# TECHNICAL ASSIGNMENT III

## LATERAL SYSTEM ANALYSIS AND CONFIRMATION DESIGN

329 INNOVATION BOULEVARD
STATE COLLEGE, PA

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TECHNICAL ASSIGNMENT III

# EXECUTIVE SUMMARY

This report explores the lateral resisting frames of 329 Innovation Boulevard. The lateral resisting frames consists of full moment resisting connections. The moment connections will be designed by the steel fabricators. However, one way to obtain a moment connection is by splicing the flange and web. This can be accomplished with a plate at each flange, and one at the web. The sizes of members that were most commonly used were W24x55's and W18x35's for beams, and the columns range from W12x53 through W12x87. In order to analyze the resisting frames, the controlling loads were determined. It was found that the wind load controlled the design of the members for the system.

The maximum base shear was found to be 270 Kips under wind loading. The overturning moment caused by wind was 10,035 Ft-Kips. The following load combination was determined to be the controlling combination:

**1.2D + 0.5L + 1.6W**

RAM Structural System was used to model and analyze the structure. RAM Frame used the fore-mentioned load combination to find the story forces and shear. The values obtained from RAM coincided with the hand calculations performed and presented in *Technical Assignment I: Structural Concepts/Structural Existing Conditions Report*. RAM Frame was also utilized to check the strengths of the members of the resisting frames. A hand check was performed, and the results verified the findings of the RAM strength check.

A drift analysis was performed and the results were compared to the industry standard H/400; meaning the desirable displacement of the floors should be less than the height (in.) divided by 400. The first through fourth floors were under the standard ratio; however, the roof's displacement was slightly greater than desired. The additional dead load of the mechanical penthouse may help lessen the displacement of the roof. The roof displaced 0.13" past the desirable length of 1.74".

The centers of rigidity and mass were obtained to analyze any torsional effects. It was found that both centers have the same location, and that any torsional effect, if any, would be minimal. The overturning moments of the resisting moments were found by hand calculations, and then compared to the resisting moments. The locations of these moments occur at the base of each frame. The resisting moments were greater than the overturning moments; therefore, no tension steel was required for added strength. The affects of the moments were discussed in terms of the foundation, as well. Overall, it was found that the lateral resisting system of 329 Innovation Boulevard was more than adequate in achieving its goal – to resist all lateral loads.

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329 Innovation Boulevard is a completed design in terms of the design phase, and is currently undergoing the construction phase. The structure will house multiple commercial tenants. It is located in the Innovation Park at Penn State, State College, PA. It will face Innovation Blvd. directly across from 328 Innovation Boulevard, which hosts the buildings designers, L. Robert Kimball & Associates. Due to the fact that tenants have not currently leased the provided space, the building utilizes an open floor plan to help facilitate any possible tenants.

The building is four stories tall, with a mechanical penthouse located on the roof. The total height is 58', and the footprint is 21,000 SF. It is a steel framed structure with a concrete composite flooring system. The veneer includes brick, aluminum panels, and glass curtain walls. It typically follows the style of the current buildings of Innovation Park. 329 Inn. Blvd. provides a pre-engineered bridge for pedestrian usage which leads to an entrance on the second floor. The image below is the East Elevation and shows the bridge to the left of the building.

The building is supported by a steel superstructure including a composite steel floor system. The following report will explore the lateral resisting system of 329 Innovation Boulevard. Topics covered include: controlling loads and load combinations, strength checks, torsion, and a brief description of the foundation. The report includes RAM Structural System output and hand calculations.

Lateral resistance is provided by several full moment connections of beams, girders, and columns. These connections can be found in the middle bay of the building on each end of the building. There are two columns on each end where the two beams and two girders are all connected by full moment connections. The floor plan below highlights the beams involved with the moment connections to the respective column. Majority of the moment connections occur in the interior of the building, and there are total of twelve moment connections on the exterior frame. The mechanical penthouse located on the roof utilizes flat strap bracing in plane with the stud wall.

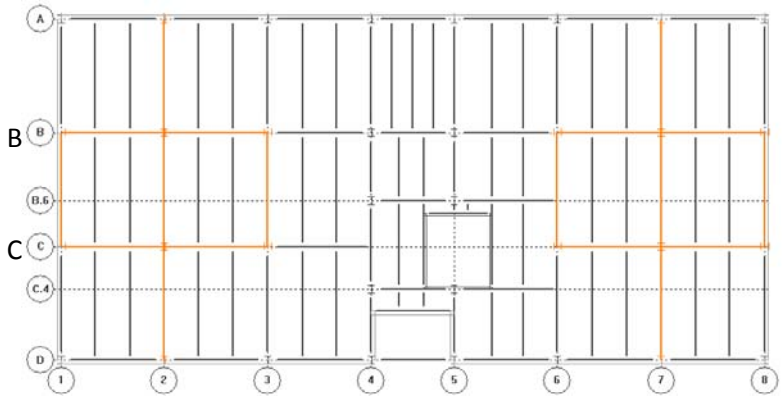



Figure 2.1

Due to the fact that 329 Innovation Boulevard is under construction, and photos of the moment connection could not be obtained, the following diagram is an example of a moment connection. Aspects that are similar to the connections in 329 include the seated beams and the web/flange connections.

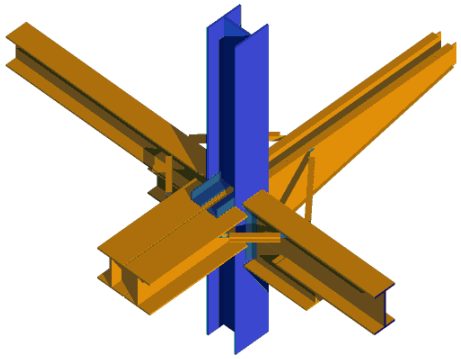


Figure 2.2

The following plan and axonometric view are intended to illustrate the location of the moment connections in 329 Innovation Boulevard. The drawings were taken from the model created using RAM Structural System, and the frames are highlighted in red. The designation for the other members include: green for the wide flange beams and columns, as well as blue for the joists on the roof. The orange designates any opening in the floor system, which is required for the elevator shaft.

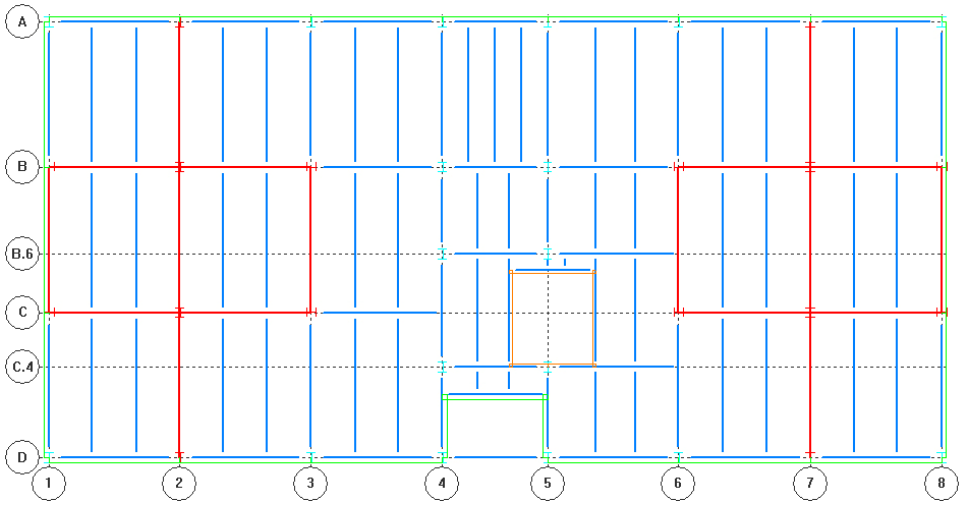



Figure 3.1 Floor Plan

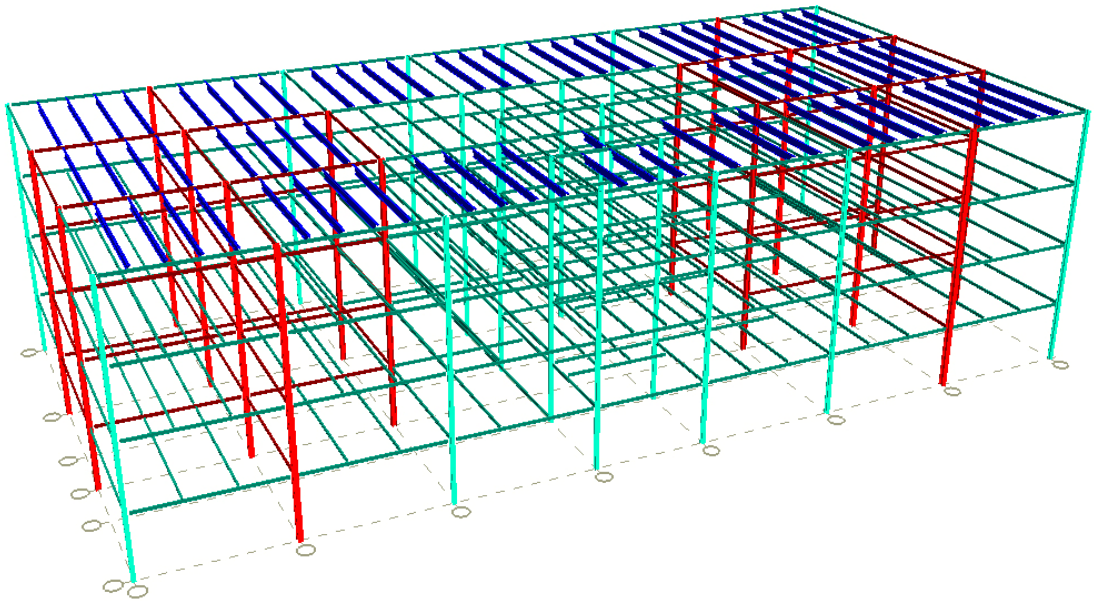


Figure 3.2 Axonometric View

In a previously submitted technical assignment, seismic and wind load cases were analyzed to determine which cases controlled the design of the lateral system. *Technical Assignment I: Structural Concepts/Structural Existing Conditions Report* explored these two load cases and utilized ASCE7-05 and IBC 2006 for design purposes. Hand calculations were performed along with Excel spreadsheets to determine which case controlled and they can be obtained through *Technical Assignment I*. The following pages include the critical aspects of the calculations and analysis performed in the technical assignment. *Technical Assignment I* concluded that wind loading controlled the design of the lateral resistive system and member sizes.

