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Editorial

In the U.S., 15% of bridge failures are due to vehicle collision. Innovative impact protection systems are now considered to protect both bridges and users from the consequences of collision. Metamaterial systems exhibit unusual properties such as negative stiffness, which permits dissipation of high levels of energy. Such systems are of interest in base isolation, impact protection, and shock absorption applications. Bi-stable elements such as pre-buckled beams can be designed to exhibit negative stiffness behavior under transverse loading. In “Analysis of metamaterial Bi-stable elements as energy dissipation systems”, Darwish and ElGawady conduct a finite element modeling (FEM) of bi-stable elements to address the bi-stability behavior and predict the force threshold as well as the amount of dissipated energy. The authors validated the FEM results with experimental results. Identification of damage or stiffness changes in a structure is mostly based on assuming a linear elastic response. However, a section will only respond in a linear elastic range up to a certain yielding point beyond which a non-linear response will take over. A non-linear behavior is more likely in the case of deteriorated structures (i.e. corrosion or cracks in reinforced concrete structures) and/or large loads and deformations, although it can also be motivated by friction at the joints or presence of non-linear material, e.g. bearings. In “Estimation of transitory changes in bending stiffness using the Hilbert-Huang transform”, González and Aied propose a two-stage method based on the Hilbert-Huang transform combined with a statistical optimization approach to characterize the stiffness changes associated with a non-linear response. Life-cycle cost analyses are often considered in bridge management in conjunction with the decision-making process for bridge maintenance, rehabilitation, or replacement. An accurate estimate for these costs requires a better understanding, and proper modeling of, deterioration rate of a bridge’s components throughout its useful time. In considering the deterioration rate in bridge life-cycle cost analysis and management, special attention is needed with regard to the potential for accelerated fatigue damage that can occur because of frequent use of overloads. Overloads and their potential for fatigue damage may in fact become a major cost item in the bridge overall life-cycle cost. In “Impact of fatigue damage from overloads on bridge life-cycle cost analysis”, Jang and Mohammadi introduce an index representing the fatigue life expended (FLE) due to overloads. The index is used as a driving factor in the deterioration curve to incorporate the significance of fatigue damage from overloads in the decision-making strategies in maintenance and rehabilitation and in bridge management. Bridges located at moderately or highly aggressive environments can be subjected to different levels of deterioration. Deterioration can be observed as cracking or spalling of concrete and corrosion of reinforcement. Corrosion of reinforcement is the main concern in capacity reduction due to loss of steel area and reduction in yield strength. In some cases, corrosion may even induce total collapse of bridge. Service life of these deteriorated bridges can be reduced significantly due to some loss in load carrying capacity, which can also negatively affect the future seismic performance. In “Condition factor for seismic performance of deteriorated bridges”, Canan Ocak and Caner investigate reduction of capacity in seismic behavior of bridges subjected to moderately aggressive environmental effects. The authors propose a condition factor to be used in future bridge analysis. Recent studies quantified the increase in load-carrying capacity of bridges, due to the presence of concrete railings. In “Effect of railing deterioration on load carrying capacity of concrete slab bridges”, Darwich et al. quantify the effect of railing deterioration and its impact on load-carrying capacity of bridges. The authors analyzed a total of 112 bridge cases, using finite element analysis (FEA). The FEA results for slab moments were calculated and compared to reference cases and AASHTO procedures.

Khaled M. Mahmoud, PhD, PE
Editor-in-Chief
BTC
New York, New York, USA