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# EB Ceiling Board

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**Abstract**: The ceiling is part of the decoration in the construction of the house, the main use of the ceiling is to hide the bottom of the roof from the floor below. Asbestos is one of the most widely used materials by the ceiling manufacturing industry in Malaysia. Asbestos ceilings are an option for use by many communities in Malaysia today. However, the mixed elements used to produce ceilings such as asbestos has a fine dusts that corrode, fall, and fly in the air that very easily enter the human body and cause various diseases such as mesothelioma. This problem is solved by replacing asbestos with egg boards and eggshells. The objective of this study is to study the suitability of egg boxes and eggshells as a replacement material for asbestos in the manufacture of ceilings. Also, Identify and compare ceiling strength rates when asbestos is replaced with egg boxes and egg shells. In addition, identify the rate of water absorption for the ceiling when asbestos is replaced with egg boxes and egg shells. The materials used to prepare this ceiling sample are cement, white cement, stopping, water, egg shells and egg boxes. To mix each ingredient for each sample, each ingredient was weighed before being mixed together. After the process of mixing the ingredients for each sample, the sample will be placed in the mold box. The sample should be compacted and leveled before being allowed to dry for 7 days. The sample, which has been dried, will be opened from the mold box carefully. From the bending test we can find the maximum load and the highest bending strength value is the ceiling made of egg box and eggshell which is 137.80N for maximum load and 5.62 N/$mm^2$. for bending strength. This is because the egg box is a fiber in the ceiling and the eggshell is rich in calcium which can strengthen the ceiling. While for the maximum load and the lowest bending strength value is the blank sample which is the sample without the mixture of egg box and egg shell. For the maximum load value is 33.97 N and the bending strength is 1.39 N/$mm^2$. From the water absorption test, the highest percentage of water absorption is the ceiling made of egg boxes which is 15.67%. This is because egg boxes absorb water. While the lowest water absorption percentage is 13.42%.

**Keywords**: Asbestos, Egg Board, Eggshell, Bending Test, Water Absorption Test

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## 1. Introduction

The ceiling is part of the finish placed over some structural components known as walls. The ceiling is also the most important component in a house. The ceiling serves as a second layer after the top layer which can withstand the ingress of water in the house [1], is able blocking excessive heat, while also helping to reduce excessive noise input and for the aesthetic purpose [2].

Ceilings have become increasingly popular in our country in recent years, demanding a variety of ceiling kinds that may be employed for various types of construction. As a result, innovation is required to produce ceilings from recyclable resources such as egg boards and eggshells rather than from commonly used ceiling materials such as asbestos. The number of waste materials can be decreased by manufacturing ceilings out of recyclable materials. Existing ceilings on the market today, such as asbestos ceilings, provide benefits such as durability and fireproofing, but the asbestos exposure also increase the risk of cancer [2]. The chances of ceilings made from recycled materials having more benefits than existing ceilings are slight, but with ongoing innovation, these ceilings may be able to compete with existing ceilings on the market. The objective of this study is to study the suitability of egg boxes and eggshells as a replacement material for asbestos in the manufacture of ceilings. Also, Identify and compare ceiling strength rates when asbestos is replaced with egg boxes and egg shells. In addition, identify the rate of water absorption for the ceiling when asbestos is replaced with egg boxes and egg shells.

## 2. Materials and Methods

### 2.1 Materials

Raw materials are utilised in a wide range of goods and come in a variety of shapes and sizes. The input commodities or inventories that a firm need to make its products are known as raw materials. There are few materials required in this study which are cement, white cement, stopping, egg board and eggshell

#### 2.1.1 Cement

Cement is a binder, a material used for construction that fixes, hardens, and adheres to other materials to bind them together. Cement used in construction is usually inorganic, often lime-based or calcium silicate, each of which can be characterized as non-hydraulic or hydraulic, depending on the ability of the cement to set in the presence of water. Portland cement is utilised for conventional building when particular qualities are not needed [3].

#### 2.1.2 White Cement

White cement is an abbreviation for white Portland cement. It is made with suitable raw materials and baked into a partial melt to obtain calcium silicate as the main material with a small iron content and added with a small amount of gypsum. Next, a milling process is performed and produces a white hydraulic material. White cement is mainly used for decorative uses and its manufacturing process is much better than ordinary cement. The nature and chemical content of white cement is the same as ordinary portland cement except for its colour.

#### 2.1.3 Stopping

Stopping Compound is a water -based powder that will produce a high quality compound form in a short period of time. It is the basis of the coating of plasterboard joints, corners and holes or cracks in the plasterboard that can also be filled using suitable tools to produce a smooth surface. Stopping Compound is also a plaster -based compound used to rinse plasterboard joints. The main stopping material is gypsum.

