Interchangeable Brake Shoe Specification

CH01-00891 – ISRAEL RAILWAYS Ltd. Technical Specification for Brake Shoes

<table>
<thead>
<tr>
<th>Prepared</th>
<th>Checked</th>
<th>Released</th>
</tr>
</thead>
<tbody>
<tr>
<td>U. Koppatsch</td>
<td>R. Urban</td>
<td>U. Koppatsch</td>
</tr>
</tbody>
</table>

Document Number: 08-03-00283

Release Date: 12.03.2020 Revision: 0.00

Revision Date: 12.03.2020 Status: Released

PROSE GmbH
Colditzstrasse 28
12099 Berlin
Germany

www.prose.one
Phone +49 30 7544 90 837
uwe.koppatsch@prose.one
Preamble .................................................................
1.1 Definitions ........................................................
2 Brake Shoe Specification .........................................
2.1 Vehicles ...........................................................
2.2 Brake Shoes in Use Today ....................................
2.3 General Requirements ........................................
2.3.1 Normative References ....................................... 
2.3.2 Operation ....................................................... 
2.3.3 Environment .................................................. 
2.4 Proof of Interchangeability ....................................
2.4.1 Pre-Selection ................................................... 
2.4.2 Proof of Stopping Distance (only composite brake shoes) ...........................................
2.4.3 In-Service-Test (only composite brake shoes) .................................................... 
2.4.4 Coefficient of Friction ......................................... 
2.4.5 UIC Requirements on Interchangeability (grey cast only) ....................................
2.5 Approval ............................................................
3 Summary ................................................................
A Bibliography ........................................................
B Vehicles of ISR ......................................................
C Drawings of Brake shoes ........................................
D Material Characteristic Sheets ................................
1 Preamble

Israel Railways (ISR) is interested to identify interchangeable brake shoes for vehicles equipped with tread brakes. Thus, alternative brake shoes shall be qualified for the use at vehicles of ISR.

This document provides the specification for the brake shoes to be searched for.

The main characteristics to be evaluated should be (e.g. EN 16452 [1]):

- brake shoe design;
- instantaneous and mean dynamic friction coefficients;
- static friction coefficient;
- wet friction behaviour;
- metal pickup formation behaviour;
- behaviour under conditions simulating a locked brake, with an applied braking force;
- brake shoe and wheel tread wear at different loads and service braking conditions;
- friction behaviour under severe winter conditions;
- influence on signalling systems (track circuits);
- brake shoe material properties.

In none of the categories the new brake shoes shall show lower performance than the brake shoes in use today.

Various local and historical terms have become established for the wear material of the tread brake. For this document, ISR requested the use of the term "brake shoe".

However, it was not possible to avoid using different terms in some cases. This is always the case when official titles of standards are involved.

1.1 Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tread brake</td>
<td>Technical term for brake systems which apply the braking force with brake shoes to the running surface of the wheels</td>
</tr>
<tr>
<td>coefficient of friction</td>
<td>Property of contacting materials; here: the coefficient of friction between brake shoe and wheel</td>
</tr>
<tr>
<td>friction performance</td>
<td>Behaviour of the coefficient of friction between brake shoe and wheel as a function of speed, humidity, temperature, etc.</td>
</tr>
<tr>
<td>brake shoe</td>
<td>In this document: the wear material of the tread brake</td>
</tr>
<tr>
<td>composite material</td>
<td>elastic materials (for brake shoes), usually a combination of metal fibers, rubber-resin compounds and additional additives</td>
</tr>
</tbody>
</table>
2 Brake Shoe Specification

This specification defines requirements for brake shoes that are intended to replace the brake shoes in use today at vehicles of ISR.

2.1 Vehicles

ISR provided the data for locomotives [2], [3], [4].

According to this information the following vehicles are equipped with brake shoes made of composite material:

<table>
<thead>
<tr>
<th>CAR series</th>
<th>CAR - type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>G12</td>
<td>Loco</td>
<td>27</td>
</tr>
<tr>
<td>G26CW-2</td>
<td>Loco</td>
<td>12</td>
</tr>
<tr>
<td>G26C-W</td>
<td>Loco</td>
<td>11</td>
</tr>
<tr>
<td>JT42BW-Bo.Bo</td>
<td>Loco</td>
<td>8</td>
</tr>
<tr>
<td>JT42CW-Co.Co.</td>
<td>Loco</td>
<td>48</td>
</tr>
<tr>
<td>NGT26-CW</td>
<td>Loco</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 1: Overview of Locos with brake shoes

For the above-mentioned vehicles brake shoes are in use which have a friction performance according to AAR RP-559. There are two types of brake shoes in use which are described by the drawings [5] and [6] (see also annex C) and the material characteristic sheets [7] and [8] (see annex D).

