MODAL CONTRIBUTION

TO

DYNAMIC ANALYSIS RESULTS

Prepared for

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1 INTRODUCTION

The Nuclear Regulatory Committee (NRC) staff on June 9-11, 1981 reviewed the criteria and calculations performed on IE Bulletin 80-11 `` Masonry Wall Design '' for the Point Beach Nuclear Power Plant. Action Item 2 resulting from the meeting stated that the licensee will provide documentation including calculation sheets that indicate that the adoption of five (5) modes of seismic response will generally provide 95 % of the total response.

This short report describes the four walls that were selected to document the results, the analyses that were performed, the results of the analyses and a discussion of results and conclusions. Appendices A through D provide summaries of the computer output from which the analysis results were obtained.

2 SELECTION OF WALLS

To provide a cross-section of the boundary conditions and openings of the masonry walls at the Point Beach Nuclear Power Plant, the four walls given in Table 1 were selected to document the results of the analyses.

The four walls include two with door openings and two without openings. Two of the walls are not connected at their top boundary but are pinned on the other three boundaries, one wall is pinned on all four boundaries and the fourth wall is pinned on only two boundaries.

TABLE 1 DESCRIPTION OF WALLS

Wall Number	Wall Thickness (in)	Boundary Conditions	Openings
5-29/2A	8	Pinned on 3 sides Free on top	Door on one side
20/9	8	Pinned on 4 sides	Door on one side
55-1/15	12	Pinned on 3 sides Free on top	None
64-E/15	42	Pinned on 2 sides Top and one side free	None

3 ANALYSIS METHODOLOGY

All walls were analyzed in accordance with the procedures given in " Criteria for the Re-evaluation of Concrete Masonry Walls for the Point Beach Nuclear Power Plant ". Specifically, plate analysis was used to assess the out-of-plane response of all walls. The computer program SAP was used to perform a finite element dynamic analysis ultilizing the response spectrum method. The Computech pre-processor program GENIN was used to generate input files for the analyses.

For each wall an eigenanalysis was carried out to extract the first five frequencies and mode shapes and the individual modal responses were combined using the square root of the sum of the squares procedure.
The SAP output was summarized using the post-processor computer program GENOUT. The computer printout of GENOUT lists seperately the values of the moments and reaction forces for first mode dynamic response, the SRSS of the first five modes of dynamic response and the values from static loads. Also given is the absolute sum of the static and SRSS dynamic response values which are the values used to assess the adequacy of the walls.

4 ANALYSIS RESULTS

The detailed results of the analyses of the four walls are given in Appendices A through D. A summary of the results is given in Tables 2 and 3. Table 2 contains a summary of results for walls 5-29/2A, 20/9, and 64-E/15. Table 3 contains a similar summary for wall 65-1/15. For each wall an analysis was performed assuming the wall was either grouted or ungrouted. The maximum moment parallel (Mx) and normal (My) to the bed joints and the maximum boundary shear force (F) are given in Tables 2 and 3. In Table 2 the value of each moment or force resulting from the first mode and the SRSS of the first five modes are given. Table 2 also contains the percentage contribution of the first mode to the SRSS of the first five modes for each maximum moment and force quantity.

Table 3 which contains a summary of results for wall 65-1/15 includes the results from the first mode, the SRSS of the first five modes and the SRSS of the first ten modes. In addition the Table also contains the percentage contribution of the first mode to the SRSS of both the first 5 and 10 modes respectively for each maximum moment and force quantity. Also included is the percentage of the SRSS of the first 5 modes to the first 10 modes for each maximum moment and force quantity.

5 DISCUSSION OF RESULTS

The results of the analyses for walls 5-29/2A, 20/9, 64-1/15 presented in Table 2 indicates that the first mode contributes between 97.9 % and 99.9 % of the SRSS of the first five modes for the maximum moments and boundary forces in the walls. Thus for the openings and boundary conditions of these three walls a first mode analysis would have been sufficient to produce 95 % of the total maximum response quantities. A five mode SRSS analysis is therefore adequate for these three walls.

The results for Wall 65-1/15 presented in Table 3 indicate that the first mode contributes 90 % of the SRSS of the first 5 modes of response and 90 % of the SRSS of the first 10 modes of response. The percentage of SRSS of the first 5 modes to the SRSS of the first 10 modes is 99.9 % for the maximum moments and forces. Thus for a wall pinned on three sides and free at the top a first mode analysis would not have been adequate. However, it is clear that an SRSS of five modes is always equivalent to an SRSS of ten modes.

6 CONCLUSIONS

Four walls were selected to provide documentation that indicates that the adoption of five (5) modes of response will generally provide 95 % of the total response. The four walls selected, covered the full range of boundary conditions and openings found in the masonry walls at the plant.
The results clearly indicate that five modes of SRSS response provide 99.9 % of the total response. In fact for three of the four walls the first mode of response provided 97.9 % or greater of the total response.

As all the masonry walls at the Point Beach plant were analyzed using the first five modes of response it is clear that 99 % of the total response of all the walls has been included in the analytical results.

TABLE 2 SUMMARY OF RESULTS FOR WALLS 5-29/2A, 20/5, AND 64-E/15

Wall Number	Mx1 (Lb-in/in)	Mx5 (Lb-in/in)	Mx1/Mx5 %	My1 (Lb-in/in)	My5 (Lb-in/in)	My1/My5 %	F1 (Lb)	F5 (Lb)	F1/F5 %
5-29/2A									
Grouted	155.4	155.4	100.0	51.66	51.71	99.9	79.93	80.07	99.8
Ungrouted	83.32	83.32	100.0	27.69	27.72	99.9	42.85	42.92	99.8
20/9									
Ungrouted	142.2	142.2	100.0	99.06	100.3	98.8	54.49	55.16	98.8
Part. Grout	173.9	173.9	100.0	121.2	122.7	98.8	66.64	67.46	98.8
64-E/15									
Grouted	84.21	85.96	97.9	101.8	103.2	98.6	229.6	231.1	99.4
Ungrouted	43.61	44.58	97.8	52.75	53.51	98.6	118.9	119.8	99.2

Notations:

M : Maximum moment per linear length
F : Maximum shear force at boundary
x : Parallel to the bed joint
y : Normal to the bed joint
1 : First mode only
5 : SRSS of the first five modes

TABLE 3 SUMMARY OF RESULTS FOR WALL 65-1/15

Wall Number	Moment or Force	1st Mode	SRSS 5 Modes	SRSS 10 Modes	1st/5 %	1st/10 %	5/10 %
65-1/15							
Grouted	Mx (Lb-in/in)	172.6	174.5	174.6	98.9	98.8	99.9
	My (Lb-in/in)	27.43	30.26	30.27	90.6	90.6	99.9
	F (Lb)	77.35	84.87	84.98	91.1	91.0	99.9
Ungrouted	Mx (Lb-in/in)	109.0	110.1	110.2	99.0	98.9	99.9
	My (Lb-in/in)	17.31	19.10	19.10	90.6	90.6	100.0
	F (Lb)	48.83	53.56	53.63	91.2	91.0	99.9

Notations:

M : Maximum moment per linear length
F : Maximum shear force at boundary
x : Parallel to the bed joint
y : Normal to the bed joint
1 : First mode only
5 : SRSS of the first five modes
10 : SRSS of the first ten modes