### 2.1.4 Egg Board

Nowadays, egg boards are made of various materials such as recycled paper, cardboard, mold pulp, different polymers and others. The two most popular materials for egg boards (cartons) are polystyrene and pulp paper. Eggs come in the market in board of different shapes and sizes and that can be designed for different egg numbers. The egg boxes that have been collected are cut using scissors into small pieces to facilitate the grinding process. Then, the egg boxes were crushed using a blender until smooth to facilitate the sample mix.

### 2.1.5 Eggshell

The eggshell is the hard outer cover of the egg as can be seen on. It is mostly composed of calcium carbonate, the basic form of calcium. The rest is made up of proteins and other minerals. In the past few decades, eggshell powder processed from chicken eggs has been used as a natural calcium supplement. Eggshells are composed of about 40% calcium, with each gram supplying 381–401 mg. Half an eggshell may supply enough calcium to meet the daily requirement for an adult, which is 1,000 mg a day. One of the most prevalent types of waste produced by food processing technology is eggshell waste [4]. The eggshells that have been collected, will be washed and dried first. Eggshells that have been dried will be ground using a blender until they become a powder.

## 2.2 Methods

Cement, white cement, stopping and water are mixed in a bucket. The mixture is then combined with the crushed egg board. Mix the mixture thoroughly with a stick. The mixture is then poured into a 300mm x 150mm x 7mm mould. Manual compaction is done by hand with a wooden stick to remove air space. The exposed upper surface is smoothed with wood. On the seventh day, the mould board will be opened. The same procedure is followed for the eggshell and egg board + eggshell mixture. **Table 1** shows four types of sample mix for ceiling fabrication as well as the amount of mix of the material that have been add.

**Table 1: Mix Design**

| Types of sample | Raw Material | Amount of raw material | No. of sample |
|---|---|---|---|
| Sample 1 | Base Material | - | 1 |
| Sample 2 | Egg shell | 70g | 1 |
| Sample 3 | Egg board | 70g | 1 |
| Sample 4 | Egg board + Eggshell | 40g + 30g | 1 |

### 2.2.1 Bending Test

Bending tests are used to determine the ability of the sample to withstand the maximum linear load it can withstand. Brittle materials, which are typically challenging to test in uniaxial tension due to cracking in the grips, can have their tensile strength measured via a bending test [5]. A load is applied to the center of the ceiling sample until it fails. The point of failure can be determined by breaking up a physical sample or dropping a graph on an on-screen data recorder. This is the most useful test, and it is used to measure maximum load and flexural strength. **Figure 1** shows a bending test machine that is often used.

Formula for flexural strength:

$$\sigma_f = \frac{FL}{wd^2} \qquad \textbf{Eq. 1}$$

**Figure 1: Bending test procedure**

2.2.2 Water Absorption Test

The purpose of this test is to determine the rate of water absorption in the ceiling mixture between egg box and eggshell, and asbestos. The goal of this test is to compare the absorption rates of two different ceilings. Human comfort and health are affected as a result of exposure to damp and smelly ceilings, which serve as breeding grounds for germs.

Formula for water absorption:

$$Mc = \frac{w-d}{w} \text{ x } 100 \qquad \textbf{Eq. 2}$$

## 3. Result And Discussion

The result and discussion were the performance of a ceiling mix made of boxes and eggshells. There were two tests we conducted namely the bending test and the water absorption test. Bending test, and water absorption tests were conducted in this study.

3.1 Bending Test

Bending test is a method of measuring the stiffness and yield properties of a particular material. Bending tests for ductility provide an easy way to assess the quality of a material by its ability to withstand cracking or other surface irregularities during a single continuous bending. The bending test can determine the bending strength and maximum load. Based on the bending test that has been carried out, the stress-strain curve can be extracted [6]. **Figure 2** is a combination of four graphs of stress against strain from sample 1 to sample 4. Based on this graph, the stress is directly proportional to the strain, but when the curves reach the maximum strength value [7], the stress decreased while the strain continues to increase.

