



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

ACADEMIC - GRADUATE STUDIES AND RESEARCH DIVISION
FIRST SEMESTER 2023-2024
Course Handout Part II

Date:12.08.2023

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course No. : CE G534
Course Title : Pavement Material Characterization
Instructor-in-charge : V. VINAYAKA RAM
Instructors : V. Vinayaka Ram

1. Course Description, Scope & Objective of the course:

This course aims at introducing the fundamental concepts as well as the advancements in the domain of pavement materials. A wide coverage of laboratory and field investigations of soil, aggregate, straight run and modified bituminous binders, bituminous emulsions and cement concrete will be done during this course. Viscosity and Superpave grading of bituminous binders will be highlighted along with other rheological investigations being carried out on the bituminous binders. Marshall's and Superpave mix design along with other performance tests such as resilient modulus, dynamic modulus, creep tests, 4-point bending fatigue test, Hamburg wheel tracking rutting test etc. will be covered in detail during this course. The state of the art Balanced Mixture Design of asphalt concrete will also be introduced during this course. Pavement Quality Concrete mix design along with the tests on joint sealants will be dealt in detail. Use of aggregated derived from Reclaimed Asphalt Pavement (RAP), Construction and Building demolition derived aggregates, fly ash, GGBS and other locally available and marginal materials will also be dealt during this course. The importance of chemical and mineral admixtures will also be dealt as a part of this course. Importance of microstructural investigations will also be discussed during this course

2. Course Outcomes: At the end of this course, the students will develop:

1. An ability to choose appropriate materials for flexible and rigid pavement structures.
2. An ability to check the quality of each of the materials being used in both flexible and rigid pavement structures.
3. An ability to design the bituminous and cement concrete mixtures for pavement application.
4. An ability to carry out various performance related tests for binders, mixtures and other materials being used for pavement structures.
5. An ability to perform and interpret the micro structural investigations, being carried out on pavement materials



3. Text Book(s)

T1: Bituminous Road Construction in India by Prithvi Singh Kandhal, Veeraragavan Amirthalingam and Rajan Chowdhury 2nd edition, PHI, 2023

Reference Books:

R1: The Shell Bitumen Handbook, by Robert Hunter, Andy Self and John Read, Sixth Edition, Shell Bitumen by ICE Publishing, London, 2015.

R2: Properties of Concrete by A.M. Neville, 5th Edition, Pearson Publications, 2012

R3: Highway Material Testing Laboratory Manual by Khanna S. K., Justo, C.E.G and Veeraragavan, A., Nem Chand & Bros.

R4: Relevant BIS, IRC, MoRT&H, AASHTO, ASTM and other relevant standards and codes of practices

R5: Advances in Asphalt materials – Road and Pavement construction by Shin Che Huang and Herve Di Benedetto, Woodhouse Publishing, 2015

R6: NAPA-IS-143-BMD-Resource-Guide-2021 – A report on Balanced Mix Design by National Asphalt Pavement Association

R7: MS2 Asphalt Mix Design Method, 7th edition, Asphalt Institute, USA, 2014

4. Course Plan:

Lecture No.	Topics to be covered	Learning Objectives	Reference	SLOs
1-2	Soil as a subgrade, Flyash as an embankment and application of Geo-synthetics in pavement engineering	Overview of soils as subgrade material, grain size distribution, Density and CBR, modulus of subgrade reaction, Soil stabilization concepts, use of Fly ash as an embankment material, introduction to the application of Geo-synthetics in pavement engineering	R3, R4	a,c,d,g,h,j,k
3-5	Aggregates	Definition, strength, shape and stripping parameters of aggregates and their significance on pavement performance. Artificial aggregates and slags as alternative aggregates	R3, R4	a,b,c,h,k
6-18	Straight run and modified bituminous binders	Bitumen Origin, Importance and functions of binders, basic tests on straight run and modified bituminous binders as per IRC, BIS, AASHTO and ASTM standards; Bitumen Grading systems: Penetration, Viscosity and Superpave performance grading systems; Modified Binders: Crumb Rubber Modified Bitumen, Polymer Modified Bitumen, Natural Rubber Modified Bitumen and Waste Plastic Modified Bitumen (dry and wet processes); Rheological characterization of bituminous binders: Rotational viscometer (RV), Dynamic shear rheometer (DSR): Performance grading, Multi stress creep and recovery (MSCR); Bending beam rheometer (BBR); Binder aging:	T1, R1, R4, R5	a,b,c,f,k



