drology :

(Run-off)

~~The first~~ flood Discharge : The first & most important factor to be decided in the design of bridges is the determination of waterway required for the bridge or culvert. The opening has to be capable of passing the peak flood without either overtopping the banks or endangering the structure itself. Since there can be no storage upstream of a bridge, unlike in case of dams, the instantaneous peak discharge has to pass through the opening at the same time.

Methods of Determination of Design flood Discharge:

i) Rational Method
ii) Emperical Method
iii) By use of hydraulic characteristics of stream.

i) Rational Method : A rational method is to make use of factors covering the anticipated intensity of rainfall & also the discharge characteristics of the catchments along with the area factor. These are applicable to small catchments.

Now, ∴ flood Discharge Q is given by

$$Q = 100 \times p \times f \times A \times I_c \quad \text{——— (1)}$$

where, Q = flood Discharge or Run Off in Cumec (m^3/sec)
p = a coeff. for losses due to absorption dependant on type of soil
f = coeff. accounting for distribution of rainfall

A = catchment area

I_c = Critical intensity of rainfall in cm/hr

$$I_c = I_o \left[\frac{2}{T_c+1}\right]$$

To find out I_c; One hour rainfall intensity of the region. I_o is to be worked out by following equation.

$$I_o = \frac{(T+1)f}{2T}$$

where, F = Total rainfall in cm

T = Duration of storm in hours.

Then, Time of concentration T_c is calculated by the following formula,

$$T_c = \left[\frac{0.89\,L^3}{H}\right]^{0.385}$$

where, L = Distance from critical point to outlet (m)

H = fall in Level from critical point to outlet (m)

Now, $I_c = I_o \left[\frac{2}{I_c+1}\right]$

Now, by knowing I_o, T_c we get I_c

& ∴ By putting I_c in eq' (1) we get Q.

~~Dicken's formula~~ Empirical Method:

a) By Dicken's formula:

Colonel Dichens selected four catchment ~~area~~ of sizes varying from 0.0125 sq. miles to 27,000 sq. miles in Central India & made observations. According to observation he gave a eqn,

$$Q = C M^{3/4}$$

where

Q = Discharge in cumec.

M = Catchment area in Sq. km.

C = Constant depending upon area of rainfall.

C Varies from 11.02 To 22.04 depending on region.

b) Khosla's formula:

It is given by,

$$R = P - L$$

where, R → run off or flood discharge

P → rainfall

L → Losses.

Main factor of losses is temperature.

$$L = 4.82\, T_m$$

where L is in mm & T_m in °C

$$\therefore R = P - 4.82\, T_m$$

(3) By use of hydraulic characteristics of stream:

Maximum flood discharge depends on velocity of flow. It may be done by actual observation during a high flood. for measurement of discharge the C/S area is divided into small strips.

$$\therefore Q = A_1V_1 + A_2V_2 + \cdots + A_nV_n$$

where $A_1, A_2 \cdots A_n$ are area of strips

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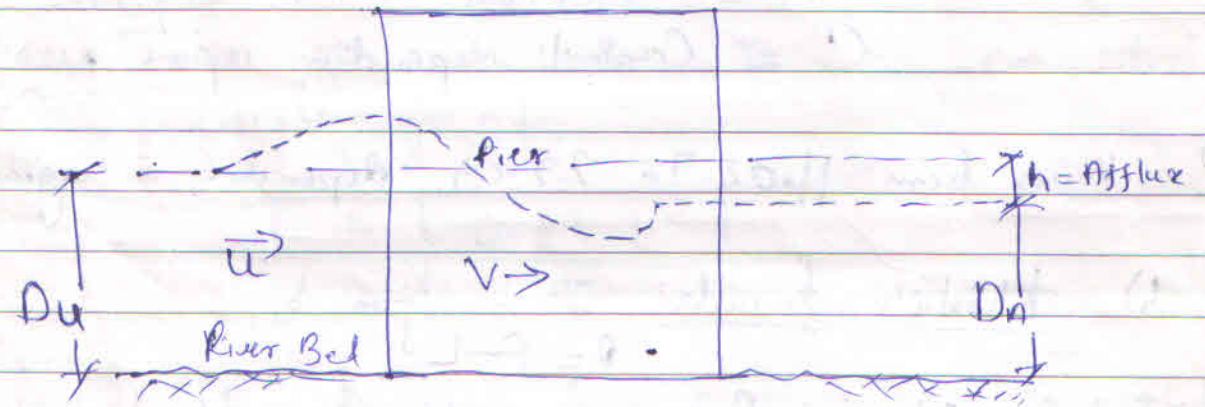
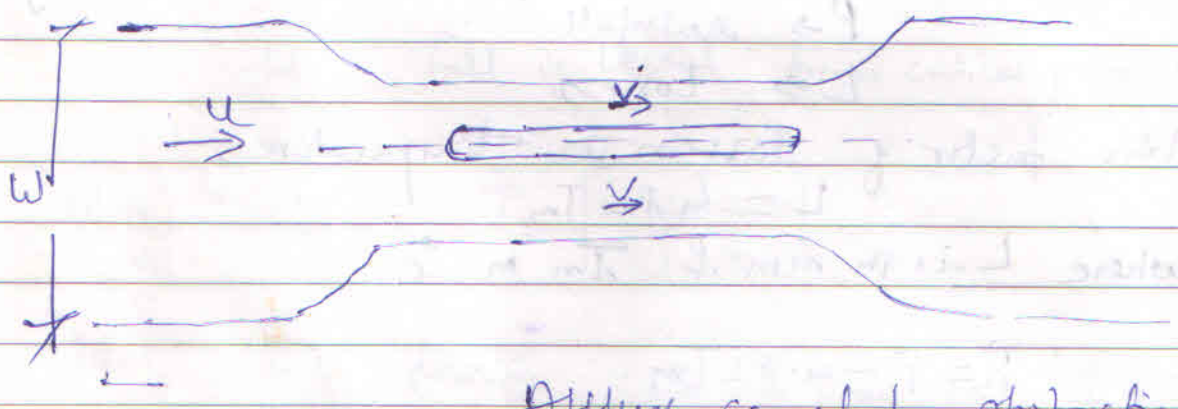
Afflux : Afflux can be defined as a ri
or 'heading up' of water level (abo
normal) on the upstream side of a
bridge or obstruction. It is caused when
the effective linear waterway at the
obstruction is less than the natural width
of the stream immediately on the upstream
side of the obstruction. The greater the
afflux, the more will be the velocity
produced through the obstructio





