Factors Influencing The Accuracy of Roll Grinding

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ABSTRACT

Maintaining the accuracy in grinding of different types of rolls plays a major role in a paper industry so as to maintain higher accuracy levels of paper caliper and to compete in the competitive market. This paper discusses the factors like Grain size, Grade, Structure and Area of contact which influences the selection of grinding wheel. In addition to this, Wheel speed, Roll speed, Traverse speed and Grinding machine bed level are also discussed. In addition it has been focussed the equipment like "Watts Microptic Auto-Collimator" and "Mechanical & Electronic Calipers" which influences the final result of the grinding.

INTRODUCTION

Rapid technological growth in recent years has forced most of the industries to seek paper of very high quality and the parameters governing paper caliper have become very stringent.

With the introduction of high speed printing machines and the demand for computer stationery going up, Paper industries have to maintain high accuracy levels of paper caliper.

Roll grinding machine plays a major roll in maintaining the grinding accuracy of rolls which in turn is reflected on the quality of the finished paper. All paper industries are now focussed on the maintaining the condition of different types of rolls installed on the machine in order to survive and be competitive in the market.

The art and skill of work involved in the operation of roll grinding machine depends upon the experience of operator. The essential factors associated with grinding operation are:

1. Selection of the grinding wheel
2. Speed of the grinding wheel
3. Roll speed
4. Traverse speed
5. Bed leveling of the Roll Grinding Machine
6. Calibration of the Roll

SELECTION OF THE GRINDING WHEEL

Grinding wheel: Grinding wheel consists of fine abrasive particles of Aluminium oxide or Silicon carbide bonded together by means of Rosinoid, Shellac or Rubber etc.

Grinding wheel manufacturer association has

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adopted a standard method in wheel making with a system divided in six parts and each parts represents its making.

SELECTING THE WHEEL AND EFFECTS

Grinding wheel selection assures crucial importance. The abrasive grit size, grade and bond type should be carefully matched to the particular job on the hand.

Selection of grinding wheel mainly depends upon the following factors:

1. The material to be ground
2. Amount of stock removal
3. Area of contact
4. Condition of grinding machine
5. Finish and accuracy required
6. Wheel speed
7. Work speed
8. Condition of grinding
9. Skill of operator

System of Marking

1	2	3	4	5	6
Kind of abrasive and manufacturer prefix	Grit or grain size	Grade or Hardness	Structure	Bond	Manufacturer's record
A: Aluminium oxide	Coarse (6) to Fine (120	Soft - G to Harder-T	1-15 Dense or Compact To Open or Porous	V- Vitrified B-Resonoid 2B-Rubber E-Shellac O-Oxy Chloride S-Silicate	
C: Carbide Silicon					
Example :					
C	46	L	5	E	AC
Silicon carbide	Grit	Grade	Structure	Bond	Manufacture record

MATERIAL TO BE GROUND

Following are the factors which influences the grinding materials.

Abrasive material: SiC is more hard and more brittle. If it be used with materials of high tensile strength then more resistance will be offered by job on wheel and abrasive particles fall of rapidly due to quick fracture. Silicon carbide abrasive is best suited for brittle and hard materials like grey cast iron, chilled cast iron, tungsten carbide, hard steel, stone, porcelain and other ceramic sustances. SiC is also recommended for low tensile strength materials such as non-ferrous metals, bronze, brass, copper, aluminum and plastic materials.

Al_2O_3 abrasive will be used with materials of low tensile strength, then resistance offered by the material on grinding wheel will be less. In such case abrasive particles do not fall off from the wheel and keep on getting blent. So grinding will be poor. Hence this wheel is preferable for grinding tough materials like high speed steel, bronze and Copper.

Grain size: Coarser grain size generally used for softer materials and fine grains are used for harder materials.

Grade: Harder grade wheel can be used for softer material and softer grade wheels for hard materials.

Shellac is a very low heat resistant bond and the heat of grinding tends to break down the shellac bond at a uniform rate so that as the grains become dull they are released from the grinding face of wheel almost one at a time, making a very smooth action and soft dressing.

Resinoid bonded is more heat resisting and does not easily break down due to heat. When the wheel becomes dull and the pressure breaks down the wheel, there is a tendency to produce a rough cutting action which produces "Chatter". This type of wheel does not dress it self as easily as shellac bonded wheel and the operator must resort to the diamond dresser more frequently.

