6. TRACTION & TRACTIVE RESISTANCE

TRACTIVE EFFORT (T_e)

$$T_e = \frac{nPd^2L}{2 \cdot D}$$

where, P = Difference of pressure on two sides of the piston.
A = Area of piston
d = Diameter of piston
L = Length of stoke
D = Diameter of driving wheel
T_e = Tractive effort on the wheel.

HAULING CAPACITY (H.C)

$$H \cdot C = \mu \cdot n \cdot w$$

where, h = Number of driving wheels.
w = Weight of one pair of driving wheels (or on each axle)
μ = Coefficient of friction

$$\mu \propto \frac{1}{V}$$

$\mu = 0.1 \rightarrow$ for high speeds
$= 0.2 \rightarrow$ for low speeds

Generally $\mu = \frac{1}{6}$.

TRAIN RESISTANCE (R_T)

$$R_T = R_{T_1} + R_{T_2} + R_{T_3}$$

$$\downarrow$$

$$R_T = 0.0016\,w + 0.00008\,w \cdot v + 0.0000006wv^2$$

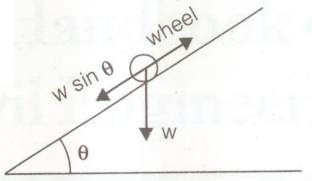
where, R_{T_1} = Resistance independent of speed.
w = Weight of train in tonnes.
= Weight of locomotive + wagons.
R_{T_2} = Resistance dependent on speed.
v = Speed of train in km/hr.
R_{T_3} = Atmospheric resistance.

RESISTANCE DUE TO TRACK PROFILE

(a) Resistance due to Gradient (R_g)

$$R_g \simeq w \tan\theta$$

where, w = Weight of train



(b) Resistance due to curve (R_C)

$R_C = 0.0004$ W.D $\rightarrow$ B.G track
$= 0.0003$ W.D $\rightarrow$ M.G track
$= 0.0002$ W.D $\rightarrow$ N.G track

where, W = Weight of train in Tonnes.
D = Degree of curve.

RESISTANCE DUE TO STARTING & ACCELERATION

(a) Resistance due to Starting (R_S)

For locomotive, $R_{LS} = 0.15\,W_1$ W_1 = wt. of locomotive in tonnes

For wagons, $R_{VS} = 0.005W_2$ W_2 = wt. of wagon in tonnes

(b) Due to Acceleration (R_a)

$$R_a = 0.028W\left(\frac{v_2 - v_1}{t}\right)$$

where, W = weight of train in tonne v_2 & v_1 are speed in km/hr & t is time in 'sec'.

WIND RESISTANCE (R_w)

$$R_w = 0.000017av^2$$

where, a = Exposed area of train in (m^2)
v = Speed in km/hr.

TOTAL RESISTANCE (R_T)

$$R_T = (0.0016\,w + 0.00008\,wv + 0.0000006\,wv^2) + \begin{bmatrix} 0.0004\,wD \rightarrow \text{for B}\cdot\text{G} \\ 0.0003\,wD \rightarrow \text{for M}\cdot\text{G} \\ 0.0002\,wD \rightarrow \text{for N}\cdot\text{G} \end{bmatrix} + \begin{bmatrix} 0.15\,w \rightarrow \text{locomotive} \\ 0.005\,w \rightarrow \text{vehicle} \end{bmatrix} + \left[0.028w\left(\frac{v_2 - v_1}{t}\right)\right] + (0.000017av^2)$$

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