Thursday December 2, 2021

Today's goal: To establish a basic understanding of structural engineering and to explore foundational topics related to bridge construction

Structural Loads:

Live load - The weight of people or goods on a structure
Dead load - Dead load refers to the weight of the bridge itself.
Static load - Loads that don't change with time; they remain constant
Dynamic load - A load exerts a varying amount weight
Environmental load - Environmental loads are loads caused by wind, waves, current, and other external forces.

Forces:

Tension forces pull and stretch material in opposite directions
Compression forces squeeze and push material inward
Torsion high wind causes the suspended roadway to rotate and twist like a rolling wave.
Shear stress occurs when two fastened structures (or two parts of a single structure) are forced in opposite directions.
A beam carries **vertical loads** by bending. As the beam bridge bends, it undergoes horizontal compression on the top

The Six Basic Bridge Forms:

The Beam:

The beam bridge is held by two or more structures to help keep the support of the deck of the bridge. As an item is crossing the bridge, the beam undergoes horizontal compression on the top of the bridge and horizontal tension from the bottom of the beam.

The Truss:

The truss bridge is simply a beam but supported from the top. This bridge needs a little material to support lots of loads, that is why it is one of the most popular bridges. On the top there is the force of compression while on the bottom tension is formed.

The Arch:

The support of the material holding the arch and abutments on the side help support the structure. When a load is crossing across the bridge, horizontal and vertical compression is applied and holds the bridge. There is no tension pressure. Its abutments help stop vertical and horizontal movement of the bridge. (Arch bridge only works under compression)

The Suspension:

This is the suspension bridge, the compression is on the vertical bars called the towers. The force of tension is on the cables.

The Cantilever:

It is generally made with three spans, where the outer spans are anchored to the ground and holds the beam at the store. And, the central span rests at the cantilever arms which are extending from the outer spans at the shore.

The Cable-Stayed:

Cable-stayed bridge carries the vertical main-span load by nearly straight diagonal cables in tension. The towers transfer the cable forces to the foundations through vertical compression.
Abutment is a structure which is used for the bridges and dams as a substructure at the end of the bridge or the dam.
Piers provide support between the two bridge spans known to hold the compression of the bridge.
Wing Walls are located adjacent to the abutments and act as retaining walls.
Beams and Girders help support the roadway and prevent bending of the support of the bridge.

The Bearing is between the bridge girder and pier cap, the bearing allows free movement of the top of the superstructure and reduces the effect of stress on the bridge foundation.
Arches are used for arch bridge construction
Cables are used for suspension and cable-stayed bridges.
Flooring is like concrete and road used on bridges.
The Bearing is between the bridge girder and pier cap, the bearing allows free movement of the top of the superstructure and reduces the effect of stress on the bridge foundation.
Truss bridge
Warren truss: has longitudinal members joined only by angled cross-members. They form equilateral triangles. It is relatively light but strong and economical truss.
Howe truss: has vertical elements and diagonals that slope up towards the center of the bridge.
K truss: has one vertical member and two oblique members in each panel (which form a letter “K”).
Pratt truss: has vertical members and diagonals that slope downward to the center. It is a variant commonly used for railroad bridges.

Sources:
Learned from presentations

Challenges / Questions:
There are so many factors that go into a bridge, what it's made of, what it can hold, what basic design you should choose. There are so many different things, I wonder when people make the bridge do they ever forget anything and what out of all of these factors you don’t need to still make the bridge work.

Accomplishments:
I talked in front of the entire class and talked about my topic. I also listened and took notes.

Tuesday December 7, 2021

Today’s Goal: Listen to the video and take notes. If I have time Gather background information on MBI and the structural engineers that we will be interviewing. Create a list of questions that you have for the engineers about their roles, experiences, portfolio, education, skills, workplace culture, etc.

A structural engineer is someone that designs and builds structures that are suppose to carry weight

How to decide what bridge to build:
Skew angle
Work points
Typical Section

Main Forces: Tension force and compression force are the forces that each part of the bridge faces

Types of Bridges:

Bridge Type		Hallmarks	Best Uses
Suspension		•Draping Cables supporting additional set of vertical cables •Piers with draping cables attached high above the roadway	•Over Rivers •Earthquake Zones •Can construct at least 2 towers
Cable-Stayed		•Straight Cables •Connected to towers •Counter acting (balancing) forces by cables on both side of towers	•Long Distances •May use only one tower •Preserving Environment •Cost less than Suspension
Arch		•Semi circular design (elliptical shaped) •Arch is either above or beneath the roadway •One of the oldest bridge types	•Durability •Easily Accessible Materials -Yes! Even natural materials •Deep gorges; preserving Environment as well
Truss		•Steel Girders, but not necessarily, wood also a common material •Triangular Shapes •Fracture critical (no load path redundancy)	•Strong Winds •Prefabricated pedestrian bridges •Temporary bridges •Very Stiff •Accommodate Dynamic Loads
Cantilever		•Pre-Stressed Steel or Concrete •No Direct Under Supports	•Extremely Safe and Secure (wouldn't say this more than any other) •Overhanging structures without additional support •Floating aesthetic
Beam		•Simple Design •Simply supported	•Cheap •Quick Construction •Standardized members and design
Rigid Frame		•One Single Construction •Some shaped like "K"	•Overpasses •More vertical clearance
Movable		•Modular •Incorporates mechanical systems to create movement	•Accommodate Various Uses •Allows Passage

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Wednesday December 8, 2021

Today's Goal: To look at the Structural Engineering Design Challenge and fully understand. To research bridge designs.

