

Evaluation of the static and dynamic structural performance of segmental pre-stressed concrete box girder bridge after repairing and strengthening

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ABSTRACT The objectives of this study are to explain the repairing and strengthening methods which are used to improve the structural performance of the bridge structure, to analyze the static and dynamic responses after strengthening, and to evaluate the performance of the bridge structure after repairing and strengthening. The methods of repairing and strengthening include reconstruction the deck of the bridge by casting 10 cm layer of concrete, strengthening the web and bottom floor of box girders of middle spans and side spans by sticking the steel plates, strengthening the whole bridge structure by using external pre-stressing tendons, and treatment the cracks. The results of theoretical analysis show that the values of tensile stress and vertical deflection are decreased and the compressive stress is increased after strengthening. There are not tensile stresses are appeared in the sections of the bridge structure. The modal analysis results show that the value of natural frequency is equal to 2.09 Hz which is more than the values before strengthening which is equal to 1.64 Hz, indicating that the stiffness of the bridge structure is improved and the strengthening process is effective to improve the cracks resistance and bearing capacity of the bridge structure.

KEYWORDS structural performance, steel plates, external pre-stressing, cracks, grouting method, static

1 Introduction

The strengthening of concrete structure includes improvement of the strength and stiffness of structural members, and the repairing process involves re-establishing the strength and function of the damaged members. The strengthening of the bridge structural members can be carried out by replacing poor quality or defective materials by using better quality materials, attaching additional load-bearing materials, and re-distribution of the loading actions through imposed deformation on the structure system [1–3].

The repairing process includes materials selection, method selection, support design, safety precaution, costs, and logistics. The performance requirements of concrete repair involve protection of re-bars, aesthetics,

integrity and computability, carry loads, and waterproofing. Concrete structure repair can be classified either as cosmetic-repairs or rehabilitation-repair [4–6].

The selection of the suitable method for the repairing and strengthening of the bridge structural members depends on many factors. These factors include the type and age of structure, the importance of structure, the magnitude of the strength required which is need to increase, the type and degree of damage, available materials, cost and feasibility, and aesthetics [3,7].

External post-tensioning is defined as a system in which the pre-stressing tendons or bars are located outside the concrete section. The pre-stressing force is transferred to the member section through end anchorages, deviators or saddles. The main aim of the bridge structure strengthening by using additional external pre-stressing tendons is to fulfill all necessary serviceability criteria and not to extend its ultimate limit state. Strengthening by using external post-tensioning is simply to apply axial load combined