

“Universal” (Performance-Based) Dowel Specification Development

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Current AASHTO Dowel Specs

- M 254 – Standard Specification for Corrosion-Resistant Coated Dowel Bars
 - “... specification covers the materials, manufacture and installation of coated dowel bars to be used where corrosion-resistant performance is essential ... [t]he dowel shall consist of a steel core covered by an organic coating.”
 - For “organically coated” (epoxy- or plastic-coated) dowels, 1.25-in diameter, 20-30 mils coating (Type A, low bond strength) or 5-9 mils (Type B, bond breaker required).
 - Dowels qualified as individual products, not systems.
- T 253 – Standard Method of Test for Coated Dowel Bars
 - “..methods to test the qualifications of the organic coating of corrosion-resistant dowel bars to withstand the effects of weathering, de-icing chemicals, and the abrading and loading stresses experienced in field joints.”

Limitations of Current AASHTO Dowel Specs

- Not applicable to many dowel products being used and developed today
 - Plate dowels
 - Hollow/Tube dowels (with or without coatings)
 - Composite dowels (FRP/steel, zinc/steel, etc.)
 - Elliptical dowels
- Can't evaluate behavior of groups of dowels
- No ability to evaluate structural performance potential (differential deflection) of nonstandard dowel spacing

What is needed:

A specification and associated suite of structural and corrosion tests that can:

- Provide manufacturers with targets and evaluation criteria for innovative improvements,

and

- Provide agencies with objective measures of the relative potential performance of competing products.

Brief History

- Effort initiated by NCC around 2014
- Much discussion and energy at first
 - Various drafts and concepts presented and discussed
 - Early 2016 version (Burnham and Snyder) gained general support/consensus of NCC agency members, but interest in concept was insufficient to drive to completion.
- In Mid-2016, ACPA's Jointing Task Force resolved to pick up where NCC left off
 - "Universal" Dowel Spec subcommittee established to include manufacturers and suppliers of dowel products, ACPA Chapter/State staff, and ACPA National staff (with interested NCC state DOT reps as subcommittee "friends")

Objectives

- Establish specifications and tests that can be used by agencies for evaluation of all dowel systems
- Provide indications of performance potential
 - Structural adequacy
 - Durability (Corrosion resistance, etc.)
- Use existing T 253/M 254 as basis of development

Current Project Status:

- Draft Standards Developed for Subcommittee Review (Nov 2018):

Standard Specification for Corrosion-Resistant Dowel Bars
Standard Method of Test for Corrosion-Resistant Dowel Bars

- May/June 2019 – Comments received, spec revisions
- Future work:
 - July 2019 – Round 2 review by JTF subcommittee
 - September 2019 – Round 2 JTF Subcommittee Review
 - October 2019 – Draft specs to full JTF and DOT “friends” for review
 - December 2019 (target) – Approval of final revised documents; solicit partner champions for AASHTO adoption process



Draft Standard Specification for
Corrosion-Resistant Dowel Bars

Key Revisions since NCC 2016

- **Type A - Single metallic material**

- **AASHTO M255, ASTM A276, ASTM A312, ASTM A1035 (CS, CM and CL) or AASHTO M 334**
- *Grade as specified by purchaser.*

- **Type B - Single nonmetallic material**

- **ASTM D4476, D6272** or as specified by the purchasing agency.

- **Type C – Steel core with metallic corrosion protection**

- Steel core : **AASHTO M 255 or AASHTO M 334**
- *Metallic corrosion protection: ASTM A249, ASTM A276 or ASTM A312 for stainless steel coatings, ASTM A513, ASTM A1035 (CS, CM and CL) for low-carbon chromium coatings, or ASTM B69 for rolled zinc coating.*

- **Type D – Metallic core with nonmetallic corrosion protection**

- Core material: **AASHTO M255, ASTM A276, ASTM A312, ASTM A513, ASTM A1035 (CS, CM and CL) or AASHTO M 334.**; grade specified by the purchasing agency.
- Type D1: mechanically bonded nonmetallic cladding material (ASTM D4476 or D6272 or as specified by purchaser), e.g., GFRP
- Type D2: one or more thin layers of epoxy, plastic or similar materials of primarily organic composition ... and total coating thickness of less than 1 mm [40 mils].

