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Silikal MMA resins for cold plastic road markings and traffic area coatings

Description

Based on the reactive monomer/polymer, mono- and multifunctional esters of (meth)acrylic acid, Silikal MMA resins feature a wide range of properties varying in flexibilty, reactivity and viscosity.

Curing is initiated by adding a catalyst such as dibenzoyl peroxide powder (BPO), or in some cases, if recommended, a BPO paste. Once the chemical reaction (polymerisation) has been started, it can't be stopped. A pot-life of five to fifteen minutes is usual, whereas the tack-free time ranges from fifteen to forty-five minutes depending on the type of resin, amount of hardener and temperature.

In general, the resins are of low viscosity and can be pumped and handled very easily for further modification. Depending on the formulation, different fillers and pigments must be added, preferably in a paint factory or similar facility providing paint dissolver mixers. Ready-to-use cold plastic is usually packed into 10 kg or 25 kg tin pails and can be stored at least for six months at a moderate temperature below +25 °C. Some guide formulations are given in the product datasheets and are subject to customer modification, depending on national product regulations and specifications.

Besides the standard product range, custom-tailored resins can be manufactured in cooperation with the customer. Resins are available in 180 kg steel drums and 900 kg IBC containers.

Comparison with other road marking systems

1. More than a hundred years ago, the first road marking system used to be a solvent-based paint containing chlorinated rubber. In a modern context, the presence of organic solvents such as toluene, acetone, etc. made this system unattractive. Despite several improvements to reduce the solvent content to 25% (high solids), these systems are still not environmentally friendly. On one hand, the costs are rather cheap, but on the other hand, there is poor durability because of the low level of thickness achieved. In cities and highways, they might disappear after a few months of extensive traffic.

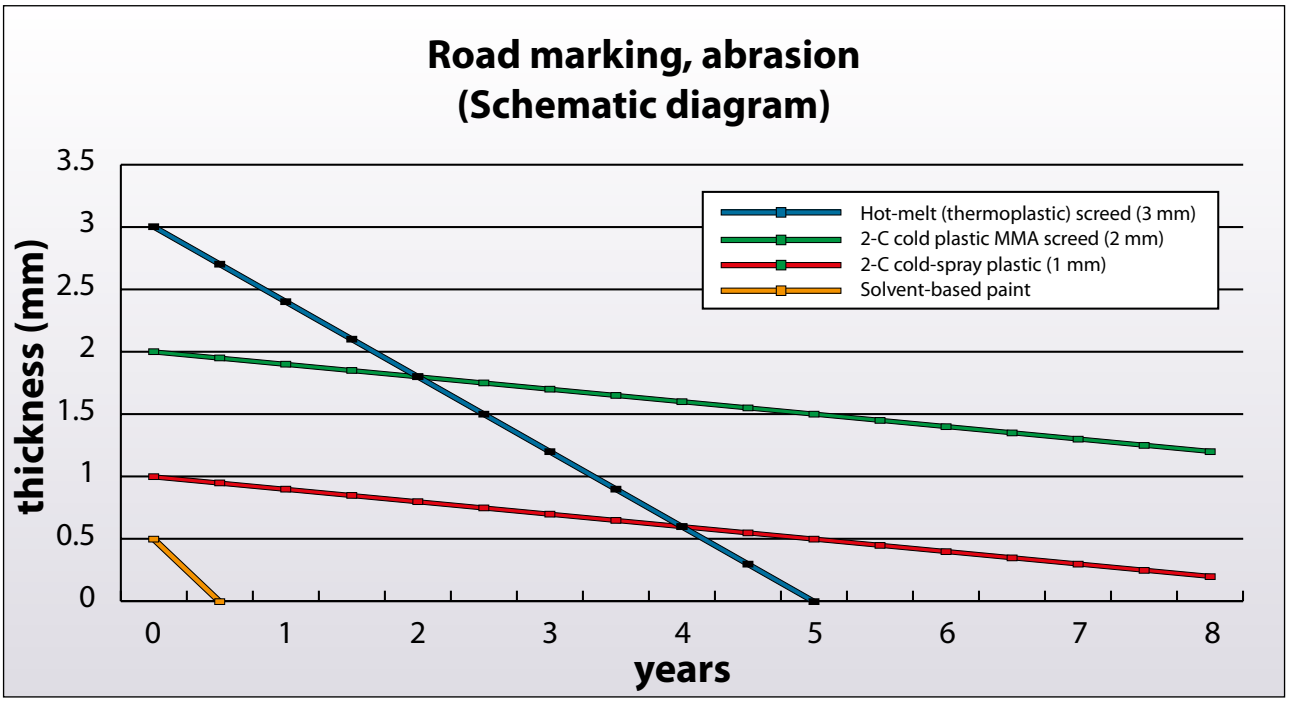
   Recently developed solvent-based paints now use water instead of organic solvents, making them very environmentally friendly but still too thin. However, in some cases, these water-based paints are useful, such as for edge lines or on country roads, especially due to the economical advantages. The only disadvantage is that sudden rainfall can cause problems shortly after application. Lines might be immediately washed away, staining the black asphalt white.

