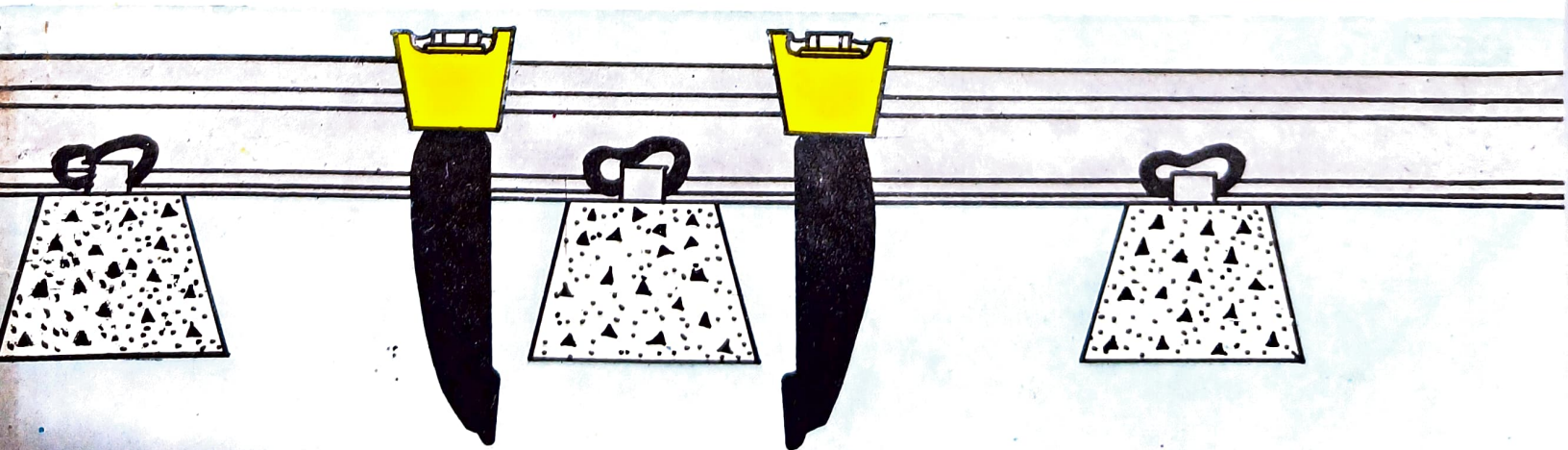
भारतीय रेलवे
रेलपथ मशीन प्रशिक्षण केन्द्र
इलाहाबाद

कर्मण्येवाधिकारस्ते

INDIAN RAILWAYS
TRACK MACHINES DIGEST
भारतीय रेल, रेलपथ मशीन डायजेस्ट

YEAR-4 ISSUE-11 QUARTERLY APRIL - 1996



OUT PUT OF TAMPING MACHINES IN KM. DURING 1995-96

Rly.	MACHINE DETAILS UT	UNO	DUO	CSM	TOTAL NO. of Machine	OUT PUT IN Kms 94-95	95-96
CR	8	-	1	8	17	6230	6591
ER	1	2	3	6	12	4732	4700
NR	1	2	5	7	15	7242	7120
NER	-	2	1MG	1	4	1025	860
NFR	2	-	1	1	4	489	404
SR	3	-	2BG 1MG	6	12	5222	4314
SCR	2	-	4	6	12	4458	4629
SER	2	1	3	8	14	5158	4943
WR	4	1	1MG 1BG	8	15	4631	5350
Total	23	8	20BG 3MG	51	105	39187	38911

TARGET

UT = 31 KM PER MACHINE
UNO = 56 KM PER MACHINE
DUO = 88 KM PER MACHINE
CSM = 110 KM PER MACHINE

OUT PUT OF BALLAST REGULATOR IN KM DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN Kms. 94-95	95-96
CR	4	1198	4689
ER	3	1323	2330
NR	3	1418	3038
NER	1		369
SR	2	622	1292
SCR	3	1356	3018
SER	3	522	631
WR	3	515	2041•
Total	22	6954	17408

TARGET 1 M/C = 100 KM/MONTH

OUT PUT OF RAIL GRINDING MACHINE RECTIFIED KM DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMS 94-95	95-96
SER	1	NIL	NIL

TARGET 1 M/C = 300 KM : ASS/MONTH

RELAYING OF TRACK BY PQRS IN KM DURING 1995-96

Rly.	NO. OF 9T PORTALS	OUT PUT IN Kms. 94-95	95-96
CR	8	110	93.6
ER	12	117.5	93.1
NR	4	83.6	98.7
NER	6	19.0	16.0
SR	15	210.7	120.2
SCR	12	197.7	160.4
SER	16	80.3	137.6
WR	8	92.1	77.8
TOTAL	81	910.9	797.4

TARGET

9 TONNE CAPACITY = 5.0/ KM/MONTH/MACHINE

OUT PUT OF BALLAST CLEANING MACHINE RM 80 IN KM DRUING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs. 94-95	95-96
CR	2	33.2	79.8
ER	2	10.4	39.4
NR	2	87.7	80.1
SR	1	40.1	28.7
SCR	2	57.9	50.4
SER	2	47.3	46.3
WR	1	28.1	64.7
TOTAL	12	304.7	389.4

TARGET 1 M/C = 12 KM/MONTH

OUTPUT OF BCM 76 FOR POINTS & CROSSING IN KM. DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN Kms 94-95	95-96
CR	1	27.8	24.8
NR	1	42.3	49.1
TOTAL	2	70.1	73.9

TARGET 1 M/C=7KM OR 12 T.O/MONTH

OUT PUT OF TRACK RELAYING TRAIN IN KM DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs.	
		94-95	95-96
CR	1	-	-
NR	1	75.8	100.5
SCR	1	-	28.5
SER	1	50.2	54.3
TOTAL	4	126	183.3

TARGET 15 KM./MC/MONTH

OUT PUT OF POINT & CROSSING TAMPER 08-275 IN T.O. DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs.	
		94-95	95-96
CR	4	2581	3923
ER	3	1712	1723
NR	4	2244	2289
SR	3	1449	1182
SCR	3	1383	1854
SER	3	1217	959
WR	3	1137	1897
TOTAL	23	11723	13827

TARGET 1 M/C = 100 T.O../MONTH

OUT PUT OF FRM-80 SHOULDER BALLAST CLEANER IN KM DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs.	
		94-95	95-96
CR	1	106.6	53.0
ER	1	74.8	201.6
NR	1	51.6	44.3
SER	1	117.0	81
TOTAL	4	350.0	379.9

OUT PUT OF DYNAMIC TRACK STABILISER IN KM DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs.	
		94-95	95-96
CR	1	-	517.4
ER	1	-	439.6
NR	2	7.7	1006.2
SR	1	-	234.4
SCR	2	-	333.1
SER	1	-	66.4
WR	1	-	195.51
TOTAL	9	7.7	2792.61

TARGET 1 M/C - 110 KM/MONTH

OUT PUT OF T-28 DURING 1995-96

Rly.	NO. OF MACHINE	OUT PUT IN KMs.	
		94-95	95-96
CR	1	37	87
ER	1	19	75
NR	1	38	92
SR	1	76	53
SCR	2	153	203
SER	1	31	70
WR	1	2	-
TOTAL	8	356	580

MAINTENANCE OF CONVEYOR BELTS

The purpose of this article is to bring to light certain facts about conveyor belting and its maintenance, so that a machine man may be guided to obtain maximum service life of the belts installed on his machine.

Some points are high lighted which will prove that it is not just proper design and manufacture of the belting that are the criteria for deciding whether the belt will serve longer, but it is essential that adequate time energy and care is devoted to ensure that the belts do not fail due to misuse and lack of attention. If carefull consideration is given to all aspects, it is certain that ample reward will be in store; as it goes without saying that a mchine man desires no greater pleasure than to see his conveyors working smoothly and satisfactorly with the least amount of down time.

In order to obtain optimum life from the belts, will have to take care of the following points, each one of which has a direct bearing on the service life of the belt.

A. Belt Design
B. Storage
C. Installation, Joining and initial Running.
D. Common problems encountered and means to over come them.

A. BELT DESIGN:

The responsibility of ordering a suitable construction of belting, either for an existing conveyor or for a proposed one, falls on machine engineer. In all cases it is preferable that belting manufacturers advice is sought to determine the best belting for the drive in question.

B. STORAGE:

When the belt drum has been received from the supplier it is the responsibility of the store & mach[illegible] staff to see that nothing detrimental to the belt takes place as this would reduce its service life.

The DO's ad DON'ts for proper storage are listed below. All attempts should be made to follow them:

DO's

- Roll or skid or hoist the drum, place bar through the centre and protect the belt edges adequately.
- Jack up the drum clear off the ground by placing bar through centre of roll.
- Store in a cool, dry, covered and well ventilated place away from direct sun light.
- Whenever lengths are cut from the belting roll, the ends should be sealed, with conveyor belting solution to prevent—ingress of moisture into the car-cass.
- As rubber belting and the packing are inflammable, adequate precaution should be taken to prevent any fires and means should be provided to extinguish it immediately, should it occur.
- Once in say 2 months, examine the drums in storage and ensure that the packing is not failing due to white ants etc. Spraying the packing with D.D.T. will help.

DON'Ts

Do not drop drum from wagon or truck as dropping will damage packing and possibly the belting.

Do not place roll with weight on one side as with constant dead weight the belt edge will get distorted through out the length.

