



TECHNICAL SUMMARY

Load Testing for Assessment and Rating of Highway Bridges

Phase II: Development of a Highway Bridge Load Rating and Assessment Program

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Phase I of this study reviewed some of the current and experimental technologies and practices used in the instrumentation (field testing) of highway bridges. The potential benefit that the South Carolina Department of Transportation could derive from the development of a bridge testing program to assess and rate highway bridges in their existing inventory was investigated. The conclusions of Phase I indicated the SCDOT would benefit from having the capability to field test bridges and use the data to assess and rate bridge structures in their inventory. It was recommended and funding subsequently approved for this project to move into Phase II activity.

One of the major objectives of Phase II was to select and purchase needed to instrument and collect data from a field test and to set-up a mobile field office to facilitate the activity related to the instrumentation of bridges and the collection of field data. Another major objective focused on the analysis of the field data and augmentation of this data with additional data from the structural analysis of appropriate computer models of bridges. The final objective was to develop a data-driven procedure for the assessment and rating of bridge structures. Several bridges were identified and field tested and modeled to determine theoretical and measured response characteristics for the purpose of developing load rating procedures. Structural assessment procedures, dependent upon data collected from the field testing and computer modeling, were developed and incorporated into the load rating of a bridge structure.

The experiences gained from field testing, computer modeling and load rating will be used as the basis to develop user manuals for bridge instrumentation, data analysis and computer modeling, and bridge assessment and load rating. The development and refinement of these manuals as well as training of SCDOT personnel to carry-out the various activities of this bridge assessment and rating program to rate other highway bridges in their inventory will be the scope of work related to the planned Phase III activity. Phase III will be initiated after the completion of Phase II and dependent upon approval of funding from the SCDOT.

Results

A 24-foot long trailer was purchased to be used as a mobile field office and to store all equipment needed to conduct a field test. In addition, an extended cab pick-up truck was purchased to pull the trailer to bridge test sites. The trailer was equipped with an electric generator to power the equipment, lightening and air-conditioning to provide a suitable work environment, work benches for the set-up or repair of sensors and cables, and data acquisition hardware (signal conditioner and computer) for the collection of field data.

Several computer modeling techniques were developed to predict bridge performance under known loads. These models were calibrated using measured field data from a series of bridges tested during this project. The models developed in SAP2000 were found to be very effective in predicting bridge performance based on measured field data. The various input parameters in the models, including rotational stiffness at connections, longitudinal and lateral load distributions, and material properties were all manipulated to determine their effect on bridge performance. Suggestions for parameters are provided to assist in the development of pre-test models. These models are then adjusted based on data collected from the field testing.

From the measured field data and prescriptive analysis documents, two subject bridges (SC-413 and Fant's Grove) were selected as test candidates for the development of rating procedures. These ratings included analyses utilizing strict AASHTO requirements, the inclusion of composite behavior as a known behavioral benefit, and the exclusion of composite behavior as a known behavioral benefit. The inclusion of composite behavior was considered a non-test benefit. The load ratings were developed based on the AASHTO HS-20 design truck to obtain a total load, in tons, for the rating of each bridge. The performance of the SC-413 and Fant's Grove bridges each indicated possible load rating capacities higher than catalogued by the SCDOT. The Fant's Grove bridge displayed significant evidence of composite action. Both bridges exhibited during the testing lower than code prescribed impact load responses. The combination of test benefits and the presence of composite action elevated the calculated load ratings of the two bridges significantly.

The SCDOT is faced with a decision on how to proceed with field testing bridges. There are many bridges in the State inventory that are listed as deficient, many of these affecting some major highways. Better understanding the behavior of these bridges could lead to changes in the anticipated load capacity of many bridges. This may in turn prevent unnecessary bridge replacement or repairs. The possible savings to the SCDOT in the short term are significant. The cost of a single bridge repair could and likely would exceed the cost of all phases of this investigation. The conclusions of this investigation clearly indicate that the SCDOT should move forward and implement a bridge testing program.

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