Quiz Test

~~Boooo~~

~~Design of slab bridge~~

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Geotechnical Lab

⇒ Determine the Relative density of soil.

* Granular soil – sand, coarse grained soil
* Relative density is the compaction of soil.

$$= \frac{\text{Natural state of soil (density)}}{\text{compacted state}}$$

$$= \frac{\text{field density}}{\text{Lab density}}$$

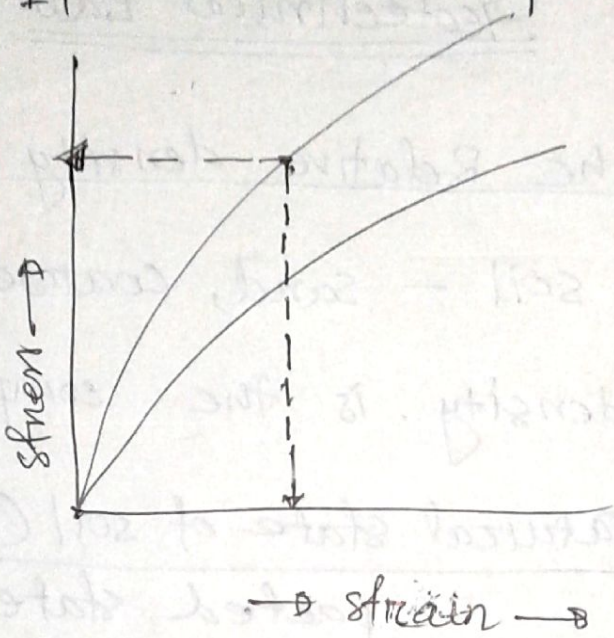
* Relative density is expressed in %.
* Relative density $= \frac{\text{looser state (density)}}{\text{Dense state (density)}} \times 100\%$

* $D_r(\%) = \frac{e_{max} - e}{e_{max} - e_{min}}$ | loose → 0%, Dense → 100% } may be

* e_{max} → void ratio at looser state
* e_{min} → void ratio at dense state.
* e → Natural state.

* $e_{ave} = e = \frac{e_{max} + e_{min}}{2}$

* $e = \frac{G_s \gamma_w}{1+w}$ $\left(e_x = \frac{G_s \gamma_w}{\gamma_x} - 1\right)$



Relative density(%)	Description of soil deposit
0 – 15	very loose
15 – 50	loose
50 – 70	Medium
70 – 85	Dense
85 – 100	very dense

s.g ⇒ $G_s = \frac{W_0}{W_0 + (W_A - W_B)}$

~~Ex 4.3~~ (Geo. Engineering 4th edition) 139 Page.

Laboratory compaction test results. —

Soln

In the field —

Problem:

Given,

S.G. of soil = 2.54

dia. of mould. d = 9.95 cm

length " l = 11.65 cm

wt of empty mould = 3126 gm.

" mould + loose sand = 4326 gm

" mould + dense sand = 4490 gm.

Determine, Dr (%) =

Soln

wt of loose sand, W_1 = (4326 − 3126) gm.

= 1.20 kg

wt of dense sand, W_2 = (4490 − 3126) gm

= 1.36 kg

volume of mould. $V = \frac{\pi}{4} D^2 H$

$= 9.05 \times 10^{-4} m^3$.

Dry unit weight —

loose → $\gamma_{loose} = \frac{W_1 * g}{V}$

$$= \frac{1.20 * 9.81}{9.05 * 10^{-4}} = 13\ kN/m^3.$$

Dense state. $\gamma_{dense} = \frac{W_2 * 9.81}{9.05 * 10^{-4}} = 14.74\ kN/m^3.$

void ratio →

$$\gamma_{loose} = \frac{W_1 * 9.81}{V} = \frac{1.20 * 9.81}{9.05 * 10^{-4}} = 13\ kN/m^3$$

$$\gamma_{dense} = \frac{W_2 * 9.81}{V} = \frac{1.36 * 9.81}{9.05 * 10^{-4}} = 14.74\ kN/m^3$$

$$e_{max} = \frac{G_s \gamma_w}{\gamma_{loose}} - 1$$

$$= \frac{2.54 * 9.81}{13} - 1 = 0.92$$

$$e_{min} = \frac{G_s \cdot \gamma_w}{\gamma_{dense}} - 1$$

$$= \frac{2.54 * 9.81}{14.74} - 1 = 0.69$$

$$e = e_{ave} = \frac{e_{max} + e_{min}}{2} = \frac{0.92 + 0.69}{2} = 0.805$$

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}} = 50\%.$$ (Ans)

Scanned by CamScanner

⇒ Determination of shear strength parameter of a soil by direct shear test.
(D 3080-98)

→ This test is due to determine the bearing capacity of soil.

→ This direct shear test is raped but not so accurate.

Main limitation:

→ The failure plane is fixed in the direct shear test.
(Sandy soil)

* dia : thickness of direct shearing app.
= 2 : 1

Significance of direct shear test:

* Design of foundation
* Design of retaining wall
* stability of slopes
* stability of cuts
* Design of sheet piles

of a soil by unconfined compressive strength test.

→ This test is applicable for clay type soil only. ($\phi = 0$)

→ Error in result for other soil.

→ sample must be undisturbed.

→ sample remains open in air.

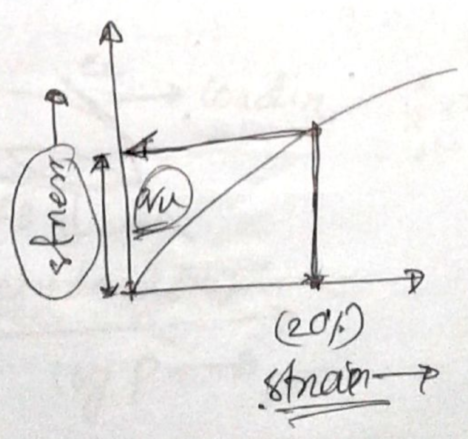
→ confining pressure $\sigma_3 = 0$; $\sigma_2 = 0$

→ $\sigma_1 = ?$ / $c_u = ?$; $\phi_u = ?$

* This unconfined compression test is one kind of unconsolidated undrained shear strength test.

* $c = c_u = \frac{q_u}{2}$.

* stress corresponding to 20% strain is q_u.



$c_u = \frac{q_u}{2}$

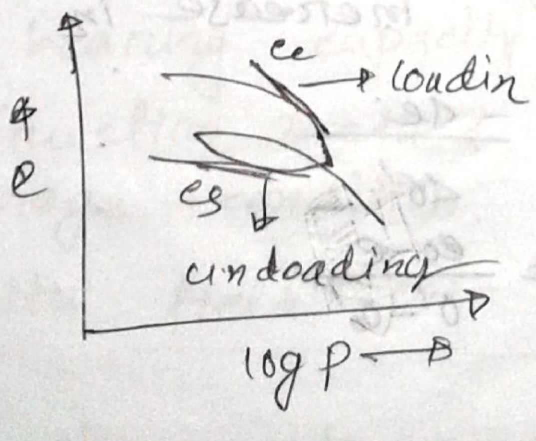
04. Determination of consolidation properties of ~~consoli-~~ a cohesive soil.

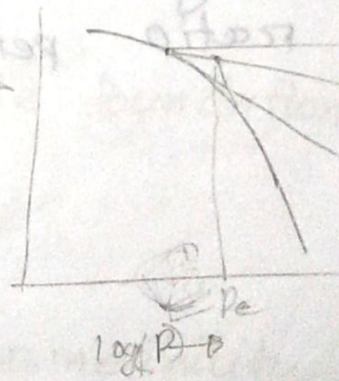
→ consolidation: consolidation is the dissipation of pore water and settlement due to static force.

→ compaction: settlement due to super imposed load. compaction is the densification of soil by removal of air, which requires mechanical energy.

* Undisturbed soil sample is used.
* Apparatus used : Oaedometer, consolidometer
  ↳ one dimensional consolidation.

* consolidation → 1D; 3D.





$c_c = 0.009(LL - 10)$

= compression index = slope of loading curve

Swell Index (C_s)

$$C_s \simeq \left(\frac{1}{5} \text{ to } \frac{1}{10}\right) C_c$$

→ $C_c = \frac{e_0 - e}{\log\left(\frac{\sigma'}{\sigma_0'}\right)} = \frac{\Delta e}{\Delta \log \sigma'}$

→ $e_s = e + C_s \log \frac{\sigma'}{\sigma_0'}$

→ Terzaghi. "Every process involving a decrease in the water content of a saturated soil without replacement of the water by air is called a process of consolidation".

→ <u>co-efficient of compressibility:</u>

The co-efficient of compressibility is defined as the decrease in void ratio per unit increase in pressure.

$$a_v = \frac{-\Delta e}{\Delta \sigma'} = \frac{e_0 - e}{\sigma' - \sigma_0'}$$

~~Name of f~~

05. A case study of field test.

Sub-soil Exploration:

Process of identifying the layers of soil deposits that under lie a proposed structure and their physical characteristics.

Purpose:

→ Determining Nature of soil at site and its stratification.

→ ~~ob~~ to get disturbed and undisturbed soil sample.

→ Depth and Nature of bed rock.

→ Position of water table

→ load bearing capacity of the foundation.

→ construction method.

→ Drainage condition.

→ in situ field test & permeability test.

→ lateral earth pressure.

S.P.T-value / N-value:

- sampler is lowered
- Number of blow required for last two intervals (2×6 = 12 in) is N-value for that depth.

