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RESEARCH ARTICLE

Experimental monitoring of the strengthening construction of a segmental box girder bridge and field testing of external prestressing tendons anchorage

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ABSTRACT Prestressed concrete segmental box girder bridges are composed of short concrete segments that are either precast or cast in situ and then joined together by longitudinally post-tensioning internal, external, or mixed tendons. The objectives of this study are to monitor the construction process of the external prestressing tendons to strengthen the bridge structure and perform a field load test to measure the strain and the deflection of the anchorage devices of the external prestressing tendons to determine the state of these devices after tension forces are applied. The monitoring process of the external prestressing tendons construction includes inspecting the cracks in the diaphragm anchorage and the deviation block devices before the tension forces are applied to the external tendons; measuring the deformation of the steel deviation cross beam during the tension process; measuring the deformation of the box girder after different levels of tension forces are applied; measuring the elongation of the external tendons in each level of the tension; and measuring the natural frequency of the external tendons after the tension process is complete. The results of the monitoring process show that the measured values of the deformation, the elongation, and the natural frequency meet the requirements. Therefore, there is no damage during the construction and the tensioning of the external prestressing tendons. A field load test is performed to the anchorage beam, the steel deviation block devices, and the steel deviation cross beam. The field load test results of the anchorage devices show that the values of the strains, the stresses, and the deflection are less than the respective allowable limit values in the requirements. Therefore, the anchorage devices have sufficient strength, and the working state is good after the tension forces are applied to the external prestressing tendons.

KEYWORDS prestressed concrete, box girder, monitoring, external tendons, strain, deflection

1 Introduction

Prestressed concrete segmental box girder bridges with externally post-tensioned tendons are one of the main new developments in bridge engineering construction in recent years. The many advantages of this type of structure include its fast and versatile construction, no disruption at the ground level, a highly controlled quality and its associated cost savings. Therefore, this type of structure is the preferred solution for many long, elevated highway bridges [1].

Prestressed concrete segmental box girder bridges are composed of short concrete segments that are either precast or cast in situ and then joined together by longitudinally post-tensioning internal, external, or mixed tendons. The cross-sectional geometry of the concrete segments has varied widely, ranging from single to multiple cells with straight or sloping webs. Prestressed box girder bridges typically exhibit small deflections during the first years of service and then continue to deflect excessively [2–4].

The concrete structure strengthening involves upgrading the strength and the stiffness of the structural members, and

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