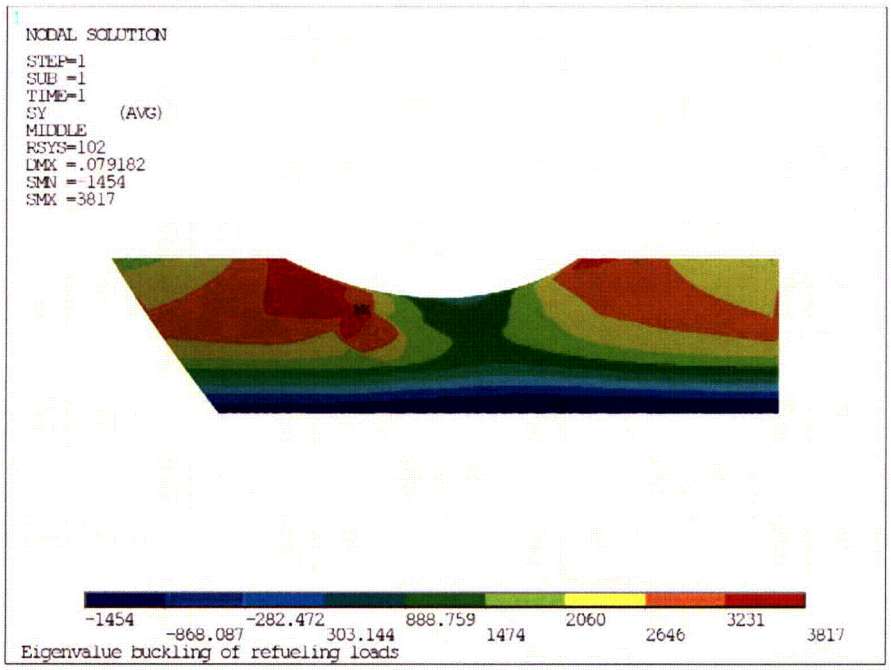



(b) Hoop Stress

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

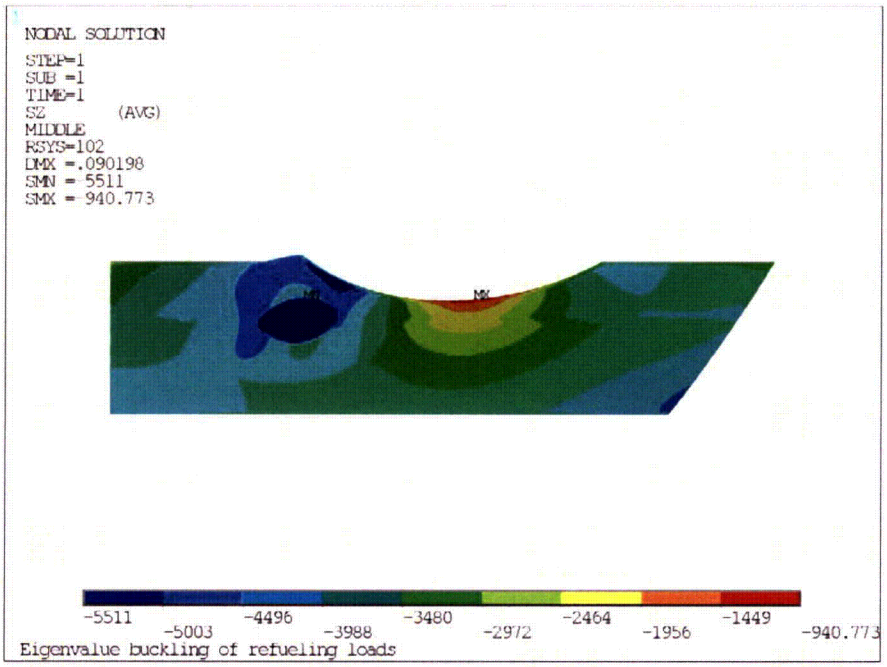



(a) Meridional Stress

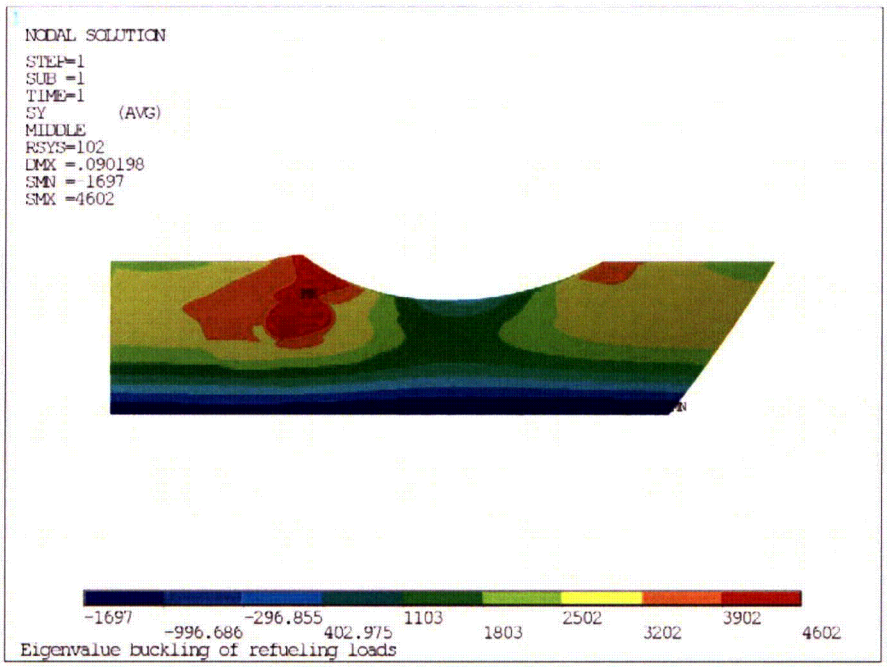



(b) Hoop Stress

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

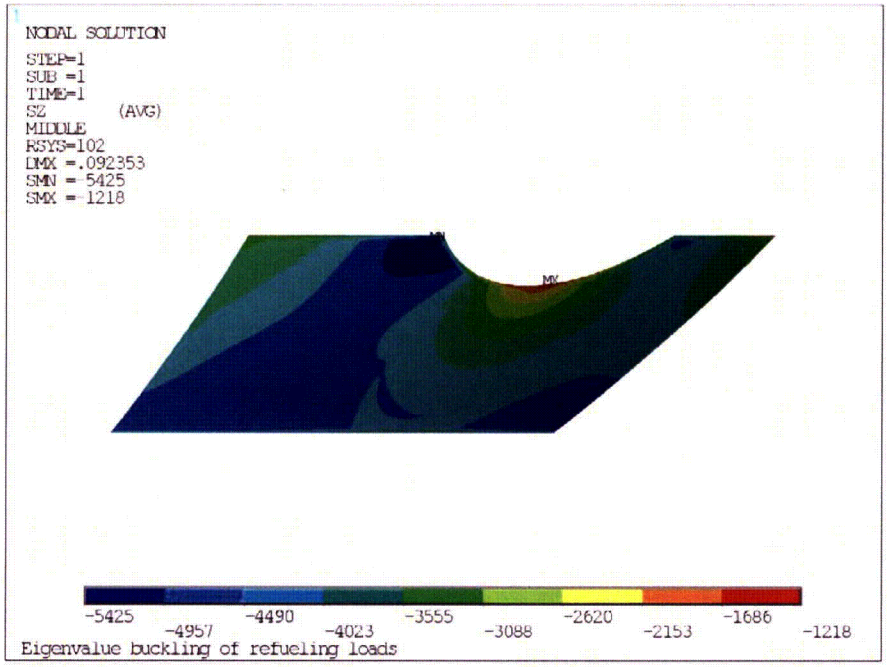



(a) Meridional Stress

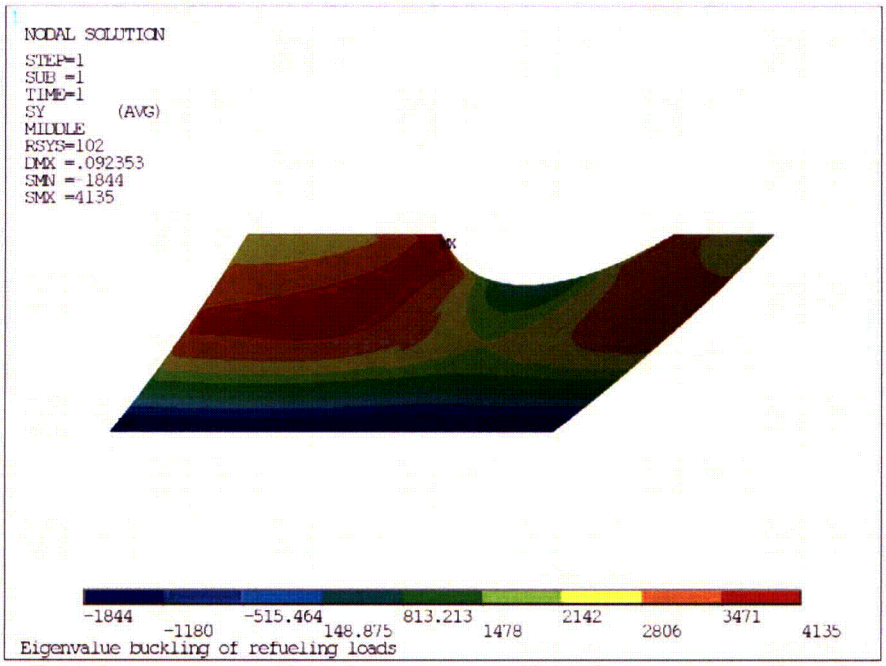



