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As the mention above, within the additional wind-resistant cable the bridge's overall stiffness is increased, whether static or dynamic crowd load, and the critical wind speed is improved. However, the critical wind velocity and displacement are small under the action of dynamic crowd load and static crowd load, which is because the additional wind-resistant cable which increasing the structure stiffness, reducing the crowd of dynamic effect and shortening the gap between the dynamic load and the static load.

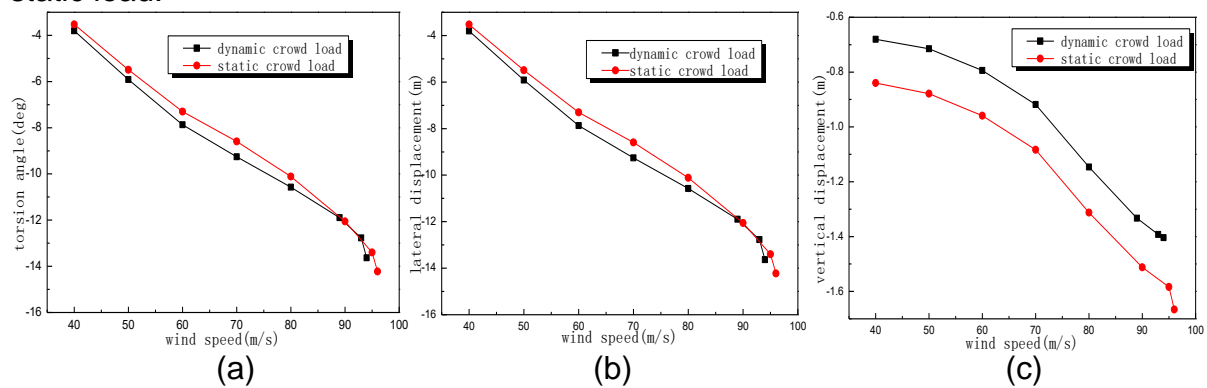


Fig.14 Aerostatic response of beam with different wind speed in different crowd load

Fig.15 represent the torsion deflection, horizontal displacement and vertical displacement of bridge axis on each section of the pedestrian suspension bridge, which with the wind-resistant cable under the action of static crowd load and dynamic crowd load, when the main girder under 65 m/s wind velocity. Can be seen from the diagram, the value of bridge axis angle and displacement of each point on bridge axis is very small under the same wind speed, and rules of the curve are similar under the action of static crowd load and dynamic crowd load. At this point, the nature of the static crowd load and dynamic crowd load is near.

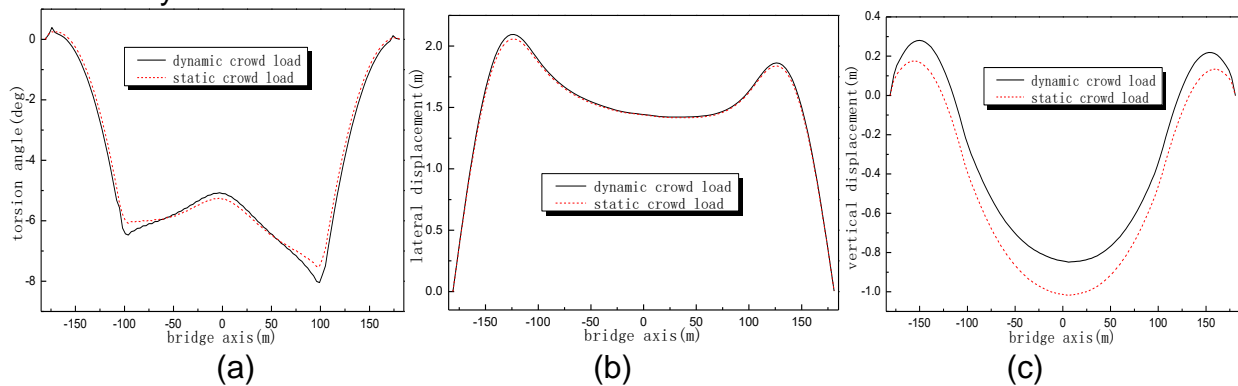


Fig.15 Aerostatic response of beam with 65m/s wind speed under different crowd load

## 6. Conclusions

Three-dimensional nonlinear aerostatic stability analysis of pedestrian suspension bridge is carried out in this paper, and the aerostatic stability is discussed in different crowd load conditions and wind resistance (wind-resistant cable) measures. Meanwhile, this paper explores the effect of buckling critical wind velocity of the main girder when the vertical dynamic crowd load on the bridge, at the same time, the deformation values on the bridge axis and the main girder torsion angle and the largest displacement of pedestrian suspension bridge are calculated under the different velocity. The results show that:

1. The overall stiffness of the bridge would be enhanced if the whole bridge is full of crowd load or the transverse half is full of crowd load, so as to improve the pedestrian suspension bridge girder's buckling critical wind velocity. Deformation of the bridge is adversely affected when the longitudinal half is full of crowd load, this situation should be avoided.

