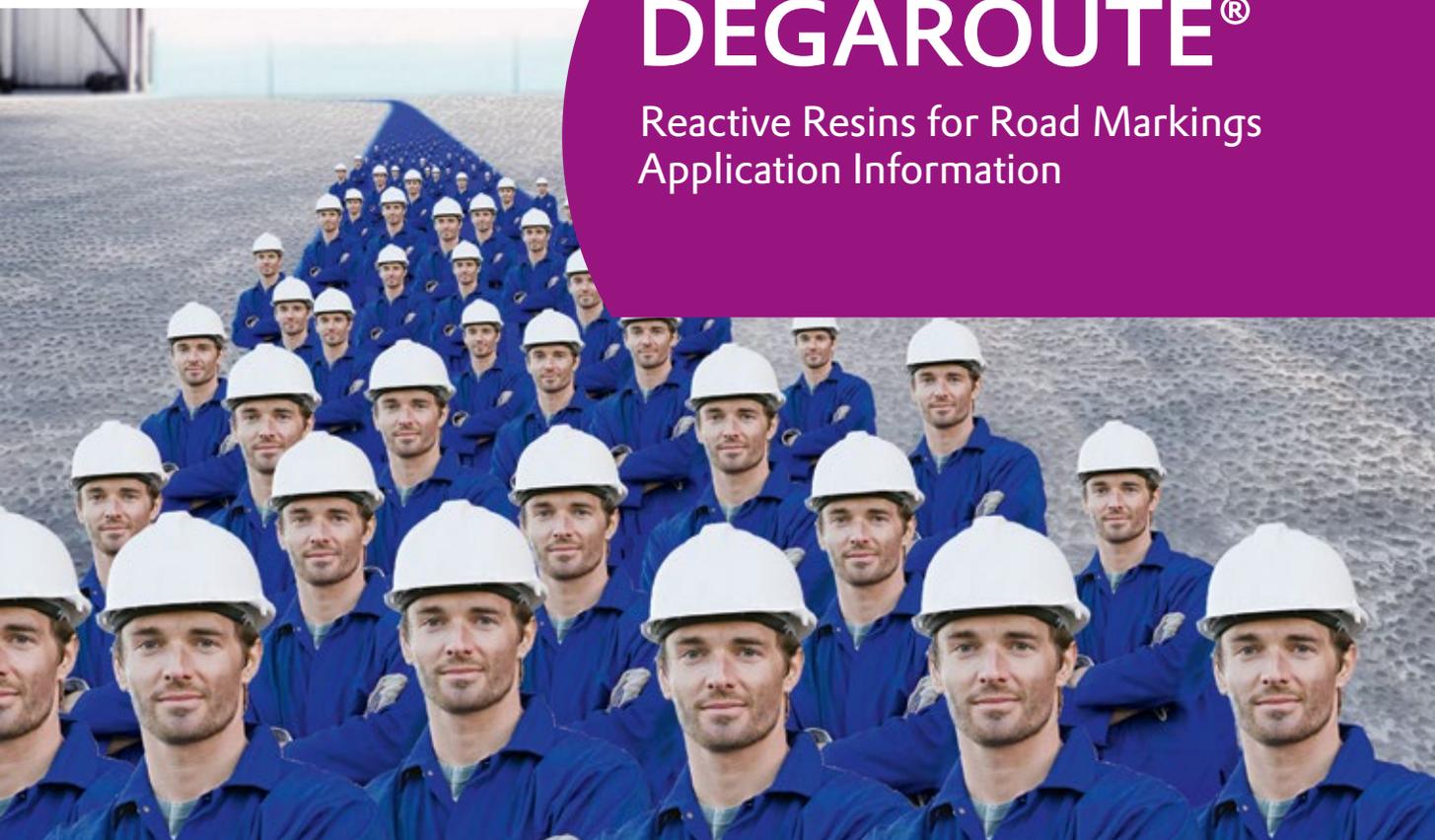


# DEGAROUTE®

Reactive Resins for Road Markings  
Application Information



**DEGAROUTE®**

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# DEGAROUTE®

## Cold Plastic Road Marking

**For decades, DEGAROUTE® reactive resins have been used to manufacture high performance road marking materials, so called cold plastics.** Cold plastics based on DEGAROUTE® binders provide long lasting functionality, a variety of colors and shapes to road markings and make our daily way a safer one and more colorful one too. Thanks to this high durability DEGAROUTE® cold plastics provide most resource efficient and environmentally friendly road marking solutions.

