



Commonwealth Edison
 One First National Plaza, Chicago, Illinois
 Address Reply to: Post Office Box 767
 Chicago, Illinois 60690

July 8, 1980

Mr. Darrell G. Eisenhut, Director
 Division of Licensing
 U.S. Nuclear Regulatory Commission
 Washington, DC 20555

Subject: Response to NRC Information Request On
 Category I Masonry Walls Employed By
 Plants Under CP and OL Review
 LaSalle County Station Unit 1 and 2;
 Byron Station Unit 1 and 2
 Braidwood Station Unit 1 and 2
 NRC Docket Nos. 50-373/374, 50-454/455
 and 50-456/457

- Reference (a): S. A. Varga letter to All CP and OL
 Applicants dated April 21, 1980
- (b): D. L. Peoples letter to J. G. Keppler
 dated July 7, 1980

Dear Mr. Eisenhut:

Enclosed are two (2) copies of the Commonwealth Edison response to the request for information regarding masonry wall design contained in Reference (a). The information provided addresses the design and application of masonry walls on LaSalle County Unit 1 and 2, Byron Unit 1 and 2, and Braidwood Unit 1 and 2. Also submitted for your information are two (2) copies of the drawings for the named units which show plans, elevations and details of all concrete masonry walls in Category I structures.

In the case of LaSalle County Station, a further review of the masonry wall design is being conducted to completely address the concerns presented in Bulletin 80-11, which was issued by the NRC Office of Inspection and Enforcement. This additional review will be documented at the plant site and will be completed prior to fuel load.

If there are any further questions in this regard, please direct them to this office.

Very truly yours,

D. L. Peoples
 Director of
 Nuclear Licensing

cc: Mr. B. J. Youngblood, Chief
 Div. of Lic. - Branch 1

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 POOR QUALITY PAGES

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S. J. / 4 DEWG
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 NRC PDR
 LPDR
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RESPONSE TO NRC INFORMATION REQUEST
ON CATEGORY I CONCRETE MASONRY WALLS

Information Request No. 1:

Are there any concrete masonry walls being used in any of the Category I structures of your plant? If the answer is "No" to this question, there is no need to answer the following questions.

Response: Yes, Commonwealth Edison Company is using concrete masonry walls in Category I structures for LaSalle Station.

Information Request No. 2:

Indicate the loads and load combinations to which the walls were designed to resist. If load factors other than one (1) have been employed, please indicate their magnitudes.

Response: Masonry walls in Category I structures are being designed for loads and load combinations as given in the attached Table 1. These walls are not subjected to other design loads such as wind, tornado, missile, pipe whip and jet impingement loads.

Information Request No. 3:

In addition to complying with the applicable requirements of the SRP Sections 3.5, 3.7 and 3.8, is there any other code such as the "Uniform Building Code" or the "Building Code Requirements for Concrete Masonry Structures" (proposed by the American Concrete Institute) which was or is being used to guide the design of these walls? Please identify and discuss any exceptions or deviations from the SRP requirements or the aforementioned codes.

Response: Concrete masonry walls are being designed in accordance with the National Concrete Masonry Association "Specification for the Design and Construction of Load-Bearing Concrete Masonry," April 1974. No exception is being taken to this specification except that no overstress factor is being used for OBE load combination as against 1.33 recommended by the specification for such severe environmental loads as wind, earthquake, etc. For the abnormal/extreme environmental loading combinations involving SSE and LOCA loads, an overstress factor of 1.67 is being used. These overstress factors are consistent with the SRP guidelines for safety-related structures.

Information Request No. 4:

Indicate the method that you used to calculate the dynamic forces in masonry walls due to earthquake, i.e., whether it is a code's method such as Uniform Building Code, or a dynamic analysis. Identify the code and its effective date if the code's method has been used. Indicate the input motion if a dynamic analysis has been performed.

Response: Seismic lateral loads are being determined by an equivalent static method using the expression $w_s = gW$.

where:

w_s = seismic lateral load

W = weight of the masonry wall including any attachment load

g = seismic acceleration in the horizontal direction obtained from the combined floor response spectra curves. The combined curves being obtained by adding the spectra from seismic, SRV and LOCA events.

The natural frequency of the walls is being determined using standard expressions for single degree of freedom systems using the section properties of the wall based on the actual masonry unit size. The response spectra curves are entered with this calculated value of frequency to obtain the value of 'g'.

Walls are assumed as simply supported or cantilevered beams, as applicable, for frequency calculations and for design and analysis.

Information Request No. 5:

How were the masonry walls and the piping/equipment supports attached to them designed? Provide enough numerical examples including details of reinforcement and attachments to illustrate the methods and procedures used to analyze and design the walls and the anchors needed for supporting piping/equipment (as applicable).

Response: Masonry walls in Category I structures are being used as non-load bearing walls and are not being included as part of shear wall system for the Category I structures. These walls will only be relied upon as interior partition walls and will be separated from the floor above by a gap.

No major piping or equipment will be attached to the Category I masonry walls. Attachments which will be allowed include small bore piping, instrument lines, conduits, junction boxes, etc. These attachments will be made either with expansion anchor or with through bolt plate assembly. Expansion anchors will not be used for hollow masonry walls.

