Indian Roads Congress
Special Publication 34

GENERAL GUIDELINES ABOUT THE EQUIPMENT FOR BITUMINOUS SURFACE DRESSING

NEW DELHI 1989

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CONTENTS

GENERAL GUIDELINES ABOUT THE EQUIPMENT FOR BITUMINOUS SURFACE DRESSING

1. INTRODUCTION

1.1. Guidelines on Surface Dressing Equipment were under consideration of the erstwhile Highway Construction and Mechanization Committee of the Indian Roads Congress. The Guidelines prepared by a Working Group were placed before the Mechanization Committee in their meeting held at New Delhi on the 23rd September, 1988, (personnel given below) :

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J.C. Tayal	S.H. Trivedi
	R. Ramaswamy

1.2. The Committee discussed the draft guidelines on the basis of the comments of the members and authorised the Convenor to finalise the same for placing before the Highways Specifications and Standards Committee.

1.3. The Highways Specifications & Standards Committee in their meeting held at New Delhi on the 24th November, 1988 discussed the guidelines and set up a Sub-group consisting of S/Shri J.K. Dugad, R.K. Saxena and P. Bhaskaran to modify the

text on the basis of the comments of the members. The Committee in their next meeting held on 7th April 1989, discussed the Draft Guidelines as modified by the Sub-group and approved the same as a Special Publication with some minor improvements which were later carried out by Shri R.K. Saxena. The Guidelines finalised by the Committee got the approval of the Executive Committee through circulation and were placed before the Council in their 126th meeting held at New Delhi on the 29th April, 1989. The Council approved the guidelines and authorised the Convenor, Highways Specifications & Standards Committee and the Convenor of the Mechanization Committee to finalise the document on the basis of the comments offered by the members of Council. The guidelines have been finalised accordingly.

2. SCOPE

Surface dressing is a very effective treatment as wearing course for road pavements if adequate care is taken in execution of the work. The Specification consists of application of a thin film of bitumen/emulsion binder onto the pavement surface, followed by a layer of stone chippings which are then rolled. The binder film acts as a deterrent to the entry of water in the pavement structure. The stone chippings protect the bituminous film from damage by vehicle tyres, and the surface dressing form a durable, skid-resistant and dust-free riding surface.

These guidelines draw attention to the specific aspects relating to the equipment to be used for surface dressing jobs to achieve optimum results. For matters related to design specifications, quality controls etc. in respect of various types of surface dressing treatments the references listed in *Appendix I* may be consulted.

3. TYPES OF EQUIPMENT

3.1 Principal items of equipment needed for surface dressing work are :

(i) Mechanical brooms,

(ii) Binder distributors,

(iii) Aggregate chip spreaders, and

(iv) Rollers

3.2. Main requirements in respect to each item are discussed furtheron.

4. MECHANICAL BROOMS

The road pavement surface must be clean and free from dust before applying the binder so that it may adhere properly. It is difficult and time consuming to obtain satisfactory results using hand brooms. Mechanical brooms, either towed or powered, may be used for obtaining a clean pavement surface prior to spreading the binder. Several types of power brooms are available. The one used most commonly is the pulled type. Other types are mounted on the front of a tractor. The bristles of the broom are usually made of fibre, steel, or nylon. Fig. 1 shows a mechanical broom.

5. BINDER DISTRIBUTORS

5.1. Success of surface dressing treatment depends very much on binder being applied uniformly at the prescribed rate of spread and temperature. The method adopted for binder application must therefore :

(i) be capable of spreading binder uniformly

(ii) be capable of spreading binder at a pre-determined rate

(iii) be capable of spraying an area matching the output of chip spreader in a working day

The use of hand-held containers such as watering cans, perforated buckets etc., is undesirable and not acceptable since requirements (i) and (ii) above cannot be met with.

5.2. Spreading of binder on a large scale requires use of a mechanical bulk binder distributor which may be either self-propelled Fig. 2 or a towed unit Fig. 3. There are basically four types of bulk binder distributors, categorised as :

(i) Pressurised tank type;

(ii) Constant rate of spread type;

(iii) Constant volume type and

(iv) Constant pressure type

5.2.1. **Pressurised tank distributor** : In this type of distributor, the binder tank is pressurised by an air compressor, thereby

