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Study of the Influence of sand nature on the macroscopic behavior of hydraulic concrete

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ABSTRACT: The main object of this study is to optimize the use of crushed sand from basalt aggregates and sand dune in hydraulic concrete. In this sense, we have studied a series of tests, of partial and/or total substitution of sand dune by crushed basalt sand, with a W/C ratio (water/cement) of 0.49. The study consists to assess the rheological and mechanical properties of the concretes (C1, C2, C3, C4, C5, and C6) with respective substitution rates of (0%, 20%, 40%, 60%, 80% and 100%). The results are then compared and discussed. The best workability is given by sand dune concrete (C1). The mechanical resistance of C6 is superior to that of C1, on the other hand the workability of C1 is greater than that of C6. The mixes based on partially substituted aggregates give the best compressive strength performance compared to those based on fully substituted aggregates (C1 or C6). Maximum compression is obtained at 20%.

KEYWORDS: Sand dune, Crushed sand, basalte and Substitution.

1 INTRODUCTION

Concrete is still one of the world's most popular building materials. It is composed of several materials that can influence its macroscopic behavior [1]. The manufacture of this product requires the use of good quality aggregates. For this reason, some people use beach sand, which is clean and has good granularity. Nevertheless, the use of beach sand has negative impacts on the environment through coastal erosion and on the structure through corrosion of the reinforcements. Thus the sand dune SD is exploited. However, it is often mixed with crushed sand to have quality requirements.

Several works have focused on the use of sand dune and crushed sand in concrete. It has been shown that the angular shape and the large size of SC lead the compressive strength of the concrete [2-4] and decrease concrete slump [5].

The partial SD replacement by SC increases the workability of self-compacting concrete. SD increases the viscosity of the mix and SC increases the bleeding of the concrete [6-9].

The objective of this study is to contribute of a SC basalt use and SD in hydraulic concrete.

In this work we will study the impact of the nature of sand on the rheological and mechanical behavior of hydraulic concrete.

2 MATERIELS ET METHODES

2.1 PRÉSENTATION & COMPOSITION

The materials used for this study come from quarries in Senegal. They are 8/16 basalt, 3/8 basalt, 0/3 basalt crushed sand and sand dune. The cement is of the CEMII type with a nominal strength of 32.5R. The mix design used are given in Table 1.

Table 1. Concrete mix design

Mix in kg/m³					
N°	Cement (en kg)	DS (kg)	CS (kg)	Gravel 8/16 (kg)	Gravel 3/8 (%)
C1	450	615	0	730	430
C2	450	492	123	730	430
C3	450	369	246	730	430
C4	450	246	369	730	430
C5	450	123	492	730	430
C6	450	0	615	730	430

2.2 Methods

2.2.1 Characterization Of Aggregates

The granulometry has been carried out using a series of standardized sieves NF P94-056 and the flattening coefficient is determined in accordance with the standard NF EN 933-3 The apparent and absolute densities are determined according to the standard NF EN 1097-6. The cleanliness of the sand is determined by the NFP-18 598.

2.2.2 Rheological Characterization Of Concrete

2.2.2.1 Workability

The workability of concrete is determined by the slump test, which consists of determining the slump of the concrete by its own weight. The test is carried out using a bottomless truncated cone mold with a base diameter of 20cm and a top diameter of 10cm and a mold height of 30cm. This mold is fixed on a base plate. The workability test is shown in Figure 1-a.

2.2.2.2 Occluded Air

The purpose of this test is to determine the amount of air entrapped in the fresh concrete paste. This is obtained by using the concrete aerometer shown in Figure 2.The test consists of applying a pressure of the order of 0.1 MPa. The scale h1 reached by the water column is noted, the pressure is reduced to zero and h2 reached by the water level is noted. The occluded air would then be given by formula 1.

