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GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF PAVER FINISHERS

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GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF PAVER FINISHERS

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GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF PAVER FINISHERS

INTRODUCTION

The Committee for Mechanization (G-4) was constituted by the Indian Roads Congress to look into various aspects of mechanization in road sector including improvements in the existing codes and practices. The Composition of the G-4 Committee is as under:

Das, S.N.	–	Convenor
Verma, Maj.V.C.	–	Co-Convenor
Basu, Kaushik	–	Member-Secretary

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Director General (RD) & Special Secretary, MORT&H	(Singh, Nirmal Jit)
Secretary General, IRC	(Indoria, R.P.)

The G-4 Committee decided that a document be prepared on 'Guidelines for Selection, Operation and Maintenance of Paver Finishers' which shall facilitate the Planning and Construction Engineers to select the appropriate type of Paver Finisher for specific work. The Committee assigned the job for preparation of draft guidelines to Shri R.K.Saxena, Former Superintending Engineer (Mechanical), MORT&H.

The draft guidelines prepared by Shri R.K.Saxena were discussed among the officers of the Mechanical Zone in the presence of the Chief Engineer (Mech). Thereafter the document was presented and discussed in G-4 Committee meeting held on 29 July and 07 October 2009 and approved with certain amendments. These were further discussed in the General Specification & Standard Committee (GSS) meeting held on 27 October 2009 and approved. Draft document approved by the Executive Committee in its meeting held on 31 October, 2009.The presentation on these guidelines was given in the Council Meeting of IRC held at Patna on 14 November 2009 and the draft was approved.

NEED FOR GUIDELINES

The huge investment and rapid mechanization in road construction in the country needs more attention to familiarize with the methodology of construction equipments. In order to achieve the required level of quality of the final product, as specified by the engineering science, it is necessary to deploy appropriate type of machine on specific project.

The purpose of these guidelines is to familiarise the construction engineers with the basic function of Paver Finishers and to use them in a manner to achieve quality work in most economical manner.

In drafting these guidelines, effort has been made to achieve compliance with the International Codes of ISO 9000 series on Quality Systems, published by International Standards Organisation. The present guidelines will be a step towards obtaining ISO Quality Certification, enabling Indian designers and contractors to compete internationally.

SCOPE

These guidelines cover the development in the design of Paver Finisher during various spell of time, its components and their function.

These guidelines will enable:

i) Classification of Paver finishers with its types, traction effort and capacity
ii) Automatic levelling control system in Hydrostatic Paver finisher
iii) Construction of paving joints
iv) Parameters to control mat quality
v) Induction of mobile feeder to lay bituminous mix
vi) Maintenance of paver and safety measures
vii) Information required by purchaser for its selection **(Annex-A)**
viii) Information to be supplied by the manufacturer to the purchaser **(Annex-B)**
ix) Sample calculation of rate of usage charges of equipment **(Annex-C)**
x) Selection of Paver Finishers **(Annex-D)**

1. BACKGROUND

Paver finishers were first introduced at the beginning of 1930 for road construction works. They were used for laying (a) Aggregate layer and (b) Bituminous layer. Necessary modifications in design of the Paver were carried out from time to time based on experience gained and the need to achieve desired road specifications. Basic function of the Paver is to spread and pre-compact the aggregates/bituminous mix. Presently, Hydrostatic Paver Finishers with sensor control device are being used to achieve quality control in respect of road evenness, desired laying thickness compactable to grading. Pre-1960, Pavers with fixed screed were in use. Thereafter, floating screed Pavers were introduced.

2. FUNCTION

Following are the main functions of Paver Finisher:

a) To lay and spread the mix to attain specified surface quality.

b) To facilitate the attainment of specified surface quality and correct grade to meet the road design specifications for a safe and comfortable ride.

c) To achieve specified camber and super elevation in normal reach.

d) To achieve required thickness, uniform degree of compaction, homogenous quality of mix during laying and uniform bearing capacity over the entire surface.

3. CLASSIFICATION

Paver finishers are classified based on the following factors:

a) Type of Paver

b) Type of Traction

c) Capacity

d) Mobility

3.1 Type of Paver

The Pavers are classified into Mechanical and Hydrostatic types based on a) Control mechanism for screed elevation via tow point mounting/actuation and b) Control of screed extension. The hydrostatic drive is through a variable displacement motor and pump for infinitely variable paving and travel speed.

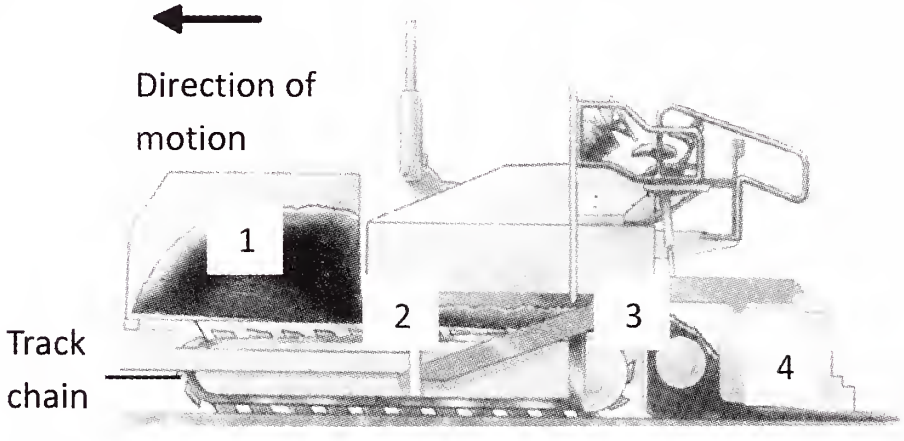
3.2 Type of Traction

Two types of traction effort can be applied on Paver finisher, which are based on the design of tractor unit.

a) Track Chain Paver Finisher (Fig.1)

It is mounted on crawler tracks, which shall be provided with a spring tensioning device or automatic hydraulic track tensioning assembly with suitable rollers, sprockets and idlers, having adequate lubricating system. The bearing pressure of crawler assembly should not exceed 22 N/cm². Following are the features of Track Chain Paver Finisher:

1) The large contact area of tracks gives good traction effort.
2) It can be used for laying in large width upto 16 m.
3) It is more suitable to work on soft or loose sub-bases, difficult under foot conditions and steep gradient.
4) There is no slippage on tack coat.



Smooth material flow during paving through 1 -Hopper, 2-Conveyor, 3 -Auger, 4 -Screed

Fig. 1 Track Chain Paver Finisher

b) Wheeled Paver Finisher

It is mounted on wheels. It can have single/double bogie axle wheels in the front and single/ double drive axles in the rear. The bogie wheels are made of steel with moulded rubber and drive wheels with pneumatic tires which shall be of adequate capacity having good traction effort. Normally, single drive axle is suitable upto 5 m width and double drive axle upto 8.5 m width. Wheeled Paver can travel more easily and at higher speeds, therefore, making its use more convenient and economical, **Figs. 2,3 & 4.**

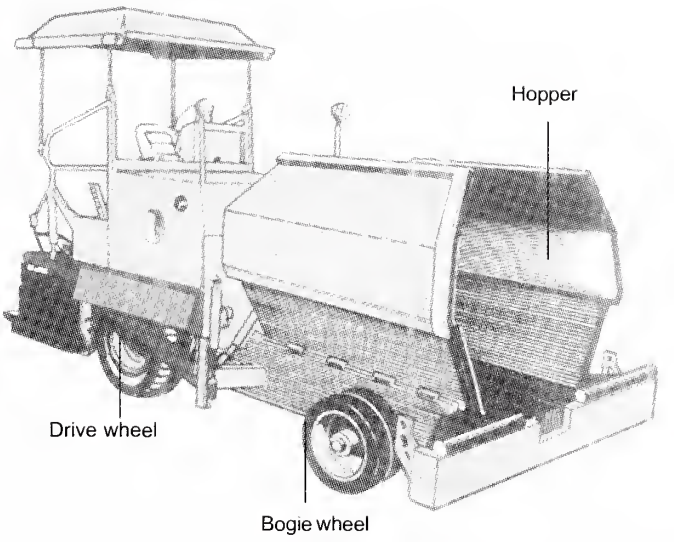


Fig. 2 Wheeled Paver with Single Bogie Axle and Single Drive Axle

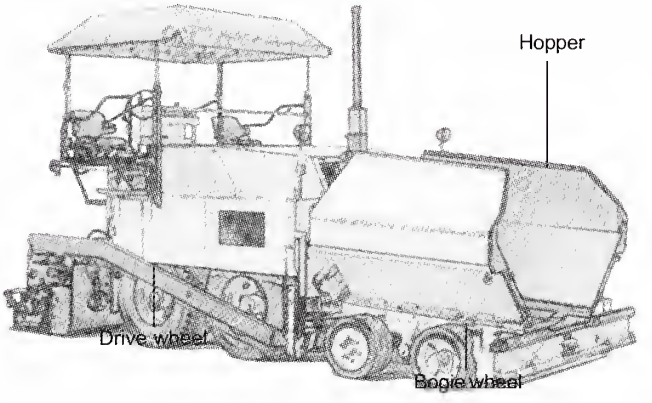


Fig. 3 Wheeled Paver with Double Bogie Axle and Double Drive Axle

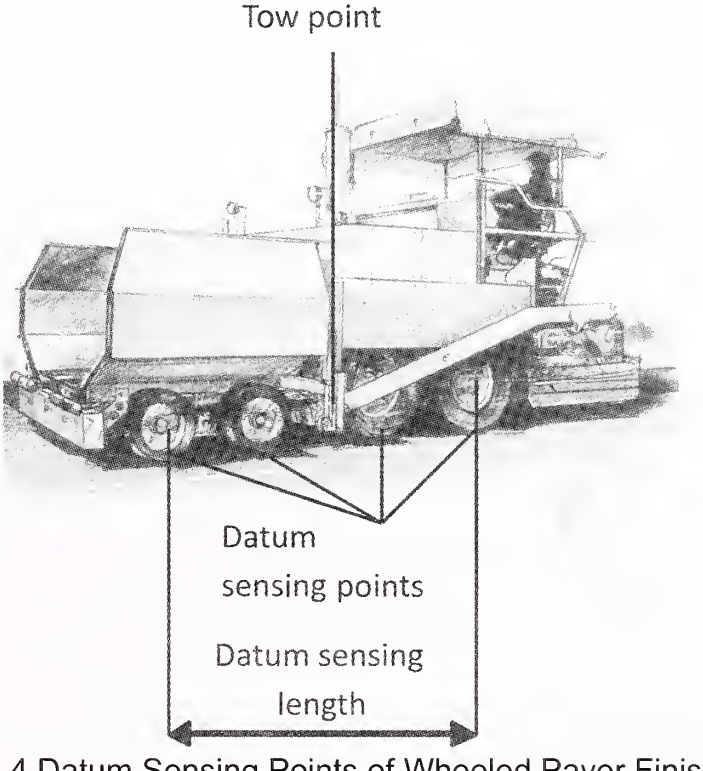


Fig. 4 Datum Sensing Points of Wheeled Paver Finisher

The Wheeled Paver has the following features:

1) It is primarily used on hard surfaces and relatively narrow paving widths.
2) In Wheeled Paver finisher there are fewer datum sensing points and have individual effect based on rolling contact length of tires. Thus, the time of application to tow points is less. Once the wheel has passed the undulations, it has no further effect on Paver finisher until the arrival of next wheel. Therefore, Wheeled Paver finisher is less affected by undulations in the base.
3) There is time saving in movement from one lane to another and end to end.
4) Less traction in two wheels drive version can result in slippage on tack coat.
5) The wear and tear of the tyres is more and causes their frequent replacement.

