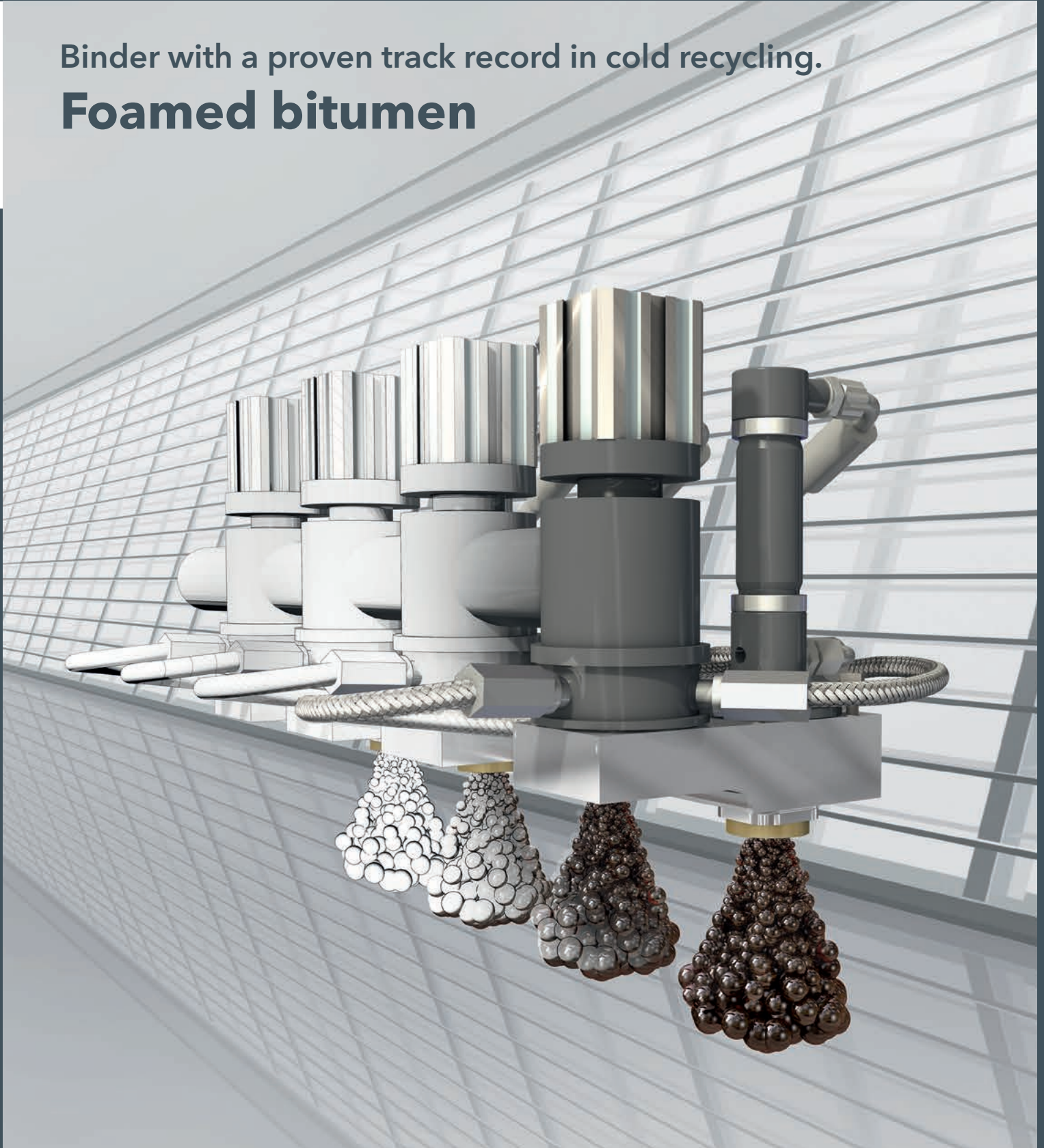


Binder with a proven track record in cold recycling.
Foamed bitumen





A large pile of grey material, likely foamed bitumen, dominates the background. In the middle ground, a yellow and white truck is parked, with a white van in the foreground. The scene is set against a backdrop of dense green trees. The text is overlaid on the image in white boxes.

Fit for the future

with foamed bitumen.

High-quality, cost-efficient, environmentally friendly. and future-proof: cold recycling with foamed bitumen, the innovative binding agent. 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. Always in line with customer requirements. Close to our customers. The tried-and-tested road construction material has scored top marks with countless users around the globe even today.

