MECHANICS OF KINEMATICALLY INDETERMINATE STRUCTURES

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Abstract

The dissertation is concerned with the structural mechanics of assemblies of pin-jointed bars, and in particular with their rigidity and performance under any load system.

A detailed review of the past developments and present knowledge is conducted, which brings back to light some long-forgotten contributions and traces the line for further study. The present investigation starts from an analyses of the rigidity of a class of triangulated hyperbolic-paraboloidal surfaces, which are found to be either, rigid and statically determinate, or not, according to the number of sides. In a more general context, the introduction for any assembly of the four linear-algebraic vector subspaces associated with its equilibrium matrix leads to the systematic evaluation of the degrees of statical and kinematical indeterminacy, and of all the states of selfstress and inextensional mechanisms. These are readily computed following a computational scheme described in detail. Criteria for the distinction of rigid-body mechanisms, infinitesimal mechanisms of first and higher order, and finite mechanisms are established and tested by means of several examples; computer-drawn pictures of these examples are enclosed.

The linear and non-linear responses of kinematically indeterminate assemblies are analysed by decomposing any applied load into its extensional and inextensional components, and by evaluating the bar tensions and nodal displacements due to them, respectively. A third-order algebraic equation is introduced for correcting large inextensional displacements. This way of proceeding leads to two efficient computer programs for the structural analysis of cable structures, in which the total external load is applied in only one step. The answers given by this method are compares to the results of some careful experiments on cable structures, and to various data available in the literature. Bye-products of the investigation are a novel formulation of the force method, in which the analyst does not have to select the ‘redundancies’, a simple and general numerical technique for finding the nodal co-ordinates

of an unloaded tensegrity structure, and a new instrument for measuring the tension in a steel wire very accurately.