Road markings serve as guides for drivers, showing the way at day and night even in misty or wet conditions. They separate the different direction of traffic, different traffic speeds, for instance, bicycle from automotive traffic and alert about particular zones and hazards, such as pedestrian crossings, school zones, bus stops, traffic roundabouts etc.

Apart from their obvious visual information, depending on their shape and structure road markings may additionally provide an audible signal. Profiled road markings, for instance, produce a loud tone when driven over by a tire and can effectively alert an unobserving driver who is about to deviate from the road. In addition to their signal functionality road markings provide other in-built safety features to the road, such as a well adjusted level of skid resistance.

Irrespective of prefabricated tape systems, road marking systems are typically composed of a pigmented marking material sprayed or casted onto the pavement and a glass bead – aggregate mixture broadcasted on the material prior to its solidification. Important safety features of a modern road marking system such as night time visibility, for instance, are obtained by this combination of the marking material serving as an anchor for the pigment and the glass beads that reflect the cars head light back to the driver's eyes to guide him safely at night.

Road marking materials are in general formulations consisting of binders, fillers, pigments (e. g. white titanium dioxide) and additives. The choice of the actual binder is important for the application characteristics of the road marking material and the durability of the final road marking system under traffic wear.

**The main binder-based road marking systems in use today are:**

- **solvent-based paints of high solids content** that are sprayed on and dry physically by evaporation of the solvent (emission of VOC); only thin layers (< 1 mm) feasible.
- **water-based paints** that are sprayed on and dry physically by evaporation of the water and a small solvent component (almost no VOC emission); only thin layers (< 1 mm) feasible.
- **thermoplastics**, that after being heated to 200 to 220 °C (390 to 430 F) are sprayed on or extruded as a melt, and cure by solidification (VOC free); thin and thick layers feasible.
- **cold plastics** that, mixed with a curing component the so-called hardener (hence the name "2-component cold plastic"), are sprayed on or extruded at ambient temperatures and cure chemically by polymerization (almost no VOC emission); thin and thick layers feasible.

# DEGAROUTE® cold plastics



Cold plastics are reactive two- or multi-component systems formulated with DEGAROUTE® binders based on methyl methacrylate (MMA) and brought to polymerization by the addition of the curing component (hardener) immediately before application. The system cures chemically after a certain lapse of time (pot life), when the volatile resin components are chemically bound in the resulting inert duroplastic polymer. Thus application can be considered to be almost **free from VOC emission**.

The chemical reaction can further be boosted in cold condition by the addition of an accelerator to facilitate proper **curing even at subzero temperatures**.

Cold plastic is applied as a **thick layer** (typically >1.0 mm) by extrusion or screed-box methods in flat or profiled shape depending on the actual formulation of the material. With appropriate equipment, cold plastic can also be used to produce a structured marking in form of stochastic agglomerates or regular agglomerates (spot flex).

Thanks to the duroplastic character and the **extremely high wear resistance** of the cold plastic material such structure remains in place for very long period of time even under high traffic and at high temperature. **Multiple renewals** of the retro reflection properties of such cold plastic structure is feasible by refreshment with a thin layer of cold spray plastic and subsequent glass bead broadcasting thanks to **good adhesion to old cold plastic** road markings.

Cold spray plastic is sprayed on as a thin layer (typically 0.3 to 1.2 mm) in an airless or a pneumatic process. This requires **low viscosity** of the sprayed material, respectively well adjusted formulations with fine-grain fillers only and specific DEGAROUTE® spray grade binders.

Thanks to high durability DEGAROUTE® cold plastics/cold spray plastics are **resource efficient and environmentally friendly** road marking solutions.

