EVALUATION OF RESERVE SHEAR CAPACITY OF BRIDGE PIER CAPS USING THE DEEP BEAM THEORY

BACKGROUND

- In Ohio, there are approx. 29,000 bridges and multiple pier caps per bridge.

- Many bridge pier caps are deep due to short shear spans. When analyzed using the sectional method, a large number of pier caps are found to be shear-overloaded even though they may not exhibit any noticeable cracking or signs of distress.

- AASHTO LRFD 2017 recommends the use of either a strut-and-tie or nonlinear finite element modeling for the analysis of deep members. Both methods require more effort than the sectional method.


RESEARCH CONTEXT

- Explore innovative strategies to reduce the complexity of the strut-and-tie method (STM) to a level comparable to the sectional method for analyzing deep cap beams.

- Develop a computer program with strong graphical capabilities to automatically generate efficient STM models while intuitively educating practicing engineers on the correct use of STM.

- Determine if sectional methods underestimate the shear capacities of deep beams, and if so, to what extent and under what conditions.

RESEARCH APPROACH

AASHTO LRFD 2017

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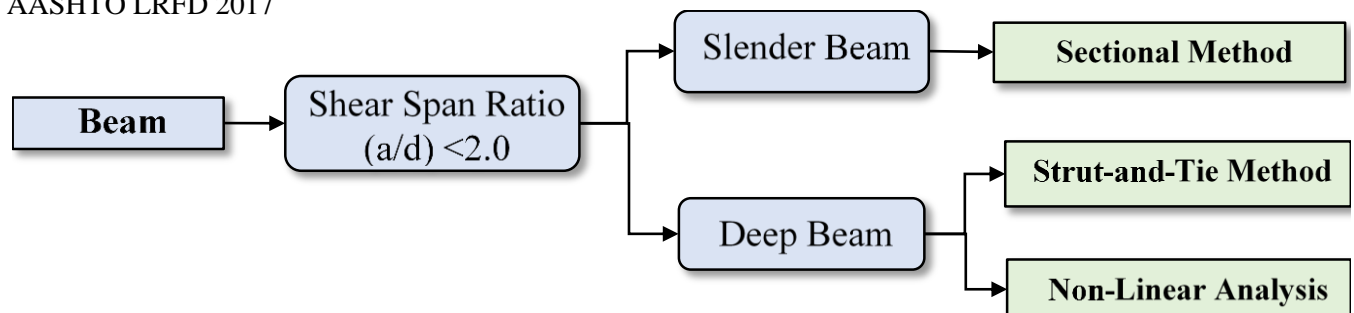
RESEARCH APPROACH

- Development, testing, debugging and refinement of the STM-CAP (*Strut-and-Tie Method for pier CAPs*), a Microsoft Excel Visual Basic Application (VBA) coding solution algorithm using STM.

- Verification of the STM-CAP results by CAST (Computer Aided Sturt-and-Tie) and modeling with Non-Linear Finite Element Analysis (NLFEA).
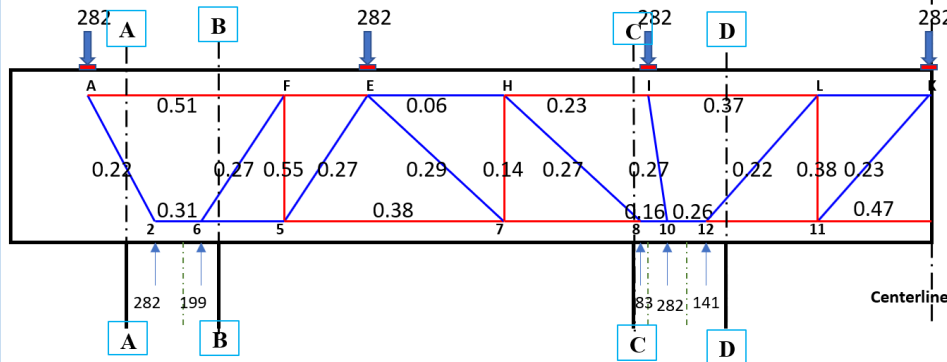
Comparison of Shear Utilization Ratio Comparison (UR)		
Sections	Sectional Method (UR)	STM-CAP (UR)
A-A	0.54	0.22
B-B	0.60	0.55
C-C	0.25	0.3
D-D	0.53	0.38

RESEARCH FINDINGS AND RECOMMENDATIONS

- STM-CAP overcomes the difficulties encountered in the practical application of STM.

- STM-CAP uses VBA coding to provide graphical solutions and eliminates the need to install and learn new software.

- STM-CAP predicts up to three times higher shear load capacities than the sectional method for a/d ratios of 0.50.

- STM-CAP predicts similar behaviors to the NLFEA.

- STM-CAP provides a good compromise between accuracy and complexity. It is more accurate than the sectional method while being much easier/faster than the NLFEA.
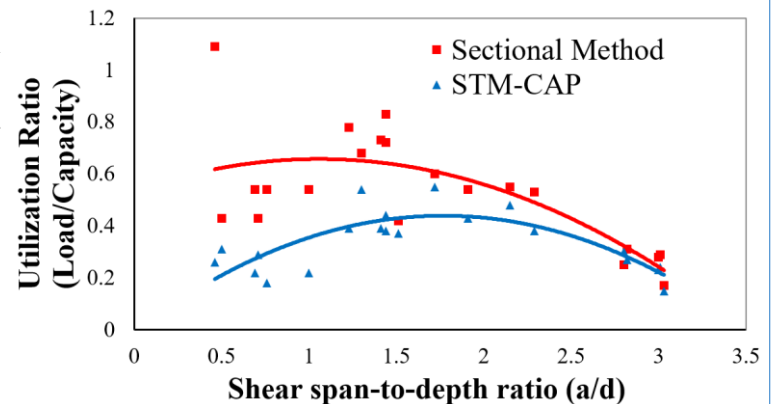
RESEARCH BENEFITS

- STM-CAP provides higher and more accurate shear strength predictions for deep pier caps and facilitates correctly identifying and ranking overloaded pier caps.
- The entire modeling and analysis process can be performed in less than an hour by a beginner user.
- STM-CAP is designed to intuitively educate practicing engineers for the correct use of STM.

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