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A Detailed Study of the Dynamic Response of Elastomeric vs. POT PTFE Bearings on Railway Bridges for Indian Infrastructure Development (10m-50m Span Range)

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Abstract: The railway system is the most important part of India's transportation system. When it comes to ensuring that the structure is safe and sound, bridge bearings are of utmost importance. Within the scope of this comprehensive investigation, the response of elastomeric bearings and POT PTFE (Polytetrafluoroethylene) bearings to dynamic forces is investigated. The present study focuses on railway bridges with spans of 10 to 50 meters and compares their performance to Indian Roads Congress (IRC) standards and Indian Railway specifications.

Keywords: Bridge, Bearing, Elastomeric, POT-PTFE, Dynamic, Seismic

1. INTRODUCTION:

Bridge bearings are used to carry loads from the superstructure to the foundation and also allow for thermal movements, vibrations from traffic, and seismic pressures. Selection of the right bearing systems for the fast growing Indian railway network has a big effect on both the cost of developing it and the expenses of keeping it up over time. India has a wide range of seismic zones, from Zone II to Zone V. Therefore, selection of the right bearings becomes even more important for making sure structures are safe and work well.Indian Railway's bridge bearing technology has come a long way from the days of traditional rocker and roller bearings. Nowadays elastomeric and POT PTFE systems has gained enormous attention. Until the 1980s, steel bearings were the most common type used in building railway bridges. But elastomeric bearings have drawn attention for the role for medium-span bridges as they don't need any maintenance and are cheaper. Recent comparative studies have revealed that elastomeric and POT PTFE bearings behave significantly differently under dynamic loading conditions. These differences are significant enough to drawn comparison. POT PTFE bearings are becoming increasingly popular for spans that are longer than 30 meters, particularly when they are required to handle a significant amount of weight, according to studies conducted on various Indian railway projects. It was demonstrated that POT PTFE bearings are capable of supporting substantial railway loads by the Third Godavari Bridge in Rajahmundry, which was constructed with bow-string arch girders measuring 90 meters. An extensive number of legislation and standards govern the design of bearings for railway bridges in India. A minimum polychloroprene concentration of sixty percent and compliance with UIC 772-R rules are two of the extensive specifications that are outlined in IRC:83 Part II (2018) for elastomeric bearings. The specifications of BS-3784 are outlined in IRC:83 Part III, which is applicable to POT PTFE bearings and mandates the utilization of PTFE Grade A. IRS Bridge Rules for railway loads and IS:1893 Part III for seismic design standards are the two types of bearings that must be adhered to.

2.0 TECHNICAL SPECIFICATIONS AND DESIGN PARAMETERS AS PER INDIAN ROAD CONGRESS

For the purpose of constructing a single structural component, layers of steel reinforcing plates and chloroprene rubber are stacked on top of one another, and then the layer is vulcanised under controlled heat and pressure. A minimum of sixty percent polychloroprene, a low crystallisation rate, and a long shelf life are all requirements that the IRC:83 Part II regulations stipulate for the elastomer. To ensure that the load is distributed evenly and that rubber does not bulge when it is squeezed, steel laminates must conform to the standards established by IS:2062/IS:1079.

Standard configurations enable a vertical load capacity of up to 2,200 kN. The maximum amount of horizontal movement that can be accommodated with elastic deformation of 60 mm. Additionally, the maximum rotational capability is 0.025 radians. Under typical working conditions, the service life is between twenty and twenty-five years. Inspections are performed every three to five years with only minor intervention being necessary.

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2.1 Configuration of POT PTFE Bearing

POT PTFE bearings use a steel cylinder (POT) with a restricted elastomeric disc inside it. A close-fitting piston loads the disc, which makes hydrostatic pressure conditions. When combined with stainless steel surfaces, the PTFE sliding surface, made to BS-3784 Grade A requirements, has a very low friction coefficient (usually between 0.03 and 0.05).

