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FIELD THERMAL PERFORMANCE OF WOOD-BASED PANELS IN HOT-DRY CLIMATE*

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Summary

Field tests on thermal performance of wood-based panels have been conducted for assessing their use as exposed building elements. Results indicate that in general the thermal performance of these panels needs considerable improvement when used as roofing materials so as to bring them at par with the conventional RCC and brick panels.

Introduction

Wood-based panels are being mostly used for internal partitions, false ceiling and interior decoration purposes. On the initiative and proposal of the Indian Plywood Industries Research Institute, Bangalore, for using such panels as exposed building elements, preliminary tests on their field thermal performance were conducted at the Central Building Research Institute, Roorkee, under severe hot-dry weather conditions. The results were also compared with conventional RCC roof and brick wall panels which are used in this region of the country.

Test Panels

The following is the list of test panels which were tested both as roof and wall and these were compared against the conventional roof and wall elements for their thermal characteristics. Each test panel consisted of two skins with a 5 cm air space in between. In one test panel expanded polystyrene (Thermocole) was used between the two skins. The construction of the test panels from the outer to the inner skin was as follows:

1. 1.5 cm plywood + 5.0 cm air space + 0.6 cm plywood.
2. 0.3 cm hardboard + 5.0 cm air space + 0.6 cm plywood.
3. 1.5 cm fibre insulation board (Celotex) + 5.0 cm air space + 0.6 cm plywood.
4. 0.6 cm plywood + 5.0 cm expanded polystyrene (Thermocole) + 0.6 cm plywood.
5. 0.6 cm AC sheet + 5.0 cm air space + 0.6 cm plywood.
6. 0.6 cm plywood + 5.0 cm air space + 0.6 cm plywood.

Conventional panels employed were of the following construction.

7. 10.0 cm RCC + 10.0 cm lime concrete.
8. 23.0 cm brick + 1.3 cm cement plaster both sides.

The skins were nailed to stringers with air gap or air gap filled with insulation. The panel sizes for roofs and walls were 60 × 60 and 90 × 60 cm respectively.

All these panels were tested in the thermal chambers at this Institute for field testing and relative evaluation of the thermal performance of small building panels. The wall test panels faced east. The test sections were placed in such a manner that one of its sides was always exposed to the weather so as to have a uniform natural unobstructed wind and solar exposure and the other face towards the interior of these chambers.

Temperature Measurements

Temperature measurements were made by 30 SWG calibrated copper constantan thermo-

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couples connected to a precision self balancing indicating potentiometer. Temperature measurements were taken correct to ± 0.3°C. Thermocouples were embedded in shallow grooves on each surface and finished with a thin coat of plaster of paris, which was painted the same colour as the original surface.

Observations

Several sets of round-the-clock observations were taken to record half hourly temperatures of the outdoor air, and outside and inside surfaces of the test panels during the month of June 1972. Data on 13 and 16 June which were clear, sunny and calm days were considered for analysis of results. 13 June was an exceptionally hot day. Ambient shade air dry and wet bulb temperatures are shown in Fig. 1.

Data for the same day only can be used for comparing the relative thermal performance of the panels.

Discussions

Inside Surface Temperatures

For thermal comfort the wall or roof panel should ensure lower internal surface temperatures to minimise the radiant heat load to the occupants. Higher inside surface temperatures also contribute indirectly in raising the indoor air temperatures. From Fig. 2 to 5 it can be seen that in general the inside surface temperature of the wood-based test panels during the period of observation is higher than that of the conventional RCC and brick panels. For walls the difference appears to be quite small as compared to the roofs, which makes a clear case for improving their thermal performance.

Peak Degree Hour (P.D.H.)