$$A = \text{h1} - \text{h2}/\text{h1} \qquad (1)$$

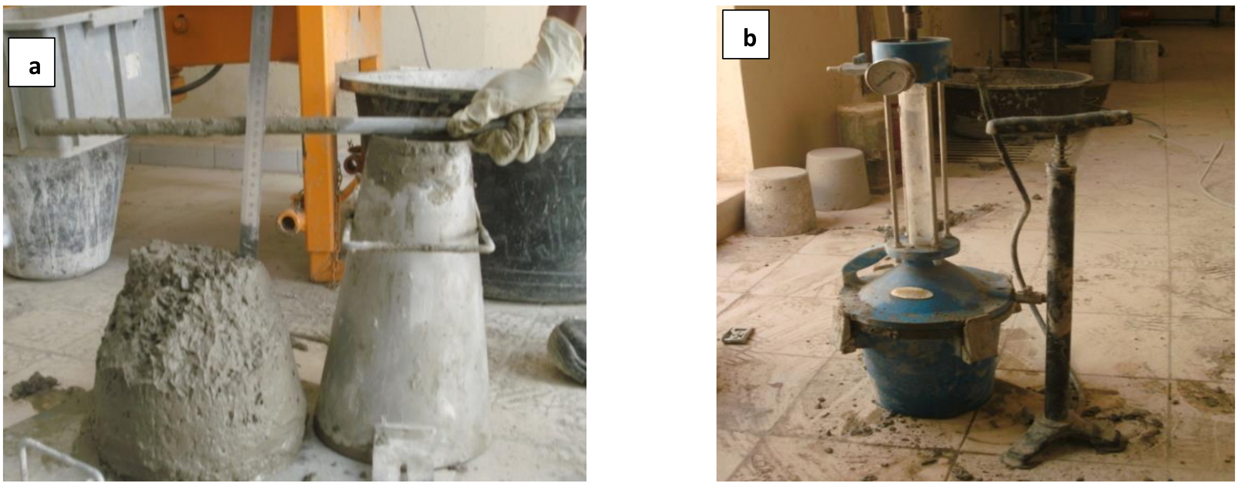

***Fig. 1.** a) concrete slump test – b) concrete aerometer*

2.2.3 Caractérisation Mécanique Du Béton

The samples used to determine the mechanical compressive strength of the various concretes studied are cylindrical specimens with a diameter of 16 cm and a height of 32 cm. After demolding, they were kept in a wet room until the specified deadline (3 days, 7 days and 28 days). Before testing, the bases of the cylinders were rectify with a coating using a mixture of plaster and fine silica sand; this mixture is applied by means of a device ensuring the flatness of the faces and their perpendicularity with respect to the generator (standard NF P 18-406). The press used is shown in Fig 2 and it has a maximum capacity of 3000kN. The compressive strength has been evaluated according to the NF P 18-406 standard.

Fig. 2. ***Concrete compression press***

3 Results And Discussion

3.1 Characteristics Of Aggregates

The aggregates characteristics are shown in table 2. DS is mainly composed of fine elements with a modulus of fineness of 1.021. The grading curves in figure 3 show that DS has a uniform granularity. On the other hand, CS has a spread grain size distribution with a modulus of fineness of 2.7The densities of the aggregates are in the same order of magnitude. The flattening coefficient of the aggregate 8/16 shows that the aggregates are Flattened. DS and CS sands are all clean.

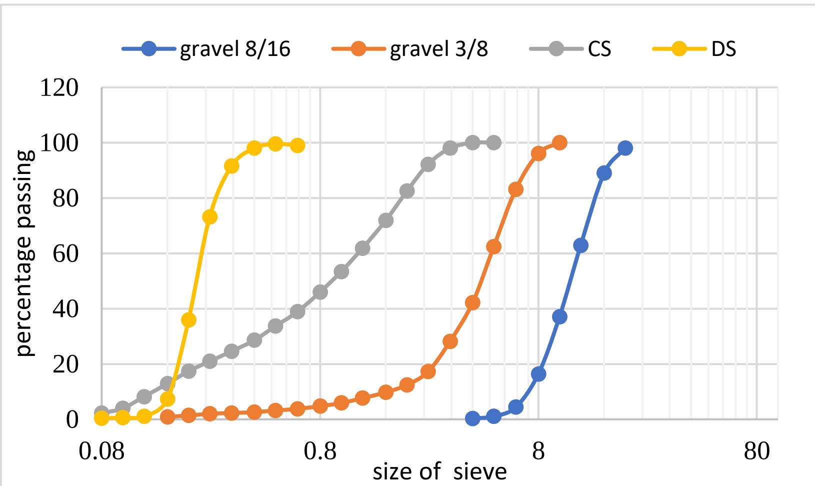

Fig. 3. ***Granular materials distribution***

Table 2. Characteristics of aggregates

	DS	CS	Gravel 3/8	Gravel 8/16
bulk density (g/cm 3)	1.6	1.7	1.7	1.7
Absolute density (g/cm3)	2.5	2.7	2.9	2.9
coeficient of flattening (%)	-	-	-	39.6
Sand Equivalent (%)	86.23	80.29	-	-
Finesse Module	1.021	2.7	-	-

3.2 Impact Of Sand On The Rheology Of Concrete.

The workability obtained with 100% DS is greater than that obtained with 100% CS. There is a decrease of 3cm for a substitution rate of 20% and then a moderate variation up to 60%. A decrease in sagging from 14 cm to 7.5 cm for the respective formulations of C4 and C5 is observed and sagging becomes constant at the value of 7.5 cm up to 100% CS.

