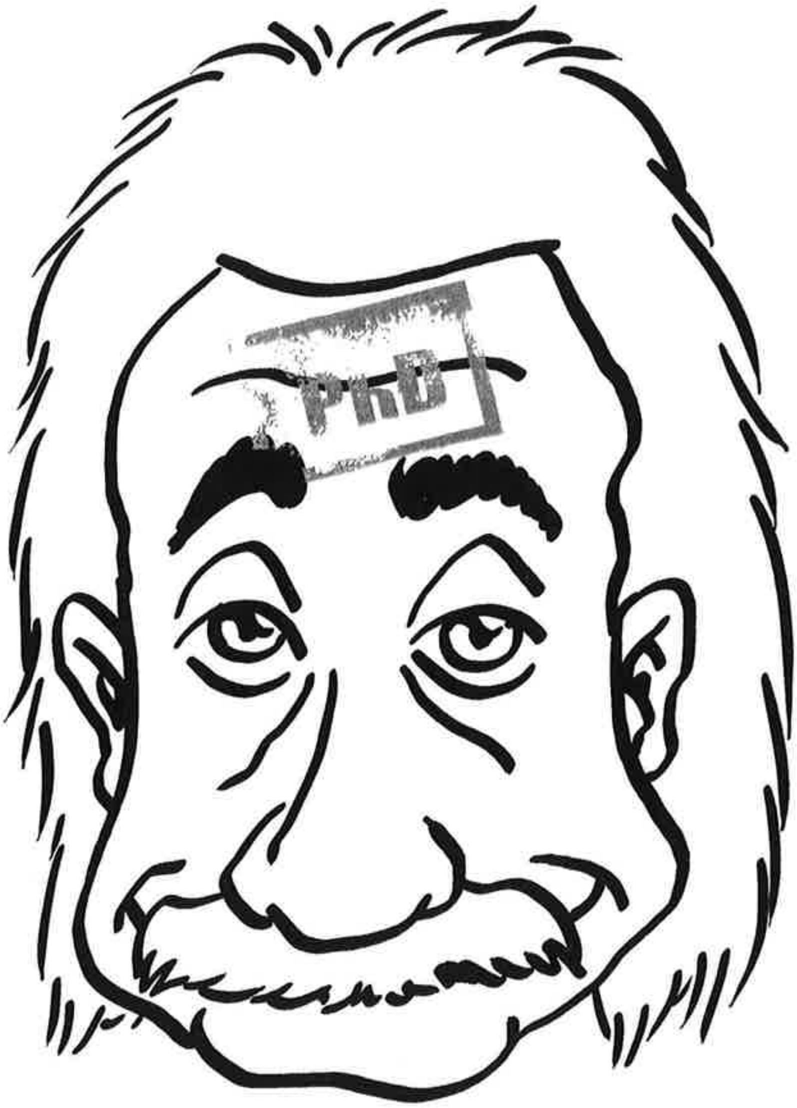
11de FirW Doctoraatssymposium



"The true sign of intelligence is not knowledge, but imagination"

FACULTY OF ENGINEERING

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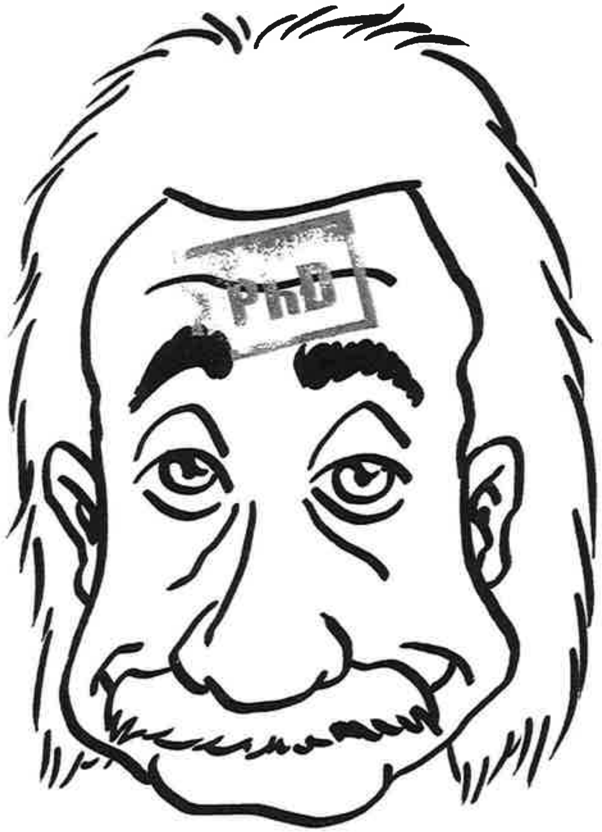

11de FirW Doctoraatssymposium

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Overview

Civil and Structural Engineering

Biomedical Engineering

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OVERVIEW

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OVERVIEW

The influence of diaphragm stiffening on welded tubular nodes in arch bridges

Dries Stael

Supervisor: Philippe Van Bogaert

I. Introduction

Bridges consisting of circular hollow sections are becoming increasingly popular. Although they are highly appreciated because of their aesthetic value, tubular arch bridges are considered to be costly, mainly due to the use of welded nodes. Due to geometric discontinuity and the welding process, various stress concentrations are introduced at the nodes, making this type of bridge prone to fatigue damage caused by the varying traffic loads. High peak values of stresses, so-called hot spot stresses, are reached near the weld toe of the nodes. If these stresses can be decreased, then the fatigue strength of the bridge will increase, allowing for a more slender design.

II. Diaphragm stiffening

The objective is to reduce the hot spot stresses near the weld toe. A possible solution is to provide diaphragms exactly at the location of the weld toe, inside the main tube. These diaphragms will reinforce the main tube thus reducing the in-plane deformation of this tube. Thanks to the reinforcements the hot spot stress concentrations at the weld toe are indeed reduced.

III. Woluwe Lane tubular arch bridge

This tubular arch bridge is a three-track elevated railway bridge. This bridge is an example of a framework tubular bridge because the bending moments in the vertical tubes are not negligible. Due to these larger bending moments, the stiffening of the nodes with diaphragms seemed imperative.

Figure 1. Model of a node with diaphragms.

The use of the hot spot stress method is recommended to calculate more precisely the stresses at the weld toe. This method relates the fatigue life of a joint to the hot spot stress range at this location, rather than the nominal stress range. The calculation of the hot spot stresses is carried out by using detailed three-dimensional FE-models. Dividing the hot spot stress ($\sigma_{h.s.}$) by the nominal stress gives a stress concentration factor (SCF). The results of these calculations are given in Table 1.

Table 1. Results of FE calculations.

Type of node	$\sigma_{h.s.}$ [MPa]	SCF
Without diaphragms	77,39	1,99
With diaphragms	42,61	1,10

IV. Conclusions

The diaphragms have a positive influence on the hot spot stresses near the weld toe. The fatigue resistance of the whole bridge increases considerably due to this reduction of the weld stresses.

D. Stael is with the Bridge Research Group, Civil Engineering Department