BITUMEN EMULSION

Green Star Industries Co.

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This paper intends to identify the advantages of using ***Bitumen Emulsion*** *over other traditional alternatives and investigates the reasons for the road engineers reluctance to use it locally.*

This paper proposes suitable remedial measures to overcome the perceived disadvantages and promote use of ***Emulsified Bitumen*** *as an environmentally friendly alternative.*

- Bitumen Emulsion
- How to identify high quality bitumen?
- Storage and Spraying Conditions
- FAQ

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- *Emulsion Bitumen and its characteristics*
- *Why are some contractors reluctant to use Emulsion Bitumen?*
- *How to identify high-quality Emulsion Bitumen from low quality?*
- *Economical benefits for government and private contractors*
- *Applying Emulsion and Paving Asphalt*
- *Emulsion Bitumen storage conditions*
- *Differences bet. Emulsified Bitumen and Dissolved (Cutback) Bitumen*

Emulsion Bitumen Applications:

a) Waterproofing

b) Preventive Maintenance Treatment (Pavement Seal & Protect):

1. Prime coat

2. Tack coat

3. Seal Coat

4. Fog Seal

5. Slurry Seal

6. Chip Seal

7. Sand Seal

8. Micro-Surfacing

9. Cold Mix

10.Mulching

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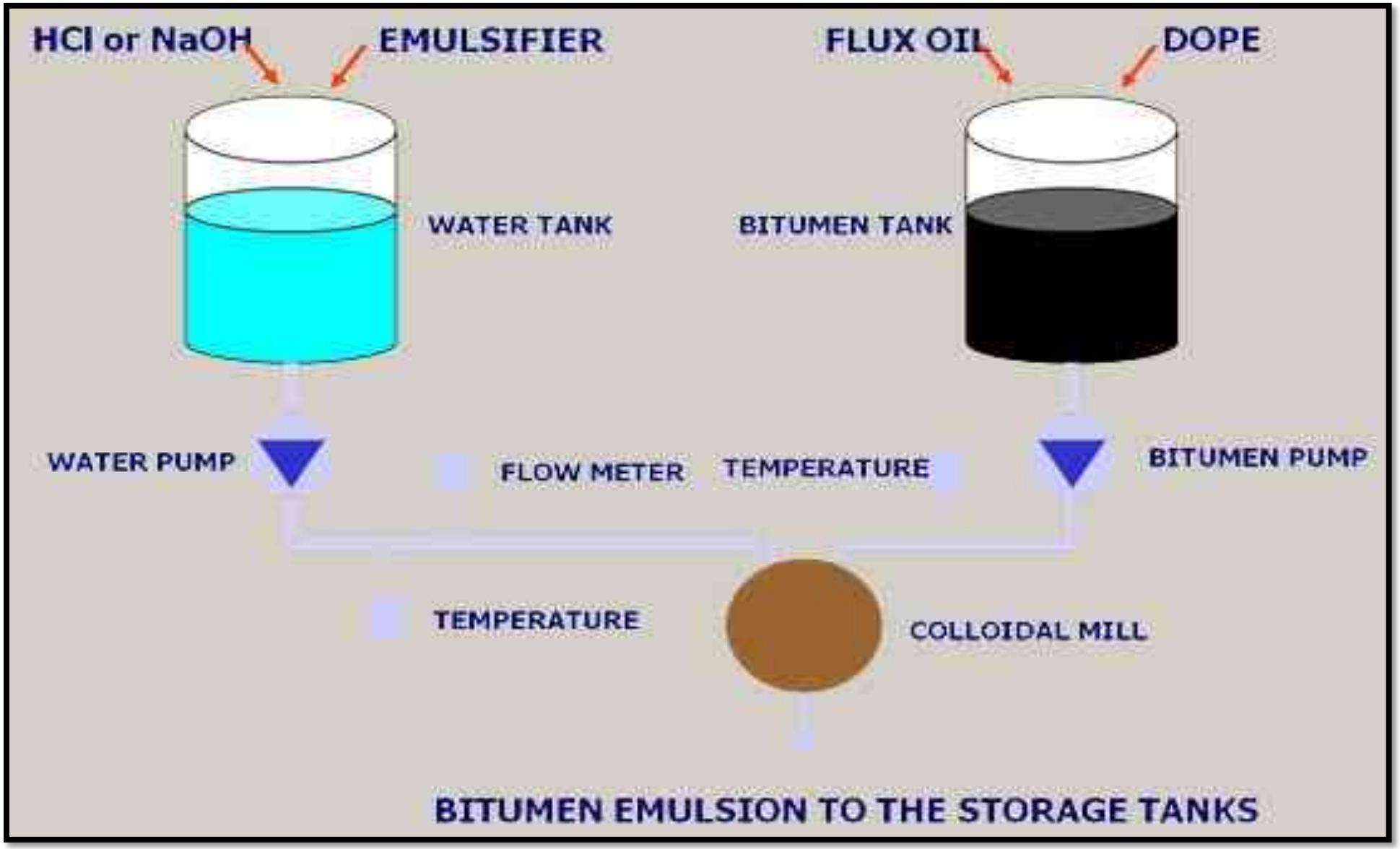
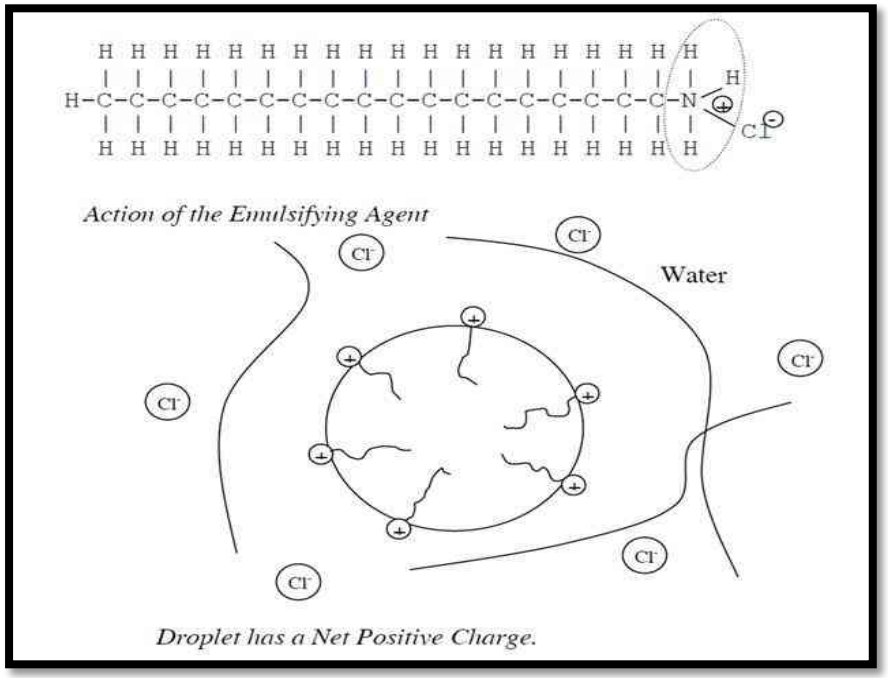
What is
Bitumen Emulsion?

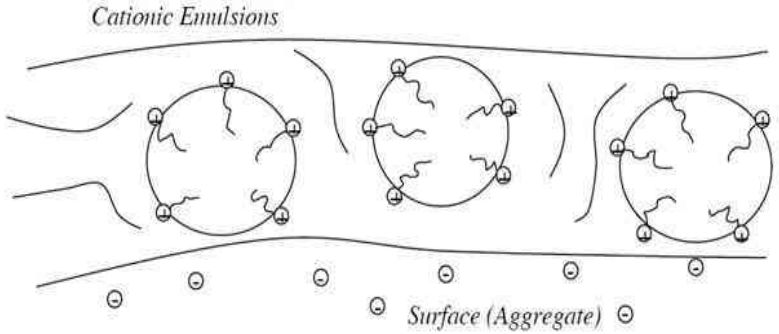
Mixture of Base Bitumen, Water, Emulsifier and Additives



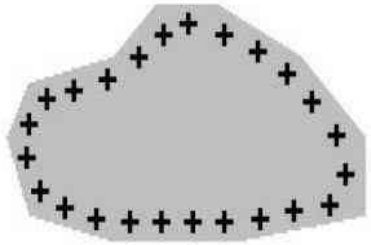
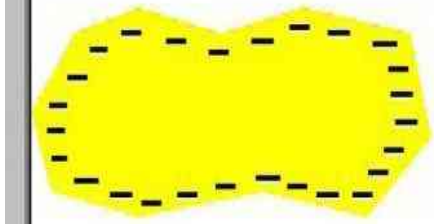
Process of Bitumen Emulsion Production



Cationic Bitumen Emulsion



Cationic Emulsion Bitumen is bonded to both positive and negative charge materials.

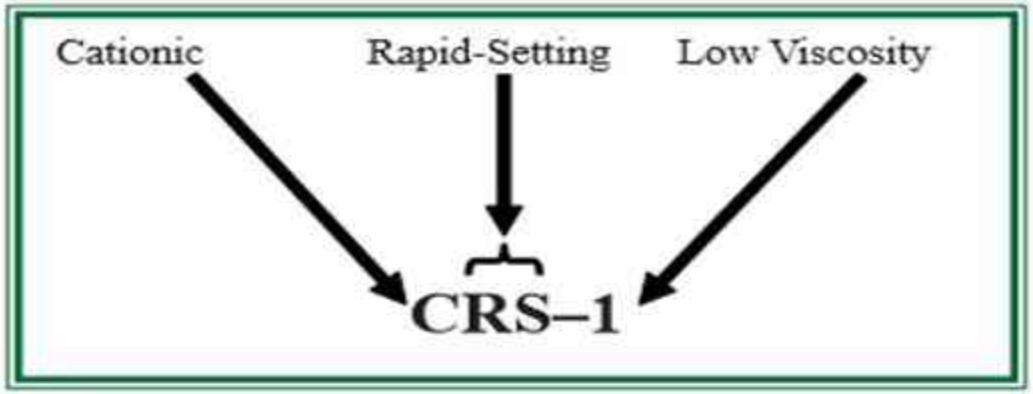
Material	Cationic emulsion	Anionic emulsion
Electropositive materials (calcium, basalt) 	Neutralizing reaction ▼ **BREAKING** ▼ forming of insoluble amine carbonate ▼ **ADHESIVENESS**	attraction ▼ **BREAKING** ▼ forming of insoluble calcium soap ▼ **ADHESIVENESS**
Electronegative materials (silex, quartz, granite) 	attraction ▼ **BREAKING** ▼ forming of insoluble amine silicate ▼ **ADHESIVENESS**	no neutralizing reaction ▼ no attraction

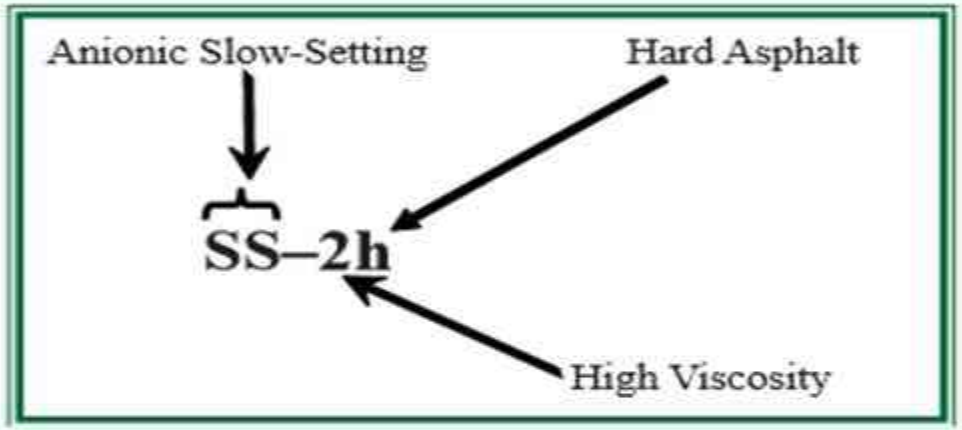
Emulsifier used in production of Emulsion Bitumen determines the rate at which the bitumen will set when exposed to air.

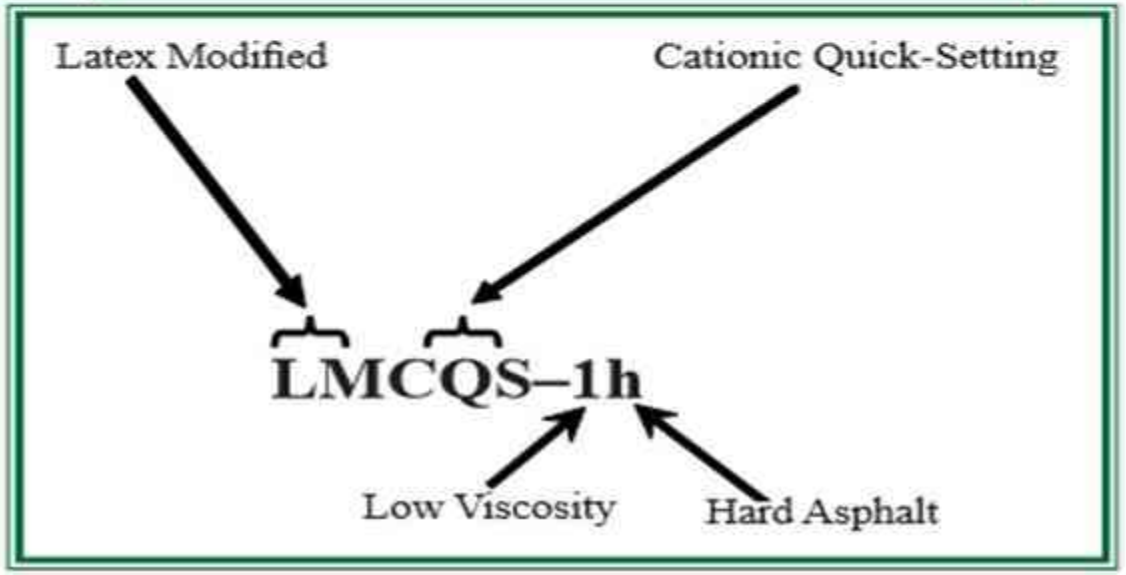
In hot weather
Bitumen: 40-50 or PG7010 and PG7610

In normal weather
Bitumen: 60-70 or PG6410, PG6416 and PG6422

In very cold weather
(snow on the surface)
Bitumen: 85-100 or PG5816, PG5822, PG5828 and PG5834







CRS: Cationic Rapid Set which has 40% to 65% primary bitumen grades: 60-70, 85-100 or 40-50 (applied depending on the climate of the paving place). It can accept foot traffic in as little as ½ hour after application under optimal conditions. At 60˚F and 75% humidity, cure time is approximately three hours. Shaded areas may delay curing time depending on nighttime temperature and humidity. CRS is considered a rapid-setting tack coat emulsion.

