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Spettabile  
RADCON ITALIA S.r.l.  
Via S. Agostino, 28  
41121 Modena (MO)  
P.IVA 02302560368

## **“RADMYX CONCENTRATE”**

QUALIFICATION TESTS FOR GETTING AN HIGH HYDRAULIC  
PERFORMANCE CONCRETE

## **1.0 Objective and scope of work**

RADMYX is considered a “capillary waterproofing system” for below grade systems.

The objective of this study is to verify and evaluate the performance of Radmyx either with old concrete (slurry) or with new mixtures (concentrate).

Therefore Radmyx has been utilized either as a slurry than as an additive.

## **2.0 Reference' standard and Test' procedure**

The tests have been executed in accordance with Italian standard UNI EN 12390/8 that regulates:

A – Test on hardened concrete (compressive strength).

B – The depth of water penetration under hydraulic pressure.

The estimation of water penetration has been made at 5 bar pressure for 72 hours measuring by volumetric method the quantity of water penetrated inside the samples.

## **3.0 Specimens manufacture**

78 cubic samples (15 cm. length for all sides) were obtained and 4 series of samples were formed.

30 samples were set a part for the compressive strength study.

The rest (48 samples) for the examination of the water depth under pressure on passive and active side.

The BF and RF series have been cracked by Brazil testing. Some thin sections were made to be submitted to the S.E.M. analysis.

The four series of samples were the following:

1° - B = with concreted as control.

2° - BF = Concrete samples cracked after seven (7) days of curing and then treated on the surface with Radmyx slurry (Radmyx concentrate / water = 0,45) at the rate of 920 grams/m<sup>2</sup>.

3° - R = Concrete samples additived with Radmyx Concentrate at the rate of 0,8 Kg. /m<sup>3</sup>.

4° - RF = Samples additived with Radmyx Concentrate at the rate of 0,8 Kg./m<sup>3</sup> and cracked by Brazil testing after seven days of curing.

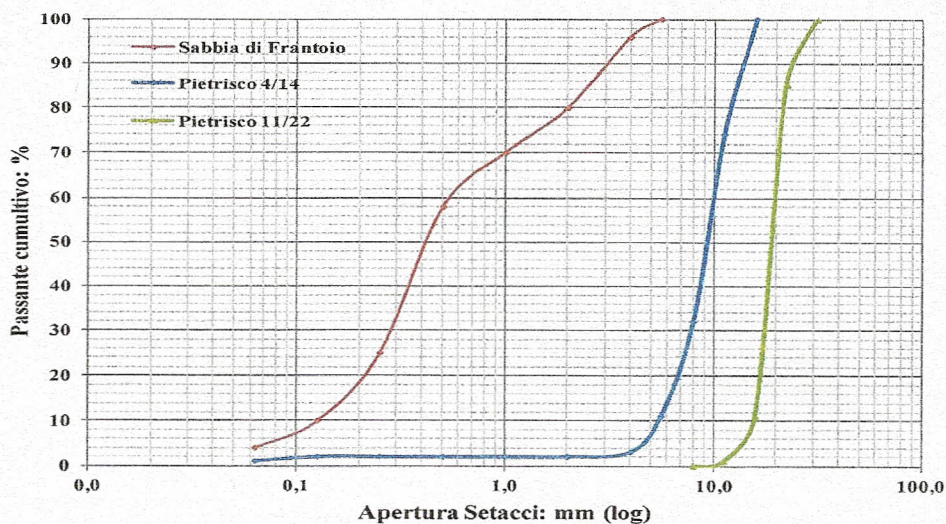
All the samples have been cured at temperature of 20+/- 2 C° outside for 24 hours and then immersed in water for all the time of the work.

### 3.1 Mix design of concrete mixture

The following graphic representation shows the granule metric curves of the aggregates utilized for the mix and the characteristics of the concrete.

