Reinsurance Group of America (RGA) Global Headquarters

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Structural Option
Faculty Advisor: Heather Sustersic

Images courtesy of Gensler & Tom Rolfes

RGA Global Headquarters Introduction

Project Team:

General Contractor: Clayco

Architect: Gensler

Structural Engineer: Uzun & Case

Civil Engineer: Stock & Associates

Landscape Architect: Forum Studio

Lighting Consultant: Randy Burkett Lighting Design

MEP/Fire Protection: Environmental Systems Design

Occupancy: General office and training

Construction: March 2013 to September 2014

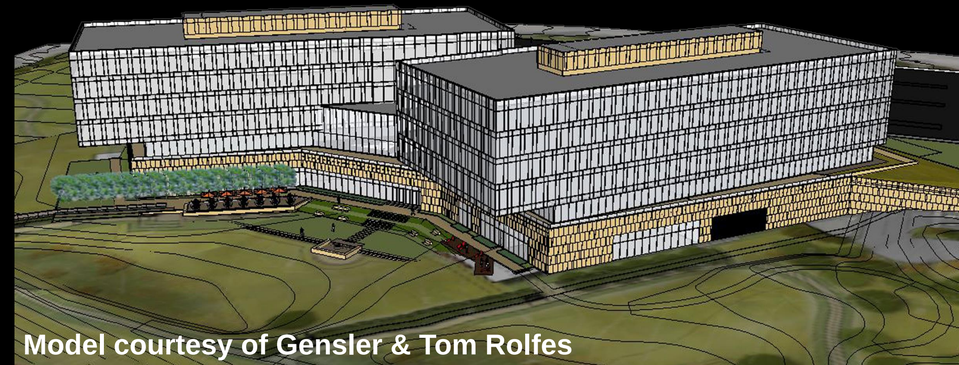
Delivery: Design-Build

2 Parking Levels

5 Office Levels per Tower

Size: 405,000 GSF

Cost: Approx. $150 million



Model courtesy of Gensler & Tom Rolfes

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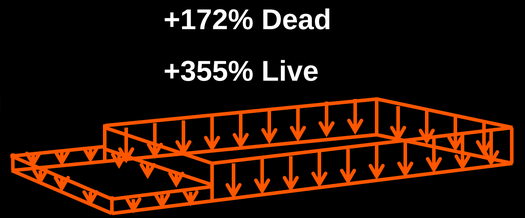
Problem Statement & Solution

Scenario:

Owner has decided to incorporate a green roof garden that is open to RGA's employees

Thesis Study Goals:

1. Interdisciplinary green roof design
2. Revise gravity and lateral systems under green roof loading
3. Explore cost and schedule impact



Model courtesy of Gensler & Tom Rolfes

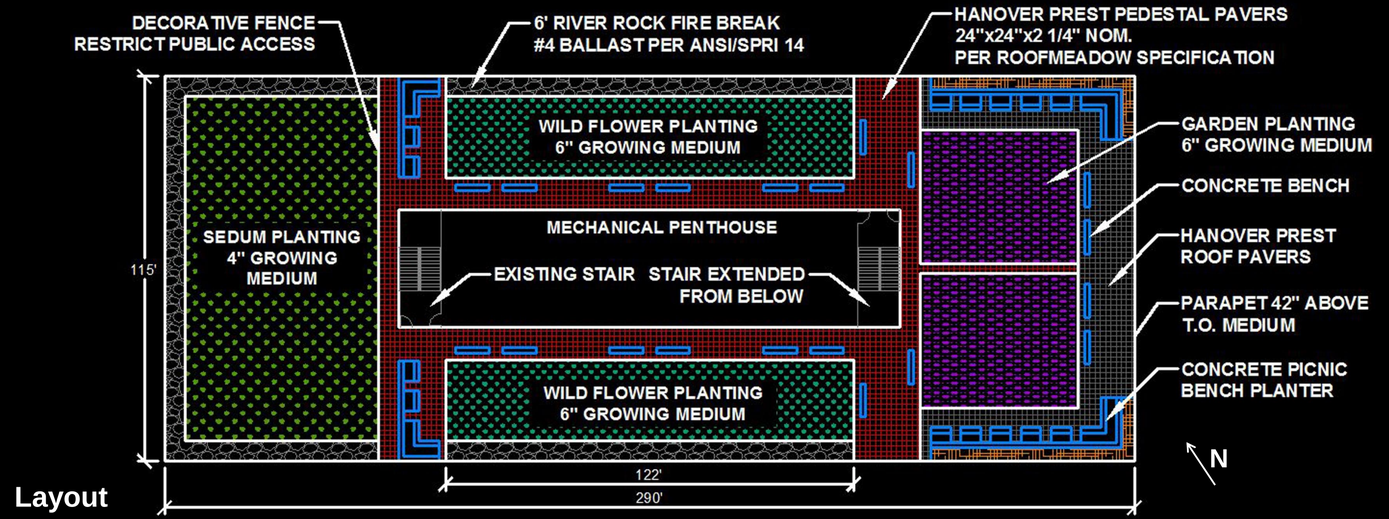
RGA Global Headquarters Green Roof Garden Breadth

