Attachment 1
NRC3-13-0017

Sargent & Lundy Report SL-011814, "Modified Subtraction Method (MSM) Reactor Building/Fuel Building Benchmark Summary Report," Revision 0, dated May 2, 2013
(following 98 pages)

DTE Electric Company
Fermi 3 – ESBWR

Modified Subtraction Method (MSM)
Reactor Building/Fuel Building
Benchmark Summary Report

SL-011814

Nuclear Safety-Related
Revision 0
May 2, 2013

Prepared by: 5/2/2013
Surendra Singh

Reviewed by: 5/2/2013
Ming S. Yang

5/2/2013
John Pop

5/2/2013
James W. McIntyre

Approved by: 5/2/2013
Javad Moslemian

Sargent & Lundy LLC

Project No.: 12583-201

Table of Contents

Section **Page**

Executive Summary

Soil-Structure Interaction (SSI) analysis of the Reactor Building / Fuel Building (RB/FB) with engineered granular backfill above the top of the Bass Islands Group bedrock will be performed to confirm that the engineered granular backfill does not adversely impact RB/FB. Considering the 50 Hz minimum required passing frequency of the SSI models, for Direct Method (DM) of analysis, the number of interaction nodes will far exceed the capacity of the SASSI2010 program which is about 20,000 interaction nodes.

As a result of this program limitation, use of Modified Subtraction Method (MSM) of analysis is required to limit the number of interaction nodes to less than 20,000. However, when using MSM, selection of additional nodes within the excavated soil volume to be declared as interaction nodes requires benchmarking of the MSM model results against the DM model results to ensure that the selected additional interaction nodes is adequate for producing reliable/accurate SSI results.

As detailed within the body of this summary report, two (2) RB/FB MSM quarter models denoted as MSM2 and MSM3 models were selected and analyzed. All pertinent SSI analysis results from these two MSM quarter models were benchmarked against the corresponding SSI analysis results from the RB/FB DM quarter model. Based on the results of this benchmarking, it is concluded that the MSM SSI analysis of the RB/FB full SSI model using the scheme considered for declaration of additional interaction nodes within the excavated soil volume of MSM2 model will produce reliable/accurate SSI results. Considering this, in the MSM model of the RB/FB for SSI analysis with engineered granular backfill, in addition to the boundary nodes of the excavated soil volume, the excavated soil volume nodes at Elevations 4.65 m (ground surface) and -2.025 m will be declared as interaction nodes.

1.0 Introduction

In the Licensing Basis Soil-Structure Interaction (SSI) analysis of Fermi 3, the engineered granular backfill surrounding the Reactor Building/Fuel Building (RB/FB) and Control Building (CB) is not included. SSI analyses for the RB/FB and for the CB with the backfill are performed to demonstrate that the seismic responses obtained from the analyses including the backfill remain bounded by the DCD design.

In the RB/FB SSI model with engineered granular backfill, the number of interaction nodes in direct method (DM) model, which is adequate for passing frequencies up to 50 Hz, becomes so large that it becomes impractical to analyze the problem with SASSI2010 program. Hence for RB/FB with engineered granular backfill, the Modified Subtraction Method (MSM), also known as Extended Subtraction Method, will be used for the SSI analysis.

In the DM model, all nodes within and at the boundaries of the excavated soil volume are the interaction nodes. In the MSM model, the nodes at the boundaries of the excavated soil volume and only some of the nodes within the excavated soil volume are defined as interaction nodes. This results in reduction of the number of interaction nodes in the MSM model as compared to the number of interaction nodes in DM model. In SASSI2010, Subtraction Method (SM) model has interaction nodes only at the side and bottom boundaries of the excavated soil volume. However, before using a MSM model, a study has to be performed for deciding the interaction nodes to be added to a SM model such that the result from the MSM model converges to the results from the DM model. This study is called Benchmarking of the MSM model

2.0 Reactor Building/ Fuel Building Benchmark

An important condition for benchmarking the MSM model with DM model is that the models are representative of the actual structure (dynamic characteristics, foundation width to depth ratio, embedment depth and weight of the structure). In addition, the soil profile and the input motion should be same as those used for the SSI analysis of the structure. Both DM and MSM models should also meet the mesh dimension requirements for the passing frequency of interest (in this case a 50 Hz frequency). To keep the DM model interaction nodes within SASSI2010 practical limits, a Quarter model of the RB/FB is used.

2.1 Use of Quarter Models

Quarter Model Acceptability for RB/FB: For a structure which is symmetric about the two horizontal axes, a quarter model is adequate to perform the seismic analyses. The RB/FB is not completely symmetric about the two horizontal axes;

however, the eccentricities are small. The transfer functions plots in SER-DTF-006 (Reference 1) and SER-DTF-008 (Reference 2) were investigated in view of the torsional effect. The review shows that the Y-direction transfer functions due to X direction excitation have considerably small amplitudes as compared to the corresponding Y-direction transfer function amplitudes due to the Y-direction excitation. Similarly, X-direction transfer functions due to Y direction excitation have considerably small amplitudes as compared to corresponding X-direction transfer function amplitudes due to the X-direction excitation. Thus, the structure has small cross coupling between the two horizontal direction responses. The related transfer functions from Reference 1 are shown in Figures 1 through 6 and from Reference 2 are shown in Figures 7 through 12.

The above investigations show that the effect of eccentricity is comparatively small as it relates to the torsional response of RB/FB. Thus, the use of quarter model of the RB/FB is reasonable for benchmarking the MSM model of RB/FB.

2.2 Quarter DM Model

For making the quarter model of the RB/FB, the structure is idealized as symmetric about the X-Z and Y-Z planes, where X and Y are horizontal axes and Z is the vertical axis. The following provides the details of the quarter SSI model and seismic input to the model.

- Figure 13 shows a schematic plan of the quarter model, its planes of symmetry, and the symmetric / anti-symmetric boundary conditions.
- The stick (beams) parts of the RB/FB model are along the Z-axis at the center of the RB/FB basemat.
- In the stick parts of the model, there are no eccentricities between the centers of mass and centers of rigidity.
- In the quarter model, the translational mass and stiffness values of the sticks are one fourth (1/4) of the respective values in the full model.
- In the quarter model, the excavated soil volume properties are the same as those in the full model (in the full model, the excavated volume is symmetric about two horizontal axes).
- In the quarter model, the exterior walls below grade, the foundation basemat and the supporting soil (rock) medium properties are the same as those in the full model (in the full model, these structural elements are symmetric about two horizontal axes).
- All excavated soil volume nodes are defined as interaction nodes for direct method of analysis.
- The upper bound (UB) soil-rock profile from Reference 3 is used in the model. The soil-rock profile properties provided in Reference 3 are corresponding to the acceleration time histories based upon the Central and Eastern United States (CEUS) Seismic Source Characterization (SSC)

Model. The soil-rock layers thickness are adjusted to be capable of transmitting shear waves with at least 50 Hz (thicknesses not greater than 20 percent of the corresponding layer shear wave length).

- The excavated volume is modeled using 8-node solid elements. To meet the SASSI2010 (Reference 5) requirements, the maximum horizontal and vertical mesh dimensions in the excavated volume are limited to less than 20 percent of the shear wave length of the subsurface material at frequency of 50 Hz.
- The interior of the RB/FB and the walls above the grade elevation are modeled by beam elements. The exterior walls below the grade elevation are modeled by thin plate (shell) elements (same as in ESBWR DCD). The aspect ratios (length/height) of the plate elements are less than 3.0.
- For calculating the lateral soil pressure on the embedded exterior wall, the embedded portion of the exterior walls have double nodes connected by 3-D rigid springs, with one end of each spring connected to the wall node and other to the adjacent boundary interaction node. The pairs of the double nodes at the same elevation have the same coordinates (location).
- The OBE damping values of 4% and 3% are used for reinforced concrete and welded steel parts of the RB/FB, respectively.
- Per SASSI2010 User's Manual (Reference 5, Section A.4.2) recommendation, upper limit of 0.48 is used for the Poisson's ratio in the soil layers below groundwater level.
- The in-column acceleration time histories representing SSI FIRS for UB soil-rock profile are applied at the elevation of the bottom of the RB/FB basemat. These acceleration time histories are from Reference 3. The acceleration time histories are based upon the CEUS SSC Model.
- Since the boundary conditions in the quarter model for the three directions of excitations are different, there is a separate SSI model for each direction of excitation (X-direction model, Y-direction model, and Z-direction model) with applicable boundary conditions.

Figure 14 shows the Quarter DM model of the RB/FB with the idealized stick at the center of the full model.

2.3 Quarter MSM Models

Two MSM models are examined to determine the adequate number interaction nodes which will lead to convergence of MSM SSI model results to the DM SSI model results.

In model 1, in addition to the interaction nodes in a standard Subtraction Method (SM) model, interaction nodes are added at two more layers, one at the ground

surface (Elevation 4.65 m) and second one within the granular backfill layer (Elevation -2.025m). This model is called MSM2 model.

In model 2, in addition to the interaction nodes in the MSM2 model, interaction nodes are added at an additional elevation of 0.971 m. This model is called MSM3 model.

The boundary conditions, soil-rock profile, layer thicknesses and input motions in these two models are same as those in the DM model described in Section 2.2. Figures 15 and 16 show the MSM2 and MSM3 models. The figures also show the additional layers which have interaction nodes in the corresponding models.

2.4 Comparison of SSI Results

The following responses are calculated for each model for three directions of excitations and the results from the three models are compared:

- Transfer functions (both calculated and interpolated) at the following key locations of RB/FB. These key locations are same as those where enveloped response spectra are provided in ESBWR DCD Appendix 3A (Reference 4):
  - RB/FB Refueling Floor
  - RCCV Top Slab
  - Vent Wall Top
  - RSW Top
  - RPV Top
  - RB/FB Basemat
- 5% damped floor response spectra (FRS) at the above key locations of RB/FB.
- Maximum absolute accelerations at the above key locations of RB/FB
- Maximum forces and moments in RB/FB key elements (elements listed in ESBWR DCD Appendix 3A)
- Relative displacements between selected nodes
- Seismic soil pressures on the exterior walls

2.4.1 Comparison of Transfer Functions

Figures 17 through 22 show the comparisons of X-direction calculated transfer functions due to X-direction excitation at various key locations of RB/FB. Figures 23 through 28 show the comparisons of Y-direction calculated transfer functions due to Y-direction excitation at various key locations of RB/FB. Figures 29 through 34 show the comparisons of Z-direction calculated transfer functions due to Z-direction excitation at various key locations of RB/FB.

A review of the calculated transfer functions show that the transfer functions from the MSM2 and MSM3 models are identical to the DM model, except some deviation at frequencies between 47 Hz and 49 Hz at RB/FB RSW Top (see Figures 21, 27, and 33). However, the deviations in the transfer functions of RB/FB RSW Top are relatively small.

Figures 35 through 40 show the comparisons of X-direction interpolated transfer functions due to X-direction excitation at various key locations of RB/FB. Figures 41 through 46 show the comparisons of Y-direction interpolated transfer functions due to Y-direction excitation at various key locations of RB/FB. Figures 47 through 52 show the comparisons of Z-direction interpolated transfer functions due to Z-direction excitation at various key locations of RB/FB.

A review of the interpolated transfer functions shows similar characteristics as the calculated transfer functions, i.e. the transfer functions from the MSM2 and MSM3 models are identical to the DM model, except some deviation at frequencies between 47 Hz and 49 Hz at RB/FB RSW Top.

A review of response spectra comparisons at RB/FB RSW Top (Figures 57, 63, and 69) shows that the response spectra from DM, MSM2, and MSM3 models are almost identical, even in the frequency range of 47 Hz to 49 Hz. This is due to the fact that the input motions have insignificant energy in this range of frequencies. Hence, the transfer function deviations observed in the 47 Hz to 49 Hz range will not have any impact on the seismic response of the building.

2.4.2 Comparison of Floor Response Spectra (FRS)

Figures 53 through 58 show the comparisons of X-direction 5% damped FRS due to X-direction excitation at various key locations of RB/FB. Figures 59 through 64 show the comparisons of Y-direction 5% damped FRS due to Y-direction excitation at various key locations of RB/FB. Figures 65 through 70 show the comparisons of Z-direction 5% damped FRS due to Z-direction excitation at various key locations of RB/FB.

A review of the FRS shows that the FRS from the MSM2 and MSM3 models are almost identical to the corresponding FRS from the DM model.

2.4.3 Comparison of Maximum Absolute Accelerations

The comparisons between the maximum absolute accelerations in X-, Y-, and Z-directions at key locations of RB/FB from the DM model and MSM2 model are provided in Tables 1 through 3. Maximum difference between the results from

DM and MSM2 models are 0.76% for X-direction acceleration, 0.83% for Y-direction acceleration and 1.27% for the Z-direction acceleration.

The comparisons between the maximum absolute accelerations in X-, Y-, and Z-directions at key locations of RB/FB from the DM model and MSM3 model are provided in Tables 4 through 6. Maximum difference between the results from DM and MSM3 models are 0.51% for X-direction acceleration, 1.16% for Y-direction acceleration and 1.03% for the Z-direction acceleration.

The above comparisons show that the maximum absolute accelerations from both MSM2 and MSM3 models are almost same as those from DM model. The maximum difference is 1.27%, which is insignificant.

2.4.4 Comparison of Maximum Forces and Moments

The comparisons between the maximum forces and moments in the X-, Y-, and Z-directions in key elements of RB/FB from the DM model and MSM2 model are provided in Tables 7 through 9. Maximum difference between the results from DM and MSM2 models are 1.03% for X-direction forces and moments, 0.49% for Y-direction forces and moments, and 0.95% for the Z-direction forces and moments.

The comparisons between the maximum forces and moments in the X-, Y-, and Z-directions in key elements of RB/FB from the DM model and MSM3 model are provided in Tables 10 through 12. Maximum difference between the results from DM and MSM3 models are 0.51% for X-direction forces and moments, 0.99% for Y-direction forces and moments, and 1.03% for the Z-direction forces and moments.

The above comparisons show that the maximum forces and moments from both MSM2 and MSM3 models are almost same as those from DM model. The maximum difference is 1.03%, which is insignificant.

2.4.5 Comparison of Relative Displacements

The comparisons between the maximum relative displacements in X-, Y-, and Z-directions between the key locations of RB/FB from the DM model and MSM2 model are provided in Tables 13 through 15.

The comparisons between the maximum relative displacements in X-, Y-, and Z-directions between the key locations of RB/FB from the DM model and MSM3 model are provided in Tables 16 through 18.

The above comparisons show that the maximum relative displacements between the key locations of RB/FB from both MSM2 and MSM3 models are almost same as those from DM model.

2.4.6 Comparison of Seismic Soil Pressures

Seismic soil pressures are calculated on the North wall (wall normal to X-axis) and on the West wall (wall normal to Y-axis) from the DM, MSM2, and MSM3 models. Figures 71 and 72 show the soil pressure profiles on the north and west walls, respectively, due to X-direction (north-south) input motion. Figures 73 and 74 show the soil pressure profiles on the west and north walls, respectively, due to Y-direction (east-west) input motion. Figures 75 and 76 show the soil pressure profiles on the west and north walls, respectively, due to Z-direction (vertical) input motion. Figures 77 and 78 show the soil pressure profiles on the west and north walls, respectively, due to combination of X-, Y-, and Z-direction input motions (using SRSS combination). In the figures, the RB/FB basemat and floor slab locations and thicknesses are shown by shaded areas.

The review of the soil pressure profiles calculated from the DM, MSM2, and MSM3 models shows that the pressure profiles from the MSM2 and MSM3 models are very close to the pressure profile from DM model. Only exception is the peak pressure on the north wall at elevation -7.5 m (near the bottom of the first floor above the basemat, Figures 71 and 78). The peak pressure from DM model exceeds corresponding peak pressures from MSM2 and MSM3 models by about 12%. At elevation -9.50 m, the pressure on the west wall from DM exceeds the pressures from MSM2 and MSM3, but the DM and MSM2-MSM3 pressure profiles crisscross between elevations -9.5m and -11.5m (see Figure 27) and the average pressures would be about the same. From benchmarking point of view these differences are small and, furthermore, from the wall panel design point of view these differences are even less important because the difference in the critical out-of-plane shear and moments will be far less than 10%.

3.0 Conclusions

The total number of interaction nodes in RB/FB SSI model with engineered granular backfill for direct method (DM) of analysis and for a passing frequency of 50 Hz becomes so large that it becomes impractical to analyze the model using SASSI2010 program. Hence, the RB/FB SSI analysis will be performed using MSM (also known as Extended Subtraction Method). In MSM, fewer interaction nodes are used compared to the DM. Use of MSM reduces the SSI problem size such that it can be analyzed using SASSI2010. However, MSM model has to be benchmarked to assure that the results from the MSM model will converge to (i.e., are acceptably close to) the corresponding results from the DM model. This study has been performed to determine the number and location of interaction nodes to be used in the MSM model. For benchmark study, generally a smaller model is used which could be analyzed using both DM and MSM. However, the smaller model should be representative of the actual full model in view of the dynamic characteristics, foundation width to depth ratio, embedment depth, the weight of the structure, soil-rock profile, and the input motion. For benchmarking study a Quarter SSI model of RB/FB is used. In this study, an assessment of the adequacy of the Quarter model to meet the above requirements is provided.

Three Quarter models are analyzed; (1) DM model, (2) MSM2 model, and (3) MSM3 model. In DM model all nodes in the excavated soil volume are interaction nodes. In MSM2 model, in addition to interaction nodes in a standard Subtraction Method (SM) model, interaction nodes are added at two additional layers in the excavated soil volume of the SSI model. In MSM3 model, in addition to interaction nodes in the MSM2 model, interaction nodes are added at an additional layer in the excavated soil volume of the SSI model.

The pertinent SSI results (transfer functions, floor response spectra, maximum absolute accelerations, maximum forces and moments, relative displacements, and seismic soil pressures) at key locations and elements of the RB/FB from the three models are compared. The comparative results are provided in the report. The comparison shows that the results from both MSM2 model and MSM3 model converge to (i.e., are acceptably close to) the corresponding results from the DM model. Furthermore, the results from MSM2 and MSM3 models are very comparable with insignificant differences. However, the number of interaction nodes for full MSM2 and MSM3 models will be 17,858 and 22,258, respectively. Since the number of interaction nodes for full MSM3 model exceeds the approximate SASSI2010 limit of 20,000 interaction nodes, MSM2 is the more preferable option.

Based on the results of this study, it is concluded that for the full RB/FB SSI analysis a MSM model will be used. The MSM model will have interaction nodes corresponding to the MSM2 Quarter model, i.e., in addition to interaction nodes in a full SM model, interaction nodes will be added at two additional layers at Elevations 4.65 m (ground surface) and -2.025 m in the excavated soil volume of the SSI model.

4.0 References

1 SER-DTF-006, Rev. 1, DTE Fermi ESBWR SSI analysis Report by Direct method for the Reactor Building/Fuel Building Complex & Control Building.

2 SER-DTF-008, Rev. 1, Shimizu Response to NRC RAI 3.7.2-06, 3.7.2-8 and 3.8.5-4 item (c).

3 DTE Electric Company Letter No. 2013-MEP-F3COLA-0021, "Soil Profile and Acceleration Time Histories Based Upon the Central and Eastern United States Seismic Source Characterization Model", February 14, 2013.

4. ESBWR Design Control Document, Tier 2, Revision 9, December 2010.

5. SASSI2010 Version 1.0 User's Manual, "A System for Analysis of Soil-Structure Interaction", Farhang Ostadan and Nan Deng, May 2012.

Table 1: Comparison of X-Direction Maximum Absolute Accelerations from DM and MSM Models (X excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM2 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM2 Model
RB/FB Basemat	-11.50	20	0.224	0.224	0.0%
RB/FB Vent Wall	17.50	701	0.394	0.391	0.76%
RB/FB RSW Top	24.18	707	0.560	0.557	0.54%
RB/FB RCCV Top Floor	27.00	280	0.417	0.417	0.00%
RB/FB RPV Top	27.64	801	1.126	1.123	0.27%
RB/FB Refueling Floor	34.00	190	0.554	0.553	0.18%

Maximum Difference = 0.76%

Table 2: Comparison of Y-Direction Maximum Absolute Accelerations from DM and MSM2 Models (Y excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM2 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM2 Model
RB/FB Basemat	-11.50	20	0.187	0.186	0.53%
RB/FB Vent Wall	17.50	701	0.370	0.371	0.27%
RB/FB RSW Top	24.18	707	0.606	0.601	0.83%
RB/FB RCCV Top Floor	27.00	280	0.509	0.510	0.20%
RB/FB RPV Top	27.64	801	0.854	0.856	0.23%
RB/FB Refueling Floor	34.00	190	0.617	0.619	0.32%

Maximum Difference = 0.83%

Table 3: Comparison of Z-Direction Maximum Absolute Accelerations from DM and MSM2 Models (Z excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM2 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM2 Model
RB/FB Basemat	-11.50	20	0.196	0.194	1.02%
RB/FB Vent Wall	17.50	701	0.270	0.271	0.37%
RB/FB RSW Top	24.18	707	0.483	0.480	0.62%
RB/FB RCCV Top Floor	27.00	280	0.326	0.325	0.31%
RB/FB RPV Top	27.64	801	0.788	0.778	1.27%
RB/FB Refueling Floor	34.00	190	0.358	0.360	0.56%

Maximum Difference = 1.27%

Table 4: Comparison of X-Direction Maximum Absolute Accelerations from DM and MSM3 Models (X excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM3 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM3 Model
RB/FB Basemat	-11.50	20	0.224	0.224	0.00%
RB/FB Vent Wall	17.50	701	0.394	0.392	0.51%
RB/FB RSW Top	24.18	707	0.560	0.558	0.36%
RB/FB RCCV Top Floor	27.00	280	0.417	0.417	0.00%
RB/FB RPV Top	27.64	801	1.126	1.123	0.27%
RB/FB Refueling Floor	34.00	190	0.554	0.554	0.00%

Maximum Difference = 0.51%

Table 5: Comparison of Y-Direction Maximum Absolute Accelerations from DM and MSM3 Models (Y excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM3 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM3 Model
RB/FB Basemat	-11.50	20	0.187	0.187	0.00%
RB/FB Vent Wall	17.50	701	0.370	0.370	0.00%
RB/FB RSW Top	24.18	707	0.606	0.599	1.16%
RB/FB RCCV Top Floor	27.00	280	0.509	0.51	0.2%
RB/FB RPV Top	27.64	801	0.854	0.855	0.12%
RB/FB Refueling Floor	34.00	190	0.617	0.619	0.32%

Maximum Difference = 1.16%

Table 6: Comparison of Z-Direction Maximum Absolute Accelerations from DM and MSM3 Models (Z excitation)

Location	Elevation (m)	Node No.	DM Model Maximum Accelerations (g)	MSM3 Model Maximum Accelerations (g)	Difference between Maximum Accelerations from DM Model and MSM3 Model
RB/FB Basemat	-11.50	20	0.196	0.194	1.03%
RB/FB Vent Wall	17.50	701	0.270	0.271	0.37%
RB/FB RSW Top	24.18	707	0.483	0.480	0.62%
RB/FB RCCV Top Floor	27.00	280	0.326	0.326	0.00%
RB/FB RPV Top	27.64	801	0.788	0.780	1.02%
RB/FB Refueling Floor	34.00	190	0.358	0.361	0.84%

Maximum Difference = 1.03%

Table 7: Comparison of X-Direction Maximum Forces/Moments from DM and MSM2 Models (X excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM2 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM2 Model
RPV Support	815 – 711 (Gr 4 El 28)	Shear	11.557	11.584	0.23%
		Moment	55.155	54.919	0.43%
RSW Base	710 – 711 (Gr 3 El 9)	Shear	4.849	4.856	0.16%
		Moment	58.410	58.254	0.27%
Vent Wall Base	704 – 705 (Gr 3 El 4)	Shear	16.013	15.942	0.44%
		Moment	94.814	94.92	0.12%
Pedestal Base	41 – 313 (Gr 1 El 24)	Shear	18.492	18.633	0.76%
		Moment	126.589	126.275	0.25%
	42 – 314 (Gr 1 El 48)	Shear	0.076	0.077	1.32%
		Moment	0.203	0.204	0.49%
RCCV Base	31 – 213 (Gr 1 El 19)	Shear	40.169	40.483	0.78%
		Moment	1109.760	1112.898	0.28%
	32 – 214 (Gr 1 El 43)	Shear	0.076	0.077	1.32%
		Moment	0.203	0.204	0.49%
RB/FB Base	21 - 113 (Gr 2 El 4)	Shear	0.136	0.137	0.74%
		Moment	7.540	7.555	0.21%

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 1.32%

Table 8: Comparison of Y-Direction Maximum Forces/Moments from DM and MSM2 Models (Y excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM2 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM2 Model
RPV Support	815 – 711 (Gr 4 El 28)	Shear	8.611	8.611	0.00%
		Moment	48.839	48.839	0.00%
RSW Base	710 – 711 (Gr 3 El 9)	Shear	4.707	4.707	0.00%
		Moment	50.839	50.839	0.00%
Vent Wall Base	704 – 705 (Gr 3 El 4)	Shear	15.562	15.581	0.12%
		Moment	109.054	109.289	0.22%
Pedestal Base	41 – 313 (Gr 1 El 24)	Shear	19.237	19.320	0.43%
		Moment	111.564	111.957	0.35%
	42 – 314 (Gr 1 El 48)	Shear	0.080	0.080	0.49%
		Moment	0.209	0.210	0.19%
RCCV Base	31 – 213 (Gr 1 El 19)	Shear	41.778	41.935	0.38%
		Moment	1701.711	1700.534	0.07%
	32 – 214 (Gr 1 El 43)	Shear	0.080	0.080	0.49%
		Moment	0.209	0.210	0.19%
RB/FB Base	21 - 113 (Gr 2 El 4)	Shear	0.160	0.160	0.00%
		Moment	6.351	6.347	0.06%

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 0.49%

Table 9: Comparison of Z-Direction Maximum Forces/Moments from DM and MSM2 Models (Z excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM2 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM2 Model
RPV Support	815 – 711 (Gr 4 El 28)	Axial	14.514	14.420	0.65%
		Moment	0.0	0.0	NA
RSW Base	710 – 711 (Gr 3 El 9)	Axial	4.127	4.111	0.38%
		Moment	0.0	0.0	NA
Vent Wall Base	704 – 705 (Gr 3 El 4)	Axial	14.044	14.177	0.95%
		Moment	0.0	0.0	NA
Pedestal Base	41 – 313 (Gr 1 El 24)	Axial	0.119	0.119	0%
		Moment	0.0	0.0	NA
	42 – 314 (Gr 1 El 48)	Axial	30.464	30.417	0.15%
		Moment	0.0	0.0	NA
RCCV Base	31 – 213 (Gr 1 El 19)	Axial	0.119	0.119	0%
		Moment	0.0	0.0	NA
	32 – 214 (Gr 1 El 43)	Axial	65.04	64.922	0.18%
		Moment	0.0	0.0	NA
RB/FB Base	21 - 113 (Gr 2 El 4)	Axial	0.0001	0.0001	0.0%
		Moment	0.0	0.0	NA

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 0.95%

Table 10: Comparison of X-Direction Maximum Forces/Moments from DM and MSM3 Models (X excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM3 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM3 Model
RPV Support	815 – 711 (Gr 4 El 28)	Shear	11.557	11.588	0.27%
		Moment	55.155	54.919	0.43%
RSW Base	710 – 711 (Gr 3 El 9)	Shear	4.849	4.856	0.16%
		Moment	58.41	58.489	0.13%
Vent Wall Base	704 – 705 (Gr 3 El 4)	Shear	16.013	406.50	0.42%
		Moment	94.814	95.049	0.25%
Pedestal Base	41 – 313 (Gr 1 El 24)	Shear	18.492	18.571	0.42%
		Moment	126.589	126.000	0.46%
	42 – 314 (Gr 1 El 48)	Shear	0.076	0.077	1.32%
		Moment	0.203	0.204	0.39%
RCCV Base	31 – 213 (Gr 1 El 19)	Shear	40.169	40.326	0.39%
		Moment	1109.76	1113.683	0.35%
	32 – 214 (Gr 1 El 43)	Shear	0.076	0.077	1.32%
		Moment	0.203	0.204	0.39%
RB/FB Base	21 – 113 (Gr 2 El 4)	Shear	0.136	0.136	0.29%
		Moment	7.540	7.563	0.31%

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 1.32%

Table 11: Comparison of Y-Direction Maximum Forces/Moments from DM and MSM3 Models (Y excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM3 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM3 Model
RPV Support	815 – 711 (Gr 4 El 28)	Shear	8.611	8.618	0.09%
		Moment	48.839	48.878	0.08%
RSW Base	710 – 711 (Gr 3 El 9)	Shear	4.707	4.707	0.00%
		Moment	50.839	50.839	0.00%
Vent Wall Base	704 – 705 (Gr 3 El 4)	Shear	15.562	15.577	0.10%
		Moment	109.054	109.289	0.22%
Pedestal Base	41 – 313 (Gr 1 El 24)	Shear	19.237	19.418	0.94%
		Moment	111.564	112.153	0.53%
	42 – 314 (Gr 1 El 48)	Shear	0.080	0.080	0.00%
		Moment	0.209	0.211	0.75%
RCCV Base	31 – 213 (Gr 1 El 19)	Shear	41.778	42.170	0.94%
		Moment	1701.711	1697.396	0.25%
	32 – 214 (Gr 1 El 43)	Shear	0.080	0.080	0.00%
		Moment	0.209	0.711	0.75%
RB/FB Base	21 – 113 (Gr 2 El 4)	Shear	0.160	0.161	0.74%
		Moment	6.351	6.335	0.25%

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 0.94%

Table 12: Comparison of Z-Direction Maximum Forces/Moments from DM and MSM3 Models (Z excitation)

Locations	Connecting Node No. (Element ID)	Response Type	DM Model Maximum Forces / Moments	MSM3 Model Forces / Moments	Difference Between Maximum Forces/Moments form DM Model and MSM3 Model
RPV Support	815 – 711 (Gr 4 El 28)	Axial	14.514	14.408	0.73%
		Moment	0.0	0.0	NA
RSW Base	710 – 711 (Gr 3 El 9)	Axial	4.127	4.107	0.50%
		Moment	0.0	0.0	NA
Vent Wall Base	704 – 705 (Gr 3 El 4)	Axial	14.044	14.189	1.03%
		Moment	0.0	0.0	NA
Pedestal Base	41 – 313 (Gr 1 El 24)	Axial	0.119	0.119	0%
		Moment	0.0	0.0	NA
	42 – 314 (Gr 1 El 48)	Axial	30.464	30.606	0.46%
		Moment	0.0	0.0	NA
RCCV Base	31 – 213 (Gr 1 El 19)	Axial	0.119	0.119	0%
		Moment	0.0	0.0	NA
	32 – 214 (Gr 1 El 43)	Axial	65.04	65.315	0.42%
		Moment	0.0	0.0	NA
RB/FB Base	21 - 113 (Gr 2 El 4)	Axial	0.0001	0.0001	0.0%
		Moment	0.0	0.0	NA

Notes:
(1) Forces are in MN units, Moments are in MN-m units
(2) The forces and moments obtained from the Quarter Model SSI analyses are multiplied by four (4.0) to report the values as for Full models.

Maximum Difference = 1.03%

Table 13: Comparison of X-Direction Maximum Relative Displacement from DM and MSM2 Models (X-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM2 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM2 Models
Top of Fuel to Center of Fuel	847	850	0.22	0.22	0%
Center of Fuel to Bottom of Fuel	850	853	0.23	0.24	4.3%*
Core Plate to Bottom of Vessel	844	828	0.04	0.04	0%
Top Guide to Vessel	838	816	0.05	0.05	0%
Top Guide to Bottom of Vessel	838	828	0.11	0.11	0%
Center of Fuel to Bottom of Vessel	850	828	0.27	0.27	0%
CRD Housing to Bottom of Vessel	868	828	0.14	0.14	0%
CRD Housing to Bottom of Head	867	827	0.13	0.13	0%
RCCV to RPV	260	807	0.10	0.10	0%
RCCV to Bottom of Vent Wall	260	706	0.20	0.20	0%
RPV to Bottom of Vent Wall	807	706	0.15	0.15	0%

*Difference is due to not enough digits after the decimal point in the result printout. Actual difference will be far less

Table 14: Comparison of Y-Direction Maximum Relative Displacement from DM and MSM2 Models (Y-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM2 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM2 Models
Top of Fuel to Center of Fuel	847	850	0.36	0.36	0%
Center of Fuel to Bottom of Fuel	850	853	0.38	0.38	0%
Core Plate to Bottom of Vessel	844	828	0.04	0.04	0%
Top Guide to Vessel	838	816	0.04	0.04	0%
Top Guide to Bottom of Vessel	838	828	0.09	0.09	0%
Center of Fuel to Bottom of Vessel	850	828	0.42	0.42	0%
CRD Housing to Bottom of Vessel	868	828	0.10	0.10	0%
CRD Housing to Bottom of Head	867	827	0.10	0.10	0%
RCCV to RPV	260	807	0.09	0.08	11%*
RCCV to Bottom of Vent Wall	260	706	0.24	0.24	0%
RPV to Bottom of Vent Wall	807	706	0.22	0.22	0%

*Difference is due to not enough digits after the decimal point in the result printout. Actual difference will be far less

Table 15: Comparison of Z-Direction Maximum Relative Displacement from DM and MSM2 Models (Z-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM2 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM2 Models
Top of Fuel to Center of Fuel	847	850	0.00	0.00	0%
Center of Fuel to Bottom of Fuel	850	853	0.00	0.00	0%
Core Plate to Bottom of Vessel	844	828	0.01	0.01	0%
Top Guide to Vessel	838	816	0.03	0.03	0%
Top Guide to Bottom of Vessel	838	828	0.02	0.02	0%
Center of Fuel to Bottom of Vessel	850	828	0.01	0.01	0%
CRD Housing to Bottom of Vessel	868	828	0.00	0.00	0%
CRD Housing to Bottom of Head	867	827	0.00	0.00	0%
RCCV to RPV	260	807	0.02	0.02	0%
RCCV to Bottom of Vent Wall	260	706	0.02	0.02	0%
RPV to Bottom of Vent Wall	807	706	0.02	0.02	0%

Table 16: Comparison of X-Direction Maximum Relative Displacement from DM and MSM3 Models (X-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM3 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM3 Models
Top of Fuel to Center of Fuel	847	850	0.22	0.22	0%
Center of Fuel to Bottom of Fuel	850	853	0.23	0.23	0%
Core Plate to Bottom of Vessel	844	828	0.04	0.04	0%
Top Guide to Vessel	838	816	0.05	0.05	0%
Top Guide to Bottom of Vessel	838	828	0.11	0.11	0%
Center of Fuel to Bottom of Vessel	850	828	0.27	0.27	0%
CRD Housing to Bottom of Vessel	868	828	0.14	0.14	0%
CRD Housing to Bottom of Head	867	827	0.13	0.13	0%
RCCV to RPV	260	807	0.10	0.10	0%
RCCV to Bottom of Vent Wall	260	706	0.20	0.20	0%
RPV to Bottom of Vent Wall	807	706	0.15	0.15	0%

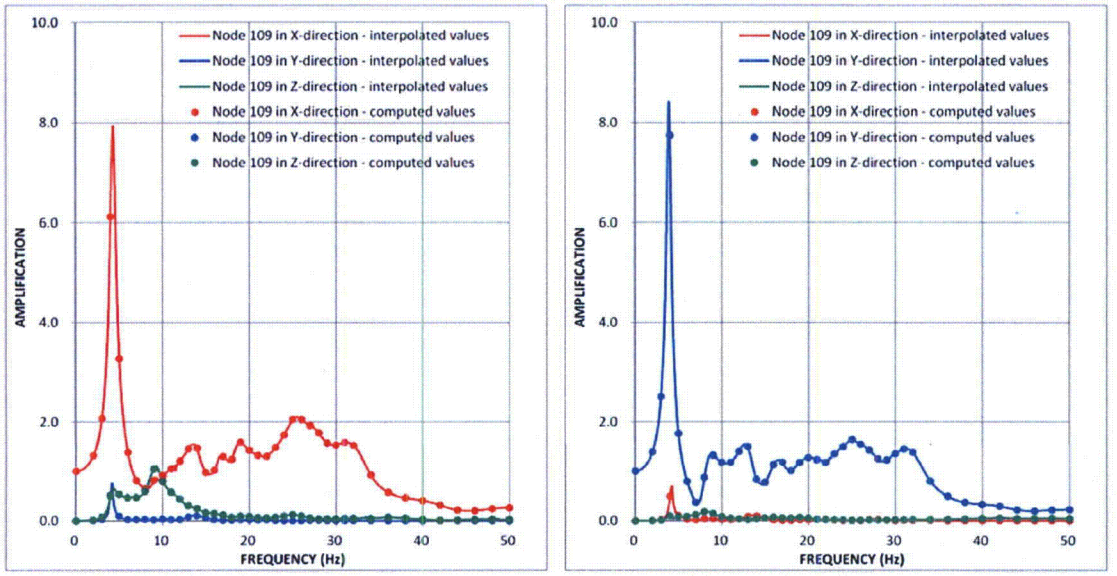
Table 17: Comparison of Y-Direction Maximum Relative Displacement from DM and MSM3 Models (Y-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM3 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM3 Models
Top of Fuel to Center of Fuel	847	850	0.36	0.36	0%
Center of Fuel to Bottom of Fuel	850	853	0.38	0.38	0%
Core Plate to Bottom of Vessel	844	828	0.04	0.04	0%
Top Guide to Vessel	838	816	0.04	0.04	0%
Top Guide to Bottom of Vessel	838	828	0.09	0.09	0%
Center of Fuel to Bottom of Vessel	850	828	0.42	0.42	0%
CRD Housing to Bottom of Vessel	868	828	0.10	0.10	0%
CRD Housing to Bottom of Head	867	827	0.10	0.10	0%
RCCV to RPV	260	807	0.09	0.08	11%*
RCCV to Bottom of Vent Wall	260	706	0.24	0.24	0%
RPV to Bottom of Vent Wall	807	706	0.22	0.22	0%

*Difference is due to not enough digits after the decimal point in the result printout. Actual difference will be far less.

