

19.09.2017

CE 451: ~~test~~

Lecture 1 : Introduction

Rationale

Materials for highway constructions

Ques. 1. What is the rationality of this course?
- (20/09/2017)

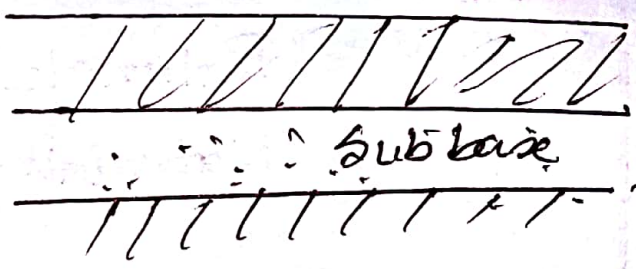
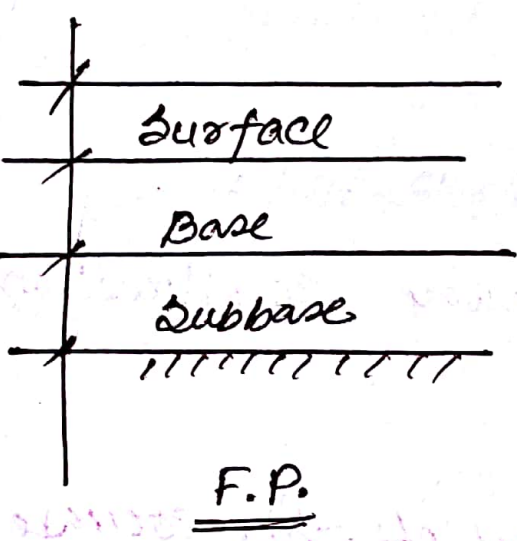
— Civil engineers plan, construct, ~~supervise~~ ^{maintain} civil engineering structure.

— Everything that is man made is civil engineering structure.

— For doing these works, we need the knowledge of structure.

* ~~Ques 2~~ What is design in (Civil Engineering)

— To find details of a civil engineering structure.



- thickness থৈৰ কাঠো হৈ। [dimension of structure]
- details of materials সামগ্ৰ - design

Rationale of this course is

- Material knowledge is important for design

Highways

Roads

Streets

Paths

- जबकि हमें proper highway/expressway/arterials नहीं। जोड़ना चाहिए। एक road एक connected रहे। एक आवाज है।
Originally हमें interruption = आवाज
है।

Ques. Why do we need roads?

→ we need roads to move from one point to another point.

→ Among another modes of transport, roads are most attractive mode of transport. Cause it gives most flexible movement. [है। एक road एक]

दरकार। - एक ही निम्न - आवाज - एक ही
Most popular means

of transport.

Q. What are the requirements of any mode of transport?

→ 4 requirements:

1. Safety
2. Efficiency
3. Comfortability
4. Economy

[BRTC test এর নাম : agg & (পড়তে হবে)]

Book:

Wright & Dickson. — [Highway Engineering]

[Next class 4 sheet আনতে হবে]

Text book: Highway Engineering

→ Paul Wright & Karen Dixon

(7th edition)

- * अवलोकन यह volume काष्ठिय प्रकर aggregate.
- for any type of civil engineering structure

Q. What is aggregate?

- Load सहिष्णुता
- Major volume occupy - कंक्रीट,
- binding material फिर binded है।

* aggregation : अवलोकन संयोजन

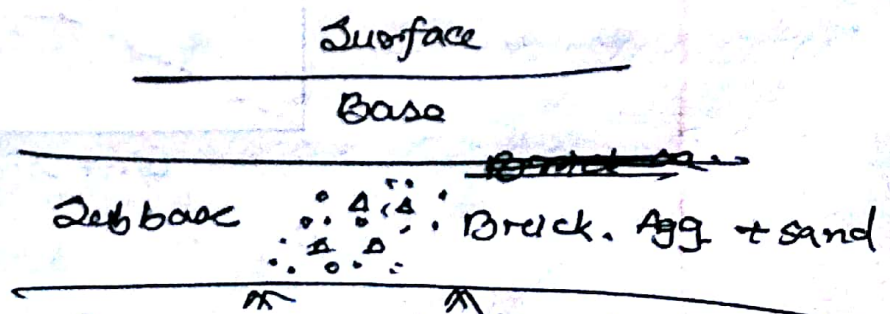
* non-metallic mineral : Best material.

Na, Mg, K etc.

* वास्तुशास्त्र में प्रयुक्त sub-base

↳ brick aggregate + sand

— use क्या है।



Page 412; 18.1

properties of aggregate.

① Particle size and gradation,

② Hardness.

③ - - -

④ - - -

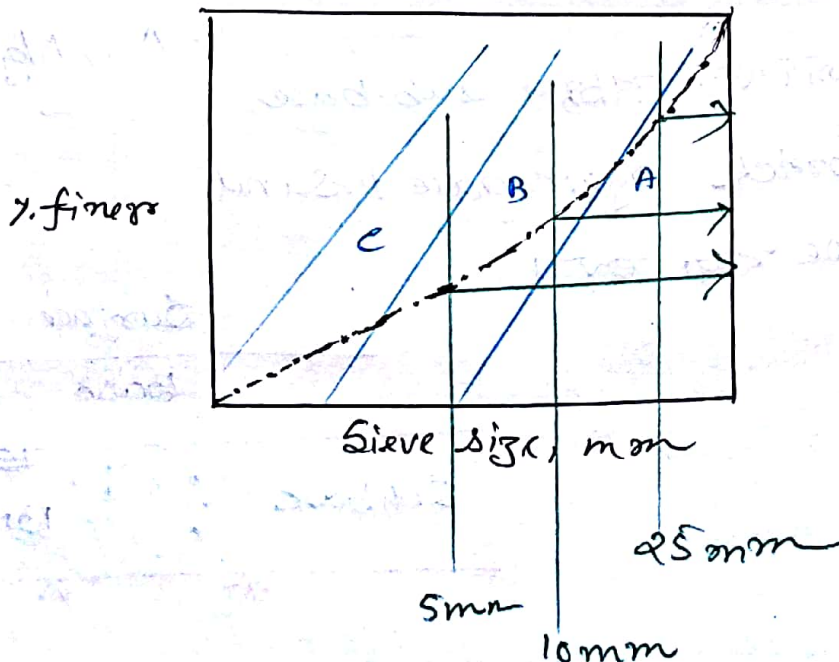
⑤ - - -

Q. What are the properties of aggregate for highway construction?

[যহে-সহক চপ্তা 15) photocopy কৰা আনব

to be checked.

