ENCLOSURE 2

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Supplement 2

Shimizu Engineering Report SER-ESB-048, Rev. 0,

"Evaluation of Modeling Details for RBFB Stress and

Seismic Analyses" October 26, 2006

Shimizu Engineering Report

Project	General Electric Company ESBWR Project	Shimizu Document No.	SER-ESB-048
Title	Evaluation of Modeling Details for RBFB Stress and Seismic Analyses	Rev.	0
		Issued Date	10/26/06
		Revised Date	

NOTE:

This report describes the evaluation results for the effects of the modeling details regarding the following portions in the ESBWR Reactor Building/Fuel Building (RB/FB) analysis models.

(i) Spent Fuel Pool slab (Basemat) thickness

(ii) Cylindrical wall thickness under the Suppression Pool

(iii) Radial walls under the Suppression Pool

Effects on the stress analysis result by NASTRAN and the seismic analysis result by SASSI were studied.

This study was performed to address to NRC's comment on the truncated model for confirmatory analysis.

Rev.	Date	Note	Approve	Review	Prepare
0	10/26/06	Initial Issue	Y. O.	N. M.	T. T.

Shimizu Corporation	Prepared by	T. Toyota	10/26/06
	Reviewed by	N. Miura	10/26/06
	Approved by	Y. Orito	10/26/06

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1. Scope

This report describes the evaluation results for the effects of the modeling details regarding the following portions in the ESBWR Reactor Building/Fuel Building (RB/FB) analysis models.

(i) Spent Fuel Pool slab (Basemat) thickness

(ii) Cylindrical wall thickness under the Suppression Pool

(iii) Radial walls under the Suppression Pool

Effects on the stress analysis result by NASTRAN and the seismic analysis result by SASSI were studied.

This study was performed to address to NRC's comment on the truncated model for confirmatory analysis.

2. Reference

1. SER-ESB-027 "Reactor Building/Fuel Buildings Truncated FE Model Analysis Data," Rev. 1
2. SER-ESB-038 "Modified RBFB Truncated FE Model Analysis Data," Rev. 3
3. SER-ESB-033 "Parametric Evaluation of Effects on SSI Response," Rev. 0

3. NASTRAN Analysis

3.1 Analysis Models

The following three models were prepared. Their differences are summarized in Table 3-1.

- Original Truncated Model (Figure 3-1):
  Partial model of the RB/FB global FE analysis model used for the design in DCD, Rev. 1. This model includes the basemat and walls up to EL -8700. Analysis data of this model is contained in Reference 1.
- Modified Truncated Model (Figure 3-3):
  Analysis model used for NRC's confirmatory analyses. Modeled region is the same as "Original Truncated Model." However, modification was made for the items (i) through (iii) above, as shown in Table 3-1 and Figure 3-2. Analysis data of this model is contained in Reference 2.

- Extended Truncated Model (Figure 3-4):
  In order to represent the constraint effects of radial walls to the basemat and the main walls more realistically, the following modifications were made to the "Modified Truncated Model."
  - Radial walls are modeled to their top levels.
  - Floor slabs supported by these radial walls are also included to consider their effects to the radial wall stiffness.
  - The cylindrical inner wall and cylindrical wall below the RCCV are also extended to B1F level.

3.2 Load

Analyses were performed for the Dead Load and Seismic Load, which are dominant loads for the basemat design. Each load contains the following components.

- Dead Load: Boundary Force + Self Weight + Hydrostatic
- Seismic Load: 0.4*NS + 1.0*WE - 0.4*V

As for the load application method, refer to Reference 2.

3.3 Analysis Results

Element forces in the basemat and cylindrical wall below the RCCV of the above three models are compared.

Figures 3-5 through 3-16 show the contours of bending moments in the basemat. Figures 3-18 through 3-29 show the distributions of bending moments in the basemat at the section shown in Figure 3-17.

Figure 3-30 through 3-38 show the contours of membrane forces and tangential shear forces in the cylindrical wall below the RCCV. Figures 3-39 through 3-41 show the distributions of membrane forces and tangential shear forces in the bottom elements of the cylindrical wall below the RCCV.

The results can be summarized as follows.

- Bending moments in the basemat obtained by the "Original Truncated Model" analyses are generally larger than those obtained by other model analyses including the regions close to the thickened cylindrical wall (item (ii)) and radial walls

(item (iii)). However, as for moment in the Spent Fuel Pool slab (item (i)), the results of "Original Truncated Model" analyses are less than other analysis results.

- Section forces in the cylindrical wall below the RCCV obtained by the "Original Truncated Model" analyses are generally larger than those obtained by other model analyses.

3.4 Conclusions

For item (i), the Spent Fuel Pool slab thickness shall be increased in the design basis NASTRAN model to its actual thickness, 5.5 m, to avoid the underestimation of section forces.

For items (ii) and (iii), the "Original Truncated Model," which represents the current design basis NASTRAN model, can conservatively evaluate the section forces and moments in the basemat and the cylindrical wall below the RCCV in the regions close to the thickened cylindrical wall and radial walls. Therefore, items (ii) and (iii) need not be incorporated into the design basis NASTARN model.

4. SASSI Analysis

4.1 Analysis Model

To address potential impact on the seismic stick model, the effect of thicker Spent Fuel Pool base slab (item (i)) is analyzed using SASSI model. The cylindrical wall under S/P (item (ii)) and radial walls under S/P (item (iii)) are not considered as seismic shear walls since they are not connected to the RCCV wall nor RPV pedestal wall through normal rigid slabs, thus contributing little to the overall stiffness of the existing RCCV wall and RPV pedestal sticks.

Figure 4-1 shows the design basis SASSI analysis model used for the RBFB soil-structure interaction analysis including the Spent Fuel Pool slab, in which the entire basemat is modeled as a plate of 4.0 m uniform thickness as described in Reference 3.

To evaluate the effect of the Spent Fuel Pool slab thickness on the seismic analysis results, an analysis was performed using a model in which the Spent Fuel Pool slab thickness is increased to 5.5 m (shaded area in Figure 4-1).

4.2 Analysis Results

Figures 4-3 through 4-11 compare the Floor Response Spectra (FRS) at the locations shown in Figure 4-2. Results compare well between two models.

4.3 Conclusions

The local thickening of the basemat in the Spent Fuel Pool region has no effect on the seismic response using the design basis seismic model.

Table 3-1 Comparison of NASTRAN Analysis Models

	(i)	(ii)	(iii)
	Spent Fuel Pool slab thickness	Cylindrical wall thickness under the Suppression Pool	Radial walls under the Suppression Pool
Original Truncated Model	4.0 m	0.6 m (south side) 0.6 m (north side)	No wall is modeled
Modified Truncated Model	5.5 m	0.6 m (south side) 1.4 m (north side)	All walls are modeled. (up to EL -8700)
Extended Truncated Model	5.5 m	0.6 m (south side) 1.4 m (north side)	All walls are modeled. (up to their top levels)
Actual Structure (Refer to Figure 3-2)	5.5 m	0.6 m (south side) 1.4 m (north side)	Total 10 walls

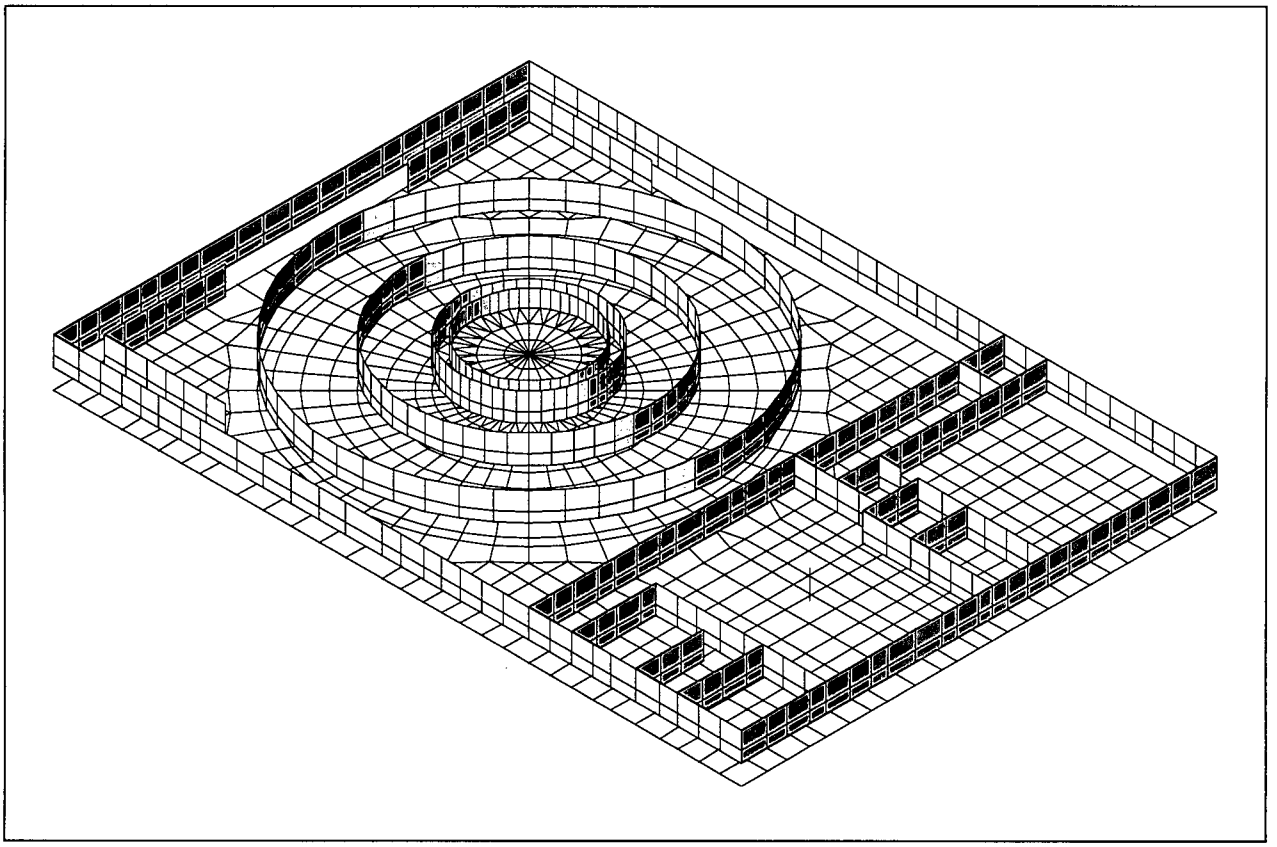
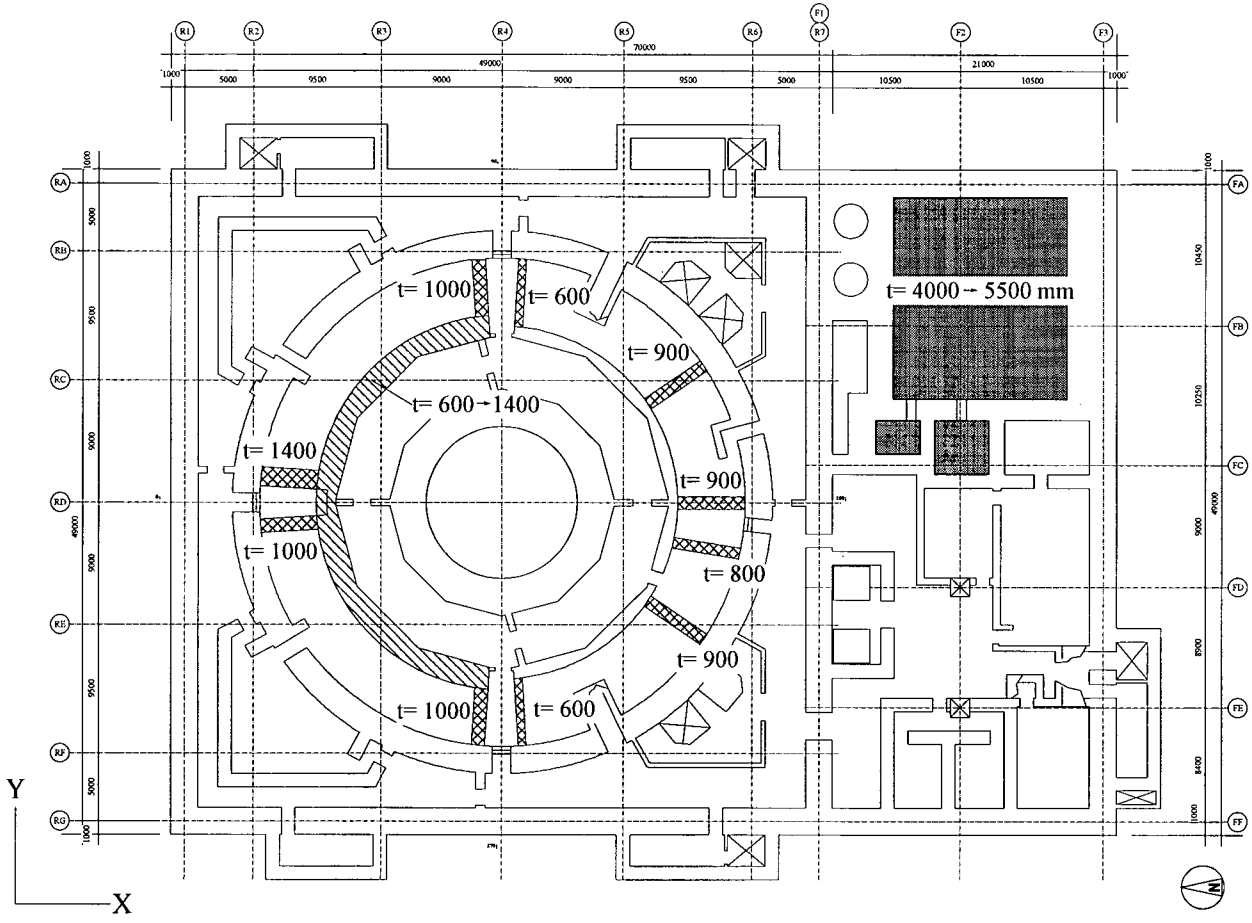


Figure 3-1 Original Truncated Model



:Spent Fuel Pool slab (basemat) thickness increase
:Thickness of half north of Cylindrical Walls under S/P increase
:Addition of Radial Walls under S/P

Figure 3-2 Modification in Truncated Model

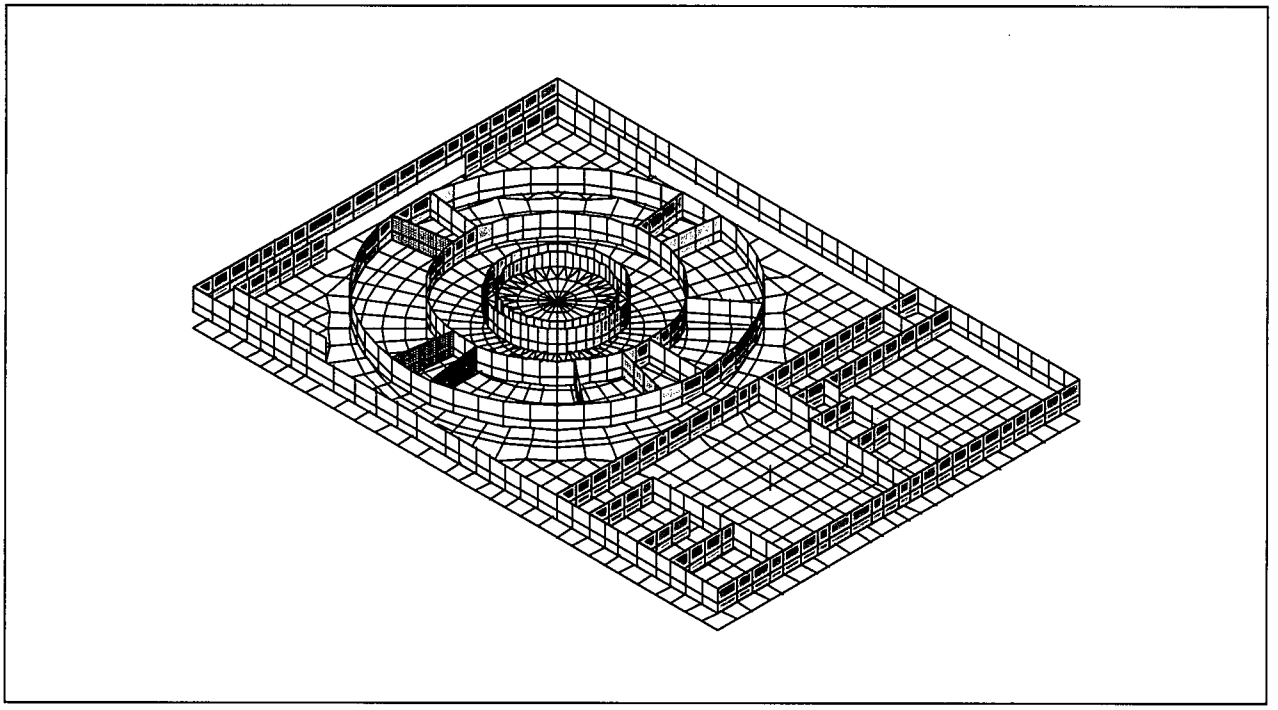
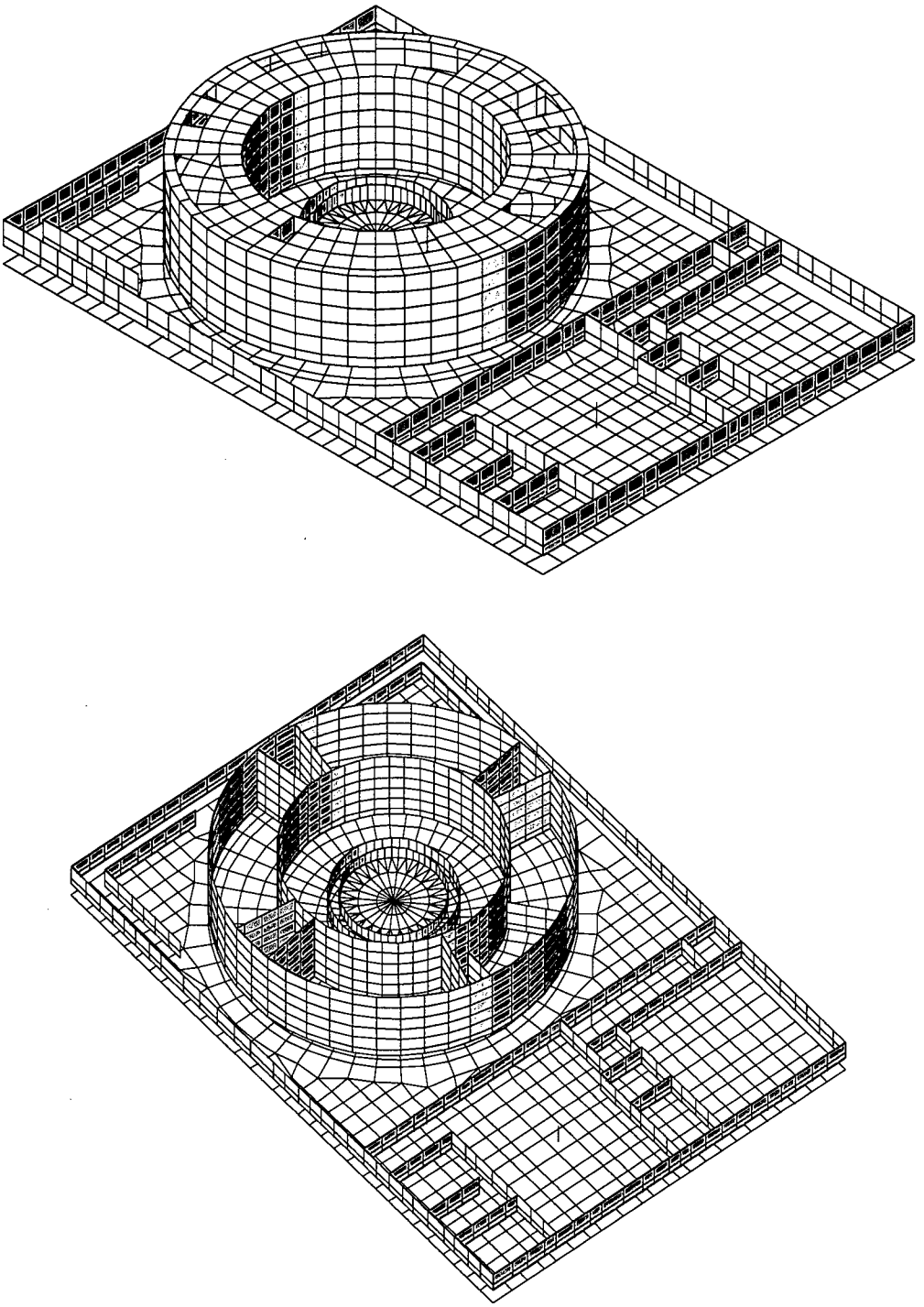
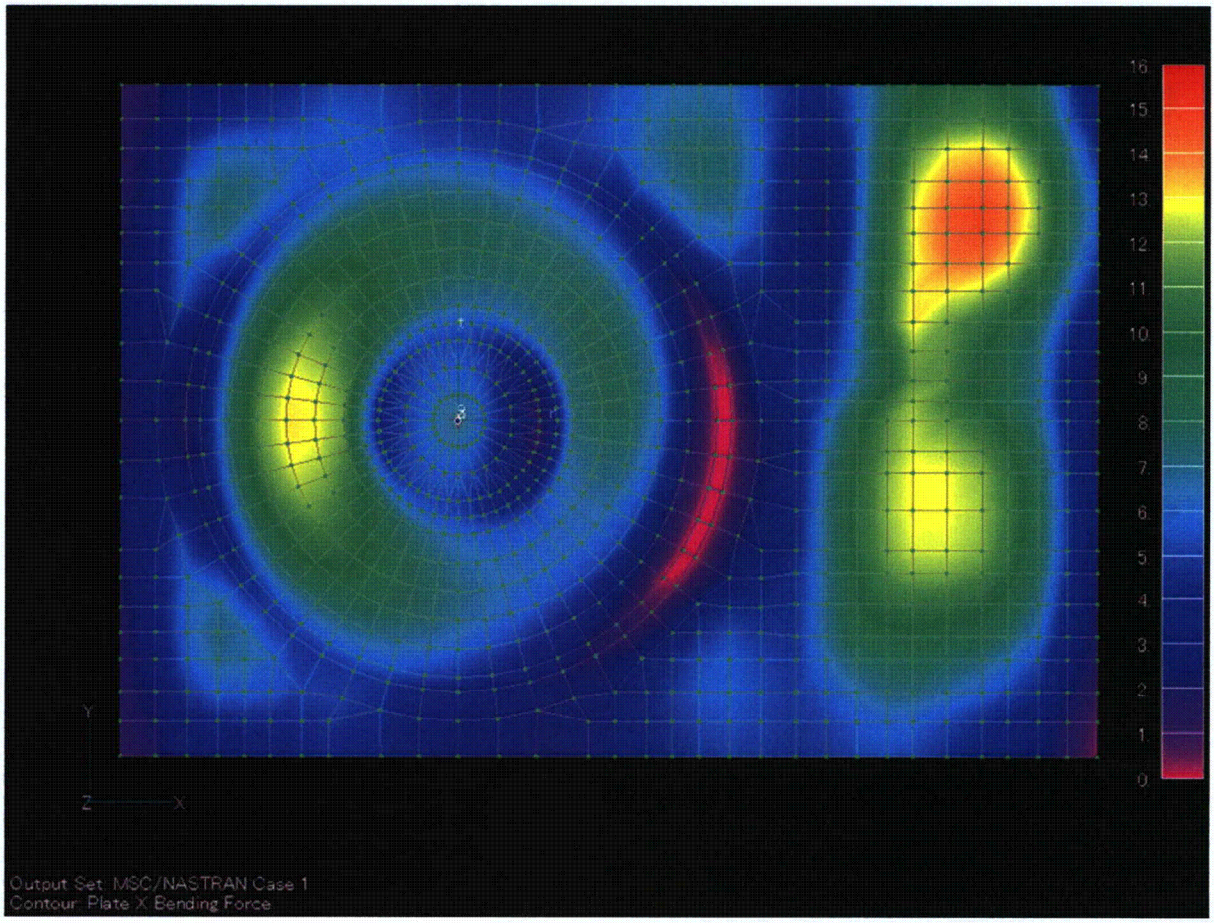


