ECO-Foamed

Warm-Mix Asphalt (WMA) with Foamed Asphalt

ECO-Foamed

Enrobé tiède (WMA) à asphalte expansé

What is foamed asphalt?

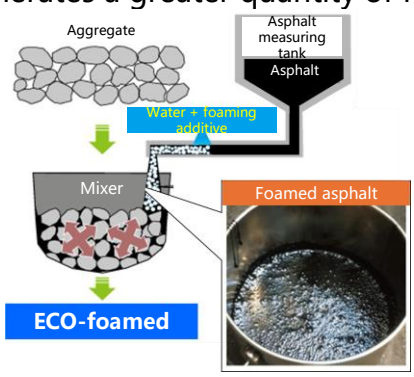
- A technology that foams asphalt by generating fine foam through the injection of a small amount of water into the asphalt.
- The bearing effect of fine foam reduces the viscosity of asphalt, enabling the production temperature to be lowered.
- Lower production temperatures reduce fossil fuel consumption, thereby reducing CO_2 emissions.

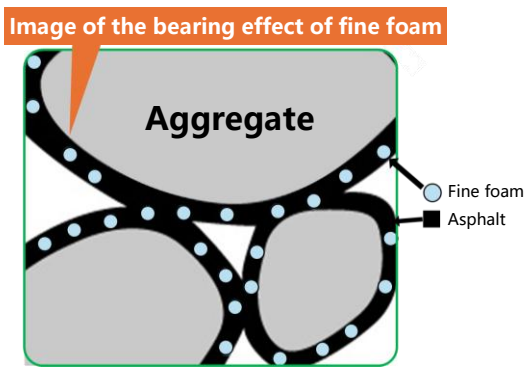
Asphalt (before foaming)

Foamed asphalt (after foaming)

Features of ECO-Foamed

- An asphalt mixture produced by combining foamed asphalt with a foaming additive.
- Generates a greater quantity of finer foam than conventional foamed asphalt.





Effects

- Lowers the asphalt mixture production temperature by approximately 20-30℃, reducing fossil fuel consumption and thereby decreasing CO_2 emissions.
- Ensures the required quality of both new and recycled asphalt mixtures, even when the production and paving temperatures are reduced.
- Reduces radiant heat from asphalt mixtures and the generation of asphalt fumes during paving work, thereby improving workers' safety, health, and working conditions.
- Shortens traffic control time, thereby reducing traffic congestion.

Demonstration test example

Location	Private factory premises in Kanagawa Prefecture, Japan
Construction period	July 2022
Mixture type	Recycled dense grain asphalt mixture (13) R60%
Temperature reduction during production	Approximately 25℃
Marshall density	2.412 g/cm^3
Density of cored specimens	2.374 g/cm^3 (98.4%)

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High-Rigidity Base

High Modulus Asphalt Optimized for Japanese Conditions

Base à haute rigidité

Asphalte à haut module optimisé pour les conditions japonaises

Resilience

What is High-Rigidity Base?

- An upper base course method that uses a high-stiffness asphalt mixture optimized for the Japanese environment through mix design and a dedicated binder, based on High Modulus Asphalt (HiMA), which has been adopted worldwide since its development in France in the 1990s.

*This pavement technology was developed through joint research with Nippon Expressway Research Institute Co., Ltd.

Features

- High stiffness reduces tensile strain at the bottom of the asphalt mixture layer, thereby suppressing the occurrence of fatigue cracking.
- A higher asphalt content improves resistance to fatigue cracking.
- Low air voids improve watertightness, and high stiffness enhances resistance to stripping (by reducing inter-aggregate abrasion), ensuring excellent water resistance.

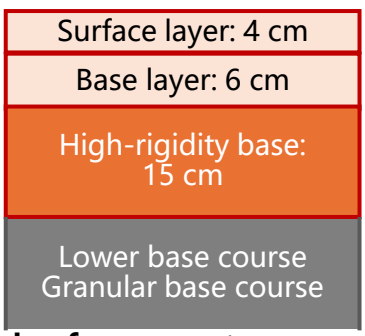
Quality standard of the dedicated binder

Test item		Reference value
Penetration (at 25℃)	1/10 mm	20 to 40
Softening temperature	℃	44.0 to 65.0
Elongation (at 25℃)	cm	50 or greater
Mass change ratio in thin film oven test	%	0.6 or less
Residual penetration ratio in thin film oven test	%	58 or greater
Penetration ratio after evaporation	%	110 or less
| G* | (20℃)	MPa	9 to 17

Quality standard of mixture

Item	Target value
Marshall stability (kN)	6.0 or greater
Air voids ratio (%)	2.0 to 3.0
Stiffness (MPa)	9,000 ±2,500
Number of cycles to failure (passes)	10,000 or greater
Dynamic stability (passes/mm)	1,000 or greater

Finished Surface



Example of pavement cross section

Effects

- High stiffness significantly improves resistance to fatigue cracking, thereby extending pavement service life.
- Low air voids increase watertightness and enhance resistance to stripping.
- Dynamic stability (rutting resistance) is equal to or greater than that of conventional base-course mixtures, making it suitable for heavy-traffic roads.

