Assigned Session: B 1 Failure Prevention for Materials and Structures

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Organization: US Army Research Laboratory: Vehicle Technology Directorate

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Paper Title: **Damage Accumulation Rate Computation in the Frequency Domain Due to Random Loading Using FEM-RFC Model**

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Abstract:

Modern military aerial and ground vehicles have given rise to a host of new reliability problems in due to random vibration loading. The loading environments generated in these systems vary randomly in both time and space over wide range of frequencies. Such loads can cause severe vibration fatigue damage leading to catastrophic failure. Modeling the fatigue damage under such complex environment is difficult and expensive in the time domain. A general model that combines the Finite Element Method (FEM) with the Rate of Frequency Change model is developed to predict fatigue life of structures experiencing random vibration using only frequency domain information. Execution of the combined FEM-RFC model requires only the input power spectral density, damping factor and material properties. In the FEM-RFC model the damage accumulation rate is computed in the frequency domain using Linear Elastic Fracture Mechanics (LEFM). The model has been validated, analytically and experimentally using a cracked cantilever beam. Integrating the FEM with the RFC model allows the model to be extrapolated to more complex geometries for which closed-form stress intensity values are not available. The model may be extended to accelerated life testing, virtual qualification and life-cycle assessment. It can be used as a degradation model to analyze the relative severities of complex structures under harsh vibration environments. No explicit knowledge of the time history is needed. Such an approach may reduce the computation time and cost required to run a fully explicit FEM analysis.