Peak inside surface temperatures can be taken as a criterion for thermal performance rating. Lower values of peak inside surface temperatures obviously provide better thermal performance. Peak degree hour above a base temperature of 30°C has been taken as one of

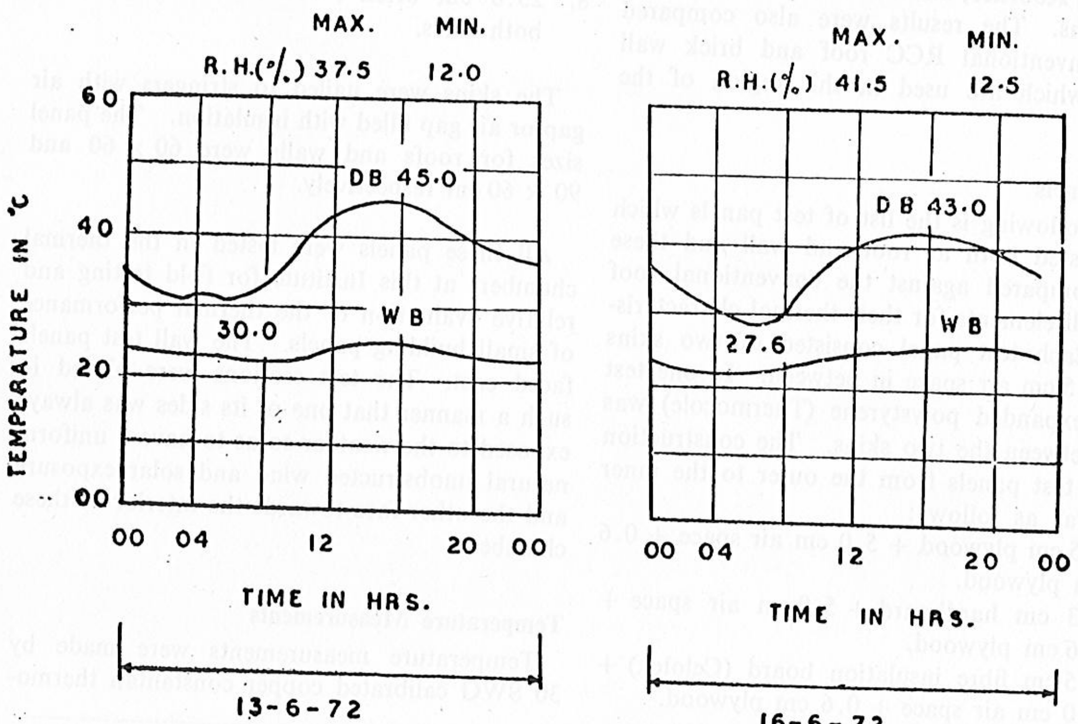

FIG. 1. Ambient shade air dry and wet bulb temperatures on 13 and 16 June 1972.