2. The wind resistant cable can reinforce the main beam and improve the overall stiffness of the bridge, and also increase the critical wind velocity. Moreover, transverse displacement of the main girder is effectively restricted.

3. The vertical dynamic crowd load causes the vibration of main girder and the deformation of main girder. What's more, the buckling instability wind girder is reduced. However, with the additional wind-resistant cable, the structure stiffness is improved, the dynamic crowd load effect is weakened and the character of the bridge is approach to under the effect of static crowd load.

## REFERENCES

- [1] Hirai A, Okauchi I, ItoM, MiyataT. Studies on the criticalwind velocity for suspension bridges. Proc. Int. Res. Semi-nar on Wind Effects on Buildings and Structures, University of Toronto Press, Ontario, Canada, 1967: 81~103.
- [2] Boonyapinyo V, Yamada H, Miyata T. Wind-induced nonlinear lateral-torsional buckling of cable-stayed bridges [J]. *Journal of Structural Engineering, ASCE*, 1994, 120(2): 486-506.
- [3] Nagai M, Xie X, etal. Static and dynamic instability analysis of 1400-Meter long-span cable-stayed bridges, IABSE Symposium Kobe 1998, IABSE Reports, 1998, 79: 281~286.
- [4] FANG Mingshan. Nonlinear Aerostatic Stability Theory of Large-span Cable-stayed Bridges [D].Shanghai: Bridge Engineering Department of Tongji University,1997.
- [5] XIAO Rucheng, JIA Lijun, CHENG Jin, eta1. Research on the Key Points Caused by Aerostatic Load in Super-long Bridges [J]. *Journal of Highway and Transportation Research and Development*, 2001, 18(6):34-38.
- [6] Boonyapinyo V, Lauhatanon Y, Lukkunaprasit P. Nonlinear aerostatic stability analysis of suspension bridges [J]. *Engineering structures*, 2006,28(5):793-803.
- [7] LI Cuijuan, GE Zhuping. Static Wind Stability Analysis of Long-span Suspension Bridge [J]. *Journal of China &Foreign Highway*, 2010, 30(4):160-166.
- [8] Cheng J, Jiang J J, Xiao R C. Aerostatic stability analysis of suspension bridges under parametric uncertainty[J]. *Engineering Structures*, 2003, 25(3): 1675-1684.
- [9] CHENG Jin, JIANG Jianjing, XIAO Rucheng, eta1. Advanced Aerostatic Stability

- Analysis of Cable-Stayed Bridge Using Finite-Element Method[J]. *Computer & Structures*, 2002, 80: 1145-1158.
- [10]CHEN Zhengqing, LIU Guangdong. Pedestrian-induced Vibration Theory and Dynamic Design of Footbridges [D]. Guangzhou: The eighteenth session of the structural engineering Academic Conference Report, 2009.
- [11]CA-1 wind tunnel laboratory. Wind Resistant Performance Research Report of Xiaoxin Bridge in Fengya Mountain[R]. Xi'an: Chang'an University, 2016.
- [12]HE Hanxin, LIU Jianxin. Effect of Wind Cable on Dynamic Property of Long-span Suspension Bridge [J]. *Journal of Highway and Transportation Research and Development*, 2010, 27(7):1-5.
- [13]Matsumoto Y. , Nishioka H. and Matsuzaki K. Dynamic design of footbridges[J], IABSE Proceeding, P. 17/78. 1978: 1. 15
- [14]CHEN Zhengqing, HUA Xugang. Vibration and Dynamic Design of Footbridges [M]. Beijing: China Communications Press, 2009:57.
- [15]Germany: Human induced Vibrations of Steel Structures-Design of Footbridges Guideline EN03[S].Research Found for Coal &steel. September, 2008.