

# CENE 476 STEEL BRIDGE CAPSTONE

Date: 12/8/23

Ponderosa SteelJacks:

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# INTRODUCTION

- Purpose:
  - Design and construct a steel bridge to compete at the Student Steel Bridge Competition judged by the American Institute of Steel Construction (AISC) and hosted by the American Society of Civil Engineers (ASCE)
- Background
  - Hideaway Park Disc Golf Course Pedestrian Bridge (Louisiana Tech University)
  - 1:10 Scale Bridge
  - Compete in a Time Competition and undergo Load Testing
- Client
  - Mark Lamer



Figure 2-1: AISC Logo [1]



Figure 2-2: Vertical Load Test [2]

# PROJECT LOCATION

- Location: Lincoln Parish Park in Ruston, Louisiana



Figure 3-1: Location Map

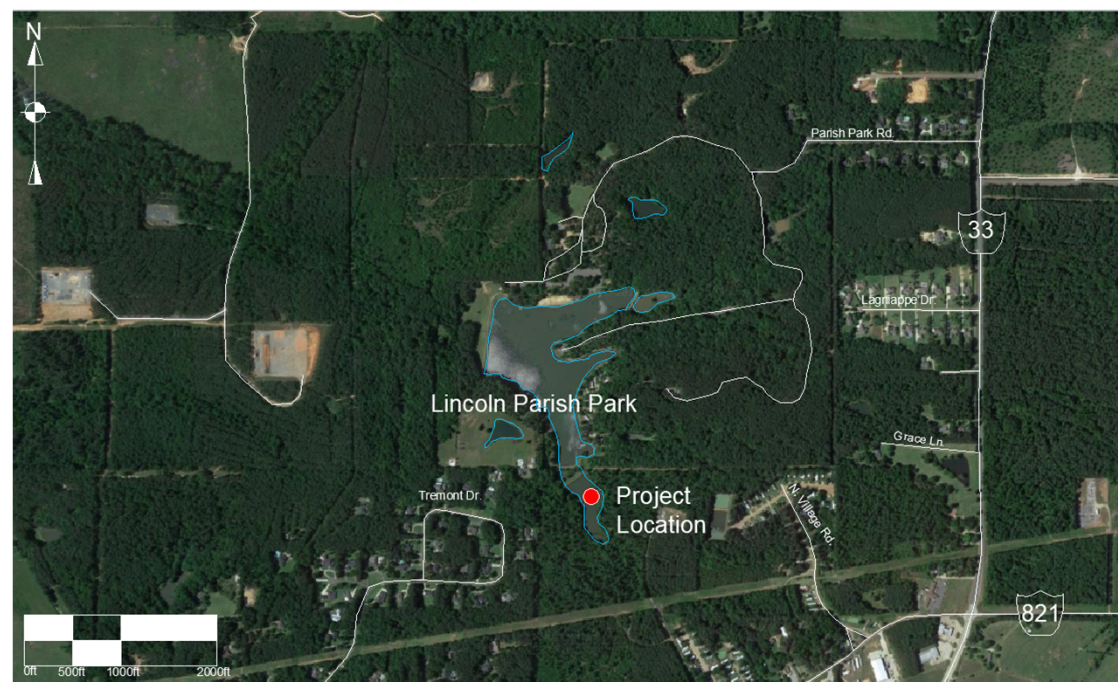


Figure 3-2: Vicinity Map

# SCOPE OVERVIEW

- Task 1: Project Background Research
- Task 2: Preliminary Analysis and Design
- Task 3: Final Analysis and Design
- Task 4: Bridge Production
- Task 5: Assembly
- Task 6: Competition
- Task 7: Project Deliverables
- Task 8: Project Management
- Task 9: Impact Analysis

