

***CIVIL ENGINEERING***  
***(TRACK)***

# ***PERMANENT WAY TRACK***



## ***REQUIREMENT OF GOOD TRACK***

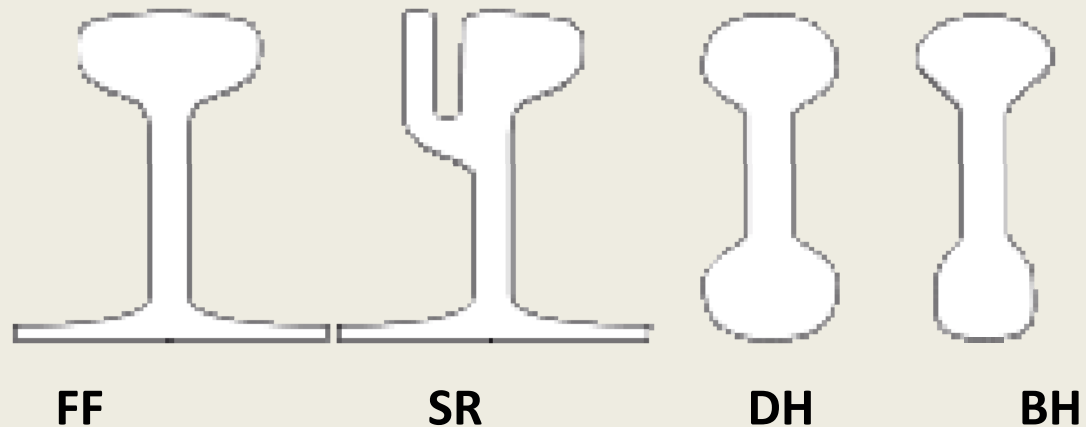
- **Safe & Smooth ride**
- **Easy to maintain**
- **Economical in Construction**
- **Minimum Fittings (Fit & Forget type)**
- **Able to resist weather changes**
- **Provide efficient drainage**
- **Safe against buckling in Summer season**
- **Rails to be free from internal defects.**

## ***GAUGES ON INDIAN RAILWAY***

- **Broad Gauge (BG)** - **1676 mm**
- **Meter Gauge (MG)** - **1000 mm**
- **Narrow Gauge (NG)** - **760 or 610 mm**

## ***TYPE OF RAIL***

- **Double Headed**
- **Bull Headed**
- **Flat Footed**
- **Special Rails**



## ***NOMINAL WEIGHT OF RAILS***

- 60kg            60.34 kg/m
- 52 kg           51.89 kg/m
- 90R            90 Lbs/yard or 44.61 kg/m
- 75R            75 Lbs/yard or 37.18 kg/m

## ***SERVICE LIFE OF RAILS***

- 90R                            250 GMT
- 52 kg 72 UTS                350 GMT
- 52 kg 90 UTS                525 GMT
- 60 kg 90 UTS                800 GMT

UTS - Ultimate Tensile Strength in Kg/mm<sup>2</sup>

GMT- Gross Million tons of Traffic

# ***SLEEPERS***

To hold the rails so as to have correct gauge and transfer load from rail to ballast.

- Strong & economical
- Able to absorb vibrations
- Easy correction of gauge.
- Provide stability (Vertical & lateral)
- Easy to maintain
- Min. damage in derailment.

## ***TYPE OF SLEEPERS***

- **Wooden**
- **Steel Trough**
- **Cast Iron**
- **Concrete Sleepers**
  - **Twin Block**
  - **Mono Block**



## ***TRACK FITTINGS***

- Dog spike, Screw spike, Bearing plate (Canted & Flat) CI ACBP
- Keys, Loose Jaws, Modified Loose Jaws.
- Pandrol Clip/Elastic Rail Clip, Rubber Pad, liners (Metal & GFN)
- IRN-202 Clip & H.M. Fastenings.

# ***BALLAST***

## **Functions**

- Provide resistance to track.
- Provide drainage
- Transfer load to formation.
- Provide lateral resistance.

## ***REQUIREMENT OF GOOD BALLAST***

- **Hard, durable, wear resistant, Angular**
- **Resist weathering effect**
- **Provide drainage**
- **Cheap & economical**

# ***FORMATION***

## **Purpose**

- Provide even & regular surface to lay ballast track.
- Laying above HFL
- Distribute load to wider area of natural ground

## **Mechanical Compaction**

- To have stability even in Rainy season.
- To achieve 95% to 98% max. dry density.
- Laid in 250-350 mm layers.
- Compaction is done using vibratory rollers.

