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Study the mechanical and physical properties of sand concrete using crushed limestone sand

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This research work deals with the effect of using crushed sand resulting from quarry waste on the mechanical and physical properties of sandy concrete. As the crushed sand was replaced by river sand in three different proportions which are 40%, 50% and 60% respectively. In this study, the flexural strength, ultrasonic pulse velocity, and the dynamic modulus of elasticity will be examined. The results obtained showed a good improvement over all the experiments studied when adding crushed sand and thus it could be used as a substitute for river sand in sand concrete, as the ideal ratio for all test results upon replacement was 60% of crushed sand.

Keywords: *Sand concrete, Flexural strength, Ultrasonic pulse velocity,Dynamic modulus of elasticity.*

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1. Introduction

Sand concrete is fine concrete, defined by standard NF P 18 500 (1995) revised in 1987 by AFNOR [1]. Sand concrete does not contain gravel, but if it can be contained, it is with a mass ratio (gravel / sand) of less than 0.7 [2].In sand concrete, the maximum dimension of aggregates is that of sand (less or equal 5 mm) [3]. The sand type effect on sand concrete properties has been the subject of several studies [4].

The main objective of the present Study the mechanical and physical properties of sand concrete using crushed limestone sand , where the focus of our study was on flexural strength, ultrasonic pulse velocity, and the dynamic modulus of elasticity of sand concrete.

2. Materials Method

2.1. Materials used

2.1.1 Sands

_ Crushed sand (CS), Extracted from Ain Touta region, In the wilaya of Batna, the grain diameter is a maximum of 5 mm.

_ River sand (RS), from the oued Liu (region Biskra), presents continuous particle size distribution ranging from 0.08 to 5 mm; but the fraction smaller than 0.16 mm remains very small.

The particle size distributions of the various sands used are shown in Fig. 1.

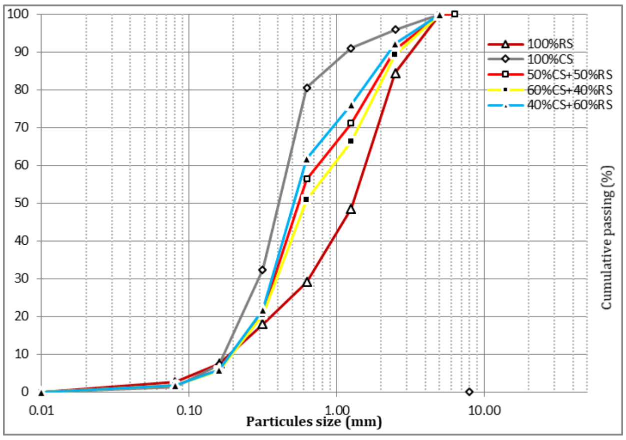

Fig.1. Granular size analysis of crushed and river sand

Table 1. Physical properties of the sand used.

Sand	Crushed sand (CS)	River sand (RS)
Apparent density (g/m^3)	1.48	1.61
Specific density (g/m^3)	2.60	2.50
Fineness modulus	3.03	1.92
Compactness (CP)	56.92	64.40
Sand equivalent	97.63	78

2.1.2 Cement

The cement employed is ordinary Portland cement (type II) of class 42.5, also known as ‘‘CPJ CEM II/A”. It is produced in the cement plant of Ain Touta (Batna).
The physical characteristics are the following: absolute density of 3.1 g / cm^3 and 370 m^2/kg fineness.

Table 2 Chemical compositions of cement.

	(%)
SiO_2	20,52
CaO	63,86
Al_2O_3	5,13
$Fe2O_3$	3,36
MgO	1,27
Na_2O	0,14
K_2O	0,76
SO_3	2,26
Cl-	0,027
L.O.I	1,09

2.2. Methods

2.2.1. Formulation of Sand Concrete

The concrete mixtures were formulated based on several studies for the formulation of sand concrete, which in turn aims to improve the compactness of the granular structure [5]–[7] Where the table 3 shows the proportion of the compositions of sand concrete.

Table 3. Compositions of sand concrete.

Compositions	Crushed sand Kg/m^3	River sand Kg/m^3	W / C
60% crushed sand +40% river sand	978.12	647	0.7
50% crushed sand +50% river sand	815.10	808.75	0.7
40% crushed sand +60% river sand	652.08	970.5	0.7

2.2.2. Experimental methods

_ Flexural strength are tested at 7and 28days on prismatic specimens (4x4x16) cm^3 in according with standard EN 196-1. The mechanical properties obtained from tests performed on three specimens testing machine three-point test configuration, the maximum flexural strength of sand concrete determined from the maximum load after the first visible crack using Eq.1.

$$R_c = \frac{F_C}{b^2} \qquad (1)$$

F_c is the maximum load and b is the width of specimen

_ Ultrasonic pulse velocity test (UPV) was used following NF EN 12 504-4 standard. It’s consists of holding the two poles for computing the pulse velocity. Used Pulse velocity was calculated by employing the following Eq.2.

$$V = \frac{L}{T} \qquad (2)$$

V: Ultrasound speed (m/s).
L: sample length in (m).
T: Duration of ultrasound time (s).

