EFFECT OF THICKNESS ON THERMAL PERFORMANCE OF SOLID BRICK WALL PANELS

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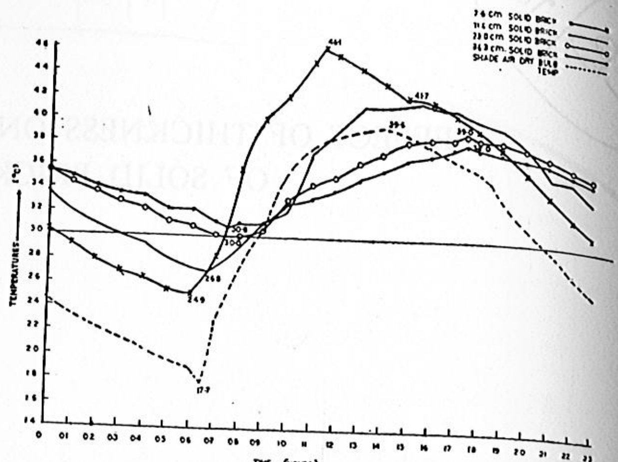

FIG (1) COMPARISON OF INSIDE SURFACE TEMPERATURES FOR DIFFERENT WALL THICKNESSES EXPOSED TO NATURAL WEATHER CONDITIONS ON A HOT SUMMER (MAY) DAY AT ROORKEE

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Abstract—Field tests on Thermal Performance of solid brick wall panels of different thickness have been conducted for assessing their relative beviour and to explore possible reductions in the cost of construction. Results indicate very clearly their relative performance Thermal performance of 11.4 cm thick wall panel, although observed to be interior than the conventional (22.9 cm thick) wall panel but it seems possible to make it thermally acceptable by suitable treatment.

INTRODUCTION

For bringing down the cost of construction the practising engineers and architects are considering to reduce the thickness of the conventional wall to a minimum value without much influencing the indoor thermal conditions. Therefore it was considered very essential to examine this aspect and the present preliminary study is an attempt to assess the effect of thickness on relative thermal performance of solid brick wall panels.

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Solid Brick Wall Panels

Panels of size 90 x 60 cms in thicknesses of 7.6, 11.4, 22.9 and 34.3 cms have been constructed with similar bricks, cement and sand using similar cement mortar and plaster mix. This was done to avoid any possible difference due to non-uniformity of materials or construction technique and workmanship.

Experimental Arrangements

All these panels have been tested in thermal chambers developed (1) at this institute for field testing and relative evaluation of thermal performance. To test panels were installed in these chambers so that the side is always exposed to the weather side to have a natural unobstructed wind and solar exposure and the other face towards the interior of these chambers. These panels were properly insulated from each other to avoid the sharing of heat and also any loss of heat from the edges. Temperature measurements were made by 30 S.W.G. callibrated Copper-constantan thermocouples connected to a precision self-balancing indicating potentiometer. Several sets of observations were made to record half hourly temperatures of the outdoor and indoor air as well as outside and inside surfaces of these test panels on hot sunny days, but the data on a clear sunny hot day was considered for interpreting the final results.

Criterion for the Assessment of Thermal Performance

Building designs in this country are largely guided by the summer season requirement and the critical timings of experiencing optimum discomforts is during the daytime when windows and doors have to be kept closed to prevent hot air to enter from outside. However, for a critical evaluation it is essential to examine the performance during day and night time separately.

Thermal Damping(2) or decreased temperature variation is a characteristic dependent on the thermal resistance and heat capacity of the material as a whole. This factor representing the extent to which the external temperature wave has been damped or the inside surface, can always be taken as a measure of the overall thermal efficiency. However, the peak temperature and the corresponding values of thermal damping do not provide any information regarding the intensity and duration of discomfort in different periods of the whole day. Therefore, the concept of Degree-Hour-Rating(3) has been used which provides the required information about intensity and duration of discomfort.

Results and Discussions

Fig. (1) shows the variation of inside surface temperatures for the four wall panels on a hot clear day and table (1) shows the corresponding values of thermal damping, inside maxima & minima temperatures with time, integrated discomfort, degree hours and duration of discomfort.

Thermal Damping of wall with 7.6 cm thickness is nearly half of the conventional (22.9 cm thick) wall whereas the value of 11.4 cm thick wall is nearly 3/4 times that of the conventional one.

Inside Surface Temperatures: For thermal comfort the panel should ensure lower internal surface temperatures to minimise the radiant heat loss to the occupants, higher inside surface temperatures also contribute indirectly in raising the indoor air temperature. From fig. (1) it is quite obvious that the performance of 7.6 cm thick wall panel is extremely poor during day time as compared to the other wall panels because of its lowest thermal capacity and resistance the performance of 34.3 cm thick brick panel is superior than the other panels during day time, and interior than the conventional wall panel during night hours. This is due to its higher thermal capacity which enables it to cool down to a lesser extent than the other walls. Wall with 11.4 cm thickness differs nearly upto 3°C at the maxima and minima temperatures than the conventional wall panel. Also the inside surface temperature maxima for 7.6 cm thick wall panel occurs about 6 hours earlier of the conventional wall whereas for 11.4 cm thick panel the maxima occurs only 2 hours earlier than the conventional wall.

Integrated Degree Hours of Inside Surface

It has been pointed out that the thermal rating of various panels, the integrated effect of duration and intensity should form a rational basis; therefore the integrated effect of duration and intensity of peak temperature are also compared. 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) when the inside surface temperature of the

TABLE 1—THERMAL PERFORMANCE OF BRICK WALL PANELS

Wall Thickness (cms)	Thermal Damping (%)	Inside Max.	Peak Time	Temperatures (°C) Mini.	Time	Integrated Discomfort: Degree hours & in degrees >30°C Day	Night	Total	Durating (hours) >30°C
7,6	35	46.1	1130	24 9	0600	138	14	152	17
11.4	53	41.7	1530	26.8	0630	96	31	127	18
22.9	69	39 0	1730	30.0	0730	70	48	118	23
34.3	80	38 0	1730	30.8	0730	65	50	115	24

panel exceed 30°C were obtained as shown in Table (1). Here it can be seen that during day time as well as during day and night time the integrated discomfort degree hours are very high for 7.6 cm thick wall as compared to the other wall panel. The 11.1 cm thick panel was found to be inferior by 26 degrees during day times and superior by 17 degrees during night hours as compared to the conventional wall panel. Very little difference could be observed between the conventional and (34.3 cm) thick wall panel.

Conclusions

Thermal performance of 7.6 cm thick wall has been found to be exceptionally poor as compared to other wall panels. Although the 11.4 cm thick panel is also inferior to the conventional brick wall panel, it should not be very difficult to make it thermally acceptable by some suitable treatment like the projectioning of bricks, suitable plastering, or white washing the exposed side.

The present panel study although provides a fairly good idea of their relative performance but more useful and direct influence on indoor thermal conditions will have to be determined by using these panels in actual enclosures for giving most practical recommendations.

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