



Suitable Replacement Of Elastomeric Bearing Installed In ROB 105, Constructed At Surya Kund Ayodhya: Material And Cost Analysis

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Abstract: This study aims to examine potential substitutes for neoprene bearings utilised in ROB 105 at Surya Kund Ayodhya. Neoprene bearings are widely used in bridge construction to withstand tension and movement. But because of variables like age, wear and tear, and new discoveries in material science, other materials that will last longer and with great strength are also researched. This study will encompass several materials that can be used instead of neoprene bearings, focusing on their mechanical properties, cost, and on the basis of purpose. The study also includes a cost analysis aspect associated with different materials that will help in developing comparative idea according to economic point of view.

Keyword: *Bridge, Bearing, Elastomeric, Neoprene, POT PTFE*

Introduction: Bridges are an important aspect of transportation infrastructure because they make it easier for people and goods to move around. Bearings are important parts of bridge design because they can tolerate many types of movement caused by traffic, temperature fluctuations, and earthquakes. Neoprene bearings are often used in bridge engineering because they are very elastic, long-lasting, and resistant to weathering. But neoprene bearings can wear out with time, which means they need to be replaced. The neoprene bearings on ROB 105, which was built at Surya Kund Ayodhya, need to be replaced and maintained on a regular basis. The goal of this research is to find other materials that can be used instead of neoprene bearings in ROB 105.

Material Analysis: The current research has been carried out with the purpose of analysing potential replacement materials for the neoprene bearings that are found in ROB 105. This study will determine whether or not these materials meet the criteria for the bridge construction in terms of their mechanical properties, durability, and compatibility. These are the materials that were substituted:

High-Density Polyethylene (HDPE) Bearings: HDPE bearings are strong, have less friction, and don't break down in chemicals or the environment. They are not as expensive as neoprene and last a long time, which is great.

Polytetrafluoroethylene (PTFE) Bearings: PTFE bearings are particularly resistant to variations in temperature and have minimal friction. They are good for things that need to operate well for a long time.

Natural Rubber Bearings: Natural rubber bearings are just as flexible as neoprene, but they may last longer. They are cheap and often used to build bridges.

Fiber-Reinforced Elastomeric Bearings: These bearings are stronger and last longer because they combine the strength of embedded fibres with the flexibility of elastomer.

Design of Elastomeric Bearing:

Effective span = 13.99m (as given in plan of ROB 105)

$$N_{\max} = 441 + 1172 + 71.7 = 1684.7 \text{ KN}$$

$$N_{\min} = 441 \text{ kN}$$

Bearing plan dimension from IS 83 –II ,2018

From annexure B Table B2

Bearing plan dimension = 320 × 630 mm

Overall thickness = 62 mm

Thickness of individual elastomer layer = 12 mm

Thickness of Steel laminates = 4 mm

No. of internal elastomer layer = 3

No. of laminates = 4

Thickness of top and bottom cover = 5 mm (confirms to index no 6 appendix 1 of IS 83 part 2)

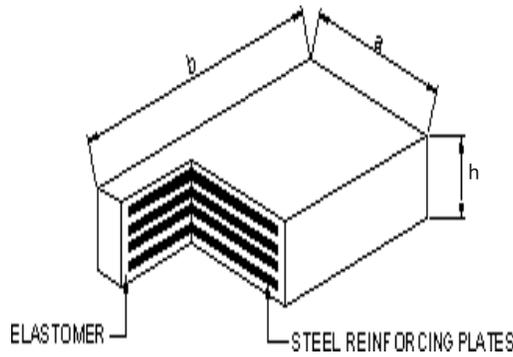


Figure 1: Layout of Laminated Elastomeric Bearing

Material Estimation

Total Steel laminate = $308 \times 618 \times 3 \times 4$
 $= 2284128 \text{ mm}^3$
 Total Elastomer = $320 \times 630 \times 62 - 2284128$
 $= 10215072 \text{ mm}^3$

Approximate Cost:

Elastomer = 0.0004 / cubic mm
 Total cost of elastomer = 4086 INR
 Overall cost = 5000 to 10000 INR

