

VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

R. H. LEASBURG
VICE PRESIDENT
NUCLEAR OPERATIONS

July 15, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attn: Mr. Robert A. Clark, Chief
Operating Reactors Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Serial No. 372
PSE&CS/RHW,III:BRC
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

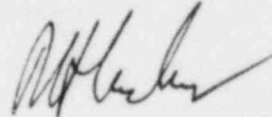
Gentlemen:

SUBMITTAL OF ADDITIONAL INFORMATION
NRC IE BULLETIN 80-11 (MASONRY WALL DESIGN)
NORTH ANNA POWER STATION, UNIT NOS. 1 & 2

This letter provides the additional information regarding NRC IE Bulletin 80-11 (Masonry Wall Design) which was requested by your letter of May 28, 1982. Clarification and justification of the criteria used in evaluating the masonry walls is provided in the Enclosure to this letter. Sample calculations and sketches are provided as Attachments to the Enclosure in order to demonstrate how the analysis was performed and illustrate the types of modifications that were installed. A list of our previous responses, which were not included on the reference list attached to your letter, is also provided.

Please contact us if you have any questions or require additional information.

Very truly yours,



R. H. Leasburg

Enclosure w/attachments

cc w/enclosure: Mr. James P. O'Reilly
Regional Administrator
Region II

brc/2623/1

A001

8207190399 820715
PDR ADOCK 05000338
Q PDR

ADDITIONAL REFERENCES
NOT INCLUDED WITH
FRANKLIN RESEARCH CENTER REFERENCE LIST
ENCLOSURE TO NRC LETTER OF MAY 28, 1982
NORTH ANNA POWER STATION

1. R. H. Leasburg
Letter to J. P. O'Reilly, NRC
Subject: I. E. Bulletin No. 80-11, Masonry Wall Design
North Anna Power Station - Units 1 & 2
Virginia Electric & Power Co. 14-Sept.-81
Serial No. 465

ENCLOSURE

Vepco Letter to NRC Dated July 15, 1982, Serial No. 372

NORTH ANNA POWER STATION

UNITS 1 & 2

The following text is provided as the response to the NRC letter of May 28, 1982 requesting additional information on I.E. Bulletin 80-11. This report provides a reprint of each of the nine (9) NRC requests with the applicable response following the question.

NRC REQUEST

1. Provide and justify the boundary conditions and modeling techniques used for the reevaluation of masonry walls at the North Anna plant and using sample calculations indicate how the potential for block pull-out was considered at equipment attachments.

VEPCO RESPONSE

1. The boundary conditions were represented as shown in Attachment A.

Boundary conditions, based on the criteria below, were assigned to each wall and held consistent throughout the review. If it was determined that a wall required modifications which would alter the boundary conditions, the calculation for that wall, was completely revised using the new boundary conditions.

The criteria used to establish the guideline cases for determining the boundary conditions, was based on a review of the original construction drawings, the field as-built wall information, and the following considerations:

A. General Criteria

1. Seismic loads are reversible therefore supports had to provide restraint in both directions.
2. Consideration was given to the relative stiffness of the block wall and its supports. If a rigid boundary could not be justified for a specific wall, then the analysis included the effect of the support's elasticity.
3. Shear load transfer mechanisms were only considered at block to block and block to concrete interfaces. No shear transfer was considered for block to steel interfaces or across expansion joints or compressible materials.

4. Consideration was given to the stiffness of the portion of the existing structure which would carry the reaction of the block wall. If it could not be demonstrated that the boundary condition case generically had sufficient stiffness to carry block wall reactions, then the analysis for that specific block wall had to carry the loads back until sufficient support capacity could be demonstrated.
5. Fixity was considered in the following cases. A.) Fixity was utilized at the base of a block wall built on a concrete slab if a cantelivered wall would exist (i.e., three sides of wall free). B.) At the perpendicular intersection of two block walls, fixity was taken at those corner joints constructed of alternating courses of running bond. If fixity was taken, then the relative stiffness of the walls had to be accounted for and the reaction was carried into the supporting wall.
6. Openings at boundaries were addressed on a case by case basis.

B. Types of Boundary Conditions

1. Block to Concrete

This type is taken as a pin except as noted in Item A5 above.

2. Block to Block

See Item A5 above. Block to block butt joints were not taken as moment transfer mechanisms.

3. Block to Steel

The wall analysis accounts for elasticity of the support at a block to steel interface. Attachment A was used as a guide for steel to block boundaries.

2. Block Pull-out

The potential for block pull-out was considered by development of local block loading criteria as shown in a sample calculation, Attachment B.

3. Modeling Techniques

All walls were analyzed based on a grid model using the previously noted boundary conditions.

Openings in Masonry Walls - Particular attention was given to the global effect of openings and discontinuities in the masonry walls.

1. Lateral Loads Around an Opening

For masonry wall interrupted by an opening, local wall sections were analyzed as spanning between local beams and were modeled as simply supported at the local beams unless a more detailed analysis was performed. The effective width of the local beam was taken as twice the wall thickness. Local beams were evaluated only for loads acting directly on them. These included: 1) The uniform lateral load across the beam width, and 2) reactions from the local wall sections.

Walls with door openings were conservatively analyzed assuming that a free edge exists at the location of the door jambs and that the door jamb would not transfer out of plane shear loads.

2. Penetrations Through Masonry Walls

Openings for pipe, conduit, or ducts were reviewed for possible load transmittal to the wall. All penetrations which were physically attached to the wall by a mechanical device, such as steel framing, were reviewed for out-of-plane loads.

The local analysis accounted for the local affects of the openings in the walls. The local effects of openings in walls were refined by a plane grid analysis of the load transfer directly into the adjacent wall.

All penetrating systems which physically attach to the wall by a mechanical device, such as steel framing, were considered as causing a load on the wall using the following outline:

1. Dead and live loads on the system were determined.
2. These loads were multiplied by the appropriate resonant range acceleration of the wall to determine loads caused by earthquake.
3. The earthquake loads were distributed around the perimeter of the opening or attachment device area as applicable.
4. The wall was analyzed for the local shears and moments produced by the load in Step 3.

Additional information on frequency calculation Inertial Loads, Equipment Loads and interstory displacement is contained in Attachment C, Vepco letter for NRC dated November 3, 1980, Serial No. 878.

NRC REQUEST

2. Using sample calculations, indicate how the effects of higher modes of vibration are included in the analysis.

VEPCO RESPONSE

2. The frequency of the fundamental mode was calculated for each wall governed by IE Bulletin 80-11. The walls having high fundamental natural frequencies, away from resonance, were analyzed using the acceleration values from conservative envelopes of the amplified response spectra (ARS). Attachment C, is a sample of this type of calculation. For the walls which were determined to have natural frequencies in the resonant range, a complete dynamic analysis was performed. This analysis reviewed the walls for the actual amplified response spectra (ARS) curves and determined the acceleration effects for at least the first ten (10) modes by combining the acceleration effects of the modes by the Square Root of the Sum of the Squares (SRSS) technique. Attachment D, is a sample of this type of calculation which includes the enveloped ARS curves and the input echo for the dynamic analysis. Therefore, the higher modes of vibration were accounted for.

NRC REQUEST

3. Provide sample calculations to show the analytical approach used for obtaining the stresses in single wythe and multiple wythe walls.

VEPCO RESPONSE

3. Single wythe walls were analyzed based on conventional beam or plate equations with the boundary conditions and modeling techniques as previously noted. Multiple wythe walls were analyzed in a similar manner except that in plane shear stresses and out of plane tension stresses were considered to be transferred across the collar joint.

Attachments E and F, are sample calculations which show the analytical approach used for obtaining the stresses in single wythe and multiple wythe walls, respectively.

NRC REQUEST

4. Justify the increase factor of 1.67 used in the criteria for allowable stresses. The allowable working stresses for load conditions which represent abnormal/severe and abnormal/extreme environmental conditions such as a design basis earthquake (DBE) may be multiplied by factors shown in the table in the SEB criteria (10) which are given below:

<u>Type of Stress</u>	<u>Factor</u>
Shear reinforcement and/or bolts	1.5
Masonry tension parallel to bed joint	1.5
Shear carried by masonry	1.3
Masonry tension perpendicular to bed joint	
-for reinforced masonry	0.0
-for unreinforced masonry	1.3

VEPCO RESPONSE

4. Section 5.1 of the Criteria for Reevaluation of Concrete Masonry Walls, Attachment C of Vepco Letter No. 878 to NRC dated November 3, 1980, states that allowable stresses for the reevaluation analysis of masonry walls shall be those given in Table 10.1 of the ACI 531-79, with a 1.33 increase for severe environmental loads (OBE) and a 1.67 increase for extreme environmental loads (DBE).

All masonry walls at the North Anna Power Station were reviewed as unreinforced. The calculated transverse shear carried by masonry did not exceed unfactored allowable.

The increase factor of 1.67, used only for masonry tension parallel to the bed joint and perpendicular to the bed joint, due to extreme environmental loads (DBE), was arrived at after an investigation of the allowables given in Table 10.1 of ACI 531-79.

The ACI 531-79 code allowables are based on test data from the National Concrete Masonry Association (NCMA). A review of NCMA test results, published as "Research Data and Discussion Relating to Specification for the Design and Construction of Load Bearing Concrete Masonry," NCMA, 1970, indicated that large factors of safety were used in determining the allowable stresses for masonry tension, from ultimate values.

For tension normal to the bed joint, twenty-seven tests were performed on uniformly loaded single-wythe hollow block walls.

Based upon the ultimate stresses obtained in these tests and the corresponding allowable stresses from Table 10.1 of ACI 531-79, the average safety factor obtained was 4.0. The minimum factor of safety, based upon these tests was found to be 2.60, which is conservative. Tests performed on composite walls, constructed of 4-inch concrete brick and 4-inch hollow blocks, which were greater than 75% solid material, indicated comparable factors of safety for solid masonry walls.

Overall, the allowable stresses from Table 10.1 of ACI 531-79 have a factor of safety of 2.8 with respect to the lower bound of tests for unfactored loads. Therefore, an increase of 1.67 for factored loads during extreme environmental conditions is considered reasonable. Allowable stresses obtained using this increase factor are still conservative.

For tension parallel to the bed joints, the results of NCMA tests on 43 walls, containing no joint reinforcement indicated an average factor of safety of 5.3. On the basis of this safety factor the allowable stresses for this case could have been increased by a factor greater than 1.67. However, the 1.67 factor was kept for the purpose of uniformity and conservatism.

The following table represents our minimum Factor of Safety (F.S.) based on the above NCMA test results for tension perpendicular (I) and parallel (II) to the bed joints.

	Mortar	Block	Avg.	Min.	Avg.	Min.
	<u>Type</u>	<u>Type</u>	<u>F.S.</u>	<u>F.S.</u>	<u>W/1.67</u>	<u>W/1.67</u>
					<u>incr.</u>	<u>incr.</u>
Tension I Bed Joint	M	Hollow	4.0	3.87	2.40	2.32
	S	Hollow	4.0	2.60	2.40	1.56
	N	Hollow	4.0	2.81	2.40	1.68
	S	Solid	4.0	2.33	2.32	1.40
Tension II Bed Joint	M,N,O	Hollow	5.3		3.17	
	M,N,O	Hollow (Load Applied at Center)	6.08	3.59	3.64	2.15

F.S. = $\frac{\text{Ultimate Stress}}{\text{Allowable Stress}}$

The 1.67 increase factor is felt to be particularly reasonable in light of other conservatisms taken in the analyses. These include load application of the acceleration values as uniform rather than sinusoidal, and the use of equipment amplified response spectra (ARS) consistent with damping values for piping and equipment rather than higher damping specified by Regulatory Guide 1.61 for reinforced concrete. Upon reviewing these conservative measures, as well as the high safety factors built into Table 10.1 of ACI 531-79, the increased allowable stresses used in the review are themselves sufficiently conservative.

A review of the allowable stresses used in evaluating the masonry walls indicates that all allowable stress levels given in the SEB criteria are met except for masonry tension perpendicular to the bed joint. For this allowable stress under abnormal/severe and abnormal/extreme environmental conditions, the SEB criteria permits an increase to 1.3 times the allowable working stress. Our criteria used in evaluating the masonry walls permitted an increase to 1.67 times the allowable working stress. As indicated above in this response, the 1.67 factor provides a minimum average factor of safety of 2.3 with respect to the NCMA test results and we believe the increase to 1.67 is conservative and fully justified.

To determine the extent to which this increased allowable stress was used in establishing that the walls were acceptable, the calculated tension perpendicular and parallel to the bed joint stress values were reviewed for all masonry walls. The results of this review indicated that all walls except twenty (20) meet the SEB criteria. For these twenty walls, the only stress not meeting the SEB criteria is the tension perpendicular to the bed joint and the calculated stresses show an increase of 1.31 to 1.56 over the allowable working stress. These values are greater than the SEB factor of 1.3 but less than the 1.67 increase allowed in our criteria.

The twenty walls in this category are identified as follows:

AB-244-15	AB-291-8	AB-291-18
AB-244-16	AB-291-9	AB-291-18A
AB-259-1	AB-291-13	AB-291-22
AB-259-12	AB-291-15	SB-271-4
AB-291-3	AB-291-16A	SB-271-8
AB-291-3A	AB-291-17	SB-271-14A
AB-291-4	AB-291-17A	

Additional information on these walls is provided in our final report submitted by our letter of September 14, 1981, Serial No. 465. This information includes location drawings and references to Design Change modifications of the walls.

NRC REQUEST

5. Provide sketches of the proposed wall modifications and indicate how these modifications will correct the wall deficiencies.

VEPCO RESPONSE

5. The masonry walls were modified to change the boundary conditions and/or reduce the unsupported span.

Attachment G is an example of a wall which was modified by changing its boundary conditions by adding steel plates on both sides of an existing structural member to provide a pinned boundary.

Attachment H is an example of a wall modification which reduced the unsupported span of the wall by adding vertical and/or horizontal members.

NRC REQUEST

6. Provide the status of the proposed wall modifications.

VEPCO RESPONSE

6. I.E. Bulletin 80-11 masonry wall modifications have been installed as indicated in our Final Report. Reference Vepco North Anna 1 & 2 letter of September 14, 1981, Serial No. 465.

NRC REQUEST

7. Provide the results of the analysis of masonry walls which do not satisfy working stress criteria in terms of actual stresses versus allowable stresses.

VEPCO RESPONSE

7. All walls except those in the Fuel Bldg. are within the allowable stress limits for elastic analyses given in the Criteria for Reevaluation of Masonry Walls, Attachment C of Vepco Letter No. 878, to NRC dated November 30, 1980 and clarified in this report. The analysis results for the walls which did not meet this criteria were addressed in an LER as stated in the final report. Ref. Vepco North Anna 1 & 2 letter of September 14, 1981, Serial No. 465. The stresses in these walls were determined to be beyond the elastic range and inelastic techniques were not attempted because of insufficient available support from the structure.

An additional response concerning the status of the LER for these walls will be submitted in the next few months.

NRC REQUEST

8. The Licensee indicates that arching theory and other inelastic analyses are used to qualify some masonry walls. The NRC, at present, does not accept the application of these analytical techniques to masonry walls in nuclear power plants in the absence of conclusive evidence to justify the application. Indicate the number of walls which have been analyzed using these techniques.

VEPCO RESPONSE

8. No arching or other inelastic analyses were used to qualify the masonry walls.

NRC REQUEST

9. Justify the allowable stresses used for collar joints.

VEPCO RESPONSE

9. The allowable tension and shear stresses in collar joints applicable for the type of masonry walls at North Anna Power Station Units 1 & 2 are taken to be 8 psi and 12 psi for severe environmental loads (OBE) and extreme environmental loads (DBE) respectively. These allowable stresses are outlined in the "Criteria for Reevaluation of Concrete Masonry Walls" which was submitted as Attachment C to Vepco's letter to NRC dated November 3, 1980, Serial No. 878. Justification for this input is based on other published sources.

Published test data pertaining to the Trojan Nuclear Power Plant is applicable to collar joint stress. The tests conducted at the Trojan Plant indicated an average tensile bond strength of 194 psi. This result was consistent with predicted values based on block compressive strength. The recommended allowable for the Trojan Plant was 20 percent of the ultimate (194) = 39 psi. The extreme environmental conditions allowable stress of 12 psi is only 6 percent of the ultimate test value for tensile bond strength. Shear bond and tensile bond strengths are taken to be the same. The previously accepted NRC allowable for shear bond strength is 12 psi. Ref. Docket No. 50-344.

The Uniform Building Code (UBC) 1979 allows a maximum value of 12 psi for shear or tension in flexure and a minimum value of 6 psi for shear and tension in flexure. Therefore, the allowables of 12 psi (DBE) and 8 psi (OBE) do not exceed maximum UBC allowables even without the permitted increase factor of 1.33 for seismic loads.

Based on the available test data and the relationship of the collar joint allowable stresses to allowable values given in the UBC 1979, the values of 12 psi and 8 psi for extreme environmental (DBE) and severe environmental (OBE) conditions respectively, are conservative.

LIST OF ATTACHMENTS

ATTACHMENT A
MASONRY WALL BOUNDARY CONDITIONS

ATTACHMENT B
POTENTIAL FOR BLOCK PULL OUT
SAMPLE CALCULATION

ATTACHMENT C
CONSIDERATION OF HIGHER MODES OF VIBRATION
SAMPLE CALCULATION

ATTACHMENT D
CONSIDERATION OF HIGHER MODES OF VIBRATION
SAMPLE CALCULATION

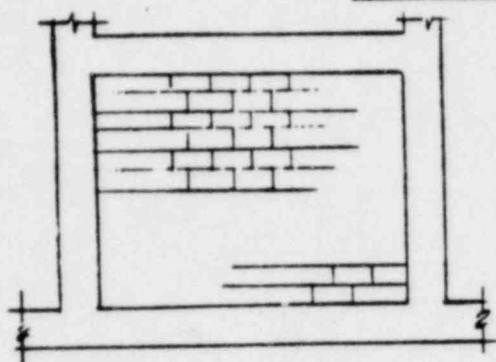
ATTACHMENT E
ANALYSIS OF SINGLE WYTHE WALLS
SAMPLE CALCULATION

ATTACHMENT F
ANALYSIS OF MULTIPLE WYTHE WALLS
SAMPLE CALCULATION

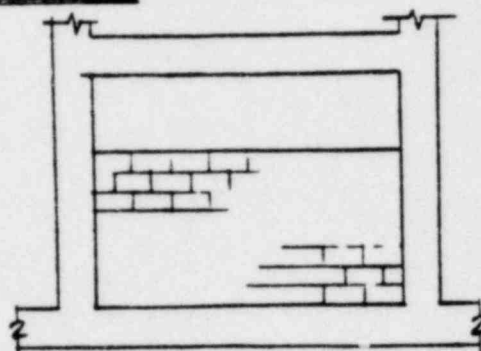
ATTACHMENT G
TYPICAL WALL MODIFICATION
BOUNDARY CONDITIONS

ATTACHMENT H
TYPICAL WALL MODIFICATION
SPAN REDUCTION

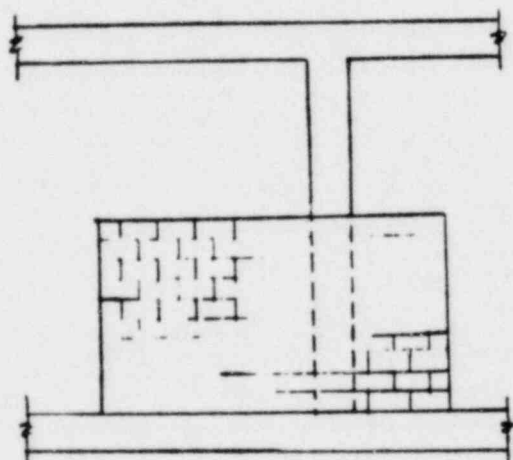
ATTACHMENT A
MASONRY WALL BOUNDARY CONDITIONS

ATTACHMENT NO. 4.2-1TYPES OF MASONRY WALLS

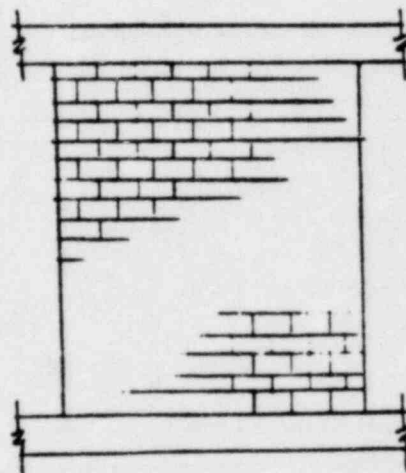
I.) Fully bounded by reinforced concrete columns, slabs, etc.



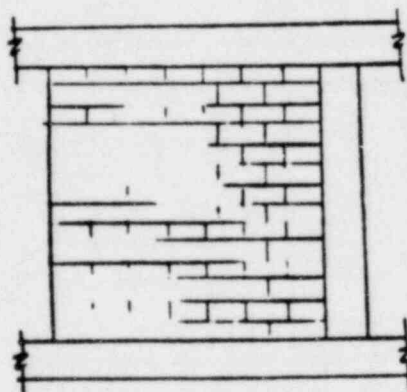
II.) Bounded on three sides by reinforced concrete columns, slabs, etc.



III.) semi-free standing supported by existing reinf. conc. walls & slabs, etc.



IV.) fully bounded by slabs

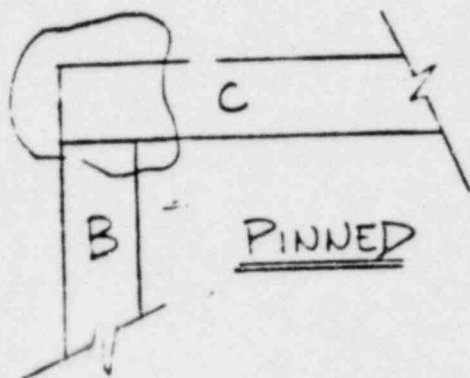
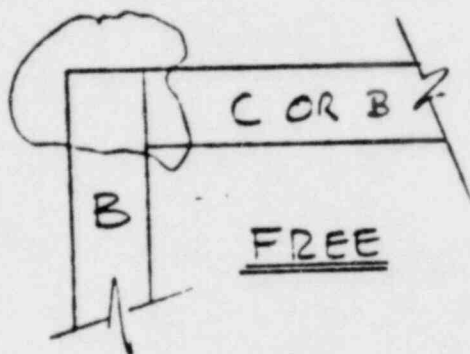
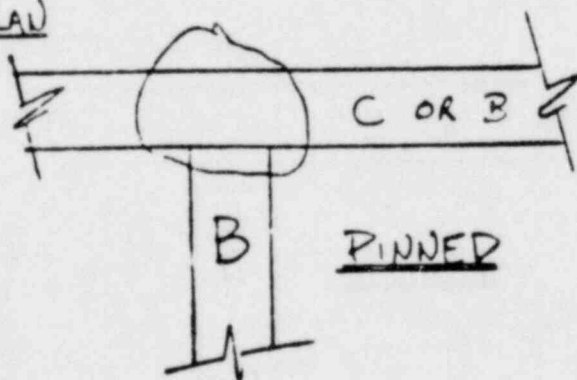


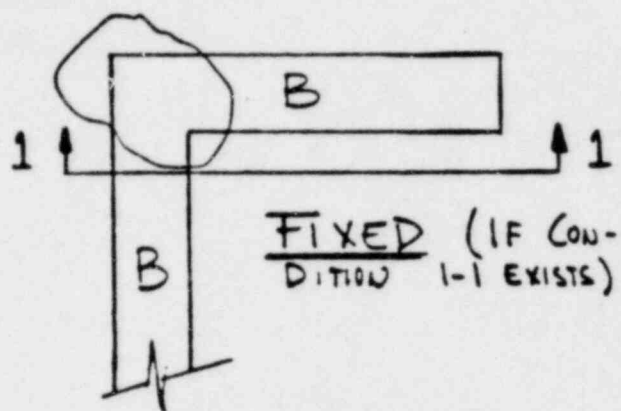
V.) Bounded on three sides by existing reinf. conc. walls, slabs, etc.

ATTACHMENT NO. 4.2-2CONNECTION TYPES

C = CONCRETE WALL

B = BLOCK WALL

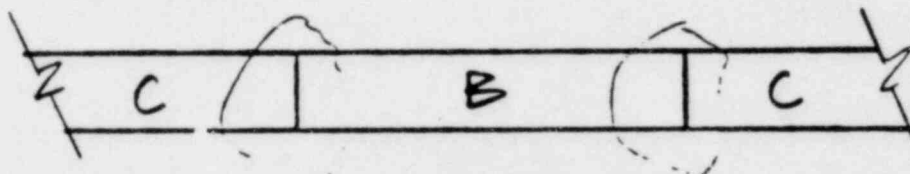
PLANCASE 1PLANCASE 2PLANCASE 3

ATTACHMENT 4.2-3PLAN

FIXED (IF CON-
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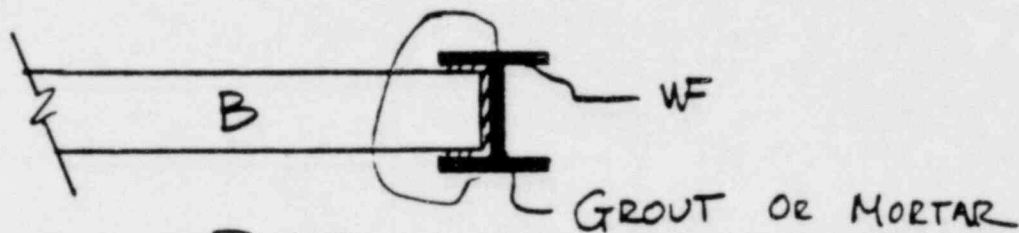


CASE #4

PLAN

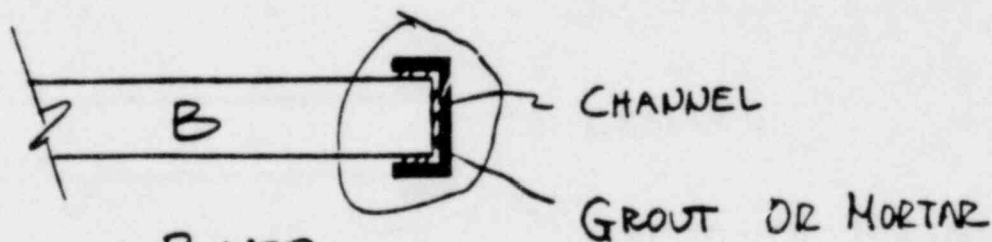
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CASE #5

PLAN

PINNED

CASE #6

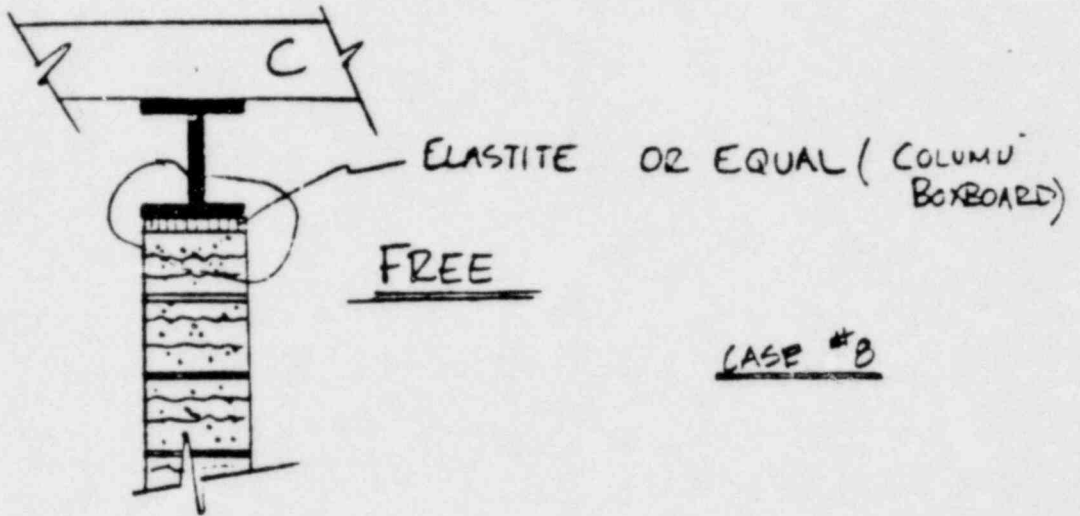
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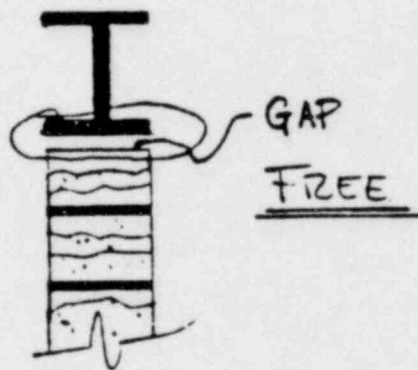
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ATTACHMENT 4.2-4

ELEV



ELEV



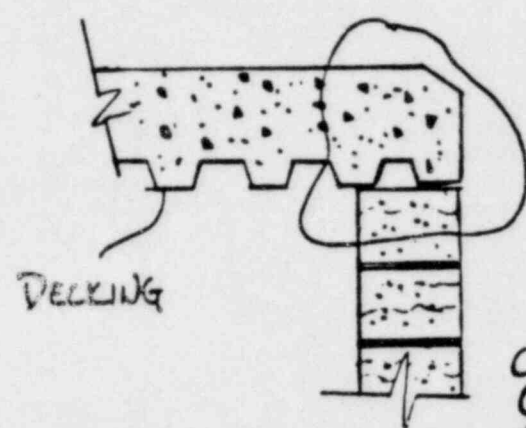
CASE #9

CASE #10

(VOID)

ATTACHMENT 4.2-5

ELEV

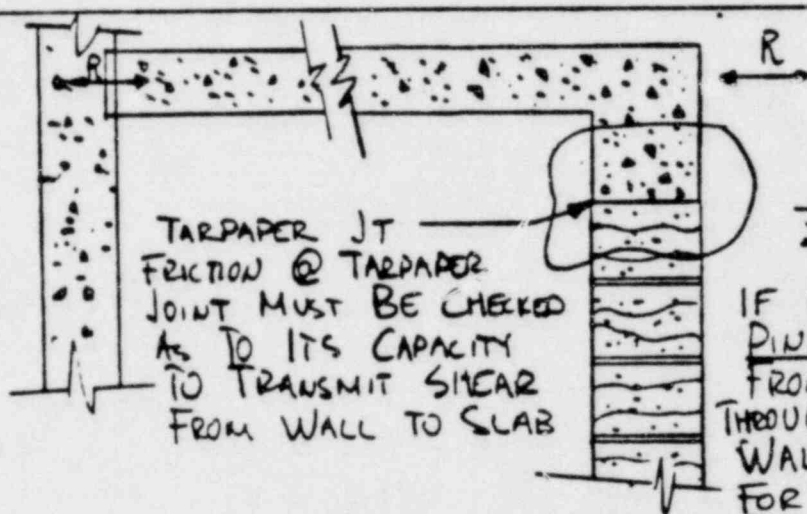


CASE #11

FREE

CONSIDER PINNED FOR SAME CONDITIONS AS STATED IN CASE #12.

ELEV

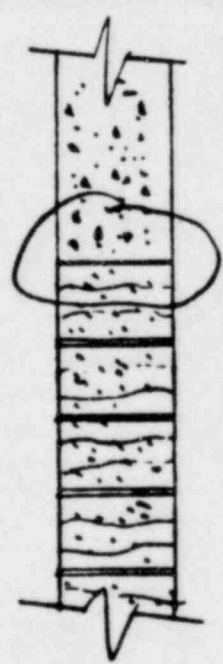


CASE #12

FREE

IF LOAD BEARING WALL - CONSIDER PINNED & HORIZONTAL REACTION FROM WALL IS TO BE TRANSFERRED THROUGH SLAB. THE OTHER WALL SHOULD BE CHECKED FOR ITS CAPACITY TO SUPPORT THIS REACTION.

ELEV

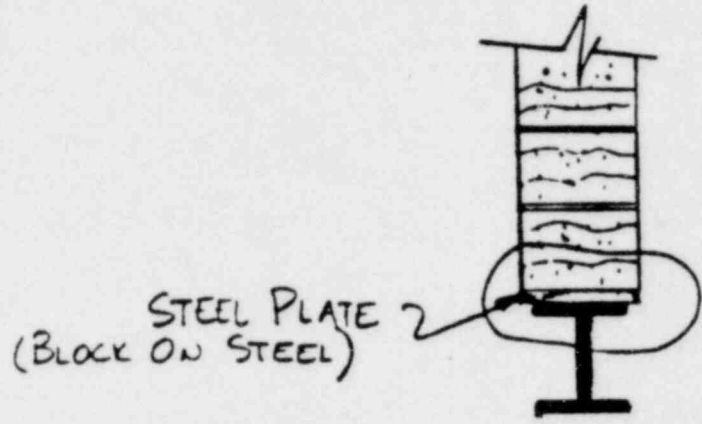


CASE #13

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ATTACHMENT 4.2-6

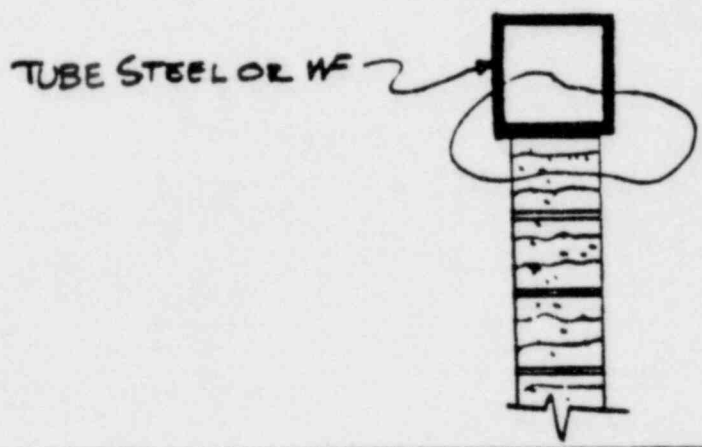
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CASE # 14

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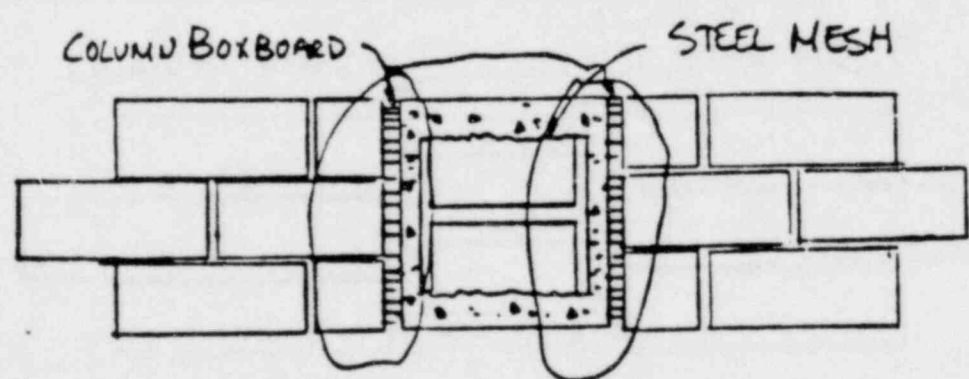
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CASE # 15

FREE

PLAN

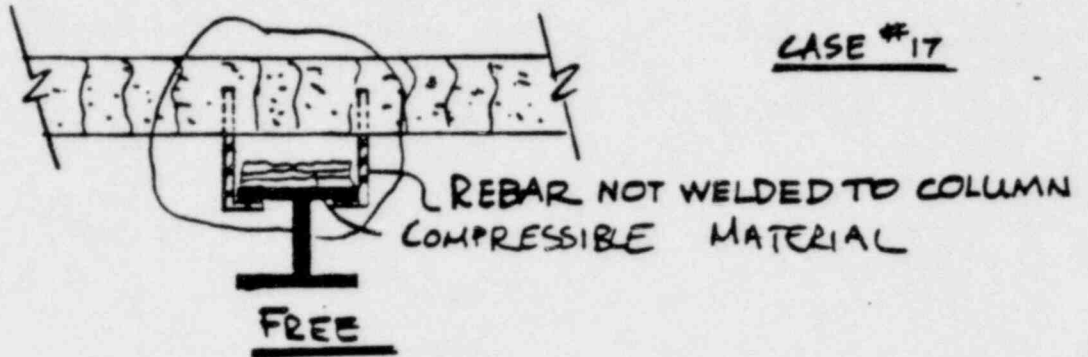


FREE

CASE # 16

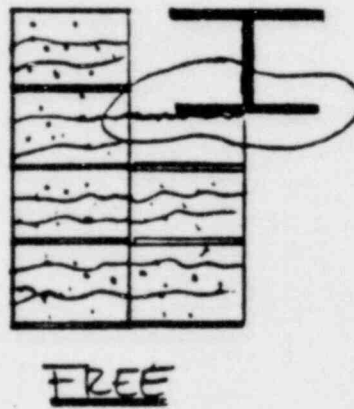
ATTACHMENT 4.2-7

PLAN



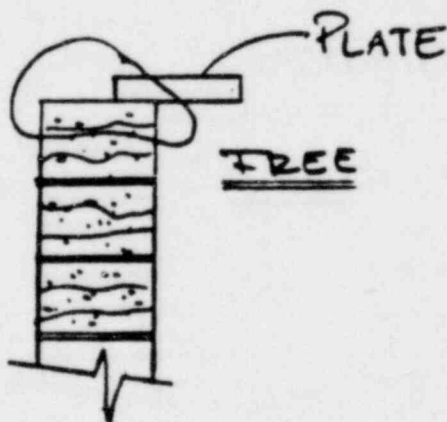
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ELEV

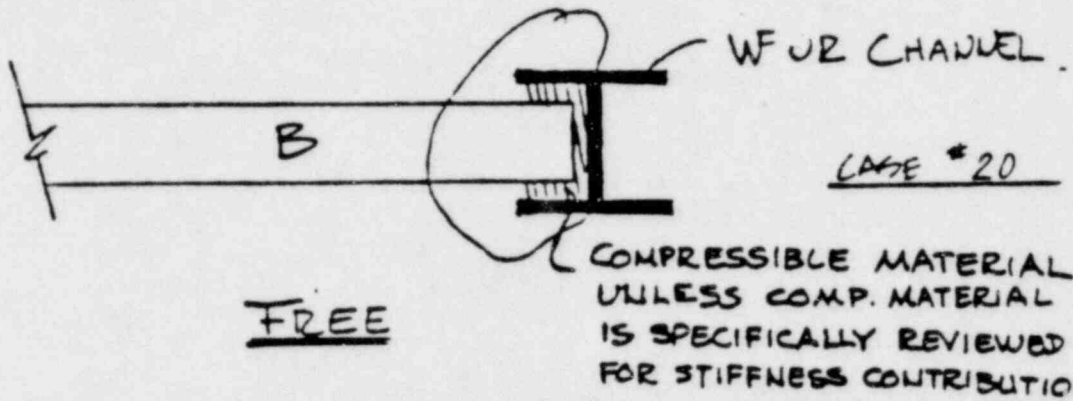
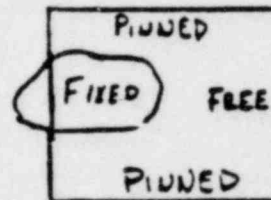
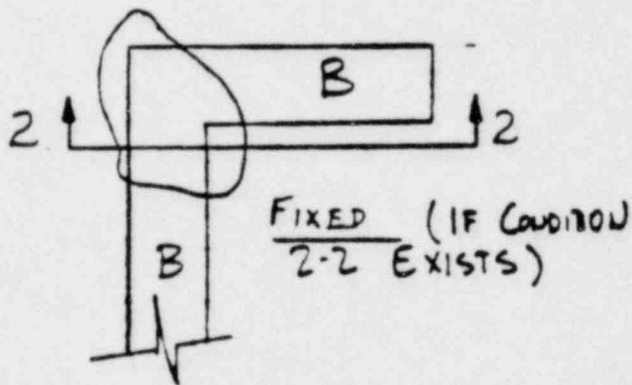


