DTZS 975

DRAFT TANZANIA STANDARD

Test methods - Determination of the foaming characteristics of bitumen.

TANZANIA BUREAU OF STANDARDS

1ST Edition

0 National foreword

The Tanzania Bureau of Standards is the statutory national standards body for Tanzania, established under the Act.No.3 of 1975, amended by Act.No.2 of 2009.
This draft Tanzania Standard is being prepared by BCDC 5 Roads Technical Committee under the supervision of the Building and Construction Standards Divisional committee (BCDC).

In the preparation of this Tanzania Standard, reference was made to **SANS 3001-BSM1:2015 Determination of the foaming characteristics of bitumen, published by SOUTH AFRICAN NATIONAL STANDARDS.**

1 Scope

This Tanzania Standard draft describes a method to determine the foaming characteristics of bitumen.

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2 Definitions

For the purposes of this Tanzania Standard, the following definitions shall apply:

2.1 optimum foam characteristics.

balance between the largest expansion ratio and the longest possible half-life of foamed bitumen

2.2 expansion ratio

measure of the viscosity of the foamed bitumen, calculated as the ratio of the maximum volume of the foam relative to the original volume of bitumen

2.3 half-life

measure of the stability of the foamed bitumen, calculated as the time taken, in seconds, for the foam to collapse to half its maximum volume

2.4 optimum water addition

quantity of water, expressed as a percentage of the volume of bitumen, that is required to achieve the optimum foam characteristics

3 Apparatus

3.1. Electronic balance,

Fine measurement type that complies with **The United Republic of Tanzania Ministry of works-Laboratory Testing Manual (2000).**has a capacity of 10 kg and is accurate to 0.1 g.

3.2. Foamed bitumen laboratory unit, capable of producing foamed bitumen at a rate of 50 g/s to 200 g/s. The method of producing the foamed bitumen closely simulates that used in full-scale production. The laboratory unit is equipped with a thermostatically controlled kettle capable of holding a mass of 10 kg of bitumen at a constant temperature in the range of 160 °C to 190 °C ± 5 °C. The unit is equipped with a water injection system, whereby the mass of water injected into the hot bitumen is variable from 0 % to 5 % ± 0,25 % (by mass of the bitumen). To assist in achieving a uniform foam, the water is injected together with compressed air. Ensure that the unit is capable of producing a predetermined mass of foamed bitumen directly into the container or a laboratory mixer.

3.3. Cylindrical container, of metal, of diameter 250 mm ± 5 mm and a capacity of at least 20 l.

3.4. Calibrated dipstick, of metal, with prongs. Ensure that the spacing between each of the five prongs is the same, indicating a consistent multiple of expansion of six times when a mass of 500 g of bitumen is foamed in the container.

3.5. Stopwatch, that reads to 1 s.

3.6. Safety equipment, that includes safety glasses or a face shield, protective gloves, well insulated and capable of withstanding 200 °C, and a long-sleeved jacket.

3.7. Sealable steel containers, of capacity approximately 5 l.

3.8. Drying oven, capable of maintaining a temperature in the range of 105 °C up to 140 °C with continuous draft or by convection.

3.9. Plastic beaker, of capacity 500 ml.

3.10. Glass measuring cylinder, of capacity 50 ml.

3.11. Suitable waste receptacle, of capacity at least 20 l, for discarded and foamed bitumen.

3.12. Supply of compressed air

4 Principles

When water is injected under pressure into hot bitumen it causes the bitumen to expand rapidly and this process is referred to as “foaming”. The objective of this test is to optimize the percentage of water that is added to the bitumen to produce foam with the largest expansion and the longest possible half-life. The effect of adding more water increases the foamed volume but reduces the half- life of the foam. The test method is carried out with the bitumen at three different temperatures using three different quantities of water to establish the relationship between the expansion ratio and half- life, and the quantity of water added. The optimum amount of water to be added is based on minimum requirements of 8 for the expansion ratio and 6 s for the half-life.

5 Preparation

5.1. Preparation of the bitumen

5.1.1 *Obtain a sample of bitumen in accordance with* ***The United Republic of Tanzania Ministry of works, Laboratory Testing Manual (2000).*** *and seal a quantity of bitumen in each container (see 3.7). Sample a minimum of 20L for determining the bitumen’s foam characteristics.*

5.2.1 *Heat the containers with bitumen in the oven to a temperature of 120 °C ± 10 °C.*

5.2. Preparation of the laboratory unit

5.2.1 *Connect the unit to the electrical power supply and switch on.*

5.2.2 *Fill the unit’s water reservoir with potable water.*

5.2.3 *Connect the unit to the supply of compressed air.*

5.2.4 *Heat the kettle of the foamed bitumen laboratory unit to a temperature of 160 °C.*

NOTE: The temperature that is set to produce the foamed bitumen depends upon the grade of bitumen being tested. Testing is usually carried out at three different temperatures to investigate the effect of bitumen temperature on the foaming characteristics. The temperatures should be varied to suit the grade of bitumen used.

