

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2016/M (L)/467/2

New Delhi, dated 07.11.2016

General Managers,
All Indian Zonal Railways.

Sub: Revision of RDSO table for calculation of time loss due to speed restrictions.

Ref: RDSO's letter no. TFC/55/Tech. dated 21.09.2016

During review of Mobility issues on Allahabad division, it was noticed that tables used by Railway for calculating time loss due to speed restrictions were not up to date. RDSO was instructed to issue revised tables for time loss calculations due to speed restrictions. Revised tables received from RDSO are enclosed herewith.

All Zonal Railways are advised to take necessary action to incorporate revised time loss calculations in Working Time Tables (WTT), for various combinations of Passenger and Freight trains hauled by Diesel Locomotives. The values may be used as guidelines and actual time loss may be fixed after conducting field trials.

Action taken by Zonal railways shall be intimated to this office.

DA: As above (11 pages).

A. dk MIT
7.11.16

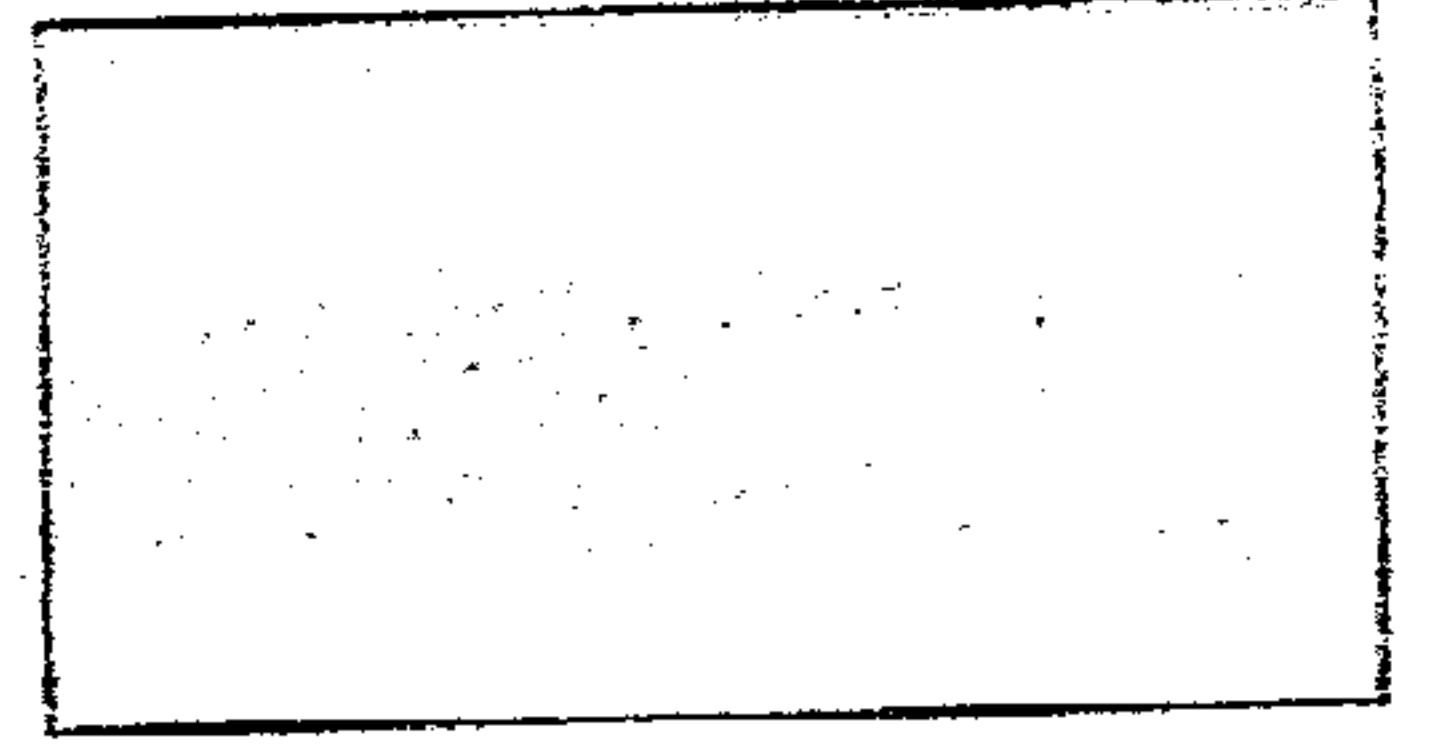
(Vivek Kumar)
Exe. Dir. Mech. Engg. (Traction)
Railway Board

Copy to: Adviser (Mobility), Railway Board.
CEEs: All Indian Zonal Railways.