(b) Hoop Stress

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

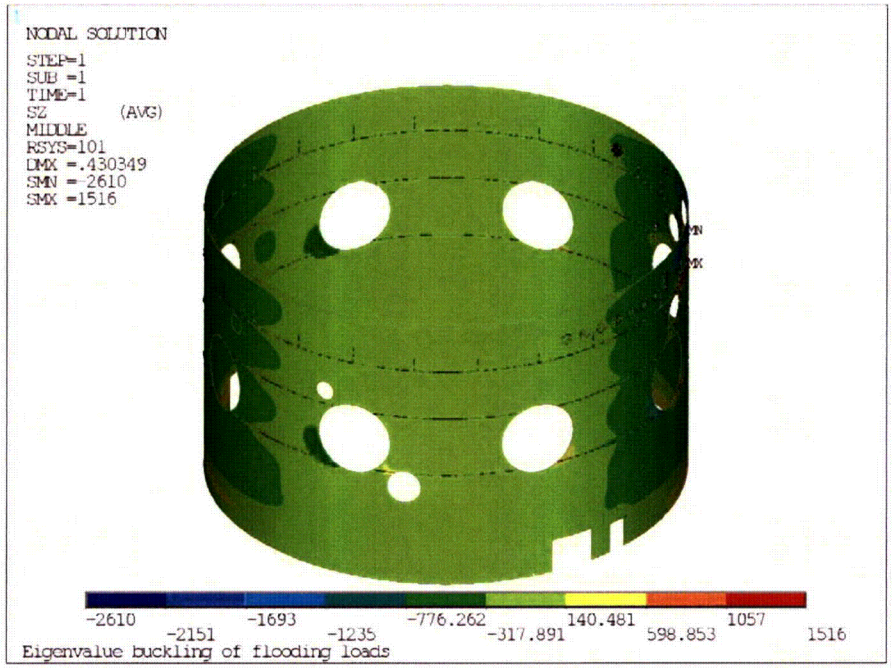



(a) Meridional Stress

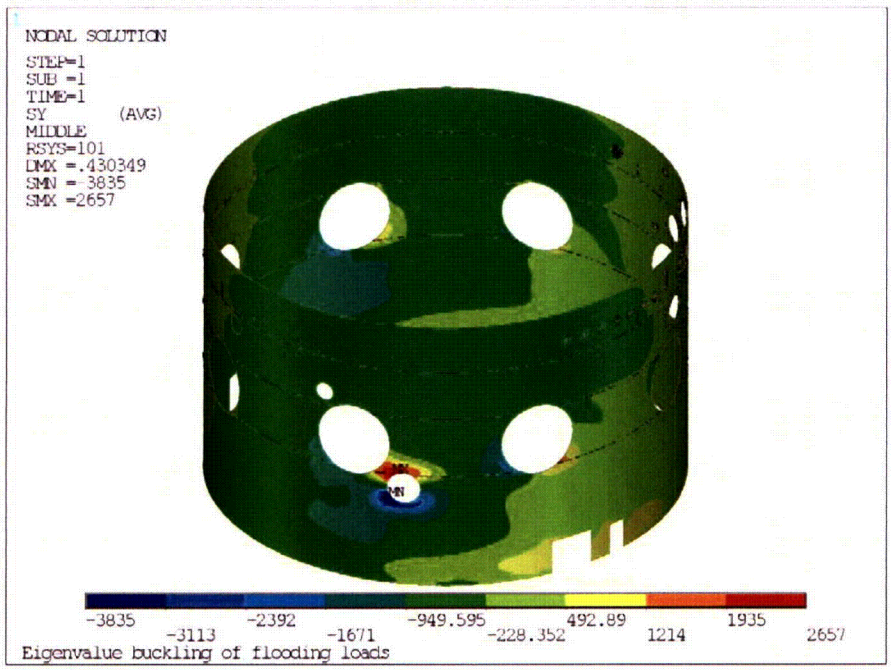



(b) Hoop Stress

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

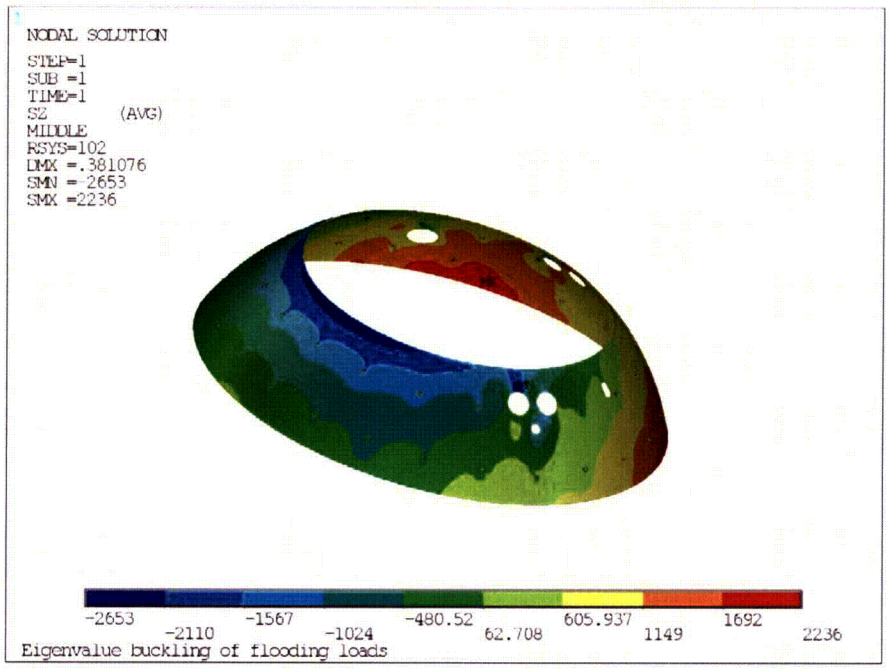



(a) Axial Stress

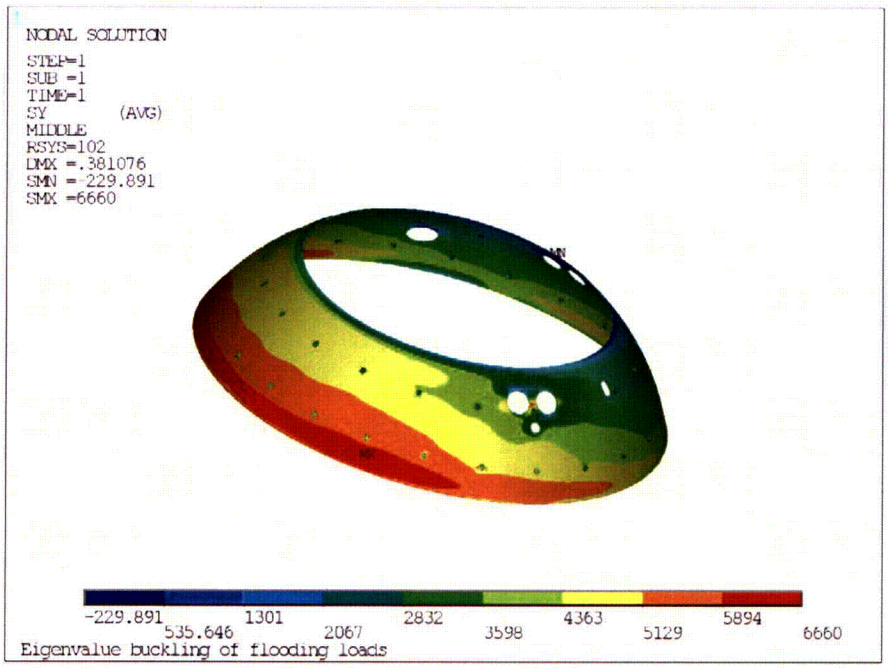



(b) Hoop Stress

