

INVESTIGATION REGARDING BRIDGE BEARINGS DETERIORATION IN PAKISTAN AND ITS REMEDIAL MEASURES

Ali Ajwad¹, Liaqat A. Qureshi², Tariq Ali³, Akhtar Abbas³, M. Ali Khan³ and Waqas Younis⁴

¹University of Management and Technology, Lahore, Pakistan

²University of Engineering and Technology, Taxila, Pakistan

³The University of Lahore, Lahore, Pakistan

⁴The University of Lahore, Lahore, Pakistan

Corresponding author email: ajwad1989@gmail.com

ABSTRACT: In highway infrastructure concrete bridges are playing a very important role. A case study of Pakistan is presented in this paper. The main problems that Pakistan is facing regarding bridges is their deterioration from last 20 years. The major reasons for deterioration is variation in specified construction methods and the lack of maintenance. National Highway Authority (NHA) Pakistan owns 6000 bridges on national highways and a number of other bridges across the country. According to a general survey about 30 percent of these bridges are not according to the ASHTOO standards. The total worth of these bridges are about 600 billion Pak rupees. The NHA budget for year 2009 was Rs 39.9 billion. This amount is insufficient to apply the standard procedures of maintenance and retrofitting in order to repair the non-functional bridges in the country. This research is mainly focused on case studies that involve damages and defects of bridge bearings only. Paper addresses all the root causes, remedial measures and recommendations regarding focused issue. This article will help nationwide engineers by providing them with basic knowledge regarding bridge flaws related to bridge bearings and will definitely help to raise the standards of bridge Construction.

Keywords: bridge, bearings, NHA, maintenance, wearing surface, deterioration

1. INTRODUCTION

Bridges play an important role in the development of transportation system for any country. It also ensures the free flow of traffic. They not only accommodate the traffic volume but also strengthen the established transportation system. In Pakistan majority of the bridges are damaged due to overloading and use of low quality construction materials. The available resources and facilities are insufficient to repair and strengthen the existing bridges. Maintenance is required at the wide scale so that majority of these structures can be functional. Unfortunately very little information is readily available on various structures in Pakistan. The highway departments, engineering societies and universities in Pakistan are not in the habit of sharing information. This article consists of information regarding present methods that are followed for the maintenance in our country and also necessary measures that can be taken to improve the standard of existing bridges. As a matter of fact it is obvious that the main concern in design of bridges is economy which is achieved by considering nominal load rather than AASHTO specified safe loading combinations. Therefore no existing bridges have zero level of unreliability or 100 percent efficiency. Every structure needs to be maintained, as every structure loses its strength and serviceability with time. In this universe no structure is perfect. Planning a structure without any deficiency is impossible. There are majority of factors which are responsible for degree of deterioration or type of degradation. Some of them are: structural form, quality of construction, constructional materials, weather, fire, scour, earthquakes, atmospheric environment, fatigue, floods, intensity and nature of the traffic loading imposed upon it. Bridges maintenance and management is a continuous process starting from design & paperwork till the proper execution of drawing while ensuring quality control on site. Bridge management is an art of enhancing the strength and load carrying capacity of structures through required maintenance and strengthening techniques.

Bridge manager is responsible for the proper functioning, maintenance and full restoration of bridges throughout their service life. Efficient, economical and effective performance of structures is characteristics of well and proper civil engineering design. In order to keep the structure in serviceable condition balanced maintenance and renovation is required during its design life. Investigation regarding deterioration problems observed in superstructure girders of reinforced concrete bridges in Pakistan and its remedial measures within the available resources based on the personal experience of authors is the topic of this paper.

2. BRIDGE BEARINGS

A bridge bearing, in simple words, can be described as the support below the superstructure at a bridge pier which carries the whole weight of the bridge upon it. Bridge bearings can either be fixed or can be seated on expansion rollers.