Figure 3-3 Modified Truncated Model



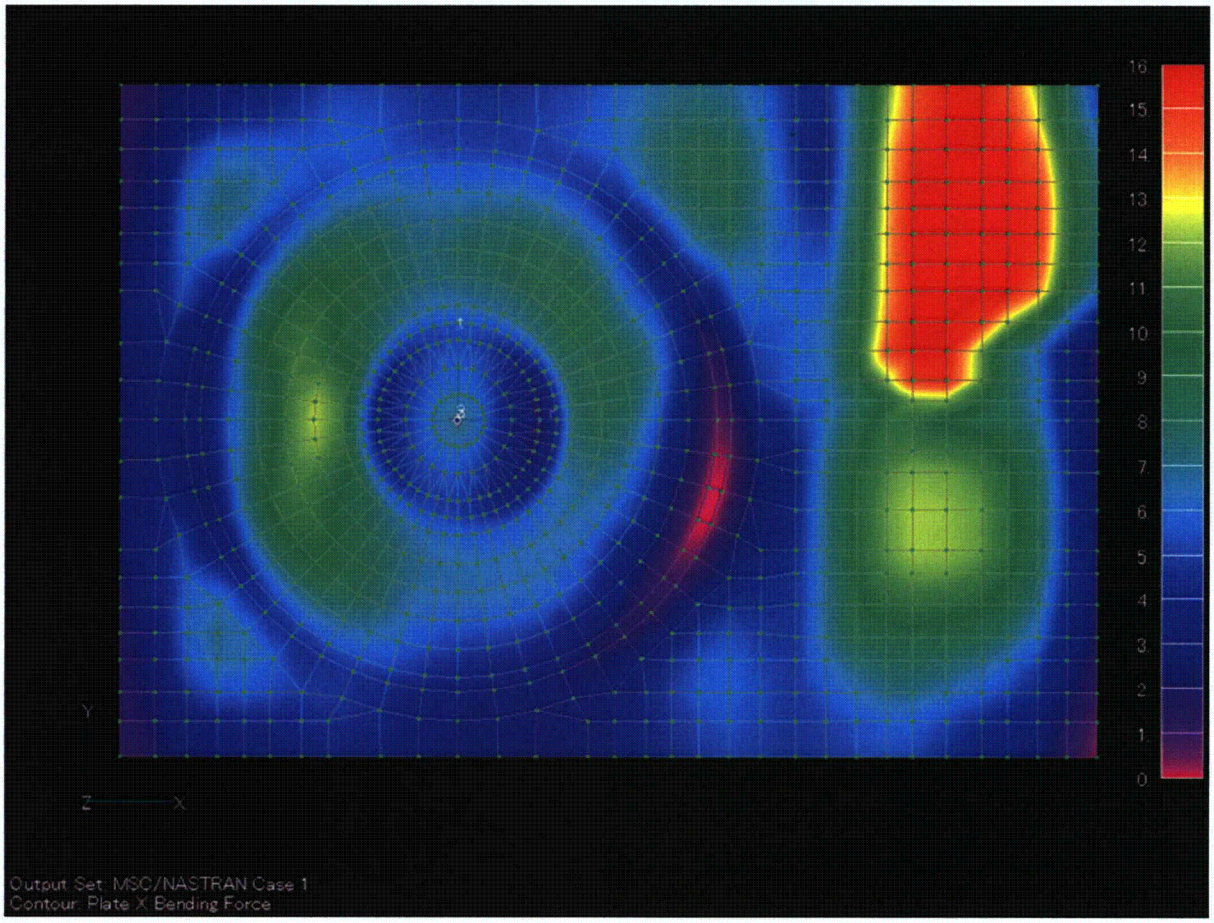
Floor Slabs are not shown to indicate the layout of radial walls

Figure 3-4 Extended Truncated Model



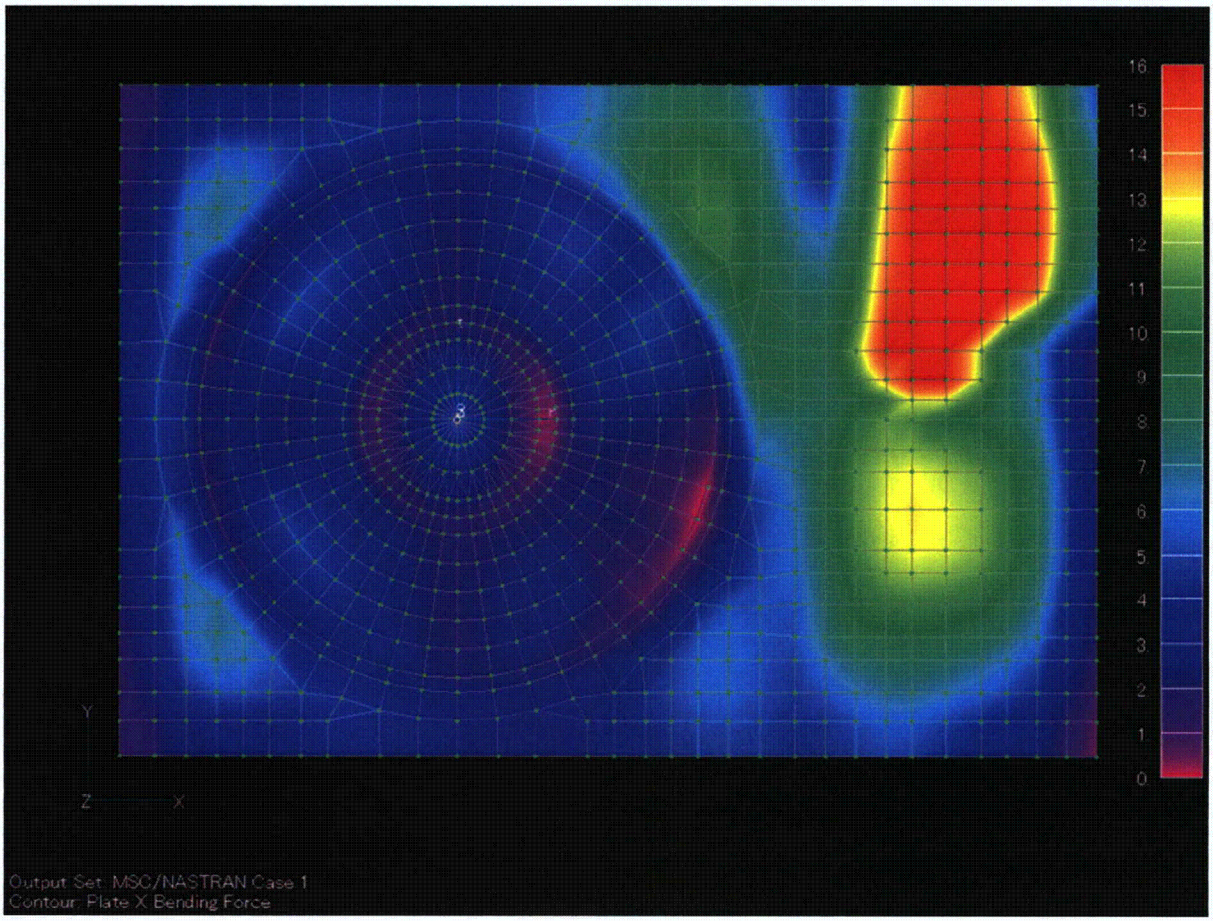
Unit: MN•m/m

Figure 3-5 Contour of Bending Moment in Basemat: Original Truncated Model (Dead Load: Mx)



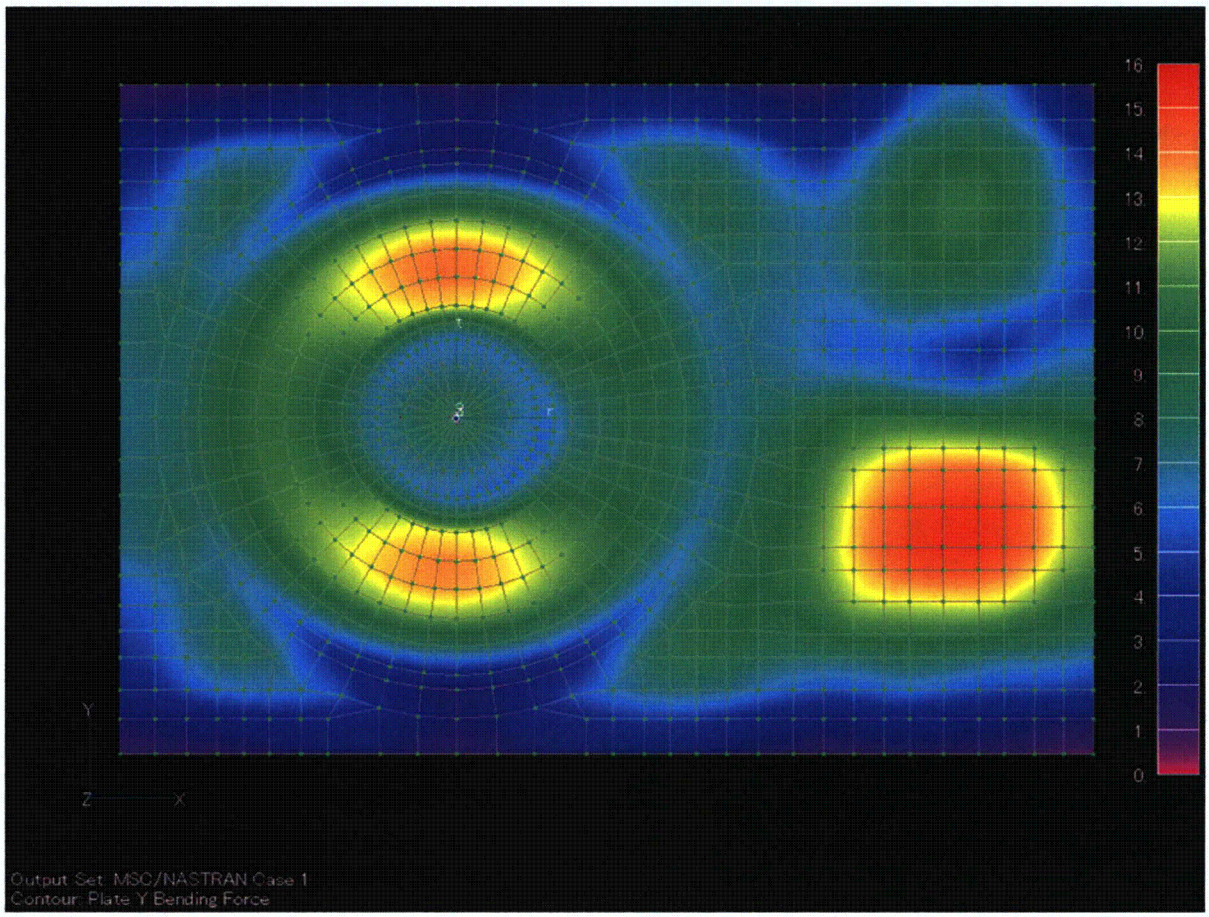
Unit: MN•m/m

Figure 3-6 Contour of Bending Moment in Basemat: Modified Truncated Model (Dead Load: Mx)



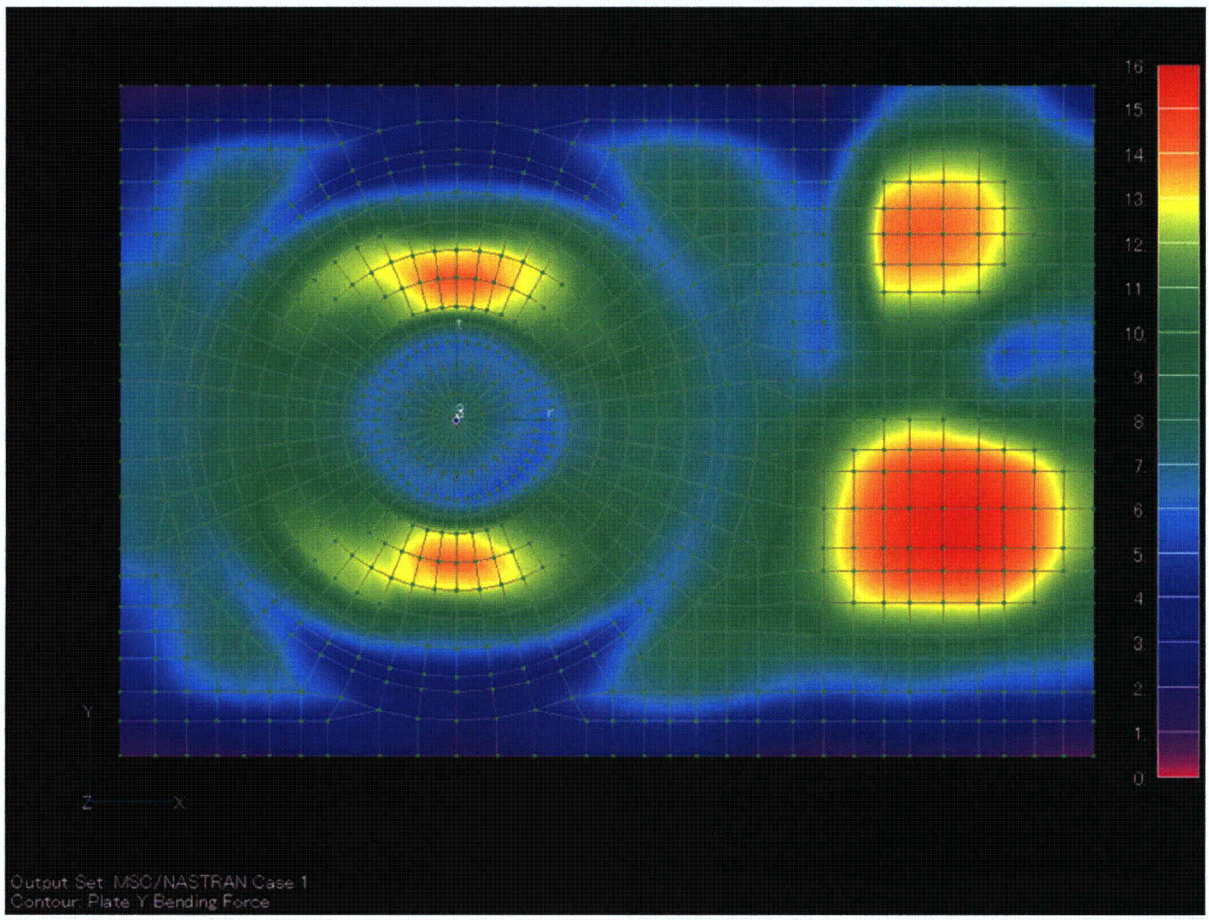
Unit: MN•m/m

Figure 3-7 Contour of Bending Moment in Basemat: Extended Truncated Model (Dead Load: Mx)



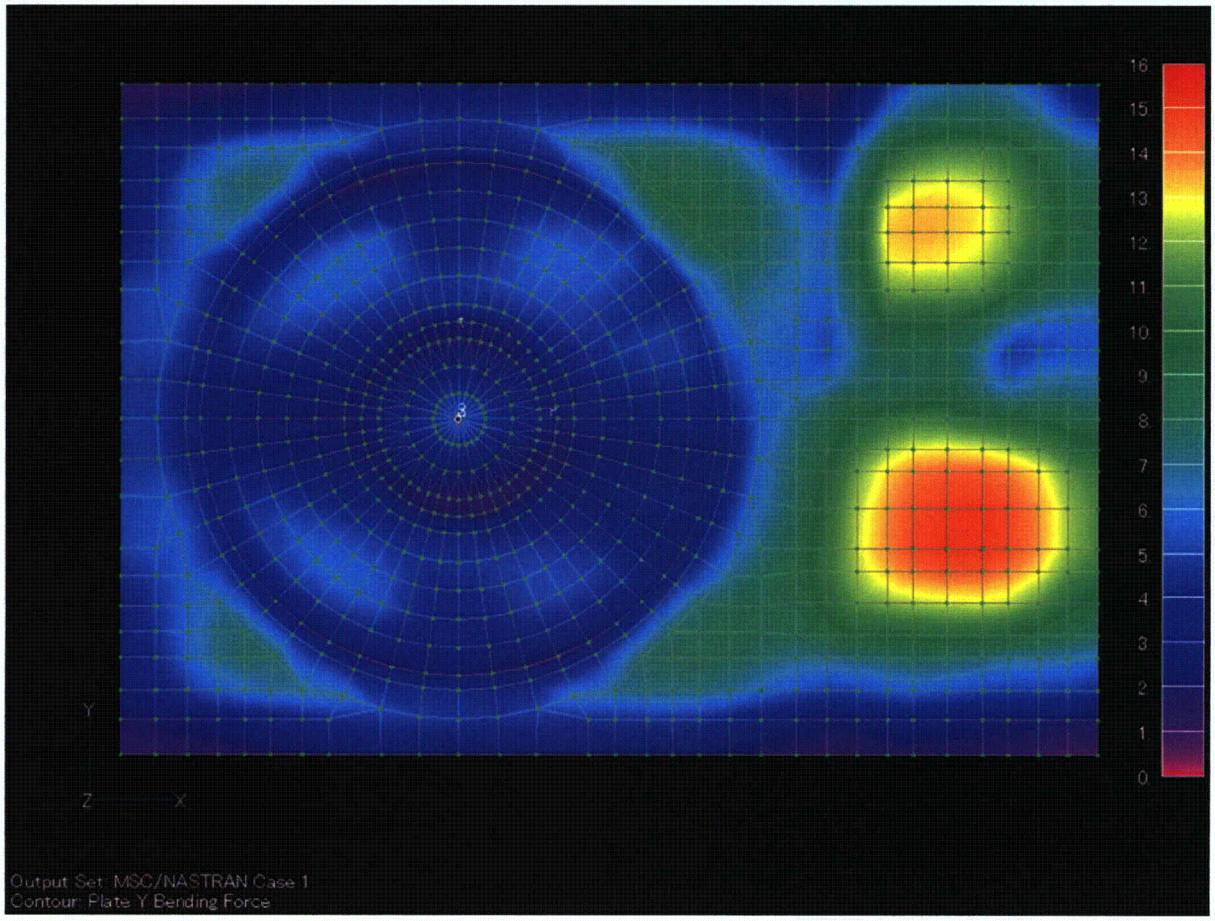
Unit: MN•m/m

Figure 3-8 Contour of Bending Moment in Basemat: Original Truncated Model (Dead Load: My)



