

SUB : TRACK MACHINE & WORKING PRINCIPLES

Duration: 22 Sessions = 44Periods

Sub Discipline: Track Machines (Lessons: 01 Sessions: 01)

Lesson-I: Types of Track Machines **Session-1:** Introduction of Track Machines in Chronological order, their functions and output.

Brief History of Introduction of Track Machines Worldwide:

World over first mechanical off-track tamper was tried out around 1920, which was doing packing only. First On-Track Tamper was produced by Matissa of Switzerland which was founded in the year 1945. It produced and marketed only one type of tamper, model B-60. Plasser and Theurer established their works at Linz Austria in the year 1953 and produced their first hydraulic tamping machine HGL for use on Austrian Federal Railways. They came into regular production line for the first tamping machine VKR 01 in Cantilever design from 1955 onwards. Further, evolution of track machines is given below:

- 1960: First leveling & tamping machine VKR 04
- 1962: First switch tamping machine with tilting tamping tools WE 75
- 1963: First automatic lining machine with two chord measuring technique
- 1964: First hydraulic ballast cleaning machine RM 62
- 1965: First two sleeper tamping machine Duomatic
- 1970: First leveling & tamping machine in 07 series
- 1972: First leveling, lining & tamping machine for switches 07-275
- 1973: First welding machine K355APT
- 1975: Dynamic Track Stabilizer - a new technology for stabilization of tracks
- 1983: First continuous action tamping machine 09 CSM
- 1996: First continuous action 3 - sleeper tamping machine came into existence

THEIR FUNCTIONS AND OUTPUT:

TYPE OF M/C	MODEL NO.	YEAR OF INTRODUC ON IR	FUNCTIONS	RATE OF PROGRESS / EFFECTIVE HOUR
Tamper single sleeper	08-16-Unomatic	1985	Correction of Longitudinal level, Cross level and Alignment	800 to 1000 Sleepers
Tamper Double Sleepers	08-32-Duomatic	1986	Correction of Longitudinal level, Cross level and Alignment	1400 to 1600 Sleepers
Continuous Tamping Machine	09-32-CSM	1989	Correction of Longitudinal level, Cross level and Alignment	2200 to 2400 Sleepers
Tamping Express Three Sleepers	09-3X-CSM	2000	Correction of Longitudinal level, Cross level and Alignment	2800 to 3500 Sleepers
Tamper Double Sleepers	08-32-New Duomatic	2003	Correction of Longitudinal level, Cross level and Alignment	1800 Sleepers
Russian Tamper Double Sleepers	VPR-02M-18	2004	Correction of Longitudinal level, Cross level and Alignment	2000 Sleepers
Points & Crossing Tamper	07-275-Unimat	1984	Correction of Longitudinal level, Cross level and Alignment.	1 Turnout in 90 min.
Points & Crossing Tamper	08-275-2S Unimat	1990	Correction of Longitudinal level, Cross level and Alignment.	1 Turnout
Points & Crossing Tamper	08-275-3S Unimat	1993	Correction of Longitudinal level, Cross level and Alignment.	1 Turnout
Multi Purpose tamper	Unimat Compact-M	1998	1. Correction of Longitudinal level, Cross level and Alignment. 2. Used for lifting loads.	1 Turnout or 600 sleepers on Straight
Dynamic Track Stabilizer	DGS-62N/62-PLS	1990	Controlled settlement of ballast.	1 to 2 Km/hr.
Ballast Cleaning Machine	BCM	1970	Screening of Ballast in plain track.	-
Ballast Cleaning Machine	RM-80	1989	Screening of Ballast in plain track.	650 Cum/hr.
	KBC-600			
Ballast Cleaning Machine for Points & Crossing	RM-76	1992	Screening of Ballast at points and crossings.	550 Cum/hr.
Shoulder Ballast Cleaning Machine	FRM-80	1992	Screening of Ballast in shoulder.	550 Cum/hr.
	KSC-600	1986		
Shoulder Ballast Cleaning Machine	FRM-85	2004	Screening of Ballast in shoulder.	550 Cum/hr.

SUB DISCIPLINE: TAMPING MACHINES (LESSONS: 06 SESSIONS: 07)

Lesson-I: 08-Unomatic/Duomatic **Session-2:** Main features, Main assemblies and components, Working Principle and Power Transmission.

08 UNO-DUO

MAIN FEATURES:

- 2 bogies of 2 - 2 axles
- Main gear box – mechanical (6 speed gear box)
- Fully electronics control machine
- Tamping units up & down proportional control
- Single chord lining system.
- Maximum permissible speed 60kmph
- Output UNO -800 – 1000 slipper/ hour duo 1400 – 1600 sleeper/ hour

MAIN ASSEMBLIES AND COMPONENTS:

CHASIS: It is welded construction out of steel girders, channel and sheets etc.

UNDER CARRIAGE: M/c is equipped with two-2 axles bogies with axles.

ENGINE: Kirloskar, Cummins diesel engine, six cylinder vertical water cooled, turbo charger modern n .t. 743 C. Output: 243 hp at 2000 rpm.

TAMPING UNITS: Unomatic model have 16 tools and duomatic model has 32 tools.

HYDRAULIC SYSTEM:

PUMP:

DUO : 3 DOUBLE PUMPS

1. **38 × 17 GPM** combined deliver to system
pressure of 120 to 140 bar.
2. **38 × 17 GPM**
38 GPM = vibration (one side) pressure 150 bar
17 GPM = counter pressure 35 bar
3. **38 × 22 GPM**
38GPM = vibration another side pressure 150 bar
22 GPM = hydraulic cooler motor pressure –50bar

UNO: - 3 DOUBLE PUMPS

1. **38 × 17 GPM** =combined for system pressure
adjusted 120 - 140 bars
2. **20 × 17 GPM**
20 GPM = vibration (one side) pressure 150 bar
17 GPM = hydraulic oil cooler pressure 50 bar
3. **20 × 22 GPM or 20 × 17 GPM**
20 GPM = vibration another side pressure 150 bar
17 GPM = hydraulic oil cooler pressure 50 bar.

HYD MOTOR = 5 nos

Vibration motor = 2 nos

Driving motor = 1 nos

Hydraulic oil cooler motor = 2 nos

ACCUMULATOR: 32 liters capacities N₂ pressure 85 bars for system pressure on both uno & duo.

Two 1.6 liter capacity N₂ pressure 20 bar for counter pressure are provided on duo only.

PROPORTIONAL VALVE	: 2nos for tamping unit up/down control
SOLONOID VALVE	: uno-16 nos; duo-18 nos
HAND OPERATED VALVE	: 01 no
CYLINDERS	: uno-30 nos; duo-38 nos
HYDRAULIC OIL COOLERS	: 02 nos
SUCTION FILTERS	: 03 nos
RETURN FILTERS	: 02 nos
PRESSURE FILTERS	: 01no
PRESSURE CONTROL VALVE	: 09 nos
PRESSURE REDUCING FILTER	: 03 nos
FLOW CONTROL VALVES	: 08 nos

PNEUMATIC SYSTEM:

Compressor	=	01 no	500 liter/minute
Unloader valve	=	01 no	pressure adjusted 7 bar
Air tank	=	02 nos	capacity 100 liters each
Brake cylinder	=	02 nos	dia 12 inch each
Cylinder	=	43 nos	off sizes.

WORKING PRINCIPLE:

1. DRIVING SYSTEM:

RUN DRIVE: 6 speed gear box is provided for driving station to station.

WORK DRIVE: hydraulic motor is provided for work drive at constant speed.

2. TAMPING UNIT:

This is first tamping machine on which proportional valves are provided for smooth and jerk less up and down.

