STRUCTURAL EXISTING CONDITIONS REPORT

THE BRENDAN IRIBE CENTER FOR
COMPUTER SCIENCE AND INNOVATION

COLLEGE PARK, MD

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Structural Option

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Executive Summary

As one of the world's top computer science institutions, the University of Maryland continues to grow. There is no longer enough room in the existing facilities to keep up with the latest advancements in virtual reality. The Brendan Iribe Center for Computer Science and Innovation will help separate the University of Maryland from its competitors.

Six stories of collaborative classrooms, research labs, seminar rooms, offices, and many common areas will welcome students and faculty alike. A 300-seat auditorium will provide the University of Maryland an opportunity to showcase its latest research such as cybersecurity, computational biology, and quantum computing. The open floor plans will help promote collaborating amongst peers, and ultimately set these students up for successful careers.

Structurally, the Brendan Iribe Center for Computer Science and Innovation utilizes steel wide flange girders and columns to support gravity loads. The curvilinear shape of the building results in unequal bays as infill beams change as the shape of the building changes. Due to the irregular shape, there are several unique components of this system such as curved HSS beams along the southern wall. The 300- seat Antonov Auditorium utilizes wide flange girders and columns, as well as a 90' truss to support the different levels and roof.

From a lateral standpoint, the Brendan Iribe Center for Computer Science and Innovation uses ordinary moment frames and vertical trusses throughout each wing of the building and the auditorium. All loads are in accordance with the 2015 International Building Code and ASCE 7-10.

This report will provide a detailed analysis of the current structural system of the building. Upon completion, this report will be used for reference for the following technical reports.

Table of Contents

1. Introduction

1.1 Purpose and Scope

The Structural Existing Conditions Report will analyze the existing structure of the Brendan Iribe Center for Computer Science and Innovation. A detailed overview of the building's foundation, gravity system, and lateral system will be provided emphasizing how these components work together as a system. After completion, this report will be referenced for the following technical reports including Building Codes, Gravity Analysis, and Lateral Analysis.

1.2 General Building Description

Figure 1: Rendering from north-east

The Brendan Iribe Center for Computer Science and Innovation (ICCSI) will increase the number of classrooms available and help sustain the University of Maryland as the leader in virtual reality research. Students and faculty will be provided with a magnificent six story building that will house eight collaborative classrooms, thirteen research labs, five conference rooms, offices, tutoring centers, a café, as well as many common areas. Adjacent to the boomerang shaped main tower will be the 300-seat Antonov Auditorium pictured below which will help the university showcase the latest advancements in the field of virtual reality.

With a main design goal of maximizing collaboration amongst classmates, the curtain wall façade will allow natural lighting to illuminate the buildings open floor plans and common spaces. Another feature of the structure includes a 30 foot cantilever on the west end and a 120 foot cantilever on the east end. Six sloping columns inset from the north and south edge of the building will support this massive cantilever on the east end. Figure 2 below shows the first floor plan, with the highlighted section designating the cantilevers.

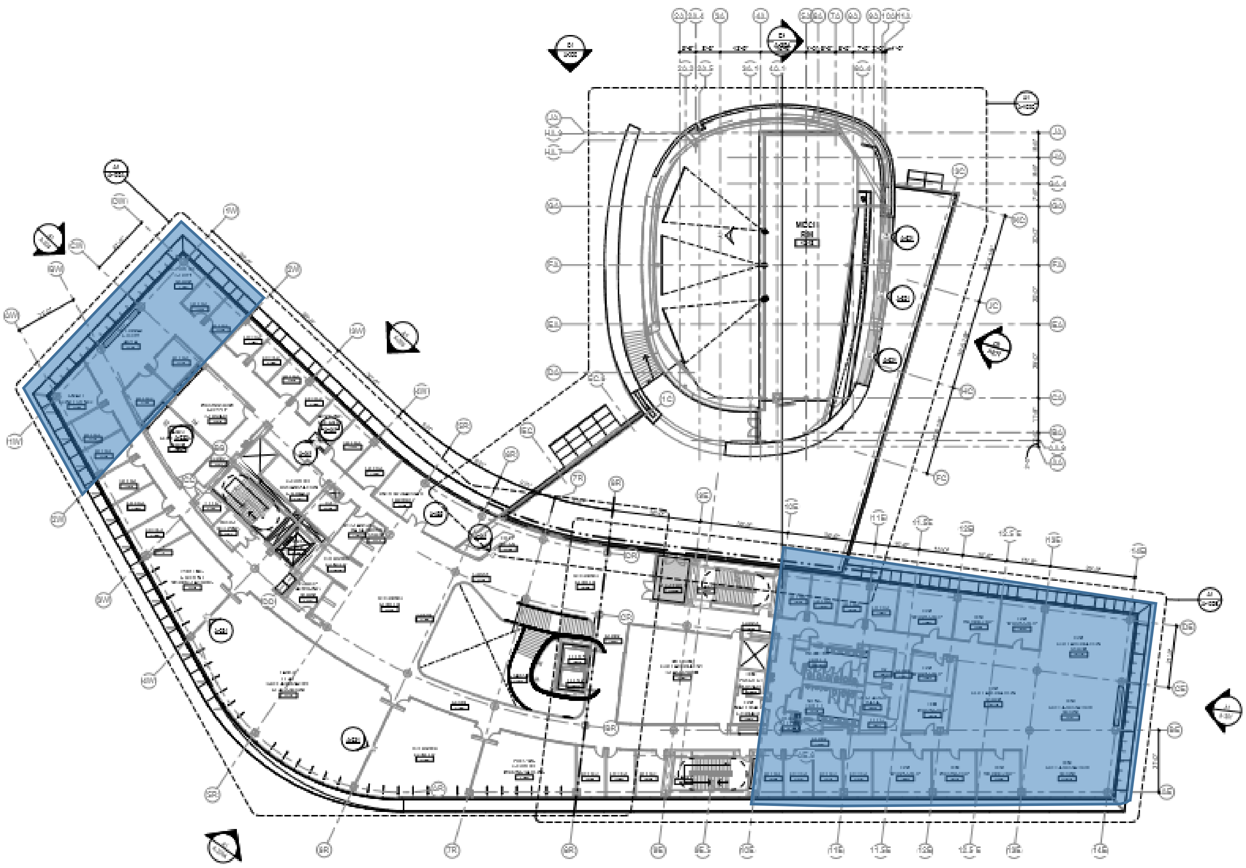


Figure 2: Plan showing cantilevers

1.3 Structural Framing System

The Brendan Iribe CCSI is a composite steel building that uses wide flange girders and columns. Due to the curvilinear sides of the building, structural bays will be of varied sizes. Girders running in the east-west direction and following the curve typically have 30 foot spans, while the filler beams range from 20'-42' based on the column layout. Typical columns range from W12 to W14.The Auditorium only has exterior columns to keep the interior an open space. A 90 foot truss spanning from the north to south supports the roof. The lateral system includes vertical trusses and moment frames at the east and west end of the main tower. The following sections will expand on the structural system of this building.