Sedums

Garden Plants

Wildflower Plants

RGA Global Headquarters Green Roof Garden Breadth



Layout

Interdisciplinary Design Requirements:

1. Reasonable initial cost
2. Amenity seating area
3. Tenant circulation
4. Low maintenance
5. Architectural lines are uninterrupted

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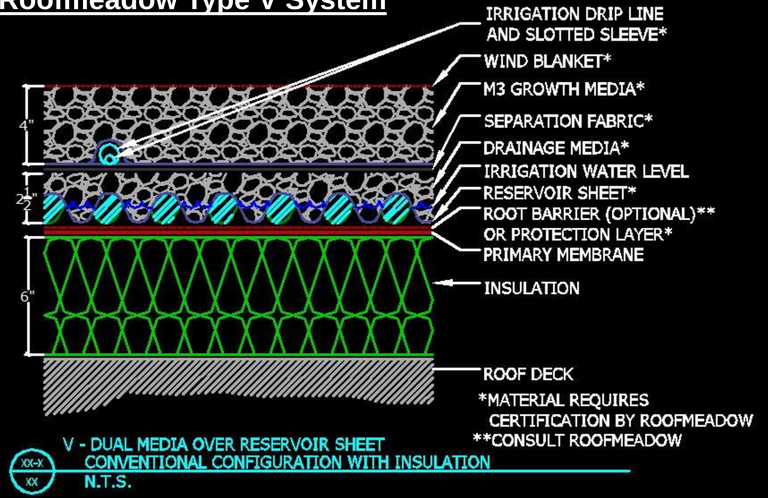
Green Roof Garden Breadth

Roofmeadow Type V System



Structural Load Cases

4" Growing Medium:

- Dead: 53 PSF
- Water Live: 26 PSF
- Roof Live: 20 PSF
- Snow: 22 PSF
- Wind: -21 PSF

6" Growing Medium:

- Dead: 68 PSF
- Water Live: 34 PSF
- Roof Live: 20 PSF
- Public Live: 100 PSF
- Snow: 22 PSF
- Wind: -21 PSF

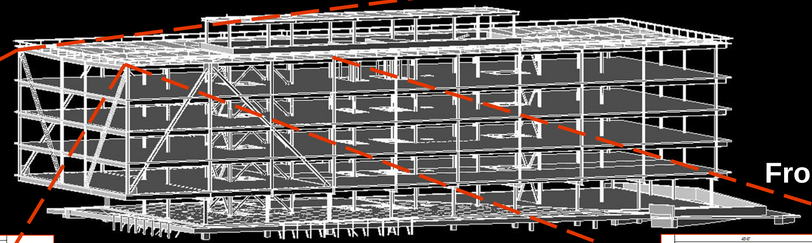
- Dead: +112%
- Live: +118%

- Dead: +172%
- Live: +355%

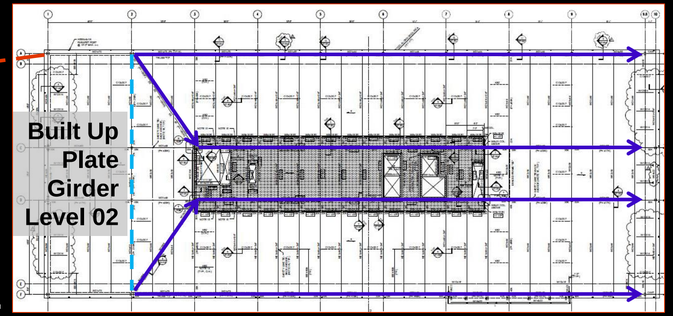
RGA Global Headquarters Structural Depth

Existing Gravity System

Cambered Truss System

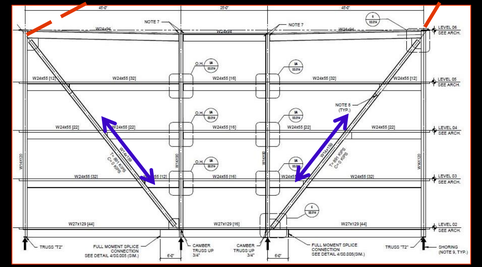


From C.D.

