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DESIGN OF LOAD BEARING WALL FOR LOW RISE BUILDING WITH PARTIALLY GROUTED REINFORCED MASONRY

A Thesis

presented in the partial fulfillment of requirements for the Honors Degree in Civil Engineering from the Sally McDonnell Barksdale Honors College The University of Mississippi

by

Anil Bhatt April 2021

Approved By:

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ABSTRACT

The seismic and wind load acting on the 2-storeyed building of dimension 120 ft x 98 ft located in Oxford, MS, were calculated and the seismic load was considered for the design of the 120 ft long and 24 ft high load-bearing wall because it being critical. The maximum loading was computed using different load combinations. The masonry behavior and masonry specifications were considered to select the masonry unit, grout, and mortar for the load-bearing wall. The seismic design requirement for the shear and slender wall was fulfilled for the special reinforced masonry wall. The in-plane and out-of-plane loading scenarios were considered for finding the required reinforcement in the wall to resist the bending moment and the shear. The special reinforced masonry wall was designed using the Strength Design method. The cost of construction of a 24 ft high wall with reinforced concrete and the reinforced masonry was computed. It was found that the construction with reinforced masonry came out much cheaper as compared to the construction with reinforced concrete.

DEDICATION

This thesis is dedicated to all my teachers and advisors who have blessed me with engineering knowledge and wisdom.

I also dedicate this work to my grandparents and parents who first taught me the value of education and hard work.

	LIST OF SYMBOLS
Α	Area (ft ²)
A_g	Gross area (ft ²)
A_n	Net area of the wall subtracting any reinforcement (ft ²)
A_{nv}	Net shear area of masonry wall (ft ²)
A_o	Openings area (ft ²)
A_s	Area of steel reinforcement in masonry wall (ft ²)
A_T	Tributary Area (ft ²)
ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
b	Width of masonry, cross-sectional (ft)
c	Coefficient for determining stress block height (ft)
С	Compression force (lb)
C _d	Deflection amplification factor
C_m	Compression force in the masonry (lb)
Cs	Seismic response coefficient
CMU	Concrete Masonry Unit
d	Effective length from the end of masonry to the centroid of the tensile steel (ft)
$d_{\rm v}$	Total depth of masonry wall (ft)
D	Site Class
e	Eccentric distance of the force from the centroid of the cross-section (ft)
E_m	Modulus of Elasticity of masonry (psi)
Es	Modulus of Elasticity of steel (psi)
$\mathbf{f}_{\mathbf{m}}$	Calculated compressive stress in masonry (psi)
f`c	Compressive stress of concrete or mortar (psi)

f m	Masonry design compressive stress (psi)
$\mathbf{f}_{\mathbf{r}}$	Modulus of rupture (psi)
$\mathbf{f}_{\mathbf{y}}$	Yield stress in the steel reinforcement for masonry design (psi)
Fa	Short Period Site Coefficient
$F_{\rm v}$	Long Period Site Coefficient
F _x	Horizontal force in the x-axis (lb)
g	Acceleration due to gravity (ft/sec ²)
G	Gust effect factor
GE	Ground Elevation (GE)
h	Height of wall (ft)
Ι	Importance factor
Ie	Seismic Importance factor
Ig	Moment of inertia of CMU (ft ⁴)
$\mathbf{I}_{\mathbf{X}}$	Moment of inertia with respect to the x-axis (ft ⁴)
k	Exponent related to the structural period
K _d	Wind directionality factor
K _{zt}	Topography factor
L	Span length of masonry wall (ft)
М	Type of masonry mortar
	Internal bending moment (lb-ft)
ØM _n	Design bending moment (lb-ft)
M _{cr}	Cracking moment capacity of a reinforced masonry (lb-ft)
M_s	Moment capacity for service loading on a reinforced masonry (lb-ft)
M_u	Ultimate moment demand of a reinforced masonry (lb-ft)
MWFRS	Main Wind Force Resisting System
	V

v

n	Modular ratio for two materials
Ν	Number of stories in building
NCMA	National Concrete Masonry Association
Р	Axial force (lb)
	Pressure (psf)
P _{fD}	Dead load from floors (lb)
P_{Lr}	Live load from occupancy (lb)
Pa	Allowable load in masonry wall (lb)
P _n	Nominal capacity (lb)
p _s	Design wind pressure (psf)
p _{s30}	Simplified design wind pressure at 30ft height (psf)
Pu	Ultimate axial load(lb)
\mathbf{P}_{uf}	Dead load from floors (lb)
P_{uL}	Live load from floors (lb)
\mathbf{P}_{uw}	Dead load from wall (lb)
$ otin P_n $	Design axial strength (lb)
r	Radius of gyration (ft)
R	Response modification factor
S	Spacing (ft)
S	Section modulus (ft ³)
S	Type of masonry mortar
S	Snow load (lb)
\mathbf{S}_1	Peak ground acceleration for period 1.0 sec
Ss	Peak ground acceleration for period 0.2 sec
\mathbf{S}_{D1}	Design spectral acceleration for period 1.0 sec
	1/1

S _{DS}	Design spectral acceleration for period 0.2 sec
S_{M1}	Site-modified spectral acceleration value for period 1.0 sec
S _{MS}	Site-modified spectral acceleration value for period 0.2 sec
t	Thickness of masonry wall (ft)
Т	Tension (lb)
Т	Time-period (sec)
TMS	The Masonry Society
V	Wind Velocity (mph)
$V_{\rm E}$	Shear force due to earthquake (lb)
V_n	Nominal shear force (lb)
V_{nm}	Shear force due to masonry (lb)
V _{ns}	Shear force due to steel (lb)
V_u	Ultimate shear force (lb)
W	Total weight (lb)
$\gamma_{\rm m}$	Unit weight of masonry (psi)
ε _m	Strain in masonry
ε _s	Strain in reinforcing steel
ρ	Reinforcement ratio in masonry design
δ_{u}	Maximum wall deflection (ft)
Δ	Deflection (ft)
λ	Adjustment factor for building height and exposure
Ω	Overstrength (or global safety) factor for ASD
Ø	Resistance factor for LRFD

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I would like to thank my grandparents, Mr. Bhiviraj Bhatt and Late Mrs. Gomati Devi Bhatt, and my parents for their love and support throughout my life.

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I am very grateful to Sally McDonnell Barksdale Honors College for providing me this opportunity and the necessary accommodations in terms of deadlines throughout the project. Special thanks to graduate student Mr. Hemant Raj Joshi for providing the technical help and resources in this project. Finally, I extend my cheers to those unnamed individuals who helped me directly or indirectly in this accomplishment.

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CHAPTER 1

INTRODUCTION

The advancements in the civil engineering and construction industry have created many structural designs for the various structural walls with various types of loading in them. The safe and reliable operation of those structural walls is very important for holding the building structure for a long period without failing, upholding public safety. While constructing any load-bearing wall the cost and function come into play. Even though the reinforced concrete wall is capable of holding the maximum loadings, the cost of a reinforced concrete wall is very high. In that scenario where cost is an important factor to consider, a reinforced masonry wall in a building structure seems to be a good alternative. The reinforced masonry wall is very resistant to the tensile and shear stress-producing forces due to its combination of masonry units, reinforcements, grout, and mortar. The reinforcement in the masonry wall provides the required ductility and additional tensile strength to the masonry wall. Thus, reinforced masonry walls in the low-rise building can aid or replace reinforced concrete walls.

1.1 Project Overview

A two-storeyed commercial building of 120 ft x 98 ft footage and 24 ft total height located in Oxford, Mississippi needed to be designed as part of the senior capstone project. In that project, the building was designed with a rigid-frame structural system where cast-in-place (CIP) reinforce concrete (RC) beams and columns are present to resist the moment caused by the dead and live gravity loads in the building. In that system, non-load-bearing 8 inches RC walls are present around the perimeter of the building between the columns, around the elevator shafts, and stairwells. Taking the same project and building as a reference, the system of RC perimeter walls and exterior RC frames of the building is replaced with the loadbearing reinforced masonry walls. This leads to a dual masonry wall-RC frame system. Replacing the RC perimeter walls and frames with reinforced masonry (RM) walls decreases the construction cost and reduces the number of columns and beams used in the building, leading to more open space within the structure, and thus would increase profitability. The RM shear wall system in the building is shown to provide adequate resistance to the lateral forces such as wind and seismic.

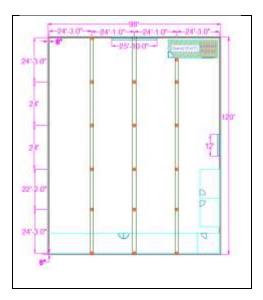


Figure 1: Top View of the Building

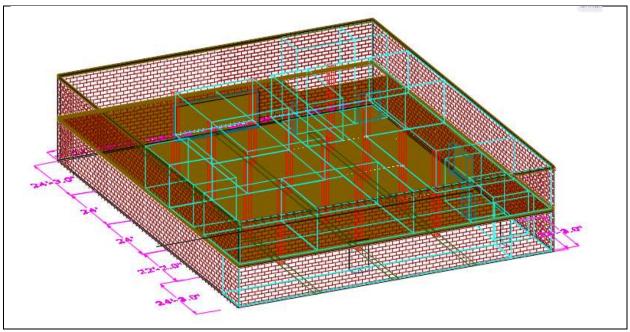


Figure 2: Isometric View of the Building

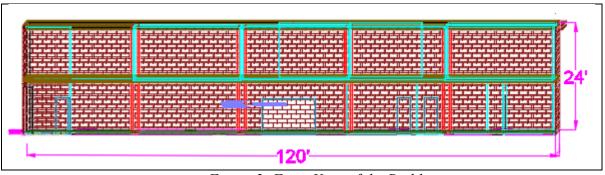


Figure 3: Front View of the Building

1.2 Masonry Wall

The building structures are categorized into three main types: low-rise, mid-rise, and high-rise based on the height from the grade level. The building of 60 feet or less height where the height is no longer than the least horizontal dimension are called low-rise buildings (SEI 7-05).

These are the buildings which are usually 4 or fewer stories in height. These buildings can be constructed with various types of masonry materials.

Masonry walls are the walls built with the masonry units like bricks, blocks, stones, marbles, tiles, granites, and so forth bounded together by a mortar, which can be cement, soil, lime, or any other material. These walls provide strength, durability, and insulation to the building structure. Based on the types of the individual masonry units selected and the functions of the wall, they are mainly classified into 5 types. They are Load Bearing Masonry Wall, Reinforced Masonry Wall, Hollow Masonry Wall, Composite Masonry Wall, and Post-Tensioned Masonry Wall. The reinforced masonry wall is the one that is particularly selected for this project. The reinforced masonry can be both load-bearing and non-load bearing. The load-bearing walls take all the load from the roof and floor level to the ground while the non-load-bearing wall doesn't take any loads from a roof or floor level. Load-bearing walls are used in this project which takes a few of the loads from the roof and the floor level to the ground. Along with the load-bearing walls, the columns in the center also takes the load from the roof and the floor to the ground in this project.

The reinforcement in the wall withstands the tension, compressive, and lateral loads like wind and seismic, and reinforcement help to avoid the cracks during heavy loading and seismic events. The horizontal and vertical reinforcement and spacing are selected based on the loading and structural condition on the wall. The mortar and grout in the masonry wall help to stabilize the reinforcement and provide the stability and strength to the wall. Based on the amount of grout used in the reinforced masonry walls, they can be partially grouted or fully grouted. Partially grouted means only adding the grouts to certain masonry units leaving the voids in the middle while fully grouted means filling the void space between the masonry units with grout, which is a cementitious

binding material. The partially grouted reinforced masonry wall is the one that is designed in this project, being a partially grouted wall more economical than a fully grouted wall.