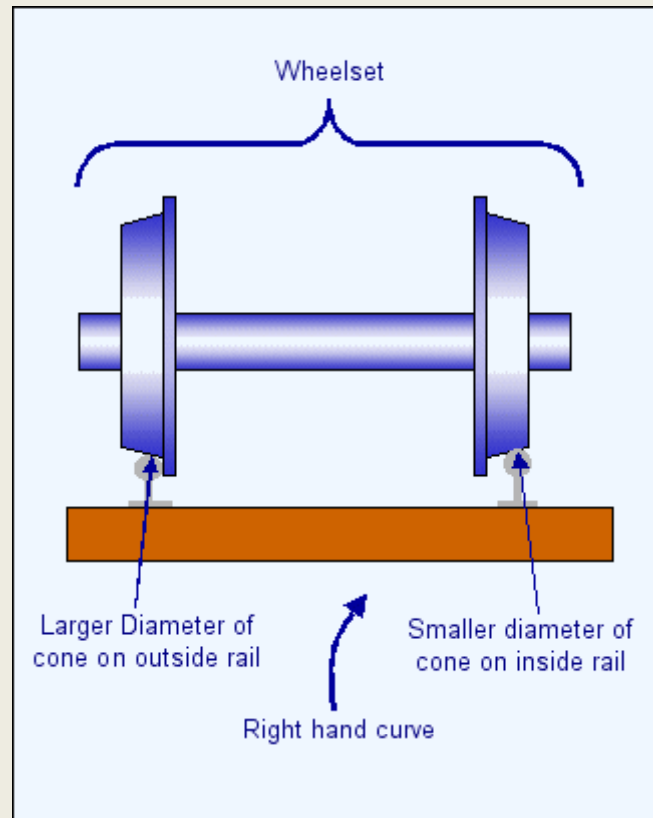
## **Blanketing**

- To increasing bearing capacity of bank.
- Top layer-coarse sand, quarry dust (1 mt. depth)
- Geo-tech or Geo-grid is used as Blanketing material.

# ***CANTTING OF RAILS***



# CONNING OF WHEELS



**1 in 20 cant**

## ***TURNOUT OR POINTS & CROSSINGS***



## ***PERMISSIBLE SPEED ON TURNOUTS***

<b>Type</b>	<b>Straight/curved</b>	<b>Speed in kmph</b>
<b>1 in 8 ½</b>	<b>Straight Curved</b>	<b>15 25</b>
<b>1 in 12</b>	<b>Straight Curved</b>	<b>15 40</b>
<b>1 in 16</b>	<b>Curved</b>	<b>50</b>
<b>1 in 20</b>	<b>Curved</b>	<b>50</b>



# ***CURVES***

## **Why curves**

- **Avoid natural obstructions.**
- **Connect cities**
- **Extra length to regulate gradient**

## **Definition (Radius or degree)**

**One degree curvature such that its 30.5m (100 ft) long chord subtends one degree angle.**

# Maximum Permissible Curvature

Gauge	Max. degree	Max. Radius
BG	10	175m
MG	16	109m
NG	40	44m

## SUPER ELEVATION OR CANT

To neutralize the effect of centrifugal force, the enter rail is raised by certain amount which is called Super Elevation or Cant.

## MAXIMUM VALUE OF SE

Gauge	Group	Normal value in mm	With special permission of Chief Engineer (in mm)
BG	A	165	185
	B&C	165	-
	D&E	140	-
MG	-	90	100
NG	-	65	75

# ***MAINTENANCE OF TRACK***

- (a) Daily Patrolling of track by Keymen**
- (b) Systematic Through packing.**
- (c) Systematic overhauling**
- (d) Picking up slacks.**

## **THROUGH PACKING**

- 1. Opening of track.**
- 2. Examination of fittings, rails & sleepers.**
- 3. Re-spacing & squaring of sleepers.**
- 4. Aligning of track.**
- 5. Packing of sleepers.**
- 6. Repacking of joint sleepers.**
- 7. Boxing of ballast & dressing.**

## **OVERHAULING OF TRACK**

- 1/3<sup>rd</sup> to 1/4<sup>th</sup> track every year.
- Screening of ballast in shoulders.
- All items of through packing.

