FIELD TESTING OF CONCRETE SLAB AND GIRDER BRIDGES

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SUMMARY REPORT 94-2 (S)

SUMMARY OF
RESEARCH REPORT 94-2

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SUMMARY REPORT 94-2 (S)

Introduction

Report 94-2 is the second in a series which summarizes a detailed investigation of the behavior of pan-formed concrete slab and girder bridge systems, which are widely used by the Texas Highway Department. The initial report treated the detailed techniques developed for the utilization of reduced scale models and also reported on the degree of correlation between the model tests and the full scale prototype testing. The subsequent final report will treat the general behavior and recommendations based thereon from the main model test series.

Report 94-2 presents detailed results of a research program to investigate the feasibility of load distribution testing of a full scale reinforced concrete bridge structure in the field and to correlate that data with the data obtained from testing of an accurate scale model. The investigation tested the feasibility and durability of a new type of field strain gage application, tried a new method for field deflection measurement, and evaluated general operations in a remote location. The results obtained from multiple loadings of the full scale structure were compared with results from a 5.5-scale microconcrete model tested in a laboratory. The results were also compared with similar laboratory-tested models differing only in skew angle and design loading.

Because of expenses of both field testing and comparison model testing, only one full scale structure was tested. To ensure accurate results, extensive pretesting was done to eliminate faulty materials or methods. This was especially true in the area of strain gage application and testing. Test beams were designed, cast, and tested to destruction to determine the accuracy and durability of the strain gages. As much equipment as possible was shop fabricated for easy field assembly to minimize wastage of time and money at the remote site.

The results of the tests were also compared with existing AASHO design specifications. Recommendations are made for revisions in design criteria and improvements in both model and full scale field testing.

Field Test Instrumentation

The primary objective of this program was the comparison of behavior under service live loads of a prototype and a reduced scale model pan-formed concrete girder and slab bridge. In order to determine relative load distribution factors for the various girders, the primary instrumentation devices were strain gages mounted on the main longitudinal and transverse reinforcement. Since the study was to be carried out in a remote field location and the bridge was being erected by a contractor who had no obligation to allow interruptions by research personnel, strain gage techniques became extremely important.

The report outlines in considerable detail pilot studies and field experience with a method for mounting and waterproofing strain gages, as shown in Fig. 1. In actual usage this technique was highly successful, as over 95 percent of the gages worked satisfactorily, even though all reinforcement was fabricated and concrete placed by the contractor with relatively little change from ordinary procedures. Much of the success of the system was due to the development of a system of remote connections

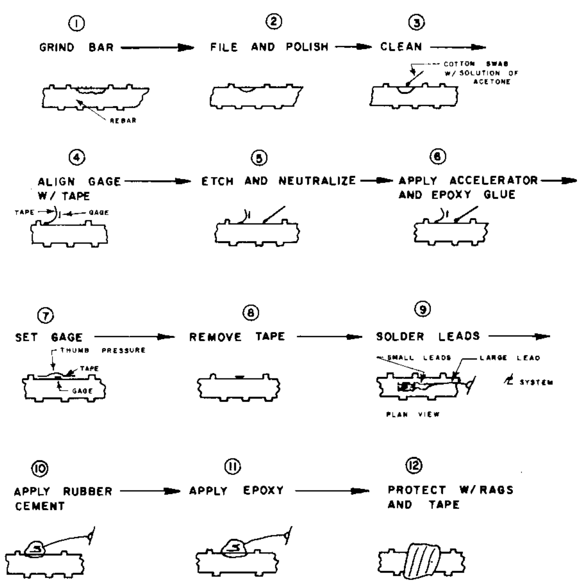

Fig. 1. Strain Gage Application Schematic.

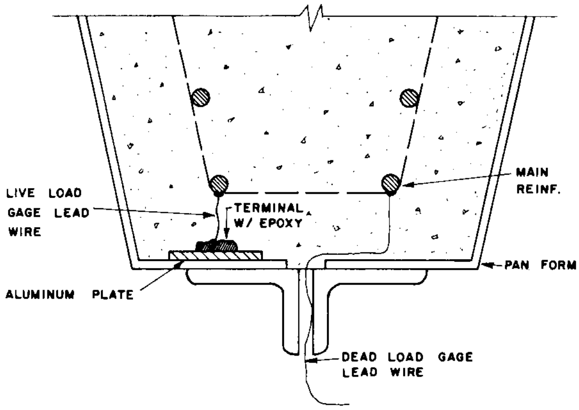

Fig. 2. Plate System and Dead Load Wire.

(shown in Fig. 2), which allowed connection of lead wires to live load gages subsequent to removal of forms.

Test Results

The main purpose of the full scale test program was to investigate the reliability of the laboratory-tested models. The secondary purpose was to investigate the feasibility of field-testing a structure of this size using improved techniques for mounting a

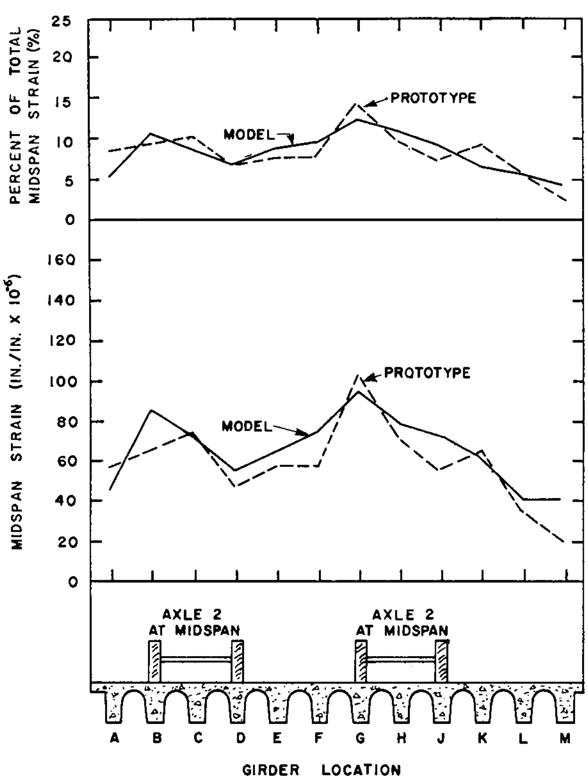

Fig. 3. Strain Data for Double Trucks, B4-D4 and G4-J4.