1.3 Material Selection

The reinforced masonry wall gets its strength and ductility from the four different components and their composite action. The four main components of the reinforced masonry wall are:

1. Concrete Masonry Units (CMUs)

These are usually hollow rectangular blocks made up of Portland cement, aggregates, and water. They are brittle and have very high compressive strength. They come in various sizes and weights. Standard Specification for Load-Bearing Masonry Units (ASTM C90) provides requirements for materials, dimensions, finish, and appearance of CMUs. The two types of CMUs are selected based on their functions and shapes for this project. They are 8x8x16 Standard CMU and 8x8x16 Bond Beam. Normally standard size concrete block is used in the wall for vertical reinforcement and vertical grouting. However, the bond beam is used in the wall where horizontal and vertical reinforcement is necessary for the wall. The actual dimensions of CMUs are 3/8 inches smaller than the nominal dimensions to allow for mortar joints. The CMUs of compressive strength (f 'm) 2000 psi, unit weight of (γ_m) 125 psi, and modulus of elasticity (E_m) 1,800,000 psi are used in the project. The actual sizes of the CMUs are shown in the figure below:

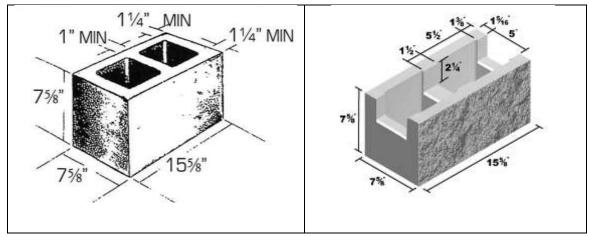


Figure 4: Concrete Masonry Units (CMUs) (4.a.Standard CMU;4.b.Bond Beam CMU)

2. Reinforcement

The reinforcement is provided in the wall in both vertical and horizontal directions, and in joints of the CMUs to provide the necessary ductility to withstand the moment, axial, and lateral loadings. The deformed and plain carbon steel bars of Grade 60 with a yield strength (F_y) of 60,000 psi in the vertical and horizontal direction and ladder-type joint reinforcement in the horizontal direction between the CMUs layers are used in the wall. The deformed bars of sizes ranging from #3 (0.375 in diameter) to #9 (1.128 in diameter) are recommended to use for the strength design of the wall. The typical way of reinforcement in a partially grouted reinforced masonry wall is shown in the figure below:

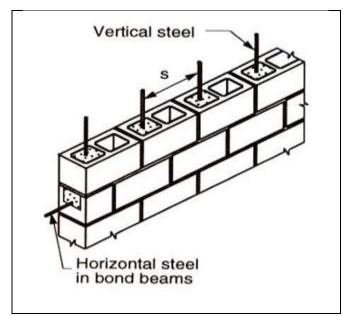


Figure 5: Reinforcement in Partially Grouted Reinforced Masonry Wall

3. Mortar

This is the mix of cementitious materials like Portland cement, fine aggregates (sand), and water. It acts as a bonding material between the individual concrete masonry units and converts individual units into a solid unit. Type M mortar made up of Portland cement with an average compressive strength (f 'c) of 2500 psi and maximum air content as 12% is selected for the wall.

4. Grout

It is the mixture of cementitious material, aggregate, and enough water (to enhance steady flow) placed in the cells or cavities in the wall (at least when steel reinforcement is present). The bonding of grout with steel and the CMUs blocks acts together for resisting the loadings in the wall. Grout for Masonry (ASCE C476) provides requirements for grout in masonry construction. The water content in the grout is adjusted in such a way that the slump is between 8 to 11 inches to increase the workability of the mix. The grout with average compressive strength (f'_c) of 2500 psi is selected for the wall.

CHAPTER 2

RESULTS AND DISCUSSION

2.1 Loading on Masonry Wall

The partially grouted reinforced masonry wall is loaded with the dead and live load from the roof and floor level whereas the lateral loading is because of the wind and the seismic force. As the 120 ft span of the wall is more critical because of the beams and columns running in the same direction, it is considered for designing purpose so that overall designing of the wall located in the outside perimeter of the building will be safe with a higher factor of safety. The dead and live load from the roof and the first floor acting in the wall is calculated by taking the tributary area equals to the area covering half of the length from the center of the wall to the nearest beam running and it is shown in the table below:

Table 1: Dead and Live Loads on Reinforced Masonry Wall on 120 ft span

Dead Load From Roof	Dead Load From 1st Floor	Live Load From Roof	Live Load From 1st Floor
(psf)	(psf)	(psf)	(p sf)
157	208.5	20	60
(<i>plf</i>)	(plf)	(plf)	(plf)
1904	2528	243	728

2.1.1 Wind Load

The wind load acting in the 120 ft long span of the partially grouted reinforced masonry wall is determined considering the wind speed of 110 mph [5]. The risk category and surface

roughness category are considered to be R2 and C respectively [5] for determining the wind loading. The Main Wind Force Resisting System (MWFRS) is an assemblage of structural elements to provide support and stability for the overall structure and wind loading from more than one surface and this approach along with Method 6: 2015 IBC Section 1609.6 is used to determine the wind pressure acting in the wall.

Table 2: Wind Load Acting on Zone A, and Zone B of Building Wall

Zone	Wind Load (<i>psf</i>)
A(i.e.Upto 10 ft from the end of the wall)	26
C(i.e. Anywhere in between 10 ft from the end of the wall)	17

The figure below shows the action of the wind pressure at zone A which is up to 10 ft from the end of the wall.

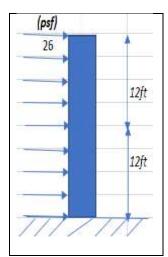


Figure 6: Wind pressure acting on Masonry Wall at zone A

2.1.2 Seismic Load

The seismic load acting in the wall is calculated considering the Risk Category for building as II and site class as D. Using the ASCE/SEI 7-05 for the structural wall, the following formula is used to calculate the out of plane seismic load for the wall.

 $F_p = 0.4 S_{DS} I_E W_p$

Where, $S_{DS} =$ Numeric seismic design value at 0.2s period

 I_E = Seismic Importance Factor = 1

W_p=Weight of the structural wall in (psf)

The out-of-plane seismic load is found to be 38.9 psf.

The total base shear (V) for the building under seismic load is 107 kips. The force is calculated at various levels of the reinforced masonry wall like as shown in the table below:

Level	Floor Height	h _x	Wx	Wx.h _x ^k	C _{vx}	F _x	V _x / Story	OTM
	(ft)	(ft)	(kips)	(kips-ft)		(kips)	(kips)	(kips- ft)
Roof	24	24	389.7	9354.0	0.543	58	0	1397
First Floor	12	12	655.1	7861.1	0.457	49	58	587
Ground Floor	0	0	581.1	0	0	0	107	0
			Σ	17215.1	1	107		

Table 3: The Force calculation at the various Heights of the Masonry Wall

The maximum overturning moment due to loading is 1397 kips-ft which is at the top of the masonry wall i.e. 24 ft.

The figure below shows the action of the forces in the reinforced masonry wall.

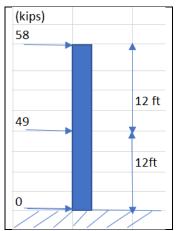


Figure 7: Force acting in masonry wall at various heights due to seismic

2.1.3 Final Loading on Masonry Wall

While comparing the wind and seismic loads acting on the reinforced masonry wall located in Oxford, MS, seismic load comes out to be more critical. So, seismic loading is considered while designing the masonry wall under both in-plane and out of plane loading. It means the wall needs to be designed for 38.9 psf out of plane loading, 107 kips base shear, and 1397 kips-ft overturning moment. The following table shows the loading applied to the reinforced masonry wall for designing with a Strength Design approach:

Loading Types		psf	plf	Direction
	Dead Load (Roof + First Floor)	365.5	4432	Along the Length
Axial	Live Load (Roof + First floor)	80	971	Along the Length
	Weight of Wall	48	576	Along the Length
Lateral	Wind Load	26	3120	Along the Height
Pressure	Seismic Load	38.9	4668	Along the Height

Table 4: Design Axial and Lateral Loading on the Masonry Wall

2.2 Design of Masonry Wall for out-of-plane loading

The masonry wall is designed to withstand the out-of-plane loading caused by lateral forces like wind and seismic. The strength design procedure is followed with the fulfillment of TMS 402-16, Building Code Requirements for Masonry Structures, and TMS 602-16, Specification for Masonry Structures. One foot length of the wall is considered for the out-of-plane loading in the wall. The shear and moment acting on the wall due to axial and lateral loading is calculated and based on the shear and moment values the primary reinforcement is determined which comes out to be #9 bars @ 32 inches center to center spacing running vertically throughout the length of 120 ft. Before finalizing the reinforcement for the out-of-plane loading case, the maximum moment strength and the deflection requirement are checked for the preliminary amount of reinforcement. The wall deflection and out-of-plane moment are calculated using the following formulas.

$$M_u = \frac{w_u h^2}{8} + \frac{P_f e}{2} + P_u \delta$$
 2.2.1

$$\delta_{u} = \frac{\left(\frac{w_{u}H^{2}}{8} + \frac{P_{uf}e}{2}\right) - M_{cr}(1 - \frac{I_{cr}}{I_{g}})}{\frac{48EmI_{cr}}{5h^{2}} - (P_{uw} + P_{uf})}$$
2.2.2

Where: $M_u = Maximum \text{ out of the plane moment}$ $\delta_u = Maximum \text{ wall deflection}$ h = Height on the wall $P_{uf} = \text{Loading from floor}$

- $P_{uw} = Loading from wall$
- $M_{cr} = Cracking moment$
- I_{cr} = Cracked moment of inertia

 $I_g = Uncracked moment of inertia$

 E_m = Masonry modulus of elasticity

The two goals of the design are:

1. The out-of-plane moment strength of the masonry wall must be greater than the factored out-of-plane moment demand.

i.e. $\emptyset M_n \ge M_u$

2. The horizontal deflection at the mid-height under service loads must be less than 0.007H. i.e. $\delta_{mid\ height} \leq 0.00H$

Table 5: Reinforcement for the Out-of-Plane Loading (Slender Wall)

Reinforcement Type	Reinforcing Bars and Spacing
Vertical	#9 bars @ 32 inches c.c spacing

2.3 Design of Shear Masonry Wall

In masonry buildings, shear walls are the main elements of the lateral load resisting system buildings. The code (TMS 402) requires 80% load resistance to be provided by lateral walls if a response modification factor (R) is greater than 1.5. There are four primary causes of shear wall deflection: Shear, Flexure, Sliding, and Rocking. Among those, shear and flexure are the two main reasons for wall deflection in this project. The shear or flexural deformation depends on the aspect ratio: wall height (H) to its length (L). If 0.25 < h/L < 4 then there is the possibility of both shear and flexural deformation. If h/L < 0.25 then the wall will more likely to deform due to shear while if h/L > 4 then it will primarily undergo flexural deformation. In the project h/L ratio is 0.24 which is less than 0.25 so it will deform due to shear. However, the wall is designed against flexural

response to resist the seismic loads and provide adequate ductility in such seismic events. The Strength Design approach is used to design the shear wall in this project.

As the Seismic Design Category (SDC) for this project is D, the only type of masonry shear wall is the special reinforced shear wall according to ASCE 7-10. The table below shows the reinforcement requirement for various types of shear walls.

Seismic Design Category	Ordinary Reinforced Masonry Shear Walls	Intermediate Reinforced Masonry Shear Walls	Special Reinforced Masonry Shear Walls				
A	Permitted	Permitted	Permitted				
В	Permitted	Permitted	Permitted				
С	Permitted	Permitted	Permitted				
D	Not permitted	Not permitted	Permitted				
E	Not permitted	Not permitted	Permitted				
F	Not permitted	Not permitted	Permitted				

Table 6: Reinforced Masonry Shear Walls in various SDCs

The vertical reinforcement in the shear wall can resist the moment demand only. The shear corresponding to the nominal flexural strength is calculated. The total shear strength is the sum of shear strength from masonry and the steel reinforcement. The vertical, horizontal, and joint reinforcements are determined based on the following inplane loading acting in the shear wall.

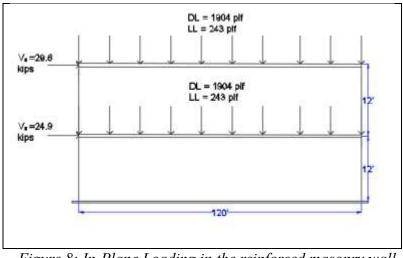


Figure 8: In-Plane Loading in the reinforced masonry wall

The reinforcement obtained in the shear wall from the calculation was verified following TMS 402-08/ACI 530-08/ASCE 5-08 codes for minimum and maximum requirement for the partially grouted special reinforced masonry wall. The following table shows the reinforcement requirement in the shear wall:

Reinforcement Type	Reinforcing Bars and Spacing
Vertical	#6 bars @ 32 inches c.c spacing
Horizontal	#5 bars @ 48 inches c.c spacing

Table 7: Reinforcement for the In-Plane Loading (Shear Wall)

2.4 Reinforcement for Masonry Wall

The ultimate reinforcement requirement from both slender (out-of-plane loading) and shear (inplane loading) wall conditions are considered for the final design so that there will be a higher factor of safety and the lateral and axial loading will not lead to the failure in the structure. The table below shows the final special reinforcement for the partially grouted reinforced masonry wall to uphold all the axial and lateral loading conditions.

