Assessment and full scale failure test of a steel truss bridge

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Abstract

Large amount of resources has been invested in maintaining existing infrastructure. Several of these structures are now becoming old and do not meet the requirements of today or are reaching the end of their lifecycle. It is not possible to replace all of these structures that are deemed or are about to be deemed obsolete, due to high cost and environmental impacts.

One way to keep these structures in use for a longer time is innovative and intelligent assessment of the actual state of stress and behaviour. In such cases, using structural health monitoring to assess the structure might be an efficient way to extend the life of the structure.

This paper will describe a unique monitoring program over two similar 33 m long steel truss bridges situated in Sweden. One of these bridges, Aby River, has a regulated axle load of 25 tons and is deemed to have reached is end of life due to fatigue. The other bridge, Rautasjokk, has a regulated axle load of 30 tons but will be in use for the coming years.

The monitoring program has the following outline; monitoring of the bridge over Aby river when it is in service, after replacement this bridge will be moved and tested under static loads to assess boundary conditions and state of stress, then parts of this bridge will be disassembled and these parts will be tested in laboratory environment for fatigue life assessment, all of these results will then be controlled by monitoring of the bridge over Rautasjokk in service limit state.

The outline of this project will give input for the fatigue life models that are used today and probably upgrade the fatigue life of the bridge over Rautasjokk.

Keywords: structural health monitoring; steel truss bridge; fatigue; model updating; Assessment

1. Introduction

Bridges have often been replaced on theoretical assumptions that they have reached the end of their lifespan. Except for the safety aspects, the economy is the single most important factor when it comes to exchanging bridges. In later years the environmental burden has also gained influence in becoming a main concern in decision-making. The Swedish Traffic Administration has declared that they intend to increase their work with Life Cycle Analysis (LCA) [1]. For bridges, this will lead to that a greater amount will be assessed for their actual capacity and thereafter necessary actions can be taken, whether it is repairs, upgrading or replacing the entire structure.

The assessment of an existing bridge can be performed with different levels of accuracy and effort. Generalized load-models might often be sufficient in order to verify if the load capacity is good enough or at least serve as an initial estimation. Conservative assumptions may, however, lead to an exaggerated safety level. Together with high safety factors regarding materials it is easy to conclude that the bridge needs to be replaced. The opposite, overestimating the capacity can however be catastrophic. Failure of a bridge results in major delays and possible human casualties.

Up to 2012, the Swedish authorities owns 3842 railway bridges and 145 tunnels and over 13,642

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