## Hardener dosage and application concepts

**BPO hardener** (Dibenzoyl peroxide) – mostly as powder with 50 wt % BPO (Hardener powder) or in liquid form containing typically 40–50 wt % BPO (liquid hardener or liquid BPO) – serves as hardening agent for cold plastics or cold spray plastics. Typically about 1–2 wt % hardener is used for application in a wide range of temperatures. For application at extreme temperatures adjustment of the mixing ratio may be done to control pot life and curing speed. Guidelines for adjustment of hardener dosage are given in technical data sheets of the respective DEGAROUTE® resin.

**Manual or semi-automatic application:** Hardener powder is most suitable, whereby the powder is manually fed and mixed with a stirrer to the cold plastic before charging it to a screed box, for instance.

**Machine application with fully-automatic dosage and mixing:** Liquid BPO is used for fully automatic machines operating with a fixed mixing ratio, whereby two major machine concepts (mixing ratios) are used:

**98:2 systems:** 98 wt % reactive cold plastic to 2 wt % liquid hardener with direct liquid BPO metering.

**1:1 systems:** 50 wt % reactive cold plastic to 50 wt % premix of inactive (accelerator-free) cold plastic and hardener. This requires an accelerator-free DEGAROUTE® grade providing enough stability to the premix batch, which is prepared off-line on site.

# DEGAROUTE® types and performance features

## DEGAROUTE® resins for cold plastics

The program of DEGAROUTE® resins is designated by three-digit numbers. The numbers 401–499 stand for resins with higher viscosity, which are used for extruded or manually applied thick-layer cold plastics. Materials that are made with these resins can be applied manually or by means of push-cart road marking units or by automatic extrusion machines. State-off the-art reactive resins like DEGAROUTE® 465 provide a **high in-build flexibility** to formulate cold plastics for almost all tasks **without** using external **plasticizers**. Structured road markings made of DEGAROUTE® 465 have proofed their durability in very cold climate of Alaska as well as in the Brazilian heat. DEGAROUTE® 465 is suitable to formulate materials for area markings that provide enough flexibility to cover larger surface areas such as bicycle lanes or zebra crossings as well.

DEGAROUTE® 465 is a resin with **good wetting properties** for fillers and thus for marking materials with a good flow capacity which can be **processed easily**. They can be applied in a wide range of temperatures from **+60°C** (140 F) down to **-10°C** (14 F), whereby addition of an accelerator is required at **subzero temperature application** on dry substrate.

## DEGAROUTE® resins for cold spray plastics

The numbers between 601 and 699 have been reserved for resins with low viscosity which can be sprayed. Resins such as DEGAROUTE® 660 or DEGAROUTE® 661 provide **low viscosity, fast curing** even at **thin layers**.

DEGAROUTE® 660 is particularly suitable for application at elevated temperatures. These grades are suitable for 98:2 – machines and in combination with their accelerator-free resin-version (for example DEGAROUTE® 660 with DEGAROUTE® 659) for 1:1-machines as well.



Reflective glass beads on top of a DEGAROUTE® based road marking

## Main DEGAROUTE® grades, properties and applications

DEGAROUTE® grade	Application	accelerator-free version	Surface Temperature range (° C)	Typical application
465	Thick-layer 98:2; 1:1	469	+5°C/41 F* to +60°C/140 F	Flat, structured or profiled lines
	Area marking 98:2		+5°C/41 F* to +45°C/113 F	Area (bicycle lanes, zebra crossings etc.)
660	Thin-layer spray 98:2		+0°C/32 F to +60°C/140 F	Flat lines
	Thin-layer spray 1:1	659	+5°C/41 F to +50°C/122 F	Flat lines
661	Thin-layer spray 98:2		+5°C /41 F to +40°C/104 F	Flat lines
	Thin-layer spray 1:1	663	+5°C/41 F to +40°C/104 F	Flat lines

\* With addition of accelerator down to -10° C/14 F on dry and clean substrate

# Manufacture of DEGAROUTE® ready-to-use

## General information

Cold plastic road marking materials based on DEGAROUTE® binders are formulated by the respective binder type, additives, pigments, fillers and glass beads. A formulation for cold spray plastics consists of additives, pigments and fine fillers. For cold plastics, coarse fillers and intermix beads are also added. The formulation is processed in explosion-proof mixers with dissolver disc. The stirring speed should be adjustable within a range of 300 to 1000 rpm. The mixing container must be closed or at least covered and the bottom outlet must have a diameter of at least 5 cm (2 inch). The respective DEGAROUTE® binder is poured into the container for mixing. Subsequently additives, pigment and fine filler are added while stirring, whereby they are individually dispersed for approx. 5–10 minutes. During production of cold plastic ready-to-use, pigment, fine filler and some of the additives are dispersed in the resin. Before coarse fillers and intermix beads are finally mixed in for a short period.