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Foamed bitumen - sustainability the effective way

06
07

1 |





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

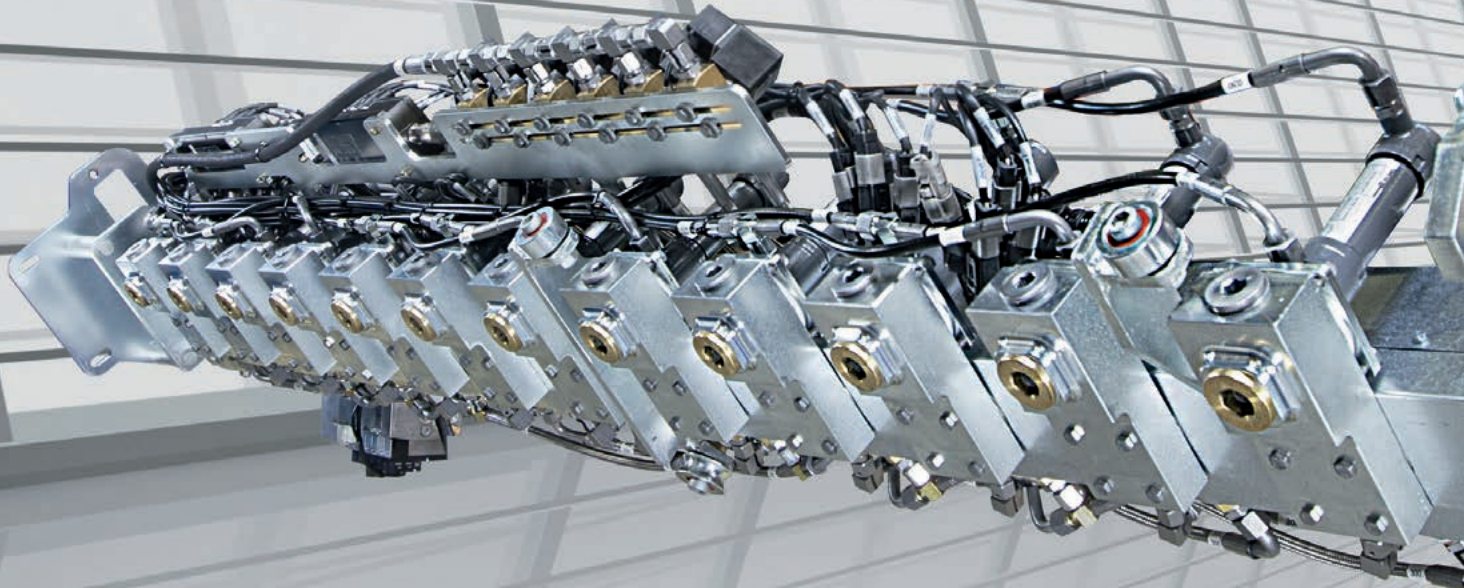
UP TO 50%

shorter construction period

UP TO 50%

reduction in overall costs

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



1 |

1 | *The foamed bitumen is injected into the mixing chamber in precisely metered quantities via special injection systems. Microprocessors ...*

Sophisticated process - perfect results

A BINDING AGENT OFFERING LOTS OF POTENTIAL

Cold recycling with foamed bitumen has become an established technology worldwide and is now increasingly moving into the focus of road authorities and construction companies for use in the rehabilitation and new construction of road pavements.

Cold recycling with foamed bitumen produces flexible and highly durable base layers. Being a part of the pavement structure, these are the perfect foundation for the final asphalt overlay to be built at reduced layer thickness. Foamed bitumen is produced from approx. 347 °F (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.

