



SECTION 6 SCRUB SEALS USING ASPHALT EMULSIONS

6.1 Scope

This guideline has been prepared for the benefit of those engaged in scrub seal construction, to highlight items that are essential for achieving consistent, high quality results. Emulsions used in scrub seal applications are generally of the slow setting type, anionic, cationic, or non-ionic, such as SS-1, SS-1H, CSS-1, CSS-1H and specialty emulsions developed specifically for scrub sealing. They may or may not be polymer modified. Scrub seals can use a wide range of cover aggregates, which are generally sands or fine crushed aggregates or cinders. Quantities of asphalt emulsion and cover aggregate to be applied, and relevant construction equipment and construction procedures that are required for successful scrub seals are outlined.

This section has been written as a guide only, and should be so employed. User specifications based on this guide should be adapted to job conditions, local usages and anticipated performance requirements.

6.2 Definitions

A scrub seal wearing surface consists of a uniform application of a slow setting asphalt emulsion to a prepared surface followed by an emulsion scrub broom which sweeps the emulsion into pores and cracks in the pavement surface. This application is then followed by a uniform application of cover aggregate which is then 'scrubbed' into the emulsion binder with a second aggregate scrub broom. The use of brooms results in a surface treatment which seals surface cracks and binds the cover aggregate intimately with the pavement. Desired surface texture is controlled by selection of cover aggregate.

Where other seals (scrub, slurry, microsurfacing) or paving mixes are subsequently placed over a polymer modified scrub seal, the scrub seal acts as a stress absorbing membrane interlayer or SAMI.

Because scrub seals use very fine aggregates or cinders, which are well bound through use of the scrub brooms, potential windshield damage from loose scrubs is eliminated. Scrub seals may be opened to traffic prior to any sweeping of excess aggregate.

- **Dense Surface**—Tight, relatively non-absorbent smooth-textured surface.
- **Open Surface**—Open, relatively porous and absorbent, rough textured surface. This type of surface will require a higher rate of application to compensate for the emulsion which flows into the large voids and cracks. Most scrub sealed surfaces are open surfaces.

6.3 Applicable Documents



6.3.1 ASTM Documents

- D70 *Test Method for Specific Gravity of Semi-Solid Bituminous Materials*
- D140 *Sampling Bituminous Materials*
- D244 *Standard Methods of Testing Emulsified Asphalts*
- D2170 *Test Method for Kinematic Viscosity of Asphalts*
- D 2171 *Test Method for Viscosity of Asphalts by vacuum Capillary Viscometer*
- D2995 *Practice for Determining Application Rate of Bituminous Distributors*
- C29 *Test Method for Unit Weight and Voids in Aggregate*
- D1139 *Specification for Aggregate for Single or Multiple Bituminous Surface Treatments*

6.3.2 AEMA Documents

- [A Basic Asphalt Emulsion Manual \(BAEM\)](#)

6.4 Materials

6.4.1 Asphalt Emulsions

The asphalt emulsions employed for scrub seals should be slow to medium setting anionic or cationic SS-1, SS-1H, CSS-1, CSS-1H; ASTM specifications for anionic (SS) emulsions are listed in D977 and for cationic (CSS) emulsions in D2397. Suppliers of other specialty emulsions for scrub sealing should supply specifications for these emulsions. Asphalt emulsions for scrub sealing may be modified with a polymer additive. Polymer-modified emulsions are generally used for scrub sealing of pavements for a tough, resilient surface, and to minimize future maintenance.

6.4.2 Cover Aggregates

Because scrub seal emulsions are slow setting, aggregates which may not be desirable (excess fines) for other emulsion sealing applications often produce an excellent scrub seal.

