

# Choosing a form release agent

*Much depends on the type of form material*

The basic task of a form release agent is to permit clean release of the form from hardened concrete during stripping. Usually, the release agent is also expected to protect the form and contribute to the quality of the concrete surface. Several types of form release agents are available, some better suited to a particular form material than others. Five basic types are described in this article (see table on page 420 for summary):

- Petroleum oils
- Emulsions
- Non-reactive coatings with volatile solvent
- Waxes
- Chemically active agents containing fatty acids

Release agents which do not fit these classifications have also produced satisfactory results. Many agents now on the market are complex combinations—with ingredients from several of the categories shown.

## Petroleum oils

*Plain oils*—Light-bodied (low viscosity) petroleum oils are available from major oil companies. The wax content of the oil varies with the source of crude and the amount of refining. Paraffin oil and pale oil are two petroleum oils sometimes used as form release agents. Pale oil has a lighter color and contains less wax than paraffin oil.

Petroleum oils provide good form release and if properly applied will produce uniform concrete color. Excess oil, however, can cause discoloration and collect dust. Plain oils also tend to leave more bugholes on the concrete surface. Thick oils may physically trap air bubbles and pre-

vent them from migrating out of the concrete. Heavy-bodied oils should thus be avoided. Because of these possible adverse effects on concrete appearance, some authorities recommend against plain oil on architectural concrete.

*Plain oil with wetting agent.* Surface activating agents are added to plain oils to dissipate the oil so it will not bead up on the form and produce bugholes. Plain oils with wetting agent can be used on all types of forms. If they are applied nonuniformly or in excess, staining or color differences may occur. The oil may also be affected by rain.

*Used oils.* Because they are less expensive, used motor oils and industrial waste oils are sometimes used as form release agents. They are generally not recommended because they may contain sulfuric acid, which is harmful to both concrete and forms. Industrial waste oils may also contain harmful PCB (polychlorinated biphenyl).

## Emulsions

Emulsions consist of a water phase, a water-insoluble phase and an emulsifier which suspends one phase in the other. Because all emulsions contain water, problems can occur in cold weather in storing and applying the release agent, and in keeping it from freezing once it is on the forms. In cold weather, emulsions may thus be restricted to jobs where forms are heated. Emulsions are not in wide use in the United States, but as the price of petroleum increases, their use may increase also.

*Water-in-petroleum emulsions.* To reduce the cost of using petroleum oil, water is suspended in the oil by an emulsifier. Water does not

provide any release properties. A nondiscoloring emulsion used in the right amount will leave the concrete uniform in color with few bugholes. Excess oil, however, can still cause color variations on the concrete surface. Water-in-oil emulsions were originally developed for use on wood forms; they should not be used on steel unless they contain a rust inhibitor. These oil-phased emulsions can be applied to damp surfaces.

*Petroleum-in-water emulsions.* Petroleum-in-water emulsions consist of globules of petroleum oil dispersed in a continuous water phase. They are rarely used in the United States, and, to our knowledge, none is manufactured in the United States. Because of their adverse effects on the appearance of concrete when applied in excess, they are not widely recommended.

*Other emulsions.* One manufacturer of a polymer-in-water release agent says that this type is more common than petroleum emulsions. It consists of a polymer mixed with a fatty acid and dispersed in water by an emulsifier. Reported cost is 25 to 50 percent less than that of oil-based release agents.

## Non reactive coatings with volatile solvent

These form release agents consist of a volatile solvent derived from petroleum combined with one or more active ingredients, such as waxes, silicones, synthetic resins and water-insoluble soaps. The solvent evaporates, and the active ingredients are left behind on the form surface. Because the solvent evaporates, it cannot stain the surface, and viscosities can be more readily adjusted to suit specific ap-

plication procedures. The form surface is left dry and non-slippery.