Do not store near heating units or where oil may come in contact with belt.

Do not store if possible for long period say over 1-1½ years as the rubber slowly ages and loses its properties with time.

Do not secure the end of a roll with nails, use binding around the roll.

INSTALLATION, JOINING AND INITIAL RUNNING :

The conveyor belt drum should be brought to site with care and mounted at a convenient location suitably fastening the end. Utmost care should also be taken to ensure that the belt does not rub or catch on sharp corners of the cenveyor when the belt is drawn over the idlers. When installing the belt, make sure that the carrying side, which is generally the branded side, is right side up. Once the belt is installed, the ends are to be joined. This may be done either by vulcanisation or by fitment of fasteners. In either case great care should be taken that the ends are cut square and the joint is not crooked, as a crooked jont could cause considerable damage to the belt and the structure. It is hence worthwhile seeking the advice of the belt and fastener manufacturers regarding the method of joining of belts. Manufacturers' advice sould also be taken regarding the type and size of fastener to be used. An incorrect size of fastener could cause shut downs either due to belt snappings or fastener pull-out.

Once the belting has been joined, trial runs of the empty belt should be made to ensure that the belt sits satisfactorily on the idlers, and that the belt runs aligned at all points of the conveyor both on the carrying and return runs. With minor idler adjustments the belt may be made to run centrally throughout its length. It is preferable to make small adjustments and watch the behaviour of the belt for a few revolutions before making further adjustments. Excessive adjustment in any one idler will result in increased back cover wear. It is hence better to make slight adjustments in several sets of idler than to make a large adjustment in one.

The general rule is that if every portion of the belt runs out at a particular point in the conveyor, the cause lies in the conveyor structure. If, however, one or more portions of the belt persistently run off-centre at every point in the conveyor, the belt or the joint is the cause. Sometimes, of course, a combination of the above two causes may well be the reason for misaligned running of the belt and in such a case the running pattern of the belt should be carefully watched for a number of revolutions and corrective action taken accordingly.

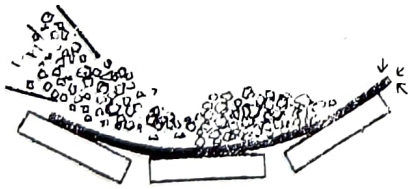
If the belt runs true when empty but offcentre with load, the obvious fault lies in the method of loading. The load should, as far as practicable, be fed on to the belt centrally in same direction as belt travel.

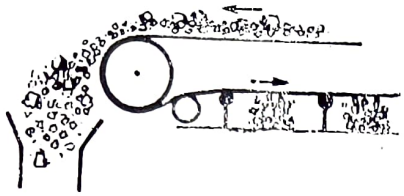
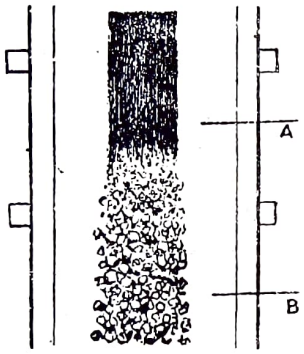
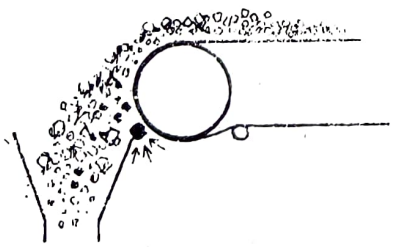
It is preferable to carry out all adjustments on the conveyor before running the belt on a production basis.

D. COMMON PROBLEMS ENCOUNTERED AND MEANS TO OVERCOME THEM:

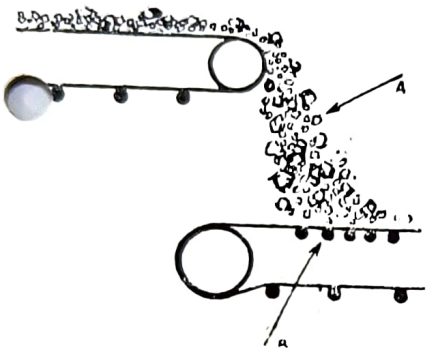
With the belts in operation on a production basis it is to be expected that various types of problems crop up. It is hence important for the Engineer at site to be able to take all possible measures to prevent such of those troubles they show up and in cases where they do occur, tobe able to identify and get to the root of what is causing the trouble.

The symptoms, the causes and the cures of common problems that occur with conveyor belts in service are listed below for easy reference.

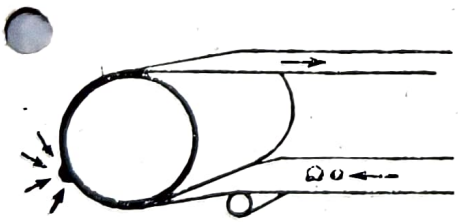
SYMPTOMS	CAUSES	CURES
I. Belt Edges:	Rubbing due to:	
Edges worn or frayed.	a. Defective joint.	a. Rectify joint.
 *Off-centre loading.*	b. Misaligned running.	b. Check conveyor alignment and re-align belt.
	c. Off-centre loading.	c. Re-position loading chute to feed load centrally.
	d. Defective self-aligning idler.	d. Rectify or replace faulty idler.
	e. Inadequate edge clearance.	e. Minimum recommended clearnace between belt edge and structure is 75 mm.
	f. Belt too stiff for adequate troughing.	f. Install a laterally more flexible belt.
A belt which does not through adequately will cause misaligned running, resulting in severe belt edge wear and material spillage.		Repair or paint edges with conveyor belt solution to prevent—ingress of moisture, grit, etc.

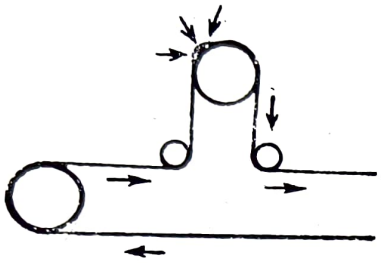
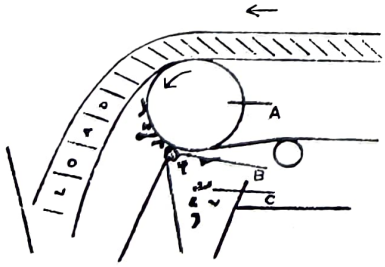
SYMPTOMS	CAUSES	CURES
II. Top Cover:	**Across the Belt Width:**	
1. Excessive uniform wear.	a. Cover under-specified or incorrect quality.	a. Specify thicker covers of correct grade depending on loading cycle and material carried.
	b. Worn or seized return idlers.	b. Install cleaning devices or rubber disc idlers. Check periodically if all idlers rotate freely. Replace seized idlers with new ones.
	c. Spilled material under tail pulley seting up abrasion.	c. Increase clearnace between tail pulley and floor, fit decking to avoid spillage.
Return run of belt rubbing against spilled material.	d. Return run of belt rubbing against spilled material along the conveyor.	d. Prevent spillage along the run of the conveyor. Check return idler spacing and belt tension. Ensure all spilled material to be removed immediately.
	e. Load distrubance due to uneven conveyor level and incorrect idler spacing.	e. Ensure correct conveyor level and recommended idler spacing.
A. Excessive cover wear.	**Narrow Central Section:**	
B. "Thin" load, speed may be High.	Speed is too high thereby belt carries a "thin" load.	Redesign drive at a reduced speed, check chutes and skirt boards to ensure that the load is fed on to the belt uniformly across its effective width. At the commencement, skirt boards may be placed about two thirds of the belt width apart and they should widen out in direction of travel to ensure uniform load distribution across the width.
2. Cuts of stripping of cover, or groovey or patchy wear beneath the skirt board.		
	a. Material jamming between belt and skirt.	a. Adjust skirt board rubber to provide minimum clearance, and install cushion idlers to hold belt against skirt.
	b. Skirt board rubber too hard and stiff or use of old belting pieces.	b. Use only plain rubber strips of correct hardness.
	c. Skirt board incorrectly set.	c. Skirt board should flare up slightly (say 1 in 42) in direction of running of belt to prevent wedging of material between belt and skirt. Board should under no circumstances come in contact with the belt.
Entrapment of material between tip of chute and belt.		

SYMPTOMS	CAUSES	CURES
	d. Jamming of material in chute.	d. Redesign and widen chute. In case the jamming is at the loading point, reduce rate of loading or increase belt speed.
	e. Worn or seized return idler roll.	e. Replace all unserviceable idlers with new idlers.
	f. Handing of wet, sharp material through tripper pulleys in the absence of proper belt cleaning facilities	f. Install proper cleaning facilities before belt wraps the second tripper pulley.
3. Cover gouging.	**Impact of Heavy**	
	Lumps:	
	a. Face rubber cover of inadequate thickness.	a. Redesign cover and grade based on loading cycle and size of material carried. Incorporate breaker, if necessary.
	b. No cushion idlers at impact section or height of fall too great.	b. Use impact idlers at loading point and install "Grizzly Screen" to ensure that fines are deposited first on the belt and larger lumps then fall on belt. Reduce the height of fall of material to a minimum.
	c. Roll back of material on inclines.	c. Reduce speed, ensure loading on horizontal, avoid if possible loading large lumps without small material accompanying them.
III. Back Cover:		
Severe cover wear and peeling of cover.	a. Slippage of drive pulley, sand thrown between belt and drive pulley.	a. Adjust tension, lag the drive pulley, increase area of contact.
	b. Carrying idlers seized.	b. Lubricate idlers regularly, replace seized idlers.
	c. Excessive forward carrying tilt of idler.	c. Adjust to not more than 2° from vertical.
	d. Material spillage on to return run of belt which is ground between belt and pulley.	d. Install decking plates or use endless belt, Use scrapers at tail end section. Proper rubber strips and not old belting pieces should be used with scrapers or ploughs.
Material spillage on to return run of belt.	e. Bolt heads in the case of lagged drums protruding.	e. Tighten bolts replace worn lagging.
IV. General Cover Problems:	Exposure to sunlight or ozone for long periods.	Protect belt suitably, particularly in storage and when idle on the conveyor for long periods.
1. Surface cracks.		
2. Cover softening and bulging.	Oil contamination.	Avoid oil or grease contamination.



