STUDY AND CHARACTERIZATION OF THE CONCRETE AND INFLUENCE OF THE TEMPERATURE ON ITS COMPRESSIVE STRENGTH

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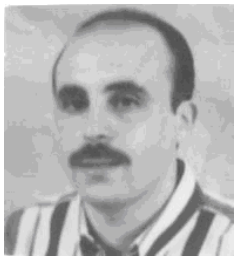
The study of the material concrete considered as a composite, constitutes a need which makes it possible to avoid interventions being able to damage or even destroy work. This analysis is intended either for the determination of the elementary composition of materials, or with the potential mineralogical composition or the grain-size distribution, with an aim of envisaging the rational use of materials and of judging the conformity of material.
In this work, one studies on the one hand the general principles of the study of the concrete in order to determine the proportioning of the constituent elements this material and on the other hand, the effect of the temperature on the mixture of cement with the aggregates to have data having a practical interest.

Keywords: structural materials, nanocomposites for application as catalysts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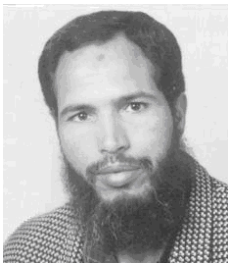
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Introduction

The concrete is a relatively recent building material since its employment spread only since the beginning of the XX century [1]. It is the building material today par excellence (meadows of 15 billion tons per year, is approximately 2 tons per human being) [2].
If this material were adopted so universally, it is thanks to the various criteria:
− It is made of primary education natural materials largely distributed to the surface of the ground.
− Its capacities of resistances exceed those of the best natural rocks.
− Its durability can be secular, and it resists corrosive environments, fire, etc…
− Its implementation is rather simple.
− It is castable.
It is thus for economic reasons and techniques that the concrete became irreplaceable in the field of construction.
The study of the composition of the concrete consists in defining the optimal mixture of the various components: aggregates, cement and water. What makes it possible to have a concrete whose quality is that required for the construction of the work in question.

The temperature is also an important parameter of which it is necessary to hold account at the time of the mixture of the various components of the concrete since its variation influences the compressive strength of this last.

Methods and analyses

Analyses were carried out on the various components of the concrete. We undertook a study detailed on cement, sand and the gravels in order to identify the type of our material.

The techniques of investigations used are: gravimetry, potentiometry, photometry with flame, colorimetry, atomic absorption spectrometry (A.A.S), the spectrometry of X-ray fluorescence (X.S.F).

For the study of the composition of the concrete one used method DREUX GORISSE.

This method is a technique which defines in a simple and fast way, a composition with little meadows adopted with the studied concrete. The clothes industry of the test-tubes makes it possible as well as possible to adjust the composition with definitively adopted according to desired qualities and of materials used [3].

Study of the components of the concrete

Identification of cement of Agadir CPJ 45

Chemical composition

The chemical analysis is determined by physical and chemical methods. Table 1 has the results obtained.

Cement of Agadir CPJ 45 is Cement of the Portland type made up of pozzolanas and it is with low contents alkalis.

Table 1

Chemical composition of the initial products of cement of Agadir CPJ 45 in %

	Synopsis chemical analyse												
	Insoluble	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	P_2O_5	PAF*	Cl-	Total
Clinker	0.1	21.6	5.75	3.65	64.4	2	0.9	0.78	0.06	0.17	0.3	-	99.7
Cement	11.8	16.7	5.48	2.80	51.8	3.1	2.7	0.80	0.01	0.28	4.7	0.02	99.8
Cru	0.1	21.2	5.79	3.65	65	1.8	1.1	0.88	0	0.24	0.1	-	99.8
Clay	-	27.8	9.55	3.63	27.7	2.3	0.4	0.35	0.13	0.1	26	-	98.4
Lime stone	-	6.91	0.86	0.39	50.4	0.6	0.1	0.46	0.07	0.11	26.5	-	86

(*) PAF = Loss on the ignition

Potential composition

The mineralogical composition of cement is determined by calculation starting from chemical analysis by using the method of bug. The potential composition of phase is calculated by the equations of bogue [4], in which the chemical formulas represent the percentage in mass of each oxide (Table 2).

