CONCRETE HAVING INCREASED SERVICE LIFE AND METHOD OF MAKING

FIELD

[0001] Aspects of the present invention generally relate to concrete having increased service life, more specifically toward admixtures and methods of making concrete that increase the concrete's resistance against deleterious species in an external environment.

BACKGROUND

[0002] As reflected in the patent literature, cementitious composites have been used widely for external wall materials of buildings and structural elements of infrastructure construction since they provide a cement hardened construction material having strength and durability. Examples of such compositions include cementitious grout prepared by adding water to a cementing agent, mortar prepared by admixing fine aggregate (i.e. sand), therewith, and concrete prepared by further admixing coarse aggregate (i.e. gravel or stone) therewith. In general, to improve the air entrainment and fluidity for workability, chemical and mineral admixtures have been added.

[0003] Cementitious grout, mortar, and concrete (herein after referred to as "concrete") are a mixture of fine and/or coarse aggregate that is bound together by a cementing agent. The purpose of the cementing agent is to coat the aggregate particles and to act as a matrix that bonds the aggregates into a monolithic product. Hydraulic cements harden by the chemical reaction of hydration and common examples thereof include ordinary Portland cement, limestone, gypsum plaster, lime, ground granulated blast furnace slag, pulverized fuel ash, and pozzolanic materials. The essential binding component formed when the cement hardens upon addition of water is typically calcium silicate hydrate.

[0004] Typical functions of the concrete chemical and mineral admixtures are to assure sufficient short-term and/or long-term performance criteria. Admixtures may be added to improve cement dispersion when the water content is decreased, to retain the fluidity and workability of the concrete during placement, and to improve the long-term durability and strength.

[0005] Concrete is typically made by a process of mixing a cementing agent, aggregate, and liquid water to produce a wet mixture and then allowing the cementing agent to react with water by assuring the continuous availability of water (curing). Often times the wet mixture is poured into a form or mold having steel reinforcing bars (i.e. rebar) or other reinforcing materials as are known in the art. The cured or hardened concrete is porous, having a pore volume of about 5% to about 15%, for example. This concrete may be permeable to deleterious elements in an external environment that may degrade the hardened concrete and/or corrode the steel reinforcing bars, reducing the service life of the concrete.

[0006] Our nation's infrastructure and the containment of nuclear waste are two of the more prominent examples of the application of structural concretes where an extended service life is very advantageous. Concrete structures are typically susceptible to attack by deleterious species in the external environment, such as chloride and sulfate ions, for example. This is exacerbated when constructing along the coast and in road and bridge construction where the external environmental may have elevated levels of salts or other deleterious species. These deleterious species may enter the concrete by diffusion through the concrete pore volume. Past attempts to increase service life have generally focused on limiting the ingress of these deleterious species by producing a less permeable concrete by lowering the water-to-cementitious material ratios (w/cm) and adding fine pozzolans such as silica fume that contribute to make a more dense cement paste matrix resulting in a less porous concrete. However, these mixture modifications also typically contribute to an increased temperature rise during curing and increased autogenous shrinkage, both of which increase the concrete's propensity to undergo early-age cracking, compromising the service life of the concrete.

[0007] What is needed is a concrete having an increased service life and methods of making.

SUMMARY

[0008] According to one aspect of the present invention, a process of making concrete having an increased service life is provided. The concrete may be made by mixing at least one organic water soluble diffusive transport modifying material with water, at least one cementing agent and at least one aggregate to form a wet mixture. The at least one organic water soluble diffusive transport modifying material may be present in the wet mixture in an amount sufficient to increase the viscosity of the water portion by at least 25%. The wet mixture is then cured forming concrete having pores containing a pore solution. The pore solution may have an amount of the at least one water soluble diffusive transport modifying material suitable to reduce an ion diffusivity coefficient of the pore solution, advantageously by at least 20%.

[0009] In another aspect of the present invention, a structural concrete material is provided having an extended service life. The concrete comprises at least one aggregate, water, at least one cementing agent, and at least one organic water soluble diffusive transport modifying material. The at least one organic water soluble diffusive transport modifying material may have a molecular weight of at most 1,000 g/mol and may be present in a pore solution in the structural concrete at a concentration suitable for reducing electrical conductivity of a 0.1 mol KCl/kg water solution by about at least 20%.

[0010] In yet another aspect of the present invention, a process for making concrete is provided where porous lightweight aggregate is mixed with at least one organic water soluble diffusive transport modifying material providing prewetted aggregate material. The pre-wetted aggregate material may then be mixed with water, optionally other nonporous aggregate materials, and at least one cementing agent forming a wet concrete mixture. The wet concrete mixture is then cured.

[0011] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

DETAILED DESCRIPTION

[0012] A detailed description will now be provided. Each of the appended claims defines a separate invention, which for infringement purposes is recognized as including equivalents to the various elements or limitations specified in the claims. Depending on the context, all references below to the "invention" may in some cases refer to certain specific aspects only. In other cases it will be recognized that references to the