A. Height of fall too great.
B. No rubber impact idlers.



SYMPTOMS	CAUSES	CURES
3. Cover hardening and cracking.	Material carried too hot.	Quench material carried or use better heat resistant.
4. Bulging of cover at palces and the same extending along belt length.	Fine material working into cuts or punctures in the rubber cover.	Immediate repair of cuts and punctures to prevent ingress of fine dust, etc.
V. Belt Carcass:		
1. Breaks in the carcass.	a. Impact of large heavy material.	a. Use cushion idlers. Keep height of fall to a minimum and load in line with the belt at a speed equal to belt speed.
	b. Material entrapment between the belt and pulley.	b. Use scrapers or ploughs at tail end section and proper decking at take-up pulley in case of gravity take-ups.
	c. Material build up on pulley.	c. Use belt cleaning device and install scraper on pulley.
 Entrapment of material at take-up pulley.	a. Belt edges folding up due to misaligned running.	a. Use limit switches to stop excessive running out and investigate reasons for running out.
2. Transverse breaks at edge.	b. Incorrect positioning of idler next to head pulley- too close or too high.	b. Re-locate or readjust idler or pulley position.
3. Lengthwise carcass break with covers intact.	a. Belt running off centre and folding over.	a. Use limit switches and determine reasons for running out.
	b. Longitudinal extension.	b. Reduce impact as explained earlier.
4. Fastener pull out, or transverse carcass breaks.	a. Too much tension.	a. Reduce tension.
	b. Incorrect size of fastener or improper joining.	b. Use correct fasteners.
5. Transverse breaks immediately behind fasterns.	c. Direct-on-line starting.	c. Use graduated starting.
6. Longitudinal rip partially or through entire belt thickness.	Fastener plates too long for pulley diameter.	Change to shorter fasteners or increase diameter of pulley.
	a. Belt running off and snagging on structure.	a. Ensure true running of belt.
	b. Tramp iron jamming in structure and ripping belt apart.	b. Redesign chute to prevent jamming.
	c. Fasteners working loose jamming in structure and ripping belt apart.	c. Use correct fastener and periodically examine joint for rectification.
A. Magnetic pulley.	d. Belt lifting off at vertical concave curves, particularly at starting, and becoming damaged by intervening skirt boards, chutes, etc.	d. Use heavier belt and if problem remains, calculate and rectify structure for safe vertical curve radius.
B. Entrapment of tramp iron.		
C. Tramp iron discharge chute.		

SYMPTOMS	CUSES	CURES
7. Ply separation.	a. Mildew or dust penetration into carcass.	a. Prevent cuts etc. Arrange for immediate repairs.
	b. Pulley diameters too small.	b. Increase pulley diameter or install synthetic duck belting.
	c. Oil contamination.	c. Remove source of contamination.
	d. Too many reverse bends.	d. Use more flexible belt.
	e. Edge wear due to rubbing and penetration of moisture and grit.	e. Correct misalignment or remove obstruction.
VI. General Operating Problems:		
1. Belt wanders at random.	Too stiff, does not conform to contour of idlers.	Use belt with more transverse flexibility.
2. Belt runs off-centre at certain times.	Wind pressures and effect sun on conveyor frame.	Use covers and wind deflector and self aligning idlers.
3. Belt stretches excessively.	Excessive starting and operating tensions.	Increase speed keeping tonnage same or reduce tonnage keeping the speed same, thereby tensions will be reduced. Lag drive pulley or increase area of contact. Use minimum counter-weight in take-up. Replace with lower elongation or higher strengthbelt.

Extracts Courtsey Dunlop India

FLUID CONTAMINATION

Thomas S. Wenke

It is estimated that 75 to 85 percent of hydraulic system failures are a direct results of fluid contamination. Contamination can be defined as any detrimental matter in the fluid. Contamination can be detrimental to the hydraulic system or to the fluid itself. Each dirt particle acts like an "abrasive seed" that products additional dirt particles as it passes through the clearances in pumps, valves, conductors, and actuators. Contamination affects the hydraulic system in many ways:

1. Increased internal leakage which lowers the efficiency of pumps, motors, and cylinders and decreases the ability of valves to control flow and pressure accurately. It also wastes horsepower and generates excess heat.

2. Corrosion of the hydraulic system from acids that form due to fluid breakdown and mixing of incompatible fluids in the system.

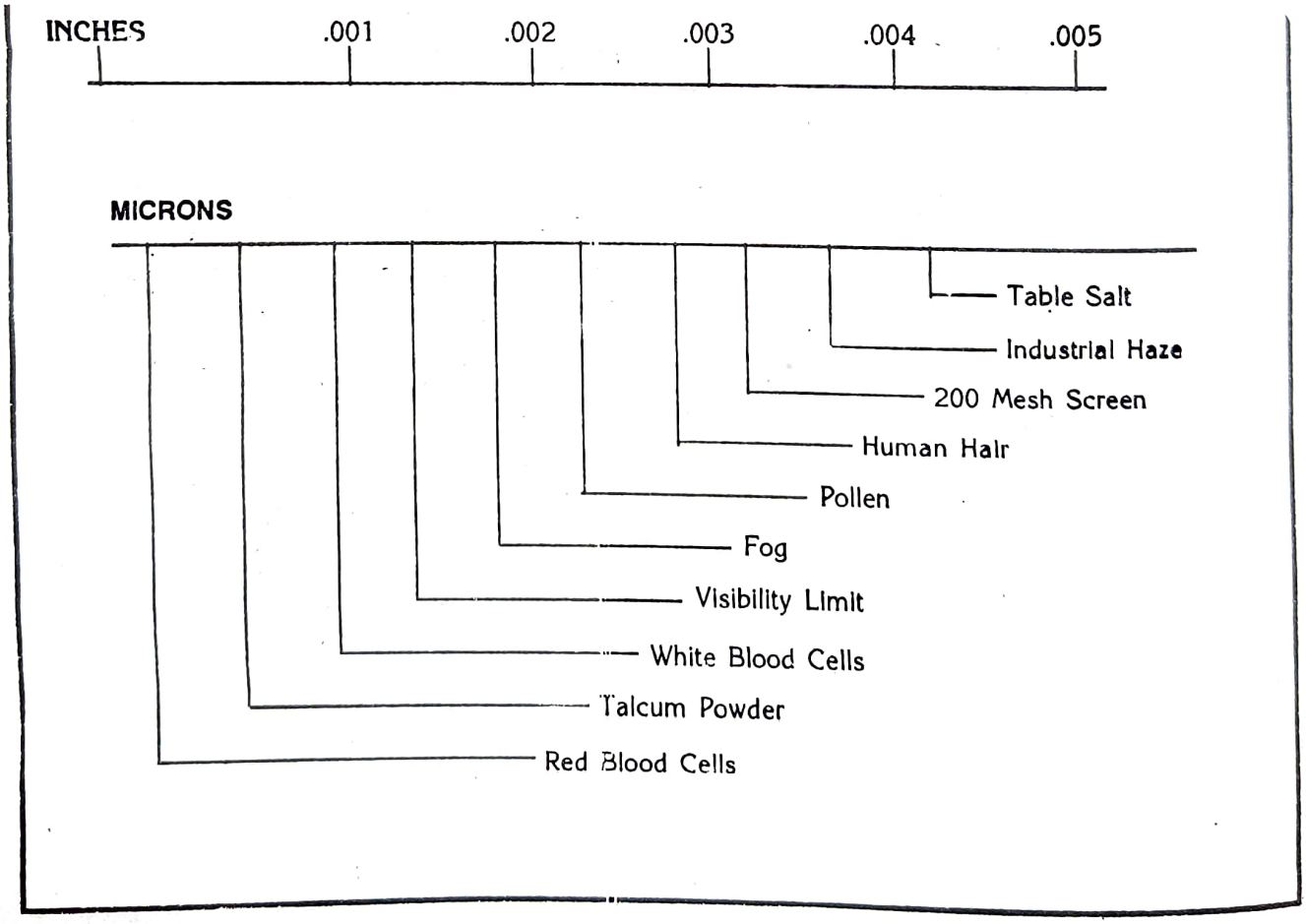
3. Sticking of parts due to sludge or silting. Silting is a collection of fine particles in critical areas of control valves which will impair the shifting of the spool.

