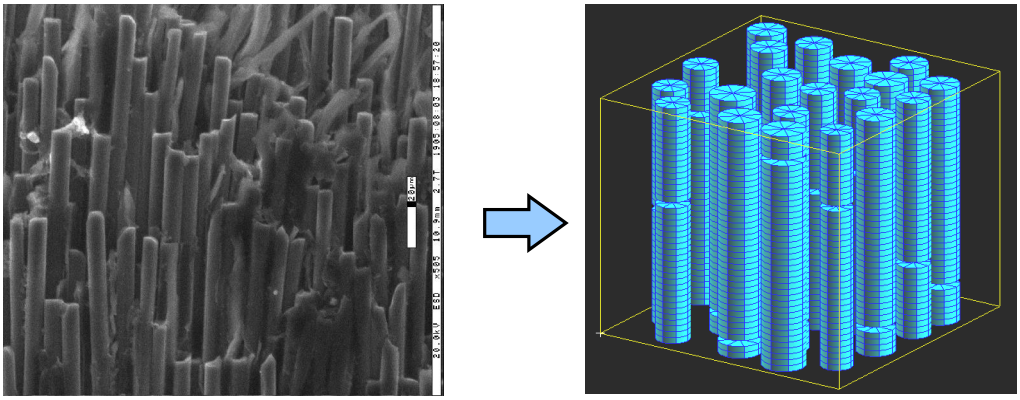


Figure 1. Micrograph of fracture surface of an unidirectional fiber reinforced composite (with failed fibers) (left) and an example of the generated FE models with 20 fibers, and removed layers of potential fracturing (right). Left picture presents carbon fibers in the polyester matrix (Courtesy of Dr. S. Goutianos, Risø National Laboratory, Denmark).

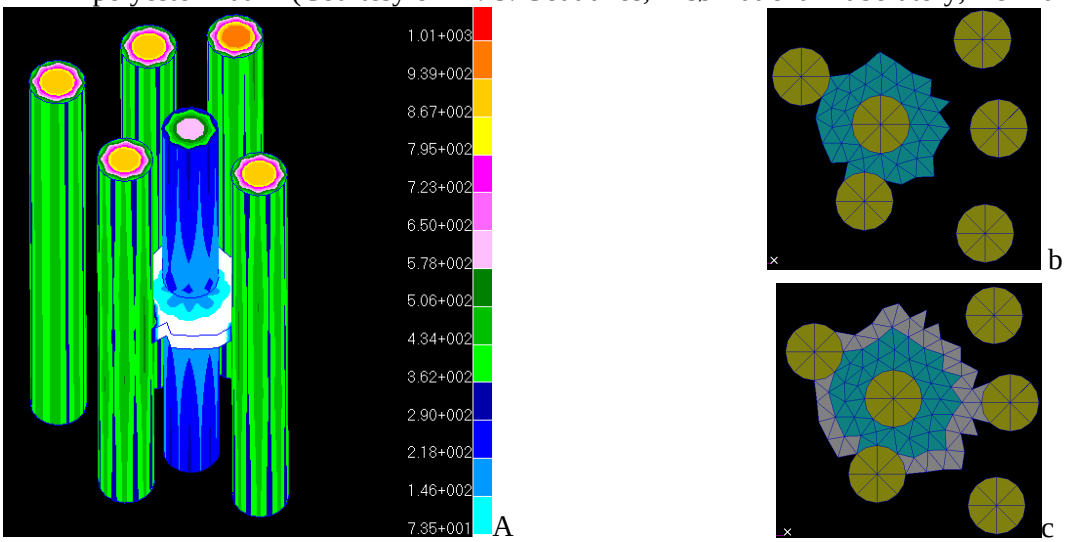


Figure 2. Formation of the matrix crack from the fiber crack (a), and the matrix crack growth from the fiber crack to the neighboring fibers (b, c).

