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Improved Asphaltic Roofing Sheet

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A process has been developed for preparing low cost asphaltic roofing sheet using waste paper and a special asphaltic composition. The sheets are superior to the commercially produced asphaltic sheets in strength and water-and fire resistance characteristics and are ideally suited as a low cost roofing material for the low income group people.

A sizeable portion of the population in India lives in temporary or sub-standard accommodation. These structures are erected with sloped roof. The inhabitants of these houses are normally very poor and cannot afford to use the conventional roofing materials such as AC sheet and GI sheet. They instead use all sorts of road pickings, leaves, etc. to cover their huts. Many a time, government and other organizations have to build a large number of such shelters for persons rendered homeless by natural disasters. A low cost but durable roofing material is, therefore, needed for such situations and a good quality asphaltic roofing sheet may be the answer. These asphaltic sheets are lightweight roofing sheets prepared basically from waste paper, asphalt and a few other materials.

Asphaltic roofing sheets currently being produced in the country[1,2] are weak and possess high water absorption and poor weather resistance. Several government construction agencies have also stressed the need to improve the quality of these sheets. Laboratory and pilot plant scale studies carried out at these two laboratories have shown that strong and durable asphaltic sheets can be produced by controlling various factors at different stages of production. The commerical feasibility of preparing the sheets has also been worked out.

Laboratory experiments

The laboratory experiments comprised (1) preparation of paper board from waste paper, (2) treatment of the paper board for imparting to it waterproofing and fire resistance characteristics.

(1) Waste paper was converted into pulp with the help of beaters and then manually formed into multi-layered boards. Various internal sizes were tried to select the most suitable one for these boards. The boards were pressed in a hydraulic press and then corrugated on wooden boards with steel rollers while still green. The boards were then dried.

(2) The boards thus obtained had a thickness of 4mm and weight ≈ 2.5 kg/m^2. These were cut to

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30 × 30 cm size. A simple experimental set-up was fabricated for carrying out the impregnation and further processing of the sheet.

Three grades of asphalt, grade I, II and III, were tried as saturant. The effects of grade of asphalt and temperature and duration of asphalt impregnation on the extent of asphalt loading and the consequential changes in water absorption and breaking load were studied to find out the most suitable grade of asphalt and the optimum conditions of asphalt impregnation for getting the best results. Similarly, for producing fire retardant sheets, a large number of inorganic and organic compositions were tried. Ultimately, a chlorinated organic composition was found to be most effective as well as economical. This composition was prepared by passing chlorine through a mixture of a mineral oil and asphalt of a specified grade till a product of the required viscosity was obtained. Apart from composition, the effect of temperature and duration of this treatment was also studied to optimize these parameters. The composition of the aluminium based surface coating for these sheets was also finalized by studying their durability in outdoor and accelerated weathering tests[3]. The stress-deflection characteristics of the finalized asphaltic sheets were studied and are plotted in Fig. 1.

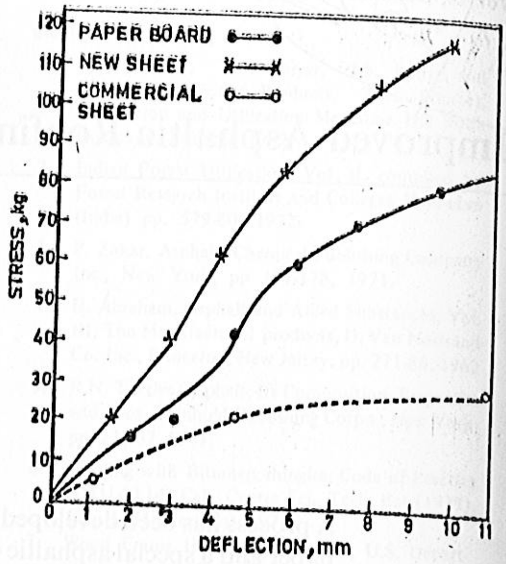

Fig. 1—Stress-deflection characteristics of different asphaltic sheets

Table 1—Characteristics of the Asphaltic Roofing Sheets Prepared

Characteristics	CBRI-RRL(J) sheet	Commerical sheet
Thickness, mm	4.0	3.0
Depth of corrugation, cm	3.7	4.0
Pitch of corrugation, cm	10.0	13.0
Weight, kg/m²	4.0	3.2
Asphalt content, %	40	50
Water absorption, %	10.0	13.0
Percolation of water	Nil	Nil
Breaking strength (width 30 cm and span 20 cm), kg	72	34
Maximum deflection at 20 cm span, cm	0.98	1.25
Estimated useful life, years	8-10	4-5
Cost, Rs/m²	9.0	9.0

Performance evaluation

There are no standard methods for testing these sheets. A few mechanical and physical tests were devised on the basis of the standard tests for other roofing materials and these sheets along with the commercial sheets were subjected to these tests. The results are given in Table 1.

