Book Review

Analysis of Pavement Structures. By Animesh Das. CRC Press: Boca Raton, FL, USA, 2014; 194p; ISBN 978-1466558557

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Abstract: Significant differences exist between pavement and building structures, particularly with respect to the type and mode of loading conditions: structural elements, beams and columns of buildings are subjected to static loads and pavement to dynamic loads. However, the design of structural members for buildings might need to address temporary dynamic loads due to wind, earthquake or other factors depending on building or structure height and application. In contrast, pavements are subjected to the moving loads of vehicles as well as to further loads due to temperature gradients. Since the layers of various materials used in pavements may vary in thickness and the statically indeterminate nature of pavement (due to the full contact with the bed soil layer or the lower layers), any deformation caused by changes in the moisture content and temperature can result in internal stresses in pavement structures. Consequently, analysis of pavement structures can be very complicated, requiring skills in material characterization, mathematics and modeling. In this regard, a useful book that covers various subjects in the pavement design and analysis was reviewed. Th details of each chapter were briefly explained. This book is recommended for consultant engineers and pavement researchers.

Keywords: pavement design; pavement analysis; thermal stress/strain; deflection; asphalt; concrete

Offering an explanation of the principles of pavement analysis in a simple and consistent manner, *Analysis of Pavement Structures* [1] is a useful textbook that presents the fundamental subjects of pavement design in 8 chapters.

Chapter 1 presents basic equations from the field of solid mechanics that are applied to stress analysis in such a way that they can be used as a base for analyzing stresses and strains in different layers of pavement structures. Chapter 2 deals with engineering properties and rheological characterization of materials, including unbound and bound, used in pavement construction. In this chapter, different models for the characterization of structural responses of asphalt mixtures are introduced briefly. Furthermore, some examples are presented to deepen understanding for applying basic and complex equations developed for characterization of structural responses of asphalt mixture and binders. Chapter 3 addresses stresses induced by structural loading in a rigid concrete pavement system. In this case, the paving layer can be assumed as a simple beam and/or plate resting on an elastic foundation as an idealized hypothesis. The analysis is based on Winkler's, Pasternak's and Kerr's theories and hypotheses and is discussed in detail with the pertinent equations. This chapter is very accommodating for students and researchers who are interested in principles and theories applied in stress analysis of rigid pavements. As the service or environment ambient temperature is assumed to be constant in this analysis, the pavements are supposed to be thermally stress-free structures. However, under practical conditions, the temperatures vary throughout the day, inducing thermal stresses in the pavement structure. Therefore, thermal stress must be considered as a load imposed by the environment for structural analysis and design of rigid pavements. Accordingly, Chapter 4 focuses on analysis of thermal stress originated from temperature variations in concrete pavements. Temperature profiles and related equations considering

boundary conditions, interface and infinite depth, are presented to clarify the nature of thermal stresses. The various thermal stresses, including axial and bending associated with the corresponding equations in concrete pavements are discussed in terms of the different types of restrains, e.g., fully and partially restrained concrete pavements. Chapter 5 focuses on analysis of stresses due to loading asphalt pavements. This chapter presents how the complicated parametrical equations and corresponding formulations are developed for structural analysis of asphalt pavements from the basic equations. Meanwhile, the chapter contains useful examples that facilitate understanding of the application of both complicated and basic equations. Chapter 6 briefly presents principles and formulations for calculating thermal stresses in the asphalt paving layer.

Although there are many computer packages, codes, guidelines and standards for pavement design, it is necessary to profoundly understand the philosophies behind the various available approaches adopted for the design methods. Chapter 7 provides a basic coverage of principles of pavement design fundamentals explained in the previous chapters, dealing with stress analysis in concrete and asphalt pavements in particular. Furthermore, the input parameters for the pavement design, including material characteristics, structural and environmental loadings, and design life, are briefly discussed. Additionally, a design process, with respect to the estimation of required thickness to withstand the loadings as well as design of the joints for concrete pavements, joint spacing, ties and dowel bar designs, is presented. This chapter also covers a basic approach that can be used for maintenance of pavement with compromising cost analysis, presenting application of the theories, complex equations, and principles presented in the previous chapters for estimation of pavement thickness while considering all input parameters. Thus, this chapter serves as a link between the fundamentals, theories of stress analysis and the structural pavement design process. Chapter 8 presents an extension of subjects for pavement analysis, including plate/beam resting on half-space foundation, as well as plate/beam resting on elastic foundation under dynamic loads. Analysis of pavement with composite structures, e.g., asphalt pavements constructed on the slab or cement-treated bases and vice versa, are briefly discussed as well. Moreover, principles of reliability in an inverse problem pavement design process are also presented. In fact, this chapter demonstrates that different subjects can be considered as being relatively new for further research to address new demands in pavement engineering.

This book is highly recommended for undergraduate students in civil engineering and engineers who are interested in pavement engineering. Furthermore, the development of the basic and fundamental equations presented in the various chapters can be avenues for further research for postgraduate students. However, it is suggested that numerical examples are added for the better understanding and interpretation of the fundamental equations presented in each chapter. The examples can be added for the future editions. In conclusion, this book can be used as a comprehensive textbook for researchers who are keen to know the origin of theories and fundamentals for structural analysis and design of paving systems.

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Reference

1. Das, A. *Analysis of Pavement Structures*; CRC Press: Boca Raton, FL, USA, 2014.