4. Seizure of parts or components caused by large amounts of contaminants getting stuck in the clearences.

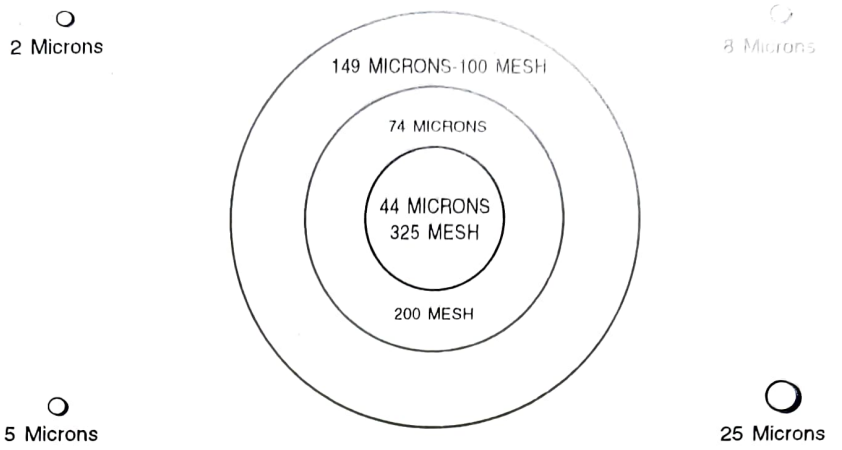
Dirt particles are usually sized using a metric unit of measure called a micrometer, otherwise known as the micron. Twenty-five microns is equal to one-thousand of an inch. Particles are sized by measuring the longest dimension. The clearances in hydraulic components can be as small as one-half micron. When abrasive particles enter the clearance between moving parts they score and hone the surfaces to greater clearances.

Generally the small particles pass through the clearance without doing damage and the large particles cannot get into the clearance. The particles that are approximately the same size as the clearnace will get lodged in the clearnace and cause the machining effect. Unfortunately the smallest particle that can be seen with the naked human eye is forty microns. Particles that do damage to most hydraulic systems are in the range of three to twenty microns.

This diagram shows the relative sizes of various elements found in the environment. There is also a comparison of the micron to the inch.



RELATIVE SIZE OF MICRONIC PARTICLES
MAGNIFICATION 500 TIMES



RELATIVE SIZES

Lower Limit of Visibility (Naked Eye)	40 Microns
White Blood Cells	25 Microns
Red Blood Cells	8 Microns
Bacteria (Cocci)	2 Microns

LINEAR EQUIVALENTS

1 Inch	25.4 Millimeters	25.400 Microns
1 Millimeter	.0394 Inches	1.000 Microns
1 Micron	25,400 of an inch	.001 Millimeters
1 Micron	$3.94 \times 10.^{-5}$	.000039 Inches

SCREEN SIZES

Meshes Per Linear Inch	U.S. Sieve No.	Opening In Inches	Opening In Microns
52.36	50	0.0117	297
72.45	70	.0083	210
101.01	100	.0059	149
142.86	140	.0041	105
200.00	200	.0029	74
270.26	270	.0021	53
323.00	325	.0017	44
		.00039	10
		.000019	.5

A Micron is 39 millionths of an inch

II. Types of Contaiminants

There are two types of contaminants, Fluids and Solids. Probably the most destructive fluid contaiminant is "Air". It causes severe cavitation and can destroy a pump in a matter of minutes. The air which is usually dissolved in the fluid is pulled out of solution at the inlet side of the pump due to the pressure at the pump suction port being a vaccum. Small bubbles form when the air is pulled out of solution. At the pump pressure port, these bubbles collapse with explosive force which can actually rip small pieces of metal from the pump's housing and wear plates causing increased leakage. Higher the vaccum at the pump suction port, the greater chance that cavitation will occur. Therefore, the inlet vacuum should be reduced as much as possible by removing any restrictions in the suction line.

Mixing incompatible oils can result in a fluid contaminant. For instance if a mineral base oil is mixed with phosphate easter, seals will swell and sludge may form plugging critical openings and filters.Water, when mixed with certain automatic transmission fluids, can cause sludge and small hard crystalline particles to form. Brake fluids, when added to a conventional hydraulic system, can destroy seals. If volatile such as diesel, gasoline, solvents, etc. are mixed with hydraulic oil the viscosity will be reduced and damage to the system may occur due to lack of lubrication. With the exception of air, most fluid contaminants do their damage over an extended period of time.

Damage from solid contaiminants is immediate and depends on the size and number of dirt particles. Resilients such as teflon sealants, pipe dopes, pieces of O-rings and seals, etc., do their damage by plugging critical orifices in control and servo valves and by robbing close fitting parts of lubrication. Other solids such as rust, system wear particles, weld spatter, sand dirt, etc., do their damage by machining away metal in close fitting areas.

III. Sources of Contaminants

There are three general sources of contaminants:

1. **Built-in contaminants.** These are paritcles remaining in the system following assembly of the hydraulic system. They include, but are not limited to core sand, weld spatter, grinding dust, metal chips from manufacturing and assembly, lint, and airborne contaminants. It is the responsibility of the machine builder to remove these contaminants before shipment. One approach is to connect up a portable filtration device and circulate oil through the complete system until a predetermined cleanliness level is achieved. Another approach is to preclean all hydraulic system components prior to assembly and utilize "good housekeeping techniques" in the assembly area. The first method is preferred because it can remove contaminants that still may get into the system during assembly, even" with good housekeeping".

2. **Introduced contaminants.** These are foreign particles which enter the hydraulic system after the machine is completed and working in its particular application. Introduced contaminants are from the surrounding environment and enter the hydraulic system through fluid filter tubes, reservoir breather caps, air leaks past seals, and added new oil.

3. **Generated contaminants.** These contaminants are produced by the hydraulic system during normal operation. They include wear contaminants such as small pieces of metal, sealing materials etc. which result from wear on the moving parts of components within the system, Chemical reaction contaminants are the result of chemical reactions that can take place in the hydraulic system.

Air:

Source: Obviously air is nearly everywhere. Fish can live and breathe under water because oxygen from the air around us is dissolved in water. In the same way air is dissolved in water, there is air and oxygen dissolved in hydraulic oils. Water based hydraulic oils, such as water-glycol fluids, contain an exceptionally high level of dissolved gasses.

Hydraulic oil also contain varying degrees of entrained air. Entrained air can either be on the surface of the oil in the form of foam, or it can be in the bulk fluid in the form of tiny bubbles. For oil to foam or become aerated there must be some mechanical force to pump the air into the fluid.Solid and Liquid contaminants cannot cause foam, however they can change the surface tension of oil in such a way that foam is stabilized and foam inhibitors are no longer effective. We have very little control of the amount of dissolved air in oils. However some of the factors that cause entrained air are maintenance related:

- Low fluid levels
- Suction leaks
- Turbulence
- Contamination

Effects: Dissolved air plays an important role in oil oxidation. It can also be a factor in cavitation with water containing hydraulic fluids.

Entrained air can cause a variety of problems, including:

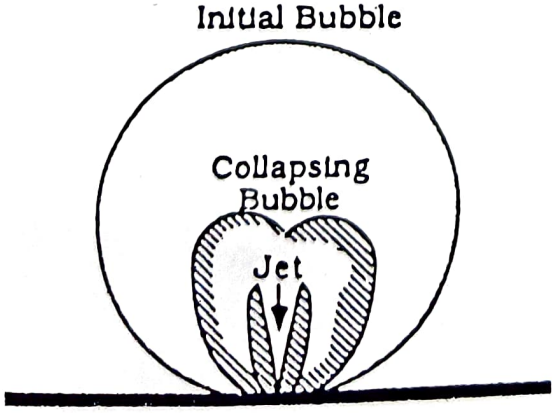
- Fluid losses due to overflow.
- "Soft" cylinder operation.
- Lubricant starvation.
- Accelerate oxidation.
- Cavitation.

Cavitation:

Cavitation wear is caused by high impact pressures created when vapor and gas bubbles in a liquid violently collapse due to gross changes in fluid pressures. Cavitation itself is a two step process.First, at low pressures a bubble or void is formed. After the void is formed, it implodes when it is subjected to high pressure. The bubble may be created by turbulence, by dissolved gasses drawn out of solution by a vaccum, or by formation of lubricant vapor when the pressure in the fluid falls below the vapor pressure of the lubricant. The best way to eliminate cavitation is to prevent the formation of bubbles in the hydraulic fluid. Some of the causes of cavity formation include:

- Inlet restrictions or leaks.
- Low temperature start-up.
- Foaming & aeration.
- Water contamination.
- Low vapor pressure fluids.
- Improper pump mounting.

A surface damaged by cavitation may have a frosted appearance or deep rough pits and grooves, depending upon the extent of damage. It is nearly impossible to eliminate sudden changes in liquid pressure (basic cause of cavitation) in some application, such as ship propellers. The cavitation damage resistance of a machine component can be improved by increasing the fatigue strength of the material.



Heat

Source: Most hydraulic systems are designed to operate at a bulk fluid temperature of 60° (140°F) or less. Many industiral systems are optimized to 50°C (120°F). A hydraulic component that is too hot to hold your hand on is probably hotter than 50°C (120°F). Below are some factors that contribute to high hydraulic system operating temperature:

- Fluid shear
- Internal leakage of pumps & valves.
- Sludge & dirt deposits.
- High ambient temperature
- Cooler malfunction

Effects: The oxidation rate of an oil doubles for every 10°C (18°F) increase in temperature above 60°C (140°F). An oil's viscosity is cut to half for every 10°C.From a practical standpoint then, an oil at 70°C (160°F) has half the life expectancy and provides half as thick an oil film as it would at 60°C(140°F). Other effects of high temperatures include:

- Seal hardening and oil leaks
- Adhesive & corrosive wear
- Additive degradation
- Copper corrosion
- Loss of demulsibility properties
- Oxidation & sludge formation

Although high temperatures lower oil viscosity, ultimately they can raise on oil's viscosity. This is because thick grease-like sludge is produced in high temperature lubricating oil oxidation.