চক্ৰ ৩]



ଆବଶ୍ୟକୀୟ C_2 - C_3 A, B, C ଆବଶ୍ୟକୀୟ ।

specific proportion ବା C_2 ବିକାଶ - ତଥ୍ୟ desired
gradation - C_3 ବା C_4 ବା C_5 blending / mixing
of aggregate.

C_2 : Chemical stability

Bituminous surface C_2 the surface should
be hydrophobic. (ମାନିକ ଭାବରେ ବା
Hydrophilic \rightarrow ମାନିକ ଭାବରେ ବା)

* Bituminous road & water is number one
enemy.

* ବାହ୍ୟାଂଶ - C_2 sand stone

ବା hydrophilic
(sedimentary) rock

* Hydrophobic \rightarrow basalt \rightarrow igneous
(positive charge)
 \rightarrow ଆବଶ୍ୟକୀୟ ବା C_2 ,

* Granite C_2 border line C_2 .

Lecture-2

Aggregates

Properties

Tests

Specifications

* Aggregate এর বিভিন্ন property বিভিন্ন particular construction এর জন্য special.

* স্রাব aggregate কে চাকরু - স্রাব ঘর্ষণের - স্রাব শক্তি - ২৩ হবে, তাই এর স্রাব resist করার জন্য strength থাকতে হবে, নীচের layers এ থাকার দরকার নাই এর property.

surface

Base

subbase

(((

* properties depends on type of use of aggregate

Book: Page 412 → onwards :

15-8-1: properties of aggregate.

15-8-2: size and gradation.

15-8-3: Resistance to wear.

15-8-4: Durability.

□ Fundamental property of any

civil engineering

1. Stability
2. Durability

material:

* weathering agents
(ca. under original characteristics change
शुद्धता।

* During ~~some~~ severe service condition (service 100% ~~हस्तांतरण कक्षा~~, ~~तुल्य शुद्ध~~ 110%), it can retain original characteristics

15.8.5

15.8.6

15.8.7

* ^{১১}কাঠকোণ flaky হবে, তার percent limited থাকে।
crushed stone

* ~~shingles~~ এর ~~resistance~~ ~~বেশ~~

- পাওয়া যায়, shingles use করলে ~~strength~~
resistance কম - যার binding
material না থাকে।

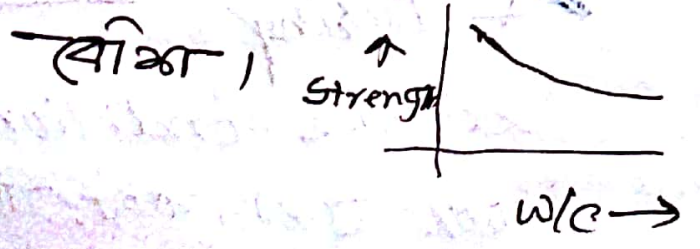
* But এখন concrete use করছি,

shingle (rounded, smooth) more

strength দেয়। কারণ এখন কম মানের

workability - পাওয়া যায়, আবার, cement

এবং ফলস্বরূপ w/c ratio কম হলে strength



* Hammer fall 18".

Sheet #6

Sheet #11

Asphalt concrete:

Binding material asphalt

Q. What are the tests for Asphalt concrete.

— Table 8.3

Q. Write 3 name of test, designation and limits of asphalt concrete?

— Table 8.3

CE 451:

Lecture 4

Sheet # 12

Bituminous materials:

Sources

Types — General properties

Production

Uses — Properties

Tests

Specifications

Sheet # 12

Q. What is common property?

এটিতে কোন set
এ common prop.

— থাকবে, কোনটায়

desirable property
— থাকবে।

page 417: 15-9.

Fig. 15-8

(বইতে হিসাব,)

(Sheet @ 4)

Sheet #12

আমরা American rule follow করে, কেউ
হবে English.

Bituminous material → General name.

→ Asphalt

→ tar: obsolete.

it is a by-product

↳ কারণ produce করা হতে destructive
distillation of coal or wood.

↳ main purpose gas তৈরি করা (methane)

Asphalt

→ Natural → As rock asphalt, lake asphalt

99.999% Manufactured from refining crude
petroleum

↳ আদির নীচে - তাইনামা, তীব্রত্ব যোগ
- গভীর হাড়। উন্নতির pressure & earth
contact এর heat হতে fatty residue
converted to petroleum

page 418 → refinery steps.

refinery এর purpose mainly gasoline, kerosene এবং দীর্ঘী বাক্য।

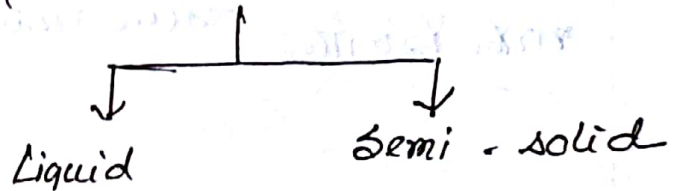
⇒ Gasoline

⇒ Kerosene

⇒ Diesel

⇒ Lubricating oil

⇒ residual asphalt



* যদি হ্যাঁক refine করা হয়, liquid হ্যাঁক semi solid হ্যাঁক ফ্যাক্ট করা হ্যাঁক।

* Semi-solid হ্যাঁক হ্যাঁক penetration grade asphalt.

* Air blown asphalt.

