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# Test of cold asphalt storability based on alternative approaches

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Abstract. Cold asphalt products for potholes repairs should be workable (soft enough) for long time to ensure their applicability. Storability is assessed indirectly using various tests of workability. Therefore, simple test methods (self-compaction and disintegration test) was developed and verified to investigate changes of storability of this group of cold asphalts. Selfcompaction of the tested mixture in the upturned Abram's cone for the cement concrete slump test and in the mould for the California Bearing Ratio test was assessed in first stage. After that the video record of disintegration test was taken. During this test, the mould was lifted up and the mixture fell off the mould (Abram's cone) or disintegrate (CBR mould). The drop of surface after 10 min self-compaction and netto time related to falling out or disintegration of the mixture were used to evaluate the mixture from storability point of view. It was found out the self-compaction test has not a potential to reveal and prove changes of mixture properties. Based on the disintegration test results it can be stated this test at 5 °C using the upturned Abram's cone could be a suitable approach to determine qualitative changes of a cold mixture from storability point of view.

#### 1. Introduction

Various cold asphalt mixtures are used in asphalt road construction and maintenance. Depending on intended use, different requirements are defined for individual cold asphalt applications. Mostly they relate to a mixture composition and performance parameters in operation. However, other characteristics are also important in the case of some cold asphalt products. Particularly, cold asphalts used for pothole repairs should fulfill a lot of requirements from applicability and performance point of view. The exhaustive list of requirements was prepared and many of laboratory tests were performed in the project POTHOLE (7 FP EU, ERA-NET ROAD call). Based on the test results it was stated [1] it seems useful to determine some requirements for components of cold asphalts and parameters of a final mixture.

From applicability point of view it is important a cold mixture for pothole repair should be workable (soft enough) for long time regardless a storage method (plastic bags, buckets or roofed free air piles). A binder is a main factor that influences consistency (or stiffness) of a cold mixture. Basically, consistency changes in two ways: curing (a binder get stiff) and disintegration (loss of binder adhesion). It is suitable to know what stage of changes a cold mixture is in. Any test methods do not exist to evaluate storability of a cold mixture. Therefore, various tests of workability ([2], [3]) or the compaction test [4] are used to assess storability indirectly. These methods use obviously compaction energy and it can be biased when storability is appraised. Unsatisfactory workability

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according to a standardized method does not mean automatically negative evaluation of storability. A reason is the comparable level of workability can be achieved using various intensity of compaction energy. On the other hand, a good result of workability can be obtained in the situation when a binder get lose its adhesiveness. In this case the results of workability test are biased and unsatisfactory state of a cold mixture can be proven using tests of stiffness.

Therefore, simple test methods were proposed and verified to investigate changes of storability of cold asphalts for pothole repairs. These procedures do not need any compaction energy.

#### 2. Experimental methods

The main idea was to find a procedure that would be able to reveal whether a cold mixture is "alive" or not. It was supposed a loose cold mixture in a good state should have a potential to self-compact. On the other hand, if a soft cold mixture is "alive" it should be able to disintegrate, when the mould is taken away. These assumptions are close to the requirements on cement concrete. Therefore, the cement concrete slump test was taken as an example and self-compaction of a cold mixture was investigated using the Abram's cone. To eliminate possible influence of the shape of the Abram's cone the cylindrical mould for the California Bearing Ratio (CBR) test was also used.

Some tentative tests were carried out to reveal possible rigours. Based on obtained experience the optimal procedure was established as follows.

#### 2.1. Self-compaction test

- A mould was positioned on a metal plate placed on a laboratory scale (the Abram's cone was positioned his narrower side on the metal plate, i.e. upturned in comparison to the cement concrete slump test)
- A cold mixture was continuously placed into the mould without any compaction till a small pile above the upper edge of the mould was originated
- Immediately, the excessed material was removed by a board and aligned to the upper edge of the mould
- Weight of the mixture in the mould was determined
- After 10 min the level of self-compaction was determined based on the distance between the surface of the mixture and the upper edge of the mould; this distance was determined as the average of five values measured at points evenly distributed on the inner area of the mould (to make the surface of the mixture even, a thin plate (approx. 2 mm thick) with the diameter 10 mm less than the diameter of the mould was placed on the surface of the mixture in the mould)

#### 2.2. Disintegration test

- The disintegration test was performed immediately after the self-compaction test, i.e. approx. 15 min after aligning the mixture to the upper edge of the mould; based on experience in the tentative tests a video record of the test was taken
- The Abram's cone was lifted up about 300 mm and it remained at this position till the mixture fell off the mould
- The CBR mould was taken away (lifted up)
- Time intervals related to beginning and end of falling out the mixture (Abram's cone) or disintegration (CBR mould) were determined from the video record

The self-compaction values and time intervals were used for evaluation of the mixture from storability point of view.

#### 3. Test results and discussion

One of cold mixtures for pothole repairs commonly available on the market was used for testing according to the mentioned procedures. The cold mixture consists of gravel 0/4 mm (36 %), crushed aggregate 4/8 mm (56.4 %) and a slow setting cationic bitumen emulsion C 65 BF 8 (7.6 %) prepared exactly for the used aggregate.

The cold mixture for the tests was taken from a roofed free air pile at a plant in monthly intervals since the cold asphalt production in November. Last sample was taken in March when stripping got started.