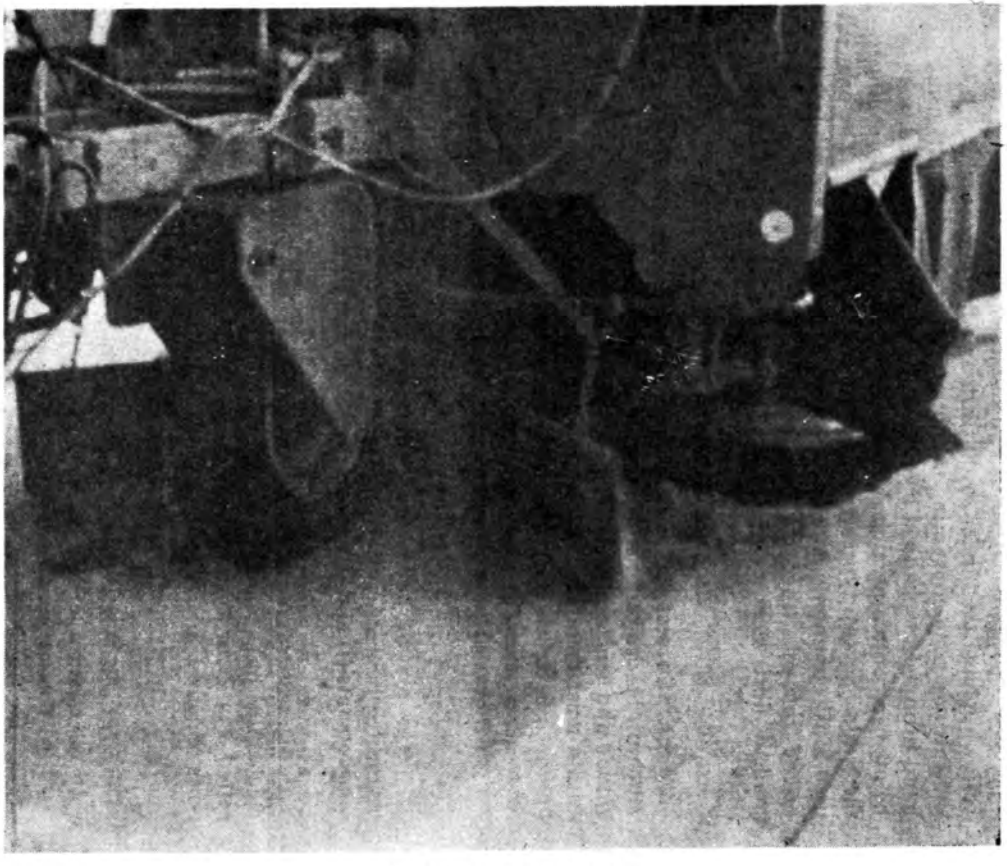

Fig. 1. Mechanical broom

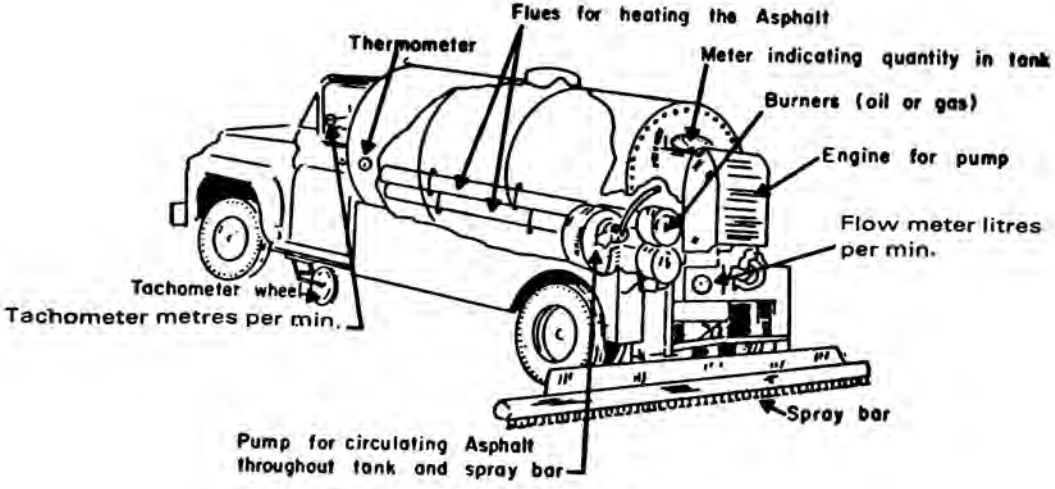

Fig. 2. Self propelled distributor

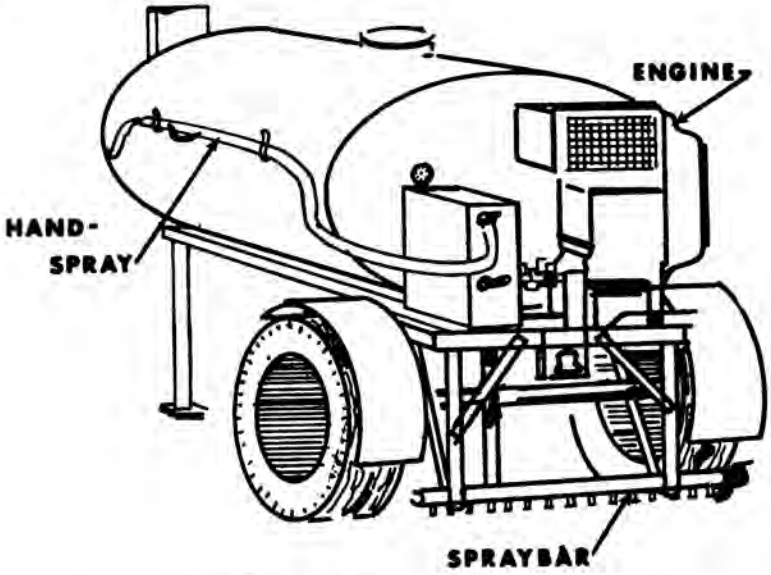

Fig. 3. Trailer-type distributor

generating the necessary constant pressure at the spray bar. In these machines, the rate of spread of binder is inversely proportional to the travel speed of the distributor. The pressurised tank system can only be used successfully with binders having very low viscosity such as emulsions, and in practice machines of this type are uncommon.

5.2.2. **Constant rate of spread distributor :** Prime objective of design of this type of distributor is to eliminate variations in the rate of spread, caused by fluctuations in the forward travel speed of the distributor, which is a common drawback of many other types of distributors. Binder is supplied to the spray bar by a metering pump which is driven from the main transmission of the vehicle through a multi-ratio transfer gearbox. The supply of bitumen to the spray bar is 'non-return' which means that during spraying operation no bitumen is allowed to bypass the spray bar and re-circulate to the tank. The required rate of spread is obtained by selecting the appropriate gear ratio at the transfer box. If a certain minimum road speed is maintained,

the metering pump will deliver the required amount of binder to the spray bar regardless of speed variations. This type of distributor suffers from the disadvantage that if it is required to close off some jets, the overall rate of spread is affected. Very few machines of this kind are in use.

