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Influence of Temperature On Compressive Strength of Crushed Limestone Sand Concrete

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ABSTRACT

Currently, concrete has become a very expensive material because the high price of aggregates which constitute three quarters of the volume of concrete. The high price of gravel is caused by the high cost of transport in the regions where gravel is scarce. Sand is typically an abundant material. The main aim of this study is the exploitation of the local materials in the manufacture of a new kind of the concrete that is made by only with sand to replace the normal concrete which we are used to. And, the main aspect which has guided this study is the current trend to make a new type of concrete that relies only on a very abundant material in quality and quantity. Also this study is devoted to evaluating the effect of temperature at the compressive strength of the sand concrete.

INTRODUCTION

The discovery of sand concrete makes it possible to make a material that is less expensive than ordinary concrete and more effective in terms of: handiness; absence of segregation and beautiful aspect of surface. These specific properties according to several researchers are explained by its low size; however it is the principal cause of the important shrinking of the sand concrete [B. Ilham Aguida].

The results of compression tests according to the temperature show clearly the increase of the compressive strength (around 20%) on the basis of the value obtained for specimen saturated with water. The increase on resistance of cement matrix can be attributed to two phenomena: the first is the effect of capillary suction. It causes a compression of the solid skeleton, which leads to a "pre stress" of the material becomes more resistant. This phenomenon is also found for the rock. Therefore increase in the compressive strength, even without water gradient. The second phenomenon is related to water gradients created in the specimen during the desiccation process: the edges of the specimen contract on the heart of this one, causing a MICROCRACKING but also a confinement of the heart of the specimen [B. Ilham Aguida][Ismail Yurtdas and all].

However, the experimental results on the effect of the temperature are very variable, the initial fast rate of hydration at high temperatures causes non-uniform distribution of the products of hydration inside the paste. In this case, the products do not have sufficient time to precipitate uniformly in interstitial space (like the case at low temperature) [A.M. Neville].

The main aspects which guide this study is the current tendency to make a concrete based only on one very abundant material in quality and quantity which is the sand. The results obtained in this study summarize up the importance of the temperature during development of the mechanical characteristics of sand concrete mainly compressive strength.

EXPERIMENTAL INVESTIGATION

Cement

Cement used in this study is the CPJ CEM II/A 42.5, its chemical composition, the proportions of principal components, physical and mechanical properties of this cement make subject to mastery and control by our own care . It is made up primarily of clinker 81%, of high quality of limestone 8%, pozzolana 6% and gypsum (regulating of catch) 5%.

Llimestone filler

The limestone filler used is a finely divided lime, obtained by crushing of limestone. Limestone filler is a white dry tender into semi-tender primarily composed of 83.64%carbonate.

Admixture

The admixture used in this experimentation is superplasticizers high reducing water MEDAPLAST SP GRANITEX (Table 1).

Table1. admixture Characteristic.

	MEDAPLAST SP
Density	1.18 ± 0.01
pH	7.0 – 8.0
Content of ions chlorides	< 1g/l

Sand

Bechar benefit of a large number of building materials, the main choice is the nearly site, they are the principal existing sands in this region and with better characteristics. We chose two sands with different qualities and different sources (north (SC 01) and south (SC 02) of Bechar city), considering the large number of crushing stations in both coasts in the same operating field.

Table 2. Physical Characteristics.

Sand	Density absolute	Density apparent	Fineness modulus	ES	VB	Nature
SC 01	2.59	1.64	3.73	42.70	0.84	Llimestone
SC 02	2.59	1.61	2.95	53.00	0.64	

Formulation of the concrete

The objective of any formulation is good compressive strength and good workability. The study of the formulation of concrete is to define the optimal mix of different the various aggregates, as well as, the mix of cement and water to make a concrete [Georges Dreux], all Sand concrete formulation based of different types of sand are summarized in Table 3.

Table 3. Different formulation of sand concrete.

