New Technique to Temporarily Support Existing Bridges Crossing Water Ways

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Summary

A new technique to temporarily support existing bridges to transport abnormal heavy loads using water-structure interaction is presented. The concept, details and applications of this technique are presented. The method was verified experimentally by a real loading test on an existing bridge. The deflections and strains at different control point are negligible. As a result, and after being approved by the Egyptian general authority of roads, bridges and land transportation (GARBLT), this technique was applied to temporarily support many old bridges crossing waterways during the transport of abnormal loads.

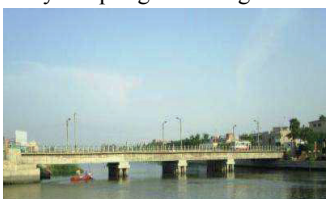
Keywords: Temporary support for bridges, Water-Structure interaction, abnormal loads on bridges.

1. Introduction

A new method to temporarily support existing bridges to transport abnormal heavy loads using water-structure interaction is introduced. In this method, the uplift force of the water is utilized to impose reversal forces on the bridge to decrease or eliminate the effect of the expected heavy packages. In addition, the process of temporarily coupling the bridge deck with barges supported by the water uplift, results in a combined rigid structure that has an effective combined rigidity much higher than the original bridge rigidity.

2. Experimental verification of this method

The above mentioned concept was investigated and verified both experimentally and analytically using an existing bridge, shown in picture 1, as described in the following parts



Picture 1: General View

3. Analytical study

The bridge deck was analyzed under the effect of 170 ton total test load on a special trailer as shown in picture 2. The bridge deck was modeled using the grillage method. The water uplift was modeled as spring forces distributed all over the area of the barge. The distributer beams were modeled as regular beams with their actual stiffness.

Picture 2: Test Load

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4. Description of the temporary water supporting system

The main components of this water-structure system, based on the analytical model mentioned above, are:

One 8m wide x 27m long x 2.2m deep barge was used, Steel props distributed under the main girders and the deck slab, Steel beams to carry these steel props, Hydraulic jacks distributed at specific points between the barge and the bridge deck. Pictures 3 and 4 show general views for the preparations of this test.

Picture 3: General view of the barge

5. Summary of the test results

Both the deflection, the strains of the deck and the deflection of the barge were observed during the different stages of loading and unloading of the bridge deck. The deflection of the combined structure, Bridge deck and barrage, is 3mm with complete recovery after unloading. This deflection may be attributed to the deformation of the steel elements used in the system. The maximum stress in both the slab and beam was calculated from the measured strains and it is 20 and 80 N/mm^2 for the slab and beam respectively with complete recovery after unloading.

Picture 4: Monitoring the tests

As a result, this technique was approved by the Egyptian general authority of roads, bridges and land transportation (GARBLT), and it has been successfully applied to temporarily support many old bridges crossing waterways during the transport of abnormal loads as shown in picture 5.

Picture 5 Moving Cargo on Saafan Bridge

6. Conclusions

A new system using water-structure interaction to temporarily support existing bridges to resist the additional loads of abnormal packages was introduced. This system has been developed and proven experimentally using a real load test. The effect of the abnormal loads on the straining actions and the deformation of the bridge deck supported by this technique were measured and found negligible. This new method, after being approved by the Egyptian general authority for roads and bridges, GARBLT, has been applied to support many existing bridge over waterways for the transport of the abnormal heavy packages. At each time this method is applied, a team from different authorities reviews the designs and supervises the construction of the system at the different locations. Moreover, health monitoring of the bridge deck is conducted using; deflection, visual inspection and dynamic test to determine any damage that may happen during the transport