_Dynamic modulus of elasticity of sand concrete is calculated according to the ultrasonic propagation velocity and the dry density of the samples. The dynamic modulus of elasticity is obtained from the following Eq.3.

$$E_d = \frac{V^2 \times \rho \times 10^{-2}}{g} \qquad (3)$$

Where Ed is the modulus of dynamic elasticity (GPa), V the UPV (km/s), q is the density of the material (kg/m^3) and g is the acceleration due to gravity (9.81 m/s).

3. Results and discussion

3.1. Flexural strength

The best value for the cement sample was 60% CS + 40% RS. This indicates that the increase in crushed sand gives good results. This is what Fig.2 shows for the results obtained from the flexural strength after 7 and 28 days

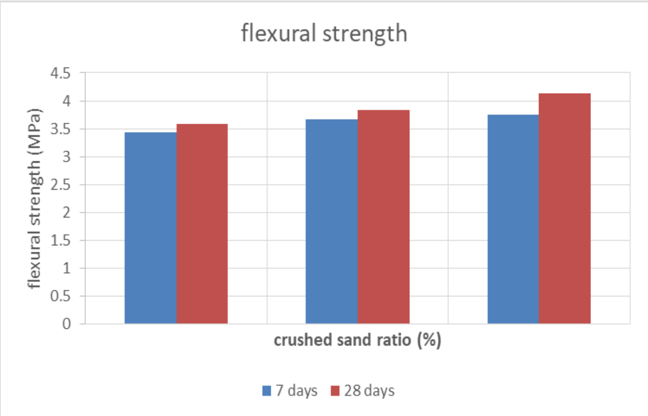

Fig.2. Flexural strength

3.2. Ultrasonic pulse velocity test

This test is used to diagnose the quality of sand concrete in a non-destructive manner. The ultrasonic pulse velocity test was performed on concrete at the age of 7 and 28 days. The best result was for samples at 60% CS + 40% RS USPV test results are shown in Fig. 3

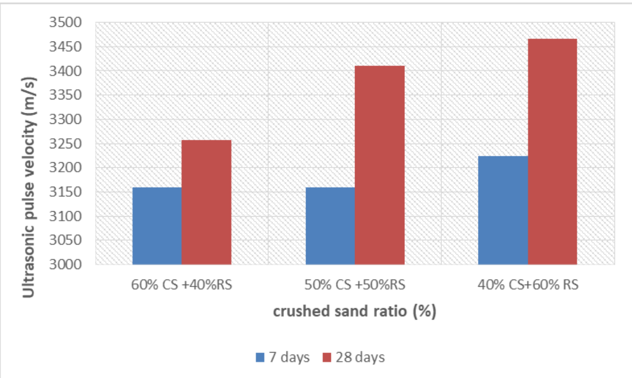

Fig.3. Ultrasonic pulse velocity

3.3. Dynamic modulus of elasticity

Fig.4 shows that the dynamic modulus of elasticity increases with the increase of crushed sand, and thus adding crushed sand can contribute to improving the dynamic modulus of sand concrete.

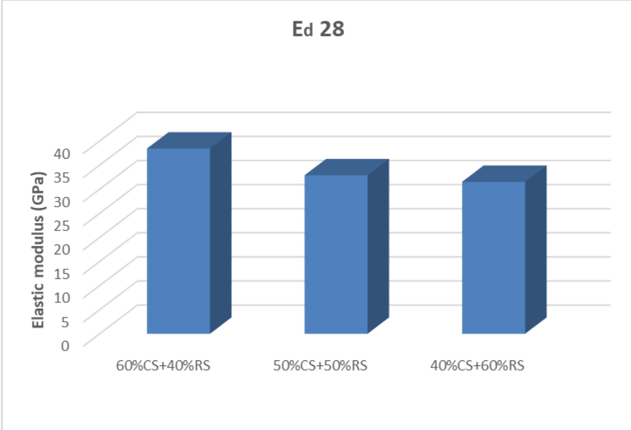

Fig.4. Dynamic modulus of elasticity

4. Conclusion

Based on the results obtained to study the mechanical and physical properties of sand concrete using crushed limestone sand, the following conclusions are obtained:
_ Best value of flexural strength obtained for the sample was 60% crushed sand + 40% river sand.
_ Ultrasonic pulse velocity of the samples increased when the percentage of crushed sand increased.
_ Good improvement in the dynamic modulus of elasticity when the percentage of crushed sand was increased.

Finally, it can be concluded from the obtained results that the effect of crushed sand on the properties of sand concrete is good and contributes to its improvement, as the best result obtained in all the studied experiments was 60%CS+40%RS.

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