

Assessing Vehicle Stability on Sea-Crossing Bridges During Strong Winds: Risk Mitigation Strategies

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Abstract: The strong side winds threaten the stability of running vehicles over the sea-crossing bridges due to the high altitude of the deck and free exposure to the upcoming winds. Therefore, bridge operators control the speed limit or close the bridges when the wind speed reaches predetermined criteria. Since sea-crossing bridges play an essential role in transportation networks, the traffic control strategy, including complete closure, requires a careful assessment of the critical wind speed at which vehicle instability can occur. As the aerodynamic forces on vehicles depend on several influential factors, including the geometrical shape of the superstructure, the critical wind speeds vary bridge by bridge. In addition, road surface conditions such as rainfall or icing can affect the stability of running vehicles. This study demonstrates a framework to determine the critical wind speed considering rain or icing road conditions in severe weather. This study reports two overturning accidents experienced on a double-deck suspension bridge and a cable-stayed bridge. The authors also extended the procedure to the probabilistic risk assessment for the whole bridge life by adding long-term wind data and weather analysis. In this way, this study provides a guideline for bridge operators on balancing driving safety and the continuous mobility of the sea-crossing bridges under hazardous weather and high wind conditions.

Keywords: Strong winds, Vehicle stability, Risk mitigation, Sea-crossing bridges, Severe weather