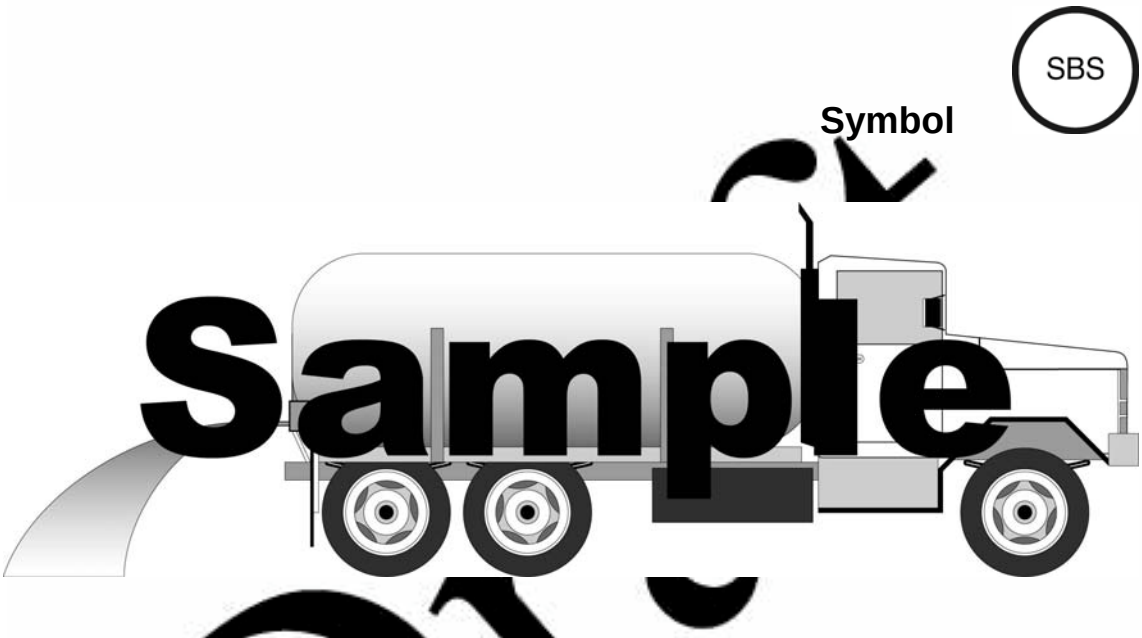
Soil Binders

EROSION CONTROL TECHNIQUE

Revegetation		Temperate Climates	✓	Short-Term	✓
Non Vegetation	✓	Wet Tropics	✓	Long-Term	
Weed Control		Semi-Arid Zones	✓	Permanent	



Key Principles

1. The application and success of soil binders can vary significantly from region to region. The best advice is to trial various methods/measures and learn from experience. This, however, must not be used as an excuse to trial techniques that clearly show little promise of success.
2. Key design issues are the potential environmental impacts, trafficability and longevity.

Design Information

The authors have not investigated any of the soil binders presented in this fact sheet and thus cannot recommend their specific use. This information is provided as reference material only. Designers should seek local product distributor advice and review State guidelines and product approval lists prior to use.

Soil binder can be grouped into the following categories:

(a) Bitumen-based
(b) Organic-based (short-life)
(c) Organic-based (long-life)
(d) Polymeric emulsion blends
(e) Cementitious-based

(a) Bitumen-based soil binders

Bitumen-based soil binders consist of a mixture of bitumen, emulsifying agent, stabilising agent, and water. They have a low viscosity and are typically by spraying (cold).

Upon application, the emulsion breaks and the bitumen particles merge as the water is absorbed or evaporates. The rate of breaking can be varied, depending on the emulsifying and stabilising agents.

Two types of bitumen emulsion are recognised:

- Anionic bitumen emulsion which is alkaline in nature and slow-breaking.
- Cationic bitumen emulsion which is acid in nature and is favoured for road sealing. These emulsions should not be used for soil conservation purposes.

Asphalt-based products should not be used as a soil binder, but may be used as a mulch tackifier, or as a surface sealer on access and haul roads. On long-term access and haul roads, the sealing of road with an application of 10mm single-coat bitumen seal can be more effective than the application of many other soil binders.

In circumstances where bitumen emulsions are required for erosion control, then slow-breaking, anionic, bitumen emulsions are typically applied at rates of around 2500L/ha on batters, and up to 4000L/ha in areas of minor concentrated flow. Cationic bitumen emulsions should **not** be used if there is the risk of the emulsion washing off into downstream water bodies.