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

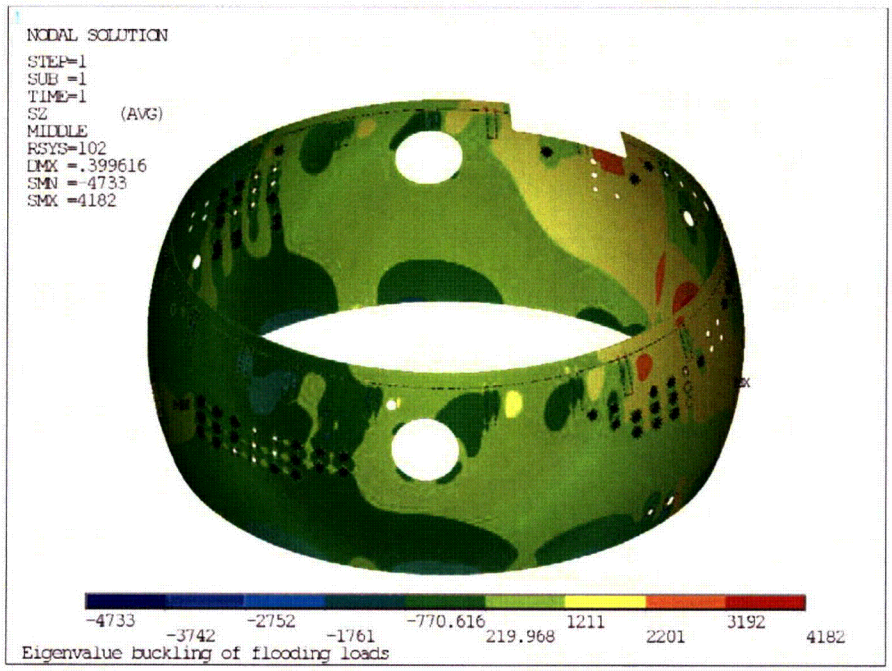



(a) Meridional Stress

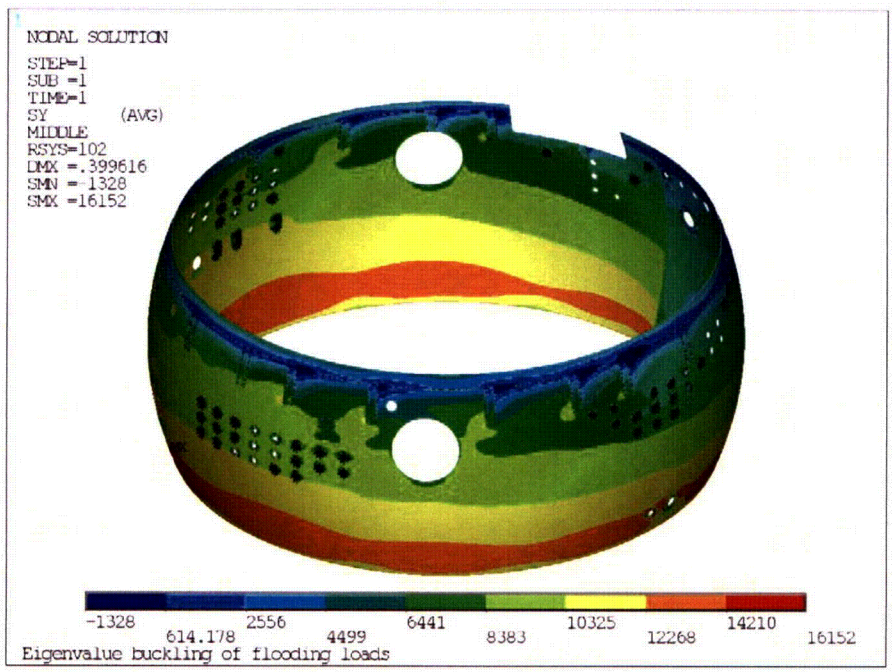



(b) Hoop Stress

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

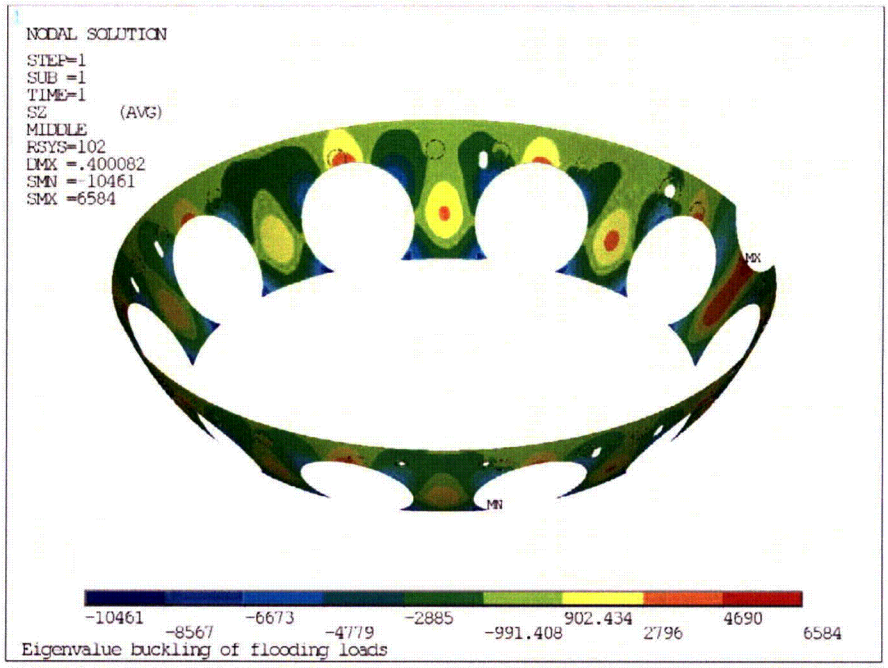



(a) Meridional Stress

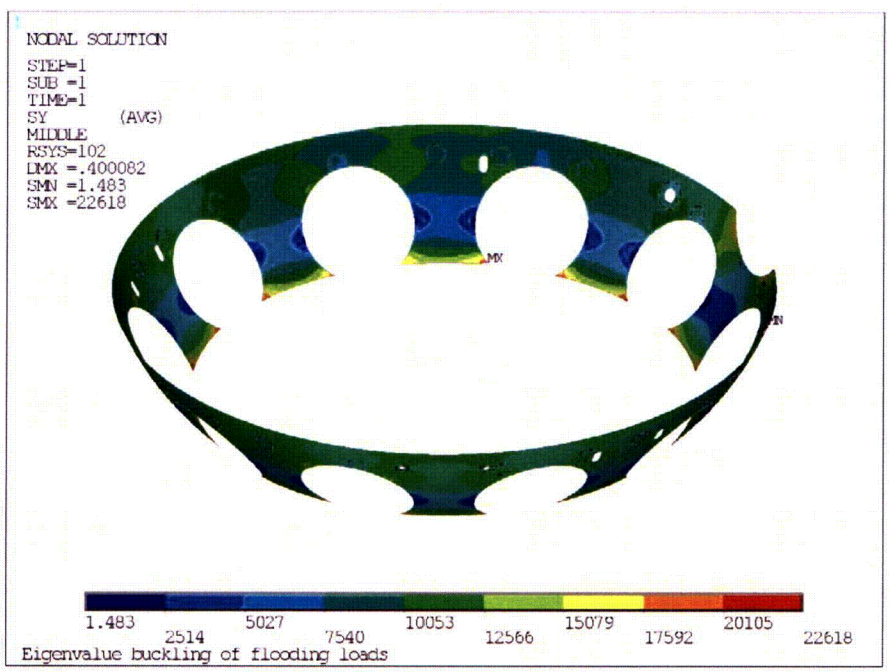



(b) Hoop Stress

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