3. LINING:

- This is first tamping machine on which single chord lining systems are provided.
- 4 point lining is called smoothening mode and
- 3 point is called precision mode.
- Design lining is possible in each mode for which offset value is fed.

4. LEVELLING

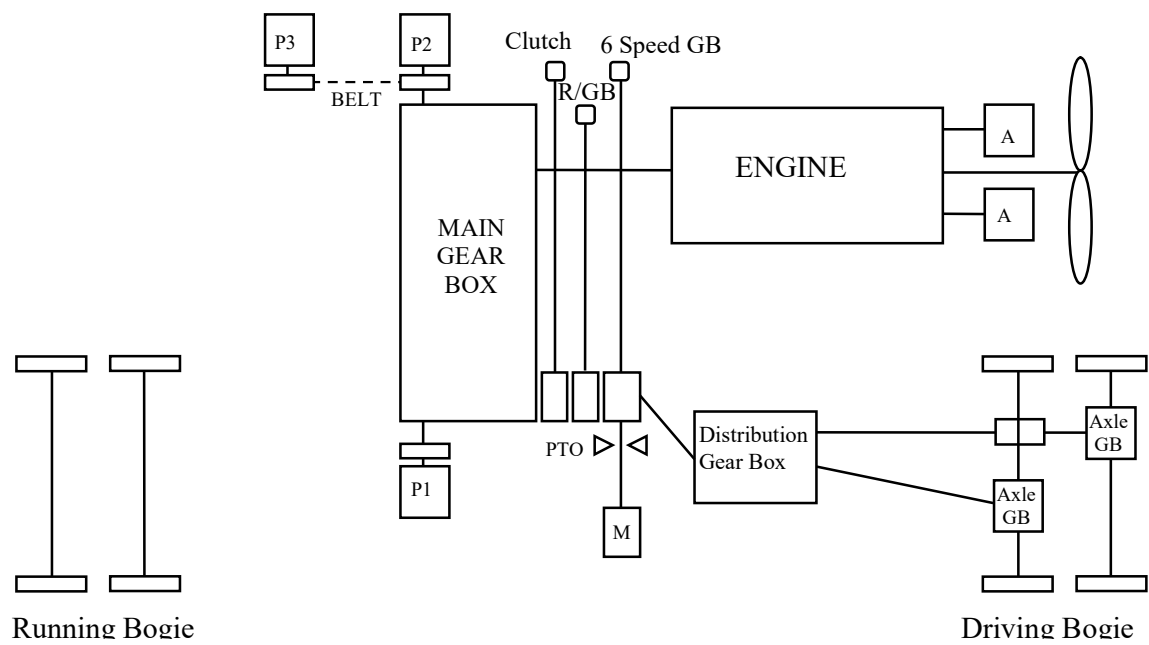
- Double chord follow up systems are provided on this series machine.
- In this method one rail is kept base line and other line is cant line.
- Cant side chord follow up base line to maintain the level of the chord with the help of front pendulum. This machine is design for cross-level correction.
- The leveling may be done by proportional mode or design mode.

BASE LINE SELECTION

ON SINGLE LINE: a good or higher rail is kept base line

ON DOUBLE LINE : non –cess rail is kept base line

POWER TRANSMISSION



SUB DISCIPLINE: TAMPING MACHINES (LESSONS: 06 SESSIONS: 07)
Lesson-II: 09-32 CSM Session-3: Main features, Main assemblies and components,
Technical data.

09 -32 CSM

MAIN FEATURES:

- Machine have in two parts i.e. Main frame & satellite
- Main gear box—ZF -- (4 speed gear box).
- Programmable logic control (PLC) machine.
- Automatic data deeding by computec (gva) only five machine.
- Laser lining (only on 5 machine)
- Lining & lifting servo control.
- Fully auto working mode
- 3- channels. data recorder, (after work)
- Twist correction.
- Maximum permissible speed 60 kmph (by RDSO)
- Output - 2200 to 2400 sleeper/hr.
- Multicheck system.

MAIN ASSEMBLIES AND COMPONENTS:

- | | |
|-----------------------------|----------------------------|
| 1. Satellite | weight 14 ton |
| 2. Main frame | weight 50 ton |
| 3. Engine | mwm 232 tbd 12 v @ 473 bhp |
| 4. Tamping units (duo type) | 32 tools |
| 5. Lifting & lining units | |
| 6. ZF gear box | 4 speed gear box. |

HYDRAULIC SYSTEM:

PUMP: 5 PUMP (4 DOUBLE PUMPS + 1 VARIABLE PUMP)

1. Double pump = **38×22 GPM** combined for system pressure adjust **120-140 bar**
2. Double pump = **38 × 17 GPM**
38 GPM = vibration (one side) pressure **150 bar**.
17 GPM = high pressure **150 bar**
3. Double pump = **38× 17 GPM**
38 GPM = vibration (another side) pressure **150 bar**;
17 GPM = counter pressure **35 bar**.
4. Double pump = **20 × 17 GPM or 20 × 114 GPM**
20 GPM = 2 hydraulic coolers motor pressure **50bar**
17 GPM = radiator + ZF oil cooler pressure **50 bar**.
5. Variable pump. = **90 lpm**, driving pressure **210 bar**
6. Charging pressure = **30 bar**.

MOTORS: 8 NOS

- | | |
|----------------------------|---------|
| Vibration motor | : 2 nos |
| Driving motor | : 2 nos |
| Hydraulic oil cooler motor | : 2 nos |
| ZF + radiator motor | : 2 nos |

ACCUMULATOR: 4 NOS

1. 32 litre capacity N₂ pressure 85 liter for system pressure – 1 no
2. 20 lts capacity N₂ pressure 100 liter for high pressure - 1 no
3. 1.5 lts capacity N₂ pressure 20 liter for counter pressure - 2nos

PROPORTIONAL VALVES: 3 NOS

Tamping units up/down control	=	2 nos
Satellite movement	=	1 no

SERVO – VALVE: 3 NOS

Lifting	=	2 nos
Lining	=	1 no

SOLENOIDS: 22 nos solenoid valve

CYLINDERS: 50 nos

SUCTION FILTER: 3 nos

RETURN FILTER: 2 nos

PRESSURE FILTER: 3 nos

PNEUMATIC SYSTEM:

➤ Twin cylinder compressor	: capacity 600 cm/minute
➤ Unloader valve	: 1 no pressure adjust 7 bar
➤ Air tank	: 2 nos capacity 100 liter each
➤ Brake cylinder for main machine	: 2 nos dia 12 inch.
➤ Brake cylinder for satellite	: 2 nos dia 8 inch.

Pressure cylinder : 56 nos off sizes.

TECHNICAL DATA:

➤ Overall length	-	27640 mm
➤ Height above rail level	-	3600 mm
➤ Width	-	3040 mm
➤ Wheel dia	-	730 mm
➤ Total weight	-	64 ton

Minimum radius working - 100 m

WORKING PRINCIPLE:

DRIVING SYSTEM:

WORK DRIVE: During work machine is driven by variable pump with variable speed 0 to 2 kmph. but satellite drive is proportional drive. the speed of satellite varies with the main frame speed.

RUN DRIVE: Hydro dynamics gear box (ZF) is provided on the machine.