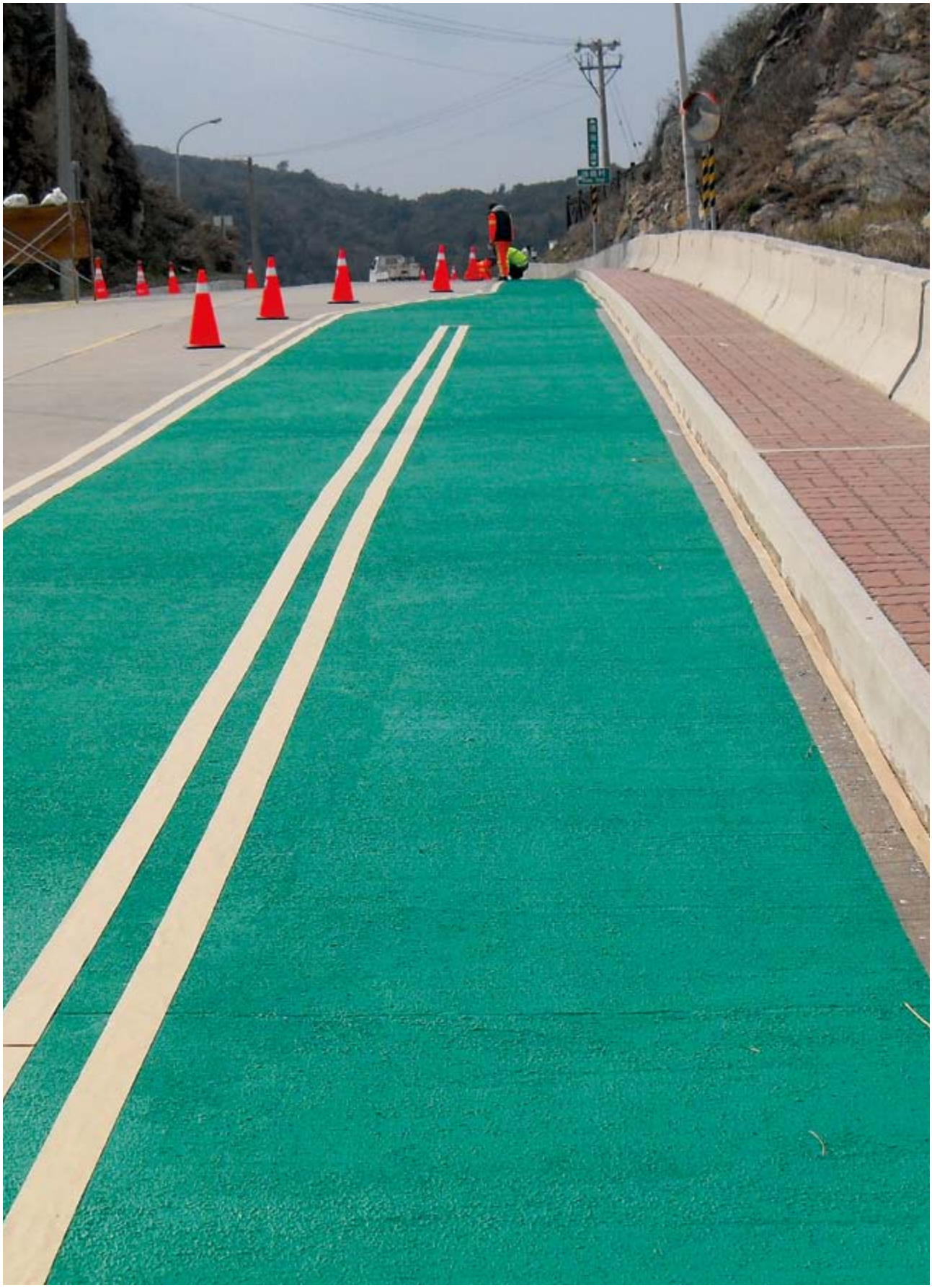
2. Hot melts or thermoplastics were very attractive over the last 40 years. These compounds must be melted in a cooker at high temperatures greater than 200 °C and must be extruded immediately onto asphalt as a melt. Compared to MMA cold plastics, hot melts are highly abrasive, meaning they are durable up to two to three years and have a minimum thickness of three millimetres. Holt melts are also rather low in price (approx. half the price of cold plastics), but do not last as long, with a lifetime of less than one-third as compared to cold plastic materials.