6.4.2.1 Aggregate Gradation

Aggregates for scrub seal applications are generally 96-100% passing the No. 4 or ¼ inch sieve and 2-8% passing the No. 200 sieve. Emulsion supplier and local agencies can offer information on locally available aggregates which have been used successfully in scrub seal applications. Where washed aggregates are used it is very important that they be 'surface dry' at time of application. Excess moisture in fine aggregate for scrub seals can result in a washboard surface under traffic. Moisture content should be specified to be not more than 1.5% by weight of aggregate.

6.4.2.2 Compatibility of Emulsion and Aggregate

Compatibility or affinity between an asphalt emulsion and an aggregate can be variable. If there is any doubt as to whether an anionic, cationic or non-ionic emulsion

would be preferable with a given cover aggregate , your AEMA emulsion supplier should be consulted.



6.5 Construction Equipment

The basic equipment for constructing a scrub seal should include:

1. Asphalt distributor
2. Emulsion scrub broom
3. Cover aggregate spreader, preferably of the mechanical self-propelled type
4. Aggregate scrub broom
5. Rollers, preferably pneumatic-tired
6. Rotary power broom and other cleaning equipment
7. Cover aggregate haul trucks equipped with special hitches for attachment to aggregate spreaders

6.5.1 Emulsion Distributor

It is the principal function of the distributor to apply asphalt emulsion uniformly in both transverse and longitudinal directions at the specified rate in L/m^2 (gal/yd^2). Failure to do so can result in streaking in which too much and too little asphalt alternate every few inches across the road surface.

Streaking usually results from incorrect positioning of the nozzles in the spray bar, from different nozzle sizes in the spray bar, from incorrect spray bar height, from damaged or nicked spray nozzles, by forcing more or less than the optimum quantity of asphalt emulsion through each spray nozzle, or from attempting to spray asphalt emulsion at too low a temperature so that it cannot fan out properly from the spray nozzles, and even by inability of the control mechanism to fully open the spray nozzles in one or more sections of the spray bar.

To avoid streaking, each nozzle in the spray bar of the asphalt distributor should be turned to make the constant angle with the longitudinal axis of the spray bar that is recommended by the manufacturer. All nozzles in the spray bar should be of the same size. The spray bar height should provide double or triple overlap of the asphalt emulsion being applied by the spray nozzles as recommended by the manufacturer. The distributor should be able to spray asphalt emulsion within ± 7.5 percent of the average application rate in the longitudinal direction and within ± 10.0 percent of the average rate of application for any 4-inch width in the transverse direction. A very simple and practical method for checking the rate of application of asphalt emulsion in both the longitudinal and transverse directions is provided by ASTM D2995.

For satisfactory application of asphalt binder uniform pressure must be maintained in the spray bar. The optimum pressure discharges asphalt binder at a constant rate through each spray nozzle, (e.g., 15.1 L/min (4 gal/min)). Only at this constant rate of discharge does the asphalt emulsion fan out uniformly from each spray nozzle. Therefore, different rates of application of asphalt binder in L/m^2 (gal/yd^2) should be achieved by changing the forward speed of the distributor and not by changing the discharge rate in L/min (gal/min) from each spray nozzle.



Important accessory equipment for each distributor includes an accurate gauge, 150 mm (6 in.) in diameter or larger, to indicate pressure in the spray bar, an accurate tachometer to show pump speed in r/min, an accurate thermometer for registering the temperature of the asphalt emulsion in the distributor, a calibrated dipstick to enable liters (gallons) of asphalt binder per millimeter (inch) of depth to be read at any time, and a bitometer that has been calibrated to accurately measure the distance traveled and the speed in m/min (ft/min) when spraying.

6.5.2 Emulsion Scrub Broom

An emulsion scrub broom is specially designed to sweep the emulsion into cracks and surface pores manufactured in accordance with [6.7.2 Emulsion Scrub Brooms](#). Note that additional weight may be added via sand bags, etc. during use if broom is not making uniform contact with surface to be sealed.

6.5.3 Cover Aggregate Spreaders

Cover aggregate spreaders may consist of tailgate spreaders, but to obtain a continuous and uniform rate of cover aggregate application, and to keep up with the asphalt distributor, they should preferably be of the mechanical self-propelled type.

