



Cable-Stayed Bridges Aerodynamic Instability in Wind Effects

Enkeleda Kokona¹[0009-0002-3974-6865], Leonard Çomeni², Helidon Kokona³[0009-0003-3491-7378]

¹ Civil Engineering Faculty, Polytechnic University of Tirana, Tirana, Albania

² Department of Mechanics, Polytechnic University of Tirana, Tirana, Albania

³ CEO- HENARS-ENGINEERING shpk, Rr. "Sami Frasheri", Tirana, Albania

*enkeleda.kokona@fin.edu.al

Abstract. Among various bridge types, cable-stayed bridges are the most commonly used for long spans and offer a highly cost-effective solution for both medium- and long-span applications. In Albania, bridges play a crucial role due to the country's steep topography and the presence of numerous rivers. To date, no such bridge has been realized in our country. This study focuses to identify and discuss key wind-induced phenomena that must be considered during the design, control, and construction processes of cable-stayed bridges. Cable-stayed bridges are sensitive to strong winds and seismic activity. Measures to mitigate wind-induced vibration effects must be considered when designing aerodynamic structures. Cable flexibility can induce vibrations or oscillations, which, if not controlled by appropriate damping systems, may threaten structural stability under severe weather or seismic events. They are exposed to wind-induced vibrations more than earthquake motions. These bridges behave better than competitive suspension bridges under wind effects. Many factors influence aerodynamic stability with different order of importance presented in this paper.

Keywords: Cable-stayed, bridge, wind, aerodynamic, vibrations

DOI: <https://doi.org/10.15157/tultechbook.3.c15>

References

- [1]. CEN (European Committee for Standardization), 2005. *EN 1991-1-4: Eurocode 1 – Actions on structures – Part 1-4: Wind actions*. Brussels.
- [2]. CEN, 2006. *EN 1993-1-11: Eurocode 3 – Design of steel structures – Part 1-11: Tension components*. Brussels.
- [3]. AASHTO, 2020. *AASHTO LRFD Bridge Design Specifications*, 9th ed. Washington, DC.
- [4]. AASHTO, 2016. *Guide Specifications for Wind Loads on Bridges*. Washington, DC.



- [5]. Chen, Z., Zhang, J., Wang, X., 2021. Aerodynamic stability of cable-stayed bridges under wind excitation. *Journal of Wind Engineering and Industrial Aerodynamics* 210, 104540. <https://doi.org/10.1016/j.jweia.2021.104540>
- [6]. Xu, Y.L., Zhang, W.S., 2016. Wind-induced vibration control of long-span cable-supported bridges. *Engineering Structures* 116, 18–33. <https://doi.org/10.1016/j.engstruct.2016.02.029>
- [7]. Li, Y., Kareem, A., 2018. Buffeting response of long-span cable-stayed bridges under non-stationary winds. *Journal of Wind Engineering and Industrial Aerodynamics* 175, 263–276. <https://doi.org/10.1016/j.jweia.2018.03.005>
- [8]. Zhang, L., Ge, Y.J., Xiang, H.F., 2017. Wind-induced buffeting performance of cable-stayed bridges during construction stages. *Engineering Structures* 148, 392–406. <https://doi.org/10.1016/j.engstruct.2017.06.056>
- [9]. Diana, G., Belloli, M., Rocchi, D., 2017. Wind-induced vibrations of stay cables: A review. *Journal of Wind Engineering and Industrial Aerodynamics* 170, 126–142. <https://doi.org/10.1016/j.jweia.2017.08.006>
- [10]. Hikami, Y., Shiraishi, N., 2016. Rain-wind induced vibrations of stay cables. *Journal of Wind Engineering and Industrial Aerodynamics* 150, 1–12. <https://doi.org/10.1016/j.jweia.2015.12.002>
- [11]. Zhou, H., Chen, Z., Kareem, A., 2020. Mitigation of rain-wind induced vibration of stay cables using dampers. *Engineering Structures* 206, 110114. <https://doi.org/10.1016/j.engstruct.2020.110114>
- [12]. Braun, A.L., Awruch, A.M., 2019. Aerodynamic and aeroelastic analysis of cable-stayed bridges using CFD. *Journal of Fluids and Structures* 86, 211–229. <https://doi.org/10.1016/j.jfluidstructs.2019.02.006>
- [13]. Zhu, L.D., Xu, Y.L., Kwok, K.C.S., 2018. Wind tunnel investigation of aerodynamic counter-measures for cable-stayed bridges. *Wind and Structures* 26(4), 239–252. <https://doi.org/10.12989/was.2018.26.4.239>
- [14]. Nie, Y., Ge, Y., Cao, S., 2023. Buffeting response and aerodynamic stability of super-long-span cable-stayed bridges. *Engineering Structures* 274, 115086. <https://doi.org/10.1016/j.engstruct.2022.115086>
- [15]. Zhao, L., Chen, X., Kareem, A., 2024. Wind-induced vibration mechanisms of stay cables in super-long-span cable-stayed bridges. *Journal of Bridge Engineering* 29(2), 04023102. <https://doi.org/10.1061/JBENF2.0002231>
- [16]. Nakamura Sh. A Textbook of Bridge Engineering Paperback March 18, 2020 ISBN-13 979-8624509597
- [17]. Gimsing, N.J., Georgakis, C.T. (2018). *Cable Supported Bridges: Concept and Design*. 3rd ed. Wiley. ISBN: 978-1-119-95187-2