   Similar to the extruded hot melts, they can be diluted with high-boiling solvent thinners or oils to achieve a lower viscostiy. Under high temperatures, these low-viscous hot melts can be sprayed onto a surface with a thickness of roughly 1 mm. The performance however lies somewhere between solvent-based paints and hot melts.

3. For temporary road markings, such as on road construction areas, PVC sheets with adhesives are very convenient and popular, because they can be removed easily after construction has been finished without damaging the asphalt. In comparison to other road marking systems, they are rather high in price.

4. The cold plastic itself can be applied as an extruded version at a thickness of 1.5–2.0 mm, as a spray-on at a thickness of 0.5–1.0 mm or applied by hand at a thickness of 2.0–2.5 mm. At a thickness of 2 mm, lifetime on high-ways is estimated to last for more than six years or, in the case of a spray-on at a thickness of 1 mm, for more than three years.





Performance of cold plastics

Cold plastics adhere well to asphalt but not as good to concrete. We recommend using a suitable MMA concrete primer to improve the adhesion to concrete. Concrete primer is used to seal off the capillaries of the porous concrete in order to keep oxygen from interfering with the curing process. Oxygen and a surface temperature above +30 °C are the biggest sources of problems for MMA polymerisation. The marking film used on the surface offers protection thanks to the paraffin wax incorporated in the resin. Only a polymer film placed underneath the marking film as a primer can protect the cold plastic against curing problems. Sometimes concrete additives, such as emulsion resins or flow additives used in the fresh concrete, can affect the chemical hardening procedure, thereby causing tacky surfaces or poor adhesion.

Due to the flow tendency of bitumen, cold plastic resins must be designed to follow movements up to a certain extent. Hard resins, high shock temperature, high thickness and a high content of soft bitumen can create cracks at least on larger coating areas or long and wide marking lines.

Once the cold plastic has been mixed with hardener, the chemical reaction starts. After approx. twenty to forty minutes, the film is usually tack-free and ready for traffic. Just remember to wait 24 hours if you plan on checking the adhesion with a pull-off tester. The marking can be exposed to the hardest traffic immediately after tack-free time but the bitumen underneath is still saturated with monomer MMA which takes several hours for delayed curing. As a result, improperly placed lines can be removed shortly after curing with a scraper, leaving no white staining behind on the asphalt.