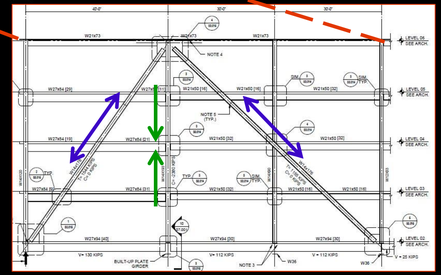


Roof Framing

N



From C.D. Truss T1



From C.D. Truss T2

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Structural Depth

- Introduction
- Problem Statement & Solution
- Green Roof Garden Breadth
- Structural Depth
  - Gravity System
  - Lateral System
- Construction Breadth Results
- Conclusions
- Acknowledgements

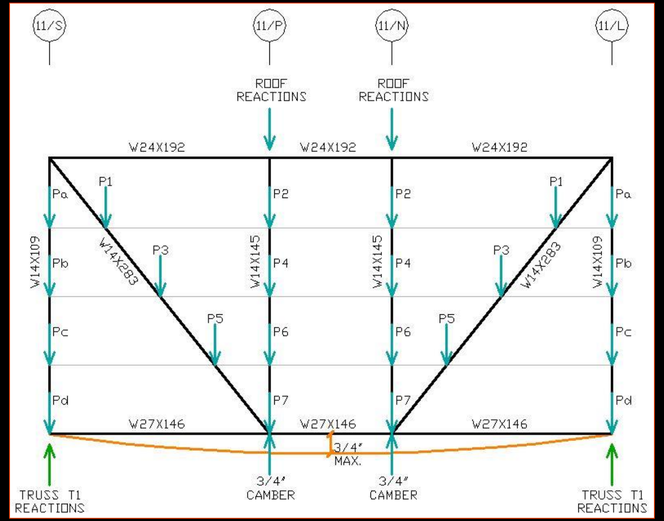
Truss T1:

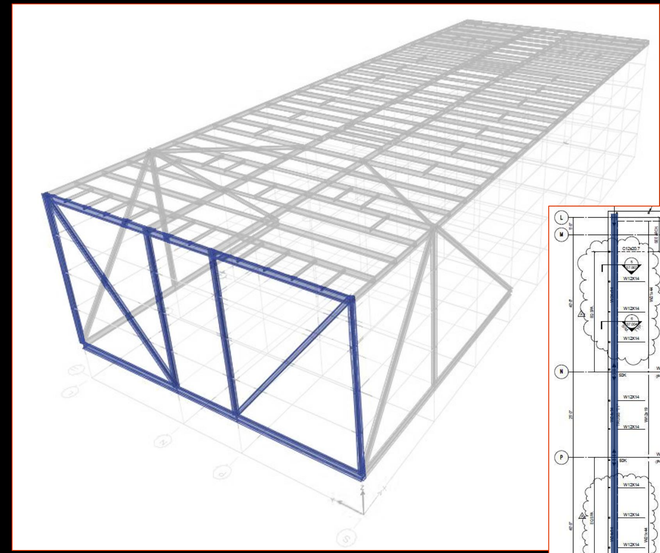
Roof Reactions

Floor Gravity

Reactions on T2

Deflection < ¾”





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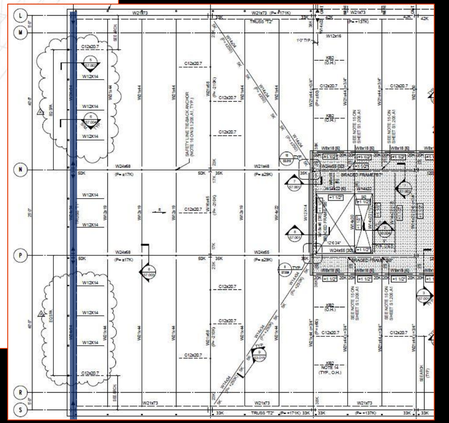


RGA Global Headquarters Structural Depth

Truss T2:

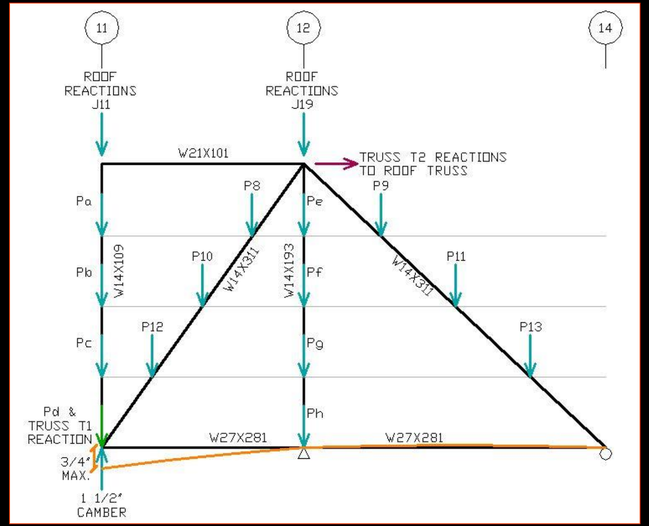
Roof Reactions

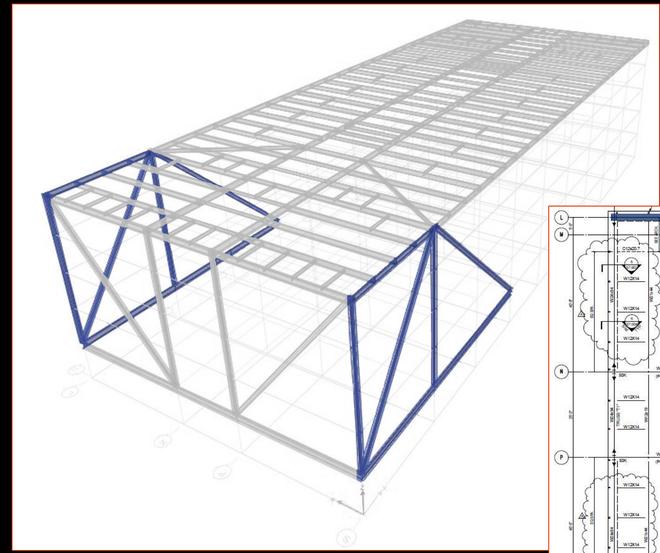
T1 Reactions

Floor Gravity

Reactions to Roof

Deflection < ¾”





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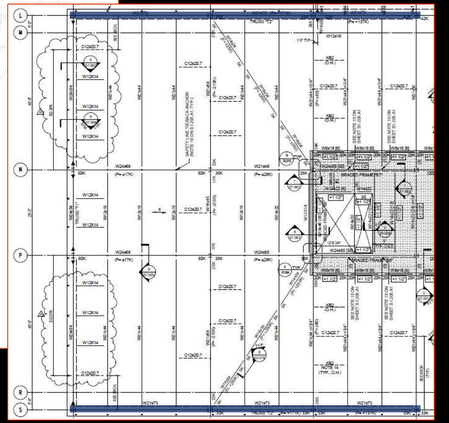


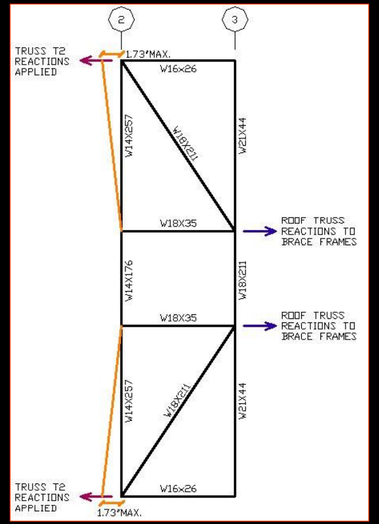
RGA Global Headquarters Structural Depth

