Kuala Lumpur Monorail Line Fleet Extension

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Summary

The monorail system in Kuala Lumpur, Malaysia, is a very effective and highly efficient public transportation system. Especially in densely populated areas such transportation systems are a cost-effective mass transport medium possibility to relieve congested inner-city traffic.

The guideway for a monorail system generally is composed of prestressed concrete girders with spans of up to 50.0 meters which are monolithically connected to form frames of several continuous spans. Due to the given train weight and the structural requirements on the “track”, 50 meter spans are actually quite large spans and the possibilities to go beyond are limited. Greater span lengths can only be achieved by supporting the guideway with other types of bridge structures. The guideway structures themselves must be inspected and maintained just like any other bridge and strengthened if traffic increases require it.

This paper is based on the final report for this project. It sums up inspection and design verification results and points out special details which should be taken into account in the design of such structures especially with regard to maintenance and durability throughout the service life.

Keywords: Inspection, maintenance, load increase, design, serviceability, durability

1. Introduction

The expansion of infrastructures is becoming increasingly important particularly in densely populated areas. The job of environmentally harmlessly connecting long distances with one another as directly as possible requires bridge structures with increasingly longer spans. Suspension or cable-stayed bridges are virtually predestined to bridge these long spans, whereby the term is not precisely defined in more detail. The possible span of a bridge structure is dependent on the own weight of the structure, the support and the traffic load that this structure is to carry

After the owner of the Monorail, Syarikat Prasarana Negara Berhad, Malaysia, decided in 2010 to increase the transportation capacity of the KL Monorail by providing larger vehicles, evaluation of the bearing structure for the increased loads became necessary. This examination included an examination of structures in accordance with DIN 1076 (Engineering structures in connection with roads; inspection and test), as well as the recalculation of the structure with the new vehicle loads.

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2. The Guideway

The guideway consists of two parallel longitudinal girders. Especially in curved sections, these girders are connected to each other by cross beams. The monorail guideway can be considered as a very long bridge structure which can have difference radiuses. The spans are limited due to the structural requirements of inner city traffic. Although long spans could be achieved by using higher girders, the guideway would appear too massive and observers would be more inclined to consider this an objectionable structure. This meant that a relatively low construction height had to be found which would make it possible to allow regular heavy traffic to pass under the guideway (see Fig. 1) and, at the same time, the individual stations would not have to be located too high up.

Fig.1: KL Monorail Car on Guideway Beam

The new 4-car-train that will be used is approximately 46 m long and weighs almost 61 tons. For example, an average girder with a length of 27 m and a height of 1.60 m weighs approximately 86 tons. The own weight of a girder is thus relatively low while the traffic to be carried is very high. This means that a guideway girder with a length of 50 m must carry a much higher traffic load than an 800-m long suspension or cable-stayed bridge. Thus the potential performance of the Monorail guideway can certainly compete with long bridge structures.

3. Inspection of Structure

The structural inspection was performed during running operation. Inspection of the girders could only be performed during the breaks in operation at night. Since the increase in train loads will affect mainly the guideway beams and bearings, the focus of this inspection was therefore mainly on these two components. The piers with crossheads and portals were of course also included in this inspection. The details on the inspection are described in the full paper.

4. Design Verification of Existing Structure

The overall structure was investigated for the new train loads. The verification included all previously mentioned individual structural members of the sub- and superstructures down to pile cap upper level. All bearings were also verified for the new train loads. The design verification included both the SLS and the ULS. As in a chain, the structural stability of the overall structure depends on its weakest element. Thus, during this investigation every individual member received appropriate scrutiny as well. More details are described in the full paper.

5. Outlook

The building inspection showed that although the structure suffered smaller damages after being in operation for 8 years, operation of the Monorail was in no way effected. The operator has thus taken all important steps to maintain the guideway correctly and ensure smooth operation.

The design verification showed that the structure has enough reserves to allow a line fleet extension without any restrictions.

Since the structure is visible to all users, the aesthetic demands on the components are greater than for conventional traffic structures. This means that purely cosmetic corrective work is necessary to increase the user's trust in the transportation system. This means that greater demands are placed on the quality of the concrete and post-treatment while the structure is being built.