(b) Organic-based (short-life) soil binders

Short-life, organic-based soil binders include: guar, pryllium and starch.

Guar:
Guar is a short-lived binder consisting of a non-toxic, biodegradable, galactomannan-based hydrocolloid, treated with dispersant agents. It is mixed with water prior to application at a rate of around 1.2 to 1.8kg per 1000 litres. Recommended application rates are presented in Table 1.

Table 1 – Typical 'guar' application rates for a soil stabiliser [1, 2]

Slope (H:V)	Flat	4:1	3:1	2:1	1:1
Rate (kg/ha)					

[1] Sourced from California Stormwater Quality Handbook – Construction, EC-5 (2003)

[2] For application rates of guar as a mulch tackifier refer to the relevant *Mulch Tackifier* and *Bonded Fibre Matrix* fact sheets

Psyllium:
Psyllium is a short-lived binder formed from the mucilloid coating of plantago seeds. It is applied either as a wet slurry or dry powder to the soil surface. After wetting, it requires 12 to 18 hours drying time, after which it forms a resistant membrane that permits germination and growth of seeds.

Application rates are typically from 90 to 225kg/ha, with enough water in solution to allow for a uniform slurry flow.

Starch:
Starch is a short-lived binder consisting of a non-ionic, cold water-soluble (pre-gelatinised) granular cornstarch. Applied in a water mixture at a typical rate of 190kg/ha. Drying time is approximately 9 to 12 hours.

(c) Organic-based (long-life) soil binders

Long-life, organic-based soil binders include: pitch and rosin emulsion.

Pitch and rosin emulsion:
A non-ionic pitch and rosin emulsion with a minimum solids content of 48% with the rosin representing a minimum total solids content of 26%. The emulsion should be non-corrosive, water dilutable, and upon application, cure to a water insoluble binding and cementing agent.

For soil erosion control, the emulsion is diluted 5 parts water to 1 part emulsion for clayey soils, and 10:1 for sandy soils. Application can be by water truck or hydraulic seeder.

Pine resin used for road surfacing:

For paving purposes, pine resin and/or pitch is mixed with crushed stone-usually decomposed granite-that includes a range of particle sizes, from 13 or 19mm down to fines that pass through a #200 sieve (75 µm). For the 19mm aggregate mix, one-quarter to one-half of the aggregate should pass through a #8 (2.4 mm) sieve. Ideally, the aggregate should not include organic matter or clay particles, though clayey mixes are sometimes used satisfactorily.

The pine resin is added to wetted (2 to 4% water) aggregate in a cold process at a rate of around 6% to 9% by weight (refer to manufacturer's advice). The aggregate and emulsion mixture is then laid down using fairly conventional paving equipment and practices. Instead of the product setting by cooling, it sets through evaporation of water leaving the mixture.

Once mixed, it can become extremely sticky if rubbed between the fingers and hard to wash off.

The compressive strength of Resin Pavement typically exceeds that of conventional asphalt by more than threefold. Given the high content of fines (required for proper hardening), the cured pavement is highly impermeable and can withstand heavy wash and even flooding. The strength of pine resin pavement varies due to the quality of application, site location, original subgrade strength, and properties of the pine resin.

Much of the energy required to lay normal asphalt is avoided because the mixture does not have to be heated up. Also, because the adhesive material is made of tree resin rather than normal petroleum based asphalt, the pavement doesn't contain any volatile petroleum-based chemicals. The final product is similar in appearance to asphalt in texture and thickness but can vary in colour. The treated surface retains a colour similar, but slightly darker, to the original subgrade.

Terminology:

Oleoresin: a natural mixture of an essential oil and a resin.

Pine pitch: a black, viscous material derived from the distillation of wood; before the development of coal-tar pitch.

Pine rosin: a residue from distillation of turpentine oil from raw turpentine.

Resin: any of a class of non-volatile solid or semisolid organic substances obtained directly from certain plants.

Rosin: the hard, brittle, transparent, slightly aromatic solid brittle resin left after distilling of the oil of turpentine from the crude oleoresin of the pine.

(d) Polymeric emulsion soil binders

Polymeric emulsion soil binders include: acrylic copolymers and polymers; liquid polymers of methacrylates and acrylates; copolymers of sodium acrylates and acrylamides; poly-acrylamide and copolymer of acrylamide; and hydro-colloid polymers.

