Department of Civil Engineering and Engineering Mechanics
Columbia University

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A VALIDATED METHODOLOGY TO ESTIMATE THE RELIABILITY AND SAFETY OF SUSPENSION BRIDGE CABLES

Arturo Montoya
PhD Student
Department of Civil Engineering & Engineering Mechanics
Columbia University

The safety of suspension bridges depends on its main cables which are constructed of thousands of high strength steel wires radially clamped together at certain locations along the cable. After many years of service, these cables are showing signs of serious distress with many wires corroded and even broken inside. A new methodology to determine the reliability and safety of this structure is suggested in this research work. A three dimensional random field simulation is used to determine the remaining tensile strength in the cable. The key idea is to determine how individual wire break affects the load transfer to the surrounding wires. This local damage eventually causes a global reduction in the load carrying capacity of the cable, up to a complete failure. A Monte Carlo technique is used to generate realizations of the wires' strength within a finite element model. A novel technique for modeling the contact-friction mechanism between thousands of wires that account for load recovery in broken wires due to friction induced by radial clamps is proposed. The idea is to place elasto-plastic springs at the contact points between wires. These springs have varying yielding limits depending on their proximity to the clamping loads, which is highest close to the clamp and decays when moving away from the clamp. This decaying behavior is assigned according to Boussinesq's solution to a point load in half space. While traditional contact algorithms have difficulties converging on this problem, this technique converges in few iterations. Moreover, parallelization of the problem enables a full stochastic analysis to determine the effect of corrosion uncertainty on the cable's failure load. This method represents a dramatic improvement compared to the current inspection methods that are unreliable and expensive.

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