

Long Span Mass Timber: Designing the University of Idaho's New Arena

Presented by: **Chris Roberts**
Judsen Williams
Lucas Epp

Opsis
KPFF
StructureCraft



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Course Description

The new University of Idaho Central Credit Union (ICCU) Arena will be a showpiece for U of I's Vandal Athletics program, provide a unique gathering place for sports, concerts and events, and celebrate Idaho's timber heritage with innovative mass timber construction. Designed as a multi-event and court sport facility, the arena will accommodate 4,000 spectators and include a basketball home court, practice court, locker rooms, conference space, concessions, media room, and offices. The project aims to serve as a national model for the use of mass timber for long-span sport facilities; the design showcases the use of innovative wood materials with a particular emphasis on Idaho forest products. In this webinar, the project's architect and structural engineer will discuss the unique aspects of designing a long-span mass timber structure. Topics will include code analysis and compliance, detailing considerations at connections, structural design processes for a long-span roof, and designer-manufacturer interface.

Learning Objectives

1. Review the code approval and local permitting steps taken to achieve compliance for a first-of-its-kind mass timber arena.
2. Explore the design team's approach to material selection for a mass timber building, emphasizing its impact on local forestry and wood utilization.
3. Discuss the structural design process for a long-span mass timber roof, highlighting connections, modeling, manufacturer coordination, and other key considerations.
4. Demonstrate the potential student benefits and learning opportunities associated with a mass timber University building, including aesthetics and occupant comfort.

Embodies **innovative** use of wood products and materials

Includes **mass timber** construction techniques

Utilizes **replicable** construction methods

Develops a more **sustainable**, “right-sized” facility

The Idaho Arena is seen as an opportunity to work with the **forest products industry** within the State of Idaho to examine and explore the use of wood and engineered wood products in a unique and innovative manner. There is specific intent to provide **research, educational and outreach opportunities** in partnership and collaboration with forest product industry partners in the design, construction and operation of a **highly visible, iconic wood structure** that stands as a symbol of the state's natural resources.

