RESEARCH
PROJECT CAPSULE [10-5ST]
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TECHNOLOGY TRANSFER PROGRAM

Development of Guidelines for Transportation of Prestressed Concrete Girders

JUST THE FACTS:

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POINTS OF INTEREST:

Problem Addressed / Objective of Research / Mehodology Used Implementation Potential

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PROBLEM

Prestressed concrete girders are an economical superstructure system for bridges. With the advent of higher strength concretes and more efficient cross sections, the use of long span (>100 ft.) prestressed girders are now specified. Such long span girders require special consideration during manufacturing, transporting, handling, and erecting. Many forces associated with construction of a precast concrete girder are well understood – less, however, is known about the forces a girder is subjected to during transport. While girders are designed for strong axis loadings and can readily accommodate such loading during transport, they are typically braced in service and may have inadequate resistance to lateral or lateral-torsional load effects. As a result, girders have arrived on job sites exhibiting cracks indicative of weak axis bending or torsion. In other instances, trucks transporting girders have rolled as the girders laterally buckled. These transportation problems can delay construction while the girders are repaired or replaced and lead to a reduced service life as moisture and chlorides infiltrate unrepaired cracked girders.

The Louisiana Department of Transportation and Development (LADOTD) has observed these transportation problems with prestressed concrete girders. Building on research into girder stability design by Laszlo and Imper and estimations of transportation stresses by Mast, LADOTD recently instrumented two 150-ft. long prestressed bulb-tees during transport in an effort to assess the forces on the girders. Transportation of these instrumented girders resulted in some weak axis cracking.

OBJECTIVE

The objective of this research is to develop guidelines that LADOTD can apply to the future design and transport of prestressed concrete bridge girders to avoid cracking and stability issues. The guidelines are anticipated to define acceptable methods of girder support and tie down during transport, recommend safe girder response limits during transportation, suggest road conditions/geometries to be avoided on transportation routes, provide a checklist for accepting precast concrete girders at the job site, and suggest design changes to improve girder shipping performance.

METHODOLOGY

The research objective is expected to be met through the execution of the following tasks:

Task 1 - Literature Search
A review of previous research, industry publications, and known girder performance problems will be conducted.

Task 2 - Parametric Study
Previous research has identified parameters affecting girder stability during handling and transportation. These parameters can be grouped into several broad categories, including girder geometry, girder properties, casting information, trailer characteristics, service loads, and environmental conditions. From this earlier research, researchers will assess the significance of each parameter as it pertains to this study and identify how each parameter can be quantified or established.

Task 3 - Girder Buckling and Cracking Analysis
Predictive cracking and buckling equations will be employed to assess the design behaviors of the test girders.

A finite element model of a trailer supported girder will be developed to estimate stresses under different load conditions. The finite element model will also be used to evaluate the sensitivity of various parameters. Areas of high tensile stresses, which could lead to potential cracking under various load conditions, will be located using the model. This information will be used to position the instrumentation on the test girders and to assist inspectors as to where to look for cracks on arrival of the girder at the job site.

Task 4 - Instrumentation Plan
The intent of the instrumentation is to assess the following:

1. Roll of the girder relative to the supports
2. Accelerations of the girder at midspan and the supports
3. Stresses in the girder at maximum location for vertical stresses (midspan), torsional stresses (supports), and lateral stresses (midspan).

Task 5 - Instrumentation Installation
The instrumentation will be installed in three phases. The first phase will occur prior to casting of the girder and involve the installation of strain gages with the lead wires routed out of the girder to enable casting of the girders. The second phase will consist of installing the remaining gages with supporting hardware accessories. Measurements of initial sweep will be made. The time between the first and second phases is anticipated to be about a day and will require only one mobilization. The third phase will occur prior to shipping the girder.

Task 6 - Transportation Monitoring
Transportation routes that offer the desired road conditions required to generate the various girder responses typically encountered during shipping will be proposed. Anticipated road conditions include travel at various speeds, turns with and without super elevation, vertical sag and crest curves, railroad crossings, and rough ride quality roads.

Task 7 - Data Analysis
The digital data collected from the field testing will be post-processed to develop time histories of each data channel. Reinforcing steel and concrete stresses will be calculated from the strain data. The acceleration data will be examined to determine and analyze the response to transient as well as the steady state response. The spectral response from fast Fourier transform (FFT) analysis will be compared with the calculated girder stresses based on the known properties and support configuration.

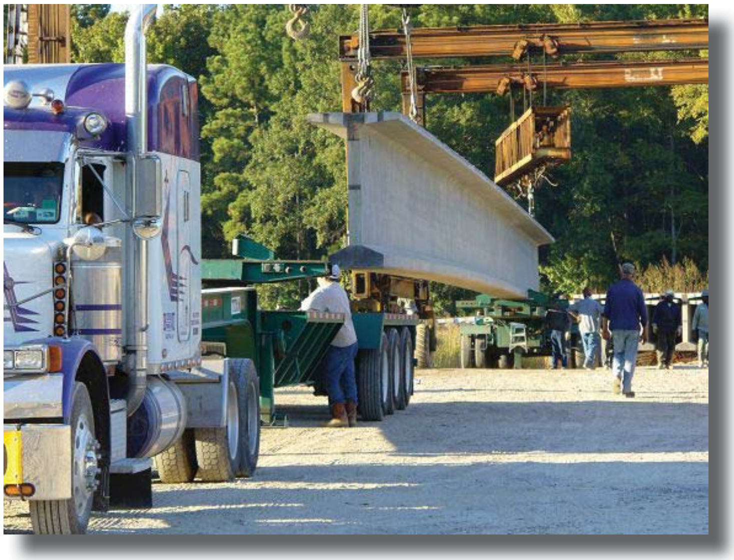
Analysis of the field instrumentation data will be further compared to the finite element models. This data will then be used to verify and further calibrate the model composition and loads.

IMPLEMENTATION POTENTIAL

LADOTD and the precast industry could use the proposed guidelines to modify trailer suspension, adjust the girder support points on the trailer, and select different stiffness bearing pads and tie downs. In addition, proposed shipping routes could be evaluated to ensure that roadway characteristics indentified in the study that have negative effects on the girders are avoided.

Findings from this study will help LADOTD, if needed, revise its design for long girders to better account for stresses incurred while in transit. It is expected that newly designed girders will pass the LADOTD bridge inspector acceptance at the bridge site, thus, avoiding any potential rejection. Such rejection will result in a longer project construction time for the state and the cost of casting replacement girders for the caster.

Practical recommendations to implement the findings of the research will be presented in the final report and as part of a training workshop.



One of two 150-ft. long bulb-tee bridge girder being loaded on a semi-trailer