2. Structural Systems

2.1 Foundation

Based on the geotechnical report, spread footings are suitable for use on this project. The bottom of all exterior columns are 4' minimum below grade while the top of all interior footings are 1' minimum below finished floor elevation. At the basement level, the footings can bear at a nominal depth, but footings founded below the first floor will need to be dropped about ten to twelve feet to reach competent bearing. An allowable bearing pressure of 5000 PSF has been used. Figure 3 shows a typical interior column footing without a pier and a typical column footing at an exterior wall.

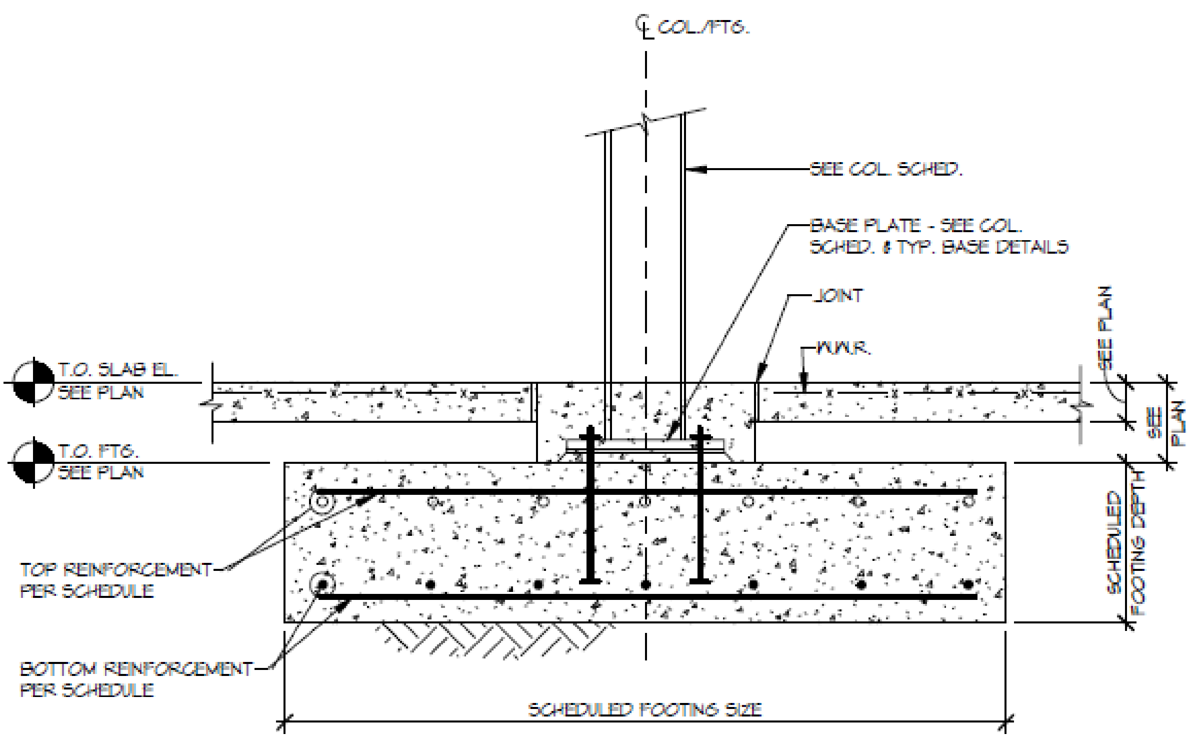


Figure 3: Typical interior column footing without pier

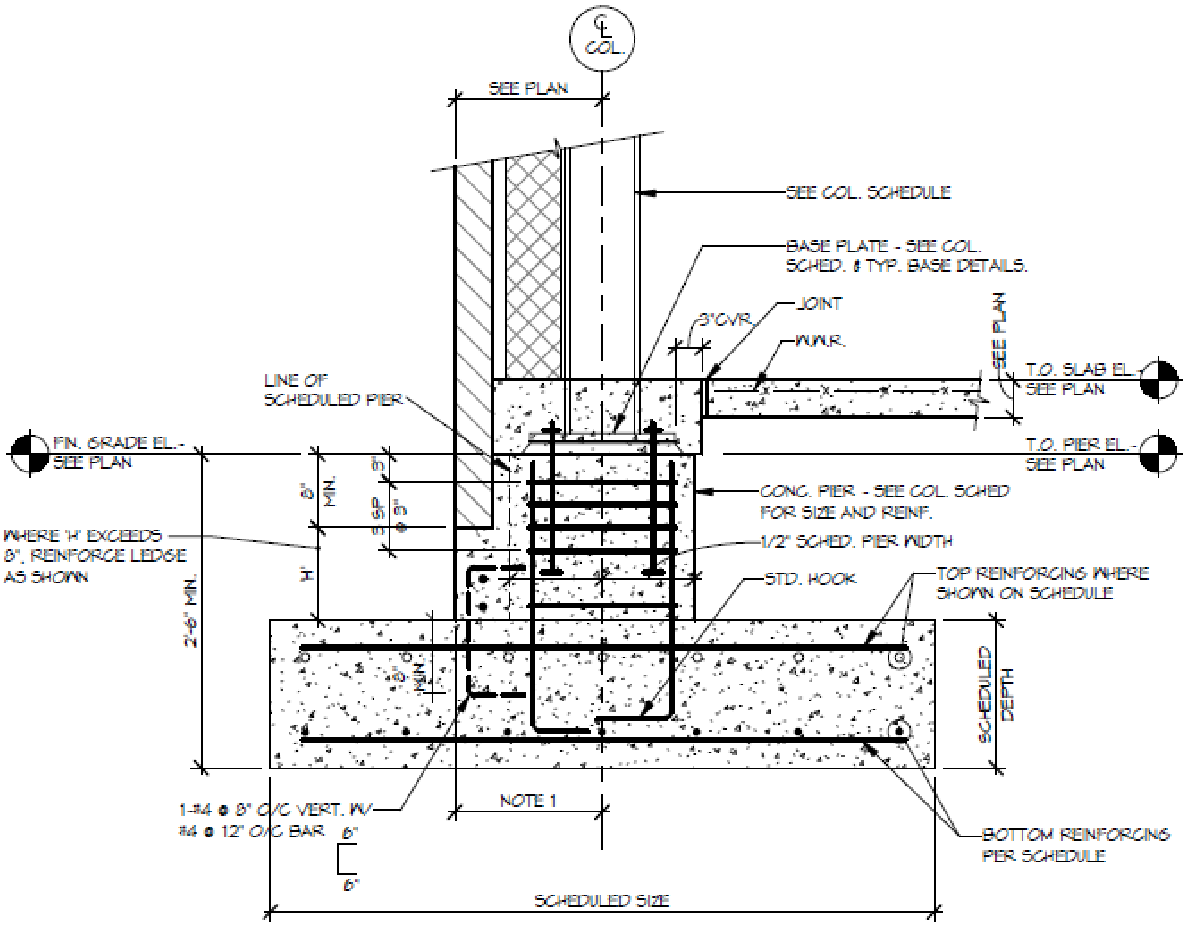


Figure 4: Typical column foundation at exterior wall

Due to the partial basement being located within the 500 year flood plain, the walls and slab on grade need to be designed for hydrostatic pressure. As a result, a 48” thick mat slab located 3’ below the top of the finished basement floor will be the foundation for columns that end at the basement level. Basement walls are 20” thick and continuous wall footings are 3’ wide x 1’-6” deep reinforced with 3- # 5 bars.

2.2 Gravity System

2.2.1 Typical Bay

As previously stated, the boomerang shaped building results in varied bay sizes along the building. At the far east and west ends, infill beams only span about 20’. However, at the center of the building where the north-south distance of the building is at its greatest, infill beams span up to 42’. Figure 5 shows a bay at the east end of the building. Typical girders are 29’ W 21X50 with 30 studs, while infill beams are W21’s with 30 studs ranging from 16’ to 22’. Infill beams are spaced about 10’ o.c.

