

# TÜV NORD MPA

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**TÜV®**

|             |                    |                |           |               |            |
|-------------|--------------------|----------------|-----------|---------------|------------|
| Ihr Zeichen | Ihre Nachricht vom | Unsere Zeichen | Akten-Nr. | Durchwahl     | Datum      |
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## Result documentation D13-00210 Comparison test with RC M040

Customer : Reynchemie nv  
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Objects : Comparison tests with RC M040

Issuer : TÜV NORD MPA GmbH & Co. KG  
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## 1 Cause

TÜV NORD MPA GmbH & Co. KG, Bauinstitut Dessau was ordered by W.R. Meadows Inc. to make a testing program with RC M040. It is a comparison test of a concrete treated with RC M040 with an untreated concrete.

The realisation of the test program and the selection of the test criteria were carried out according to client requirements. In particular, we agreed to test the concrete regarding the following characteristics:

- Curing
- Abrasion resistance
- Water impermeability
- Freeze –Thaw-Resistance
- Coefficient of friction

For the test program a concrete slab (plate measurement approx.. 1m x 2m x 0.20m) was produced at the 29.01.2013 in the production hall of a concrete factory. The concrete was submitted with the bucket pail and compacted after bringing in the form with an internal vibrator. After smoothing by means of a power trowel half of the slab was treated with RC M040 in accordance to the processing guideline of the manufacturer.



Image 1: The concrete surface after smoothing and applying of RC M040

While the time spent was the concrete slab not covered. The sampling from the treated and untreated concrete slab half was after reaching a concrete age of 90 days

## 2. Results

### 2.1 Concrete quality of the test slab

The following mix design was used for the slab preparation:

|                    |  |
|--------------------|--|
| Cement             | 320 kg/m <sup>3</sup> , CEM I 42,5 R                             |
| Aggregates         | 1.898 kg/m <sup>3</sup> , sand + gravel, maximal grit size 16 mm |
| Water              | 159 kg/m <sup>3</sup>  |
| Water/cement ratio | 0,5  |
| Additives          | Plasticizer, 0,4 % by weight of cement                           |

Calculation of the used concrete mix including the representation of the grading curve is contained in the appendix 1.

The concrete corresponds to a compressive strength class C 30/37 and the exposure classes XC3, XA1 and XM1 (usual strength class and exposure classes for the concrete floors in open halls without increased requirements).

### 2.2 Curing

For assessing the barrier effect (reduction of water loss of fresh or young concrete) by RC M040 was the test of the blocking coefficient based on the test specification in the technical delivery conditions for liquid concrete curing agent (TL NBM-StB 9). For this purpose, the test samples dimensions 14 cm x 16 cm x 4 cm are were used.

The curing compound (BNM in German) can be defined as liquid substances which are applied homogeneously on the concrete surface, forming a thin film, preventing the loss of water from the fresh concrete. RC M040 is not liquid curing compound by the above-mentioned Technical Delivery Conditions. RC M040 reacts with components near the surface of the concrete and causes there a strengthening and compaction of the concrete structure.

The test report 28809 with the results is contained in Appendix 2. The following table shows the observer mean moisture loss after 24 hours of the treated and untreated concrete.

Table 1: Moisture loss of young concrete

|                      | <b>Moisture loss (g) / blocking coefficient (-)</b> |             |
|----------------------|---|-------------|
|                      | Treated with RC M040                                | Untreated   |
| Moisture loss        | <b>5,5</b>  | <b>27,5</b> |
| Blocking coefficient | <b>80</b>   |             |

Based on the test results after 24 hours is lower by 80% of moisture loss of the treated with RC M040 concrete surface relative to the untreated concrete.

## 2.3 Resistance to Abrasion

To determine the abrasion resistance, 3 drilled cores were extracted from the RC M040 – treated and untreated part of the concrete. The preparation of the test specimens and the tests as it is based on the instructions of DIN 52108 “A Test with Grinding Disk by Böhme.” The test reports 28525 and 28526 are contained in the appendix 3.

With the grinding wheel method the behaviour of inorganic non-metallic materials is tested at the wear by a sharpening use. The type of the use corresponds to an aggregate abrasive wear.

While only the thicknesses and the volume loss according to specification in the testing standard at the end of the test (after 16 testing cycles) is indicated in the test reports in the appendix 3, the results (mean average values) of the abrasion resistance test are presented in the following Table 1 also after 4th, 8th and 12th testing cycles below.

The test specimens were dried up to the mass constancy before the test. The test was carried out without rough grinding of the samples.

