Techno India NJR Institute of Technology

B.Tech. VII Semester

Course File

Pavement Design (8CE4-22)

Session 2022-23

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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, NewDelhi

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 ofload, 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=UHWnn4J_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

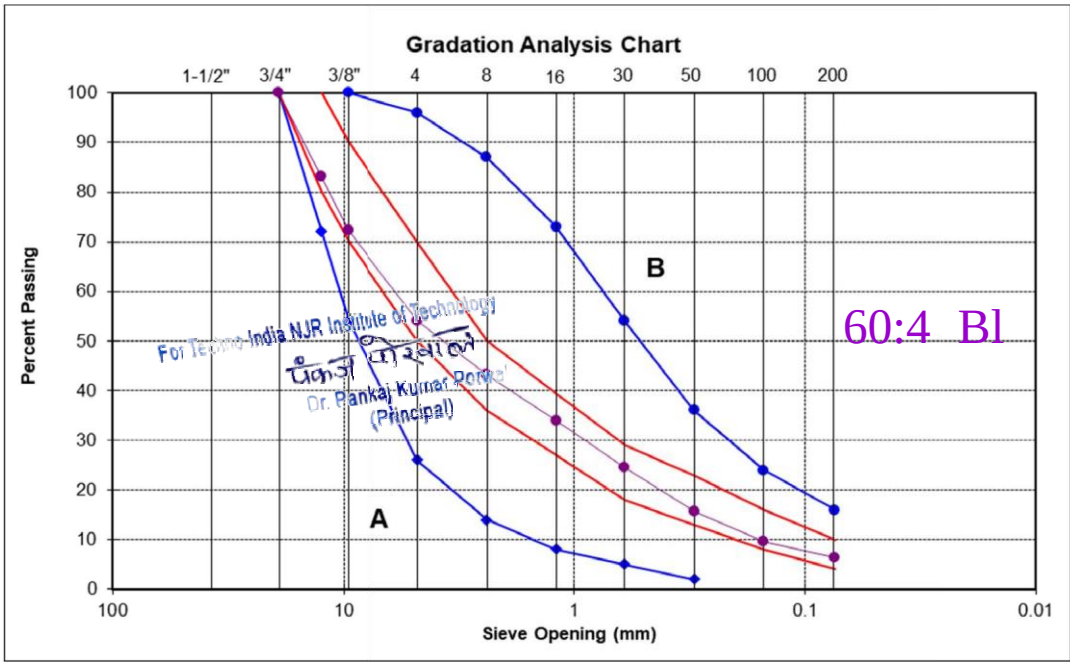
To meet the gradation specifications for a concrete or asphalt mix, we usually have to blend aggregate from several sources together. To find an aggregate source with exactly the right gradation is highly improbable. If we only have to blend two aggregates together, we can usually calculate the proportions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

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

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

f = fraction of blend contributed by material x

TWO AGGREGATE EXAMPLES



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 thelatter as natural binder
- Water-bound macadam, the above constituents, mixed together (pre-mix or in-situ) withwater 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 bitumen emulsions 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 mmor 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 sufficientflexibility at low temperature to prevent shrinkage cracks.

Constituents of a mix

Coarse aggregates: Offer compressive and shear strength and shows good interlockingproperties. 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, stiffensthe binder and offers permeability. E.g. Rockdust, 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 goodinterlocking 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-layerbituminous 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 *effectivelyimpervious* 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-particle friction, 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 whencontent 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 airand 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. Shrinkagecracks 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 aggregates improve 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

B. TECH IV– YEAR (VIII Sem)

SUBJECT: Pavement Design (8CE4-22)

(6CE4-23)

Viva

Q. What is the asphalt?
Ans. A dark brown to black cementatious material which the predominating constituents are bitumen's which occur in nature or are obtained in petroleum processing.

Q. What are the main desired properties of asphalt?
Ans.
1) Consistency: Asphalt is a thermoplastic material because they gradually liquefy when they are heated. They are characterized by their consistency at different temperatures. Consistency is the term used to describe the degree of fluidity or plasticity of asphalt at any particular temperature. At a standard temperature consistency of paving asphalt cement is commonly specified and measured by a viscosity test or penetration test.
2) Purity: Asphalt cement is composed almost more than 99.5% of bitumen, which by definitions is soluble in carbon disulphide.
3) Safety: Asphalt cement is heated to a high temperature, which will release the fumes that will flash in presence of spark or open flame. There is an adequate margin of safety, if the flash point of the asphalt is known.