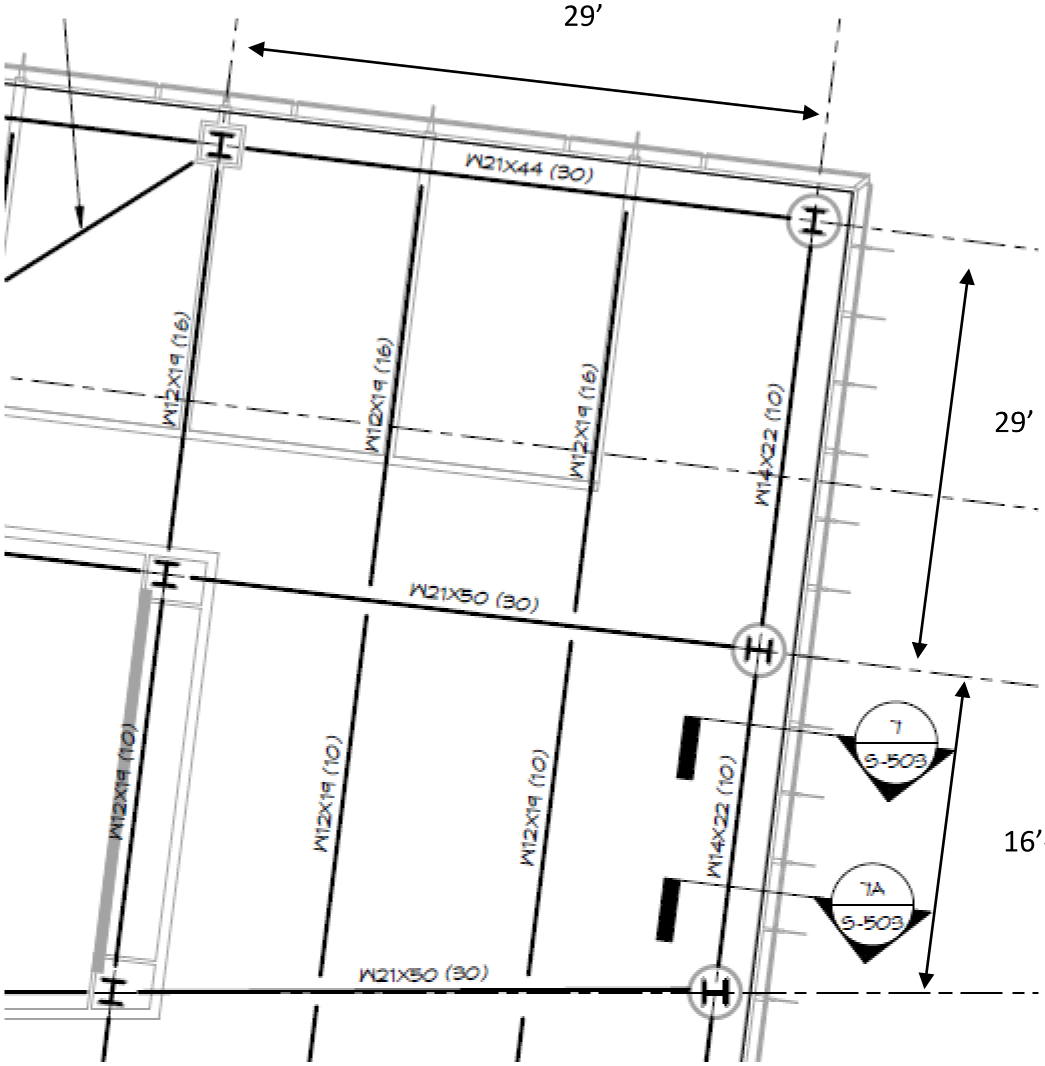


Figure 5: Bay in eastern wing

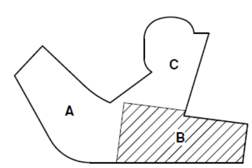
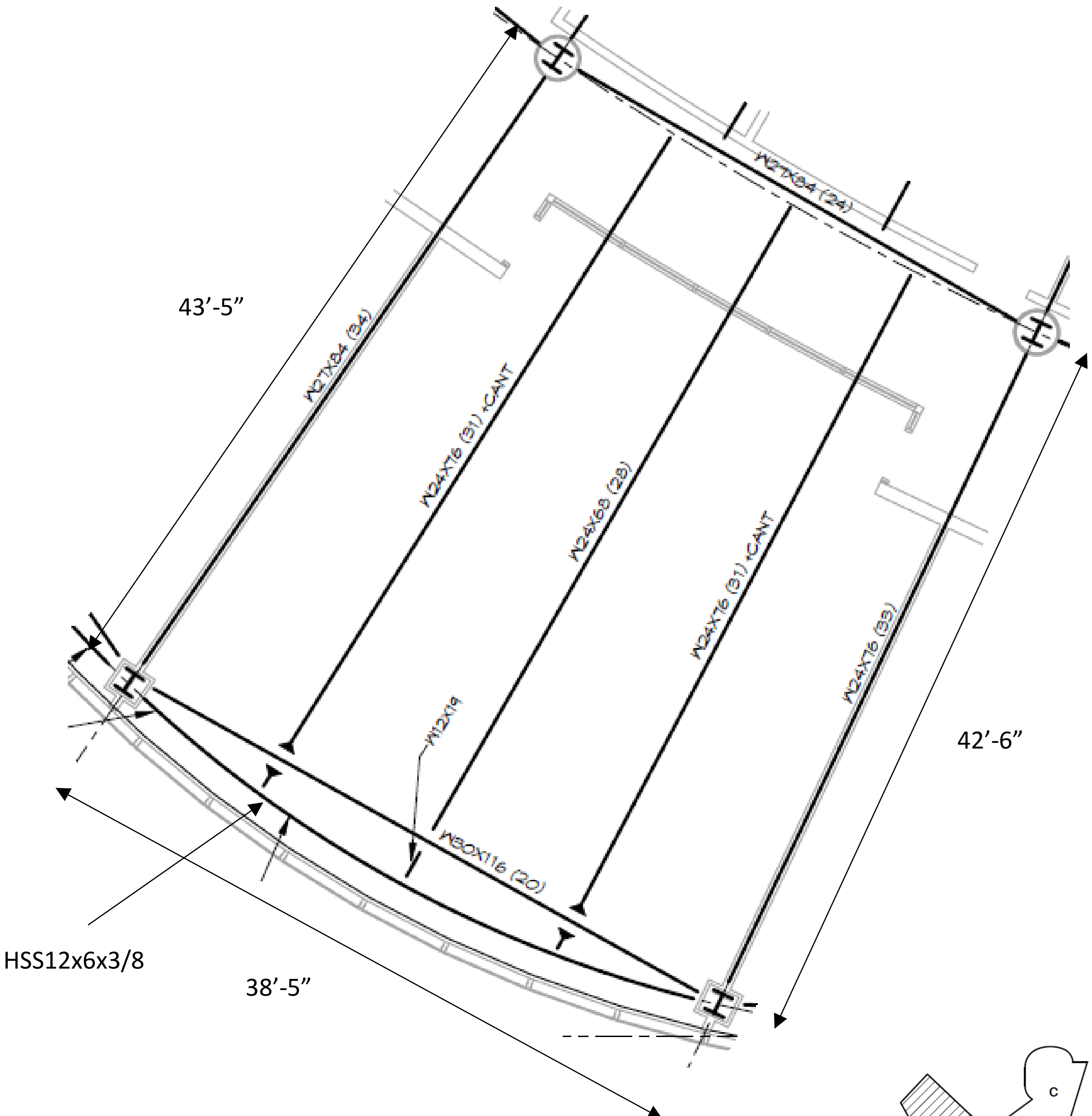


Figure 6 shows a bay towards the center of the building close to the building's western stairwell. At this bay, the girder along the curved wall is a W30x116 with 20 studs while the infill beams are W24's reaching spans up to 44'. Infill beams are spaced about 9' o.c. Due to the curve in the building, there is a curved HSS12x6x3/8 to match the radius of the grid arc.