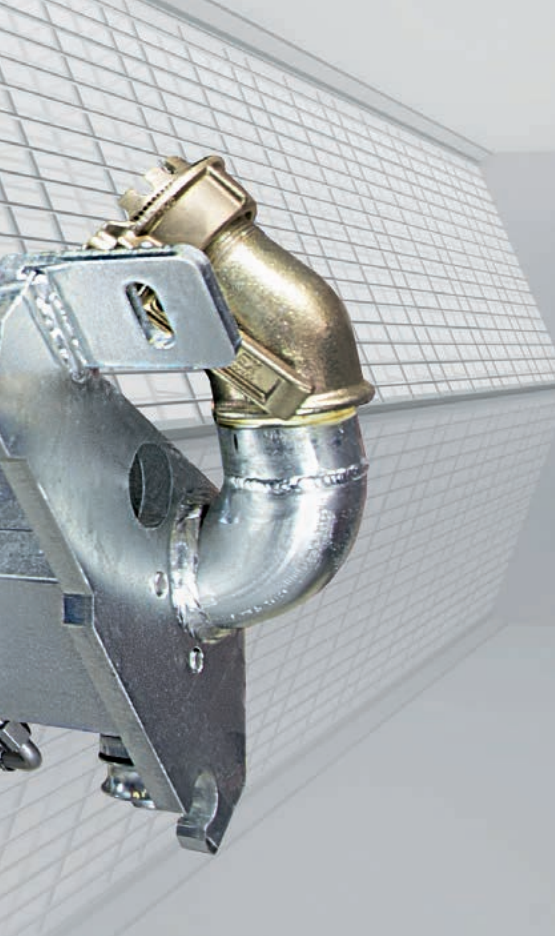


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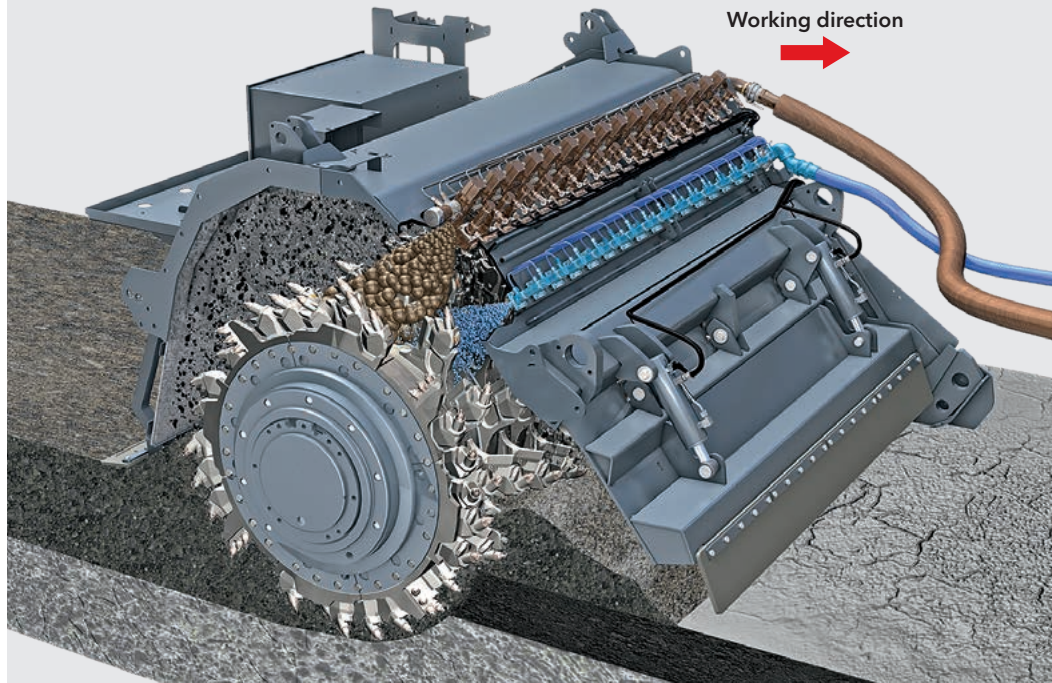
2 | *... govern the process across the full working width and in accordance with the recycler's advance speed and recycling depth.*

THE PERFECTLY ENGINEERED PROCESS IMPRESSES WITH:

- > exceptionally high durability of layers
- > economic viability
- > saving of natural resources
- > reduction of CO₂ emissions
- > reduction of construction times.



INJECTION OF FOAMED BITUMEN AND WATER INTO THE 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 results in the bitumen foaming and expanding to around 10 to 20 times its original volume. The bitumen foam is then injected into a mixer via injection nozzles. It is eminently suitable for mixing with cold and moist construction materials. The new material - frequently produced using reclaimed asphalt pavement (RAP) - is called BSM (bitumen-stabilized material).



1 |

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 foamed bitumen laboratory unit enables the foamed bitumen quality to be precisely determined in the laboratory even prior to the start of construction. Extremely simple handling enables parameters such as the water quantity, air pressure and temperature to be varied quickly and easily.

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.



THE MIX MAKES ALL THE DIFFERENCE

The WLB 10 S foamed bitumen laboratory unit is used for:

- > general testing of the types of bitumen used to determine their suitability for the foaming process.
- > optimizing the foaming process by adjusting the temperature and the quantity of water to be added.
- > mix production in the laboratory using different rates of bitumen application.

