



Accelerated creep and inverse Omori law: interplay of randomness and instability

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Statistics for micro-fracture events in the laboratory scale shares many aspects with those for earthquakes: the GR and the Omori-Utsu laws. For instance, creep test, in which constant stress is applied to a specimen, generally exhibits the Omori-Utsu law in terms of strain rate. The power-law decay of strain rate is followed by the secondary creep with nearly time-independent strain rate. In the subsequent tertiary creep, the strain rate increases rapidly, leading to breakdown of a specimen. This acceleration of strain rate is described by the inverse Omori law.

There have been some physical models that can reproduce these power-law behaviors. Most of them are classified into the fiber bundle model. This is an assembly of fictitious fibers that support the mechanical load in parallel. Each fiber has its own failure threshold, which is randomly set according to a specific probability distribution function. Aiming at reproducing creep-like behaviors, some studies adopt probabilistic rules for the elementary failure process, which may model thermal activation processes or introduce additional variables that may correspond to the accumulated damage in the fibers.

These attempts may be legitimate because creep involves thermal activation processes as its microscopic origin.

In the present study, we adopt a simple deterministic model to show that it is sufficient to reproduce creep-like behaviors. We investigate the time evolution toward breakdown for both the mean field and the local stress concentration cases. Although the model does not include any thermal activation process, it resembles most properties observed in creep tests including the above-mentioned three stages. Particularly, the Omori-Utsu and the inverse Omori laws are reproduced, and the exponent and the c -value are obtained. We show the dependence of c -value on the external load and disorder in the system.