MODIFIED ISOPARAMETRIC ELEMENTS FOR VIBRATION PROBLEMS

G.C. Nayak[I] and A.R. Chandrasekaran[II]

In the solution of vibration problems, there is invariably a tendency to assume the mass matrix to be diagonal and its elements as positive numbers. This simplifies the solution of eigenvalue problem and the direct integration of differential equations in case of both linear and nonlinear problems. Further, it gives an idea of the equivalent mass lumped at the nodes. In the case of four noded quadrilateral elements, nodal loads corresponding to body forces have positive values. However, in the case of higher order parabolic and cubic elements (derived from shape functions of serendipity family (Zienkiewicz, 1971), the nodal forces have both positive and negative values. In such cases, either consistent mass matrix formulations are used or if mass matrix is diagonal, the nodal masses have been determined based on physical intuition. This method is debatable particularly when the generalised mass consists of mass moment of inertia. In order to circumvent this problem but at the same time improve the accuracy of the stiffness matrix, addition of incompatible displacement modes had been proposed by some authors.

In this paper new shape functions have been proposed for higher order two dimensional, three dimensional and thick shell elements. For these elements, the basic characteristics of existing isoparametric elements are retained with several choices available for improving the elements and without adding any surplus variables or interior nodes. These have been derived from the basic Lagrangian polynomials. In these new elements, the nodal loads due to body forces are always positive. Depending upon the choice of shape functions, different distribution of the total mass of an element among the nodes are possible. For two-dimensional cantilever type problems, the best stiffness matrix is obtained corresponding to serendipity function. Positive equivalent nodal masses can be obtained by using different shape functions as compared to that of stiffness.

REFERENCES

Zienkiewicz, O.C. "The Finite Element Method in Engineering Science", McGraw Hill Book Co., London, 1971.

I Prof. Civil Engineering) University of Roorkee,
II Prof. Earthquake Engineering) Roorkee-247667, India