Before use on any given job, a mechanical self-propelled aggregate spreader should be calibrated for the particular cover aggregate to be applied. The forward speed of the aggregate spreader during calibration should approximate the speed required to remain close to the distributor. The object of calibration therefore, is the gate opening at this speed that results in the application of cover aggregate by the scrub seal spreader at the rate specified.

Calibrating the aggregate spreader avoids the application of either too little or too much cover aggregate, either of which can be costly. Too little cover aggregate can result in shortened service life, while too much represents a waste of cover aggregate that over a state or province can amount to a loss of many thousands of dollars per annum. Furthermore, there is a shortage of good quality cover aggregates in some areas. Consequently, by applying the correct quantity of cover aggregate per m^2 (yd^2) a vanishing valuable natural resource is being conserved.

6.5.4 Aggregate Scrub Broom

An aggregate scrub broom should be manufactured in accordance with [6.7.1 Aggregate Scrub Brooms](#). Note that additional weight may need to be added to broom during use to ensure uniform contact of broom with aggregate surface.

6.5.5 Rollers

The objective of the rolling operation is to press the cover aggregate firmly into the asphalt emulsion. This improves particle embedment, promotes more thorough wetting and better adhesion between asphalt emulsion and cover aggregate, and achieves better cover aggregate interlock. For single scrub seals, rollers should be of the pneumatic-tire type. No existing surface is entirely smooth, and because of their flexibility, pneumatic tires can reach down into small depressions and press the cover

aggregate into the asphalt emulsion. Steel wheel rollers bridge over these depressions. Steel wheel rollers also tend to crush cover aggregate particles.

For an average scrub seal construction operation, a minimum of two rollers should be used.



6.5.6 Rotary Power Broom

A powerful rotary broom is needed to thoroughly clean the existing surface before a scrub seal is applied.

A layer of dust tends to accumulate near the edges of an existing surface which can prevent good bond between the new scrub seal and the old surface. For this reason this layer of dust should be carefully removed with a power broom.

By light brooming, the powered rotary broom should also be used to remove excess cover aggregate from a new scrub seal preferably during the coolness of early morning immediately following the construction of the scrub seal.

6.5.7 Cover Aggregate Trucks

To avoid costly delays in scrub seal construction operations due to lack of cover aggregate an adequate number of haulage trucks should be provided.

Each haulage truck should be equipped with a suitable hitch for connection to the aggregate spreader. The trucks should be designed to avoid contact between the truck body and the aggregate spreader at all times and the truck body should be modified if necessary to empty cleanly and completely into the hopper of a self-propelled aggregate spreader. Spill-age of cover aggregate onto the road surface when the truck is emptying into this hopper should not be tolerated.

6.6 Construction Operations

The sequence of construction operations is as follows:

1. Adequate preparation, repair, and thorough cleaning of the surface that is to receive the scrub seal. Because they are invariably quite porous, new patches made with pre-mix material should preferably be made several weeks ahead of the scrub seal.
2. Consideration of temperature and weather
3. Spraying the asphalt emulsion
4. Brooming the asphalt emulsion
5. Applying the cover aggregate
6. Brooming the aggregate to achieve a uniform cover aggregate distribution
7. Rolling cover aggregate into scrub seal
8. Sweeping off excess cover aggregate

6.6.1 General Considerations

It cannot be overemphasized that poor scrub seals may result from poor construction practice in spite of the excellent quality of the asphalt emulsion and cover aggregate.

Application rates of both asphalt emulsion and aggregate sufficient to accommodate the degree of oxidation and porosity of the existing surface and the characteristics of the cover aggregate (dense, porous, high in fines, etc.) should be established with the assistance of the emulsion supplier and an experienced contractor.



6.6.2 Preparation of a Granular or Stabilized Base

The granular or stabilized base should be scarified if necessary, bladed, watered, and rolled to provide a surface that is uniform, firm, smooth, and that conforms to specified profile and cross section.