5.2.3. **Constant volume distributor :** These machines are fitted with positive displacement pumps, the output of which can be pre-set. All the binder delivered by the pump is fed to the spray bar when spraying is in progress and there is no by-pass arrangement for re-circulating binder to the tank. For a spray bar of given length and output, the rate of spread of binder on the road is inversely proportional to the forward travel speed of the distributor

Constant volume distributors can spray a wide variety of binders and they are quite common in tropical developing countries. Disadvantages of constant volume distributors are :

(i) calibration involves three inter-related variables, i.e. the pump output, the travel speed and the spray bar width; hence the calibration procedures need to be extensive

(ii) whilst suitable for spraying heavy applications of binder, this type of distributor is not well suited to spraying light applications

(iii) the relative mechanical complexity of the machines means that they are not suitable for operation by semi-skilled operators

5.2.4. **Constant pressure distributor** : In these machines, a pump of adequate capacity delivers binder to the spray bar at a pre-set pressure. A relief valve regulates the pressure and permits binder to by-pass the spray bar and return to the tank. The pressure in the spray bar is not affected by the number of nozzles in use, and hence recalibration is not required when spray bar extensions are fitted. Similarly, the number of nozzles in use can be changed at will without affecting the rate of spread of binder.

As in the case of constant volume machines, the rate of spread of binder varies inversely with the travel speed of the distributor, but no other factors are involved unless the type of binder is changed from a bitumen binder to a tar binder

Whirling spray jets, which are commonly fitted to constant pressure distributors, may require different calibrations for bitumen binders and tar binders.

5.2.5. On the whole, both types of distributors, i.e constant volume and constant pressure, will be suitable. However, for heavy application, constant volume distributor might be preferred.

5.3. Principal Components of Binder Distributors

All types of binder distributors spray the binder through some kind of spray bar to which the binder is supplied by a pump, drawing the binder from a heated insulated storage tank. Brief description of these principal components and general guidelines about their operation are given below :

5.3.1. **Spray bars and spray jets :** There are basically two types of spray jets : slotted jets, and whirling jets The former are high output jets while the later have relatively lower output. Slotted jets are particularly useful for grouting operations and very heavy application rates. But whirling spray jets have an advantage for surface dressing, in that the forward speed of the distributor can be slower than that of slotted jet distributor. This helps in controlling the speed more easily so that chipping operation can keep pace with the spraying of binder. The spray bars can be of lengths varying from 2.5 to 7.5 m with extensions.

5.3.2. **Binder pump and air compressor :** On most distributors, the binder pump is driven by a separate engine, usually mounted either at the rear of the tank or between the tank and the driving cab. The pump is normally of gear type with positive displacement. It can be located either inside the binder tank so that it is kept hot by the surrounding binder or close to the heated casing of the tank. The engine drive to the pump is usually through a clutch and the same engine drives a small air compressor which supplies air and fuel under pressure to the burners. On some distributors the pump drives are taken either from the main power transmission of the vehicle or through a hydraulic system driven by the main engine.

5.3 3. **Tanks and burners :** The capacity of tanks varies between 5000 and 16000 litres. The tanks are invariably made of steel and are insulated to reduce heat loss. The baffles are fitted internally to minmise surge and a dipstick or contents gauge indicates the level of the binder. Flue tubes fitted with burners run through the tank to heat the binder. The burners run either on kerosine or diesel fuel. The burners in a distributor should be used to make only relatively small increase in the binder temperature. To prevent 'coking' of binder in the vicinity of the burners, the binder should be circulated when the burners are lit A thermometer and fire extinguishers should be located at convenient positions.

5.3.4. **Distributor speed control and calibration :** Most distributors are equipped with a fifth wheel which operates a low range speedometer located in the driver cabin. Now-a-days electronically operated speedometers are also being used. The calibration charts are normally supplied by the manufacturers. To spray binder at a specified rate with constant pressure distributor, all that is necessary is to read the corresponding travel speed from the calibration chart. With constant volume machines, it is necessary to select from the chart both the pump output and the forward speed so as to get the required rate of spread for the width of spray bar being used.

If the distributor has not been calibrated previously, or if the calibration chart is not readily available, either of the following two methods may be used to calibrate the machine :

Method A

The distributor is loaded with the binder raised to spraying temperature. Hot binder is then circulated around the spray bar and a short spraying run is made to check the evenness of the appearance of the binder spray by the jets. The binder is then spread onto a suitable tray or tank for an accurately measured time and the amount of binder in the tray/tank is determined by measuring the volume or by weighing. The amount of binder delivered by the spray bar per minute is calculated and the rate of spread/speed relationship is determined as under :

Method B

(i) To find the quantity of spray in litres per square metre when speed of travel is known

$$\text{Litres/sq. metre} = \frac{\text{Out put of sprayer bar (litres/min)}}{\text{Speed of vehicle (metre/minute)} \times \text{Spraying width (in metres)}}$$

(ii) To find the speed of vehicle for a known application

$$\text{Speed (in metres/minute)} = \frac{\text{Application rate (liters/sqm)}}{\text{Out put of sprayer bar (litres/minute)} \times \text{Spraying width (in metres)}}$$

Four or five weighed metal trays of known area are placed in the path of the distributor as it makes a spraying run at a constant speed The trays are then picked up and weighed and the rate of spread of binder calculated. The process is repeated with different distributor speeds until the required rate of spread/ speed chart can be drawn. This kind of test should be repeated from time to time when the distributor is in use to check the consistency of the calibration.

5.3.5. Requirements of distributors

(i) The distributor should be either a self-propelled unit or a trailor unit

(ii) It must have a heating system

(iii) It must have a binder circulating pump to circulate the bitumen in the tank to prevent overheating near the flue tubes and through spraybar when the distributor is standing idle to prevent clogging of the nozzles

(iv) Spraybar width must be adjustable, so that the desired application width can be obtained

(v) It should have a hand-hose attachment for spraying areas which cannot be covered with the regular spraybar

(vi) It must have a thermometer mounted in the tank

(vii) The height of spraybar must be adjustable

(viii) Each nozzle must have a cut-off valve to stop the flow immediately without dripping and the angle of spray openings on the nozzles must be adjustable

(ix) The tank should have a contents gauge

(x) It must have a tachometer located in front of the driver to show the travelling speed of the distributor in metres per minute

(xi) The distributor operator must have adequate charts for determining the discharge in litres per minute for each size nozzle and the proper truck speeds to obtain the correct application rate. The charts are supplied by the manufacturer or these can be prepared as mentioned in para 5.3.4.