MMA cold plastic markings are very abrasion-resistant. With traffic under 10,000 vehicles per day, the average abrasion is approximately 0.2 mm per year. Shorter lifetimes sometimes result, not due to traffic, but rather because of improper application of the markings. If it rains during application, humidity and moisture will shorten the lifetime and result in delamination. Hot temperature during the curing phase will cause a higher residual monomer content, leading to soft marking lines which can absorb traffic dust and will darken very soon. Dust on pavement works like a release agent similar to flour used in the kitchen to stop dough from adhering to the worktop. Nowadays it is not common for damage to arise due to abrasion and wear. Occasionally damage does occur to cold plastic lines mainly because of delamination due to improper application.

MMA resins have different names on the market. Examples include methacrylic resins, acrylic resins, cold plastic resins, methacrylates, MMA, PMMA, etc. No matter the name, they are all of the same nature as described before. As described in many books and as you may know yourself, these resins are fully weather-resistant: UV radiation, heat, snow and ice as well as rain do not affect the properties. As a result, the line surface is sometimes improved due to the absence of these weather conditions. In countries located in the Near East and North Africa, where there is not much rainfall, road markings are usually not as white as they should be. Some countries use bitumen in pavements with a high crude oil content, meaning that in under intense sunshine, this oil can sometimes sweat out. Tyres transfer this grease onto the white lines and after months the road markings (all systems) are no longer visible.

Environmentally friendly

Since MMA resins do not contain solvents, they are VOC friendly according to ASTM 2369 test method. 99% of the monomers turn solid during the hardening procedure. Only a very small monomer amount can be identified by the typical odour of methacrylates.

During manufacturing, storage, transport and application, safety regulations must be considered. The MMA monomer and the resin made thereof are flammable liquids with a low flash point of more than +10 °C. Avoid open fire and sparks, and check the regulations for limited storage quantities, if you do not obtain permission by the authorities to keep flammable liquids in stock at your premises. The same applies to transport conditions of dangerous goods.

According to regulations for hazardous substances and mixtures, cold plastic compounds are usually classified as flammable (F) and irritant (Xi). When applying markings on outdoor surfaces, there are no health risks associated with the maximum MMA vapor concentrations. For indoor areas, such as line markings in warehouses or factory facilities, please refer to each product's Material Safety Data Sheet (MSDS). (Under special formulations, cold plastic compounds can be made without warning labels by using very low viscous resins and a very high filler content.)

Application methods

2 mm screed applied by hand with a trowel:

Cold plastic compound is supplied in small pails to the road site. An electric drill with a stirrer is required. To apply the compound, all that is needed is a simple trowel with some masking tape. Draw the pattern line around a stencil using chalk and put the masking tape along the outside of the line. Calculate the amount of compound required for that area (i.e. an arrow) and mix it with the required amount of BPO hardening powder for approx. thirty seconds. Pour it out and smoothen it without leaving trowel marks behind. Scatter some glass beads with white granules onto the freshly painted surface to increase the reflectivity and grip early on. Remove the tape before the marking has been fully cured.

2 mm screed applied by hand with a draw box:

Prepare the cold plastic material as described before. Instead of a trowel you will need a so-called draw box made of steel plate, similar to the one used for hot-melt material. Put down a piece of masking tape at each the starting and ending line. Fill the draw box with the liquid cold plastic which has been premixed with hardener and pull the draw box along a straight bar. Two workers are required for this job. Remove the two pieces of tape and scatter glass beads.

2 mm screed applied with hand-pushed machines:

Some simple machines exist on the market which work according to the draw box application method. Instead of pulling a draw box over the asphalt by hand, you can use a steel frame with four wheels. It is a device which fixes the draw box and has a bottom outlet plate which can be opened and closed to control the start and stop of the line.