Immediately after this preliminary preparation, it may be primed with from 0.9 to 2.3 Lm² (0.2 to 0.5 gal/yd²) of a suitable asphalt primer. Priming will be facilitated if the surface is damp, but the use of calcium chloride can hinder penetration of the primer. The grade of primer selected and the quantity to be applied should be completely absorbed into the surface in 24 hours, and depends very largely on the porosity of the surface. In many instances, priming is not required prior to scrub sealing. The recommendation of the emulsion manufacturer should be taken into consideration.

If a primed surface is to be exposed to traffic for sometime, it should be protected by an immediate application of from 3.2 to 5.4 kg/m² (6 to 10 lb/yd²) of clean coarse sand. The priming operation should be completed far enough ahead of the scrub seal to enable the asphalt primer to cure. Depending upon local conditions and the season of the year, this could be from two to three days to two weeks.

Immediately before applying the scrub seal, the primed surface should be broomed with a rotary power broom to remove all loose and foreign material. Hardened patches of mud or clay may have to be removed with a pick and shovel.

6.6.3 Preparation of a Paved Surface

The paved surface should be made as uniform as possible before a scrub seal is applied. In order to prevent subsequent bleeding, all rich patches should be removed, and all holes, depressions, and other defective or distressed areas should be repaired. It cannot be overemphasized that unless a scrub seal is constructed on a uniform surface, the appearance of the scrub seal after several weeks of traffic will not be uniform.

New patches that have been made on the surface will be porous, and may absorb some of the asphalt emulsion applied for the scrub seal. These should be sprayed with 0.45 L/m² (0.1 gal/yd²) of SS-1h or CSS-1h emulsion that has been diluted 50 percent (1 + 1) with water, and covered with from 3.2 to 5.4 kg/m² (6 to 10 lb/yd²) of clean coarse sand, for example bank sand, and opened to traffic for two weeks before scrub sealing.

If the old pavement is noticeably porous, it may absorb some of the emulsion applied for a scrub seal. A simple quick test for porosity of an existing surface is to apply to it a couple of drops of lubricating oil from the dipstick of an automobile. If the surface is porous it will absorb the oil almost immediately. If it is non-porous most of the oil will remain on the surface after 10 minutes. If the existing surface is porous, the application

rate should be established to accommodate this porosity as well as to bind the cover aggregate.

Severely pocked (AEMA BAEM Table VI-3) surfaces, also require consideration in establishing the optimum asphalt emulsion application rate.

Scrub seals are designed to accommodate these kinds of surface imperfections and should result in a well sealed and reasonably uniform surface.

Immediately before a scrub seal is constructed, the existing surface should be thoroughly broomed with a rotary broom to re-move all dust and other foreign material. Hardened patches of mud or clay may have to be removed with a pick and shovel.



6.6.4 Temperature and Weather Restraints

The temperature of the surface on which a single scrub seal is to be constructed should be not less than 10° C (50° F) and rising, although some specialized products have been developed for use through a wider range of temperatures. Check with the emulsion supplier for recommended temperature ranges.

A weather forecast that no rain is expected for a minimum period of 24 hours is essential.

6.6.5 Spraying the Asphalt Emulsion

Five very important items that can be easily checked are:

1. Alignment of the nozzles in the spray bar
2. That all spray nozzles are of the same size, and are not nicked or otherwise damaged
3. That every spray nozzle is free from even partial clogging, is clean, and can spray normally
4. Height of spray bar above the road surface
5. Recommended application temperature for emulsion is from 52 – 85 C (125-185 F).

Unless the distributor has been calibrated for its ability to spray the specified quantity of asphalt emulsion uniformly over every 0.1 m² (yd²) of surface, this should be checked. It is not enough to determine that the total gallons applied to a measured section of road surface is correct. This tells nothing about the uniformity of application centimeter by centimeter transversely across the sprayed width.