The Paver finisher whether mounted on tracks or wheels should be powered with an engine providing sufficient traction effort, while working on a firm unyielding base, to push up a fully loaded dumper at 10 percent gradient.

3.3 Laying Capacity

Laying capacity of Paver finisher is expressed in tonne per hour. It depends on following factors:

a) Paving speed
b) Paving width
c) Mat thickness
d) Type of material to be paved
e) Prime mover's output

3.3.1 *Paving and travel speed*

The paving speed should match with feeding of material in the hopper as well as its laying on the surface. **Table 1** gives the range of paving speed and travel speed available in Paver Finisher.

Table 1 Paving Speed and Travel Speed for Paver Finishers

Speed	Wheeled Paver		Tracked Paver
	Mechanical	Hydrostatic	Hydrostatic
a) Paving speed	0-25 m/minute	0-40 m/minute	0-16 m/minute
b) Travel speed	0-16 km/h	0-7.5 km/h	0-3.6 km/h

3.3.2 *Paving width*

The screed of the Paver Finisher decides the paving width. Normally, Paver Finishers are provided with the following screed.

a) Mechanically Extendable Screed

Mechanically extendable screed needs bolt on extension boxes for larger width. The extension needs shims for alignment of bottom plate. The Paver finisher using such screed is known as Mechanical Paver Finisher, in which screed width is 2.5 m with mechanical extension upto 4.0 m.

The Paver having minimum 1.5 m screed width can be used for hill roads and shoulders on other roads.

b) Hydraulically Extendable Screed (Fig. 5)

Hydraulically extendable screed is telescopic, operated through hydraulic pump.

In Hydrostatic Paver Finisher, the basic width of the screed is 2.5 to 3.0 m with infinite variable hydraulic screed width normally upto 6.0 m. It can further be extended upto 10 m with the provision of screed extensions.

For Hydrostatic Paver for paving width beyond 10 m, Mechanical Screeds with heating system upto 16 m width are also available, **Fig. 6**.

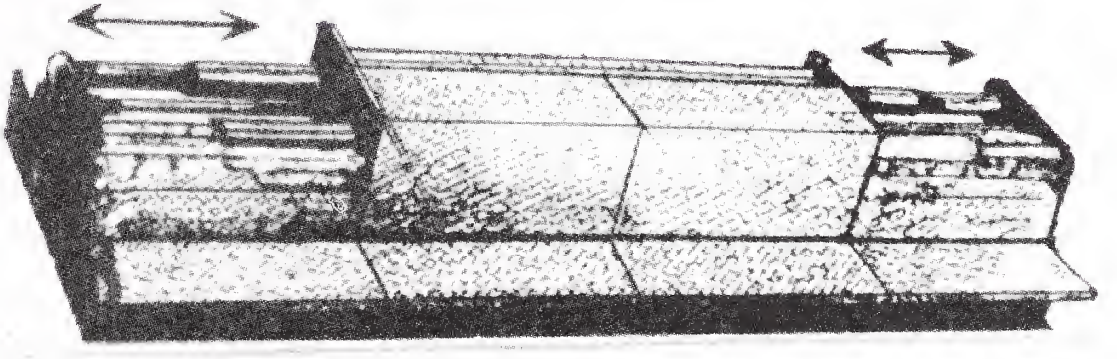


Fig. 5 Hydraulically Extended Screed

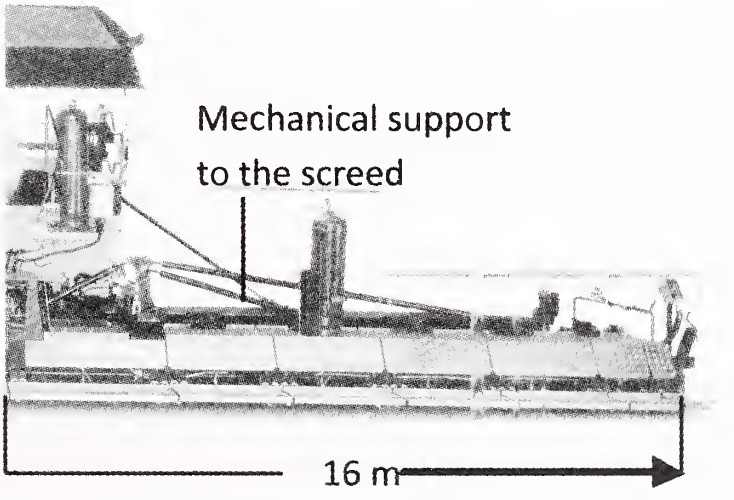


Fig. 6 Tracked Paver Finisher of 16 m Paving Width

3.3.3 *Paving thickness*

The following paving thickness is normally possible for laying the mix.

a) Mechanical Paver finisher : 10 mm to 200 mm

b) Hydrostatic Paver finisher : 10 mm to 350 mm

3.3.4 *Type of material to be paved*

The Paver should be capable of laying any of the following types of materials :

a) Aggregate mixes such as wet mix macadam.

b) Bituminous mixes, such as, bituminous macadam, dense bituminous macadam, semi-dense bituminous concrete, bituminous concrete, etc.

In case paving width requirement is 8 m and above, it is recommended to use Tracked Paver for better control over traction and pavement quality also.

3.3.5 *Prime mover's output*

The prime mover fitted on the Paver Finisher should be diesel engine of repute make, with adequate capacity conforming to IS/BIS/DIN Standards.

3.3.6 *Output of paver finisher*

Output of the Paver Finisher (lay down rate) is measured in tonnes per hour and depends on the following factors:

a) Width being paved

b) Thickness being paved

c) Paving speed

d) Density of mix

The time to complete the paving operation during specified period plays an important role on the output of Paver finisher. The output of different types of Paver finisher is in the following range:

1) Mechanical Paver Finisher Upto 100 tonnes per hour

2) Hydrostatic Paver Finisher Upto 700 tonnes per hour

It is essential that paver stoppages should be minimum during paving operation. More frequency of stoppages will result in poor riding quality and surface finish of the pavement being laid.

The requirement of Paver Finisher on a specific project shall depend on the frequency and distance to which the Paver is to be shifted from one site to other. It is recommended that a wheeled Paver be used, if there is frequent shifting involved during the execution of paving job.

4. PAVER COMPONENTS AND THEIR FUNCTION

The Paver consists of following two units **(Fig. 7)**:

a) Tractor Unit

b) Screed Unit

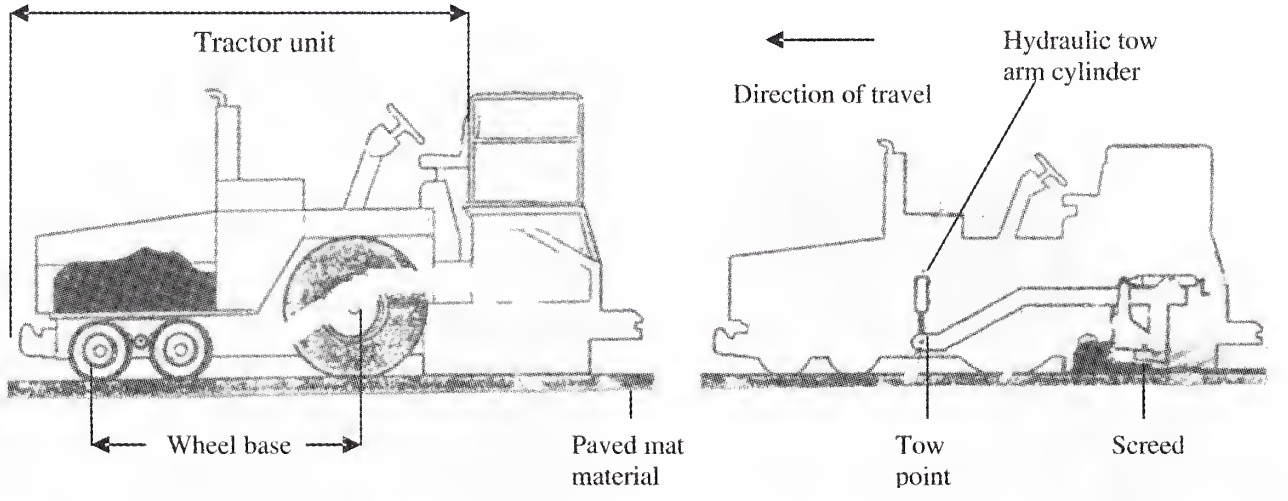


Fig. 7 Different Components of Wheeled Paver Finisher

4.1 Tractor Unit

Tractor is the front part of Paver Finisher, which houses the prime mover, conveyors, augers, hydraulic system, operator's cabin and driving system. The primary function of the tractor is to propel the tipper, to convey and distribute the paving material through the augers and tow the screed. The main components and functions of tractor unit of the Paver Finisher are as under:

a) Pushing Rollers

The front end of the main frame of the tractor are equipped with two cylindrical steel rollers with adjustable height and oscillation arrangement, properly spaced to contact the rear wheel of tipper, when feeding premixed material from tipper into the receiving hopper of Paver finisher (**Fig. 8 & Fig. 9**).

