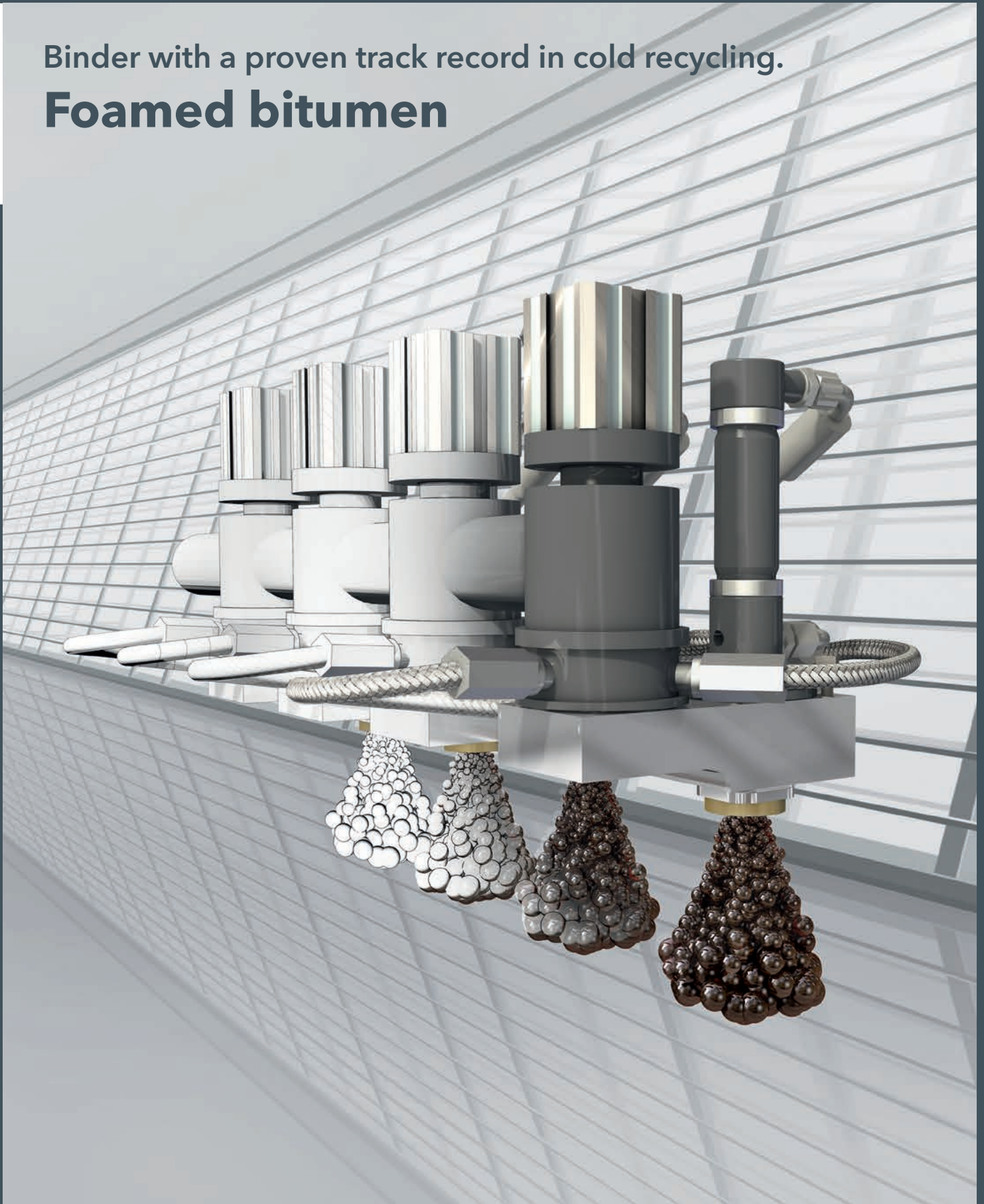


Binder with a proven track record in cold recycling.

Foamed bitumen





Fit for the future with foamed bitumen.



High-quality, cost-efficient, environmentally friendly. And future-proof: cold recycling with foamed bitumen - the innovative binder. Inextricably tied to the name of WIRTGEN - the pioneer in foamed bitumen. Our vision to fully realize the potential inherent in the foamed bitumen technology has matured into many years of proven expertise and experience in the field. Always with the requirements of our customers in mind. In touch with our customers. The tried-and-tested road construction material has scored top marks with countless users around the globe even today.

