Numerical analysis of elasto-plastic bending of layered Mindlin plates

A.Parayandeh-Shahrestany, N.Fallah
Department of Civil Engineering, University of Guilan, P.O. Box 3756, Rasht, Iran

fallah@guilan.ac.ir

Abstract

In this paper, a cell centered finite volume formulation for analyzing the problem of elasto-plastic bending of a rectangular plate is proposed. A layered approach is adopted where the plate is subdivided into a chosen number of layers. Therefore, it is possible to monitor the plasticity evolution through the plate thickness along with the spread of the plastic phenomena on the plate surface. The Mindlin-Reissner plate theory is utilized and the solution is obtained by applying an incremental loading procedure.

For evaluation purposes the proposed method is applied for the analysis of plate with three types of boundary conditions. It is found that the results obtained are in good agreement with the reference results obtained by using other numerical methods.

Keyword: elasto-plastic bending, Mindlin plate, Finite volume, Layered approach

Introduction

In recent years, tremendous efforts have been made in the development of numerical methods for the analysis of solids and material. The elasto-plastic behavior of plates has been analyzed by numerical methods such as the Finite Element [1-6], Finite Strip [7], Boundary Element [8-9] and etc.

In this paper, a Cell Centered Finite Volume method for analyzing the elasto-plastic bending of rectangular plate is proposed. Recently, there has been growing interest in developing FV discretization approach for the solution of solid mechanics problem. Stress analysis of elasto-plastic solids [12], bending analysis of elastic plates [13-16] are among of them.

FV formulation for plate analyzing has some advantages:

(1) It is simple and transparent.
(2) It behaves well in the analysis of very thin to thick plates.
(3) It predicts accurate results without using any adjustable parameter for thin plates.

In this paper Mindlin-Reissner plate theory is utilized. The Von- Mises yield criterion is applied and an incremental loading procedure is used.

In order to consider the extent yield phenomena through the plate thickness, the plate is divided into some layers. Hence, plasticity progress can be monitored through the plate thickness. The layers assumed to have isotropic and homogeneous material properties, to be perfectly joined and to have constant thickness.

For the evaluation of the proposed approach, a square plate with three types of boundary conditions is considered. Simply supported plate (SSSS), fully clamped plate (CCCC) and a plate with two opposite edges simply supported and the two other edges clamped (SCSC) are used as test problems. All plates are subjected to uniformly distribute lateral loads.

Result from this work has shown non-locking behavior of the FV formulation for the thin plate analysis.

1. Plate formulation with cell centered finite volume method