N_{60} value:

$$N_{60} = \frac{N \cdot \eta_H \cdot \eta_B \cdot \eta_S \cdot \eta_R}{60}$$

N_{60} → Corrected in field condition

η_H → hammer efficiency

η_B → bore hole dia. correction

η_S → sampler correction

η_R → rod length co.

Area ratio:

degree of disturbance for a soil sample.

$$Ar(\%) = \frac{D_o^2 - D_i^2}{D_i^2} \times 100$$

06. Triaxial compression test.

* Soil specimen cylindrical in shape.
* Major ~~load~~ stress σ_1 vertically applied
* $\sigma_2 \Rightarrow \sigma_3$ horizontally.

V.V.I

CD (consolidated drained)

determining shear strength in which the soil specimen is first subjected to an all around confining pressure and drainaged is permitted.

$$\tau_f = \sigma' \tan \phi'$$

V.V.I

CU (consolidated undrained)

intest soil specimen (saturated) is consolidated by an all around confining pressure, drainage is not permitted.

$$\tau_f = \sigma \tan \phi.$$

V.V.I

UU (unconsolidated - undrained)

test, drainage is not permitted. during the application of chamber pressure σ_3.

Imp. I

B- value:

ratio of —

$$B = \frac{\text{increase in pore water pressure}}{\text{confining pressure}}$$ / stress change

$$= \frac{\Delta u}{\Delta \sigma_3} \Big/ \frac{\Delta u}{\sigma_3}$$

Application

* To determine pore water pressure
* confining pressure
* classify the soil based on consolidation State.

V. V. I

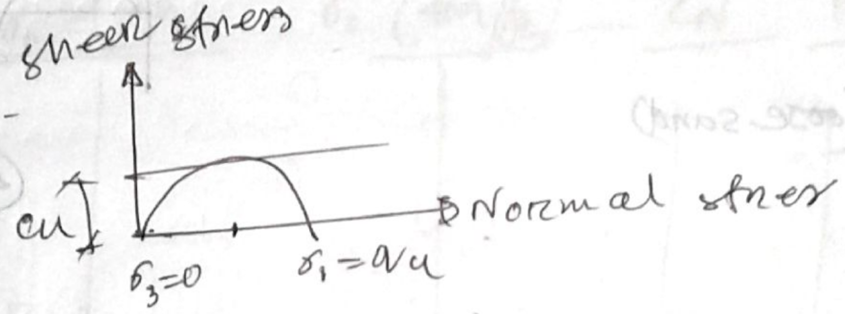
Unconfined compression test : (CU)

The unconfined compression test is a special type of un-consolidated undrained test, that is commonly used for clay specimen.

In this test the confining pressure $\sigma_3 = 0$. An axial load is rapidly applied to the specimen to cause failure. At failure the total minor principal stress is zero and the total major principle stress is σ_1.

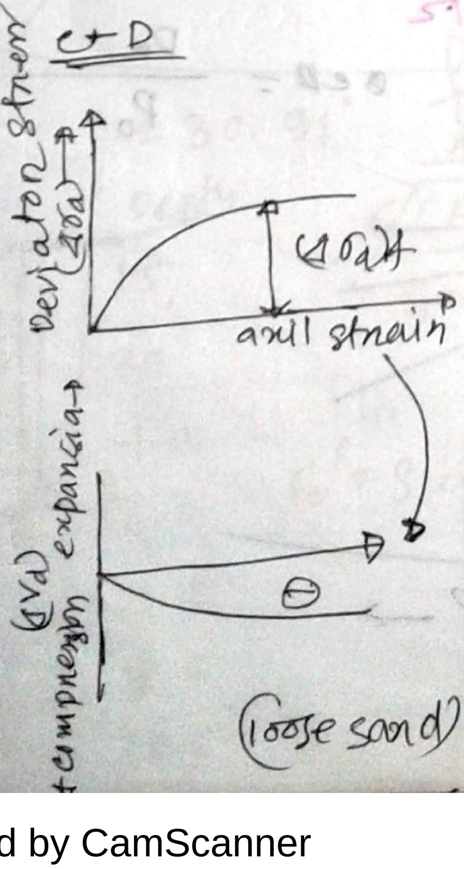
so,—

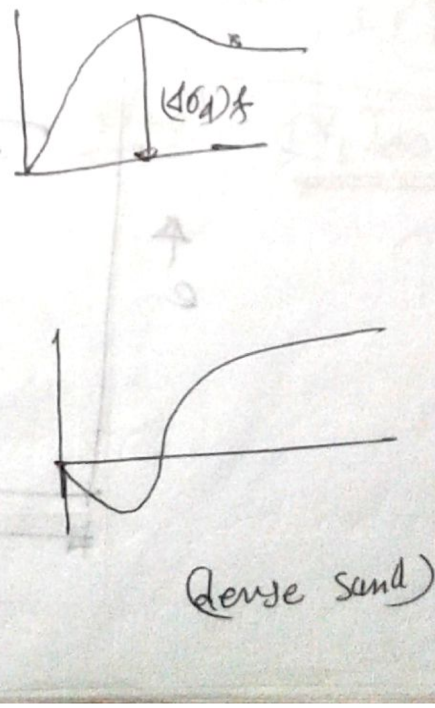
$$\frac{\sigma_1}{2} = \frac{q_u}{2} = c_u.$$



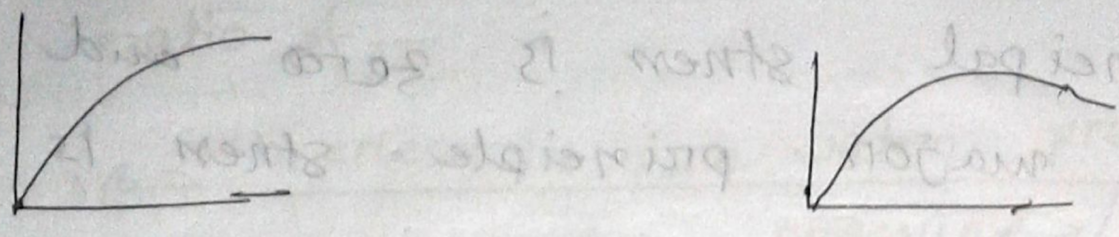
⊛ Typical curve ~~for~~ in CD and CU test.

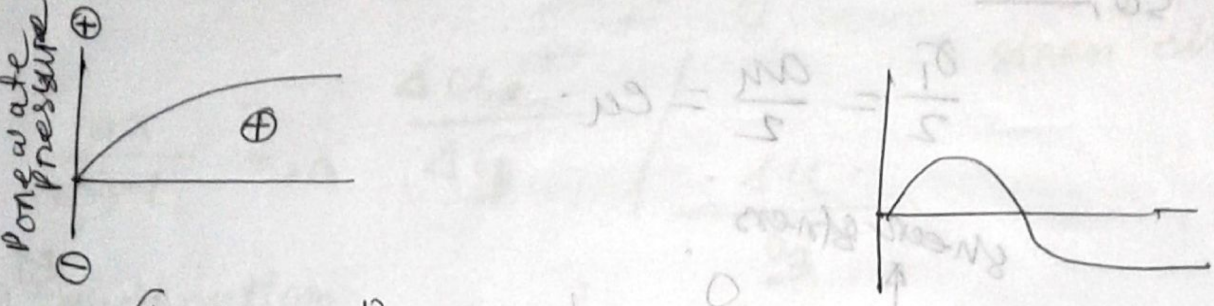
CD





CU test





(loose sand)

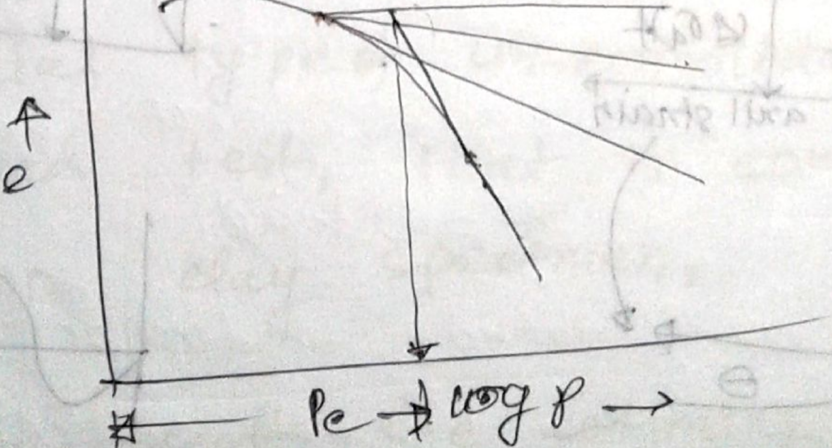
(dense sand)

V.V.I

N → value Determine করার Problem.

(CT-01) After sir

$$OCR = \frac{P_c}{P_o}$$



$(N_1)_{60} = C_N \cdot N_{60}$

$C_N = \frac{2}{1 + \sigma_0'}$

$\gamma = 110 \ lb/ft^3$

$1 \ lb/ft^2 = \frac{1}{2000} \ ton/ft^2$

$1 \ kN/m^2 = \frac{1}{95.6} \ ton/ft^2$

Depth	$\sigma_0' = \gamma h$	σ_0' (ton/ft²)	C_N	N_{60}	$(N_1)_{60}$
5					
10					
15					
20					
25					

$\gamma_d = 18$

$\gamma' = 9.68$

$\phi' = 27.1 + 0.3 (N_1)_{60} - 0.00054 (N_1)_{60}^2$

$= 30.91°$

$Pa = 100$

$C_N = \frac{2}{1 + (\sigma_0'/P_a)}$

Depth	σ_0' (kN/m²)	C_N	N_{60}	$(N_1)_{60}$
1.5	$\sigma_0 = \gamma h$			
3.0				
4.5				
6.0				
7.5				
9.0				
10.5				

$\sigma_0' = 5 \cdot \gamma_d + 0.5 \times \gamma'$

6.5

0.5

Scanned by CamScanner

U.C

dia. of mould = 1.30 in.