(xii) Constant volume distributor having a variable pump must have a pump tachometer or a volume meter for setting and maintaining the proper volume of discharging in litres per minute

(xiii) Constant pressure distributor having a constant speed pump must have a pressure gauge and relief valve for setting and maintaining the proper pressure which results in a given output in litres per minute

6. AGGREGATE CHIP SPREADER

6 1. The aggregate chip spreader is as important as the bitumen distributor. Its function is to apply a uniform aggregate cover at a specified rate over the freshly spread bitumen film on the pavement surface

Aggregate spreaders for use in surface treatment work consist of three basic types :

(i) Tail gate spreader;

(ii) Truck attached (towed) spreader; and

(iii) Self-propelled spreader.

6.2. Tail gate chip spreader (Fig. 4) is bolted in place of tail gate of a tipping truck. It is the cheapest and simplest kind of mechanical chip spreader. Since the rate of spread of the chippings is dependent on gravity and the speed of the tipper truck, the skill of the truck driver is crucial in ensuring even distribution of chippings.

However, to reduce dependency on the skill of the tipper driver, metering devices are available for tail gate chip spreaders (Fig 5a and 5b). Metering device consists of a hopper with a feed roller which is activated by attachment of small wheels driven by truck wheels or from a fifth wheel attached to the chip spreader. In this way, variations in forward speed of tipper produce corresponding variations in the rate of discharge of the chipping.