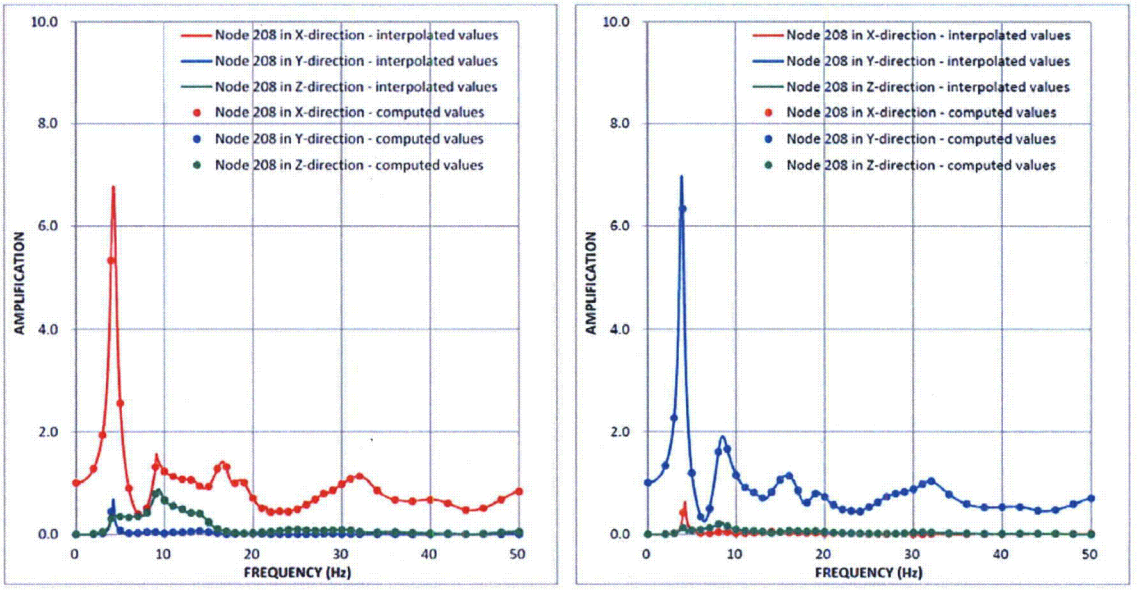
Table 18: Comparison of Z-Direction Maximum Relative Displacement from DM and MSM3 Models (Z-Excitation)

Location	Selected Node Number	Reference Node Number	DM Model Maximum Relative Displacement (cm)	MSM3 Model Maximum Relative Displacement (cm)	Difference Between Maximum Relative Displacements from DM and MSM3 Models
Top of Fuel to Center of Fuel	847	850	0.00	0.00	0%
Center of Fuel to Bottom of Fuel	850	853	0.00	0.00	0%
Core Plate to Bottom of Vessel	844	828	0.01	0.01	0%
Top Guide to Vessel	838	816	0.03	0.03	0%
Top Guide to Bottom of Vessel	838	828	0.02	0.02	0%
Center of Fuel to Bottom of Vessel	850	828	0.01	0.01	0%
CRD Housing to Bottom of Vessel	868	828	0.00	0.00	0%
CRD Housing to Bottom of Head	867	827	0.00	0.00	0%
RCCV to RPV	260	807	0.02	0.02	0%
RCCV to Bottom of Vent Wall	260	706	0.02	0.02	0%
RPV to Bottom of Vent Wall	807	706	0.02	0.02	0%



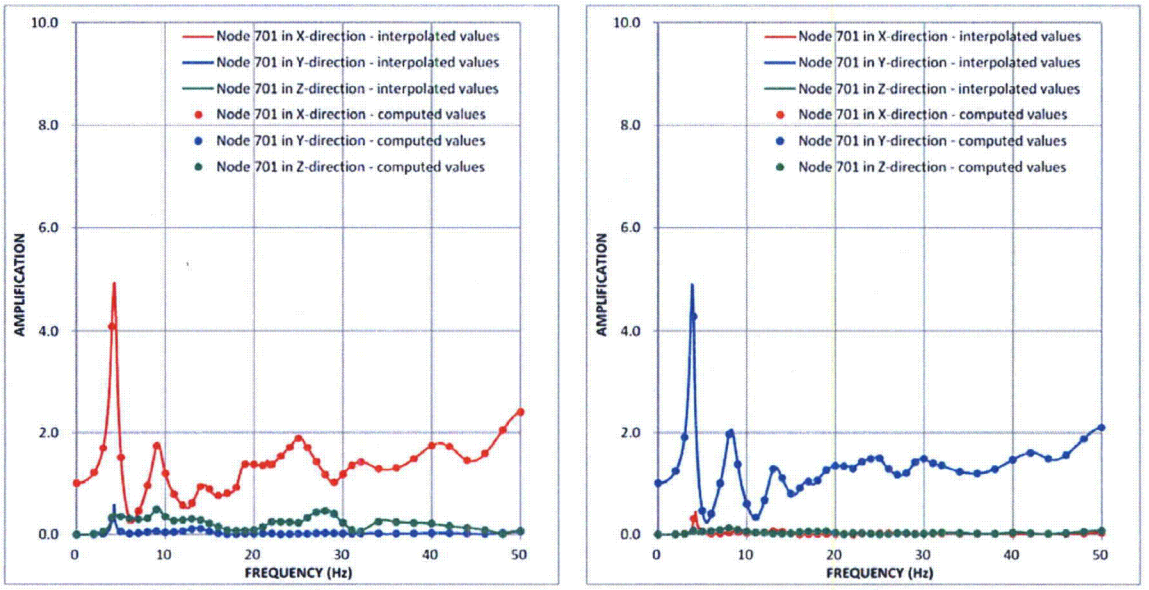
(a) X-Direction Input (b) Y-Direction Input

Figure 1: Transfer functions – RB/FB refueling floor at best estimate subsurface profile (from SER-DTF-006)



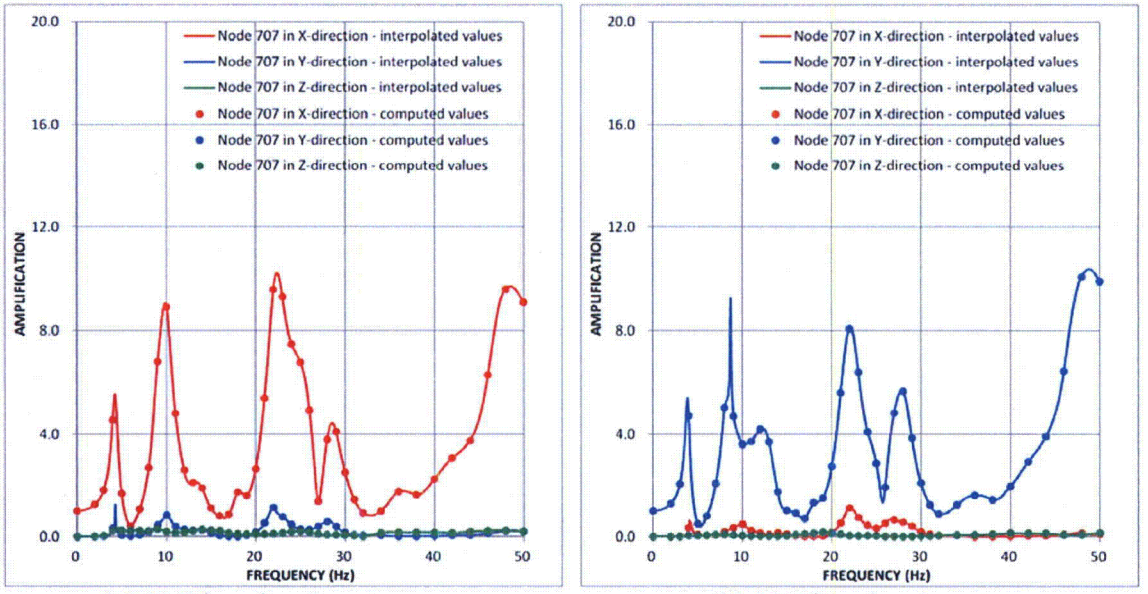
(a) X-Direction Input (b) Y-Direction Input

Figure 2: Transfer functions – RCCV top slab at best estimate subsurface profile (from SER-DTF-006)



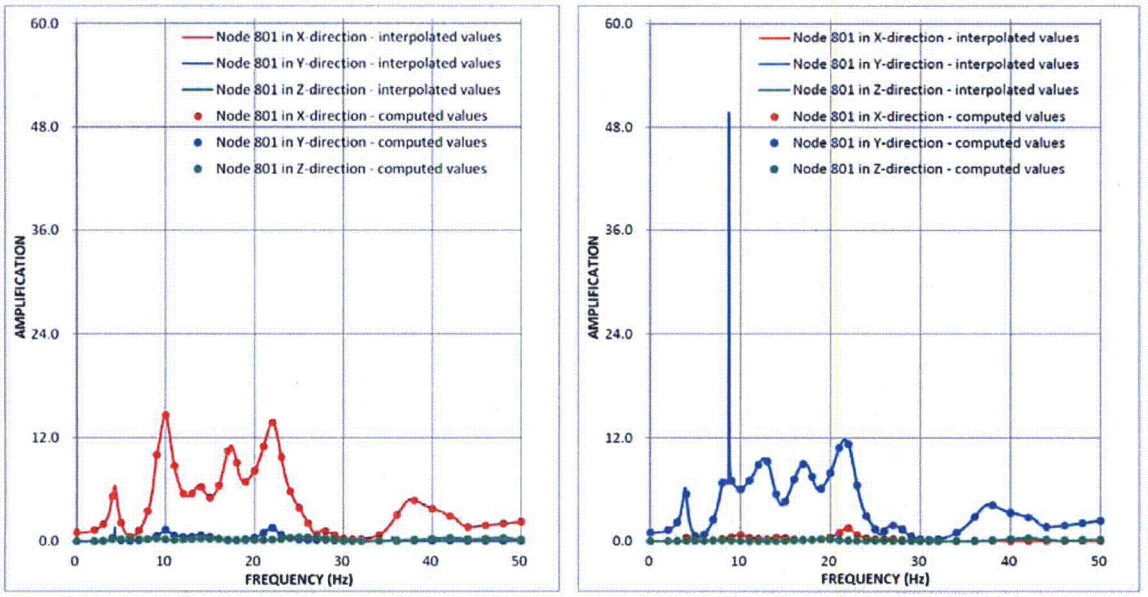
(a) X-Direction Input (b) Y-Direction Input

Figure 3: Transfer functions – vent wall top at best estimate subsurface profile (from SER-DTF-006)



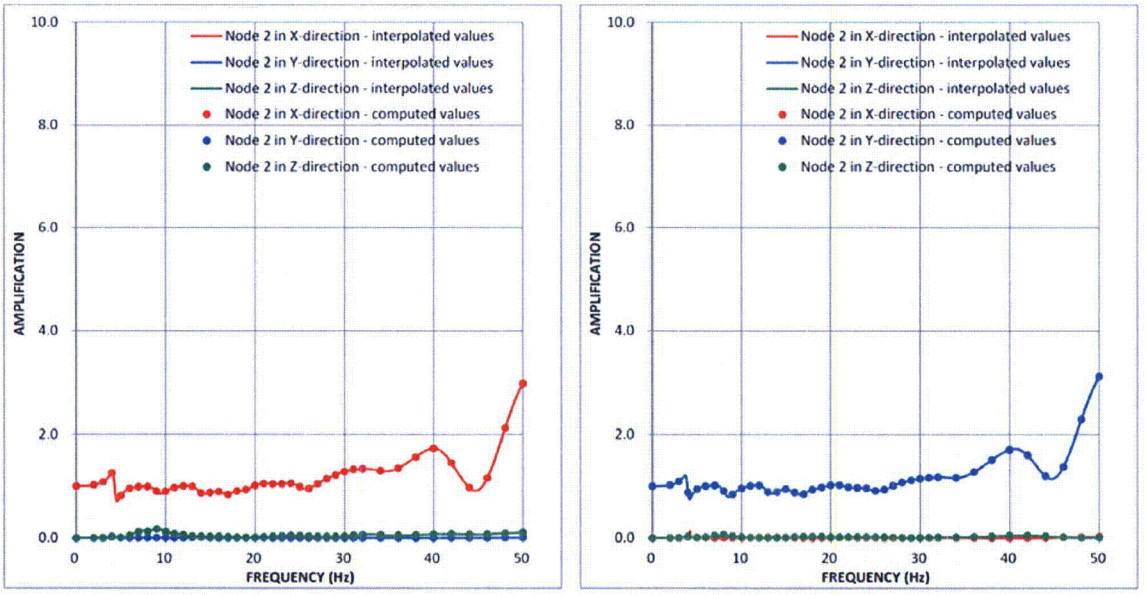
(a) X-Direction Input (b) Y-Direction Input

Figure 4: Transfer functions – RSW top at best estimate subsurface profile (from SER-DTF-006)



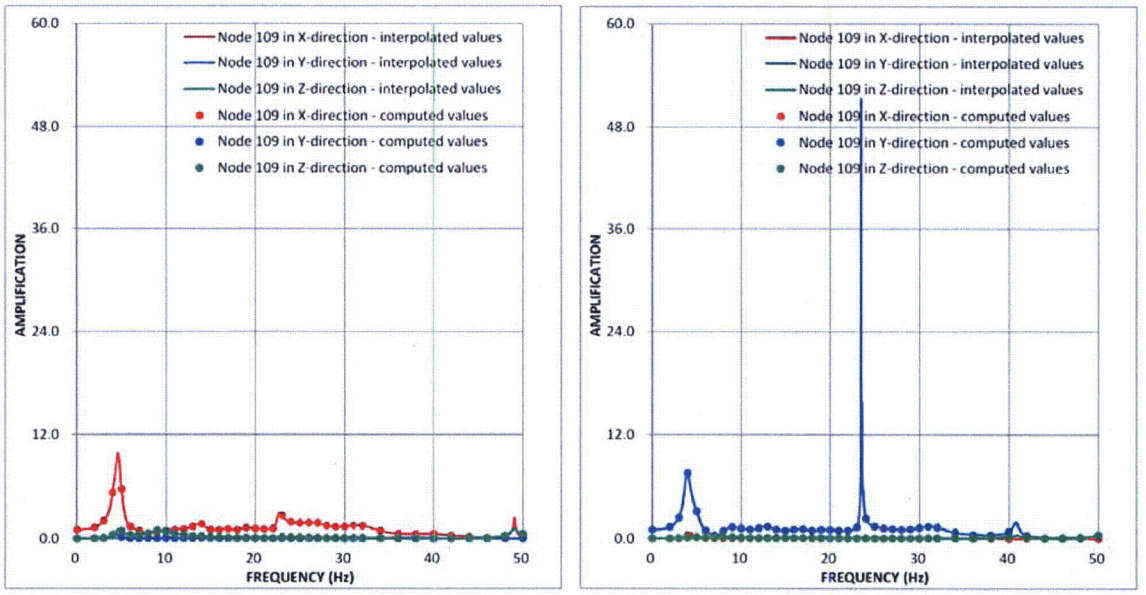
(a) X-Direction Input (b) Y-Direction Input

Figure 5: Transfer functions – RPV top at best estimate subsurface profile (from SER-DTF-006)



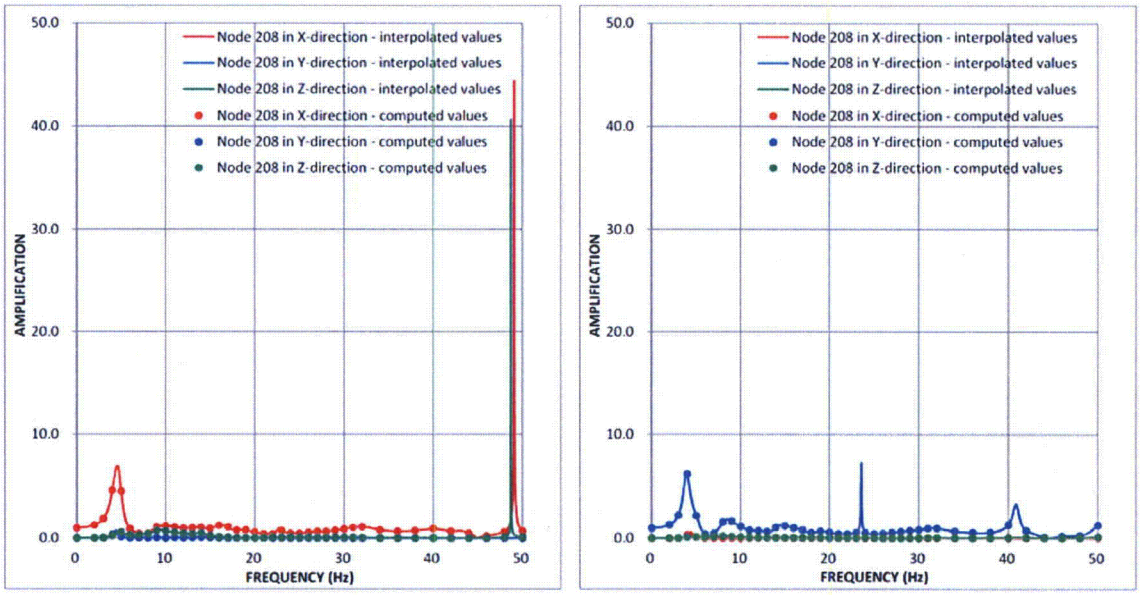
(a) X-Direction Input (b) Y-Direction Input

Figure 6: Transfer functions – RB/FB basemat at best estimate subsurface profile (from SER-DTF-006)



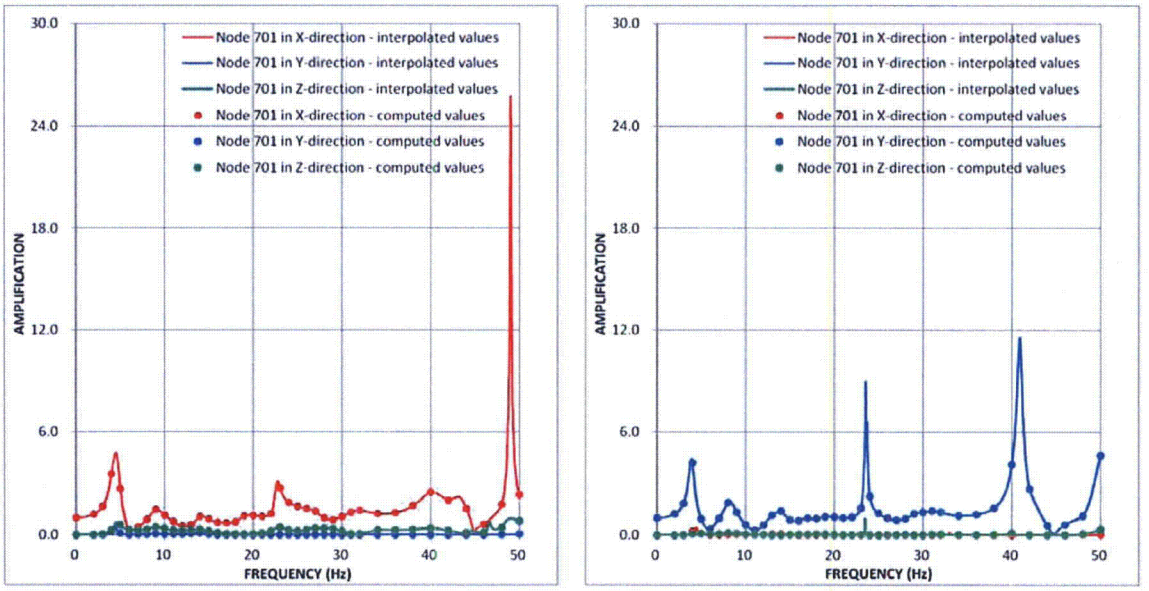
(a) X-Direction Input (b) Y-Direction Input

Figure 7: Transfer functions – RB/FB refueling floor at best estimate subsurface profile – Case RFB (from SER-DTF-008)



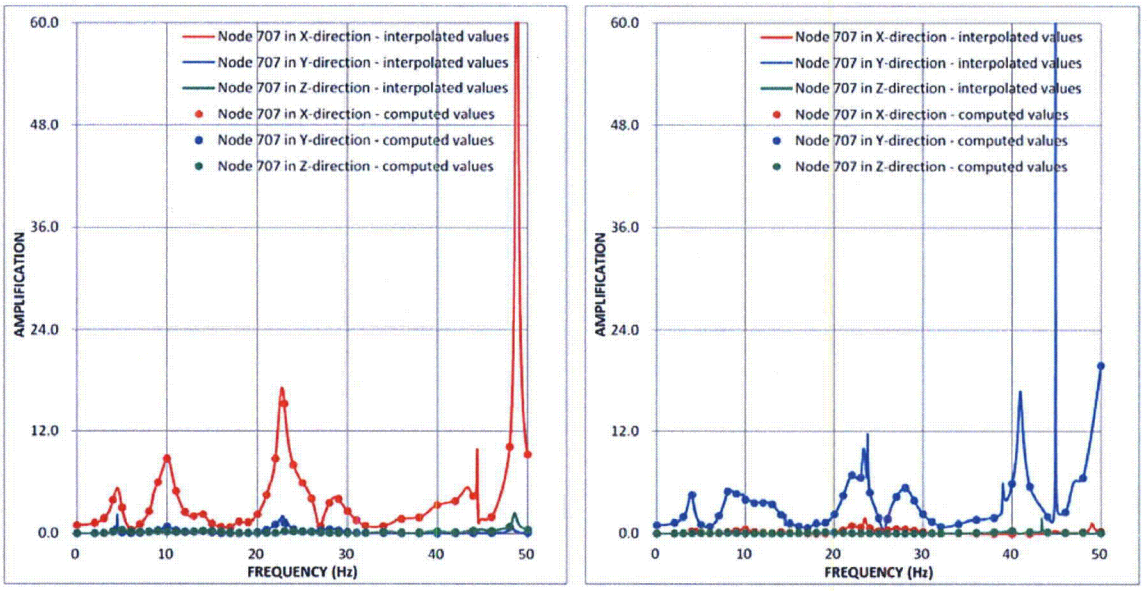
(a) X-Direction Input (b) Y-Direction Input

Figure 8: Transfer functions – RCCV top slab at best estimate subsurface profile – Case RFB (from SER-DTF-008)



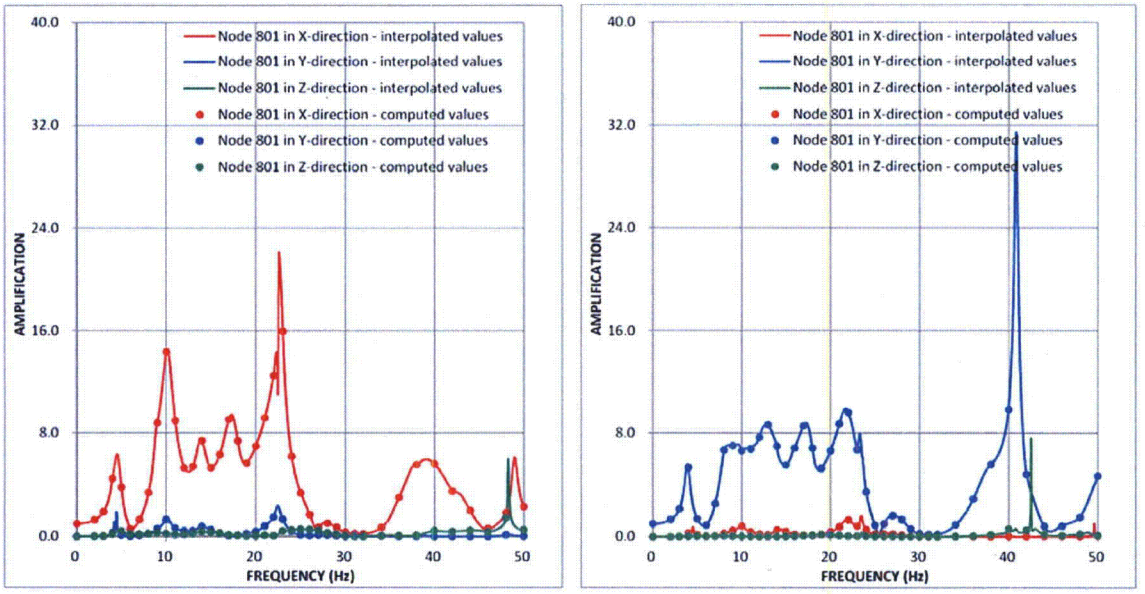
(a) X-Direction Input (b) Y-Direction Input

Figure 9: Transfer functions – vent wall top at best estimate subsurface profile – Case RFB (from SER-DTF-008)



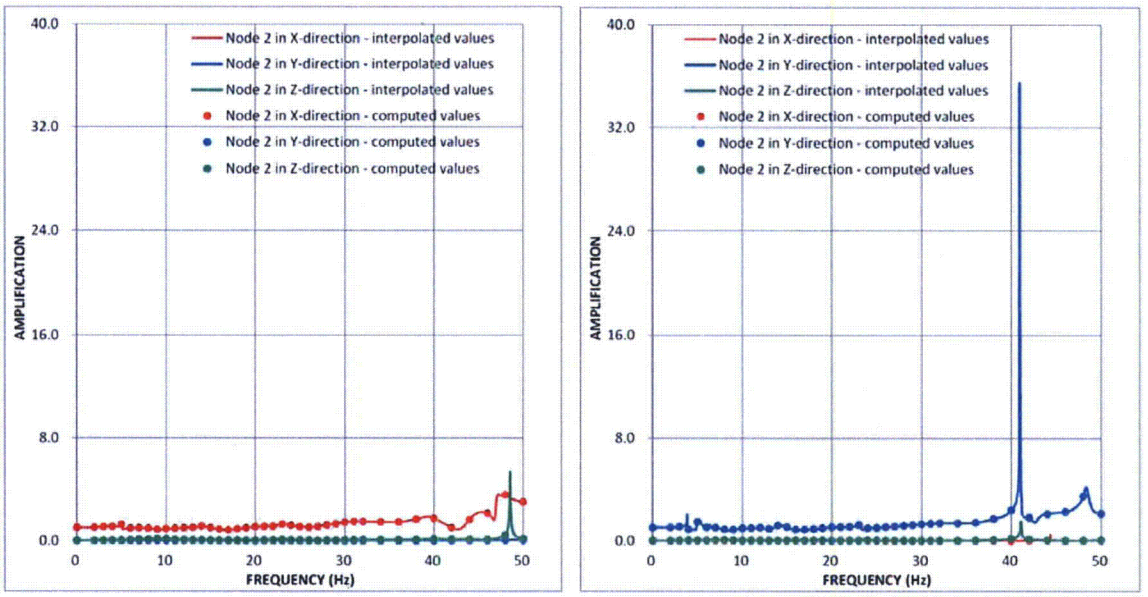
(a) X-Direction Input (b) Y-Direction Input

Figure 10: Transfer functions – RSW top at best estimate subsurface profile – Case RFB (from SER-DTF-008)



(a) X-Direction Input (b) Y-Direction Input

Figure 11: Transfer functions – RPV top at best estimate subsurface profile – Case RFB (from SER-DTF-008)



(a) X-Direction Input (b) Y-Direction Input

Figure 12: Transfer functions – RB/FB basemat at best estimate subsurface profile – Case RFB (from SER-DTF-008)