When necessary adjustments have been made, the distributor should be able to make a uniform application of asphalt emulsion at the rate specified. Before spraying begins, a line should be placed along one edge of the road as a guide. This line may consist of string or even suitably spaced small rocks. To protect concrete curbs in urban areas a removable shield may be attached to the pertinent end of the spray bar.

The distributor should not be permitted to start spraying until the emulsion broom, aggregate spreader, aggregate broom, loaded trucks and rollers are in line and ready to proceed.



The asphalt emulsion should preferably be sprayed full width to avoid the need for a longitudinal joint in the center of the road that can be unsightly due to either too much or too little asphalt. and can also be a location for distress and even failure within the scrub seal. When this is not possible. an inside strip of uncovered asphalt emulsion from 75 to 100 mm (3 to 4 in.) wide should be left when constructing the first half, to provide center joint overlap when the second half of the scrub seal is placed. To obtain smooth, well constructed transverse joints, the distributor should always begin and preferably stop spraying on a strip of kraft or building paper placed across the lane under construction at right angles to the direction of traffic.

6.6.6 Scrubbing the Emulsion

The tractor pulled emulsion broom should follow immediately behind the distributor scrubbing the emulsion into the cracks and voids. Weight may be added to the broom to assure adequate and uniform filling of cracks and voids with emulsion.

6.6.7 Applying the Cover Aggregate

The gate opening and forward speed of the aggregate spreader, which should preferably be the same as the forward speed of the asphalt distributor and emulsion broom should be adjusted to apply the number of kilograms of cover aggregate per square meter (lb/yd^2) indicated by the application requirement.

Truck loads of cover aggregate should be in position before any asphalt emulsion is applied. When scrubbing of asphalt emulsion begins the aggregate spreader should follow within a distance of 15 to 50 m (50 to 150 ft). This distance is needed for a layer of asphalt emulsion of more uniform thickness to develop under the influence of gravity.

A self-propelled aggregate spreader should pull the truck, which should be in neutral gear.

Use of a tachometer assists in maintaining a uniform forward speed of the aggregate spreader.

Oversize cover aggregate particles and other foreign material can interfere with the uniform application of the cover aggregate by partially clogging the gate opening of the aggregate spreader. This can result in streaking, and should not be tolerated.

Note:

The cover aggregate may be damp when applied, but should never be wet.

When cover aggregate is spilled on to the scrub seal it should be removed with hand shovels. In small areas where not enough cover aggregate has been applied, broadcasting cover aggregate with hand shovels from a truck can be employed to make up the deficiency.

6.6.8 Scrubbing the Cover Aggregate

A tractor pulled cover aggregate (sand) broom shall immediately follow the aggregate spreader. Weight may be added to the sand broom to assure uniform and adequate scrubbing of the sand cover aggregate into the emulsion.



6.6.9 Rolling

Rolling should begin as soon as possible after the cover aggregate has been scrubbed, and one pass of a roller should be made before the emulsion breaks.

On scrub seal projects of average size, two pneumatic-tired rollers should make one or two initial passes over the cover aggregate before the emulsion breaks. A third pass should be made after the emulsion has broken for uniform seating of the cover aggregate particles.

Rolling should proceed from the outer edge to the center, with each pass overlapping the previous pass by one-half.

6.6.10 Removing Surplus Cover Aggregate

When specifying the quantity of cover aggregate to be applied, some allowance must be made for loss of cover aggregate due to whip-off and unevenness of spread. Consequently, the quantity of cover aggregate applied exceeds by from 2 to 10 percent the amount that will remain in the scrub seal. This surplus aggregate may be removed by light brooming with a power broom during the cool morning after construction, when the asphalt binder is reasonably hard. Care must be taken to avoid turning over any of the cover aggregate particles embedded in asphalt.

