METHOD FOR ASPHALT DEGRADATION RESISTANCE USED IN CONNECTION WITH PURCHASING OF DEICERS, ASPHALT PAVEMENTS AND BITUMEN

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PAPER

In the 1990´s, asphalt durability problems due to the use of new deicing chemicals were observed at some Nordic airports. Degradation and disintegration of asphalt pavements occurred and there were also softening and stripping effects on bitumen and asphalt concrete together with loose stones on the runways.

The problems occurred when many airports in Norway and Sweden changed from urea to potassium acetate and potassium formate. Requirements from environmental authorities come because of nitrogen problems and over-fertilisation of soil and watercourses around airports caused by urea.

For this reason, a method for determining adhesion of asphalt concrete after storage in deicing agent was developed. This method is named LFV Method 2-98 (see enclosure). The storage time in the method is 70 days in the temperature of 40 °C. Comparison with adhesion value of specimen not stored in deicing agent is then done. The project to develop LFV Method 2-98 carried out by Norwegian and Swedish Civil Aviation Administrations. Later on has Finnish Civil Aviation Administration joined the project.

To get a resistant asphalt pavement as possible on runways LFV Method 2-98 is used as a technical criteria in connection with purchasing of runway and aircraft deicers, asphalt pavements and bitumen. Swedish CAA has general agreements for runway and aircraft deicers together with bitumen. In connection with purchasing of asphalt pavement and bitumen the actual deicers at the airports are used in the tests. The CAA´s in Norway, Sweden and Finland use the same technical requirement specification including LFV Method 2-98 in purchasings of runway deicers. The major airports in Denmark are also interested in using the same technical requirement specification.

LFV Method 2-98 is also an European standard method within CEN (European Committee for standardization) named EN 12697-43. Likewise there is standardization work going on in the SAE G-12 Fluids Subcommittee to get LFV Method 2-98 as standard method within the international requirement specifications for deicers. The aim is to introduce requirements of the runway deicing agent influence on asphalt and bitumen in the SAE AMS specifications 1431 and 1435. In the long run it is also planned to introduce the same requirements for aircraft deicing agents in SAE AMS 1424 and 1428.

A round robin test has been carried through to have the repeatability (within a laboratory) and the reproducibility (between participating laboratories) of the method well defined. The precision data is according to ISO 5725.

ENCLOSURE

LFV Method 2-98
EFFECT OF DE-ICING FLUID ON THE SURFACE TENSILE STRENGTH OF ASPHALT CONCRETE FOR AIRFIELDS
- ADHESION TEST

1 INTRODUCTION

The purpose of the test is to determine the effect of storage in de-icing fluid on the surface tensile strength of asphalt concrete. The surface strength is the force in N/mm² required for failure to occur in the upper surface of the asphalt concrete under perpendicular ”pull off” tension with an increase in tensile force of 200 N/s.
The test is performed largely in the same way as the method used for testing the adhesion of road markings to a road pavement and/or the adhesion of bridge deck waterproofing to an underlying concrete or steel surface.

2 TEST METHODS

2.1 Principle

Testing shall be performed on a sawn cylindrical test specimen on which a well-defined test surface has been carefully drilled out in the asphalt concrete to a depth of about 5 mm. A steel plate shall be bonded to the test surface. The specimen with test plate shall then be stored in de-icing fluid. During testing, the plate is pulled off with an increase in tensile force of 200 N/s, the force being applied perpendicularly to the test surface. The surface strength upon failure and the type of failure shall be recorded.
The results are compared with those for specimens which have not been stored in de-icing fluid.

2.2 Apparatus and materials

a) Vessel with tight-fitting lid for storing specimens in de-icing fluid.

b) Vacuum exsiccator.

c) Vacuum pump for evacuation of the exsiccator. The pump shall be capable of achieving a pressure of 6.7 kPa within 10 min and maintaining this pressure (within ± 0,3 kPa) throughout the vacuum treatment.

d) Manometer for measuring absolute pressure in the exsiccator.

e) Approved equipment for laboratory mixing of bituminous asphalt mixture.

f) Approved equipment for compaction of Marshall specimens or other approved laboratory compaction equipment such as gyratory compaction machine, roller or vibrating hammer.

g) Circular steel plates with a diameter of 50 mm and a tolerance of 0,5 mm. The steel plate shall be attached by suitable means (e. g. screwed) to the tensile test machine.

Minimum thickness of steel plate shall be 10 mm from bottom of steel plate to bottom of screw hole.

h) Suitable adhesive (e.g. two part epoxy resin) for bonding the steel plates to the test specimen.

i) Base and holder for fixing the specimen prior to testing (see Fig. 1).

j) Tensile test machine, with force increasing rate control and automatic load recording, fitted with suitable clampings and base to ensure that the tensile force can be applied without momentum perpendicular to the test specimen.

k) Equipment for drilling out a test surface.

l) Conditioning device giving a temperature of (23 ± 1) °C.

m) Circular saw capable of cutting asphalt with finish that has no imperfections discernible by touch.

n) Heating cabinet giving a temperature of (40 ± 2) °C for heated storage of specimens.

o) Exsiccator grease.

2.3 Preparation of test specimens

Produce a number of specimens by compaction according to Marshall or other laboratory compaction method. The specimens should have a diameter of
(100 ± 5) mm and a height of (60 ± 10) mm.
The asphalt mix may be produced in an asphalt mixing plant or in the laboratory.

2.4 Determination of dry weight and bulk volume

Allow the specimens to reach room temperature. Mark them with a waterproof marking.
Store the specimens overnight in room temperature on a flat surface.
The next day, determine the bulk density for each specimen according to EN 12697-6.
Divide the specimens into two equal groups (a wet and a dry group) with regard to bulk density. The mean bulk density must not differ by more than 30 kg/m^3 between the groups.