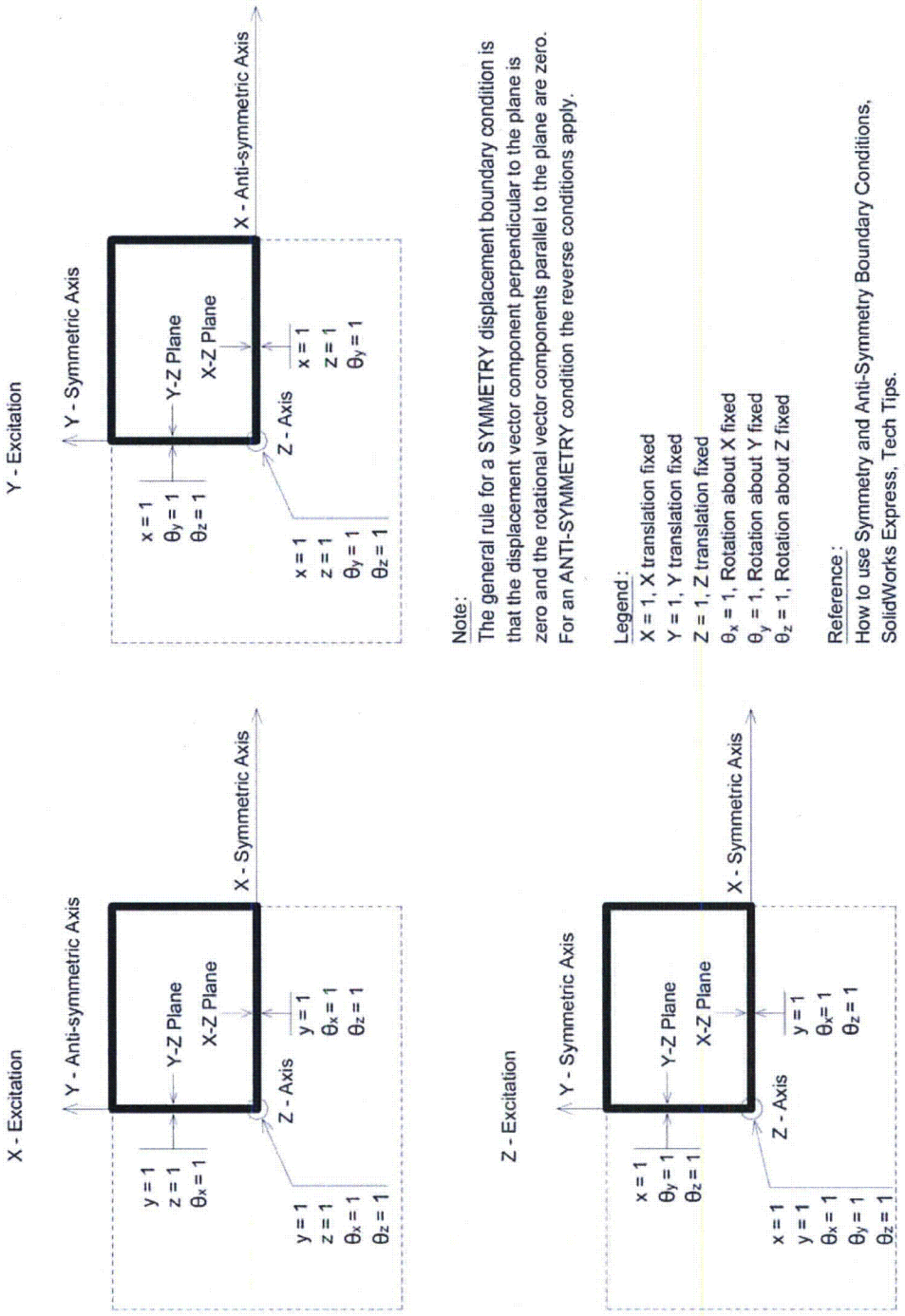


Figure 13: Plan and boundary conditions for quarter model

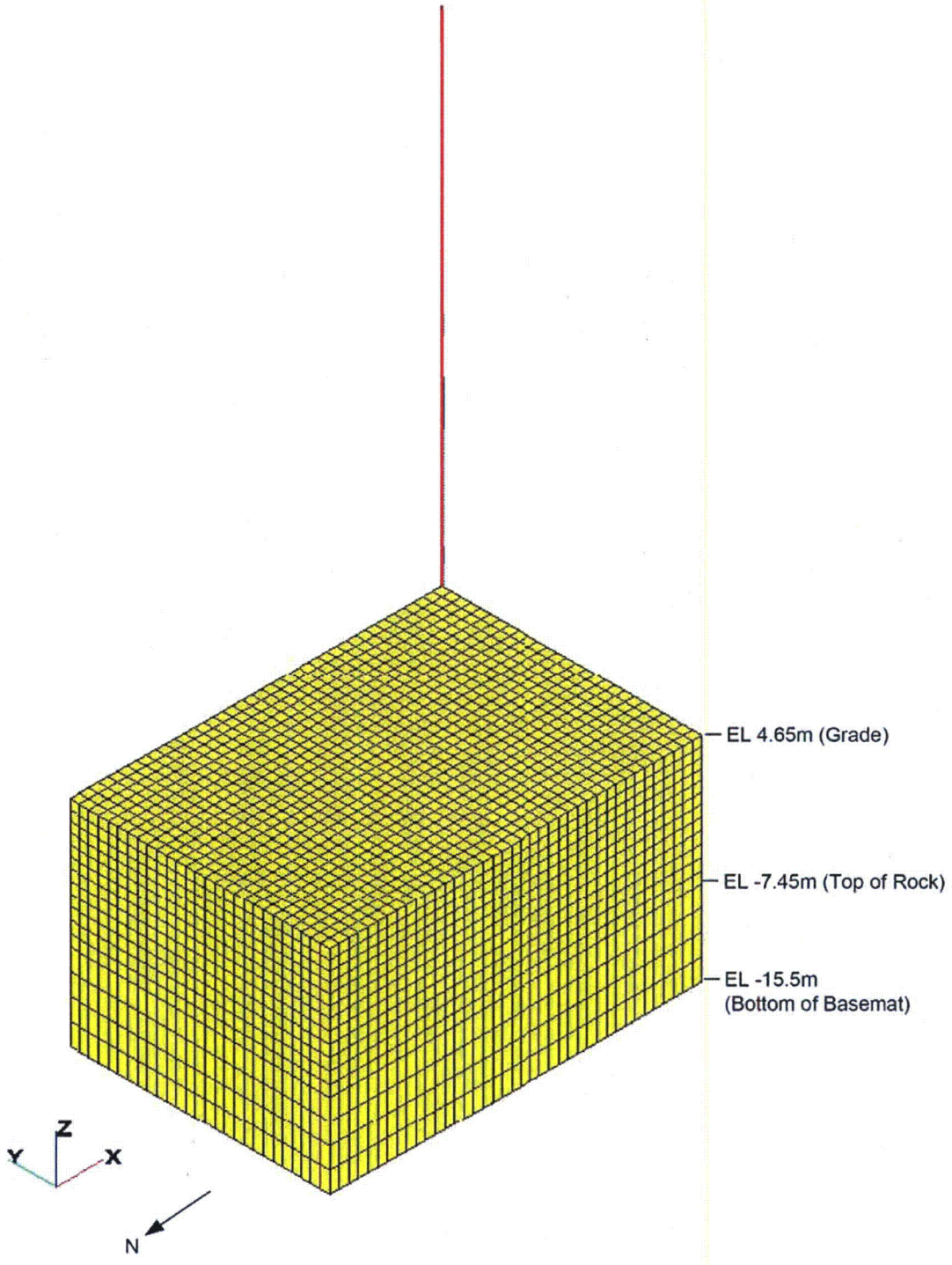


Figure 14: DM quarter model

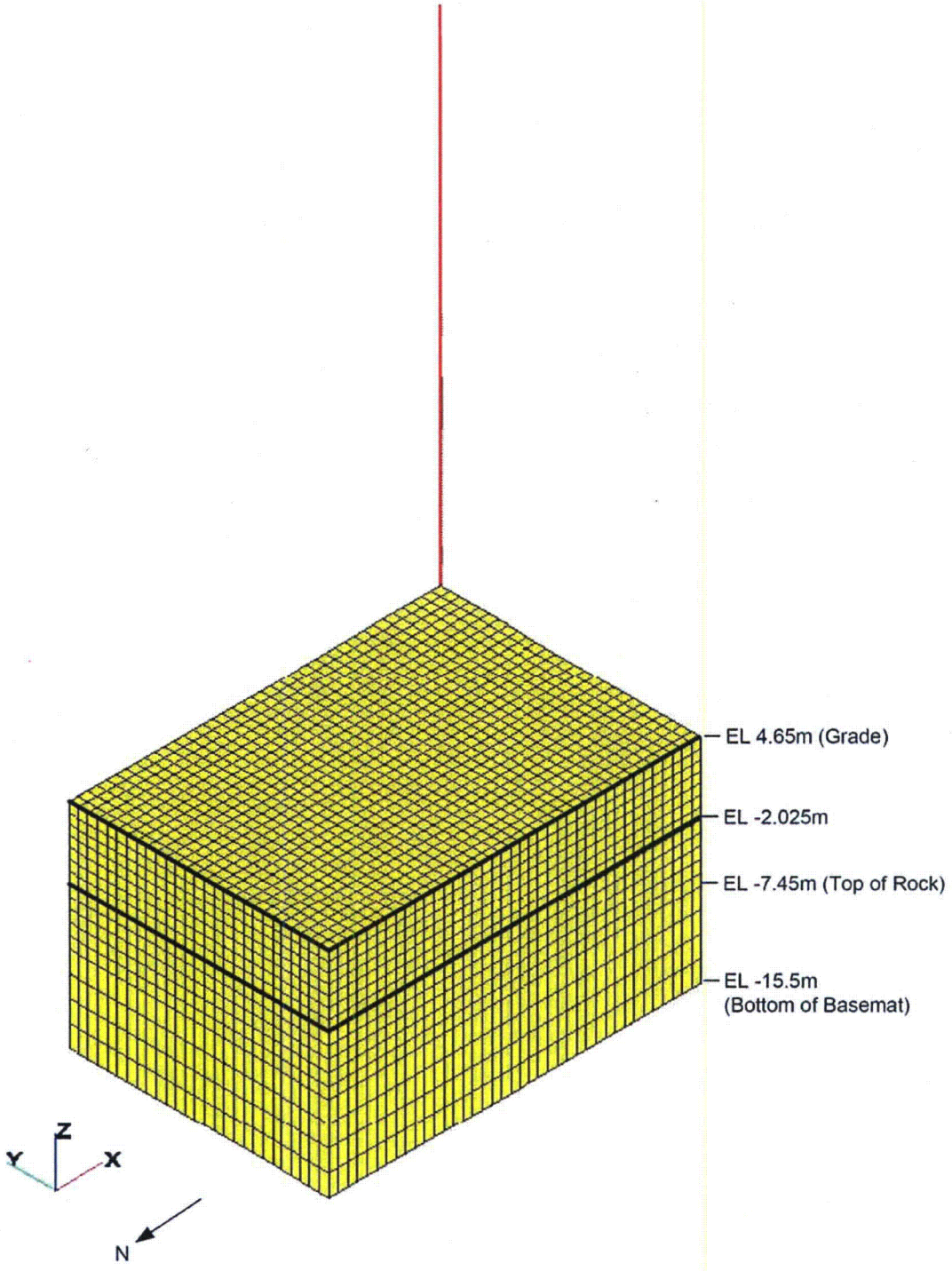


Figure 15: MSM2 quarter model

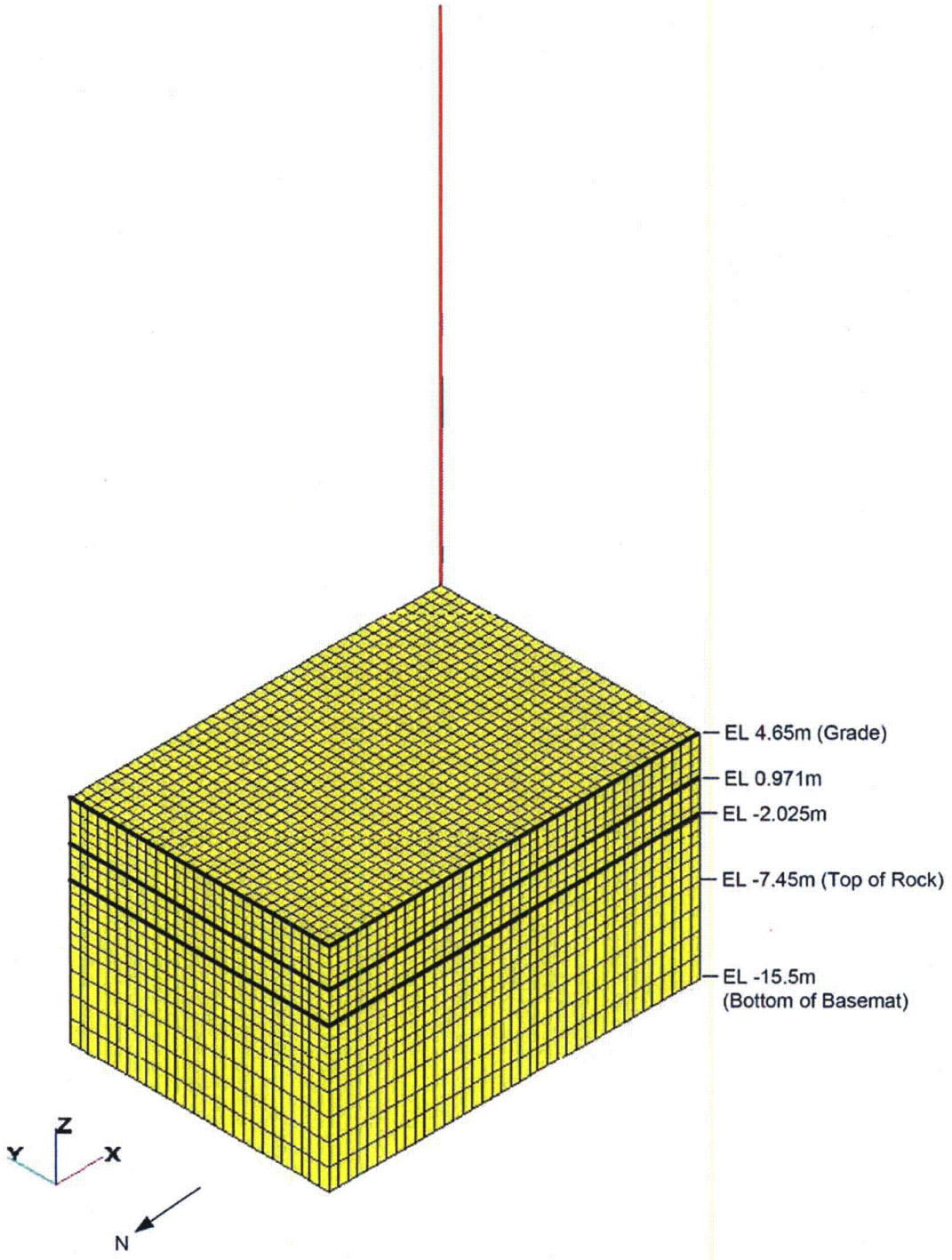


Figure 16: MSM3 quarter model

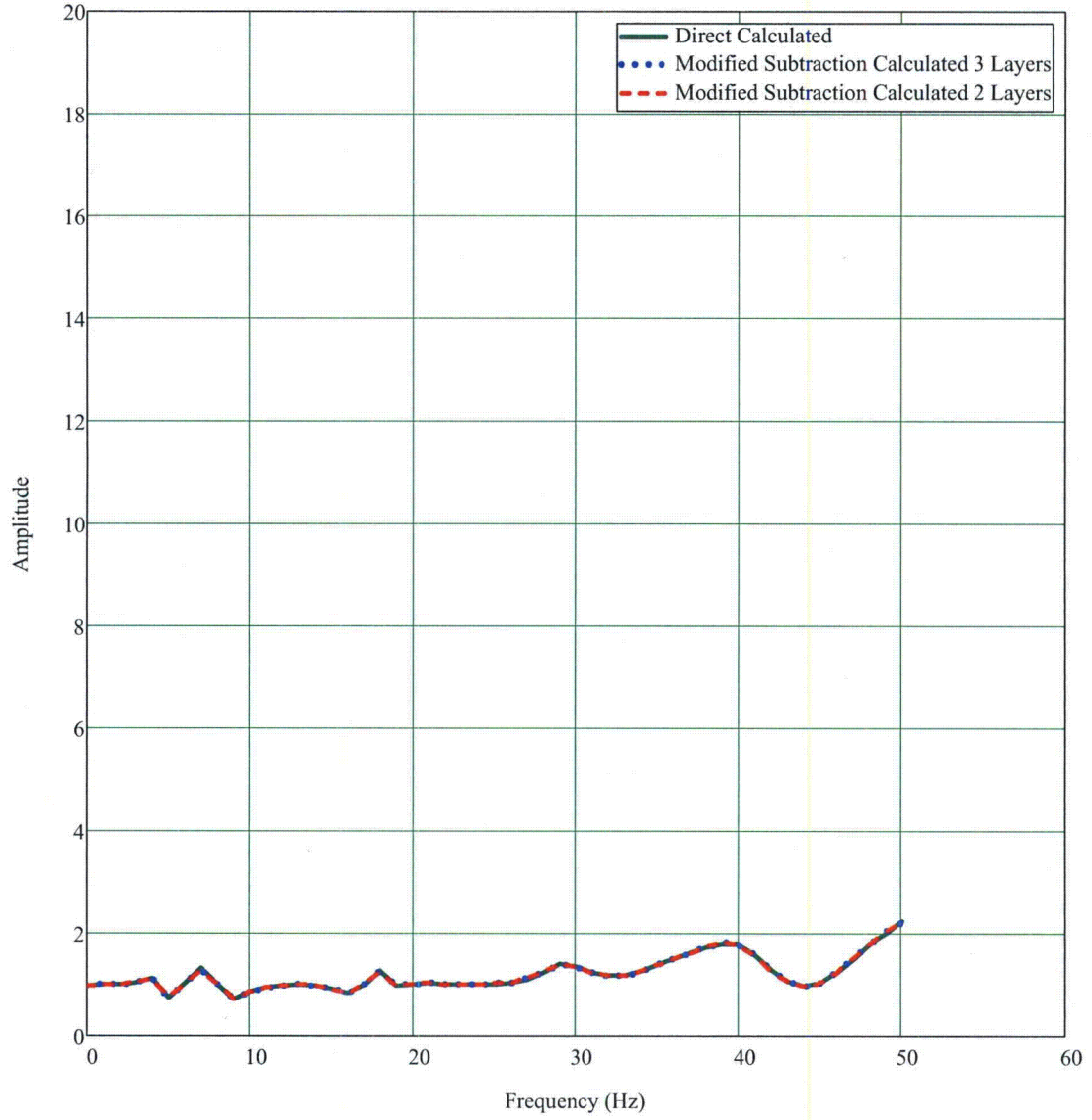


Figure 17: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

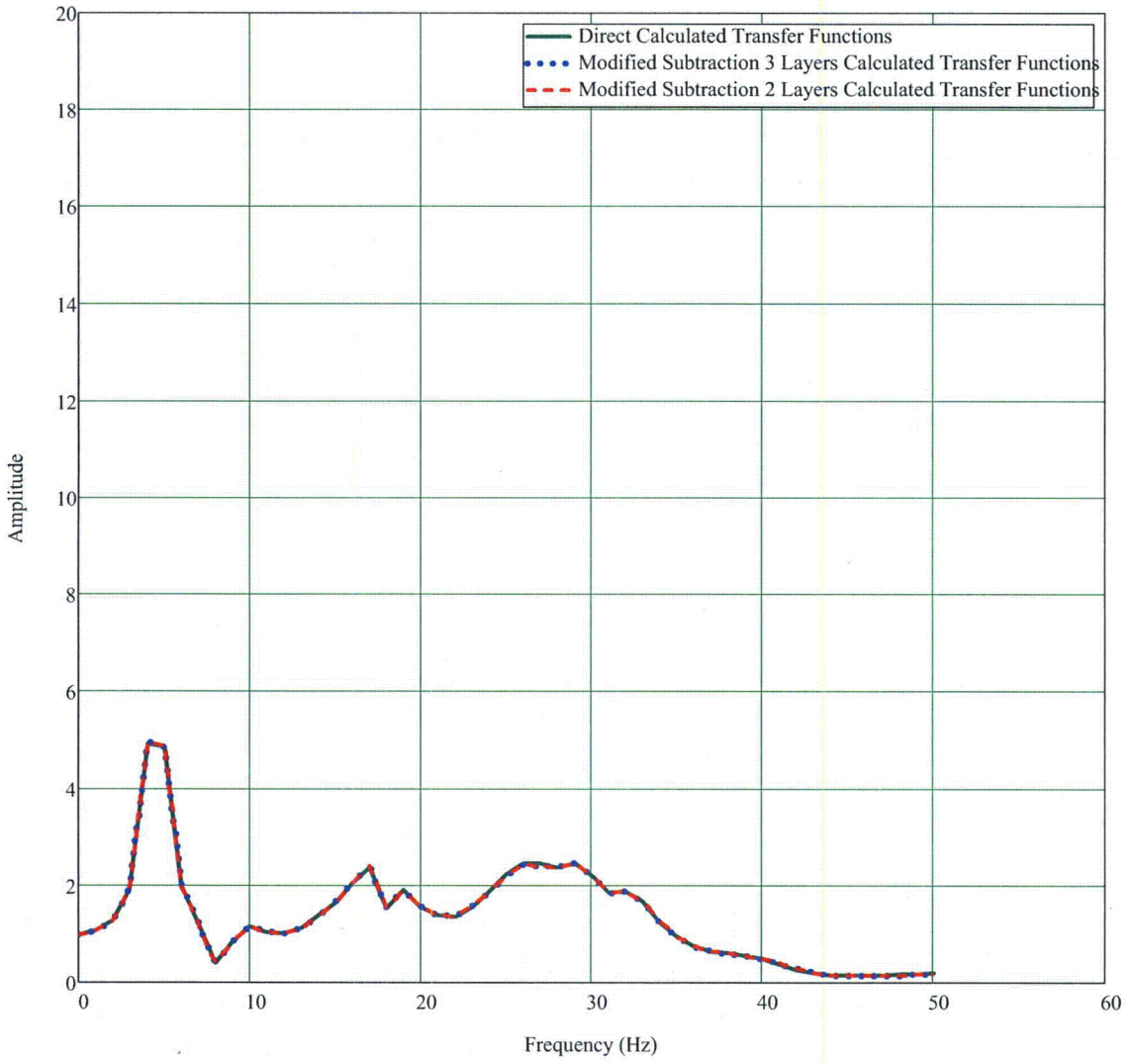


Figure 18: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

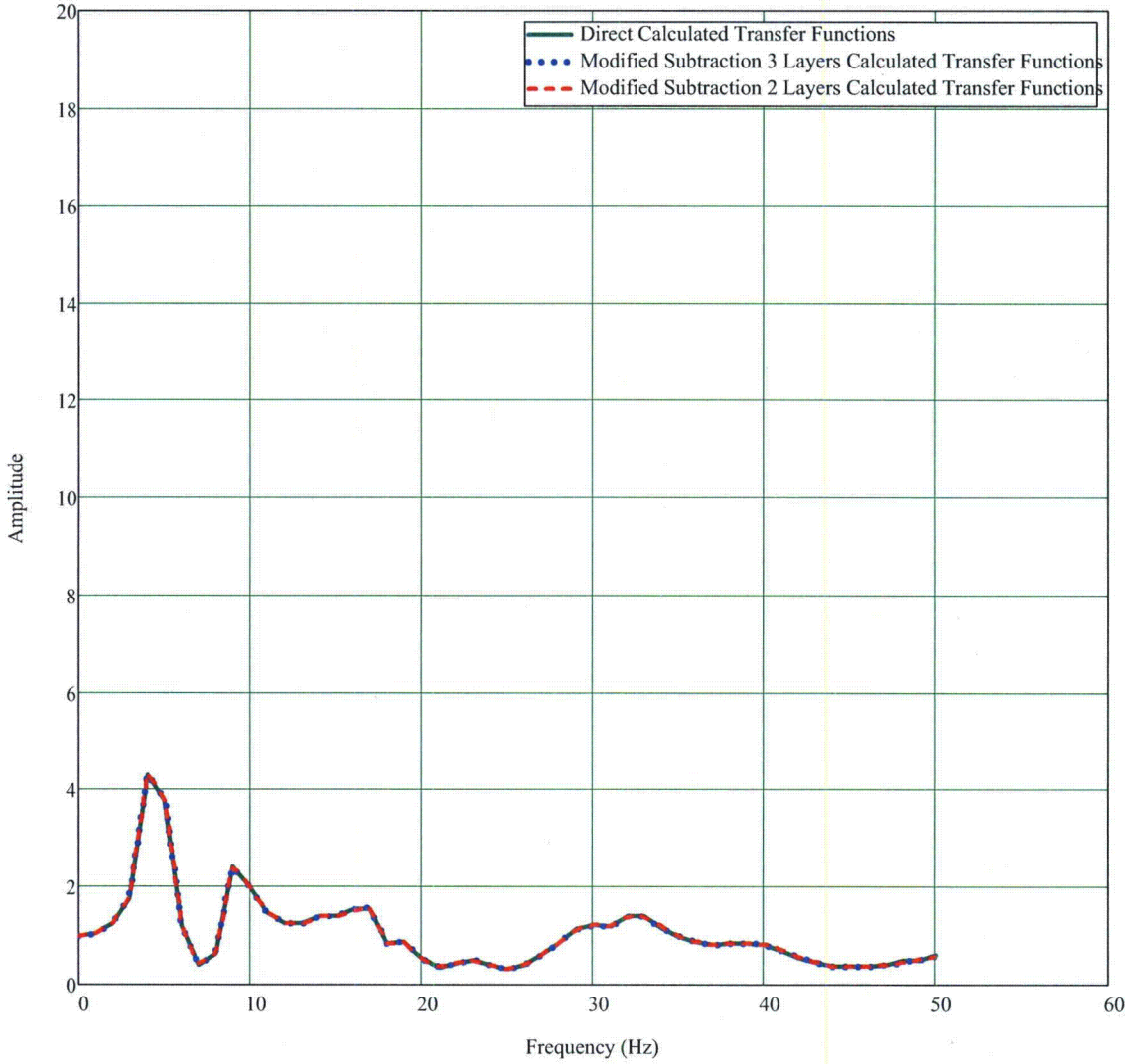


Figure 19: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

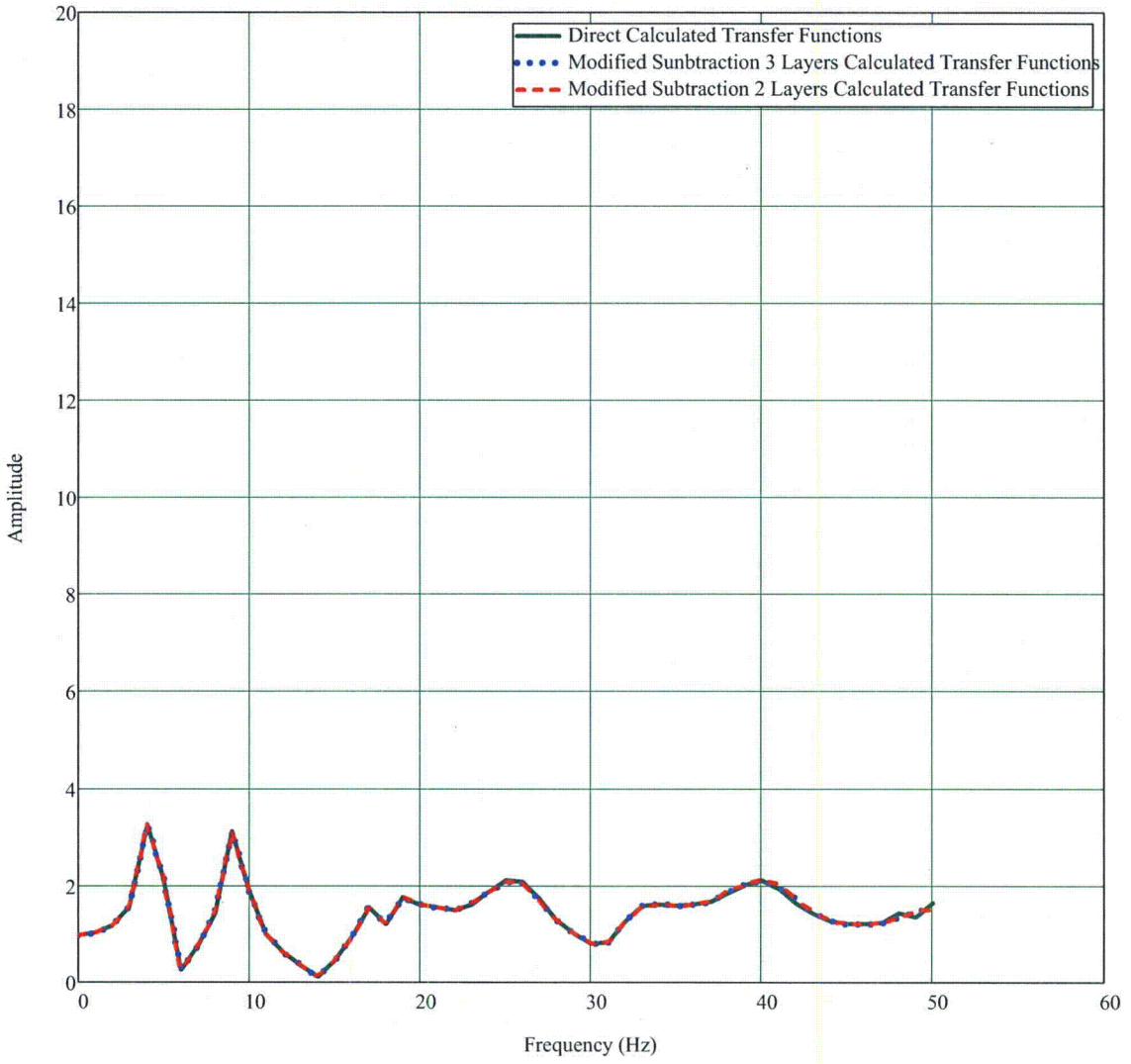


Figure 20: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

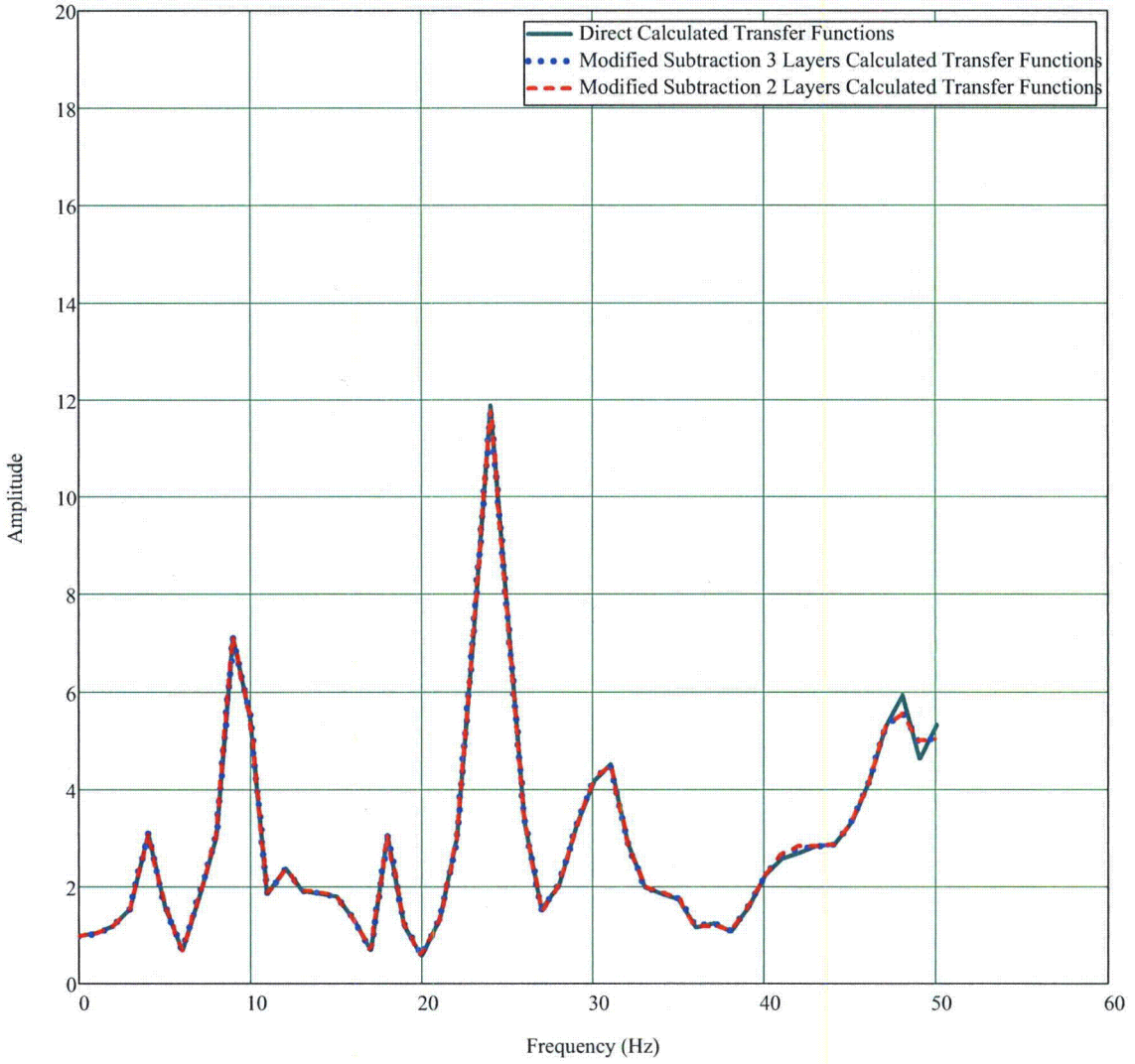


Figure 21: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

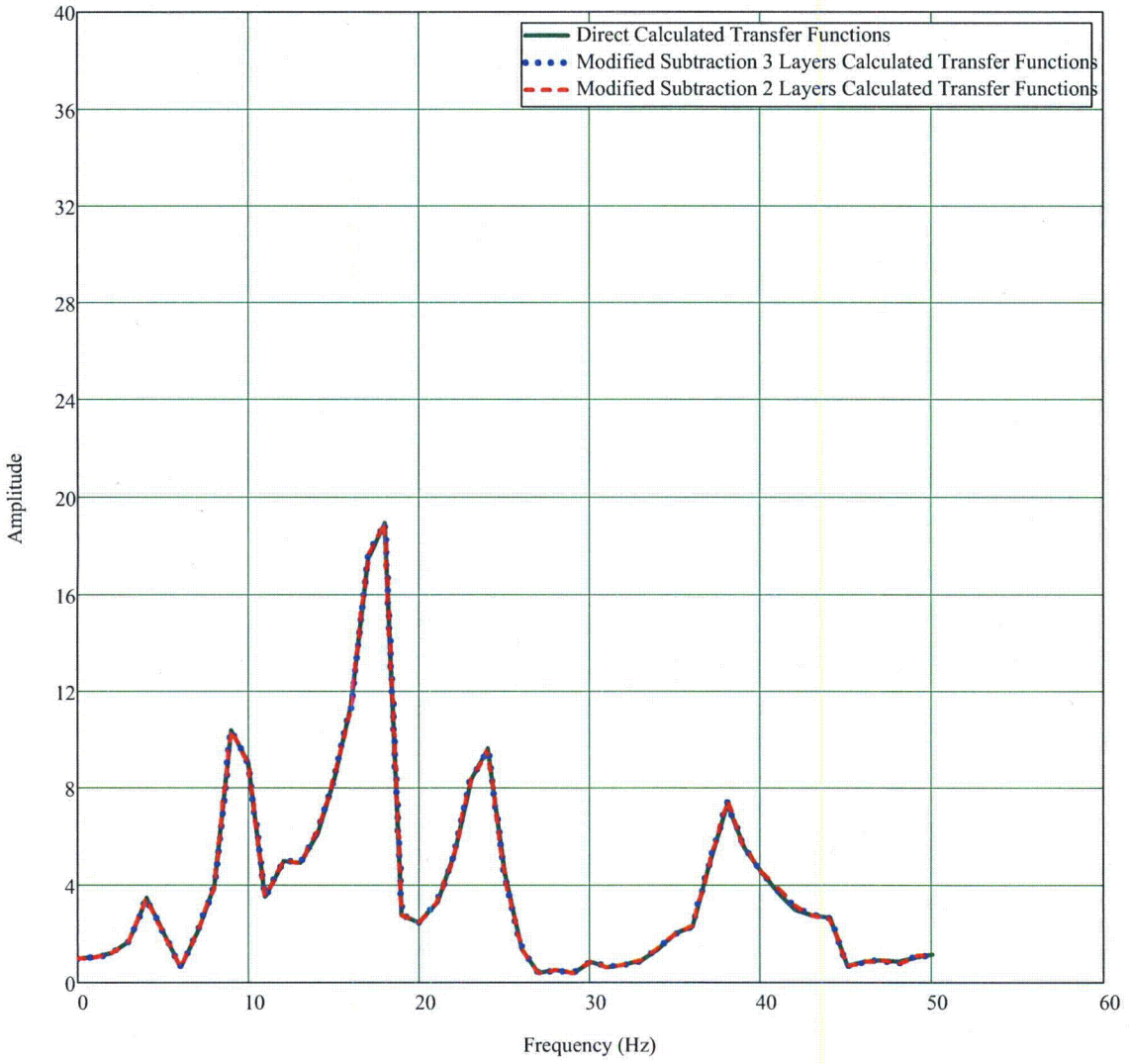


Figure 22: X-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

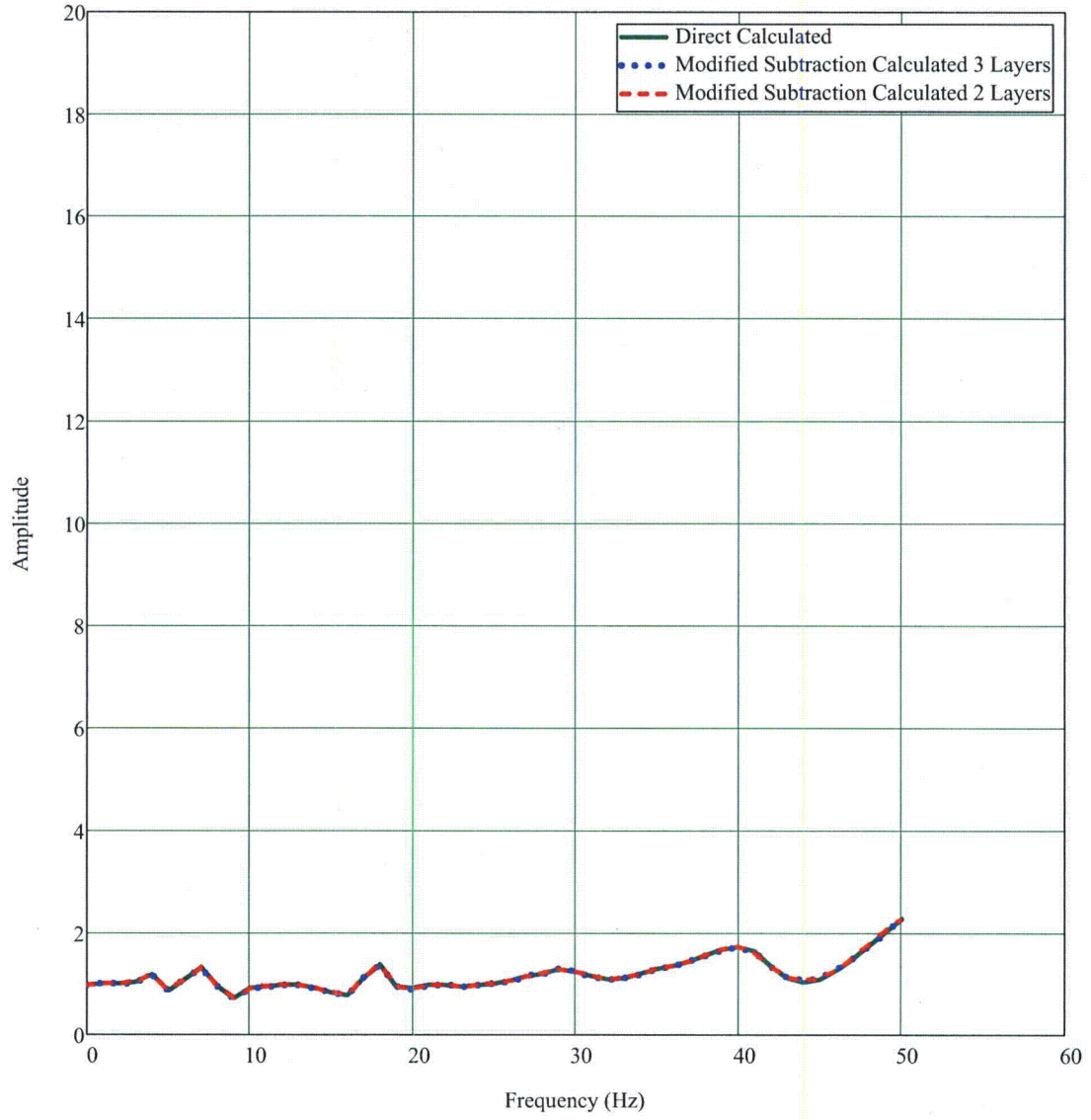


Figure 23: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

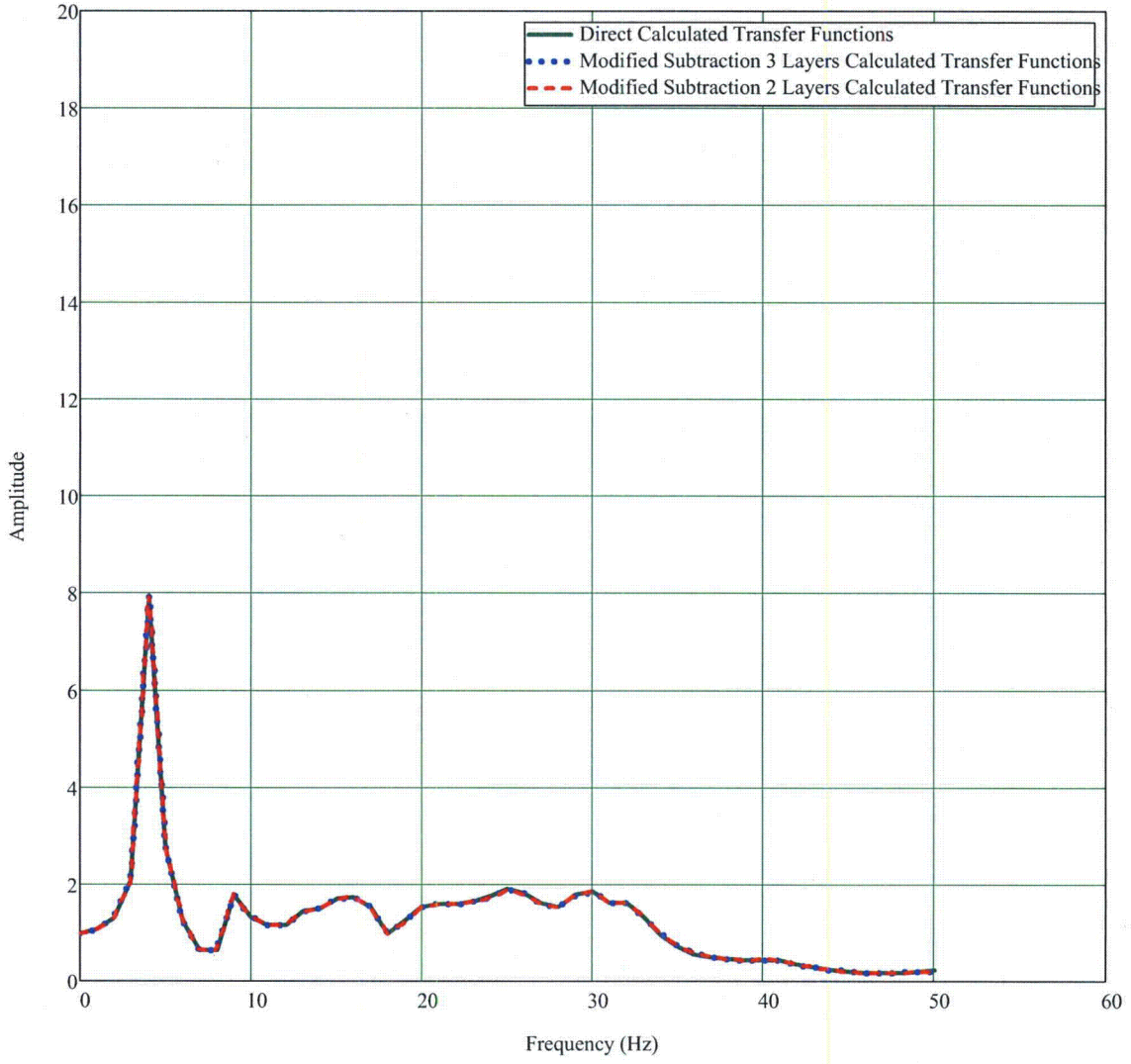