## **ANNUAL PROGRAMME OF TRACK MAINTENANCE.**

- |     |                |  |
|-----|----------------|--|
| (a) | Monsoon        | Through packing, overhauling, lubrication of joint, Gap adjustments.   |
| (b) | Pre-Monsoon    | Cleaning of drains, repairs to bank & picking up slacks.               |
| (c) | During Monsoon | Attention to run down track, attention to drains, patrolling of track. |

# ***MECHANISED MAINTENANCE***

## **Need**

- **Heavy track structure**
- **Not possible manually.**
- **Higher speeds & large number of trains.**

## **Track Machines**

- **UT, Duomatic, CSM, 09-3X,**
- **BCM, P&C Tamper, T-28**
- **Dynamic stabilizer.**
- **PQRS, TRT**
- **Ballast Regulator.**

## ***INSPECTION OF TRACK***

- To check loose fittings, wear in rail/sleepers, Levels, Curves, P&Cs, Ballast deficiency, LWRs, Level Xings, Bridges, Gap at joint, Track condition in General, Drainage etc.

## **METHODS OF INSPECTION**

- Keyman's daily patrol.
- Push Trolley/Motor Trolley.
- Rear Window/Foot plate Inspection of Fast train.
- OMS
- TRRC

# **WELDING OF RAILS**

## **THERMIT WELDING**

- Site welding.
- Portion (Thermit Mixure), Mould.
- Gap- 25mm.
- Hetrogeneous.

## **REACTION**

Iron Oxide+ Aluminum Powder =  
Aluminum Oxide+ Iron + Heat (2450<sup>0</sup> C) .

## **HEATING**

- Oxy-Acetelene.
- LPG
- Petrol

# ***FLASH BUTT WELDING***

- **Welding Machine (Stationary/Mobile).**
- **5V-35000 Amperes.**
- **Flashing**
- **Butting**
- **Removal of extra Metal.**
- **Grinding**
- **Final finish**
- **Record of weld parameters.**
- **USFD testing.**
- **Despatch of welded panels.**
- **Cost of machine Rs. 6 - 8 cr.**
- **Quick- 3-4 minutes.**
- **Quality- As good as Rail.**



# ***LONG WELDED RAILS***

- Length >250m on BG and 500 m on MG.

- Theory

$$P = E a x t$$

P - Force in tons.

E - Modulus of Elasticity of rail steel ( $2.15 \times 10^6$  kg/cm<sup>2</sup>)

a - X-Sectional area of rail (a=66.15 sq. cm for 52kg. Rail).

X - Co-efficient of linear expansion = $0.00001152 \times 10^{-6}$

T - Temp. variation in degree C

P - 1.633 t/degree centigrade.

## ***Track Structure for LWR/CWR***

- Rails- 60kg/52kg/90R for BG & 90R/75R for MG.
- Sleepers-Concrete (PSC) with Elastic Fastenings for BG & MG.
- Ballast Cushion- 250mm-350mm.

## ***TRACK MAINTENANCE FOR LWR & CWR***

- Temperature below  $td+10^{\circ}C$
- Lifting ( $>50mm$ )  $td+10^{\circ}C$
- Special attention to breathing lengths & SEJs.
- Fastening to be kept tight.
- Ballast should not be deficient.

## ***DESTRESSING OF LWRs***

- To release locked up stresses.
- Between temperature  $t_m+5$  to  $t_m+10$  °C
- At the time of laying.
- Fracture.
- Movement at SEJ is abnormal.
- After accident.

# ***MODERNISATION***

- Longer trains, Fast speed, Safe, Economical, Better productivity & better consumer service.
- Better designed track, rolling stock, traction, signalling, communication, modern techniques of operation.

## ***HEAVIER TRACK STRUCTURE & MAINTENANCE.***

- Rails                      52kg/60kg of 90 UTS & 110 UTS.
- Sleepers                 PSC, 1660/km to 1880/km.
- Ballast Cushion        Min. 250mm.

### **Use of**

- LWRs & CWRs
- Flash Butt Welds.
- Consolidation of formation.
- Mechanised Maintenance.
- Directed Track Maintenance.
- Laying of PQRS & TRTs, T-28.
- SPURT Car & TRRC for Inspection.

# Thanks



***CIVIL ENGINEERING  
(WORKS)***



# CIVIL ENGINEERING (WORKS)

Civil Engineer to have knowledge of

- Building materials.
- Strength of materials.
- Surveying
- Hydraulics
- Geology
- Soil mechanics.
- Theory of structure
- Design of structures
- Design of P.Way
- Hydrology and River Training works.

