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The 400: Bremerton, WA
November 21, 2005
AE 481W

# Structural Technical Report 3
## Structural Concepts / Structural Existing Conditions Report

The 400 is a condominium complex located in Bremerton, Washington, right across the bay from Seattle. The building consists of two levels of structural concrete, both slabs and post-tensioned, parking below four stories of residential light gage metal frame construction. The majority of the parking is above ground. Ground has recently been broken for construction of The 400, and updated plans are in the process of being developed.

As discussed throughout this technical assignment, the lateral system of The 400 proves to be adequate. Methods of analysis used to come to this conclusion were lateral load distribution, drift, overturning moment, and horizontal reinforcement.

The forces distributed to each shear wall were input into ETABS to determine both story and overall drifts. When compared to industry standards as well as allowable story drift height of 0.02h from the IBC, actual story drifts due to lateral loads only clearly passed. The gravity forces, however, were not taken into consideration for the analysis of drift. A combination of gravity and lateral loads will be developed in preparation for the proposal.

Relative stiffnesses were calculated for each wall, and since the concrete topping of each floor acts as a rigid diaphragm, the lateral loads of the controlling seismic case were distributed according to their stiffnesses to their corresponding shear walls.

The horizontal reinforcement of a shear wall was then checked to determine adequate reinforcement. There was a slight increase in design when compared to required reinforcement, which was most likely to increase ease of erection.

## Introduction:

The 400 is a condominium complex located in Bremerton, Washington, right across the bay from Seattle. The building consists of two levels of structural concrete, both slabs and post-tensioned, parking below four stories of residential light gage metal frame construction. The majority of the parking is above ground. Ground has recently been broken for construction of The 400, and updated plans are in the process of being developed.

The 400 is located within walking distance from the ferry boat which connects directly to downtown Seattle, and the condominium complex is going to be built right along the Port Washington Narrows. Maximum use of the site is being implemented for design, and careful design considerations needed to be taken into account because the building is so close to the water. Due to the heavy seismic activity possible in the geographic location of The 400, additional design requirements need to be considered.

Each story in The 400 is approximately 10 feet tall, comprising a total building height of about 60 feet. Due to the relatively small building height of The 400 when compared to commercial buildings, structural stud walls as well as concrete shear walls are used to transfer vertical loads to the concrete parking levels. The shear walls are also the sole lateral system of The 400 because the stud walls are considered relatively insignificant for carrying lateral loading.

## Existing Lateral System:

As previously stated in the first Technical Assignment, the existing lateral system consists of 13 shear walls located throughout the building footprint. A sketch of shear wall locations is shown in Figure 2 on page 5. As shown in the sketch, the building is symmetrical about the N-S axis. These shear walls are surrounding both the elevators and stairwells. Shear walls 5, 6, 9, 11, and 13 contain anywhere from one to 6 openings to accommodate either the elevators or stairwells. Additional horizontal reinforcement is located above the upper and below the lower opening to transfer the load around the opening. All shear walls are of constant thickness (12”), concrete strength (5000psi), and run the entire height of the building (61.75’).

The lateral loads are transferred from the façade to the shear walls by means of the rigid diaphragm created from the rigid concrete topping located throughout each floor. While the structural stud walls partially resist the lateral loads, when relative stiffness is considered, the structural stud walls are considered insignificant when compared to the shear walls.

Topics to be further considered in this Technical Assignment:

- Loads and Load Cases
- Distribution
- Analysis
- Member Checks
- Conclusions

**Loads and Load Cases:**

ACI 318-05 was used to determine controlling load cases. A summary of controlling load cases used for analysis is below:

- Gravity only: 1.2D + 1.6L
- Lateral only: 1.2D + 1.0E + 1.0L

As described earlier in Technical Assignment 1 and summarized on page in the table below of the Appendix, seismic forces control for the lateral analysis in both the N-S and E-W directions.

Summary of controlling lateral forces

| Level | Wind E-W (k) | Wind N-S (k) | Seismic (k) |
|---|---|---|---|
| Roof | 7.3 | 14.9 | ***497.4*** |
| 6 | 11.8 | 24.2 | ***554.6*** |
| 5 | 9.4 | 19.2 | ***445.4*** |
| 4 | 8.9 | 18.2 | ***335.2*** |
| 3 | 8.7 | 17.7 | ***223.4*** |
| 2 | 8.5 | 17.3 | ***224.0*** |

Figure 1

**Distribution:**

*Assumptions*

- Only in-plane stiffness considered for this technical assignment
- Solid shear walls are considered; door openings of certain shear walls near the stairwell are not taken into consideration for this analysis
- Shear wall and building layout considered when determining the center of mass
- 5% accidental torsion is considered on shear walls, but only if they increase the force on the shear walls

A sketch of the lateral force flow from the façade to the shear walls is shown in Figure 4.

Relative stiffnesses were calculated for each wall and the lateral loads were distributed according to those stiffnesses.  A summary of these forces is shown in Figure 3.  More detailed calculations of relative stiffnesses, and both the torsional and direct components of the lateral forces acting on each shear wall are located on page 23 of the Appendix.

Each shear wall is considered to act as a cantilevered beam attached to the foundation and extending a length of the full height of the building and loading equivalent to the controlling seismic forces.

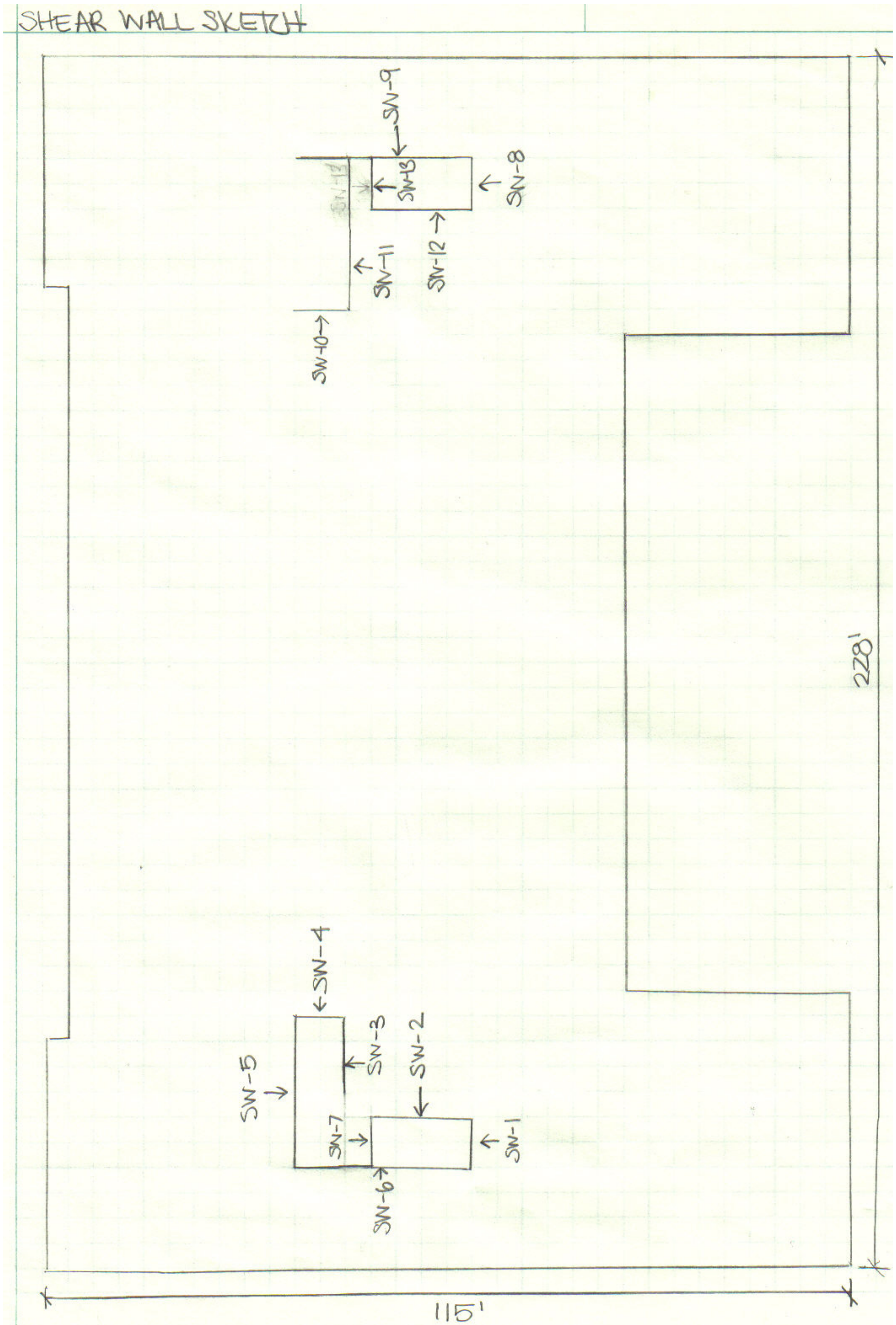

SHEAR WALL SKETCH
SW-1
SW-2
SW-3
SW-4
SW-5
SW-6
SW-7
SW-8
SW-9
SW-10
SW-11
SW-12
SW-13
228'
115'

Figure 2

**Analysis:**

The lateral forces seen by each shear wall are summarized in Figure 3. These values make sense because the largest walls are most stiff and, therefore, see the largest lateral loads. The loads on shear wall 6 are so large because of the torsion created on that particular wall. The wall is fairly symmetrical to shear wall 9, but the torsional component that was so large in that direction is negative on shear wall 9 and, therefore, not considered because it does not increase the load seen by that particular shear wall.

| SW | $F_i$ (kip) |
|---|---|
| 1 | 1.74 |
| 2 | 12.21 |
| 3 | 3.17 |
| 4 | 1.22 |
| 5 | 21.15 |
| 6 | 65.17 |
| 7 | 0.66 |
| 8 | 1.27 |
| 9 | 11.33 |
| 10 | 0.30 |
| 11 | 22.19 |
| 12 | 2.39 |
| 13 | 0.94 |

Figure 3

Next, based on the relative stiffnesses found, a center of rigidity was determined. Calculations supporting the center of rigidity calculation can be produced upon request. Besides the two levels of parking, each level has a relatively identical floorplan, so the center of rigidity (as well as the center of mass) is constant on each floor. The center of rigidity and the center of mass are then used to calculate the eccentricity. As stated earlier, a minimum of five percent eccentricity is considered. Torsional effects which decrease the load are not considered because they may not always be apparent.

