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Nonlinear Finite Element Analysis of I-Steel Beam with Sinusoidal Web

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Abstract

For structural models, existing research frequently uses deterministic numerical analysis. Test findings, however, constantly point out uncertainties, especially about variables like the imposed load's amplitude, geometrical dimensions, material unpredictability, and inadequate experiential data. In response, scholars have focused more on probabilistic design models, realizing their importance for precisely forecasting structural performance. This research aims to incorporate reliability-based analysis into the numerical modeling of steel beams with sinusoidal webs. A steel welded plate beam with an I-section and a sinusoidal web has been taken into consideration in this study. The web height is 750 mm, the web thickness is 2.0 mm, the flange width is 300 mm, and the flange thickness is 5.0 mm. The beam's length, l = 1000 mm, has two 10.0 mm thick stiffeners positioned beneath the applied load to stop the flange from failing locally as a result of load concentration and end plate supports that are 5 mm thick. The commercial software application ANSYS ver. 2019 R3 has been used to perform a nonlinear finite element analysis in order to examine the failure modes and load capacities. In the first stage of this study, the changing of the amplitude/period ratio, A/P, was taken into consideration to examine the failure capacity loads and deformed shapes to optimize the amplitude/period ratio. In the second stage, the optimum amplitude/period ratio, A/P, was taken, and changing the period/span ratios, P/L, made the best use of the period/span ratios by examining the failure capacity loads and deformed forms.

Keywords: I-Steel Beam; Sinusoidal Web; Nonlinear Analysis; Amplitude/Period Ratio; Period/Span Ratio.

1. Introduction

A steel beam with a sinusoidal web is a type of structural component used in building and construction. It is a variation of a steel I-beam. Depending on the dimension of the beam and level of loading, the design and specifications of the steel I-beam mostly require the plain web to be strengthened by discrete transverse and longitudinal stiffeners. The sinusoidal web, on the other hand, could be the alternative choice to overcome the web instability and at the same time provide more rigidity and strength to the I-beam. This alternative gives a chance to resist more loading for the same span and depth and the same or even less use of material, in addition to expecting more torsional resistance compared to the standard I-beam. Steel beams with sinusoidal webs are made by folding a flat steel plate into a wavy shape, with alternating peaks and valleys along the length of the beam. This design creates a series of interconnected triangles that provide greater rigidity and strength than a straight web due to the curvature of the web and more surface area than the I-beam with a flat web. The sinusoidal shape could also reduce the weight of the beam due to a reduction in the web thickness, and that could make it easier to transport and handle during construction.

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