## WIND LOADING

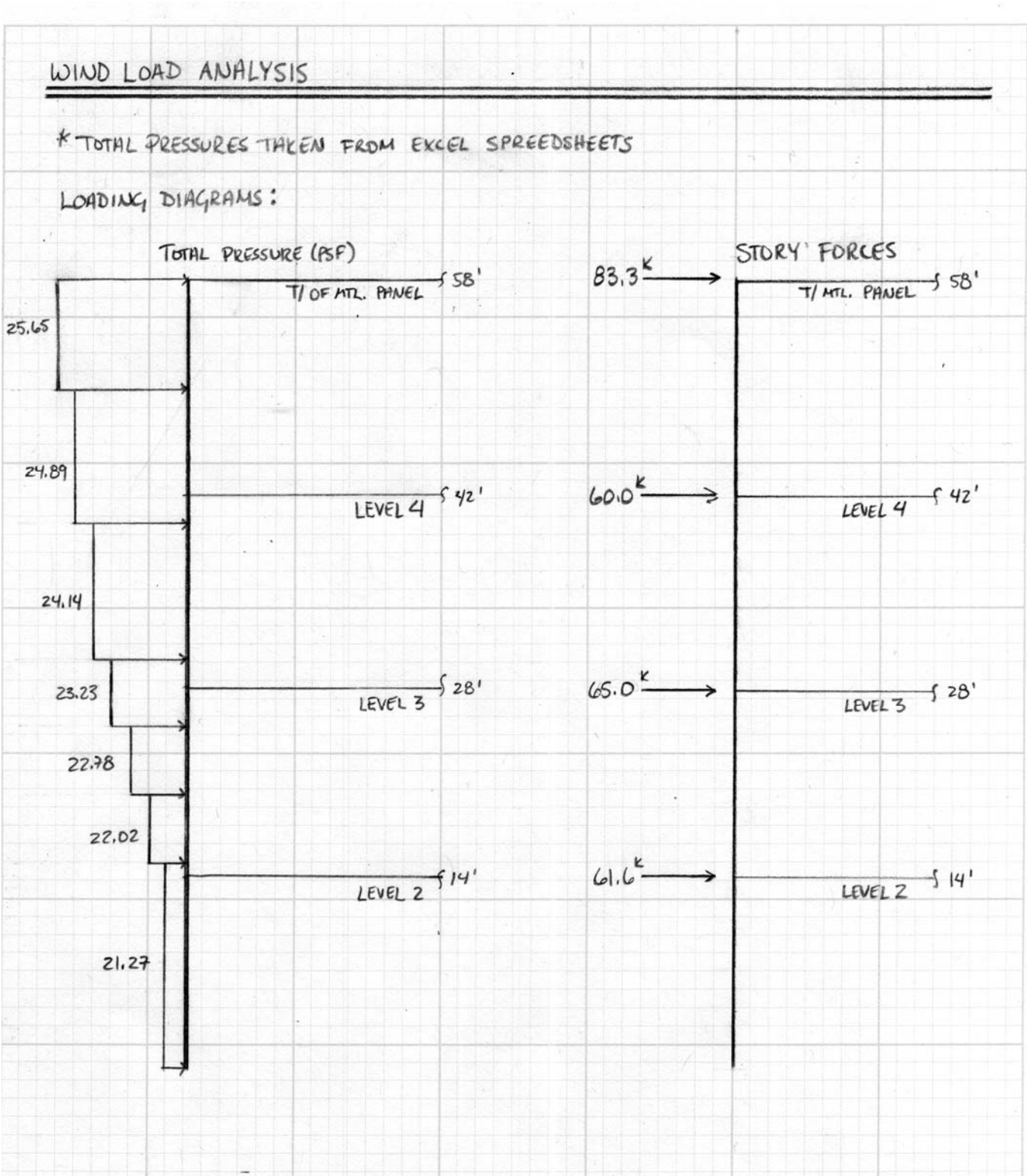
| Wind Loading According to ASCE7-05 | |
|---|---|
| Basic Wind Speed | 90 MPH |
| Exposure Category | II |
| Enclosure Classification | Enclosed |
| Building Category | C |
| Importance Factor | 1.0 |
| Internal Pressure Coefficient | 0.18 |

| North/South Wind Pressure Values | | | | | | |
|---|---|---|---|---|---|---|
| z (ft) | $K_z$ | $q_z$ | $P_{windwardl}$(PSF) | $P_{leeward}$(PSF) | $P_{sidewall}$(PSF) | $P_{total}$(PSF) |
| 0-15 | 0.85 | 14.98 | 12.84 | -8.43 | -14.83 | 21.27 |
| 20 | 0.90 | 15.86 | 13.59 | -8.43 | -14.83 | 22.02 |
| 25 | 0.95 | 16.74 | 14.35 | -8.43 | -14.83 | 22.78 |
| 30 | 0.98 | 17.27 | 14.80 | -8.43 | -14.83 | 23.23 |
| 40 | 1.04 | 18.33 | 15.71 | -8.43 | -14.83 | 24.14 |
| 50 | 1.09 | 19.21 | 16.46 | -8.43 | -14.83 | 24.89 |
| 60 | 1.14 | 20.09 | 17.22 | -8.43 | -14.83 | 25.65 |

**Base Shear (N/S):** **270 Kips**
**Overturning Moment:** **10,035 Ft-Kips } Controls Over Seismic**

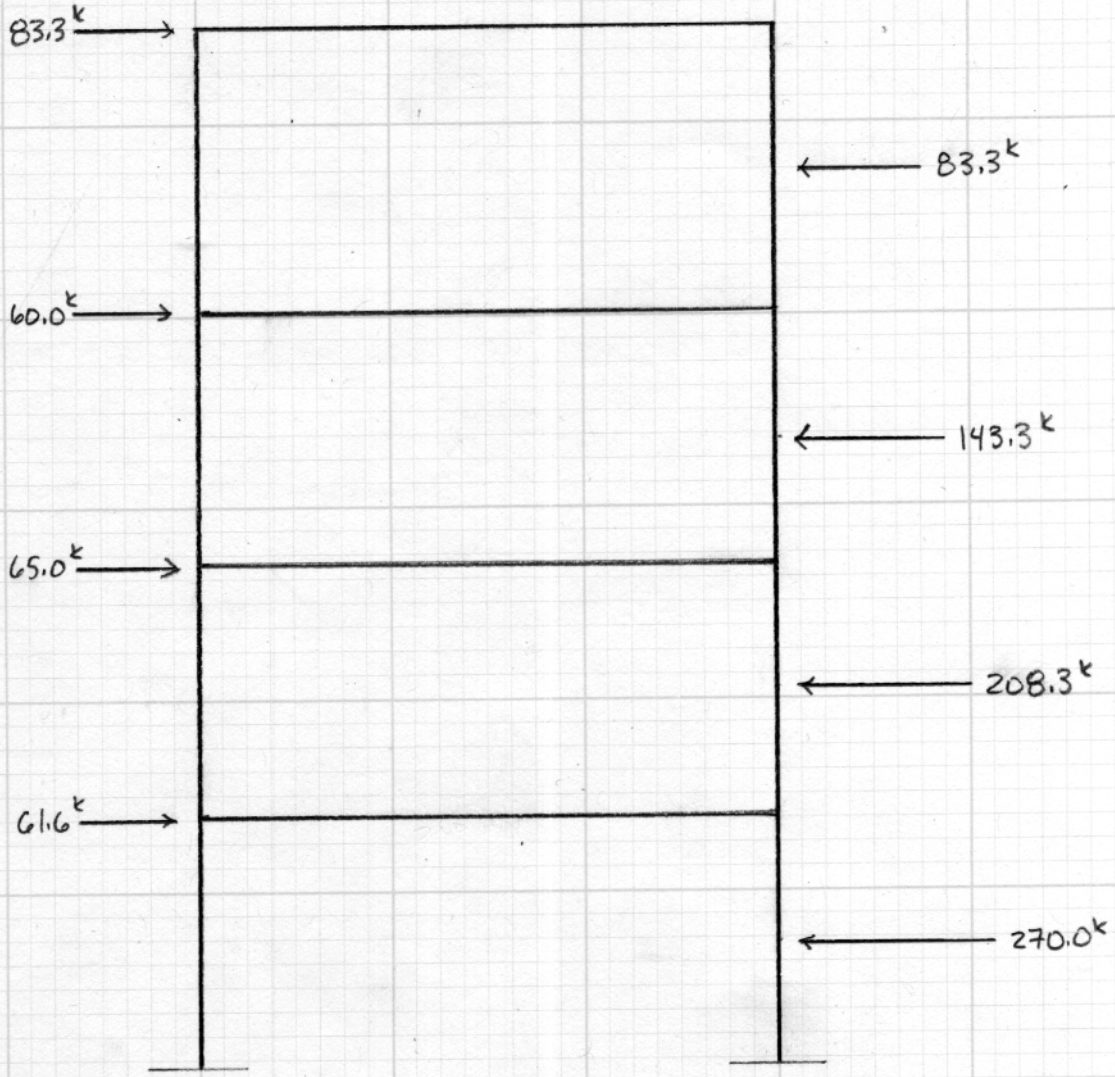
The following pages include the hand calculations that were completed to find the story forces and story shear. The North/South wind pressures were used due to the fact that the values were greater than the East/West direction. The pages following the hand calculations revisit the East/West wind pressures in order to show their lesser values, and the seismic loading. The base shear and overturning moment values obtained using seismic analysis are clearly less than the values obtained by wind loading, thus making the wind loading the controlling element.