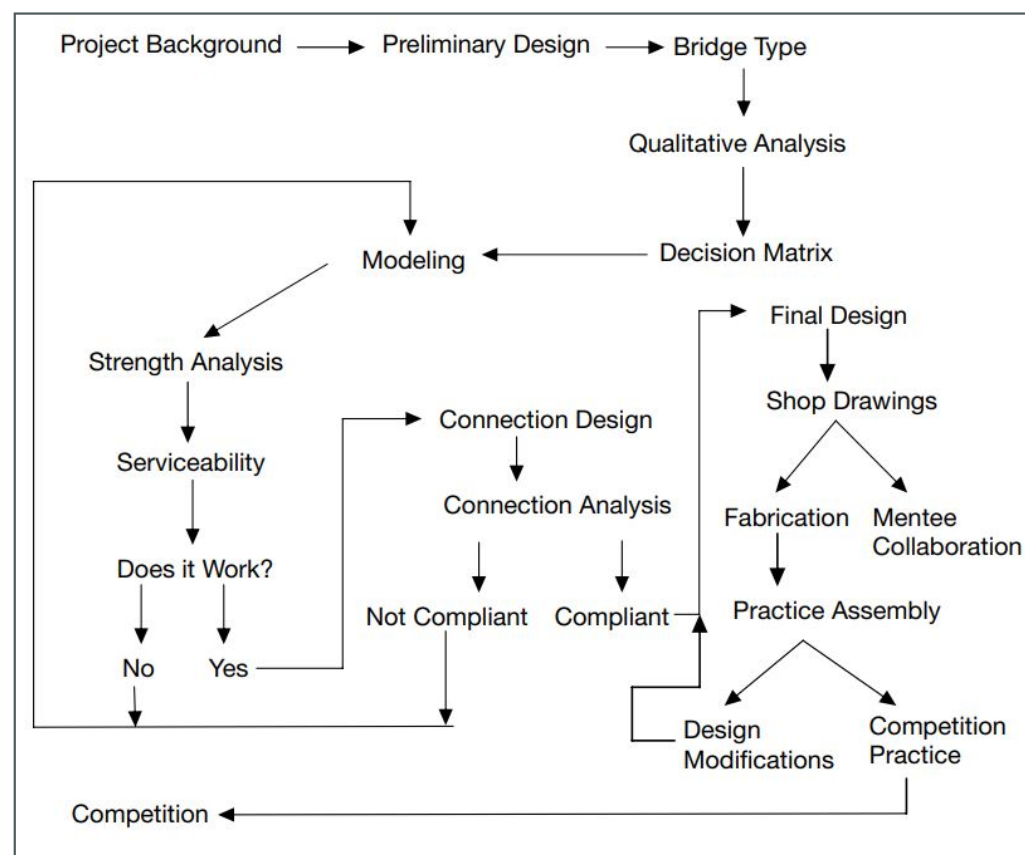


Figure 4-1: Technical Design Progression Flow Chart 4

# SCOPE TASK 1 : PROJECT BACKGROUND RESEARCH



- Task 1.1: Competition Details
  - Competition rules provided by AISC
- Task 1.2: Material Availability
  - Steel constraints
- Task 1.3: Research Connections
  - Connection constraints
- Task 1.4: Truss Design Ideas
  - Types of Bridges
  - Previous competition winners