Reference		BS SS 01	BS SS 02	BS SS 03
Formulate	Sand [Kg/m3]	1728	1600	1471
	Cement [Kg/m3]	350	350	350
	Llimestone filler [Kg/m3]	75	75	75
	Aduxture* [%]	2.5	3	3
	Water [Kg/m3]	155	210	250
Calculate	Mass total [Kg/m3]	2319.14	2247.7	2158.6
	Volume total [l/m3]	1000	1000	1000
	E/C+k.A	0.42	0.57	0.67
	A/A+C	0.176	0.176	0.176
* function of percentage of the weight of the cement and filler				

EXPERIMENTAL PROCEDURE

Criteria for selecting temperature

In order to better studies the effect of temperature on sand concrete is preferable to have three thermal degrees which are high temperature, low and the freeze one:

- ✓ Freeze temperature around -20°C ;
- ✓ Low temperature around +5°C ;
- ✓ High temperature around +40°C.

After 24 hours of the introduction into the mould, specimens will be preserved in different thermal degrees. We note that to eliminate the influence of the formulation, work up and the temperate setting influence, specimens conserved in different temperatures are from the same wasted [B. Ilham Aguida, 2007].

To avoid any change in the characteristics of sand concrete by thermal action, specimens are protected by a sticker aluminum foil usually used in this type of test [Ismail Yurtdas and all].

In this regard, it is underlined that the packaging of specimens ensures the internal humid stability of the moisture, even if this stability is guaranteed only within the packing. After 28 days of conservation, specimens will be tested for compressive mechanical testing.

Fig. 1. Conservation of specimens at high temperature (40°C).

RESULTS AND DISCUSSIONS

In several experiments, the temperature released during the hydration of cement paste, enters into an exchange relationship with the ambient conditions, the hydration becomes fast in a high temperature, but slow in a low temperature.

Influence of freeze temperature (-20°C)

The sand concrete at a freeze temperature as it is represented in the figure below does not seem to increase its resistance at this temperature, where the order of the loss of the compressive strength varies from 78.83% to 92.61 %. One can say that these losses are the deteriorations caused by freeze. the cold lengthens the duration of intake and may even stop it completely [Ismail Yurtdas and all].

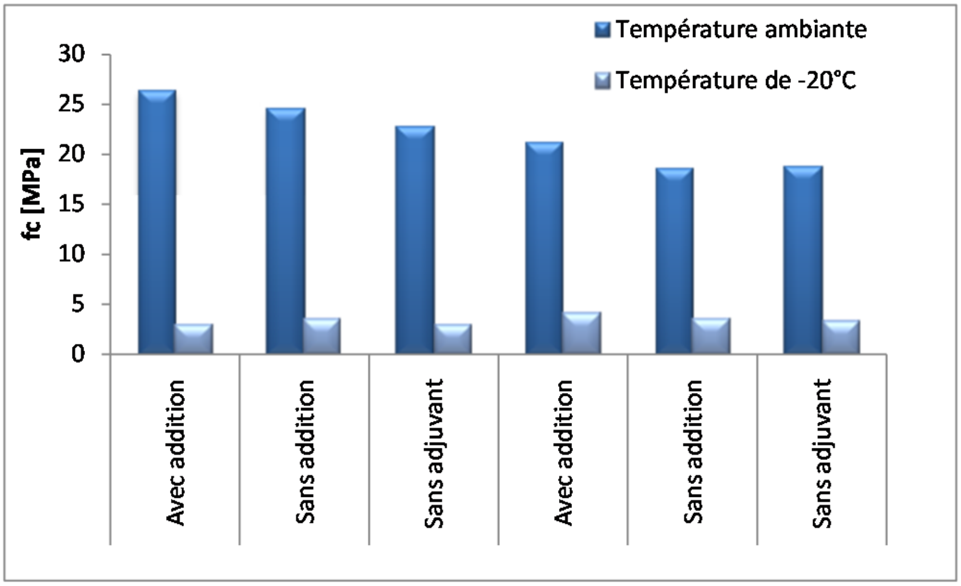

Fig. 2. The evolution of compressive strength of sand concrete.

However, the action of the freeze on the concrete slows down, even, stops the process of the intake, and transforms mixing water into ice, causing an expansion of its volume with formation inside a thermal gradient, creating a migration of water towards cold surfaces from where formation of ice lenses. At young age of the concrete, it acts on the hardening process, away from the intake of the concrete, slowing it down and causing disorders due to the formation of internal cracks, if these mechanical characteristics did not reach the value of 5 [MPa] [Georges Dreux], which being a minimal value estimated for that the concrete resists intrinsically to the effect of freezing. This level one notes on the figure (2) that this order of magnitude does not show great differences due to the change in its parameters.

