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Structural Option
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Peggy Ryan Williams Center
Ithaca, New York
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Peggy Ryan Williams Center

Proposal

Executive Summary

The Peggy Ryan Williams Center, formerly known as "The Gateway Building," is a four story office building located on the Ithaca College campus, Ithaca, New York. The building was originally known as "The Gateway Building" because the college saw the building as a gateway to the campus. At the time, the college was moving into a new era of sustainability and they wanted to show their prospective students, employees, and visitors the strides that they were making towards their goal.

Sustainability and a desire to connect with nature were both driving forces for the building's architectural features. The large areas of glass, offering vistas to Cayuga Lake, allow the occupants to feel like they are part of the nature around them. Another eco-friendly architectural feature is the "V" shaped roof which promotes rainwater collection.

The structural system components are fairly common; however, their placement and size variations make the framing irregular. The roof of the building is constructed of roof decking, which spans perpendicular to the beams, girders, and columns. The floor of Level 1 through Level 3 consists of composite decking and wide flanged beams, girders, and columns. Various beams and girders are provided with shear studs for composite action. Sizes and spans of the wide flanges vary greatly throughout the building and even throughout a single floor framing system. At locations where the building cantilevers, moment connections and larger beam/girder sizes make the cantilevers possible.

Another distinctive feature of the Peggy Ryan Williams Center is the pedestrian bridge, which connects the building to the adjacent Dillingham Center. The bridge is a box truss supported in a double cantilever configuration with a 2" expansion joint on either end.

Purpose and Scope

The purpose of this proposal is to provide an overview of what will be studied during the spring semester of 2014. Various aspects of the Peggy Ryan Williams Center will be redesigned in order to explore different areas of structural engineering and the consequences of those changes on the building. The pedestrian bridge will be altered in order to reflect on New York's historical covered bridge (the Newfield Bridge) or the original name of the building ("The Gateway Building"). A reinforced concrete design will then be implemented on the main part of the building. The original steel design of the building was found to meet all strength and serviceability requirements. One of the reasons that this system was originally chosen was to shorten the schedule. However, a scenario has now occurred in which the schedule is no longer critical. Therefore, a reinforced concrete design will be explored. By changing the building material to concrete, and due to the fact that the building is only four stories, the gravity system will also act as the building's new lateral system.

By redesigning the bridge to either reflect a covered bridge or the title "The Gateway Building," the architecture of the bridge will need to be altered in order to truly reflect the new concept of the bridge. Therefore, an architectural breadth will be done on the bridge. The new architecture will need to serve two purposes. It will need to truly reflect the new concept while still relating to the rest of the Peggy Ryan Williams Center.

The redesign of the bridge also lends itself to a lighting breadth of the bridge. An exterior lighting design will be developed for the new bridge design. When completing the new design, the surroundings of the bridge will be taken into consideration. Upon completing the design, a maintenance cost estimate will be performed to determine if the design is feasible.

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Building Introduction

With the global push towards sustainability, the Ithaca College decided that it was important to show that their college was moving forward with the times, being eco-friendly, and wanting to incorporate their beautiful surroundings into the campus design. This led to a new era of architecture at Ithaca campus.

The Peggy Ryan Williams Center (PRWC) is a key aspect of fulfilling the new architectural objectives of the college because it is seen as a gateway. The occupants of this 58,200 square foot, 74 foot tall building include the college's admissions staff as well as numerous administrative offices. A typical floor plan may be viewed below in Figure 1. The building is also one of the first sights that visitors see upon arriving to the campus. Therefore, Ithaca College saw the building as a way to show perspective students, employees, and visitors that their college was moving forward to be more "green" and incorporate the surrounding nature.

The architecture of the building was also driven by a desire to allow its occupants to not only view the nature around them; but, also, to feel as if they are a part of it. These sensations were achieved by providing large areas of glass and designing a floor plan at angles other than 90 degrees. The irregular angles help to direct the occupants' eye to the most appealing surroundings, such as the breath-taking view of the nearby Cayuga Lake. The resultant irregular floor plan may be seen on Figures 1 and 2 below.

Another important feature of the PRWC is the pedestrian bridge, which may be viewed in Figure 3 below. The bridge allows its users to go between the PRWC and the adjacent Dillingham Center without going outdoors. A glass façade allows large amounts of light penetration while tying this façade feature to the main building.

LEED Platinum is the prestigious title that the Peggy Ryan Williams Center was awarded by USGBC. However, this achievement required years of planning and sustainability considerations. Most of the architectural appearance of the building was governed by sustainability. Some examples of sustainability include the main roof taking on a slight "V" shape as to help collect rain water, the atrium being designed to assist with natural ventilation, green roofs, geothermal heat wells, solar shading, and many large areas of glass to allow for day lighting.

