

Design and Analysis of Hybrid Cable-Stayed Bridges: A Comprehensive Study

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Abstract:

This research paper aims to explore the design, analysis, and anticipated performance of hybrid cable-stayed bridges, with a specific focus on the Krishna River Bridge. Hybrid cable-stayed bridges offer structural advantage derived from unique combination of cable stayed and suspension structural arrangements leading to improved load-carrying capacity, structural efficiency, better foundation strata due to pylons placed nearer to the river banks, cost-effectiveness, and aesthetic appeal.

The paper will present a comprehensive study into various aspects involved in the analysis and design of hybrid cable-stayed bridges, with a particular emphasis on Krishna River Bridge Project on NH-167K in the States of Telangana & Andhra Pradesh in India. This will include examining the optimal structural configuration, cable arrangement and material selection for the bridge under different loading conditions. By conducting thorough analyses and simulations, this case study indicates that engineers and the client can make informed decisions during the design and construction phases of a bridge ensuring its safety, durability, functionality and cost effectiveness while achieving high aesthetic value making the structure an Iconic structure very well suited to the terrain and topographical features of the landscape at the Bridge site.

Keywords: Hybrid cable stayed structure, Bridge, anchor block, suspension, concrete, cable-stay, pylon, steel, composite, load, aesthetics.

1 Hybrid Cable-Stayed Bridges

1.1 Definition and classification

A hybrid cable-stayed bridge is a type of bridge that combines features and components from multiple bridge types, typically incorporating elements from cable-stayed bridges and other structural systems such as suspension bridges or beam bridges. This combination results in a unique bridge design that takes advantage of the strengths and characteristics of different structural systems.

Classification of hybrid bridges can be based on different criteria as below.

1.1.1 Hybrid Structure based on structural systems:

Cable-stayed and suspension hybrid structure: This type of hybrid bridge combines the cable-stayed and suspension bridge systems, typically by incorporating pylons with cables supporting the deck, along with cables extending to anchorages on the sides of the bridge. With a suspension cable supported on the same pylons/anchorages thereby facilitating longer spans without attendant increase in the height of the pylons.

Hybrid based on construction materials: Steel and concrete hybrid: This involves combining steel and concrete elements in the bridge design. For example, the tower or pylon may be made of reinforced concrete, while the deck is constructed using steel. This allows optimal utilization of properties of both the material.