During the processing of DEGAROUTE® cold plastic ready-to-use, the following basic precautions must be observed:

- **Equipment in workrooms must be explosion-proof.**
- Barrels or containers must only be opened with non-sparking tools. Methylmethacrylate (MMA) evaporates when the resin is stirred or filled into other containers. The evaporation loss should be kept as low as possible so that the properties of the marking material will not be changed. Long stirring times and heating of the material over 40°C/104 F must be avoided.
- Adjustment of viscosity is depending on wetting properties of fillers, pigments and used additives. This must be considered with regard to the sedimentation and flow behavior as well as for the application of broadcast material (reflective beads).

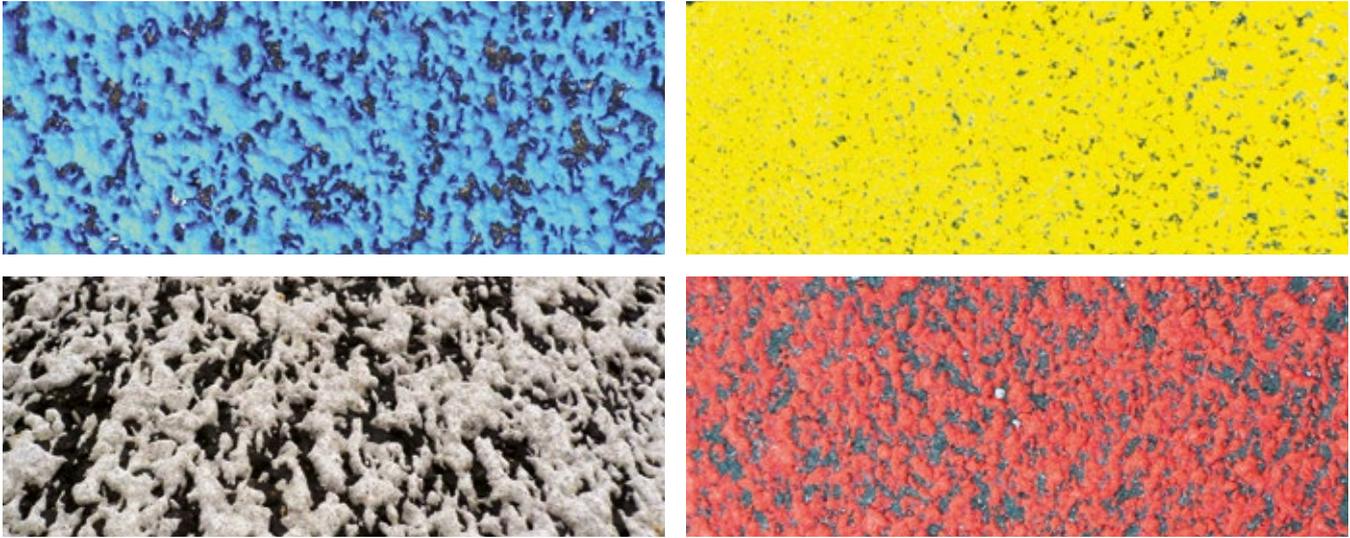
## Special information

DEGAROUTE® binders contain paraffin which is necessary for tack-free hardening. After long storage periods at lower temperature, paraffin can migrate to the surface. In this case the paraffin has to be homogenized with an explosion-proof (e. g. air-driven) barrel mixer in order to guarantee equal distribution in the individual batches.

Even slight contamination of the batches with BPO hardening agent must be avoided. The non-accelerated component should be processed in a separate mixing container to avoid contamination with accelerator.