Denominazione aggregato	Sabbia Frantoio	Pietrisco 4/14	Pietrisco 11/22	Totale
Dosaggio classi aggregato	48,0	25,0	27,0	100,0
Apertura Setaccio [mm]	Passante %	Passante %	Passante %	Passante %
31,5	100,00	100,00	100,00	100,00
22,4	100,00	100,00	85,00	95,95
16,0	100,00	100,00	11,00	75,97
11,2	100,00	74,00	1,00	66,77
8,0	100,00	32,00	0,00	56,00
5,6	100,00	11,00	0,00	50,75
4,0	96,00	3,00	0,00	46,83
2,0	80,00	2,00	0,00	38,90
1,0	70,00	2,00	0,00	34,10
0,500	58,00	2,00	0,00	28,34
0,250	25,00	2,00	0,00	12,50
0,125	10,00	2,00	0,00	5,30
0,063	4,00	1,00	0,00	2,17

**Granulemetric distribution of the aggregates**



Il Tecnico Ricercatore  
Ing. Andrea Basile

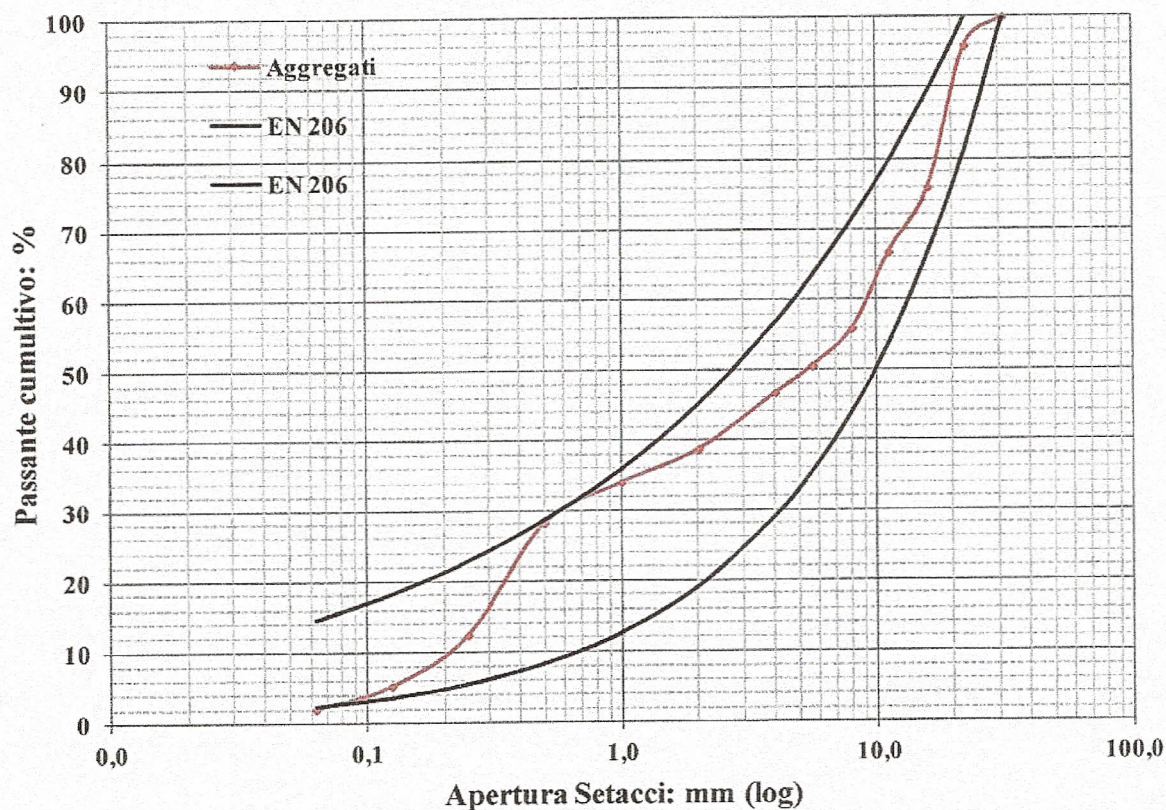
*Andrea Basile*

Il Direttore del Laboratorio  
Prof. Ing. Roberto Volpe

*Roberto Volpe*



### Granulemetric curve



### Mix design data:

**Concrete** guaranteed performance

**RCK** 30.0 N/mm<sup>2</sup>

Maximum diameter of granulate 22 mm.

