

Interchangeable Brake Pad Specification

Report



PRM.220.00 – Israel Railways Ltd. Brake Pad Specification - ISR

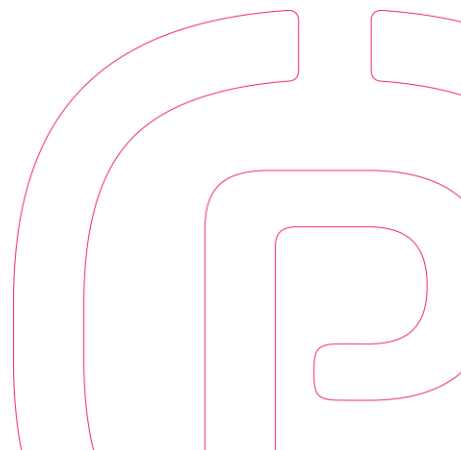
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1 Preamble

Israel Railways (ISR) are interested to identify interchangeable brake pads for disc brakes. Thus, alternative pads shall be qualified for the use at vehicles of ISR.

This document provides the specification for the pads to be searched for. These pads will be assessed in terms of performance, means:

- coefficient of friction,
- performance under wet condition,
- wear of pad (total wear, uneven wear),
- wear of disc and cracks of discs,
- burnt smell,
- noise,
- and others.

In general, the performances of the pads which are in use today at ISR are appropriate and accepted by the operator. In none of the categories the new pads shall show lower performance than pads today.

2 Pad Specification

This brake pad specification defines requirements on brake pads, which should be appropriate to replace pads, which are in use today at vehicles of ISR.

2.1 Vehicles

All vehicles of ISR equipped with disc brakes are considered. Refer to Table 2-1 for overview and detailed list in Annex B.

BRAKE WEIGHT AND WEIGHT FOR PASSENGER WAGONS AND LOCOS - EQUIPPED WITH DISC BRAKES													
CAR type	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Basic weight (t)	Max. weight (t)	Bogies	Axis in each bogie	Nr. of discs per axle	max. speed km/h	Type of pad	Quantity
	Mode P	Mode <R>	Mode R (red)	Mode R+Mg (red)	Mode G								
PASSENGER COACHES													
Siemens	65 - 75	90 - 103	96 - 111	124	N/A	47.9 - 56.1	60.5 - 63.1	2	2	3	160	Becorit 922	118
Bombardier	66 - 75	86 - 101	N/A	N/A	N/A	48 - 59	56 - 65	2	2	3	160	Becorit 946	425
ALSTOM	52 - 76	69 - 99	N/A	N/A	N/A	46 - 52	60.8 - 63	2	2	2	140	Becorit 922	35
LOCO / TRAINSETS													
EURO -3200	97	141	N/A	N/A	77	90		2	2	2	160	Becorit B36	24
EURO-4000	153	N/A	N/A	N/A	125	121		2	3	2	130	Becorit B36	14
IC3	205	N/A	N/A	N/A	99 - 101	119 - 125		4	2	block + disc or disc	140		40
Traxx AC3	91	132	N/A	N/A	76	84		2	2	2	160	Becorit B36	62

Table 2-1 Vehicles of scope of the project

2.2 Pads in Use Today

Today the following brake pads are in use (for comparison):

- Becorit B36, UIC-approved brake pad, in use at locomotives,
- Becorit 922, no UIC-approval, in use at Siemens and Alstom coaches,
- Becorit 946, no UIC approval, in use at Bombardier coaches.

The pads in use show appropriate performance. No serious negative issues are known. Both wheel mounted discs and axle mounted discs are in good condition. The wear of pads (an example is shown in Figure 2-1) and discs is even.

The average mileage reached with a set of pads is xxx km (Input ISR requested).

2.3 General Requirements

Requested pad size is 400 cm². Thickness is 35 mm (ISR to confirm or specify, if other thickness is needed).