Height of the mould = 2.83 in.

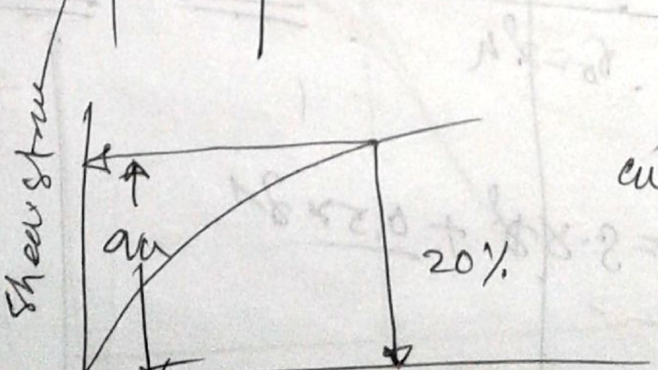
cross-sectional area —

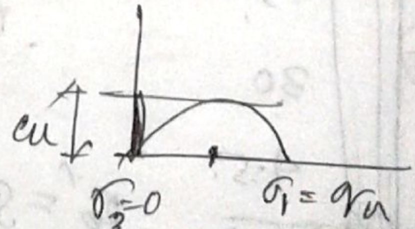
$$= \frac{\pi}{4} D^2$$

$$= \frac{\pi}{4} \times (1.30)^2 = 1.33 \ in^2$$

U.C. Test

Defor. dial guage (div)	Defor. $\Delta L = div \times 0.001$ (in)	load dial guage	shear load $P = D \times 0.735$	Axial strain $e_a = \frac{\Delta L}{L} \times 100$	$A_c = \frac{A_0}{1 - e_a}$	$q_u = P/A$





$$D_r(\%) = 12.2 + 0.75\left[222\, N_{60} + 2311 - 711\, OCR - 779\left(\frac{\sigma_o'}{P_a}\right) - 50\, C_u^2\right)^{0.5}$$

$$OCR = \frac{\text{Pre}\cdot\text{con Pressure. } \sigma_c'}{\text{eff. overburden}\cdot\text{Press.}\ \sigma_o'}$$

$\frac{4}{20} \times 100$ 50

5

AASHTO → American Association of State Highway and Transportation officials.

USCS → Unified Soil classification system.

Transportation LAB

① Ductility test of Bitumen.

Ductility ⇒ Elongation without breaking.

Flexibility ⇒ No resistance to bending.

Importance and why?

→ যখন heavy load আসে তখন elongation property না থাকলে bitumen crack করবে। তাতে aggregate ও bitumen আলাদা হয়ে যাবে।

→ Aggregate না উঠে কেবল ছড়ালে, Map cracking হবে।

→ Elongation 100cm এর বেশি হলে, Result 100 plus.

Bitumen পানির ভিতরে রাখা হয় কেন?

→ Experiment এ Bitumen এর temperature 25°C রাখতে হয়। এই কারনে পানিতে temperature দিয়ে control করা যায়।

→ আবার —

→ পানির specific gravity কম, bitumen এর চেয়ে। So, bitumen এর elongation এর

সময় sag হয়। তাই পানির s.g বাড়ানোর জন্য পানিতে প্রয়োজনীয় লবন মিশিয়ে দেওয়া হয়।

নয় হলে sag হয় না।

The ductility value gets seriously affected by

(i) Puring temperature
(ii) Dimension of briquat
(iii) ~~Imp~~ Improper level of briquatte placement.
(iv) ~~Temp~~ test tempeture
(v) rate of uting.

Appication

⇒ A certain minimum ductility is necessary for a bitumen binder.

⇒ If the bitumen has low ductility value, the bituminous pavement may crack, especially in cold weather.

→ value varies 5 – 100.
→ Minimum value – 50 cm. (must be).

② Ring ball softening point:

⇒ Bitumen is pured into the cane forming convex surface, coz after cooling it forms concave surface.

⇒ Ans. 50°

glesarine/dexorine

⇒ Result: The temperature when ball will touch the bottom plate with bitumen.

⇒ Objective:

35°–70°c

① To measure the consistancy of bitumen.

consistancy can be measured by —

① Penetration test
② Ring ball softening point test
③ Viscosity test.

Viscosity ∝ consistancy.

⇒ 60/70G → ग़ Ring ball softening point test ন temperature বেশি থাকে 80/100

bitumen গুণ দেখো।

→ The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test.

→ It is obvious that harder grade bitumen (VG60/70) posses higher softening point than softer grade bitumens.

35-70°c

Applications:

softening point is essentially the temperature at which bitumens binder have an equal viscosity; the softening point of a tar is therefore related to the equiviscous temp (e.v.t). The softening point found by the ring and ball apparanates is approximately 20°c lower than the e.v.t.

→ It gives an idea of the tem. at which the bituminous materials attains a certain viscosity.

⇒ Bitumen with higher softening may be preferred in warmer place.

⇒ Softening point is also sometimes used to specify <u>hard bitumen</u> and <u>pitches</u>.

Ex: Loss of heating of bitumen:

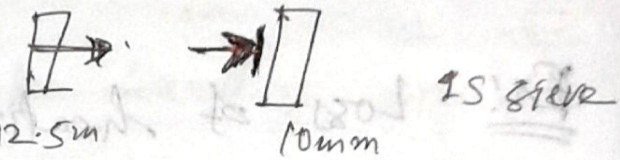
→ Temperature 163°C এ 5 hours রাখা হয়।

③ AeV - test:

⇒ To determine strength.

⇒ The strength of course aggregates is assessed by aggregate crushing test.

⇒ sample selected



⇒ 3 layer এ ভরতে হয় । 25 times tamped

⇒ crushed portion passes through a 2.36mm IS sieve.
↳ collected.

4 ton/min

⇒ Agg. crushing value, for cement concrete

⇒ load 400 KN / 40 tones → | pavement of surface should not exceed 30%.

④ Ten percent fine value test:

⇒ Reverse of AeV test

⇒ 10% crush করতে যে load লাগে তাকে determine করে।

⇒ 10% fine value is a measured of resistance of the aggregate to the crushing

Procedure :

⇒ The load is applied at a uniform rate to cause a total penetration of the plunger of about 20mm for normal crushed aggregate.

⇒ for rounded or partially rounded aggregate, honeycombed aggregate like expanded shales / on slags → 24mm is applied in 10 min.

⇒ crushed agg. 2.36mm IS sieve → Pass.

⇒ % by weight test sample → % ÷ (7.5 – 12.5) must.

⑤ AIV test

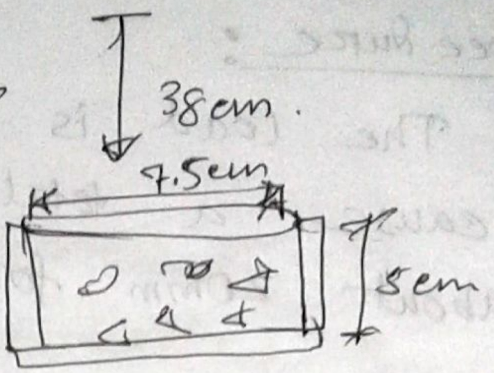
⇒ sudden application of load – impact.

⇒ To determine toughness.
↓
resistance to impact load.

⇒ Impact load on speed breaker / due to traffic loads.

⇒ The aggregate impact value indicates a relative measures of the resistance of an aggregate to a ~~stat~~ sudden shock on an impact.

⇒ Metal hammer 13.5 - 14.0 kg



Procedure

① → aggregate sample passing 12.5 mm - retained 10 mm sieve. is dried 100° - 110°c

Impact value :

< 10% → Exceptionally strong

10-20 → strong

20-30 → satisfactory for road surfacing

> 35% → weak for road surfacing.

⇒ It has been found that for majority of aggregate → AcV = AIV within a close time.

→ But in case of fine grained highly siliceous aggregate which are less resistant to impact than to crushing.

∴ AIV ≠ AcV.

⑥ s.g of bitumen :

pounding

পিচ → কয়লা – tar

Bitumen → crude oil থেকে (উৎপত্তি হয়).

⇒ Production and functions are same for Bitumen and পিচ।

Application of s.g :

(i) convert the specified bitumen content by weight to volume.

(ii) s.g is useful to identify the source of bituminous binder.

⇒ Pure bitume . s.g (0.97–1.02) / (1.02–1.05)

⇒ Bitumen contains mineral impurity s.g is higher.

~~⇒ ...~~

s.G

⑦ solubility test :

→ Bitumen কে carbon-disulphite (solid) (CS_2) or carbon tetra-chloride (CCl_4) এ soluble করাই হয়। কেরোসিন দিয়েও সল্ভেন্ট যায়।

→ ~~[illegible]~~ : solution - টিকে asbestos এ funnel এর ভিতর দিয়ে Pass করানো হয়।

⇒ এতে impurity Asbestos এ জমা থেকে যায়।

⇒ Then weight compare করে। purity check করতে হয়।

⇒ limit 99% is allowable ; but 99.5% is good

(8) Flash point Fire point:

Flash point → heat দিলে Bitumen এর থেকে Spark হয়ে।

→ ~~Result~~ Result 300°c

Fire point → heat দিলে bitumen এর উপরে বিদ্যুতের আগুন ধরে। (5 sec)

→ Result 310°c.