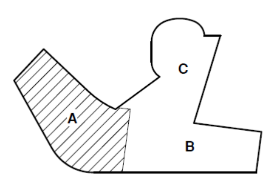


Figure 6: Bay in western wing

Framing for the Antonov Auditorium includes wide flange girders. Figure 7 shows a bay at the north east corner of the auditorium. Girders are W24s and reach spans up to 32' spaced at 10'. A 90' truss supports the first floor and the roof in the north-south direction of the auditorium.

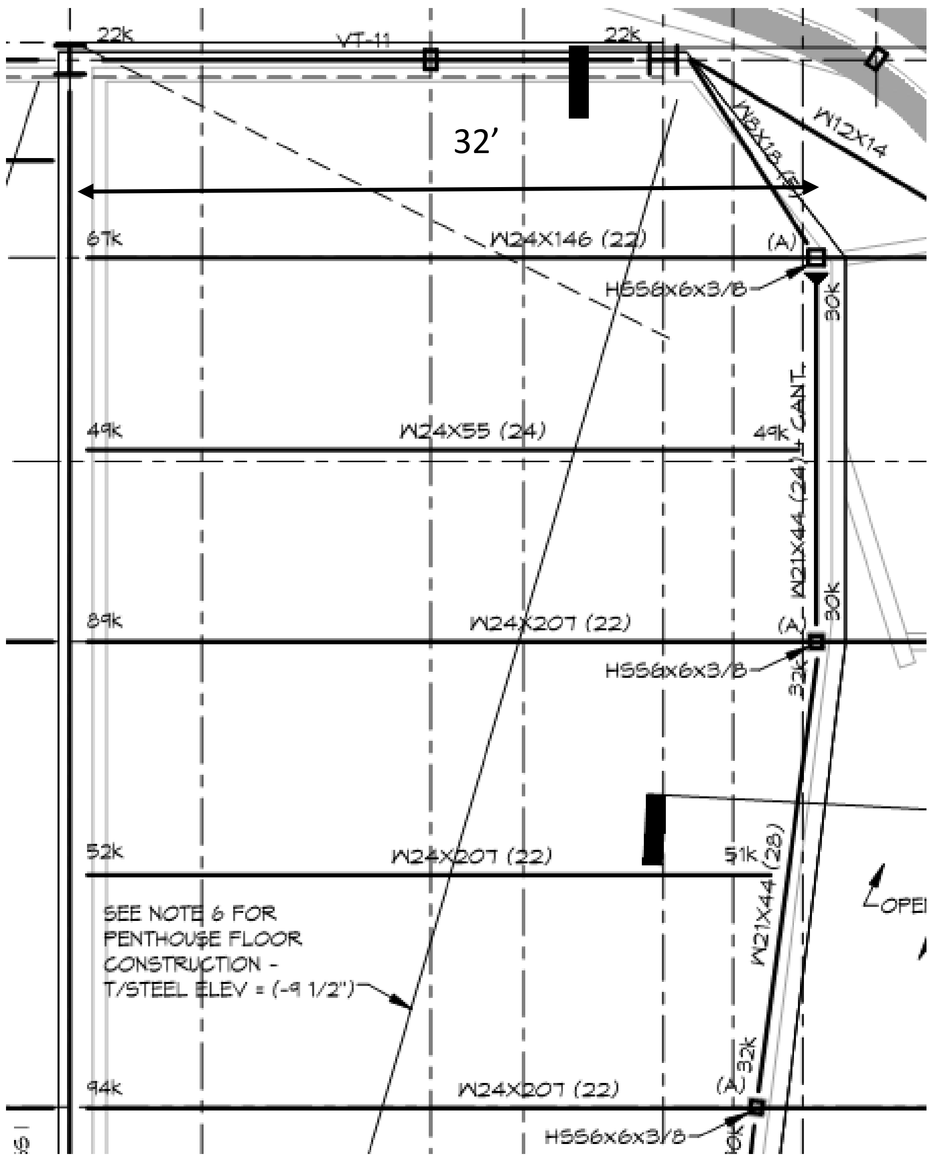
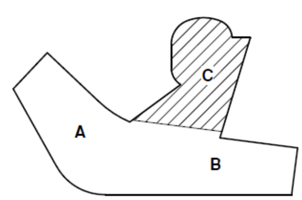


