Building materials used in construction

\n[toc title="Table of Contents"]\n

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In the world of construction, the king of building materials is concrete. It is the most common material and it constitutes the base of a lot of constructions like buildings, roads, bridges, tunnels, water pipes dams etc. It is an absolutely indispensable tool of civil engineers that is used for more than a century. Before its existence the largest portion of constructions was covered by two other materials, wood and stone, while the last years is very widespread the use of the reinforced concrete; which is concrete with bars of steel in it.

Concrete Analysis

We can say that concrete is a type of an artificial stone, a mixture of four elements; cement, water, sand and aggregates that is succeed by the process of hydration. This process converts the slushiness mixture into an artificial stone just in a few hours. The tight concrete continue to harden for many years but in the seven fist days has already taken more than 70% of its total resistance and in 28 days will have take practically its total resistance. Making the concrete we should be very careful to the proportioning. Cement and water are the two chemically reactive elements while sand and aggregates are chemically inactive. The proportions of each material in the mixture affect the properties of the final hardened concrete. As the cement (created by crushing up clay and limestone together and roasting it in a kiln) content increases, so does the strength and durability of the concrete (a good rate is 12%), the water should be pure and not overtop the 17% because the mixture will be weak and as it concerns the aggregates, too much fine aggregate gives a sticky mix while too much coarse aggregate gives a harsh mix. All these materials together give to concrete some properties and the basic property is that concrete has a very high resistance in compression but low resistance in tension. For this reason, as it mentioned before, we use a lot the reinforced concrete; because the steel bars can handle the concrete in tension. As exists the term of resistance so on the opposite will be another term, this of fatigue.

Explanation of Fatigue

Fatigue is a process of progressive, permanent structural change occurring in a material which is subjected to conditions that produce time fluctuating stresses and strains. The structural changes appeal in cracks or complete fracture after a sufficient number of fluctuations. The fatigue process occurring in concrete has been under investigation since about 1900 with the majority of the significant work having been done during the past twenty years. This process has been observed in concrete under repeated compressive and flexural loading and small amounts of experimental work show that it also occurs under reversed flexural loading and repeated tensile loading.

Reasons of damage on concrete

In perfect conditions, that means an artificial environment of a laboratory and without considering the human mistake, concrete can last without any corrosion about 50 years. But in our environment the fatigue of concrete will start to appear in 30 years and after that the construction need to be watched and maintained. We can examine the fatigue of concrete with two different points of view; macro scale and micro scale.

As it concerns the fatigue of the concrete from a macro scale view we can refer the following reasons. Concrete is a mixture of materials that is decayed in time so the first reason of the fatigue of the concrete is because of its old. Another cause is the intense alkaline environment of the atmosphere and this phenomenon is appeared especially at the urban centers because of the exhausts that are coming out from vehicles and factories. The proximity of the concrete in the water environment, such as big amounts of salt in the air and big amounts of moisture, is also an erosive factor. Furthermore, the boisterous change of the temperature as much as in winter and summer months in combination with the high amounts of moisture cause intense shrinkages and expansions on concrete. It is characteristically observed that the boisterous change of temperature per 10Î¿ C doubles the velocity of corrosion in concrete. Earthquake is the most dangerous reason of all. It can affect the concrete less or too much. It can cause a damage that is invisible but this may affect the building for years creating a bigger damage later. But the earthquake also can cause a complete fracture of concrete. The last important reason tin the macro scale view is the fire. During the fire the most common problems that are presenting are firstly the fracture part of the concrete because of the violent development of pressures from the evaporation of the water contain in concrete, secondly the thermal expansion of the concrete which also leads to fracture and finally the various change of stresses on concrete because of the abrupt freezing extinguishing of fire.

If we want to study it from a micro scale view we could refer the following causes of the fatigue on concrete :

Sulfate Deterioration. Sodium, magnesium, and calcium sulfates are salts These sulfates react chemically with the hydrated lime and hydrated aluminate in cement paste and form calcium sulfate and calcium sulfoaluminate. The volume of these reaction byproducts is greater than the volume of the cement paste from which they are formed, causing disruption of the concrete from expansion.