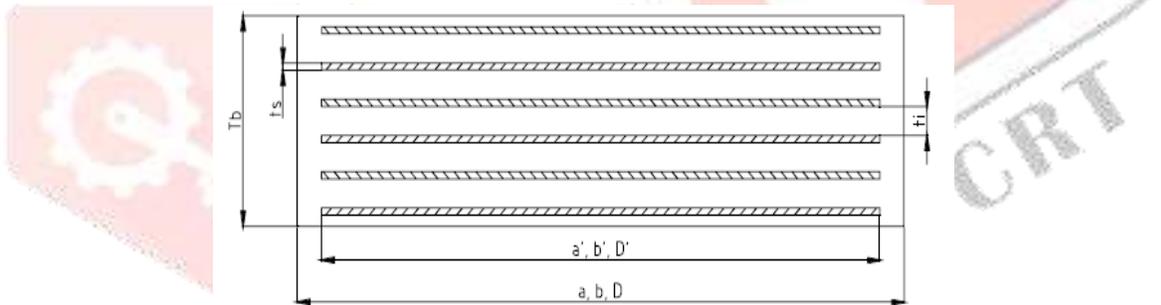


Figure 2: Typical Cross Section of Elastomeric Bearing

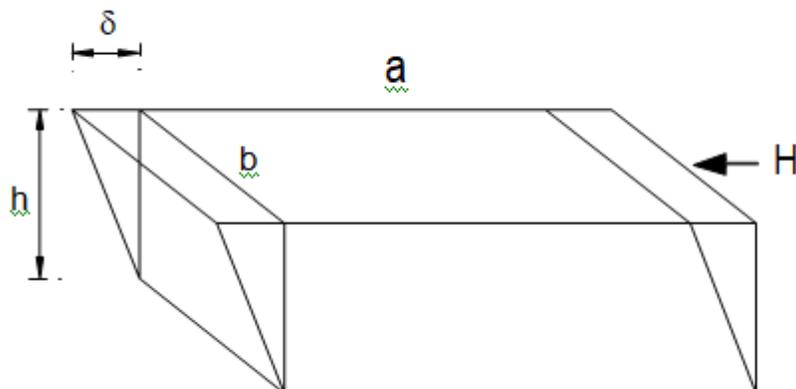


Figure 3: Deformation of Elastomeric Bearing

Design of POT PTFE Bearing:**A. Design of POT cylinder**

Longitudinal force per bearing = 110 kN

Lateral force due to wind = 10.28 KN

Seismic in Transverse direction = 28kN

$$\begin{aligned} \text{Resultant with wind Pressure} &= \sqrt{110^2 + 10.28^2} \\ &= 110.479 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{Resultant with Seismic Force} &= \sqrt{110^2 + 28^2} \\ &= 113.5 \text{ kN} \end{aligned}$$

Out of two, only one will considered at a time, Maximum will be considered for Design

So design Horizontal force = 113.5 kN is considered

113 < 25% of 1683 kN

OK

But must be minimum of 10% of 1683

So it must be 168.3 kN minimum.

1. Axial tension in cross section of cylinder will be due to

- a. Fluid Pressure
- b. Horizontal Force = 168.3 kN

a. Fluid Pressure

$$= \frac{d_i \times h_e \times \sigma_{ce}}{2b_p \times h_c}$$

$$d_i = 300 \text{ mm}, h_e = 40 \text{ mm}$$

$$\sigma_{ce} = \frac{1684 \times 1000}{\frac{\pi}{4} + 300^2}$$

$$= 23.82 \text{ N/mm}^2$$

b_p = thickness of cylinder wall

h_c = height of cylinder wall

$$\text{Fluid Pressure} = \frac{300 \times 40 \times 23.82}{2 \times b_p \times h_c} \text{ (i)}$$

b. Axial or hoop Tensile stress due to H

$$= \frac{H}{2b_p \times h_e}$$

$$= \frac{168.4 \times 10^3}{2b_p \times h_e} \text{ (ii)}$$

Total (i) and (ii)

$$= \frac{28.07 \times 10^4}{b_p \times h_c} \text{ N/mm}^2$$

This value should not exceed $0.6 f_y$

$$= 0.6 \times 280$$

$$= 168 \text{ MPa}$$

Therefore

$$\frac{28.07 \times 10^4}{b_p \times h_c} = 168$$

$$b_p \times h_c = 1670.83$$

$$\text{Taking } b_p = h_c = \sqrt{1670.83}$$

$$= 40.87 \text{ mm}$$

Say 50 mm

Results & Analysis: On the basis of design data, following parameters are analyzed and presentation in graphical form.