Dirt

Every day we breath in dirt particles that can choke servo-valves and cause pump wear. That is why hydraulic reservoirs have breathers on them and we for the most part, breath unfiltered air.Some of the most common sources of dirt in hydraulic fluids include:

- Built in dirt
- Installed dirt from repairs
- New and make-up hydraulic fluid
- Cylinder rod seals
- Leaky breathers
- Wear debris

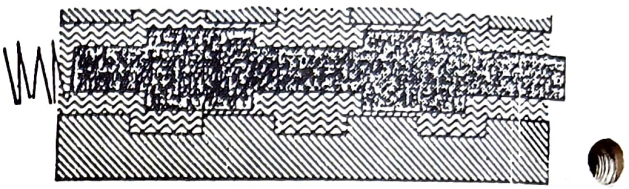
Particulate contamination is the number one source of hydraulic fluid related failures. Below are just some of the problems associated with contaminated hydraulic oils:

- Fatigue & abrasive wear
- Stuck valves & burnt out solenoids
- Accelerated oxidation & sludge buildup
- Plugged suction strainers and filters

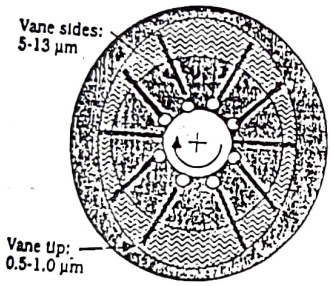
Particle Initiated Fatigue

ABRASIVE CONTAMINANTS

Hydraulic systems can't tolerate dirt. Tight clearance within a pump are necessary to transport fluid without leakage. Particles become trapped between the sealing surface of a pump and increase the pump's dynamic clearances through abrasive wear. This results in greater pump leakage, heat generation, and reduced efficiency.



Vane Pump Dynamic Clearnaces



Dynamic Clearnaces	
Gear pump	
Tooth to side plate	0.5-5Mm
Toothtip to case	0.5-5Mm
Piston Pump	
Piston to bore	05-40Mm
Cylinder to plate	0.5-5Mm

Clearances in hydraulic valves are extremely small to prevent leakage. Dirt can jam spools and cause solenoids to burn out. Contamination also can create quality control problems because it causes valves to perform eratically.

Typical Valve Dynamic Clearances

Servo Valve	1-4 um
Directional Valve	2-8 um

WATER

Water is present in air at levels as high as 3.5% weight. Water is also naturally present inoil at some equilbrium level. The water content of an oil varies with fluid temperature composition, and atmosphere conditions. Generally, inherent water concentrations in all are 500 ppm (0.05%wt.) or less. The sources of water contamination include:

- Condensation
- Metalworking coolants
- Improper oil storage
- Leaky coolers

Water contamination in oil based lubricants and hydraulic fluids dramatically decreases lubricant life. Additives used in oils are polar compounds that generally are active on metal surfaces. Water is a polar compound too. Therefore water-additive interactions tend to be significant. Water hydrolytically degrades oil additives. It can also cause them to be stripped out by filters and separators. Other effects of water contamination include:

- Cavitation
- Decreased oil film thickness
- Accelerated oxidation rates
- Corrosion & sludge formation
- Bearing fatigue

Bearing Fatigue Test Results

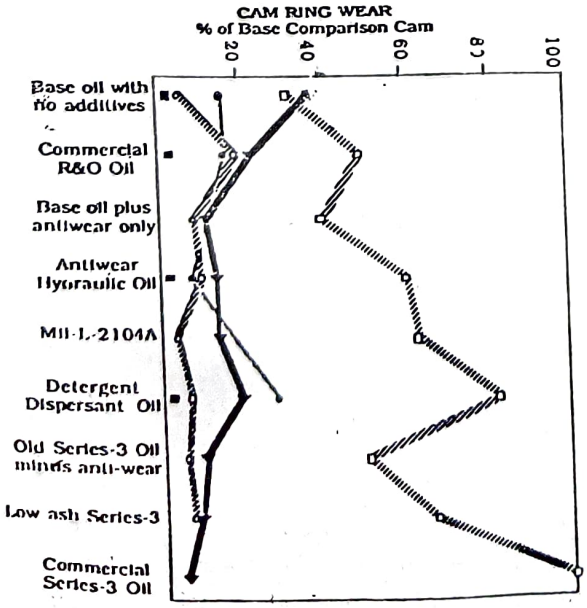
Lubricant	Water Concentration	Life Ratio
SAE 20	25 PPM	4.98
SAE 20	100 PPM	1.92
SAE 20	400 PPM	1.00

Effect of Dirt, Water & Lube Additives on Vane Pumps

A series of 24 hour vane pump tests conducted by Swain & Adams of Denison revealed a distinct synergism between the effects of water and dirt in vane pump wear rates. Neither water nor dirt alone produced as much wear as the combination.

Wear rates also appear to be related to oil composition. More sophisticated oils produced high wear rates when contaminated with both dirt and water. The most plausable explanation is that more sophisticated oils are more active on surfaces and promote a corrosion related wear mechanism. Water alone can produce troublesome wear, but not nearly as severe as when dirt is present.

- ○ Oil as received
- ♦ Oil as received plus 0.75 tap water
- □ Oil as received plus 0.75 tap water plus 0.04 g/gal dirt
- ■ Oil as received but dried with nitrogen
- ● 0.04 g/gal dirt added but dried with nitrogen



I. Detection of Contaminants

In order to determine it there are any contaminants in a hydraulic system, it is necessary to obtain a sample of fluid from the system that is representative of the fluid in the system. In order to do this two things are required.

1. A container to put the sample in and
2. A method of taking the sample of fluid.

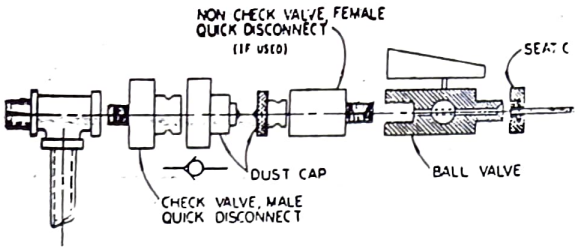
Probably the most important of the two items is the container. A container that has been specifically cleaned for this purpose must be used. Any old container lying around the shop simply will not suffice. Chances are it is dirtier than the fluid in the system. If a dirty container is used, the containants in the container will mix with the fluid sample and cause erroneous results. A good sample container exhibits the following:

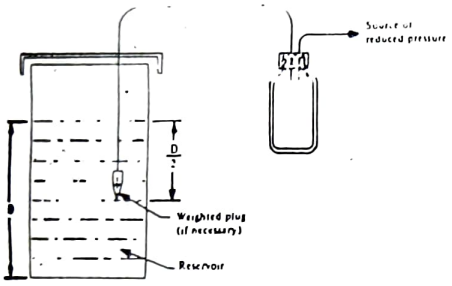
1. About 250 milliliter in size
2. Glass construction
3. Wide-mouth
4. Have a screw-on cap.
5. Have a plastic film between the cap and bottle.
6. Have a lable to write on.
7. Be cleaned and qualified in accordance with ISO 3722 Hydraulic Fluid Power Fluid Sample Containers Qualifying and Controlling Cleaning Methods.

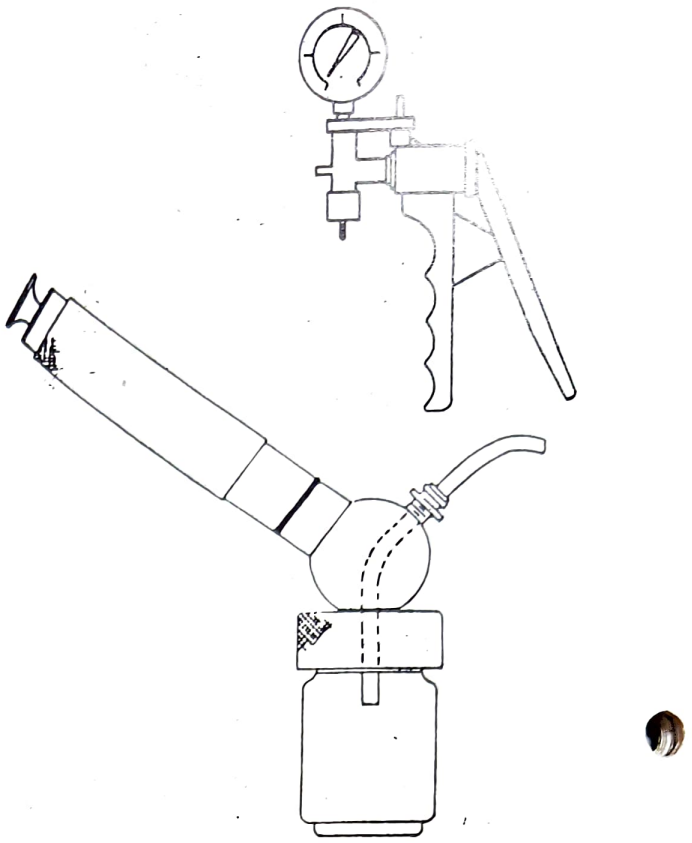
II. Currently two methods are used to draw a sample of fluid from the system. One method utilizes a sample tap installed in an area of turbulent flow in a low pressure line, usually a return line. The sample is taken while the system is running after it has been warmed-up and all circuits and actuators have been energized several times to insure complete mixing of the fluid in the system. The other method involves taking the sample out of the reservoir using a small syringe type pump to extract the sample and pump it into the container. As in the previous method, the system should be warmed-up and running when the sample is taken. More detailed information on obtaining a sample can be found in ISO 4021 Hydraulic Fluid Power Particulate Contamination Analysis Extraction of Fluid Samples from lines of an operating system.