Questions About Structural Engineering Design Challenge:

What partner am I going to get?
How much do I have to write?
What is the due date for this project?
Are we going to use any machinery in this project?

Research for the Structural Engineering Design Challenge:

In this project I will try to challenge myself by building a K-truss Bridge. A K-truss bridge is a more complicated version of a Pratt truss bridge. A Pratt Truss bridge has been used for a long time and people claim it to be an effective method. Skyciv.com says that “The vertical members of the bridge are in compression, whilst the diagonal members are in tension. This simplifies and produces a more efficient design since the steel in the diagonal members (in tension) can be reduced. This has a few effects: it reduces the cost of the structure due to more efficient members, reduces the self-weight, and eases the constructability of the structure.” The main difference between these two bridges is that the vertical members of the K-truss bridge have become shortened, improving its resistance against buckling. The Bridge features two subdivided diagonal beams per panel that meet at the center of the vertical beam, featuring the letter “K” in the alphabet.
Now, how will I build the K-Truss Bridge?
The website garretts bridges says that the bridge “The K Truss design was a variant from the Parker truss design. ... The idea of the K truss is to break up the vertical members into smaller sections. This is because the vertical members are in compression. The shorter a member is, the more in can resist buckling from compression.” Now how do you make a truss bridge. Truss bridges support the weight of a bridge by spanning a series of trusses from one end to the other, supporting the weight of the bridge beneath. There are several types of truss bridge designs. The Warren truss uses equilateral triangles. The Pratt and Howe truss also uses triangles, but the triangles are slanted to change the distribution of weight. The K truss uses the same shape as the letter "K" to distribute weight. A model truss bridge can be made from balsa wood using any of these designs, or you can construct a truss bridge of your own design. I found a website that can help make the k-truss bridge. https://www.ehow.com/how_7887613_make-truss-bridge-balsa-wood.html.
The steps are:
Designing the Bridge
Step 1: Gather pictures or designs of the truss bridge you would like to construct, or use them as the basis for your own design. Pay close attention to the details of the design, including how the trusses are connected to the bridge, where the joints connect, and how the design of the structure distributes loads on the bridge to the trusses.
Step 2 :Determine the scale you would like to use. For example, a 1:12 scale would mean that every foot of a life-sized bridge would be one inch on your model.
Step 3: Draw the design of your bridge on a piece of graph paper showing the side view of the bridge. Use the squares on the graph paper to correspond to the units of your model. For example, one square might equal one inch on your model.
Step 4: Draw a second view of your design, looking down from the top, on a second piece of graph paper.
Step 5: Determine the amount of balsa wood required for your bridge by measuring your designs with a ruler.
Constructing the Bridge
Step 1: Measure two pieces of 1/8-inch balsa wood for the base of the bridge. Cut your pieces of balsa wood using a ruler and a sharp utility knife. Score the wood with moderate pressure several times. Do not try to cut balsa wood in a single cut, as too much pressure will crush the edges of the wood.
Step 2: Measure and cut the pieces necessary for your trusses, using 1/16-inch balsa wood, according to your design. Use whole pieces of wood wherever possible. Where joints between pieces are made, cut the wood so weight will be put on wood, rather than on glue. For example, a vertical beam would be placed on top of a horizontal beam, not glued to the side.
Step 3: Glue the pieces together using white glue. Clamp larger pieces with wood clamps where possible. Use masking tape to hold together smaller pieces until the glue has dried.
Step 4: Test the strength of your bridge by placing a small amount of weight on the bridge, then gradually increase it until you are satisfied your truss bridge is of sound design and construction.

Tuesday December 15, 2021

Today's Goal: Start working on the bridge sketch number 1

First I started sketching an outline of the bridge in 1:2 scale, I wanted to make my bridge a k truss bridge so first I made my bottom 12 inches and the top 9 so it could give the bridge a good looking design and would be structurally sound.

