AASHTO TRAC 2016-2017 Truss Bridge Challenge

Team Name: TRAC Triple Threat

School: TRAC High School

Team members: Jordyn XXXXXX (Team Captain)

Brittany XXXXXX

Samantha XXXXXXXX

Advisor: XXXXXXXX

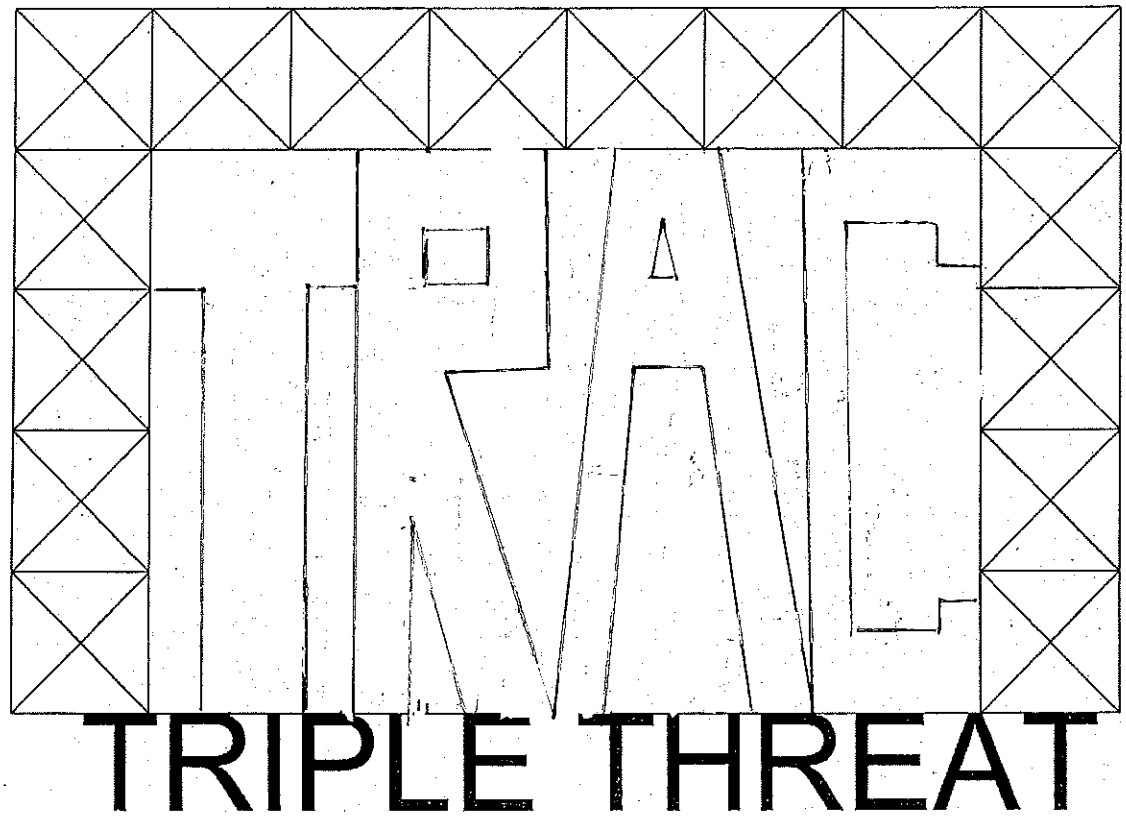


Table of Contents

Summary

We first learned about the TRAC Bridge Design and Build Challenge when someone came to our school and gave a presentation about the yearly bridge challenge. They gave us brochures, and told us about the highlights of the competition. It sounded like a good opportunity and we got excited and then formed a team.

Our first step was to start really planning out our bridge. We started with idea and modified those ideas where we knew they were weak. We drew bridges and tested them on computer programs like ModelSmart. The computer program helped us to be more confident that we had all the components of a successful bridge. Next, we started making our test bridge. We used the internet to look at many different bridges. We feel that being able to see a variety of bridges helped us to make our bridge better. Next, we did a little bit of testing. Our testing included looking at density's of different types of wood and testing the strength to weight ratio calculation given to us in the rules for this competition.

Once we had a good idea of what our bridge should look like, we used the Bentley program to draw our bridge. It seemed like it took us forever to get the bridge onto the program, but it just seemed that way.