University of Idaho

REGIONAL HISTORY

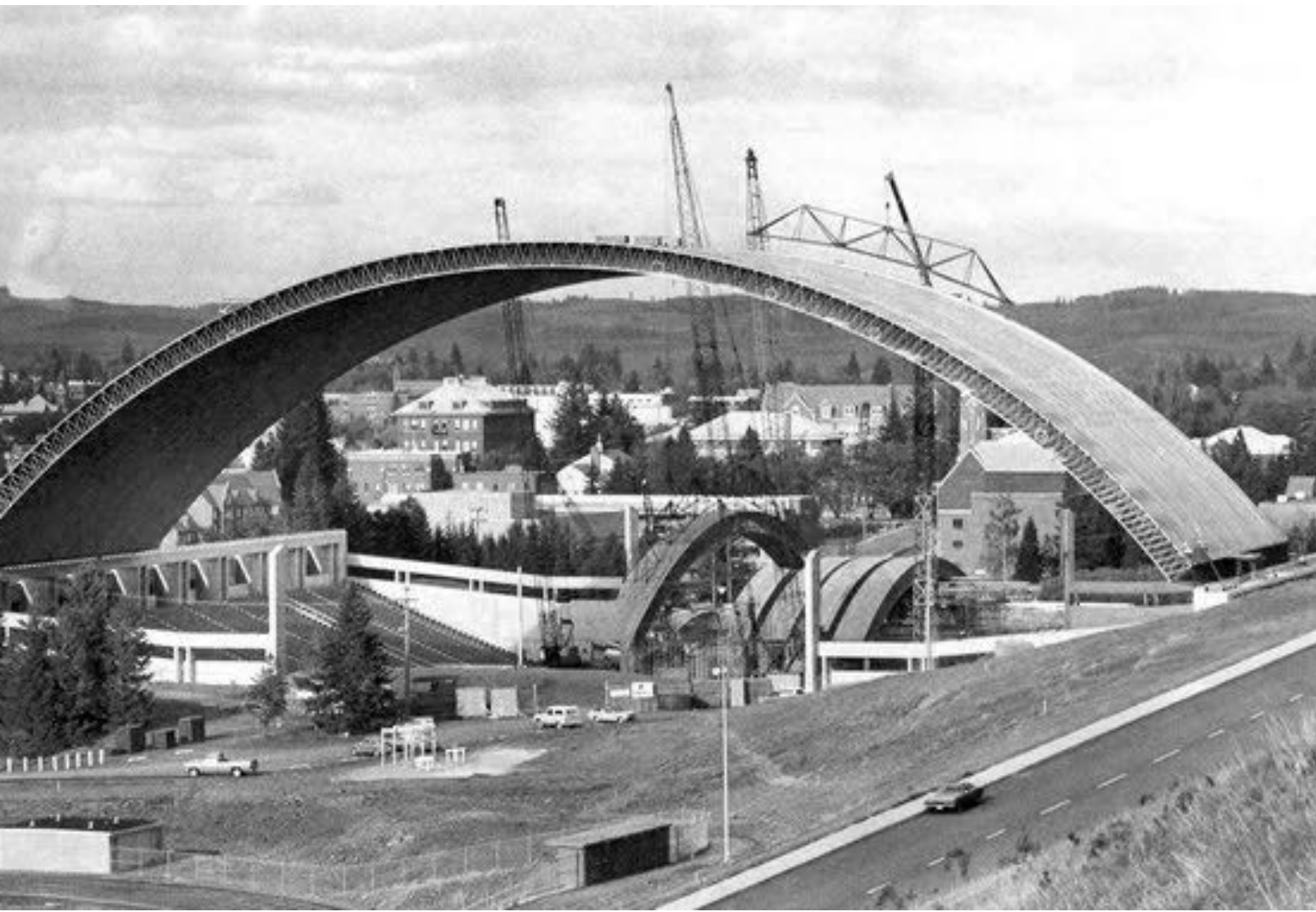
Forestry Building



LEWIS & CLARK EXPOSITION 1905

REGIONAL HISTORY

Kibbie Dome at UI





Original

Concept



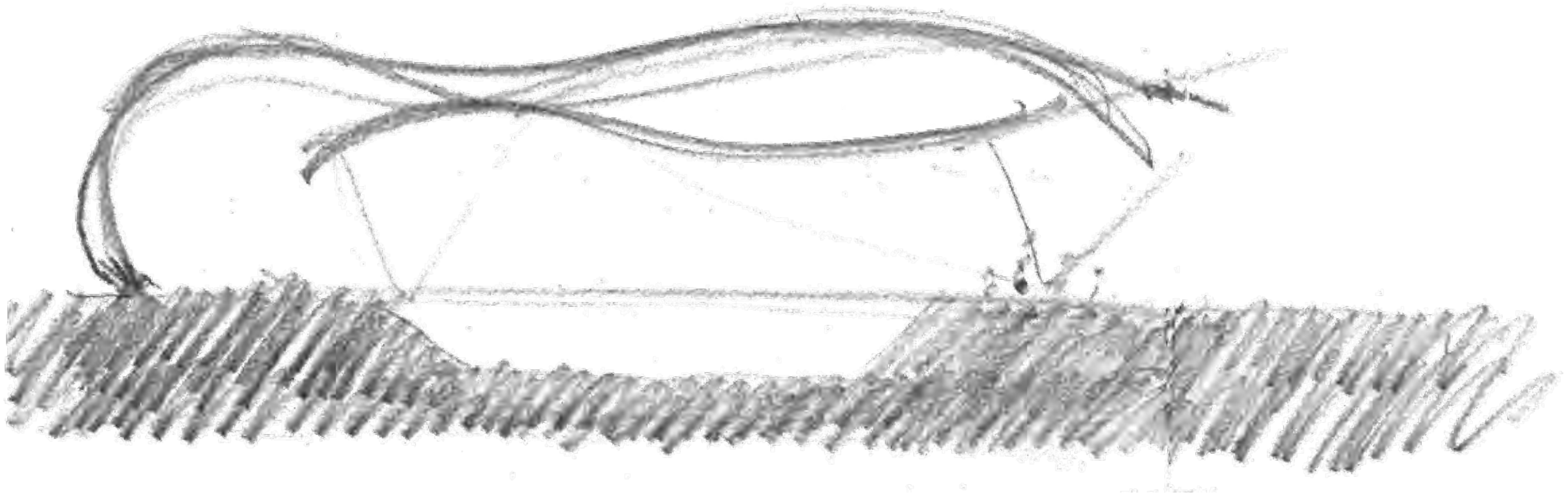
Final
Design

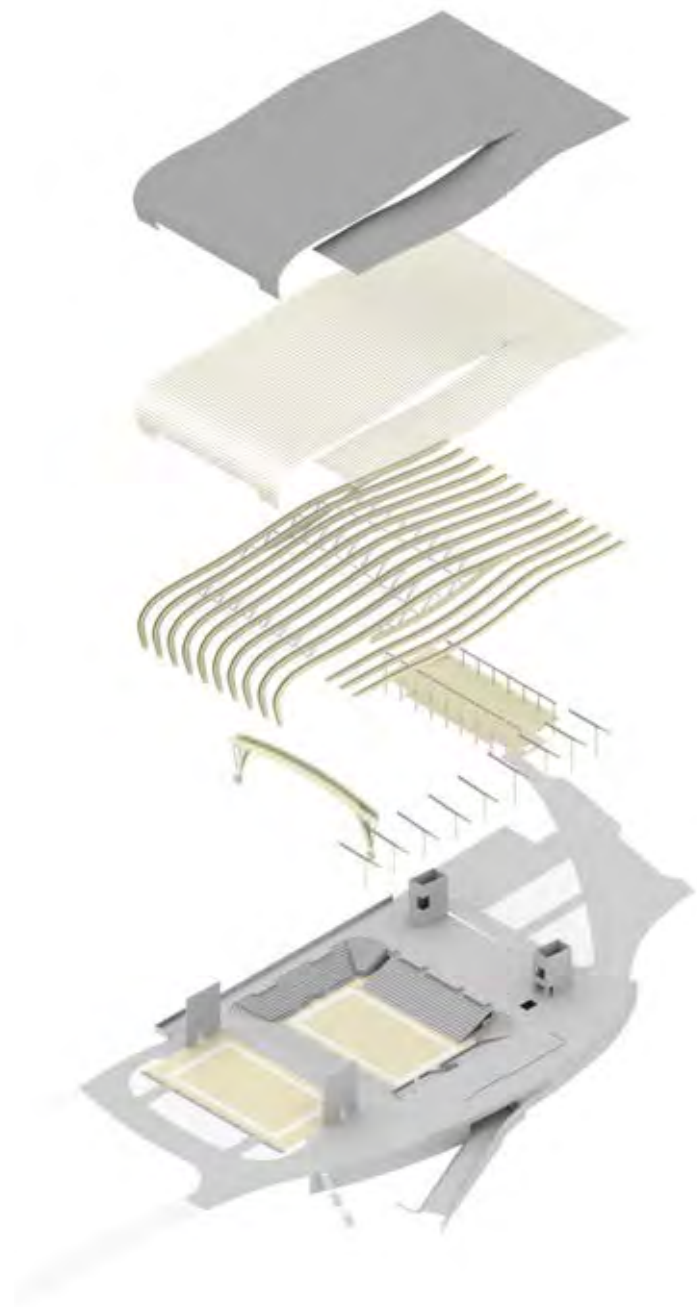




PROTOTYPE

Concept



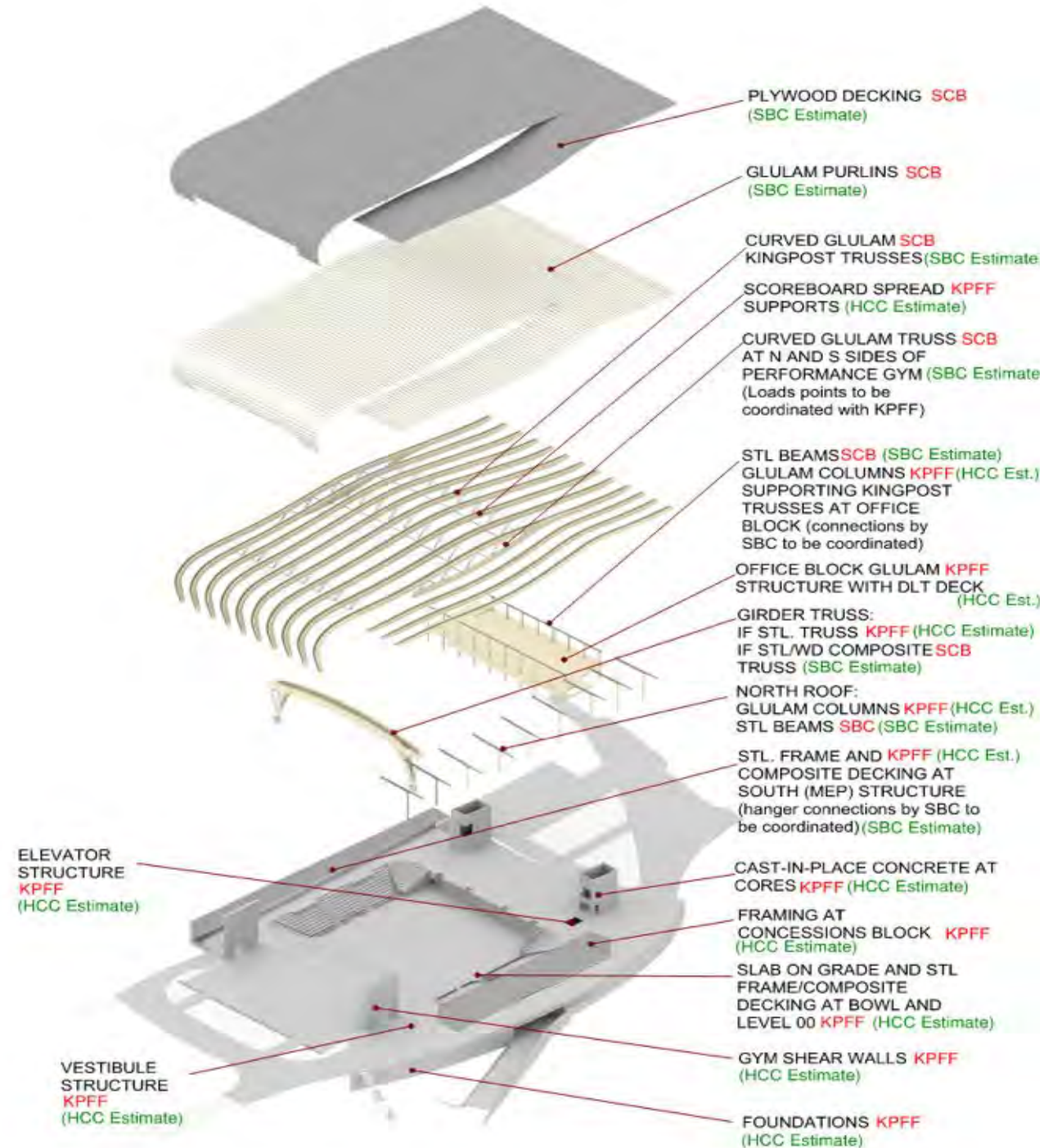




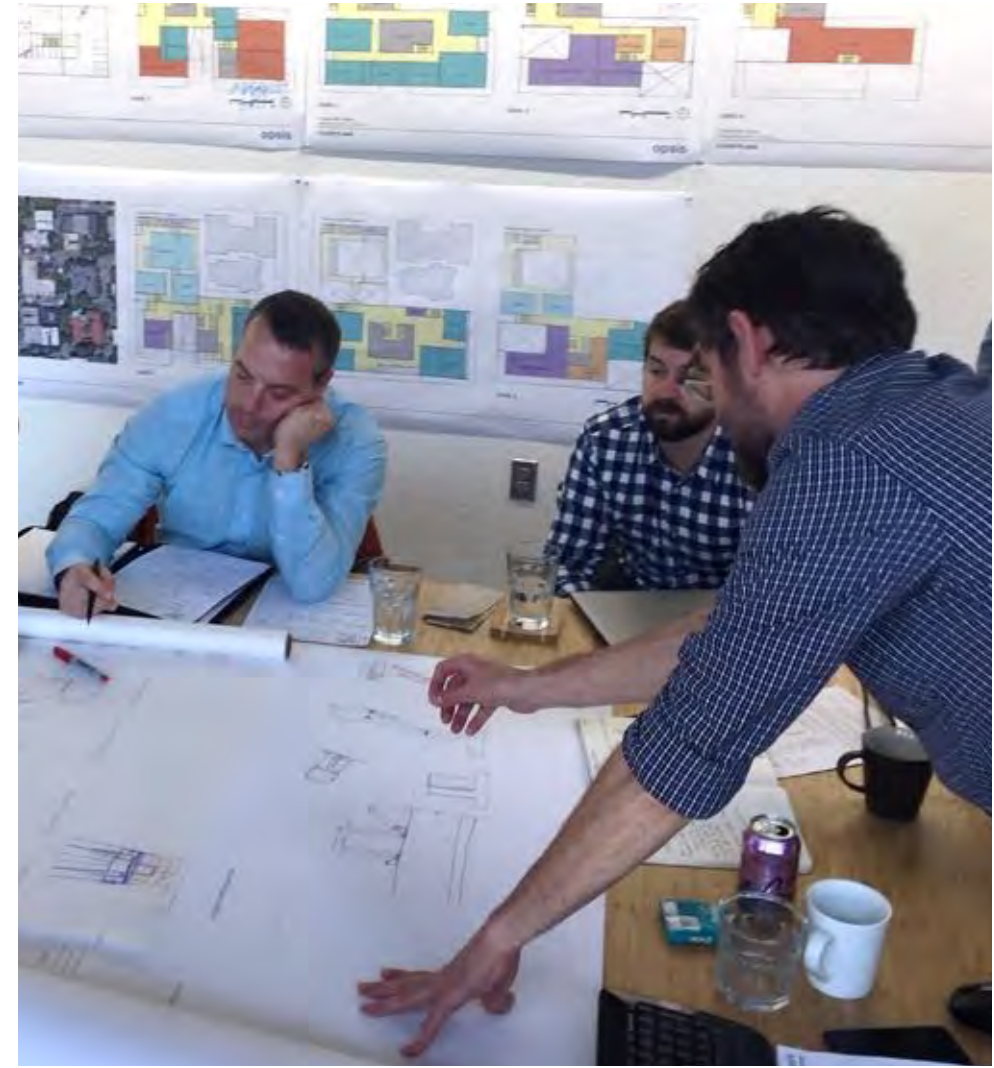
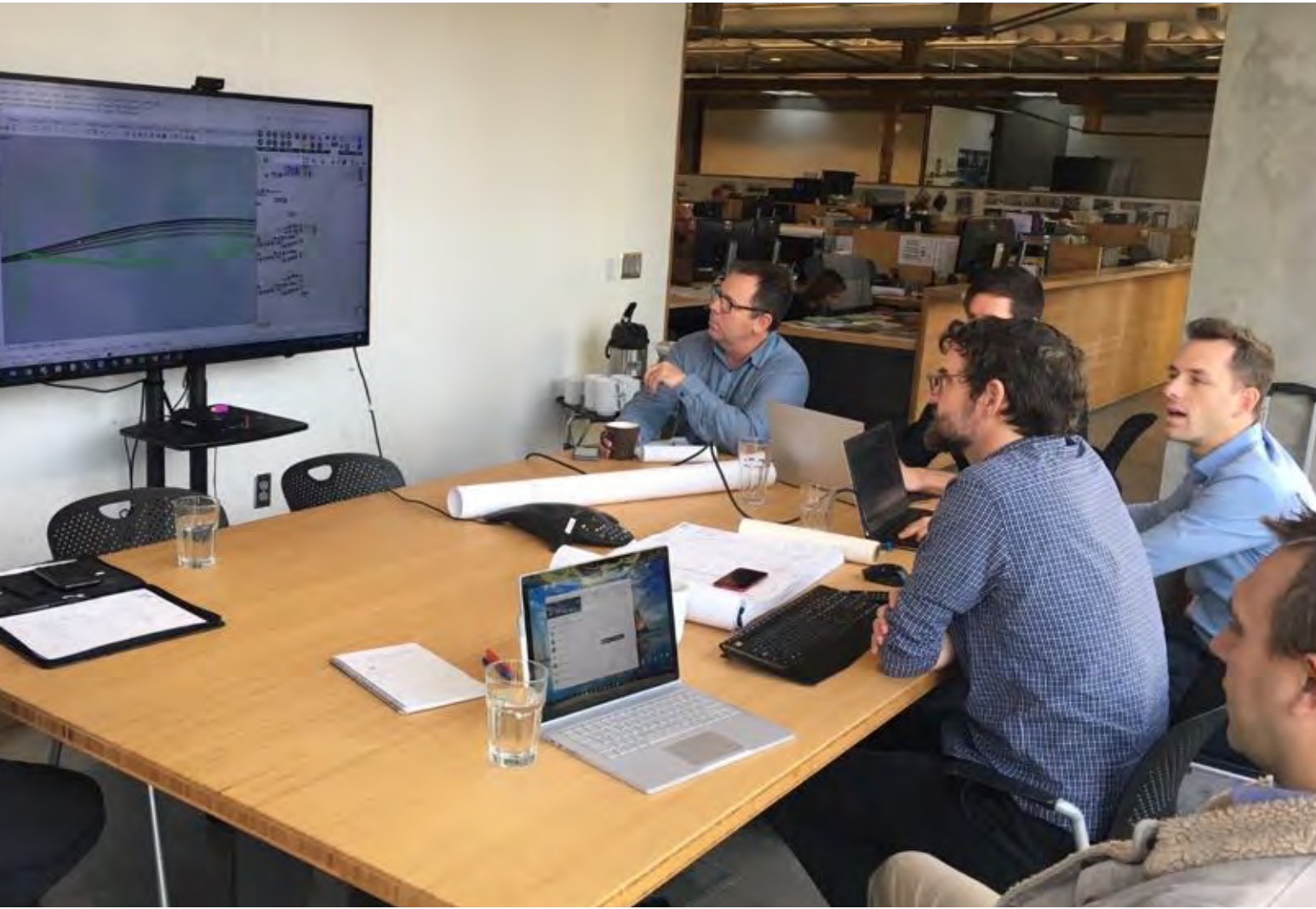
Collaboration

| | Design Roles and Responsibilities | | | | |
|-------------|-----------------------------------|-------------------------|--------------------------------------|-------------------------|------------------------------------|
| KPFF | Overall Project SEOR | Main POC w/ AHJ | Foundation/ Lateral Element Modeling | Overall Design Criteria | Lateral and Community Block Design |
| SC | Roof SEOR | Roof Modeling/ Geometry | Portal Frame Design | Long Span Truss Design | Diaphragm Design |