TABLE OF CONTENTS

| | |
|---|-------|
| FOAMED BITUMEN - SUSTAINABILITY THE EFFECTIVE WAY | 6-7 |
| PERFECTLY ENGINEERED PROCESS, PERFECT RESULTS | 8-9 |
| PRODUCTION OF FOAMED BITUMEN IN THE LABORATORY | 10-11 |
| PROPERTIES OF BSM (BITUMEN-STABILIZED MATERIAL) | 12-13 |
| APPLICATION IN-SITU OR IN-PLANT | 14-15 |
| COLD MIXES WITH FOAMED BITUMEN | 16-17 |
| EXAMPLES OF BSM LAYERS IN THE PAVEMENT STRUCTURE | 18-19 |
| WIDE RANGE OF APPLICATIONS FROM A SINGLE SOURCE | 20-21 |
| THE FULL RANGE OF PROFESSIONAL SUPPORT SERVICES | 22-23 |
| HISTORY OF THE FOAMED BITUMEN TECHNOLOGY | 24-25 |
| FOAMED BITUMEN IN USE AROUND THE GLOBE | 26-27 |



Foamed bitumen - sustainability the effective way

06
07

11





CONSTRUCTION MATERIAL FOR THE HIGHEST ENVIRONMENTAL STANDARDS

UP TO 100%

reduction in costs of material disposal

UP TO 90%

reduction in transport volume

UP TO 90%

reduction in resource consumption

UP TO 50%

reduction in binder use

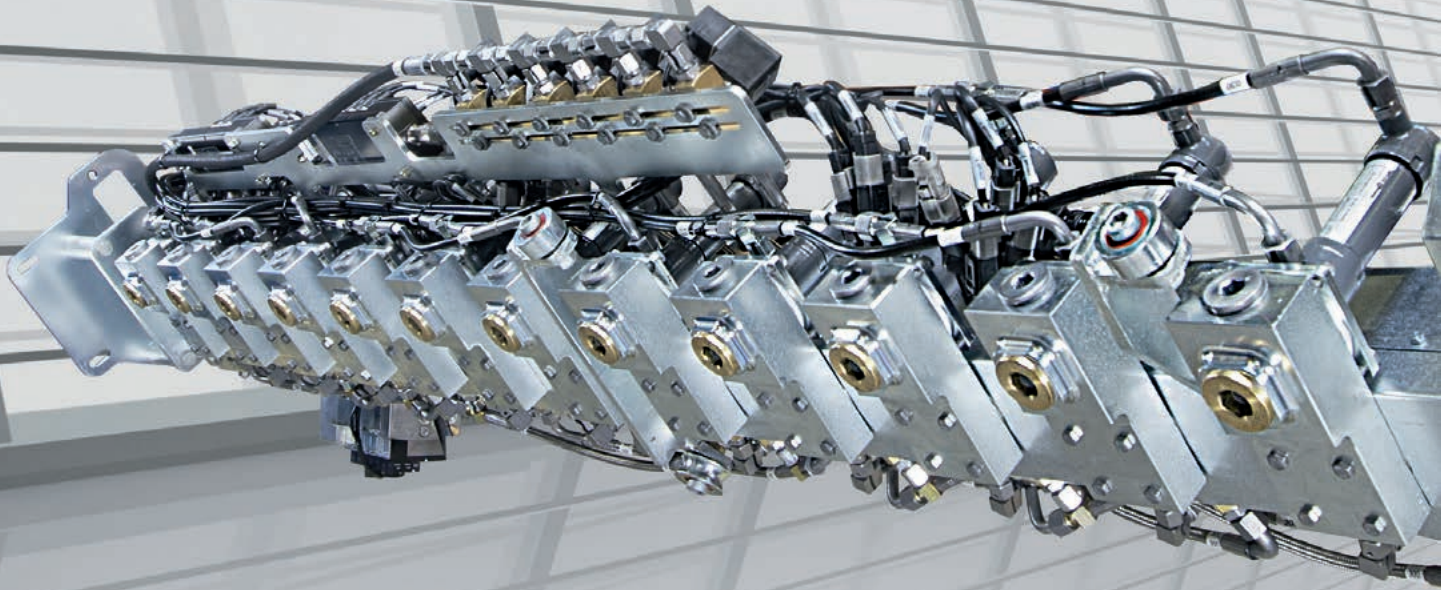
UP TO 50%

shorter construction period

UP TO 50%

reduction in overall costs

1 | *Cold recycling with foamed bitumen uses reclaimed materials, adding only binders to the process.*



1 |

1 | *Special injection systems are used to inject the foamed bitumen into the mixing chamber.*

Perfectly engineered process, perfect results

A CONSTRUCTION MATERIAL OFFERING LOTS OF POTENTIAL

Cold recycling with foamed bitumen is an established technology worldwide and is increasingly moving into the focus of road authorities and construction companies for the rehabilitation and new construction of roads.

Cold recycling with foamed bitumen enables the production of flexible and highly durable base layers. As part of the pavement structure, they are the perfect foundation for the upper asphalt layers built at reduced layer thicknesses. Foamed bitumen is produced from approx. 175°C hot road-grade bitumen using state-of-the-art technology. Microprocessor-controlled injection systems installed in the WIRTGEN recyclers produce the foamed bitumen and inject it into the mineral aggregate in precisely metered quantities.



