Getting LA to Net Positive Competition for Innovation in Design
Senior Project Report

By: Alexander Lohr
Introduction

For my senior project I participated in the Getting LA to Net Positive Competition for Innovation in Design competition which is part of the living building challenge. The Living Building Challenge™ is a building certification program, advocacy tool and philosophy that define advanced measure of sustainability in the building environment. The Challenge is comprised of seven performance categories called Petals: Place, Water, Energy, Health & Happiness, Materials, Equity and Beauty. Petals are subdivided into a total of twenty Imperatives, each of which focuses on a specific sphere of influence. The competition is run by the Living Building Challenge Collaborative: Los Angeles.

For the competition the class ARCH 351 has decided to do a redesign of the Olympic Village. Los Angeles will host the summer games in 2024 and already have a plan for their Olympic Village; the ARCH 351 class hopes to accomplish an Olympic Village design that will better fit LA for the future as opposed to the current design which they feel only reflects the whims of the moment. I partnered with an architectural student named Sergio Sanchez and acted as his structural advisor for the project. For this project I researched green roof systems, offered structural input on the design of the structure, and created structural drawings with the structural calculations to support them.

Goals

I worked closely with Sergio Sanchez, an architecture student, to help him design a structurally sound building for the competition. My input was given to help shape his design and I designed the structural system around his evolving design. The project was submitted as a poster that uses visuals to describe how the project achieves the living Building Challenge guidelines for the competition.

My partner and I designed an alternative Olympic Village transportation center for the summer games of 2024 that will be hosted in Los Angeles. The rest of the Olympic Village will be designed by the other architects in Sergio’s class but while the remainder of the class designed the residential, amphitheater, and recreation center I am designing the transit center with Sergio because of the unique structural challenges that his design creates by having a slanted green roof incorporated into the design.

The rules for the project were that the building had to be between 30,000 and 50,000 SF (our building is 43,800 SF), the project must meet the needs of the Olympic Village in the short term and the needs of the city Los Angeles in the long-term, and the project must align with the students master plan that the entire class came up with to address the living Building Challenge. This master plan includes solar panels for the roofs, a sloped site to collect water during storms, use of sustainable materials, and encouraging walkability through numerous walkways while limiting cars. The transit center building I worked on houses the standard ticket booth, restrooms, and info booth you would expect in the main transportation hub of the Olympic Village as well as a bike shop and Olympic exhibits to better fit the needs of the Olympic village and the master plan. The bike shop and the exhibits will benefit the Olympic Village in the short run and the community in the long run by helping to promote walkability (or bikeability in this case) during and after the Olympic games and the exhibits can function as art gallery’s after the games.

---

1 Appendix A: 2015 LBC LA Competition Guidelines
2 Appendix B: Master Plan
3 Appendix C: Final board
Methodology

While Sergio designed the floor plan I helped him with structural input on his designs and researched green roofs to find a type that would work for the structure. For the design calculations the focus was for the elements of the structure that would affect the visual design of the building. The prime concerns were the gravity and the seismic loads because this defined the beams, girders, columns and lateral system of the building and how it will look.

Once I was given the floor plan I started with the load take off for the roof. For this we needed to decide on the material that the structure will be made out of and the type of green roof that will be used. After researching different types of green roof systems I presented the architect of the Optigreen system type “Pitcher Roof type P” [Figure 2]. The picture roof type P was chosen because it was a green roof system that does not come with a gravel strip and one that can support a slope. Because the roof already slopes into a collection point for collecting rainwater, as per the master plan, a gravel strip is not needed and because the roof is angled the green roof system needs to be able to support a slope.

Next the material that the structure is going to be made out of needed to be agreed upon. Timber would have been ideal as we wanted the building to represent sustainable practices, to follow the master plan, but the loads that a green roof imposes upon the structure made timber unrealistic so steel was chosen because it is an efficient building material that would allow all the structural members to remain relatively small.