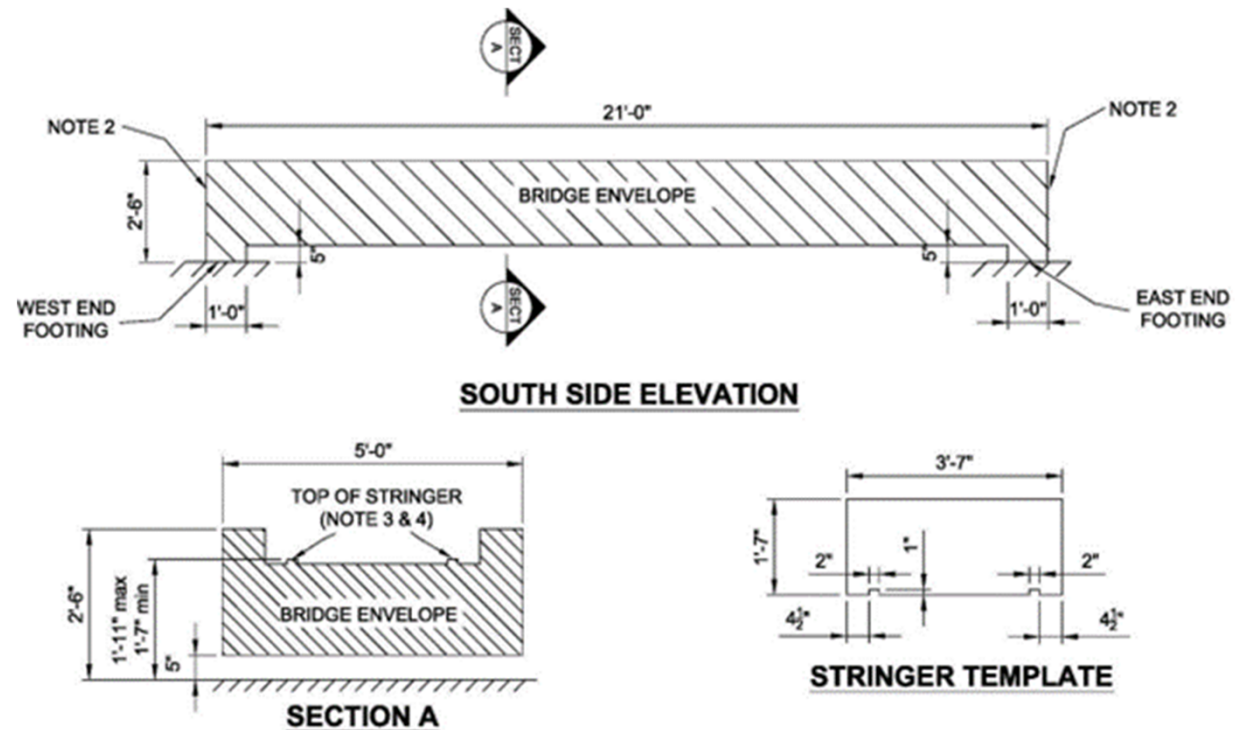


Figure 5-1: AISC Construction Site Plans [3]

# SCOPE TASK 2: PRELIMINARY ANALYSIS AND DESIGN



- Task 2.1: Structural Configuration
  - Estimate strength
  - Estimate weight
  - Estimate number of connections
  - Aesthetics
- Task 2.2: Material Specifications
  - Determine the optimum material for selected design
- Task 2.3: Connection Design
  - Ease of Fabrication
  - Repetition of connections
  - Speed connections
- Task 2.4: Decision Matrix

**Engineering Decision Matrix**

Ratings: 5 (Ideal balance between time and money spent) — 4 (Good) — 3 (Acceptable) — 2 (Bad) — 1 (Unacceptable)

Criteria	Weight	Current Solution		Alternative 1		Alternative 2	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Customer Pain	5	1	5	5	25	4	20
Design Time	2	3	6	3	6	5	10
Development Time	2	1	2	4	8	2	4
Training Time	1	2	2	2	2	4	4
<b>Total Score</b>			<b>15</b>		<b>41</b>		<b>38</b>

Table 6-1: Decision Matrix Example

# SCOPE TASK 3: FINAL ANALYSIS AND DESIGN



- Task 3.1: Modeling
  - Model the final design in RISA 3D
  - Load cases
  - Overall weight design
- Task 3.2: Strength Analysis and Design
  - Perform ASD (Allowable Stress Design) code checks following AISC-13 codes
  - Analyze critical members
- Task 3.3: Serviceability Analysis and Design
  - 1" of aggregate deflection
- Task 3.4: Connection Analysis and Design
  - Design strength required of bolt
  - Bearing strength and tear out of plate
  - Required plate thickness
  - Required spacing of holes

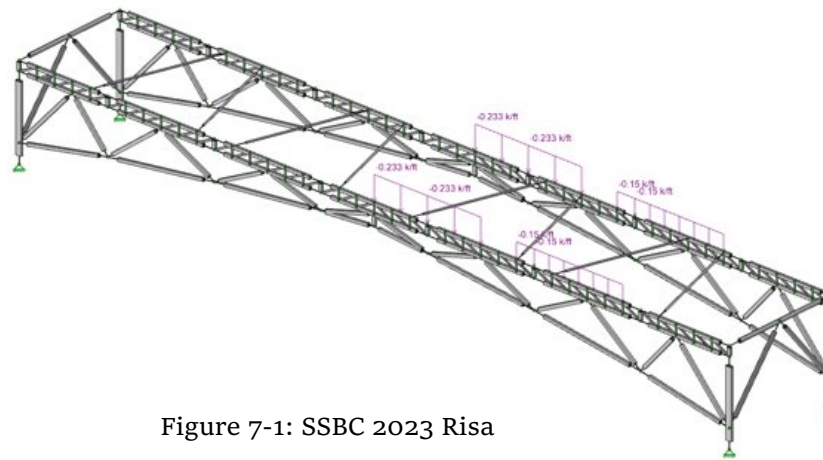


Figure 7-1: SSBC 2023 Risa

# SCOPE TASK 4: BRIDGE PRODUCTION

- Task 4.1: Shop Drawings
  - Create and detail shop drawings for fabrication
- Task 4.2: Fabrication Coordination
  - Outreach and schedule confirmation
  - Inspections
- Task 4.3: Mentee Collaboration
  - Recruit students for competition and assembly