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No.TFC/55/Tech.

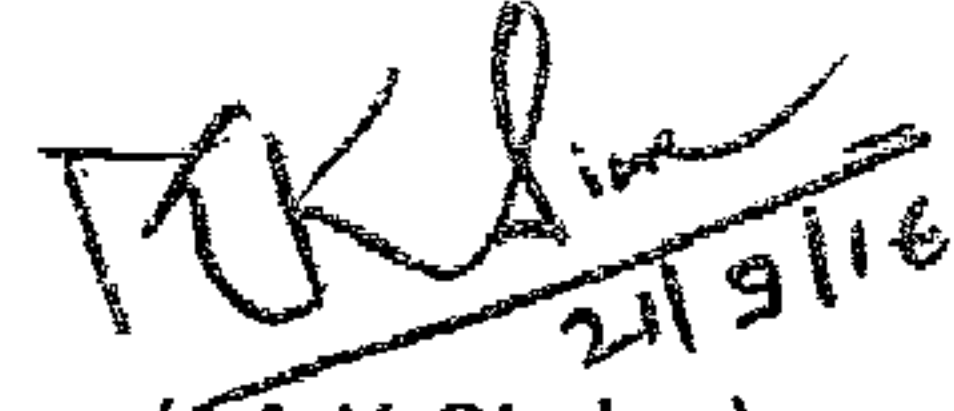
Date: 21.09.2016

Advisor/Mobility,
Railway Board,
Rail Bhawan,
New Delhi.

Sub: Revision of RDSO table for calculation of time and loss for speed restrictions.
Ref: (i) Adviser (Mobility)/ Railway Board letter no. 2016/M (L)/467/2 dated 29.07.2016.
(ii) This office letter of even number dated 02.09.2016.

In continuation of RDSO letter under reference (ii), Motive Power Directorate of RDSO has also derived through theoretical Computer simulation time loss in negotiating speed restrictions for various combinations of Passenger and Freight trains hauled by diesel Locomotives. Time loss sheets are enclosed as annexure A/1 to A/3 and B respectively. Theory of time loss calculation has been adopted from RDSO Mechanical Engineering Investigation Report No. MR-46. Relevant pages of the report are attached as Annexure - C. The values may be used as guidelines and actual time loss may be fixed after conducting actual field trials.

DA: As above (10 sheets)


21/9/16
(M.K.Sinha)
Executive Director/Traffic

चाळान शक्ति निदेशालय

Note no.SD.Genl.3

Date. 20.09.2016

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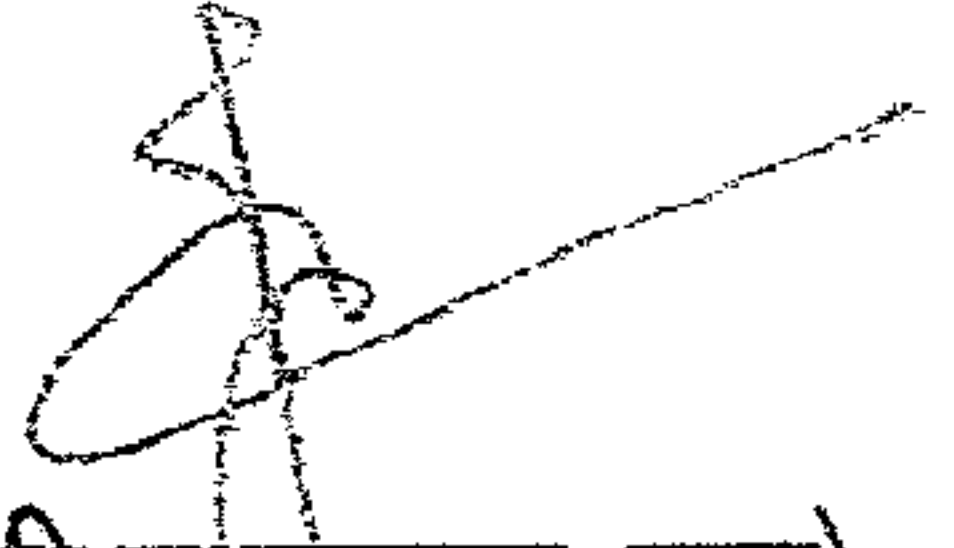
विषय:Revision of RDSO table for calculation of time loss for speed restrictions.