STRUCTURE

Dense structure is advised for harder material as rate of metal removal is less with small size chips. For softer material, the open structure is prescribed as the rate of metal removal is high and size of chips is also big.

AMOUNT OF STOCK REMOVAL

Grain, Grade and Structure influences the amount of stock removal.

For fast removal of metal coarse grain size is required and vice versa. Soft grade is used for fast removal of metal at the cost of wheel life. Open structure is desirable for fast removal of metal and vice versa.

AREA OF CONTACT

It mainly influences the grade of wheel and some extent grain size. Softer grade wheels are advised where the area of contact is large and harder grade wheels where area of contact is less. Coarse grit is recommended where the area of grinding is large and fine grit wheels are used for less area of contact.

CONDITION OF GRINDING MACHINE

Condition of grinding machine plays a major role for grinding of roll. Heavy rigid machine demands the softer grade of wheel.

FINISH AND ACCURACY REQUIRED

Where a high degree of accuracy and fine finish required, small size grain wheels should be used.

WHEEL SPEED

Peripheral speed, that is the speed at which the grinding edge of the wheel passes the work surface, should be chosen very carefully. Too slow speed may effect the productivity while excess speed may result in breakage. For higher wheel speeds, soft grade wheel is preferable.

ROLL SPEED

The selection of roll speed is a factor which can't be tabulated for different type of rolls for the guidance of the operator. It is entirely dependent on the knowledge gained from the experience by the operator.

The speed will vary according to:

1. The grinding of wheel used
2. The material to be ground
3. The weight of the roll
4. The finish required

A good rule, assuming correct wheel grinding is to set the speed at the maximum obtainable without introducing vibration. When grinding a finishing cut, it is essential that the traverse per revolution of the work is reduced to a minimum. High work speeds decrease this ratio of traverse to work speed and therefore desirable.

TRAVERSE SPEED

For Roughing a rate of traverse equivalent to about two-thirds of the wheel width per revolution of the roll is recommended where as for finishing the slowest traverse speed is usually required.

CONDITION OF GRINDING

Depending on whether the operation is wet or dry the grade of wheels must be chosen. To minimise the heat generation, soft grade wheels should be used in dry grinding and hard grade can be used in wet grinding where coolants will reduce the heat.

SKILL OF OPERATOR

Skill and experience of operator plays a major role in the accuracy of grinding of roll.

CAUSES OF CHATTER

1. Glazed wheel
2. Loaded wheel
3. Wheel out of balance
4. Heavy cut
5. Slack driving belt

When chatter marks appear on a roll being ground, the cause can usually be traced to one of the above. It could also be caused by some mechanical fault such as "Play" in the spindle bearings. But invariable the common cause is a wheel which is not suitable for work being carried out.

When a wheel becomes glazed it ceases to cut because the glazing prevents new cutting points from preventing themselves to do the work.

Glazing can be caused by high wheel speed. By reducing the wheel speed the break down of the wheel will increase and new cutting points will be presented.

Again, if the wheel is too hard, Glazing will quickly take place. If after reducing the wheel speed there is no improvement, then undoubtedly the right wheel is not being used.

A wheel out of balance will hammer the work and create deep chatter marks.

Even a slight variation in speed of the wheel or traverse can seriously affect the grinding of the roll.

CALIBRATION OF ROLLS

Measurement of roll plays a vital role to get correct accuracy. Measurement of the roll can be done by Mechanical Display or Electronic display.

