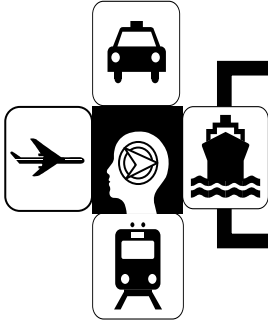


JERSEY DOT'S

"Turning Problems into Solutions"



Need a solution?
Think Jersey DOT

Tech Brief

Finite Element Modeling of Bridge Approach and Transition Slabs

FHWA/NJ-2002-007

September 2002

SO, HERE'S THE PROBLEM...

The crack development in reinforced concrete bridge approach and transition slabs has been a persistent problem for many years. Transverse and longitudinal cracking has led to distress of concrete approach slabs, which results in a decrease of their life expectancy and increased maintenance costs for the repair and stabilization of the system. Bridge approach slabs provide a transitional roadway between pavement and the actual structure of the bridge. This transition is crucial in reducing the dynamic effects imposed on the bridge by heavy truckloads. Figure 1 illustrates the cracking of approach slabs, Figure 2 is a schematic of the bridge at exit 64 in I-295 showing the crack locations on the approach slab, and Figure 3 is photograph of some the cracks on that bridge.

The objective of this research study is to identify the probable causes of cracking, the location of cracks, and factors influencing crack development and to recommend new design alternatives that reduce or eliminate crack development in approach and transition slabs.

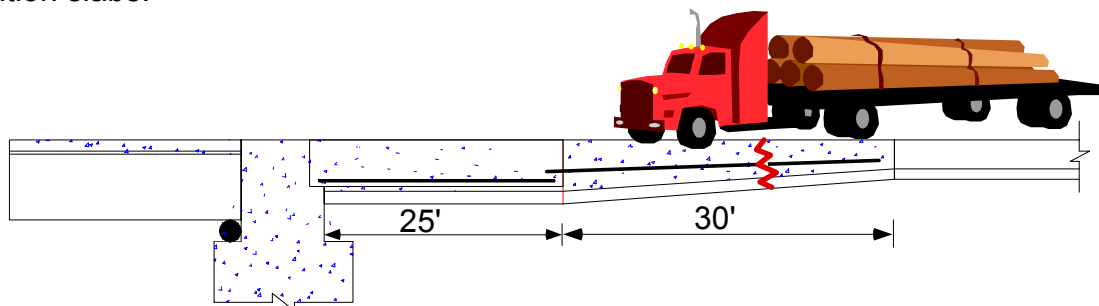


Figure 1. Profile view of approach slab with cracks due to truck load.

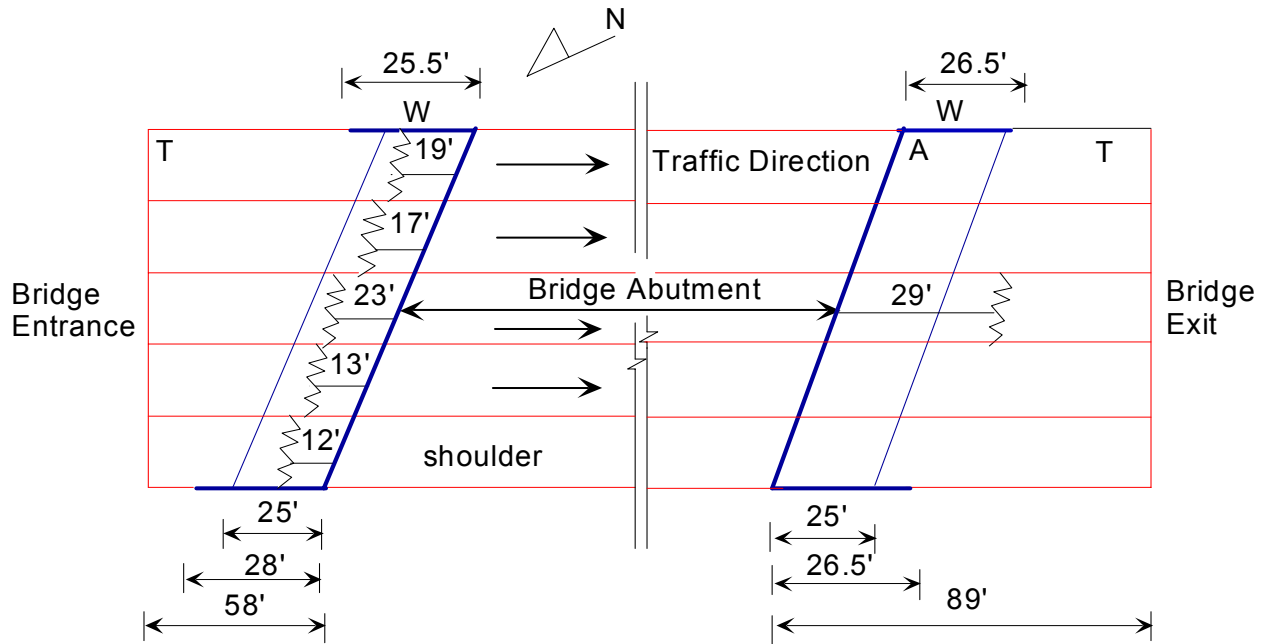


Figure 2. Typical transverse cracks on bridge exit 64 on I-295.

