INFLUENCE OF OPERATING CONDITIONS AND HUMIDITY ON ADHERENCE OF REPAIR MORTARS

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Abstract
The contractors are usually wetting the concrete support before the application of a PCC mortar. This study wants to point out clearly the influence of the water content of the support on the adherence properties.
Two mortars applied on concrete slabs with different water saturation levels have been used and measurements of the adherence by tensile tests have been realized. The conclusions are given and will permit to avoid some surprises during application.
Keywords: adherence, water saturation level, concrete support, repairing mortar.

1 Introduction

It is well known that the temperature and the humidity of the support, as well as the temperature and the hygrometric conditions during the application of the coating or the mortar have an influence on the adherence properties.
Sometimes, we can observe :
- disturbances in the hardening process;
- insufficient absorption of the binder by the substrate, due to water excess in the substrate or untimely evaporation of the solvents;
- untimely creep and/or thermal creep, in addition of hardening creep,...

Thermal creep will also be produced if the application is realized in too thick layers.

The Construction Materials Laboratory has realized an important research, taking into account some parameters of disturbance, in order to quantify their influence on adherence properties.

2 Experimental program

The aim of this experimental research is to determine precisely the influence of the humidity level of the support on the adherence properties.
This is in relation with the observation that, with CC or PCC mortars, the contractors insure a preventive humidity of the support before the application of the mortar. We also studied the influence of an external apport of humidity, voluntary given by the worker.

2.1 Description of the test program

2.1.1 Materials

The tests are realized on 2 types of PCC mortars referred A and B with the following characteristics :

- mortar A is a two-components mortar with a ratio liquid component/powder component = 1050/10000 in weight. A slop is necessary before the application of the mortar;
- mortar B is a one-component mortar with a ratio water/powder component 950/10000. It needs also a slop.

2.1.2 Support

The repairing systems are applied on a sand-blasted concrete slab of 100 x 50 x 5 cm.
The internal cohesion of concrete has been verified and gives a mean value of 4,16 N/mm^2.
Regulation of the water content : the water contents were determined between two extremal values :

- dry value corresponding to the water content of a concrete slab in hygrometric equilibrium with the ambient conditions of the area where the application happened, that means 20°C and 60 % relative humidity;
- wet value corresponding to saturated concrete after 2 weeks immersion.

As it is not easy to induce an humidity value into a concrete slab, the following procedure was adopted :

- after sand-blasting, each slab is cut at the two/third of the length. This part is devoted to the application and the other third will be used for evaluation of the water content. The two pieces of concrete are conserved in the same conditions;
- the conservation conditions of Table 1 have been adopted .

Table 1.

Slab 1	85 % relative humidity and 20°C
Slab 2	external conservation with protection against rain
Slab 3	100 % relative humidity and 20°C
Slab 4	immersion in water during 30 sec + drying with moisty tissue + conservation in plastic bag
Slab 5	conservation in water + drying with moisty tissue + conservation during 3 hours at 50 % relative humidity and 23°C + conservation in plastic bag
Slab 6	idem but only 1 hour of conservation at 50 % R.H./23°C
Slab 7	idem but only 15 min of conservation at 50 % R.H./ 23°C
Slab 8	conservation in water + conservation in plastic bag
Slab 9	idem slab 1
Slab 10	idem slab 3
Slab 11	immersion in water during 15 min + drying with moisty tissue + conservation in plastic bag
Slab 12	idem slab 8

After 18 days, the slabs are taken out of the plastic bags and immediately used for application. The percentage of humidity is determined by weighing the little piece of slab (1/3).
For each slab, we can determine the percentage of saturation given by the ratio water content / maximum water content.
The results are given hereafter (table 2).

Table 2.

	Water content	Percentage of saturation
Slab 1	3,30 %	± 50 %
Slab 2	3,54 %	± 52 %
Slab 3	3,71 %	± 55 %
Slab 4	4,80 %	± 70 %
Slab 5	6,11 %	± 90 %
Slab 6	6,35 %	± 93 %
Slab 7	6,60 %	± 97 %
Slab 8	6,71 %	100
Slab 9	3,77 %	± 50 %
Slab 10	3,98 %	± 60 %
Slab 11	5,16 %	± 70 %
Slab 12	7,24 %	100

2.1.3 Operating conditions

The slabs are verticaly disposed and the mortar is applied with a thickness of 10 mm. The slabs are taken out of the bags only when the components are mixed or the slop is ready to be used.