		Significance of binder aging, aging simulation tests viz. Rolling thin film oven (RTFO), Pressure aging vessel (PAV), Aging of bituminous concrete (AASHTO R30)		
19-20	Un modified and Polymer modified Bitumen Emulsions	Introduction to emulsions; application of emulsions for slurry seal and micro-surfacing as surface maintenance treatment.	T1, R1,R5	a,d,f,k
21-30	Marshall's, Super Pave Mix Designs along with Balanced Mix Design concepts and Performance tests of bituminous mixtures	Bituminous Mix Design as per Asphalt Institute Manual Series 2 (MS-2); Rutting behaviour, Fatigue and creep behaviour of bituminous mixes, Dynamic Modulus, moisture resistance, balanced mix design concepts and introduction to microstructural investigations namely FESEM, EDX, FTIR, XRD, XRF.	T1, R1, R4, R5	a,b,c,d,e,k
31-35	Special Mixes and Alternative materials	Stone Matrix Asphalt, Pervious Asphalt, Warm and Half Warm Mix Asphalt and RAP based mixture designs	T1, R1, R5	a,b,c,e,k
36-42	Cement and Cementitious Materials, Cement Concrete Mix Design	Concrete Mix Design for Road works as per IRC: 15, IRC:44, materials and mix design for low volume roads as per IRC: SP: 62	R2, R4	a,b,c,e,k

***Student Learning Outcomes (SLOs):**

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

- a) An ability to apply knowledge of mathematics, science and engineering
- b) An ability to design and conduct experiments, as well as to analyze and interpret data
- c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) An ability to function on multidisciplinary teams
- e) An ability to identify, formulate, and solve engineering problems
- f) An understanding of professional and ethical responsibility
- g) An ability to communicate effectively
- h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) A recognition of the need for, and an ability to engage in life-long learning
- j) A knowledge of contemporary issues
- k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

5. Laboratory Component:

Session 1: Introduction to Highway Material Testing Laboratory

Session 2: Project involving Marshall's mixture design MS 2 manual procedure

Session 3: Rheological studies on fresh binders (DSR)

Session 4: Rheological studies on aged binders (DSR)

Session 5: Soxhlet Extraction to determine the bitumen content in RAP material

Session 6: Mix design project with varying proportions of RAP materials

Session 7: Hamburg Wheel Tracking test

Session 8: Investigations with ITFT

Session 9: Micro structural investigations: FESEM, EDX



Session 10: Micro structural investigations: FTIR, XRD

6. Evaluation Scheme:

S. No.	Evaluation Component	Duration (Min)	Weightage (%)	Date & Time	Remarks
1	Mid semester Examination	90 min	25	10/10 - 11.30 - 1.00PM	Partially OB and Partially CB (Relevant codes books will be allowed, if needed for the CB part)
2	Comprehensive Examination	180 min	35	09/12 FN	Partially OB and Partially CB (Relevant code books will be allowed, if needed for the CB part)
3	Lab based Projects, experiments and Presentations	-	20	Throughout the semester	OB
4	Term Paper and Presentations	-	10	Throughout the semester	OB
5	In-class and take home Assignments	-	10	Throughout the semester	OB

7. Chamber Consultation Hour: To be announced during the first class

8. Notices: Notices will be displayed on CMS

9. Make-up Policy:

- Make up requests received on social networking platforms / SMS / WHATSAPP etc. will be ignored and no further action will be initiated. **Makeup requests through emails / typed or hand written letters with necessary documentary proofs only will be accepted.**
- Make up will be granted only for genuine reasons and will be considered on a case to case basis. However, prior permission is a must.
- For medical cases, a certificate from the concerned physician should be submitted as a proof. Made-up medical certificates / other proofs will be seriously considered and referred to disciplinary committee for further necessary action.
- **Make up policy is applicable only for mid semester and the comprehensive examinations only.** Other listed components will not have any scope for make-ups. Students are advised to adhere to the schedules without fail
- **Attending Laboratory Sessions is Mandatory and no makeups are possible for these sessions**



10. Academic honesty and academic integrity Policy:

Academic honesty and academic integrity are to be maintained by all of the students throughout the semester and no type of academic dishonesty is acceptable. Students are encouraged to **use anti-plagiarism software** to check reports / assignments before submission. Submissions with high plagiarized contents will be ignored and students will not be given chance to submit the assignments again in such cases.

INSTRUCTOR-IN-CHARGE
CE G534