Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 156 (2016) 207 – 211

Procedia Engineering

www.elsevier.com/locate/procedia

9th International Conference „Bridges in Danube Basin 2016“, BDB 2016

# Another Stage in the Research into Deck Bridges with Encased Filler-Beams – Dynamic Load Tests

Vincent Kvočák[a], Viktória Kožlejová[a,*], Daniel Dubecký[a]

[a]*Faculty of Civil Engineering, Technical University of Košice*
*Vysokoškolská 4, 042 00 Košice, Slovakia*

**Abstract**

Deck bridges with encased filler-beams are traditionally exploited as load-bearing structural systems. From the structural point of view, there have not been major changes in their design over time. What has changed, however, is the approach to the calculation of the resistance of such composite structures. First, concrete used to fulfil a reinforcing function only. Later, it was assigned a load-bearing role (acting in compression) and the resistance of a composite structure was determined using the method of permissible stresses. Nowadays, the verification of cross-sectional resistance is based on limit state design principles stipulated by European technical standards – EUROCODES. These standards allow for material plasticization, even in bridge structures.

Peer-review under responsibility of the organizing committee of BDB 2016
*Keywords:* dynamic load tests, encased filler beams, deck bridges

## 1. Introduction

Deck bridges with encased filler-beams are used mainly for short- or mid-span simply-supported structures. The upper part of the section is supposed to act in compression; therefore, it would be highly desirable to eliminate steel from this part of the section and allow concrete to fully transmit the compression forces. This idea has led the researchers at the Faculty of Civil Engineering to explore deck bridges with encased filler-beams in more detail and modify their sections so as to find the most efficient structural arrangement. Steel sections in the specimens are designed in the manner that their centres of gravity are pushed lower within the sections so that the steel mass is

* Corresponding author. Tel.: +421 55 602 4289.
*E-mail address:* viktoria.kozlejova@tuke.sk


Peer-review under responsibility of the organizing committee of BDB 2016
doi:10.1016/j.proeng.2016.08.288

concentrated at the bottom part of such sections. The recent short-term and long-term loading tests carried out at the Faculty have shown that such composite structures combining concrete slabs and encased steel beams of prevailingly T-sections appear to yield the expected results. Nevertheless, the crucial aspect is the method of composite action given by shear connectors providing bond between steel and concrete, which is a matter requiring special attention.

It seems necessary to verify the resistance of these newly-designed structures under dynamic loads prior to their utilization in bridge engineering. Dynamic load tests are currently underway at the Institute of Structural Engineering. Since the tests are extremely time-and-energy-consuming, there is only one specimen of its kind being tested at a selected range of cyclic stress at the moment

## 2. Basic fatigue strength curve

Wöhler curves are applied when fatigue characteristics of materials, structural elements or constructions are assessed. A Wöhler curve shows the range of stress in a material $\sigma_a$ plotted against the number of cycles to failure N. Values for the curve are obtained in fatigue testing with so-called soft loading.

Fatigue tests under soft loading are historically the oldest tests and they are performed on hydraulic load-controlled servo-hydraulic pulsators. The results of tests are represented as $\sigma_a$-N relationships.

Wöhler curves may be derived for various mean stresses $\sigma_m$, which obviously influence their shapes. The following figure depicts a Wöhler curve for an alternating symmetric cycle [1].

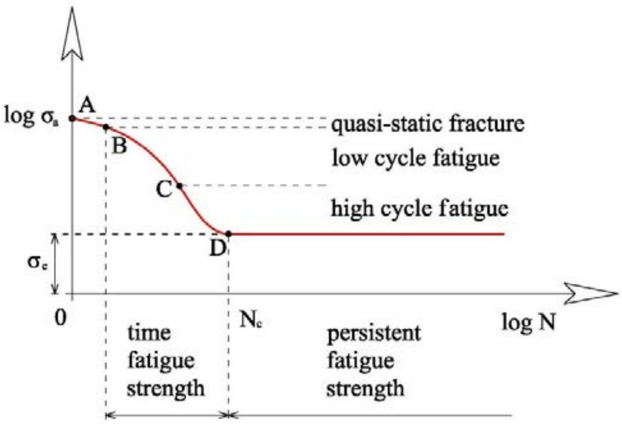


Fig. 1. Wöhler curves are usually divided into the following areas:
1. Quasi-static fracture: fracture occurs as early as after several tens of cycles
2. Low-cycle fatigue: characterised by stresses greater than the yield point/yield strength
3. High-cycle fatigue: characterised by stresses lower than the yield point/yield strength

Whether all-round or only at stress concentration points in the sections, bridge structures and/or vehicle chassis frames often fail due to low-cycle fatigue effects

## 3. Fatigue tests on composite beams

### *3.1. Preparation of test specimens*

Experimental beams were concreted in the Laboratories of the Institute of Structural Engineering at the Civil Engineering Faculty of the Technical University in Košice. Steel beams and reinforcement bars were supplied by specialised companies in the dimensions and shapes required (Figure 2). Concrete was delivered from a central mixing plant. During each phase of the experiment three beam specimens and concrete specimens to test the tensile