INDIAN RAILWAYS

FUNCTIONAL REQUIREMENT SPECIFICATION

FOR

STANDARDIZATION OF BRAKE DISC

FOR LHB COACHES

OF

INDIAN RAILWAYS

RESEARCH DESIGNS AND STANDARDS ORGANISATION
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Functional Requirement Specification for Standardization of Brake Disc of LHB Coaches

1.0 FOREWORD

LHB type coaches of Indian Railways have been provided with axle mounted disc brake system wherein brake disc is that part of vehicle brake system that serves to convert kinetic energy into heat by means of friction. Axle mounted brake disc are ring-shaped castings made from cast steel or grey cast iron with crosswise cooling ribs. Presently, LHB Coaches have two types of Brake Discs i.e. 9 Bolt & 12 Bolt Design supplied by two renowned suppliers. This specification is intended to standardize the Brake Disc for LHB coaches so as to achieve the ease of interchangeability and maintenance requirements.

2.0 FUNCTIONAL REQUIREMENT

2.1 The brake disc of Axle Mounted Disc Brake system shall fulfill the following requirement, under Indian Railway service conditions without crack, damage over permitted under DIN27205-3, damage or degradation other than normal wear of the friction face beyond permissible limits

2.1.1 Brake Disc shall permit a braking moment or torque to be generated, supported and transmitted to the rail vehicle axle.

2.1.2 Brake Disc shall permit, by frictional engagement of a brake pad or pads, the conversion into heat of the kinetic and potential energy involved in retarding the vehicles which is attributed to the use of the disc brake.

2.1.3 Brake disc shall absorb part or all of the kinetic and potential energy arising from the braking of coaches.

2.1.4 Brake disc shall dissipate the absorbed energy by radiation, convection and conduction.

3.0 DESIGN REQUIREMENT

3.1 The axle mounted brake disc shall consist of the friction ring with cooling ribs and the hub. The friction ring of Brake Disc shall have to be cast as a single piece followed by its machining on required surfaces as per EN 14535-1.The thickness of the friction ring, and the size of the cooling ribs are related to prevent overheating during brake application.

3.2 The brake disc (including friction ring and spokes) shall have adequate mechanical and thermal capacity for service on and off the Indian Railways, under the environmental and operating conditions identified in Annexure-II.

3.3 Brake discs are intended to be mounted on the axle to RCF Drg. No.LW02100 alt 'Nil'. It shall be ensured by the firm that disc/discs offered by him are suitable to be fitted on to the axle as per this drawing.

3.4 Brake Disc shall be of standard design with number of bolts and mounting arrangement for fixing of friction rings of different make on the hub. Broad specification of the brake disc shall be as under:

a)	Dimensions	640 x 110 mm
b)	Outer Diameter of friction ring	640 +0/-1mm
c)	Inner Diameter of friction ring	350 mm
d)	Width of friction ring	$110^{+0/-0.3}$ mm
e)	Inner bore	199 mm (H6)
f)	Width of hub	150 mm

3.5 The imbalance of new discs shall be equal to or less than 16gm.

3.6 All parts of the brake disc shall be designed for fatigue strength.

3.7 In the design of axle mounted discs, the fatigue life of the connection between the hub and friction ring must take into account cyclic loading from thermal and shock environments that are separately considered and are encountered in normal service.

3.8 The fatigue life at the most highly stressed location in the connection between the hub and spoke, due to combined strains from thermal load and shock load, shall be equal to or greater than the projected service life of the friction ring or 20,00,000 km whichever is greater.

3.9 Brake disc shall be designed and constructed in such a way that in case of hitting of flying stones raised from ballast track, it does not affect the functional efficiency or cause failure of disc.

3.10 The connections between brake discs and wheel set axle must satisfy the following requirements:

3.10.1 Transmission of brake power.

3.10.2 Largely unrestricted thermal expansion of friction faces and friction segments.

3.11 A minimum true specific weight shall be of great importance

3.12 The friction ring shall be designed additionally with a view to minimizing their overall weight.

3.13 The friction ring of brake disc shall have a groove around their outside circumference to indicate the condemning limit and when they have to be exchanged.

3.14 The crosswise cooling ribs carry off the heat and serve simultaneously to maintain a thermal balance within the friction rings.