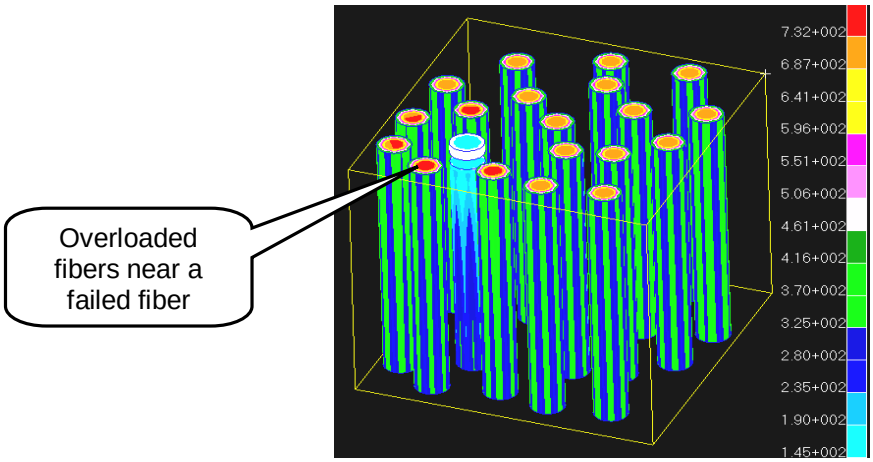


Figure 3. Load sharing and localization around a failed fiber (after the first fiber failure, ε=0.008)

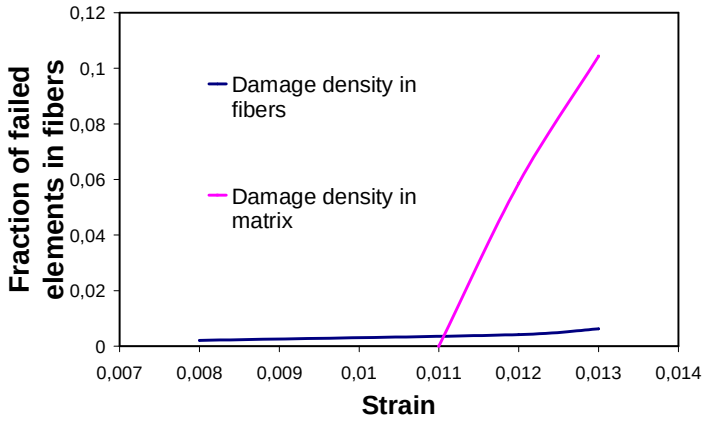


Figure 4. Damage-strain curves: the matrix cracking is triggered by the fiber failure, but the crack in matrix grows much quicker than the cracks in fibers