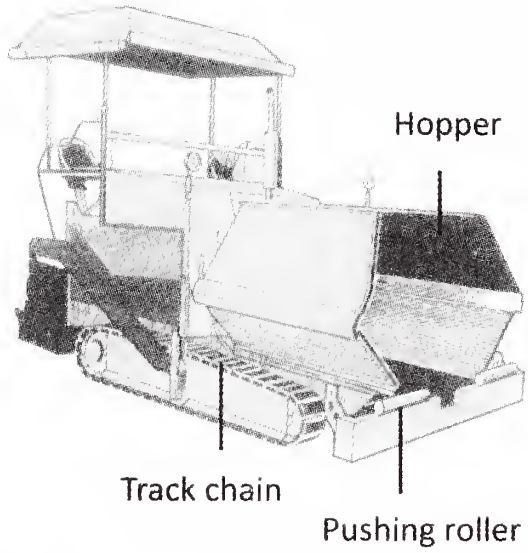


Fig. 8 Components of Tracked Paver Finisher

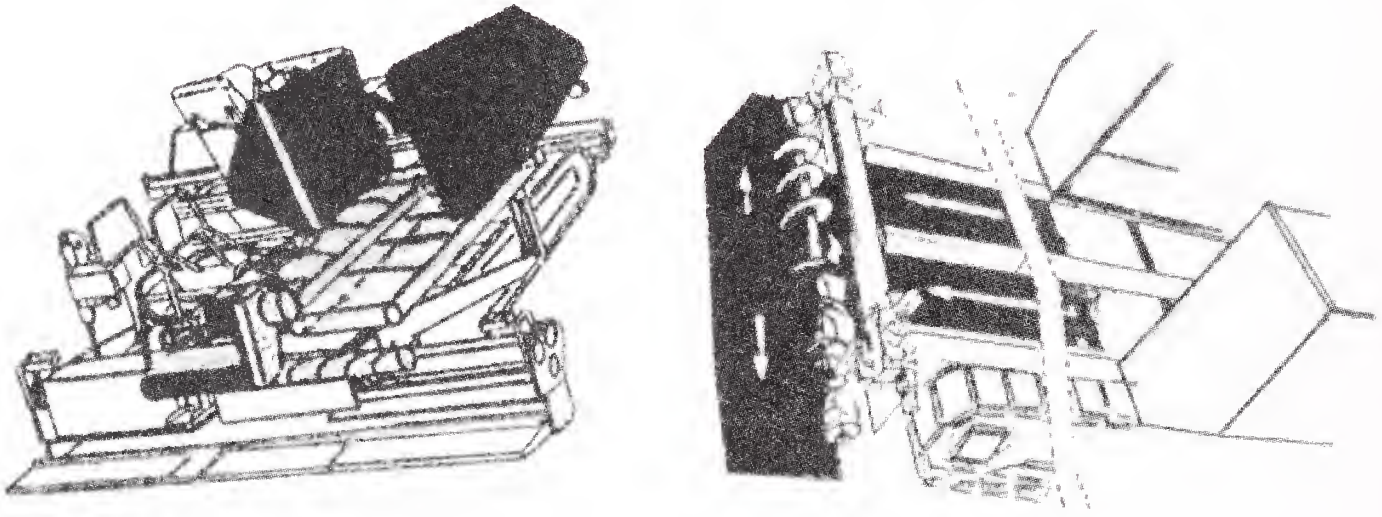


Fig. 9 Main Components of Tractor Unit of Paver Finisher

b) Receiving Hopper and Feeding Conveyor

1) The size of the hopper should be adequate. Larger size of hoppers can accept larger quantities of mix which helps to keep the mix hot for longer period. Besides, a larger size of hopper enables the Paver to continue the work, even when the tippers are being interchanged.

2) The Paver finisher shall be provided with a wear resistant steel hopper to receive the material directly from tippers. The hopper for the Paver finisher shall have two bar (slat) type conveyors with variable hydrostatic drive arrangement for independent traction transmission and their individual operation.

3) The floor of the hopper shall be constructed of abrasion resistant steel plate. The size of the hopper shall consist of wings so arranged, that each hopper wing may be individually raised or lowered by hydraulic ram to a position within the Paver's overall width for travel or to prevent accumulation of material in the corners of the hopper. This is essential as the material in contact with any outside part of the Paver tends to cool more rapidly.

4) The conveyor moves the premixed material from hopper to rear of the machine in front of spreading augers. The speed and size of the conveyors, governs the capacity of a Paver. The volume of material moved is controlled by variable speed conveyor motors. The feed is controlled using either limit switches or non contact type ultrasonic sensors which automatically control the conveyors on either side independently, to ensure even flow of material to the screed so that surging is avoided and the required "Head of Material" maintained constantly.

NOTE: For large production jobs, where large widths have to be paved and high tonnage laid accurately, non contact type ultrasonic sensors should be used for controlling conveyors, unlike old design pavers which are fitted with contact type ON-OFF limit switches (for controlling the slat conveyors and augers).

c) Auger System

The Paver finisher should be provided with two spreading augers having independent drives and capable of distributing the material evenly, delivered by the bar (slat) type conveyor over the desired width to be surfaced. The material for augers shall be Ni-hard steel, which shall be hydraulically operated. It is possible to raise or lower the augers mechanically or hydraulically, to suit the varying layer thickness.

The auger system consists of two types:

1) Both screw conveyors driven by a central gear unit (**Fig.10**),

2) The augers driven by separate drive units at the outer end of the shafts.

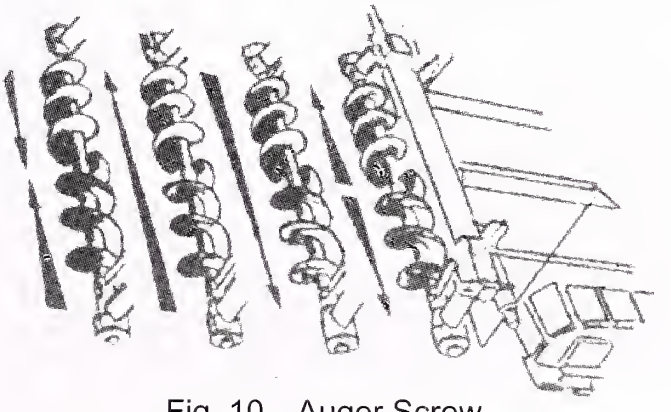


Fig. 10 Auger Screw

The direction of screws of auger system shall be as follows:

Two screws can rotate in opposite directions (one auger shall have a right hand thread and other left hand thread) allowing the material to be conveyed in different direction :

i) From the center to the side

ii) From the sides to the center

iii) Over full width of the screed

Reverse direction auger flights, one each on either side, should be provided at the middle to ensure positive head (pressure) of material at the center of the augers so as to avoid any "segregation" at the center.

The capacity of auger is governed by its diameter, pitch of the flights and maximum revolutions per minute.

Optional:

Contact less ultrasonic sensors are provided at auger ends (out board position) of the screed to ensure smooth material flow as shown in **Fig.11.** The function and advantages of contactless ultra sonic sensor in the Paver finisher are as under:

a) The sensor does not come in contact with material.

b) Smooth material flow can be controlled by the operator by turning a knob placed on, outside the governor.

c) Quantity of material can be controlled via auger.

d) It allows smooth and desired quantity of material flow to screed in best possible manner.

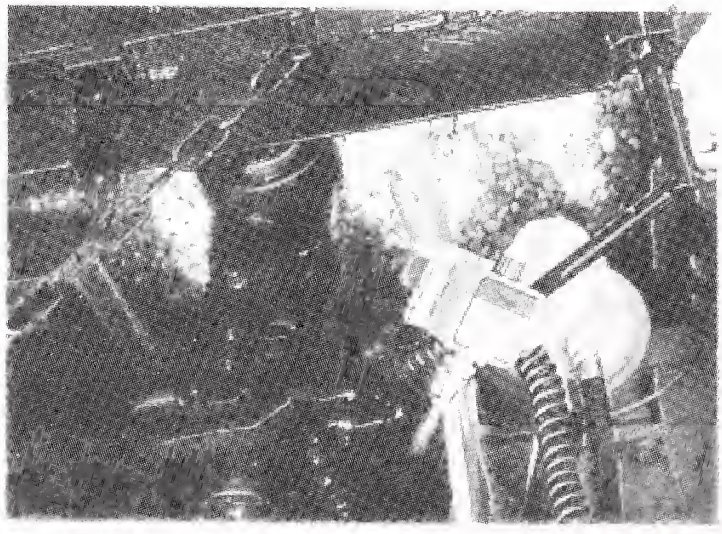


Fig. 11 Use of Ultrasonic Sensor

For large production jobs, contactless type ultrasonic sensors may be used in receiving hopper and feeding conveyor system to control augers for better control of material flow.

4.2 Screed Unit

It is the most important part of paving machine which lays and finishes the mat surface to the desired profile, grade and slope. The screed unit consists of :

a) Screed

b) Two tow arms

c) Mat thickness adjustment mechanism

The screed is attached to the Paver by two arms at the tow points on each side of the Paver. The screed is mounted to the tow arms at each screed pivot point as shown in **Fig.12**.

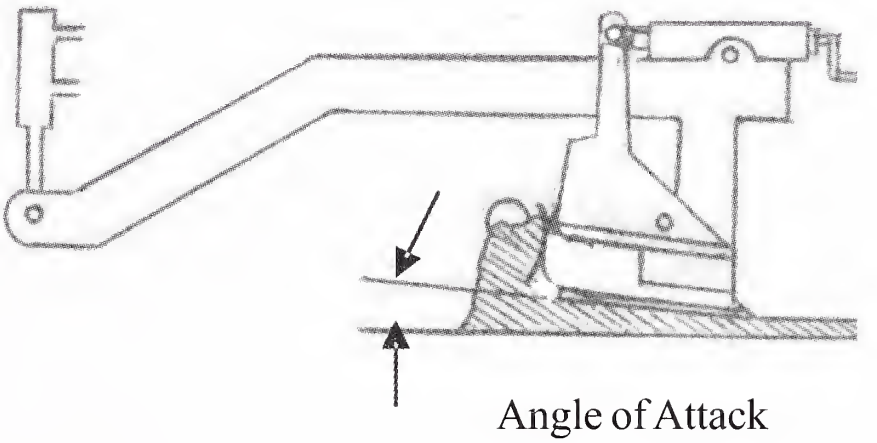


Fig. 12 Function of Screed and its Angle of Attack

4.2.1 *Function of screed*

The function of the screed is to strike off the material in preparation for further compaction, as shown in the **Fig.12.**

The screed on Paver is "floating, self leveling" type. As the Paver tows the screed unit forward, paving material flows under the screed. This causes the screed to float on the mat of the material, thus establishing mat thickness as shown in **Fig.12.** Since, the screed is mounted to the Paver only at tow points, the screed is completely free to float up or down. The screed will always seek its own "Planning Angle, or Angle of Attack" , depending on the combination of forces acting upon the screed.

The key to the leveling performance of the screed is to fill in low spots and decrease the influence of high spots, thus acting as an averaging device (**Fig. 13**). As the screed's angle of attack changes, the mat thickness also varies. The amount of self leveling is determined by the length of the tow arms and the wheel base of the Paver. A longer wheel base and longer tow arms tend to increase the Paver's ability to average high and low spots in new mat surface.