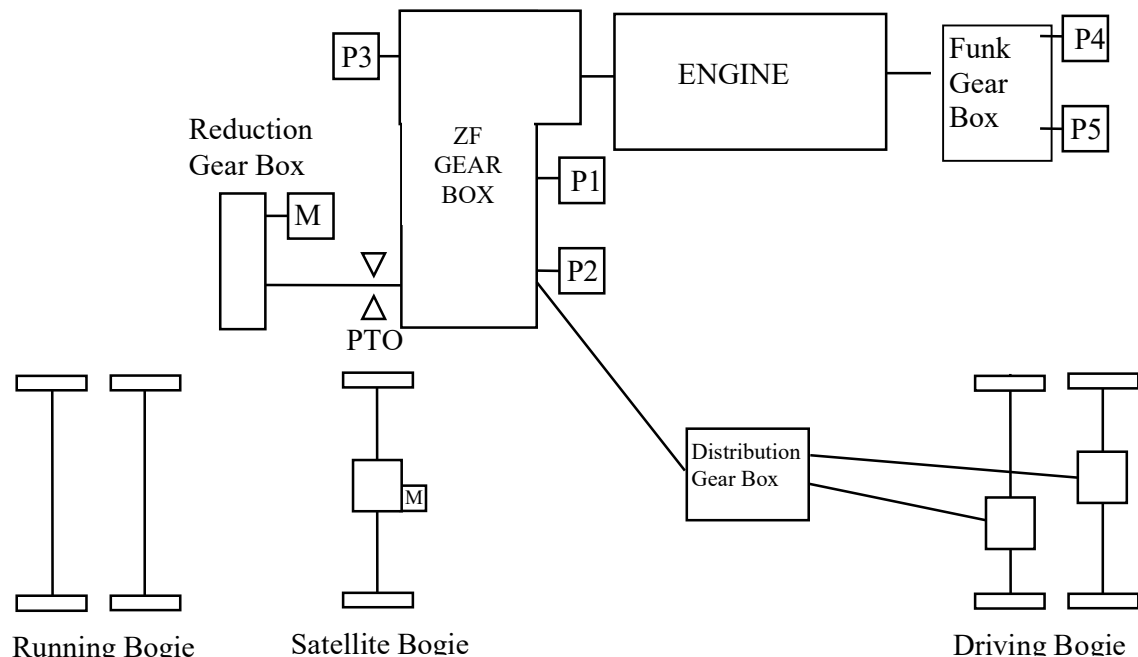
LINING: Single chord lining system is provided on CSM few machine (only 5 machines) are provided laser lining systems.

LEVELING: On this machine fixed chord double chord leveling is provided. this machine is designed for the twist correction for that rear pendulum is given.

RECORDER: 3 channel recorders are provided on each machine to recorder the parameters i.e. versine, cross level and lift value after work.

GVA: Geometrical value assessment computer is provided on only first five CSM. computer feeds the required data to the machine automatically with respect to distance. linear feeding is only possible in this method.

POWER TRANSMISSION:



SUB DISCIPLINE: TAMPING MACHINES (LESSONS: 06 SESSIONS: 07)

Lesson-III: 08-275-2S UNIMAT **Session-5:** Main features, Main assemblies and components, Working Principle and Power Transmission.

08 – 275 UNIMAT

MAIN FEATURES:

- This machine has got 16 tamping tools .which can be tilted.
- Main gear box - ZF
- Three cabins i.e. front, rear & working
- PLC control
- Multicheck system
- Two operators required in working cabin.
- Double chord fixed leveling system.
- Hook block for lifting
- Maximum permissible speed 60 kmph
- Maximum output 90 minute/T.O.

MAIN ASSEMBLIES AND COMPONENTS:

- Engine - Cummins nt 855 l 320 hp @ 2000 rpm
- Chassis - high quality channel sturdy welded
- Main gear box - ZF gear box
- Tamping units - with tilting arrangement
- Lining and lifting - monoblock with separate lift arrangement.
- Distribution gear box - distribute the load from gear box both axles
- Reduction gear box. - reduce the speed of driving motor

HYDRAULIC SYSTEM

PUMPS - 3 double pumps are provided

1. D/pump **38×22 GPM** combined for the system pressure.120- 140 bar.
2. Double pump - **20 × 17 GPM**
20 GPM = vibration (one side) pressure 150 bar
17 GPM = 3 hydraulic coolers motor pressure 150 bar
3. 3 double pump **20×22 GPM**
20 GPM = vibration (another side) pressure 150 bar.
22 GPM = high pressure. 150 bar.

MOTOR: 7 motors are used on this machine.

- Vibration motor - 2 nos
- Driving motor - 2 nos
- Hydraulic oil cooler - 2 nos
- ZF cooler motor - 1 no

ACCUMULATOR:-Two accumulators bladder type.

1. 32 liters capacity nitrogen pressure 85 bar for system pressure.
2. 20 liters capacity nitrogen pressure 100 bar for high pressure.

PROPORTIONAL VALVE:-

Two nos for tamping unit up/down control.

SOLENOIDS: 43 solenoids.

CYLINDERS: 57 cylinders off sizes.

PNEUMATIC SYSTEM:

- | | | |
|-------------------|---|---------------------------------|
| 1. Compressor | = | 1 no capacity 500 cum/minute |
| 2. Pressure tank | = | 2 nos capacity 100 liter/ inch |
| 3. Brake cylinder | = | 2 nos. dia. = 12 inch. |
| 4. Cylinder | = | 48 nos of sizes |
| 5. Solenoid | = | 12 nos |
| 6 unloader valve | = | 1 no pressure adjusted on 7 bar |

WORKING PRINCIPLE**DRIVING:**

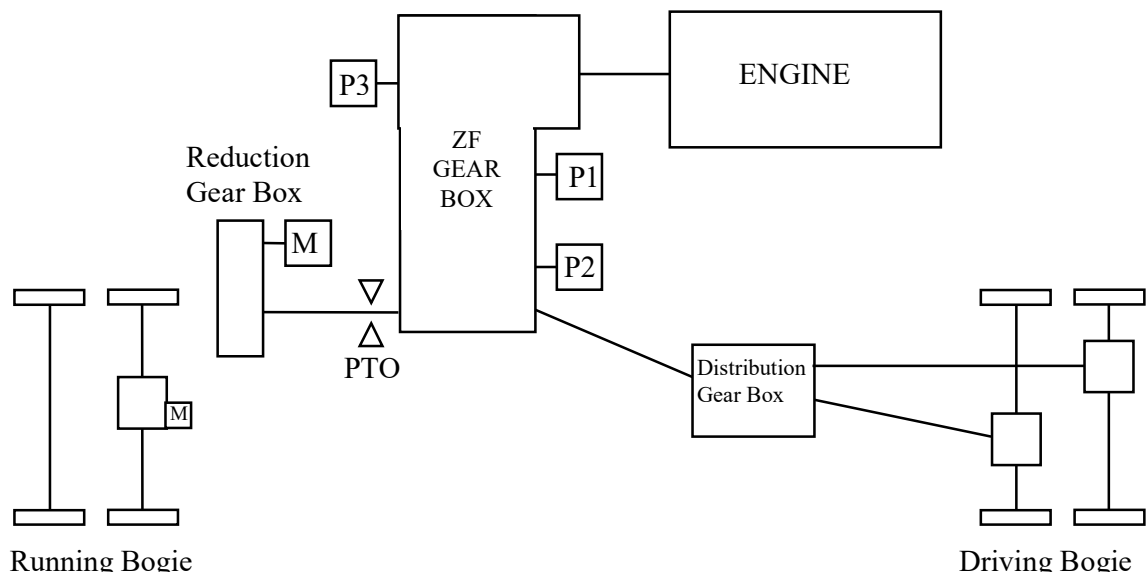
RUN DRIVE: By hydrodynamics (ZF) 4-speed gear box.

WORK DRIVE: By hydraulics motor with constant speed.

LINING: Single chord lining system.

LEVELLING: Double chord fixed type system and cross-level recording rear pendulum is provided.

RECORDER: 2 - channel recorder is used to record cross level and versine after the work.

