Scope of Work

2.1 Task 1.0 Research

1.1 Competition Rules

The competition rules were read in order to determine the potential loads combinations that could be applied to the bridge, and to ensure the bridge meets all requirements.

1.2 Analysis Methods

Various structural analysis and design software was researched including RISA 2D, RISA 3D, Solidworks, and Bentley STAAD.pro.

1.3 Materials Research

Research was performed on grades of steel and the shapes of members to use.

2.2 Task 2.0 Fundraising

2.1 Bank Account

It was attempted to create a bank account, but required a unique tax identification number. Obtaining a tax identification for this capstone is beyond the scope.

2.2 Sponsorships

The team called and emailed local businesses to ask for donations and sponsorships.

2.3 Go Fund Me

A Go Fund Me page will be created and shared on social media in order to target donations from friends and family.

2.3 Task 3.0 Structural Analysis and Design

3.1 RISA Model

A RISA model of the bridge was developed. The load combinations for the loading at the conference were applied, and the deflections and member stresses were determined. All of the loads were multiplied by a factor of 1.2. This gives the bridge a 20% factor of safety, which can help account for any minor errors during the fabrication process. The base RISA model was refined in order to best meet the judging criteria. A final RISA model was generated including member lengths, steel types, and all potential load combinations, as shown in Appendix A.

1x1x1/16, 0.5x0.5x1/16, 0.75x0.75x1/16, and 0.5x1x1/16 HSS tubing along with ¼" rod was used for this design. All of the HSS tubing was designed to be A513 steel, which has a yield strength of 72 kips per square inch (ksi). The ¼" rod was designed to be A36 steel, which has a yield strength of 36 ksi. The members in RISA were "moment released" at the ends. This tells the software that the members will be bolted at this location instead of being fixed or welded together. The bridge was analyzed as having a "pin-pin" connection and also as having a "pin-roller" connection. This was done because the way the bridge will behave at the competition will be somewhere in between these idealized boundary conditions. Under the vertical load test, according to the RISA model, the worst case vertical deflection is 0.646 inches. The maximum lateral sway under vertical loading is 0.67 inches. Under the lateral load tests, the anticipated lateral deflection is 0.26 inches.

During the loading at the conference, the load will be applied first somewhere near mid-span, and the deflection will be measured. The second load will then be placed over the cantilever end and the deflection will be measured again. Because of this, the bridge design in RISA was analyzed under the application of just the load applied near min-span, and then was also analyzed when there was load near mid-span and over the cantilever.

3.2 Connection Design

The connections were designed to withstand the maximum moment as determined in RISA from the member forces by considering applicable moment capacity. A SolidWorks model was generated to determine locations of maximum stress, as shown in Appendix B.

3.3 Materials Analysis

After the steel was received, samples of the materials underwent tensile testing. The team recorded the force and displacement from each of these tests. The yield force was determined from using the 2% offset rule, and the yield stress was then calculated by dividing the yield force by the cross sectional area. The measured yield stress was then compared to the anticipated yield stress for that material. It was found that all of the tested yield strengths were higher than specified, which verified that the team received the correct grade of steel.

3.4 Fabrication Drawings

Shop drawings were created in AutoCAD with a plan view, profile view, details, and section cuts for plate members, as shown in Appendix C. These plans were given to KZell Metals so plates could be precision cut with a laser cutter to specified dimensions.

2.4 Task 4.0 Fabrication

4.1 Construction Drawings

Construction drawings were created in AutoCAD and show an overall side view, front view and side view of the bridge, and details of members and connections, as shown in Appendix C. This was done for the team to use during fabrication and construction.

4.2 Jig Creation

Jigs for the span members, cantilever members, lateral bracing members, center span members, and leg members were designed and constructed to minimize fabrication variations in dimensions and to help create parts that are constructed to specified dimensions. This ensured that the capacity of the bridge is in accordance to the design.

4.3 Fabricate Components

Components will be fabricated using prescribed techniques to minimize distortions and maximize components strength. Members will be cut to specification and any needed holes will be drilled using guides to ensure accuracy and correct member placement when being constructed. This task is currently in progress, and this section will be completed for the final design report.

4.4 Finalize Welding and Fabrication

Welds will be made approximately every six inches in order to minimize distorting and weakening of the metal. If material with a yield strength equal to or

greater than 50 ksi, the steel will need be preheated to 50-125 degrees Fahrenheit before it is welded to ensure a full weld. This task is currently in progress, and this section will be completed for the final design report.

4.4.1 Material surfaces will be prepared by sanding and grinding the surface layer. All members will be inspected for quality and uniformity. This task is currently in progress, and this section will be completed for the final design report.

4.5 Inventory of Bridge Components and Final Layout

A final inventory of parts and members will be performed before construction practice begins. This task will be completed for the final design report.

2.5 Task 5.0 Construction

5.1 Construction Methods

Construction methods will be developed and tested. Construction methods that meet the conference criteria will be brainstormed. This task will be completed for the final design report.

5.2 Method Selection

After all construction methods have been tested and timed, a final construction method will be chosen. This will include assigning who will be constructing at conference, which side of the river they will be on, and what their role will be. This task will be completed for the final design report.

5.3 Construction Practice

The chosen method will be practiced under a similar setting to what is expected at conference. The building envelope including the footings, river, construction zone, and transportation zone will be taped out, and each time the bridge construction is being practiced, a mentee will keep track of the time and violations during building. After each practice, the pros and cons will be discussed and improved upon for the next construction practice. This task will be completed for the final design report.

2.6 Task 6.0 PSWC

The display board provided by the mentees will be printed. It will be printed in order for the display board to be set up next to the bridge on display day and be judged on aesthetics. The team will construct the bridge and display the poster provided by mentees for the display day at the PSWC for judging. The team will also construct the bridge at the conference during timed construction. If the bridge is constructed in the allowable time and has not been disqualified, the bridge will undergo the vertical and lateral load tests. This task will be completed for the final design report.

2.7 Task 7.0 Project Management

7.1 Project Schedule

A project schedule and Gantt chart was developed to ensure on time completion of the project, as shown in Appendix D.

7.2 50% Design Report/ Plans

A 50% design report and plan set will be submitted to the client and technical advisor for redlines and comments.

7.3 Final Design Report

A final design report will be written after the PSWC Steel Bridge Competition. The report will include the 100% design, results from the PSWC, and discussion on the performance of the bridge.

7.4 Final Presentation

A presentation will be given at the Undergraduate Research and Design Symposium (UGRADS) which will convey the objective and scope of the project, the design and analysis of the bridge, and results of the bridge at the PSWC Steel Bridge Competition. This task will be completed for the final design report.

7.5 Website

A website will be generated including team information, the final project proposal, final design report, AutoCAD drawings of the bridge, and results of the PSWC conference. This task will be completed for the final design report.

7.6 Team Meetings

The team is holding weekly meetings in order to ensure progress on the project.

7.7 Client communications

Meetings were held with the client, grader, and technical advisor in order to receive feedback on the design and project deliverables. The technical advisor meetings provided feedback about the design and technical aspects of the bridge, meetings with the client will helped guide the constraints of the bridge design, and meetings with the grader provided clarity on course deliverables and feedback from redlines.