For mix production in the road laboratory, the WLB 10 S is connected directly to the WLM 30 twin-shaft pugmill mixer. The foamed bitumen produced by the WLB 10 S is then injected into the mixing process taking place in the WLM 30. The materials are mixed precisely and without any losses. Mixes for the manufacture of test specimens are thus produced in next to no time.



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

3 | The WLM 30 twin-shaft pugmill mixer is suitable for batches of approx. 55.1 lbs (25 kg) and is distinctive for its high mixing intensity.



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

Properties of BSM (bitumen-stabilized material)

USING BSMS IN THE FIELD

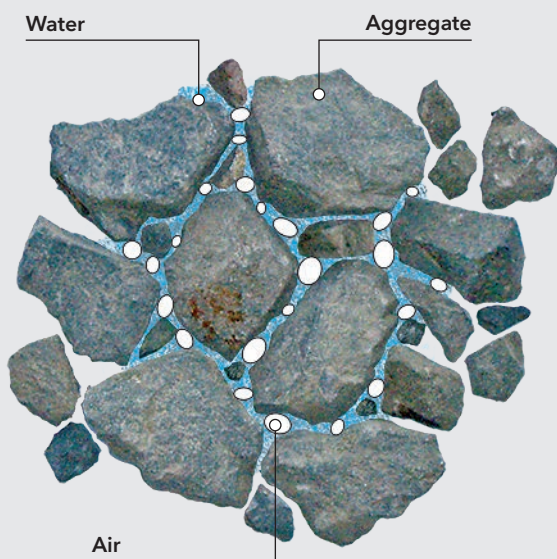
Easy workability is one of the distinctive features of BSM mixes. When sufficiently moist, there are no time limitations for the subsequent compaction process. Yet another very important hallmark of BSM layers is that they can be opened to traffic temporarily immediately after completion.

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

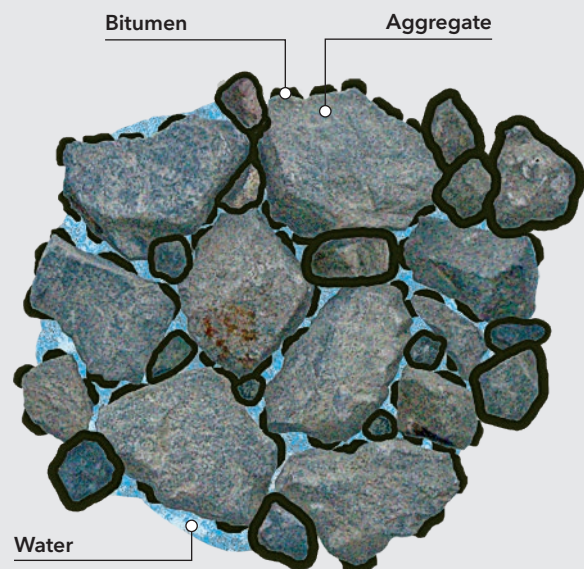
MATERIAL STRUCTURE

Cold mixes produced with foamed bitumen behave like a construction material with constant inter-particle friction but significantly increased 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 mixing of the bitumen binder and aggregate. Typical bitumen quantities range between 1.5 % by mass and 2.5 % by mass of the mixed material. After final compaction, the material is characterized by good flexible properties and high bearing capacity. It has a proven track record around the globe.

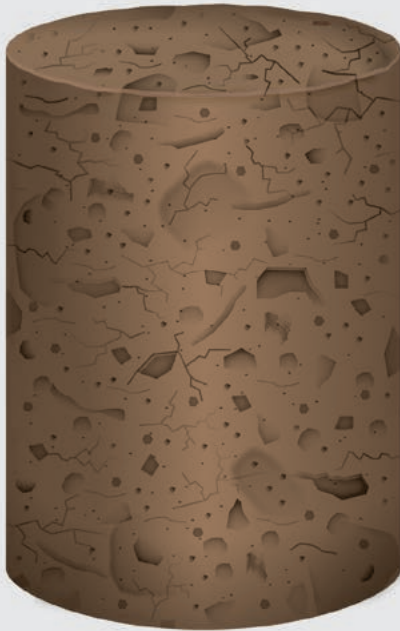


A Crushed-stone material, mixed with water for optimum compaction

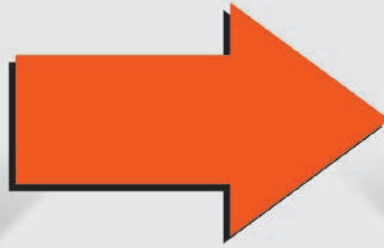


B Bitumen-stabilized material with foamed bitumen, mixed with water for optimum compaction

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:
4.4 to 8 psi (30 to 55 kPa)

Angle of friction:
43-51°

B Bitumen-stabilized material

Cohesion:
29 to 43.5 psi (200 to 300 kPa)

Angle of friction:
40-49°



1 | Material treated with foamed bitumen is distinctive for its optimal strength and bearing capacity.