Friday December 17, 2021

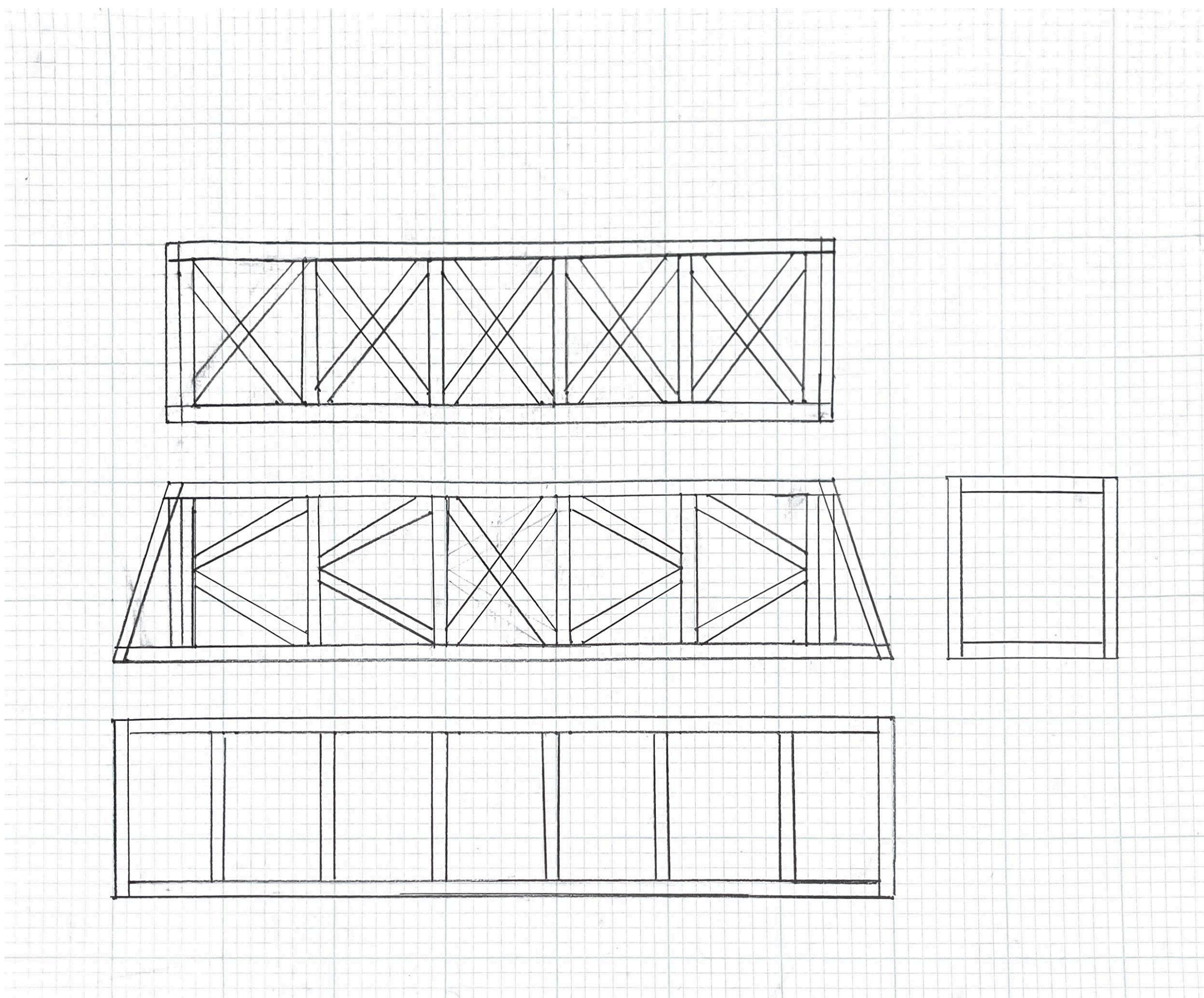
Today's Goal: Welcome my sister from college

I took a day off so I could pick my sister up from the train station

Monday December 20, 2021

Today's Goal: Finish working on the bridge sketch number 1 and start the 2nd one

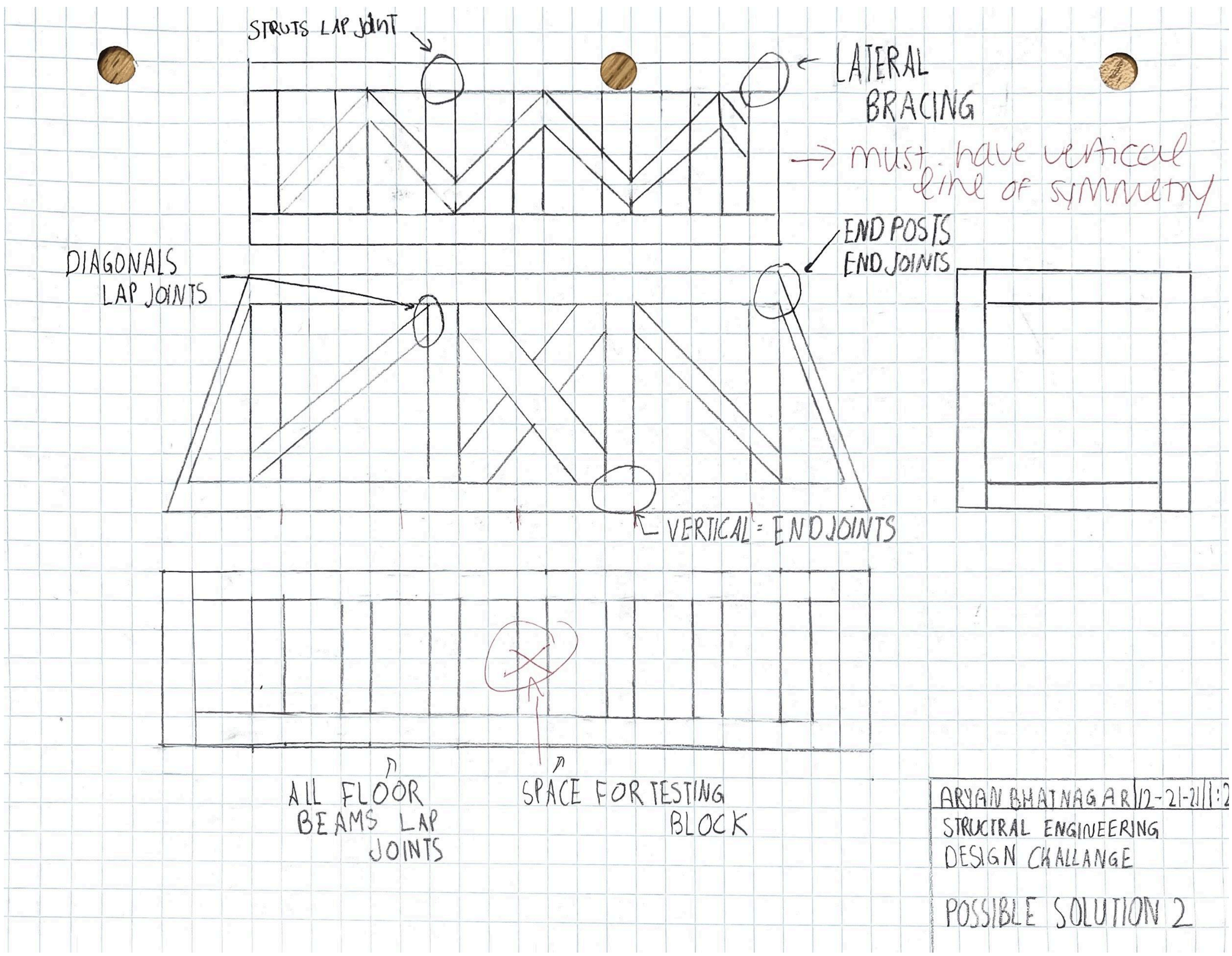
I finished my first sketch this class and it looked like this:



Tuesday December 21, 2021

Today’s Goal: Finish the second sketch, make it a hybrid

I finished this sketch and it looks like this:



Wednesday January 5, 2022

Today's Goal: Figure out what a cut list is and try to fill it

Possible Solution:	1

Component	Size (¼” or ⅛”)	Length	Multiplier	Total length
Top Chords	1/4	10 in	2	20 in
Portal Struts	1/4	3 in	2	6 in
Struts	1/4	3 in	4	12 in
Top Lateral Bracing	1/8	3 in	10	30 in
Portal Bracing	N/A	0	0	0 in
End posts	1/4	3 in	4	12 in
Vertical members	1/4	3 in	12	36 in
Diagonal members	1/8	3 in	16	48 in
Bottom chords	1/4	12 in	2	24 in
Floor beams	1/4	3 in	8	24 in
Bottom lateral bracing	N/A	0	0	0 in

Total ¼” balsa	**134 inches**
Total ⅛” balsa	**78 inches**

Monday January 10, 2022

Today's Goal: Finish cut list 1

Today I finished the cut list and now I am going to work on the second one

Component	Size (¼" or ⅛")	Length	Multiplier	Total length
Top Chords	¼"	8.8 in	2	17.6 inches
Portal Struts	¼"	3 inches	2	6 inches
Struts	¼"	3 inches	1	3 inches
Top Lateral Bracing	⅛"	3 inches	4	12 inches
Portal Bracing				
End posts	¼"	3.6 inches	4	14.4 inches
Vertical members	¼"	3.7 inches	10	37 inches
Diagonal members	⅛"	2.4 inches	8	19.2 inches
Bottom chords	¼"	12 inches	2	24 inches
Floor beams	⅛"	3 inches	20	60 inches

Tuesday January 11, 2022

Today's Goal: Finish cut list 2

Today I finished my second cut list and now that I am looking at them, I think I will make the cutlist #1 work because it is a k-truss bridge and I want to challenge myself. I will have to cut down on some materials, but other than that it should work.

Friday January 14, 2022

Today's Goal: Decide what bridge to work on, make a cut list for it

Since I was absent yesterday I did not get the final sketch paper that I have to draw on, so what my partner and I did was decide on what bridge to build and we chose to combine my sketch #1 with his sketch so we could get a hybrid bridge with both our designs.

Component	Size (¼" or ⅛")	Length	Multiplier	Total length
Top Chords	1/4	9 in	2	18
Portal Struts	1/4	3 in	2	6
Struts	1/4	3 in	5	15
Top Lateral Bracing	1/8	3 in	10	30
Portal Bracing				
End posts	1/4	4 in	4	16
Vertical members	1/4	3 in	5	15
Diagonal members	1/8	2 in	16	32
Bottom chords	1/4	12 in	2	24
Floor beams	1/4	3 in	5	15
Bottom lateral bracing	1/8	3 in	10	30