CASE #18

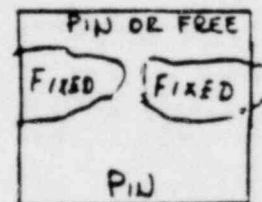
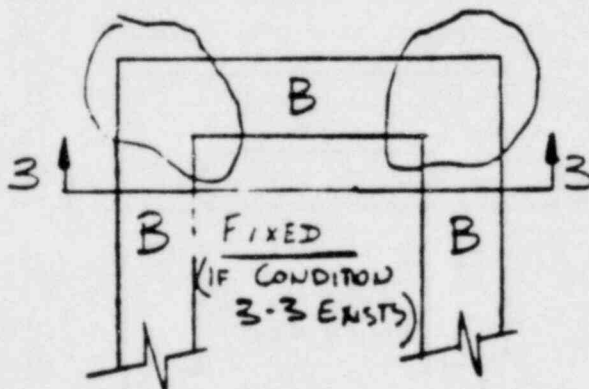
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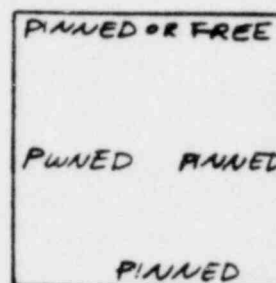
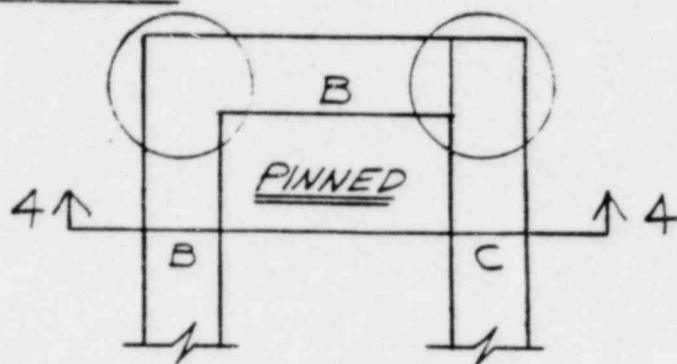
CASE #19

ATTACHMENT 4.2-8PLANPLAN

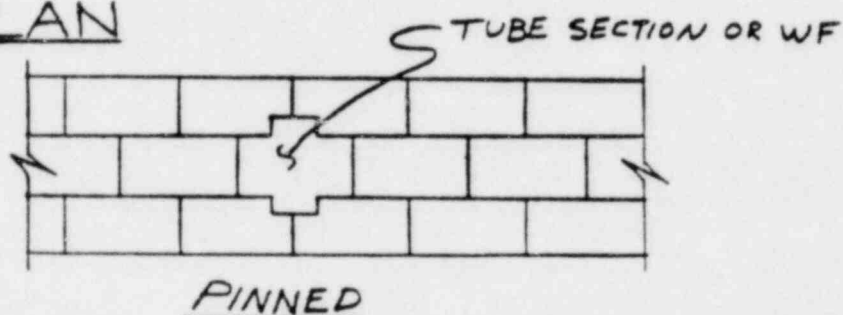
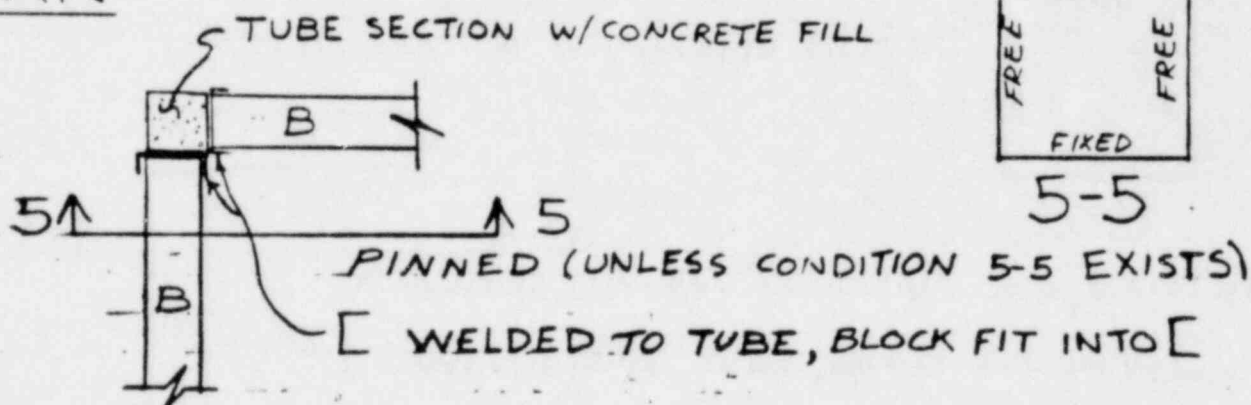
2-2

PLAN

3-3

ATTACHMENT 4.2-9PLAN

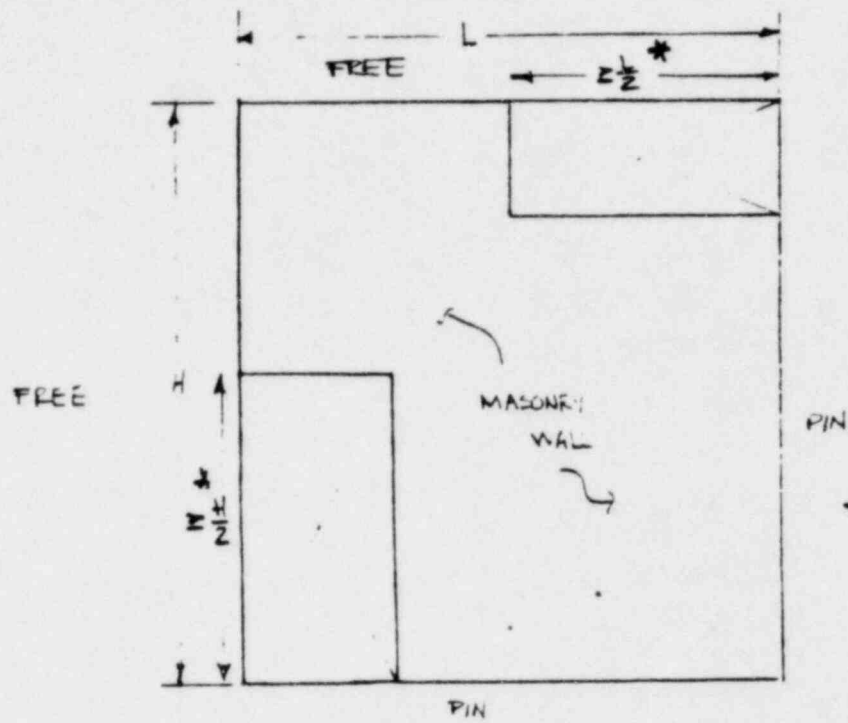
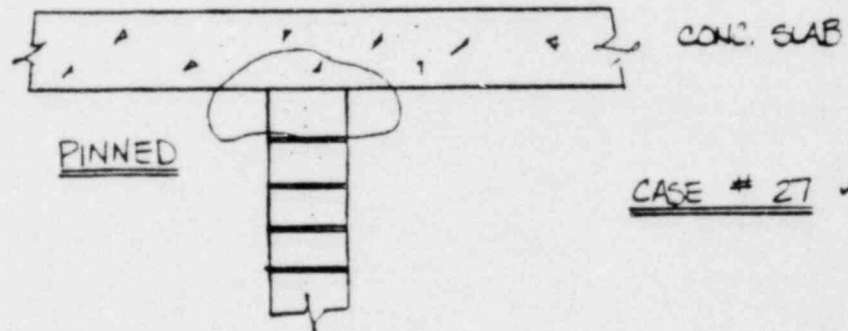
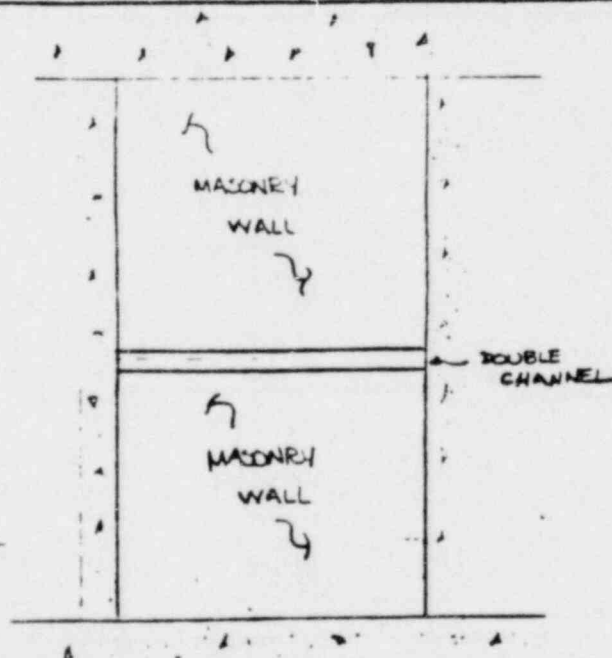
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CASE #23PLANCASE #24PLAN

5-5

CASE #25

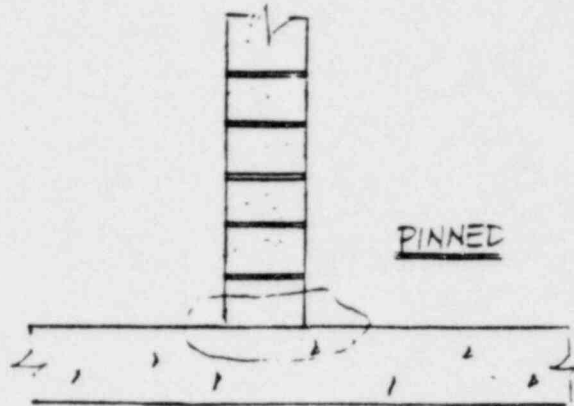
ATTACHMENT 4.2-10

ELEVCASE # 26 ✓* IF $\leq L/2$ THEN
PINNED EDGEELEVCASE # 27 ✓ELEVCASE # 28 ✓

PINNED

ATTACHMENT 4.2-11

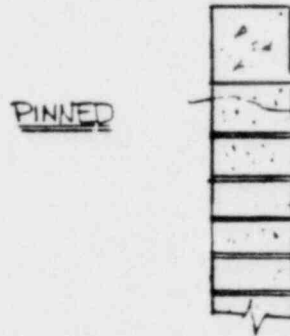
ELEV



CASE #29 ✓

PINNED

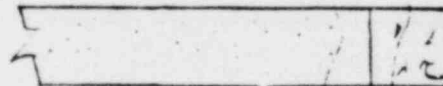
ELEV



PINNED

CONC BEAM (MAY HAVE WF IMBEDDED)
 (→ " " WF FIRE PROTECTED)
CASE #30 ✓

PLAN

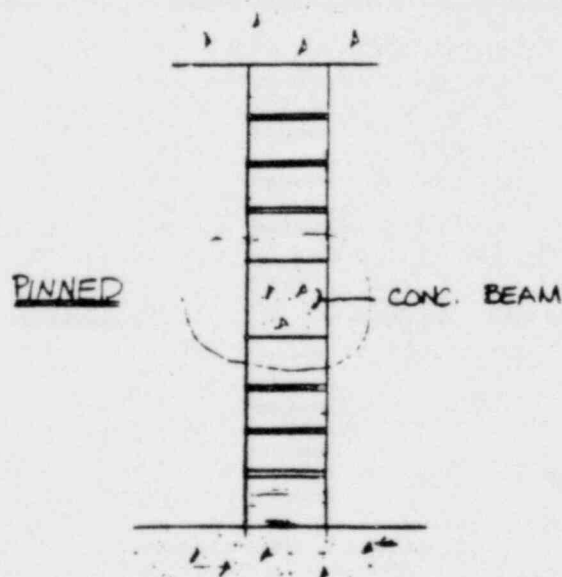


PINNED

CONC. COL.
 (SIZE MAY VARY)
 (MAY HAVE WF IMBEDDED)
 (WF FIRE PROTECTED)

CASE #31 ✓

ELEV



PINNED

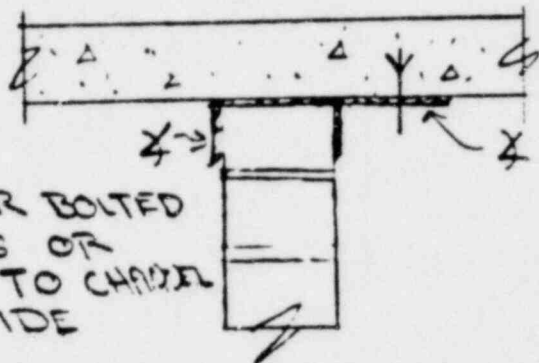
CONC. BEAM

CASE #32 ✓

MAY HAVE WF FIRE PROTECTED

ATTACHMENT 4.2-12

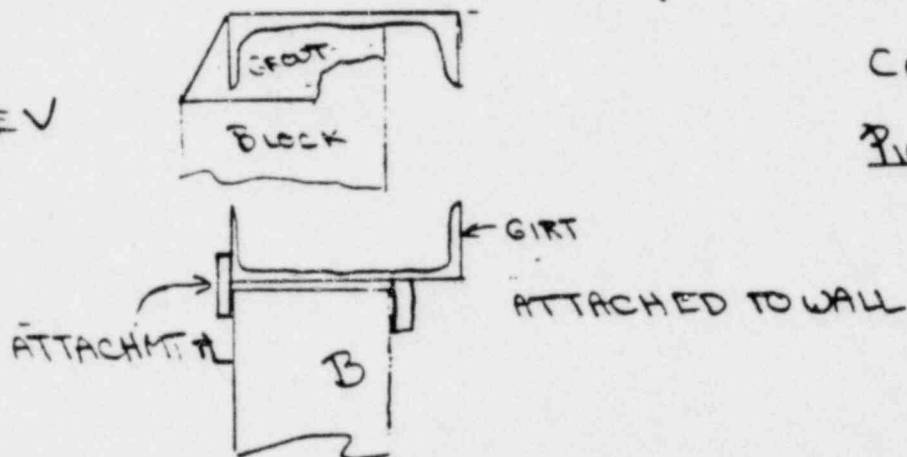
ELEV



X IS EITHER BOLTED
TO CEILING OR
WELDED TO CHANSEL
OTHER SIDE

CASE # 33 ✓
PINNED

ELEV



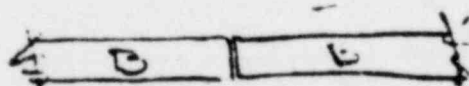
CASE # 34 ✓
PINNED

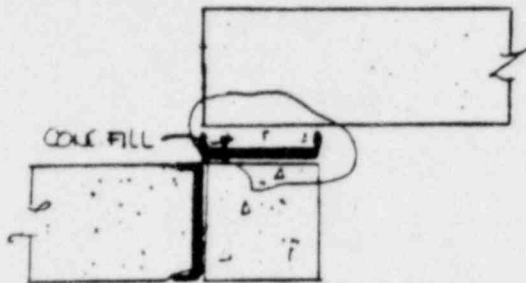
BUT WALL CONTINUES PAST POINT WE NEED CASE # 35 ✓
TO ANALYZE SO TAKE FREE AB-27-6-6N ONLY
FREE

EXPANSION JOINT

CASE # 36
FREE

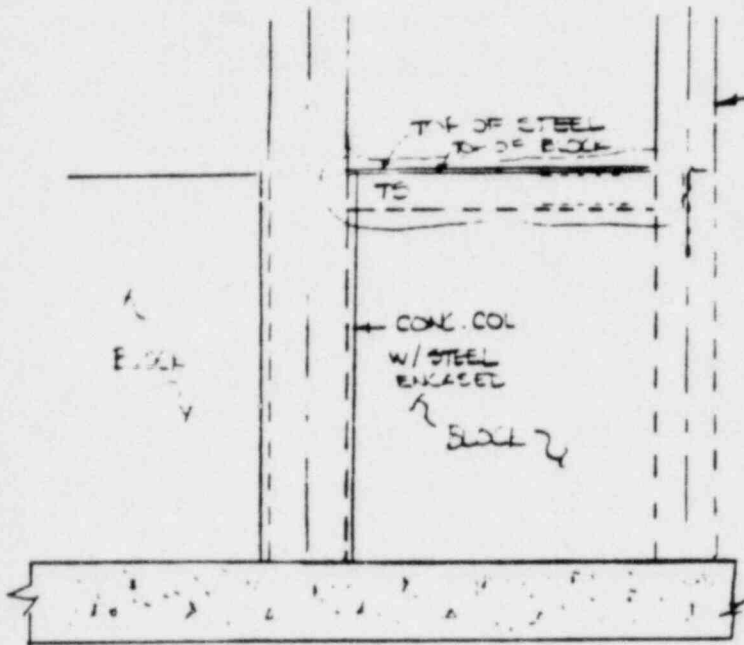
CASE # 37
FREE





CASE #38

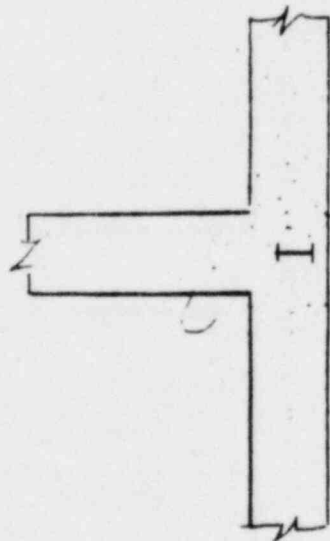
FREE



CASE #39

PINNED

(TUBE STEEL EMBEDDED AT TOP OF WALL)



CASE #40

PINNED

ATTACHMENT B
POTENTIAL FOR BLOCK PULL OUT
SAMPLE CALCULATION

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.
12846.60 STR-6

REVISION
0

PAGE
14 81/18

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David A. McCormick 4-1-81

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PW Ciriello 4-6-81

INDEPENDENT REVIEWER/DATE

PW Ciriello 4-6-81

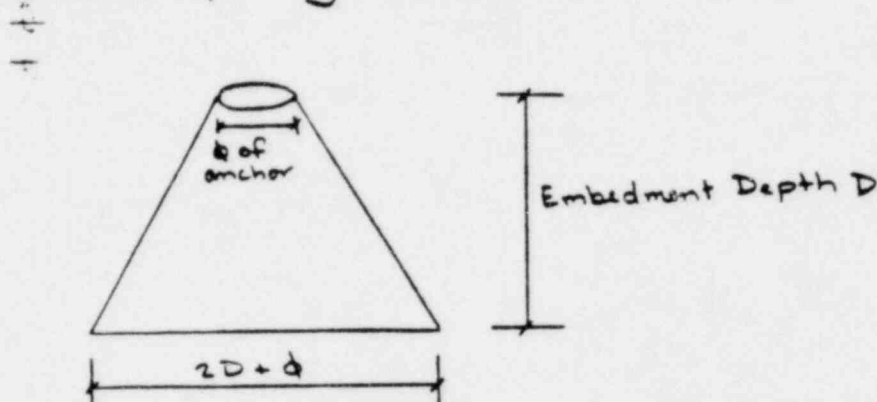
SUBJECT/TITLE

Development of Local Block Loading Criteria

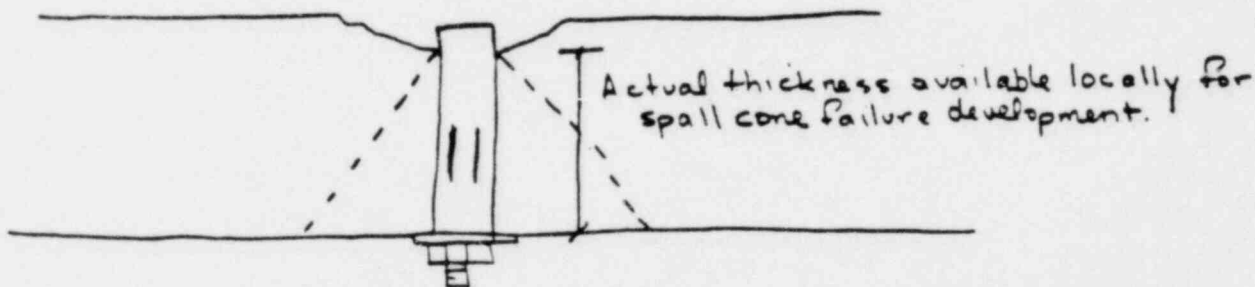
QA CATEGORY/CODE CLASS

QA12

Consider Spalling Failures



By figure, spalling would vary as D^2 . However, test results do consider spalling caused by initial drilling which diminishes the thickness of the block locally where a spall cone would form.



Since development of spalling loads considered values where drilling had decreased the actual thickness to as low as 1.05" (where the lowest value of spall failure was found) on the Hilti 5/16" ϕ Sleeve Anchor, a linear decrease in strength values is considered to conservatively account for changes in thickness of the block and actual effective embedment depths approaching 1.0".

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B2

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AW Ciello 4-6-81

SUBJECT/TITLE

Development of Local Block Loading Criteria

QA CATEGORY / CODE CLASS

QA 12

Allowable Loads on Concrete Block For Local Shell Loading - Hollow Block

Purpose: To develop allowable loads for use in local shell analysis of the block. These loads are to be used in the Block Wall Review as part of the work covered under the scope of IE 80-11. These loads are allowable loads on the block face itself, based on failure of the block (spalling or cracking of the face shell) and do not consider failure of the particular anchor or toggle bolt assembly. Excessive anchorage slip is considered to be a failure of the anchor itself.

Consider Allowable Tension Load on Face Shell - C-90 Block

Envelop Ultimate Tensile Load = $950^{\#} = P_u$ for C-90 block with minimum face shell thk = $1\frac{1}{4}"$ (8" hollow block)
(From p 12)

Consider a safety factor of 2.75 for tension failure of the block. This high factor will be used to cover limited test data, and differences which may develop between different types of anchors in tension.

Note that $350^{\#}$ is well below average pullout value of $791^{\#}$ for Hilti $3/16"$ ϕ sleeve anchors, which had embedment depth $\geq 1.0"$ or less. Also note discussion of spalling on page 14.

Allowable Tension Load on C-90 Block = $950/2.75 = 345^{\#}$ say $350^{\#}$

Use $350^{\#}$ For DBE
 $200^{\#}$ For OBE = $350/1.25$

Δ See following page 15 a which summarizes tests of $3/8"$ ϕ and $1/2"$ ϕ Hilti sleeve anchors @ Sunny

Consider Allowable Shear Load on Face Shell C-90 Block

Envelop Ultimate Shear Load = $2617^{\#} = S_u$ for C-90 block with minimum face shell thk = $1\frac{1}{4}"$ (8" hollow block)
(p 13)

Use factor of safety = 2.0 (noting that failure mode for small anchors is shear of bolt)

Allowable Shear Load = $2617/2 = 1308.5^{\#}$ say $1300^{\#}$

Use $1300^{\#}$ For DBE
 $1040^{\#}$ For OBE = $1300/1.25$

Allowable Tension Load on C-129 Block

Consider minimum 4" hollow block with minimum face shell thickness = $1.0"$

Assume tension strength between C-90 & C-129 to be a function of:

- 1) Thickness Effect - ratio of Section Modulus = $(1.0)^2/(1.25)^2 = 0.64$
 - 2) Assume strength varies as ratio of $\sqrt{f'_c}$ = $(600/2000)^{1/2} = 0.55$
- Total = $0.64 \times 0.55 = 0.35$

Allow. Tension Load = $350(0.35) = 122.5^{\#}$ say $125^{\#}$

Use $125^{\#}$ For DBE
 $100^{\#}$ For OBE = $125/1.25$

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15a

ASD1061

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David D. McCormick 10-5-81

REVIEWER/CHECKER/DATE

BN Michie 10/15/81

INDEPENDENT REVIEWER/DATE

BN Michie 10/15/81

SUBJECT/TITLE

Development of Local Block Loading Criteria

QA CATEGORY/ CODE CLASS

QA I

An On-Site Testing Program was performed @ Surry Power Station on May 8, 13, 15 & 20, 1981. This testing program included both tension and torque testing of the $3/8"$ ϕ and $1/2"$ ϕ Hilti Sleeve Anchors.

A short summary of the results as pertaining to the 'Development of Local Block Loading Criteria' are given below:

All $3/8"$ ϕ Hilti Sleeve Anchors failed as a result of excessive slippage of the anchorage system and eventual anchor pullout. Failure loads for the $3/8"$ ϕ Hilti Sleeve Anchor were well above the 350 LBS allowable load for C-90 block.

Several $1/2"$ ϕ Hilti Sleeve Anchors had a spall cone failure mechanism. The smallest load which involved a spall cone failure was 1871.1 LBS, well above the 350 LBS allowable load for C-90 block.

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SUBJECT/TITLE Development of Local Block Loading Criteria		QA CATEGORY/CODE CLASS QA I		

Allowable Shear Load on C-129 block

Consider minimum 4" hollow block with minimum face shell thickness = 1.0"
 Assume same reduction as for tension load since failure criteria used to develop shear load for C-90 block was a result of block cracking.
 Allow. Shear Load = $1300^* (0.35) = 455^*$

Use	455*	DBE
	365*	OBE = 455/1.25

Use Interaction Equation for Block:

$$(T/T_A)^{5/3} + (S/S_A)^{5/3} \leq 1.0 \quad \text{where: } T = \text{actual Tension Load}$$

$T_A = \text{allow. " "}$
 $S = \text{actual Shear Load}$
 $S_A = \text{allow. Shear Load}$

Note:

- a) Maximum Load for 1/4" Toggle = $600^* < 950^*$ block value
 1/4" Toggle Bolts need not be considered under IE 80-11.

Flow charts for IE 80-11 Local Block Loading criteria are developed in Attachment I-III. Length of flow chart is due to the desire to check only tension loads on block.

Equipment dead loads / # of bolts maximum was developed as follows:
 that effects the block wall reevaluation

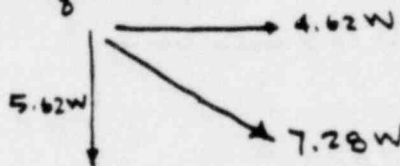
Maximum acceleration without checking interaction equation = 4.62g

Assume that in-plane accelerations in horizontal and vertical directions constitute the worst condition and that both accelerations = 4.62g.
 This is very conservative and can be over ruled in flow chart by going to shear-tension interaction equation:

$$P_v = (1 + 4.62) W = 5.62 W$$

$$P_h = 4.62 W$$

W = Equipment wt per bolt



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17 **B5**

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Development of Local Block Loading Criteria

QA CATEGORY/CODE CLASS

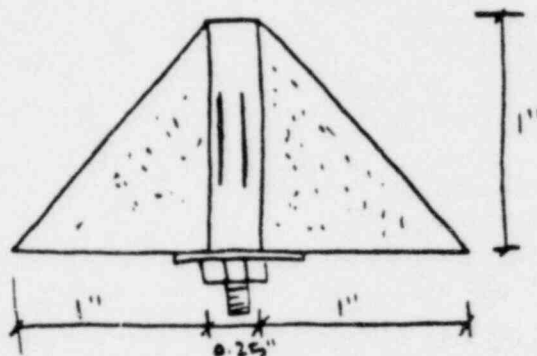
QA I

Cone Pullout For C-145 Solid Block $f'_c = 1800 \text{ psi}$

Consider the worst condition to be a $1/4"$ anchor - w/ $\#10$ machine bolt.

Assume minimum embedment = length of expanded portion of anchor = $1.0"$ = effective embedment depth.

Assume the anchor to be some type of expansion anchor.



Assume cone to start at out side face of anchor where bearing develops against block from expansion of anchor.

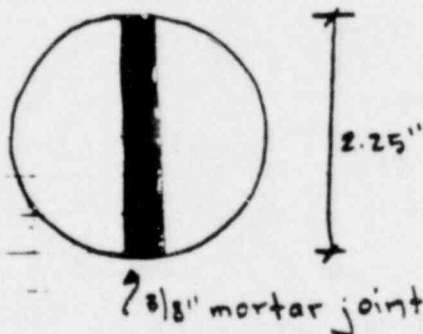
The pullout strength of concrete block is a function of tensile strength of block.

$$\text{Ult. Pullout} = (\text{Projected Tensile Area}) (4.0) \sqrt{f'_c}$$

$$\text{Proj. Tensile Area} = (2.25)^2 \pi / 4 - (0.25)^2 \pi / 4 = 3.93 \text{ in}^2$$

$$\text{Ultimate Pullout} = 3.93 (4.0) \sqrt{1800} = 666.9 \text{ lb} = P_u$$

Consider effect of mortar being in spall cone area:
Worst Case:



$2 \frac{3}{8}"$ mortar joint

Proj. area of mortar / proj. total area

$$0.375 (2.25) / (2.25)^2 \pi / 4 = 0.21 \text{ say } 0.20$$

Reduce P_u by 20% to account for possibility that mortar may lie in spall cone region.

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P. C. Ciriello 4-6-81

SUBJECT/TITLE

Development of Local Block Loading Criteria

QA CATEGORY/CODE CLASS

QA I

$$P_u = 0.80(666.9^*) = 533.5^*$$

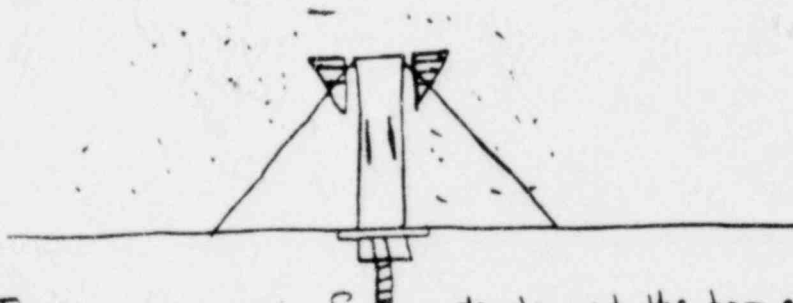
Take Factor of safety = 2.0

$$P_w = 533.5 / 2 = 266.8^* \text{ say } 270^*$$

$$P_w = 270^*$$

Use $270 / 1.25 = 216^*$ For OBE Condition

Note: Tests on hollow block indicate that this value is low. However, test data which specifically addresses solid block is not available in sufficient quantity to use to develop allowable loads. For 3/16" Ø tilt anchors which were embedded only 1" maximum in the face shell of a hollow block, the average ultimate load = 791[#] when anchor is properly set. This load was due to pullout of the anchor and did not fail the block due to a spall cone failure. This indicates that the above load is probably conservative. One thing that the above analysis does not consider is the compressive bearing stresses which develop in the concrete block when the anchor expands against the side of the drilled hole:



These compressive forces develop at the top of the anchor, where in normal steel embedments in concrete, the maximum principle tension stresses develop, which begin the crack propagation for the spall cone failure. These compressive forces, depending on their magnitude (which is a function of anchor type and torque), would act to increase the pullout loads above those indicated in the analysis above.

Allowable Shear Load

Use same load developed for hollow block = 1300[#] For DBE
= 1040[#] For OBE

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INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE

QA CATEGORY/CODE CLASS

Development of Local Block Loading Criteria

QA/I

Consider Cone Pullout with $\frac{3}{8}" \phi$ Bolt } $\frac{3}{8}" \phi$ WEDGE Anchor
 $\frac{1}{2}" \phi$ SLEEVE Anchor

Assume conservatively a $\frac{1}{4}"$ minimum embedment depth:

$$\text{Projected Tensile Area} = [1.25(2) + 0.375]^2 \pi/4 - (0.375)^2 \pi/4 = 6.38 \text{ in}^2$$

$$U1 \text{ Fill} = 6.38(4.0) \sqrt{1800} = 1082.7 \text{ N}$$

If a 20% reduction is again taken for the possibility that the spall cone zone may encompass the mortar joint:

$$P_u = 0.80(1082.7) = 866.2 \text{ N}$$

$$P_{wDBE} = 866.2/2 = 433.0 \text{ N}$$

$$P_{wDBE} = 433.0/1.25 = 346.0 \text{ N}$$

Local Analysis - Block Loading Criteria - C-90 Hollow Block (Minimum 8" thick block)

DBE Condition (For OBE Condition divide all values by 1.25)

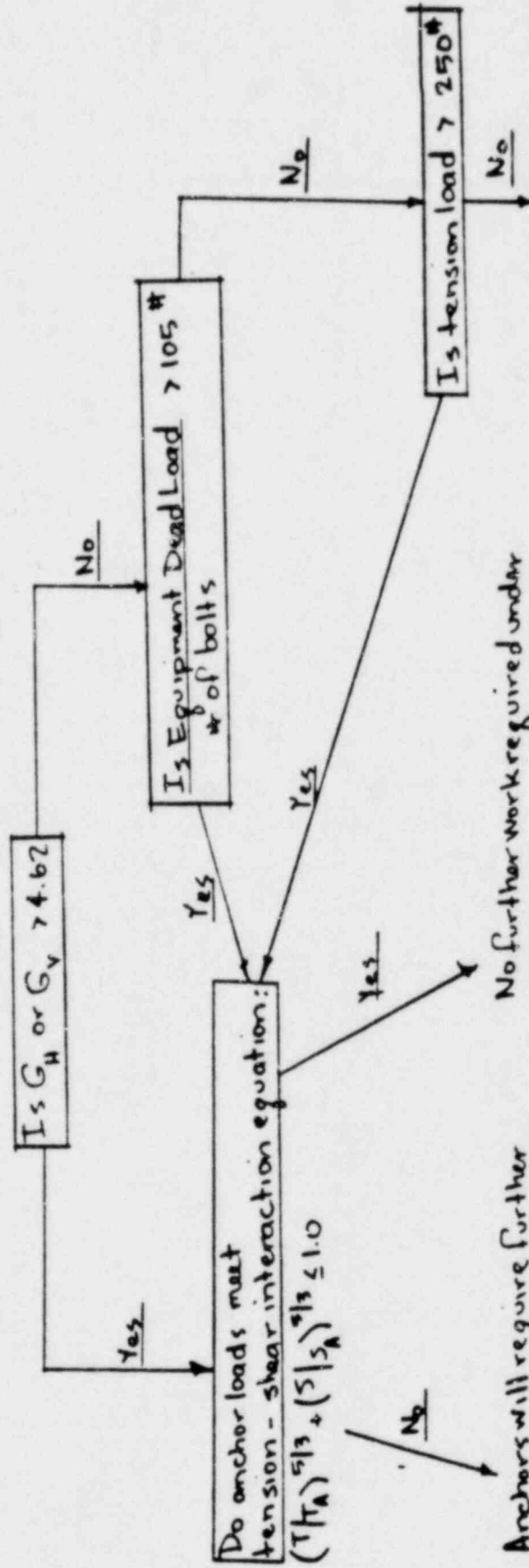
Allow. Tension Load = $35n^{\#} = T_A$

Allow. Shear Load = $1300n^{\#} = S_A$

Tension & Shear Interaction = $(T/T_A)^{5/3} + (S/S_A)^{5/3} \leq 1.0$

Allowable Tension Load Not Considering Tension-Shear Interaction = 250[#]
(Based on maximum shear per bolt = 780[#])

Flow Diagram (Valid only for 8" thick or above C90 block)



No further work required under IE 80-II.
Individual anchors may have to be evaluated as to their capacity

Anchors will require further investigation under IE 80-II.

No further work required under IE 80-II.
Individual anchors may have to be evaluated as to their capacity.

Local Analysis - Block Loading Criteria C-145 Solid Block

Allow. Tension Load = $270^{\#} = T_A$

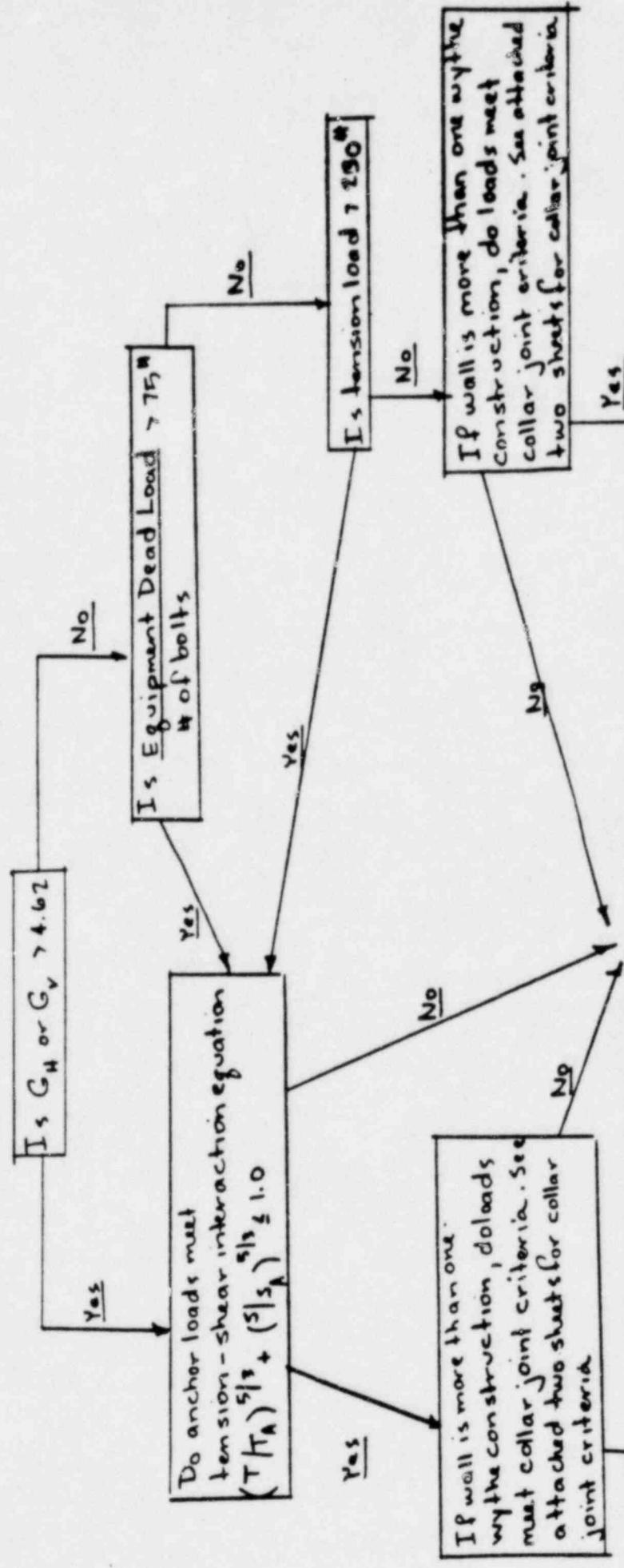
Allow. Shear Load = $1300^{\#} = S_A$

Tension & Shear Interaction

$$(T/T_A)^{5/3} + (S/S_A)^{5/3} \leq 1.0$$

Allowable Tension Load Not Considering Tension-Shear Interaction = $230^{\#}$
(Based on maximum shear per bolt = $545^{\#}$)

Flow Diagram (Valid only for C-145 Solid Block)



Anchors will require further investigation under IE 80-11.

No further work required under IE 80-11. Individual anchors may have to be evaluated as to their capacity.

No further work required under IE 80-11. Individual anchors may have to be evaluated as to their capacity.