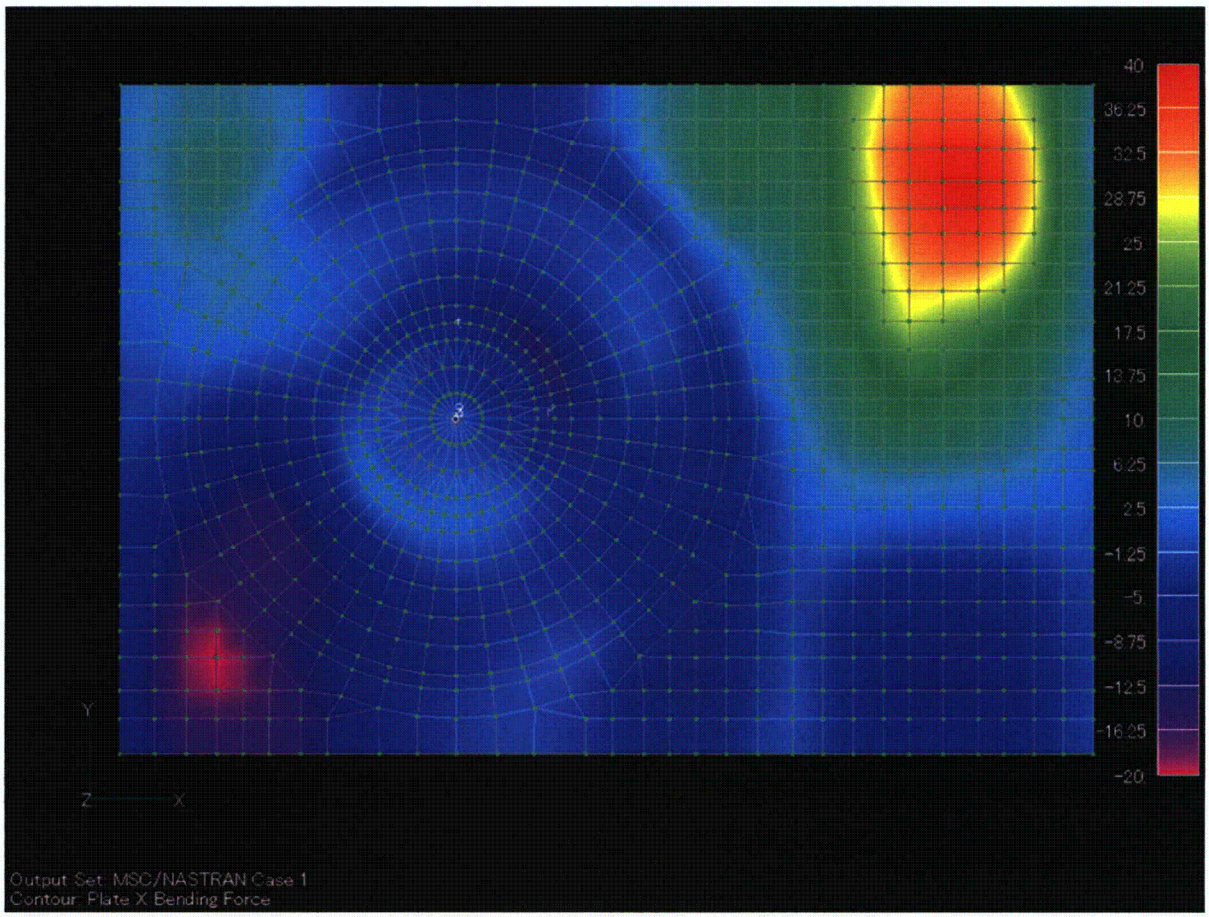
Unit: MN•m/m

Figure 3-9 Contour of Bending Moment in Basemat: Modified Truncated Model (Dead Load: My)



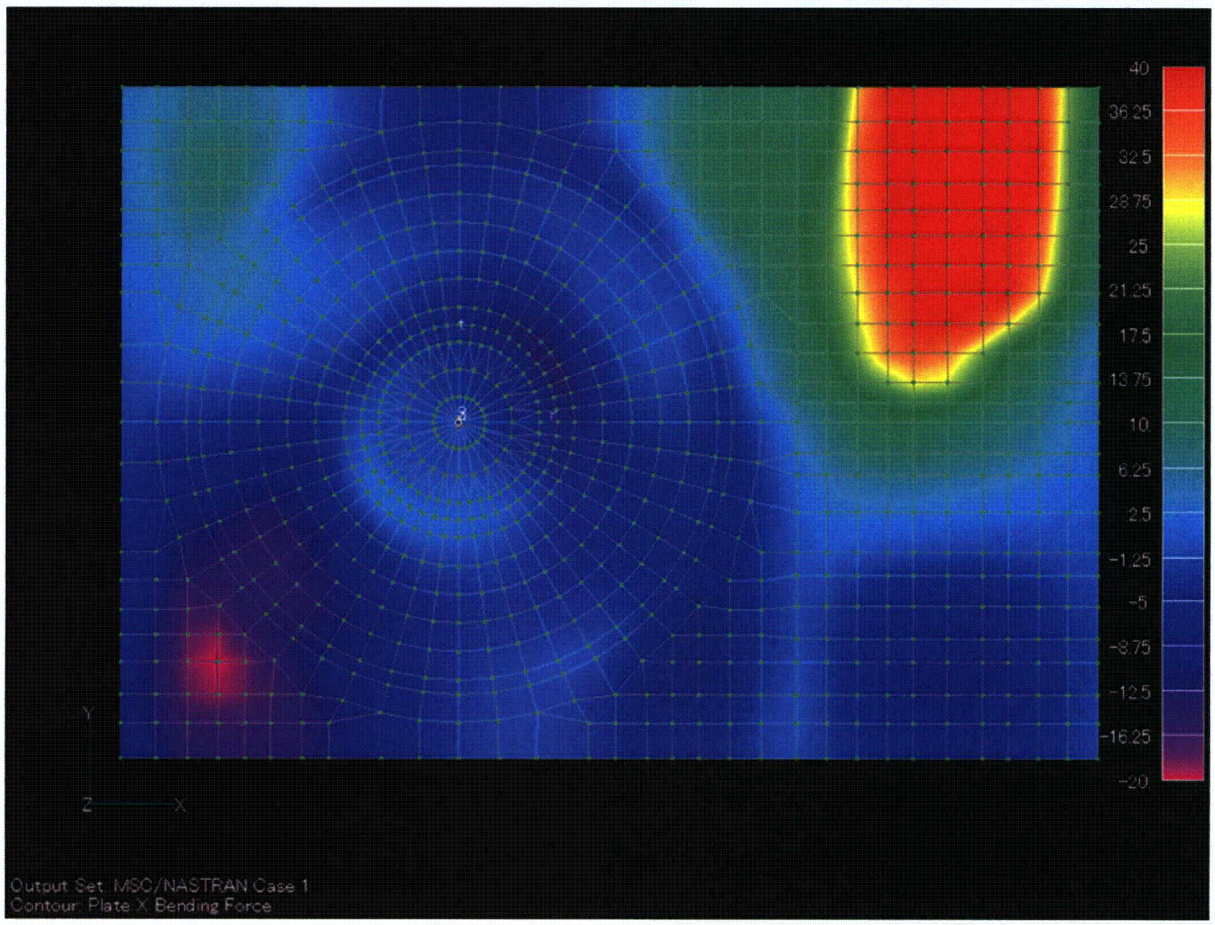
Unit: MN•m/m

Figure 3-10 Contour of Bending Moment in Basemat: Extended Truncated Model (Dead Load: My)



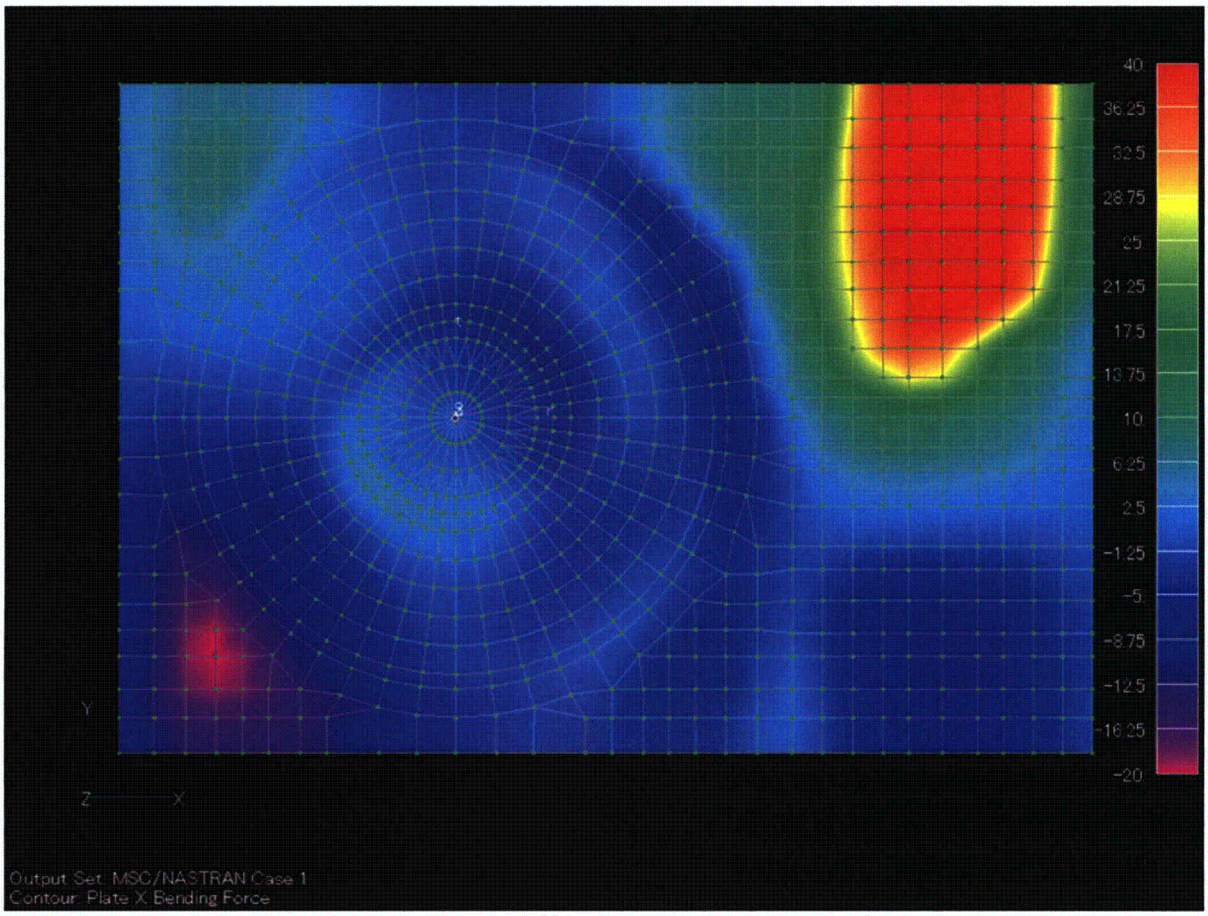
Unit: MN•m/m

Figure 3-11 Contour of Bending Moment in Basemat: Original Truncated Model (Seismic Load: Mx)



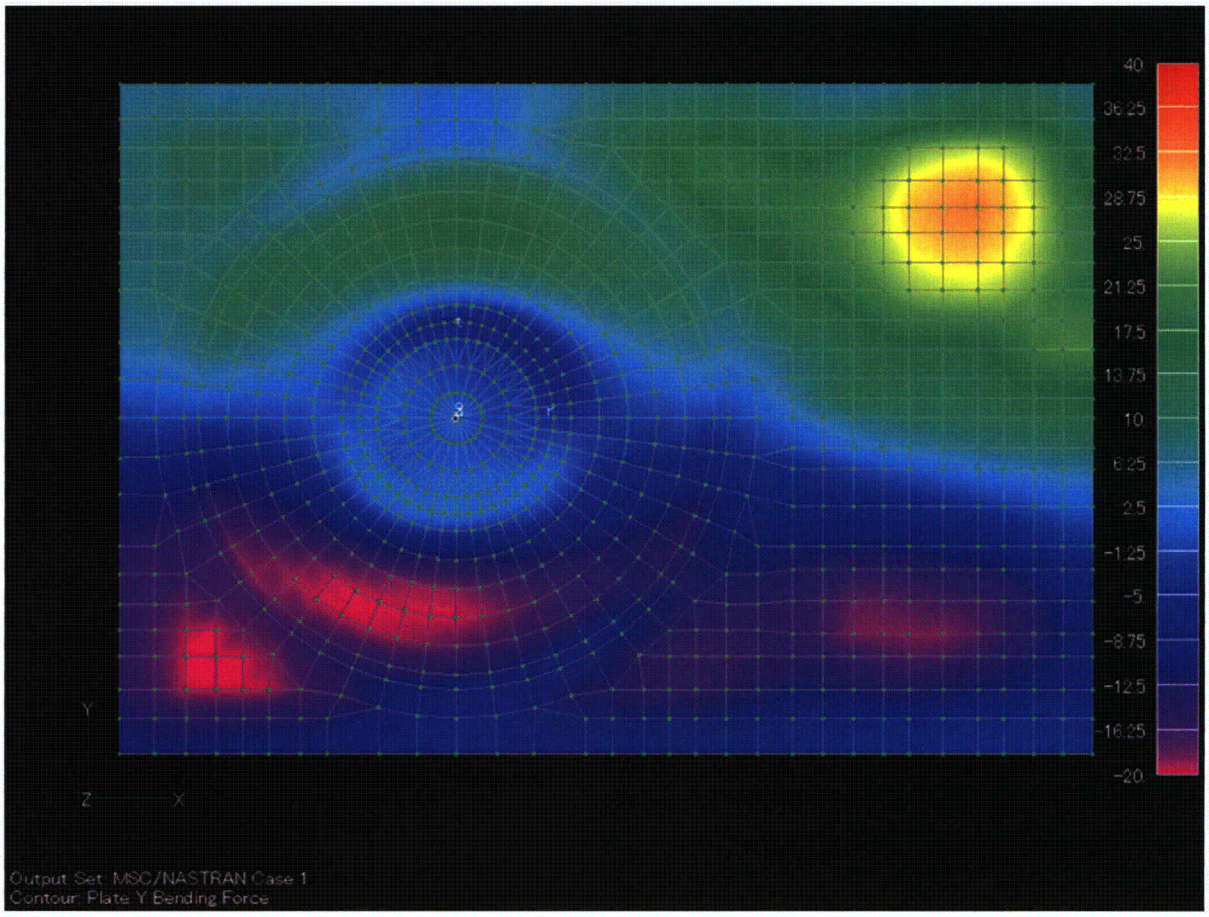
Unit: MN•m/m

Figure 3-12 Contour of Bending Moment in Basemat: Modified Truncated Model (Seismic Load: Mx)



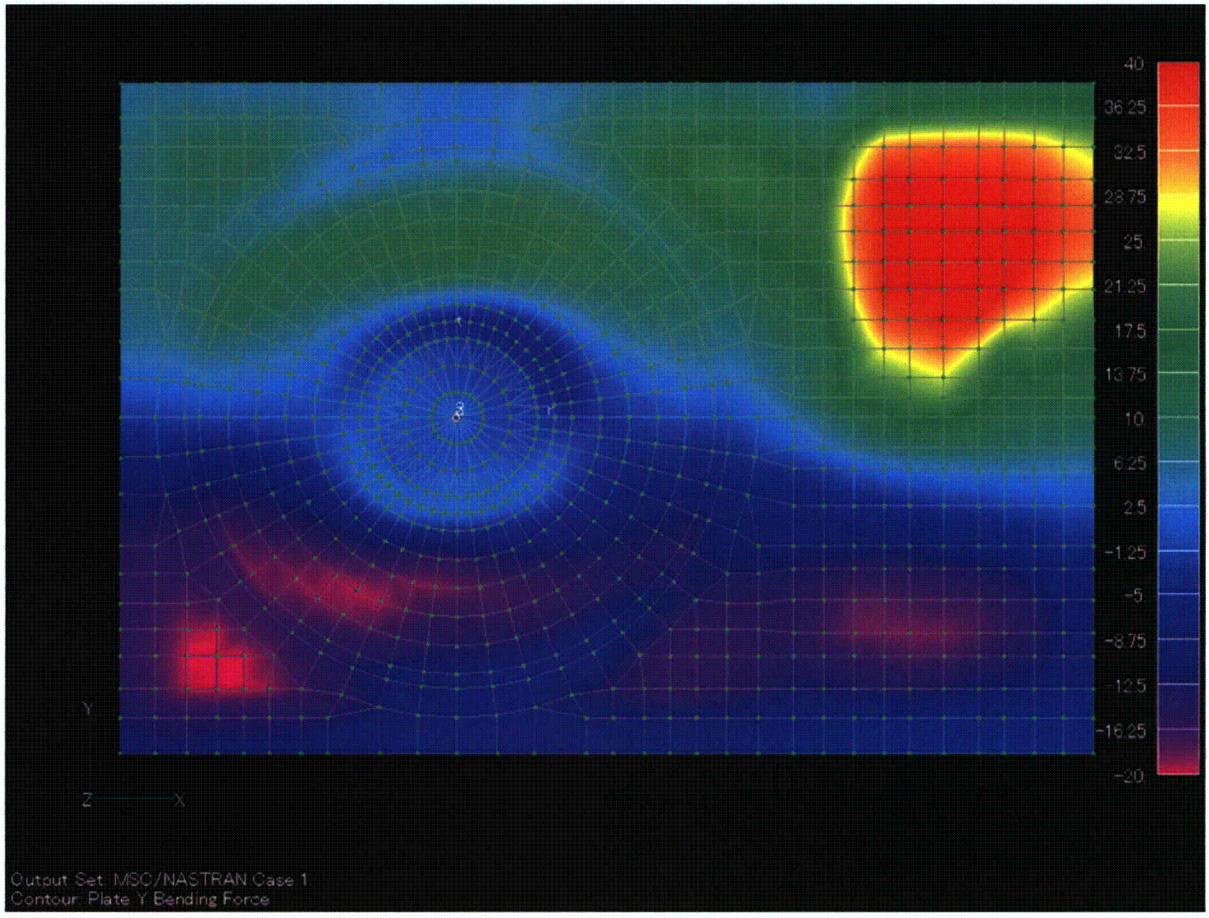
Unit: MN•m/m

Figure 3-13 Contour of Bending Moment in Basemat: Extended Truncated Model (Seismic Load: Mx)



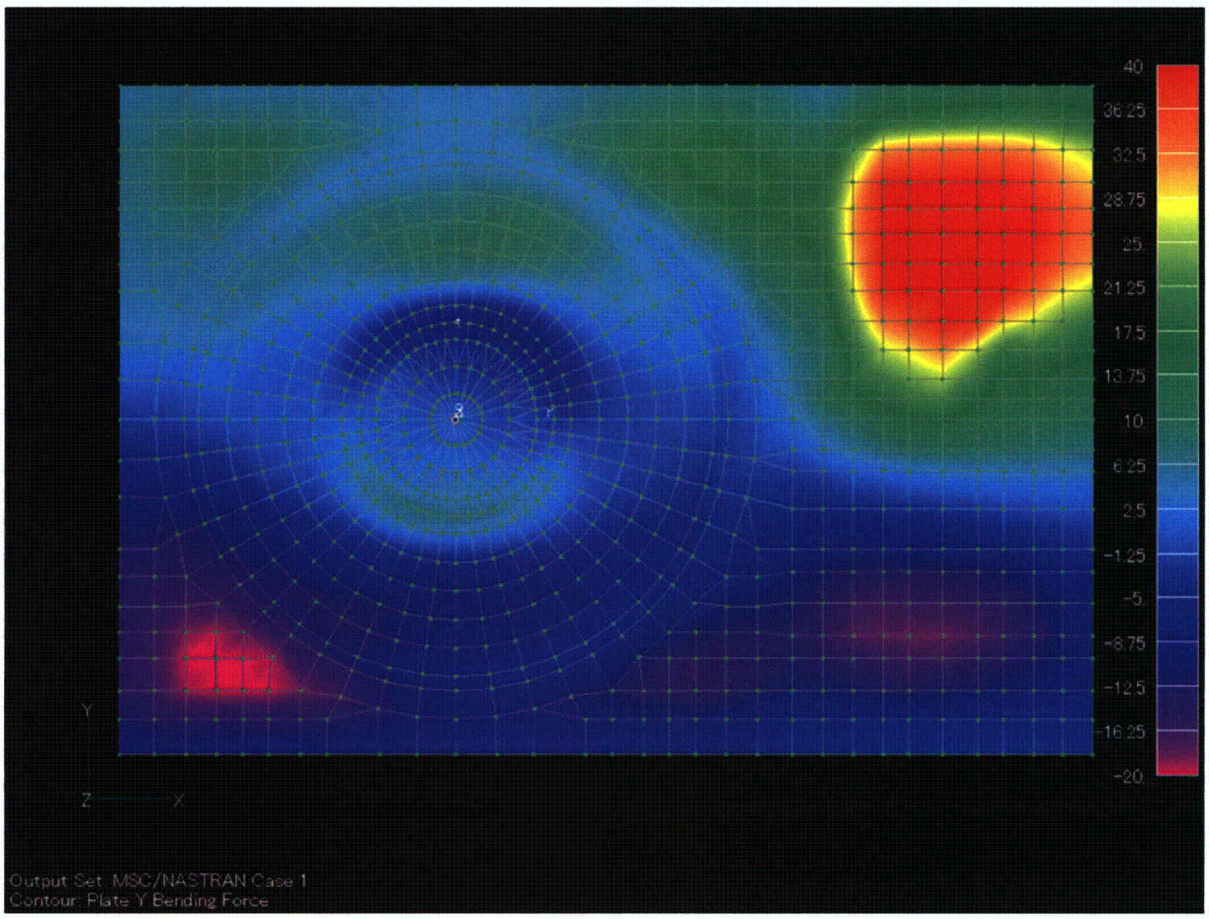
Unit: MN•m/m

Figure 3-14 Contour of Bending Moment in Basemat: Original Truncated Model (Seismic Load: My)