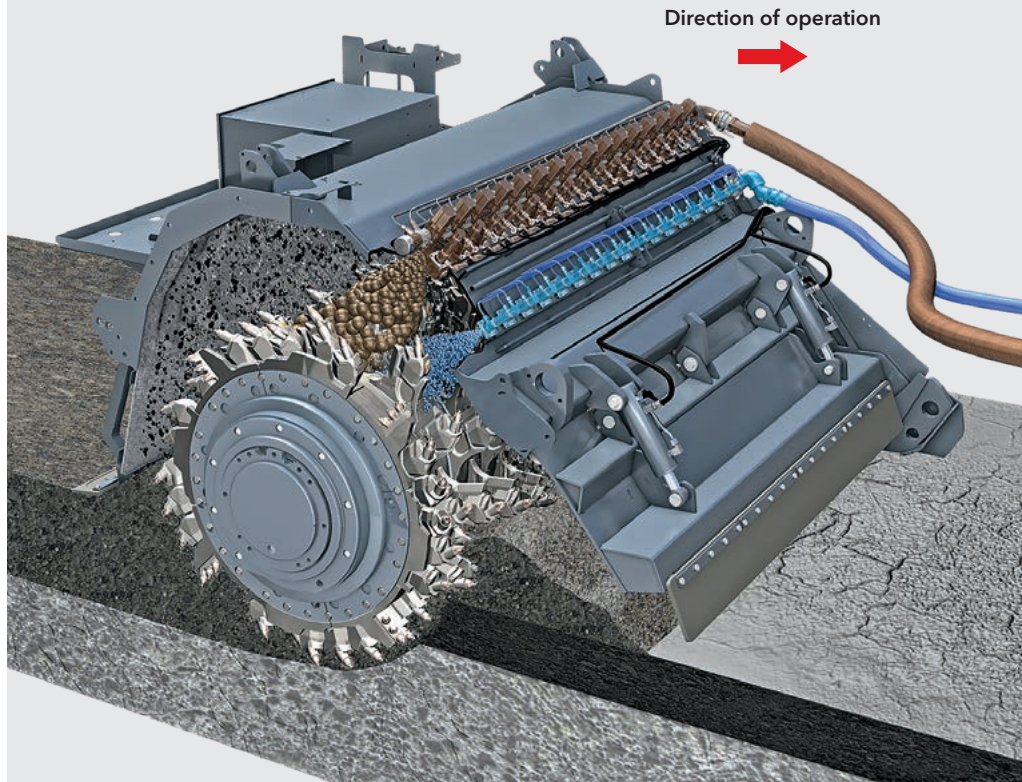
2 | *Microprocessors ensure precise metering across the full working width and in accordance with the recycler's advance speed and recycling depth.*

THE PERFECTLY ENGINEERED PROCESS IMPRESSES WITH:

- > exceptional durability of the pavement layers
- > cost-efficiency
- > resource efficiency
- > reduced CO₂ emissions
- > shorter construction periods



INJECTION OF FOAMED BITUMEN AND WATER INTO THE MINERAL AGGREGATE VIA SEPARATE INJECTION SYSTEMS



PRODUCING FOAMED BITUMEN

Foamed bitumen is produced by foaming standard road-grade bitumen. In the process, small amounts of water and air are injected into the hot bitumen at high pressure, which causes the bitumen to foam and to expand to around 20 times its original volume. The bitumen foam, which is ideal for processing with cold and moist construction materials, is then injected into a mixer by means of spraying nozzles.

The resulting construction material - frequently produced using reclaimed asphalt pavement (RAP) - is called BSM (bitumen-stabilized material).



11

1 | *Small amounts of water cause an abrupt increase in volume of the hot bitumen (foamed bitumen).*

Production of foamed bitumen in the laboratory

DETERMINING THE FOAMED BITUMEN QUALITY IN ADVANCE

Preliminary testing with the mobile WLB 10 S laboratory plant enables the foamed bitumen quality to be precisely defined in the laboratory even prior to the start of construction. Exceptionally easy handling enables parameters such as the water quantity, air pressure and temperature to be varied quickly.

The quality of foamed bitumen is primarily described in terms of its expansion ratio and half-life.

With the mobile WLB 10 S laboratory foamed bitumen plant, WLM 30 twin-shaft compulsory mixer and WLV 1 laboratory compactor, we have translated our many years of field experience into state-of-the-art laboratory technology. The innovative machines enable suitable test specimens to be produced in next to no time at all.

The WLV 1 laboratory compactor is additionally used to manufacture test specimens from bitumen-stabilized material. Defining the specimen height, number of layers and maximum time of compaction is quick and simple.



2 |

IT'S THE MIX THAT COUNTS

The WIRTGEN WLB 10 S laboratory foamed bitumen plant is used for:

- > General testing of the bitumen grades used to determine their suitability for the foaming process.
- > Optimization of the foaming process by adjusting the temperature and quantity of water to be added.
- > Production of mixes adding different amounts of bitumen in the laboratory.