# WIND LOADING DIAGRAMS



## WIND LOAD ANALYSIS

STORY FORCES VS. STORY SHEAR COMPARISON



| East/West Wind Pressure Values | | | | | | |
|---|---|---|---|---|---|---|
| z (ft) | $K_z$ | $q_z$ | $P_{windward}$(PSF) | $P_{leeward}$(PSF) | $P_{sidewall}$(PSF) | $P_{total}$(PSF) |
| 0-15 | 0.85 | 14.98 | 11.34 | -4.31 | -14.83 | 15.65 |
| 20 | 0.90 | 15.86 | 12.01 | -4.31 | -14.83 | 16.32 |
| 25 | 0.95 | 16.74 | 12.67 | -4.31 | -14.83 | 16.98 |
| 30 | 0.98 | 17.27 | 13.07 | -4.31 | -14.83 | 17.38 |
| 40 | 1.04 | 18.33 | 13.87 | -4.31 | -14.83 | 18.18 |
| 50 | 1.09 | 19.21 | 14.54 | -4.31 | -14.83 | 18.85 |
| 60 | 1.14 | 20.09 | 15.21 | -4.31 | -14.83 | 19.52 |

Base Shear (E/W): 100 Kips
Overturning Moment: 3885 Ft.-Kips

## SEISMIC LOADING

| Seismic Loading According to ASCE7-05 | | |
|---|---|---|
| Seismic Design Category | | A |
| Seismic Use Group | | II |
| Importance Factor ($I_E$) | | 1.0 |
| $S_S$ | | 0.168 |
| $S_1$ | | 0.059 |
| $S_{DS}$ | | 0.134 |
| $S_{DI}$ | | 0.067 |
| Site Class | | C |
| Response Coefficient | | |
| | N-S | 0.045 |
| | E-W | 0.045 |
| Response Mod. Factor | | |
| | N-S | 3.0 |
| | E-W | 3.0 |
| Period | | 0.72 |
| V (kips) | | 60 |
| K | | 1.11 |

| Floor | Weight | Height (ft) | K | $h^K$ | $W*h^K$ | Cvx | V (K) | Fx |
|---|---|---|---|---|---|---|---|---|
| 2 | 330 | 14 | 1.11 | 18.716 | 6176.28 | 0.09 | 60 | 5.2 |
| 3 | 330 | 28 | 1.11 | 40.397 | 13331.01 | 0.19 | 60 | 11.2 |
| 4 | 330 | 42 | 1.11 | 63.359 | 20908.47 | 0.29 | 60 | 17.5 |
| Roof | 343.3 | 58 | 1.11 | 90.658 | 31122.89 | 0.44 | 60 | 26.1 |
| **Totals** | **1333.3** | | | | **71538.65** | **1.00** | | **60.0** |
| **Base Shear:** | | | 60.0 Kips | | | | | |
| **Overturning Moment:** | | | 2480 Ft.-Kips | | | | | |

The introduction of a lateral load causes story forces and shears. These forces are used to determine the overturning moment of the entire frame as well as the shear at each story. The following table is a comparison between the values obtained by hand calculations and the values obtained using RAM Frame. The values obtained from RAM utilized IBC 2003 LRFD load combinations, while the hand calculation values used the more current code (IBC 2006.) There are minor discrepancies between the two values, and they may stem from the fact that two different codes were used. The hand calculations can be found under the load cases section of the report. The RAM Output can be found in Appendix A.2. The story forces are located at each floor, excluding the ground floor. The story shear is located at the midpoint of each floor level. Refer to following table for clarity, the location of forces are measured upward from the ground (0'-0"):

| Location of Reaction | | |
|---|---|---|
| **Floor** | **Story Forces** | **Story Shear** |
| Roof | 58'-0" | N/A |
| 4th Floor | 42'-0" | 50'-0" |
| 3rd Floor | 28'-0" | 35'-0" |
| 2nd Floor | 14'-0" | 21'-0" |
| 1st Floor | N/A | 7'-0" |

| Story Force/Shear Comparison | | | | | | |
|---|---|---|---|---|---|---|
| | | | Hand Calculations | | RAM Output | |
| **Floor** | **Height (ft.)** | **FF Height (ft.)** | **Story Forces (K)** | **Story Shear (K)** | **Story Forces (K)** | **Story Shear (K)** |
| Roof | 58 | 16 | 83.3 | N/A | 85.8 | N/A |
| 4th Floor | 42 | 14 | 60.0 | 83.3 | 64.6 | 85.8 |
| 3rd Floor | 28 | 14 | 65.0 | 143.3 | 67.8 | 150.4 |
| 2nd Floor | 14 | 14 | 61.6 | 208.3 | 62.8 | 218.2 |
| 1st Floor | 0 | N/A | N/A | 270.0 | N/A | 281.0 |

A strength check was performed using the RAM Structural System model. The results were obtained by loading the model and analyzing it using numerous load combinations. The load combinations were generated by RAM through the load combinations drop-menu. RAM used IBC 2003 LRFD to obtain the combinations. Knowing that wind controls the resisting system - dead, live, and wind loads only were applied to the model. The combinations (involving wind loads) analyzed includes:

- 1.4D
- 1.2D + 1.6L
- **1.2D + 0.5L + 1.6W**
- 1.2D + 0.5L – 1.6W
- 1.2D + 1.6W
- 1.2D – 1.6W
- 0.9D + 1.6W
- 0.9E – 1.6W

The combination that is in bold-faced type is the one that controlled. It obviously produced the greatest values compared to the other combinations. RAM used the combination to check the resisting members according to strength. It uses a scale so that anything less than 1.0 is an acceptable value. The following diagram shows the color-coded results of RAM's analysis. Note that all members use less than 80% of the maximum strength, with majority less than 50%, meaning that the frames are adequate in strength. The color scale is shown to the right of the diagram.

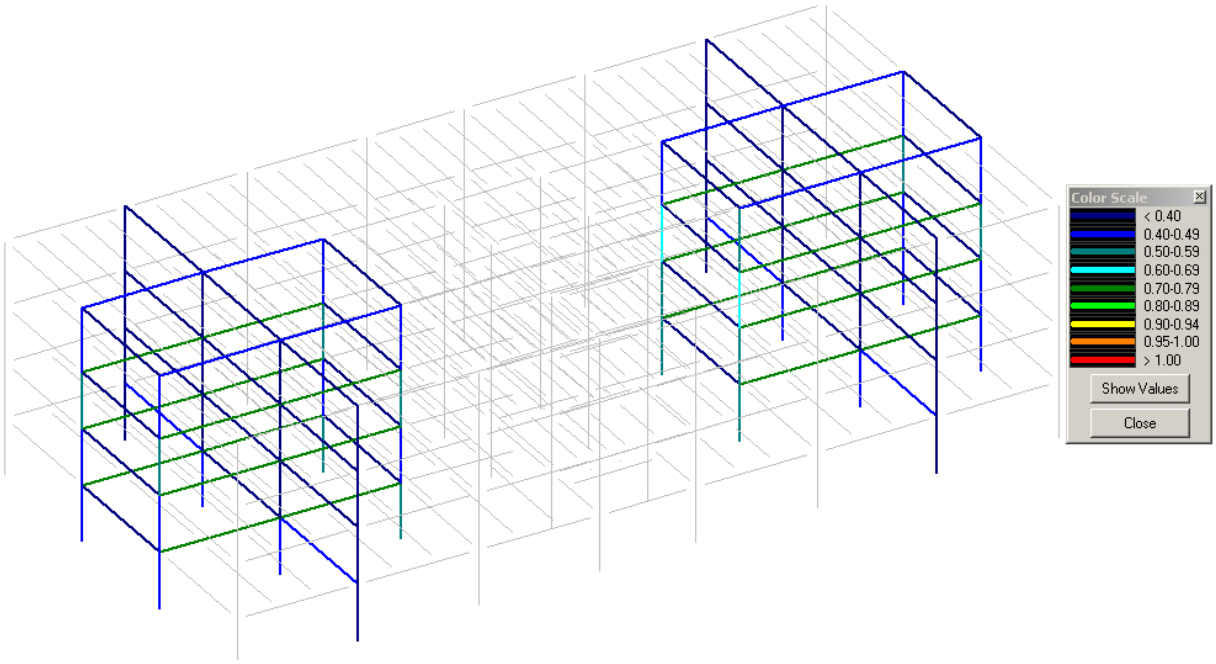
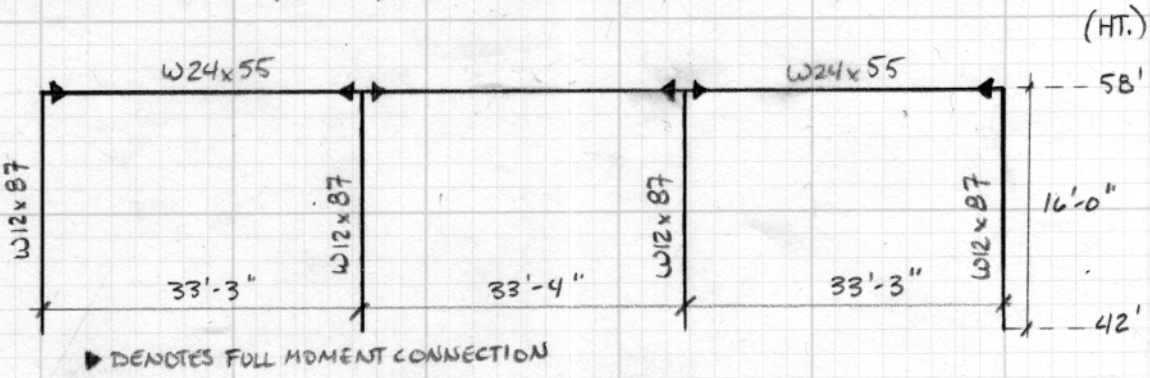