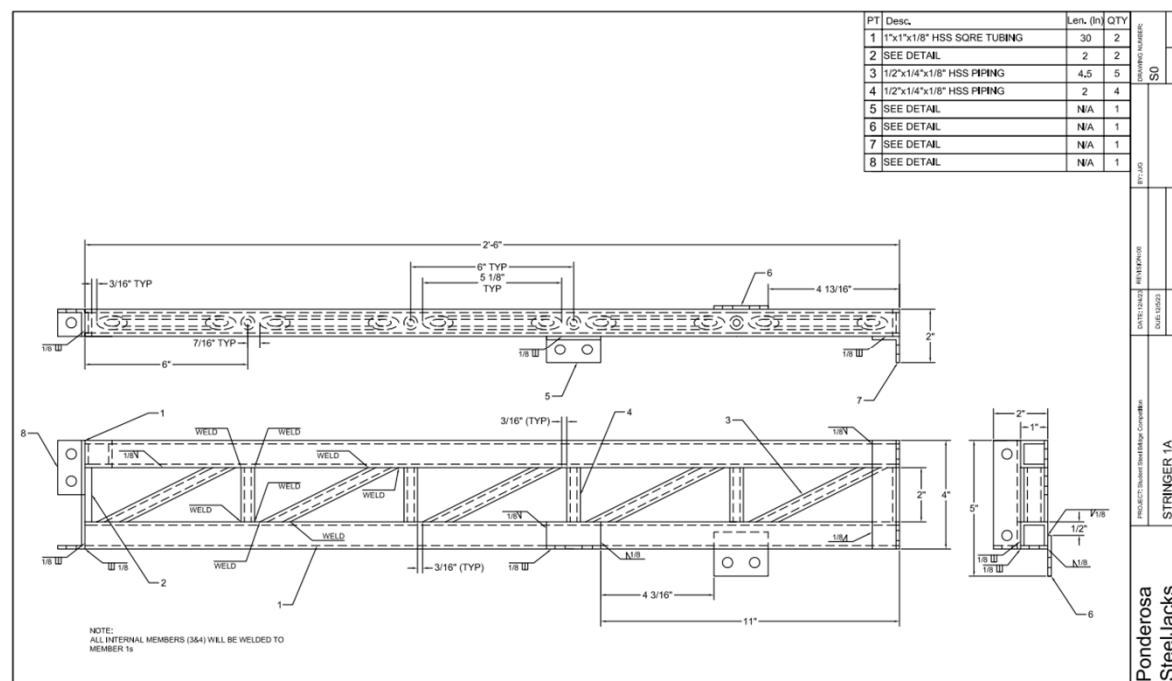


Figure 8-1: SSBC 2023 Shop Drawings



# SCOPE TASK 5: PRACTICE ASSEMBLY

- Task 5.1: Conduct Initial Assembly of Members
- Task 5.2: Design Modifications
  - Coordinate with fabricators for any weldment modifications or adjustments.
- Task 5.3: Practice Assembly Prior to Competition



Figure 9-1: Practice Assembly [4]

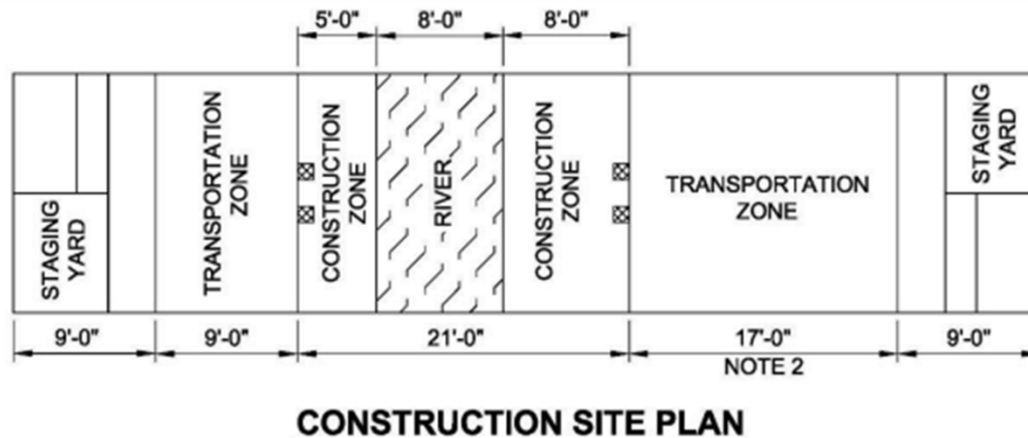


Figure 9-2: Site Plan [3]

# SCOPE TASK 6: COMPETITION



- Submit Structural and Cost Estimates
- Construct Bridge and Compete in Load Test
- Display Poster Board Detailing Critical Member



Figure 10-2: Lateral Load Test [6]