Physical Test Requirements

- Pullout (measure surface shear instead of total force; all dowel types)
- Abrasion (all dowel types except solid, uncoated metallic)
- Corrosion (all dowels with metallic components; alt procedures for cathodic systems)
 - Primary consideration to lateral surfaces, not ends
- Chemical Resistance (Types C and D only; alt procedures for D1)
- Cathodic Disbonding (Type D2 only)
- Impact Resistance (Types D1 and D2 only; alt procedures)
- Delamination Resistance (Types C and D1 only; alt procedures)
- UV Exposure (Types B and D1 only)
- Load Deflection Testing (all dowel types)

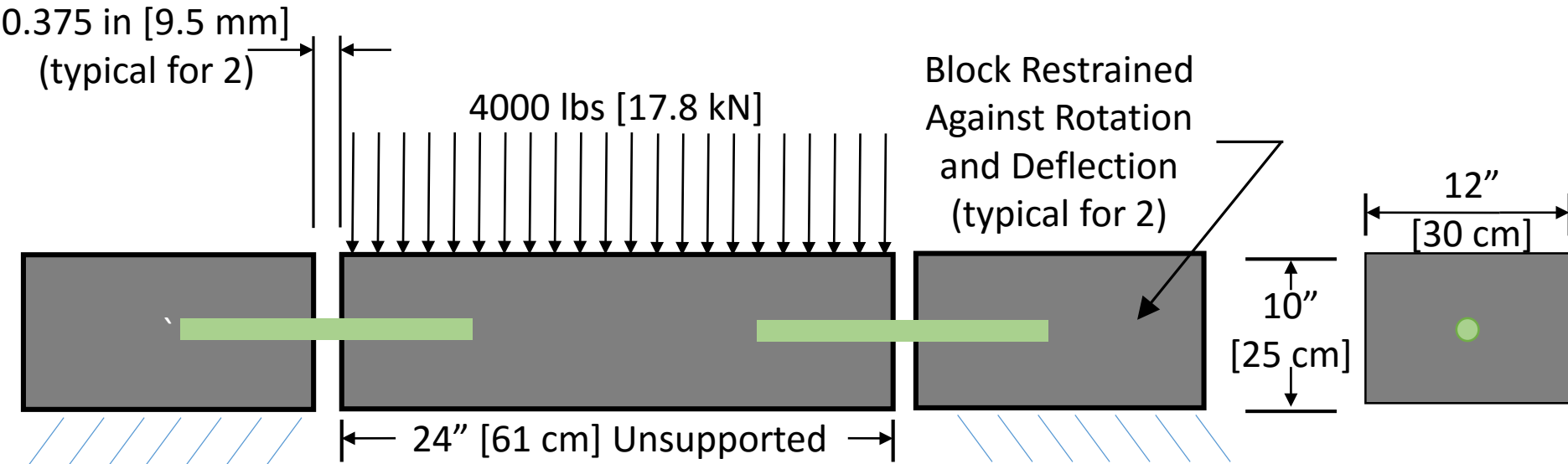
Performance Tests

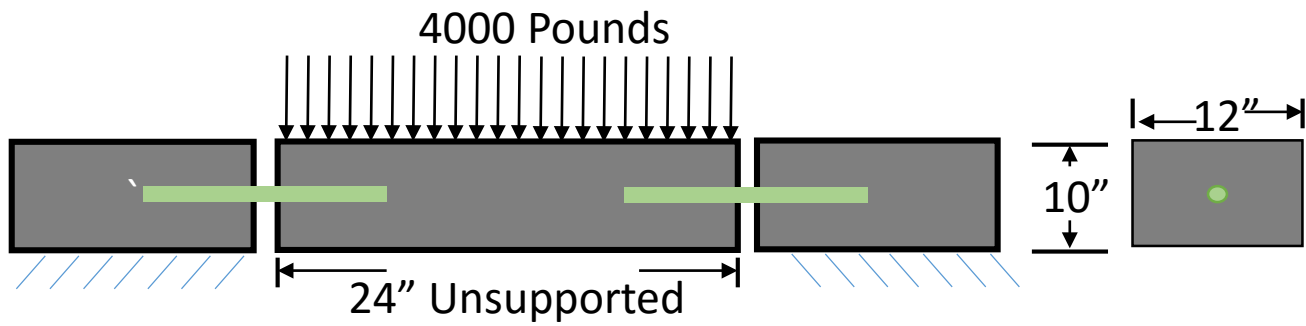
- Tests provide only results, not acceptance/rejection criteria
 - Note that different types of tests apply to different dowel types
- Agencies determine limit values and how they are categorized for service life and/or climate
 - Concept is similar to specs for determining PCC compressive strength and other material properties
- Commentary guidance to be provided to aid agencies in setting limits