Before mixing semi-solid or liquid

231

heat

Gasoline, kerosene, Diesel → Cutback Asphalt

RC-CA

(Rapid Curing)

Cut back asphalt)

MC-CA

[medium curing]

SC-CA

(Slow Curing)

unmodified asphalt

Lecture 5

Bitumen

Classification of Asphalt Cement

- ① penetration grade.
- ② Based on capillary viscosity test.
AC-25, 25±50 poise
AC-40
- ③ Based on capillary vis on residue of TFO

Total classification (Page 428)

Common properties }
Desirable properties } Sheet no. 12

Modified binders → sheet # 10

Tests - ~~table # 8~~ page: 422
Sheet no. 05

Specification - } Sheet no. 11 → table 8.4
 } Sheet no 14 → table 1.2

Bitumen Quality for road construction in BD.

Total classification is from

① Straight Run Asphalt:

⇔ Air blown Asphalt.

⇒ Penetration Grade.

⇒ Cut back -	Rc	50
	Mc	-25
	Sc	

⇒ Emulsified asphalt	- Air -
	- Cut -

15.8 (Page 488)

(স্বতন্ত্র তালিকা হতে)

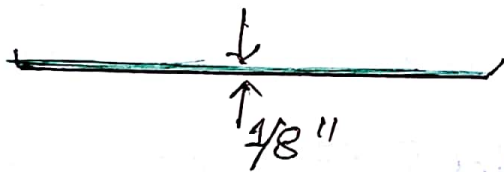
Total classification (Page 428)

(গায়েব Table →)

→ Viscosity is a quality that enables to retard the flow. Opposite to fluidity.

[যত স্থিতিশীল - সঞ্চার - শক্তি - যাবে, তত η (viscosity) তত স্থিতিশীল]

→ TFO : Thin Film Oven



lab এ আমরা বসি thick layer দিয়ে loss on heating test. Thin film এ loss হয়

বেশ। এই কারণে condition ও represent

করে। কারণ aggregate এর উন্নত thin layer of bitumen যাবে।

* Table 1 থেকে Table 3 এর value বেটা,

কারণ TFO কাজে হয় তাহলে 150 গু.

viscosity বেটা।

Sheet 14; table 1, 2

Table 1 → ~~UK~~ USA

Table 2 → ~~USA~~ UK

** Asphalt cement is the commercial name of penetration grade.

Sheet #12

Common properties

Desirable properties.

Sheet #10

Modified binders. (sheet → photocopy of book → page 467)

Tar-bitumen

Rubberised tar and bitumen.

polymer modified bitumen.

* SBS सबसे अधिक common है।

[Table 20.6, Sl no. 2, example]

→ Polymer block

SBS को बिटुमिन में जोड़ा जाता है ताकि anti-stripping quality

→ Aggregate हटने से बचाव
निर्दिष्ट गुण ना रहे।

Ques. Exam ① What are the advantages of modified bitumen?

② What are used for modification?

③ What are the requirements for modifiers?

(Not sure) ④ What are the types of bituminous courses?

Testing of Bitumen:

Table 15.6

Page 422

(42)

[5-61 group]

- ① → purity: solubility ✓
- ② → consistency: Penne
- ③ → ductility
- ④ → Volatility
- ⑤ →

आवर्गीय group आहे general group.

Sheet #5:

आवर्गीय खणनार्थ खणनार्थ वगैरे?

Specification Table 1.2

Ques. Compare AASTO & BS classification for penetration grade asphalt or bitumen

→ ans. কোনটা কি কি test আছে?

→ কোনটা কি কি value আছে?

Sheet #1

overlay

→ specification for overlay.

Ques. What are the ~~require~~ test for asphalt cement for overlay mixes?

⇒ Table 8.4 [Asphalt cement]

⇒ [requirements for asphalt cement for overlay mixes] [কোন কোন table exam এ আছে]

Penetration

Flush point

(ক্রমে নিচে যাবে)

Retained penetration after thin film

oven test: retained penetration

value 52 এর বেশি হতে হবে, এর

কম হলে গ্রহণযোগ্য না।

52 এর অনেক নিচে হলে বুঝায় we

করা হলে - প্রতিদিনের তাপে আচ্চে

আচ্চে brittle হয়ে যাবে,

[Next class - Class test]

↳ Syllabus ⇒ আজকের lecture

24.10.17

Lecture 7

Emulsified asphalt

Bitumen Quality for road const. in BD

Asphalt .

Sheet #12

Ques. What is it?

Emulsion is the mixture of two immiscible ingredients. Mixture of asphalt & water.

Ques why is required?

For road construction, we need to coat the total surface of aggregate. Most of the bitumen is in semi-solid state. So, for coating, we need to make it in liquid state.

One way \rightarrow applying heat. Not environmental friendly, costly.
In mixing plants \rightarrow ok.

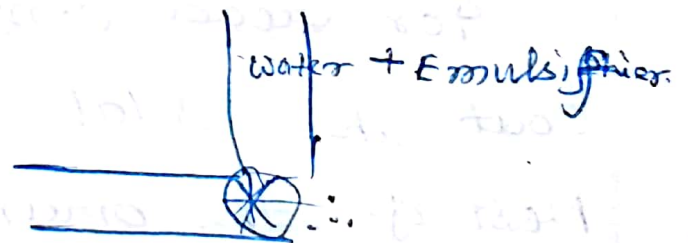
* We can use oil material with asphalt. (gasoline, kerosine)
→ costly.

* But if we can mix it with water, it is not costly, easy to find.

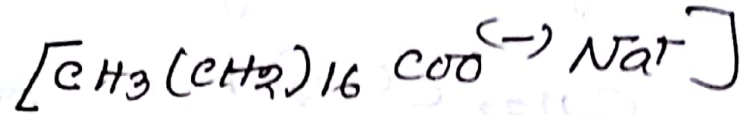
Ques. How is done?