*Load Path:*

The lateral forces hit the façade of the building and are transferred accordingly to the roof or a particular building level. The concrete topping is used as a rigid diaphragm to then transfer the lateral forces. These loads are then transferred to the corresponding shear walls. While the structural studs do contribute partially to absorbing part of the lateral loading, all of the shear walls are able to withstand complete lateral loading for the seismic controlling lateral case. A sketch of this load path is shown in Figure 4 and actual forces as they are applied to each shear wall are shown on Figure 5.

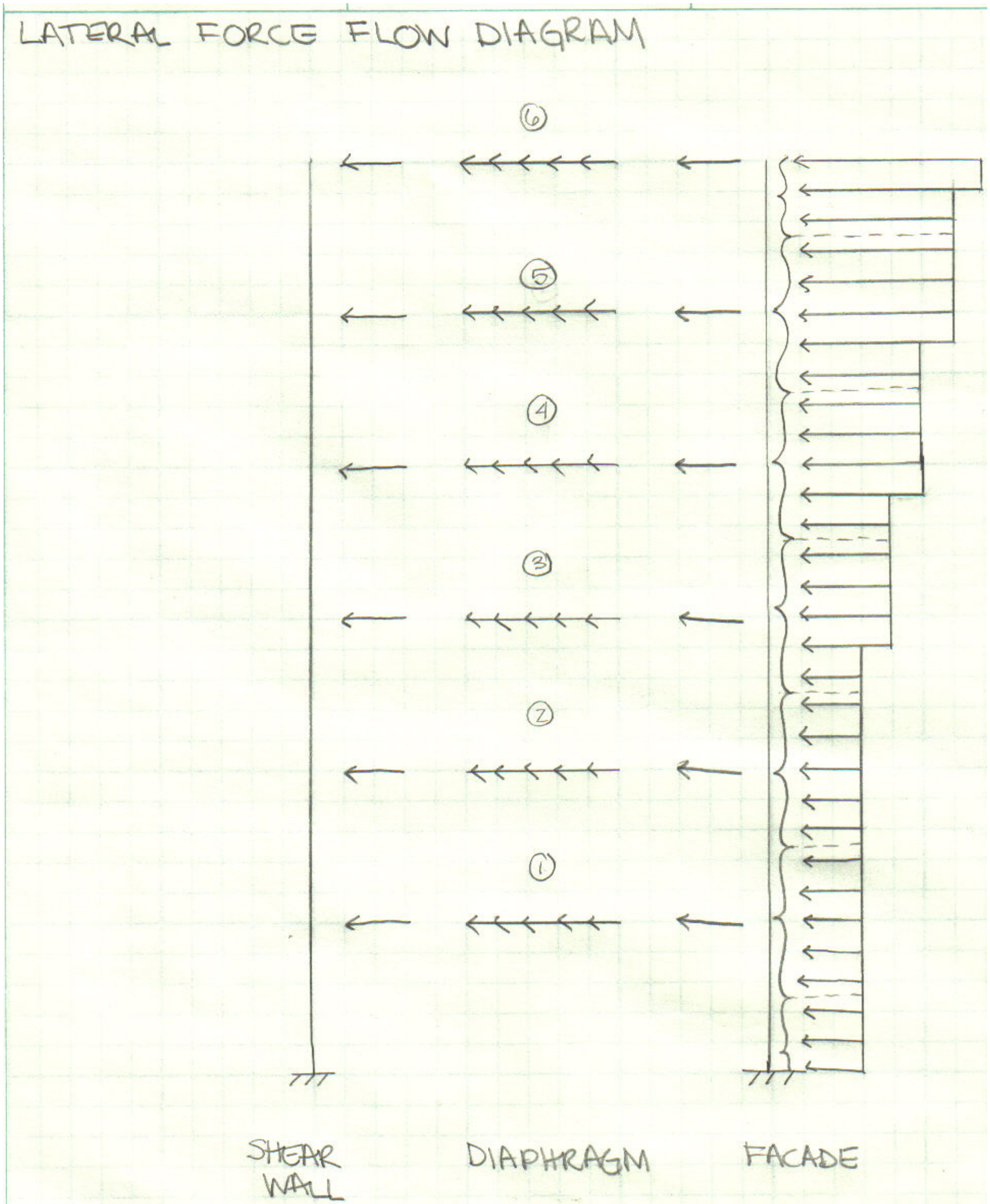



Figure 4

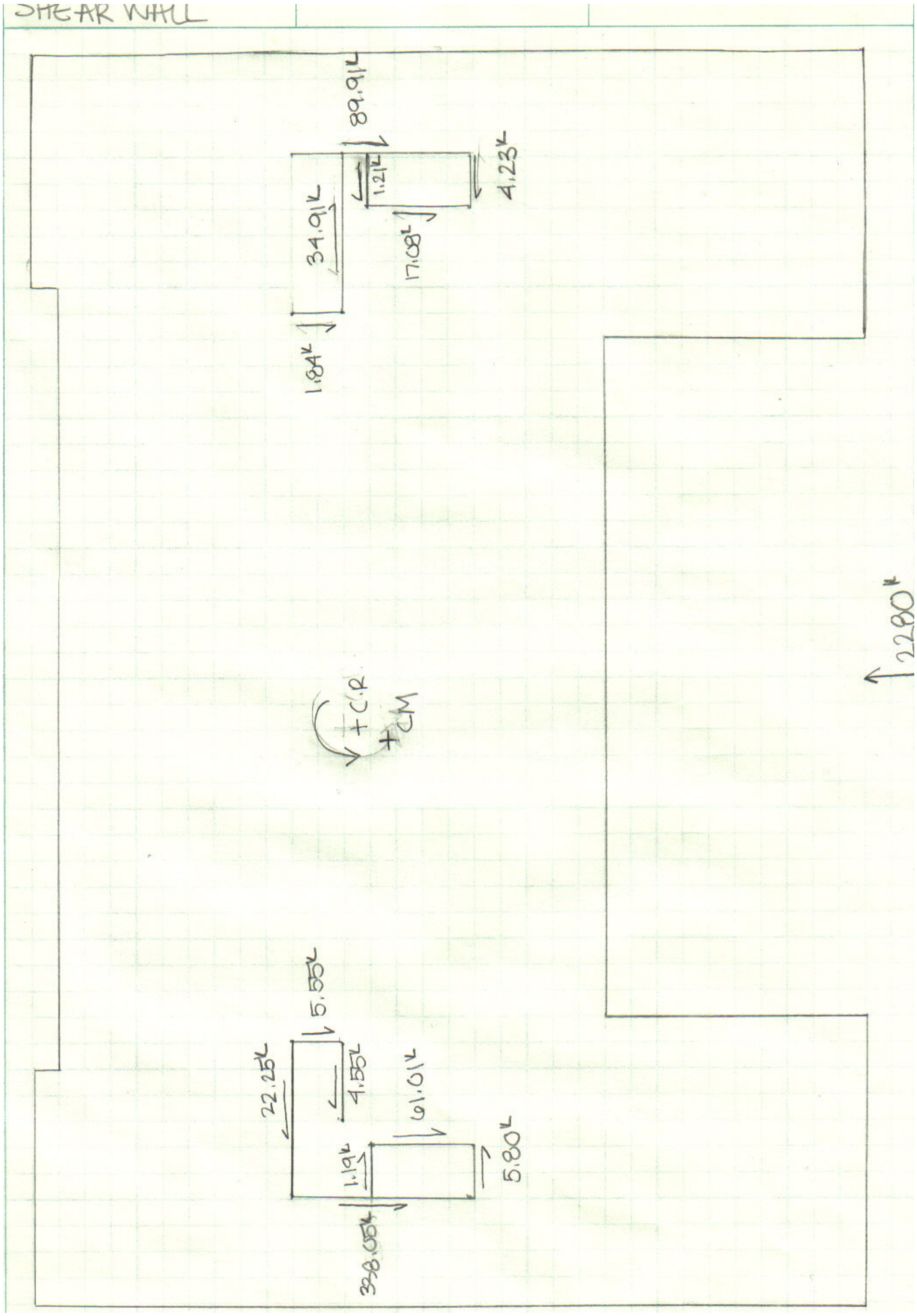

SHEAR WALL
89.91k
1.21k
4.23k
34.91k
17.08k
1.84k
C.R
CM
2280k
5.55k
22.25k
4.55k
61.01k
1.19k
5.80k
338.05k

Figure 5

*Drift:*

| *SW* | *d (ft)* | *I ($in^4$)* | *Defl. At 1 (in.)* | *Defl. At 2 (in.)* | *Defl. At 3 (in.)* | *Defl. At 4 (in.)* | *Defl. At 5 (in.)* | *Defl. At 6 (in.)* | *SUM OF DRIFT (in.)* |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 1728000 | 0.019 | 0.018 | 0.032 | 0.043 | 0.053 | 0.041 | ***0.206*** |
| 2 | 14.4 | 10077696 | 0.003 | 0.003 | 0.006 | 0.007 | 0.009 | 0.007 | ***0.035*** |
| 3 | 11.2 | 4741632 | 0.007 | 0.007 | 0.012 | 0.016 | 0.019 | 0.015 | ***0.075*** |
| 4 | 7.2 | 1259712 | 0.025 | 0.025 | 0.044 | 0.058 | 0.073 | 0.056 | ***0.283*** |
| 5 | 22.4 | 37933056 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | ***0.010*** |
| 6 | 25.6 | 56623104 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | ***0.007*** |
| 7 | 6.4 | 884736 | 0.036 | 0.036 | 0.063 | 0.083 | 0.104 | 0.080 | ***0.402*** |
| 8 | 7.2 | 1259712 | 0.025 | 0.025 | 0.044 | 0.058 | 0.073 | 0.056 | ***0.283*** |
| 9 | 25.6 | 56623104 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | ***0.007*** |
| 10 | 7.2 | 1259712 | 0.025 | 0.025 | 0.044 | 0.058 | 0.073 | 0.056 | ***0.283*** |
| 11 | 22.4 | 37933056 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | ***0.010*** |
| 12 | 14.4 | 10077696 | 0.003 | 0.003 | 0.006 | 0.007 | 0.009 | 0.007 | ***0.035*** |
| 13 | 7.2 | 1259712 | 0.025 | 0.025 | 0.044 | 0.058 | 0.073 | 0.056 | ***0.283*** |
| | | Allowable Drift | 2.4 | 4.8 | 7.32 | 9.84 | 12.36 | 14.76 | |
| | | L/400 | 0.3 | 0.3 | 0.315 | 0.315 | 0.315 | 0.3 | ***1.845*** |