POWER TRANSMISSION:

SUB DISCIPLINE: TAMPING MACHINES (LESSONS: 06 SESSIONS: 07)
Lesson-IV: 08-275-3S UNIMAT Session-6: Main features, Main assemblies and components, Working Principle and Power Transmission.

08-275-3S UNIMAT

MAIN FEATURES

- All four bogies are powered.
- Tamping unit can be swing 8.5 degree on each side.
- 3rd rail lifting arranged also provided.
- Lining and lifting: - servo valve
- Squeezing: - proportional system up 150 bar
- Max. Permissible speed: - 60 kmph.
- Output: 60 minute/T.O.

MAIN ASSEMBLIES AND COMPONENTS:

- Engine - Cummins nt 855 l 320 hp @ 2000 rpm
- Chassis - high quality channel sturdy welded
- Main gear box - ZF gear box
- Tamping units - with tilting arrangement
- Lining and lifting - monoblock with separate lift arrangement.
- Distribution gear box - distribute the load from gear box both axles
- Reduction gear box. - reduce the speed of driving motor

HYDRAULIC SYSTEM

PUMPS - 3 double pumps are provided

3. D/pump **38×22 GPM** combined for the system pressure.120- 140 bar.
4. Double pump - **20 × 17 GPM**
20 GPM = vibration (one side) pressure 150 bar
17 GPM = 3 hydraulic coolers motor pressure 150 bar
4. 3 double pump **20×22 GPM**
20 GPM = vibration (another side) pressure 150 bar.
22 GPM = high pressure. 150 bar.

MOTOR: 7 motors are used on this machine.

- Vibration motor - 2 nos
- Driving motor - 2 nos
- Hydraulic oil cooler - 2 nos
- ZF cooler motor - 1 no

ACCUMULATOR:-Two accumulators bladder type.

3. 32 liters capacity nitrogen pressure 85 bar for system pressure.
4. 20 liters capacity nitrogen pressure 100 bar for high pressure.

PROPORTIONAL VALVE:-

Two nos for tamping unit up/down control.

SOLENOIDS: 43 solenoids.

CYLINDERS: 57 cylinders off sizes.

PNEUMATIC SYSTEM:

- | | | |
|-------------------|---|---------------------------------|
| 6. Compressor | = | 1 no capacity 500 cum/minute |
| 7. Pressure tank | = | 2 nos capacity 100 liter/ inch |
| 8. Brake cylinder | = | 2 nos. dia. = 12 inch. |
| 9. Cylinder | = | 48 nos of sizes |
| 10. Solenoid | = | 12 nos |
| 6 unloader valve | = | 1 no pressure adjusted on 7 bar |

WORKING PRINCIPLE

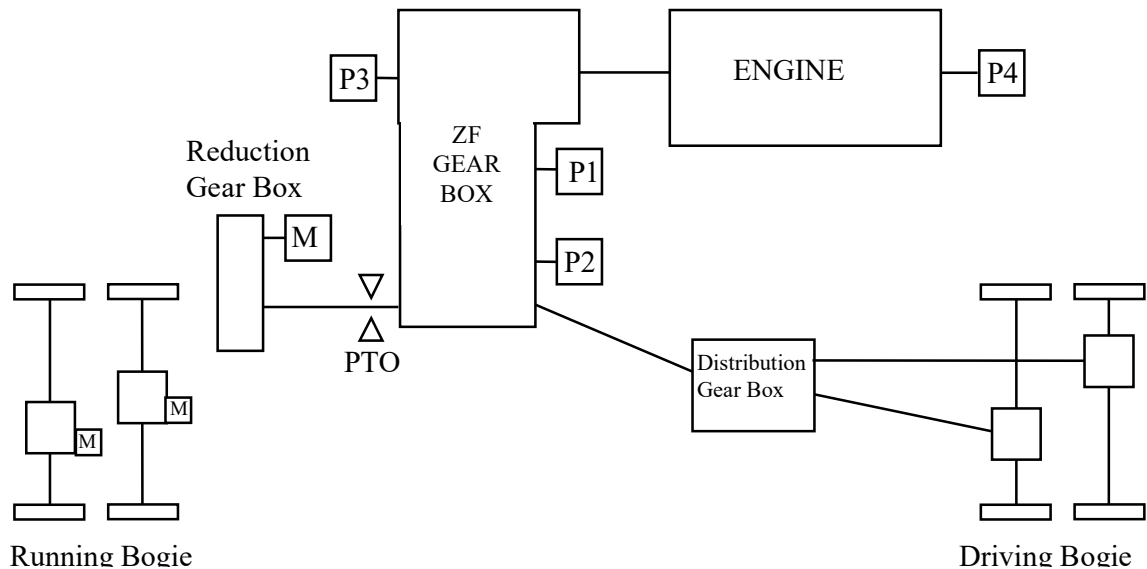
DRIVING:

RUN DRIVE: By hydrodynamics (zf) 4-speed gear box.

WORK DRIVE: By hydraulics motor with constant speed. Normally two motors are working but on gradient third motor is applied

LINING: Single chord lining system with pneumatic follow up system left over error is very less **LEVELLING:** Double chord fixed type system third rail lifting arrangement is given which can lift adjacent rail and packed manually

POWER TRANSMISSION:



SUB DISCIPLINE: TAMPING MACHINES (LESSONS: 06 SESSIONS: 07)
Lesson-V: Tamping Express Session-7: Main features, Main assemblies and components,
Working Principle and Power Transmission.

MAIN FEATURES:

- Latest version of CSM
- Programmable logic control (PLC) mechanism.
- Computer
- ALC: - for automatic data feeding
- 3 bogies of 2 – 2 axles (including satellite bogie)
- 2 – engines of Cummins nt 855 & KTA 1150
- Maximum permissible speed 60 kmph (by RDSO)
- Output - 2700 slipper/hour

MAIN ASSEMBLIES AND COMPONENTS:

- Four tamping units
- Engine: two engines are provided KTA 1150L and NT 855
- Satellite having two axles with hydraulic brakes
- ZF gear box with four speed
- Differential gear box

HYDRAULIC SYSTEM:

PUMP: 6 DOUBLE PUMP AND ONE VARIABLE PUMP.

1. **Double pump** 38×22 GPM Combined for system pressure adjust 130 bar.
2. **D/ Pump** 35×25 GPM = 01 No.
35 GPM = Vibration + 2nd tam/ v Pressure 150 bar
17 GPM = ZF Cooler motor + Radiator of KTA 1150 L
3. **D/Pump** 35 ×17 GPM = 01 No
35 GPM = Vibration (another side) pressure 150
17 GPM = Counter pressure for big cylinder and small Cylinder.
4. **D/Pump** 35 X 17 GPM
35 GPM = Vibration of tamping unit
17 GPM = Hydraulic coolers
5. **D/Pump** 38 X 25 GPM Combined for the system pressure 130 bar
6. **D/Pump** 35 X 17 GPM
35 GPM = Vibration of tamping unit
17 GPM = Hydraulic cooler motor drive
7. **Variable Pump** Capacity 125 LPM for continuous drive

WORKING PRINCIPLE

DRIVING SYSTEM:

WORK DRIVE: During work machine is driven by variable pump with variable speed 0 to 2 kmph. But satellite drive is proportional drive. The speed of satellite varies with the main frame speed.

