Valorization Of Sand Dune Of Taghit (South-Western Algeria) In The Construction: Technical And Eco-Environmental Aspect

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***Abstract*— Currently, it is necessary to replace Portland cement with environmentally friendly materials. The cement production process is associated with a high consumption of energy, resources and of course a large amount of carbon dioxide emissions. This research work deals with the valorization of dune sand of Taghit (south-western Algeria) in construction and more particularly the new concretes namely self-compacting concretes (SCC) and high performance concretes (HPC). The results obtained on the different materials studied show that the use of Taghit sand dune as a partial replacement of cement considerably improves both their rheological properties and their mechanical performance.**

***Keywords*— Dune sand, New materials, rheological characterization, mechanical performance, Eco-environmental study**

I. INTRODUCTION

Sand Dune has many uses around the world. The granulometry, the uniformity, the chemical purity and the nature of the dune sand make it a unique resource. Demand for this resource is increasing due to an increase in the number of products using dune sand and because other new uses have been developed [1]. The main use of dune sand is in the construction of materials [2-4]. Sand is used to make molds and cores. Molds are used to form new materials. Core sand fills spaces and voids. Silica sand (quartz) is also used in the manufacture of glass. Railroads use large amounts of sand to improve traction on wet or slippery rails. Sand is used in sanding. The floors of some large open hearth furnaces are covered with siliceous sand. Sand is an excellent filter for removing sediment and bacteria from water. Finally, one area of increased use of sand is in fiberglass manufacturing [1].

Sand is a unique raw material for the construction industry at present. Not only is it used for glass but more so for making concrete, filling roads, reclamations and building sites [2]. Each has its own requirements in respect of the quality of the sand [5-6].

The main objective of this research work is to develop the Taghit dune sand (south-western Algeria) in the construction and more particularly the new concretes namely self-compacting concrete (SCC) and high performance concrete (HPC).

II. TECHNICAL CHARACTERIZATION OF BASIC MATERIALS

A. Physical properties

The cement used is Portland cement resistance real 425 bars. The dune sand coming from crushing sand dune which is on the level of Taghit, wilaya of Bechar (Algeria), the maximum coarse aggregate of crushed dune sand does not exceed 80µm. Table 1 present a Physical properties of Portland cement and dune sand.

TABLE I
PHYSICAL PROPERTIES OF PORTLAND CEMENT AND DUNE SAND [7]

Items	Portland Cement	Dune Sand	Regulatory
Absolute density	3.05	2.8	NF P 18-558
specific surface (cm^2/g)	3200	3000	EN 196-6
Unit weight (kg/m^3)	1120	1300	NF P 18-554

B. Mineralogical and chemical properties

The results of DRX analysis carried out on the dune sand of Taghit and Portland cement are presented graphically on Fig 1. It was noticed a peak of approximately 100 % of silica with dune sand and calcite for cement which translated the predominance of SiO_2 and $CaCO_3$, the others revealed elements present at small percentages.

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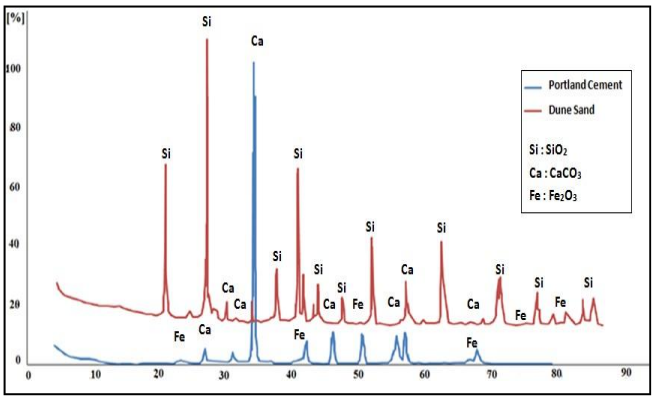

Fig. 1 XRD analyze of Portland cement and dune sand

From the fig 2, it was observed that the shape of Portland cement particle is angular, dappled, broken or round forms observed for dune sand.

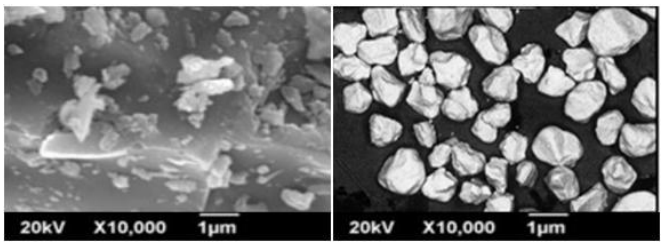

Fig. 2 SEM photographs of: (a) Portland cement; (b) Dune sand

The chemical compositions of Portland cement and dune sand are presented in table 2.