Figure 7: Bay in auditorium



2.2.2 Floor

The floor consists of 3 ¼" lightweight concrete on 3"x 20 gage galvanized metal deck (6 ¼" total thickness) reinforced with 6x6- W2.0 W.W.R. At the penthouse level, the slab is 4 ½" normal weight concrete on 3" x 18 gage galvanized metal deck (7 ½" total thickness) reinforced with 6x6- W2.9XW2.9 W.W.R. The increased thickness will provide additional dampening of the mechanical units to the floors below. Finally the roof level consists of 1 ½" x 20 gage Type B galvanized metal roof deck on steel filler beams and girders.

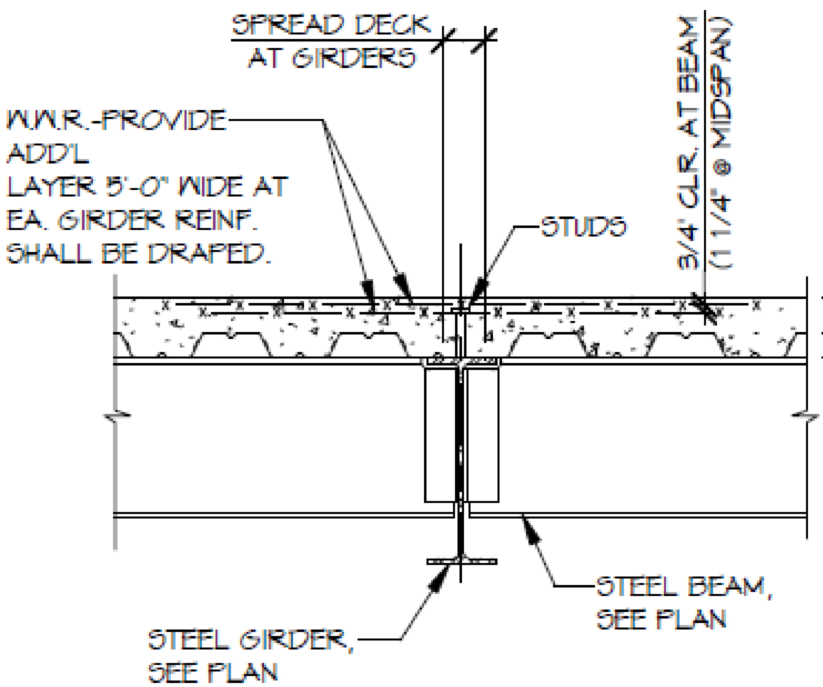


Figure 8: Typical Composite Floor Construction

2.2.3 Columns

All columns in the Brendan Iribe CCSI are W12s or W14s spliced every two stories, usually 1'-6" above the finished floor slab. Splices can be welded or bolted as shown below. Figure 9 shows the welded detail while figure 10 shows the bolted detail. Some columns can reach sizes up to W14x370 due to the severe axial loads acting on it.