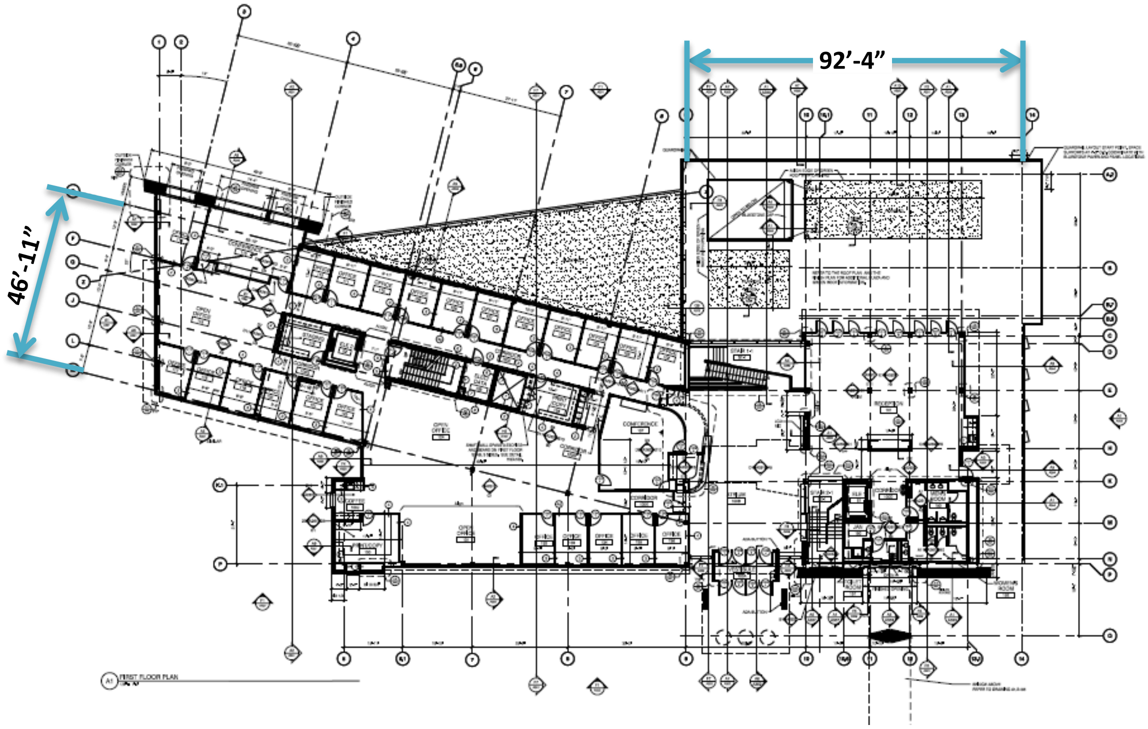


Figure 1: Typical Floor Plan (Level 1)
Drawing A101

Figure 2: View from the North Showing Irregular Façade of the PRWC
Photo provided courtesy of Holt Architects.

Figure 3: View from the Southeast Showing the Pedestrian Bridge
Photo provided courtesy of Holt Architects.

Structural Overview of the Building

The structural gravity system of the Peggy Ryan Williams Center consists of composite decking supported by wide flange beams, girders, and columns. The foundation consists of reinforced concrete grade beams and piers. The lateral system is comprised of concentrically braced structural steel frames. The following sections of this proposal will discuss these components in detail, as well as material strengths.

Materials

The structural materials used throughout the PRWC are various strengths of steel and concrete. These material strengths may be viewed below in Figures 4 and 5.

Figure 4: Structural and Miscellaneous Steel Strengths (*Drawing S001*)

Steel Shape	Steel Grade
Rolled Steel W Shapes	ASTM A992 Grade 50
Rolled Steel C and MC Shapes	ASTM A36
Rolled Steel Plates, Bars, & Angles	ASTM A36
Hollow Structural Sections (HSS)	ASTM A500, Grade B or C
Pipe	ASTM A53, type E or S, Grade B
*For connections, provide higher grade as required for capacity.	

Figure 5: Concrete Material Strengths (*Drawing S001*)

Concrete Component	Concrete Strength
Footings, Foundation Walls, Piers, Miscellaneous	f'c = 4,000 psi
Interior Slabs on Grade or Slabs on Deck	f'c = 3,500 psi
Retaining Walls, Basement Walls, Exterior Slabs, and Grade Beams	f'c = 4,000 psi
*Reinforcing Steel for Concrete → ASTM A615, Grade 60	

Geotechnical Report and Recommendations

Through their studies, the Geotechnical Engineer (CME Associates, Inc.) made numerous recommendations for the foundation of the Peggy Ryan Williams Center. On the north side, shale bedrock was found 15 feet below grade with unprepared fill on top. The bedrock stratum is underlain by silt. The 2002 Building Code of New York State (BCNYS) does not allow a foundation to bear on unprepared fill. Therefore, all foundations were required to bear on competent shale bedrock. The competent bedrock was presumed to have a soil bearing pressure of 20,000 psf. There is no need to drill into the exposed bedrock on the south side. In order to have competent bearing, CME Associates, Inc. recommends using drilled piers. This conclusion was drawn due to the variable depth to a competent bearing surface and the risks associated with large excavations close to groundwater. CME also recommended that all drilled piers should have a planned bottom elevation not less than 2'-6" below the top of the shale bedrock and a diameter not less than 2'-0". In regards to the drilled piers, the design and construction should follow ACI 336.3R.

