Train Resistance (Results and Test Procedure)

1 Resistance on Straight Level Track

A series of tests have been carried out to determine the frictional resistance of model rolling stock. An article describing the early tests in detail was published in the Gazette, Volume 9, No. 5. Due to the wide variation in vehicle weight (bogie coaches weighed from 360 grams to 980 grams and four wheel wagons from 75 grams to 350 grams) the resistance cannot be quoted for an 'average' vehicle but is expressed as grams per kilogram of vehicle weight. This follows prototype practice where train resistance is expressed in kilograms per tonne.

The test results fall into four groups as follows:

Group 1 Resistance 10 grams per kilogram of vehicle weight.
Stock with Delrin wheels on steel axles with pin-point journals running in Delrin bearings. Stock with Nylon or PTFE bearing bushes will also be in this group.

Group 2 Resistance 16 grams per kilogram.
2/a Stock with metal wheels on steel axles with pin-point journals running in brass bearings.
2/b Exley coaching stock with metal wheels on steel axles with parallel journals running in wire loops.
2/c Rivarossi stock with 'hard' plastic wheels on steel axles with needle journals running in 'hard' plastic bearings.
2/d Lima stock with plastic wheels and axles with pin-point journals running in plastic bearings.

Note: Some Lima vehicles gave results in Group 4. When examined the journals and wheel treads were found to be worn due to prolonged use on a large layout. This increased resistance could be eliminated by replacing the wheelsets and bearings by ones more resistant to wear.

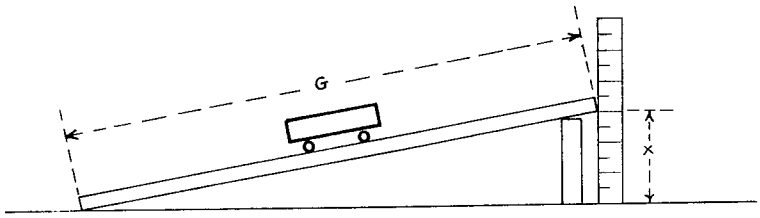
Group 3 Resistance 20 grams per kilogram
Stock with metal wheels on steel axles with parallel journals running in white metal bearings.

Group 4 Resistance 30 grams per kilogram
Stock with plastic wheels on steel axles with parallel journals running in plastic or white metal bearings.

2 Using the Test Results to Improve Rolling Stock

All rolling stock should have its bearings oiled and wheel treads cleaned on a regular basis to ensure optimum performance. Testing rolling stock for frictional resistance occasionally will show whether the procedures are achieving the desired result. In addition, modifying stock by changing bearings and wheelsets to conform to a lower group, the number of vehicles that a particular locomotive can pull will be increased, e.g. a locomotive that can pull 10 Group 4 vehicles could pull 30 similar vehicles if they were modified to Group 1.

The test apparatus is very simple and consists of a straight length of wood with track mounted on it, a support block and a ruler. Testing is carried out by placing the length of wood on a level surface and supporting one end on the block to form an inclined plane. The gradient of the incline is adjusted until a vehicle placed on the track runs down it at a steady speed, although it may be necessary to start the vehicle rolling to overcome the static friction. The steady speed shows that the force causing the vehicle to roll down the incline is just equal to the vehicle resistance. By measuring the gradient, the resistance in grams per kilogram can be found using the formula R/1000 = x/G. The sketch shows the basic layout and where x and G are measured.



Gradient is x/G

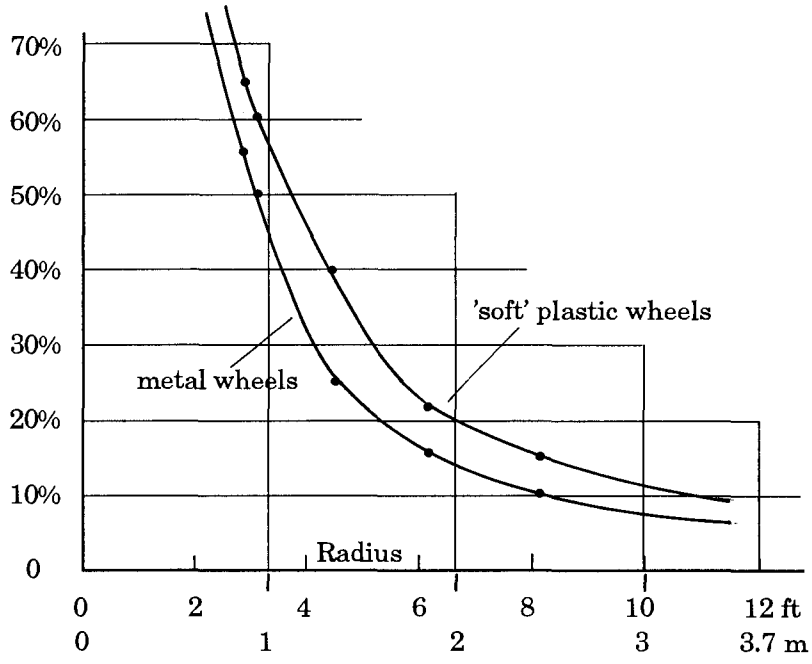
Example: A length of wood 2 meters (2000mm) long is used as the gradient. A vehicle whose running gear falls into the Group 3 category rolls steadily down the incline which has had its end raised 47mm. Using the simple formula above - R/1000 = 47/2000 and, hence, R = 23.5grams per kilogram. This is about the upper limit for Group 3 vehicles and indicates that the running gear needs attention. If x had measured, say, 38mm, R would have been 19grams per kilogram which is better than average. The only additional improvement possible would be to modify the running gear.

3 Curve Resistance on Level Track

The drawbar pull required to overcome the tractive resistance of a set of vehicles on curved level track is greater than the drawbar pull required to move them on straight level tracks and the smaller the radius, the greater the resistance. Measurements of the tractive resistance of a range of vehicles on curved track gave a nearly constant percentage increase over the value on straight track regardless of the type of running gear. 'Soft' plastic wheels gave a larger increase than other types due to their higher flange friction.

The table and graph show the curve resistance as a percentage of that on straight track.

Curve Resistance (Percentage of Resistance on Straight Track)		
Radius	Metal Wheels	'Soft' Plastic Wheels
2.4m (8ft)	10	15
1.8m (6ft)	17	22
1.4m (4ft 6in)	25	40
0.9m (3ft)	50	60
0.8m (2ft 8in)	55	65



4 Using the Test Results for Performance Calculations

a) Select the vehicles that will form the largest train that a locomotive will be required to haul.
b) Check the running gear and segregate them into groups following the descriptions given above.
c) Weigh the vehicles in each group and multiply each groups total weight by the appropriate factor to give the group rolling resistance.
d) Add the group resistances to give the total rolling resistance of the train.
e) From the curve resistance table or graph select the appropriate increase factor for the sharpest curve to be traversed and multiply the total by this figure.

The result obtained represents the drawbar pull the model locomotive must exert to overcome train resistance on level track.