Attachment loads are being accounted for in the design by assuming a concentrated mass at mid-span with a maximum eccentricity of 6 inches from face of the wall. Magnitude of the mass on any 1-foot wide horizontal strip of masonry wall is 180 lbs. for solid block walls, and 135 lbs. for hollow walls 12-inches thick or more and grouted block walls. Actual attachment loads will be field verified and a final check will be made to ensure the adequacy of the walls.

Masonry walls are being designed using working stress principles with unfactored loads and are being analyzed based on conventional elastic methods. Design is being made using actual masonry unit size

rather than the nominal. Horizontal reinforcement is ignored in the flexural design of the masonry walls, except for a few walls where the reinforcement is considered in the design.

Allowable stresses used for the design are given in attached Table 2. Whenever expansion anchors will be used for attachment of piping, there is a factor of safety of 4.0 for SSE. Effect of the anchor plate flexibility is taken into account for the design of expansion anchors.

Expansion anchors which will be allowed to be used are either wedge or sleeve type anchors with their sizes varying from 3/8" diameter to 3/4" diameter and with a minimum embedment length equal to 8 times the diameter.

Masonry walls in Category I structures are being constructed as single or multi-wythe hollow or solid block walls with full mortar bedding of the units using running bond construction. No cavity wall construction will be allowed. Properties of the different materials used for masonry wall construction are given in attached Table 3. Wythes will be bonded together by full mortar collar joints and by continuous truss bar reinforcement which overlaps the adjacent wythes every second course.

Sample calculations for concrete masonry walls in Category I structures for LaSalle Station are attached.

Information Request No. 6:

Provide plan and elevation views of the plant structures showing the location of all masonry walls for your facility.

Response: The following is a list of drawings attached showing the plans, elevations and details of all the concrete masonry walls in Category I structures for LaSalle Station:

A-64	A-180 thru A-182	A-264
A-65	A-184 thru A-198	A-266 thru A-268
A-74	A-206 thru A-213	A-270
A-75	A-217 thru A-244	A-271
A-79	A-246 thru A-248	A-275 thru A-277
A-91	A-250	A-280
A-92	A-252	A-281
A-176	A-257	A-293
	A-259	A-294
	A-260	A-296 thru A-304

Total Number of Drawings - 92

TABLE 1

Load Combination Table For
Category I Concrete Masonry

Load Category	Load Factors								Allowable Stresses
	D	L	P _o	P _a	E _o	E _{ss}	SRV	LOCA	
Normal	1.0	1.0	1.0				1.0		Table 2
Severe Environmental	1.0	1.0	1.0		1.0		1.0		Table 2
Abnormal	1.0	1.0		1.0			1.0	1.0	1.67 X Table 2
Extreme Environmental	1.0	1.0	1.0			1.0	1.0		1.67 X Table 2
Abnormal/Severe Environmental	1.0	1.0		1.0	1.0		1.0	1.0	1.57 X Table 2
Abnormal/Extreme Environmental	1.0	1.0		1.0		1.0	1.0	1.0	1.67 X Table 2

Load symbols are defined as follows:

- D = Dead load of masonry wall including attachment load
- L = Live load
- P_o = Operating pressure differential across a masonry wall
- P_a = Accidental pressure differential across a masonry wall
- E_o = Operating Basis Earthquake (OBE)
- E_{ss} = Safe Shutdown Earthquake (SSE)
- SRV = Loads associated with safety relief valve discharge, where applicable
- LOCA = Loads associated with loss of coolant accident, where applicable

TABLE 2

Allowable Stresses for Category I Non-Reinforced Concrete Masonry^(d)

S No.	Description	Type of Unit ^(c)	Type of Mortar ^(c)	Allowable Stresses (psi)		
				Symbol	Related to f'_m	Actual Value
1	Compressive a) Flexure	Hollow, Grouted or Solid	M	F_m	$0.3 f'_m$	405 ^(a)
	b) Axial	Hollow, Grouted or Solid	M	F_a	$0.2 f'_m$	270 ^(a)
2	Shear	Hollow, Grouted or Solid	M	v_m	--	34 ^(b)
3	Tension in Flexure a) Normal to bed joints	Hollow	M	F_t	--	23 ^(b)
		Grouted or Solid	M	F_t	--	39 ^(b)
	b) Parallel to bed joints	Hollow	M	F_t	--	45 ^(b)
		Grouted or Solid	M	F_t	--	78 ^(b)
4	Bearing a) on full area	Hollow, Grouted or Solid	M	F_b	$0.25 f'_m$	337 ^(b)
	b) on 1/3 area or less	Hollow, Grouted or Solid	M	F_b	$0.375 f'_m$	506 ^(b)
5	Modulus of elasticity			E_m	$1000 f'_m$	1,350,000 ^(a)

NOTES:

- (a) Actual values are based on $f'_m = 1350$ psi for Grade N-I hollow or solid masonry blocks.
- (b) Applied to the net mortar bedded area.
- (c) Material properties as per Table 3.
- (d) Table 2 is adopted from NCMA specification, April 1974.

TABLE 3

Concrete Masonry Material Properties

- | | |
|---|---|
| 1) Hollow Concrete Masonry Blocks: | ASTM C90, Grade N-I |
| 2) Solid Concrete Masonry Blocks: | ASTM C145, Grade N-I |
| 3) Grouted Masonry Blocks: | Hollow blocks as per ASTM C90
Grade N-I and grout to conform
to ASTM C476 |
| 4) Mortar: | ASTM C270, Type M |
| 5) Reinforcement for Concrete
Masonry: | Truss reinforcement, ASTM A82
with $f_y = 65$ ksi |

RESPONSE TO NRC INFORMATION REQUEST
ON CATEGORY I CONCRETE MASONRY WALLS

Information Request No. 1:

Are there any concrete masonry walls being used in any of the Category I structures of your plant? If the answer is "No" to this question, there is no need to answer the following questions.