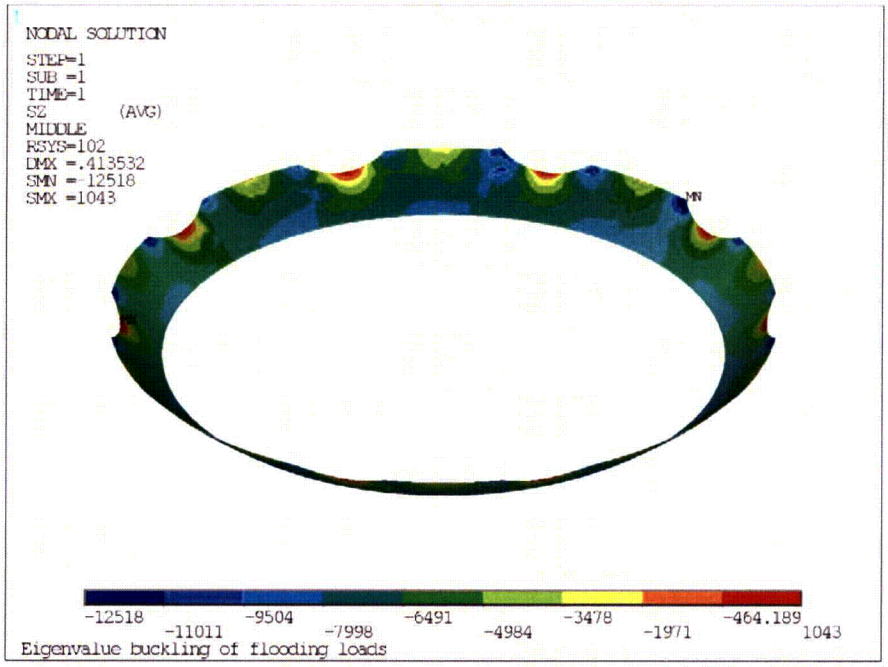



(a) Meridional Stress

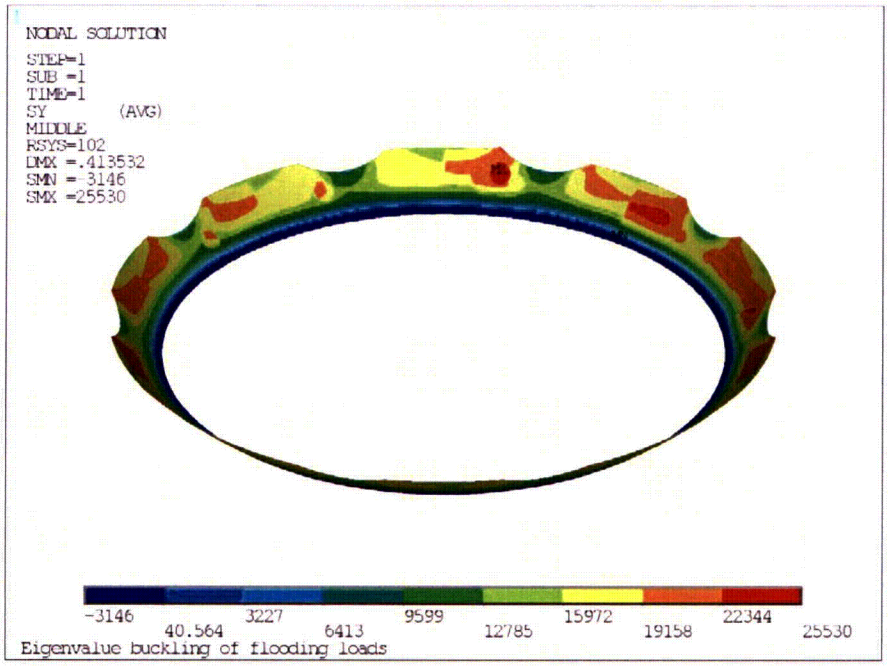



(b) Hoop Stress

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

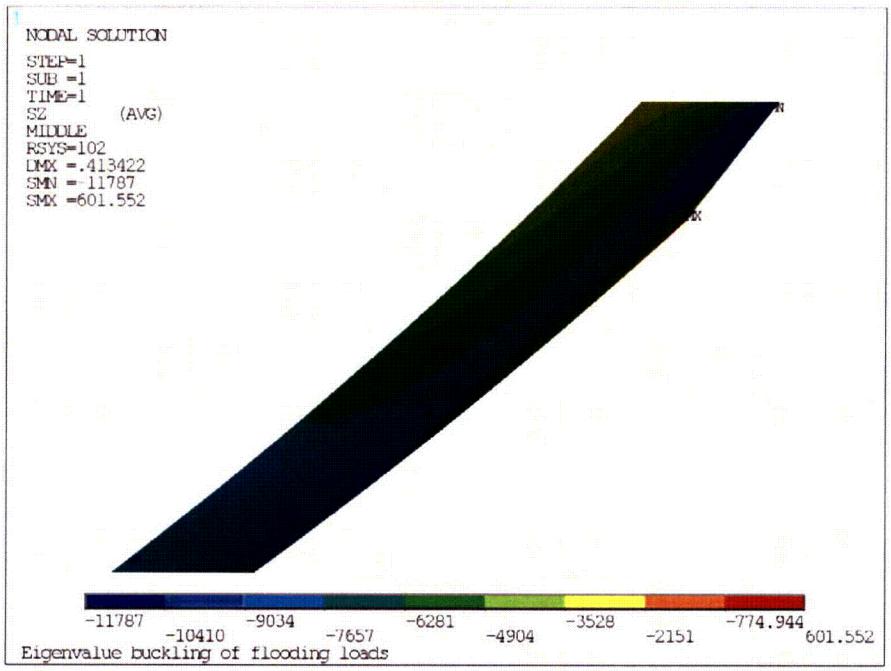



(a) Meridional

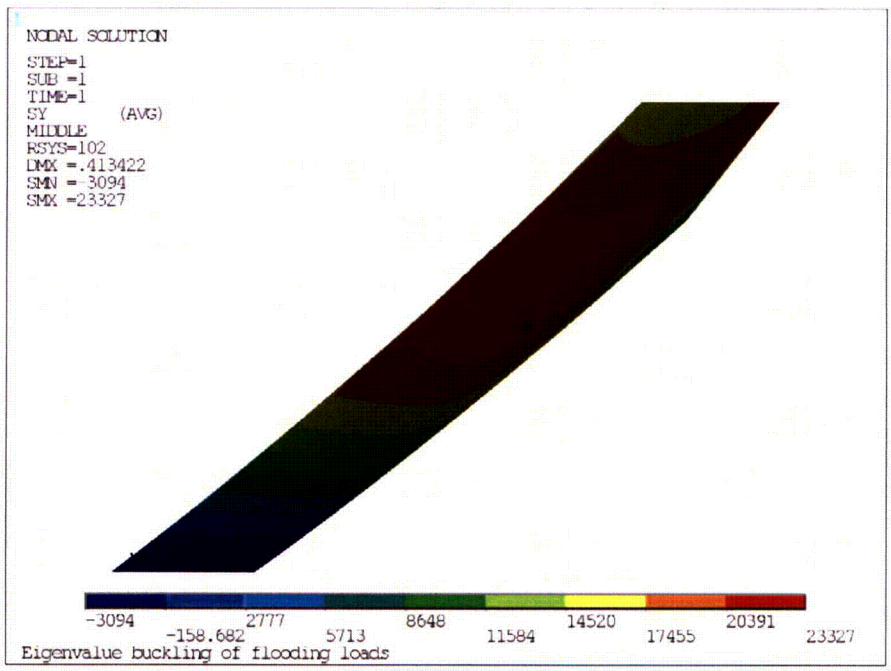



(b) Hoop Stress

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

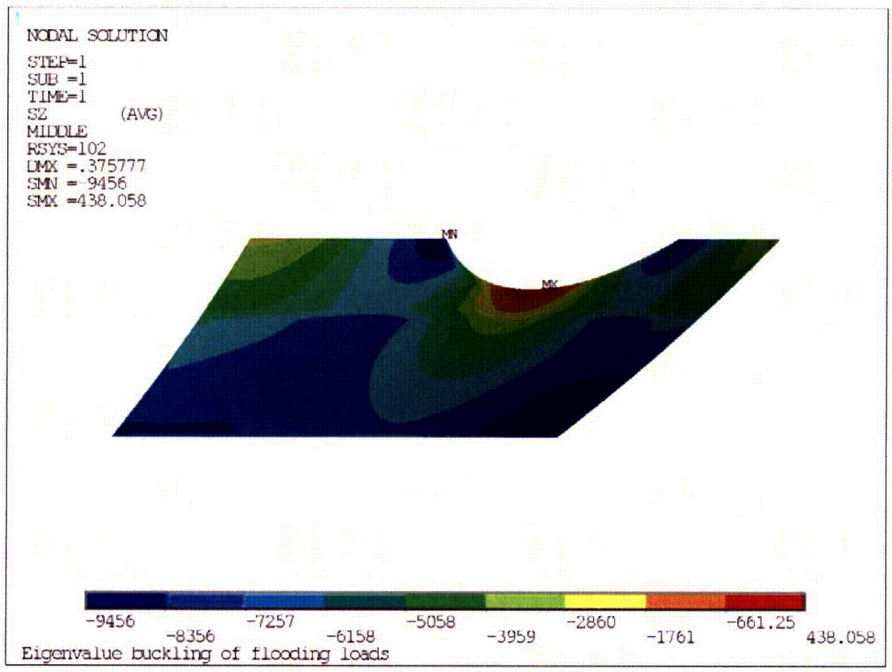