III. Fluid Sample Testing ore

After obtaining a sample a visual inspection c
Holding the sample to the light will reveal an
than 40 microns. Water in the sample will
or milky. An extremely large numb







20,000 per ml greater than 10 microns may also give the sample a cloudy appearance. All fluids are different and they will not appear the same when a given amount of water or dirt particles are present. In order to obtain quantitative and qualitative results, the sample must be analyzed by a trained individual using very specilized equipment.

Listed below are various tests and their descriptions that can be performed on a fluid sample. Not all tests are performed on all samples. Testing depends on the type of fluid and the type of system that the sample come from and the requirements of the individual responsible for maintaining the system.

1. **Air content :** The entrained (not dissolved air) can be measured by removing it using a vacuum and measuring its volume. In order to obtain accurate results, this test must be conducted immediately after obtaining the sample. Therefore, it is always done" in house" which required equipment and trained personnel. This test is usually not performed unless severe aeration of the hydraulic system is occuring.

2. **Water content :** Water content can be measured in two ways. The first method use a centrifuge which measures the water mixed with the oil. (Held in suspension with the oil due to the additive package). The water is collected at the bottom of the centrifuge tube and its volume is compared to the total volume of sample originally placed in the centrifuge tube. The results are usually expressed as percent water by volume. This method is used where large amounts of water are present, usually 0.5 percent by volume and greater. The second method utilizes the Karl Fischer Titrometer which measures the total water present by determining the electrical conductivity of the sample when compared to a known reference. This method can measure the dissolved water and the water that is held in suspension. It is good for very small amounts of water, usually down to 0.01 percent by volume.

Water can be very destructive to a hydraulic-system therefore, it is a test that is run quite frequently if water is suspected contaminant.

3. **Clarity test:** A turbidity meter can be used to measure the relative amount of suspended particles, either fluid or solid in a sample, by comparing it to the virgin fluid using light blockage to a photocell. The color or clarity of the used sample is compared to the new oil. If there was a significant difference between the two colors, the fluid was generally replaced. This test does not confirm the type, size, and quantity of contaminant just that the used fluid has changed its color for one of various reasons. However, this test is an indicator that the fluid may have undergone irreversible damage. This test is not performed very much because in today's economy fluid cost is high, therefore, testing has to determine what the contaminant is so that the proper action can be taken to solve the problem and save the fluid by recycling or refining it.

4. **Filter patch test:** The patch test can measure the relative amount above a given size of solid particles by filtering measured amount of sample through a known pore size filter patch and comparing the patch color to a reference chart of weighing the patch before and after the sample is run through it. If the patch is weighed before and after, the results are usually given as mg of dirt per eitre of fluid which is known as the gravimetirc level. This is an industry accepted standard method. Further information can be obtained by examining the filter patch under a mciroscope. For instance the size distribution of particles can be estimated and the type of contaminants can also be determined i.e., aluminium, rust, pieces of o-ring, etc., using a trained eye.

5. **Particle count test:** The particle count is determined by passing the fluid sample through the sensor of a particle counter which is a sophisticated machine that can count particles in predetermined micron sizes which are usually selectable by the operator. Most particle counter can count and size particle in five or six different micron sizes simultaneously. Results are usually given as number of particles per ml greater than a given micron size. This is also an industry accepted standard for determining system cleanliness. Particle counting is probably the most common test that is run on fluid samples. For more information refer to ISO 4402 Method for Calibration of Liquid Automatic Particle counter Using "AC" Fine Test Dust.

6. **Infra-red spectrograph:** The Infra-red spectrograph can detrmine the type and relative amount of liquid contaminants or additives in the sample by passing light whose wavelength is varied across the infra-red spectrum through the sample. The amount of light absorbed by the sample is measured at each wavelength and since each chemical compound has its own characteristics wavelength it can be identified. This test is performed when liquid or other chemical contaminants are suspected. The results of the infra-red scan indicate whether or not the fluid sample has changed chemically. Usually the virgin fluid is run first in order that a comparison can be made between the used and new fluids.

7. **Atomic absorption spectrograph:** The actomic absorption spectrograph measures the amount of each metallic chemical such as iron, copper,lead, zinc, silicone, aluminium, tin, nickel, chromium, etc. A light of fixed characteristic wavelength for the chemical element being tested is passed through the sample which has been essentially vaporized by an extremely hot flarne. The amount of light absorbed indicates the quantity of that chemical element. The results are usually presented as parts per million (ppm) by weight. Atomic absorption spectrograph is performed on a wide variety of samples to determine wear metal contents in order to predict which component may be undergoing irreversible degradation and possible catastrophic failure.

Reduction of Contaminants in Hydraulic System:

There are three ways to reduce contaiminants in hydraulic systems.

1. Design
2. Prevention
3. Filtration

The level of contamination can be reduced by proper system design. For instance, the system can be sealed to keep dirt out, the reservior can be slightly pressurized to prevent dirt from entering, filtering type breather caps can be used, and better shaft and rod seals could be used.

Preventing contaminants from being added to the system is a little more difficult because the "human factor" is usually involved. However, requiring the use of pipe plugs, tube caps, etc. during diassembly, assembly operations for repair or routine maintenance operations and requiring the use of portable filter buggy when adding or replacing fluid are two methods of preventing contaminents from entering the system **Banning shop rags and replacing them with throw-away lint free paper cloth is another method. A pump has a much better chance of surviving bout with a paper cloth than a cotton one.**

After the contaiminant is already in the hydraulic system, the only way of remove it is likeby fltration.

By Courtesy **M/S Fluid Power Society of India. Bangalore**

SYSTEMATIC MAINTENANCE OF SWITCHES & OPTIMISING THE POTENTIALS OF 'UNIMAT' TAMPERS

S. Devaguru Prasad*
Foreman, S. Rly.

Synopsis

Maintenance of Points and Crossings by Machines gives higher precision of Track geometry. This paper describes method of maintenance of switches by 'UNIMAT' Tampers, operations involved, problems faced and makes certain recommendations for improved performance.

1. Switches and crossings represent a considerable portion of the fixed assets of Railways and they form an expensive and heavily-stressed element in the track network requiring intensive maintenance.Defects in constructions, even quite insignificant errors in geometry, can result in the occurrence of hgh dynamic forces leading to further amplification of geometry faults and pre-mature wear. In such a context and more so, with the adoption of prestressed concrete sleepers for turnouts, the logical corollary is the need for the deployment of up-to date machine systems equiped with precision levelling & lining devices and their systematic use for bringing out their optimum potential.

   The Unimat Switch tamping machines of 08-275 series from Plasser introduced in Indian Railways help meeting these challenges. Let us first have a glance of their design, features for better appreciation of their built-in-capacity.

2. Nuances of unimat switch tamping machine:

2.1 These are basically self-propelled machines, 8 wheeler with bogie type chassis of robust construction and suspension system of coil spring, shock absorbers and megi-springs. The speed potential under its own power is 80 kmph provided by ZF Gear box driving arrangement with hydrodynamic, and hydraulic-drive for work drive circuit.

2.2 The machine is basically designed for lifting, levelling, aligning and tamping of the track with the tamping bank providing for sixteen tamping tool sockets for single sleeper tamping at a time.

2.3 The tamping banks have an additional facility for lateral sliding to suit the location of the work and the tamping tool arms have a tilting arrangement when the tools are likely to infringe the rail in switches and corssings.

2.4 The LH and RH units can be operated independently also.

2.5 The machine is equipped with a standard proportional levelling system with the front, intermediate and rear feelers for measuring and controlling the lifts and with a chord wire stretched taut forming the datum for longitudinal levelling, the lift being fed through proportional transducers. Two electrical pendulums bridging the two rails in the front feeler and tamping zone takes care of the cross level corrections.

2.6 The popular single chord lining system takes care of the versine adjustments. The automatic mode for bringing uniformally acceptable pattern of versines and the design mode for obtaining exactly calculated slews help cent percent versine corrections.

It must however be remembered that this lining system is applicable only for circular curves and the machine system treats every stretch of track as a curve (the straight track with zero versines being deemed as a curve with infinite radius). It is in this context, that while working transition portions, of curves of varying radius necessary compensations have to be applied as would be deduced from the readily available charts for the corresponding radius and lengths of transition.

These compensation values are called 'v' or 'f' values and this principle will have to be extensively applied, with the ingenuity of the operator in various compound curve layouts, as obtained in the switches and crossing assemblies, as explained in para 4.5

2.7 Combined lifting & lining units: The unit consists of a 'rail going car' with two lining rollers and a laterally displaceable lifting hook per rail and two roller clamps for each rail.

The roller clamps help in lifting plain track and the hook

in switch areas for lifting the rail at bottom of [illegible] at the bottom flange level. The lifting/lining actions are applied through hydraulic cylinders.

2.8 The Plasser's pressure vibration tamping in accordance with the non-synchornous constant pressure tamping principle help achieving uniform consolidation.

