Time-delay vibration reduction control of tension leg in submerged floating tunnel

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Abstract. Based on the Euler-Bernoulli beam theory and the time-delay feedback control strategy, the vibration control equation of the tension leg of the underwater suspension tunnel under parametric excitation is established. The Galerkin method and linear stability analysis are used to obtain the stability boundary conditions of the control system with time delay. The influence of different control parameters on vibration response is analyzed through numerical simulation. The results show that reasonable time delay and gain values can greatly reduce the vibration response to the tension leg of the underwater floating tunnel and improve the structural stability.

Introduction

Submerged Floating Tunnel, also known as SFT, also known as Archimeders Bridge[1], is a potential traffic structure across long waterways and deep straits, mainly relying on the buoyancy and support system of its own structure to ensure that it is in a fixed position, which has its unique advantages over traditional tunnels and bridges, and has a wide range of application prospects. However, due to the complex marine environment, the vibration and stability problems of the suspended tunnel need to be solved urgently [2,3]. In recent years, underwater suspension tunnels and suspension tunnel tension legs have attracted a lot of attention from scholars[4]. In this paper, the vibration control of the suspended tunnel tension leg is studied by using the time-delay vibration damping technology. The tunnel pipe body is assumed to be a mass point, and the Euler-Bernoulli beam theory is adopted, and the tension leg is assumed to be a nonlinear beam structure with a fixed hinge at one end and movable articulation at the other end, and the time-delay velocity feedback vibration control of the suspended tunnel tension leg under parameter excitation is studied.

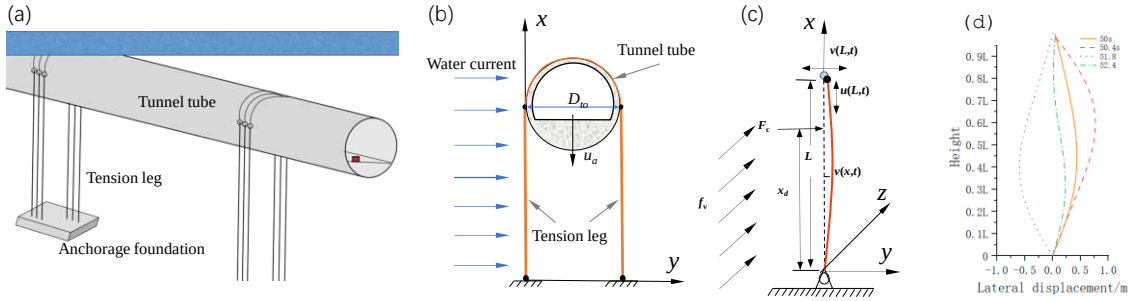

Figure 1: The configurations of the controlled model and displacement deformation diagram. (a) Schematic of the SFT structure. (b) Simplified physical model at the cross-section. (c) Vibration control model of the Tension leg. (d) Displacement deformation diagram of tension leg.

Results and Discussion

The effect of the delay velocity feedback control on the large lateral vibration control of the submerged floating tunnel tension leg is analyzed by using the Euler-Bernoulli beam theory. The results show that the time delayed feedback control can greatly reduce the lateral vibration of the tension leg, improve the structural stability and reduce the fatigue damage. And by determining the stability domain, adjusting the time delay value and gain amount to the appropriate value, the control is set in the middle position of the tension leg, which can make the vibration reduction effect reach the best, and the highest suppression effect can reach more than 90%.

References

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