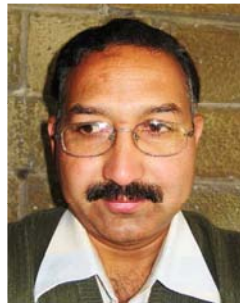


## Performance Assessment and Maintenance of Masonry Arch Bridges

**Pardeep Kumar**  
Assistant Professor  
NIT Hamirpur  
Hamirpur, HP, India 177005  
*Pkumar256@yahoo.co.in*



Pardeep Kumar, born 1968, received his Civil Engineering degree from NIT Hamirpur India, Masters in structural Engineering from NIT Kurukshetra, India and Ph. D. From IIT Roorkee, India. He is in Teaching Profession since 1991. He is Presently with NIT Hamirpur. He is involved in consultancy, research guidance and his main area of research is related to FE Analysis of Masonry and concrete structures.

### Summary

In order to maintain as many as 19600 masonry arch bridges on Indian railway network alone and innumerable of them on Indian Highways, it becomes de rigueur to assess the performance and devise a maintenance strategy for timely diagnosis of shortcoming / deficiencies in these existing ageing bridges. These techniques are essential to boost the confidence level of designers in masonry arch bridges and maintain the state of health of existing masonry arch bridges. At the same time, performance assessment and maintenance for newly constructed bridges, which are seldom is of prime importance due to the fact that freight hauliers are quick to see the advantage of heavier goods vehicles. The axle loads are on increase and limits do not seem likely to decrease in future. The Performance assessment and maintenance can prevent the catastrophic failure and revolutionize the maintenance economics including the replacement of the distressed bridges in a phased manner. Available structural performance assessment techniques are reviewed here in the paper. The advantages, disadvantages and the applicability of these techniques for the masonry arch bridges are also discussed. Finally a strategy for the performance assessment of existing and newly constructed masonry arch bridges is proposed. At the end the maintenance strategy on the basis of diagnosis as an Indian experience on railway masonry arch bridges has also been included in the paper.

**Keywords:** Masonry arch bridges; Inspection; Performance Assessment; Maintenance strategy.

### 1. Introduction

In recent years, a considerable amount of effort has gone into research concerning the load carrying capacity of the masonry arch bridges. The reason for this upsurge in interest can be largely attributed to the increase in the traffic volume and higher axle loads. In India, the oldest and still surviving masonry arch bridge dates back to Eleventh century, near Jagannathpuri in Orissa state [1]. Masonry arch bridges built during pre independence era are present in surprising numbers on the local road and railway network in India. There are approximately 19600 masonry arch bridges on Indian railway network alone, many of which are over 100 years old [2]. In the European railway system thousands of masonry bridges are still in service; in the Italian railway network more than 7000 of them span over 8 m. In Republic of Ireland the population of masonry arch bridges is approximately 20000 [3]. In UK alone there are around 40000 masonry arch bridges ranging from small bridges to major viaducts carrying arterial mainline railways. All such bridges were built when their designers could not have envisaged the nature and volume of today's traffic. These are able to carry such high loads due to the inherent strength of structural form of arch and considerable factors of safety by way of conservative values for stresses in the materials used at the time of the design.

The strength of masonry arch bridges is difficult to be determined with precision due to their complexity. As a result of which a variety of approaches viz. elastic method [4], three hinge analysis [5], Rigid Block analysis [6], Discontinuous Deformation Analysis [7, 8 & 9], 1D finite element analysis [11, and 12], 2D finite element analysis [13, 14, 15 and 16] and 3D finite element analysis [15, 17, 18, 19 and 20] using the inbuilt material models and the failure functions has been