A number of items will help to insure a successful scrub seal project:

1. Never permit anionic and cationic asphalt emulsions to be mixed because this will cause each emulsion to break, leaving tanks or other equipment partially filled with semi-solid asphalt, and a difficult cleaning job.
2. Thoroughly wash out with diesel fuel any equipment in which an anionic emulsion has been used before using it for a cationic emulsion and vice versa.
3. At the end of each day, flush out with diesel fuel the pumping and spraying system on the asphalt distributor. This will avoid clogging, binding, or seizure if the asphalt emulsion otherwise left in this system should break.
4. Do not allow an asphalt emulsion to either freeze or boil — it will break.
5. When pumping asphalt emulsions, keep the end of the discharge pipe submerged in emulsion to avoid entrapment of air and foaming. This may also cause an emulsion to break.
6. Avoid tight fitting pumps when pumping asphalt emulsion. They may bind and seize due to breaking of the emulsion.
7. Avoid excessive pumping or handling of asphalt emulsions, because this can result in a reduction of their viscosity.
8. Have a clear mental image of what an excellent scrub seal looks like as a target for achievement.
9. For scrub seals, tailor rapid setting emulsions to break after the first pass of a

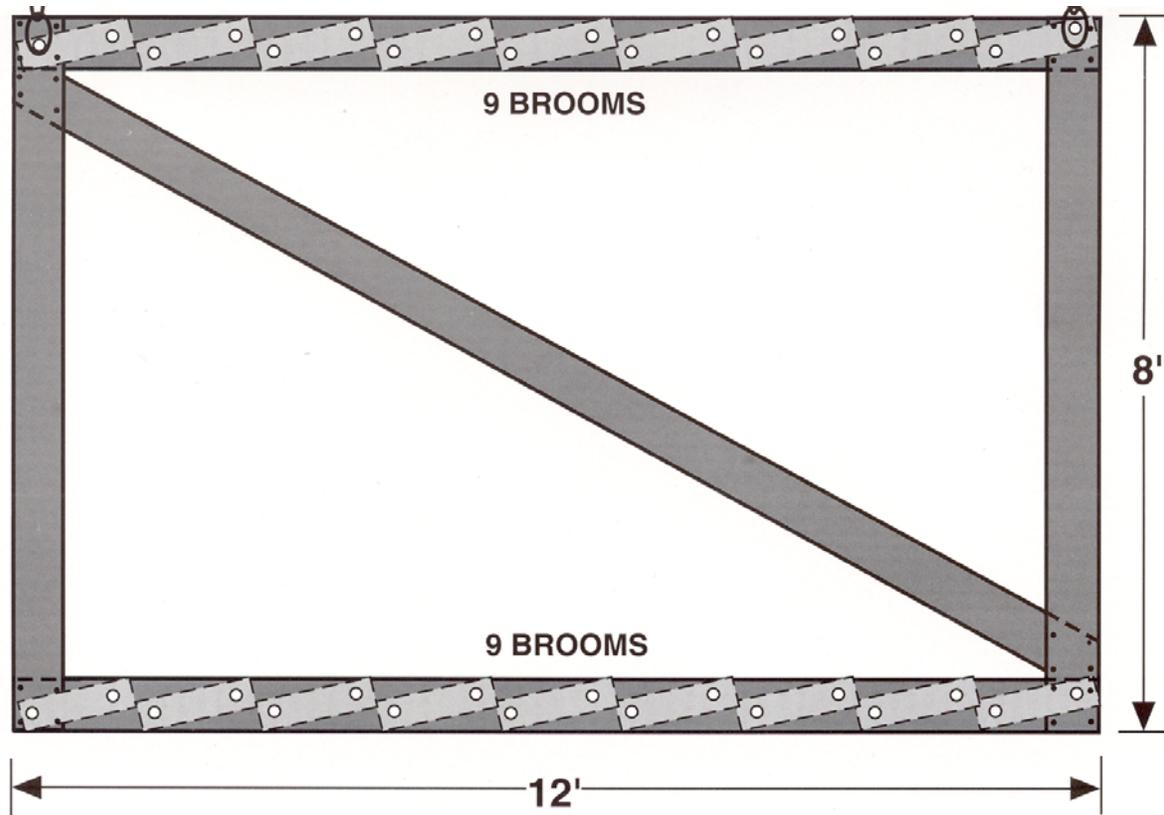


- roller has been made immediately behind the aggregate spreader, which in turn should follow from 15 to 50 m (50 to 150 ft) after the distributor.
10. A lack of uniformity of texture in an old asphalt surface that is to be scrub sealed will result in a lack of uniformity in the finished scrub seal. Therefore, rich patches or flushed and bleeding areas may be repaired before a scrub seal is applied.
 11. Since they tend to be porous and could absorb a portion of the asphalt emulsion applied, new patches on an old pavement should be placed several weeks before a scrub seal is constructed, so as to obtain compaction and closing up by traffic.
 12. The quantity of cover aggregate to be applied per unit area for a scrub seal depends on the aggregate gradation and nominal size.