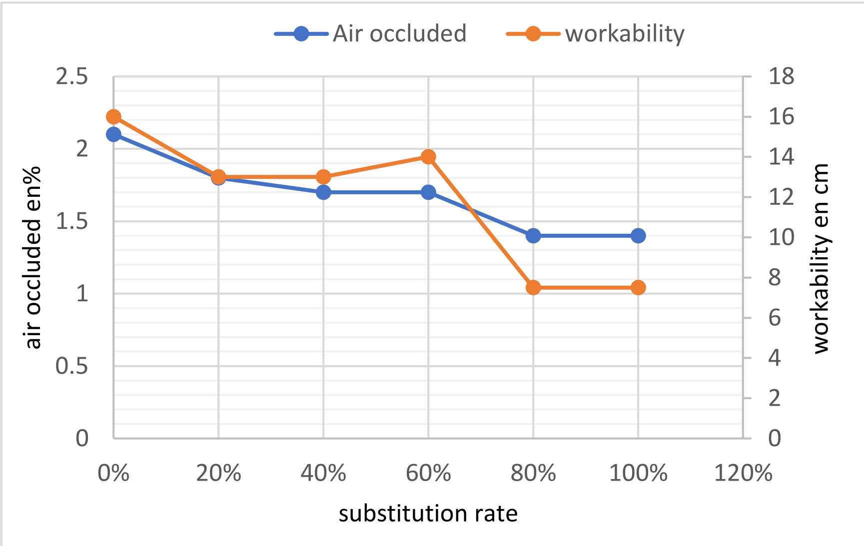

Fig. 4. Variation of workability and air occluded from fresh concrete

The figure 4 shows a decrease of 0.3% of the air occluded between the concrete of C1 and C2, then a stagnation with a moderate variation between the concretes of C2 to C4. From C4 to C5, there is also a decrease of 0.3% of air occluded and then a constancy up to 100%, which implies that the introduction of crushed sand reduces the content of air occluded.

3.3 Impact Of Sand On Mechanical Strength

The mechanical resistances of concrete at 3, 7 and 28 days are shown in the figure 8. At 3 days, the trend in mechanical resistance increases with the rate of substitution of sand dune by crushed sand, contrary to the trend at 7 days, which decreases. At 28 days, the 100%CS concrete is better than the 100% DS concrete and for the substitution concretes a regression of the trend is noted.

