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Comparative Study on (Non-)Destructive Techniques for On-Site Strength and Durability Assessment of Limestone Based Concrete Slabs

Bart Craeye[1,2], Daan van Keijzerswaard[1] and Patricia Kara De Maeijer[1]

[1] Energy & Materials in Infrastructure & Buildings (EMIB), Faculty of Applied Engineering, University of Antwerp, Campus Groenenborger, 2020-Antwerp, Belgium, bart.craeye@uantwerpen.be

[2] Durable (re-)Building in Team (DuBiT Research Core), Department of Industrial Sciences & Technology, Odisee University College, Campus Aalst, 9300-Aalst, Belgium, bart.craeye@odisee.be

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1 Introduction

Assessment of strength and durability related properties can be performed by (i) time-consuming and labour-intensive destructive testing of drilled cores and testing in lab and/or (ii) indirect methods by using non- or semi-destructive techniques on site. In this study, an experimental program was conducted on concrete slabs with an approximate age of 5.5 years, intended for various exposure classes based on a limestone inert matrix (Solís-Carcaño *et al.* (2008)). These slabs are investigated, both in 2014 and 2019, by means of destructive testing (compressive strength tests, chloride migration testing, and determination of carbonation rate), and non-destructive techniques: the rebound hammer, the ultrasonic pulse velocity tester, the Wenner probe for concrete resistivity and the air permeability tester. Best fit correlations between the output of these different techniques were established. The effect of age (e.g. carbonation) on the established predictive models is being evaluated (Kim *et al.* (2009)).

2 Materials and Methods

The study was initiated in 2013, with the casting of 14 non-reinforced slabs using 7 concrete mixtures with strength classes varying from C12/15 up to C50/60, as mentioned in (Craeye *et al.*, 2017)). The slabs are stored in an outside, un-sheltered environment for 5 years. Out of each slab 7 cores (diameter 100 mm, height 100 mm) are drilled to perform compressive strength, chloride migration and carbonation tests. Prior to the drilling the slabs are examined in a non-destructive way: ultrasonic pulse velocity (direct transmission), air-permeability, surface resistivity, and rebound hammer.

3 General Findings

- A slight strength decrease is found after 5.5 years, keeping in mind the samples were stored outside. Higher strength loss is found for higher strength classes.
- Strength is linear proportional with rebound hammer (Figure 1a) and ultrasonic pulse velocity and inversely proportional with air permeability. Compared to the results of 2014 (i) higher coefficient of determination on the obtained correlation curves is found, (ii) a shift on the correlation curves is noticeable, linked to the aging effect due to

carbonation (Figure 1a). This aging effect is more pronounced for the rebound hammer results.

- The effect of strength class on carbonation rate is clearly noticeable for slabs of lower strength classes (up to C25/30). For higher strength classes the effect of cement type is more pronounced.
- A linear correlation with high coefficient of determination is found between carbonation coefficient, air permeability (directly proportional, Figure 1b) and ultrasonic pulse velocity (inversely proportional). Note that the air permeability testes is a good non-destructive alternative for the ultrasonic pulse velocity tester (Torrent *et al.* (2012)): elements with high permeability have a lower pulse velocity, mainly due to the scattering of the pulse through air present in the pores.
- No trend is noticeable regarding effect of strength class on chloride migration and a higher chloride migration is found in case of higher air permeability or surface resistivity, however a clear correlation cannot be established.

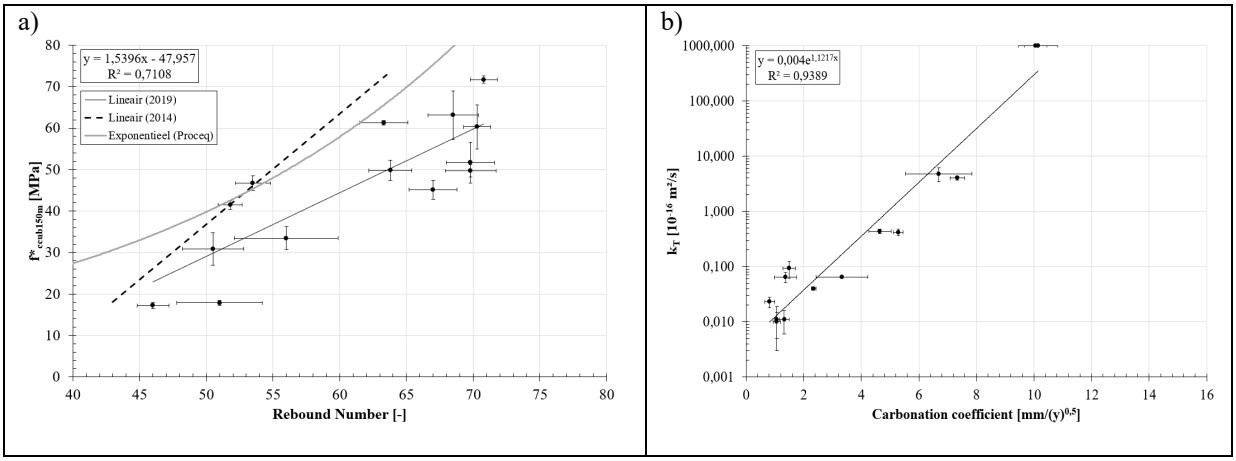

Figure 1. a) Correlation $f^*_{ccub150m}$-rebound number and the effect of carbonation, b) Correlation air permeability and carbonation rate.

ORCID

Bart Craeye: http://orcid.org/0000-0003-4628-8057 & Patricia Kara De Maeijer: http://orcid.org/0000-0002-7038-712X

References

Craeye, B., van de Laar, H., van der Eijk, J. and Lauriks, L. (2017). *On-site strength assessment of limestone based concrete slabs by combining non-destructive techniques*, Journal of Building Engineering, vol. 13, pp. 216-223.

Kim, J.-K., Kim, C.-Y., Yi, S.-T. and Lee, Y.(2009). *Effect of carbonation on the rebound number and compressive strength of concrete*, Cement and Concrete Composites, vol. 31, no. 2, pp. 139–144.

Solís-Carcaño, R. and Moreno, E.I. (2008). *Evaluation of concrete made with crushed limestone aggregate based on ultrasonic pulse velocity*, Construction and Building Materials, vol. 22, no. 6, pp. 1225–1231.

Torrent, R., Denarié, E., Jacobs, F., Leemann, A. and Teruzzi, T. (2012). *Specification and site control of the permeability of the concrete cover*, Materials and Corrosion, vol. 63, no. 12, pp. 1127-1133.