---

4 Appendix D: Design Calculations
The shape of the structure kept evolving over the entire course of the project from a simple box design to a more complicated angled design. The structure started off as a simple box design with a slanted roof [Figure 3] and over the course of its development was stretched out and in the west wall was angled [Figure 4] which meant I had to constantly update the beam design as the project evolved. This in turn made it difficult to design. To compensate for this I used spreadsheets to quickly update the design of the structural system to keep up with the architects changes. This allowed me to give quick feedback on the architect’s changes and quickly identify problems I need to solve. A couple of important issues that came up that I was able to solve this way were column placement and complications to the north-south lateral system.
Because the structure is partially buried underground the east west level system can be easily supported through hidden shear walls. The north-south system is more complicated because the architect wanted the west facing exterior wall to be made of glass with minimal supports. Because the architect wanted a glass exterior a compromise had to be made for the lateral system. Shear walls were out for the obvious reason that you can’t see through one and I reasoned that moment frames would not work because the columns and beams of the moment frame would prevent exterior from looking uniform which was important to the architect, this left brace frames which worked for Sergio [Figure 5].

![Figure 5: brace frames for the west facing glass wall](image)

**Conclusion**

The unique opportunity I had with this project was that because I came on the project while the architect was still in the early stages of the project’s design I was able to directly influence said design. Instead of having a design handed to me, which I had to fit a structural system to, the architect and I worked together to come up with a design that took into consideration the structural systems that held it together. Of course neither of us got everything that we wanted but because we were always aware of each other’s needs we knew which sacrifices need to be made for the betterment of the project as a whole.

The importance of communication between architect and engineer is of major importance. Sergio and I would meet at least once a week in person and throughout the week with text messages to make sure we’re both on task. We were also connected to the file sharing program Drop Box which was our primary method of transferring files back and forth between each other. This allowed us to always be up to date with what each other were doing. What the architect trying to accomplish and what the engineer’s needs are has to be understood by both the architect and engineer. Both of our needs are reflected on each other’s design, which is especially evident in how I laid out the columns affected Sergio’s room placement and how Sergio’s room placement affected how I was able to place the columns. How the architect design affects the structural system and vice versa, if not understood by both parties, could lead to misunderstandings and conflict. Therefore the ability to be flexible and adapt
to changing needs of the architect is the most important skill I learned during this collaboration. The use of spreadsheets to quickly update design of structural systems to keep up with architect’s changes allowed me to give quick feedback on his design changes.
Appendix

Appendix A: 2015 LBC LA Competition Guidelines

Appendix B: Master Plan

Appendix C: Final board

Appendix D: Design Calculations

Appendix E: Senior Project Presentation
Getting LA to Net Positive

Competition for Innovation in Design

“A Visionary Path to a Regenerative Future”

“The Living Building Challenge . . . defines the most advanced measure of sustainability in the built environment possible today and acts to rapidly diminish the gap between current limits and the end-game positive solution we seek.”

“Imagine a building designed and constructed to function as elegantly and efficiently as a flower: a building informed by its bioregion’s characteristics, and that generates all of its own energy with renewable resources, captures and treats all of its water, and operates efficiently and for maximum beauty.”

Competition Guidelines

Using one of the provided innovation categories, students are invited to develop a presentation poster using compelling visualizations to describe how their projects can achieve and transcend the Living Building Challenge.

The poster should include graphics, text and explanatory information such that the topic is self-evident without the student’s verbal assistance. The poster title, along with the category, students’ names, degree program, and advisor/professor name should appear on the upper section of the board. A text description of the project no longer than 300 words should also be included on the poster.

Registration Closes: October 16, 2015
Poster Submissions Due: December 21, 2015
Presentation & Awards: January 11, 2016

Instructions for Submitting Posters:

1. All materials should be submitted via email to: lbclacollaborative@gmail.com
2. Posters should be 30” x 40” in a portrait orientation submitted as a PDF file less than 10mb
3. You should receive a confirmation email following your submittal
4. You cannot edit your submission once submitted
Accepted Posters:

Authors of accepted posters will be notified by 20 December 2015. Finalist shall be responsible for printing, mounting, and transporting their 30” x 40” posters on vertically formatted foam core to the final presentation. Teams will have the opportunity to present their poster and answer questions from a distinguished panel of jurors on 11 January 2016 at Gensler Los Angeles, 500 S. Figueroa St. Los Angeles, CA 90071 from 6pm to 8pm.

Eligibility

Contestants must be enrolled at a college or university and be able to attend the final presentations in Downtown Los Angeles on 11 January 2016. The competition is not limited to architecture but studies in agriculture, business administration, real estate development, urban planning, building science, material science, engineering, product design, public policy, historic preservation, environmental studies and more. Integrated teams are encouraged. Teams must be at least two (2) and no more than five (5) students and one (1) advisor / professor.
**Design Innovation**

Submissions must meet the requirements of all seven (7) Petals and applicable Imperatives outlined in the Living Building Challenge version 3.0 to create an architectural proposition within one mile of a Los Angeles Metro Rail Line. The Metro Line must be existing or currently under construction. Use a holistic and innovative approach to net-positive design that explores a paradigm shift within one of the typologies listed below.