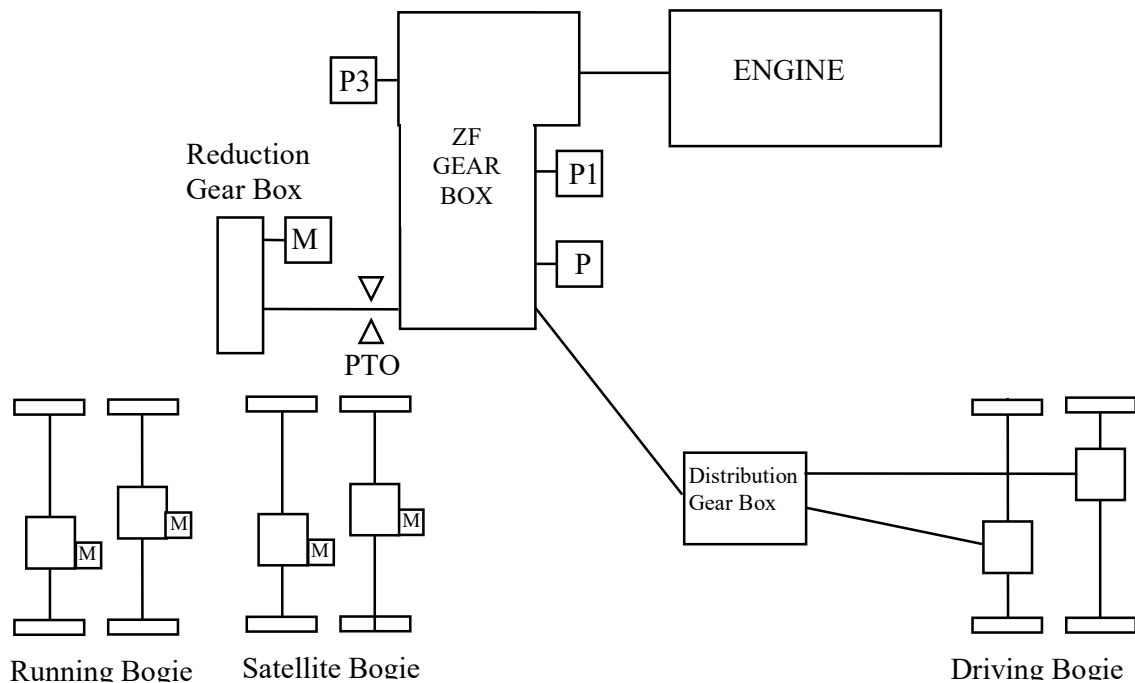
RUN DRIVE: Hydro dynamics gear box (ZF) is provided on the machine.

LINING: Single chord lining system is provided on 3X. ALC is provided on this machine for measuring run and automatic data feeding.

LEVELING: On this machine double chord fixed type leveling system is provided. This machine is designed for the twist correction for that rear pendulum is given.

RECORDER: ALC is provided for recording the datas during the measuring run mode

POWER TRANSMISSION:



Sub Discipline: Tamping Machines (Lessons: 06 Sessions: 07)
Lesson-VI: WST Session-8: Main features, Main assemblies and components, Working Principle and Power Transmission.

MAIN FEATURES:

- ZF hydrodynamic gear box is provided instead of main gear box, drive clutch, reversing gear box, 6-speed gear box, PTO assembly.
- Two triple hydraulic pump & one double pump provided.
- One emergency pump provided for back-up system.
- Two hydraulic motors are provided for work drive.
- Central lubrication system is provided.
- Servo valves are provided for lining & lifting
- The progress is relatively more.
- Air dryer is provided in pneumatic system.
- Cummins engine NTA855-L 380hp (280 KW) is provided instead of NT-743C in old model.

MAIN ASSEMBLIES AND COMPONENTS:

ENGINE: CUMMINS NTA 855L HP: 380 HP @ 2100 RPM

CHASIS: Sturdy welded construction of welded steel girders and sheet provide utmost stability.

UNDER CARRIAGE: The machine is equipped with 2 axle bogies with rigid axles i.e. front & rear bogie.

SUSPENSION: It is done by bonded metal-rubber springs between axles & bogie frame and two rubber spring disc between bogies and machine frame, provides sufficient absorption of vibrations and smooth running of the vehicle.

AXLE BEARINGS: Axles are supported by means of cylindrical roller bearings (02 Nos. on each side) (NJ 2224 & NJP 2224) outside the wheels in separate bearing housing.

BRAKES: Pneumatic operated block brakes are applied on all wheels. During travel drive, brakes are operated by hand controlled valve i.e. brake valve. During work drive hydraulic operated brakes are operated automatically by working control.

DRIVE POWER TRANSMISSION: ZF hydrodynamic gear box model No. 4WG 65 II WK is provided to drive the machine in traveling mode.

WORKING PRINCIPLE:

DRIVING:

RUN DRIVE: By hydrodynamics (ZF) iv speed gear box.

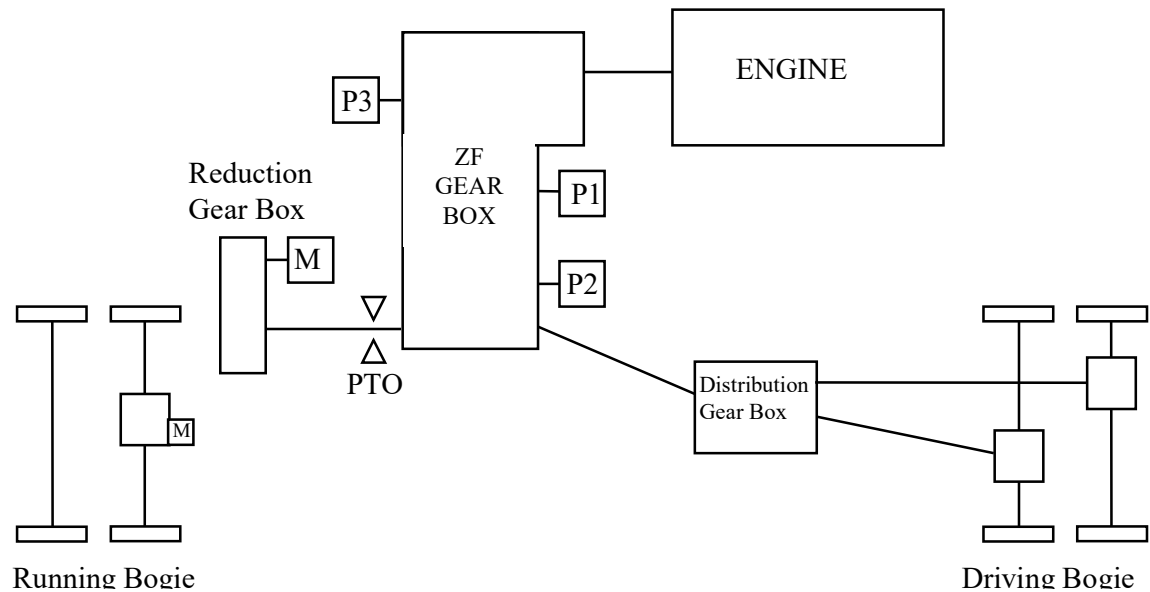
WORK DRIVE: Two hydraulic motors are provided. Machine works in constant speed.

LINING: Single chord lining system.

LEVELLING: Double chord fixed type system and cross-level

TAMPING UNIT: Duomatic type (32 tools) provided on the machine

POWER TRANSMISSION:



SUB DISCIPLINE: WORKING PRINCIPLE (LESSONS: 02 SESSIONS: 03)
Lesson-I: Lining Session-20: Principle of Single chord lining, 4 point lining & their Left over error.

