**ASSIGNMENT**

**PRODUCT DESIGN**

**(MEE510)**

**BRIEF REPORT ON**

**PRODUCTION OF CEILING SHEET FROM SAW DUST**

**BY**

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**MECHANICAL ENGINEERING**

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**INTRODUCTION**

A ceiling board is a horizontal slab covering the upper section of a room or internal space. A ceiling board is generally not structural but is a shell concealing the details of the structure above. However, the ceiling might be holding up building materials such as heat or sound insulation.

In modern buildings, electric lights, smoke detector, security cameras and signage are commonly attached to ceilings.

            This project however, is based on the production of ceiling board from local raw materials. These local raw materials include cement, fibre cellulose, fibre obtained from saw dust, water and some other additives.

            There are different types of ceiling boards. These include;

1)      Gypsum ceiling boards;

2)      Acoustical ceiling boards;

3)      Gypsum fibre ceiling boards;

4)      Cement fibre-ceiling boards. Etc

These types of ceiling boards are grouped in accordance to the raw materials used for the production. Gypsum ceiling boards are produced from gypsum, Acoustical ceiling boards are obtained from mineral wool, gypsum and small amount of paper and starch. Gypsum fibre ceiling boards are produced from gypsum and fibre to reinforce the ceiling board.

            This study however will be based mainly on the production of fibre cement ceiling boards. This consist essentially of an inorganic binder usually calcium silicate formed by the chemical reaction of a siliceous material and a calcareous material. This is reinforced by organic fibres(saw dust), fillers and pigment compatible with the fibre-reinforced cement to form a ceiling board.

In the past, ceiling boards were produced using Asbestos, a fibre present naturally in rocks. It was used because of its high tensile strength, poor heat conductivity and high fire resistance. However, asbestos causes asbestosis, which leads to cancer. As a result of this problem, manufacturers of ceiling boards went into research to find out substitutes that can be used in the production of ceiling boards.

This substitute is shredded wood (saw dust), fibre from agricultural waste. Rather than industrial products (glass-fibre, iron fillings) and man-made materials, the fibres best suited to the socio-economic circumstances of developing countries are natural fibres.

This project therefore, is based on how a natural fibre can be used in the production of ceiling boards in order to reduce cost and as well comparing the product with that which has been produced naturally.

**MATERIALS SELECTION**

The materials selected for the execution of the production of the ceiling sheet are those required to give it its best quality, with use of natural fibre.

These materials are as follows:

1. Cement
2. Saw dust
3. Calcium carbonate (CaCO3)
4. Kaolin
5. Additives (Admixtures)
6. Water

**FACTORS CONSIDERED IN MATERIAL SELECTION**

Each material has its individual role to play as a content of a ceiling sheet. They all play various benefitting roles that help to yield quality performance, which are considered as the factors for their selection.

They are as follows:

1. **CEMENT**

* It serves as a filler.
* Due to its insulting property, it improves the insulating property of the ceiling boards.
* The incorporation of cement gives a binding effect.
* It adds to the strength of the product.
* Since cement is fire resistant, it reduces the rate of combustion of the produced sheets.

1. **SAW DUST**

* **Prevention of cracks during shrinkage:** Cracks occur during shrinkage in the cement hardening period. Shrinkage occurs when the water trapped in the voids evaporates. The saw dust therefore helps to give the mix a kind of general bond and as well plasticity.
* **Production of thinner ceiling boards:** In time past before the use of fibre in the production of ceiling boards, it was necessary to produce thick boards. This resulted in an increase of load per square of ceiling. The adjunction of fibre to the mix makes it possible to reduce the thickness. Secondly, less cement is needed to produce the same number of boards.
* **Improvement of impact strength:** In the course of handling, ceiling boards are often subjected to various shocks and constraints. Careless transport and handling are the main causes of breakage. Adding fibre to the mix improves the boards resistance to the hazards.

1. **CALCIUM CARBONATE**

* It helps to increase the duration of the product
* It promotes better dispersion of chemical
* It maximizes the brightness
* It innovates the production.
* It prevents cracking
* It also helps to strengthen the sheet during and after drying.

1. **KAOLIN**

* **Plasticity:** Kaolin helps the sheet to exhibit the properties of plasticity and shrinkage. With larger percentages of water, the kaolin forms a slurry, or watery suspension. The amount of water required to achieve plasticity and viscosity varies with the size of the kaolinite particles and also with certain chemicals that may be present in the kaolin.

1. **ADDITIVES**

* It increases strength (compressive, tensile or flexural)and accelerate the rate of strength development at early ages.
* Improve impact resistance and abrasion resistance.
* To produce desired effects more economically.

1. **WATER**

* It is the universal solvent, so it dissolves the other materials into a unified mix (slurry).