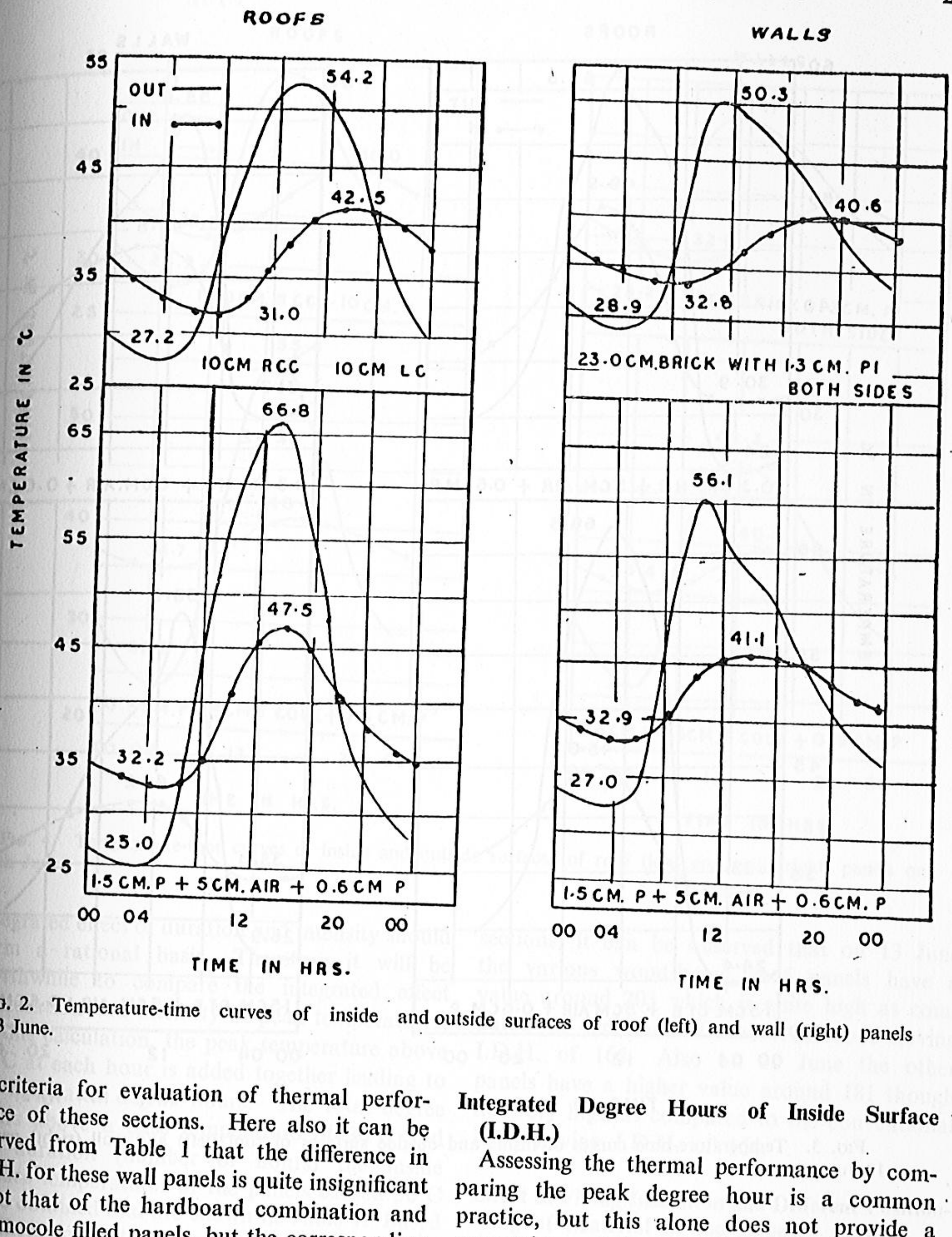

FIG. 2. Temperature-time curves of inside and outside surfaces of roof (left) and wall (right) panels on 13 June.

the criteria for evaluation of thermal performance of these sections. Here also it can be observed from Table 1 that the difference in P.D.H. for these wall panels is quite insignificant except that of the hardboard combination and Thermocole filled panels, but the corresponding difference in peak inside surface temperatures are quite appreciable in the case of roof panels.

Integrated Degree Hours of Inside Surface (I.D.H.)

Assessing the thermal performance by comparing the peak degree hour is a common practice, but this alone does not provide a comparison of the overall performance of the materials. It has been pointed out that for thermal rating of the roof and wall panels, the