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J.O./W.O./CALCULATION NO. 12846.60 STR-6	REVISION 0	PAGE Att (v) of 4
PREPARED / DATE David J. M. Connick	REVIEWER / CHECKER / DATE P. L. Linnello / 4-6-81	INDEPENDENT REVIEWER / DATE P. L. Linnello / 4-6-81
SUBJECT / TITLE Attachment IV		QA CATEGORY / CODE CLASS QA1

ATTACHMENT IV
Collar Joint Criteria

IV. Collar Joint Tension

1.50

Single anchor allowable load in double width solid concrete masonry block wall are as follows: 1.52

(Based on limiting collar joint tension to 8 psi for OBE and 12 psi for DBE) 1.53

For effects of adjacent anchors on collar joint stress, see following sheet. 1.54

ANCHOR SIZE (W) Ø	EMBEDMENT DEPTH AFTER INSTALLATION (IN)	TENSION LOAD (LBS)					
		* 6x8x16		* 8x8x16		* 12x8x16	
		OBE	DBE	OBE	DBE	OBE	DBE
1/4	1 - 1/8	390	584	613	919	1210	1814
3/8	1 - 1/2	467	701	710	1064	1344	2016
1/2	2 - 1/2	481	722	1002	1502	1737	2605
5/8	3	428	641	943	1414	1952	2928
3/4	3 - 1/2	378	566	867	1301	2176	3269
7/8	4	330	495	795	1193	2328	3492

* Standard Block Dimensions Used

▲ For standard manufacturer's shell-type anchors, above embedments are conservative for collar joint stress. For wedge or sleeve type anchors, embedments may vary on unconservative side.

V. Collar Joint Tension Stress - Adjacent Anchors

1.59

Use elastic half-space solution for point loads; determine 2.2
 pressure distribution at joint for each anchor and then find 2.3
 maximum combined stress at a point.

$$\sigma = \frac{T}{\pi Z^2 [1 + (R/Z)^2]^{3/2}} \quad (\text{WESTERGAARD})$$

σ - STRESS AT 'R & Z'

Z DIST. FROM 1/2 EMBED TO COLLAR JT.

R RADIAL DIST. FROM C OF ANCHOR

T TENSILE LOAD ON ANCHOR

MAX ALLOWABLE $\sigma_{DBE} = 12 \text{ PSI}$

MAX ALLOWABLE $\sigma_{OBE} = 8 \text{ PSI}$

6

EX.

2.12

2 - 3/4" ϕ Anchors 6" Block 7 - 1/2" Spacing Min Embed 2.14
 Depth = 3 - 1/2" $\therefore Z = 5.625 - 3.5/2 = 3.88$

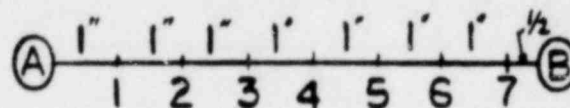
$$\sigma_{DBE} = 12 \text{ psi}$$

Find maximum allowable tension which can be applied to both 2.15
 anchors simultaneously without over-stressing collar joint. 2.16

For calculation purposes, consider limiting allowable from 2.17
 anchor slippage as acting on each anchor and calculate

induced collar joint tension: 2.18

R	0	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
σ	18.86	15.64	12.74	9.95	7.62	5.8	4.43	3.41	2.66	2.1	1.67	1.36	1.11	.92	.77



STRESS LOC'N	STRESS (PSI)	Σ STRESS (PSI)	STRESS LOC'N	STRESS (PSI)	Σ STRESS (PSI)
A	18.86 + 0.77	19.63	5	2.1 + 7.62	9.72
1	15.64 + 1.11	16.75	6	1.36 + 12.74	14.10
2	9.95 + 1.67	11.62	7	0.92 + 17.96	18.88
3	5.8 + 2.66	8.46	B	0.77 18.86	19.63
4	3.41 + 4.43	7.84			

Since calculated tension exceeds allowable (= 12 psi for DBE case), factor down
 anchor tensions to a level which will
 produce a 12 psi joint tension

$$\therefore T = \frac{12}{19.63} \times 892 = 545 \text{ lbs}$$

INTEROFFICE CORRESPONDENCE

Attachment V

1085

B14

TO: J. Albrecht/B Khalifa

LOCATION
13

SUBJECT / REFERENCE / J.O. NO. 12846-00

FROM: D. McCormick

LOCATION
13

Black Pullout

MESSAGE

The question was raised by Mr B Khalifa whether or not ~~black~~ pullout needed to be considered in further local black criteria calculations. The black pullout values are considerably higher than other local criteria (shell face pullout, cone pullout etc) and will not be critical. Therefore, black pullout does not have to be considered in further calculations. This IOC and the back-up tables will be included as part of the engineering calculations 12846 cc STR-6.

c.c. B Mahvire

4-22-81
DATE

D. McCormick
SIGNATURE

0494

TELEPHONE

REPLY

DATE

SIGNATURE

TELEPHONE

CALCULATION SHEET

J.C./W.B./CALCULATION NO

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PREPARED/DATE

CREW M CARON

3/5/81

PORT (Hollow) 3/9/81

DEPENDENT REVIEWER/DATE

Port's Friedman 3/9

SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/EDGE CLASS

I / NLSR

NORTH ANNA

Page 2 of 5

BLOCK PULLOUT (HOLLOW BLOCK C90)

BLOCKSIZE	ALLOWABLE TENSION FORCE (LBS)	
	OBE [†]	DBE [†]
4x8x16	2331	2913
6x8x16	1664	2080
8x8x16	2079	2598
12x8x16	2495	3118
18x8x16	2911	3638

BLOCK PULLOUT* (SOLID BLOCK C90)

BLOCKSIZE	ALLOWABLE TENSION FORCE (LBS)	
	OBE [†]	DBE [†]
6x8x16	4676	5845
8x8x16	6340	7925
12x8x16	9669	12087
18x8x16	14657	18322

* BLOCK PULLOUT ARE BASED ON TYPE S MORTAR

† THE ALLOWABLE TENSION FORCE HAS BEEN INCREASED BY 33% FOR OBE AND 67% FOR

PREPARED BY / DATE

CREW M. CARON 3/4/81

38711 3/7/81

INDEPENDENT REVIEWER / DATE

Edna Friedman 3/1

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BLOCK WALL REVIEW

IE 80-11

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PULLOUT BASED ON PERIMETER AREA, HOLLOW BLOCKS

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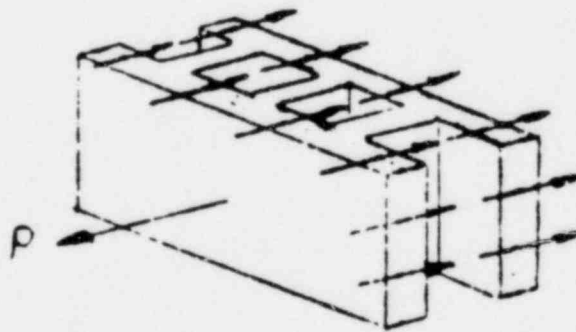
SURRY

$$P_{ALLOW} = AREA \times ALLOWABLE \text{ SHEAR}$$

$$= AREA \times 1.1 \sqrt{f'_m} = AREA \times 1.1 \sqrt{1000}$$

$$= AREA \times 34.8$$

HOLLOW	2 SHORT, 2 LONG		1 SHORT, 2 LONG		2 SHORT, 1 LONG		1 SHORT, 1 LONG		1 SHORT, 1/2	
	AREA (IN ²)	P _{ALLOW} (LBS)	AREA (IN ²)	P _{ALLOW} (LBS)	AREA (IN ²)	P _{ALLOW} (LBS)	AREA (IN ²)	P _{ALLOW} (LBS)	AREA (IN ²)	P _{ALLOW} (LBS)
4 x 8 x 16	117.78	4079	90.14	3137	86.53	3011	58.89	2049	43.27	15
6 x 8 x 16	93.00	3236	77.75	2706	61.75	2149	46.50	1618	30.88	10
8 x 8 x 16	116.24	4045	97.18	3382	77.18	2686	56.12	2023	38.59	13
12 x 8 x 16	139.52	4855	116.64	4059	92.64	3224	69.76	2423	46.32	16
18 x 8 x 16	162.76	5664	136.07	4735	108.07	3761	81.38	2832	54.04	18



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OREW M. CARON 3/5/81

DESIGNED/DATE

Loris Friedman 3/9/81

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Loris Friedman 3/9/81

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SURRY BLOCK PULLOUT (HOLLOW BLOCK C90)

Page 4 of 6

BLOCKSIZE	ALLOWABLE TENSION FORCE (LBS)	
	OBE [†]	OBE [†]
4x8x16	2008	2510
6x8x16	1433	1791
8x8x16	1731	2238
12x8x16	2143	2687
18x8x16	2508	3135

BLOCK PULLOUT* (SOLID BLOCK C90)

BLOCKSIZE	ALLOWABLE TENSION FORCE (LBS)	
	OBE [†]	OBE [†]
6x8x16	4028	5035
8x8x16	5461	6827
12x8x16	6320	10412
18x8x16	12025	15782

* BLOCK PULLOUT ARE BASED ON TYPE N MORTAR

† THE ALLOWABLE TENSION FORCE HAS BEEN INCREASED BY 33% FOR OBE AND 67% FOR

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BLOCK PULLOUT* (HOLLOW BLOCK C129)

BLOCKSIZE

ALLOWABLE
TENSION FORCE (LBS.)

OBE[†]

DBE[†]

4x8x16

1586

1983

6x8x16

1132

1415

8x8x16

1415

1769

12x8x16

1638

2123

8x8x16

1981

2475

BLOCK PULLOUT (SOLID BLOCK C129)

BLOCKSIZE

ALLOWABLE
TENSION FORCE (LBS.)

OBE[†]

DBE[†]

6x8x16

3183

3979

8x8x16

4315

5395

12x8x16

6581

8228

18x8x16

9976

12471

* BLOCK PULLOUT ARE BASED ON $f_m = 625$ PSI Note: for $f_m = 500$ psi, multiply above values by $(500/625)^{1/2} = 0.89$ OK
† THE ALLOWABLE TENSION FORCE HAS BEEN INCREASED BY 33% FOR OBE AND 67% FOR DBE.

ATTACHMENT C
CONSIDERATION OF HIGHER MODES OF VIBRATION
SAMPLE CALCULATION

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CALCULATION SUMMARY

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CLIENT/PROJECT

VERCO - North Anna

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

OBJECTIVE OF CALCULATION

To Assure Stresses in Existing Block Walls Due to Various Loading Conditions Conform to IE Bulletin 80-11 - "Masonry Wall Design."

CALCULATION METHOD/ASSUMPTIONS

SOURCES OF DATA/EQUATIONS

Ref. "ACI 531-79 Building Code Requirements for Concrete Masonry Structures."

CONCLUSIONS

See Pages 20, 21, 39

Wall Stresses Within Allowable Yes ~~Not Allowable~~

Re-Analysis Req'd. No

Modification Req'd. —

① CONCLUSION NOT CHANGED

① PREPARED: G.J. HILLMAN 2-13-81

① CHK'R: H. Braughach 2-18-81

② CONCLUSION NOT CHANGED

② PREPARED: N. ZERRINY 8/18/81

② CHK'R: G.J. HILLMAN 8-20-81

REVIEWER(S) COMMENTS

PREPARED

T.J. Lynch

DATE

9/11/80

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CHECK LIST - REQUIRED INFORMATION FOR MASONRY WALL DESIGN

Wall No. AB-244-2 Natural Frequency 160 cps

Range: Rigid YES Resonant —

G - Factors:	OBE	DBE	Relative Displ.	OBE	DBE
Horizontal	<u>.28</u>	<u>.37</u>	<u>In Plane</u>	<u>N/A</u>	<u>N/A</u>
Vertical	<u>.21</u>	<u>.30</u>	<u>Out of Plane</u>	<u>N/A</u>	<u>N/A</u>

Req'd. Items	Information Available	If Not, Remarks on Req'd Information
Type & Size of Masonry Block	Solid Normal Weight Block 12 X 8 X 16	
Dimensions of Wall	t = 12", h = 7'-4", l = 4'-6"	
Boundary Cond.	Pinned 2 sides (some fixity) Free 2 sides	
Wall Function	Shielding Wall	
Reinf. Details	N/A	
Attach. on Wall	Yes	
Unusual Loads	N/A	
Mortar Type	M or S	
No. of Wythes	one	
Type of Bond	running bond	

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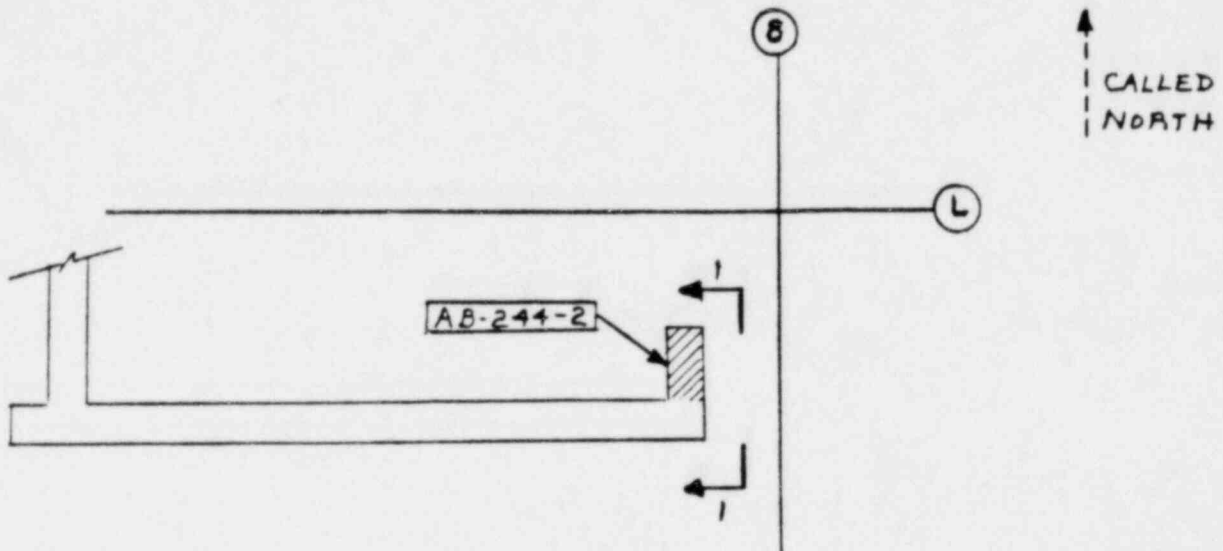
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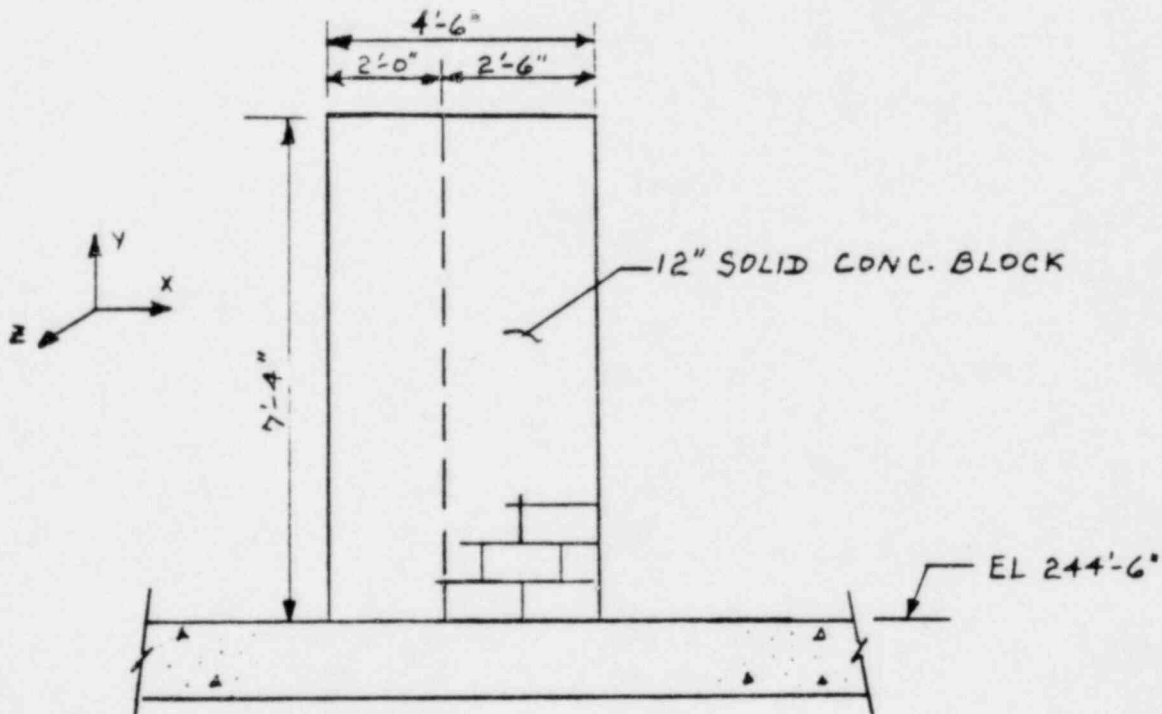
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KEY PLAN
NTS



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Purpose:

The purpose of these design calculations is to determine the stresses in AB-244-2 and AB-244-4.

Design Data:

For 12 X 8 X 16 solid block:

$$\text{Weight} = 150 \text{ lb/ft}^2$$

$$A_n = 140 \text{ in}^2/\text{ft}$$

$$A_H = 140 \text{ in}^2/\text{ft}$$

$$I_y = 1571 \text{ in}^4/\text{ft}$$

$$S_y = 270 \text{ in}^3/\text{ft}$$

$$I_x = 1571 \text{ in}^4/\text{ft}$$

$$S_x = 270 \text{ in}^3/\text{ft}$$

The block wall is considered to be pinned on 2 sides, uniform, homogeneous and free of cracks.

Consider two way action $a/b = 2.5/7.33 = .34$ say .375 for tables

The AB-244-2 analysis will apply to AB-244-4

Determine Frequency:

$$K = \frac{8EI}{l^3}$$

$$E = 1350000 \text{ psi}$$

$$I = 1571 \text{ in}^4/\text{ft}$$

$$l = (2.5 \times 12) = 30"$$

$$K = \frac{(8 \times 1350000 \times 1571)}{(30)^3} = 628400 \text{ lb/in/ft}$$

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FREQUENCY (CONT'D)

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{K_{LM} M_T}}$$

$$K = 628400 \text{ lb/in/ft}$$

$$K_{LM} = .64$$

$$M_T = \frac{wl}{g}$$

$$w = 150 \text{ lb/ft}^2$$

$$l = 2.5'$$

$$g = 386 \text{ in/sec/sec}$$

$$M_T = \frac{(150 \times 2.5)}{386} = .97$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{628400}{(.64 \times .97)}} = 160 \text{ cps} > f_c = 10 \therefore \text{Rigid}$$

$$\left. \begin{array}{l} G_H = .37 \\ G_V = .30 \end{array} \right\} \begin{array}{l} \text{DBE accelerations will be used in the} \\ \text{calculations. At the end of the calculations} \\ \text{OBE stresses will be factored from the DBE.} \end{array}$$

Determine Stresses due to a Z Seismic Acceleration:
(WALL INERTIA)

$$M_x = \beta_2 q b^2$$

$$\beta_2 = .0589$$

$$q = w G_H$$

$$q = (150)(.37) = 55.5 \text{ lb/ft}^2$$

$$b = 7.33'$$

$$M_x = (.0589)(55.5)(7.33)^2 = 175.63 \text{ ft-lb/ft}$$

$$f_{mx} = \frac{M_x}{S_x}$$

$$f_{mx} = \frac{(175.63)(12)}{270} = 8 \text{ psi}$$

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WALL INERTIA (CONT'D)

$$M_y = \beta_1 q b^2$$

$$\beta_1 = .0642$$

$$q = 55.5 \text{ lb/ft}^2$$

$$b = 7.33'$$

$$M_y = (.0642)(55.5)(7.33)^2 = 191.44 \text{ ft-lb/ft}$$

$$f_{my} = \frac{M_y}{S_y}$$

$$f_{my} = \frac{(191.44)(12)}{271} = 9 \text{ psi}$$

$$f_{vy} = \frac{2 q b}{A_n}$$

$$f_{vx} = \frac{2 q b}{A_n}$$

$$f_{vy} = \frac{(1.6709)(55.5)(7.33)}{140} = 2 \text{ psi}$$

$$f_{vx} = \frac{(1.4125)(55.5)(7.33)}{140} = 1 \text{ psi}$$

$$f_{vmax} = 2 \text{ psi}$$

Determine Dead Load Bearing Stress :

$$DL = wh$$

$$w = 150 \text{ lb/ft}^2$$

$$h = 7.25'$$

$$DL = (150)(7.25) = 1088 \text{ lb/ft}$$

$$f_{DL} = \frac{DL}{A_n}$$

$$A_n = 140 \text{ in}^2/\text{ft}$$

$$f_{DL} = \frac{1088}{140} = 8 \text{ psi at base}$$

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Determine Stresses due to a Y Seismic Acceleration:

$$f_{sv} = \frac{G_v DL}{A_n}$$

$$G_v = .30$$

$$DL = 1088 \text{ lb/ft}$$

$$A_n = 140 \text{ in}^2/\text{ft}$$

$$f_{sv} = \frac{(.30 \times 1088)}{140} = 2 \text{ psi at base}$$

Determine Stresses due to an X Seismic Acceleration:
(not required)

$$DL_H = wL$$

$$w = 150 \text{ lb/ft}^2$$

$$L = 2.5'$$

$$DL_H = (150 \times 2.5) = 375 \text{ lb/ft}$$

$$f_{sh} = \frac{G_H DL_H}{A_H}$$

$$G_H = .37$$

$$A_H = 140 \text{ in}^2/\text{ft}$$

$$f_{sh} = \frac{(.37 \times 375)}{140} = 1 \text{ psi}$$

Determine Stresses due to Interstory Displacement:

The block wall will not receive any additional loads from interstory displacement.

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BLOCK WALL REVIEW

BULLETIN IE 80-11

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WALL NO. AB-244-2, ELEV. 244' 6", CLASS II
 ECCENTRICITY, +Z EAST DIRECTION, (MEASURED FROM ~~FACE~~ FACE OF WALL)

EQUIPMENT DESCRIPTION	EQUIPMENT SUPPORT CONDITION	FASTENER DESCRIPTION	P _{ey} (LBS.)	±Z (IN.)	M _x (IN-LB.)	COMMENT
JUNCTION BOX	BOLTED TO WALL	(4) 3/8" BOLTS	22.0	3"	66.0	
GALV. STEEL	BOLTED TO WALL		22.0	2.625	57.75	
2" CONDUIT	UNISTRUT		49.1	2.35	121.50	INCLUDES 10% INCREASE TABLE AS 10% OF CONDUIT WT
UNISTRUT			1.7			
			98.0		245.25	Σ

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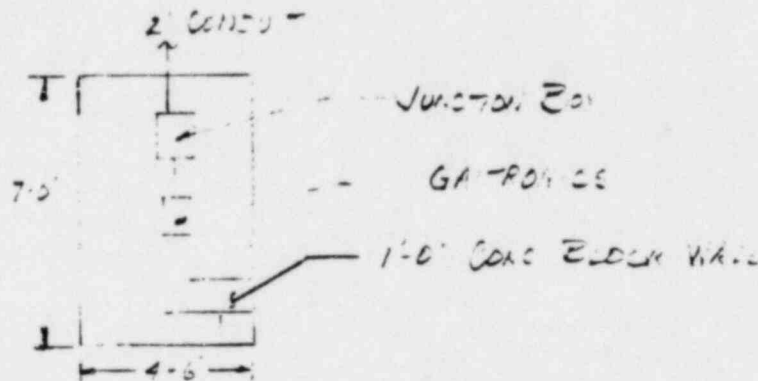
Block Wall Review

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Equipment Weight Calculation:



JUNCTION BOX - WT = 22.0

GAP FOR CS - WT = 22.0

2' CONDUIT - LENGTH = 2 (DI WALL) + 8' (BEYOND D OF WALL)
= 10'
WT = 10 x 4.9 = 49.0

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Determine Stresses due to Equipment Loads:

The equipment loads are calculated based on a load distributed uniformly over the full area of the wall. The out of plane seismic acceleration is considered to be the only significant loading condition. The equipment will be considered to be in the resonant range. ($G_H = 2.47$)

$$W_T = 98 \text{ lb} \quad (\text{total equipment weight})$$

$$w = \frac{W_T}{A}$$

$$A = (7.25 \times 2.5) = 18.12 \text{ ft}^2$$

$$w = \frac{98}{18.12} = 5.4 \text{ lb/ft}^2$$

$$M_x = \beta_c q b^2$$

$$\beta_c = .0589$$

$$q = w G_H$$

$$q = (5.4 \times 2.47) = 13.34 \text{ lb/ft}^2$$

$$b = 7.33'$$

$$M_x = (.0589)(13.34)(7.33)^2 = 42.22 \text{ ft-lb}$$

$$f_{mx} = \frac{M_x}{S_x}$$

$$f_{mx} = \frac{(42.22)(12)}{270} = 2 \text{ psi}$$

$$M_y = \beta_i q b^2$$

$$\beta_i = .0642$$

$$q = 13.34 \text{ lb/ft}^2$$

$$b = 7.33$$

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Block Wall Review IE 80-11

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STRESSES DUE TO EQUIP. LOADS (CONT'D).

$$M_y = (0.0642 \times 13.34 \times 7.33)^2 = 46.01 \text{ ft-lb/ft}$$

$$f_{my} = \frac{M_y}{S_y}$$

$$f_{my} = \frac{(46.01)(12)}{270} = 2 \text{ psi}$$

$$f_{ey} = \frac{f_{my}}{A_H}$$

$$f_{ex} = \frac{f_{mx}}{A_n}$$

$$f_{ey} = \frac{(0.6709 \times 13.34 \times 7.33)}{140} = 0.46 \text{ say } 0$$

$$f_{ex} = \frac{(0.4129 \times 13.34 \times 7.33)}{140} = 0.29 \text{ say } 0$$

$$f_{eymax} = 0$$

The additional mass of the equipment attached to the wall will not significantly affect the frequency.

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Block Wall Review IE 80-11

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Final Stresses Due to DBE Acceleration of the Wall:

$$f_{ts \text{ parallel}} = f_{my}$$

$$f_{ts \text{ parallel}} = 9 \text{ psi}$$

$$f_{ts \text{ normal}} = f_{mx} - f_{DL} + f_{SV}$$

$$f_{ts \text{ normal}} = 8 - 8 + 2 = 2 \text{ psi}$$

$$f_{cs} = f_{mx} + f_{DL} + f_{SV} \text{ or } f_{my}$$

$$f_{cs} = 8 + 8 + 2 = 18 \text{ psi or } 9 \text{ psi} \therefore 18 \text{ psi}$$

$$f_v = 2 \text{ psi}$$

Final Stresses Due to Equipment Loads (DBE)

$$f_{e \text{ parallel}} = f_{my}$$

$$f_{e \text{ parallel}} = 2 \text{ psi}$$

$$f_{e \text{ normal}} = f_{mx}$$

$$f_{e \text{ normal}} = 2 \text{ psi}$$

$$f_{ec} = f_{mx} \text{ or } f_{my}$$

$$f_{ec} = 2 \text{ psi or } 2 \text{ psi} \therefore 2 \text{ psi}$$

$$f_{ev} = 0 \text{ psi}$$

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Final Stresses Due to DBE Acceleration of the Wall:

The DBE stresses will be determined by factoring the DBE stresses using the appropriate ratio of accelerations. ($S_{DBE} = N S_{DBE}$)

For stresses due to horizontal acceleration:

$$N = \frac{G_{HDBE}}{G_{HDBE}}$$

$$N = \frac{.28}{.37} = .76$$

For stresses due to vertical acceleration:

$$N = \frac{G_{VDBE}}{G_{VDBE}}$$

$$N = \frac{.21}{.30} = .70$$

$$f_{mx} = (.76 \times 8) = 6 \text{ psi}$$

$$f_{my} = (.76 \times 9) = 7 \text{ psi}$$

$$f_v = (.76 \times 2) = 2 \text{ psi}$$

$$f_{DL} = 8 \text{ psi at base}$$

$$f_{sv} = (.70 \times 2) = 1 \text{ psi}$$

$$f_{sh} = (.76 \times 1) = 1 \text{ psi}$$

$$f_{ts \text{ parallel}} = f_{my}$$

$$f_{ts \text{ parallel}} = 7 \text{ psi}$$

$$f_{ts \text{ normal}} = f_{mx} - f_{DL} + f_{sv}$$

$$f_{ts \text{ normal}} = 6 - 8 + 1 = -1 \text{ psi} \therefore 0 \text{ psi}$$

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OBE STRESSES (CONT'D)

$$f_{cs} = f_{mx} + f_{my} + f_{sv} \text{ or } f_{my}$$

$$f_{cs} = 6 + 8 + = 15 \text{ psi or } 7 \text{ psi} \therefore 15 \text{ psi}$$

$$f_v = 2 \text{ psi}$$

Final Stresses Due to Equipment Loads (DBE)

The DBE stresses will be determined by factoring the OBE stresses using the appropriate ratio of accelerations. ($S_{DBE} = N S_{OBE}$)

For stresses due to horizontal acceleration:

$$N = \frac{G_{H OBE}}{G_{H DBE}}$$

$$N = \frac{3.95}{2.47} = 1.60$$

For stresses due to vertical accelerations:

$$N = \frac{G_{V OBE}}{G_{V DBE}}$$

$$N = \frac{2.95}{2.11} = 1.40$$

$$f_{mx} = (1.60 \times 2) = 3 \text{ psi}$$

$$f_{my} = (1.60 \times 2) = 3 \text{ psi}$$

$$f_{sv} = (1.60 \times 0) = 0 \text{ psi}$$

$$f_{te \text{ parallel}} = f_{my}$$

$$f_{te \text{ parallel}} = 3 \text{ psi}$$

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Block Wall Review IE 80-11

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OBE STRESSES (CONT'D)

$$f_{te \text{ normal}} = f_{my}$$

$$f_{te \text{ normal}} = 3 \text{ psi}$$

$$f_{ec} = f_{mx} \text{ or } f_{my}$$

$$f_{ec} = 3 \text{ psi or } 3 \text{ psi} \therefore 3 \text{ psi}$$

$$f_{ev} = 0 \text{ psi}$$

Computed Stresses:

Inertial Stress

$$f_{ts} (\text{parallel to jt})$$

DBE 9 psi

OBE 7 psi

$$f_{ts} (\text{normal to jt})$$

DBE 2 psi

OBE 0 psi

$$f_{cs}$$

DBE 18 psi

OBE 15 psi

$$f_v$$

DBE 2 psi

OBE 2 psi

$$f_{DL} + f_{sv}$$

DBE 10 psi

OBE 9 psi

External Load Stress

$$f_{te} (\text{parallel to jt})$$

DBE 2 psi

OBE 3 psi

$$f_{te} (\text{normal to jt})$$

DBE 2 psi

OBE 3 psi

$$f_{ec}$$

DBE 2 psi

OBE 3 psi

$$f_{ev}$$

DBE 0 psi

OBE 0 psi

Based on the above DBE - OBE stress comparison the DBE seismic condition is considered to be critical.

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REVISED FREQUENCY CALCULATION

DATA: f_n (WALL DL ALONE) = 160 cps

$W_{EXT} = 5.4 \text{ psf}$

$f_c = 10 \text{ cps}$

$W_{DL} = 150 \text{ psf}$

SINCE THE WALL IS WELL INTO THE RIGID RANGE, AND SINCE THE WALL'S MASS IS VERY LARGE COMPARED TO THE EQUIPMENT DEAD LOAD, THE NATURAL FREQUENCY WILL NOT CHANGE SIGNIFICANTLY DUE TO EQUIPMENT DL

⇒ WALL REMAINS RIGID

IN-PLANE STRAIN

SINCE THE WALL IS FREE AT THE TOP AND IS NOT BOUNDED AT THE SIDES BY THE BUILDING'S STEEL FRAMING SYSTEM, IT WILL NOT BE SUBJECTED TO IN-PLANE STRAIN

GLOBAL AND LOCAL STRESS DUE TO EQUIPMENT

SINCE THERE ARE NO LARGE PIECES OF EQUIPMENT ON THE WALL, GLOBAL AND LOCAL STRESS ANALYSIS IS NOT REQUIRED. LOADS ARE LESS THAN THOSE CALCULATED IN WALL AB-291-9.

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Flock Wall Review IE AB-II

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COMBINED STRESS SUMMARY SHEET

ALLOWABLE STRESS

1) Max. collar joint stress: $f_{cj} = \underline{N/A}$ psi

N/A psi

2) Max. tensile stress: $(f_{ts} + f_{tc}) = \underline{11}$ psi
(parallel to joint) $9 + 2$

64 psi

3) Max. tensile stress: $(f_{ts} + f_{dx} + f_{te}) = \underline{4}$ psi
(normal to joint) $2 + 0 + 2$

40 psi

4) Max. Comp. stress:
a) If $[f_{mx} + f_{dl} + f_{sv} > f_{my}]$:

o $(f_{dl} + f_{sv} + f_{dx})$ at base $= \underline{10}$ psi
 $8 + 2 \text{ or } 0$

302 psi

o $(f_{cs} + f_{dx} + f_{ce})$ at pt of max. flex. $= \underline{20}$ psi
 $18 + 0 + 2$

302 psi

b) If $[f_{mx} + f_{dl} + f_{sv} < f_{my}]$:

o $(f_{dl} + f_{sv} + f_{dx})$ at base $= \underline{N/A}$ psi
 $8 + 2 \text{ or } 0$

N/A psi

o $(f_{cs} + f_{ce})$ at pt of max. flex $= \underline{N/A}$ psi

N/A psi

5) Max shear stress: $(f_v + f_{dv} + f_{ev}) = \underline{2}$ psi
 $2 + 0 + 0$

40 psi

FURTHER ANALYSIS IS REQ'D

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BLOCK WALL REVIEW IE BULLETIN 80-11

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PURPOSE OF CALCULATION

The purpose of this calculation is to reevaluate Wall #AB-244-2 under new boundary conditions and assure that stresses conform to IE BULLETIN 80-11 - "Masonry Wall Design." Because AB-244-2 and AB-244-2A have a common interlocking corner, there is some rigidity ^{and interaction} between the two walls which was ignored in the previous analysis. A STRUDL "Space frame" model will be used here to evaluate the walls for the new boundary conditions. Also, Wall AB-244-2A was considered to have a pinned end condition on the side abutting the reinforced concrete wall in the previous calculation but in this model the side will be conservatively considered as free. This model and conclusions shall be applicable to walls AB-244-4 and AB-244-4A as they are mirror images.

CONCLUSION

The reevaluation of this wall, AB-244-2, with the new boundary conditions reveals that stresses conform to IE Bulletin 80-11.

