Surface coatings for 3-piece freight bogie centre bearings

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Appendix A: Method used to calculate the centre bearing rim wall elastic contact length, average and maximum contact pressures

The centre bearing rim wall elastic contact length, average and maximum contact pressures are calculated according to Hertzian elastic contact equations for a cylinder-in-circular groove [107].

Given the total load on rim wall, $N_{rim\ wall}$, and the rim wall contact height, $H_{rim\ wall}$, the load (N) per mm of rim wall contact height, $p_{rim\ wall}$, is calculated:

$$p_{rim\ wall} = \frac{N_{rim\ wall}}{H_{rim\ wall}}$$  \hspace{1cm} (27)

Given the Poisson's ratio of the top centre and centre bowl liner, $v_{tc}$ and $v_{cbl}$, respectively, and the elastic modulus of the top centre and centre bowl liner, $E_{tc}$ and $E_{cbl}$, respectively, the reduced elastic modulus, $E_r$, can be calculated:

$$E_r = \left\{ \left[ (1-v_{tc}^2)/E_{tc} \right] + \left[ (1-v_{cbl}^2)/E_{cbl} \right] \right\}^{-1}$$  \hspace{1cm} (28)

The elastic contact length, $b$, can be calculated:

$$b = 1.6 \times \sqrt{\left[ p \times D_{cbl} \times D_{tc} \right]/\left[ E_r \times (D_{cbl} - D_{tc}) \right]}$$  \hspace{1cm} (29)

where $D_{cbl}$= centre bowl liner diameter, and $D_{tc}$= top centre diameter (NB: $D_{cbl} > D_{tc}$)

The apparent contact area, $A$, can be calculated:

$$A = H_{rim\ wall} \times b$$  \hspace{1cm} (30)

The average contact pressure, $p_{ave}$, can be calculated:
The maximum contact pressure, $p_{\text{max}}$, can be calculated:

$$p_{\text{max}} = \frac{3/2 \cdot N_{\text{rim \ wall}}}{(\pi \cdot H_{\text{rim \ wall}}/2 \cdot b/2)}$$

Equation 32 simplifies to:

$$p_{\text{max}} = \frac{6 \cdot N_{\text{rim \ wall}}}{(\pi \cdot H_{\text{rim \ wall}} \cdot b)}$$
Appendix B: Flat-on-flat friction and wear test results of alternative centre bearing materials [from 103].

Friction and wear test conditions

- Reciprocating flat-on-flat (8 mm diameter pin face).
- Load = 201 N.
- Average contact pressure = 4 MPa.
- Average sliding speed = 40 mm/s.
- Sliding distance = 475 m and 950 m.

Materials

DP4 – Steel backing plate + porous bronze sinter + PTFE + calcium fluorite + fillers
DU-B – Bronze backing plate + porous bronze sinter + PTFE + lead
DU – Steel backing plate + porous bronze sinter + PTFE + lead
Hilube 10, Hilube 20 - polyethylene liners.
Green, orange (HDPE), and black polyethylene liners.

Please see print copy for Figure 147

Figure 147 Hadfield steel pins showing 8 mm diameter flat pin face [from 103].
Figure 148 Co-efficient of friction of various plate materials [from 103].
Figure 149 Calculated volume loss for sliding distance of 475 m and 950 m [adapted from 103].
Figure 150 Calculated normalized or specific wear rate for sliding distance of 475 m and 950 m [adapted from 103].