The proposal came next. The proposal was the longest part of all. Over the course of a couple weeks, we chipped away piece by piece and created this proposal. The proposal caused us to look deeper and reconsider some of our previous decisions.

So far, we have learned a lot, and are excited to learn more. We've had to work on our own and we've had to schedule our own meetings, forcing us to be responsible. If we were assigned individual parts, we had to have them done by the deadlines we set or risk disappointing other team members. We had to plan carefully and have a strategy. Not

only did we have to develop this strategy, but we also had to follow it. We know this project will benefit us greatly when we are older. We will already have had experiences that other kids will not have had. Participating is this challenge will better prepare us for things like writing college essays, or even being able to complete deadlines for a job.

Introduction

Team Name:

Our team name is TRAC Triple Threat. We believe with the three of us working together, we will be a competitive threat to other teams. Our team captain is Jordyn, but there is little difference in our group between our captain and other members. We all worked equally hard to make our project a success.

Meet the Members:

Jordyn: My family includes my sister, my mom and my dad. For the past four years I've been perfecting my skills at horseback riding and training. It's become a passion that I live for and I work toward getting better and better. My other passion is music whether singing, playing the piano, or practicing my oboe. I am always happy making melodies. I have been working hard and since third grade, I am still maintaining a perfect 4.0 average. My biggest responsibility on this project was figuring out the Bentley program because I am really good at working for long periods and listening to directions.

Samantha: I am fifteen years young. I was born in Chicago, Illinois, and I dread going there every summer to visit family. My life basically consists of softball and basketball. I

love competition. When I

grow up, I still do not have any idea what I see myself doing, maybe something that has to do with stars. My greatest fears are butterflies, boats, fish, and cancer. My biggest responsibility was working on the proposal because I am very good at writing. I believe family should always come first. I love bright colors, and strive to be different. ☺

Brittany: I am fifteen years old, and I was born on June twenty-fifth. I attend the TRAC High School and get mostly A's and B's. I have many hobbies like basketball and running. I play basketball on the freshman team. My biggest responsibility was testing the bridge and creating the graphs/charts because I am a creative thinker and I am good with computers.

Working Together Toward Success:

Jordyn worked more on the bridge Bentley drawing, while Samantha worked more on the proposal, and Brittany worked more on the charts, graphs, and testing. Even though we all had our strengths and some weaknesses, we all helped each other out. No one did any part completely by themselves.

Body

Scientific Principles:

The scientific principles behind our design include use of triangles, density of materials, and how forces act and react. We used a lot of triangles because our teachers taught us that they are the most efficient geometric shape.

We weighed each piece of balsa wood to determine which weighed more because we wanted to use the densest wood available to us. We also tested each piece of wood to see how easily it would bend.

Finally, we went on the internet and looked up how forces affected a bridge. We learned that compression and tension are the two major forces. Compression is a force that pushes the bridge together. Tension pulls on the bridge and tries to stretch it, kind of like how you pull on a rubber band. There is also a bending force. When you apply a load at the middle of the bridge the bridge want to "bend" and the ends try to lift up.