Total ¼" balsa	**109 in ~ 9 Feet**
Total ⅛" balsa	**92 in ~ 7.6 feet**

Tuesday January 18, 2022

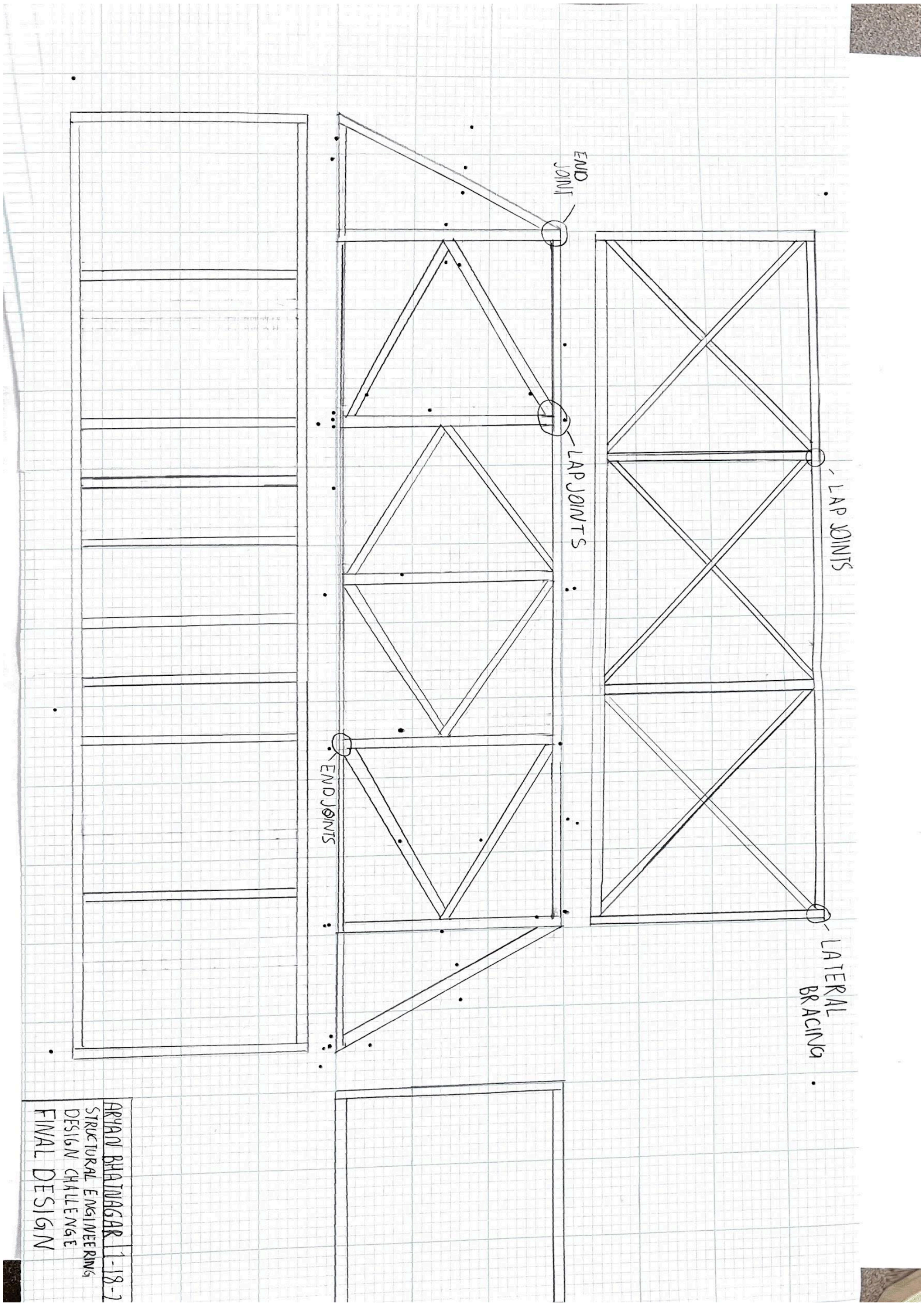
Today's Goal: Start and finish the final sketch

Today my partner and I started to work on our final sketch. We were trying to sketch a k-truss bridge with struts on the top that were making an x shape. We finished the basic outline of the bridge.