Figure 24: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

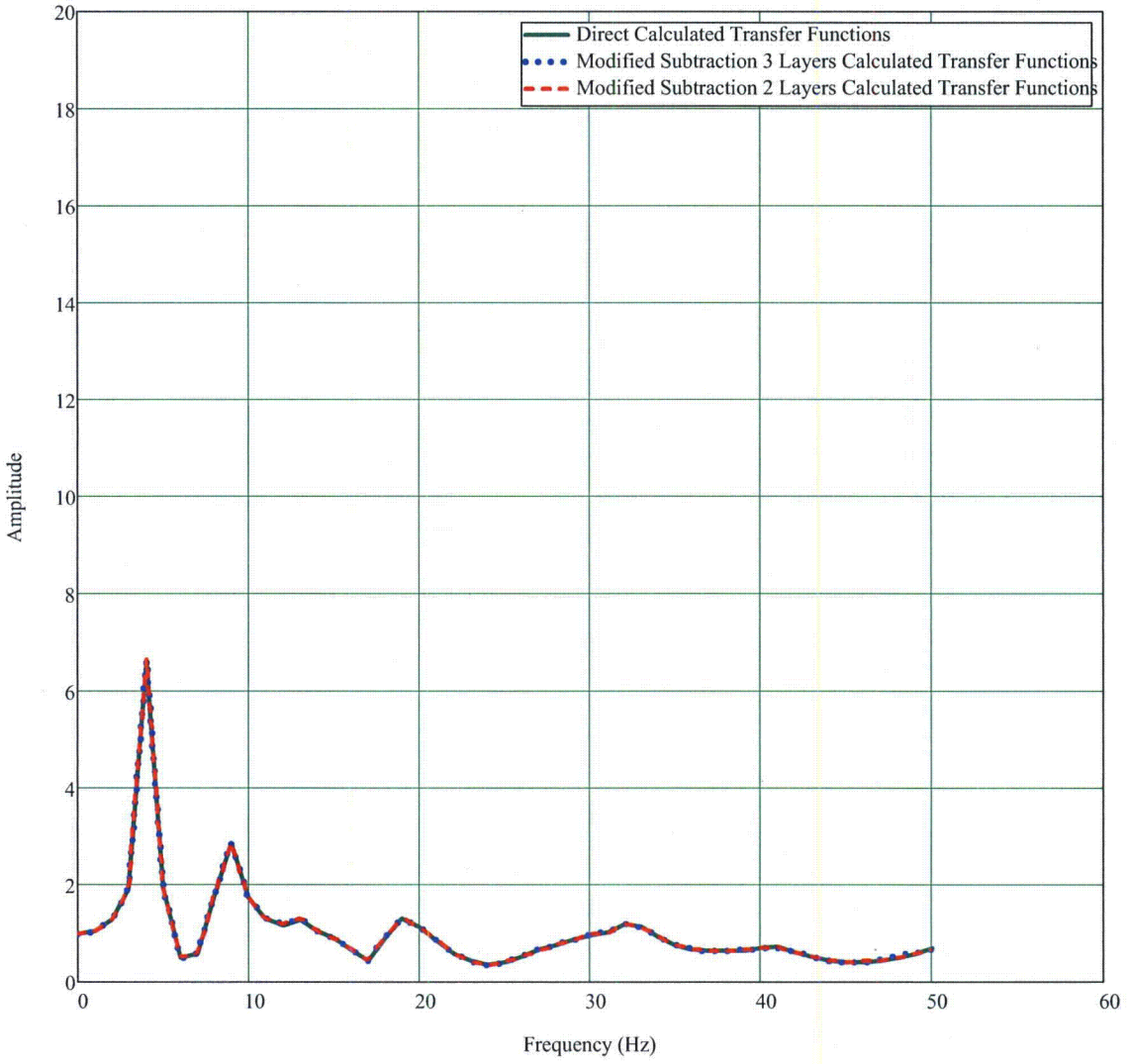


Figure 25: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

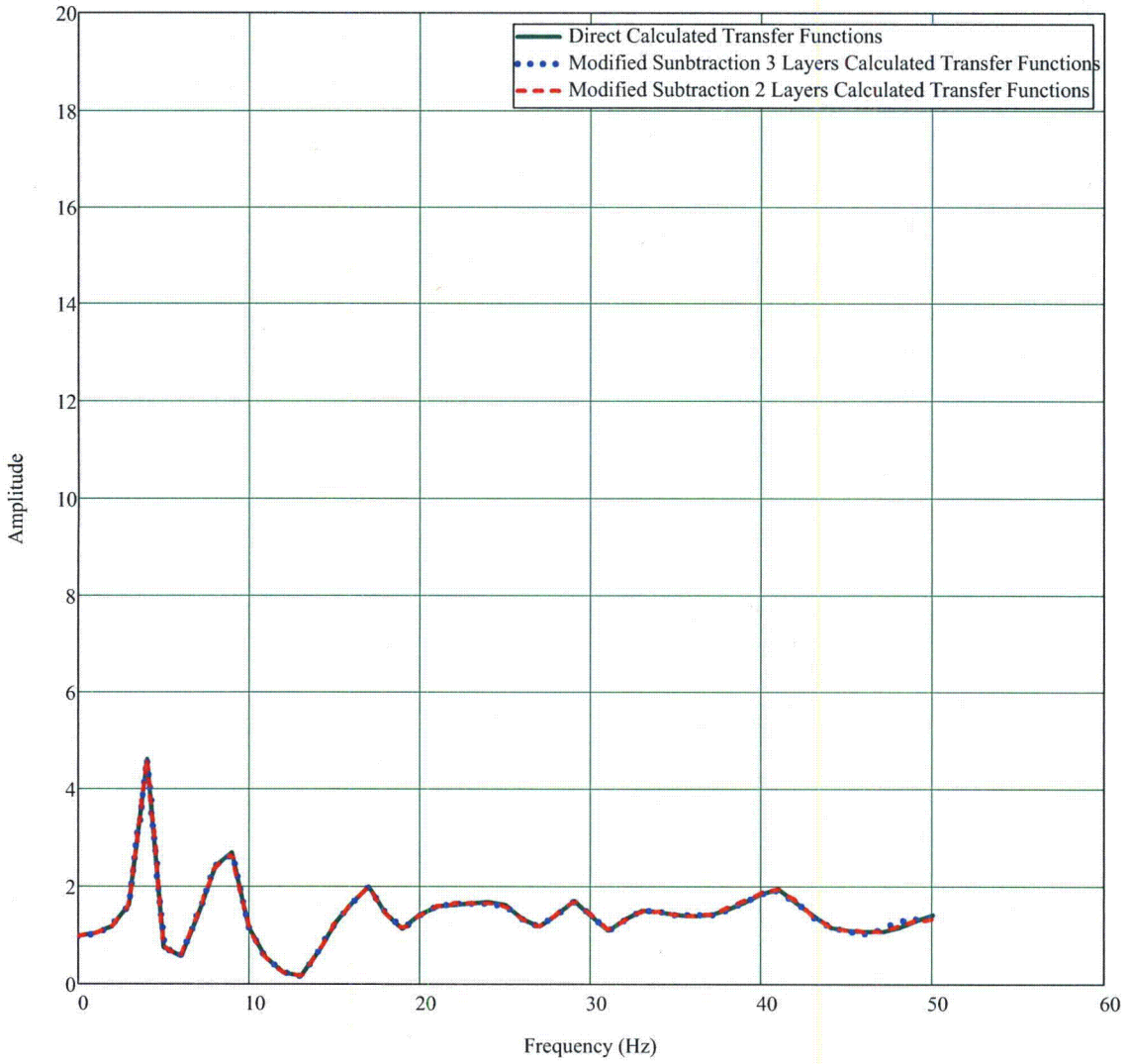


Figure 26: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

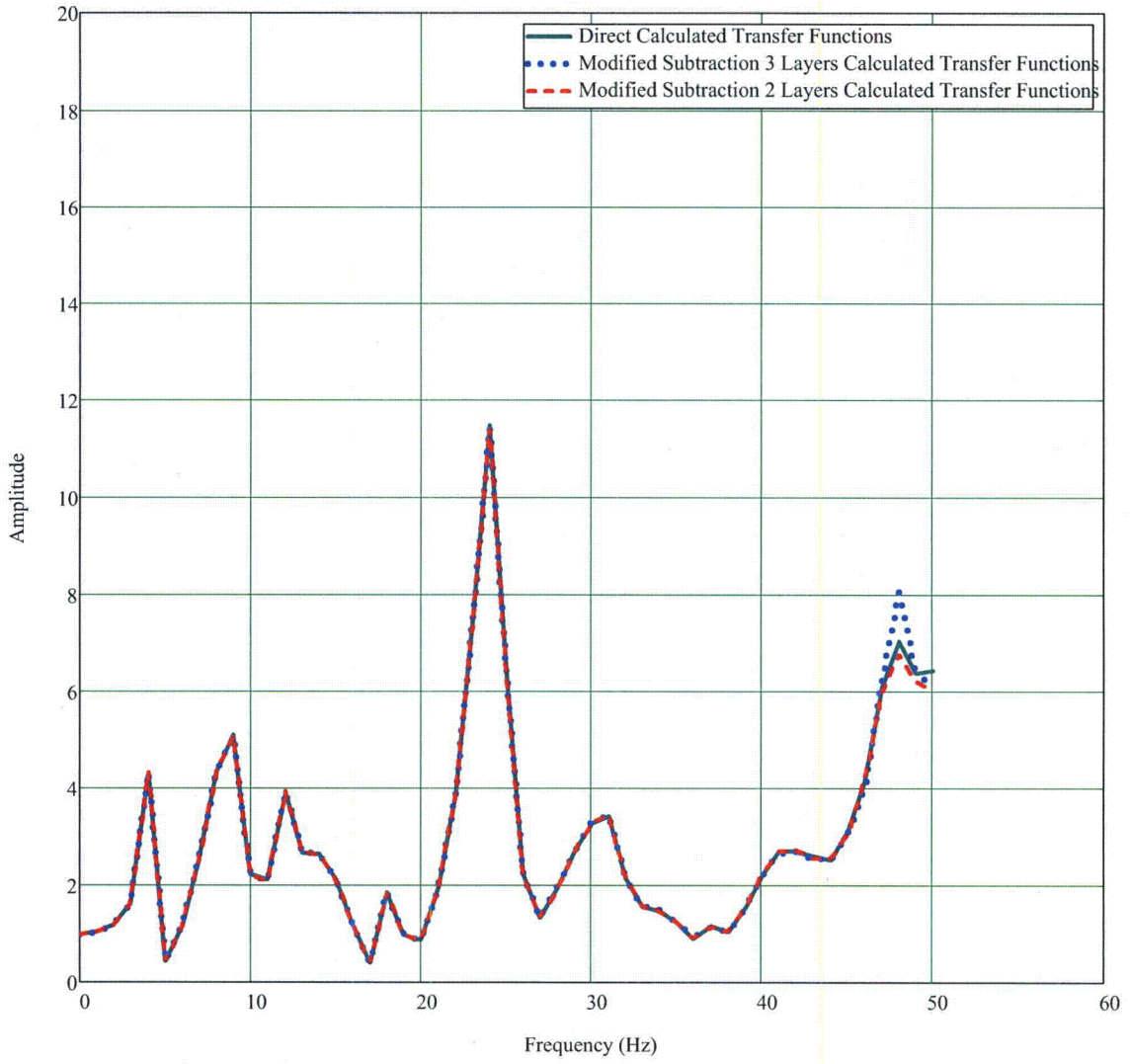


Figure 27: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

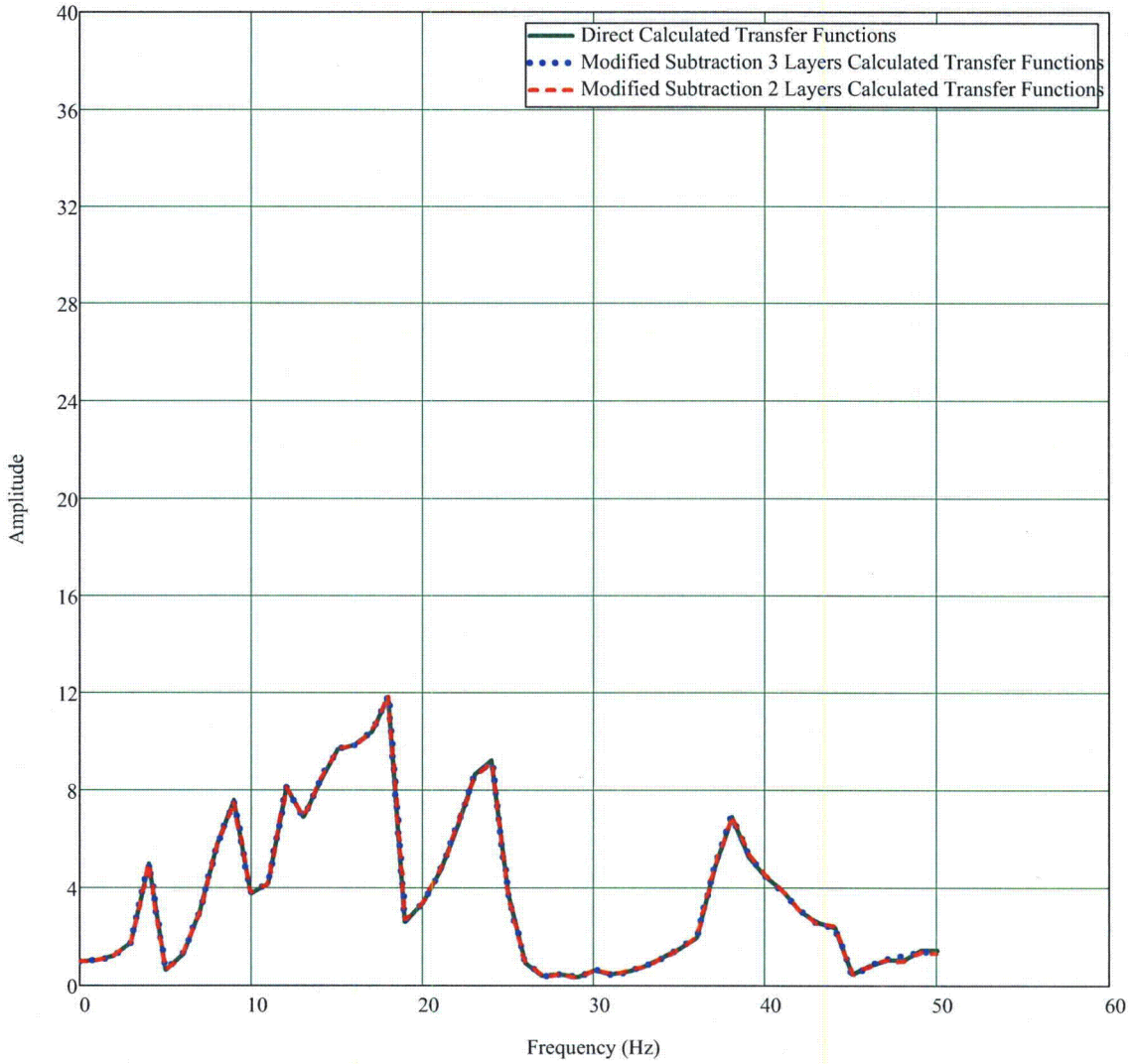


Figure 28: Y-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

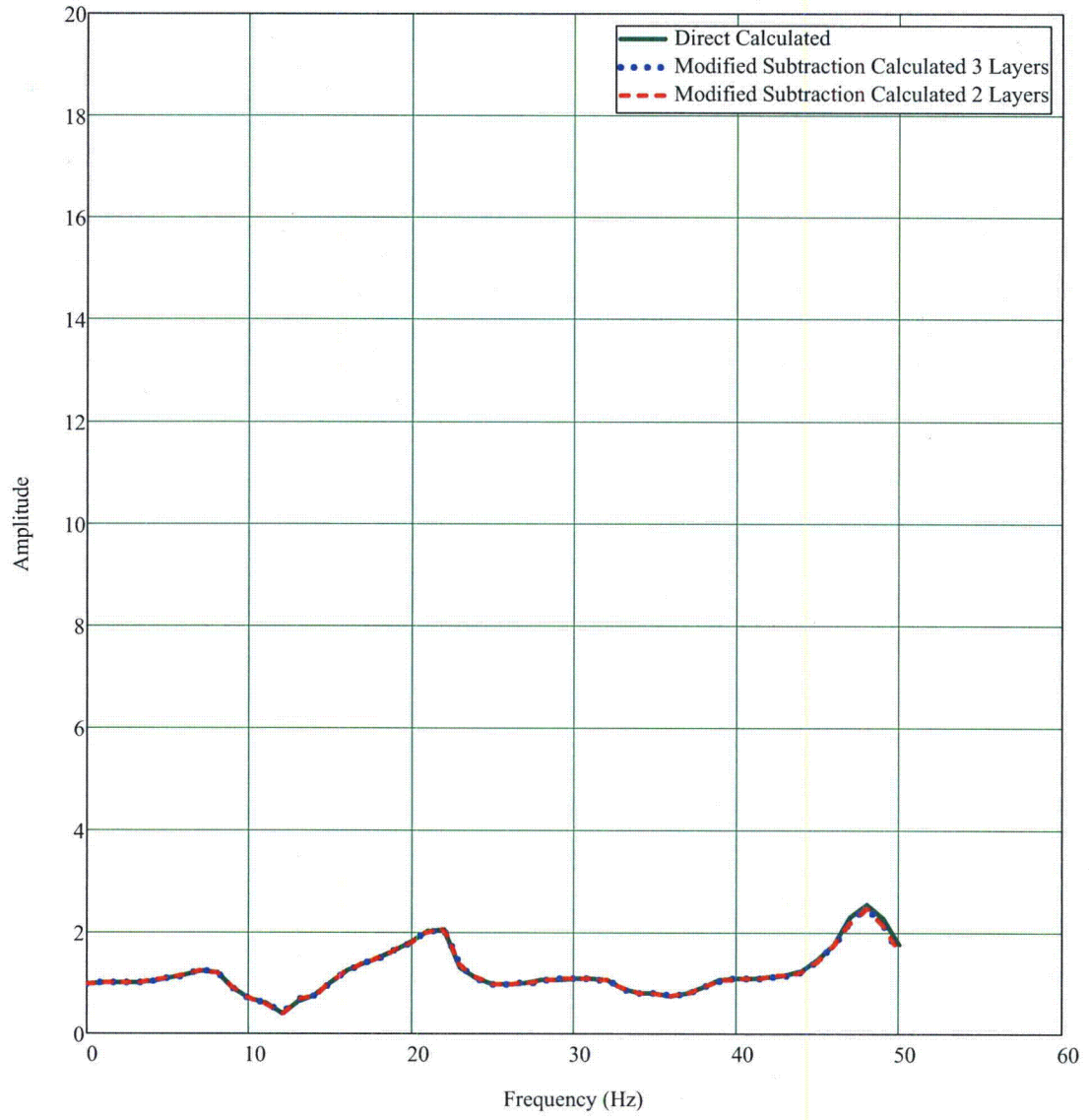


Figure 29: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

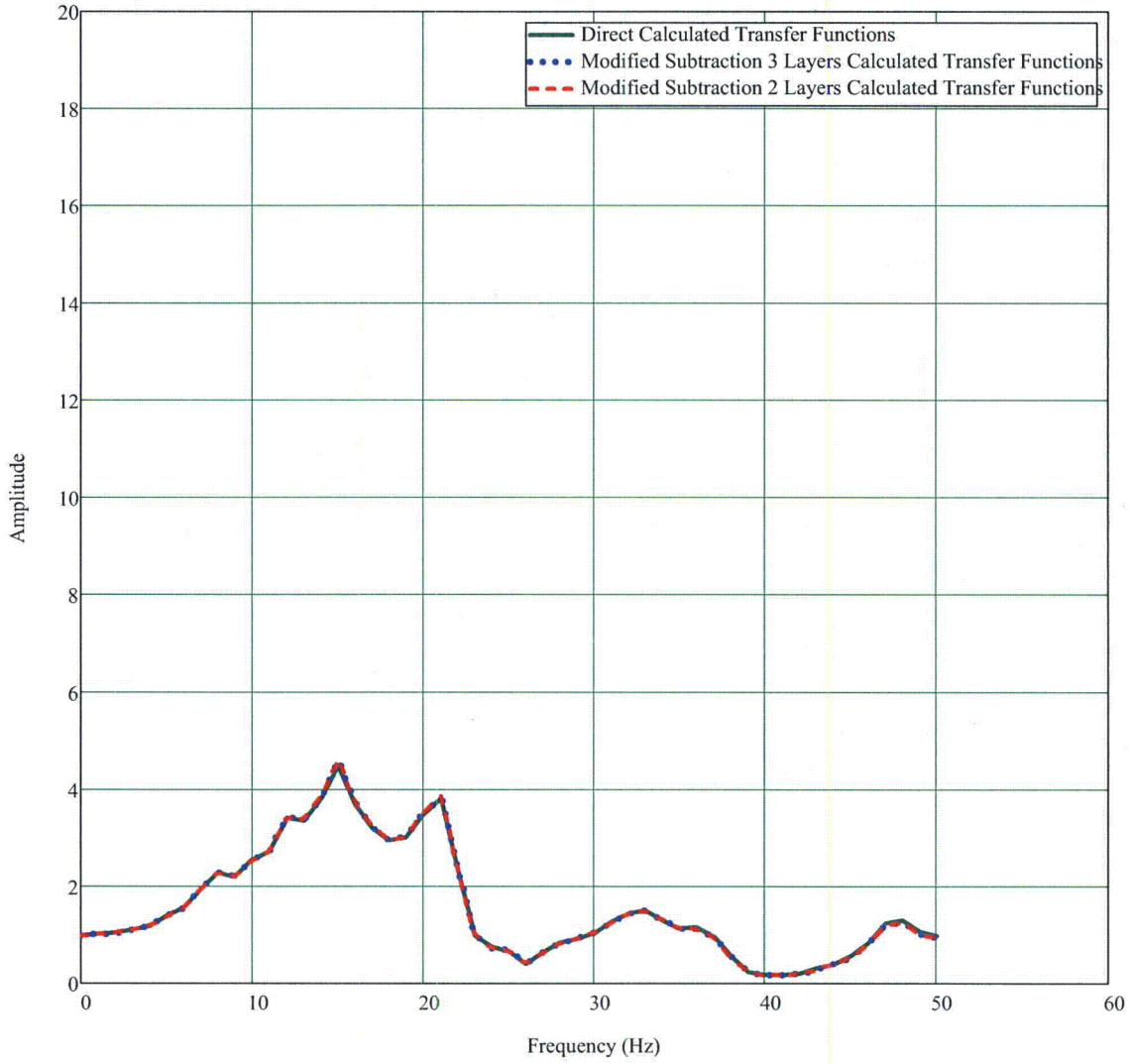


Figure 30: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

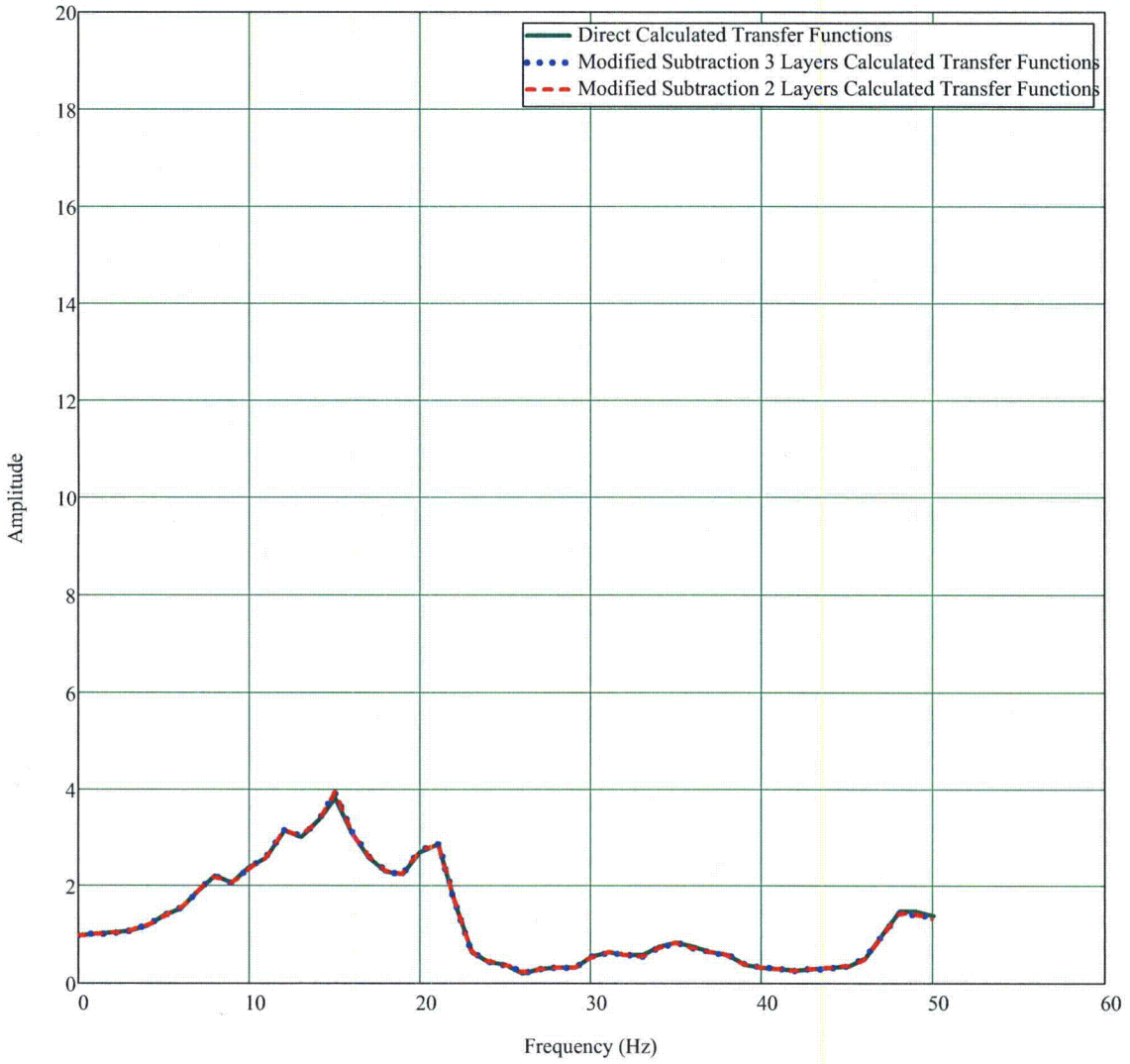


Figure 31: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

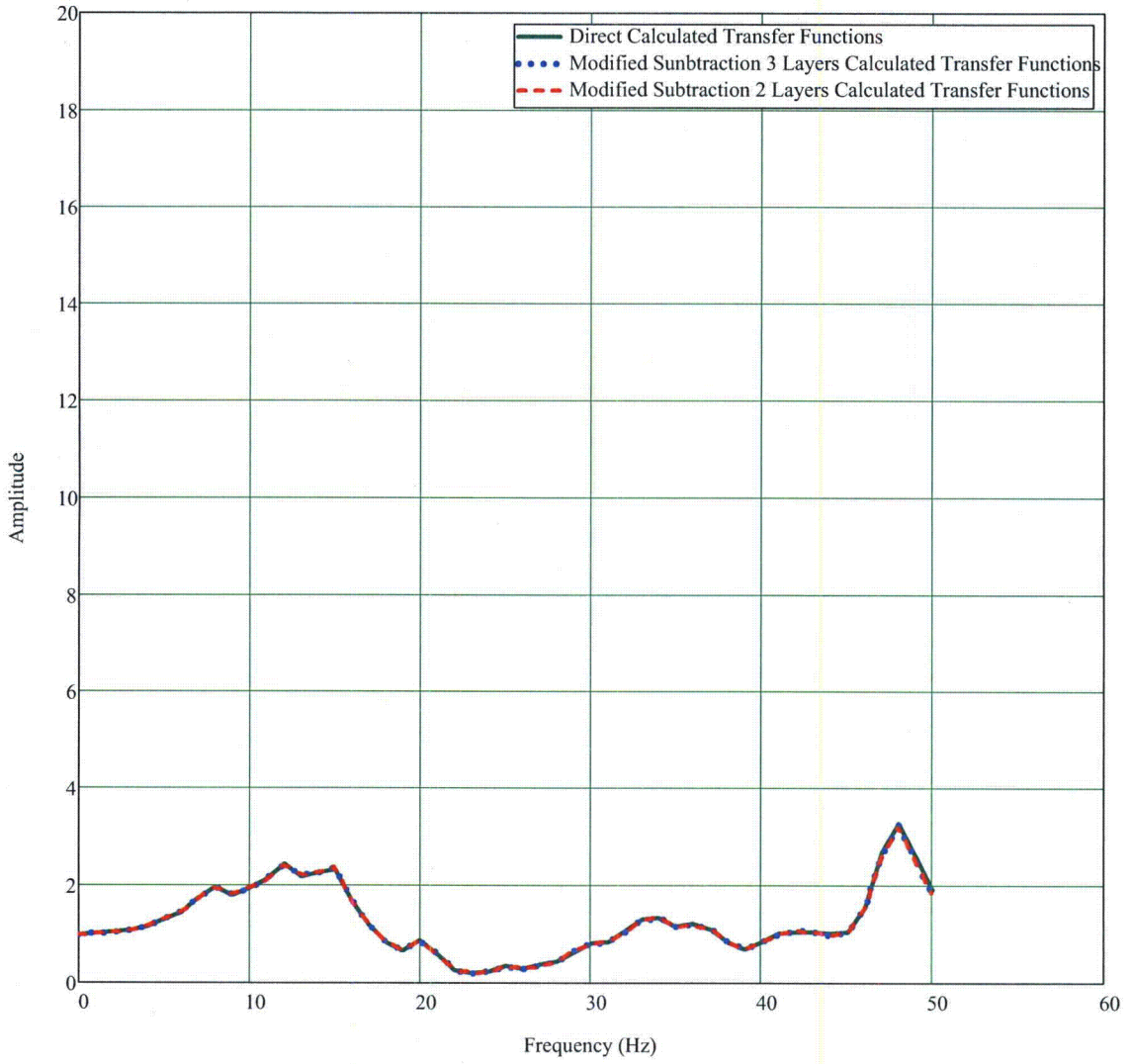


Figure 32: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

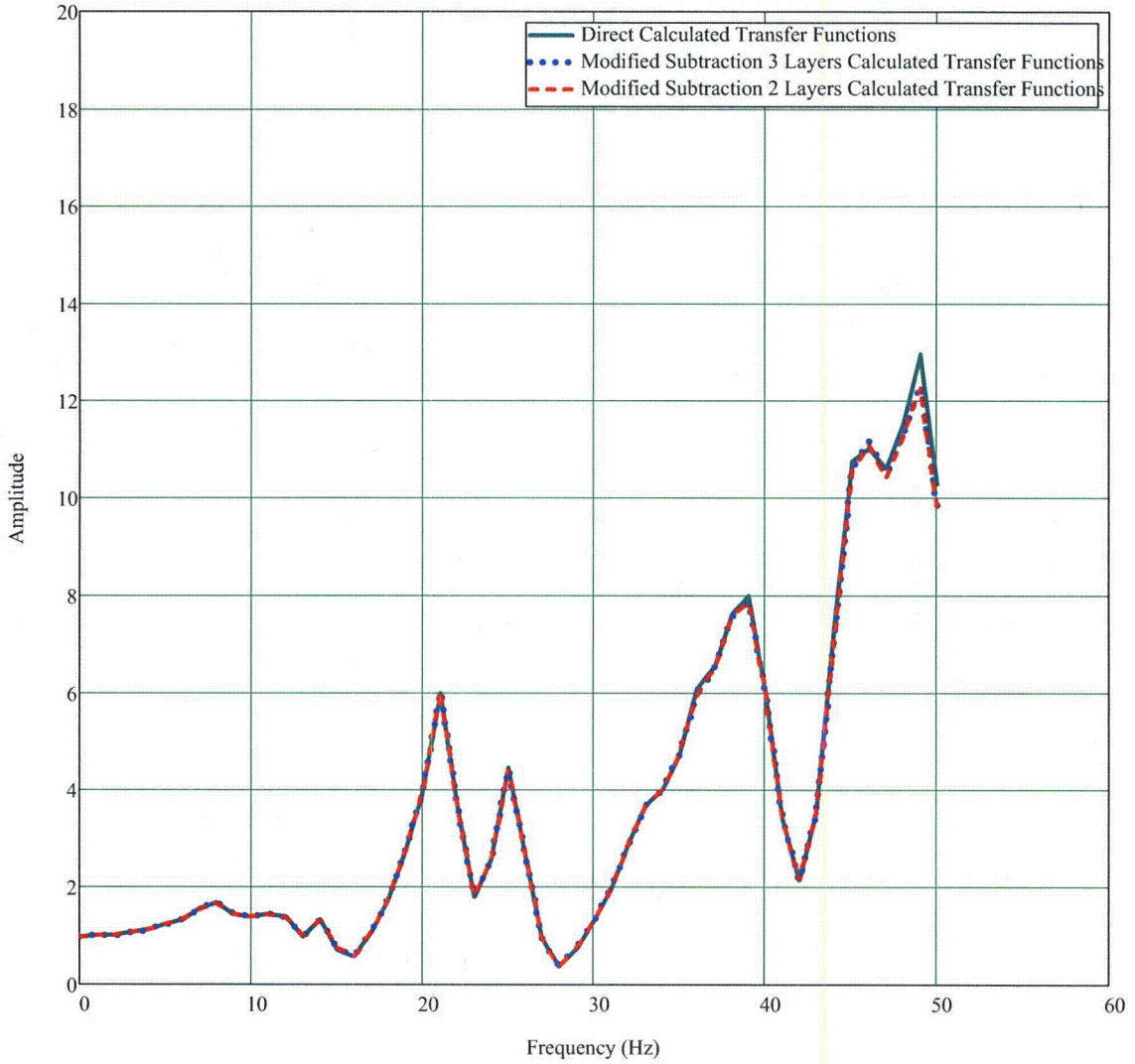


Figure 33: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

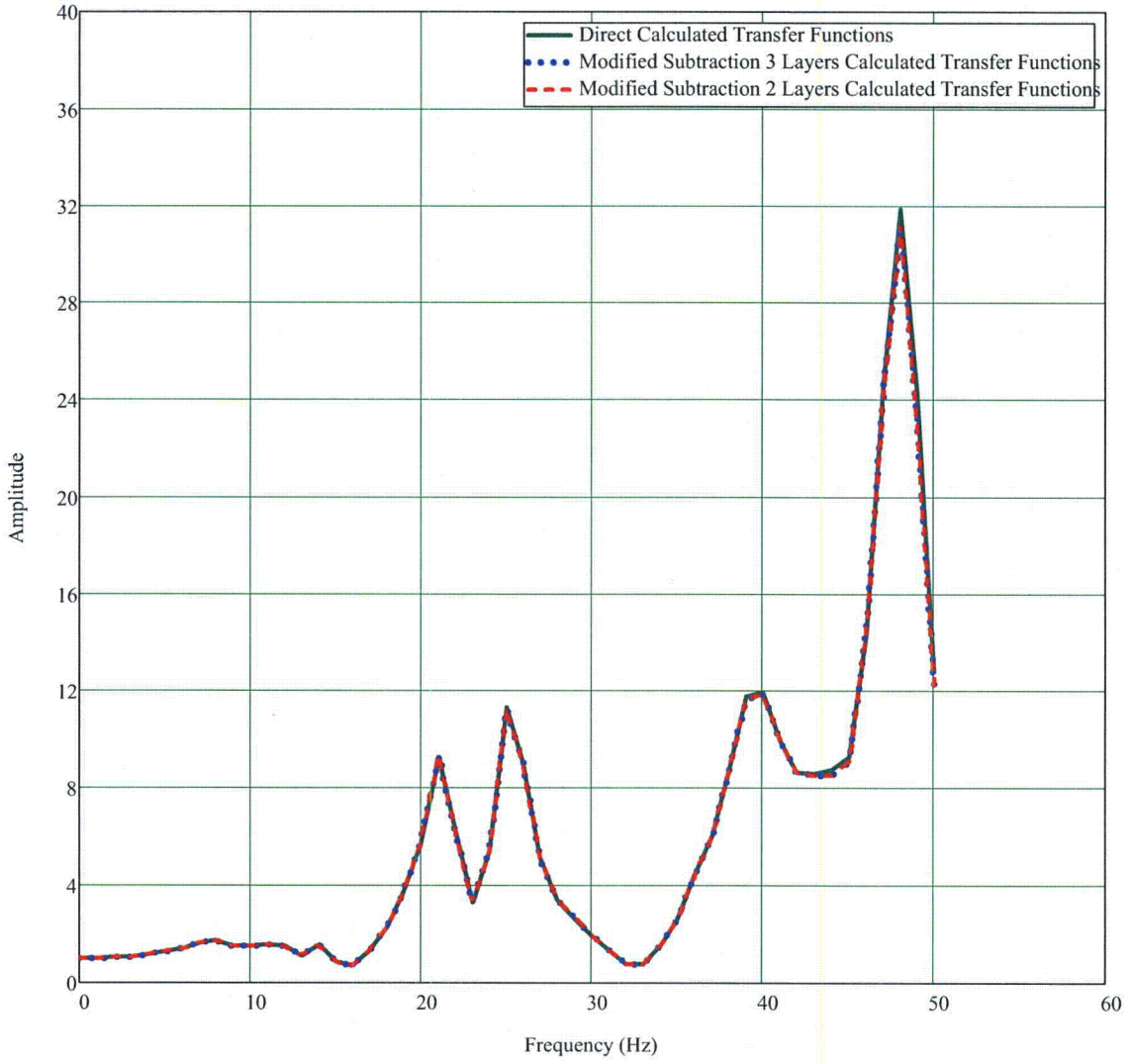


Figure 34: Z-Direction MSM3, MSM2 and DM Calculated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

