Latest Changes to pot bearing requirements to reduce life-cycle costs
AS5100.4

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Premature failure of POT Bearings

1. The Problem

2. Causes

3. Solutions

4. Proposed DRAFT Changes to AS5100.4

5. Q/A

SWAN River Pedestrian Bridge - Courtesy: MRWA
The Problem

(Photo: State Library of Queensland and John Oxley Library; #78999)
Kooragang island - NSW
POT bearings Installed in 2013 – Rubber ‘Spaghetti’ extruded from the bearings

Kooragang island - NSW
POT bearings Installed in 2013 – Failure Mode of Metal internal Seal

Kooragang island - NSW
POT bearings Installed in 2013 – Razor Sharp edge developed, causes rubber ‘shaving’

Kooragang island - NSW
POT bearings Installed in 2013 – ‘Big Chunks’ of rubbers in extreme conditions after Failure
The Problems Continue…

Pilbara - WA
POT bearings Installed in 2010 – Rubber ‘Spaghetti’ extruded from the bearings

South headland - WA
POT bearings Installed in 2011 – NO Rubber left in the bearings – NO ROTATIONS!!!!

Pilbara - WA
POT bearings Installed in 2010 – Razor Sharp edge developed, causes rubber ‘shaving’

South headland - WA
POT bearings Installed in 2011 – ‘Extrusion and shaving just started….}
And many more….

Kooragang Island Rail Bridges - Courtesy: ROBSONS
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SWAN River Pedestrian Bridge - Courtesy: MRWA
Composition of mageba RESTON®POT bearing

- upper shear studs - optional
- upper anchorplate - optional
- sliding plate (steel)
- sliding sheel (stainless steel)
- sliding element (confined PTFE)
- central guide (steel)
- sliding element (composite material)
- dust seal (silicon rubber)
- sealing chain (POM)
- piston (steel)
- elastomeric pressure pad
- pot (steel)
- lower anchorplate - optional
- lower shear studs - optional
POT Bearing during Rotation
Components Critical for functioning of POT bearings.

- Certified PTFE with grease dimples
- Certified special silicon grease
- Polished stainless steel sheets

Increasing substantially the life time of structural bearings

WHAREMAUKU Stream Bridge - Courtesy: M2PPA
Most critical and Neglected Component.....!

POM sealing vulcanised into the elastomeric pad

Hard, highly wear resistant plastic with secure anchoring

Karapiro Gully Viaduct- Courtesy: NZTA
Other MOST COMMON Seal materials

- Stainless Steel Rings
- Brass Rings
- Carbon Filled PTFE

Increasing substantially the life time of structural bearings

Premature Failed POT - Courtesy: ARTC
Premature failure of POT Bearings

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SWAN River Pedestrian Bridge - Courtesy: MRWA
Solutions.....

No thanks!

We are too busy

image - Courtesy: John Kim, Linkedin.com
➢ Extensive R&D

➢ Prescribed Tested Materials

➢ Simplified guidance on selection of best type of bearing
4.1 General

A pot bearing shall be capable of transferring applied vertical and horizontal loads between the superstructure and substructure and shall permit limited rotational movement (see 6.1.2). The internal seal system shall prevent extrusion of the elastomer from the pot.

These requirements shall be met with adequate reliability and durability, see EN 1990.

It is assumed that adequate reliability, durability, load bearing capacity and rotation capability result from adopting the design procedures given in clauses 5 and 6.

When using an internal seal system indicated in annex A, pot bearings designed and used in accordance with this part of EN 1337 are considered to meet the aforementioned requirements.
4.2 Tests for durability

When necessary (see 5.4) the long term functioning according to 4.1 shall be tested in accordance with annex E.

Acceptance criteria for these tests are:

— there shall be **no extrusion** of cohesive elastomeric material.

— the compression deformation under the test load shall have **not increased** for at least 24 h.

**NOTE** Wear of the seal and discoloration of the lubricant is acceptable in these tests.
Accumulated Slide path (m) for Different materials as per EN1337-5

- POM, Carbon Filled PTFE
- Brass
- Stainless Steel
How is Accumulated Slide path related to service life of the bearings?

- 500m – approx. 5-7 yrs
- 1000m – approx. 15-20 yrs
- 2000m – approx. >50 yrs
How to Calculate required Sliding Path for your bridge?

\[ S_{A, D} = n v \times \Delta \alpha_2 \times \frac{D}{2} \]

\[ S_{A, D} \leq c \times S_T \]

- \( S_{A, D} \) = Actual accumulated slide path due characteristic traffic loads
- \( n_v \) = number of vehicles (lorries) for the intended life of the bearing
- \( \Delta \alpha_2 \) = resultant rotation angle due to traffic loads, in radians
- \( D \) = internal diameter of pot, in millimetres
- \( c \) = Correction Factor for Accumulated Slide path (c=5)
- \( S_T \) = accumulated slide path prescribed in EN1337-5, 5.4
For a bridge on sub arterial road with traffic volume of 30,000 trucks/yr, for 100yrs...assuming POT Internal diameter based on vertical load to be 360mm and resultant rotation angle resultant 0.015rads...

\[ S_{A_D} = (30,000 \times 100) \times 0.015 \times \frac{360}{2} \]

\[ = (30,000 \times 100) \times 0.015 \times \frac{360}{2} \]

\[ = 8,100,000\text{mm} \]

\[ = 8100\text{m} \]

So to ensure the POT bearings outlast the expected service life of bridge, select the POT bearings that has internal seal with accumulated slide path of 2000m, so that...

8000m \leq 10000m ......(5 \times 2000)

Hence use POT Bearing with POM Internal seal....!
Premature failure of POT Bearings

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SWAN River Pedestrian Bridge - Courtesy: MRWA
1. Prohibit use of Metal internal seal bearings from Railway bridges and long span steel bridges

2. Include “prescriptive” texts for the seal materials – similar to clause 5.4 and Annex A of EN1337-5

3. Include Application or Selection guideline for type of POT bearings similar to EN1337-5 Annex G table G.1
To prevent extrusion of the elastomer, the pot shall incorporate a seal around the top corner of the elastomeric disc. The internal seal shall be either a set of brass rings. A POM chain or a carbon-filled PTFE seal complying with requirements of EN 1337-5.

The maximum accumulated slide path (ASP) of the internal seals, defined as the sum of the relative movements of the seal on the pot wall due to cycles of rotation of the bearing caused by traffic loading shall be taken to be 2000 m for POM chain and carbon-filled PTFE seals and 1000 m for brass rings.

Due to the large number of loading cycles only pot bearings with POM chain or carbon-filled PTFE seals shall be used on rail bridges and road bridges where the number of heavy vehicles per lane day in the first year of service is predicted to exceed 1000 as defined by Clause 13.1(d) to AS 5100.2
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SWAN River Pedestrian Bridge - Courtesy: MRWA
Any questions…
Thank you for your attention!

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