संदर्भ :Your note no. TFC/55/Tech., dtd.23.08.2016, 02.09.16&15.09.16

In reference to above, time loss sheet for various combinations due to speed restrictions for passenger & freight service for diesel electric locomotive have been prepared and enclosed as **Annexure – A/1 to A/3 & B** respectively. The theory of time loss calculation has been adopted from RDSO Mechanical Engineering investigation Report No. MR-46.Relevant pages of the report are enclosed as **Annexure – C**.

2. The values are derived through theoretical computer simulation and may be used as a guideline and actual time loss may be fixed after conducting actual field trials.

Encl: As above


(सी.मधुसुदन राव)
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EDSMP

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PASSENGER SERVICE**Time loss for negotiating speed restrictions over a stretch of 1 km length with different load and locomotive**

No. of ICF coaches	Max. Speed (km/h)	Restricted speed (km/h)	Time loss during braking (Min)	Time loss for negotiating 1 km length speed restriction (Min)	WDM3A		WDP3A		WDM3D		WDP4	
					Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)
			(a)	(b)	©	(a+b+c)	(d)	(a+b+d)	(e)	(a+b+e)	(f)	(a+b+f)
18	110	75	0.09	0.25	1.13	1.47	1.04	1.38	0.88	1.22	0.59	0.93
		70	0.12	0.31	1.35	1.78	1.25	1.68	1.07	1.50	0.75	1.18
		60	0.19	0.46	1.75	2.40	1.68	2.33	1.43	2.08	1.03	1.68
		45	0.32	0.79	2.31	3.42	2.31	3.42	2.00	3.10	1.47	2.58
		30	0.48	1.45	3.08	5.01	3.05	4.98	2.69	4.62	2.15	4.08
		20	0.61	2.45	3.82	6.88	3.81	6.87	3.59	6.65	3.00	6.06
21	110	75	0.09	0.25	*	*	1.41	1.75	1.13	1.47	0.72	1.06
		70	0.12	0.31	*	*	1.67	2.10	1.37	1.80	0.90	1.33
		60	0.19	0.46	*	*	2.17	2.82	1.78	2.43	1.23	1.88
		45	0.32	0.79	*	*	2.87	3.98	2.41	3.52	1.72	2.83
		30	0.48	1.45	*	*	3.74	5.67	3.20	5.13	2.42	4.35
		20	0.61	2.45	*	*	4.67	7.73	4.07	7.13	3.32	6.38
24	110	75	0.09	0.25	*	*	*	*	*	*	0.89	1.23
		70	0.12	0.31	*	*	*	*	*	*	1.10	1.53
		60	0.19	0.46	*	*	*	*	*	*	1.48	2.13
		45	0.32	0.79	*	*	*	*	*	*	2.02	3.13
		30	0.48	1.45	*	*	*	*	*	*	2.80	4.73
		20	0.61	2.45	*	*	*	*	*	*	3.79	6.85

Note: * indicates that locomotive could not achieve maximum speed on given load.