# ***FUNCTIONING OF CIVIL ENGINEERING DEPARTMENT***

- **Construction & Maintenance of :**
  - (a) Track (b) Rly. Bridges. (c) Water Supply Plants & Systems. (d) Residential & Service Buildings. (e) Roads in Railway Boundary.
- **Surveying & Investigations.**
- **Soil Investigation**
- **Construction & Maintenance of**
- **Maintenance of – Buildings, Sheds, Workshops, Track, Track Machines,**
- **Land records, encroachments, River Training works.**
- **Procurement of P.Way materials and Building materials.**
- **Inspections of Rly. affecting works.**

## ***Duties of Works Inspectors.***

- **Inspection and maintenance of services buildings staff quarters and other structure including water supply, drainage and sewerage systems.**
- **Inspection of bridge works.**
- **Execution of all new building/structural works.**
- **Accountal and periodical verification of stores and tools in his charge.**
- **Maintenance of land boundaries.**
- **Removal of encroachment at his headquarters and at other places;**
- **Afforestation and other horticulture works.**
- **Ensuring required training to his staff.**

## Other Duties

- Execution of works.
- Measurement of works
- Imprest of tools and materials
- Accompanying important inspections
- Witnessing payment to staff
- Journal of daily duties
- Medical examination
- Service Books
- Provisions in the payment of wages Act, the Workmen's Compensation Act and other regulations
- Relinquishment of charge

# *Engineering Code*

- **Organisational structure of Engineering Department for maintenance and construction activities.**
- **Surveys and investigations Project Reports**
- **Investment planning and Works Budget**
- **Estimates.**
- **Railway land (Acquisition and Management)**
- **Tender and contracts**
- **Records and method of measurement**
- **Revenue works expenditure and Budgetary control.**
- **Commissioning of new lines.**
- **Management of buildings and working out rent.**

# *Indian Railway P. Way Manual*

- Duties of various Permanent way (track) officials.
- Procedure for the general maintenance of track and its components.
- Track structure on bridges.
- Maintenance of track in electrified sections.
- Treatment of formation.
- Renewal of track.
- Curve maintenance.
- Short welded and continuous welded rails.
- Track recording and analysis of results.
- Management of accidents.
- Precautions in rainy season and dealing with floods.
- Speed restrictions for maintenance works, indicators, detonators and flare signals.

- **Inspection and maintenance of level crossings.**
- **Patrolling of Railway track (rainy season and safety patrolling).**
- **Working of material trains, track machines and trolleys.**
- **Laying and maintenance of concrete sleepers.**
- **Training of staff.**

# ***TRACK MANUAL***

**Specified details of track component & layouts.**



# ***WORKS MANUAL***

- Duties of Engineering officials.
- Training for works staff.
- Planning inspection and maintenance of buildings and structures.
- Maintenance of stations buildings, yards and Railway colonies.
- Station and yards.
- Water supply.
- Drainage and sewerage
- Garden and plantation.
- Acquisition, management and disposal of land.
- Preparation of plans.
- Preparation of estimate.
- Surveys, projects estimates, and construction of new lines.

- **Miscellaneous works.**
- **Contracts and measurement.**
- **Execution of works and progress.**
- **Budget account and control.**
- **Engineering stores and their accountal.**
- **Storage and use of explosives.**
- **Police jurisdiction and security of Railway materials.**
- **Books of references.**

## ***I.R. BRIDGE MANUAL***

- Duties of bridges.
- Maintenance of bridges.
- Investigations and survey for construction of bridges.
- Construction of foundations of bridges.
- Rehabilitation of bridges.
- Construction of substructure and super structure.
- Rivers and Floods.
- River training and protection works.
- Turn tables and weigh bridges, pits and approaches.
- Fabrication, erection, inspection and maintenance of steel structures.
- Inspection and maintenance of tunnels and deep cuttings.
- Inspection of bridges.
- Plant and machinery of engineering department.
- Training for the bridge staff.
- Books of reference.