TABLE 2
CHEMICAL PROPERTIES OF PORTLAND CEMENT AND DUNE SAND [8]

Elements (%)	Cement	Dune sand
SiO_2	17.49	97.15
Al_2O_3	4.51	0.79
$Fe2O_3$	3.02	0.21
CaO	62.78	0.11
MgO	2.15	0.05
SO_3	2.38	0.14
Na_2O	0.05	0.18
TiO_2	0.64	0.05
Others	0.02	< 0,02
Loss of ignition	8.10	0.58

III. VALORIZATION OF DUNE SAND IN NEW MATERIALS

A. Self-compacting concrete

The SCC must satisfy many tests, we chose three that are recommended by AFGC. |3] that allow to characterize the principal properties of SCC in the fresh state (fluidity , static and dynamic stability, free and confined environment) spreading Abrams cone flow box L and stability through a sieve. The test slump flow (fig.3-a) is carried with the Abrams cone consists of measuring the diameter of concrete spread on two perpendicular lines and takes the mean. The test L-box (fig 3-b) is used to check the mobility of confined concrete and verify the implementation of concrete will not be thwarted by blocking phenomena. The test of stability (fig. 3-c) by sieve can qualify compacting concrete to the risk of segregation and indicates the degree of segregation of SCC.

Fig. 3 Qualification test of self-compactability concrete: a-Slump flow, b- L-Box and c-Stability in sieve

According to Table 3, all self-compacting concrete (SCC) must meet the recommended criteria for testing [AFGC, 2008].

TABLE 3
RHEOLOGICAL PROPERTIES OF SELF- COMPACTING MIXES

SCC mixes	Rheological properties		
	Slump flow (cm)	L-box	Segregation index (%)
Limited values according to AFGC. [9]	60 - 75	≥ 0.80	≤ 15

B. High performance concrete

The Compressive strength is an indicative characteristic of concrete that allows us to envisage other properties. Generally, enhanced durability properties can be obtained with concretes of higher compressive strength. The fig 4 presents the compressive strength of various HPC mixes determined at different ages. As expected, the compressive strength of HPC increased with age. As can be observed, the compressive strength slightly increased with increase of amount of dune sand. This is due to the physical nature of better packing, as addition of dune sand governs the compressive strength due to the denser matrix and the better dispersion of cement grains [6]. Fineness of the dune sand also affects the strength as it filled up the micro pores within the concrete matrix and densified the concrete [7]. The dune sand have improved the properties of HPC such as porosity reduced and better bonding in inter transition zone [6].

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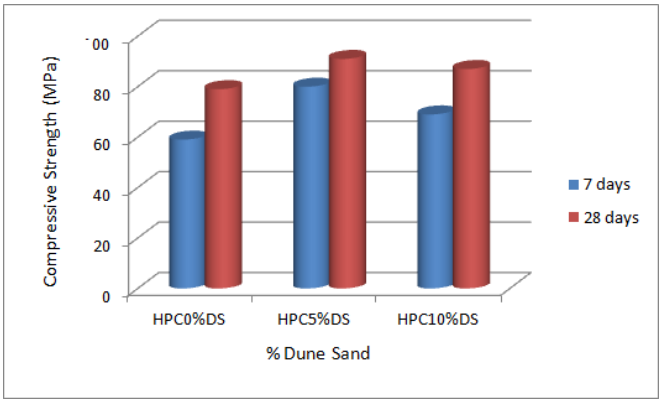

Fig. 4 Mechanical properties of high performance concrete mixes

IV. Conclusions

In light of the results obtained during this research work, this study allowed us to extract the following conclusions:

- It is possible to manufacture a new concrete (SCC and HPC) based on dune sand with better rheological and mechanical performances;
- The incorporation of dune sand slightly improves the mechanical resistance of concretes. The addition of dune sand can help increase the compactness of concrete by forming a more compact granular skeleton;
- The use of sand dune of Taghit in the construction is very interesting economically and ecologically on the one hand through the partial replacement of cements, and on the other hand, it contributes to the improvement of physical and mechanical properties of concretes.

Finally, we can say that the development of sand dune can provide a solution for some work in the desert regions of our country.

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