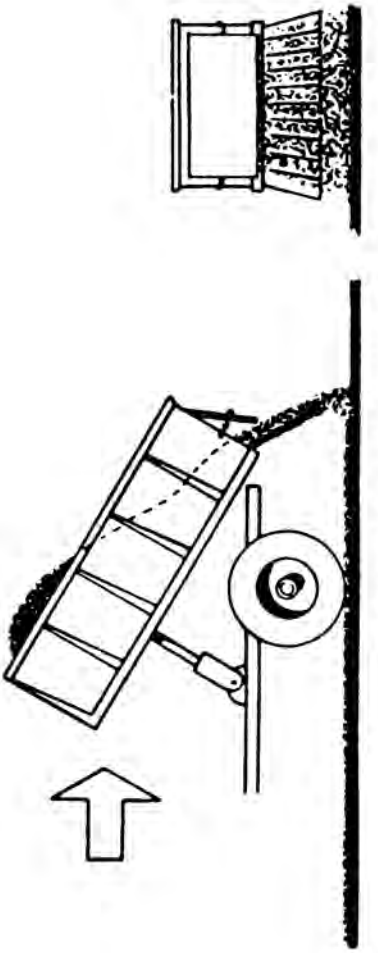

Fig. 4. Tail gate vane spreader

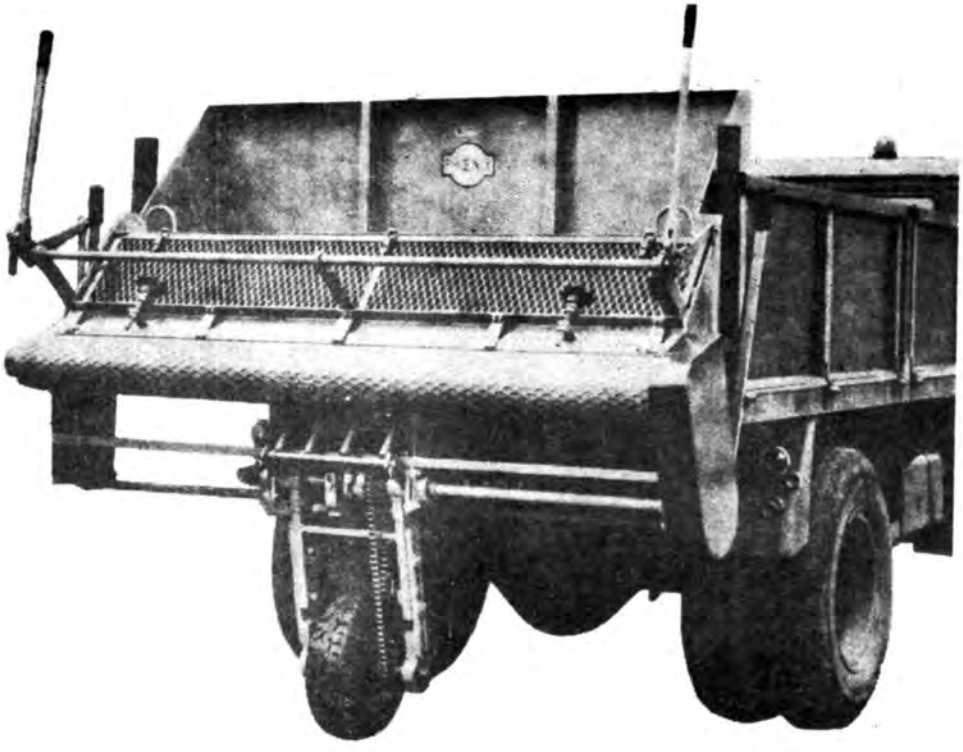

Fig. 5(a). Tail board metering chipping spreader

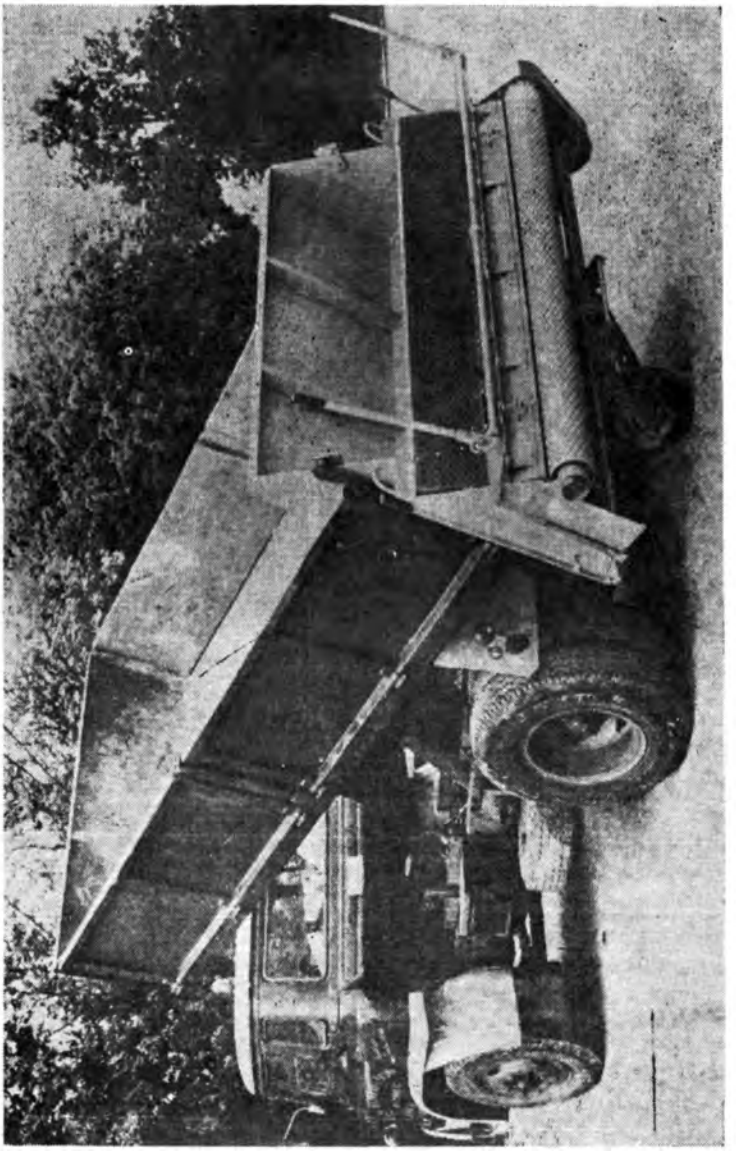

Fig. 5(b). Tail board metering chip spreader

6.3. Truck attached spreaders (Fig. 6) are hoppers on wheels which are hooked on to and propelled by aggregate tippers. The feed is driven by the wheels of the hopper and the chippings in the hopper are replenished from the raised body of the tipper. Hoppers contain augers to distribute the aggregate to the full width of the box.

6.4. Self-propelled spreader (Fig. 7 a & b) is the most effective machine available for applying chippings. It has a hopper at the rear into which chippings are discharged from the delivering tipper truck. During the transfer of chippings, the tipper truck is towed along in the reverse by the chip spreader. Conveyor belts transfer the chippings to a transverse hopper at the front of the machine. At the bottom of the hopper is the metering roll that delivers the chippings to the road pavement.

7. COMBINED BITUMEN AND AGGREGATE SPREADER

Now-a-days combined bitumen-cum-aggregate spreaders are also available. It is a tail gate type of spreader capable of simultaneously spreading bitumen and aggregate in the required quantity.

8. ROLLERS

8.1. Rolling of aggregates is important to ensure their retention by assisting the initial orientation and embedding in the binder. Traditionally steel wheel rollers have been used. But they have the following disadvantages :

(i) they tend to crush weaker aggregates.

(ii) they crack poorly shaped chippings.

(iii) they have a tendency to bridge slight depressions in the pavement, thereby causing improper embedding of some of aggregates.

8.2. In general, pneumatic tyred rollers (Fig. 8) with smooth tread are preferable. These have the advantage that the kneading action of the resilient tyres forces the aggregates firmly into the binder without splitting or crushing.

8.3. Currently, vibratory rollers with rubber-coated drums are also being used. These achieve better compaction as well as better embedment of the aggregates.