The new pads shall be environmental friendly. It shall be free of asbestos and free of other hazardous materials.

The noise caused by brake application shall be not higher than today.

It is intended to replace the new pads per vehicle by alternative pads. The supplier may allow to replace the pads also per bogie, per axle or per disc, which would be of advantage for the maintenance procedure and the handling of the pads.

2.3.1 Normative References

Main normative reference is the UIC Leaflet

- UIC-541-3 *Brakes – Disc brakes and their application – General conditions for the certification of brake pads* [1]

This UIC-leaflet will be replaced in future by an European Standard, for which a draft version is available now:

- prEN15328, Railway applications — Braking — Brake pads, Enquiry version, Feb. 2018, [4]

Relevant for assessment of brakes is further:

- UIC544-1, Brakes – Braking Performance, 6th edition, October 2014, [5]

Classification of requirements can also be found in EN14535-3 even if this document is more relating to brake discs:

- EN 14535-3, Railway Applications – Brake discs for railway rolling stock – Part 3: Brake discs, performance of the disc and the friction couple, classification, December 2015 [3].

2.3.2 Operation

Typical operation at ISR is characterized by:

- Passenger service up to 160 km/h,
- Locomotives are also in service for freight trains.
- All passenger trains remain in its configuration during operation.
- No shunting and re-configuration occurs during operation.
- The service of ISR is solely national service.

In general, the application at ISR is quite unique. Some trains do not stop at every station, but timetables do not define a significant split in regional and long-distance traffic.

Transition from Diesel traction to electric traction is coming up and should be considered.

2.3.3 Environment

Environmental conditions of Israel apply:

- typically, environmental conditions are less challenging in winter times than in northern countries,
- no heavy winter conditions with a lot of snow,
- however high temperatures in summer time.

2.3.4 Running Profile

No steep and long gradients are within the network of Israel. A typical running profile is the route from Hertzliya to Tel Aviv as specified in [5].

Supplier shall show, that the proposal is appropriate for this route.

2.4 Performance Specification

The performance specification for new pads is based on specifications of UIC-leaflet 541-3. However, not the full range of UIC-requirements is needed for the intended application. It will be sufficient to fulfil a selection of requirements according to the kind of service. The selection of relevant UIC-requirements is listed in chapter 2.4.3.

UIC-certificate is not mandatory for new pads.

2.4.1 Classification

The table of vehicles (Table 2-1) show main parameters which determine the classification (class of the vehicle, speed of vehicle and braked mass per disc).

As summary, the classes may apply as given in Table 2-2, which determines the classifications as defined by [1].

Class of vehicle	max. speed [km/h]	Braked mass per disc [t]	Energy to stop per disc [MJ]	Classification UIC541-3 prEN15328 EN14535-3
Passenger Coaches	160	4.7 to 5.4	4.6 to 5.3	4.2 / B1
Passenger Coaches	140	7.6 to 7.9	5.7 to 6.0	4.2 / B1
Locos	160	10.5 to 11.3	10.4 to 11.1	C3
Loco	130	10.1	6.6	C3
Trainsets	140	7.4 to 7.8	5.6 to 5.9	B1

Table 2-2 Main vehicle parameters and classification

Note: Braked mass and - following from that - energy per disc are calculated from the max. total weight of the vehicle and does not consider the rotational contribution to kinetic energy, which pretend an increase of mass about 5% to 10%.

Pad supplier might prefer to use class 4.2 for coaches as defined in UIC leaflet or class B1 as defined in EN.

Due to the fact, that the definition of classes (both in UIC and EN) does not exactly correspond to the data of the vehicle, pad supplier might propose to assign other classes based on their own experience.

Pad supplier may also prefer to use a programme adapted from the generic programme in Annex E of UIC541-3.

2.4.2 Stopping Distance Performance

Most important performance requirement is the stopping distance. It is a prerequisite that the new pad can substitute the pads in use today.

