TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

SCHOOL OF ARCHITECTURE, BUILDING & DESIGN

Center for Architecture Studies in Southeast Asia (MASSA)

Bachelor of Science (Honours) in Architecture

BUILDING CONSTRUCTION 2 [ARC 2513]

Project 1: Skeletal Construction "A Shelter For One"

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GROUP MEMBERS:

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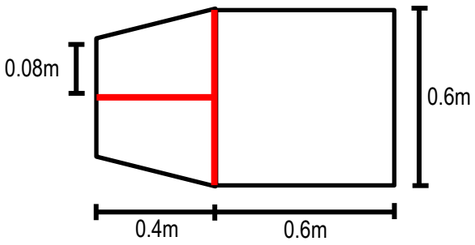
Table of Content

Methodology

Height of model : 1.5m

Base Area :

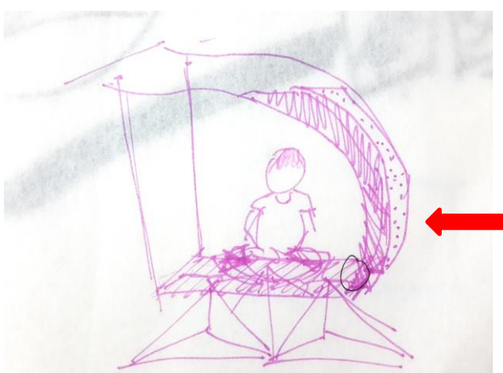


Objective:
To create an understanding of skeletal structure and its relevant structural components and how it reacts under a certain load. We should also be able to demonstrate how skeletal construction works and make manipulations to ensure some oblique design problems have been solved.

To recognize the implication of construction systems in design as well as to analyse the issues of strength, stiffness and stability of structures including modes of structural systems, forces, stress and strain and Laws of Static

Project Requirement:
The platform of the shelter is elevated about 5 inches of the ground and is tested to withstand the weight of average 60kg person up to 2 minutes.
Use recycled materials.

Hypothesis:
The heavier the dead load, the lighter the mass of the model, the higher the height of the model, the greater the efficiency of the model.