Use on the construction site - in-situ or in-plant

14
15

COLD RECYCLING IN-SITU

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

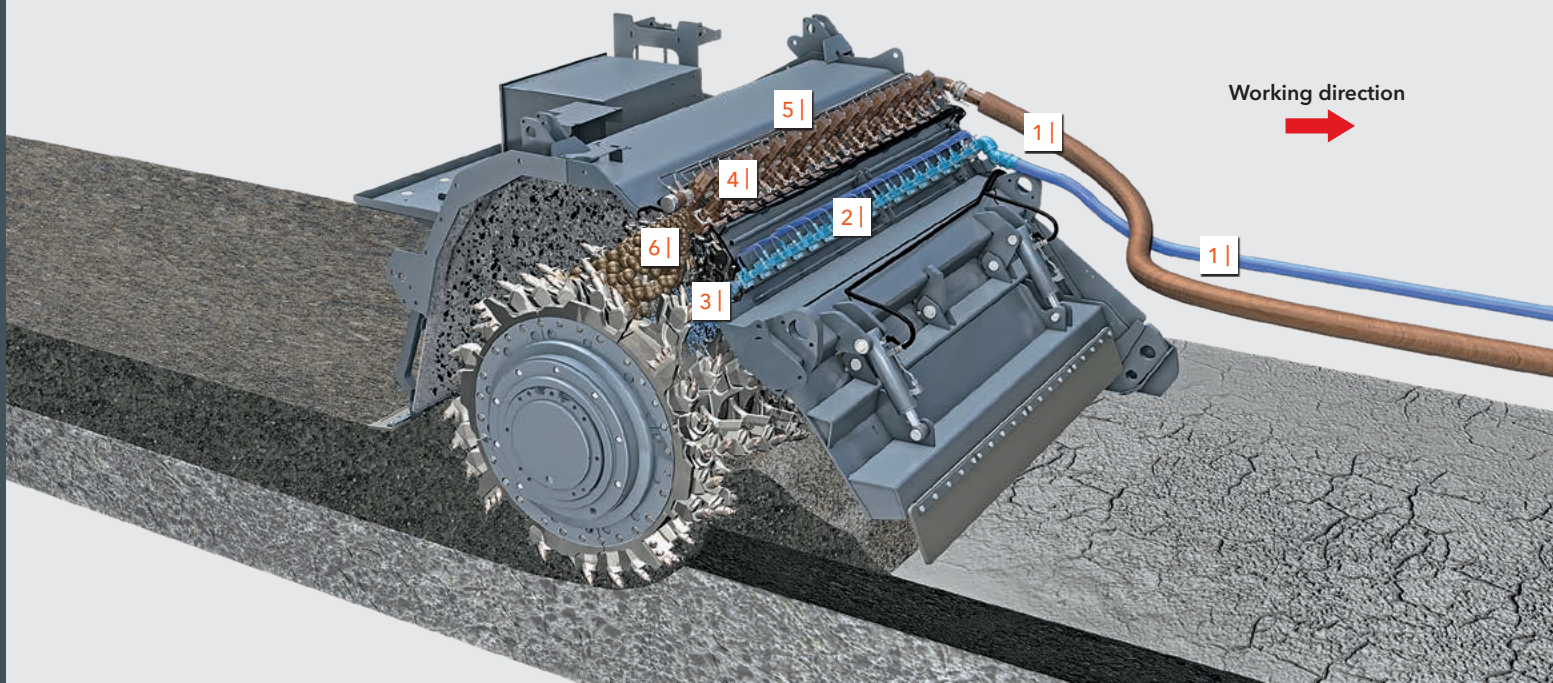
When cold recycling in-situ, a cold recycler granulates the damaged road pavement while at the same time mixing in foamed bitumen, water and cement in the required quantities. This method produces a new, homogeneous construction material (BSM) in a single operation. The in-situ cold recyclers are equipped 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 material mix.