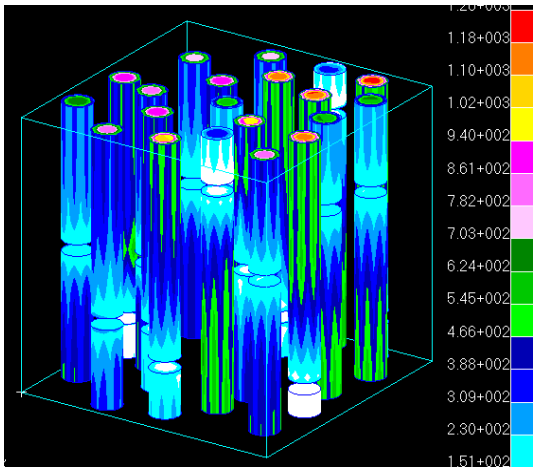
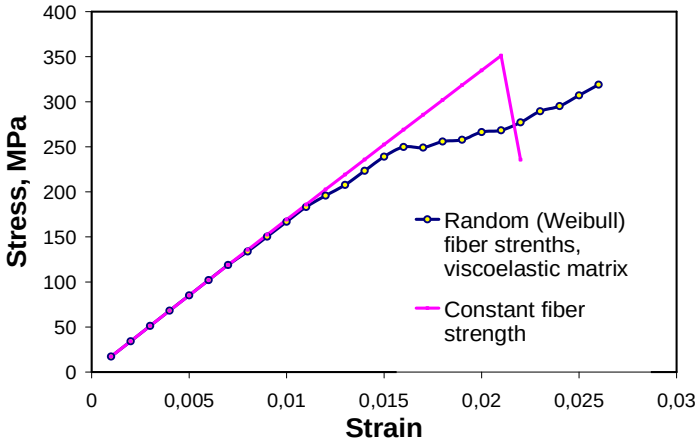
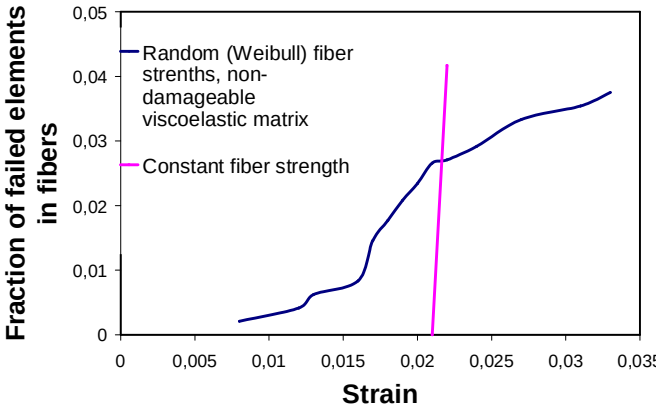


Figure 5. Von Mises stress distribution in fibers after cracking for the case of constant fiber strength



A



b

Figure 6. Stress-strain and damage strain curves: random (Weibull) and constant fiber strengths.

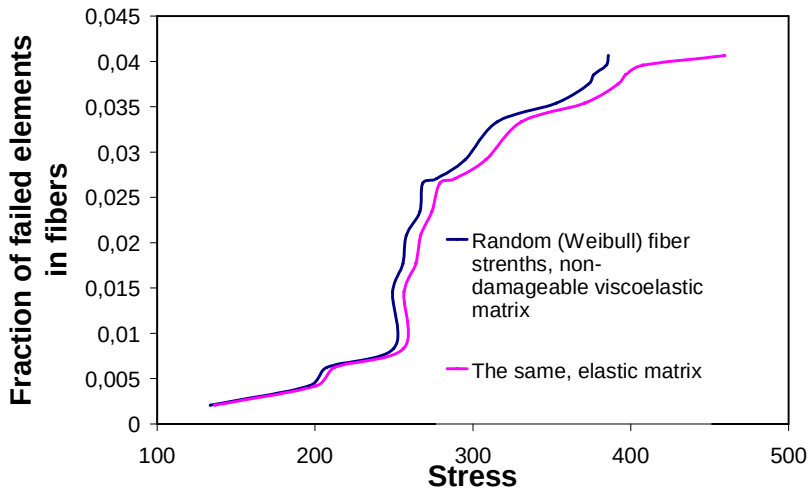


Figure 7. Damage strain curves: viscous matrix and the elastic matrix (with the same elastic coefficients)