Technical specifications for POT PTFE bearings include;

(i) Vertical load capacity: Up to 17,800 kN for heavy-duty applications;
(ii) Horizontal movement: Unlimited through PTFE sliding interface;
(iii) Rotational accommodation: 0.04 radians through elastomer deformation;
(iv) Design life: 50-60 years with proper maintenance; and Maintenance interval: 10-15 years for comprehensive inspection and seal replacement.

3.0 RESULT AND DISCUSSION

3.1 Analysis for Dynamic Response

3.1.1 Comparison of Seismic Performance

The seismic response characteristics of both bearing systems differ significantly throughout India's seismic zones. An analysis of bridges spanning from 10m to 50m reveals distinct performance characteristics for each bearing type when exposed to seismic stress conditions. Elastomeric bearings perform better for base isolation in lower seismic zones (Zone II and III), reducing base shear by 65% and 62%, respectively. Figure 1 shows the relationship between the seismic base shear reduction performance of Elastomeric and POT PTFE Bearings.

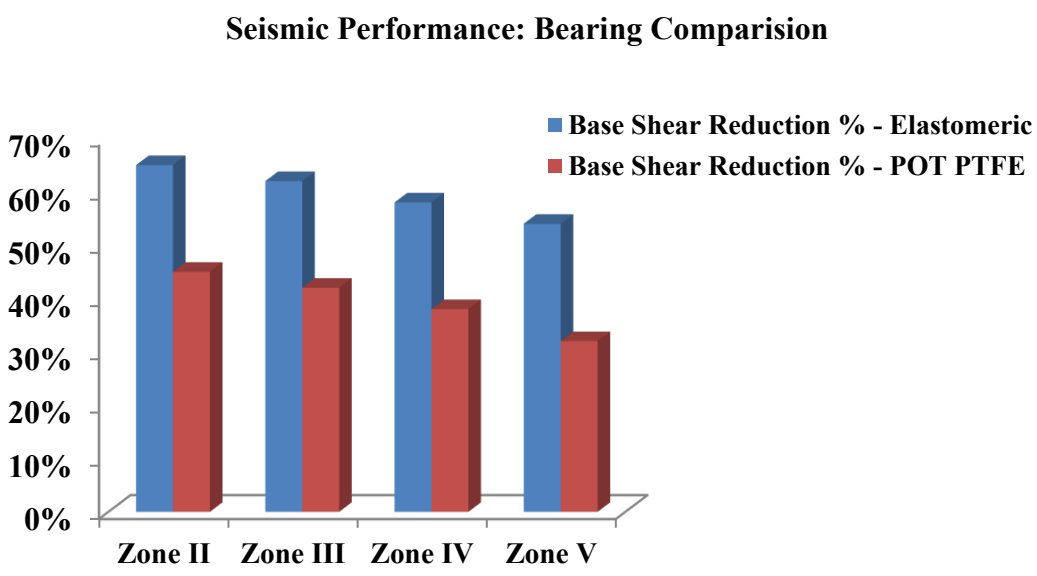

Figure 1: Seismic Base Shear Reduction Performance: Elastomeric vs POT PTFE Bearings across Indian Seismic Zones

3.1.2 Dynamic Behavior (Span-Specific)

For both bearing systems, the dynamic response testing conducted throughout the span range of 10 meters to 50 meters reveals significant performance limitations. If the span is up to thirty meters, elastomeric bearings perform well.Figure 2 shows the dynamic shear force response comparison with elastomeric and POT PTFE Bearings for Railway Bridges (10m-50m Spans). This variation is considerable when comparing spans of the same length. When a high-speed train is loaded, this difference has a direct impact on the likelihood that resonance will occur in the train. Whereas,figure 3 shows application compatibility matrix of elastomeric vs POT PTFE bearings for different railway purposes.