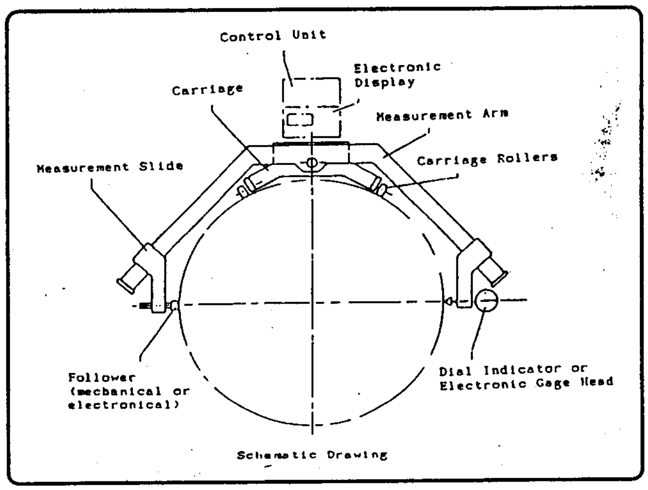
AUTO CALIPERS

This Equipment mainly consists of

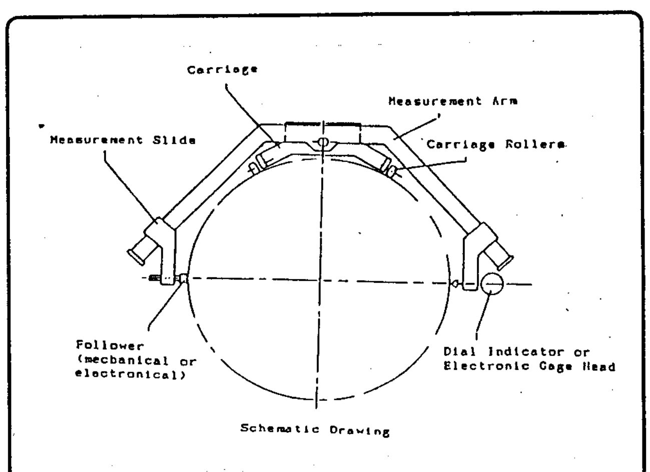
1. Carriage
2. Measurement arm
3. Measurement slide
4. Carriage rollers
5. Follower
6. Dial Indicator

Measurement of rolls can be done by adjusting the carriage wheels, Follower, Measurement slide and dial indicator having accuracy of 1 Micron according to the roll diameter. Push the carriage back wards and forwards several times to establish the starting point and calibrate the precision indicator to zero by means of the fine adjustment. Now starts taking readings at different stations. Here again the skill of the operator play the major role while viewing the pointer of Dial gauge.

(Fig. 2) Indicates the arrangement of Mechanical auto caliper.



Schematic Drawing Fig.-2



Schematic Drawing Fig.- 2 A

RECOMENDED PRACTICE FOR ROLL GRINDING

Material to be ground	Abrassive	Grit size	Grade Density	Bond Roughing	Wheel speed Finishing ft/min (m/min)	Wheel Speed Finishing ft/min (m/min)	Roll speed Roughing ft/min (m/min)	Roll speed Finishing ft/min (m/min)	Traverss Roughing ft/min (m/min)	Traverss Finishing
Chiled Iron	C 37	46	L or M	E 4	4500-5000	4900-5000	60-70	70-80	1/2 width	4 width of
			13		(1370-1520)	(1460-1520)	(18-21)	(21-24)	of wheel	wheel or less
	60	100	L or O	VC		4800-5000		50-65		1/3 width of
			·13			(1460-1520)		(15-20)		wheel or less
Rubber	R C	24	L6	B	4500-5000	4500-5000	90-110	90-110	Full width	1/3 width of
		46			(1370-1520)	(1370-1520)	(18-21)	(21-24	of wheel	wheel or less
	37 C	24	J 5-7	B	- DO -	- DO -	- DO -	- DO -	- DO -	- DO -
		46								
Granite	6 C	46	H 7-9	B2	4600-5200	4800-5200	90-110	90-110	Full width	1/2 width of
					(1400-1580)	(1460-1580)	(27-34)	(27-34)	of wheel	wheel or less
	37 C	46	J or K	E 4	4600-5000	- DO -	- DO -	- DO -	- DO -	- DO -
		7		(1400-1520)						
	C	46	H or N	B	5000-5500	5000-5500	- DO -	- DO -	- DO -	1/3 width of
			7 - 9		(1520-1670)					wheel or less
Brass	6 C	46	H 9	B2	4200-5000	4200-5000	80-100	70-90	2/3to full	1/4 width of
					(1280-1520)	(1280-1520)	(24-30)	(21-27)	width of	wheel or less
									wheel	
	37 C	36	K 7	E 4	- DO -	- DO -	- DO -	- DO -	- DO -	- DO -
			J 7							
Steel	32 A	36	J - 8	VBE	4200-4500		80-90		2/3 to full	
					(1280-1370)		(24-27)		width of	
									wheel	
	38 A	60-80	GorH	VBE	4800-5000	4900-5500	- DO -	80-90	- DO -	1/4 width of
			8		(1460-1520)	(1460-1670)		(24-27)		wheel or less
Hard stain less steel	32A	60-80	6 or H	VBE	4000-4500	4500-5000	60-70	85-95	1/3 to 2/3	very slow
			8		(1220-1370)	(1370-1520)	(18-21)	(26-28)	width of	
									wheel	
Soft stain less steel	6 C	46	H 9	B 2	(4200-45000		70-80		Full width	
					(1280-1370)		(21-24)		of wheel	
Chrome	37 A	60	H - KB	VBE	4200-4500	4000-4200	80-90	90-100	1/2 width	1/4 width of
	32A	80	KB	VBE	(1280-1370)	(1220-1280)	24-27)	(27-30)	of wheel	wheel or less
	2 A	60	K 5	VE	- DO -	- DO -	- DO -	- DO -	- DO -	- DO -
Fiber Glass	6 C	46	H	B	4500-5000		90-100		3/4 to full	
			7 to 9		(1370-1520)		(27-30)		width of	
	6 C	180	L - M	VC		4800-5000		65-75		1/4 width of
		320	13			(1460-1520)		(20-23)		wheel or less