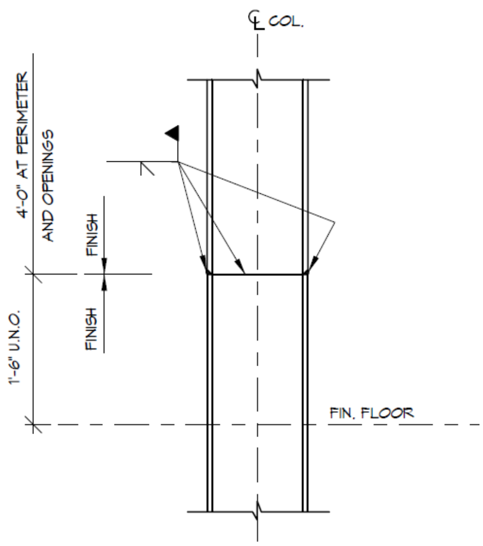


Figure 9: Typical Welded Detail

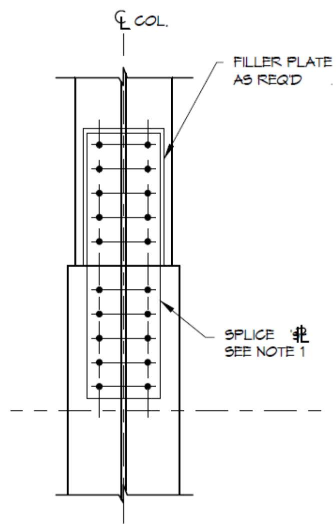


Figure 10: Typical Bolted Detail

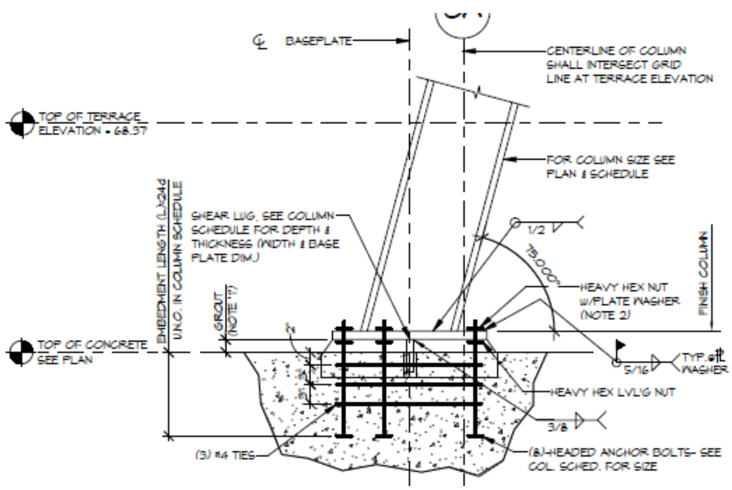


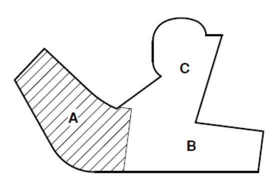
Figure 11: Sloped Column Foundation

The sloping columns located at the eastern cantilever require severely large sizes. As the sloping turns the column into a beam-column, a W14x730 must be used for two of these columns. This large size results in a 48" x 48" x 5" base plate which weighs over 3000 pounds. Figure 11 shows a detail of the sloped column foundation.

2.3 Lateral System

The lateral force resisting system of the main tower consists of moment frames and vertical trusses located in the eastern and western wings of the building. The next two figures show the configuration on the structural plan where red designates moment frames and green designates vertical trusses. Moment frames are W24's or W27's and range from 8' to 24' spans.

Figure 12: Lateral System in western wing



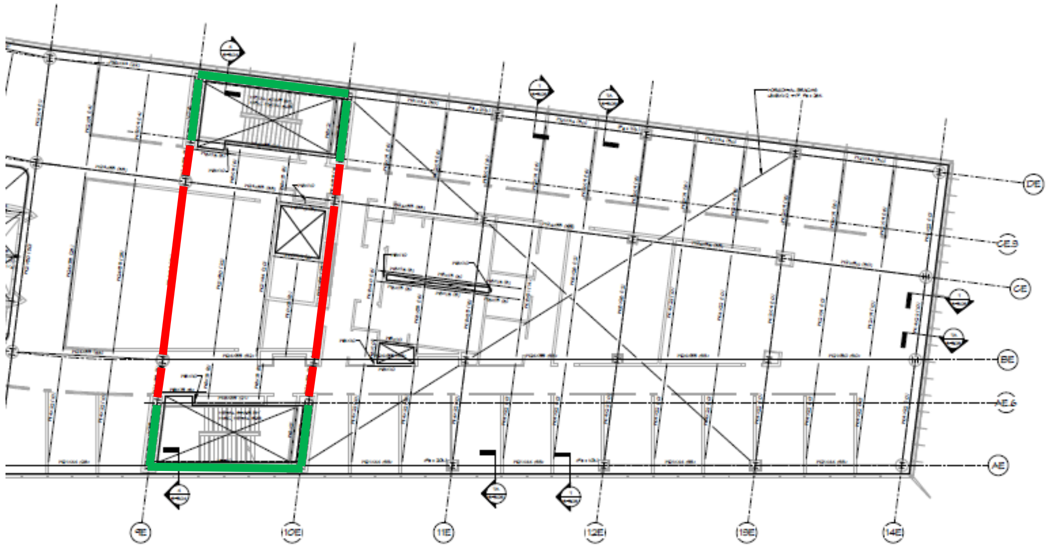


Figure 13: Lateral System in eastern

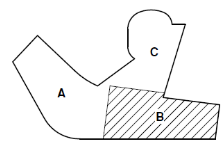
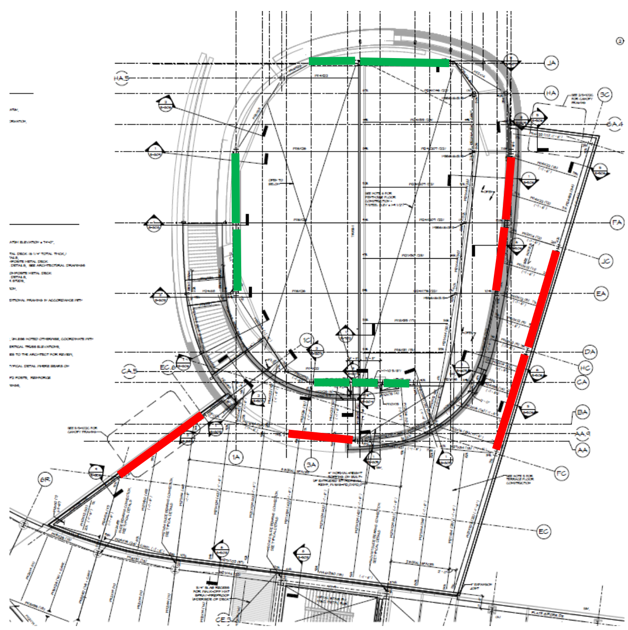


Figure 14 below shows the lateral system in the auditorium consisting of moment frames and vertical trusses. Due to the open floor plan, moment frames and vertical trusses are located along the perimeter of the auditorium.



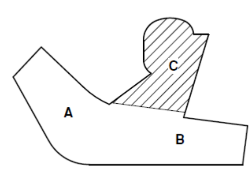


Figure 14: Lateral System in auditorium

There are thirteen separate braced frame configurations located throughout the building including diagonal, double diagonal, and chevron bracing (k-brace). The vertical trusses use W10x112, W12x120 and HSS 20x12x1/2 for the bracing members. Figure 14 shows the elevation for Vertical Truss 1 which is located adjacent to the stairwell in the buildings western wing.