(a) Meridional Stress

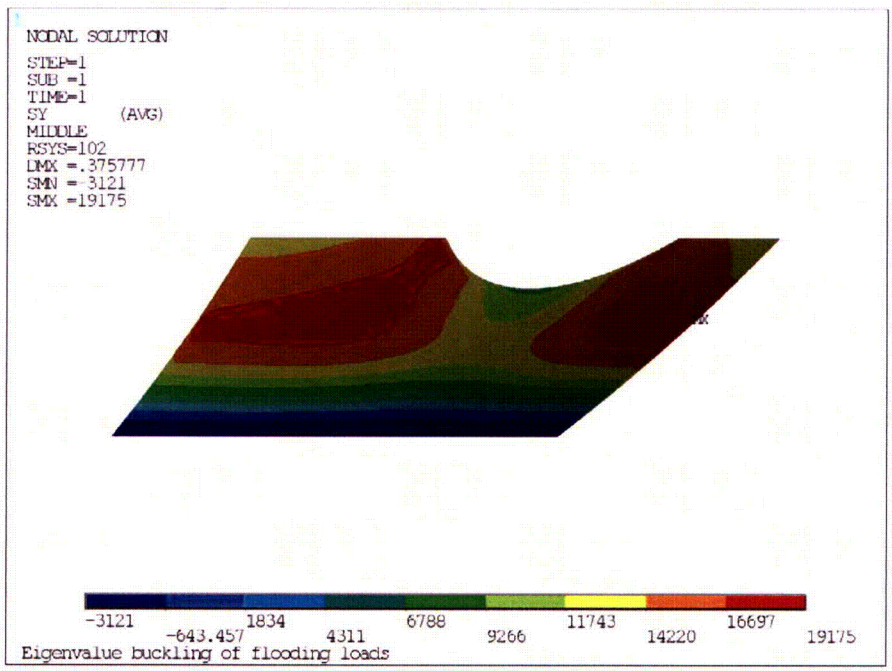



(b) Hoop Stress

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

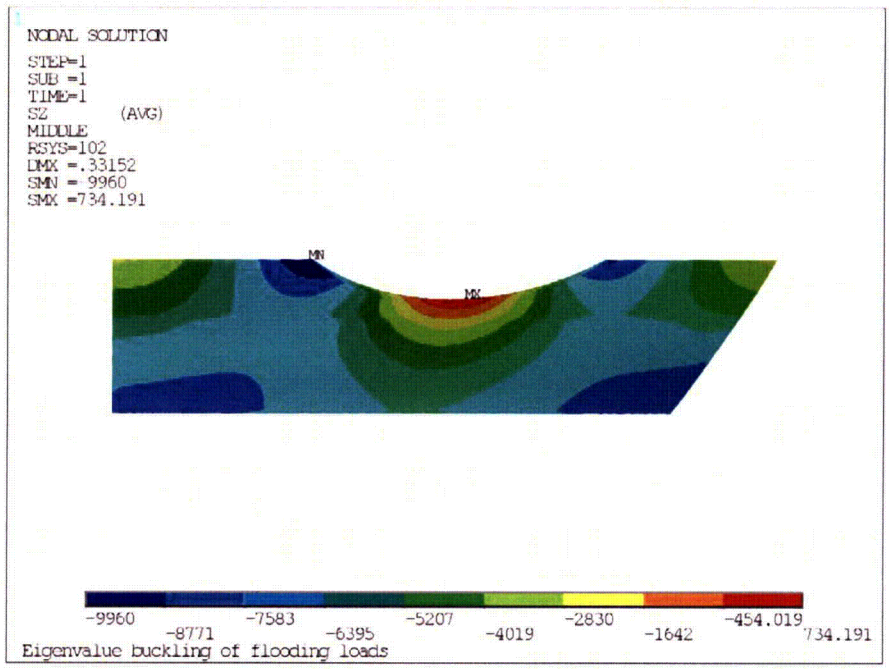



(a) Meridional Stress

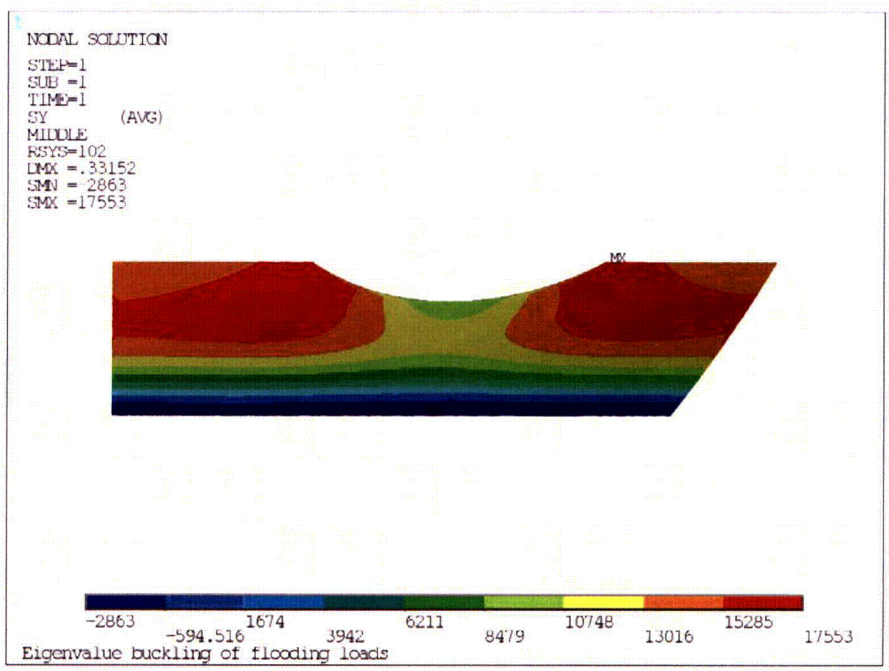



(b) Hoop Stress

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

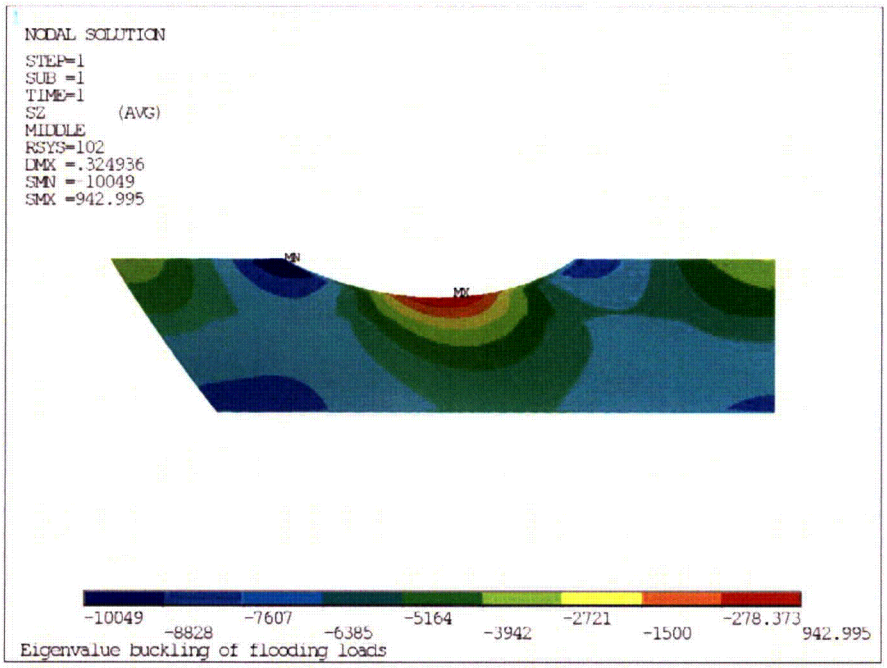



(a) Meridional Stress