Table 8: Final Reinforcement for the Partially Grouted Reinforced Masonry Wall

Reinforcement Type	Reinforcing Bars and Spacing
Vertical Reinforcement	#9 bars @ 32 inches c.c spacing
Horizontal Reinforcement	#5 bars @ 48 inches c.c spacing
Horizontal Reinforcement around the	#5 bars with a development length of 28
openings	inches past the opening
Joint Reinforcement	Ladder-type joint reinforcement

The figures below show the designed special reinforcement in the partially grouted reinforced

masonry wall:

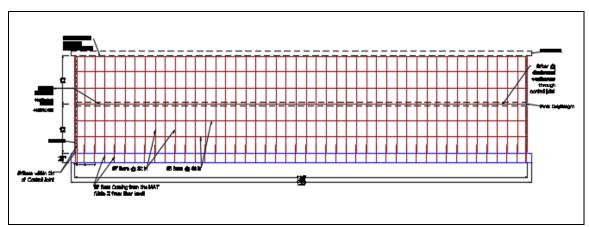


Figure 9: Reinforcement Detailing for Partially Grouted Reinforced Masonry Wall (Front view)

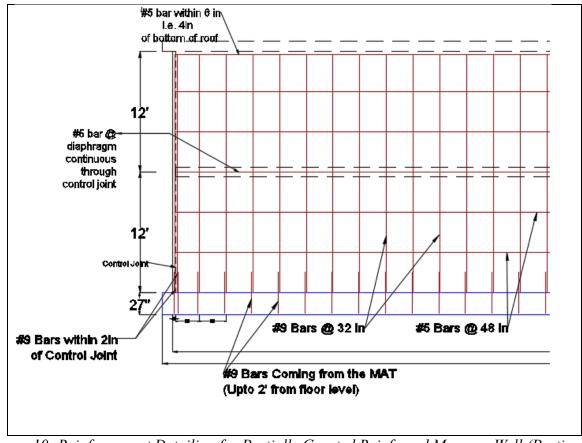


Figure 10: Reinforcement Detailing for Partially Grouted Reinforced Masonry Wall (Portion

of the front view)

2.5 Cost Analysis

The construction of the perimeter wall of the building with the reinforced concrete and the partially grouted reinforced masonry is calculated and compared. The reinforced concrete wall is a non-load-bearing wall of thickness 8 inches while a partially grouted reinforced concrete masonry wall is a load-bearing wall which means the masonry wall takes a certain portion of the roof and floor load to the ground. Also, using load-bearing masonry wall replaces the 8 columns of 12 in x 12 inches dimensions and 4 beams of 22 in x 30 in cross-section in the 120 ft span of the building from the construction of the non-load-bearing wall. Considering,

the cost of concrete for 27 cubic feet or 1 cubic yard as \$120, the cost of one concrete masonry block of dimension 8in x 8in x 16 in, as \$2, and the grout is placed at every 32 inches horizontal distance between the center of the bars, the construction cost is calculated. The cost for construction with both types of materials is shown and compared in the table below:

 Table 9: Cost Comparision of the Reinforced Concrete Wall and Partially

Grouted	l Reinforced	Masonry	Wall
---------	--------------	---------	------

	Reinforced Concrete Wall	Partially Grouted Reinforced Masonry Wall
	From 8 in Wall: \$29,955	From Blocks: \$23,058
	From 4 Beams: \$9,778	From Grout: \$7,751
	From 8 Columns: \$853	
Total (round figure)	\$41,000	\$ 31,000
Total Saving	\$10,00	0

The table shows the selection of reinforced masonry load-bearing wall as construction design will reduce the cost by almost \$10,000 as compared to the construction of a non-load bearing reinforced concrete wall of 8 inches.

CHAPTER 3

CONCLUSION AND RECOMMENDATION

The partially grouted special RM load-bearing wall in the outer parameter of the 2 storeyed commercial building located in Oxford, MS is designed for the axial loading due to dead and live gravity loads from the roof and the first floor, and lateral loading from wind and earthquakes. The vertical, horizontal, and joint reinforcement along with the partial grouting is determined based on the minimum requirements and the 2009 International Building Code (2009 IBC), and Building Code Requirements for Masonry Structures (TMS 402-08/ACI 530-08, ASCE 5-08). The cost of construction with 8 inches wide partially grouted reinforced masonry is almost \$10,000 cheaper than that of the RC wall of 8 inches wide.

More detailed analysis and calculations are needed to get the most economical and safest partially grouted reinforced masonry wall. The masonry wall will gain strength if it is grouted fully, filling all the void spaces in the masonry blocks rather than partially grouting it. However, that will be expensive from the costing point of view.

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APPENDIX

A. Excel Worksheet for Material Selection

	"Designir	ng of low-rise build	ling with pai	rtially	grouted reinfo
Reinforc	ed Masonry Unit:				
		8 x 8 x 16 Bond Bea	am		t
	Thickness of CMU (b	Y.	8	in	1
	Actual Thickness of C	MU (t)	7.625	in	75
	Compressive Strengt	h (f' _m orσ _w)	2000	psi	
	Unit Weight of Masor	hary <mark>(</mark> γ _m)	125	psi	
	Modulus of Elasticity	(E _m)	1800000	psi	75
Mortar:					
		Туре М			
	28 Days Compressive	Strength (f' _c)	2500	psi	1" MIN
	Maximum Air Percen	tage	12	%	
Steel:					75%"
		Grade 60			
	Yield Strength of Rein	nforcing Steel (f _y)	60	ksi	
	Modulus of Elasticity	(E _s)	29000000	psi	75%"
Grout:					
		Slump	8 to 11	in	(For Workabilit

Image A: Materials Selection for Masonry Wall

B. Excel Worksheet for Wind Load Calculation

	ading:																					
	Risk Catego	ry .				R2																
	Basic Wind	Speed (3 S	Second G	est)		110	mph	(At 33 ft)	sbowe gro	und in	Expos	ure	Cate	gary	Can	d Spe	ed {\	I) of	ASC	E 7-1	a)	
	Mean Roof	Height (h)				24	ft	(For root o	ngle < 10 c	legrees	res , h = a) So for Flat roof h=a)											
	For Exposur	e Category	e i				100	10100-000	-2.5.1611	Ci Donara			27		2011	1.						
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ncloses	d Classificatio	MC.				-			-7	10				1,00					UR			
	Area (Ag)					2352	1000	2880	μ.	2				18					-			
	Openings A	rea (A _c)				354	ft*	(For Main	Doors)	-	1						1.1	-				
		0.01Ag		23.52 ft ²																		
				4 115																		
	Since, A.>4 ft ² , 50, Partial Enclosed Bui					ilding																
	Wind Direct	ionality Fac	ctor (Kg)			0.85	1	(0.85 g for	Buildings,	From A	SCE 7	- 10 1	Table	26.6	-13							
	Topography	Factor (K_)				1	1. (No abrupt changes in the Topogra						y and	d stru	chare	in on	Level	Gro	und)			
								(From ASC	E 7-10 Sect	tion 26.	5)											
	Gust Effect P	actor (G)				0.85		(For Rigid	Structures	1												
	According t	o ASCE 7-1	10 Section	26.9.2. L	w Rise 8	wildings (N	fean ra	of height (h)	< 6o ft) or	e cons	dere	d Rig	sid									
	The building	phave Fun	damenta	frequenc	y >= 1HZ	and Funda	menta	Period =< 1	(econd			-										
				- Contract of the second second																		
tain Wio	nd Force Resisting	System (M)	WFRS)																			
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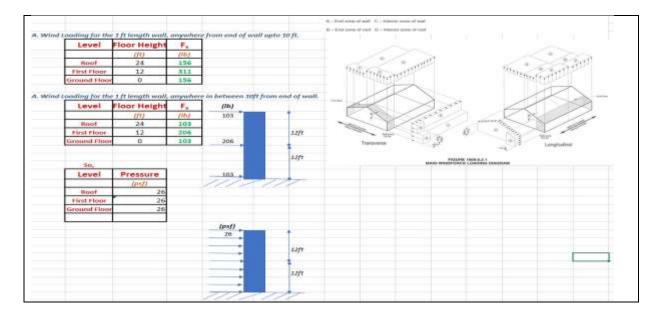


Image B: Wind Load Calculation

arthquake Design Paramet	ters:								
Risk Category for B	uilding		u						
Site Class			D						
MCE _a Peak ground	motion (period	=0.2s) (S _z)	0.414g	(Based or	ASCE 7-1	6) and ATC H	azard Calcu	ulation)	
MCE ₈ Peak ground	motion (period	=1.0s) (S ₁)	0.178g	(Based or	ASCE 7-1	6) and ATC H	azard Calcu	ilation)	
Short Period Site Co	oeffecient (F _a)		1.457	(ASCE 7-1	6, Table 1	1.4-1) and By	straightlin	e interpolation	
				OK, as gr	eater than	1.2 for site c	lass D)		
Long Period Site Co	effecient (F ₄)		1.884	(ASCE 7-1	6, Table 1	1.4-2) and By	straightlin	e interpolation	
Site-modified spect	ral acceleration	value (S _{MS})	0.608g	(S MS = F	x5,)				
Site-modified spect	ral acceleration	value (S _{M1})	0.4g	(5 MI = F	x5;)				
Numeric seismic de	sign value at 0.	Zs SA (S _{os})	0.405g	(S ps = (2/	3)x5 MS)				
Numeric seismic de	sign value at 1.	Os SA (S _{D1})	0.267g	(S pt = (2/	3)x5 MI)				
Risk Category			c	(0.33 g ≤	S _{D5} < 0.5	g)(From ASC	E 7-16, Tab	le ASCE 11.6-1)	
Selsmic Importance	Factor (I_)		1	(From AS	CE 7-16, T	able 1.5-2, Fo	r Risk Cate	gory II)	
Structural Roof Pea	k Height (h _n)		24	ft					
Number of Stories	in Building (N)		2						
Response Modificat	tion Factor (R)		2	(From AS	CE 7-16, T	able 12.2-1)			
Overstrength Facto	r (Ω)		2.5	(From AS	CE 7-16, T	able 12.2-1) (For Ordani	ry reinforced AA	C Masonry Shear W
Deflection Amplific	ation Factor (C _d)	2	(From AS	CE 7-16, T	able 12.2-1)			
The Seismic Respon	ise Coeffecient	(C ₄)	0.2025	(Cs = S os)	/(R/1.))				
Time Period (T)			0.22	sec		(T=C, *h,*)		
T _L			12	sec	>T	(So, T <t<sub>L)</t<sub>			
		(Cs) _{Max}	0.93376	>0.2025	(OK)	[Cs = 5 ps/(T(R/I .))]		
So, The Seismic Res	ponse Coeffecia	ent (Cs)	0.2025				1000000		

C. Excel Worksheet for Seismic Load Calculation

	ght of Building:	Dead	head	Live	Load								
	1	ps			of								
	Roof	po	157		20								
	First Floor	1 3	208.5		50								
	Ground Floor	-	208.5	-	00								
	Σ	-	365.5		10								
	Area of Building (/	ui in	11760	#2									
	Total load		39.08										
or Wa		-											
01 110		w.	Course	n 2									
	Tributory Area (A		1455										
	Slab(Live +Dead)		55.12		ж.		kips						
	Number of Masor	and the second se				11529		10.044		PROVING N			
	Masonry Wall		472.7			(41 lb for)						1410 5 11 10 1	1. 0. 671 11. 45
	Bars			Kips		and the set of the second s				d at 32 inches dis			15 2.67 lb/f
	Grout in Masonry		54	Kips				Street and the second second		ced at 32 inches of the wall		r the wally	
	No. of Masonry wi Grout	th 34	4			In crout 1	s placed a	as by mch	es or dis	tance in the wall)			
	Wt. of Masonry W	/all	528.9	Kine		(Bond Bea	m + Grou	t + Harel					
	Total Weight of Bu		520.3	and a	581.8	A standard and the first large		(+ uars)					
	Total Weight of bi	minue (sa)			361,6	nips							
	Base Shear (V)					107	Kips	17					
	ouse snew (1)						colles.	V =	CS V	V			
/ertical	Distribution Of Lat	eral Forces	e :-										
	Exponent related			od (k)		1		(k =1 fc	r Perior	0.5 sec or less, k	=2 for Period	12.5 Sec or mo	ore)
	Number of Stories			12.830		2		ASC. 5.45					
	Ground Elevation					505							
				-				W/J	R.				
							- C,	$=\frac{m_{R}}{\Sigma}$	1.0	$F_x = c_{vx} V$			
								2, 10,	n _i	4 14		(kips)	
								_			_	58	
		Level	Floor	Height	h	Wx	Wx.h _z *	Ca	Fx	V ₄ /Story	OTM		
				(t)	(角)	(kips)	(kips-ft)		(hipa)	(kipa)	(kips-ft)		
		Roof		24	24		9354.0	0.543	54				12 🕈
		First Floor		12	12	and the second division of the second divisio	7861.1	0.457	4	-		49	191
		Ground Floor	9	0	1		0	0	the second s	0 107	0		1
						Σ	17215.1	1	10	7		-	12ft
	r	50,	11		i							0	111
		Level	-	ssure	-							1111	111
			<u>i</u> P	usf)	-								
		Roof	-	81									
	1	First Floor	_	.34				1.1					
		Ground Floor	-	0	6			(psf) 81					
	61			-	-			01		+			
	Plane Seismic Loading												
he out of			10/15	F	= 0.45 _{ps}	W.				12 ft			
he out of	F. #	111 97	Kine										
he out of	F _p =	111.92 38.9	1			7-051		34					
he out of	104	38,9	psf		(ASCE/SE	7-05]		34		1			
he out of	104		psf			7-05)		34		1 12ft			
he out of	104	38,9	psf			7-05]		34		1 12ft			