These compounds tend to be more expensive than oils or emulsions, and, depending on the composition of the active ingredients, they do not necessarily provide better performance. Note: because

made of concrete, but uniform application is difficult to obtain with regular waxes. Emulsified waxes used in the past could overcome this difficulty. Wax residue left on the formed concrete surface can prevent paints or other coatings from adhering to the concrete.

acids react slowly with the alkalis in concrete to produce water-insoluble soaps. This process is called saponification. It prevents the set of a thin film of concrete in contact with the form. When wet, this slippery soap film allows air bubbles to slide up the form surface and es-

### QUESTIONS TO ASK WHEN CHOOSING A FORM RELEASE AGENT

The best way to evaluate a form release agent is to try it out under actual job conditions. Make a test panel or use the unfamiliar release agent on a non-architectural portion of the concrete. Also get the manufacturer's advice on what types of forms it can be used on and how it should be applied. Here are a few things to consider:

- Will coatings be applied to the finished concrete? If the concrete surface is to be plastered or painted, the release agent should not leave any residues that prevent adhesion. Waxes and silicones are known to do this.
- Are the forms being used for architectural concrete? If so, stains, dusting, and conspicuous bugholes are probably unacceptable. Use the same release agent throughout the entire job, and take care to apply it in a thin, uniform coating. As far as the appearance of the concrete is concerned, care in applying the release agent is probably as important as the choice of any particular type.
- Is a superplasticizer used in the concrete mix? Increased slump that occurs with superplasticized concrete facilitates the movement of air bubbles and water drops, but the early slump loss tends to trap these voids at the surface. Form release agents with special additives can help reduce friction at the form face so air bubbles and water drips can rise and escape more easily.
- Is concrete surface retarder used? Many retarder manufacturers recommend applying a volatile-type release agent before applying retarder, so

form cleaning is easier after stripping.

- How long can the release agent stay on the forms before concrete is placed? Some release agents must be applied the same day that the concrete is placed; others are effective after they have been on the forms several weeks. Get the manufacturer's recommendation.
- Will the form release agent still be effective, if the forms are not stripped for a long time?
- How does the release agent affect the form surface? Does it rust metal? Does it soften plastic? Is it absorbed by wood? or does it provide a waterproof barrier that preserves the form?
- Does the release agent dry out on the forms? Dry release agents aren't slippery, and they don't get tracked onto reinforcement as easily as others.
- In what environment will the concrete be placed? How cold will it be? What is the freezing point of the release agent? What is the flash point? Can it be used in dusty areas? In ice and snow? Will it wash off in the rain? If the concrete is to be steam cured, can the release agent tolerate the high temperatures?
- Does the release agent produce toxic fumes or cause skin rashes?
- What is the cost per square foot? Bulk material costs and coverage rates vary. The material that costs more per gallon may cost less per square foot.
- Is the release agent premixed or a concentrate? With a concentrate you can save on shipping and storage costs. But a premixed release agent saves time on the job.

benzene is a suspected carcinogen, mixtures of stearic acid and benzene which have been used in the past are not recommended now.

### Waxes

Though rarely used today, waxes have excellent release characteristics. They can be used on forms

### Chemically active agents containing fatty acids

A majority of the proprietary form release agents on the market today are chemically active, in the sense that they react with the free lime in concrete. The reactive component is usually fatty acid in the form of animal fat or vegetable oil. These weak

cape. Bugholes are thus reduced. When dry, the soap film becomes a release agent.

Fatty acids are usually used in formulations with other ingredients such as emulsions, petroleum oil, and volatile solvents, sometimes along with waxes. Because of the fatty acids, the resulting form re-

lease agent will usually react with the alkalis in concrete. Fatty acid release agents based on volatile solvents leave a dry film on the form surface after the solvent has evaporated. On deck forms, particularly in high-rise construction, this dry, nonslip coating makes walking safer and prevents transfer of release agent from footwear to reinforcement. Drying-type fatty acid release agents used on forms for precast concrete keep release agent off prestressing cables, and the dry film is not washed off by rain. Release agents that contain fatty acids can also usually be used at high temperatures with heated formwork. Bulk cost of fatty acid release agents is higher, but some of them allow greater coverage rates than do plain oils.

