Techno India NJR Institute of Technology

Course File

Pavement Design (8CE4-22)

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Syllabus

IV Year-VIII Semester: B. Tech. (Civil Engineering)

8CE4-22: Pavement Design

Credit 1 **Max. Marks: 50(IA: 30, ETE: 20)**
0L+0T+2P

1.	**Pavement Mix Analysis**: Aggregate blending, bituminous mix design – Marshall Stability approach, concrete mix design for DLC and PQC with IS a code provision.
2.	**Pavement Basics:** Types & comparison, vehicular loading pattern, factors affecting design and performance of pavements, sub grade requirements.
3.	**Design of Flexible Pavements**: Analytical approach, flexible pavement layers, ESWL, repetitions of load, techniques of design methods, wheel load analysis, traffic analysis, stress distribution in sub grade soil, Burmister's theories, group index method, CBR approach, IRC 37 and other guidelines.
4.	**Design of Concrete Pavements**: Westergaard's approach, temperature & frictional stresses, design of expansion & longitudinal joints, design of dowel & tie bars, IRC 58 and other guidelines.
5.	**Specifications for rural roads:** Important aspects of IRC SP 020, Rural Road Manual. NRRDA publications

Course Overview:

It gives Recommendations for the structural design of flexible pavement and gravel roads. This lab is intended for civil engineers responsible for the design of new road pavements and is appropriate for roads which are required to carry cumulative equivalent standard axles in one direction. Course Outcomes**:**

CO.NO.	Cognitive Level	Course Outcome
1	Understand	Identify the pavement components, functions and the differences between different types of pavement.
2	Analyze	Relate the response characteristics of soil, aggregate, asphalt, and asphalt mixes
3	Analyze	Analyzing the flexible pavement using empirical and semi empirical methods
4	Analyze	Analyze the warping, friction, wheel load stress and calculate the combined stress
5	Create	Design rigid pavements by IRC method and evaluate the pavements

TEXT/REFERENCE BOOKS

1. Project management with CPM/PERT by B.C. Punmia, Laxmi Publication (P) Ltd.
2. Construction Project Management by K.K Chitkara, Tata Mc Graw Hills.
3. Project Management by Modder & Phillph, CBS Publishers.
4. Project Planning and Control by Punmia and Khandelwal K.K., Laxmi Publication (P) Ltd.
5. Project Management by Choudhary S., Tata McGraw Hill Publishing Company Limited, New Delhi

Assessment Methodology:

1. To check practical file work based on related pavement design experiments.
2. Internal assessment based on Viva and MCQ test.
3. Final Written Exam (practical paper) at the end of the semester.

Course Coverage Module Wise:

Lab No.	Experiment List according to RTU Syllabus
1	Bituminous mix design – Marshall Stability approach
2	Concrete mix design for DLC and PQC with IS a code provision.
3	Comparison of various pavements and factors affecting design of pavements
4	Analytical approach, flexible pavement layers,ESWL, repetitions of load, techniques of design methods, CBR approach, IRC 37 and other guidelines.
5	Design of Concrete Pavements

TEACHING AND LEARNING RESOURCES OF PAVEMENT DESIGN

VideoTutorials:

https://www.youtube.com/watch?v=0_PxVAArtjw&list=PLLy_2iUCG87CHFdFEAVGc2iISoF9DD554&index=41

https://www.youtube.com/watch?v=qskX6gUrhIg&list=PLLy_2iUCG87CHFdFEAVGc2iISoF9DD554&index=42

https://www.youtube.com/watch?v=UHW_nn4J_So&list=PLLy_2iUCG87CHFdFEAVGc2iISoF9DD554&index=53

https://www.youtube.com/watch?v=pFxk3KQfrvg&list=PLLy_2iUCG87CHFdFEAVGc2iISoF9DD554&index=57

https://www.youtube.com/watch?v=uJntLOgEHD4

https://www.youtube.com/watch?v=CX-qs752-x4

Theory concepts:

http://www.gpcet.ac.in/wp-content/uploads/2017/04/TE-I-Unit-V-LEcture-Notes.pdf

Sample Quiz:

https://edurev.in/course/quiz/attempt/7812_Test-Pavement-Design/2b1ef3e1-54b2-4f2d-b2f2-a7dea76475c4