Image C: Wind Load Calculation

D. Excel Worksheet for Designing the Reinforced Masonry Wall for Out-of-Plane Loading

lotater / Out of pla	In the second states			-											
y 130 p Side:	Contraste table														
Roof Dea	t load		7 at	1404(46/7	1										
	DeedLast		Signaf	25.285 (4)77											
Rout Uke			11 44	143 4/7											
	rUse load		a put	728 M/T											
Total We	gar or Well	48	104	1152 4/10	10	The twice	N LOOK BET	ve tribical with o	oss section i	estre no	neight				
Self Weig	ht of Hall at mid he	igte 24	5.00	575 (A/N			Pro	4432 /0/0							
5		0.4		1915	2		P.,	970 (4/2							
frequence.	to (e) of Rost/Stah 8		g le				P.	575-0/2							
	rje Cartzueke Loed		1.00				1.1	- svejajve	-						
1000	ination for Factored L	64 au													
			C.R.												
1-20+1.05		()#C fq 3													
11.2-4.88	50-y0F+8.9-025	Utiling 45	CE 7-16 Section	1242 W D	Combination	u	(Note: a fi	octor of 0.5 applies	101913100	(44)					
0.90+1.07		(182.60.31	67)							1					
10.9-0.25	10+/10 ₁₇	(thing AS	CE T-16 Section	12.4.2 tor to	(Contrinution	20									
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Dead Los	d due to Roof And Si		17 36/91	acapaged 40	3679.23	_	-		-	Deed Lost	chue to Roof And S		1	and the second s	
	d dae to Weil jP_1		HE BUTT						1		due to Wall (F_)	645 0,02	1		
	on Roof and Stab (F		es a/m								n Root and State of	and the second sec			
									-				a summer of	International Contractory	
	loods on the Milat Guile			HIGHLSHLSHLS						and the second sec		ng Completentions 2: 1	A # 01250K,8049K2;	(TMS 402 Section 33.5.4.2)	
10	6900.64	(From Can	nokination 13		(1M5 403 Sec	00+935	A.2)		-	10	5504 8,01				
1./Ac	75.4 pt	14	1257m	320 per	Okay				-	P./Ap.	81.2 pt	< ziðfm	10 pai	likay	
1															
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Partially provest CMU.		wight of		midth 2	r :										
		and a	8.04		7.62	in .		I							
lipe Miniasonaria serre	not maintain	2.0	2000 pt											able 1: Reivforcement per foor af	nell
Reinforcest is sevtered		1.0	60.44		5812	a									
		£,+800F.			2 Tanie 4 2 27			1000.900			Tabé	3-7 Areas of Ba	s per Foot Widt	th of Siab-A _n (in. ² /ff)	
		E.*	39000000 pt		2 Table 4.2.21	t		COLUMN ST		1 Bar			Bar spacing in	U. U.	
		1 C	Carponent be	· (100.40	1.1906.67.51		1.1	11440		A2#	4 7 7	9 9 10		13 54 18 19 17	10.
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								33.15		85	0.62 0.53 0 0.68 0.75 0	45 0.41 0.37 66 0.92 0.93	9.34 0.31 1 9.48 0.44	0.29 0.27 0.25 0.20 0.29 0.47 0.38 0.38 0.33 0.21	0.24
	900 AR (1) 18.8 Ant	C Section 1001.1						and the second			1.22 1.03 0	50 0.072	0.05 0.00 1	0.55 0.51 0.45 0.45 0.42	3,40
W.P. 1	1	controls in th	atteny design				-	6.98.82		45	1.08 1.30 1	18 1.05 0.06 50 1.33 1.00	1.88 0.79 1	0.72 0.48 0.62 0.89 0.56 0.62 0.66 0.60 0.73 0.71	0.59
Equation 18-6	0.90+1.0W							Sec. 2.1		#10	14 11 1	91 1.69 1.52	1.39 1.87	0.02 0.00 0.00 0.73 0.71 1.17 1.00 1.02 0.94 0.90 1.44 1.34 1.25 1.17 1.10	18
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2,+10W+	265.84	(stear da	granty		-	1		12 273							-
	t the Proficiency And	ant of Relegances	-			1		C. Markey							-
(Pritemionition of				H(7)= 4.18	19			200 200							
(Pritzensketike a			12 Det .					Seat							
Priternikador a	and the		ay .41					W. Alexan							
Christenkootier e	2P d-1 .	M _p				1	-	24124							
Determination of $a = d - \sqrt{d^2}$	$2P_{q}\left(d-\frac{1}{2}\right)$	M ₂						COMPANY OF THE OWNER							
$a = d + \sqrt{d^2}$	2 P ₂ d - <u>t</u> #0.87 _ b	M _p					247	12022-1422							
Determination of $a = d - \sqrt{d^2}$	2 P _a d - <u>t</u> #0.8F _a b	M ₂					pet .	1000100							
$a = d - \sqrt{d^2}$	2 P ₂ (d - <u>1</u>) #0.8F_b						pet .	1							
$a = d - \sqrt{d^2}$ $0.8t^2 = be$	$\frac{2P_{s}\left(d-\frac{1}{2}\right)}{d0.8F_{s}b}$	0.2	78 in ² /10	Destand											
$a = d - \sqrt{d^2}$	$\frac{2P_{e}\left(d-\frac{1}{2}\right)}{d(0.8F_{e},b)}$	22 Dame #		4,46.381 inf per	fact of the well	CN.		e estranta	-COTS IN ¹ and	fuel of the w					

						No: Horstonial S	artista Programma (Massarra	Spanning Tormally)	
ASCE-7 Cor	nmentary Table C	3-1			the desired	Motor A.	Art store accimuted properties	Accord to the section of proper B1 4_1in.191 A_1in.191 A_08.190	9. mil
Wall weig	ht = 13	psf			Hallow No.gov Hallow No.gov	en Facuend	10.01 10.02.7 01.01	41.9 104.0 87.0	3.84
Wall prope	rties based on NCM	MA TEK 14-18			1007's which initially Mailine 10	protect Pull	0.0 441.0 114.0	10.0 APT 0 11.0 D	3.39
A _s =	53.7	in²/ft			Mollow 24 Hollow 27	Naty shall	2.0 3%,6 98,3 4,1 385,3 90,3 8,0 645,7 90,1	48.8 387.7 1017.8 377.7 368.4 96.0 112.7 566.0 96.0	2.43
1e-	360.5	in"/ft			Hallon de Hallon de	Environment.	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	11.5 MA.0 VA.0 21.3 246.2 00.1 26.4 251.7 07.2	240
r=	2.59	in			Hallow 73 Holton 90 Hallow 130	Tana shall	 a)7 512,0 27,3 b)7,1 3,28,3 85,0 b)3 3,28,4 84,0 b)3 3,28,4 84,0 a)3 128,8 95,8 	48.0 342.8 88.9	246 279 274 216
Checking t	he factored Axia	l Stress	(5 m	0.9					
P.,-	3945.9	Ib							
P./A_=	73.5	psi	<	0.05f'	100	psi	Okay!	(TM5 402 Secti	on 9.3.5.4.2
Mu= wuh2/8	i + Puteu/2+Pu⇔u			25711271.70	1			(TMS 402 Eq. 9	-23)
<i>d</i> =	(5Mah ²)/(48E	(₁₀ 1 ₄₁)	ir.	M _u <m<sub>er</m<sub>	1			(TMS 402 Eq. 9	-25)
ð #	(5M _c ,h ²)/(48E	"Ig)+(5(MM.)h²)/(48E	imler)	17	Mu> or =!	M _{er}	(TMS 402 Eq. 9	-26)

Assume,	e _u =	0	in								
f,=	153 psi (1 gr	outed cell/4 c	ells) + 51	psi (3 ungr	outed cells/	4 cells)	76.5	psi	(TMS 402	Table 9.1.9.2)	
	(Note: Linea	r interpolatio	on for 1/6 o	ells groute	ed)						
M _{cr} = (f _r +P/A _g)	$(I_g/(t/2)) =$	14182	in-lb		(TMS 402	Section 9.	3.5.4.4)				
C=(A _s f _y +P _u)/(0).64f' _m b)=	2.7	in		(TMS 402	Eq. 9-31)					
I _{cr} =E _s /E _m (A _s +(F	P _{utsp} /f _y 2d))(d-c) ² +bc ³ /3=	61.7	in ⁴	(TMS 402	Eq. 9-30, t	_{sp} /2d=1 for	centered rein	forcement)	
Solving for M	1							$M_{ij} = -$	$\frac{h^2}{8} + P_{ut} = \frac{\theta}{2}$	$\frac{u}{2} \text{if } M_u < M_{cr}$	
Mu=	43248	in-Ib	>	Mcr	14182	in-Ib	Okay	1	$-\frac{5P_uh^2}{48E_ml_n}$		
Dete	ermination of N	ominal and De	sign Streng	gth				W.	h ² . p e	$5M_{\rm e}P_{\rm e}h^2(1,1)$	
$a = (A_s f_y + P_u)$	/φ)/(0.80f° _m b) =	2.19	in				M _u =	3 + P _W 2	$\frac{\frac{\mu}{2} + \frac{5M_{cr}P_{v}h^{2}}{48E_{m}} \left(\frac{1}{I_{n}} - \frac{1}{I_{cr}}\right)}{1 - \frac{5P_{v}h^{2}}{48E_{m}I_{cr}}} \text{if} \ $	$M_u \ge M_{cr}$
$M_n = (P_u / \phi + A)$	A _s f _y)*(d-a/2)	=	76261.7	lb-in						$1 - \frac{5P_{d}h^{2}}{48E_{m}l_{cr}}$	
Design flexu	ral strength =	φM _n =	68635.5	lb-in	>	Mu	43248	lb-in	Okay		
Deflection:											
ð=	0.6	in	<	0.007H	1.008	in	(Okay)	$\delta_s \leq 0$.007h	(Deflection at Mid Height)	
			So, USE	#9 Bars @	32 in C.C S	pacing	OR	So, USE #8 E	ars @ 24	in C.C Spacing	
						Choose:	#9 Bars @	32 inches	-		