Unit: MN•m/m

Figure 3-15 Contour of Bending Moment in Basemat: Modified Truncated Model (Seismic Load: My)



Unit: MN•m/m

Figure 3-16 Contour of Bending Moment in Basemat: Extended Truncated Model (Seismic Load: My)

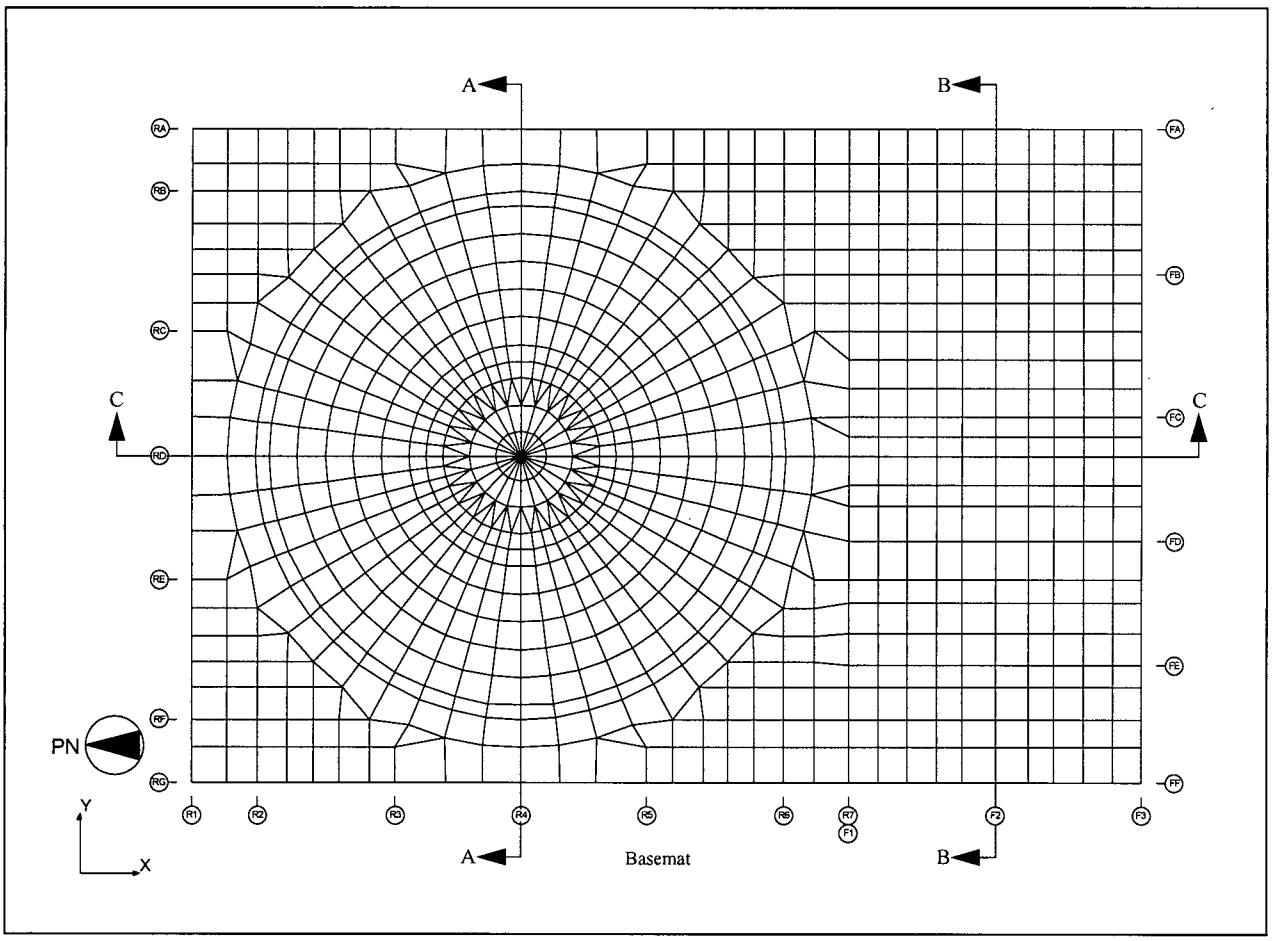


Figure 3-17 Section Positions

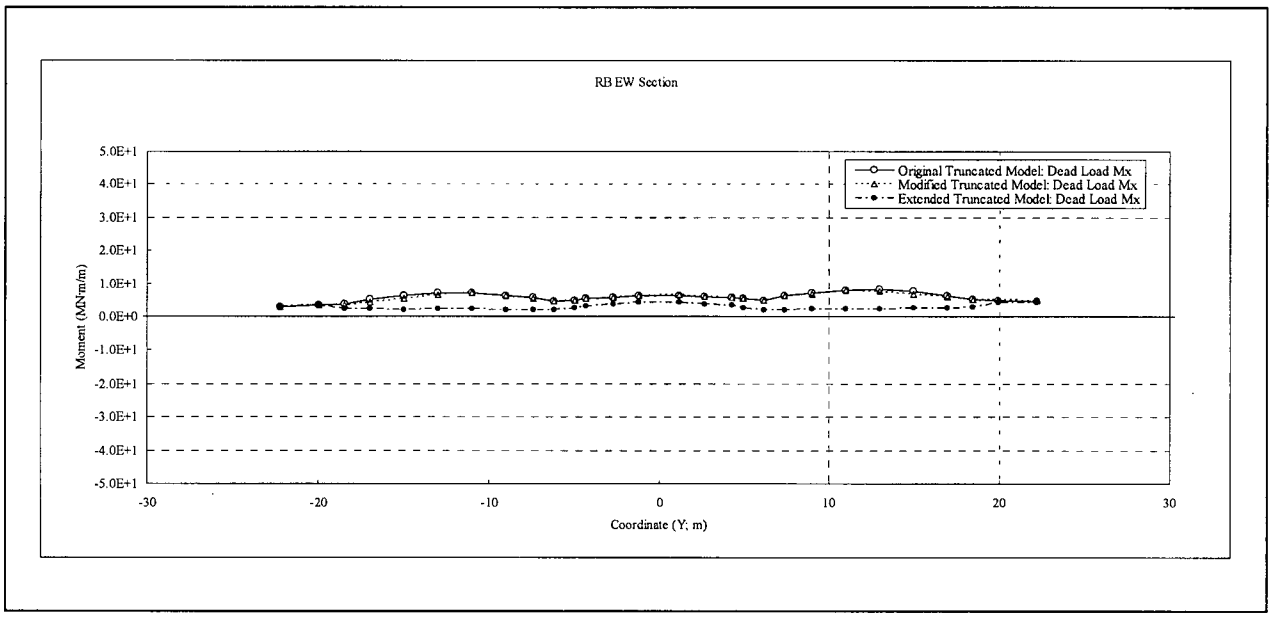


Figure 3-18 Bending Moment at A-A Section in Basemat (Dead Load: Mx)

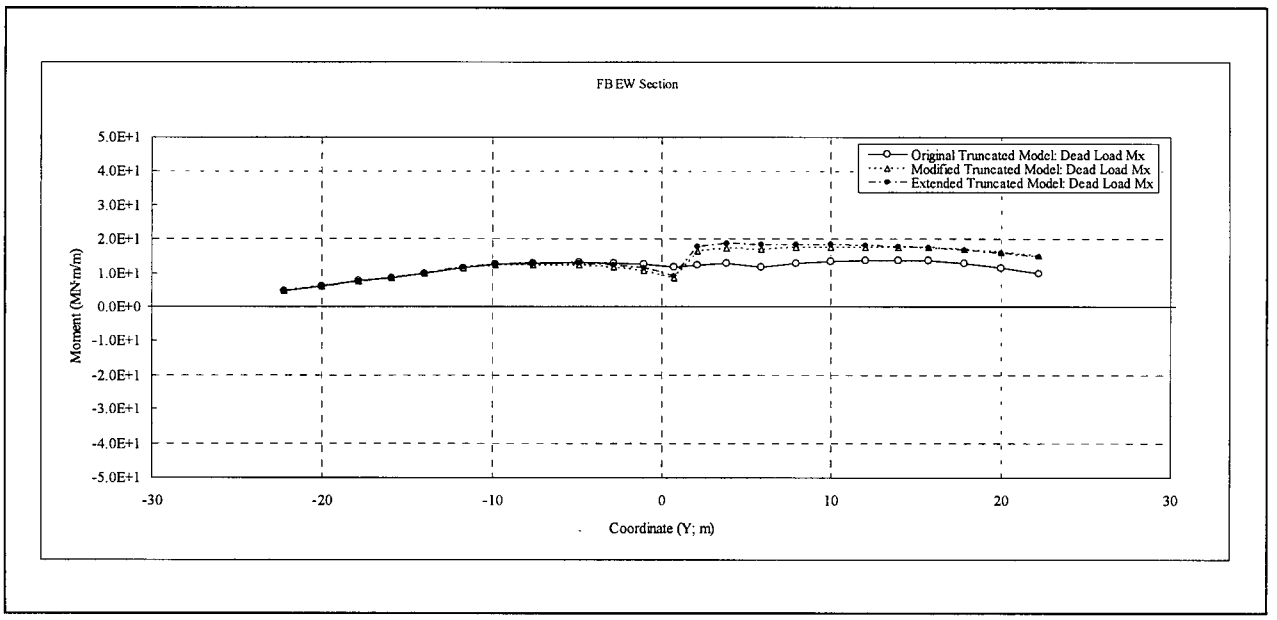


Figure 3-19 Bending Moment at B-B Section in Basemat (Dead Load: Mx)

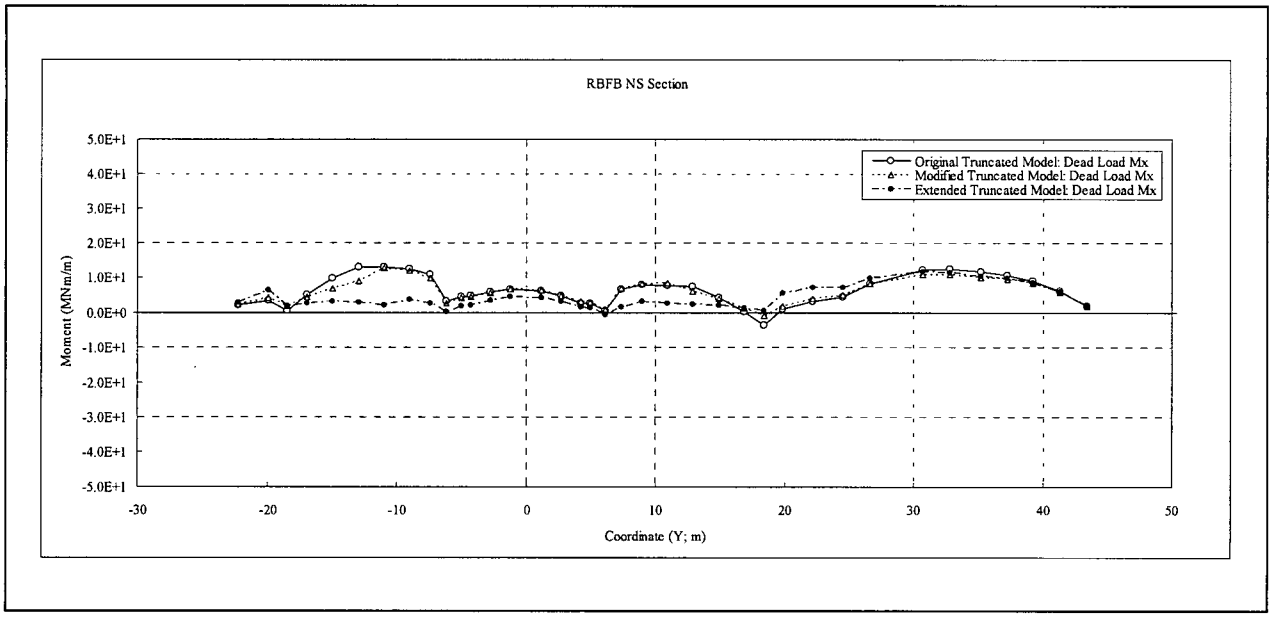


Figure 3-20 Bending Moment at C-C Section in Basemat (Dead Load: Mx)

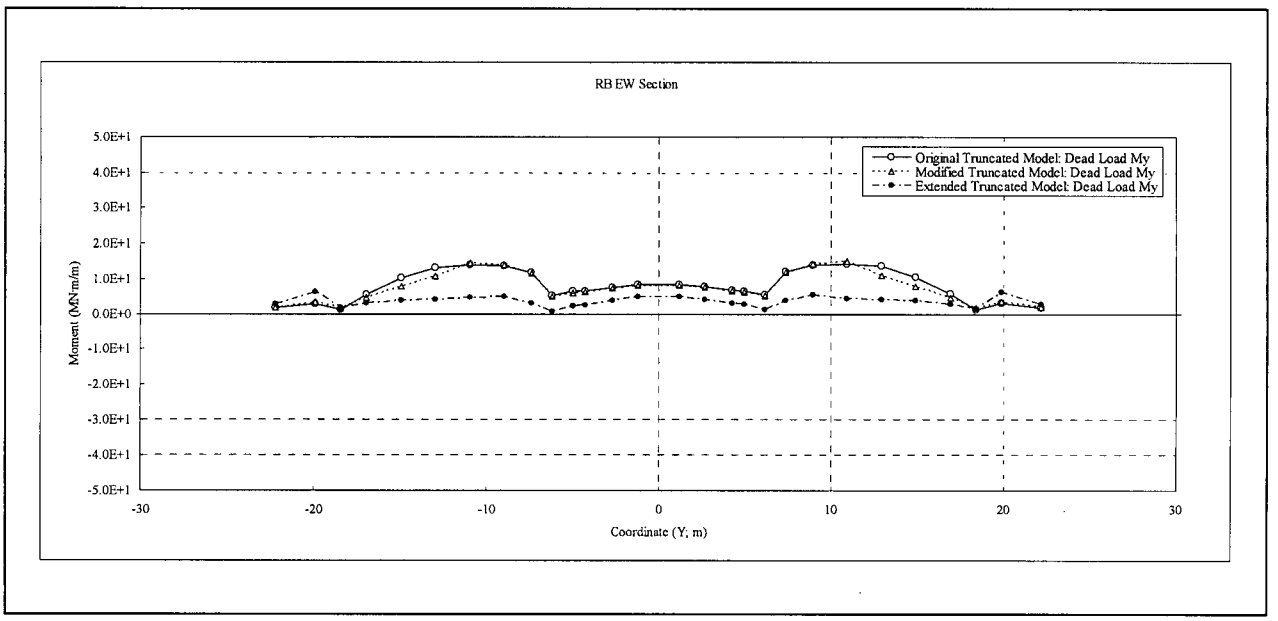


Figure 3-21 Bending Moment at A-A Section in Basemat (Dead Load: My)

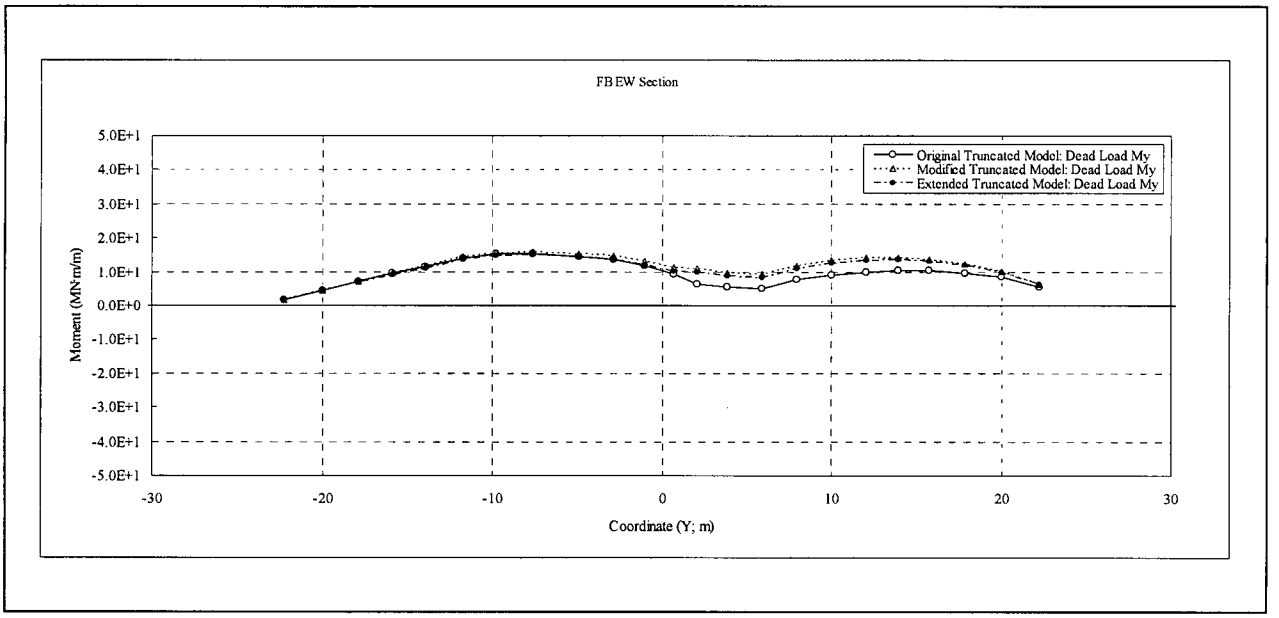


Figure 3-22 Bending Moment at B-B Section in Basemat (Dead Load: My)

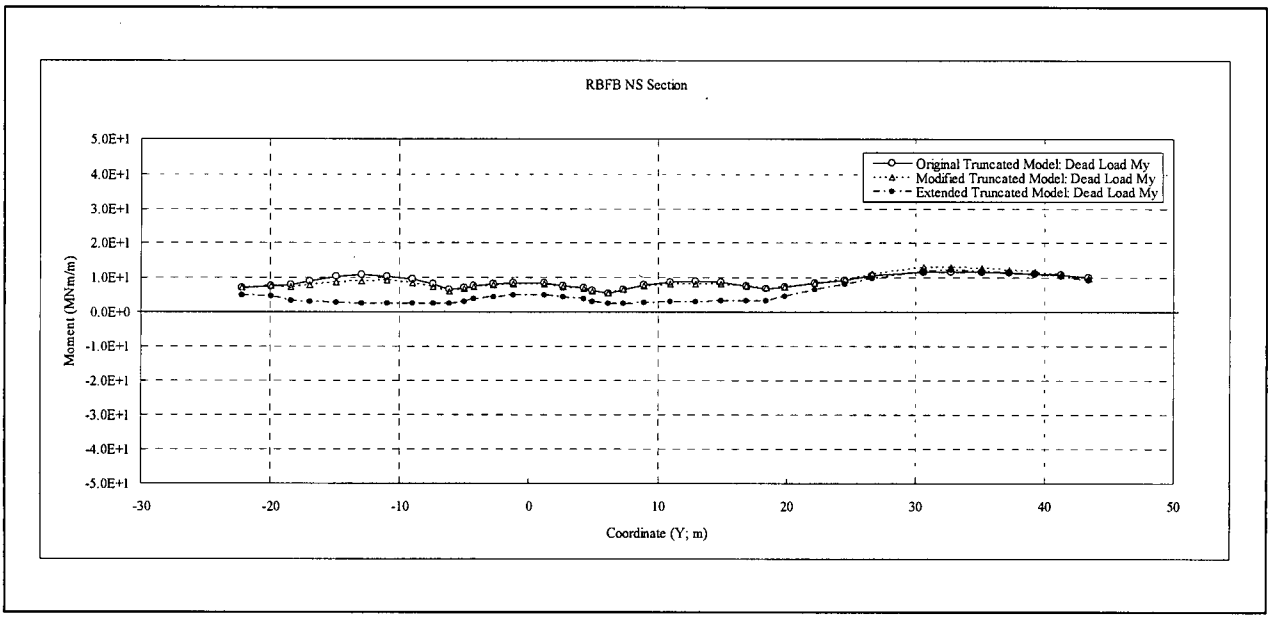


Figure 3-23 Bending Moment at C-C Section in Basemat (Dead Load: My)