EXPERIMENT NO. 1

Aggregate Blending

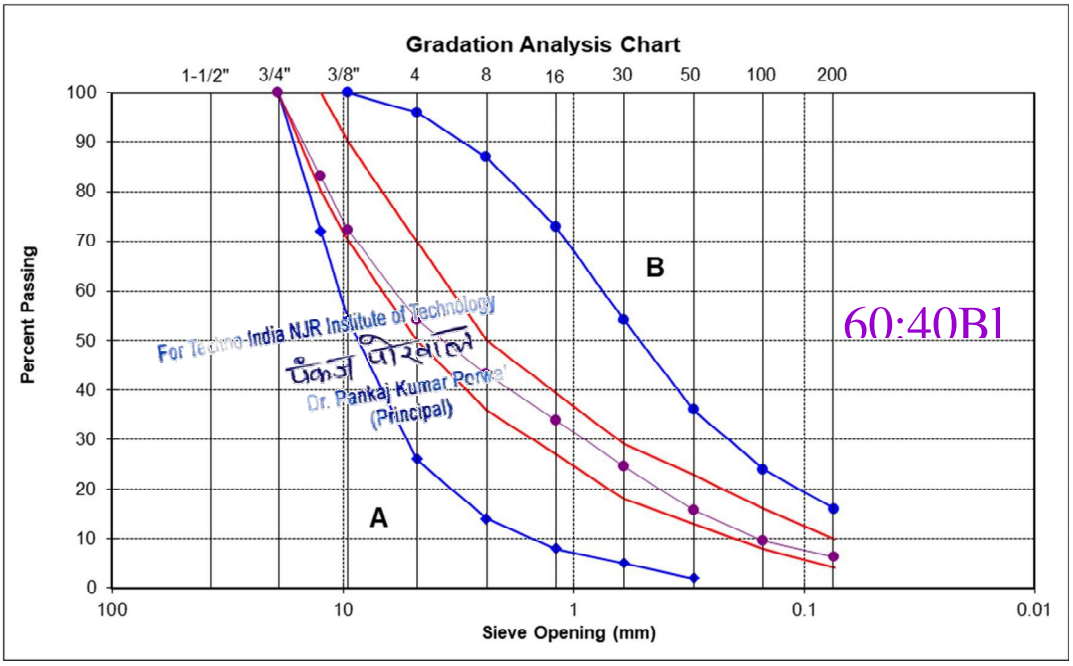
To meet the gradation specifications for a concrete or asphalt mix, we usually have to blend aggregate from several sources together. To find an aggregate source with exactly the right gradation is highly improbable. If we only have to blend two aggregates together, we can usually calculate the proportions directly. If we need to combine three or more aggregates, we have to resort to trial-and-error.

$$pi = f\ pi + f\ pi + f\ pi$$

p^{i}_{x} = percent of material x passing sieve i

f = fraction of blend contributed by material x

TWO AGGREGATE EXAMPLES



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Dr. Pankaj Kumar Porwal
(Principal)

EXPERIMENT NO. 2

Bituminous mix design

Overview

The bituminous mix design aims to determine the proportion of bitumen, filler, fine aggregates, and coarse aggregates to produce amix which is workable, strong, durable and economical. The requirements of the mix design and the two major stages of the mixdesign, i.e dry mix design and wet mix design will be discussed.

Evolution of road surface

- Unsurfaced earthen roads, or cart-track
- Unsurfaced earthen roads upgrades with natural soil from borrow pits and attention to drainage, and compaction is by traffic
- Dry aggregate and sand-clays mix, in which the the former act as wear resistant and the latter as natural binder
- Water-bound macadam, the above constituents, mixed together (pre-mix or in-situ) with water and compacted to improve the strength
- Oiled roads, introduced to reduce dust by bitumen stabilized soils
- Seal coat: the base course is protected from traffic and moisture by sealing the surface with a thin film of bitumen aggregate mix, which is structurally strong surface for pneumatic-tyred traffic. This is provided on firm and smooth base course after a tack coat using cutback bitumen or bitumenemulsions with a penetration of 5 mm.
- Asphaltic concrete: Traffic and the axle configuration are increasing very much which raises demand for the new type of pavement which can meet the above requirements. The asphaltic concrete is one which is the high dense graded premix and it is termed as the highest quality pavement surface course.
- Bitumen mix or asphalt mix overlays of minimum 20 - 40 mm to as high as 300 - 500 mm or even more.

Objectives of mix design

The objective of the mix design is to produce a bituminous mix by proportionating various components so as to have: sufficient bitumen to ensure a durable pavement, sufficient strength to resist shear deformation under traffic at higher temperature, sufficient air voids in the compacted bitumen to allow for additional compaction by traffic, sufficient workability to permit easy placement without segregation, sufficient flexibility to avoid premature cracking due to repeated bending by traffic, and sufficient flexibility at low temperature to prevent shrinkage cracks.