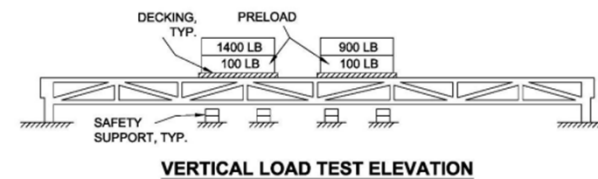
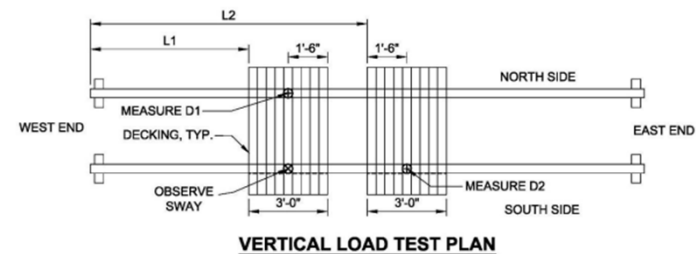


Figure 10-1: Vertical Load Testing Cutsheet [3]

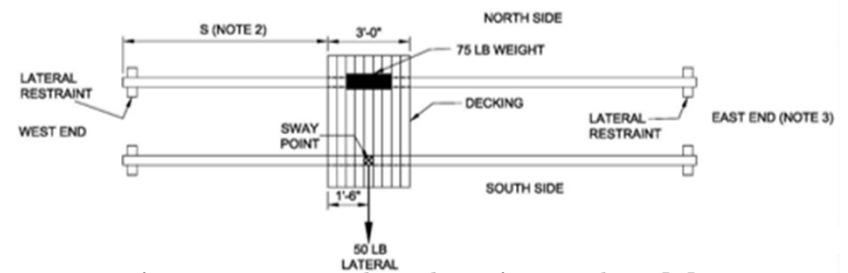


Figure 10-3: Lateral Load Testing Cutsheet [3]

## SCOPE TASK 7: IMPACT ANALYSIS

- Environmental Impacts
- Social Impacts
- Economic Impacts



Figure 11-1: Lincoln Parish Park [8]



Figure 11-2: Louisiana Tech University Logo [9]

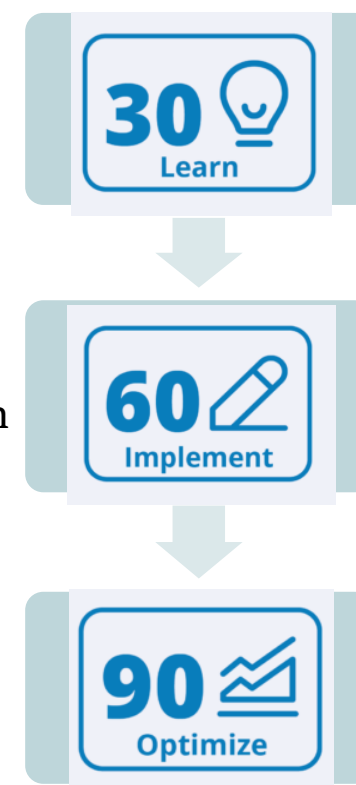


Figure 11-3: Hideaway Disc Gold Course [8]



## SCOPE TASK 8: PROJECT DELIVERABLES

- Task 7.1: 30 Percent Deliverable
  - Project Understanding and Research
- Task 7.2: 60 Percent Deliverable
  - RISA model
- Task 7.3: 90 Percent Deliverable
- Completed bridge design, shop drawings, and final cost estimation
- Task 7.4: Final Report
  - Completed design process/analysis/results
- Task 7.5: Project Website
- Task 7.6: Final Presentation



# SCOPE TASK 9: PROJECT MANAGEMENT

- Task 8.1: Schedule Management
  - Task assignments to team members
  - Deadline and milestone management
- Task 8.2: Resource Management
  - Determining resources needed for tasks
  - Managing expenses for tasks and bridge procurement
- Task 8.3: Meetings
  - Coordinate meetings with grading instructor, client, technical advisor, and fabricator



# STAFFING



## Staff Positions:

- Senior Engineer
  - Experience: 10 years of experience, Professional Licensure (PE) and Structural Engineering Licensure (SE)
  - Responsibilities: Reports, Project Management, Overseeing/Reviewing Engineer Tasks
- Engineer
  - Experience: 3 years of experience, Engineering in Training (EIT) license
  - Responsibilities: Preliminary Analysis, Final Analysis, Design Modeling Overseeing Drafter and Shop Tech Tasks
- Technician
  - Experience: 5 years of experience
  - Responsibilities: Fabrication, Assembly
- Drafter
  - Experience: 2 years of experience
  - Responsibilities: Drafting Shop Drawings, Design Modeling