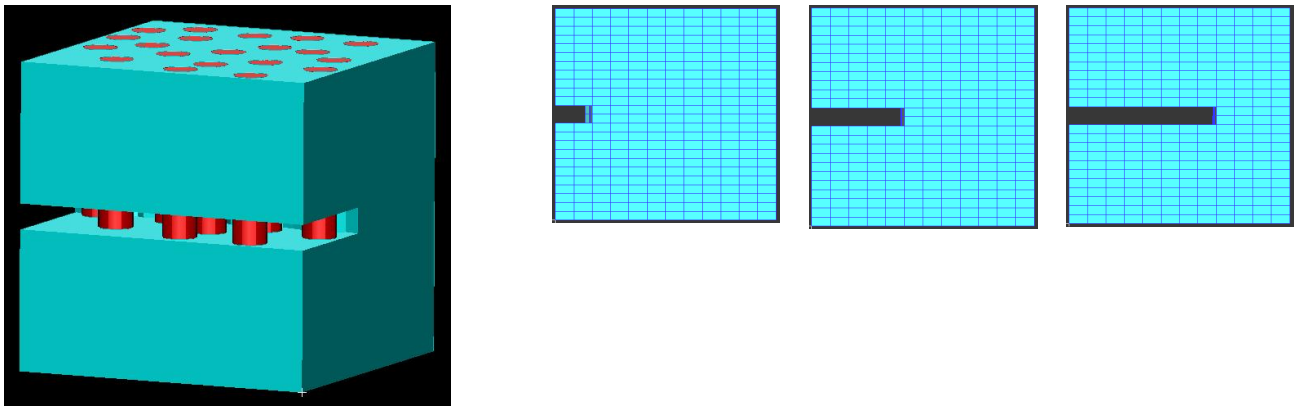
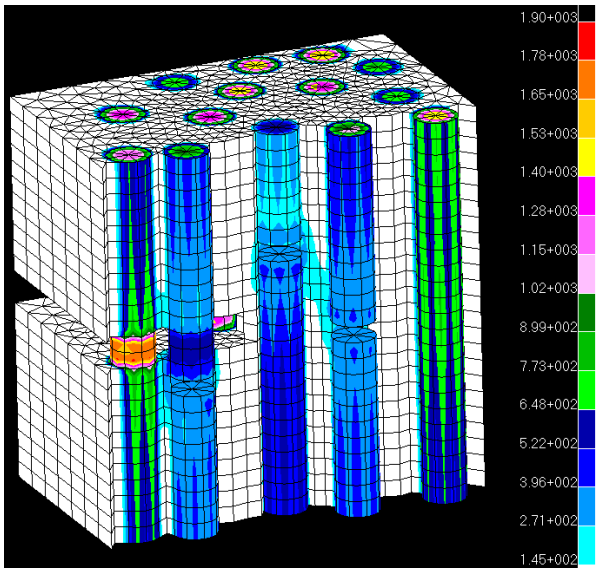
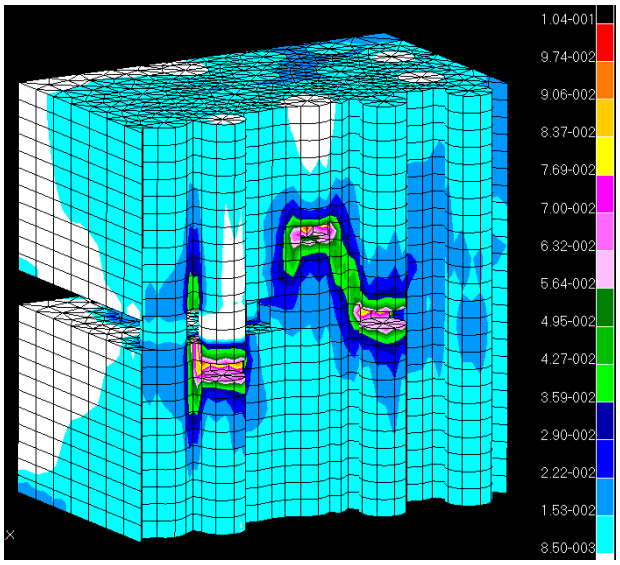


Figure 8. Unit cell with a matrix crack and bridging fibers [1, 35]