Class of exposure XC1 XC2

Class of workability S4

### Concrete mix design

Type of cement	II/A-LL 42,5R	320 Kg/m <sup>3</sup>
Additive SPF	Rheobuild (BASF)	3,2 l/m <sup>3</sup>
Agg.1	Sand	870 Kg/m <sup>3</sup>
Agg.2	Gravel (crushed stone) 4/14	460 Kg/m <sup>3</sup>
Agg.3	Gravel (crushed stone) 11/22	500 Kg/m <sup>3</sup>
Water	Total	180 l/m <sup>3</sup>
Specific weight of the mix		2.330 Kg/m <sup>3</sup>
Ratio water/cement		0,56
Workability class	S4	160-210 mm.

### 3.2 Slurry

The slurry has been applied over the cracked samples.

The slurry has been made with ratio water/Radmyx Concentrate = 0,45.

Before the application of the slurry the samples were abraded superficially to remove the cement crust, then the slurry has been applied on and inside the crack (1.120 u), finally on all the surfaces utilizing altogether 920 grams/m<sup>2</sup> of the slurry.

#### **4.0 RESULTS OF THE INQUIRY**

##### **4.1 Compressive strength**

Average strength observed over 3 samples for each series

<b>Curing days</b>	<b>Series B N/mm<sup>2</sup></b>	<b>Series R N/mm<sup>2</sup></b>
<b>7</b>	<b>24,6</b>	<b>26,6</b>
<b>14</b>	<b>31,0</b>	<b>32,4</b>
<b>28</b>	<b>35,6</b>	<b>36,4</b>
<b>60</b>	<b>36,8</b>	<b>37,2</b>
<b>90</b>	<b>37,1</b>	<b>38,0</b>

##### **4.2 Water' penetration depth under pressure**

The following table shows the average values of penetration obtained measuring volumetrically for difference the water quantity and also its temporal graphic representation.

Average value obtained measuring for difference the water quantity

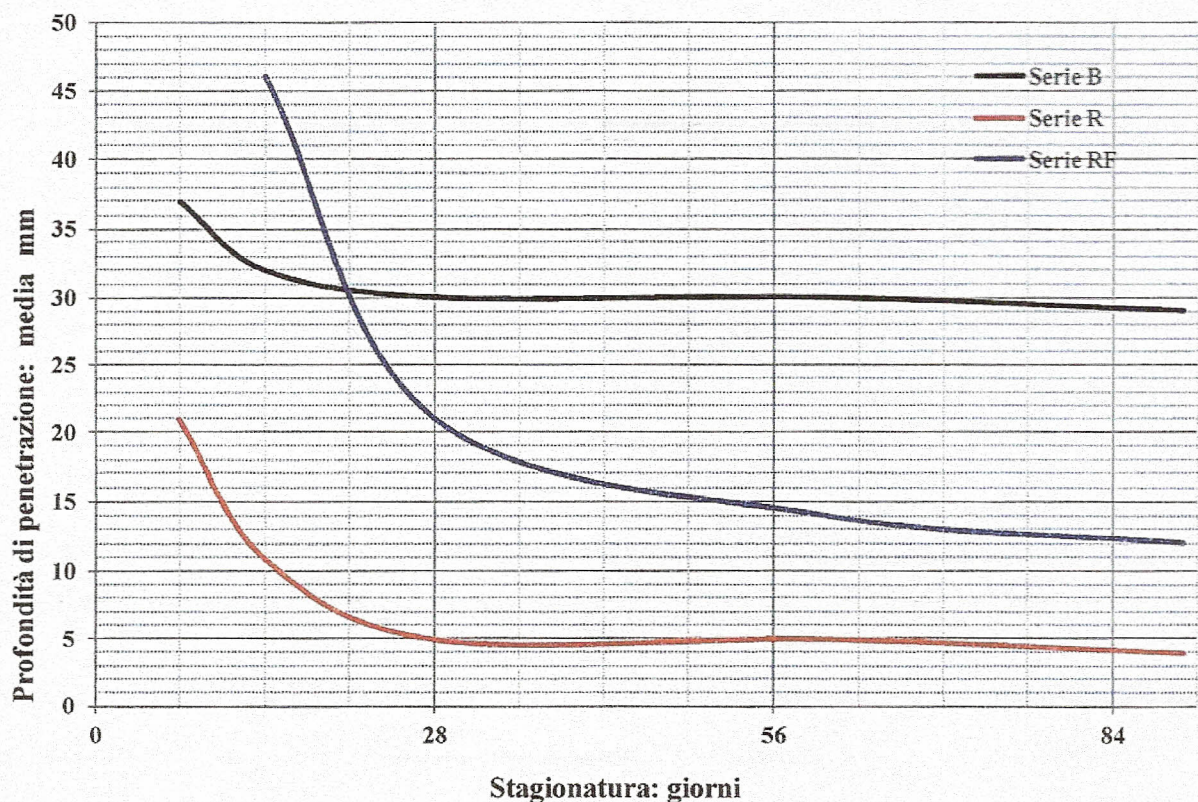
<b>Curing days</b>	<b>Series B mm</b>	<b>(1) Series BF</b>	<b>Series R mm</b>	<b>(2) Series RF mm</b>
<b>7</b>	<b>37</b>	<b>-</b>	<b>21</b>	<b>-</b>
<b>14</b>	<b>32</b>	<b>N.S.</b>	<b>11</b>	<b>46</b>
<b>28</b>	<b>30</b>	<b>N.S.</b>	<b>5</b>	<b>21</b>
<b>60</b>	<b>30</b>	<b>N.S.</b>	<b>5</b>	<b>14</b>
<b>90</b>	<b>29</b>	<b>N.S.</b>	<b>4</b>	<b>12</b>

