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EVALUATION OF SEAMLESS BRIDGES

(TXDOT NO.0-7011)

CENTER FOR TRANSPORTATION RESEARCH SYMPOSIUM

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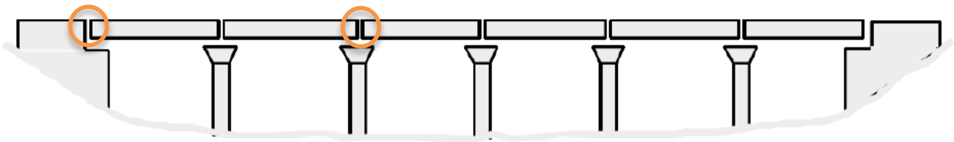
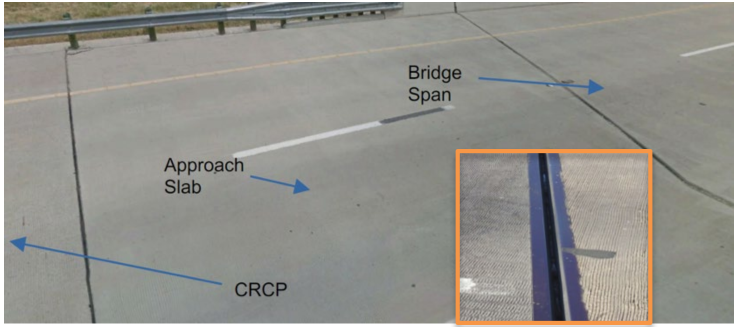
Background

- Conventional bridges have expansion joints to accommodate deck expansion/contraction.
- The expansion joints have issues:
  - Deterioration of bridge elements
  - High maintenance costs
  - Bad rideability due to bumps



Expansion joints of a conventional bridge (Griffith., 2018)

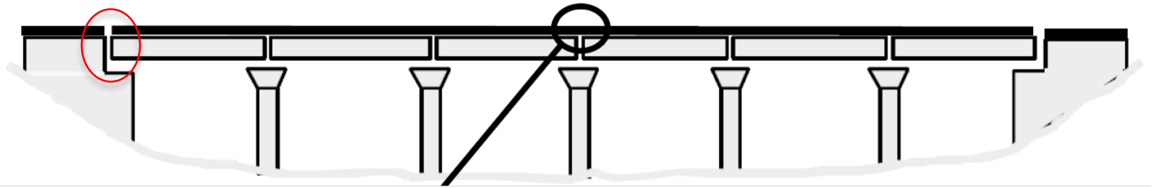
> *The only good joint is no joint.*
> *--Henry Derthick*



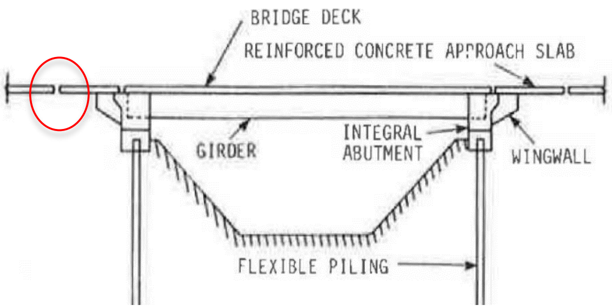
Expansion joints between pavement and bridge (Beer., 2021)

Background

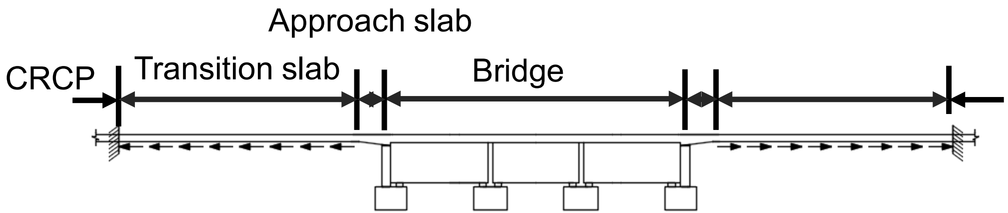
- Structural types to eliminate joints:



Jointless deck bridges (link slab/poor-boy continuous joint) (Griffith., 2018)

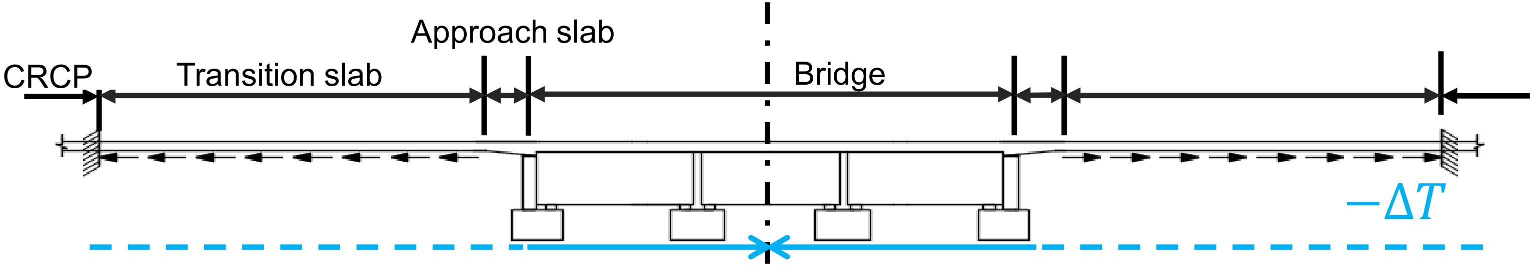


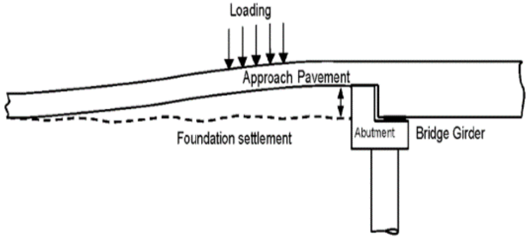
Integral/semi-integral bridges (Hyzak., 2018)



Fully jointless/seamless bridges

Behavior: Axial and Bending Effects



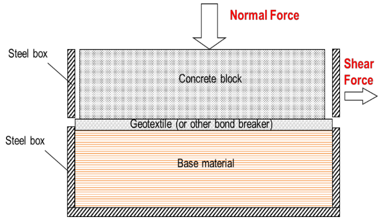


- Sources of axial effects:
  - Seasonal temperature change (critical: $-\Delta T$)
  - Concrete shrinkage, and creep
- Sources of bending effects:
  - Differential embankment settlement
  - Traffic load

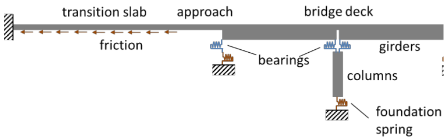
Research Goals

Develop comprehensive design guidelines for implementing seamless bridge technology in Texas.

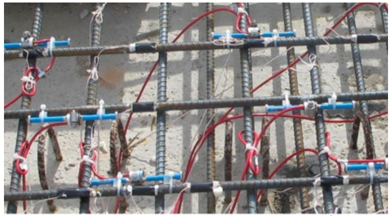
- Provide guidance on bond breakers/bases for transition slab and characterize the **slab-base interaction**.
- Develop **analytical models** to study the structural response and develop guidelines for **optimal length and reinforcing steel of transition slab**.
- Identify **design issues for standard bridge structures** associated with seamless connections.
- **Monitor the field performance** of a seamless bridge.