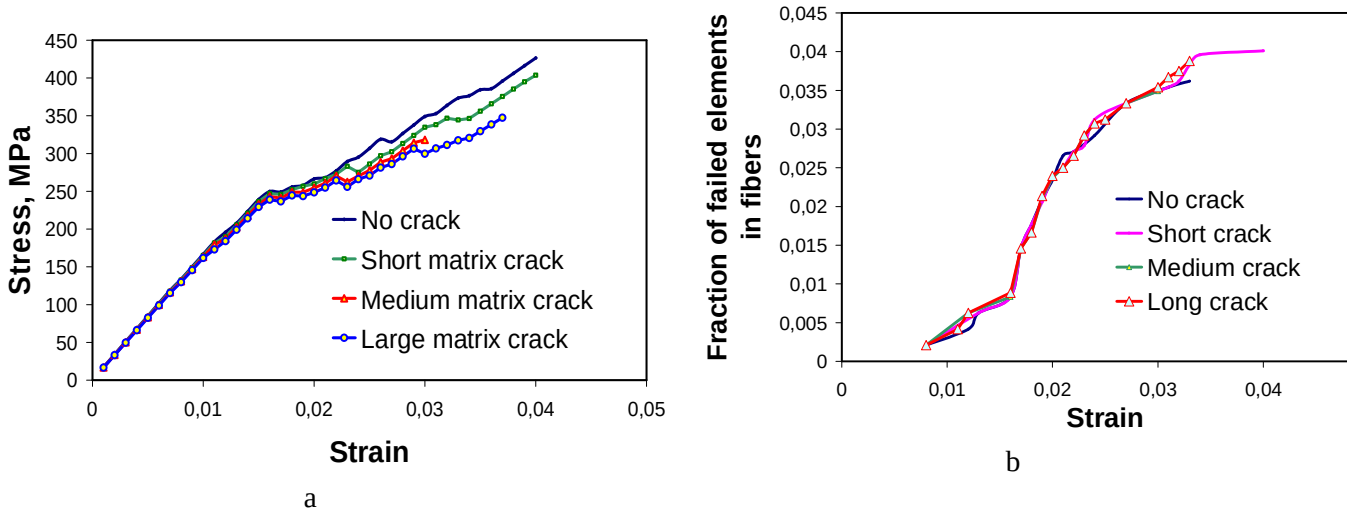


a



b

Figure 9. Von Mises stress distribution in the fibers and matrix (a), and maximal shear strain in the matrix (b) after the fiber cracking



a b

Figure 10. Stress-strain (a) and damage (fraction of damaged elements in the damageable sections of the fibers) versus strain (b) curves for the unit cells with and without the matrix cracks.

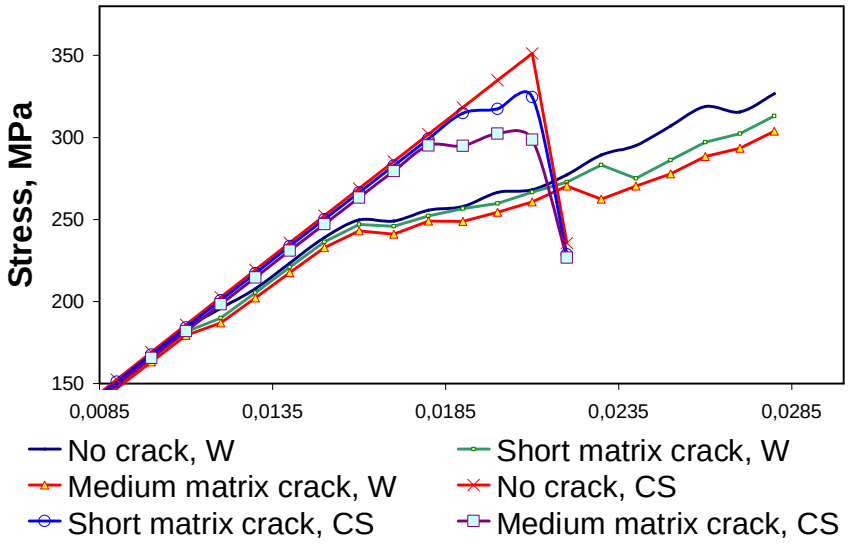


Figure 11. Stress-strain curves for the unit cells with and without the matrix cracks, with constant (CS) and randomly distributed (W-Weibull) strengths of fibers.