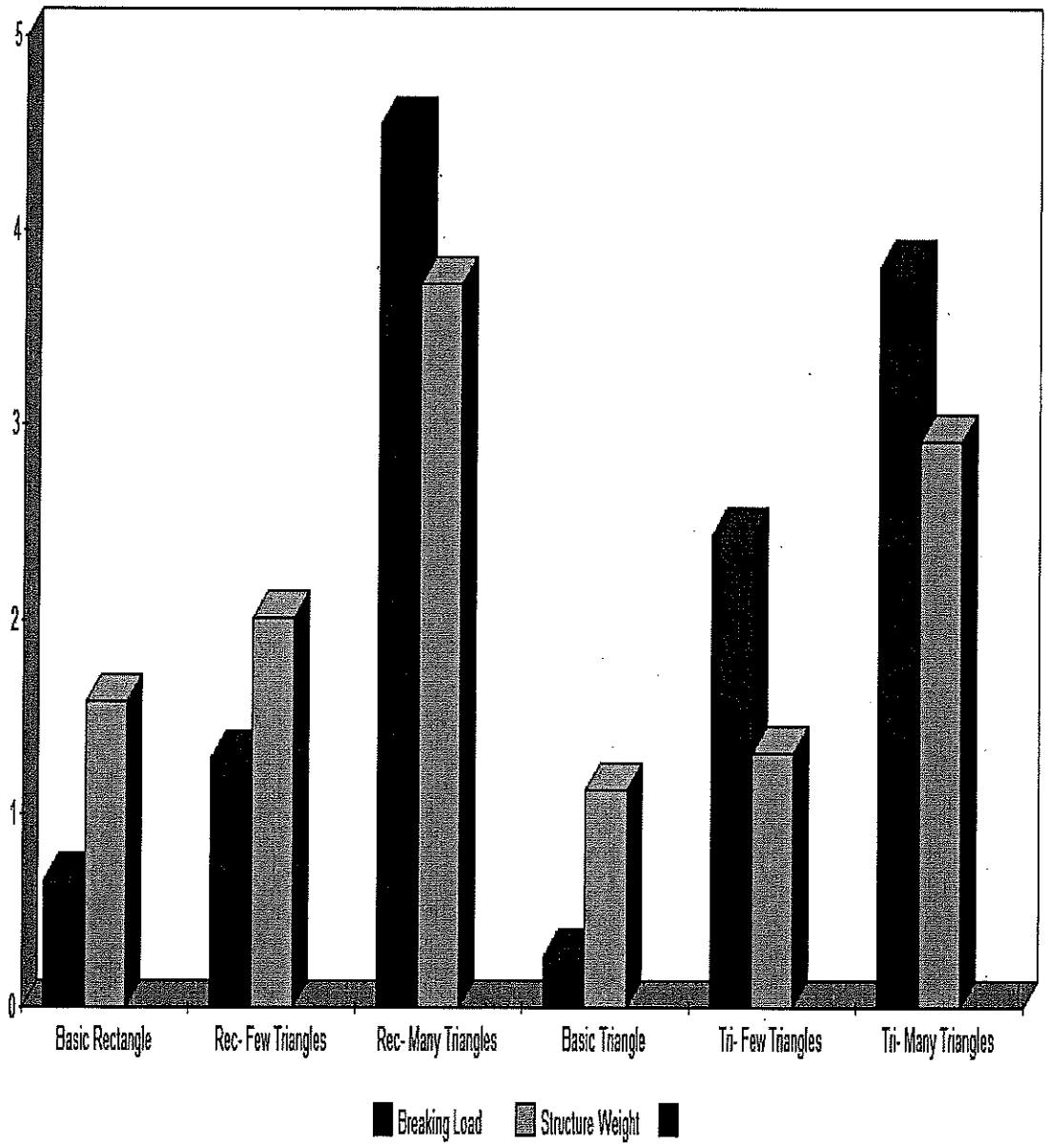
Design Challenges:

The biggest challenge that our team encountered was determining the exact bridge that we were going to build. We each did research to determine what the best truss bridge would like look and we came up with three different ideas. We decided the solution to this problem was to combine the best part of each of our designs to create a single bridge. The next problem that we encountered was to try to design the bridge in a way that allowed the testing rod to extend through the entire height of the bridge. Once we solved these two problems, the rest of the design process went a lot better.