CMS: Cationic Medium Set which has 52% to 65% primary bitumen grades: 60-70, 85-100 or 40-50 (applied depending on the climate of the paving place). They are usually made by passing the mixture of hot bitumen and water phase between a rotating disc, cone or wheel and a stator. In the emulsification process, the hot binder is mechanically separated into minute globules about 3-4 hours, dry and ready to drive or the implementation of the next layer of asphalt.

CSS: Cationic Slow Set which has 50% to 65% primary bitumen-grades: 60-70, 85-100 or 40-50 (applied depending on the climate of the paving place). It can accept foot traffic in as little as ½ hour after application under optimal conditions. At 60˚F and 75% humidity, cure time is approximately 4 to 8 hours. Shaded areas may delay curing time depending on nighttime temperature and humidity. CSS is considered a rapid-setting prime coat emulsion

Advantages of Bitumen Emulsion

- ✓ It offers proper solution for any kind of asphalt and maintenance (Streets, Roads & Airstrips).
- ✓ It can be implemented in ambient temperature.
- ✓ It can even be used on wet surfaces.
- ✓ It can be applied by simple paving machines with narrower nuzzles.
- ✓ It is completely environmentally friendly in the whole process of production, transportation, pavement and breaking.
- ✓ It is not toxicant and there isn't any aroma.
- ✓ No need for heating the product in most cases.
- ✓ Practicality of asphalt and Seal Coat applications with low thickness.
- ✓ High speed of asphalt paving and coating.
- ✓ Fast breaking in the vicinity of stone materials.
- ✓ High penetration rate due to high fluidity.
- ✓ Possibility of Long distance transportation in bulk packaging or in drums.
- ✓ It is not flammable- safe storage, secure transportation and easy and safe paving operations.

Advantages of Bitumen Emulsion

- ✓ After breaking process, the color changes from brown to black.
- ✓ To avoid getting cold, Bitumen Emulsion must be kept at temperature bet. 5°C to 50°C .
- ✓ In case that heating is not possible, it must be mixed with a steel or Teflon blender every other week or once within 2 weeks for 1 hour to remain homogeneous and intermixed well.
- ✓ Bitumen Emulsion must be pumped into the bottom of the storage tank (and not from the top) so that water and bitumen remain intermixed.
- ✓ To ensure the best quality application, it is important to install paving nozzles at the right place. It is also recommended that two nuzzles are used to cover any part of the surface.

Advantages of Bitumen Emulsion

- ✓ If you are looking to wind up with a low percentage of asphalt you can get better coating with emulsion because water helps to spread it around to cover and coat aggregate particles.
- ✓ There are also savings that benefit the environment because you don’t have solvents that evaporate from the emulsion (other than water) and going into the air as unburned hydrocarbons.
- ✓ You also save energy because you don’t need to keep the emulsion heated up to use it as you do with cutback.

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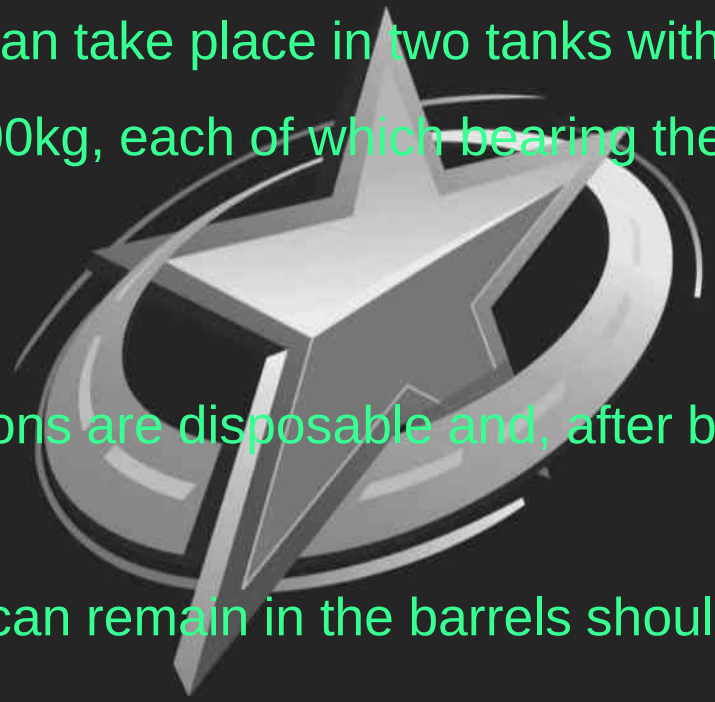
Best Practice for Storage

- ✓ Temporary storage of emulsions can take place in two tanks with a total capacity of 8 tons.
- ✓ Packaging is done in barrels of 200kg, each of which bearing the following details:

  Product Type

  Production Date
- ✓ The barrels containing the emulsions are disposable and, after being emptied, are transported for recycling.
- ✓ The maximum time the emulsion can remain in the barrels should not exceed two (2) months from its production and packaging.



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Technical Notes about Emulsion Bitumen

- Low viscosity (low penetration grade) bitumen is commonly consumed in the countries where oil extraction and production of refined oil products are cost intensive, at the same time climatic conditions are often characterized by autumn weather and humid cold winters,. In fact, pure petroleum bitumen is subjected to shorter degree of oxidation process for producing road construction bitumen such as Emulsion Bitumen.

- In case of using less adhesive and less viscous bitumen grades 150/200 or 200/300, compared to bitumen grades 50/60 and 80/85, Bitumen Emulsion (e.g. CRS-1) shall have a content of approximately 60 to 65 percent of bitumen (in some sources, say 70%). This will cause a strong bitumen–aggregate bond and Saybolt Furol viscosity (SFV) will be more than 20 m2/s. In the countries with a climate similar to Iran, we can use bitumen 60-70 grade with a content ranging from 52 to 55 percent so as to have SFV of 20 to 100 m2/s.

- According to Iran Highway Asphalt Paving Code Number 234 which is in fact a Persian translated version of US ASTM standard, in Standard Test Method for Distillation of Emulsified Bitumen, penetration shall range from 100 to 250. As you may know, in this test method, American native bitumen behavior is considered as the standard benchmark of the test, whereas penetration grade of Iranian-made bitumen is between 40 and 120. That's why Iranian-produced bitumen is commonly called Hard Asphalt or Hard Grade Bitumen (based on the international definition of Hard Bitumen). Hence, according to the international standards, Iranian Bitumen Emulsions shall be called CRS-1H, CSS1-H and CQS1-H, obviously due to the usage of Hard Grade Bitumen and Emulsified Bitumen CRS-1 or CSS-1 is not commonly used in Iran.

“The Bitterness of poor quality remains long after the Sweetness of low price is forgotten.”

Contractors traditionally rely on Cutbacks for road construction projects. Some construction contractors are also unable to use Emulsion Bitumen for paving applications effectively. During the recent past years, in most parts of the world usage of bitumen emulsion as a road construction material has increased, partially replacing penetration grade bitumen (tar) and cutback bitumen due to environmental reasons. However, there is still somewhat reluctance among road engineers to use Bitumen Emulsion as a substitute for other types.

There are numerous uses for Bitumen Emulsion utilizing highly varied techniques, which results in several different formulations; namely cationic and anionic depending on particle charges and rapid setting, medium setting and slow setting depending on the speed of separation of bitumen from aqueous medium. In Iran, cationic type Bitumen Emulsions is used, as majority of the available local aggregates are acidic.

Bitumen Emulsion has proven itself as a binder with very low energy consumption in road maintenance and laying of surface dressings. Penetration grade bitumen requires heating at construction sites, which emit smoke with chemicals and also it needs fuel, which is non-renewable. Kerosene used for cutting back the viscosity of bitumen is also a non-recoverable waste when curing takes place on the road.

Impact of Poor Bitumen Emulsion on the Asphalt Pavement

Why road engineers are reluctant to use Bitumen Emulsion?

1) Undesirable experience caused by low quality product in previous projects.
2) Improper penetration of Bitumen Emulsion into 100 percent- compacted road base soil (similar to MC bitumen)! After applying MC bitumen on a 100- percent compacted base, the surface becomes apparently black and it seems that spraying has been done correctly, while no penetration has happened at all. The reason for this mistake is that MC is not coagulated after spraying.
3) Inadequate absorption & adhesion of low quality Bitumen Emulsion to the underlying base surface which leads to imperfect bonding between bitumen and aggregates, bitumen coagulation and pick-up of sprayed Bitumen Emulsion from the base surface. In the same condition, Cutbacks are less sensitive.

Impact of Poor Bitumen Emulsion on the Asphalt Pavement

4) Adhesion of sprayed Bitumen Emulsion residues to a rubber-tired paver finisher.

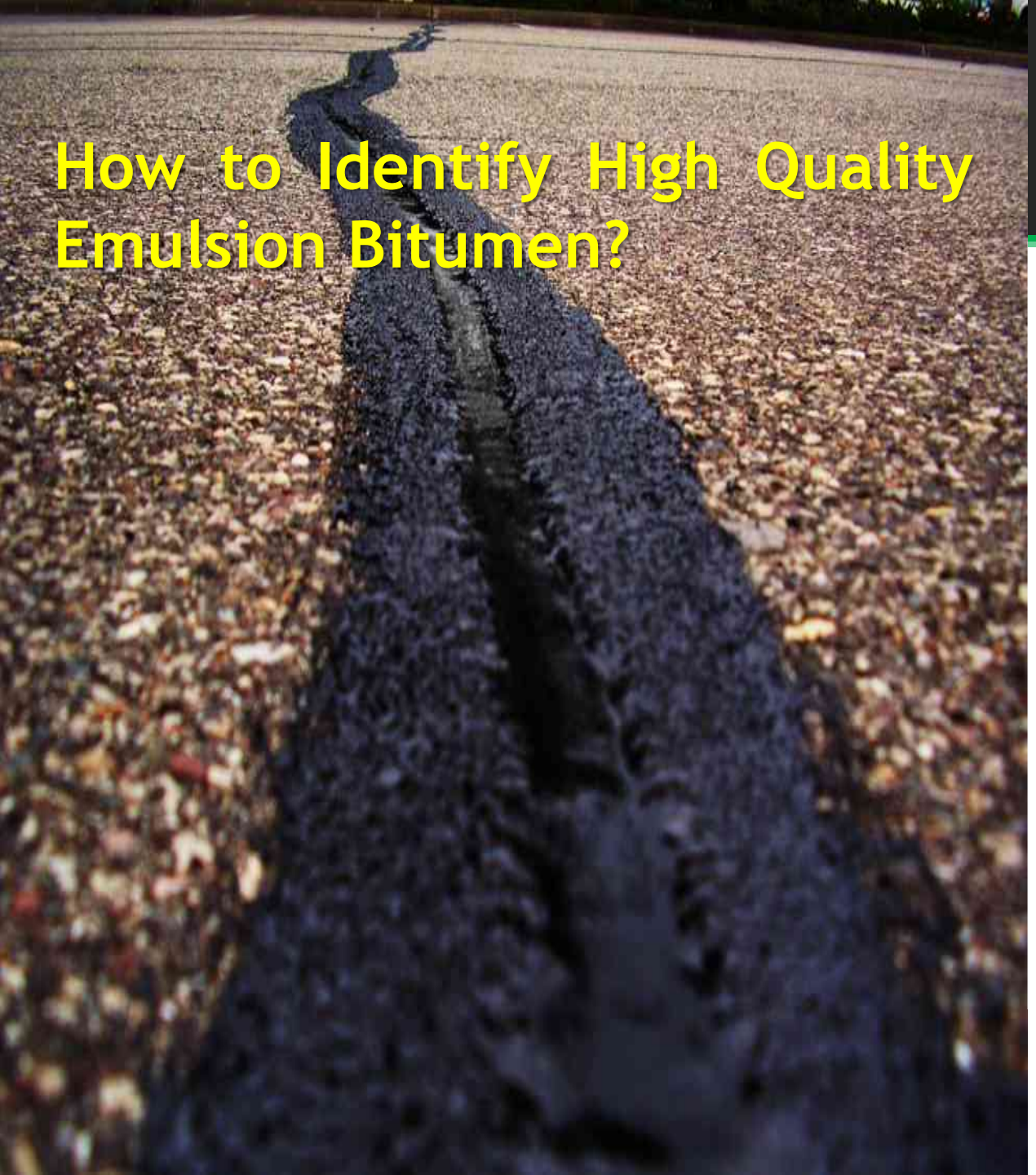
5) Slow setting process leads to traffic congestion and boredom.

6) Little knowledge of some contractors about Emulsion Bitumen and its properties, its storage time and spraying method. In order to spray Emulsion Bitumen, there is no need for using special emulsion sprayer truck or special storage tank. Using a MC sprayer is simply practical.

7) Bad quality Bitumen Emulsion causes phase separation in paver sprayer tank. In this condition, many contractors resort to directly pre-heating of two phase emulsion to remove it from the sprayer tank. Consequently, bad quality emulsion will block pumps and spray nozzles.

8) Bad quality Bitumen Emulsion also causes phase separation in the reservoir tank only after one-week storage and as a result, makes emulsion removal impossible.

9) There is a traditional substitute called Cutbacks, or MC, that can be manually produced in a workshop.