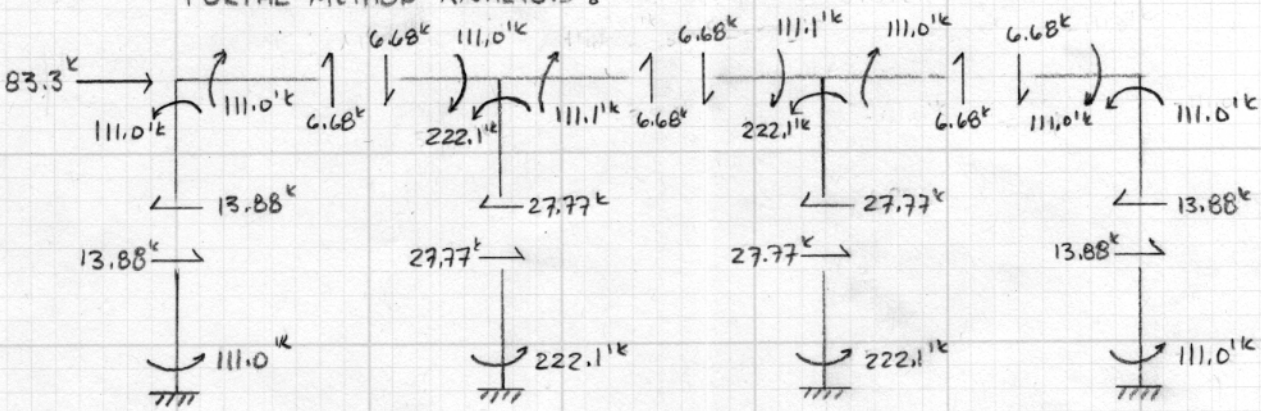

Figure 9.1

## LATERAL RESISTING SYSTEM CHECK

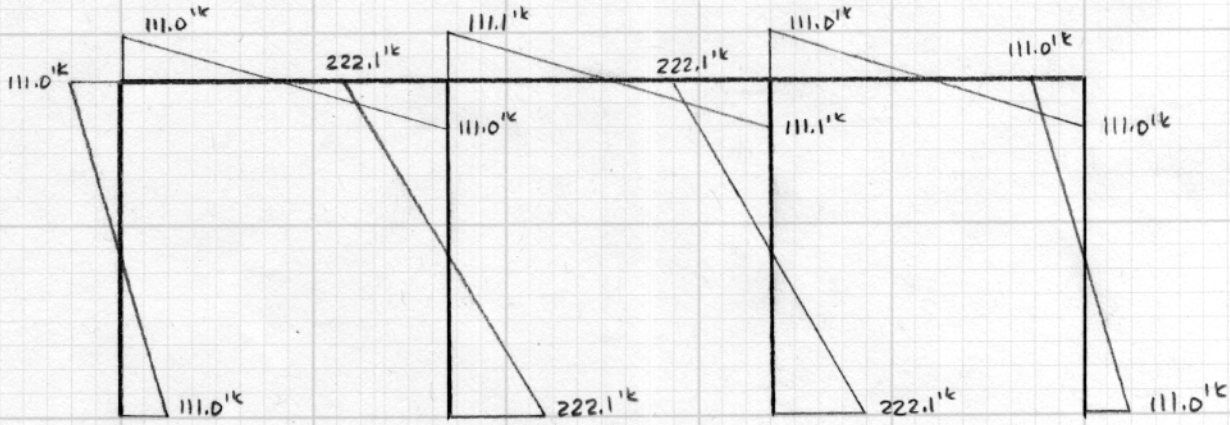
FRAME RUNNING ALONG #2 GRID LINE FROM A-2 TO D-2 (4TH FLOOR)




PORTAL METHOD ANALYSIS:




MOMENT DIAGRAM



## LATERAL RESISTING SYSTEM CHECK CONT'D

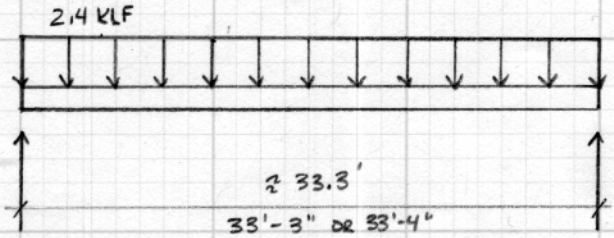
DEAD + LIVE LOADING

DEAD LOAD = 25 PSF
LIVE LOAD = 100 PSF
TRIB. WIDTH = 30'

LOAD COMBINATION: 1.2D + 0.5L + 1.6W

1.2 (25) + 0.5(100) = 80 PSF

$w_u$ = 80 PSF (30') / 1000 = 2.4 KLF




$V_u = w_u L/2$

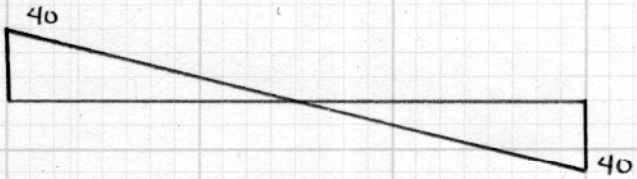
$V_u = 2.4(33.3)/2$

$= 40.0^k$

$M_u = w_u L^2/8$

$= 2.4(33.3)^2/8$

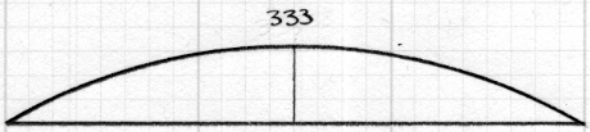
$= 333^{'k}$




V (k)

EQUATION:

$y = -1.201x^2 + 40x$

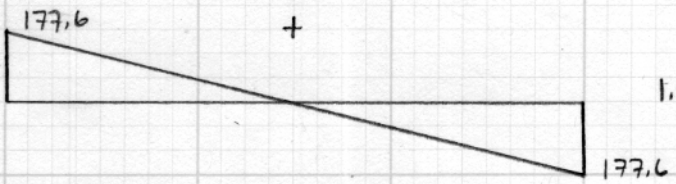



M ('k)

COMBINATION:

1.2 D + 0.5 L

$y = -10.66x + 177.6$




M ('k)

1.6 W (FROM PORTAL)

ADDITION OF EQUATIONS:

$$y = -1.201x^2 + 40x + 0$$
$$+\ y = 0x^2 - 10.66x + 177.6$$
$$2y = -1.201x^2 + 29.34x + 177.6$$
$$\therefore\ y = -0.6x^2 + 14.67x + 88.8$$

MAXIMUM OCCURS WHEN Y = 12.22', X = 178.5 'k

## LATERAL RESISTING SYSTEM CHECK CONT'D

### SIZING OF MEMBERS:

BEAMS - $M_{MAX} = 178.5^{'k}$

$\phi M_n = \phi F_y Z_x$

$(12)178.5^{'k} = 50(ksi)(Z_x)$

$42.84\ in^3 = Z_x$

SMALLEST ADEQUATE BEAM:

$W16\times31$, $Z_x = 54.0\ in^3$, $\phi M_n = 203^{'k}$

$\therefore$ DESIGNER USED $W24\times55$, $Z_x = 135\ in^3$ and $\phi M_n = 506^{'k} >> 178.5^{'k}$

STRENGTH CHECK DONE BY RAM REFLECTS THIS, LESS THAN 50% OF MAX. STRENGTH OF MEMBERS ARE USED.

COLUMNS - $V_{MAX} = \underset{(PORTAL)}{6.68^k}(1.6) + \underset{(D+L)}{40^k} = 50.7^k$

EFFECTIVE LENGTH, KL, $\approx 30'$ (SPANS FROM 3RD - 4TH FLOOR)

SMALLEST ADEQUATE COLUMN: $W12\times40$, $\phi P_n = 72.5^k$

$\therefore$ DESIGNER USED $W12\times87$, $\phi P_n = 397^k >> 50.7^k$

COLUMN SPANS TWO STORIES, SO IT MUST SUPPORT LOADS FROM THE STORY BELOW. STRENGTH CHECK FROM RAM REFLECTS THIS W/ LESS THAN 50% OF TOTAL STRENGTH OF MEMBER USED.

### CONCLUSION:

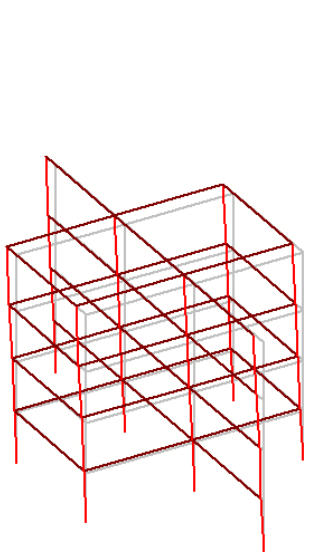
THE LATERAL RESISTING SYSTEM IS MORE THAN ADEQUATE IN TERMS OF RESISTING THE LATERAL LOAD OF WIND. THE RESULTS FOUND BY THIS SPOT-CHECK VERIFY THE FINDINGS OF THE RAM MODEL.

The maximum displacement and story drift were calculated using RAM Frame. The maximum values were found under the wind loading, due to the fact that it was the only lateral force applied to the frame. These values were compared to H/400, which yields the acceptable total displacement and story drift. 329 Innovation Boulevard is 58' tall, and therefore the acceptable amount of drift is 1.74". Below is a table containing the comparison of the RAM values and the acceptable drift values. The fourth floor displacement exceeds the desired drift. Factors that may have caused this to occur include: a lesser wind load applied, or perhaps the mechanical penthouse located on the roof would add considerable dead load to help lessen the displacement. Following the comparison table is the deflected shape produced by RAM frame. The values in the comparison table correspond to the red deflected shape of the frames.