5.2.5 *Remove the containers with the bitumen from the oven and pour 10 l from each container into the kettle.*

5.2.6 *Once the temperature of the bitumen in the kettle is above 140 °C, circulate the bitumen through the system and continue circulating whilst heating to achieve the required temperature.*

5.2.7 *Determine the mass of the 20l metal cylindrical container (see 3.3) on the balance (M1), and place the container under the foamed bitumen outlet.*

5.2.8 *Set the bitumen discharge rate using the manufacturer’s instructions, typically 100 g/s for 5 s*

NOTE With some systems the amount of bitumen required is set on the display panel and the pump rate is adjusted to provide the correct amount of bitumen.

5.2.9 *Discharge bitumen for the pre-set period into the container and determine the mass again (M2). Determine whether the mass of bitumen discharged is 500 g ± 20 g. If the mass of discharged bitumen in the container falls outside this range, repeat the procedure, adjusting the stopwatch until the required mass is obtained.*

5.2.10 *Set the water injection rate for 2 % on the water flow meter using the manufacturer's instructions. Discharge water for the pre-set period into the beaker. Transfer the water into the measuring cylinder and read the volume of water discharged. Determine whether the volume of water is within 5 % of the indicated volume. If the volume of water falls outside this range, repeat the procedure, adjusting the water flow meter until the required volume is obtained.*

5.2.11 *Ensure that the dipstick is clean and the 20 l container is empty.*

5.2.12 *Pre-heat the metal cylindrical container in the oven set at 75 °C for at least 5 min*.

6 Procedure

6.1 Circulate the bitumen in the kettle through the system at 160 °C for at least 5 min before the test.

6.2 Check that the stopwatch for the foamed bitumen discharge and the flow meter for the water injection measurement have been set. The water flow meter is normally set to inject 2 % of water (by mass of bitumen) during the first testing cycle, and 3 % and 4 % for the next two cycles. When the minimum expansion ratio and half-life are not achieved, adjust the water percentages accordingly.

6.3 Discharge foamed bitumen into the pre-heated container for the pre-established time to spray 500 g of bitumen.

6.4 Start the stopwatch immediately after the foamed bitumen discharge stops.

6.5 Use the dipstick to measure the maximum level that the foamed bitumen reaches in the container and record it as the expansion ratio (eR1).

6.6 Continue to measure the time that the foam takes to dissipate to half of its maximum volume in the container. When this point is reached, stop the stopwatch. Record the time lapsed to the nearest second as the foamed bitumen's half-life (t1). Decant the foamed bitumen into the waste receptacle.

6.7 Repeat 6.3 to 6.6 twice more or until similar results are obtained (eR2, t2, eR3, t3)

6.8 Determine the expansion ratio and half-life at 3 % and 4 % of water, following steps 6.3 to 6.7.

6.9 Repeat 6.1 to 6.8 with the bitumen at 170 °C and 180 °C.

7 Calculations

7.1 Calculate the mass of bitumen discharged in 5 s using the following equation:

$$M_{bit} = M_2 - M_1$$

M_{bit} is the mass of the bitumen discharged in 5 s, in grams (g);
M_2 is the mass of the container and bitumen, in grams (g);

M_1 is the mass of the metal cylindrical container, in grams (g).

7.2 Calculate the average expansion ratio at predetermined water addition (see 6.5) using the following equation:

$$e_{R.ave} = \frac{e_{R1} + e_{R2} + e_{R3}}{3}$$

$e_{R.ave}$ is the average expansion ratio;

e_{R1} is the result of the first expansion test;

e_{R2} is the result of the second expansion test;
e_{R3} is the result of the third expansion test.

7.3 Calculate the average half-life at the predetermined water addition (see 6.6)

$$t_{ave} = \frac{t_1 + t_2 + t_3}{3}$$

t_{ave} is the average expansion, in seconds (s);

t_1 is the result of the first half-life test, in seconds (s);

t_2 is the result of the second half-life test, in seconds (s);

t_3 is the result of the third half-life test, in seconds (s).

7.4 Calculate the average expansion ratio and half-life of the foam at the other two water additions.

7.5 Prepare a chart and plot the average expansion ratio and average half-life at the three different percentages of water injected into the bitumen in the following way:

Horizontal axis:

Abscissa: Injected water

Unit: Percentage (%)

Scale: 20 mm = 0,5 %

Vertical axis:

Left ordinate: Expansion ratio

Unit: Ratio (volume of foam compared to original volume of the bitumen)

Scale: 5 mm = 5 times original volume

Right ordinate: Half-life

Unit: Seconds

Scale: 5 mm = 10 seconds

7.6 Plot the average expansion ratio obtained at each water content measurement and join the points together.

7.7 Plot the average half-life obtained at each water content measurement and join the points together.

7.8 Select the optimum water content as the average of the two water contents required to comply with the minimum requirements for an expansion ratio of 8 and a half-life of 6 s, respectively (see figure 1).