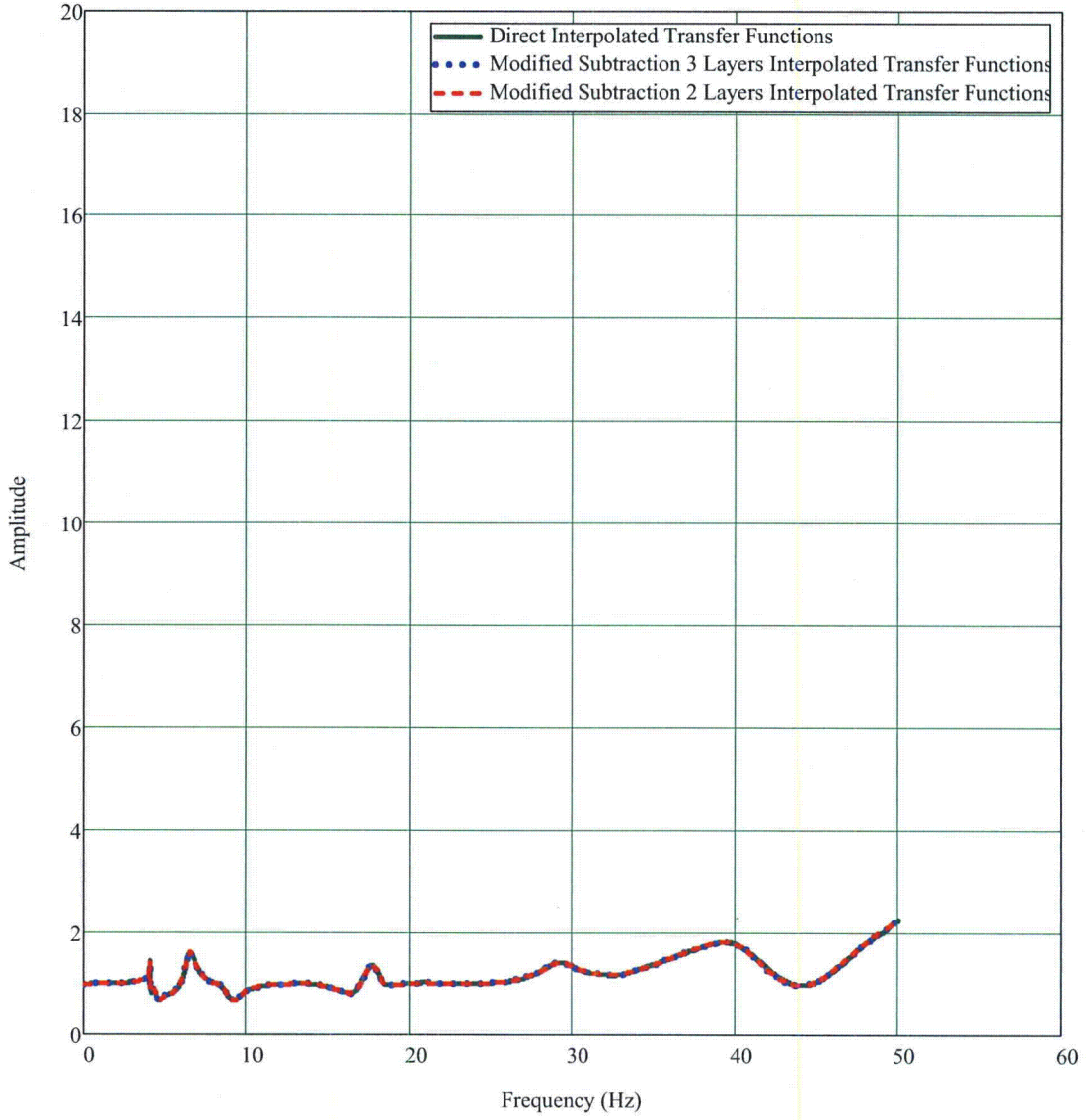


Figure 35: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

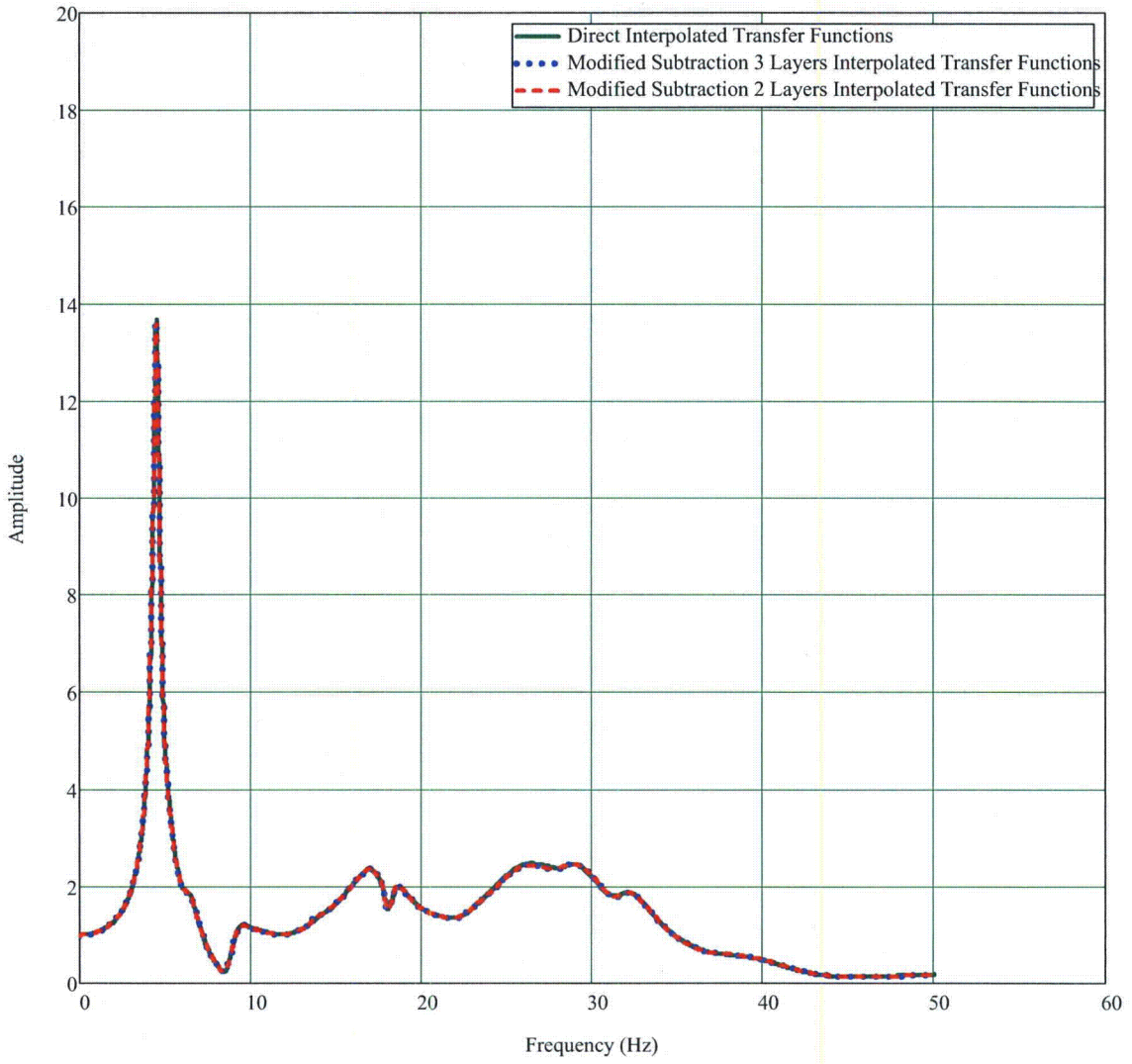


Figure 36: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

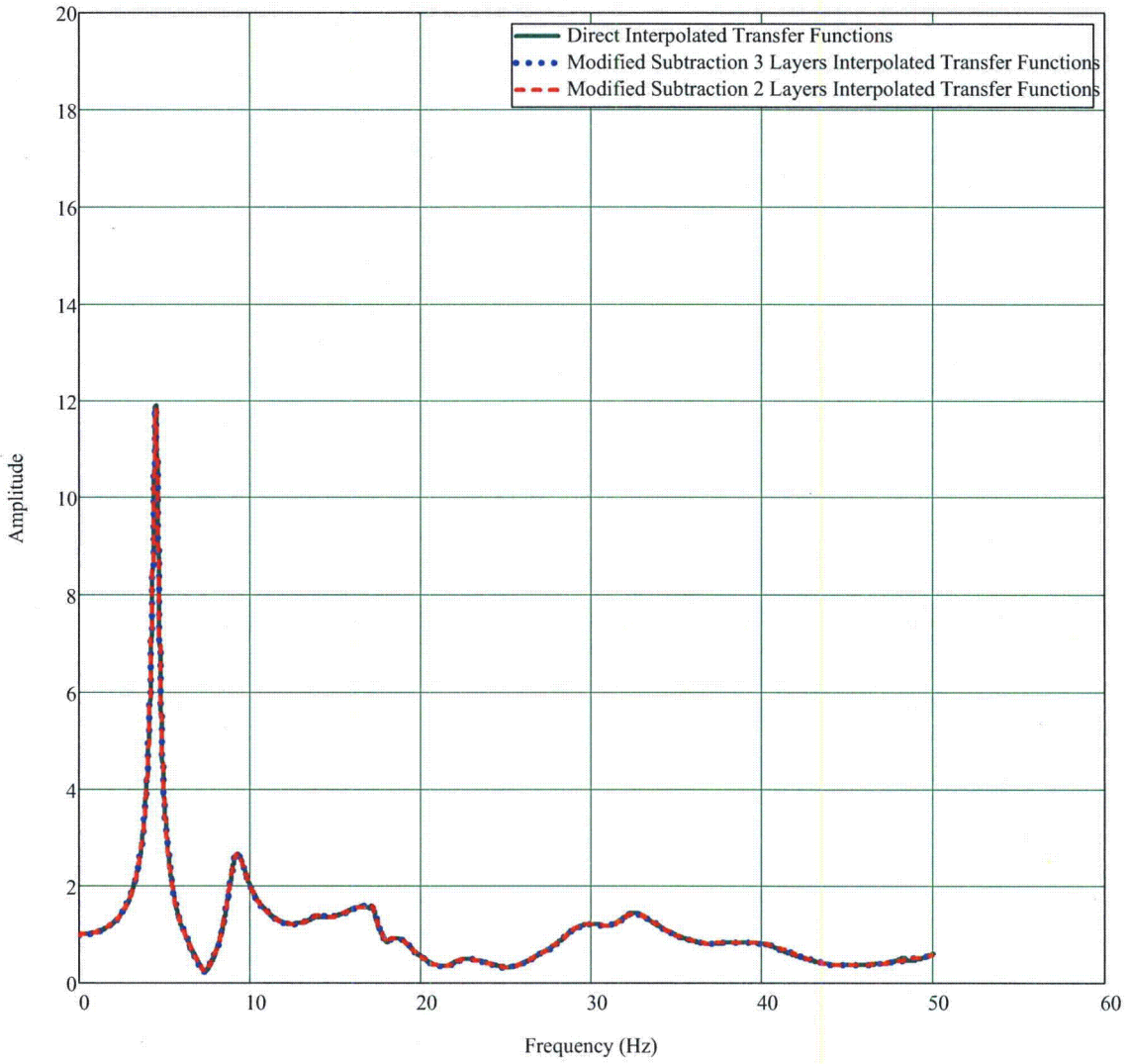


Figure 37: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

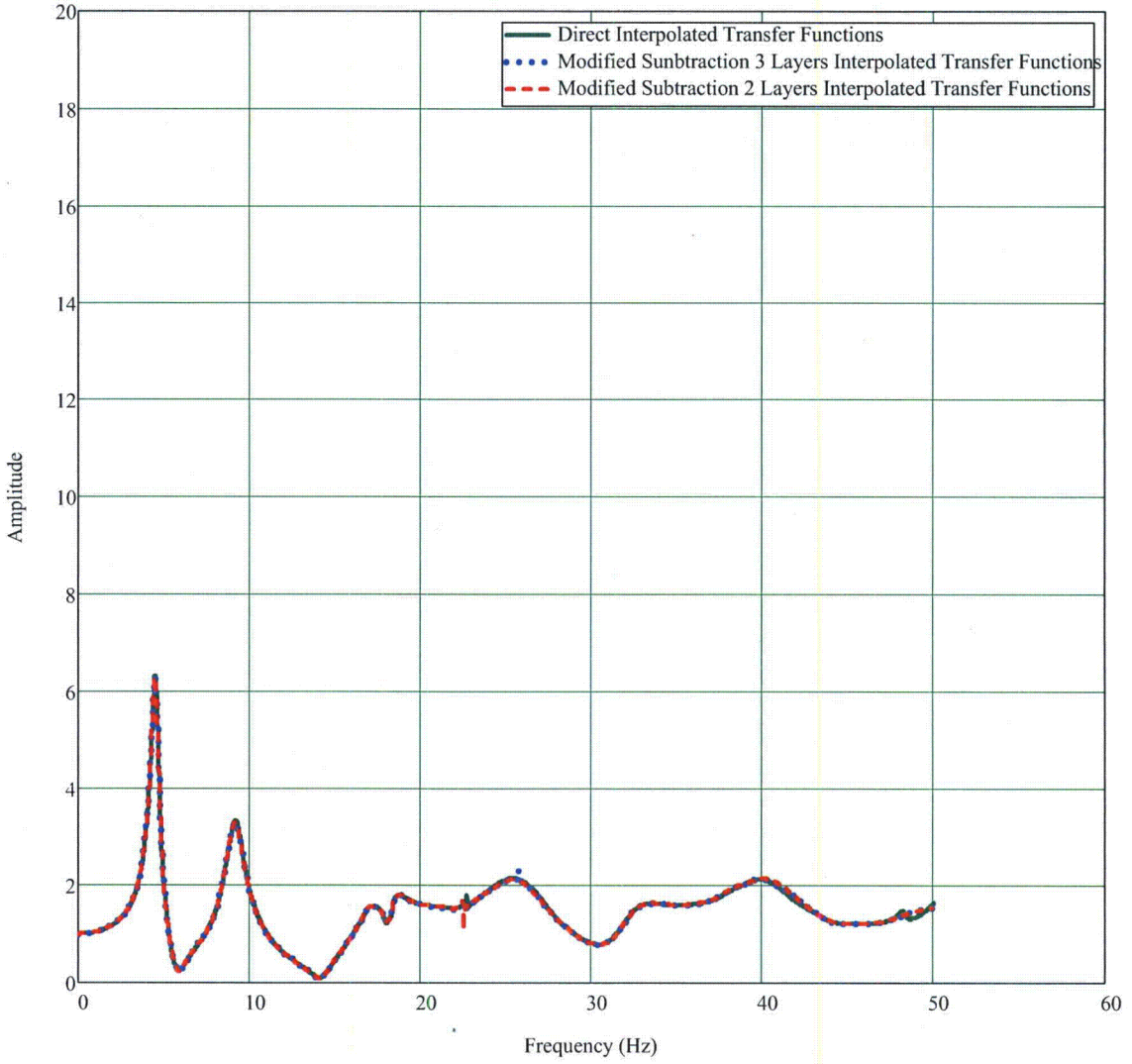


Figure 38: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

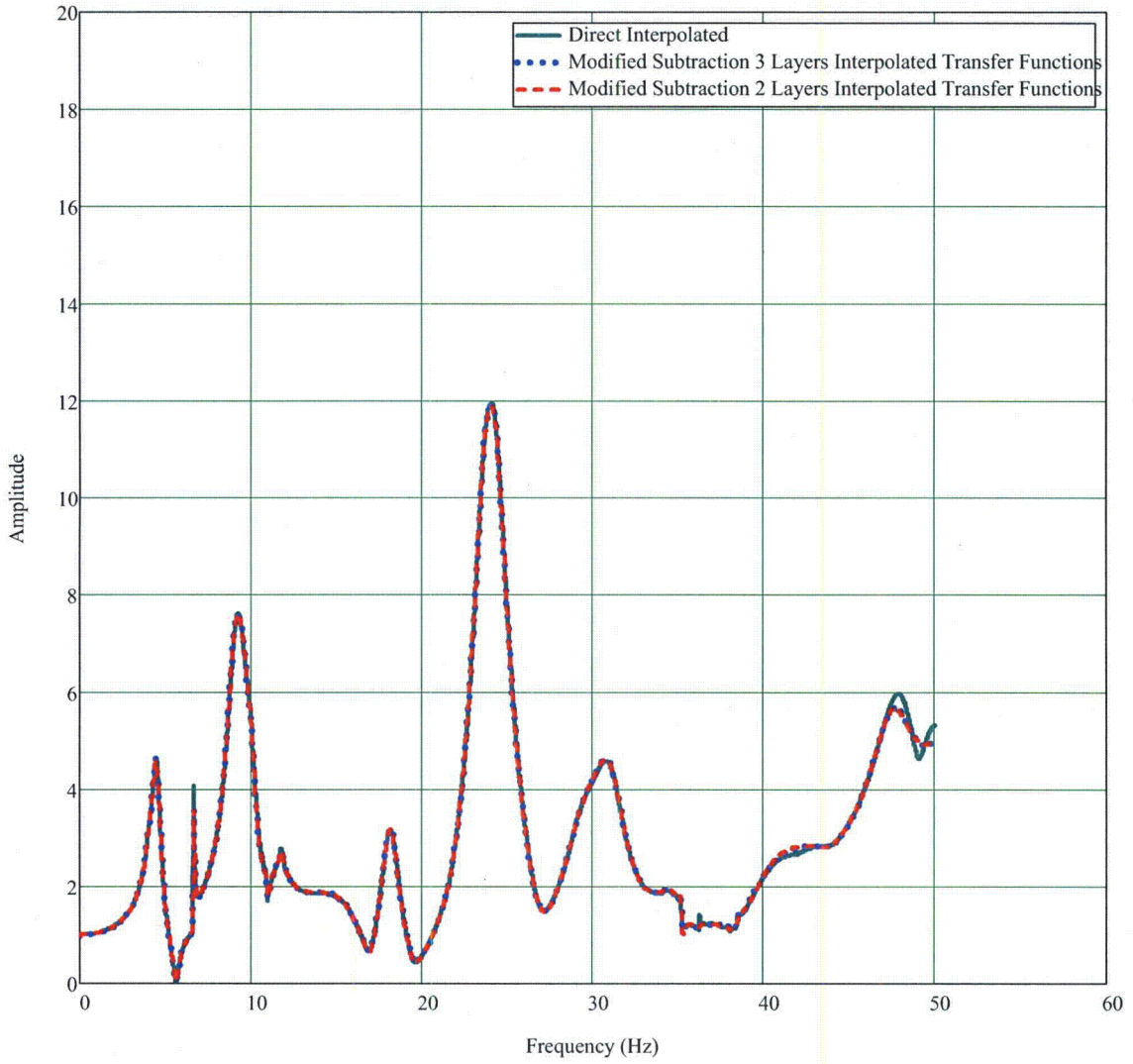


Figure 39: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

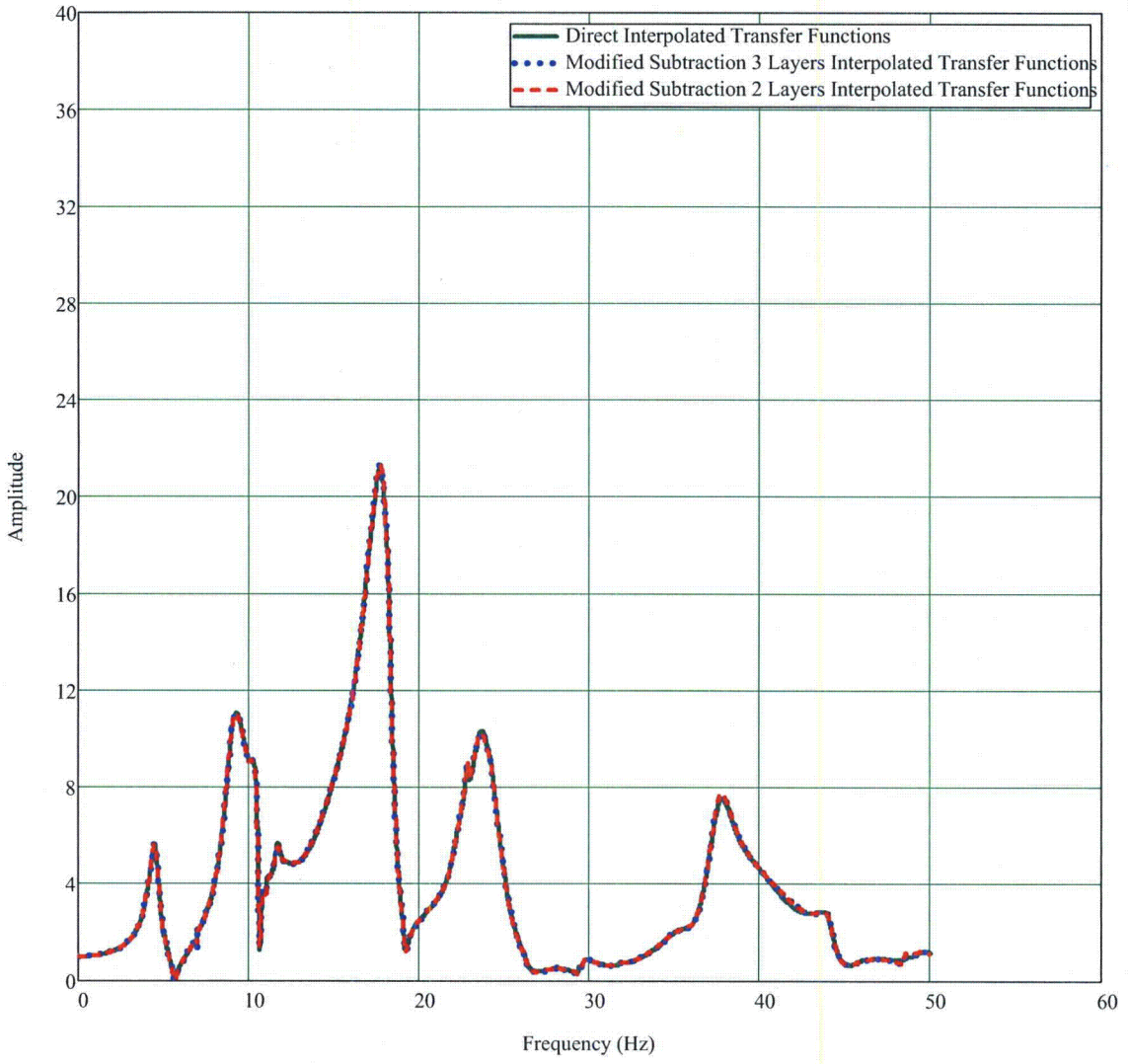


Figure 40: X-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

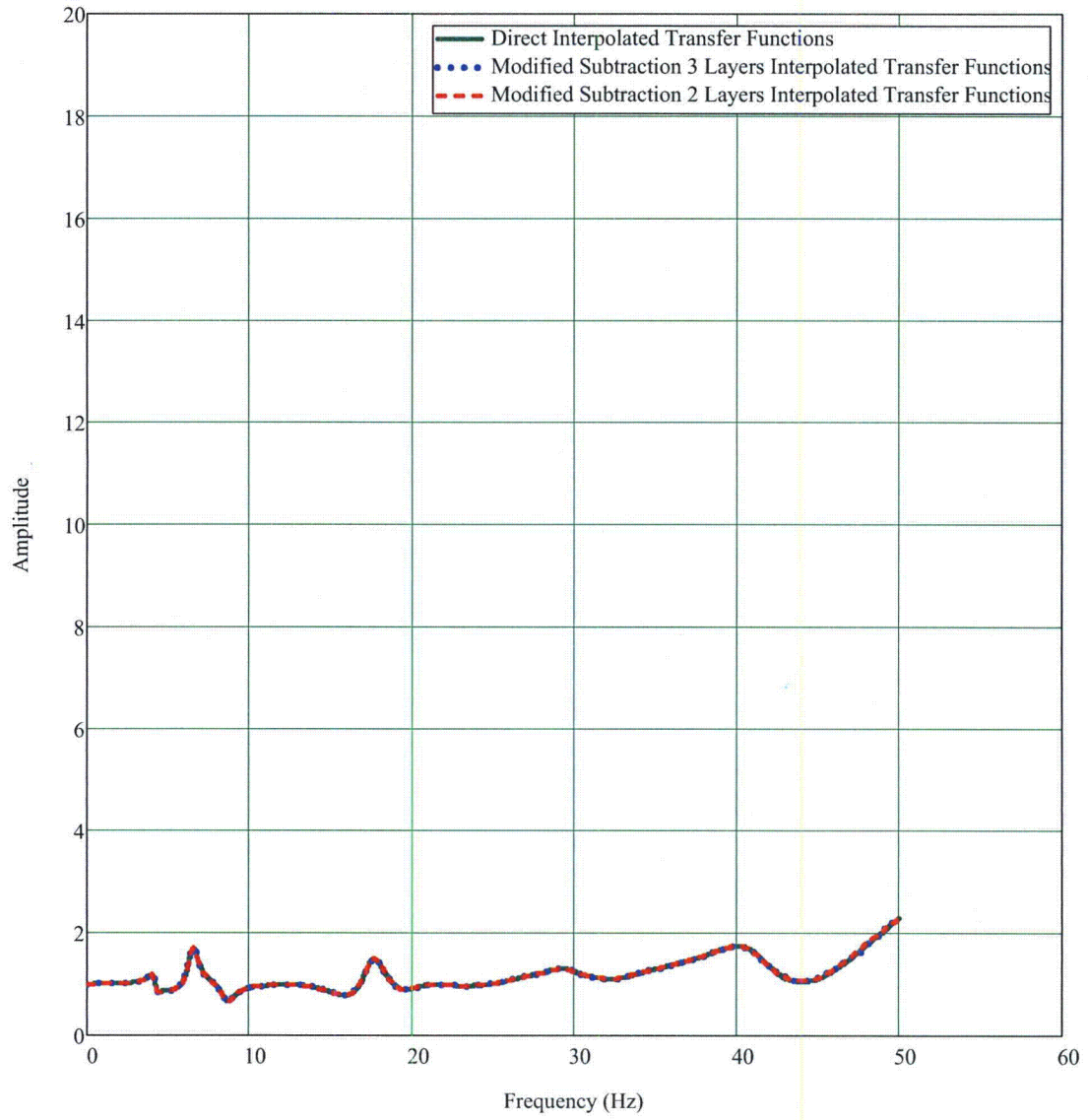


Figure 41: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

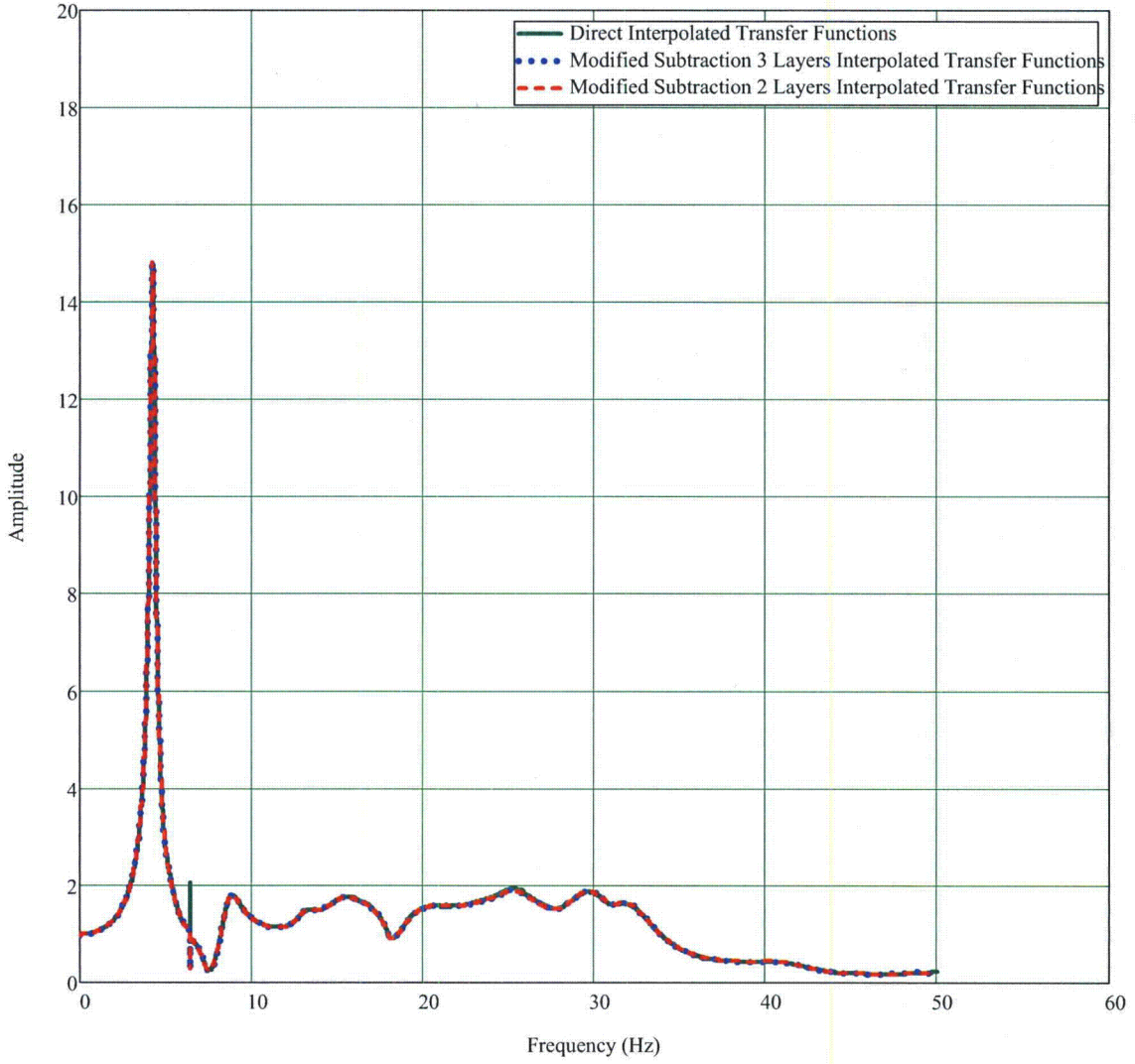


Figure 42: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

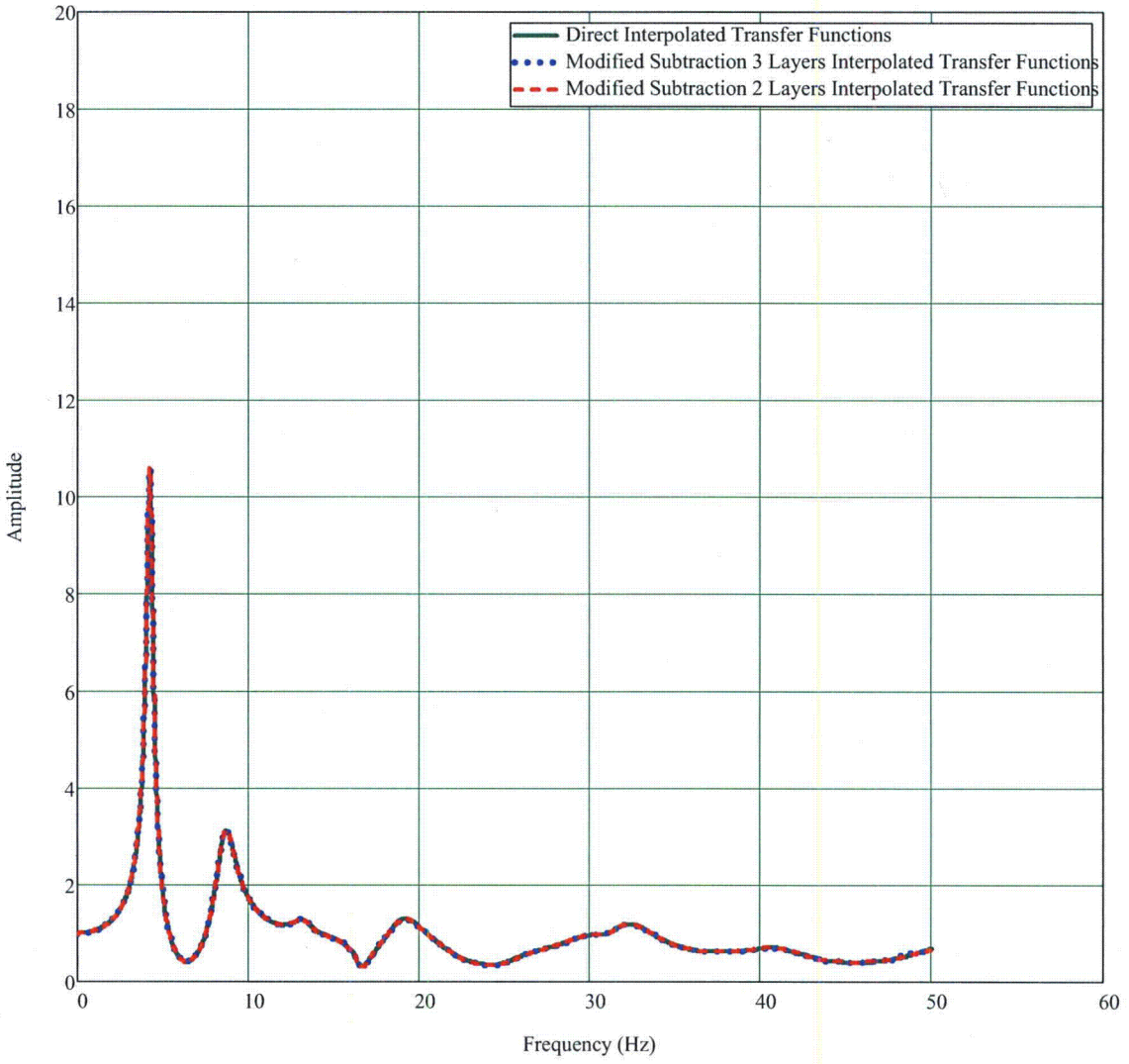


Figure 43: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

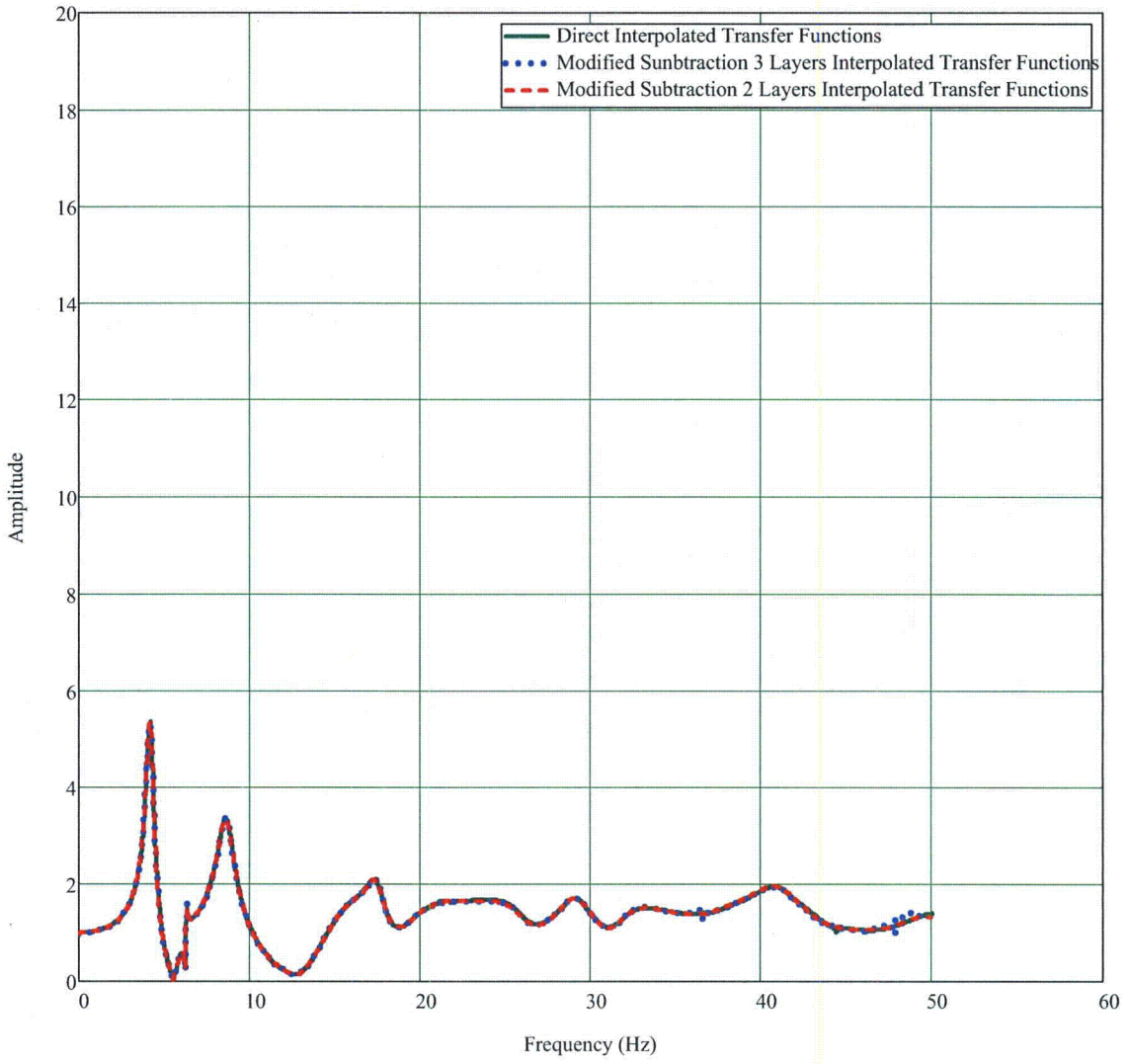


Figure 44: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

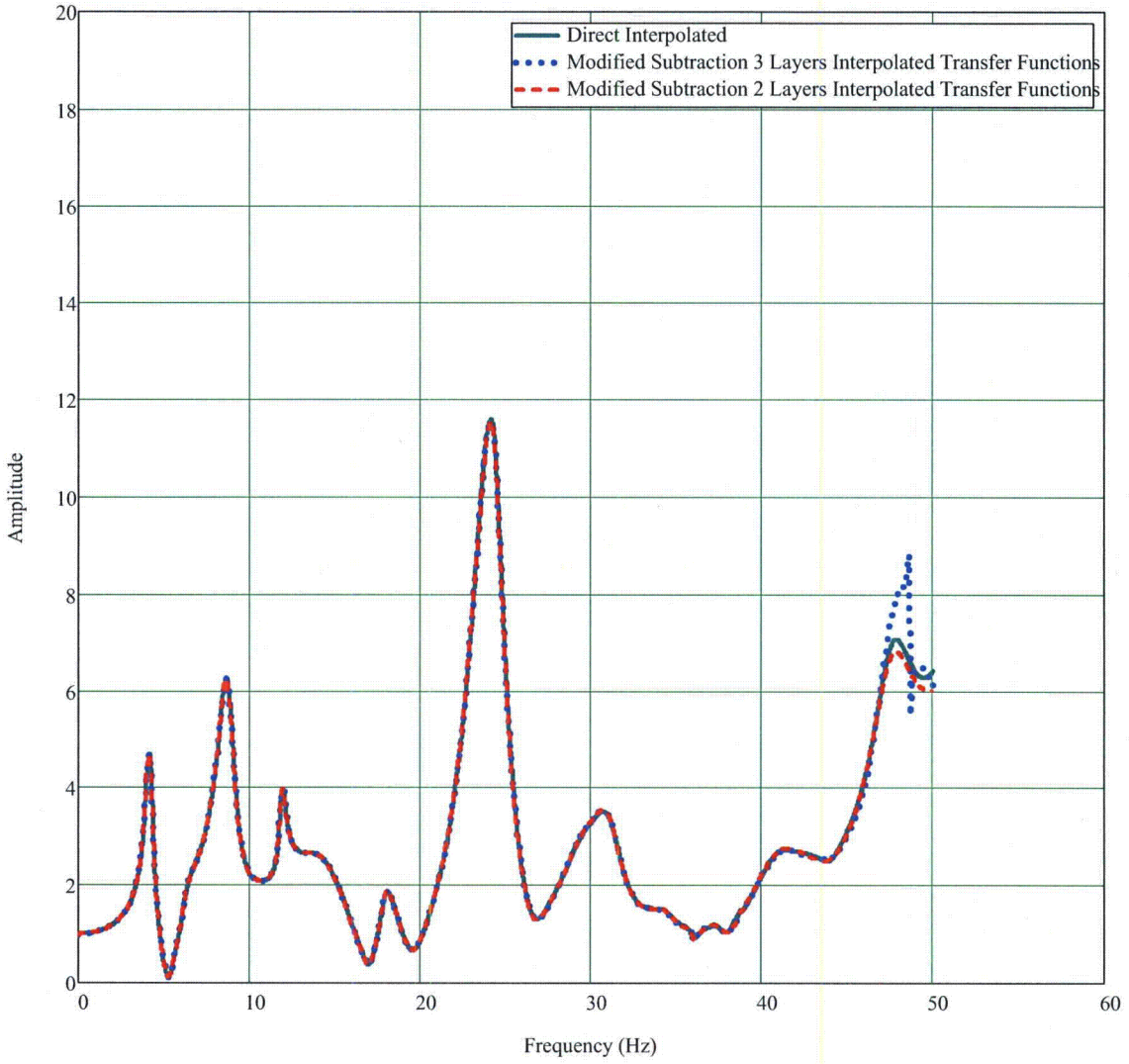


Figure 45: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

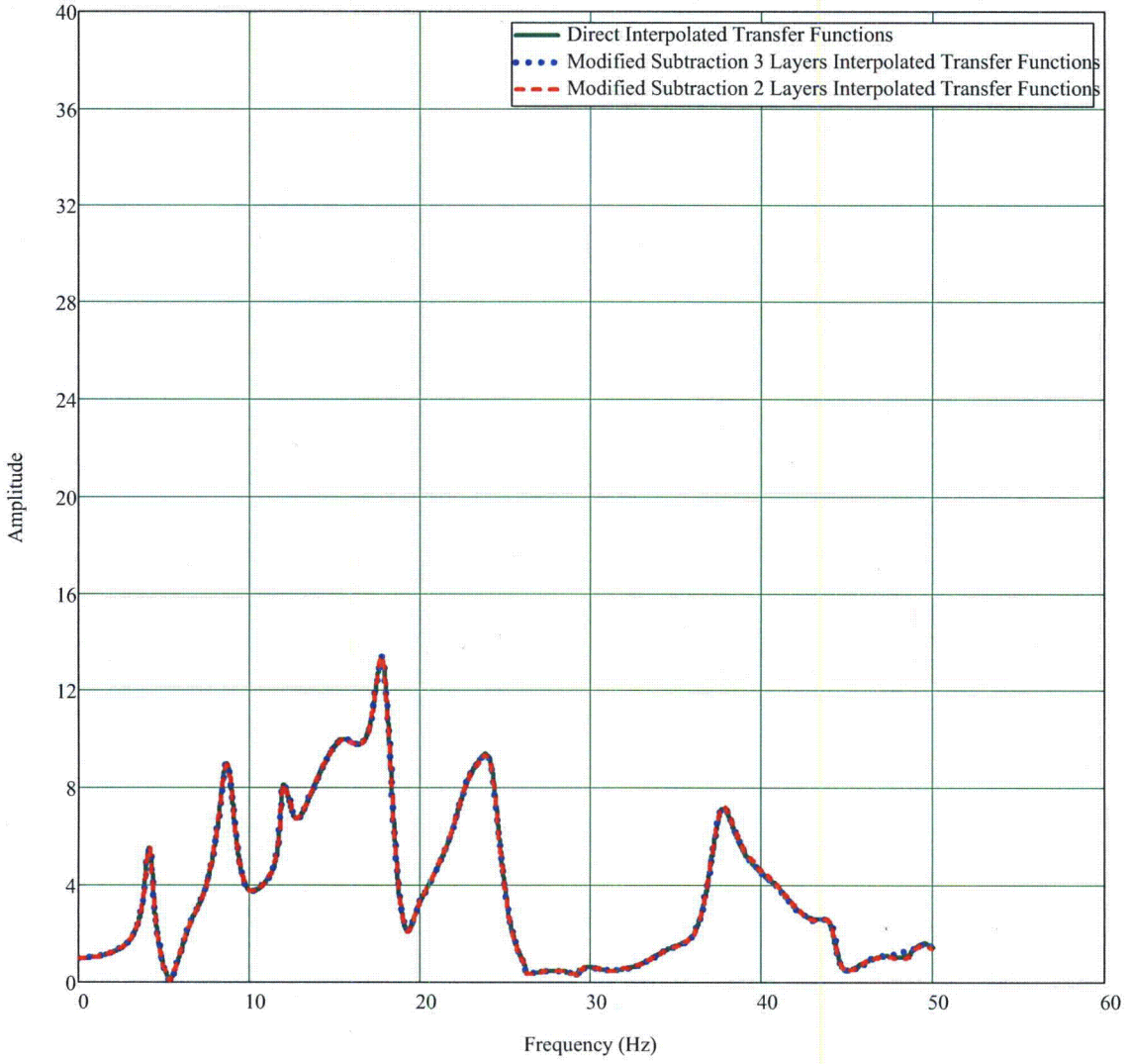