Teams must identify one typology that aligns with the project to determine which Imperatives apply:

**Renovation**: This typology is for any project that does not form the substantial portion of a complete building reconstruction. Sample projects include single-floor tenant improvements, residential kitchen remodels or historic rehabilitations of a portion of a building.

**Landscape or Infrastructure** (non-conditioned development): This typology is for any project that does not include a physical structure as part of its primary program, although open-air ‘park-like’ structures, restrooms, amphitheaters and the like do fall into this category. Projects may be as diverse as roads, bridges, plazas, sports facilities or trails.

**Building**: This typology is for any project that encompasses the construction of a roofed and walled structure created for permanent use – either new or existing.

**Neighborhood**: This typology is for any project that contains multiple buildings in a continuous campus, neighborhood, district or village. Sample projects include university, college or corporate campuses; residential streets; business or industrial districts; or small villages and towns.

Every project must select a Living Transect category from the following options:

**L4. General Urban Zone**: This is comprised of light- to medium-density mixed-use development found in larger villages, small towns or at the edge of larger cities. (FAR of 0.5 – 1.49)

**L5. Urban Center Zone**: This is comprised of a medium- to high-density mixed-use development found in small to mid-sized cities or in the first ‘ring’ of a larger city. (FAR of 1.5 – 2.99)

**L6. Urban Core Zone**: This is comprised of high-to very high-density mixed use development found in large cities and metropolises. (FAR. ≥ 3.0)

Other requirements include:

- Mandatory public transit tie-in.
- Link neighborhoods together using new or existing transportation systems (address car problem).
- Link economic centers and create a destination for future economic growth.
- Perform a climate and place analysis, site specific.
- Address natural resource availability in Southern California.
- Project must be within 1 mile of a new or currently under construction Los Angeles Metro Rail Line.
Prizes

1st: $2,500
2nd: $1,000
3rd: $500
4th: $500
5th: $500

Jury

The Innovation Awards are judged by an esteemed panel of key professionals from top architectural, engineering, institutional, analytical backgrounds and select members of the collaborative team. The judges’ identities are held in confidence until the awards are presented to avoid any potential influence that may occur prior to the selection of the winners.

Criteria:

Innovative/Creative: 20%
Adhering to LBC Imperatives: 30%
Viability/Practicality of Concept: 30%
Collaboration: 20%

Registration:

Register at: www.eventbrite.com/e/getting-la-to-net-positive-tickets-18636501277

Then email the following to lbclacollaborative@gmail.com:

- Full Institution Name
- Team Name
- Contact Information for All Team Members (name, email, & major/degree)
- Team Manager
- Academic Advisor (name & email)
- How did you hear about us?
- Payment Information ($25 Registration Fee)

Competition & LBC Resources

http://living-future.org/
http://living-future.org/lbc
http://living-future.org/cascadia

Questions

Contact Jeffrey Landreth at: jeffrey.landreth@gmail.com
OLYMPIC VILLAGE MASTER PLAN

TEAM RHYTHMIC GYMNASTICS: Jeffery Baucom  Karina Riis-Vestergaard  Sergio Sanchez  Dylan Snelling

EXISTING SITE

OLYMPIC PROPOSAL

CLIMATE ANALYSIS

DIAGRAMATIC ANALYSIS

OLYMPIC MODE

LEGACY MODE

PETALS

All the high rise residential buildings have solar collection on the north facing wall, helping reduce the energy consumption of the Olympic Village.

Our site is a sloped site having been previously occupied, it is now being redeveloped for the Olympic Village.

All the materials used on the site will be reused and recycled purpose throughout the construction of the Olympic Village.

Each building is carefully designed with both form and function in mind, all of which contribute to create a cohesive and well designed master plan.

The Olympic Village encourages walkability and cycling through the numerous walkways, pedestrian paths, and bicycle paths throughout the site.

Our Olympic Village is designed to bring cultures from all around the world together, and the legacy will carry on this theme, celebrating the diversity of the Los Angeles area.
This hub serves as a point of origin to the site, welcoming both locals and tourists alike. Within this transportation center visitors will be introduced to a brief history of the Olympic Games as well as a history of Los Angeles, the host of the 2024 Olympics in their own respective exhibit wing of the project. The main lobby space will be an introduction to the site, the synthesis of both cultures and traditions being introduced with the rest of the master plan.
Appendix D: Design Calculations

Sample Calculations for all beams between lines “D” and “E” (See Roof Framing Plan)

First determine the loads and dimensions associated with the beams in question.