ELECTRONIC AUTO-CALIPERS

To avoid Human errors while taking readings with Dial-Gauge, it is proposed to go for electronic auto calipers where the skill of the operator is not required. All the parts of this instrument are similar of Auto calipers except Electronic monitor and Electronic probe which will connected to carriage for accurate and perfect reading.

Fit Mechanical follower- equipped with roller type contact-in measurement slide.

Fit electronic probe in measurement slide.

Place carriage on the roll and move close to starting point for measurement. Use a spirit level to level it and take suitable measurement to prevent it rolling away.

With aid of the scale, set the measurement slide to the diameter or roll.

Apply follower so that it locates snugly against the roll through its own weight. Make sure the measurement arm still has sufficient freedom of movement.

Fit indicating instrument and connect up power cable.

Fig. 2A) Indicates the arrangement of Electronic auto calliper connect the probe to socket on the rear of the indicating instrument. Apply probe so far that the display shows approx., Zero. Reset to zero with potentiometer "Zero".

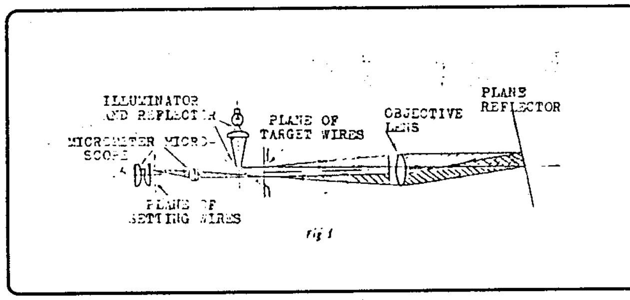
Push carriage backwards and forwards several times to obtain Zero. Recalibrate if necessary at potentiometer to "Zero". Starts taking the readings at different stations of the rolls.

WATTS MICROPTIC AUTO-COLLIMATOR

Foundation of the bed and bed leveling of a roll grinding machine is also plays a major role in maintaining the grinding accuracy or roll. Even though the selection of the grinding wheels, and its speed, roll speed and traverse speed are good, we will not get proper accuracy of roll with out proper bed leveling. Watts Microptic Auto-Collimator is used to check the bed condition.

The main purpose of this instrument is for precise measurement of small angular deflections of a beam of light. It has a range of 10 minutes of arc and a sensibility of a fraction of a second. Any movement or variation which can be around to deflect a small mirror can be accurately measured with this instrument. It can be used where conditions make it inconvenient or even impossible to use dial indicators, Comparators or other methods.

(Fig. 1) Illustrated the principle of Microptic Auto-Collimator



Principle of Microptic Auto-Collimator Fig.- 1

TYPICAL APPLICATION OF THE AUTO-COLLIMATOR ARE

1. Alignment of machine beds etc.
2. Alignment of perpendicular surfaces
3. Alignments of machine slides
4. Squareness testing
5. Indexing fixtures etc.
6. Small mechanical movement.

Alignment of machine bed of Roll Grinding Machine can be done by this Auto-collimator:

Error in flatness of surfaces or Machine ways can be determined by fitting a reflector to a small block fitted with supporting feet and moving the block step by step along the surface. If the contour of the surface is uneven, the small variation in angle of block can be measured and after calculation can be plotted in terms of linear variations from a true plane.