As cold asphalt mixtures for pothole repairs can be used at various temperatures, the tests were performed at the laboratory temperature of 20 °C  $\pm$  2 °C with the cold mixture temperature of 5 °C  $\pm$  1 °C and 20 °C  $\pm$  2 °C to cover a probable range of application temperatures. The cold mixture was conditioned to the test temperature during 24 h. The mould was also conditioned to the laboratory temperature of 20 °C  $\pm$  2 °C.

The following test outputs were evaluated for both test temperatures:

- Weight of the mixture necessary to fill in the mould
- The distance between the surface of the mixture and the upper edge of the mould (a drop of the surface) after 10 min of self-compaction
- Time since the mould was lifted up to the moment when the mixture started falling out the mould (Abram's cone) or to disintegrate (CBR mould)
- Netto time of falling out the mixture from the mould or disintegation

The test results of self-compaction tests are shown on the next figures. There are no noticeable differences and no clear trend as for weight of the mixture at the temperature of 20 °C. May be a slight trend could be supposed for weight of the mixture at the temperature of 5 °C. There is a relatively strong decrease between November and February (about 400 g for both moulds) with the leap in March to the value higher than in November. The single one statement valid for all periods is weight of the mixture at 5 °C is lower when compared to 20 °C. It is reasonable and with high probability relate to the binder viscosity and workability of the mixture.



Figure 1. Weight of the mixture necessary to fill in the mould.

The drop of the mixture surface in the mould (self-compaction) after 10 min (Figure 2) demonstrates differences between 5  $^{\circ}$ C and 20  $^{\circ}$ C.

The self-compaction at the temperature of 20 °C is the highest in November. When the results for the Abram's cone are evaluated, it is evident weight of the mixture from December to March was a little bit lower than in November. As the volume of the mould was the same, it means, air void content of the mixture in the mould in these months was higher than in November. If the mixture would be still "alive" at the same level as in November, an anticipation of the higher drop of the surface is

legitimate. However, the results are in contradiction with the expectation. It can be perceived as some proof of change (worsening) of the mixture properties. Worsening of the mixture properties can be also deducted from the CBR mould results. Weight of mixture was approximately the same (except of January). It means, air void content of the mixture in the mould was also approximately the same. Therefore, the values of the self-compaction should be similar to the value in November. This did not become, although the differences are not significant. It seems the drop of surface after 10 min of self-compaction at the temperature of 20 °C could indicate a change of mixture properties (regardless the used mould) but there is not any clear difference in consecutive month that could be used as an unequivocal indication that a mixture is not in good state.



Figure 2. Drop of the mixture surface after 10 min self-compaction.

The values of the drop of the surface at the temperature of 5 °C have an inverse course when compared to the values at the temperature of 20 °C. The lowest value is in November, the next are higher. No trend can be observed. However, when weight of the mixture in the mould is taken into account, it seems the drop of the surface correspond to air void content of the mixture in the mould due to different weight of the mixture. Only exception is in March when weight of the mixture was higher than in November but the drop of the surface was also higher. It could be also perceived as an indication of a change of the mixture properties but it is not any indisputable proof.

The results of the disintegration tests (Figure 3, Figure 4) show starting and netto time determined from the video records. It is obvious the both time are higher for the temperature of 5 °C. It is in accordance with the assumption that the binder should have different viscosity that subsequently influences the mixture consistency. It was also supposed if a binder in a mixture lost its adhesive properties starting and netto time should be shorter. However, this expectation became real only in the case of netto time for Abram's cone and the temperature of 5 °C. There is a clear difference among the value in March and the previous values. A reason can be netto time is sufficiently long in this case (unlike the others situations) and the differences are more visible.



Figure 3. Starting time to falling out or disintegration.



Figure 4. Netto time of falling out or disintegration.

Taking into account the outputs of the disintegration test, probably only the test at the temperature of 5 °C using Abram's cone has a potential to reveal and prove changes of a mixture from storability point of view due to worsening a binder parameters (mainly adhesion to aggregate).

#### 4. Conclusions

The alternative self-compaction and disintegration tests were performed five times in the monthly intervals on one cold mixture for pothole repairs using upturned Abram's cone and CBR mould. All tests were carried out at laboratory temperature of 20 °C  $\pm$  2 °C with the cold mixture temperature of 5 °C  $\pm$  1 °C and 20 °C  $\pm$  2 °C. The test outputs taken into evaluation were the drop of the surface (self-compaction test) and starting and netto time of the mixture disintegration (disintegration test).

No clear trend, as for weight of the mixture in the mould, was founded out. The single one statement is weight of the mixture in the mould at 5 °C is lower when compared to 20 °C.

The results of the self-compaction test have showed the drop of surface after 10 min of selfcompaction at the temperature of 20 °C could indicate a change of mixture properties (regardless the used mould). However, there is not any clear difference in the consecutive month that could be used as an unequivocal indication that a mixture changed its properties. The same statement has to be accepted based on the self-compaction test results at 5 °C. It seems, the alternative self-compaction test has not a potential (or it is not suitable) to prove changes of a mixture properties.

Starting and netto time determined from the video records of the disintegration test was higher for the temperature of 5 °C. The expectation of shorter netto time in subsequently month due to the loss of adhesive properties of the binder was confirmed only in the case of netto time for the Abram's cone and the temperature of 5 °C. It is probably only the test that has a potential to reveal and prove changes of a mixture from storability point of view.

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