1.5–2 mm screed applied with extrusion machines:

MMA cold plastic can also be applied with some commercially made machines which use different adapters in various ways and hardener dosages. One method is to add the hardener powder using a so-called ”B“ component. This accelerator-free MMA resin acts similiar to a reactive one but it is designed especially for application times of under 24 hours. The BPO does not initiate the curing in the B component. Only when the B component is mixed together with the A component containing a reactive resin using a static mixer does it begin to cure. Once both components are united and extruded does the chemical reaction starts. The other method to create cold plastic is to use the same method used when applying by hand. Here 2% hardener with a consistency similiar to a BPO paste must be added to the machine. This method requires a perfect mixing ratio and precise handling.

Safety or structured markings for improved reflectivity when wet (3 mm):

If you have wet conditions, no film is applied to the pavement. Instead many small drops are placed side by side to make the line appear whiter when there is low visibility. Each drop has a raised peak so that the rainwater runs off. This keeps the raised glass bead free of water, so that they can better reflect light when the road is wet. A special machine has a built-in rotating cylinder with spikes on it. The highly viscous cold plastic compound flows down to the rotating cylinder and is slinged onto the pavement. The advantages here are: less wheel noise, improved night visibility in wet conditions, better durability against snowploughs and less costs due to reduced consumption per square metre.

0.5–1 mm spray-on application:

Special resins are available for spray-on application. These resins have a very low viscosity and faster curing time. The spray machine is usually an airless spray system built onto a conventional marking machine. The mixing ratio is similar to the one for extrusion machines: either 1 : 1 or 98 : 2. Furthermore, special spray resins are available with a very high reactivity so that the paint can be sprayed on as if it were a one-component paint without hardener. The hardener is finally added separately as a mixture, either with glass beads or special BPO-coated glass beads. The wetting property of the paint must allow the glass beads to sink down the entire film thickness to provide a safe curing. The film is 0.6 mm when wet, but upon scattering the beads and drying, it expands to a thickness of 1 mm.

2 mm flexible prefabricated sheets:

Many years ago some companies tried to prefabricate MMA cold plastic marking strips during the wintertime and to use a resin glue to stick them onto the asphalt. It worked well by using very high flexible MMA resins with an enormous curing speed, but in the end the costs of manufacturing were too high.

1–3 mm traffic area coatings:

Besides ordinary road markings, cold plastic compounds can also be used for area coatings outside, such as bus stops, bicycle lanes, walkways, restricted areas, car parks, etc. A wide range of colours can be combined together in order to design a highly decorative image. Particularly in cities, it has become very popular to visually divide different traffic areas. Depending on the system and thickness required, it is very simple to apply the coating using a roller or trowel.

Formulating resin and fillers:

Our Silikal MMA resins for cold plastic are pure binder resins. In order to formulate the right compound for the end user, special pigments, fillers and additives have to be added to the resin.

Pigments:

The most important pigment for the colour white is titanium dioxide. There are two types available: rutile and anatase. Rutile is the more common of the two, because the resin/oil absorbtion factor is very low, meaning a high percentage of pigment allows a low viscosity compound. In addition, it does not chalk under weather conditions. Nevertheless, if a small amount of anatase is combined, filler sedimentation can be stabilised much like with thixotropic agents. A small chalking allows a better white colouring. The percentage of pigment depends on how light or dark the other fillers are, whereas viscosity is influenced by the total weight by 5% to 10%. Other pigments include iron oxides or organic pigments. Organic pigments are not always stable and can lead to a reduced shelf life of the cold plastic.

Powder fillers:

Cold plastic compounds must be always be made using a sieve line with different aggregate particle sizes. Powder filler is very important since it provides a high filler content at a good flow and helps stop filler sedimentation. The particle size itself is not very important due to the fact the entire filler mix has a final thickness of between 1 µm and 0.5 mm (0.8 mm). We suggest using non-treated types of fillers such as calcium carbonate, baryte, dolomite, silica powder, talc, etc. ranging between 0–20 µm or 0–50 µm. The content of powder filler in the total mixture is equal with the quantity of resin (15–25%).