(1) *Asphalt content*—A piece of asphaltic sheet was torn into very small bits after removing the painted surface. All the bits were shuffled and then about 0.5 g portion was weighed. To this, 250 ml pure mineral turpentine was added and the mix allowed to stand for 24 hr. The supernatant liquid was decanted and then 20 ml of fresh mineral turpentine was added to the residue. The paper pieces were stirred gently, filtered, dried first in air and then in an oven at 50 ± 2°C and weighed. The asphalt content was calculated from these weights.

(2) *Breaking load and deflection*—The breaking load was determined by testing 30 × 30 cm size sheet in flexural strength testing machine. While the width of the sheet was 30 cm, the span was kept at 20 cm. Deflection was noted by using one more gauge below the sheet in the same machine.

(3) *Water absorption*—Water absorption was calculated from the gain in weight when 5 × 5 cm sheet was immersed in water at 27 ± 0.5°C for 24 hr.

(4) *Percolation of water*—A 60 cm long glass tube of 2.5 cm internal diameter was put vertically on a horizontally placed 5 × 5 cm sheet piece. The lower edges of the glass tube were joined with the sheet externally with the help of araldite. 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 to avoid its evaporation. The fall in the level of water in 24 hr and appearance of moisture on the lower side of the sheet were noted.

(5) *Estimated useful life*—The estimated useful life was determined by exposing the sheets for accelerated weathering in a twin arc carbon electrode weatherometer with alternate water spraying and drying cycles of 18 and 102 min respectively. Visual examination of the sheets was carried out at regular intervals of exposure. Exposure studies were carried out up to 1080 hr.

Pilot plant trials

Based on the results of laboratory experiments, large sized roofing sheets were prepared in a pilot plant developed for this purpose. More than one thousand sheets (90 × 70 cm) were prepared under optimum conditions worked out from the laboratory experiments. A full size cycle stand and a hut (Fig. 2) were constructed with these sheets for outdoor weathering studies. They have withstood the weather well.

Results

The studies carried out on the effect of grade of asphalt, temperature and duration of impregnation on the various physical and mechanical properties such as asphalt impregnation, water absorption, percolation of water, breaking strength, deflection, etc. helped to select three most vital parameters of asphalt treatment—grade of asphalt, and temperature and duration of impregnation. A comparative study of the performance of these sheets and commercial sheets showed the former to be superior to the latter in several respects.

It is easier to handle these sheets as they are thicker as well as tougher. Their better corrugation dimensions result in higher structural strength. Lower asphalt content by about 10 % not only reduces the consumption of asphalt but also lowers the thermal susceptibility of the sheet and hence the chances of softening and flattening are reduced and there is lesser fire hazard. The sheets have lower water absorption, which is due to the better quality of paper board used and proper asphalt impregnation. The basic structure of the sheet being cellulosic, lower water absorption would ensure lesser contact of cellulosic fibres with water and hence better decay resistance and longer life. These sheets possess high breaking strength compared to commercial sheets. This is an important requirement for better utilization of this product. This sheet has lower deflection than the commercial one (Fig. 1). Better physical and mechanical properties of these sheets are reflected in their longer life compared to commercial sheets.