Table 2

Potential composition of phase of cement of Agadir CPJ 45

Phase	**Chemical formula**	**Value**
C_3A	$C_3A = 2.65\ Al_2O_3 - 1.69\ Fe_2O_3$	9.07
C_3S	$C_3S = 4.07\ CaO - 7.6\ SiO_2 - 1.43\ Fe_2O_3 - 6.72\ Al_2O_3$	50
C_2S	$C_2S = 88.60\ SiO_2 + 1.08\ Fe_2O_3 + 5.07\ Al_2O_3 - 3.07\ CaO$	24.38
C_4AF	$C_4AF = 3.04\ Fe_2O_3$	11.1

Granulometric analysis

The granulometric analysis is carried out on tamisat with depression of air (sifter alpine). In Table 3 are gathered the results obtained.

The granulometric characteristics of this cement answer largely the usual specifications of cements of quality [5]. That makes it possible to advance that cement of Agadir CPJ 45 presents grains rich in fine elements. Indeed, the granulometry is the dominating factor of the compressive strength at the long limits [6].

Table 3

Results of analysis of the granulometry of cement of Agadir (CPJ 45)

Diametre in µm	**40**	**80**	**160**
% refusal	26	3.8	2
% tamisat	74	96.2	98

Mechanical test: compression and inflection

Normal resistance and the strength to the youth of Portland cement CPJ 45 are the mechanical resistances to compression determined respectively after 28 days and 2 days or 7 days. The results of this mechanical test are deferred in Table 4.

Table 4

Mechanical test: Compression and inflection on cement of Agadir CPJ 45

Resistance to	2 days	7 days	28 days
Compression (MPa)	17.1	29.9	46.1
Inflection (MPa)	4.1	5.8	7.7

According to the results of this mechanical test, one can deduce that cement of Agadir satisfies the mechanical specifications suitably and to the values limit guaranteed according to Moroccan standard NM 10.1.005 [7].

Identification of the aggregates

Granulometric analysis

The grading curves of gravels GI, GII and of the sand of Souss Wadi are represented in Fig. 1.

The grading curve of the aggregates of Souss Wadi is continuous and present a current form, which allows a good implementation.

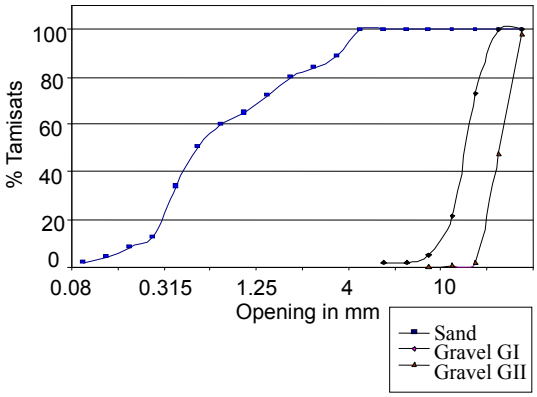

Fig. 1. *Grading curves of the aggregates of Souss Wadi*

Composition of the components by spectrometry of X-ray fluorescence

The spectrometry of X-ray fluorescence makes it possible to determine the centesimal composition in elements (Si, Al, Ca, Fe…) constituting the aggregates. The results obtained are deferred in Table 5.

It arises from the analysis of different constituting concrete which they present largely of the characteristics answering the usual specifications of the concretes of quality.

