RG&E

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50-244

July 13, 1984

Director of Nuclear Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Request for Additional Information
Masonry Wall Design, I.E. Bulletin 80-11
R.E. Ginna Nuclear Power Plant

Dear Mr. Crutchfield:

Enclosed are responses to your letter dated September 21, 1983 regarding "Masonry Wall Design." These responses are made to technical questions on the construction and re-evaluation criteria for the masonry walls at R. E. Ginna Nuclear Power Plant. Since the original evaluation, the number of safety-related masonry walls has been reduced through work done for the SEP Program (see our letter dated April 28, 1983; Attachment 1 to this submittal). As described in the enclosure, one additional wall has been deleted. Thus, this submittal only addresses the current list of 37 safety-related masonry walls.

Very truly yours,

Roger W. Kober

Roger W. Kober

Enclosure

IE:1
1/1

REQUEST FOR ADDITIONAL INFORMATION
MASONRY WALL DESIGN, IE BULLETIN 80-11
R. E. GINNA NUCLEAR POWER PLANT
DOCKET NO. 50-244
STRUCTURAL AND GEOTECHNICAL ENGINEERING BRANCH
STRUCTURAL ENGINEERING SECTION A

INTRODUCTION

As stated in the cover letter, the number of safety-related block walls has been reduced through work done for the SEP Program. One additional wall, number 15 in the list provided in April, 1983, has been deleted since the wall has been removed from the plant. In order to respond to question #3, regarding the use of the floor response spectra method of seismic analysis, each safety-related wall has been reanalyzed. The criteria used in the reanalysis were the criteria listed in the Appendix A to SRP Section 3.8.4 with exceptions taken to 3(b) and 3(c). This re-evaluation also excluded the operating base earthquake as a loading combination. A detailed comparison of the differences between the original 80-11 criteria and the revised criteria is listed in Attachment 2.

The three levels of analysis are listed below:

Level 1 - Safe Shutdown Earthquake (0.2g SSE)

With Appendix A to SRP 3.8.4 acceptance criteria.

Level 2 - Safe Shutdown Earthquake (.17g SSE)
(Site specific SEP earthquake)

With Appendix A to SRP 3.8.4 acceptance criteria.

Level 3 - Level 2 analysis with the exception that a 1.5 overstress factor for tension normal to the bed joint is used instead of the SRP value of 1.3 as acceptance criteria.

To the extent required further evaluations and modifications will be completed as stated in the response to question #15.

Question:

1. The SGEB criteria (5) do not allow an increase in allowable stresses for load combinations containing OBE or wind loads. Provide justification for the 1/3 increase in allowable stress (Reference 3, Section 3.4.2) used for load combinations (normal operating conditions). Identify the affected walls and include the calculated stresses for each wall. Also explain all conservative measures (if any) used in the analysis to justify the increase in allowable stresses.

Answer:

As noted in the NRC's Safety Evaluation Report of August 22, 1983 concerning the Integrated Plant Safety Assessment Report, the loads and load combinations for safety-related structures at Ginna (including masonry block walls) were defined during the Systematic Evaluation Program. These loads included the site specific spectra for the SSE case, but specifically excluded any consideration of the Operating Basis Earthquake (OBE), reasoning that the more severe SSE case was the major safety issue. Thus, the Ginna masonry block walls were not evaluated to the OBE conditions.

For normal wind loadings, no increase in allowable stresses was used in the evaluation of masonry wall design.

Question:

2. Justify the use of an allowable stress increase factor of 1.67 for load combinations containing accident pressures or SSE loads. This is in excess of several factors permitted by the SGEB criteria (5); they are listed below by type of stress:

masonry shear in flexural members	1.3
masonry shear in unreinforced shear walls	1.3
reinforcement takes entire shear	1.5
tension normal to bed joint	1.3
tension parallel to bed joint	1.5

If any existing test data will be used to justify this increase factor, discuss the applicability of these tests to the walls at the Ginna plant with particular emphasis on the following:

- boundary conditions
- nature of loads
- size of test walls
- type of masonry construction (block or mortar type, grouted or ungrouted)

The Licensee is also requested to indicate the number of walls that would not be qualified if the SGEB criteria were to be used and to specify the percentages of exceedance. The Licensee is advised to explain all conservative measures (if any) used in the analysis to justify this increase factor.