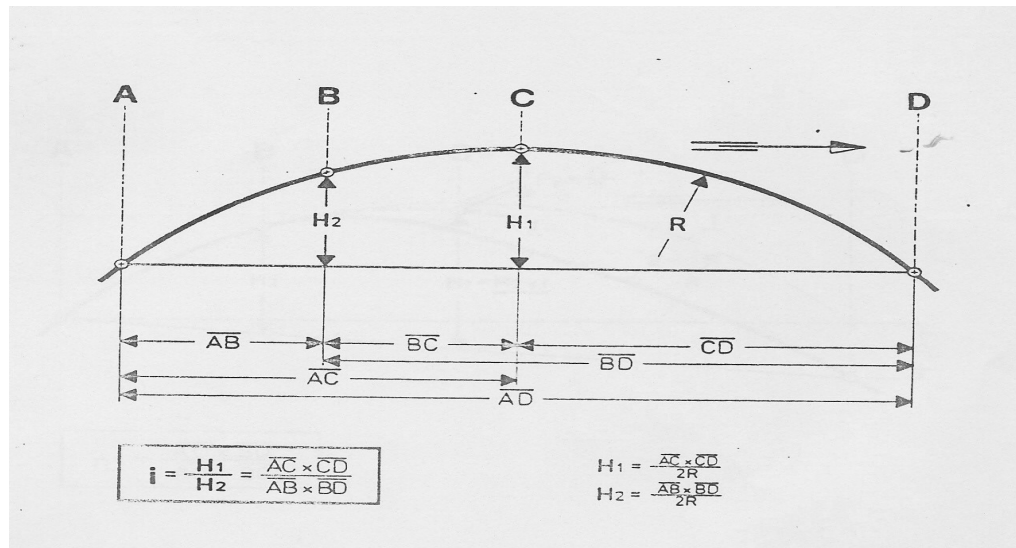
PRINCIPLE OF LINING:

- Machine measures only one rail and rectify that rail i.e. datum rail.
- Other rail is fixed with the sleeper hence that is also rectified.
- If there is a gauge problem that will remain there.
- During alignment machine corrects versine.
- The versine of straight track is zero and
- Versine on curved track depends on radius of curves, measuring chord length and measurement method.

SINGLE CHORD SYSTEM:

On UT machine double chord lining system was used. In this system, two chords i.e. long chords and short chords was used for measuring the versine. But in single chord lining system, one chord is used to measure the versine. This system is used in all machine except UT.

PRINCIPLE OF 4 POINT LINING (IN CURVE):



In this method versines at two places are compared which is a constant for all the circles in dependent of radius a straight may be considered a curve of infinite radius from the figure given above.

$$H_1 = \frac{AC \times CD}{2R}$$

$$H_2 = \frac{AB \times BD}{2R}$$

$$\text{Versine Ratio (i)} = \frac{H_1}{H_2} = \frac{AC \times CD}{AB \times BD}$$

$$H_1 = i \times H_2$$

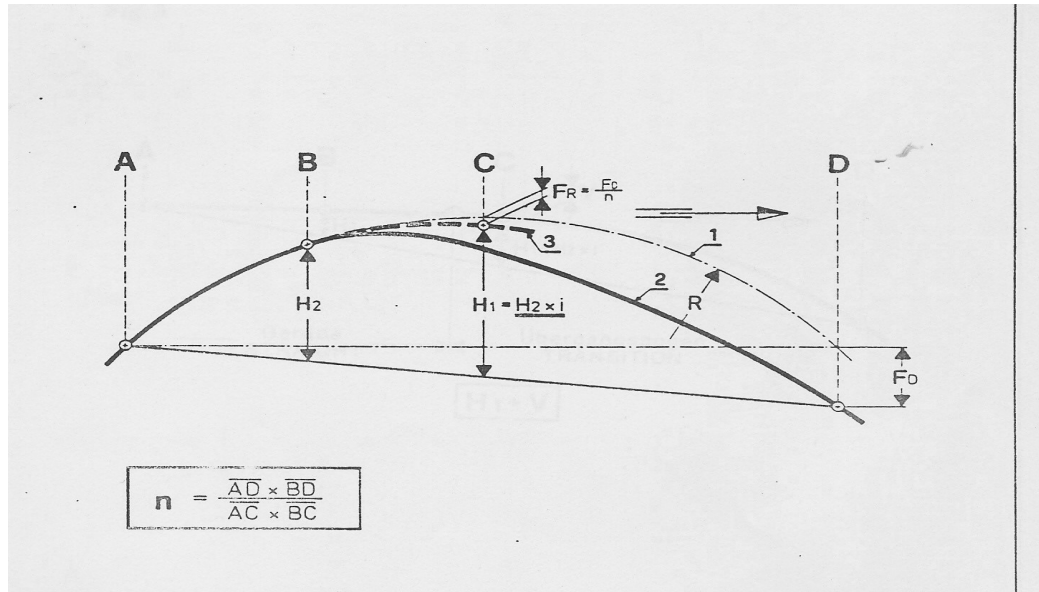
For 08 series machine AC = 10 m CD = 10m AB = 5m BD = 15m

$$i = \frac{10 \times 10}{5 \times 15} = 1.33$$

$$H_1 = 1.33 H_2 \text{ or } H_1 - 1.33 H_2 = 0$$

In practice point B always remains on aligned track. Points C & D remain on unaligned track. H_2 and H_1 are separately measured by measuring and lining bogies respectively by the machine.

ERROR REDUCTION:



Ideal line	=	1
Before lining	=	2
After lining	=	3

Error reducing ratio

$$(n) = \frac{AD \times BD}{AC \times BC} \quad n = \text{Reduction Ratio}$$

$$\text{Left over error} \quad F_R = \frac{F_D}{n}$$

$$\text{For 08 Machine} \quad F_R = \frac{F_D}{n} \quad (n = \frac{20 \times 15}{6} = 6) \quad 10 \times 5$$

Sub Discipline: Working Principle (Lessons: 02 Sessions: 03)

Lesson-I: Lining Session-21: Calculation of V_m value, 3 point lining & their left over error and Design lining.

CALCULATION OF V_m VALUE ON TRANSITION CURVE:

The constant versine ratio (i) applied only to tracks with the constant curvature (Straight or circular curve). But when there is change in curvature, the constant versine ratio remains no more applicable. As an example, let us consider a case of the machine entering from straight to transition.

Machine measure the versine H_2 at the measuring bogie and the versine H_1 at the lining bogie. Had the machine been on a regular curve the relationship

$$H_1 = 1.33 \times H_2 \text{ would have been true.}$$

For the changing curvature, we actually have

$$H_1 = 1.33 \times H_2 + V$$

Therefore, even though the curvature of the transition is true the machine still experiences an "Error" V . Therefore, we have to apply some adjustment at the lining bogie to compensate versine for V . Maximum versine compensation is called V_m value.

V_m value = $\frac{\text{Constant}}{\text{Transition}}$; R = Radius of curve L = Length of

$$R \times L$$

The procedure of applying V for the different situations is calculated by above formula and distributed in the machine cord length. The tables are also available with each machine. V value is feeded when machine enters from straight to transition, transition to curve, curve to transition and transition to straight. The direction of versine compensation is decided by toggle switch.

