A review of using marble powder wastes on self-compacting concrete

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Abstract

The topic of replacing cement by materials with cementitious properties and less harmful to the environment has caught the attention of a large number of researchers in the concrete production sector, satisfactory results were achieved in this regard, especially cement replacement with fly ash, silica fume, limestone and other pozzolan materials, both in normal concrete or self-compacting concrete. Despite the world's interest in recycling industrial waste, the researches about the use of marble powder in self-compacting concrete is very little comparing with other materials wastes, researches agree that it is difficult to produce self-compacting concrete without additives that reduce water content, Whereas, many studies have proven the success of high rang water-reducing admixtures in giving self-compacting concrete its properties required and which depends on its composition on Polycarboxylate, (as well as mineral additives) pozolan or inert materials to improve the gradation of the grain which is important to ensure the homogeneity of the self-compacting concrete.

this paper present the main recent studies on the effect of marble waste on self-compacting concrete properties, Due to the need for some facilities to use self-compacting concrete, and the fact that they require a high content of fine materials for high fluidity without segregation or bleeding.

Keywords: marble powder, self-compacting concrete, wastes.

1. Introduction

Self-compacting concrete (SCC) is a sophisticated technology in the concrete sector with a high flowability and filling ability without separation or exudation and used to improve casting in congested reinforcement only under its own weight and without the need to use vibrators. This concrete was developed in Japan in the late 20th century to be used mainly in densely reinforced or geometrically complex structural elements and to reduce problems caused by bad compaction and poor labor skill due to high workability, and can be poured into narrow and heavily reinforced sectors without segregation.

This concrete is suitable for underwater casting and foundation implementation thanks to high flow and separation resistance, and has also been used in the repair and treatment of some of the damaged parts of bridges, parking stations and support walls due to its ability to fill full places that are difficult to reach when using traditional concrete. Interest in its development has increased to become a high-performance concrete condition used in large-scale construction projects such as the construction of towers and bridges and pre-cast concrete factories[1].

Superplastics are one of the key components to ensure the necessary operating capacity and can be used to improve viscosity (VMA) additives for stability and trapped air additives (AEA) to improve resistance to freezing and melting, in addition to the use of metal additives (inert materials or pozlana) as fillers to improve and maintain workability, adjust cement content and reduce the heat of the rehydration.

Researchers around the world have recently turned to recycling industrial waste and reusing it as a special building material in concrete, being the most sought after building material, the use of metal additives such as Fly Ash and Silica Fume can reduce cost and improve the performance of self-compacting concrete, but these additives are not available in Libya and must be imported from abroad so it was necessary to look for an alternative that meets the needs of self-compacting concrete available within the country to reduce costs and exploit local resources.

The remnants of marble plants are produced from the cutting, spreading, trimming and leveling of marble surfaces in these factories, which are large solid wastes of different size of marble, can be disposed of using this waste using in the manufacture of concrete as a aggregates or grinding and used as a filler, and there are heavy sticky liquid residues consisting of sawdust resulting from the cutting, dispublishing, trimming and leveling of portable marble surfaces with large amounts of water used for the cooling of the mechanisms that must be collected, usually these are collected. Waste in natural or artificial lakes and left to dry under the influence of weather factors to keep the sedimentary substances collected and dumped in often random places.

Recycling of these wastes and using them as a building material can contribute even to a small extent to the use of these residues to produce a self-compacting concrete with high performance and appropriate resistance, which in turn is a solution to the difficulty of compacting and handling concrete in some facilities as it will work to reduce the harmful effects of the cement process by reducing the cement content. The reuse of such residues also reduces the consumption of natural raw materials, thereby reducing the energy consumption required for industrialization and production processes.

2.Using marble powder wastes in self- compacting concrete:

Self compacting concrete is known as high workability, so monitoring and characterization of fresh concrete properties is very important to ensure successfully and include fresh concrete properties, All characteristics are related to concrete final set, set time, fresh properties only affect the casting process but also in hardened properties such as strength amd durability.

Uysal and Sumer (2011)[2] The incorporation of MP as partial replacement of OPC has been found to increase the slump of the SCC mixture. And the slump observed for 10–20% MP gives similar slump of about 710 mm which is higher compared to that of the control which is about 690 mm. However, when the percentage of MP was increased to 30%, a decrease in the slump of about 700 mm was observed. As the difference in the slump between 10 and 30% replacement of OPC with MP is about 10 mm, this effect can also be deemed insignificant.

