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Three Variable Polynomial Displacement Function Method for Structure Strength Analysis

-A Tool for Primary Strecture Strength Design of Ships-

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Summary: This paper proposes Polynomial Displacement Function Method where elements are assumed to strain by a system of displacement functions of polynomial form in 3 variables with enough degrees of freedom to satisfy both equilibrium equations and connect conditions that are required to form a structure model as a ship hull. This method can calculate strength of structures contain panels, beams, frames, and pillars. It is also applicable to evaluation of elastic buckling stability and to vibration analysis by using the same model. The way of forming structure models is quite intuitive and easy to understand the relations between elements, substructures and their total structure. In this method, the element-model is developed in three steps. The first step is to enumerate all independent polynomials in 3 variables of 6th order that satisfy local equilibrium equations. A solid elastic body is assumed to deform in the way expressed by linear combination of these polynomial displacement functions. At second, the body is degenerated to a plate, to two-dimensions, with full degrees of freedom in deformation. Lastly, the shape of the elements and connect conditions are determined so as to three-dimensional structures can be built with the elements. In section 2,the calculation of degree-of-freedom and the requirements for structural elements are explained briefly. In section 3-8, the procedure of strength analysis by this method is shown. As local equilibrium condition is already satisfied in element displacement function, only total energy balance is considered. In section 9, some results by this method are compared with theoretical ones. One three dimensional structure example, a box-beam case, is illustrated and one actual case, a deck-vibration analysis, is presented.

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