Technique:

→ Make globules of bitumen
(छोटे-छोटे कण) (2-3 micron)



Emulsifier → 1. Sodium Stearate



globule surface e⁻
ଅଣୁ. ଧାରଣ ଥାଏ

anionic emulsion
same charge
— ସାକାମ ବିକାଶିତ କରା

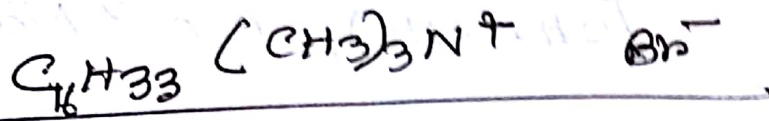
otherwise globule ଛୁଲୋ ଉପସ୍ଥାପିତ

lump ହୋଇ ଯାଏ,

ସାକାମ ଉପ ଗlobule ଛୁଲୋ ଉପସ୍ଥାପିତ

ସାକାମ — ଗାଠି ଗଠି ଗାଠି ସାକାମ — ୨୧୫, ୨୧୫, ୧

2. Cetyl Trimethyl Ammonium Bromide.



Cationic emulsion

Ques. कौनसा कौनसा use करा?

* Sandstone, quartz, wet aggregate

असले cationic emulsion use

करा, काला रंग निर्यात करा.

charged. Pavement / road construction

→ Cationic emulsion use करा, roof

→ use करा time. So

असले cationic emulsion.

Emulsion is made specially for maintenance, good in adverse weather condition.

Q. What are the test?

↳ Particle

Q. What are the specific test for emulsified asphalt?

*** Special test for emulsified asphalt.

Sheet #14

Last class (17.10.17)

CE 451 : Lecture 7

Bituminous mixes

- Types.
- Classification

High type bituminous pavements

Ch. 19, Text book

* Sheet 15, 16, 17

Sheet 13 * Lec. 7 এর প্রথম part আছে।

Sheet 16 * প্রথম page.

* Types of bituminous mixes

* Sheet 13 এ আছে purpose wise

Ques. What is Bituminous mix?

Low, intermediate, high type

depends on specification of the work.

* Types of surfaces!

Ques. What is types of surfaces/ surface treatment?

* Any work or maneuver to treat the surface
→ surface treatment.

* prime coat

* Tac coat → ভালি স্তর

* Seal coat → impervious to penetration of water
বন্ধ হয়।

✓ Single dressing:

bituminous layer + aggregate layer.

✓ Macadam

Road এর কাজের process. নীচের কাজ aggregate
দিয়ে তৎপর করে agg. দিয়ে then compaction.

✓ Premix surfaces

আগে mixing করা হয়, then surface এর
টানা করা হয়।

patented mixtures:

কোন ব্যক্তি বা কোন প্রতিষ্ঠান বাচ্চায় mix বানাতে না,
কর থেকে বানাতে নিষেধ আছে। বিশেষ বানাতে
unknown. • specific strength attain করতে
সাফল্যই হয়।

Miscellaneous mixes:

Sheet 16

Exam: Imp.

Ques What are the characteristics of high type bituminous mixes?

→ 1st page (chp 19)

→ Sheet को आर (sheet no. 16)

वर्षे ह्याक [They are capable of carrying -----]
वर्षे point और
sheet 3 नार

Ques What are the types of high type mixes?

Sand asphalt → बालु र शुकुत (:) (:)
↳ बिना बदल विभिन्न (:)

Rolled asphalt → sand asphalt + aggregate
नरम अवस्था stone insert करा गर
शुकाणु आनक = काकु र (र - यार)

50 pen bitumen → 50 penetration bitumen.

डावम सुदुल penetration grade यम

३० रम, penetration grade यम रम

आनक काकु रम, penetration grade २०

दुलि, ३० मरम ।

* Asphaltic concrete / rolled asphalt.

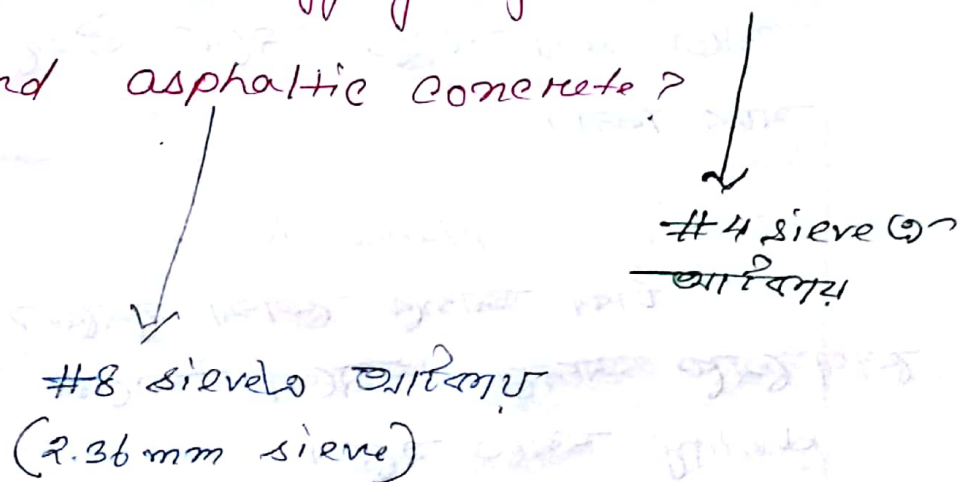
Chapter 19

19.1 Design of high type paving bituminous mixture (sheet is photocopy of the book)

Ques What are the fundamental properties of any civil high type paving mixture?

1. Stability
2. Durability
3. Skid resistance
4. Economy.

Ques Define coarse aggregate for cement concrete and asphaltic concrete?



CE 451 : Lecture 8

Design of bituminous mixes

Design steps:

1. } 19.1.4 text book
2. } page : 534
3. } [7th edition]

Steps for mix design

* Step 2 and step 3 বইয়ে 19.1 এ বর্ণিত আছে।

* Design testing:

design কে আগে কিছু test করতে হয়।
আগে test করতে হবে প্রকৃত design করা
থাবে কিনা।

Source acceptance testing:

একটি আসন্ন প্রকল্পে কীভাবে materials
সংশোধন আসন্ন প্রকল্পে আসছে source
identify করতে হবে।

আমাদের দেশে অনেক project রয়েছে

इस aggregate availability पर कारगर, हमारा ज्ञान है, पर यह आर कितना।

Job-mix control testing: mixing for control पर अन्य testing करते हैं।

Construction control testing:

किसी test everyday करते हैं।

किसी test 6 जाम पर करते हैं। या फिर

अन्य।

Step 1:

Asphaltic cement or must mineral filler चाहेगा है। fines, dust etc.