Uysal and yilmaz (2011)[3] The use of MP as partial replacement of 10% OPC in SCC has been reported to give similar strength compared to those made with 100% OPC, no significant effect on the strength of SCC was observed when MP was used as a partial replacement of OPC at 10 and 20%. However, when the level of MP was increased to 30%, a decrease in the compressive strength of about 5 MPa was observed at 28 days. Based on the lower difference in the compressive strength observed at all levels up to 30%, the effect on compressive strength at these levels can be deemed insignificant. This insignificant effect of MP on the compressive strength of SCC might be as a result of the pozzolanic and pore-filling ability of the MP which complements the OPC replacement. The UPV results also confirmed these effects, as there was only a slight decrease in the velocity of 30%, whereas the UPV at 10 and 20% were similar to that of the control.

Tayeb et.all (2011)[4] applied (30%-42%-50%) marble powder as binder in cement in self-compacting concrete all specimens were compared with together. it can be seen that, at 28-day age, the compressive strength decreases with an increase in marble powder Content.

Belaidi et.al (2012)[5] They studied the effect of natural marble and pozzolana powder on the rheological and mechanical properties of self-compaction concrete, where they performed the relative substitution of natural marble and pozzolana powder with proportions of (10-40)%. Then they tested the operability of fresh concrete using circulating tests and the compressive strength of the concrete was

calculated for ages (7, 56, 28, 90) days and the results obtained reported improved operational performance of concrete containing marble powder and natural pozzolana, as for the compressive strength, it decreased by increasing the percentage of natural marble and pozzolana powder, but at the age of 28 and 90 days, the compressive strength resistance value was appropriate even at 40%.

Mamun et.al(2017)[6] They studied the possibility of benefiting from the remnants of marble and building stones and their use as coarse aggregate in concrete, where they used in proportions of 10, 20, 30%. The process of extracting it is a problem for the environment.

Boukhelkhal (2017)[7] find that SCC made with waste marble powder at replacement level of 5% developed approximately similar compressive strength with control SCC At 28 days, compressive strength values ranging from 26 to 37 MPa were obtained. These results allow the use of different replacement levels of WMP for different concrete purposes, For example, SCC containing WMP content of 10% can be used in a structure when the desired strength is about 35MPa. Concerning the water capillary absorption and water absorption by immersion, a slight increase in amount of water absorbed was observed when the cement is partially replaced by WMP. Correlations between compressive strength at 28 days and water absorption properties were found very good with a coefficient of correlation more than 0.9. Incorporating WMP in SCC mixes immersed in magnesium sulfate solution was found to decrease the expansion and to improve the resistance to sulfate aggressions.

Abd ALHamid Qenaw (2018)[8] He studied the effect of replacing marble powder, partially with cement, on the properties of self-compaction concrete, where he carried out self-compaction mixtures with water content (0.45, 0.50, 0.55), and then partially replaced the marble with proportions of (5, 10, 15)% for all mixtures and the amount of coarse aggregate was The fine additives are stable and I used Viscocrete-N by 1% for all mixtures.

It was found from the drop test that the drop diameter decreases by increasing the percentage of marble for the same water content, but it is still within the limits of the specifications for all mixtures, and the results also showed improvement in the permeability of concrete by increasing the substitution ratio, although the pressure resistance decreased by increasing these percentages.

Rayed Alyousef (2018)[9] The effects of the cement-MP paste volume on the SCC properties by a microstructure analysis were studied, The powder obtained from the sludge of cutting marble blocks, can be used as a filler added to cementitious

matrix of self-compacting concrete The cement-MP paste volume has asignificant effect on rheological properties in fresh state of SCC and on its compressive strength , There was a good correlation between fresh and hardened properties for the four SCCs with different cement-MP paste volume, XRD patterns indicate that the large variation in chemical composition of marble powder paste does not affect the hydration process of the mix, SEM images show that the large adding amount of marble powder provides a mix with porous microstructures which affect the rheological properties and the compressive strength of SCC.

6. Conclusion :

From the above review the following can be concluded:

- The production of cement causes emission of greenhouse gases and dust. Using recycling matrial such as marble poweder can decline the air pollution as the production of cement is decreased.
- The best percentage of marble powder wastes replacement is between 5 and 10 %. On the other hand, percentages higher than 10% leads to lower compressive strength.
- Adding marble powder wastes to self-compacting concrete improves the workability of self-compacting concrete, the best pecantage of marble powder wastes is between 5-10%.
- The construction industry is a key consumer of raw materials. So,the construction sector is directly and indirectly responsible for large amount of global greenhouse gases emissions.

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