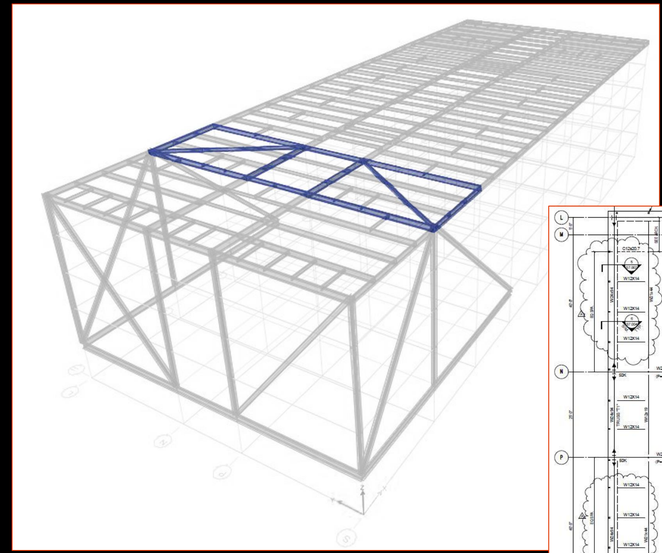
Roof Truss:

T2 Reactions

Reactions to BFs

Deflection < 1.73”





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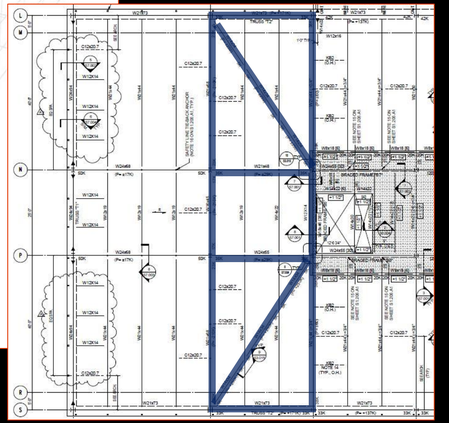
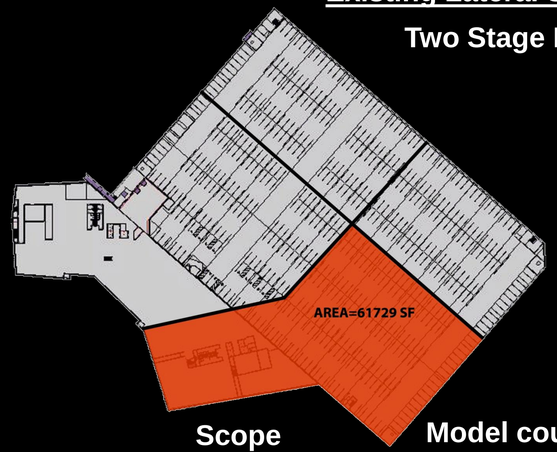


RGA Global Headquarters Structural Depth

Existing Lateral System

Two Stage Procedure

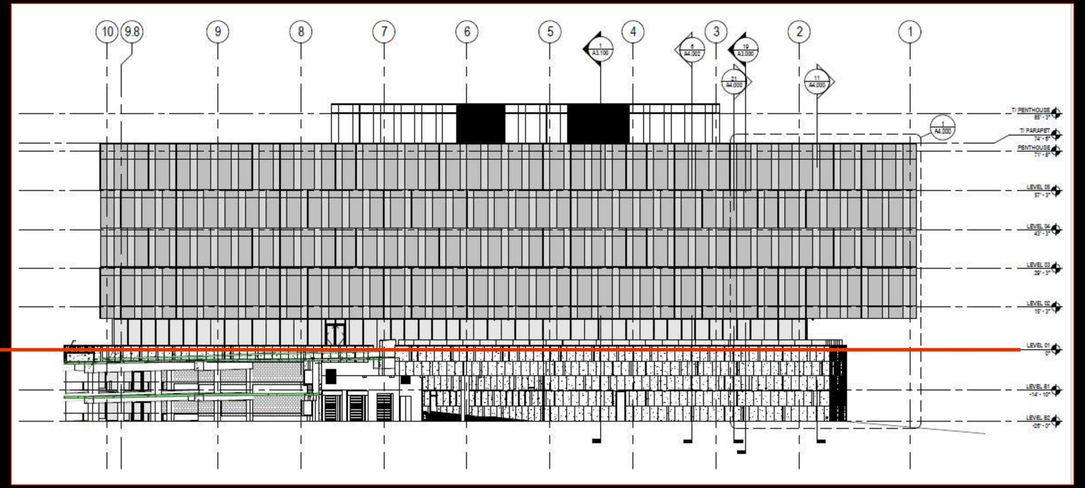


Scope

Model courtesy of
Gensler & Tom Rolfes

Steel Braced Frames

Concrete Shear Walls



From C.D.

