Chapter 3

Kinematically Moderately Nonlinear Theory

In Chapter 2 a full nonlinear description of kinematics and statics was given. Since the derivation of the kinematics of the kinematically moderately nonlinear case follows exactly the same line, we will not redo that part of the foundation but refer the reader to Section 2.2. Moreover, in the three-dimensional case the savings by using this reduced theory are negligible, so we do not travel this path further, but refer to the formulas (2.36)–(2.41). And, finally, the equilibrium equations become *more* complicated in this case. Thus, instead of (2.59)

$$t_{ik,i} + \left(t_{ij} u_{k,j}\right)_{,i} + \bar{q}_k = 0 \tag{3.1}$$

by use of (2.38) we get

$$t_{ik,i} + \left(t_{ij} \left(e_{kj} + \omega_{kj}\right)\right)_{,i} + \bar{q}_k = 0 \tag{3.2}$$

The assumption that the strains are small and that the rotations are moderate $|\omega_{mn}| \ll 1$, but $|\omega_{mn}| > |e_{mn}|$, see page 42, entails that

$$t_{ik,i} + \left(t_{ij} \omega_{kj}\right)_{,i} + \bar{q}_k = 0 \tag{3.3}$$

which may be expressed in terms of the displacements instead of the rotation, see (2.37)

$$t_{ik,i} + \left(t_{ij} \left(u_{k,j} - u_{j,k}\right)\right)_{,i} + \bar{q}_k = 0 \tag{3.4}$$

which looks more complicated than (3.1) and seems to offer no advantages over the latter.

On the other hand, for one- and two-dimensional bodies such as beams and plates the kinematically moderately nonlinear theories offer great advantages in terms of computational ease, and we shall return to them in Part II.

E. Byskov, *Elementary Continuum Mechanics for Everyone*,
Solid Mechanics and Its Applications 194, DOI: 10.1007/978-94-007-5766-0_3,