Foundation System

The PRWC foundation includes a wide variety of structural components ranging from grade beams to drilled piers. The foundation walls themselves range from 1'-0" thick with 3'-0" wide footings to 1'-8.5" thick with 6'-0" wide footings. In areas where the footings cannot reach down to competent bedrock, drilled piers are used in combination with piers to reach bedrock. Most areas of the building on the Garden Level are provided with a 5" concrete slab-on-grade. This slab is depressed in areas where special flooring is used. In various portions of the building, grade beams are utilized to transfer the loads of bearing walls from above (stairwell and elevator shaft), braced frames, and to help tie back the column supporting the overhang in the north corner of the building. The grade beam sizes range from 12" wide and 36" deep to 51" wide and 48" deep.

Loads from the grade beams are then transferred to piers and in turn to the drilled piers in order to finally reach competent bedrock. The piers range in size and shape depending on the location. The loads from these piers are then transferred to the drilled piers. All of the drilled piers are 3'-0" in diameter. Pier depths range from simply resting on top of the bedrock to being drilled 4'-0" below the surface of the bedrock.

Gravity System

Floor System

Each level of the PRWC has a 6" concrete slab on a 3"x20 gauge galvanized composite metal deck. However, a few areas have some deviation from this typical floor system. One example of this deviation occurs on the plaza deck and green roof areas. These areas have reinforcement in the deck system to lessen the effects of shrinkage and thermal contraction/expansion. Due to this slab being exposed to the weather, it is prone to the above thermal effects. The corrugations of each of the various types of decking run perpendicular to the wide-flange beams.
(Note: The Garden Level floor system (slab-on-grade) was discussed above in the foundation system section.)

Framing System

The structural framing system of the PRWC is very irregular due to changes in geometry, cantilevers, and locations of increased loads (such as adjacent to elevator shafts and stairwells). Levels 1 through 3 include numerous beam and girder sizes and spans. On those levels there are three different regions which utilize consistent beam shapes and sizes up through the levels. These regions may be viewed in Figure 6 below.

The vast majority of the columns from the foundation (Garden Level) continue up through the building. The columns range from W8x28 to W10x60, while some HSS5x5x5/16 are also present. Column type 2 (W10x49) is the most commonly used size throughout the superstructure of the building. On Level 1, various W10x39 columns were added along the southern perimeter of the building. These columns bear on the load bearing foundation. A few columns are also added to the cantilevered regions in upper levels of the building. These columns are typically W8x48 or W8x31. The column schedule may be viewed in Figure 7 below. These columns have a pinned connection at their base which allows no moment transfer to the pier below.