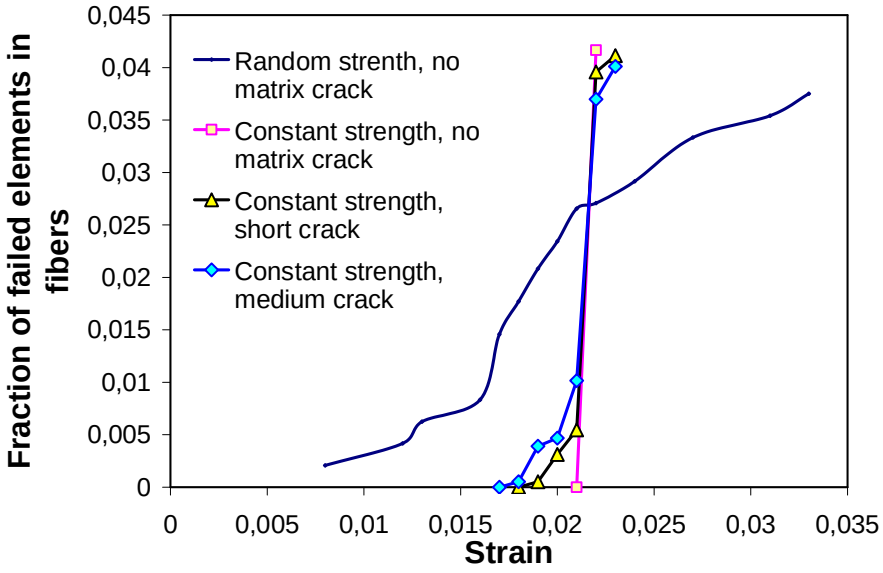
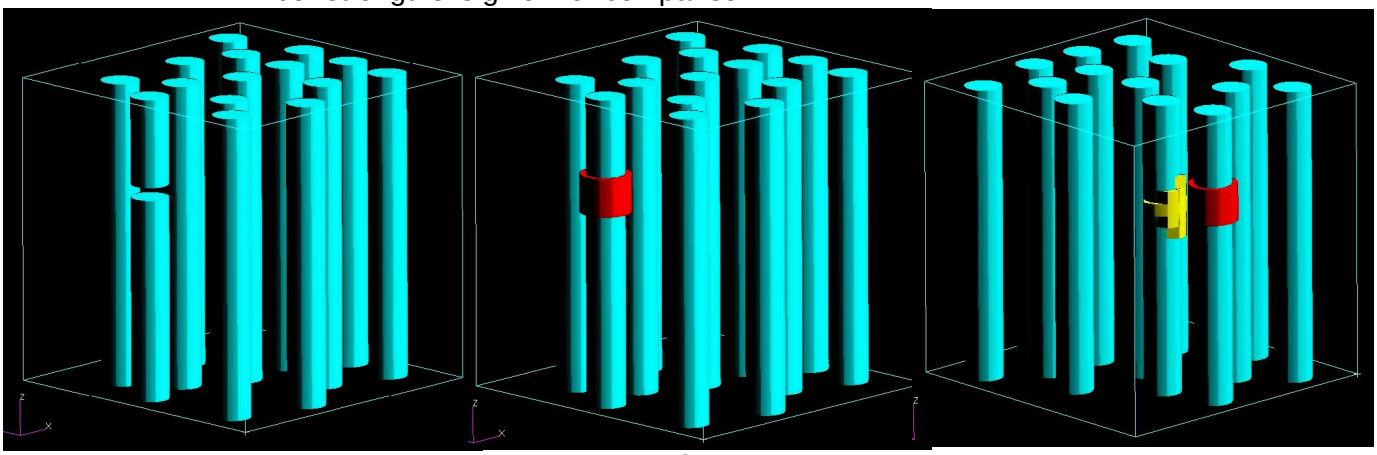


Figure 12. Damage (fraction of damaged elements in the damageable sections of the fibers) versus strain curves for the unit cells with and without the matrix cracks, with the constant strength of fibers. A curve for randomly distributed fiber strengths is given for comparison.



a b c

Figure ***13.*** Damage evolution in a composite with damageable interface and fibers, and strong matrix: (a) Fiber cracking, ε=7e-4, ε - applied strain, (b) Interface damage nearby the fiber crack, ε =7.2e-4, (c) Interface damage near the neighbouring fiber, ε =9.4..9.8e-4.

