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Structural Reliability of Bridges Made with EAF Concretes

Mariano A. Zanini

Dept. of Civil, Environmental and Architectural Engineering, University of Padua, Via Marzolo 9, 35131 Padua, Italy, marianoangelo.zanini@dicea.unipd.it

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1 Introduction

Among the viable solutions to improve the environmental sustainability of cement-based materials, the use of recycled materials inside concrete mixes is acknowledged to be one of the most effective. Both non-conventional binders and aggregates can be successfully used to design concrete with satisfactorily high properties, both in terms of fresh properties, mechanical strength and durability. However, less research has been devoted both in laboratory and at field-scale about other manufactured aggregate types, even if the use of some of them in concrete has shown promising results. This is the case of electric arc furnace (EAF) slag, a stony, very hard, heavy-weight crushed material, which has been successfully employed to produce concrete (Geiseler, 1996). Following the positive results achieved in small-scale specimens, some research works have been carried out to study also the structural behavior of full-scale structural elements made of reinforced concrete (RC), including EAF slag at varying replacement ratio inside the mixes (*e.g.* Pellegrino and Faleschini, 2013; Faleschini *et al*., 2017a; Faleschini *et al.,* 2017b; Faleschini *et al.,* 2017c; De Domenico *et al.,* 2018). The above literature has evidenced that EAF slag concrete can be suitably applied in gravity structures, where its heavy-weight and high strength result as positive features. However, doubts might arise about its efficacy when applied in elevation RC structures, because the enhanced mechanical strength might not sufficiently balance the increased dead loads of the RC EAF concrete elements.

2 Aims of the Paper

Accordingly, this paper aims to solve this question, analyzing three classes of EAF concrete, characterized by increasing aggregates replacement ratio, through reliability-based analyses of the capacity of RC structural elements made with EAF concretes. Two different bridge types, *i.e.* a single- span simply supported prestressed reinforced concrete (PRC) bridge and a two-span continuous steel/concrete composite I-girder bridge, are designed according to the 2008-Italian Building Code prescriptions and considering a classic NA concrete mix. A reliability assessment is then performed for them, investigating the impact of full replacement of NA concrete with each of the three EAF concrete classes considered (*i.e.* C1, C2, A) on structural safety, thus quantifying the variation of structural safety margins related to the use of the sustainable EAF concretes in replacement to a classic NA concrete mix.

3 Conclusions

The present work investigated the influence on structural safety margins related to the replacement of common NAC mixes with EAF ones, with special emphasis to the field of the design of common bridge types. A general structural reliability workflow was proposed in order to formalize the methodology to be used in assessing the structural reliability index for a generic n-dimensional problem. Two bridge case studies were then analyzed, showing reliable outcomes when using EAF concretes for structural elements subject to compressional regimes, like bridge piers or PRC beams. Among future improvements of the present study, further efforts will also be required in order to investigate the impact of EAF concretes on seismic reliability of RC structural systems.

ORCID

Mariano Angelo Zanini: https://orcid.org/0000-0001-9326-802X

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