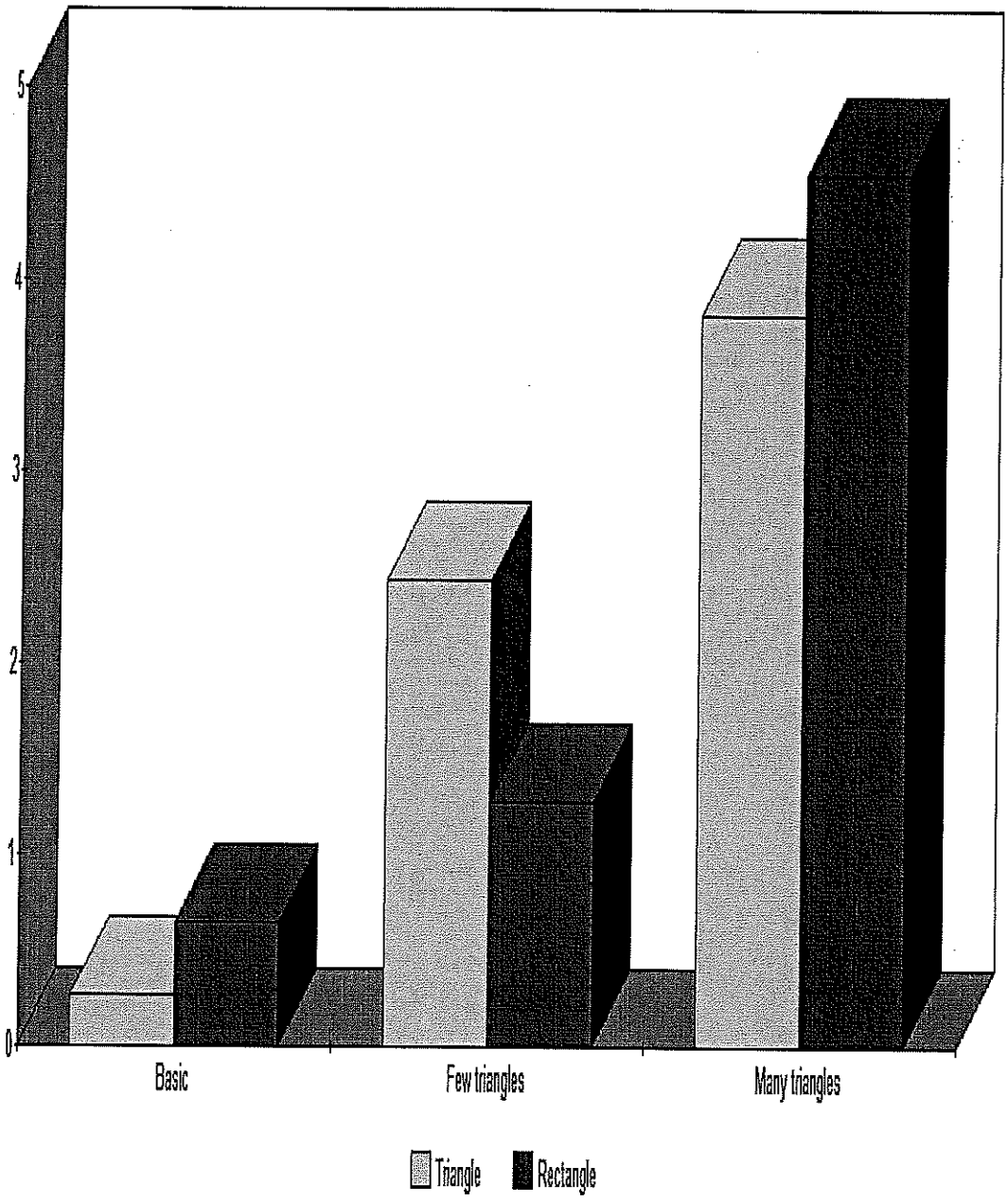
Data Tables and Graphs:

Breaking Loads and Structure Weights

Compared



BREAKING LOAD OF BRIDGES IN POUNDS



Supporting Calculations

Equation for Density

Density = Mass/Volume

Balsa Wood:

Mass: 170 kg.
Volume: 1 m3

Density: 170 kg/m3

Popsicle Sticks (maple):

Mass: 755 kg.
Volume: 1 m3

Density: 755 kg/m3

The popsicle sticks are more dense making them stronger and heavier. The popsicle sticks should be used where more weight will be pulling, while the balsa wood should be used where there is less weight pulling.

Solving for Vertical Deflection:

$$V = \frac{PL3}{4xExBxH3}$$

V = Vertical Deflection

P = Force = 1 lbs.

