CENE 476 Steel bridge Capstone

Date: 12/8/23 Ponderosa SteelJacks: Kristina Finley-Encinas, William Skaggs, Andrew Castillo, Jonathan Gospodnetich



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)
- o Background
 - Hideaway Park Disc Golf Course Pedestrian Bridge (Louisiana Tech University)
 - o 1:10 Scale Bridge
 - Compete in a Time Competition and undergo Load Testing
- o Client
 - o Mark Lamer



Ponderosa

Figure 2-1: AISC Logo [1]



Figure 2-2: Vertical Load Test [2]



PROJECT LOCATION

o Location: Lincoln Parish Park in Ruston, Louisiana





Figure 3-2: Vicinity Map

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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



- Competition rules provided by AISC
- Task 1.2: Material Availability
 - Steel constraints
- Task 1.3: Research Connections
 - Connection constraints
- o 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
 - o Estimate weight
 - o 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



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
 - \circ Bearing strength and tear out of plate
 - Required plate thickness
 - Required spacing of holes





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
 - o 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]



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] Ponderosa Steel JACK9

SCOPE TASK 8: PROJECT DELIVERABLES

- Task 7.1: 30 Percent Deliverable
 - Project Understanding and Research
- Task 7.2: 60 Percent Deliverable
 - o 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
1.0 Project Background Research	0	20	0	0	20
2.0 Preliminary Analysis and Design	5	45	0	0	50
3.0 Final Analysis and Design	20	100	30	30	180
4.0 Bridge Production	20	20	60	80	180
5.0 Assembly	5	20	50	20	95
6.0 Competition Preparation	5	0	15	0	20
7.0 Project Deliverables	20	55	20	0	95
8.0 Project Management	35	20	10	10	75
Subtotal	110	275	185	140	710



EXCLUSIONS

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



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

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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			
Subtotal \$92,635							
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			
Subtotal \$3,280							
3.0 Subcontract		Hours	Rate, \$/hr	Cost			
Fabrication		\$100	\$92	\$9,219			
4.0 Misc.	No.	Unit	Unit Cost	Cost			
Supplies	-	l LS	N/A	\$1,534			
Equipment		l LS	N/A	\$3,084			
5.0 Total Cost				\$109,752			



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				
Subtotal \$1,534								
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				
Subtotal				\$3084				

REFERENCES

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- [2] <u>https://www.youtube.com/watch?app=desktop&v=pbr_mEygjf0</u>
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QUESTIONS