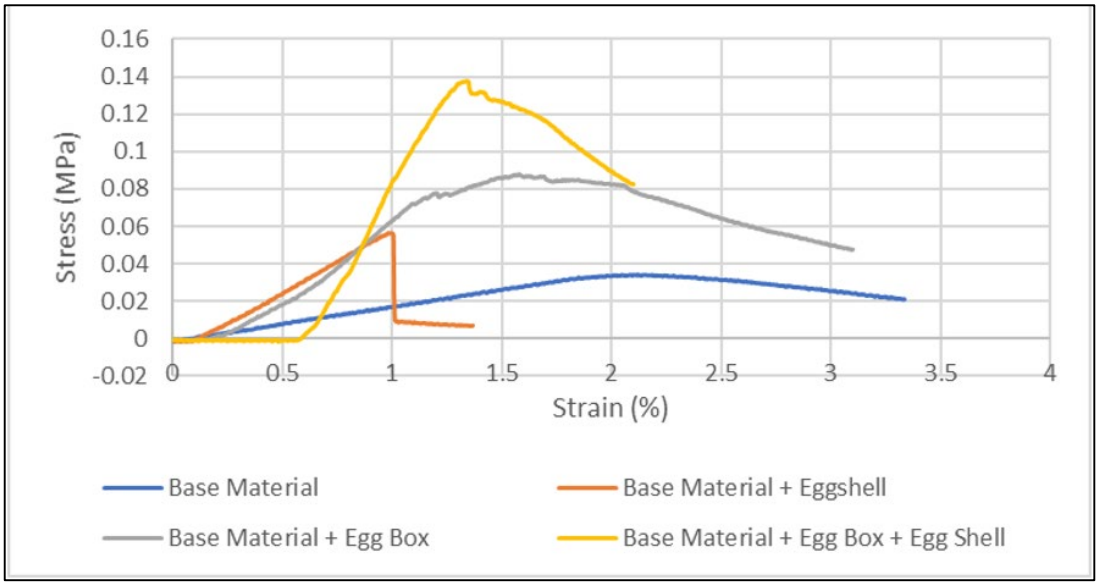


**Figure 2: Stress-Strain Graph of Each Sample**

**Table 2: Result Flexural Strength**

| Type Of Sample | Maximum load (N) | Flexural Strength, $\sigma_f$ (N/$mm^2$) |
|---|---|---|
| Sample 1 | 33.97 | 1.39 |
| Sample 2 | 56.48 | 2.31 |
| Sample 3 | 87.76 | 3.58 |
| Sample 4 | 137.80 | 5.62 |

The highest maximum load that can be accommodated is sample 4, which is 137.80 N as shown in **Table 2**. Sample 1 is the sample that can accommodate the lowest maximum load which is 33.79 N. The results of the flexural strength were calculated using the formula in **Eq. 1**. The flexural modulus indicates how much the material can flex before permanently deforming. From the data obtained, we can conclude that the highest value for bending pressure is the mixture of base material, egg box and eggshell which is 5.62 N/$mm^2$ and the lowest is the mixture of base material which is 1.39 N/$mm^2$. For the egg box and eggshell mixture, they have a bending pressure of 3.58 N/$mm^2$ and 2.31 N/$mm^2$, respectively. Asbestos ceilings have an average flexural strength of about 1.00 N/$mm^2$ [8]. Therefore, it is clearly more fragile when compared to ceilings made of egg boxes and eggshells. **Figure 3** shows a bar chart of the relationship between maximum load and flexural strength.