E = 4030509 psi

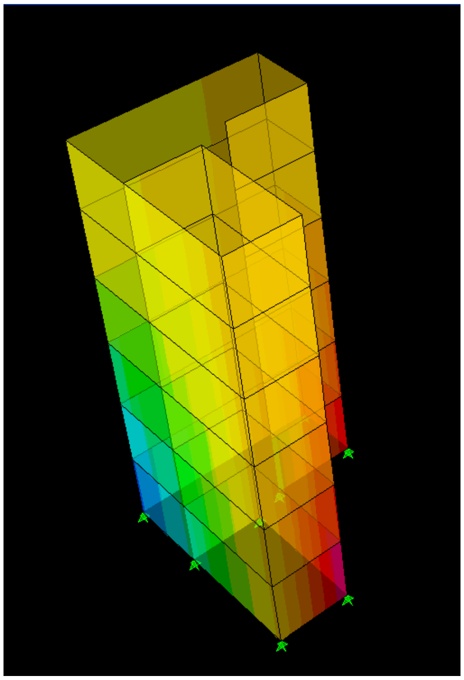
Figure 6

None of the sum of drifts or deflections at any particular floor exceed either the allowable drift per story ($0.02h_{sx}$) or the L/400 allowable drift. These calculations show that as far as drift is concerned, the lateral system is adequate.

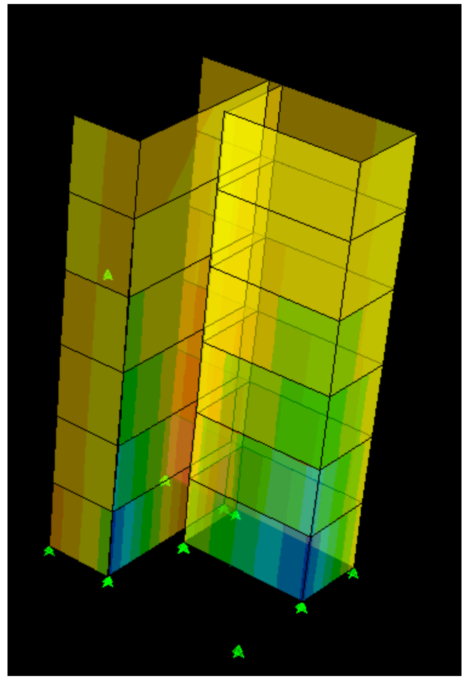
The calculations of story drift were determined based on the PCI Handbook, and separate equations are used for calculation depending on the type of wall. For tall walls (for which H/L > 3), flexural governs, and for short walls (for which H/L < 0.3), shear governs. For any walls in between tall and short, they see a combination of both flexural and shear.

A limit of H/400 is generally used by the industry to limit story drifts and was thus compared to make sure the allowed value was not exceeded by the actual drift. As noted in the previous Figure, Figure 6, the allowable overall building drift is 1.845 in. This is a relatively small allowable deflection, as is expected with such a relatively small building.

Analysis using ETABS was conducted to determine actual story drifts. These values are summarized in Figure 6. A summary of the shear walls follow in Figures 7 and 8.



Left Shear Wall Core
Figure 7



Right Shear Wall Core
Figure 8

NOTE: Red indicates failing members. These members are located at the core of the shear walls. ETABS does not allow for you to include any vertical or horizontal reinforcement, and the failure of the shear walls is most likely due to insignificant reinforcement. Because the shear loads accumulate vertically, they will be the largest at the base of the shear wall, which explains why the failing part of the wall would be at the bottom.

**<u>Member Checks:</u>**

*Shear Walls:*

Shear Wall 3 was spot checked in accordance with ACI 11.10. Calculations may be referred to on page 29 of the Appendix. Below, in Figure 9, the relevant forces and moments on each shear wall are summarized. As concluded from the calculations, the reinforcement in shear wall 3 (#6 at 12 inches on center) was determined to be adequate. In fact, #5 at 12 inches on center proves to be adequate for horizontal reinforcement. This additional reinforcement is most likely to allow for easier erection. If #5 and #6 are used throughout shear wall design, they are more likely to get "mixed up" during erection.

Shear wall 3 was chosen as a good representation because it does not contain any additional openings which would alter horizontal and vertical reinforcement.

| SW | Nu (lb) | Mu (in-lb) | Vu (lb) | L (ft) |
|---|---|---|---|---|
| 1 | 38801400 | 3320637.19 | 1739.27 | 10 |
| 2 | 27937008 | 17533478.63 | 12213.89 | 18 |
| 3 | 81482940 | 5502860.01 | 3169.92 | 14 |
| 4 | 45397638 | 2288698.28 | 1217.51 | 9 |
| 5 | 76050744 | 28303774.65 | 21145.14 | 28 |
| 6 | 99331584 | 76759141.77 | 65167.12 | 32 |
| 7 | 46561680 | 1367754.55 | 663.67 | 8 |
| 8 | 1.01E+08 | 2475559.53 | 1267.93 | 9 |
| 9 | 99331584 | 14972783.37 | 11329.98 | 32 |
| 10 | 48889764 | 672280.74 | 299.11 | 9 |
| 11 | 86915136 | 29313962.72 | 22188.61 | 28 |
| 12 | 97779528 | 3985389.52 | 2392.86 | 18 |
| 13 | 41905512 | 1902036.39 | 944.95 | 9 |

Figure 9

*Overturning Moment/Foundation:*

The gravity loads transferred through the building to the foundation are much higher when compared to the overturning moment. This shows that overturning moment is not an issue that needs to be considered for The 400. More detailed calculations can be found on page 28 of the Appendix. For the analysis, only dead loads were used, as live loads cannot count on being apparent when the overturning moment reaches full capacity.

## Conclusion:

As discussed throughout this technical assignment, the lateral system of The 400 proves to be adequate. Methods of analysis used to come to this conclusion were lateral load distribution, drift, overturning moment, and horizontal reinforcement.

The forces distributed to each shear wall were input into ETABS to determine both story and overall drifts. When compared to industry standards as well as allowable story drift height of 0.02h from the IBC, actual story drifts due to ***lateral loads only*** clearly passed. The gravity forces, however, were not taken into consideration for the analysis of drift. A combination of gravity and lateral loads will be developed in preparation for the proposal as the next part of thesis assignment.

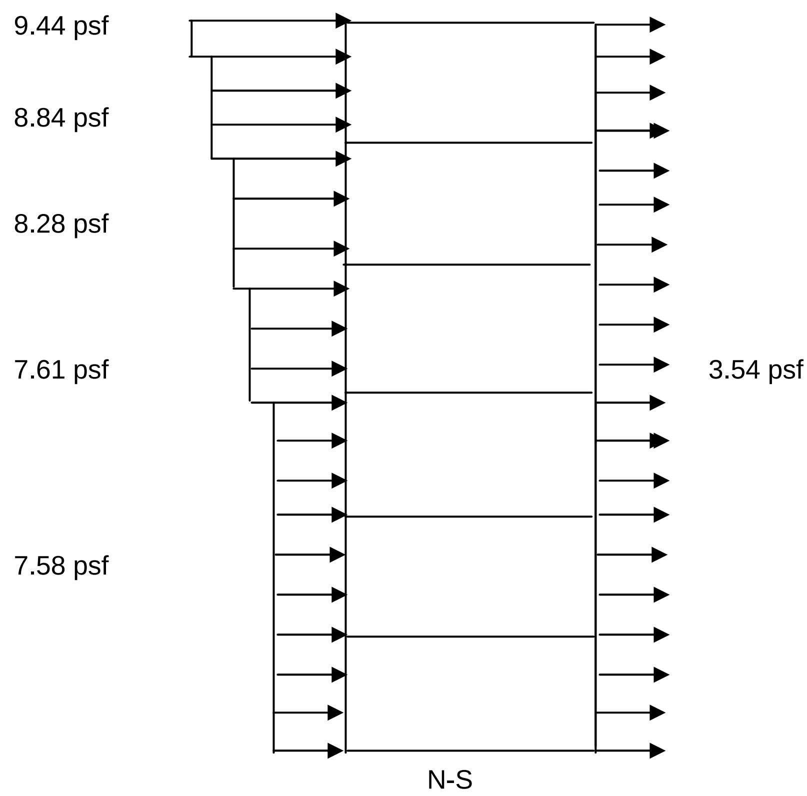
Relative stiffnesses were calculated for each wall, and since the concrete topping of each floor acts as a rigid diaphragm, the lateral loads of the controlling seismic case were distributed according to their stiffnesses to their corresponding shear walls.