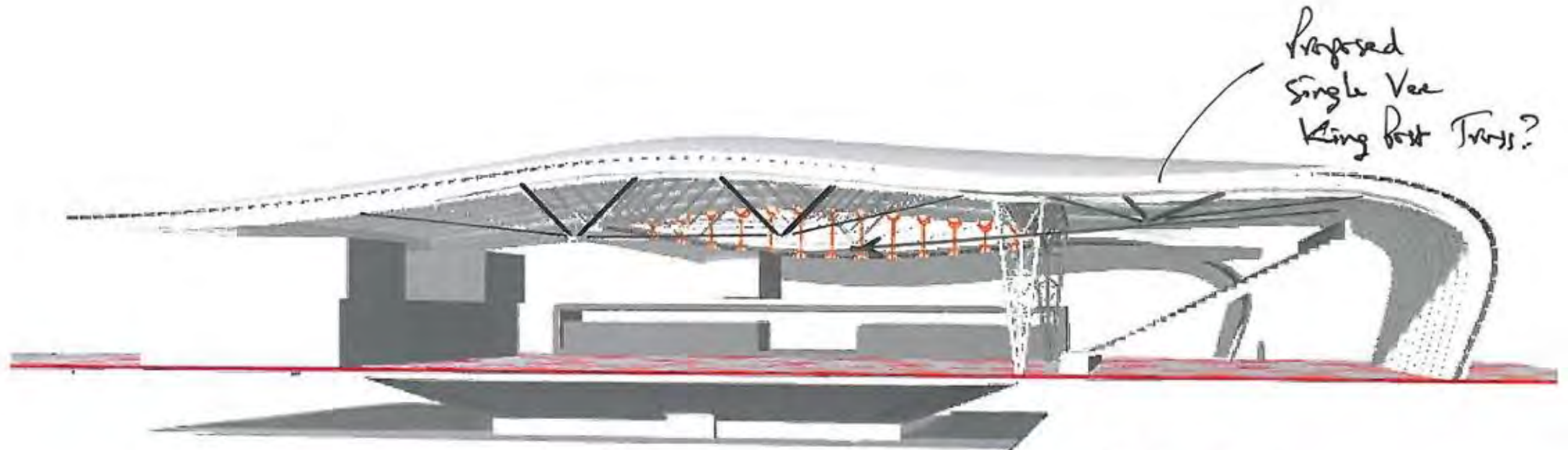
Collaboration



Process Workshops



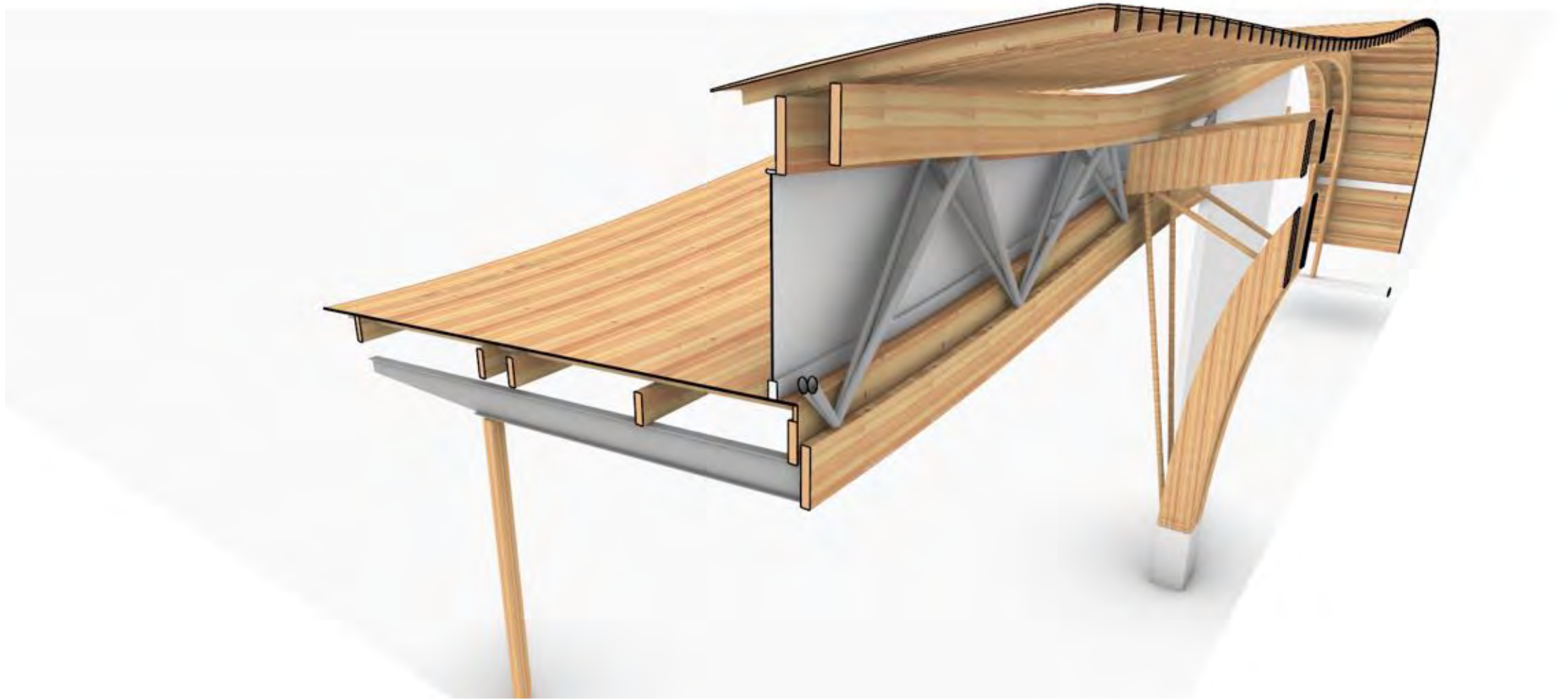
Structural Concepts



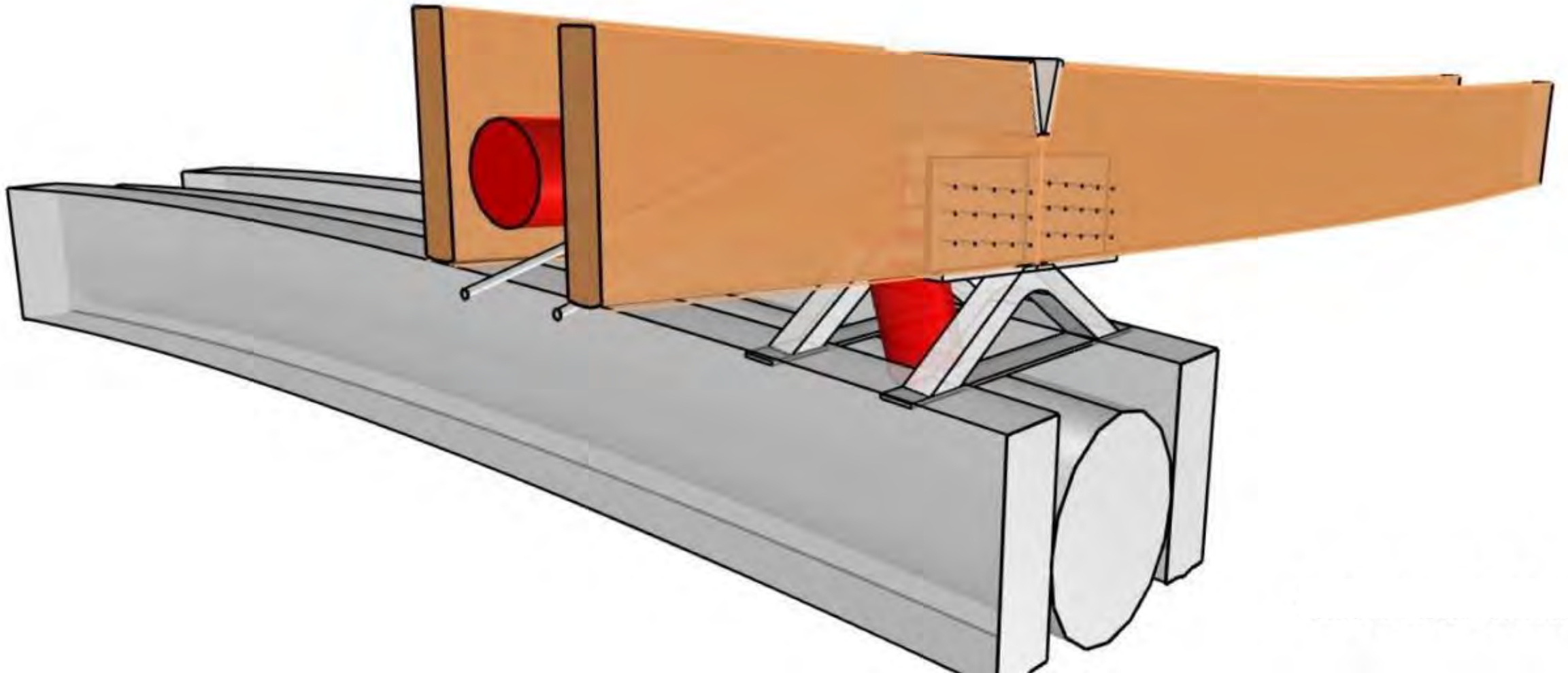
Refinement



Detail



MEP Integration

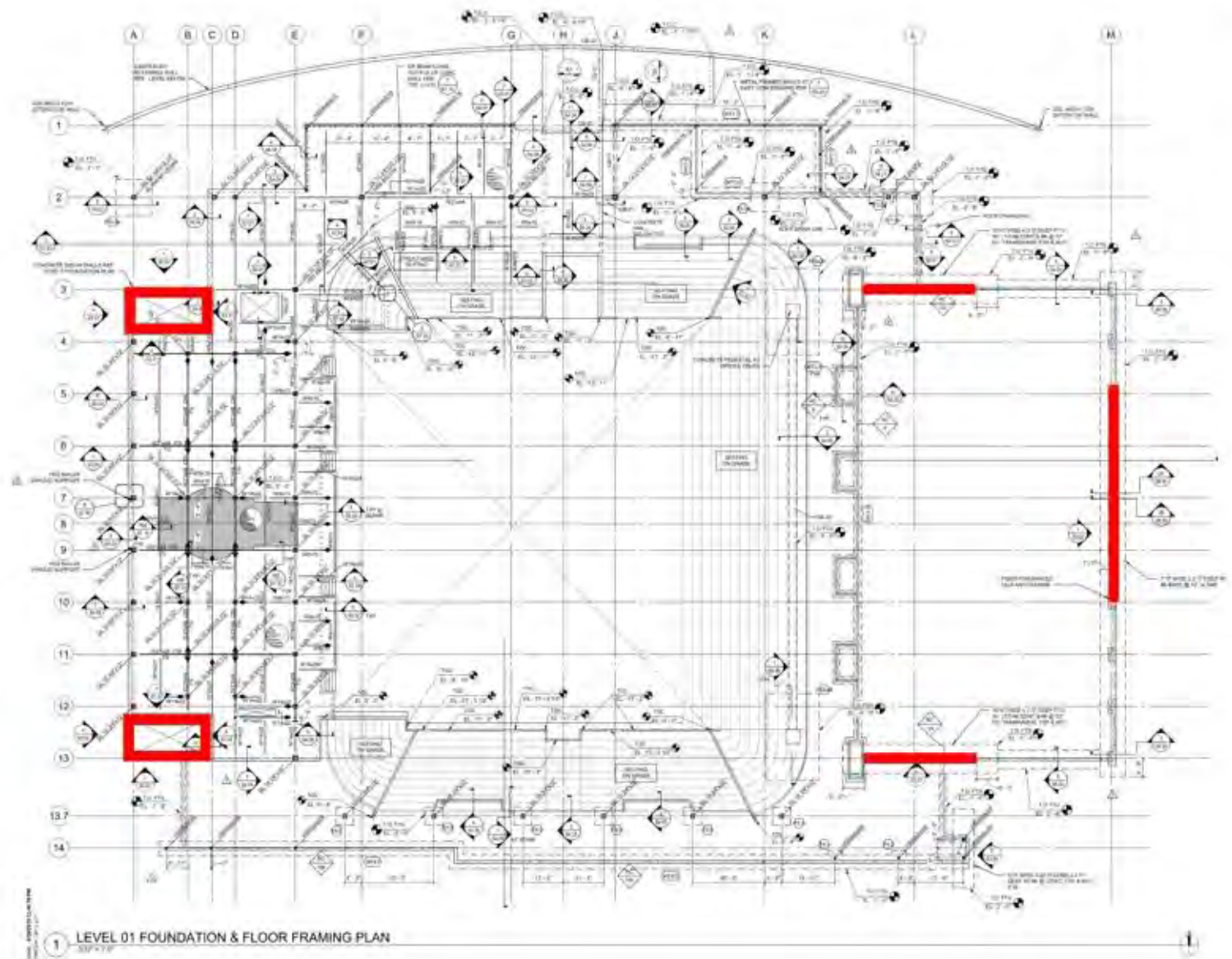


STRUCTURE

Lateral System

- Ordinary Concrete Shear Wall
- Steel Brace Frame
- $R = 3$
- Wind Governed

Complex Yet Simple



opsis
Hastings+Chivetta
ARCHITECTURAL PLANNING ENGINEERING

kpf
Kohn Pedersen Fox Associates LLP
ARCHITECTS

University of California

PROJECT: **OSAKA CENTRAL CREDIT UNION AVENUE**
LOCATION: **300 STADIUM DRIVE, MOSCOW, ID 83843**

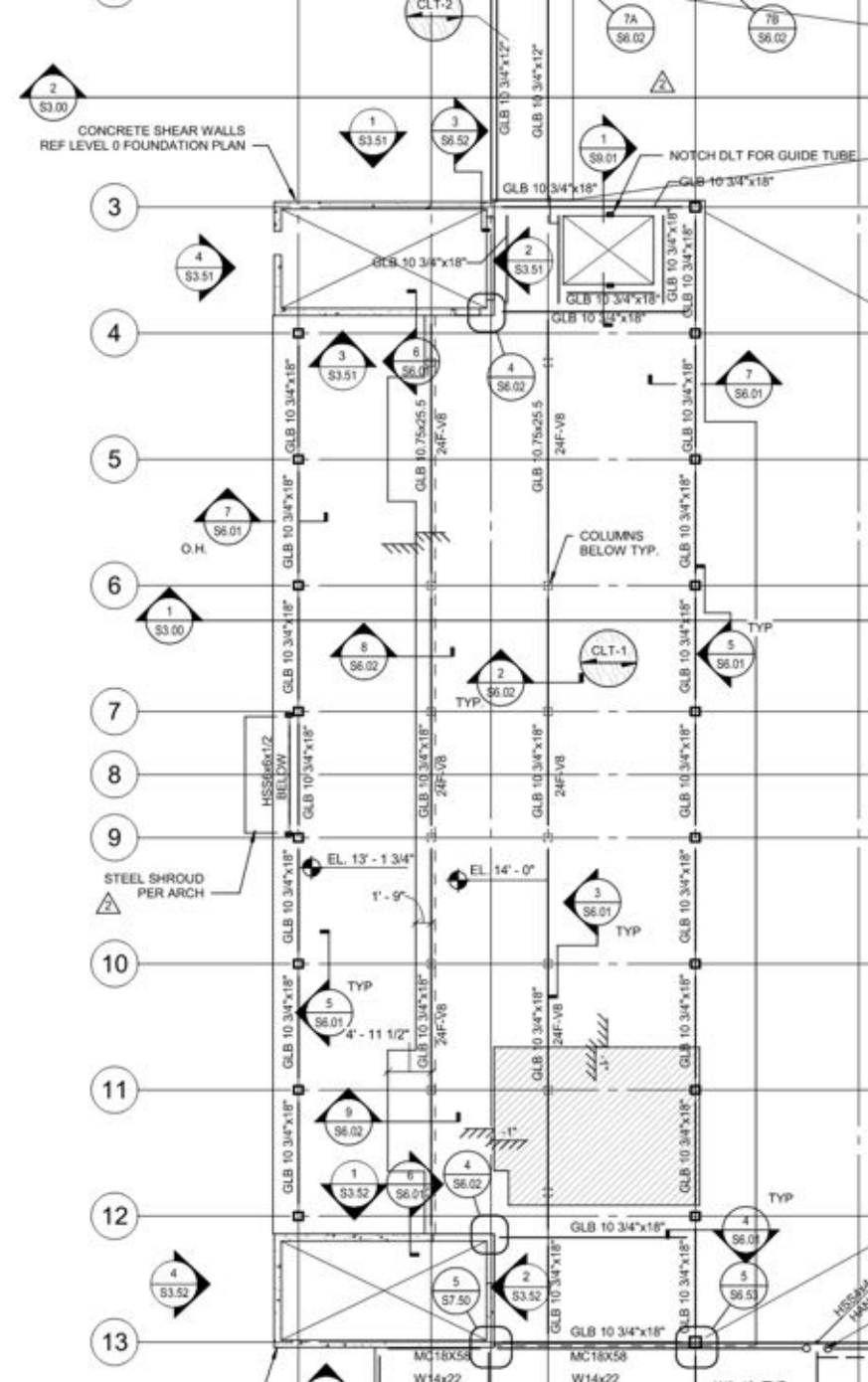
CONSTRUCTION PLAN SYMBOLS

FOUNDATION PLAN SYMBOLS

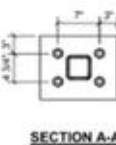
STEELING PLAN SYMBOLS

CONFORMED SET
DATE: 06.21.2019
LEVEL 01 FOUNDATION & FLOOR FRAMING PLAN
S1.21
10021700261

- Steel/Conc Filled Metal Deck at Coaches Offices



1



1" = 1'-0"

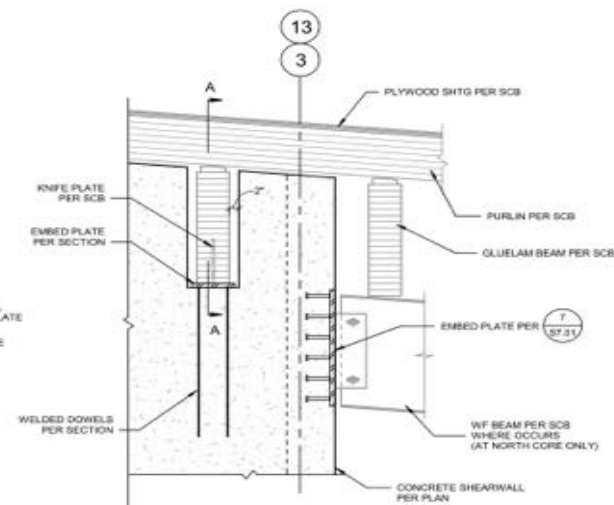

$$3/4" = 1'-0"$$


6

$$\frac{3}{4}'' = 1'-0''$$

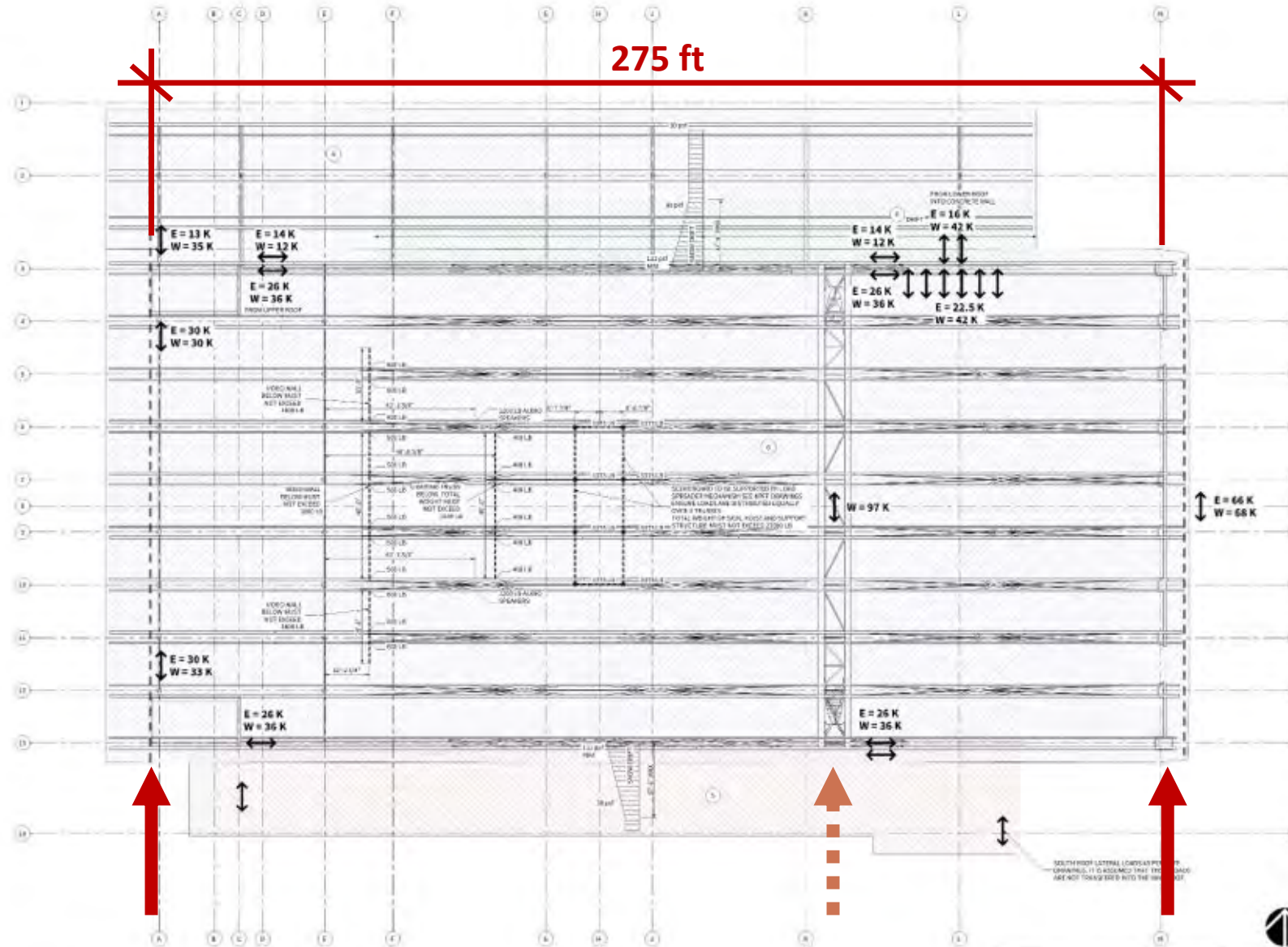

5

SCALE = 40.0



6

$$\frac{3}{4}'' = 1'-0''$$



1 ROOF LOADING PLAN
SCALE: 1/8" = 1'-0"

| LOADING SCHEDULE | | | | | |
|------------------|------|----------------------|--|--------------|--------------------------------------|
| ACTIVITY | TYPE | DESCRIPTION OF AREA | SUPERIMPOSED DEAD LOADS | LIVE LOAD | WINDY LOAD |
| | 1 | ROOF DECK | 15 psf (dead load and permanent equipment) | 20 psf (1.0) | 15 psf (1.0) + 20 psf (1.0) = 35 psf |
| | 2 | ROOF MECHANICAL ROOM | 15 psf | 10 psf (1.0) | 15 psf (1.0) + 10 psf (1.0) = 25 psf |

| NOTES | |
|--|--|
| 1. UNLESS OTHERWISE NOTED, ALL LOADS ARE TO BE APPLIED TO THE ROOF DECK. | |
| 2. UNLESS OTHERWISE NOTED, ALL LOADS ARE TO BE APPLIED TO THE ROOF DECK. | |
| 3. UNLESS OTHERWISE NOTED, ALL LOADS ARE TO BE APPLIED TO THE ROOF DECK. | |
| 4. UNLESS OTHERWISE NOTED, ALL LOADS ARE TO BE APPLIED TO THE ROOF DECK. | |
| 5. UNLESS OTHERWISE NOTED, ALL LOADS ARE TO BE APPLIED TO THE ROOF DECK. | |

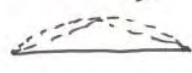
5 parameters - $\alpha, \beta, \theta, \gamma$, and a $\delta_{1/2}$ interpolation



Sym. \updownarrow Center

| Truss | Left KP | | Right KP | | δ options | | |
|--------|-------------------|------------------------------|-------------------------------|-------------------|------------------|-----|-----|
| Outer | α | $\alpha \pm \beta$ | $\theta \pm \gamma$ | θ | 1.0 | 1.0 | 1.0 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| Center | $\delta_1 \alpha$ | $\delta_1(\alpha \pm \beta)$ | $\delta_2(\theta \pm \gamma)$ | $\delta_2 \theta$ | 1.5 | 0.7 | 1.0 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| Outer | α | $\alpha \pm \beta$ | $\theta \pm \gamma$ | θ | 1.0 | 1.0 | 1.0 |

$\delta=1.0$



Interp options

Interpolate w/
graph mapper
i.e. either linear
or arc.