How to Identify High Quality Emulsion Bitumen?

a) High quality Bitumen Emulsion can keep its quality for a transport distance of about 2000 km inside a tanker truck without using a mixer and a heater, while low-quality Emulsion Bitumen requires constant mixing and heating and it cannot be planned for a long distance move.

b) The best reservoir tank for Emulsion Bitumen storage is a double-wall mixing tank. High quality Emulsion Bitumen can be stored in an active state for up to 4 months simply by rotary mixing for one hour a week. Good quality Bitumen Emulsion can also be stored in a petroleum or water reservoir tank at least for 3 months, while low-quality one has to be always kept at a temperature above 50 degrees Celsius (122 Fahrenheit) and requires daily mixing as well.

c) Depending on the setting time, high quality Emulsified Bitumen allows the surface to dry after a given time of 5 to 8 hours, so it doesn't adhere to the tires of paver finisher. But in case low quality Emulsion Bitumen applied, setting not only occurs at least one day after application, but, most likely, it coagulates and picks up from the pavement surface. As a result, bitumen residues stick to the tires of paver finisher.

d) High quality Emulsion Bitumen is sprayed from spraying nozzles fluently and uniformly, allowing a uniform distribution and perfect coating on a specified surface. On the contrary, application of low quality Emulsion Bitumen may lead to an uneven spray result and unsatisfactory distribution of coagulated bitumen layer on the surface.

e) Due to stability of high quality Bitumen Emulsion, it is simply sprayed without the need for water or gasoline addition. But when low quality Bitumen Emulsion is applied, emulsion may separate out into two phases- since it is inherently unstable- thus, contractors have to add water or gasoline to the emulsion.

f) Sometimes, nozzles may be blocked and clogged. In this case, contractors have to pre- heat unstable low quality emulsion by a flame torch in order to remove and spray it on the pavement surface.

g) By using genuine Emulsified Bitumen to build a road, we enhance long-term asphalt performance. Its performance characteristics can be regarded as benchmarks for behavior of genuine emulsions in general consisting of:

i. entire coverage of aggregates with bitumen film,
ii. suitable bitumen- aggregate adhesion,
iii. binding the aggregate particles together,
iv. prolonged kinematic viscosity maintenance rate; longer than 20 seconds,
v. Demulsification speed or turning color from brown to black in less than 60 seconds for rapid set and less than 120 seconds for slow set.

Spraying Tips for Road Work

How to apply Asphalt Emulsion on a surface?

Primecoat Application Guidelines:

In order to leave about 600 to 800 g/sqm of residual bitumen on base soil surface, spray acc. to the following instructions:

- Approx. 1150 to 1500 g/sqm of 52-percent Bitumen Emulsion.
- Approx. 1050 to 1400 g/sqm of 57-percent Bitumen Emulsion.

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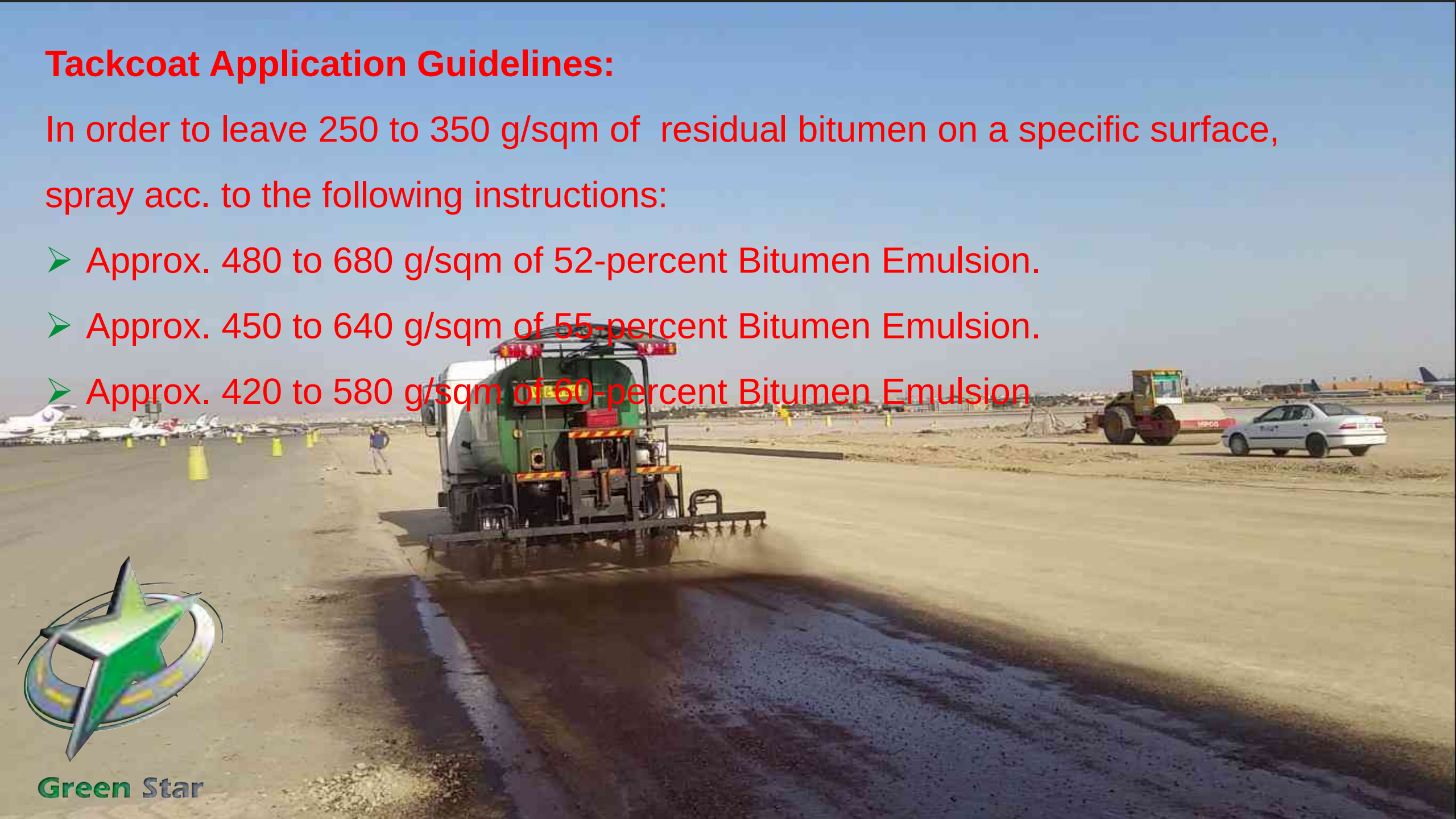
Tackcoat Application Guidelines:

In order to leave 250 to 350 g/sqm of residual bitumen on a specific surface, spray acc. to the following instructions:

- Approx. 480 to 680 g/sqm of 52-percent Bitumen Emulsion.
- Approx. 450 to 640 g/sqm of 55-percent Bitumen Emulsion.
- Approx. 420 to 580 g/sqm of 60-percent Bitumen Emulsion



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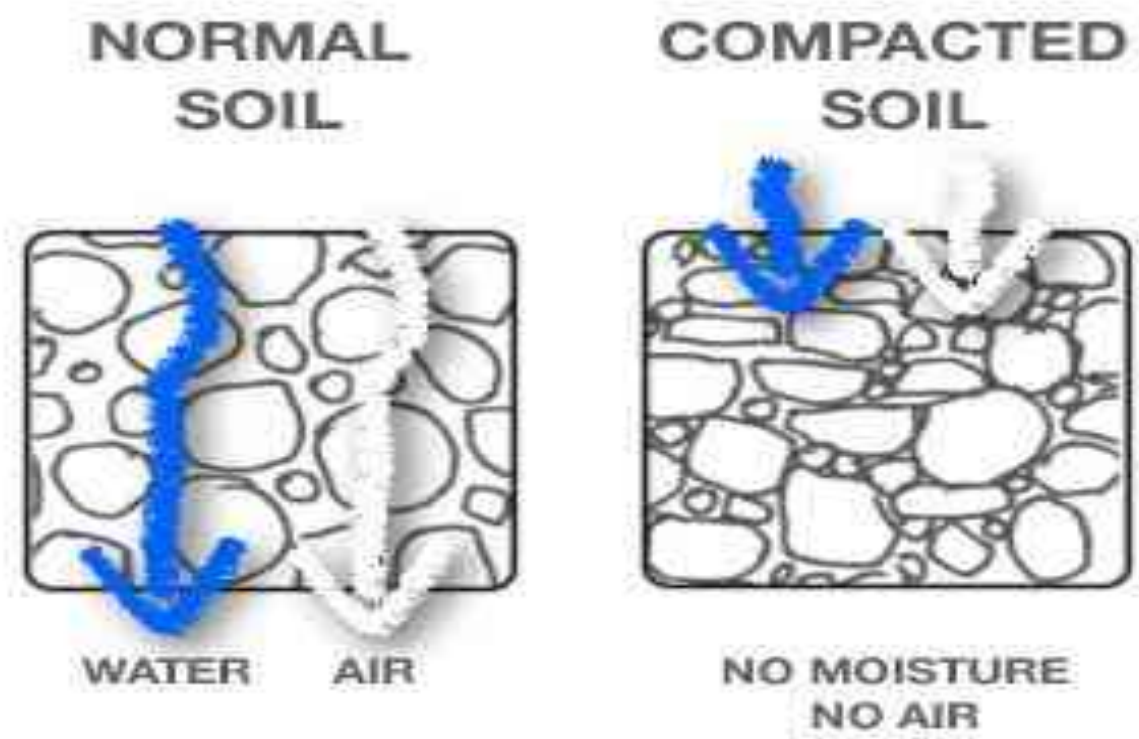
Note, not only Bitumen Emulsion, but Cutback Bitumen don’t penetrate into a soil surface with 100% compaction, irrespective of the quality of Emulsified or Cutback Bitumen. Even under water spray, a 100%- compacted soil resists to penetration and water moves on the surface. Therefore, it is better to prepare and moisten the surface – slightly damp- by a pump sprayer or with a wire bristle broom to help emulsion binder to penetrate into the base soil.



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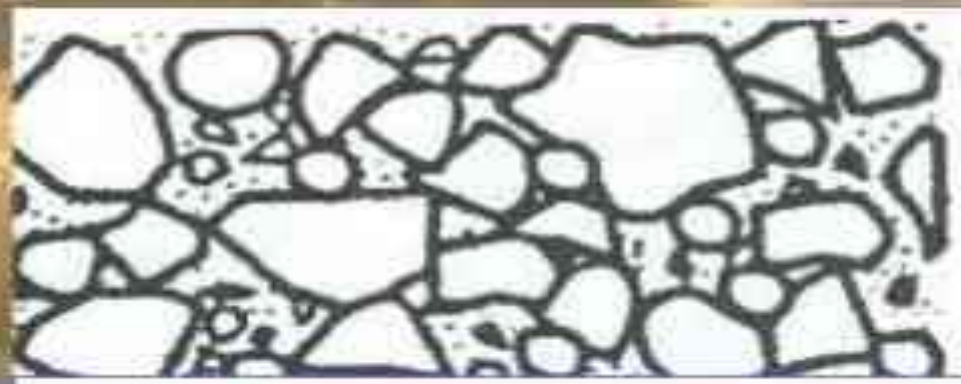
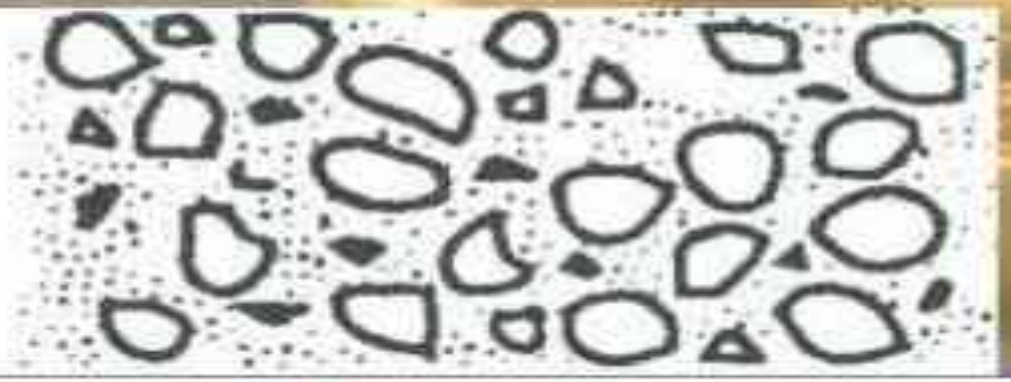
Open graded bases are ideal for ground penetration.

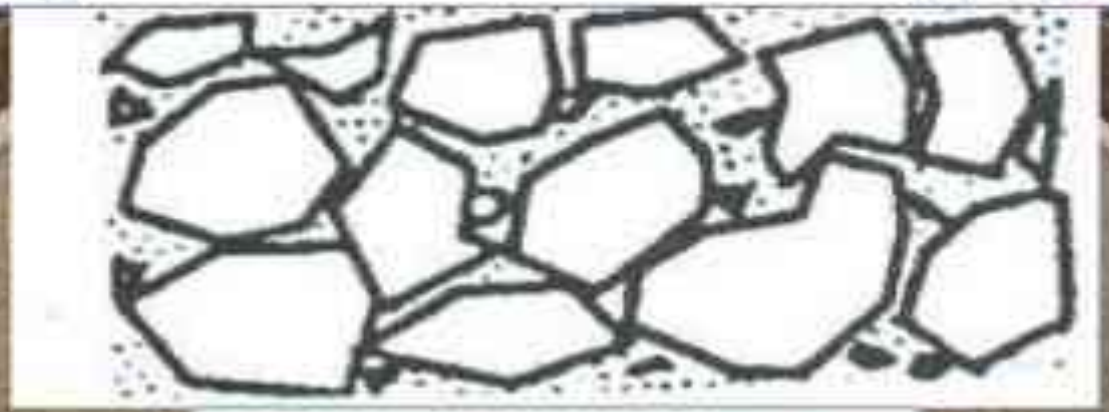
open gradation of aggregate lacks the mid-sized aggregates



Dense graded.



Gap graded



Open graded

Open-graded aggregate is an aggregate containing little or no mineral filler, or in which the void spaces in the compacted aggregate are relatively large.

Nozzle used for Bitumen Emulsion spray is narrower than the one used for Cutbacks because it is more fluid.

