

Bridge Engineering & Tunneling

Complete Subject Formulae

Civil Engineering
Formulas



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1. Discharge through / for bridge

a) From use of empirical formula -

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

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

iii) Inglis's formula : $Q = 123 \cdot 2 \sqrt{A} \text{ m}^3/\text{s}$

iv) For small catchment, Inglis's formula : $Q = \frac{123 \cdot 2A}{\sqrt{A+10.36}} \text{ m}^3/\text{s}$

v) Khosla's formula : $\text{Runoff} = \text{rainfall} - \text{losses}$

where $A = \text{area in km}^2$
 $C = \text{area coeff}$

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b) Rational formula -

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

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

where, P_o - one hour rainfall

T_c - time of conc.

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

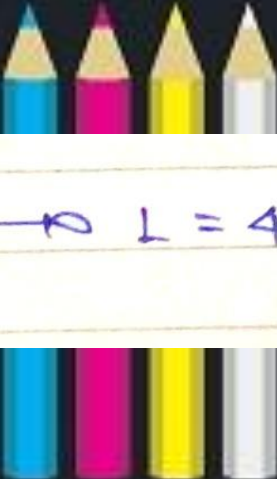
P = total precipitation in cm

$$T_c = (0.89 \times L^{3/4})^{0.385}$$

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2. Alluvial Stream $\rightarrow L = 4.75 \sqrt{Q}$ (m³/s)

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C. Linear waterway & Cipolesworth's formula:

Cyple'sworth formula

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

Spiniron 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^2

a = contracted area in m^2

c = discharge co-eff.

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

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4. Economic span of bridge

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

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

Econo. span \rightarrow span for which
(cost of superstructure) = (cost of substructure)

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5. Determination of scours depth for alluvial streams:

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

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

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

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

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6. Determination of scours depth for quasi-alluvial streams -

i) When velocity is known

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

$$d = Q / W \cdot V \quad \left\{ \begin{array}{l} W - \text{surface width} \\ V - \text{velocity} \end{array} \right.$$

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

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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 of earth ; kN/m^3

• For hard rock - min^m 500 mm, with doveled bars of anchorage

• For erodible strata -

Foundation depth below HFL = $1.33 \times \text{max}^{\text{m}}$ scour depth

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8. Forces in bridge design

i) Impact load

$$I = \left(\frac{4.5}{6+L} \right) \text{ --- Rcc bridge} \quad \left\{ \begin{array}{l} L = \text{span in 'm'} \\ 3\text{m to } 45\text{m} \end{array} \right.$$
$$I = \left(\frac{9}{19.5+L} \right) \text{ --- steel bridge}$$

ii) Wind load :

$$\text{Wind pressure} = P = K \cdot V^2 \quad \text{kg/m}^2$$

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iii) Water pressure:

$$P = \gamma H^2$$

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

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

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v) Centrifugal force :

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

$\left\{ \begin{array}{l} W - \text{wt. of vehicle} \\ v - \text{velocity} \\ R - \text{radius of curve} \end{array} \right.$

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

$\left\{ \begin{array}{l} \alpha - \text{basic seismic co-eff} \\ \beta - \text{factor on soil fdn system} \\ I - \text{importance factor (1.5 for imp. bridges)} \\ W - \text{wt. ignored / red? due to buoyancy} \end{array} \right.$

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Tunnelling

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1. No. of faces available for excavation if "N" is no. of shaft
 $= 2N + 2$
2. Yield of blast $\rightarrow 2.25 \times$ when explosive is equidistant from both faces
3. Rate of compressed air injection = $6 \text{ m}^3/\text{min}/\text{m}^2$

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