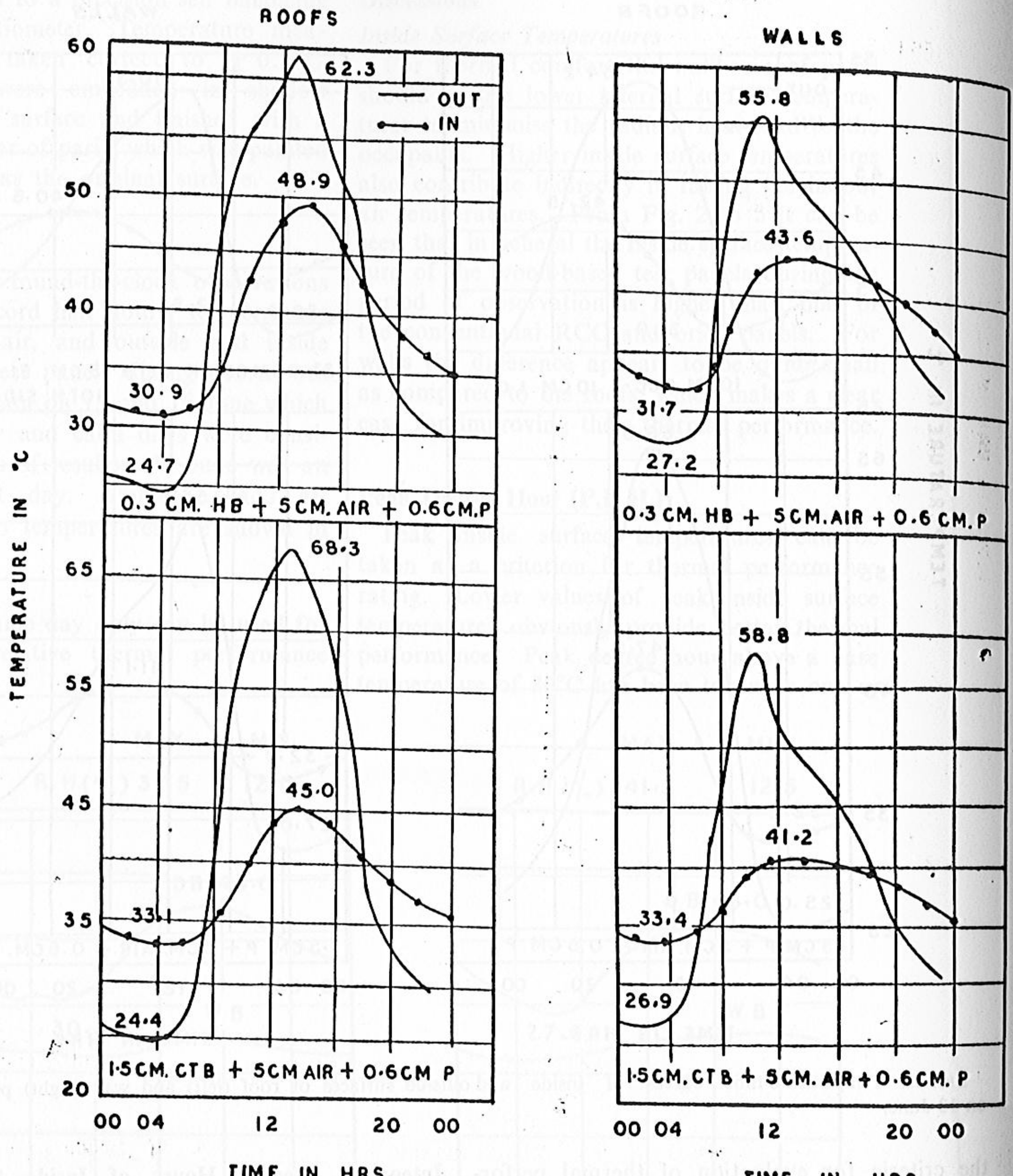

FIG. 3. Temperature-time curves of inside and outside surfaces of roof (left) and wall (right) panels on 13 June.

