AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL POWER ENGINEERING DEPARTMENT

THE ANALYSIS OF THE NON-RESIDENTIAL INSTANTANEOUS COOLING LOAD COMPONENTS AND ITS PARAMETERS FOR CONTINUOUS SUMMER AIR-CONDITIONING ON A HEAT BALANCE BASIS USING FINITE-DIFFERENCES

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Mechanical Engineering

by

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STATEMENT

This thesis is submitted to the Faculty of Engineering, Ain Shams University, in partial fulfillment of the requirements for the degree of Master of Science in Mechanical Engineering, Power Section.

The work included in this thesis was carried out by the author in the Mechanical Power Engineering Department, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Prediction of building cooling loads is one of the key factors in building design where the selection of an appropriate air-conditioning system necessitates accurate information associated with the cooling load. Cooling load calculations can significantly affect the first cost of building construction, and the comfort and productivity of building occupants, as well as the building operating cost and energy consumption.

Actually, accurate estimation of building cooling loads requires the application of the heat balance method (HDM). This method is the most scientifically rigorous method that comprises the implementation of a full heat balance, i.e. the application of the first law of thermodynamics, to the external and the internal fabrics of the conditioned zone, together with its outside and inside boundary conditions, and solving the transient heat conduction equations for all of the structural components enveloping the zone.

This thesis utilizes a one-dimensional transient heat conduction numerical model to calculate zone cooling loads on a heat-balance basis. The Barakat and Clark alternating direction explicit (ADE) unconditionally-stable finite difference scheme is applied to solve the fundamental transient heat conduction equations for all of the structural components enveloping the zone with suitable initial and steady-periodic boundary conditions. The ASHRAE Clear-Sky Solar Model is used with its revised solar data in 2005 to calculate the total incident solar radiation. The differences between the revised and the old solar data of this solar model and their effects on the cooling load results are explained.

Cooling loads for different zone classes are calculated and the contributions of different heat gain components to the cooling loads are investigated. Some of the cooling load results are compared with the ASHRAE cooling load data and pronounced differences have been obtained from this comparison.

The effects of corners, as well as the effects of the external and the internal thermal conditions, on the cooling loads are also investigated. Moreover, the current model is also used to generate updated and revised cooling load tables to serve as a single-step cooling load calculation method on a heat balance basis .

The validation process of the applied numerical model is incorporated in this thesis with the choice of the suitable spatial and time increments that give results with acceptable degree of accuracy. The verification of the constructed computer code is also included.

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