Table 5

Chemical composition of the aggregates of Souss Wadi

	Synopsis chemical analyse											
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	P_2O_5	PAF	Total	Moisture
Gravette I	3.84	0.51	0.18	49.8	4	–	0.19	0.02	0.14	42	101	0.026
Gravette II	4.82	0.59	0.20	50.9	2.9	–	0.24	0.01	0.14	41	101	0.045
Sand	64.24	1.14	–	4.87	–	–	–	–	–	1.13	–	–

Study of the composition of the concrete

The method used for the formulation of the concrete is method DREUX GORISSE. It is based on the preliminary knowledge of a grading curve of reference obtained by the rational export of experimental study.

It makes it possible to determine the composition of a sand, cement concrete and gravel, in order to carry out a concrete of satisfactory workability, suitable plasticity and whose mechanical characteristics is those as a preliminary definite.

In this work, we study the formulation of a three-component concrete made up of the sand of Souss Wadi and two gravels of Wadi Souss GI and GII (Fig. 2).

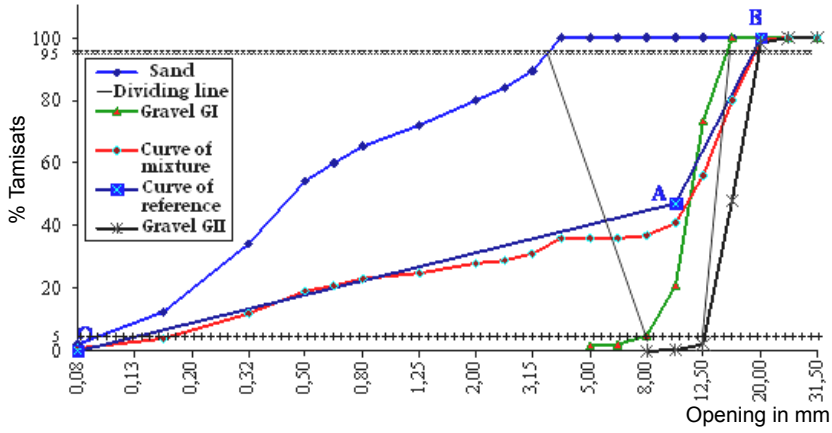

Fig. 2. *Chart of the grading curves of the aggregates, the curve of reference, the dividing lines and the curve of optimal mixture*

The research of the composition of concrete consists in defining the optimal mixture of the various aggregates, the proportioning out of cement and water which makes it possible to have a concrete whose quality is that required for the construction of the work in question.
The curve of mixture is represented on Fig. 2, it presents a continuous form. What allows an easy implementation.
The results of the composition for 1 m^3 of the concrete are gathered in Table 6.

Table 6

Results of the composition of the concrete

Dosage	Sand	Gravel GI	Gravel GII	Cement	Water
Weight (kg)	644	504	715	350	196
Volume in (l)	441	336	473	363	196

Influence temperature on the evolution of the resistance of the concrete in time

After having defined the corrected proportioning of the aggregates, the test-tubes were made according to standard NF P18-422. They were struck after 24 hours in their moulds, then preserved in different temperatures. Three test-tubes are produced per series for each time of conservation. That makes it possible to obtain an acceptable average and to decrease the variation of the results due to problems at the time of the realization of crushing (surfacing for example). The mechanical test consists in placing these test-tubes on a hydraulic press. The results obtained are breaking strengths, expressed in MPa. They are given for various temperatures, and shelf lives of 3.5 and 7 days.
The Fig. 3 shows the evolution of the compressive strength of a proportioned concrete with 350 Kg/m^3 according to the temperature.