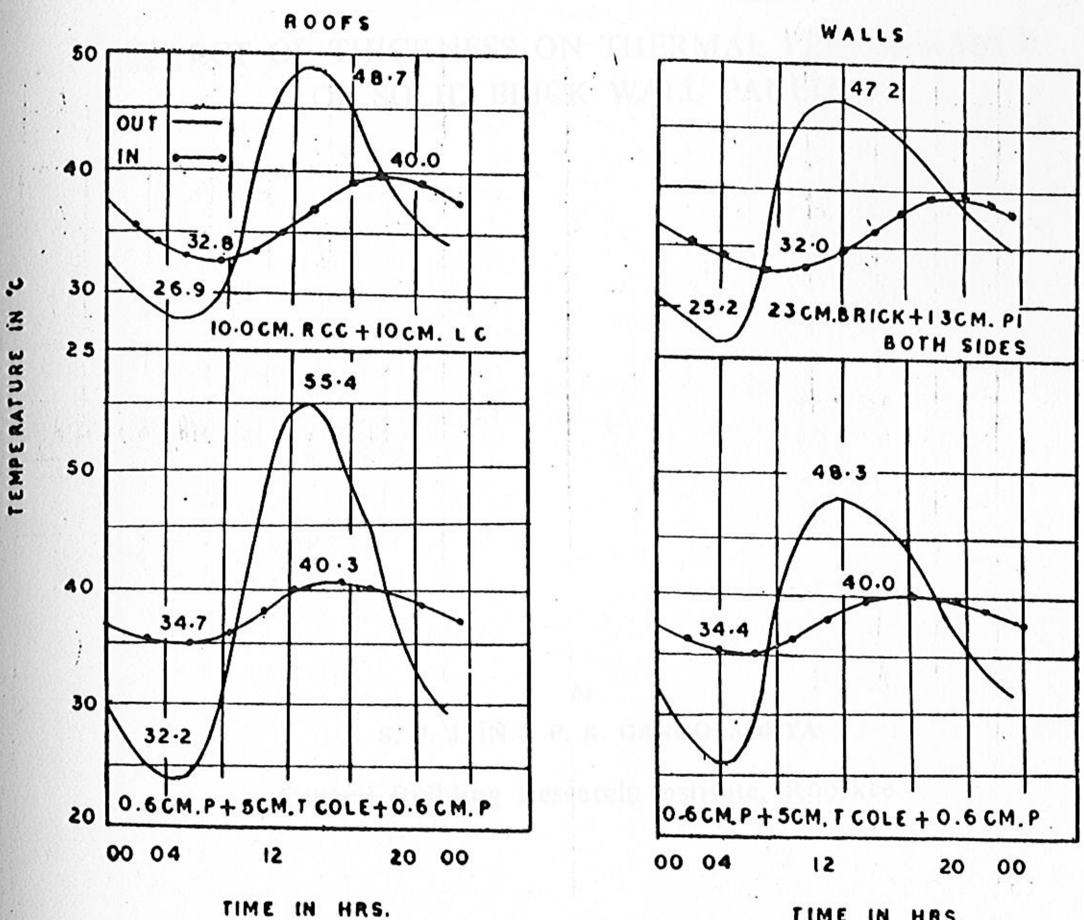

FIG. 4. Temperature-time curves of inside and outside surfaces of roof (left) and wall (right) panels on 16th June.

integrated effect of duration and intensity should form a rational basis. Therefore it will be worthwhile to compare the integrated effect of duration and intensity of peak temperatures. In this calculation, the peak temperature above 30°C at each hour is added together leading to the integrated degree hours. The total degree hours above a base temperature of 30°C and the duration (number of hours) the inside surface temperatures of the panels exceed 30°C were obtained and are shown in Table 1. Based on these concepts it can be seen that the wood-based wall panels tested are a little inferior to the conventional brick panel. Similarly on comparing the integrated degree hours of roof sections, it can be observed that on 13 June the various wood-based roof panels have a value around 203 which is quite high as compared to the conventional RCC roof having I.D.H. of 164. Also on 16 June the other panels have a higher value around 181 though not very high as compared to the conventional RCC having I.D.H. of 154.

Effect of Filling Insulation and Different Positioning of Material at the Exposed Surface

On comparing the roof and wall panels No. 8 and 10 as shown in Table 1 it can be observed that there are improvements in the peak degree hour temperatures and those