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# Effect of ageing in fibre bundle models on the evolution of acoustic and silent damage in time-dependent failure

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The spatio-temporal evolution of damage in brittle materials is often modelled by fibre bundle models. In real fibre bundles (such as suspension bridge ropes), and in other composite materials such as rocks and ceramics, the evolution of damage as a function of stress and time can be recorded using acoustic emissions (AE), and used to asses the integrity of the sample and its lifetime. Such monitoring however tells only part of the story, since time-dependent, effectively 'silent' damage also occurs without AE, and small AE events may not be recorded below some recording threshold set by the background noise. The proportion of seismic to aseismic deformation is important for a number of applications, for example providing a strong constraint on plate boundary dynamics and estimates of earthquake hazard. Accordingly we have modified the usual fibre bundle model by introducing some additional ageing, which results in silent damage below a nominal threshold for more dynamic deformation. This enables us to model the effect of the model parameters on the ratio of acoustic to total damage, and how it evolves in time under a given stress history. We found that the silent damage dominates the process and that for a constant applied stress the ratio between acoustic and silent emissions is approximately constant over a wide range of time. The proportionality factor depends strongly on the applied stress and only weakly on the ageing parameter, while it is the other way around for the failure time which depends more on the ageing parameter than on the applied stress.