

Influence of endurance of stud shear connectors on the reliability of steel-concrete superstructures of road bridges

Nikolai Kozak, Anton Syrkov, Vladimir Bystrov, Dmitry Yaroshutin

Saint Petersburg State University of Architecture and Civil Engineering, St. Petersburg, Russia

Contact: kozak.spbgasu@gmail.com

Abstract

The research considers the influence of fatigue failures of shear stud connectors on the overall reliability of steel-reinforced concrete superstructures. There are considered possible models of failures of the joint members and steel-reinforced concrete superstructures as a whole both for the First (Ultimate) Limit State (ULS) and for the Second (Serviceability) Limit State (SLS). There have been developed scenarios for excluding joint members from the operation of the superstructure and a list of basic scenarios and levels of their progress has been compiled. For five models of road bridges steel-reinforced concrete superstructures, there was conducted a numerical experiment to simulate the exclusion of joint members from the work of the structure. The calculation results for each scenario and scenario level are analyzed with regard to possible structural failures. There are also drawn conclusions about the risks of violating the normal operation of superstructures due to the exclusion of the joint members from operation.

Keywords: bridge, superstructure, steel-reinforced concrete, joint member, shear stud connector, reliability, failure, fatigue, endurance

1 Introduction

Reliability is one of the most important properties of road bridges due to their responsibility level and strategic importance for the transport system. Recent studies of world statistics show that there is an increasing trend in the collapse of operated bridges, including fatigue defects [1–3]. A distinctive feature of the operating modes of bridge structures is the non-stationary dynamic loading mode. In such operating modes, which presume a large number of cycles of changing forces and stresses in the elements, the endurance of structural elements has significant influence on the formation of failure, the issues of determining which have been studied to a much lesser extent than the issues of strength.

In general, for superstructures, the topic connection of structural elements endurance to overall reliability has been sufficiently investigated; in studies [4–7], the results of studies of the influence of the main load-bearing elements endurance on the superstructure reliability were presented. In all these works there was considered a situation in which the failure of an element due to the exhaustion of its endurance led to the entire system failure according to the of the Ultimate Limit State criterion.

Meanwhile, for the steel-reinforced concrete superstructures that have become widespread nowadays, one of the least studied is the question of the endurance of the joint members that connect steel beams and reinforced concrete slabs. The results of the field experiments performed by the authors of [8] showed that the joint members