**Estimation of Concrete Compressive Strength using 1.6GHz Ground Penetrating Radar Images**

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ABSTRACT

Portland cement concrete is the most widely used engineering material in human civilizations. Among its many properties, the compressive strength of concrete is most important to the safety, durability, and sustainability of concrete structures such as bridges and buildings. In this paper, we studied the compressive strength estimation of concrete using 1.6 GHz ground penetrating radar (GPR). The mix design of concrete was 1:2:4 for cement:sand: gravel for two different water-to-cement (w/c) ratios (0.55 and 0.6). Two concrete panels (12”x12”x5”) and twelve concrete cylinders (4”x8”) were manufactured for nondestructive testing (NDT) and destructive testing (DT) for compressive strength. Three different ages (7-day, 14-day, and 28-day) of concrete were considered. Effective dielectric constant of each concrete panel was calculated and used to estimate the compressive strength of concrete at different ages. From our GPR imaging result, it is found that the increase of concrete age leads to the nonlinear decrease of effective dielectric constant of concrete. The time-dependent decrease of effective dielectric constant of concrete also depends on the w/c ratio of concrete. Concretes of lower w/c ratios showed a stronger attenuation in effective dielectric concrete than the ones of higher w/c ratios. After the removal of the time factor in our analysis, it is found that the effective dielectric constant of concrete is nonlinearly dependent on the compressive strength of concrete. In general, the increase in the effective dielectric constant of concrete results in the decrease of concrete’s compressive strength. Spatial variation of dielectric constant in concrete was also investigated, suggesting the spatial variation of compressive strength in concrete.

**Keywords:** compressive strength, concrete, ground penetrating radar, effective dielectric constant