Limits:

$$20^\circ < \alpha/\theta < 60^\circ$$

$$20^\circ < \alpha + \beta/\theta + \gamma < 70^\circ$$

i.e. β/γ need to be limited relative to
the chosen α/θ values.

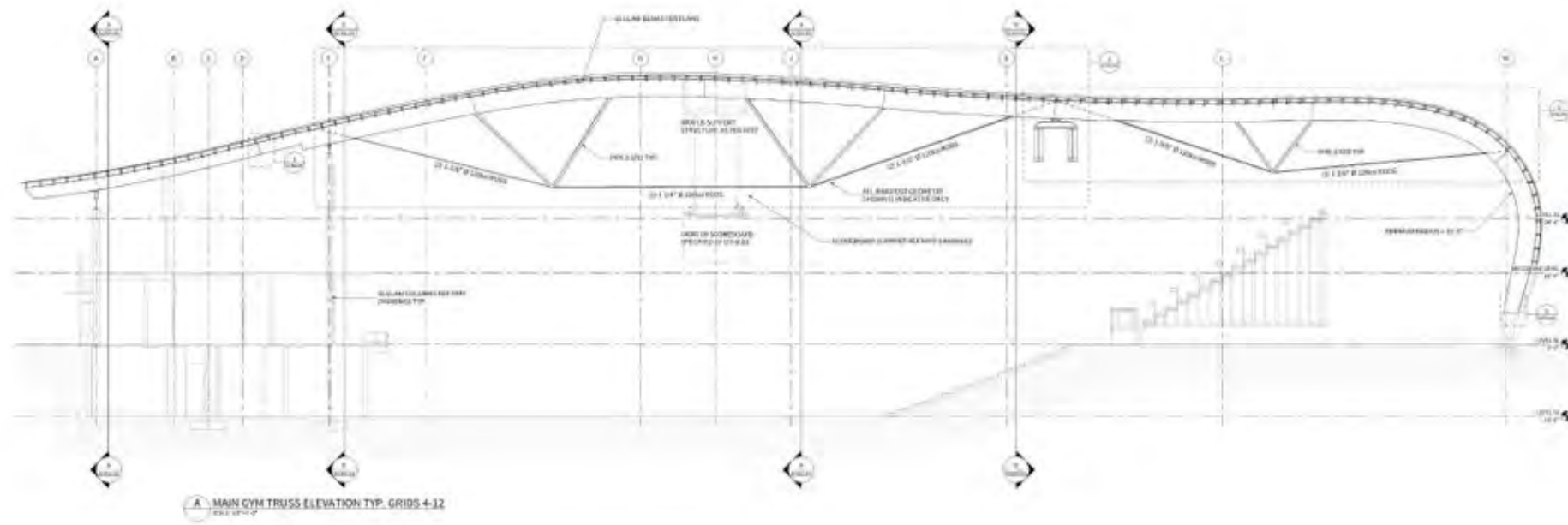
$$20^\circ - \alpha < \beta < 70^\circ - \alpha$$

$$20^\circ - \theta < \gamma < 70^\circ - \theta$$

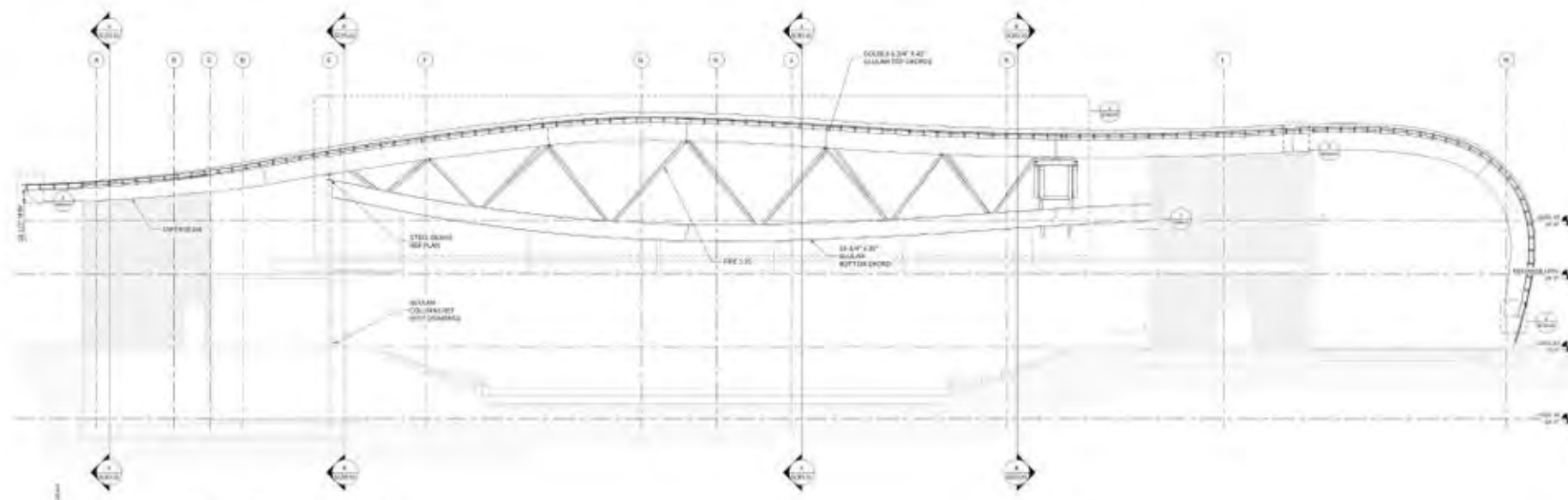


Project Name
University of Idaho

Project Name
UNIVERSITY OF IDAHO
ARCHITECT
MOSCOW, IDAHO
Site Plan



A MAIN GYM TRUSS ELEVATION TYP. GRIDS 4-12

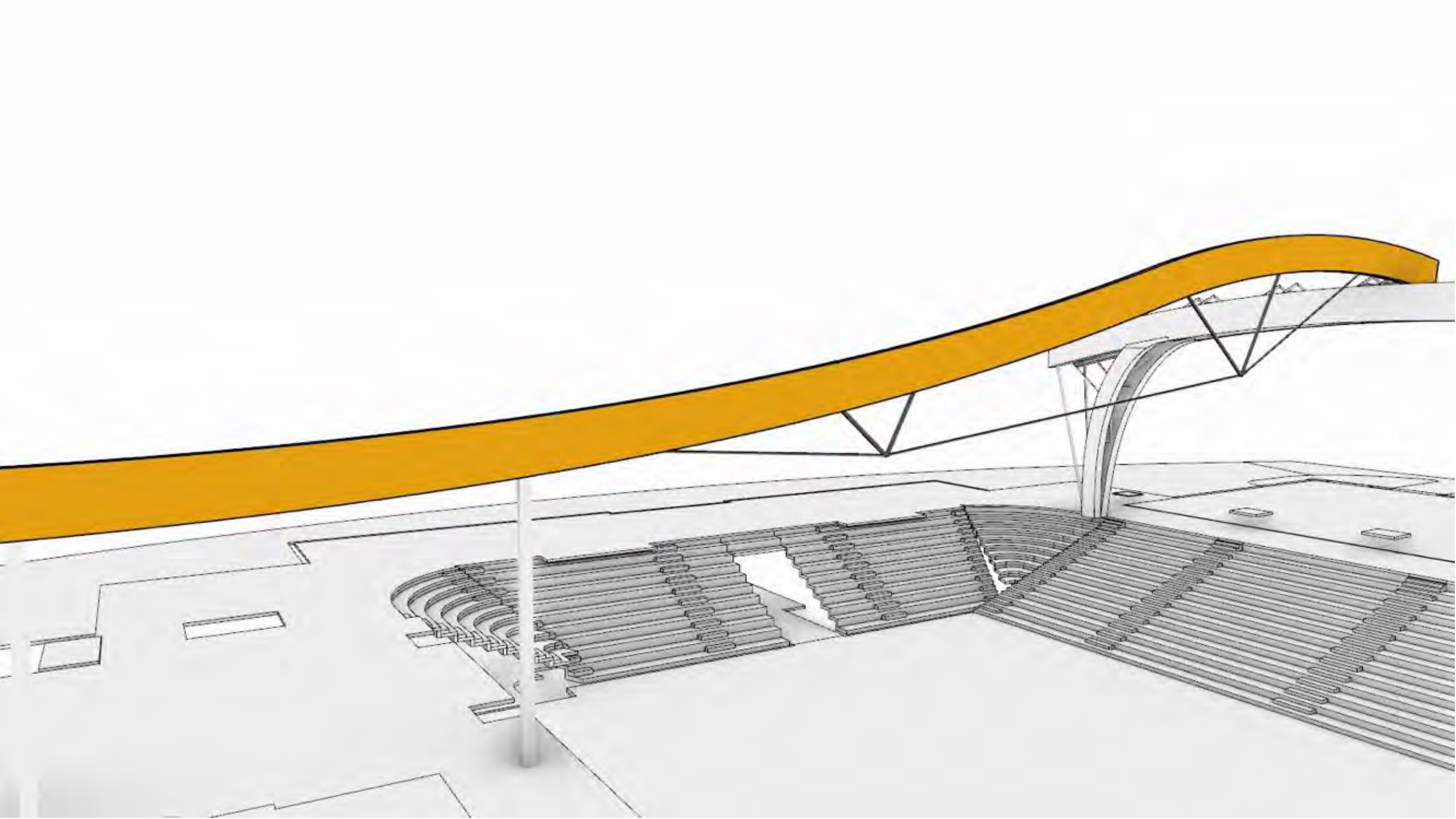


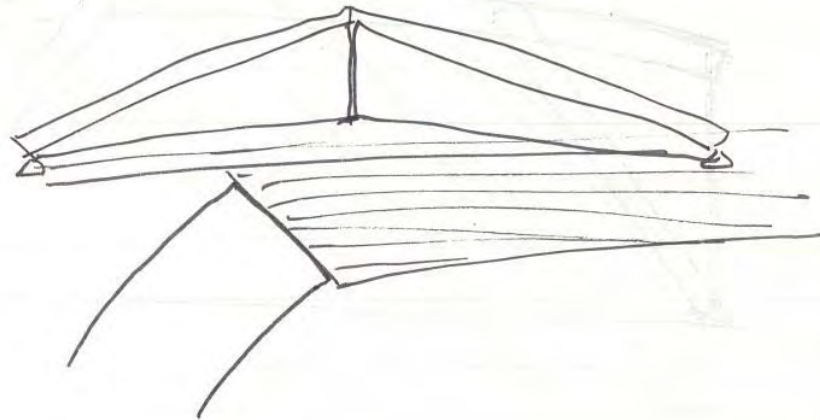
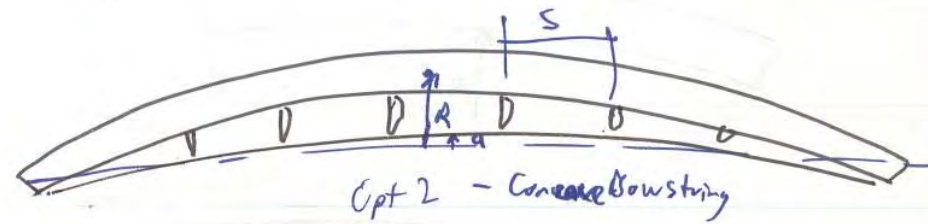
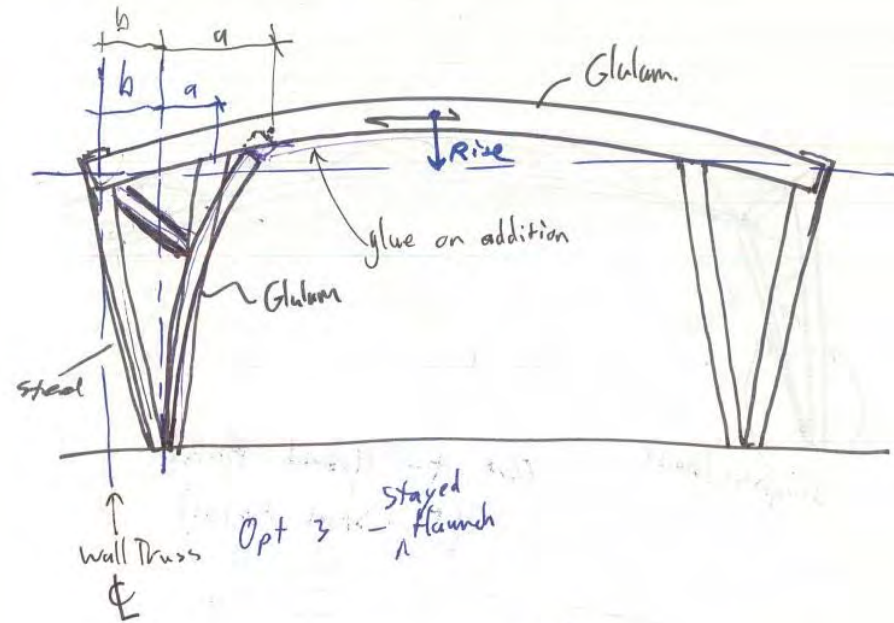
B SOUTH CLERESTORY TRUSS ELEVATION

Project Name
UNIVERSITY OF IDAHO
ARCHITECT
MOSCOW, IDAHO
Site Plan

Project Name
UNIVERSITY OF IDAHO
ARCHITECT
MOSCOW, IDAHO
Site Plan

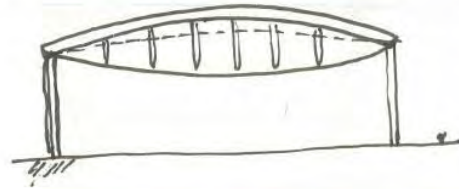
Sheet No.
SCB3.01
S324



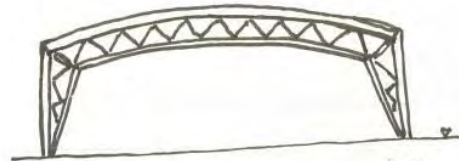




Opt 1
Tied Arch



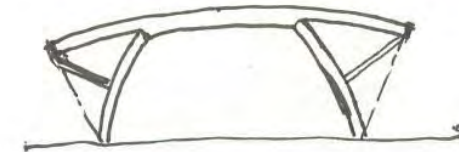
Opt 2/3
Convex / Concave
Bowstring Truss