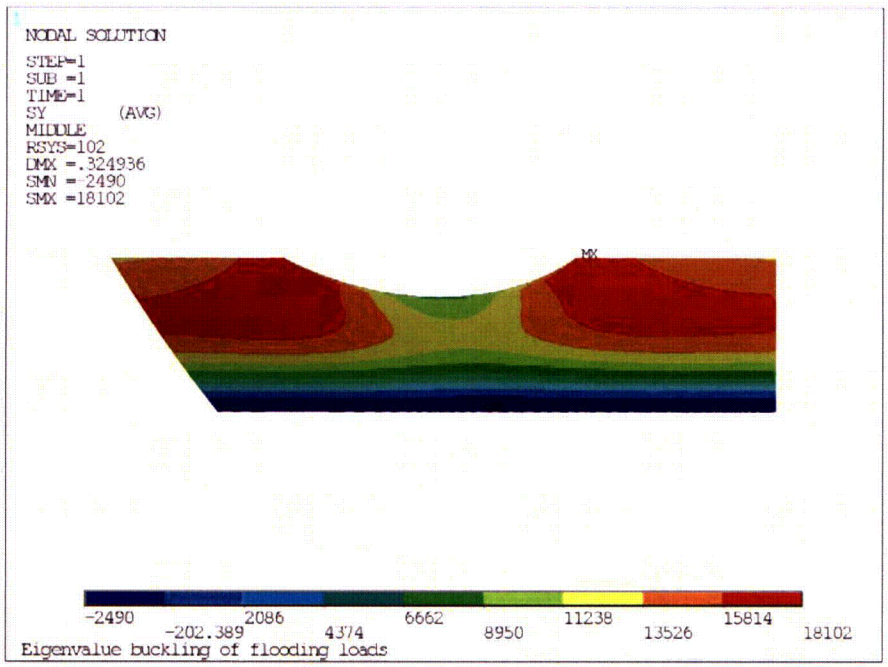



(b) Hoop Stress

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

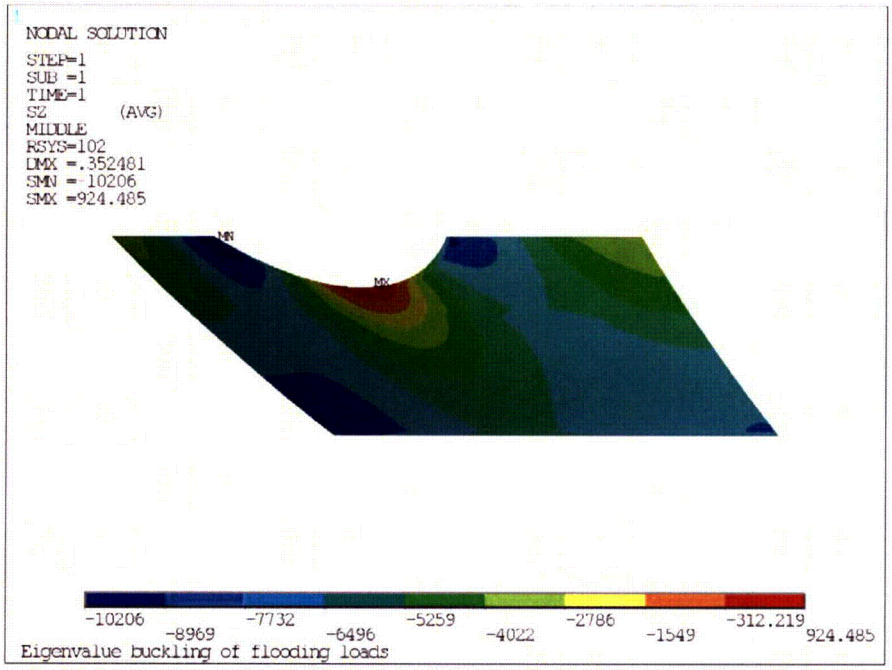



(a) Meridional Stress

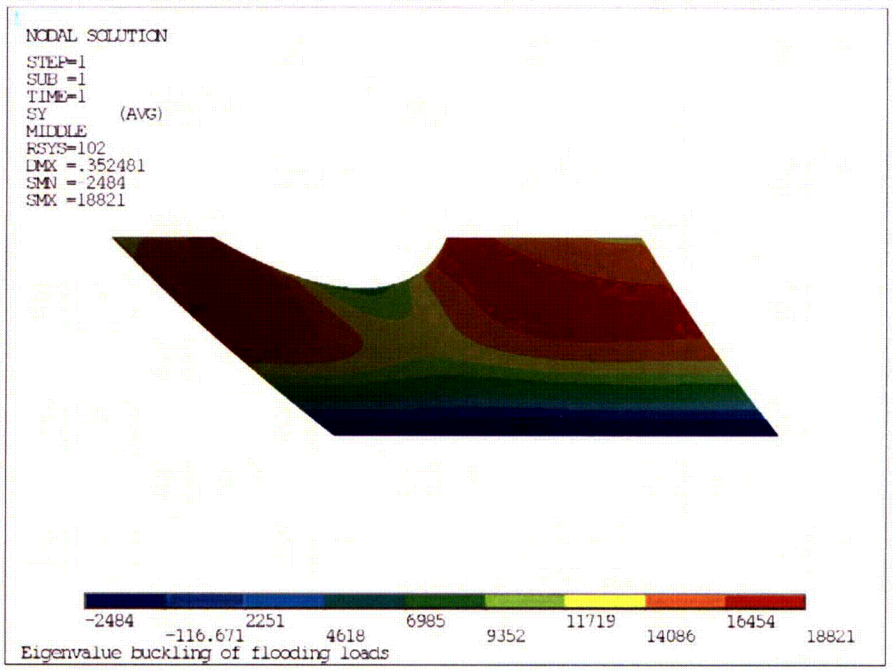



(b) Hoop Stress

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

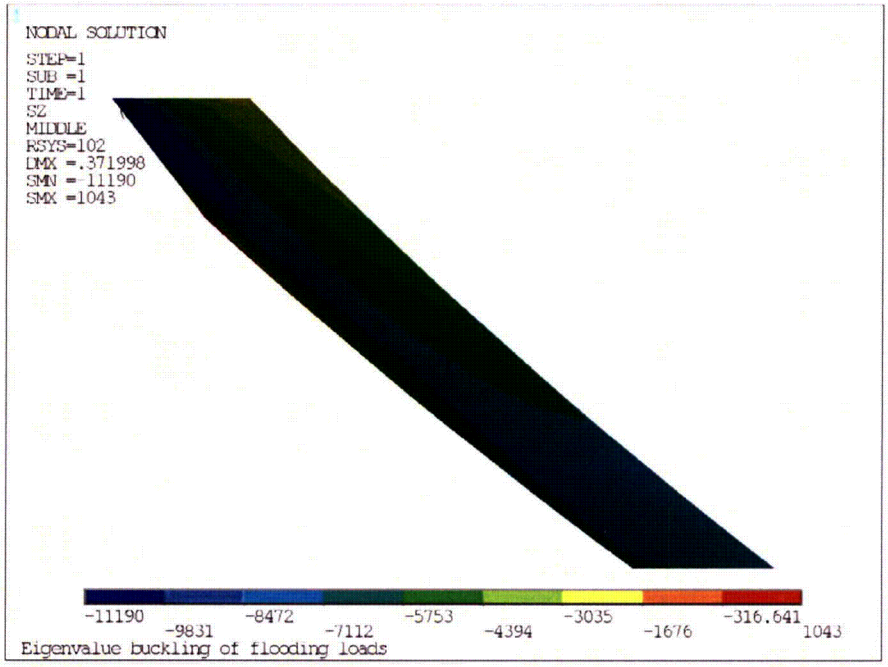



(a) Meridional Stress

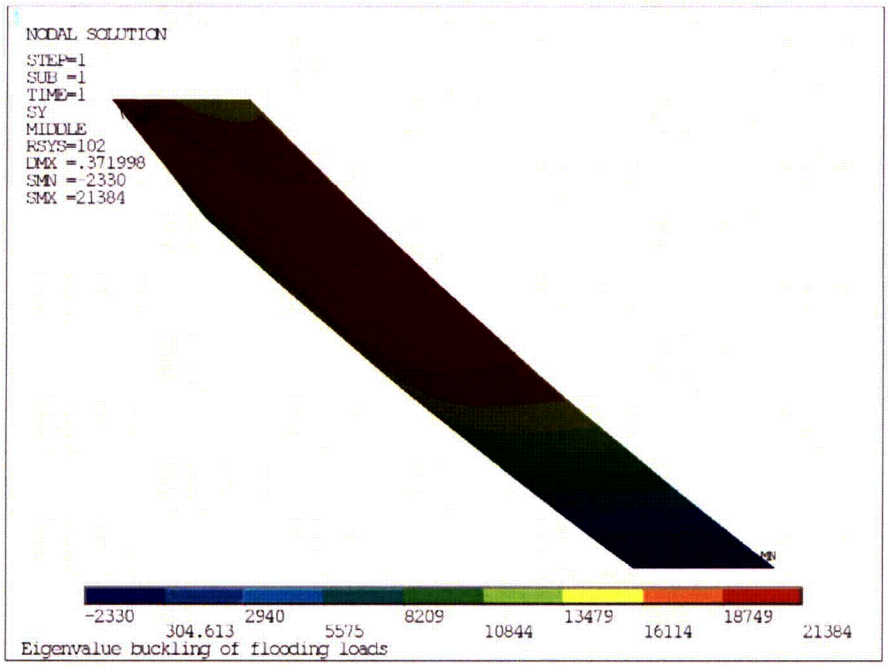



