

Assessment of masonry arch bridges

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Abstract

This paper is about the assessment of masonry arch bridges in the Netherlands. A large part of the public road network in old city centres is still formed by masonry arch bridges. The general question of the local authorities is “can masonry arch bridges withstand motorised traffic including busses and occasionally heavy trucks?” Nonlinear finite element analysis in PLAXIS is applied for the assessment of the failure behaviour of the structure and its limits related to cracking and failure loading. A proof-loading of a real bridge increased the reliability of the calculation methodology. To assess a large group of single span masonry arch bridges, suggestions for a risk-based approach are made.

Keywords: Masonry arch bridge, NLFEA, PLAXIS, Proof-loading, assessment, residual lifetime

1 Introduction

The masonry arch is one of the oldest known type of bridge structure. In the historic cities in the Netherlands, a large part of the public road network is still formed by masonry arch bridges. For most of these single span masonry arch bridges the (exact) geometry, material qualities, design criteria and design load are unknown. Many bridges even have an unknown year of construction. Over the lifespan, the loading has developed from pedestrians and horses towards motorised traffic with busses and (occasionally) heavy trucks up to 60 metric tons. Over the years, degradation of the masonry occurs and sometimes cracks appear. The question of the local administrators is how the structural safety can be ensured over the next decades in accordance with the Eurocode and the national codes for existing structures (NEN 8700+A1). Research started with developing a reliable assessment method based on destructive investigation and current assessment codes. Detailed advice is provided for the assessment of a larger group of masonry arch bridges. Figure 1 gives an overview of typical terminology for masonry arch bridges.

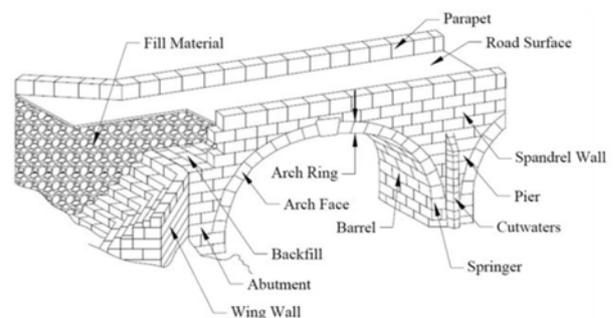


Figure 1: Overview of typical terminology for masonry arch bridges [1].

2 Comparison of assessment methods

Different types of calculation models are validated by comparing the results with results from lab tests found in the literature. The validation is based on three lab tests with destructive loading of masonry arch bridges: two Bolton laboratory tests (BLT 3-1 and BLT5-2) [2], [3], [4] with spans of 3 and 5 m and Salford laboratory tests (SALT-1) [5] with a span of 3 m. Where the BLT tests examine the capacity of a massive arch (BLT3-1) and multiple stacked arches