- **Dimensions**
  - Tributary width: **16.5 ft**
  - Length of beam: **53.3 ft** (with the roof slope taken into account)

- **Loads (Load takeoff located on Senior Project Calculations Spreadsheet)**
  - Dead Load: **40 PSF**
  - Live Load: **100 PSF**

  - **Live Load Reduction**
    - Because the roof is meant to be walked on, I am using the basic uniform live load reduction instead of the roof live load reduction (IBC 2012 1607.10.1)

    \[ L_r = L_0 \left( 0.25 + \frac{15}{\sqrt{K_{LL} \cdot A_T}} \right) \]

    - \( L_r \) = reduced live load
    - \( L_0 = 100 \text{ PSF} \)
    - \( K_{LL} = 4 \) (IBC 2012 T 1607.10.1)
    - \( A_T = 879.23 \) (taking into account the slope of the roof)

    Therefore \( L_r = 50.3 \text{ PSF} \)

  - **Distributed load: \( W_u \)**

    Distributed load determined using LRFD based on ASCE/SEI section 2.3
    Assume self weight of the beam is 100 PLF

    \[ W_u = [1.2(D) + 1.6(L_r)](trib. \, width) + (self \, wt.) \]

    - \( D = 40 \text{ PSF} \)
    - \( L_r = 50.3 \)
    - Trib. Width = 16.5 ft
    - Self weight = 100 PLF

    Therefore \( W_u = 2220 \text{ PLF} \)
- Free Body Diagram for the Beam

\[ W_u = 2220 \text{ PLF} \]

\[ L = 53.3' \]

- Largest Shear: 59.1K
- Largest Moment: 787.9K'

- Need to find the moment of inertia the beam needs to meet
  - Allowable deflection (IBC 2012 T 1604.3)

\[ \Delta_L = \frac{53.3(12)}{360} = 1.78'' \]

\[ \Delta_{D+L} = \frac{53.3(12)}{240} = 2.67'' \]

\[ I_{\Delta L} = \frac{5(L_r \times \text{trib. width})(L^4)(12^3)}{(384 \times 29000000 \times \Delta_L)} \]

\[ I_{\Delta D+L} = \frac{5(W_u)(L^4)(12^3)}{(384 \times 29000000 \times \Delta_{D+L})} \]

\[ I_{\Delta L} = 2922.4 \text{ in}^4 \]

\[ I_{\Delta D+L} = 5211.6 \text{ in}^4 > 2922.4 \text{ in}^4 \text{ use } I_{\Delta D+L} \]
Try W30X124 (AISC 2011 T3-2)

\[ \Theta M_n = 1530 \text{ K'} > 788.17 \text{ K'} \]
\[ \Theta V_n = 530 \text{ K} > 59.2 \text{ K} \]
\[ I = 5360 \text{ in}^4 > 5211.6 \text{ in}^4 \]

Use W30X124 for all beams between lines “D” and “E”

Sample Calculations for all Girders on line “E” (See Roof Framing Plan)

First determine the loads and dimensions associated with the Girders in question.

- **Dimensions**
  - Tributary width: 51 ft
  - Length of girder: 25 ft (with the roof slope taken into account)

- **Loads** (Load takeoff located on Senior Project Calculations Spreadsheet)
  - Live Load: 100 PSF
    - **Live Load Reduction**
      - Because the roof is meant to be walked on, I am using the basic uniform live load reduction instead of the roof live load reduction (IBC 2012 T 1607.10.1)
      
      \[ L_r = L_0 \left( .25 + \frac{15}{\sqrt{K_{LL} * A_T}} \right) \]

      \[ L_r = \text{reduced live load} \]
      \[ L_0 = 100 \text{ PSF} \]
      \[ K_{LL} = 4 \text{ (IBC 2012 T 1607.10.1)} \]
      \[ A_T = 1499.9 \text{ (taking into account the slope of the roof)} \]

      Therefore \[ L_r = 44.4 \text{ PSF} \]

- Self weight: \( W_{self} \) (Assume 100 PLF)
- Point Load: \( P = 2 \times 59.1 = 118.2 \text{K} \)
• Free Body Diagram for the Girder

\[ P = 118.2 \text{ K} \]
\[ W_{\text{self}} = 100 \text{ PLF (assume)} \]
\[ L = 33' \]

