

टेलैक्स : 0535-2424 RDSO-IN
फैक्स : 91-0522-458500
तार : 'रेलमानक' लखनऊ
Telegram : 'RAILMANAK', Lucknow
टेलीफोन/Tele : 451200 (PBX)
450115 (DID)



भारत सरकार - रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ - 226 011
Government of India-Ministry of Railways
Research Designs & Standards Organisation
LUCKNOW - 226 011

TECHNICAL CIRUCLAR NO. 16

**Ramesh Chandra,
Executive Director Stds.**

D.O.No. EL/3.1.39/1

Dt.23.3.98

Dear Shri Garg / Goel / Sen / Bansal / Prasad / Punnuswami / Nagpal / Aggarwal / Jain /
Adhikari

Sub: Starting Capabilities of locomotives for graded sections

At many forums in Indian Railways, there is talk of producing a locomotive, which can start and haul 58 BOX'N' loads on grades of 1:100 and 1:150. It is in this light, an analysis has been made for your information and is given in following paragraphs.

The starting capability of a locomotive is limited by two external factors these are:

- (a) Maximum axle load permitted by track structure
- (b) Adhesion between rail and wheel.

These are discussed below:

- (a) The track structure on Indian Railways permits the maximum axle load for electric locomotives as 22 tonne \pm 2%. The various maximum permissible speeds on different axle loads are as under:

S.NO.	Axle Load (tonnes)	Speed (kmph)
1.	18.8	160
2.	19.5	120
3.	20.5	100
4.	22.0	80

- (b) The available adhesion on Indian Railway track conditions has been measured during various trials by RDSO on different types of DC,AC, thyristor, 3-phase electric locos and diesel locos, is as under:

S.NO.	Type of Loco	% Adhesion
1.	DC Loco WCG2 (with vernier control)	26.9 %
2.	AC loco WAM4 (with trimount Co-Co bogie)	34.3 %
3.	AC loco WAG7(with high adhesion bogies)	35.7 %
4.	Thyristor Locos WAG6 (A,B,C,)	36 to 37 %
5.	3-Phase loco WAG 9	38 %
6.	Diesel Loco WDM 2	27 %
7.	Diesel Loco WDG 2	34 %

The adhesion is primarily dependant on number of notching steps and the direction of mounting of TMs. That explains the variation in adhesion values of above class of locomotives.

The maximum possible adhesion limits of 38% have been achieved on 3-phase locos due to the stepless control employed in three phase locomotives. There is no further scope to increase the adhesion further as limited by Nature.

With this adhesion and axle load of 20.5 tonne for a speed of 100 kmph for goods locomotive, the maximum possible starting tractive effort is Adhesion X Weight = 0.38 X 123 = 46.7t.

The requirement of tractive effort for different gradients are as under:

S.No.	Grade Level	Load (tonnes)	Starting Tractive Effort Required (tonnes)
1.	Level	4700	19.54
2.	1 in 500	4700	29.2
3.	1 in 400	4700	31.59
4.	1 in 200	4700	44
5.	1 in 150	4700	53
6.	1 in 100	4700	70

From above, it is clear that for starting 4700 t loads on 1:150 or 1:100, there is no option but to go for two loco concept till the limit of maximum permissible axle loads are revised upwards. Details of the requirement of number of locomotives for different gradients is enclosed as Annexure. You may like to use this information during discussions in various forums.

With regards,

Yours sincerely,



Encl:As above

(Ramesh Chandra)

1. Sh.V.N. Garg, CEE / Western Rly, Churchgate, Mumbai-400 020
2. Sh.J.K.D.Garg, CEE / CORE. Allahabad
3. Sh.S.C.Goel. CEE / S.C. Rly, Rail Nillayam, Secunderabad-500 371
4. Sh.A.Sen, CEE / Eastern Rly, Fairlie Place, Calcutta-700 001
5. Sh.D.K.Bansal, CEE / Southern Rly, Park Town.Chennai-600 003
6. CEE / Northeast Frontier Railway, Maligaon-781 001
7. Sh.Binod Prasad, CEE/N.E.Railway, Gorakhpur-272 601
8. Sh.P.Punnuswamy, CEE / Central Railway, Mumbai CST-400 001
9. Sh.S.C.Nagpal, CEE / N.Rly, Baroda House, New Delhi-110 001
10. Sh.V.K. Aggarwal, CEE / S.E.Rly, Garden Reach, Calcutta-700 043
11. Sh.A.K. Jain, CEE / CLW,Chittaranjan
12. Sh.Anil Adhikari, CEE / ICF, Chennai-600 038

Copy to: Secretary (Electric Traction) Railway Board, New Delhi-110 001

Copy to: Sr.D.E.E.(O)

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- Central Railway, DRM office. Bhusawal (Maharashtra)
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- Central Railway, DRM office, Jabalpur, (M.P.)
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- Western Railway, DRM office, Vadodara
- Western Railway, DRM office, Kota.

Encl : As above

Ramesh Chandra

(Ramesh Chandra)
for Director General/Elect.

ANNEXURE

NUMBER OF LOCOS REQUIRED FOR STARTING 4700t (BOXN) LOAD

Type of Loco	T.E. Available in tonnes per loco	Gradient							
		1/400		1/200		1/150		1/100	
		TE reqd.	No.of Locos	TE reqd.	No.of Locos	TE reqd.	No.of Locos	TE reqd.	No.of Locos
WDM2	30	31.50	2	43.54	2	52.60	2	69.60	3
WDG2	38	31.60	1	43.60	2	52.62	2	69.76	2
GM	52***	31.62	1	43.62	1	51.64	1	69.81	2
WAG5	33.6	31.56	1	43.60	2	52.59	2	69.70	3
WAG7	42**	31.60	1	43.60	1**	52.62	2	69.76	2
WAG9	46.89	31.60	1	43.60	1	51.62	1*	69.76	2

* Upgraded to 53t starting T.E. for special applications.

** Upgraded to 44t starting T.E.by use of 16:65 gear ratio.

*** Tentative figure based on adhesion, actual values yet to be ascertained.