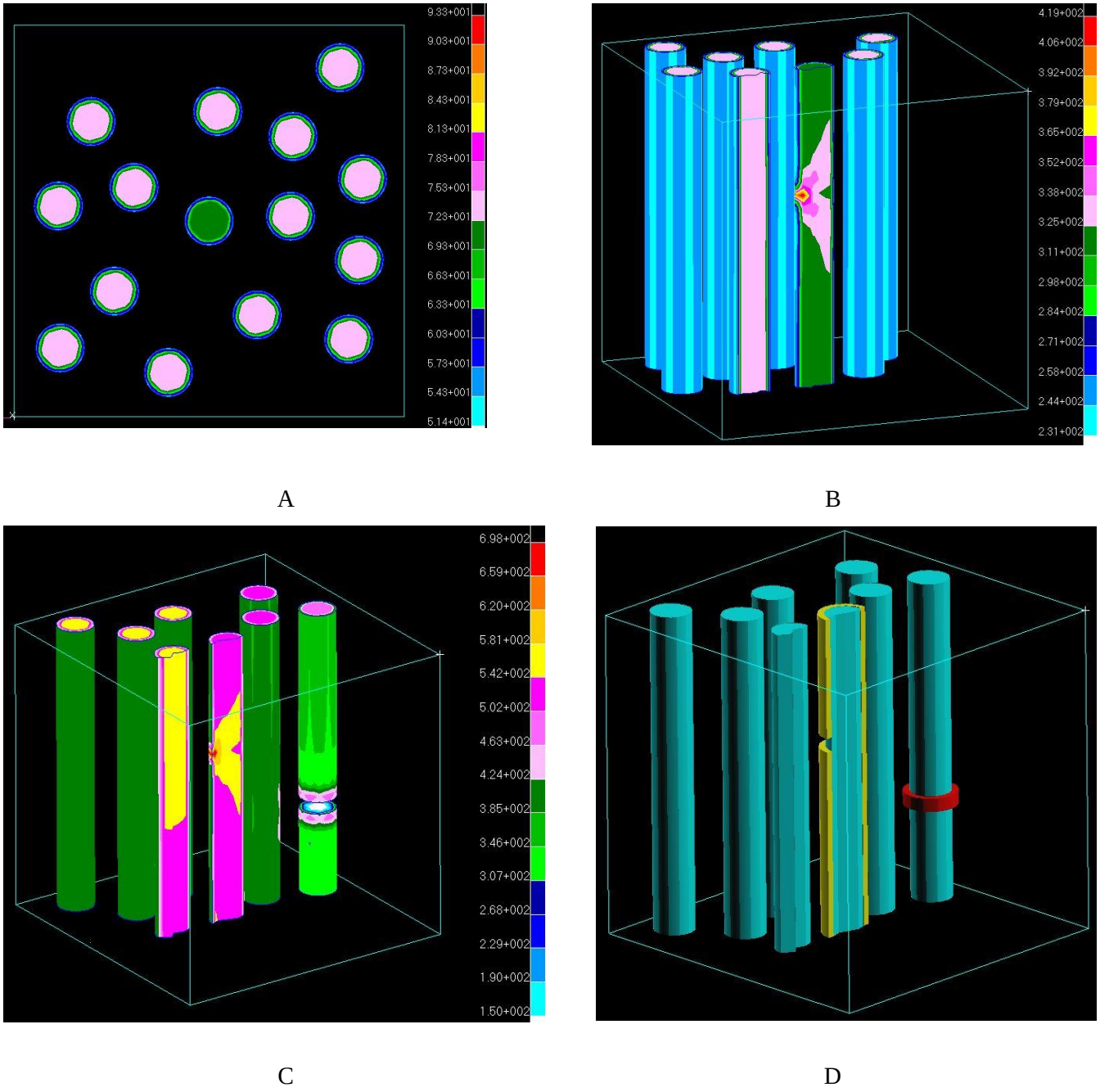


Figure 14. Stress distribution in the unit cell with microdamaged interface: the Mises stress distribution in a horizontal section of the cell (a), in a vertical section of the fibers with intact and damaged interface layers before (b) and after (a) first fiber cracking, and the formation of interface cracks in the unit cell (d).

