ANALYSIS OF PLATES BY THE BOUNDARY ELEMENT METHOD

conclusions, summary and suggestions for further applications

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SUMMARY

The Boundary Element Method (BEM) is one of many tools applied to numerical analysis of structures. The main advantage of BEM is the relative simplicity of formulating and solving problems of potential theory, the theory of elasticity and the analysis and optimization of engineering structures. This method went through numerous scientific studies. Burczyński [1] described in a comprehensive manner the boundary element method and its application in a variety of tasks, the theory of elasticity together with the appropriate solutions and a discussion of the basic types of boundary elements. The boundary element method also found wide application in the analysis of plates. Altiero and Sikarskie [2], Bezine and Gamby [3] and Stern [4] used the boundary element method to solve the plate bending problem. Debbih [5], [6] compared the effectiveness of the boundary element method with finite element method and used BEM in thick plate analysis. Beskos [7] and Wen et al. [8] applied BEM in dynamic analysis of plates. A number of works devoted to the analysis of plates were presented by: Katsikadelis [9], [10], Katsikadelis and Yotis [11], Katsikadelis, Sapountzakis and Zorba [12], Katsikadelis and Kandilas [13], Katsikadelis and Sapountzakis [14], Guminiak et al. [15] proposed a modified formulation of boundary integral equation for thin plate. This concept was extended and generalized for the task of statics, dynamics and stability of thin plates and are presented together with several numerical examples in the works [16], [17], [18], [19], [20] and others. Litewka and Sygulski [21], [22], [23] used fundamental solutions for Reissner plates derived by Ganowicz [24]. These solutions are characterized by a relatively simple form and are easy to adapt the numerical procedures. Aliabadi and Wrobel [25] described application of BEM in thick plate analysis together with the procedures for calculating singular and hypersingular integrals. Application of BEM in the analysis of plates in a wide range of tasks has been described by J.T. Katsikadelis [26], [27]. Noteworthy is a completely new approach to the tasks that are difficult to solve directly using BEM. To remedy this, the task is formulated using Analog Equation Method combined with the typical formulation of BEM.
The Analog Equation Method was introduced into scientific literature by J.T. Katsikadelis, and its foundations are described in the work [28]. Using AEM, it is necessary to define the value of investigated function and its derivatives within the body domain as functions of unknown fictitious source (fictitious loading). It is easy to obtain its by solving another differential equation with the operator of the same order as in governing differential equation and with known fundamental solution. Solution of new equation can be expressed in terms of integral representation. The classic BEM approach allows establish investigated function and its suitable derivatives as functions of fictitious source. Substituting expressions describing investigated functions and its derivatives into the governing differential equation, the set of equation is obtained in which unknown variables are values of fictitious source in chosen point inside the body domain. The AEM connected with BEM is particularly useful in non-linear problems [29] and non linear analysis of structures as plates [30], the meshless method [31] and system identification method [32].

In this paper, analysis of plate bending by the boundary element method will be presented. The analysis will draw on the classical [26], [27] and modified [16] formulation of the problem of bending a thin plate. Additionally, the results of calculations are compared with those obtained for Reissner plates, using fundamental solutions proposed by R. Ganowicz, which are less known in the scientific literature.

CONCLUSIONS

Static analysis of plates by the BEM was presented. This issue was solved using Kirchhoff theory of plates by classic and modified approach, in which the boundary conditions are defined so that, there is no need to introduce variables used only to satisfy biharmonic differential equation. This is a novelty with respect to the classical formulation of the problem, which allows significant simplification of the construction of boundary integral equations. In classic formulation, hexagonal boundary elements were applied, but angle of rotation in normal direction was expressed by linear approximation. In modified approach, typical boundary elements of the the constant type were used. The boundary integral equations were formulated in singular and non-singular approach. These equations were derived using classic and modified formulation of thin plate bending [26], [27]. It also examined how to behave the boundary integrals in the case when the collocation point is located in a corner of the plate. The task of bending plate theory was extended by applying Reissner theory. In this problem, the fundamental solutions given by R. Ganowicz is used [24] and boundary element of the constant type are applied. The boundary integral equation for Reissner plate were formulated in non-singular approach. Proposed methods of solving the plate problems are characterized by good convergence of results with a low degree of discretization. Singular and non-singular integral equation formulation in conjunction with the boundary elements and linear and curvilinear can be used successfully in plate bending problems.

Boundary element method is a very useful tool in combination with Analog Equation Method. This method, coupled with BEM was described for plates in work of J.T. Katsikadelis [27]. In the future, combination of these two methods can be used to analyze the following issues: static, dynamic and stability analysis of plates with variable thickness, static analysis of plates rested on foundation with linear or non-linear characteristic, dynamic analysis of plates with variable thickness considering influence of surrounded fluid, plate bending analysis considering large deformation.

BIBLIOGRAPHY
