First Pan American Congress on Computational Mechanics
PANACM 2015
April 27-29, 2015, Buenos Aires, Argentina

Analysis of Splice Joint Behaviour in Hard Loaded Tensile Chords of Warren Trusses

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ABSTRACT

During the last few decades most efforts have been devoted to the elaboration of automatic design tools for structures, and a high level of performance and cost-effectiveness have been achieved. At the same time some accidents which have happened have forced professionals to undertake a deeper study of methodologies for design. The current study is devoted to the analysis of hard loaded splice joint behavior in tensile chord of Warren truses. The splice joint behaviour problem is analysed basing on the theory of statically indeterminate beam on elastic supports.

To gain deeper insight into the behaviour of elements and joints in hard loaded Warren trusses, some issues are discussed in the current paper: 1) suggestions for analysis of splice joints in tensile chords considering additional stresses induced by bending moment; 2) step by step methodology for analysis and numerical examples of end-plate joint design considering elastically deformed tensioned bolts due to axial force action, 3) determination of more unfavourable values of internal forces in elements depending on truss topology and design model selected, underlining the link between stiffness properties of a structure and bending moment values expected. A reasonable consistency between the real structure and the design model has been discussed according to a practical example which illustrates the case when serious consequencies may be expected due to the disability of the design model defined to reveal a more unfavourable internal forces in the structural system.

A design model is presented for end-plate connection acceptable for analysis by using common software (MS Excel, MathCAD) for engineering calculations. The end-plate is modelled as a continuous beam on discrete elastically deformed supports (representing tying bolts), and loaded by concentrated forces transferred by flanges and the web of I section correspondingly.

The known Clapeyron's theorem of three moments has been used at the first step of the end-plate behaviour analysis assuming bolts as rigid supports. Consequently the first approximation of reactive forces expected to be acting in bolts (as supports) has been determined. At the next step of analysis a model of continuous beam on elastic supports has been examined taking into account the additional rotations due to differences of support displacements, and leading to five moments equations. Analogous calculation cycles have been repeated until bending moment values of two last calculation cycles differ insignificantly.

It is concluded that the design models leading to disregarding some portion of stresses or strains in the comparison with a real structural behaviour, may be assessed as simplified and insufficient for the design of bearing structures, and always thorough analysis of the entire space system is needed taking into account every practicable loading situation and deformations developed. It is necessary to increase the requirements for risk assessment of public building structures, and of trade buildings especially following the bad experience with yearly accidents.

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