

4 Non-Linear Elasticity

Non-linear elastic materials, in particular elastic materials subjected to large strains, are examined in this chapter. Most of the chapter is concerned with hyperelastic materials, that is, elastic materials for which the stress can be derived from an elastic strain-energy potential function.

Some of the different types of elastic material models are reviewed in §4.1. Hyperelastic materials are studied in the sections which follow. General constitutive relations are derived for both the material and spatial descriptions and for both compressible and incompressible materials. It is shown how the principle of material frame-indifference restricts the form a constitutive equation may take. The more commonly used isotropic material models are discussed in §4.4 and material anisotropy is discussed in §4.5.

A de-coupled formulation of hyperelasticity is presented, which is useful for materials which are nearly incompressible.

Finally, some of the equations for isotropic materials are linearised, showing how they are consistent with the linear elastic model.