Answer:

The increase factors permitted by the SGEB criteria for load combinations containing SSE loads have been used for the current evaluation with one exception. For tension normal to the bed joint, an increase factor of 1.5 vs. 1.3 has been used to qualify 2 walls. The 1.3 factor is exceeded by 10% for wall 3-17A-5 and 7% for wall 2-2I. This corresponds to increase factors of 1.43 and 1.38, based on the actual wall stresses, rather than 1.5. The allowable stresses identified in ACI 531 include a safety factor of 3. Therefore, the use of 1.43 and 1.38 as increase factors still provides margins of safety of 2.10 and 2.17 for the two walls, which are judged to be acceptable for these limited cases.

Question:

3. When the response spectrum method of seismic analysis is used, the accelerations of walls on a particular floor should be based on the floor reponse spectrum for the floor elevation. However, as stated in Section 3.5.1 of Reference 3, the License derives all wall accelerations from the ground response spectrum. Justify the use of the ground response spectrum instead of the floor response spectra.

Answer:

The seismic analysis of the safety-related masonry walls has been redone using the response spectrum method. The response spectrum input for these seismic analyses is based on averaging the floor response spectra for the top and bottom elevations of the wall, if the wall is supported at both locations. If the wall is not supported at the top, the floor response spectrum at the base of the wall is used.

Question:

4. With reference to the reinforcement in masonry walls, the ACI 531-79 Code specifies that the minimum area of reinforcement in a wall in either direction, vertical or horizontal, shall be 0.0007 (0.7%) times the gross cross-sectional area of the wall and that the minimum total area of steel, vertical and horizontal, shall not be less than 0.002 (0.2%) times the gross cross-sectional area. In view of this, clarify whether the reinforced walls at this plant meet the above requirements. The Licensee is also requested to provide the type and spacing of vertical reinforcement and the total number of vertically reinforced walls. It should be noted that the horizontal reinforcement is installed to satisfy the minimum reinforcement requirement for a reinforced wall.

   With reference to the joint reinforcement, identify the number of walls qualified by the tensile strength of joint reinforcement and indicate the type and spacing of the joint reinforcement.

   Based on the review of existing codes and published literature, the NRC does not, at present, approve the use of joint reinforcement, as a structural element. A staff position on this issue is being developed and will be provided to the licensee in the future.

Answer:

Twelve of the thirty-seven safety-related walls are reinforced vertically. Of this total, seven are reinforced with 1 #3 bar on 32" centers. The remaining five are reinforced with 2 #3 bars on 16" centers. The joint reinforcement is DUR-O-WAL standard truss type on 8" centers or DUR-O-WALL "extra heavy" truss type on 16" centers.

To date, the wall panels listed as passing in the response to question 15 have all passed as unreinforced walls. No credit was taken for either horizontal or vertical reinforcing. In the event that any of the failing panels are modified so the reinforcement can be utilized in the wall qualification, a response regarding this question will be sent to the Commission.

Question:

5. Indicate the boundary conditions used in the analysis and verify that they resemble the real physical conditions. Identify all of the mechanisms used to transfer shear and moment (if any) with particular emphasis for walls qualified by arching action. If any doubt exists (i.e., whether simply supported or fixed-end conditions should be assumed), verify that the assumed boundary conditions will produce conservative results.

Answer:

Details for the installed boundary fixes were submitted in the November 4, 1980 and the January 30, 1981 reports. There are 29 types of boundary fixes which were installed. The different types of boundary conditions used in the analysis are listed below. Each wall fix type was designed to insure that the modeled boundary conditions were correct.

Boundary Type: Fixed (This boundary type is representative of wall bases only)

Analysis Condition: Joint translation and rotation restrained.

Actual Conditions: Joint translation is restricted by reinforcing steel which ties the wall to a concrete slab, where applicable, and by mortar bond and friction. Mortar bond and friction are reliable mechanisms since a net vertical compressive force exists at the boundary due to wall dead weight. Joint rotation is restricted by the reinforcing steel and by mortar tension strength. If allowable mortar tension strength was exceeded at the boundary, then the boundary was considered pinned. Only three walls were considered to have a fixed boundary (at their base).

Boundary Type: Pinned

Analysis Condition: Only joint translation restrained.

Actual Conditions: Joint translation is restricted by mortar bond, friction, and installed boundary modifications. Details of the boundary modifications are shown in RG&E's response to I.E. Bulleting 80-11 report (ref. letter J. E. Maier, RG&E to B. H. Grier, NRC, dated 11/04/80 and 01/30/81). The installed boundary modifications have been engineered to provide support for seismic loads. The majority of the walls analyzed have pinned boundary conditions.

Boundary Type: Free

Analysis Condition: No restraint.

Actual Conditions: Joint translation and rotation are unrestricted. Examples are edges of wall panels where boundary supports have not been installed or are totally free, and the edges of openings in walls. No restraint by door frames or components running through openings has been relied upon.