Thursday January 20, 2022

Today's Goal: Finish the final sketch

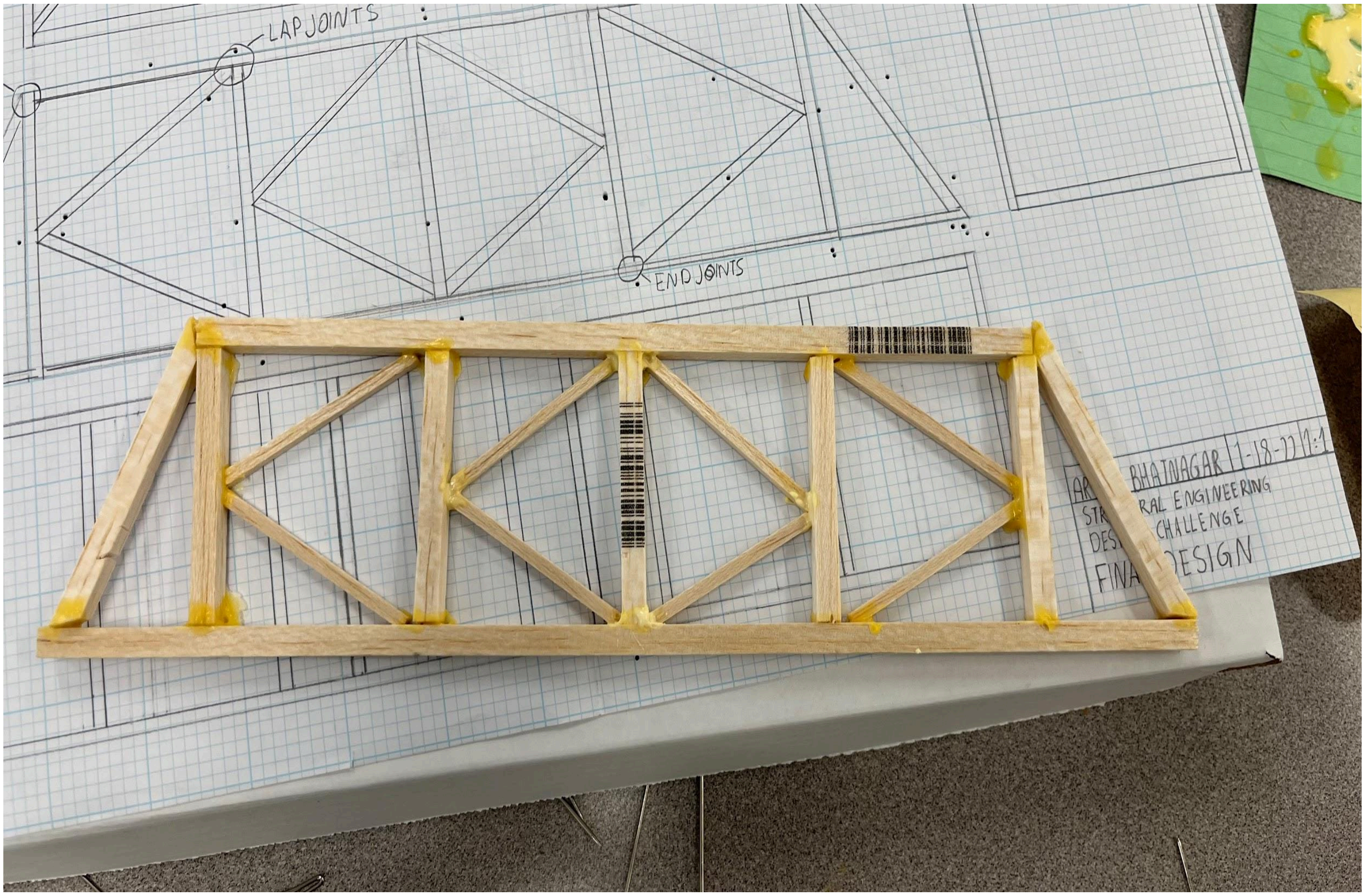
Today we finished the final sketch



Tuesday January 25, 2022

Today's Goal: Finish building the truss of the bridge

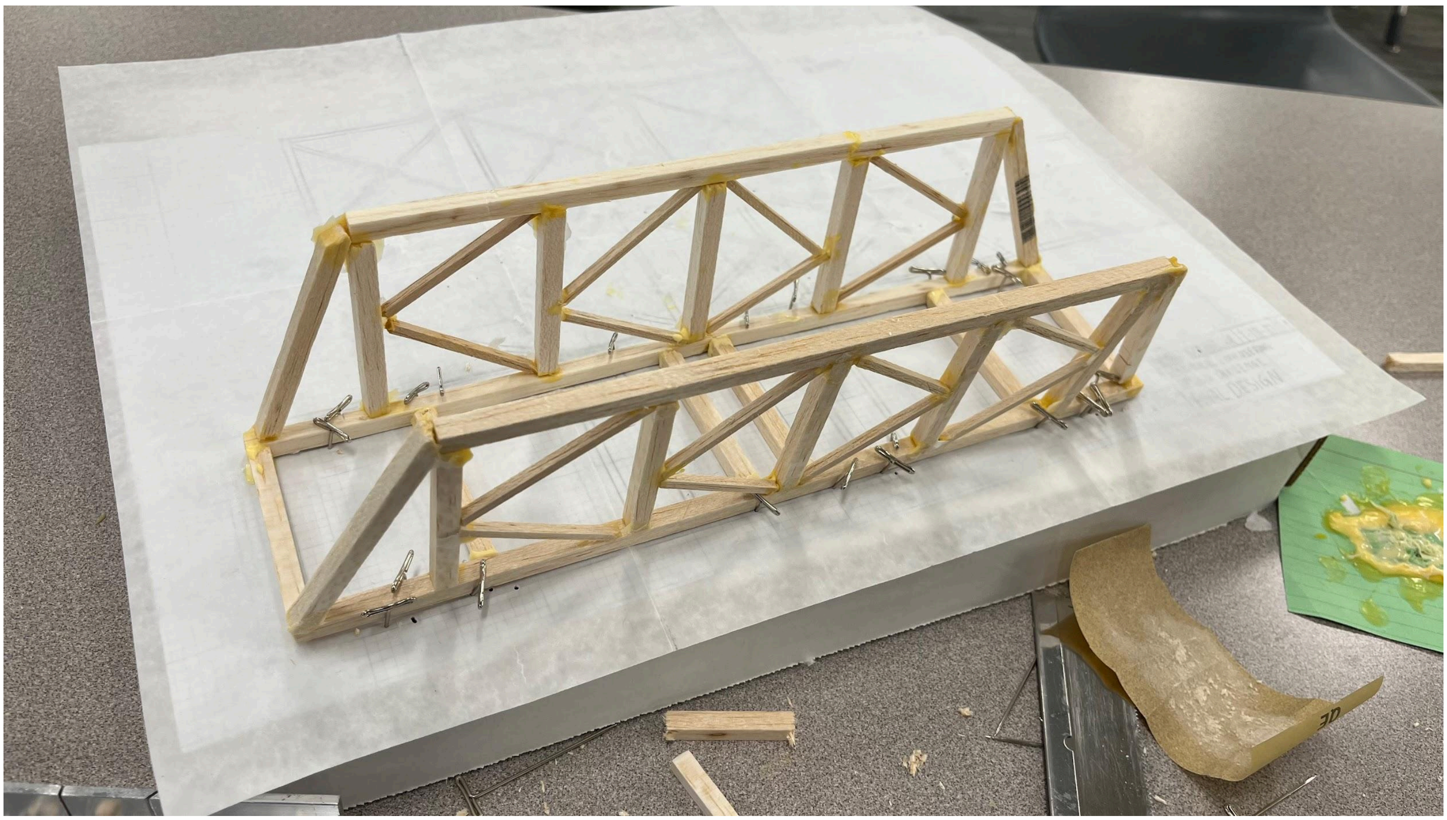
We finished building the 2 trusses, but We were behind on our project and we wasted Balsa wood (undercutting and oversanding)



