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# Experimental Verification of Reinforced Concrete Member under Cyclic Loading

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**Abstract**

Fatigue failure is characterized by a fracture in a local area of a structure which is subjected to varying cyclic loading. This loading can be caused by traffic, wind, ocean waves or likewise. The fatigue life of a reinforced concrete structure depends as much on the stress levels as on the stress range and the number of loading cycles and their importance is related to which material that is considered. Concrete structures are verified for the fatigue resistance only if it is recommended by the European Standard STN EN 1992-1-1[1]. The purpose of this paper is to compare the damaged equivalent stress range methods for fatigue assessment available in above mentioned standard to the experimental verifications.


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*Keywords:* concrete structures; fatigue; cyclic loading; experimental study

## 1. Introduction

Fatigue is generally effect of degradation, which reduces the structural service life. The service life of reinforced concrete structure directly depends on the stress level, stress range and number of the loading cycles during the cyclic loading.

The structures under static loading have been generally verified according to the current European standards for the standard shear, bending resistance or their combination or another one that depends on the loading effects character. Concrete structures under dominant cyclic loading effects have to be verified from the fatigue resistance point of view. The fatigue assessment approach according to the STN EN 1992-1-1[1] consists of the verification procedures for the concrete and reinforcement separately. For the concrete the damage equivalent compression stresses have been verified using the boundary stresses $\sigma_{c,min}$ and $\sigma_{c,max}$ in concrete. The damage equivalent stress range method the real operational loading is condensed to a single amplitude at N* cycles. The damage equivalent stress in reinforcement is $\Delta\sigma_{S,Equ}(N^*)$.The comparative value of the steel fatigues resistance at N cycles is $\Delta\sigma_{Rsk}(N^*)$

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practically derived from the appropriate S-N curve, which the standard offer, or the curve which can be obtained from the experimental measurements.

The main goal of this paper has been to verify the standard approach and compare to our experimental results from the number of cyclic loading during the element service life. For that purpose we chose the reinforced concrete T- beam, which was designed from the bending moment and shear reliability condition satisfied from the static character of the load effect but did not satisfy for the cyclic loading condition.

## 2. Experimental program description

Five specimens of T-beam were made-up from the concrete class of C35/45 with reinforcement 3 ϕ 12 mm, steel B500 B. All tested beams are designed as simple supported elements. Some details of the T-beam are shown in (Fig. 1 a, b) and (Fig. 2 a, b).

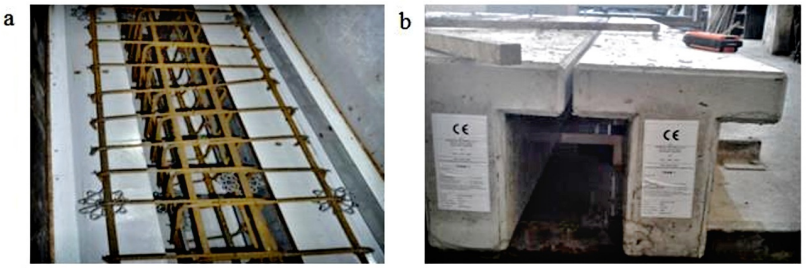


Fig. 1.(a) Reinforcement in the mould; (b) Concrete T-beam.

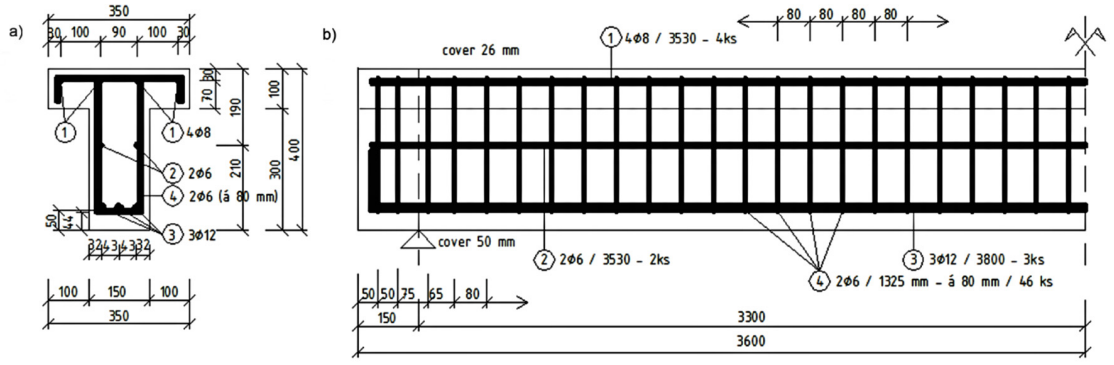


Fig. 2.(a) Cross section of the T-beam; (b) longitudinal section of the T-beam.

Two beams were tested under the 4-point bending to this time. One beam as a comparative element under static load and other one for the cyclic load. Following parameters have been recorded:

- Beam deflection – three measurement points – in the middle of the span and in the quarters, using the potentiometric sensors,
- Propagation, development and width of the cracks (bending and shear) along the span,
- Strains of the concrete – on the top of the flange and reinforcement – one steel rod using the strain gauges in the middle of the span,
- The support area deformation control – at two measurement points.

The next 3 beams will be tested in summer 2014. These beams will be strengthened by the system of NSM (near surface mounted). There is planning of the strengthening system using the strips MBRACE 20/1.4 mm. One beam will be tested under static loading and two ones will be tested by dynamic loading. That research works will be focused to the possibility how to increase the actual fatigue resistance of concrete members using the bond materials strip - adhesive - concrete.