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Building with Toys

Bhavana P
9th Sem, RVCA

Abstract

Apart from the intangible factors that govern architecture, it is essentially the integration of material and structure within a larger framework of intent, driven by function and aesthetic. Material and structure determine the nature of volumes, thickness, texture, shape, construction methods and cost. With the added emphasis on sustainability in architecture, materials and structures undergo constant evolution. We as architects, have a responsibility to be informed enough to come up with innovative methods and means to display our skills. I had always been interested in dynamic relationships and movement in architecture, therefore, the material I chose was scientifically known as a non-Newtonian fluid. This is a material that act as a solid when under stress and liquid otherwise. The understanding was that there needs to be a sturdy base and a proportional load placed on top for the Oobleck to act as a solid. I needed the material to be visible so that Oobleck could be seen acting as a solid and a liquid alternatively. Hence, the casing not only had to have the ability to contain liquids but also had to be transparent and flexible. The only material that fit all 3 criterions was Plastic. The regular geometry of this project was questioned through an exploration in understanding organic forms. The explorations noted above may not be fool proof and probably have many unforeseen limitations, disadvantages and problems. Experimentation leads to discovery and understanding. It always holds the possibility to learn something new, even if it is to learn how not to address a subject.

Key words –
Architecture, meta sustainability, construction materials, equilibrium, non-Newtonian fluid, Oobleck

We often hear the word experiment as something we did in school, in the lab as part of the science curriculum. When we came to Architecture College, we often experimented with the implications of a line on paper depending on its spacing, thickness and scale. I strongly remember being made aware that every line I drew had a 3-dimensional implication to it, and thus began the experiment of making spaces. Shaping the solid or shaping the void, two sides of the same coin. In theory, we were taught of various material and a very general understanding of how columns, beams, vaults and domes stand. We are taught how to draw them, such that the forces are at equilibrium and that the built doesn't collapse or succumb to natural forces.

Apart from the intangible factors that govern architecture, it is essentially the integration of material and structure within a larger framework of intent, driven by function and aesthetic. Material and structure to a large extent, determine the nature of volumes, thickness, texture, shape, construction methods and cost.

With the added emphasis on sustainability in architecture, materials and structures undergo constant evolution, with new research papers questioning the actual implications of materials predominantly used. We as architects, have a responsibility to be informed enough to come up with innovative methods and means to display our skills.

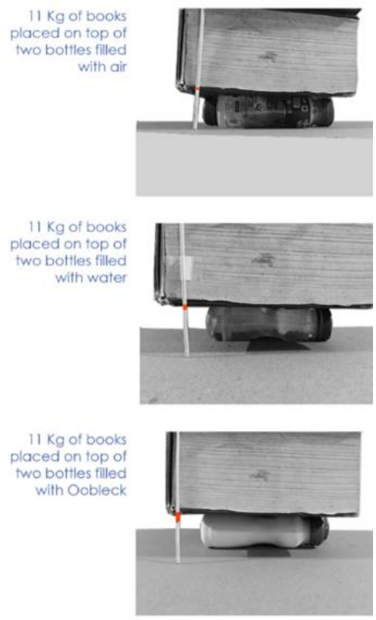

Figure 1: Source: Author

Figure 2-: Exploration of Shape, Structure and Material

Source: Author

In our 7th semester, we were asked to look at sustainability and meta through the lens of architecture. It was an opportunity to understand the possibilities and limitations of a material of our choice. I had always been interested in dynamic relationships and movement in architecture, therefore, the material I chose was scientifically known as a non-Newtonian fluid. This is a material that act as a solid when under stress and liquid otherwise. It was already used in protective gears, products and automobile manufacturing, but the most common use was as the home-made DIY toy called silly-putty or Oobleck.

Oobleck was 2 portions cornstarch and 1 portion water and it made a material that was liquid at rest and a solid when under stress. I tested the strength of this material with methods I could apply at home(Figure 1 testing of Oobleck).
The understanding was that there needs to be a sturdy base and a proportional load placed on top for the Oobleck to act as a solid. The materials' structural scope was to be load bearing only and could not handle tensile stresses. Therefore, the uses of it to build were extremely limited in scale and application.

However, something to note was that this material needed a casing. As Oobleck is essentially a liquid when at rest, it is impossible to work with. The material needs to be piped into a casing. The casing also limits the displacement of the material by providing a rigid framework for it to function within.

Essentially the casing could be any material that can hold a liquid but for the purposes of my experimentation, I needed the material to be visible so that Oobleck could be seen acting as a solid and a liquid alternatively.

Hence, the casing not only had to have the ability to contain liquids but also had to be transparent and flexible. The only material that fit all 3 criterions was Plastic. The added advantage was that plastic could be reused, recycled and pre-manufactured, based on the need. Now that an understanding of what Oobleck is, was attained, the next step was to determine how it could be applied in architecture.