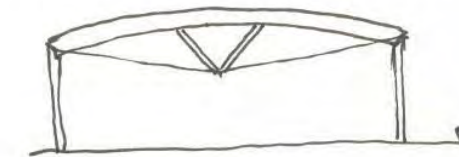
Opt 4
Glulam / Steel
Hybrid Portal



Opt 5
Propped Cantilever

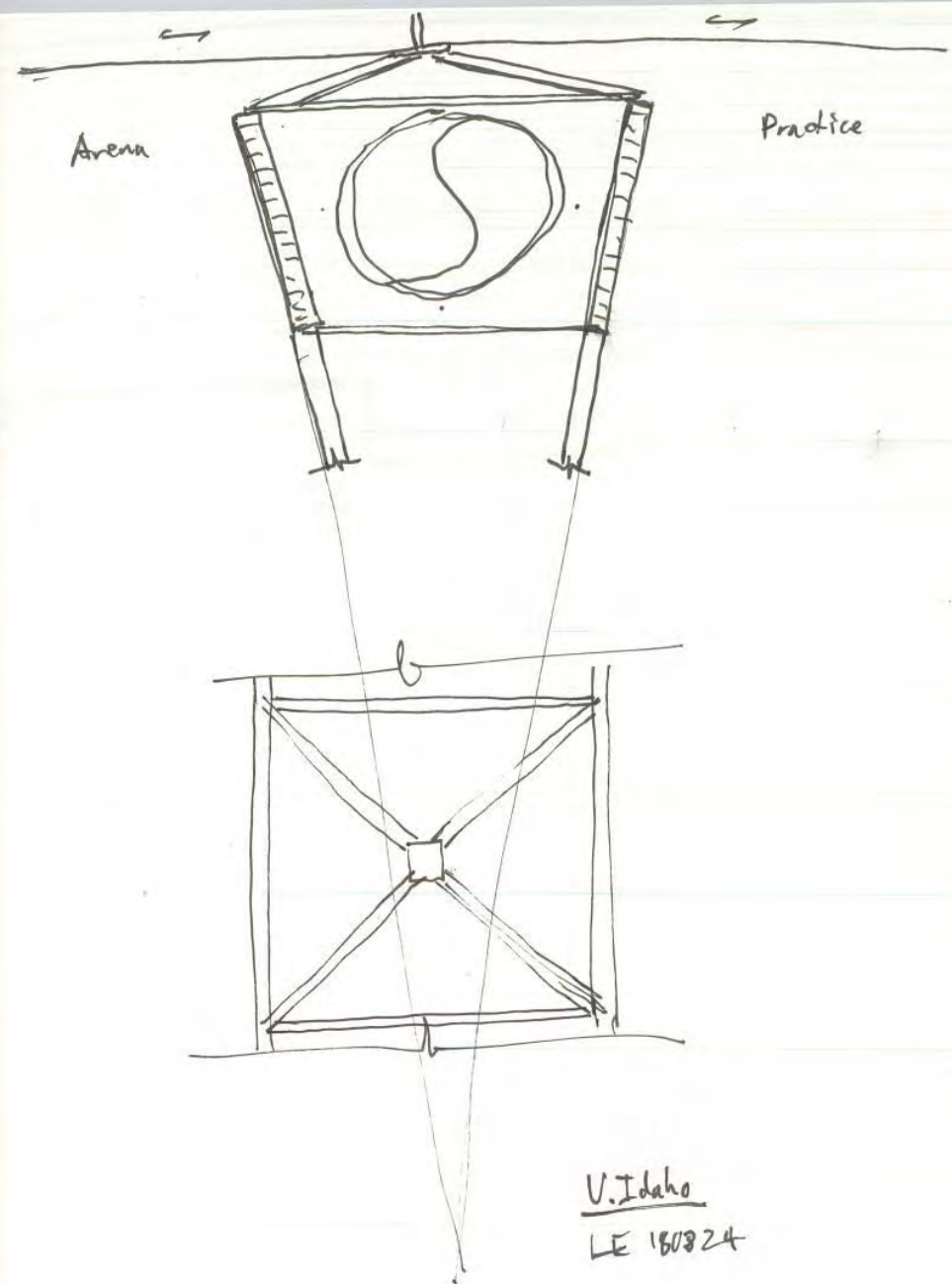


Opt 5A
Move Cols inboard

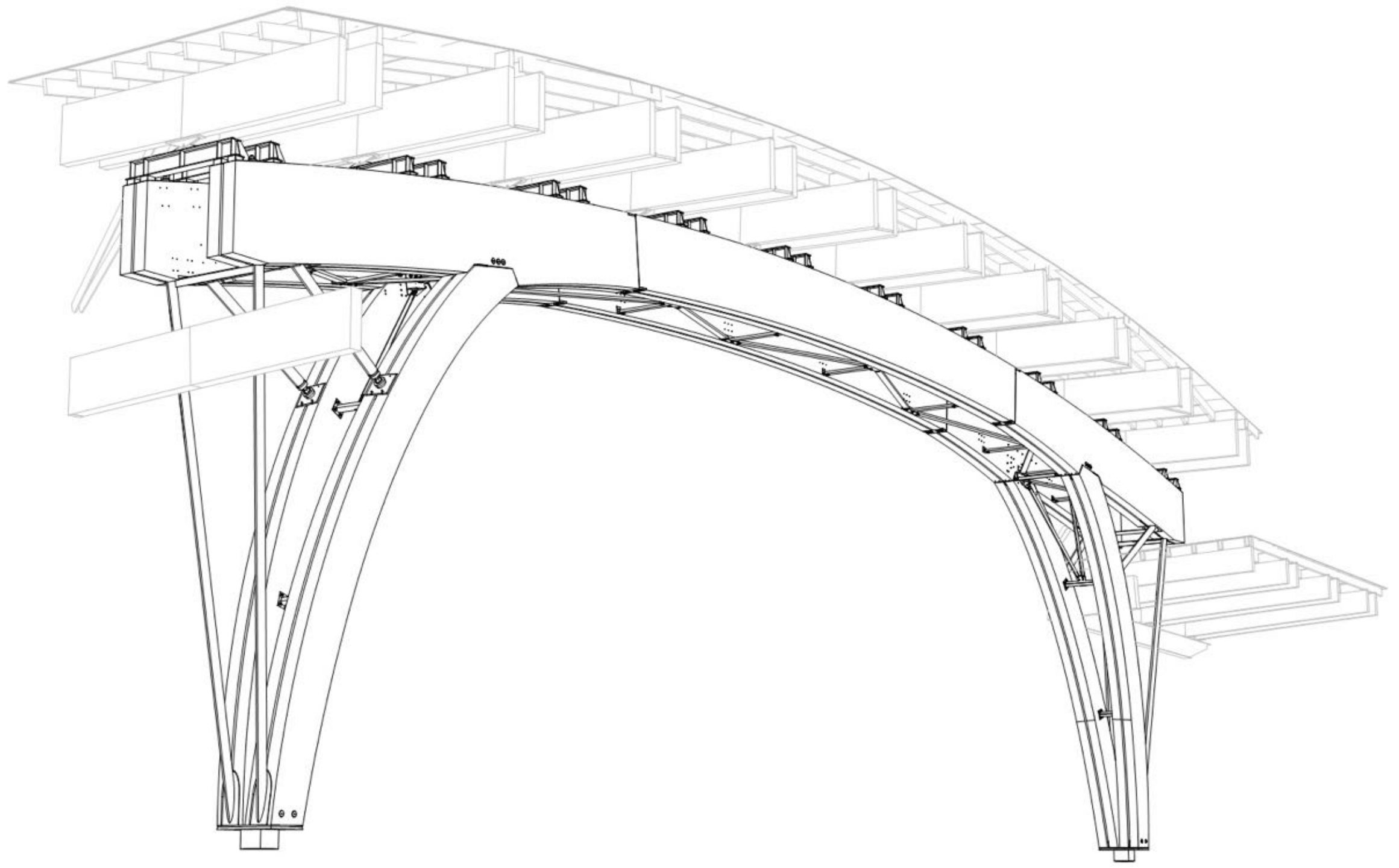


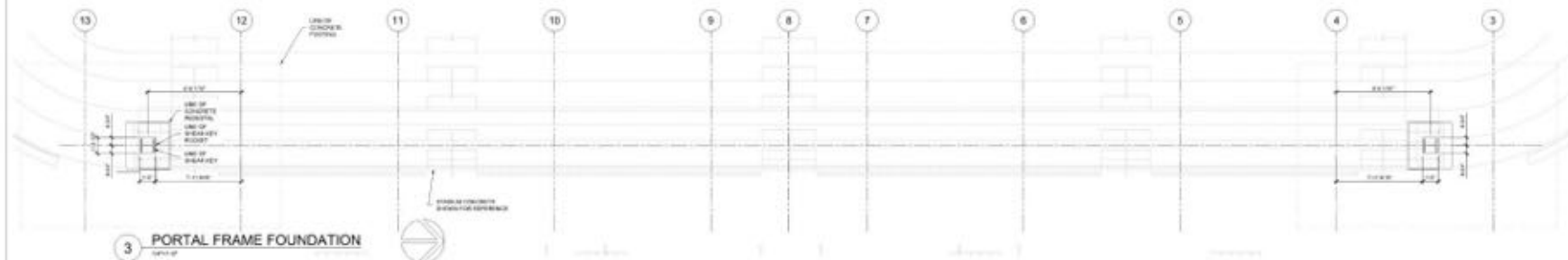
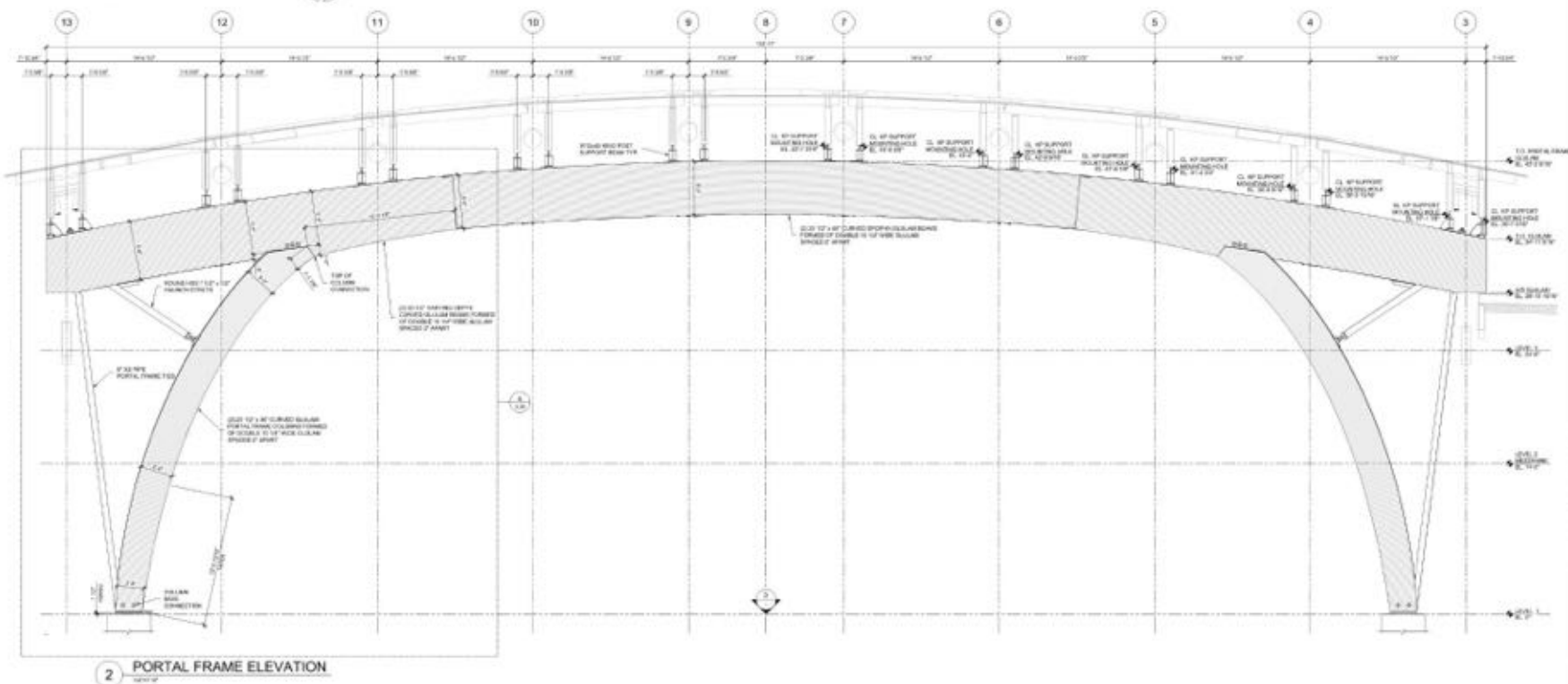
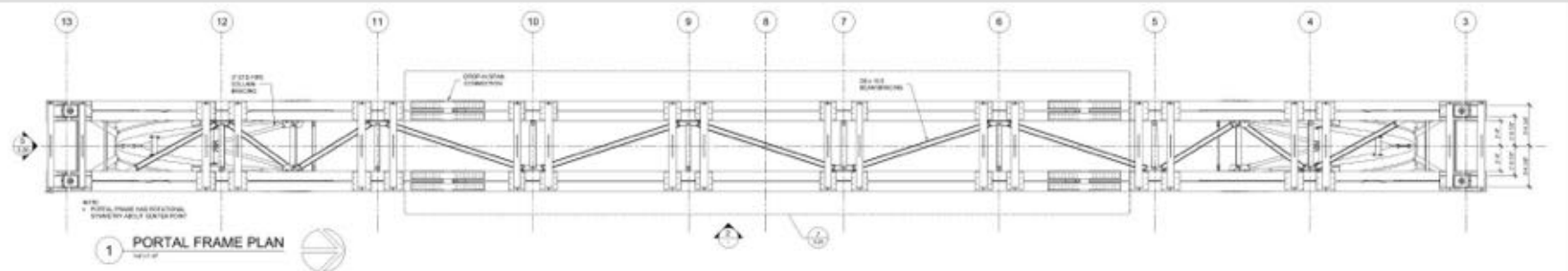
Opt 6
King Post Truss

U. Idaho Truss Concepts
LE 180824



U. Idaho
LE 180824



[illegible]

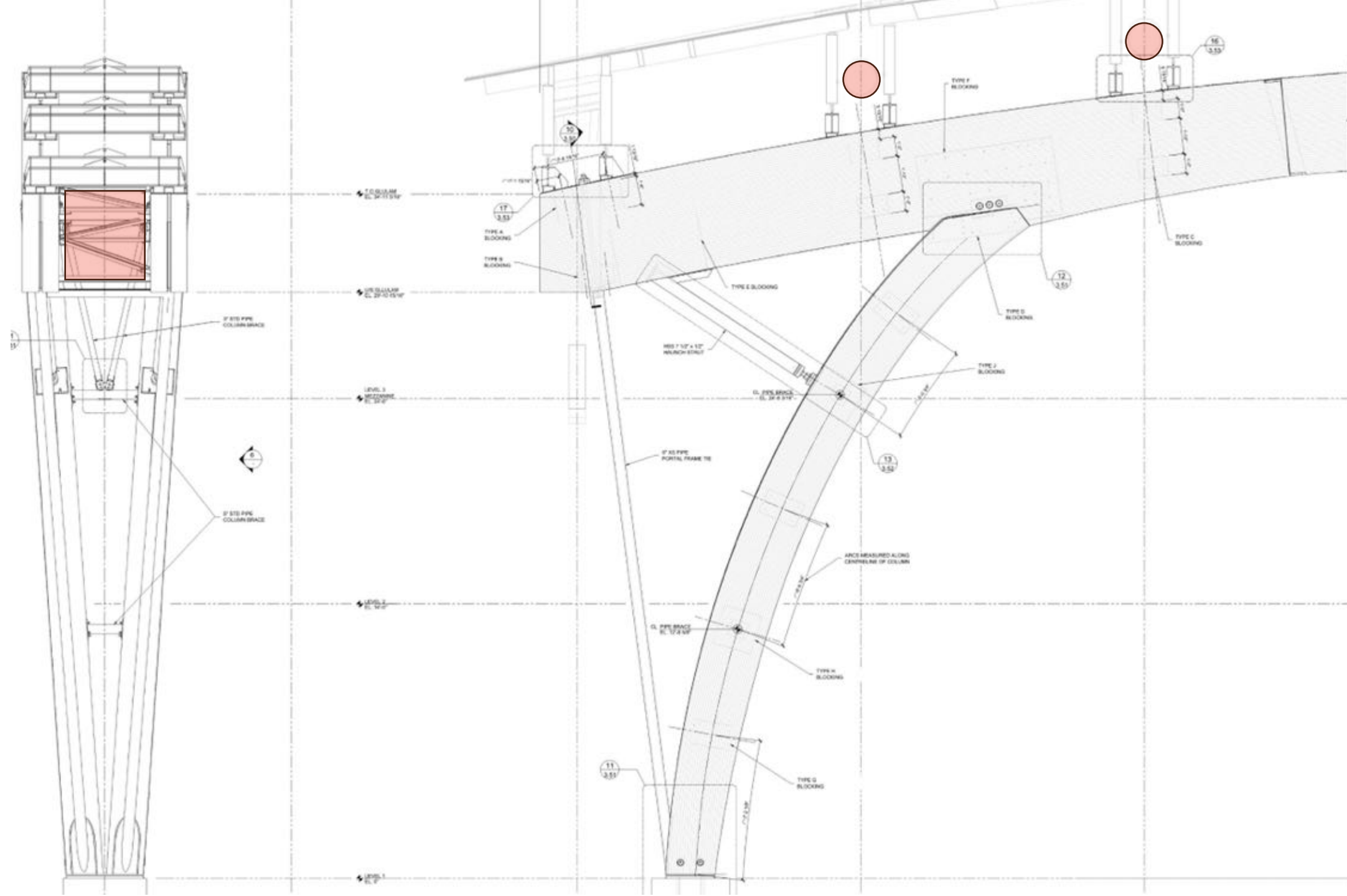
StructureCraft
 Modpack
 1.10.2
 1.10.2
 1.10.2