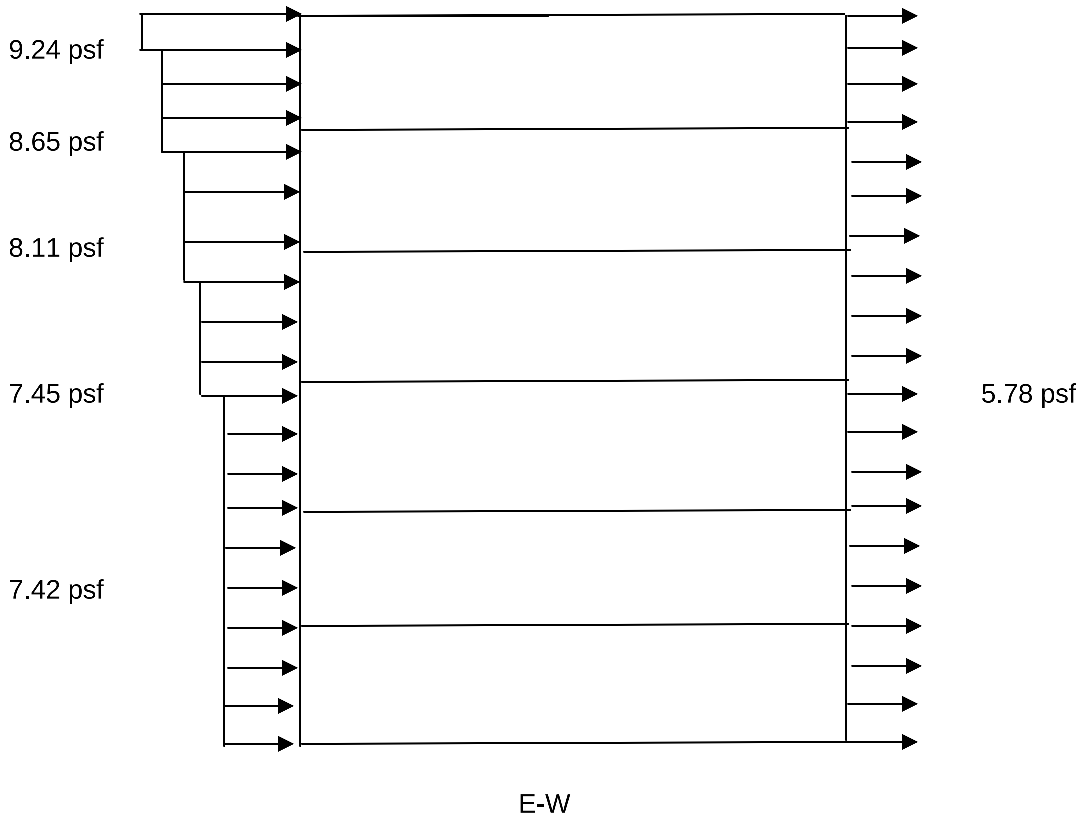
The horizontal reinforcement of a shear wall was then checked to determine adequate reinforcement. There was a slight increase in design when compared to required reinforcement, which was most likely to increase ease of erection. As fully displayed in this Technical Assignment, The 400 adequately meets lateral design analysis.

# APPENDIX

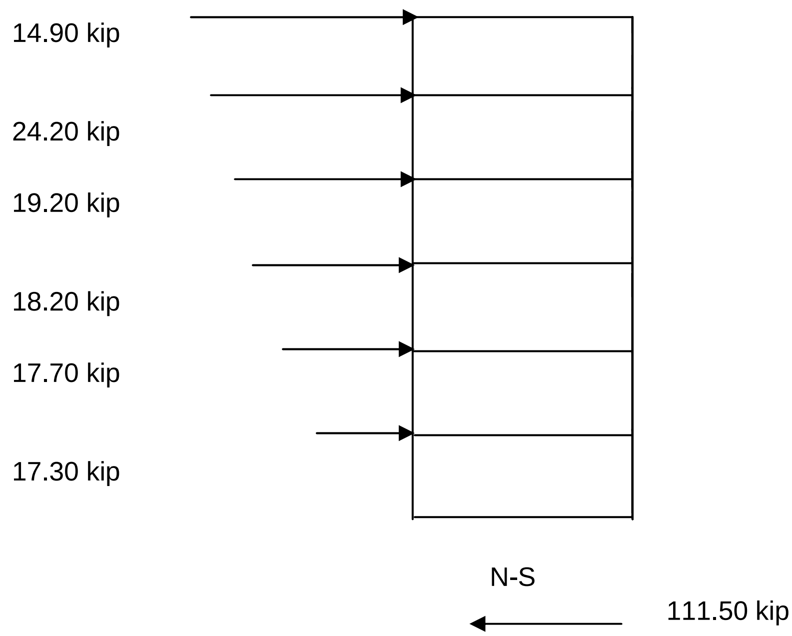
## Wind Analysis:

| z(ft) | $K_z$ (Table 6-3) | qz (lb/ft2) | qh (lb/ft2) | qzCpG (lb/ft2) Windward | qhCpG (lb/ft2) Leeward | qzCpG - qhCpG (lb/ft2) Total | qzCpG (lb/ft2) Windward | qhCpG (lb/ft2) Leeward | qzCpG - qhCpG (lb/ft2) Total |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.7 | 11.01 | 13.71 | 7.58 | (3.54) | 11.12 | 7.42 | (5.78) | 13.20 |
| 15 | 0.7 | 11.01 | 13.71 | 7.58 | (3.54) | 11.12 | 7.42 | (5.78) | 13.20 |
| 20 | 0.7 | 11.01 | 13.71 | 7.58 | (3.54) | 11.12 | 7.42 | (5.78) | 13.20 |
| 25 | 0.7 | 11.01 | 13.71 | 7.58 | (3.54) | 11.12 | 7.42 | (5.78) | 13.20 |
| 30 | 0.7 | 11.01 | 13.71 | 7.58 | (3.54) | 11.12 | 7.42 | (5.78) | 13.20 |
| 40 | 0.76 | 11.95 | 13.71 | 8.23 | (3.54) | 11.77 | 8.06 | (5.78) | 13.83 |
| 50 | 0.81 | 12.73 | 13.71 | 8.77 | (3.54) | 12.31 | 8.59 | (5.78) | 14.36 |
| 60 | 0.85 | 13.36 | 13.71 | 9.20 | (3.54) | 12.74 | 9.01 | (5.78) | 14.79 |
| 70 | 0.89 | 13.99 | 13.71 | 9.64 | (3.54) | 13.18 | 9.43 | (5.78) | 15.21 |
| | | | | | N-S | | | E-W | |