**Critical Displacements**

| Floor | Height (ft.) | FF Height (ft.) | H/400 (in.) | RAM Disp. Values (in.) | RAM Drift Values (in.) | H/400 (in.) |
|---|---|---|---|---|---|---|
| Roof | 58 | 16 | 1.74 | 1.87 | 0.45 | 0.48 |
| 4th Floor | 42 | 14 | 1.74 | 1.42 | 0.53 | 0.42 |
| 3rd Floor | 28 | 14 | 1.74 | 0.89 | 0.49 | 0.42 |
| 2nd Floor | 14 | 14 | 1.74 | 0.40 | 0.40 | 0.42 |
| 1st Floor | 0 | N/A | N/A | N/A | N/A | N/A |

- The drift values do not apply to the 1st floor due to the fact that is considered the ground floor, and the ground prevents any displacement.



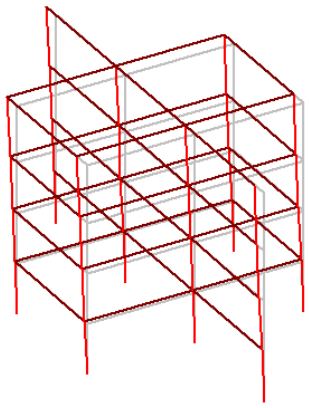


Figure 12.1

**RAM Output: Deflected Shape (Scale Factor = 30)**

Along with resisting lateral loads, the moment connections must be able to withstand any torsional forces that may occur. Story shear is assumed to act through the center of mass of each level, and when the center of mass does not coincide with the center of rigidity a moment or torsion force is induced. RAM Frame was used to obtain the centers of rigidity and the centers of mass. RAM's output file can be viewed in Appendix A.4. The following table contains those values:

**Torsion Values**

| Floor | Centers of Rigidity | | Centers of Mass | |
|---|---|---|---|---|
| | X (Ft.) | Y (Ft.) | X (Ft.) | Y (Ft.) |
| 4th Floor | 101.92 | 49.90 | 101.92 | 49.87 |
| 3rd Floor | 101.92 | 49.90 | 101.68 | 50.26 |
| 2nd Floor | 101.92 | 49.89 | 101.68 | 50.25 |
| 1st Floor | 101.92 | 49.89 | 101.68 | 50.92 |

A straight comparison of the center of rigidity and center of mass shows that they do coincide almost exactly. The dimensions of 329 Innovation Boulevard are approximately 203'x100', which means the location of the center of mass/rigidity is at the center of building. However, according to code, "where diaphragms are not flexible, the mass at each level shall be assumed to be displaced from the calculated center of mass in each direction a distance equal to 5% of the building dimension at that level perpendicular to the direction of the force under consideration. The effect of this displacement on the story shear distribution shall be considered." RAM Frame has accounted for the 5% eccentricity, and the values remain practically identical. The symmetry of 329 Innovation Boulevard in both layout and member sizes aspects have adequately resisted any possible torsional moment created by the lateral loads. No torsional forces have been prepared due to the fact that they will be very minimal. The rotations of nodal points on the fourth floor are located in Appendix A.5, and the greatest rotation is about 0.15" which is negligible. Therefore, 329 Innovation Boulevard's design has done an exceptional job foreseeing possible torsional problems and accounted for them.

The overall overturning moment was found to be 10,035'$^{K}$ due to the wind load acting in the North/South direction (Refer to Wind Loading under the Load Cases Section). Each moment resisting frame will experience an overturning moment as well. This moment will be transferred to the foundation, and it is up to the foundation to resist these moments. Due to the symmetry of 329 Innovation Boulevard, the overturning moments of the frames located on the left side of the plan will be the same as those located on the right side. Refer back to Figure 2.1 for the location of the resisting frames. The following table compares the overturning moments of each frame to the resisting moments. If the overturning moment exceeds that of the resisting moment, then additive tension reinforcing is required at the foundation.

**Moment Comparison**

| Frame | Grid Line Location | | Overturning Moment | Resisting Moment | Tension |
|---|---|---|---|---|---|
| | Left Side | Right Side | (Ft.-Kips) | (Ft.-Kips) | Req'd |
| A-D | Along #2 | Along #7 | 10,035 | 150,000 | No |
| B | 1-2 | 6-8 | 3,885 | 9,990 | No |
| C | 1-2 | 6-8 | 3,885 | 9,990 | No |

The comparison shows that no tension steel is required to resist the overturning moments. The dead loads alone are adequate. Foundations are discussed in the next section, and it is noted that micropiles are used as anchorage. Although they are not required because of the overturning moment, they may be used for other uplift forces not explored.

The foundation system consists of grade beams and pile caps. The first floor is a slab-on-grade, which consists of 4" normal weight concrete reinforced with fibrous reinforcement. The pile caps are anchored by micropiles, which consist of 7" O.D. steel casing specified by the contractor. These micropiles span a certain length past the competent limestone, which is determined by the specialty contractor. The moments due to the lateral and gravity loads are transferred from the columns into the footings. The largest footings are located under the lateral resisting frames, due to the fact that they see majority of the overturning moments. The largest footings are located under the frames that span along the #2 and #7 grid lines. Their dimensions are 9'-0"x9'-0"x2'-9". The following are typical foundation details:

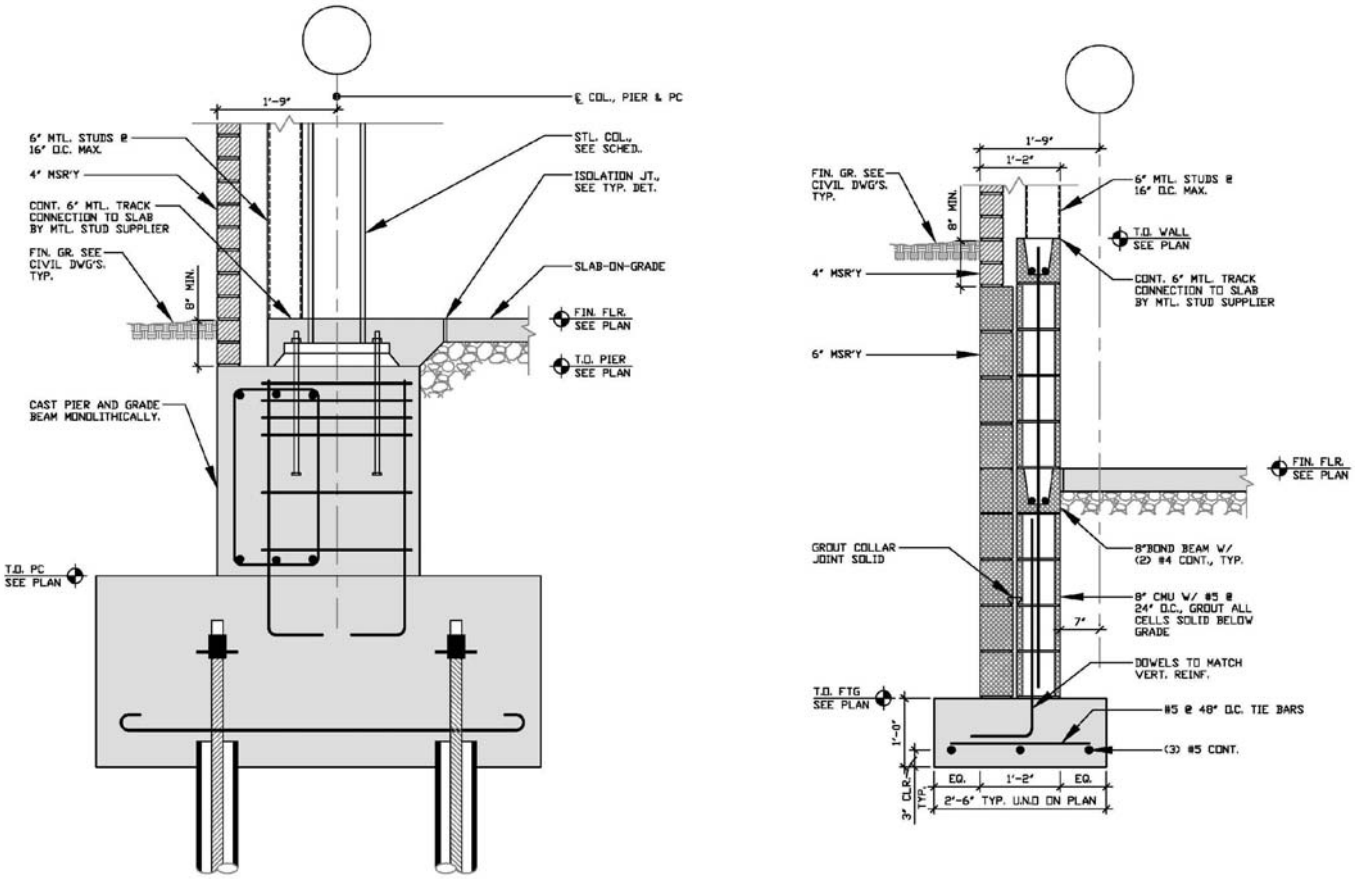



Figure 16.1

**(See Appendix A.7 For Larger Scale)**

The following is a list of conclusions that can be made after analyzing the lateral resisting frames of 329 Innovation Boulevard:

- Wind loads control over seismic loads. Although 329 is only 58' tall, it is not unusual that the wind controls, because State College is an area of very little seismic activity.
- The wind load creates story forces and story shears. The overall base shear designed for is 270 Kips.
- RAM Frame was utilized to analyze the structure under the controlling load case: 1.2D + 0.5L + 1.6W. The story forces and story shears found using RAM are relatively close to the values obtained by hand calculations. The comparable base shears are 281 Kips (RAM) to 270 Kips (Hand).
- A strength check was done by RAM Frame using numerous load combinations including the controlling one mentioned before. All members used less than 80% of the maximum capacity with majority using less than 50%.
- The lateral resisting system was checked by a hand calculation, and the results were that the members were adequate to handle the loads.
- Drift analysis was performed and every floor's displacement was less than the industry standard of H/100 except for the roof. There is a lot of dead load not taken into consideration on the roof (i.e. mechanical penthouse) that may help to reduce this displacement.
- The locations of the center of rigidity and center of mass are practically the same. The accidental torsional eccentricity of 5% has been taken under consideration using RAM. Due to the locations of the centers of mass and rigidity being the same, negligible torsional forces are applied to the structure.
- The resisting moments is greater than the overturning moments. Therefore, tension steel is not required at the foundation, but is provided by introducing micropiles to the pile caps.