Demonstration test example

Location	Prefectural road, Aomori Prefecture, Japan
Construction period	December 2022
Traffic volume classification (Pavement design traffic volume)	N6 (1,000 to 2,999 vehicles/day/direction)
Stiffness	10,363 MPa
Number of cycles to failure	67,733 passes
Dynamic stability	6,300 passes/mm

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Under R&D

Icetool Pavement

Elastic Resin-Bonded Anti-Icing Pavement

Revêtement Icetool

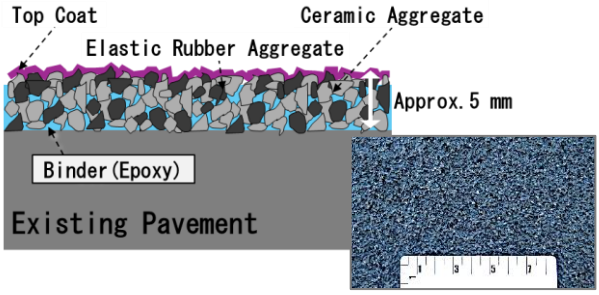
Revêtement antigel élastique à liant résine

What is Icetool?

- A type of pavement in which elastic aggregate and hard aggregate are bonded to the pavement surface with resin. Snow and ice that form on the road surface in winter are stripped and crushed by the elasticity of the elastic aggregate, while the hard aggregate suppresses tire slippage, thereby ensuring vehicle safety during winter conditions.

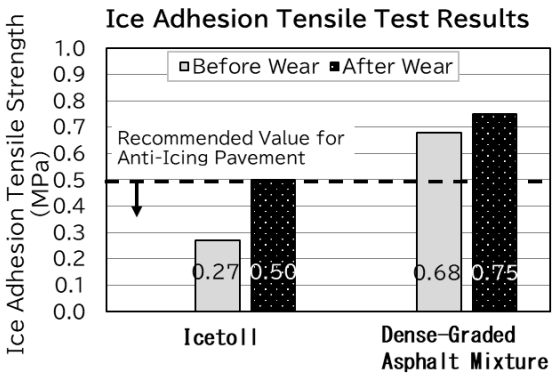
Features

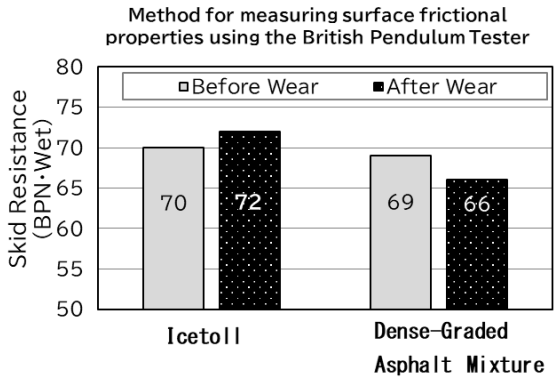
- Anti-icing pavement in which a mixture of rubber elastic aggregates and hard aggregates is bonded to the pavement surface with a resin binder.
- The elastic force of the elastic aggregate strips and crushes snow and ice that form on the road surface under vehicle traffic in winter.
- The hard aggregate improves skid resistance, thereby suppressing tire slippage.



Effects

- Strips and crushes snow and ice on the road surface under vehicle traffic in winter.
- The hard aggregate improves skid resistance, thereby suppressing tire slippage.





Ice Adhesion Tensile Test

- A test to evaluate the ease of ice plate detachment from an anti-icing pavement: After water is absorbed, a jig with nonwoven fabric attached is frozen onto the specimen surface for a specified time at a controlled subzero temperature (−5 ± 1℃), and a tensile test is then performed.
- After abrasion: The test results are obtained after abrading the specimen surface using a raveling test to simulate road surface wear caused by winter tires and chains.

Demonstration test example

Location	City road, Nagano Prefecture, Japan
Construction area	75 m^2
Construction period	November 2020
Traffic volume classification (Pavement design traffic volume)	N4 (100 to 249 vehicles/day/direction)
Ice adhesion tensile test	0.20 MPa
Skid resistance BPN	66

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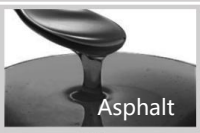
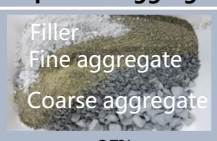
Under R&D

Recycled Plastic Asphalt Pavement

Revêtement en asphalte à granulats de plastique recyclé

What is recycled plastic asphalt pavement?