Furthermore, there is a fleet of 1'378 freight wagons and 45 service vehicles equipped with brake shoes according to ISR specification M-04-240 [9]. This document is about grey cast iron brake shoes. The content of ISR specification M-04-240 [9] is based on the UIC leaflets UIC832 and UICS42.

Additional vehicle data, necessary for the supplier to identify a suitable product can be find in the vehicle tables in annex B.
2.2 Brake Shoes in Use Today

Today the following brake shoes are in use (Source: E-Mails from ISR [10], [2]):

- **Shoe Cobra 14”**
  - Drawing-No. V-573 [5] (see Figure 2)
  - Dimension in inches (does not correspond to UIC versions)
  - Friction Material W-663 (composite) [7] (see Figure 7)
  - Friction coefficient: 0.13 – 0.26
  - Friction performance acc. to AAR RP-559
  - Recommended field of application: locomotives
  - Equivalent UIC friction class: L/LL
  - Supplier: Wabtec (USA)
  - Average mileage: 12'500 km

- **Shoe Cobra 250 mm**
  - Drawing No. V-648 [6] (see Figure 3)
  - Dimensions in mm and identical to version "Bg" according to UIC 542
  - Friction material: W-620 (composite) [8] (see Figure 8)
  - Friction coefficient: 0.22 – 0.33
  - Friction performance acc. to AAR RP-559
  - Recommended field of application: locomotives
  - Equivalent UIC friction class: K
  - Supplier: Wabtec (USA)
  - Average mileage: 12'500 km

- **Cast Iron Brake Shoes according to "Technical Specification M-04-240" [9]**
  - Types: AF-2 and DX-2
  - Based on UIC 832
  - Friction material: cast iron P14 (phosphorus content 1.35 – 1.55%)
  - Drawing Numbers:
    - AF-2: TW 284.00.1 A (see Figure 4)
    - DX-2: MDD 190.00.3 A (see Figure 5)
  - Additional information on cast iron brake shoes: see handwritten modified drawing DX-2 [11] in the annex C (see Figure 6)
  - Dimensions in mm
  - Presumed field of application: freight wagons and service vehicles
  - Average mileage: 15'000 km
2.3 General Requirements

All materials used in the manufacture of the friction material and the resulting wear products shall comply with the relevant environmental health regulations applicable at the time of use.

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

It is intended to replace the brake shoes per vehicle by substitute brake shoes. The supplier may allow to replace the brake shoes also per bogie, per axle or per wheel, which would be of advantage for the maintenance procedure and the handling of the brake shoes.

The new brake shoes to be procured must correspond to the different brake shoes previously used regarding their specific friction characteristics and mechanical interfaces. It must be possible to use the newly procured brake shoes 1:1 in exactly the same way as the brake shoes previously used on the existing vehicles without any conversion.

2.3.1 Normative References

There are two main categories of brake shoes which are also represented by different standards:

Brake shoes made from cast iron:

Normative references are the UIC leaflets:

- UIC 832; Technical specification for the supply of brake-shoes made from phosphoric iron for tractive and trailing stock [12]
- UIC 542; Brake Parts – Interchangeability [13]

Brake shoes made from composite material:

According to the information available from the ISR [10], composite brake shoes must comply with AAR standard AAR RP-559 with respect to their coefficients of friction. The mechanical interfaces are specified by the drawings [5] and [6].

