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BARGE IMPACT TESTING OF THE ST. GEORGE ISLAND CAUSEWAY BRIDGE, PHASE II : DESIGN OF INSTRUMENTATION SYSTEMS

PROBLEM STATEMENT

The opportunity to conduct full-scale barge impact tests on an existing structure has arisen with the replacement of the existing St. George Island Causeway Bridge with a new structure. Once the new structure has been opened to traffic in the fall of 2003, impact testing will commence on the old bridge structure. Inherent in preparing for experimental testing of this sort is the need to develop an instrumentation network that can accurately (i.e. within an acceptable margin of error) measure data of interest. Prior to designing an instrumentation network, the types of measurements desired and their anticipated magnitudes needed to be identified. Types of desired measurement include—but are not limited to—barge-to-pier impact force, barge crush depth, pier displacement, and load redistribution to the foundation and adjacent piers. To determine the anticipated magnitudes of these measurements, finite element simulations were conducted using models developed during the previous phase of this project. Throughout the course of Phase II, the finite element models have been refined. Furthermore, logistical concerns—such as scheduling, coordination with the construction contractor, permitting, and barge acquisition—have also been addressed.

OBJECTIVES

To achieve the objectives listed above, the following tasks were included in this phase of the project:

- Determine the quantity and type of sensors needed to obtain the desired measurements based upon results obtained from finite element simulations.
- Design an apparatus to transfer the impact load through the load cells and into the pier.
- Design an overall instrumentation network capable of collecting, processing, and storing the measured data.
- Develop procedures for reducing the data that will be collected during the actual impact tests.
- Determine sensor positions on the barge, piers, and superstructure.
- Provide a detailed schedule of events for the impact testing.
- Conduct site inspections on the existing bridge.
- Refine the current finite element models.
- Develop improved models for representing soil behavior.
- Conduct static barge crush simulations to evaluate the influence of pier geometry.

FINDINGS AND CONCLUSIONS

Using the results obtained from impact simulations, an instrumentation network has been designed for the experimental tests. The models have been used to determine the type of sensors needed and their locations on the piers and barge. In addition, they have been used to determine the optimal impact conditions to be used for testing (barge impact speed and payload). Results from static pushover analyses have been validated against the FB-Pier bridge substructure analysis program, thereby improving confidence in the soil models used in the barge impact simulations.

With a major portion of the instrumentation system designed, considerable progress has been made towards the completion of the physical impact testing. During Phase III, the instrumentation network will be constructed and tested extensively prior to installation at the site. Furthermore, logistical planning and scheduling efforts will continue into the next phase of the project.

BENEFITS

Results from this phase of the project will allow the research team to proceed with the physical testing phase. The current phase has resulted in both the development of an instrumentation network for the full-scale impact tests and the refinement of existing finite element models. The full-scale tests and the finite element simulations will be jointly used to expand the current body of knowledge base regarding barge impact loading conditions.

The results of this research program will likely yield information that will influence bridge design codes throughout the world. The current codes may be modified to produce vessel collision force results that better predict actual impact forces. Moreover, the research results will assist engineers of many disciplines. For example, the geotechnical engineer will better understand the stiffening effect pore water provides when soil is rapidly loaded, and the bridge designer will better understand how to model a bridge to achieve the correct distribution of load to an impacted pier and to predict the loads shed to the adjacent piers. The bottom line, however, is that the knowledge gained through this research may save lives by resulting in a better understanding of the vessel impact event.

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