Q. What are the main function of Base and Sub base in asphalt?
Ans. Base and sub base are structural elements of the pavement, in conjunction with the overlying asphalt surface, their purpose is to distribute traffic wheel loads over the sub grade or foundation, to perform this function base and sub base must be built with necessary internal strength properties, In this respect full depth asphalt pavement have a special advantage over pavements with granular bases.

Q. What is the purity of asphalt?

Ans. Asphalt cement is composed almost more than 99.5% bitumen, which by definition is soluble in carbon disulphide.

Q. What is the function of asphalt Base Course?

Ans. A foundation course layer which consisting of mineral aggregate, it bounds together with asphalt material on which successive course are placed.

Q. What is the allowable normal thickness of asphalt layer?

Ans. Normal thickness for Asphalt Base course should be 80mm and for Wearing course 40mm.

Q. What is the stripping test of aggregates?

Ans. The coating of aggregate by bitumen at 150ºC for keeping 1 hour in oven, visually assessment only required for results explanations.

Q. What is the stiffness (Rigidity) and how it to calculate?

Ans. Stiffness is caused that where low penetration asphalt is used. Such low penetration asphalt causes the volume changes making the pavement rigid; such asphalt mixes give higher stability values and low flow values.

Stiffness = Stability/Flow

Q. What is the stability?

Ans. Stability of the test specimen is the maximum load resistance in Kgs. that the standard specimen will develop at 60°C in 30 minutes while remain in water when tested.

Q. What is the “Flow value”?

Ans. The flow value is the total movement or displacement in units of “mm” occurring in the specimen between no load and maximum load during stability test.

Q. What are the “Air voids”?

Ans. The total volume of small pockets of air between the coated aggregate particles thru out a compacted paving mixture.

Q. What is the consistency of asphalt?

Ans .It is the term used to describe the viscosity of fluidity or plasticity of asphalt at any particular temperature.

Q. What is the penetration test?

Ans. It is the measurement of asphalt consistency test, based on this test asphalt cement can be classified into grades such as 40-50, 60-70, 85-100, 125-150, 200-300.The hardest grade is 40-50 and the softest grade is 200-300.

Q. Describe the procedure of penetration test?

Ans. In this test a container of asphalt cement is heated at a standard temperature 25 Degree in a controlled water bath. A prescribe needle weighing 1000 g is allowed to bear the surface of the asphalt for 5 seconds. This distance in unit of 1/10th of mm (0.1 mm) the needle penetrate into the asphalt cement is the penetration measurement.

Q. What is the softening point of bitumen 60° to 70° grade?

Ans. 47°C to 54°C

Q. What is the refusal density?

Ans. It is the density at which we get the highest value of Marshall density with the regular increase of blows.

Q. What is the difference between the theoretical and compacted density?

Ans. Theoretical density based on the Sp.G value and the other is simple density by calculation

Q. What is the overheated and over burnt asphalt? What should be max temperature of asphalt at the batching plant?

Ans. The mixing temperature of asphalt should be 160 5°C at the batching plant but if the temperature is more than 205±5°C it is considered overheated and to be rejected and if the temperature is between 163 to 105°C it can be used if the sample is tested and the over all properties are falling within specified limits.

Q. Why the loss of stability test is done in hot mix?

Ans. To know the durability of asphalt.

Q. What are the tests to be performed after taking the sample from site?

Ans.

1) Preparation of Marshall molds
2) Sp.Gravity of molds (Gmb)
3) Stability of molds
4) Loss of stability of molds
5) Extraction of bitumen
6) Grading of Aggregate (Extracted sample)

Q. What is the variable speed of bitumen extraction machine?

Ans. The variable speed of extraction speed of extraction apparatus should be up to 3600 R/Min

Q. Which chemicals are used to extract the bitumen from the bituminous mixture?

Ans.