Additional information

Furthermore, the following documents are relevant for assessment of brakes:

- UIC 544-1, Brakes – Braking Performance [14]
- EN 14198 Railway applications - Braking - Requirements for the brake system of trains hauled by locomotives [15]
- FprEN 15329 Railway applications - Braking - Brake block holder and brake block key [16]

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.
2.3.3 Environment (important for composite brake shoes)

Climate and Environmental Conditions

<table>
<thead>
<tr>
<th>Term</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height Above Sea Level</td>
<td>m</td>
<td>- 400 to +800</td>
</tr>
<tr>
<td>Max. Temperature</td>
<td>°C</td>
<td>47 (shadow)</td>
</tr>
<tr>
<td>Min. Temperature</td>
<td>°C</td>
<td>- 5</td>
</tr>
<tr>
<td>Rain</td>
<td>mm/year</td>
<td>400 - 800</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>%</td>
<td>10 to 90</td>
</tr>
<tr>
<td>Sunshine</td>
<td>h/year</td>
<td>3300 h</td>
</tr>
<tr>
<td>UV Radiation</td>
<td>MJ/m² per year</td>
<td>360 - 600</td>
</tr>
</tbody>
</table>

2.4 Proof of Interchangeability

Cast iron brake shoes can always be interchanged without any field testing. Procurement must be carried out in accordance with the specifications in UIC 832 [12].

Composite brake shoes are generally interchangeable within the same friction level (e.g. UIC friction levels K, L, LL) and the same geometrical shape. Since the specific material composition of a composite brake shoe is not specified, its suitability for use under certain conditions may vary.

In the present case, the friction characteristic of the composite brake shoes to be procured must correspond to the material characteristic sheets [7] and [8].

The supplier must be able to refer to test results under similar operating conditions as those occurring at ISR (see section 2.3.2 and 2.3.3).

2.4.1 Pre-Selection

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

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

ISR will provide brake shoes in use today to enable brake shoe suppliers to perform the comparing dynamometer tests.

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

2.4.2 Proof of Stopping Distance (only composite brake shoes)

The conduction of a stopping distance test is only necessary if no fully approved product can be found.

The stopping distance is the most important parameter of the performance of the new brake shoes. The comparison of mean coefficient of friction gained by 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.
2.4.3 **In-Service-Test (only composite brake shoes)**

The performance of an in-service-test is only necessary if no fully approved product can be found. The test will then be done with a range of pre-selected brake shoes. The in-service-test will finally show, if alternative brake shoes are available which cover the full range of applications. Or it will show if a range of brake shoes could be defined, each to be preferred for a specific type of vehicle.

One possibility of testing the brake shoes is described in UIC leaflet UIC 541-4 [17]. As the brake shoes used up to now comply with US standards, it is recommended to follow a corresponding US regulation.

2.4.4 **Coefficient of Friction**

Brake shoes belong to classes of different levels of friction. That means that brake shoes which belong to the same class do have a coefficient of friction which is similar within a defined tolerance range.

In general, the coefficient of friction of the brake shoes is an essential parameter for design and overall performance of the brake system. The coefficient of friction of the new brake shoes must be “the same” as of the brake shoes currently in use.

- If the coefficient of friction is too low, the brake system will not reach the required performance in terms of stopping distance.
- If the coefficient of friction is too high
  - the brake system might exceed the available adhesion force between wheel and rail. The result will be more likely wheel flats.
  - the brake system might overload brake mechanics, structure of the vehicle and the wheelset by higher forces.

Thus, the transition project must take specific care, that the coefficient of friction of alternative brake shoes is in good accordance with the coefficient of friction of the shoes currently in use.

In the case of locomotives, it should also be considered whether the vehicles have wheel slide protection.
2.4.5 UIC Requirements on Interchangeability (grey cast only)

The leaflet UIC542 [13] requests for interchangeability of cast iron brake shoes as shown in the following Figure 1.

Furthermore, of course, brake shoes should only be replaced with brake shoes of the same friction level. The friction values of cast iron brake shoes depend on the phosphorus content of the material. This is specified by the manufacturer using the codes P10, P14 and P30. P10 means 1% phosphorus. The higher the phosphorus content, the higher the coefficient of friction. ISR only uses brake shoes of type P14.

2.5 Approval

In case of appropriate and convincing performance, the proposed new brake shoe will be taken to the list of brake shoes approved for the use at the specific type of vehicle.
3 Summary

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

After a pre-qualification based on documentation to be provided by the brake shoe supplier, ISR either selects certified products or (if such products are not available) performs an in-service test to obtain data for an economic assessment of a transition.