Response: Yes, Commonwealth Edison Company is using concrete masonry walls in Category I structures for Byron/Braidwood Stations.

Information Request No. 2:

Indicate the loads and load combinations to which the walls were designed to resist. If load factors other than one (1) have been employed, please indicate their magnitudes.

Response: Masonry walls in Category I structures are being designed for loads and load combinations as given in the attached Table 1. These walls are not subjected to other design loads such as wind, tornado, missile, and loads generated by a postulated pipe break.

Information Request No. 3:

In addition to complying with the applicable requirements of the SRP Sections 3.5, 3.7 and 3.8, is there any other code such as the "Uniform Building Code" or the "Building Code Requirements for Concrete Masonry Structures" (proposed by the American Concrete Institute) which was or is being used to guide the design of these walls? Please identify and discuss any exceptions or deviations from the SRP requirements or the aforementioned codes.

Response: Concrete masonry walls are being designed in accordance with the National Concrete Masonry Association "Specification for the Design and Construction of Load-Bearing Concrete Masonry," April 1974. No exception is being taken to this specification except that no overstress factor is being used for OBE load combination as against 1.33 recommended by the specification for such severe environmental loads as wind, earthquake, etc. For the abnormal/extreme environmental loading combinations involving SSE loads, an overstress factor of 1.67 is being used. These overstress factors are consistent with the SRP guidelines for safety-related structures.

Information Request No. 4:

Indicate the method that you used to calculate the dynamic forces in masonry walls due to earthquake, i.e., whether it is a code's method such as Uniform Building Code, or a dynamic analysis. Identify the code and its effective date if the code's method has been used. Indicate the input motion if a dynamic analysis has been performed.

Response: Seismic lateral loads are being determined by an equivalent static method using the expression $w_s = gw$.
where:

w_s = seismic lateral load

W = weight of the masonry wall including any attachment load

g = seismic acceleration in the horizontal direction obtained from the horizontal floor response spectra curves which are generated using the dynamic analysis.

The natural frequency of the walls is being determined using standard expressions for single degree of freedom systems using the section properties of the wall based on the actual masonry unit size. The response spectra curves are entered with this calculated value of frequency to obtain the value of 'g'.

Walls are assumed as simply supported or cantilevered beams, as applicable, for frequency calculations and for design and analysis.

Information Request No. 5:

How were the masonry walls and the piping/equipment supports attached to them designed? Provide enough numerical examples including details of reinforcement and attachments to illustrate the methods and procedures used to analyze and design the walls and the anchors needed for supporting piping/equipment (as applicable).

Response: Masonry walls in Category I structures are being used as non-load bearing walls and are not being included as part of shear wall system for the Category I structures. These walls will only be relied upon as interior partition walls and will be separated from the floor above by a gap.

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Attachment loads are being accounted for in the design by assuming a concentrated mass at mid-span with a maximum eccentricity of 6 inches from face of the wall. Magnitude of the mass on any 1-foot wide horizontal strip of masonry wall is 180 lbs. for solid block walls, and 135 lbs. for hollow block walls. Actual attachment loads will be field verified and a final check will be made to ensure the adequacy of the walls.

Masonry walls are being designed using working stress principles with unfactored loads and are being analyzed based on conventional elastic methods. Design is being made using actual masonry unit size rather than the nominal. Horizontal reinforcement is ignored in the flexural design of the masonry walls.

Allowable stresses used for the design are given in attached Table 2. Whenever expansion anchors will be used for attachment of conduits, instrument lines, junction boxes, etc., there is a factor of safety of 4.0 for SSE. Effect of the anchor plate flexibility is taken into account for the design of expansion anchors.

Expansion anchors which will be allowed to be used are either wedge or sleeve type anchors with their sizes varying from 3/8" diameter to 3/4" diameter and with a minimum embedment length equal to 8 times the diameter.

Masonry walls in Category I structures are being constructed as single or multi-wythe hollow or solid block walls with full mortar bedding of the units using running bond construction. No cavity wall construction will be allowed. Properties of the different materials used for masonry wall construction are given in attached Table 3. Wythes will be bonded together by full mortar collar joints and by continuous truss bar reinforcement which overlaps the adjacent wythes every second course.

Sample calculations for concrete masonry walls in Category I structures for Byron/Braidwood Stations are attached.

Information Request No. 6:

Provide plan and elevation views of the plant structures showing the location of all masonry walls for your facility.