**In general, the storage stability of DEGAROUTE® ready-to-use material is very good especially if the material contains titanium dioxide.** Ready-to-use materials prepared without titanium dioxide, an early gelling may occur under unfavorable conditions (e. g. high storage temperature). Therefore we recommend adding a small quantity of titanium dioxide (approx. 1 wt %) to yellow marking materials. Besides, heavy spar should not be used as filler in these cases.

Material should be stored at maximum 30°C/86F without direct exposure to sun light.



DEGAROUTE® cold plastic can be used for many different color markings

## Additives

**For ready-to-use materials based on DEGAROUTE® binders only recommended and approved additives should be used (for detailed information, please contact our technical service managers).**

### Pigments

Mostly titanium dioxide (rutile) is used. Please be aware of moisture (causing thickening) and organic post treatment agents (potentially causing yellowing, tackiness) of the pigments. Suitable and tested pigments with good UV stability can be used for pigmentation (for detailed information, please contact our technical service managers).

### Fillers

Many commercially available, fire-dried fillers in various sizes can be used as fine fillers. The fillers should be kept in a dry place in order to avoid the absorption of moisture. Fine fillers with large surface or high oil absorption and hydrophobic qualities are not suitable.

The following may be used: quartz powder, dolomite, feldspar, calcined flint or quartz (cristobalite), calcite and heavy spar. The above order roughly indicates the in-

creasing degree of filling; however, attention should be paid to the moisture content (thickening). As already stated the storage stability of formulations may be affected if they do not contain titanium dioxide. Heavy spar should not be used with highly reactive resins (e. g. DEGAROUTE® 660).

Different qualities of quartz sand, dolomite, calcite, calcined flint or cristobalite may be used as coarse fillers. Round shapes improve the degree of filling and the flow behavior of the ready-to-use material.

Depending on the formulation, we recommend the use of intermix beads with a size of 0.05 to 0.8 mm. Reflective beads have to be broadcast to the applied road marking, to achieve the required day and night visibility.

As reflective beads for flat line markings, we recommend to use a mixture of glass beads with anti skid aggregate (e. g. Cristobalite M 72). These mixtures are available on the market in ratio 3:1 or 4:1.

Cold plastic application will be broadcast with approx. 150 to 400 g/m<sup>2</sup> and cold spray plastic markings with 400 to 600 g/m<sup>2</sup> reflective beads. If too much or to

fine glass beads and anti-skid aggregates will be applied on a road marking, an excessive soiling of the surface could happen.

Much larger reflective beads (up to 2.5 mm) are also used for improved wet-night visibility.

Intermix and reflective glass beads with silane treatment show improved adhesion in DEGAROUTE® based ready-to-use material. Glass beads with silicon treatment, however, should not be used since they show poor adhesion in DEGAROUTE® ready-to-use material.

### Paint additives

For formulation use suitable thixotropic agents (e. g. Byk® 410) and suitable wetting agents (e. g. Disperbyk® 163) to adjust viscosity. Solvents and air release agents (e. g. silicone oil) almost always have a negative influence on the paraffin film and prevent a tack-free hardening. For all other additives detailed tests are required.

Our technical service department will be glad to help you with these tests.

# Application of DEGAROUTE® road markings

Bonding performance of any road marking material depends on substrate quality in general. DEGAROUTE® based cold plastics require appropriate conditioning of the pavement and suitable ambient conditions to achieve full performance. Both the pavement surface and ambient air temperature must be in accordance with the temperature limits as specified in the technical data sheets of DEGAROUTE® resins in use. Surface and ambient temperatures should be checked hourly at a minimum if weather conditions cause temperatures to fluctuate during the course of the application.

## Application conditions

**DEGAROUTE® markings have to be applied to dry, clean, mechanically intact road surfaces that are free of oil.**

Markings are usually applied at surface temperatures of +5°C /41 F to +40°C/ 104 F; with special resins (e. g. DEGAROUTE® 465) markings are possible up to a temperature of +60°C/140 F.

