A WIRTGEN GROUP COMPANY

WIRTGEN

BSM Cold Recycling.

Laboratory Handbook

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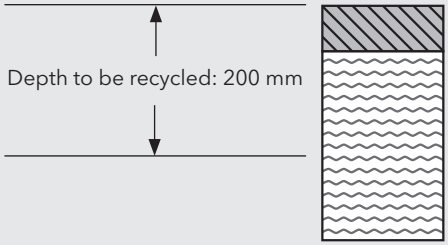
1. Standard mix design procedure for foamed bitumen stabilisation

Example

Existing upper pavement structure



Blend the materials in proportion to layer thickness and in situ density as follows:

Material (layer thickness, in-situ density)	Mass (kg/m²)	Proportion by mass	Per 10 kg sample (g)
Asphalt (60 mm at 2,300 kg/m³)	0.06 x 2,300 = 138	138/418 = 0.33	0.33 x 10,000 = 3,300
GCS (140 mm at 2,000 kg/m³)	0.14 x 2,000 = 280	280/418 = 0.67	0.67 x 10,000 = 6,700
Total	418	1.00	10,000

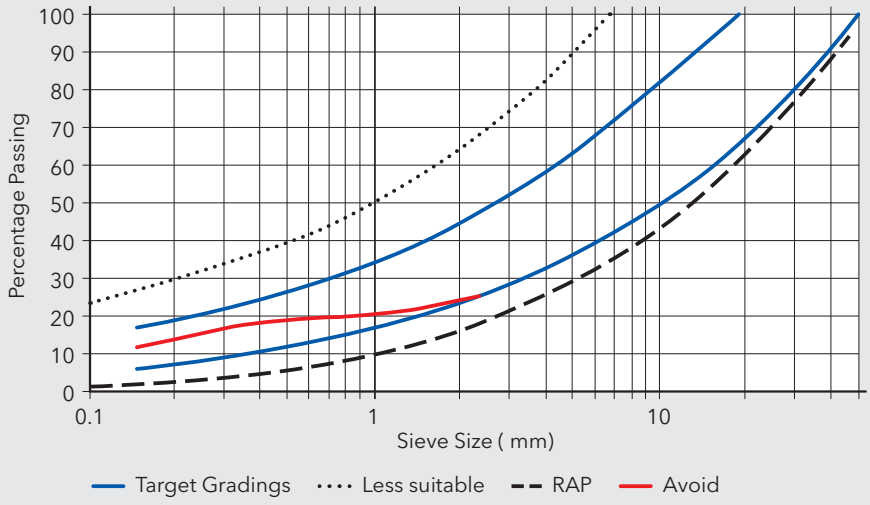
Notes. 1. Repeat the standard tests listed in Section 1.1.2 above to determine the grading, plasticity index and the moisture/density relationship of the blended sample.
2. Repeat the special test in section 1.1.3 above to ensure that the selected blend has eliminated the activity of the bitumen in the recycled asphalt.

1.1.5 Gradings (sieve analyses)

Plot the grading curve for the sample that will be used in the mix designs. Include on the graph the "Recommended gradings" and "Less suitable" envelops from the table below. This plot will indicate whether additional blending with freshly imported material may be required. However, if the plot includes a "bulge" in the fractions between the 0.075 mm and 2.0 mm sieves (as shown by the red line entitled "Avoid" in the graph below), the sample should be blended with a sufficient suitable fine material (e.g. 10% by mass of minus 5 mm crusher dust) to reduce the magnitude of the bulge.

Note. This exercise is advisable as it allows a preliminary indication of performance after the material has been treated with foamed bitumen. (A poorly graded material is difficult to compact and the consequent low density achieved will significantly affect the strength, especially under saturated conditions.)

Target grading curves for bitumen stabilisation



Sieve size (mm)	Percentage passing each sieve size (%)			
	Target gradings		Typical RAP	Less suitable (e.g. gravel)
	Coarse	Fine		
50	100	100	100	100
37.5	87	100	85	100
26.5	76	100	72	100
19	65	100	60	100
13.2	55	90	50	100
9.5	48	80	42	100
6.7	41	70	35	100
4.75	35	62	28	88
2.36	25	47	18	68
1.18	18	36	11	53
0.6	13	28	7	42
0.425	11	25	5	38
0.3	9	22	4	34
0.15	6	17	2	27
0.075	4	12	1	20

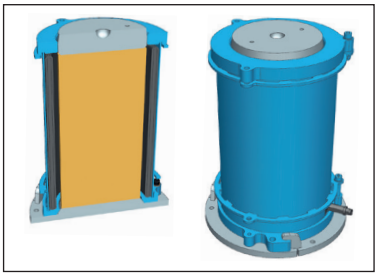
3. Test procedure determination of the shear properties of Bitumen Stabilised Material (BSM)

3.1 SCOPE

This procedure describes the Monotonic Triaxial test for determining the shear properties (Cohesion (C) and Angle of Internal Friction (ϕ)) from large specimens (152 mm in diameter and 300 mm high).

3.2 APPARATUS

3.2.1 Triaxial cell (confining cylinder). The cell must be capable of safely withstanding the confining pressures that are applied to the specimen. The internal dimensions of the cell must be sufficient to accommodate a specimen enclosed in an inflatable rubber bladder.



3.2.2 Bladder for applying confining pressure. A rubber bladder with an uninflated internal diameter of 160 mm (±5 mm) and 300 mm in height.

3.2.3 An air compressor complete with pressure gauge and regulator capable of inflating the bladder and maintaining a constant pressure up to a maximum of 200 kPa.