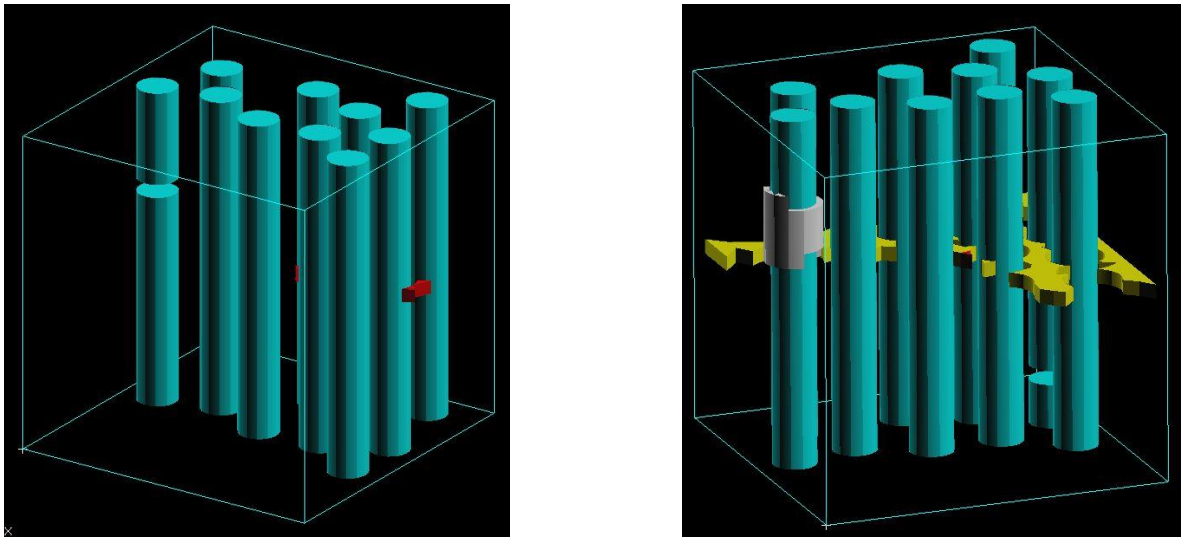


Figure 15. Competition of damage modes: (a) one failed fiber and a few microcracks in the matrix (red), ε =0.01, and (b) two fibers have failed, the interface crack is formed in the vicinity of a fiber crack and the matrix crack is formed (ε =0.015).

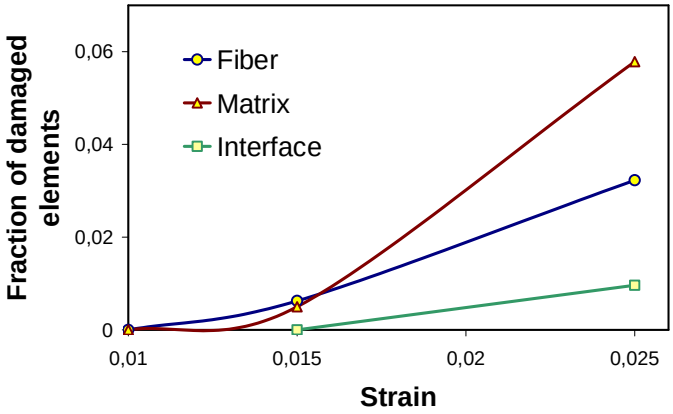


Figure 16. Damage-strain curves for the case of three acting damage mechanisms