Structural Integration: Exercises in Structural Framing [Pavilion + Tower]
arc321 Structures III _ Fall 2009, arc322 Building Technology V _ Structures II _ Spring 2010-12

Structural design can be defined as the art and science of configuring material into self-supporting and load-bearing systems employed to accommodate a specific programmatic use. In the context of architecture, the program includes the technical mediation of site, the definition of quantitative space for human occupation and the rendering of qualitative space for human experience.

Previous laboratory projects have provided students the opportunity to explore and study structural behavior in abstract realms; as self supporting sculptural systems and as elements and systems defined in terms of force, form, material and connection. This laboratory project addresses application. Students are provided a simple architectural program which establishes constraints and quantitative requirements. Aspects of the program are flexible and subject to interpretation in order to provide students the opportunities typically afforded an architect during schematic design and design development. Students are required to conceive and develop a structural design for the program. The structural designs focus on framing, tributary areas, horizontal and vertical systems, and foundations. Students are required to utilize references and rules-of-thumb for the sizing and spacing of all members. The designs are developed and illustrated in a series of structural drawings and physical models. Students work in teams of four. This exercise is repeated two to three times; each with a different programmatic challenge and a different material palette [open-air pavilion in wood and observation tower in steel]. Following the completion of this series of laboratory projects each student is expected to have the ability to effectively design a simple and technically accurate schematic structural design, given a simple architectural program.

Objectives: following the completion of this project students should have:
- the ability to conceive and develop a comprehensive structural design for a small scale architectural program
- the ability to schematically size and space structural members
- the ability to illustrate a structural design in drawings and model
- an informed understanding of tributary areas, structural framing and foundations
- an informed understanding of the qualitative and quantitative relationships between structural and architectural design

Course Context:
The 1-2-3 way exercise is administered concurrently with lectures on structural systems, structural space and strategies for structural integration. It is also administered concurrently with computational exercises related to tributary areas and force flow, and the calculation of loads, reactions, shear and moment in beams, and the sizing of wood beams, columns and connections.
Open-Air Pavilion | Wood - Example Project Model
**LATERAL STABILITY**

**TENDENCY:** INDIVIDUAL MEMBERS EXPERIENCE HORIZONTAL DEFLECTIONS AT THEIR TOPS

**STRUCTURAL SOLUTION:** SHEAR PLANE TO BRACE INDIVIDUAL MEMBERS AND TO RESIST EXCESSIVE LATERAL DEFLECTION POTENTIAL WIND LOADS

TRIANGULATION INHERENTLY STABLE RESISTING LATERAL MOTION OPPORTUNITY FOR PIN CONNECTIONS [MOMENT FREE, TRANSLATION RESISTANT]

CANTILEVERED ROOF REQUIRING MOMENT RESISTANT CONNECTION [RESISTING FLEXURE/BENDING]

**FORCE & MOMENT DIAGRAMS**

SCALE: 1/4"=1'-0"

WATER FLOW TO THE WEST

ENTRANCE FROM THE NORTH & CIRCULATION FLOW TO THE WEST

SLOPE OF THE STRUCTURE AND THE SHAPE OF THE ROOFING ENCOURAGE ACTIVITY AND USER OCCUPATION WITHIN THE SPACE

GATHERING & STANDING [INCREASED ROOF HEIGHT, OPEN SPACE]

SITTING & REFLECTION [DECREASED ROOF HEIGHT, BENCH]

ARCHITECTURAL CONCEPT

PROCESSION SEQUENCE

ENVIRONMENTAL RESPONSE

WATER FLOW INTO FROM ROOF TO DRAINAGE TROUGH

SUMMER SOLSTICE

WINTER SOLSTICE

ROOF AS BARRIER AGAINST WINDS
Open-Air Pavilion | Wood - Example Project Model
PAVILION [PROJECT 1.2]

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water orientation

EW
circulation
introversion vs. extroversion
direction

8134
N S

2' 3" pin

1'-0"

6'-0"

1'-6"

4'-6"

T Y P.

14'-0"

13'-0"

4'-0"

1'-0"

N Scale:  1/4" = 1'-0"

FULL FOUNDATION PLAN

Scale: 1/16" = 1'-0"

Member Schedule

F1 Concrete Pilaster is extended from the concrete footing as extra support for the glulam beams.

F2 0'- 6" slab on grade reinforced with #4 rebar 18" on center grid

F3 1'- 0" channel to provide water movement in over flow situation.

F4 #4 rebar Support for concrete footing, placed 3" above ground with anchor bolts spaced 4' o.c.

A C E G I K M O Q

B D F H J L N P R

B

scale:  1/4" = 1'-0"

2' - 0" o.c.

typ.

6' - 0" o.c.

typ.

13' - 0"

26' - 0"

48' - 0"

2' - 0" o.c.

typ.

Member Schedule

t1 tension cable, 1/2" steel cable.

B1 Primary Beam 12" tapering to 18" depth, 6" width glulam southern pine wood member

b2 secondary beam, 2"X4"

ACGIEGIKMOQ

BDLFHJLPNR

DETAIL 2_ Roller Connection

D5 6" width glulam southern pine wood beam, end tapering to 12" from 18" maximum depth.

d6 1/2" plate steel cap over end of glulam beam.

d7 notch cut into concrete footing to allow for roller connection of steel capped glulam member.

DETAIL 3_4

D8 1/2" Plate steel tension connector, welded to steel cap.

D9 1/2" plate steel cap over end of glulam beam.

D10 6" steel pin

DETAIL 1 _ PIN CONNECTIONS

D1 1/4" plate steel gussets to prevent shear around pin connection

D2 6" Steel Pin connection.

D3 6" width glulam southern pine wood beam, end tapering to 12" from 18" maximum depth.

d4 1' steel gutter at 1/4" thick for water drainage and tension support at Extremities 6" Steel Pin connection.

Open-Air Pavilion | Wood - Example Project Drawings
Open-Air Pavilion | Wood - Diverse Examples
Observation Tower | Steel - Example Project Model
Observation Tower | Steel-Diverse Examples

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