The mean coefficient of friction shall be equivalent or better. However, it may not be much higher. This would overload wheel/rail-adhesion and mechanics of the vehicle.

Lower brake performance by new pads would be adverse for operation and shall be avoided.

2.4.3 Requirements from UIC- 541-3

The selection of requirements from UIC 541-3 as listed in Table 2-3 are to be fulfilled by the new type of pad.

Chapter	Title	Comment
1.2.2	Coefficient of friction	general requirement, details tested by test programme
1.2.3	Environmental impact, health and safety	important!
1.2.4	Usage requirements	general requirement, details tested by test programme
1.3	Frictional requirements for brake pads	for classes B1 and C3
1.4 (1.4.6 excl.)	Frictional requirements for brake pads for coaches	for class 4.2 (if chosen)
1.5	Geometrical features of the brake pads	
1.6. (1.6.2 excl.)	Mechanical, physical and chemical characteristics	
1.8	Marking of ... brake pads	
1.10.1.1	Classification scheme for locomotives, motor units and freight cars	classes B1 and C3, see Table 2-2
1.10.1.2	Classification scheme for coaches	class 4.2, if chosen for coaches
2.2	Brake pad material	
2.3	Brake discs	
2.4	Brake performance	

A	Generic conditions for the execution of test programs	as long as applicable
B.2	Test Program: Brake pads on Discs of Energy Class B1 and C1	according to class B1
B.4	Test Program: Brake pads on Discs of Energy Class C3	according to class C3
B.11	Test programme P - Definition of static friction coefficients	parking brake performance could be tested a the rig.
C.3	Test program No. S1 (vmax = 200 km/h – organic pads)	type S1.1, if 4.2 chosen for coaches
C4	Test program No. S2 (wet tests)	type S2.1, if 4.2 chosen for coaches, less importance
C.8	Instantaneous coefficient of friction for test program S1, S2 and T1, T2	NOT necessary even if 4.2 chosen for coaches, if comparison is done to the old pads
C.9	Mean coefficient of friction for test program S1, S2 and T1, T2	NOT necessary even if 4.2 chosen for coaches, if comparison is done to the old pads
E.2	Locomotives and motor units	if generic test programme is proposed by supplier
F	Brake pad shape and envelope	Figure 1
G	Drawing for dove tail	Figure 4

Table 2-3 Relevant Requirements from UIC 541-3

Full UIC-certification is not the goal of performing the test programme. Therefore, the long list of brake applications within the specific test programme might be shortened according to the application, e. g. considering the lower maximum speed.



Figure 2-1: Brake pads at bogie

2.5 Proof of Interchangeability

The proof of interchangeability of new pads will be done in three steps:

- pre-selection,
- stopping distance test,
- in-service-test.

2.5.1 Pre-Selection

For pre-selection the supplier shall show, that the proposed pad is suitable for the intended service and that the proposal fulfils the requirements.

This is to be done either by UIC-certification. Or the supplier shall show test results from bench tests or other evident information showing appropriate experience for the specified service.

For doing this the supplier is asked to follow the classification of Table 2-2 and the requirements of Table 2-3, and to provide relevant documents on comparison of his proposal to pads in use today.

The parking brake performance could be proven by comparison of test bench results.

ISR will provide pads in use today to enable pad supplier to perform the comparing dynamometer tests.

Based on documents by supplier ISR will do a pre-selection. If the proposed pad shows good performance and appropriate performance, it might be selected for stopping distance test and in-service test.

2.5.2 Proof of Stopping Distance

The stopping distance is most important parameter of the indispensable performance of the new pad. The comparison of mean coefficient of friction only on test bench results might not give enough precise confirmation. Therefore, such stopping distance test will be done at least for a selection of most critical load and speed.

It is sufficient to do the stopping distance test in the following way. This due to the fact, that all trains remain during service in fixed configurations.