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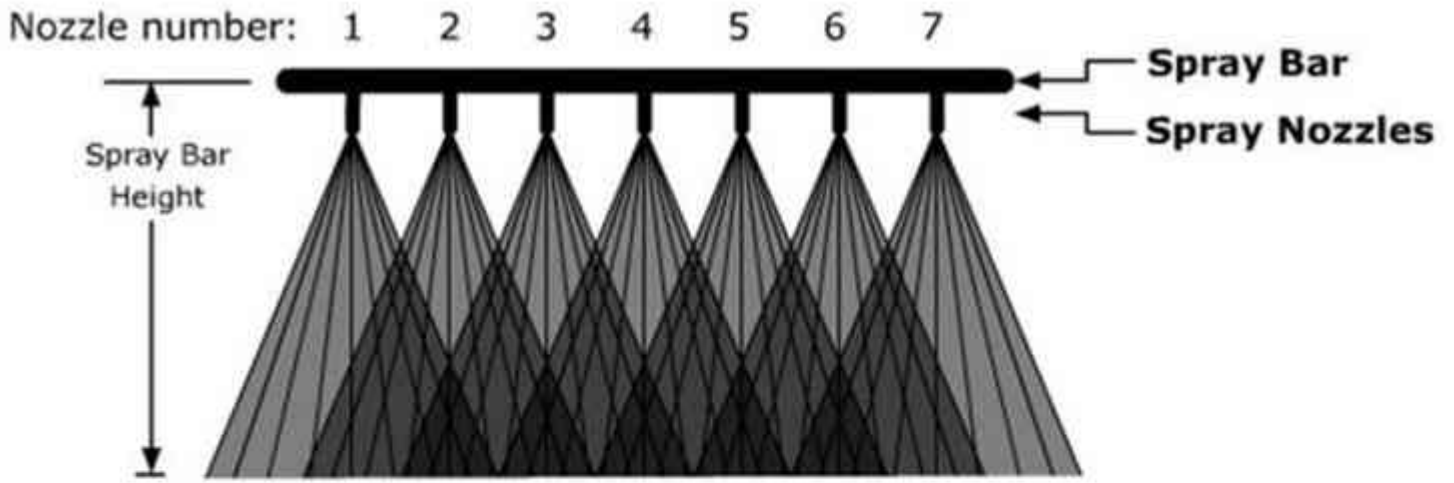
Correct Spray Pattern

For a greater application rate, it is highly recommended that the spray nozzles to have a triple lap pattern (as per following picture)



Good coverage - triple lap

Except for the outside nozzles, each point on the pavement surface is covered by exactly three spray nozzles - a triple lap. For a given nozzle flow rate, this results in a greater application rate than for a double lap.

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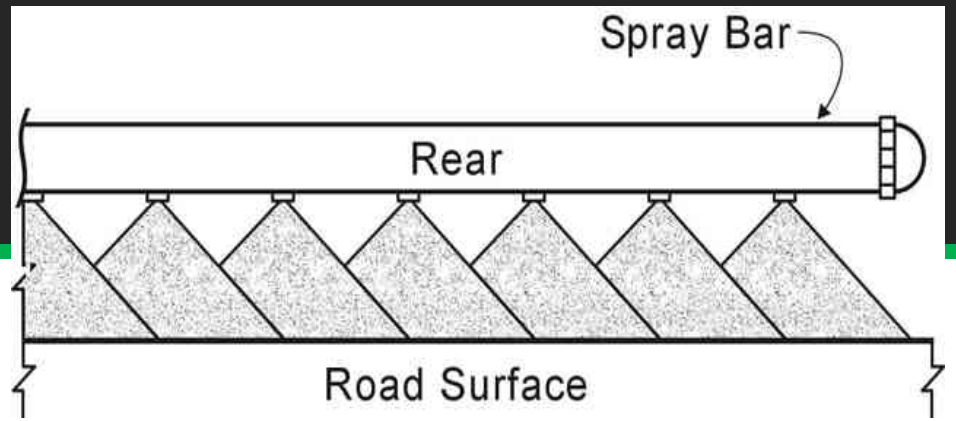
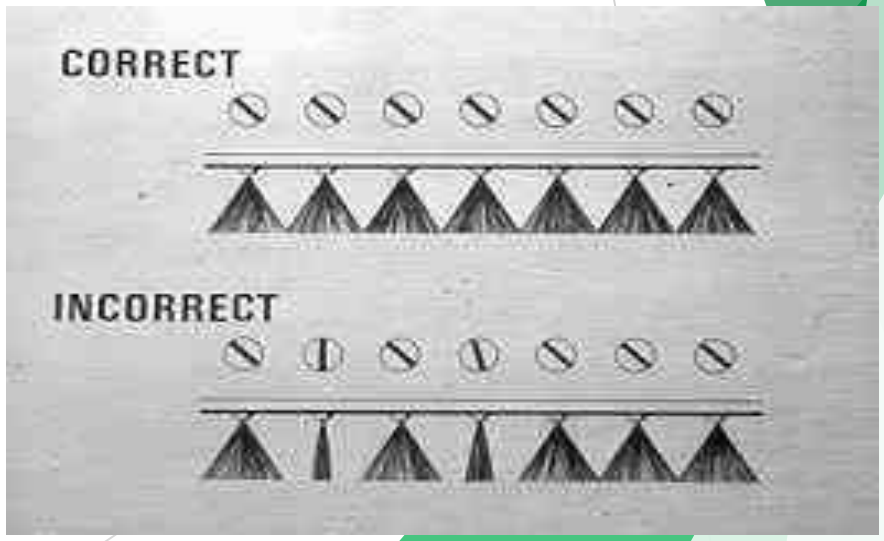
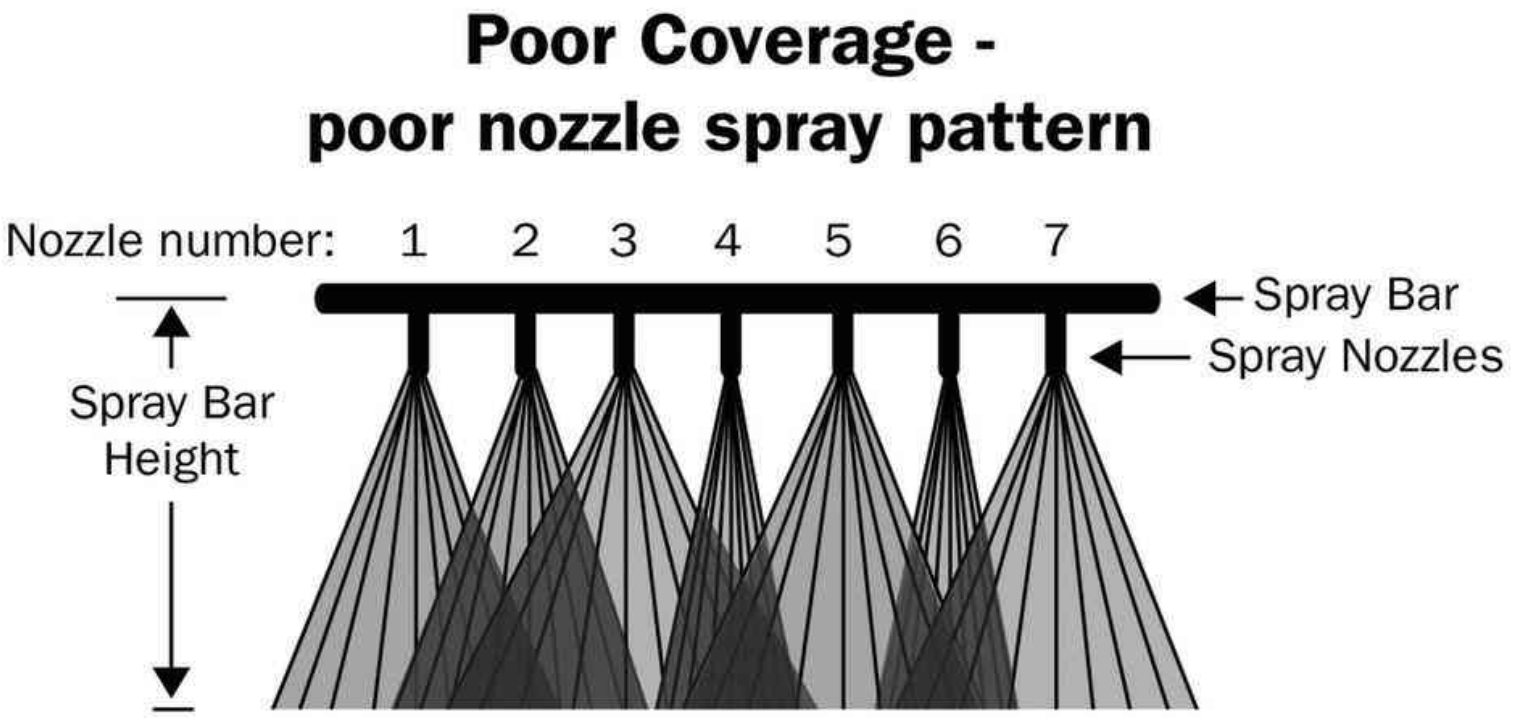

Spray Bar
Rear
Road Surface


CORRECT
INCORRECT

Wrong Spray Pattern

For a greater application rate, it is highly recommended that the spray nozzles to have a triple lap pattern (as per following picture)



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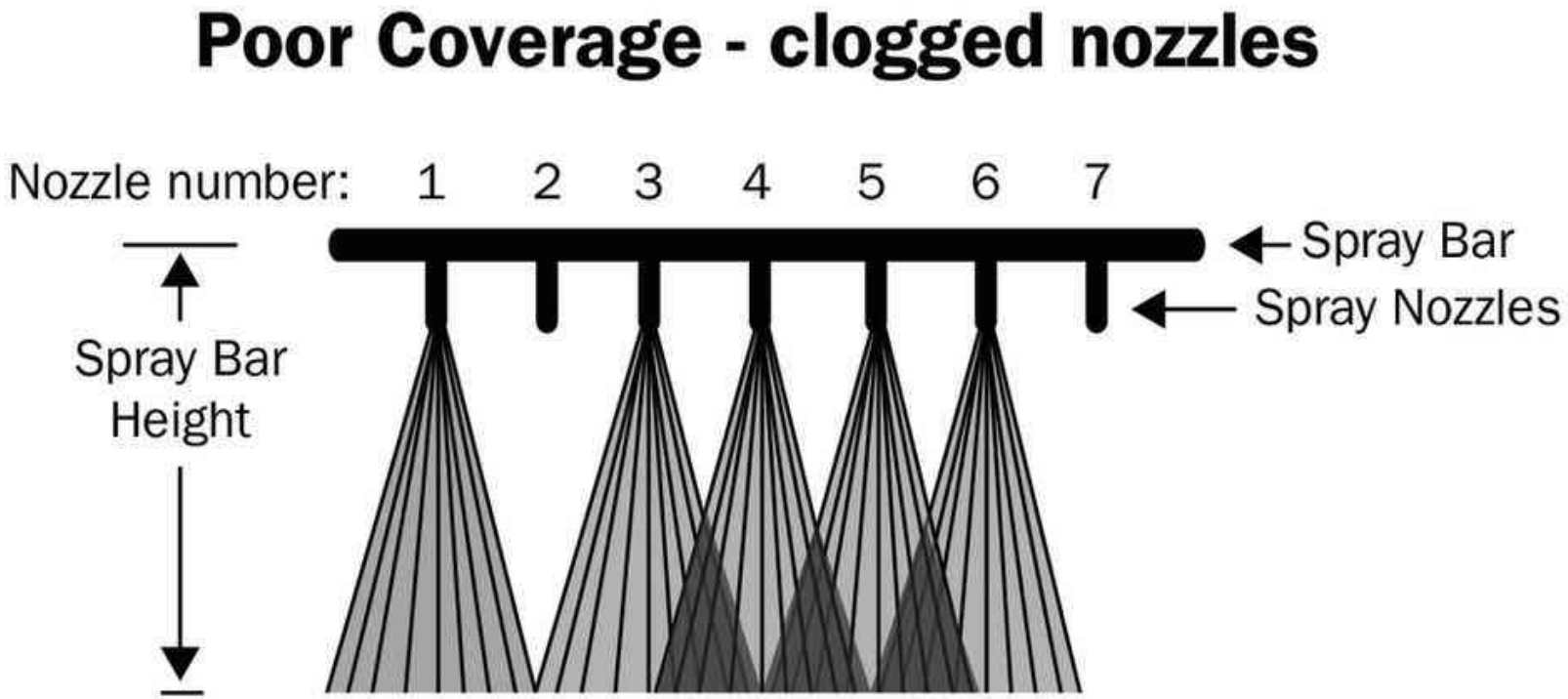
Clogged Nozzles

Check nozzles flow rate and fix any blocked or clogged spray nozzle.



