

A review paper on the Repairing and Strengthening Techniques for Historic Masonry Arch Bridges

Mr. Anand R. Chavan¹, Prof. D. B. Desai² & Dr. A. K. Gupta³

¹ PG Student, Civil Engineering Department, Dr.J.J.Magdum College of Engineering, Jaysingpur, Maharashtra, India.

² Asso. Professor, Dr.J.J.Magdum College of Engineering, Jaysingpur, Maharashtra, India.

³ Principal & Professor, Dr.J.J.Magdum College of Engineering, Jaysingpur, Maharashtra, India.

Abstract: *Historic Bridges have been important throughout history in connecting cultures, sharing ideas, and providing the backbone of transportation networks. It is necessary to restore and preserve these structures for their particular functionality and cultural heritage value. Masonry arch bridges are found throughout the world. Many have both an important function for the infrastructure and an important heritage value. Due to prolonged weathering, environmental forces, wars, increased live loads, and other causes of damages, a large number of these bridges require repair and strengthening works. The dissertation work consists of study of various Repairing and Strengthening Techniques For Historic Masonry Arch Bridge with case study.*

1. Introduction

Most of masonry arch bridges, not only in India but world over, are more than 80-100 years old. After advent of concrete, masonry arch bridges are no more being constructed. Contrary to doubts, masonry arch bridges are proving durable with life-cycle costs significantly more economical than for the majority of other type of structure. Masonry arch bridges are part of our heritage. To preserve our heritage and to utilize these bridges to their maximum capacity, understanding of arch bridges is vital. As no more masonry arch bridges are being constructed in modern times, engineers have forgotten the old thumb rule methods of their design and also there are no common software available which can analyse the arch bridges correctly taking into account effect of fill, spandrel walls etc. The design of these structures was based on empirical rules which were too conservative, this has resulted in structures with an inherent ability to withstand the applied loads and extreme weathering conditions. Masonry arch bridges form an integral part of the railway infrastructure. They are the oldest structure type of the railway bridge population with thousands still in service despite their age and the significant changes in loading conditions that have occurred since their construction. Today many masonry arches

carry a load that is radically different from that when they were constructed.

The condition of masonry arch bridges can vary from good to very poor, but nevertheless they have proven durability with life-cycle costs significantly lower than the majority of other structure types.

Total replacement of deteriorated masonry bridges is generally unnecessary and is also expensive and therefore maintenance strategies should promote solutions that preserve and restore arch structures. In order that the railways may accommodate increased axle loads, train speeds and a greater volume of freight traffic, it is necessary to assess the load carrying capacity of existing masonry arch bridges. Assessment of masonry arch bridges is fraught with difficulties as there is little knowledge or experience of the design of arch structures to modern standards, and such structures may have parts hidden from view. The hidden parts, however, influence the structural behavior and have a major effect on the load carrying capacity of these bridges. To provide confidence in the assessment result, reliable input parameters are required. Accordingly effective inspection and measuring methods to establish the parameters are necessary. In addition to visual inspections, there has been a tendency in recent years towards the use of non-destructive testing techniques and destructive investigation to establish the necessary dimensional and material parameters.

2. Literature Review

Title - Damages to masonry arch bridges

Author - J. Bien

Proposal for a standardized classification of damages to masonry arch bridges is presented. The hierarchical classification is based on damage effects. Six main damage types are distinguished: contamination, deformation, destruction, discontinuity, displacement and loss of material. The most common mechanisms of masonry bridge degradation and the relationships between damage

types and processes causing them are considered. Finally, basic testing methods useful in identifying such damages are indicated and a range of their applications is discussed

Title - Repair, strengthening and replacement.

Author - J. Darby

Maintenance of bridge structures has undergone rapid development over recent decades. New deterioration mechanisms have become evident as bridge stocks age, requiring new testing and remedial techniques. Bridges assets are of critical value to the economy, and demand maintenance with the minimum disruption to the flow of traffic. The chapter considers the techniques required for particular materials – concrete, metal and masonry. These include methods of repair and strengthening, with particular reference to those which have undergone rapid recent development, such as plate bonding.