Table 15-1: Staffing Table

Task	SENG Hours	ENG Hours	TECH Hours	DRFT Hours	Total Hours
<b>1.0 Project Background Research</b>	0	20	0	0	<b>20</b>
<b>2.0 Preliminary Analysis and Design</b>	5	45	0	0	<b>50</b>
<b>3.0 Final Analysis and Design</b>	20	100	30	30	<b>180</b>
<b>4.0 Bridge Production</b>	20	20	60	80	<b>180</b>
<b>5.0 Assembly</b>	5	20	50	20	<b>95</b>
<b>6.0 Competition Preparation</b>	5	0	15	0	<b>20</b>
<b>7.0 Project Deliverables</b>	20	55	20	0	<b>95</b>
<b>8.0 Project Management</b>	35	20	10	10	<b>75</b>
<b>Subtotal</b>	<b>110</b>	<b>275</b>	<b>185</b>	<b>140</b>	<b>710</b>

# EXCLUSIONS

- Life Cycle Cost Analysis
- AutoCAD Rendering of Design
- Full Scale Design
- Full Scale Set of Drawings

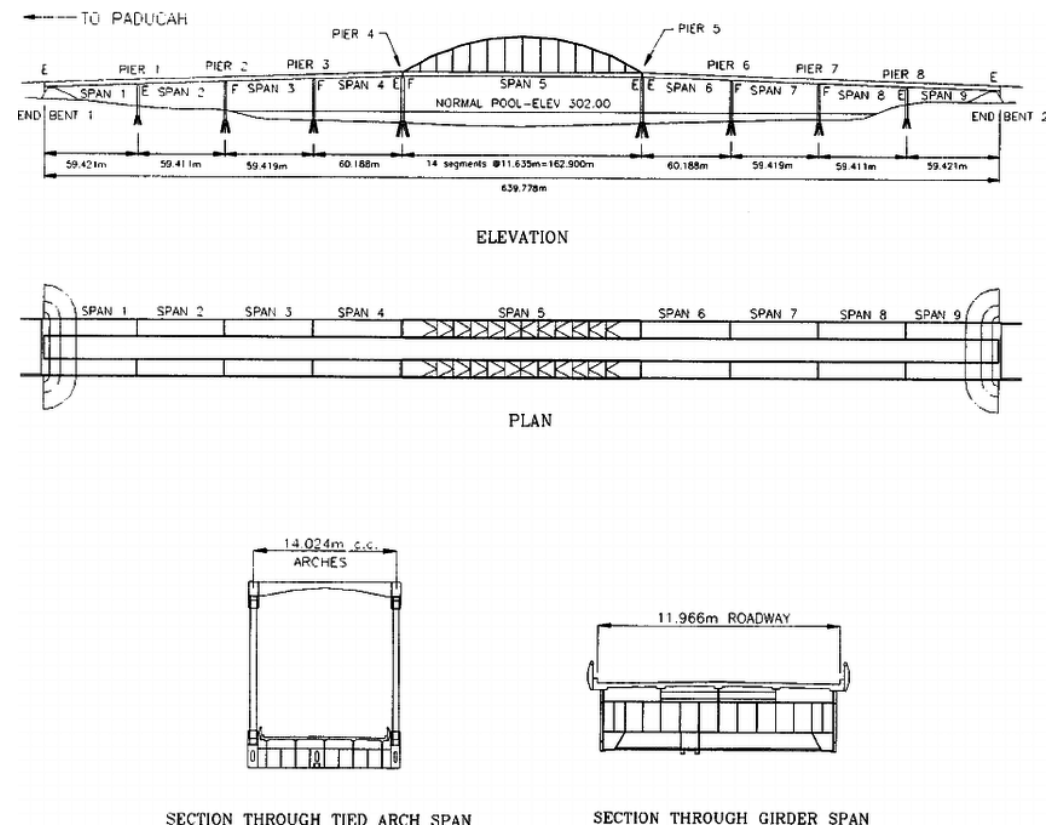
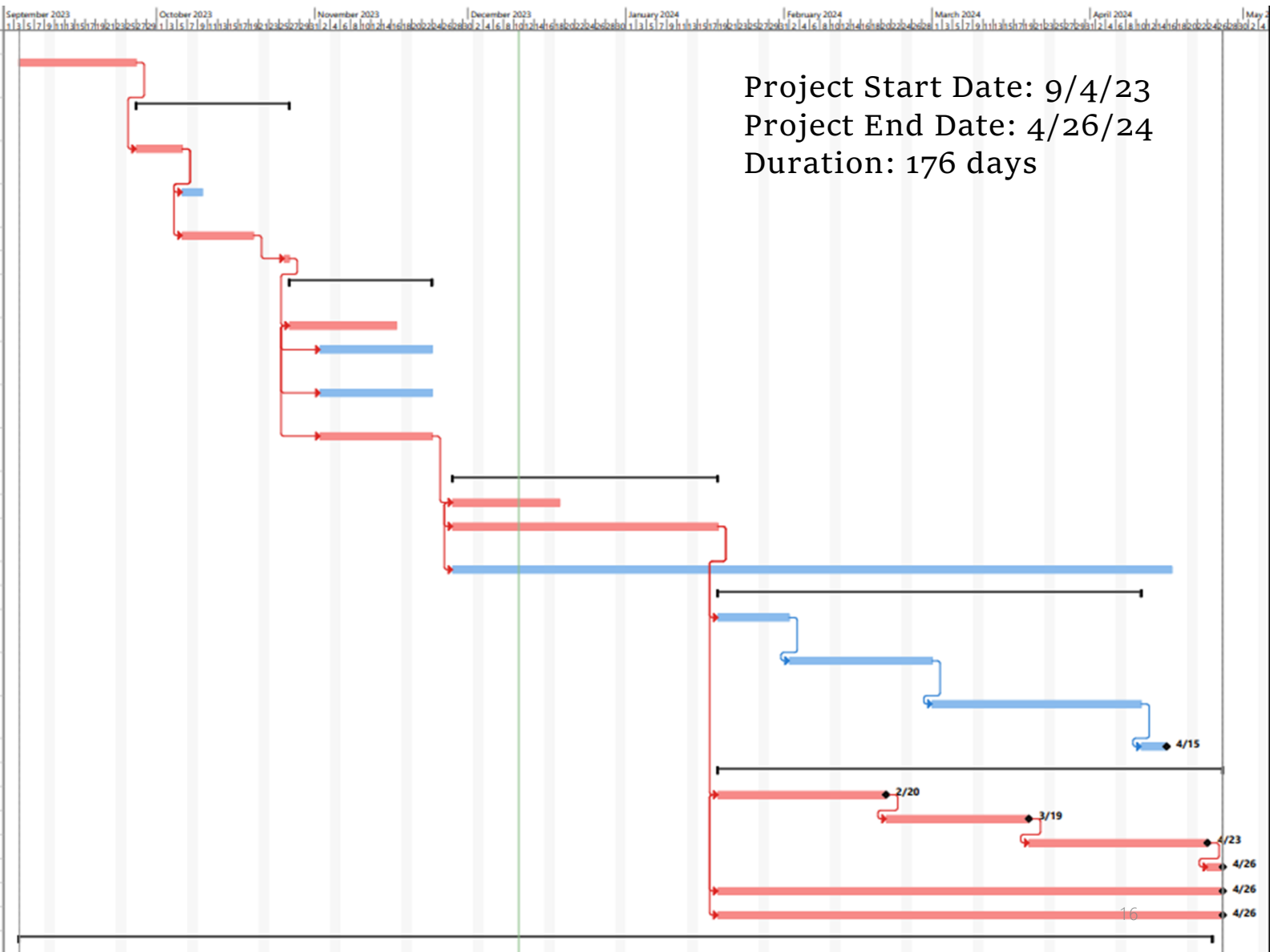