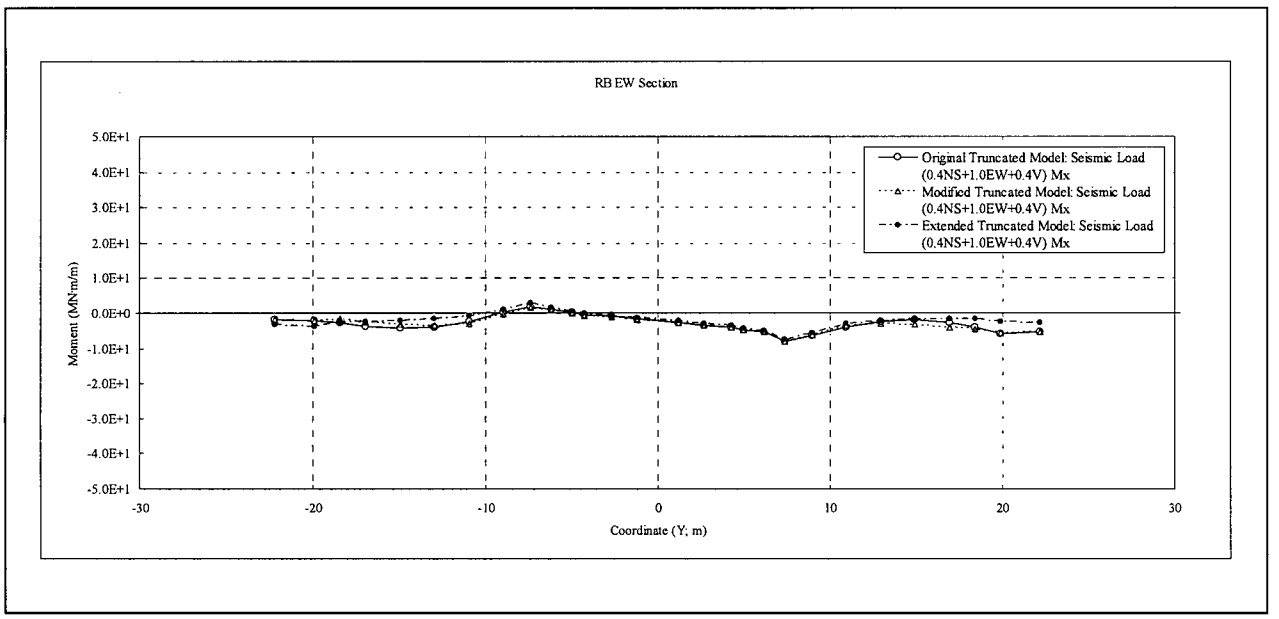


Figure 3-24 Bending Moment at A-A Section in Basemat (Seismic Load: Mx)

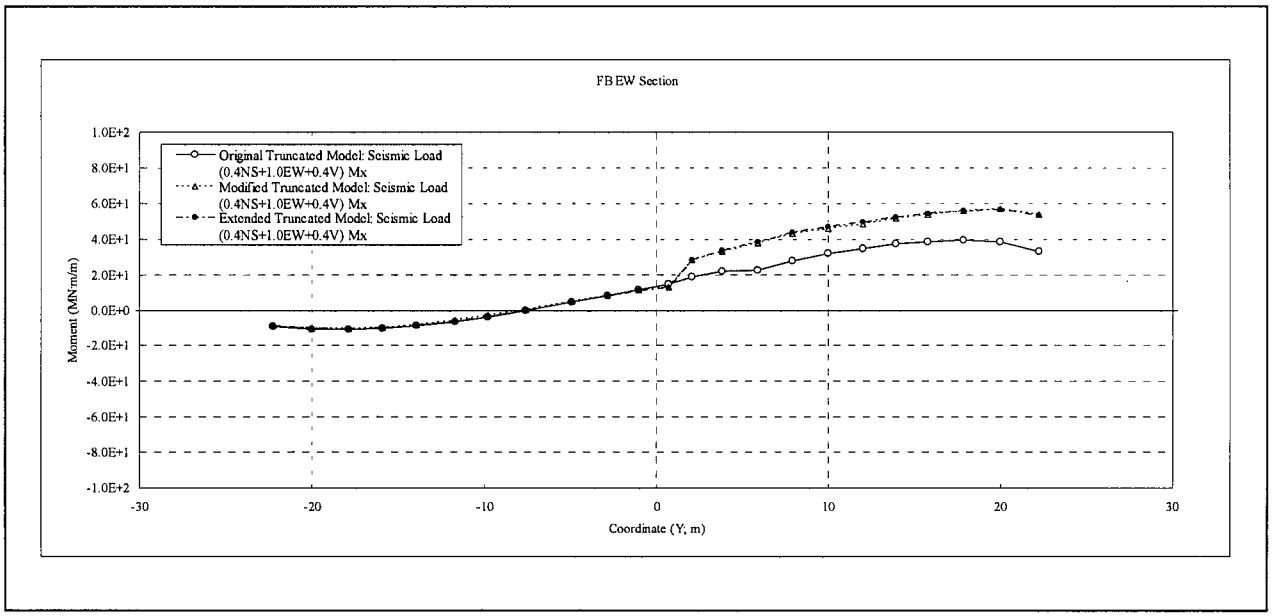


Figure 3-25 Bending Moment at B-B Section in Basemat (Seismic Load: Mx)

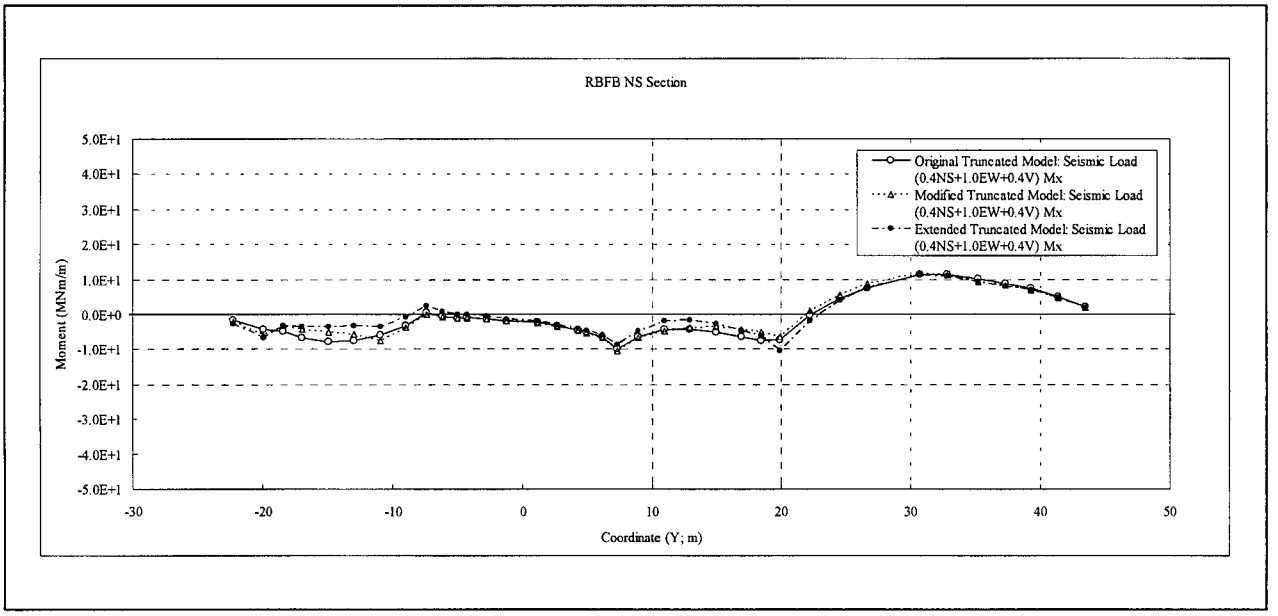


Figure 3-26 Bending Moment at C-C Section in Basemat (Seismic Load: Mx)

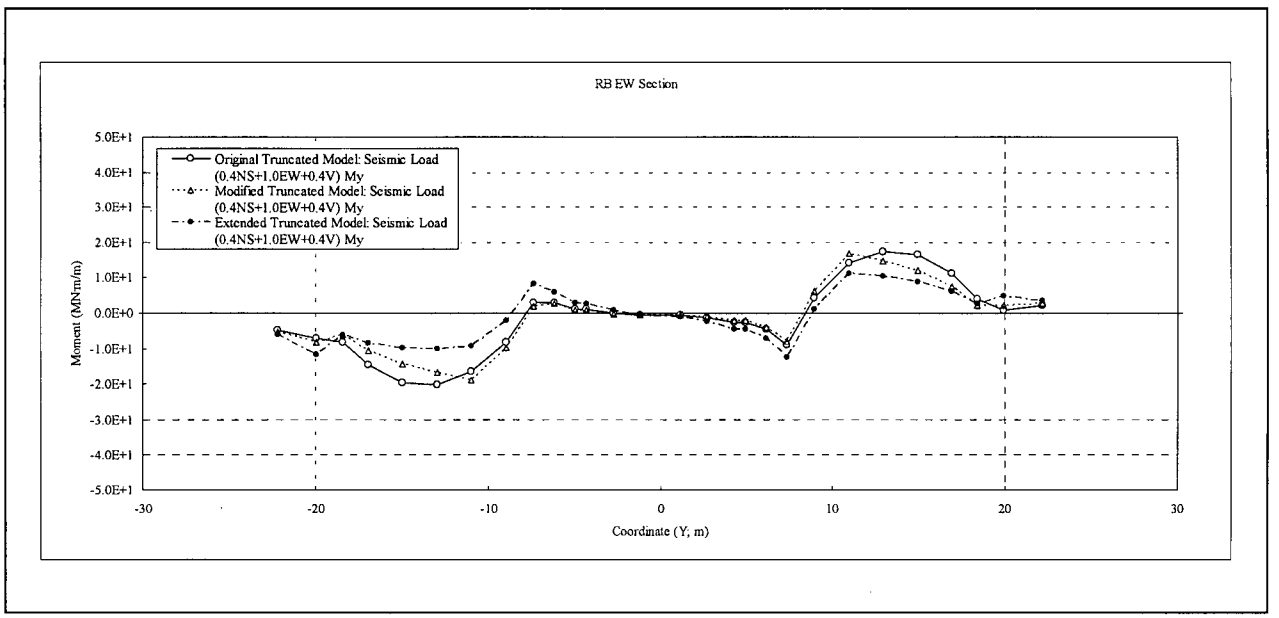


Figure 3-27 Bending Moment at A-A Section in Basemat (Seismic Load: My)

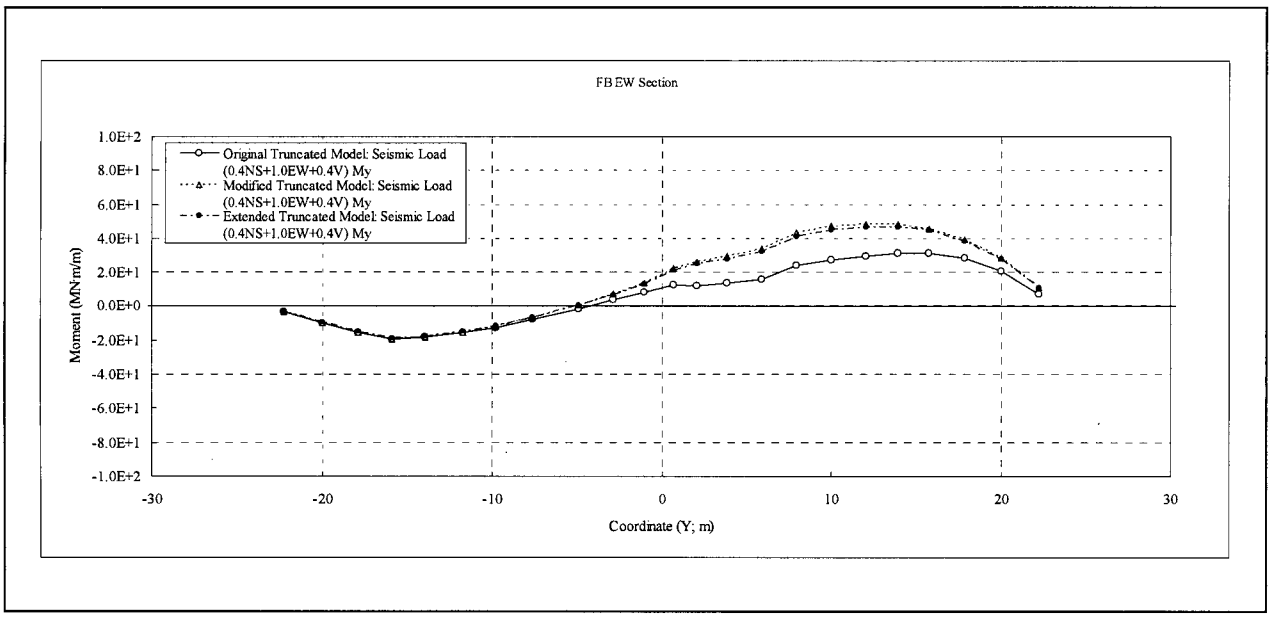


Figure 3-28 Bending Moment at B-B Section in Basemat (Seismic Load: My)

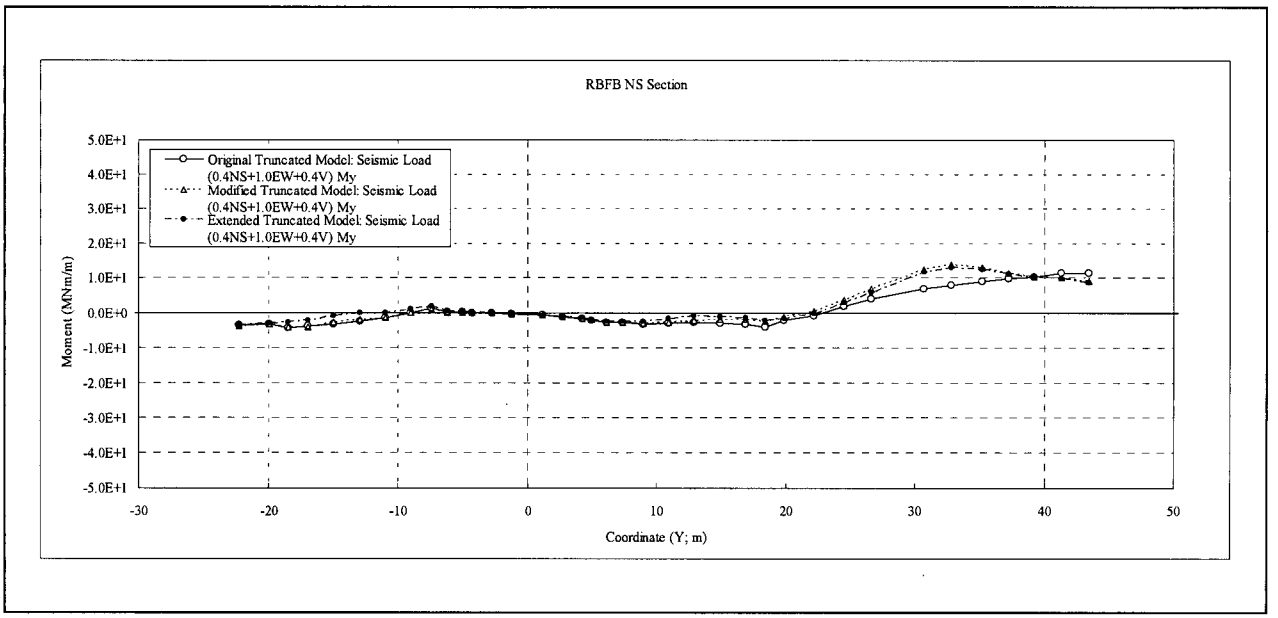
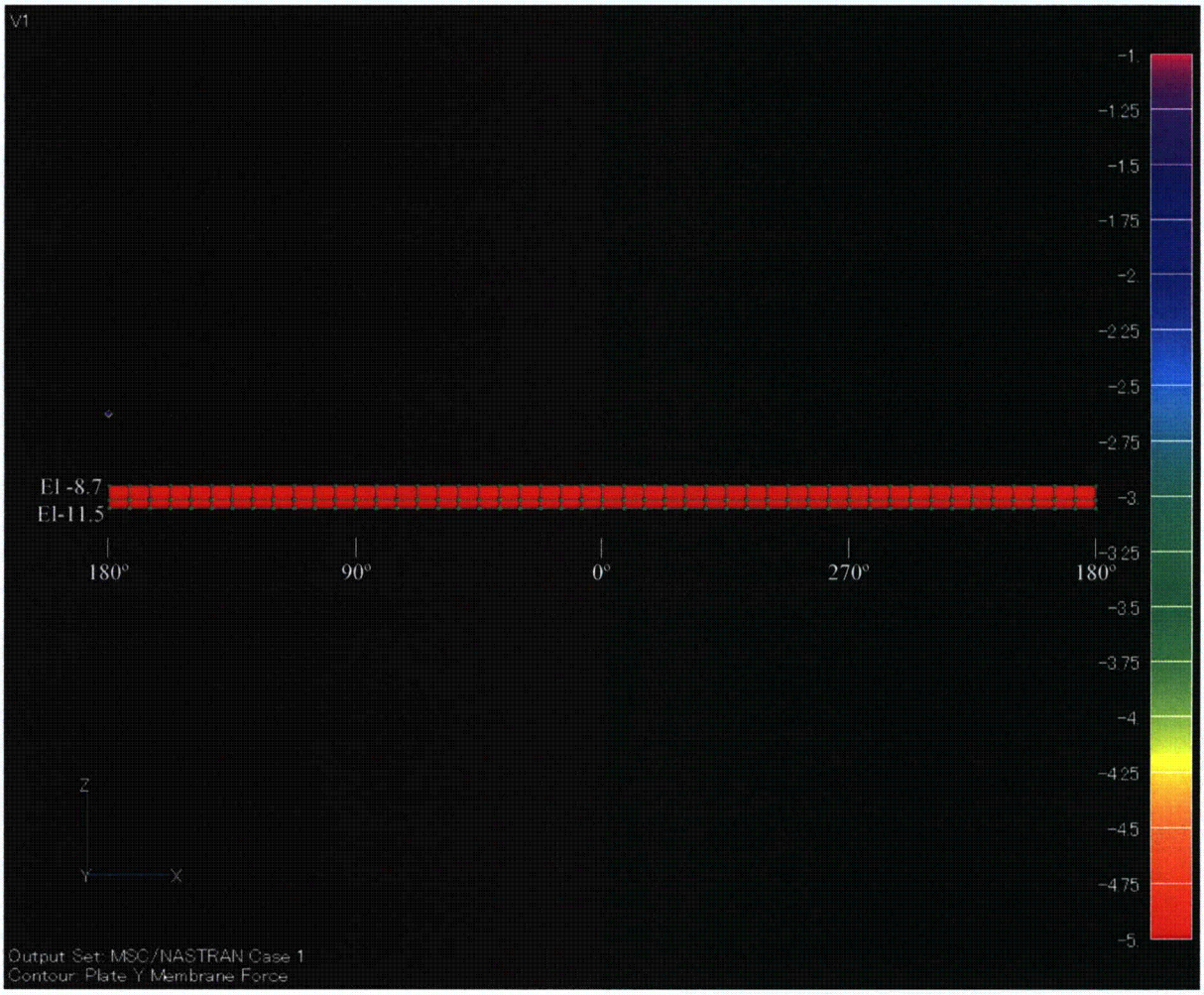
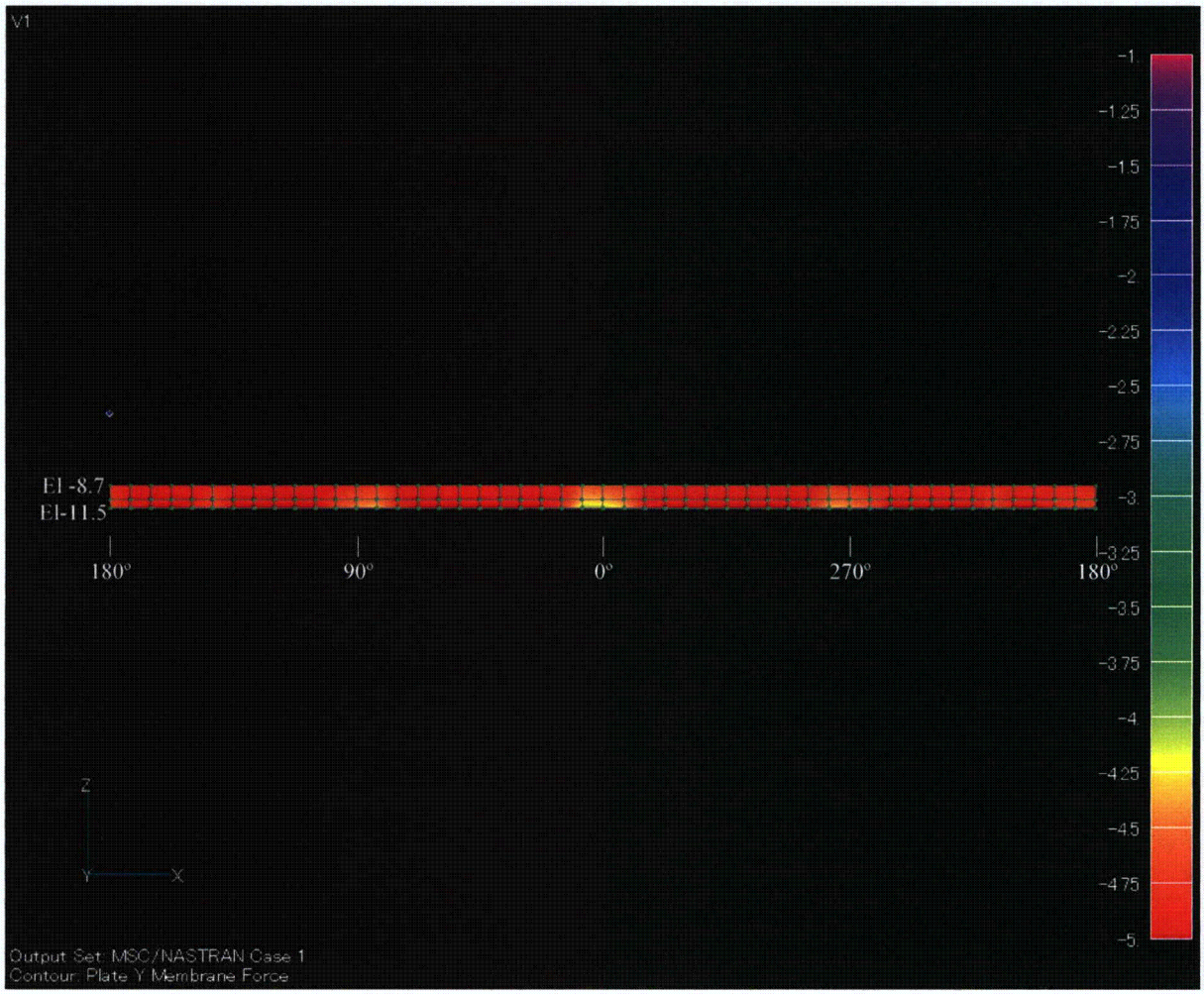