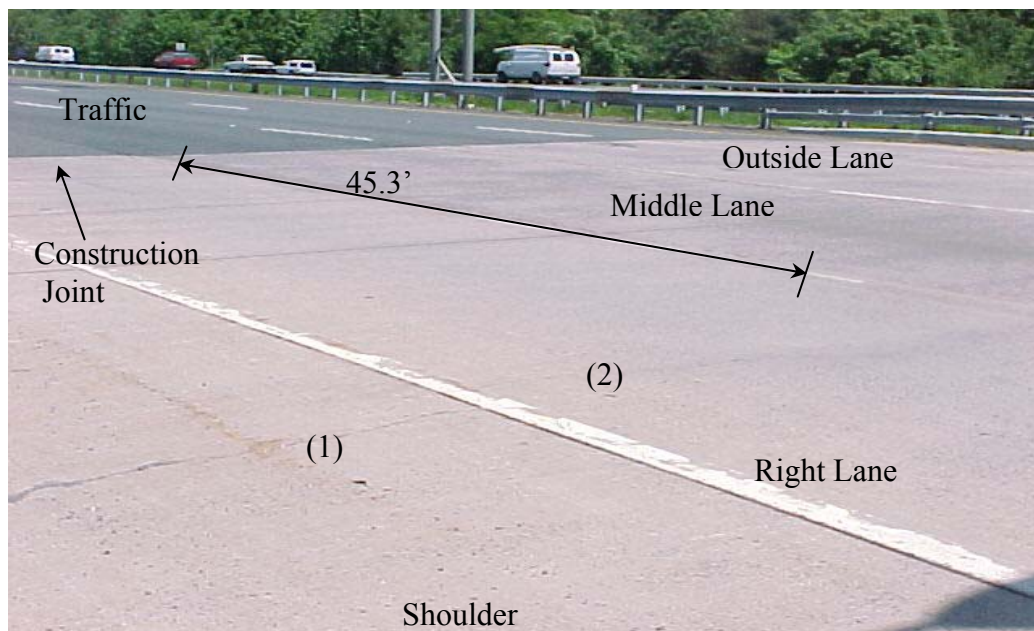


Figure 3. Photograph of transverse cracks (1) and (2) in the shoulder and right lane on bridge exit 64 on I-295.

AND, HERE'S OUR SOLUTION

The project identifies the procedures and parameters that affect the behavior of approach and transition slabs. The scope of the project was as follows:

1. Develop a detailed 3-D finite element model that will incorporate the nonlinear and cracking behavior of reinforced concrete as well as the inelastic soil properties. The model should simulate actual cracking behavior under various types of truck loading and the soil-structure interaction.

2. Compare results from the 3-D model with distress observed on actual structures. The research team observed bridge approach slabs and evaluated predictions from the FE Model with actual cracking patterns observed in the field.
3. Perform a comparative parametric study to optimize the slab design.
4. Recommend new design alternatives.

HERE'S WHAT WE CAME UP WITH...

The parametric study concluded that the slab thickness is the most effective parameter in reducing the tensile stresses in the critical elements. Therefore three new designs are proposed:

1. Constant Thickness Design
2. Deep Beam Design
3. Embedded Beam Design



THE BOTTOM LINE...

Based on the results of the study, the following conclusions are made:

- (1) Increasing the concrete compressive strength, f'_c , increases the cracking load capacity up to 14% for f'_c of 5500 as compared to f'_c of 4500. However, it is not very effective in comparison with an equivalent increase in the thickness of the slab.
- (2) Increasing the steel reinforcement yielding stress, F_y , has no effect on neither the cracking load capacity of the approach and transition slab nor the stresses in the critical elements. The effect of the steel rebar is limited to post cracking which is manifested in the bond between the steel rebar and concrete. This bond is represented by tension stiffening in the finite element modeling.
- (3) Increasing the approach and transition slab thickness results in an effective increase in the cracking load capacity of up to 33% for a 3 inch slab thickness increase.
- (4) Increasing soil settlement decreases the cracking load capacity of the slab.
- (5) Among the three design alternatives recommended, the most practical; Constant Thickness Design and Embedded Beam Design.

RECOMMENDATIONS

- 1- Use two design alternatives, Embedded Beam and Constant Thickness.
- 2- Instrument and monitor the recommended design alternatives on a new project contracted by NJDOT.
- 3- Perform long-term monitoring for the following:
 - 1) Static strain from embedded VWSG in concrete and rebars.
 - 2) Thermal strain due to change in temperature.
 - 3) Shrinkage strain at restrained and un-restrained edges.
 - 4) Soil settlement and void development underneath the concrete slab.

FOR MORE INFORMATION CONTACT:

NJDOT PROJECT MANAGER:	Nicholas Vitillo
PHONE NO.	(609) 530-5966
e-mail	Nick.Vitillo@dot.state.nj.us
UNIVERSITY PRINCIPAL INVESTIGATOR:	Hani H. Nassif, P.E., Ph.D.
UNIVERSITY:	Rutgers University -CAIT
PHONE NO.	(732) 445-4414
e-mail	nassif@rci.rutgers.edu

A final report is available online at

<http://www.state.nj.us/transportation/research/research.html>

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to

Research.Bureau@dot.state.nj.us and ask for:

**FINITE ELEMENT MODELING OF BRIDGE APPROACH AND
TRANSITION SLABS**

NJDOT Research Report No: FHWA/NJ-2002-007