Figure 14-1: Full Scale Bridge Example [7]

Task Name	Duration	Start	Finish
Kickoff Meeting	0 days	Mon 9/4/23	Mon 9/4/23
Task 1: Project Background Research	17 days	Mon 9/4/23	Tue 9/26/23
<b>Task 2: Preliminary Analysis and Design</b>	<b>22 days</b>	<b>Wed 9/27/23</b>	<b>Thu 10/26/23</b>
Task 2.1: Member Design and Analysis	7 days	Wed 9/27/23	Thu 10/5/23
Task 2.2: Material Specifications	2 days	Fri 10/6/23	Mon 10/9/23
Task 2.3: Connection Design	10 days	Fri 10/6/23	Thu 10/19/23
Task 2.4: Design Matrix	1 day	Thu 10/26/23	Thu 10/26/23
<b>Task 3: Final Analysis and Design</b>	<b>20 days</b>	<b>Fri 10/27/23</b>	<b>Thu 11/23/23</b>
Task 3.1: Design Modeling	15 days	Fri 10/27/23	Thu 11/16/23
Task 3.2: Strength Analysis and Design	16 days	Thu 11/2/23	Thu 11/23/23
Task 3.3 Serviceability Analysis and Design	16 days	Thu 11/2/23	Thu 11/23/23
Task 3.4: Connection Analysis and Design	16 days	Thu 11/2/23	Thu 11/23/23
<b>Task 4: Bridge Production</b>	<b>38 days</b>	<b>Tue 11/28/23</b>	<b>Thu 1/18/24</b>
Task 4.1 Shop Drawings	15 days	Tue 11/28/23	Mon 12/18/23
Task 4.2: Fabrication Coordination	38 days	Tue 11/28/23	Thu 1/18/24
Task 4.3 Mentee Collaboration	101 days	Tue 11/28/23	Tue 4/16/24
<b>Task 5: Assembly</b>	<b>59 days</b>	<b>Fri 1/19/24</b>	<b>Wed 4/10/24</b>
Task 5.1: Conduct Initial Assembly of Members	10 days	Fri 1/19/24	Thu 2/1/24
Task 5.2: Design Modifications	20 days	Fri 2/2/24	Thu 2/29/24
Task 5.3: Practice Assembly Prior to Competition	29 days	Fri 3/1/24	Wed 4/10/24
Task 6: Competition	3 days	Thu 4/11/24	Mon 4/15/24
<b>Task 7: Project Deliverables</b>	<b>71 days</b>	<b>Fri 1/19/24</b>	<b>Fri 4/26/24</b>
Task 7.1: 30% Deliverable	23 days	Fri 1/19/24	Tue 2/20/24
Task 7.2: 60% Deliverable	20 days	Wed 2/21/24	Tue 3/19/24
Task 7.3: 90% Deliverable	25 days	Wed 3/20/24	Tue 4/23/24
Task 7.4: Final Report	3 days	Wed 4/24/24	Fri 4/26/24
Task 7.5: Project Website	71 days	Fri 1/19/24	Fri 4/26/24
Task 7.6: Final Presentation	71 days	Fri 1/19/24	Fri 4/26/24
<b>Task 8: Project Management</b>	<b>168 days</b>	<b>Mon 9/4/23</b>	<b>Wed 4/24/24</b>





