Enhancements to CAST (Computer-Aided Strut-and-Tie) Analysis and Design Tool

The Strut-and-Tie Method (STM) is a rational method for design of the so-called D-regions in concrete structures as it helps with the understanding of concrete behaviour and leads to a safe design. It has been widely used and incorporated in concrete design codes. Although the STM is conceptually simple, there are two groups of challenges in its implementation. The first one is related to the need to deal with iterative and time-consuming calculations and multiple graphical representations of strut-and-tie models, which can easily distract the attention of design engineers from focusing on the more essential design activities. The second one is associated with the intrinsic limitations of the method, i.e. it is approximate, only considers the strength aspect of design (no serviceability and stiffness considerations) and yields conservative design solutions only if ductile behaviour is ensured. These intrinsic limitations result in designers having to select appropriate strut-and-tie models and/or resort to other complementary design methods to ensure that the design exhibits good performance under loading. So far, there has still been a lack of proper STM-based design tools that is easy to use to overcome these challenges and at the same time cover the code requirements.

CAST (Computer-Aided Strut-and-Tie) is a graphically interactive computer program developed to overcome the iterative and time-consuming aspect of design per the STM. It has been disseminated to and used by practicing, academic, and research communities. However, to better equip engineers to design complex D-regions, it needs to be improved to include features that can be used to overcome the implementation challenges associated with the intrinsic limitations of the STM and to include new strut-and-tie types. Furthermore, to maintain its efficiency and effectiveness, the current CAST needs to be updated to comply with revisions to strut-and-tie design provisions.

This project is aimed at enhancing the versatility of the existing CAST to have the abovementioned features and updates. The product of this project will be an enhanced CAST that (1) allows designers to quickly gain considerable insight into the flow of forces in complex D-regions, which is useful for selecting appropriate strut-and-tie models for complex D-regions; (2) allows engineers to deal with statically indeterminate D-regions; (3) includes new strut-and-tie types; and (4) includes updates of the design features that comply with recent major revisions of the strut-and-tie design provisions of AASHTO LRFD[1] Bridge Design Specifications.

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[1] American Association of State Highway and Transportation Officials' (AASHTO) Load and Resistance Factor Design (LRFD)