3. Additional Features in the latest model 08-275-3S machines:

3.1 The tamping tool pairs can be tited towards the centre line of the rail or away steplessly up to a maximum of 15° inwards and 85° outwards. In practice, this helps the tools being adjusted selectively and multi-laterally to optimum convenience to suit locations.

3.2 The tamping units are slewable to ± 8.5° and this facilitates a problem-free tamping of sleepers lying in slanting position.

3.3 A synchronous three rail additional lifting unit (connected via cable to a telescopic beam) helps to lift the third rail also. (Which has to be supported by blocks and given kutchapacking for maintaining the levels) Main line fittings are not over stressed.

4.0 Sequencing of Operations:

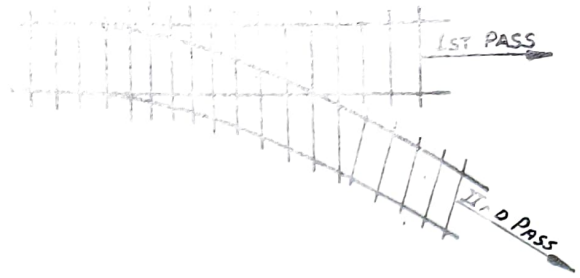
A natural process in tackling the switches and crossings is to first level, align, tamp the mainline portion and then come to turnout portion where 'tamping' only is resorted to as further corrections may disturb the level in the mainline already achieved. The sequences prescribed for different layouts have been shown in sketch.

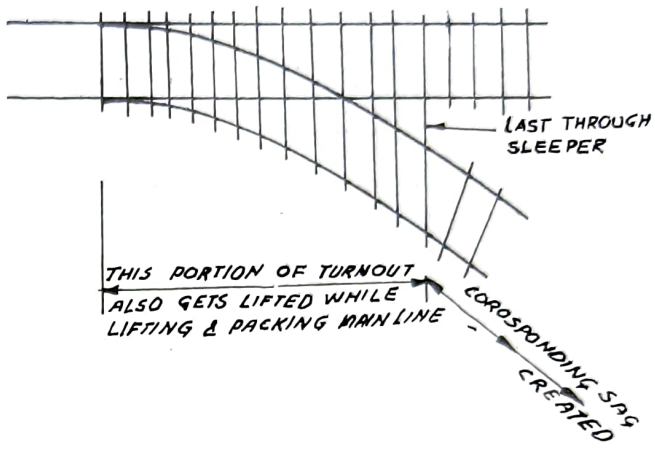
However a lot of ingenuity on the part of the operator is necessary to get best results from these machines. Let us discuss certain typical layouts.

4.1 It is now well known that the machine has to work in a P & C in two passes-one to correct the cross level, surface and alignment on the mainline portion, the other to pack the turnout without disturbing any parameter that has been already corrected for the mainline.

4.2 As the main line track is lifted and slewed, this will have considerble effect on the turnout, particularly.

a) In back of common sleeper turnout will have some sag (atleast) and this depends mainly on the lift given for the main-line portion of the point.





If the lift on the mainline portion is more, then sag will also be more.

b) Similarly, if the slew on the mainline portion is more, then alignment variation in this portion of the turnout will be more.

4.3 Any defect (surface or alignment) in the mainline portion of the point can be attended in the same manner as we do for any other track using Viseur and Miyeor or any other method.

But the subsequent kink and sag in this portion of the turnout has to be corrected with the machine carefully.

4.4 In this regard, the direction of working of the machine plays an important role. As we may not be able to change the direction frequently, alternative methods have to be resorted to, to ensure quality work.

a) Sag in this portion of a turnout:

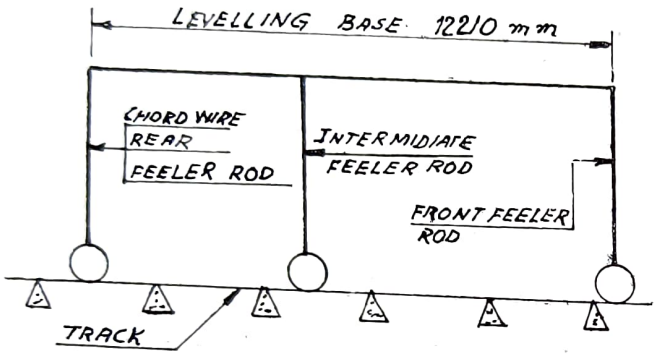
By Simple logic, this sag is likely to be the amount of lift already given for the mainline portion of the point.

But if the P&C is newly laid (or) was having sag on the turnout already-it is better to measure it with an optical instrument.

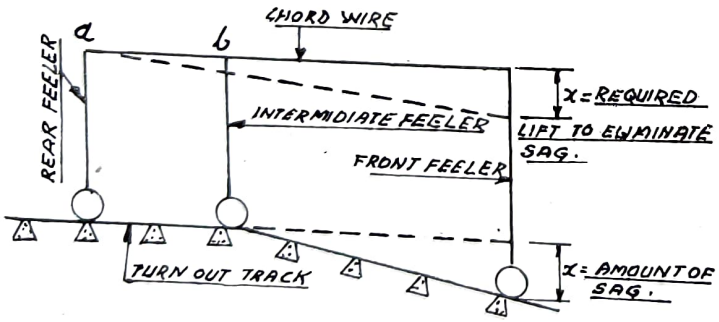
The machine levelling system itself can also be used for measuring this sag. As mentioned earlier, the machines levelling system has three sensing elements for surface defect.

1) Front feeler rod
2) Intermediate feeler rod
3) Rear feeler rod.

A levelling chords wire stretched between measuring and front feeler rods just works like any optical instrument. The centre feeler rod is the sensing element for the lift achieved.

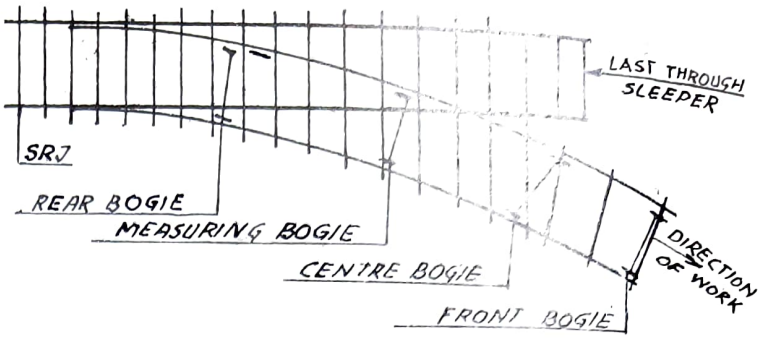


Simply, if the measuring and front feeler rods are kept in an ideal track, the centre feeler will sense the surface defect within that levelling base. In this portion of turnout we can place the measuring feeler rod and centre feeler rod on the turnout rail & front feeler on the approach to it.



As the machines employ single chord lining system only, the process becomes much easier. We can apply the four pt. lining system to this process.

i) In case the machine works, in direction of SRJ to heel of crossing



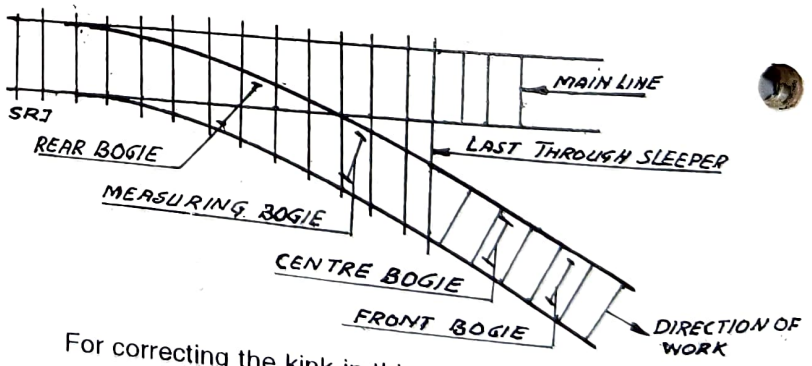
Since the measuring and rear bogie are in an ideal track the machine automatically senses any defect on the approach of the turnout using the centre bogie.

Care has to be taken to switch on the lining automatic system only when the centre bogie is out of the last through sleeper. The versine compensation for machine to work on curves without transition should be followed to achieve 100% results.

This method has been followed at Tinnappati yard while working on a newsly laid PSC turnout and found good.

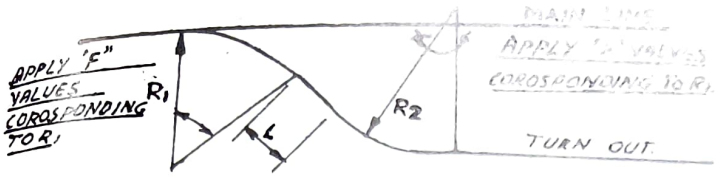
ii) In case the machine works in the direction of heel of Xing to SRJ :-

This is more complicated due to the fact the machine is going to align this portion and merge it with the turnout exactly at the last through sleeper.



For correcting the kink in this portion of turnout, the following parameters will be required.

1) R1 = Mean radius of the turnout.
2) R2 = Radius of the connecting curve.
3) L = Length of straight track between them.
4) X = Amount of kink = Amount of slew already given for the main portion of the point.



Here, the machine will work the connecting curve first and pass to the in between straight portion and on to the (reverse) turnout curve.

Simply the machine cannot accept reverse curves within its lining base.

If allowed to work on the automatic mode of the 4 point lining system, the machine will slew in such a way as to create a straight portion of at least the length of its lining base between the reverse curve.