Arching Action: Arching action has not been relied upon in the analyses.

Question:

6. Indicate how interstory drift effects, both in-plane and out-of-plane, were considered in the analysis. Also, indicate and justify by available test data the permissible strains used for both confined and unconfined walls.

Answer:

In-plane strain criteria used to verify the adequacy of the walls is discussed in "Recommended Guidelines for the Reassessment of Safety-Related Concrete Masonry Walls" prepared by the Owners and Engineering Informal Group on Concrete Masonry Walls, October 6, 1980. The acceptance criteria in this reference is based upon an uncoupled system (separate treatment of in-plane and out-of-plane loads), which is consistent with the FSAR seismic requirements for Ginna Station. Evaluations indicate that the in-plane strains induced on the walls due to interstory drift are less than the allowables permitted in the reference in the majority of instances, regardless of whether a mechanism exists to induce the drift into the walls. In the remaining instances, the implied strains would exceed the acceptance criteria if a positive transfer mechanism existed. For these latter instances, a specific case-by-case review was conducted of the wall configuration with respect to the surrounding structure, displacements, and drift inducement mechanics. From this review, it was judged that a sufficient mechanism does not exist to induce significant interstory in-plane drift. It should be noted that the masonry walls at Ginna are not relied upon to provide horizontal shear load resistance (i.e., shear walls). Out-of-plane interstory drift has no significant effect on the walls in that they can be considered simply supported between stories.

Question:

7. Indicate whether concrete block walls are stacked or running bond. If any stack bond wall exists, provide sample calculations for stresses in a typical wall. Also identify the number of stacked bond walls and their appropriate allowable stresses.

Answer:

All safety-related masonry block walls listed in our April 28, 1983 letter to the NRC are running bond masonry walls, not stacked bond masonry walls.

Question:

8. Reference 3 indicated that some brick walls were constructed at the plant. Indicate the number of brick walls and specify the allowable stresses from appropriate codes used in the analysis. If any increase factor were used for SSE loading case, justification should be provided.

Answer:

The list of safety-related masonry block walls provided to the NRC in the April 28, 1983 letter to Mr. Dennis M. Crutchfield contains 1 wall which consists of brick. This wall, 971-2M, is composed of 4" interlocking lead bricks. The wall, 2'-3" wide at the base and 5'-4" high, was analyzed taking no credit for the interlocking effect of the brick. It has been determined that the steel framing network surrounding the wall can adequately restrain the wall in one direction during an earthquake. It has also been determined that wall failure in the other direction will not affect any safety-related equipment. In conclusion, wall 971-2M is not dependent on any masonry brick allowable stresses, but is, however, seismically acceptable.

Question:

9. With reference to Section 3.2.5 of Reference 3, the Licensee indicated that accident pressure and associated temperature loads are considered only inside containment when applicable. Provide a sample calculation (and any explanations necessary to make it understandable) illustrating the analysis procedures in this case.

Answer:

There are no safety-related masonry walls subject to pressure or temperature differentials; therefore, no analysis to consider the effect of these loads is required.

Question:

10. In Section 3.5.1 of Reference 3, the Licensee indicated that the computed stresses are increased 5% to account for higher modes of vibration. Justify by sample calculation that 5% is an appropriate percentage for multimode effects.

Answer:

The masonry walls have been reevaluated since the initial response indicated in the question. This reevaluation has taken into account the combined effects of all modes of vibration up to 33 HZ, which corresponds to the rigid range of the floor response spectra. For walls whose frequencies are greater than 33 HZ, the floor response accelerations of 33 HZ have been used for the analysis.

Question:

11. Provide sample calculations (with explanations necessary to make the calculations understandable) for:

- a single-wythe wall analysis
- a multi-wythe wall analysis
- a brick wall analysis

Answer:

There are no multi-wythe or brick masonry walls at Ginna which fall under the scope of this evaluation.

The computer program SAP 4 was used to determine the stress in single-wythe walls. Wall geometry, boundary support conditions, material and physical properties, attachment loads, and response spectra information were input into the SAP 4 program. The program then performed static and dynamic analyses to determine stresses in the walls for the various loads in the scope of the program.

The stresses determined by the SAP 4 program were then compared to allowable stresses using a special purpose post-processor program designed to combine stresses obtained from the static and dynamic analyses of the SAP 4 and compare the resultant stresses against allowable valves. Attachment 3 provides sample calculations.

