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ROOFING SHEET BASED ON CEMENT GYPSUM AND AGRICULTURE/FOREST WASTE

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To replace cement fully or partially by gypsum plaster and to utilize agriculture/forest waste fibre for making low-cost fibre board, the board prepared from cement, gypsum plaster mixture (1:1) is comparable in all respects with the board prepared from cement alone. The fibre board, thus prepared can be used as roofing sheets, partition sheets for low-cost housing as these boards are tough, light weight and water resistant.

Key words: Gypsum, Cement, Vegetable fibre.

INTRODUCTION

A large portion of our rural population live in temporary shelters and can not afford to use the conventional roofing materials. Roofing is one of the major and important part of the house providing protection from the elements of weather. At present, R.C.C. roofing is common in urban areas, but the poor masses cannot afford it. In rural areas wood and that roofs are mostly used, which do not provide sufficient protection from the harsh climatic conditions. In order to solve this acute and urgent problem, investigation were carried out to find suitable alternatives for a low cost roofing of houses in rural areas which may be structurely sound, having maximum functional effeciency durability and should be also within the reach of a common Man.

Keeping in view the above requirements a process has been developed in which fibre from agriculture/forest [4] waste material like rice husk, baggasses, wheat straw, pine needles etc. are mixed with cement, gypsum [1] slurry and casted in sheets both plane and corrugated.

MATERIALS AND METHODS

Extraction fibres. The fibre is extracted by treating the pine needles, wheat straw, baggasse etc. with 4 % commercial [3] sodium hydroxide or by soaking the material in water for 7-10 days. After soaking for the said period, the fibre is beaten using ordinary beaters manually.

Cement, gypsum plaster composition and moulding of sheet. The fibre is soaked in water for about one hour. The excess water is allowed to drain off. At this stage, it should hold merely 25 % of water by weight.

In order to explore the possibility of replacement of portland cement by Gypsum [1,2] plaster, a few composition were studied for the development of strength under humid condition as given in Table 1 various proportions of cement, gypsum plaster were mixed with a fixed percentage of fibre and developed in a slurry [1] by the addition of measured quantity of water for normal consistency as given in Table 1. The slurry thus prepared was spread in the form of a mate of uniform thickness on a metallic corrugated mould and pressed. The mould is then clamped on a vibrating table so as to attain maximum unformity. The vibrating table operation is continued for 2- 3 min. The mould is then removed from the vibrating table. After 20-30 minutes the sheet is demoulded. The sheets thus obtained are cured for 72 hours in damp conditions. The sheets thus obtained have the following characteristics.

Table 1.

Mixture No.	Cement gypsum plaster proportion	Water needed for normal consistency for slurry (%)	Fibre (%)
1.	10:0	42.3	5
2.	6:4	45.3	5
3.	5:5	17.6	5
4.	3:7	54.9	5
5.	0:10	59.5	5

Size	=	22 cm x 46 cm
Thickness	=	1.5 cm
Depth of corrugation	=	2.5 cm
Pith	=	10 cm.

RESULTS AND DISCUSSION

Gypsum plaster for this purpose has certain definite advantages if used exclusively or as partial replacement for portland cement. Gypsum binder is nothing but calcined gypsum. It forms a hemihydrate known as gypsum plaster.

$$CaSO_4.2H_2O \xrightarrow[130^\circ - 180^\circ]{\text{Calcining at}} CaSO_4.\tfrac{1}{2}H_2O + \tfrac{3}{2}H_2O$$
(Gypsum plaster)

Beside substantial saving in cement, gypsum plaster accelerate the rate of production as it sets quickly and develops sufficient demoulding strength in much shorter time.

Performance evaluation. A few mechanical and physical tests were devised on the basis of standard test for other roofing material.

(a) *Density.* The sheets obtained are of light weight. The density of the sheets falls with proportion of the gypsum plaster increases as indicated from Table 2.

(b) *Water absorption.* Water absorption was calculated from the gain in weight when 5x5 cm sheet was immersed in water at room temperature for 24 hrs. (Table 2).

(c) *Percolation of water.* The sheet casted is to be used for roofing purposes. Therefore, it has been felt to make it water resistance. In order to make the sheet water proof, a cheap and easy process has been developed. This process consists of applying the lime and sodium silicate solution with the help of brush in alternate coatings and then to allow the sheet to dry. The water percolation experiments were performed for the treated and untreated samples. The treated samples show very encouraging results as indicated from Table 2.

A 60 cm glass tube of 2.5 dm internal diameter was put vertically on a horizontally placed 5x5 cm piece. The lower edge of the glass tube was joined with the sheet externally with the help of glue. Water was filled in the glass tube to a height of 30 cm, a few drops of an oil were placed at the top of water surface to avoid its evaporation. The fall in the level of water in 24 hours and appearance of moisture on the lower side of the sheet were noted.

Breaking strength. The breaking [5,6] load was determined by testing 2x2 cm size sheet in flexural strength testing machine. The span of the sheet was kept 30 cm.

The modulus of repture was also calculated Table 3.

$$\text{Flexural strength No. } R = \frac{\text{Max. load}}{\text{Area}}$$

OR

$$\frac{A}{B \times T} \quad \text{OR} \quad \frac{A}{Bcm \times Acm}$$

Compressive strength. The compressive [5] strength was determined by compression strength testing machine.

The compression strength data were obtained on 2cmx2cm after 28 days and 90 days as indicated from Table 4.

Table 4 indicates that sufficient strength development takes place in all the cement gypsum plaster mixture under humidity curing. This also shows that the strength is increasing when they are dried after 28 days and 90 days. This resulted in the fast that there is no danger of reduction in strength with the passage of time.

Table 2.

Mixture No. cement gypsum	Average density g/cubic cm	% of water absorption	Water percolation/ 24 hr. untreated	Water percolation per 24 hr. treated samples (water proofing)
10:0	1.47	14.0	9 ml	1.2 ml
6:4	1.28	17.9	10.8 ml	1.2 ml
5:5	1.24	18.5	12.5 ml	1.9 ml
3:7	1.18	26.2	15.5 ml	3.5 ml
0:10	1.13	34.48	17.1 ml	3.8 ml

Table 3.

Mixture No.	Cement gypsum	Maximum load kg	M.C. R.kg/cm^2
1.	10:0	39	11.712
2.	6:4	33	10.61
3.	5:5	31	10. 3
4.	3:7	30	3.762
5.	0:10	27	8. 24

Table 4.

Mixture No.	Cement: Gypsum	Compressive strength after 28 days kg/cm^2	Compressive strength after 90 days kg/cm^2
1.	10:0	109	131
2.	6:4	99	125
3.	5:5	94	119
4.	3:7	82	114
5.	0:10	78	102

(2) The sheet made with cement gypsum plaster binder or gypsum plaster also can be safely demoulded with 4–6 minutes and thus enhance the rate of production and the moulds can be used repeatedly.

(3) It is easier to handle these sheets as they are tough and light in weight.

(4) Their better corrugation dimensions resulted in higher structural strength.

(5) The sheets have lower water absorption which would ensure lesser contact of cellulosic fibre with water and hence better decaying resistance and longer life.

(6) These sheets can be sawn nailed and alsc drilled easily.

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