Afflux caused by obstructio

Afflux can be calculated by the following two formulae:

1) Merriman's formula:

$$h = \frac{V^2}{2g}\left[\left(\frac{A}{C.a}\right)^2 - \left(\frac{A}{A_1}\right)\right]$$

where, V → velocity of approach in m/sec
A → natural waterway at the site ($L \times D$)
a → artificial waterway
C → Coeff. of discharge

$$\therefore C = 0.75 + 0.35\left(\frac{a}{A}\right) - 0.1\left(\frac{a}{A}\right)^2$$

2) Molesworth's formula:

$$h = \left[\frac{V^2}{17.87} + 0.0125\right]\left[\left(\frac{A}{a}\right)^2 - 1\right]$$

Scouring:

Scour is vertical cutting of the river bed due to action of flowing water. The depth of vertical cutting or erosion of bed is scour depth. Scouring results in increasing depth of water at the section under consideration due to vertical cutting of river bed. The scour depth should be determined very precisely because the improper determination of scour depth may lead to damage the substructure of bridge.

Lacy's developed following equations for regime characteristics of alluvial channel to ascertain scour depth.

1) Linear waterway of bridge not less than Regime width
ie $L > W$.

W → regime width in L = Linear waterway

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

where, d - Scour depth, Q ⇒ discharge m^3/sec, f → Lacey's silt factor

$f = 1.76\sqrt{m}$, m = Particle size in mm.

2) $W > L$,

$$d_1 = d \left(\frac{W}{L}\right)^{0.61}$$

where, d_1 = Scour depth

d = Scour depth from above eqn.

Now, actual scour depth calculated from above is converted to maximum scour depth,

a) for Straight reach - Max^m scour depth = 1.27 d

b) At Sewer Bent - —"— — = 1.75 d.

c) At Nose of Pier - —"— — = 2.0 d

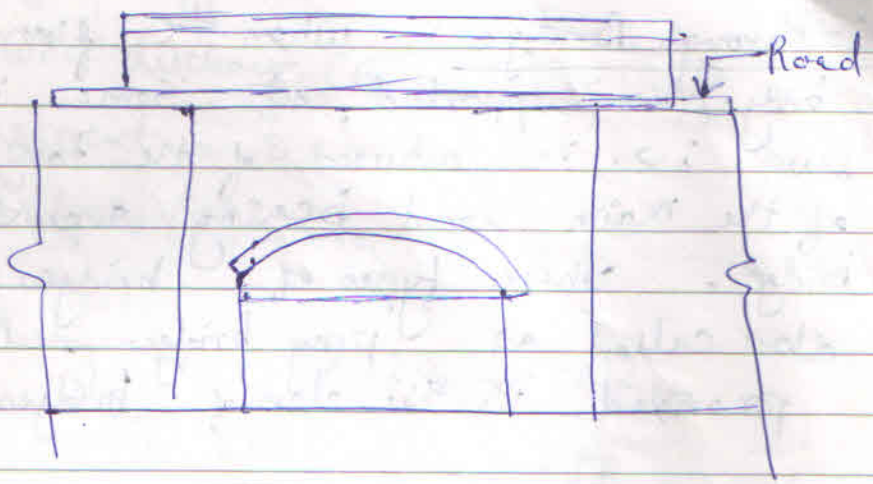
Clearance & free board:

Clearance: The least or minimum distance between the specified positions of a bridge is called as clearance. It may be horizontal as well as vertical. The vertical distance is the clear height from the H.F.L to the lowest point of the bridge structure. For arched opening the clearance below the crown of the arch should not be less than 0.1 of the minimum depth of water plus 0.33 rise.

