A 3D hierarchical computational model of damage and strength of wood is developed. The model takes into account the four scale microstructures of wood, including the microfibril reinforced structure at nanoscale, multilayered cell walls at microscale, hexagon-shape-tube cellular structure at mesoscale and annual rings at the macroscale. With the use of the developed hierarchical model, the influence of the microstructure, including microfibril angle (MFA), the cell shape and the wood density (annual ring structure), differences between earlywood and latewood as well as microstructural arrangements and cellulose strength distributions on the tensile strength of wood is studied numerically. Good agreement of the theoretical results with experimental data has been obtained.