EGU21-8845, updated on 28 Jun 2022
https://doi.org/10.5194/egusphere-egu21-8845
EGU General Assembly 2021

A GPR based estimation of concrete strength changes under extreme temperatures exposure: An experimental study

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There are certain situations where concrete structures are required to resist high temperatures. This applies to cases where exposure to high temperature is expected due to the special character of buildings or where the concrete structure is required to resist severe conditions caused by traffic accidents, terrorist attacks, or natural disasters (earthquakes, fires, etc.). Under such applications, the effect of elevated temperature on mechanical and physical properties may determine whether the concrete element or structure will maintain its structural integrity or not. In this context, fire resistance is defined as the ability to withstand exposure to fire without loss of load-bearing function or ability to act as a barrier to spread a fire. In most cases, structural health monitoring of concrete structures is performed as the visual appraisal of the external characteristics of structures or destructive testing (e.g., concrete coring), and little use has been made of the modern non-destructive testing (NDT) techniques including Ground Penetrating Radar (GPR). GPR, emitting short pulses of electromagnetic energy into the material, is primarily used for location of rebar, estimation of rebar size, industrial quality control, defect and decay detection, and measurement of electrical properties, in case of concrete diagnostics.

This paper comprises a series of GPR and core compressive strengths on low-strength concrete samples. The samples were produced and tested by GPR before and after extreme temperature exposure in an electric furnace at the following temperature levels: 300, 400, 500, 600, and 700 ℃. Then, the compressive test results of the cores taken from the specimens are compared with the GPR data for each temperature level. For GPR tests, the IDS Aladdin system was used with a double polarized 2 GHz antenna. For compressive strength tests, a compression test machine with a capacity of 3000 kN was used.

Based on GPR measurement, Relative Dielectric Permittivity (RDP) values were calculated based on known dimensions of samples and two-way travel time (twt) values obtained from A-scans. The change in RDP values of samples before and after exposure to extreme temperature was then calculated. This variation was then correlated with the change of compressive strength values with regard to the applied temperature levels. This experimental study thus gives an insight into the

potential use of GPR, as an NDT tool, in estimating the strength loss in concrete structural elements exposed to aggressive fire.

All GPR tests were conducted in Educational and Research Centre in Transport; Faculty of Transport Engineering; University of Pardubice. This work is supported by the University of Pardubice (Project No: CZ.02.2.69/0.0/0.0/18_053/0016969).