# COST OF ENGINEERING SERVICES

Table 17-1: Cost of Engineering Services Table

Cost Estimate of Engineering Services				
1.0 Personnel	Classification	Hours	Rate, \$/hr	Cost
	SENG	110	\$216	\$23,760
	ENG	275	\$131	\$36,025
	TECH	185	\$114	\$21,090
	DRFT	140	\$84	\$11,760
<b>Subtotal</b>				<b>\$92,635</b>
2.0 Travel	No.	Unit	Unit Cost	Cost
Rental Truck	5	Days	\$129	\$645
Truck Fuel	1232	Miles	\$0.22	\$271
Rental Van	3	Days	\$48	\$145
Van Fuel	1100	Miles	\$0.45	\$242
Hotel	9	Rooms(3-nights)	\$113	\$1,017
Per Diem	6	People (\$40/day)	\$40	\$960
<b>Subtotal</b>				<b>\$3,280</b>
3.0 Subcontract		Hours	Rate, \$/hr	Cost
Fabrication		\$100	\$92	\$9,219
4.0 Misc.	No.	Unit	Unit Cost	Cost
Supplies	1	LS	N/A	\$1,534
Equipment	1	LS	N/A	\$3,084
<b>5.0 Total Cost</b>				<b>\$109,752</b>



Table 17-2: Miscellaneous Expenses Table

Miscellaneous Expenses				
Supplies	No.	Unit	Unit Cost	Cost
Steel	147	LFT	\$8.61	\$1,266
Tool Belt	6	Belts	\$30	\$180
Bolts	100	Bolts	\$0.44	\$44
Nuts	100	Nuts	\$0.44	\$44
<b>Subtotal</b>				<b>\$1,534</b>
Equipment	No.	Unit	Unit Cost	Cost
Wrenches (Usage)	12	Person Days	\$7	\$84
Battery-Powered Drill (Usage)	12	Person Days	\$50	\$600
Lab Rental	24	Days	\$100	\$2,400
<b>Subtotal</b>				<b>\$3084</b>

# REFERENCES

- [1] <https://informedinfrastructure.com/74424/students-showcase-ideas-for-wildlife-crossing-at-ssbc-national-finals/>
- [2] [https://www.youtube.com/watch?app=desktop&v=pbr\\_mEygjfo](https://www.youtube.com/watch?app=desktop&v=pbr_mEygjfo)
- [3] <https://www.aisc.org/education/university-programs/student-steel-bridge-competition/ssbc-rules-and-clarifications/>
- [4] <https://www.aisc.org/modernsteel/news/2017/march/steel-shots-student-steel-bridge-season-kicks-off/>
- [5] <https://uandigive.uidaho.edu/project/16773>
- [6] <https://www.youtube.com/watch?v=DsGVdoGhGBg>
- [7] <https://designscad.com/downloads/plan-drawing-composite-bridge-dwg-plan-autocad/>
- [8] <https://www.onlyinyourstate.com/louisiana/lincoln-park-la/>
- [9] <https://logowik.com/louisiana-tech-university-logo-vector-svg-pdf-ai-eps-cdr-free-download-17355.html>



# QUESTIONS