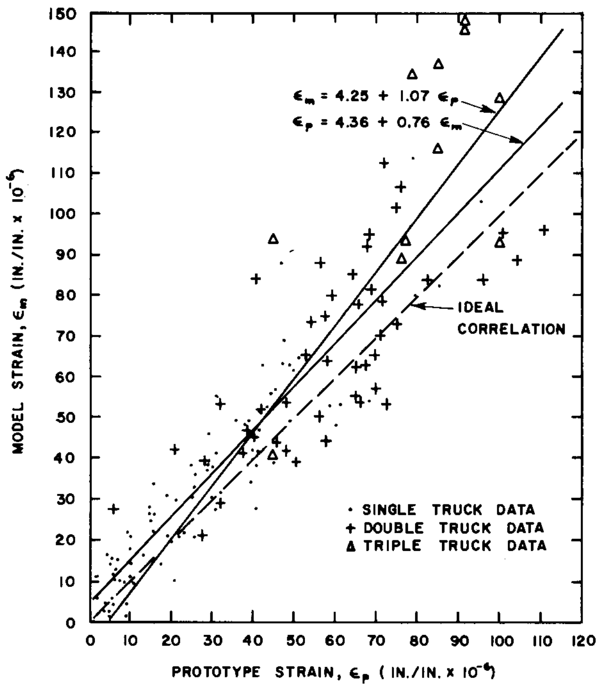

Fig. 4. Summary of Model and Prototype Data with Regression Analysis.

large number of strain gages on the reinforcement. The report presents detailed comparisons of data obtained in the field with that from the laboratory-tested models.

Enough field data were taken to obtain fairly complete and conclusive information for one, two, and three truck combinations with the rear axles located over the midpoints of girders. Data were obtained for trucks at locations other than midspan, but the non-midpoint loadings resulted in generally low and thus less sensitive strain readings.

Figure 3 shows a typical comparison of the measured prototype strains for axle 2, placed at midspan, with the corresponding measured model strains found by Leyendecker. These comparisons are presented in two forms. The lower portion of the figure compares absolute strains measured at the midpoint of each girder, while the upper portion compares the percentages of the total measured midspan strain. These comparisons indicate very similar patterns of strain distribution in both model and prototype. The qualitative agreement seems well within the accuracy expected.

Definite conclusions cannot be drawn from the data as presented in Fig. 3. An expression of correlation of data is available by plotting measured absolute midspan strain of prototype model for each load location. The plot is shown in Fig. 4. A perfect fit would be represented by the 45° straight line labeled "ideal correlation." A less-than-perfect fit is shown for the model as the dependent variable and again with the prototype as the dependent variable. The equations for the lines were found by using a least squares fit of the data. Using either of the equations, a coefficient of correlation is found as +0.90. The range of the coefficient of correlation is from —1.0 for negative correlation to 0.0 for no correlation to +1.0 for perfect correlation. A coefficient of +0.90 indicates very good correlation.

Conclusions

(1) Reliable methods were developed to determine relative girder live load strain distributions in field tests at service live loads for standard Texas Highway Department pan-formed concrete slab and girder bridges.

(2) Direct reinforced microconcrete modeling techniques are valid procedures for measuring relative girder load distribution. This conclusion is based on the close comparison of model and prototype data, as shown in Figs. 3 and 4.

(3) The AASHO service load distribution factors for moments in longitudinal girders are overconservative when compared to factors developed from field test data. Data for a single truck load and double truck loads indicate increased AASHO factors are possible.

Recommendations

(1) Carefully constructed direct microconcrete scale models can be used with confidence to accumulate data beyond the scope of field testing. For instance, a field test to destruction to determine the ultimate strength and ultimate safety factor of this type of bridge was economically unfeasible. Testing of a number of ultimate strength models can be accomplished for the same dollar amount. However, important information concerning service live load behavior can be determined economically in field testing.

(2) The methods developed for strain gage application, load application, and strain data in this field test are adequate for the purpose. Further improvements in equipment and test procedure can be made:

   (a) Strain gages should be applied to positive moment steel in all girders, thus eliminating the need for mirror image truck loadings.

   (b) Where possible, the reinforcing steel should be shipped from the fabrication shop to the testing base for gage application instead of the bridge site. The cost incurred in transporting the steel to and from the laboratory could be more than made up for in labor saved and improved quality control.

   (c) The deflection bridge designed was inadequate for the field test.

   (d) Improved techniques for accurate appraisal of dead load strain need to be developed. Special interest should be given to the time effects which complicate measurement of dead load strains.

(3) Although each individual span was designed as a simple beam, strains changed as trucks moved on adjacent spans. This indicates continuity of spans. Further tests are indicated for assessment of conditions at the supports.

The full text of Research Report 94-2 can be obtained from R. L. Lewis, Chairman, Research and Development Committee, Texas Highway Department, File D-8 Research, 11th and Brazos Streets, Austin, Texas 78701 (512/475-2971).