1. Trichloroethaylene
2. Trichloroethane
3. Methylene chloride
4. Benzene
5. Ammonium carbonate

Q. If the grading is out or aggregate content is more what you will do?

Ans. 1 m x 1 m sample by jack hammer for extraction, stop the plant and take the sample from hot bin aggregate and done the individually grading, if the problem is coming than check the hot bin sample source if the problem is coming also now than check the plant using sieves, check the computer functioning if again ask for calibration, if not than take the trial and modify the plant trial.

Q. What is the use of silicons in hot mix?

Ans. Silicons are added to asphalt under certain conditions to reduced the effects of moisture, it may be added to hot asphalt to prevent foaming while in storage, used to prevent hardening of asphalt concrete in storage, to prevent slumping and segregation of the mixture during transportation and tearing of the mix during lay down.

Q. What is the use of rubber in asphalt?

Ans. Natural synthetic and reclaimed rubber in the form of powder, crumbs, pellets, and latex has been used in asphalt to alter certain properties, usually in amounts ranging from 1 to 5% materially changes the properties of asphalt. The purpose for using the rubberized asphalt has been to obtain a material possessing improved elasticity, increased adhesion and greater resistance to fracture at low temperature.

Q. What is the Cut Back asphalt and what are the different types of this?

Ans. The viscosity of which has been reduced by a volatile diluents. The volatile gets the evaporated and the binder develops the binding properties. The viscosity of cut back asphalt and its rate of hardening the road depend upon the quality of bitumen and volatile petroleum solvents.

Q. What are the main types and their function of cut back of asphalt?

Ans.

1) Rapid Curing (RC)
2) Medium Curing (MC)
3) Slow Curing (SC)
4) Raid Curing (RC) It composed asphalt cement and naphtha or gasoline-type diluents of high volatility.
5) Medium Curing (MC) It composed of asphalt cement and kerosene-type diluents of medium volatility.
6) Slow Curing (SC) It composed of asphalt cement and oil of low volatility.

Q. What is Tack Coat of asphalt?

Ans. It is very light application of asphalt, usually asphalt emulsion diluted with water, it provides a bond between an existing pavement and an asphalting layer, which is too being placed over it.

Q. What is the rate of application of Tack Coat?

Ans. < 0.25 liters/M^2

Q. What is a Prime coat?

Ans. A prime coat is an initial application of low viscosity emulsified or cut back asphalt to an absorbent surface, it is used to prepare an untreated base for an asphalt surfaces. It penetrates into the base and plugs the voids, hardens the top and helps bind it to the over lying asphalt course.

Q. What are the applications of Prime coat?

Ans.

1) Water proofing the surface of the base
2) Reducing the capillary voids
3) Coating and bonding loose mineral particles
4) Hardening or toughening the surface
5) Promote adhesion between the base and the overlying asphalt course.

Q. What is the range of rate of application of Prime Coat?

Ans. 0.65 to 1.75 liters/M^2.

Q. In case of the excessive spray what should be done?

Ans. In this case when asphalt is not entirely absorbed by the base with in 24 hours the excess should be removed with just enough sand to prevent pick up under traffic.

Q. If spray on wet surface, what will be the side effect?

Ans. It will strip off; in this case extend the curing time and normally 24 hours required for curing period after initial spray

Q. How to recognize the RC-2 from MC-1?

Ans.

1) RC – 2: It gives the smells of gasoline as bitumen is diluted with gasoline and it is thinner than MC-1and when it is dried it is faster than MC-1.
2) MC – 1: It gives the smells of kerosene as bitumen diluted with kerosene is called MC-1

Q. What is the Seal Coat? How many types of seal coat?

Ans. Actually a seal coat is a thin surface treatment that may or may not be covered or combined with aggregates.

Types:

1. Fog Seal
2. Slurry seal

Q. What is Fog seal?

Ans. It is a light application of emulsified asphalt usually without aggregate cover. The main purposes of fog seal are

1) Reduced entrance of air and water into the pavement.
2) Prevent raveling of a pavement.

Q. What is the slurry seal?

Ans. It is the mixture if slow setting Asphalt emulsion, Fine Agg, Mineral filler and water the mixer is poured into the pits and cracks in the pavement.

Q. What is the surface treatment of asphalt?

Ans. A sprayed on application of asphalt to a wearing surface, with or without a thin layer of covering an aggregate is called asphalt surface treatment.