Granule fillers:

Coarse particles not only provide good skid resistance but they are also very economical and thereby help to reduce costs of material. Round-shaped aggregates such as quartz sand are easier to handle since the oil absorbtion factor is very low and a high percentage can be added. On the other hand however, the skid resistance suffers. Crushed rock minerals, such as calcinated quartz, broken quartz or synthetic minerals (aluminium oxide), have a bigger particle surface so that the aggregate adheres to the resin much better and thereby creates better skid resistance. Remember the colour: the lighter the colour of the aggregates, the less titanium dioxide or other pigments are required. The percentage in the mixture ranges between 15–25%.

Glass beads:

Similar to granule fillers, glass beads are used on all areas where there is an absence of light on the streets. Sometimes national specifications do not allow for glass beads to be used, meaning others must be used. The particle size ranges between 0.2–0.8 mm. In order to improve adhesion to the resin, special silane-coated glass beads are available from glass bead manufacturers (15–25%).

Additives:

The most important additive is a non-treated, amorphous, lightweight silica powder. A small percentage (0.1–0.5%) stabilises the fillers during storage and prevents sedimentation. Testing must be completed in case other thixotropic agents as well as other additives like wetting agents, anti-foaming or anti-tack additives are used. In some cases, they can influence the chemical reaction and cause curing problems, a tacky surface or high dirt pickup.

Hardener powder (paste):

Hardener must be handled separately since it will immediately start the curing process once it makes contact with the resin or compound. When operating machines according to the A/B mixing system, make sure the containers are completely clean, since a small amount of hardener is enough to start polymerisation overnight. Please refer to the MSDS for safety regulations. Keep it out of heat and sun; do not store it together with the resins/compounds and wear suitable protection. The amount of BPO hardener powder depends on the temperature: the colder it is, the more you should use; the warmer it is, the less you should use. It can vary beween 0.2% and 2% for ready-to-use material or 1% to 7% for binder resins.

Curing problems:

All experts have faced at least one curing problem in their life. Here are some examples which may lead to curing / problems:

a) After a long storage period (especially in the winter), the paraffin wax in the resin was not properly stirred, before it was removed from the container (paraffin under- and overdosage).

b) The amount of hardener was not exactly calculated to the quantity of material. Either there is not enough or too much.

c) Cold plastic cannot perfectly cure on very hot surfaces. In the summertime, depending on the type of resin, the maximum surface temperature must not exceed +35 °C to +45 °C because the paraffin cannot protect the polymerisation against oxygen (inhibition). At the same time, there is a high loss of MMA monomer due to evaporation, like a solvent missing afterwards for perfect curing.

d) As previously mentioned, if non-suitable pigments, fillers or additives are used they can cause curing problems (surface treated).

e) Concrete and mortar admixtures, such as concrete retarder, accelerator or emulsion plasticiser, silane or silicon surface treatments as well as epoxy coatings can disturb the curing process. That is the reason why we recommend conducting tests on modified surfaces.

f) Last but not least, the recommended thickness could have been ignored. If the film thickness is too thin, curing will not properly take place. The result: slow or bad curing. The same is true with extremely high thicknesses. The exothermic temperature during curing process creates a self-heated system which exceeds the maximum allowed surface temperature. The high residual monomer content leads to tacky surfaces, bubbles or soft layers.

Product data sheets (PDS) can be found on separate pages. For each product, we can also provide a Material Safety Data Sheet (MSDS) upon request or delivery. Our product information applies to the resin only and does not release the manufacturer of the road marking compound or applicator from fulfilling national technical specifications, health and safety regulations at work as well as any other standards.

Silikal MMA resins provide just the binder resin for you to make your own road marking compound.

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