Question:

12. According to Attachment 3 of Reference 3, only 84 walls were identified as safety-related; however, in a meeting at the NRC on January 20, 1983 with regard to the use of the non-linear analysis technique (arching theory), the Licensee identified 101 walls qualified by arching theory. Explain this discrepancy.

Answer:

The initial IE 80-11 November 4, 1980 submittal listed 84 safety-related masonry walls. This number corresponded to 101 panels, a panel being a division isolated for engineering analysis. Since the 1980 submittal, the number of safety-related walls has been reduced to 37. The 37 walls now correspond to 56 panels. RG&E has been involved with technical meetings on arching action as a potential method for qualifying block walls, however, no wall qualifications have relied on any non-linear analysis techniques, including arching.

Question:

13. Indicate how the uncertainties due to variations in mass, materials, and sections properties were accounted for in the analysis.

Answer:

The response spectra used in the seismic analysis of the masonry walls were broadened by 15% to account for uncertainties in the analytical model compared with the physical structure.

Question:

14. Indicate whether collar joint strength has been used in the analysis. If so, provide and justify the allowable stresses of the collar joint.

Answer:

There are no multi-wythe masonry walls within the scope of this evaluation; therefore, it is not necessary to use collar joint strength to qualify any walls.

Question:

15. Confirm whether all modifications have been completed and the modified walls are in compliance with the SGEB criteria.

Answer:

All modifications to walls, based on analysis to the original criteria, were completed at the time of the report.

Of the current 56 safety-related panels, the modifications installed under the original re-evaluation criteria result in 29 panels meeting the SGEB criteria. For the remaining 27 wall panels, RG&E will use the following evaluation methods to determine wall qualification requirements:

(1) At present, a wall is considered safety-related if equipment is located within one full wall height of the base of the wall. RG&E will investigate the justification of using less than one full wall height, if applicable, on a wall-by-wall basis. If it is concluded that the collapse mechanism is such that the equipment is not hit, no further evaluation is required.

(2) If a wall failure can impact safety-related equipment, additional analyses will be performed to determine if in fact the equipment is actually damaged and inoperable. If the equipment can withstand the wall impact and remain operable, no modification will be performed.

(3) Modifications to protect safety-related equipment potentially impacted by wall failure will be designed and installed so that wall failure has no safety consequences.

(4) Wall modifications will be designed and installed such that the wall will meet the re-evaluation criteria.

<u>Question:</u>

16. Explain how earthquake motions in three directions are treated in the analysis. Indicate whether any walls are subject to in-plane loading. If so, provide a sample calculation illustrating how the wall is qualified with respect to the SGEB criteria.

<u>Answer:</u>

Three directions of earthquake were considered in the analysis by evaluating walls for both vertical plus out-of-plane and vertical plus in-plane load combinations. The vertical plus out-of-plane load combination was found to be the limiting load case in the analysis.

All walls in the plant are subjected to in-plane loading, and as stated above, this load combination was evaluated. Sample calculations for an in-plane evaluation are provided in Attachment 3 of this report.

<u>Question:</u>

17. Explain and justify how cracked and uncracked moment of inertia was calculated.

Answer:

A cracked section analysis was performed on one wall panel. Due to the minimum reinforcing available in the evaluated panel, no significant benefit was gained from the cracked section analysis. No walls, to date, have been qualified using cracked section analysis. Uncracked moments of inertia were calculated using conventional mechanics taking into account the cellular configuration on the masonry units.

Question:

18. In Attachment 4 of Reference 3, the Licensee provided the test data for the compressive strength of concrete masonry walls. Provide the basis for selecting those five specimens for testing and indicate whether they represent the variety of material construction in all buildings. Since no detailed records relating to the masonry block walls construction were maintained, justify the strength of the mortar used in the analysis.

Answer:

The Intermediate Building at Ginna contains the majority of safety-related block walls listed in our April 28, 1983 submittal. These walls are all unreinforced. Three concrete masonry units were removed from this building; two 12" hollow blocks and one 8" hollow block. Twelve inch wide hollow block constitute approximately 55% of the 37 safety-related walls at Ginna and 8" hollow blocks constitute approximately 45%. Two concrete blocks were removed from the control building where the majority of reinforced walls exist. The basis for selecting samples was representation of the greatest number of similar wall thicknesses and block configurations (i.e., hollow unreinforced or hollow reinforced).

A specification, SP-5360, which controlled all the masonry work for the turbine, auxiliary and intermediate buildings, was reviewed this specification required mortar in accordance with ASTM C270-64T, Type N. Based on the controlling construction specification for masonry wall work, the strength of the mortar has been jusitifed for reanalysis.