(b) Hoop Stress

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

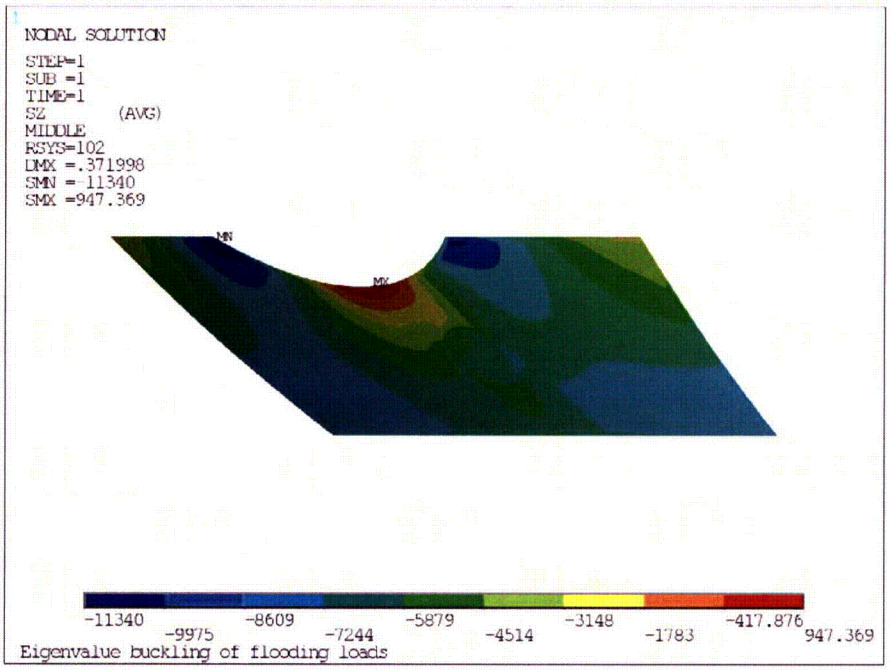



(a) Meridional Stress

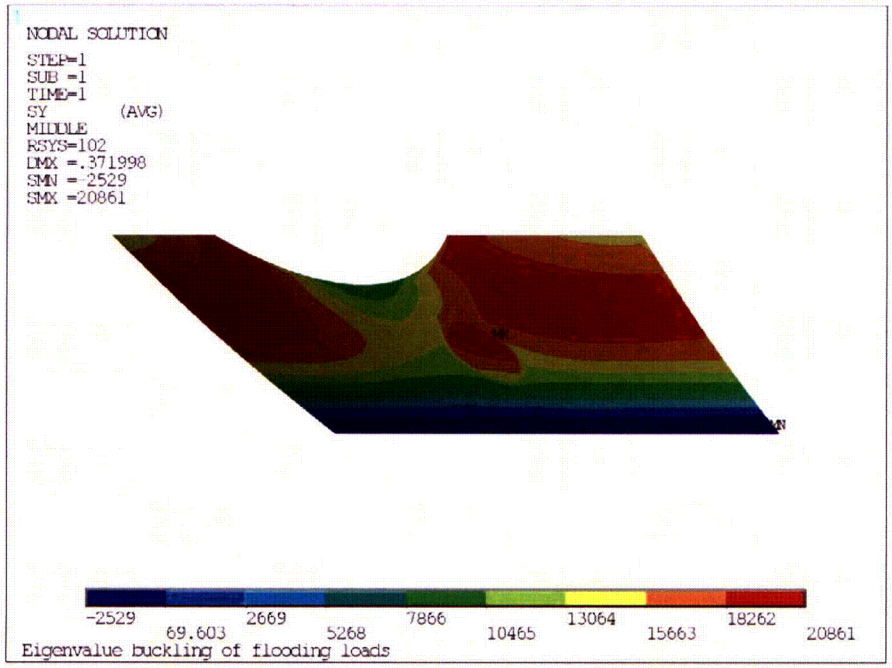



(b) Hoop Stress

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

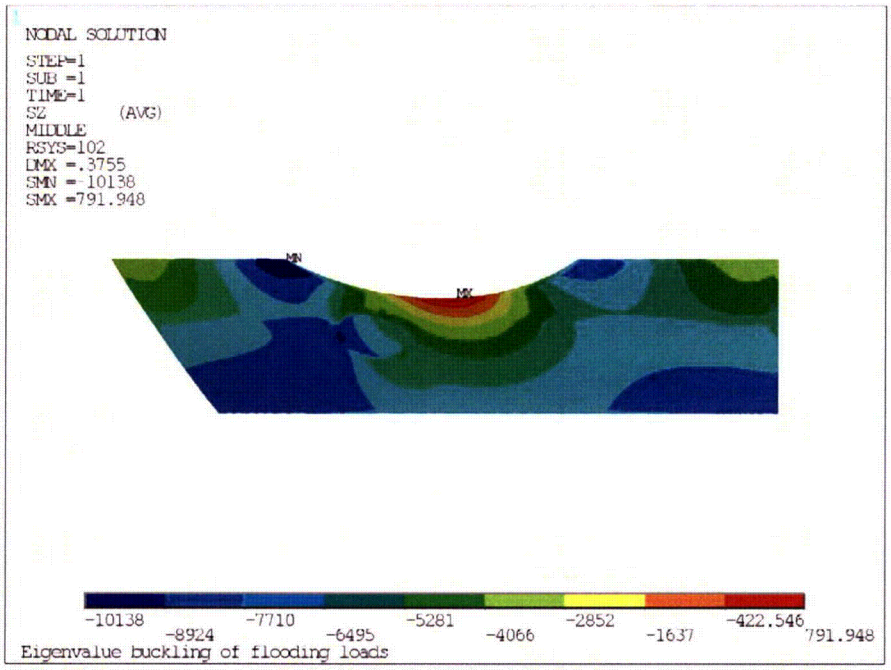



(a) Meridional Stress

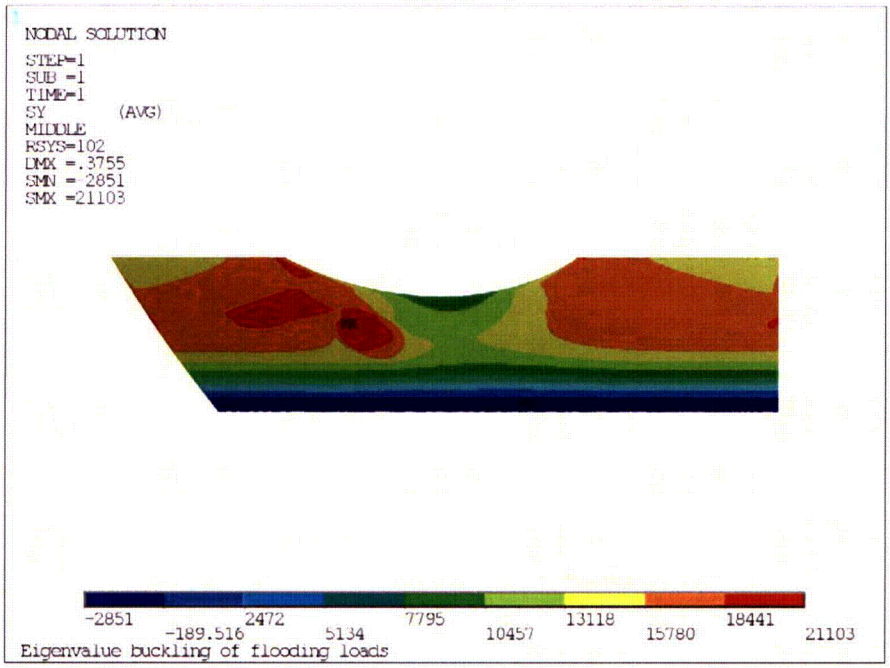



(b) Hoop Stress

