

NCDOT Project 2004-14

Developing a Simplified Method for Predicting Deflection of Steel Plate Girders Under Non-Composite Load For Stage-Constructed Bridges

Principal Investigators: Emmett Sumner and Sami Rizkalla
Graduate Student: Todd Whisenhunt

Project Kick-Off Meeting
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Problem Statement

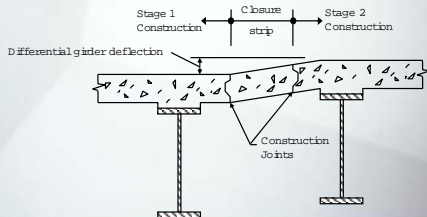
- **Problem:**
 - Inability to accurately predict deflection of non-composite steel plate girders
- **Proposed Solution:**
 - Simplified method to predict deflection of non-composite plate girders in different geometrical configurations
- **Customer:**
 - Structures Design Unit Engineers



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Problem Details

- Differential deflections of two adjacent girders in different stages of construction
 - Can result in costly deck grinding or overlays



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Problem Details

- Excessive or insufficient slab depths
 - Can result in insufficient deck slab reinforcement cover
- Inaccuracies in determining girder build-ups and setting deck screed elevations
 - Can result in construction delays



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Current Analysis Procedure

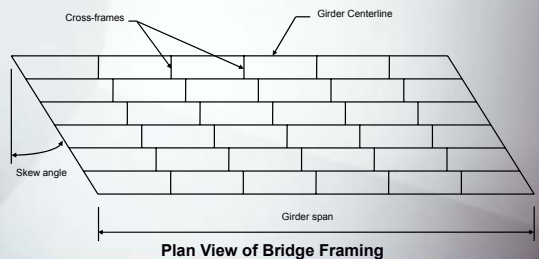
- For staged construction projects, NCDOT has been creating detailed computer models to more accurately predict the non-composite deflections
 - Requires experienced personnel
 - Very time consuming



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Current Analysis Procedure

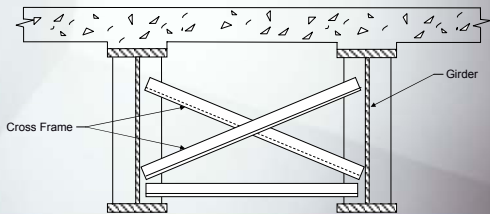
- Girder deflection based upon a single girder line model



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Current Analysis Procedure

- Typically, the transverse load distribution does not consider stiffness of the cross-frames



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Research Plan

- Literature review
- Three-dimensional finite element simulation
- Field measurements of non-composite girder deflections
- Correlation of field data with finite element results
- Development of simplified deflection prediction procedure

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Finite Element Simulation

- Three-dimensional finite element modeling (SAP 2000, ANSYS)
- Detailed modeling of cross-frames
- Numerous bridge structures modeled to investigate critical parameters

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Critical Parameters

Critical Parameter	Range
Skew angle	0 to 75 degrees
Span configuration	Single span, Two span continuous, Three span continuous
Girder spacing	2 to 4 meters
Girder span	25 to 100 meters
Number of girders	4 to 12 girders
Deck slab thickness	230 millimeters

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Field Measurements

- Measure the plate girder deflections during placement of the bridge deck slab
- Deflections measured at supports, quarter points, and mid-span of girders
- Electronic instrumentation and survey instruments used to collect data at quarter points along the span

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Field Measurements

- Simple and continuous span configurations
- Single and multiple stage construction projects considered
- In-place deck slab thickness recorded

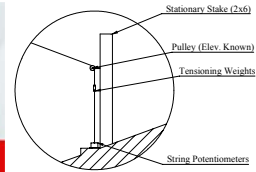
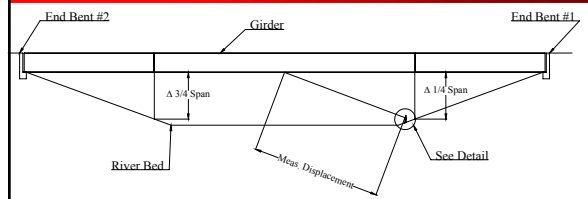
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Guess Rd. Bridge Over the Eno River



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Guess Rd. Bridge Over the Eno River

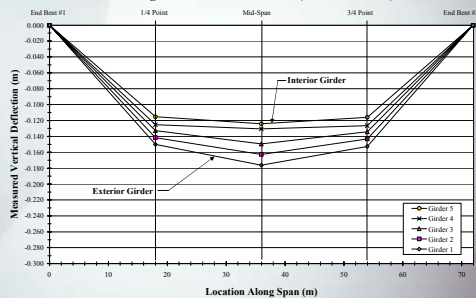


- 72 meter HPS span
- No skew

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Guess Rd. Bridge Over the Eno River

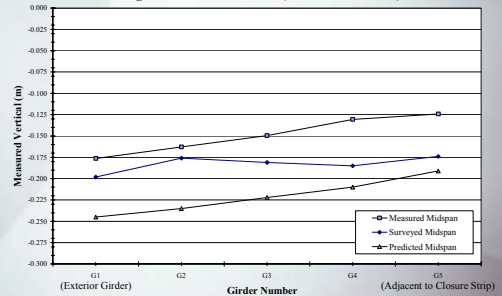
Measured Non-Composite Girder Deflections Due to the Weight of the Deck Concrete (Elevation View)



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Guess Rd. Bridge Over the Eno River

Non-Composite Girder Deflections Due to the Weight of the Deck Concrete (Cross Section View)



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Correlation of Field Data

- Three-dimensional finite element models created for each field measured bridge
- The recorded field measurements and the finite element results will be compared
- The results will be used to validate the finite element models

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Development of Simplified Procedure

- Finite element simulation results and field measured data used to develop modification factors
- Simple modification factors applied to the predicted single girder line deflections
- Modification factors will be presented in the form of simple equations or design charts

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Anticipated Results

- A simplified procedure for predicting deflection of steel plate girders under non-composite dead load
- Increased knowledge of the behavior of steel plate girder structures under non-composite dead load
- The influence of critical parameters on the non-composite deflection plate girder structures



Project Schedule

Task	Year		Year 1				Year 2			
	Quarter		1	2	3	4	1	2	3	4
Literature Review			■							
Finite Element Simulation				■	■	■				
Field Data Collection				■	■	■				
Correlation of Field Data				■	■	■				
Development of Simplified Method							■	■	■	
Preparation and Review of Final Report										■



Resources Supplied by NCDOT

- Access to appropriate bridge construction sites for measurement girder deflections
- Detailed design drawings and calculations for field measured bridge structures
- Personnel and surveying equipment to assist with the field measurements



Potential Bridges for Study

- Guess Rd. over Eno River (72 m HPS span, no skew) *Completed Spring '03*
- I-85 over Camden Ave (43 m, 152° skew)
- Wilmington St. Bridge (46 m, 152° skew)
- US 70 over Avondale Dr. (34 m, 53° skew)
- US 70 over Duke St. (36 m, 111° skew)



Thank You!

Questions?