- It is asphalt pavement in which all aggregate is made from waste plastic.
- Binder technology which enables even waste plastic aggregate having low interlocking to develop strength.

	Purpose of binder	Purpose of aggregate
Ordinary asphalt pavement	 Asphalt 5%	 Filler, Fine aggregate, Coarse aggregate 95%
Developed recycled plastic pavement	Asphalt  Recycled plastic Type A 	Recycled plastic Type B 

Percentage is based on weight

Challenges in using waste plastic as the entire aggregate

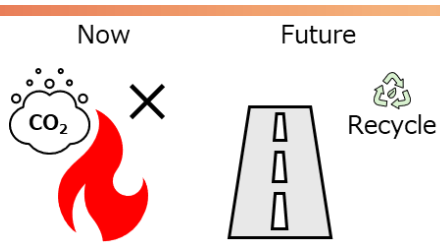

Improved Type II binder


Developed binder

Wheel tracking test result

Features

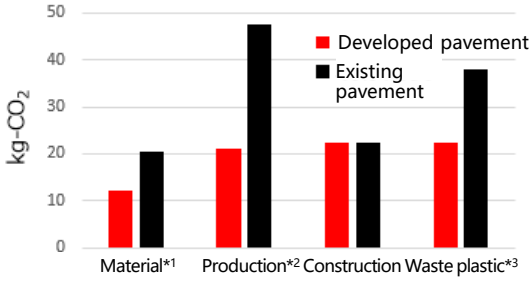
- Waste plastic that is normally incinerated is used as aggregate
- Lightweight (low density)
- All constituent materials are hydrophobic
- Low heat capacity
- Binder that functions as the structural skeleton



Effects

- Reduces CO_2 emissions (approximately 40% less than conventional asphalt pavement)
- Requires less energy for transportation
- High water resistance
- Low energy consumption for mixture production
- High durability (high dynamic stability)

CO_2 emissions per m² of pavement (kg-CO_2)



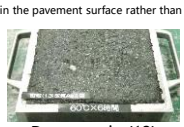
*1 The figure for material includes material extraction, material production, and material transportation.
*2 The figure for production includes mixture production and mixture transportation.
*3 The figure for waste plastic includes intermediate treatment, incineration, and landfilling.

Performance evaluation result

Test item	Test condition	Unit	Recycled plastic mixture	Dense grain (13) StAs60/80	Dense grain (13) Improved AsII type
Binder amount	—	wt%-in	**30.0**	5.2	5.4
Marshall density	20°C	g/cm³	**0.962**	2.394	2.394
Marshall stability	Submersion at 60°C for 30 minutes	kN	**13.4**	8.9	13.4
Dynamic stability	60°C	Passes/mm	**63,000**	1,430	9,000
Raveling loss	-10°C	cm²	**0.09**	0.50	0.28
Cantabro loss	-10°C	%	**0.09**	20.3	12.2
Bending fracture strain	20°C	—	**77.0×10^{-3}**	20.7×10^{-3}	18.3×10^{-3}
	-10°C	—	**21.6×10^{-3}**	1.7×10^{-3}	2.6×10^{-3}
Bending fatigue strain	0°C/900 × 10^{-6}	Passes	**Over 8 million**	—	—
Submerged WT test*	60°C/6Hr	—	**No deformation**	Granulates in 3.5 hours	Stripping on entire surface
	60°C/12Hr	—	**No deformation**	—	—
Repeated surface stripping depth	60°C/1,000 passes	mm	**0.5**	Over 25	9.3

*With reference to the "Flooded wheel tracking test" in the Pavement Design and Construction Guidelines (June 2019) issued by Metropolitan Expressway Co., Ltd.
An evaluation was performed based on changes in the pavement surface rather than the ratio of stripped area on the specimen cross-section.


Dense grain (13) StAs 60/80 6 Hr, 60°C


Dense grain (13) Improved type II 60/80 6 Hr, 60°C


Recycled plastic asphalt 12 Hr, 60°C

Flooded wheel tracking test result

Demonstration test example

Test item		Test condition
Construction site		ENEOS Platform Hitachino-Ushiku SS (Ushiku City, Ibaraki Prefecture)
Construction area		Total: 25 m²
Traffic volume classification		Parking lot for EVs and walkway
Construction period		March 2024
Recycled plastic aggregate	Type	Cross-linked polyethylene (waste wire coating material)
	Usage	Total: 1 ton
	Usage per unit area	40 kg/cm²
CO_2 emission reduction effect	Reduction amount	Total: 1.2 tons
	Reduction amount per unit area	48 kg/cm²

Demonstration at the ENEOS Platform Hitachino-Ushiku SS

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