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

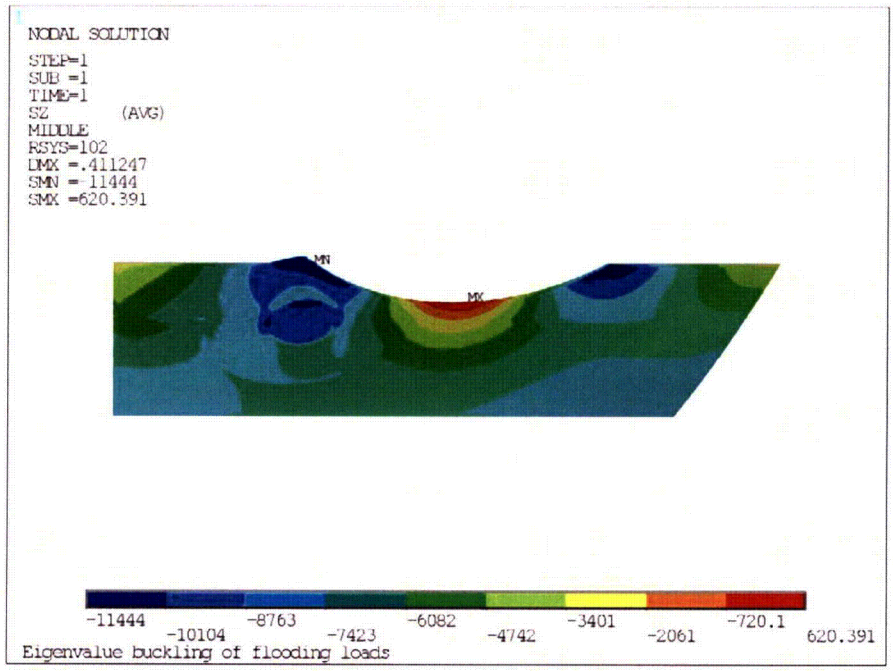



(a) Meridional Stress

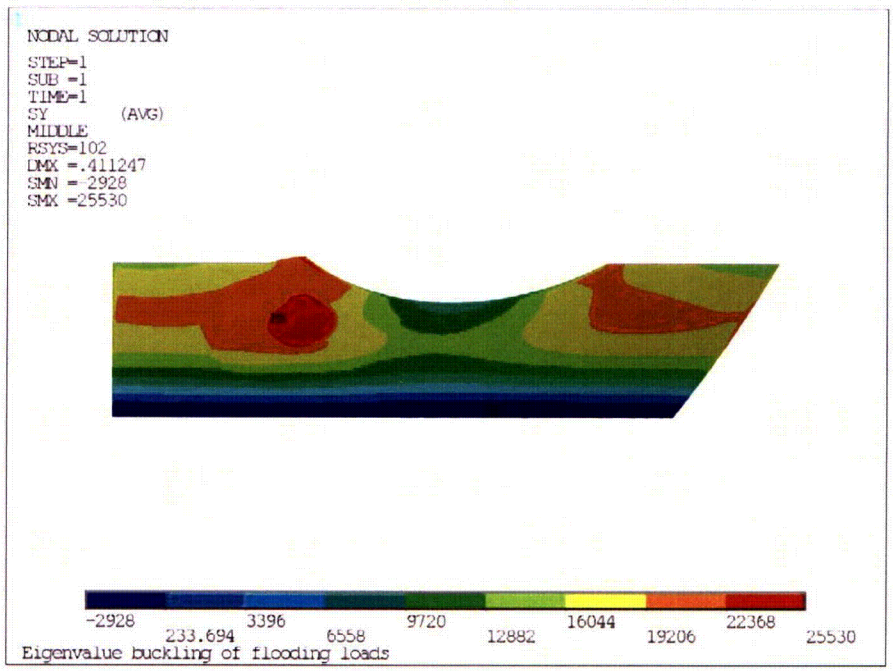



(b) Hoop Stress

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

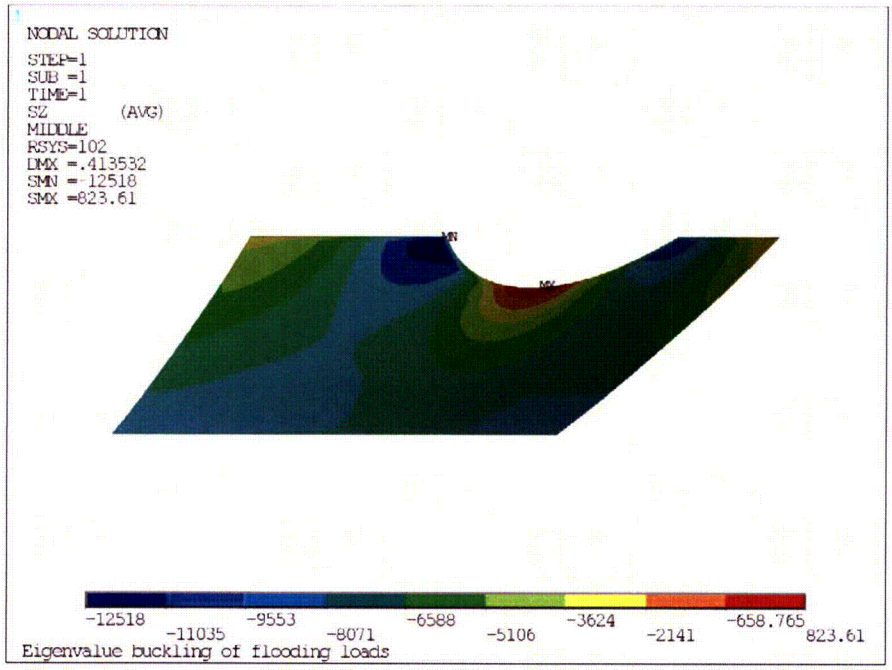



(a) Meridional Stress

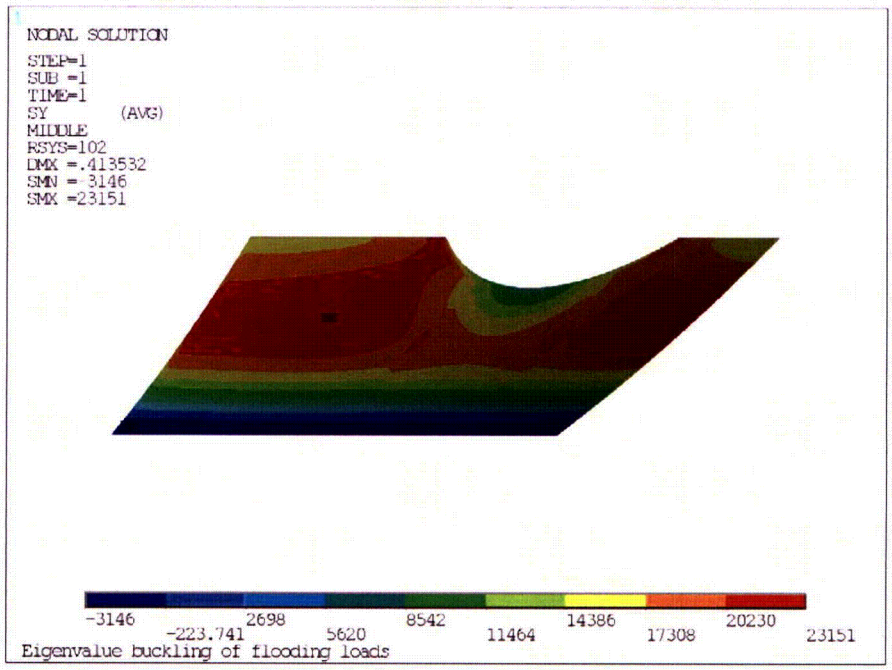



(b) Hoop Stress

**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.