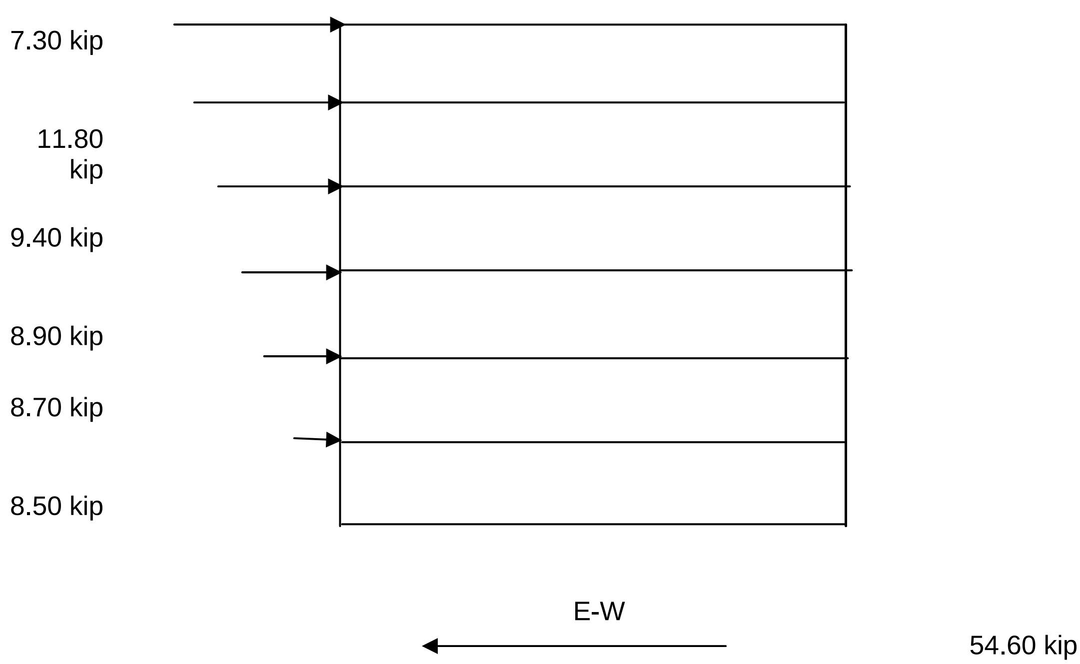



9.24 psf
8.65 psf
8.11 psf
7.45 psf
7.42 psf
5.78 psf
E-W

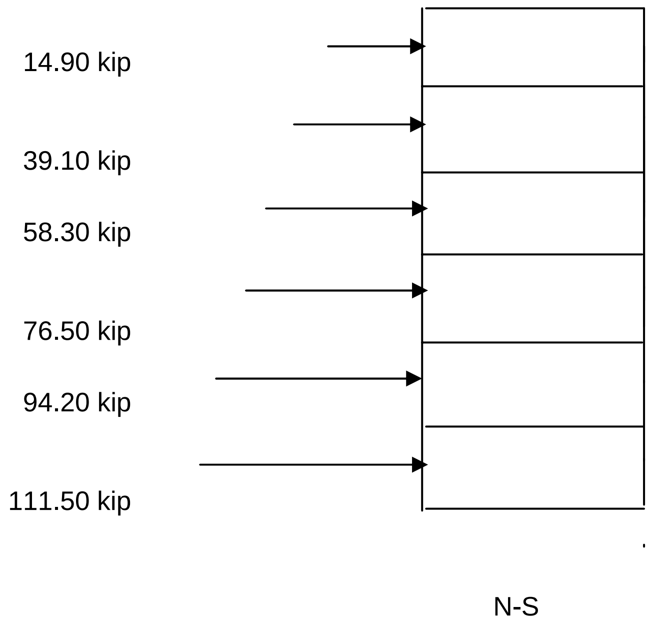
**Wind Diagrams (Story Force $F_x$)**



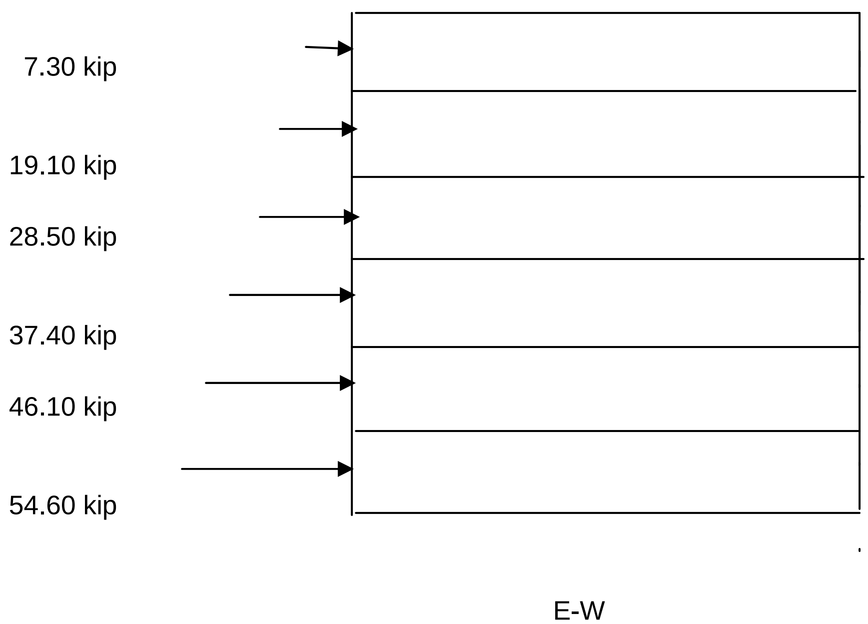

**Wind Diagrams (Story Force $F_x$ Continued)**



**Wind Diagrams (Story Shear $V_x$)**




**Wind Diagrams (Shear $V_x$ Continued)**



## Seismic Design:

| ASCE Reference | Design Parameters | | | |
|---|---|---|---|---|
| | Location | Bremerton, WA | | |
| | Number of stories | N | 6 | |
| | Story Height | $h_s$ | 10.5 | ft |
| | Mean building height | $h_n$ | 58.5 | ft |
| | Building Width | W | 115 | ft |
| | Building Length | L | 228 | ft |
| | Approximate Floor Area | A | 26220 | $ft^2$ |
| Table 9.1.3 | Seismic Use Group | I | I | |
| | Occupancy Importance Factor | | 1 | |
| Table 9.4.1.2.1 | Site Classification | | C | |
| Figure 9.4.1.1a | 0.2 Acceleration | $s_s$ | 1.480 | g-s |
| Figure 9.4.1.1b | 1 s Acceleration | $s_1$ | 0.500 | g-s |
| Table 9.4.1.2.4a | Site Class Factor | $F_a$ | 1.000 | |
| Table 9.4.1.2.4b | Site Class Factor | $F_v$ | 1.300 | |
| | Adjusted Accelerations | $s_{MS}$ | 1.480 | g-s |
| | | $s_{M1}$ | 0.650 | g-s |
| | Design Spectral Response Accelerations | $s_{DS}$ | 0.987 | g-s |
| | | $s_{D1}$ | 0.433 | g-s |
| Table 9.4.2.1a/b | Seismic Design Category | | D | |
| | **Equivalent Lateral Load Method can be used** | | | |

| 9.5.3.2 | Seismic Base Shear Coefficient | | |
|---|---|---|---|
| | N-S Direction | | |
| Table 9.5.2.2 | Response Modification Factor | $R_{N-S}$ | 5 |
| Equation 9.5.3.2.1-1 | Seismic Response Coefficient | $C_{s, N-S}$ | 0.197 |
| Table 9.5.5.3.2 | | $C_{T, N-S}$ | 0.020 |
| Table 9.5.5.3.2 | | x | 0.750 |
| | Period of Structure | $T_{N-S}$ | 0.423 |
| Equation 9.5.3.2.1-2 | | $C_{S\ max\ N-S}$ | 0.205 |
| Equation 9.5.3.2.1-3 | | $C_{S\ min}$ | 0.043 |
| | | $C_{s, N-S}$ | 0.197 |
| | E-W Direction | | |
| Table 9.5.2.2 | Response Modification Factor | $R_{E-W}$ | 5 |
| Equation 9.5.3.2.1-1 | Seismic Response Coefficient | $C_{s, E-W}$ | 0.197 |
| Table 9.5.5.3.2 | | $C_{T, E-W}$ | 0.020 |
| Table 9.5.5.3.2 | | x | 0.750 |
| | Period of Structure | $T_{E-W}$ | 0.423 |
| Equation 9.5.3.2.1-2 | | $C_{S\ max\ E-W}$ | 0.205 |
| Equation 9.5.3.2.1-3 | | $C_{S\ min}$ | 0.043 |
| | | $C_{s, E-W}$ | 0.197 |

**Loading**

| | | | |
|---|---|---|---|
| Roof | | | |
| Dead | | | |
| | Trusses | 20 | psf |
| | Ceiling | 5 | psf |
| | MEP | 20 | psf |
| Total | | 45 | psf |

| | | | |
|---|---|---|---|
| Parking | | | |
| Dead | | | |
| Slab | | 100 | psf |
| MEP | | 15 | psf |
| Total | | 115 | psf |

| | | | |
|---|---|---|---|
| Residential | | | |
| Dead | | | |
| | Metal roof deck | 2 | psf |
| | Concrete | 30 | psf |
| | Ceiling | 5 | psf |
| | MEP | 15 | psf |
| Total | | 52 | psf |

| | | | |
|---|---|---|---|
| | Live | | |
| 9.5.3.2 | Moveable Partition | 10 | psf |

| | | |
|---|---|---|
| Perimeter Wall | | |
| Dead | 15 | psf |

| | | |
|---|---|---|
| Snow Load | 25 | psf |

**Do not include because does not exceed 30 psf**

| | | |
|---|---|---|
| $w_{roof} = A \times (q_{roof}) + 2(W+L) \times .5 \times h_s \times q_{wall}$ | 1233.92 | kips |
| $w_{per\ residential\ floor} = A \times (q_{floorf}) + 2(W+L) \times h_s \times q_{wall}$ | 1733.69 | kips |
| $w_{per\ parking\ floor} = A \times (q_{floorf}) + 2(W+L) \times h_s \times q_{wall}$ | 3385.55 | kips |
| $w_{all\ floors} = (1) \times w_{per\ parking\ floor} + (4) \times w_{per\ residential\ floor}$ | 10320.29 | kips |
| Total Building Weight, W | 11554.21 | kips |
| Seismic Base Shear, $V_{N\text{-}S} = C_{s,\ N\text{-}S}W$ | 2280.03 | kips |
| Seismic Base Shear, $V_{E\text{-}W} = C_{s,\ E\text{-}W}W$ | 2280.03 | kips |

**Vertical Distribution**

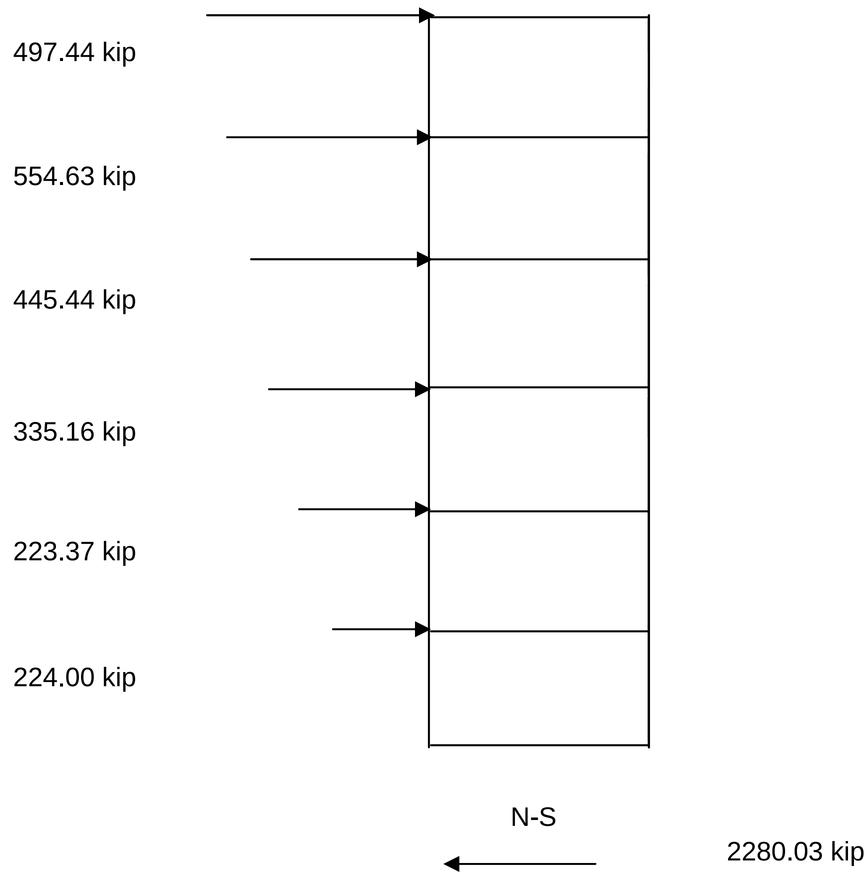
**N-S:** $k_{N-S} = 1 + (T_{N-S} - 0.5) / (2.5 - 0.5)$ 0.96

| Level | $w_x$ (kips) | $h_x$ (ft) | $w_x h_x^k$ (ft-kips) | $C_{vx}$ | $F_x$ (kips) | $V_x$ (kips) | $M_x$ (ft-kips) |
|---|---|---|---|---|---|---|---|
| Roof | 1233.9 | 65.5 | 68810.4 | 0.2 | 497.4 | | 32582.0 |
| 6 | 1733.7 | 51.5 | 76722.0 | 0.2 | 554.6 | 497.4 | 28563.4 |
| 5 | 1733.7 | 41.0 | 61617.8 | 0.2 | 445.4 | 1052.1 | 18263.0 |
| 4 | 1733.7 | 30.5 | 46362.3 | 0.1 | 335.2 | 1497.5 | 10222.3 |
| 3 | 1733.7 | 20.0 | 30899.1 | 0.1 | 223.4 | 1832.7 | 4467.4 |
| 2 | 3385.5 | 10.0 | 30985.3 | 0.1 | 224.0 | 2056.0 | 2240.0 |
| 1 | | | | | | 2280.0 | |
| Sum: | 11554.2 | | 315397.0 | 1.0 | 2280.0 | | 96338.2 |