Response: The following is a list of drawings attached showing the plans, elevations and details of all the concrete masonry walls in Category I structures for Byron/Braidwood Stations:

A-206 thru A-213	A-740	S-1288 thru S-1290
A-219	A-742	S-1296
A-220	S-670	S-1298
A-222 thru A-226	S-672 thru S-677	S-1302
A-228 thru A-234	S-679	S-1303
A-237 thru A-243	S-680	S-1306
A-246 thru A-249	S-682	S-1313
A-251 thru A-264	S-684	S-1315
A-266 thru A-272	S-690 thru S-694	S-1317
A-274 thru A-280	S-696 thru S-701	S-1319
A-282	S-705 thru S-707	S-1320
A-283	S-749	S-1322
A-295	S-799 (Details)	S-1335
A-296	S-800	S-1412
A-312	S-812	S-1560
A-313	S-906	S-1561
A-318	S-997	S-1600 thru S-1613
A-319	S-1099	S-1616 thru S-1619
A-320	S-1286	

Total No. of Drawings - 141

TABLE 1

Load Combination Table For
Category I Concrete Masonry

Load Category	Load Factors						Allowable Stresses
	D	L	P _o	P _a	E _o	E _{ss}	
Normal	1.0	1.0	1.0				Table 2
Severe Environmental	1.0	1.0	1.0		1.0		Table 2
Abnormal	1.0	1.0		1.0			1.67 X Table 2
Extreme Environmental	1.0	1.0	1.0			1.0	1.67 X Table 2
Abnormal/Severe Environmental	1.0	1.0		1.0	1.0		1.67 X Table 2
Abnormal/Extreme Environmental	1.0	1.0		1.0		1.0	1.67 X Table 2

Load symbols are defined as follows:

- D = Dead load of masonry wall including the attachment load
- L = Live load
- P_o = Operating pressure differential across a masonry wall
- P_a = Accidental pressure differential across a masonry wall
- E_o = Operating Basis Earthquake (OBE)
- E_{ss} = Safe Shutdown Earthquake (SSE)

TABLE 2

Allowable Stresses for Category I Non-Reinforced Concrete Masonry (d)

S No.	Description	Type of Unit ^(c)	Type of Mortar ^(c)	Allowable Stresses (psi)		
				Symbol	Related to f'_m	Actual Value
1	Compressive	Hollow or Solid	M	F_m	$0.3 f'_m$	405 ^(a)
	a) Flexure					
	b) Axial	Hollow or Solid	M	F_a	$0.2 f'_m$	270 ^(a)
2	Shear	Hollow or Solid	M	v_m	--	34 ^(b)
3	Tension in Flexure	Hollow	M	F_t	--	23 ^(b)
						Solid
	b) Parallel to bed joints	Hollow	M	F_t	--	46 ^(b)
						Solid
4	Bearing	Hollow or Solid	M	F_b	$0.25 f'_m$	337 ^(b)
	a) on full area					
	b) on 1/3 area or less	Hollow or Solid	M	F_b	$0.375 f'_m$	506 ^(b)
5	Modulus of elasticity			E_m	$1000 f'_m$	1,350,000 ^(a)

NOTES:

- (a) Actual values are based on $f'_m = 1350$ psi for Grade N-I hollow or solid masonry blocks.
- (b) Applied to the net mortar bedded area.
- (c) Material properties as per Table 3.
- (d) Table 2 is adopted from NCMA specification, April 1974.

TABLE 3

Concrete Masonry Material Properties

- | | |
|--|--|
| 1) Hollow Concrete Masonry Blocks: | ASTM C90, Grade N-I |
| 2) Solid Concrete Masonry Blocks: | ASTM C145, Grade N-I |
| 3) Mortar: | ASTM C270, Type M |
| 4) Reinforcement for Concrete Masonry: | Truss reinforcement, ASTM A82
with $f_y = 65$ ksi |

DESIGN OF CATEGORY I
CONCRETE MASONRY WALLS
SAMPLE CALCULATION

EXAMPLE I (12" Thick Hollow Block Wall)

I. DESIGN PARAMETERS:

Density = 105 lbs/ft³; Type M mortar;
Modulus of Elasticity (E_m) = 1,350,000 psi. 2 Core-hollow
block; Masonry wall lateral support column spacing see Fig. 1.
Masonry compressive strength f'_m = 1350 psi

II. ALLOWABLE STRESSES (Per NCMA; Inspected Workmanship)

Tension in Flexure (F _t)		
Parallel to bed joints	=	46.0 psi
Perpendicular to bed joints	=	23.0 psi
.	.	.
Shear (V _m)	=	34.0 psi

III. WALL DESIGN (See Figure 1)

Assume the "g" value due to vertical excitation to be less than 1.0.

Assume the masonry wall not acting as a lateral support for another wall. (When masonry wall acts as a support, it is designed for in-plane shear.)

1. Span # 1 - Assume no attachments.

Assume 1-ft wide strip spanning vertically, L = 8'-0"

<u>Section Properties:</u>			
	W _w	=	42.6 psf/ft
	I	=	1022.0 in ⁴ /ft
	S	=	175.8 in ³ /ft
	A	=	58.4 in ² /ft

Frequency Calculations:

$$f = \frac{56}{2\pi} \sqrt{\frac{144 \times W_w \times L^4}{1350000 \times I}}$$

Substituting the Values:

$$f = \frac{56}{2\pi} \sqrt{\frac{144 \times 42.6 \times 8^4}{1350000 \times 1022.0}} = 66.0 \text{ cps}$$

$$\text{Period } T = \frac{1}{f} = \frac{1}{66.0} = 0.0152$$

Wall Acceleration Values in Horizontal Direction

From the appropriate floor response spectra curves

$$g_{OBE} = 0.11$$

$$g_{SSE} = 0.24$$

$$g_{SSE} \text{ (Reduced)} = 0.24/1.67 \quad (\text{Overstress factor} = 1.67)$$
$$0.144 \leftarrow \text{Governs}$$