- 1 | Hose connections
- 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 220i cold mixing plant upgrades the different materials to produce a high-quality cold mix (BSM).*

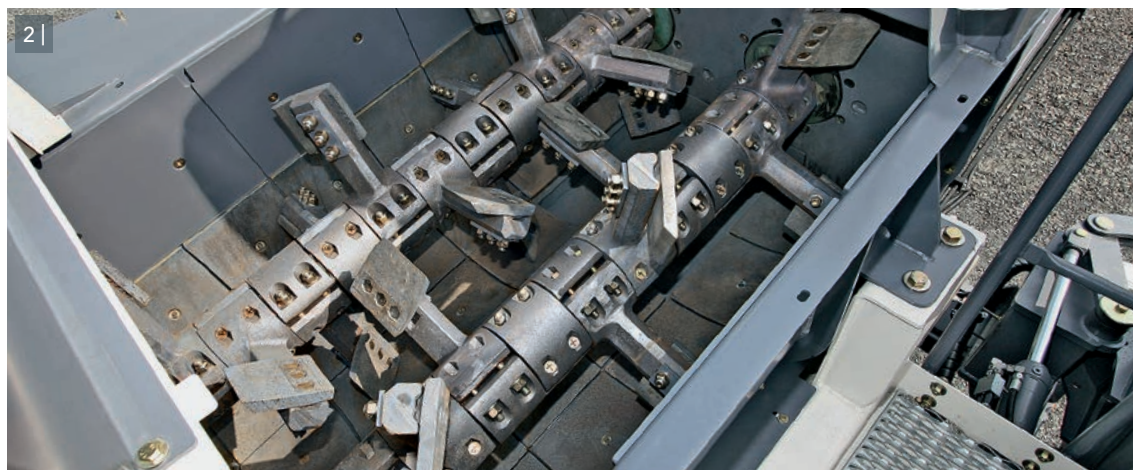
COLD RECYCLING IN-PLANT

When cold recycling in-plant, the pavement material is removed and transported to a mobile cold mixing plant located in the vicinity of the construction site. The milled material is then processed with foamed bitumen, water and cement in the required quantities to produce a new, homogeneous cold mix (BSM) which is suitable for immediate placing true to line and level or can be placed in stockpile for later use.

STATE-OF-THE-ART INJECTION SYSTEM

Highest quality guaranteed: a thermostatically 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.

The foaming process and application rates are governed by microprocessor control.



2 |

2 | *The powerful twinshaft continuous mixer installed in the KMA 220 / KMA 220i mixes the milled material and foamed bitumen injected into the process.*

Cold mixes containing foamed bitumen

16
17

CONSTRUCTION

MATERIALS IN-SITU

Generally, all granular construction materials - and RAP materials - 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 high-quality bituminous base layer has thus been produced that is capable of withstanding extremely high traffic loads.



RAP MATERIAL IN-PLANT

The RAP material recovered by a WIRTGEN cold milling machine can usually be processed right after milling or placed in stockpile for an extended period of time. The mobile 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.

RECOVERED AND NEW MATERIALS

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

All road construction materials with suitable grading characteristics are qualified for recycling with foamed bitumen.



LABORATORY TESTING

The WIRTGEN WLW 1 laboratory compactor provides an ideal solution for the manufacture of specimens from bitumen-stabilized material (BSM). The core element of the WLW 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 mold in multiple layers.

Once the final, predetermined mold height (density) has been reached, the specimen can be simply removed from the mold by means of a quick-release fastener and prepared for the testing method to be applied. Specimens of 6 in (152 mm) in diameter and 3.7 in (95 mm) in height can be manufactured for determining the indirect tensile strength (ITS). Large specimens of 6 in (152 mm) in diameter and 11.8 in (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



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

LOW OVERALL COST

The pavement structures depicted in the chart are examples of three different construction classes. These construction methods are especially economical in terms of construction costs due to low binder requirements, the use of RAP material and fast completion times.

Reducing the thickness of the asphalt overlay results in additional, significant cost reductions.

In addition, maintenance costs are extremely low. Unlike aging conventional asphalt layers, BSM layers are not prone to cracking, which requires only the upper, thin asphalt surfacing to be replaced at regular intervals. Cost-intensive replacement of the asphalt pavement at full depth is not required.