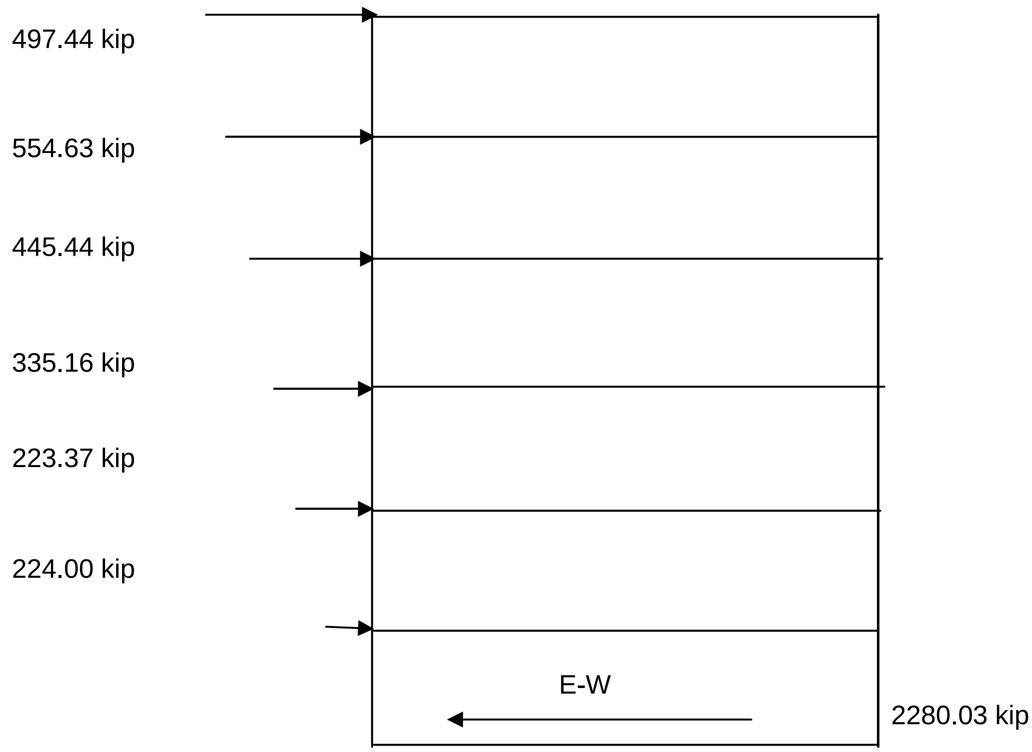
**E-W** $K_{E-W} = 1 + (T_{E-W} - 0.5) / (2.5 - 0.5)$ 0.96

| Level | $w_x$ (kips) | $h_x$ (ft) | $w_x h_x^k$ (ft-kips) | $C_{vx}$ | $F_x$ (kips) | $V_x$ (kips) | $M_x$ (ft-kips) |
|---|---|---|---|---|---|---|---|
| Roof | 1233.9 | 65.5 | 68810.4 | 0.2 | 497.4 | | 32582.0 |
| 6 | 1733.7 | 51.5 | 76722.0 | 0.2 | 554.6 | 497.4 | 28563.4 |
| 5 | 1733.7 | 41.0 | 61617.8 | 0.2 | 445.4 | 1052.1 | 18263.0 |
| 4 | 1733.7 | 30.5 | 46362.3 | 0.1 | 335.2 | 1497.5 | 10222.3 |
| 3 | 1733.7 | 20.0 | 30899.1 | 0.1 | 223.4 | 1832.7 | 4467.4 |
| 2 | 3385.5 | 10.0 | 30985.3 | 0.1 | 224.0 | 2056.0 | 2240.0 |
| 1 | | | | | | 2280.0 | |
| Sum: | 11554.2 | | 315397.0 | 1.0 | 2280.0 | | 96338.2 |

**Seismic Diagrams (Story Force $F_x$)**



**Seismic Diagrams (Story Force $F_x$ Continued)**




Summary of controlling lateral forces

| Level | Wind E-W (k) | Wind N-S (k) | Seismic (k) |
|---|---|---|---|
| Roof | 7.3 | 14.9 | ***497.4*** |
| 6 | 11.8 | 24.2 | ***554.6*** |
| 5 | 9.4 | 19.2 | ***445.4*** |
| 4 | 8.9 | 18.2 | ***335.2*** |
| 3 | 8.7 | 17.7 | ***223.4*** |
| 2 | 8.5 | 17.3 | ***224.0*** |

## Lateral Load Distribution:

Lateral Load Distribution Procedure For Seismic (Controlling Case):

| SW | L (ft) | h/L | T/S/O (*) | k / (Et/h) | $x_i$ (ft) | $y_i$ (ft) | $k_ix_i$ | $k_iy_i$ | $k_i$ for x | $k_i$ for y | $d_i$ | $k_id_i^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | 6.18 | T | 0.066 | | 40 | | 2.62 | | 0.07 | -26.37 | 45.60 |
| 2 | 18 | 3.43 | T | 0.382 | 50 | | 19.12 | | 0.38 | | -64.98 | 1614.45 |
| 3 | 14 | 4.41 | T | 0.180 | | 64 | | 11.51 | | 0.18 | -2.37 | 1.01 |
| 4 | 9 | 6.86 | T | 0.048 | 66 | | 3.15 | | 0.05 | | -48.98 | 114.66 |
| 5 | 28 | 2.21 | O | 1.259 | | 72 | | 90.67 | | 1.26 | 5.63 | 39.87 |
| 6 | 32 | 1.93 | O | 1.810 | 40 | | 72.42 | | 1.81 | | -74.98 | 10178.21 |
| 7 | 8 | 7.72 | T | 0.034 | | 58 | | 1.95 | | 0.03 | -8.37 | 2.35 |
| 8 | 9 | 6.86 | T | 0.048 | | 40 | | 1.91 | | 0.05 | -26.37 | 33.24 |
| 9 | 32 | 1.93 | O | 1.810 | 190 | | 343.99 | | 1.81 | | 75.02 | 10189.80 |
| 10 | 9 | 6.86 | T | 0.048 | 162 | | 7.74 | | 0.05 | | 47.02 | 105.68 |
| 11 | 28 | 2.21 | O | 1.259 | | 64 | | 80.60 | | 1.26 | -2.37 | 7.09 |
| 12 | 18 | 3.43 | T | 0.382 | 180 | | 68.83 | | 0.38 | | 65.02 | 1616.57 |
| 13 | 9 | 6.86 | T | 0.048 | | 58 | | 2.77 | | 0.05 | -8.37 | 3.35 |
| | | | | | | | 515.26 | 192.03 | 4.48 | 2.89 | | 23951.90 |

| | E-W | N-S | E-W | N-S | E-W | N-S | |
|---|---|---|---|---|---|---|---|
| SW | $F_{iDirect, x}$ | $F_{iDirect, y}$ | $F_{iTorsion, x}$ | $F_{iTorsion, y}$ | $F_{i, x}$ | $F_{i, y}$ | **$F_i$ (kip)** |
| 1 | 0.78 | 0.78 | 0.69 | 0.16 | 1.46 | 0.94 | **1.74** |
| 2 | 1.69 | 1.69 | 9.85 | 2.31 | 11.54 | 4.01 | **12.21** |
| 3 | 2.14 | 2.14 | 0.17 | 0.04 | 2.31 | 2.18 | **3.17** |
| 4 | 0.21 | 0.21 | 0.93 | 0.22 | 1.14 | 0.43 | **1.22** |
| 5 | 14.95 | 14.95 | -2.81 | -0.66 | 14.95 | 14.95 | **21.15** |
| 6 | 8.01 | 8.01 | 53.79 | 12.65 | 61.81 | 20.66 | **65.17** |
| 7 | 0.40 | 0.40 | 0.11 | 0.03 | 0.51 | 0.42 | **0.66** |
| 8 | 0.57 | 0.57 | 0.50 | 0.12 | 1.07 | 0.68 | **1.27** |
| 9 | 8.01 | 8.01 | -53.83 | -12.65 | 8.01 | 8.01 | **11.33** |
| 10 | 0.21 | 0.21 | -0.89 | -0.21 | 0.21 | 0.21 | **0.30** |
| 11 | 14.95 | 14.95 | 1.18 | 0.28 | 16.14 | 15.23 | **22.19** |
| 12 | 1.69 | 1.69 | -9.85 | -2.32 | 1.69 | 1.69 | **2.39** |
| 13 | 0.57 | 0.57 | 0.16 | 0.04 | 0.73 | 0.60 | **0.94** |

height of wall: 61.75 ft

(*) Tall wall (T) with h/L > 3 / Short wall (S) with h/L < 0.3 / Other (O) with 0.3 < h/L < 3

For Tall Walls, $k = L^3/(4h^2) \times (Et/h)$

For Short Walls, $k = L/2.78 \times (Et/h)$

For Other Walls, $k = 1/( (4h^2/L^3) + (2.78/L) ) \times (Et/h)$

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| x-CM | 114.00 ft | x-CR | 114.98 ft | Px | 2280.03 kip | $e_x$ | -0.98 ft | $M_{tE-W}$ | -9491.73 ft-kip |
| y-CM | 62.21 ft | y-CR | 66.37 ft | Py | 2280.03 kip | $e_y$ | -4.16 ft | $M_{tN-S}$ | -2231.39 ft-kip |

**Drift:**

The following is a summary of each floorplan node from the shear wall diagram and their corresponding displacements and drifts, all in inches. The nodes are specified on the shear wall diagram in on page 30 of the Appendix.

