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Geometrical probability of a capsule hitting irregular crack networks: application to capsule-based self-healing materials. (English) Zbl 1481.74667

Appl. Math. Modelling 101, 406-419 (2022).

Summary: Cracks are vitally detrimental to the load-bearing capacity of materials and further to the durability and service-life of various structures. Autonomous self-healing via embedded capsules or hollow fibres with healing agent has recently become more popular to repair the damage of structural materials. Figuring out the exact amount of capsules required to repair the cracks is indispensable to develop and design the capsule-based self-healing materials. In this paper, by means of surveying the irregular crack patterns appear on the surface of composite materials the approximated cracks models are induced in the self-healing materials and the probability model of capsules which are randomly dispersed intersecting with the crack networks is developed from the viewpoint of geometry probability. Further, the proposed probabilities for different crack patterns are applied to gain the theoretical solutions on the exact dosage of capsules containing healing agent that are used to obtain a specific self-healing efficiency in capsule-based self-healing materials (cementitious materials, for instance). Finally, the accuracies of these probabilities values and theoretical solutions are verified via computer simulation where the event of capsules intersection with different crack networks are reproduced.

MSC:

74R10 Brittle fracture
74A40 Random materials and composite materials
60D05 Geometric probability and stochastic geometry

Keywords:

self-healing materials; capsules; crack patterns; analytical model; geometry probability; Monte-Carlo simulations

Full Text: DOI

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