Stress Calculations: For 1-ft wide horizontal strip

$$\text{Uniform load } W_S = 0.144 (42.6) = 6.13 \text{ lbs/ft}$$

$$\text{Moment} = \frac{W_S L^2}{8} = \frac{6.13(8)^2}{8} = 49.0 \text{ ft-lbs}$$

$$\text{Shear} = W_S L / 2 = 6.13 \times 8 / 2 = 24.5 \text{ lbs}$$

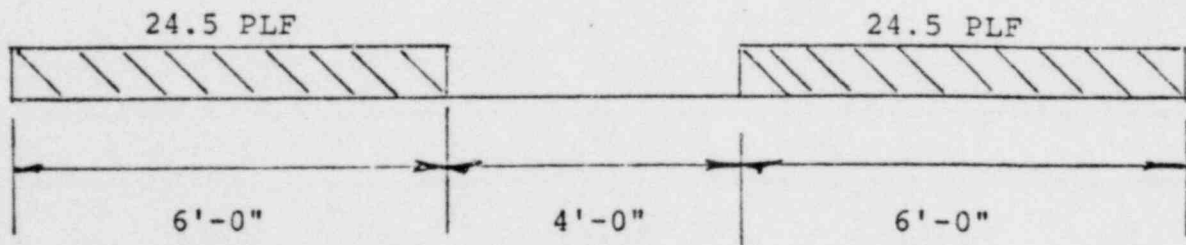
$$f_{t_s} = \frac{M}{S} = \frac{49(12)}{175.8} = 3.35 \text{ psi} < 23.0 \text{ psi (O.K.)}$$

$$v_s = V_s/A = 24.5/58.4 = 0.42 \text{ psi} < 34 \text{ psi (O.K.)}$$

Load Contribution on Span # 2 From Span # 1 (See Fig. 1)

Assume a 2'-0" wide beam band above the opening

$$R = \frac{W_S L}{2} = \frac{6.13(8)}{2} = 24.5 \text{ lbs.} \quad (\text{See Fig. 3})$$



Additional Load on Span # 2 from Span # 1

FIGURE 3

Equivalent Uniform Load on 1-ft Wide Strip of Span # 2
Due to Load Contribution of Span # 1

$$\text{Moment from additional load } R = \frac{2wa^2}{2} = \frac{2(24.5)(3^2)}{2}$$

$$a = 6.0/2 = 220.5 \text{ ft-lbs.}$$

$$\text{Equivalent Uniform Load } W = \frac{8M}{L^2} = \frac{8(220.5)}{(16)^2} = 6.9 \text{ PLF}$$

2. Span # 2 - (See Fig. 1)

Assume 1-ft wide strip spanning horizontally $L = 16'-0''$
(See Fig. 1)

Section Properties:

W_w	=	42.6 psf/ft
I	=	929.4 in ⁴ /ft
S	=	159.9 in ³ /ft
A	=	36.0 in ² /ft

Frequency Calculations:

$$f = \frac{56}{2\pi} \sqrt{\frac{144 \times 42.6 \times 16^4}{1350000 \times 929.4}} = 15.7 \text{ cps}$$

$$T = \frac{1}{15.7} = 0.0635$$

Wall Acceleration Values in Horizontal Direction

From the appropriate floor response spectra curves

$$g_{OBE} = 0.18$$

$$g_{SSE} \text{ (Reduced)} = 0.60/1.67 = 0.36 \leftarrow \text{Governs}$$

Stress Calculations:

$$\text{Uniform Load } W_s = 0.36 (42.6) + \text{Equiv. Uniform Ld. - Span \# 1} \\ = 15.3 + 6.9 = 22.2 \text{ lbs/ft.}$$

$$\text{Moment} = \frac{W_s L^2}{8} = \frac{22.2(16)^2}{8} = 710 \text{ ft-lbs.}$$

$$\text{Shear} = W_s L/2 = 22.2 \times 16/2 = 178 \text{ lbs.}$$

$$f_{ts} = \frac{M}{S} = \frac{710(12)}{159.9} = 53.3 \text{ psi} > 46.0 \text{ psi (N.G.)}$$

$$v_s = V_s/A = 178/36 = 4.9 \text{ psi} < 34.0 \text{ psi (O.K.)}$$

Reduce Span by Changing Support Column Spacing (See Fig. 2)

Reanalyze Span # 2 with reduced span length

- Span # 1 - Vertical Span - no change
- Additional Loading on 2 ft. wide beam band of Span # 2 From Span # 1 (See Fig. 4)
- $R = W_s L/2 = 6.13(8)/2 = 24.5 \text{ lbs.}$

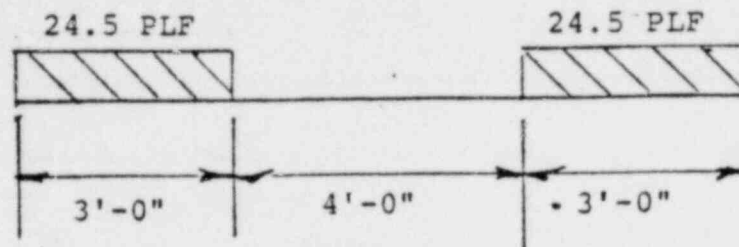


FIGURE 4

Equivalent Uniform Load on 1 ft. Wide Strip of Span # 2 Due to Load Contribution of Span # 1

$$\text{Moment from Additional Load } R = \frac{2wa^2}{2} = \frac{2(24.5)(1.5^2)}{2} = 55 \text{ ft-lbs.}$$

$$\text{Equivalent Uniform Load } W = \frac{8M}{L^2} = \frac{8(55)}{(10)^2} = 4.4 \text{ lbs/ft.}$$