# Drift

RAM Frame v11.0
DataBase: 329 Inn Blvd
Building Code: IBC Steel Code: IBC

**CRITERIA:**

Rigid End Zones: Ignore Effects
Member Force Output: At Face of Joint
P-Delta: Yes Scale Factor: 1.00
Diaphragm: Rigid
Ground Level: Base

**LOAD CASE DEFINITIONS:**

| | | |
|---|---|---|
| D | DeadLoad | RAMUSER |
| Lp | PosLiveLoad | RAMUSER |
| W1 | Wind | W_User |

**RESULTS:**

**Location (ft): (59.555, 66.290)**

| Story | LdC | Displacement X in | Displacement Y in | Story Drift X in | Story Drift Y in | Drift Ratio X | Drift Ratio Y |
|---|---|---|---|---|---|---|---|
| FOURTH | D | 0.0001 | 0.0017 | 0.0000 | 0.0007 | 0.0000 | 0.0000 |
| | Lp | 0.0003 | 0.0045 | 0.0002 | 0.0013 | 0.0000 | 0.0000 |
| | W1 | 0.0000 | 1.8715 | -0.0000 | 0.4494 | 0.0000 | 0.0023 |
| THIRD | D | 0.0000 | 0.0011 | 0.0000 | 0.0005 | 0.0000 | 0.0000 |
| | Lp | 0.0001 | 0.0023 | 0.0001 | 0.0015 | 0.0000 | 0.0000 |
| | W1 | 0.0000 | 1.4221 | 0.0000 | 0.5321 | 0.0000 | 0.0032 |
| SECOND | D | 0.0000 | 0.0006 | 0.0000 | 0.0004 | 0.0000 | 0.0000 |
| | Lp | 0.0000 | 0.0018 | 0.0000 | 0.0012 | 0.0000 | 0.0000 |
| | W1 | 0.0000 | 0.8899 | 0.0000 | 0.4853 | 0.0000 | 0.0029 |
| FIRST | D | -0.0000 | 0.0002 | -0.0000 | 0.0002 | 0.0000 | 0.0000 |
| | Lp | -0.0000 | 0.0006 | -0.0000 | 0.0006 | 0.0000 | 0.0000 |
| | W1 | 0.0000 | 0.4047 | 0.0000 | 0.4047 | 0.0000 | 0.0024 |

# Building Story Shears

RAM Frame v11.0
DataBase: 329 Inn Blvd

**CRITERIA:**

Rigid End Zones: Ignore Effects
Member Force Output: At Face of Joint
P-Delta: Yes Scale Factor: 1.00
Ground Level: Base
Wall Mesh Criteria :
Wall Element Type : Shell Element with No Out-of-Plane Stiffness
Max. Allowed Distance between Nodes (ft) : 8.00

**Load Case: D DeadLoad RAMUSER**

| Level | Diaph. # | Shear-X kips | Shear-Y kips |
|---|---|---|---|
| FOURTH | 1 | 0.00 | 0.01 |
| THIRD | 1 | 0.00 | 0.01 |
| SECOND | 1 | 0.00 | 0.01 |
| FIRST | 1 | 0.00 | 0.01 |

**Summary - Total Story Shears**

| Level | Shear-X kips | Change-X kips | Shear-Y kips | Change-Y kips |
|---|---|---|---|---|
| FOURTH | 0.00 | 0.00 | 0.01 | 0.01 |
| THIRD | 0.00 | 0.00 | 0.01 | 0.00 |
| SECOND | 0.00 | 0.00 | 0.01 | 0.00 |
| FIRST | 0.00 | -0.00 | 0.01 | -0.00 |

**Load Case: Lp PosLiveLoad RAMUSER**

| Level | Diaph. # | Shear-X kips | Shear-Y kips |
|---|---|---|---|
| FOURTH | 1 | 0.00 | 0.02 |
| THIRD | 1 | -0.02 | 0.01 |
| SECOND | 1 | 0.00 | 0.04 |
| FIRST | 1 | 0.00 | 0.02 |

**Summary - Total Story Shears**

| Level | Shear-X kips | Change-X kips | Shear-Y kips | Change-Y kips |
|---|---|---|---|---|
| FOURTH | 0.00 | 0.00 | 0.02 | 0.02 |
| THIRD | -0.02 | -0.02 | 0.01 | -0.01 |
| SECOND | 0.00 | 0.02 | 0.04 | 0.03 |
| FIRST | 0.00 | -0.00 | 0.02 | -0.02 |

**Load Case: W1 Wind W_User**

| Level | Diaph. # | Shear-X kips | Shear-Y kips |
|---|---|---|---|
| FOURTH | 1 | 0.00 | 85.82 |

# Building Story Shears

RAM Frame v11.0
DataBase: 329 Inn Blvd

| | | | |
|---|---|---|---|
| THIRD | 1 | 0.00 | 150.44 |
| SECOND | 1 | 0.00 | 218.22 |
| FIRST | 1 | 0.00 | 281.00 |

**Summary - Total Story Shears**

| Level | Shear-X kips | Change-X kips | Shear-Y kips | Change-Y kips |
|---|---|---|---|---|
| FOURTH | 0.00 | 0.00 | 85.82 | 85.82 |
| THIRD | 0.00 | 0.00 | 150.44 | 64.62 |
| SECOND | 0.00 | 0.00 | 218.22 | 67.78 |
| FIRST | 0.00 | 0.00 | 281.00 | 62.78 |

# Criteria, Mass and Exposure Data

RAM Frame v11.0
DataBase: 329 Inn Blvd

**CRITERIA:**

Rigid End Zones: Ignore Effects
Member Force Output: At Face of Joint
P-Delta: Yes Scale Factor: 1.00
Ground Level: Base
Wall Mesh Criteria :
Wall Element Type : Shell Element with No Out-of-Plane Stiffness
Max. Allowed Distance between Nodes (ft) : 8.00

**DIAPHRAGM DATA:**

| Story | Diaph # | Diaph Type |
|---|---|---|
| FOURTH | 1 | Rigid |
| THIRD | 1 | Rigid |
| SECOND | 1 | Rigid |
| FIRST | 1 | Rigid |

Disconnect Internal Nodes of Beams: Yes
Disconnect Nodes outside Slab Boundary: Yes

**STORY MASS DATA:**

**Includes Self Mass of:**

Beams
Columns (Half mass of columns above and below)
Walls (Half mass of walls above and below)
Slabs/Deck

**Calculated Values:**

| Story | Diaph # | Weight kips | Mass k-s2/ft | MMI ft-k-s2 | Xm ft | Ym ft | EccX ft | EccY ft |
|---|---|---|---|---|---|---|---|---|
| FOURTH | 1 | 1077.4 | 33.46 | 147015 | 101.92 | 49.87 | 10.25 | 5.05 |
| THIRD | 1 | 1176.0 | 36.52 | 166154 | 101.68 | 50.26 | 10.30 | 5.10 |
| SECOND | 1 | 1182.0 | 36.71 | 167350 | 101.68 | 50.25 | 10.30 | 5.10 |
| FIRST | 1 | 1174.0 | 36.46 | 167851 | 101.68 | 50.92 | 10.30 | 5.10 |

| Story | Diaph # | Combine |
|---|---|---|
| FOURTH | 1 | None |
| THIRD | 1 | None |
| SECOND | 1 | None |
| FIRST | 1 | None |

**WIND EXPOSURE DATA:**

**Calculated Values:**

| Story | Diaph # | Building Extents (ft) | | | | Expose | Parapet ft |
|---|---|---|---|---|---|---|---|
| | | Min X | Max X | Min Y | Max Y | | |
| FOURTH | 1 | -0.58 | 204.42 | -0.58 | 100.42 | Full | 0.00 |
| THIRD | 1 | -1.08 | 204.92 | -1.08 | 100.92 | Full | 0.00 |
| SECOND | 1 | -1.08 | 204.92 | -1.08 | 100.92 | Full | 0.00 |
| FIRST | 1 | -1.08 | 204.92 | -1.08 | 100.92 | Full | 0.00 |

# Center of Rigidity

RAM Frame v11.0
DataBase: 329 Inn Blvd

**CRITERIA:**

Rigid End Zones: Ignore Effects
Member Force Output: At Face of Joint
P-Delta: Yes Scale Factor: 1.00
Ground Level: Base
Wall Mesh Criteria :
Wall Element Type : Shell Element with No Out-of-Plane Stiffness
Max. Allowed Distance between Nodes (ft) : 8.00

| Level | Diaph. # | Centers of Rigidity Xr ft | Yr ft | Centers of Mass Xm ft | Ym ft |
|---|---|---|---|---|---|
| FOURTH | 1 | 101.92 | 49.90 | 101.92 | 49.87 |
| THIRD | 1 | 101.92 | 49.90 | 101.68 | 50.26 |
| SECOND | 1 | 101.92 | 49.89 | 101.68 | 50.25 |
| FIRST | 1 | 101.92 | 49.89 | 101.68 | 50.92 |

# Nodal Displacements

RAM Frame v11.0
DataBase: 329 Inn Blvd

**CRITERIA:**

| | | | |
|---|---|---|---|
| Rigid End Zones: | | Ignore Effects | |
| Member Force Output: | | At Face of Joint | |
| P-Delta: | Yes | Scale Factor: | 1.00 |
| Diaphragm: | Rigid | | |
| Ground Level: | Base | | |

Wall Mesh Criteria :
Max. Allowed Distance between Nodes (ft) : 8.00

**LOAD CASES:**

| | | |
|---|---|---|
| D | DeadLoad | RAMUSER |
| Lp | PosLiveLoad | RAMUSER |
| W1 | Wind | W_User |
| E1 | Siesmic | EQ_User |

Note: Nodal Displacements for Live Load Cases are based on Unreduced Live Loads.