Time loss for negotiating speed restrictions over a stretch of 1 km length with different load and double headed locomotives

No. of coaches	Max. Speed (km/h)	Restricted speed (km/h)	Time loss during braking (Min)	Time loss for negotiating 1 km length speed restriction (Min)	2 WDM2		2 WDM3A		2 WDP3A		2 WDM3D	
					Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)
			(a)	(b)	(c)	(a+b+c)	(d)	(a+b+d)	(e)	(a+b+e)	(f)	(a+b+f)
18	110	75	0.09	0.25	0.63	0.97	0.51	0.85	0.49	0.83	0.44	0.78
		70	0.12	0.31	0.77	1.20	0.64	1.07	0.62	1.05	0.55	0.98
		60	0.19	0.46	1.05	1.70	0.87	1.52	0.87	1.52	0.77	1.42
		45	0.32	0.79	1.42	2.53	1.19	2.30	1.18	2.29	1.09	2.20
		30	0.48	1.45	2.02	3.95	1.72	3.65	1.71	3.64	1.65	3.58
		20	0.61	2.45	2.69	5.75	2.44	5.50	2.43	5.49	2.29	5.35
21	110	75	0.09	0.25	0.74	1.08	0.59	0.93	0.58	0.92	0.51	0.85
		70	0.12	0.31	0.92	1.35	0.75	1.18	0.75	1.18	0.65	1.08
		60	0.19	0.46	1.23	1.88	1.02	1.67	1.02	1.67	0.88	1.53
		45	0.32	0.79	1.74	2.85	1.42	2.53	1.42	2.53	1.25	2.36
		30	0.48	1.45	2.45	4.38	2.09	4.02	2.09	4.02	1.85	3.78
		20	0.61	2.45	3.29	6.35	2.95	6.01	2.95	6.01	2.64	5.70
24	110	75	0.09	0.25	0.89	1.23	0.69	1.03	0.69	1.03	0.59	0.93
		70	0.12	0.31	1.09	1.52	0.87	1.30	0.87	1.30	0.75	1.18
		60	0.19	0.46	1.45	2.10	1.17	1.82	1.17	1.82	1.03	1.68
		45	0.32	0.79	2.01	3.12	1.62	2.73	1.62	2.73	1.42	2.53
		30	0.48	1.45	2.80	4.73	2.35	4.28	2.35	4.28	2.08	4.01
		20	0.61	2.45	3.72	6.78	3.06	6.35	3.06	6.35	2.94	6.00

Time loss for negotiating speed restrictions over a stretch of 1 km length with loaded Passenger coaches
With double headed locomotive on level tangent track

ANNEXURE - A/3

No. of coaches	Max. Speed (km/h)	Restricted speed (km/h)	Time loss during braking (Min)	Time loss for negotiating 1 km length speed restriction (Min)	2 WDP4 (4000 HP)		2 WDP4B/4D (4500 HP)	
					Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)
					(a)	(b)	(c)	(a+b+c)
24 ICF coaches (Including 5 SGAC)	140	100	0.09	0.26	4.7	5.05	4.0	4.35
		90	0.15	0.36	5.3	5.81	4.6	5.11
		80	0.21	0.49	5.8	6.50	5.1	5.80
		70	0.29	0.66	6.2	7.14	5.3	6.24
		60	0.38	0.87	6.5	7.75	5.6	6.85
		50	0.48	1.18	6.8	8.45	5.9	7.55
		40	0.59	1.64	7.0	9.22	6.1	8.32
		30	0.71	2.40	7.2	10.31	6.3	9.41
		20	0.85	3.93	7.3	12.08	6.4	11.18
	150	100	0.14	0.31	7.5	7.95	*	*
		90	0.20	0.41	8.0	8.60	*	*
		80	0.27	0.54	8.5	9.30	*	*
		70	0.35	0.70	8.9	9.95	*	*
		60	0.45	0.92	9.2	10.56	*	*
		50	0.55	1.22	9.5	11.27	*	*
		40	0.67	1.68	9.7	12.05	*	*
		30	0.80	2.45	9.9	13.14	*	*
		20	0.93	3.98	10.0	15.01	*	*
	160	100	0.19	0.34	14.6	15.13	*	*
		90	0.25	0.45	15.2	15.90	*	*
		80	0.33	0.57	15.6	16.50	*	*
		70	0.42	0.74	16.0	17.15	*	*
		60	0.52	0.96	16.2	17.67	*	*
		50	0.63	1.26	16.4	18.28	*	*
		40	0.74	1.87	16.6	19.06	*	*
		30	0.87	2.49	16.8	20.16	*	*
		20	1.01	4.02	17.0	22.02	*	*