| NODE | X-DISPL | Y-DISPL | TOTAL DISPL | X-DRIFT | Y-DRIFT | TOTAL DRIFT |
|---|---|---|---|---|---|---|
| 34 | 0.017933 | -0.005785 | 0.018843002 | 0.000047 | 0.000016 | 4.96488E-05 |
| | 0.012265 | -0.003861 | 0.012858365 | 0.000036 | 0.000011 | 3.76431E-05 |
| | 0.00774 | -0.002437 | 0.00811459 | 0.000028 | 0.000009 | 2.94109E-05 |
| | 0.004261 | -0.001306 | 0.004456653 | 0.000019 | 0.000006 | 1.99249E-05 |
| | 0.001831 | -0.000563 | 0.001915602 | 0.000011 | 0.000004 | 1.17047E-05 |
| | 0.000466 | -0.000143 | 0.000487447 | 0.000004 | 0.000001 | 4.12311E-06 |
| | | | ***0.046675659*** | | | ***0.000152455*** |
| 35 | 0.017933 | -0.00455 | 0.018501216 | 0.000047 | 0.000012 | 4.85077E-05 |
| | 0.012265 | -0.003067 | 0.012642655 | 0.000036 | 0.000009 | 3.7108E-05 |
| | 0.00774 | -0.001934 | 0.007977967 | 0.000028 | 0.000007 | 2.88617E-05 |
| | 0.004261 | -0.001029 | 0.004383487 | 0.000019 | 0.000005 | 1.96469E-05 |
| | 0.001831 | -0.000444 | 0.001884064 | 0.000011 | 0.000003 | 1.14018E-05 |
| | 0.000466 | -0.000112 | 0.00047927 | 0.000004 | 0.000001 | 4.12311E-06 |
| | | | ***0.045868659*** | | | ***0.000149649*** |
| 41 | 0.015487 | -0.003998 | 0.015994723 | 0.00004 | 0.000011 | 4.14849E-05 |
| | 0.010692 | -0.002713 | 0.011030831 | 0.000031 | 0.000008 | 3.20156E-05 |
| | 0.006743 | -0.001709 | 0.006956201 | 0.000024 | 0.000006 | 2.47386E-05 |
| | 0.003712 | -0.000906 | 0.003820966 | 0.000017 | 0.000004 | 1.74642E-05 |
| | 0.001595 | -0.000391 | 0.001642226 | 0.00001 | 0.000002 | 1.0198E-05 |
| | 0.000405 | -0.000099 | 0.000416924 | 0.000003 | 0.000001 | 3.16228E-06 |
| | | | ***0.039861871*** | | | ***0.000129064*** |
| 42 | 0.015487 | -0.0026 | 0.015703731 | 0.00004 | 0.000007 | 4.06079E-05 |
| | 0.010692 | -0.001814 | 0.01084479 | 0.000031 | 0.000005 | 3.14006E-05 |
| | 0.006743 | -0.00114 | 0.006838688 | 0.000024 | 0.000004 | 2.43311E-05 |
| | 0.003712 | -0.000592 | 0.00375891 | 0.000017 | 0.000003 | 1.72627E-05 |
| | 0.001595 | -0.000256 | 0.001615414 | 0.00001 | 0.000002 | 1.0198E-05 |
| | 0.000405 | -0.000064 | 0.000410026 | 0.000003 | 0.000001 | 3.16228E-06 |
| | | | ***0.039171558*** | | | ***0.000126963*** |
| 43 | 0.014321 | -0.0026 | 0.014555104 | 0.000036 | 0.000007 | 3.66742E-05 |
| | 0.009944 | -0.001814 | 0.010108102 | 0.000029 | 0.000005 | 2.94279E-05 |
| | 0.006268 | -0.00114 | 0.006370826 | 0.000022 | 0.000004 | 2.23607E-05 |
| | 0.003451 | -0.000592 | 0.003501409 | 0.000016 | 0.000003 | 1.62788E-05 |
| | 0.001483 | -0.000256 | 0.001504934 | 0.000009 | 0.000002 | 9.21954E-06 |
| | 0.000377 | -0.000064 | 0.000382394 | 0.000003 | 0.000001 | 3.16228E-06 |
| | | | ***0.036422768*** | | | ***0.000117123*** |
| 45 | 0.001572 | -0.005785 | 0.005994782 | 0.000041 | 0.000016 | 4.40114E-05 |
| | 0.010842 | -0.003861 | 0.011508965 | 0.000032 | 0.000011 | 3.38378E-05 |
| | 0.006838 | -0.002437 | 0.007259285 | 0.000024 | 0.000009 | 2.5632E-05 |
| | 0.003764 | -0.001306 | 0.003984135 | 0.000017 | 0.000006 | 1.80278E-05 |
| | 0.001618 | -0.000563 | 0.001713153 | 0.00001 | 0.000004 | 1.07703E-05 |
| | 0.000411 | -0.000143 | 0.000435167 | 0.000003 | 0.000001 | 3.16228E-06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | ***0.030895486*** | | | ***0.000135442*** |
| 46 | 0.01572 | -0.00455 | 0.016365234 | 0.000041 | 0.000012 | 4.272E-05 |
| | 0.010842 | -0.003067 | 0.011267451 | 0.000032 | 0.000009 | 3.32415E-05 |
| | 0.006838 | -0.001934 | 0.007106237 | 0.000024 | 0.000007 | 0.000025 |
| | 0.003764 | -0.001029 | 0.00390212 | 0.000017 | 0.000005 | 1.772E-05 |
| | 0.001618 | -0.000444 | 0.001677814 | 0.00001 | 0.000003 | 1.04403E-05 |
| | 0.000411 | -0.000112 | 0.000425987 | 0.000003 | 0.000001 | 3.16228E-06 |
| | | | ***0.040744843*** | | | ***0.000132284*** |
| 48 | 0.017933 | 0.0011477 | 0.017969688 | 0.000047 | 0.000035 | 5.86003E-05 |
| | 0.012265 | 0.007234 | 0.014239416 | 0.000036 | 0.000021 | 4.16773E-05 |
| | 0.00774 | 0.004597 | 0.009002222 | 0.000028 | 0.000016 | 3.2249E-05 |
| | 0.004261 | 0.002563 | 0.004972433 | 0.000019 | 0.000012 | 2.24722E-05 |
| | 0.001831 | 0.001104 | 0.002138078 | 0.000011 | 0.000007 | 1.30384E-05 |
| | 0.000466 | 0.000282 | 0.000544683 | 0.000004 | 0.000002 | 4.47214E-06 |
| | | | ***0.048866522*** | | | ***0.000172509*** |
| 49 | 0.014321 | 0.011477 | 0.018352454 | 0.000036 | 0.000035 | 5.02096E-05 |
| | 0.009944 | 0.007234 | 0.012296906 | 0.000029 | 0.000021 | 3.5805E-05 |
| | 0.006268 | 0.004597 | 0.007773045 | 0.000022 | 0.000016 | 2.72029E-05 |
| | 0.003451 | 0.002563 | 0.004298647 | 0.000016 | 0.000012 | 0.00002 |
| | 0.001483 | 0.001104 | 0.001848812 | 0.000009 | 0.000007 | 1.14018E-05 |
| | 0.000377 | 0.000282 | 0.0004708 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.045040665*** | | | ***0.000148225*** |
| 50 | 0.015487 | 0.008681 | 0.017754068 | 0.00004 | 0.000027 | 4.82597E-05 |
| | 0.010692 | 0.005437 | 0.011994992 | 0.000031 | 0.000016 | 3.48855E-05 |
| | 0.006743 | 0.003458 | 0.007577982 | 0.000024 | 0.000012 | 2.68328E-05 |
| | 0.003712 | 0.001936 | 0.004186531 | 0.000017 | 0.000009 | 1.92354E-05 |
| | 0.001595 | 0.000834 | 0.001799884 | 0.00001 | 0.000005 | 1.11803E-05 |
| | 0.000405 | 0.000214 | 0.000458062 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.043771519*** | | | ***0.000143999*** |
| 51 | 0.014321 | 0.008681 | 0.016746665 | 0.000036 | 0.000027 | 0.000045 |
| | 0.009944 | 0.005437 | 0.011333318 | 0.000029 | 0.000016 | 3.3121E-05 |
| | 0.006268 | 0.003458 | 0.007158602 | 0.000022 | 0.000012 | 2.50599E-05 |
| | 0.003451 | 0.001936 | 0.003956956 | 0.000016 | 0.000009 | 1.83576E-05 |
| | 0.001483 | 0.000834 | 0.001701424 | 0.000009 | 0.000005 | 1.02956E-05 |
| | 0.000377 | 0.000214 | 0.000433503 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.041330469*** | | | ***0.00013544*** |
| 54 | 0.01572 | 0.010196 | 0.018737044 | 0.000041 | 0.000032 | 5.20096E-05 |
| | 0.010842 | 0.00641 | 0.012595121 | 0.000032 | 0.000019 | 3.72156E-05 |
| | 0.006838 | 0.004075 | 0.007960143 | 0.000024 | 0.000014 | 2.77849E-05 |
| | 0.003764 | 0.002276 | 0.004398622 | 0.000017 | 0.00001 | 1.97231E-05 |
| | 0.001618 | 0.00098 | 0.001891646 | 0.00001 | 0.000006 | 1.16619E-05 |
| | 0.000411 | 0.0000251 | 0.000411766 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.04599434*** | | | ***0.000152001*** |
| 55 | 0.001572 | 0.011477 | 0.011584158 | 0.000041 | 0.000035 | 5.39073E-05 |
| | 0.010842 | 0.007234 | 0.013033791 | 0.000032 | 0.000021 | 3.82753E-05 |
| | 0.006838 | 0.004597 | 0.008239578 | 0.000024 | 0.000016 | 2.88444E-05 |
| | 0.003764 | 0.002563 | 0.004553753 | 0.000017 | 0.000012 | 2.08087E-05 |
| | 0.001618 | 0.001104 | 0.00195876 | 0.00001 | 0.000007 | 1.22066E-05 |
| | 0.000411 | 0.000282 | 0.000498443 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.039868483*** | | | ***0.000157648*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 145 | 0.015408 | 0.011473 | 0.019210315 | 0.000039 | 0.000035 | 5.24023E-05 |
| | 0.010692 | 0.007237 | 0.012910966 | 0.000031 | 0.000021 | 3.74433E-05 |
| | 0.006743 | 0.004599 | 0.008162037 | 0.000024 | 0.000016 | 2.88444E-05 |
| | 0.003712 | 0.002564 | 0.004511434 | 0.000017 | 0.000012 | 2.08087E-05 |
| | 0.001595 | 0.001105 | 0.001940374 | 0.00001 | 0.000007 | 1.22066E-05 |
| | 0.000405 | 0.000283 | 0.000494079 | 0.000003 | 0.000002 | 3.60555E-06 |
| | | | ***0.047229204*** | | | ***0.000155311*** |
| 190-3 | 0.017935 | 0.010194 | 0.020629636 | 0.000047 | 0.000032 | 5.68595E-05 |
| | 0.012266 | 0.00641 | 0.013839901 | 0.000036 | 0.000019 | 4.07063E-05 |
| | 0.007741 | 0.004075 | 0.008748069 | 0.000028 | 0.000014 | 3.1305E-05 |
| | 0.004261 | 0.002276 | 0.004830766 | 0.000019 | 0.00001 | 2.14709E-05 |
| | 0.001832 | 0.00098 | 0.002077649 | 0.000011 | 0.000006 | 1.253E-05 |
| | 0.000466 | 0.000251 | 0.000529299 | 0.000004 | 0.000002 | 4.47214E-06 |
| | | | ***0.050655318*** | | | ***0.000167344*** |
| 44 | 0.014321 | -0.005785 | 0.015445299 | 0.000036 | 0.000016 | 3.93954E-05 |
| | 0.009944 | -0.003861 | 0.010667261 | 0.000029 | 0.000011 | 3.10161E-05 |
| | 0.006268 | -0.002437 | 0.006725087 | 0.000022 | 0.000009 | 2.37697E-05 |
| | 0.003451 | -0.001306 | 0.003689856 | 0.000016 | 0.000006 | 1.7088E-05 |
| | 0.001483 | -0.000563 | 0.001586272 | 0.000009 | 0.000004 | 9.84886E-06 |
| | 0.000377 | -0.000143 | 0.00040321 | 0.000003 | 0.000001 | 3.16228E-06 |
| | | | ***0.038516984*** | | | ***0.00012428*** |