Constituents of a mix

Coarse aggregates: Offer compressive and shear strength and shows good interlocking properties. E.g. Granite

Fine aggregates: Fills the voids in the coarse aggregate and stiffens the binder. E.g. Sand, Rock dust

Filler: Fills the voids, stiffens the binder and offers permeability. E.g. Rock dust, cement, lime

Binder: Fills the voids, cause particle adhesion and gluing and offers impermeability. E.g. Bitumen, Asphalt, Tar

Types of mix

- **Well-graded mix:-** *Dense mix, bituminous concrete* has good proportion of all constituents and are called dense bituminous macadam, offers good compressive strength and some tensile strength
- **Gap-graded mix:-** Some large coarse aggregates are missing and has good fatigue and tensile strength.
- **Open-graded mix:-** Fine aggregate and filler are missing, it is porous and offers good friction, low strength and for high speed.
- **Unbounded:-** Binder is absent and behaves under loads as if its components were not linked together, though good interlocking exists. Very low tensile strength and needs kerb protection.

Different layers in a pavement

- **Bituminous base course** Consist of mineral aggregate such as stone, gravel, or sand bonded together by a bituminous material and used as a foundation upon which to place a binder or surface course.
- **Bituminous binder course** A bituminous-aggregate mixture used as an intermediate coarse between the base and surface courses or as the first bituminous layer in a two-layer bituminous resurfacing. It is sometimes called a leveling course. **Asphaltic/Bituminous concrete** Bituminous concrete consists of a mixture of aggregates continuously graded from maximum size , typically less than 25 mm, through fine filler that is smaller than
- 0.075 mm. Sufficient bitumen is added to the mix so that the compacted mix is *effectively impervious* and will have acceptable dissipative and elastic properties.

Sieve size			Passing (%)		-	
26	.	5	mm		-	100
19	.		mm	90	-	100
9	.	5	mm	56	-	80
4	.	75	mm	35	-	65
2	.	36	mm	23	-	49
300	.		micron	5	-	19
75	.		micron	2	-	8

Requirements of Bituminous mixes

Stability

Stability is defined as the resistance of the paving mix to deformation under traffic load. Two examples of failure are (i)*shoving* - a transverse rigid deformation which occurs at areas subject to severe acceleration and (ii) *grooving* - longitudinal ridging due to channelization of traffic. Stability depend on the inter-particlefriction, primarily of the aggregates and the cohesion offered by the bitumen. Sufficient binder must be available to coat all the particles at the same time should offer enough liquid friction. However, the stability decreases when the binder content is high and when the particles are kept apart.

Durability

Durability is defined as the resistance of the mix against weathering and abrasive actions. Weathering causes hardening due to loss of volatiles in the bitumen. Abrasion is due to wheel loads whichcauses tensile strains. Typical examples of failure are (i) *pot-holes,* -deterioration of pavements locally and (ii) *stripping,* lost of binder from the aggregates and aggregates are exposed. Disintegration is minimized by high binder content since they cause the mix to be air and waterproof and the bitumen film is more resistant to hardening.

Flexibility

Flexibility is a measure of the level of bending strength needed to counteract traffic load and prevent cracking of surface. Fracture is the cracks formed on the surface (hairline-cracks, alligator cracks), main reasons are shrinkage and brittleness of the binder. Shrinkage cracks are due to volume change in the binder due to aging. Brittleness is due to repeated bending of the surface due to traffic loads. Higher bitumen content will give better flexibility and less fracture.

Skid resistance

It is the resistance of the finished pavement against skidding which depends on the surface texture and bitumen content. It is an important factor in high speed traffic. Normally, an open graded coarse surface texture is desirable.

Workability

Workability is the ease with which the mix can be laid and compacted, and formed to the required condition and shape. This depends on the gradation of aggregates, their shape and texture, bitumen content and its type. Angular, flaky, and elongated aggregates workability. On the other hand, rounded aggregatesimprove workability.

Desirable properties

From the above discussion, the desirable properties of a bituminous mix can be summarized as follows:

- Stability to meet traffic demand
- Bitumen content to ensure proper binding and water proofing Voids to accommodate
- compaction due to traffic
- Flexibility to meet traffic loads, esp. in cold season Sufficient workability for
- construction
- Economical mix

Summary

Bituminous mixes should be stable, durable, flexible, workable and should offer sufficient skid resistance. The mix consists of coarse and fine aggregates, filler and binder. It may be well graded, open graded, gap graded or unbounded as per the requirements. As far as possible, it should be economical also.