Calculation of Brake Force Data for Rolling Stock Library

Synopsis
This Railway Group Standard defines the method of calculating the brake force data for inclusion in the Rolling Stock Library.

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## Calculation of Brake Force Data for Rolling Stock Library

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Part A

Issue record
This standard will be updated when necessary by distribution of a complete replacement.

Amended or additional parts of revised pages will be marked by a vertical black line in the adjacent margin.

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<td>1</td>
<td>May 95</td>
<td>Original Document (Formerly referred to as GM/TT0269)</td>
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Responsibilities and distribution
Controlled copies of this Railway Group Standard shall be distributed to all Train Operators and other organisations who have responsibilities for the provision of mandatory data for rail vehicles. The contents of this Railway Group Standard shall be disseminated to all personnel who are responsible for the calculation of brake force data for rail vehicles.

Implementation
The provisions of this Railway Group Standard are mandatory and apply from 1st July 1995.

Disclaimer
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Part B

1 Purpose
This standard defines the standard method for the calculation of rail vehicle brake force data, for inclusion in the Rolling Stock Library (RSL).

2 Scope
The contents of this standard apply to all rail vehicles, operating on the infrastructure controlled by Railtrack, excluding those vehicles required to operate only in possessions and self-propelled on-track machines not required to be moved in a train formation.

3 Definitions
Brake Force
See GM/TT0168

Brake Retarding Force
See GM/TT0168

Brake Force Factors
Are factors that enable the TOPS computer system to calculate the brake force on a rail vehicle fitted with a device that varies the brake force in proportion to the vehicle mass.

Equivalent Brake Force
Is the value of brake force that needs to be exerted on an equivalent tread brake arrangement with a standard coefficient of friction, to produce the same value of brake retarding force as that given by the actual combination of brake force and coefficient of friction on the vehicle.

4 Introduction
4.1 Railway Group Standard GM/RT2211 defines the mandatory data that must be recorded for each rail vehicle that is registered on the Rolling Stock Library and includes a requirement for brake force data to be supplied.

4.2 The brake force data for a rail vehicle is required to enable the total equivalent brake force available in a train to be established and thus allow the maximum permissible speed, from the point of view of braking, to be determined.

4.3 For freight trains, Classes 4, 6, 7 and 8, defined in the Appendix to the Rule Book, the information on the maximum permissible speed for different combinations of train mass (including locomotive) and total available brake force (including that for the locomotive, but excluding that for any vehicles in the train with brakes isolated) is given in Table E1, in Part 6 of the Working Manual for Rail Staff.
4.4
The standard method of calculation defined in this standard must be used for all rail vehicle types where a value of brake force has not already been supplied to the RSL.

5 Calculation of Brake Force Data

5.1 Vehicles with either a single value of brake force, or values fixed for the tare and laden conditions.

5.1.1
The approach defined in the paragraphs 5.1.2 to 5.1.4 shall also be used for coaching stock, as required by Appendix A of GM/RT2211, even though they may have a brake force that varies with the vehicle load. The value of equivalent brake force calculated shall be that for the tare condition of the vehicle.

5.1.2
The equivalent brake force declared to the Rolling Stock Library (RSL) is the total for the vehicle and is directly related to the vehicle brake retarding force acting at the rail.

5.1.3
The declared value of brake force is used directly as an index of the braking ability of the vehicle and to be consistent with existing values, is the force that needs to be exerted on an equivalent tread brake arrangement to give the same brake retarding force at the rail, using a standard mean coefficient of friction at the friction braking interface. The standard mean coefficient of friction historically used as the basis for the calculations is 0.13.

5.1.4
The equivalent brake forces as required by GM/RT2211, must be calculated from the brake retarding force as follows:

$$B_T = \frac{F_T}{0.13 \times 9.81}$$  and  $$B_L = \frac{F_L}{0.13 \times 9.81}$$

Where:
$$B_T =$$ the equivalent brake force to be declared as the mandatory data to the RSL for the rail vehicle in tare condition (tonnes).

$$B_L =$$ the equivalent brake force to be declared as the mandatory data to the RSL for the rail vehicle in laden condition (tonnes).
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$F_T$ & $F_L$ = the vehicle brake retarding force, appropriate for the tare or laden condition respectively, that acts at the rail and over the period during which the brake cylinder pressure has reached at least 95% of its maximum value (kN).

0.13 = the standard mean coefficient of friction (-).

9.81 = acceleration due to gravity (m/s$^2$).

5.2 Vehicles with a value of brake force that varies in proportion to the load

5.2.1 For those vehicles defined in Appendix A of GM/RT2211, for which it is necessary to calculate brake force factors, that are in the form of a constant and a variable component, these shall be calculated as follows:

(a) Brake force factor $1 = C_L$ or $C_T$ (tonnes)

where $C_L = B_L - (m \times W_L)$

and $C_T = B_T - (m \times W_T)$

See below for the derivation of $m$

(b) Brake force factor $2 = \frac{(B_L - B_T)}{(W_L - W_T)} = m$ (tonnes / tonne)

Where $B_L$ = Equivalent brake force in max laden condition (tonnes).
$B_T$ = Equivalent brake force in tare condition (tonnes)
$W_L$ = Max laden mass (tonnes)
$W_T$ = Tare mass (tonnes)

The values of brake force factor calculated at (a) & (b) above are those that must be supplied to the RSL.

5.3 Factors to be considered in the derivation of brake force

5.3.1 The brake retarding force for a vehicle can be calculated from design data or derived from the results of braking distance tests, in either case this must be from the rail vehicle maximum speed. Where actual tests are undertaken, the value of equivalent brake force calculated must be validated.
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5.3.2
For tread braked vehicles, the brake retarding force is calculated from the product of the total value of the brake force and the coefficient of friction between the brake blocks and wheel tread. In the case of a disc brake, it is the product of the brake force, coefficient of friction and the ratio of effective radius at which the disc pad acts and the new wheel radius of the vehicle.

5.3.3
When calculating brake retarding force, account must taken of any losses due to rigging efficiency, or slack adjusters within the brake force application system, between the brake cylinder and brake blocks or pads. If a reliable value for brake force cannot be derived, it should be measured directly at the block or pad. In this case account must be taken of the effects of vibration on the value of static friction in the rigging.

5.3.4
The coefficient of friction used must take account of all influencing aspects, such as the brake force, the area of the friction material and vehicle speed, as all these factors affect the value of the coefficient of friction. For example, for a given brake block area, increasing block loads and speeds will reduce the effective value of the coefficient of friction for cast iron brake blocks.

5.3.5
If there is no data available giving the coefficient of friction for particular combinations of load, speed and area of the friction interface, tests must be undertaken to establish a value, if it is used to calculate brake retarding force.

5.3.6
Where there is one vehicle number to cover vehicles that are semi-permanently coupled by bar type couplers or are articulated, the correct brake retarding force must be calculated for each distributor by using the vehicle weight controlled by each distributor.
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References

GM/RT2211  Mandatory Data for Rail Vehicles
GM/TT0168  Braking Policy for Traction & Rolling Stock, Including On-Track Plant
BR 87109/43  Rule Book Appendix
BR 30054/6  Working Manual for Rail Staff Part 6 White Pages