Attachment 1

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649

JOHN E. MAIER
Vice President

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April 28, 1983

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: SEP Topics II-2.A, III-2, III-4.A, and III-7.B
"Structural Reanalysis Program" - Block Walls

Dear Mr. Crutchfield:

In our April 22, 1983 submittal, "Structural Reanalysis Program for the Robert E. Ginna Nuclear Power Plant", RG&E provided our recommendations for structural elements which should be considered for upgrade to withstand tornado effects. The basis for selection of these structures is noted as those which are required to assure:

- o the integrity of the reactor coolant pressure boundary,
- o the capability to shut the reactor down and maintain it in a safe shutdown condition, and
- o the capability to prevent accidents which could result in offsite exposure in excess of the dose guidelines of 10 CFR Part 100.

Based upon the safe shutdown scenario discussed in Section 3.5 of the April 22 report, the attached list indicates those walls that RG&E currently considers safety-related and whose integrity must be maintained to assure safe shutdown. Specifically, RG&E stated that the block walls whose failure could damage required main steam and feedwater line components in the intermediate building, and those which would affect the spent fuel assemblies, should be considered for upgrading. No other block walls potentially exposed to tornado effects are considered as safety-related.

Several other block walls are located such that tornadoes could not cause any structural damage, and thus were not evaluated in the April 22 report. However, using the same safety design basis, the following additional walls are considered safety-related:

- o Control building walls which could damage vital equipment in the battery room, relay room, and air handling room; and,
- o Walls which are internal to containment, as listed in our response to I.E. Bulletin 80-11, submitted by letter of November 4, 1980.

Very truly yours,

John E. Maier

J. E. Maier

SAFETY-RELATED MASONRY WALLS

NO.	BUILDING	RG&E DWG. AND IDENTIFICATION*	
1	Control	33013-971	1C
2	Control	33013-971	2C
3	Control	33013-971	3C
4	Control	33013-971	4C
5	Control	33013-971	5C
6	Control	33013-971	6C
7	Control	33013-972	1C
8	Control	33013-972	2C
9	Control	33013-972	3C
10	Control	33013-972	4C
11	Control	33013-972	5C
12	Control	33013-972	6C
13	Control	33013-973	3C
14	Control	33013-973	4C
15	Control	33013-973	5C (THIS WALL HAS BEEN REMOVED)
16	Auxiliary	33013-973	16A
17	Auxiliary	33013-973	17A
18	Containment	33013-971	1M
19	Containment	33013-971	2M
20	Containment	33013-971	3M
21	Containment	33013-972	1M
22	Containment	33013-973	1M
23	Containment	33013-973	2M
24	Intermediate	33013-972	1I
25	Intermediate	33013-972	2I
26	Intermediate	33013-972	3I
27	Intermediate	33013-972	4I
28	Intermediate	33013-972	5I
29	Intermediate	33013-972	6I
30	Intermediate	33013-972	7I
31	Intermediate	33013-972	8I
32	Intermediate	33013-972	9I
33	Intermediate	33013-972	10I
34	Intermediate	33013-972	11I
35	Intermediate	33013-972	12I
36	Intermediate	33013-973	Part of 1I
37	Intermediate	33013-973	11I(P)
38	Intermediate	33013-973	9I(P)

*Referenced drawings were submitted as part of the I.E. Bulletin 80-11 Response submitted November 4, 1980.

Attachment 2

DIFFERENCES BETWEEN ORIGINAL 80-11 CRITERIA

AND THE REVISED CRITERIA

(1) The floor response spectra method of seismic analysis has been used in the revised criteria.

(2) The OBE loading case is not addressed in the current criteria, therefore, eliminating the use of the 1.33 overstress factor.

(3) The 1.67 allowable overstress value has been replaced by the overstress factors listed in 3 (d) of Appendix A to the SRP Section 3.8.4. Two exceptions to this criteria have been made and are described in the answer to question 2.

(4) The damping valve for the SSE case was increased from 5% to 7% to be consistent with Appendix A to the SRP Section 3.8.4.

(5)* For Level 2 analyses, a site specific ground acceleration of .17g for the safe shutdown earthquake was utilized. The floor response spectra have been generated by directly ratioing the .20g SSE acceleration floor response spectra developed for the piping seismic upgrade.

(6) In the revised criteria interstory drift effects are included in the analysis as required by SRP 3.84 Appendix A item 4f.

(7) In addition to evaluating walls for attachment loads of either 15 PSF or 5 PSF, the revised criteria allows a reduction in attachment load if it can be justified as representative of the actual field condition.