The steps will be:

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

## LOCOS EQUIPPED WITH BRAKE SHOES IN IR FLEET - DATE 10.06.2019*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>G12</td>
<td>Loco</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
<td>76,5</td>
<td>no data</td>
<td>no data</td>
<td>2</td>
<td>2</td>
<td>block</td>
<td>no data</td>
<td>no data</td>
<td>27</td>
</tr>
<tr>
<td>G26CW-2</td>
<td>Loco</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>45 - 50</td>
<td>116</td>
<td>no data</td>
<td>2</td>
<td>2</td>
<td>block</td>
<td>no data</td>
<td>no data</td>
<td>12</td>
</tr>
<tr>
<td>G26C-W</td>
<td>Loco</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>45 - 50</td>
<td>89,84</td>
<td>no data</td>
<td>2</td>
<td>2</td>
<td>block</td>
<td>no data</td>
<td>no data</td>
<td>11</td>
</tr>
<tr>
<td>JT42BW-Bo.Bo</td>
<td>Loco</td>
<td>72</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>67</td>
<td>89,5</td>
<td>no data</td>
<td>2</td>
<td>2</td>
<td>block</td>
<td>110</td>
<td>no data</td>
<td>8</td>
</tr>
<tr>
<td>JT42CW-Co.Co.</td>
<td>Loco</td>
<td>114</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>85</td>
<td>112</td>
<td>no data</td>
<td>2</td>
<td>3</td>
<td>block</td>
<td>140</td>
<td>no data</td>
<td>48</td>
</tr>
<tr>
<td>NGT26-CW</td>
<td>Loco</td>
<td>90</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>122</td>
<td>no data</td>
<td>no data</td>
<td>2</td>
<td>3</td>
<td>block</td>
<td>no data</td>
<td>no data</td>
<td>11</td>
</tr>
</tbody>
</table>

* source: E-Mail from Milad Assaf; 2019-12-11
**FREIGHT WAGONS and SERVICE WAGONS EQUIPPED WITH BRAKE SHOES IN ISR FLEET**