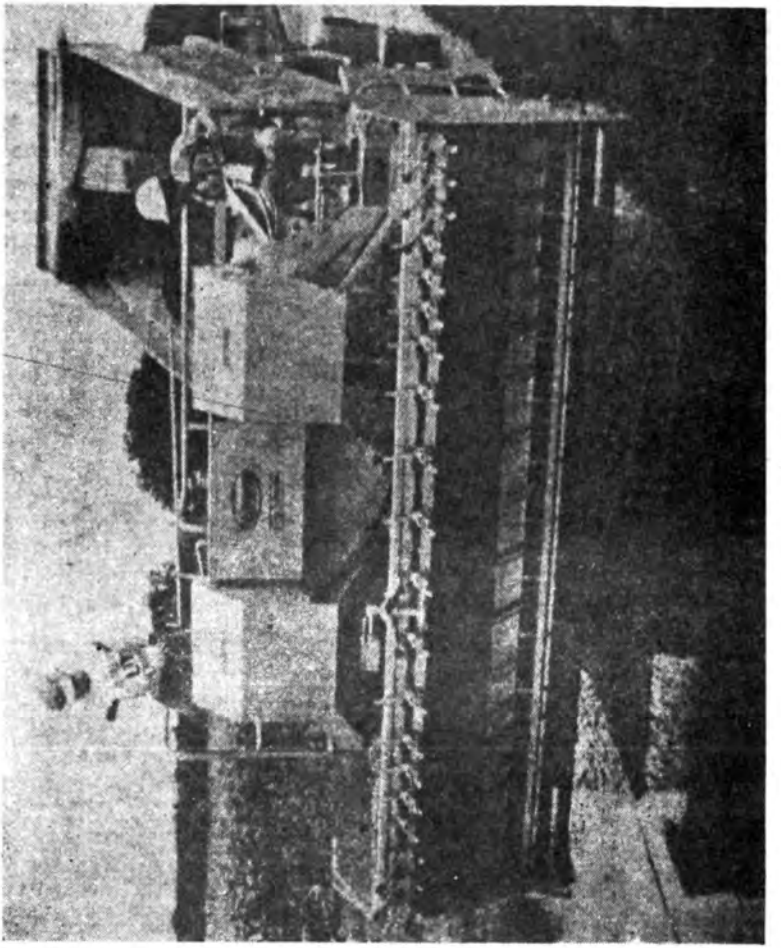

Fig. 6. Truck attached mechanical spreader

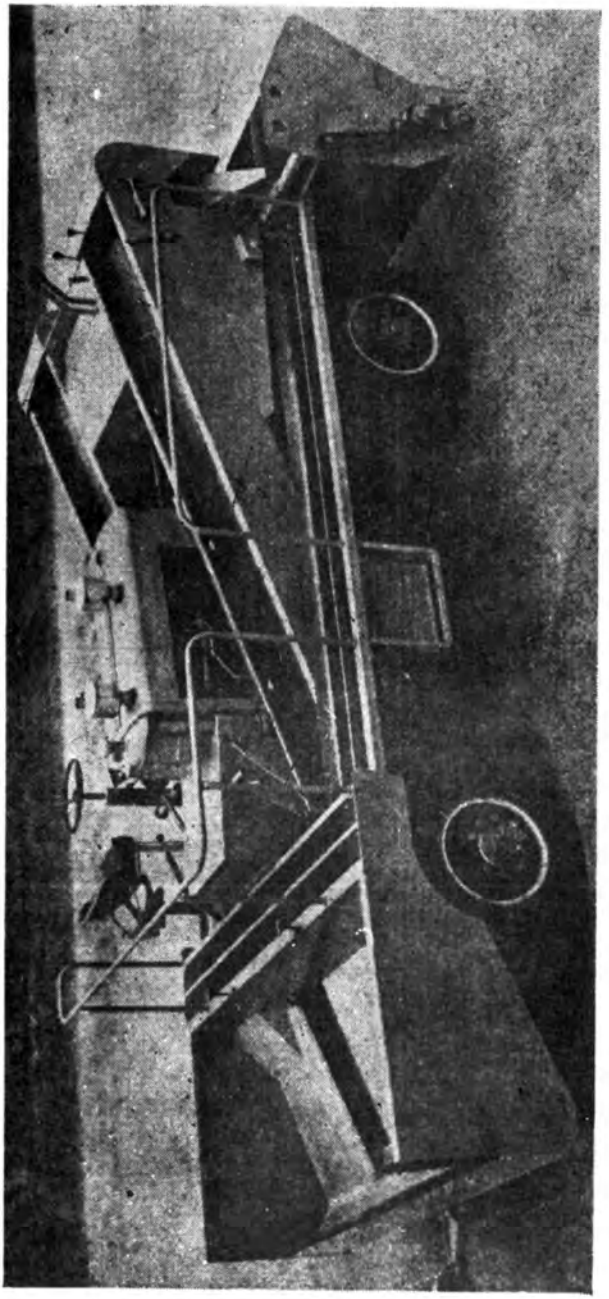

Fig. 7(a). Self-propelled mechanical spreader

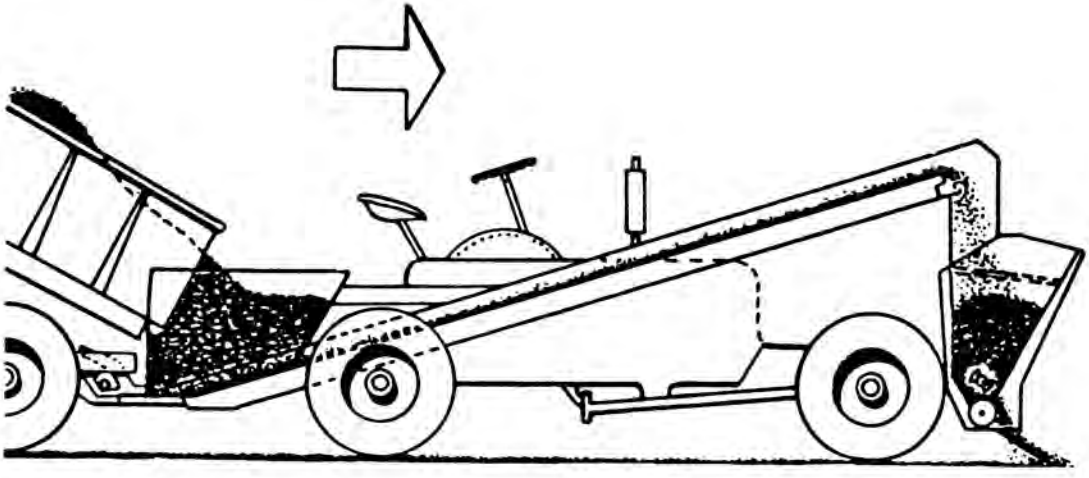

Fig. 7(b). Flow of aggregate through mechanical spreader

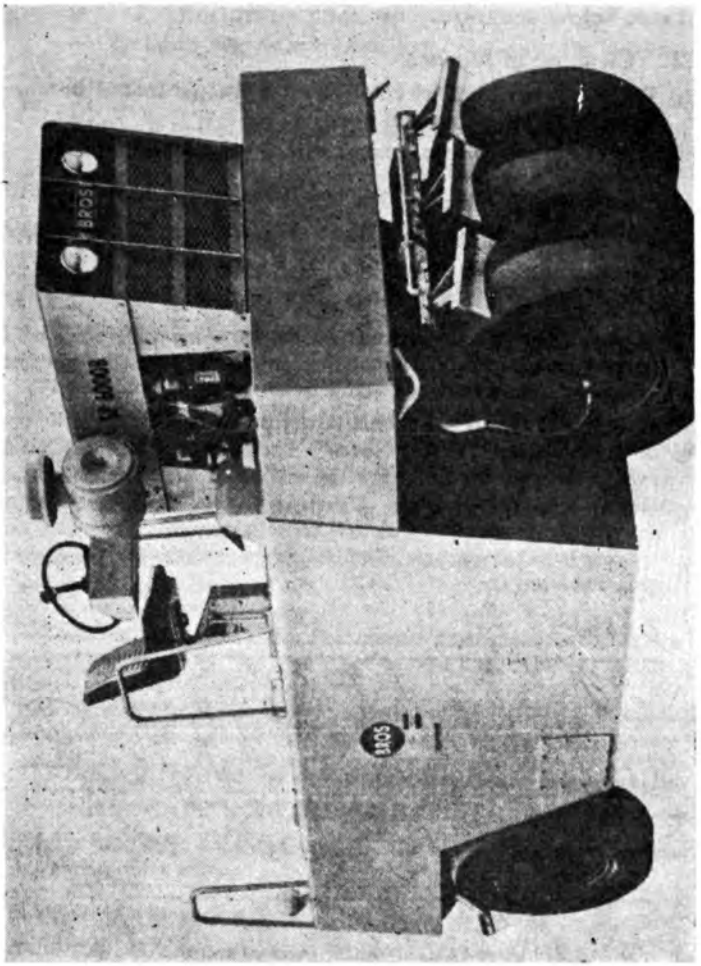

Fig. 8. Pneumatic tyred roller

9. USE OF EQUIPMENT AND PRECAUTIONS

9.1. The sequence of construction operations including preparation of base is basically the same for all types of pavement surface treatments as laid down in relevant specifications. Points of good practice, and the precautions to be adopted, are brought out below separately for each operation.

9.2. Cleaning of Surface

(i) The condition of bristles or wires of the brooms should be checked regularly before the start of work

(ii) Bristles/wires should be replaced as and when found necessary

9.3. Spraying Bitumen

Prior to start of bitumen spraying, the distributor and all its components should be checked to see that they are in good working order.

(i) To ensure satisfactory performance of the spray bar, strainers and in-line filters in the binder feed system must be cleaned regularly, otherwise blocked jets will result

(ii) Height of the spray bar should be adjusted to get right single, double or triple overlap (Fig. 9) of spray. The height of the spray bar from the ground and the nozzle spacing will determine whether the overlap will be double or triple. Usually a double overlap is used when nozzles are spaced 150 mm apart and a triple overlap when nozzle spacing is 100 mm apart. The following procedure is adopted to check overlap :

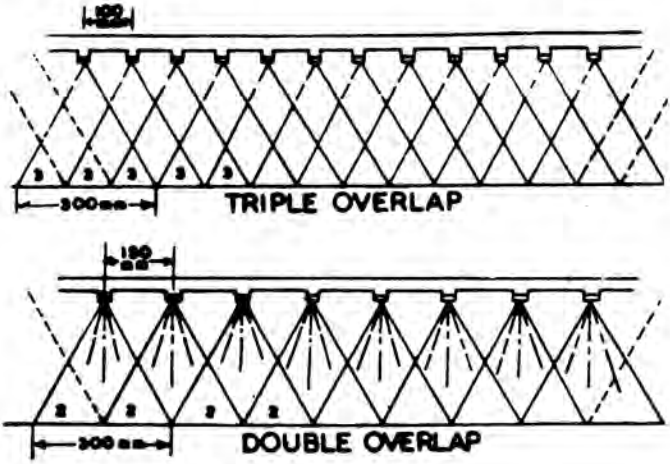

Fig. 9. Overlap of spray

(a) Double overlap-with 150 mm nozzle spacing (Fig. 10) :

—Shut-off or plug every alternate nozzle in a short section of the spray bar