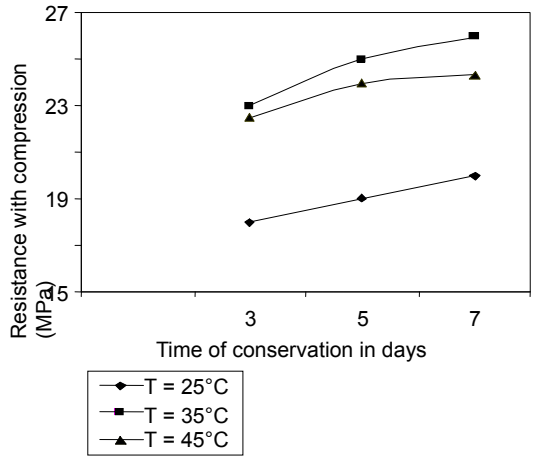

Fig. 3. *Evolution of the compressive strength for various temperatures*

In order to evaluate the impact of the temperature of treatment on long-term resistances (age of at least 28 days), of the test-tubes were preserved during 5 days in various temperatures then maintained in wet room up to 28 days. Fig. 5 has the results obtained.

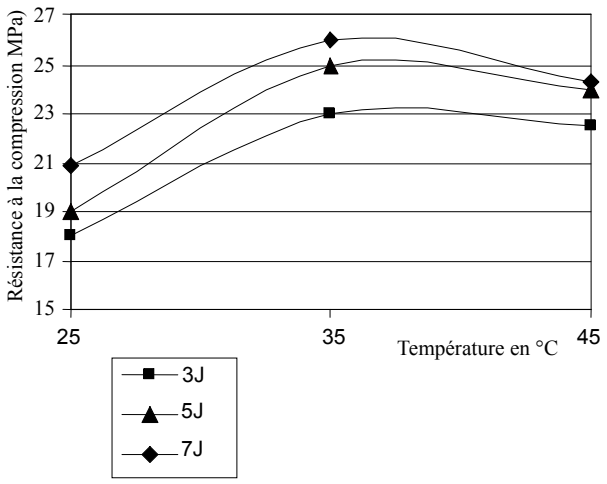

Fig. 4. *Influence of temperature on the evolution of the compressive strength of the concrete in time*

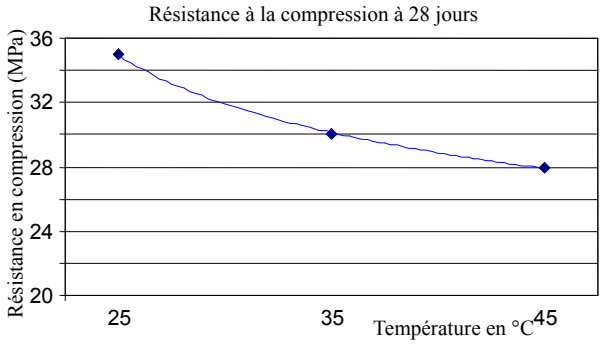

Fig. 5. *Influence of temperature on resistance in long-term compression*

According to Fig. 3, 4 and 5 the strengths to the youth and long-term are influenced by the temperature i.e. the higher the temperature of the concrete is, the more short-term resistance is high. Whereas in the long run the phenomenon is reversed since resistances are worse during rise in the temperature. What makes it possible to advance that heat accelerates the reactions of hydration of the concrete, as it modifies also the speed of hardening. The fall of resistant in the long run comes from important evaporation of the water and with the increase in porosity.

Conclusion

In order to identify the type of material and to lay down the tendencies of the elements which deteriorate the durability of the concrete one carried out a detailed study which consists in carrying out mineralogical and physicochemical tests of analysis on the various components of the concrete: cement, sand and gravels.

Thus, it comes out from these analyses that the latter present physical specifications, chemical, mechanical and geometrical meeting largely the usual characteristics of the concretes of quality. Thereafter, one adopted the method of DREUX GORISSE to determine the formulation of the optimal mixture while making the corrections necessary to the proportioning of cement, the mixing aggregates and water.

The mechanical test consisted in measuring the compressive strengths for various temperatures, and different shelf lives. The concrete matured under conditions of high temperatures develops, in the short run, a strong mechanical resistance. On the other hand, the profit of long-term resistance proves weaker than that of the same concrete preserved at low temperatures. This result is allotted to the important evaporation of water and the increase in porosity. This study enabled us to clear up the behaviour of the concrete under the effect of the temperature.

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