Alkali – Aggregate Reaction. Certain types of sand and aggregate, such as opal, chert, and flint, or volcanics with high silica content, are reactive with the calcium, sodium, and potassium hydroxide alkalies in portland cement concrete. These reactions, though observed and studied for more than 50 years, remain poorly defined and little understood. Some concrete containing alkali reactive aggregate shows immediate evidence of destructive expansion and deterioration. Other concrete might remain undisturbed for many years. Petrographic examination of reactive concrete shows that a gel is formed around the reactive aggregate. This gel undergoes extensive expansion in the presence of water or water vapor (a relative humidity of 80 to 85 percent is all the water required), creating tension cracks around the aggregate and expansion of the concrete. If unconfined, the expansion within the concrete is first apparent by pattern cracking on the surface.

Deterioration Caused by Cyclic Freezing and Thawing. Freeze-thaw deterioration is a common cause of damage to concrete constructed in the colder climates. For freeze-thaw damage to occur, the following conditions must exist:

The concrete must undergo cyclic freezing and thawing.

b. The pores in the concrete, during freezing, must be nearly saturated with water (more than 90 percent of saturation).

Water experiences about 15 percent volumetric expansion during freezing. If the pores and capillaries in concrete are nearly saturated during freezing, the expansion exerts tensile forces that fracture the cement mortar matrix. This deterioration occurs from the outer surfaces inward in almost a layering manner. The rate of progression of freeze-thaw deterioration depends on the number of cycles of freezing and thawing, the degree of saturation during freezing, the porosity of the concrete, and the exposure conditions.

Acid Exposure. The more common sources of acidic exposure involving concrete structures occur in the vicinity of under-ground mines. Drainage waters exiting from such mines can contain acids of sometimes unexpectedly low pH value. A pH value of 7 is defined as neutral. Values higher than 7 are defined as basic, while pH values lower than 7 are acidic. A 15- to 20-percent solution of sulfuric acid will have a pH value of about 1.

Such a solution will damage concrete very rapidly. Acidic waters having pH values of 5 to 6 will also damage concrete, but only after long exposure.

Construction Defects. Some of the more common types of damage to concrete caused by construction defects are rock pockets and honeycombing, form failures, dimensional errors, and finishing defects. Honeycomb and rock pockets are areas of concrete where voids are left due to failure of the cement mortar to fill the spaces around and among coarse aggregate particles.

Solutions

Generally when a crack affects the performance of the structure, then we will repair it to restore its structural properties. Epoxy injection is typically the basis for this type of repair, with or without added reinforcement. The injected epoxy is actually stronger than the concrete and can restore the concrete strength. To use epoxy injection to repair a crack, the crack is first cleaned by vacuuming or flushing with water to get out any dirt or contamination. The cracks on the surface are then sealed with an epoxy gel to prevent the injected epoxy from running out. Injection and venting ports are installed and the epoxy is injected. High pressure is not used since that could actually widen the cracks. Once the cracks have been filled, the ports and surface seals are removed, typically by grinding the surfaces flush with the concrete matrix. When concrete is too deteriorated for epoxy injection, then all unsound concrete is removed and new concrete is placed. (http://www. concretenetwork. com/concrete-repair/structure. html) (accessed 17/04/2011)

Portland cement mortar may be used for repairing defects on surfaces not prominently exposed, where the defects are too wide for dry pack filling or where the defects are too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface. Repairs may be made either by use of shotcrete or by hand application methods. Replacement mortar can be used to make shallow, small size repairs to new or green concrete.

Surface grinding can be used to repair some bulges, offsets, and other irregularities that exceed the desired surface tolerances. Excessive surface grinding, however, may result in weakening of the concrete surface, exposure of easily removed aggregate particles, or unsightly appearance.

The dry pack concrete repair technique shall be limited to areas that are small in width and relatively deep, such as core holes, holes left by the removal of form ties, cone-bolt and she-bolt holes, and narrow slots cut for repair of cracks. Epoxy bonded dry pack shall be used for critical repairs or for repairs expected to be exposed to severe service conditions. Dry pack mortar shall consist of type I or II Portland cement, clean sand that will pass a 1. 18-mm sieve, and clean water.

Epoxy-bonded concrete is defined as freshly mixed Portland cement concrete that is placed over a fluid epoxy resin bond coat on hardened existing concrete. Epoxy-bonded concrete repair may be used when the depth of repair is 30 cm â€” 50 cm or greater.

Resin injection is used to repair concrete that is cracked or delaminated and to seal cracks in concrete to water leakage. Two basic types of resin and injection techniques are used to repair Reclamation concrete. Epoxy Resins and Polyurethane Resins.

Conclusion

Without concrete, the history of constructions would not be the same and our concern must be to make it stronger and friendlier to the environment and make even more impressive constructions.