RGA Global Headquarters Structural Depth

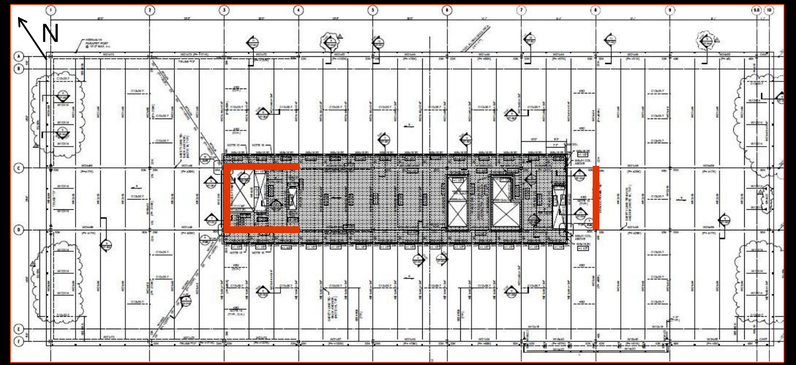
Existing Layout:

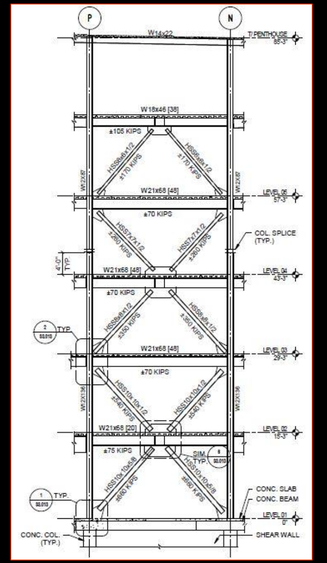
Concentrically Braced Frames

HSS Braces

R = 3

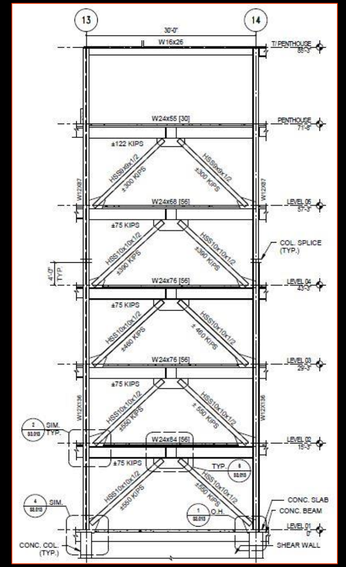
From C.D.





BF 5 & 6

From C.D.



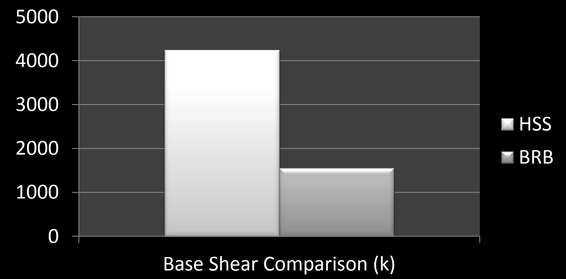
BF 7 & 8

RGA Global Headquarters Structural Depth

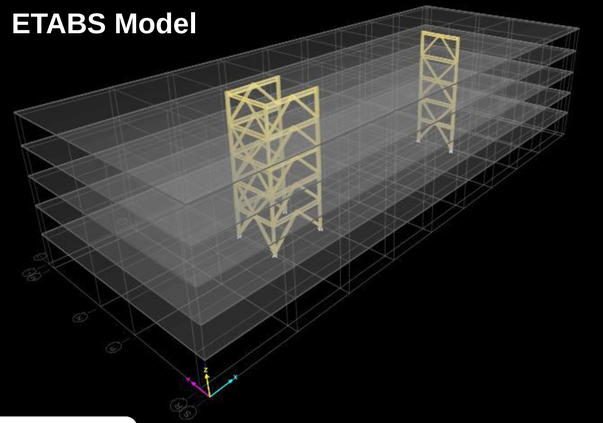
Seismic Force Adjustments:

Assume Seismically Detailed R = 7

Two stage procedure impact



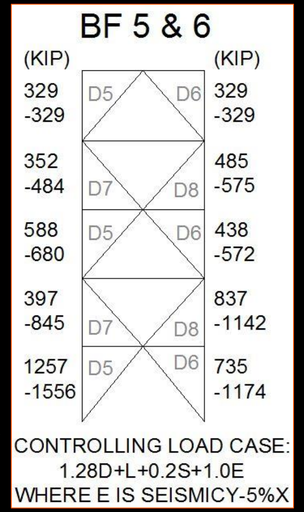
ETABS Model



New Response	New Period	New Office Base Shear	New Ratio	New Structure Base Shear
R = 7	Ta = 8.42 sec.	V = 323 k	1.75	V = 1552 k
• As-Built: R = 3	• As-Built: 0.561 s	• As-Built: V = 3338 k	• As-Built: 1.0	• As-Built: V = 4235 k