Figure 46: Y-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

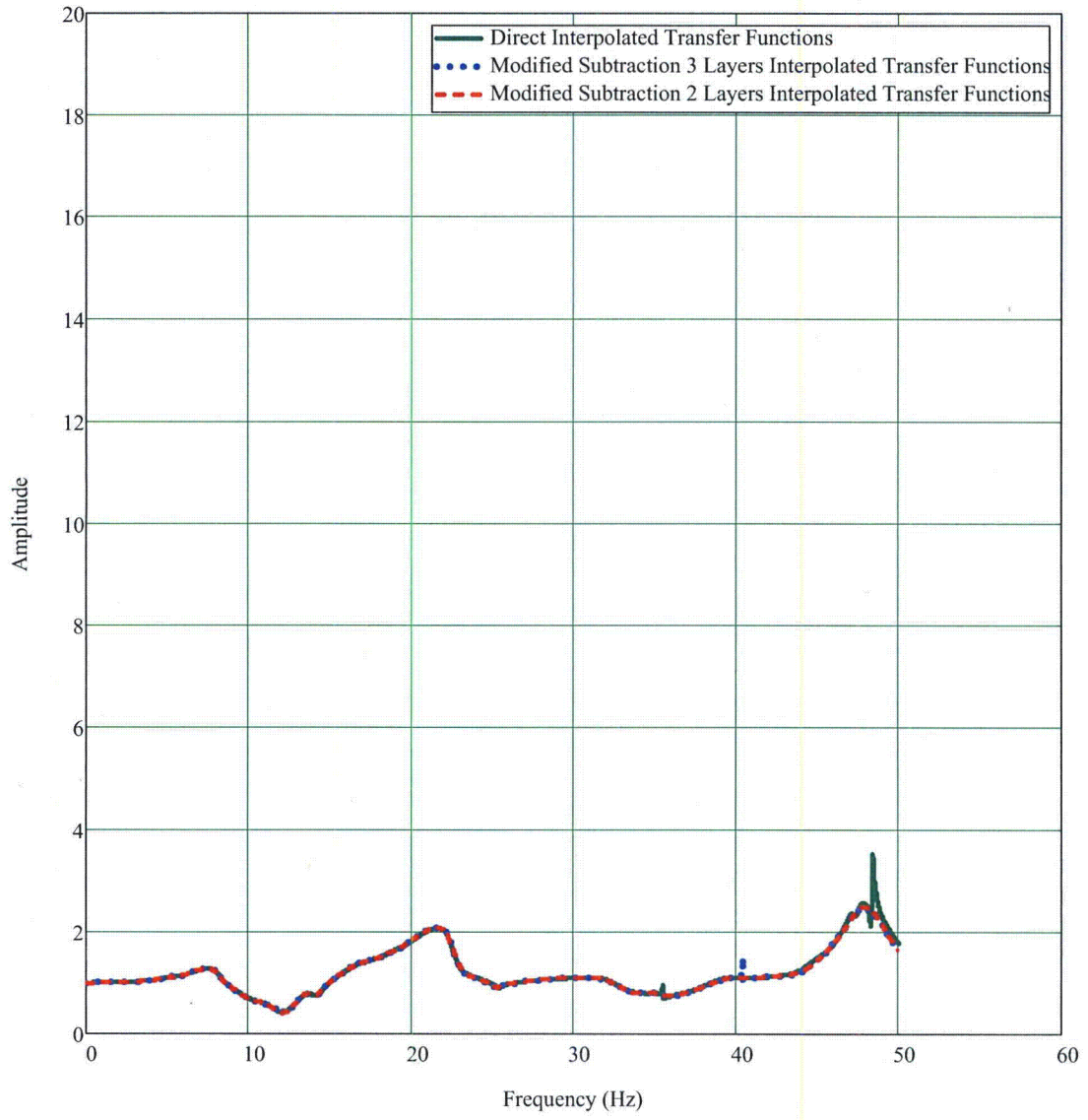


Figure 47: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Basemat (Elevation -11.50 m)

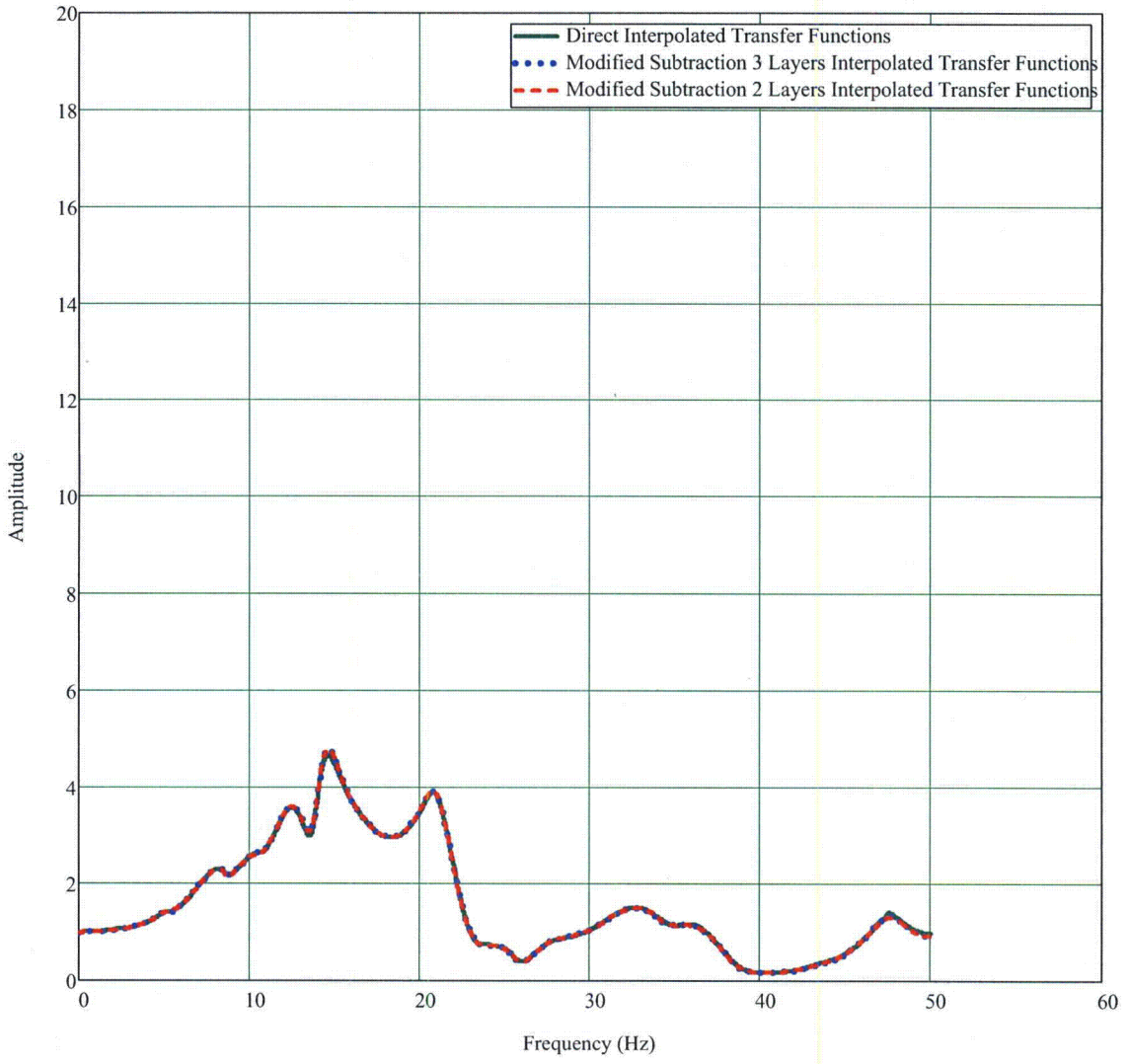


Figure 48: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

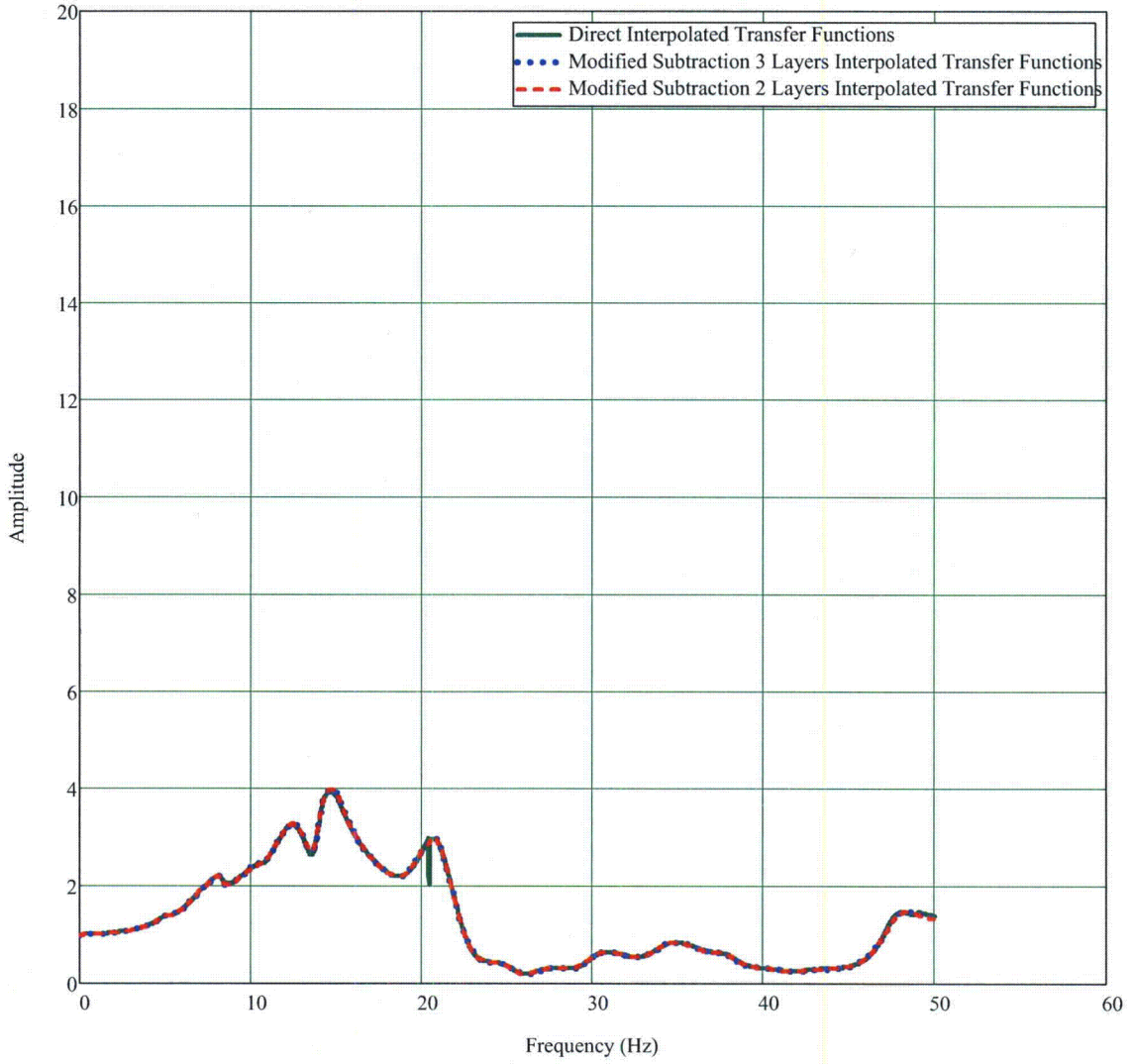


Figure 49: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RCCV Top Slab (Elevation 27.00 m)

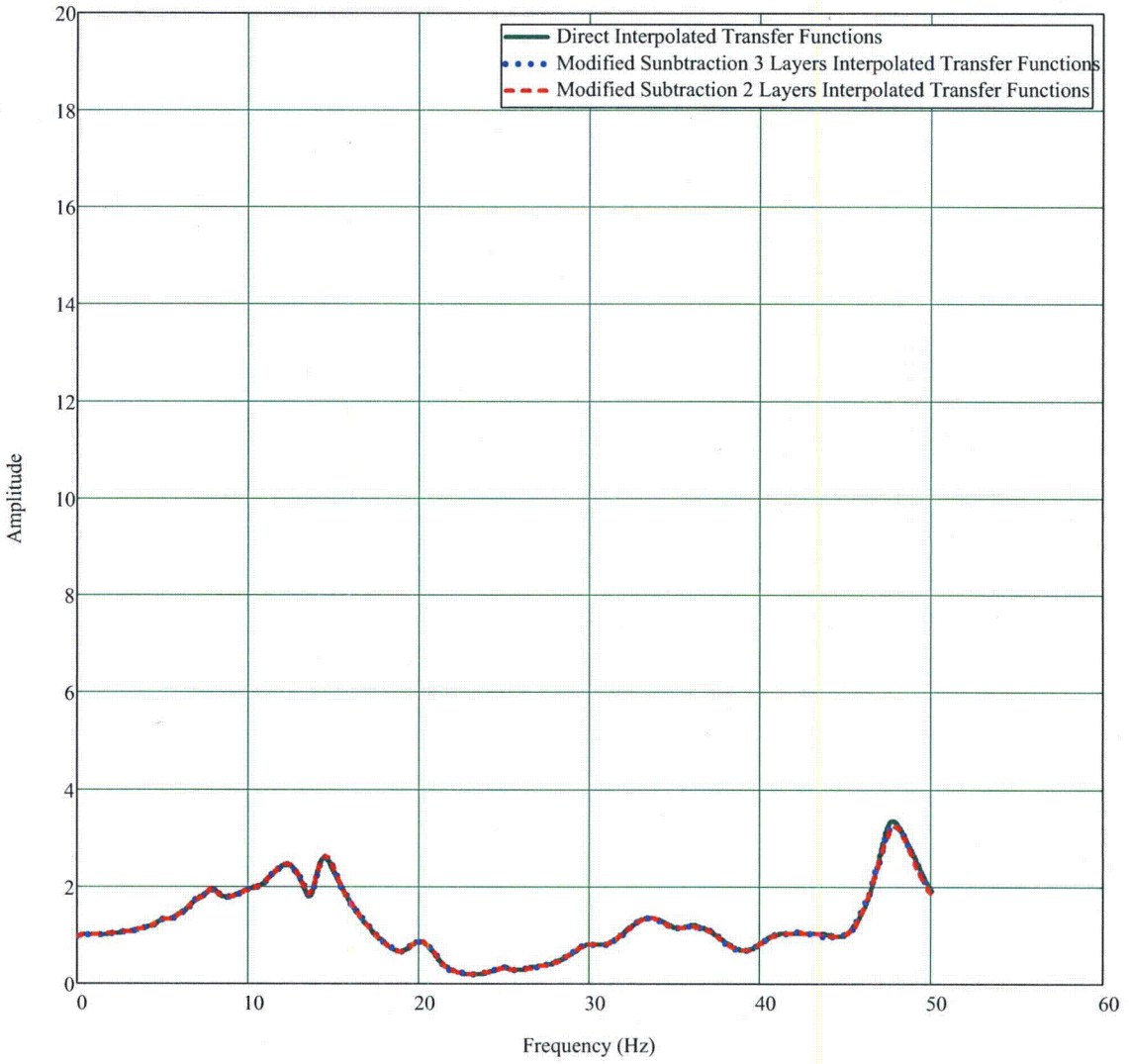


Figure 50: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB Vent Wall (Elevation 17.50 m)

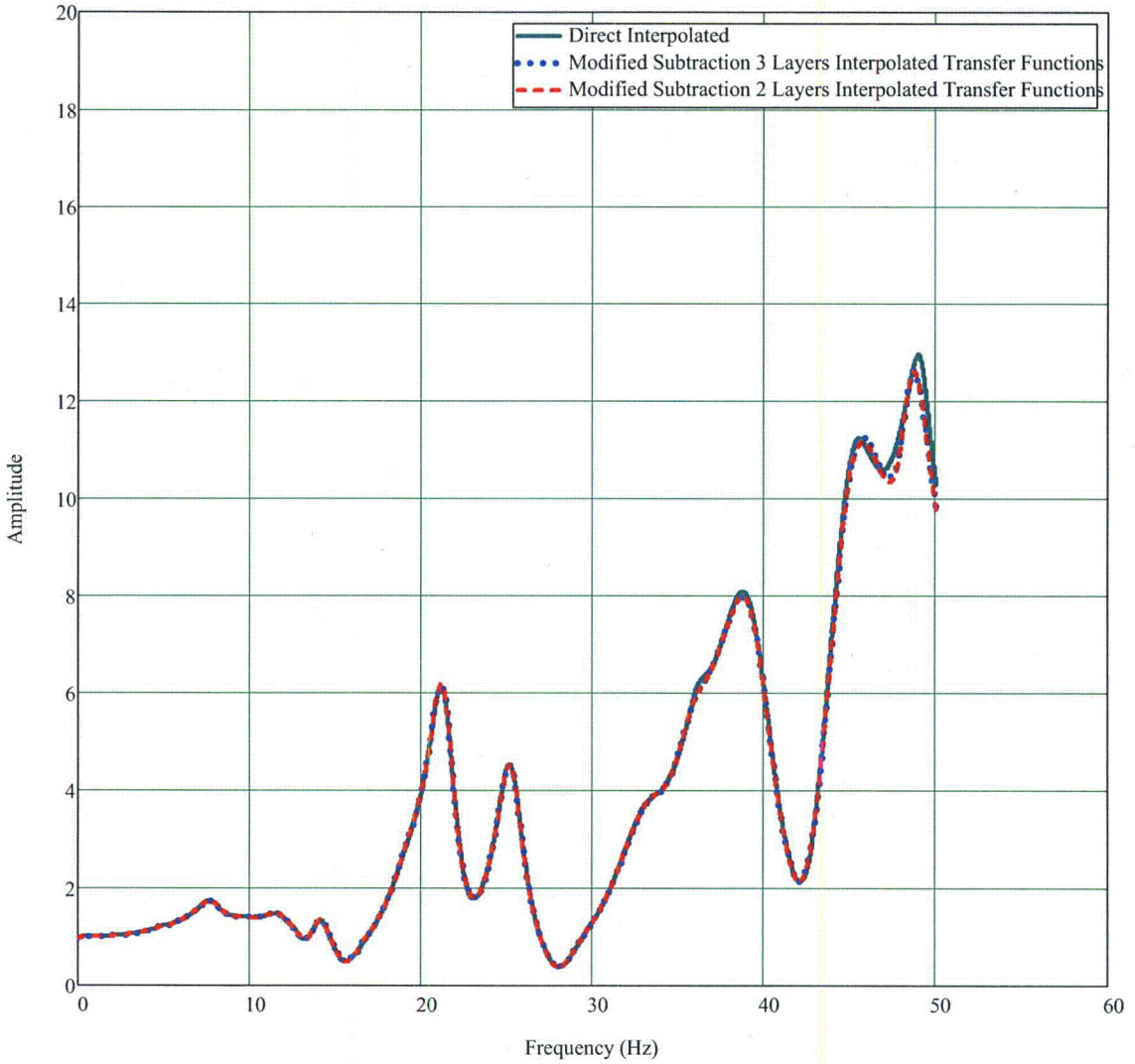


Figure 51: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RSW Top (Elevation 24.18 m)

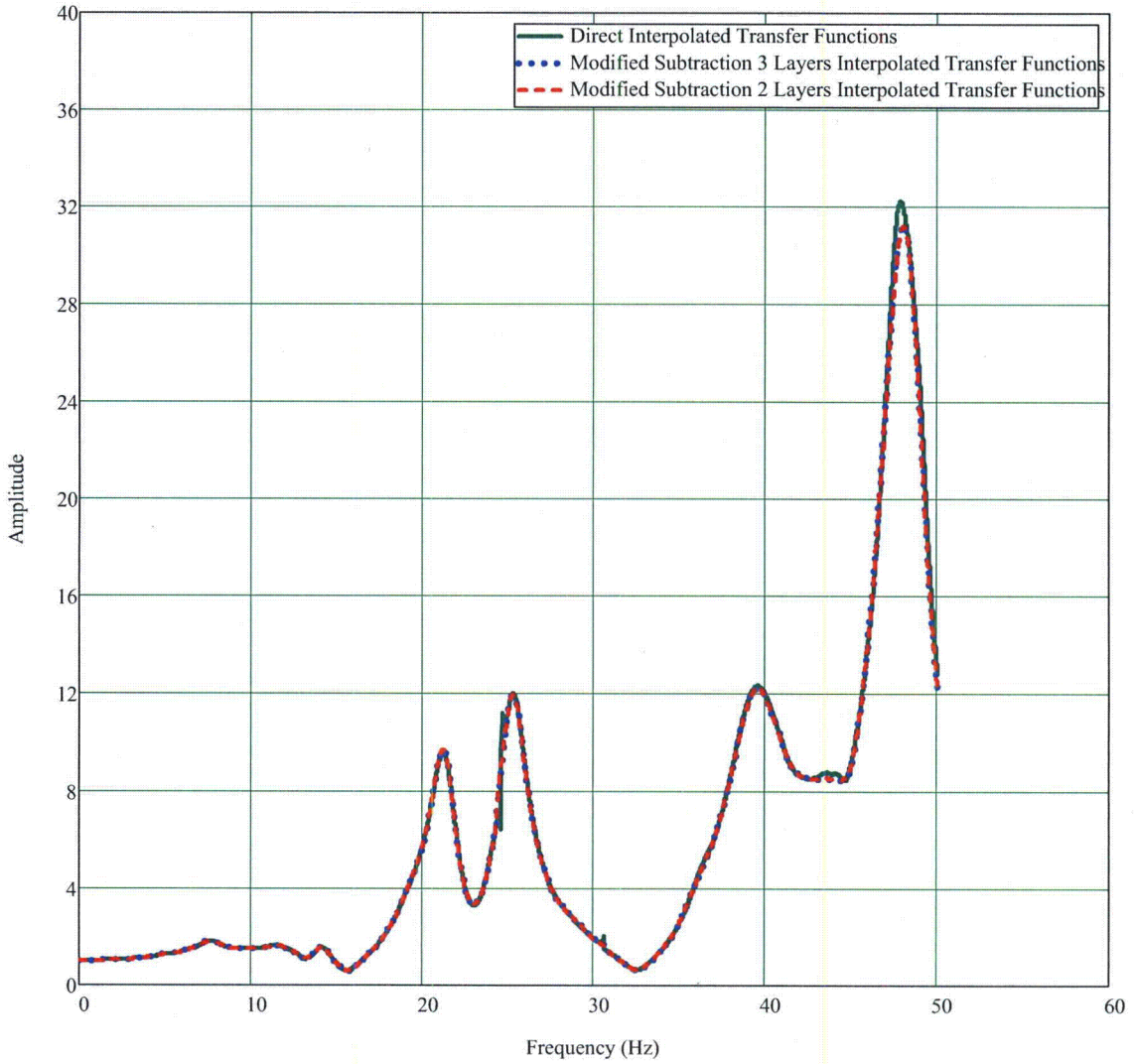


Figure 52: Z-Direction MSM3, MSM2 and DM Interpolated Transfer Functions Comparison - RB/FB RPV Top (Elevation 27.64 m)

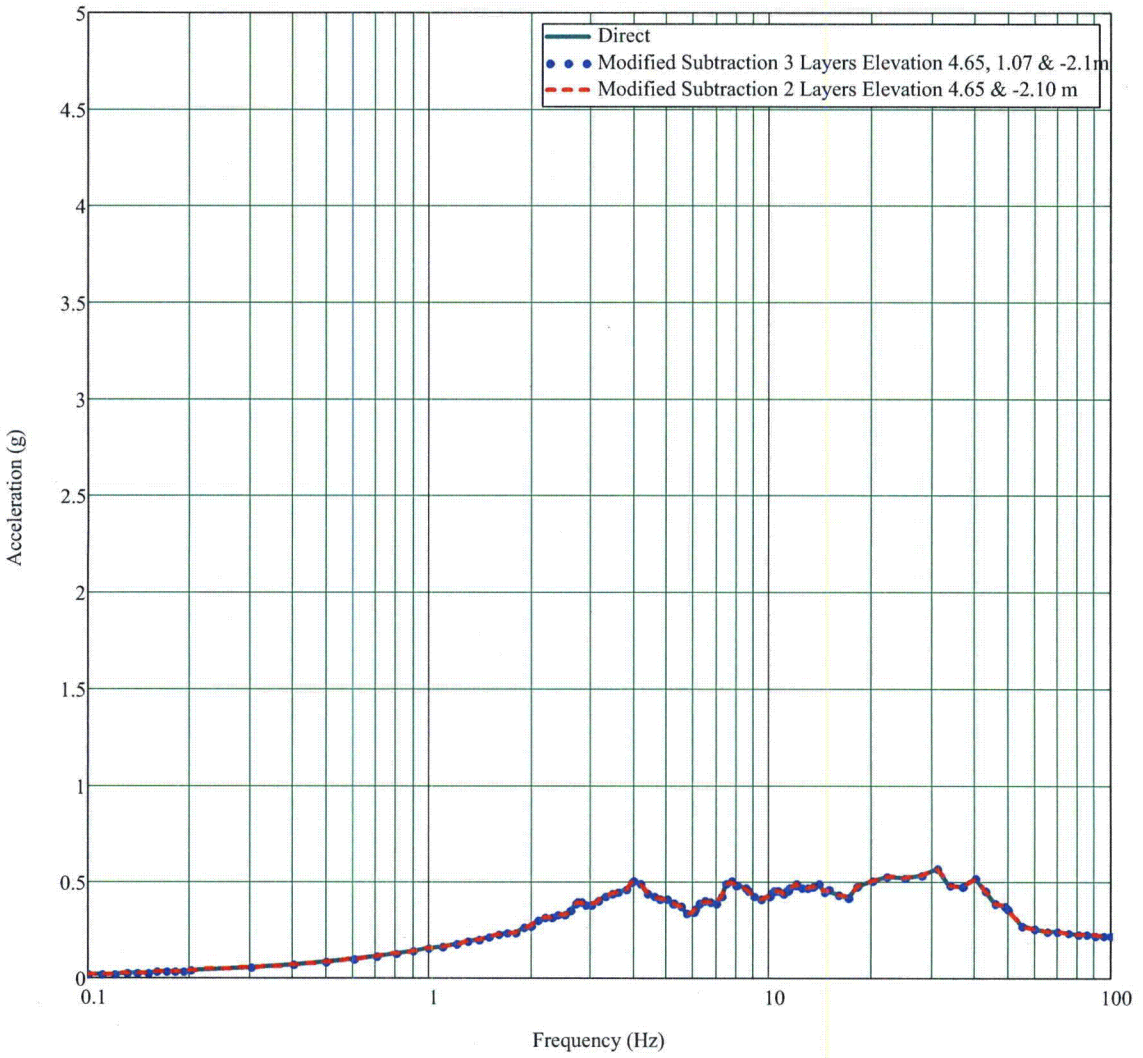


Figure 53: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Basemat (Elevation -11.50 m)

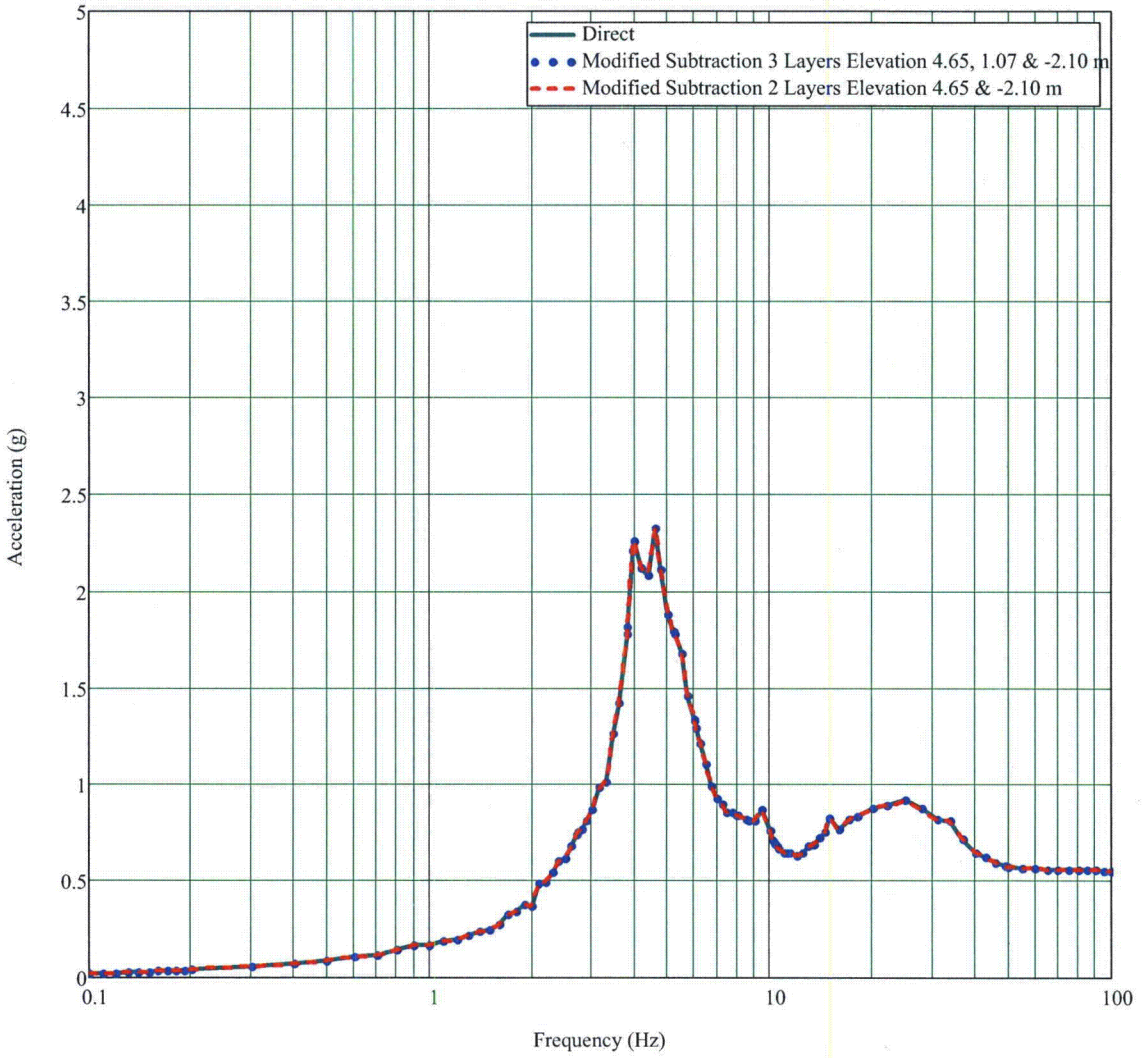


Figure 54: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

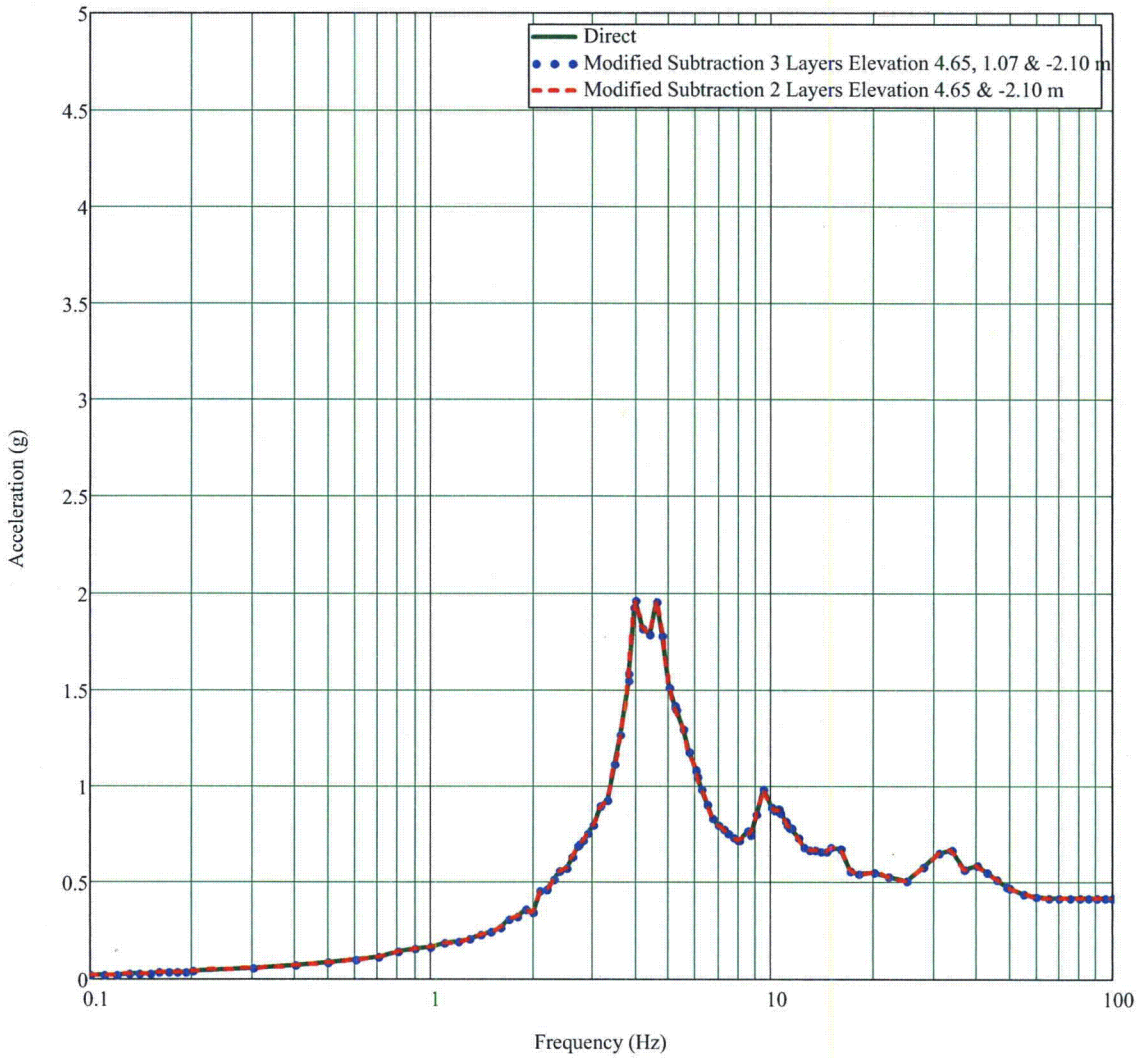


Figure 55: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RCCV Top Floor (Elevation 27.00 m)