For mix production in the road laboratory, the WLB 10 S is directly connected to the WLM 30 twin-shaft compulsory mixer. The foamed bitumen produced by the WLB 10 S is injected into the mixing process taking place in the WLM 30. The materials are mixed precisely and without loss. Mixes for the manufacture of test specimens are thus produced within an extremely short period of time.



3 |



4 |

2 | The WLB 10 S laboratory plant can be used to perform test series for determining the foamed bitumen properties.

3 | The WLM 30 twin-shaft compulsory mixer is suitable for batches of approx. 25 kg and impresses with high mixing intensity.

4-7 | Different grades of foamed bitumen can be produced quite easily to determine the ideal composition of the recycling mix.



5 |



6 |



7 |

Properties of BSM (bitumen-stabilized material)

USING BSM IN THE FIELD

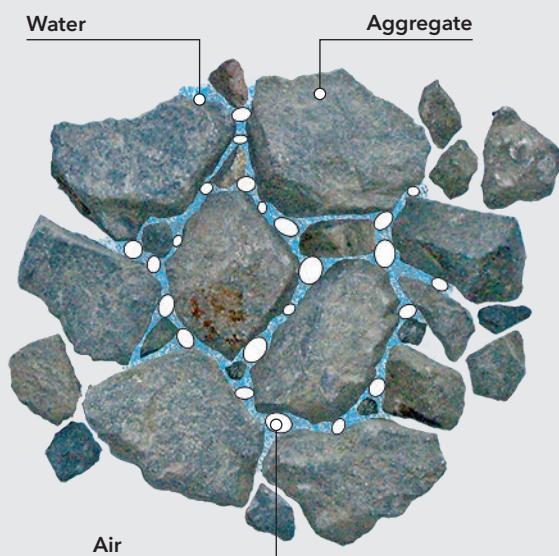
Easy processing is one of the hallmarks of BSM mixes. When the material is sufficiently moist, there are no time limitations for the subsequent compaction process. Another vital aspect of BSM layers is that they can be temporarily opened to traffic right after completion.

In many cases, the cold recycled layer is simply overlaid with a thin asphalt surface course serving as a wearing course. Road maintenance interventions usually focus on the asphalt surface course, leaving the cold recycled layer undisturbed. This approach pays off in low road maintenance costs.

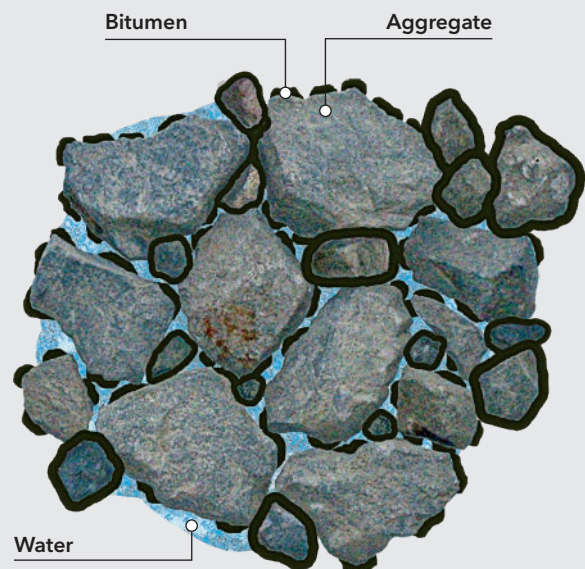
MATERIAL STRUCTURE

Cold mixes produced with foamed bitumen are similar in behaviour to construction materials with constant inter-particle friction but exhibit significantly higher cohesion (adhesion force) and strength. This type of material is also called BSM (bitumen-stabilized material).

BSM mixes do not involve coating of the aggregate but homogeneous admixing of the bitumen binder. Typical bitumen quantities range between 1.5% by mass and 2.5% by mass of the mixed material. After final compaction, the construction material is characterized by good flexible properties and high bearing capacity. It has a proven track record around the globe.

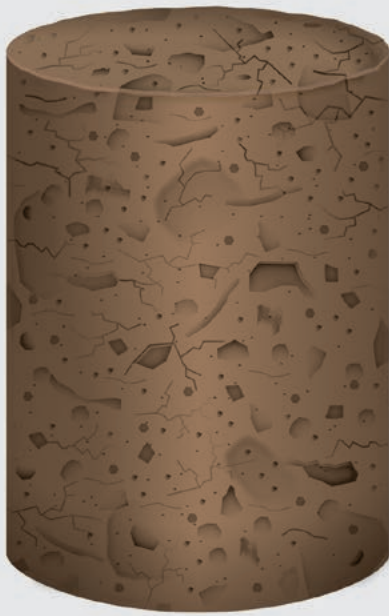


A Crushed-stone material, mixed with water for optimum compaction



B Bitumen-stabilized material with foamed bitumen, mixed with water for optimum compaction

MATERIAL PROPERTIES OF BSM



Addition of:
2.2% bitumen
1.0% cement
(identical density and moisture content)



| | |
|----------|---|
| A | Aggregate crushed as per grading curve |
| | Cohesion (adhesion force): 30 to 55 kPa |
| | Angle of friction: 43 to 51° |

| | |
|----------|---|
| B | Bitumen-stabilized material |
| | Cohesion (adhesion force): 200 to 300 kPa |
| | Angle of friction: 40 to 49° |



11 | Material treated with foamed bitumen impresses with high strength and bearing capacity.