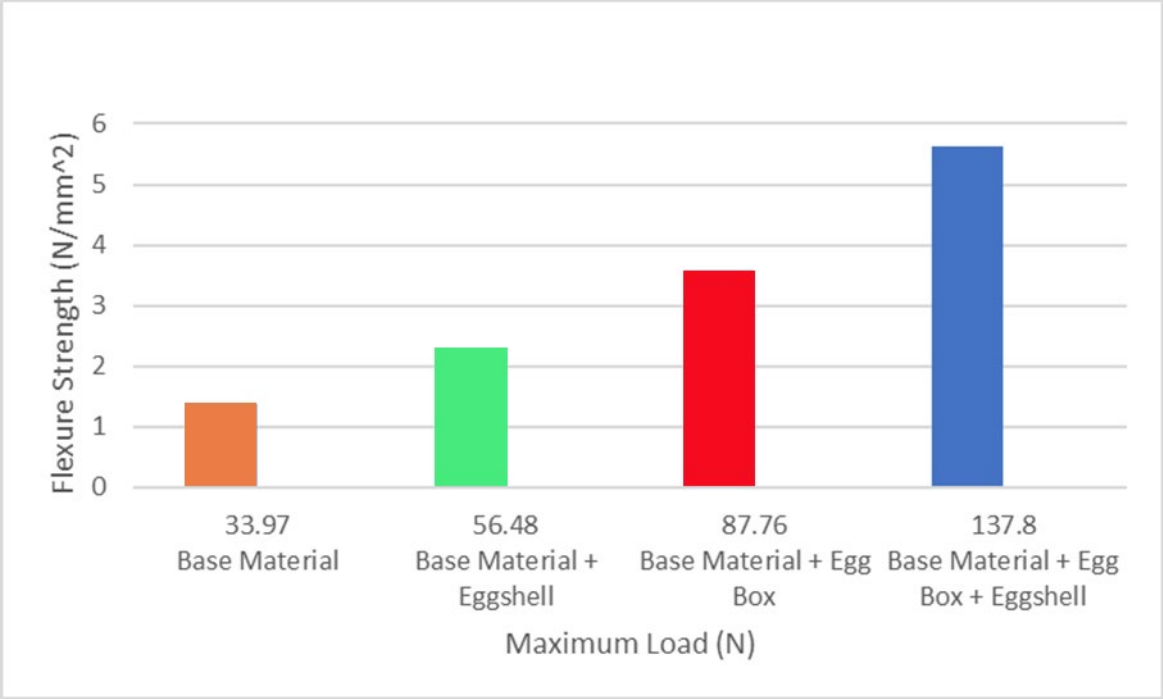


**Figure 3: Bar chart of maximum load and flexural strength**

3.2 Water Absorption

This test was carried out by cutting four ceiling samples of 50 mm x 50 mm with different mixed materials. Following that, all samples were weighed before being placed in a water-filled container for 24 hours. The sample must be completely submerged in the container's water [9]. After 24 hours, the samples will be removed and weighed in order to collect data.

**Table 3: Water Absorption Percentage Data**

| Type of Sample | Weight before (g) | Weight after (g) | Water Absorption Percentage (%) |
|---|---|---|---|
| Sample 1 | 27.1 | 31.3 | 13.42 |
| Sample 2 | 27.0 | 31.9 | 15.36 |
| Sample 3 | 34.3 | 40.8 | 15.67 |
| Sample 4 | 38.3 | 45.4 | 15.64 |

From **Table 3**, the water absorption percentage results were calculated using the given formula in **Eq. 2** and recorded. The absorption percentage of egg box samples was the highest at 15.67%. This is because the egg box is made of paper which is water -absorbent. The egg box and eggshell sample had a water absorption percentage of 15.64%, almost equal to the water absorption percentage of the egg box sample. This is because the content of this sample also contains 40 g of egg box in the mixture and 30 g of eggshell which results in almost the same percentage of water absorption. The lowest water absorption percentage was the basic material mixture sample which was 13.42%, because this sample did not contain water absorbent material. While the percentage of water absorption for eggshell samples is 15.36%. **Figure 4** shows a bar chart generated from the percentage of water absorption calculated for each sample.

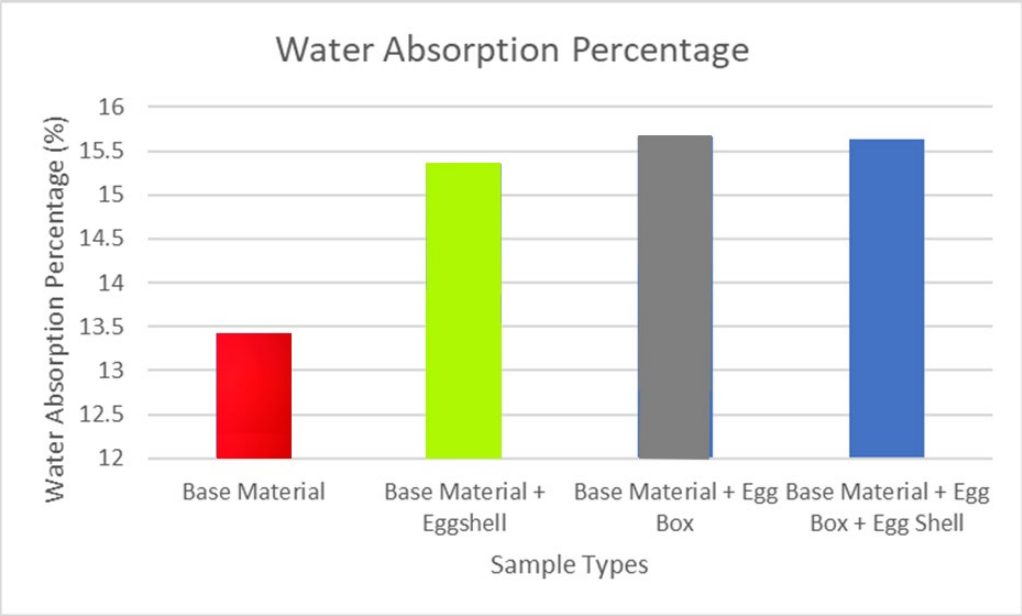


**Figure 4: Graph of percentage of water absorption vs sample type**

## 4. Conclusion

Finally, egg box and eggshell ceilings have the potential to replace asbestos ceilings. This is because bending tests on ceiling samples revealed that these ceilings have a high resistance to withstand large loads. In the water absorption test, however, the ceiling of the egg box and eggshell absorbs a relatively high percentage of water due to the egg box being made of water-absorbent paper. This ceiling can be improved by reducing the percentage of egg boxes used and adding waterproof materials to reduce water absorption.

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