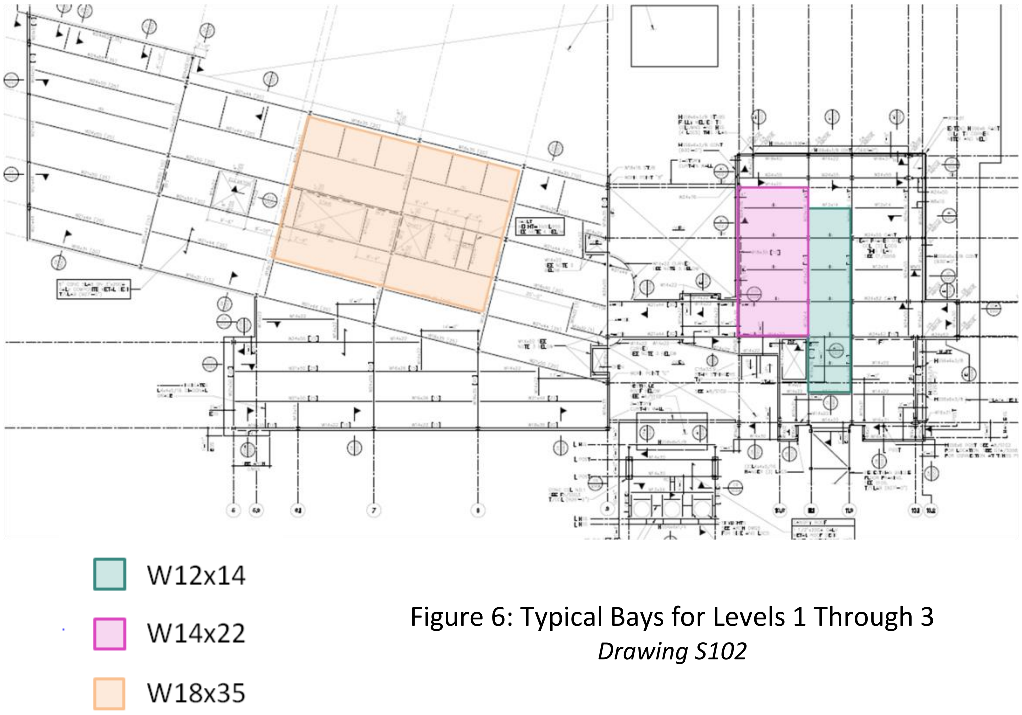


Figure 6: Typical Bays for Levels 1 Through 3
Drawing S102

COLUMN SCHEDULE		
MARK	SIZE	BASE PLATE TYPE
C1	W10x60	BP1
C2	W10x49	BP1
C3	W10x39	BP2
C4	W8x48	C1/S559
C5	W8x31	C1/S559
C6	HSS5x5x5/16	BP6
C7	W8x28	BP3

NOTE:
BASE PLATE TYPES ARE TYPICAL FOR COLUMNS INDICATED IN SCHEDULE UNLESS NOTED OTHERWISE ON PLAN. SEE F1/S555 FOR BASE PLATE DETAILS.

Figure 7: Column Schedule
Drawing S555

Roof Gravity System

The roof system of the PRWC follows the same basic structural system of the floors below; decking, wide-flange beams, girders, and columns. However, the roof is not supported by a composite deck. Instead, since the roof does not support as large of a load, a much lighter 1.5”x20 gauge galvanized metal roof deck is used. The deck is then supported by wide flange steel beams and girders. A tapered HSS8x6x3/8 sits on top of the wide-flange girders along the perimeter of the building. The HSS is tapered to match the slope of the roof deck which it supports. A roof cantilever (5’-10”) is formed from wide-flange beams spaced at 5’-3”.

Lateral System

In both the North-South and the East-West directions, concentrically braced structural steel frames resist the lateral load. The braced frames are located throughout the building and may be seen on the plan below (Figure 8). Braced frame columns are typically W10s, while HSS6x6x3/8 are commonly used for the diagonal braces. A typical braced frame may be viewed below in Figure 9.

Various braced frames are provided in the north-south direction to resist the lateral loads. However, in the east-west direction, there is a lack of effective braced frames. In order to resist unbalanced loads there should be at least two (staggered) frames in each direction.