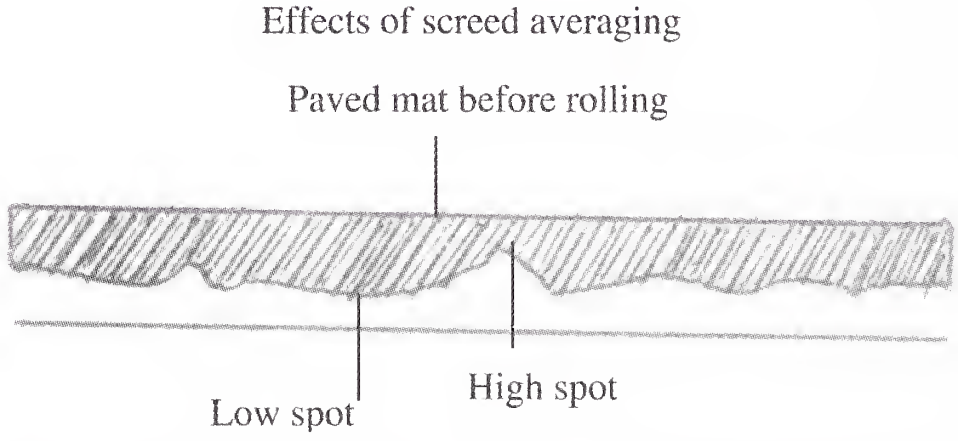


Fig. 13 Performance of Screed to Remove High and Low Spots

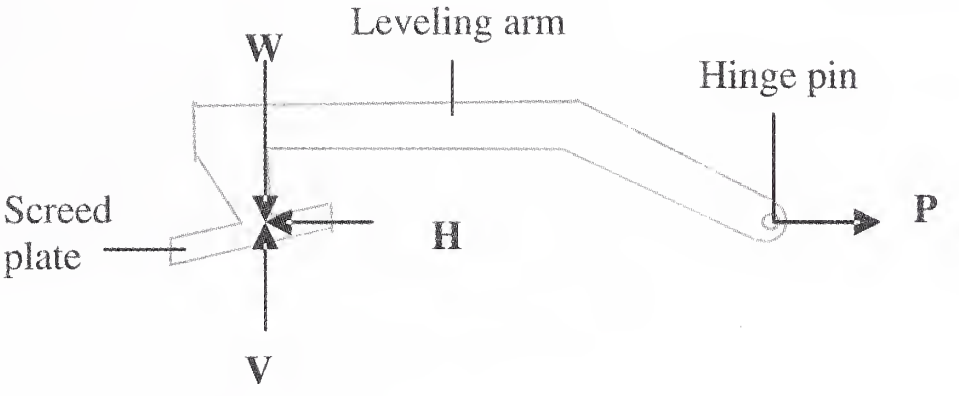
4.2.1.1 Major forces acting upon a floating, self-leveling screed

Major forces acting upon the screed are shown in **Fig.14.** The key element of smooth pavement is to keep these forces as constant as possible. Change in any of these forces will result in change of screed angle of attack ultimately affecting the mat thickness as per details shown below:

P - Pulling Force

The tractor unit's primary function is to provide motive force to the machine, move it forward, convey and distribute the paving material in front of the screed. Force **-P** will remain constant if the total resistance to forward motion is constant. If any component of the forces resisting forward motion is changed, such as a) Tipper bumping b) Holding tipper's brakes c) A significant change in head of material and d) Changing the width of an extendable screed; the total forces resisting forward motion will change and result in change of Paver speed . As a consequence of change in Paver speed, the screed will tend to rise or fall **(Fig.14)**. Therefore, it is essential to maintain a constant paving speed to minimise the fluctuations in the pulling force.

If change in speed is unavoidable, it should be made as gradually as possible. This will stretch the effect of changes in screed forces over a longer paving distance and reduce mat irregularities. The proper paving speed is reached when the amount of material being placed matches the material delivery rate at the site.



P- Pulling force, H- Horizontal resistance on screed,
W- Weight of screed, V- Vertical resistance on screed

Fig. 14 Forces Acting on the Screed

W - Weight of Screed

Weight of screed–**W,** or downward pressure exerted by the screed on the paving material should remain constant. The downward pressure of the screed, can be significantly altered during the paving operation by three common changes.

a) Members of the paving crew getting on and off the walkway of the screed.

b) Turning the screed vibrators off and on, or changing the frequency of vibration.

c) Changing the operating width of extendable screeds.

The extendable screed weight remains the same, whether used in fully retracted or fully extended mode. However, the wider the extension of the screed, the greater shall be the surface area of paving material to support the screed. Therefore, force of screed on mat surface (kg/cm^2) will vary with changes in screed width, ultimately affecting the mat thickness.

Reaction of Material under Screed

Ideally, material delivered by every tipper to the Paver would be exactly the same. However, it has been observed in practice that changes in mix characteristics such as mix temperature, density, gradation, fines etc. will affect the internal stresses developed within the mix, which in turn affects the resistance of the mix to the weight of the screed. The screed passing over the paving material will compact it to a certain degree. Variations in the resistance of the material to compaction forces will cause change in screed's angle of attack, which in turn will affect mat thickness and its smoothness. The reaction of the material under the screed will be normal to the surface.

The forces H and V represent the net of the resolved components of the forces (Reaction, Friction and Shearing) acting on the screed.

4.2.1.2 Head of material

The primary function of the Paver tractor is to convey and distribute paving material onto the ground in front of the entire width of the screed. The screed will pass over the head of the material deposited in front of the screed. For smooth paving, the head of material should be maintained as constant as possible. The head of material affecting the height of screed is shown in **Fig.15**.

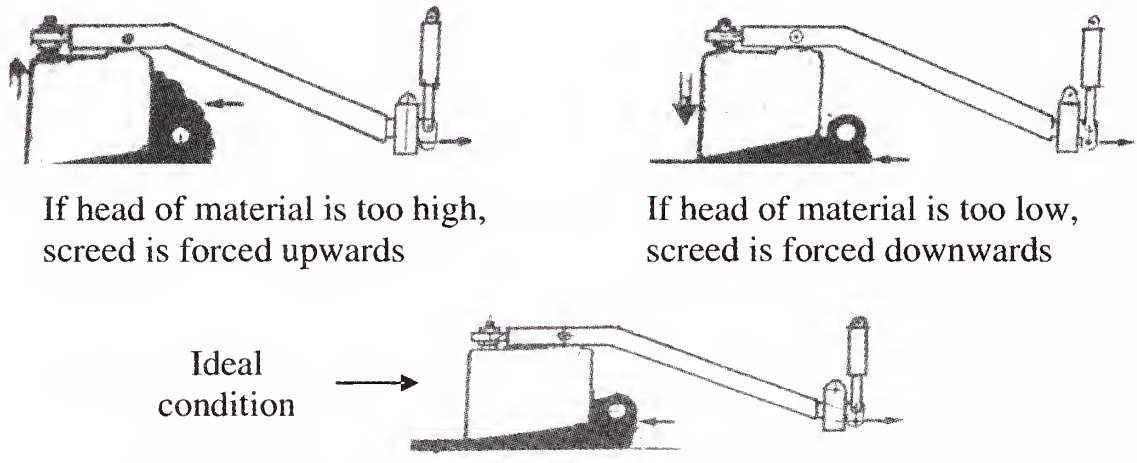


Fig. 15 Head of Material Affecting the Height of Screed

4.2.1.3 Components of screed and their function

The functions of different components of screed are as under:

a) Compaction effect through tampers and vibrators

b) Heating system

c) Screed assist system

a) Compaction Effect

The compaction effect of a screed is determined by :

1) Screed weight and contact area of tamping or vibrating element

Harsh mixes and stabilized gravel require heavy screed to achieve desired pre-compaction and uniform even surface; while tender bituminous mixes in which screed has a tendency to sink, need light screed. The contact area of compacting element determines the compaction force on a certain unit area.

The tamper should have a small contact area to achieve good compaction effect.

2) Paving speed

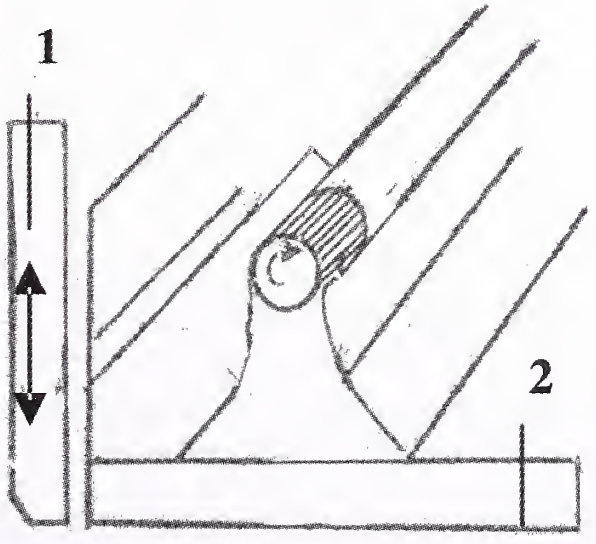
Higher the paving speed, lesser shall be the number of tamper impacts per unit area, ultimately lower shall be the density achieved.

3) Frequency and amplitude of tamping unit and screed plate

Tamping Unit:

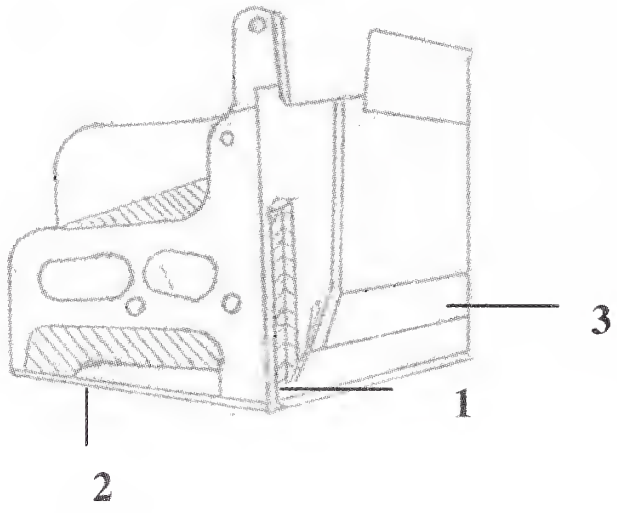
The tamping bars, provided all along the length of the screed, are steel bars with chamfered edges, which provide pre compaction to the mix being paved. The tamper bars move up and down vertically with an amplitude between 3 to 5 mm. They operate at a frequency between 0-2000 strokes per minute, which should be infinitely adjustable within this range (**Fig. 16**).

All wearing parts of the tamping unit should be made of high heat and wear resistance alloy steel and easily replaceable (**Fig. 17**). An adjustment mechanism should be provided to obtain the optimum position of the tamping bars with respect to screed plates as they wear out. The tamping action shall provide sufficient initial compaction to the material. The tamping bar shall be operated hydraulically. The inclined tamping stroke in comparison to vertical one gives better compaction effect and reduces the tendency towards crushing the aggregate as shown in **Fig.18**.



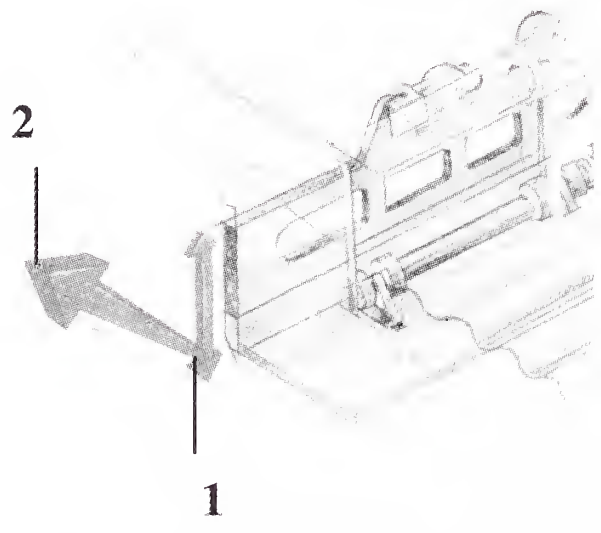
1- Tamper, 2- Vibrating Screed

Fig. 16 Tamping Unit Combined with Vibrating Screed



1-Tamper, 2-Bottom plate,
3-Striking of plate

Fig. 17 Screed of Rigid and High Quality Wear Parts



1-Tamper, 2-Vibrating screed

Fig. 18 Screed Equipped with Tamping and Vibrating Mechanism

NOTE: On high quality and precision jobs, the Paver finisher should be equipped with an electronic system with provision to alter timing 'ramps' (adjustable timing setting for tamper to achieve the desired/preset frequency) during stopping and starting of the Paver to eliminate crushing of aggregates and related mat defects.