Commercial feasibility

Studies carried out on the commercial feasibility of this product showed that an 8 tonnes per day commercial plant based on this know-how can be installed and run profitably. The flow diagram of

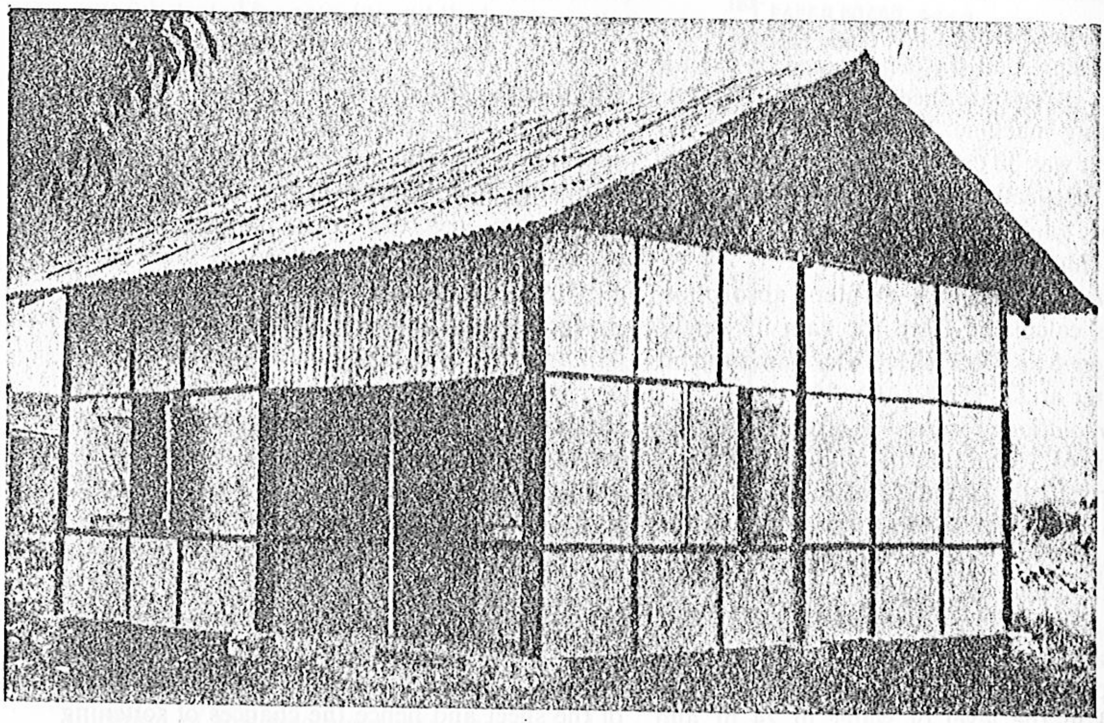

Fig. 2—A typical hut constructed using the improved asphaltic sheets

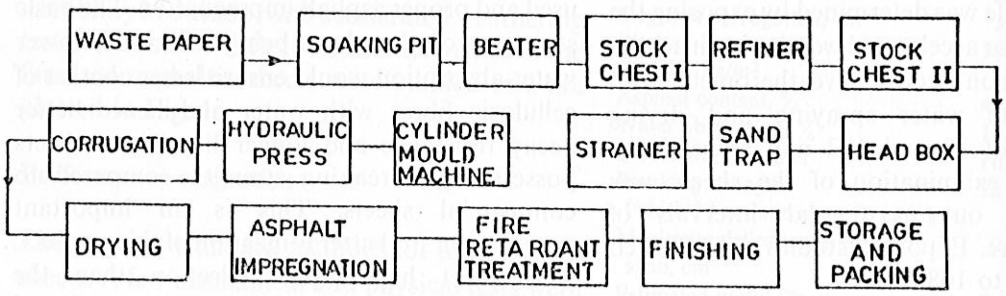

Fig. 3—Process for preparing asphaltic roofing sheets: Flow diagram

the process* is given in Fig. 3. The plant can be located at any place in the country where the procurement of raw materials and utilities does not pose any problem. The location should have dry weather and bright sun, if mechanical drying of the green boards is to be avoided in preference to sun drying. An 8 tonnes/day plant can be set up at an estimated cost of Rs 25.5 lakhs, out of which Rs 4.5 lakhs would be needed for land and building, Rs 13.0 lakhs for plant and machinery and Rs 8 lakhs for working capital and other expenses. The plant has a capacity of producing nearly 0.6 million sq m of sheet per annum. All

*Process know-how can be obtained through the National Research Development Corporation of India, New Delhi.

the raw materials and plants and equipment are available indigenously.

Acknowledgement

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References

1 Rao A V R, *Journal N B Ó*, 15(2) (1970) 8.
2 Aslam M, *Civil Engng Constr Public Works J*, 6(4) (1973) 35.
3 Aslam M & Satiya R C, *J Colour Soc*, 13(1) (1974) 7.