Chemically active release agents based on fatty acids produce concrete surfaces uniform in color, with a dull, flat finish. If applied in excess, though, dusting of concrete can occur.

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**Other products**

Some manufactured release agents contain soaps made by combining a fatty acid with an alkali or an amine. One release agent on the market based on an amine soap is said to eliminate bugholes, even when superplasticized concrete is used. Another release agent based on a soap is said not to react with the alkalis in concrete.

A release agent based on an ester is also available. The ester is formed by combining a fatty acid with an alcohol. It reportedly does not react with concrete. Its high carbon content and high molecular weight provide a slick, water-insoluble surface.

Some release agents that contain fatty acids are purposely formulated so they do not react with concrete. Why? One manufacturer claims that the reaction of chemically active release agents is influenced by heat and vibration. Areas that are vibrat-

ed will react at a different rate and thus be a different color than other areas.

**Which release agents can be used on which forms?**

Select the form material, then select the release agent. A given release agent may perform differently on different form materials.

*Wood and plywood forms.* For wood forms most commercial oils and chemically active agents are satisfactory. Some producers of plywood for forms recommend either oils or chemically active release agents. Release agents that contain waxes or silicones should not be used where the concrete is to be painted. Diesel and other fuel oils are sometimes used in the field on plywood, but the American Plywood Association (APA) considers them poor substitutes for proper form oils. Says the APA: "They have neither sufficient lubricity nor body for good release."

<b>TYPES OF FORM RELEASE AGENTS</b>	
<b>Petroleum oils</b>	Light-bodied plain petroleum oils provide good release and produce uniform concrete color. May leave more bugholes than other release agents, and if over applied may stain concrete. Relatively inexpensive. Petroleum oils with an added wetting agent reduce bugholes. They can be used on all types of formwork.
<b>Emulsions</b>	Emulsions contain a water phase and a water-insoluble phase. All emulsions freeze in cold weather. Usually they cost less than plain oils. <i>Water-in-petroleum.</i> Emulsions of water in petroleum oil where the external phase is oil. For all types of formwork except steel; especially for absorbent forms such as wood. <i>Petroleum-in-water.</i> Emulsions of petroleum oil in water where the external phase is water. Excessive application may cause severe retardation, discoloration and dusting. Inexpensive, but not widely recommended. <i>Other emulsions.</i> Emulsions that contain little or no petroleum oil. Polymer-in-water emulsion is an example.
<b>Non-reactive coatings with volatile solvent</b>	Volatile solvent is derived from petroleum. Active ingredients may be waxes, silicones, synthetic resins or water-insoluble soaps. Petroleum solvent evaporates so it cannot stain concrete. Tend to be more expensive than oils or emulsions.
<b>Waxes</b>	Good for forms made of concrete. Excellent release characteristics but difficult to apply. Wax residues on formed concrete surface can prevent paint from adhering. Emulsified waxes are easier to apply.
<b>Chemically active agents containing fatty acids</b>	React with alkalis in concrete. Reduce bugholes. Those suspended in volatile distillate dry on form face and resist washoff by rain. Excess application can cause dusting of concrete. More expensive for given volume, but rate of coverage is often greater.

Form grade plywood is oiled at the mill, unless otherwise specified, generally with 100 or higher viscosity pale oil. Unless the mill oiling is still reasonably fresh when the panels are first used, the plywood will require another oiling. To prolong the life of the plywood form, improve its release characteristics and minimize staining, the APA recommends that a liberal amount of oil be applied a few days before concrete placement, then wiped so a thin film remains. The form oil—either pale oil or paraffin oil—should be capable of penetrating the wood to some extent while leaving the surface only slightly greasy to the touch with no free oil on it. For best performance and longest form life a light coat should be applied before each use, especially if the concrete mix is rich in cement, the curing is rapid, or there is to be a long time before forms are stripped.

