

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/265619942>

Creep–damage coupling

Article · January 2006

CITATION

1

READS

66

5 authors, including:



Frédéric Dufour

Grenoble Institute of Technology

122 PUBLICATIONS 1,177 CITATIONS

SEE PROFILE



G. Pijaudier-Cabot

Université de Pau et des Pays de l'Adour

312 PUBLICATIONS 6,364 CITATIONS

SEE PROFILE



Theocharis Baxevanis

University of Houston

41 PUBLICATIONS 373 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



Mechanical properties of nanoporous materials [View project](#)



Fracture in SMAs [View project](#)

CREEP-DAMAGE COUPLING

F. DUFOUR*, G. PIJAUDIER-CABOT*, T. BAXEVANIS[†], R. DESIASSYIFAYANTY[‡] AND M. OMAR

* R&DO, GeM, CNRS, Ecole Centrale de Nantes † University of Creta
1 rue de la Noë, BP 92101 Heraklion, Greece
44321 Nantes, France ‡ University of Indonesia
Frederic.Dufour@ec-nantes.fr Depok, Indonesia

The failure of quasi-brittle materials under mechanical loading can be divided into two different parts. Initially, diffuse microcracking (damage) occurs in the Fracture Process Zone (FPZ) due to heterogeneities at the micro-scale. Further on micro-cracks coalesce into a macro one yielding strain localization. As the size of the FPZ is related to the microstructure, this type of fracture yields a size effect extensively studied by Bazant since the 70's [1]. For prestressed concrete structures for which permanent load level is large, the influence of creep on the fracture process should be taken into account. We tackled the coupling between creep and failure properties from experimental, analytical and numerical point of view keeping in mind the perspective of size effect. Therefore, several analyses have been performed on three point bending tests on a notched beam of three homothetic sizes.

We first put experimentally in evidence the coupling between creep and damage with several levels of sustained load. Tertiary creep yielding failure has eventually been observed for some of the largest beams and loaded at the highest level. For surviving beams a residual capacity test has been performed to evaluate peak load and fracture energy after three months of creep at different load levels. The conclusion of this study is that the bearing capacity is slightly influenced by creep whereas the fracture energy decrease is not negligible. Therefore we observe a shift towards the LEFM response in the size effect plot.

In a second stage to get some insights of the bifurcation problem we perform an analytical analysis [2]. The conditions for localization in a rate-independent material described by a non-local damage based constitutive relation coupled with a Kelvin type creep relation are derived in a closed form. The inception of a localized mode is considered as a bifurcation into a harmonic mode. The criterion of bifurcation is reduced to the classical form of singularity of a pseudo acoustic tensor; Based on the wavelength of the localization mode, a shift on the size effect plot towards the strength criterion, i.e. towards ductility, is found when the fraction of creep release energy which contributes to damage is decreasing. Moreover, the normal to the localization band depends only upon the elasto-damage state of strain.

Finally, we numerically simulate the experimental tests with a finite element code using the coupling between the Benboudjema's creep model [3] and the Mazars' damage model [4]. Experimental results are qualitatively reproduced in terms of failure due to tertiary creep, fracture energy reduction.

References

- [1] Z. P. Bazant, "Instability, ductility and size effect in strain-softening concrete," *J. Eng. Mech.* **103**, 331–344, 1976.
- [2] T. Baxevanis, Pijaudier-Cabot G. and Dufour F., "Bifurcation and creep rate-effects in a viscoelastic non-local damageable continuum," *In preparation*.
- [3] F. Benboudjema, Meftah F., and Torrenti J.-M., "Interaction between drying, shrinkage, creep and cracking phenomena in concrete," *Eng. Struc.* **27**, 239–250, 2005.
- [4] J. Mazars, "Application de la mécanique de l'endommagement au comportement non linéaire et à la rupture de béton de structure," Ph.D. thesis (in French), 1984.

Keywords: creep, damage, size effect, concrete, failure, localization