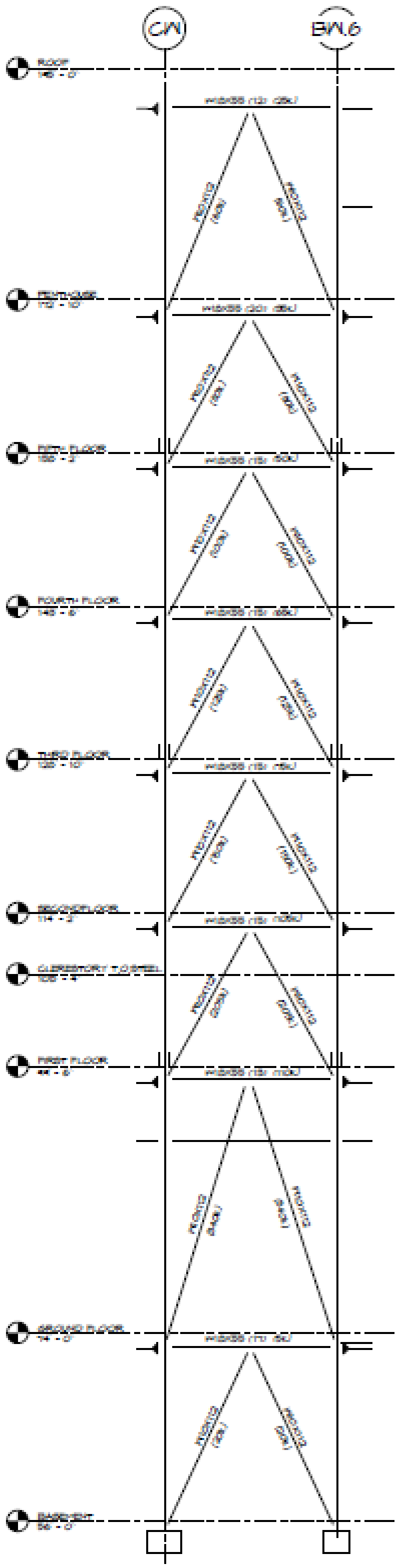


Figure 15: Typical vertical truss elevation

2.4 Structural Details

2.4.1 Secondary Elements

Two architectural features on the Antonov Auditorium include canopies located beyond the southwest corner of the auditorium and at the northeast corner. The canopy consists of L2x2x1/4 kickers bolted to W12x19s with ¼” full depth stiffener plates at each side of the web and kicker. Figure 15 below shows a detail of the northeast canopy.

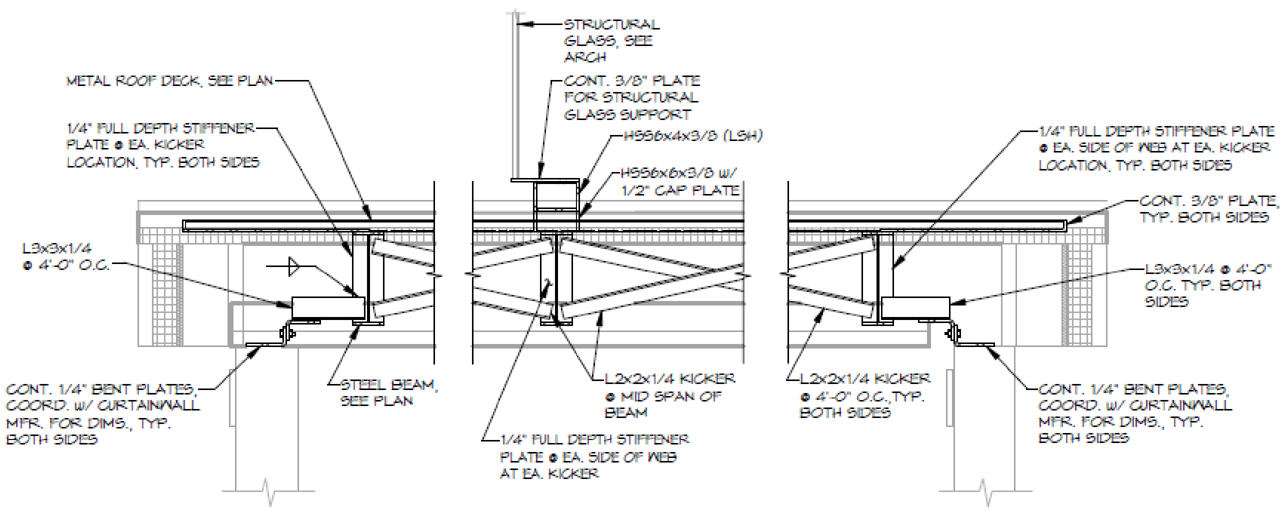


Figure 16: Northeast canopy detail

2.4.2 Joint Details

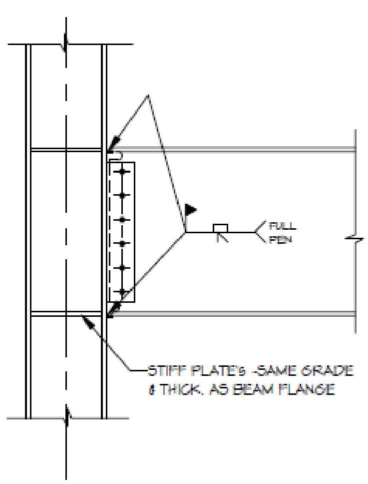


Figure 17: Typical moment connection to column flange

The Brendan Iribe CCSI has many cases where different connection details are required. Several cases include moment connections to wide flange columns, moment connections to HSS, vertical truss connections, and truss connections. All connections have ¾” A325 bolts using single angles unless otherwise noted. Figure 17 shows a typical detail of a moment connection to a column flange. Figure 18 on the following page shows a typical truss connection. A claw angle on each side of the gusset plate connects the diagonal member to the gusset plate.

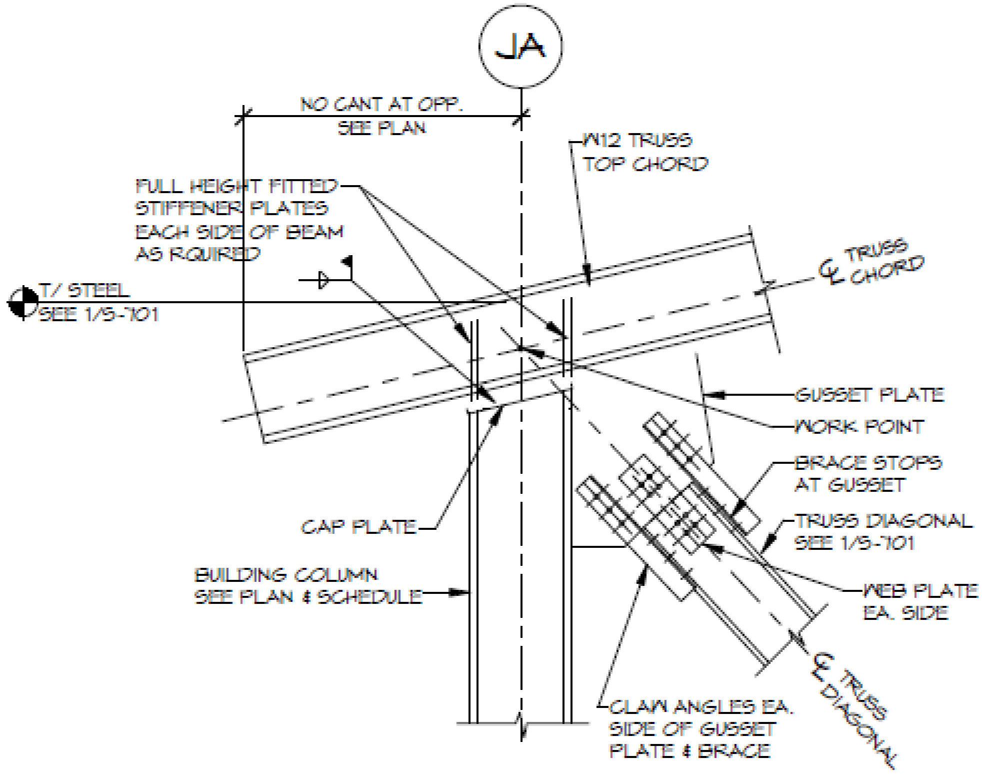


Figure 18: Typical truss connection

3. Loading and Codes

3.1 Applicable Codes

The following codes and standards apply to the design and construction of this project.

