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A Comprehensive Finite Element Model for Incremental Launching of Bridges: Optimizing Construction and Design

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Abstract : Incremental launching, a widely adopted bridge erection technique, offers numerous advantages for bridge designers. However, accurately simulating and modeling the dynamic behavior of the bridge during each step of the launching process proves to be tedious and time-consuming. The perpetual variation of internal forces within the deck during construction stages adds complexity, exacerbated further by considerations of other load cases, such as support settlements and temperature effects. As a result, there is an urgent need for a reliable, simple, economical, and fast algorithmic solution to model bridge construction stages effectively. This paper presents a novel Finite Element (FE) model that focuses on studying the static behavior of bridges during the launching process. Additionally, a simple method is introduced to normalize all quantities in the problem. The new FE model overcomes the limitations of previous models, enabling the simulation of all stages of launching, which conventional models fail to achieve due to underlying assumptions. By leveraging the results obtained from the new FE model, this study proposes solutions to improve the accuracy of conventional models, particularly for the initial stages of bridge construction that have been neglected in previous research. The research highlights the critical role played by the first span of the bridge during the initial stages, a factor often overlooked in existing studies. Furthermore, a new and simplified model termed the "semi-infinite beam" model, is developed to address this oversight. By utilizing this model alongside a simple optimization approach, optimal values for launching nose specifications are derived. The practical applications of this study extend to optimizing the nose-deck system of incrementally launched bridges, providing valuable insights for practical usage. In conclusion, this paper introduces a comprehensive Finite Element model for studying the static behavior of bridges during incremental launching. The proposed model addresses limitations found in previous approaches and offers practical solutions to enhance accuracy. The study emphasizes the importance of considering the initial stages and introduces the "semi-infinite beam" model. Through the developed model and optimization approach, optimal specifications for launching nose configurations are determined. This research holds significant practical implications and contributes to the optimization of incrementally launched bridges, benefiting both the construction industry and bridge designers.

Keywords : incremental launching, bridge construction, finite element model, optimization
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