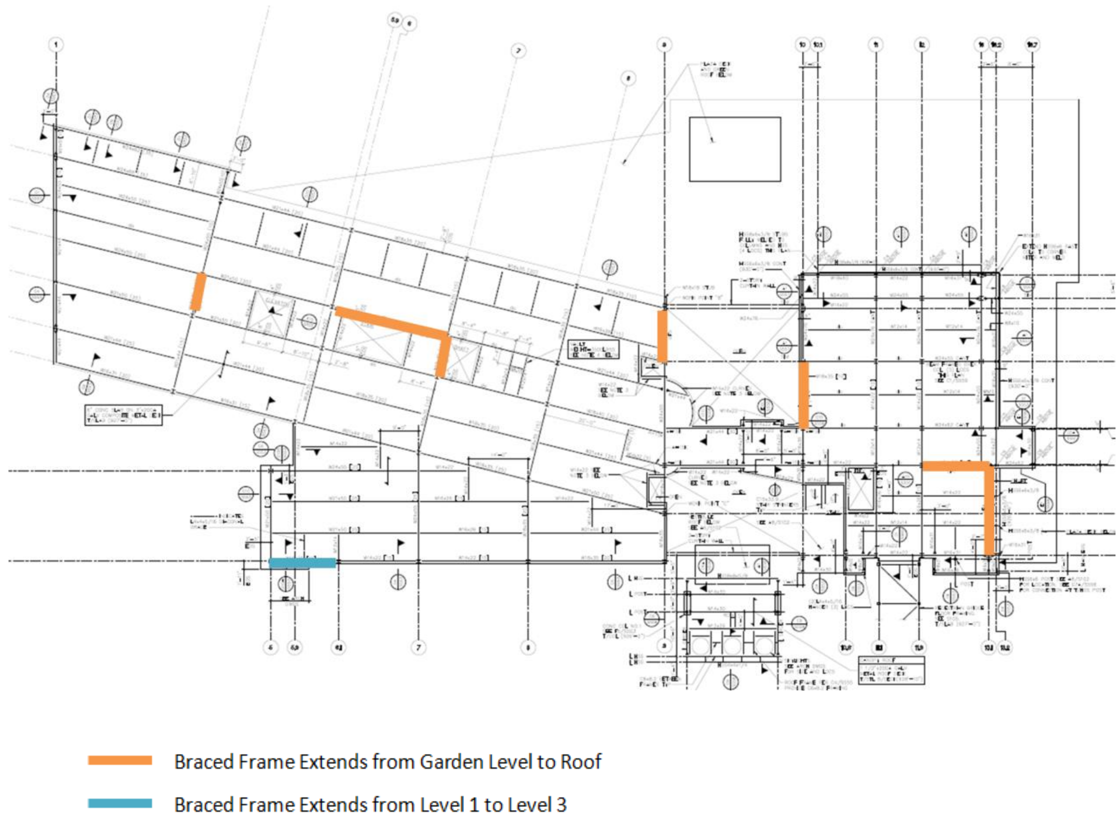


Figure 8: Level 2 Braced Frame Layout
Drawing S102

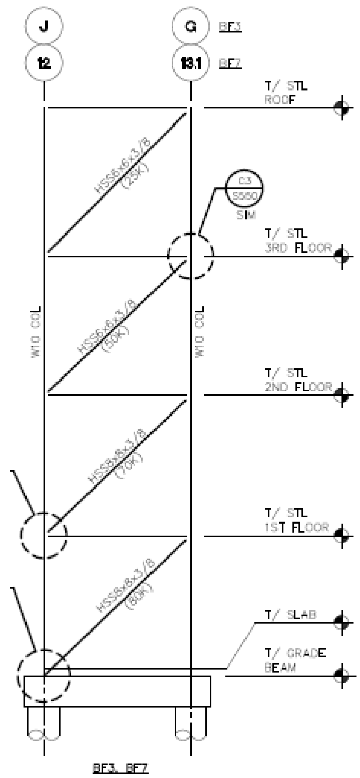


Figure 9: Typical Braced Frame
Drawing S550

Structural Overview of the Pedestrian Bridge

A 100-foot long box truss pedestrian bridge connects the Peggy Ryan Williams Center to the adjacent Dillingham Center.

Foundation and Columns

The pedestrian bridge has a separate foundation system from that of the PRWC, in which its columns rest on a 5’-0”x13’-0”x1’-6” footing.

The columns take on a hexagonal shape, roughly 11’-0”x3’-6”. They are constructed of concrete with #8 vertical reinforcement and various #4 rebar ties. Figure 10 below shows the bridge column detail.

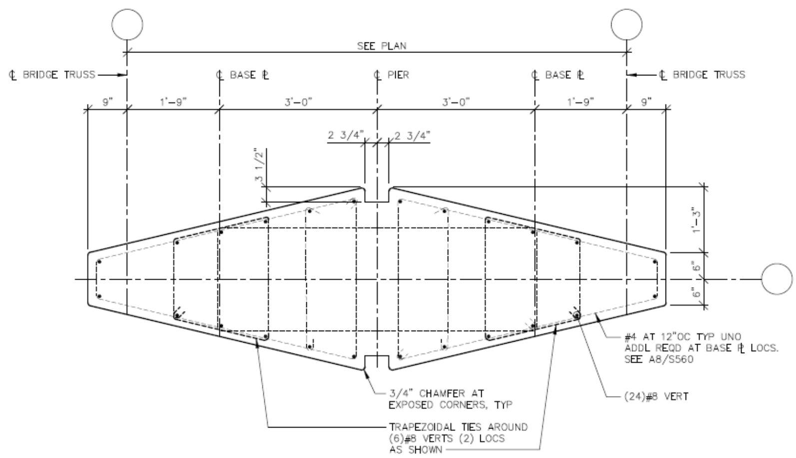


Figure 10: Bridge Column Detail
Drawing S560

Structural Framing

The pedestrian bridge is a box truss which is constructed using various hollow structural steel shapes and pipes. The top and bottom chords are both framed with HSS12x6x3/8 and the horizontal and diagonal braces are typically HSS4x4x1/4. The two side Pratt trusses have HSS5x5x5/16 vertical members and 3.5” pipe diagonal braces. There is a 2” expansion joint on either end of the bridge. This allows for expansion and contraction of the bridge due to variations in temperature. Figure 11 below shows the bridge truss schematic.