Limestone dolomite dust.

NP-soil
cheap material
Non plastic

** Grades of asphalt:

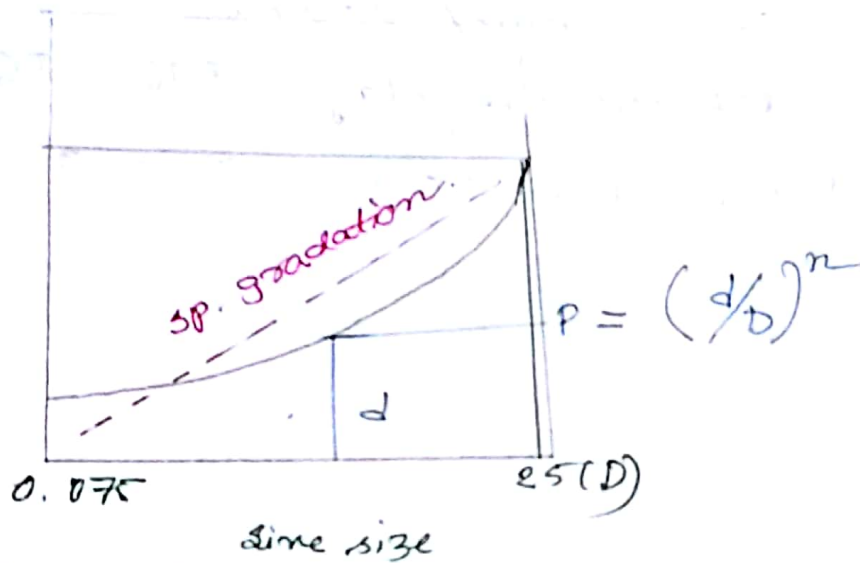
- penetration grade [एक worldwide not used]
- Viscosity grade [" " " "]
- Performance grade [worldwide used]

একই bitumen ২ বিভিন্ন classifly ব্যপ

সাধি, বিভিন্ন সিনিং মিচ ব্যপ হয়।

Step 2:

Requirements related to aggregate gradation.



$n = 0.45$ হলে এর straight line হয়ে যায়।
Still it's dense graded.

Specified gradation - সামগ্র্য উল্য available aggregate হক মিচ ব্যপ হয়। এক ব্যপ

blending of aggregate.

* Gradation \rightarrow বিভিন্ন size এর proportion.

Step 2 & Step 3 (20 marks) [19.14] or

[page 534] or (20 marks) Determination of job-mix formula.

↳ particular job or any job mix formula.

* formula or 2 parts:

- ① Aggregate combination.
- ② Selection of optimum asphalt content.

[Table 19.5] trial and error method:

∴ after long trial (Table 19.5) a final result is reached.

** Chapter 18.

* 1st math [problem 18.5]

↳ blending formula.

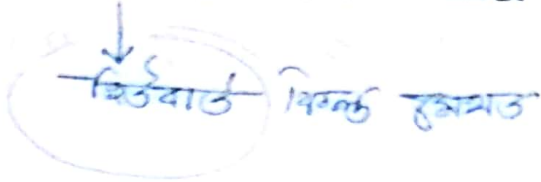
[18.5] problem → math example.

Step 3:

Asphalt
Optimum binder content

→ getting actual
mix design. And
lab to step 3
→ Marshall mix
design

* Hubbard - Field method



** BS 594 → Marshall method - use

** Lees Asphaltic concrete → complex method.

** Leeds Design method

↓
name of a city

General step:

उदाहरण : विभिन्न percentage का ? Required

के मातापिता के।

** Graph का lab Co, (Marshall
method of mix design)

কমি মিক্সের ১% bitumen
১২ part

১২০০ total mix ~~১২০০~~ ১২০০ gm.
১২০০ bitumen. তার মধ্যে bitumen
কতটুকু?

⇒ Aggregate আছে ১২০০ gm.

⇒ bitumen মাত্র ৬৩ gm
??

Q. 19-1.7 Density voids analysis.

→ এই topic এর সর্বত্র হার formula
দিয়ে math আছে।

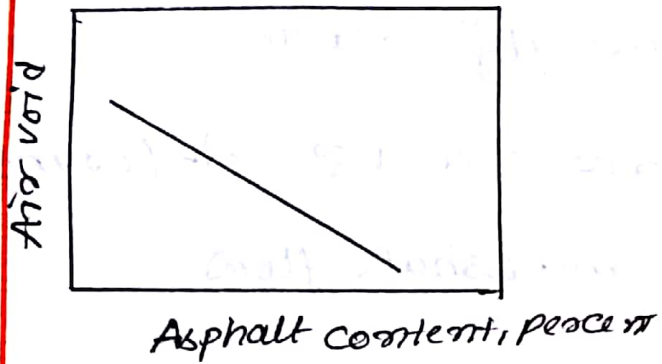
(* Ref. M.S. 2 of the asphalt radio document
(সর্বত্র - এর জন্য সর্বত্র))



- * Height সর্বত্র,
- * split cylinder test.

↳ on the diameter split সর্বত্র

↳ tensile strength সর্বত্র



Graph

Fig. 5-5
 → Ques. Draw Qualitative Marshall
 property curve

Ques Optimum binder content — কমত শতাংশ?

At which percentage, it fulfills the design criteria.

↳ উন্নিত traffic condition এর জন্য বিস্ট .

* * percent air void এর সীমা (80%) fail করে।

* * আসফাল্ট method এর সীমা 3-5% এর

যদি নিম্নের কাজ সূচ্য করা হয়। এই percent air void সীমা সূচ্য।
Suppose সীমা 4% air void — আসফাল্ট।

উদা-1 আসফাল্ট — সীমা — 4.8% asphalt content হবে
(table 5.2)

প্রথম: 4.8 asphalt content এর flow

সীমা $> 1800 \text{ kg/m}^3$: ok. প্রমাণ সূচ্য

asphalt content এর against এ সূচ্য design criteria check করে।

↳ table 5-2 & 5-3 অনুসারে check ok বলে

sample ok .

