South Dakota Department of Transportation Tolerances for Placement of Tie Bars in Portland Cement Concrete (PCC) Pavements

Poster By: **Darin Hodges, PE**
Concrete Engineer SDDOT

Project SD2011-09

PI: Nadim Wehbe, PhD, PE
South Dakota State University

INTRODUCTION

- Misaligned or missing tie bars are commonly seen in newly constructed PCC pavements
- Effects of misaligned or missing tie bars are unknown
- Previous research suggests that they could be a contributing factor to longitudinal joint distresses

Source: Mallela, J. (2011). Evaluation of Longitudinal Joint Tie Bar System. Denver, CO: Colorado Department of Transportation.

- Conduct a comprehensive literature review on the design and performance of longitudinal joints with tie bars
- Perform experimental testing and analytical modeling to determine the effects misplaced tie bars have on the longitudinal joint
- Develop tie bar placement tolerances for the South Dakota DOT to implement

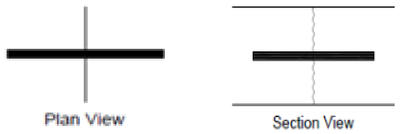
South Dakota DOT Specifications

Type: # 5, Grade 40/60, Epoxy Coated, Deformed Bar

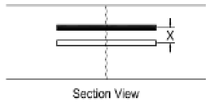
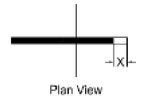
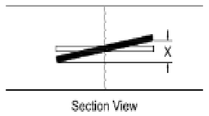
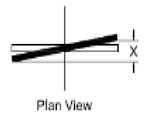
- Length:
  - 30” if Installed in Fresh Concrete
  - 24” if Installed in Hardened Concrete
- Spacing:
  - 48” C-C for Sawed or Construction Joints w/ Keyway
  - 30” C-C for Construction Joints without Keyway

Placement:

- Mid-depth of the slab
- Perpendicular to the joint
- Parallel to the ground
- Half of the tie bar is embedded on each side of the joint

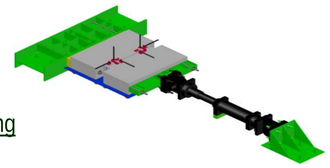


Testing Matrix

MISALIGNMENT TYPE	MISALIGNMENT MAGNITUDE	MISALIGNMENT TYPE	MISALIGNMENT MAGNITDUE
Vertical Translation: 	X = 1 inches X = 2 inches X = 3 inches X = 4 inches	Longitudinal Translation: 	X = 3 inches X = 5 inches X = 7 inches X = 9 inches
Vertical Skew: 	X = 2 inches X = 4 inches X = 6 inches X = 8 inches	Horizontal Skew: 	X = 16 inches X = 20 inches X = 24 inches X = 28 inches

Experimental Testing Result Summary:

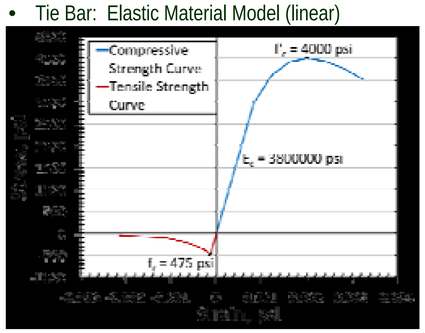
- Vertical Translation: Results were similar to the Aligned Specimens.
- Vertical Skew: Found a slight increase in the Joint Faulting.
- Longitudinal Translation: Results were identical to the Aligned Specimens.
- Horizontal Skew: Effected the Actuator Load, Joint Opening, and Joint Faulting; Joint Opening exceeded 1/8 of an inch when the misalignment magnitude was 20 inches (CRITICAL)



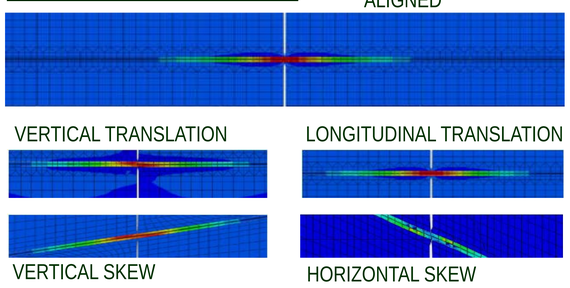
Analytical Modeling

MATERIALS:

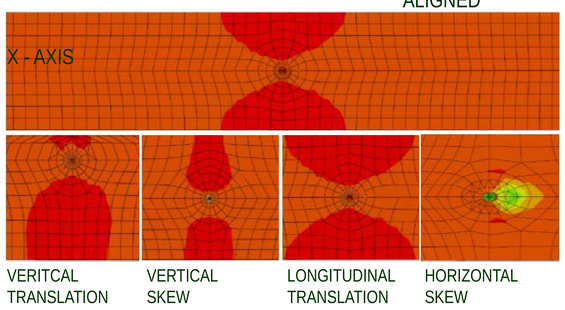
- Concrete: Damaged Plasticity Model
- Tie Bar: Elastic Material Model (linear)

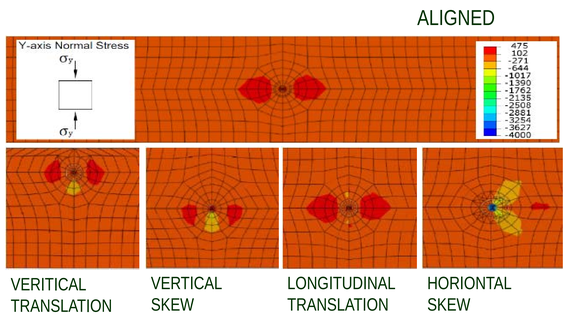


TIE BAR STRESS DISTRIBUTIONS:



CONCRETE STRESS DISTRIBUTIONS:

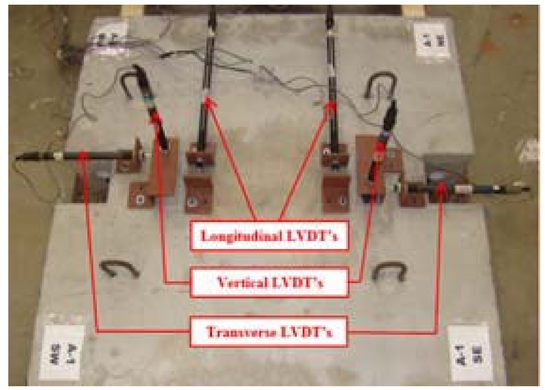




CONCRETE PAVEMENTS: THINKING BIGGER, THINKING BETTER

TEST SPECIMEN INSTRUMENTATION

- Two - 24”x48”x10” concrete slabs connected by a 30” long, #5, Grade 60, epoxy coated tie bar
- Tie bar was installed with the various misalignment types and magnitudes specified in the test matrix
- Joint between slabs created by 1/8th inch thick acrylic sheet
- Strain gages were installed on the tie bar at the joint
- LVDT’s measured displacement in all three directions



CONCLUSIONS

- The Horizontal Skew misalignment type had the most significant effect on the actuator load and joint opening
- The misaligned tie bars performed adequately within the current placement tolerances: (Jason Smith SDDOT Poster)
- The results indicate the current tie bar placement tolerances may even be too strict
- Recommendations for future research:
  - Look into effects of multiple misalignments
  - See how the different misalignments perform under vertical loads or fatigue loading

INTERNATIONAL CONFERENCE ON CONCRETE PAVEMENTS
San Antonio, Texas, USA 2016