Experimental Study of Concrete Curing in Hot Climate

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Abstract— Concrete mixed, placed and cured at elevated temperature may develop a high initial strength in a short time. But, in hot climate such as that of south of Algeria, the rate of gain in strength can be lower and the final strength could be negatively affected resulting in a reduced resistance at long term.
This paper summarizes a work in which the concrete was cured in different environments thus simulating the climate of M'sila region (hot and wet in the south area, hot and dry in the north of the region). The experimental test results obtained are discussed here in and show well the importance of the cure in the hot climate. The results are compared with those reference specimens preserved at ambient temperature without any cure. Thus the influence of the climate conditions and that of the cure types is illustrated.

Keywords— Concrete, Cure type, Hot climate, Temperature.

1. Introduction

The concrete is, by far, the manufactured material mostly used in the world. Its consumption does not cease growing; but steady in the developed countries. However, it is explosive in the developing countries. The problem is that the concrete, like other materials, can be harmed by cracking with the effects of the actions coming from the surrounding medium (temperature and moisture). This will influence negatively the resistance and the final durability of the concrete.

The effect of the principal climatic factors on the rate of evaporation of surface water of the concrete is well known and demonstrated; however one can give a precise conclusion on their effects only by one specific detailed study of each factor.

One of the most significant climatic factors is the ambient temperature which often reaches 45 to 50 °C in the shade in the presence of a relatively weak hygrometry. Such conditions cause a fast evaporation of mixing water; first of all of the surface layers what involves an irregular shrinkage and consequently, the creation of the severe thermal stresses in the concrete. These effects can harm the quality of the concrete, especially during hardening where the phenomenon of hydration is touched considerably and the concrete being relatively weak, cannot consequently support the generated stresses.

The second major factor which can also affect the quality of the concrete is the low moisture which can cause a premature evaporation of mixing water involving, in hot periods, the fast hardening of the concrete. It was deferred that when the relative humidity is lowered by 90 to 50%, the rate of water evaporation increases by 5 times what shows the influence of the relative humidity on the water loss [1].

This study is a part of a research work aiming to develop methods of cure adapted to the hot climate. Simple, efficient and less expensive methods are achieved so that the concrete will possess good mechanical properties at high temperature. The purpose of the current part of this work is to study the compressive strength of the concrete based on local materials and preserved during its hardening in various cure ways simulated to the environment of M'SILA area.

2. Climatic and Data

2.1 Climatic Data of M'SILA Region

The area of M'SILA or the region of HODNA is characterized, in general, by an arid climate with a hot summer where the temperature exceeds the 38°C and a rigorous winter where the temperature decreases until 2,6°C, with periods of strong frosts which are prolonged from December till March. Rainy times are irregular with an average rate of 16, 53 mm/month, the relative humidity passes from 31% in July to 84% in December. The sirocco is the wind characterizing the area; it is a hot, dry and very frequent wind in summer with a very high temperature and very low moisture supporting the evaporation [2].

The meteorological data related to the previous ten years is represented in table I.

Table I meteorological data of M'sila region

		Jun	Febr	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	Max	12.9	16.48	22.63	23.3	29.42	37.01	38.64	38.08	31.41	25.81	18.97	14.75
	Min	5.12	5.2	8.07	10.75	16.81	21.65	25.03	24.56	19.31	15.31	8.65	5.02
Relative Humidity (%)		75.2	66.2	59.2	59.95	49.8	43.3	39.1	41.8	56.7	63.1	70.3	75.6
Solar radiation		187	231.4	271.4	218.7	324.3	327.2	342.9	303.8	252.7	258	203.9	183.8
Evaporation (mm)		93.2	132.1	188.1	232.8	297.7	364.8	406	368.7	298	198.4	126.6	97.1
Precipitation		28	10.9	9.38	18.1	20.2	7.27	1.3	7.8	34.8	26.5	14.23	19.1
Wind speed		3.94	3.89	3.78	4.59	4.61	4.77	4.49	4.24	3.76	3.32	3.67	3.94

The first conclusion drawn from this table is that there is a very hot period (summer period) with a temperature which can exceed 38.64 °C in the shade and, in extreme cases, even 50 °C, a low relative humidity which does not exceed the 39.1%, a solar radiation which reaches 342.9 mm with an evaporation rate that exceeds 406 mm and a wind speed of 4.49 km/s. These data related to the weather of the region are very essential for a performing concreting realization under severe climatic conditions like those of M'sila region.

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