Table 2: Loss of thickness / loss of volume

| Cycles | Loss of thickness in mm | Loss of volume in cm <sup>3</sup> /50 cm <sup>2</sup> |
|--------|-------------------------|---|
|        | Treated Concrete        | Treated Concrete                                      |
| 4      | 0,37                    | 1,88  |
| 8      | 0,79                    | 4,00  |
| 12     | 1,22                    | 6,12  |
| 16     | <b>1,62</b>             | <b>8,16</b>   |

Altogether, it has to be noticed that a good abrasion resistance, i.e. a low thickness and volume loss was proved. Values with mean volume losses of 8,16 cm<sup>3</sup>/50 cm<sup>2</sup> by the treated while the coefficient is up to 12cm<sup>3</sup>/50cm<sup>2</sup> for a concrete classified into a group C30/37 which corresponding to a wear resistance class A9 according to DIN EN 13813 Table 4.

## 2.4 Impermeability

Three drill cores with diameter 150 mm each were taken for the test of the water impermeability. The penetration of the test specimens and testing were carried out according to DIN EN 12390-8. The test reports 22957 and 22958 with the single values are contained in the appendix 4.

In the test of the water impermeability into concrete the samples were exposed with water with the pressure of 0.5 N/mm<sup>2</sup> for 3 days. The given penetration depth corresponds to the maximum penetration depth of the water. The height of the penetration depth is also a measure for the impermeability of the concrete.

The middle water penetration depths of the concrete samples which are treated with RC M040 and the untreated ones are in the following table arranged.

Table 3 : Penetration depths of the water

| Penetration depth in mm       |                    |
|-------------------------------|--------------------|
| Concrete treated with RC M040 | Untreated Concrete |
| 7                             | 30                 |

**With the measured average penetration depth of 7 mm for treated with RC M040 concrete has a low water penetration of 76% relative to the untreated concrete determined.**

## 2.5 Freeze-Thaw-Resistance in Salt Solution

To investigate the ability of concrete to resist against freeze and salts, 5 core samples with diameter approx. 100 mm each were used from treated with RC M040 and untreated concrete. The tests were made according to DIN CEN/TS 12390-9 in the CDF test procedure. The test reports 23187 and 23186 with the individual trial results of weight loss are contained in the appendix 5.

Note : The used basic concrete is not any concrete which satisfy the requirement of a high freeze-thaw-salt resistance.

The following table shows the results in dependence of the number of freeze-thaw changes are summarized again.

Table 4 : Weight loss

| Number of freeze-thaw cycles | Weight loss in g/m <sup>2</sup> |                    |
|------------------------------|---------------------------------|--------------------|
|                              | Treated with RC M040            | Untreated Concrete |
| 6                            | 4                               | 0                  |
| 10                           | 22                              | 16                 |
| 14                           | 34                              | 34                 |
| 20                           | 58                              | 490                |
| 26                           | 130                             | 1.031              |
| 28                           | 163                             | 1.440              |

According to the Basic Condition, established by Prof. Setzer (Essen) the following criterion was used as the acceptable standard:

*Average acceptable weight loss after 28 freeze – thaw cycles in salty solution is 1500 g/m<sup>2</sup>.*

**For the RC M040 treated concrete the weight loss measured after 32 cycles reached average value of 177,3 g/m<sup>2</sup>. According to these results, no air – entrainment agent has to be added. The treatment with RC M040 makes it unnecessary**

In the following image 2, the concrete surfaces at the end of the freeze-thaw impingement are exemplary documented.



Image 2 : Right the concrete surface treated with RC M040, left the untreated concrete surface.

## 2.6 Coefficient of friction

The treatment with RC M040 induced a change in a near-to-face area of the concrete. With increasing concrete age the surface seems to become more “smooth”. The sure accessibility is in dependence of the operating conditions of decisive importance for the industry floors.

In the context of the comparison test, the determination of the coefficient of friction by using RC M040-treated and untreated concrete surface was carried out according to DIN 51131 with the FSC 2000 Print.

The individual results are contained in the test reports 28521 and 28524 in the appendix 5.

The mean determined coefficients of friction are in the following table 5 compared.

Table 5 : Coefficient of friction

| Coefficient of friction |             |           |      |
|-------------------------|-------------|-----------|------|
| Treated with RC M040    |             | Untreated |      |
| Air dry                 | Wet         | Air dry   | Wet  |
| <b>0,52</b>             | <b>0,48</b> | 0,65      | 0,51 |

The higher the coefficient of friction  $\mu$  is, the more favorable is to judge the slip resistance. Areas with coefficients of friction of  $> 0.45$  can be as judged for certain.

**Both the untreated and the treated with RC M040 concrete surface can be classified as safe to walk. The slip resistance is sufficient.**

### 3. Summary

To assess the effectiveness of RC M040 on a concrete surface were comparative tests performed on treated and untreated concrete surfaces.

The results are summarized in the following graphic representations (Figures 1 to 4).

