Adrian Bionka

Abstract

The network arch bridges are arch bridges with network-type hangers' arrangement developed by Per Tveit since the 1960s. In principle, the hangers cross each other at least twice providing great mechanical performance over the vertical and Nielsen arrangements, which makes them more cost-efficient. Various types of network arrangements were developed in literature and optimization investigations helped determining the suitable arrangement type and other parameters in terms of structural performance or weight minimization. However, the analyses were not generalized and considered either known arrangements or custom arrangements but with limitations. The literatures did not include in-plane geometrically nonlinear buckling of the arch, which reduced resistance and impacted the optimized results in comparison with linear elastic bifurcation. The generalized optimization algorithm with implemented more accurate in-plane buckling resistance determination was investigated in this dissertation.

The in-plane geometrically nonlinear buckling analysis resulted in non-negligible lower buckling resistance compared to linear elastic bifurcation analysis. The multi-periodic sinusoidal imperfection form was achieved in geometrically nonlinear post-critical analysis matching expectation from literature, but the approach was generalized comparing to the literature solution.

Two authored optimization algorithm combined genetic algorithm with evolutionary structural optimization and genetic algorithm with gradient-based algorithm. The new approach of cost-oriented goal function implementation into optimization of network-type arch bridges was presented. The possibility of having any hangers' arrangement at the same time with geometry, cross section, material capacity modification and any number of hangers in the optimization process defined with cost-oriented objective function allowed to obtain more cost-efficient solutions than the known and well-defined optimal network arch arrangement suggested in literature. The new hangers' arrangement was discovered and named Multi-Variant Angular Divergence Model. The guidelines for optimal shaping in terms of cost minimization of network-type arch bridges were presented.

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