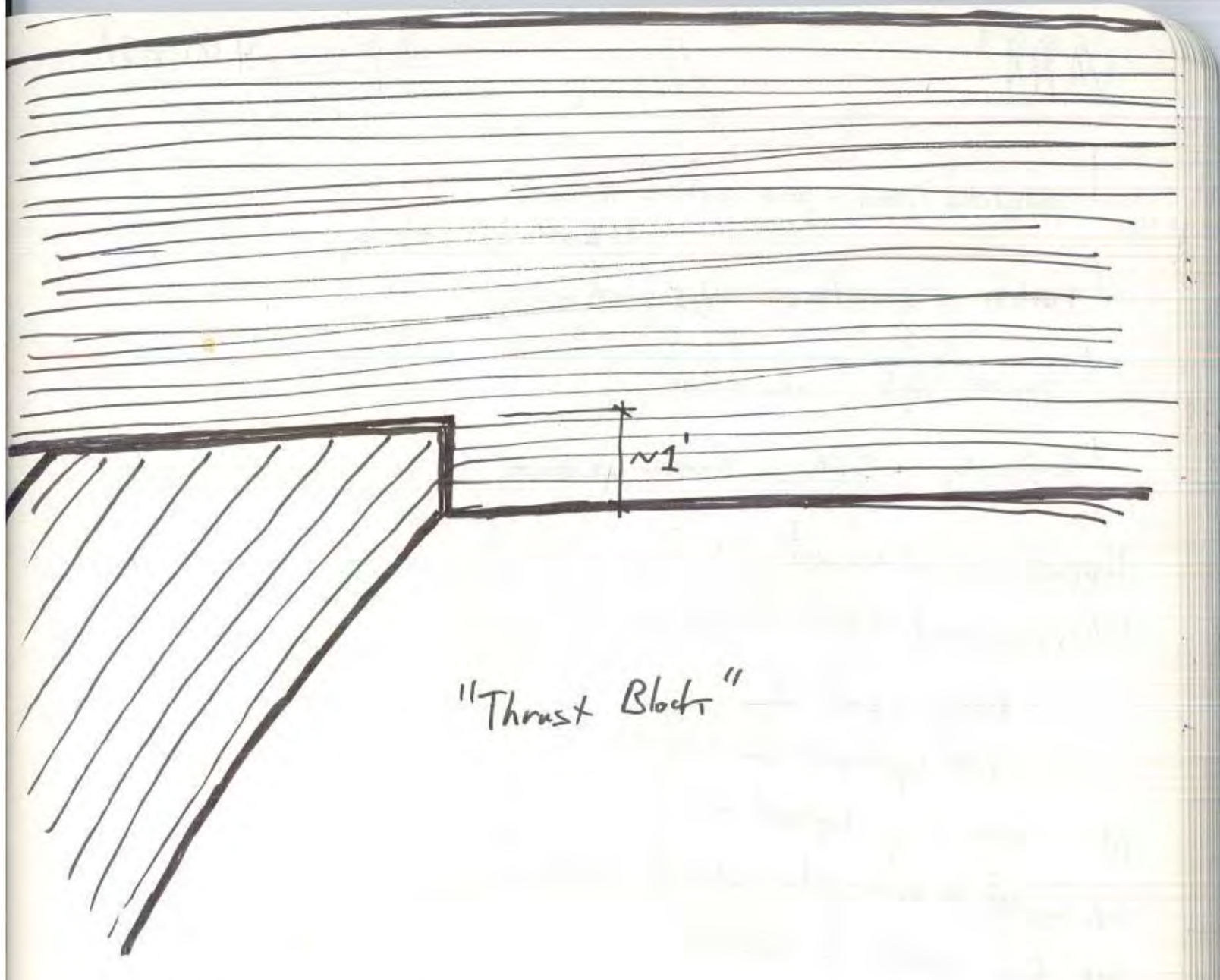
| | |
|---------|------------------------------|
| PROJECT | GPSC |
| CLIENT | HOFFMAN CONSTRUCTION |
| PROJECT | UNIVERSITY OF IDAHO ARENA |

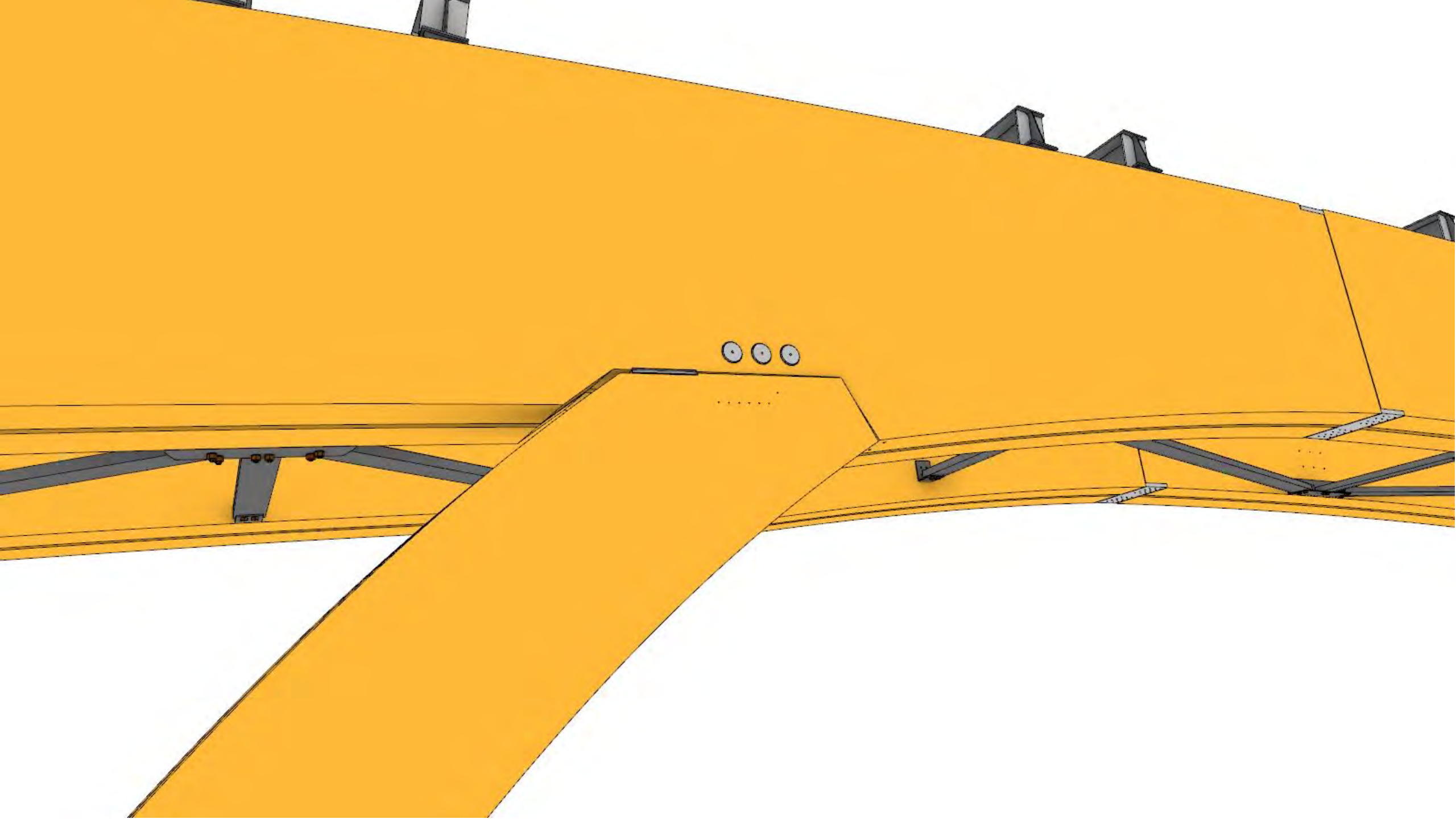
PORTAL FRAME PLAN,
ELEVATION,
FOUNDATION PLAN

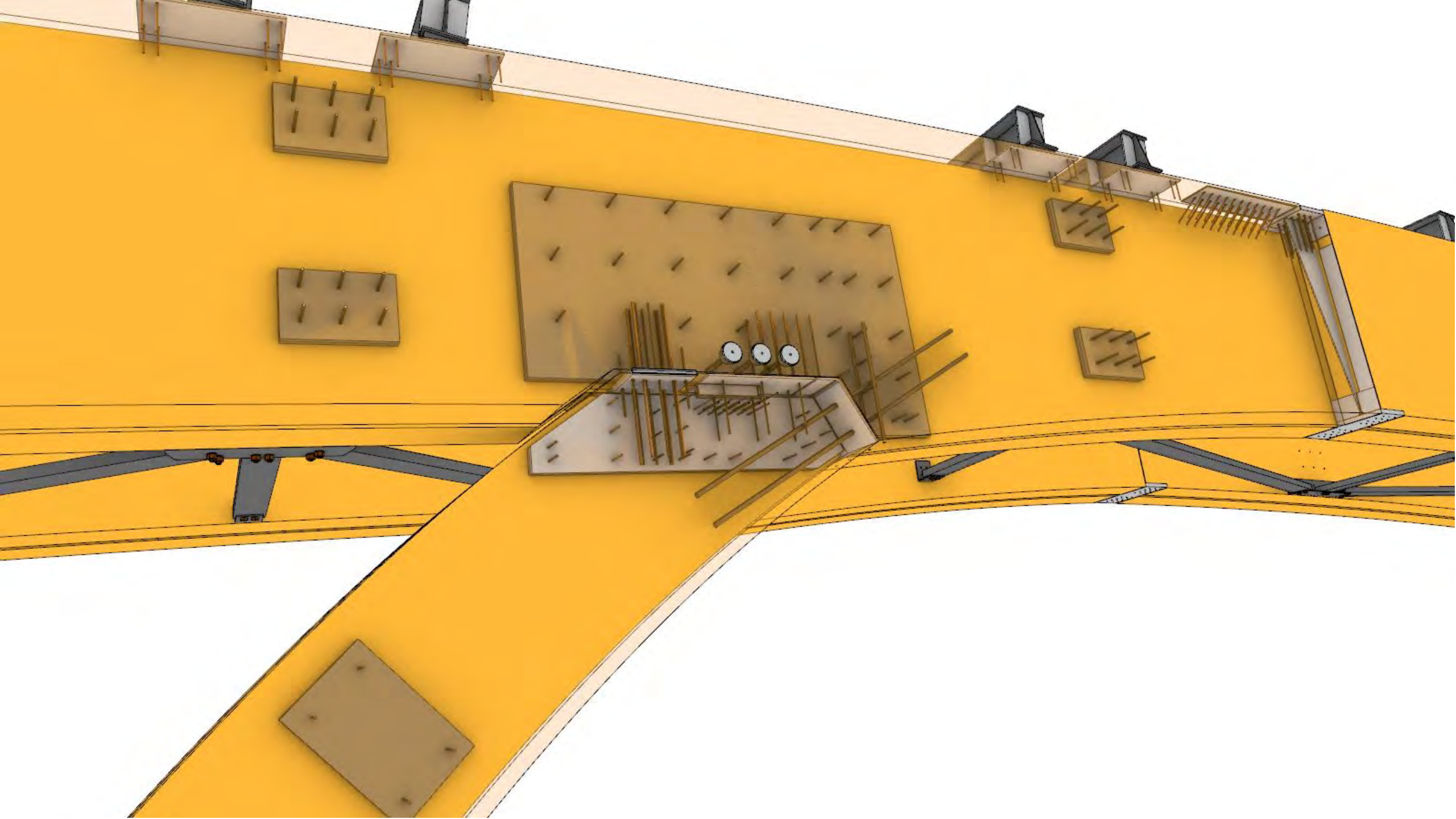
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| 0000 0000 | |