- Span # 2 - Reduced span $L = 10'-0''$ (See Fig. 2)

Frequency Calculations:

$$f = \frac{56}{2\pi} \sqrt{\frac{144 \times 42.6 \times 10^4}{1350000 \times 929.4}} = 40.3 \text{ cps}$$

$$T = \frac{1}{f} = \frac{1}{40.3} = 0.0248$$

Wall Acceleration Values in Horizontal Direction

From the appropriate floor response spectra curves

$$g_{OBE} = 0.14$$

$$g_{SSF} \text{ (reduced)} = 0.32/1.67 = 0.192 \leftarrow \text{Governs}$$

Uniform Load $W_s = 0.6$
 $= 8.18$

$$M = \frac{W_s L^2}{8} = \frac{12.6(12.6)^2}{8} = 157 \text{ ft-lbs.}$$

$$f_{t_s} = \frac{M}{S} = \frac{157(12.6)}{159.9} = 1.8 \text{ psi}$$

By inspection actual stress is less than allowable.

3. Span # 3

Assume 1 ft. wide strip
(See Fig. 2)

Wall Frequency:

As calculated on Page 6

$$f = 40.3 \text{ cps}$$

$$T = 0.0248$$

Wall Acceleration Value

As calculated on Page 6

$$g_{OBE} = 0.14$$

$$g_{SSE} \text{ (Reduced)} = 0.02$$

Uniform Load $W_s = 0.16$

$$\text{Moment} = \frac{W_s L^2}{8} = \frac{8.18(12.6)^2}{8} = 102 \text{ ft-lbs}$$

$$f_{t_s} = \frac{M}{S} = \frac{102(12.6)}{159.9} = 0.6 \text{ psi}$$

By Inspection actual stress is less than allowable.

Add effect of attachment

$$f_{t_s} = 7.6 \text{ psi. For conditions see Page 6}$$

$0.6) + \text{Equiv. Unif. Ld.} - \text{Span \# 1}$
 $= 12.6 \text{ lbs./ft.}$

$$= 157 \text{ ft-lbs.}$$

$$1.8 \text{ psi} < 46.0 \text{ psi (O.K.)}$$

stress is less than allowable.

ing horizontally, $L = 10'-0"$

Horizontal Direction

— Governs

$$0.6) = 8.18 \text{ PLF}$$

$$\frac{2}{8} = 102 \text{ ft-lbs}$$

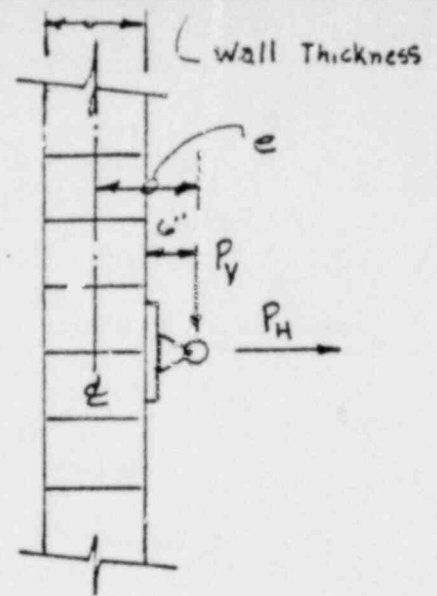
$$0.6 \text{ psi} < 46.0 \text{ psi (O.K.)}$$

stress is less than allowable

ad to the tensile stress
tions see Page 6

IV. DESIGN FOR ATTACHMENT LOADS

Assume 1 - ft. wide horizontal strip.
 Maximum assumed attachment
 load "P" for 12" hollow block wall
 at an eccentricity of 6"
 from face of the wall = 135 lbs.



There are three loads due to Load P

1. Horizontal load $P_H = g_H P$
2. Vertical load $P_V = (1+g_V) P$
3. Eccentric Moment = $P_V \times e$

Different mortar surfaces, horizontal as well as vertical, at the location of attachment, have enough shearing resistance to resist the block-pulling effect from the loads mentioned above. The overall bending effect of load P_H is considered assuming a 1 - foot horizontal strip acting as a beam between the supports. The attachment load is considered either as one concentrated load at mid-span or two concentrated loads, one at each quarter point of the span. Tensile stresses due to this bending are directly added to the tensile stresses f_{t_s} calculated on Page 5.

Moment 'M' due to $P_H = P_H L / 4$ ft-lbs.

where

$L = 10'-0"$

$P_H = g_H P = 0.192 \times 135 = 25.92$ lbs.

($g_H = 0.192$ calculated earlier on Page 5)

$M = P_H L / 4 = \frac{25.92 \times 10}{4} = 64.8$ ft-lbs.