(8) A value for the compressive strength of masonry, Fm', has been calculated based on the compressive strength of tested blocks for the new criteria.

*The FSAR stated that a .20g SSE ground acceleration was used in design. The original seismic criteria did not have any floor response spectra.

Attachment 3

Gilbert Associates, Inc. Reading, Pennsylvania CALCULATION	SUBJECT RG&E - GINNA STATION BLOCK WALL EVALUATION		IDENTIFIER		PAGE OF PAGES
	REV.	0	1	2	3
	MICROFILMED				
	ORIGINATOR				
	DATE				

ATTACHMENT 3

SAMPLE CALCULATIONS FOR QUESTION #11

AS STATED IN THE RESPONSE, THE WALL STRESSES ARE DETERMINED BY THE SAP4 COMPUTER PROGRAM FOR BOTH STATIC AND DYNAMIC ANALYSES. THESE STRESSES ARE THEN COMBINED IN THE APPROPRIATE LOAD COMBINATIONS AND COMPARED TO ALLOWABLE STRESSES BY A POST-PROCESSOR. THE INPUT TO THESE PROGRAMS IS LISTED BELOW.

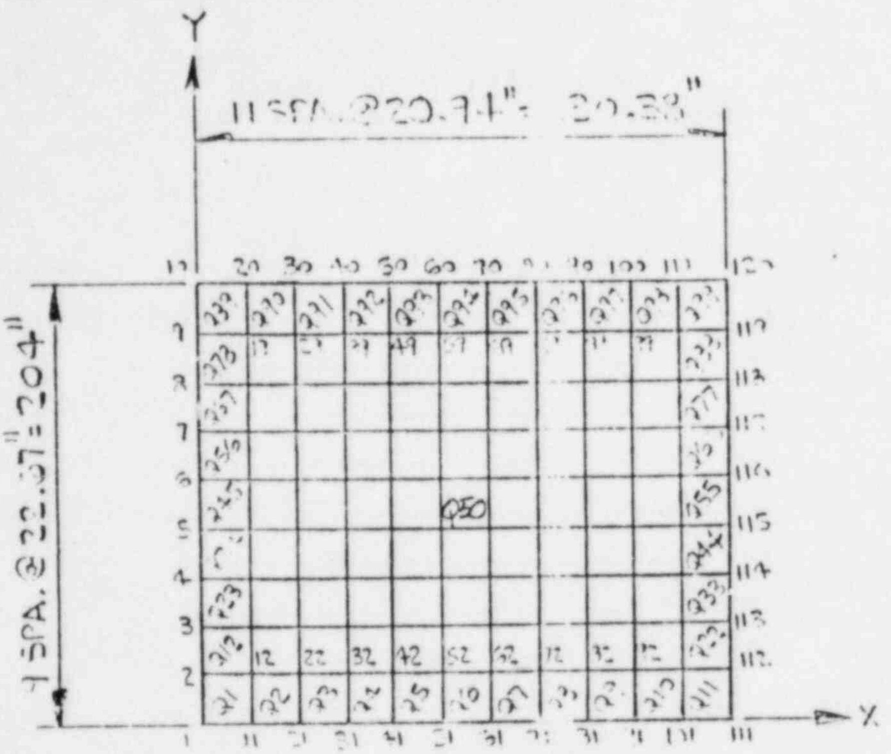
WALL GEOMETRY — REF. FINITE ELEMENT COMPUTER MODELS F.C. 1:44.1.12

MAT'L & PHYSICAL PROPERTIES — REF. F.C. 1:44.1.9 & 1:68.3

SEISMIC RESPONSE SPECTRA — REF. F.C. 1:68.3

THE FOLLOWING EXAMPLE ILLUSTRATES THE CALCULATIONAL PROCEDURE USED IN THE POST PROCESSOR. WALL 2-1I IS CHOSEN AS A SAMPLE WALL. CHECK STRESSES IN ELEMENT 50 IN THE CENTER OF THE WALL. (SEE FOLLOWING PAGE FOR FINITE ELEMENT MODEL)

FINITE ELEMENT COMPUTER MODEL



WALL 11

DWG. No. RGE 33013-972

STRESS CHECK LEVEL 1

FROM "INTERIM CRITERIA FOR SAFETY-RELATED MASONRY WALL EVALUATION", APPENDIX A TO SRP SECTION 3.8.4, USNRC, REV. 0, JULY 1981, INCREASE FACTORS ARE 2.5 FOR AXIAL OR FLEXURAL COMPRESSION, 1.3 FOR TENSION NORMAL TO THE BED JOINT, AND 1.5 FOR TENSION PARALLEL TO THE BED JOINT, FOR LOAD COMBINATIONS INCLUDING SSE LOADS.