Vibration System of Screed Plate:

This is necessary to smoothen out the tamper edge marks on the pre compacted mat and provide additional compaction and smooth finish to it. A hydraulically operated system, capable of providing low amplitude, high frequency vibration to the screed plates shall be provided. A variable frequency ranging from 0 to 3700 vibrations per minute normally achieves the optimum frequency in relation to mat thickness, density, working speed and material specification.

4) Physical Condition of Compacting Elements

New screed plate or tamper will produce the best pre-compaction effect and surface evenness. In case screed plate/tamper is worn out due to their use, the compaction effect shall be reduced, resulting in an open textured mat. Thus, the same should be replaced.

b) Heating System

This system is provided to preheat the screed plate and tamper, to desired temperature before starting the paving of hot bituminous mixes which prevent the bitumen picking up or sticking . There are three types of heating devices a) Diesel/Oil fired burners b) Gas burners c) Electrical heaters.

Gas is a cleaner and gentler device provided on baffle plate. Safety device may be provided to protect the crew against risk of explosion.

Electrical heating system requires an extra generator. It is power consuming and slower as compared to other systems. It takes approximately 45 minutes to reach the operating temperature. The choice of system will depend on the supply of fuel and selection of purchaser.

The screed is required to heated before putting it to use. Thereafter it is heated by the temperature of the Hot Mix.

c) Screed Assist System

This system provides partial neutralization of screed load and ensures constant pressure of the screed on the mix regardless of the bearing capacity of mix and width being paved. It also enables transferring part of the screed weight to the drive axle/tracks of the machine, in order to avoid spinning of the wheels/tracks under adverse gradients or under foot conditions.

4.2.1.3 Adjustment of screed

a) The screed shall be so carried and drawn over the material that it will maintain the required grade level and profile and will not be affected by sudden or

minor changes in the level of the base layer, over which the material is being paved. The screed shall be equipped with mechanism for adjusting the angle of attack. The height of tow points to which the side arms are attached shall be hydraulically adjustable to enable the changes in the angle of attack during operation. The required thickness being laid is achieved by varying the angle of attack of the screed either manually or automatically by longitudinal and transverse electronic leveling devices (grade controller and slope controller respectively), attached to the screed.

b) For paving width upto 6 m the basic screed shall be hydraulically extendable, so that the width of the mat is infinitely variable between the minimum and maximum specified width. The telescopic system of the hydraulic extensions shall have independent operating guide cylinders (to have higher stability/ rigidity of the hydraulic screed extensions, it shall be preferred to have two such telescopic guide cylinders on each side). Screed extensions must have the arrangement for compaction such as tamper and vibration and also provision for heating.

c) For paving width between 6.00 and 10.00 m, suitable mechanical screed extensions, auger extensions, strengthening and locking devices fitted with tampers, vibrators and heating system must be provided.

d) For paving widths more than 10 m, a fixed screed (mechanical type) comprising of mechanical extension pieces, each equipped with tampers, vibration, heating system and suitable tensioning system (using tie-bars or hydraulic system) for rigid locking of screed elements should be provided.

e) All screed wear parts coming into contact with material being paved, shall be constructed from abrasion resistant steel and shall be replaceable.

f) To facilitate travel of the Paver during shifting, a hydraulic system shall be provided to raise the screed unit by a power operated hydraulic ram or similar device to a raised position clear of the road surface. Mechanical locks shall be provided for holding the screed in the raised position while moving the Paver from one working point to another.

4.2.1.4 Adjustment of screed plate for normal crossfall/superelevation

The screed plate can be adjusted at the centre through its a) Leading b) Trailing edge. Leading edge of screed plate should be provided with slightly more crown, to ensure better flow of material to trailing edge. Adjustment of screed plate is done while paving and set at that point, where best surface texture of mat behind Paver is achieved (**Fig. 19**).

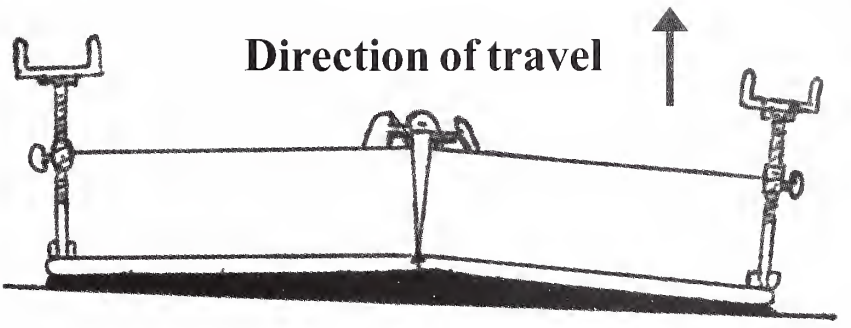


Fig. 19 Screed Plate Adjustment in Positive Crown Position

Normal crossfall or superelevation can be provided in the profile by adjusting both halves of screeds to same required slope. Crown can be adjusted on the screed from -10 mm to + 50 mm (**Fig. 20**).

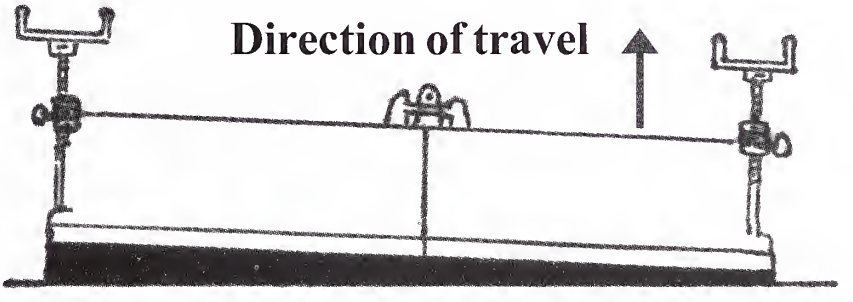


Fig. 20 Screed Plate Adjustment in Super Elevation Crown Position

5. AUTOMATIC LEVELLING CONTROL SYSTEM

This system consists of electronic sensing instruments fitted on Hydrostatic Paver finisher which automatically controls the mat thickness for precision laying.

5.1 Operation of Automatic Leveling Control System

Basically, automatic leveling control system can be operated in two ways.

a) Surface String Line System

In this method, the grade reference is established by erecting a string line with the help of nylon stretched wire and grade shakes to the desired level of the profile by a survey crew on one side of the pavement. A vane fitted to the sensor remains in contact with tensioned wire and transmits signals to the control system as shown in **Fig. 21**. The accuracy of string line system depends on the accuracy of fixing tensioned wire. The string line should be supported by grade stakes not more than 8 m apart and proper amount of tension maintained to keep it true without sagging.

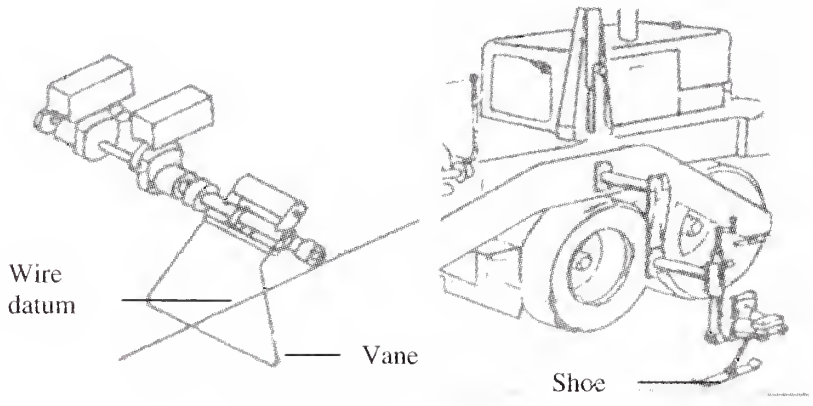


Fig. 21 Automatic Levelling Control System being Operated through String Line

b) Sonic System

It is a non contacting grade control system based on sonic pulses in which pulses of high frequency sound are sent and the time for the echoes reflected from physical objects are measured. The speed of sound calculates the exact distance of the object. The control box based on this evaluated information raises or lowers the tow point cylinders and maintains proper mat thickness.

5.2 Components of Automatic Leveling Control System

Following are the components of Automatic leveling control system:

a) Control Box – 2 no.

It is fitted on both sides of the Paver finisher, receives the signals from sensors (elevation control sensor/slope sensor), determines the correction in grade or slope and transmits the signals to the valves, controlling the tow point cylinders on each side of machine, which raises or lowers them thus maintaining correct mat thickness.

b) Elevation Control Sensor - 2 no.

It controls the grade or slope with respect to a reference surface, automatically maintains the height of screed and layer thickness of the material. The reference level should be as leveled as possible, to achieve the best result. Elevation control sensor either in sonic/string line sends the information to the control box, which evaluates and raises or lowers the tow point cylinder to maintain proper mat thickness.

c) Slope Sensor - 1 no.

It is a precision electronic sensor which functions like a precision carpenter's level. It maintains the specified left and right hand cross slope of the mat during laying. It detects any deviation

in inclination (tilt) of the screed from a preset cross slope and sends the signals to both control boxes to restore the original setting.

d) Junction Box - 2 no.

Its primary function is to route power from paving machine to control box, correction signals from elevation control sensor or slope sensor to control box and corrected signals from control box to hydraulic valves of paving machine.

The components of automatic leveling control system fitted at screed unit and their functional relation are shown in **Figs. 22 and 23**.