7.9 Compile a separate chart for each temperature.

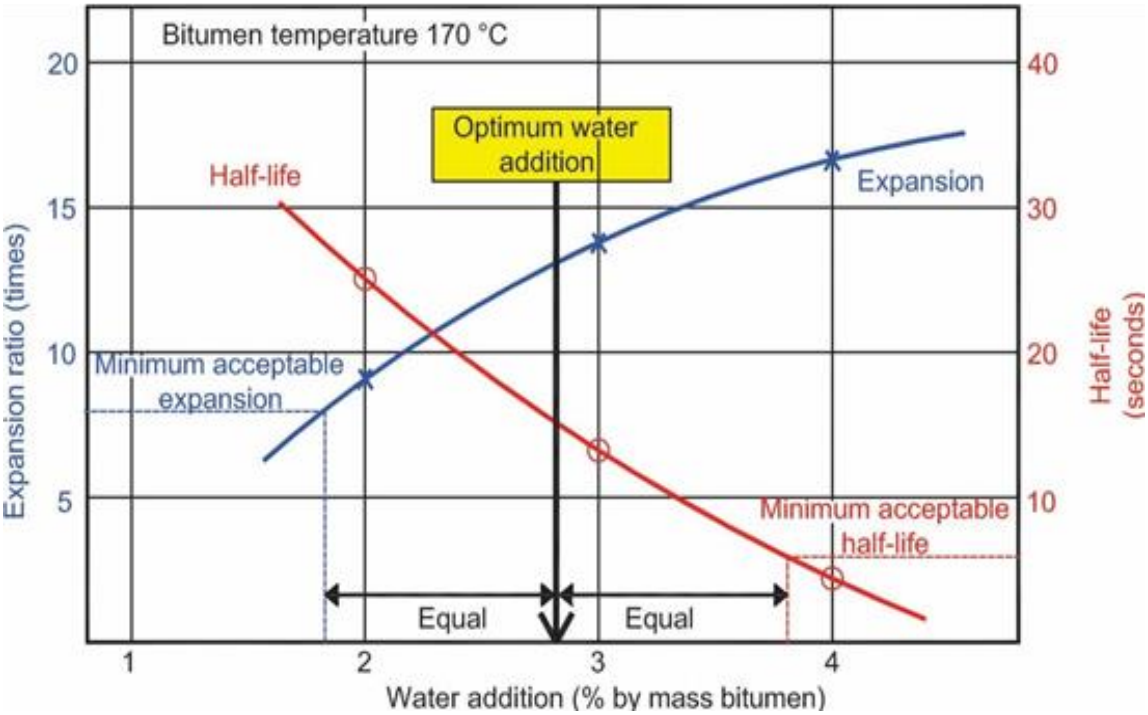

Figure 1 — Example of selection of optimum water addition.

8 Test report

Report the foam characteristics to the nearest 0.5 % on a suitable form and include the following information in the test report:

a) the bitumen temperature to the nearest 1 °C;

b) the optimum water addition to the nearest 0.1 % of water;

c) the expansion ratio at the point of optimum water addition to the nearest whole number;

d) the half-life at the point of optimum water addition to the nearest second (s)

Annex A

(informative)

A.1 General

Use the following information for 2 % of water added to bitumen at a temperature of 170 ^{O}C, to calculate A.2 to A.4:

M_1 = 1704.2 g

M_2 = 2209.5 g

e_{R1} = 10

e_{R2} = 8

e_{R3} = 9

t_1 = 27s

t_2 = 25s

t_3 = 26s

A.2 Calculate the mass of bitumen discharged in 5 s for 2 % of water

$M_{bit} = M_2 – M_1$ = 2 209.5 – 1 704.2 = 505.3 g

A.3 Calculate the average expansion ratio for 2 % of water

$$e_{R.ave} = \frac{10 + 9 + 8}{3} = 9$$

A.4 Calculate the average half-life for 2 % of water

$$t_{ave} = \frac{27 + 25 + 26}{3} = 26s$$

A.5 Determine the optimum water addition

Use the information in table A.1 to determine the optimum water addition.

Table A.1 — Expansion ratio and half-life for three water contents

1	2	3
Water addition (% of bitumen)	Average expansion ratio	Average half-life, s
2	9	26
3	13	13
4	17	4
Minimum acceptable values: Expansion ratio: 8 Half-life: 6s		

A.6 Average expansion ratio and average half-life

Plot the average expansion ratio and average half-life given in table A.1 (see figure 1).

A.7 Optimum water addition.

From figure 1 read off the following:

a) the water content at minimum acceptable expansion ratio is 1,8 %;

b) the water content at minimum acceptable half-life is 3,8 %;

c) the optimum water addition is

$$\frac{3.8 + 1.8}{2}$$

= 2.8%

Bibliography

- **The United Republic of Tanzania-Ministry of Work,** Laboratory Testing Manual (2000).
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- **The United Republic of Tanzania-Ministry of Work – 2000,** Laboratory Testing Manual
- **SANS 1649,** Non-automatic self-indicating, semi-self-indicating and non-self-indicating weighing instruments with denominated verification scale intervals.
- **TMH5,** Sampling methods for roads construction materials