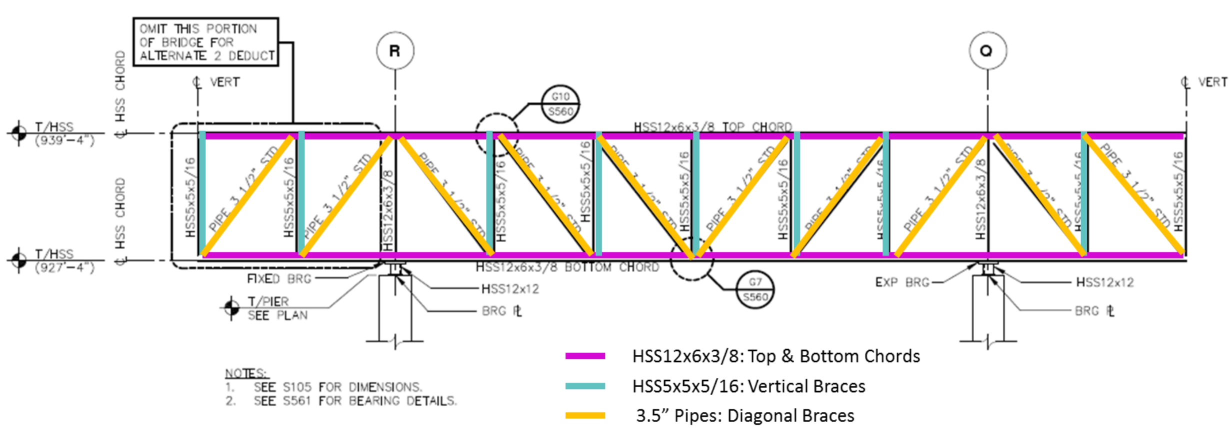


Figure 11: Bridge Truss Schematic
Drawing S560

Problem Statement

As previously stated, the steel structure of the Peggy Ryan Williams Center meets strength and serviceability requirements. The steel system was a good solution for dealing with the irregular geometry of the building and its floor openings. However, since a scenario has been created in which the schedule for the project is no longer critical, a reinforced concrete system may also prove to be a good design for the building. The concrete system would prove to be beneficial when it comes to the cantilevers since steel moment connections add significant cost to a project. A post-tensioned concrete slab design was explored in Technical Report 3. The system was found to be beneficial in terms of the floor system depth. However, the region of the building designed using that system had the building's longest spans. Therefore, when it is taken into account that the east end of the building contains much smaller spans, a post-tension slab is not the best solution. Instead, a one way concrete slab system with pan joists and girders will be designed. The pan joist system will better accommodate the varying spans. By changing the structural system to reinforced concrete, the lateral system will also need to be redesigned. Because the building is only four stories, the concrete gravity system may act as the lateral system.

The existing structure of the pedestrian bridge is a box truss comprised on Pratt trusses on either side. In order to create a learning opportunity, the bridge structure will be redesigned. As previously discussed, there are two options which will be considered for the bridge redesign. The first option is a reflection of New York's historical covered bridges, in particular that of the Newfield Bridge. The second option for the bridge redesign reflects on the original name of the building, "The Gateway Building" by mimicking the aesthetics of the Golden Gate Bridge.

Proposed Solution

Because the schedule is no longer critical, the structure of the building will be redesigned using reinforced concrete. For reasons previously stated, a one way concrete slab system with pan joists, girders, and columns will be designed. This system appears to be a good choice for the irregular geometry of the building because it lends itself to the varying bay sizes and the cantilevers. The various floor openings would also not cause problems with this system. A thinner slab can be used because it only needs to span the short distance between the pan joists. The pan joists will run in the direction of the existing beams of the structure. In turn, the girders will be located where the existing girders are located. This will minimize the architectural effects within the building due to columns' locations not changing. The floor system will first be designed through the use of computer programs such as spSlab and spBeam. Time permitting, the design will then be checked by hand. Because the building is only four stories, this gravity system may also work as the lateral system for the building. All structural framing members will be designed using ACI318-11.

In order to provide a learning opportunity, two different redesigns of the pedestrian bridge structure will be considered. Early on in the spring semester, sketches will be done to determine which redesign will best fit the existing site and its adjacent buildings. The first option is a reflection of New York's historical covered bridges, in particular that of the Newfield Bridge. For this redesign, the bridge supports will be moved closer to either building creating a longer span to give the illusion of the bridge only being supported by either building. A steel Warren truss will then be designed. The façade of the bridge will lend itself to an architectural breadth in which the façade will reflect on the covered bridge concept while incorporating some of the materials of the façade of the Peggy Ryan Williams Center. The second option for the bridge redesign reflects on the original name of the building, "The Gateway Building." This redesign will reflect upon the Golden Gate Bridge. Two towers (similar to those of the

Golden Gate Bridge) will be designed near the location of the existing two supports. A box truss will then be designed to be suspended from the towers. This option also lends itself to an architectural breadth. Both of these options allow for the consideration of a study of the exterior lighting systems.