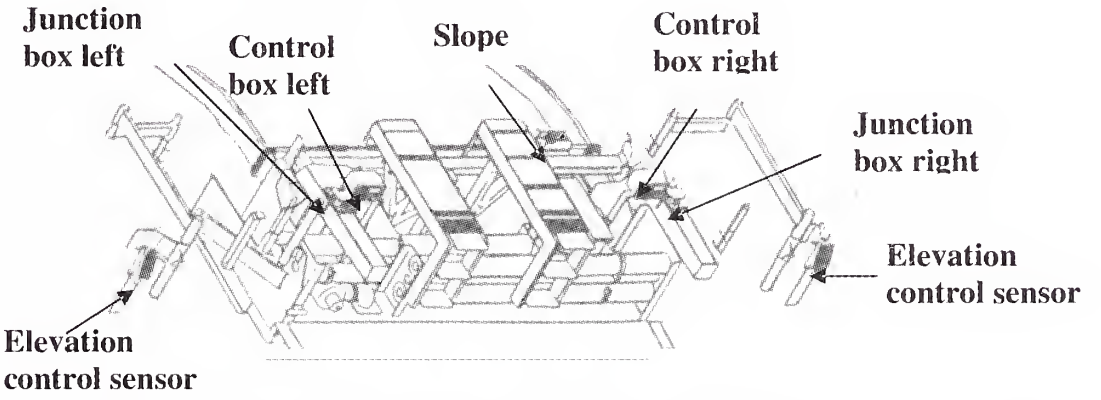


Fig. 22 Different Components of Automatic Levelling Control System

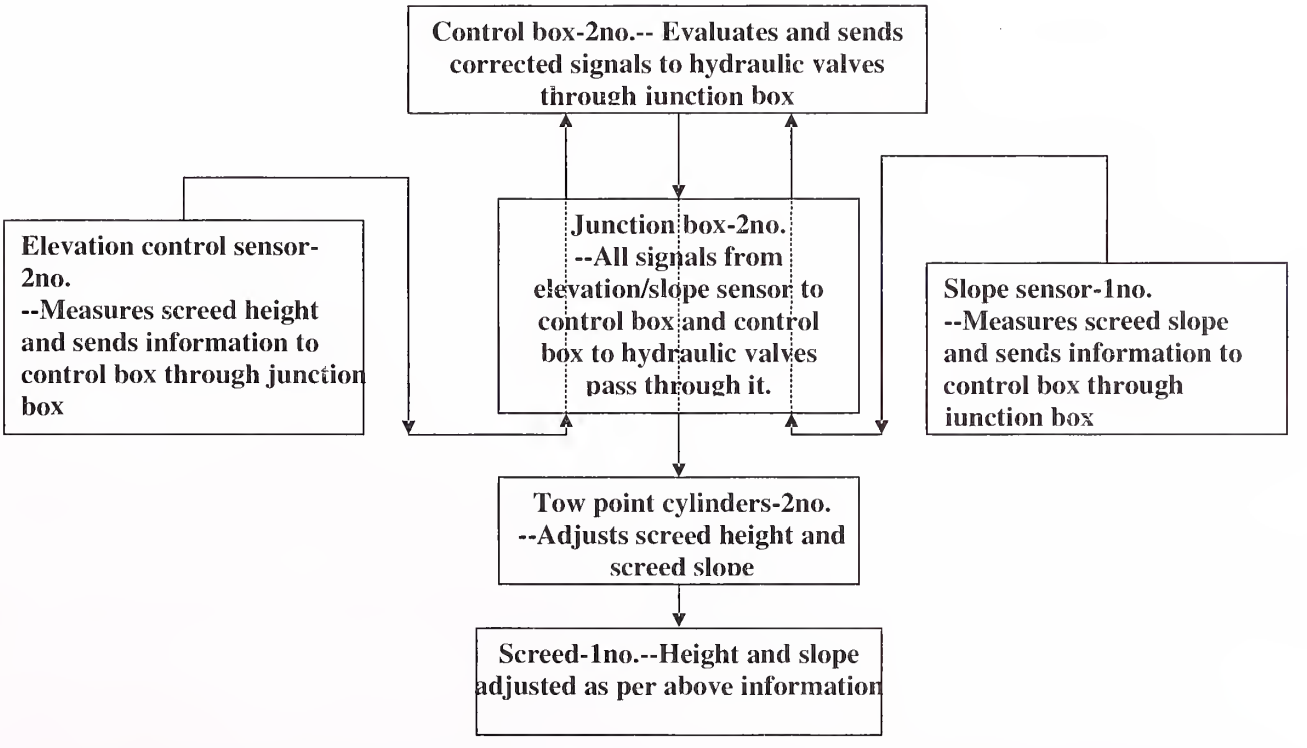


Fig. 23 Function of Different Components of Automatic Levelling Control System in Hydrostatic Sensor Paver Finisher

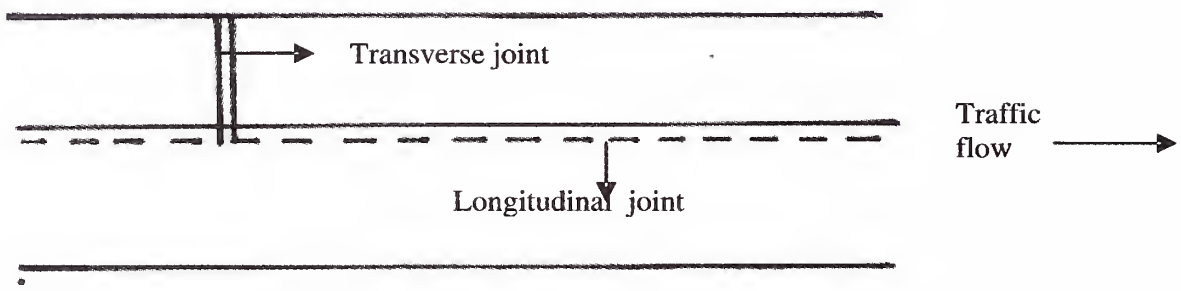
6. PAVING JOINTS

Joint are of two types:

a) Transverse joint

- It is perpendicular to normal direction of traffic flow.

b) Longitudinal joint



It is normally along (a) centre line in two lane (b) line edge in multilane as shown above. Paving and compaction procedures adopted for longitudinal and transverse joints are of great importance for the quality and appearance of the bituminous surface.

6.1 Construction of Transverse Joint

It can be made in two ways:

a) By cutting the road end section perpendicular to the mat known as perpendicular joint.

b) Laying the mix material in slope known as slope joint.

6.1.1 *Perpendicular joint (**Figs. 24, 25 and 26**)*

There are two procedures to make the perpendicular joints.

First procedure:

a) The wooden block equal in thickness to the mat being paved, may be put in front of the Paver, where paving operation is to be completed.

b) The mix material coming out from the Paver, can be used to support the wooden block as well as formation of ramp.

c) The wooden block and the ramp already laid shall be removed on subsequent day, before commencement of work. Thereafter, the material is laid with the help of a paver. It will form right angle to transverse joint.

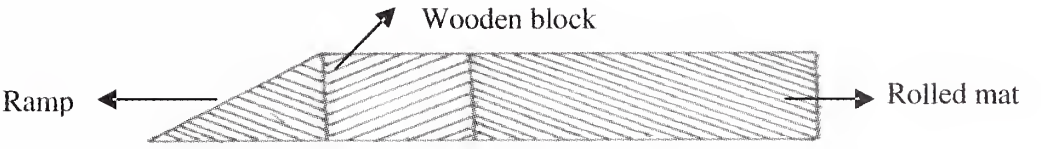


Fig. 24 Formation of Transverse Joint through Perpendicular Process

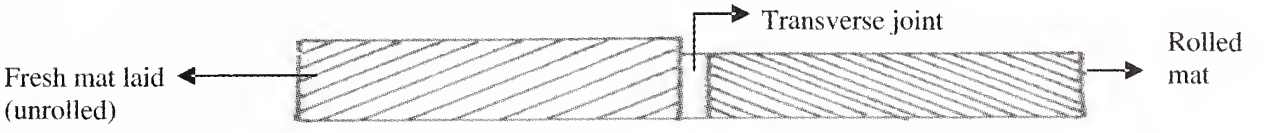


Fig. 25 Formation of Transverse Joint through Perpendicular Process

Second procedure:

a) Lay the material from paver up to location of joint and form short smooth ramp.

b) Compact all material including ramp.

c) The ramp along with mix material up to 25 mm width from the end of full thickness must be removed on subsequent day before commencement of work. The vertical face of end surface should be cut by a saw cutter.

d) New material may be laid now with the Paver finisher, which will form right angle in transverse joint.

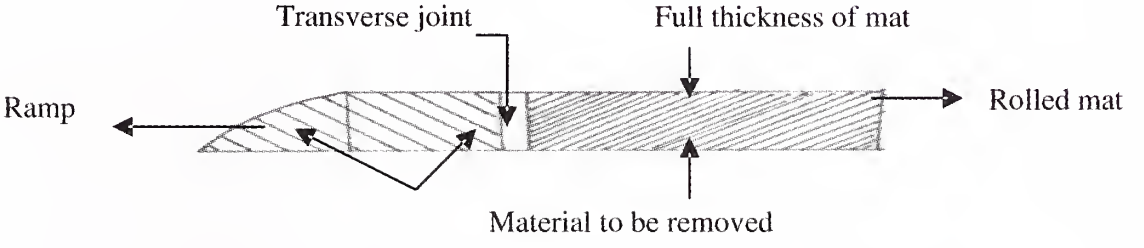


Fig. 26 Formation of Transverse Joint through Perpendicular Process

6.1.2 *Slope joint (**Fig. 27**)*

It can be made in following way.

a) After completing the paving operation, the mix material may be shaped into slope with straight edge.

b) Compact it along the slope.

c) On subsequent day, the work may be started from the point where slope starts.

d) The thickness of the fresh mat being laid out will depend on the compaction factor of the material being compacted.

e) It will form slope joint in transverse joint.

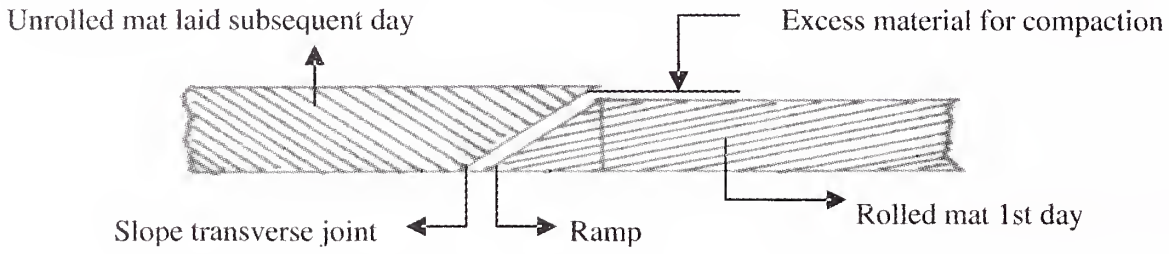


Fig. 27 Formation of Transverse Joint through Slope Process

6.1.3 *General precautions*

a) The ramp slope should be 1) 1:20, if speed < 75 kmph 2)1:10, if speed >75 kmph.

b) Joint faces to be sprayed with thin uniform coat of bitumen or emulsion before placing fresh mix.

c) Joint line should be true to joint alignment.

d) Minimum transverse joint offset between 1st and 2nd lane to be 2 m as shown in **Fig.28**.

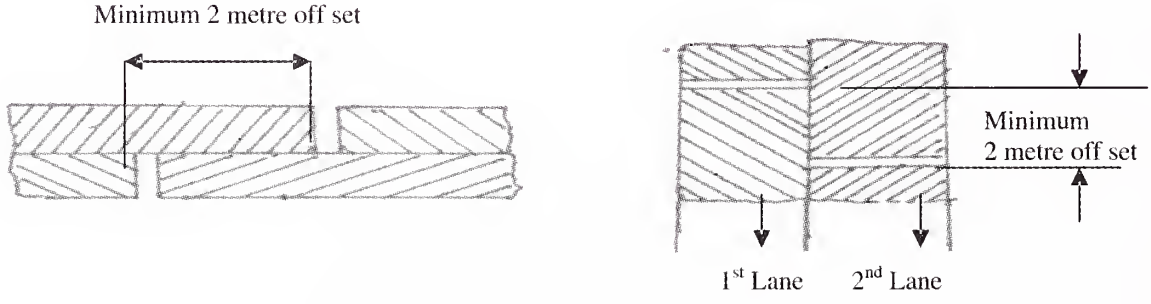


Fig. 28 Position of Offset of Joints

6.2 Construction of Longitudinal Joint (Fig. 29)

It can be made in following way:

a) The screed height of bitumen laying layer adjoining to existing lane should be cautiously adjusted, to allow compaction effect of following roller.

b) Automatic grade controller working off the adjacent lane shall be useful for joint matching.

c) The uncompacted layer should depend on the compaction factor of the material being compacted

d) The side over lap of longitudinal joint should be about 25 to 50 mm.

e) The exposed surface should be sprayed with thin uniform tack coat of bitumen or emulsion (as per contract specifications) before placing fresh mix.