N.S. = No bubble or detachment

(1) Average width of the crack: 8 to 1.120 8

(2) Average width of the crack: 8 to 475 8





#### 4.3 The Radmyx evaluation at S.E.M. – scanning electron microscope over the RF series

An inquiry at electron microscope has been carried out over the samples of RF series, that is to say the samples additived with Radmyx Concentrate and cracked by Brazil method. The photos under reported show how the initial crack has been totally or almost stopped by the formation of amorphous crystals.

**Figure 1:** Initial cracking condition, average width 475 u obtained after 7 days of curing.

**Figure 2:** Cracking condition after 90 days of curing. The micro cracks has been blocked.

**Figure 1**

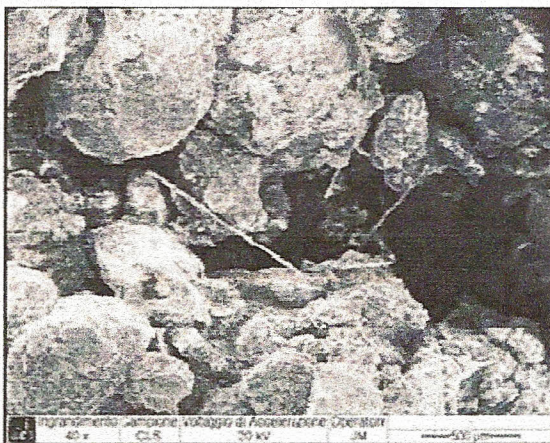


Fig. 1a - stato fessurativo iniziale, ampiezza media 475 u

**Figure 2**

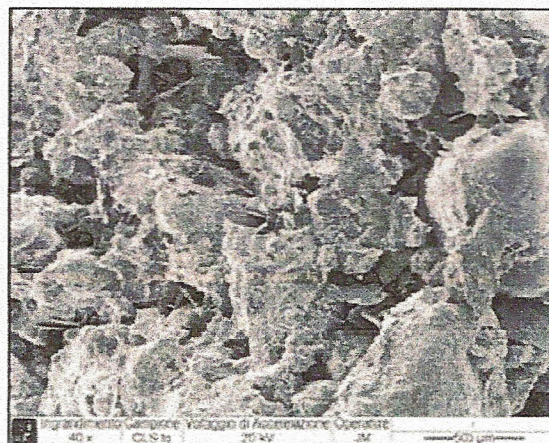


Fig. 1b - stato fessurativo dopo 90 gg. complessivi di



#### **4.4 Examination at S.E.M. – scanning electron microscope - over the BF series to estimate the Radmix crystals' depth penetration**

From two samples of BF series , after 90 days curing in water, we have extracted some thin sections to be submitted for examination at S.E.M.

In order to study the surface of the samples we have removed mechanically with tribometer the layer of the Radmix slurry.