CALCULATION OF V_m VALUE ON REVERSE CURVE:

For the reverse curve or compound curve the value of V is decided as under:

Say R_1 & R_2 are the radius of the two curves and V_1 & V_2 are the corresponding adjustment for the individual curve (page no. 4 & 5)

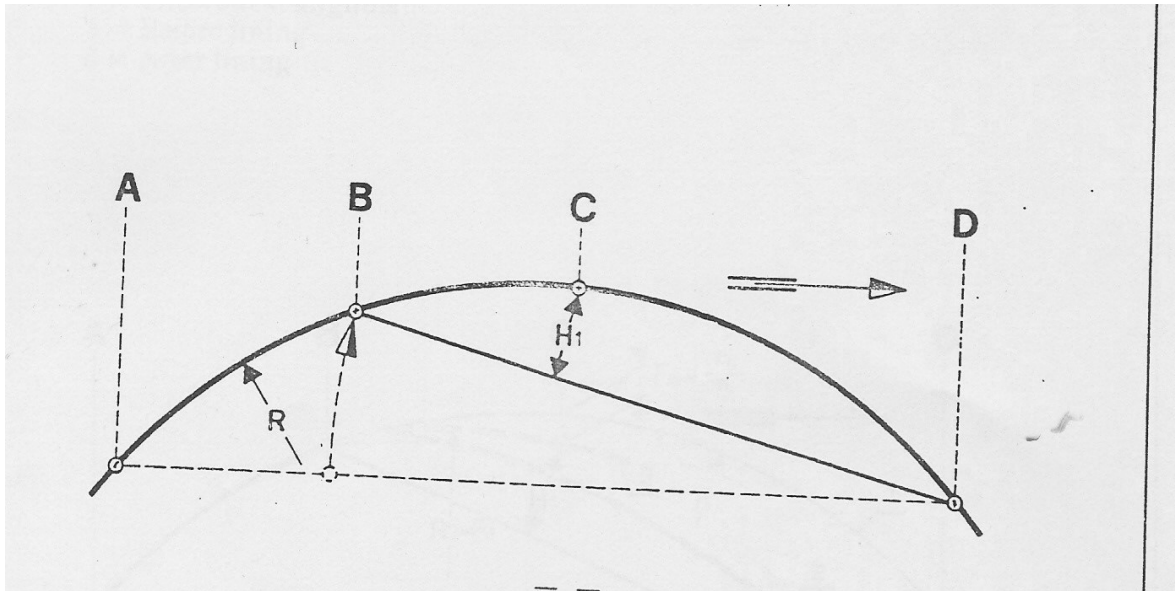
1. If the R_1 is bigger than R_2 , the net adjustment, V_0 will be $V_0 = V_2 - V_1$ or $V_{0m} = V_{2m} - V_{1m}$,
2. The applicable of adjustment will start as soon as the front tightening starts entering the transition.

This during working 1/6 of the error will be left and therefore it is called smoothening lining of some procedure is available with which it is possible to give exact location of various points like beginning & end of transition and amount of fault at a particular location established with some permanent works these, by shifting front and f the chord by the amount of fault. We can achieve exact alignment.

But in the field it is difficult to obtain correct reference marks as such generally smoothening system is adopted which is fairly accurate for smooth running of trains.

If we are tamping constructed line we can always, lay a parallel reference line from which difference can be calculated for feeding into the machine to achieve exact alignment.

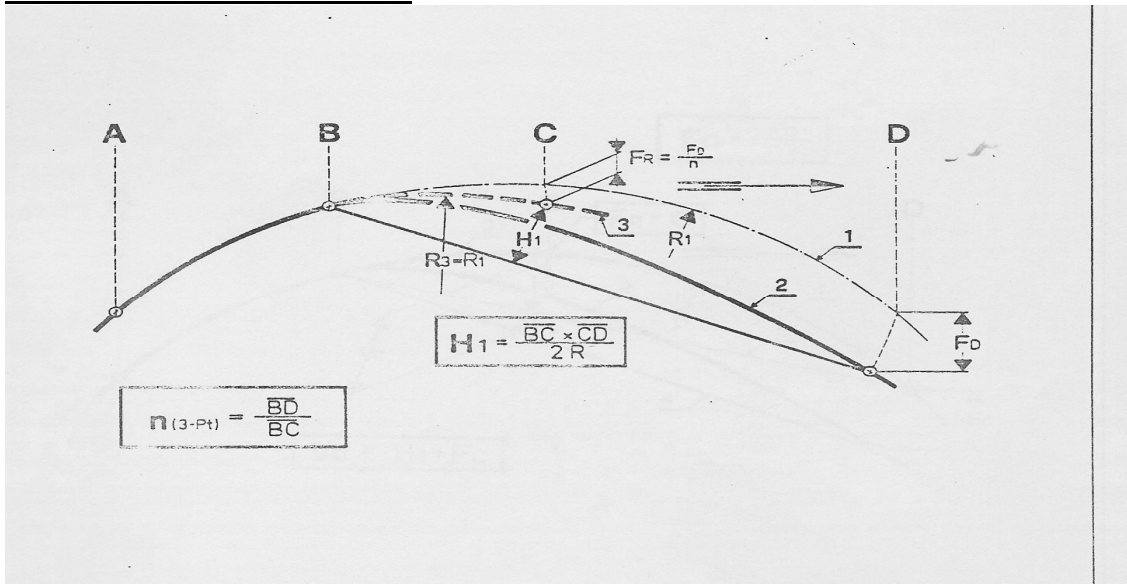
3 POINT LINING:



$$H_1 = \frac{BC \times CD}{2R}$$

The versine "H2" at point "B" is not measured. The track is measured at three points. The lining versine "H1" at point "C" is specified according to the curvature. Lining commences until the THEORETICAL versine "H1" is achieved. Using the 3-point system, the chord is generally fixed at point "B" which results in a reduction of the distance A-B.

ERROR REDUCTION RATIO:



Point "B" is on the already lined track behind the machine. The front end of the chord, point "D" is at the lining error "FD". Point "C" is lined until "H1" corresponds with the specified THEORETICAL versine.

Specifying the THEORETICAL versine "H1" shifts point "C" in a position which corresponds with the required radius "R". The remaining error "FR" is a result of the ratio of the measuring point distances.

Proceeding with the lining, point "B" is at the remaining error and influences therefore the next measurement.

DESIGN LINING:

DATUM LINE:

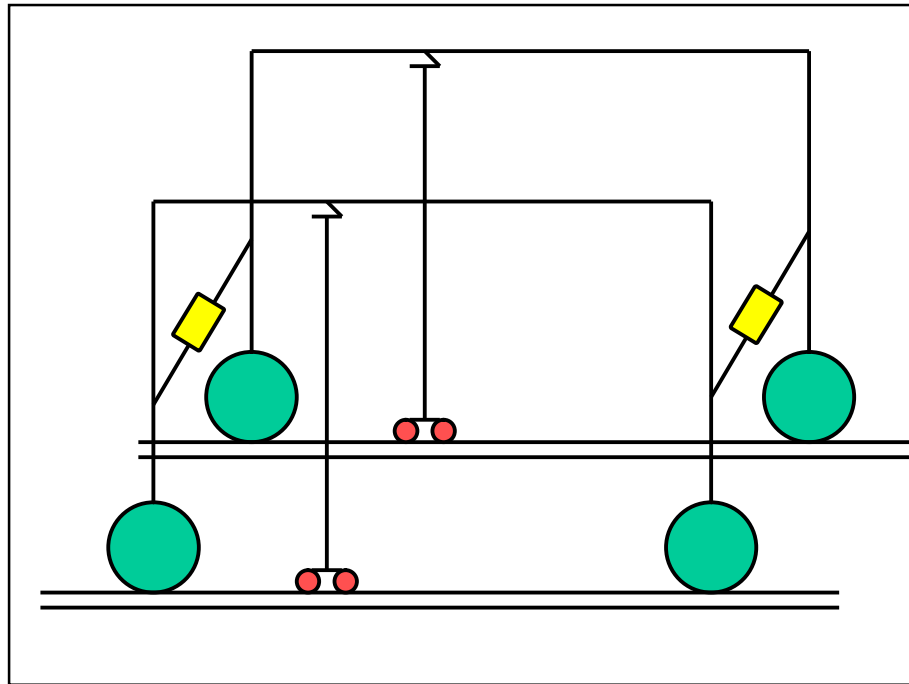
The datum rail for carrying out attentions to longitudinal profile and alignment should be selected as given below:

- i. Longitudinal section: Non-cess rail on straight track in double line section and inner rail on curves.
- ii. For alignment: Non-cess rail on straight track in double line section and outer rail on curves.
- iii. For single and middle line in multiple line sections, any of the two rails which is less disturbed may be selected as datum rail, both for alignment and L-section in straight track.