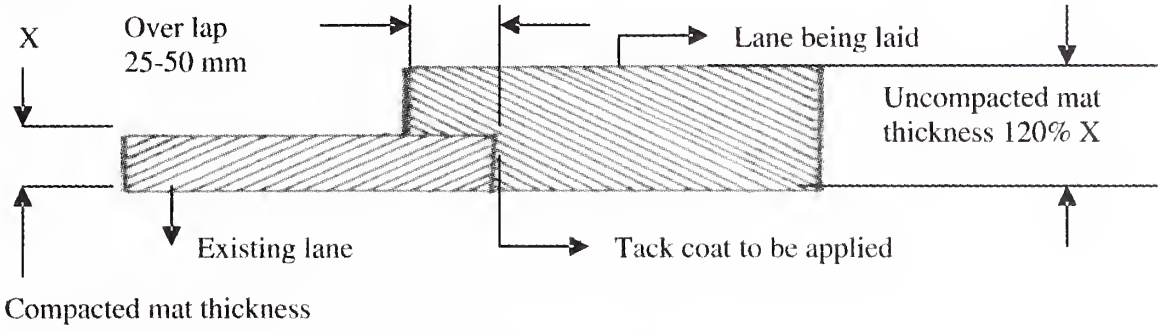


Fig. 29 Formation of Longitudinal Joint

7. MAT QUALITY CONTROL

The basic purpose of bitumen Paver is to lay a smooth mat of material. The function of the sensor control is to adjust the vertical and lateral movement of screed in relation to the surface being paved. The mat quality depends not only on the sensor control but on other factors also.

a) Continuous Operation of Paver

The Paver should be allowed to work continuously, It should not be allowed to wait for the tippers for unloading the mix during laying. In case the Paver stops every time, the forces acting upon the screed are severely disturbed resulting in the screed to settle down in fresh mat and leave a mark. During restarting the Paver, the material force against the screed will increase, causing the screed to rise. It takes approximately 3 to 4 tow arm lengths for the screed to restabilise at the previous planned angle with a resultant bump. Thus, the Paver speed should match the rate of material delivery to allow continuous operation of Paver and eliminate its starting and stopping.

b) Constant Speed of Paver

The Paver should move continuously, uninterrupted to produce smooth, seamless pavement. An abrupt change in paving speed causes an immediate disturbance in the balance of forces acting upon the screed. Sometimes it is not possible to maintain constant forward speed of Paver; in such cases the interruptions should be minimised and change in paving speed carried out gradually to achieve smoother finished mat.

c) Exchange of Tipper

The exchange of tipper should be carried out as smoothly as possible to avoid disturbing the

smooth, uninterrupted forward motion of the Paver. The following precautions should be taken in this connection:

1) The mix delivery tipper should be stopped close but not too short of the Paver. The Paver should be allowed to pick up tipper for shifting of mix during running.

2) Never allow tipper to bump the Paver.

3) The applying and holding the brakes of tippers excessively while dumping their load may cause the Paver to slow down which in turn will cause the screed to rise. The tipper driver should apply only light pressure on the brakes sufficient to maintain contact with the Paver.

4) Avoid tippers pulling away prior to completely dumping all material in the hopper.

d) Constant Head of Material

The head of material should be maintained across the entire width of screed and the material should cover approximately 2/3rd auger screw as shown in **Fig. 30.** If the head of material is too high, the resistance to forward travel increases and the screed starts to rise resulting in the formation of ridge in the mat and excessive wear on augers. In case the head of material is low, the screed will settle because there is not enough material to support it.

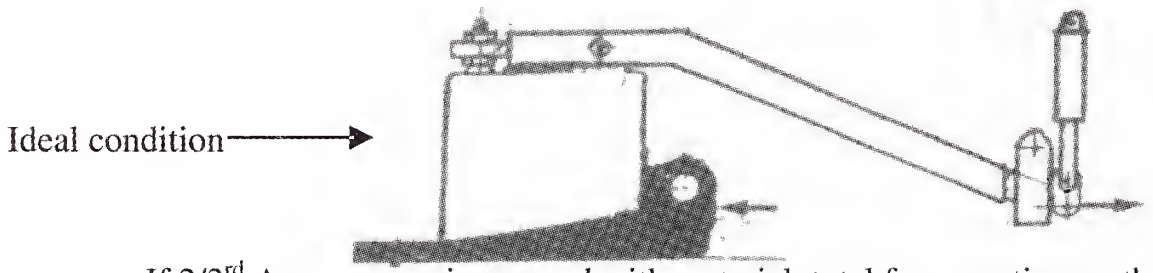


Fig. 30 Appropriate Head of Material on Auger Screw to Maintain in Desired Height of Screed

e) Mix Design Specifications

1) Maximum aggregate size, ratio of aggregate, fines and bitumen should be selected carefully.

2) Segregation

It is a material deficiency caused by separations of larger size aggregates from the bulk of paving material.

3) Mix temperature

The temperature of the mix should be uniform while dumping it from the tipper to hopper of Paver, for which following precautions should be observed:

- All tippers should take the shortest and most practical route to the Paver.
- Ensure all tippers take the same route to the Paver. All tippers arrive in same order, in which they were loaded at hot mix plant.
- No bunching of tippers should occur at the Paver. The "lay down rate" should match the material delivery rate.

f) Screed Compaction

The Paver must be maintained in sound mechanical condition to deliver a smooth mat.

g) Quality of Base being Paved

In case there are undulations in base being paved, the affected stretch should be paved in multiple lifts, to increase the averaging effect of screed.

8. LAYING OF BITUMEN MIX

It is the normal practice to lay the bitumen mix from Paver finisher by discharging the mix from tipper to receiving hopper of Paver, with its transfer to conveyor, auger screw and screed. There is a pair of free running push rollers in the front of hopper of Paver Finisher, which remains in contact with rear tyres of delivery tipper during unloading of mix from tipper to Paver Finisher. The tipper deposits the mix in receiving hopper of Paver in a steady flow manner, while Paver is in motion slowly pushing the tipper ahead of it.

Some times due to bumping of tipper with pushing rollers of Paver, insufficient material in hopper of tipper; the screed is adversely affected due to change of various forces acting on it and mat surface gets undulations.

Mobile Feeder (Fig. 31):

To avoid the above situation, an equipment known as Mobile feeder can be inducted between tipper and Paver Finisher. It is a transport and conveying system which is used as a non-contact connecting element between Paver finisher and tipper to carry out mixed material. The equipment mainly consists of engine, hopper, conveyor and hydraulic system. The hopper of mobile feeder is used to store the mix material. The hopper wings can be folded up for better emptying and even distribution of mix material. The mix material is transported on a heat- resistant rubber type belt conveyor, which leads the material to a sensor controlled, automatically height adjusted conveyor belt at the front end of the feeder. It prevents the mix from cooling down and from segregation. Normally, the capacity of hopper is 20-30 tonnes.

For transportation of mobile feeder on a truck, the conveyor along with foldable sun roof can be lowered down. The mobile feeder is commonly used for construction of roads in Europe, Canada and USA.

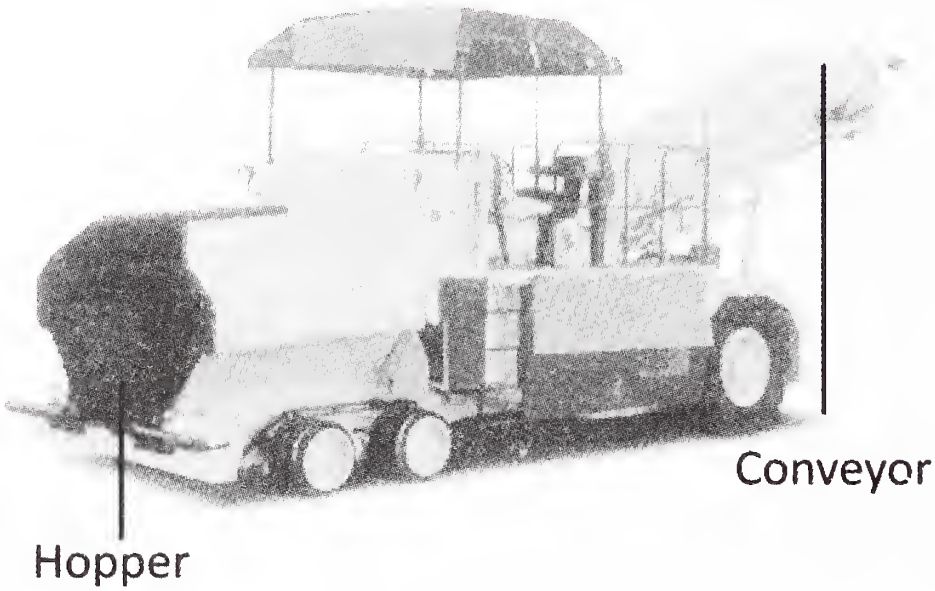


Fig. 31 Mobile Feeder

Truck Hitches (Fig. 32) :

Truck hitches (Fig. 32) are used to keep the truck in contact with the paver, to keep it from rolling away. The Paver operator controls the truck hitches. Truck hitches hold the truck against the paver. The truck must back in straight to avoid the truck hitch popping a tyre.

On the front of the Paver are the push rollers **(Fig. 33)** and the truck hitches. The truck rests against the push rollers as the Paver is pushing it while paving. The rollers must be kept clean and be free to rotate while pushing the truck.

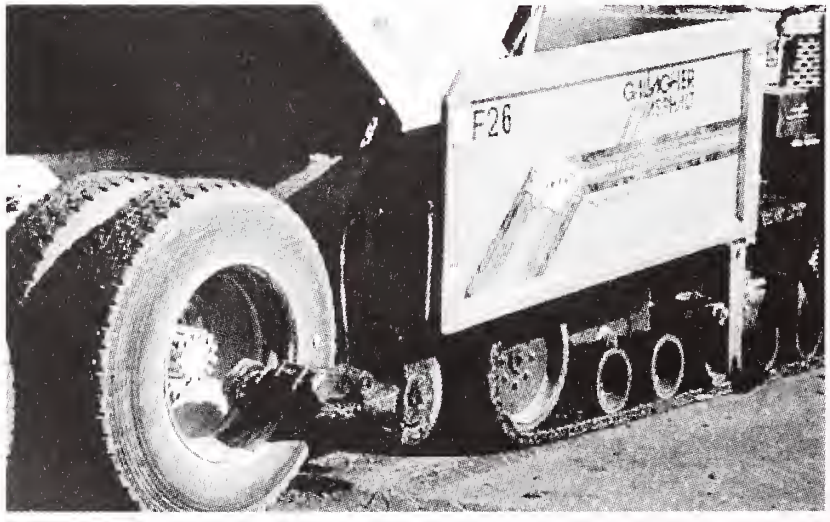


Fig. 32 Truck Hitches

Fig. 33 Resh Roller with Truck Hitch

9. MAINTENANCE AND UPKEEP OF PAVER FINISHER

Proper maintenance and upkeep of Paver finisher shall lead to its longer life, avoidance of frequent breakdown, i.e. saving in unnecessary expenses for stoppage of work and replacement of components. Following measures should be taken in this regard.

a) Follow the instructions given in the manufacturer's maintenance manual.

b) The schedule for routine maintenance given below should be observed.