Figure 3-29 T Bending Moment at C-C Section in Basemat (Seismic Load: My)



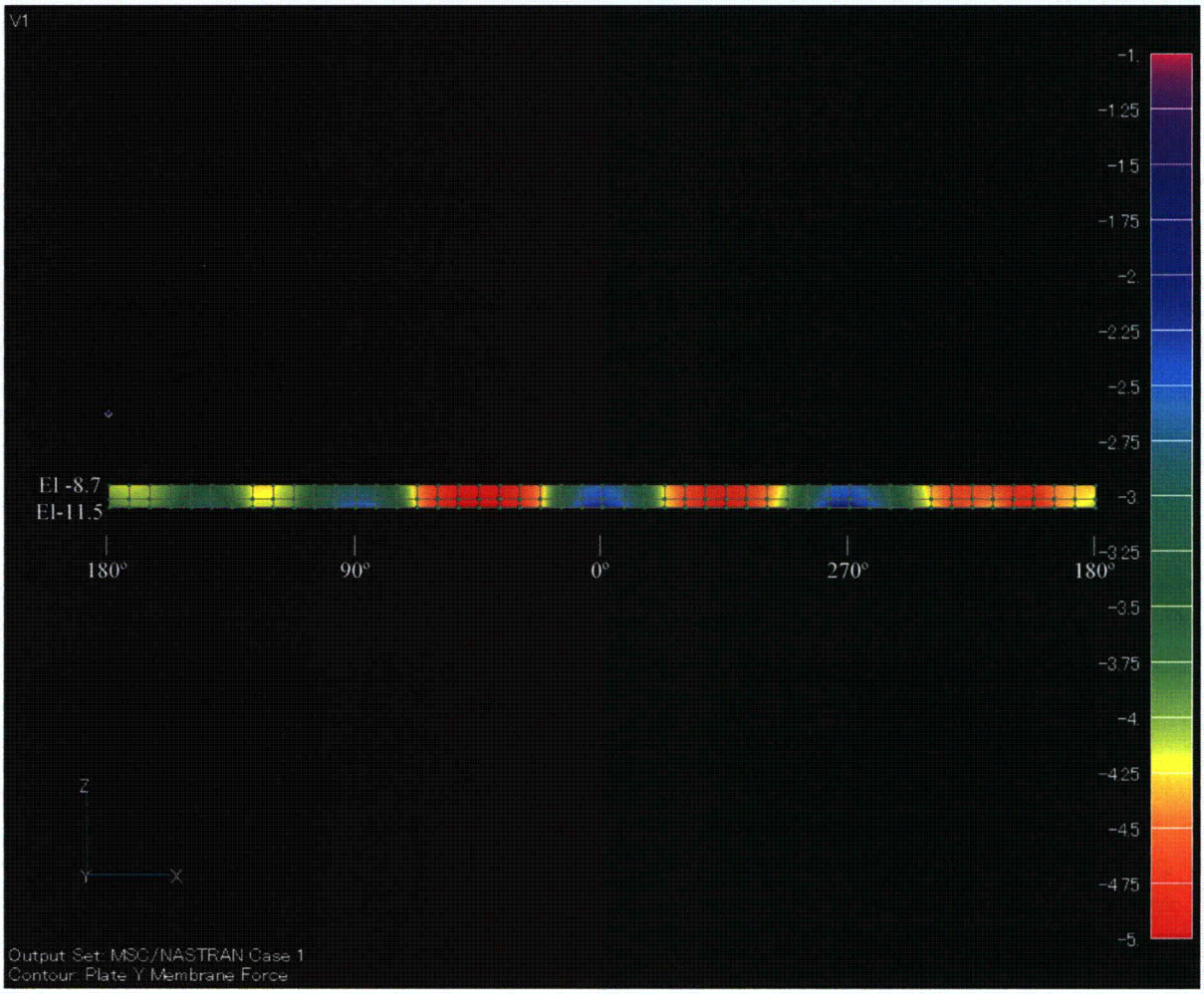
Unit: MN/m

Figure 3-30 Contour of Membrane Force in Cylinder Wall below RCCV: Original Truncated Model (Dead Load: Ny)



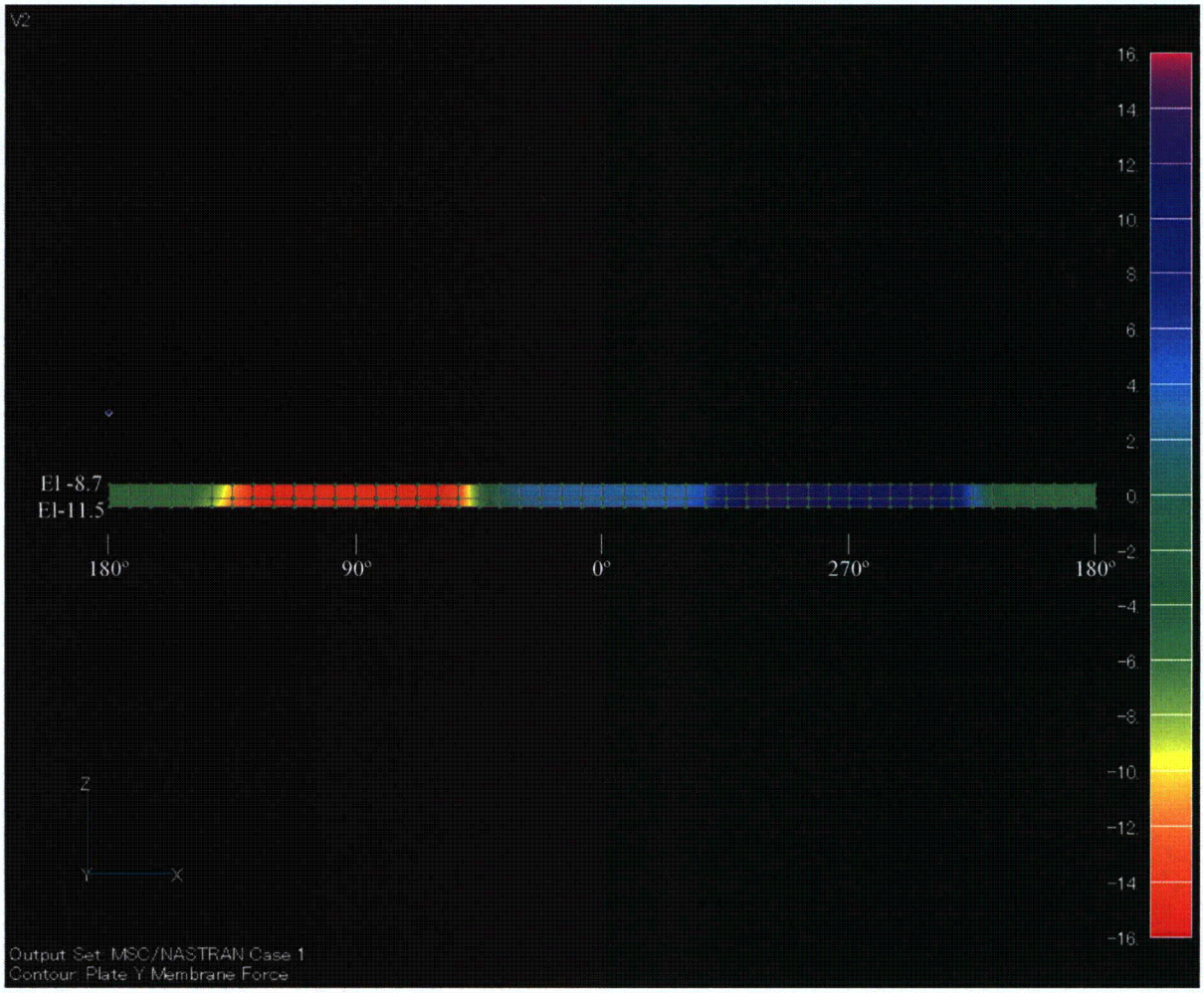
Unit: MN/m

Figure 3-31 Contour of Membrane Force in Cylinder Wall below RCCV: Modified Truncated Model (Dead Load: Ny)



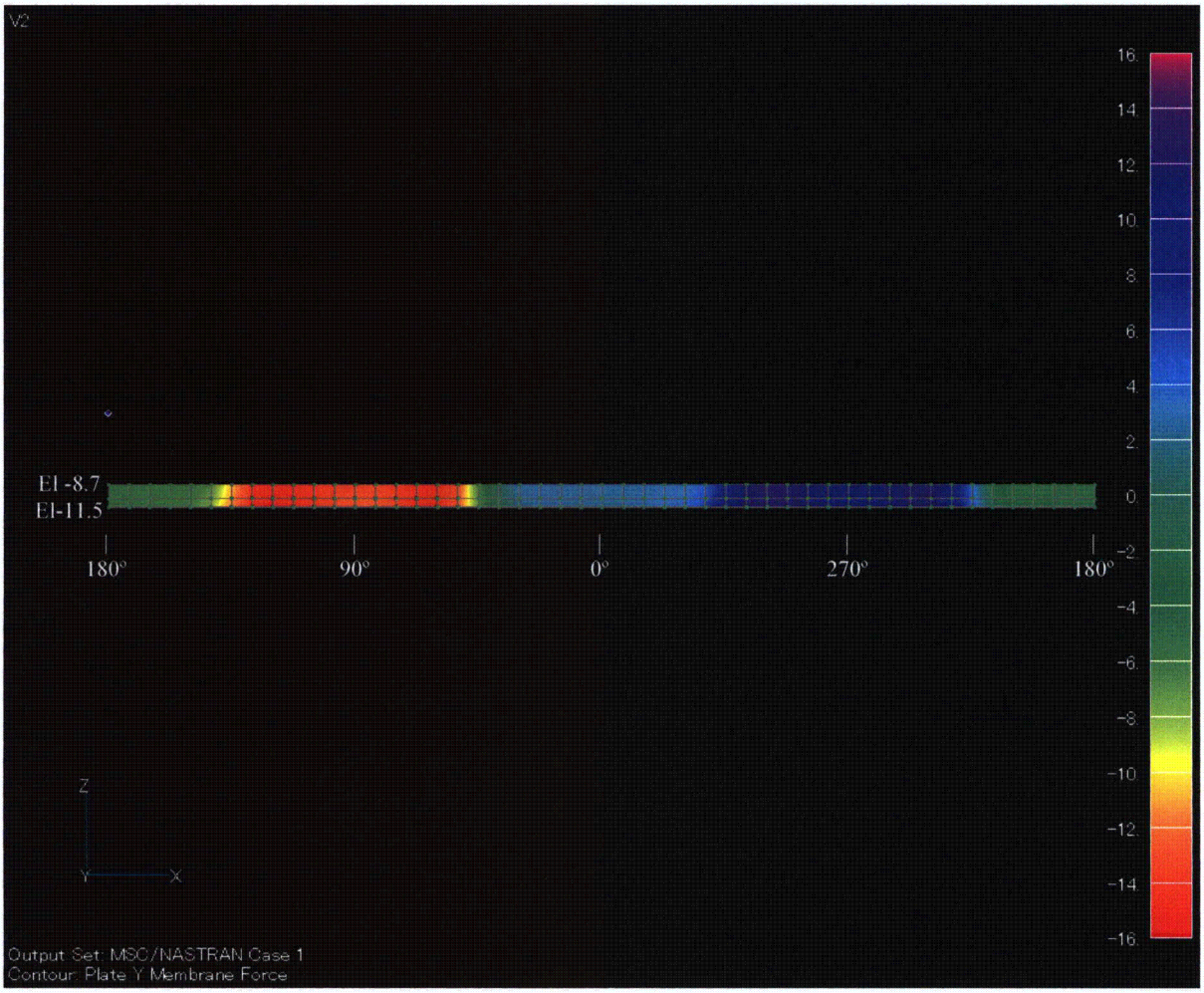
Unit: MN/m

Figure 3-32 Contour of Membrane Force in Cylinder Wall below RCCV: Extended Truncated Model (Dead Load: Ny)



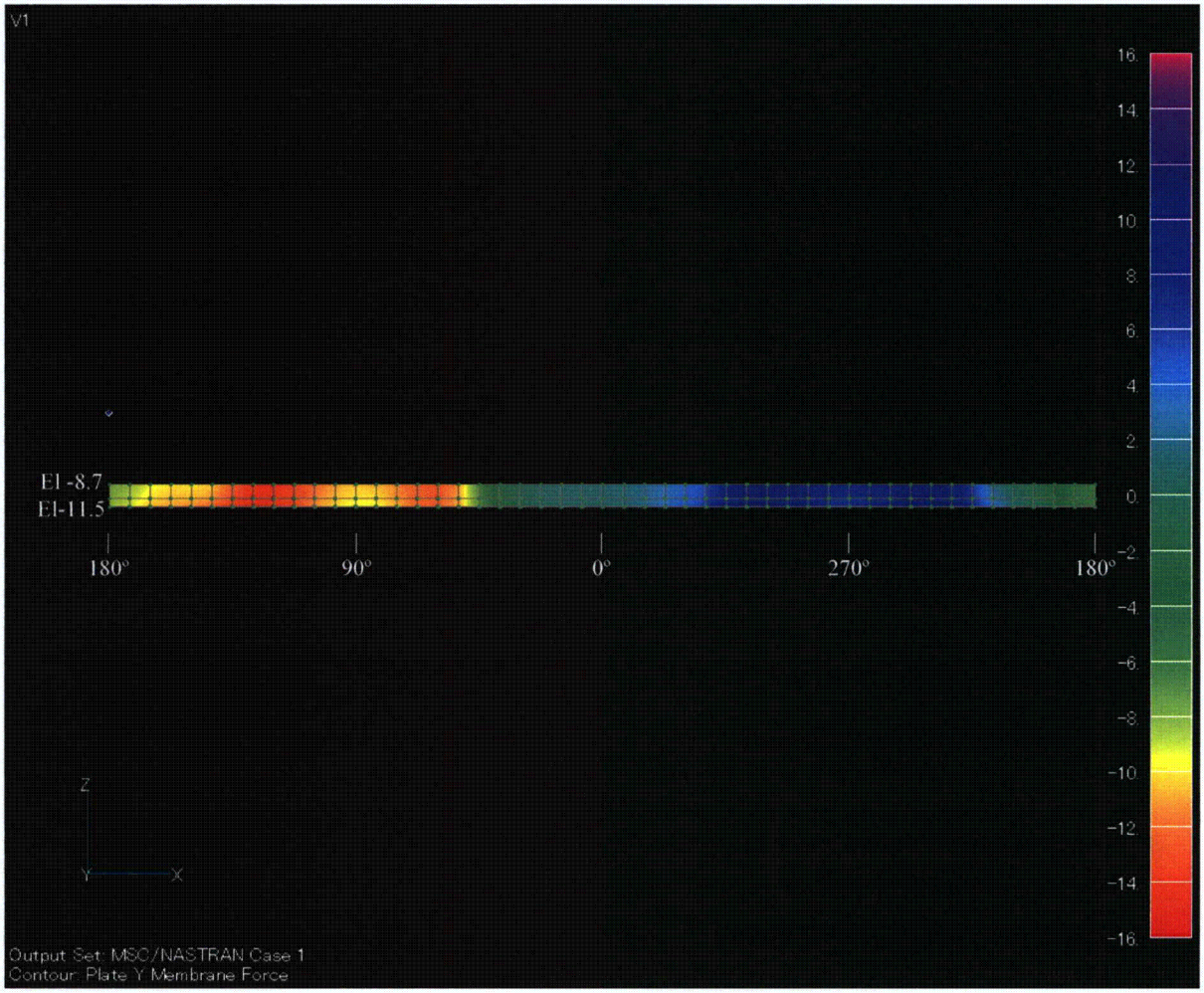
Unit: MN/m

Figure 3-33 Contour of Membrane Force in Cylinder Wall below RCCV: Original Truncated Model (Seismic Load: Ny)



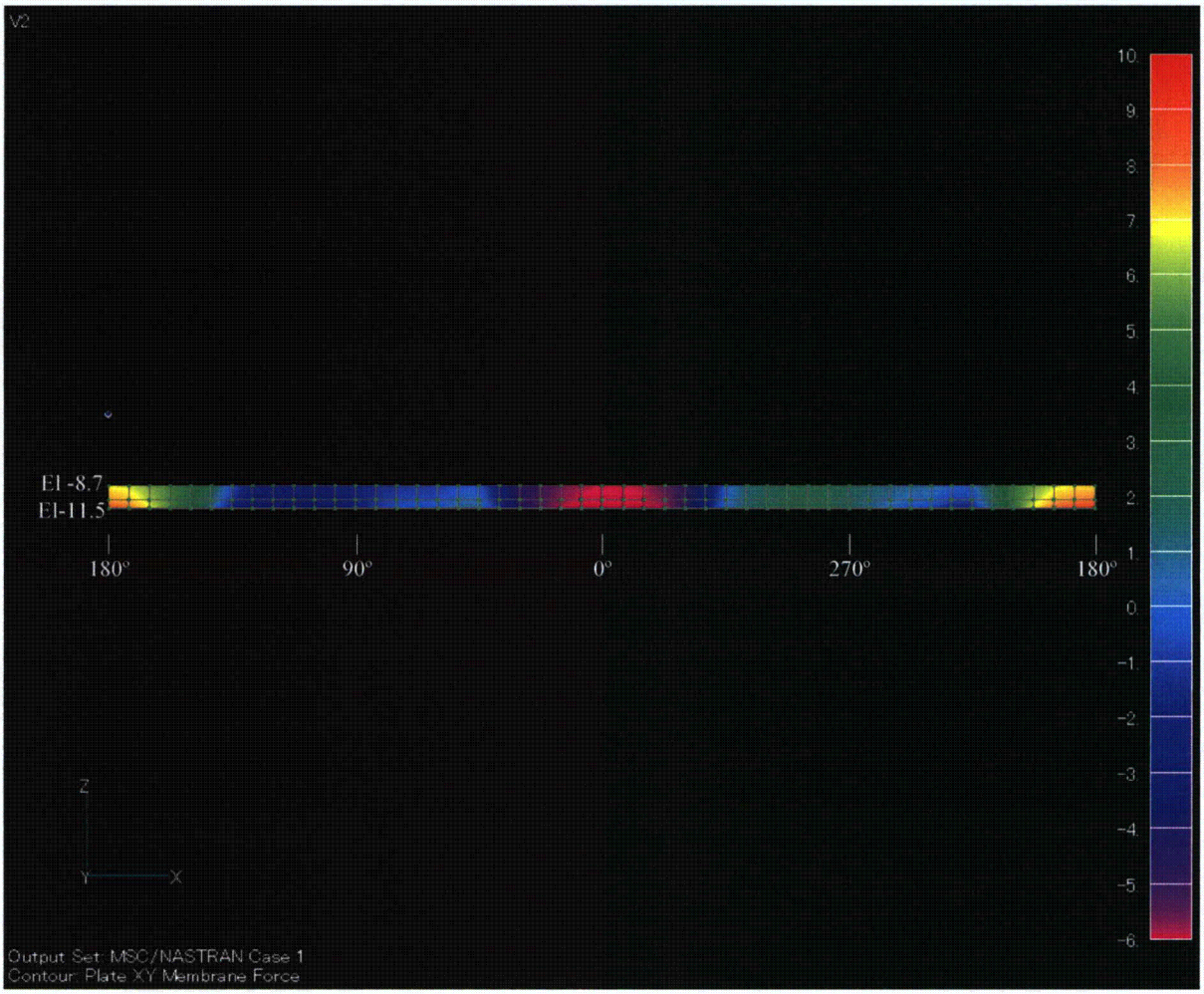
Unit: MN/m

Figure 3-34 Contour of Membrane Force in Cylinder Wall below RCCV: Modified Truncated Model (Seismic Load: Ny)