Acrylic copolymers and polymers:
Polymeric soil binders consist of a liquid or solid polymer or copolymer with an acrylic based containing a minimum 55% solids. Polyvinyl acrylic polymer emulsion (PVA) produce a soil surface binding film which can be used for dust control.

Polymeric soil stabilisers should be:
- readily mixable in water;
- non-injurious to seed or animal life;
- non-flammable;
- not re-emulsify after curing.

Polymeric emulsion should not be allowed to exceed their shelf life, should be mixed in a manner that avoids foaming (anti-foaming agent may need to be included).

Liquid copolymers should be diluted at a rate of 10 parts water to 1 part polymer, and the mixture applied at a rate of around 11,000L/ha, but not at a rate that totally inhibit water infiltration into the soil. Drying time is around 36 to 48 hours.

Liquid polymers of methacrylates and acrylates:
Liquid polymers of methacrylates and acrylates are an aqueous, 100% acrylic emulsion blend of 40% solids by volume. They are required to be free of styrene, acetate, vinyl, ethoxylated surfactants, or silicates. The emulsion is diluted with water in accordance with manufacturer's specifications then applied at a rate of around 190L/ha. Drying time is around 12 to 18 hours.

Copolymers of sodium acrylates and acrylamides:
These copolymers are a non-toxic, dry powder copolymer mixed with water and applied at a rate appropriate for the soil slope, such as provided in Table 2.

Table 2 – Typical application rates for copolymers of sodium acrylates and acrylamides [1]

Slope (H:V)	Flat to 5:1	5:1 to 3	3:1 to 1:1
Rate (kg/ha)			

[1] Sourced from California Stormwater BMP Handbook – Constr ion, EC-5 (20

Poly-acrylamide and copolymer of acrylamide:
Packaged as a dry, flowable solid, these products can be used as stand-alone der. It is diluted to a rate of around 1.32kg per 1000 litres of water and ied at a rate of around 5.6kg/ha.

Hydro-colloid polymers:
These polymers consist of various combination of poly-ac midos, copolymers and hydro-colloid polymers that are mixed with wat nd applied to th surface at rates of 60 to 70kg/ha. Expected drying time is from ep to 4 hours.

(e) Cementitious-ba nders

A formulated gypsum-based b compos of high purity gypsum that is ground, calcined and proces into calcium sulfat mihydra with a minimum purity of 86%. It is applied at rates of 4500 to 13,500kg/ diluted in water about 0.22kg/L. Temperatures must be above 5.6°C ring application a curing, and winds must be less than 16kph during application. Dry time is 4 to 8 hou

Cementitious produ form a crust to 9mm deep over the soil surface once set. The crust is water permeable yet le enough to hold soil, seed and fertiliser in place long enough for seed germination and blishment. The soil surface must be treated with an alkaline amendment, like liquid lim before application (seek expert advice).

Cementitious-based soil binders are suitable for soil stabilisation and dust control. The formed crust is inorganic and does not break down in sunlight, and thus can be used for dust control in dry and arid climates.

Products considered unsuitable for use as a soil binder:

The following materials must not be used for dust suppression purposes:

- oil;
- land-fill gas condensate;
- any contaminated leachate or stormwater when the use of such material is likely to cause unlawful environmental harm.

Characteristics of various soil binders are provided in Tables 3 and 4.

Table 3 – Soil binder characteristics [1]

Class	Type	Erosion control effectiveness (%)	Degradability	Longevity (months)	Residual impact on future construction	Potential water quality impact
Organic-based (short-life)	Guar		Biodegradable			
	Psyllium					
	Starches					
Organic-based (long-life)	Pitch/rosin emulsion					
Polymeric emulsion blends	Acrylic polymer and copolymers		Photochemical degradable			
	Methacrylates and acrylates					
	Sodium acrylates and acrylamides					
	Polyacrylamide					
	Hydro-colloid polymers					
Petroleum/resin-based emulsions	Emulsified petroleum r					
Cementitious-based binders	C					

[1] Sourced from California Depar of Trans ation (2002)

4 – Generalised properties of soil binders for erosion control [1]

Evaluation criteria	Binder type			
	ic-based t-life)	Organic-based (long-life)	Polymeric emulsion blend	Cementitious-based binders
Resistance to leaching				
Resistance to abrasion				
Longevity				
Curing time (minimum)				
Compatibility with vegetation				
Liquid or powder				
Surface crusting				
Clean up				

[1] Sourced from California Stormwater BMP Handbook – Construction, EC-5 (2003)

Description

Soil binders are a form of chemical surface stabiliser and/or soil-bonding agent applied to exposed soil surfaces to control erosion.