Breadth Topics

Architectural Breadth – Bridge Façade

By changing the structure of the pedestrian bridge, an architectural breadth will need to be performed. If the covered bridge option is chosen, the roof of the bridge will mirror that of a traditional covered bridge. However, various façade materials will be considered which incorporate the materials of the nearby buildings, especially those of the Peggy Ryan Williams Center. The Warren truss will lend itself to large diamond shaped windows on the façade of the bridge. These windows will not only mirror the lattice truss of the Newfield Bridge; but, also, play off of the angles of the roof of the Peggy Ryan Williams Center. If the Golden Gate Bridge option is chosen, the façade of the bridge will most likely remain entirely glass. The appearance, placement, and materials of the towers will need to be taken into consideration. In order to explore these options, hand sketches will be completed. A Revit model of the chosen design will then be created and rendered.

Lighting Breadth – Exterior Lighting of the Bridge

In order to complement the structural redesign of the bridge and the architectural breadth, an exterior lighting breadth will be performed. Use of such techniques as wall washers will be investigated in order to create a modern façade that will complement its surroundings. Luminaires will then be selected. Revit and lighting software will be used to perform a rendering of the new lighting design. A lighting power density calculation will also be performed. Finally, a maintenance cost will be calculated to determine if the new design is feasible.

Tasks

I. Task 1 | Explore Two Bridge Design Options
   a. Sketches
   b. Choose design to move forward with

II. Task 2 | Redesign Building Gravity System
   a. Design floor system (slab, pan joists, girders)
      i. One bay by hand
      ii. Remaining bays of one story (using computer program and/or CSRI Manual)
   b. Design columns
   c. Write-up Building Gravity System Redesign

III. Task 3 | Redesign Lateral System
   a. Calculate lateral loads
   b. Distribute lateral forces
   c. Analyze plane frames in RISA
   d. Write-up Lateral System Redesign

IV. Task 4 | Research Bridge Design

V. Task 5 | Redesign Bridge Structure
   a. Preliminary design
   b. Determine Load Conditions
   c. Select member sizes
   d. Check design in SAP
   e. Write-up Bridge Structure Redesign

VI. Task 6 | Architectural Breadth – Bridge Façade
   a. Conceptual Sketches (by hand or using AutoCAD)
   b. Detailed model using Revit
   c. Write-up Architectural Breadth

VII. Task 7 | Lighting Breadth – Exterior Lighting of the Bridge
   a. Research possible lighting solutions
   b. Select luminaires
   c. Render design
   d. Lighting power density calculation
   e. Maintenance cost calculation/system feasibility
   f. Write-up Lighting Breadth

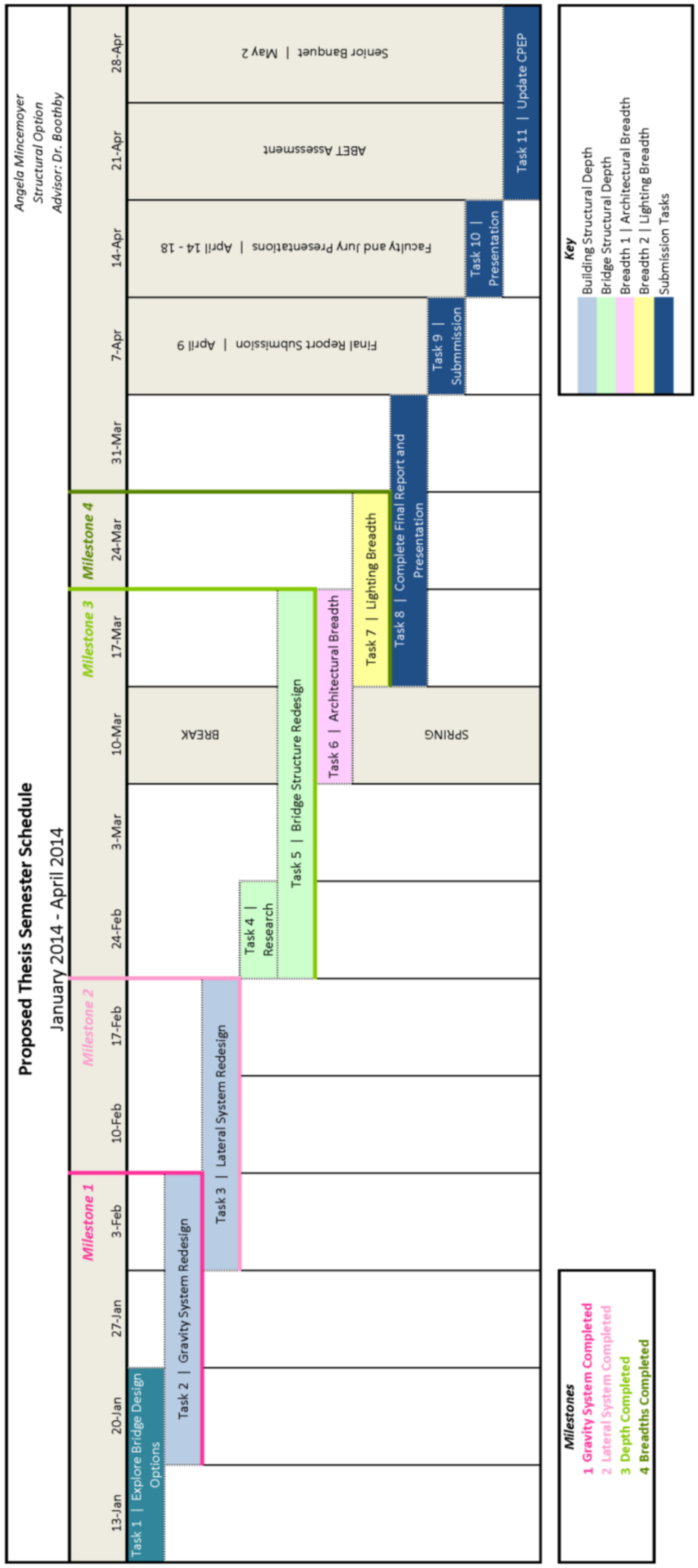
VIII. Task 8 | Final Report and Presentation
   a. Finalize Final Report
   b. Outline Final Presentation
   c. Prepare Final Presentation