→ flash point, fire point ~~---~~ — Accident কমানোর জন্য জানা প্রয়োজন। এটি জানা না থাকলে Bitumen heat দেওয়ার সময় অতিরিক্ত heat এ আগুন ধরে যেতে পারে।

→ To maintain the quality of bitumen by heat.

→ Quality can be changed in excessive temperature.

→ Fire point → lowest temperature to burn (5 sec).

→ The fire point is always higher than the flash point of a material.

Flash point:

The flash point of a material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified condition of test.

Fire point:

The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test.

→ heating 5°c - 6°c per minute.

→ stirring is done at a rate of 60 per/min.

→ Important for safety point of view.

⑨ Loss of heating

⇒ Heat এর কারনে কত % কমছে।

⇒ 163°c (Result)

⇒ field এ কত bitumen প্রয়োজন বা দিতে হবে determine করা যায়।

⑩ Flakiness index

→ Shape and size test of aggregate.

Shape of aggregate →

→ Round
→ Angular
→ Elongated
→ Flaky

⇒ The flakiness index of aggregate means the percentage by weight of particle whose least dimension is less than three fifths (0.6) of their mean dimension.

→ Not applicable to size smaller than 6.3mm.

→ Sieve size 63, 50, 40, 31, 25, 20, 16, 12.5, 10, 6.3 mm.

→ In construction the flaky material is

to be avoided particularly surface course. If flaky particle on aggregate are present in the appreciable proportion the strength of pavement layers would be adversely affected due to possibility of breaking down under loads.

(11) Soundness test:

⇒ Resistancey ~~against~~ to durability against weather.

⇒ লবণ পানির ভিতরে Aggregate ডুবিয়ে রাখতে হয় (16 hrs)

⇒ উঠিয়ে wash করতে হয়।

⇒ আবার ডুবিয়ে রাখতে হয়। এভাবে 5 বার।

⇒ salt ~~u~~sed — $Na_2SO_4 \cdot 10H_2O$ → (25°C - 30°C)
$MgSO_4 \cdot 7H_2O$

⇒ The solution ~~was~~ is maintained at

temperature 27°c ± 2°c and stirred at frequent intervals until use.

⇒ Solution s.g ~~<1.15<1.175~~ $1.150 < s.g < 1.175$
for Na_2SO_4

⇒ for $MgSO_4$ → $1.295 < s.g < 1.308$

⇒ Result 3%
average loss $\leq$ 12% for Na_2SO_4
$\leq$ 18% for $MgSO_4$

(12) Los-Angeles abrasion test:

⇒ To determine hardness.

⇒ To find percentage wear due to relative rubbing action betn the aggregate and steel balls used as abrasive charge.

→ machine rotated at a speed 30-33 rpm

uniform speed.

⇒ 1.70 mm sieve ~~was~~ is used to seperate the material.

⇒ Retained 1.70mm aggregate was recorded.

⇒ The abrasion value varies 30-60%

⇒ Result 12%. ; so good.

(13) Penetration

⇒ 30/40 grade ; means ~~the~~ Bitumen এ needle 30 to 40 division or. $\frac{1}{10}$ mm (30 to 40) 3 mm to 4 mm penetrate করে।

⇒ শীত প্রধান দেশে soft bitumen ব্যবহার করা হয়। কারণ hard bitumen গলাতে অনেক temperature লাগে। ~~[illegible]~~

→ Property : Penetration grade.

120/180 G
80/100
60/70
30/40

↓ hard ↑ soft.

Temperature → 25°C (AASHTO)

⇒ To determine supeeptibility (গ্রহণের প্রবণতা)

⇒ Bitumen নরম হলে গ্রীষ্মকালে -গরমে গলে যায়।

⇒ এই Hard bitumen use হয় (গ্রীষ্মপ্রধান দেশে)

Obstacle of the test

(i) Air bubble (ii) Sand particle.

It hampers the result of penetration.

⇒ This test also used ~~to~~ widely for classifying the bitumen into different grades.

Procedure

~~Q~~ The bitumen is softened to a puring consistancy 75°C to 100°C.

⇒ 5 seconds / measurement

⇒ 3 measurement.

(14) Traffic capacity

⇒ Traffic capacity studies is the ability of a roadway to accomodate traffic volume.

⇒ It is expressed as the maximum number of vehicle in a lane or a road, vehicle pass a given point in unit time.

⇒ vehicle/hour/ lane on roadway.

Basic capacity: vehicles/hr/lane → pass a point
→ most nearly ideal traffic condition.

Possible capacity:
→ under prevailing traffic condition.

Practicle capacity:
without causing unreasonable delay and hazard to the traffic. It is also known as design capacity.

PCU:

Theoretical capacity →

$$C = 1000 * \frac{V}{S}$$

~~V~~ = 40 km/hr

t = 2.5 sec.

f = 0.35

~~1000x~~

$S = L + SD$

↓

5

$$SD = 0.278\,Vt + \frac{V^2}{254f}$$

Ductility:

Bitumen → heated to bring it in the fluid slate and poured into briquette assembly → palaced in brass plate and cooled in air.

→ Surface level by knife (hot)

→ whole ~~aggerran~~ assembly was kept in water bath and maintained at 27°c. 85-95 min

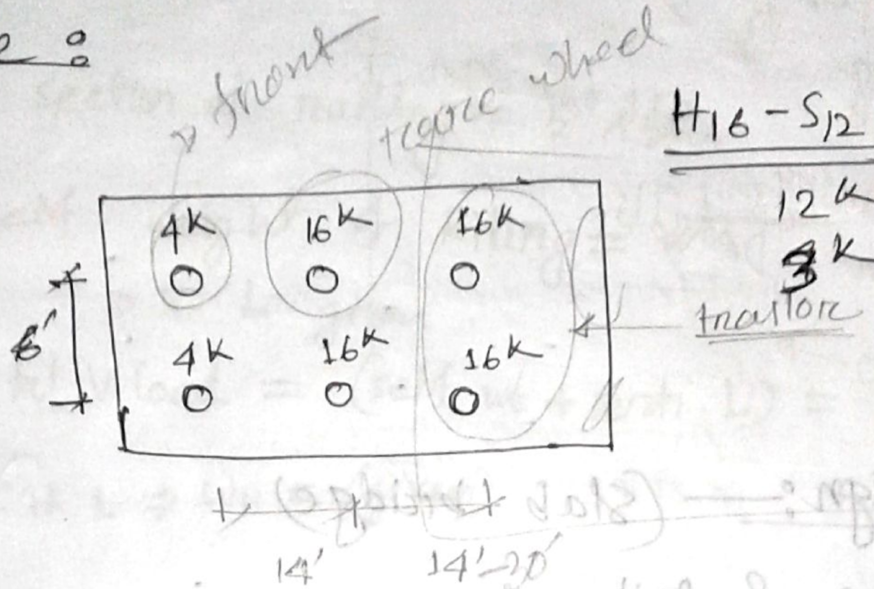
→ side mould removed → clips hooked mover

→ 50 mm/min.

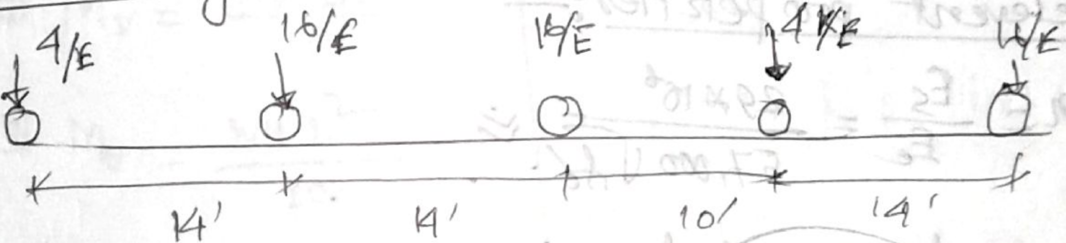
R.CC LAB

Slab Bridge :

$H_{20}-S_{16}$



Effective loading



No of Girder is affected—

1. No of traffic
2. width of bridge
3. form work.

⇒ If the span length is less than 60' then it is wheel load

→ more than 60' it is lane load.

⇒ 4 lane = 40'

→ No of Ginder
→ spacing
Wall design
→ Retaining
→ Rein. & Details
→ H_2O →

Design :— (Slab bridge)

Railing & Railpost :

Relevent properties :—

$$n = \frac{E_s}{E_c} = \frac{29 \times 10^6}{57{,}000\sqrt{f_c'}} \simeq$$

$$r = \frac{f_s}{f_c} = \frac{0.40 f_y}{0.45 f_c'} =$$

$$K = \frac{n}{n+r} =$$

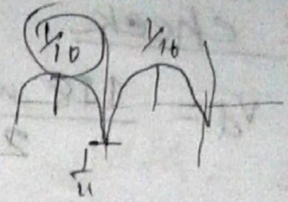
$$J = 1 - \frac{K}{3} =$$

$$R = \frac{1}{2} f_c J K =$$

Let the spacing of rail post, $S_L = 6'$

$$\therefore N_{RP} = \frac{L}{S_L} + 1 \simeq x \text{ (round)}$$

Actual spacings $S_{RP} = \frac{L}{N_{RP} - 1}$



Assume, section of railing = 5"x5"

→ Self weight of Riling = w

→ V. L given.