The unit that was to be used was a plastic bag filled with Oobleck. The nature of construction was load bearing and hence, these bags were to be stacked one on top of the other as a wall. The self-weight of the second row would keep the first row under compression and hence, more layers could be built to a certain restricted height.
The 4 points that were to be addressed at this stage was

1. The relationship between the top-most row of material and roof
2. The nature of openings
3. The resistance of shear forces
4. The shape the wall would take

One, the roof had to be heavy in order to keep the wall under compression constantly. This was a fairly straightforward solution. The roof also needed to have an overhang to prevent rain and harsh sun from entering into the intervention.

Two, as established earlier Oobleck needs to have a strong base and stress from top to act as a solid. Hence when it comes to an opening thought the sill can stand on its own self weight the lintel and layers above the lintel need to be addressed. One option would be to use a plank of a rigid material such as wood to be placed as the lintel and then go on to place layers of Oobleck above that or to have no lintel and extend the opening till the roof.

Three, all walls are subject to shear forces and are constructed in a manner to resist these forces either by using composite materials or construction methods. In this case considering that the material used is plastic bags with Oobleck, the height that can be achieved just by stacking is minimal. Therefore, a frame of round wooden posts that do not touch the roof are used to ensure that the walls are held in place at all times.

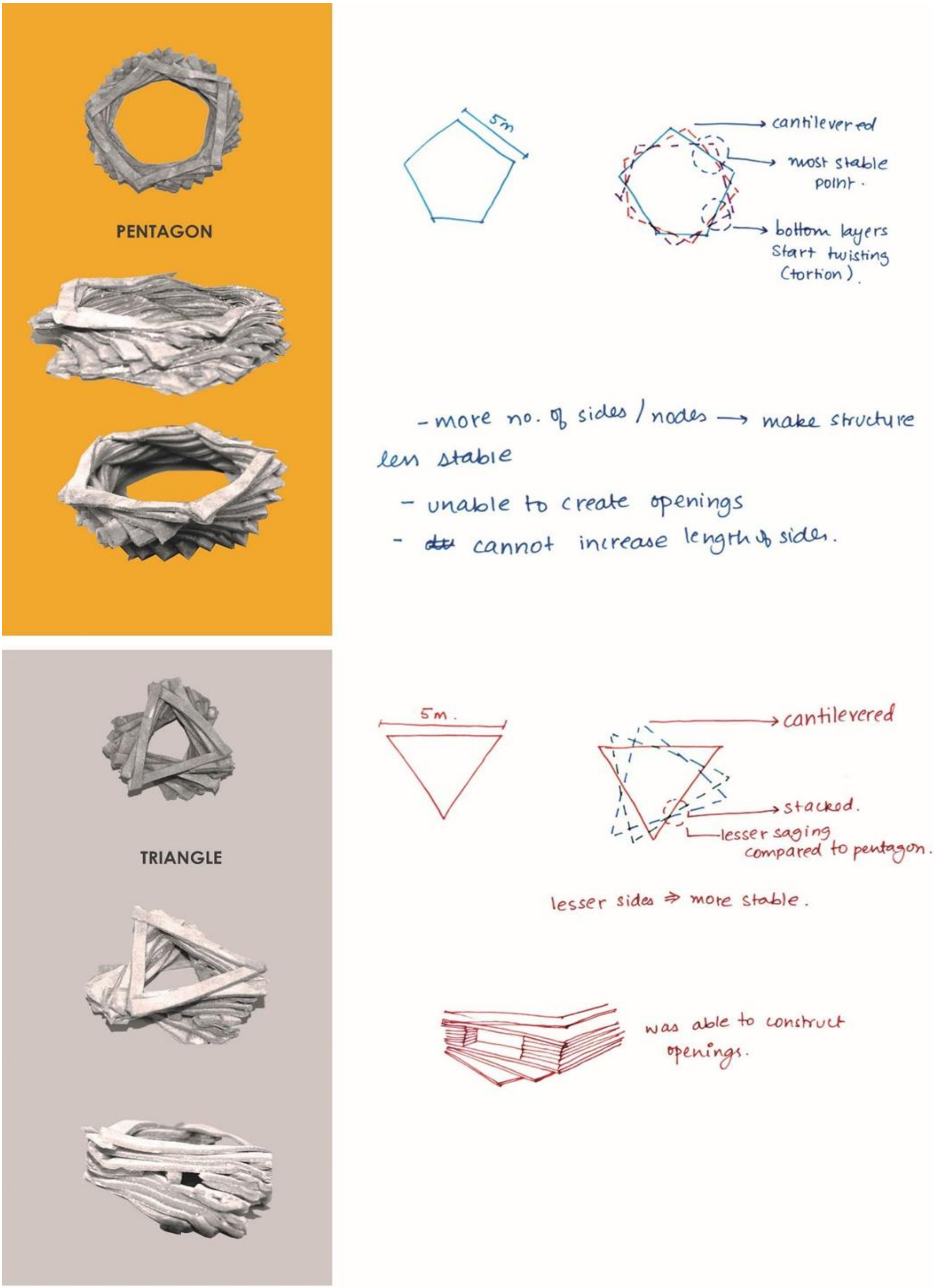

Figure 3- Inferences of Form 1

Source: Author

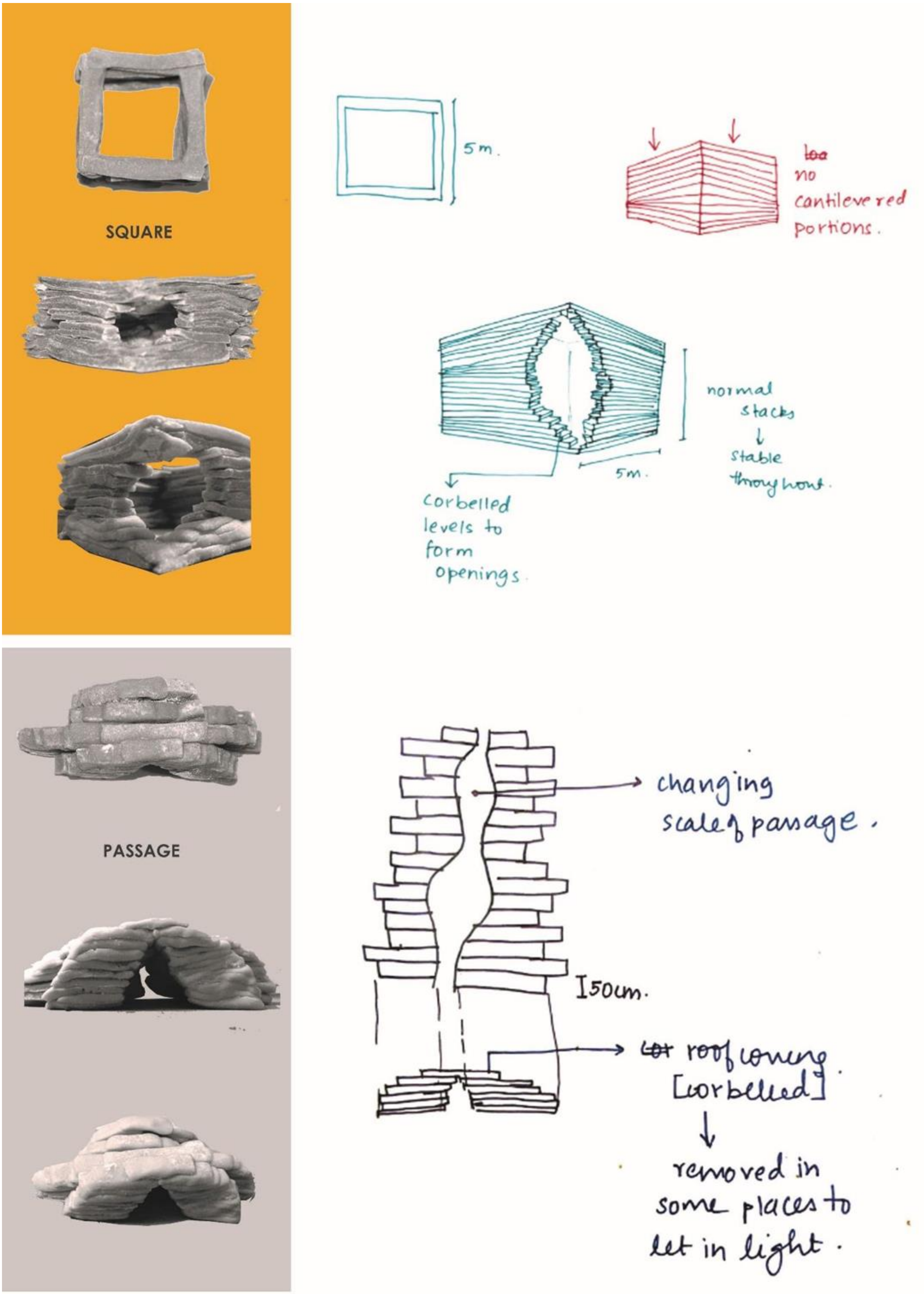

Figure 4- Inferences of form 2

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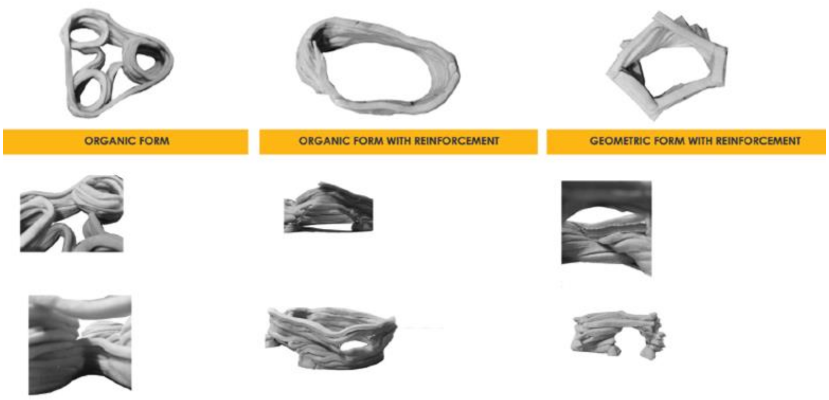

Figure 6: Exploration in understanding organic forms

Source: Author

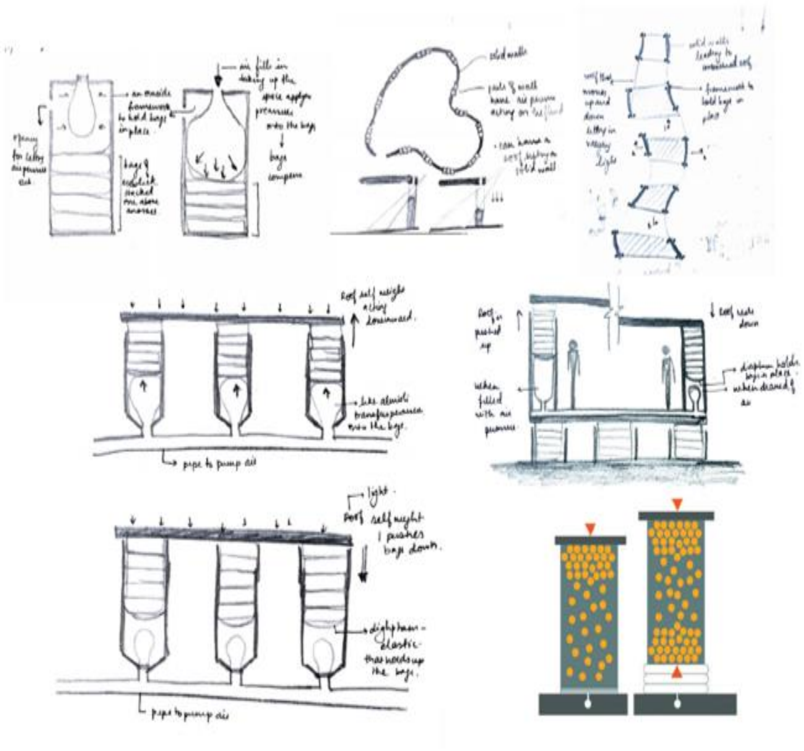

Figure 7: System of Pavilion

Source: Author

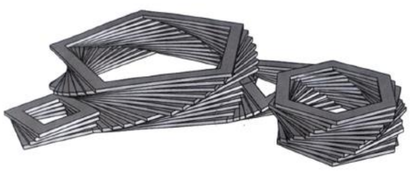

Figure 5: View of the installation

Source: Author

Four, we are mostly surrounded by walls that are straight and orthogonal but organic curves are shown to have more intrinsic structural stability compared to a straight wall. A cylinder for example is more stable than a cuboid of the same height, material and surface area.

The study in the studio was to understand the applications of this one unit as a structure and through that, explore the construction method and extents to which the application of the unit could be pushed.

The process of experimentation was to use dough*, to experiment with the scale and relationship between shapes, structure and the material.

(Figure 2 exploration of shape, structure and material)

These formed the basis for the first application of Oobleck in the form of an installation, for children to climb, jump and play in. (Figure 5 view of the installation)

The regular geometry of this project was questioned through an exploration in understanding organic forms (Figure 6- exploration in understanding organic forms). This led to the development of a pavilion whose roof responded to the position of the sun. It relieved the load bearing walls in some sections of the pavilion from compression, allowing the wall to temporally act as a non-rigid entity. Pneumatic pumps and air sacs were used to aid the process of movement. (Figure 7 system of pavilion).

The explorations noted above may not be fool proof and probably have many unforeseen limitations, disadvantages and problems. However, it encourages one to think outside the conventional routes and look at new possibilities. Further development of such ideas may lead to new studies in material and structural sciences and eventually shape architecture to inform one of new routes that can / cannot be taken.

Experimentation leads to discovery and understanding. It always holds the possibility to learn something new, even if it is to learn how not to address a subject.

**dough was used as the medium of experimentation as it displayed similar properties to that of a plastic bag with Oobleck. It was also a convenient mode to experiment forms, structure and stability*

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