<table>
<thead>
<tr>
<th>Braking weight</th>
<th>Max Load</th>
<th>Empty</th>
<th>Qty</th>
<th>Non Balance side to side</th>
<th>Permit Load (ton)</th>
<th>Max wheight</th>
<th>Tara wheight</th>
<th>length</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freight Wagons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>51</td>
<td>24</td>
<td>70</td>
<td>29</td>
<td>1:1.1</td>
<td>60</td>
<td>84</td>
<td>21.5</td>
</tr>
<tr>
<td>-</td>
<td>44</td>
<td>25</td>
<td>70</td>
<td>33</td>
<td>1:1.1</td>
<td>60</td>
<td>84</td>
<td>21.5</td>
</tr>
<tr>
<td>-</td>
<td>49</td>
<td>26</td>
<td>70</td>
<td>58</td>
<td>1:1.1</td>
<td>60</td>
<td>84</td>
<td>21.5</td>
</tr>
<tr>
<td>-</td>
<td>51</td>
<td>27</td>
<td>70</td>
<td>1</td>
<td>no data</td>
<td>60</td>
<td>84</td>
<td>23.5</td>
</tr>
<tr>
<td>-</td>
<td>59</td>
<td>28</td>
<td>80</td>
<td>68</td>
<td>1:1.2</td>
<td>65</td>
<td>90</td>
<td>25</td>
</tr>
<tr>
<td>-</td>
<td>50</td>
<td>27</td>
<td>80</td>
<td>59</td>
<td>1:1.2</td>
<td>66</td>
<td>90</td>
<td>24</td>
</tr>
<tr>
<td>-</td>
<td>50</td>
<td>27</td>
<td>20</td>
<td>604</td>
<td>1:1.1</td>
<td>60</td>
<td>84</td>
<td>22.7</td>
</tr>
<tr>
<td>-</td>
<td>52</td>
<td>29</td>
<td>80</td>
<td>56</td>
<td>1:1.2</td>
<td>65</td>
<td>90</td>
<td>24.7</td>
</tr>
<tr>
<td>-</td>
<td>59</td>
<td>28</td>
<td>80</td>
<td>52</td>
<td>1:1.2</td>
<td>65</td>
<td>90</td>
<td>24.5</td>
</tr>
<tr>
<td>-</td>
<td>59</td>
<td>28</td>
<td>80</td>
<td>24</td>
<td>1:1.2</td>
<td>66</td>
<td>90</td>
<td>24</td>
</tr>
<tr>
<td>-</td>
<td>52</td>
<td>28</td>
<td>80</td>
<td>15</td>
<td>1:1.2</td>
<td>54</td>
<td>80</td>
<td>26</td>
</tr>
<tr>
<td>-</td>
<td>52</td>
<td>28</td>
<td>80</td>
<td>15</td>
<td>1:1.2</td>
<td>57</td>
<td>80</td>
<td>23</td>
</tr>
<tr>
<td>-</td>
<td>48</td>
<td>24</td>
<td>80</td>
<td>20</td>
<td>1:1.2</td>
<td>58</td>
<td>80</td>
<td>21.5</td>
</tr>
<tr>
<td>-</td>
<td>56</td>
<td>20</td>
<td>80</td>
<td>60</td>
<td>1:1.2</td>
<td>63</td>
<td>80.7</td>
<td>17.7</td>
</tr>
<tr>
<td>-</td>
<td>56</td>
<td>20</td>
<td>80</td>
<td>75</td>
<td>1:1.2</td>
<td>63</td>
<td>80.8</td>
<td>17.8</td>
</tr>
<tr>
<td>-</td>
<td>51</td>
<td>23</td>
<td>80</td>
<td>182</td>
<td>1:1.2</td>
<td>70</td>
<td>90</td>
<td>19.7</td>
</tr>
<tr>
<td>-</td>
<td>58</td>
<td>22</td>
<td>80</td>
<td>74</td>
<td>1:1.2</td>
<td>72</td>
<td>90</td>
<td>18</td>
</tr>
<tr>
<td>-</td>
<td>72</td>
<td>21.2</td>
<td>80</td>
<td>160</td>
<td>1:1.25</td>
<td>72</td>
<td>90</td>
<td>18</td>
</tr>
<tr>
<td>-</td>
<td>72</td>
<td>no data</td>
<td>80</td>
<td>100</td>
<td>01.03</td>
<td>73</td>
<td>90</td>
<td>17</td>
</tr>
<tr>
<td>-</td>
<td>48</td>
<td>24</td>
<td>70</td>
<td>30</td>
<td>1:1.1</td>
<td>60</td>
<td>80</td>
<td>23.5</td>
</tr>
<tr>
<td>-</td>
<td>48</td>
<td>24</td>
<td>70</td>
<td>17</td>
<td>1:1.1</td>
<td>61</td>
<td>80</td>
<td>19</td>
</tr>
<tr>
<td>40</td>
<td>-</td>
<td>25</td>
<td>60</td>
<td>17</td>
<td>1:1.1</td>
<td>50</td>
<td>72</td>
<td>20.5</td>
</tr>
<tr>
<td>40</td>
<td>-</td>
<td>26</td>
<td>60</td>
<td>2</td>
<td>1:1.1</td>
<td>50</td>
<td>72</td>
<td>20</td>
</tr>
<tr>
<td>-</td>
<td>40</td>
<td>19</td>
<td>90</td>
<td>25</td>
<td>1:1.1</td>
<td>61</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>42</td>
<td>-</td>
<td>21</td>
<td>60</td>
<td>2</td>
<td>1:1.1</td>
<td>50</td>
<td>72</td>
<td>18</td>
</tr>
<tr>
<td><strong>Service Wagons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>48</td>
<td>24</td>
<td>60</td>
<td>18</td>
<td>no data</td>
<td>60</td>
<td>no data</td>
<td>23.5</td>
</tr>
<tr>
<td>-</td>
<td>41</td>
<td>25</td>
<td>60</td>
<td>1</td>
<td>no data</td>
<td>50</td>
<td>no data</td>
<td>25</td>
</tr>
<tr>
<td>-</td>
<td>21</td>
<td>70</td>
<td>1</td>
<td>no data</td>
<td>72</td>
<td>58</td>
<td>no data</td>
<td>18</td>
</tr>
<tr>
<td>31</td>
<td>-</td>
<td>16</td>
<td>60</td>
<td>1</td>
<td>no data</td>
<td>68</td>
<td>no data</td>
<td>18</td>
</tr>
<tr>
<td>31</td>
<td>-</td>
<td>16</td>
<td>60</td>
<td>2</td>
<td>no data</td>
<td>70</td>
<td>no data</td>
<td>20.5</td>
</tr>
<tr>
<td>40</td>
<td>-</td>
<td>25</td>
<td>60</td>
<td>2</td>
<td>no data</td>
<td>58</td>
<td>no data</td>
<td>18.61</td>
</tr>
<tr>
<td>31</td>
<td>-</td>
<td>16</td>
<td>40</td>
<td>2</td>
<td>no data</td>
<td>60</td>
<td>no data</td>
<td>18</td>
</tr>
<tr>
<td>42</td>
<td>-</td>
<td>25</td>
<td>50</td>
<td>15</td>
<td>no data</td>
<td>50</td>
<td>no data</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Table 3: Data of freight wagons and service wagons with brake shoes
C  Drawings of Brake shoes