- Stopping distance of locos. The locos, equipped with new pads, shall show at least same stopping distance as with old pads. This test shall be done with the loco running as single vehicle.
- Stopping distance test with the whole consist of coaches, as these are in operation. This is not to be done with each single type of coach. Doing it this way, no decoupling test of the coaches would be necessary. The coaches must be equipped with the new pad to examine the performance of the new pad. The loco should be with old pads. This procedure will show the summary of the performance of the coaches

Both tests shall be performed also with the pads of today, even if results from former tests are available. This improves the comparison by applying same circumstances of test. For test of coaches the same locomotive shall be used for old/new pads.

The alternative method of checking the stopping distance is to do the test with the single vehicle. However, for the coaches this would need “decoupling” tests. Moreover, this kind of test would need to do it with each type of vehicle. This approach is not recommended. The effort of performing such tests is like a re-assessment of the brake of the vehicle.

2.5.3 In-Service-Test

A test will be done with a range of pre-selected brake pads. The in-service-test will finally show, if alternative pads are available which cover the full range of applications. Or it will show if a range of pads could be defined, each to be preferred for specific type of vehicle.

2.5.3.1 Selection of Vehicles for In-Service-Test

The in-service-test will start on selected vehicles by having new pads on individual vehicles.

To get valuable results comparable applications are to be selected. Therefore, the test for comparison old/new pads should be done at least within specific trains. This guarantees same running profile. Moreover, it is recommended to do the test old/new within selected vehicles. This avoids any influence on the test results by variation of axle loads from one vehicle to the other.

The test should be done at not more than one third of the vehicles of a trainset. This would limit the effect of the new pad in case of any deficiency.

Further the selection of vehicles should consider the most challenging type of vehicle in each class (highest weight, highest brake weight).

It would be beneficial, if one single type of pad can fulfil the requirements for the whole fleet, at least for some of the types of vehicles, not only a single type.

2.5.3.2 Performing the Test

The supplier shall support an in-service-test of some vehicle of each class.

ISR will manage maintenance work during the test in such way, that the old pads on the test vehicles are replaced by same type and the new pads are also replaced by the new type.

ISR will document each replacement of brake pads. The mileage which is reached by new pads and pads of today will be documented for the whole duration of the test. Any irregularities in the use of the new pads will be documented, either problems with the pad or problems with the disc.

A pad showing adverse behaviour against the disc should be refused. The later economical evaluation will hardly be positive.

The in-service test will run over a certain period of time (e.g. three replacements of brake pads) or at least a period to get an overview about performance during all weather conditions.

Further definition of in-service test is given in [3], Annex H, refer to Table 2-4.

Inspection	Pad condition	Disc condition	Documentation
Initial	Integrity of friction material and attachment	Surface condition, thickness	Tables, photographic evidence
Intermediate	Integrity of friction material and attachment, thickness	Surface condition, thickness	Tables, photographic evidence
Final	Integrity of friction material and attachment, thickness	Surface condition, thickness	Tables, photographic evidence

Table 2-4 Inspections and required evidence during in-service tests, [3]

After this phase of in-service-test the results will be evaluated and exchanged with the supplier. The supplier will provide recommendations based on the results of the test phase.

2.6 Approval

In case of appropriate and convincing performance the proposed new pad will be taken to the list of pads approved for the use at the specific type of vehicle.

The preferred result is that a single type of pad can cover full range of requirements. However, compared to situation of today, even a variety of pads, each covering specific requirements of a specific type of vehicle is certainly of advantage.

The final application of newly approved pads will depend on the economic evaluation. The total volume of pads purchased by ISR can go up to an amount of xxx thousand (ISR to specify) (“one side of the disc”) per year.

ISR will take into account the price information of supplier of alternative pads for the final evaluation.

3 Summary

The brake pad supplier is asked to provide an offer based on the specification in this document.