And thus, at this stage of temperature (- 20°C) no significant (meaningful) conclusion, can be drawn only that from the disorders caused by the effect of freezing intercepting the process of the hardening of the sand concrete.

Influence of low temperature (+5°C)

At low temperature, one noted, the formation of a layer of water on specimen’s surface in the form of lenses, where at this temperature the concrete test-tubes seem to lose part of their mixing waters.
Unlike the behavior of the sand concrete at a temperature lower than the temperature of ice, the concrete behaves differently, where one notices that the temperature of (+5°C) causes a weak (slight) loss of resistance compared to the ambient temperature, the hydration of the concrete at low temperature becomes slow (figure 3) [Jacques Baron, and all].

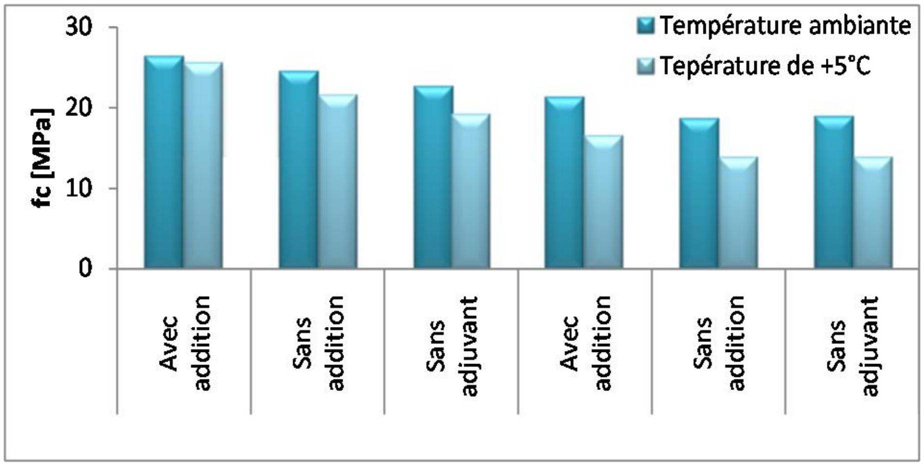

Fig. 3. Evolution of resistance at low temperature.

As we already evoked, the presence of a layer of water on specimen's surface is the result of a phenomenon of capillarity from the corps towards surfaces, for this reason the loss of resistance is important for the compositions with low ratio eau/(cement+addition), and by consequence a large fineness modulus, on the other hand, the loss is weak if the fineness modulus decreases [B. Ilham Aguida].

It is very difficult to explain the influence of a phenomenon such as temperature with a heterogenic material such as concrete, where it was noted for limestone sand concrete overlapping of several parameters, but using different identification tests of materials, we can eliminate some parameters as it is explained later on (figure 4) [B. Ilham Aguida].

In general, the presence of the addition in the formulation of sand concrete gives it some thermal resistance when it is an addition mostly limestone. However, in absence of an element deflocculates as an admuxture (superplasticizers), the loss becomes slightly important if the eau/(cement+addition) ratio is important, owing to the fact that the presence of this element eliminates the vacuums considerably and increases the density of the concrete [B. Ilham Aguida].

Influence of high temperature (+40°C)

On the contrary, the high temperature, is used in the field of civil engineering to activate the hydration of the concrete and achieve appreciably the resistance of concrete at early age. It is considered that the high temperature promotes hydration, while the temperature is a result of this phenomenon.
In addition, one considers that the high temperature increases the compressive strength of the concrete, due to the capillary suction which causes a compression of the concrete within in a saturated medium, where this phenomenon is also found for the rock [Nicolas Burlion an all].