E = Elastic Modulus of the Beam Material = 185, 300 lb/in3

L = Length of beam = 15"

H = Height of Beam = 0.125"

B = Width of Beam = 0.125"

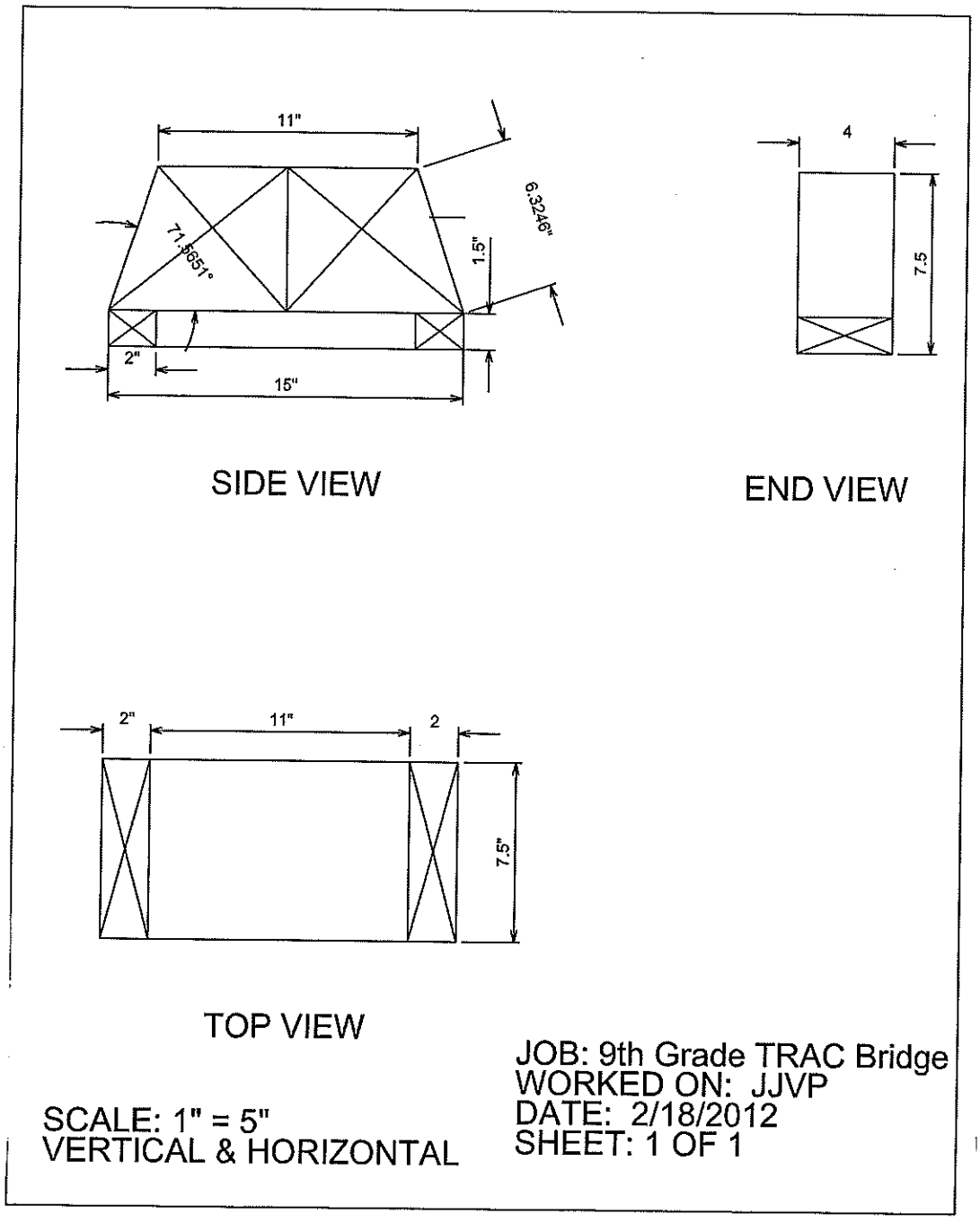
Solve for V

$$V = \frac{1 \cdot 1.5^3}{4 \cdot 185,300 \cdot 0.125 \cdot 0.125^4} = \frac{3375}{741,200 \cdot 0.000244} = \frac{3375}{180.8528} =$$

$$V = 18.661586 \text{ in.}$$

One 15" long piece of balsa wood ha a deflection of 18.7in. If a one pound weight was placed in the center.

Bentley Cad drawing:



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Testing and Resulting Improvements:

We tested our bridge on computer programs, and made practice bridges. We used past experience and knowledge from the computer programs to improve our bridge. Some of our improvements are keeping the weight out of the center of the bridge. Plus, we are making our bridge complex with many triangles, but not to the point where the small parts could not support themselves. We have observed new techniques by watching our peers make and break their bridges. It is good to have triangles, but not too many of them. Building a bridge with the weight in the center of the bridge is not good because the center is the part of the bridge that is least supported. We have observed the center is the place most likely to break first. To counter act this, our bridges strongest point will be in the center.