## Accumulation of Loads to Foundation:

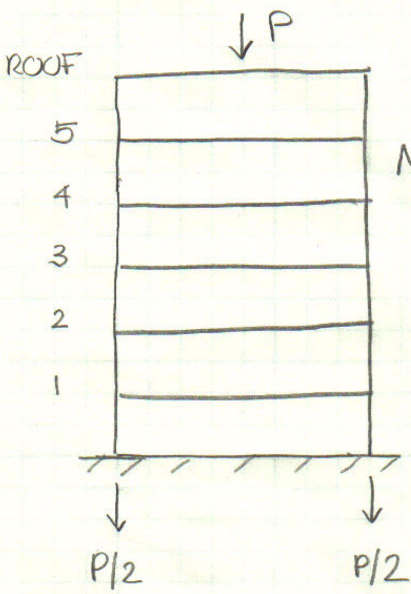
***Accumulation of Dead Loads***

| Structural Wall | L (ft) | W (ft) | Roof | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|
| 1 | 38 | 16 | 27.36 | 31643.36 | 63259.36 | 94875.36 | 126491.36 | 196411.36 |
| 2 | 12 | 15 | 8.10 | 9368.10 | 18728.10 | 28088.10 | 37448.10 | 58148.10 |
| 3 | 68 | 17 | 52.02 | 60164.02 | 120276.02 | 180388.02 | 240500.02 | 373440.02 |
| 4 | 40 | 20 | 36.00 | 41636.00 | 83236.00 | 124836.00 | 166436.00 | 258436.00 |
| 5 | 44 | 15 | 29.70 | 34349.70 | 68669.70 | 102989.70 | 137309.70 | 213209.70 |
| 6 | 22 | 18 | 17.82 | 20609.82 | 41201.82 | 61793.82 | 82385.82 | 127925.82 |
| 7 | 24 | 18 | 19.44 | 22483.44 | 44947.44 | 67411.44 | 89875.44 | 139555.44 |
| 8 | 24 | 22 | 23.76 | 27479.76 | 54935.76 | 82391.76 | 109847.76 | 170567.76 |
| 9 | 22 | 22 | 21.78 | 25189.78 | 50357.78 | 75525.78 | 100693.78 | 156353.78 |
| 10 | 28 | 22 | 27.72 | 32059.72 | 64091.72 | 96123.72 | 128155.72 | 198995.72 |
| 11 | 68 | 22 | 67.32 | 77859.32 | 155651.32 | 233443.32 | 311235.32 | 483275.32 |
| 12 | 12 | 20 | 10.80 | 12490.80 | 24970.80 | 37450.80 | 49930.80 | 77530.80 |
| 13 | 28 | 20 | 25.20 | 29145.20 | 58265.20 | 87385.20 | 116505.20 | 180905.20 |
| 14 | 20 | 20 | 18.00 | 20818.00 | 41618.00 | 62418.00 | 83218.00 | 129218.00 |
| 15 | 36 | 20 | 32.40 | 37472.40 | 74912.40 | 112352.40 | 149792.40 | 232592.40 |
| SW-1 | 10 | 10 | 4.50 | 5204.50 | 10404.50 | 15604.50 | 20804.50 | 32304.50 |
| SW-2 | 18 | 4 | 3.24 | 3747.24 | 7491.24 | 11235.24 | 14979.24 | 23259.24 |
| SW-3 | 14 | 15 | 9.45 | 10929.45 | 21849.45 | 32769.45 | 43689.45 | 67839.45 |
| SW-4 | 9 | 13 | 5.27 | 6089.27 | 12173.27 | 18257.27 | 24341.27 | 37796.27 |
| SW-5 | 28 | 7 | 8.82 | 10200.82 | 20392.82 | 30584.82 | 40776.82 | 63316.82 |
| SW-6 | 32 | 8 | 11.52 | 13323.52 | 26635.52 | 39947.52 | 53259.52 | 82699.52 |
| SW-7 | 8 | 15 | 5.40 | 6245.40 | 12485.40 | 18725.40 | 24965.40 | 38765.40 |
| SW-8 | 9 | 29 | 11.75 | 13583.75 | 27155.75 | 40727.75 | 54299.75 | 84314.75 |
| SW-9 | 32 | 8 | 11.52 | 13323.52 | 26635.52 | 39947.52 | 53259.52 | 82699.52 |
| SW-10 | 9 | 14 | 5.67 | 6557.67 | 13109.67 | 19661.67 | 26213.67 | 40703.67 |
| SW-11 | 28 | 8 | 10.08 | 11658.08 | 23306.08 | 34954.08 | 46602.08 | 72362.08 |
| SW-12 | 18 | 14 | 11.34 | 13115.34 | 26219.34 | 39323.34 | 52427.34 | 81407.34 |
| SW-13 | 9 | 12 | 4.86 | 5620.86 | 11236.86 | 16852.86 | 22468.86 | 34888.86 |

A similar distribution follows to determine the overturning moment and how the overturning moment is resisted by solely gravity loads.

# OVERTURNING MOMENT:

| | DEAD LOAD (PSF) | AREA ($FT^2$) | KIPS TRANSFERRED |
|---|---|---|---|
| ROOF | 45 | 22270 | 1002.15 |
| 5 | 52 | 22270 | 1158.04 |
| 4 | 52 | 22270 | 1158.04 |
| 3 | 52 | 22270 | 1158.04 |
| 2 | 52 | 22270 | 1158.04 |
| 1 | 115 | 22270 | 2561.05 |
| | | P = TOTAL | $8195.36^k$ |




$$\frac{P}{2} = 4097.68^k$$

M = OVERTURNING MOMENT:

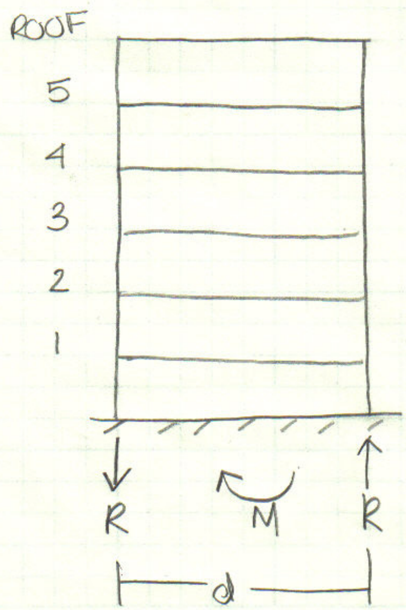
$96338.2'^k$

$$R = \frac{M}{d} = \frac{96338.2'^k}{115'} \leftarrow \text{CONTROLLING}$$

$$R = 837.7^k$$

$$\frac{P}{2} = 4097.68^k >> 837.7^k = R$$

∴ OVERTURNING NOT AN ISSUE WHEN CONSIDERING SOLELY DEAD LOAD



Shear wall spot check: HORIZONTAL REINFORCEMENT

$V_c = 2\sqrt{f'c}\,hd = 2\sqrt{5000\,psi}\,(12")(134.4") = 228.1^k$

NOTE: THIS SHOULD BE USED FOR Vc BECAUSE $3.3\sqrt{f'c}\,hd + \frac{N_u d}{4 l_w}$ AND

$$\left[0.6\sqrt{f'c} + \frac{l_w\left(1.25\sqrt{f'c} + 0.2\left(\frac{N_u}{l_w h}\right)\right)}{\frac{M_u}{V_u} - \frac{l_w}{2}}\right] hd$$

ARE MUCH LARGER IN COMPARISON AND WILL NOT CONTROL. CALCULATIONS SUPPORTING THIS CONCLUSION ARE AVAILABLE UPON REQUEST.

$\phi V_c = 0.75(228.1^k) = 171.1^k$

$V_n \geq \frac{V_u}{\phi} = \frac{3169.9^k}{0.75} = 4226.5^k$

$V_s = V_n - V_c = 4226.5^k - 228.1^k = 3998.4^k$

$A_v = \frac{V_s S}{f_y d} = \frac{3998.4^k (12")(1/12")}{60\,ksi\,(134.4")} = 0.496\,in^2$

2 ROWS ARE DESIGNED, SO EACH ROW WOULD REQUIRE $\frac{0.496\,in^2}{2} = 0.248\,in^2$

\# 5'S @ 12" WOULD WORK

THE DESIGN USES #6'S @ 12", WHICH CAN BE DUE TO ERECTION; THE CONTROLLING CASE MAY REQUIRE #6'S AND USING #5'S COULD CAUSE CONFUSION IN THE FIELD DURING ERECTION.

Nodes for Shear Walls: