



# Analytical Methods to Adjust the Distribution of Dead Loads of a Suspension Bridge with Three Cable Planes to Three Cables in The Transverse Direction

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## Abstract

Suspension bridges with three cable planes (SB-3CP) provide an excellent solution to the suspension bridges' downwarp problem with ultrawide decks. However, the middle cable bears most of the deck load, which affects the torsional rigidity, and force status of the upper transverse beam on the pylon. It is necessary to adjust the distribution of dead loads to three cables in the transverse direction. In this paper, two analytical methods respectively based on the hanger cross sectional area (Method 1) and unstrained length (Method 2) are proposed. By altering the cross-sectional area of each hanger (Method 1) and increasing the unstrained length of the middle hanger (Method 2), the load share beard by the middle cable reduces. Finally, an SB-3CP was taken as an example. As the results show, the more load the side cable bears, the more torsional rigidity the bridge has, and the less vertical force is applied by the main cable to the upper transverse beam on the pylon.

**Keywords:** triple-cable suspension bridge; ultrawide deck; dead load allocation; transverse direction of the bridge; hanger cross sectional area; hanger unstrained length; torsional rigidity; tower's top transverse beam.

## 1 Introduction

Suspension bridges have a long global history and unparalleled spanning capacity among all bridge types due to main cables hanging between the towers and serving as the primary load-bearing parts [1][2][3][4]. With the continuous progress in design theories and construction technologies, the suspension bridge spans reached ultra-large lengths. Several ultra-long-span suspension

bridges are currently under construction, including the Çanakkale 1915 Bridge (main span of 2023 m) in Turkey [5], the Zhangjinggao Yangtze River Bridge (main span of 2300 m) in China, and Guangdong Lion Ocean Bridge (main span of 2180 m) in China. In recent years, the designers have preferred to use an ultra-wide bridge deck to accommodate more vehicle lanes in the suspension bridge.