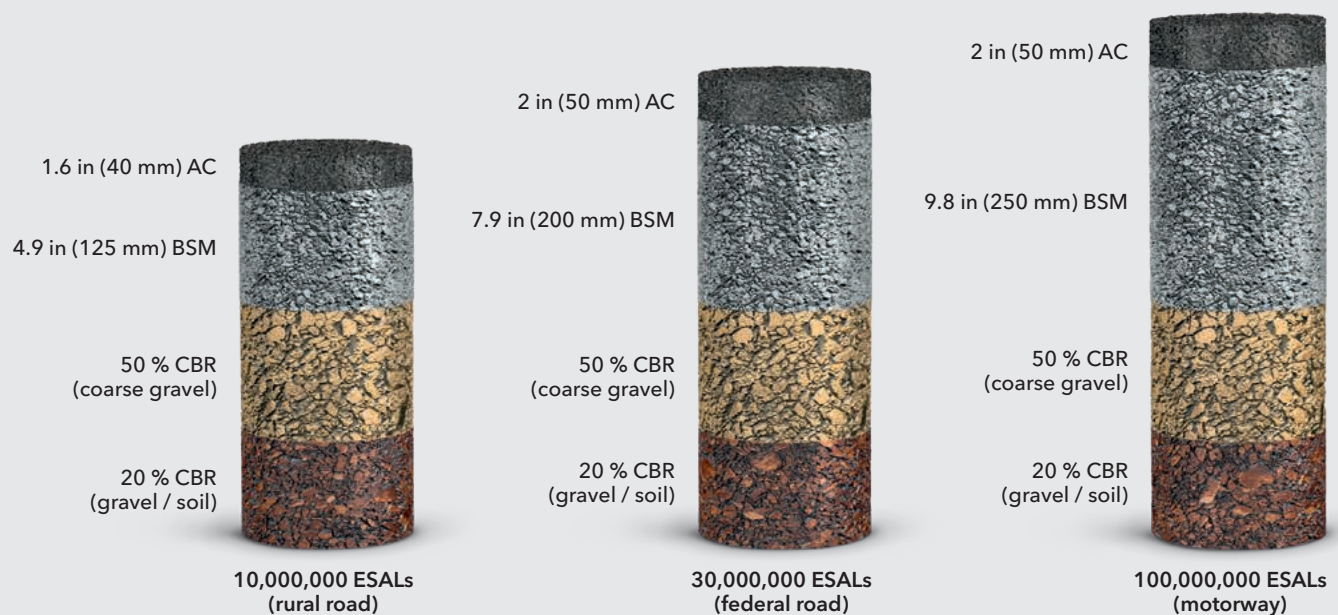
Owing to the advantages offered by the construction method and their exceptional material properties, bitumen-stabilized materials are increasingly used also in Public Private Partnership (PPP) projects.

11





2-3 | Homogeneous asphalt mix processed by the cold recycler.



AC = asphalt surface course
 BSM = bitumen-stabilized material
 CBR = California Bearing Ratio
 ESAL = equivalent standard axle load (= 9 t (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.

100 % REUSE

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

Processing without having to heat the source materials results in a huge reduction of CO₂ emissions.

Low application rates of only 1.5 % to 2.5 % of the total mass incur correspondingly low 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 | Cold recycling is an extremely fast-paced method: short construction times enable 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. 347 °F (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 AT THE CUTTING EDGE OF TECHNOLOGY

We see ourselves as an innovative specialist for the highly efficient cold recycling technology. In addition to the machinery required for the process, we offer customers a comprehensive range of services. In close cooperation with users in the field, we are driving the development of new products. We then share our experiences with industry peers to enable our 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.

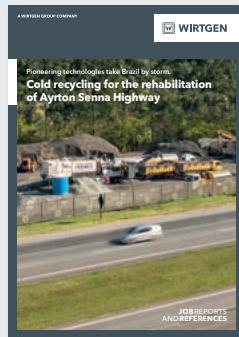
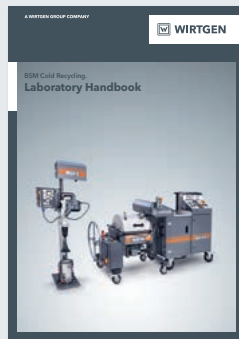
The global WIRTGEN service network with its sales and service companies offers professional customer support. Our employees keep up to date on foamed bitumen by attending regular trainings providing theoretical and practical knowledge.



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

6 | WIRTGEN experts provide customized and application-based support right on the job site.