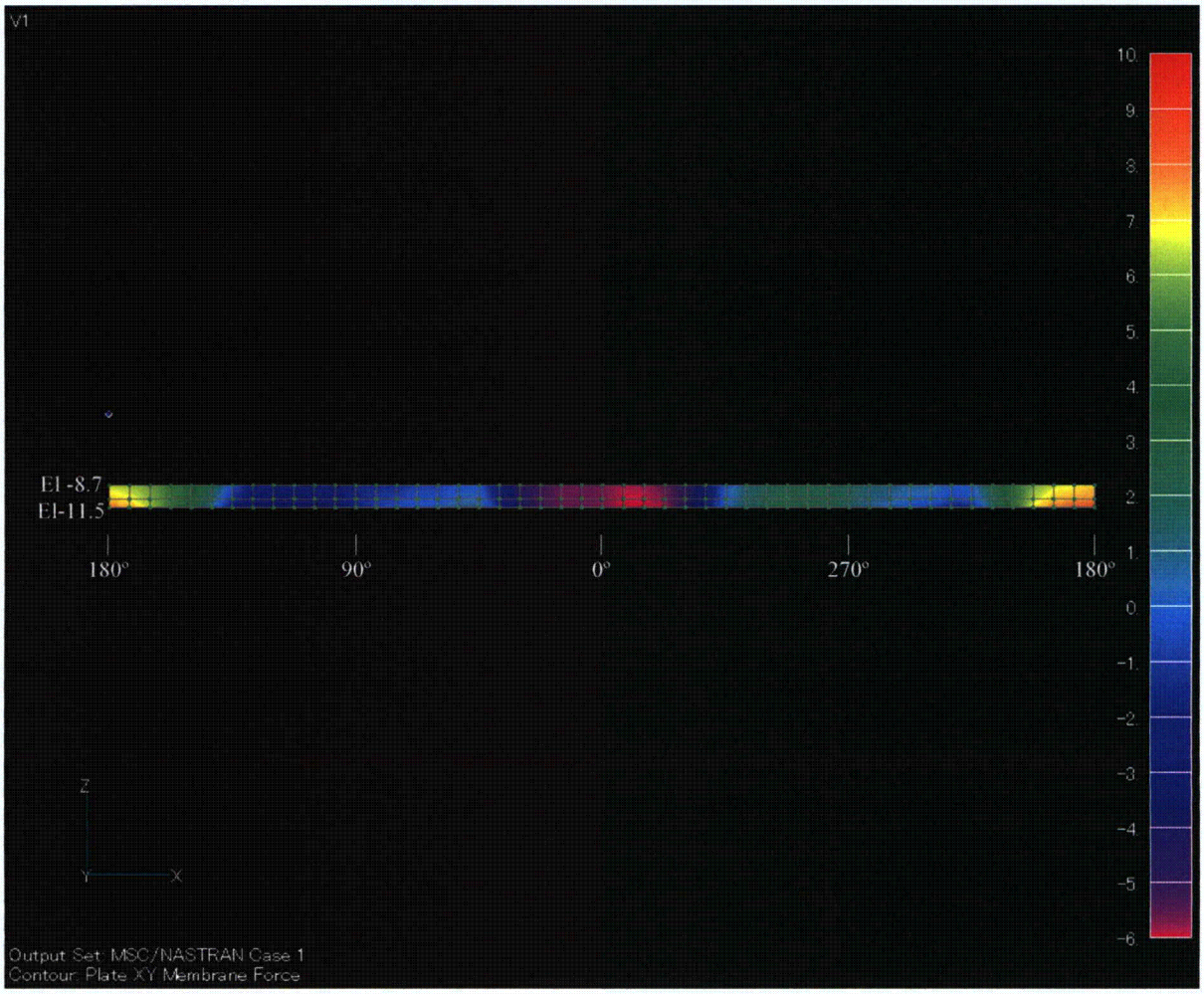
Unit: MN/m

Figure 3-35 Contour of Membrane Force in Cylinder Wall below RCCV: Extended Truncated Model (Seismic Load: Ny)



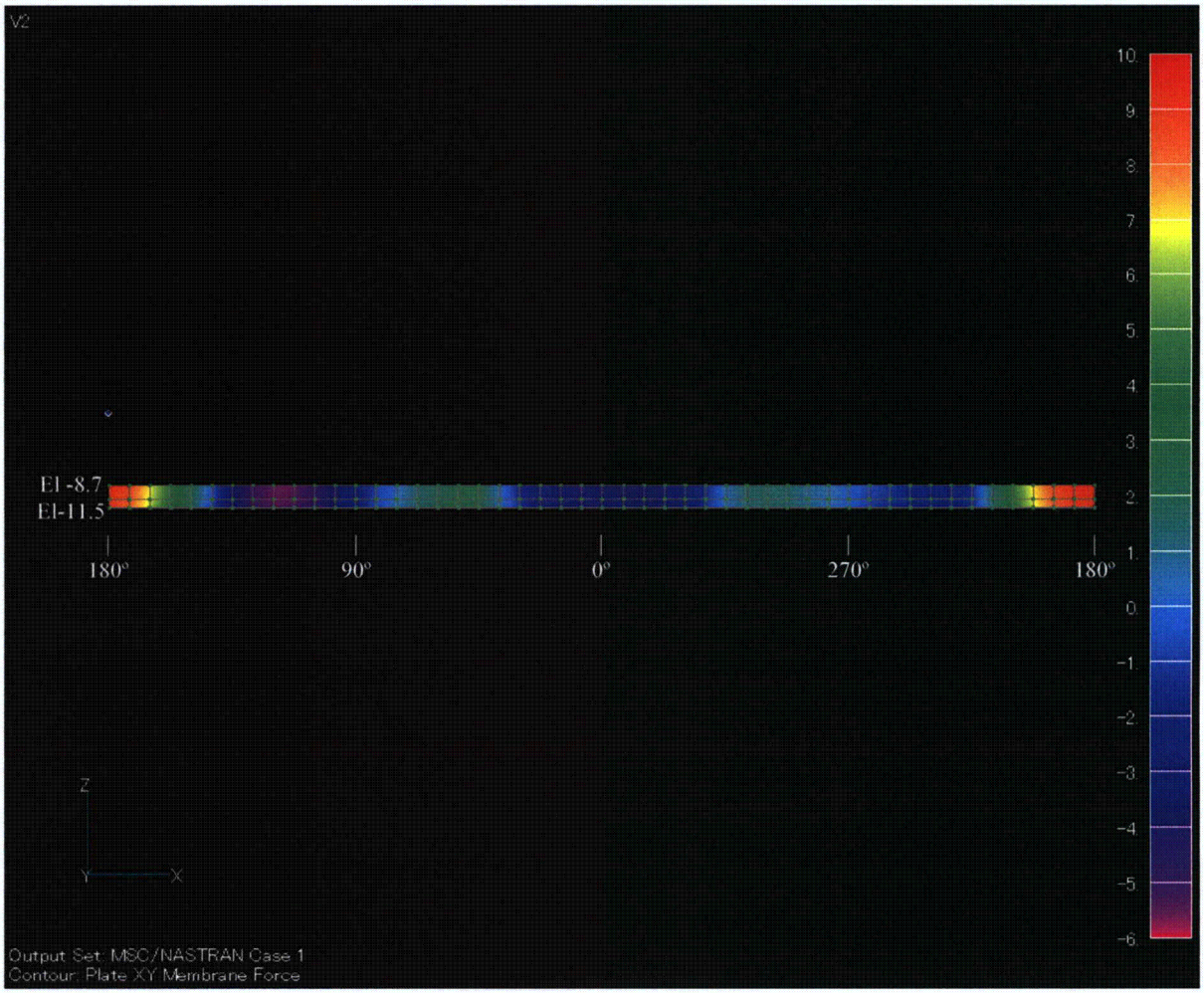
Unit: MN/m

Figure 3-36 Contour of Tangential Shear in Cylinder Wall below RCCV: Original Truncated Model (Seismic Load: Nxy)



Unit: MN/m

Figure 3-37 Contour of Tangential Shear in Cylinder Wall below RCCV: Modified Truncated Model (Seismic Load: Nxy)



Unit: MN/m

Figure 3-38 Contour of Tangential Shear in Cylinder Wall below RCCV: Extended Truncated Model (Seismic Load: Nxy)

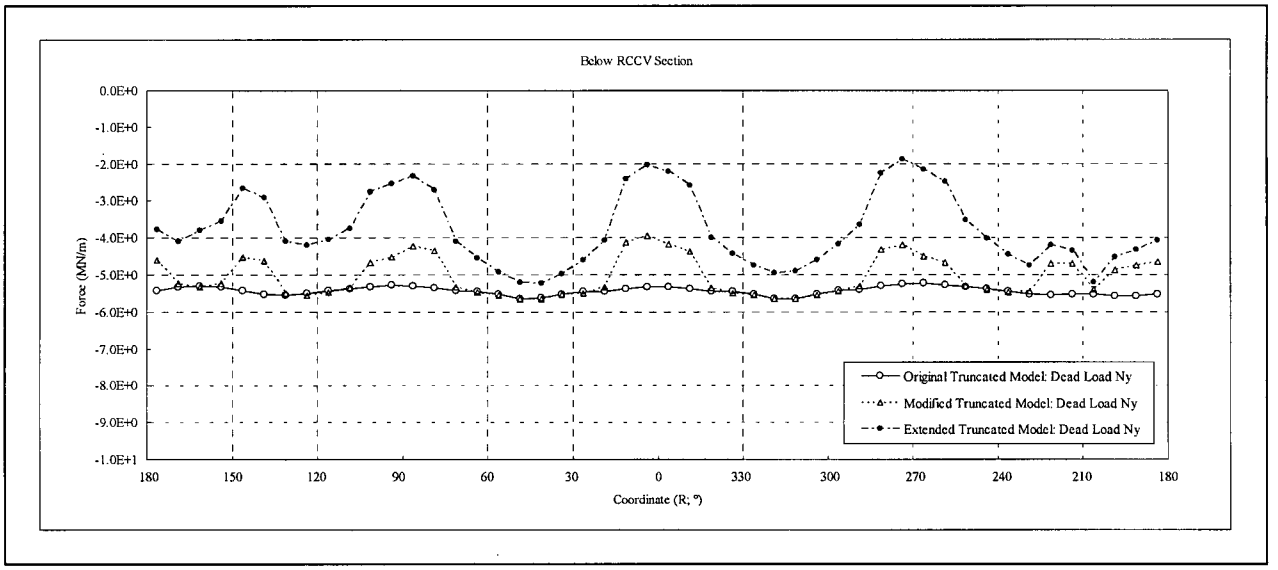


Figure 3-39 Membrane Force in Cylindrical Wall below RCCV (Dead Load: Ny)

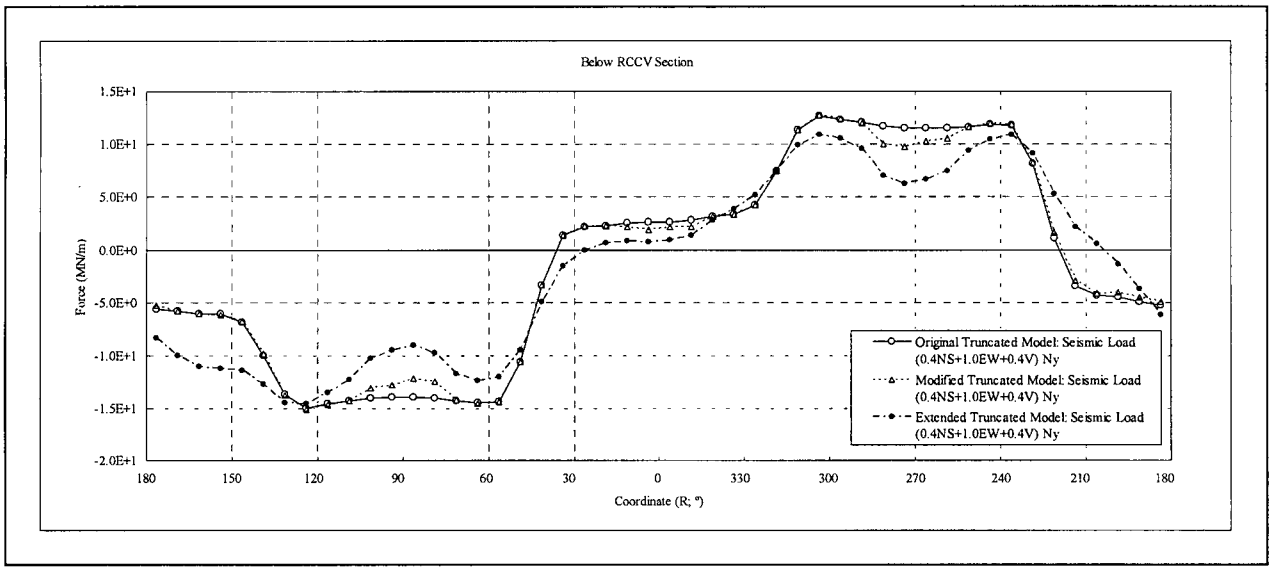


Figure 3-40 Membrane Force in Cylindrical Wall below RCCV (Seismic Load: Ny)

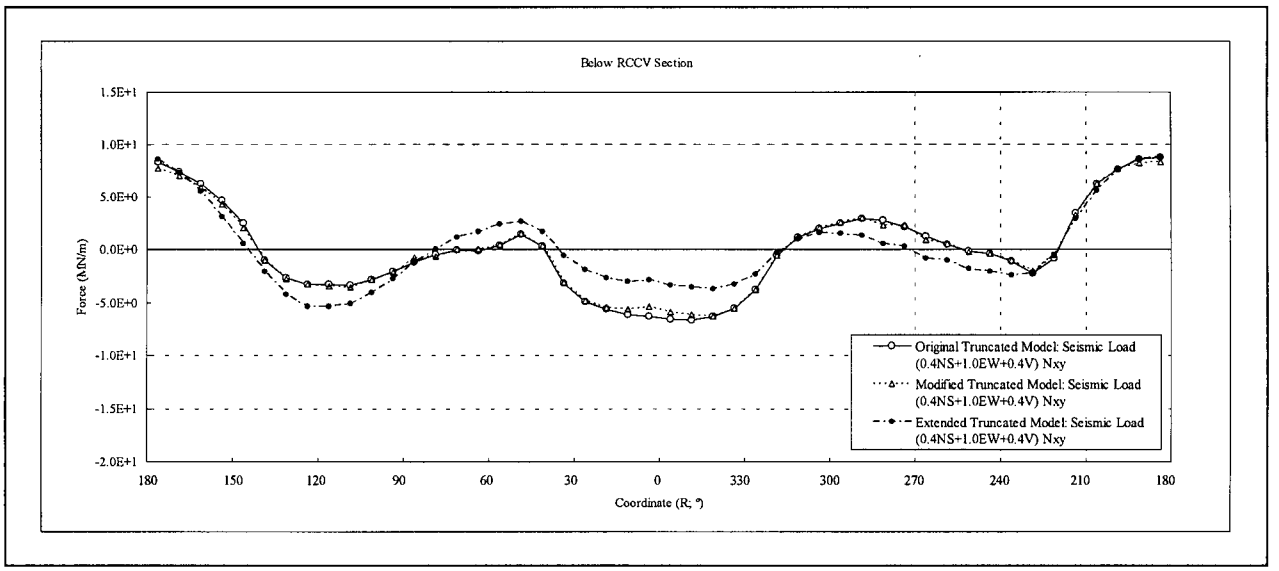


Figure 3-41 Tangential Shear in Cylindrical Wall below RCCV (Seismic Load: Nxy)

