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Editorial

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Only four months after it was opened to traffic, the first Tacoma Narrows Bridge suffered a spectacular collapse. During its brief life, the bridge had been frequently observed to go into wind-induced vertical oscillations. Central diagonal stays were added, limiting relative motion of the main cables and deck at mid-span, but on 7 November 1940, after several hours of a storm with relatively low winds of up to about $20\,\mathrm{m\,s^{-1}}$, it was speculated that one or more of these diagonal stays broke loose. This then permitted violent torsional oscillations to build up and the bridge collapsed [1]. Since the collapse of the first Tacoma Narrows Bridge, there have been significant advances in bridge aerodynamics. In modern bridge design, the practice of wind-tunnel tests is universal in the design of long span bridges due to its benefits in identifying aerodynamic parameters. In addition to wind-tunnel tests, theoretical modeling of wind activities is of paramount importance. In practice, both experimental and theoretical aerodynamics are essential for wind stability. The commonly used approach entails the extraction of fundamental aerodynamic data of key structural elements such as the deck, towers, and cables, either experimentally or numerically, and the application of theoretical models for evaluation of structural responses to turbulent winds. This phenomenon called buffeting is extremely complex and, to date, there is no closed-form theoretical model to reproduce how the wind converts to structural responses and loads which the bridge must resist. In “Buffeting response analysis – the stack state-space approach” Stoyanoff et al. explore the base of the problem, namely the transformation of wind gusts to actual loads, and the response estimations. The time domain response approach has been adopted for solution of the generalized equations of motion allowing the exploration of details in the performance of various theoretical interpretations. Aerodynamic and structural data of Pierre-Laporte Bridge in Québec City, and the IABSE Working Group 10, long-span bridge validation example, are utilized as representative cases in this study. Main cables are the most critical and vulnerable elements of a suspension bridge. Operating in harsh environments, bridge cables are susceptible to wire embrittlement, cracking, and breakage. All these phenomena culminate in reduction of the cable strength. It is therefore imperative to the long-term asset management and preservation strategy for main cables to ensure that the condition of cables is known. Several cable inspection and strength assessment strategies have been used over the years, aiming at the preservation of cables against deterioration. Some of these strategies are focused on visual assessment of corrosion along wire surface, whereas other strategies depend on reliability-based techniques, measured mechanical properties, and assessed fracture parameters. The latter approach is supported by evidence of embrittled broken wires retrieved from bridge cables, which display a wide range for critical crack sizes [2]. Practical experience has shown that wire cracking presents a significant risk and is a main driver of cable strength degradation. A risk-based methodology utilizes inspection findings of broken wires and results of wire testing to estimate the cable strength. The risk of concern is missing wire deterioration, which is typically masked. Risk-based analysis employs fracture mechanics principles, in which fractographic examination identifies preexisting cracks in wire samples, to evaluate the strength of cracked wires and thus mitigate the surreptitious risk of cracks in wires [3] and [4]. In visual assessment