 13. The quantity of asphalt emulsion to be applied per unit area for a scrub seal depends upon the gradation of the cover aggregate, the texture of the surface on which the scrub seal is to be placed, and the percent residual asphalt in the emulsion.
 14. Aggregate spreaders should be calibrated on each project to apply uniformly the quantity of cover aggregate per unit area that has been stipulated, and the asphalt distributor should have been calibrated to spray uniformly the specified quantity of asphalt emulsion per unit area.
 15. Before starting to spray asphalt emulsion on any scrub seal project, the nozzles in the spray bar should be checked for angle to the spray bar, for clogging, for damage, and for size, and the spray bar height should be adjusted and then maintained either by a special mechanism for automatic adjustment, or by chaining or otherwise tying the frame to the axle.
 16. Do not proceed with the construction of an asphalt emulsion scrub seal if rain is impending within two hours after completion of the scrub seal.
 17. The asphalt distributor should not be permitted to start spraying until the brooms, aggregate spreader and loaded trucks are in line and ready to apply the cover aggregate, and pneumatic-tire rollers are ready to begin rolling the cover aggregate as soon as it has been spread.
 18. When constructing a scrub seal in half-road widths a strip of uncovered asphalt emulsion 75 to 100 mm (3 to 4 in.) wide should be left along the inside edge when spraying the first half-width, for overlap when spraying the second half-width.
 19. To obtain satisfactory transverse joints free from the common faults of bumps or of flushing and bleeding, the asphalt distributor should start spraying and should preferably stop spraying on a strip of Kraft or building paper placed across the construction lane at right angles to the direction of traffic.
 20. To avoid damage by high speed traffic to a newly opened scrub seal, control of traffic during this initial critical period is required. The most effective method is conveying traffic over the new scrub seal with a half-tonne (half-ton) truck at a speed not exceeding 30 km/h (20 mph).

6.7 Aggregate and Emulsion Scrub Brooms



6.7.1 Aggregate Scrub Brooms



- 2 - 2 x 6 x 8 ft
- 2 - 2 x 6 x 12 ft
- 1 - 2 x 6 x 14 ft
- 18 - Street Broom
3½"W x 6"H x 16"L