⇒ Total V. load = (self wt + verti. L) = W_V

⇒ T. H. L ⇒ W_H = (given)

Moment:

① $M_V = \frac{W_V \cdot L^2}{10}$

(ii) $M_H = \frac{W_H \cdot L^2}{10}$

$L = S_{RP}$

Actual Max → M =

depth check:

$d = \sqrt{\frac{M}{Rb}} =$

$d_{actual} = 5 - 1 = 4" > d$ (OK)

Reinforcement calculation

$A_s = \frac{M}{f_s j d}$

$A_{s\,min} = 0.0018bt$ (60ksi)

0.0020bt (40ksi)

Shear check

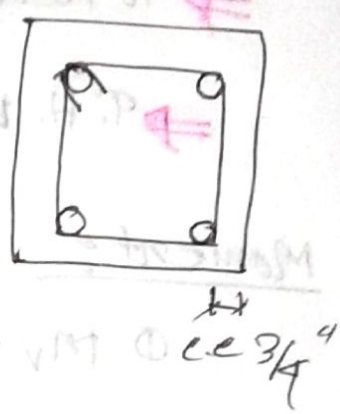
$$V_d = \frac{1.18\, wL}{2} \quad \Big| \quad V_{all} = 1.1 \sqrt{f'_c}\; bd$$

Stirrup spacing:

web reinforcement spacing

(i) $S = 3t$

(ii) $S = \dfrac{A_v}{0.0015 b}$ → $(0.11 * 2)$ #3 U



⊛ Rail Post:

$$M_V = \frac{w_V \cdot \left(\frac{S_{RP}}{2}\right)^2}{2} * 2$$

$$M_H = w_H * S_{RP} * H_T + w_H * S_{RP} * H_b + w_H * H_{RP} * \frac{H_{RP}}{2}$$

Design of slab:

clean span, $L = 22.6'$; clear width $= 8'$

thicknen of the slab, $t = 14''$

$\therefore$ Effective span, $L_{eff} = L + t$

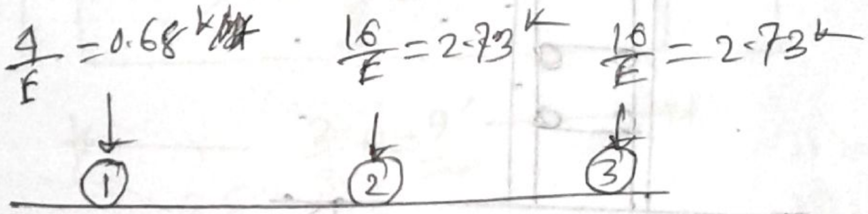
$= 22.6 + \frac{14}{12} = 23.77'$

$\Rightarrow$ Average thickness of wearing coat $= 3''$

$\Rightarrow$ Effective loading zone, $E = 4 + 0.060 L_{eff}$

$= 4 + 0.060 \times 23.77$

$= 5.42' \leq 7'$



Effective loading

$E = 5.88$

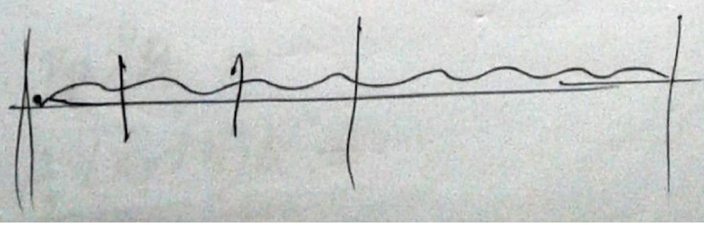
D.L.C

S. Wt of slab =

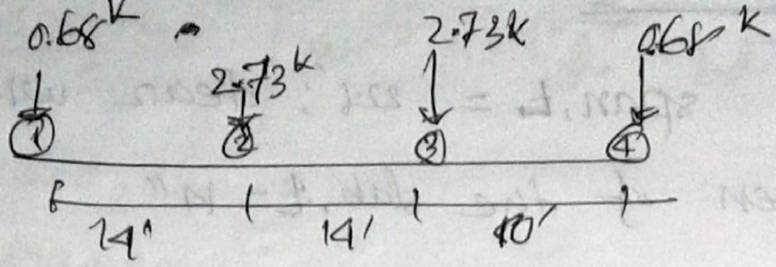
S. Wt of wearing coat =

T. D.L = W_D =

D.L.S

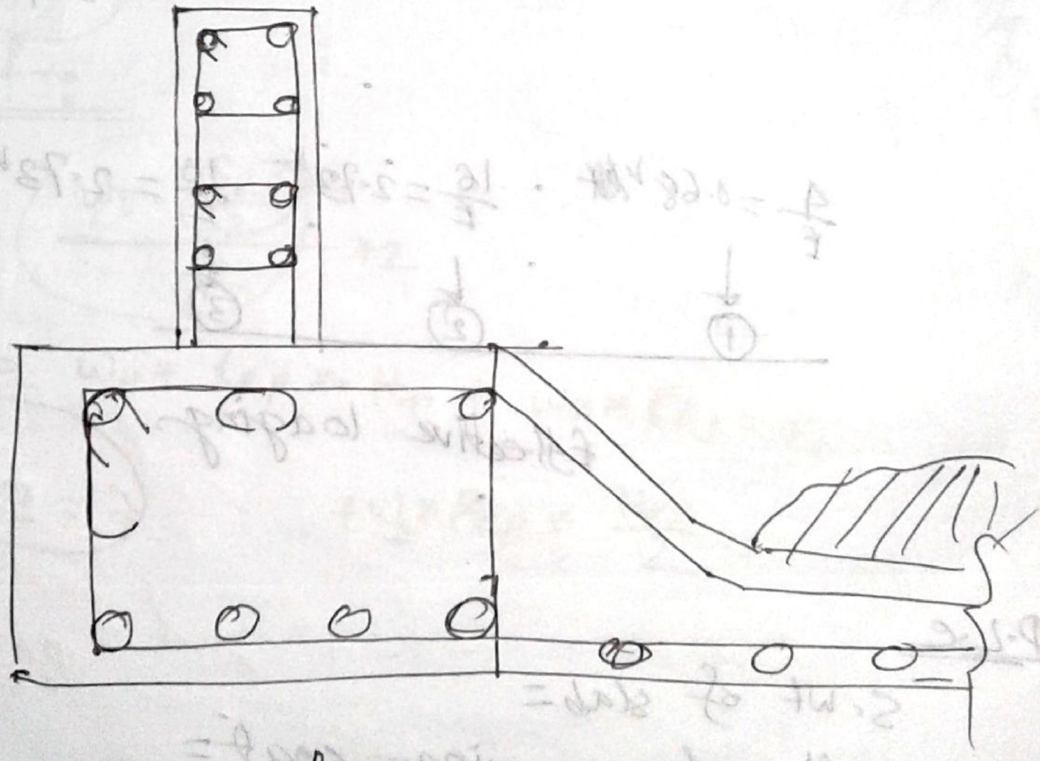


L.L. S & M



Impact coefficient (For L.L)

co-efficient ⇒ $I = \dfrac{50}{L_{eff} + 125}$ ($\ngtr 0.30$)



cross section slab with kerb beam and rail post

V.V.I

Design of abutment (slab bridge)

overall height of Abu. = 13′ (say)

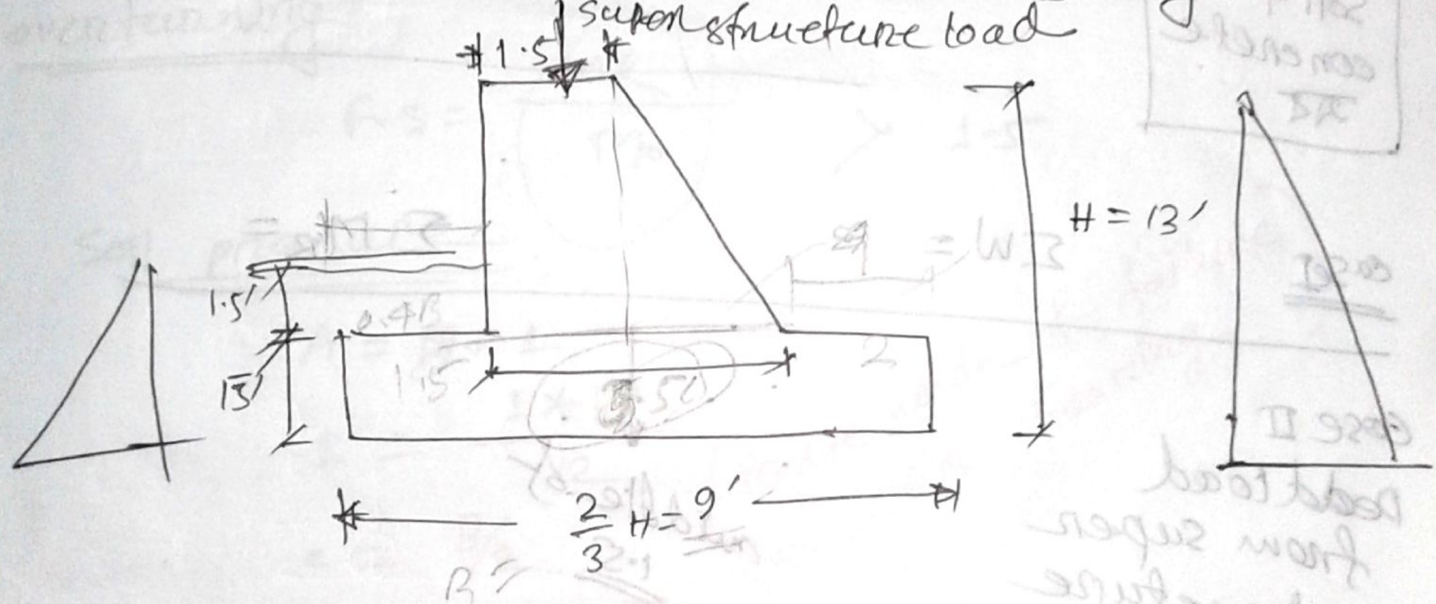
Bearing capacity = 4 ksf

$\phi = 30^\circ$

$f = 0.30$

F.S = 1.5

Abutment constructed with masonary.



