Designing Bridges for a Long Service Life

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Abstract

Major bridges are lifelines of our modern economies. As engineers, we are obliged to design robust and long-lasting structures, which are prepared for future developments. This contribution summarizes the state of the art of sustainable bridge design, with a focus on major cable-stayed bridges. Sustainable bridge design can be broken down into three principles:

- Use of durable materials,
- Design with replaceable components, and
- Planning for inspection and monitoring.

Besides giving a critically review of existing solutions, a list of innovative developments will be highlighted and their future implementation discussed.

Keywords: service life, new materials, bridge access, monitoring, replaceable components, sustainable design, FRP, composites, smart structures

1 Introduction

Major bridges are typically designed for a service life of 100 years – in certain cases even up to 125 years or more. The public authority typically requires the planner to design the bridge for an increased live load to cover future traffic grow. The engineer must also ensure that the used materials and components achieve the desired design life and that all components can be monitored, in order to timely recognize potential defects. Scheduled maintenance and replacement works should typically have an impact on the serviceability of the bridge, e.g. through lengthy lane closures.

During past years, the majority of major projects were part of a Public Private Partnership (PPP) where the contractor does not only construct, but also service and maintain the bridge for a certain amount of years. For example, the 'New Bridge over the St. Lawrence (NBSL)' in Montreal, Canada will be run by the private partner for 30 years. In addition, the minimum acceptable condition of the bridge at handback is precisely defined in the contract documents. If deficiencies are found, the contractor will be required for mitigation before fulfilling his contract obligations. This procedure makes it more attractive for the contractor to invest in a sustainable design, since he is – at least partially - liable for the risk. The procedures developed for the NBSL can be seen as template for future projects where sustainability is a paramount goal.

2 Use of Durable Materials

In this section, the sustainability and service life of reinforced concrete, structural steel and fiber-reinforced polymers (FRP) are discussed. While other materials such as timber, stainless steel or aluminium are also common to bridge design, they don't play a significant role for major bridges, as focussed on within this contribution.

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