SUMMARY AND CONCLUSIONS

Quarry dust (QD), is byproducts from the crushing process during quarrying activities. It is one of the materials that have recently gained attention to be used as concreting aggregates, especially as fine aggregate QD is normally dumped in large amounts around the quarry plants and causes some environmental problems.

Limestone (LD) is an important material for cement manufacture. The addition of LD to Portland cement may significantly improve several cement properties such as compressive strength, water demand, workability durability and can also decrease the production costs of cement. There is evidence that, the influence of LD on concrete properties depends on C$_3$A content of cement clinker, because CaCO$_3$ in LD reacts with C$_3$A to produce mono carboaluminate hydrate (AFm), which has moderate binding properties. It causes a better packing of cement specimens.

Basalt is one of igneous rocks, which are formed during the cooling and recrystallization of magma. Most of igneous minerals are present in active states, which are changed under environment conditions to more stable clay minerals. The pozzolanic activity of fresh basalt was studied and it was concluded that, basalt has slightly pozzolanic at early ages and increases with the time.

In the present work, three different quarry dusts were used as cement, fine aggregate and coarse aggregate replacement materials. The quarry dust-modified cement specimens were prepared with different QD types (LD, GD and BD) and percentages (4, 8, 12 and 16 mass, %). The investigated cement pastes (PC and dust-modified pastes) were prepared
with the water of standard consistency to attain the same workability. Also, the initial and final setting times for all pastes were determined according to ASTM specifications. The all investigated mortars and concretes were hydrated at different curing ages (3, 7, 14, 28 and 90 days). At each curing time, the hydration reaction was stopped by during the hydrated cement specimens in oven drier at 100-110°C for 4 hours, and then the mechanical properties were studied by measuring the compressive, flexural strengths for mortars and compressive, Brazilian tensile strengths for concretes.

In order to identify the hydration products, some selected hydrated cement mixes were investigated using different techniques, i.e., XRD, DTA and SEM. From the previous results, it can be concluded that:

i) For pastes specimens the substitution of PC by quarry dusts (LD, GD and BD) tends to increase the water of standard consistency and elongates the setting times. This is mainly due to the higher fineness and the more hydraulicity of QDs in comparison with PC.

ii) The compressive and flexural strengths of the hydrated cement mortars with the same chemical composition increases with curing time. This is mainly attributed to the continuous hydration of cement phases as well as the formation of hydrated carboaluminates, silicates and aluminosilicate from the reaction of LD, GD and BD with the main cement clinker compounds. These hydrates precipitate and accumulate to fill up the open pores, originally filled with water, leading to the formation of more dense, compact, homogeneous microstructure. Therefore, the bulk density of cement specimens increases with curing time.
iii) The strength properties (compressive and flexural strengths) of the blended cement mortars with quarry dusts are higher than those of the control mortars, especially at lower quarry dusts contents (4-12 mass, %). But, at 16 mass, % of GD and LD the blended mortars give lower mechanical properties than PC mortar at the same curing age. The increase of strength characteristics of cement mortars with QD content up to 12 mass, % may be due to the filling and nucleation effects of quarry dusts. Also, BD and GD act as pozzolanas to react with the liberated portlandite during the hydration of cement clinker phases, especially C₃S and β-C₅S, leading to the formation and accumulation of additional amounts of hydrated silicates (CSH), which is the main source of strength.

iv) For mortar specimens at a given time of hydration and the same fine aggregate dust content, the basalt dust containing mortars behave mechanically better than those of GD and LD mortars. The strength values increase ascendingly in the order LD-mortar < GD-mortar < BD-mortar. The variation of strength properties of quarry-modified mortars with QD type is attributed to that, LD acts as a filler and non-pozzolanic fine material. It reacts with cement phases, especially C₃A to form calcium carboaluminate hydrate with mediate binding properties. On the other hand, GD and BD act as fillers and pozzolanic materials with different pozzolanic activities. Basalt dust has higher pozzolanic activity than GD, due to the higher amorphous (vitreous) silica content of BD in comparison with GD. The later contains higher content of crystalline silica (quartz) than BD. It is well known that, the hydrated silicates has higher binding properties comparing to carboaluminate hydrates, therefore the hydrated products of BD-mortars are more denser than those of hydrated LD-mortars. The maximum replacement level of each dust,
which gives desirable mechanical properties, varies according to the QD type. This level is found to be 8, 8 and 12 mass, % of LD, GD and BD, respectively.

v) The blended cement mortars and concretes with 8, 8, and 12 mass, % of LD, GD and BD, respectively showed the higher mechanical characteristics and better micrographs. The hydrated mortars and concretes with 12 mass, % of BD at 90 days has the best mechanical behavior than the others.

vi) In case of PC and QD-modified concretes, the compressive and Brazilian tensile strengths were measured and compared with each other. It was found that, the compressive and tensile strengths increase with dust dosage up to a certain level depending on the dust type. The increase of strength properties of QD-concretes than that of PC, especially at lower dust contents up to 12 mass, %. This improvement of mechanical properties is mainly due to that, QDs not only act as fillers but also as chemical activators for cement hydration. After 12 mass, % of quarry dust aggregates (QDAs), the mechanical properties (compressive and tensile strengths) decrease with QDA dosage up to 16 mass, %. This mainly due to the negative effects of QD As on the strength properties. At 16 mass, % replacement level of coarse aggregate with QDAs, the transition zone becomes thicker due to the increase of concrete defects and consequently the decrease of its homogeneity in presence of excessive amounts of QDs.

vii) The results of compressive, flexural, and tensile strengths of the all investigated mortars and concretes are in a good agreement with each other and with those of XRD, DTA, and SEM.