Q. What is an asphalt surface treatment? What are the types of surface treatment?

Ans. Asphalt surface treatment is an application of asphaltic material to any type of road pavement surface with or without the cover of mineral aggregates, which produced an increase in thickness of not less than 25mm.

Types:

1) Single surface treatment
2) Multiple surface treatment
3) Double surface treatment

Q. What is the mineral filler?

Ans. The mineral filler is consisting of limestone dust, Portland cement or other suitable (inert) mineral matter. It should be thoroughly dried and free of lumps consisting of aggregates of fine

particle. It should be pass from the sieve no.30 and 65% passing on sieve no.200

Q. What are the various types of mineral filler?

Ans. There are four different types of mineral filler

1. Limestone dust
2. Kaoline clay
3. Fuller's earth
4. Short-fibered asbestos

Q. What is the grading range of filler?

Ans.

Sieve No	Passing %
No. 30	100
No. 50	95-100
No. 200	70-100

Q. What is the asphalt laying procedure?

Ans. Hot mix should be laid longitudinally in lane and joint should be cut in straight line or by using the straight edge to maintain the uniformity in lane.

Q. What is the permissible speed of paver while paving the asphalt?

Ans. While paving the asphalt the speed of paver should be 4 to 6 l.m/min.

Q. What is the weight of STR (steel tandem roller)?

Ans. The weight of roller should be in between 8 to 12 Tons.

Q. What is the weight of PTR (pneumatic tandem roller)?

Ans. The weight of PTR should be in between 20 to 25 Tons. And tyre pressure should be in between 6 to 6.3Kg/cm² or 80 to 110 Psi.

Q. What is the permissible speed of roller?

Ans. Roller speed should be 5Km/h.

Q. What should be the FRL (finish road level)?
Ans. FRL should be 15cm below the curbstone.

Q. What is the range of volume of asphalt mold for the unit correction factor?
Ans.509 to 522 cc for 4" (inches) diameter and 2.5 in height.

Q. What is the rolling operation on the asphalt pavement?
Ans. Rolling should start as soon as possible after material has been spread at temperature of 140°C, rolling consist of three consecutive phases.
1. Breakdown rolling
2. Intermediate rolling
3. Final rolling - rolling compacts the material beyond the compaction imparted by the paver, to obtain practically all of the needed density. Final rolling removes roller marks and other blemishes left from previous rolling.
Steel wheeled rollers vibrating by configuration are the two axles tandem rollers weighing 3 to 14 tons or more.
Pneumatic tired rollers have to eight wheels in the front and four to eight heels in the near weighing about 3 to 35 tons for the final rolling combination of steel vibrating and pneumatic tired rollers are used.

Q. What temperature of asphalt is required to stop the rolling?
Ans. No proper temperature has been assigned where the rolling of asphalt can be stopped. Rolling can be stopped only where it is observed that asphalt will probably gives not good results of density even far from the specified values and also if the temperature of asphalt is below than 90C rolling cannot be done in a proper way and asphalt can not be compacted.

Q. What is the limitation of Marshall method of mix design?
Ans. It is applicable to the asphalt mixes having up to 1" maximum size of aggregate.

Q. What are the specified "air voids" for asphalt wearing and base course?
Ans.
Wearing Course = 4 – 7%

Base Course = 5 – 8%

Q. What is the specified flow for asphalt wearing and base course?

Ans.

Wearing Course = 2 – 3.5 (Heavy traffic) and 2.4 – 4 (Light to Medium)

Base Course = 2 – 3.5 (Heavy traffic) and 2.4 – 4 (Light to Medium)

Q. What is the minimum value of marshal stability?

Ans.

1) Wearing Course = 1000 Kg

2) Base Course = 1000 Kg

Q. What is the tolerance between the maximum and minimum Sp.G values of the marshall molds?

Ans. 0.02gm/cc

Q. How many blows are given on each side of the moulds?

Ans. The marshall specimen are compacted with "75" blows of hammer on both sides.

Q. What is the compacting temperature while performing the marshall moulds? How it is affects of Gmb.?

Ans. The compacting temperature for marshall mould test is 145± 5ºC.

In case the temperature during the process of making marshall test is higher as compared to 145 ±5°C, higher "Gmb" results are obtained. If it is lower than 145 ±5°C"Gmb" results are obtained.

