

MECHANICAL CHARACTERIZATION OF BITUMINOUS MATERIALS

MULTI-FACULTY

PRE-REQUISITES : This is a self-contained course for students and practitioners alike, and hence, no prerequisite is required. For those who do not have an undergraduate degree in civil engineering, familiarity with construction of bituminous pavements will be helpful.

INTENDED AUDIENCE : Highway Engineers

INDUSTRIES APPLICABLE TO : Engineering Staff working in Oil Refineries, Modified Bitumen Manufacturers, State, and Central Highways Departments and PWD, Ministry of Road Transport and Highways, and National Highways Authority of India.

COURSE OUTLINE :

Bituminous materials exhibit a complex mechanical response, and an understanding of the same is paramount in pavement engineering. This course will include introductory elementary linear viscoelasticity, and use that framework to introduce different grading system for bitumen. Use of polymers to enhance the rheological properties will be discussed along with the various test methods to quantify such improvement. Mechanical characterization of bituminous mixtures for modulus determination for design purposes as well as quantification for laboratory performance in rutting and fatigue damage will be discussed.

ABOUT INSTRUCTOR :

Prof. J. Murali Krishnan is currently a faculty member in the department of civil engineering, IIT Madras. He obtained his Ph.D. from IIT Madras during 1999 and was a post-doctoral research associate at Texas A&M University, College Station, USA from 1999 to 2004. Before his Ph.D., he worked as a bituminous pavement engineer in various construction firms for more than six years.

Prof. A Padma Rekha is currently working as an Associate Professor in the department of Civil Engineering, SRM Institute of science and Technology. She received her Ph.D. degree from IIT Madras during 2013. Her area of research interest includes, Rheological characterization of bitumen and bituminous mixture, aging characteristics of bituminous material and bituminous pavement design.

Prof. Neethu Roy is working as Dean (R&C) and Professor, Department of Civil Engineering, Mar Baselios College of Engineering and Technology, Kerala. She got her Ph.D. from IIT Madras during 2013. Her research interest includes rutting and fatigue characterization of bituminous mixtures, bituminous pavement design and pavement management system.

Prof. M. R. Nivitha is currently a faculty member in the Department of Civil Engineering, PSG College of Technology, Coimbatore. She received her Ph.D. from IIT Madras in 2016. Her research interests include rheological and microstructure characterization of bitumen, interaction mechanisms in modified bitumen and aging kinetics.

COURSE PLAN :

Week 1: Outline of the course; Introduction to bituminous pavements; Overview of distresses such as rutting and fatigue cracking in bituminous layers; Influence of binders and mixtures on such distresses; Role of mechanical characterization for design and laboratory performance.

Week 2: Introduction to linear viscoelasticity; Elastic, viscous and viscoelastic response; Viscoelastic solid and viscoelastic fluid; Linearity of response - scaling and superposition;

Week 3: Introduction of material functions for viscoelastic materials - creep compliance function and, stress relaxation function in the time domain and complex creep compliance and complex stress relaxation function in the frequency domain.

Week 4: Influence of temperature on the linear viscoelastic response; Thermorheologically simple behavior, time-temperature superposition, and construction of master curve.

Week 5: Introduction to refinery processing of bitumen; Chemical composition of bitumen; Relationship between chemical composition and physical parameters of bitumen; Aging of bitumen and bituminous mixtures.

Week 6: Introduction to the grading system for bitumen; Penetration and viscosity grading of bitumen

Week 7: Industry lecture on Dynamic Shear Rheometer - Dharmesh Gala from Anton Paar; Performance grading of bitumen - Issues related to reliability, slow-moving traffic, and high volume and grade-bumping.

Week 8: Modifiers for bitumen; Performance characterization of modified bitumen; Introduction to MSCR test method.

Week 9: Introduction to Bituminous Mixture and the associated volumetrics; Mixing and compaction of unmodified and modified bituminous mixtures

Week 10: Stiffness modulus (van der Poel), dynamic modulus, and resilient modulus of bituminous mixtures - experimental protocol, and post-processing.

Week 11: Simulation of rutting of bituminous mixtures in the laboratory: flow number, flow time and dry rut wheel testing - experimental protocol, and post-processing.

Week 12: Simulation of fatigue damage of bituminous mixtures in the laboratory: beam bending and repeated indirect tensile testing - experimental protocol, and post-processing.