RGA Global Headquarters Structural Depth

Controlling Frame Design Forces For Preliminary Sizing



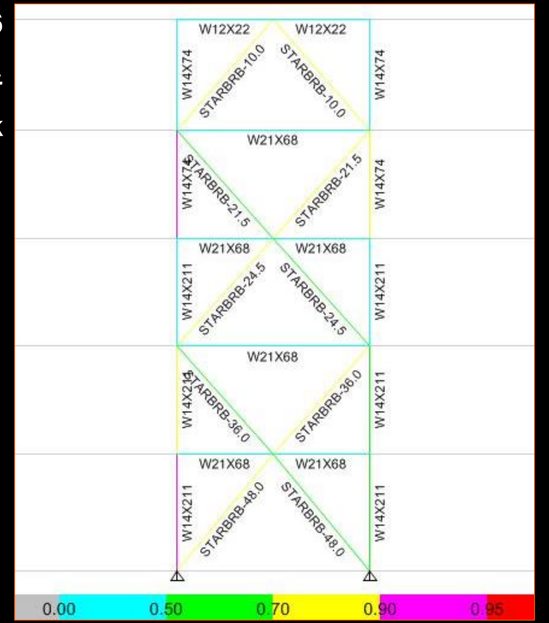
Controlling load combination:

$(1.2 + 0.2S_{DS})\ D + \rho Q_E + L + 0.2S$

From ASCE 7-05 12.4.2.3

- **SDC C**
- **I = 1.25**
- **ρ = 1.0**
- **S_{DS} = 0.400**
- **R = 7**
- **C_d = 5.5**
- **F_y = 46 ksi**

BF 5 & 6 Member Sizes & Code Check



STARBRB-36.0 = Buckling-Restrained Brace with 36 sq. in. steel core area

RGA Global Headquarters Construction Breadth

Roof System & Supporting Structure Cost Summary:

As-Built Project : $1,717,700

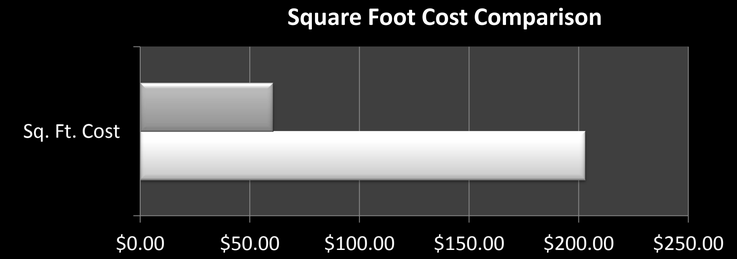
$60.38 per SF

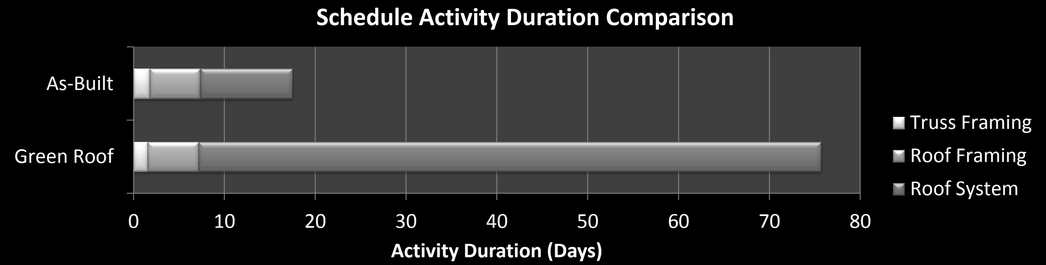
Green Roof : $5,774,600

$202.97 per SF

Includes:

- **10% Overhead and Profit**
- **4% Missouri Sales Tax**
- **5% Contingency**
- **Location**
- **Time**