4 |



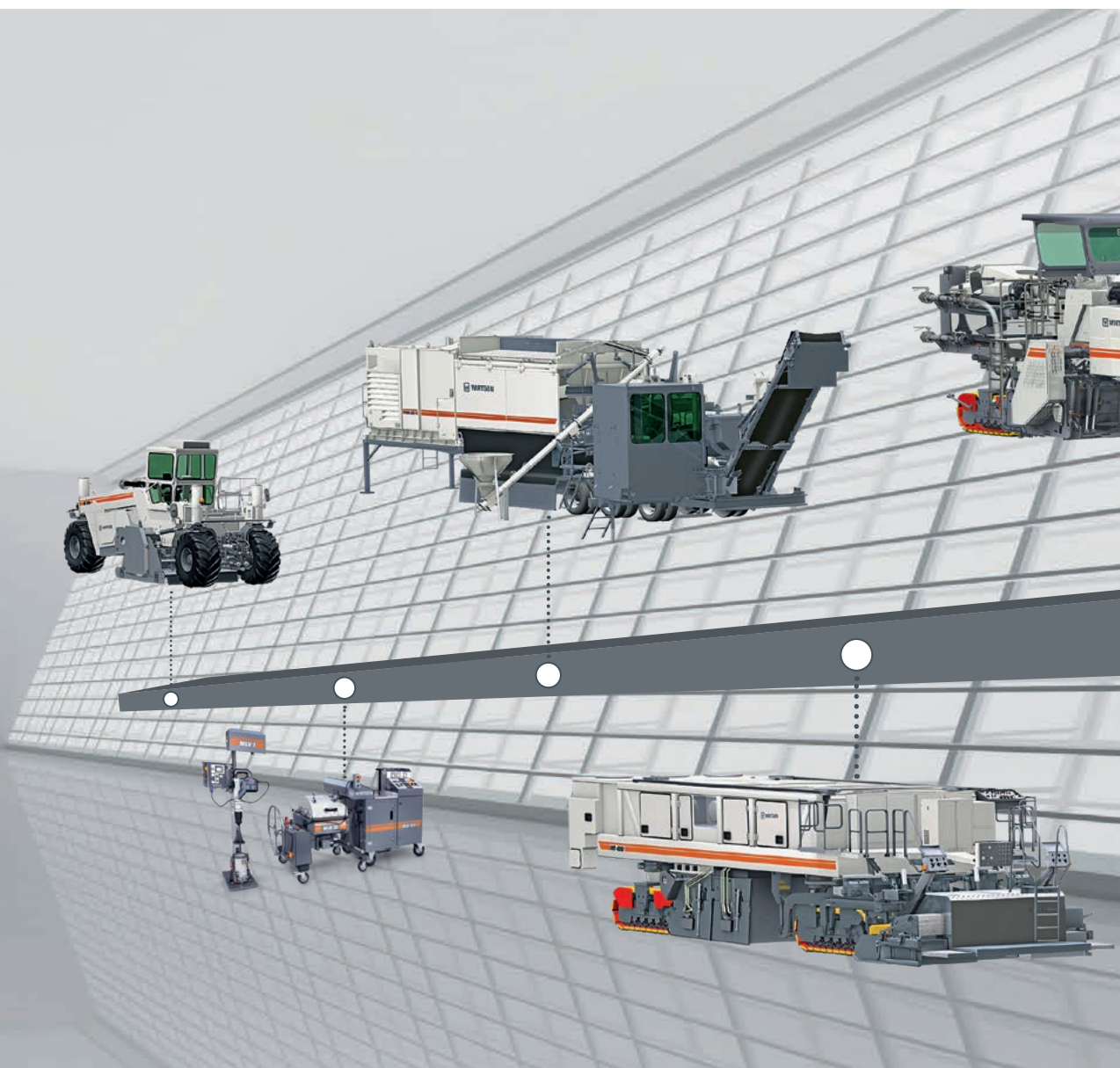
The history of foamed bitumen

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 binding agent. 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 binding agent. Integrating the system into the WIRTGEN recyclers in 1995 finally sparked 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 foamed bitumen laboratory unit to enable 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 its customers 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 TECHNOLOGY

The success and approval gained in over 90 countries and across almost all climates reflect the high level of acceptance for the use of foamed bitumen as a binding agent. The technology is preferably used wherever road pavements are exposed to high traffic volumes or particularly economical and sustainable construction is required.

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

Mixes containing foamed bitumen are construction materials capable of meeting the highest requirements. Using the innovative binding agent in all climatic conditions and in pavements subject to the highest traffic volumes has stood the test: in excess of 2,500 machines from the broad range of WIRTGEN recyclers are currently in operation around the globe.





**IN EXCESS
OF 120 MILLION SQUARE
YARDS (100 MILLION SQUARE
METERS) ALTOGETHER HAVE BEEN
RECYCLED WITH FOAMED
BITUMEN IN NUMEROUS
COUNTRIES AROUND
THE WORLD.**



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