Research Project Brief

Report 26-R49: Effect of Bridge Deck Placement Sequences on Cracking Performance

VTRC Virginia Transportation Research Council

Background

Questions exist within VDOT as to whether allowing continuous deck placement—rather than the required sequential (checkerboard) placement process, in which positive moment areas are placed first and negative moment areas afterward to limit tensile stress development in negative moment regions—might increase the likelihood of deck cracking. These questions were prompted by repeated contractor requests to use continuous placement to improve construction productivity.

Research Objectives

The objective of this study was to gain an understanding of the effect of bridge deck placement methods on bridge deck cracking performance.

Approach

To accomplish the research objective, this project was organized into three main tasks:

- Literature review.
- Survey of state DOTs and VDOT districts.
- VDOT's bridge condition database analysis.

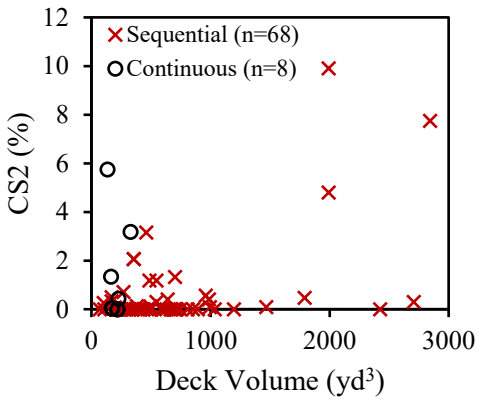
Outcomes

Results show that shrinkage-related mechanisms—drying, autogenous, and thermal—are the primary drivers of deck cracking, whereas placement sequence plays a secondary role. The results emphasize the importance of limiting concrete paste content (preferably below 26.5%) and maintaining high-quality construction practices (proper consolidation, finishing, and curing). Although continuous placement is often perceived to result in more cracking, most survey respondents reported no significant long-term performance differences between continuous and sequential placement. Some agencies mitigate potential risks by limiting the length or volume of continuous placements, using low-shrinkage concrete, or using retarding admixtures to keep the concrete plastic for extended times, limiting the development of tensile stresses during placement. Analysis of cracking data from 76 VDOT multi-span continuous steel-beam bridges (8 placed continuously) showed no statistically significant differences in cracking between placement methods. Overall, the results suggest that continuous placement may be suitable for multi-span continuous steel bridges with concrete volumes under 360 yd^3 when the concrete can be kept plastic during placement and when the contractor has demonstrated successful experience with continuous deck placement.

Research Benefits

This study provides data-driven guidance to support VDOT's decision-making regarding deck placement methods that promote crack-free decks or decks exhibiting only narrow, non-detrimental cracks, while also enabling more efficient construction practices.

CS2 Cracking Area vs. Deck Volume



Percent Area of the Deck with Conditions State 2 (CS2) Cracking for Sequentially and Continuously Placed Decks Constructed Since 2017

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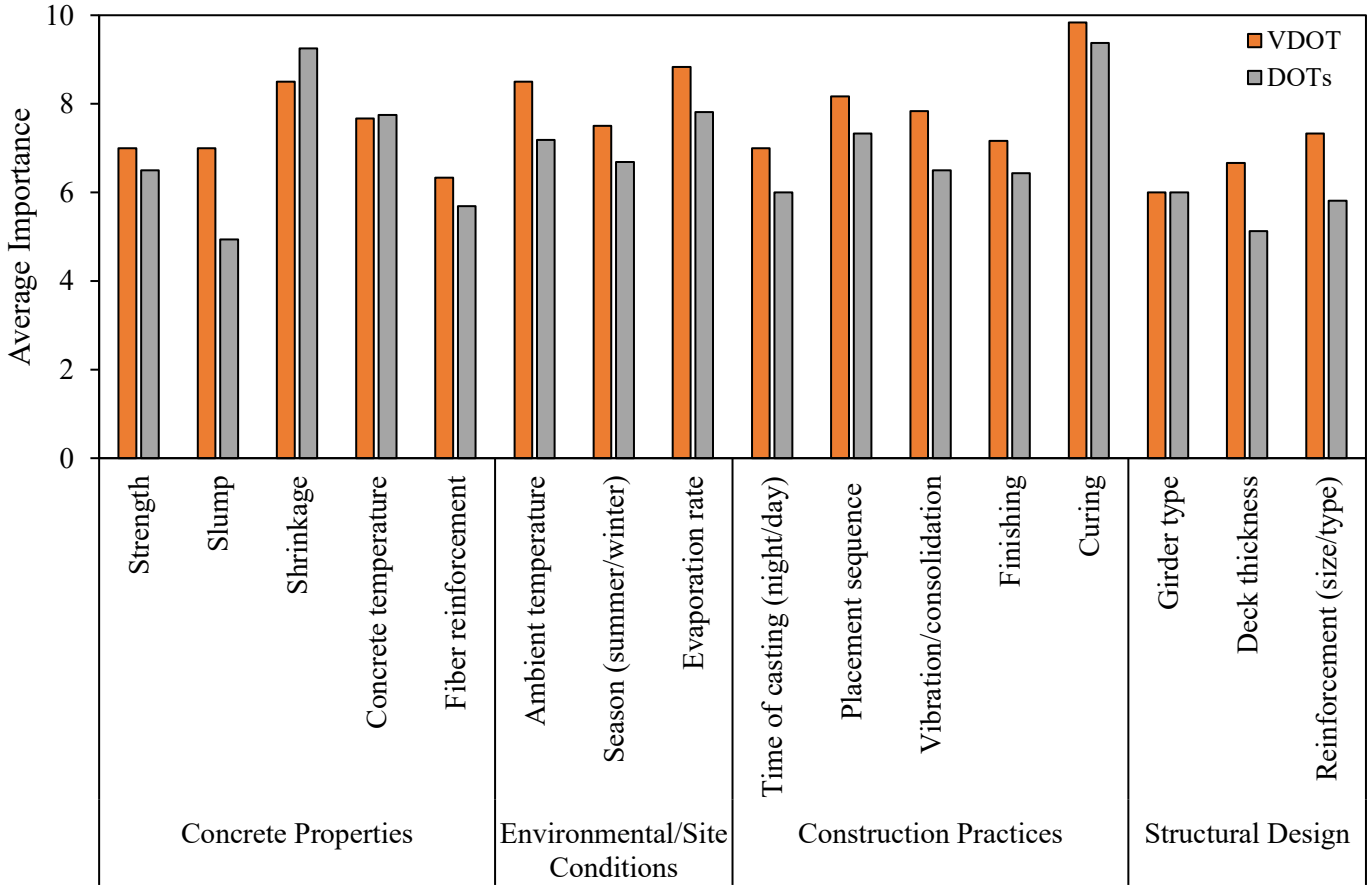
Research Findings



Average Importance of Different Factors Impacting Bridge Deck Cracking (from 1 to 10, where 1 means "not important" and 10 means "critically important")

Factors Affecting Cracking

Shrinkage-related mechanisms (drying, autogenous, and thermal) are the primary contributors to deck cracking. Accordingly, low cracking performance depends heavily on controlling concrete paste content (preferably below 26.5%). Furthermore, good construction practices (consolidation, finishing, and curing) are very important.

Placement Sequence

Although continuous placement is often perceived to cause more cracking, most survey respondents reported no significant differences in long-term performance. In addition, VDOT's bridge conditions data did not show a statistically significant difference in cracking for decks placed continuously versus those placed sequentially.