## ***OTHER BOOKS***

- **General condition of contract.**
- **Schedule of Dimensions.**
- **Standard specification**
- **Standard schedule of Rates.**
- **A.T. Welding & Flash Butt Welding Manuals.**
- **LWR Manual**
- **CE Circulars.**

## ***COMMISSION OF RLY. SAFETY***

- **Headed by CCRS under Ministry of Civil Aviation**
- **CRS for Zonal Railways.**
- **Responsible for safety in working and operation.  
(Direct, advice, caution)**

# ***FUNCTION OF CRS***

- **Inspection of new Railway lines prior to authorization for passenger traffic.**
- **Periodical inspection of open lines.**
- **Approval of works and renewals affecting passenger carrying lines.**
- **Investigation into accidents and enquiries accidents of passenger trains.**
- **General advice on matters concerning safety of train operation; The Commissioner of Railway Safety have Statutory powers under section 4,5 and 6 of Indian Railway Act to inspect the railway systems, conduct in place of inquiries in the causes of accidents and sanction execution of all works affecting the safety of running lines.**

# ***SAFETY AT WORK SITES***

- Suitable warning boards and men with banner flats.
- Proper caution order must be given to the stations on Look either side.
- out for moving train on the adjacent track.
- Equipments and tools should be in good working condition.
- Adjacent track should be safeguarded by providing fencing.
- Remove extra debris from the vicinity of the track.
- Provide fire fighting equipments at all key points.
- All works should be medically fit to work.
- Wearing of helmets and safety reflective jackets.

# ***BUILDING MATERIALS***

- **Mud, Stone.**
- **Brick Masonary**
- **Concrete Construction.**
- **Pre-stressed Reinforcement Concrete (PRC)**
- **Steel**
- **Timber**



# **STONE**

- **Soft Stone, Hard Stone**

**Test: Strength (1000 to 1400 kg/cm) Hardness, Attrition test (stone not to loose weight), Water absorption (5% of weight) and specific gravity Test (Heaviness of stone).**

**Bricks:**

**Test: Visual, Dimensional (+80mm, +40mm, +40mm for 20 Bricks), compressive strength, Efflorescence .**

**Concrete Construction:**

**Concrete : Mix of Cement, Sand & Course aggregate.**

**RRC : Mix of Cement, Sand & Course aggregate + Steel Bars**

# ***CEMENT***

**Is a binding agent. Is a mix of calcareous, Siliceous and aluminous materials.**

## ***STOREAGE OF CEMENT***

- **Packed in 50 kg. Bags.**
- **Stored for shortest period.**
- **Kept in weather tight room**
- **Damp go down and floors to be avoided.**
- **Not to be stored against walls (0.6m away).**
- **Close formation and covered with tarpaulin.**
- **Not more than 10 bags stored over each other.**

## ***PORTLAND CEMENT***

- Store quarried at Portland (UK)
- Main Constituents- Lime, Silica & Alumina (60-67%, 17-25% & 3 to 8%).

In addition Iron Oxide, Magnesia, Sulphur Tri-Oxide & Alkalies are also added (0.5 to 5%).

## ***SPECIAL CEMENTS***

- OPC, Rapid Hardening, Low heat, Sulphate Resisting, Water Proof & Quick Setting Cement.