(Fig. 3) indicates the arrangement for checking errors in flatness.

(Fig. 4) indicates the arrangement for checking perpendicular surfaces.

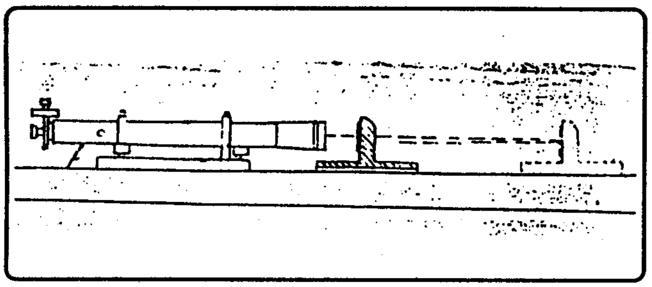


Fig. 3 Arrangement for checking Errors in Flatness.

The height of the centre line of the reflector above the feet of the carriage is now the same as that of the axis of the microptic Auto-collimator with its three foot screws resting on the round foot plates supplied with the instrument.

(Fig. 5) indicates Datum setting when reflector axis normal to optical axis.

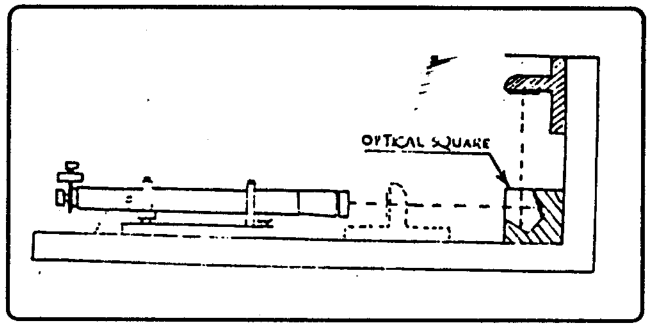


Fig. 4 Arrangement for checking perpendicular surfaces.

(Fig. 6) indicates Datum setting when reflector displacement is Horizontal.

(Fig. 7) indicates datum setting when reflector displacement is vertical.

Reflector carriage normally supplied has a base length of 5, 2, 4, 6, 8 and 10 inches. The relative

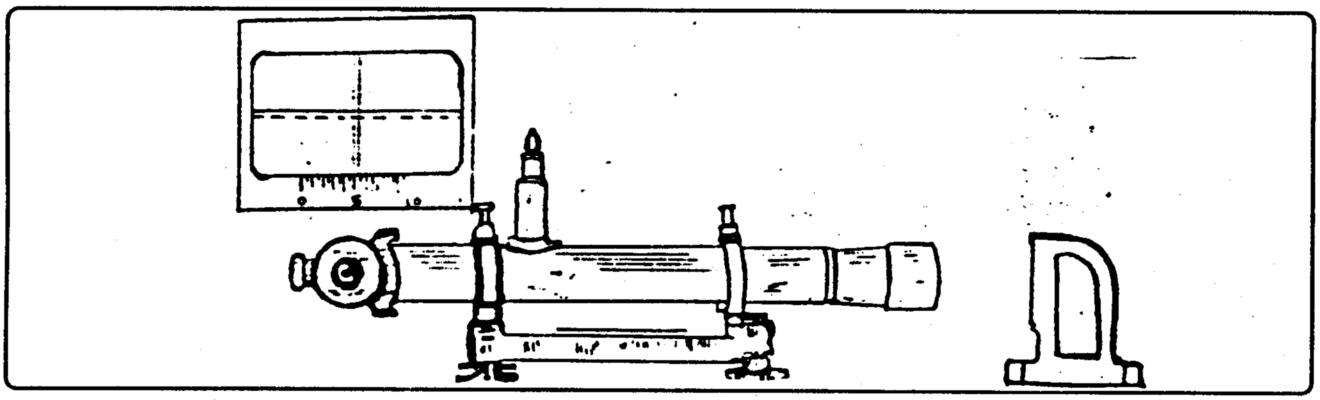


Fig. 5 Microptic Autocollamator Datum Setting Reflector axis normal to optical axis and return image approximately centred. Readings taken as datum.