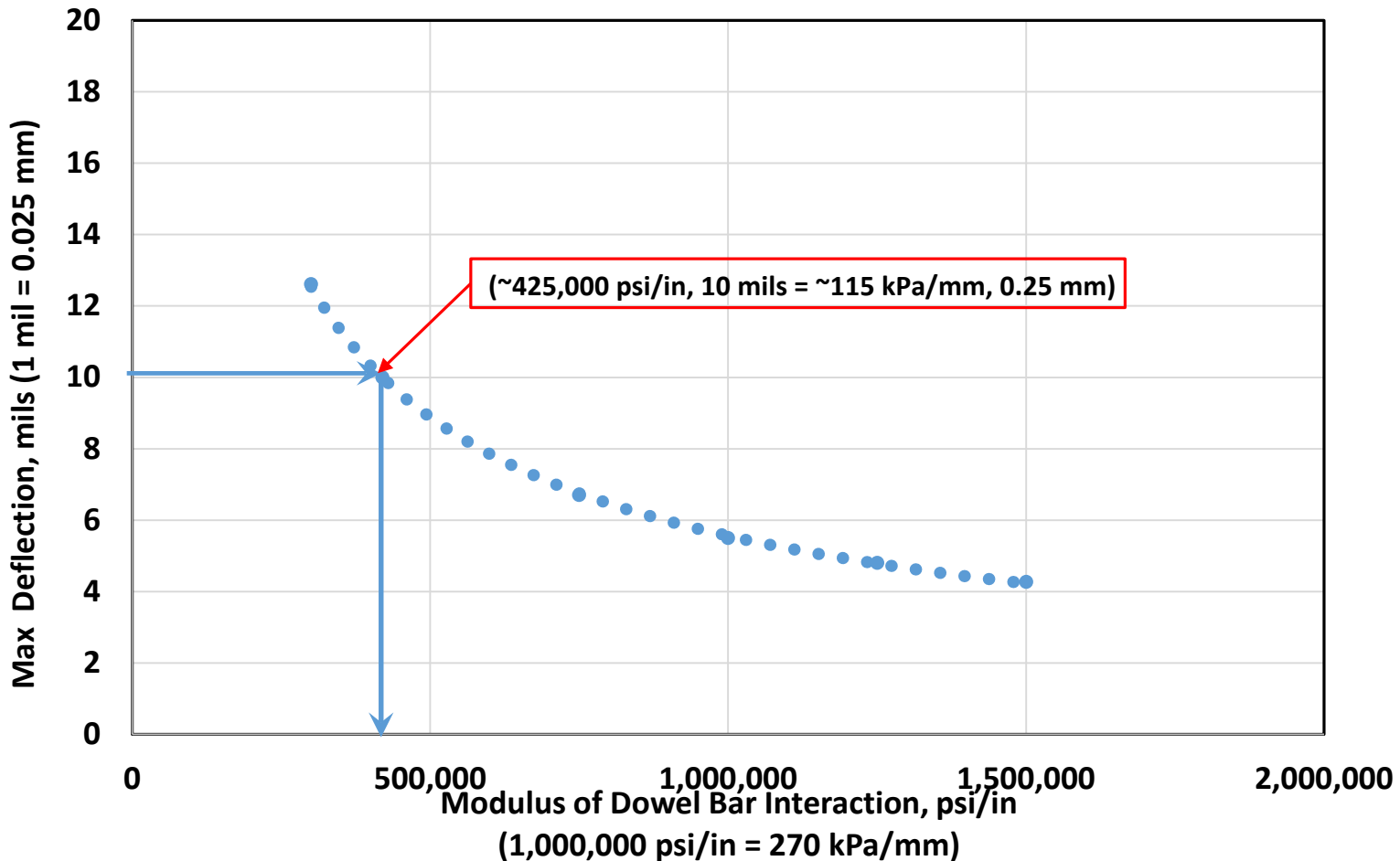
Structural Testing of Dowel Systems

AASHTO T253 Test Setup

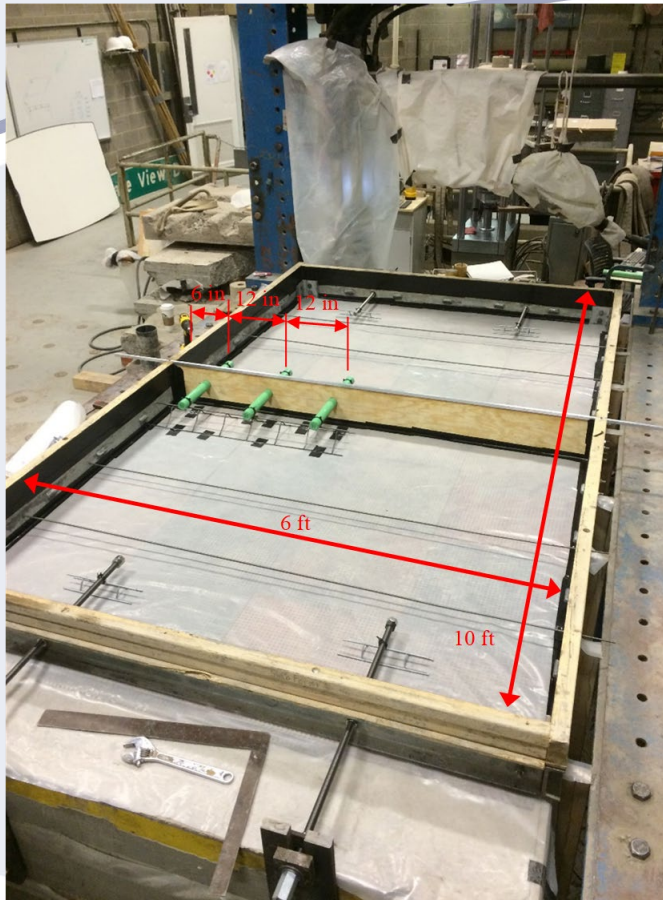