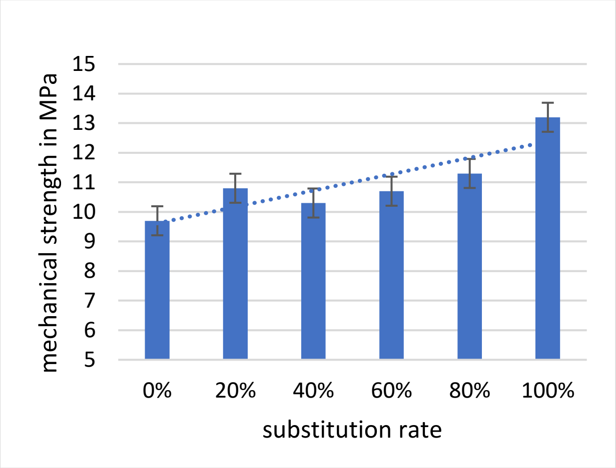

Fig. 5. Compressive strength at 3 days

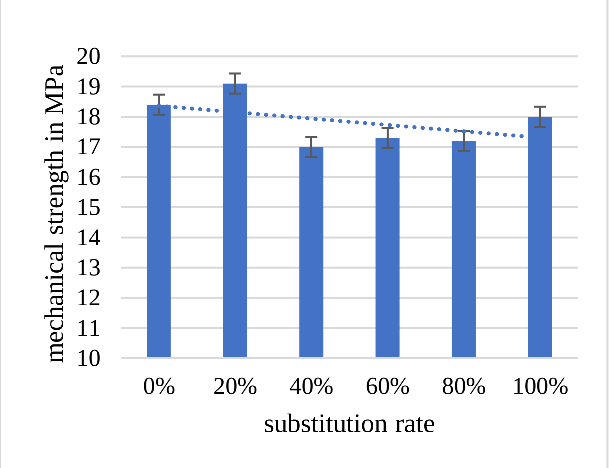

Fig. 6. Compressive strength at 7 days

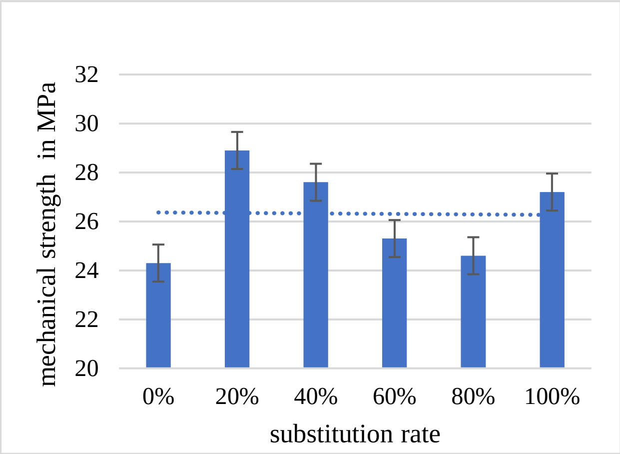

Fig. 7. Compressive strength at 28 days

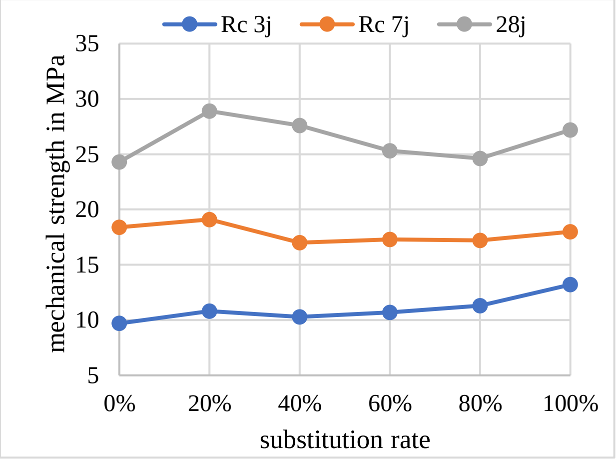

Fig. 8. Evolution of compressive strength at 3, 7 and 28 days

According to the mechanical results shown in figure 7, the resistance of concrete made with crushed sand is better than that made with sand dune after 28 days of curing, with respective resistances of 27.2MPa against 24.3MPa. The greatest resistance is obtained with the substitution concrete with a value of 28.9MPa at 20%. At a young age of 3 days the compressive strengths in figure 5 increases from 9.7MPa to 13.2 with a typical deviation of 1.2MPa. On the other hand, at 7 days of curing, the compressive resistances observed in figure 6 decrease from 19.1MPa to 17MPa with a standard deviation of 0.81MPa

4 Conclusion

This study aims to contribute on the formulation of concrete with sand dune and crushed sand. Information from this work is presented below:

Crushed sand has a larger grain size distribution than sand dune. Crushed sand has a greater fineness modulus than sand dune.

The angular shape of the crushed sand and the not insignificant content of fine wires means that the substitution of sand dune reduces workability and air entrapment.

The optimal substitution of sand dune by crushed sand increases the compressive strength of the concrete.

The percentage of crushed sand used in an ordinary concrete formulation must be optimized because above 20% of substitution (CS ≥20%) the performance of the concrete decreases

References

[1] Douara Taha-Hocine, Guettala Salim, Effets de divers types de sables sur les propriétés d'un béton autoplaçant, Conference Paper April 2017.

[2] M. drissi (1), b. mezghiche (2), m. l. k. khouadjia (3), influence des parametres de compostion du béton sur sa resistance de compression, courrier du savoir – n°20, décembre2015, pp.73-78.

[3] De Larrard F, Belloc A. The influence of the aggregate on the compressive strength of concretes. Bulletin de liaison des Laboratoires des Ponts et Chaussées, n° 219, Janvier-Février, 1999,.

[4] Lecomte A, De Larrard F and Mechling J.M. Compressive strength of hydraulic concretes to the unoptimised granular skeleton. Bulletin LPC n° 234, 2001, pp. 89-105.

[5] Houria Hebhoub, Mouloud Belachia, Introduction de sable de déchet de marbre dans le béton hydraulique, Nature & Technologie,2010, pp41-46.

[6] Rmili A. Study of the formulation and behavior of self-compacting concretes: incorporation crushed sand and desert sand. Thèse de Doctorat de l'Ecole Nationale d'Ingénieurs de Tunis, 2010.

[7] Rmili A, Ben Ouezdou M. Valorization of the crushed sand and of the desert sand in the composition of the self compacting concrete. MATEC Web of Conferences 2, 01001, published by EDP Sciences. 2012. p. 1-9.

[8] Rmili A, Ben Ouezdou M, Added M, Ghorbel E. Incorporation of crushed sands and Tunisian desert sands in the composition of self compacting concretes. Part I: Study of formulation. Int J Concr Struct Mater 2009; 3: 3-9.

[9] Rmili A, Ben Ouezdou M, Added M, Ghorbel E. Incorporation of crushed sands and Tunisian desert sands in the composition of self compacting concretes. Part II: SCC fresh and hardened states characteristics. Int J Concr Struct Mater 2009; 3: 11-14.