Application in-situ or in-plant

COLD RECYCLING IN-SITU

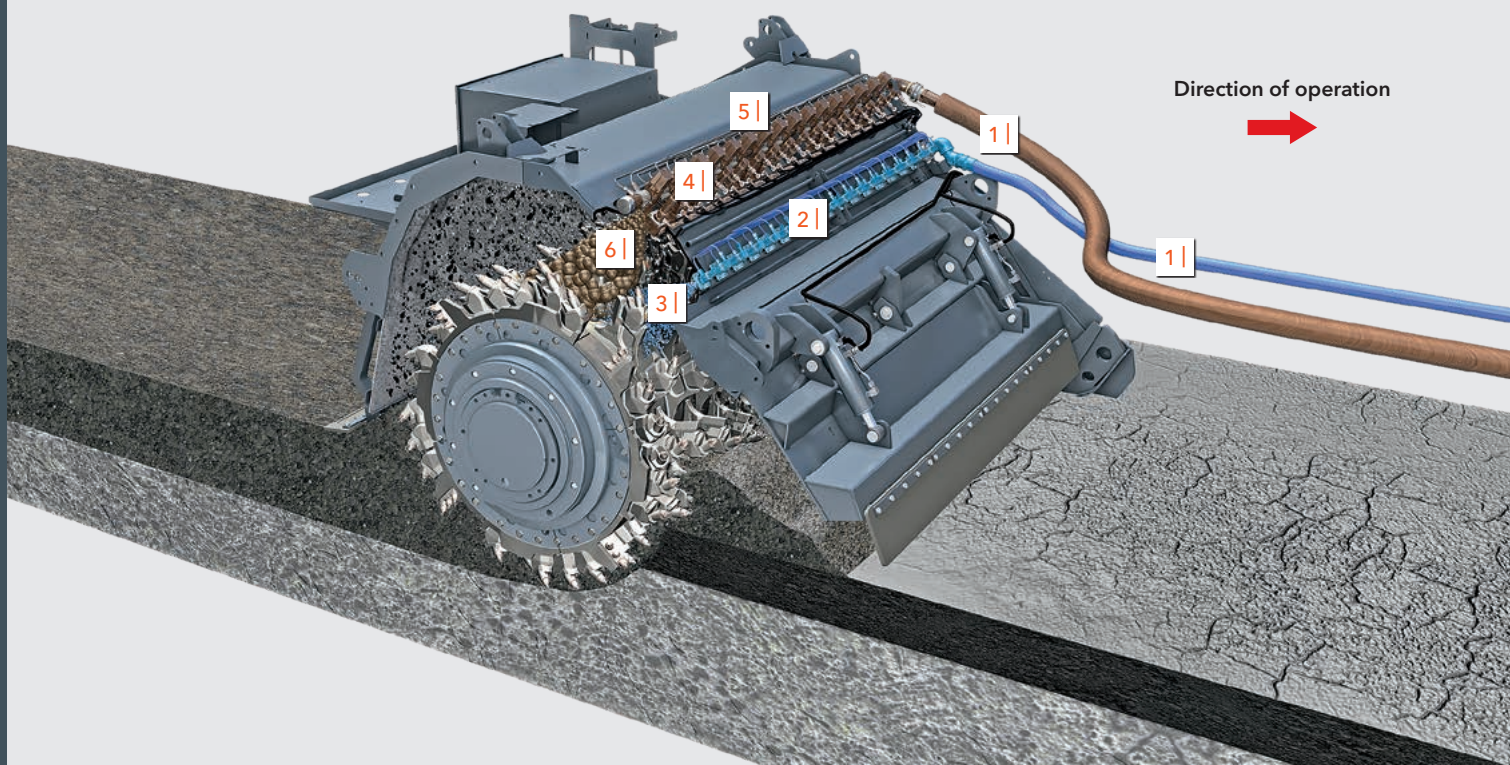
Cold recycling with foamed bitumen can be performed either in-situ (on site) or in-plant (in a mixing plant).

When cold recycling in-situ, a cold recycler granulates the distressed road pavement while at the same time mixing in foamed bitumen, water and cement homogeneously and in accordance with requirements. This process produces a new construction material mixture (BSM) in a single operation. The cold recyclers used for in-situ recycling are equipped with a powerful milling and mixing rotor and an injection system.

Some models are additionally fitted with a screed for paving and pre-compaction of the new construction material mix.