Sprayed over the soil surface, these products stabilise the soil by providing a thin surface crust (cap) and/or binding loose soil particles to a depth of around 5cm.

Products include: petroleum oils, petroleum resins, asphaltic emulsions, potassium chlorides, calcium chlorides, magnesium chlorides, pine tars, tree sap, molasses, silicic acid, alcohols, gilsonite resins, hydrophilic colloids, tall oil pitch, polymers, polyurethanes, acrylics, glues, sealers, and so on, **but** not all are desirable or even accepted for use by regulators.

Purpose

Soil stabilisers are considered a short-term (6 months or less) erosion control measure. Most soil binders can be used to control both wind and water-induced soil erosion.

They can be a good alternative to mulches in areas where earthworks will soon resume. Some soil binders can also b used to stabilise earth stockpiles.

Limitations

Most products have a limi ife and consideratio should be given to use of geotextile he exposed surfaces ed to be protecte extended periods o ring the wet seaso

Traffic can dama some product more than others. Prote e fencing maybe required to control trai ovemt.

Some products may ma the soil water repellent, possibly resu ing in long-term revegetation problems.

Effective soil stability may not be achieved on slopes steeper than 3:1 (H:V).

Most product are not suitable for use within drainage channels.

Asphalt-based products should not be used as a soil binder, but may be used as a surface sealer on access and haul roads.

Advantages

Once dry, most products provide instant protection.

Suitable for temporary stabilisation while construction is in progress.

Most products also help control dust.

Disadvantages

Usually less effective than mulching in the control of raindrop impact erosion.

The established surface crust must remain intact to be effective.

Bitumen products can breakdown and pollute receiving waters.

Vegetation may establish through surface cracks causing crumbling of the surface material.

Some products can reduce water infiltration into the soil.

Most products are temporary in nature and may requi bin application.

Usually require a m um curing time (say 24 hour until fully ef ve.

Can expe e spot fa during heavy rainfall. Re cation may equi ed after storm events, n if only rec pplied.

Susceptible to cular and pedestrian dam mage.

They may not adequately penetrate soil surfaces c isting primarily of silt and clay, par cularly well compacted.

So soil binders may not perform well is appl ring periods of low humidity, or if the soil is too dry.

During periods of wet weather, some soil binders can become slippery and/or leach out of the soil.

Adequate curing of the soil binder may not occur if low temperatures occur within 24 hours of placement.

Some soil binders may not be compatible with existing vegetation.

Limited information exists on the full water quality and environmental impacts of some soil binders.

Special Requirements

Soil binder must be environmentally benign (i.e. non-toxic to plant and animal life) and non-combustible. Potential impacts on stormwater must be considered.

When selecting a product, consideration must be given to the binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust.

More than one treatment is often required, although ongoing treatment may require a lower application rate.

For many products, the protective layer must remain intact to be effective and therefore no traffic, of any kind, is permitted.

Specialised machinery is generally needed for their application.

Site Inspection

Ensure no material is displaced from the site during the application and curing periods.

Check site logbook for duration between application and reapplication.

Check traffic control measures (if required).

Application

Application procedures vary with product type. Always seek manufacturer's advice and specifications.

1. Refer to approved plans for location, extent, and application details. Where there are questions or problems with the location, extent or method of application contact the engineer or responsible on-site officer for assistance.
2. Ensure the use of a given soil binder is approved by the State prior to its use.
3. Soil binders must be applied in accordance with the manufacturer's recommendations regarding application rates, pre-wetting of the surface, and cleaning of equipment.
4. Ensure the treatment area is suitably roughened prior to application of the soil binder.
5. Only apply soil binder when the soil is at or near the required optimal moisture content. The soil must contain sufficient moisture to assist the agent in achieving uniform distribution.
6. Ensure the soil binder is applied with sufficient time to allow drying prior to anticipated rainfall.
7. Ensure the binder is not applied to frozen soil, or when the temperature is below 5 degrees Celsius.
8. Ensure soil binders are not be applied during or immediately before anticipated rainfall, or to areas containing standing water.
9. Overlap spray a minimum 150mm.