AASHTO T253/M254 Sensitivity to Modulus of Dowel Bar Interaction



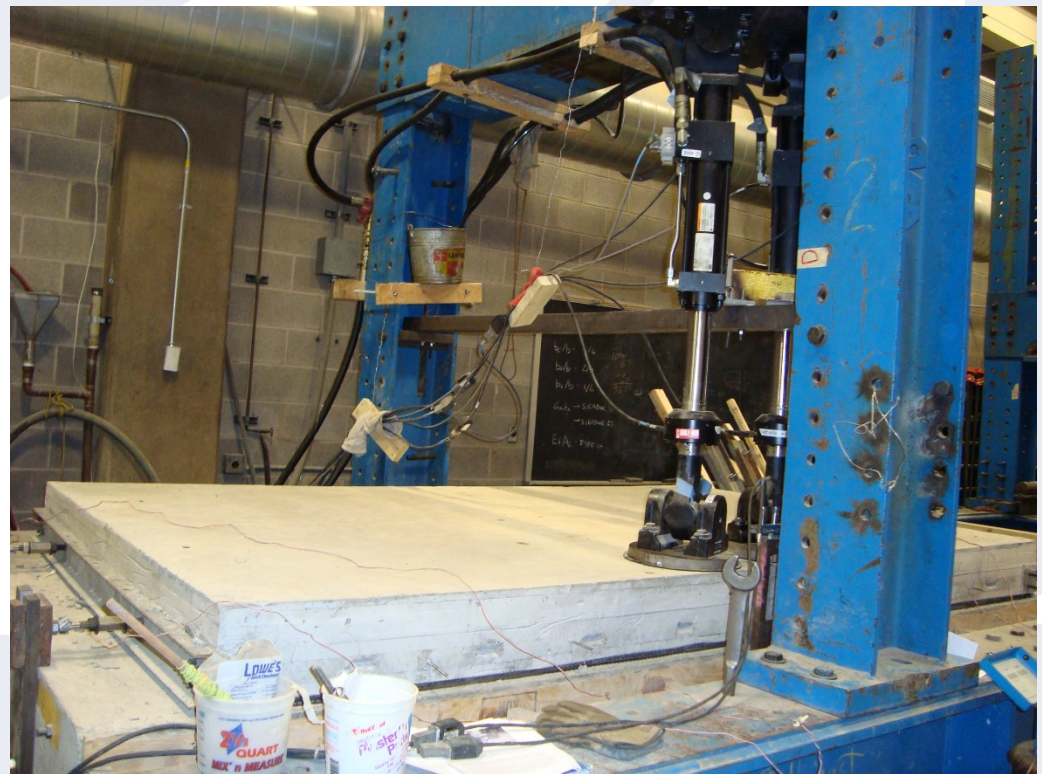
Current Test of Alternate Dowel Systems



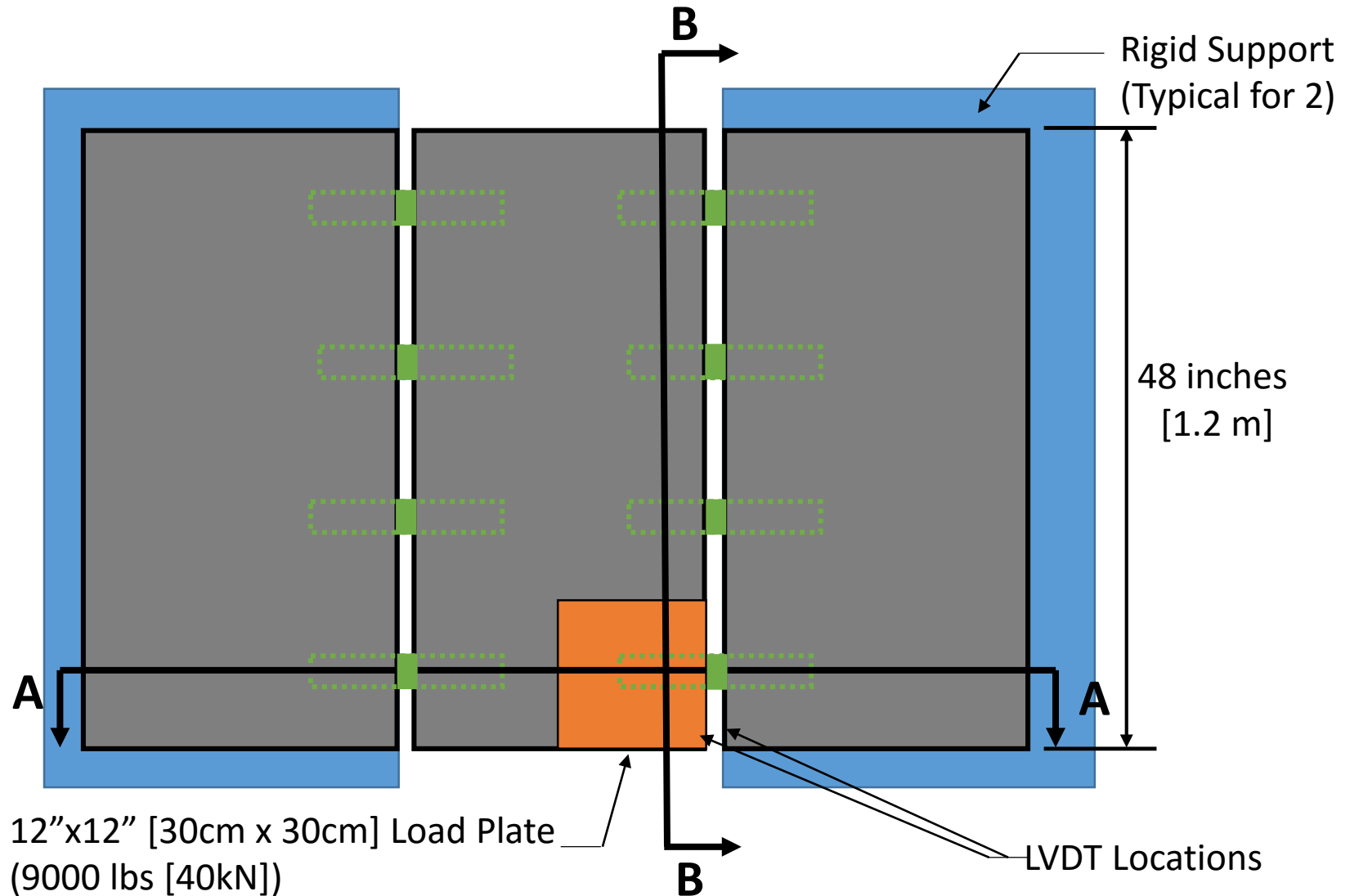
Used as alternate dowel acceptance standard by several DOTs

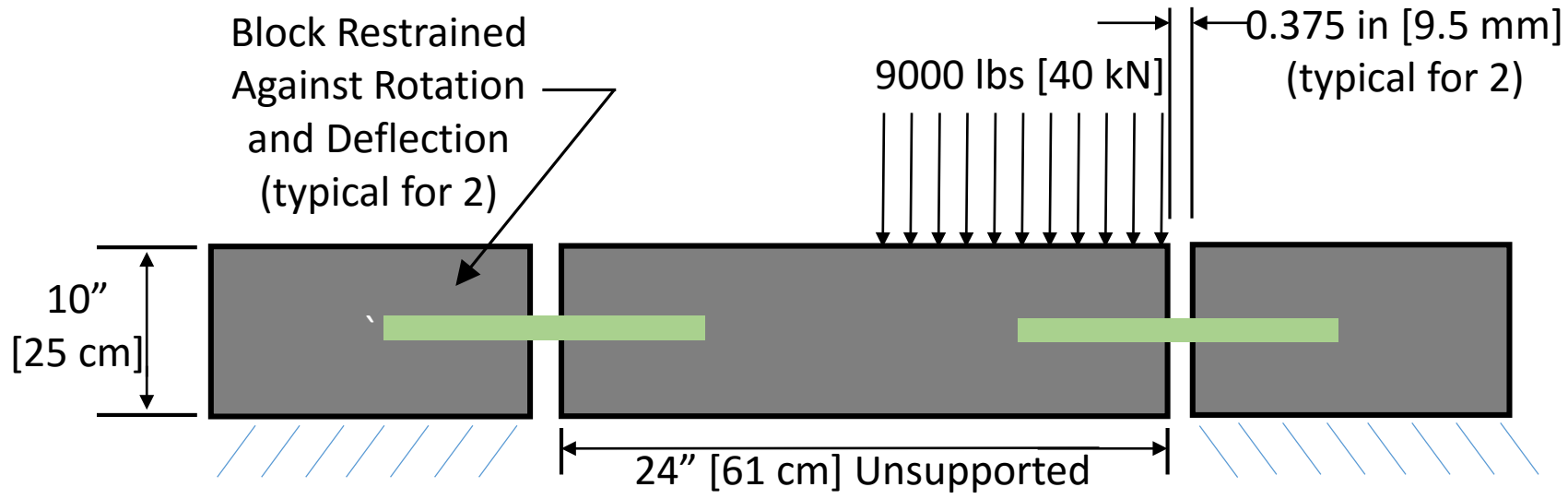
Test:

- 10M Load Cycles
- Simulate 9000 lb wheel load
- Simulate 45mph vehicle speed
- Costly and time-consuming

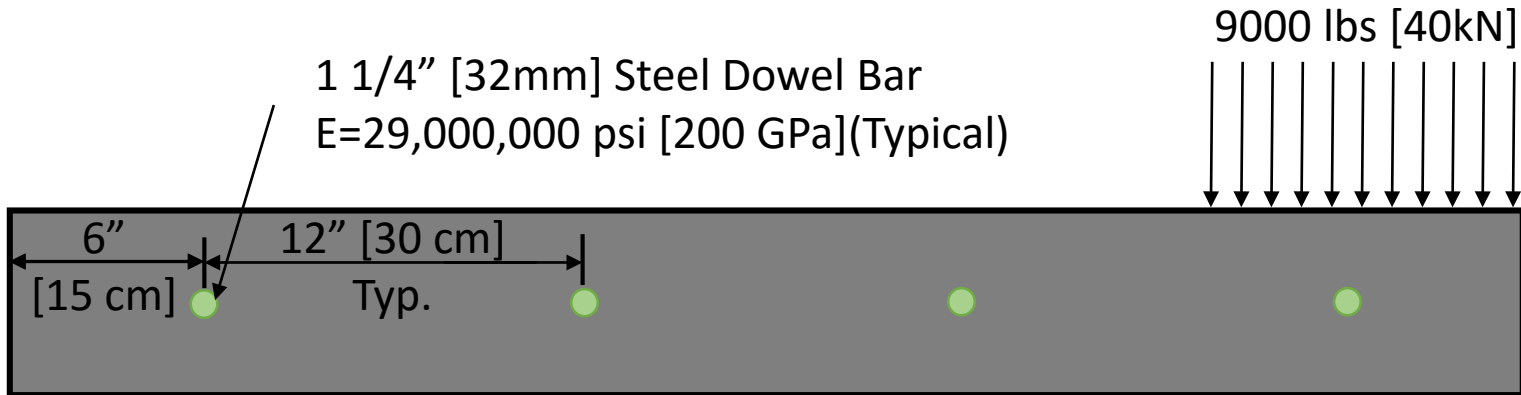


Proposed Test Setup For Dowel Bar System Equivalency Evaluation

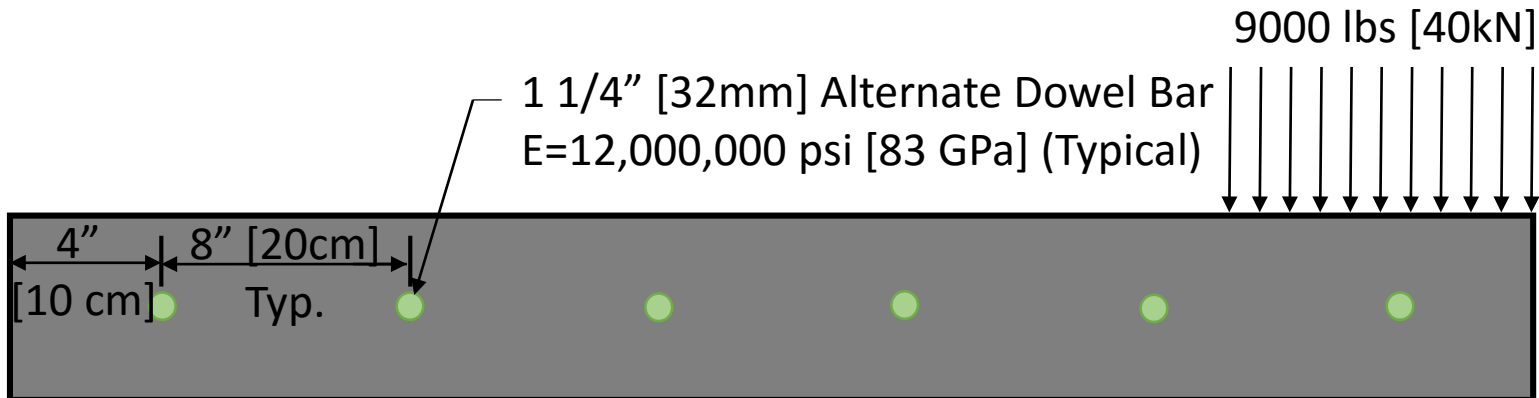




Section A-A

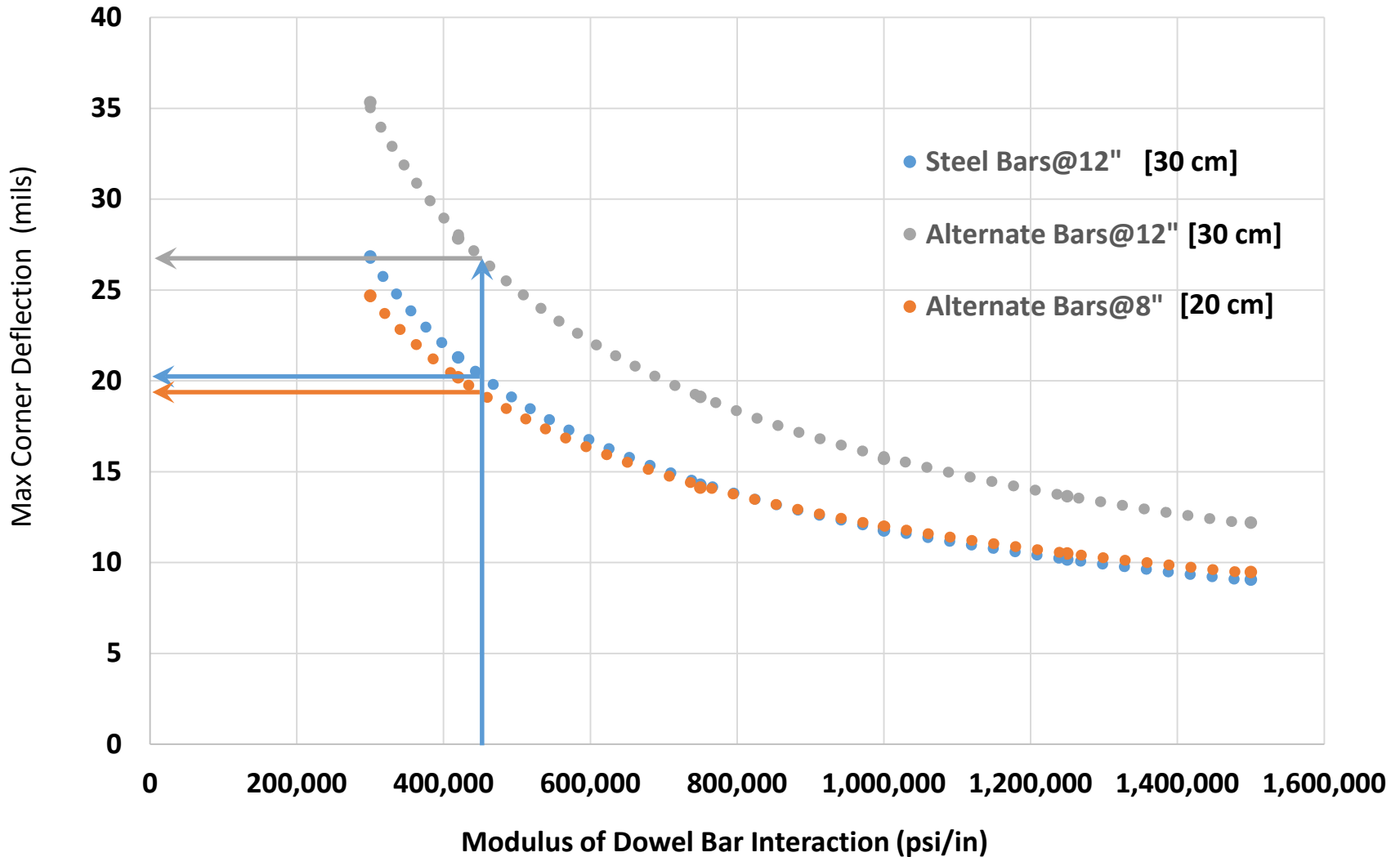


Section B-B
Steel Dowels @ 12" [30cm]



Section B-B
Alternate Dowels @ 8" [20cm]

Sensitivity of Proposed Dowel Equivalency Test to Modulus of Dowel Bar Interaction



Suggests 20-mil relative deflection requirement for standard dowels in new test ... should be verified with lab tests ...

Concepts for Validating New Structural Test Protocol

Goal:

- Validate multi-dowel structural model behavior (load-deflection) and acceptance threshold (~20 mils) when compared with current AASHTO T253 single-dowel behavior and acceptance threshold (~10 mils).

Proposed Testing:

- 3 replicates AASHTO T253 load-deflection testing
 - 1.25-inch diameter epoxy-coated steel dowels
 - Yields 6 measurements of relative deflection
- 2 replicates of the proposed modified version of this test
 - Four 1.25-inch diameter epoxy-coated steel dowels per joint
 - Four test locations per specimen (one in each of the four corners of the unsupported slab)
 - Yields 8 measurements of relative deflection
- Companion compressive strength/elastic modulus test cylinders

Estimated Test Cost: \$25,000 - \$30,000

Thank You For Your Attention!