Q. How much variation allowed in routine results of stability tests compared to design value?

Ans. Marshall stability should not more than looser than ±200 as compared to design value.

Q. What is the permissible time duration between taking out the mold from the water bath and testing the marshall stability?

Ans. Test should be finished in 30 seconds.

Q. What is the procedure for testing the stability and checking the flow value?

Ans. The test specimen are immersed in a water bath at 60°C for 30 minutes testing, lubricate the guide rod with a thin film of oil. Place the specimen in the machine mould and also place the flow

meter and apply the load at constant rate the point of failure is the maximum load reading record the load reading and flow reading. The test should be finished within the 30 seconds after removal the specimen from the water bath.

Q. When correction factor is applied in stability test?
Ans. Correction factor is applied according to the volume of asphalt mold or thickness of asphalt mold, it is determined by multiplying the correction factor with obtained stability.

Q. How much variation is allowed in routine results of marshal stability as compared to design value?
Ans. Marshall stability should not vary by more than ± 200 Kgs. from the design value.

Q. What is fall and weight of Marshall hammer?
Ans. Hammer weight = 6.5 Kg and fall of Hammer = 18”.

Q. Define the DBM (Dense Base course Macadam) mix method?
Ans. Dense Base course Macadam) DBM mix is the mix which have coarse aggregate than base course 1-1/2 inch and have a separate method.

Q. What are the different types of mix design methods?

Ans.

1) Marshall method (ASTM D 1559)

2) Haveem method (ASTM 1560 D 1561)

3) Hubbard Field method (AASHTO T 169 & ASTM D 1138)

4) Immersion compression method (ASTM D 1075 & AASHTO T 165)

Q. How will you find out the optimum asphalt content while preparing hot mix design?

Ans.

1) Asphalt content at maximum stability = 4.83 %

2) Asphalt content at maximum unit weight = 5.1 %

3) Asphalt content at median of Air voids = 4.8 %

4) Optimum Asphalt Content = 4.91

Q. What are the desired properties of asphalt mix design?

Ans.

Stability

Durability

Flexibility

Fatigue resistance

Skid resistance

Impermeability

Workability

Q. What problems come out if the hot mix contains little asphalt content?

Ans. The hot mix containing little asphalt content will give low stabilities and flow values, air voids will be higher and voids filled with asphalt will be lower. So that the quantity of asphalt should be used which ensures a durable pavement. Therefore much care should be adopted while calculating the optimum asphalt content as little increase or decrease can affect many other properties.

Q. What is the precautionary measure taken if a hot mix results low voids and low stability?

Ans. It is possible to improve the stability and increase the voids of the mix by increasing the amount of crushed material. Care should also be adopted in the use of asphalt content because hot

mix having little asphalt cannot be compacted properly.

Q. What is the effect of “Asphalt content percentage on the Sp.Gravity” or Marshall molds (Gmb)?

Ans. Gmb increase with the increase of asphalt content. At optimum asphalt content value of Gmb is maximum and than start to decrease asphalt content increase.

Q. What is the precautionary measure taken if a hot mix results in excessive voids?
Ans. The increasing of the asphalt content can decrease the percentage of air voids. Increasing the mineral filler contents can also reduce voids. Care should be taken that asphalt content may be increased up to certain limits avoid further problems of rutting and bleeding.

Q. What is the precautionary measure to be adopted if the hot mix results low stability but the air voids satisfactory?
Ans. Low stability when voids and aggregate grading are satisfactory may indicate some deficiencies in the aggregate consideration should be given to improve the quality of aggregates. The aggregates may have to be changed and crushed hard materials may be used to improve the stability.

Q. What precautionary measures are adopted if the stability is coming abnormally higher?
Ans. If the stability is abnormally higher it can be controlled by reducing the coarse aggregate and adding the fine aggregates more. Coarse job mix for heavy traffic is the most suitable whereas the less coarser job mix is suitable for medium to light traffic The aggregate gradation and asphalt content must strike a favorable balance between the stability and durability requirements for the use intended. Reducing the asphalt content can also reduce Stability but the care should be adopted not to use little asphalt content to avoid the further problems in the pavement.
Stability can also be reduced in case the percentage of crushed sand may be lowered, but care should be taken not use the excess quantity of natural sand. It is always better to maintain the ration in the mix.
Crushed Sand = 80 and Natural Sand = 20

Q. What is the rea segregation in asphalt mix?
Ans.
Improper Mix batching
Improper cold feed
Wrong bitumen content

Q. What is the relation between voids filled with asphalt and asphalt content in the hot mix?
Ans. Voids filed with asphalt increase as the asphalt the asphalt content increase, as the asphalt content decrease voids filled with asphalt starts decreasing.