$F_a = .225 f'_m \left[1 - (h/40t)^3\right] \times 2.5$

$= .225(1400)\left[1 - (204/40(11.62))^3\right] \times 2.5$

$=$ 721.0 psi

$F_m = .33 f'_m \times 2.5$

$= .33(1400) \times 2.5$

$=$ 1155 psi

$F_{tn} = .5\sqrt{m_o} \times 1.3$ (TENSION NORMAL TO THE BED JOINT)

$= .5\sqrt{750} \times 1.3$

$=$ 17.80 psi

$F_{tp} = 1.0\sqrt{m_o} \times 1.5$

$= 1.0\sqrt{750} \times 1.5$

$=$ 41.08 psi

ACTUAL WALL STRESSES FROM COMPUTER RUN SQE2VDJ (4/26/84) ARE -

VAS - VERTICAL AXIAL STRESS = 4.46 psi COMPRESSION
SYB - FLEXURAL COMPRESSION/TENSION NORMAL TO BED JOINT = 44.89 psi
SXB - FLEXURAL COMPRESSION/TENSION PARALLEL TO BED JOINT = 35.92 psi

CHECK STRESS PARALLEL TO BED JOINT

$$\frac{SXB}{\text{SMALLER OF } F_m \text{ OR } F_{tp}} = \frac{35.92}{41.08} = .874 < 1.0 \therefore OK$$

CHECK STRESS NORMAL TO BED JOINT

$$\frac{VAS}{F_a} + \frac{SYB}{F_m} = \frac{4.46}{721} + \frac{44.89}{1155} = .045 < 1.0 \therefore OK$$

$$\frac{SYB - VAS}{F_{tn}} = \frac{44.89 - 4.46}{17.80} = 2.27 > 1.0 \therefore \text{NO GOOD}$$

CHECK STRESS LEVEL 2

STRESS CHECK LEVEL 2

THIS EVALUATION LEVEL FOLLOWS THE SAME METHOD AS LEVEL 1 EXCEPT THAT THE ACTUAL STRESSES FROM SEISMIC LOADS ARE BASED UPON A SITE SPECIFIC SSE OF 0.17g VS. 0.30g USED IN LEVEL 1.

FOR THIS LEVEL - VAS = 5.06 PSI COMPRESSION
SYB = 38.15 PSI
SXB = 30.53 PSI

CHECK STRESS PARALLEL TO BED JOINT

$$\frac{30.53}{41.08} = 0.743 < 1.0 \therefore OK$$

Gilbert Associates, Inc. Reading, Pennsylvania CALCULATION	SUBJECT RG&E - GINNA STATION BLOCK WALL EVAL. - APPENDIX A		IDENTIFIER SAMPLE CALC'S		PAGE A5 OF PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR R.S. BROWN				
	DATE 6-11-84				

CHECK STRESS NORMAL TO BED JOINT

$$\frac{5.06}{721} + \frac{38.15}{1155} = .040 < 1.0 \quad \therefore \text{OK}$$

$$\frac{38.15 - 5.06}{17.80} = 1.86 > 1.0 \quad \therefore \text{CHECK STRESS LEVEL 3}$$

STRESS CHECK LEVEL 3

THIS LEVEL INCORPORATES THE REDUCED SEISMIC LOADS OF LEVEL 2 AND INCREASES THE ALLOWABLE STRESS FOR TENSION NORMAL TO THE BED JOINT BY 1.5 INSTEAD OF 1.3. ALL OTHER ALLOWABLE STRESSES ARE THE SAME AS USED IN LEVELS 1 AND 2.

$$F_{tn} = .5\sqrt{m_o} \times 1.5 = .5\sqrt{750} \times 1.5 = 20.54 \text{ PSI}$$

THE VAS, SYB & SXB ARE THE SAME AS FOR LEVEL 2. THE GOVERNING RATIO IS FOR TENSION NORMAL TO THE BED JOINT, $R = \frac{38.15 - 5.06}{20.54} = 1.61 > 1.0 \therefore$ MODIFICATIONS ARE REQUIRED FOR THIS WALL.