3.2.4 A water bath with perforated bottom, at least 350 mm deep, thermostatically controlled so as to maintain a temperature of 25° C ± 1° C.

3.2.5 A forced-draft drying oven, thermostatically controlled and capable of maintaining the temperature within 1° C of the setting (minimum 240 litres capacity)

3.2.6 A suitable compression testing machine with sufficient clearance to accommodate the assembled confining cylinder. The machine must be able to apply the load required to achieve a constant vertical displacement rate of 3 mm/min. The machine must also be capable of applying a maximum load of 200 kN and must measure and record the following information at 1 second intervals:

- applied load to an accuracy of 0.05 kN; and
- vertical displacement to an accuracy of 0.05 mm.

The preferred geometry of the testing machine is a moving actuator/loading ram situated above the triaxial cell with the fixed reaction base below the triaxial cell.

3.2.7 A balance to weigh up to 20 kg, accurate to 1 g.

3.2.8 A digital thermometer capable of measuring between 0° C and 100° C, calibrated to an accuracy of 1° C.

3.2.9 Plastic bags (± 10 litres)

3.3 PREPARING THE SPECIMENS FOR TESTING (CURING)

Ten specimens, 152 mm in diameter and 300 mm high are manufactured for each test following the procedure for manufacturing test specimens using vibratory hammer compaction (Appendix 2).

Note. Specimens are manufactured at the Optimum Moisture Content (OMC).

3.3.1 Leave all ten specimens overnight in their respective moulds covered with a moist hessian cloth.

The following morning, remove the specimens from their respective moulds, mark each one with an appropriate identity number and carry out the following measurements for each specimen:

> Determine the mass.
> Measure the height at four evenly-spaced locations around the circumference and calculate the average height.
> Calculate the bulk density using the equation in paragraph 3.5.1

Calculate the mean and standard deviation of the bulk density for all ten specimens. Using the equation in paragraph 3.5.2, determine if any of the specimens are outliers and exclude them from further testing.

Note. If more than two specimens are excluded, the test must be abandoned.

3.3.2 Place the specimens in a forced-draft oven at a temperature of 40° C (± 1° C) for a period of 8 hours. After 8 hours, remove all specimens from the oven, place each in a loose-fitting plastic bag, seal the bags and return the specimens to the oven at 40° C (± 1° C) for a further 48 hours.

3.3.3 Take the specimens out of the oven after 48 hours. Remove two of the specimens from their plastic bags and place under water in a soaking bath for 24 hours. (Ensure that the specimens are submerged with at least 25.4 mm of water covering the top faces.)

The remaining specimens are placed in fresh (dry) plastic bags, sealed and left to cool to 25° C (± 2° C) (minimum cooling period of 12 hours). The specimens are only removed from their plastic bags and weighed immediately before testing.

3.3.4 Remove the soaked specimen(s) from the water after soaking for 24 hours, surface dry and weigh before testing.

Note. Specimens are manufactured at the Optimum Moisture Content (OMC).

Appendix 1 – Application catalogue: Laboratory Unit WLB 10 S / WLM 30

A1.1 PREFACE

The application catalogue indicates correct handling and working methods, and is intended to communicate how to use the WIRTGEN laboratory equipment for practical purposes.

It by no means replaces the instruction manual for the particular devices or the safety manual.

A1.2 FOAM-BITUMEN UNIT (WLB 10 S)

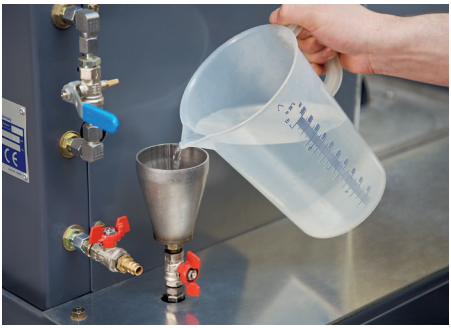
A1.2.1 Utilisation purpose

The WLB 10 S is used for:

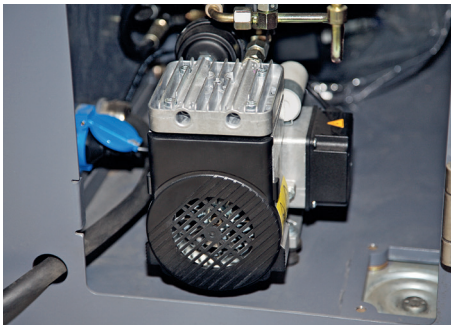
1. Checking the bitumen provided with regard to its foam properties.
2. Calculating the optimum amount of bitumen water for foaming the bitumen.
3. Adding a defined quantity of foamed bitumen to the WLM 30 lab mixer.

A1.2.2 Tasks required before starting work

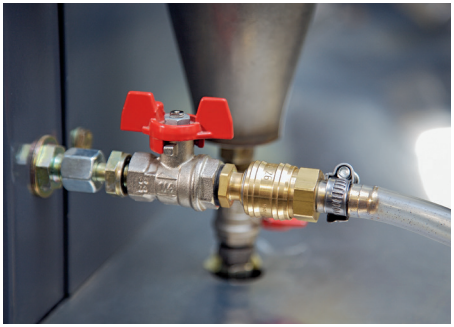
1. The water tank of the WLB 10 S must be filled with sufficient water. A half filling of the water tank is adequate initially.



2. The system requires a compressed air supply (6 bar / 87 psi). Either via the optionally installed air compressor or from an external supply.



Integral unit



External supply

3. The bitumen to be foamed (approx. 15 litres) must be preheated in a suitable oven to a temperature of at least 120° C (250° F).