- 1 | Feed hoses
- 2 | Injection bar for water
- 3 | Injected water
- 4 | Injection bar for foamed bitumen
- 5 | Expansion chambers
- 6 | Injected foamed bitumen





1 |

1 | *The KMA 220 / KMA 220i cold mixing plant upgrades the different additives to produce a high-quality cold mix (BSM).*

COLD RECYCLING IN-PLANT

When cold recycling in-plant, the reclaimed asphalt pavement is removed and transported to a mobile cold mixing plant set up in the vicinity of the construction site. The milled material is mixed with foamed bitumen, water and cement in the specified quantities to produce a new, homogeneous cold mix (BSM) suitable for immediate placing. The material can be either paved back immediately true to line and level or stockpiled for later use.

STATE-OF-THE-ART INJECTION SYSTEM

Highest quality is guaranteed: a thermostat-controlled heating system maintains the specified operating temperature of the entire injection system at all times both prior to and during the foamed bitumen production. This feature dispenses with having to flush the system after breaks in operation or at the end of the working day.

Microprocessors control both the foaming process and the amounts of foamed bitumen added.



2 |

2 | *The powerful twin-shaft continuous mixer installed in the KMA 220 / KMA 220i mixes the milled material and injected foamed bitumen.*

Cold mixes with foamed bitumen

16
17

CONSTRUCTION MATERIALS IN-SITU

As a general rule, all types of granular construction materials – as well as RAP – are suitable for recycling with foamed bitumen. WIRTGEN recyclers granulate both the asphalt layer and the underlying layer, mixing the material with foamed bitumen in-situ in a single operation.

After compaction, a bituminous base layer of high quality has been produced which is capable of withstanding extremely high traffic loads.



MILLED MATERIAL IN-PLANT

The milled material reclaimed by a WIRTGEN cold milling machine can usually be processed right after milling or stockpiled for an unlimited period of time. The mobile WIRTGEN KMA 220 / KMA 220i cold mixing plant uses this source material to produce cold mix in-plant for subsequent reuse by a VÖGELE asphalt paver.

RECLAIMED AND NEW MATERIALS

Materials reclaimed from existing pavements, recycling materials and new materials are processed using appropriate crushing and screening technology and can subsequently be mixed with foamed bitumen in the KMA 220/KMA 220i cold mixing plant.

All road construction materials with suitable particle grading can be recycled with foamed bitumen.



LABORATORY TESTING

The WIRTGEN WLV 1 laboratory compactor provides an ideal solution for the manufacture of specimens from bitumen-stabilized material (BSM). The core element of the WLV 1 laboratory compactor is a height-adjustable vibrating hammer mounted on a vertical column. The vibrating hammer uses a heavy-duty tamping foot to transfer a precisely defined amount of impact energy on the material filled into a cylindrical mould in multiple layers.

Once the final, predetermined mould height (density) has been reached, the specimen can be simply removed from the mould by means of a quick-release fastener and prepared for the testing method to be applied. Specimens of 152 mm in diameter and 95 mm in height can be manufactured for determining the indirect tensile strength (ITS). Large specimens of 152 mm in diameter and 300 mm in height are manufactured for use in triaxial testing.

1-3 | *Specimens of different height are manufactured depending on the testing method to be applied.*

4 | *Even large specimens can be manufactured quite easily for triaxial testing.*



Examples of BSM layers in the pavement structure



Additional significant reductions in cost can be achieved by reducing the thickness of the upper asphalt layers.

Maintenance costs are also extremely low. Unlike conventional asphalt layers, BSM layers are not prone to cracking as a result of ageing. This requires only the thin asphalt surface course to be replaced as necessary, dispensing with the expensive replacement of the complete asphalt pavement.

Bitumen-stabilized materials are increasingly used also in Public Private Partnership (PPP) projects due to their exceptional material properties and the advantages offered by this type of construction.