- Largest Shear: 50.1K
- Largest Moment: 501.5K'

• Need to find the moment of inertia the beam needs to meet
  - Allowable deflection (IBC 2012 T 1604.3)

\[ \Delta_L = \frac{33(12)}{360} = 1.1'' \]
\[ \Delta_{D+L} = \frac{33(12)}{240} = 1.65'' \]

\[ I_{\text{load}} = \frac{P(L \times 12)^3}{(48 \times 29000000 \times \Delta_{D+L})} \]

\[ I_{\text{self}} = \frac{5(W_{\text{self}})(L^4)(12^3)}{(384 \times 29000000 \times \Delta_{D+L})} \]

\[ I = I_{\text{self}} + I_{\text{load}} = 55.7 + 3198.1 \]
Try W30X90 (AISC 2011 T3-2)

\[ \Theta M_n = 1060 K' > 788.17 K' \]
\[ \Theta V_n = 374 K > 59.2 K \]
\[ I = 3610 \text{ in}^4 > 3254 \text{ in}^4 \]

Use W30X90 for all beams for line “E”

Sample Calculations for all Columns between lines “D” and “F” (See Roof Framing Plan)

First determine the loads and dimensions associated with the Columns in question.

- **Dimensions**
  - Tributary Area: 990 SF
  - Length of Column: 32 ft (with the roof slope taken into account)

- **Loads** (Load takeoff located on Senior Project Calculations Spreadsheet)
  - Dead Load: 55.43 PSF
  - Live Load: 100 PSF

- **Live Load Reduction**
  - Because the roof is meant to be walked on, I am using the basic uniform live load reduction instead of the roof live load reduction (IBC 2012 1607.10.1)

\[ L_r = L_0 \left( .25 + \frac{15}{\sqrt{K_{LL} \cdot A_T}} \right) \]

- \( L_r = \) reduced live load
- \( L_0 = 100 \) PSF
- \( K_{LL} = 4 \) (IBC 2012 T 1607.10.1)
- \( A_T = 990 \) (taking into account the slope of the roof)

Therefore \( L_r = 48.8 \) PSF

- Self weight: \( W_{self} \) (Assume 1600 PLF)
- Point Load: \( P_u \):

\[ P_u = (1.2(D) + 1.6(L_r))A_T \]
P_u = 143.2 lb

- Free Body Diagram for the Column

Try W10X49
  - Nominal compressive strength: \( P_n \) (AISC 2011 E3-1)

\[
P_n = \Phi \times F_{cr} \times A_g
\]

\( \Phi = .9 \) (AISC 2011 T4-22)
\( R = 2.88 \) (AISC 2011 TT1-1)
\( A_g = 14.4 \) (AISC 2011 TT1-1)

\[
F_e = \frac{\pi^2 E}{(K \times L)^2} = 16.08 \text{ (AISC 2011 E3 - 4)}
\]

\[
F_{cr} = 0.877F_e = 14.11 \text{ (AISC 2011 E3 - 3)}
\]

\[ P_n = 182.8 > 143.2 \]

Use W10X49 for all Columns between lines “D” and “F”
Sample Calculations for Brace Frame (See Roof Framing Plan)

First find the soil information from the USGS summary report

**USGS Design Maps Summary Report**

**User-Specified Input**


**(which utilizes USGS hazard data available in 2008)**

**Site Coordinates**: 34.05699°N, 118.21676°W

**Site Soil Classification**: Site Class D – "Stiff Soil"

**Risk Category**: /II/III

**USGS-Provided Output**

\[
S_d = 2.513 \text{ g} \quad S_{M3} = 2.513 \text{ g} \quad S_{UD} = 1.675 \text{ g} \\
S_1 = 0.877 \text{ g} \quad S_{M1} = 1.315 \text{ g} \quad S_{UL} = 0.877 \text{ g}
\]

For information on how the \( S_d \) and \( S_1 \) values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject matter knowledge.
Seismic Base Shear (ASCE 12.8-1):

\[ V = C_s \, W \]

\( C_s = \text{Seismic response coefficient (ASCE 12.8.1.1)} \)
\( W = \text{Seismic weight (ASCE 12.7.2)} \)

Seismic response coefficient (ASCE 12.8.1.1):

\[ C_s = \frac{S_{DS}}{R/I_e} \leq \frac{S_{D1}}{T\left(R/I_e\right)} \]