Image D: Design of Reinforced Masonry Wall for out-of-plane loading

E.	Excel Worksheet for D	Designing the Reinforced N	Masonry Wall for In-Plane Loa	ding

Shear Wall Design																	
Wall Properties:																	
b=	8 în	(thick	ness of CMU wol	0	t=	7.625 in	(actual width	of CM	<i>u</i>)								
P _m =	2000 pel	(medi	um-weight)														
t _j =	60 kal	(Grad	e 60 steel)														
S _{DS} -	0.405 g	(Calcu	lated based on k	ication)													
w=	184 paf	(weig)	ht of 8 in thick pa	rtial growted r	nasonry @ 1	12 inches with m	edium wt, Fro	m Calc	u 7	e	0.3	rs (Fo	r Part	tially G	iroute	d Shea	(Wall)
7*	125 pcf	(unit i	weight of mason	(vr													
Dimension and Load			10.12														
.Le	120 ft	/lengt	h of the wall)	For W	/all 1: (No Op	pening)				- 22	- 2	6					
						/Flexibility (A_)	0.608		4	$\left(\frac{n}{T}\right)^{2}$	$+ 3\left(\frac{H}{L}\right)$)		R 1	$=\frac{1}{\Lambda_1}$		
First Floor:				The	elative Rigid	lity (R.)	1.64				Sec. 1				- set		
V _f =	24.9 kips	Inach	quake load)			ng of 10ft x 8ft	of the context		d ante	(visti =	$\left(\frac{H}{L}\right)^{3}$ +	3(7)					
h=	0.0.000	100000				d wall (A _{util will}	0.608					10.00					
1112	12 A		ht of the wall	10000					A setu	ang -	$(\frac{8}{2})^{4} +$	$3(\frac{3}{7})$					
wp=	2528 plf		(Load)	// 5352		d strip (A _{ssid sow}					-	8		1.		-	1
W ₄ π	728 plf	[Live i			ction of pier	and the second se	0.448		4 100	= (q))2 + 3((A)		a pi	-14	1	1 + 1 2 pie
w _n =	264425.9 /br	(weig)	ht of the wally	1000010	ction of pier	0.0.500	0.224									pier1	p la
Roof:				Wall	2 Deflection	/Flexibility (Δ_2)	0.632			- 1	od jent?	4 860	of aire	pra ;	piers:		
Via	29.6 kips	(Earth	iguake lood)	Then	elative Rigid	lity (R ₂)	1.50		R 3 =	The last							
h=	12 ft	(Heigh	ht of the woll?								- 1.						
w _p =	1904 plf	(Dead	(Loud)	Force	In Wall 1 : @	9 24 ft	29.6 kip	¥.	F3 =	6.0	<u>+</u>)x1	Tatul					
w.=	243 plf	(Live L	1.1.1	Force	In Wall 2 : #	@24ft	28.5 kip		F. =	14	1.)x1	Tare					
W	264425.9 fbs		ht of the wall)	2005	1000	8530	000	9	10.00	12.74	d 2/	scoredand.					
		1.0.0		Force	In Wall 1:6	P12 ft	24.9 kip										
Earthquake Design P	arameters				in Wall 2: 6		24.0 kip										
Seismic Design Cater		D		14.85			1000										
				Base	Shear in Wal	11.1:	54.6 kip	s	VTe	nal = l	10147	$i + F_1$	(e) (z)	fr			
				Base	Shear in Wal	11 1:	54.6 kip	\$	VTe	ral = l	10147	$t + F_1$	@ 12)	ft			
0-				Base	Shear in Wal	111:	54.6 kip	\$) 	VTe	nal = 1	10247	$r + F_1$	@ 12)	ft.			
ρ=		1		Base	Shear in Wal	111:	54.6 kip	5	VTe	nal = 1	10147	, * F ₁	(@.12)	ft.			
p= S _{bi} #	0	1 105 g		Base	Shear in Wal	11.1:		0.012			1 @ 14 /	100		1			
300	0			Base	Shear in Wal	11 1:		0.012			in be (100	S. Osm	1			
300		105 g	Deflection due		Shear in Wal	H 1:		0.012			in be (a?)-41	S. Osm	many Ca			_
S _{bs} #	Cali	105 g	Deflection due	e to shear:	Shear in Wal	H 1:	Table	2	of George	of Bani	and Bee () B	a. ²)—41 Nether 0 8 1.18	S Oum Chesi 1 U	t I	1 1 19 1	77 L	04
300	Cali 1800000	105 g station of C psi	and the second se		Shear in Wal	H 1:	Table	2 0.18 0.61	of George 5 0.38 0.91	4 0.78	and Days () 8 5 0.98 1.53	n. ²)—41 Nether 1 8 1.18	S Com then 1 1 2	1 1 1 2	10 1 40 2	77 L 26 3	04
S _{bs} #	Cali 1800000	105 g	<i>E</i> ₂₀₁ =	to shear: 900fm	Shear in Wal	11 1:	Table	2 0.19 0.41 0.39 0.41 0.39 1.20	of Geosge 6,38 0,99 1,32 1,89	4 0.78 1.33 1.77 5.44	8 100 100 100 100 100 100 100 100 100 10	4 ²)-41 Nether 0 8 1.18 2.65 3.61	S. Outer Chesi 11 21 23 43	t 8 37 L 25 J 20 3 31 4	10 1 10 1 10 1 10 1 11 1	77 L 26 3 18 4 41 6	04 07 42 01
S _{bs} #	Cali 1800000	105 g station of C psi	$E_{ss} =$ $E_{v} = 0.$	e to shear: 900fm 4Em	Shear in Wal	111:	Table	2 0.18 0.41 0.41 0.41 0.41 0.41 0.41 0.41 0.41	of Geospi 5 6.38 6.99 1.32 1.89 2.19	4 0.78 1.33 1.77 5.44 5.14	8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	8 1.18 1.84 1.44 1.44 1.44 1.44 1.44 1.4	S. Outer Chesi 11 21 21 23 41 25	1 1 17 1. 18 3 10 3. 11 4. 59 6	17 1. 18 2. 19 3. 19 3. 28 7	277 L 276 3 186 4 41 6 127 7	(M) (0) (0) (0) (0)
S _{bi} = E _m = E _v =	Cair 1800000 259 103680	adation of C psi 200 ksf ksf	<i>E</i> ₂₀₁ =	e to shear: 900fm 4Em	Shear in Wal	111:	Table 1 8 arms 4 5 6 7 8 9 10	2 0.38 0.41 0.38 1.20 1.57 1.00 2.53	of George 5 6.38 9.91 1.38 1.89 1.38 3.09 3.79	4 0.78 1.31 1.77 5.42 5.14 5.06	ind lines () 8 0.98 1.30 2.21 3.09 5.09 6.30	8 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.19	Chesi Chesi 11 21 21 21 21 21 21 21 21 21 21 21 21	t 1 17 L 18 3 10 3 11 4 10 5 10 6 10 8 10 8	17 1. 18 2 19 3 11 45 2 19 3 11 45 21 7 10 1 11 11	277 L 236 3 366 4 41 6 41 6 107 7 30 10 39 12	()) ()) () () () () () () () () () () ()
5 ₀₅ # E _m = E _v = A =	Cali 1800000 259 103680 7	105 g psi 200 ksf ksf .25 ft ²	$E_m =$ $E_\nu = 0.$ A = t.2	e to shear: 900fm 4Em	Shear in Wal	111:	7486- 8 arm 4 5 6 7 8 8 9 10 11	2 0.38 0.41 0.38 1.20 1.57 1.50 2.55 3.12	of Geosp 5 6.38 0.91 1.30 1.80 3.00 3.79 4.48	4 0.78 1.39 1.77 5.44 5.14 4.00 5.06 6.25	1441 Ben 3 8 5 0.98 1.50 2.21 3.09 3.50 5.50 6.33 7.31	8 1.18 1.84 1.49 1.49 1.49 1.49 1.49 1.49 1.49 1.4	5 Outer Charst 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	t 1 17 L 18 J 19 3 10 3 10 5 10 8 10 8 10 8 10 94 12	1 1 17 1 46 2 10 3 11 4 21 7 10 9 11 11 10 9	177 L 2% 3 36 4 41 6 37 7 39 12 39 12 36 15	用 印 印 市 市 総 総 品
S _{bi} = E _m = E _v =	Cali 1800000 259 103680 7	adation of C psi 200 ksf ksf	$E_m =$ $E_\nu = 0.$ A = t.2	e to shear: 900fm 4Em			Table 1 8 arms 4 5 6 7 8 9 10	2 0.38 0.41 0.38 1.20 1.57 1.00 2.53	of Geoup 5 0.38 0.99 1.32 1.89 2.35 5.09 4.68 6.75	4 0.38 1.39 1.77 5.45 5.06 6.25 8.00	and liter (1) 8 0.98 1.50 2.21 3.04 3.50 5.09 6.39 7.81 11.25	8 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.19	S. Outer Charst 11 21 31 31 31 41 51 51 51 51 51 51 51 51 51 51 51 51 51	1 1 17 L 18 2 19 3 14 5 19 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5	1 17 1. 17 1. 18 2 19 3 14 5 28 7 10 1 10 10 1 10 10 1 10	177 L 2% 3 4日 6 277 7 200 20 29 日2 28 日5 22 72	()) ()) () () () () () () () () () () ()
5 ₀₅ # E _m = E _v = A =	Cali 1800000 259 103680 7	105 g psi 200 ksf ksf .25 ft ²	$E_{ss} =$ $E_{v} = 0.$	e to shear: 900fm 4Em			Table / Barm. 4 5 6 7 8 10 11 14	2 0.38 0.41 0.38 1.20 1.57 2.000 2.55 3.15 4.50	of Geosp 5 0.38 0.99 1.32 1.89 2.55 3.09 4.48 6.75	4 0.38 1.39 1.77 5.45 5.06 6.05 8.00	and lines (1 8 0.98 1.53 2.21 3.94 3.50 5.99 6.39 7.81 13.25 20.08	8 1.19 1.84 1.49 1.49 1.49 1.49 1.49 1.49 1.49 1.4	S. Outer Charst 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 17 L 18 2 19 3 14 5 19 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5	1 17 1. 17 1. 18 2 19 3 14 5 28 7 10 1 10 10 1 10 10 1 10	177 L 2% 3 4日 6 277 7 200 20 29 日2 28 日5 22 72	00 07 01 01 01 01 01 02 05 05 05 05 05 05 05 05 05 05 05 05 05
S _{DS} = E _m = E _v = A = I =	Cali 1800000 259 103680 7 91	105 g psi 200 ksf ksf .25 ft ²	$E_m =$ $E_\nu = 0.$ A = t.2	e to shear: 900fm 4Em			Table / Barm. 4 5 6 7 8 10 11 14	2 0.38 0.41 0.38 1.20 1.57 2.000 2.55 3.15 4.50	of Geosp 5 0.38 0.99 1.32 1.89 2.55 3.09 4.48 6.75	4 0.38 1.39 1.77 5.45 5.06 6.05 8.00	and liter () 8 5 0.98 1.53 2.21 3.09 5.09 5.09 5.09 5.09 1.125 2000 7.21 11.25 2000	4,1)-41 Nether 0 1,10 1,44 1,44 1,44 1,44 1,44 1,44 1,4	S. Outer Charst 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 17 L 18 2 19 3 14 5 19 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5 10 5	1 17 1. 17 1. 18 2 19 3 14 5 28 7 10 1 10 10 1 10 10 1 10	77 L. 2% 3. 66 4 41 6. 97 7. 60 90. 99 12 66 15 23 72. 60 40	00 07 01 01 01 01 01 02 05 05 05 05 05 05 05 05 05 05 05 05 05
5 ₀₅ # E _m = E _v = A =	Cali 1800000 259 103680 7 91 0.00	105 g psi 200 ksf ksf .25 ft ² 500 ft ²	$E_m =$ $E_\nu = 0.$ A = t.2	e to shear: 900fm 4Em		$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Telle / Rarmo 4 5 6 7 8 10 11 14 14 15 16 16 17 18 18 18 18 18 18 18 18 18 18	2 0.38 0.41 0.38 1.57 2.00 2.55 3.15 3.15 3.15 3.15 3.15 3.15 3.15 3	of Giosep 3 6.38 6.99 4.32 1.89 2.55 3.09 4.48 6.75 12.00 12 2.36	4 0.39 1.31 1.77 2.42 9.00 9.50 6.422 9.00 16.00 17 225	and lines 0 8 0.98 1.53 2.21 3.04 3.549 5.69 6.33 7.81 15.25 20100 7 74 175	1.19-41 wether of 4.11 1.44 1.44 1.44 1.44 1.44 1.44 1.4	5. Outer fhesi 1 12 1 22 1 30 4 1 70 4 1 52 1 70 1 8 1 1 70 1 8 1 1 70 1 12 1 12 1 12 1 12 1 12 1 12 1 12 1 1	17 L 17 L 15 J 10 3 10 3 10 3 10 4 10 8 10 18 10 18	177 11 177 11 143 22 170 33 144 5 28 7 100 9 101 12 100 20 200 30 101 101 102 103 103 103 103 103 103 103 103	177 L 276 3 188 4 41 6 42 7 40 90 39 12 36 15 12 72 30 40 19 10 10 10 10 10 10 10 10 10 10	06 00 40 40 40 40 40 50 50 20 20 20
S _{DS} = E _m = E _v = A = I =	Cali 1800000 259 103680 7 91 0.00	105 g psi 200 ksf ksf .25 ft ² 500 ft ⁴	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{1}{\Delta = \frac{V_{1}}{12}}$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barms 4 5 7 8 10 11 13 14 18 18 18	44 Amm 2 0.39 0.61 0.08 1.37 1.00 2.55 1.52 1.52 1.52 1.52 1.52 1.52 1.52	of Ginapp 3 6,38 0,99 1,30 1,50 3,59 4,57 1,200 112 2,36 3,48 122	4 0.38 1.33 1.77 2.42 5.06 5.06 5.06 5.06 5.06 5.06 5.06 5.06	ind lites () 8 0.08 1.50 2.21 3.04 3.50 5.50 6.30 7.81 1525 2000 7 14 2.78 4.36	1.7)-41 Norther of 8 1.18 1.44 1.44 1.44 1.44 1.44 1.44 1.	S Oum Chesi 1 13 30 43 53 43 53 53 1 13 53 1 13 53 1 13 53 1 13 53 1 13 53 1 13 1 13	17 L 17 L 18 J 19 L 19 L 10 S 10 S 1	10 1 10 1 10 2 10 3 14 4 20 3 14 4 21 7 10 1 10 10 1 10	17 L 2% 3. 18 4. 41 6. 42 7. 30 10. 39 12. 10 10. 39 12. 30 40. 10 30. 11 31. 12 72. 30 40. 10 3.	04 00 00 00 00 00 00 00 00 00 00 00 00 0
S_{DS} $E_m =$ $E_v =$ A = I = $\Delta \oplus <12$ ft =	Cali 1800000 255 103680 7 91 0.00 0.00	105 g slation of 1 psi 200 ksf ksf .25 ft ² 100 ft 12 in	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{1}{\Delta = \frac{V_{1}}{12}}$		$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barms 4 5 7 8 10 11 13 14 18 18 18	2 0.38 0.41 0.38 1.57 2.00 2.55 3.15 3.15 3.15 3.15 3.15 3.15 3.15 3	of George 0.38 0.38 0.39 1.30 1.30 3.00 3.00 3.00 3.00 3.00 3.00	4 0.39 1.33 1.47 5.44 8.00 1.64 8.00 1.64 1.14 8.00 1.64 1.14 1.14 1.14 1.14 1.14 1.14 1.14	1444 Been (3) 8 5 0.088 1-539 2-211 3-091 5-599 6-539 7-81 11-25 7040 1-75 4-36 0.19 1-75 4-36 0.19 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-75 1-7	n.*)41 wetter o 8 1.18 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.444 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44	5. Outer Chest 1. 1. 2. 3. 3. 4. 4. 5. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 2. 1. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.	r 1 173 L 100 3 14 6 16 6 16 6 16 6 16 6 16 6 16 6 16 7 17 1 17 1 12 1 13 1 14 6 16 6 16 1 17 1 12 1 1 12 1 12 1 1 12 1 1 12 1	1 17 1. 18 2 19 3 14 5 29 7 10 1 10	17 L 2% 3 3% 44 441 6 441 6 441 6 441 6 441 6 39 12 39 12 39 12 30 40 19 3.73 5.53 8.39 1.40 1	04 07 42 08 18 18 18 18 18 18 18 19 19 11 11 11 11 11 11 11 11 11 11 11
S _{DS} = E _m = E _v = A = I =	Cali 1800000 255 103680 7 91 0.00 0.00	105 g psi 200 ksf ksf .25 ft ² 500 ft ²	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{1}{\Delta = \frac{V_{1}}{12}}$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barms 4 5 7 8 10 11 13 14 18 18 18	2 Annue 2 0.39 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61	5 638 038 031 130 130 130 130 130 130 130 130 130	4 0.13 1.37 1.44 5.06 6.05 8.05 8.05 8.05 8.05 8.05 8.05 8.05 8	100 min 100 mi	h. ²)-41 weber e 1.18 1.44 1.44 1.44 1.44 1.44 1.44 1.44	5. Outer (bas) (bas) (bas) (bas) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	177 L 178 L 179 L 170 L 170 L 180 S 181 4 190 S 181 4 190 S 181 4 191 1 191 L 191 L 19	1 17 1 17 1 14 2 19 3 14 5 21 7 10 1 10 1 10 2 10 1 10 2 10 2 10 1 10 2 10 1 10 2 10 2 10 10 2 10 2 10 10 2 10	17 L 26 3. 186 4. 41 6. 127 7. 100 10. 39 12. 100 40. 101 5.00 102 77. 103 5.00 104 1. 1140 1. 14.00 1.	04 00 40 00 20 26 50 50 50 50 50 50 50 50 50 50 50 50 50
S_{DS} $E_m =$ $E_v =$ A = I = $\Delta \oplus <12$ ft =	Cali 1800000 255 103680 7 91 0.00 0.00 0.01 0.00	105 g slation of 1 psi 200 ksf ksf .25 ft ² 100 ft 12 in	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{1}{\Delta = \frac{V_{1}}{12}}$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barms 4 5 7 8 10 11 13 14 18 18 18	4 Annu 2 0.19 0.19 0.19 1.20 2.00 2.55 3.12 2.00 2.55 3.12 2.00 2.55 3.12 4.50 4.50 4.50 6.61	of George 0.38 0.38 0.39 1.30 1.30 3.00 3.00 3.00 3.00 3.00 3.00	4 0.13 1.37 1.44 5.06 6.05 8.05 8.05 8.05 8.05 8.05 8.05 8.05 8	and Base 0 8 0.099 1500 222 304 3000 5000 5000 5000 5000 5000 5000	1.19-41 wether a 1.18 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44 1.44	5. Outer Chest 1. 1. 2. 3. 3. 4. 4. 5. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 1. 2. 1. 2. 1. 1. 2. 2. 1. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.	r 1 37 1 13 1 14 2 16 6 10 3 13 4 16 6 10 5 13 1 13 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10 17 1. 17 1. 18 23 3. 18 4. 19 3. 18 4. 19 3. 19 4. 10	IT L 2% 3. 18 4. 41 6. 187 7. 00 30. 39 12. 100 40. 39 12. 300 40. 39 1. 530 5. 8.39 1. 1.432 1. 14.92 1. 19.00 2.	04 00 42 00 08 46 50 50 50 50 514 8.84 2.00 5.01 5.01 5.00 5.00 5.01
S_{DS} $E_m =$ $E_v =$ A = I = $\Delta \oplus <12 \text{ ft} =$	Cali 1800000 255 103680 7 91 0.00 0.00 0.01 0.00	105 g slation of f psi 200 ksf ksf 125 ft ² 100 ft 12 in 111 ft	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{1}{\Delta = \frac{V_{1}}{12}}$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm / 4 5 7 8 10 11 14 14 14 14 14 15 6 7 8 9 10 11 14 15 16 17 18 19 10 11 14 19 10 10 11 14 15 16 10 10 11 14 15 16 10 10 11 14 15 16 17 16 17 16 17 16 16 17 16 16 17 16 16 17 16 16 16 16 16 16 16 16 16 16	4 Amar 1 0.19 0.01 0.00 1.00 2.557 2.00 2.557 2.00 1.00 2.557 2.00 1.00 2.557 2.00 1.00 2.557 2.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.	of Groups 5 0.33 1.88 3.55 3.56 3.79 12.06 12 2.36 5.16 5.16 5.16 5.16 5.16 5.16 5.16 5.1	4 0.19 1.39 1.77 1.44 0.06 5.56 6.22 8.00 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1	and line: 0 8 0.08 1.30 3.04 3.06 3.07 1.125 2.000 7 11.25 2.000 7 11.25 2.000 7 11.25 2.000 7 11.25 2.000 7 11.25 2.000 7 11.25 11.25 2.000 7 11.25 11.25 11.25 11.25 11.25 11.26 11.26 11.26 11.25 11.26 11.25 11.26 11.27 11.27 11.27 11.27	n. ²)42 Kardar o 8 1.18 1.44 1.44 1.44 1.44 1.45 1.46 1.40 7.99 1.46 2.46 1.13 2.46 1.13 2.46 1.13 2.46 1.13 2.46 1.13 2.46 1.13 2.46 1.13 2.46 1.14 1.14 1.14 1.14 1.14 1.14 1.14 1	5 Outer Chart 11 12 13 13 14 13 14 13 14 15 17 14 15 17 10 10 17 10 10 17 10 10 17 10 10 10 10 10 10 10 10 10 10	r 1 17 1 18 2 59 6 60 6 59 6 60 8 59 6 60 8 94 12 15 18 10 11 13 2 13 4 13 5 14 2 13 2 14 2 15 18 15 2 16 2 17 18 15 2 16 2 17 18 18 2 18 2	8 177 177 11 184 2 179 11 184 5 179 11 184 5 179 11 184 5 184 5	177 L 276 3. 188 4. 41 6. 197 7. 00 30. 39 12. 105 15. 107 8.599 11.407 1 199.002 2 204.005 2 204.005 2 204.005 2 204.005 2 204.005 2 204.005 2 204.005 2 204.005 2 204.005 2	08 00 42 00 88 66 65 65 70 70 70 70 70 70 70 70 70 70 70 70 70