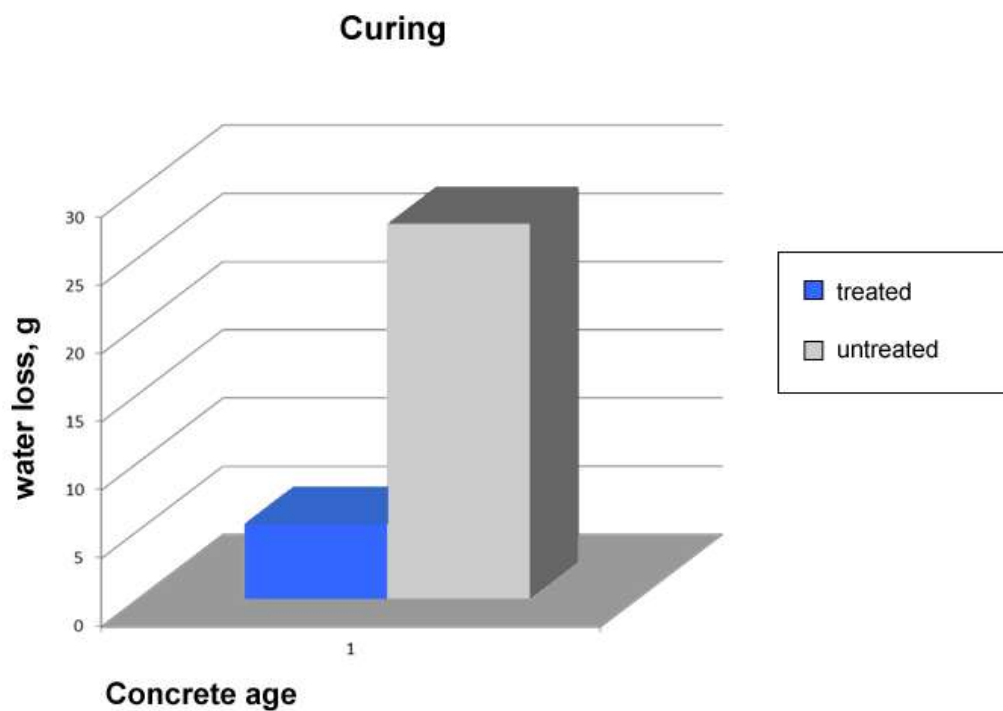


Figure 1: Improvement of capacity for water retention

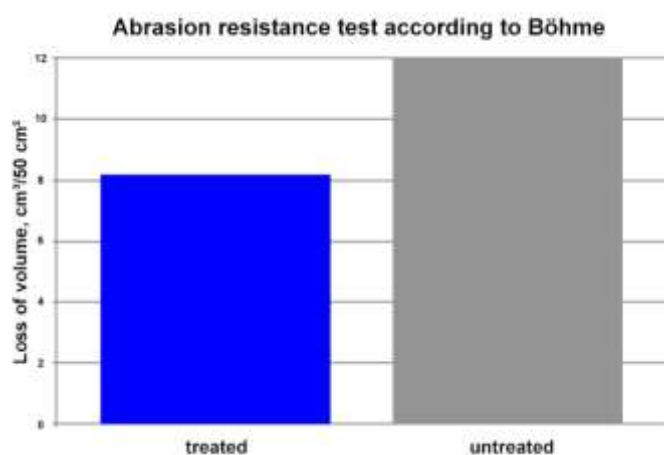


Figure 2: Abrasion resistance by comparison



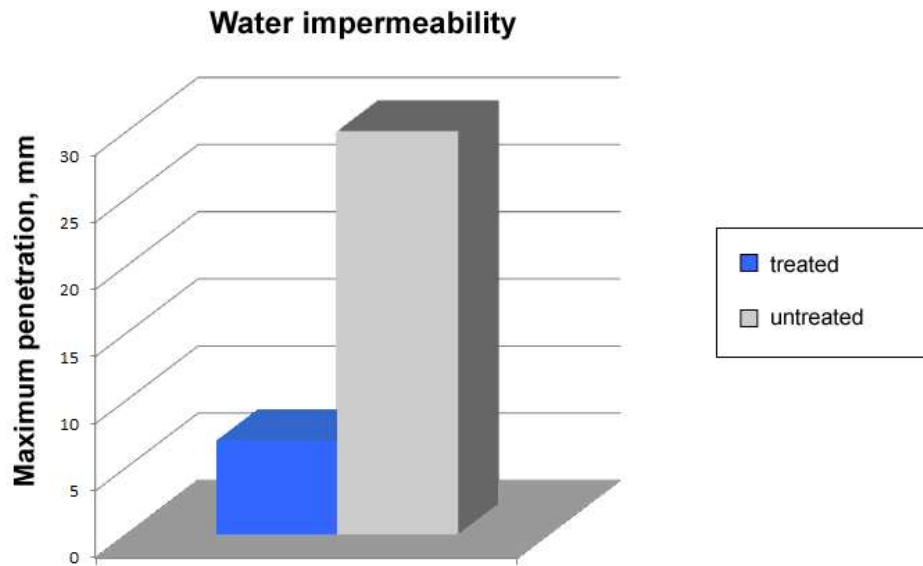


Figure 3: Penetration depth of the water by comparison



Figure 4: Coefficient of friction by comparison

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