[এই আসফাল্ট সীমা 4.8% sheet এ সূচ্য graph

সীমা]

[chapter 19]

CE 451: Lecture 10

Hveem method of mix design

Salient features.

Design steps.

Determination of estimated asphalt content.

Differences between Marshall & Hveem

Aug 2016 [similar to problem 19.3 page 570]

An asphaltic concrete sample cut from a completed pavement weighs 3540 gm in air and 1962 gm in water. The lab compacted specimen of the same mix has a bulk sp. gr $G_{mb} = 2.384$ and voids percentage of 5.5%. Is the mix satisfactory? [5-7 marks]

→ Next class 9 का वीडियो
 लाइक करें।

Contd. from prev. lecture Determination of OAC/DBC/OBE

~~* Margin~~

* Marginal value of marginally fail part adjustment करण

Evaluation of adjustment for design.

suppose range (8-14) → 8.5 of 7.8 करण

अन allow करण, same for 14.2 / 13.8.

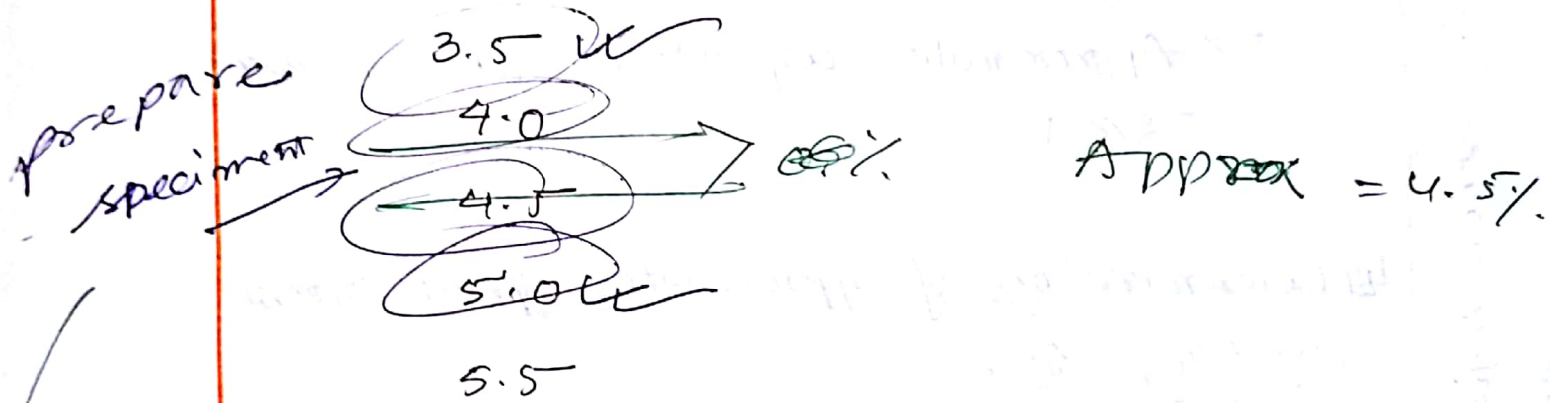
अन adjustment करण

Medium to low range

Outline of method:

* For organic soil -> use Marshall method

Major diff between Marshall method and HVLEM method: Stage D.



Approximate or estimated asphalt content.

↳ Optimum asphalt content Material property

→ HVLEM method,

→ Marshall method

Lecture 11

Hveem method of mix design.

Stage D: Determination of approximate/ estimated asphalt content by C.K.E. procedure.

Material

↳ Aggregate & bitumen

↳ Approximate asphalt content \approx 5.5% (approx)

□ Determination of approximate asphalt content.

(page 546) ~ 553)

↳ 7th edition book (सिग्नाचर sheet 15th prev. edition \approx 5.5%)

* Surface area \approx 100% chart आहे.

Gradation \approx अनुसार. Example चर्चा \approx 100%

आहे (chart) - सिग्नाचर चर्चा \approx 100%

Step 2

वर्ग \approx 2.65 इतके चर्चा.

Step 1: Surface area
Sub: Calculate surface area ...

Ques. How to find/determine c.k.f surface constraint. (১ম প্যারায় আছে)

↳ কোর্সে স্যাটুরেড বস্তু হয়। এখন dry weight থেকে বোঝা হবে saturated weight.

→ 400 times gravity হতে centrifugal force দেয়া হয় ০২ মিনিট ধরে। এতে কিছু

Residue হবে ~~১০০~~ হয়ে যায়।
100% course aggregate

→ Suppose ১ saturated বস্তুর weight হয় 102 গুণ।

→ Centrifugal force apply করার পর হয় 100.5 গুণ।

→ ∴ increase বস্তুটা 0.5%।

→ এটা হল c.k.f. এটা হলো centrifugal

Kerosene Equivalent.

* * Course aggregate ⇒ ~~At~~ #3 passing.

#4 retained.

→ S.A.E. no. 4 lubricating oil L এর

কুমার রাখতে হবে 5 min agg. &

funnel. (room temperature)

Step 3

→ 15 min free drainage, (60°C)

→ The amount of oil retained on course aggregate is surface capacity.

