ACTION ITEM 5

EVAL. ATION OF SINGLE WYTHE ASSUMPTION TO REPRESENT MULTIPLE WYTHE WALLS

Prepared for

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1 INTRODUCTION

The Nuclear Regulatory Commission (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 5 resulting from the review meeting stated that with regard to out-of-plane loading, the licensee shall demonstrate that the use of the single wythe assumption for multiple wythe walls results in a conservative evaluation with respect to frequency shift and out-of-plane drift consideration.

This short report presents the analyses that were performed, the results of the analyses, a discussion of the results, and the conclusions.

2 ANALYSIS METHODOLOGY

All walls were analyzed in accordance with the procedures given in "Criteria for the Re-evaluation of Concrete Masonry Walls for Point Beach Nuclear Power Plant." Specifically, plate analysis was used to assess the out-of-plane response of the wall. The computer program SAP5A was used to perform a finite element dynamic analysis, utilizing the response spectrum method.

All wythes in a multiwythe wall were assumed to respond as single wythe walls because of the difficulty in verifying the adequacy of the collar joint between the wythes. This was assumed to be conservative when using the re-evaluation criteria and the objective of Action Item 5 is to validate the degree of conservatism.

Two double wythe walls (Wall Nos. 24 and 65-1) were selected to compare the results obtained from the wall acting either as a single or double wythe wall using the re-evaluation criteria. In using the re-evaluation criteria the walls were assumed to have pinned supports at all appropriate boundaries. As a consequence no forces are induced in the wall due to out-of-plane drift. The validity of this assumption is addressed in Computech Engineering Services, Inc. Report No. R553.11. Some of the results of Report No. R553.11 are included in this report for the purpose of addressing Action Item 5. Wall 24 is 104 inches long, 156 inches high and consists of two wythes of twelve inch wide units. Wall 65-1 is 109 inches long, 176 inches high and consists of two wythes of six inch wide units. Each wall was analyzed as both a single and double wythe wall using the same number of nodes, mesh size and boundary conditions. Two boundary conditions were used for each wall: one simply supported on each boundary and the other fixed. For the fixed boundary condition the out-of-plane drift effects were included as reported in Report No. R553.11.

3 RESULTS

The results of the analyses performed using the simply supported boundary conditions are given in Table 1 and 2. Table 1 compares the frequencies of each wall acting either as a single or double wythe wall. Table 2 compares the maximum stress ratios for each wall acting either as a single

or double wythe wall. The values given in Table 2 are based on the procedures given in the re-evaluation criteria. That is the walls are assumed to have simply supported boundary conditions.

The results given in Table 3 are extracted from Report No. R553.11 and provide a comparison of the single or double wythe wall with fixed boundary conditions incorporating the effects of out-of-plane drift.

4 DISCUSSION OF RESULTS

From the results presented in Table 1 it is clear that the single wythe assumption is conservative with respect to frequency shift. The fundamental or first mode frequency of the double wythe wall is approximately twice that of the single wythe wall. For walls with more than two wythes the shift in frequency would be even greater. The effect of out-of-plane drift effects depends on how this is incorporated in the analysis of the walls and is further discussed in Report No. R553.11. For the case of simply supported boundary conditions, out-of-plane drift does not induce forces in the walls and the maximum stress ratios given in Table 2 indicate that the maximum stresses in the wall due to other out-of-plane forces for the double wythe wall are approximately one-half of those of the corresponding single wythe wall.

For the case of fixed boundary conditions, incorporating out-of-plane drift effects the results given in Table 3 indicate that the maximum stress ratios for the double wythe walls are from 50 to 130 percent less than the corresponding single wythe walls except for Wall 24 spanning in the vertical direction. In this case the maximum stress ratio for the double wythe wall is 7.5 percent greater than the single wythe wall. Therefore, for Walls 24 and 65-1 the use of the single wythe assumption to represent double wythe walls generally results in a conservative evaluation regardless of how out-of-plane drift effects are incorporated.

5 CONCLUSIONS

Two walls were selected to demonstrate that the use of the single wythe assumption for multiple wythe walls results in a conservative evaluation with respect to frequency shift and out-of-plane drift considerations. The results indicate that the frequency of the double wythe walls are almost twice those of the equivalent single wythe wall. Therefore, from frequency shift considerations the use of the single wythe assumption is conservative. The impact on out-of-plane drift considerations depends on how this is incorporated in the analysis. With the method used in the re-evaluation criteria no forces are induced in the wall due to out-of-plane drift effects and the maximum stress ratios from other out-of-plane forces in the double wythe wall are approximately one-half of those in the single wythe wall. If fixed boundary conditions are used and out-of-plane drift effects are included, then the maximum stress ratios in the double wythe walls were 50 to 130 percent less than those in the single wythe wall, except for one case in which the maximum stress ratio for the vertical span of the single wythe wall was 7.5 percent greater than the double wythe wall.

The single wythe assumption is therefore conservative for the procedures specified in the re-evaluation criteria and is reasonably conservative for the procedure of including out-of-plane drift effects specified in Report No. R553.11.

TABLE 1

FREQUENCY OF WALLS WITH SIMPLY SUPPORTED BOUNDARY CONDITIONS

Wall No.	Thickness	Wythes	Frequencies (Hz)
24	12	1	15.39, 37.72
	25	2	32.06, 78.57
65 - 1	6	1	15.28, 24.99, 43.97
	12	2	30.56, 49.98, 87.95

TABLE 2

MAXIMUM STRESS RATIOS OF WALLS WITH SIMPLY SUPPORTED BOUNDARY CONDITIONS

Wall No.	Thickness	Wythes	M_x/M_{xa}	M_y/M_{ya}
24	12	1	.3726	.1561
	25	2	.1809	.0751
65-1	6	1	.4834	.1572
	12	2	.2146	.0697

Note: Subscripts x and y denote stress ratios on horizontal and vertical strips respectively

TABLE 3

MAXIMUM STRESS RATIOS OF WALLS WITH
FIXED BOUNDARY CONDITIONS INCLUDING
OUT-OF-PLANE DRIFT EFFECTS

Wall No.	Thickness	Wythes	M_x/M_{xa}	M_y/M_{ya}
24	12	1	0.244	0.210
	25	2	0.129	0.226
65-1	6	1	0.264	0.136
	12	2	0.117	0.097

Note: Subscripts x and y denote stress ratios on horizontal and vertical strips respectively