# Bridge Engineering & Tunneling

## *Complete Subject Formulae*

Civil Engineering Formulas

Simplified Learning

1. Discharge through / for bridge

a) From use of empirical formula -

i) Dicken's formula : $Q = C A^{3/4}$ $m^3/s$
($C = 11$ to $22$)

ii) Ryve's formula : $Q = C \cdot A^{3/4}$ $m^3/s$

iii) Ingli's formula : $Q = 123.2\sqrt{A}$ $m^3/s$

iv) For small catchment, Ingli's formula : $Q = \frac{123.2A}{\sqrt{A+10.36}}$ $m^3/s$

v) Khosla's formula: Runoff = rainfall − losses

where A = area in $km^2$
C = area coeff

b) Rational formula -

$$Q = \frac{1}{36} \cdot K \cdot P_c \cdot A \quad m^3/s$$

& $$P_c = P_0 \left(\frac{2}{1+T_c}\right)$$

whr, $P_0$ - one hour rainfall

$T_c$ - time of conc.

$$P_0 = \frac{P}{2} \cdot \frac{T+1}{T} \quad cm/hr$$

P = total precipitⁿ in cm

$$T_c = (0.87 \times L^3/H)^{0.385}$$

2. Alluvial Stream → $L = 4.75\sqrt{Q}$ $(m^3/s)$

Q3. Linear waterway & Molesworth's formula:

Molesworth formula

$$h = \left(\frac{v^2}{17.9} + 0.015\right)\left[\left(\frac{A}{a}\right)^2 - 1\right]$$

Marriman formula

$$h = \frac{v^2}{2g}\left[\left(\frac{A}{c}\right)^2 - \left(\frac{A}{A_1}\right)\right]$$

whr,

h = afflux in m

v = velo in m/s o approach

A = natural waterway area in $m^3$

a = contracted area in $m^2$

C = discharge co-eff.

$A_1$ = enlarged area at u/s o bridge in $m^2$

4. Economic span ò bridge

$$N(a_1 l^2 + a_2 l) + (N-1)C_p + 2C_{ab} + 2C_{ap} = \text{total cost}$$

for minimum cost, $l = \sqrt{\dfrac{C_p}{a_1}}$

Econo. span → span for which
(cost ò superstructure) = (cost ò substructure)

5. Determination of scour depth for alluvial streams:

i) When linear waterway is not less than regime width -

$$d = 0.473 (Q/f)^{1/3}$$

$f = 1.76 \sqrt{d_{mm}}$ (d - mean dia. of bed mat.)

Q = discharge in $m^3/s$

f = Lacey's silt factor

ii) When linear waterway is less than regime width -

$$d_1 = d (W/L)^{0.61}$$

W - regime width of stream

L - waterway under bridge

6. Determination of scour depth for quassi-alluvial stream -

i) When velocity is known

$$Q = AV = (W \cdot d) \cdot V \therefore$$

$$d = Q / W \cdot V$$

{ W - surface width
V - velocity

ii) When slope is known - $Q = \frac{1}{n} \cdot y^{5/3} \cdot s^{1/2} \cdot W$

7. Depth of foundation

- Minimum depth - $d = \frac{P}{W}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$

P - bearing capacity ; $kN/m^2$
W - spec. gravity o' earth ; $kN/m^3$

- For hard rock - $min^m$ 500 mm, with dowel bars o' anchorage

- For erodable strata -
Foundation depth below HFL = 1.33 × $max^m$ scour depth

8. Forces in bridge design

i) Impact load

$$I = \left(\frac{4.5}{6+L}\right) \text{ — RCC bridge}$$

$$I = \left(\frac{9}{13.5+L}\right) \text{ — steel bridge}$$

{ L = span in 'm'; 3m to 45m }

ii) Wind load :

Wind pressure = $P = K \cdot V^2$ kg/$m^2$

iii) Water pressure:

$$P = 52HY^2$$

iv) Earth Pressure : $P = \frac{1}{2} K_a \cdot w \cdot H^2$

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

v) Centrifugal force :

$$P = \frac{W}{127} \cdot \frac{V^2}{R}$$

- W - wt. o vehicle
- V - velocity
- R - radius o curve

vi) Seismic force : $F = (\alpha \cdot \beta \cdot I) \cdot W$

- $\alpha$ - basic seismic co-eff
- $\beta$ - factor on soil fdn system
- I - importance factor (1.5 for imp. bridges)
- W - wt. ignored / redⁿ due to buyoncy

# Tunnelling

DATE

1. No. ȯ faces available for excavation if "N" is no. ȯ shaft
= 2N+2

2. Yield ȯ blast → 2.25 X when explosive is equidistant from both faces

3. Rate ȯ compressed air injection = $6m^3/min/m^2$