(Fig no. 19-5^r)

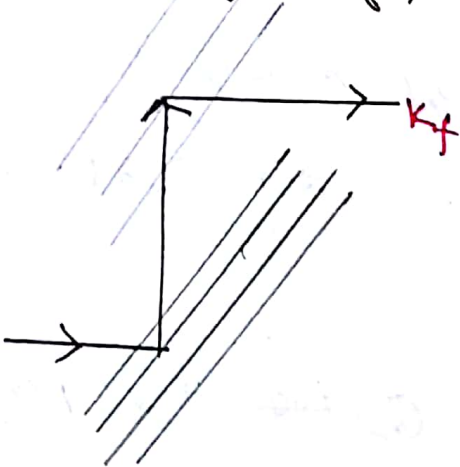
Step 4

→ Corrected CKE पुरुषा कुवला

→ Surface area मरतु 2174,

→ उपलब्ध % passing #4 sieve (gradation curve परसे)

→ काले क्य. मारवा,



~~* deformation is~~

Steps

Chart of combining K_f & K_c to determine K_m

* Course aggregate (percentage passing
(100 - percent passing #4 sieve))

Step no. 07

(Fig 19.8)

based on cutback asphalts of RC-250,
MC-250 and

Case 1

Oil ratio

↳ liquid asphalt

* Scale A & Scale C to point निव, straight
line दिह्य हुआ वरुण 1 एवम scale B के

एव point ए cut वरुण, तारु वरुण approximate
asphalt content. (only for cutback
asphalt, RC, SC - - - etc)

Case 2

→ Scale D रूबरु कुरु वसुधर

→ Avg. SP-Gir ए गिरा Vertically downward

होनामास ।

→

→ Right ए गिरा दाई ओर ratio

सुवान वर्धुयहिन्, सुपुन नार्थ

* *

K_f & K_c value वगशकगिरि इल्ल वसुधर
Case 1 use वसुधर ।

* * K_f & K_c value significantly वसुधर
Case 2

↑

एइ इइ case एइ इ

for liquid asphalt .

(Fig 19-9)

Liquid asphalt 250 — માણ SC - 250, MC - 250 etc

AR → Asphalt residue

↳ thin film over test ત્રા કરે પણ
— થોડા માટે — ત્રા-વેગ test કરશે

* વાહક તરફથી liquid

* penetration value — (વેગ આને viscosity

— વધારા કરશે) penetrate વધારે માટે

Scale A → point ઠીક કરવામાં (કોન વિદ્યુશન,

Scale B → surface area (પાનામાં)

Case 1/2 ત્રા value દિવ ~~case~~ scale D હો

Scale B and C connect કરાઈનામ, B & D

હો connect કરામાં રહે કરીને connect

— વાસ extend વાસ મા

page 428 → Viscosity grade ત્રા table → AR & SC.

(Table 1, Table 2 — તેમજ આગળ આગળ
ચિત્રમાં પણ મળે)

સુધારા કરવા માટે
સુધારા કરવા માટે
સુધારા કરવા માટે
સુધારા કરવા માટે

* Marshall method এর জন্য

→ optimum asphalt content.

Atveem method এর জন্য ২২ design asphalt content.

for hot-mix design, using an average aggregate tests are scheduled as,
→ shut এ নাই, দিতে হবে

AE 5.0%

- = 6.0%
- = 5.5%
- = 5.0%
- = 4.5%

এই percentage এর sample

⇒ যানাও হবে। যদি

approx 4.5% লোডাঙ্ক, তখন:

5.5%, 5%, 4.5%, 4% ২০।

→ এটি হচ্ছে design asphalt content হবে

বছর, (অতিরিক্ত জাবার ২টি specimen

লিভী করণ।)। Jwel check বছর।

Marshall method এ দিন $3 \times 5 = 15$

প্রয়োগ যদিও বলা হবে (জাল ৬ ঘণ), বছর ২
টি যেন অব্যক্তি নিত পারি।

Lecture 12

* Hveem method of mix design

* Super pave mix design.

☐ Preparation of test specimens:

Approximate asphalt content by C.K. $E = \frac{4.5}{5.5}$

6.0
 → 2% ବ୍ୟକ୍ତି,
 2% ବ୍ୟକ୍ତି,

+ ଆହୁ 2% = 4% specimen total.

↓
 ଆହୁ 4% କରୁଥିବା ସହିତ design asphalt content ହେବ, ତାହା ଦିଆ ଯାଉଥିବା ଆହୁ 2% ।

* Marshall method ଏ ଟ୍ରାକ୍ଟର କମ୍ପ୍ୟାକ୍ଟିଂ ମାଧ୍ୟମରେ ହେବ । Hveem method ଏ ଗାଡ଼ି ।

* Marshall method ଏ compaction ବ୍ୟବସ୍ଥା ହେଉଛି 100 mm deep hammer ମାଧ୍ୟମରେ । Hveem method ଏ compaction ବ୍ୟବସ୍ଥା ହେଉଛି kneading compaction ମାଧ୍ୟମରେ ।

→ kneading machine का प्रयोग।

→ Heem method & Marshall specimen height 2.5"।

* and the levelling of load of 56 KN by applied by the plunger method. [Sheet is last line]

* Stabilometer test.

* Swell test:

मानिक उपाय द्वारा कर।

* To represent worst condition.

[आमद करी CBR का]

→ Load bearing capacity का

अर्थ कर।

मानिक उपाय द्वारा कर।

* Cohesometer test → Ductility का

अर्थ कर।

* Stability test to axial test for 30 /
 vertical & horizontal load for test rig /

$$S = \frac{22.2}{\frac{P_{MD}}{P_h - P_n} + 0.22}$$

Marshall method of flow value test

fig 6.14 Chart for correcting stabilometer value ~~test~~ to effective specimen ~~test~~ height of 64 mm

6.20 Design criteria

Table 6.2 Atvrum mix design criteria

Ques what is

ESAL ?

↳ Equivalent ^{Standard} ~~Single~~ Axle Load

⇒ Design ^{Structure} ~~or~~ 1st thing ~~is~~ → for

whom? → road load ~~or~~ ~~any~~ ?

→ 2. कि material दिना क्या रहे।

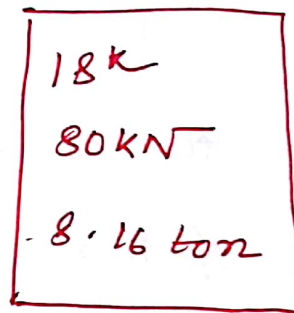
→ 3. लोअर - इव structure design?

indoor/ outdoor/ underwater
etc.

