Birla Institute of Technology & Science, Pilani
Hyderabad Campus

ACADEMIC - GRADUATE STUDIES AND RESEARCH DIVISION
FIRST SEMESTER 2022-2023
Course Handout Part II

Date:10.08.2022

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 Md. Ikramullah Khan

Course Description:

Field and Laboratory tests on soil, stabilization techniques. Geosynthetics testing and specifications. Tests on aggregates including the quarrying, crushing, stacking and gradation. Tests on bitumen and importance of viscosity grading, tests on bitumen emulsions and application, tests on modified bitumen. Performance grading of bitumen and the rheology test as per ASTM standards. Bituminous mixture design using Marshall's and Super-Pave methods. Performance tests on bituminous mixtures such as resilient modulus, dynamic modulus, creep tests, 4-point bending fatigue test and Hamburg wheel tracking rutting test. Pavement Quality Concrete (PQC) mixture design and tests on joint filler and sealant materials. Admixtures for bituminous and cement concrete. Alternate materials such as Reclaimed Asphalt Pavement (RAP) material, fly-ash, slags and other marginal materials.

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. Pavement Quality Concrete mix design along with the tests on join 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.

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 Signh Kandhal, PHI, 2016

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

4. Course Plan:

Lecture No.	Topics to be covered	Learning Objectives	Reference	SLOs

***Student Learning Outcomes (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 and alternatives	Definition, strength, shape and stripping parameters of aggregates and their significance on pavement performance. Use of slags as alternative road construction materials	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 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: Significance of binder aging, aging simulation tests viz. Rolling thin film oven (RTFO), Pressure aging vessel (PAV), Aging of bituminous concrete (AASHTO R30)	T1, R1, R4, R5	a,b,c,f,k
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 and Super Pave Mix Designs and Performance tests of bituminous mixtures	Bituminous Mix Design as per Asphalt Institute Manual Series 2 (MS-2) and Super Pave Series 2; Rutting behaviour, Fatigue and creep	T1, R1, R4, R5	a,b,c,d,e,k

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

		behaviour of bituminous mixes, Dynamic Modulus, moisture resistance and introduction to microstructural investigations namely FESEM, EDX, FTIR, XRD, XRF.		
31-35	Special Mixes and Alternative materials	Stone Matrix Asphalt, Pervious Asphalt, Warm Mix Asphalt, Half Warm Mix Asphalt and RAP based mixes	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 the testing of aggregates
Session 3: Project involving the basic testing of bitumen
Session 4: Project involving Marshall's mixture design
Session 5: Rheological studies on unmodified binders (DSR)
Session 6: Rheological studies on modified binders (DSR)
Session 7: Rheological studies on aged unmodified binders (DSR)
Session 8: Rheological studies in aged modified binders (DSR)
Session 9: Soxhlet Extraction to determine the bitumen content in RAP material
Session 10: Mix design project with varying proportions of RAP materials
Session 11: Micro structural investigations: FESEM and EDX
Session 12: Micro structural Investigations: XRD

6. Evaluation Scheme:

S.No.	Evaluation Component	Duration (Min)	Weightage (%)	Date & Time	Remarks
1	Mid semester Examination	90 min	25	31/10 3.30 - 5.00PM	Partially OB and Partially CB (Relevant codes books will be allowed, if needed for the CB part)
2	Comprehensive Examination	180 min	35	19/12/2022, AN	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: Every Saturday: 4 PM to 5 PM

8. Notices: Notices will be displayed on CMS / Course Google class room

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 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