Journal of Constructional Steel Research 76 (2012) 112–120

Contents lists available at SciVerse ScienceDirect

Journal of Constructional Steel Research

Moment resistance of composite steel and concrete connection in sinusoidal-web girders

A.G. Martins [a,*], R.H. Fakury [a], R.J. Pimenta [b], G. Queiroz [a], F.C. Rodrigues [a]

[a] Structural Engineering Department, Federal University of Minas Gerais, Brazil
[b] Codeme Engenharia S.A, Brazil

ARTICLE INFO

Article history:
Received 27 August 2011
Accepted 22 March 2012
Available online 26 April 2012

Keywords:
Composite connection
Sinusoidal-web girder
Finite element method
Parametric analysis
Tests

ABSTRACT

Steel girders have been successfully used for many years in the composite steel and concrete construction market. Further developments and advances in manufacturing technology have led to a new generation of structural shapes. One of these developments, the composite sinusoidal-web girders, has been recently introduced in the construction of Brazilian buildings. In spite of the advantages this type of composite construction may offer, there are no design standards dealing with the behavior of such girders. As a result, there is a need to develop design recommendations that properly address the flexural and rotation capacities and initial stiffness of these elements and their connections to the adjacent members. To this end: (i) experimental tests of connections on cruciform arrangements were performed, (ii) finite-element models for the connections and the composite girders have been developed, using the commercial finite element software ANSYS, (iii) finite element models were validated by experimental data, (iv) a parametric study was carried out and (v) a theoretical model is proposed. It is shown that the proposed theoretical model, despite all the complexities involved, is in compliance with both experimental and numerical analyses.

1. Introduction

A sinusoidal-web girder is a built-up I-girder with a thin-walled corrugated web (with a sinusoidal profile) and flat plate flanges — see Fig. 1. The presence of corrugations considerably increases the rigidity and the resistance to shear forces and local effects, reducing the possibility of shear and local buckling. Therefore, it allows for the use of thinner web sheets without the need for transverse stiffeners. It also allows for the reduction of self-weight and increase in load capacity, leading to economical benefits, when compared to conventional flat-web I-girders.

Due to the high structural efficiency and relatively simple production, the sinusoidal-web girder has been increasingly adopted in several segments of construction such as bridges, pedestrian walkways, hangars and industrial buildings. At present, sinusoidal-web girders have not yet been used in floor systems. However, with the increasing interest in these shapes and the large volume of research in this area, it is expected that they eventually will be used in composite steel and concrete construction, especially in large span floor systems.

In spite of the advantages this type of composite construction may offer, there are no design standards or specifications dealing with the behavior of such beams. As a result, there is a need to develop design recommendations that properly address the composite flexural capacity of these elements, under both positive and negative moments, and their connections to the adjacent members.

The research herein reported is part of a comprehensive study on sinusoidal-web girders underway in Brazil at the Federal University of Minas Gerais [1]. In addition to this research the ultimate limit states of lateral-torsional buckling, lateral distortional buckling and flange local buckling have been developed by Gonzaga [2], Calenzani [3] and Souza [4], respectively. The findings on the flexural capacity of composite sinusoidal-web beams under positive moments are presented elsewhere (Martins [1] and Pimenta et al. [5]). In this paper, the flexure and rotation capacities of composite connection in sinusoidal-web girder are presented. To this end: (i) experimental tests of connections on cruciform arrangements were performed, (ii) finite-element models for the connections and the composite girders have been developed, using the commercial finite element software ANSYS, (iii) finite element models were validated by experimental data, (iv) a parametric study was carried out and (v) a theoretical model is proposed.

2. Experimental investigation

The experimental program consisted of tests carried out on three full-scale composite connections in cruciform arrangement — see Fig. 2a. The steelwork connection consisted of a flush end-plate welded to the beam end and bolted to the adjacent beam via the column web. The sinusoidal-web beams were denominated PSS $600 \times 150 \times 12.5 \times 2.0$ for specimens 1 and 2 and PSS $600 \times 150 \times 8/12.5 \times 2.0$ for specimen 3, nominal dimensions. In this denomination,

* Corresponding author. Tel.: +55 31 88058954.
E-mail address: alxgalvao@hotmail.com (A.G. Martins).

0143-974X/$ – see front matter
doi:10.1016/j.jcsr.2012.03.017