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High cycle and low cycle fatigue to estimate the remaining life of steel bridges

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High cycle fatigue (HCF) caused by low amplitude loading is considered as a major cause of bridge failures and it is generally checked at the design stage of bridges. However, a number of fatigue failures have been reported in the past which cannot be explained by HCF phenomena. Detailed studies on such failures have revealed that high amplitude loading due to earthquakes and cyclones is one of the causes of failure. During events of such high amplitude loadings, structural members of bridges may be subjected to stresses in the plastic range causing low cycle fatigue (LCF) damage which may lead to sudden failures. The commonly used approach of damage prediction is based on Von Mises Strain, Coffin-Manson Strain-Life Relationship with Miner's Rule. However, Von Mises Strain does not accurately represent the fatigue behavior in multiaxial HCF and LCF. Also, HCF and LCF interaction is not accurately represented by the Coffin Manson Curve. Further, Miner's Rule does not predict accurate results in variable amplitude loadings as it is not able to capture the loading sequence effect. In view of these considerations, this study was conducted with the objective of developing a new combined high and low cycle fatigue model to predict the life span of structures, including bridges subjected to combined effect of high and low amplitude loadings. The model developed consists of modified Von-Mises Equivalent Strain as the damage indicator and fatigue damage computations were carried out using a sequential law that can simulate the load sequence effect. The verification of the proposed model was then carried out, based on experimental test results of a selected structural material. The results of the study indicate that the proposed fatigue model predicted fatigue life more accurately than the previous model based on the Miner's Rule.

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