For steel bridges sufficient vertical clearance must be provided so that no metallic bearings are submerged. The minimum horizontal clearance should not be less than 3.6 m.

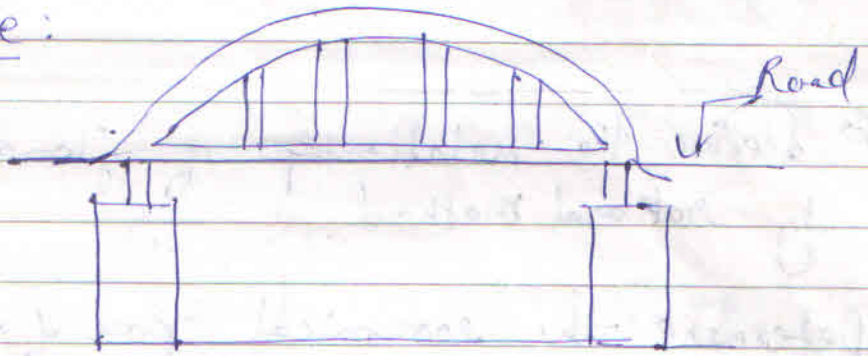
Free board: The difference between the high flood level & the level of the crown of the ~~road~~ road at its lowest

eck Bridge :



If the flooring of a bridge which carries the traffic is supported at the top of main girders of the bridge, then the bridge is called as deck type bridge.
In case of plate girder bridge of deck type, the floor is placed on the top of the chords. No bracing is provided over the top of the traffic.

Thrayh Bridge :



When the flooring of the bridge which carries the traffic is supported at the bottom of the main girders of the bridge or at the bottom of dead bearing super-structure it is called as Thrayh bridge.
In plate girder bridge of thrayh type, the floor is placed on the bottom flanges of the girdy.
Bracing is provided over top of traffic.

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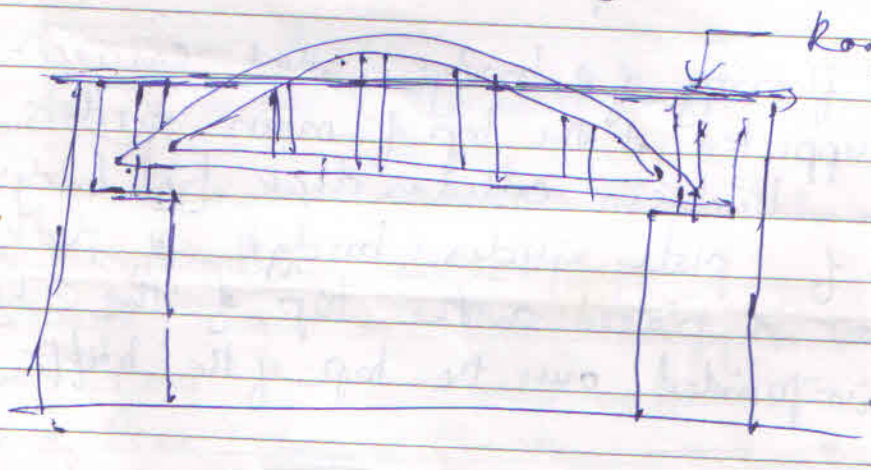
Semi-Through Bridge: when the flooring of the bridge is supported at some intermediate level i.e. in between of the top & bottom level of the main load bearing superstructure of the bridge. These types of bridges sometimes are also called as pony bridges. No bracing is provided in this class of bridges



Q:- Derive the relation of flood discharge by rational method.

Q: Determine the economical span of a bridge. Following are the details regarding span, cost of superstructure & cost of substructure.

Span (m) (l)	Superstructure Cost	Substructure Cost	Cost of (a_1)
4	1800	22000	$= \frac{1800}{4^2} = 112.5$
8	7500	23400	$= \frac{7500}{8^2} = 117.19$
12	18000	24000	125
16	25000	24500	97.65
		Σ 93900	ΣK = 452

Sol^n $l = \sqrt{\frac{P}{a_1}}$

where P → Cost of one Pier with found^n $\boxed{a_{1\,avg} = \frac{452}{4} = 113}$

a_1 is Cost of superstructure & $a_1 l^2$ ∴ a_1 = Cost of Sub

∴ Calculation of $P_{avg} = \frac{93900}{4} = 23475$ $\boxed{23475}$