1) Daily schedule.

2) Weekly schedule (50-60 hours operation)

3) Monthly schedule (200-250 hours operation)

4) Quarterly schedule (800-1000 hours operation)

Periodical overhauling should also be carried out based on manufacturer's guidelines.

c) Sufficient quantity of fast moving spare parts and P.O.L. should be available in the store.

d) Necessary action for procurement of spare parts likely to be worn out in near future should be taken in advance, to avoid equipment remaining idle.

e) The tools required for day to day maintenance and on other specific jobs,should be made available at works site, as per manufacturer's recommendations.

f) In case Tracked Pavers is to move more than 250 m, it is suggested to use a trailor rather than to move the machine on its own power. The wear and tear of rubber pads on crawler shoes should be avoided, due to its high travel speed.

10. SAFETY MEASURES

a) Design Features

1) Railing should be provided in all exposed areas to ensure that an operator cannot fall off.
2) Safety guards should be provided over the auger to stop any thing from falling down into the auger system.
3) The screed covers and platforms should have good anti skid projection.
4) Safety in heating system for heating the screed should be observed to prevent the risk of explosion and injury to the crew.
5) On Wheeled Paver, hand brake and an emergency foot brake should also be provided in addition to hydrostatic braking system.
6) Closed cabin should not be used as they accumulate fumes from hot bitumen.
7) All controls must be within easy reach of operator and give him good all round visibility.
8) The operator's seat should be comfortable and easily adjustable to the height and physique of the operator.
9) Towing hook should be provided.
10) The operator should have appropriate safety glass and personal protection equipment while operating the machine.
11) The machine should be safely parked, while the machine is not in operation.

b) Jobs for Operation and Maintenance of Equipment

1) Provide proper training to operators and maintenance staff.
2) Employ well trained, skilled and medically fit workers.
3) Follow equipment's operation and maintenance manual instructions.
4) Keep the equipment in good working condition.
5) Operators should familiarise themselves with all controls, instruments, emergency stop switch etc.
6) Never leave the machine unattended with its engine running.
7) Keep operator's platform clean and free from oil and grease.
8) Look around before starting

9) Never carry out servicing, repairs and adjustments, while the equipment is working.

10) Periodical maintenance schedules should be followed.

11) During shut down of machine, put all controls to neutral position.

12) Shut-off the engine after allowing it to idle, as per the recommendations of the manufacturer.

13) Ensure use of safety gadgets such as helmets, goggles, gloves etc.

14) Ensure use of proper tools and tackles.

15) During maintenance, close fuel shut off valve and avoid fire accidents.

c) Tips for Loading and Transportation of Equipment

1) Load and unload the equipment on leveled ground only.

2) Lift the equipment as per the recommendations of the manufacturer.

3) Use ramps of adequate strength.

4) Block the transport vehicle firmly during loading process.

5) Tie and block the equipment securely during transportation.

ANNEX-A

INFORMATION REQUIRED BY THE PURCHASER WHILE MAKING AN ENQUIRY WITH THE MANUFACTURER

There are number of manufacturers of Paver finishers having different models with their salient features. The essential features of the equipment required by the purchaser while making an enquiry from the manufacturers are suggested as under:

1. Site Conditions

a) Temperature and climate.

b) Altitude above mean sea level

c) Any other special conditions under which equipment is to be used.

2. Type of Pavers finisher

a) Mechanical/Hydrostatic.

3. Type of Traction Effort Required

a) Tracked/Wheeled Pavers finisher

b) Pavers finisher capable of pushing up a fully loaded tipper minimum 20 tonne capacity at 10 percent gradient.

c) In case of wheeled Paver:

1) Number of bogie wheels required.

2) Number of axles along with pneumatic tyre size.

4. Prime mover

a) Make

b) Model

c) Horse Power

5. Paving Width

a) Fixed screed width

b) Hydraulically extendable width

c) Provision of screed extension width

6. Paving Thickness

a) Maximum layer thickness to be laid.

b) Minimum layer thickness to be laid.

7. Rate of Laying in Tonne Per Hour

8. Type of Material to be Paved

a) Bituminous mix

b) Wet mix macadam.

9. Speed of The Paver finisher

a) Travel speed

b) Paving speed

10. Capacity of Receiving Hopper

11. Screed

a) Type of heating device

i) Diesel/oil fired burners.

ii) Gas burners.

iii) Electrical heaters.

b) Tamping unit

i) Amplitude

ii) Frequency.

12. Auger

i) Auger diameter

ii) Proportional speed control of each auger halves

13. Crown Control Mechanism

ANNEX-B

INFORMATION TO BE SUPPLIED BY THE MANUFACTURER TO THE PURCHASER

The manufacturer should furnish the information to the purchaser as shown in Annex A. In addition to that, following information should also be supplied to the purchaser to get him acquainted with the product and assist him in selection of equipment.

1) Model and type of Paver finisher offered.
2) Brief description of the equipment.
3) Optional features of the equipment.
4) Overall dimensions and weight of the equipment for transportation purpose.
5) After sales service-nearest manufacturers service centre/office of the supplier.
6) Supply of spare parts catalogue, operation and maintenance manual assured.
7) List of fast moving components assured.
8) Number of similar model of equipment supplied so far.
9) Provision of training facility.

ANNEX-C

SAMPLE CALCULATION OF RATE OF USAGE CHARGES OF EQUIPMENT

Assumptions

a) Salvage value = 15 percent of the cost of equipment at site

b) Storage charges = 1 percent of total investment to be depreciated, spread over the economic life

c) Repair and maintenance charges per hour including replacement of tyres = 150 percent of total investment to be depreciated, spread over the economic life

d) Over head charges @ 5 percent of the sum of wages per hour + Servicing charges (Man power and material cost)

1. For Equipments Used Departmentally

1.1 Ownership charges

A) Total investment at site of work (This includes A/T cost, sales tax, excise/ custom and other duties, transport expenses consisting of freight by ocean or rail, insurance, loading/ unloading charges, erection and commissioning on receipt) = Rs. X (say)

B) Deduct salvage value @ 15 percent of total investment = 0.15X

C) Total investment to be depreciated = 0.85X

D) Economic life of machine in hours = Y hours

E) Depreciation per hour = Rs. 0.85 X/Y per hour

F) Storage charges per hour (1 percent of "C" spread over the economic life) = 0.01x Rs.0.85 X/ Y

Total ownership charges = (E) + (F) I

1.2 Operation charges

(G) Repair and maintenance charges per hour (including maintenance and replacement of tyres) is 150 percent of "C" spread over the economic life = 1.5x(C)/(D) II

1.3 Over head charges

5 percent of ownership and operation charges = 0.05x (I+II)

Ownership charges per hour = Rs ————————III

Operation charges per hour = Rs.

Overhead charges per hour = Rs.

1.4 Running charges

Operating staff/ labour wages

Designation	No.	Unit wage per month	Wages per month
i) Operator			
ii) Helper			
iii) Cleaner			
iv) Misc. Expenses			

Total wages required for Operating staff and labour per month = Sum of wages per month

(H) Total wages required for Operating staff and labour per hour = Total wages required for Operating staff and labour per month/ Hours per month

(I) Servicing charges

Servicing charges includes man power cost

Designation	No.	Unit wage per month	Wages per month
i) Mechanic			
ii) Cleaner			

Total wages required for servicing staff per month = Rs.

-Total wages required for servicing staff per hour = Total wages required for servicing staff per month/ Hours per month

(J) Servicing charges (Material cost)

Fuel/lubricant	Rate per litre	Consumption (In litre/kg) per month	Expenditure per month
i) Fuel			
ii) Lubricants			

iii) Grease

iv) Hydraulic oil

v) Gear oil

vi) Cotton waste

vii) Furnace oil (In case of hot mix plant)

Total expenditure per month = Rs

Total servicing charges (material cost) = Total expenditure per month/ Total hours per month

(K) Cost of lubricating oil, fuel consumed per hour

(L) Total running charges per hour = H+I+J+K IV

1.5 Over head charges @ 5% of total = 0.05x(L) V

Hire charges = I+II+III+IV+V

2. For Equipments Given to Contractor and Outside Agencies

When the equipments are issued to contractors, interest and insurance charges @ 10 percent of the average investment per year will be calculated as under and added.

$$= \frac{A}{1500} \times \frac{60^*}{100} \times \frac{10}{100}$$ * on 5 years life

= Rs

(M) Interest and insurance charges per hour

Therefore the total charges in that case would be as follows:

Ownership charges (E+F+M)	= I
Operational charges	= II
Running charges	= IV
Over head charges @ 5 percent of total charges per hour (I+II+IV)	= V
Hence hire charges per hour	= I+II+IV+V

ANNEX-D

SELECTION OF PAVER FINISHER

S.No.	Attribute	Mechanical Paver	Hydrostatic Paver
1.	Paving width		
a)	Based on screed control mechanism	Minimum 1.5 m Basic width 2.5 m extendable up to 4.0 m	Basic width 2.5 to 3.0 m with infinitely variable hydraulically extendable up to 16 m width
b)	Based on traction mechanism	Up to 8 m (Wheeled Paver) 8 to 16 m (Track chain Paver)	
2.	Paving thickness	10 to 200 mm	10 to 350 mm
3.	Type of material to be used	Wet mix macadam, Bituminous mixes	
4.	Lay down rate required (In tonne per hour)	Up to 100 tonne per hour	Up to 700 tonne per hour
5.	Mobility requirement at job site	Wheeled Pavers is preferred over Track chain Pavers, if there is frequent shifting involved during the execution of paving job.	
6.	Desired paving speed		
a)	Wheeled Paver finisher	0-25 metre per minute	0-40 metre per minute
b)	Track chain Paver finisher	0-16 metre per minute	
7.	Desired travel speed		
a)	Wheeled Paver finisher	0-16 km per hour	0-7.5 km per hour
b)	Track chain Paver finisher	0-3.6 km per hour	

In addition to the above, following points need to be considered while selecting the Paver finisher.

a) Quality of the pavement (NH, SH, MDR, ODR, VR, Urban Road)

b) Terrain through which the road passes (Hill Road/ Plain Road)

c) Frequency of shifting the Pavers finisher (Wheeled/ Track chain Pavers)

d) Project cost

e) Fuel consumption (In litre per hour)

f) Maintenance cost per hour (lubricants, grease, filters etc.)

g) Product support and training available – Availability of spares, service net work of manufacturer/ dealer

h) Repair and maintenance cost

i) Availability and proposed utilization of equipment in percentage

j) Warranty of the equipment

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the code/guidelines/manual, etc. from the date specified therein)