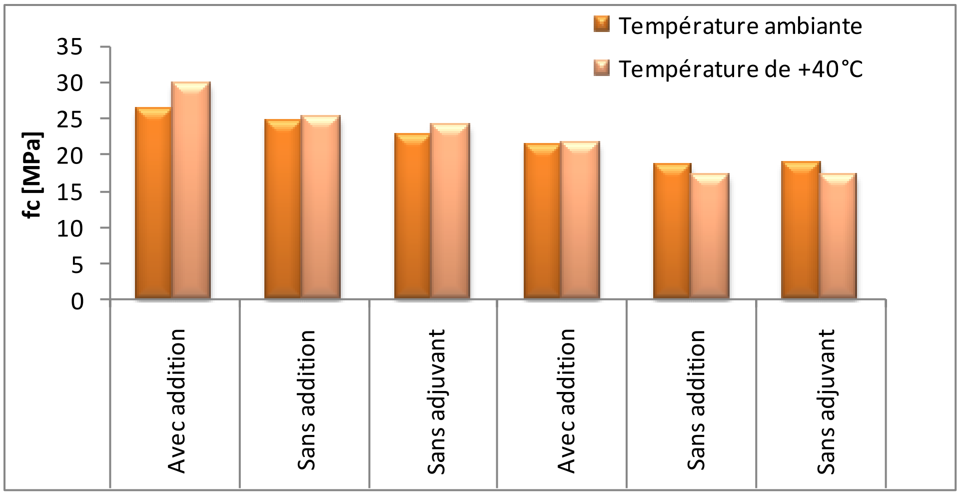

Fig. 4. Evolution of resistance at high temperature.

It is found that the presence of the limestone addition increases the thermal resistance. Moreover, the presence of an element deflocculated eliminates a large part of vacuums, as it increases the density, owing to the fact that its presence facilitates the rearrangement of the concrete components and thereby increases the homogeneity of the concrete [B. Ilham Aguida].

The containment which was noted is the result of a capillarity (capillary pressure) of surfaces towards the body, which puts in compression the concrete or in pre-stress, consequently, one noted the increase in the resistance of the concrete.

CONCLUSIONS

The temperature is one of the results of the reaction of cement. The concrete during its desiccation develops a temperature, in relationship mainly to the cement nature, for this reason one says that the hydration of the cement paste is exothermic reaction and heat activated [Jacques Baron, and all].

In several experiments, the temperature released during the hydration of the cement paste, enters in an exchange relation with the environment, the hydration becomes faster if the temperature rises, but slowly in a low temperature.

In general the behavior of concrete sand is no different from the ordinary concrete, the freeze temperature completely stopped the reaction of hydration of the sand concrete, in addition to the deformation caused by the formation of ice lens.

Whereas, at low temperature about 5°C the compressive strength of the sand concrete is low, compared to a sand concrete preserved at an ambient temperature, because the low temperature makes the hydration reaction slow thing that is found in many experiments. according to several literature [Jacques Baron, and all], the limestone aggregates resistant to the thermal changes, for this reason the sand concrete (SC 01) resists better compared to the sand concrete (SC 02), because of the important carbonate rate in it owns (SC 01).

With high temperature the limestone sand concrete (SC 01), has the capacity to develop a compressive strength acceptable, with a profit of order 13.26 % compared to 2.12 % for the limestone sand concrete (SC 02). That finds its explanation only thanks to the mineralogical nature of each kind of sand, because the percentage of carbonate. According to J BARON Limestone has a very good thermal resistance [Jacques Baron, and all].

Finally, one should not forget to note only even if losses of resistances are important, the contractions are carried out without any visual cracking, which makes sand concrete a project of several future work benefitting from its specifications.

REFERENCES

B. ILHAM AGUIDA. (2007). “sand concrete, optimal composition and the humidity and the temperature effect on the compressive strength.” master thesis, Bechar university Algeria, 2007.

M. NEVILLE. (2000). “concrete property.” Eyrolles edition CRIB, 2000.

GEORGES DREUX, “new Guide of concrete.” 8th Eyrolles edition, 1999.

ISMAIL YURTDAS, NICOLAS BURLION et FREDERIC SKOCZYLAS. (2003). “Hydrous damage of cementing materials. " 16th mechanics French congress of Nice, 2003.

JACQUES BARON et RAYMOND SAUTEREY. (1982). “LE BETON HYDRAULIQUE connaissance et pratique.” édition Techniques de l’Ingénieur, traité Construction, 1982.

NICOLAS BURLION, ISMAIL YURTDAS et FREDERIC SKOCZYLAS. (2003) “Mechanical behavior and material drying have matrix cementing comparison mortar - concrete " 16th mechanics congress French of Nice , 2003