After a pre-qualification based on documents to be provided by brake pad supplier, ISR will perform an in-service-test to gain data for an economic evaluation of a transition.

The steps will be:

- Bid by brake pad suppliers, based on specification of chapter 2 of this document.
- Brake pad supplier will need to support following steps
 - pre-selection by documents,
 - stopping distance test,
 - in-service-test.
- ISR will do a final economic evaluation, considering performance parameters and price.

A Bibliography

- [1] UIC541-3
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- [2] UIC 541-3, Appendix I
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- [3] EN 14535-3
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- [4] prEN15328
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- [5] UIC544-1
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- [6] Running profile
Hertzliyya - Jerusalem Biniane Hauma.xlsb

B Vehicles of ISR

BRAKE WEIGHT AND WEIGHT FOR PASSENGER WAGONS AND LOCOS - EQUIPPED WITH DISC BRAKES														
CAR type	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Brake Weight (t)	Basic weight (t)	Maximum weight (t)	Bogies	Axis in each bogie	Nr. of discs per axle	max. speed km/h	Type of pad	Quantity
	Mode P	Mode <R>	Mode R (red)	Mode R+Mg (red)	Mode G	Mode G								
PASSENGER COACHES														
PC-Siemens	75	103	111	N/A	N/A	N/A	56.1	63.1	2	2	3	160	Becorit 922	118
TC-Siemens	65	90	96	124	N/A	N/A	48.1	60.5	2	2	3	160	Becorit 922	
TCHC-Siemens	65	90	96	124	N/A	N/A	47.9	63	2	2	3	160	Becorit 922	
PC-Serial I (400-500)	75	100	N/A	N/A	N/A	N/A	58	64	2	2	3	160	Becorit 946	425
TC-Serial I (400-500)	70	91	N/A	N/A	N/A	N/A	48	59	2	2	3	160	Becorit 946	
TCHC-Serial I (400-500)	66	86	N/A	N/A	N/A	N/A	48	56	2	2	3	160	Becorit 946	
PC-Serial II (2000)	75	100	N/A	N/A	N/A	N/A	58	64	2	2	3	160	Becorit 946	
TC-Serial I (2000)	68	89	N/A	N/A	N/A	N/A	48	58	2	2	3	160	Becorit 946	
TCHC-Serial I (2000)	66	86	N/A	N/A	N/A	N/A	48	56	2	2	3	160	Becorit 946	
PC-Serial II (160)	N/A	101	N/A	N/A	N/A	N/A	59	65	2	2	3	160	Becorit 946	
TC-Serial I (160)	N/A	93	N/A	125	N/A	N/A	50	60	2	2	3	160	Becorit 946	
TCHC-Serial I (160)	N/A	90	N/A	122	N/A	N/A	50	58	2	2	3	160	Becorit 946	
PC -PP ALSTHOM	61-TARE 76 MAX.LOAD	79-TARE 99 MAX.LOAD	N/A	N/A	N/A	N/A	52	63	2	2	2	140	Becorit 922	35
PC -TC ALSTHOM	52-TARE 72 MAX.LOAD	69-TARE 94 MAX.LOAD	N/A	N/A	N/A	N/A	46	60.8	2	2	2	140	Becorit 922	
LOCO / TRAINSETS														
EURO -3200	97	141	N/A	N/A	77	90	90		2	2	2	160	Becorit B36	24
EURO-4000	153	N/A	N/A	N/A	125	121	121		2	3	2	130	Becorit B36	14
ic3 series(1) 1-10	205	N/A	N/A	N/A	99	119	119		4	2	block + disc	140		5
ic3 series (2-4)11-41	205	N/A	N/A	N/A	101.226	125	125		4	2	block + disc	140		26
ic3 series (5)42-50	205	N/A	N/A	N/A	101.226	125	125		4	2	disc	140		9
Traxx AC3	91	132	N/A	N/A	76	84	84		2	2	2	160	Becorit B36	62