Applications at temperatures as low as -10°C/14 F are possible with DEGAROUTE® 465 based marking materials by addition of Accelerator 50 (See Technical Regulations and Guidelines "Application of Cold Plastic below 5°C [+41°F]").

**The following has to be borne in mind:**

### Mastic asphalt

Normally, good adhesion is achieved. On new surfaces, adhesion problems might occur due to flux oils (pretesting is recommended!).

### Asphalt concrete

Good adhesion. Application conditions – Tar asphalt and emulsion surfaces not suitable since hardening and adhesion problems may occur.

### Cement concrete

Fresh concrete must be fully cured (minimum 28 days after installation) and laitance, concrete surface treatment agents need to be removed completely. The concrete surface has to be dry, free of any loose particles, dust, dirt, oil, grease etc.

Old road marking have to be removed except existing cold plastic materials. Moisture content of the concrete should be not more than 4%.

Porous surface texture is required to ensure good resin penetration for a high adhesion.

It should be noted that, some concrete formulation components (e.g. post treatment additives, waxes) as well as potential surface contaminations may have negative impact on bonding.

If there are justified doubts as to the adhesive strength of the marking on the substrate, this can be tested according to DIN EN ISO 4624. A pull off strength of minimum 1.5 N/mm<sup>2</sup> should be achieved in general.

To achieve an ultimate adhesion performance and durability of cold plastic, the following must be considered:

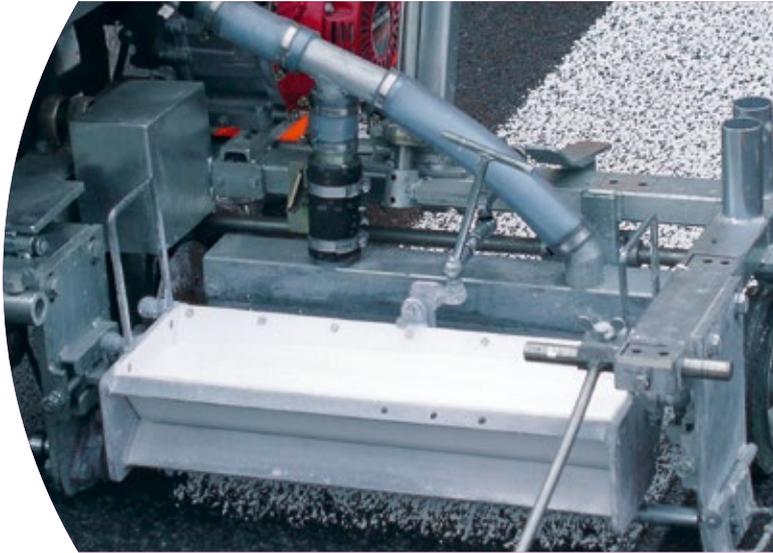
Depending on concrete quality and pavement contamination a cleaning by broom or steam cleaners could not be sufficient. If necessary a pre-treatment by e.g. high-pressure water jet blasting or grinding and vacuuming to open the substrate is recommended.

Depending on DEGAROUTE® grade and formulation, priming with a suitable concrete primer is necessary. Typical primer consumption ranging from 100 to 500 g/m<sup>2</sup> depending on the absorption of the concrete (puddle formation must be avoided in any case).

## Manual application

Direction arrows, symbols as well as letters and numbers are drawn on the pre-cleaned road surface using typically templates and chalk.

Remove the templates and mask the edges with tape. The masked area will be filled and smoothed to the desired thickness with the catalyzed marking material (smoothing trowel).



Application by means of Plastomarker function according to the draw box principle



Manual application of a crosswalk, based on DEGAROUTE® reactive resins

The tape should be removed before the curing is completed.

Additionally, reflective beads and an anti-skid agent may be sprinkled over the freshly marked surface. So-called draw boxes can be used for stop lines and non-traffic zones. Such applicators consist of variously constructed metal frames with a slit to release marking compound at the rear. The width of the draw box determines the width of the marking line. The release slit height determines the layer thickness.

## Application by means of rollers

Especially for area markings we offer a flexible DEGAROUTE® resin. Usually it's applied on 1 or 2-layer application as coloured area markings or anti-skid marking for bike and walk ways, bridges, bus lanes, hazardous points like school zones or roundabouts. To mask the edges, templates or tape can be used. Hardener powder is added to achieve curing.