LOW OVERALL COSTS

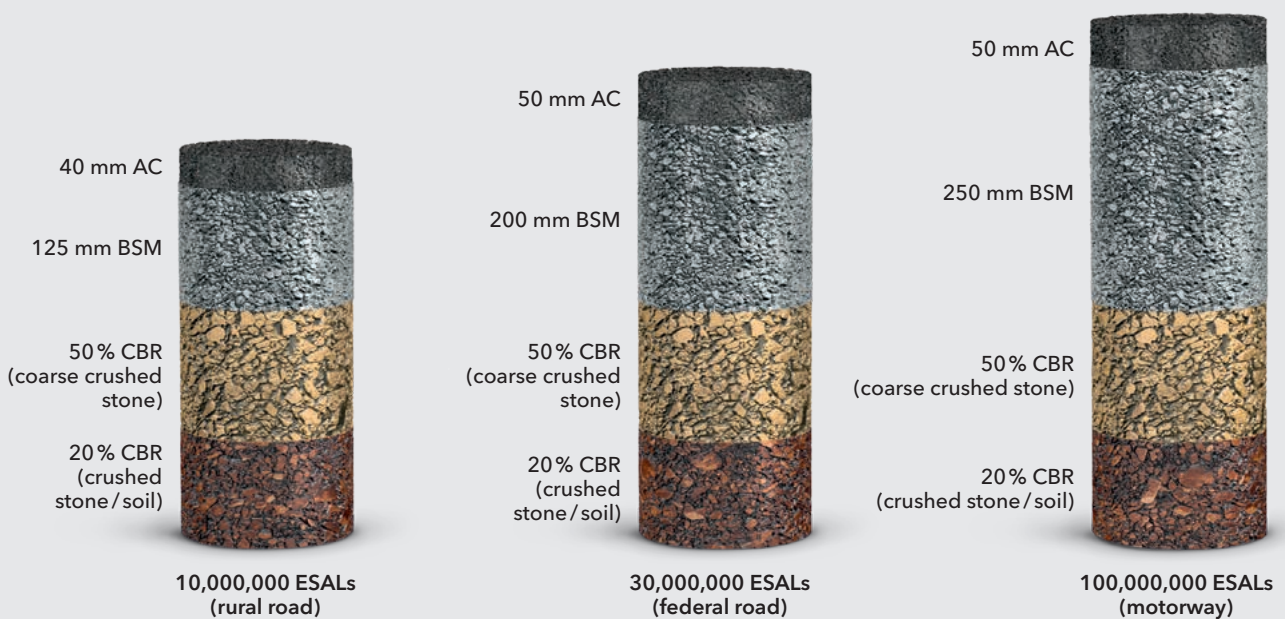
The pavement structures shown in the illustration are examples of three different construction classes. Due to low binder requirements, the use of reclaimed asphalt pavement and exceptionally quick completion times, these construction methods are especially economical in terms of construction costs.

1 | *The W 380 CRi is recycling an asphalt layer with added foamed bitumen, transferring the recycled mix to the VÖGELE paver following behind.*





2-3 | Recycled, homogeneous asphalt mix behind the cold recycler.



AC = asphalt surface course
 BSM = bitumen-stabilized material
 CBR = California Bearing Ratio
 ESAL = equivalent standard axle load (= 8.16 t)

Wide range of applications from a single source

20
21



1 | Cold recycling in-situ using the W 240 CRi cold recycler with integrated paving screed.

FULL REUSE

As foamed bitumen offers numerous advantages, it enjoys a prominent position among the range of binders used in road construction. Adding foamed bitumen to granulated asphalt enables the material to be recycled 100% even in cold condition.

Significant reductions in CO₂ emissions are possible as the source materials can be processed without prior heating.

Low application rates of only 1.5% to 2.5% of the total mass result in low binder costs. Road-grade bitumen can be obtained worldwide and is suitable for immediate use without requiring additional processing. Construction materials mixed with foamed bitumen can be placed, compacted and reopened to traffic immediately, thus minimizing construction times and disruptions to traffic.



2 |



2 | *Extremely fast-paced method: short construction times enable the recycled layers to be reopened to traffic quickly.*

3 | *Bitumen can be obtained worldwide and is added to the mixing process after foaming at a temperature of approx. 175 °C.*



1 | *Exchanging experiences during a visit to the construction site makes a convincing case also for road authorities.*

2 | *WIRTGEN supplies the full range of laboratory equipment.*

3 | *Our expert lectures, real-life demonstrations and articles in trade journals create an awareness of foamed bitumen around the globe.*

4 | *Documents compiled by experts and published in numerous languages provide comprehensive application details.*

The full range of professional support services

WIRTGEN AS THE TECHNOLOGY LEADER

We see ourselves as an innovative process specialist for the highly efficient cold recycling technology. That is why we offer an extensive range of customer services in addition to state-of-the-art machine technology. In close cooperation with users in the field, we are actively advancing the development of new products. We share our experience with industry peers, enabling customers to benefit from new markets opening up.

Consulting services offered at specific project and target group levels are yet another strong point guaranteeing a made-to-measure, cost-effective recipe for success in each application.

The WIRTGEN service network comprising sales and service companies around the globe offers professional customer support. Our employees keep up to date on foamed bitumen by attending regular trainings providing both theoretical and hands-on knowledge.



5 | *Operating personnel around the globe is trained and supported in the field by experienced trainers.*

6 | *WIRTGEN experts provide made-to-measure, application-based support right on the construction site.*