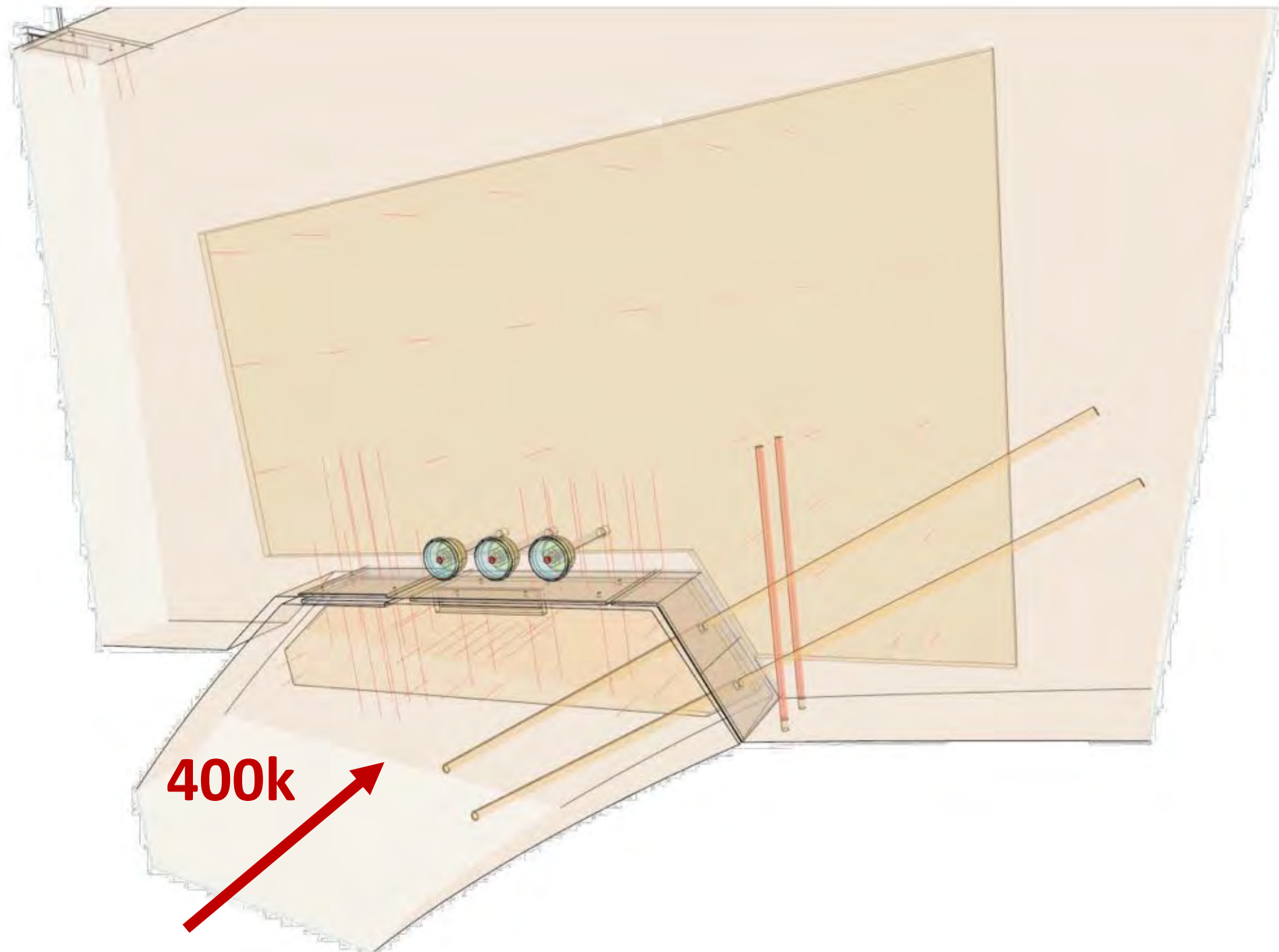
SC3.11



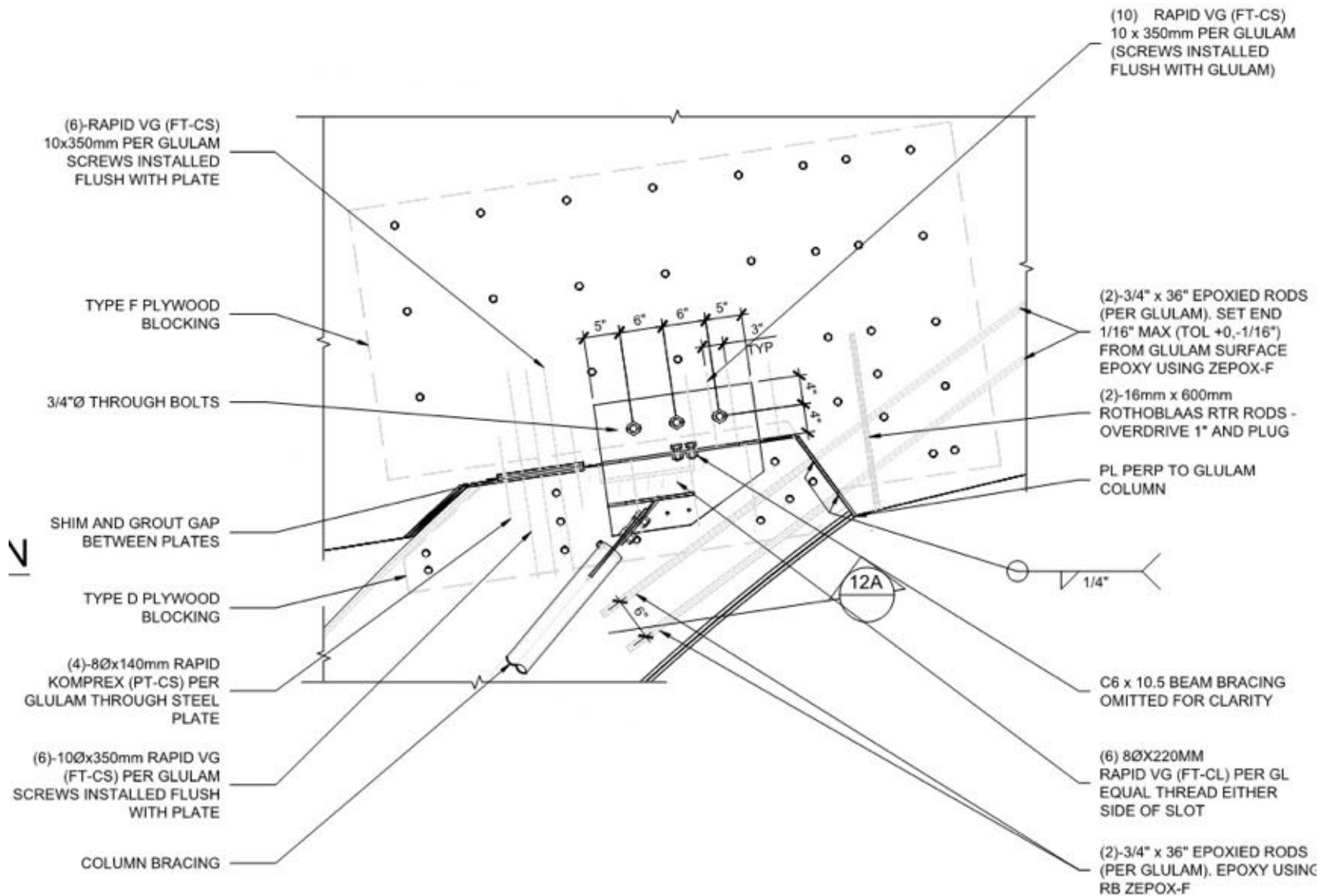








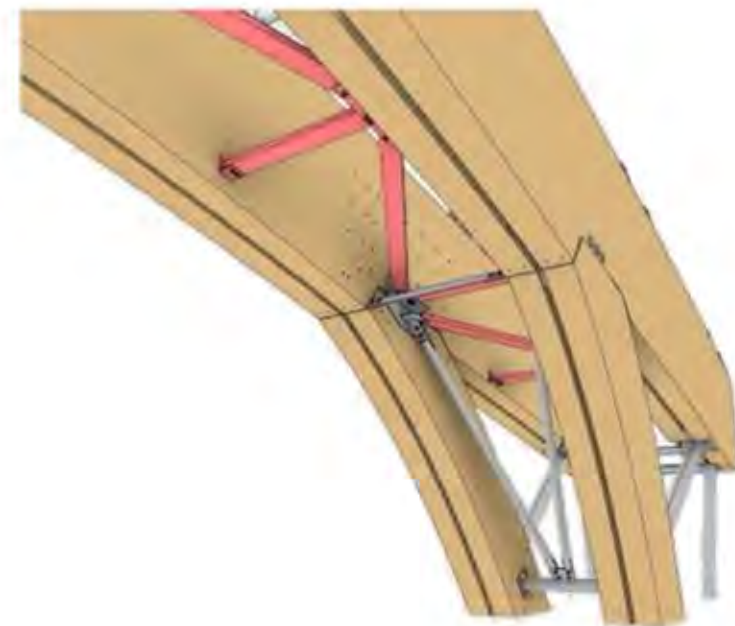
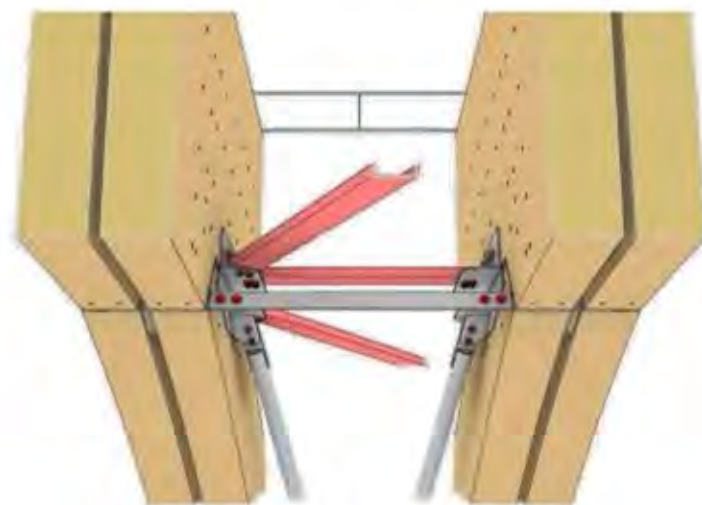
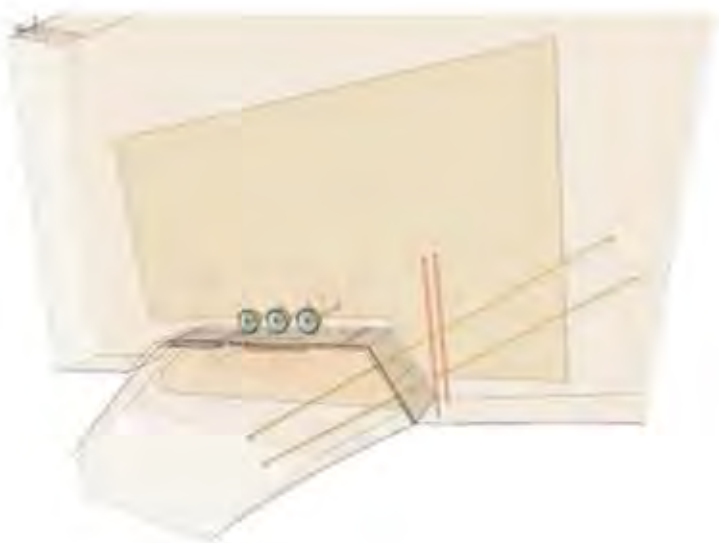
400k



12A

BRACING AT COLUMN TOP CONNECTION

3/4"=1'-0"



LC: D+S, 40psf balanced K=700 kip/ft

Loads

Dead = 25psf

Snow = 40psf

Deflection

5.1" on a 129ft span = L/304 under D+S

Forces

Arch M_max=1914kip-ft

Arch N_max=144kip

GLHaunch N_max=297kip

GLHaunch M_max=251kip-ft

SteelTie N_max=83kip

SteelColumn N_max=22kip

Reactions

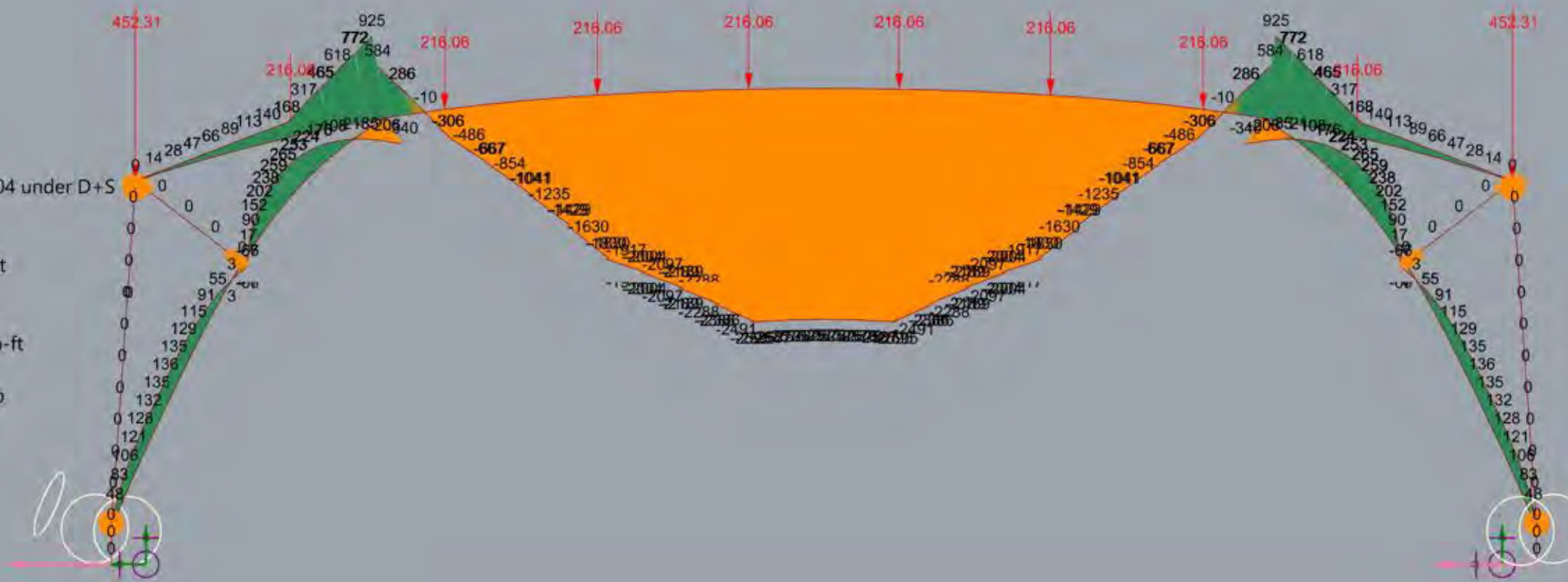
Reaction Z=592kip

Reaction Y=-226kip

Lateral Spring

K = 10000kN/m

Lateral Defl @Base=3.95"



LC: D+S, 40psf balanced
K=7,000 kip/ft

Loads

Dead = 25psf

Snow = 40psf

Deflection

2" on a 129ft span = $L/783$ under D+S

__Forces__

Arch $M_{max}=1258\text{kip-ft}$

Arch $N_{max}=157kip$

GLHaunch N_max=338kip

GLHaunch $M_{max}=288\text{kip-ft}$

SteelTie N_max=100kip

SteelColumn N_max=16kip

Reactions

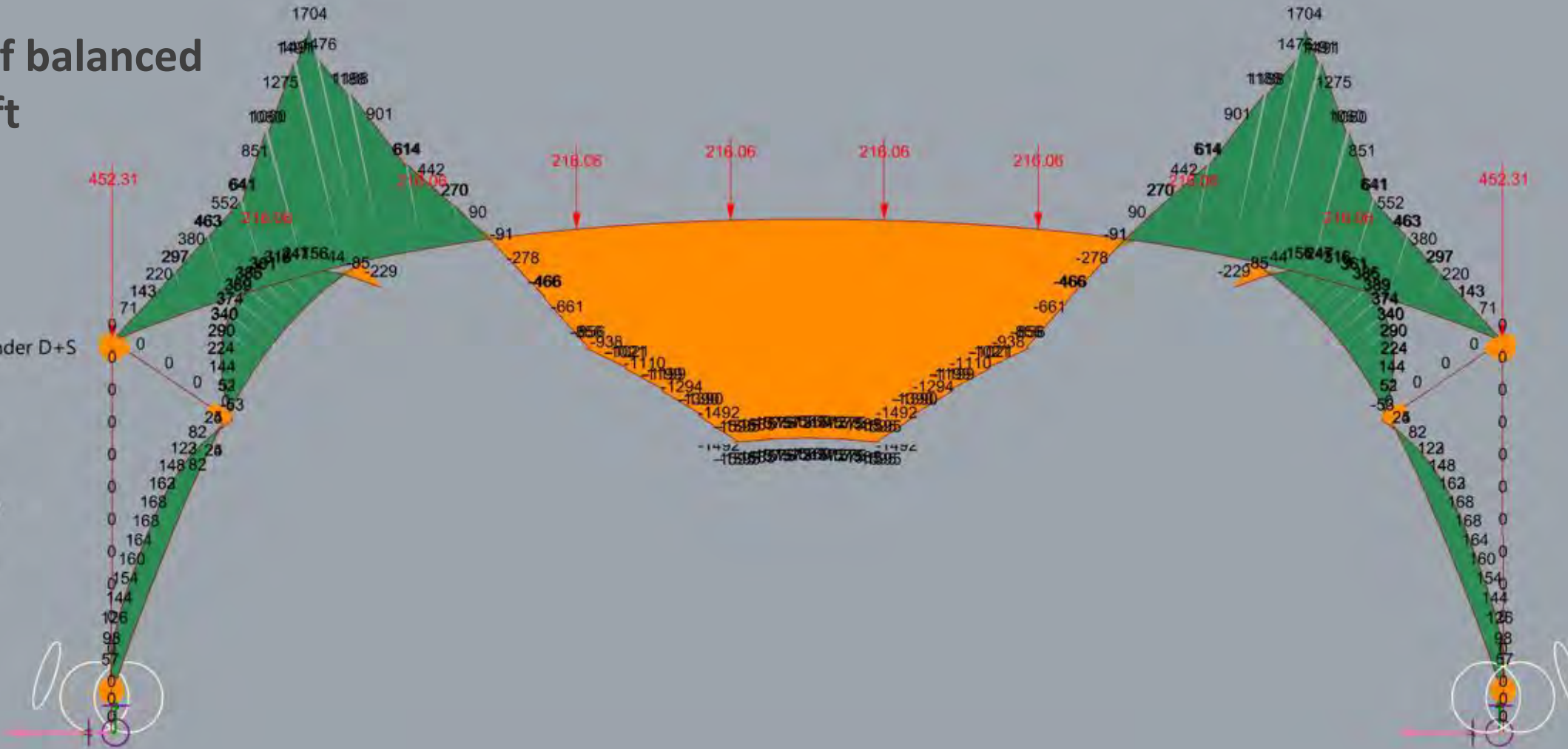
Reaction Z=592kip

Reaction Y = -252 kip

Lateral Spring

 $K = 100000 \text{ kN/m}$

Lateral Defl @Base=0.44"