Title - Rehabilitation of Historic Masonry Bridges

Author – Gonzalez Rodrigo

In the Iberian Peninsula there are many masonry bridges enduring over time that require inspection and maintenance. In 2007 it was carried out a restoration project on the bridge of Sant Andreu de Terri (Girona Spain). Prior to this intervention, the bridge did not meet the safety and comfort requirements for the crossing of people and the walls showed loss of masonry stones and material from joints. The surface was cleaned and replaced the existing metal rail. The board was replaced; waterproof and longitudinal drainage pipes were installed to prevent water infiltration. As result of this action a historical, and architecture heritage construction was recovered re-offering the use for which it was conceived.

Title - Novel Method of Strengthening Masonry Arch Bridges

Author - Graham P Tilly

During recent years much attention has been given to the performance of masonry arches and it has attracted a considerable volume of research. In the UK there are some 40,000 masonry arch bridges in daily use on highways, railways and canals. Most are over 100 years old, some are 500 years old. Traffic loads have increased many times since construction and bridges are now being assessed to the new EC loading requirements. It has become evident that many bridges are not strong enough, either because they have been weathered and deteriorated over time or their design is inadequate. It is necessary to replace or strengthen the bridges by

one means or another. Various methods of strengthening have been used, one of the most popular being saddling. Here, the fill is removed so that the top surface of the arch barrel is exposed. A reinforced concrete saddle is then cast in place over the original barrel. Saddling undoubtedly raises the strength by a sufficient margin but has the drawbacks of expense, considerable interruption to traffic and potentially major environmental disturbance. It is therefore appropriate to look at other more cost effective and flexible methods of strengthening.

Title - Masonry Arch Bridges

Author - Tomasz Kaminski

The general info on railway and road masonry arch bridges. It involves statistical data with age profiles of railway structures and classification manners commonly applied to masonry arches. Typical damages are shown in exemplary photos and their division into 7 main categories is proposed. A structure of the management system is schematically presented with methods of inspections and testing associated with it. Such an ordered data organization is believed to be helpful in maintenance of these important and often monumental structures. .

1. Scope, Methodology and Purpose

3.1 Scope:-

Following are the objectives of the proposed dissertation work.

- a) To study History of masonry arch bridge and their Construction.
- b) To study the various damages and failures of masonry arch bridge
- c) To identify the various methods adopted for the Investigation and testing of masonry arch bridge.
- d) To study and understand the various methods used for repair and strengthening.
- e) To give suggestive techniques for Repairing and Strengthening of Masonry Arch Bridge. Above all points are studied with case study.

3.2 Methodology:-

For carrying out the proposed work, following methodology will be adopted for data collecting and analysis.

- a) To collect information related to bridge history through literature review and or preliminary study.
- b) To study of construction of Historic bridge.
- c) To study the various damages and failures of masonry arch bridge through study of visual observation.
- d) Investigation and testing of masonry arch bridge.

- e) To discuss and conclude the methods for Repairing and Strengthening of Bridge which can be suggested for selected case studies.

3.3 Purpose of Dissertation:-

Historic Bridges have been important throughout history in connecting cultures, sharing ideas, and providing the backbone of transportation networks. It is necessary to restore and preserve these structures for their particular functionality and cultural heritage value. Masonry arch bridges are found throughout the world. Many have both an important function for the infrastructure and an important heritage value. Due to prolonged weathering, environmental forces, wars, increased live loads, and other causes of damages, a large number of these bridges require repair and strengthening work. For Historic Masonry Arch Bridges The Purpose of Dissertation is to find out the Repairing and Strengthening Techniques

References

[1] Jay Bien, "Damages to masonry arch bridges", 5th *International Conference on Arch Bridges* 2006, pp - 655-663.

[2] Jay Darbr(2008),"Repair, strengthening and replacement".*ICE Manual of Bridge Engineering - 2008 Institution of Civil Engineers.*

[3] Gonzalez Rodrigo(2014), "Rehabilitation of Historic Masonry Bridges Lessons Learned from a Medieval Bridge in Northeast Spain".*Revista de la Construcción Journal of Construction.* , 3, 1, 2014, pp. 13-23.

[4] Carl L Brookes and Dr Graham P Tilly,"Novel Method Of Strengthening Masonry Arch Bridges,1999.

[5]Jan Bien and Tomasz Kaminski,"Masonry Arch Bridges In Poland",2004.