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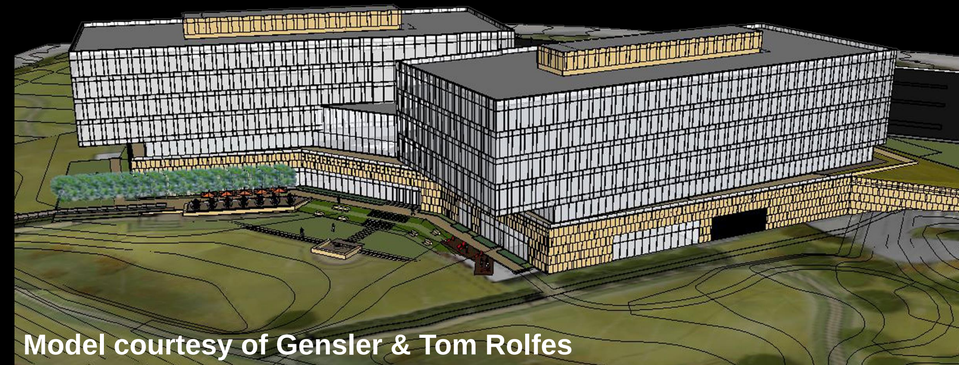
Conclusions

System Conclusions:

- Green roof garden system is feasible
- Cantilever impact minimized
- Buckling-restrained braces work, but are not most efficient in this application
- Cost and schedule increase reasonable, but final decision rests in the owner's hands

Thesis Study Conclusions:

- Green roof designed with interdisciplinary approach
- Implications on gravity and lateral systems considered and minimized where possible
- Accounted for cost and schedule factors



Model courtesy of Gensler & Tom Rolfes

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Acknowledgements

Heather Sustersic

Ruby+Associates

Perry Esslinger & Tom Rolfes with Clayco

Family, Friends, God

Images courtesy of Gensler & Tom Rolfes

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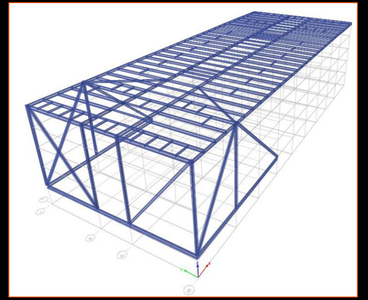
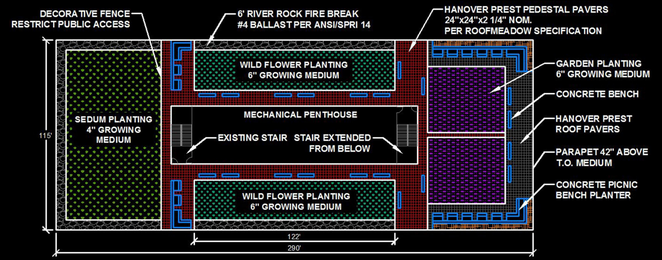
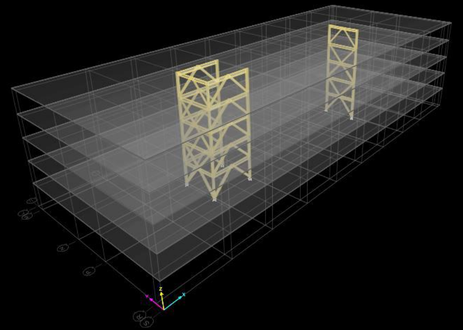
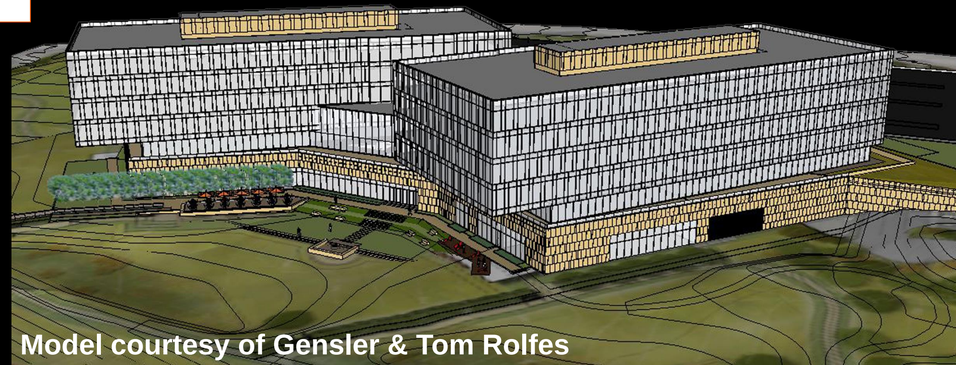
Questions?









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