IX. Task 9 | Submit Report

X. Task 10 | Present to jury

XI. Task 11 | Update CPEP

Schedule


Proposed Thesis Semester Schedule
January 2014 - April 2014
Angela Mincemoyer
Structural Option
Advisor: Dr. Boothby
13-Jan
20-Jan
27-Jan
3-Feb
10-Feb
17-Feb
24-Feb
3-Mar
10-Mar
17-Mar
24-Mar
31-Mar
7-Apr
14-Apr
21-Apr
28-Apr
Milestone 1
Milestone 2
Milestone 3
Milestone 4
Task 1 | Explore Bridge Design Options
Task 2 | Gravity System Redesign
Task 3 | Lateral System Redesign
Task 4 | Research
Task 5 | Bridge Structure Redesign
Task 6 | Architectural Breadth
Task 7 | Lighting Breadth
Task 8 | Complete Final Report and Presentation
Task 9 | Submission
Task 10 | Presentation
Task 11 | Update CPEP
SPRING BREAK
Final Report Submission | April 9
Faculty and Jury Presentations | April 14 - 18
ABET Assessment
Senior Banquet | May 2
Milestones
1 Gravity System Completed
2 Lateral System Completed
3 Depth Completed
4 Breadths Completed
Key
Building Structural Depth
Bridge Structural Depth
Breadth 1 | Architectural Breadth
Breadth 2 | Lighting Breadth
Submission Tasks

Conclusion

The existing structural system of the Peggy Ryan Williams Center is comprised of composite metal decking and wide flange beams, girders, and columns. This system was found to be adequate in regards to strength and serviceability requirements. In order to allow for a quicker erection of the building, the original steel system was chosen instead of concrete. However, a scenario has been created in which the schedule is no longer critical. Therefore, a reinforced concrete system will be used for a structural redesign. The redesign will consist of a one way slab, pan joists, girders, and columns. Because the building is only four stories tall and the new gravity system is reinforced concrete, the system will also act as the new lateral system of the building. In turn, the existing braced frames will be removed.

In order to create a learning experience, the bridge structure will be redesigned as well. The current bridge is a double cantilever box truss supported by two concrete columns. The new design will reflect either New York's covered bridges (in particular the Newfield Bridge) or the original name of the building, "The Gateway Building." If the covered bridge design is chosen, a Warren truss will be used for the design. The supports will also be moved out toward either building in order to create a longer span and provide the illusion that it is only supported by the two adjacent buildings. If the design is a reflection of "The Gateway Building," the design will consist of a box truss suspended from two towers, a design similar to that of the Golden Gate Bridge. Both of these redesigns lend themselves to an architectural breadth of the building.

Depending on which structural redesign is chosen, the architecture of the bridge will change greatly. During the architectural breadth the façade of the bridge will be carefully considered. The intent is to reflect the inspiration of the bridge while still allowing the bridge to complement its surroundings.

The bridge redesign also lends itself to an exterior lighting breadth. For this breadth, wall washers will be considered in order to further accent the new façade. After the new design is completed, a maintenance cost will be calculated in order to determine if the lighting design is feasible.

All in all, the purpose of this assignment is to learn new aspects of structural engineering and how they affect other areas of design. In order to accomplish this, a reinforced concrete design will be explored to see if the building can be economic structurally with the use of concrete. The bridge will also be redesigned to provide a learning experience. Finally, two breadths will be completed on the bridge to tie together an understanding of bridge design.