## **SAND**

- **free from silt, clay, salts & organic matters.**

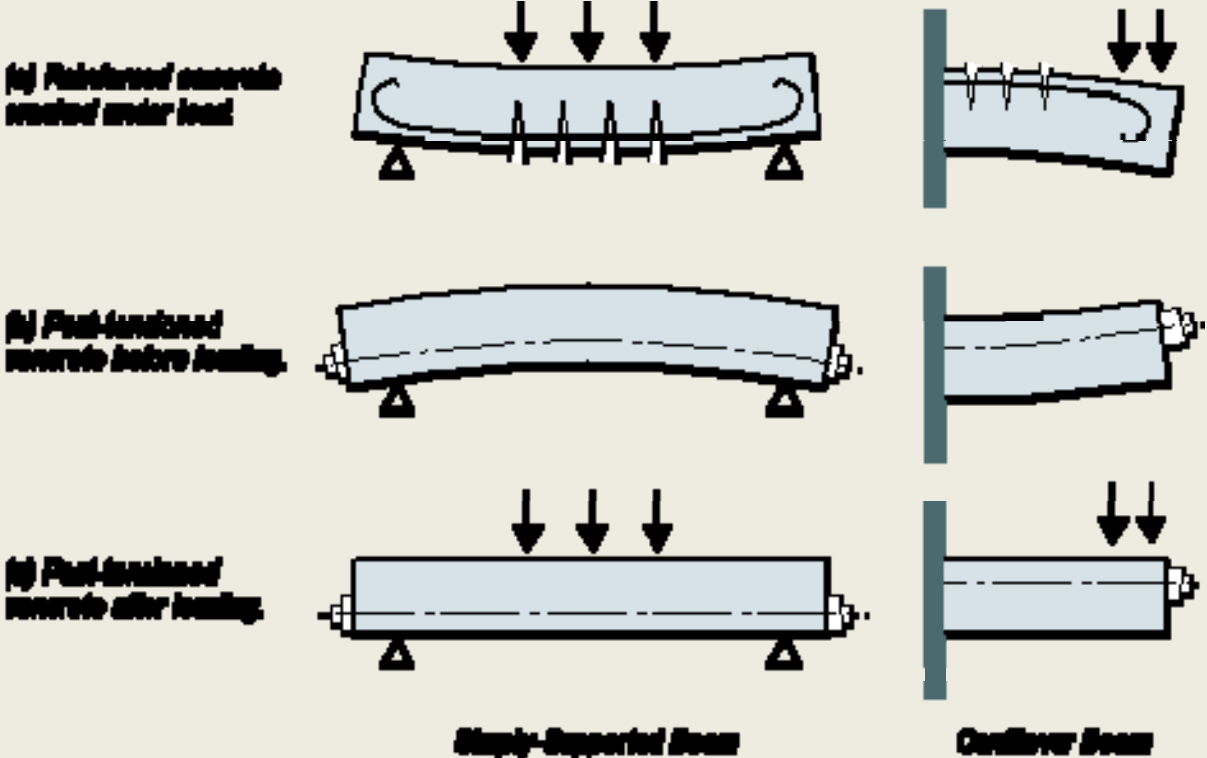
## **COURSE AGGREGATES**

- **Stone pieces, size 20mm & 40mm.**

## **RCC**

- **Concrete & Steel.**

# PRE-STRESSED REINFORCED CONCRETE (PRC)



# ***TIMBER***

## **Advantages:**

**Strong, Workable & Economical.**

**Any size & shape.**

**Decorative surfaces.**

**Less wastage.**

**Non-conductor.**

**Scrap value.**

**Teak, Sal, Deodar, Babul, Chir, Mango, Shisham, Fur etc.**

## ***SAFE BEARING CAPACITY OF SOIL***

<b>Type of Soil</b>	<b>Safe Bearing capacity in Tonnes/m</b>	
<b>Soft clay</b>	<b>10</b>	
<b>Fine sand and silt</b>	<b>15</b>	
<b>Hard stiff clay</b>	<b>20-40</b>	
<b>Coarse sand compacted</b>	<b>45</b>	
<b>Soft rock</b>	<b>45</b>	
<b>Sand stone</b>	<b>165</b>	
<b>Granite</b>	<b>330</b>	

## ***METHODS OF IMPROVING SBC OF SOIL***

- **Increasing depth of foundation**
- **Blending-sand, gravel, crushed stone**
- **Sand piles.**
- **Improving drainage & lowering water level.**



# ***FOUNDATIONS***

- **Shallow**
- **Grillage**
- **Raft**
- **Pile**

# ***DESIGN OF STRUCTURES***

- **Dead load**
- **Live load**
- **Wind load**
- **Seismic load.**
- **Thermal load**
- **Hydraulic forces**