FREIGHT SERVICE

ANNEXURE - B

Time loss for negotiating speed restrictions over a stretch of 1 km length with different load and locomotive

Load	Max. Speed (km/h)	Restricted speed (km/h)	Time loss during braking (Min)	Time loss for negotiating 1 km length speed restriction (Min)	2WDG3A (2x3100 HP)		2WDG4 (2x4000 HP)		2WDG4D (2x4500HP)	
					Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)	Time loss for acceleration from restricted speed to max. speed (Min)	Total time loss (Min)
					(a)	(b)	(c)	(a+b+c)	(e)	(a+b+e)
59 BOXN (CC+8+2t) 5400 t	75	60	0.07	0.20	5.5	5.77	3.1	3.37	2.8	3.07
		50	0.21	0.40	7.6	8.21	4.3	4.91	3.5	4.11
		40	0.40	0.70	8.9	10.00	5.3	6.40	4.7	5.80
		30	0.67	1.20	9.9	11.77	5.9	7.77	5.1	6.97
		20	0.97	2.20	10.5	13.67	6.4	9.57	5.8	8.97
59 BOXN (CC+4+2t) 5165 t	75	60	0.07	0.20	3.54	3.81	2.15	2.42	1.92	2.19
		50	0.21	0.40	5.31	5.92	3.24	3.85	2.54	3.15
		40	0.40	0.70	6.55	7.65	4.05	5.15	3.39	4.49
		30	0.67	1.20	7.01	8.88	4.64	6.51	3.91	5.78
		20	1.00	2.20	7.96	11.13	5.04	8.21	4.26	7.43
59 BOXN (CC) 4810 t	75	60	0.07	0.20	3.15	3.42	2.21	2.48	1.62	1.89
		50	0.21	0.40	4.75	5.36	3.25	3.86	2.79	3.40
		40	0.40	0.70	5.88	6.98	3.95	5.05	3.45	4.55
		30	0.67	1.20	6.66	8.53	4.49	6.36	3.94	5.81
		20	1.00	2.20	7.18	10.35	4.87	8.04	4.26	7.43
44 BCN (CC+8+2t) 4030 t	75	60	0.07	0.20	3.03	3.30	1.73	2.00	1.41	1.68
		50	0.21	0.40	4.30	4.91	2.45	3.06	2.23	2.84
		40	0.40	0.70	5.21	6.31	3.16	4.26	2.78	3.88
		30	0.67	1.20	5.85	7.72	3.60	5.47	3.18	5.05
		20	1.00	2.20	6.28	9.45	3.92	7.09	3.45	6.62

TIME LOST BY TRAINS HAULED BY DIESEL AND ELECTRIC LOCOMOTIVES DUE TO SPEED RESTRICTIONS

1. Introduction

1.1 As the time allowed for observing speed restrictions differed considerably from railway to railway and requests were being received from railways regarding extra time that should be allowed under different conditions, an attempt was made to arrive at rational figures of time allowance for various speed restrictions for BG and MG trains and the results of these investigations were reported in Mechanical Engineering Investigation Report No. 22. In this report only steam traction was considered and calculations were made for passenger trains hauled by WP and YP locomotives and for goods trains hauled by WG and YG locomotives.

1.2 With the rapid increase of electrification and dieselisation of both goods and passenger services, the Railway Board desired that an investigation should be made regarding time lost by trains under electric and diesel traction due to speed restrictions. This report deals with the study of time lost by trains hauled by electric and diesel locomotives due to speed restrictions. The speed/time and speed/distance characteristics for various trains required for this study were derived with the help of the train schedule computer of RDSO, Lucknow.

2. **Object:** To determine the time lost by trains hauled by diesel and electric locomotives due to various speed restrictions.

