Book Review

Energy Modeling and Computations in the Building Envelope

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In this book, the author Alexander V. Dimitrov, at a microwave level, aims to analyze the overall envelope system that defends the building from environmental effects while also addressing an aesthetic function, with respect to a building, including the roof and facades. The author considers the building envelope with its energy transformation by the phonon and electron energy particles motion origin and direction. Together with physical models, the general mathematical functions are described for energy transfer in the building envelope with numerical examples. The building envelope is also considered as a place where uncontrolled or controlled energy transformation occurs which effects the total energy balance of the building by affecting the energy efficiency of the building. The book also proposes models and mathematical formulations and numerical examples as the source for further programing coding applications. Additionally, by inclusion of the author's experience in engineering practice and methods of building envelope elements for better building energy efficiency, a cutback of the consumption of primary energy carriers is achieved, hence, and enhance of ecological sustainability of construction materials. Considering the building envelope as an integrated system which provides that the building energy demands are accomplished, the book includes various chapters.

In Chapter 2, details of microscopic level inspection of energy transportation within the building envelope are considered. In this chapter, firstly, for the building envelope being an energy exchanging medium, the physical models from the literature are investigated from a microscopic point of view.

It is stated in this chapter that the classical thermodynamics and heat transfer evaluates the energy flux vector, due to the availability of a temperature gradient. Additionally it results from the literature review that, all known mathematical models of energy transfer in solids at microscopic level concern closed systems only, which have specific characteristics in relevant forms of quantized energy, degrees of freedom of motion and inertial. This part recommends the design of adequate physical and mathematical models of energy transfer and relate micro quantities to macro ones. The building envelope is suggested to be treated as an open thermodynamic system at a micro level. Also in this chapter a phonon generation physical model in solids design for scatter of solar radiation within the solids is investigated. The chapter is concluded with the micro–macroscopic assessment of the state of the building envelope within the lights of the literature survey made.

In Chapter 3, the author proposes a generalized physical model for energy exchange describing the microscopic level interactions given in the previous chapter, using macroscopic thermodynamic characteristics. In this chapter, the energy drive model between the envelope and the ambient is offered as a Free Energy Potential which is constituted of three different types of works: Mechanical, Electrical and Thermal. At the end of the chapter, some mathematical methods for the distribution of the free energy within the building envelope are presented.

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In Chapter 4, the definition of the macroscopic characteristics of energy transfer is provided using the concepts informed about in the previous chapters. Additionally, mathematical models for predicting the effects of energy interactions with the help of classical analytical tools are provided by the author.

The author further extends the study at the macroscopic level in Chapter 5 and a numerical study of transfer in building envelope components is provided. The method of differential relations and the method of integral forms are introduced to the reader as two effective techniques of transport evaluation. It is stated that, the differential relations method provides an approximation of differential equations expressing the transfer balance in the vicinity of a point. Regarding some cases where a study of transfer in bodies with complex geometry is to be performed, researchers employ other numerical techniques, which enable them to plausibly model the body shape and the basic model in that area is a finite element method (FEM). Finally, the weighted residuals methodology is introduced to assess the ETS (electrothermomechanical system). Free energy function and energy transfer determination using 1-D, 2-D and 3-D finite elements are provided also in this chapter.

Chapter 6 is an extension of Chapter 5 and it considers the initial and boundary conditions of a solid wall element, effects of the environmental air on the building envelope, various initial and boundary conditions of solid structural elements. The author also gives selection recommendations of boundary conditions of solid structural elements.

In Chapter 7, the author provides his engineering experiences in methods of estimating the effect of the surroundings on the building envelope with a control of the heat transfer through the building envelope. The concept of thermal resistances in a structure within the solid wall elements and their mathematical formulation are introduced. Mathematical modeling of solar shading devices (shield), and its interaction with the window and the surroundings are provided in this chapter. Design of minimal-admissible light-transmitting envelope apertures using the coefficient of daylight (CDL), method of reducing the tribute of the construction and the thermal bridges to the energy ınefficiency, assessment of leaks in the building envelope and the air-conditioning systems, and a mathematical model of the environmental sustainability of buildings are other engineering issues provided to the reader for a full understanding the energy transfer in building envelopes.

At the end of the book, the author provides a solved examples part in order to supply the mathematical formulations to engineering problems to the reader.

This book is a valuable contribution to the worlds of science and of practice, a service to building and environmental protection and, herewith, to the next generations. We express our thanks and compliments to both author Alexander V. Dimitrov and to Engineering & Environmental Sciences at CRC Press of Taylor & Francis Group.

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