* * * → Standard 18 kip axle load का

उपलब्ध road design क्या है।

Standard axle load



EWL F → Equivalent wheel load factor.

factor ← $(\frac{36}{18})^4$ for 36 K.
 $= 16$

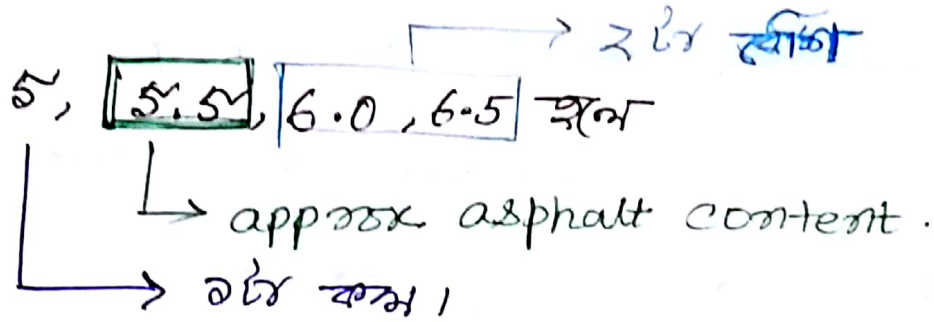
Not sure ⇒

मान 36 K load 1 बार - याउना मान

18K load 16 बार आना याउना करना।

Design asphalt content

Ques. what is design asphalt content?



* m.s.f → maximum surface flushing.

Step 1: fail करने बाद।

Step 2: Suppose 5, 5.5, 6.0 - निर्धारित पदों पर
stabilometer test करें। यह निर्धारित
asphalt content है, लेकिन, तैयार करें।

Superspave mix design:

→ uses PG (performance grade) bitumen.

इसके निर्माण पर penetration value at 25°C ~~सुझाव~~
एक ही test पर ही same result आना चाहिए, यद्यपि
इसके diff. कारण - use कर सकते हैं; ~~तथा~~ behaviour

different (different) temperature
diff. (diff.)

→ performance grade is different
temperature is different behavior
basis is classify

PG-64-10
Min^m temperature (-10)°C
→ 100 mm
→ temp. is brittle

Maximum temperature 64°C

→ High temperature is not

→ High temperature is not
→ High temperature is not

→ 64°C is test
→ 64°C is test
→ 64°C is test

→ Modified with SBS co-polymer.

CE 451: Lecture 12

* Exam questions

Superpave mixes:

* Superpave

↳ Superior performing Pavement

* Performance grade bitumen.

* Material same, classification based on performance criteria.

* Min^m temp : -10°C Max^m : 64°C Requirements:

Page 552 & 553

1. Selection of ... (22)

2.

3.

4.

* Aggregate structure: for aggregate structure, ...

- for structure for ...

③ Water is no. 1 enemy for road structures.

↳ damage or deterioration is main reason.

→ Moisture sensitivity

↳ Mist, fog, flood, rain etc.

→ अधिकतम वास्तु में water का use, Moisture

→ अधिकतम वास्तु में save.

Page 553 → Selection

Page 556 → Selection of aggregates.

Page 558 → design agg. structures

(19.12)

↑

gradation

~~558~~ → Selection of

↑

remaining steps

→ evaluation of moisture sensitivity

→ moisture sensitivity determine test.
(TSR test)

* Moisture sensitivity is judged by TSR value
(Tensile Strength Retaining)

TSR 75%
80%

[TSR value 75% or 80%
20]

3 sample

no-
moisture

3 sample

conditioned with
moisture

↳ जानिहुन फुवाय freeze अ दाया रा,

Feb 17, Aug 16

1. What are the most important properties of aggregate

→ Chapter 15 (Aggregate & bitume)

→ 19 (Design of high-type mixes)

— Mix design

— ~~Construction~~ (एक पार नाई)

2. How can you find specified grading?

— Blending

— Available mix या मिश्रण

— example या उदाहरण

3. Laboratory test of bituminous materials

— Laboratory या प्रश्न

4. What are the requirements for Asphalt cement for overlay mix?

→ table 8-4

5. Major classification of asphalt binder
→ ১২, sheet (flow chart ১২, ১৩)

6. Briefly state performance ~~grade~~ grade binder, equipment.

→ ~~১২~~ ~~১৩~~ lecture, ৬ ~~১২~~ table ~~১২~~ ~~১৩~~ table ~~১২~~ ~~১৩~~ para

Special qualities required for road construction in BD.

exam ১২
Sheet 14

The Bitumen quality for road construction Bangladesh. (১০০ (page 49)

(Improvement of Bitumen ~~১২~~ ~~১৩~~ para)

How to improve qualities?
(১২ ~~১৩~~ topic heading ১২)

8. How to find CKE & surface capacity in HYFEM method

→ Page 547 रव अग्रम चव लारन ,

9. Math:

core रव air & water 2 weight लारन

$G_{mb} = 2.384$, air void

find $V = 8\%$

Ques. is this mid satisfactory?

→ $V\%$ ⇒ field sample रव G_{mb}

↓
 G_{mm} (formula (A))

↓
 P_a (air void लवक वरुण)

filled sample 2 11.1% air void

आठ 1 lab 2 आठ 3-5%

∴ not satisfactory

16

Math

→ repeat

11. Group properties of agg → repeat

12. Superpave or asphalt & agg. requirements

कि?

आकलन Lecture

13 → sheet 19 step बना आदि

14

— destructive

— Steam distillation

— Cutback

} flow chart प्रारंभ
बनी है

15 Viscosity grade of asphalt cement

Viscosity grade of asphalt cement table

→ page 428

(6)

— sheet # 11

— Table 8.3 → Aggregate test 22, 28, 31, 64

— Table 8.4 → Bitumen

(7) Test of impulsified asphalt?

→ page ~~427~~ 427

(8) बसनापत्कार उन विद्यार्थी Que. के आसरे ।

— Last Lecture of 4-1 —

End of the
journey as

CE - Sec. - C (ii)

[Thanks to all of you for
your kind co-operation!]

(iii)