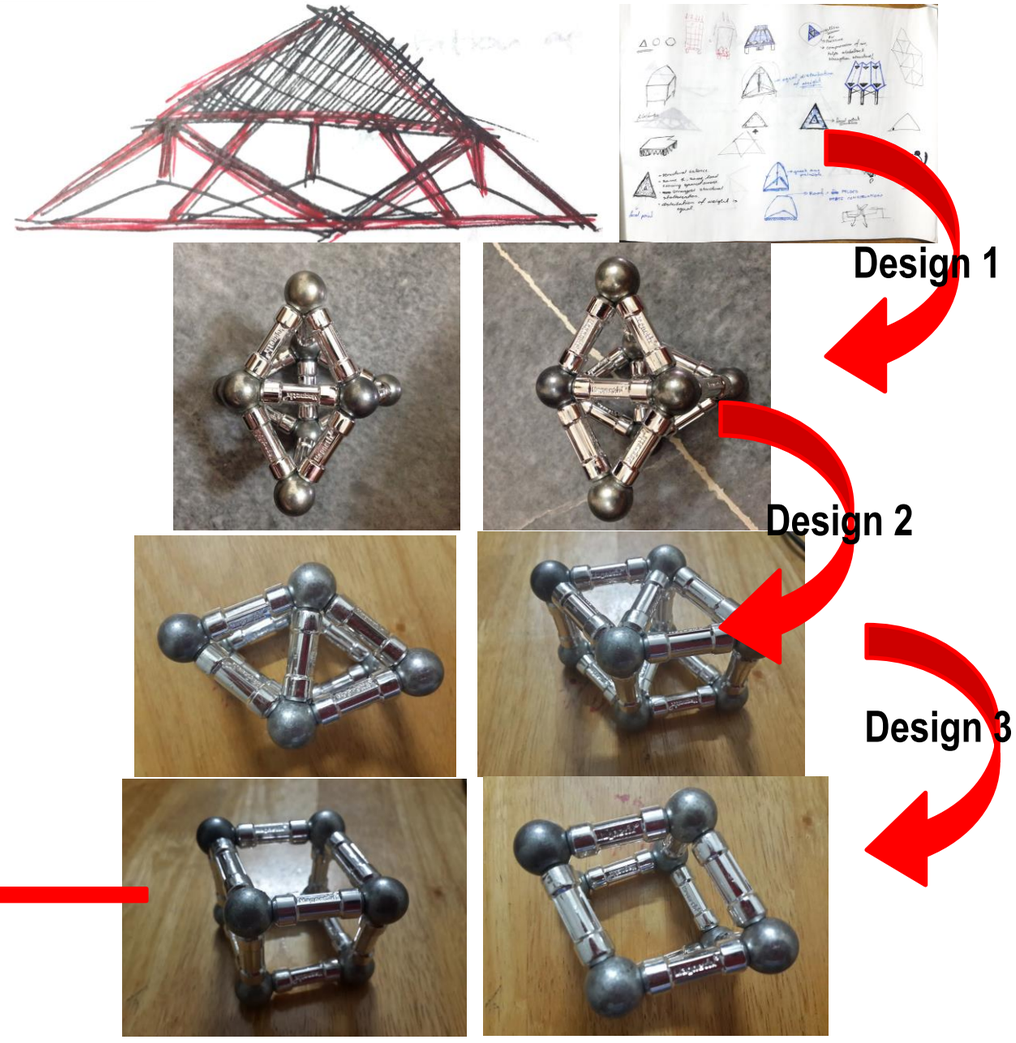


Design Concepts & Considerations

Considerations Taken :

- Considerations were taken in terms of the compressive strength of our model and the weight distribution of load it will be carrying in the end as well as the ability to disassemble and reassemble on site.
- Consideration regarding the choice of material was also taken. Wood was used due to an assumption of the wetness of the ground during our presentation.
- To ensure the minimum height of 5 inches is achieved.
- Equilateral triangles were also used as our basic shape as this shape is most stable and allows the most evenly distributed load.

Design Concepts



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Materials

The project brief required us to make use of recycled materials to build up this shelter.
In reference to that, we've managed to obtain and fully utilise 6 types of recycled materials;

1. **Cardboards**
   Source : Recycled cardboard from a warehouse
   Utilisation : The platform and the entire shell structure was built using cardboard.
   Both sides of the shell structure is a combination of 2 pieces of cardboard, making the whole shell structure to be stronger and less likely to collapse.

2. **Wood**
   Source : Dismantled from a broken table (Soft wood), Dismantled from pallets from a warehouse.
   Utilisation : The 2 types of wood is used as the main base structure in which the entire load is going to be distributed evenly. The shape of the structure uses the soft wood while the supporting beams utilises the wood obtained from the pallets.

3. **Egg crates**
   Source : Obtained from market
   Utilisation : The egg crates are used beneath the platform as an extra supporting system to ensure the Platform is unable to be bent or dented when a dead load is placed on it.

4. **Plastic bottles**
   Source : Collection from housemates for an entire month.
   Utilisation : Having the characteristics of being water proof, we decided to utilise this material as our shell. This enables the person testing from getting hit by direct sunlight during a hot day and minimal rain exposure.

5. **Raffia string**
   Source : Personal belonging
   Utilisation : This material is used to join together and hold in place the cardboards on the platform and the egg crates.

6. **Metal wire**
   Source : Personal belonging
   Utilisation : Having a very flexible feature, this material is used to connect together the plastic bottles of the shell and the main cardboard shell structure.

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Construction Methods & Joints

Construction Methods.