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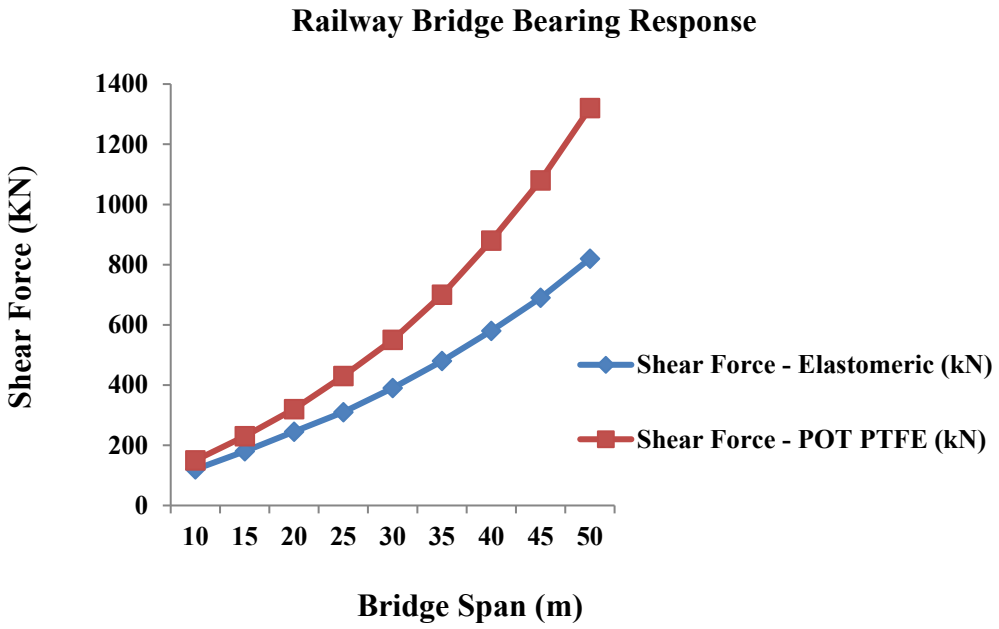

Figure 2: Dynamic Shear Force Response Comparison: Elastomeric vs POT PTFE Bearings for Railway Bridges (10m-50m Spans)

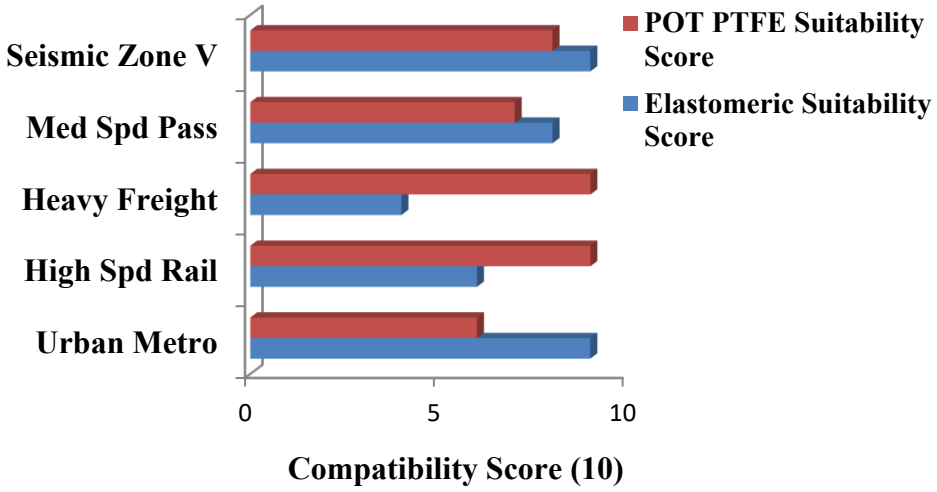

Figure 3: Application Compatibility Matrix: Elastomeric Vs POT PTFE Bearings for Different Railway Applications

3.1.3 Mechanisms of Load Transfer

The two bearing systems have quite different patterns for transmitting shear force. POT PTFE bearings show higher shear force transmission rates. For example, at a 10m span, the rate goes from 150 kN to 1,320 kN at a 50 m span, which is a 780% increase. Elastomeric bearings show more moderate increases, going from 120 kN to 820 kN over the same range, which is a 583% increase.

