ACTION ITEM 7

# JUSTIFICATION OF USING PLATE SOLUTION FOR WALL 3-1/1

Prepared for

Point Beach Nuclear Power Plant, Units 1 and 2

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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 7 resulting from the review meeting stated that the licensee shall provide justification for a finite element plate solution for Wall 3-1/1.

This short report is in response to that action item and presents the analysis methodology, the analysis results, a discussion of the results, and the conclusions.

## 2 ANALYSIS METHODOLOGY

Wall 3-1/1 was originally 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, a finite element plate analysis was used to assess the out-of-plane response of the wall. The computer program SAP5A was used to perform the finite element dynamic analysis, utilizing the response spectrum method.

The dimensions of Wall 3-1/1 are 69 inches long, 126 inches high, and 33 inches thick, consisting of 4 wythes of 8 inch thick units. The original analysis was performed using a single wythe wall 8 inch thick. In order to justify the use of the single wythe plate analysis, Wall 3-1/1 was re-analyzed using a more sophisticated finite element. The finite element used in the re-analysis was the 16-node three dimensional isoparametric element of the SAP5A computer program. The element represents orthotropic solid elastic media and provides the best representation for the response of a solid thick wall.

Wall 3-1/1 was re-analyzed using the 16-node three dimensional isoparametric element both as an 8 inch and 33 inch thick wall with fixed boundary conditions. These results were compared with those obtained from the plate analyses using both fixed and simply supported boundary conditions.

## 3 RESULTS

The following analyses were performed on Wall 3-1/1.

(a) Finite element plate analysis with simply supported boundary conditions.
(b) Finite element plate analysis with fixed boundary supports.
(c) Finite element analysis using the 16-node three dimensional isoparametric element with fixed boundary supports.

For each type of analysis the wall was assumed to be either 8 or 33 inches thick.

The maximum stress ratios on both horizontal and vertical strips for the

six analyses are given in Table 1.

## 4 DISCUSSION OF RESULTS

The maximum stress ratios on a vertical strip for the fixed boundary conditions are 0.125 and 0.201 for the solid and plate, 8 inch thick finite elements, respectively. The corresponding ratios for the 33 inch thick finite elements are 0.031 and 0.043, respectively. Thus the plate solution is conservative in determining stress ratios on a vertical strip. Furthermore, when the fixed boundary plate analysis results are compared with those of the simply supported boundary plate results (i.e. those used in the re-evaluation criteria), another 10 to 20 percent of conservatism results.

The maximum stress ratios on a horizontal strip for the fixed boundary conditions are 0.071 and 0.098 for the solid and plate, 8 inch thick finite elements, respectively. The corresponding ratios for the 33 inch thick finite elements are 0.024 and 0.022, respectively. Thus the plate solution is conservative for the 8 inch thick wall and 10 percent non-conservative for the 33 inch thick wall. When the fixed boundary plate analysis results are compared with those of the simply supported boundary results (i.e. those used in the re-evaluation criteria), the fixed boundary results are a factor of one third less than those used in the re-evaluation.

## 5 CONCLUSIONS

Wall 3-1/1 was re-analyzed using the 16-node three dimensional isoparametric solid element of the SAP5A computer program to justify the use of finite element plate elements. Comparative analyses of the wall were performed using fixed boundary conditions and single (8 inch) and multiwythe (33 inch) thickness. It was shown for the single wythe wall that the use of plate elements was conservative. For the multiwythe wall the results of the plate analysis were conservative when considering the stresses on a vertical strip of the wall and approximately 10 percent non-conservative when considering the stresses on a horizontal strip of the wall.

When either of the fixed boundary plate or solid element results were compared with those of the simply supported boundary conditions used in the re-evaluation criteria, the simply supported boundary results were conservative in all instances.

Therefore, for the analyses performed on Wall 3-1/1, the use of finite element plate analysis is justified, since it produces conservative results when compared to the results obtained using an isoparametric solid element.

TABLE 1

MAXIMUM STRESS RATIOS

| | Thickness | Mx/Mxa | My/Mya |
|---|---|---|---|
| Solid Element Fixed Boundary Conditions | 8" | 0.071 | 0.125 |
| | 33" | 0.024 | 0.031 |
| Plate Element Fixed Boundary Conditions | 8" | 0.098 | 0.201 |
| | 33" | 0.022 | 0.043 |
| Plate Element Simply Supported Boundary Conditions | 8" | 0.28 | 0.22 |
| | 33" | 0.061 | 0.049 |

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