3. Approach

3.1 **Elements of time lost:** When a train has to observe a speed restriction, it has to decelerate from the normal booked speed to the restricted speed, run at the restricted speed for the specified distance over which the speed restriction applies plus a distance equal to the train length and then accelerate to the booked speed. In observing the speed restriction, therefore, the loss in time comprises of the losses during three distinct phases, detailed below:

Phase (A): Time lost during deceleration from the booked speed to the restricted speed.

Phase (B): Time lost due to the train running at the restricted speed instead of the booked speed, for the specified distance over which the speed restriction exists.

As the entire train length has to clear the section where the speed restriction exists at the restricted speed, the 'T' board—termination indicator—is located alongside the track to denote the point from which the driver can resume normal speed. The Indian Railways Way and Works Manual stipulates that the 'T' board should be located beyond the point where the need for speed restriction exists, at a distance equal to the length of the longest goods train operating on the section. The train length already having been taken into account while placing the 'T' board, it is not necessary to make further allowances for the individual train lengths in this report. However, the distance of the 'T' board beyond the point where the need for speed restriction exists has to be added to the actual length over which speed restriction exists, to get the total distance over which the train has to run at restricted speed.

Phase (C): Time lost during acceleration from the restricted speed to the booked speed.

In calculating the time lost, the total distance covered and the total time taken during the three phases indicated above are determined. The time that the train would have taken to cover this total distance, had there been no speed restriction, is then calculated. The difference between the two timings is the time lost due to speed restriction.

3.2 Factors influencing time lost due to speed restrictions

- (i) Tractive effort characteristics of the locomotive
- (ii) Load to be hauled
- (iii) Booked speed from which the train has to decelerate for observing speed restrictions
- (iv) Speed restriction imposed
- (v) Braking characteristics of the train
- (vi) Track gradient
- (vii) Distance of 'T' board beyond the point where the need for speed restriction exists.

4. Motive power and trailing load particulars

4.1 Locomotives and loads : To make this investigation fairly representative of actual conditions obtaining in service, computations have been made for various diesel and electric locomotives hauling different passenger and goods loads as tabulated in Table 1 where the booked speeds of various trains have also been indicated.

4.2 Locomotive characteristics

4.2.1 Diesel locomotives : The tractive effort values at various speeds for different diesel locomotives have been taken from the rating curves obtained during dynamometer car trials. In the case of diesel locomotives the power delivered by the diesel engine varies with the altitude and ambient temperature obtaining at site. The tractive effort values given in the dynamometer car reports are for standard conditions *ie* sea level and 15.6°C ambient temperature. The tractive efforts as obtaining under standard conditions have been reduced by three percent to allow for the derating of the engine due to higher ambient temperature at site (a temperature of 35°C has been considered for arriving at the derating factor; this is approximately the range of summer and winter temperatures) and by another five percent to allow for the reduction of power due to ageing of the diesel engines. The locomotive resistance at various speeds for these diesel electric locomotives has also been taken from the data obtained during dynamometer car trials.

4.2.2 Electric locomotives : The tractive effort and locomotive resistances of all the electric locomotives except WAM₁ have been taken from the data obtained during dynamometer car trials. For WAM₁ for which dynamometer car tests have yet to be conducted, the values have been taken from the makers' curves.

4.3 Resistance of trailing loads : The specific resistances of the trailing loads have been calculated from the following formulae,

where R = specific resistance in kg/tonne

and V = speed in kmph.

For BG light weight coaching stock

$$R = 1.425 + 0.00818 V + 0.00031 V^2$$

(Dynamometer Car Report No. 11)

For BG BOX wagons

$$R = 0.87 + 0.0103 V + 0.000056 V^2$$

(Mechanical Engineering Report No. M. 192)

For BG 4-wheeler wagons

$$R = 1.4 + 0.00483 V + 0.000238 V^2$$

(Dynamometer Car Report No. 11)

For MG coaching stock

$$R = 1.98 + 0.0026 V + 0.000295 V^2$$

(Mechanical Engineering Report No. M. 189)

For MG 4-wheeler wagons

$$R = 1.744 + 0.00113 V + 0.000506 V^2$$

(Mechanical Engineering Report No. M. 189).