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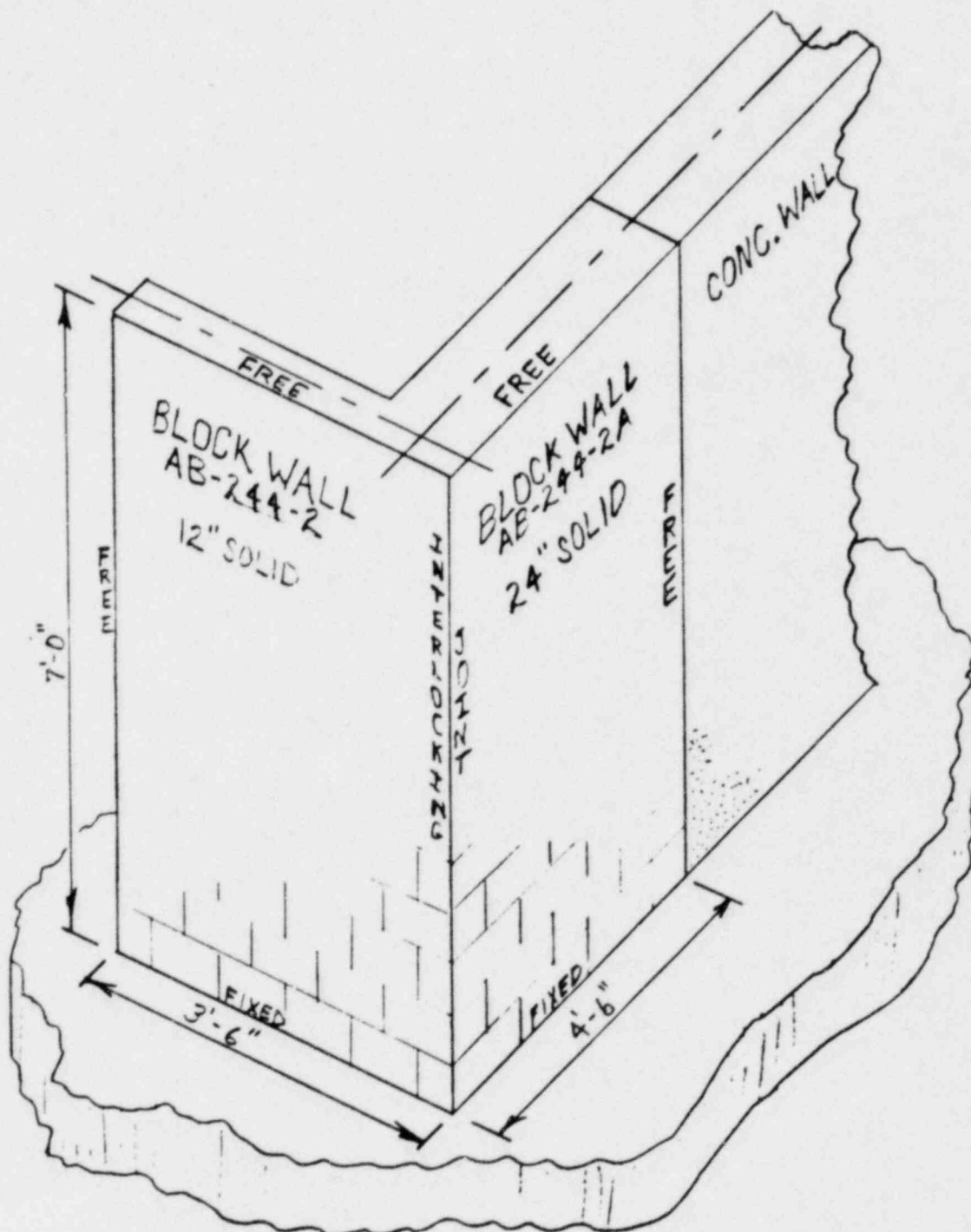
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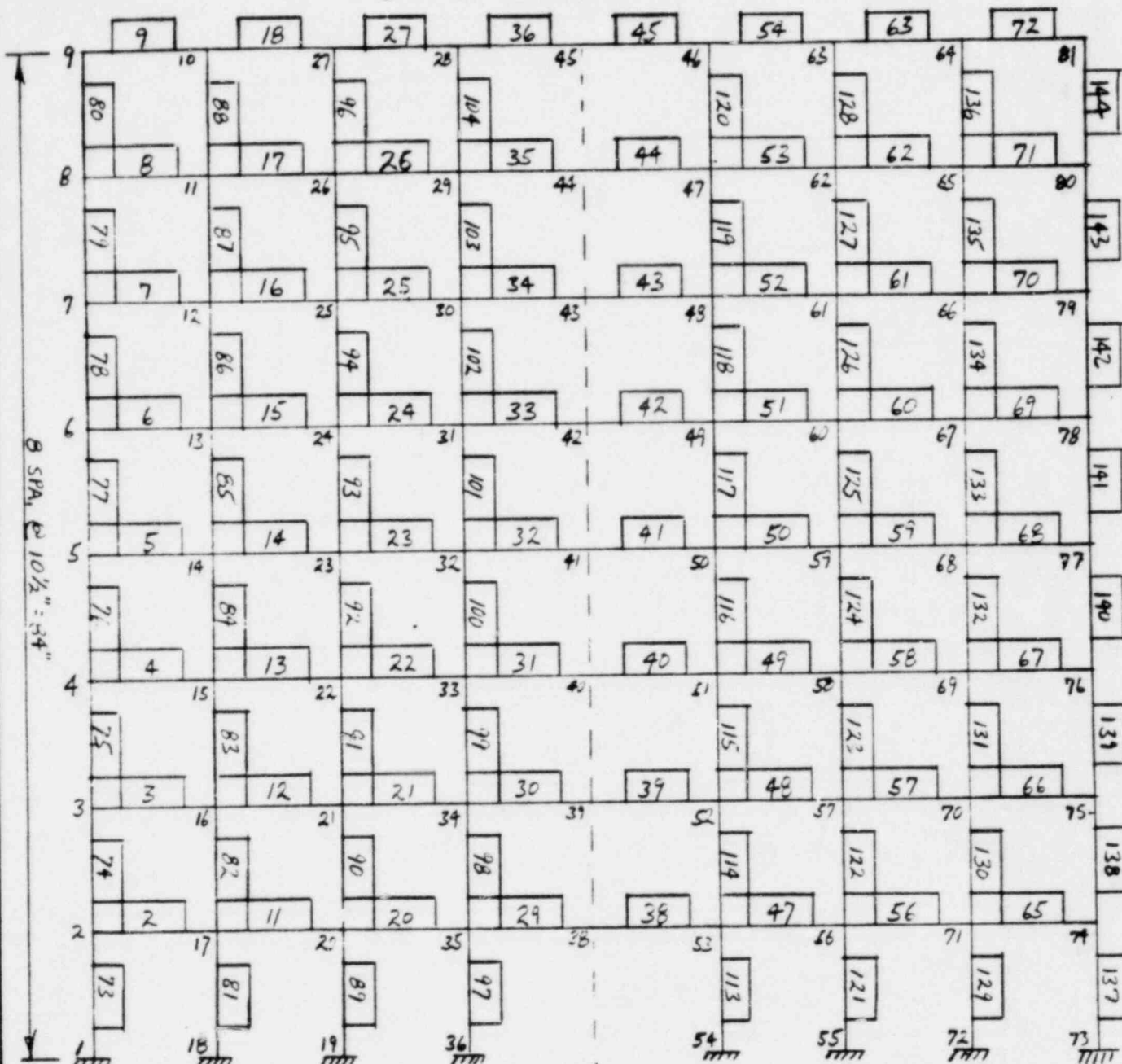
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SPACE FRAME MODEL



Y
X

4 SPA @ 10 1/2" = 42"

WALL * AB-244-2
SOLID BLOCK (2" THICK)

Y

Z
4 SPA @ 10 1/2" = 42"

WALL * AB-244-2A
SOLID BLOCK (24" THICK)

INTERLOCKING JOINT

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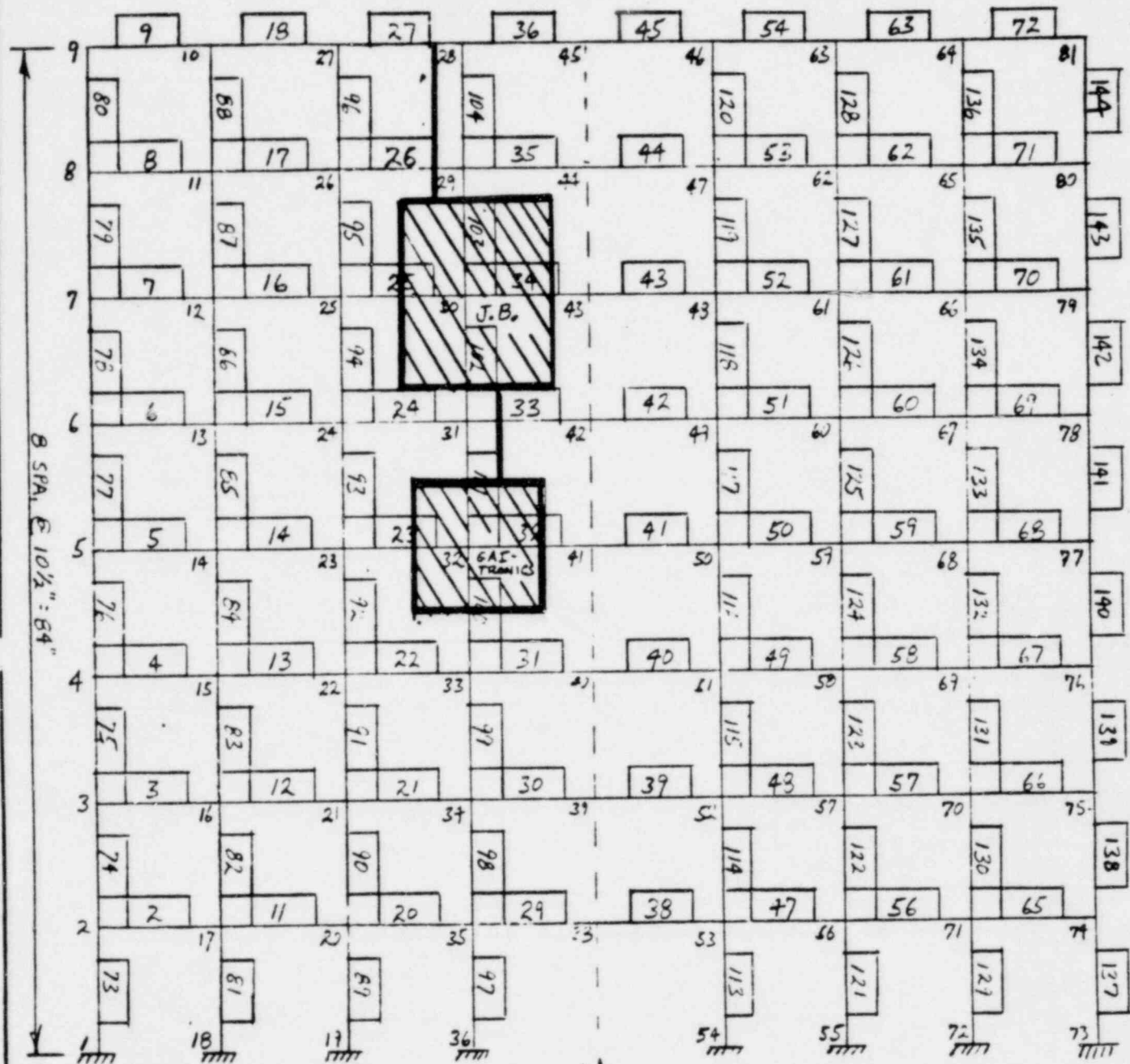
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SPACE FRAME MODEL - EQUIPMENT LOCATION



WALL * AB-244-2
SOLID BLOCK (12" THICK)

WALL * AB-244-2A
SOLID BLOCK (24" THICK)

INTERSECTION

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LOAD CONDITIONS

LOAD CONDITION 1 "SEISMIC + EQUIPMENT AB-244-2"

SEISMIC - JOINT LOADS

∴ loads for joints 2-8, 38-44, 10, 27, 28

Wall mass = 150 PSF

HORIZONTAL ACCELERATION G-FACTOR = .37

$$F = 150 \times .37 = 55.5 \text{ PSF}$$

$$\frac{55.5 \text{ lb}}{144 \text{ in}^2} = \frac{42.5 \text{ lb}}{10.5' \times 10.5'} \quad \frac{42.5 \text{ lb}}{2} = \boxed{21.3 \text{ lb} = F \text{ in z-direction}}$$

∴ loads for joints 9, 45

$$\frac{42.5 \text{ lb}}{4} = \boxed{10.6 \text{ lb} = F \text{ in z-direction}}$$

∴ loads for joints 11-17, 20-26, 29-35,

$$\boxed{42.5 \text{ lb} = F \text{ in z-direction}}$$

EQUIPMENT - JOINT loads

∴ loads for joint 30

JUNCTION BOX MASS = 22 lb

CONDUIT TO JUNCTION BOX = $49 \text{ lb/ft} \times 10' = 49.2 \text{ lb}$

TOTAL MASS = $49 + 22 = 71 \text{ lb}$

HORIZONTAL ACCELERATION G-FACTOR = 2.47

$$F = 71 \text{ lb} \times 2.47 = \boxed{175 \text{ lb} = F \text{ in z-direction}}$$

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BLOCK WALL REVIEW IE BULLETIN 80-11

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I/NSR

LOAD CONDITIONS (CONT.)

EQUIPMENT - JOINT loads

∴ load for joint 32

GAI-TRONICS BOX = 22 lbs

$$22 \text{ lb} \times 2.47 = 54 \text{ lb} = F_{in \text{ z-direction}}$$

COMBINE "SEISMIC" & "EQUIPMENT" LOADS

loading 1 'INERTIA + EQUIPMENT'

joint loads

2 TO 8, 38 TO 44, 10, 27, 28 FORCE Z 21.3

9, 45 FORCE Z 10.6

11 TO 17, 20 TO 26, 29, 31, 33, 34, 35 FORCE Z 42.5

30 FORCE Z 175.

32 FORCE Z 54.

LOAD CONDITION 2 "SEISMIC + EQUIPMENT ... AB-244-2A"

SEISMIC - JOINT LOADS

∴ loads for joints 38-44, 46, 63, 64, 74 TO 80

wall mass = 300 PSF

horizontal acceleration = .37

$$F = 300 \times .37 = 111 \text{ PSF}$$

$$\frac{111 \text{ lb}}{144 \text{ in}^2} = \frac{85 \text{ lb}}{110.25 \text{ in}^2}$$

$$\frac{85 \text{ lb}}{2} = 42.5 \text{ lb} = F_{in \text{ x-direction}}$$

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QA CATEGORY/CODE CLASS

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LOAD CONDITIONS (CONT.)

∴ loads for joints 45, 81

$$\frac{85^{lb}}{4} = 21.3^{lb} = F_{in\ X-direction}$$

∴ loads for joints 47-53, 56-62, 65-71

$$85^{lb} = F_{in\ X-direction}$$

EQUIPMENT - JOINT loads

THERE IS NO EQUIPMENT ON THIS WALL

loading 2 'INERTIA + EQUIPMENT'

joint loads

38 TO 44, 74 TO 83, 46, 63, 64 FORCE X 42.5

45, 81 FORCE X 21.3

47 TO 53, 56 TO 62, 65 TO 71 FORCE X 85.

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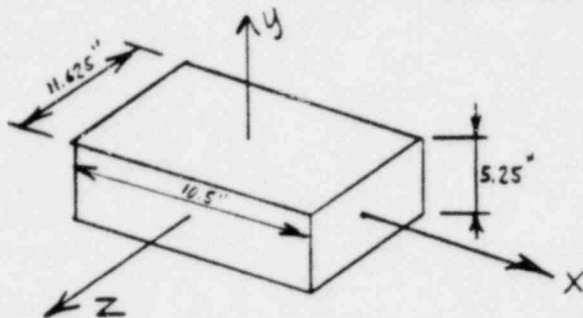
BLOCK WALL REVIEW IE BULLETIN 80-11

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I/NSR

MEMBER PROPERTIES

MEMBERS 9, 18, 27, 36



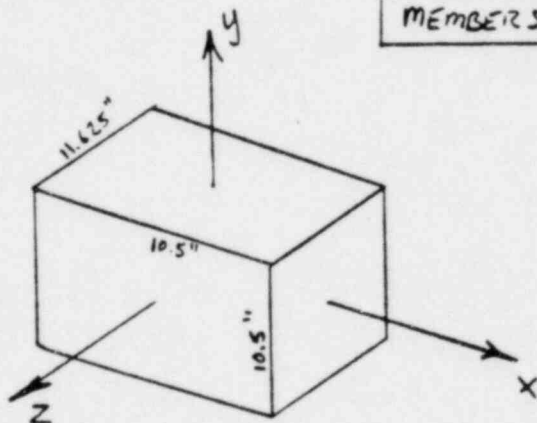
$$A_x = 5.25 \times 11.625 = 61.0 \text{ in}^2$$

$$I_y = \frac{(5.25)(11.625)^3}{12} = 687.3 \text{ in}^4$$

$$I_z = \frac{(11.625)(5.25)^3}{12} = 140.2 \text{ in}^4$$

$$I_x = \frac{(11.625)(5.25)^3}{3} = 560.7 \text{ in}^4$$

MEMBERS 2 TO 8, 11 TO 17, 20 TO 26, 29 TO 35



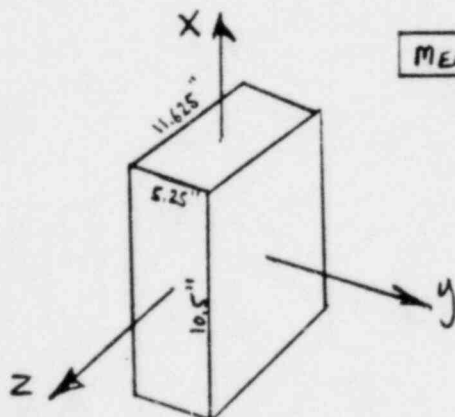
$$A_x = 10.5 \times 11.625 = 122.1 \text{ in}^2$$

$$I_z = \frac{11.625(10.5)^3}{12} = 1121 \text{ in}^4$$

$$I_y = \frac{10.5(11.625)^3}{12} = 1374.6 \text{ in}^4$$

$$I_x = \frac{(11.625)(10.5)^3}{3} = 4485.6 \text{ in}^4$$

MEMBERS 73 TO 80



$$A_x = 5.25 \times 11.625 = 61.0 \text{ in}^2$$

$$I_z = \frac{11.625(5.25)^3}{12} = 140.2 \text{ in}^4$$

$$I_y = \frac{(5.25)(11.625)^3}{12} = 687.3 \text{ in}^4$$

$$I_x = \frac{(11.625)(5.25)^3}{3} = 560.7 \text{ in}^4$$

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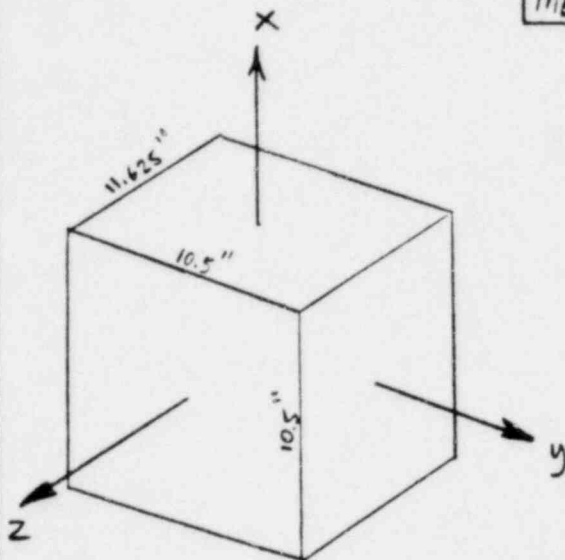
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MEMBER PROPERTIES (CONT.)

MEMBERS 81 TO 104



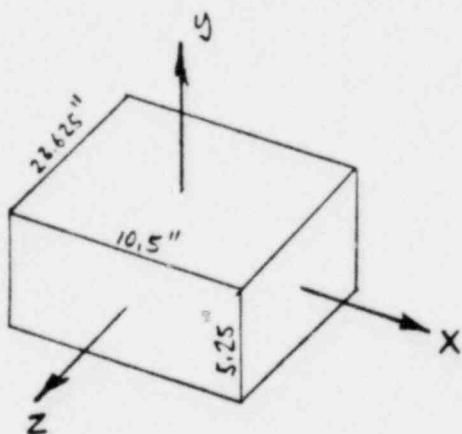
$$A_x = 11.625 \times 10.5 = 122.1 \text{ in}^2$$

$$I_y = \frac{(10.5)(11.625)^3}{12} = 1374.6 \text{ in}^4$$

$$I_z = \frac{(11.625)(10.5)^3}{12} = 1121.4 \text{ in}^4$$

$$I_x = \frac{11.625(10.5)^3}{2} = 4485.8 \text{ in}^4$$

MEMBERS 45, 54, 63, 72



$$A_x = 5.25 \times 23.625 = 124.0 \text{ in}^2$$

$$I_y = \frac{5.25(23.625)^3}{12} = 5768.9 \text{ in}^4$$

$$I_z = \frac{(23.625)(5.25)^3}{12} = 284.9 \text{ in}^4$$

$$I_x = \frac{23.625(5.25)^3}{2} = 1139.5 \text{ in}^4$$

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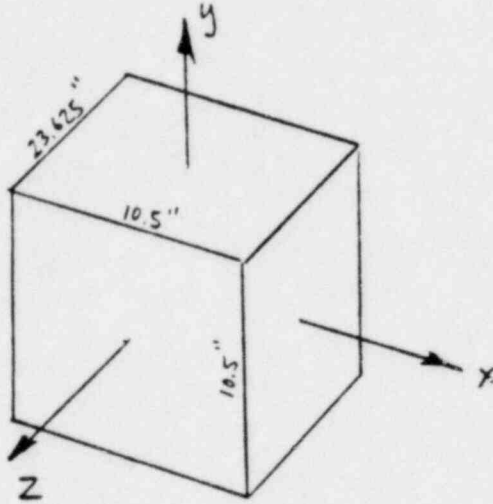
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MEMBER PROPERTIES (CONT.)

MEMBERS 38 TO 44, 47 TO 53, 56 TO 62, 65 TO 71



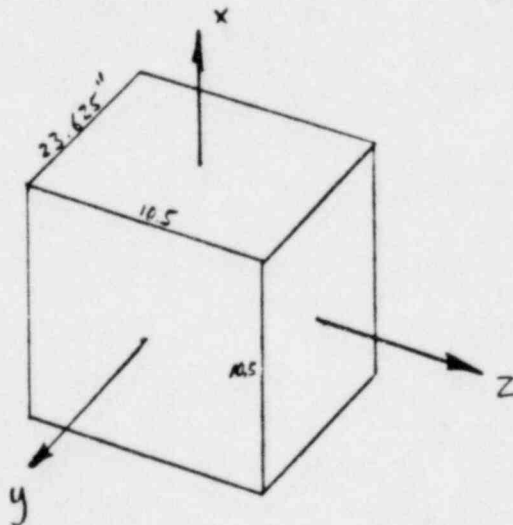
$$A_x = 10.5 \times 23.625 = 248.1 \text{ in}^2$$

$$I_z = \frac{23.625(10.5)^3}{12} = 2279.1 \text{ in}^4$$

$$I_y = \frac{10.5(23.625)^3}{12} = 11,537.8 \text{ in}^4$$

$$I_x = \frac{23.625(10.5)^3}{3} = 9,116.3 \text{ in}^4$$

MEMBERS 113 TO 136



$$A_x = 23.625 \times 10.5 = 248.1 \text{ in}^2$$

$$I_z = \frac{10.5(23.625)^3}{12} = 11,537.8 \text{ in}^4$$

$$I_y = \frac{23.625(10.5)^3}{12} = 2279.1 \text{ in}^4$$

$$I_x = \frac{23.625(10.5)^3}{3} = 9,116.3 \text{ in}^4$$

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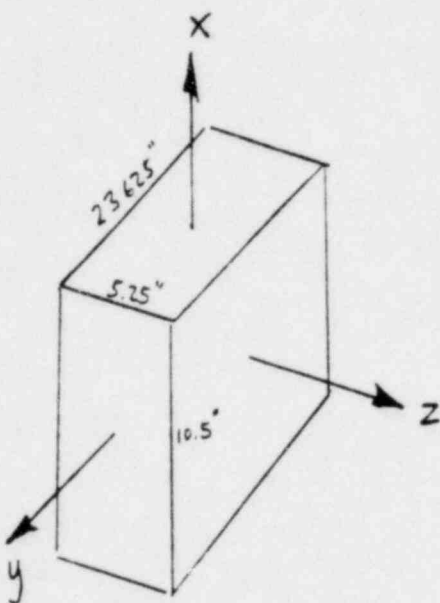
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MEMBER PROPERTIES (CONT.)

MEMBERS 137 TO 144



$$A_x = 23.625 \times 5.25 = 124.0 \text{ in}^2$$

$$I_y = \frac{23.625(5.25)^3}{12} = 284.9 \text{ in}^4$$

$$I_z = \frac{5.25(23.625)^3}{12} = 5768.9 \text{ in}^4$$

$$I_x = \frac{23.625(5.25)^3}{3} = 1139.5 \text{ in}^4$$

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BLOCK WALL REVIEW IE BULLETIN 80-11

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MAXIMUM STRESS SUMMARY

LOAD CONDITION 1 "SEISMIC INERTIA + EQUIPMENT... AB-244-2"

WALL # AB-244-2

FOR MEMBERS 9, 18, 27, 36 FIND MAX MOMENT (M_y)

M_y

MEMBER 36

JOINT 45

$$M_y = 1124 \text{ in-lb}$$

$$\text{STRESS} = \frac{M_y}{I} = \frac{(1124) \left(\frac{11.625}{2} \right)}{687.3} = \underline{9.5} \text{ psi}$$

FOR MEMBERS 2 TO 8, 11 TO 17, 20 TO 26, 29 TO 35 FIND MAX MOMENT (M_y)

M_y

MEMBER 34

JOINT 43

$$M_y = 2184 \text{ in-lb}$$

$$\text{STRESS} = \frac{2184 \left(\frac{11.625}{2} \right)}{1374.6} = \underline{9.2} \text{ psi}$$

FOR MEMBERS 73 TO 80 FIND MAX MOMENT (M_y)

M_y

MEMBER 73

JOINT 1

$$M_y = 2422 \text{ in-lb}$$

$$\text{STRESS} = \frac{(2422) \left(\frac{11.625}{2} \right)}{687.3} = \underline{20.5} \text{ psi}$$

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LOAD CONDITION 1, WALL # AB-244-2 (CONT.)

FOR MEMBERS 81 TO 104 FIND MAX. MOMENT (M_y)

M_y

MEMBER 81

JOINT 18

$M_y = 3422$ "lb

$$\text{STRESS} = \frac{(3422) \left(\frac{11.625}{2} \right)}{1374.6} = 14.5 \text{ psi}$$

WALL # AB-244-2A

FOR MEMBERS 45, 54, 63, 72 FIND MAX MOMENT (M_y)

M_y

MEMBER 45

JOINT 45

$M_y = 1490$ "lb

$$\text{STRESS} = \frac{(1490) \left(\frac{23.625}{2} \right)}{5768.9} = 3.1 \text{ psi}$$

FOR MEMBERS 38 TO 44, 47 TO 53, 56 TO 62, 65 TO 71 FIND MAX MOMENT (M_y)

M_y

MEMBER 43

JOINT 43

$M_y = 2183$ "lb

$$\text{STRESS} = \frac{(2183) \left(\frac{23.625}{2} \right)}{11,537.8} = 2.2 \text{ psi}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

REVISION

PAGE

13075.63-AB-244-2

0

35 C-33

PREPARED/DATE

MARK A. FABRIZIO

11/13/80

REVIEWER/CHECKER/DATE

OREW M. CARON 11/17/80

INDEPENDENT REVIEWER/DATE

OREW M. CARON 11/17/80

SUBJECT/TITLE

BLOCK WALL REVIEW IE BULLETIN 80-11

QA CATEGORY/CODE CLASS

I/NSR

LOAD CONDITION 1, WALL #AB-244-2A (CONT.)

FOR MEMBERS 113 TO 136

FIND MAX

MOMENT. (M_z)

M_z

MEMBER 113

JOINT 54

$M_z = 2868 \text{ in-lb}$

$$\text{STRESS} = \frac{(2868) \left(\frac{23.625}{2} \right)}{11537.2} = 2.9 \text{ PSI}$$

FOR MEMBERS 137 TO 144

M_z

MEMBER 137

JOINT 73

$M_z = 2558 \text{ in-lb}$

$$\text{STRESS} = \frac{(2558) \left(\frac{23.625}{2} \right)}{5768.9} = 5.2 \text{ PSI}$$

FOR LOAD CONDITION 1, MAXIMUM STRESS OCCURS AT MEMBER 73, JOINT 1, ON WALL #AB-244-2 EQUAL TO 20.5 PSI

LOAD CONDITION 2 "SEISMIC INERTIA + EQUIPMENT ..., AB-244-2A"

WALL #AB-244-2

FOR MEMBERS 9, 16, 27, 36 FIND MAX MOM. (M_y)

M_y

MEMBER 36

JOINT 45

$M_y = 654 \text{ in-lb}$

$$\text{STRESS} = \frac{(654) \left(\frac{11.625}{2} \right)}{687.3} = 5.5 \text{ PSI}$$

CALCULATION SHEET

J.O./W.O./CALCULATION NO.

REVISION

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13075.63-AB-244-2

0

36 C-34

A5010.61

PREPARED/DATE

MARK A. FABRIZIO

11/13/80

REVIEWER/CHECKER/DATE

OREW M. CARON

11/17/80

INDEPENDENT REVIEWER/DATE

OREW M. CARON

11/17/80

SUBJECT/TITLE

BLOCK WALL REVIEW IE BULLETIN 80-11

QA CATEGORY / CODE CLASS

I/NSR

LOAD CONDITION 2, WALL # AB-244-2 (CONT.)

FOR MEMBERS 2 TO 8, 11 TO 17, 20 TO 26, 29 TO 35 FIND MAX. MOM. (M_y)

M_y

MEMBER 35

JOINT 44

$$M_y = 1097^{11-1b}$$

$$\text{STRESS} = \frac{(1097) \left(\frac{11.625}{2} \right)}{1374.6} = 4.6 \text{ PSI}$$

FOR MEMBERS 73 TO 80 FIND MAX. MOM. (M_y)

M_y

MEMBER 73

JOINT 1

$$M_y = 404^{11-1b}$$

$$\text{STRESS} = \frac{(404) \left(\frac{11.625}{2} \right)}{687.3} = 3.4 \text{ PSI}$$

FOR MEMBERS 81 TO 104 FIND MAX. MOMENT (M_y)

M_y

MEMBER 81

JOINT 18

$$M_y = 405^{11-1b}$$

$$\text{STRESS} = \frac{(405) \left(\frac{11.625}{2} \right)}{1374.6} = 1.7 \text{ PSI}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

45010-61

J.O./W.O./CALCULATION NO.

13075.63-AB-244-2

REVISION

0

PAGE

37 C-35

PREPARED/DATE

MARK A. FABRIZIO 11/13/80

REVIEWER/CHECKER/DATE

OREW M. CARON 11/17/80

INDEPENDENT REVIEWER/DATE

OREW M. CARON 11/17/80

SUBJECT/TITLE

BLOCK WALL REVIEW IE BULLETIN 80-11

QA CATEGORY/CODE CLASS

I/NSR

LOAD CONDITION 2, WALL # AB-244-2A (CONT.)

WALL # AB-244-2A

FOR MEMBERS 45, 54, 63, 72 FIND MAX. MOMENT (M_y)

M_y

MEMBER 54

JOINT 63

$$M_y = 1262^{11-1b}$$

$$\text{STRESS} = \frac{(1262) \left(\frac{23.625}{2} \right)}{5768.9} = 2.6 \text{ PSI}$$

FOR MEMBERS 38 TO 44, 47 TO 53, 56 TO 62, 65 TO 71 FIND MAX. MOMENT (M_y)

M_y

MEMBER 44

JOINT 44

$$M_y = 1097^{11-1b}$$

$$\text{STRESS} = \frac{(1097) \left(\frac{23.625}{2} \right)}{11537.8} = 1.1 \text{ PSI}$$

FOR MEMBERS 113 TO 136

FIND MAX. MOMENT (M_z)

M_z

MEMBER 129

JOINT 72

$$M_y = 18280^{11-1b}$$

$$\text{STRESS} = \frac{(18280) \left(\frac{23.625}{2} \right)}{11,537.8} = 18.7 \text{ PSI}$$

FOR MEMBERS 137 TO 144

FIND MAX. MOMENT (M_z)

M_z

MEMBER 137

JOINT 73

$$M_z = 10905^{11-1b}$$

$$\text{STRESS} = \frac{(10905) \left(\frac{23.625}{2} \right)}{5768.9} = 22.3 \text{ PSI}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

AS010 61

J.O./W.D./CALCULATION NO.

REVISION

PAGE

13075.63-AB-244-2

0

38 C-36

PREPARED/DATE

MARK A. FABRIZIO

11/13/80

REVIEWER/CHECKER/DATE

DREW M. CARON

11/20/80

INDEPENDENT REVIEWER/DATE

DREW M. CARON

11/20/80

SUBJECT/TITLE

BLOCK WALL REVIEW IE BULLETIN 80-11

QA CATEGORY/CODE CLASS

I/NSR

LOAD CONDITION 2 (CONT.)

FOR LOAD CONDITION 2, MAXIMUM STRESS OCCURS AT MEMBER 137, JOINT 73, ON WALL #AB-244-2A EQUAL TO 22.3 PSI

COMBINE STRESSES FOR DBE

ITEM 1 - N/A

ITEM 2 - ($f_{ts} + f_{te}$) parallel to joint

$$f_{ts} = f_{mg} = 9.5 \text{ PSI}$$

ITEM 3 - ($f_{ts} + f_{dx} + f_{te}$) - normal to joint.

$$\begin{aligned} f_{ts} &= f_{mx} - f_{dL} + f_{sV} & 14.5 + 0 &= 14.5 \text{ PSI} \\ f_{ts} &= 20.5 - 8 + 2 & &= 14.5 \end{aligned}$$

ITEM 4 - Max comp. stress

$$\begin{aligned} \text{a) } (f_{dl} + f_{sv} + f_{dx}) @ \text{ Base} \\ 8 + 2 + 0 &= 10 \text{ PSI} \end{aligned}$$

b) ($f_{cs} + f_{dx} + f_{ce}$) @ pt. of max flexure.

$$\begin{aligned} 30.5 + 0 &= 30.5 \text{ PSI} \\ f_{cs} &= f_{mx} + f_{dL} + f_{sv} \\ &= 20.5 + 8 + 2 = 30.5 \text{ PSI} \end{aligned}$$

ITEM 5 - Max Shear stress ($f_v + f_{dv} + f_{ev}$)

FROM STRUDL RUN JOINT 1 Z force = 175^{lb}

$$\frac{175 \text{ lb}}{61} = 2.9 \text{ PSI} = f_v$$

$$(2.9 + 0) = 2.9 \text{ PSI}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

13075.63 AB-244-2

REVISION

1

PAGE

38.16-81

45010.61

PREPARED/DATE

G. HILLMAN 2-13-81

REVIEWER/CHECKER/DATE

Hadi Barghout 02/18/81

INDEPENDENT REVIEWER/DATE

Hadi Barghout 02/18/81

SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

CHANGE IN POISSON'S RATIO

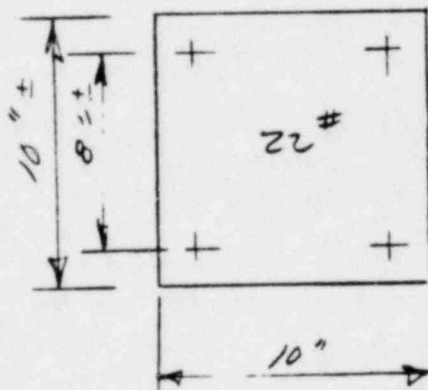
THIS ADJUSTMENT TO CALC'S IS NOT NECESSARY. THIS CHANGE REDUCES STRESSES. THE CALCULATED STRESSES ARE WITHIN THE ALLOWABLES.

HEAVY WEIGHT BLOCK DENSITY

THIS CALCULATION IS NOT NECESSARY; FOR THE SAME REASON AS GIVEN ABOVE.

BLOCK PULL OUT

THE JUNCTION BOX IS ONLY 22#. THE GAITRONICS ALSO IS 22#. LOOK AT GAITRONICS.



SAY $d = 3"$

$$P_z = G_H (WT)$$

$$OBE = (3.95)(22) = 86.9 \#$$

$$DBE = (2.47)(22) = 54.3 \#$$

$$P_y = G_v (WT)$$

$$OBE = (2.95)(22) = 64.9 \#$$

$$DBE = (2.11)(22) = 46.4 \#$$

$$\text{MAX BOLT TENSION} = \frac{P_z}{4} + \frac{WT(d) + P_y(d)}{8 \times 11}$$

$$OBE \quad T = \frac{86.9}{4} + \frac{22(3) + 64.9(3)}{8(2)} = 38.0 \#$$

G_H is 3.45 (OBE) 3.95 is OK, MORE CONSERVATIVE. G. Hillman

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

45010 61

J.O./W.O./CALCULATION NO. 13075.63 AB-244-2		REVISION 1	PAGE 38.2 (38)
PREPARED/DATE G. HILLMAN 2-13-81	REVIEWER/CHECKER/DATE Hadi Boughlos 02/18/81	INDEPENDENT REVIEWER/DATE Hadi Boughlos 02/18/81	
SUBJECT/TITLE BLOCK WALL REVIEW IE 80-11		QA CATEGORY/CODE CLASS I/NSR	

BLOCK PULL OUT (CONT'D)

$$DBE = \frac{54.3^{\#}}{4} + \frac{22(3'') + 46.4(3'')}{8''(2)} = 26.4^{\#}$$

DBE

SAY 2 BOLTS IN 1 BLOCK

$$26.4 \times 2 = 52.8^{\#} < 12087^{\#}$$

OBE

2 BOLTS IN 1 BLOCK

$$38.0^{\#} \times 2 = 76.0^{\#} < 9669^{\#} \underline{\underline{OK}}$$

CHECK FASTENER LOADS

USE 1/4" (CONSERVATIVE)

$$26.4^{\#} < 38.0^{\#} < 160^{\#} \underline{\underline{OK}}$$

DBE OBE ALLOWABLE

CHECK CONE PULL-OUT

$$DBE \quad 26.4^{\#} < 227^{\#} \underline{\underline{OK}}$$

$$OBE \quad 38.0^{\#} < 181^{\#} \underline{\underline{OK}}$$

13075.63-AB-244-2

0

39 C-39

PREPARED / DATE

MARK A. FABRIZIO

11/15/80

REVIEWER / CHECKER / DATE

OREW M. CARON

11/20/80

INDEPENDENT REVIEWER / DATE

OREW M. CARON

11/20/80

SUBJECT / TITLE

Block wall review IE B3-11

QA CATEGORY / CODE CLASS

I / NSC

COMBINED STRESS SUMMARY SHEET

Allowable stress

1) Combined collar joint stress: $(f_{js} + f_{jd} + f_{je}) =$ N/A psi

N/A psi

2) Max. tensile stress: $(f_{ts} + f_{te}) =$ 9.5 psi
9.5
MEMBER 36
JOINT 45

64 psi

3) Max. tensile stress: $(f_{ts} + f_{dx} + f_{te}) =$ 14.5 psi
MEMBER 73
JOINT 1

40 psi

4) Max. Comp. stress:
 a) If $[f_{mx} + f_{dx} + f_{sx}] > f_{my}$:

o $(f_{dx} + f_{sx} + f_{dx})$ at base = 10 psi

302 psi

o $(f_{cs} + f_{dx} + f_{ce})$ at pt. of max. flex. = 30.5 psi

302 psi

b) If $[f_{mx} + f_{dx} + f_{sx}] < f_{my}$:

o $(f_{dx} + f_{sx} + f_{dx})$ at base = N/A psi

N/A psi

o $(f_{cs} + f_{ce})$ at pt. of max. flex. = N/A psi

N/A psi

5) Max. shear stress: $(f_v + f_{vr} + f_{vr}) =$ 2.9 psi

40 psi

ATTACHMENT D
CONSIDERATION OF HIGHER MODES OF VIBRATION
SAMPLE CALCULATION

STONE & WEBSTER ENGINEERING CORPORATION
CALCULATION SHEET

D1/9

CALCULATION IDENTIFICATION NUMBER			
JOINT NO. 13075.63	DIVISION & GROUP STRUCTURAL	CALCULATION NO. 13075.63 SE-254-6	OPTIONAL TASK CODE 00300

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of 4

1-31-8

ATTACHMENT NO. C

TITLE DESIGN C DATA

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J.D./W.O./CALCULATION NO. 13075.67 58-254-6		REVISION 0	PAGE C-2
PREPARED/DATE P. Fisher 11/12/80	REVIEWER/CHECKER/DATE T J Lynch 11/19/80	INDEPENDENT REVIEWER/DATE T J Lynch 11/19/80	
SUBJECT/TITLE Block Wall Review IF 80-11		QA CATEGORY/CODE CLASS 115B	

RESPONSE SPECTRA for WALL INERTIA

D-2

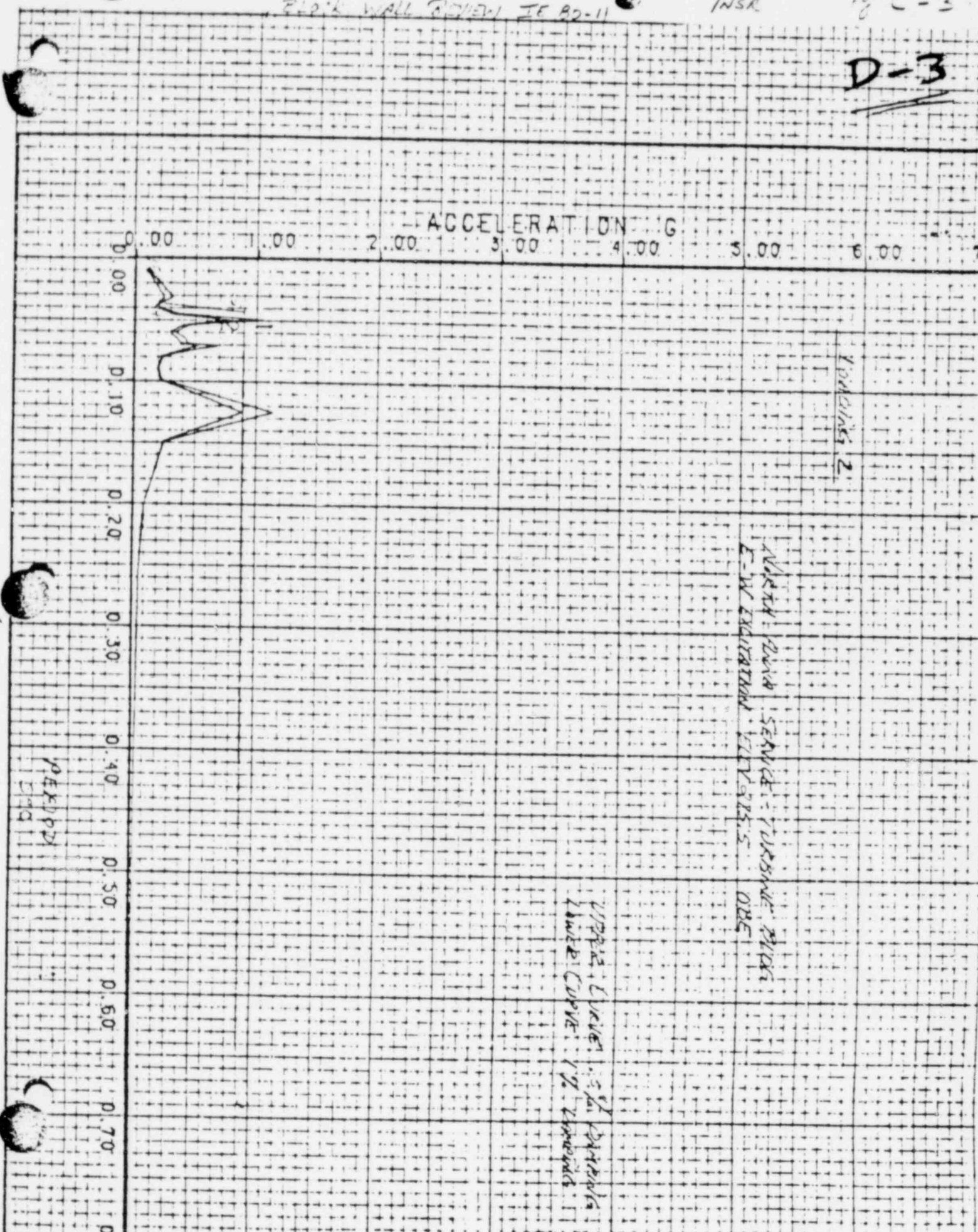
LOADING	Point	ACCELERATION	PERIOD
1 (DBE)	1	.15	.001
	2	.15	.007
	3	.35	.026
	4	.35	.034
	5	.95	.041
	6	.95	.70

LOADING	Point	ACCELERATION	PERIOD
2 (DBE)	1	.1	.001
	2	.11	.007
	3	.25	.026
	4	.25	.036
	5	.87	.043
	6	.87	.70

11/10/80 CMR #13075.63
 CHECK BY TJ Lynch 11/15/80
 BLOCK WALL COVER IE B2-11

REV 0
 1/NSR
 28 C-3

D-3



PREPARED BY: R EAGLES

11/10/85 CALL# 13075.123

REV 0

CHECKED BY: T J Lynch

11/10/85

SR-254-6

1/NER

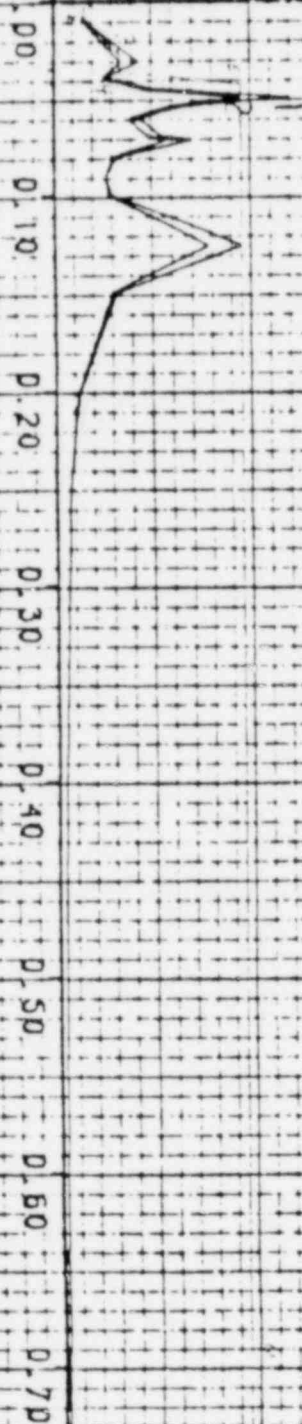
PG C-4

BACK WALL REVIEW, IE RD-11

D-4

ACCELERATION G

0.00 1.00 2.00 3.00 4.00 5.00 6.00 7



4090 IN 9.1

NORTH-ANNA SERVICE TUNNEL BLDG.
A-W EXCAVATION ELEV 275.5 DBL

PEAK CURVE: 0.5% VIBRATIONS
LOWER CURVE: 1% VIBRATIONS

788.8410.20
SEC

99 D-10
//R3901711 JOB 13, 'BLOCK WALLS', HSCLEVEL=1
//*JOBPARM REGION=3000K, TIME=5, DRIVES=0, RESTART=Y, X=6925, LINES=60000

JOB 2433

/*
/* *****STRUCL-II ST-015*****
/* *** NO INPUT DECK * DATA FROM STORE ***
/* ***** STORED UNDER : SB-254-6 *****
/*

/*FICHE TITLE1='IE BULLETIN 80-11 BLOCK WALL REVIEW'
/*FICHE TITLE2='JOB 13075.63, WALL SB-254-6 DYNAMIC ANALYSIS GJH-1'
/*FICHE ORIGTO JALBRECHT/TLYNCH, 245/13 COPIES=2
/*LIST

CALC NO. 13075.63
SB-254-6
2-18-81

C-5

OTITLE,
 TEXT 'BLOCK WALL REVIEW, IE 80-11, DYNAMIC ANALYSIS', COL 15
 DATE COL 75
 PAGE COL 120
 TEXT 'VEPCO NORTH ANNA UNITS 1 & 2 , JOB 13075.63', COL 17, LINE 2
 TEXT 'M', COL 1, LINE 3
 STRUDL, 'BLOCKS', 'DYNAMIC ANALYSIS FOR SB-254-6', MESSAGE 'OFF'
 \$ INPUT PREPARED BY G.J. HILLMAN, CHECKED BY
 TYPE PLANE GRID XY
 UNITS INCHES POUNDS DEGREES
 \$ GENERATING JOINT COORDINATES
 REF JOINT COORDINATES

1	0.	234.
5	0.	138.
6	0.	120.
8	0.	96.
9	18.	246.
10	18.	234.
14	18.	138.
15	18.	120.
17	18.	96.
18	42.	246.
19	42.	234.
23	42.	138.
24	42.	120.
26	42.	96.
27	42.	78.
29	42.	30.
30	42.	9.
31	42.	0.
32	54.	246.
33	54.	234.
37	54.	138.
38	54.	120.
40	54.	96.
41	54.	78.
43	54.	30.
44	54.	9.
45	54.	0.
46	72.	246.
47	72.	234.
51	72.	138.
52	72.	120.
54	72.	96.
55	72.	78.
57	72.	30.
58	72.	9.
59	72.	0.
60	96.	246.
72	96.	9.
73	96.	0.
74	120.	246.
75	120.	234.
79	120.	138.
80	120.	120.
82	120.	96.
83	120.	78.
85	120.	30.
86	120.	9.
87	120.	0.