\( S_{DS} = 1.675 \text{ (USGS summary report)} \)
\( S_{D1} = .877 \text{ (USGS summary report)} \)
\( R = 6 \text{ (ASCE T 12.14-1)} \)
\( I_e = 1 \text{ (ASCE 11.5.1)} \)

\[ C_s = .279 \leq .323 = .279 \]

\( W = 3679 \text{ K (Weight of Beams + Girders + Columns + Roof)} \)

\[ V = (.279)(3679) = 1727.5 \text{ K} \]

Half of base shear goes to brace frame: 863.75 K

Plug into RISE:
$P_u = 297.8 \text{ KSI}$

$F_y = 46 \text{ KSI}$

$E = 29,000 \text{ KSI}$

Try HSS 14 X 14 X ½ (AISC 2011 T4-4)

$\Phi P_n = 609 > 297.8 \text{ OK}$
Getting LA to Net Positive Competition for Innovation in Design

Senior Project Engineer: Alexander Lohr
Architect: Sergio Sanchez
Submissions must meet the requirements of all seven (7) Petals and applicable Imperatives outlined in the Living Building Challenge version 3.0 to create an architectural proposition within one mile of a Los Angeles Metro Rail Line. The Metro Line must be existing or currently under construction.

Criteria:
- Innovative/Creative: 20%
- Adhering to LBC Imperatives: 30%
- Viability/Practicality of Concept: 30%
- Collaboration: 20%

Prizes
- 1st: $2,500
- 2nd: $1,000
- 3rd: $500
- 4th: $500
- 5th: $500
Olympic Village Transportation Center
Sergio Sanchez | Advisor: Alexander Lohr | Arch 351 Stacey White | Fall 2015

This hub serves as a point of origin to the site, welcoming both locals and tourists alike. Within this transportation center visitors will be introduced to a brief history of the Olympic Games as well as a history of Los Angeles, the host of the 2024 Olympics in their own respective exhibit wing of the project. The main lobby space will be an introduction to the site, the synthesis of both cultures and traditions being introduced with the rest of the master plan.
OLYMPIC VILLAGE MASTER PLAN

PETALS

- All of the high-rise residential buildings have solar collection on the roofs negating much of the energy consumption of the Olympic Village.

- Our site is sloped to funnel water to a collection point where it will be able to be filtered for use in the buildings. During storms, flooding can occur, so the overflow pipe lets water flow out into the Los Angeles River.

- The site is a brownfield site, having been previously occupied. It is now being restored and given purpose through the construction of the Olympic Village.

- All the materials used in the site will be red list approved and carefully selected considering sustainability and locality.

- Each building is carefully designed with both form and function in mind; all composed together to create a cohesive and well designed master plan.

- The Olympic Village encourages walkability through the numerous walkways, limitation of cars in the center of the site, and a bicycle center to promote human powered movement.

- Our Olympic Village is designed to bring cultures from all around the world together, and the legacy will carry on this theme, celebrating the diversity of the Los Angeles area.
First Need Load Take Off

- Rejected by architect

- Roof slopes into ground so we don’t need the gravel strip

- Can handle a slope up to 35 degrees (Roof has an 8 degree slope)

Distributed Roof Load:

<table>
<thead>
<tr>
<th>Component</th>
<th>Load (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Roof</td>
<td>25</td>
</tr>
<tr>
<td>3&quot; Rigid insulation</td>
<td>4.5</td>
</tr>
<tr>
<td>Fire Proof.</td>
<td>2</td>
</tr>
<tr>
<td>MEP</td>
<td>4</td>
</tr>
<tr>
<td>Ceiling – suspended w/A CT</td>
<td>2</td>
</tr>
<tr>
<td>MISC</td>
<td>2.5</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

Roof Live Load: 100 PSF
The Iterations

The shape of the structure has evolved over the entire course of the project making it difficult to design.
Solution: Spreadsheets

- Use spreadsheets to quickly update design of structural systems to keep up with architect’s changes. Thus able to give quick feedback on his design changes.

- Needs more columns

- Can’t have entire wall made of glass
Lateral System

Architect wants Glass exterior:
Shear walls ✗
Moment Frames ✗
Brace Frames ★
Conclusion

Importance of communication between architect and engineer
- What is the Architect trying to accomplish
- What are the engineer’s needs
- How does the architect’s design affect the structural system

The ability to be flexible and adapt to the changing needs of the architect