SAMPLE CALCULATIONS FOR QUESTION #16

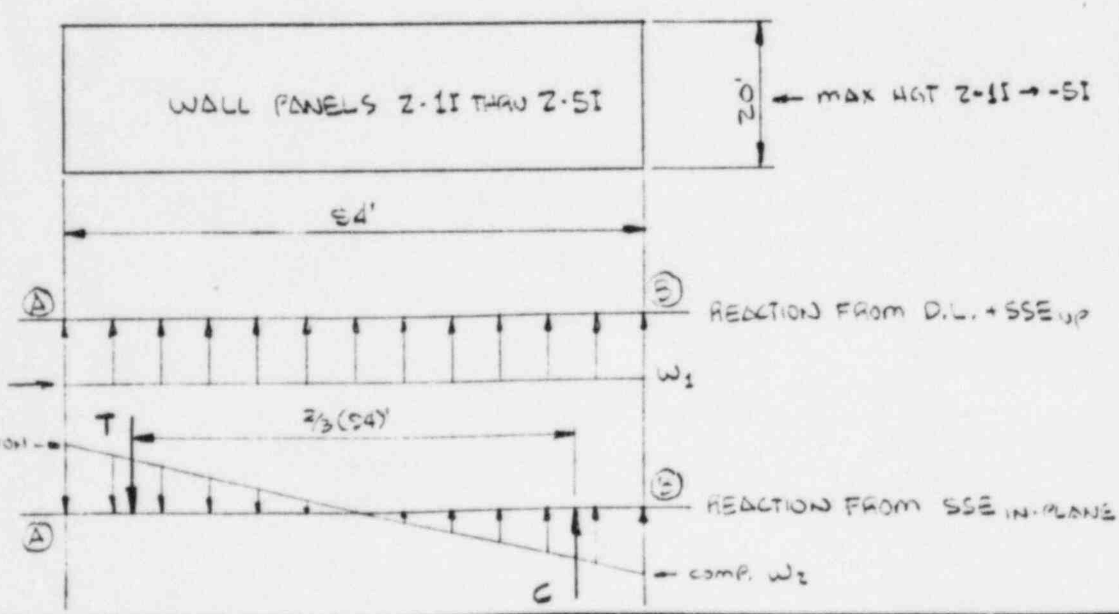
OBJECTIVE: CALCULATE STRESSES FROM IN-PLANE HORIZONTAL COMBINED WITH VERTICAL SSE LOADS FOR WALL PANEL Z-1I, AND DETERMINE IF STRESSES ARE WITHIN ALLOWABLE LIMITS.

WALL PANEL Z-1I IS SHOWN ON GAI DRAWING SS-581-443. THIS WALL PANEL IS PART OF A CONTINOUS WALL MADE UP OF PANELS Z-1I THRU Z-5I. THE TOTAL LENGTH OF THIS CONTINOUS WALL IS APPROXIMATELY 54'.

ASSUME THAT ALL SEISMIC LOADS ARE RESISTED AT THE BASE OF THE WALL.

SEISMIC ACCELERATIONS - $a_h = .725\,g$, $a_v = .468\,g$ } NOTE: AVERAGE ACCELERATION BETWEEN TOP & BOTTOM OF WALL PANEL.

WEIGHT OF BLOCK (12" HOLLOW - UNREINF'D) = 55 psf OF WALL SURFACE
ATTACHMENT WEIGHT = 5 psf (MAXIMUM FROM Z-1I THRU Z-2I)



REACTIONS AT BASE OF WALL:

$$w_1 = 20' \times (55+5)^{psf} \times (1 - .468) = 638 \text{ plf} = 53.2 \text{ pli}$$

$$C = T = \frac{\left[(20' \times 94') \times (55+5)^{psf} \times .725 \times {}^{17'}/_{2} \right]}{{}^{2}/_{3} \times 94'} = 11093^{\text{lb}}$$

$$w_2 = \frac{2 \times 11093}{\frac{1}{2}(94)} = 472 \text{ plf} = 39.3 \text{ pli} \quad \text{TENSION OR COMPRESSION}$$

COMBINED VERTICAL REACTIONS:

AT Ⓐ : W = 53.2 − 39.3 = 13.9 pli COMPRESSION

AT Ⓑ : W = 53.2 + 39.3 = 92.5 pli COMPRESSION

CHECK STRESSES: A_{net} for 12" HOLLOW BLK = 5.07 $^{in^2}/_{in}$

NO TENSION IN WALL

COMPRESSIVE STRESS = $^{92.5}/_{5.07}$ = 18.24 psi ok INSPECTION

INPLANE SHEAR STRESS:

V_{SSE} = .725 × 20' × (55 + 5) = 870 plf = 72.5 pli

STRESS = $^{72.5}/_{5.07}$ = 14.3 psi ok INSPECTION

∴ WALL ACCEPTABLE FOR SSE IN-PLANE + VERTICAL LOADS