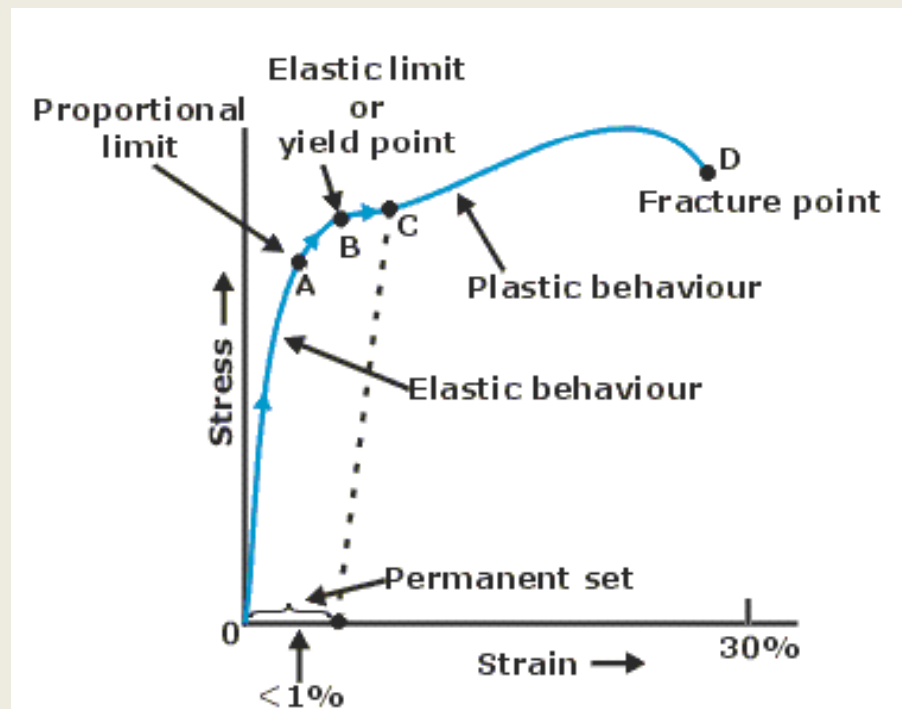
# ***STRESSES***

- **Direct**
- **Tensile**
- **Compressive**
- **Bending**
- **Shear**
- **Torsional**

# YOUNG'S MODULOUS OF ELASTICITY

$$E = 2.15 \times 10^6 \text{ kg/cm}^2 \text{ for steel.}$$

(Stress-Strain Curve)

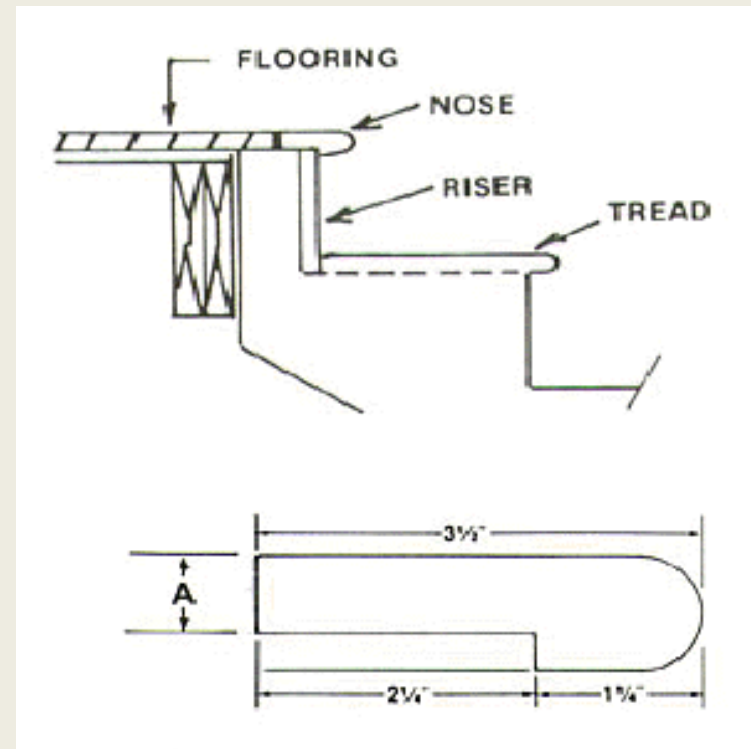


A typical stress-strain curve for a ductile metal

# STAIRS

Steps, Tread, Rise, Flight, Landing, Winders, Hand rail, Baluster

Tread- 30 cm  
Riser-14 cm.



# ***CLASSIFICATION OF STATIONS***

## **1. Category 'A'**

- (i) Non-Suburban stations with annual passenger earning of Rs. 6 crores and above.**
- (ii) Divisional and zonal Railway Headquarters.**

## **2. Category 'B'**

- (i) Non-Suburban stations with annual passenger earning of between Rs. 3 crores and Rs. 6 crores.**
- (ii) Stations serving places of tourists interest and having a very significant tourist traffic and Junction stations.**

## **3. Category 'C'**

**All Suburban stations.**

#### **4. Category 'D'**

- (i) Non-Suburban stations with annual passenger earning of between Rs. 1 crore and Rs. 3 crores.**
- (ii) District Headquarters and stations of local importance to be classified by the railway.**

**5. Category 'E' - Non-Suburban stations with earning less than Rs. 1 crore.**

**6. Category 'F' Halt Stations.**

# ***WATER SUPPLY***

- **Open Well,**
- **Hand Pumps,**
- **Tube Wells,**
- **River Water**



# ***PUMPS***

- **Reciprocating Pump**
- **Centrifugal Pump**
- **Vertical Spindle Pump**
- **Submersible Pump**

# ***TREATMENT OF WATER***

- Disinfection of water- Chlorination.
- Residual chlorine- 2ppm at last point.