Standard	Applicable Code
International Code Council, Inc.	2015 International Building Code
American Society of Civil Engineers	Minimum Design Loads for Buildings and other Structures (ASCE 7-10)
American Concrete Institute	Building Code Requirements for Structural Concrete (ACI 318-14)
American Institute of Steel Construction	Manual of Steel Construction, 14th Edition
The Masonry Society	Building Code Requirements for Masonry Structures (TMS402-11)
American Welding Society	Structural Welding Code (ANSI/AWS D1.1-2010)

Table 1: Applicable Codes

3.2 Gravity Loads

Dead Loads have been formulated by the engineers through office standards. Dead loads do not include weight of primary members or rooftop mechanical equipment. Live loads are in accordance with the 2015 International Building Code, and reduction has been included where applicable by code. Drifting and sliding snow loads are accounted for in the 2015 International Building Code, but not included in the figure below. Figure 19 shows the loading schedule provided by Hope Furrer Associates, the structural engineer on this project.

LOADING SCHEDULE (PSF)

LOADING \ LOCATION	BASEMENT	TYP. ELEVATED FLOOR (GROUND FLOOR TO SIXTH FLOOR)	PENTHOUSE (AREA A & B)	ROOF (AREA A, B)	ROOF (AREA C)	TERRACE	ELEVATED AUDITORIUM FLOOR	AUDITORIUM PENTHOUSE
CONCRETE SLAB	VARIES	46	75	63	-	75	46	100
METAL DECK	-	2	3	2	2	3	2	3
M/E/C/L	-	10	10	10	10	10	10	10
MEMBRANE	-	-	-	1	1	-	-	-
INSULATION	-	-	-	4	4	-	-	-
PARTITION	-	-	-	-	-	-	-	-
SOIL (GREEN ROOF)	-	-	-	40	-	200	-	-
TOTAL DEAD LOAD	VARIES	58	88	120	17	288	58	113
LIVE LOAD	100	100	150	30	30	100	100	150
TOTAL LOAD	VARIES	158	238	150	47	388	158	263

NOTES:

1. ALL LIVE LOADS ARE IN ACCORDANCE WITH INTERNATIONAL BUILDING CODE 2015 EDITION.
2. LIVE LOAD REDUCTION HAS BEEN INCLUDED IN THE DESIGN WHERE APPLICABLE AND ALLOWED BY CODE.
3. TOTAL DEAD LOADS DO NOT INCLUDE WEIGHT OF STEEL OR PRIMARY FRAMING MEMBERS.
4. LOADS IN SCHEDULE DO NOT INCLUDE WEIGHTS OF ROOF TOP MECHANICAL UNITS. THE PROVISION FOR THE SUPPORT OF THESE UNITS HAVE BEEN MADE ON AN INDIVIDUAL BASIS. ANY CHANGE FROM SPECIFIED MECHANICAL UNIT (SIZE, WEIGHT AND LOCATION) SHALL BE BROUGHT TO THE ATTENTION OF THE STRUCTURAL ENGINEER.
5. SEE PLANS FOR LOCALIZED CONCENTRATED LOADS.
6. DRIFTED AND SLIDING SNOW LOADS ARE ACCOUNTED FOR IN ACCORDANCE WITH INTERNATIONAL BUILDING CODE 2015 EDITION, BUT ARE NOT INCLUDED IN THE LIVE LOADS INDICATED ABOVE.

Figure 19: Loading Schedule

From ASCE 7-10, the ground snow load for College Park, MD is 35 PSF with an exposure factor of 0.9, importance factor of 1.1, and thermal factor of 1.0. The flat roof snow load is 24 PSF plus unbalanced, drifting, and sliding where applicable.

3.3 Lateral Loads

3.3.1 Wind Loads

Wind Loads were determined in accordance with ASCE 7-10. College Park, MD has an ultimate design wind speed of 120 mph and a nominal wind speed of 93 mph. The Brendan Iribe CCSI falls under exposure B and risk category III. An internal pressure coefficient of +/- 0.18 has been used. Components and Cladding wind loads for parapets have also been determined in accordance with ASCE 7-10.

3.3.2 Seismic Loads

Seismic Loads have been calculated using the equivalent lateral force procedure. A risk Category of III, Site Class D, and Seismic Design Category B have been used for these calculations. The basic seismic force resisting system is ordinary braced frames and ordinary moment frames.

3.4 Load Paths

Although construction starts at the foundation, design starts at the top of the building. All gravity loads act downwards, which is absorbed by the composite deck and transferred to the infill beams. After the beams, the load travels to the girder. Finally it is transferred to the column where the load travels to the foundation and is distributed at the ground.

Lateral loads can act horizontally or even cause uplift. To negate this lateral load, moment frames and vertical trusses have been placed to absorb this lateral load. Moment connections in moment frames and bracing in vertical trusses transfer the load to the columns, which ultimately travel to the ground. Columns that are part of moment frames or vertical trusses are typically larger than gravity columns as they have to resist gravity and lateral loads.

4. Conclusion

Structurally, the Brendan Iribe Center for Computer Science and Innovation has many components to further discuss. The irregular shape of the building will certainly have an impact on future design consideration, especially where spans are large and vibration could be an issue. The sloping columns at the 120 foot cantilever also provides a unique feature towards the gravity system of the building. In addition to the main tower, the auditorium provides structural opportunities in making sure the open space is not disturbed.

Moving forward, there will certainly be many challenges to overcome. The irregular shape will provide a much more difficult analysis of wind and seismic calculations. Analyzing axial loads of the sloped columns will also prove to be a challenge. Overall, there are many directions to go with this building, and the next three technical reports should help decide which path to take.