$S = 159.9$ in³

$f_{t_a} =$ tension due to attachment load
 $= \frac{64.8 \times 12}{159.9} = 4.9$ psi

f_{t_s} due to wall seismic load = 7.6 psi
 (calculated on Page 5)

Total tensile stress, $f_t = f_{t_s} + f_{t_a}$
 $= 7.6 + 4.9 = 12.5$ psi < 46.0 psi (O.K.)

V. MASONRY WALL SUPPORT COLUMN DESIGN

Uniform Load on Column:

For loading on the column assume two concentrated attachment loads, one at each quarter point of the span.

$$W = LW_s + 2(135\# \text{ attach.}) g_{SSE} \text{ (reduced)}$$

$$= 10 \times 8.18 \text{ PLF} + 2 (135) 0.192 \text{ PLF}$$

$$= 81.8 + 51.8 = 133.6 \text{ PLF}$$

$$M = \frac{w L^2}{8} = \frac{133.6(20.0^2)}{8} = 6700.0 \text{ ft-lbs.} = 6.7 \text{ ft-kips}$$

Allowable $F_b = 0.66 F_y$ for g_{OBE} (column fully embedded in masonry)

since $1.67 (.66 F_y)$ exceeds $0.95 F_y$;

$$F_b = \frac{0.95 F_y}{1.67} = 0.57 F_y \text{ for reduced } g_{SSE}$$

$$S_{\text{req'd}} = \frac{M}{F_b} = \frac{6.7 \times 12}{0.57 \times 36.0} \quad (F_y = 36 \text{ ksi})$$
$$= 3.92 \text{ in}^3$$

Use Minimum Size W8x18 ($S = 15.2 \text{ in}^3$) for Steel Column as Masonry Wall Support.

EXAMPLE II (36" Thick Solid Block Concrete Masonry Wall)

I. DESIGN PARAMETERS:

Non-load bearing masonry wall

Density = 140 lbs/ft³

Type M mortar; Masonry compressive strength $f'_m = 1350$ psi

Modulus of elasticity (E_m) = 1,350,000 psi

II. ALLOWABLE STRESSES (As per NCMA, Inspected Workmanship)

Tension in flexure (F_t)

Parallel to the bed joints = 78.0 psi
Perpendicular to bed joints = 39.0 psi

Shear (V_m) = 34.0 psi

III. WALL DESIGN

36" thick solid block wall is multi-wythe construction bonded together by full mortar collar joint and by continuous truss bar reinforcement which overlaps the adjacent wythes every second course. As such, the section properties of 36" thick solid block wall are used for design. The design procedure is essentially the same as shown for 12" hollow block wall in Example No. 1 except for the section properties of 36" solid block wall which are as follows:

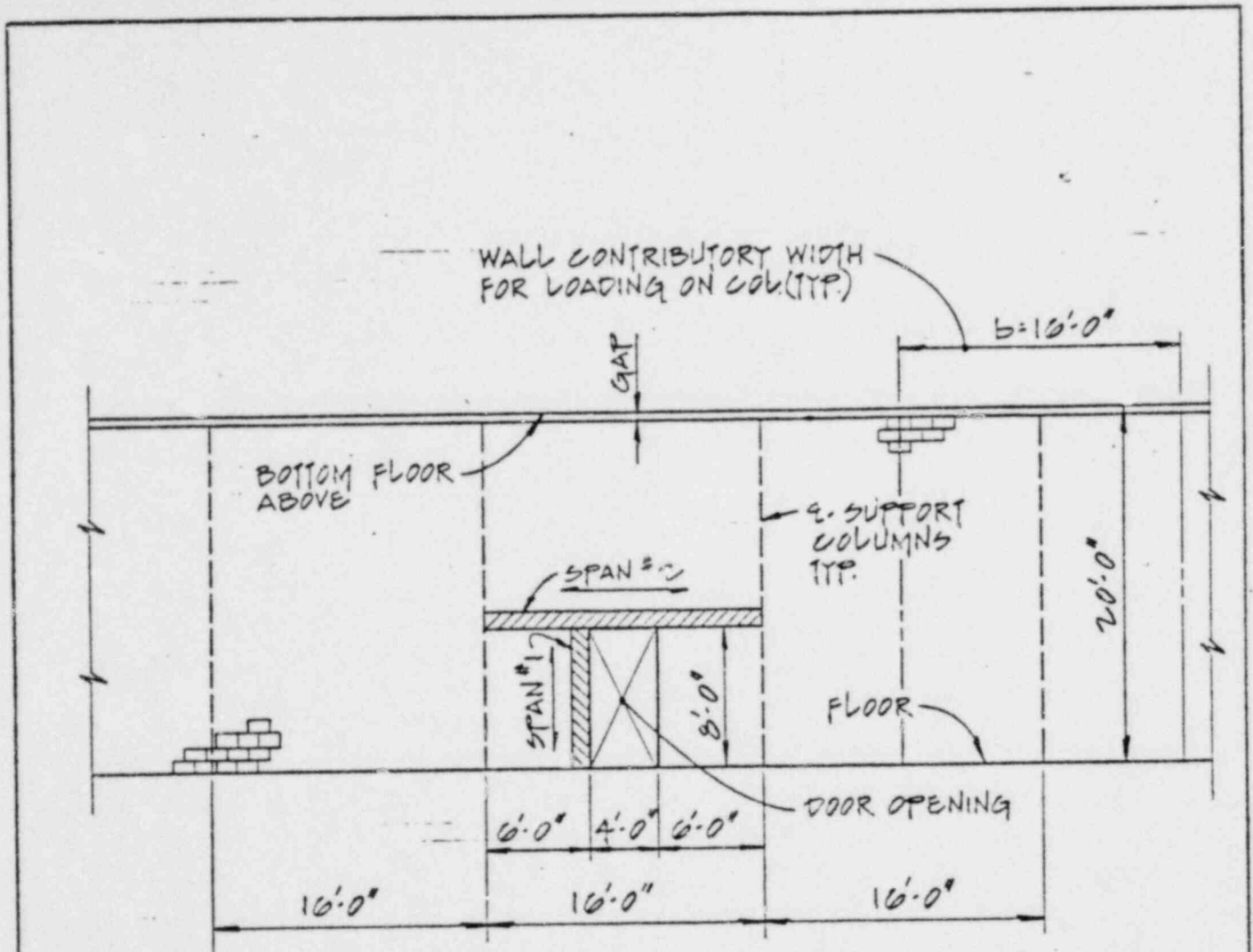
$$A = 427.5 \text{ in}^2/\text{ft}$$

$$I = 45213.0 \text{ in}^4/\text{ft}$$

$$S = 2538.3 \text{ in}^3/\text{ft}$$

wall weight $W_w = 430.5$ PSF of wall area for 140#/ft³ solid block wall

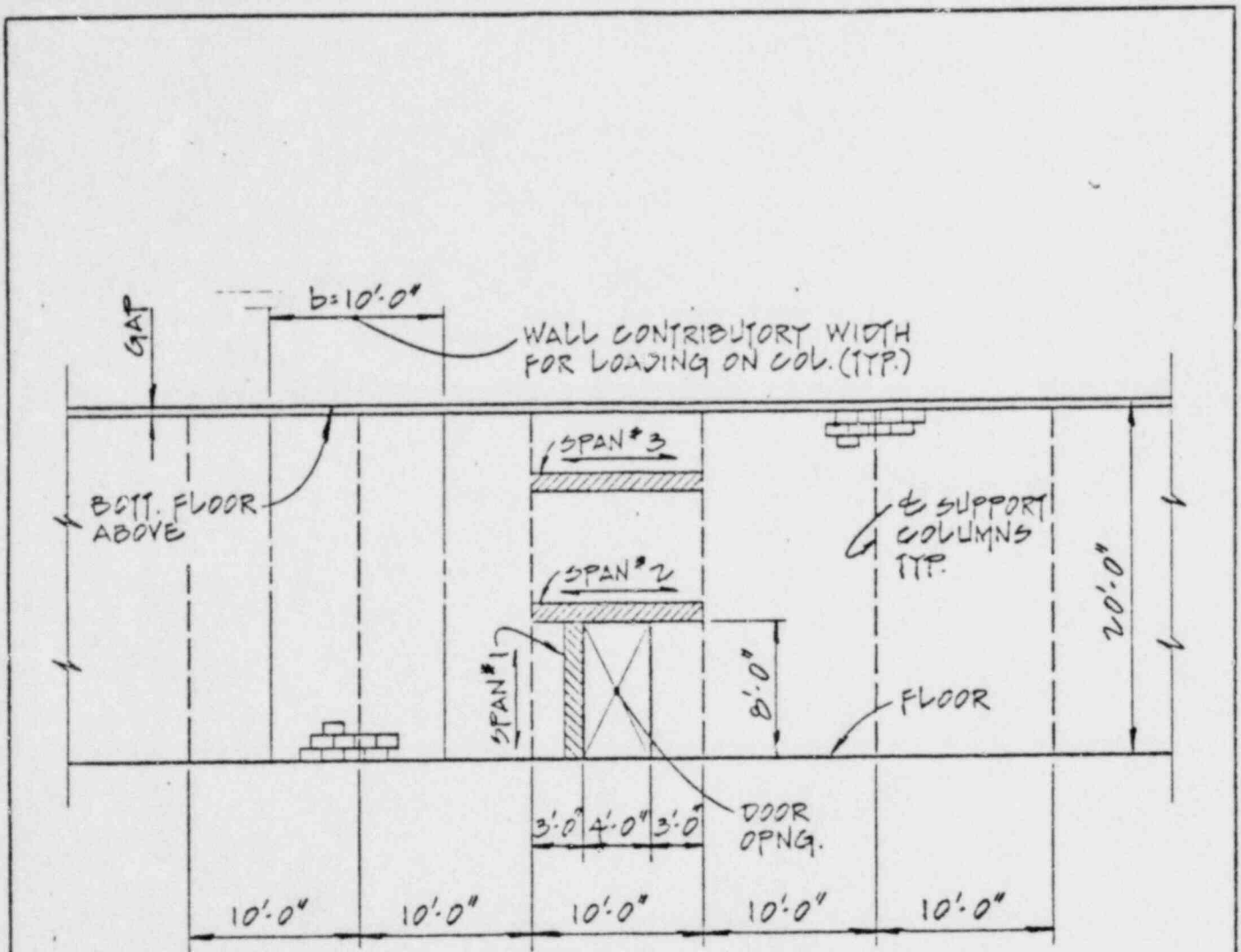
Frequency calculations are based on the section properties of 36" solid concrete block wall.



MASONRY WALL ELEVATION

FIGURE 1

MIKE YONAN



MASONRY WALL ELEVATION

FIGURE 2

MIKE TONAN