A wet and a dry slops are applied on each half part of the slab. The time between the slop application and the mortar application is about 30 sec.

2.1.4 Conservation of the samples

The samples are conserved during 28 days at 20°C/65 % R.H.

Six core-samples of 50 mm diameter are taken out of each half slab : 3 for adherence determination and 3 for freezing tests.

3 Tests results

The results given hereafter are the average values of the three samples tested.

Table 3 Mortar A

Water content of the support (%)		Adherence (N/mm²)	
Percentage in weight	Saturation level	with dry slop	with wet slop
3,3	50	0,83	2,32
3,54	52	2,80	2,14
3,71	55	2,09	2,89
4,80	70	2,75	2,65
6,11	90	3,54	3,36
6,35	93	2,13	3,06
6,60	97	1,81	2,58
6,71	100	1,43	1,48

Table 4 Mortar B

Water content of the support (%)		Adherence (N/mm²)	
Percentage in weight	Saturation level	with dry slop	with wet slop
3,77	50	1,41	1,34
3,98	60	2,90	2,72
5,16	70	2,95	1,41
7,24	100	1,09	1,43

The results are shown in Figure 1.

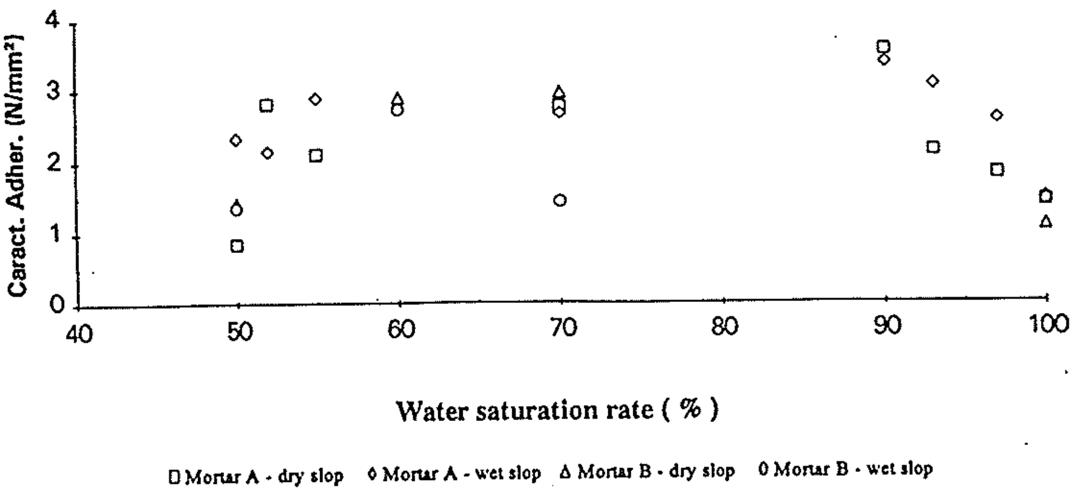

Fig. 1. Adherence strength of mortars

4 Comments and conclusions

The adherence strength changes in a clock-shape as a function of the water saturation level of the support. The characteristic adherence is relatively weak for weak saturation levels (≤ 50 %); it reaches to classical values for saturation levels between 55 and 75 %. After that, we observe a decrease of the strength (> 90 %).

A weak saturation level produces a disturbance into the hardening process of the cement while a too high saturation level acts on the attractive forces, the porosity, the kinetics of contact and, finally, the adherence properties.

Optimal humidification of the substrate will be obtained by conservation at 100 % relative humidity, which can be easily reached in a laboratory.

We must also note that the best adherence values are reached for a large scale of saturation levels, so that it doesn't sensitively depend on variation of water content, except for extremal conditions.

The influence of water content of the slop seams to be neglected for mortar A between 70 and 90 % of saturation level for substrate. Out of this range, the wet slop gives always better results. For mortar B, the adherence values with dry slop seams to be better than with wet slop; it can be due to the fact that, because mortar B uses only water - and not polymeric emulsion - there is an increasing of E/C ratio and than an increasing of porosity.

The quantifying of the limits in which the value of the saturation level of the concrete support must be is of prime importance for the adherence characteristics and is directly usefull for the contractors.

5 References

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