3D Nonlinear Analysis of a Composite Steel/Concrete Viaduct

Rui PINHEIRO
Civil Engineer
Minho University
Guimarães, PRT
a58701@alunos.uminho.pt

Rui Pinheiro, born 1988, received his civil engineering degree from Minho University.

Jose MATOS
Assistant Professor
Minho University
Guimarães, PRT
jmatos@civil.uminho.pt

Jose Matos, born 1979, received his civil engineering degree by Porto University, has a PhD in civil engineering and his research work covers nonlinear analysis, safety and reliability, monitoring and management systems.

Summary

In this paper it is studied the nonlinear behaviour of the composite steel-concrete Sousa river viaduct, located in A43 highway, Portugal. Used software to model such viaduct is ATENA®, which is a nonlinear structural analysis software that incorporates interface models. A 3D numerical model, that considers torsional effects, is developed. In order to validate this model, obtained data from developed load test as well as the results from a 2D model, developed in the same software ATENA®, will be used. Once the model is developed and calibrated, it is intended to process all obtained results, namely, overall deformation, maximum displacements, strengths and strains in all directions. The potentialities of a nonlinear 3D numerical model are therefore elicited.

Keywords: composite steel/concrete viaduct, load test, ATENA® software, nonlinear analysis, interface stresses, torsional effects.

1. Introduction

The viaduct over the Sousa river is a composite steel-concrete structure with a 44 m span, and a total length of 202 m. It presents a cross-section with two steel beams and a slab in reinforced concrete with 13.1 meters wide and 2 meter high, see Figure 1. The connection between these two parts, made with different materials, is achieved through steel connectors (headed studs) welded to the steel profile.

Fig. 1: Sousa river viaduct.

This viaduct, before being in operation, was submitted to a load test. Its behaviour analysis was based on such load test results. During this test it was measured the vertical displacement in specific points as well as the weight per axle of each vehicle.

A more detailed analysis of the structural behaviour until failure was already performed in a two-dimensional model (2D), developed in nonlinear analysis software (ATENA®) [5]. However, this model presents some limitations as it is impossible to model all load cases, such as those related with torsional effects.

Within this work a three-dimensional (3D) model of this viaduct was developed with the same nonlinear analysis software (ATENA®) [4]. During this procedure, obtained results from previous analyses were considered. This model included all the deck elements, being developed a simple model for the support conditions.

The model was initially validated with obtained results from load test. Later it was found that this model would be very heavy, due to the large number of three-dimensional elements. Accordingly, only the first span was analysed. Therefore, specific restrain conditions were incorporated to simulate the remainder part of the viaduct.

https://doi.org/10.2749/222137814814027756
Distributed by structurae