Experimental testing



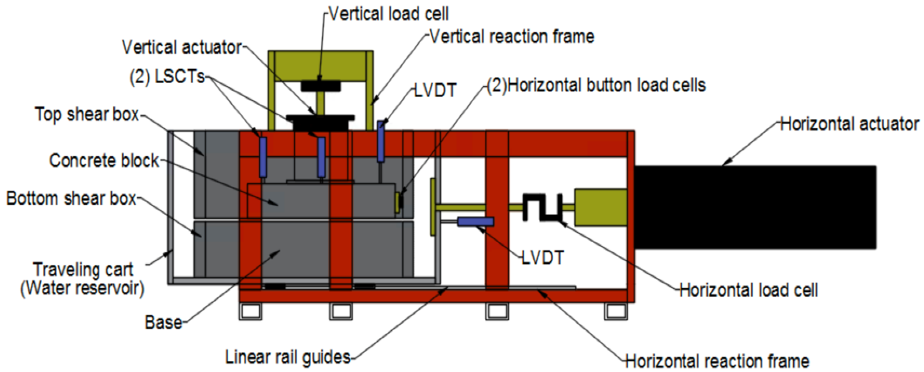
Finite element modeling



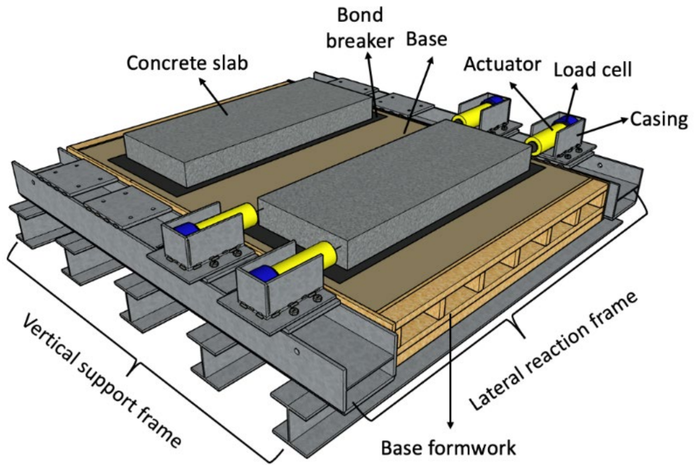
Instrumentation and field monitoring

Experimental Testing on Slab-base Interaction

	Phase I: Unit-cell direct shear tests	Phase II: Full-scale push-off tests
Specimens	Concrete block (15 in. × 15 in.)	Concrete slab (5 ft. × 2 ft.)
Bond breakers	11 different interface conditions	Promising bond breakers from Phase I
Loading protocol	Monotonic	Cyclic (expansion-contraction)



Phase I test setup

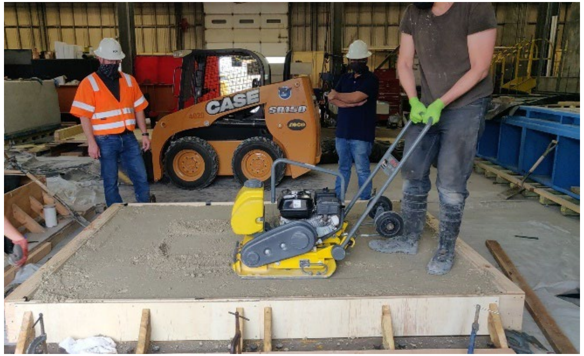


Phase II test setup

Test Matrix

	Series	Base type	Interface material/Bond breaker
Phase I	1	AASHTO Gravel No.8	-
	2	Grade 3 Aggregate	-
	3		Two LDPE sheets
	4	**Hot-mix asphalt (HMA)**	-
	5		Two LDPE sheets
	6	**Cement stabilized base (CSB)**	-
	7		1 in. Type D HMA
	8		Woven geotextile
	9		Non-woven geotextile
	10		One LDPE sheet
	11		Two LDPE sheets
Phase II	1	**CSB**	One LDPE sheet
	2		Two LDPE sheets
	3		Single-sided spike LDPE sheet
	4		Double-sided textured LLDPE sheet
	5		Felt paper
	6	**1 in. HMA on CSB**	Double-sided textured LLDPE sheet
	7		Felt paper