$$K_a = \frac{1 - \sin\phi}{1 + \sin\phi} = 0.33$$

$$K_p = \frac{1}{K_a} = 3$$

$$p_a = K_a \gamma H$$

$$P_a = \frac{1}{2}(K_a \gamma H)\,H =$$

$$p_p = K_p \gamma H =$$

$$P_p = \frac{1}{2}(K_p \gamma h)\,h =$$

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Over turning Moment. $M_o = P_a * H/3$

=

Resisting moment

Section	W	arm	Resis. Moment
Soil + concrete সব			
case I	$\Sigma W =$		$\Sigma M_R =$
case II Dead load from super structure reaction at sec- ④-④	ΣW	middle of 1.5	$\Sigma M_R =$
case III L.L on super structure	ΣW	=	$\Sigma M_R =$

stability check

case : I

sliding $f.s = \frac{W * f}{Pa} > 1.5$ (OK)

~~case II~~

~~case III~~

overturning

$$f.s = \frac{M_R}{M_o} > 1.5$$

Soil pressure

$$A = B * 1$$

$$I = \frac{1 * B^3}{12}$$

(Possible mode of failure is bearing)

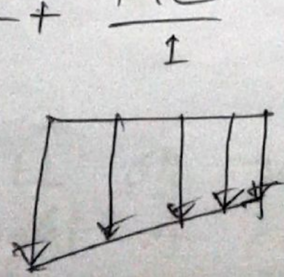
$$e = B/2$$

$$a = \frac{M_R - M_o}{W}$$

$$e = B/2 - a \;/\; a - B/2 =$$

$$M = W * e$$

$$\sigma_1 = \frac{W}{A} + \frac{Mc}{I} < 4000 \text{ psf} \quad \text{(OK)}$$

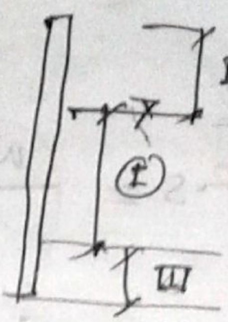


Abutment height depends on —

(i) Water level (height)

(ii) free board

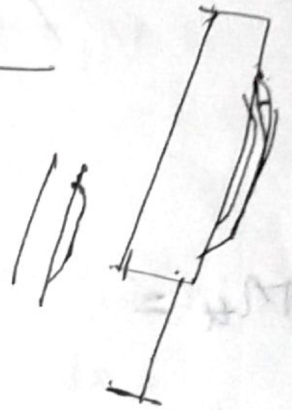
(iii) Scour depth



Design of Deck Girder bridge

* OR, Slab beam bridge.
* Every Girder is a Beam but every Beam is not Girder.
* Girder size is larger than Beam.

No. of Girder depends on ——



1. No of traffic
2. width of bridge
3. Form-work.

Specification:

* span of bridge = Roll+20 =
* width of bridge (4 lane) = 4×10′ = 40′
* Minimum no. of Girder = 6
* width of girder = 18″

Load calculation

(i) V. L from post $= \dfrac{\frac{6\times8}{144}\times3.5\times150}{6.75}$

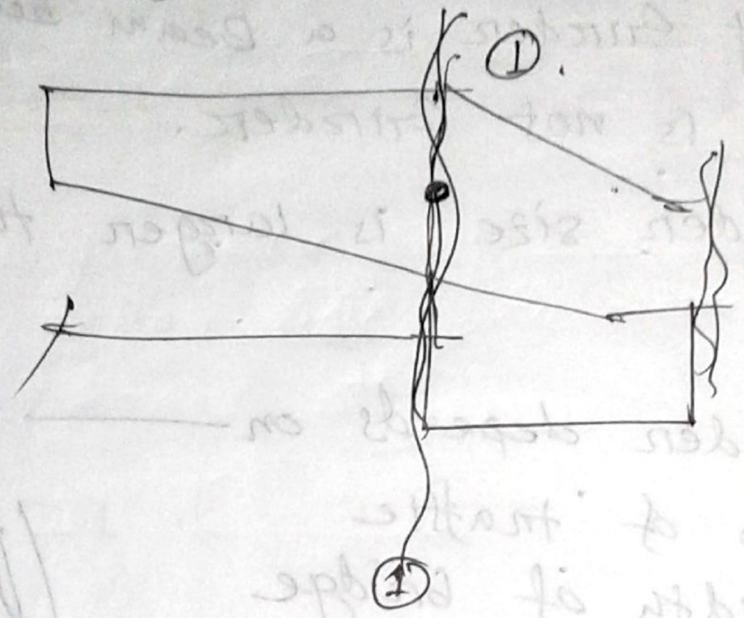
=

(ii) V. LL on railing = 150×2

(iii) weight of railing $2\times2\times\frac{6\times6}{144}\times150$

$M_V = \text{wt of post} \times 3.33 + V.L \times 3.3$

$+ \text{wt of rail} \times 3.33$



$M_H =$

$\therefore T.M = M_V + M_H.$

Design of slab (D.G.B)

width of the bridge — 40'

Min. Girder = 6

c/c spacing betn girder = $\frac{40}{6-1}$ = 8'.

clear spacing = c/c spacing − width of beam

= 8' − 18"

= 6.5'

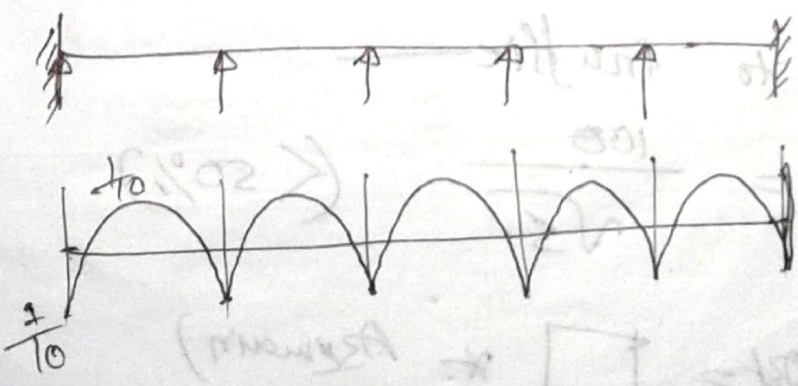
thickness = 8" (say)

load cal

DL self weight =

wearing coat =

∴ T.D.L =



$M_{max} = \frac{wl^2}{10}$

D.L-M =

V.V.I. Live load Analysis

Main rein. perpendicular to traffic —

$$M_{2-2} = \frac{S+2}{32} * P_{15} \rightarrow P\ 12000$$

(S → 6.5)

A continuity factor 0.8 — is accounted
) slab continuous over 3 or more supports —

$$M_{L2} = 0.8 * \frac{S+2}{32} * 12000$$

V.V.I. Distribution reinforcement → B

main rein. perpendicular to the traffic

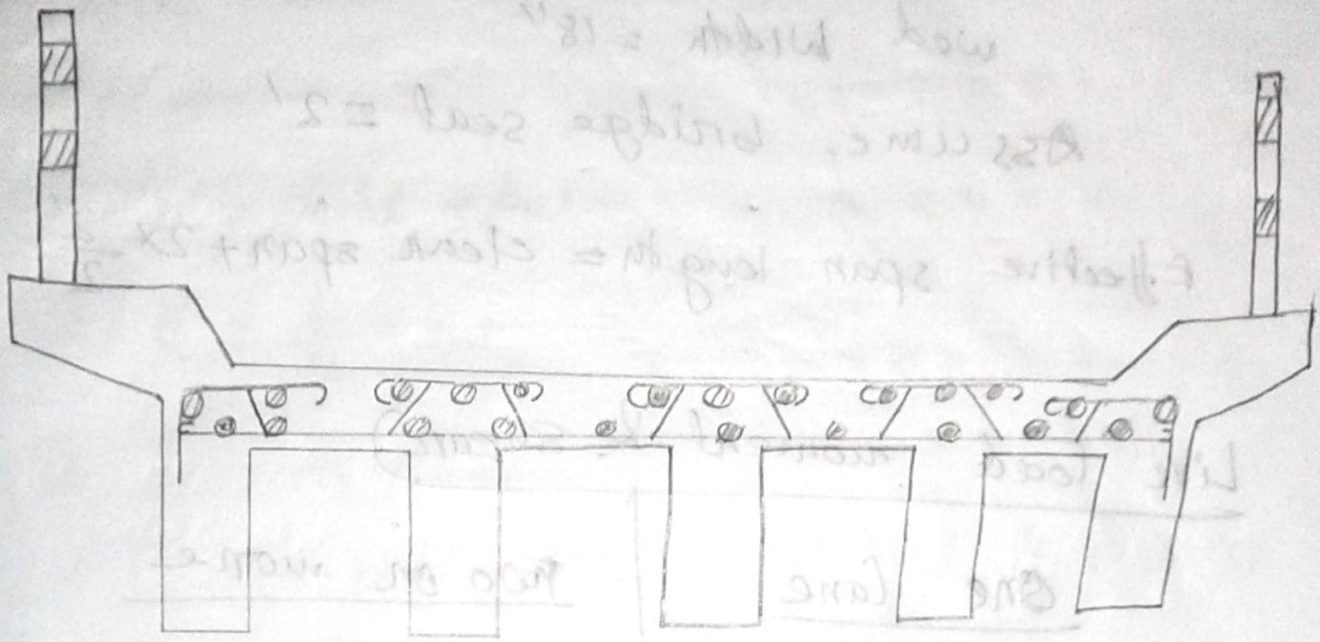
$$\text{factor} = \frac{220}{\sqrt{S}} \quad (> 67\%)$$

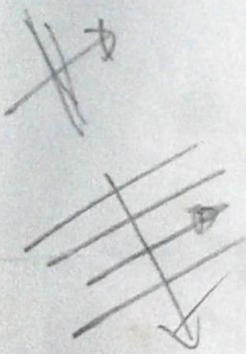
$$\rightarrow A_{st} = 0.67 * A_s\ (\text{main})$$

parallel to traffic —

$$\text{factor } A_{st} = \frac{100}{\sqrt{S}} \quad (< 50\%)$$

$$\therefore A_{st} = \square * A_s(\text{main})$$





Slab.

