5. TRACK STRESSES

DYNAMIC AUGMENT (SPEED EFFECT)

- For N.G

$$\text{Speed factor} = \frac{V}{18.2\sqrt{\mu}}$$

where, V = Speed in km/hr.
μ = Track modulus in kg/cm/cm.

- For B.G & M.G

$$\text{Speed factor} = \frac{V^2}{30,000} \quad (V \leq 100 \text{ km/hr})$$

$$\text{Speed factor} = \frac{4.5V^2}{10^5} - \frac{1.5V^2}{10^7} \quad (V > 100 \text{ km/hr})$$

HAMMER BLOW EFFECT

$$\text{Hammer blow} = 0.14 \cdot \frac{M}{g} \cdot (2\pi n)^2 \cdot \sin\theta$$

where, M = Net over weight in kg.
r = Crank pin diameter in m.
n = Number of revolutions of wheel per sec.
θ = Crank angle.

STEAM EFFECT

The vertical component of pressure of steam acting on piston is given in F.P.S units.

$$= \frac{\pi}{4} \cdot d^2 \cdot P \cdot \frac{r\sin\theta \pm h}{L}$$

where, L = Length of connecting rod in inches.
d = Diameter of piston in inches.
h = Height of cross head above the centre line of driving wheels in inches.
θ = Crank angle.

INERTIA OF RECIPROCATING FORCES

$$F_v = \frac{M}{g} \cdot r(2\pi n)^2 \left(\cos\theta + \frac{r}{L}\cos 2\theta\right)\frac{r\sin\theta \pm h}{L}$$

where, F_v = The vertical component of the accelerating force in the connecting rod (Fv) at crank

M = Mass of reciprocating Parts

L = Length of connecting rod.

N = Number of revolutions per sec.

h = Height of cross head above the centre line of driving wheel in inches.

θ = Crank angle.

METHOD OF CALCULATING LONGITUDINAL BENDING STRESS IN RAIL

- $$x_i = 42.33\sqrt{\frac{I}{\mu}}$$

  where x_i = Distance from the load to the point of contraflexure of the rail in cm.

  I = Vertical moment of inertia of rail section in cm^4.

  μ = Track modulus in kg/cm/cm.

- $$f_{comp} = \frac{M_0}{z_{comp}} \text{ tonnes/cm}^2$$

- $$f_{tension} = \frac{M_0}{z_{tension}} \text{ tonnes/cm}^2$$

- $$d = \frac{9.25P}{\sqrt[4]{I\mu^3}}$$

  where, M_o = The bending moment in tonne-cm immediately under an isolated load P tonne on one rail.

f_{comp} = The consequent compressive stress in the rail head under the load P in tonne per square cm.

$f_{tension}$ = The consequent tensile stress in the rail foot, under the load P, in tonne per square cm.

d = Deflection of track in cm.

P = Load on one rail in tonnes.

z_{comp} = Section modulus of rail in compression (cm^3).

$z_{tension}$ = Section modulus of rail in tension (cm^3).

RAIL WHEEL CONTACT STRESSES

The maximum contact shear stress which occur in the transverse direction at right angle to the rail is,

$$T_{max} = 4.13\sqrt{\frac{Q}{R}}$$

where, T_{max} = Maximum shear stress in kg/mm^2.

Q = Static wheel load in kg (P), increased for on-loading on curves. This on-loading is taken as 1 ton (1000 kg)

Q = (P + 100) kg.

R = Wheel radius in mm (fully worn condition).

FORMATION PRESSURE

$$P_{max} = \frac{2PS}{\pi DL}\sqrt[4]{\frac{\mu}{64EI}}$$

where, P_{max} = Maximum formation pressure

S = Sleeper spacing

D = Depth of ballast under sleeper

L = Effective length of sleeper under one rail seat.

= 76 cm for BG & 63 cm for MG

μ = Track modulus (only track modulus in elastic range is considered)

I = Moment of inertia of worn rail along horizontal axis.

E = Modulus of elasticity of rail steel.

TRACK DETERIORATION AND MAINTAINABILITY OF TRACK

$$TD = P^3(1+3S^2)$$

where, TD = Track deterioration factor

P = Nominal wheel load

$$S = \frac{\text{Standard deviation of wheel load}}{\text{Nominal wheel load}}$$

$$\therefore \quad TD \propto P^3$$

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