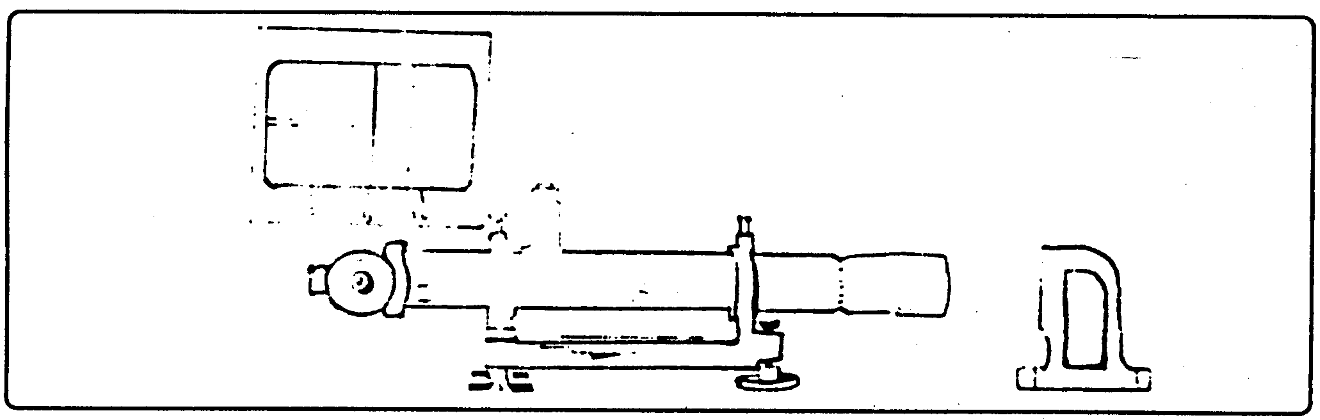


Fig. 6 Horizontal Displacement when the reflector is displaced about the vertical axis in the direction indicated, the return image responds as shown in the field or view.

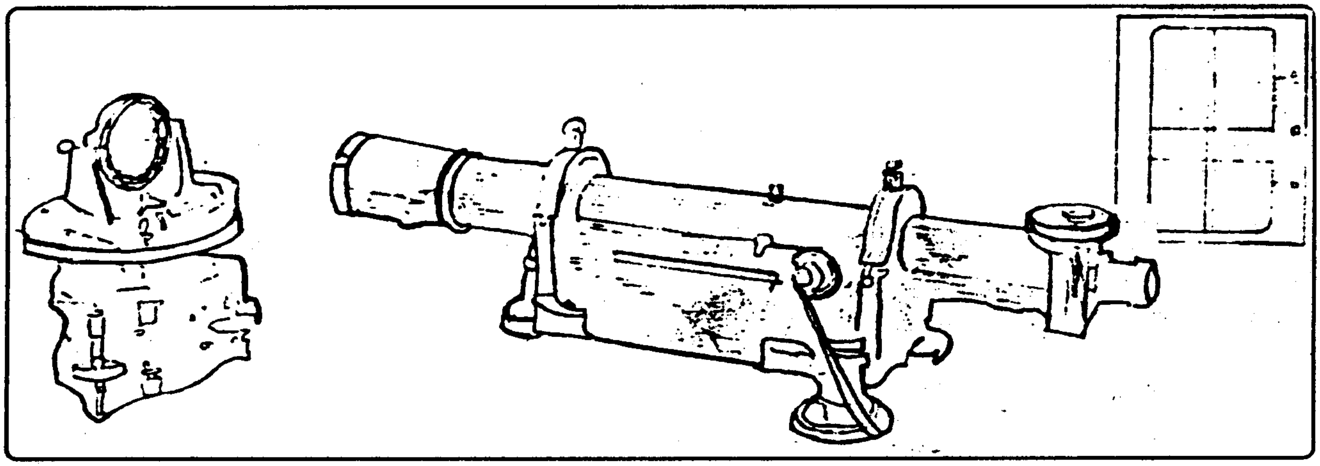


Fig. 7 Vertical Displacement: The complete telescore unit is rotated in its cradle through 90° to measure displacement about the horizontal axis, the return image responding as indicated.

change in height of its feet corresponding to a tilt of one second.

Eg. : 5 In. base length, 1 second tilt = 0.000025 In.

The choice of base length for reflector carriage depends upon the length of the surface to be tested. Base length : 1/12 th Length of the bed to test.