Interior Girder design

flange width = c/c betn. gir = 8'

web width = 18"

Assume, bridge seat = 2'

Effective span length = clean span + $2 \times \frac{2'}{2}$

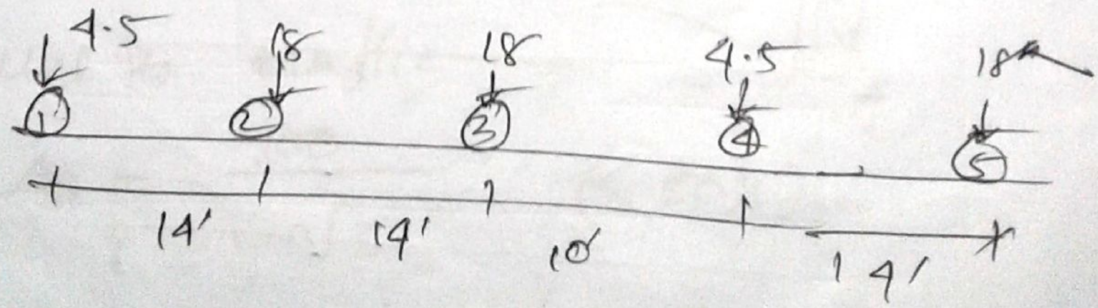
Live load moment & shear)

One lane	Two or more
$S/6$	$S/5$

load from rane wheel = 1.5×12^K

front = $1.5 \times 3 = 4.5^K$

trailer = $1.5 \times 12 = 18^k$



Exterior Girder Design

Check for concrete stress:—

Effective width of ~~concrete~~ compression flange —

(i) $b' = 6h_f + b_w$

(ii) $b' = \frac{L}{12} + b_w$

(iii) $b' = \frac{S}{2} + b_w$

Mini — $b' =$

$p = \frac{A_s}{bd} =$

$n = 10$

$pn =$

$$k = \frac{pn + \frac{1}{2}\left(\frac{h_f}{d}\right)^2}{pn + (h_f/d)}$$

$kd > h_f$ T beam.

Design of abutment:

* overwall height of abutment = 20'

Proportioning of the abutment —

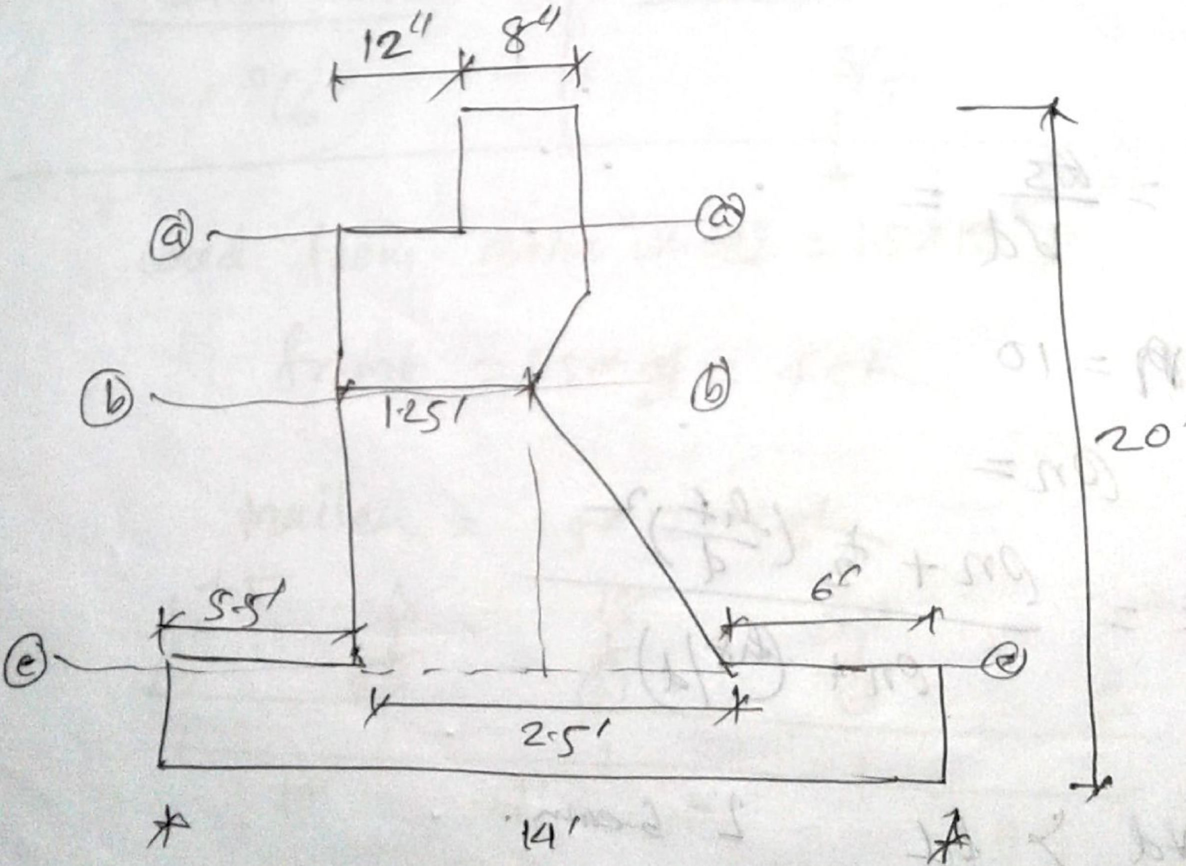
① width of abut.

= width of bridge + 2 side walk + clearance

= 40 + 2 * 4.5' + 2'

= 51'

② width of bridge = $\frac{2}{3}H$ = 13.33 ≃ 14'



$$K_a = \frac{1 - \sin\phi}{1 + \sin\phi} = 0.33$$

$$K_p = \frac{1}{K_a} = 3.$$

$P_a =$

$M_o = P_a * H/3 =$

Load coming from superstructure —

T.DL = No.of inter Girder * D.L Reaction of int. gir.

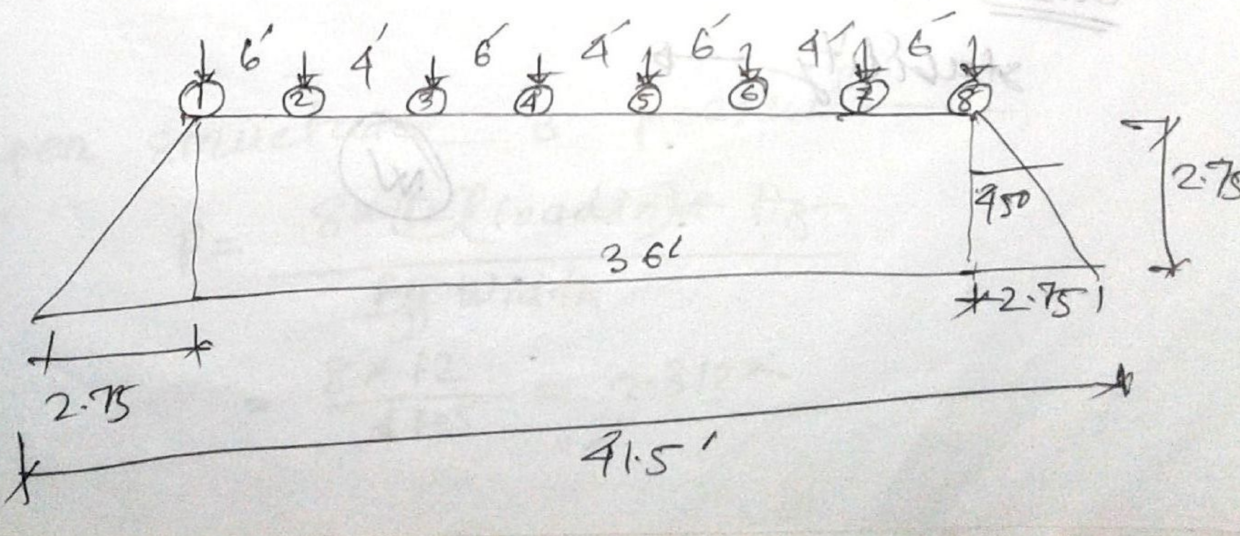
+ 2 * D.L of Exteri. girder

= 9 * ______ + 2 * ~~25.9~~ = k

T.L.L = No. of int G. * LL. Reaction of I.G

+ ~~2~~ * LL. of Ex.G.