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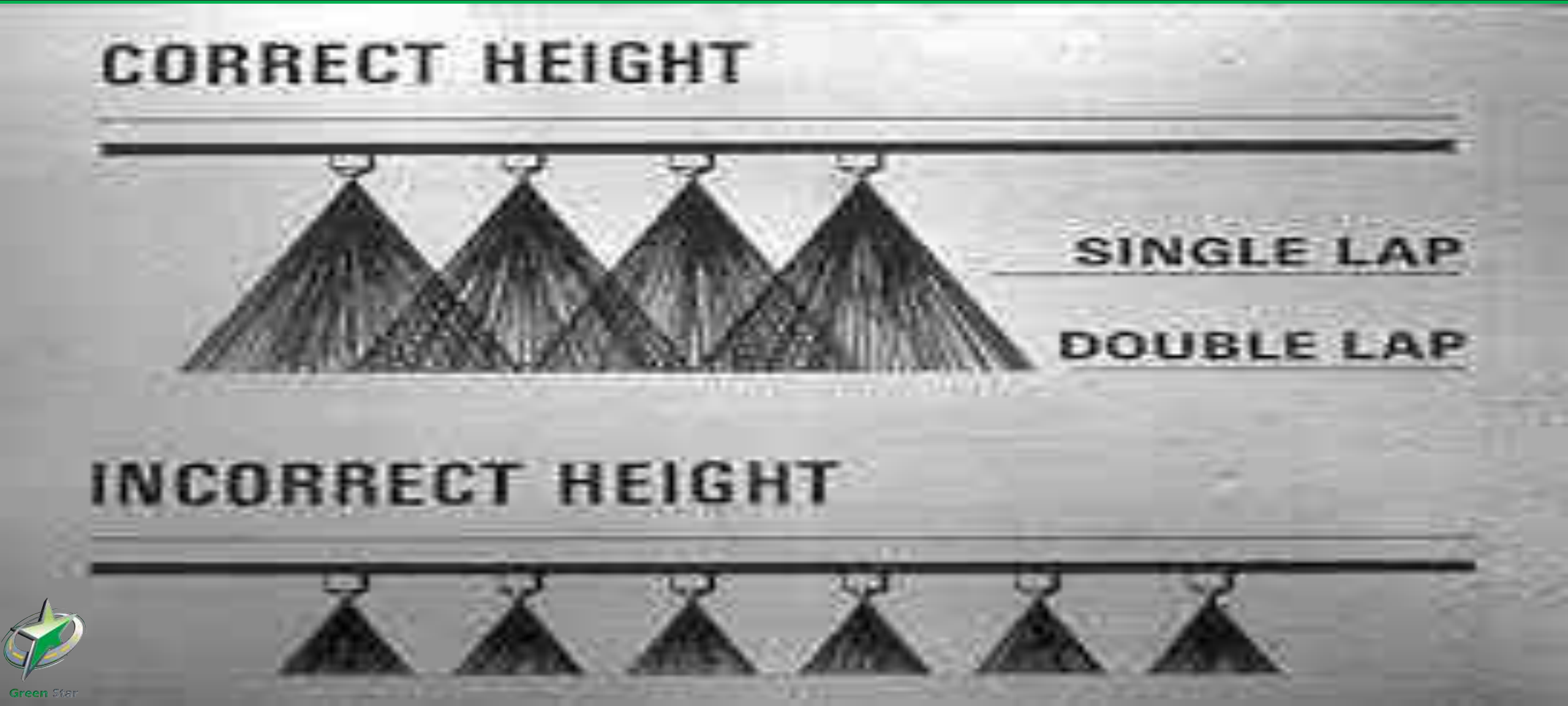
To adjust the bar height



Storage & Handling Tips

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Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

GENERAL

- Use the correct type and grade of emulsion.
- Transport emulsion in full containers fitted with baffle plates to minimize surging that may cause foaming and breaking.
- Do not mix anionic and cationic bituminous emulsions. This will cause each emulsion to break and separate into water and bitumen, leaving tanks or other equipment partially filled with semi-solid bitumen, and a difficult cleaning job.
- Always use clean containers. Bituminous emulsion must not be loaded into storage tanks, tank cars, tank transports or distributors containing remains of incompatible materials.
- Bituminous emulsions can cause corrosion in non-ferrous metals such as brass, copper and aluminum. The use of such materials in the components of valves, pumps, pipe work and fittings should be avoided.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Safety

Bituminous Emulsions are the safest form of Bitumen products as they are handled at ambient temperatures which eliminate any chance of burns which can occur with hot applied binders. Whilst Standard Emulsions are applied at ambient temperatures, it is always advised to avoid direct contact with skin and to have adequate ventilation and follow the advice in the relevant product Safety Data Sheet.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Storage life

The length that emulsions can be stored varies according to the emulsion type and components used. For example rapid-set emulsion has a shorter shelf life than a slow-set emulsion. You should seek advice from your emulsion supplier on the shelf life of their products.

Sedimentation and sieve tests are good indicators of an emulsion’s potential storage life.

During long-term storage, sedimentation of the bitumen droplets occurs due to the higher density of the bitumen versus water. Regular circulation will help increase the shelf life of the emulsion but care must be taken not over circulating which can shear the emulsion and cause residue build up.

Emulsions may increase in viscosity (thickness) over time and warming the emulsion prior to use will reduce the viscosity.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Bulk Storage

Tank design

All regulatory and company engineering standards must be followed when designing and constructing a tank. Tanks may be made from mild or stainless steel, high density polyethylene, polypropylene co-polymer and many engineering plastics. The selection of materials to be used will depend on the heating system to be employed. It is always recommended that the emulsion supplier be consulted when considering a new tank or repairing tanks. We recommend the following features be included:

- liquid level measurement (counterweight, pressure or electronic) to manage stock on hand.
- access hatch to enable inspection and cleaning.
- ability to bottom fill to avoid breaking up and re-entraining the emulsion skin
- a means of earthing the tank.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Tanks may be raised on a platform to allow gravity feeding or for space considerations. In areas where excessive cold/freezing may occur, consideration should be given to :

- Heat tracing and Insulating pipework/pump housing
- Enclosing of the under section of the tank to protect the pump/pipework
- Tank insulation and shrouding. A product, such as mineral wool, may be used for insulation then clad with aluminum or a similar material.
- Tank heating to protect the product from freezing/excessive cooling. Bunding is required and must conform to local statutory requirements. Basic spill protection may consist of a moat around the tank, usually with some absorbent material such as sand.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Vertical Tanks

Vertical tanks are ideal for the storage of standard emulsions. With an angled return pipe, a round shape tank creates a whirlpool, promoting gentle circulation of the emulsion. This tank type also has a reduced surface area resulting in less exposure of emulsion to air and skin formation. They also occupy less space, are easier to heat, insulate and monitor for product level.

Horizontal Tanks

Horizontal tanks are generally not recommended because they present a larger surface area to the air that can form a large skin, are more difficult clean and circulate. Their use should be limited to short term field storage. Horizontal tanks may be set with a slight slope to facilitate draining and a directional return pipe to promote circulation.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Tank safety It is always advised to consult your Emulsion supplier when considering purchasing, modification, repair or replacement of your Emulsion Tank.

If considering a Used tank, it is always advised to:

- learn the history of the tank e.g. Age, Previous use, internal design,
- thoroughly clean before use to ensure the best environment for the storage of your Bituminous Emulsion. Cleaning can involve the use of use steam, high pressure water, low pressure water, dry ice and/or kerosene.

Before commencing any work on a tank care should be taken to ensure it is safe to do so and that there is no flammable or harmful liquid, gas or residue present.

Never cut a used tank unless an appropriate hot work permit is obtained.

Care is required when siting storage tanks, for example they should not be located near high tension power lines. Where practicable, they should be located away from waterways.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Tank inspections

A build-up of residue inside a tank will occur over time and can reduce the storage life and the effectiveness of an emulsion. However with simple proactive maintenance practices, operators of bituminous emulsion storage tanks will be able to ensure the storage tank is kept free of excessive residue.

An annual inspection of the inside of the tank is highly recommended to determine the volume and viscosity of any residue. This will then dictate the best course of action required in terms of the need for flushing, cleaning or dig out.

Only those with a confined spaces permit and the appropriate PPE should enter a tank.

Prior to changing over emulsion suppliers, we recommends that an inspection of the tank is performed by the new supplier to determine what cleaning procedure will be required to ensure the emulsion will not be adversely affected by the previous product.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Storage of Emulsion in Packaged form

Packaged Emulsion egg Pails, Drums or IBC’s, are suited to situations where only small amounts are needed or the use of emulsion will be infrequent. As with Bulk Emulsion the same best practices apply to storage and handling of emulsion in packaged form, this includes the following practices:

- Keeping packaged Emulsion undercover in areas where the product won’t be exposed to temperatures below 5°C to avoid freezing and damage from frost.
- Store packaged emulsion in an upright position off the ground (e.g. on a pallet).
- Circulating:
    - o IBC’s.: Use an agitation tool/pump to stir the emulsion within the IBC
    - o Pails/Drums.:
        1) Use an agitation tool to stir the emulsion within the drum.
        2) Use an engineered pail/drum rotator to help keep emulsion homogenous.
        3) Ensure vessel is sealed and lay the pail/drums on their side and roll them for several meters along the ground to mix the emulsion and then return them to their upright position.
- Ensure good stock rotation practices and use emulsion within 3 months from the date of manufacture

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Do not heat emulsion when it is in a sealed packaged format as this can increase the risk of an explosion. Heating of emulsion should only occur once it is transferred to a vessel designed for such a purpose.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Recommended storage temperatures Emulsions are sensitive to extremes of temperature. It is best to keep them within a temperature range as recommended by the manufacturer. The table below gives a guide to the minimum and maximum storage temperatures for Standard Emulsion types.

Emulsion	Minimum °C	Ideal °C	Maximum °C
Standard Emulsion – Anionic and Cationic Slow, Medium or Rapid Set ≤ 69% Bitumen Content	10	20 – 30	60

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

STORAGE TIPS

- Store at the temperature recommended for the particular grade.
- Some specialty products such as high bitumen content and polymer modified emulsions are designed for use within a short period (commonly less than one week) after manufacture.
- Regularly mix tank contents by gentle agitation or circulation to prevent buildup of sedimented bitumen particles.
- In bulk storage, mix the emulsion every 1–2 weeks (more frequently in cold weather) or as recommended by the supplier. Mixing may be by paddle agitator (slow), loose gear pump, slow centrifugal pump, or other suitable low shear pump.
- Do not bubble air through an emulsion to agitate it, as this will create excessive foam and may cause the emulsion to break.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

STORAGE TIPS

- A thin layer of kerosene or cutter oil (0.5 L/m2) spread on top of emulsion in storage tanks can prevent scum formation on materials that cannot be regularly agitated.
- Where there is doubt on the effectiveness of emulsions that may have been affected by extended storage or poor handling, its condition can be checked using the setting time test (AS/NZS 3241.29).

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Seven best practices for storing and handling asphalt emulsions in short:

1. USE STORAGE TANKS THAT KEEP THE EMULSION FROM FREEZING OR OVERHEATING.
2. 2. USE VERTICAL TANKS RATHER THAN HORIZONTAL TANKS.
3. 3. USE GENTLE AGITATION.
4. 4. AVOID REPEATED PUMPING AND RECIRCULATION.
5. 5. FOLLOW ALL SAFETY PROCEDURES.
6. 6. GATHER GOOD SAMPLES.
7. 7. TRAIN TECHNICIANS ON PROPER PROCEDURES.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

Loading Emulsion

When loading road tankers or sprayers, or filling drums, the emulsion should be passed through a filter consisting of a mesh sieve with an aperture of 4 – 6 mm. This will prevent lumps of bitumen blocking nozzles in the spray bar. These sieves should be checked and cleaned regularly to maintain acceptable loading rates.

Loading of emulsion should be done by sucking the product into to bottom of the sprayer or by lowering the filling hose to the bottom of the road tanker. This is to avoid foaming or breaking of the emulsion due to splash filling.

It is not recommended that emulsion be returned into storage as it can compromise the quality of the product.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

CLEANING OF TANKS & EQUIPMENT

a) Clean tanks properly at product changeover.

b) Thoroughly wash out equipment with kerosene or cutter oil when changing emulsion grade or type, particularly when changing between anionic and cationic emulsion types.

c) At the end of each day, flush out the pumping and spraying system on the bitumen distributor with kerosene or cutter oil. This will avoid clogging, binding or seizure from breaking of bituminous emulsion left in the system.

d) Clear lines by blowing them out with air and leave drain plugs open when out of service.

e) Fill pumps with kerosene or cutter oil to ensure a free start-up when they are to be out of service for even a short period of time.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

PUMPING

- When pumping emulsions, keep the end of the discharge pipe submerged in emulsion (near bottom of tank) to avoid entrainment of air and foaming that can also cause an emulsion to break.
- Place inlet pipes and return lines near the bottom of tanks to prevent foaming and minimize contamination from skinning that may have formed on the surface.
- Use pumps that have proper clearances for emulsion use. Tight pump clearances can cause breaking of the emulsion and pump seizure. Particular care should be taken when using new pumps that may have tight clearances.
- Use slow pump settings and limit the amount of recirculation. Excessive pumping can lead to breaking of the emulsion, especially in cold weather, as well as a potential for a reduction in viscosity and instability though entrainment of air bubbles.

Dos and Don’ts for safe and proper storage and handling of bituminous emulsions

HEATING

- Use gentle heating systems with heating element surface temperatures below 85°C.
- Do not heat above the recommended storage temperature as water may be driven off at elevated temperatures, resulting in a skin of bitumen on the surface.
- When heating bituminous emulsion, agitate it gently to eliminate or reduce skin formation.
- Pumps should be heat-traced to prevent overload at start-up. Warming the pump to about 65°C can facilitate start-up.
- Heat tracing and warming of pipe lines can prevent emulsion breaking in the lines and blockages.
- Use mild heat to unblock lines or valves, or to free a seized pump. Avoid overheating that may cause hardening of deposited bitumen, with particular risk of potential damage to pumping systems. The use of propane torches should be avoided.

CHECK LISTS FOR EMULSION STORAGE AND HANDLING

STORAGE

- Store emulsion in vertical tanks. for long-term storage.
- Store at a temperature between 50°F and 180°F.
- Don’t let the emulsion freeze.
- Don’t allow emulsion temperatures to exceed 212°F or water boiling point.
- Don’t allow emulsion to free-fall into vessel from loading line or recirculation line.
- Do bottom load.
- Circulate material every two weeks.
- Protect pump, valves and lines from freezing.

HANDLING

- Don’t mix anionic and cationic emulsions.
- Don’t load elevated temperature material above 212°F on top of asphalt emulsion.
- Circulate vessel while heating with direct fire tubes. (Low fire on heating tubes).
- Dilute emulsion by adding warm water to the emulsion.
- Check with the emulsion manufacturer for guidance on dilution of emulsion.
- Wear proper personal protective equipment (PPE) to safely handle the emulsion.
- Asphalt emulsions are nonhazardous materials.
- Asphalt emulsions do not require placards.

Bitumen Emulsion Application for Water Proofing

For water proofing, you can simply spray Bitumen Emulsion on a specific surface such as wall, roof, floor, pool, rest room and etc. No heating is required. You just need to spread it with a broom or use a sprayer to dress the surface and then it breaks after about 30 minutes (unlike Cutbacks). In addition to easy application, it is very economical.