CALC NO. 13075.63

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2-18-81

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pg D-12

88	138.	246.
89	138.	234.
93	138.	138.
94	138.	120.
95	138.	96.
97	138.	78.
99	138.	30.
100	138.	9.
101	138.	0.
102	144.	234.
103	162.	202.
104	162.	210.
107	162.	138.
108	162.	120.
110	162.	96.
111	162.	78.
113	162.	30.
114	162.	9.
115	162.	0.
116	180.	210.
119	180.	138.
120	180.	120.
122	180.	96.
123	180.	78.
125	180.	30.
126	180.	9.
127	176.	138.
128	176.	90.
129	176.	108.

CALC NO. 13075.63

58-254-6

2-18-81

\$ GENERATE JOINTS

VARY JOINTS IN SET 1 SEPARATELY FROM 1 TO 5 BY 1
 VARY JOINTS IN SET 2 SEPARATELY FROM 6 TO 8 BY 1
 VARY JOINTS IN SET 3 SEPARATELY FROM 10 TO 14 BY 1
 VARY JOINTS IN SET 4 SEPARATELY FROM 15 TO 17 BY 1
 VARY JOINTS IN SET 5 SEPARATELY FROM 19 TO 23 BY 1
 VARY JOINTS IN SET 6 SEPARATELY FROM 24 TO 26 BY 1
 VARY JOINTS IN SET 7 SEPARATELY FROM 27 TO 29 BY 1
 VARY JOINTS IN SET 8 SEPARATELY FROM 33 TO 37 BY 1
 VARY JOINTS IN SET 9 SEPARATELY FROM 38 TO 40 BY 1
 VARY JOINTS IN SET 10 SEPARATELY FROM 41 TO 43 BY 1
 VARY JOINTS IN SET 11 SIMULTANEOUSLY FROM 47 TO 75 BY 14
 FROM 47 TO 51 BY 1
 VARY JOINTS IN SET 12 SIMULTANEOUSLY FROM 52 TO 80 BY 14
 FROM 52 TO 54 BY 1
 VARY JOINTS IN SET 13 SIMULTANEOUSLY FROM 55 TO 83 BY 14
 FROM 55 TO 57 BY 1
 VARY JOINTS IN SET 14 SEPARATELY FROM 89 TO 93 BY 1
 VARY JOINTS IN SET 15 SEPARATELY FROM 94 TO 96 BY 1
 VARY JOINTS IN SET 16 SEPARATELY FROM 97 TO 99 BY 1
 VARY JOINTS IN SET 17 SEPARATELY FROM 104 TO 107 BY 1
 VARY JOINTS IN SET 18 SEPARATELY FROM 108 TO 110 BY 1
 VARY JOINTS IN SET 19 SEPARATELY FROM 111 TO 113 BY 1
 VARY JOINTS IN SET 20 SEPARATELY FROM 116 TO 119 BY 1
 VARY JOINTS IN SET 21 SEPARATELY FROM 120 TO 122 BY 1
 VARY JOINTS IN SET 22 SEPARATELY FROM 123 TO 125 BY 1

\$ DEFINE REFERENCE MEMBERS

REF MEMBER INCIDENCES

1	1	10
8	8	17
9	10	

D-7

pg. D-13

16 17 26
17 19 33
28 30 44
65 75 89
76 86 100
78 90 104
88 100 114
89 104 116
99 114 126
100 9 10
107 16 17
108 18 19
120 30 31
173 88 89
185 100 101
186 103 104
197 114 115

CPLC NO. 1307563

SB-254-6

2-18-81

\$ GENERATE MEMBERS

VARY MEMBERS IN SET 1 SIMULTANEOUSLY FROM 1 TO 9 BY 8
FROM 1 TO 8 BY 1

VARY MEMBERS IN SET 2 SIMULTANEOUSLY FROM 17 TO 65 BY 12
FROM 17 TO 28 BY 1

VARY MEMBERS IN SET 3 SIMULTANEOUSLY FROM 78 TO 89 BY 11
FROM 78 TO 88 BY 1

VARY MEMBERS IN SET 4 SEPARATELY FROM 100 TO 107 BY 1

VARY MEMBERS IN SET 5 SIMULTANEOUSLY FROM 108 TO 173 BY 13
FROM 108 TO 120 BY 1

VARY MEMBERS IN SET 6 SEPARATELY FROM 186 TO 197 BY 1

\$ DEFINE MEMBERS

MEMBER INCIDENCE

77 89 102
198 37 39
199 127 107
200 129 128
201 127 129
202 129 109
203 39 41

\$ DEFINE SUPPORTS

JOINT 1 TO 9,18 31 32 37 39 45 48 59 60 73 74 87 88 101 102 103 115 -
116 TO 126 128 -

STATUS SUPPORT

\$ RELEASE MOMENT AT SUPPORTS

JOINT RELEASES

1 TO 9,18 31 32 37 39 45 46 59 60 73 74 87 88 101 102 103,115 TO 126 -
MOM X,Y

37 39 KFZ 1745258.

\$ RELEASE VERTICAL STEEL MEMBER FROM HOR. STEEL MEMBER

MEMBER RELEASES START MOMENT X Y

198 199 202 203

MEMBER RELEASES END MOMENT Y

198

\$ DEFINE MEMBER PROPERTIES

MEMBER PROPERTY PRISHATIC

\$ MEMBER PROPERTY #1

100 TO 107, 186 TO 197 AX 90. IX 46.9 IY 927. SY 243.

\$ MEMBER PROPERTY #2

108 TO 115, 173 TO 185,121 TO 129,24,36,48,60,72,84,95 -

93,94,6,14,22,34,46,58,70,82 -

AX 30. IX 11. IY 309. SY 81.

\$ MEMBER PROPERTY #3

D-8

134 TO 172, 1 TO 4, 9 TO 12, 17 TO 20, 29 TO 32, 41 TO 44 -
 53 TO 56, 65 TO 68, 77 TO 80, 89 TO 92, 25 TO 27, 37 TO 39 -
 49 TO 51, 61 TO 63, 73 TO 75, 85 TO 87, 96 TO 98 -
 AX 60. IX 31.3 IY 618. SY 162.
 \$ MEMBER PROPERTY #4
 28,40,52,64,76,88,99 AX 45. IX 24. IY 464. SY 122.
 \$ MEMBER PROPERTY #5
 130 TO 133,7,15,23,35,47,59,71,83 AX 121.4 IX 125. IY 6152.
 \$ MEMBER PROPERTY #6
 198 199 202 203 AX 91.4 IX 109. IY 5843.
 \$ MEMBER PROPERTY #7
 8,16,116 TO 120 AX 40.9 IX 16. IY 309. SY 81.
 \$ MEMBER PROPERTY #8
 200 201 AX 91.4 IX 109. IY 1903.
 \$ MEMBER PROPERTY #9
 5,13,21,33,45,57,69,81 AX 151.4 IX 140.3 IY 6461.
 \$ DEFINE CONSTANTS
 CONSTANTS
 E 1350000. ALL
 G 540000. ALL
 DENSITY .0611 ALL
 \$ REQUEST A PLOT
 PLOT PLANE XY THROUGH JOINT 1
 \$ DEFINE INERTIA PROPERTIES
 INERTIA OF JOINTS LUMPED
 \$ STORE RESPONSE SPECTRA
 STORE RESPONSE SPECTRA ACCEL VS PERIOD 'DBE'
 DAMPING 0. FACTOR 386.
 .15 .001 .15 .007 .35 .026 .35 .034 .95 .041 .95 .70
 STORE RESPONSE SPECTRA ACCEL VS PERIOD 'OBE'
 DAMPING 0. FACTOR 386.
 .11 .001 .11 .009 .25 .026 .25 .036 .89 .043 .89 .70
 END OF RESPONSE SPECTRUM
 \$ DEFINE DYNAMIC LOADING
 DYNAMIC LOADING 1 & SUPPORT ACCEL & TRANSLATION Z FILE 'DBE' FACTOR .86
 DYNAMIC LOADING 2 & SUPPORT ACCEL & TRANSLATION Z FILE 'OBE' FACTOR .86
 END OF DYNAMIC LOADING
 \$ REQUEST DATA BE PRINTED
 PRINT DATA
 CONSISTENCY CHECK
 DUMP ORTHOGONALITY
 OUTPUT MODAL CONTRIBUTIONS
 \$ DEFINE DYNAMIC ANALYSIS
 DYNAMIC ANALYSIS MODAL 10 REDUCE
 \$ REQUEST OUTPUT
 LIST DYNAMIC EIGENVALUES EIGENVECTORS
 LIST DYNAMIC PARTICIPATION FACTOR
 OUTPUT DEC 3
 LIST DYNAMIC FORCES
 OUTPUT DEC 5
 LIST DYNAMIC DISPLACEMENT
 FINISH
 /*

CALC No. 13075-63

SB-254-6

2-18-81

6-9

ATTACHMENT E
ANALYSIS OF SINGLE WYTHE WALLS
SAMPLE CALCULATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

E-1/31

12/10/84 (FRONT)

CLIENT & PROJECT VERCO - <u>NORTH ANNA</u> UNITS 1 & 2				PAGE 1 TOTAL PAGES <u>21</u> ³²	
CALCULATION TITLE (Indicative of the Objective): BLOCK WALL REVIEW IE 80-11 - WALL # 58-254 - F				QA CATEGORY (✓) <input checked="" type="checkbox"/> I - NUCLEAR SAFETY RELATED <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> OTHER	
CALCULATION IDENTIFICATION NUMBER					
J.O. OR W.O. NO	DIVISION & GROUP	CURRENT CALC. NO	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.	
13075.63	Structural	^{13075.63-} 58-254-8	00300	N/A	
* APPROVALS - SIGNATURE & DATE					
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO OR NEW CALC NO	SUPERSEDES * CALC NO OR REV NO.	CONFIRMATION * REQUIRED (✓) YES NO
<i>James E. Foley</i> 9-13-80 9/26/80	<i>David M. Caron</i> Sept. 13, 80 9/26/80	<i>David M. Caron</i> Sept 13, 80 9/26/80	0	N/A	✓ <u>B</u>
<i>James E. Foley</i> 9-6-80	<i>James E. Foley</i> 9-1-80	<i>James E. Foley</i> 9-9-80	0	N/A	○ <u>B</u>
<i>James E. Foley</i> 9-9-80	<i>David M. Caron</i> Sept. 19, 1980	<i>David M. Caron</i> Sept. 19, 1980	0	N/A	○ <u>B</u>
<i>Ann Chymner</i> 2/18/81	<i>Boris Friedman</i> 2/24/81	<i>Boris Friedman</i> 2/24/81	1	N/A	○ <u>B</u>
<i>E. Parabue</i> 7.16.81	<i>M. Sayaborn</i> 7/17/81	<i>M. Sayaborn</i> 7/17/81	2	N/A	○ <u>B</u>
<i>Madison Zering</i> 9/10/81	<i>D. Palmer</i> 9/15/81	<i>D. Palmer</i> 9/15/81	3	N/A	✓
DISTRIBUTION *					
GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE)	J. FOLEY 245/14 Fire File 401	✓			

13075.63

SB-254-8

(1) 1

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PREPARED/DATE

J.W. FINIK / 9-13-80

REVIEWER/CHECKER/DATE

DREW M. CARON / SEPT. 13, 80

INDEPENDENT REVIEWER/DATE

DREW M. CARON / SEPT. 13, 80

SUBJECT/TITLE

BLOCK WALL, REVIEW TO 80-11

QA CATEGORY CODE CLASS

I/NSR

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REV. 1 CALCULATIONS	21 thru 31	△
REV. Stress Comparison Sheet	32	△
REV. Stress Summary Sheet	33	△

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/MGR

CHECK LIST - REQUIRED INFORMATION FOR MASONRY WALL DESIGN

Wall No. 58-254-B Natural Frequency 87.8 cpsRange: Rigid YES Resonant

G - Factors:	OBE	DBE	Relative Displ.	OBE	DBE
Horizontal	<u>.30</u>	<u>.43</u>	IN PLANE Horizontal	<u>N/A</u>	<u>.0028"</u>
Vertical	<u>.37</u>	<u>.55</u>	OUT OF PLANE Vertical	<u>.0025"</u>	<u>.0035"</u>

Req'd. Items	Information Available	If Not, Remarks on Req'd Information
Type & Size of Masonry Block	HOLLOW - LIGHTWT. BLOCK <u>8" $\frac{1}{2}$ 12" x 8" x 16"</u>	
Dimensions of Wall	<u>L = 8'-2" , H = 10'-3 1/2" . + - 1'-0" $\frac{1}{2}$</u>	
Boundary Cond.	<u>PINNED ON ALL 4 SIDES</u>	
Wall Function	<u>FIREWALL</u>	
Reinf. Details	<u>N/A</u>	
Attach. on Wall	<u>YES</u>	
Unusual Loads	<u>N/A</u>	
Mortar Type	<u>M OR S</u>	
No. of Wythes	<u>One</u>	
Type of Bond	<u>RUNNING BOND</u>	

DESIGNER: E. Parantus 7.1.81

CHECKER: M. SAYABOVORN 7/7/81

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

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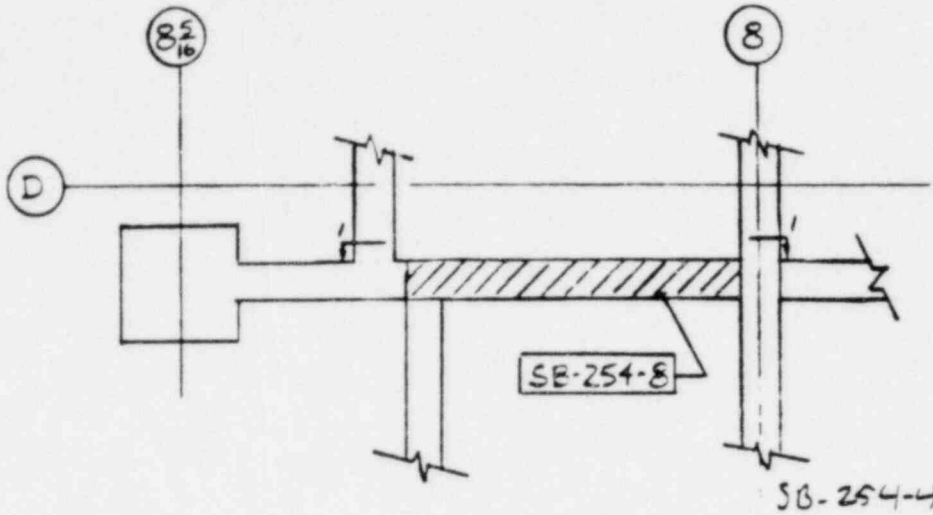
DREW M. CARON SEPT. 13, 80

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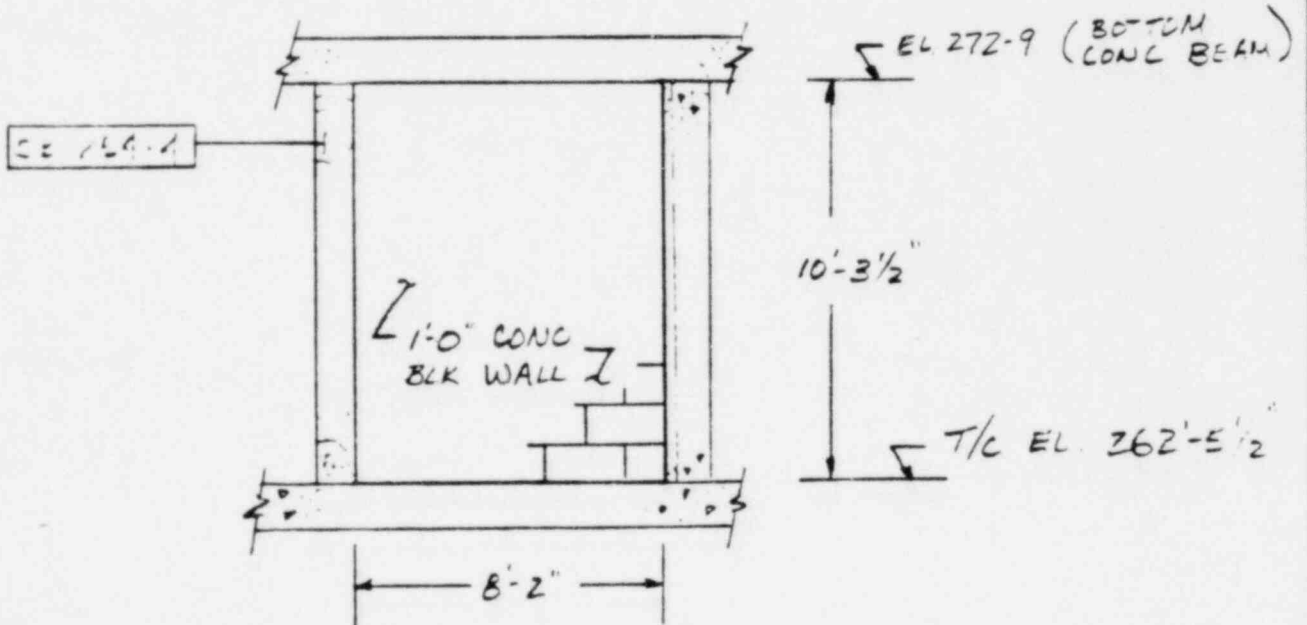
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I/NSR



KEY PLAN
(NTS)



1-1
ELEV LKG SOUTH

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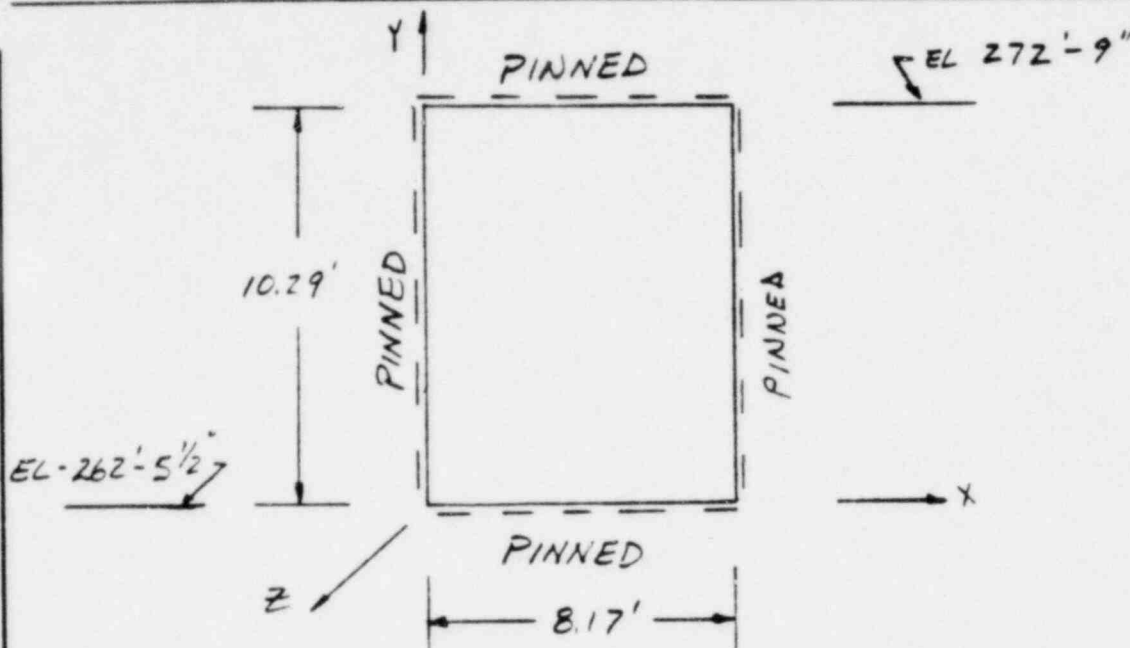
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ELECT. WALL REVIEW IE 80-11

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I/NSR



FREQUENCY CALCULATION

$$a/b = 8.17/10.29 = .79 \approx 0.8$$

TWO-WAY COEFFICIENTS

$$K_{LM} = 0.71$$

$$\beta_1 = .0626$$

$$K = \frac{212EI}{a^2}$$

$$\beta_2 = .0501$$

$$\gamma_1 = .71$$

$$\delta_2 = .29$$

BLOCK PROPERTIES

$$W = 49 \text{ psf}$$

$$I_{yy} = 930 \text{ in}^4$$

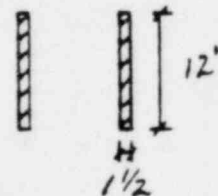
$$S_{yy} = 160 \text{ in}^3$$

$$A_{rect} = 64 \text{ in}^2$$

$$I_{xx} = 1090 \text{ in}^4$$

$$S_{xx} = 188 \text{ in}^3$$

$$A_H = .24 \text{ in}^2$$



$$f_n: K = \frac{212EI}{a^2} = \frac{212(1,350,000)(930)}{(8.17 \times 12)^2} = 27,691,468 \text{ #/1}$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{K_{LM} M_t}} = \frac{1}{2\pi} \sqrt{\frac{27,691,468 \times 386/12}{.71 \times 4119.39}}$$

$$= 87.8 \text{ cps} > f_c = 35 \text{ cps} \Rightarrow \text{RIGID}$$

$$M_t = \frac{12wab}{g} = \frac{(12)(49)(8.17)(10.29)}{386} = \frac{12 \times 4119.39}{386}$$

$$G_H^{DBE} = .43$$

$$G_V^{DBE} = .55$$

$$G_H^{DBE} = .30$$

$$G_V^{DBE} = .37$$

CALCULATION SHEET

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(NEW) K. CARON SEPT. 13, 80

SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

PART I: SEISMIC INERTIA STRESSES (DBE)

$$G_H = .43 \rightarrow q = G_H \times W = .43 \times 49 = 21.1 \text{ psf}$$

$$M_x = \beta_2 q a^2 = .0501 \times 21.1 \times (8.17)^2 = 70.6 \text{ #'}'$$

$$M_y = \beta_1 q a^2 = .0626 \times 21.1 \times (8.17)^2 = 88.2 \text{ #'}'$$

$$f_{wx} = M_x / S_x = 70.6 \times 12 / 188 = 4.5 \text{ psi}$$

$$f_{wy} = M_y / S_y = 88.2 \times 12 / 160 = 6.6 \text{ psi}$$

$$R_x = \delta_2 b / 2 = .29 \times 21.1 \times 10.29 / 2 = 31.5 \text{ #/1}$$

$$R_y = \gamma_1 a / 2 = .71 \times 21.1 \times 8.17 / 2 = 61.2 \text{ #/1}$$

HORIZONTAL SEISMIC SHEAR: f_v

$$f_v \text{ @ SIDES } R_y / A_H = 61.2 / 36 = 1.7 \text{ psi} \leftarrow \text{GOV}$$

$$\text{@ BOTTOM } R_x / A_v = 31.5 / 64 = 0.5 \text{ psi}$$

DEAD LOAD: f_{DL}

$$\text{@ MIDHEIGHT: } \frac{W \times h / 2}{A_n} = \frac{49 \times 10.29 / 2}{64} = 3.9 \text{ psi}$$

$$\text{@ BASE } W \times h / A_v = \frac{49 \times 10.29}{64} = 7.9 \text{ psi}$$

VERTICAL SEISMIC

$$f_{sv} = \frac{(G_v)(W)(h)}{2 A_v} = \frac{.55 \times 49 \times 10.29}{2 \times 64} = 2.2 \text{ psi}$$

AXIAL COMPRESSION: f_{cs}

$$\text{@ MIDHEIGHT: } f_{wx} + f_{DL} + f_{sv} = 4.5 + 3.9 + 2.2 = 10.6 \text{ psi}$$

$$\text{@ BASE: } f_{DL} + f_{sv} = 7.9 + 2.2 = 10.1 \text{ psi}$$

MAX TENSION \perp JT

$$f_{ts} = -f_{wx} + f_{DL} - f_{sv} = -2.8 \text{ psi}$$

MAX TENSION \parallel JT

$$f_{ts} = -f_{wy} = -6.6 \text{ psi}$$

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

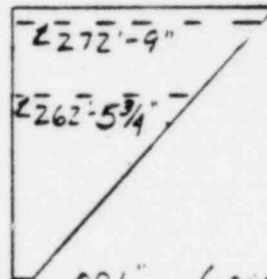
QA CATEGORY/CODE CLASS

I/NSR

PART II: INTERSTORY DISPLACEMENT (DBE)

N-S DISPLACEMENTS

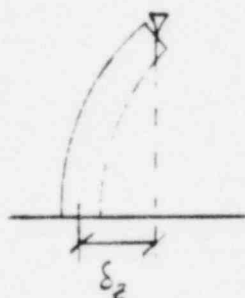
EL 274.0' ——— .01385" (.0095" for DBE)



EL 236.0' ——— .001" (.0004" for DBE)

$$\delta_2 = (10.29'/38') \times (.01385" - .001") = \boxed{.0035"} \text{ for DBE}$$

$$\delta_2 = (10.29'/38') \times (.0095" - .0004") = \boxed{.0025"} \text{ for DBE}$$



$$P_2 = \frac{\delta_2}{\frac{h^3}{3EI_v} + \frac{1.2h}{GA_n}}$$

$$= \frac{.0035}{\frac{(10.29 \times 12)^3}{3 \times 1,350,000 \times 1090} + \frac{1.2 \times 10.29 \times 12}{540,000 \times 64}}$$

$$= 8.1 \text{ \#/1}$$

SHEAR FROM DISPLACEMENT:

$$f_{dv} = P_2/A_n = 8.1/64 = \underline{0.1 \text{ psi}}$$

FLEXURAL STRESS AT MIDHEIGHT:

$$M_{dx} = P_2 h/2 = 8.1 \times 10.29/2 = 41.7 \text{ \#'-1'}$$

$$f'_{dx} = M_{dx}/S_x = 41.7 \times 12/188 = \begin{cases} \underline{2.7 \text{ psi}} & \text{@ MIDHEIGHT} \\ \underline{5.4 \text{ psi}} & \text{@ BASE} \end{cases}$$

PREPARED BY/DATE

J.E. HORAN 9-6-80

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J.W. FINIK 9-9-80

INDEPENDENT REVIEWER/DATE

J.W. FINIK 9-9-80

PROJECT/TITLE

WALL REVIEW

BULLETIN IE 80 11

QA CATEGORY / CODE CLASS

I / NSR

EQUIPMENT DESCRIPTION	EQUIPMENT SUPPORT CONDITION	FASTENER DESCRIPTION	P	Z	M _x	COMMENT
LOOKING SOUTH						
1"Ø CONDUIT			135.15			
3/4"Ø CONDUIT			33			
2"Ø CONDUIT			187.4			
③ 4"Ø CONDUIT			346.2			
⑧ ④ ⑨ 7-CONDUIT			201.64			
⑩ 3"Ø CONDUIT			76.4			
⑪ 4"Ø CONDUIT			346.2			
LOOKING NORTH						
3/4"Ø CONDUIT			13.07			
			1339.1			
		10%	133.9			
			1473			
			10			LIGHT
			1483#			

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

13075.63-SB-254-8

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J.W. FINIK / 9-9-80

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J.W. FINIK / 9-9-80

SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

ELEVATION LOOKING SOUTH

$$1" \phi \text{ CONDUIT} \quad 4 (16'-2") (2.09 \#/\text{FT}) = 135.15 \#$$

$$3/4" \phi \text{ CONDUIT} \quad 16'-2" (.65 \#/\text{FT}) = 10.5 \#$$

$$16'-2" (1.39 \#/\text{FT}) = 22.5 \#$$

$$2" \phi \text{ CONDUIT} \quad 38'-2" (4.91 \#/\text{FT}) = 187.4 \#$$

FIELD DATA NO. 3

$$4" \phi \text{ CONDUIT} \quad (2) 18'-3" (9.46 \#/\text{FT}) = 346.2 \#$$

FIELD DATA 8 & 9

2CC 950 RA

" " WA

" " WB

2CC 950 RB

2CX 001 RB

" " WA

2CX 001 EA

$$[4(1.98 \#/\text{FT}) + 3(2.48 \#/\text{FT})] (17.75') = 201.64 \#$$

FIELD DATA NO. 10

$$3" \phi \text{ CONDUIT} \quad 7 (10.91 \#/\text{FT}) = 76.4 \#$$

FIELD DATA NO. 11

$$4" \phi \text{ CONDUIT} \quad 2 (18.3') (9.46 \#/\text{FT}) = 346.2 \#$$

$$\underline{\underline{1325.99 \#}}$$

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J.W. FINIK / 9-9-80

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J.W. FINIK / 9-9-80

SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

ELEVATION LOOKING NORTH

$\frac{3}{4}$ " ϕ CONDUIT

9.4 (1.39 #/FT)

= 13.07 #

LIGHT

10 #

TOTAL WT →

$\frac{1325.99 \#}{13.07 \#}$

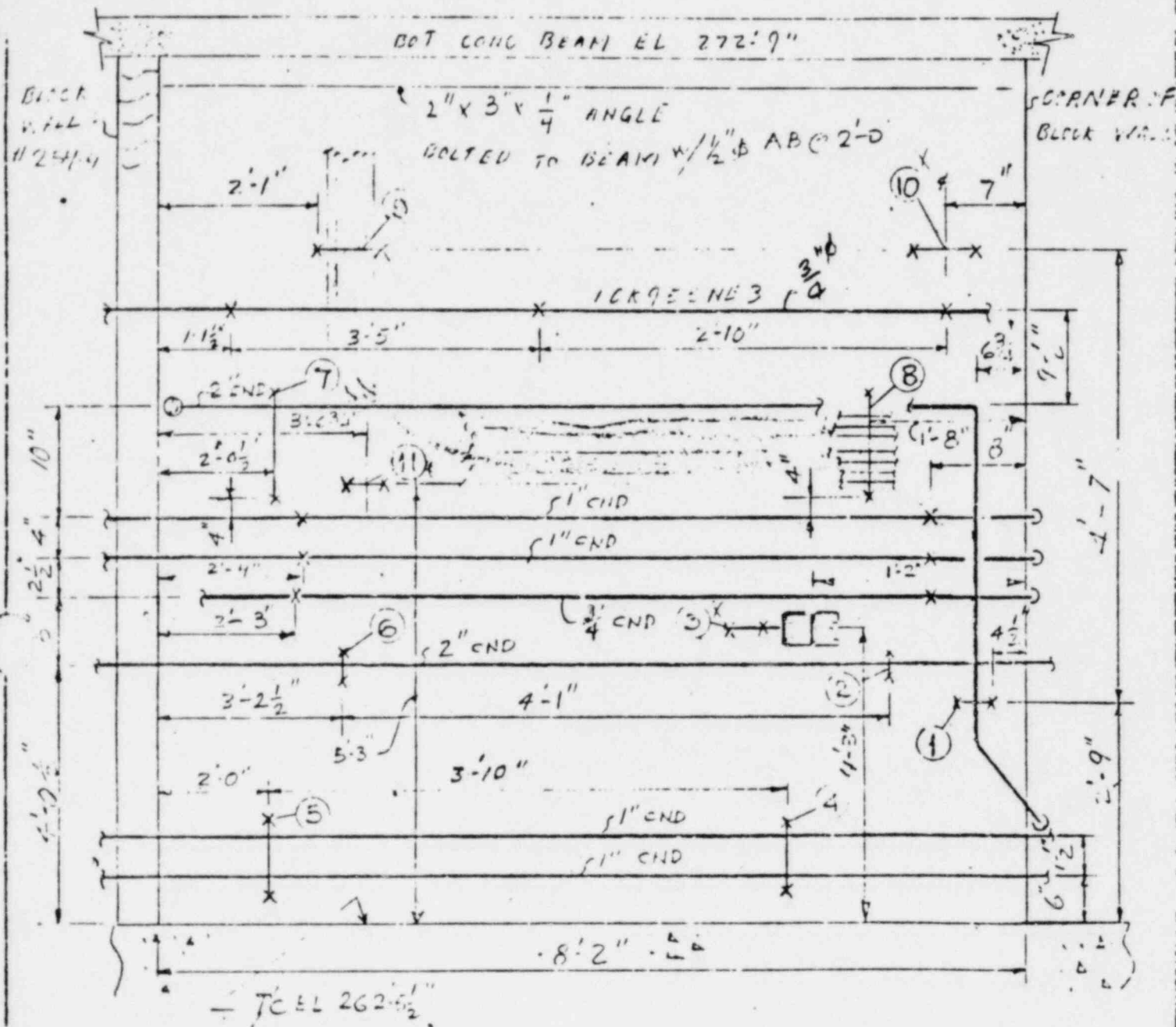
10%

$\frac{1339.06 \#}{133.9}$

$\frac{1473 \#}{10 \#}$

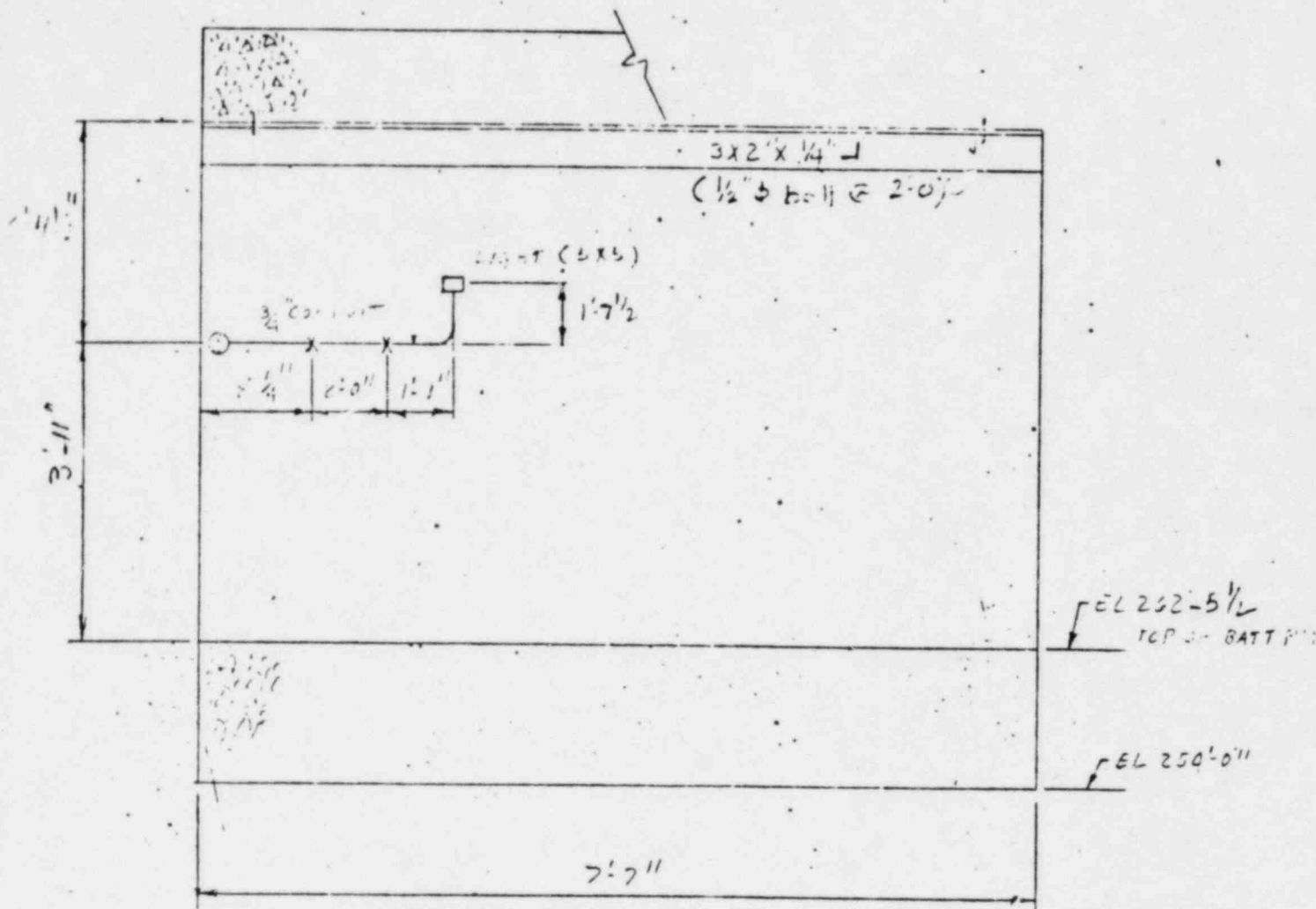
LIGHT

$\frac{1483 \#}{10 \#}$



FIELD DATA NO.