Q. What is the relation between “Gmm & Asphalt content percentage”?

Ans. The asphalt content percentage increase Gmm starts decreasing and with the decreasing of asphalt content Gmm increase.

Q. What is the relation between “Stability & Asphalt content”?
Ans. Stability starts increasing as the asphalt content %ge increase but at certain point stability decrease even with the increase of asphalt content %.

Q. What is the relation between “Loss of stability & Asphalt content”?
Ans. With the increasing of asphalt content the loss of stability starts decreasing.

Q. What is the effect of “Gmm on Gse”?
Ans. Higher values of Gmm will give higher values of Gse in the hot mix.

Q.What is the relation between the “Gmb and Air voids”?
Ans. The value of Gmb decreases air voids starts increase.

Q. How to determine the voids in mineral aggregates (VMA%) in hot mix?
Ans. The volume of intergranular voids space between the aggregate particles of a compacted paving mixtures that includes air voids and effective asphalt content, expressed as a %ge of total vol. of sample.

Q. What is the effect of Sp.G of aggregates on the maximum Sp.G of compacted mix (Gmm).
Ans. The higher the Sp.G of aggregates, the higher the Gmm and if the Sp.G of aggregates is less low value of Gmm will be obtained.

Q. What is the effect of “Gmm” on effective Sp.G.
Ans. Higher values of Gmm will give higher values of effective Sp.G.

Q. What precautionary measures are adopted if the asphalt absorption in the hot mix is coming abnormally higher?
Ans.
1. Sp.G of aggregates from hot bin may be checked and recalculate the combine Sp.Gravity (Gsb).
2. Effective Sp.Gravity of hot mix (Gse) may be checked.
In case of higher absorption either there is an error in Gsb or Gse and probably the erroneous results of Gmm can also affect the asphalt absorption.
Higher the Gmm value, higher values of Gse and obtained for higher value of Gse the value of Gsb may be close to Gse with a little difference between the values of Gse and Gsb higher

absorption value.

Q. What is the effect of combined bulk Sp.G (oven dry) on asphalt absorption?

Ans. The combine bulk Sp.G is calculated by the Sp.G of all aggregates used in the hot mix therefore Sp.G of aggregates plays an important role in increasing or decreasing the asphalt absorption in asphalt concrete. The higher the combined bulk Sp.G of aggregates, the lesser the asphalt absorption. The lesser the combined bulk Sp.G of aggregates achieves the higher absorption of asphalt.

Q. What is the asphalt quantity measurement method for required area?

Ans. For Example!

Area = 20m x 10m x 600mm (Thickness)

= 20 x 10 x 0.6

= 120m^3

= 120m^3 x 2.50 (Density of Asphalt)

= 300

=300 x 100 / 1000

= 30 Tons.

Q. What are the main parts of asphalt plant?

Ans.

1. Cold bins
2. Cold feed gate
3. Cold elevator
4. Dryer
5. Dust controller
6. Exhaust stack
7. Hot elevator
8. Sieves unit
9. Hot bins
10. Weighing box
11. Mixing unit (Pugmill)
12. Mineral filler storage
13. Hot asphalt cement storage

B. TECH IV– YEAR (VIII Sem)

SUBJECT: Pavement Design (8CE4-22)

(6CE4-23)

Quiz

1. Which of the below is the correct formula to find group index (GI) of soil?

a) GI = 0.1a+0.0025ac+0.005bd

b) GI = 0.2a+0.005ac+0.01bd

c) GI = 0.01a+0.025ac+0.05bd

d) GI = 0.02a+0.05ac+0.001bd

Answer: B

2. Soils having _____ values of liquid limit and plastic limit are generally considered to be poor engineering materials.