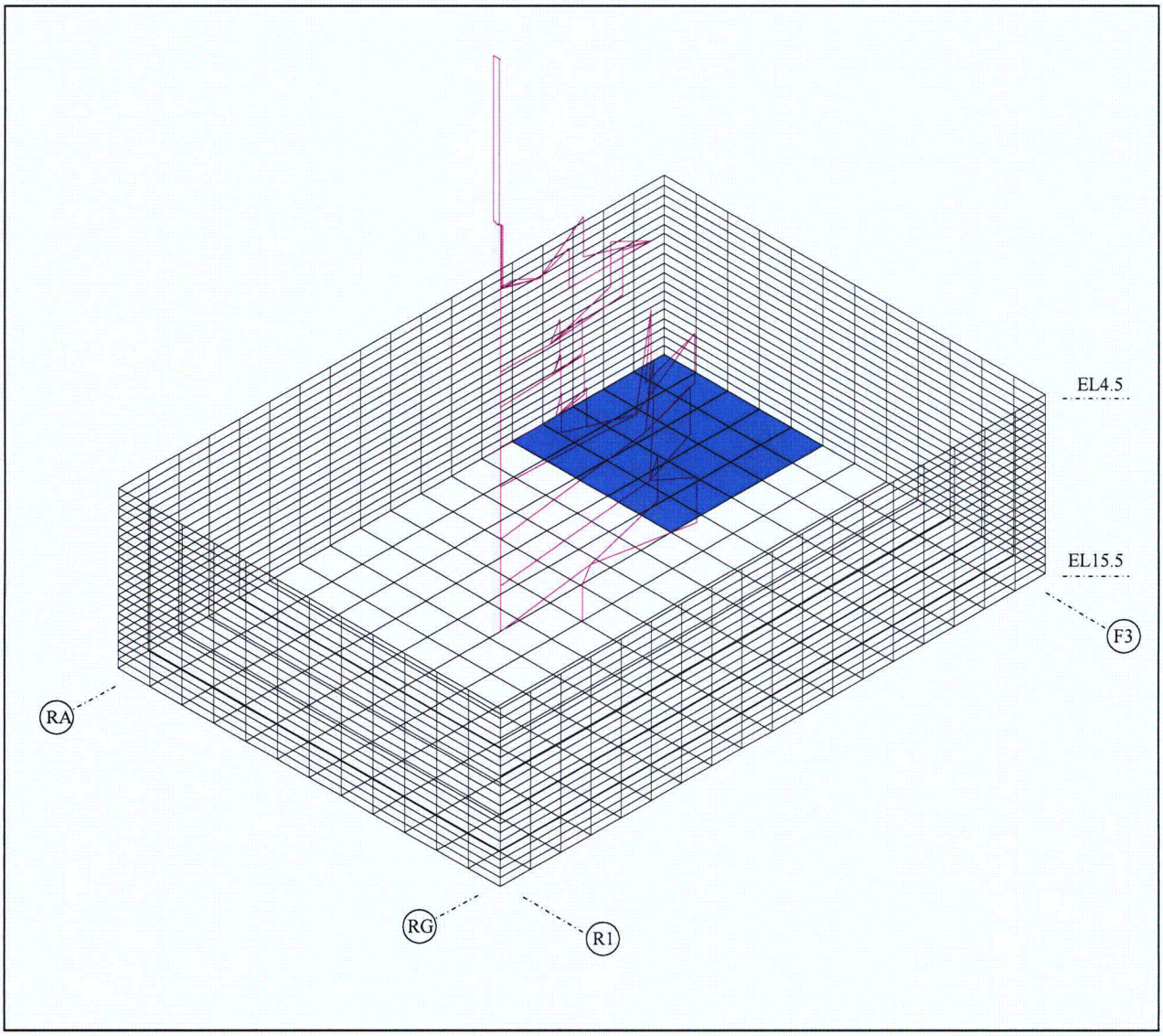


Figure 4-1 SASSI Analysis Model

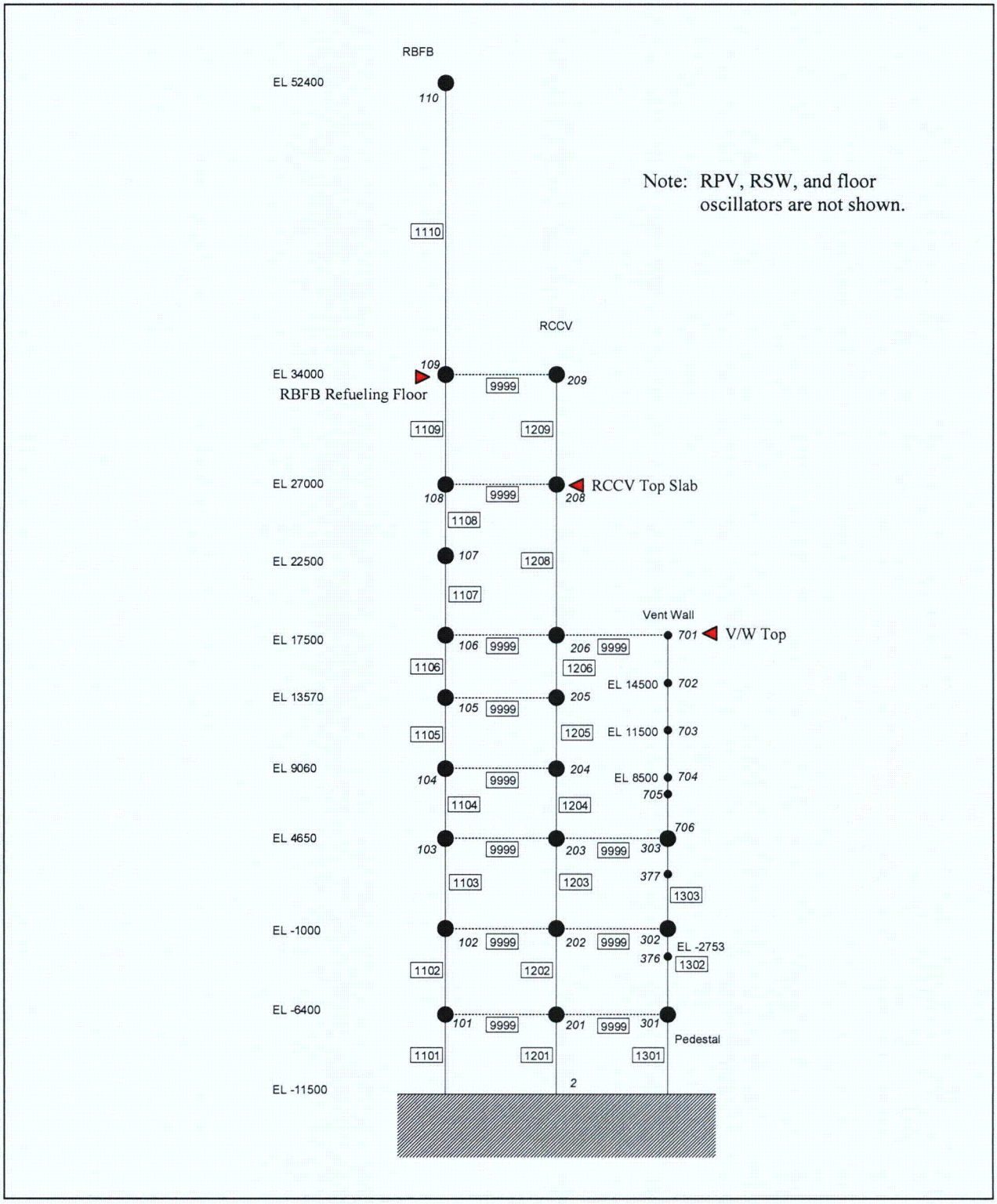


Figure 4-2 FRS Selected Point

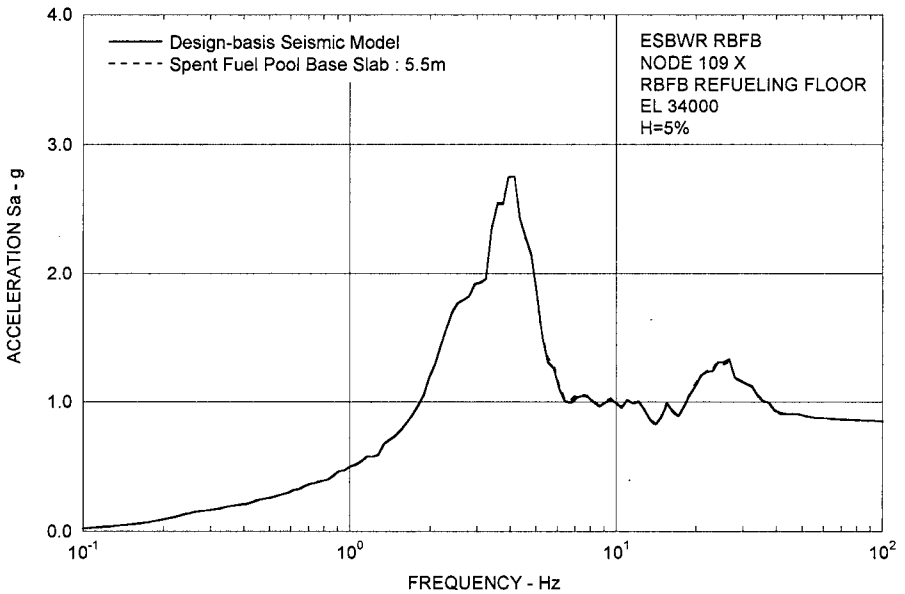


Figure 4-3 Floor Response Spectra at RBFB Refueling Floor -X-dir-

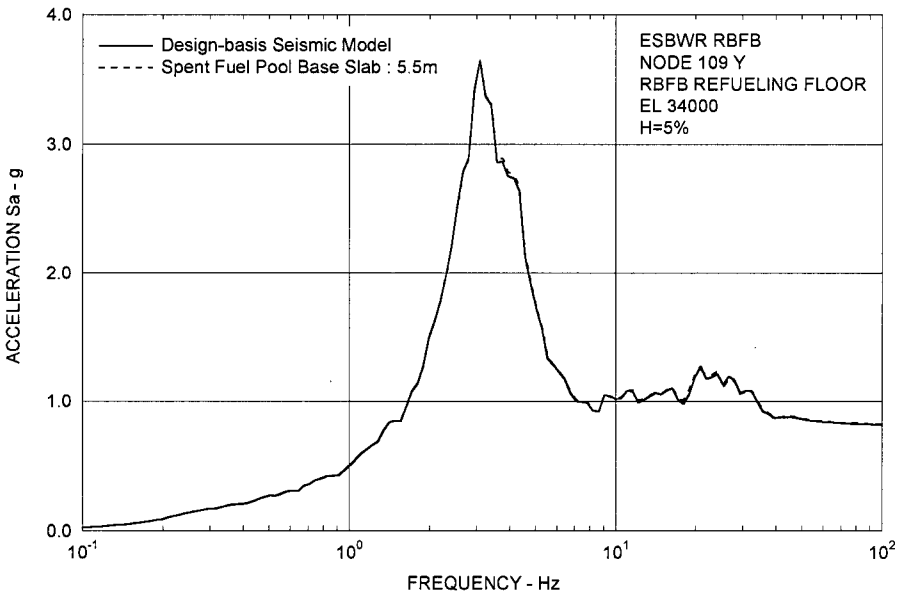


Figure 4-4 Floor Response Spectra at RBFB Refueling Floor -Y-dir-

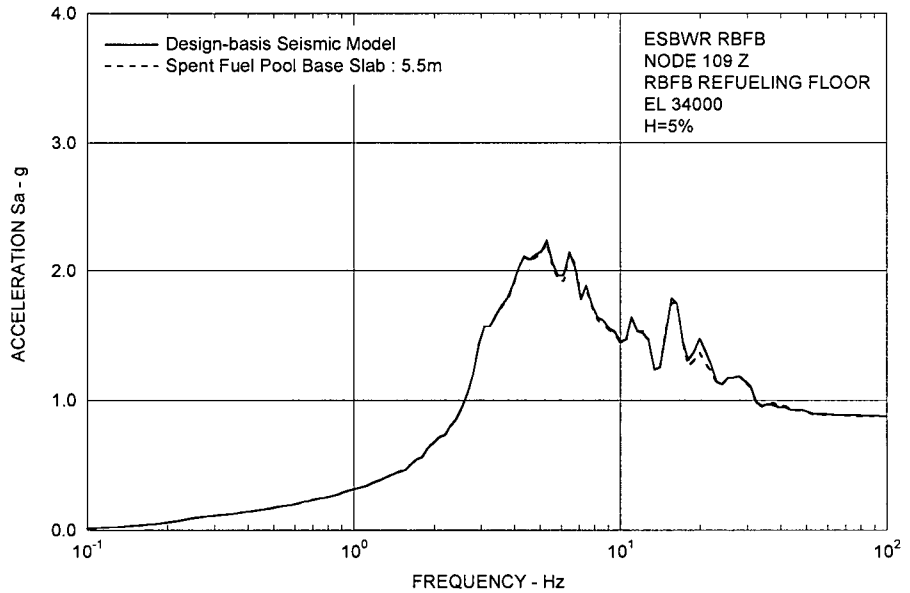


Figure 4-5 Floor Response Spectra at RBFB Refueling Floor -Z-dir-

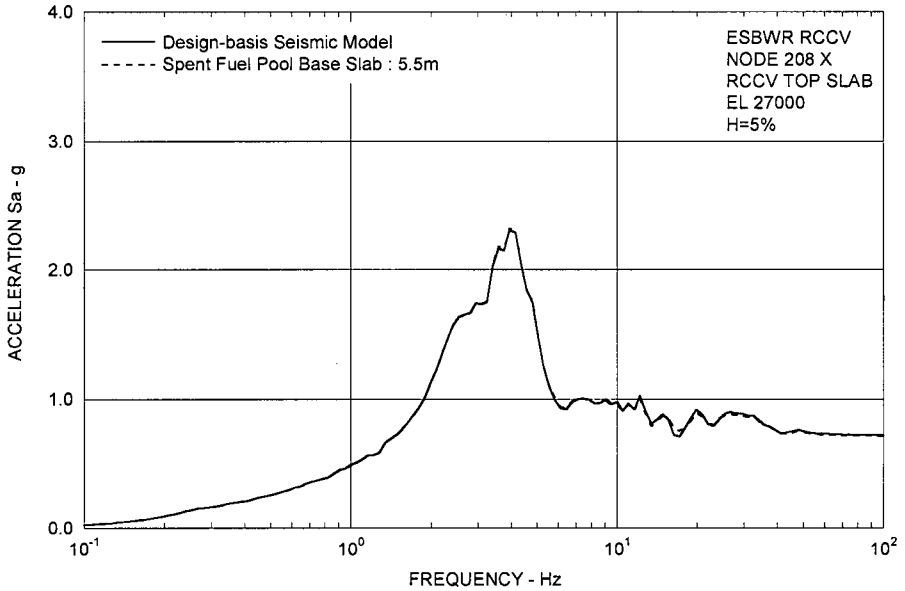


Figure 4-6 Floor Response Spectra at RCCV Top Slab -X-dir-

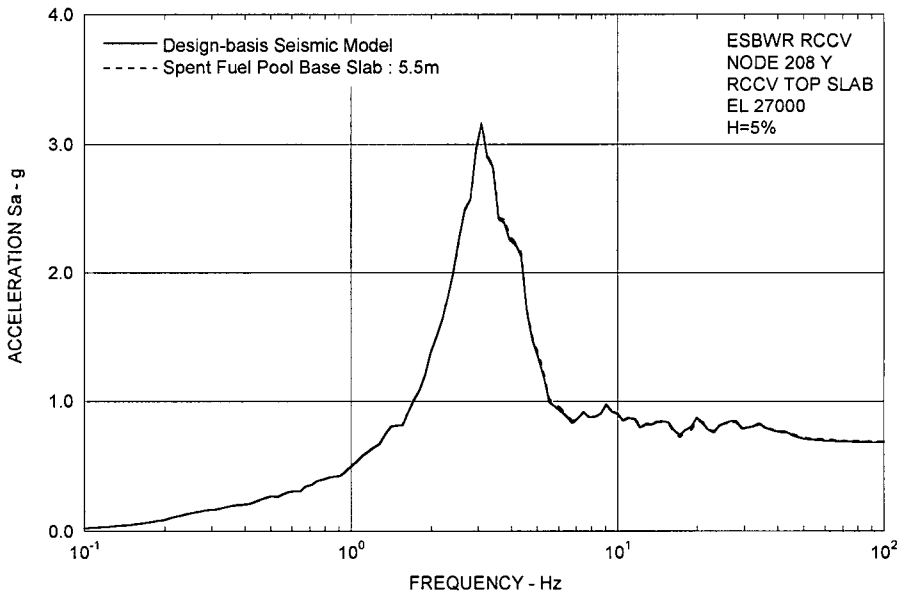


Figure 4-7 Floor Response Spectra at RCCV Top Slab -Y-dir-

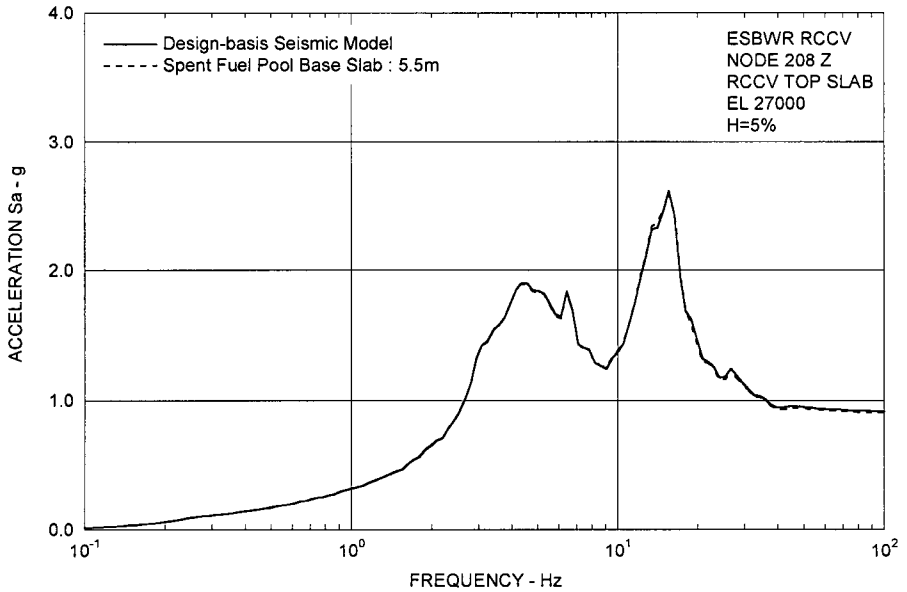


Figure 4-8 Floor Response Spectra at RCCV Top Slab -Z-dir-

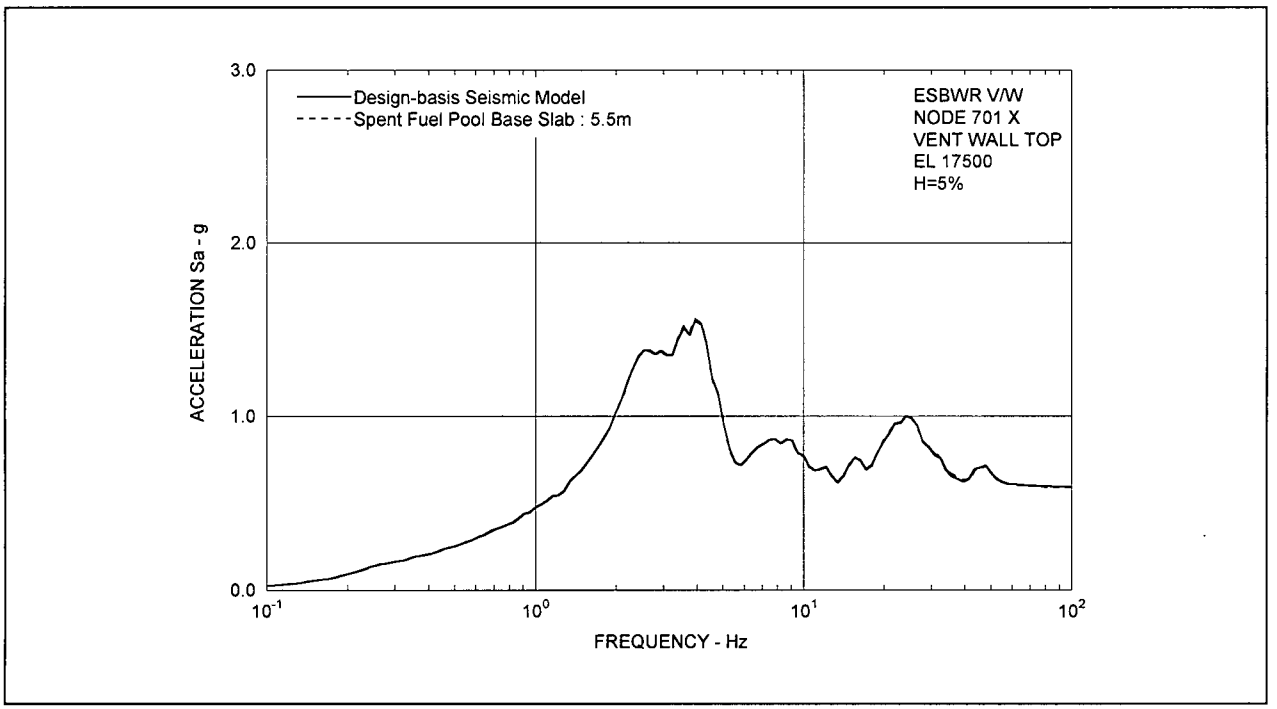


Figure 4-9 Floor Response Spectra at V/W Top -X-dir-

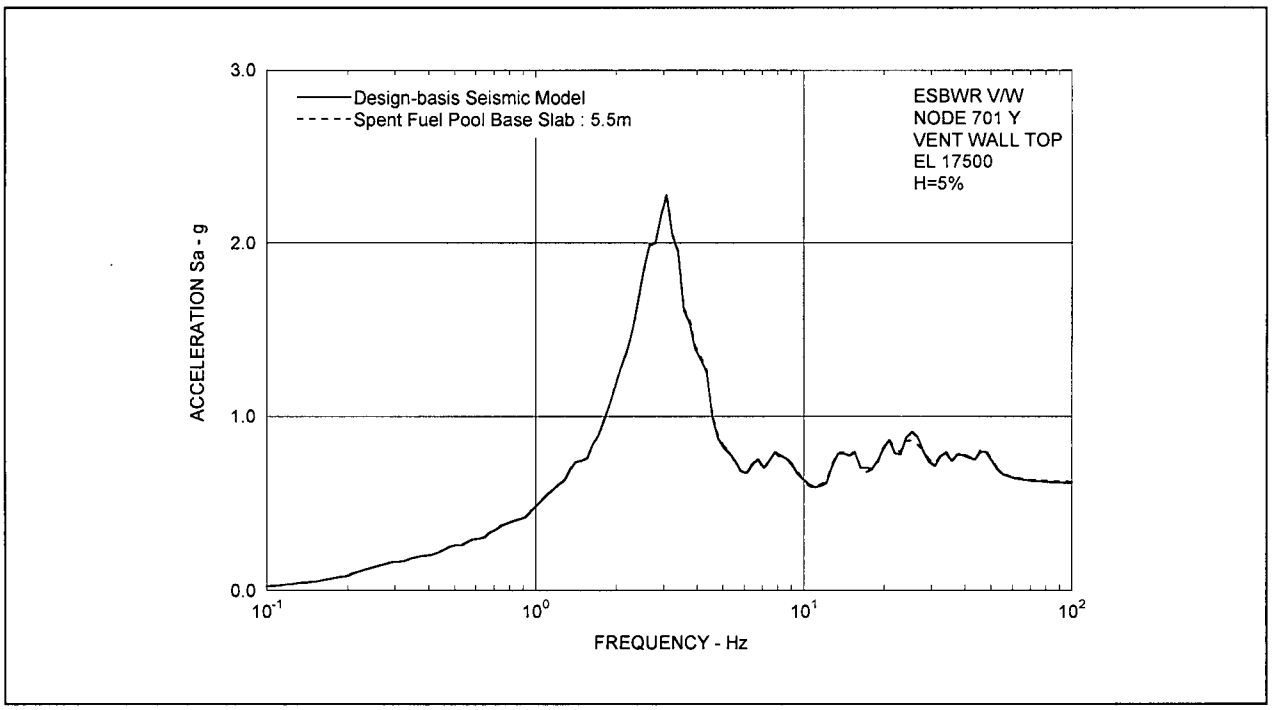


Figure 4-10 Floor Response Spectra at V/W Top -Y-dir-

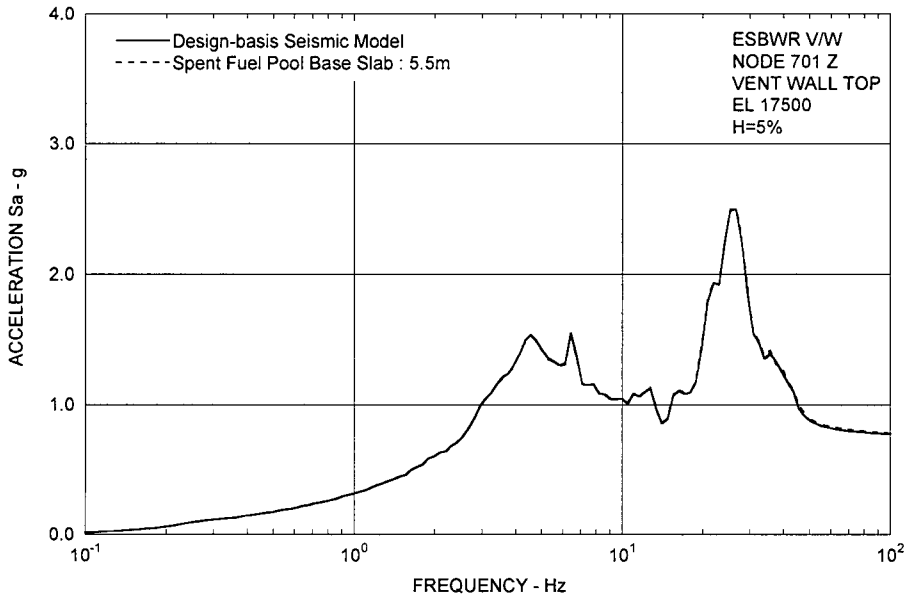


Figure 4-11 Floor Response Spectra at V/W Top -Z-dir-

ENCLOSURE 3

MFN 06-262
Supplement 2

NASTRAN Analysis Input Data and

NASTRAN Analysis Results