# A STUDY ON THE INFLUENCE OF VOID AND MOISTURE CONTENTS OF SOME BUILDING MATERIALS ON THEIR THERMAL TRANSPORT PROPERTIES AND IMPLICATIONS ON THERMAL PERFORMANCE OF BUILDING ENVELOPE

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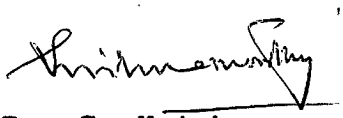
## CERTIFICATE

This is to certify that thesis entitled "A STUDY ON THE INFLUENCE OF VOID AND MOISTURE CONTENTS OF SOME BUILDING MATERIALS ON THEIR THERMAL TRANSPORT PROPERTIES AND IMPLICATIONS ON THERMAL PERFORMANCE OF BUILDING ENVELOPE" being submitted by Mr. B. Bhattacharjee to the Indian Institute of Technology, New Delhi, India for award of the DOCTOR OF PHILOSOPY in CENTRE FOR MATERIALS SCIENCE AND TECHNOLOGY is a record of bonafide research work carried out by him under my guidance and supervision.

To the best of my knowledge the thesis has reached the requisite standard. The material present in this thesis has not been submitted in part or full to any other university or institution for award of degree or diploma.



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## ABSTRACT

In this study, a large number of samples of ordinary clay bricks, fire clay bricks, dense concrete and autoclaved aerated concrete, have been tested for their porosity and thermal conductivity at dry and saturated states. Quite a few samples have also been tested at predetermined values of partially saturated conditions.

Mercury porosimetry was also conducted on a limited number of samples for determining certain aspects of their pore structure, porosity was determined by standard boiling water test.

A model which simulates two types of pore structure and the overall porosity of material has been successfully developed. The two types of pores are enclosed pores and enclosing pores.

A three dimensional internal heat conduction problem, within each componant model of the material under an unidirectional temperature gradient has been solved using finite element technique. The pores may be dry or be saturated with water.

The two calibration parameters of the model are the solid conductivity, and the fraction of enclosed pores in the total porosity.

The calibration factors of the model have been obtained from experimental values of thermal conductivity at dry and saturated states of a material.

For the purpose of taking into account, conditions of partial saturation the phenomenon of evaporation -- condensation has been taken into account, in terms of equivalent conductivity for such pores.

An empirical equation has been proposed for predicting the thermal conductivity of dry materials and a graphical method for predicting that of saturated materials. Values of solid conductivity, the fraction of enclosed pores and porosity are needed in such predictions.

Values of thermal conductivity of bricks reported in some published work have been predicted with a reasonable accuracy for dry bricks and with somewhat larger variation for saturated bricks using the model developed in this work and experimentally determined calibration factors.

The solid conductivity and the fraction of enclosed pores have been found to be nearly constant for a given type of material. Values determined in this work have been recommended for adoption with reasonable confidence.

An empirical correlation has been proposed between the fraction of enclosed pores in a material and the retention ratio obtained from mercury porosimetry.

From values of conductivity predicted for partially saturated materials at different degrees of saturation and from experimental results some guidelines have been suggested for estimating approximately values of conductivity at different degrees of saturation without a need for calculating through the model itself.

Building fabric performance factors such as admittance, decrement factor, U-value and time-lag have been calculated for two types of constructions; one normal brick construction and the other with aerated concrete, for different degrees of saturation. The effects of the type of material and the degree of saturation on the values of these parameters have been presented and discussed.

The influence of the type of construction and the degree of saturation on the heating or cooling loads of building enclosures has been presented with a simplified example and it is noted that with increased moisture these energy requirements for maintaining a constant indoor temperature increase and constructions made of aerated concrete walls require lower amounts of energy than conventional brick wall construction.

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