= k



Effective width = 41.5

DL per foot of abut = $\frac{UFD.L}{41.5}$ =

LL " " = $\frac{T.L.L}{41.5}$ = x

<u>Section</u> | <u>W</u> | <u>arm</u> | <u>M_R=</u>

<u>case I</u>

<u>case II</u>

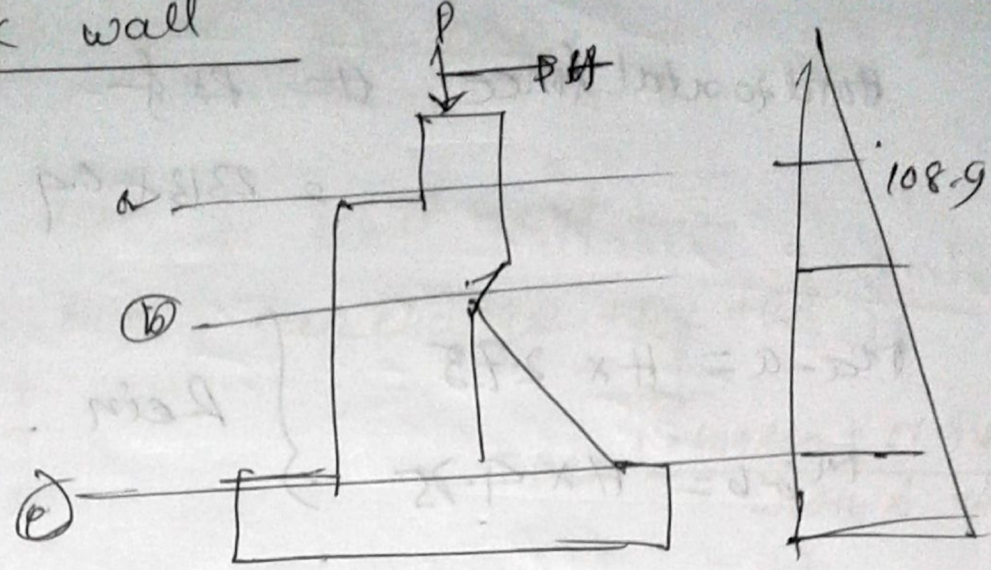
<u>case III</u>

<u>check</u>

stability →

(W)

Design of back wall



case I

Super structure B not present

$M_{a-a} = \frac{1}{2} \times 2.75 \times 108.9 \times 2.75/3$

M_{b-b}

$d = \sqrt{\quad}$

Acm ______

case II

Super structure B present

$P = \frac{8 \times (12)(\text{loadin}) \times H_B}{\text{Eff Width}}$

$= \frac{8 \times 12}{41.5} = 2.313^{k}$

Horizontal force - H = P × f

= 2313 × 0.4

M_{a-a} = H × 2.75

M_{b-b} = H × 4.75

} Rein.

Design of Stem

$M_{e-e} = \frac{1}{2} \times$

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Design of pile and pile cap.

① load per foot of abutment —

= section + surcharge + D.L + L.L

T.D.L = (No. in area + No. of ...) / width of abutment

② Total load on pile cap = ① * 57 =

③ Un confine compression strength q_u = 4 ksf.

case : I — Individual action —

Allowable shearing strength —

$$c = \frac{q_u}{2} * \frac{1}{F.S}$$

c = x

su. area of pile = $\pi d l$

∴ capacity = c * area.

$$\text{No. of pile} = \frac{\text{T.L on pile cap}}{\text{capacity}}$$

= x.

Spacing. ① $S \geq 2 * D$ ② $S \leq 3.5'$

B_{eff} = Width of abutment $- 2 \times 2.5$

along B direction

$N_B = \frac{B_{eff}}{3.5} + 1 = 15$

$S_B = \frac{B_{eff}}{N_B - 1} = 4$

along $N_L = \frac{\text{T. No of pile}}{N_B}$

$S_L = \frac{L - 2 \times 2.5}{N_L - 1}$

** Determination of design discharge methods :

The maximum discharge with a bridge across a natural stream ——

① **Emperical formula** →

$Q = CA^n$.

Here, Q = Max. flood discharge (m^3/sec)

A = catchment area in (km^2)

Ryre's formula →

$Q = CA^{2/3}$

Here, $C = 6.5$; near the coast

$= 8.5$; areas betn 25 and 50 km^2.

$= 10$; limited area near the hills.

② **Rotational formula**.

$Q = A \cdot I_0 \cdot \alpha$

Here ; I_0 = Peak intensity of rain fall (mm/hr)

α = function depending on the characteristics of the catchment of peak runoff.

(3) Area velocity method:

$$Q = AV$$

Here, A = wetted area (m^2)

V = velocity of flow in m/sec.

$$= \frac{1}{n} \cdot R^{2/3} \cdot S^{1/2}$$

Here, n = co-efficient of roughness

S = slope of stream

R = Hydraulic mean radius. (m)

$$R = \frac{\text{wetted area}}{\text{wetted perimeter}}.$$

(4) Economic span:

The cost of railing, flooring etc is proportional to the total length of the bridge.

$$C = A + B + (n-1)P + nKl^2 + K'L$$

Here, A = cost of approaches

B = cost of two abutment including

foundation.

L = total linear water way

l = length of the span.

n = number of spans.

P = cost of an points including foundations.

e = cost of bridge.

The economical section (l_e), can then be computed from $l_e = \sqrt{\frac{P}{K}}$

Scour depth:

↓

(মার্জন / পরিমার্জন / ধুয়ে যাওয়া)

The scour is aggregated at the nose of the piers and at bends —

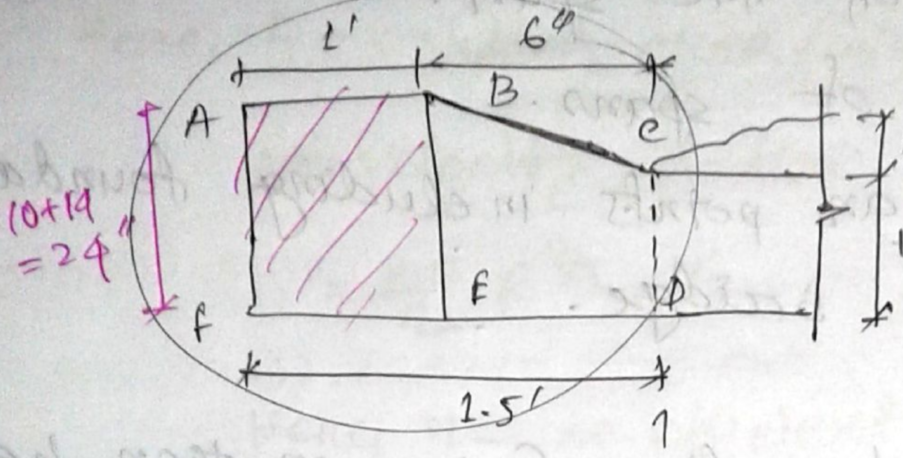
Normal depth of scour may be computed —

$$d = 0.473\left(\frac{Q}{f}\right)^{1/3}$$

Here, d below H.F.L

f = lacy's silt factor for a representative sample of the bed material.

Kerb / curb / Edge beam design:



Kerb

(i) D.L from curb = $\left(\frac{10+14}{12} \times 1\right) + \left(\frac{24+14}{2 \times 12}\right) \times \frac{6}{12}$

(ii) Load coming from railing and rail post ——

$$= \frac{\left(\frac{5 \times 15}{144} \times 12 \times 2\right) + \frac{(8 \times 9)}{144} \times H_{RP} \times N_{RP}}{L} \times 150$$

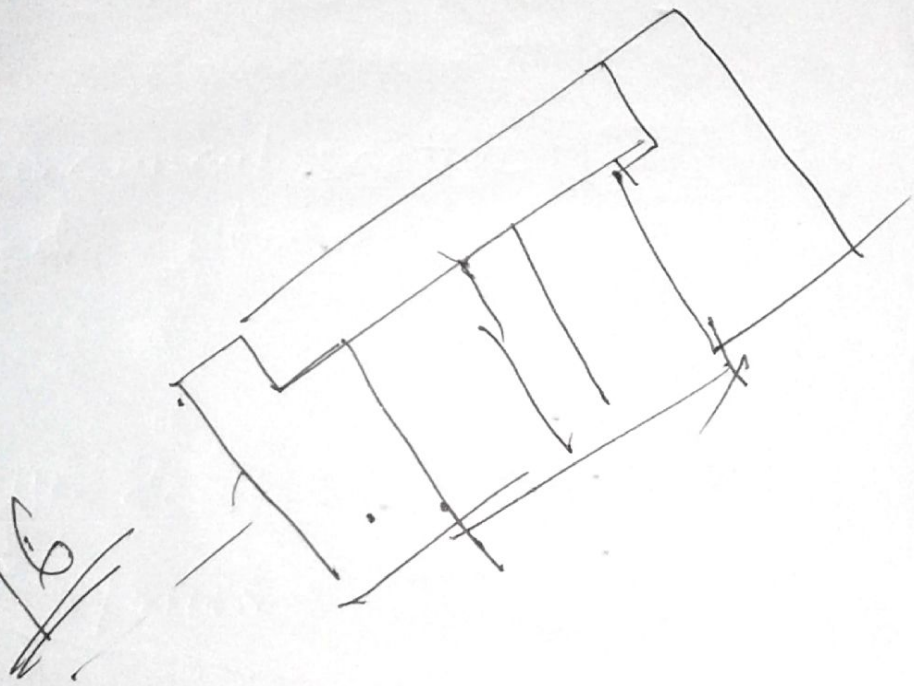
= W plf.

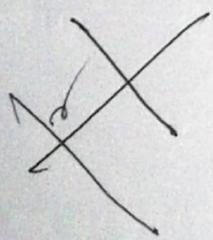
∴ T. D.L = (i) + (ii)

D.L.M ⇒ $M_D = \frac{W_D L^2}{8}$

L.L. M ⇒ $M_L = 0.1 \times (H_{20} - S_{16}) \times L$

Total . M ⇒ $M_D + M_L$





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