SURVEY FOR ALIGNMENT CORRECTION:

- i. All the weld and rail kinks should be rectified/eliminated by dekinking or cutting and welding before measurement for alignment defects are taken. Hydraulic jim-crows may be used for removing kinks.
- ii. In case some horizontal curves on the section to be surfaced warrant realignment, then the process of realignment should be carried out along with surfacing.
- iii. Alignment should be measured on a 40 m chord on straight track and required slew at alternate sleeper should be worked by measuring the offsets at every 5 m interval and interpolating the offsets. The slews are marked on every alternate sleeper.
- iv. On curved track, versines should be measured on 20 m chord at 10 m intervals. The required slews at the stations are worked out taking note of the obligatory points and interpolated to give slews at every alternate sleeper. The slews are then marked on alternate sleepers.
- v. While working out slews, position of fixed structures should be noted and infringement to moving dimensions shall not be allowed.

DOUBLE CHORD LEVELING SYSTEM:

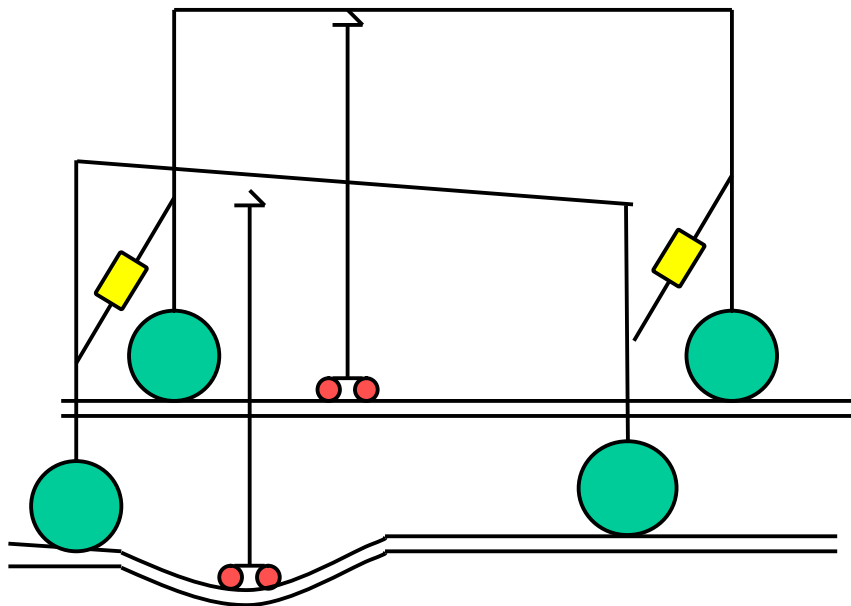


CRITERIA FOR SELECTION OF BASE LINE:

The datum rail for carrying out attentions to longitudinal profile and alignment should be selected as given below:

- (i) On straight & single line, higher rail will be kept as base line.
- (ii) On straight and double line, non cess rail is kept base line.
- (iii) In curve, inner rail is kept base line.

Note: Direction of cant selector switch to be opposite of base line.

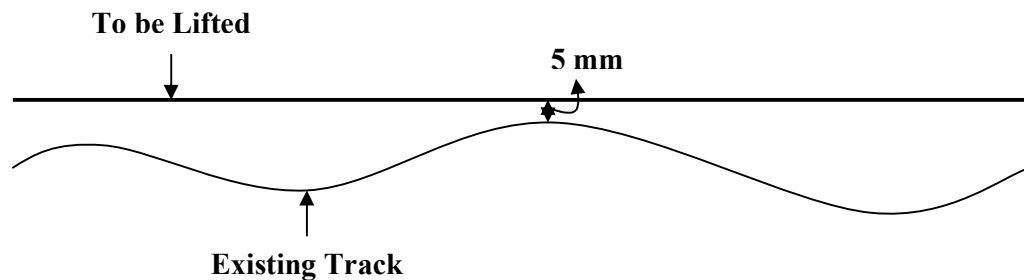


GENERAL LIFT:

The amount of lift which is given to track while tamping to cover all undulations, is called general lift. It is decided on the magnitude of the dips/peak generally available in the track. General lift should always more than the largest of dips which shall be ascertained by P.Way supervisor in advance.

General Lift for Curve:

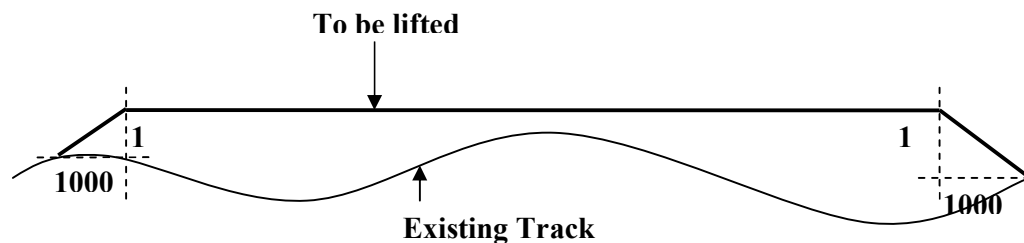
- (i) When existing SE is less than equilibrium SE. General lift will be equal to track irregularities over the base line. (Inner line + 5mm)
- (ii) When existing SE is more than equilibrium SE. The general lift will be the track irregularities in machine base line + Max. different in SE. (Between existing & equilibrium))
- (iii) Long wave defects measured on 30m. chord & short wave defects measured on 10m chord .Machine will remove short wave defect in proportional Made. To remove long wave defect design leveling is required.



General lift = Peak/Dips + 5 mm.

At one time lift value should not exceed 50 mm. if more than 50 mm lift is required then it can be achieved by lifting (tamping) two times.

RAMP IN & RAMP OUT:



Run-in ramp of 1 in 1000 and while closing the work, run-out ramp of 1 in 1000 is given for smooth transition. Leveling system consists of two chord wires, one for each rail which are stretched tightly from front tower to measuring bogie. Contact boards are mounted on feeler rollers which rest on track at the place where tamping is actually done. These contact boards are also lifted when the track is lifted.

Design Leveling:

Longitudinal section: Non-cess rail on straight track in double line section and inner rail on curves.

For single and middle line in multiple line sections, any of the two rails which is less disturbed may be selected as datum rail, both for alignment and L-section in straight track.

Survey For Vertical Profile:

The section identified for surfacing should be divided by stations marked at 10 m interval. The starting point should be opposite a kilometer post and the starting station should be marked 0. station locations and station numbers should be painted in yellow paint on the web of the datum rail.

Bench Marks:

Bench marks should be established at 200-1000 m interval, relating them to the GTS bench mark levels so that the plotted drawings are properly related to the existing index section. Fixing bench marks in relation to arbitrary levels should be avoided. These bench marks could be established on the top of concrete foundation of OHE masts in electrified sections.

Recording Of Actual Rail Levels:

The SE/JE (P.Way) should record the actual rail levels at all the stations of the datum rail, making use of the established bench marks. However, on the stretches where the datum rail is super-elevated, being on a horizontal curve, the rail levels should be taken on the other rail of the track, opposite the station locations. The stretch, for which station levels are taken on “non-datum” rail, should be noted in the level book.

In view of the voluminous survey work involved, auto setting leveling instruments should be used to save time and achieve accurate results.

The profile designed should be analytically verified so that the above mentioned unevenness limits are not exceeded. The final levels at various points should be calculated rather than the scaling out from the drawing which mainly serves the purpose of visual appreciation.