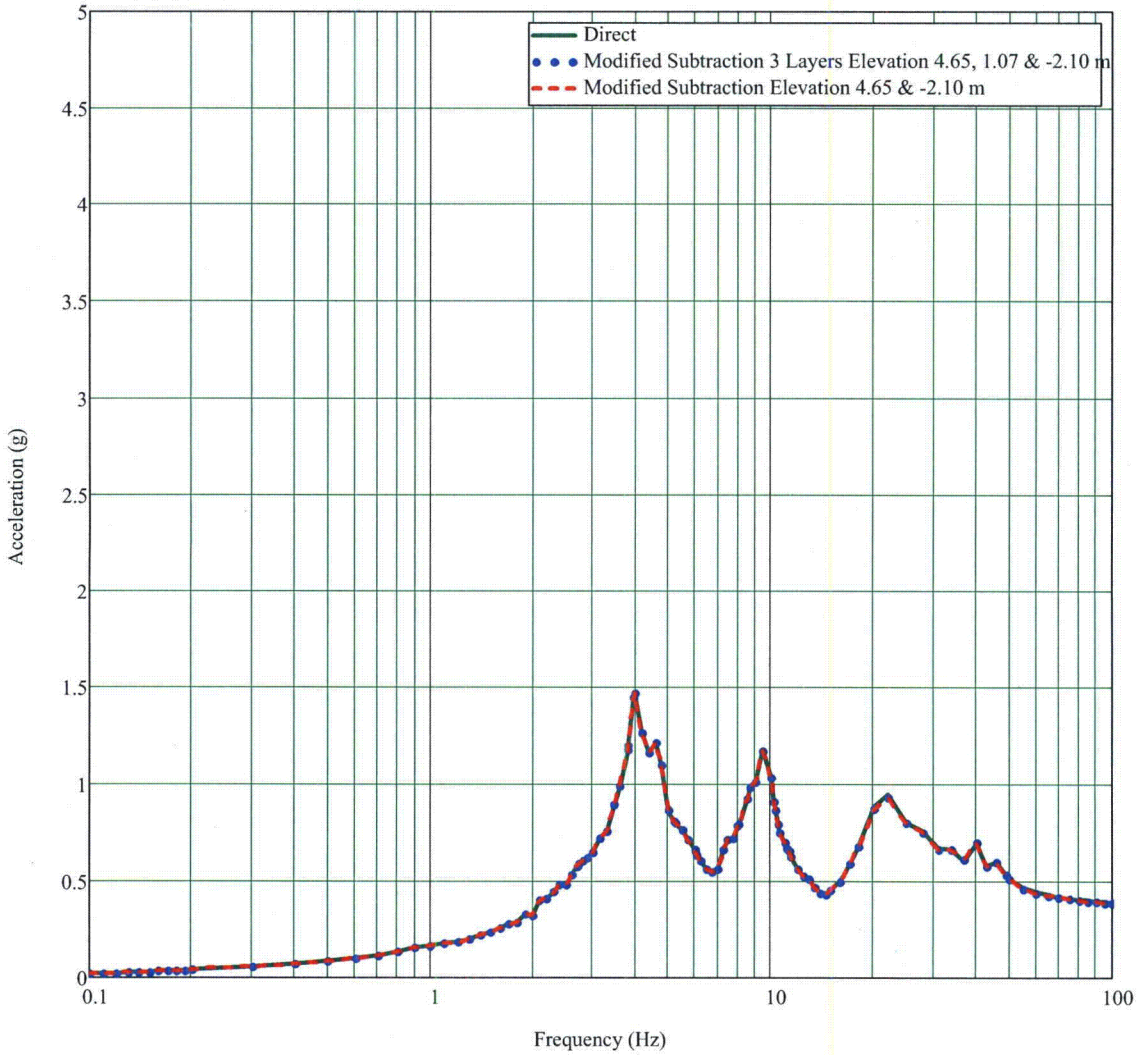


Figure 56: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Vent Wall (Elevation 17.50 m)

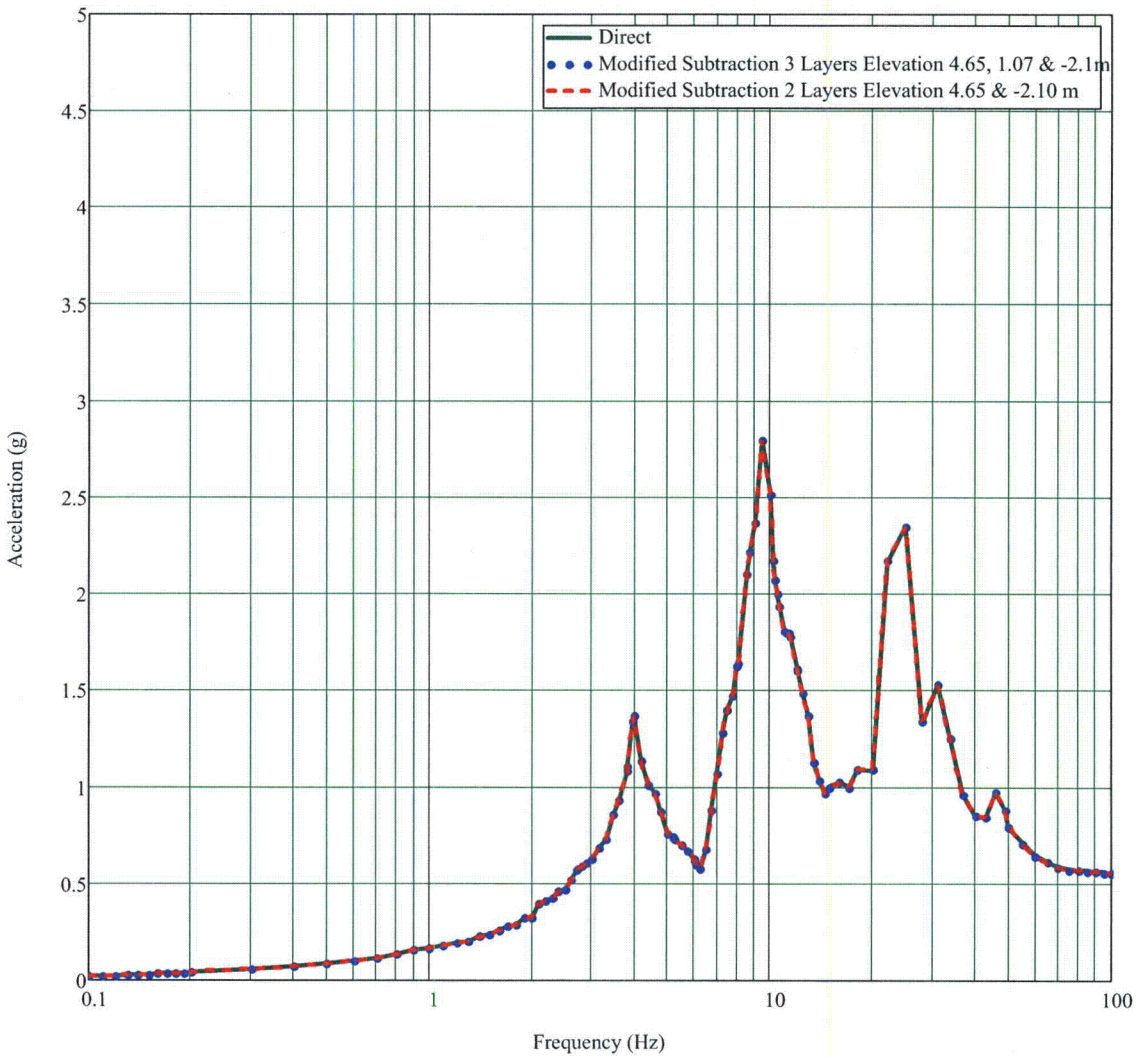


Figure 57: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RSW Top (Elevation 24.18 m)

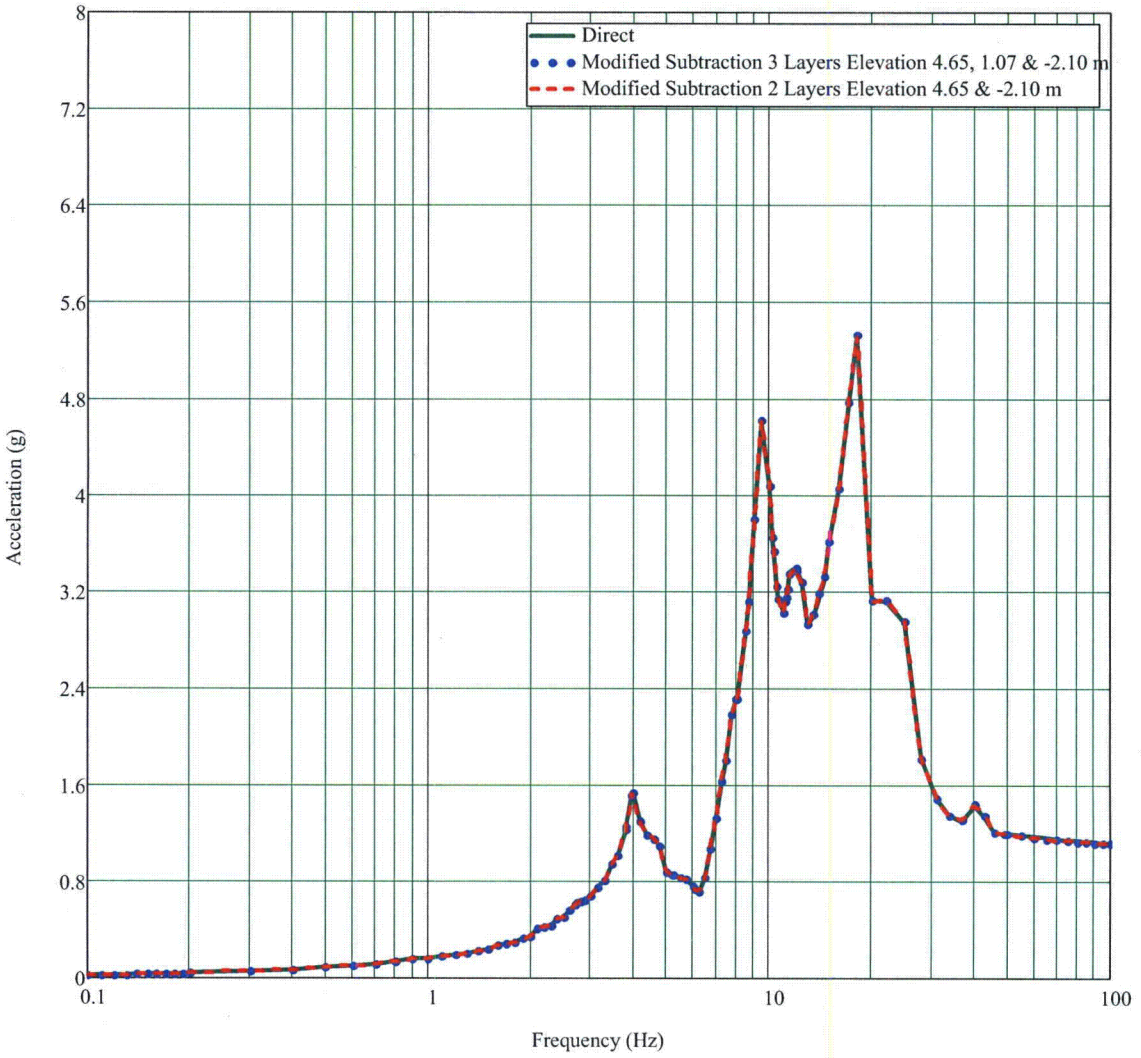


Figure 58: X-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RPV Top (Elevation 27.64 m)

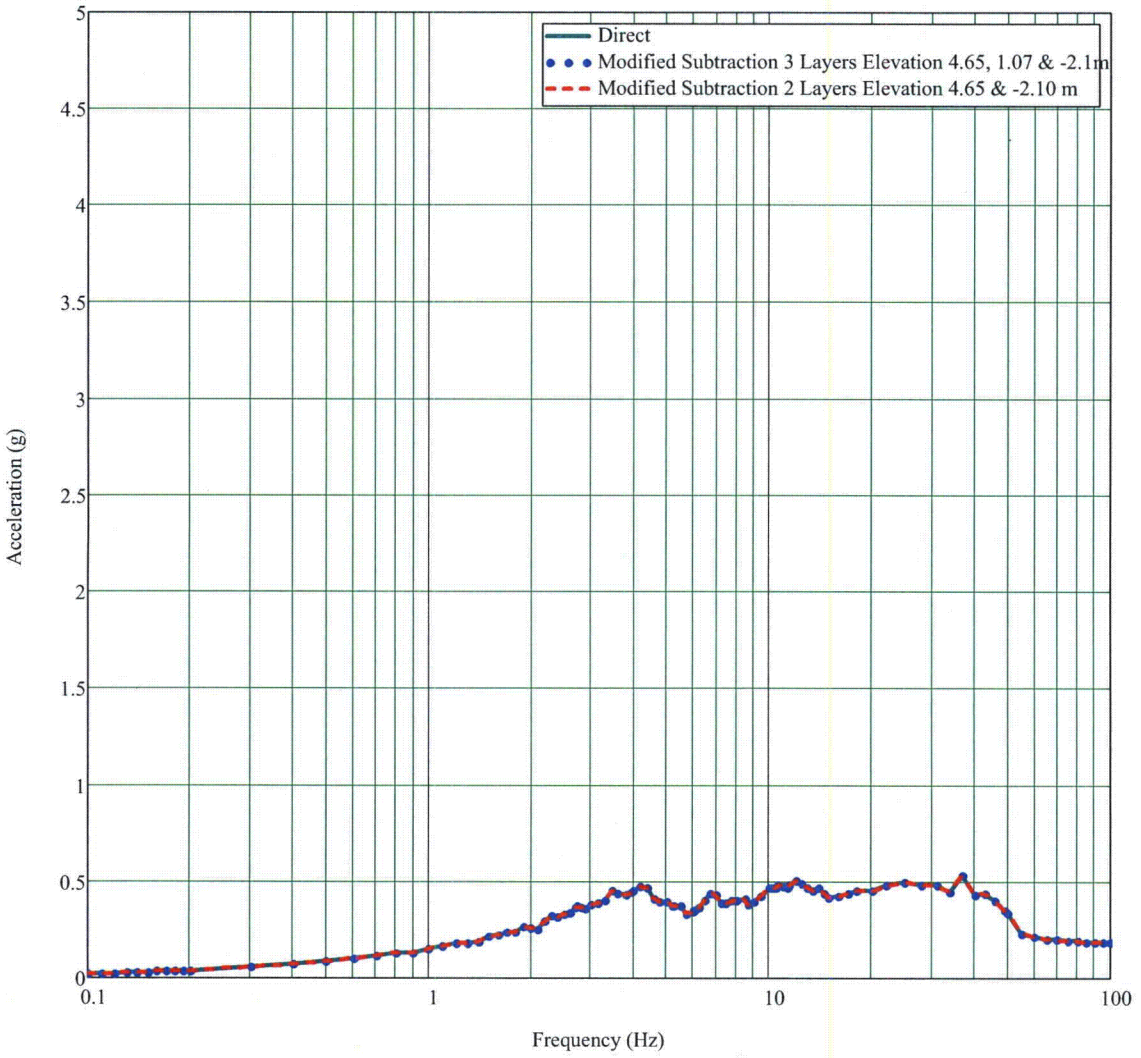


Figure 59: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Basemat (Elevation -11.50 m)

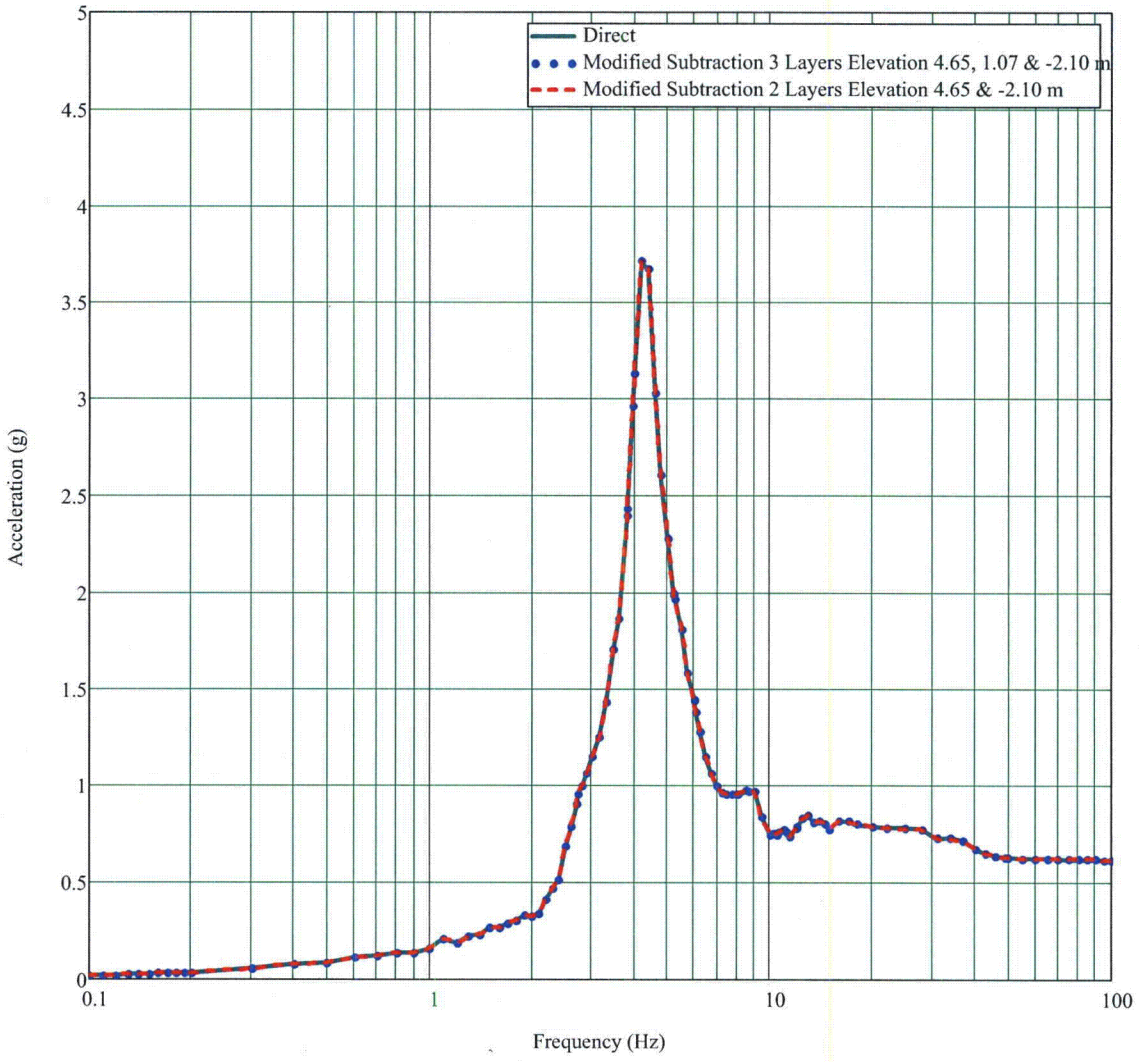


Figure 60: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

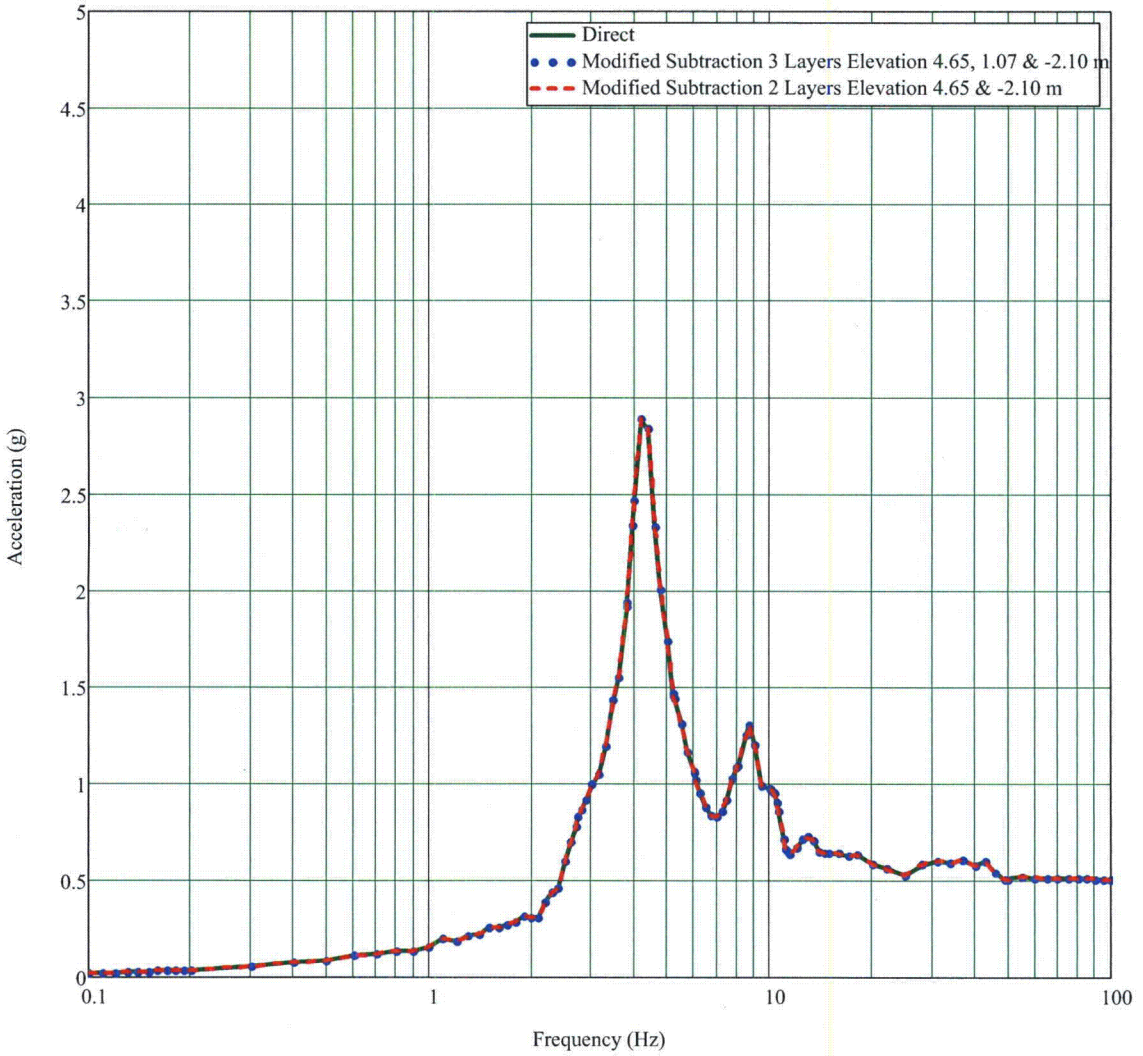


Figure 61: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RCCV Top Floor (Elevation 27.00 m)

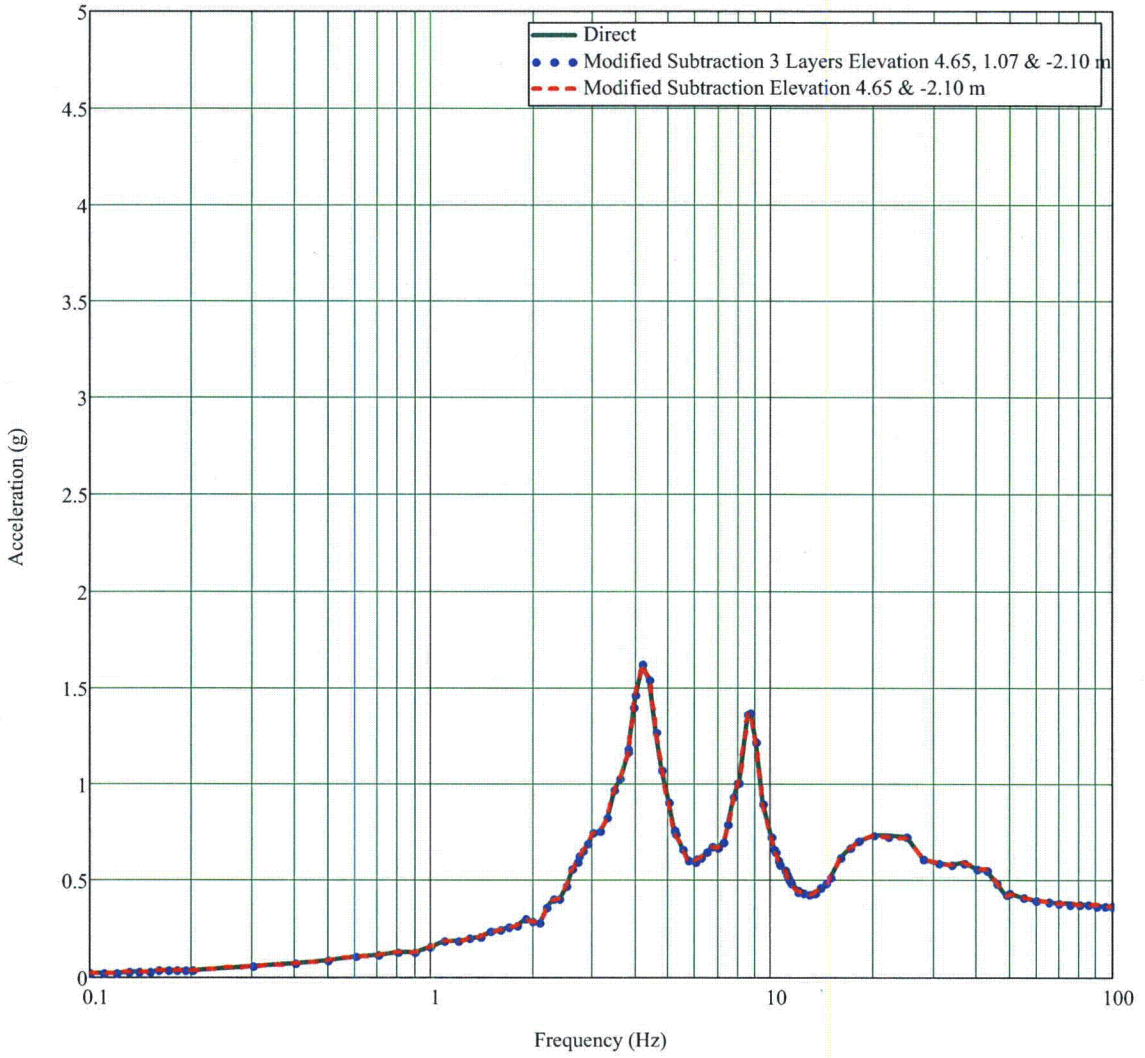


Figure 62: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Vent Wall (Elevation 17.50 m)

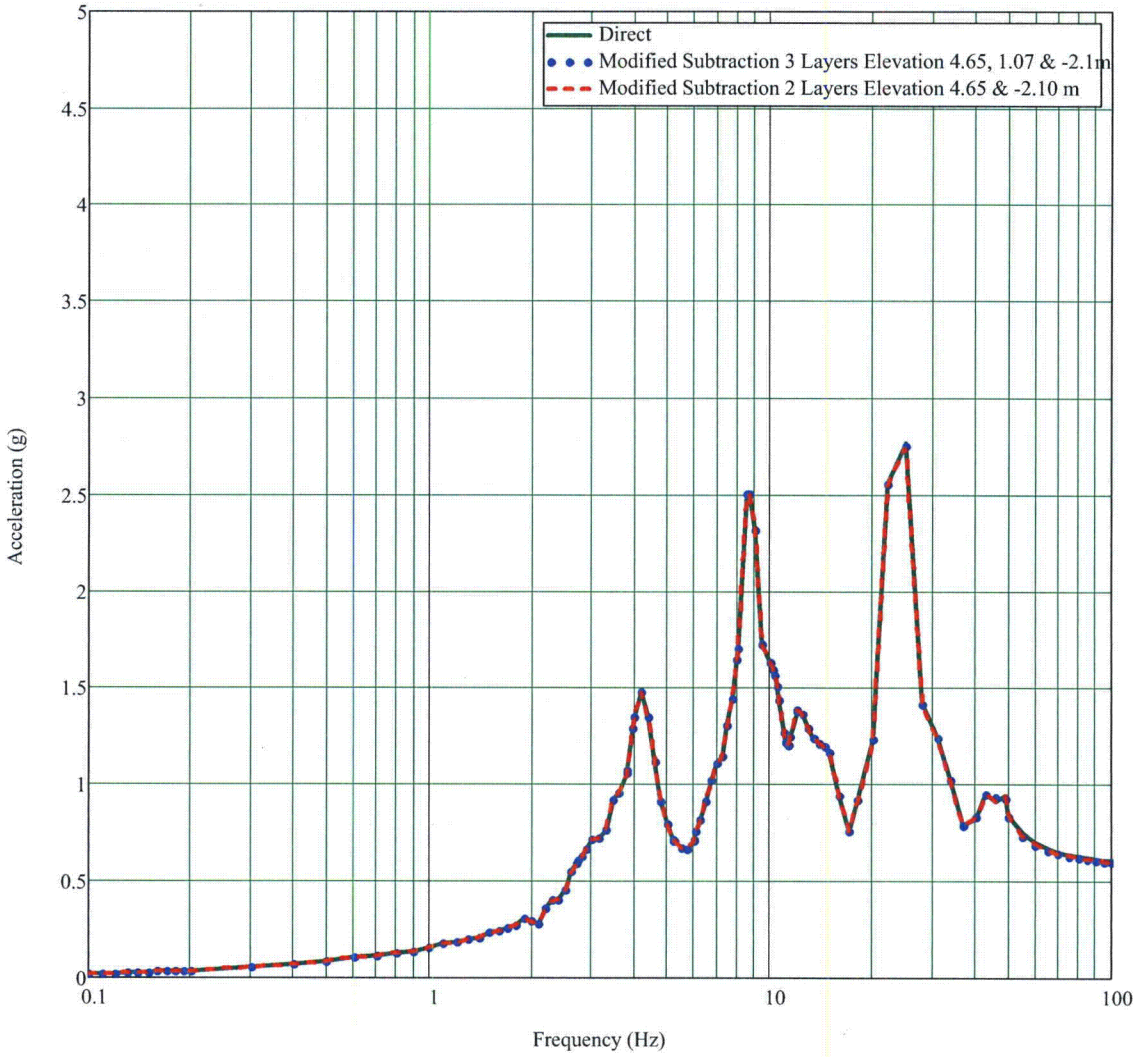


Figure 63: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RSW Top (Elevation 24.18 m)

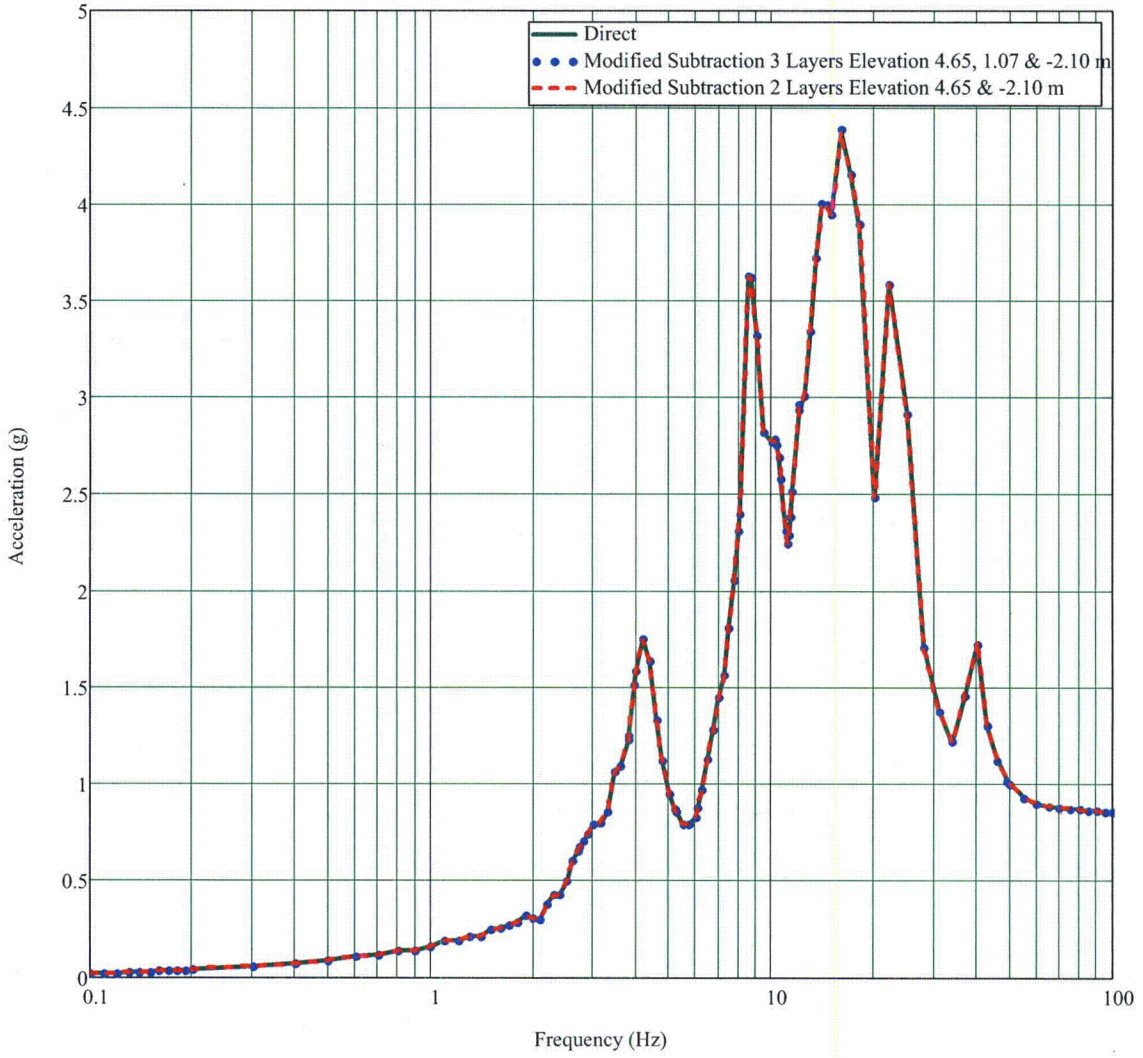


Figure 64: Y-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RPV Top (Elevation 27.64 m)