The principle underlying such tests is shown in (Fig. 8). In case of a machine bed, the Auto-collimator is set up very rigidly to view along the direction of the bed and is sighted on a vertical mirror, supported on a reflector carriage, which rests on the bed. The under surface of this carriage is limited to two flat strips at its ends, separated by a centre distance denoted by step from its initial position A-B at one end of the bed to other positions B-C, C-D etc., through out the length of the bed. It is guided by side ways against a straight edge. any lack of straightness of the bed in elevation will cause the carriage to tilt through small angles in its passage along the bed. These angles which are denoted by 01, 02, etc., with respect to the initial position A-B are measured with the Auto-collimator for each successive position of the carriage. Knowing the base length L of the carriage, it is a simple matter to calculate the corresponding differences in heights of the two feet of the carriage at each position. These are denoted by Q1, Q2, etc. Successive algebrical additions of these differences in height then give the

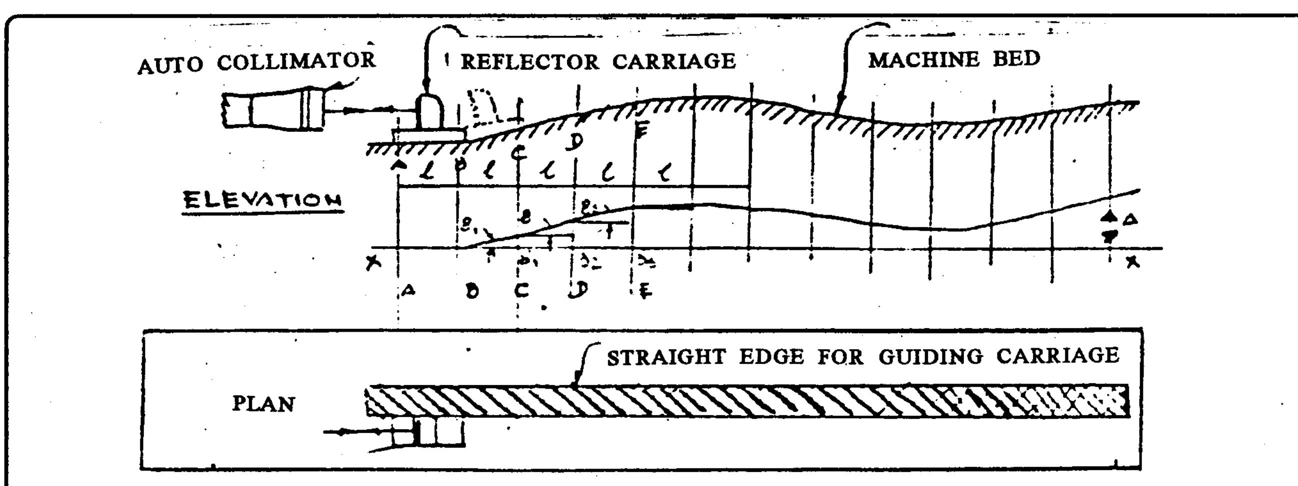


Fig. 8 Measurement of Angular deflections on Machine Bed.

departures from straightness of the bed (in elevation) from a base line XX drawn through the feet of the carriage when in its initial position A-B. For convenience, it is usual to adjust these departures by calculation so as to refer them to another base-line joining the two ends of the bed.

SETTING UP AND TAKING READINGS ON A MACHINE BED (Ref. Table A)

Example : Testing the upper surface of the bed of a machine, 5 feet long, using a reflector carriage with a 5 inch base length. Set the Auto-collimator and reflector carriage. The direction of the latter is adjusted until a reflected image of its cross wires is seen near the centre of the field. The carriage is then moved to the other end of the bed. For simplicity, the mean readings in column 2 are given to the nearest whole seconds. The third column shows the differences of the readings from the first reading. In column 4 these angular differences are converted into the corresponding values of "D" by multiplying them by 0.000025 in. which is the equivalent of one second over the 5 inch base length of the carriage used. (Note: 1 Second of arc represents very closely a slope of 0-000005 in. per inch). It will be noted that an additional zero is inserted at the top of column 4 : these two zeros then represent the heights of the carriage when its initial position A-B. To find the subsequent heights of the feet above the base line drawn through their initial position, the values in column 4 are added together algebraically one after the other, giving the values in column 5. This summation results in a terminal rise in the surface of the bed amounting to 0.0010 in. column 6 gives the proportional amounts of this terminal value which are subtracted from these in column 5 to give the errors in the bed from a straight line joining the terminal points covered by this test. The values obtained in columns 5, 6, 7 of the table have been plotted. (Fig 9 and 10). It will be noted that the straight line joining the end points of the curve in (Fig. 9) has been brought down to the axis in (Fig. 10) and that curve bears the same relationship to this line in both figures. It will be seen from (Fig. 10) that the bed is concave by a few Ten Thousandths