4.4 Track gradient: As the track gradient varies from place to place and no definite assumption can be made on this point, a level tangent track has been considered for this investigation. However, to give an idea of the effect of both up and down gradients on the time lost due to speed restrictions, the case of a 15-coach BG passenger train hauled by WDM₂ (diesel) and WAM₁ (electric) locos at a speed restriction of 16 kmph on grades of 1 in 500, 1 in 200 and 1 in 100 both up and down has been computed and results are presented in Table 2.

It will be seen that in the time lost on grades, as compared to that on level, the differences in Phases A and C, more or less mutually cancel out. The overall result is that the time lost on grades is not materially different to that on level. The time lost for different speed restrictions on level section, as computed with the help of data in this report may, therefore, be used for restrictions on graded sections as well without introducing any error in the computations for all practical purposes.

5. Basic data

5.1 Accelerating force: Values of drawbar pull on level track for different locomotives at various speeds used for deriving the speed/time and speed/distance characteristics on the train schedule computer are given in Data Sheet 1. The tractive resistance of trailing load at various speeds calculated from the formula in Para 4.3 is tabulated in Data Sheet 2.

The net accelerating force in kg/tonne weight of the train for various combinations of locomotives and loads were derived from the data given in Data Sheets 1 and 2 and fed to the train schedule computer to get the speed/time and speed/distance characteristics during acceleration for various trains. The speed/time and speed/distance graphs as derived on the train schedule computer for different locomotives have been presented in Fig. 1 to 10.

5.2 Retarding force during braking: Brake efficiency* is defined as the percentage weight of train, which when applied as a constant retarding force, would stop the train in a distance equal to the observed braking distance. This in effect is an index of average retardation during braking. During emergency braking distance trials on normal service trains (Mechanical Engineering Report No. M. 190), it was found that the brake efficiency was 4.4 percent for passenger trains and 1.5 percent for goods trains. Assuming the average retardation for service brake application to be about 2/3 that for emergency brake application, the brake efficiency values of 3 percent for passenger trains and 1 percent for goods trains have been considered for arriving at the distance covered and the time taken during deceleration in Phase A. The decelerating force of 3 percent of the train's weight for passenger trains and 1 percent of the train's weight for goods trains were fed to train schedule computer and the speed/time and speed/distance characteristic during deceleration of the train obtained. The relationship between initial speed and stopping distance and time required from that speed during Phase A for passenger and goods trains have been presented in Fig. 11 and 12.

6. Calculation of time lost due to speed restrictions

6.1 Deceleration from booked speed to restricted speed—Phase A: The time lost during this phase, when the train has to decelerate from the booked speed to the restricted speed, depends only on the booked speed, restricted speed and average retardation (brake efficiency). It is, therefore, independent of the type of locomotive and the train load. For calculating the time lost during this phase, the distance covered and time taken during deceleration from booked speed to the different restricted speeds are read off from Fig. 11 for passenger trains (brake efficiency 3 percent) and from Fig. 12 for goods trains (brake efficiency 1 percent). The time required to cover the above distance, had the train run at the booked speed is then calculated. The difference between this calculated time and the decelerating

*The retardation of trains, Graff Baker W. S., ILE 1937, P. 290.

time as read off from Fig. 11 and 12, will give the time lost during Phase A. The time lost during the phase can also be readily calculated for different values of brake efficiency, booked speeds and speed restrictions from the general formula :

$$t_a = \frac{(u-v)^2}{42.3 \times b \times u}$$

where t_a = time lost during deceleration (minutes),

u = booked speed (kmph),

v = restricted speed (kmph)

and b = brake efficiency (percentage)

Appendix I may be referred for the derivation of this formula.

The results of calculations of time lost during Phase A made on the basis of this formula for different booked speeds and restricted speeds for passenger trains (brake efficiency 3 percent) and goods trains (brake efficiency 1 percent) are given in Data Sheets 3 & 4. These values have been graphically presented in Fig. 13 for passenger trains and Fig. 14 for goods trains.