S_{DS} $E_m =$ $E_v =$ A = I = $\Delta \oplus <12 \text{ ft} =$	Cali 1800000 255 103680 7 91 0.00 0.01 0.00 0.01 0.00 0.00	105 g slation of 1 psi 200 ksf ksf 125 ft ² 100 ft 12 in 111 ft 113 in	$E_m = 0$ $A = t.1$ $I = \frac{tL^4}{12}$	$\frac{4 \text{ to shear:}}{900 f_m'}$ $4 E_m$ $\Delta = \frac{V_1}{121}$ $\Delta = \left(\frac{H}{L}\right)$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm 4 5 7 8 10 13 14 14 18 18 18 18 19 10 11 14 18 10 11 11 11 11 11 11 11 11 11 11 11 11	44 Amm 2 0.39 0.41 0.39 0.41 0.39 1.20 1.20 1.20 1.23 3.12 3.12 3.13 4.50 1.21 4.50 1.21 4.50 1.21 4.50 1.21 4.50 1.21 1.21 1.21 1.21 1.21 1.21 1.21 1.2	5 6,28 0,99 1,32 1,88 2,55 1,20 1,20 1,20 1,20 1,20 1,20 1,20 1,20	4 0.19 1.39 1.77 1.44 0.06 5.56 6.22 8.00 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1	144 Bee 0 8 5 0.0% 5.0% 5.0% 5.0% 5.0% 7.0% 1.0% 1.0% 1.0% 1.0% 1.0% 1.0%	n.*)-41 Sector of 4 1.11 1.44 3.44 3.44 3.44 3.44 3.44 3.	5 Oum 5 besi 5 besi 1 12 1 21 1	1 11 17 1. 18 2. 18 4. 19 6. 10 4. 19 6. 10 4. 10 4. 10 1. 10 4. 10 4. 10 1. 10 4. 10 1. 10 4. 10 1. 10 4. 10 4. 10 4. 10 1. 10 4. 10	8 1 37 1 44 2 39 3 44 4 24 3 10 1 12 14 130 14 14 4 15 1 16 1 15 1 15 1 16 1 1537 552 7.86 1 10.82 1 14.14 1 16.00 12.37 18.12 13.32	177 L 276 3. 188 4. 441 6. 197 7. 000 300. 399 12. 385 15. 100 30. 399 12. 300 40. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 311 3. 312 3. 313 3. 314 3. 315 3. 316 3. 317.0 3. 312.0 3. 313.0 3. 314.0 3. 314.0 3. 315.0 3. 316.0 3. 317.0 3. 318.0 <t< td=""><td>04 00 42 00 08 46 50 50 50 50 514 8.84 2.00 5.01 5.01 5.00 5.00 5.01</td></t<>	04 00 42 00 08 46 50 50 50 50 514 8.84 2.00 5.01 5.01 5.00 5.00 5.01
$E_m =$ $E_v =$ $A =$ $I =$ $\Delta_{e0} < 12 \text{ ft} =$ $\Delta_{e0} < 24 \text{ ft} =$	Cali 1800000 255 103680 7 91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m =$ $E_\nu = 0.$ A = t.2	$\frac{4 \text{ to shear:}}{900 f_m'}$ $4 E_m$ $\Delta = \frac{V_1}{121}$ $\Delta = \left(\frac{H}{L}\right)$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm 4 3 6 7 8 10 11 14 13 14 18 16 5 6 7 6 9 11 11 13 13 11 13 13 13 13 13 14 13 13 14 14 15 15 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	4.4 Amm 2 0.39 0.41 0.39 0.41 0.41 0.41 0.42 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	5 038 038 039 130 130 130 130 130 130 130 130 140 120 120 120 120 120 120 120 120 120 12	4 0.39 1.33 1.47 5.42 5.06 5.06 5.06 5.06 5.06 16.00 12 2.55 2.09 10.25 10 2.51 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.2	144 Bee 0 8 5 0.0% 5.0% 5.0% 5.0% 5.0% 7.0% 1.0% 1.0% 1.0% 1.0% 1.0% 1.0%	n.*)-41 Sector of 4 1.11 1.44 3.44 3.44 3.44 3.44 3.44 3.	5 Oum 5 besi 5 besi 1 12 1 21 1	1 11 17 1. 18 2. 18 4. 19 6. 10 4. 19 6. 10 4. 10 4. 10 1. 10 4. 10 4. 10 1. 10 4. 10 1. 10 4. 10 1. 10 4. 10 4. 10 4. 10 1. 10 4. 10	8 1 37 1 44 2 39 3 44 4 24 3 10 1 12 14 130 14 14 4 15 1 16 1 15 1 15 1 16 1 1537 552 7.86 1 10.82 1 14.14 1 16.00 12.37 18.12 13.32	177 L 276 3. 188 4. 441 6. 197 7. 000 300. 399 12. 385 15. 100 30. 399 12. 300 40. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 311 3. 312 3. 313 3. 314 3. 315 3. 316 3. 317.0 3. 312.0 3. 313.0 3. 314.0 3. 314.0 3. 315.0 3. 316.0 3. 317.0 3. 318.0 <t< td=""><td>08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80</td></t<>	08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80
$E_m =$ $E_v =$ $A =$ $I =$ $\Delta_{e0} < 12 \text{ ft} =$ $\Delta_{e0} < 24 \text{ ft} =$	Cali 1800000 255 103680 7 91 0.00 0.01 0.00 0.01 0.00 0.00	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m = E_v = 0.$ $A = t.1$ $I = \frac{tL^2}{12}$ n Solution	e to shear: $900f''_m$ $4E_m$ $\Delta = \frac{V_1}{12!}$ $\Delta = \left(\frac{H}{L}\right)$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm 4 3 6 7 8 10 11 14 13 14 18 16 5 6 7 6 9 11 11 13 13 11 13 13 13 13 13 14 13 13 14 14 15 15 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	4.4 Amm 2 0.39 0.41 0.39 0.41 0.41 0.41 0.42 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	5 038 038 039 130 130 130 130 130 130 130 130 140 120 120 120 120 120 120 120 120 120 12	4 0.39 1.33 1.47 5.42 5.06 5.06 5.06 5.06 5.06 16.00 12 2.55 2.09 10.25 10 2.51 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.2	144 Bee 0 8 5 0.0% 5.0% 5.0% 5.0% 5.0% 7.0% 1.0% 1.0% 1.0% 1.0% 1.0% 1.0%	n.*)-41 Sector of 4 1.11 1.44 3.44 3.44 3.44 3.44 3.44 3.	5 Oum 5 besi 5 besi 1 12 1 21 1	1 11 17 1. 18 2. 18 4. 19 6. 10 4. 19 6. 10 4. 10 4. 10 1. 10 4. 10 4. 10 1. 10 4. 10 1. 10 4. 10 1. 10 4. 10 4. 10 4. 10 1. 10 4. 10	8 1 37 1 44 2 39 3 44 4 24 3 10 1 12 14 130 14 14 4 15 1 16 1 15 1 15 1 16 1 1537 552 7.86 1 10.82 1 14.14 1 16.00 12.37 18.12 13.32	177 L 276 3. 188 4. 441 6. 197 7. 000 300. 399 12. 385 15. 100 30. 399 12. 300 40. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 311 3. 312 3. 313 3. 314 3. 315 3. 316 3. 317.0 3. 312.0 3. 313.0 3. 314.0 3. 314.0 3. 315.0 3. 316.0 3. 317.0 3. 318.0 <t< td=""><td>08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80</td></t<>	08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80
$E_m =$ $E_v =$ $A =$ $I =$ $\Delta_{e0} < 12 \text{ ft} =$ $\Delta_{e0} < 24 \text{ ft} =$	Cali 1800000 255 103680 7 91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m = E_v = 0.$ $A = t.1$ $I = \frac{tL^2}{12}$ n Solution	e to shear: $900f''_m$ $4E_m$ $\Delta = \frac{V_1}{12!}$ $\Delta = \left(\frac{H}{L}\right)$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm 4 3 6 7 8 10 11 14 13 14 18 16 5 6 7 6 9 11 11 13 13 11 13 13 13 13 13 14 13 13 14 14 15 15 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	4.4 Amm 2 0.39 0.41 0.39 0.41 0.41 0.41 0.42 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	5 038 038 039 130 130 130 130 130 130 130 130 140 120 120 120 120 120 120 120 120 120 12	4 0.39 1.33 1.47 5.42 5.06 5.06 5.06 5.06 5.06 16.00 12 2.55 2.09 10.25 10 2.51 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.2	144 Bee 0 8 5 0.0% 5.0% 5.0% 5.0% 5.0% 7.0% 1.0% 1.0% 1.0% 1.0% 1.0% 1.0%	n.*)-41 Sector of 4 1.11 1.44 3.44 3.44 3.44 3.44 3.44 3.	5 Oum 5 besi 5 besi 1 12 1 21 1	1 11 17 1. 18 2. 18 4. 19 6. 10 4. 19 6. 10 4. 10 4. 10 1. 10 4. 10 4. 10 1. 10 4. 10 1. 10 4. 10 1. 10 4. 10 4. 10 4. 10 1. 10 4. 10	8 1 37 1 44 2 39 3 44 4 24 3 10 1 12 14 130 14 14 4 15 1 16 1 15 1 15 1 16 1 1537 552 7.86 1 10.82 1 14.14 1 16.00 12.37 18.12 13.32	177 L 276 3. 188 4. 441 6. 197 7. 000 300. 399 12. 385 15. 100 30. 399 12. 300 40. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 311 3. 312 3. 313 3. 314 3. 315 3. 316 3. 317.0 3. 312.0 3. 313.0 3. 314.0 3. 314.0 3. 315.0 3. 316.0 3. 317.0 3. 318.0 <t< td=""><td>08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80</td></t<>	08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80
S_{DS} $E_m =$ $E_v =$ A = I = $\Delta_{\oplus} < 12 \text{ ft} =$ $\Delta_{\oplus} < 24 \text{ ft} =$ Load Combina	Cali 1800000 255 103680 7 91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m = 0$ $A = t.1$ $I = \frac{tL^4}{12}$	e to shear: $900f''_m$ $4E_m$ $\Delta = \frac{V_1}{12!}$ $\Delta = \left(\frac{H}{L}\right)$	$H^3_{E_m I} + \frac{1.21}{AB}$	$\frac{VH}{S_{\pi}} + \Delta_F \frac{2H}{L}$	Table / Barm 4 3 6 7 8 10 11 14 13 14 18 16 5 6 7 6 9 11 11 13 13 11 13 13 13 13 13 14 13 13 14 14 15 15 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	4.4 Amm 2 0.39 0.41 0.39 0.41 0.41 0.41 0.42 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	5 038 038 039 130 130 130 130 130 130 130 130 140 120 120 120 120 120 120 120 120 120 12	4 0.39 1.33 1.47 5.42 5.06 5.06 5.06 5.06 5.06 16.00 12 2.55 2.09 10.25 10 2.51 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.25 10.2	144 Bee 0 8 5 0.0% 5.0% 5.0% 5.0% 5.0% 7.0% 1.0% 1.0% 1.0% 1.0% 1.0% 1.0%	n.*)-41 Sector of 4 1.11 1.44 3.44 3.44 3.44 3.44 3.44 3.	5 Oum 5 besi 5 besi 1 12 1 21 1	1 11 17 1. 18 2. 18 4. 19 6. 10 4. 19 6. 10 4. 10 4. 10 1. 10 4. 10 4. 10 1. 10 4. 10 1. 10 4. 10 1. 10 4. 10 4. 10 4. 10 1. 10 4. 10	8 1 37 1 44 2 39 3 44 4 24 3 10 3 112 14 130 4 14 4 15 1 16 3 15 5 7.86 1 10.82 1 16.14 1 16.00 12.37 18.12 13.32	177 L 276 3. 188 4. 441 6. 197 7. 000 300. 399 12. 385 15. 100 30. 399 12. 300 40. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 310 3. 311 3. 312 3. 313 3. 314 3. 315 3. 316 3. 317.0 3. 312.0 3. 313.0 3. 314.0 3. 314.0 3. 315.0 3. 316.0 3. 317.0 3. 318.0 <t< td=""><td>08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80</td></t<>	08 00 42 00 80 80 80 80 80 80 80 80 80 80 80 80
$E_m =$ $E_w =$ $A =$ $I =$ $\Delta \oplus <12 \text{ ft} =$ $\Delta \oplus <24 \text{ ft} =$ Load Combina $1.2D+1.0E+f_1 \text{ ft}$	Cali 1800000 255 103680 7 91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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Eq.	$\Delta = \frac{V_{i}}{12i}$ $\Delta = \frac{V_{i}}{12i}$ $\Delta = \left(\frac{H}{L}\right)$ $\Delta = (100)$	$\left(\frac{H^3}{E_{\pi}I} + \frac{1.21}{AB}\right)^3 + 3\left(\frac{H}{L}\right)$	$\frac{VH}{E_{\pi}} + \Delta_F \frac{2H}{L}$ $\frac{V}{tE_m}$	Table / Rarm. 4 3 6 7 8 10 13 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 15 10 11 14 15 15 15 15 15 15 15 15 15 15	4 Annue 2 0.59 0.61 0.61 0.61 1.00 2.55 2.16 2.16 2.16 2.16 2.16 2.16 2.17 2.19 2.55 2.16 2.16 2.17 2.19 2.16 2.16 2.16 2.16 2.16 2.16 2.16 2.16	of Groups 5 0.83 0.94 1.35 2.54 4.75 1.20 1.2 2.56 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 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$E_m =$ $E_w =$ $A =$ $I =$ $\Delta \oplus <12 \text{ ft} =$ $\Delta \oplus <24 \text{ ft} =$ Load Combina $1.2D+1.0E+f_1 \text{ ft}$	Cali 1800000 255 103680 7 91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m =$ $E_v = 0.$ $A = t.1$ $I = \frac{tL^2}{12}$ n Solution (i8C Eq.	e to shear: $900f''_m$ $4E_m$ $\Delta = \frac{V_1}{12!}$ $\Delta = \left(\frac{H}{L}\right)$	$\left(\frac{H^3}{E_{\pi}I} + \frac{1.21}{AB}\right)^3 + 3\left(\frac{H}{L}\right)$	$\frac{VH}{E_{\pi}} + \Delta_F \frac{2H}{L}$ $\frac{V}{tE_m}$	Table / Barm 4 3 6 7 8 10 11 14 13 14 18 16 5 6 7 6 9 11 11 13 13 11 13 13 13 13 13 14 13 13 14 14 15 15 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	4 Annue 2 0.59 0.61 0.61 0.61 1.00 2.55 2.16 2.16 2.16 2.16 2.16 2.16 2.17 2.19 2.55 2.16 2.16 2.17 2.19 2.16 2.16 2.16 2.16 2.16 2.16 2.16 2.16	of Groups 5 0.83 0.94 1.35 2.54 4.75 1.20 1.2 2.56 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 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(Using))	e to shear: $900 f_m^{\prime}$ $4E_m$ $\Delta = \frac{V_1}{12J}$ $\Delta = \left(\frac{H}{L}\right)$: . 16-5) ASCE 7-16 St	$\left(\frac{H^3}{E_{\pi}I} + \frac{1.21}{AB}\right)^3 + 3\left(\frac{H}{L}\right)$	$\frac{VH}{E_{\pi}} + \Delta_F \frac{2H}{L}$ $\frac{V}{tE_m}$	Table / Rarm. 4 3 6 7 8 10 13 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 15 10 11 14 15 15 15 15 15 15 15 15 15 15	4 Annue 2 0.59 0.61 0.61 0.61 1.00 2.55 2.16 2.16 2.16 2.16 2.16 2.16 2.17 2.19 2.55 2.16 2.16 2.17 2.19 2.16 2.16 2.16 2.16 2.16 2.16 2.16 2.16	of Groups 5 0.83 0.94 1.35 2.54 4.75 1.20 1.2 2.56 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 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$E_m =$ $E_w =$ $A =$ $I =$ $\Delta \oplus <12 \text{ ft} =$ $\Delta \oplus <24 \text{ ft} =$ Load Combina $1.2D+1.0E+f_1 \text{ ft}$	Cali 1800000 255 103680 7 93 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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to shear: $900 f_m^{\prime}$ $4E_m$ $\Delta = \frac{V_1}{12J}$ $\Delta = \left(\frac{H}{L}\right)$: . 16-5) ASCE 7-16 St	$\left(\frac{H^3}{E_{\pi}I} + \frac{1.21}{AB}\right)^3 + 3\left(\frac{H}{L}\right)$	$\frac{VH}{E_{\pi}} + \Delta_F \frac{2H}{L}$ $\frac{V}{tE_m}$	Table / Rarm. 4 3 6 7 8 10 13 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 15 10 11 14 15 15 15 15 15 15 15 15 15 15	4 Annue 2 0.59 0.61 0.61 0.61 1.00 2.55 2.16 2.16 2.16 2.16 2.16 2.16 2.17 2.19 2.55 2.16 2.16 2.17 2.19 2.16 2.16 2.16 2.16 2.16 2.16 2.16 2.16	of Groups 5 0.83 0.94 1.35 2.54 4.75 1.20 1.2 2.56 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 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$S_{DS} =$ $E_m =$ $E_u =$ $A =$ $I =$ $\Delta_{(0)} <12 \text{ ft} =$ $\Delta_{(0)} <24 \text{ ft} =$ Load Combina $1.2D+1.0E+f_1 I$ $(1.2+0.25DS)D$	Cali 1800000 255 103680 7 93 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1005 g station of I psi 200 ksf 200 ksf 201 ft ² 100 ft 12 in 121 ft 131 in th Desig	$E_m =$ $E_v = 0.$ $A = t.1$ $I = \frac{tL^2}{12}$ n Solution (iBC Eq. (Using))	e to shear: $900 f_m^{\prime}$ $4E_m$ $\Delta = \frac{V_1}{12J}$ $\Delta = \left(\frac{H}{L}\right)$: . 16-5) ASCE 7-16 St	$\left(\frac{H^3}{E_{\pi}I} + \frac{1.21}{AB}\right)^3 + 3\left(\frac{H}{L}\right)$	$\frac{VH}{E_{\pi}} + \Delta_F \frac{2H}{L}$ $\frac{V}{tE_m}$	Table / Rarm. 4 3 6 7 8 10 13 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 16 7 8 9 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 10 11 14 15 15 10 11 14 15 15 15 15 15 15 15 15 15 15	4 Annue 2 0.59 0.61 0.61 0.61 1.00 2.55 2.16 2.16 2.16 2.16 2.16 2.16 2.17 2.19 2.55 2.16 2.16 2.17 2.19 2.16 2.16 2.16 2.16 2.16 2.16 2.16 2.16	of Groups 5 0.83 0.94 1.35 2.54 4.75 1.20 1.2 2.56 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.22 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 9.45 5.36 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 7.20 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	First Floo	r Design							
Loads at the base of	the walls:								
P _ =	1060.7	kips							
P=	87.3	kips							
P _{Lr} =	29.1	kips							
$Q_E = V_E =$	54.6	kips							
Using the load comb	vinations and L	oads:							
M _u =	1011	kip-ft	1010535	lb-ft					
P _u =	1229	Kips	Combina	tion: Pu	= D + 0.7	$5L + 0.525Q_{I}$	3		
P _u =	1402	kips	[Combin	ation 1]					
P _u =	869	kips	[Combin	ation 2]					
Preliminary Am Select Initial reinfor				trength	design,	Distribute	d Reinfor	cement	t case
#8	@	48	in						
So, Number of Bars	(n)	29.8							
		31.0	bars						
Area of #8 Bars		0.76							
	A _s)	0.76 23.56							
	27		in ²	the centro	oid of tensio	n steel)			
Total Area of steel (27	23.56 in	in² (Assume		-	n steel) ngular stress	block)		
Total Area of steel (c _t =	4	23.56 in in	in² (Assume	th of equiv	-		block)		
Total Area of steel (c _t = d=	4 1436	23.56 in in	in ² (Assume (The dep (Total Lei (For CML	th of equiv ngth)	alent recta		block)		

