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Effect of nonlinear behaviour of cable structures

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Analysis of structures for nonlinear behaviour has become one of the major challenges for the modern structural engineer. Even though almost all the structures have some form of nonlinear behaviour, due to the complexity of analysis and limitations of computational techniques, which consider all such effects, are cumbersome, hence most of the analyses are simplified. Considerations of all such nonlinearities are extremely difficult in structural analysis.

In this study of nonlinear behaviour, the scope is limited to geometrical nonlinearity issues. Geometrical nonlinear behaviour is significant in large deformation structures such as suspension bridges, guyed towers, transmission lines, cable stayed bridges etc. Equilibrium of such structures has to be considered in its deformed configuration, which itself is an unknown prior to the analysis.

Although in some methods it is considered null bending stiffness of cables, actual description of the cables has to consider both bending and axial effects. In linear analysis it is adequate to use bending deformation relationship for curvature. But when the deformations are large, actual bending deformation relationship is given by large deformation formula, which is known as the Euler-Bernoulli Equation. Axial effects also have to be considered in the equation when the deformations are large. Hence the equilibrium equation for the large deformation structures becomes a nonlinear second order integral differential equation where an analytical solution has not been found.

Scope of this paper has been limited to single dimensional structures in a two dimensional plane. This paper described the effects of consideration of large bending deformation relationship, and other large deformation nonlinear effects on cable structures. All possible causes of geometrical nonlinearities were considered and behaviour of the cable structures was studied. Analysis is carried out by using MATLAB programme, which is capable of accommodating all mathematical operations. Results were compared between with and without nonlinear effects. It is found that the effect of consideration of actual bending deformation relationship is very much significant when the deformations are large.

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