Wednesday January 26, 2022

Today's Goal: Connect the 2 trusses by gluing floor beams

By the end of class we achieved our goal: we glued on 6 floor beams and connected the 2 trusses together. But we also had a few challenges, one of them being that when the class started, me and elijah were trying to separate the trusses from the paper and while doing that one of the trusses brock and because we did not have enough time or materials for a brand new truss, we had to glue it on together again and that caused our bridge to be structurally deficient. And due to the lack of materials and our worry about the trusses, we completely overlooked the fact that our floor beams were only held together by glue, because there was compression between them. To sum it up, this day went pretty badly because we broke one of our trusses and also glued on the floor beams the wrong way.



Thursday January 27, 2022

Today's Goal: Finish building the bridge

Today we finished building the bridge and at the end:

Design

- K-truss bridge
- ⅛ & ¼ balsa wood usage

Bridge vs Design Plan

- Less ¼ wood
- Joints not the same

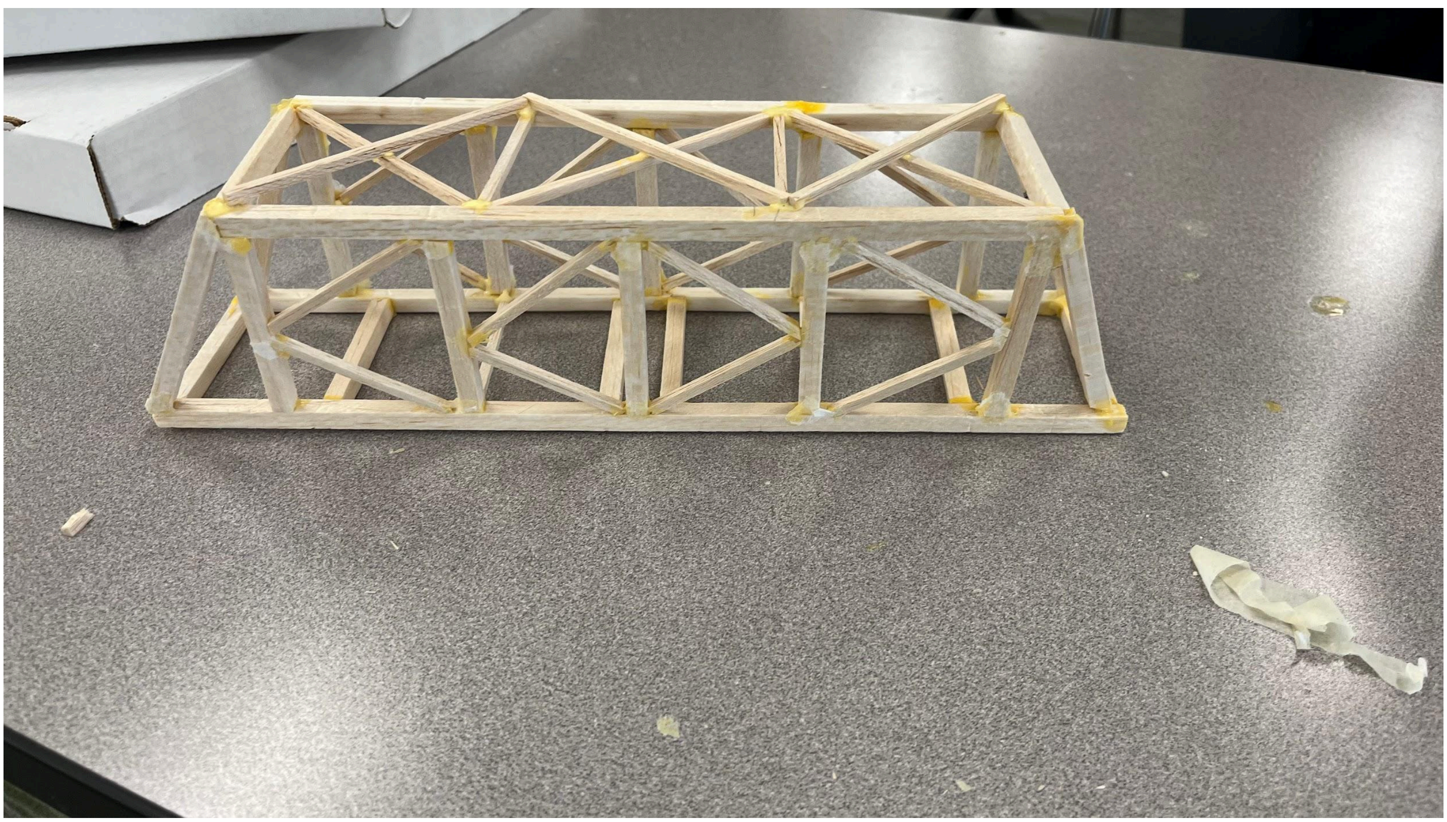
Strengths

- Looks nice
- Sturdy
- Plenty of space

Weaknesses

- Joints not stable (held together by wood glue)
- Slightly tilted to the right

It can probably hold about 5 kg



Monday January 31, 2022

Today's Goal: Finish the SEDC Presentation

Even though I was absent today, I still worked on the slide and finished most of it. I also created a script for the presentation.

Here the is the link for the presentation

SEDC Final Presentation Script

Our design was based on a k-truss bridge. The idea of the K truss is to break up the vertical members into smaller sections. This is because the vertical members are in compression. The shorter a member is, the more it can resist buckling from compression. We thought it would be a good idea to build a k truss bridge because we wanted to accept a challenge and also because the k-truss shape is made up of shorter elements and because of this it can withstand bulking from compression to a large degree. We also created a cut list for the final design plan so we could stay more organized and see if we had enough ⅛ and ¼ inch wood.