LC: D+S, 40psf balanced
K=7,000,000 kip/ft

__Loads__

Dead = 25psf

Snow = 40psf

Deflection

1.6" on a 129ft span = $L/978$ under D+S

__Forces__

Arch $M_{max}=1330\text{kip-ft}$

Arch $N_{max}=159kip$

GLHaunch N_max=343kip

GLHaunch $M_{max}=299\text{kip-ft}$

SteelTie N_max=102kip

SteelColumn $N_{max}=21\text{kip}$

Reactions

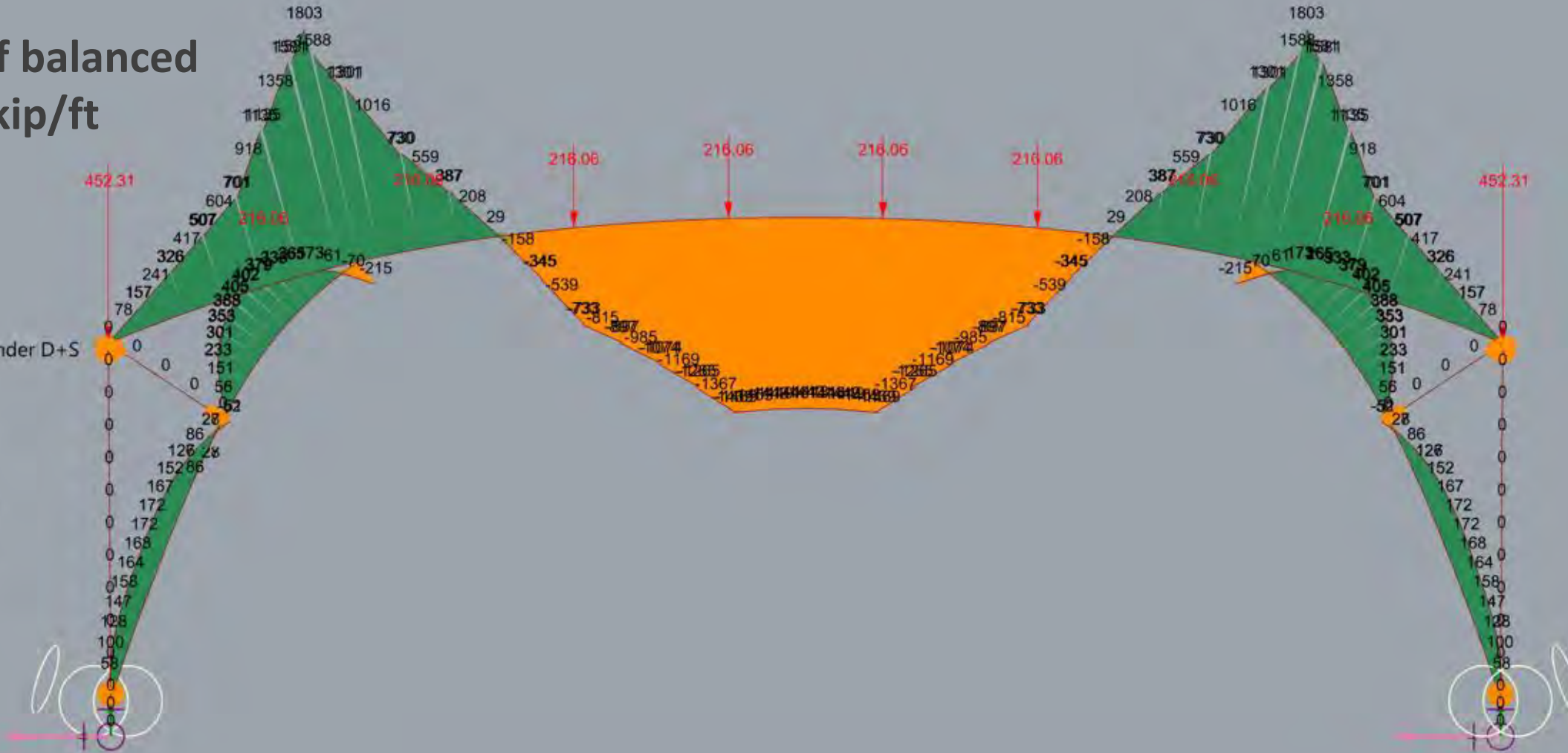
Reaction Z=592kip

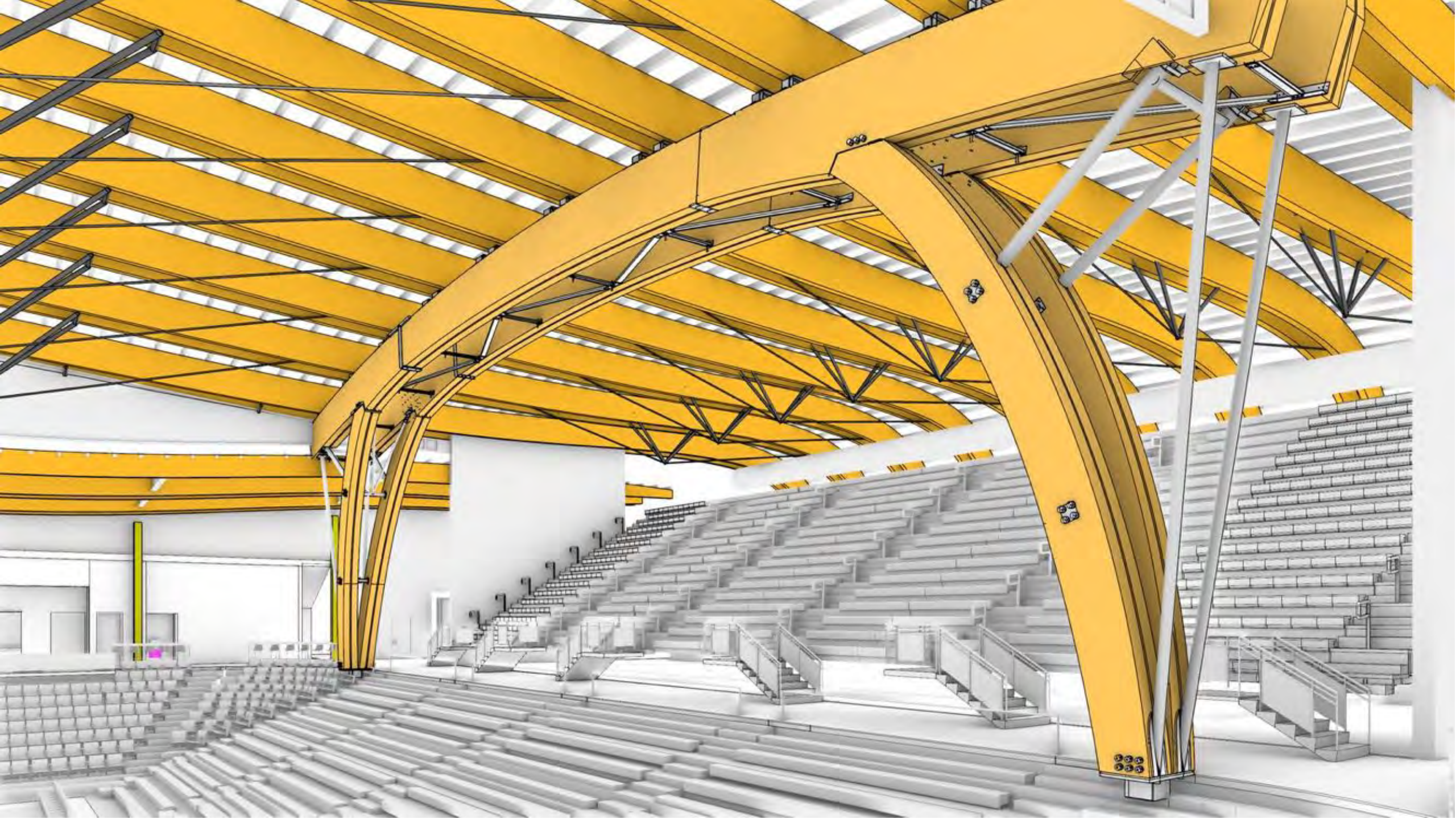
Reaction $Y = -256 \text{ kip}$

Lateral Spring

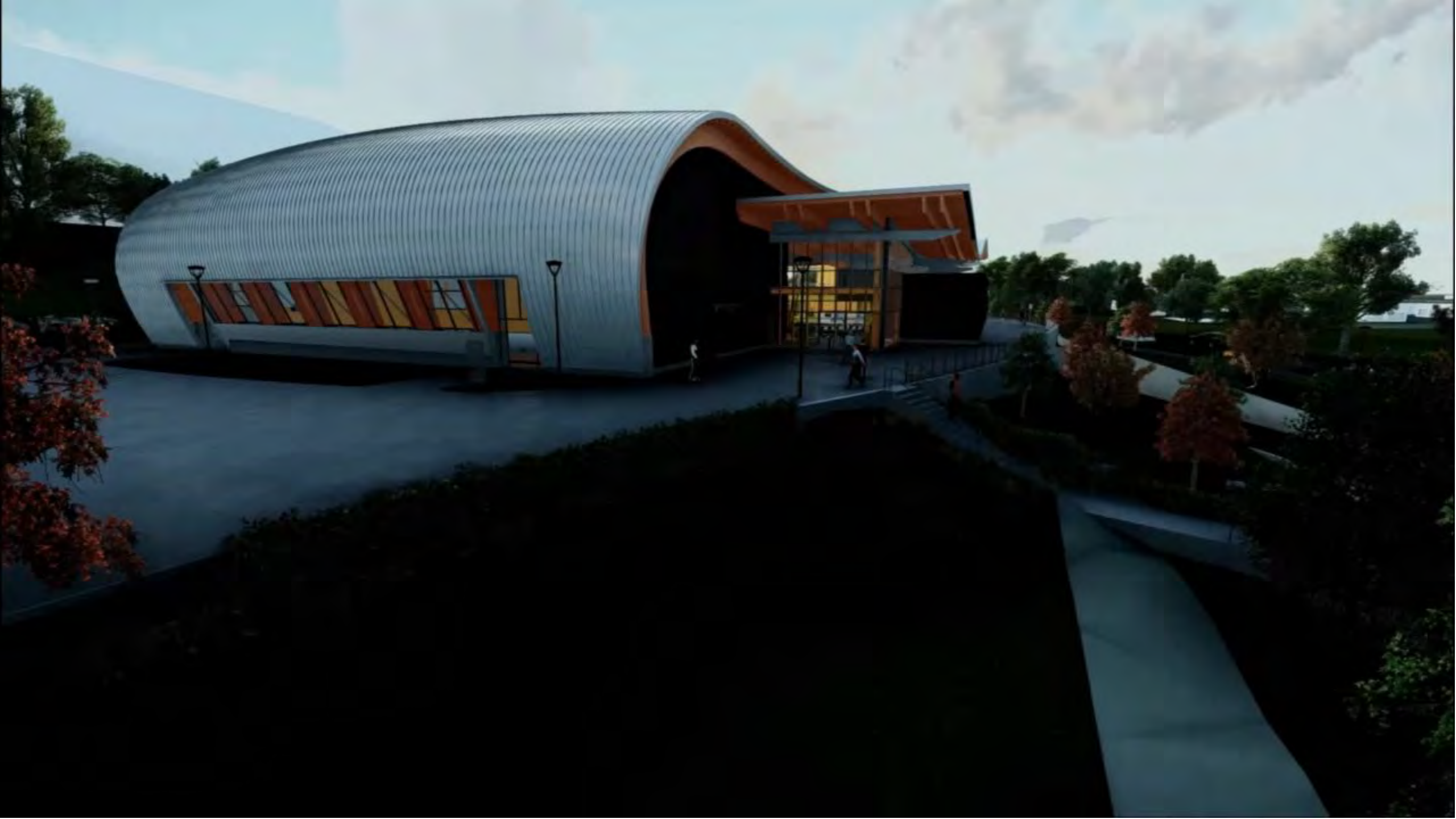
$$K = 1000000000 \text{ kN/m}$$

Lateral Defl @Base=0"





FABRICATION







INSTALLATION













Approval Path

Early Engagement with AHJ

- State of Idaho Division of Building Safety
- Define Expectations and Submittal Schedules
- KPFF Primary Point of Contact for Structural Reviewer
- Deferred Submittal for Roof Timber Package



Code Path

Alternate Means and Methods

Permitted by IBC §104.11

Hybrid Construction Type

Steel Roof Member Fireproofing

Plywood Roof Decking

Reduced Snow Load



Code Path

Hybrid Construction Type

Code Requirement: IBC §602.1 – Each building shall be classified in one of the construction types defined in Sections 602.2 through 602.5 and Table 601.

Code Intent: To account for the expected performance of the building during fire conditions as a result of its size, occupancy, and fuel load.

Alternate Request: To allow a hybrid construction type with all noncombustible components designed with the intent of meeting [Type IIA](#) construction and all combustible components designed with the intent of meeting [Type IV](#) construction.

Justification: Type IIA and Type IV construction carry equal allowances with regards to allowable height and number of stories and are very similar with regards to allowable area. Each Type of construction would be permitted independently.

Code Path

Steel Roof Member Fireproofing

Code Requirement: IBC Table 601, Footnote B - Fire protection of roof construction (for Type IIA construction), including roof framing and decking, shall not be required where every part of the roof construction is 20 feet or more above any floor immediately below.

Code Intent: To account for the expected performance of the building during fire conditions as a result of its size, occupancy, and fuel load.

Alternate Request: To allow multiple steel members supporting the roof construction to be unprotected despite the following:

- Type IV construction does not permit a reduction in fire-resistance of roof construction.
- The steel members are considered part of the primary structural frame as defined by IBC Chapter 2.
- There is telescopic seating with walking surfaces and seating less than 20 feet below the roof members.

Justification: Fire model shows that the steel members will not reach failure temperature for the established design fire scenarios.

Learning Opportunities

Create a **Living Laboratory** on campus for architecture, engineering and college of natural resources faculty and students

- Presentations and tours for school of architecture
- On site testing with college of natural resources
- Showcase innovative construction and fabrication techniques
- Fostering forest industry partnerships as a catalyst for regional economic growth





Future home of the
**IDAHO CENTRAL
CREDIT UNION
ARENA**

Idaho Central
CREDIT UNION

opsis architecture
HASTINGS-CHIVETTA

HOFFMAN
CONSTRUCTION
COMPANY





> QUESTIONS?

This concludes The American Institute
of Architects Continuing Education
Systems Course



Chris Roberts AIA

Associate Principal

chrisr@opsisarch.com



Judsen Williams PE, SE

Principal

Judsen.Williams@kpff.com



StructureCraft



Lucas Epp PE, P.Eng.

Head of Engineering

lepp@structurecraft.com