SIGNATURE			EXISTING ATTACHMENT AND EQUIPMENT ON MASONRY WALLS DETAILS	VEPCO UNIT <u>2</u>	
				<u>JO. 13075.63</u>	
BY	DATE			REF. <u>11715-FA-E-19</u>	
REF.				PROCEDURE <u>80-11</u>	
REV'D			BIDG ELEV WALLING SERVICE <u>254'-0" 254-</u>	SHEET <u>1</u> OF <u>13</u>	
REV'N					



STAIR WELL
ZKG NORTH

FIELD DATA NO.

SIGNATURE			EXISTING ATTACHMENT AND EQUIPMENT ON MASONRY WALLS DETAILS	VERCO UNIT 2	
BY	DATE			JO 13075.63	
PREP.				REF. 11715-FA-1E-19	
REV'D				PROCEDURE 80-11	
REV'D				SHEET 2 OF 13	
			BLOG	ELEV	WALL NO.

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DREW M. CARON SEPT. 19, 80

INDEPENDENT REVIEWER/DATE

(FE) M. CARON SEPT. 15, 80

SUBJECT/TITLE

KICK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

PART III: EQUIPMENT LOADS (DBE)

ESTIMATE EQUIPMENT LOAD TO BE UNIFORMLY DISTRIBUTED OVER THE FACE OF THE WALL

TOTAL LOAD ON WALL: $P^{EXT} = 1483^*$ (SEE SHEET 10)

UNIFORM SURFACE LOAD $W^{EXT} = \frac{P^{EXT}}{a \times b} = \frac{1483}{10.29 \times 8.17} = 17.6 \text{ psf}$

CONSERVATIVE - TAKE EQUIPMENT TO BE IN THE RESONANT RANGE:

$G_{DBE} = 1.95$ $G_{DBE} = 1.69$

$q^{(1)} = G_1 \times W^{EXT} = 1.95 \times 17.6 = 34.3 \text{ psf}$

$M_1 = K_1 q a^2 = .0501 \times 34.3 \times (8.17)^2 = 114.7^*$

$M_0 = K_0 q a^2 = .0626 \times 34.3 \times (8.17)^2 = 143.3^*$

$f_{mx} = M_1 / c_1 = 114.7 \times 12 / 188 = 7.3 \text{ psi}$

$f_{my} = M_0 / c_0 = 143.3 \times 12 / 160 = 10.7 \text{ psi}$

$R_1 = 8.2\% / 2 = .22 \times 34.3 \times 10.29 / 2 = 51.2^*$

$R_0 = 8.2\% / 2 = .71 \times 34.3 \times 8.17 / 2 = 99.5^*$

HORIZONTAL SEISMIC SHEAR: f_{vc}

@ SIDES: $R_0 / A_n = 99.5 / 6 = 2.8 \text{ psi} \rightarrow \text{GOV}$

@ BOTTOM: $R_1 / A_n = 51.2 / 64 = 0.8 \text{ psi}$

AXIAL COMPRESSION: f_{cc}

$f_{cc} = \text{MAX} \{f_{mx}, f_{my}\} = \text{MAX} \{7.3, 10.7\} \rightarrow f_{cc} = 10.7 \text{ psi}$

MAX TENSION \perp JT: $f_{cc} = -f_{mx} = -7.3 \text{ psi}$

MAX TENSION \parallel JT: $f_{cc} = -f_{my} = -10.7 \text{ psi}$

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INDEPENDENT REVIEWER/DATE

(J.E.W. CASH) / SEPT. 14, 80

SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY / CODE CLASS

I/NSR

OBE STRESSES

(FACTORED FROM DBE STRESSES USING G-FACTOR RATIOS)

$$\begin{aligned} G_{HDBE}^{DBE} &= .43 \\ G_{VDBE}^{DBE} &= .55 \end{aligned} \left. \vphantom{\begin{aligned} G_{HDBE}^{DBE} &= .43 \\ G_{VDBE}^{DBE} &= .55 \end{aligned}} \right\} \text{RIGID}$$

$$\begin{aligned} G_{HDBE}^{DBE} &= .30 \\ G_{VDBE}^{DBE} &= .37 \end{aligned} \left. \vphantom{\begin{aligned} G_{HDBE}^{DBE} &= .30 \\ G_{VDBE}^{DBE} &= .37 \end{aligned}} \right\} \text{RIGID}$$

$$\begin{aligned} G_{HDBE}^{DBE} &= 1.95 \text{ (RESONANCE)} \\ G_{VDBE}^{DBE} &= .0035 \end{aligned}$$

$$\begin{aligned} G_{HDBE}^{DBE} &= 1.69 \text{ (RESONANCE)} \\ G_{VDBE}^{DBE} &= .0025 \end{aligned}$$

I SEISMIC INERTIA

$$f_{ts} \parallel JT = -f_{my} = -6.6 \times \frac{.30}{.43} = -4.6 \text{ psi}$$

$$f_{ts} \perp JT = -f_{mx} + f_{DL} - f_{VS} = -4.5 \times \frac{.30}{.43} + 3.9 - 2.2 \times \frac{.37}{.55} = -0.7 \text{ psi}$$

AXIAL COMPRESSION

$$f_{cs} @ \text{MID-HEIGHT} = f_{ts} = f_{mx} + f_{DL} + f_{SV} = 4.5 \times \frac{.30}{.43} + 3.9 + 2.2 \times \frac{.37}{.55} = 8.5 \text{ psi}$$

$$@ \text{BASE} \quad f = f_{DL} + f_{SV} = 7.9 + 2.2 \times \frac{.37}{.55} = 9.4 \text{ psi}$$

HORIZONTAL SEISMIC SHEAR

$$f_v = 1.7 \times \frac{.30}{.43} = 1.2 \text{ psi}$$

II INTERSTORY DISPLACEMENT

$$f_{dv} = 0.1 \times \frac{.0025}{.0035} = 0.1 \text{ psi}$$

$$\begin{aligned} f_{dx} &= 2.7 \times \frac{.0025}{.0035} = 1.9 \text{ psi} @ \text{MID-HEIGHT} \\ &= 3.8 \text{ psi} @ \text{BASE} \end{aligned}$$

III EQUIPMENT LOADS

$$f_{tc} \parallel JT = -f_{my} = -10.7 \times \frac{1.69}{1.95} = -9.3 \text{ psi}$$

$$f_{te} \perp JT = -f_{my} = -7.3 \times \frac{1.69}{1.95} = -6.3 \text{ psi}$$

$$f_{ce} = f_{my} = 10.7 \times \frac{1.69}{1.95} = 9.3 \text{ psi}$$

$$f_{ve} = f_{re} = 2.8 \times \frac{1.69}{1.95} = 2.4 \text{ psi}$$

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J. FINIK / 9-10-80

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DREW M. CARON SEPT. 1980

INDEPENDENT REVIEWER / DATE

DREW M. CARON SEPT. 1980

SUBJECT / TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY / CODE CLASS

I / MSR

OBE/DBE COMPARISONI. INERTIAL STRESSES (psi)• f_{ts} (parallel to joint)

6.6

4.6

• f_{ts} (normal to joint)

2.8

0.7

• f_{cs} (at point of max. flexure)

10.6

8.5

• f_{vs}

1.7

1.2

• $(f_{ot} + f_{sv})$ using entire strip height

10.1

9.4

• $I_f (f_a - f_{sv}) < 40$ check

> 0

> 0

II. DISPLACEMENT STRESSES (psi)• f_{dx} (at base)

5.4

3.8

• f_{dv}

0.1

0.1

III. EXTERNAL LOAD STRESSES (psi)• f_{te} (parallel to jt.)

10.7

9.3

• f_{te} (normal to jt.)

7.3

6.3

• f_{ce}

10.7

7.3

• f_{ve}

2.8

2.4

GOVERNING :
EARTHQUAKE :

DBE



CBE



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INDEPENDENT REVIEWER/DATE

GEORGE HILLMAN 9-19-80

SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

REFINED FREQUENCY CALCULATION

DATA: $f_n(\text{WALL ALONE}) = 87.8 \text{ cps}$

$f_c = 35 \text{ cps}$

NEXT: $\frac{1483}{10.29 \times 8.17} = 17.6 \text{ psf}$

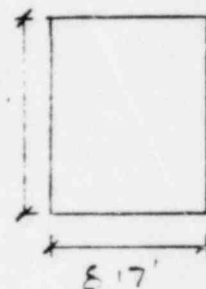
$w_{cl} = 49 \text{ psf}$

$w' = 49 + 17.6 = 66.6 \text{ psf}$

$$f_r = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{2 \times 60 \times 468 \times 320}{1.7 \times 66.6 \times 8.17 \times 12}} = 75.3 \text{ cps}$$

(% CHANGE: $\frac{75.3 - 87.8}{87.8} = 14\%$)

WALL REMAINS RIGID



IN-PLANE STRAIN (EAST-WEST DISPLACEMENT)

SINCE THE WALL IS LOCATED ENTIRELY BETWEEN ELEVATIONS 236.0' AND 274.0', THE STRAIN IS:

$$\epsilon = .000023 < \epsilon_{allow} = .0001$$

$$(\delta = \epsilon \times h = .000023 \times 10.29 \times 12" = .0028")$$

PASSED

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QA CATEGORY/CODE CLASS

I/NSR

PROJECT/TITLE

BLOCK WALL REVIEW - IE bulletin 80-11

ELABORATE COND.

[DBE]

computed stresses

(psi)

ALLOWABLE stresses (psi)

hollow	solid	solid and hollow blocks
$10\sqrt{f'_m}$	$10\sqrt{f'_m}$	$0.33f'_m$
42	21	44
21	$—$	298
$10\sqrt{f'_m}$	$10\sqrt{f'_m}$	$0.225f'_m$
42	21	298
$10\sqrt{f'_m}$	$10\sqrt{f'_m}$	$0.33f'_m$
42	21	44
21	$—$	298
$10\sqrt{f'_m}$	$10\sqrt{f'_m}$	$0.225f'_m$
42	21	298
$10\sqrt{f'_m}$	$10\sqrt{f'_m}$	$0.33f'_m$
42	21	44
21	$—$	298

Note: These values are not to exceed ACI 531-79 allow.

I) INERTIAL STRESS

o f_{is} (parallel to jt)

6.6

☒

☐

o f_{is} (normal to jt)

2.8

☒

☐

o f_{cs} (at point of max. flexure)

10.6

☒

o f_v

1.7

☒

o $(f_{cs} + f_v)$ using entire strip height

10.1

☒

o f_t (horizontal) check

> 0

☐

II) DISPLACEMENT STRESSES

o f_{ax} (at base)

5.4

☒

o f_{av}

0.1

☒

III) EXTERNAL LOAD STRESS

o f_{te} (parallel to jt)

10.7

☒

☐

o f_{te} (normal to jt)

7.3

☒

☐

o f_{te}

10.7

☒

☐

o f_{te}

2.8

☐

FURTHER ANALYSIS REQ'D
SEE REV. SMT, P. #32

Key:

- ✓ denotes acceptable
- ✗ denotes unacceptable
- denotes not applicable

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SUBJECT / TITLE

Block Wall Review IE 80-11

QA CATEGORY / CODE CLASS

I / NSR

COMBINED STRESS SUMMARY SHEET

1) Combined corner joint stress: $(f_{tj} + f_{vj} + f_{cj}) =$ psi

ALTERNATE stress

 psi

2) Max. tensile stress: $(f_{ts} + f_{tc}) =$ 17.3 psi
(parallel to joint)

42.4 psi

3) Max. tensile stress: $(f_{ts} + f_{tx} + f_{tc}) =$ 12.8 psi
(normal to joint)

21.2 psi

4) Max. Comp. stress:

a) If $[f_{tm} + f_{tv} + f_{tx} > f_{my}]$:

o $(f_{ts} + f_{tv} + f_{tx})$ at base = 15.5 psi

298 psi

o $(f_{ts} + f_{tx} + f_{tc})$ at pt of max. flex = 24.0 psi

298 psi

b) If $[f_{tm} + f_{tv} + f_{tx} < f_{my}]$:

o $(f_{ts} + f_{tv} + f_{tx})$ at base = psi

 psi

o $(f_{ts} + f_{tc})$ at pt of max. flex = psi

 psi

c) Max. shear stress: $(f_v + f_{dv} + f_{ev}) =$ 4.6 psi

40.4 psi

FURTHER ANALYSIS REQUIRED

SEE PAGE 28 33

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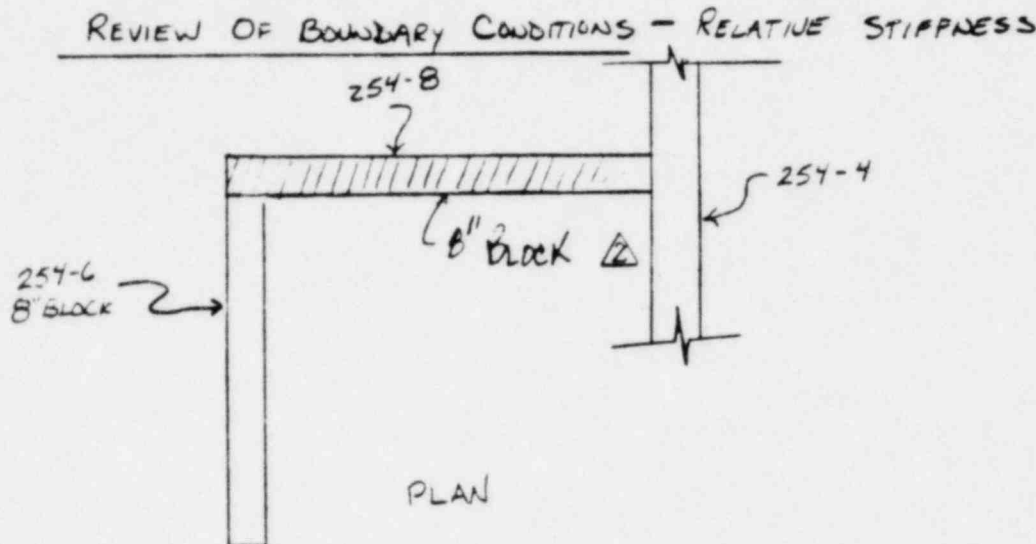
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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY / CODE CLASS

I/NSR



SPRING CONSTANT K OF BLOCK WALL SB-254-8 = 27,691,468 lb/ft from p. 7

K OF SUPPORT SHOULD BE 10 TIMES LARGER

$$K = \frac{wL}{\Delta} \text{ OF SUPP. WALL}$$

$$\Delta = \frac{wL^4}{185EI} \text{ FOR WALL FIXED AT BASE \& PINNED AT TOP}$$

→ WALL 254-6 IS 18' LONG, 20.5' HIGH

$$\Delta = \frac{(1)(20.5)^4}{185(1350,000)I}$$

$$I_{zz} = 2\left(\frac{1}{2}\right)(1.25)(18)(12)^3 \text{ NOT IN WEBS}$$

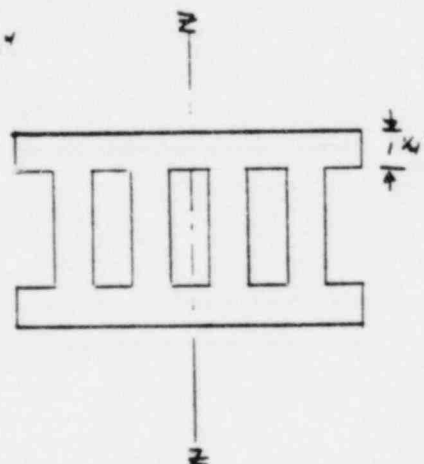
$$I = 2100000 \text{ in}^4$$

$$\Delta = 5.8 \times 10^{-7}$$

$$K = \frac{(1)(20.5)(12)}{5.8 \times 10^{-7}}$$

$$K = 4.24 \times 10^8$$

$$\frac{K_{SUPP.}}{K_{WALL}} = 15.3 > 10 \therefore \text{OK}$$



SINCE WALL 254-4 IS 12" AND SIGNIFICANTLY LONGER THAN WALL 254-6, IT WILL BE CONSIDERED STIFF ENOUGH WITHOUT FURTHER ANALYSIS.

CALCULATION SHEET

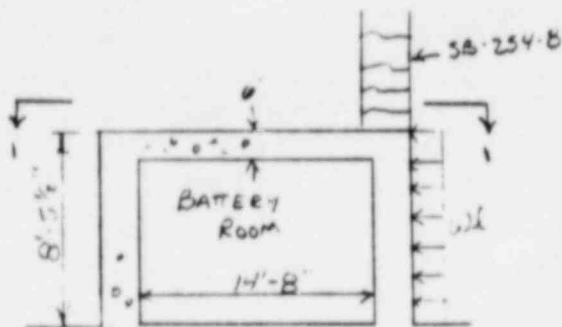
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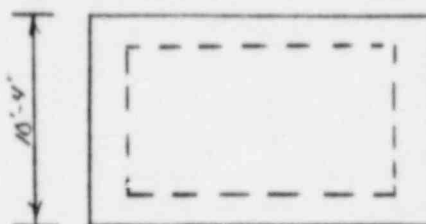
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SUBJECT/TITLE BLOCK WALL REVIEW IE-80-11		QA CATEGORY/CODE CLASS I/NSR	

BOUNDARY CONDITION - RELATIVE STIFFNESS

CHECK 8" REINF. CONC. WALL BELOW SB-254-B



ELEVATION



1-1

CONSIDER ENTIRE BATTERY ROOM FOR BOUNDARY STIFFNESS SINCE IT IS SMALL AND COVERED WITH A 6" REINF. CONCRETE SLAB. COMPUTE STIFFNESS OF BOX SHAPED CANTILEVER. NEGLECT BENEFIT OF BLOCK WALLS ABOVE BATTERY ROOM.

FROM P. 7, K OF SB-254-B = 27,691,468 lb/ft = 2.308×10^6 lb/in

STIFFNESS OF BATTERY ROOM:

$$I = \frac{bd^3}{12} = \frac{(124)(192)^3}{12} - \frac{(108)(170)^3}{12} = 2.407 \times 10^9 \text{ in}^4$$

$$\Delta = \frac{wL^4}{8EI} = \frac{1(8.5)^4 1728}{8(3200,000)(2.407 \times 10^9)} = 1.46 \times 10^{-8} \text{ in.}$$

$$K = \frac{wL}{\Delta} = \frac{1(8.5)}{1.46 \times 10^{-8}} = 5.82 \times 10^8$$

$$\frac{K_{Batt.}}{K_{Wall}} = \frac{5.82 \times 10^8}{2.308 \times 10^6} = 252 > 10 \therefore \underline{\underline{OK}}$$

REVISED POISSONS RATIO

STRESSES WERE NOT RECALCULATED USING A REVISED POISSONS RATIO OF 0.15 SINCE STRESS REDUCTIONS WERE NOT NECESSARY.

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SUBJECT/TITLE

BLOCK WALL REVIEW IE80-11

QA CATEGORY / CODE CLASS

I/NSR

REVISED BLOCK PROPERTIES BASED ON NO MORTAR
INTEGRITY IN WEB OF 2x8x16" HOLLOW BLOCKS

$$\begin{aligned} W &= 49 \text{ psf} \times 36 \times 2 \\ I_{xx} \lambda &= 929 \text{ in}^4/\text{ft} \\ S_{xx} \lambda &= 160 \text{ in}^3/\text{ft} \\ I_{yy} &= 929 \text{ in}^4/\text{ft} \\ S_{yy} &= 160 \text{ in}^3/\text{ft} \\ A_{nt} \alpha &= 36 \text{ in}^2/\text{ft} \end{aligned}$$

Where:

$$\begin{aligned} \lambda &= \text{REDUCTION FACTOR OF } I_{xx} = .8523 \\ \alpha &= \text{REDUCTION FACTOR OF } A_{nt} = .5625 \end{aligned}$$

VOIDED

REVISED DBE STRESSES NOT COMPUTED SINCE G FACTOR
COMPARISON SHOWS DBE WILL ALWAYS GOVERN.

NO CHANGE IN FREQUENCY SINCE FOUND USING I_{yy}

I DEAD LOAD & INERTIA STRESSES

$$\begin{aligned} q &= G_{HW} = .43 \times 49 = 21.1 \text{ psf} \\ M_x &= 70.6 \text{ ft} \cdot \text{lbs} \quad \left\{ \begin{aligned} M_x &= 0.0501 \times 15.48 \times 8.17^2 = 51.77 \\ M_y &= 85.2 \text{ ft} \cdot \text{lbs} \quad \left\{ \begin{aligned} M_y &= 0.0626 \times 15.48 \times 8.17^2 = 64.68 \end{aligned} \right. \end{aligned} \right. \\ (f_{ny})_{new} &= f_{ny} \lambda' = 1.5 \times (.8523) = 5.3 \text{ psi} \quad f_{my} = \frac{51.77 \times 12}{81} = 7.67 \text{ psi} \\ f_{ny} &= 6.6 \text{ psi} \quad f_{my} = \frac{64.68 \times 12}{81} = 9.60 \text{ psi} \\ R_x &= 31.5 \text{ lb/ft} \quad R_x = 0.29 \times 15.48 \times 10.29 = 23.1 \\ R_y &= 61.2 \text{ lb/ft} \quad \left\{ \begin{aligned} R_y &= 0.71 \times 15.48 \times \frac{8.17}{2} = 44.9 \end{aligned} \right. \end{aligned}$$

HORIZONTAL SEISMIC SHEAR f_v

$$\begin{aligned} (f_v)_{new} &= f_{v\alpha} \quad \left\{ \begin{aligned} @ \text{SIDES} &= 1.7 \times \text{NO CHANGE} \\ @ \text{BOTTOM} &= .5 (.5625) = .28 \text{ psi} \end{aligned} \right. \quad \text{STILL GOVERNS} \\ f_v &= \frac{R_y}{A} = \frac{44.9}{30} = 1.5 \text{ psi} \end{aligned}$$

DEAD LOAD f_{dl}

$$\begin{aligned} (f_{dl})_{new} &= f_{dl\alpha} \quad \left\{ \begin{aligned} @ \text{MIDHEIGHT} &= 3.9 (.5625) = 6.9 \text{ psi} \\ @ \text{BASE} &= 7.9 (.5625) = 14.0 \text{ psi} \end{aligned} \right. \quad \begin{aligned} W \cdot h/2 &= \frac{36 \times 10.29}{36 \times 2} \\ &= 5.15 \text{ (mh)} \end{aligned}$$

$$\text{VERTICAL SEISMIC: } f_{sv} = \frac{G_v \cdot W \cdot h}{2A} = \frac{0.55 \times 36 \times 10.29}{2 \times 36} = 5.15 \times 2 = 10.3 \text{ (BASE)}$$

$$(f_{sv})_{new} = f_{sv\alpha} = 2.2 (.5625) = 3.9 \text{ psi} \quad 2.83 \text{ psi}$$

AXIAL COMPRESSION: f_{cs}

$$\begin{aligned} @ \text{MIDHEIGHT: } f_{mx} + f_{dl} + f_{sv} &= 5.3 + 6.9 + 3.9 = 16.1 \text{ psi} \\ @ \text{BASE: } f_{dl} + f_{sv} &= 14 + 3.9 = 17.9 \text{ psi} \end{aligned}$$

MAX. TENS \perp JT

$$f_{ts} = -f_{mx} + f_{dl} - f_{sv} = -5.3 + 6.9 - 3.9 = -2.3 \text{ psi}$$

MAX TENS \parallel JT

$$f_{ts} = -f_{my} = -6.6 \text{ psi} \quad 9.6 \text{ psi}$$

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

II INTERSTORY DISPLACEMENT STRESS

N-S DISPLACEMENTS $\delta_2 = .0035"$

$$(P_2)_{NEW} = \frac{\delta_2}{\frac{1.2}{3E_s A_s} + \frac{1.2}{6A_n}} = \frac{.0035}{\frac{1.2}{3(1350,000)929} + \frac{1.2}{(540,000)36}} = \frac{.0035}{\frac{1.2}{3(1350000 \cdot 309)} + \frac{1.2}{540000 \cdot 36}} = 2.32 \Delta$$

$P_2 = 6.9 \Delta$ 2.32 16/ft Δ

SHEAR FROM DISPLACEMENT: f_{dv}

$$(f_{dv})_{new} = \frac{(P_2)_{new}}{A_{nd}} = \frac{6.9}{36} = 0.19 \text{ PSI}$$

$\frac{2.32}{36} = 0.08 \text{ PSI}$ Δ

FLEXURAL STRESS AT MIDHEIGHT:

$$M_{dy} = P_2 h/2 = \frac{6.9 \times 10.29}{2} = 35.5 \text{ ft-lb/ft}$$

$$f_{dx} = M_{dy}/S_x = \frac{35.5 \times 12}{100} = 4.26 \text{ PSI}$$

$$f_{dy} = \frac{2.32 \times 10.29}{2} = 11.94 \Delta$$

$$\frac{11.94 \times 12}{81} = 1.77 \text{ PSI} \Delta$$

AT BASE = 3.54 PSI Δ

III EQUIPMENT LOAD STRESSES

$P = 1483 \text{ lbs}$

DISTRIBUTE UNFORMELY ON WALL $\rightarrow W'' = 17.6 \text{ lb/ft}^2$

$q_{ext} = 34.3 \text{ lb/ft}^2$

$$M_x = 114.7 \text{ lb-ft} \Delta \quad f_{mx} = \frac{114.7 \times 12}{81} = 17.0 \Delta \quad f_{my} = \frac{143.3 \times 12}{81} = 21.2 \text{ PSI} \Delta$$

$M_y = 143.3 \text{ lb-ft}$

$$(f_{ex})_{new} = (f_{ex})_{old} = 7.3 (.8523)^{-1} = 8.6 \text{ PSI}$$

$f_{ey} = 10.7 \text{ PSI}$

$R_x = 51.2 \text{ lb/ft}$

$R_y = 99.5 \text{ lb/ft}$

HORIZONTAL SEISMIC SHEAR: f_{vc}

$$(f_{vc})_{new} = f_{vc} = 28 \text{ PSI}$$

$$\text{@ BASE} = .8 (.5625)^{-1} = 1.4 \text{ PSI}$$

$$\frac{99.5}{30} = 3.32 \text{ PSI} \Delta$$

$$\frac{51.2}{30} = 1.7 \Delta$$

AXIAL COMPRESSION: f_{cc}

$$f_{cc} = \text{MAX} \{ f_{ex}, f_{ey} \} = 10.7 \text{ PSI} \quad 21.2 \text{ PSI} \Delta$$

MAX TENS \perp JT:

$$f_{te} = -f_{ex} = -8.6 \text{ PSI} \quad 17.0 \text{ PSI} \Delta$$

MAX TENS \parallel JT:

$$f_{tc} = -f_{ey} = -10.7 \text{ PSI} \quad 21.2 \text{ PSI} \Delta$$

DESIGNER: S. Friedman 7.1.81 CHECKER: M. SAYABOVORN 7/7/81

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SUBJECT/TITLE BLOCK WALL REVIEW IE 80-11		QA CATEGORY/CODE CLASS I/NSR

BLOCK PULLOUT ANALYSIS

$$1" \phi \text{ CONDUIT} - AL = .98 \text{ lbs/ft}$$

$$2" \phi \text{ CONDUIT} - AL = 2.48 \text{ lb/ft}$$

$$\text{CONSIDER LENGTH OF } 1" \phi = 4 \left(\frac{12.75}{2} \right) = 35.5' \quad P = 34.8 \text{ lbs}$$

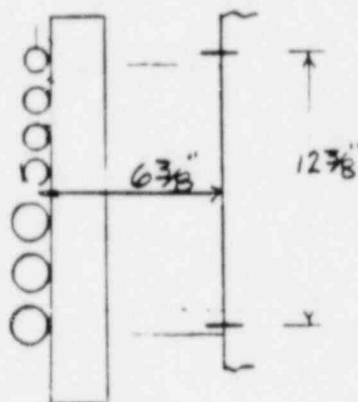
$$2" \phi = 3 \left(\frac{12.75}{2} \right) = 26.6' \quad P = 66.0 \text{ lbs}$$

$$100.8 + 10.0 = 110 \text{ lbs.}$$

CONSIDER LOAD $P = 110^P$ ACTS AT GEOMETRIC CENTER OF EQUIPMENT

$$G_v = 0.98$$

$$G_H = 1.95$$



MAX TENS. IN TOP ANCHOR:

$$\frac{[110 + (110 \times .98)] \times 6.37}{12 \frac{3}{8}} + \frac{110 \times 1.95}{2} = 219.4 \text{ lbs}$$

$$\text{ALLOWABLE} = 286 > 219.4 \quad \text{OK}$$

FIELD DATA NO 9

$$3/4" \phi = .65 \text{ lb/ft} \quad L = 4 \left(\frac{12.75}{2} \right) = 35.5' \quad P = 23.1$$

$$1 1/2" \phi = 1.75 \text{ lb/ft} \quad L = 3 \left(\frac{12.75}{2} \right) = 26.6' \quad P = 46.6$$

$$P1000 \text{ UNISTRUT} = 3.8 \text{ lb/ft} \quad L = 13.3' \quad P = 50.5$$

$$P = 120.2$$

CONSIDER Z DIRECTION SINCE SINGLE ROW OF BOLTS (5/16" X 11 1/2")

$$P_z = 120.2 \times 1.95 = 234.4 < \text{ALLOWABLE}$$

$$P_x = 234.4 \text{ APPLIED AT GEOMETRIC CENTER}$$

$$\text{MAX TENS PER ANCHOR} = \frac{234.4 \times (15.125)}{3 \times 13.3} = 90.9 \text{ lbs} < \text{ALLOWABLE}$$

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I/NSR

FIELD DATA NO 11 CHECK 10 & DIR. ONLY

$$4" \phi \text{ CONDUIT} - 9.46 \text{ lb/ft} \quad L = (18.3/2) 2 = 18.3$$

$$P = 173.1 \text{ lbs ON SURF}$$

$$P_e = 173.1 \times 1.95 = 337.6 \text{ lbs}$$

$$\frac{P_e}{N} = \frac{337.6}{2} = 168.8 \text{ lbs} < 286 = \text{ALLOWABLE}$$

POSITIVE PRESSURE

THE PRESSURE MAINTAINED IN THE CONTROL ROOM IS ONLY 0.26 PSF. THIS IS NEGLIGIBLE AND WILL NOT AFFECT CALCULATED STRESS.

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BLOCK WALL REVIEW IE 80-11

QA CATEGORY/ CODE CLASS

I/NSR

GLOBAL ANALYSIS FOR CONCENTRATED EQUIPMENT LOADS

CHECK FIELD DATA NO. 9 (HEAVIEST EQUIP. LOAD)

$$P = 120.2 \text{ lbs (PAGE 25)}$$

$$P_z = P G_H = (120.2)(1.95) = 234.4 \text{ lbs, CONSIDER AS CONCENTRATED LOAD}$$

FROM CONCRETE ENGR HANDBOOK, REF 4
DISTRIBUTE LOAD P ON WALL WITH $r = \frac{0.25}{8.17} = 1.26$.

BY INTERPOLATION OF TABLE 9-6 FOR
 $y/L_T = \frac{6.96}{10.29} = .29$ AND $\frac{7.33}{8.17} = .41$

DISTRIBUTION OF LOAD IN L-DIRECTION = .60

$$\therefore P_x = 234.4 \times .60 = 140.6 \text{ lbs}$$

$$P_y = 234.4 \times (1 - .60) = 93.8 \text{ lbs}$$

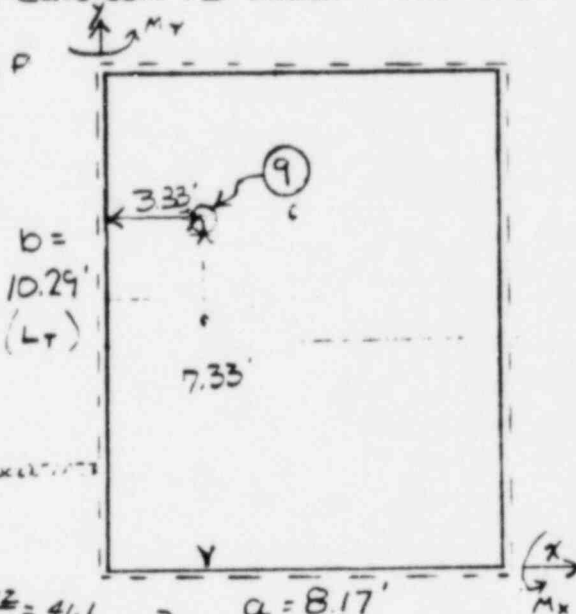
CONSIDER 1' STRIP AS SIMPLY SUPPORTED BEAM W/ CONCENTRATED LOAD P

$$M_y = \frac{P_x b}{L} = \frac{(140.6)(3.33)(4.84)}{8.17} = 277.4 \text{ lb-ft}$$

$$f_{m_y} = \frac{277.4 \times 12}{160} = 20.8 \text{ PSI}$$

$$M_x = \frac{P_y a}{L} = \frac{(93.8)(2.96)(7.33)}{10.29} = 197.8 \text{ lb-ft}$$

$$f_{m_x} = \frac{197.8 \times 12}{160} = 14.8 \text{ PSI}$$



CHECK ALL STRESSES AT POINT OF CONCENTRATED LOAD

INTERFER DEAD LOAD

|| TO JT. $M_y = W \frac{1}{2} (1 - \frac{1}{L}) B p$ WHERE $W = q b = (21.1)(8.17) = 172.4$ Δ
 $z = 3.33, L = 8.17$
 $p = .0023$ FROM AT 4.2

$$M_y = 84.8$$

$$f_{m_y} = \frac{84.8 \times 12}{160} = 6.4 \text{ PSI}$$

$$\frac{62.19 \times 12}{81} = 9.21 \text{ } \Delta$$

⊥ TO JT. $M_x = W \frac{1}{2} (1 - \frac{1}{L_T}) 8r$
 $W = q a = (21.1)(10.29) = 217.1$
 $y = 7.33, L_T = 10.29$
 $r = .0261$

$$M_x = 47.8$$

$$f_{m_x} = \frac{47.8 \times 12}{160} = 3.6 \text{ PSI}$$

$$\frac{35.1 \times 12}{81} = 5.2 \text{ } \Delta$$

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CHECKER: M. SAYABOVON 7/17/81 Sup

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

13075.63

SB-254-B

REVISION

① 2

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PREPARED/DATE

A. CHEZMAR 2-18-81

REVIEWER/CHECKER/DATE

BOTIS Friedman 2/24/81

INDEPENDENT REVIEWER/DATE

Boris Friedman 4/24/81

SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY / CODE CLASS

I/NSR

INERTIA & DEAD LOADS (CONT)

DEAD LOAD AT POINT OF CONC. LOAD

$$\begin{aligned} f_{DL} &= \frac{14 \text{ PSI}}{10.3} @ \text{Base} 2.96 \\ f_{DL} &= \frac{2.96}{10.29} (14) = 4.0 \text{ PSI} \end{aligned} \quad \Delta$$

DESIGNER: E. Parake 7.98,

CHECKER: M. Sayaborn 7/3/81

VERTICAL SEISMIC

$$f_{SV} = 3.9 \text{ PSI} = \text{CONSTANT}$$

INTERSTORY DISPLACEMENT AT POINT OF CONC. LOAD

$$\begin{aligned} f_{dx} &= \frac{5.4 \text{ PSI}}{3.54} @ \text{Base} \\ f_{dx} &= \frac{5.4}{3.54} = 1.6 \text{ PSI} \end{aligned} \quad \Delta$$

EXTERNAL LOAD STRESS AT POINT OF CONC. LOAD

$$\begin{aligned} \parallel \text{ TO JT} \quad M_y &= W \frac{1}{2} (1 - \frac{1}{4}) 8P \quad W = qb = (34.3)(8.17) = 280.2 \\ M_y &= 137.7 \end{aligned}$$

$$f_{ey} = \frac{137.7 \times 12}{100 \times 81} = 10.3 \text{ PSI} \quad 20.4 \quad \Delta$$

$$\begin{aligned} \perp \text{ TO JT} \quad M_x &= W \frac{1}{2} (1 - \frac{1}{4}) 8P \quad W = qa = (34.3)(10.29) = 352.9 \\ M_x &= 77.7 \end{aligned}$$

$$f_{ex} = \frac{77.7 \times 12}{100 \times 81} = 5.8 \text{ PSI} \quad 11.5 \quad \Delta$$

$$\begin{aligned} \text{INERTIA: MAX TENS } \perp &= -f_{mx} - f_{sv} + f_{DL} = -3.5 : f_{+s} \quad \Delta \\ \text{MAX. TENS } \parallel &= -f_{my} \quad 6.4 : f_{+s} = 9.24 \end{aligned}$$

$$\begin{aligned} \text{EX. LOADS (INC. CONC.) MAX. } \perp &= -f_{mx} - f_{ey} = -29.5 - 11.5 = -40.8 \quad \Delta \\ &= -17.8 - 5.8 = -20.6 = f_{+e} \\ \parallel &= (-f_{my})_{conc} - f_{ey} = -20.8 - 10.3 = -31.1 \text{ PSI} = f_{+e} \\ &= -41.1 - 20.4 = -61.5 \quad \Delta \end{aligned}$$

SUMMARY AT POINT OF CONC. LOAD (FIELD DATA #9)

$$\begin{aligned} \text{MAX. TENSILE STRESS } \perp &= f_{+s} + f_{+e} + f_{dx} \\ &= 3.5 + 20.6 + 1.6 = 25.7^* \text{ PSI} < 21.2 (\frac{4}{3}) = 28.3 \quad \Delta \end{aligned}$$

$$\begin{aligned} \text{MAX. TENSILE STRESS } \parallel &= f_{+s} + f_{+e} \\ &= 6.4 + 31.1 = 37.5^* \text{ PSI} < 42.4 = \text{ALLOWABLE} \quad \Delta \end{aligned}$$

* THESE VALUES ARE CONSERVATIVE SINCE GLOBAL EXTERNAL LOAD STRESSES WERE ADDED TO THE CONC. LOAD STRESS. (SEE PP. 30-31)

N.G.