Our goal for the 2nd day of building was to connect the 2 main trusses together by gluing the floor beams together. By the end of class we achieved our goal: we glued on 6 floor beams and connected the 2 trusses together. But we also had a few challenges, one of them being that when the class started, me and elijah were trying to separate the trusses from the paper and while doing that one of the trusses brock and because we did not have enough time or materials for a brand new truss, we had to glue it on together again and that caused our bridge to be structurally deficient. And due to the lack of materials and our worry about the trusses, we completely overlooked the fact that our floor beams were only held together by glue, because there was compression between them. To sum it up, this day went pretty badly because we broke one of our trusses and also glued on the floor beams the wrong way.

Our final design was a k-truss bridge like I said earlier and I already showed you the cut list. I am just going to say it again, the bridge and the design were somewhat different because in the design we added some joints so the bridge could support more weight and be more stable, but when we built it, it was kind of tilted and did not have the same joints.

Our bridge can probably support 5 kg

Students names	Vlad, Nadish	Type of bridge	K-truss
Width of bridge	2 in	Height of bridge	3 in
Where lap joints were used	Struts	Where end joints were used	End posts
Where notch joints were used	none	Where gussets were used	n/a
Location of ¼”	Verticals, floor beam, center diagonals	Location of ⅛”	struts
Misc. Details	⅛ inch along the length without glue		
Weight of structure (g)	22.86 grams	Failure load (lbs)	337.62
Calculation	$$\text{EFFICIENCY NUMBER} = \frac{\text{FAILURE LOAD (lbs) X 454 (g/lbs)}}{\text{WEIGHT OF STRUCTURE (g)}}$$		
Efficiency score			

Students names	Varun, Mahesh	Type of bridge	Howe Truss Bridge
Width of bridge	3 in	Height of bridge	3 in
Where lap joints were used	End posts	Where end joints were used	Vertical
Where notch joints were used		Where gussets were used	
Location of ¼”		Location of ⅛”	
Misc. Details			
Weight of structure (g)	18.28	Failure load (lbs)	13 pounds
Calculation	$$\text{EFFICIENCY NUMBER} = \frac{\text{FAILURE LOAD (lbs) X 454 (g/lbs)}}{\text{WEIGHT OF STRUCTURE (g)}}$$		
Efficiency score	322.866		

Students names	Simran, Jack	Type of bridge	Warren truss
Width of bridge	3 in	Height of bridge	2 ½ in
Where lap joints were used	Diagonals	Where end joints were used	Verticals
Where notch joints were used	n/a	Where gussets were used	n/a
Location of ¼”	Top bottom chords, center floor beams	Location of ⅛”	Floor beams
Misc. Details			
Weight of structure (g)	19.71	Failure load (lbs)	10
Calculation	$\text{EFFICIENCY NUMBER} = \dfrac{\text{FAILURE LOAD (lbs) X 454 (g/lbs)}}{\text{WEIGHT OF STRUCTURE (g)}}$		
Efficiency score	230.3		