World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Drying Shrinkage of Concrete: Scale Effect and Influence of Reinforcement

Authors : Qier Wu, Issam Takla, Thomas Rougelot, Nicolas Burlion

Abstract : In the framework of French underground disposal of intermediate level radioactive wastes, concrete is widely used as a construction material for containers and tunnels. Drying shrinkage is one of the most disadvantageous phenomena of concrete structures. Cracks generated by differential shrinkage could impair the mechanical behavior, increase the permeability of concrete and act as a preferential path for aggressive species, hence leading to an overall decrease in durability and serviceability. It is of great interest to understand the drying shrinkage phenomenon in order to predict and even to control the strains of concrete. The question is whether the results obtained from laboratory samples are in accordance with the measurements on a real structure. Another question concerns the influence of reinforcement on drying shrinkage of concrete. As part of a global project with Andra (French National Radioactive Waste Management Agency), the present study aims to experimentally investigate the scale effect as well as the influence of reinforcement on the development of drying shrinkage of two high performance concretes (based on CEM I and CEM V cements, according to European standards). Various sizes of samples are chosen, from ordinary laboratory specimens up to real-scale specimens: prismatic specimens with different volume-to-surface (V/S) ratios, thin slices (thickness of 2 mm), cylinders with different sizes (37 and 160 mm in diameter), hollow cylinders, cylindrical columns (height of 1000 mm) and square columns (320×320×1000 mm). The square columns have been manufactured with different reinforcement rates and can be considered as mini-structures, to approximate the behavior of a real voussoir from the waste disposal facility. All the samples are kept, in a first stage, at 20°C and 50% of relative humidity (initial conditions in the tunnel) in a specific climatic chamber developed by the Laboratory of Mechanics of Lille. The mass evolution and the drying shrinkage are monitored regularly. The obtained results show that the specimen size has a great impact on water loss and drying shrinkage of concrete. The specimens with a smaller V/S ratio and a smaller size have a bigger drying shrinkage. The correlation between mass variation and drying shrinkage follows the same tendency for all specimens in spite of the size difference. However, the influence of reinforcement rate on drying shrinkage is not clear based on the present results. The second stage of conservation (50°C and 30% of relative humidity) could give additional results on these influences.

Keywords : concrete, drying shrinkage, mass evolution, reinforcement, scale effect
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020