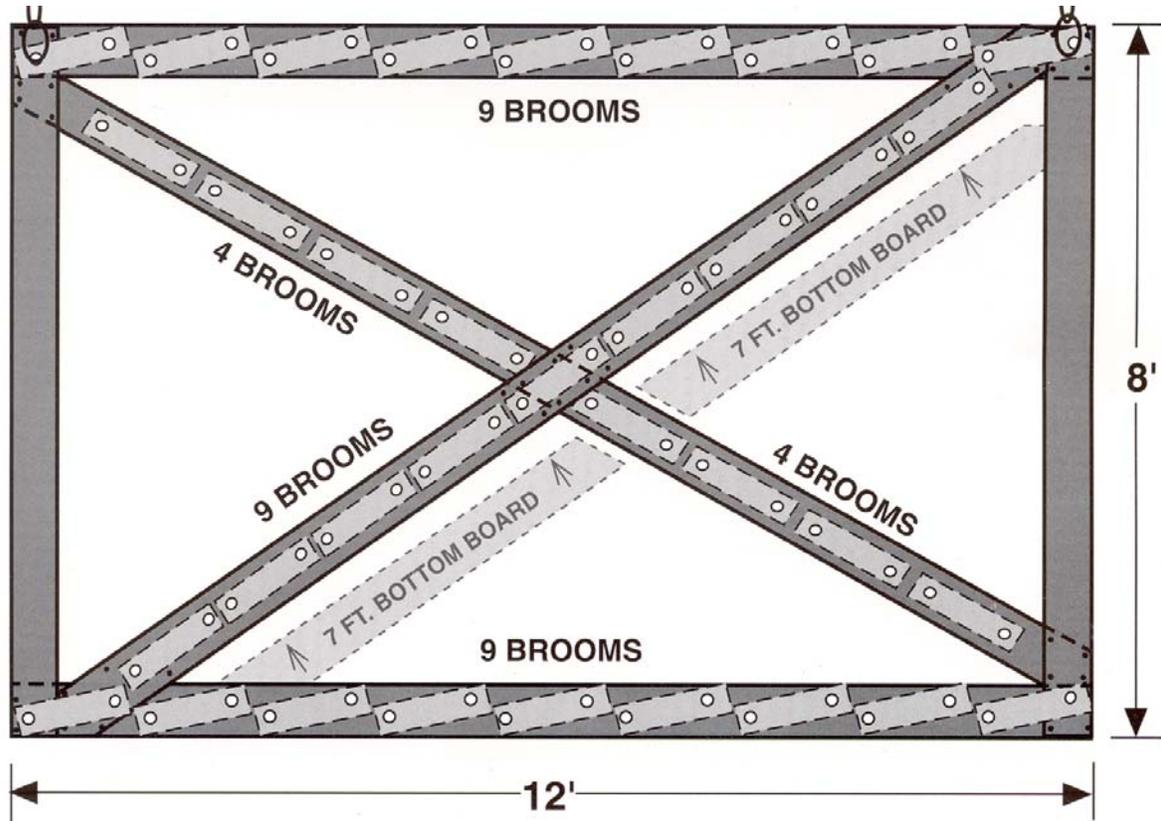
- 62 - 5/16 nuts
- 62 - 5/16 flat washers
- 62 - 5/16 lock washers
- 62 - 5/16 x 5 in. carriage bolts
- 2 - 3/8" x 2' chain w/ hooks
- 2 - 3/8" x 6' bolts w/ nuts, locks, and washers

 = Street Broom w/ nylon bristles

 = 3/8" Chain with hooks

Figure 6-1 Aggregate Scrub Brooms

6.7.2 Emulsion Scrub Brooms



- | | |
|--------------------------------|--|
| 2 - 2 x 6 x 7 ft | 112 - $\frac{5}{16}$ nuts |
| 4 - 2 x 6 x 8 ft | 112 - $\frac{5}{16}$ flat washers |
| 2 - 2 x 6 x 12 ft | 112 - $\frac{5}{16}$ lock washers |
| 2 - 2 x 6 x 14 ft | 112 - $\frac{5}{16}$ x 5 in. carriage bolts |
| 35 - Street Broom | 2 - $\frac{3}{8}$ " x 2' chain w/ hooks |
| $3\frac{1}{2}$ "W x 6"H x 16"L | 2 - $\frac{3}{8}$ " x 6' bolts w/ nuts, locks, and washers |

 = Street Broom w/ nylon bristles

 = $\frac{3}{8}$ " Chain with hooks

Figure 6-2 Emulsion Scrub Brooms