The construction process were separated into 4 different sections, in which were the construction of the;

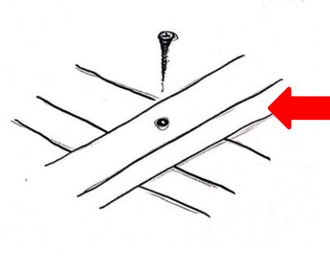
1) Base structure
2) Platform
3) Skeletal structure
4) Shell

1) Base Structure

- For the construction of the base, 4 pieces of wood taken from the broken furniture of length 45cm were used.
- These pieces were connected individually using the lap joint method.
- In using this method, we measured and marked the required dimensions, and manually sawed and chiselled out the section in which are going to be connected with its other half.
- After carefully joining the 2 pieces of wood together, we further secured them by screwing them together.
- These few steps are then repeated twice until the 8 pieces of wood were firmly joint together to produce 2 sets of base of the same dimensions.
- In ensuring the 5 inches elevation was achieved, we then used 6 pieces of the wood obtained from the pallets with length 50cm each.
- These wood were then stacked up, 3 on each level on one of the base allowing the part with the platform to be elevated.
- This stacking process was secured using screws.





2) Platform

- For the construction of the platform, the materials utilised were cardboards, egg crates, raffia string and the base without the elevation.
- The first step in the creation of the platform is the connection between the platform and the base itself.
- The shape of the base was first traced onto a large piece of cardboard and was cut off. Then, the base was inserted through the cut section and was secured into place using raffia strings. Double knot was used to ensure the tied strings were unable to be removed and remain in position.
- After this, the base was screwed onto the elevated base allowing the whole structure to be elevated.
- A series of egg crates were then placed on the secured base. This step was taken in consideration of the compressive strength of the base. The egg crates were assembled in a Lego form to increase its strength in the acceptance of a compressive load.
- The egg crates were stapled together and were tied together to the cardboard with raffia strings.
- Another piece of cardboard of the same dimensions was then placed on the egg crates, creating a sandwich form of cardboards and egg crates.

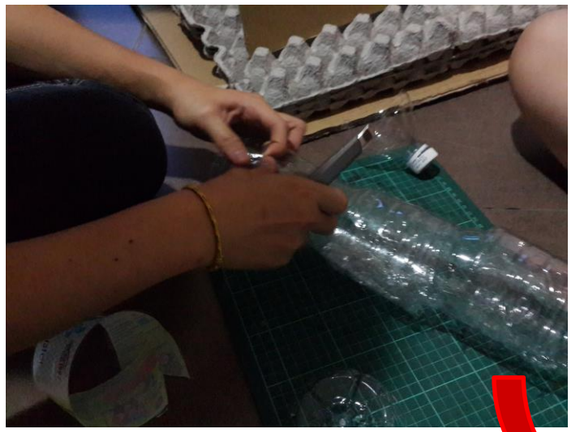


2) Skeletal Structure

- The whole structure was produced using cardboards and the method of slitting in.
- The measurements were first taken and the marking were made according to its width and length.
- The length decreases by 5cm each time as the height of placement increases.
- The thickness of each of the cardboard was doubled to ensure they wouldn't bend or tear apart during the testing.
- This step ensure the strength of the structure as well as the ability to hold the load created by the plastic bottles in the end.
- The marking were then cut and tested to see if it was a perfect fit.
- These cardboards were then connected together using the slitting in method.
- This methid was used as a consideration of enabling it to be dissembled and reassembled on site, rather than bring the whole structure all assembled.
- Not only easing the transportation method, but also creating a more clean finish.

4) Shell

- As for the shell, the entire structure was created using plastic bottles.
- This material was used in consideration of the water-proofing in mild rain.
- 3 bottles were used in creating 1 fin for the shell. The head from 2 bottles were cut off while both the end and head on one. The 2 bottle with the head cut off were then put through and into the fully opened mid part on both sides.
- This creates a long tube of plastic bottle which was used as the shell.
- Openings were made on each side of the bottle according to the depth of the skeletal cardboard. This allows the bottles to be slitted into the cardboard.
- Holes were then drilled at the bottom of the bottles at each side and cardboards. This step was taken to tie the bottles with the cardboard to ensure the bottles don't fall and stays in place.
- The 2 different materials were tied together using metal wire and they were assembled on site before the presentation.