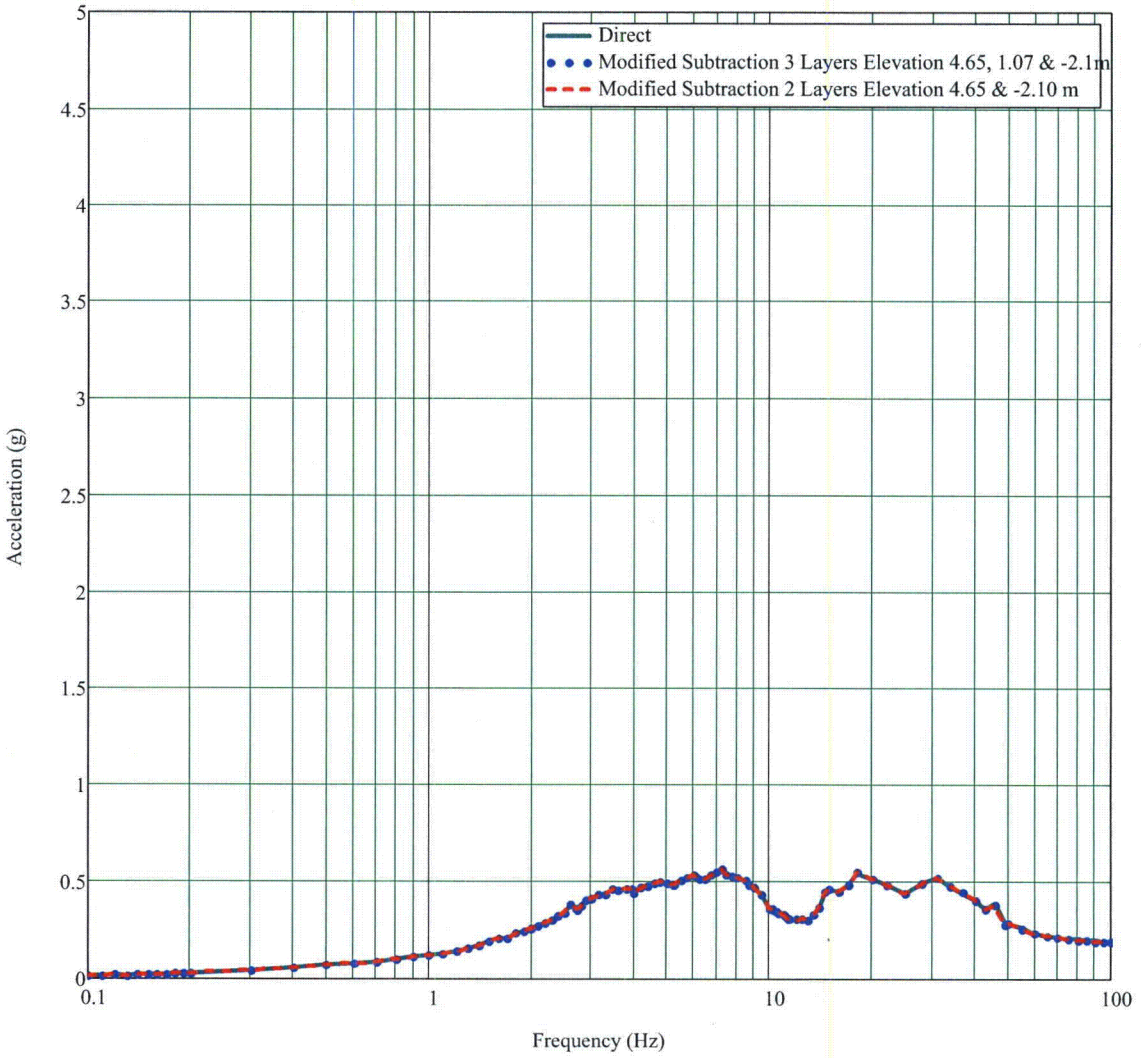


Figure 65: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Basemat (Elevation -11.50 m)

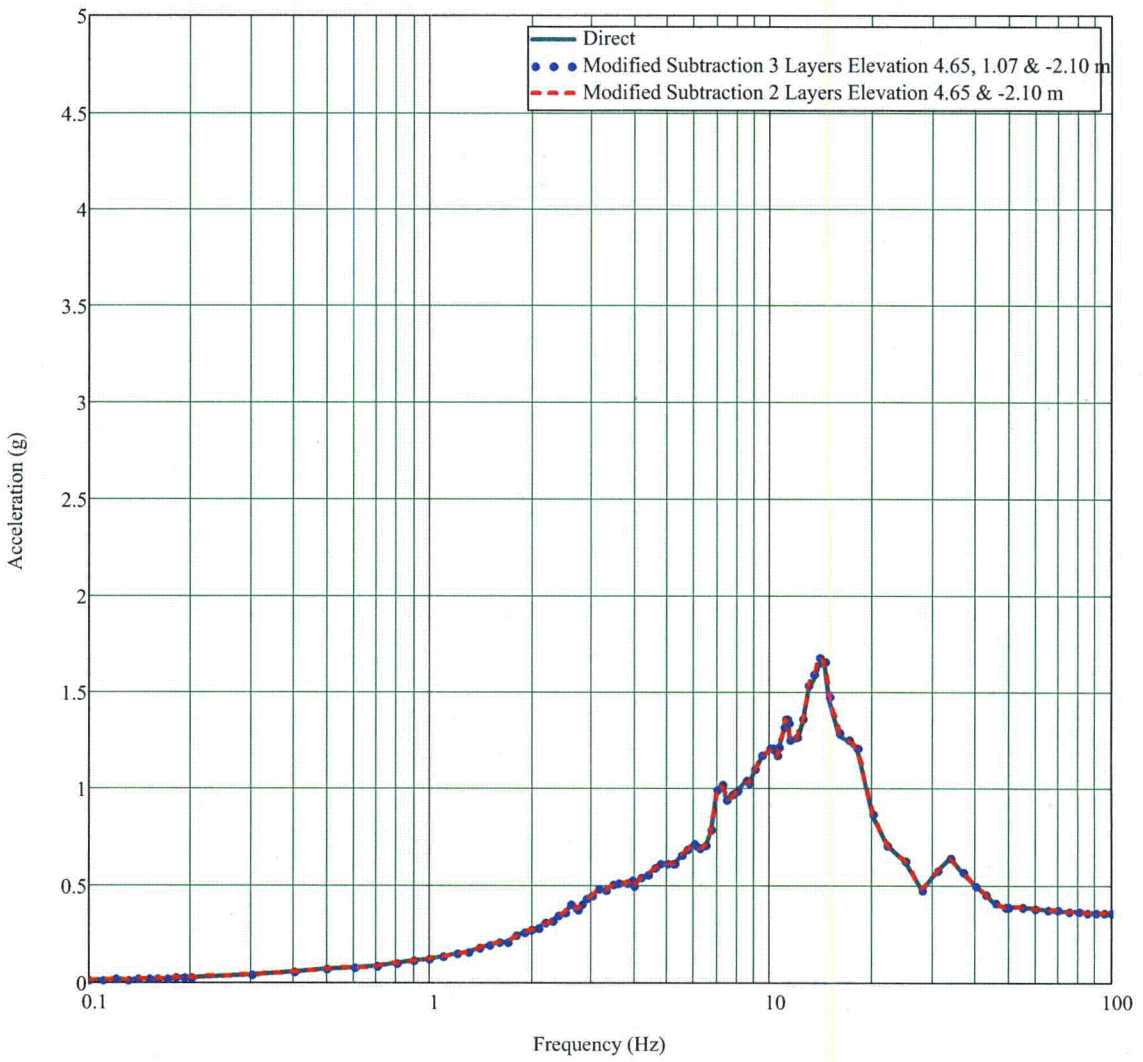


Figure 66: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Refueling Floor (Elevation 34.00 m)

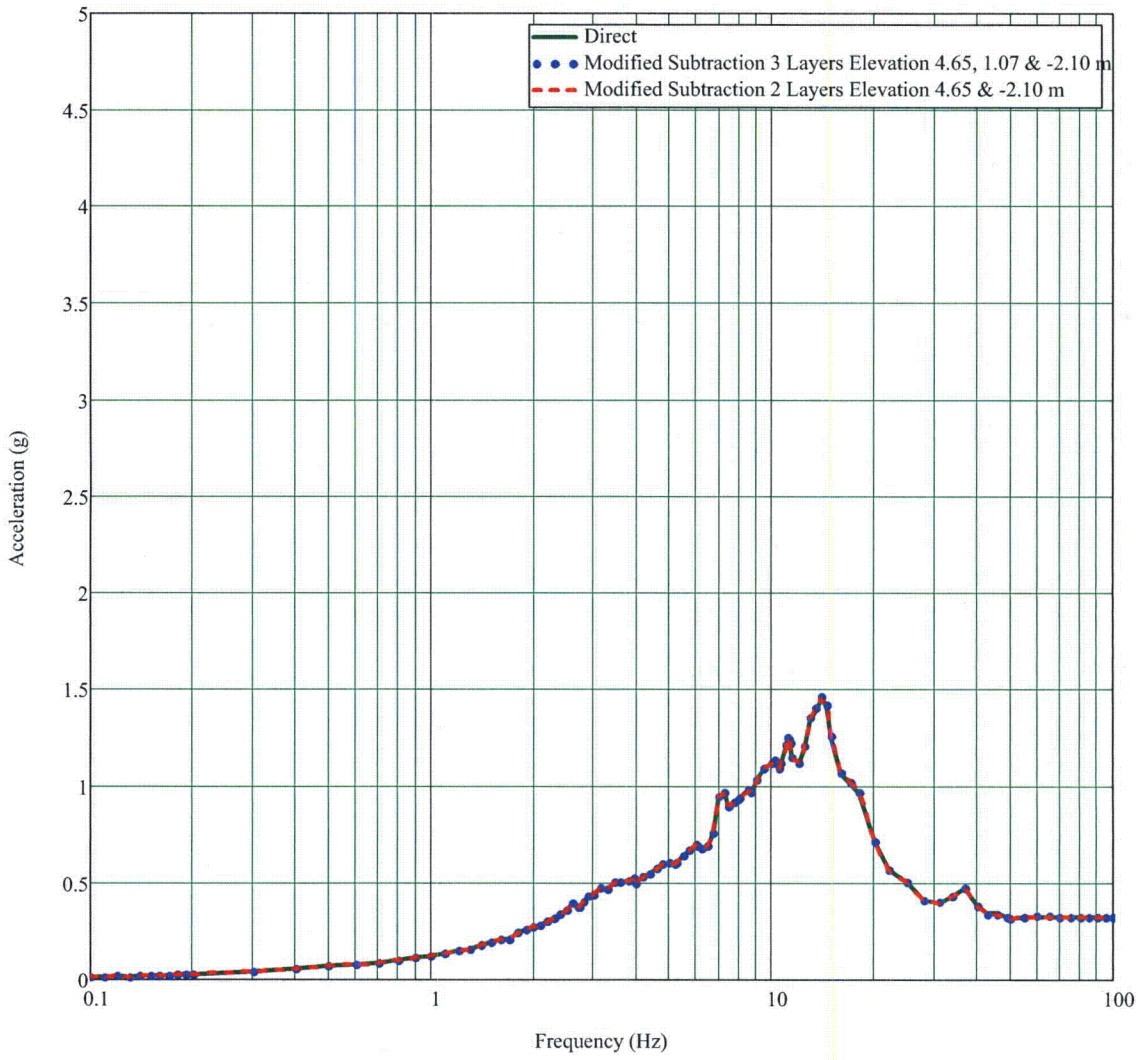


Figure 67: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RCCV Top Floor (Elevation 27.00 m)

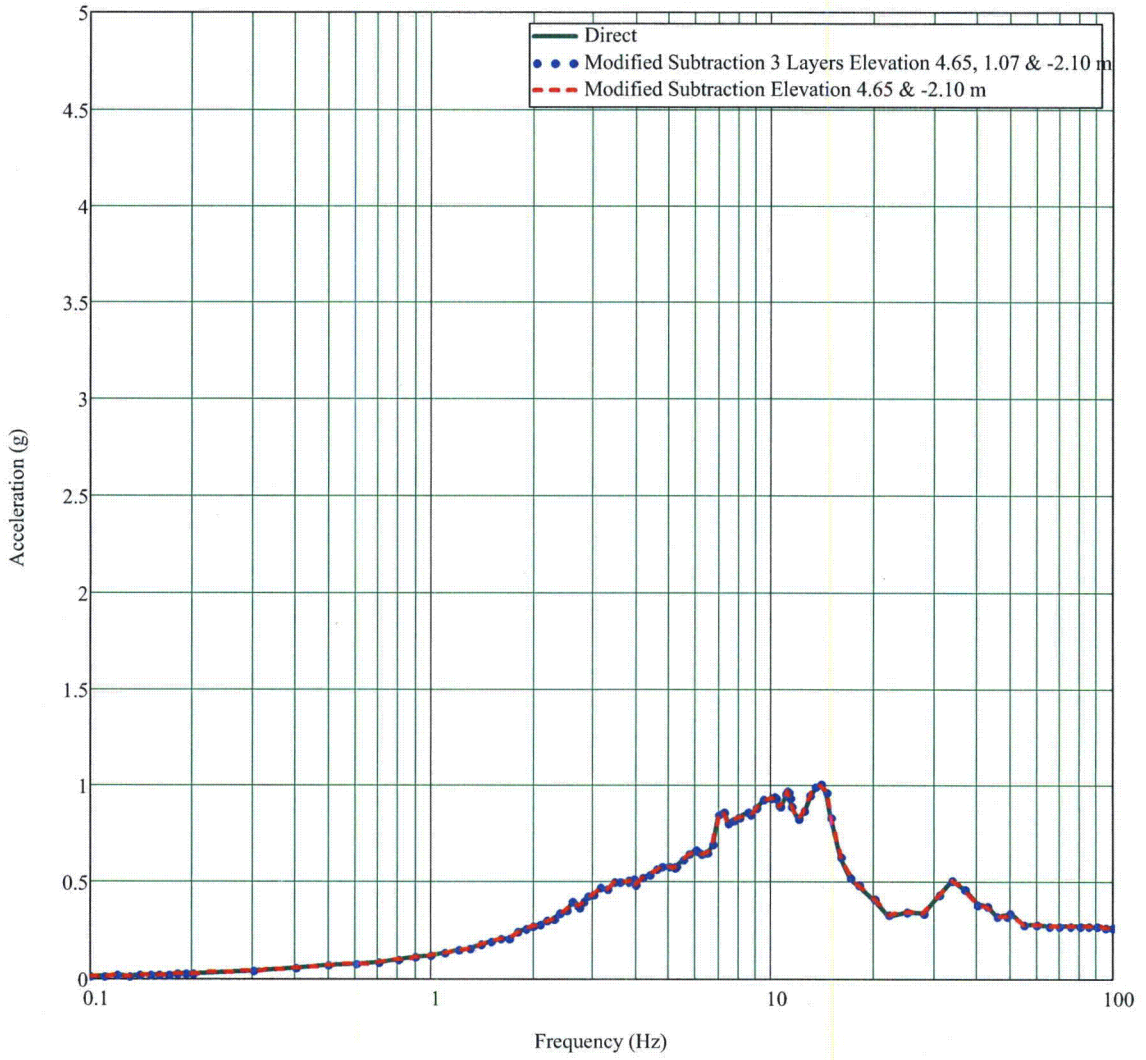


Figure 68: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB Vent Wall (Elevation 17.50 m)

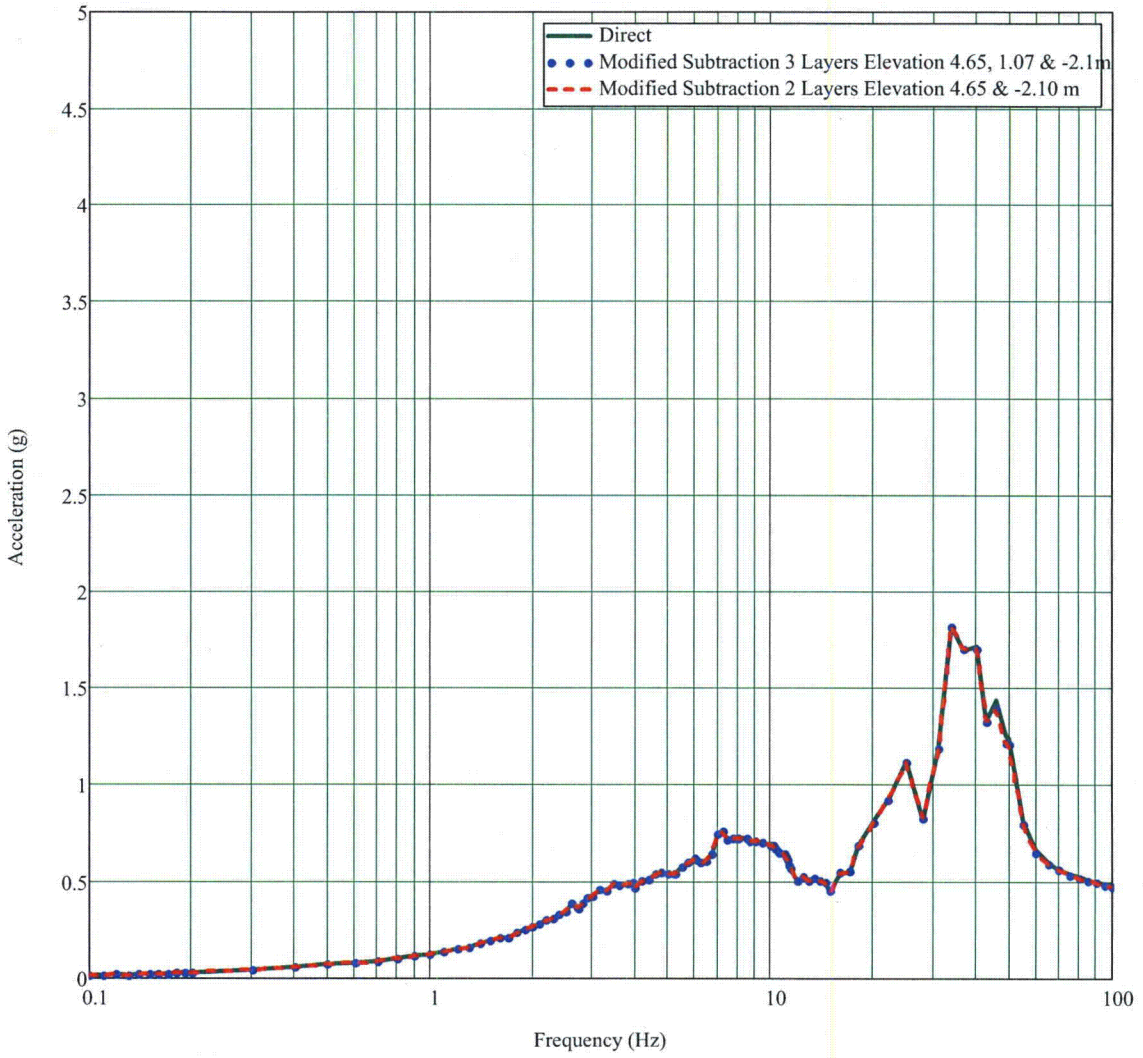


Figure 69: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RSW Top (Elevation 24.18 m)

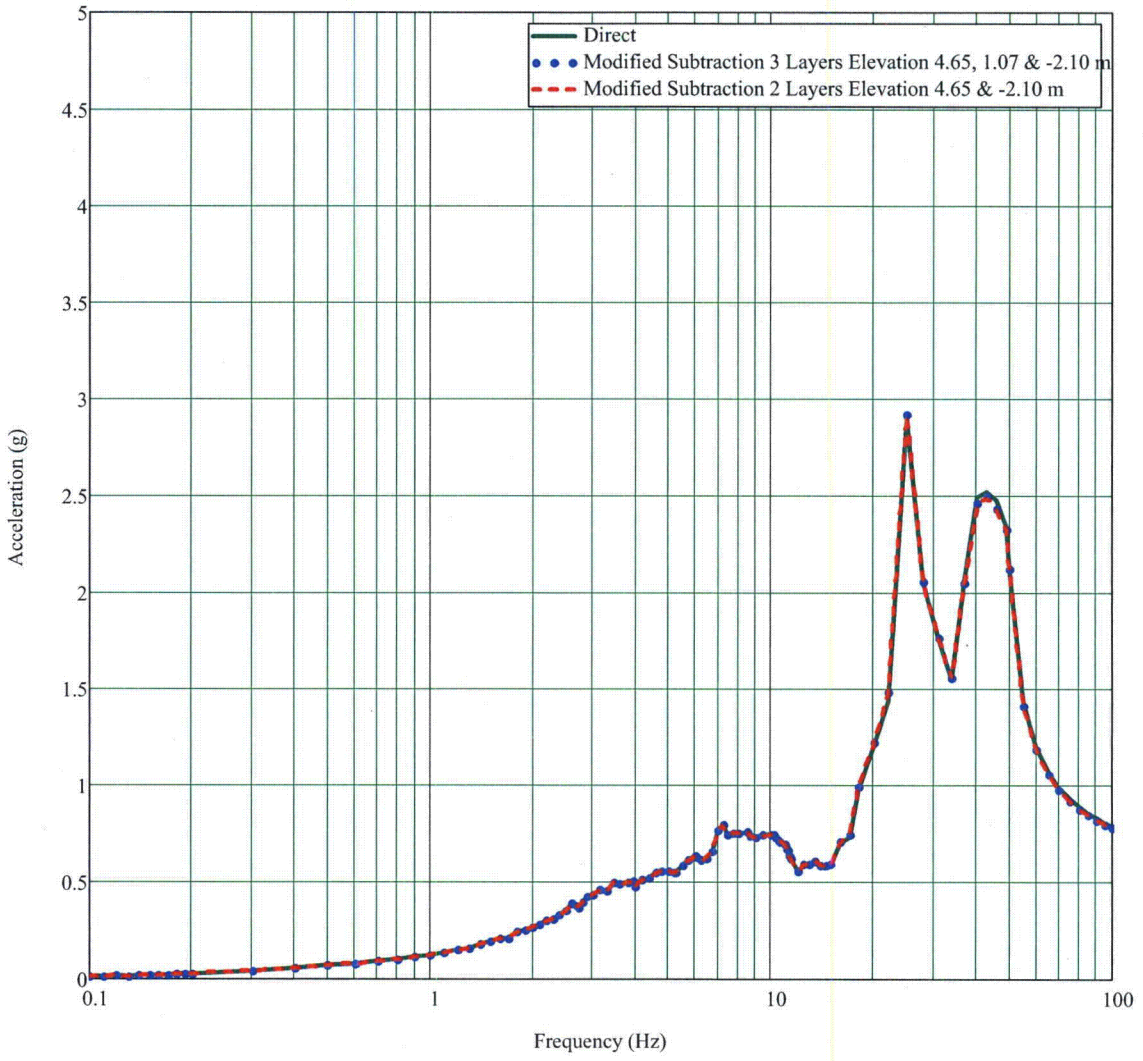


Figure 70: Z-Direction DM, MSM2 and MSM3 5% Damped Response Spectra Comparison - RB/FB RPV Top (Elevation 27.64 m)

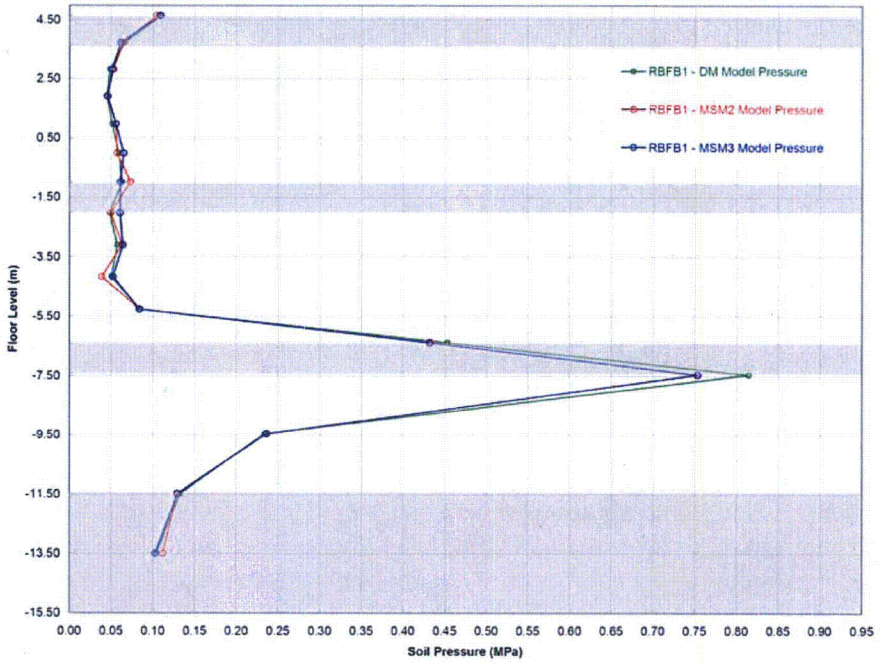


Figure 71: Lateral soil pressure for north wall from X direction (north-south) input motion

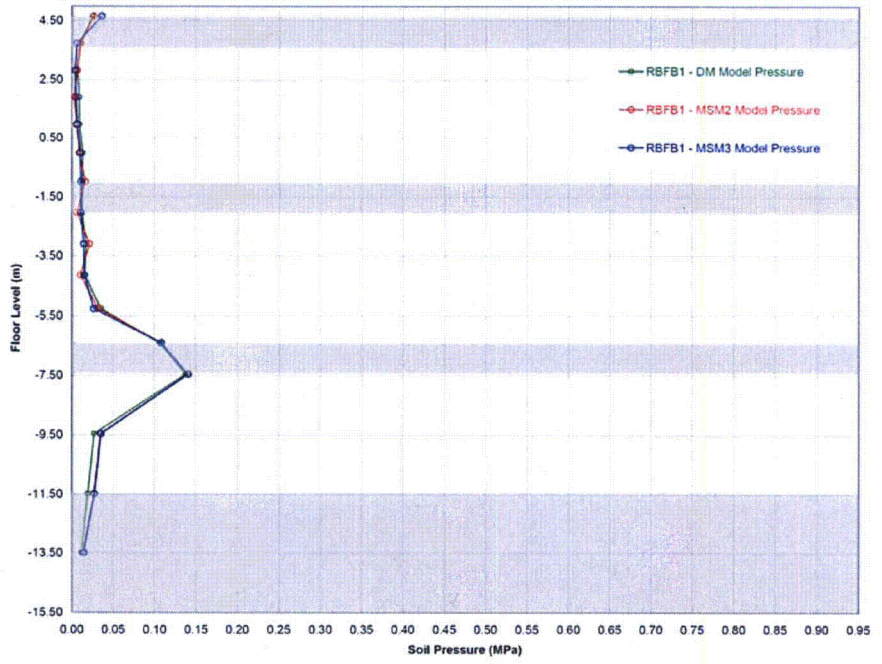


Figure 72: Lateral soil pressure for west wall from X direction (north-south) input motion

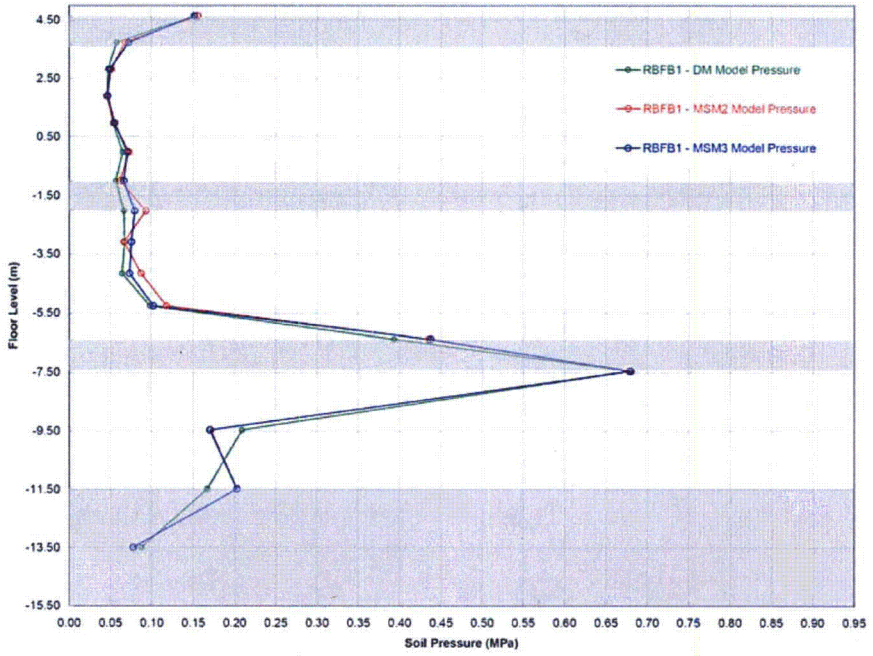


Figure 73: Lateral soil pressure for west wall from Y direction (east-west) input motion

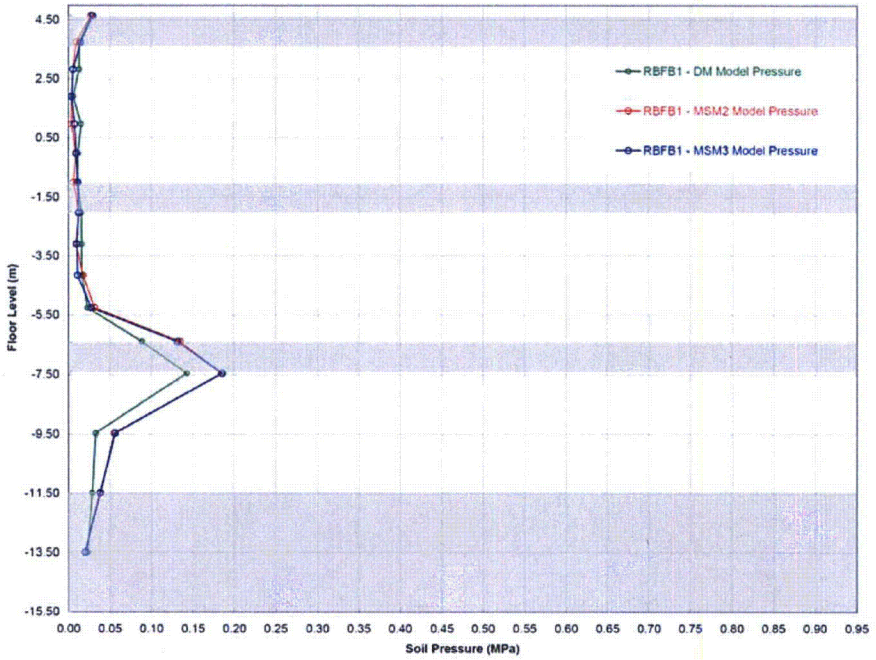


Figure 74: Lateral soil pressure for north wall from Y direction (east-west) input motion

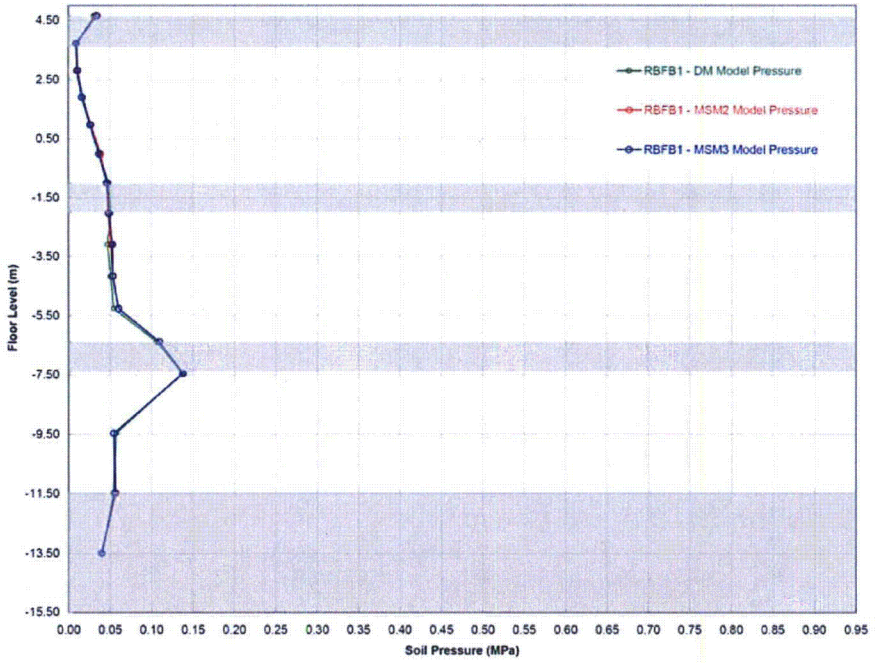


Figure 75: Lateral soil pressure for west wall from Z direction (vertical) input motion

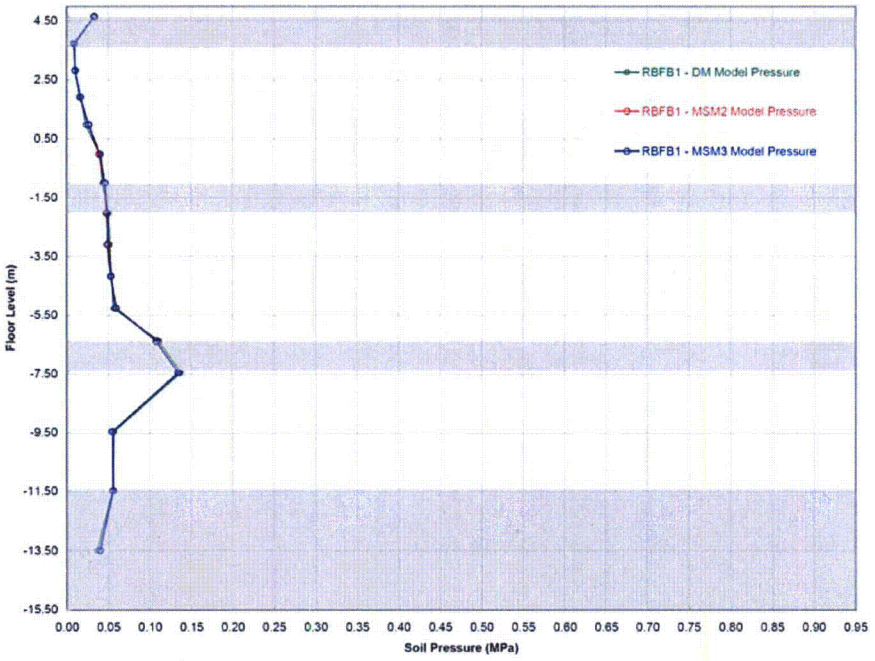


Figure 76: Lateral soil pressure for north wall from Z direction (vertical) input motion

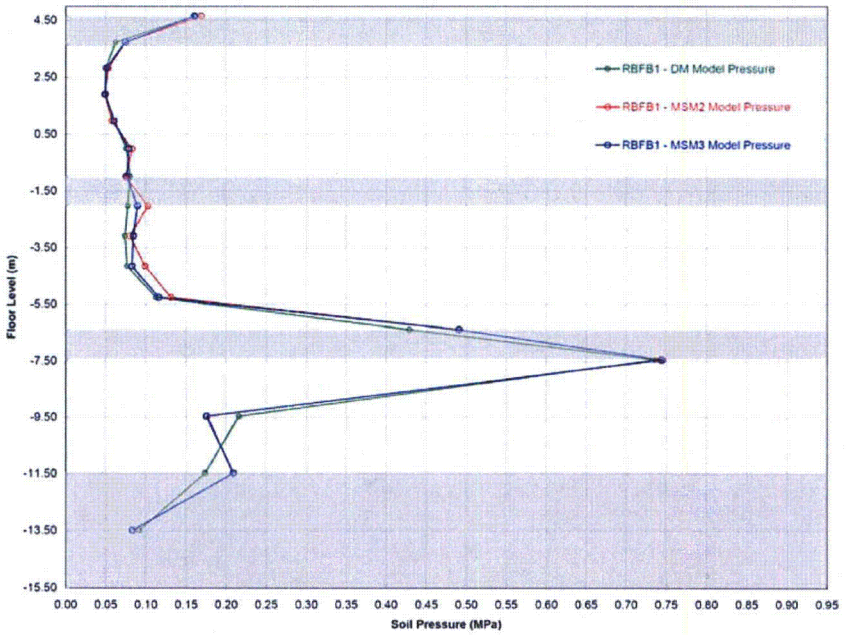


Figure 77: Lateral soil pressure for west wall. SRSS pressure from X, Y, and Z direction input motion

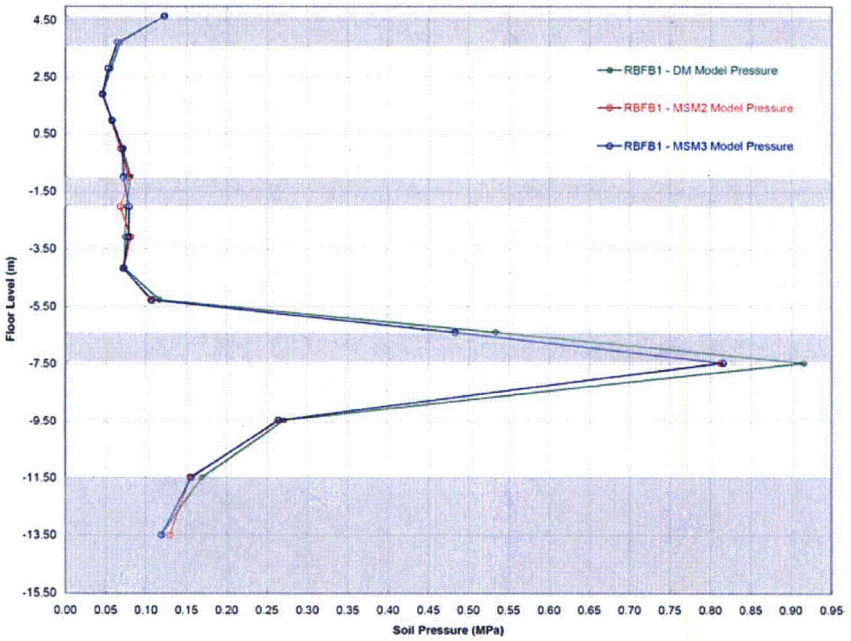


Figure 78: Lateral soil pressure for north wall. SRSS pressure from X, Y, and Z direction input motion