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procedures, attempts have been made to correlate visual appearance of wire to strength characteristics. However, test results, obtained from actual cable investigations, show that there is no reliable correlation between corrosion stages and either the ultimate strength or ultimate elongation of tested wires. Statistically speaking, the visual corrosion observed on wire surface does not appear to affect the inherent strength of the material. The wire tensile tests show that visual corrosion is almost meaningless as a predictor of wire strength. Further, statistical analysis of fatigue test results on wire specimens extracted from cables, shows that there is no significant difference in the number of cycles to failure for visually classified corroded and uncorroded specimens. In other words, the corroded wire specimens tend to have fatigue life like the fatigue life of uncorroded specimens. Similar observations have been noted in wire samples, which were subject to laboratory-induced corrosion, then tested under fatigue loading. In "Correlation between corrosion level and fatigue strength of high-strength galvanized steel wires used for suspension bridge cables", Miyachi et al. study the relationship between "rust color distribution ratio," "corrosion surface shape," and "fatigue strength" of high-strength galvanized steel wires used in suspension bridge cables. The study utilizes a digital image color analysis system to classify the rust color distribution rate and categorizes corrosion levels based on the distribution ratio. The study concludes that fatigue and tensile strengths of the specimens from the corrosion levels set in the study are equivalent to or higher than those of new wires. The findings of the study echo observations by many investigators in practice [2, 3 and 4]. Rail-structure interaction (RSI) analysis and vehicle-track-structure-interaction (VTSI) analysis are often required during bridge design. For example, the California High-Speed Train Project requires RSI analysis for final design of all structures, as well as VTSI analysis, with the level of interaction to be modeled determined by the complexity of a structure. The goal of RSI analysis is to ensure that superstructure deformations and rail stresses are within acceptable limits. VTSI analysis is a dynamic analysis that considers influence of actual trainsets. VTSI Level 1 analysis includes train loads as a series of moving loads. This analysis allows evaluation of dynamic impact effects from trainsets and vertical accelerations of the deck. For complex high-speed railway bridges, VTSI Level 2 might be required, accounting for full dynamic interaction between the trainset and the bridge. To represent this interaction, the trainset is modeled as a multibody system consisting of rigid bodies, springs, and dashpots. The interaction between wheels and rails is accounted for through kinematic constraints and Lagrange multipliers. In "Rail-structure interaction and vehicle-track-structure interaction level 1 and 2 analyses", Fedorova et al. present modeling, RSI, and VTSI analyses of a railway bridge, where the track and superstructure are modeled using a macro that generates the track, approach, and bridge geometries. Fasteners are modeled as hysteretic springs and automatically positioned along the curved geometry of the track. RSI analysis is performed accounting for temperature differentials between rails and the deck, vertical train loads, acceleration, and braking forces. Break in the rail is introduced using stage construction analysis, followed by progressive collapse analysis (with adapting increments and arc-length control) or nonlinear dynamic analysis. The authors finally perform VTSI Level 1 and 2 analyses and compare the results and compare car body accelerations to limit values to ensure passenger comfort. Over time, owners may face challenges with management of bridges with outdated details. One such detail that is no longer used today is the steel girder shiplap connection. These were originally employed to simplify analysis of continuous girders while also moving joints away from the piers, improving longevity of bridge bearings and substructures. Unfortunately, fatigue issues have appeared in these connections resulting in cracking at critical load-carrying locations. In "Evaluation and retrofit of steel girder shiplap connections", Kozy et al. investigate connection fatigue and strength and retrofit design verification for the Chain of Rocks Bridge, a 43-span continuous, cantilevered steel girder bridge constructed in 1966 just north of Granite City, Illinois, USA. Results utilizing non-linear analysis showed that while stresses from ultimate loading could adequately redistribute throughout the web, high stress concentrations were created, exacerbating fatigue. Stress calculations for shiplap web details are not well codified or easily assessed with simple hand calculations, so finite element analysis was utilized. Results showed web fatigue life had been exhausted with more cracking expected at other locations, convincing the owner retrofit was necessary even though the bridge was programmed for replacement. The Dutch economy relies heavily on mobility, transport and logistics, and accessibility to the main economic centers. The Dutch mobility policy serves 2 goals: reliable journey times and better accessibility.

Motorists travelling during rush hour must be able to arrive to their destination without delay 95% of the time, despite increased mobility and unexpected congestion. Rijkswaterstaat (RWS), the Dutch Directorate-General for Public Works and Water Management, strives among its objectives to improve and maintain their network of highways and waterways. This is a very important task, since various bridges, tunnels, and roads date back to the 1950s and 60s while in the meantime traffic volumes have risen significantly and trucks have become heavier which has resulted in increasing pressure on the Dutch infrastructure. In response to fatigue problems observed on steel orthotropic decks, RWS began a refurbishment program of eight major steel bridges to provide strengthening design and engineering for an extended life of at least 30 years. Among those is the Van Brienenoord bridge, which is located on the Netherlands' busiest highway, and comprises 12 lanes of traffic split across the eastbound bridge built in the 1960s and the western bridge built in the 1990s. The Van Brienenoord bridge complex consisting of two parallel 300 m span steel arch bridges, approach structures and three parallel bascule bridges over the New Meuse. The bridges carry about 230,000 vehicles daily. A strengthening and replacement strategy was developed to reduce road closures to one of the two bridges at a time and reducing this time to weeks instead of months. The strengthening consists of plate stiffeners to the main girders and arches and a new deck. Construction begins in 2025 and is expected to extend the bridge's useful life to another 100 years. In "Renovation of the Van Brienenoord Bridge, The Netherlands", Acosta et al. present details of the bridge assessment and strengthening design. The strengthening instead of replacement is in line with RWS' commitment to adopting circular economy principles for infrastructure network.

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