8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

CONTINUOUS DAMAGE DEACTIVATION IN MODELLING OF LOW CYCLE FATIGUE OF METALLIC AND CONCRETE MATERIALS

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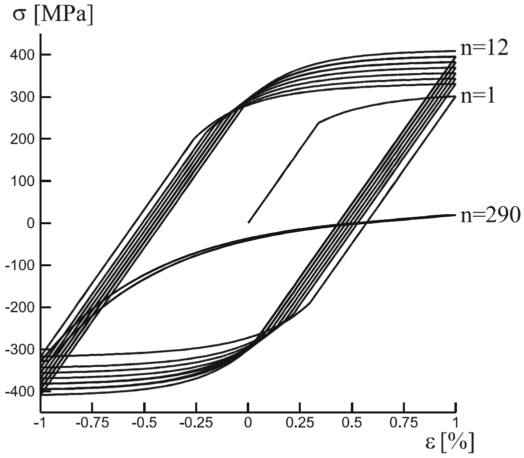
Key Words: *Continuous Damage Deactivation, Low Cycle Fatigue, Metallic and Brittle Materials.*

ABSTRACT

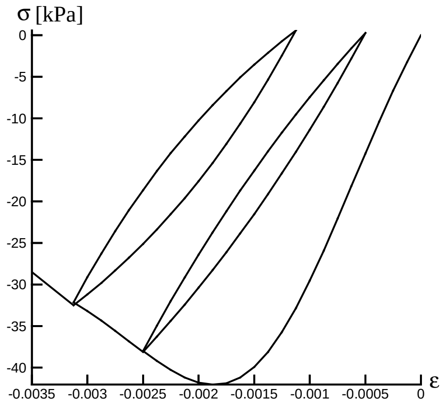
The phenomenon of the unilateral damage, also called the damage deactivation or the crack closure/opening effect is typical for metallic materials subjected to reverse tension-compression cycles or concrete materials subjected to cyclic compression.

In the simplest one-dimensional case of metallic materials, if the loading is reversed from tension to compression, the cracks close completely such that the material behaves as uncracked, or in other words, its initial stiffness is recovered. If the material is strain loaded damage induces a drop of the stress amplitude and the decrease of the elasticity modulus. Damage evolution theory, suitable to model such phenomenon is shown in [3, 8]. The fundamental assumption is that, the damage is related to the accumulated plastic strain. However, the defect of such model is the switch at loading path corresponding to different modulae of elasticity referring to its tensile and compressive parts, respectively. In order to eliminate this unrealistic behaviour the concept of continuous damage deactivation is proposed [6, 7]. Numerical modelling of tension/compression test for aluminium alloy Al-2024 reported in [1] is presented in the left side of figure.

A typical uniaxial compressive stress-strain curve of concrete material under cyclic loading exhibits plastic softening with characteristic loops changing size and decreasing of average slope in subsequent unloading-reloading phases. The consistent approach to stiffness degradation of concrete is presented in [5]. In typical stress-strain relation for a primary loading curve [2] damage depends on positive strain in the direction transverse to a loading [4]. Application of the unilateral damage effect, which corresponds to friction inside microcracks, allows to model subsequent unloading-reloading loops. Numerical modelling of uniaxial cyclic compressive concrete specimen reported in [9] is shown in the right side of figure.



Numerical modelling of tension/compression test of Al-2024 (experiment by Abdul-Latif and Chadli [1])



Numerical modelling of uniaxial cyclic compressive concrete specimen (experiment by Sinha et al. [9]

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