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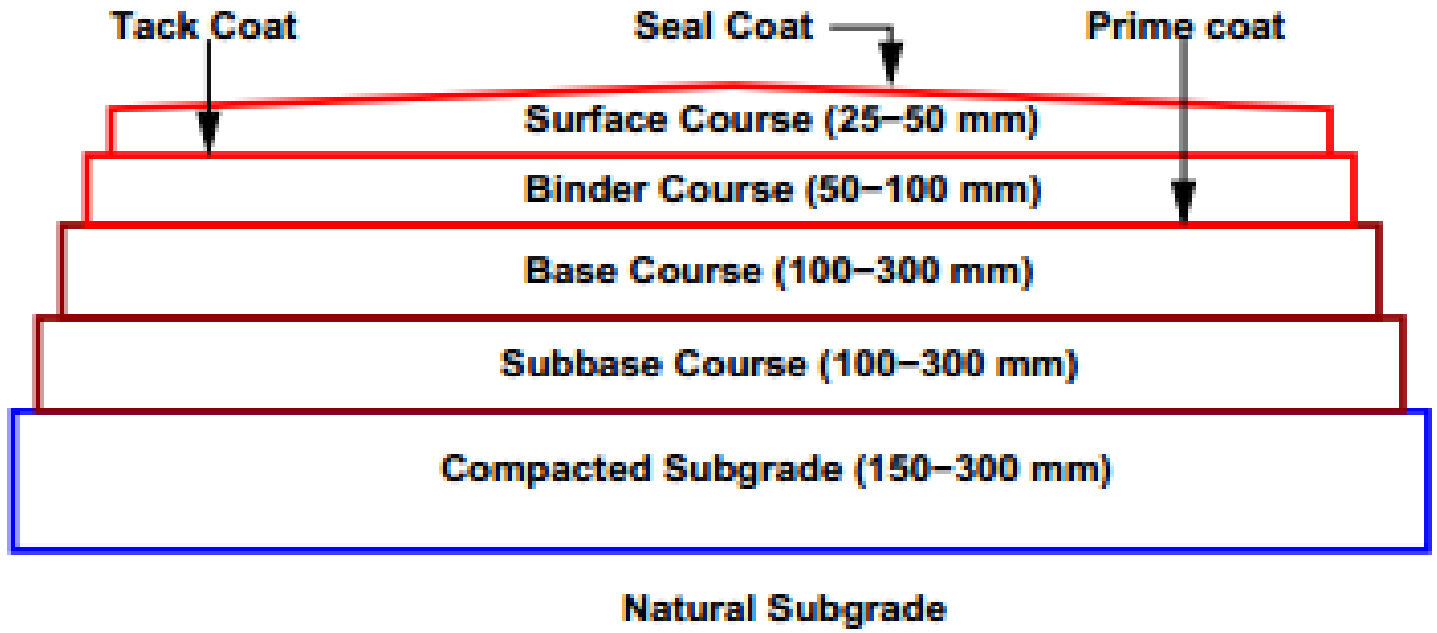
Bitumen Emulsion Applications for Asphalt Pavement, Preventive & Maintenance Treatment

An overview of Asphalt Layers and Coatings

When Bitumen Emulsion is applied for Prime Coat, Tack Coat and Seal Coat layers, pavers must obey asphalt laying process acc. to the model depicted below:



Different Application and Bituminous Emulsion to be used for road work

	ANIONIC			CATIONIC		
	RAPID SETTING	MEDIUM	SLOW	RAPID SETTING	MEDIUM	SLOW
SPRAY APPLICATIONS						
Surface Dressing (Chip Seal)	•			•		
Fog Seal		•	•		•	•
Tack Coat		•[a]	•	•	•[a]	•
Prime Coat			•	•		•
Penetration Macadam				•		
SLURRY SURFACING						
Slurry Seal			•			•[b]
Cape Seal			•			•[b]
Microsurfacing						•[b]

a) May contain solvent. b) Need to pass cement mix test.

Types of Applications for Asphalt Pavement and Preventive & Maintenance Treatment

Prime Coat

Tack Coat

Seal Coat

Fog Seal

Slurry Seal

Chip Seal

Sand Seal

Micro Surfacing

Cold Mix

Mulching

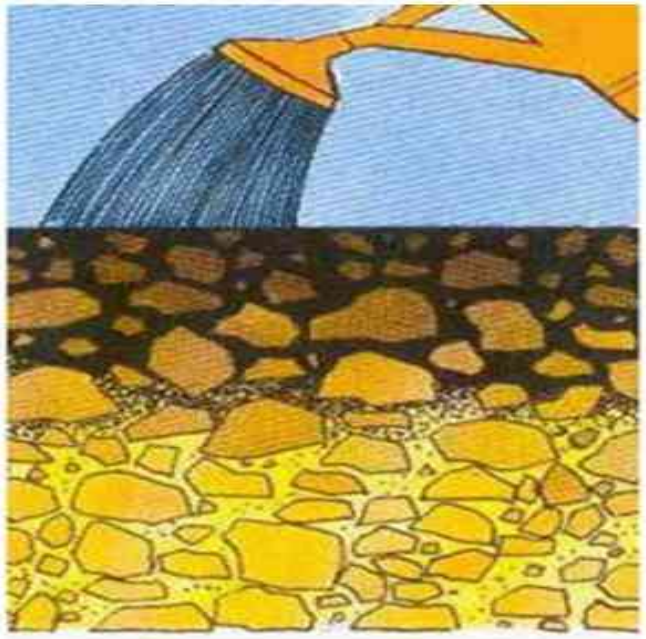
Asphalt Pavement, Preventive & Maintenance Treatment

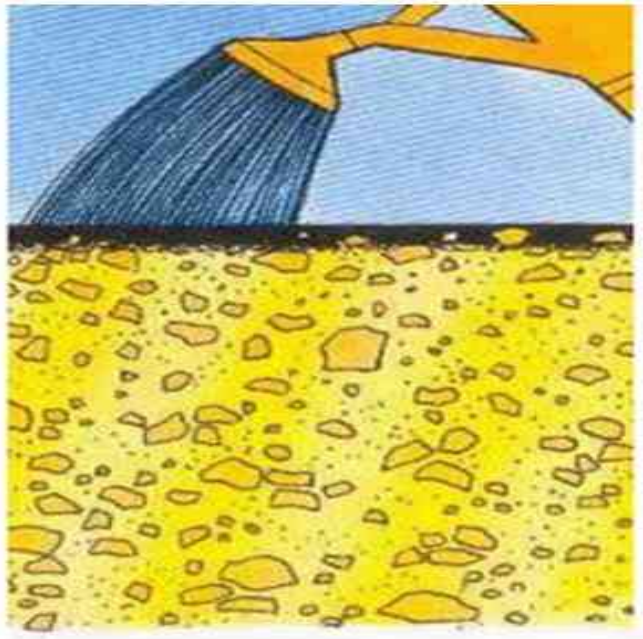
Prime Coat Applications: Implementation of a layer of Bitumen Emulsion on the base. It prepares the base for performing another asphalt layer on it. Cationic Slow Set (CSS) or Rapid Set (CRS) type of Bitumen Emulsion is used for this kind of application.

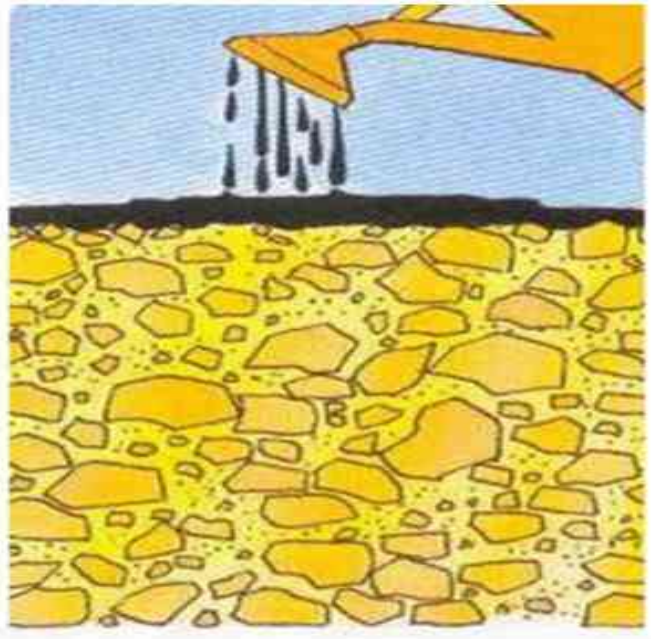
Prime Coat

Prime Coat Facts:

1. It penetrates to the base layer. It acts like a binder among soil-based building materials and binds them together in their position.
2. It makes the base layer hard and tough. It also makes the base layer water proof and acts as a sealant by filling the voids and cavities.
3. It binds base surface to asphalt layer paved on it.
4. Only 1 to 1.2 kg of Bitumen Emulsion is enough to be used per each square meter, while Cutbacks must be paved 1.2 to 1.8 kg per each square meter.







Prime Coat Facts:

5. If the road has water holes or the surface is water saturated, prime coat must not be applied until water is removed.
6. It is highly suggested to spray water on the base soil surface for better penetration of prime coat esp. when the surface is dusty (a tip often neglected by road contractors).
7. If the base density is more than 96%, it is highly recommended to remove the dust off the base surface and spray water onto the surface, before prime coat application.
8. After 4 to 15 hours, the first asphalt layer can be paved.
9. It is worth saying this application is cost-effective.

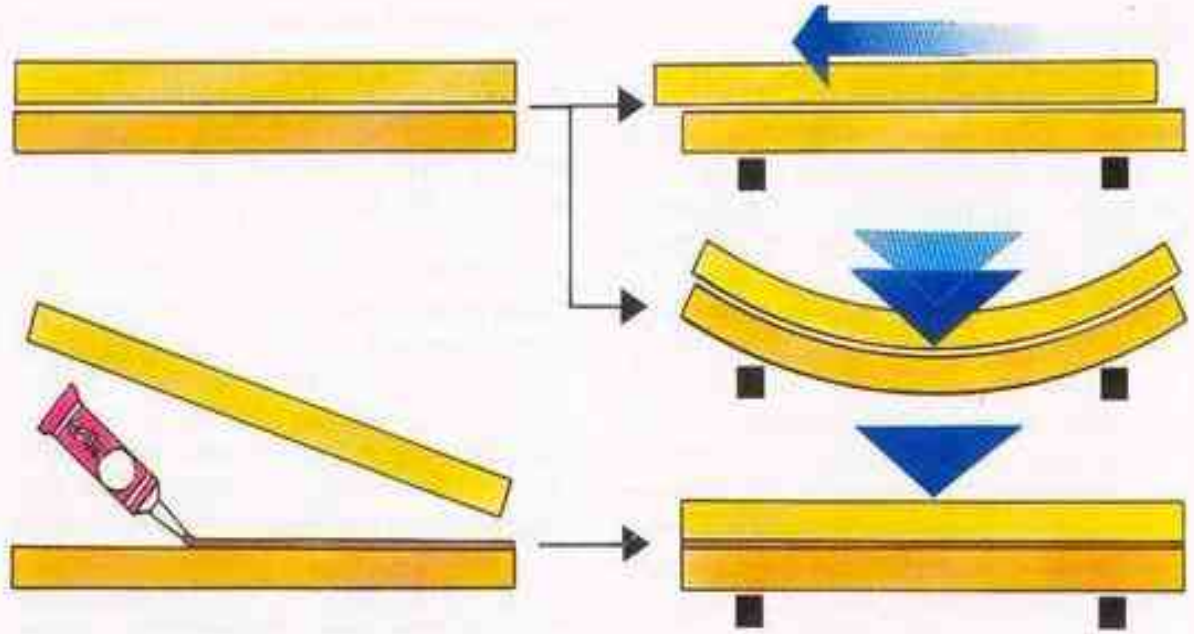
Asphalt Pavement, Preventive & Maintenance Treatment

Tack Coat Application: Applying one layer of Bitumen Emulsion between surface below the road and the road surface which results in binding two asphalt layers. It prevents asphalt layers from slipping over each other. Cationic Rapid Set (CRS) or Cationic Slow Set (CSS) Bitumen Emulsions are used for this application.

ack Coat

Tack Coat Facts:

1. This application is necessary to bind two asphalt layers together.
2. It prevents pavement layers from slipping over each other.
3. Only 400 to 800 grams of Bitumen Emulsion is needed to spray per each square meter.
4. By applying Tack Coat, two layers act as one result in terms of consistency and stability.
5. It is cost-effective compared to other methods.



Asphalt Pavement, Preventive & Maintenance Treatment

Seal Coat Application: Applying a layer of Bitumen Emulsion and adding an aggregate layer on it. Usually, CRS type is used for this purpose. It is mostly used for parking lots.

Seal Coat

Asphalt Pavement, Preventive & Maintenance Treatment Applications

As a general guideline, we should seal every 3-5 years. The average life span of work depends on a number of different factors, such as:

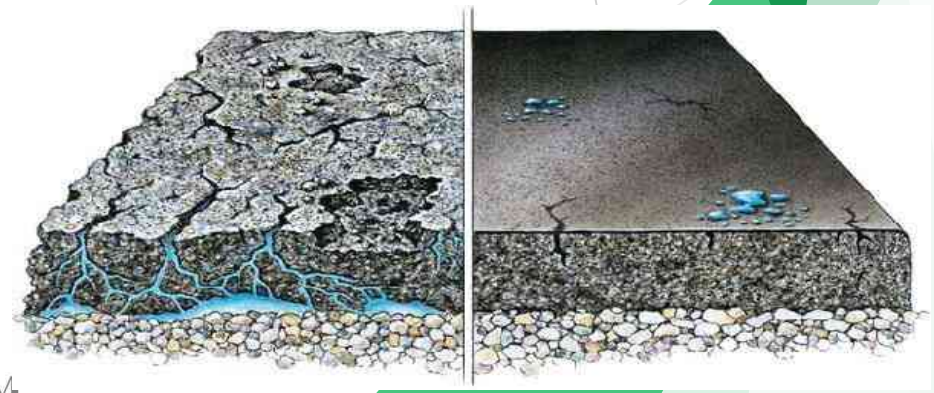
- High vehicle traffic
- Heavy-duty vehicles
- Overhead vegetation
- Harsh winter weather
- Degrading (crumbling) surface
- Scraping from snow plowing
- Chains on tires
- Chemical spills
- Low spots that hold water

Asphalt Pavement, Preventive & Maintenance Treatment

- Cleaning is the most crucial step in the sealcoating process, because it ensures that the sealer will adhere properly. We clean your parking lot using robust equipment –combination walk behind blowers/rotary brooms, turbine blowers, and sweepers.
- Sealcoating prevents asphalt surface oxidation by forming a tough protective outer skin. It also helps prevent damaging water penetration, and protects your asphalt from the deteriorating effects of gasoline, oil, de-icers, and other harsh chemicals. Most importantly, sealcoating saves you money.
- Weather is the most important factor when it comes to a durable, high quality sealcoating project. There are multiple weather factors that must be taken into consideration to ensure that the sealer will dry properly. Both air temperatures and pavement temperatures must be at least 60ºF and rising, with direct sunlight and relative humidity below 60%. Other important factors are wind and sunshine. Do not schedule projects when rain is imminent, or if it has rained the night before.