3. CAUSES OF DETERIORATION

The possible causes of deterioration of elastomeric bearings as observed in Pakistan are as below;

1. Procurement of bearings without specified testing as recommended in AASHTO and BS EN 1337 standards.
2. Casting of bearing plinths with ordinary cement sand mortar rather using some non-shrink grout having higher value of compressive strength.
3. Slippage of steel plates in the bearing due to longitudinal gradient in the bridge.
4. Lack of precision while casting the plinth. Any imperfections on the top surface will decrease the contact area with the bearing pad and thus uniform distribution of load.
5. Any imperfections on the soffit of the girder also reduce the contact area. Slippage of the steel plates is resulted during movement of the girders.
6. Debris accumulation.

Examples of the deteriorated bearings are quite apparent in the below photographs:



Figure 1 A view showing a failed elastomeric bearing pad observed in Sutlaj bridge



Figure 2 A view showing a failed elastomeric bearing pad observed in Sutlaj bridge



Figure 3 Failure of elastomeric bearing under Steel girders

4. PROPOSED REMEDIAL MEASURES

1. If all the above mentioned aspects be taken into account, the desired service life of the bearings and thus the whole bridge can be insured. However, routine inspection and maintenance should be done to avoid growing of vegetation as shown in the figure below;



Figure 4 Vegetation near the bridge bearings at Kokbridge on Islamabad Highway

2. **Replacement option:** The first thing that needs to be done is to make alternative arrangements for transferring the load from the superstructure to the piers for the whole replacement duration. Usually in such types of scenarios, hydraulic jacks are used to lift the superstructure and the affected bearing is then treated or replaced. This can be done in two ways depending upon the size of the substructure. If the substructure has enough space left on the sides and has the capacity to bear the load of the superstructure at that very point, then the jack can be placed on top of it. If such is not the case then supporting frame has to be erected from the ground making it more expensive. Bearing replacement option requires considerable experience as different aspects such as effective load transfer mechanisms, bearing pressures, balanced gradual lifting, speed of replacement and most important of all the stability of the superstructure needs to be considered carefully.

3) As a matter of fact, every structure that has to be built with decent features would require use of appropriate materials. That's why use of suitable and proper materials would count as major in determining the service life of a bridge.

4) Another way to increase the safe service life of a bridge is to implement advanced methodologies of construction.



Figure 5 Arrangement for replacement of a mechanical pot bearing of a bridge

5. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

- 1) The main conclusion that can be made from the comprehensive research and looking through all perceptions is that the bridges start to weaken after some time, due to miserable and scarce workmanship. All these short-comings can result in
 - a. Inadequate or less concrete cover addition,
 - b. Honey-combing of concrete,
 - c. Improper drainage and water management.
- 2) Rebar corrosion is another problem that tends to happen when chlorides, water and carbonates are present. This can also cause damage to concrete in forms of cracks.



Figure 6 Arrangement for replacement of an elastomeric bearing of a bridge

5.2 Recommendations

- 1) Non-destructive analysis of buildings should be practiced more by the local authorities as compared to destructive ones which can damage the building elements.
- 2) Time to time assessment should be made which can be either weekly or monthly basis. This practice is necessary because if there are any problems with the structure, it can be monitored and dealt with efficiently. If anything comes up that requires fast response, it can be dealt with systematically repairs over a certain span of time.
- 3) Consistent use of coatings can act as a barrier against wear and tear and can actually add up 5 to 20 years of service life to a bridge.
- 4) Corrosion-inhibiting methods which are locally available in Pakistan's market can also be used which include concrete admixtures, rebar coatings and different types of coatings that can be applied on concrete surface.

6. REFERENCES

- [1] Patros P. Xanthakos, Transportation Structures Series, Prentice Hall PTR, Upper Saddle River, New Jersey, (2000).
- [2] M. Mulherone, Durability of Bridges and Structures Module, MSc. Thesis in bridge engineering, Internal Publication, University of Surrey, (2002).
- [3] G. Tilly, Gifford and Partners, Conservation of Bridges, Spon Press, London, pp 299-332, (2002).
- [4] ACI Committee Report, Routine Maintenance of Concrete Bridges, (ACI 345.IR-92, reapproved 2005).