24/02/2016
CE435 – Railway Engineering
Tutorial #3

Model Answer

Q1: An electrical freight train composed of 3- locomotives, weighing 130 tons, having 4-axles.25-freight cars, each weighing 30 tons, with 3 –axles. At a speeds of 50 mi/h on a level straight route.
Calculate:

- ❑ Total train resistance for the train.

$$R = 1.3\,W + 29N + bWV + CAV^2$$

Answer:

For Loco:

$R_{Loco} = 1.3\,W + 29N + bWV + CAV^2$ where A=120 sq.ft , b = 0.03 and c = 0.0024 (see the table)

$R_{Loco} = [(1.3 * 130) + (29 * 4) + (0.03 * 130 * 50) + (0.0024 * 120 * 50^2)] * 3 = 3600$ lbs

For Freight:

$R_{Freight} = 1.3\,W + 29N + bWV + CAV^2$ where A= 90 sq.ft , b = 0.045 and c = 0.0005 (see the table)

$R_{Freight} = [(1.3 * 30) + (29 * 3) + (0.045 * 30 * 50) + (0.0005 * 90 * 50^2)] * 25 = 7650$ lbs

∴ Total train resistance = 3600 + 7650 = 11250 lbs

Q2: How many 5,000 horsepower locomotives at 85% efficiency will it take to provide the pull of the 77,450 lb. if the resistance of each engine is 1,200 lb , At a speed 90 mi/h.

Answer:

$$TE = \frac{375 * HP * e}{v}$$

$$77450 + 1200N = \frac{375 * (5000N) * 0.85}{90}$$

$$77450 + 1200N = 17708.33N$$

$$N = \frac{77450}{1608.33} = 4.69 \rightarrow \quad Take\ \mathbf{5}\ Locomotives$$

Q3: Explain three of ballast functions?

Answer:

1. Holds the sleeper in position during passage of train (lateral and longitudinal stability of the track).
2. It transfers and distribute the load from sleepers to larger area information.
3. It provides resilience and elasticity to the track (leads to comfort and riding quality).

Q4: Define the rail sleepers, explain rail sleepers in term of main function and types.

Answer:

- ***Sleepers are*** members generally laid transverse to the rails on which the rails are supported and fixed**.**

- The main purpose/ Function of the sleepers is to cushion and transmit the load of the train to the ballast section as well as to maintain gauge

- ***Sleepers types***
    1. Timber or wooden sleepers {hardwood, softwood}.
    2. Metal sleepers {cast iron or steel}.
    3. Concrete Sleepers {Reinforced, Pre-stressed}.

"Davis" equation (Total Resistance)

$R = 1.3\,W + 29N + bWV + CAV^2$

Where :

R = Resistance in lbs

W = Weight, tons

N = Number of axles

V= velocity mi/h

b = an experimental friction coefficient.

A = cross-sectional area of vehicle

C = drag coefficient based on the shape of the front of the train and other features affecting air turbulence etc.

Recommended values for "Davis" equation:

Equipment Type	A sq.ft	b	C
Locomotives -50 tons	105	0.03	0.0024
70 tons	110	0.03	0.0024
100 tons and over	120	0.03	0.0024
Freight cars	85-90	0.045	0.0005
Passenger car	120	0.03	0.00034

Tractive Effort

$$TE = \frac{375 * HP * e}{v}$$

Where:

TE = Tractive Effort

HP = power hose

e = efficiency

v = velocity in mi/h