2.5 Preparation of test surface

Saw the specimens in half and carefully drill a test surface with a diameter of
50 mm and a depth of about 5 mm approximately in the centre of the sawn surface of the specimen.
Allow the specimens to dry on a flat surface at room temperature for at least three days.
Bond the test plate to the test surface by carefully applying a thin layer of epoxy adhesive.
Allow the specimen to cure at room temperature until the following day. Prepare the test surfaces of specimens from both groups.

2.6 Storage in de-icing fluid

Store the specimens with bonded test plate from the wet group in de-icing liquid at
(40 ± 2) °C and perform the test at (23 ± 1) °C.

Store the specimens in de-icing fluid, first for 3 hours ± 5 min under vacuum and room temperature, and then for a further 70 days ± 1 hour at normal pressure and specified storage temperature. Four specimens are normally stored for testing.
Place the specimens with the test plate upwards in the exsiccator. Pour de-icing fluid at room temperature into the exsiccator to a level 2-3 cm above the top of the asphalt concrete surface.
Evacuate to an absolute pressure of 6,7 ± 0,3 kPa within 10 ± 1 min. Adjust the evacuation rate and pressure with a valve or rubber hose with clamp.
Keep the absolute pressure at (6,7 ± 0,3) kPa for 3 hours. Turn off the pump and carefully admit air into the exsiccator until atmospheric pressure is reached.
Continue storage in a vessel at (40 ± 2) °C for a further 70 days ± 1 hour. Here again, the specimens must be placed with the test plate upwards immersed in de-icing fluid to a level 2-3 cm above the top of the asphalt concrete specimen surface. During storage, the vessel shall be covered with a tight-fitting lid. At the same time, the group of dry specimens is stored on a flat surface at room temperature.
After storage, condition the specimens to test temperature in the de-icing fluid not longer than until the next day.

2.7 Procedure

Take the specimen out of the de-icing fluid. Directly fix the specimen in the tensile test machine and the test plate attached to the machine. Apply the tensile force perpendicularly to the test surface and perform the test with an increase in tensile force of 200 N/s until failure occurs.
Record the tensile force together with the mode of failure. The following general modes of failure may occur:

- in the asphalt concrete, 5mm or deeper;
- superficially in the asphalt concrete surface;
- adhesive failure.

The test is carried out at (23 ± 1) °C.
At least three valid tests shall be carried out. The mean surface strength shall be calculated from a minimum of three accepted test results.

Test results for specimens stored in de-icing fluid are compared to test results for not stored specimens.

2.8 Expression of results

2.8.1 Method of calculation

The surface strength shall be calculated, to the nearest 0,1 N/mm^2, as the stress at maximum force by the following equation:

$$\sigma_{max} = \frac{F_{max}}{A}$$

where:

σ_{max} surface strength at failure, in N/mm²

F_{max} recorded maximum force, in N

A test area, in mm²

The mean value of the three test results shall be calculated.

2.8.2 Precision of the test method

Reproducibility and repeatability of the test method have been determined in accordance with ISO 5725 for 7 laboratories using different equipment. The experiment was done on gyratory compacted test specimens with maximum particle size 16 mm and void content 7 %. The origin of the aggregate was Skärlunda in Östergötland, the binder was a Laguna 160/220 and the nominal binder content was 5,7 % by weight. Five different storage agents were used.

Results relating to σ_{max} (6 laboratories, 1 excluded by statistical tests):

- repeatability, standard deviation:
  s_r = 130 N

- repeatability, critical range at 95 % confidence level
  when testing three specimens:
  CR_r = 430 N

- reproducibility, standard deviation:
  s_R = 220 N

2.9 Test report

The test report shall include at least the following information:

- all details necessary to identify the de-icing product tested (such as type, product name, density, pH value and concentration);

- a reference to this method and any deviation from it;

- information on preparation of test specimens in accordance with clause 2.3, type of asphalt, including aggregate and bitumen designation;

- bulk density of all specimens and mean and SD for each group according to clause 2.4;

- information on storage according to clause 2.6;

- the test results and failure mode according to clause 2.7 for each individual test, mean values;

- the dates of delivery and preparation of specimens;

- the date of tests.

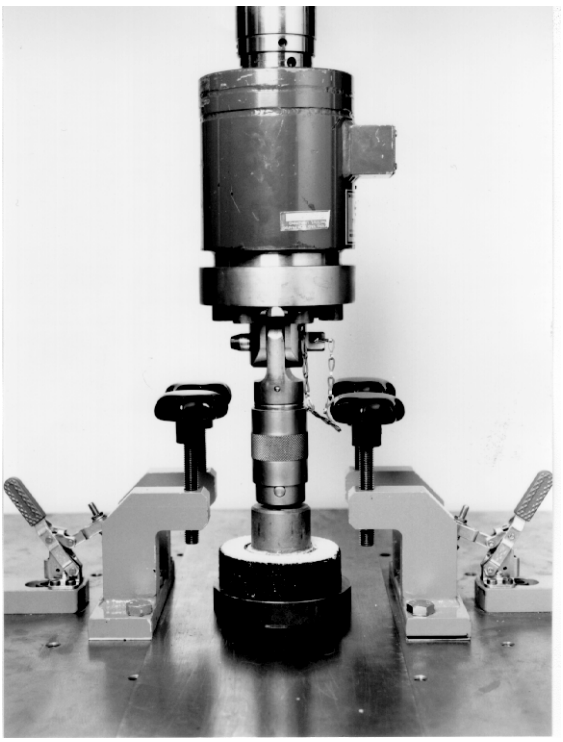

Figure 1 *Example of base, test specimen and equipment for adhesion testing (road markings).*