**DESIGN SPECIFICATIONS**

The ceiling board is to be produced having the following dimensions:

* Length and width of 2 by 2 feet
* Thickness of 4mm, having thickness range with upper and lower limits of (4.02mm - 3.98mm)

Also, the project is mechanized, and the machine has its specifications as thus;

|  |  |  |  |
| --- | --- | --- | --- |
| ITEM NO. | EQUIPMENT | DESCRIPTION | QTY |
| 1. | Frame | 2 inches angle iron | 1 |
| 2. | Cooking chamber | 3mm plate | 1 |
| 3. | Electric motor | Induction motor, 1400rpm | 3 |
| 4. | Mold | 3mm plate | 2 |
| 5. | Slider | 3mm plate | 1 |
| 6. | Threaded shaft | Mild steel rod | 2 |
| 7. | Rail | Mild steel block | 4 |
| 8. | Bearing | 30mm pillow bearing | 2 |
| 9. | Support plate 1 & 2 | 5mm plates | 4 & 2 |
| 10. | Press plate | 3mm plate | 1 |
| 11. | Mold holder | 3mm plate | 1 |
| 12. | Mold collector | 2mm plate | 1 |
| 13. | Motor pulley | Mild steel | 2 |
| 14. | Shaft pulley | Mild steel rod | 2 |
| 15. | 4-bolt flange bearing(UCF206) | 30mm flange bearing | 2 |
| 16. | Cooking shaft with paddle | 30mm & 20mm rod | 1 |
| 17. | Belt1-15 press1 | Fiber | 1 |
| 18. | Belt2-16 press2 | Fiber | 1 |
| 19. | Belt3-17 cooking | Fiber | 1 |
| 20. | Press base plate | 3mm plate | 1 |

**B.E.M.E.**

Sir, the breakdown of the B.E.M.E. is currently with my supervisor, whom I am unable to reach because of an unforeseen occurrence on my end.

**CALCULATIONS**

1. Thermal conductance of the sheet. The thermal conductance, U-value of the structure will be reciprocal of the total resistances. Thus for a composite structure, the thermal transmittance. U = 1/R and

R = Rsi + Rso = L1 + L2

(k2) k2 etc + Ra + RH.

Where:

R = Total thermal resistance of structure

Rsi = Surface resistance of inner face I/F

Rso = Surface resistance of outer face I/FO

Ra = Resistance of air gap, if present

RH = Resistance of unit materials such as hollow block for which resistivity per unit thickness does not apply.

U = Thermal transmission of the composite complete structure.

1. **TABLE OF OBSERVATIONS AND CALCULATIONS CARRIED OUT**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SAMPLE** | **HUMID WEIGHT** | **PERCENTAGE HUMIDITY** | **WET WEIGHT** | **WATER WEIGHT** | **VOLUME CM3** | **DRY WEIGHT** | **DENSITY (G/CM3** |  |
| **A** | **16.72kg** | **34.2%** | 209.4g | **5.06g** | 15.36 | **11.00g** | **1.396** | **46.2%** |
| **B`** | **17.82g** | **34.9%** | **21.19%g** | **5.27g** | **15.92** | **11.60g** | **1.372** | **52.0%** |
| **C** | **18.70g** | **17.5%** | **22.77g** | **8.44g** | **14.33** | **15.43g** | **1.076** | **82.7%** |

The formula used for the calculation of the test above to obtain the figures is as follows:

a. Percentage humidity: Humid weight-Dry weight x 100%

Humid weight.

b. volume = length x breadth x thickness

c. Density = Dry weight

volume

the humid weight and dry weight are as a result of direct weighing of the material using an analytical weighting balance. Also the wet weight and water weight are as a result of direct weight of the material using an analytical weight in water.

**PROCESS OF MANUFACTURE**

The production of the ceiling sheet was carried out mostly by means of automation, but some stages by hand.

So the saw dust was first spread under the sun to eliminate moisture content. It was then grinded using mortar and pistol to have a finer texture. The required quantity of saw dust to be used was weighed out. The other raw materials which include powdered kaolin, calcium carbonate and water were all measured. The saw dust was poured into the cooking chamber; next cement was poured and thoroughly mixed with the help of the rotating cooking shaft and paddles. The calcium carbonate and kaolin were then added one after the other while mixing continued. Finally, water was added sparingly and gradually until a very smooth slurry was obtained.

After thorough mixing the slurry is allowed passage through an opening close to the bottom of the cooking chamber into the press base plate. The slurry is spread evenly on the surface of the press base plate. The motor is then turned on which then rotates the pulley via the pulley belt to lower the press plate down to the base plate along the length of the vertical threaded shaft (conversion of rotary motion to upward and downward motion). The press plate is allowed a certain downward distance to travel which helps it press on the slurry evenly without over compacting it.

It is left to solidify a bit then for about three days to dry for the ceiling sheet to be ready.