## Application by means of hand guided machines

Various favorable marking devices for flat-, profile-, as well as for structure markings that can be transported easily have been developed for the application of center and side lines as well as pedestrian crossings with widths of 10–50 cm.

They all function according to the draw box principle. The catalyzed material flows into the box which is opened and closed manually by means of a system of levers. When using these units, the beginning and end of the line must be marked off beforehand.

## Fully automatic application

For thick layer (flat-, profile- as well as structure marking) as well spray applications self-driven machines with automatic line length device are normally used for application of large batches, e. g. on highways and national roads. For these purposes different machines are available:

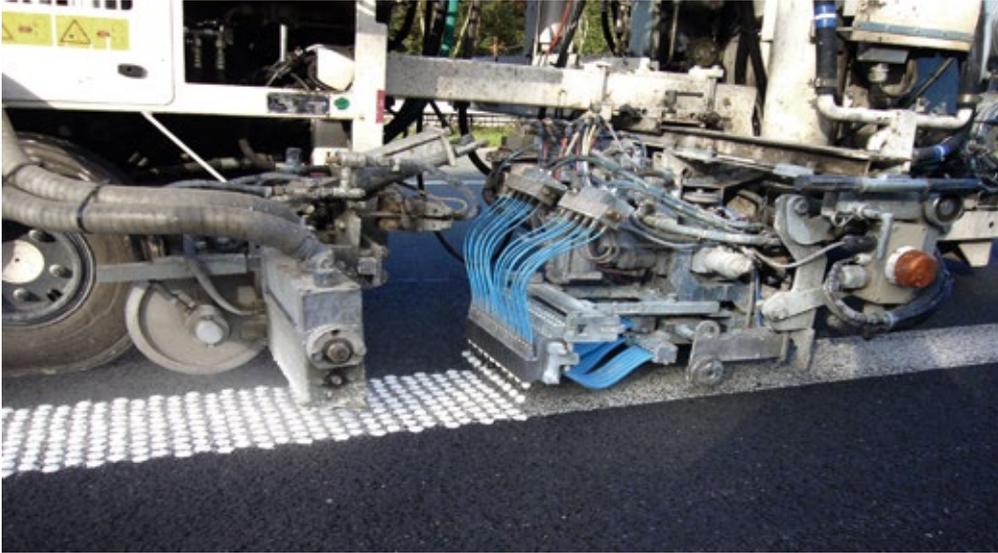
a) Machines that work according to the called 98:2 system: For this application, automatically 1–2 wt % of liquid hardener

is mixed with the marking material inside the application unit while the application process.

b) Machines that work according to the so called 1:1 system: For this application immediately before processing is needed to add 4 wt % of hardener powder to the "non accelerated" component. The containers of the two components must be clearly marked in order to avoid confusion! The two components are then poured into separate tanks and machine fed, mixed and sprayed or extruded in a ratio of 1:1.

Caution: Once the hardener has been added, the shelf life of the "non accelerated" component is limited.

1:1 spray applications are also typically used in smaller walk behind spray equipments for legend as well as striping applications.



DEGAROUTE® cold plastic opens up a variety of applications and application methods

## Renovations of markings

Older DEGAROUTE® markings can be renovated using on top fresh DEGAROUTE® cold plastic or spray plastic. The remaining DEGAROUTE® marking, however, must be swept clean and must still adhere firmly to the road. Renovation by means of thermoplastics is not recommended.

Cold plastics should not be applied to old thermoplastics either; in such cases the old marking must be removed by grinding.