—Make a short run with the operating nozzles spraying

—The edges of the spray fans should just touch each other at the ground

—If the spray fans do not touch each other, raise the spray bar.

—If the spray fans overlap, lower the spray bar

—Make sure that the spray bar is at the proper height throughout the length

(b) Triple overlap-with 100 mm nozzle spacing (Fig. 11)

(i) Operate only every third nozzle, shut off others in a short section of the spray bar

(ii) Rest of the procedure is the same as for double overlap

(iii) Nozzles should be checked for angle setting (Fig. 12). The angle of the spray opening or slots on the nozzles must be adjusted as per manufacturer's recommendations (so that spray fans do not interefere with each other). Usually, angle varies from 15° to 60° Whatever may be the setting, all nozzles must be set at the same angle. In other words, parallel to each other

(iv) Before commencing spraying, the spray bar and jets should be preheated by circulating hot binder and thin jets should be operated for a few seconds discharging on to waste ground to ensure that they are operating freely

(v) A short test run should be made to check the rate of application and uniformity

(vi) In case of less bitumen, the cover aggregates will not be firmly held in place

(vii) If bitumen is applied in a streaked manner, the cover aggregates will be retained in a streaked manner

(viii) Excess bitumen. will bleed through the cover aggregates and cause sticky, slippery surface

(ix) If spraying is interrupted briefly, the spray bar should be kept hot by circulating binder

(x) When the spray is stopped for a longer period, binder supply to the spray bar should be closed, and jets blown out with compressed air

(xi) At the end of the day, the pump and the spraying system should be flushed with diesel