Seal Coat Facts:

1. It makes asphalt layer smooth, safe, steady and prevents from driving on slippery road.
2. It creates a color contrast between main road and shoulder of the road.
3. It resists Chemicals: having asphalt sealcoating will protect the pavement from chemicals from vehicles.
4. It creates a water- insulated surface.
5. Seal Coat application is cheaper than repairing & maintaining a deteriorated asphalt layer.
6. Seal Coat lifetime is between 3 to 5 years and it is better to be sprayed on a warm day.
7. Seal Coat is more economical than using Cutbacks.
8. Seal Coating is also recommended for roads which we do not decide to rehabilitate.



Sealed vs Unsealed

Asphalt Pavement, Preventive & Maintenance Treatment

Fog Seal Application: Spraying a CSS or CRS Bitumen Emulsion film on the underlying asphalt surface.

Fog Seal

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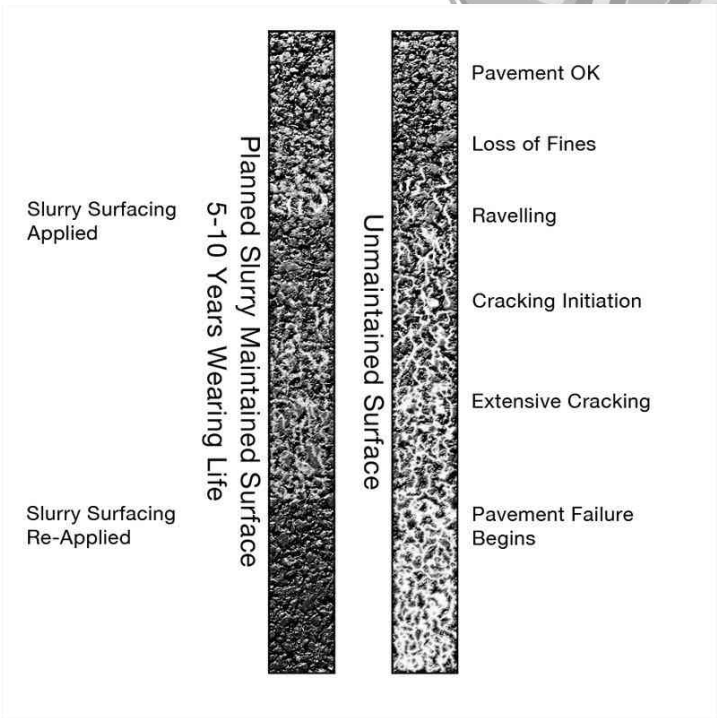
Fog Seal Facts:

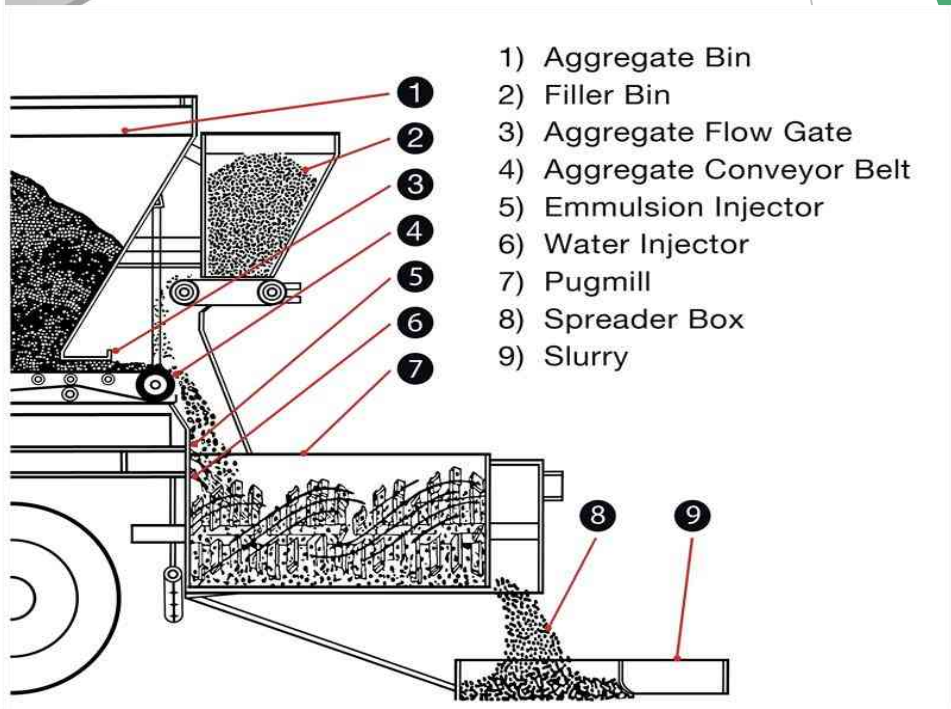
1. It rejuvenates dry and old asphalt surface.
2. It caulks narrow cracks and fills voids of the asphalt layer.
3. It prevents asphalt surface from raveling caused by segregation; (usually used for open graded mixtures).
4. It stabilizes shoulders of the road.
5. Fog Seal can be applied once in 6 months up to 1 year in case surface of the road is usually dry.
6. The surface on which Fog Seal is going to be sprayed must have voids and porosities so as to hold emulsion in itself. Moreover, the surface must be clean without dust or oil droplets on it.
7. 2 to 3 hours is the time needed for CRS Bitumen Emulsion to set and traffic must move slowly on it at the first hours.
8. Fog Seal's life time is two years and it is very cost effective.

Asphalt Pavement, Preventive & Maintenance Treatment

Slurry Seal Application: A mixture of aggregates, water, CSS Bitumen Emulsion and filler (usually cement) that must be paved with special Slurry Seal paving machine. Slurry Seal not only fills the voids, but it helps the surface to be more resistant.

Slurry Seal





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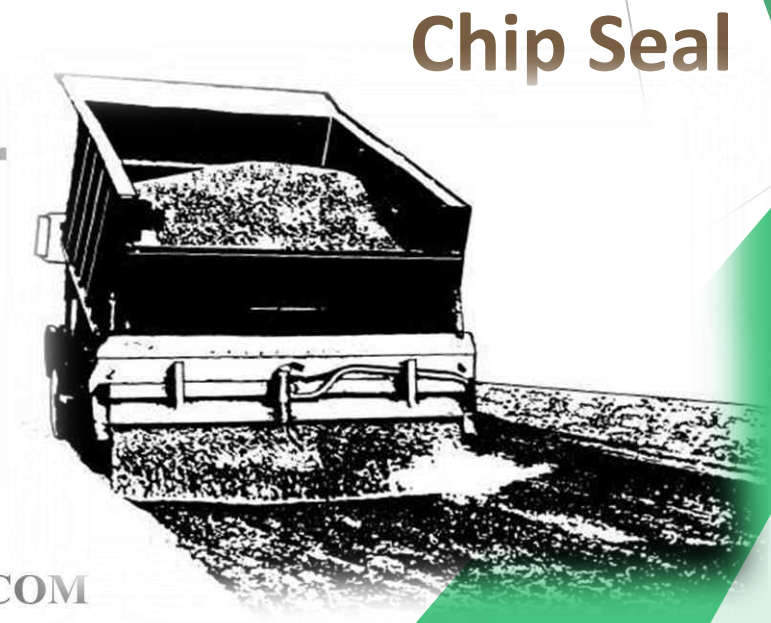
Slurry Seal Facts:

1. It fills the surface voids and small cracks.
2. It covers potholes of the surface.
3. It improves fractures of the surface.
4. It improves surface coarse problems and treats oxidized surface.
5. It delays potholes and cracks of the paved surface.
6. The specific surface must be cleaned off the dust by a broom or blower machine.
7. If surface has fast growing cracks or big holes or the surface is completely damaged, we must not use this application.
8. Thickness of this sealing is about 3 to 10 mm dependent on the place condition and after about 2 hours, traffic can pass on it.
9. It is better to apply Slurry Seal when the road surface temperature is at least 10°C and there isn't any risk of freezing within the first 24 hours after implementation.
10. Slurry Seal's life time is 3 to 5 years. Fast paving process, usage of less aggregates, high resistance to fracture, preventing height difference between road surface and shoulder of the road as well as notable cost reduction are other main advantages of this application.

Asphalt Pavement, Preventive & Maintenance Treatment

Chip Seal Application: paving a layer of CRS Bitumen Emulsion and a layer of aggregates on it. It is suitable for surfaces on which about 600 vehicles or less pass daily. In case the road is busy or there is a high traffic street, we must implement an asphalt layer or one or two Slurry Seal layers or one or two Micro-Surfacing layers after applying Chip Seal.



Chip Seal Facts:

1. After applying Chip Seal, we can implement Slurry Seal or Micro-surfacing to fill the voids between aggregate particles and to have a black and monotonous surface.
2. At least half and at maximum, two thirds of the height of aggregates must be applied with Bitumen Emulsion and at least one third of aggregates must be free of bitumen.
3. It prevents Bitumen Emulsion binder lying under and over an asphalt layer from freezing.

Chip Seal Facts:

4. It improves surface texture, waterproofs the surface, makes road beautiful and protects the underlying pavement from oxidation, fatigue, aging as well as traffic wear.

5. It gives new life to dry and weathered surfaces and seals small cracks and imperfections.

6. It is an economical method to resurface roads.

7. Size of aggregates must be 3 up to 12 mm. Usually, 1.5 to 1.8 kg of Bitumen Emulsion and 16 to 18 kg of aggregate materials are enough to be applied per 1 square meter.

Asphalt Pavement, Preventive & Maintenance Treatment

Sand Seal Application: Applying a CRS or CSS Bitumen Emulsion layer with fine aggregates or clean and washed sand.

Sand Seal

Sand Seal Facts:

1. It offers slippery driveway solution and increases skid resistance of road surface during vehicle pass and helps tires to hold driveway surface.
2. It makes the surface smooth and seals the cracks.
3. Size of aggregates must be 6 up to 10 mm.
4. Sand Seal is very cost effective.

Micro Surfacing

Asphalt Pavement, Preventive & Maintenance Treatment

Micro-Surfacing Application: Applying a mixture of aggregates, water, CSS Bitumen Emulsion, filler (usually cement) and some additives based on the place conditions. This operation requires a special paving machine that can be assembled on project site.

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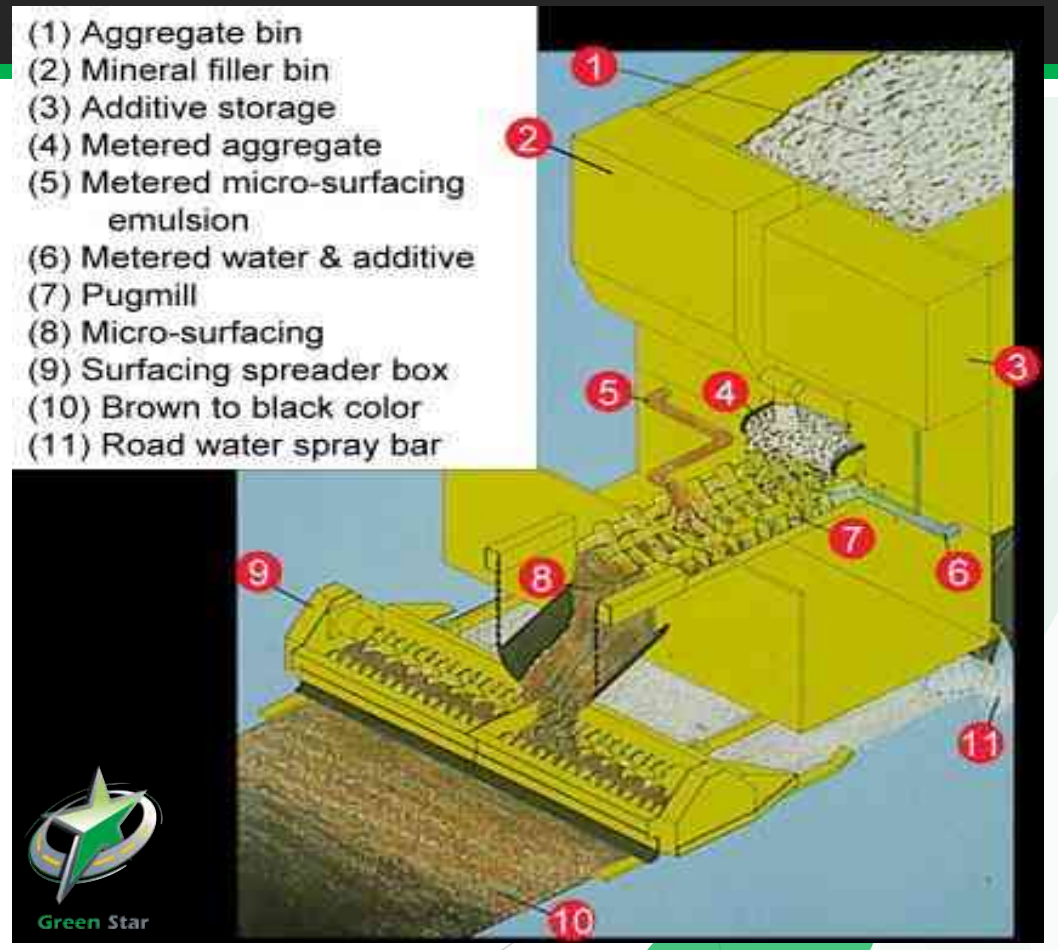
Micro-Surfacing Facts:

1. There is no need to be rolled by any kind of road roller.
2. We can find out the end of breaking process when brown color turns to black.
3. It is so recommended for places with high traffic like big cities, airports and highways.
4. It is very resistant to fatigue and attrition.
5. It creates a good color contrast.
6. It can be used as a colored coat by adding some additives (used for bike lanes).
7. When using Micro-surfacing for bridge resurfacing, there is no need to remove previous surface due to its light weight and low thickness.
8. It can be used on both asphalt and concrete surfaces.
9. Its average life time is 5 to 7 years.