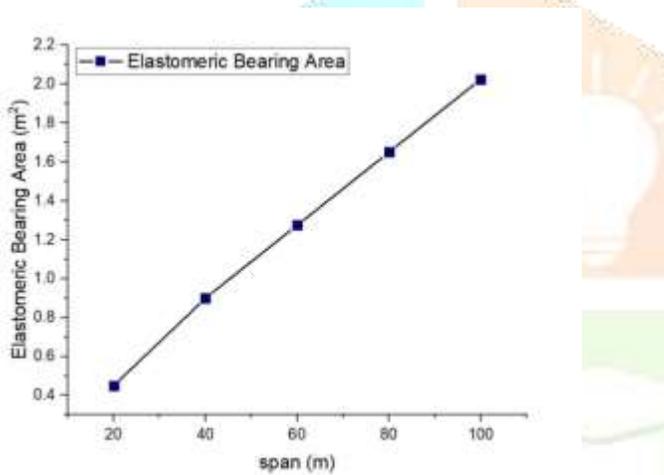


Figure 4: Span vs Area :Elastomeric Bearing

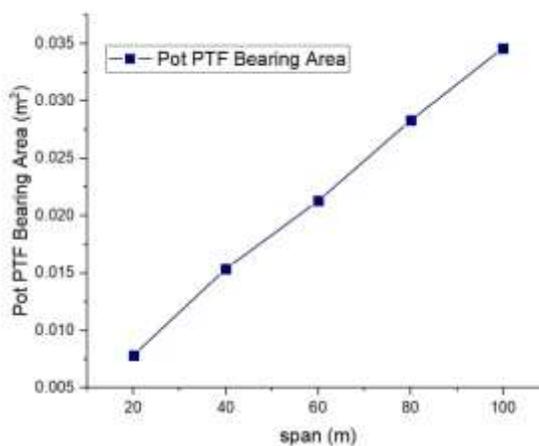


Figure 5: Span vs Area : POT PtFe Bearing

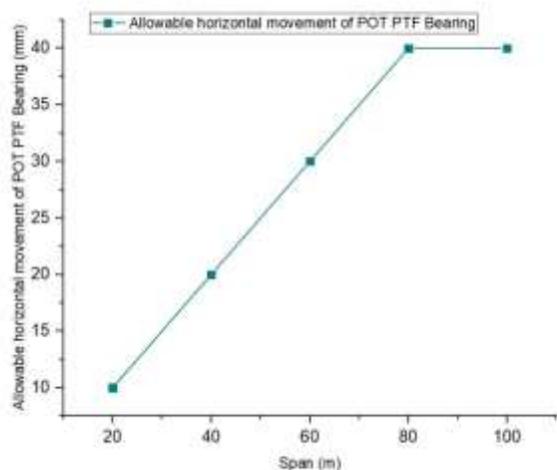


Figure 6: Span vs Allowable Horizontal Movement: POT PTFE Bearing

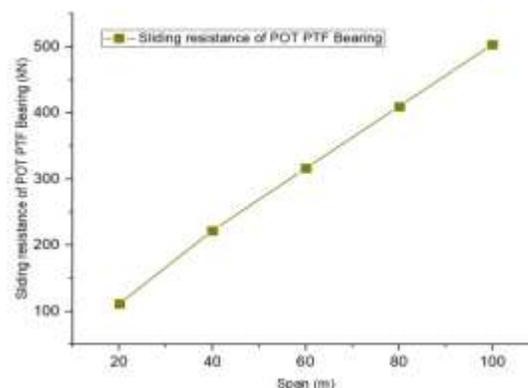


Figure 7: Span vs Sliding Resistance : POT PTFE Bearing

Conclusion

The replacement of neoprene bearings in ROB 105 discusses about the considerations associated to material procurement, installation labor, and potential bridge downtime. The present study presented a comparative cost and material performance analysis of alternative bearing materials, with particular attention to initial costs, long-term maintenance requirements, installation complexity, and the economic impacts associated with traffic disruption during replacement activities. The analysis indicates that HDPE, PTFE, and natural rubber bearings are important substitutes for conventional neoprene bearings. These materials demonstrate mechanical performance and durability comparable to those of neoprene, while also offering potential reductions in long-term maintenance costs. Although initial material and installation expenses may vary among the alternatives, their improved service life and reduced maintenance demands can offset upfront costs over the lifecycle of the structure. However, the selection of an optimal bearing material must extend beyond cost considerations alone. Factors such as compatibility with existing bridge infrastructure, ease of installation, availability of technical expertise, and budgetary constraints play a critical role in the final decision-making process. Furthermore, site-specific operational conditions may influence bearing performance and should be carefully evaluated. Therefore HDPE, PTFE, and natural rubber bearings emerge as promising alternatives for ROB 105. However further experimental validation, field testing, and performance monitoring is required to ensure their long-term effectiveness and suitability under actual service conditions.

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