Table A:

Position	Mean Reading of Auto-Collimator (Sec.)	Difference from First reading (Sec.)	Rise / Fall in 5 inches (d inches.)	Cummulative rise / fall (d inches.)	Adjustment to bring both ends to zero (inches.)	Errors from straight line (inches.)
1	2	3	4	5	6	7
00-05	20	0	0	0	- 0.00010	- 0.00010
05-10	22	+ 2	+ 0.00005	+ 0.00005	- 0.00020	- 0.00015
10-15	24	+ 4	+ 0.00010	+ 0.00015	- 0.00030	- 0.00015
15-20	30	+ 10	+ 0.00025	+ 0.00040	- 0.00040	0
20-25	26	+ 6	+ 0.00015	+ 0.00055	- 0.00050	+ 0.00005
25-30	16	- 4	- 0.000.10	+ 0.00045	- 0.00060	- 0.00015
30-35	18	- 2	- 0.00005	+ 0.00040	- 0.00070	- 0.00030
35-40	24	+ 4	+ 0.00010	+ 0.00050	- 0.00080	- 0.00030
40-45	30	+ 10	+ 0.00025	+ 0.00075	- 0.00090	- 0.00015
45-50	30	+ 10	+ 0.00025	+ 0.00100	- 0.00100	0

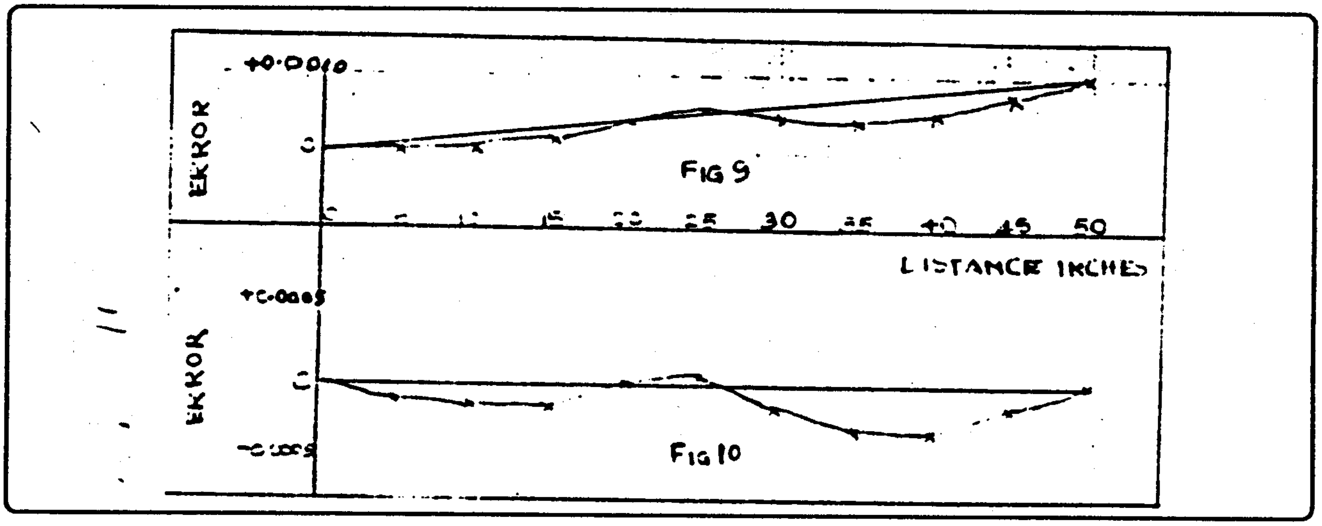


Fig. 9 Cumulative raise or fall of Bed Level

and

Fig. 10 Bed level Position

of an inch over each half of its length, The error at the centre being very small relative to the ends.

REFERENCES

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2. 1981 TAPPI artical TIS 405 - 2.
3. Watts microptic auto - callimator manual.
4. Schonthaler roll callipers manual.