**Frame #0**

**Level: FOURTH**

| Node | LdC | Disp X in | Disp Y in | Disp Z in | Theta X (rad) | Theta Y (rad) | Theta Z (rad) |
|---|---|---|---|---|---|---|---|
| 1 | D | 0.00074 | 0.00053 | -0.03917 | -0.00048 | 0.00120 | 0.00000 |
| | Lp | 0.00204 | 0.00133 | -0.07696 | -0.00010 | 0.00048 | 0.00000 |
| | W1 | -0.00001 | 1.87157 | 0.00699 | -0.00052 | 0.00001 | -0.00000 |
| | E1 | -0.00014 | 0.51838 | 0.00202 | -0.00016 | 0.00000 | -0.00000 |
| 2 | D | 0.00007 | 0.00053 | -0.03918 | 0.00048 | 0.00120 | 0.00000 |
| | Lp | 0.00025 | 0.00133 | -0.07698 | 0.00010 | 0.00048 | 0.00000 |
| | W1 | 0.00001 | 1.87157 | -0.00699 | -0.00052 | -0.00001 | -0.00000 |
| | E1 | 0.00014 | 0.51838 | -0.00202 | -0.00016 | -0.00000 | -0.00000 |
| 3 | D | 0.00141 | 0.00113 | -0.02519 | -0.00028 | 0.00000 | 0.00000 |
| | Lp | 0.00383 | 0.00293 | -0.04607 | -0.00007 | 0.00001 | 0.00000 |
| | W1 | -0.00003 | 1.87155 | 0.00840 | -0.00125 | 0.00000 | -0.00000 |
| | E1 | -0.00041 | 0.51814 | 0.00244 | -0.00039 | 0.00000 | -0.00000 |
| 4 | D | 0.00074 | 0.00113 | -0.04957 | 0.00001 | 0.00005 | 0.00000 |
| | Lp | 0.00204 | 0.00293 | -0.09486 | -0.00007 | 0.00010 | 0.00000 |
| | W1 | -0.00001 | 1.87155 | -0.00162 | -0.00075 | 0.00000 | -0.00000 |
| | E1 | -0.00014 | 0.51814 | -0.00048 | -0.00023 | 0.00000 | -0.00000 |
| 5 | D | 0.00007 | 0.00113 | -0.04956 | -0.00002 | 0.00005 | 0.00000 |
| | Lp | 0.00025 | 0.00293 | -0.09486 | 0.00007 | 0.00010 | 0.00000 |
| | W1 | 0.00001 | 1.87155 | 0.00162 | -0.00075 | -0.00000 | -0.00000 |
| | E1 | 0.00014 | 0.51814 | 0.00048 | -0.00023 | -0.00000 | -0.00000 |
| 6 | D | -0.00060 | 0.00113 | -0.02520 | 0.00028 | -0.00000 | 0.00000 |
| | Lp | -0.00153 | 0.00293 | -0.04610 | 0.00007 | -0.00000 | 0.00000 |
| | W1 | 0.00003 | 1.87155 | -0.00840 | -0.00125 | -0.00000 | -0.00000 |
| | E1 | 0.00041 | 0.51814 | -0.00244 | -0.00039 | -0.00000 | -0.00000 |
| 7 | D | 0.00074 | 0.00174 | -0.07178 | -0.00071 | -0.00117 | 0.00000 |

# Nodal Displacements

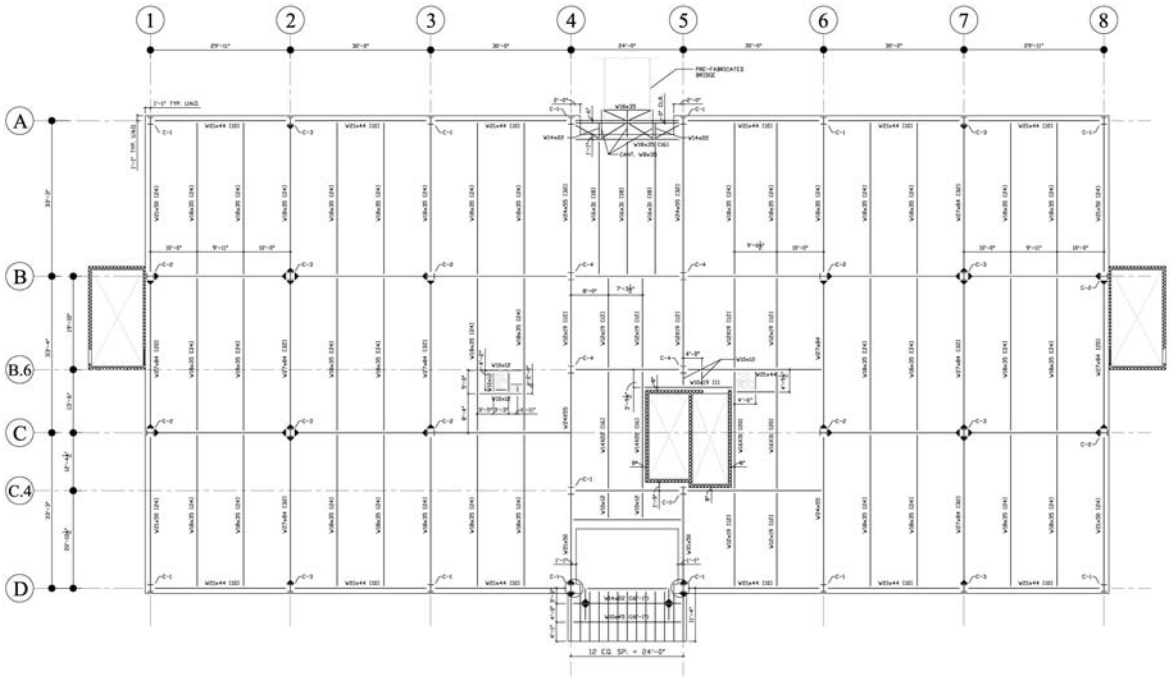
RAM Frame v11.0
DataBase: 329 Inn Blvd

| Node | LdC | Disp X | Disp Y | Disp Z | Theta X | Theta Y | Theta Z |
|---|---|---|---|---|---|---|---|
| | Lp | 0.00204 | 0.00454 | -0.14857 | -0.00019 | -0.00039 | 0.00000 |
| | W1 | -0.00001 | 1.87153 | 0.00699 | -0.00052 | -0.00001 | -0.00000 |
| | E1 | -0.00014 | 0.51790 | 0.00202 | -0.00016 | -0.00000 | -0.00000 |
| 8 | D | 0.00007 | 0.00174 | -0.07180 | 0.00070 | -0.00118 | 0.00000 |
| | Lp | 0.00025 | 0.00454 | -0.14859 | 0.00019 | -0.00040 | 0.00000 |
| | W1 | 0.00001 | 1.87153 | -0.00699 | -0.00052 | 0.00001 | -0.00000 |
| | E1 | 0.00014 | 0.51790 | -0.00202 | -0.00016 | 0.00000 | -0.00000 |
| 9 | D | 0.00074 | 0.00343 | -0.06906 | -0.00160 | 0.00118 | 0.00000 |
| | Lp | 0.00204 | 0.00906 | -0.13974 | -0.00062 | 0.00041 | 0.00000 |
| | W1 | -0.00001 | 1.87147 | 0.00699 | -0.00052 | 0.00001 | -0.00000 |
| | E1 | -0.00014 | 0.51721 | 0.00202 | -0.00016 | 0.00000 | -0.00000 |
| 10 | D | 0.00007 | 0.00343 | -0.07218 | 0.00144 | 0.00117 | 0.00000 |
| | Lp | 0.00025 | 0.00906 | -0.15084 | 0.00049 | 0.00039 | 0.00000 |
| | W1 | 0.00001 | 1.87147 | -0.00699 | -0.00052 | -0.00001 | -0.00000 |
| | E1 | 0.00014 | 0.51721 | -0.00202 | -0.00016 | -0.00000 | -0.00000 |
| 11 | D | 0.00141 | 0.00403 | -0.02518 | -0.00028 | 0.00000 | 0.00000 |
| | Lp | 0.00383 | 0.01067 | -0.04603 | -0.00008 | 0.00001 | 0.00000 |
| | W1 | -0.00003 | 1.87145 | 0.00840 | -0.00125 | 0.00000 | -0.00000 |
| | E1 | -0.00041 | 0.51697 | 0.00244 | -0.00039 | 0.00000 | -0.00000 |
| 12 | D | 0.00074 | 0.00403 | -0.04955 | 0.00001 | -0.00005 | 0.00000 |
| | Lp | 0.00204 | 0.01067 | -0.09480 | -0.00008 | -0.00008 | 0.00000 |
| | W1 | -0.00001 | 1.87145 | -0.00162 | -0.00075 | -0.00000 | -0.00000 |
| | E1 | -0.00014 | 0.51697 | -0.00048 | -0.00023 | -0.00000 | -0.00000 |
| 13 | D | 0.00007 | 0.00403 | -0.04956 | -0.00002 | -0.00005 | 0.00000 |
| | Lp | 0.00025 | 0.01067 | -0.09487 | 0.00007 | -0.00010 | 0.00000 |
| | W1 | 0.00001 | 1.87145 | 0.00162 | -0.00075 | 0.00000 | -0.00000 |
| | E1 | 0.00014 | 0.51697 | 0.00048 | -0.00023 | 0.00000 | -0.00000 |
| 14 | D | -0.00060 | 0.00403 | -0.02522 | 0.00027 | -0.00000 | 0.00000 |
| | Lp | -0.00153 | 0.01067 | -0.04614 | 0.00006 | -0.00000 | 0.00000 |
| | W1 | 0.00003 | 1.87145 | -0.00840 | -0.00125 | -0.00000 | -0.00000 |
| | E1 | 0.00041 | 0.51697 | -0.00244 | -0.00039 | -0.00000 | -0.00000 |
| 15 | D | 0.00074 | 0.00464 | -0.03917 | -0.00048 | -0.00120 | 0.00000 |
| | Lp | 0.00204 | 0.01228 | -0.07696 | -0.00010 | -0.00048 | 0.00000 |
| | W1 | -0.00001 | 1.87143 | 0.00699 | -0.00052 | -0.00001 | -0.00000 |
| | E1 | -0.00014 | 0.51673 | 0.00202 | -0.00016 | -0.00000 | -0.00000 |
| 16 | D | 0.00007 | 0.00464 | -0.03919 | 0.00047 | -0.00120 | 0.00000 |
| | Lp | 0.00025 | 0.01228 | -0.07702 | 0.00009 | -0.00047 | 0.00000 |
| | W1 | 0.00001 | 1.87143 | -0.00699 | -0.00052 | 0.00001 | -0.00000 |
| | E1 | 0.00014 | 0.51673 | -0.00202 | -0.00016 | 0.00000 | -0.00000 |