The need for oiling between concrete placements is reduced by coating the plywood with epoxies or moisture-cured urethanes. Shellacs, varnishes, lacquers and plastic-base compounds have also been used, but epoxy and urethane coatings are more popular today. The waterproofing provided by these coatings offers benefits for both form life and concrete surface quality.

*Overlaid wood panels.* Plywood and waferboard are available today with resin-fiber overlays that extend the life of the wood form face. High-density overlays have a resin-fiber ratio close to 50/50. The APA claims high-density overlays do not need oiling, but says many users nevertheless apply a light coat. Release agents that are recommended for use on glass fiber reinforced plastic (see below) should be used on high-density overlays. Medium-density overlays have a resin-fiber ratio close to 35/65. Most release agents can be used with medium-density overlays, but chemically active release agents are recommended.

*Metal forms.* Form release agents that are satisfactory on wood are not always suitable for steel forms. Release agents for steel forms should

contain a rust inhibitor. Materials that have been used successfully include plain oil with wetting agent, fatty acids in pale oil, and saponified fatty acid emulsions—all applied very lightly. With aluminum forms, vegetable oils, oil-based emulsions, and chemically active agents containing fatty acids have been used. Special additives may be required to compensate for aluminum's porosity and reactivity.

*Glass fiber reinforced plastic (GFRP) and stiff plastic.* So-called "fiber glass" forms are really plastic forms reinforced with glass fibers. GFRP forms and forms made of ABS (acrylonitrile butadiene styrene) plastic should be coated with form release agent with each use to minimize bugholes, prevent sticking and save on cleanup. Uniform color is obtained by using a release agent throughout the job from the very first use. Color of the concrete surface is different when a release agent is not used.

Water-in-oil emulsions and most chemically active release agents can be used on GFRP and ABS plastic. One manufacturer makes a polymer-in-water emulsion specifically for use on GFRP or ABS plastic forms and form liners. A silicone release coating can also be used if curing requires high temperatures, but the silicone may permanently stain the concrete.

Various plasticizers that may be incorporated in the plastic to permit fabrication may not always remain inert in the presence of form release chemicals. Their effect on forming materials or concrete may not be apparent until after several reuses, but they can cause crazing of concrete or dusting of the form surface. Such tendencies should be watched for, and if there are any problems, the manufacturer of the plastic should be consulted.

*Rubber and elastomeric liners.* Oil causes most rubbers to disintegrate and should therefore not be used on rubber liners. Most rubber liners do not require a release agent if the surface is cleaned and moistened with water just before concrete is placed.

A vegetable oil or emulsified wax can be used, though, if desired.

Elastomeric form liners—those flexible, rubber-like plastics—are used more than rubber form liners today. Almost any type of form release agent can be used on elastomers, but since so many chemical types of elastomers are available, the elastomer manufacturer's instructions should be followed. In no event should elastomeric liners or liners made of ABS plastic or GFRP be coated with surface retarders containing toluene or xylene. Because elastomers are slightly absorbent, the form release agent should be applied on the day of concrete placement.

*Plastic foams.* Polymer-in-water emulsions and conventional concentrated liquid detergents have been used as release agents on form liners made of plastic foam. CAUTION: Since some of the foam plastics can be dissolved by some release agents, consult the manufacturer or make a small test before proceeding.

*Concrete forms.* Forms made of concrete require a release agent to prevent sticking, even if they are ground, smoothed, and polished. Light-colored oils and oil emulsions have been used. Tilt-up bond breakers that contain fatty acids and silicones are also recommended. For detailed information on bond breakers, see the article, "Bond Breakers and Their Effective Use," in the October 1977 issue of CONCRETE CONSTRUCTION, pages 547-552.

*Plaster molds.* When plaster waste molds are thoroughly dry, a white shellac or an epoxy or urethane sealer should be applied to the mold surface to make it waterproof and nonabsorbent. Before concrete is placed, a release agent recommended for use on stiff plastic should be applied.