Figure 2: brake shoe drawing V-573
Figure 3: brake shoe drawing V-648
Figure 4: Brake Shoe AF-2 (extract from [9])
Figure 5: Brake Shoe DX 2 (extract from [9])
Figure 6: Brake Shoe DX 2 with handwritten modifications [11]
D Material Characteristic Sheets

RAILROAD FRICION PRODUCTS CORPORATION

MATERIAL CHARACTERISTICS SHEET MCS-035-m

MATERIAL DESIGNATION: W-663

DESCRIPTION: Non-asbestos Low Friction Composition Friction material with synthetic resin / rubber binder system, formulated to mimic the friction characteristics of Cast Iron Locomotive Brake Shoes. Friction performance is consistent with requirements of AAR Recommended Practice RP-599 when conducted with applied Net Shoe Forces appropriate for Low Friction Locomotive Brake Shoes. The equivalent UIC friction classification would be LL- or L-type depending on the application specifics.

MAXIMUM RECOMMENDED APPLICATION CONDITIONS:

VELOCITY - 100 km/hr
SPECIFIC PRESSURE - 210 N/cm²
SUSTAINED TEMPERATURE - 260 °C
PEAK TEMPERATURE - 480 °C

MATERIAL PROPERTIES:

SPECIFIC GRAVITY - 1.76
HARDNESS - 100 - 130 Rockwell HRX
COMPRESSION STRENGTH - 7,410 N/cm²

AVERAGE FRICTION CHARACTERISTICS AS A FUNCTION OF SPEED:

Note: Technical Data shown above is representative of available laboratory test data, and implies no guarantee of performance.

Figure 7: Material Characteristic Sheet MCS-035-m [7]
RAILROAD FRICITION PRODUCTS CORPORATION

MATERIAL CHARACTERISTICS SHEET MCS-052-m

MATERIAL DESIGNATION: W-620

DESCRIPTION: Non-asbestos High Friction Composition Friction material with fiber-reinforced phenolic resin/synthetic rubber binder system, formulated for service with high net shoe forces, high weight per axle, and moderate speeds. Friction performance is in accordance with all requirements of AAR Recommended Practice PR-599 for Locomotive Brake Shoes.

MAXIMUM RECOMMENDED APPLICATION CONDITIONS:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VELOCITY</td>
<td>160 km/hr</td>
</tr>
<tr>
<td>SPECIFIC PRESSURE</td>
<td>220 N/cm²</td>
</tr>
<tr>
<td>SUSTAINED TEMPERATURE</td>
<td>290 °C</td>
</tr>
<tr>
<td>PEAK TEMPERATURE</td>
<td>480 °C</td>
</tr>
</tbody>
</table>

MATERIAL PROPERTIES:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFIC GRAVITY</td>
<td>2.42</td>
</tr>
<tr>
<td>HARDNESS</td>
<td>70 - 100 Rockwell R</td>
</tr>
<tr>
<td>COMPRESSION STRENGTH</td>
<td>750 N/cm² yield 5100 N/cm² ultimate</td>
</tr>
</tbody>
</table>

AVERAGE FRICTION CHARACTERISTICS AS A FUNCTION OF SPEED:

Note: Technical Data shown above is representative of available laboratory test data, and implies no guarantee of performance.

Figure 8: Material Characteristic Sheet MCS-052-m [8]