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Assessment of Railway Steel Bridge Structures

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Abstract

The assessment of an existing structure producing the evidence that it will function safely over a specified residual service life should be also a continuous activity to ensure the security of the public. Usually bridges were designed by safe life method and a limited serviceability was considered. Such structure requires to be replaced once this designed durability would be achieved. This is however often not possible since most of the infrastructure cannot be economically taken out of service. Alternatively, the damage tolerant method should provide an acceptable reliability that a structure will perform reasonably for its service. But a prescribed inspection and maintenance regime for detecting and correcting fatigue damage should be identified. The present practice is illustrated in the paper by case studies on existing railway bridges under exploitation. Procedures for service-load-level analyses are given to estimate the residual service life.

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Keywords: Steel bridge ; inspections ; structural imperfection ; load carrying capacity ; fatigue

1. Introduction

With respect to construction industry, four principal activities can be distinguished, as research and development, designing, construction and management, but also maintenance and eventual retrofitting. Science and structural theory development is being executed simply by appropriately skilled research workers in the relevant subject. Design engineering is a process, which involves preparing a set of plans and specifications that defines the structure in its completed configuration. Only experienced publicly chartered engineers may be authorised to design specified types of buildings. Construction engineering involves governing and guiding the fabrication and erection operations needed to produce the structural members to the proper shape, and get them safely and efficiently in place in the

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structure. The building processes can be realised only by approved company, adequately staffed, engaging experienced and trained key employees.

During execution stage, a bridge building is obviously properly supervised. But, inspections, maintenance and structural management provide quality assurance for constructions and play either a very important role during entire and long-time exploitation. Regular maintenance is important factor influencing durability of structure. Over the past decades, the construction inspection program evolved into the sophisticated management systems. The existing infrastructure has been generally designed in accordance to safe life criteria. This attitude means that bridge structures have to be replaced after a defined operational life. Even without a critical damage to be evidently discovered or the true loading conditions well monitored and the possible deficiencies occurred.

However, if the criticality of damages could be assessed and the respective damage could be monitored reliably through an inspection process well defined, then the operational usage of such a structure could be extended for a significant additional portion of its life. Generating such procedures has become possible today due to an enhanced understanding of materials' deterioration processes as well as their physical parameters characterising those. It has been further made possible through the fact that detecting procedures including the devices for data acquisition and processing have become increasingly accessible from a logistic as well as a cost point of view.

2. Bridge management system

2.1. Maintenance Inspection

Each bridge document needs to have items such as structure information, structural data and history, description on and below the structure, traffic information and load rating. Regulations require that each bridge that is opened to public should be in practice inspected at regular intervals not exceeding specified period. Inspection findings should be recorded in bridge document. The purpose of bridge inspection is to maintain the public safety, confidence, and investment in bridges. To this end, inspection staff should be knowledgeable in material and structural behaviour, bridge design, and typical construction practices. The frequency, scope, and depth of the inspection generally depend on several parameters such as age, traffic characteristics, and state of maintenance, fatigue-prone details, load limit situation level and known deficiencies. The specific frequency of inspections may be finally established based on the above factors. In the case of traffic accident, the extra-special bridge check must be executed. Some of the main responsibilities of a bridge inspection are especially identification of even minor problems that can be corrected before they develop into major repair, recognizing bridge components that require repairs in order to avoid total replacement, finding unsafe conditions, preparing accurate inspection records, documents, recommendation of corrective actions and providing bridge inspection program support. The findings and results of a bridge inspection are to be recorded on standard inspection forms. After inspecting a bridge, reasonable conclusions should be communicated and practical recommendations to correct or preclude bridge defects or deficiencies advised [1].

When recommendations call for bridge repairs, the type of retrofitting, the scope of the work, and an estimate of the quantity of materials must be carefully described. The assistance of experienced personnel should be sought, when the inspection findings cannot be interpreted or the cause of a specific defect determined. All instructions for maintenance work, stress analysis, posting, further inspection, and repairs should be included in the recommendation. It is also important to recognize that these inspection reports are legal documents and could be used in future litigation.

2.2. Bridge superstructure rating

The evaluation of existing bridges under operation is a continuous activity to ensure the safety of the public. First of all, as bridges were built gradually in different time periods. Thus they were designed according to time-knowledge and live-load, which reflected the level of transport technique. Even if bridges are designed for the standard load model specified in codes, actually EC1 [2], they might not have adequate capacity to handle the actual traffic. Some changes in a few details during the construction phase, failure to attain the recommended strength or properties and unforeseen damage to a member could influence the capacity of the bridge. Also, the live load