SURVEY OF RECENT DEVELOPMENTS IN THE FIELDS OF HEAT CONDUCTION IN SOLIDS AND THERMOELASTICITY

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The developments of the last few years in both the fields of heat conduction in solids and of thermoelasticity are reviewed. Attention is centered in both instances on solutions, results and techniques of direct engineering application, with comparatively less emphasis on those of primarily theoretical interest. Thus in the calculation of either the temperature or of the consequent mechanical response both exact and approximate approaches are treated; in the latter case this includes an assessment of the error involved, and in some problems the determination of bounds to the exact solution.

The paper starts with a brief review of the basic theory, including the effects of thermo-mechanical coupling and the conditions under which these effects may safely be ignored in practice. The problem of heat conduction is taken up next, including a summary of recent solutions for rods, cylinders and other structural members, and of recent advances in numerical techniques. Some extensions of known approximate analytical procedures are indicated, and the conclusions to which they lead are compared with pertinent exact results. The status of heat conduction calculations involving changes of phase is summarized; results pertaining to plates, cylinders and spheres are given, and analytical short-time solutions and numerical long-time calculations are discussed, and results in two- and three-dimensional melting is presented.

Recent thermoelastic results pertaining to rods, beams, plates, cylinders and spheres are then reviewed. The importance of thermally induced vibrations is assessed, and an approximate formula for its evaluation is presented. Bounds for the stresses, deflections and the torsional rigidity of beams and plates under arbitrary temperature distributions are calculated by means of a simple analogy. The calculation of thermal stresses in indeterminate structures such as rings is critically examined, and the proper use of energy methods in such cases is indicated. Some new results concerning the mechanical response of melting plates are quoted. Developments concerning thermal-stress calculations in which an extension to viscoelastic materials is readily carried out, are briefly referred to.

The paper includes a comprehensive bibliography of recently published papers in heat conduction and thermoelasticity.