Journal of Constructional Steel Research 80 (2013) 346–354

Contents lists available at SciVerse ScienceDirect

Journal of Constructional Steel Research

Fatigue assessment and strengthening measures to upgrade a steel railway bridge

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A R T I C L E I N F O

Article history:
Received 15 May 2012
Accepted 5 October 2012
Available online 10 November 2012

Keywords:
Fatigue assessment
Steel truss
Railway bridge
Steel bridge
Retrofit

A B S T R A C T

The present paper deals with the experimental and analytical study of a 19th century riveted steel truss railway bridge to assess its current condition and remaining time of life. The analysis includes static and dynamic field measurements and laboratory tests. The evaluation of the capacity of the bridge for the trainloads, as well as for the seismic and wind loads, as specified by current design codes, was performed using a finite element model. Besides, after the owner's recent decision to upgrade the bridge to meet modern standards and new types of trains, the necessary strengthening was proposed, and the new estimation of the remaining fatigue life of the bridge after the suggested strengthening was also provided.

1. Introduction and bridge description

Around the 19th century, a large number of riveted steel bridges were built in Greece. Today, after over a hundred years of operation, the remaining working life, which had not been estimated in the initial analysis of these bridges, is required. Many of them have undergone repair or strengthening after damages or due to changes of service requirements [7,8]. Although, in many cases, there are no visible indications of deterioration or fatigue, a condition assessment is required. The bridge replacement, as a consequence of approaching the design life, is usually more expensive than the retrofit and replacement of some particular members. Besides, the replacement of this type of riveted bridges is not acceptable from the historical point of view.

The present paper deals with the experimental and analytical study of an existing steel-truss bridge, in order to assess its current condition and remaining time of life [6,9]. Besides, after the owner's recent decision to upgrade the bridge to meet modern standards and new types of trains, the necessary strengthening was proposed.

The bridge under consideration (Fig. 1) is a simple beam space truss, which consists of a symmetric steel structure with a total length of 51.60 m. The main girders are two riveted trusses 5.20 m high and 3.40 m apart, consisting of L shape sections and combined plates (Fig. 2).

Fig. 1. General views of the steel bridge.

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0143-974X/$ – see front matter
http://dx.doi.org/10.1016/j.jcsr.2012.10.004

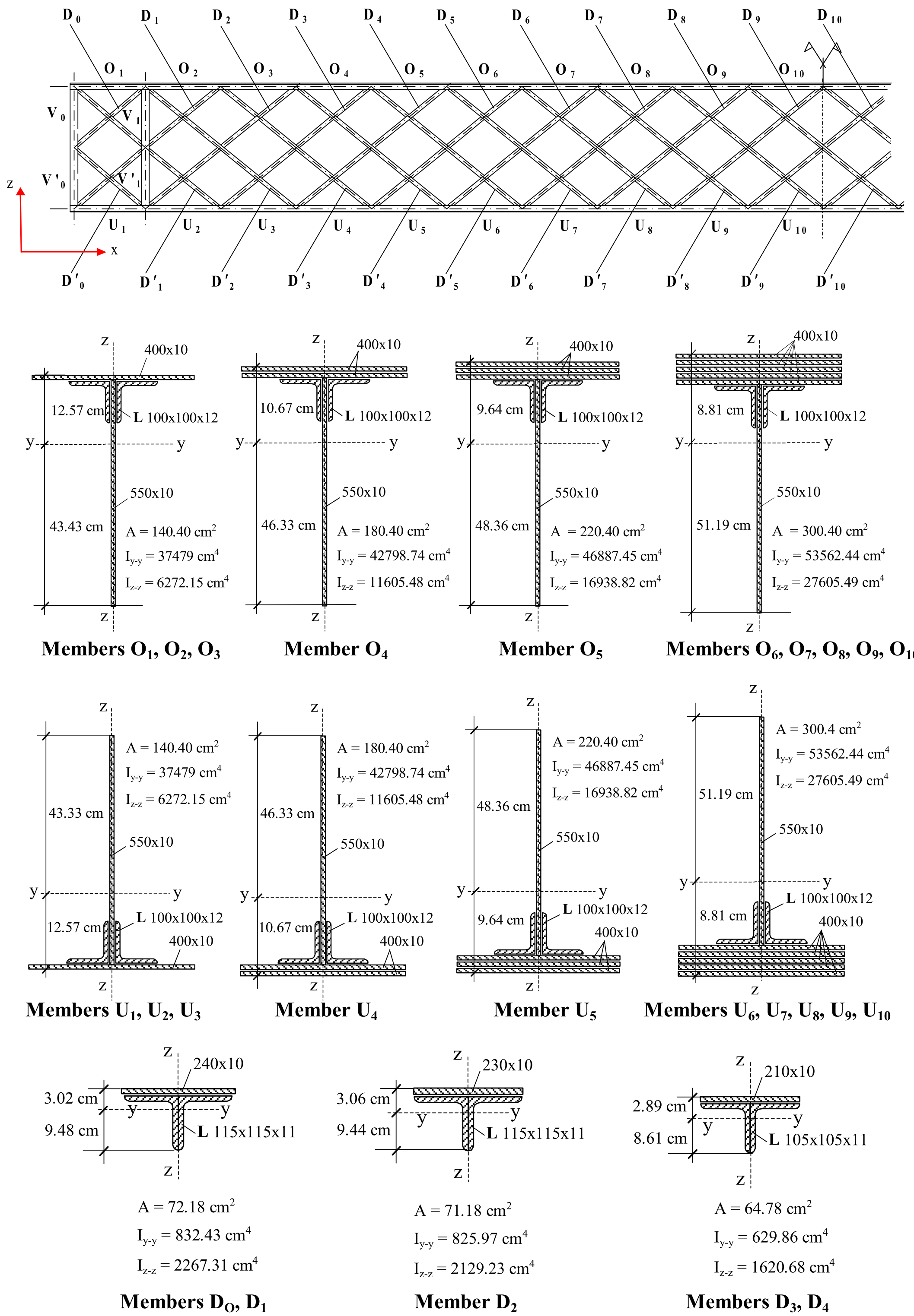

Fig. 2. Main truss girder and representative cross-sections.

At the top chord, the main trusses are connected with transverse main beams (TMB), a horizontal bracing system, and the longitudinal stringers (LS) (Fig. 3a). A typical connection of the transverse main beams (TMB) at the top chord is shown in Fig. 4. In 1960, in order to fulfill the increased traffic loads the bridge had undergone replacement of some members, such as secondary beams and some bracings.

The bridge is supported at one end with a restraining bearing on a massive unreinforced masonry pier and at the other end with one simple sliding bearing masonry pier (Fig. 5).

2. Inspection, field measurements and laboratory tests

For a preliminary evaluation, an intensive study of the drawings and the available informative material was carried out. Besides, in order to identify the compliance of the actual bridge construction with the drawings, as well as the bridge modifications and the evidence of possible degradation, a visual inspection of the structure was performed, including in situ measurements of members and their sizes, as well as the connections and the support bearings.