a) Low

b) High

c) Same

d) Different

Answer: B

3. According to the BIS soil classification system, what does SM represent?

a) Sandy silt

b) Silty sand

c) Sandy clay

d) Clayey sand

Answer: B

4. Identify the right classification as per the unified soil classification system for the following data provided:

SIEVE SIZE (mm)	PERCENT PASSING
4.75	70
2.00	40
0.60	10
0.40	5
0.20	0

Cu = 2.45 and Cg = 1.1

a) SP

b) SW

c) SM

d) SC

Answer: B

5. In the textural soil classification chart, the base of the triangle represents the percentage of _____

a) Peat

b) Silt

c) Clay

d) Sand

Answer: D

6. The cohesion of a soil _____ with the increase in moisture content.

a) Doesn’t change

b) Decreases

c) Increases

d) Decreases then increases

Answer: C

7. Which of the below is the soil classification for the given data?

Passing 0.074 mm sieve = 60%

Liquid limit = 45%

Plastic limit = 39%

Use Highway research board classification system.

a) A – 4

b) A – 3

c) A – 5

d) A – 7

Answer: C

8. Which of the below soil group – value as subgrade pair has been paired correctly according to the unified soil classification system?

a) GC – good

b) SW – excellent

c) SC – poor

d) CH – good

Answer: A

9. Dry sieve analysis is carried out on cohesive soils.

a) True

b) False

Answer: B

10. Using the below given data, which of the options represent the group index of the soil?

Passing 0.074 mm sieve = 50%

Liquid limit = 46%

Plastic limit = 37%

a) 4.45

b) 3.45

c) 4

d) 3

Answer: C

11. The ISC system of soil classification consists of a total of 18 groups of soil.

a) True

b) False

Answer: A

12. In a CBR test, the load values corresponding to different deflection values are noted.

a) True

b) False

Answer: B

13. Determine the sensitivity of the soil if the undisturbed undrained shear strength is 52.78 kN/m2 and the disturbed undrained shear strength is 23.54 kN/m2.

a) Less sensitive

b) Sensitive

c) Highly sensitive

d) Quick

Answer: A

14. The test results from the dynamic cone penetration test can be related to CBR.

a) True

b) False

Answer: A

15. In a drained test, the drainage is permitted during the application of _____

a) No stress

b) Deviator stress

c) Cell pressure

d) Cell pressure and deviator stress

Answer: D

16. What is the CBR value of the soil if the CBR value at 2.5 mm penetration is found to be 4.5% and that at 5 mm penetration is found to be 4.3%?

a) 4.5%

b) 4.4%

c) 4.6%

d) 4.3%

Answer: A

17. The cone penetration test is also called _____ test.

a) Swiss cone

b) Dutch cone

c) Dynamic cone penetration

d) Static cone penetration

Answer: B

18. What is the cohesion for a soil sample that fails under axial stress of 140 kN/m2 when subjected to unconfined compression test and has an angle of internal friction of 17°?

a) 38.33 kN/m2

b) 0 kN/m2

c) 38 kN/m2

d) 40 kN/m2

Answer: A

19. Which of the below facts about the particle size distribution graph is false?

a) Uniformity coefficient can be obtained from the graph

b) Particle size is plotted on the X-axis

c) Helps in understanding the physical properties of soil

d) It is also called a semi-log graph

Answer: D

20.What is the liquidity index of soil if the plastic limit is 24%, the liquid limit is 49% and the natural water content is 35%.

a) -54%

b) -44%

c) 44%

d) 54%

Answer: C

21. The diameter of the standard plate used to find the value of modulus of subgrade is _____

a) 7.5 cm

b) 75 mm

c) 75 cm

d) 750 cm

Answer: C

22. A vane of 80 mm diameter and 160 mm height was pushed into the soil using a torque of 80 Nm. What will be the undrained shear strength of the soil?

a) 4.263×10-5 kN/m2

b) 4.263×105 kN/m2

c) 42.63 kN/m2

d) 4.263 kN/m2

Answer: C

23. Which of the below soil samples has better shear strength at the plastic limit?

CONSISTENCY LIMITS	SOIL A	SOIL B	SOIL C	SOIL D
Wl	38%	60%	33%	53%
Wp	21%	21%	18%	26%
If	4	12	8	14%

a) Soil A

b) Soil B

c) Soil C

d) Soil D

Answer: A