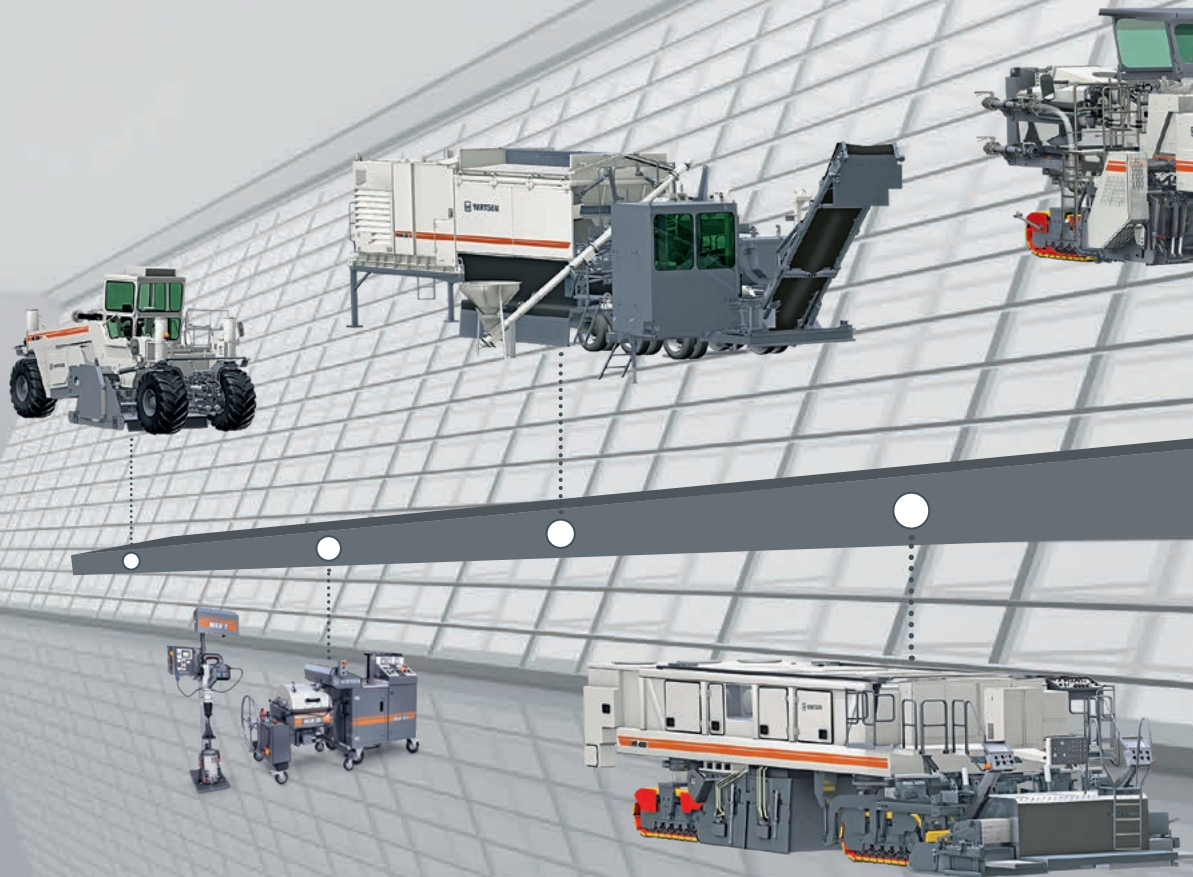
The history of foamed bitumen

WIRTGEN - A PIONEER IN FOAMED BITUMEN

In 1956, Professor Ladis Csanyi from Iowa State University (USA) was the first to recognize the suitability of foamed bitumen for use as a binder. This technology was later refined by Mobil Oil. Mobil Oil developed the first expansion chamber in which bitumen was mixed with water to produce bitumen foam. WIRTGEN has taken the lead in the industry since the 1990s in working with this innovative binder. Integrating the system into the WIRTGEN recyclers in 1995 was the final step sparking the interest of industry peers.

The WR 2500 was the first recycler to be fitted with this system. In 1997, WIRTGEN additionally developed the WLB 10 laboratory foamed bitumen plant for the production of foamed bitumen in the laboratory. Well over 300 laboratory units have since been sold around the globe, used by contractors, construction materials testing laboratories, institutes, universities and consulting engineers. Today, WIRTGEN offers a fleet of state-of-the-art cold recyclers equipped with foamed bitumen technology for in-situ or in-plant cold recycling applications.

1995





Foamed bitumen in use around the globe

26
27



AN INTERNATIONALLY ESTABLISHED PROCESS

The success and approval gained in over 90 countries across virtually all climate zones are convincing proof that foamed bitumen has been fully accepted as a binder in road construction. Foamed bitumen is the technology of choice wherever road pavements are exposed to high traffic volumes or an exceptionally cost-efficient and sustainable type of construction is called for.

The foamed bitumen technology offers truly forward-thinking solutions and is used in both structural rehabilitation and new construction projects.

Mixes produced with foamed bitumen are construction materials capable of meeting even the highest requirements. The innovative binder has stood the test in all climate conditions and in pavements subject to extremely high traffic loads: more than 2,500 machines from the comprehensive range of WIRTGEN recyclers are currently in operation around the globe.





**IN EXCESS OF 100 MILLION
SQUARE METRES ALTOGETHER
HAVE BEEN RECYCLED WITH
FOAMED BITUMEN IN
NUMEROUS COUNTRIES
AROUND THE WORLD.**



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