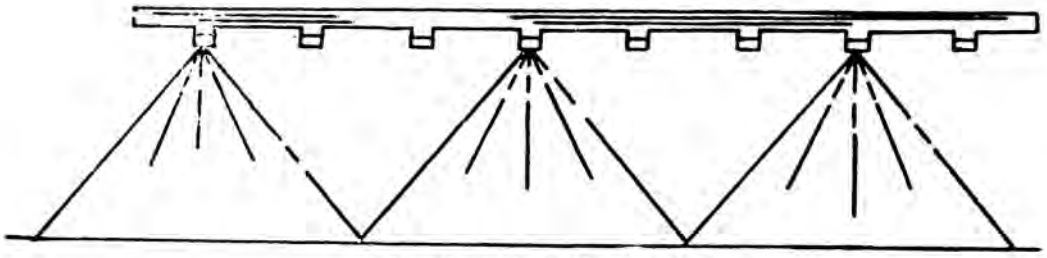

Fig. 10. Checking of double overlap

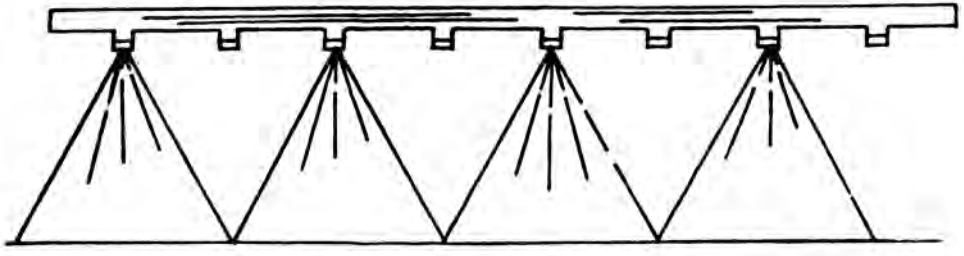

Fig. 11. Checking of triple overlap

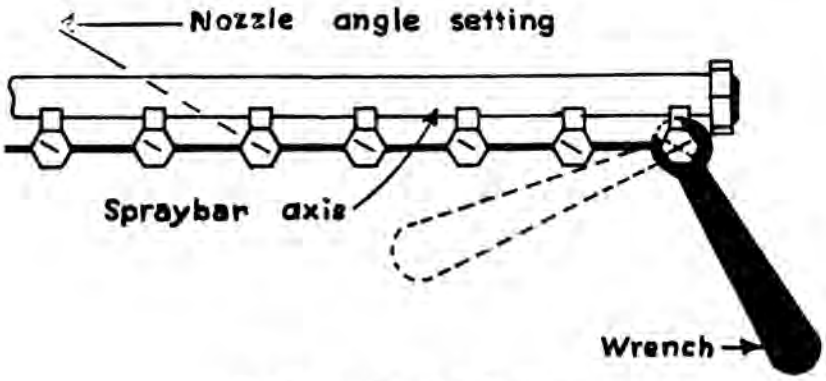

Fig. 12. Angle setting of nozzles

(xii) Burners must not be operated when the distributor is spraying or moving

(xiii) A curtain at the end of the bar (Fig. 13) will provide more uniform coverage at the edge

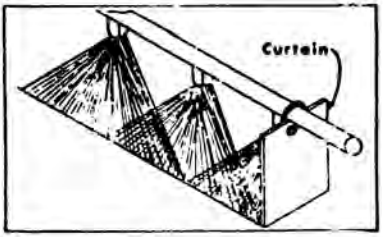

Fig. 13. End curtain

(xiv) When making adjacent passes, a double overlap spray bar must overlap 150 mm and a triple overlap spray bar 200 mm over the previous pass

(xv) The tachometer wheel must be kept clean to ensure correct reading of the distributor speed

(xvi) The ideal spray fan should be a solid sheet of bituminous material, which can only be formed when the material is pumped at proper pressure. Low pressure will cause streaking and high pressure will atomise the bitumen and distort the spray fan

(xvii) Streaking is the most common problem in bitumen spraying. It is caused by a combination of one or more of the following :

(a) Clogged nozzles.

(b) Imporper pump pressure.

(c) Interference of spray fans.

(d) Improper spray bar height.

Each of these conditions should be monitored and set right daily and again whenever streaking is encountered during the spraying operation

(xviii) To spray binder at the specified rate with the constant pressure machines all that is necessary is to select the corresponding travel speed of distributor from the manufacturers calibration chart. With the constant volume machines, it is necessary to select from the chart both the pump output and forward speed for the width of spray bar being used

(xix) Some distributors have variable—speed pump. Such distributors must have pump tachometer or flow metre for setting proper discharge in litres per minute

(xx) The distributor must travel at exact and constant speed while spraying to ensure a uniform and proper application rate

9.4. Spreading Aggregates

(i) Self-propelled metering chip spreaders are the most effective machines for uniform distribution of aggregates

(ii) The calibration and adjustment of all types of aggregate spreaders should be made according to manufacturers' instructions

(iii) A tachometer helps in maintaining uniform spreader speed

(iv) Distribution rates can be closely controlled by marking on the road the length that each truck load of aggregates should cover

(v) A quick check on the amount of aggregates (rate of application) can be made by laying one sq. metre cloth or paper or a shallow box above the binder and passing the chip spreader over it. The cloth paper or box is then carefully lifted and aggregates on it weighed

(vi) A strip of binder 150 mm wide should be left unchipped at the edge of the lane to allow for overlap of adjacent run of the binder distributor

(vii) The fuel tank of the spreader or any other machine should not be refilled while it is parked on the roadway

9.5. Rolling

(i) The direction of the roller should be such that the new surface is rolled first by the driving wheel (s)

(ii) Rolling should begin immediately after spreading of the aggregates.

(iii) Three passes should be completed within 30 minutes of binder application. Rolling should be discontinued when the binder has set

(iv) The roller speed must not exceed 8 km/hr

(v) Each pass should overlap the previous pass by about one half the width of the front wheel

9.6 Removing Excess Aggregates on the Surface

Loose aggregates, if any, on the finished surface should be removed with a power broom using light broom pressure. The brooming operation should be done only after traffic has passed and a good bond has developed between the bitumen and aggregates.

Appendix-I

LIST OF DOCUMENTS RELATING TO SURFACE DRESSING

1. Ministry of Surface Transport (Roads Wing)'s Specifications for Road & Bridge Works (2nd Revision) 1988.
2. IS:2093-1962 Specifications for Distributors for the Tar and Bitumen.
3. IS:2094-1962 Specifications for Heater for Tar and Bitumen.
4. IRC:23-1966 Tentative Specifications for Two Coat Bituminous Surface Dressing
5. IRC:48-1972 Tentative Specifications for Bituminous Surface Dressing using Precoated Aggregates
6. IRC:96-1987 Tentative Specification for Two Coat Surface Dressing using Cationic Bitumen Emulsion
7. IRC HRB Special Report No. 7. State of Art : Surface Dressing.