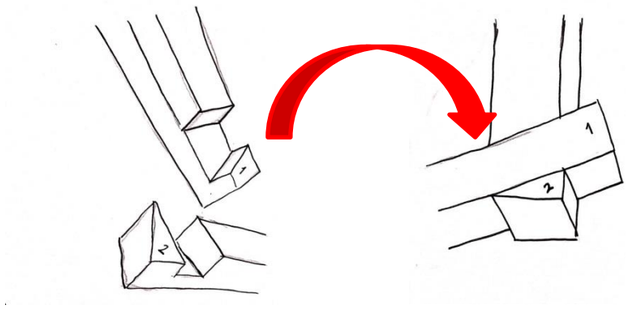


Joints used

Multiple types of joints were used in this structure. These joints vary from the types of materials were intended to be joint.

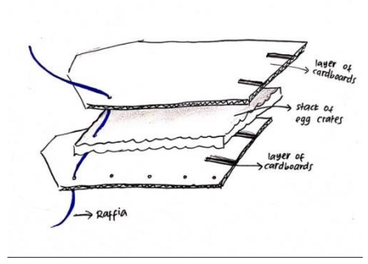
1) Lap Joints

The lap joint method was used to join the 2 pieces of wood in creating the main base for this structure.
This joint which is usually done in a 90° joint was improvised to a 60° joint.



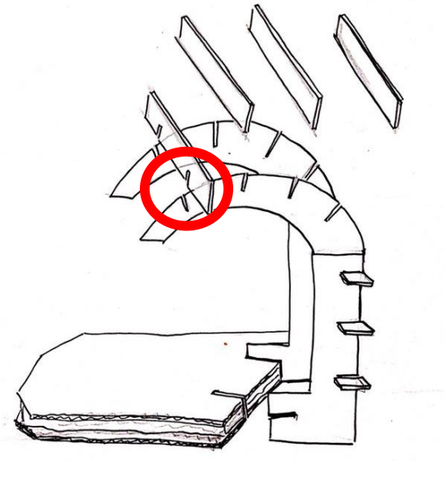
2) Joints using raffia string and metal wire

Raffia strings were used as a method of tying together the cardboards and the egg crates. Metal wire on the other hand, was used to secure the plastic bottles and the cardboard skeletal structure.
This joint was done using a double knot to ensure its firm.



3) Slitting in method

The slitting methods, the most basic method of connection were used in this structure, mainly to connect the skeletal shell structure. All the cardboards which are connected in this project uses this method. Besides the cardboards, the connection between the plastic bottles and the cardboards also uses this method.



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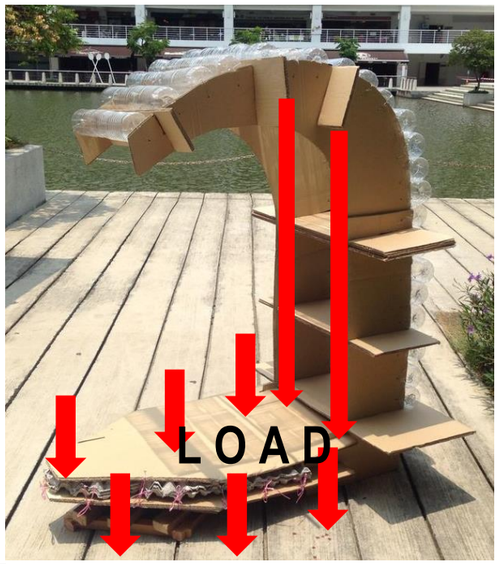
Testing (Forces & Structural Movement)

Load Distribution Analysis



Vertical Dead Load

The point dead load in this structure is distributed equally from the cardboard to the egg crates. The egg crates which has a high compressive strength, further distributes the load equally to the wooden base which eventually transfers the load to the ground.

Trial Load Test

Problem Faced

- We faced problems in stabilising the whole skeletal structure.
- The weight distribution was also constrained to the base as the platform was big.

Improvement made

- Long cardboard pieces were placed in between the main 2 skeletal structure to stabilize it.
- The platform was made smaller to allow a more distribution of load.

Final Load Test

On the day of the testing, a total dead load of 187kg was impacted on the structure. The structure managed to withstand this amount of load for more than 2 minutes, thus, achieving the project goal.

The structure also managed to withstand the mild drizzle which happened on that day, thus, enabling its water proofing properties.