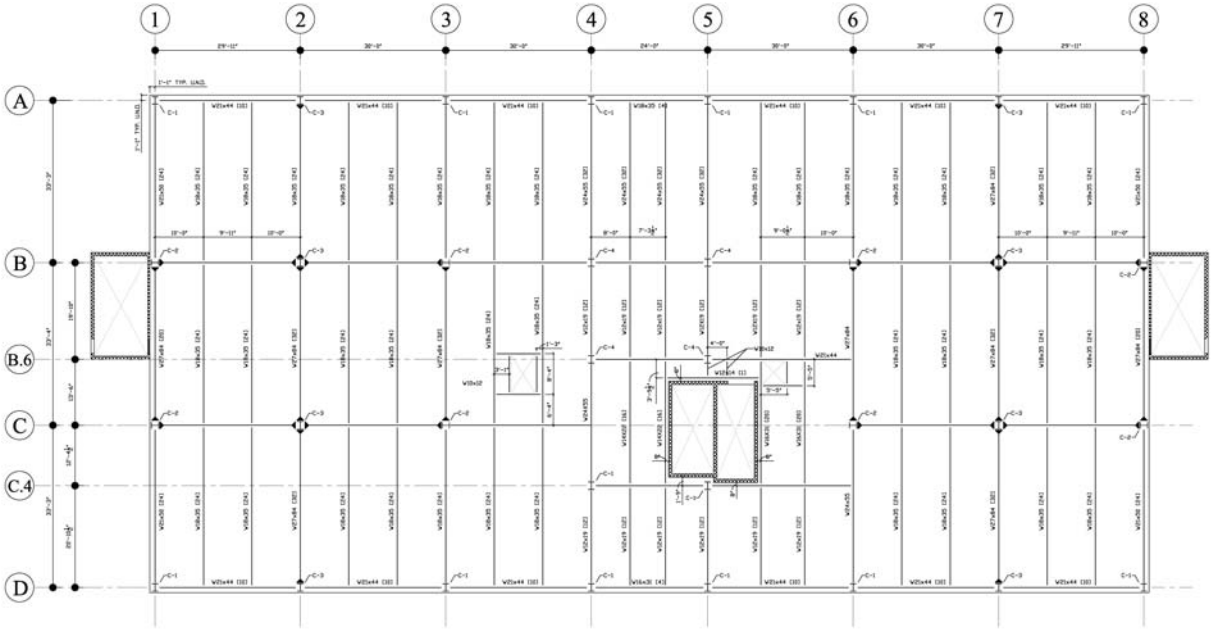
**Level: THIRD**

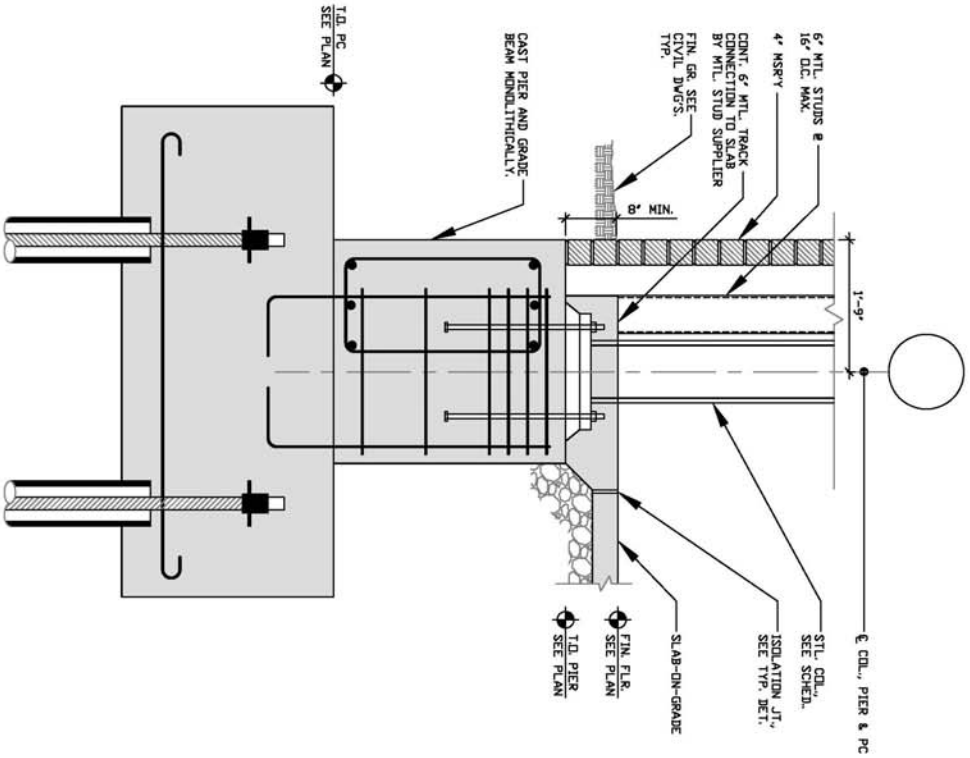
| Node | LdC | Disp X in | Disp Y in | Disp Z in | Theta X (rad) | Theta Y (rad) | Theta Z (rad) |
|---|---|---|---|---|---|---|---|
| 17 | D | 0.00045 | 0.00033 | -0.03415 | -0.00035 | 0.00056 | 0.00000 |
| | Lp | 0.00133 | 0.00100 | -0.07355 | -0.00098 | 0.00222 | 0.00000 |

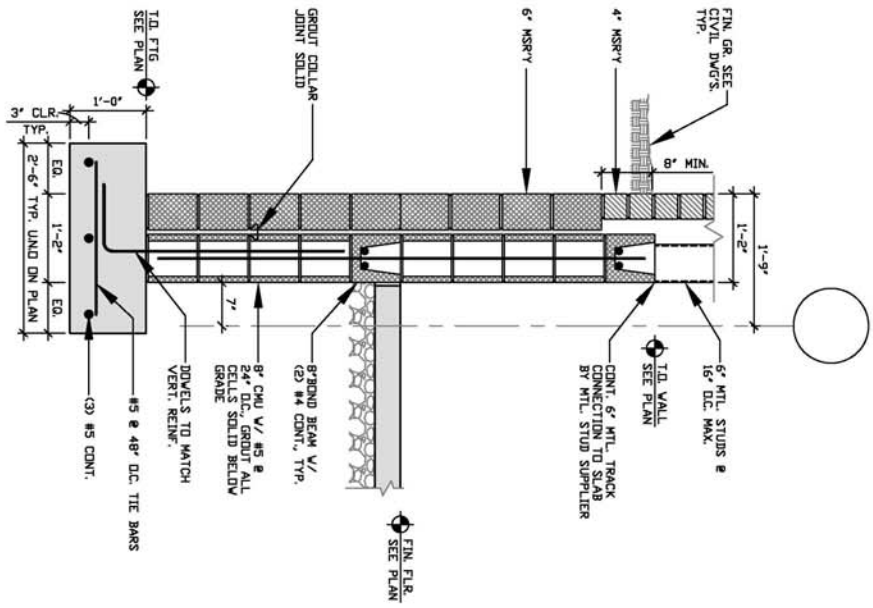
## Second Floor Framing Plan




## Typical Framing Plan




T.O. PC
SEE PLAN
CAST PIER AND GRADE BEAM MONOLITHICALLY.
FIN. GR. SEE CIVIL DWG'S. TYP.
CONT. 6" MTL. TRACK CONNECTION TO SLAB BY MTL. STUD SUPPLIER
4" MSRY
6" MTL. STUDS @ 16" O.C. MAX.
8" MIN.
1'-9"
℄ COL., PIER & PC
STL. COL. SEE SCHED.
ISOLATION JT., SEE TYP. DET.
SLAB-ON-GRADE
FIN. FLR. SEE PLAN
T.O. PIER SEE PLAN


T.O. FTG SEE PLAN
1'-0"
3" CLR. TYP.
EQ.
2'-6" TYP. UNO ON PLAN
1'-2"
EQ.
GROUT COLLAR JOINT SOLID
6" MSRY
4" MSRY
FIN. GR. SEE CIVIL DWG'S. TYP.
8" MIN.
1'-2"
1'-9"
7"
8" CMU W/ #5 @ 24" O.C., GROUT ALL CELLS SOLID BELOW GRADE
8"BOND BEAM W/ (2) #4 CONT., TYP.
DOVELS TO MATCH VERT. REINF.
(3) #5 CONT.
#5 @ 48" O.C. TIE BARS
CONT. 6" MTL. TRACK CONNECTION TO SLAB BY MTL. STUD SUPPLIER
T.O. WALL SEE PLAN
6" MTL. STUDS @ 16" O.C. MAX.
FIN. FLR. SEE PLAN