Solving Challenges:

We didn't have many problems building our bridge because of our experience from our industrial arts class. The problems we did have were very minor, like what our bridge should look like. Our biggest problem was once again figuring out how to make the deck bridge. By looking at pictures of bridges, we were able to combine our ideas with theirs and make our bridge work in a way that we think will keep the deck strong. When we came to problems, we did what we've done in the past and we put our heads together and found a way to overcome them.

Conclusion and Recommendations

Recommendations:

If we were to do this project again, we have recommendations of things we would do differently. The first thing is we would change is that we would schedule our get-togethers a little better. Another thing that could be improved is that we would start a little earlier, so we could get a better jump on it. The last thing we would change is that we would probably want to divide the project by what we know, and be specific on how we handle different components.

Success:

So far, our bridge has been a success. We have done almost everything we could think of to make sure our bridge is as strong as it can be. We have tested our bridge and improved it accordingly. We have stuck to a schedule and gotten everything together. We have worked through problems, and succeeded. The failures we faced did not stop us. So we are ready to continue in the competition, and ready to try our hardest to create a good Power Point presentation.

What We Learned:

We have learned a lot so far, and have no doubt that we will learn more. We have had to work on our own for most of this competition and have had to be independent. We even have had to schedule our own meetings which made us more responsible. When others failed to do what they were supposed to we had to look for ways to make things work, and take turns taking the lead. We also had to get the parts done that we were assigned, if we

were assigned parts, we also set deadlines. We had to plan carefully and have a strategy. Participating in MDOT's bridge challenge will give us experiences that will put us far of other students our age and help us advance all throughout our lives.

Acknowledgements

Adults who Advised us:

- Mrs. Connor

-Mr. Jankowski

Adults and how they assisted us:

Mrs. Connor agreed to be our advisor and made sure we had everything we needed to complete the challenge.

ACKNOWLEDGEMENTS

Mr. Jim Jankowski helped us with the MDOT Design and Bridge Build Challenge.

Mr. Jankowski came to our class and told us about the bridge program. He is one of our advisors and is available to answer questions about the program and how to design bridges.

Mrs. Connor answered questions and reviewed the proposal requirements with us.

We hereby certify that the majority of the ideas, design work, and other work was originated and performed by the students, with limited assistance by adults, as described above.

Team Members:

Samantha

Brittany

Jordyn

Advisors:

Jim Jankowski

Tammy Connor

Bibliography:

- http://www.boston.com/news/local/breaking_news/Drawbridge%20Struck.jpg
- http://www.michigan.gov/documents/mdot/2010_TRACBridgeCompChecklist78_REV_296987_7.pdf
- Bentley PowerDraft CAD Software

Appendices I

Scheduling and Accomplishments

Timeline:

November - sign up, go over rules, and start proposal

January - start talking about our design, do Bentley tutorial, and make the bridge drawing

February - Finish proposal, and put everything together

March & April - Build our final bridge!

Schedule Management:

Scheduling was done on a weekly basis assuming members had no conflicts. Often time members met at school and/or worked independently. We are all very busy so it was hard to work around individual schedules. We often worked separately, but when we were together we wrote down dates and what was done. Meetings usually started by discussing, deciding on a plan and then getting to work.

Appendices II

Daily Journal:

November- Learned about the bridge challenge from school announcement.

22 December - We met during lunch to go over the packet of rules.

5 January- We worked on the proposal and did tests for the graphs/charts.

8 January- We worked on "views" (what our bridge would look like). Talked

about how we wanted it to work and what would make it stronger.

9 January- We started our proposal and worked on our logo.

10 January- We worked some more on the proposal and started making our graphs/charts.

15 January- We worked more on the proposal and worked on some equations to support our bridge.

17 January- We met with Mrs. Connor at our school library and finished our Bentley Draft.

23 January- We did the last of our testing and completed our graphs/charts and equations.

25 January- We started putting our proposal together and filling in the missing parts.

27 January- We proofread the proposal and made sure everything was together.

28 January- We turned in our proposal!