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NUMERICAL SIMULATION OF FATIGUE LIFE PREDICTION OF METALS AND NON-METALS – ULTRA LOW CYCLE FATIGUE (ULCF), LOW-CYCLE FATIGUE (LCF) AND HIGH-CYCLE FATIGUE (HCF)

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Abstract. The mechanical phenomenon known as fatigue produces a loss of material strength as a function of the number of cycles, load amplitude, reversion index, etc. This loss of strength induces the material to inelastic behavior, micro-cracking followed by crack coalescence, leading to the final collapse of structural parts.

Fatigue phenomenon is defined more generally as: “the process of permanent, progressive and localized structural change which occurs to a material point subjected to strains and stresses of variable amplitudes which produce cracks which lead to total failure after a certain number of cycles”. In this definition it is possible include “Ultra Low Cycles Fatigue” (ULCF), “Low Cycles Fatigue” (LCF)” and “High Cycles Fatigue” (HCF).

High Cycle Fatigue (HCF) or classical fatigue can be defined as a permanent process, progressive and localized structural change which occurs on the material point subjected to variable amplitudes of strains for stresses level below the static strength limit of the material.

Ultra-Low Cycle Fatigue (ULCF) can be defined as a failure that occurs at a relatively small number on the repeated stress or strain cycles. The upper limit in low-cycle life has generally been selected arbitrarily by different researchers to lie in the range of 10^4 - 10^5 cycles.

Low Cycle Fatigue (LCF) is an appropriate combination of the two previously types of fatigue and is characterized by a small number of post-endurance stress reversals (has been recognized to be a cause of structural failure in steel frames during earthquakes).

The talk will be oriented to describe a broad new mechanical-numerical approach for the treatment of Ultra-Low, Low and High cycle fatigue, as well as the ability to simulate the transition between them. Also will be presented a time advance strategy for the cyclic loading treatment, which is considered by the aforementioned fatigue formulation.

The full treatment of all possible types of fatigue provides a comprehensive approach; that together with the cyclic loading treatment offers a significant reduction in computational cost doing it possible to use this approach in the predicting life of the structures.