عنوان مقاله:

Flexibility Matrix and Stiffness Matrix of ۳D Curved Beam with Varying Curvature and Varying Cross-Sectional Area using Finite Displacement Transfer Method

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نویسندگان:

Ashwinkumar Hansora - *Gujarat Technological University, Ahmedabad, Gujarat, ۳۸۲۴۲۴, India*

Harshvadan Patel - *Government Engineering College, Patan, affiliated to Gujarat Technological University, Ahmedabad, Gujarat, India*

خلاصه مقاله:

Curved beams are widely used in combination with the linear elements of various civil engineering structures. Many researchers attempted to analyze beam curved in plan, beam curved in elevation, and spatial curved beam using different methods and different approaches and presented analytical exact solution and approximate numerical solution. The analytical exact integration of the governing differential equations is the major difficulty for the analysis of the geometrically non-linear curved beams. To overcome this difficulty, a finite displacement transfer method is proposed to eliminate analytical differentiation and integration, completely. This paper deals with the stiffness matrix of ۳D curved beam with varying curvature and varying cross-sectional area. A novel finite displacement transfer method is used to determine displacements of the freely supported node of the cantilever ۳D curved beam. The flexibility matrix is derived using the finite displacement transfer method. The stiffness matrix is derived by employing equilibrium and transformation matrix. The finite difference method is used for the numerical solution of the differential equations. Results of the calculation method are compared with the results of other methods in the literature and the FEM based analysis software. For the circular helix with uniformly varying cross-sectional area and ۳۶۰۰ elements, the maximum and minimum percentage difference in the stiffness coefficient is ۲.۸۹% and -۰.۶۵% respectively. For the elliptic helix with the uniform cross-sectional area and ۷۲۰ elements, the maximum and minimum percentage difference in the stiffness coefficient is ۲.۶۹% and -۲.۶۵% respectively. The novel of this study lies in the generation of the stiffness matrix of the ۳D curved beams without tedious analytical differentiation and integration of governing .equations. The stiffness matrix of the spatial curved beam is applicable to the planer curved beam also

کلمات کلیدی:

Rotation Matrix, Transformation matrix, Internal Forces, Equilibrium Equations, Cartesian Coordinates