65' travel

$$5.07 + 40.8 + 1.02 = 46.89 > 28.3$$

(w/ K=1.33)

INCREASE ALLOWABLE BY 1/3

$$9.21 + 61.5 = 70.71 > 42.4$$

67%

0.57%

N.G.

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SUBJECT/TITLE BLOCK WALL REVIEW - IE 80-11		QA CATEGORY/CODE CLASS I/NSR	

LOCAL STRESS CALCULATIONS

FIELD DATA No. 8 $P = 110.163$ (page 25)

$$M_y = P_y z \quad P_y = 110 + (110 \times .98) = 217.8 \text{ lcs}$$

$$z = 6.37$$

$$M_x = 1387.4 \text{ lcs in}$$

$$S_x = 160 \text{ in}^3$$

$$f_{m3} = 8.7 \text{ psi}$$

f_{cy} FOR GLOBAL EQUIP. ANALYSIS = 8.6 PSI

\therefore STRESSES NEED NOT BE RECALCULATED

FIELD DATA No. 9 $P = 120.2 \text{ lcs}$

$$M_y = P_y z \quad P_y = (120.2)(1.95) = 234.4$$

$$z = 15.12$$

$$M_y = 3544.1 \text{ lcs in}$$

$$f_{m3} = 22.2 \text{ PSI}$$

f_{cy} FOR GLOBAL EQUIP. ANALYSIS = 10.7 PSI

\therefore CHECK SUMMATION OF INERTIAL & LOCAL STRESS @ THIS POINT

$$f_{m3} (\text{INERTIAL @ POINT OF LOAD}) = 6.3 \text{ PSI}$$

$$22.2 + 6.3 = 28.5 \text{ PSI} < 42.4 = \text{ALLOWABLE}$$

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M. Kuyalov 7/17/81

INDEPENDENT REVIEWER/DATE

M. Kuyalov 7/17/81

SUBJECT/TITLE

ROBLOC WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

GLOBAL ANALYSIS FOR CONCENTRATED EQUIPMENT LOAD

$$P = 120.2^{\#}$$

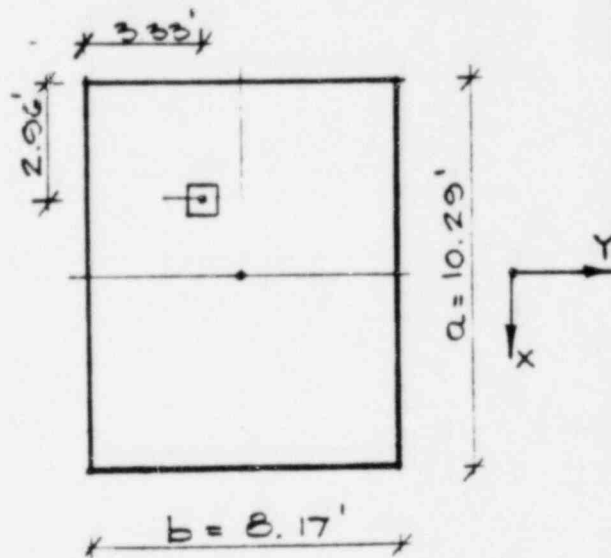
$$P_z = P \cdot G_H = 120.2 \cdot 1.95 = 234.4^{\#}$$

$$P_y = 234.4 \cdot 0.6 = 140.6^{\#}$$

$$P_x = 234.4 \cdot (1 - 0.6) = 93.8^{\#}$$

(SEE P. 27)

PINNED ON 4 SIDES



$$y/b = \frac{3.33}{8.17} = 0.4; \quad x/b = \frac{2.96}{8.17} = 0.36$$

$$\gamma = \frac{a}{b} = 1.26 \text{ (SAY 1.2)}$$

$$K \begin{cases} M_{x \text{ MAX}} = 0.2936 \\ M_{y \text{ MAX}} = 0.303 \end{cases}$$

$$M_x = 0.2936 \cdot \frac{93.8 \cdot 3.33 \cdot 4.87}{8.17} = 54.7^{\#}$$

$$M_y = 0.303 \cdot \frac{140.6 \cdot 2.96 \cdot 7.33}{10.29} = 89.8^{\#}$$

$$f_{Mx} = \frac{54.7 \cdot 12}{81} = 8.1 \text{ PSI}$$

$$f_{My} = \frac{89.8 \cdot 12}{81} = 13.3 \text{ PSI}$$

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M. Szabo 7/17/81

SUBJECT/TITLE

POLLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

SUMMARY AT POINT OF CONC. LOAD

$$\begin{aligned} \text{MAX TENSILE STRESS I: } f_{ts} + f_{te} + f_{dx} &= \\ &= 5.07 + 19.6 + 1.02 = 25.69 < 28.3 \text{ O.K.} \end{aligned}$$

$$\begin{aligned} \text{MAX TENSILE STRESS II: } f_{ts} + f_{te} &= \\ &= 9.21 + 33.7 = 42.91 \approx 42.4 (1.2\%) \text{ O.K.} \end{aligned}$$

FOR REVISED EXTERNAL LOAD STRESSES SEE P. 28

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

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45010 61

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A CHEZMAR 1/27/81

REVIEWER / CHECKER / DATE

Boris Friedman 2/12/81

INDEPENDENT REVIEWER / DATE

Boris Friedman 2/12/81

SUBJECT / TITLE

Black Wall Review - IE Bulletin 80-11

QA CATEGORY / CODE CLASS

I / NSR

EARTHQUAKE LOAD. [DBE]	ALLOWABLE STRESS (psi)	CHECKING COMPUTED STRESSES					
		hollow	solid	solid and hollow blocks			
I) INERTIAL STRESS	9.61						
o f_y (parallel to jt)	6.6	✓	—				
o f_y (normal to jt)	2.3	✓	—				
o f_{cs} (at joint of max. flexure)	15.65	2	✓	✓			
o f_v	1.7	13/13	2	✓			
o (bal + f_v) using entire cripp height	17.9			✓			
o If (bal + f_v) < 0 check	70	—	—				
II) DISPLACEMENT STRESSES							
o f_{ax} (at base)	35.4	2	✓	✓			
o f_{ax}	5.4	✓	—	✓			
o f_{ax}	0.2	0.08	2	✓			
III) EXTERNAL LOAD STRESS							
o f_{ce} (parallel to jt)	21.2	2	✓	—			
o f_{ce} (normal to jt)	10.7	✓	—	—			
o f_{ce} (normal to jt)	17.02	✓	—	—			
o f_{ce}	8.6	2	✓	✓			
o f_{ce}	21.2	2	✓	✓			
o f_{ce}	10.7	2	✓	✓			
o f_{ce}	3.34	2	✓	✓			
o f_{ce}	2.8	2	✓	✓			

REVIEW OF DESIGN PROPERTIES

CHECKING COMPUTED STRESSES

Note: These

values are

not to

exceed ACI

531-79.1.

ALLOW.

DESIGNER:

B. Friedman

7.1.81

CHECKER:

M. Sayabovdan

7/7/81

Key:

✓ denotes acceptable

x denotes unacceptable

— denotes not applicable

CALCULATION SHEET

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SUBJECT / TITLE BLOCK Wall Review IE 80-11		QA CATEGORY / CODE CLASS I / N/R	

COMBINED STRESS SUMMARY SHEET
REVIEW OF BLOCK PROPERTIES

1) Combined axial joint stress: $(f_{ts} + f_{cjd} + f_{cjc}) =$	$\frac{N/A}{961 + 21.2 \cdot 2}$	psi	$\frac{N/A}{961 + 21.2 \cdot 2}$	psi
	$6.6 + 10.7$	$30.81 \cdot 2$		
2) Max. tensile stress: (parallel to joint)	$(f_{ts} + f_{tc}) =$	17.3	psi	42.4
	$5.35 + 1.77 + 17.0$	$24.12 \cdot 2$		
3) Max. tensile stress: (normal to joint)	$(f_{ts} + f_{tx} + f_{tc}) =$	13.6	psi	21.2
	$2.3 + 2.7 + 8.6$			(13.6 / OVERSTRESSED) < 50% O.K.
4) Max. Comp. stress:				
a) If $[f_{mx} + f_{dx} + f_{sv} > f_{my}]$:				
o $(f_{dx} + f_{sv} + f_{tx})$ at base	$17.9 + 5.4$	$13.13 + 3.5 \cdot 2$	$16.67 \cdot 2$	298
	23.3	psi		
o $(f_{cs} + f_{dx} + f_{cc})$ at pt. of max. flex	$16.1 + 2.7 \text{ OR } 10.7$	$15.65 + 1.77 + 21.2 \cdot 2$	$38.62 \cdot 2$	298
	29.5	psi		
b) If $[f_{mx} + f_{dx} + f_{sv} < f_{my}]$:				
o $(f_{dx} + f_{sv} + f_{tx})$ at base	N/A	psi	N/A	psi
o $(f_{cs} + f_{cc})$ at pt. of max. flex	$1.5 + 3.32 = 4.82$	$4.82 \cdot 2$		
	$17 + 0.2 + 2.8$	4.7	psi	40.4
5) Max shear stress: $(f_v + f_{dv} + f_{ev}) =$	4.7	psi	40.4	psi

DESIGNER: E. Parauluc 7.1.81
CHECKER: M. SAYABOVORN 7/7/81

ATTACHMENT F
ANALYSIS OF MULTIPLE WYTHE WALLS
SAMPLE CALCULATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

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CALCULATION TITLE (Indicative of the Objective): BLOCK WALL REVIEW IE 30-11 - WALL # AB-291-B				QA CATEGORY (✓) <input checked="" type="checkbox"/> I - NUCLEAR SAFETY RELATED <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> OTHER	
CALCULATION IDENTIFICATION NUMBER					
J. O. OR W.O. NO 13075.63		DIVISION & GROUP Structural		CURRENT CALC NO AB-291-8	
		OPTIONAL TASK CODE 00100		OPTIONAL WORK PACKAGE NO N/A	
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				CONFIRMATION * REQUIRED (✓) YES NO	
J. Foley 9-26-80		Drew M. Canon Sept. 26, 80		0 N/A (✓) (✓)	
George Hillman 9-19-80		George Hillman Sept. 19, 1980		0 N/A (✓) (✓)	
M. E. Walker 9-19-80		M. E. Walker 09/19/80		0 N/A (✓) (✓)	
Hadi Barghout 02-25-81		Hadi Barghout 02/25/81		1 N/A (✓) (✓)	
Lev Bantman 5/19/81		Lev Bantman 5/20/81		1 N/A (✓) (✓)	
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CALCULATION TITLE (Indicative of the Objective): BLOCK WALL REVIEW IE 80-11 WALL & AB-291-0					QA CATEGORY (✓) <input checked="" type="checkbox"/> I - NUCLEAR SAFETY RELATED <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> OTHER	
CALCULATION IDENTIFICATION NUMBER						
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M.D. Coffey 10/9/81	Robert J. Tolman 10/9/81	Robert J. Tolman 10/9/81	3	MA	✓	
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AB-291-8

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2-13

PREPARED/DATE

JOHN FINIK / 9-19-80

REVIEWER/CHECKER/DATE

DREW M. CARON / SEPT. 19, 80

INDEPENDENT REVIEWER/DATE

DREW M. CARON / SEPT. 19, 80

SUBJECT/TITLE

BLOCK WALL, SECTION 1E 80-11

QA CATEGORY / CODE CLASS

1/NR

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JO. 13075.63 AB-291-8 X 1 4 F-4
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 REVIEWER/CHE. FR. DATE: DREW M. CARON / SEPT 19, 80
 INDEPENDENT REVIEWER/DATE: DREW M. CARON / SEPT 19, 80
 SUBJECT/TITLE: BLOCK WALL, REVIEW TO 80-11
 QA CATEGORY/CODE CLASS: 1/MSR
 PREPARED: A Cheedow 2-25-81
 CHECKED: Hado Banger 02/28/81 (GR)

CHECK LIST - REQUIRED INFORMATION FOR MASONRY WALL DESIGN

Wall No. AB-291-8 Natural Frequency 23.5 CPD 25.4 8/2

Range: Rigid ☒ Resonant ☐

G - Factors:	OBE	DRE	Relative Displ.	OBE	DRE
Horizontal	<u>.21</u>	<u>.48</u>	<u>1 P</u>	<u>N/A</u>	<u>N/A</u>
Vertical	<u>.35</u>	<u>.30</u>	<u>0 P</u>	<u>N/A</u>	<u>N/A</u>

Req'd. Items	Information Available	If Not, Remarks on Req'd. Information
Type & Size of Masonry Block	3 @ 6" x 8" x 16" = 18" THICK SOLID NORMALWEIGHT BLOCK	
Dimensions of Wall	t = 1'-6", L = 15'-6 3/4", H = 8'-0 3/4"	
Boundary Cond.	PINNED 3 SIDES, FREE @ TOP	△ CAPTIVE WALL, FIXED @ BOTTOM
Wall Function	SHIELDING	
Reinf. Details	N/A	
Attach. on Wall	YES	
Unusual Loads	N/A	
Mortar Type	M OR S	
No. of Wythes	3	
Type of Bond	RUNNING	

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

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M.E. Walker 09/04/80

INDEPENDENT REVIEWER/DATE

M.E. Walker 09/04/80

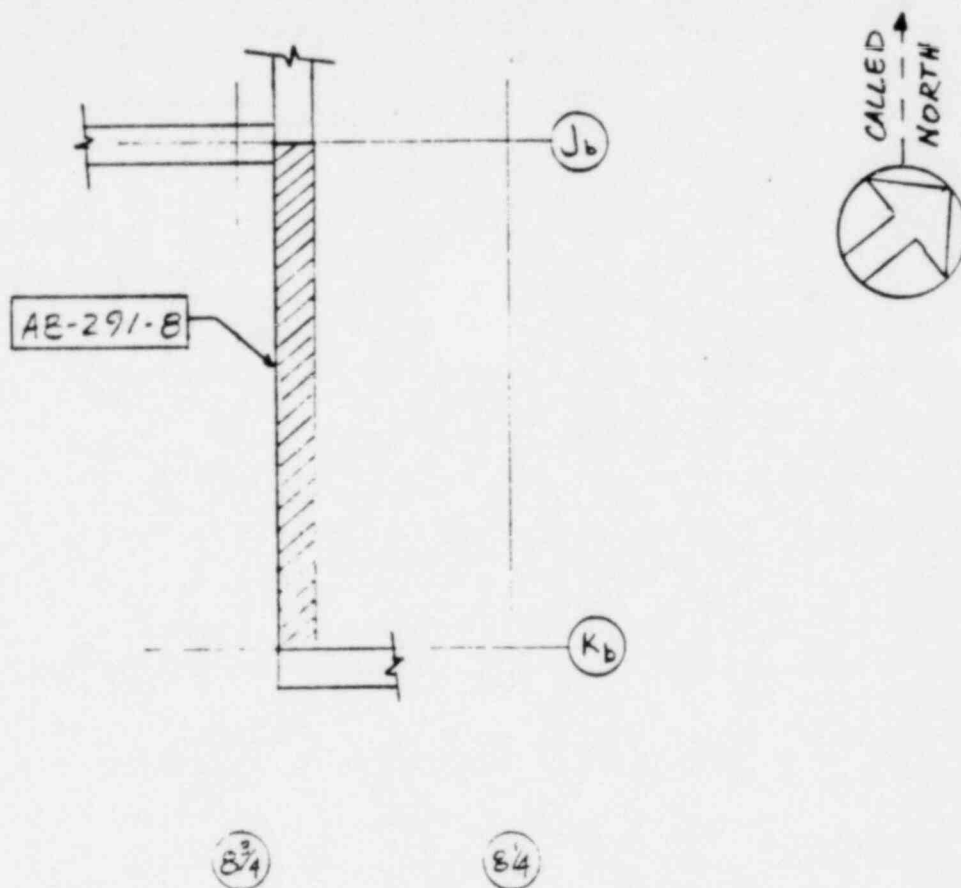
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ELOCK WALL REVIEW

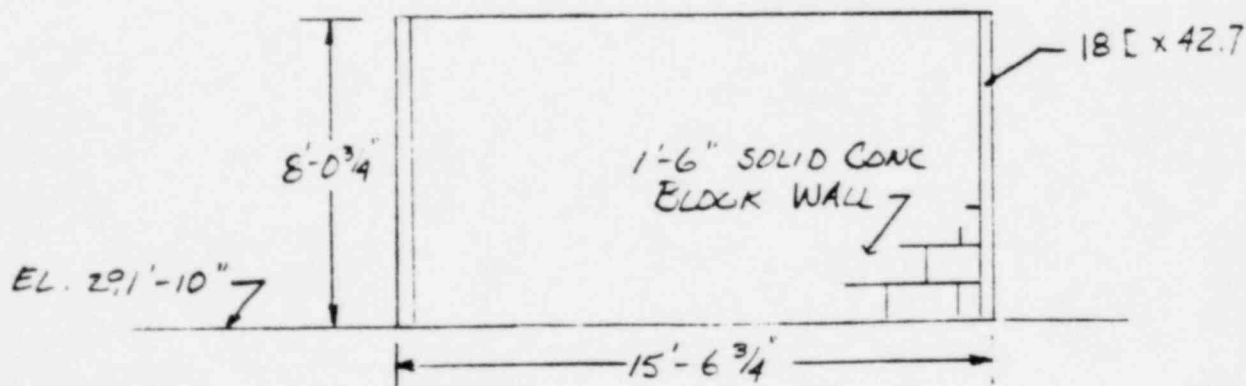
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QA CATEGORY/CODE CLASS

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KEY PLAN
(NTS)



ELEV L&G WEST

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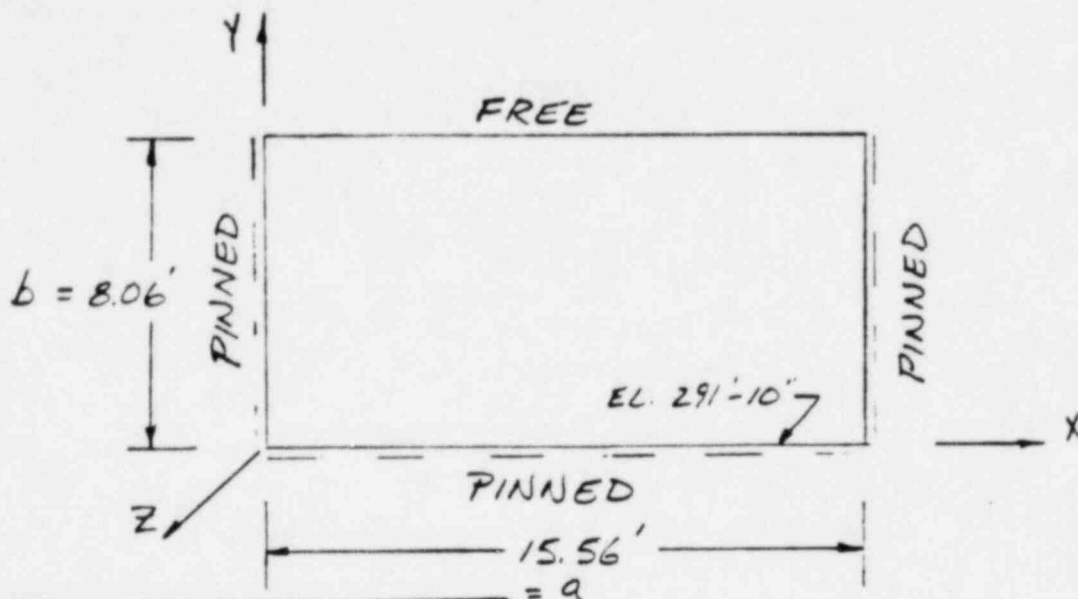
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BLOCK WALL REVIEW IE 80-11

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FREQUENCY CALCULATION

$$R = b/a = 8.06/15.56 = .52$$

COEFFICIENTS (BY INTERPOLATION IN TABLE I)

$$C = .00740$$

$$\beta_2 = .063$$

$$\beta_1 = .023$$

$$K_{eff} = .71$$

BLOCK PROPERTIES
(NOTE: SINCE THE WALL IS COMPOSED OF 3 ROWS OF SOLID 6" X 8" X 16" BLOCK, PROPERTIES OF SOLID 18" X 8" X 16" NORMALWEIGHT BLOCK WILL BE USED)

$$W = 225 \text{ psf}$$

$$I_{yy} = 5475 \text{ in}^4/\text{ft}$$

$$S_{yy} = 621 \text{ in}^3/\text{ft}$$

$$A_{net} = 211 \text{ in}^2/\text{ft}$$

$$I_{xx} = 5475 \text{ in}^4/\text{ft}$$

$$S_{xx} = 621 \text{ in}^3/\text{ft}$$

$$A_g = 211 \text{ in}^2/\text{ft}$$

$$f_n: K = \frac{EI R}{a^2(1-\nu^2)C} = \frac{(1,350,000)(5475)(.52)}{(15.56 \times 12)^2(1-.25^2)(.00740)} = 15,890,463 \text{ #/1}$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{K_{eff} M_t}}$$

$$= \frac{1}{2\pi} \sqrt{\frac{15,890,463 \times 386/12}{.71 \times 28,218.06}}$$

$$= 25.4 \text{ cps} > f_c = 10 \text{ cps} \Rightarrow \text{RIGID}$$

$$M_t = \frac{12Wob}{9} = \frac{12 \times 225 \times 15.56 \times 8.06}{386} = 12 \times 28,218.06/386$$

$$G_H^{DBE} = .48$$

$$G_V^{DBE} = .30$$

$$G_H^{DBE} = .35$$

$$G_V^{DBE} = .21$$

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M. E. Walker 09/04/80

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BLOCK WALL REVIEW IE ED-11

QA CATEGORY/CODE CLASS

I/NSR

PART I: INERTIA STRESSES (DBE)

$$G_H = .48 \rightarrow g = G_H \times W = .48 \times 225 = 108 \text{ psf}$$

$$M_x = B_1 g a^2 = .023 \times 108 \times (15.56)^2 = 601.4 \text{ ft-lb}$$

$$M_y = B_2 g a^2 = .063 \times 108 \times (15.56)^2 = 1647.3 \text{ ft-lb}$$

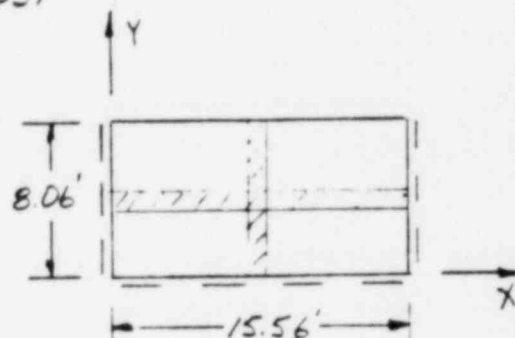
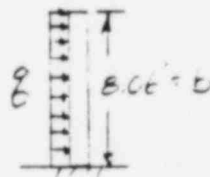
$$f_{mx} = M_x / S_x = 601.4 \times 12 / 621 = 11.6 \text{ psi}$$

$$f_{my} = M_y / S_y = 1647.3 \times 12 / 621 = 31.8 \text{ psi}$$

DETERMINE REACTIONS

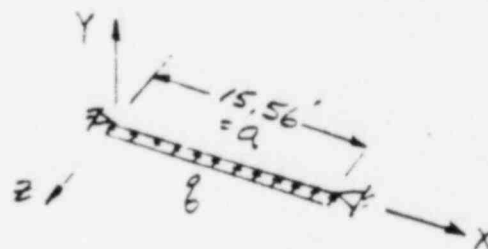
R_x: CONSIDER A 1' WIDE VERTICAL CANTILEVER FIXED AT BASE

$$\begin{aligned} R_x &= g b \\ &= 108 \times 8.06 \\ &= 870.5 \text{ #/ft} \end{aligned}$$



R_y: CONSIDER A 1' DEEP SS. BEAM

$$\begin{aligned} R_y &= \frac{1}{2} g a \\ &= \frac{1}{2} \times 108 \times 15.56 \\ &= 840.2 \text{ #/ft} \end{aligned}$$



HORIZONTAL SEISMIC SHEAR: f_v

$$\text{@ SIDES: } f = R_y / A_h = 840.2 / 211 = 4.0 \text{ psi}$$

$$\text{@ BASE: } f = R_x / A_h = 870.5 / 211 = 4.1 \text{ psi} \leftarrow \text{GOV}$$

$$f_v = 4.1 \text{ psi}$$

DEAD LOAD: f_d

$$\text{@ MIDDLE: } f = \frac{225 \times 8.06 / 2}{211} = 4.3 \text{ psi}$$

$$\text{@ BASE: } f = \frac{225 \times 8.06}{211} = 8.6 \text{ psi}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

1307563-AB-291-8

REVISION

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PAGE

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PREPARED/DATE

J. FINIK 1/9-3-80

REVIEWER/CHECKER/DATE

M. E. WALKER 09/04/80

INDEPENDENT REVIEWER/DATE

M. E. WALKER 09/04/80

SUBJECT/TITLE

ELOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I / NSR

$$\text{VERTICAL SEISMIC: } f_{sv} = \frac{(G_N)(DL)(h)}{A_n} = \frac{(0.30)(22.5)(8.06)}{211} = \underline{2.6 \text{ psi}}$$

AXIAL COMPRESSION:

$$f_{cs}: \left\{ \begin{array}{l} \text{@ MIDDLE: } f_{cs} = f_{mx} + f_{DL} + f_{sv} = 11.6 + 4.3 + 2.6 = 18.5 \text{ psi} \\ \text{OR: } f_{cs} = f_{my} = 31.8 \text{ psi} \leftarrow \text{Gov} \end{array} \right.$$

$$\text{@ BASE: } f_{cs} = f_{DL} + f_{sv} = 8.6 + 2.6 = 11.2 \text{ psi}$$

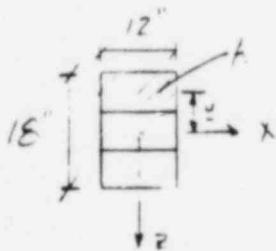
$$f_{cs} = 31.8 \text{ psi}$$

$$\text{MAX TENSION } \perp \text{ JT: } f_{ts} = -f_{mx} + f_{DL} - f_{sv} = -11.6 + 4.3 - 2.6 = \underline{-9.9 \text{ psi}}$$

$$\text{MAX TENSION } \parallel \text{ JT: } f_{ts} = -f_{my} = \underline{-31.8 \text{ psi}}$$

CHECK SHEAR AT COLLAR JT

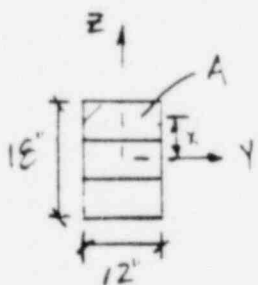
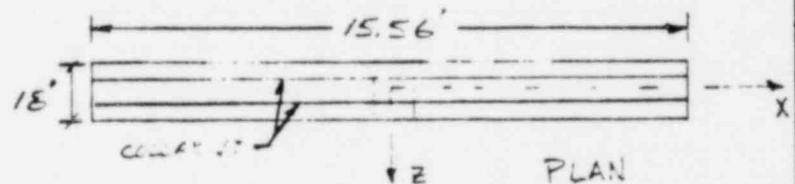
@ BASE



$$f_{cs} = \frac{VQ}{I \cdot t}$$

$$\begin{aligned} V &= R_x = 870.5 \text{ #/ft} \\ Q &= A_y = (6' \times 12') \times 6' = 432 \text{ in}^3/\text{ft} \\ I_{xx} &= 5475 \text{ in}^4/\text{ft} \\ t &= 12' \end{aligned}$$

$$f_{cs} = \frac{(870.5 \text{ #/ft})(1')(432 \text{ in}^3/\text{ft})}{(5475 \text{ in}^4/\text{ft})(12')} = \underline{5.7 \text{ psi}}$$

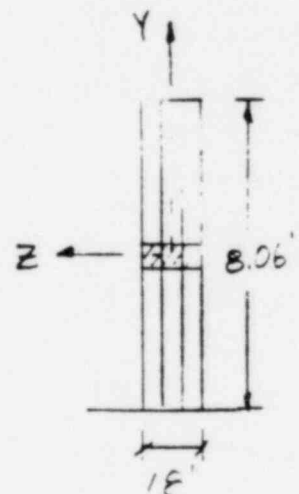


@ SIDES

$$f_{cs} = \frac{VQ}{I \cdot t}$$

$$\begin{aligned} V &= R_y = 840.2 \text{ #/ft} \\ Q &= A_x = (6' \times 12') \times 6' = 432 \text{ in}^3/\text{ft} \\ I_{yy} &= 5475 \text{ in}^4/\text{ft} \\ t &= 12' \end{aligned}$$

$$\begin{aligned} f_{cs} &= \frac{(840.2 \text{ #/ft})(1')(432 \text{ in}^3/\text{ft})}{(5475 \text{ in}^4/\text{ft})(12')} \\ &= \underline{5.5 \text{ psi}} \end{aligned}$$



AB-291-8 291'-10" I

ECCENTRICITY, +Z _____ DIRECTION, (MEASURED FROM C OF WALL)

EQUIPMENT DESCRIPTION	EQUIPMENT SUPPORT CONDITION	FASTENER DESCRIPTION	P _{ey} (LBS.)	+Z (IN.)	M _x (IN.-LB.)	COMMENT
Junction Box 12x18x6			53 [#]			
ICX120ND			21 [#]			$(5.88^{#1} \times 3.55') = 20.95^{#}$
2" ϕ Conduit			36 [#]			$(4.91^{#1} \times 7.38') = 36.24^{#}$
Junction Box 24x12x8			99 [#]			
$\frac{1}{2}$ " ϕ Copper Tube			30 [#]			$(17.73' \times 1.68^{#1}) = 29.78$
ICC989N22			4 [#]			$(6.08 \times .65) = 3.95$
ICC989N21			4 [#]			$(6.08 \times .65) = 3.95$
ICC989N22			36 [#]			$(6.08 \times 5.88) = 35.75$
ICC989N21			36 [#]			$6.08(5.88) = 35.75$
ICL989N5			4 [#]			$6.08(.65) = 3.95$
Ground Cable			66 [#]			$(30.11' \times 2.2^{#1}) = 66.24$
3 ϕ ICX120ND			32 [#]			$(5.88^{#1} \times 5.5) = 32.24$

REVIEWER/DATE
M. Brennan 9/6/80
BLOCK WALL REVIEW

REVIEWER/CHECKER/DATE
VW FINIK 9-18-80
BULLETIN IE 80-11

INDEPENDENT REVIEWER/DATE
VW FINIK 9-18-80
QA CATEGORY/CODE CLASS
I/MSR

13025.63

AB-291-8

10F-9

AB-291-8 EL. 291'-10" I

ECCENTRICITY, +Z _____ DIRECTION, (MEASURED FROM C OF WALL)

EQUIPMENT DESCRIPTION	EQUIPMENT SUPPORT CONDITION	FASTENER DESCRIPTION	P _{ey} (LBS.)	±Z (IN)	M _x (IN-LB.)	COMMENT
1"φ ICC138NS			14 [#]			(14.03' X .98 [#] /1) = 13.75 [#]
7/8"φ Fire Line			21 [#]			(1.68 [#] /1 X 12.59') = 21.15 [#]
1/2"φ Fire Line (2)			42 [#]			(1.68 [#] /1 X 12.59') = 21.15 [#]
1/2"φ Elec. Conduit			30 [#]			Assumed w/1/4" = 1.39 [#] /1 1.39 (21.19) = 29.45 [#]
ICC947N22			5 [#]			(3.0')(1.75 [#] /1) = 5.25 [#]
ICC947N21			7 [#]			(7.25' + 4')(1.65 [#] /1) = 7.3 [#]
3'x3'x3'x3'x3'x3'			15 [#]			
JB2821			50 [#]			
ELec. Conduit			15 [#]			
IEP-CB-89			200 [#]			
			200 [#]			Sub Total
			88.2			10%
			970.75			Total

READER/DATE M. BRENNAN 9/18/80
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 REVIEWER/CHECKER/DATE J.W. FINIK 9-18-80
 BULLETIN IE 80-11
 INDEPENDENT REVIEWER/DATE J.W. FINIK 9-18-80
 QA CATEGORY/CODE CLASS I/MSR
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J.O./W.O./CALCULATION NO.

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J.W. FINIK / 9-18-80

SUBJECT/TITLE

No. Anna Block wall REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

ICX120ND :

$$\text{horizontal length} = (2.46 - 2) + 1.02 = 1.48$$

$$\text{vertical length} = \underline{2.08}$$

$$\text{total length} = 3.56 \text{ ft}$$

2" ϕ Conduit to Radiation monitor :

$$\text{vertical length} = (3.81 + .18) - 2.28 = 1.71$$

$$\text{horizontal length (assumed)} = 1.67$$

$$\text{tributary length} = \underline{4.0}$$

$$\text{total length} = 7.38 \text{ ft}$$

$\frac{1}{2}$ " ϕ Copper Tube :

$$\text{vertical length} = (8.06 + 4) = 12.06$$

$$\text{horizontal length} = .17 + 1.5 + 4 = \underline{5.67}$$

$$\text{total} = 17.73 \text{ ft}$$

Ground Cable :

$$\text{vertical length} = 12.06$$

$$\text{horizontal length} = 1.5 + 4 + 3.25 + 4 = \underline{12.75}$$

$$\begin{array}{r} \text{total} \\ 24.81 \text{ ft} \\ + 5.3 \\ \hline 30.11 \end{array}$$

3 ϕ ICX120ND :

$$\text{horizontal length} = 1.5 + 4 = 5.5 \text{ ft}$$

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M. Brennan 9/18/80

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JW FINIK / 9-18-80

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SUBJECT/TITLE

No. Anna Block Wall REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

1" ϕ ICK 138NS:

$$\text{horizontal length} = 1.5' + 1.23 + 1.02 + .5 + 4 = 8.25 \text{ ft}$$

$$\text{vertical length} = 8.06 - 2.28 = \underline{5.78}$$

$$\text{total length} = 14.03 \text{ ft}$$

Fire lines:

$$\frac{7}{8} \text{ " } \phi \text{ line ; } 3.96 + .63 + 4 + 4 = 12.59 \text{ ft.}$$

$$\frac{1}{2} \text{ " } \phi \text{ line ; total length} = 12.59$$

$\frac{1}{2}$ " ϕ Electrical Duct:

$$\text{vertical length} = 4.65 \text{ ft.}$$

$$\text{horizontal length} = (15.56 - 3.02) + 4 = 16.54$$

$$\text{total length} = 21.19 \text{ ft}$$

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DREW M. CARON SEPT 18, 80

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DREW M. CARON SEPT 18, 80

SUBJECT/TITLE

ELECT. WALL REVIEW J.E. 80-11

QA CATEGORY/CODE CLASS

I/NSR

II INTERSTORY DISPLACEMENT (DBE)

INTERSTORY DISPLACEMENT CAN BE NEGLECTED SINCE THE WALL DOES NOT EXTEND FULLY FROM FLOOR TO CEILING

III EQUIPMENT LOADS (DBE)

CONSIDER EQUIPMENT LOAD TO BE UNIFORMLY DISTRIBUTED OVER WALL

$$P_{EXT} = 970 \text{ lb} \Rightarrow W_{EXT} = \frac{970}{8.06 \times 15.56} = 7.7 \text{ psf}$$

CONSIDER EQUIPMENT TO BE IN RESONANT RANGE:

$$G_n = 4.04 \Rightarrow g = G_n \times W = 4.04 \times 7.7 = 31.1 \text{ psf}$$

$$M_1 = \frac{1}{2} \times 2 \times 2 \times 0.023 (21.1)(15.56)^2 = 173.2 \text{ ft-lb}$$

$$M_2 = \frac{1}{2} \times 2 \times 2 \times 0.063 (21.1)(15.56)^2 = 474.4 \text{ ft-lb}$$

$$f_{ux} = \frac{M_1}{P \times e_1} = \frac{173.2 \times 12}{621} = 3.3 \text{ psi}$$

$$f_{uy} = \frac{M_2}{P \times e_2} = \frac{474.4 \times 12}{621} = 9.2 \text{ psi}$$

$$R_{shear} = (31.1)(8.06) = 250.7 \text{ lb/ft}$$

$$R_{shear} = \left(\frac{1}{2}\right)(31.1)(15.56) = 241.9 \text{ lb/ft}$$

SEE PART I ANALYSIS, SHEET 8

$$\text{MAX TENSION // JT} : f_{ec} = f_{ux} = \underline{-9.2 \text{ psi}}$$

$$\text{MAX TENSION \perp JT} : f_{ec} = f_{uy} = \underline{-3.3 \text{ psi}}$$

$$\text{AXIAL COMPRESSION} : f_{ec} = f_{uy} = \underline{9.2 \text{ psi}}$$

$$\text{SHEAR} : f_{ve} = \frac{250.7}{21} = \underline{1.2 \text{ psi}}$$

CHECK SHEAR @ COLLAP JT.

$$f_{ve} = \frac{VQ}{It} = \frac{(250.7 \text{ lb/ft}) \left(\frac{1}{2} (6 \times 12) \right)}{(5475 \text{ in}^4) (12)} = \underline{1.6 \text{ psi}}$$

$$\begin{aligned} V &= R_s = 250.7 \text{ lb/ft} \\ Q &= (6 \times 12) \times 12 = 432 \text{ in}^3 \\ I &= 5475 \text{ in}^4 \\ t &= 12 \text{ in} \end{aligned}$$

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SUBJECT/TITLE

KIDCK WALL REVIEW

IE 80-11

QA CATEGORY / CODE CLASS

I/NSA

OBE STRESSES

$$G_H^{DBE} = .48$$

$$G_H^{OBE} = .35$$

$$G_V^{DBE} = .30$$

$$G_V^{OBE} = .21$$

I SEISMIC INERTIA

$$f_{cs} \perp JT \quad f_{cs} = -f_{mx} + f_{DL} - f_{SV} = -11.6 \times \frac{.35}{.48} + 4.3 - 2.5 \times \frac{.21}{.30} = -5.9 \text{ psi}$$

$$f_{cs} \parallel JT \quad f_{cs} = -f_{my} = -31.8 \times \frac{.35}{.48} = -23.2 \text{ psi}$$

AXIAL COMPRESSION:

$$\text{@ MIDDLE: } f_c = f_{mx} + f_{DL} + f_{SV} = 11.6 \times \frac{.35}{.48} + 4.3 + 2.5 \times \frac{.21}{.30} = 14.5 \text{ psi}$$

$$\text{or } f_{cs} = -f_{my} = -31.8 \times \frac{.35}{.48} = -23.2 \text{ psi} \quad \leftarrow G_{OV}$$

$$\text{@ BASE: } f_c = f_{DL} + f_{SV} = 5.6 + 2.5 \times \frac{.30}{.30} = 10.4 \text{ psi}$$

$$f_{cs} = 23.2 \text{ psi}$$

HORIZONTAL SEISMIC SHEAR

$$f_v = 4.1 \times \frac{.35}{.48} = 3.0 \text{ psi}$$

SHEAR AT COLLAR JOINT

$$\text{@ BASE: } f_{cs} = 5.7 \times \frac{.35}{.48} = 4.2 \text{ psi}$$

$$\text{@ SIDES: } f_{cs} = 5.5 \times \frac{.35}{.48} = 4.0 \text{ psi}$$

II INTERSTORY DISPLACEMENT

CAN BE NEGLECTED

III EXTERNAL LOADS

$$G_H^{DBE} = 4.04$$

$$G_H^{OBE} = 5.65$$

(NOTE THESE G-FACTORS ARE CONSERVATIVE)

$$f_{cc} (\text{parallel to } JT) = -9.2 \times \frac{5.65}{4.04} = -12.9 \text{ psi}$$

$$f_{cc} (\text{normal to } JT) = -3.3 \times \frac{5.65}{4.04} = 1.6 \text{ psi}$$

$$f_{cc} = 9.2 \times \frac{5.65}{4.04} = 12.9 \text{ psi}$$

$$f_{ve} = 1.2 \times \frac{5.65}{4.04} = 1.7 \text{ psi}$$

$$f_{ye} = 1.6 \times \frac{5.65}{4.04} = 2.2 \text{ psi}$$

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PREPARED BY / DATE J W FINIK / 9-3-80	REVIEWER / CHECKER / DATE M. G. Walker 09/04/80	INDEPENDENT REVIEWER / DATE M. G. Walker 09/04/80	
SUBJECT / TITLE BLOCK WALL REVIEW IE 80-11		QA CATEGORY / CODE CLASS I / NSR	

OBE / DBE COMPARISON

I. INERTIAL STRESSES (psi)

- f_{cs} (parallel to joint)
- f_{ts} (normal to joint)
- f_{cs} (at point of max flexure)
- f_v
- $(f_{bt} + f_{sv})$ using entire strip height
- If $(f_{bt} - f_{sv}) < 0$ Check

DBE	OBE
31.8	23.2
9.9	5.9
31.8	23.2
4.1	3.0
11.2	10.4
> 0	> 0

II. DISPLACEMENT STRESSES (psi)

- f_{dx} (at base)
- f_{dv}

—	—
—	—

III. EXTERNAL LOAD STRESSES (psi)

- f_{te} (parallel to jt)
- f_{te} (normal to jt)
- f_{ce}
- f_{ve}

9.2	12.9
3.3	4.6
9.2	12.9
1.2	1.7

GOVERNING :
EQUIVALENT

DBE ☒ OBE ☐

CALCULATION SHEET

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

REVISED FREQUENCY CALCULATION

DATA: f_n (WALL DL ALONE) = 25.4 cps

$f_c = 10$ cps

$W_{EXT} = 7.7$ psf

$W_{DL} = 225$ psf

$W' = W_{EXT} + W_{DL} = 7.7 + 225 = 232.7$ psf

$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{M}} = \frac{1}{2\pi} \sqrt{\frac{15,890,463 \times 386/12}{71 \times 232.7 \times 15.56 \times 8.06}} = 25.0$ cps $> f_c = 10$ cps

→ WALL REMAINS RIGID

IN-PLANE STRAIN (NORTH-SOUTH DEFLECTION)

SINCE THE WALL IS FREE AT THE TOP AND IS NOT BOUNDED AT THE SIDES BY THE BUILDING'S STEEL FRAMING SYSTEM, IT WILL NOT BE SUBJECTED TO IN-PLANE STRAIN

→ FREE

CONCENTRATED

GLOBAL ~~AND~~ STRESSES DUE TO ~~THE~~ EQUIPMENT LOADS

SINCE THERE ARE NO LARGE CONCENTRATED LOADS ON THE WALL, GLOBAL ~~STRESS~~ STRESS ANALYSIS IS NOT REQUIRED.

