PAVEMENT ANALYSIS AND DESIGN
(Professional Elective – III)

Course Code: 20CE1158

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Pre-requisites: Transportation Engineering, Building Materials and Concrete Technology

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Outline pavement design principles and traffic consideration
CO2: Explain about material characterization
CO3: Discuss about analysis and design of flexible pavement
CO4: Discuss about analysis and design of concrete pavement
CO5: Explain pavement evaluation and overlay design

UNIT-I **(10 Lectures)**

PRINCIPLES OF PAVEMENT DESIGN:

Types of Pavements, Concept of pavement performance, Structural and Functional failures of pavements. Different types of pavement performance criteria. Different pavement design approaches. General framework for pavement design.

TRAFFIC CONSIDERATIONS IN PAVEMENT DESIGN:

Vehicle types. Axle configurations. Contact shapes and contact stress distributions. Concept of standard axle load. Vehicle damage factor. Axle load surveys. Lateral placement characteristics of wheels. Estimation of design traffic.

Learning outcomes:
1. Explain various types of pavement performance based on various failures in pavements (L2)
2. Evaluate various pavement performance criteria (L4)
3. Express the commercial vehicles into standard axles from axle load survey data (L2)

UNIT-II **(10 Lectures)**

PAVEMENT MATERIAL CHARACTERIZATION:

Identification of different material inputs required for analysis and design of pavements. Selection of appropriate conditions (temperature, moisture content, loading time, etc) for characterizing pavement materials. Brief description of the principles of different laboratory and field methods adopted for characterizing pavement materials. Elastic, Non-elastic Visco-elastic.

Learning outcomes:
1. Discuss various material inputs and their effect on design and analysis of pavements(L2)
2. Analyze principles of various laboratory methods to characterize mixes (L4)
3. Describe how field methods are performed to identify the response of pavement(L2)

UNIT-III **(10 Lectures)**

ANALYSIS OF FLEXIBLE PAVEMENTS:

Selection of appropriate theoretical models for analysis of flexible and concrete pavements, analysis of layered flexible pavement systems using linear elastic layered theory. Discussion of the need for use of advanced analytical techniques for flexible pavements. Discussion of

different software available for analysis of flexible pavements.

FLEXIBLE PAVEMENT DESIGN METHODS:

Detailed discussion of different methods of design of flexible pavements. Indian Roads Congress guidelines - IRC:37 American Association of State High and Transport Officials (AASHTO) – 1993 method. TRRL Design method, brief discussion of salient features of the AASHTO 2002 draft design guidelines for flexible pavements. Comparison of design concepts adopted in different approaches. Comparison of original & revised versions of codes.

Learning outcomes:

1. Analyze flexible pavement analysis evolved from empirical methods to mechanistic (L4)
2. Explain the input required in AASHTO and perform design of flexible pavement (L3)
3. Differentiate each revised versions from time to time and how they evolved (IRC & AASHTO) (L2)

UNIT-IV **(10 Lectures)**

ANALYSIS OF CONCRETE PAVEMENTS:

Discussion of different theoretical models for analysis of different types of concrete pavements. Analysis of wheel load stresses, curling/ warping stresses due to temperature differential, critical stress combinations. Discussion of the need for use of advanced analytical techniques for concrete pavements.

CONCRETE PAVEMENT DESIGN METHODS:

Detailed discussion of different methods of design of concrete pavements. Indian Roads Congress guidelines - IRC:58. American Association of State High and Transport Officials (AASHTO) – 1993 method, PCA method, Concept of Continuously Reinforced Concrete Pavement, Brief discussion of salient features of the AASHTO 2002 draft design guidelines for concrete pavements. Comparison of design concepts adopted in different approaches. Comparison of original & revised versions of codes.

Learning outcomes:

1. Analyze how rigid pavement analysis evolved from empirical method to closed form solutions and thereafter mechanistic based methods (L4)
2. Explain the input required in AASHTO and perform design of rigid pavement (L3)
3. Differentiate each revised version from time to time and discuss how they evolved (IRC and AASHTO)(L2)

UNIT-V **(10 Lectures)**

PAVEMENT EVALUATION TECHNIQUES:

Functional and Structural Evaluation of pavements. Concept of roughness. International Roughness Index. Measurement of Roughness using different types of equipment. Structural evaluation of in-service pavements using Benkelman beam and Falling Weight Deflectometer methods.

PAVEMENT OVERLAY DESIGN METHODS:

Overlay design as per Indian Roads Congress guidelines (IRC:81); Overlay design as per AASHTO-1993 guidelines.

Learning outcomes:

1. Explain various structural evaluation techniques(L2)
2. Differentiate various functional evaluation techniques(L2)
3. Evaluate different possible overlay methods using IRC: 81 and AASHTO-1993(L2)

TEXT BOOKS:

1. Yoder, E.J. and Witczak, M.W., "Principles of Pavement Design", John Wiley & Sons,1st Edition, 1975.
2. Yang H Huang, "Pavement Analysis and Design", Pearson Education, 2004.

REFERENCES:

1. Animesh Das, "Analysis of Pavement Structures", 1st Edition, CRC Press, 2014.
2. IRC 37- 2018 Design of Flexible pavement design
3. IRC 58- 2017 Design Rigid Pavement
4. American Association of State Highway Transport Officials - 1993 & 2002