6. ENGG. FUNDAMENTALS OF EQUIPMENTS

ROLLING RESISTANCE

Rolling Resistance R (kg/tonne)

$$R = \frac{P}{W}$$

where P = Required tractive force, kg
W = Gross weight of vehicle, tonnes

The low cable is fitted with a dynamometer which measures the average tension in the cable.

- **Grade Resistance**

The effect of grade is to increase, for a plus slope, or to decrease, for a minus slope, the required tractive effort by 10 kg per gross tonne of weight for each 1 per cent of grade.

It is the physical property which is affected by the type of equipment or the construction or the type of road.

- **Coefficient of Traction**

The coefficient of traction is affected by:

(i) Weight on the driving wheels or tracks
(ii) Gripping action of the wheel or track i.e. type of tread on the tyre or design of the grouser of tracks
(iii) Ground conditions

- **Drawbar Pull**

Effective drawbar pull = Available drawbar pull ± Rolling resistance on a level haul surface ± grade resistance for upgrade/downgrade slope

- **Rimpull**

It defines the tractive force between the rubber tires of driving wheels and the surface on which the tires operate.

It is expressed in kg and is calculated as per following conditions:

(i) If the coefficient of traction is high enough such that slippage is eliminated, then

$$\text{Maximum rimpull} = \frac{375 \times HP \times \text{Efficiency}}{\text{Speed in mph}}$$

(ii) If the coefficient of traction is such that slippage starts before its rated capacity, then

Maximum rimpull = Total pressure between driving wheels and the surface × coefficient of traction.

- **Effect of temperature and pressure on IC Engine**

The rated horse power of an IC engine is the power tested under standard conditions of temperature and pressure.

If the test is carried out under conditions different from the standard, the horse power may be determined by using the following formula:

$$H_c = H_o \frac{P_s}{P_o}\sqrt{\frac{T_o}{T_s}}$$

where,

H_c = Corrected horse power for standard condition.
H_o = Observed horse power as determined for test
P_s = Standard barometric pressure (760 mm of Hg)
P_o = Observed barometric pressure in mm of Hg at time of test
T_o = Absolute observed temperature, (equal to 273°C + Observed temperature in °C)
T_s = Absolute temperature for standard condition, (Equal to 273° + 15.5°)

DEPRECIATION COST

$$\text{Annual depreciation} = \frac{\text{Initial value} - \text{Salvage value}}{\text{Useful life of equipment (in years)}}$$

Initial value = Price of equipment + transportation cost + loading and unloading charge + Installation charge

- **Investment Cost**

Annual Investment Cost = 10-20% of the average annual cost of the equipment

The average annual cost of the equipment may be found out in following ways :

(i) When there is no salvage value of the equipment

$$P_{av} = \frac{P + \frac{P}{n}}{2} \qquad P_{av} = \frac{P(n+1)}{2n}$$

where, P = Total initial cost
P_{av} = Average annual cost
n = life in years

(ii) When there is salvage value of the equipment;

$$P_{av} = P + \left(\frac{P - s}{n}\right) + s \qquad P_{av} = \frac{P(n+1) + s(n-1)}{2n}$$

where,
P = Total original cost
P_{av} = Average annual cost
n = Life in years
s = Salvage value

- **Fuel Consumption Cost**

Fuel consumption in litre per hour

(i) For a gasoline engine = operating factor × rated HP × 0.30

(ii) For a diesel engine = operating factor × rated HP × 0.20

Operating factor = Engine factor × Time Factor

- **Lubricating oil cost**

An empirical formula may be used to estimate the quantity of lubricating oil;

$$q = \frac{\text{rated HP} \times \text{Operating factor} \times 0.003 \text{ kg per HP-hr}}{0.74 \text{ kg per liter}} + \frac{C}{t}$$

where;
q = Quantity of consumed lubricating oil in litre/hr
C = Capacity of crankcase of engine in litre
t = Number of hours between changes

The operating factor may be assumed as 0.6 when sufficient data is not available for the purpose.

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