3.15 Cooling fins that are arranged radially between the friction surfaces provides for sufficient cooling at the friction ring. They convey a stream of cooling air from the hub through the interior of the friction ring to the outside, using a centrifugal force that is controlled by speed.

3.16 Low-noise behaviour by the brake disc under all operational conditions shall be of great importance.

3.17 The replacement of worn, damaged brake discs/sections without dismounting of the wheels should be possible.

3.18 Supplier should also offer split disc designso that replacement for damaged or wornout discs can be achieved with ease without the necessity of dismounting of wheels from the axles.

3.19 Unless the purchaser requests otherwise, a suitable hole and groove feature shall be incorporated to facilitate pressurized liquid assisted assembly and/or disassembly of hub and axle. The threaded hole connection is to be closed with a locking bolt G1/4A x 8 DIN 910 and sealing ring A14 x 20 x 1.5 DIN 7603.

4.0 PERFORMANCE REQUIREMENTS

4.1 The brake disc is to be so designed that it provides faultless operation under the conditions of use mentioned at Annexure – II for a period of at least 6 years from the date of commission.

4.2 Brake disc should be designed in such a way that it has minimum wear and tear and maintenance possibility. The goal for the wear limit on friction faces and friction segments shall be 2 million kilometers.

4.3 Design of the brake disc shall be such that the performance is not adversely affected under extreme positions of wheel and suspension movements under maximum wear conditions.

4.4 The brake disc offered shall be suitable to work with any UIC approved Organic Brake Pads suitable for speeds upto 200 kmph and must qualify frictional and thermal characteristics as stipulated in UIC 541-3.

DESIGN DATA AND LOAD CASES FOR BRAKE DISC

a) THERMAL LOAD AND BRAKING SCENARIO

S. No.	Description	Unit	Emergency Braking	Service Braking
1.	Mean Braking Radius (m)	Meter	0.247	0.247
2.	Wheel diameter (New) (m)	Meter	0.915	0.915
3.	Wheel diameter (Worn) (m)	Meter	0.845	0.845
4.	Mean Co-efficient of friction of Brake Pads	-	0.35	0.35
5.	Surface Area of Brake Pads	cm^2	400	400
6.	Braked Mass	Kg	8000	8000
7.	Starting velocity	Kmph	**160**	**160**
8.	Final velocity	Kmph	0	0
9.	Brake application time	Sec	4	4
10.	Deceleration rate	m/sec^2	1.2	0.80
11.	Clamping force per disc	kN	42	25
12.	Kinetic energy	MJ	**7.9**	**7.9**
13.	Load cycles	-	6000	62500

b) IMPACT LOAD

S.No.	**Description**	Vertical	Axial
1.	Standard Impact	25g	3g
2.	Extraordinary Impact	100g	100g

ANNEXURE-II

OPERATING CONDITIONS FOR BRAKE DISC

1.	Coach Type	:	LHB Type BG Passenger Coaches
2.	Axle Load	:	16.25t (max.)
3.	Gross Load (Coach)	:	65t (max.)
4.	Gross Load (Train)	:	1700t (max. without loco)
5.	Operating speed (max)	:	160 Kmph
6.	Maximum deceleration	:	1.3 m/sec^2
7.	Emergency Braking distance	:	1200 meter
8.	Wheel diameter	: :	915 (New) 845 (Worn)
9.	Wheel base	:	2560mm
10.	Minimum clearance above rail level	:	102 mm under loaded and worn Condition
11.	Maximum bogie rotation and swing	:	3.5^0, 82mm
12.	Track Parameters		
	a) Steepest Gradient	:	1 in 37
	b) Sharpest curvature	:	175 m radius
	c) Super elevation (max)	:	1765 mm max.
13.	Environmental condition		
	a) Maximum temperature under sun	:	70 ^{0}C
	b) Maximum temperature under shade	:	45 ^{0}C
	c) Minimum temperature at Night	:	- 5 ^{0}C
	d) Altitude	:	Sea level to 652 meters
	e) Humidity	:	100% saturation during rainy Season
	f) Rain falls	:	Fairly heavy
	g) Atmosphere during hot weather	:	Dusty

Environment: Coaches shall be working in coastal area with saline and corrosive atmosphere.

14. The vibrations and shocks normally to be encountered in service.

a)	Maximum vertical acceleration	=	3.0 g
b)	Maximum longitudinal acceleration	=	5.0 g
c)	Maximum transverse acceleration	=	2.0 g