SUMMARY

The dissertation concerns the environmental aspects of the self – compacting concretes in the terms of their carbon footprint. The carbon footprint is the most common applied measures of the environmental impact of analyzed material. This is due to the fact that the problem of the global warming is amajor challenge nowadays. Therefore, apart from the analysis of technical aspects of the applied material, the environmental impact is becoming more and more important. The proper analysis that takes into account the entire product life cycle is indispensable for this purpose. This is especially important in the case of self-compacting concretes, which due to the higher content of binder, are not perceived as a material meeting the requirements of sustainable development. The solution to this problem was the development of self-compacting concretes with a lower cement content.

The purpose of the dissertation was to recognize the actual carbon footprint of self-compacting concrete with a lower cement content compared to self-compacting concrete used in engineering practice in Poland.

Three series of self-compacting concretes - Green SCC, Regular SCC and Skanska SCC were studied. In each series two types of samples were casted- typical cubic samples 100x100x100 mm and crushed aggregate samples that were reflecting concrete rubble after demolition. For this purpose, after the period of curing, the cylindrical samples were crushed to grain size 8 - 31.5 mm. The samples were placed in the carbonation chamber for 56, 112 and 168 days. The chamber had a constant CO_2 concentration of 1%, temperature of 21 ° C and relative humidity of 60%. After the lapse of individual periods, the carbonation depth was determined with the chemical indicator and FTIR method. In the indicator method, 1% of phenolphthalein solution and Rainbow Test were applied. Due to the fact that the range of the color change of the Rainbow Test coincided with the changes indicated by the phenolphthalein solution, in subsequent study periods (112 and 168 days), only the phenolphthalein solution was used. Achieved results indicated the greatest carbonation depth for Green SCC concrete samples, and the lowest for Regular SCC samples. The results of Skanska SCC depth were very similar to results of Regular SCC.

For FTIR analysis, a novel method of collecting material was proposed. The previous method, based on drilling the sample, did not give certainty whether the drilled material came from aggregate or a cement matrix where carbonation occurs. To confirm the assumptions regarding the advantages of the innovative grinding method, the comparative analysis for samples stored in the chamber for 56 days was performed. The results of the spectrometric

analysis of the samples collected with different method from the same concrete varied significantly. Results of samples collected with novel grinding method indicated greather progress of the carbonation process, than the one collected with drilling method. In order to confirm the above observations, samples stored for 168 days were taken for thermogravimetric analysis with differential thermal analysis. The achieved results confirmed that the grinding method allows obtaining more accurate results of the carbonation analysis in comparison to the drilling method.

The remaining samples in the FTIR analysis were collected using the grinding method. Achieved results unambiguously showed the progress of the carbonation process along with the extended storage period of the samples in the concrete carbonation chamber. FTIR analysis compared to the index method showed a significantly greater progression of carbonation in all tested samples. With the extension of the concrete storage period in the concrete carbonation chamber, the difference in the achieved results increased. The achieved results of the aggregate samples indicated an uniform progress of the carbonation process, as the results of samples collected from the surface were similar to the ones collected from the middle of the sample. The obtained values for aggregate samples indicated greater progress of carbonationin relation to the results of cube samples in individual periods.

Based on thermal analysis of samples stored for 168 days, the amount of absorbed carbon dioxide was determined. The obtained results allowed to determine the total carbon footprint of the tested concretes, taking into account the stage after the demolition of the structure. Both the carbon footprint analysis at the production stage, as well as the analysis after the entire life cycle based on the analogy described in the literature (Kikuchi & Kuroda, 2011) showed that the amount of cement is not the most important factor determining the carbon footprint. Obtained results determining the amount of absorbed carbon dioxide in the entire life cycle of the self-compacting concretes tested were compared with the theoretical amount of absorbed CO_2 in fully carbonated concrete in accordance with PN - EN 16757: 2017 - 07 [N13]. In addition, the results of the analysis were also compared with the theoretical models described

in literature. The results obtained in the studies were only convergent with the theoretical model described by Woyciechowski (Woyciechowski, 2013). According to the thesis presented in the paper, the theoretical values described in the PN-EN 16757: 2017 - 07 [N13] standard are considerably overestimated, assuming the concrete life cycle, not the geological time scale (Habert, 2015).