Micro-Surfacing Facts:

10. Micro-Surfacing seals cracks and voids and completely makes the surface smooth.
11. It is very economical.
12. Due to its low thickness, we don't need to bring up the position of guard rails, curbstones or shoulder of the road.
13. Use of thermal energy, fuel and aggregates are notably less than similar methods in the whole paving process.
14. Environmentally speaking, Micro-Surfacing is a very proper paving method.
15. Since there is no need for rolling, Micro-Surfacing surface may crack or it may cause reflective cracks in places with big cracks, places where two lanes reach together or places where two roads intersect. So, we take special care to seal it.

(1) Aggregate bin
(2) Mineral filler bin
(3) Additive storage
(4) Metered aggregate
(5) Metered micro-surfacing emulsion
(6) Metered water & additive
(7) Pugmill
(8) Micro-surfacing
(9) Surfacing spreader box
(10) Brown to black color
(11) Road water spray bar



Micro-Surfacing Facts:

16. The aggregates' sizes must be proper for the Micro-surfacing, usually between 3 to 12mm.
17. The surface must be clean and any dust or oil must be removed off.
18. If there are transverse, longitudinal, block cracks or vehicle tire deep grooves, they must be sealed first (by CSS or CRS Bitumen Emulsion) and then, it is prepared for Micro-Surfacing paving.

Asphalt Pavement, Preventive & Maintenance Treatment

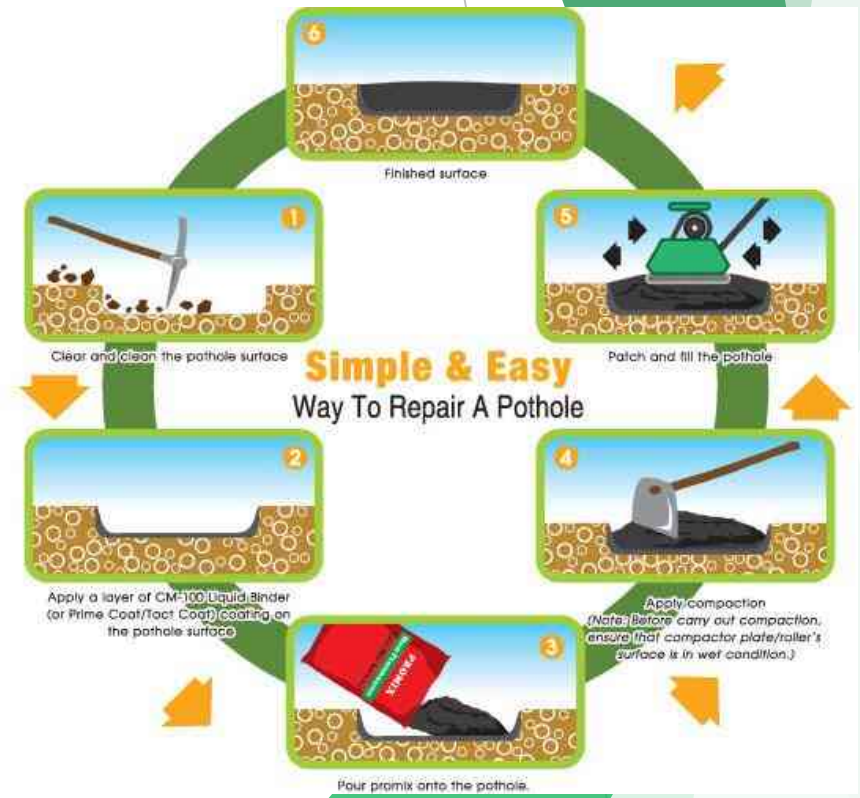
Cold Mix

Cold Mix (Cold Asphalt) Applications: A mixture of CMS or CSS Bitumen Emulsion and aggregates which can be produced at the factory or on project site. It can be kept or transported in bulk packaging or in a double-layer poly bag. If Bitumen Emulsion is not mixed with aggregates, it will remain in optimum quality for 4 to 6 months.

However, after Bitumen Emulsion and aggregates are mixed, this mixture should be applied within 1 to 2 days. Cold Mix remains brown and ready for use within 1 up to 7days without heating, if packed into double-layer bags or packed with vacuumed bags. Mixing Bitumen Emulsion and aggregates can be done at the factory or on project site by a mixer or betonier.

Cold Mix Facts:

1. It is suitable for temporary crack sealing and can be used on wet surfaces.
2. It is flexible, however stable against climatic changes.
3. Cold Mix can be produced on site or at the factory.
4. Only Bitumen Emulsion is proper for producing Cold Mix because it adhere to the aggregates very well.
5. It is environmentally friendly during both production & application processes. No heating is required.
6. The traffic can pass on it after breaking process.
7. When producing Cold Mix, aggregates must be washed free from dust. 0 to 3 mm aggregates must be removed to prevent the mixture from being coagulated.
8. Cold Mix can be kept for 6 to 12 hours in bulk packaging or if packed into a double-layer poly bag for 7 to 14 days. It can be recycled either.
9. Cold Mix is the only choice & solution for places far from hot- mix asphalt plants.
10. Dust and oil must be cleaned off the cracks and holes.
11. Production and transportation are cost effective.



Mulching

Mulching Application: Spraying CSS Bitumen Emulsion on a specific surface to prevent dust lifting.

Mulching Facts:

1. Since Bitumen Emulsion has an ionic structure, its adhesion is very stronger than neutral Cutback Bitumen for different applications such as Mulching.

Mulching Facts:

2. Mulching with Bitumen Emulsion is flexible and while facing with climatic changes, it remains stable.
3. It is completely harmless for environment and can be applied in ambient temperature upper than 4 degrees without heating.
4. Breaking process of Mulching takes between 8 to 12 hours.
5. The application cost is low.

Cutback Bitumen vs Emulsion

Cutback=solution of bitumen and non-polar solvent.

Cutback Bitumen – A blend of conventional bitumen and a cutting agent i.e. Kerosene blended to the desired ratios

Emulsion=Bitumen and water in an emulsion.

Bitumen Emulsion – The dispersion of bitumen binder and water to create an emulsified solution, applied at the desired blend ratios

Asphalt. "Asphalt" means a dark-brown to black solid, liquid or semisolid cementitious material composed primarily of bitumen that occur naturally or are obtained as a residue of petroleum refining.

Cutback Asphalt/Bitumen. "Cutback Bitumen" means asphalt that has been liquefied by blending with a diluent of petroleum solvents or any other diluent that contains VOC.

Emulsified Asphalt/Bitumen. "Emulsified Bitumen" means an emulsion of asphalt and water that contains a small amount of an emulsifying agent; it is a heterogeneous system containing two normally immiscible phases (asphalt and water) in which the water forms the continuous phase of the emulsion, and minute globules of asphalt form the discontinuous phase.

Cutback Bitumen vs Emulsion

Cutback Bitumen and Emulsified Bitumen are used for a number of applications during road construction. In preparing these products, asphalt cement is mixed with either a petroleum diluent to produce Cutback Bitumen or with emulsifiers, water, and sometimes petroleum diluent to produce Emulsified Bitumen. Once the liquefied asphalt cement is applied during road construction, the diluent petroleum solvent (in the case of asphalt cutbacks) and water (in the case of asphalt emulsions) evaporates leaving the cured residual asphalt cement. The application of asphalt causes emissions of volatile organic compounds (VOC) through the evaporation process described above and contributes to the creation of ground-level ozone and particulate matter, which are major components of smog.

Cutback Bitumen vs Emulsion

Traditional Cutback Bitumen has been widely accepted throughout the pavement industry and has been coupled with undesirable curing times. In practice, the use of Cutback Bitumen for priming applications requires a minimum of 5 days and for primer sealing a minimum of 3 months (depending on prevailing weather conditions) for the volatile cutter to evaporate, leaving the bitumen prime. If the overlying material is placed over the prime/primer seal prior to curing, the volatile material can deteriorate overlying bituminous material.

To overcome this waiting period, the use of Bitumen Emulsion as a primer binder can limit the curing time of both primes and primer seals to 24 hours (upon favorable weather conditions), however this can often involve additional cost.

Cutback Bitumen vs Emulsion

Why Emulsification?

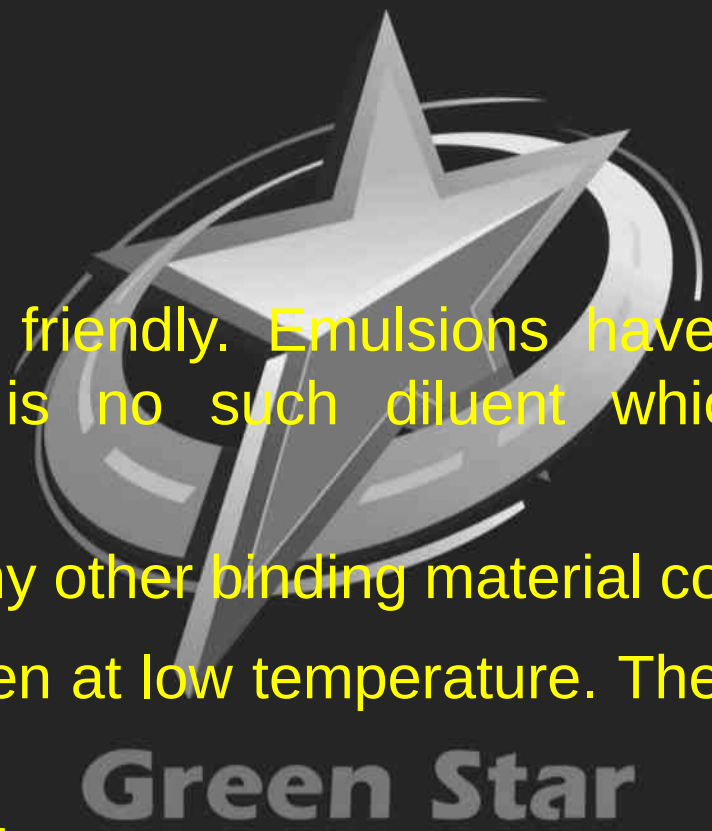
Bitumen emulsions provide a range of benefits over heated and cutback forms. Emulsifying Bitumen allows you to reduce the viscosity without the need to continuously heat the product.

Bitumen Emulsions are particularly useful when it is difficult to use bulky machinery in remote or hard to reach areas, such as rural locations or confined spaces.

As there is no need to heat the emulsified product, customers can also make huge savings on energy costs.

In comparison to Cutbacks, Bitumen Emulsions are easier to handle as the diluent is water, not a volatile petrochemical solvent. The reduction in VOC release not only decreases the environmental impact of the product, but the lower volatility helps to reduce storage and transportation costs. The reduction in VOC emissions is especially significant when considering the manual handling of Bitumen Emulsions in coatings and paints applications, where the Bitumen Bmulsions may need to be applied in enclosed, poorly ventilated areas, hence making it safer to use.

Properties Comparison Of Emulsion And Cutbacks



EMULSION

- Emulsions are environmental friendly. Emulsions have no effect on environment, because in emulsion there is no such diluent which has negative effect on environment.
- Emulsions are cheaper than any other binding material containing same properties.
- Emulsions can easily apply even at low temperature. Therefore, this saves the cost of fuel.
- These have no side effects, safe to use.
- It can be applied even wet surfaces. There is no requirement of dry surface before spraying.

Properties Comparison Of Emulsion And Cutbacks

CUTBACKS

Cutbacks have some benefits, but also have many disadvantages too:

- Cutbacks are not environmental friendly. Cutbacks create air pollution, because in cutbacks solvent is not water which evaporates after spraying.
- As in case of Cutbacks solvent is not water that become the reason of high energy diluents wastage in the atmosphere.
- Cutbacks are not safe to use, because of high energy products chances of catching fire is possible.
- Cutbacks cannot be applied at every temperature. Therefore, in this an extra fuel cost is required.
- Dry pavement is required for spraying of Cutbacks. Therefore, these cannot be applicable on wet surfaces and due to this reason many days will be required for drying of surface.

Environmental Impacts of Bitumen Emulsions

- Greenhouse gas emissions from the use of Cutback bitumen are significantly higher than for Bitumen Emulsions due to the large amount of fossil fuels used for heating Cutback Bitumen and through the evaporation of kerosene from Cutback Bitumen. We don’t need to heat Bitumen Emulsion in most cases.
- The increased transportation emissions associated with Bitumen Emulsion are not significant when compared with the production and heating emissions.
- Replacing Cutback Bitumen with Bitumen Emulsion would reduce the amount of CO2 produced from sealing operations by almost two thirds.

Environmental Impacts of Bitumen Emulsions

- Replacing Cutbacks with emulsions would also reduce production of photochemical smog generating VOC emissions to atmosphere.
- It is not safe to grow food plants near the road because Cutback Bitumen can damage plants near the road. Emulsion Bitumen is not toxicant and there isn't any aroma.
- Emulsified Bitumen offers proper solution for any kind of asphalt and maintenance (Streets, Roads & Airstrips).
- Emulsion Bitumen can be implemented in ambient temperature.
- Emulsion Bitumen can even be used on wet surfaces.
- Emulsion Bitumen is not flammable- safe storage, secure transportation and easy and safe paving operations.

Protection of Environment, Health, Safety and National Capital

Green Star

Thank you so much for your attention