c _t =	4	in	(Assum	e the centro	id of tensio	n steel)					
d=	1296	in	(The de	pth of equiv	alent rectar	ngular stress	block, for dist	ributed	reinforcen	nent)	
d _v =	1440	in	Approxi	mate $d = 0.9d$	p		F				
C _{bal} =	709.0	in	1998			c _{bal} =	$=\frac{\varepsilon_{mu}}{\varepsilon_{mu}+\varepsilon_y}d$			·	
a=	51.63	in					emu + ey		a = d -	$d^2 - \frac{2[P_u]}{d^2}$	$\frac{d - d_v/2}{\phi(0.8f_m^* t_{sp})} + M_u$
c =	64.53	in	<	Cbai	709.0	in	Okay			1 9	$\phi(0.8f'_mt_{sp})$
			(So Ten	sion Control	lled)		1000			0.051+	a D / A
As, required ^{im}	12.26	in ²					$A_{s,reqd}^* = \frac{A_{s,i}}{0.6}$	regd	Asread	$=\frac{0.8 f_m t_{s_i}}{0.8 f_m t_{s_i}}$	$\frac{pa - P_u/\phi}{f_v}$
A*s, required=	0.16	in ² /ft					0.6	$5d_v$			Jy
Choose	44		bars	A _s =	19.36	in ²					
	Spacing (s)	32.5	in		(>19.2in ²	with 0.16 in ²	/ft)	(Use a	t least 32i	n spacing fo	or #6 Bars)
Choose	32	#7	bars	A _s =	19.2	in ²					
	Spacing (s)	44.8	in	100 m	(>19.2in ²	with 0.16in ² ,	/ft)	(Use	at least 40	in spacing f	for # 7 Bars)
Choose	96	#4	bars	A _c =	19.2	in ²					
	Spacing (s)	14.9				with 0.16in²,	/ft)	(Use	at least 8 ir	n spacing fo	or #4 Bars)
Choose	62	#5	bars	A _s =	19.22	in ²					
	Spacing (s)	23.1	in		(>19.2in ²	with 0.16in ² ,	/ft)	(Use	at least 16	In spacing f	for #5 Bars)
Choose	25	#8	bars	A.=	19.75	in ²					
	Spacing (s)	57.3		1500 a Co	Contraction of the local division of the loc	with 0.16 in 2 ,	(ft)	(Use a	t least 56	in spacing f	for #8Bars)

