

# 2 Kinematics

Kinematics is concerned with expressing in mathematical form the deformation and motion of materials. In what follows, a number of important quantities, mainly vectors and second-order tensors, are introduced. Each of these quantities, for example the velocity, deformation gradient or rate of deformation tensor, allows one to describe a particular aspect of a deforming material.

No consideration is given to what is *causing* the deformation and movement – the cause is the action of forces on the material, and these will be discussed in the next chapter.

The first section introduces the material and spatial coordinates and descriptions. The second and third sections discuss the strain tensors. The fourth, fifth and sixth sections deal with rates of deformation and rates of change of kinematic quantities. The theory is specialised to small strain deformations in section 7. The notion of objectivity and the related topic of rigid rotations are discussed in sections 8 and 9. The final sections, 10-13, deal with kinematics using the convected coordinate system, and include the important notions of push-forward, pull-back and the Lie time derivative.