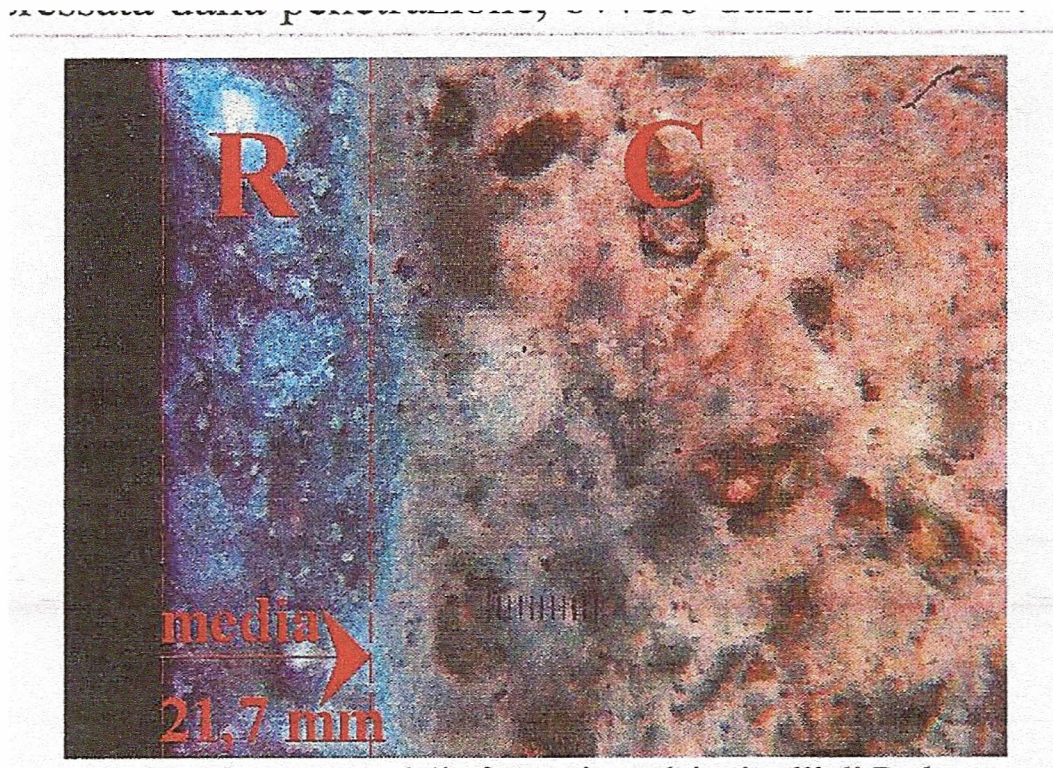
The surface of thin sections obtained from the BF samples, immediately before the examination, has been bathed with an hydroalcoholic solution of methylene blue (0.1%) in order to favour the contrast between the zone of crystals penetration, or the zone of admix crystals diffusion and the zone without crystals formation.

The results of this test have showed that the layer interested from the presence of the Radmix crystals, after 90 days of curing, is very homogeneous and the crystals diffusion's depth measured with optical micrometer has obtained an

**average value of 20,6 – 22.9 mm**

below you can see the image with description :

Fig. 3



R= zone interested with Radmix crystals  
C= concrete not yet interested

## **5.0 Conclusions**

The study carried out at our laboratory has pointed out the Radmyx ability to reach the objective either as an additive for improving the concrete waterproofing and for repelling the concrete chemical attack than as a slurry product suitable for re-establishing the waterproofing performance of an old concrete.

In order to study the concrete waterproofing, the Italian Building Regulation D.M. 14/01/2008 “Technical Standard for Building” and the rule UNI EN 12390 do not establish any concrete cut-off value to determine concrete waterproofing.

Therefore:

- if the German rule DIN 1045 considers waterproofed the concrete of 40 cm thickness with value of water penetration under pressure not superior to 50 mm depth.
- if the old Italian rule UNI 9858/1991 imposed the maximum value of water penetration of concrete to 20 mm.

We can clearly conclude that the Radmyx Concentrate has given to an ordinary concrete the better waterproofing characteristics, that is to say an high hydraulic performance concrete even with cracks of about 500 u.