		Desig	n Strengt	n Detern	ninatio	n			
Ø =	0.9								
C-T	=P _n		(Fro	m Free B	ody Dia	igram)		
P _u =	869	lbs	(Fro	m Comb	ination	2)			
$P_n = P_u / \phi =$	965.2					-	P _u		
a=	115.95	in	A _s	= 0.8	f.	•	Ø		
c=	144.93				, y				
C=	1414565.2	1							
T=	1413600	lbs							
M _n =	1.75E+09	lb-in							
	145892713								
Design Stre	ngth ØMn=	1	31303 kips	-ft	>	Mu	1011		Okay
P _u =	1402	4	(Fro	m Comb	ination	1)			
$P_n = P_u / \phi =$	1558								
a=	95	in							
c=	119	4							
C=	1163002	4							
T=	1161600								
M _n =	1451009911	lb-in							
	120917493	lb-ft							1
Design Stre	ngth ØMn=	1	08826 kips	-ft	>	Mu	1011		Okay
	Nominal Axia	l Strengt	h Calculat	ion [TMS	402 Se	ction !	9.3.4.1.1]		
Ø =	0.9								
r =	2.59 in		(Partiall	grouted	wall @	32 in,	From Table 3	a)	
H/r=	55.6 in	/in	<		99	-	(Use TMS Equ	uation 9	-15 for P _n
Nominal Axial Ca	pacity:						ſ	21	
P _n =	12764953 lb	5	$P_{} = 0.$	8[0.8f'(A. – A.)	$+f_{\cdot}A$	$ _{1-(\frac{H}{-})}$)	
Design axial streng			- 11 - 0.		-ns)	. Jyu	$\left[1-\left(\frac{H}{140}\right)\right]$	1	
	11488.5 ki	ps							
ØP _n =				1					
Ø P _n = Maximum P _u value			1402	<	1	L1488	(Design axial	Okay	

			Normina		ength:			_	
Ø =	0.8								
M _u /V _u d _v =	0.15	≤ 0.25]	So,	α =	1.5			
Nominal Mason	ry Shear Strength	:	5						
Numbers of bars									
Net Area (A _{nv}) =	4871	in²	(Net are	a except ho	ollow spac	e of bond be	am)		
V _{nm} =	839.8	kips	$V_{nm} = 4$	$-1.75\left(\frac{M_{\rm H}}{V_{\rm eff}}\right)$	$A_{nv}\sqrt{f'_m} +$	0.25Pu	$V_{ns} = 0.5 \left(\frac{A_v}{s}\right) f_y$	d_v	
A., =	0.19	in²/ft		(viintali)					
V _{ns} =	128.25	kips					U (U .)		
V _n =	968.1	kips		(V _u) =			$V_n = (V_{nm} + 1)$	$(n_s)\gamma_g$	
ØV₀=	774.5	kips	>	54.6	kips	Okay			
Maximum Nomi	nal Shear Limit:			V _n =		$V_n \leq ($	$\left(6A_{nv}\sqrt{f'_m}\right)\gamma_g$	For v	¹⁴ 1 . d
$(6A_{nv}\sqrt{f'_m}) =$		kips	>=	968.1	kips	Okay			1
		M	aximum S	Spacing requ	irement:	,	,		
M						third length,	one-third he	eight, 4	8
Maximum Spaci	ng (S _{max})		inches	• minin	num{ one-	third length,	one-third he	eight, 4	8
	ng (S _{max}) ement Just CMU ur	48	inches		num{ one-		one-third he	eight, 4	18
		48 iits (Wall):	inches Shear S	minin trength De Except V _n nee greater than 2	ed not be		one-third he	eight, 4	8
With No Reinforc	ement Just CMU ur 109.1	48 iits (Wall):	inches Shear S	• minin	ed not be		one-third he	ight, 4	18
With No Reinforc	ement Just CMU ur 109.1 0.0	48 nits (Wall): <i>kips</i>	inches Shear S	• minin	ed not be		one-third he	eight, 4	18
With No Reinfor o Vn = Area of Bar	ement Just CMU ur 109.1 0.0	48 its (Wall): kips in ²	inches Shear S	• minin	ed not be		one-third he	eight, 4	18
With No Reinford Vn = Area of Bar Av =	ement Just CMU ur 109.1 0.0 0	48 nits (Wall): kips in ² in ²	inches Shear S	• minin	ed not be			eight, 4	18
With No Reinford Vn = Area of Bar Av = Ø=	ement Just CMU ur 109.1 0.0 0 0.8 0.08 0.08	48 hits (Wall): $kips$ in^{2} ≤ 0.25	inches Shear S	• minin Except V_n nee greater than 2 shear) a_n or $\phi V_n = \phi 2$.	num{ one- esign: ed not be $2.5V_{u}$. (double: $5V_{u} = 2.0V_{u}$	s		eight, 4	18
With No Reinford Vn = Area of Bar Av = ○= Mu/Vudv=	ement Just CMU ur 109.1 0.0 0.8 0.8 0.08	48 hits (Wall): $kips$ in^{2} ≤ 0.25	inches Shear S V _n = 2.5V _u	• minin Except V_n nee greater than 2 shear) a, or $\phi V_n = \phi 2$. So,	num{ one- esign: ad not be $2.5V_{\mu}$. (doubled $5V_{\mu} = 2.0V_{\mu}$	s		eight, 4	18
With No Reinford Vn = Area of Bar Av = © = M _u /V _u d _v = Numbers of bar	ement Just CMU ur 109.1 0.0 0 0.8 0.08 0.08 0 3600	48 hits (Wall): $kips$ in^{2} ≤ 0.25	inches Shear S V _n = 2.5V _u (Net are	• minin Except V_n nee greater than 2 shear) a, or $\phi V_n = \phi 2$. So,	num{ one- esign: ad not be $2.5V_{u}$. (doubles $5V_{u} = 2.0V_{u}$ $\alpha =$	1.5 ce of bond be		eight, 4	8
With No Reinford Vn = Area of Bar Av = © = Mu/Vudv= Numbers of bars Net Area (Am) =	ement Just CMU ur 109.1 0.0 0 0.8 0.08 0.08 0 3600	48 hits (Wall): $kips$ in^{2} ≤ 0.25 in^{2}	inches Shear S $V_n = 2.5V_u$ (Net are $V_{nm} = [4]$	• minin • minin Except V_n nee greater than 2 shear) a, or $\phi V_n = \phi 2$. So, • a except ho • - 1.75 $\left(\frac{M_u}{V_u d_y}\right)$	num{ one- esign: ad not be $2.5V_u$. (doubled $5V_u = 2.0V_u$) $\alpha =$ b) $A_{nv}\sqrt{f_m'}$	1.5 ce of bond be		eight, 4	18
With No Reinford Vn = Area of Bar Av = © = M _u /V _u d _v = Numbers of bars Net Area (A _{nv}) = Masonry Shear: V _{nm} =	ement Just CMU ur 109.1 0.0 0 0.8 0.8 0.08 0 3600 929.5	48 hits (Wall): $kips$ in^{2} ≤ 0.25 in^{2}	inches Shear S $V_n = 2.5V_u$ (Net are $V_{nm} = [4]$	• minin Except V_n nee greater than 2 shear) a, or $\phi V_n = \phi 2$. So,	num{ one- esign: ad not be $2.5V_u$. (doubled $5V_u = 2.0V_u$) $\alpha =$ b) $A_{nv}\sqrt{f_m'}$	1.5 ce of bond be		eight, 4	18
With No Reinford Vn = Area of Bar Av = Ø = Mu/Vudv= Numbers of bars Net Area (Anv) = Masonry Shear: Vnm=	ement Just CMU ur 109.1 0.0 0 0.8 0.08 0.08 0 3600 929.5 Strength:	48 hits (Wall): $kips$ in^{2} ≤ 0.25 in^{2}	inches Shear S $V_n = 2.5V_u$ (Net are $V_{nm} = [4]$ $V_n = (1)$	• minin • minin Except V_n nee greater than 2 shear) v_n or $\phi V_n = \phi 2$. So, • a except ho • $-1.75 \left(\frac{M_u}{V_u d_y} + V_{ns}\right) \gamma_g$	num{ one- esign: ed not be $2.5V_u$. (double: $5V_u = 2.0V_u$ $\alpha =$ $\alpha =$ $\alpha =$	1.5 e of bond be		eight, 4	18
With No Reinford Vn = Area of Bar Av = ⊙ = Mu/Vudv= Numbers of bars Net Area (Anv) = Masonry Shear: Vnm= Required Steel S	ement Just CMU ur 109.1 0.0 0 0.8 0.08 0.08 0 3600 929.5 Strength:	48 hits (Wall): $kips$ in^{2} ≤ 0.25 in^{2} $kips$ $kips$	inches Shear S $V_n = 2.5V_u$ (Net are $V_{nm} = [4]$ $V_n = (1)$	• minin • minin Except V_n nee greater than 2 shear) a, or $\phi V_n = \phi 2$. So, • a except ho • - 1.75 $\left(\frac{M_u}{V_u d_y}\right)$	num{ one- esign: ed not be $2.5V_u$. (double: $5V_u = 2.0V_u$ $\alpha =$ $\alpha =$ $\alpha =$	1.5 e of bond be		eight, 4	18

Vertical Reinforc	ement :	#6 bars @	32	in	Spacing
	0.00180	>	0.0007		Okay
Horizontal reinfo	rcement:	Use Minimu	m	$\rho \ge 0.0007$ in	
		0.00070		$-\rho_{p} + \rho_{h} \ge 0.00$	2
		1.5372	in ²		
	Select,	#5 bars			
	Layers Required	5	Layers		
	Spacing Require	57.6	inches		
	USE	48	inches	spacing	
	So, Use	#5 bars @	48	in	
	Total reinforcem	ent check:			
	0.00250	>	0.002		Okay
				Ī	

Image E: Design of Reinforced Masonry Wall for in-plane loading

F. Excel Worksheet for Final Reinforcement for Partially Grouted Reinforced Masonry Wall

Vertical Reinforcement :		#9 bars @	32	in	Spacing
		Starts from 4 i	of the wall		
Horizontal Reinforcement		#5 bars @	48	in	Spacing
Horizonta					
			# 5 bars		
	Development length Past Opening		28	in	Dev. Length
Base Concrete in Foundation					
Earthquak					

Image F: Final Reinforcement for Partially grouted Reinforced Masonry Wall

G. Excel Worksheet for Cost Analysis

Cost Calc	ulation of Re	inforced Cor	ocrete Wall				
Concrete Cost:		\$113 and \$126 per cubic yard (27 cubic feet)					
Total Ar	op of Wall (۵)	10110	f + ²			
Total Area of Wall (Cost of Wall		A) Ś					
COSCOL	vvali	Ş	29955				
Extra Column Cost		\$	853				
Extra Beams Cost:		\$	9778				
	Total Cost:	\$	40586				
Cost Calc	ulation of Pa	rtially Grout	ed Reinforced	Masonry	Wall		
Take Average:		\$	2	per block	(In	Home Depo)	
Number of Blocks			11529				
Cost of Blocks		\$	23058				
Cost of Grout		\$	7751				
	Total Cost:	\$	30809				
Saving	\$	9777	(Exact figure)				
	Ś	10000	(Round Figure)				

Image G: Cost Analysis between construction with Reinforced Concrete and Reinforced Masonry

VITA

Anil Bhatt, born and raised in Nepal, came to the University of Mississippi to pursue a Bachelor of Science in Civil Engineering. He completed his high school at St. Xavier's College, Nepal. During his bachelor's study, he is involved in the Sally McDonnell Barksdale Honors College, Americal Society of Civil Engineers chapter at the University of Mississippi, and many other student organizations. He is involved in the summer and part-time internship with Precision Engineering Corporation (PEC) as a Construction Material Testing Technician since his junior year at the college. After graduating from the University of Mississippi, he is planning to work full time as a Structural Engineer.