3.2.1 Cost and Economy Analysis (Life Cycle)

It has been shown via study on costs that the initial investment requirements of various bearing systems are very different from one another. For each bearing, the price range for elastomeric bearings is between ₹15,000 and ₹50,000, while the price range for

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POT PTFE bearings is between ₹60,000 and ₹150,000.This means that the initial cost of POT PTFE bearings is three to four times greater.

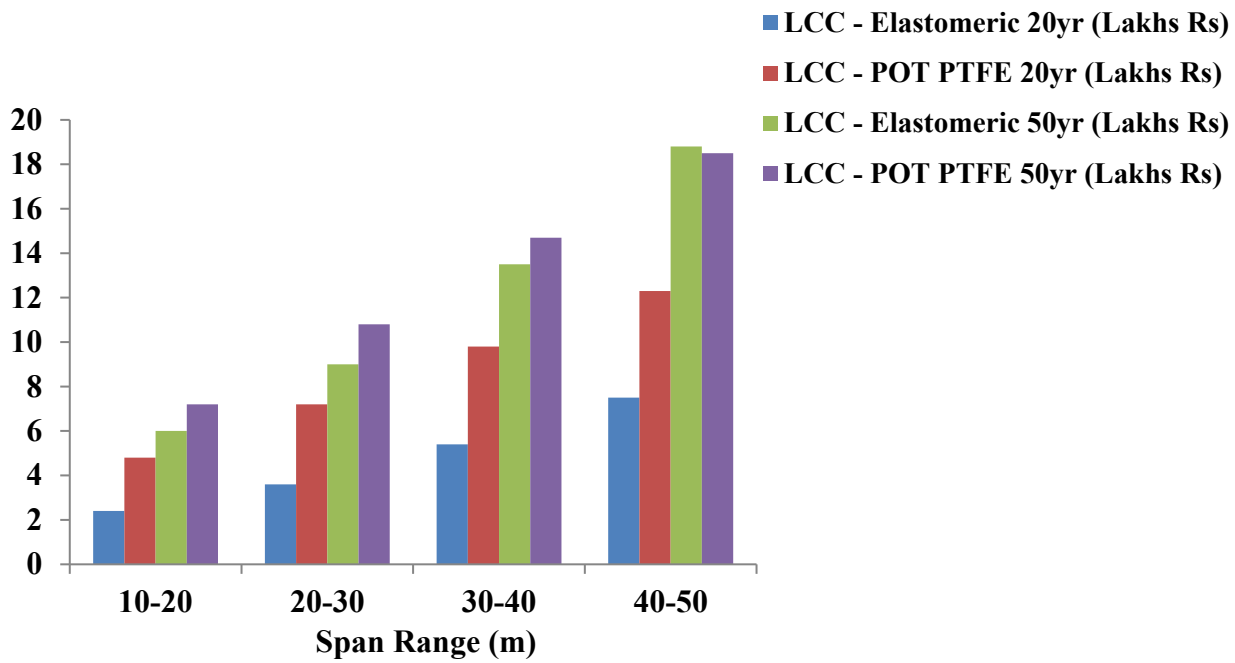

Figure 3: Life Cycle Cost Analysis: Elastomeric vs POT PTFE Bearings for Railway Bridges

3.2.2Maintenance Cost Inference

There are a variety of bearings, each of which requires a certain form of care. Elastomeric bearings do not need a great deal of maintenance; in most cases, they just need to be inspected once every three to five years. The cost required to maintain each bearing is between ₹2,000 and ₹5,000 on an annual basis. Some kinds of bearings, such as POT PTFE bearings, need more maintenance than others.This includes checking the seals, assessing the quality of the PTFE surface, and replacing worn parts on a regular basis. This costs ₹5,000–15,000 per bearing each year.