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INDEPENDENT REVIEWER/DATE

M.E. Walker 09/04/80

SUBJECT/TITLE

BLOCK WALL REVIEW - IE bulletin 80-11

QA CATEGORY/CODE CLASS

I/NSR

EARTHQUAKE COND.
[DBE]

ALLOWABLE
STRESS

CONCRETE
STRESS
(psi)

ALLOW

40

64

446

30 ±

40.4

338

solid and hollow blocks

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

10' to 15' m

I. INERTIAL STRESS

0 fts (parallel to ft)

31.8

—

✓

0 fts (normal to ft)

9.9

—

✓

0 fcs (at point of max. flexure)

31.8

—

✓

0 fv

4.1

—

✓

0 (fa+fv) using entire strip width

11.2

—

✓

0 If (fa+fv) < 0 check

> 0

—

✓

II. PLACEMENT STRESSES

0 fax (at base)

—

—

✓

0 fav

—

—

✓

III. EXTERNAL LOAD STRESS

0 fte (parallel to ft)

9.2

—

✓

0 fte (normal to ft)

3.3

—

✓

0 fce

9.2

—

✓

0 fcv

1.2

—

✓

Note: These values are NOT TO EXCEED PCI 531-79 allow.

Key:

✓ denotes acceptable
x denotes not acceptable
— denotes not checked

FURTHER ANALYSIS REQUIRED

CALCULATION SHEET

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J. F. WILK / 9-10-80

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DREW M. CARON SEPT 18, 80

INDEPENDENT REVIEWER/DATE

DREW M. CARON SEPT. 18, 80

SUBJECT/TITLE

Block wall review JL 80-11

QA CATEGORY/CODE CLASS

E/N/R

COMBINED STRESS SUMMARY SHEET

1) Combined action joint stress: $(f_{tjt} + f_{tjt} + f_{tjc}) = 7.3$ psi
 $5.7 + 1.6$

Allowable stress

12.0 psi

2) Max. tensile stress: $(f_{tcs} + f_{tcs}) = 41.0$ psi
 (parallel to joint)

64.0 psi

3) Max. tensile stress: $(f_{tcs} + f_{tcs} + f_{tcs}) = 13.2$ psi
 (normal to joint)

40.0 psi

4) Max. comp. stress:

a) If $[f_{tms} + f_{tcs} + f_{tcs} > f_{tms}]$:

o $(f_{tcs} + f_{tcs} + f_{tcs})$ at base = $\frac{11.2}{1}$ psi

30.3 psi

o $(f_{tcs} + f_{tcs} + f_{tcs})$ at pt. of max. flex = $\frac{41.0}{1}$ psi

30.3 psi

b) If $[f_{tms} + f_{tcs} + f_{tcs} < f_{tms}]$:

o $(f_{tcs} + f_{tcs} + f_{tcs})$ at base = $\frac{11.2}{1}$ psi

30.3 psi

o $(f_{tcs} + f_{tcs})$ at pt. of max. flex = $\frac{41.0}{1}$ psi

30.3 psi

c) Max. shear stress: $(f_v + f_{tv} + f_{tv}) = 5.3$ psi

40.4 psi

FURTHER ANALYSIS REQ'D

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A. CHERMAR 2-24-81

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1-1-1-1-1-1 02/28/81

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Hed. K. K. K. K. 04/28/81

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BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

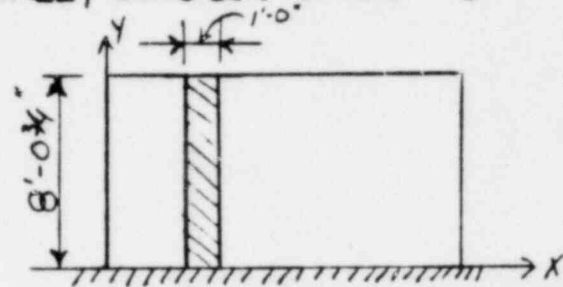
I/NSR

BOUNDARY CONDITIONS

BECAUSE OF THE UNCERTAINTY OF THE SUPPORTS ON EITHER SIDE OF THE BLOCK WALL, CONSIDER WALL AS CANTILEVERED FROM THE FLOOR.

$$W = 225 \text{ lb/ft}^2 \quad I_x = I_y = 5475 \text{ in}^4/\text{ft}$$

$$S_x = S_y = 621 \text{ in}^3/\text{ft} \quad A_n = 211 \text{ in}^2/\text{ft}$$



ELEVATION

NATURAL FREQUENCY

$$K = \frac{8EI_y}{b^3} = \frac{8(1350,000)(5475)}{(96.75)^3} = 65291.2 \text{ lb/ft}^2$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{K_{LM}(\frac{W}{g})}} = \frac{1}{2\pi} \sqrt{\frac{65291.2(386)}{.64(225 \times 800)}} = 23.5 \text{ CPS} > 10.$$

DBE

GBE

∴ RIGID

$$G_H = .48$$

$$G_H = .35$$

$$G_V = .30$$

$$G_V = .21$$

EQUIPMENT MASS IS SO SMALL THAT IT WOULD NOT AFFECT FREQ

INERTIAL STRESSES (DBE)

$$q = W G_H = (.48)(225) = 108 \text{ lb/ft}^2$$

$$M_x = \frac{q b^3}{2} = \frac{(108)(800)^2}{2} = 3508 \text{ lb-ft/ft}$$

$$f_{mx} = \frac{M_x}{S_x} = \frac{(3508)(12)}{621} = 67.8 \text{ PSI @ BASE}$$

$$R_x = b q = (8.06)(108) = 870.5 \text{ lbs/ft}$$

HORIZONTAL SHEAR: f_v

$$f_v = \frac{870.5}{211} = 4.1 \text{ PSI}$$

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13075.63

AB-291-8

REVISION

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H. J. Longshore 02/28/81

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Hadi Bana Lwin 02/28/81

SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

INERTIAL STRESSES (CONT.)

DEAD LOAD, f_{DL}

$$DL = Wb = (225)(8.06) = 1813.5 \text{ lb/ft}$$

$$f_{DL} = \frac{1813.5}{211} = 8.6 \text{ PSI}$$

VERTICAL SEISMIC, f_{SV}

$$f_{SV} = \frac{0.1}{A} = \frac{(0.3)(1813.5)}{211} = 2.6 \text{ PSI}$$

COLLAR JOINT, f_{CJS}

$$f_{CJS} = \frac{VQ}{I\epsilon}$$

$$V = R = 870.5$$

$$Q = 6 \times 12 \times 5.625 = 405$$

$$f_{CJS} = \frac{(870.5)(405)}{(5475)(12)} = 5.4 \text{ PSI}$$

COMBINED INERTIAL STRESSES

$$f_{ts} \perp \text{ TO JT.} = -f_{mx} + f_{DL} - f_{SV} \\ = -67.8 + 8.6 - 2.6 = -61.8 \text{ PSI @ BASE}$$

$$f_{CS} = f_{mx} + f_{DL} + f_{SV} \\ = 67.8 + 8.6 + 2.6 = 79.0 \text{ PSI}$$

$$f_v = 4.1 \text{ PSI}$$

$$f_{DL} + f_{SV} = 8.6 + 2.6 = 11.2 \text{ PSI}$$

NO INTERSTORY DISPLACEMENT

CALCULATION SHEET

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AS010-51

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BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

EQUIPMENT STRESSES (DBE)

CONSIDER EXT. LOADS UNIFORMLY DISTRIBUTED OVER WALL

$$q = G_H W, G_H \text{ RESURF} = 3.29$$

$$W = \frac{9 \times 75}{(8.06)(5.56)} = 7.74 \text{ lb/ft}^2$$

$$q = (3.29)(7.74) = 25.5 \text{ lb/ft}^2$$

$$M_x = \frac{qb^2}{2} = \frac{(25.5)(8.06)^2}{2} = 828.3 \text{ ft.lbs/ft}$$

$$f_{ex} = \frac{828.3 \times 12}{621} = 16.0 \text{ PSI @ BASE}$$

$$f_{ev} = \frac{q}{A} = \frac{(25.5)(8.06)}{211} = .97 \text{ PSI SAY } 1.0 \text{ PSI}$$

$$f_{ec} \perp \text{ TO JT.} = -f_{ex} = -16 \text{ PSI}$$

$$f_{cc} = f_{ex} = 16 \text{ PSI}$$

COLLAR JT STRESS, f_{cje}

$$f_{cje} = \frac{KV}{I_T}, V = (25.5)(8.06) = 205.5$$

$$f_{cje} = \frac{(205.5)(405)}{(5475)(12)} = 1.3 \text{ PSI}$$

EQUIPMENT REDUCTION FACTOR = .5 (DBE)

REDUCE EQUIP. STRESSES BY

$$f_{ec}(\perp) = (-16)(.5) = -8 \text{ PSI}$$

$$f_{cc} = (16)(.5) = 8 \text{ PSI}$$

$$f_{ev} = (1)(.5) = .5 \text{ PSI}$$

$$f_{cje} = (1.3)(.5) = .65 \text{ PSI}$$

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Andi Boudjaneh 02/28/81

SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

10% DECREASE IN HEAVYWEIGHT BLOCK DENSITY

$$\text{NAT. FREQ. } f_n = 1.0541(23.5) = 24.8 \text{ CPS}$$

INERTIA

$$f_{m2} = (67.8)(.9) = 61.0 \quad f_{sv} = 2.6(.9) = 2.3 \quad f_{dl} = 8.6(.9) = 7.7$$

$$f_{ts}(1) = (61.8)(.9) = 55.6 \text{ PSI}$$

$$f_v = (4.1)(.9) = 3.7 \text{ PSI}$$

$$f_{dl} + f_{sv} = (11.2)(.9) = 10.1 \text{ PSI}$$

$$f_{cs} = (7.9)(.9) = 7.1 \text{ PSI} \quad f_{cjs} = (5.4)(.9) = 4.9 \text{ PSI}$$

SRSS

$$\text{MAX TENS } \perp \text{ TO JT} = \sqrt{(f_{m2} + f_{cs})^2 + f_{sv}^2} - f_{dl}$$

$$= \sqrt{(61 + 8.)^2 + 2.3^2} - 7.7$$

$$= 61.3 \text{ PSI} < \frac{1}{3}(40) = 66.7$$

$$\text{MAX. NORMAL COMP.} = \sqrt{(f_{m2} + f_{cs})^2 + f_{sv}^2} + 7.7$$

$$= 76.7 \text{ PSI}$$

CHECK OBE STRESSES

$$\text{RIGID } \frac{G_H(OBE)}{G_H(OBE)} = .73$$

$$\frac{G_V(OBE)}{G_V(OBE)} = .70$$

$$\text{RESONANT } \frac{G_H(OBE)}{G_H(OBE)} = 1.40$$

∴ ONLY EQUIP. STRESSES WILL BE INCREASED BY OBE LOADING
WHILE INERTIA STRESSES WILL DECREASE. BY INSPECTION, OBE
STILL GOVERNS.

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

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SUBJECT/TITLE

BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

I/NSR

BLOCK PULLOUT ANALYSIS

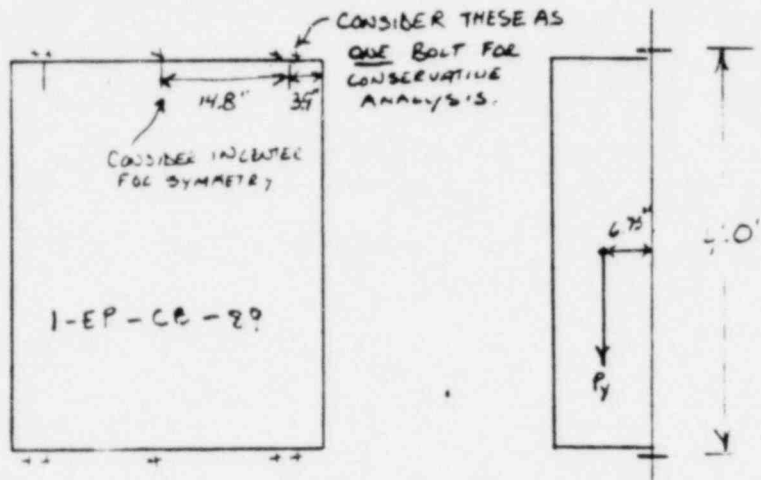
CHECK FIELD DATA NO 7

$P = 273 \text{ lbs}$

RESONANT $G_H = 3.29$ $G_V = 2.12$ (DBE)

$$P_y = 273 + (273 \times 2.12) = 851.8 \text{ lbs}$$

$$P_x = P_z = 273 \times 3.29 = 898.2 \text{ lbs}$$



MAX. TENS. CAUSED BY:

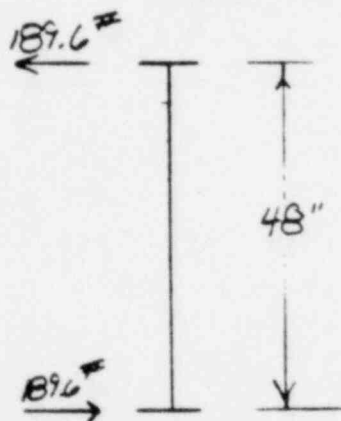
$$\frac{P_y \cdot z}{n \cdot y} + \frac{P_x}{n} \quad \text{or} \quad \frac{P_y \cdot z}{n \cdot y} + \frac{P_z \cdot z}{n \cdot x}$$

$$\frac{851.8 \times 6.75}{3 \times 48} + \frac{898.2}{6} = 189.6 \text{ lbs}$$

$$\text{OR } 39.9 + \frac{898.2 \times 6.75}{3 \times 48} = 176.5 \text{ lbs}$$

LOCALIZED STRESSES

CHECK FIELD DATA NO 7.



$$M_x = P(48) = (189.6)(48)$$

$$M_x = 9101 \text{ in-lbs/ft}$$

$$f_y = 9101/621 = 14.7 \text{ psi}$$

SINCE f_{ex} FOR GLOBAL EQUIP. ANALYSIS = 16 PSI @ BASE AND MAX. STRESSES OCCUR AT BASE, THE ANALYSIS IS ALREADY CONSERVATIVE WITHOUT CONSIDERING LOCAL STRESSES

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

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BLOCK WALL REVIEW

IE 80-11

QA CATEGORY/CODE CLASS

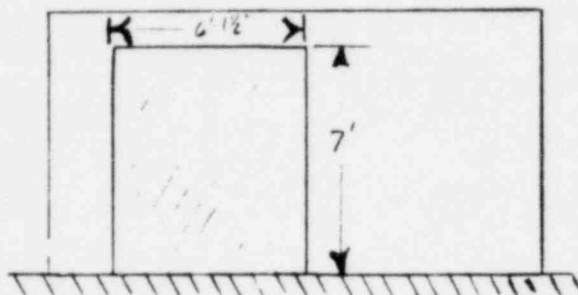
I/NSR

GLOBAL ANALYSIS FOR CONCENTRATED LOADS

CHECK FIELD DATA NO. 7

$$P = 273 \text{ lbs}$$

$$P_2 = (273)(3.29) = 898.2 \text{ lbs}$$



SINCE PIECE OF EQUIPMENT IS LARGE, CONSIDER LOAD UNIFORMLY DISTRIBUTED OVER AREA WITH DIMENSIONS OF EQUIPMENT PLUS 2X THICKNESS OF WALL
 WIDTH = $37\frac{1}{2} + 2(18) = 73.5'' = 6.125'$
 HEIGHT = $48 + 2(18) = 84'' = 7'$

$$W = \frac{P}{AL} = \frac{898.2}{(6.125)(7)} = 20.9 \text{ lb/ft}^2$$

CONSIDER 1' STRIP TO DETERMINE STRESSES AT BASE.

$$W = q = 20.9 \text{ lb/ft}^2$$

$$M_x = \frac{qL^2}{2} = \frac{(20.9)(7^2)}{2} = 512.0 \text{ ft-lbs}$$

$$f_{bx} = \frac{512 \times 12}{621} = 9.9 \text{ PSI}$$

SUM ALL STRESSES @ BASE

$$\text{MAX TENS. } \perp \text{ TO JT} = \sqrt{f_{m1}^2 + f_{bx}^2 + f_{sv}^2} - f_{dl}$$

$$= \sqrt{61^2 + 9.9^2 + 2.3^2} - 7.7$$

$$= 54.1 < \frac{5}{3}(40) = 66.7 = \text{ALLOWABLE}$$

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O. / W.O. / CALCULATION NO.

13075.63 AB-291-B

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BLOCK WALL REVIEW IE-80-11

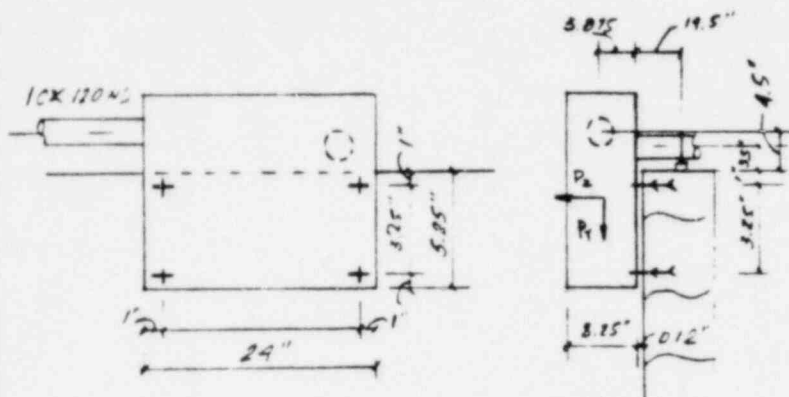
QA CATEGORY / CODE CLASS

1/NSR

LOCAL ANALYSIS - FACE SHELL & CONE PULLOUT

AB-291-B

FIELD DLT NO. 2



WEIGHT

$$\begin{aligned} 10 \times 120 \text{ ND} &= (5.88") (1.8") = 10.5" \\ \text{JUNCTION BOX} &= 99" \\ 10 \times 120 \text{ ND} &= (5.88") (0.6") = 3.6" \\ \text{DL} &= 113.1" \end{aligned}$$

$$G_H^{DE} = 4.62 \quad G_V^{DE} = 2.99 \quad \} < 4.62 \quad \text{OK}$$

$$\frac{DL}{4} = \frac{113.1}{4} = 28.3" < 60" \quad \text{OK}$$

$$P_Y = DL (1 - G_V) = (113.1) (1 - 2.99) = 451"$$

$$P_X = P_Z = (DL) (G_H) = (113.1) (4.62) = 523"$$

P_Y Z

$$\begin{aligned} (10.5") (3.99) (3.875) &= 162.3" \\ (99 + 3.6) (3.99) (4.25) &= 1740" \\ \hline &= 1902" \end{aligned}$$

$$\begin{aligned} \frac{P_X \cdot Z}{(10.5) (4.62) (3.875)} &= 188" \\ \frac{(102.6) (4.62) (4.25)}{2203} &= 2015" \end{aligned}$$

MAX TENSION ON BOLTS

$$\frac{P_Y \cdot Z}{n_Y} + \frac{P_Z}{N} = \frac{1902}{(2) (3.25)} + \frac{523}{4} = 292.6 + 130.8 = 423.4" \rightarrow \text{GOVERNS}$$

$$\frac{P_Y \cdot Z}{n_Y} + \frac{P_X \cdot Z}{n_X} = 292.6 + \frac{2203}{(2) (22)} = 292.6 + 50.1 = 342.7"$$

SE SRSS

$$T^2 = (292.6)^2 + (130.8)^2, \quad T = 320.5" > 184" \quad \text{N.B.}$$

FURTHER ANALYSIS REQ'D. → FOR MODIFICATION - 27 FEB 82 SEE PAGE 49 & 40

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O. / W.O. / CALCULATION NO.

13075.63 AB-291-B

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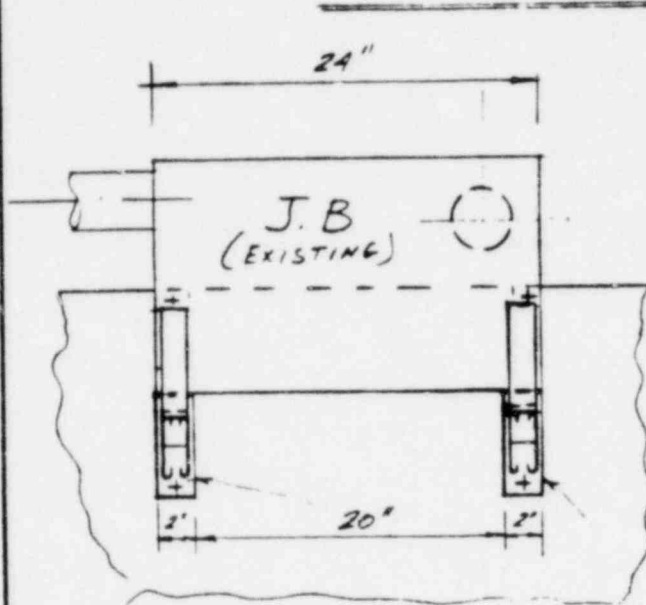
SUBJECT / TITLE

BLOCK WALL REVIEW IE BO-11

QA CATEGORY / CODE CLASS

1/NSR

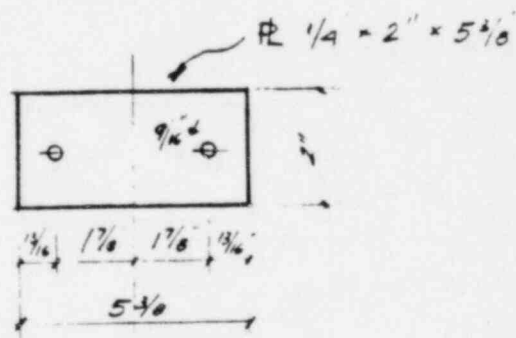
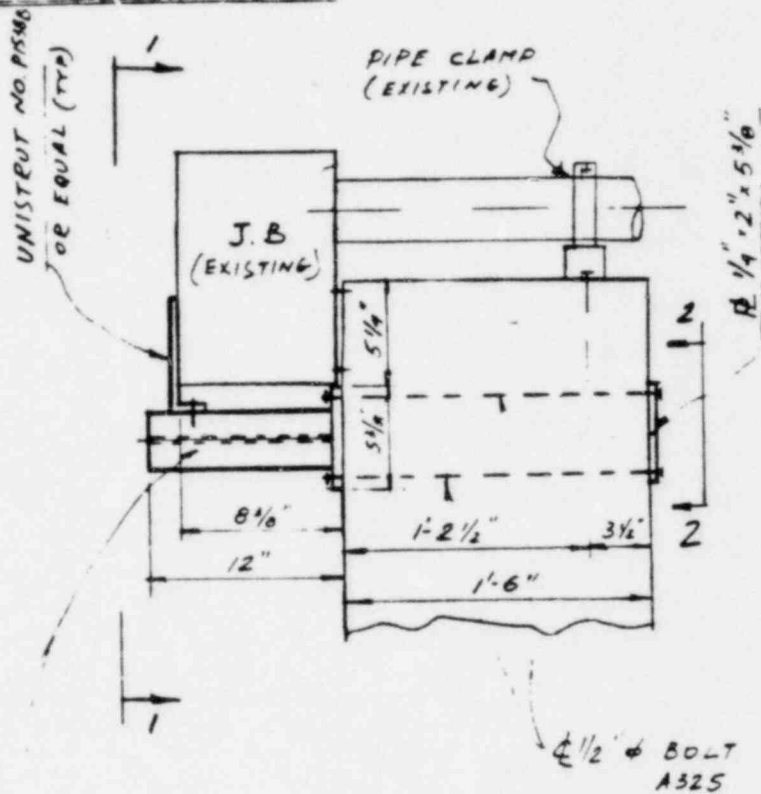
PROPOSED MODIFICATION



1-1

BRACKET UNISTRUT NO P2542

OR EQUAL



2-2

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

13075.63 - AB-291-B

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SUBJECT/TITLE

BLOCK WALL REVIEW IE 80-11

QA CATEGORY/CODE CLASS

1/NSR

LOCAL ANALYSIS PROPOSED MODIFICATION

AB-291-B

FIELD DATA NO. 2

$$DL = 113.1^{\circ}$$

$$\frac{11.3^{\circ}}{125^{\circ}}$$

(ADDED 10% FOR UNISTRUT)

TAKE INTO ACCOUNT ONLY 4 BOLTS $\frac{1}{2}''$ d

TENSION LOAD IN BOLT

$$T = \frac{P_1 Z}{n \cdot Y} + \frac{P_2}{N}$$

$$P_1 = (125)(3.99) = 499^{\circ}$$

$$T = \frac{P_1 Z}{n \cdot Y} + \frac{P_2 Z}{n \cdot X}$$

$$P_2 = P_2 = (125)(4.62) = 577.5^{\circ}$$

$P_1 Z$

$$\begin{aligned} (10.5)(3.99)(3.875) &= 162.3^{\circ} \\ (114.5)(3.99)(4.25) &= 1941.5^{\circ} \\ \hline &2104^{\circ} \end{aligned}$$

$P_2 Z$

$$\begin{aligned} (10.5)(4.62)(3.875) &= 188^{\circ} \\ (114.5)(4.62)(3.875) &= 2298^{\circ} \\ \hline &2436^{\circ} \end{aligned}$$

$$T = \frac{(2104)}{2(3.75)} + \frac{577.5}{4} = 280.5 + 144.4 = 425^{\circ}$$

$$T = 280.5 + \frac{(2436)}{(2)(22)} = 280.5 + 60.9 = 341.4^{\circ}$$

CHECK TENSION STRESS IN BOLT

FOR BOLT #325

$$\frac{425}{0.196} = 2168 \text{ psi} < 44 \text{ ksi} \quad \text{OK}$$

CHECK BEARING OF $\frac{1}{4}'' \times 2'' \times 5\frac{1}{8}''$ E

$$\frac{425}{(2)(5.875)} = 39.5 \text{ psi} < 0.25 f'_m = 337 \text{ psi} \quad \text{OK}$$

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Hadi Boughdadi 02/28/81

SUBJECT/TITLE

Black Wall Review IE 80-11

QA CATEGORY/CODE CLASS

E/NR

COMBINED STRESS SUMMARY SHEET

1) Combined collar joint stress: $(f_{jt} + f_{jd} + f_{jc}) = 5.6$ psi

ALLOWABLE STRESS

12 psi

2) Max. tensile stress: $(f_{ts} + f_{tc}) = 3$ psi
(parallel to joint)

— psi

3) Max. tensile stress: $(f_{ts} + f_{tx} + f_{tc}) = 61.3$ psi
(normal to joint)

$SESS \sqrt{(61+8)^2 + 23^2} = 7.7$

* 66.7 psi

4) Max. Comp. stress:
a) If $[f_{mx} + f_{al} + f_{sv} > f_{my}]$:

• $(f_{al} + f_{sv} + f_{ax})$ at base = 10.0 psi

298 psi

• $(f_{cs} + f_{tx} + f_{tc})$ at pt. of max. flex = 76.7 psi

298 psi

b) If $[f_{mx} + f_{al} + f_{sv} < f_{my}]$:

• $(f_{al} + f_{sv} + f_{ax})$ at base = — psi

— psi

• $(f_{cs} + f_{tc})$ at pt. of max. flex = — psi

— psi

5) Max. shear stress: $(f_v + f_{av} + f_{ev}) = 4.2$ psi

40.4 psi

* $\frac{2}{3}$ INCREASE IN ALLOWABLE STRESS

$40 \times \frac{5}{3} = 66.7$ psi

MAX TENSILE STRESS (SESS) = 61.3

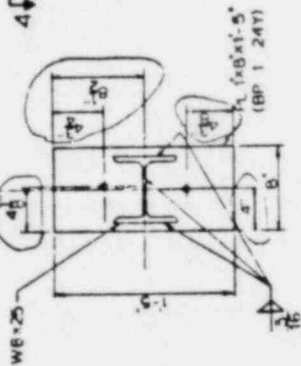
$\frac{61.3}{40} = 1.53$

53% OVER ALLOWABLE

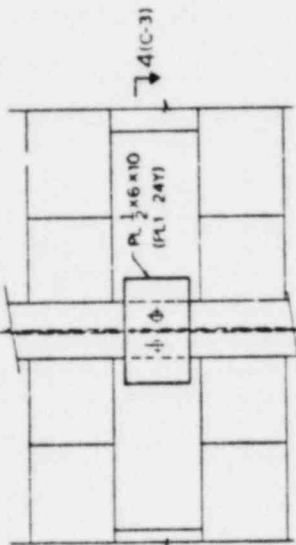
ATTACHMENT G
TYPICAL WALL MODIFICATION
BOUNDARY CONDITIONS

WB-17(EXTING)

PL 3" x 8" LONG
MULTI RIVET BOLTS

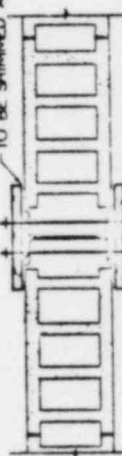


DET P (CS-24H, C-2)
SCALE 1 1/2" = 1'-0"



DET Q (CS-24H, E-2)
SCALE 1 1/2" = 1'-0"

TO BE SHIMMED AS REQUIRED



DET R (CS-24H, F-2)
SCALE 1 1/2" = 1'-0"



APPROVED *J.R. [Signature]*
REGISTERED PROFESSIONAL ENGINEER NO. 6-7-76
COMMONWEALTH OF VIRGINIA

DC-80-559-J

NUCLEAR SAFETY RELATED DATA I

AUXILIARY BUILDING

BLOCK-WALL SUPPORTS

WALL NO AB-259-12 SH-2

MONTH ABILITY POWER STATION UPTAKE 1.8

VERMONT ELECTRIC AND POWER COMPANY

DWG NO 13075 CS-24J-2

STONE & WEBSTER ENGINEERING CORP

DESIGNED BY T. SHAM

CHECKED BY S. K. M. L. J. H.

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G2

ATTACHMENT #4
TYPICAL WALL MODIFICATION
SPAN REDUCTION

DETAIL - A (D-3) ICS-240, C-1 & G-1)
SCALE 1 1/2" = 1' - 0"

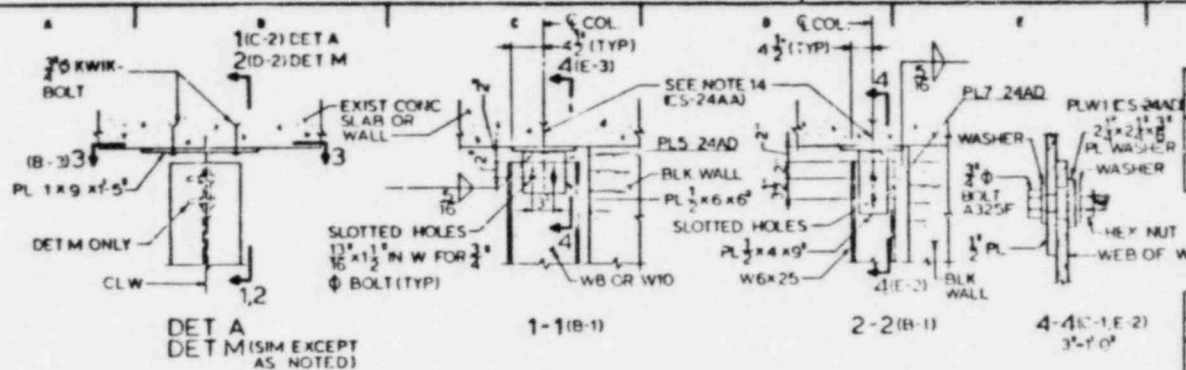
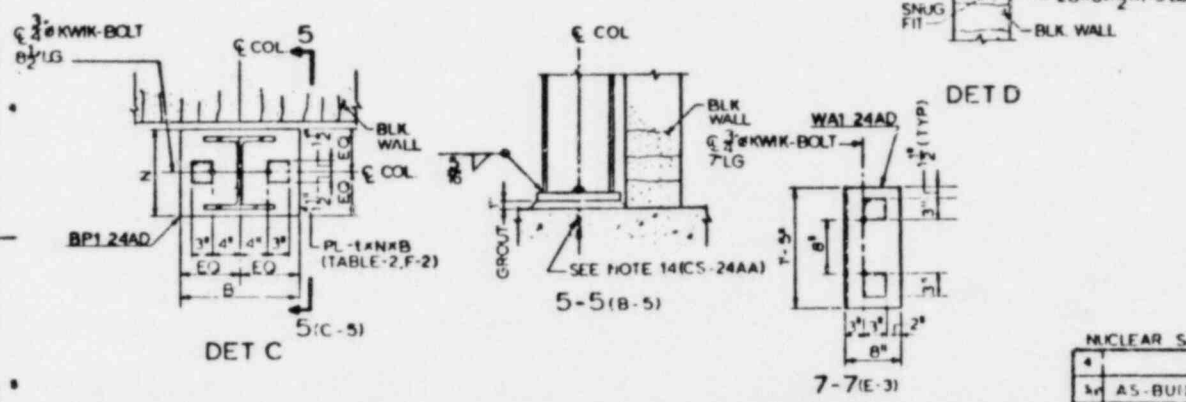
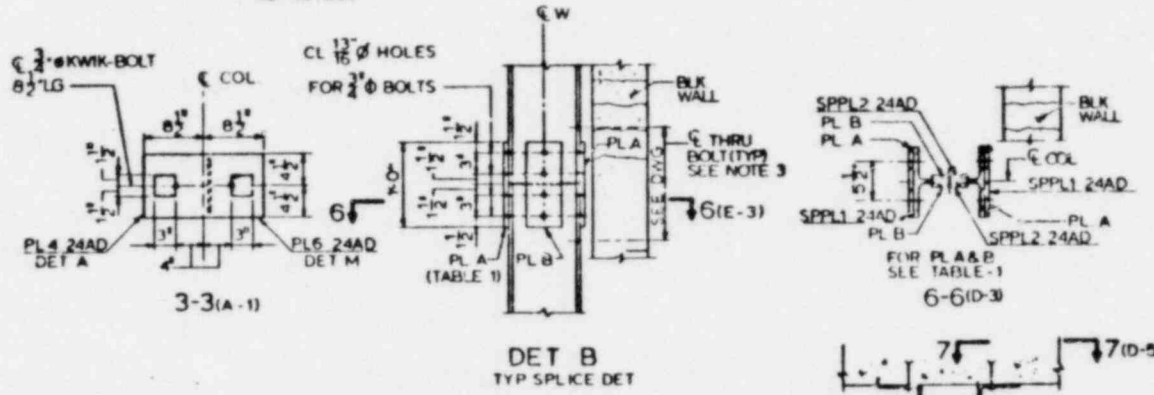


TABLE-1 SPLICE PLATES			
	WBx67	W10x49	W10x67
PL A	1x8x1'-0"	1x10x1'-0"	1x10x1'-0"
PL B	1/2x5x1'-0"	1/2x5x1'-0"	1/2x6x1'-0"

TABLE-2 BASE PLATES			
	WBx25	WBx67	W10x49
	1x9x1'-5"	1x10x1'-5"	1x12x1'-5"

NOTES
 1 SCALE: 1/2"=1'-0"
 2 GENERAL NOTES, CS-24AA
 3 TYP SPLICE DET B MUST BE CENTERED BETWEEN PAIRS OF THRU BOLTS. SEE SECT 9-9ICS-24AE 4G) FIELD TO LOCATE ALL SPLICES



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 REGISTERED PROFESSIONAL ENGINEER NO. 6176
 COMMONWEALTH OF VIRGINIA

NUCLEAR SAFETY RELATED QA CAT I				TYPICAL DETAILS SH 1 BLOCKWALL SUPPORTS			
4	AS-BUILT	25	25	25	25	25	25
2	SEE PCS-24AC-2	25	25	25	25	25	25
1	PROJECT JOINT	25	25	25	25	25	25
STONE & WEBSTER ENGINEERING CORP.				DWG NO. 13075-CS-24AC-3			
DESIGNED BY T. ALEXSONIS CHECKED BY M. BURRATO				APPROVED BY R. GLEN CHECKED BY C. GOLDENFLOE			

REVISIONS
 1. AS-BUILT
 2. SEE PCS-24AC-2
 3. PROJECT JOINT