Test Specimens



Compaction of cement stabilized bases

Smooth LDPE

Single-sided spike HDPE

Double-sided textured LLDPE

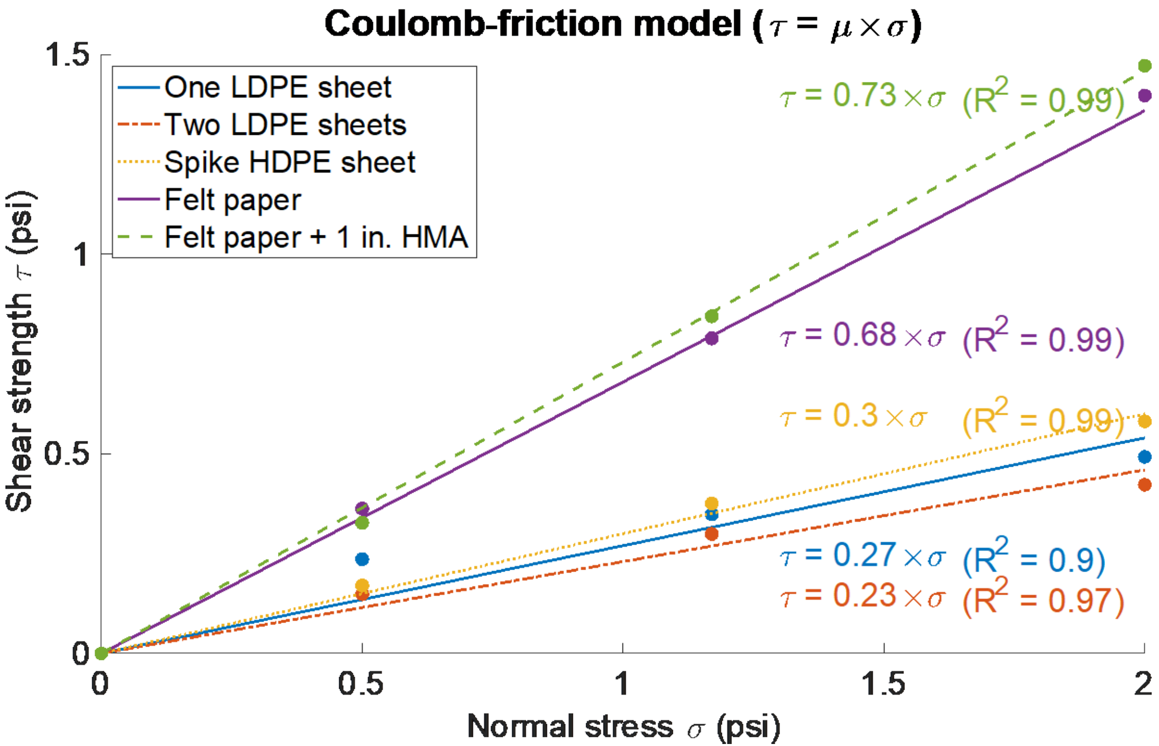
Felt paper

CSB with bond breakers

CSB + 1 in. HMA layer with bond breakers

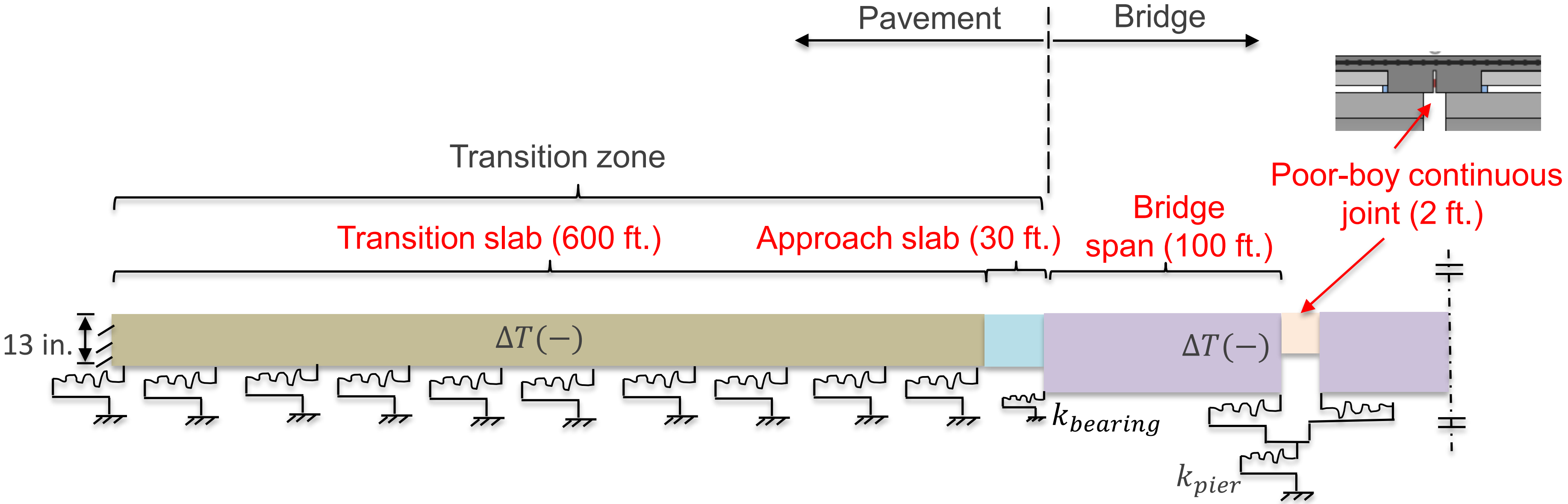
Effects of Bond Breakers

CRCP thickness (in.)	6	14	24
Normal stress (psi)	0.5	1.17	2



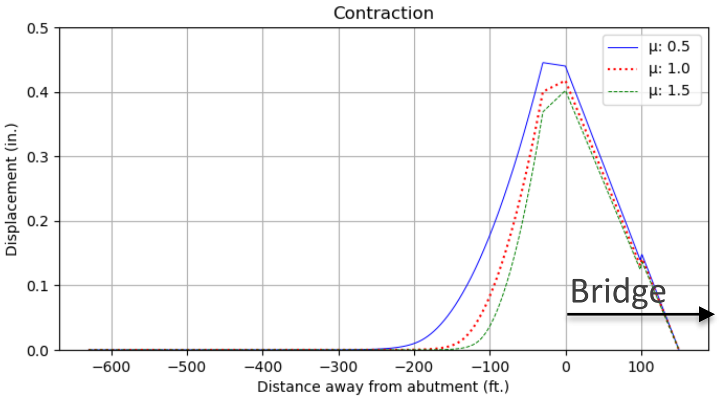
Structural Analysis of Seamless System

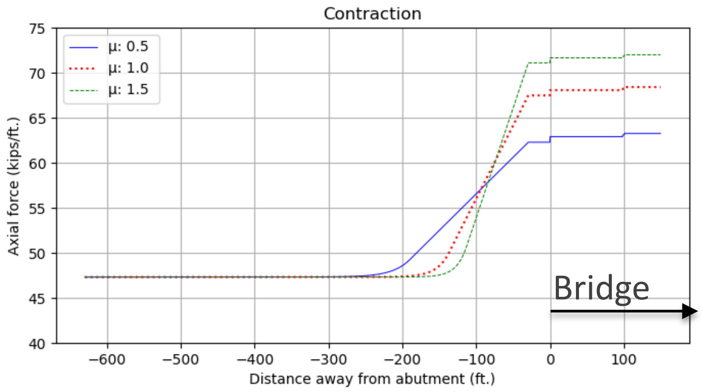
Develop finite element models to study the axial and bending response of the **entire seamless bridge-CRCP system**.



Scheme of Abaqus model for seamless system (using truss elements)

Parametric Study: Slab-base Interaction





- A higher restraint dissipates the movement faster and requires a shorter length of transition slab (250 ft for $\mu = 0.5$ vs 150 ft for $\mu = 1.5$), but generates larger axial forces in the system.

TEXAS
The University of Texas at Austin

Texas Department of Transportation

THANK YOU!