6.2 Running at restricted speed—Phase B: The time lost during Phase B is the difference in time obtained as a result of the train running at the lower restricted speed, instead of at the normal booked speed, for a specified distance.

If, u is the booked speed in kmph,

v is the restricted speed in kmph,

s is the total distance in km over which the train has to run at restricted speed

and t_b is the time lost in minutes during Phase B due to the train running at (v) instead of (u) kmph over a distance (s) km,

$$\text{then, } t_b = \frac{60 s (u-v)}{uv} \text{ minutes.}$$

If, s is taken as 0.1 km, then time lost in minutes will be

$$\frac{6 (u-v)}{uv} \text{ minutes.}$$

If, s is taken as the distance between consecutive telegraph poles, since there are 24 telegraph poles to a mile, s will be 67 metres i.e. 0.067 km, and the time lost in minutes over one telegraph pole distance will be :

$$\frac{4.02 (u-v)}{uv} \text{ minutes}$$

The time lost in minutes during Phase B, for different booked speeds and restricted speeds have been calculated, and tabulated for 0.1 km distance in Data Sheet 5 and for one telegraph pole in Data Sheet 6.

These values have been graphically presented in Fig. 15 (unit of distance—0.1 km) and at Fig. 16 (unit of distance—one telegraph pole). From these graphs the time lost for any combination of speeds can be directly read off for different total distances over which the train has to run at restricted speed.

As already explained in Para 3.1 the 'T' board i.e. the termination indicator is located beyond the point where need for speed restriction exists, at a distance equal to the length of the longest goods train operating on the section. Therefore, for purposes of calculating the time lost, the total distance from the start of the speed restriction to the location of the 'T' board has to be reckoned. In this investigation a distance of 600 metres (being the length of the longest goods train that can be accommodated within the present loops) has been considered as the distance of 'T' board beyond the point where the need for speed restriction exists.

It is seen from the general and subsidiary rules of the different zonal railways that the 'T' board distance beyond the point where the need for speed

restriction exists is in many cases less than 600 metres and varies from railway to railway. For cases where the actual 'T' board distance is less than the 600 metres assumed in this investigation, provision exists in Fig. 15 and 16 for computing the time lost as applicable to the actual 'T' board distance.

6.3 Acceleration from restricted speed to booked speed—Phase C: The time lost during the acceleration phase depends on the locomotive characteristics and the load being hauled and as such it will be different for the various combinations of locomotives and loads considered. For determining the time lost during this phase, the distances covered and time taken during acceleration from different restricted speeds to the normal booked speed are read off from Fig. 1 to 10. The time taken to cover the accelerating distance, had the train run through at the normal booked speed is then calculated. The difference between this calculated time and accelerating time as read off from the graphs gives the time lost during this accelerating phase.

The time lost during this phase for different values of restricted and booked speeds has been worked out for the various combinations of locomotives and loads. The results are graphically presented in Fig. 17 to 28. A typical tabulated calculation sheet for working out the time lost as depicted in these graphs is shown in Data Sheet 7 to serve as an example.

7. Total time lost: The total time lost due to any speed restriction is the sum of time lost during the three Phases A, B & C mentioned above. The time lost during Phase A can be read off from Fig. 13 for passenger trains and from Fig. 14 for goods trains. The time lost during Phase B can be read off from Fig. 15 if the distance is reckoned in kilometres and from Fig. 16 if the distance is reckoned in telegraph poles. The time lost during Phase C for different combinations of locomotives and loads can be read off from Fig. 17 to 28. The total time lost is obtained by adding up the individual times read off from the various graphs as mentioned above.

8. Ready reckoner for total time lost: The time lost by different trains due to out of course stoppages and certain specific speed restrictions, as obtained from the graphs, have been presented in tables as mentioned below for ready reference:

Table 3: Passenger trains hauled by diesel locomotives.

Table 4: Goods trains hauled by diesel locomotives.

Table 5: Passenger trains hauled by electric locomotives.

Table 6: Goods trains hauled by electric locomotives.