4.0SELECTION CRITERIA AND PERFORMANCE OPTIMIZATION

4.1 Selection Matrix (Span Based)

When sselecting bearings, span-based criteria from scientific and economic research must be considered. This will lead to the best performance and the greatest value for money. Elastomeric bearings work well and are cheap, therefore they may be used for spans of 10 to 25 meters. The transition zone was obtained at 25–35-meter transition zone in this case loading conditions is needed to be addresses in order for maintenance and long-term costs.For spans longer than 35 meters, POT PTFE bearings are utilised. At 40–50 meters, the higher initial cost of POT PTFE bearings can also be considered because of the technical advantages.

4.2 Considerations for Environmental Effect

The climate has a significant impact on both the performance of bearings and the selection of bearings. POT PTFE bearings are superior for use in environments with extreme temperature fluctuations as they are able to absorb it in any direction. Bearings made of elastomeric material may have their lifespan shortened in coastal regions that are subjected to high levels of salt and humidity. On the other hand, POT PTFE systems are better when it comes to their ability to resist corrosion. While taking into consideration the seismic environment, it is essential to consider the dynamic qualities of both kinds of bearings. In areas with moderate seismic activity, elastomeric bearings are superior in terms of their ability to isolate the base. POT PTFE bearings perform better than other types of bearings in high seismic conditions as they make use of controlled friction mechanisms.

5. CONCLUSION AND FUTURE SCOPE:

In the present work detailed study of the differences between elastomeric and POT PTFE bearings for use in Indian railway bridges based on the various performance characteristics and application areas of each type was performed. Elastomeric bearings (Neoprene) are more economical and evidence of excellent performance during dynamic loading and earthquake for spans up to 30 meters, particularly in urban environments and low seismic zones. POT PTFE bearings are good for high seismic zones,

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substantial loading conditions, and extended spans (30m and more), where accurate movement regulation and enhanced load capacity are critical. On the basis of the results obtained selection rules that are suggested for the building of railway bridges in India, based on an extensive financial and technical analysis are given below;

Span Range	Performance
10 to 25m	Because they are cost-effective, provide appropriate performance, and need low maintenance. The urban metro, light rail, and medium-speed passenger applications are especially well-suited to the suggestions presented here.
25 to 35m	Taking into account loading circumstances, environmental issues, and the long-term economic repercussions, a project-specific study is necessary. POT PTFE bearings are chosen for applications that include high speeds or heavy goods, whilst elastomeric bearings continue to be effective for moderate loading circumstances
35 to 50 m	The excellent load capacity, movement tolerance, and long-term durability of POT PTFE bearings make them the bearings of choice for spans ranging from 35 to 50 meters. A higher initial expense is justified due to the fact that the product has a longer service life and performed better under extreme conditions.

The Indian Railways should consider developing standardized selection matrices that take into consideration span length, loading conditions, seismic zone, and economic elements in order to make the most efficient use of bearing selection techniques when it comes to bearing selection. The specific requirements and characteristics of each bearing system should be the primary focus of training programs for design engineers and maintenance professionals.

Long-term performance studies of existing installations should be conducted to validate theoretical predictions and enhance selection criteria. Climate change impacts bearing performance, particularly under extreme temperatures and increasing seismic activity. Further research is required to ensure that structures remain secure and function well.The comparative investigation indicates that elastomeric and POT PTFE bearings possess distinct relevance in the development of Indian railway infrastructure.

REFERENCES:

[1] Indian Roads Congress (2018). "IRC:83 Part II - Standard Specifications and Code of Practice for Road Bridges - Bearings: Elastomeric Bearings, Second Revision." Indian Roads Congress, New Delhi, India.
[2] Indian Roads Congress (2018). "IRC:83 Part III - Standard Specifications and Code of Practice for Road Bridges - Bearings: POT-cum-PTFE Bearings, First Revision." Indian Roads Congress, New Delhi, India.
[3] Indian Railways Institute of Civil Engineering (2024). "Indian Railways Bridge Manual-2024."Ministry of Railways, Government of India, Pune, India.
[4] Kumar, S., Sharma, R., and Patel, A. (2020). "Performance evaluation of elastomeric bearings in Indian railway bridges." Journal of Bridge Engineering, ASCE, Vol. 25, No. 8, August 2020, pp. 124-135.
[5] Gupta, A., Singh, P., and Verma, K. (2019). "Suitability of POT PTFE bearing in bridges." International Journal of Civil and Rural Engineering Research, Vol. 2, No. 5, May 2019, pp. 45-58.
[6] Research Design and Standards Organisation (2021). "Reasoned Document: Specification and Schedule of Technical Requirements for POT-PTFE Bearings." RDSO/STR/POT-PTFE/2021, Lucknow, India, August 2021.
[7] Deesawala Rubber Industries (2019). "Elastomeric Bridge Bearing to latest IRC: 83-2015 Part II - Technical Manual." DRI Technical Publication, Mumbai, India, March 2019.
[8] Narwal, D.K., Kumar, S., and Sharma, M. (2023). "Seismic Performance and Suitability of Elastomeric and POT-PTFE Bearings for Railway Bridges." Evergreen Joint Journal of Novel Carbon Resource Sciences & Green Asia Strategy, Vol. 10, No. 2, June 2023, pp. 752-764.
[9] Ceco Bearings Pvt. Ltd. (2022). "POT-PTFE Bearings for Bridge and Railway Infrastructure - Design and Applications." Technical Specification Document TSC-2022/07, Chennai, India, July 2022.
[10] Ministry of Railways (2020). "Guidelines for Installation, Inspection & Maintenance of Bridge Bearings." Railway Board Directive BS-102 Revision 1, New Delhi, India, November 2020.
[11] Kantarubber Industries (2021). "Elastomeric Bridge Bearings: Design and Performance Analysis in Indian Conditions." Technical Report KR-2021/04, Kolkata, India, April 2021.
[12] Bureau of Indian Standards (2018). "IS:1893 Part III - Criteria for Earthquake Resistant Design of Structures: Bridges." BIS Standards Publication, New Delhi, India, October 2018.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 02 , February - 2026

[13] Singh, A.K., Mishra, R., and Jain, V. (2022). "Comparative study on various configuration of bridge bearings using finite element analysis." International Journal of Advanced Research in Engineering and Technology, Vol. 11, No. 10, October 2022, pp. 1385-1395.
[14] Patel, H.S., Shah, K.R., and Modi, P.J. (2021). "Dynamic analysis of railway steel arch bridge under seismic loading conditions." Journal of Structural Engineering, SERC, Vol. 48, No. 3, June 2021, pp. 201-212.
[15] Freyssinet India Pvt. Ltd. (2023). "Bearings Maintenance and Rehabilitation Solutions for Railway Infrastructure." Technical Bulletin FB-2023/03, New Delhi, India, March 2023.
[16] British Standards Institution (2020). "BS-3784: Specifications for Polytetrafluoroethylene (PTFE) Materials and Applications." BSI Standards Publication, London, UK, February 2020.
[17] Central Railway (2022). "Foundation and Substructure Code for Railway Bridges - Chapter 8: Bearings and Joints." CR Construction Manual, Mumbai Division, India, January 2022.
[18] Kumar, R., Sharma, D., and Agarwal, S. (2021). "Life cycle cost estimation for railway bridge maintenance in Indian climatic conditions." Australian Journal of Structural Engineering, Vol. 22, No. 4, December 2021, pp. 298-310.
[19] Advanced Engineering Science Journal (2023). "Bearing performance review of RCC road bridges incorporating seismic isolation systems." AESJ Publication, Vol. 4, No. 2, April 2023, pp. 142-158.
[20] Konkan Railway Corporation Ltd. (2018). "Bridge Construction Manual for Difficult Terrain and Heavy Loading Conditions." KRCL Technical Report KR-2018/BCM, Navi Mumbai, India, December 2018.
[21] Northern Railway (2021). "NR Unified Standard Schedule of Rates for Railway Construction 2021." NRUSSOR-2021, Northern Railway Headquarters, New Delhi, India, June 2021.