IABSE SYMPOSIUM
7-9 October 2020
Synergy of Culture and Civil Engineering
- History and Challenges
IABSE 2020
WROCŁAW POLAND

THE COLLAPSE OF THE MORANDI'S BRIDGE: REMARKS ABOUT FATIGUE AND CORROSION

S. Invernizzi[1], F. Montagnoli[1], A. Carpinteri[1]

[1]Politecnico di Torino, Department of Structural, Geotechnical and Building Engineering, Torino, Italy.

e-mail: stefano.invernizzi@polito.it

SUMMARY

On August 14, 2018, a few spans of the cable-stayed viaduct crossing the Polcevera river (Genoa, Italy) collapsed, causing tens of fatalities along with considerable material damage and hundreds of people displaced. The viaduct, as well as many others belonging to the national road network, was built in the second half of the last Century and has been in service for over fifty years. The bridge has experienced a dramatic increase in the heavy lorries traffic, together with degradation that developed much faster than expected due to the aggressive environment. In the present paper, a possible scenario is proposed to put into evidence how the combined effect of fatigue at very-high number of cycles and corrosion could have been responsible for the sudden failure of one of the strands and the subsequent collapse of the so-called balanced system conceived by the designer Morandi. Our purpose is to warn the scientific community and the public administrations about the combined effects of low amplitude cycle fatigue and corrosion, which can be dangerously underestimated in the safety assessment of last Century bridges asset.

Keywords: *Cable-Stayed Bridge, Corrosion Fatigue, Very-High Cycle Fatigue, Cultural Heritage, Bridge Collapse.*

1. INTRODUCTION

The present European standards concerning the fatigue assessment in bridges prescribe to adopt the stress life approach, and to refer to a bounded Wöhler's curve with cut-off in correspondence of 10^8 cycles [1]. Although the existence of the fatigue limit is still controversial [2], this approach looks reasonable, at least when degradation is avoided and when the load spectrum due to the heavy traffic has been correctly estimated [3].

The standards provide also methods for the correct estimation of the load spectrum [3], together with prescriptions regarding the limitation of degradation, the monitoring of steel tendons, and the possibility of replacement of degraded elements.

The picture is different if existing bridges are considered. Especially in the case of last Century bridges, the corrosion of metallic parts can be developed more than expected due both to poor maintenance and to underestimation of the aggressiveness of the environment. At the same time, the load spectrum has dramatically increased in terms of relative and absolute frequency of the heavy lorries.

As a consequence, there is a consistent number of bridges that should be assessed with respect to very-high cycle fatigue phenomena, since they have already overcome more than 10^8 cycles, or will exceed them soon in the next decades.

The corrosion of steel elements subjected to cyclic loading in aggressive environment is known as corrosion fatigue [4], and the resulting effects include both the reduction of the resisting cross sections and the downwards translation of the Wöhler's curve together with the vanishing of the fatigue limit. When aggressive environment is combined with poor maintenance and very-high cycle fatigue, the phenomena interact together reducing the safety margin of the structure much faster than expected.

https://doi.org/10.2749/wroclaw.2020.1040
Distributed by structurae