Solving of nonlinear algebraic equations is an obligatory stage of studying the equilibrium paths of nonlinear deformable systems. The iterative method for solving a system of nonlinear algebraic equations stated in an explicit or implicit form is developed in the present work. The method consists of constructing a sequence of polygons in Euclidean space that converge into a single point that displays the solution of the system. Polygon vertices are determined on the assumption that individual equations of the system are independent from each other and each of them is a function of only one variable. Initial positions of vertices for each subsequent polygon are specified at the midpoints of certain straight segments determined at the previous iteration. The present algorithm is applied for analytical investigation of the behavior of biaxially compressed nonlinear-elastic beam-column with an open thin-walled cross-section. Numerical examples are made for the I-beam-column on the assumption that its material follows a bilinear stress-strain diagram. A computer program based on the shooting method is developed for solving the problem. The method is reduced to numerical integration of a system of differential equations and to the solution of a system of nonlinear algebraic equations between the boundary values of displacements at the ends of the beam-column. A stress distribution at the beam-column cross-sections is determined by subdividing the cross-section area into many small cells. The equilibrium path for the twisting angle and the lateral displacements tend to the stationary point when the load is increased. Configuration of the path curves reveals that the ultimate load is reached shortly once the maximal normal stresses at the beam-column fall outside the limit of the elastic region. The beam-column has a unique equilibrium state for each value of the load, that is, there are no equilibrium states once the maximum load is reached.