Hence, here also the compensation 'F' values for working on curves without transition has to be applied both for turnout curve and the connecting approach curve. And also the amount of kink should also be fed to the machine. This will give 100% results.

Summary of Recommendations:

1. General pre-tamping attention as applicable for plain track i.e. to ensure 'tight-fastenings' and adequate clean ballast cushion and replacement of resilient pads is necessary.

2. The lift should be minimum 10 mm at the high points. The lift is decided depending upon the position of the switch and 15-25 mm lifts give out best results.

3. When the levelling is poor a longer distance in the approach is taken up for maintenance so as to get better results.

4. While tackling the mainline portion, the turnout portion also gets lifted via 'thorough sleepers' and hence adequate supporting by jacks, wooden blocks is necessary so that subsequent with one round of tamping the turnout, the work could be completed without disturbing the already corrected mainline portion.

5. When heavy sags/dips are noticed in the crossing portion, supporting the crossing with blocks and special treatment may be necessary.

6. Generally the mainline (crossing & switches) should be tackled in one pass. In case of inadequate time, when the switch is not tamped completely this part of switch should be supported with wedges and kutcha packing should be ensured.

7. The manufacturers have recommended the various sequences to be followed in tackling a points and crossing assembly for good results. These have been shown in the following Sketch. These sequences may have to be followed up scrupulously.

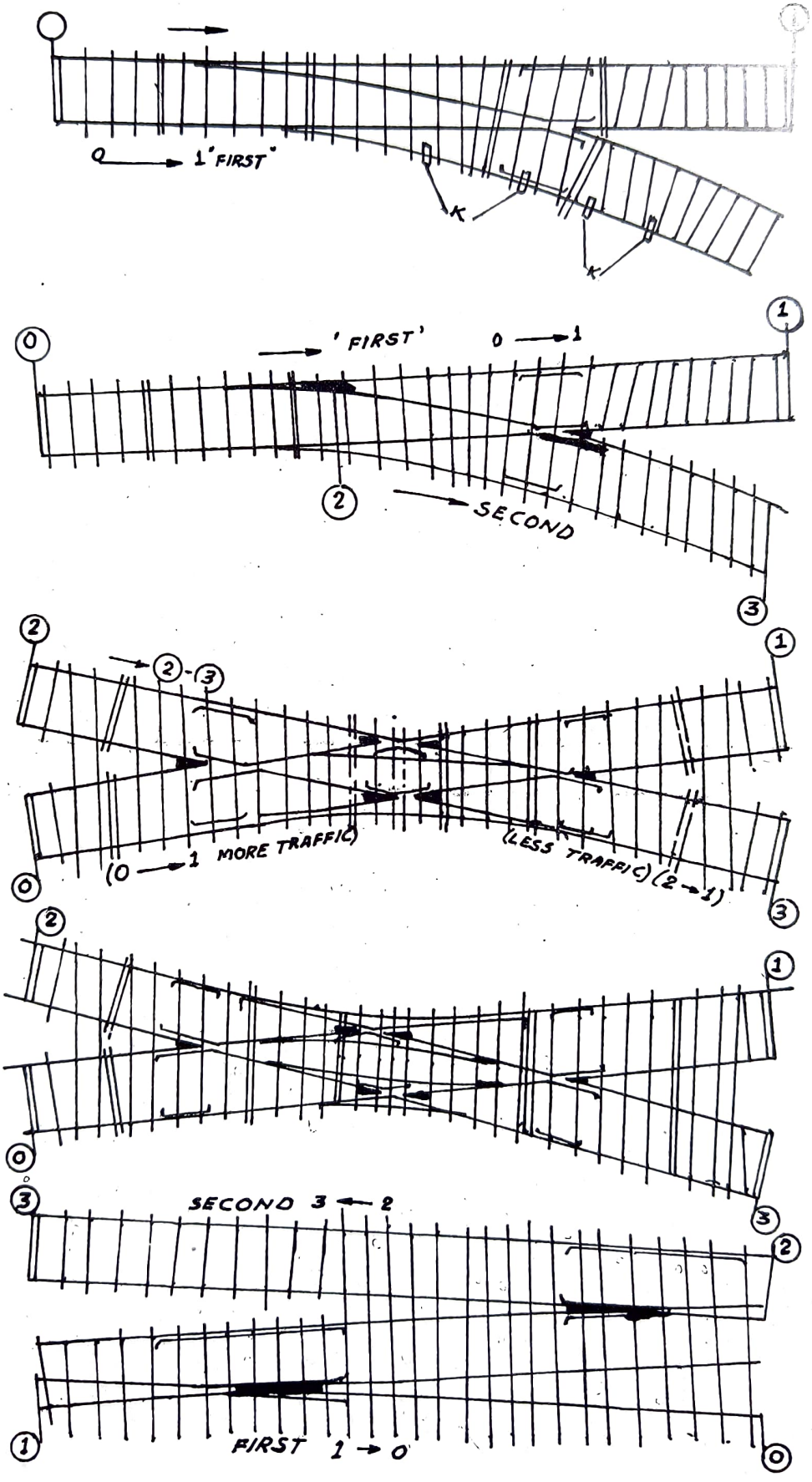
8. There must be absolute interaction and pre-planning between the machine staff and permanent way staff in tackling complicated layouts as 'v/'f' values may have to be applied as already explained for better results.

   The co-operation of 'S&T' staff also is equally necessary in attending to the turnouts as heavy 'lifting' may affect the operation of Points and resetting of point motors may have to be done for their trouble-free functioning. Availability of a walkie-talkie is a mustfor contacting the station/centre for extension of blocks.

9. Sufficient wooden blocks/shims, jacks and power tools like 'Kango' tampers etc. for kutcha tamping in the portions uncovered by machines should be available till such time further improved models with 4 rail tamping (4S model) are available.

10. The lateral movement facility of tamping banks, provision of lifting hooks and operating inner/outer clamps according to the needs, alignment corrections of even sharper curves of 7°-8° ranges etc. Improve the manouvreability of this machine making it versatile and useful for multivarious jobs, which by proper utilisation, could be made into a precious assest for Track Maintenance.

SEQUENCES OF TAMPING



DO YOU KNOW

Manohar Singh
V. Principal
IRTMC

1. Conveyor ends are damaged due to [illegible] board rubber.
2. Chain conveyors of FRM-80 are damaged due to dropping of ballast between skirt board holding steel plates and converyor.
3. To avoid damage to conveyor cover scrappers should work effectively and to be adjusted time to again.
4. Conveyors should not be exposed to excessive heat and rain. The machine should be covered with tarpauline after stabbling.
5. Any damage of conveyor cover should be immediately repaired with portable valcaniser to avoid excessive damage to conveyor by ingress of moisture.
6. Bearings of vibration shaft of tamping unit for all the tamping machine i.e. 06-UT, 08-DUO, & UNO, 09-CSM, 08-Unimat 2S&3S are same.
7. The only difference in vibration shafts of all machines is at end mountings only.
8. The combination of pumps and motors for drive of vibration shaft for different TT, machines is :

Type of Machine	Pump GPM	Motors GPM	Pressure Setting
06-UT	17	14	140
08-UNO	20	17	150
08-DUO	38	35	150
08-UNIMAT 2 S	20	17	150
08-UNIMAT 3 S	25	22	150
09-CSM	38	35	150

9. Short wave defects in surfacing can be removed in proportional levelling but long wave defects can be removed only in Target (Design) mode.
10. False curve in Alignment can only be removed by machine in design mode.
11. Goose Neck at entry and exist of curve are formed during lining in sharp curve i.e. 3° and above if 'V' values are not fed.
12. The tamping unit is damaged by vibration if counter pressure is not switched on before putting on vibration circuit.
13. The counter pressure for the following machine :

Type of Machine	Sq. Cyld.	Counter Pressure	Pump which supplies flow
06-UT	Male & Female	120-140 as per system pressure	38 GPM
08-UNO	Male & Female	130-140	38+17 GPM
08-DUO	Male & Female Big. Sq. Cyld.	130-140	38+17 System pump
-do-	Male & Female Small Sq. Cyld.	35	17 GPM pump
08-2S	Male & Female	150	22 GPM pump
08-3S	Male & Female	180	Axial piston pump
09-CSM	Male & Female Big.Sq.Cyld.	150	17 GPM pump
-do-	Male & Female Small Sq.Cyld.	35	2nd 17 GPM pump.

14. To avoid damage to the hydraulic pumps the Hydraulic oil should be brought to working temprature before operation, (Never less than 40°C)
15. The oil can be heated by running the engine at 1500 RPM and keeping control cock to switch on the pump, just loose by one turn and the vent cock fully open.

EDITORIAL

Dear Reader, 11th issue of IRTM digest is now with you. To provide exhaustive, sound, upto date theoretical and practical knowledge and indepth study of failures of track machines taking place throughout Indian Railways, the 'Volume of this magazine was increased from 8 pages to 24 pages. Quality and the volume of this digest can be maintained only when IRTMTC receives articles on latest developments, experience and failures encountered by concerning ranks of officers and staff in operation, running maintenance and overhauling of track machines.

Through trainees attending this training centre, it was gathered that the copy of the digest is not reaching concerning supervisors deployed with machines. It is requested to ensure that copies of this magazine is sent to all concerning staff to take maximum advantage out of published articles.

Thanks

M.M. Banerjee
PRINCIPAL

NOTE : IRTMC ACCEPTS NO RESPONSIBILITY FOR THE VIEWS EXPRESSED BY THE AUTHORS.

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