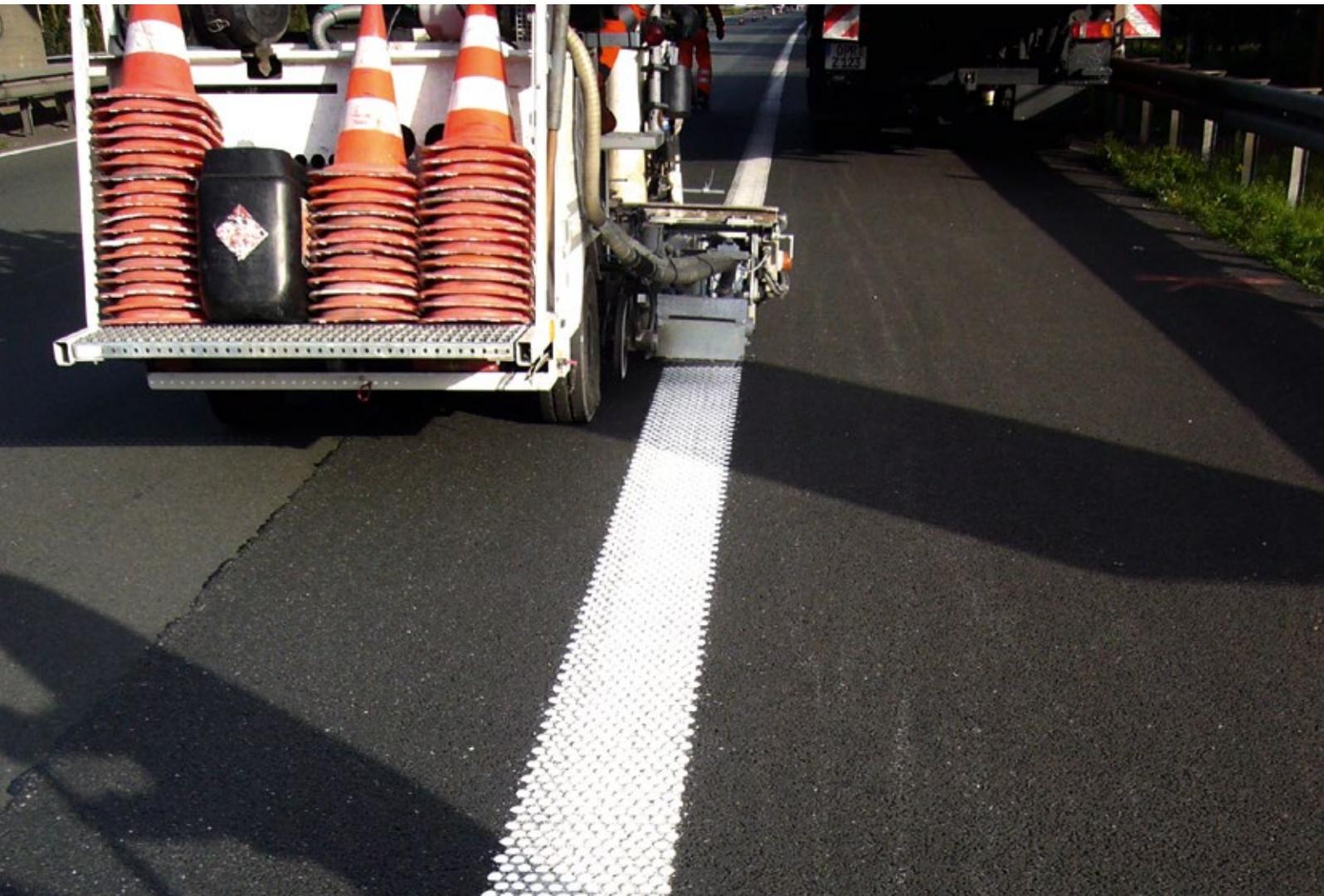
## Removal of markings

Removal of markings is preferably carried out with marking removal units like grinder or water blasting that are commercially available. For smaller types of work we recommend heating the DEGAROUTE® marking carefully with a propane flame and removing it with a flat trowel.

## Industrial safety & environmental protection

The current regulations and information on correct transportation, handling, storage, first aid, toxicology and ecology are described in detail in our material safety data sheets for DEGAROUTE® resins. Our experts at the corresponding departments will answer any questions on the classification of these products in accordance with handling and transport legislation.

**DEGAROUTE® based road markings lead the way for 50 years.** They are highly visible even at night and wet, thus they help to prevent accidents and save lives. They are extremely durable, eco-friendly, cost-efficient and easy to apply.



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