# ***SANITARY ENGINEERING***

- Refuge
- Garbage
- Sewage
- Sewerage
- Plumbing
- Trap
- Vent Pipe
- Soil Pipe
- Waste Pipe
- Drain
- Drainage
- Manhole
- Soil Waste
- Invert
- Sewage Collection
- Sewage Treatment
- Sewage disposal

# ***SEWAGE TREATMENT***

- **Natural Method** - Untreated or treated sewage is disposed off directly.
- **Artificial** - Disposed off after treatment.
- **Screens, Grit Chambers, Detritus Tanks, Skimming tanks, sedimentation tanks.**
- **Filtration for treatment of effluent.**
- **Activated sludge process for treatment of sludge.**

**Thanks**



***General Management  
of  
Indian Railways***

## ***Mode of Transport***

**Rail**

**Road**

**Air**

**Water**

## ***Railway as a Mode of Transport***

**Tractive Resistance**

**Right of way**

**Cost Analysis**

**Gradient & curves**

**Flexibility of movement**

**Energy efficiency**

**Environment pollution**

**Land economy**

**Suitability of type of traffic**

## ***Organisation***

***Railway Board***  
***Zonal Railways***  
***Divisions***  
***RDSO***

***Net Work- 1,13,115 KMs***

***Railway Board- Members, Addl. Members, Advisors, Exe. Directors***

***Zonal Railways – GMs & PHODs***

***Divisions- DRM, ADRM & branch Officers***



## *Commission of Railway Safety*

**RITES**

**IRCON**

**IRFC**

**CONCOR**

**KRCI**

**CRIS**

**IRWO**

**RailTel**

**RVNL**

**IRCTC**

**DFCCIL**

## *Various Gauges on World Railways*

*Type of Gauge*

*Gauge in mm*

- |                                   |             |
|-----------------------------------|-------------|
| <i>1. Cape Gauge</i>              | <i>1067</i> |
| <i>2. Standard Gauge</i>          | <i>1435</i> |
| <i>3. Broad Gauge</i>             | <i>1676</i> |
| <i>4. Broad Gauge</i>             | <i>1524</i> |
| <i>5. Metre Gauge</i>             | <i>1000</i> |
| <i>6. 23 various other gauges</i> |             |
- Different gauges.*

## *Choice of Gauge*

*The choice of gauge is very limited as each country has fixed its own gauge and all new lines are to be constructed with this gauge. The following factors, however theoretically influence the choice of gauge.*

- 1. Cost considerations.*
- 2. Traffic considerations*
- 3. Physical features*
- 4. Uniformity of Gauge.*

## ***Classification of Railway lines***

***All B.G routes (Gauge 1676 mm ) of Indian Railways have been classified in five categories based on speed criteria as given below :***

- 1. Group 'A; lines. These line should have speed potential of 160 kmph.***
- 2. Group 'B' lines These line should have speed potential of 130 kmph.***
- 3. Group 'C' lines Suburban Sections.***
- 4. Group 'D' lines Sections having MSS of 100 kmph***
- 5. Group 'E' lines Other sections and branch lines.***

***Metre Gauge Routes. These routes have been classified as under based on speed.***

***Q routes- Where max permissible speed will be 75 kmph.***

***R routes - Where peed potential will be 75 kmph.***

***S routes These routes will the routes where speed potential will be less than 75 kmph and traffic density less than 1.5 GMT.***

***Narrow Gauge Routes. There is no special classification for Narrow Gauge routes having gauge width of 762 mm or 610 mm.***

## ***Training of Railway Employees***

***Indian Railways have developed their own facilities for conducting extensive training Programme for their officers and staff to enable them to improve upon their skill/abilities And equip them with latest technological developments.***

***Training to railway staff is given in zonal training schools set up on each railway zone. Training for officers is however organised in five centralised institutions.***

- (i) Railway Staff College, Vadodra***
- (ii) Indian Railways Institute of Civil Engineering, Pune,***
- (iii) Indian Railways Institute of Signal and Tele communication Engineering, Secundrabad.***
- (i) Indian Railways Institute of Mechanical Engineering, Nasik,***
- (ii) Indian Railways Institute of Electrical Engineering, Nasik***

***Social Costs being born by the Indian Railways.***

***Railway finances & their control***

***Achievements of Indian Railways***

**Thanks**

