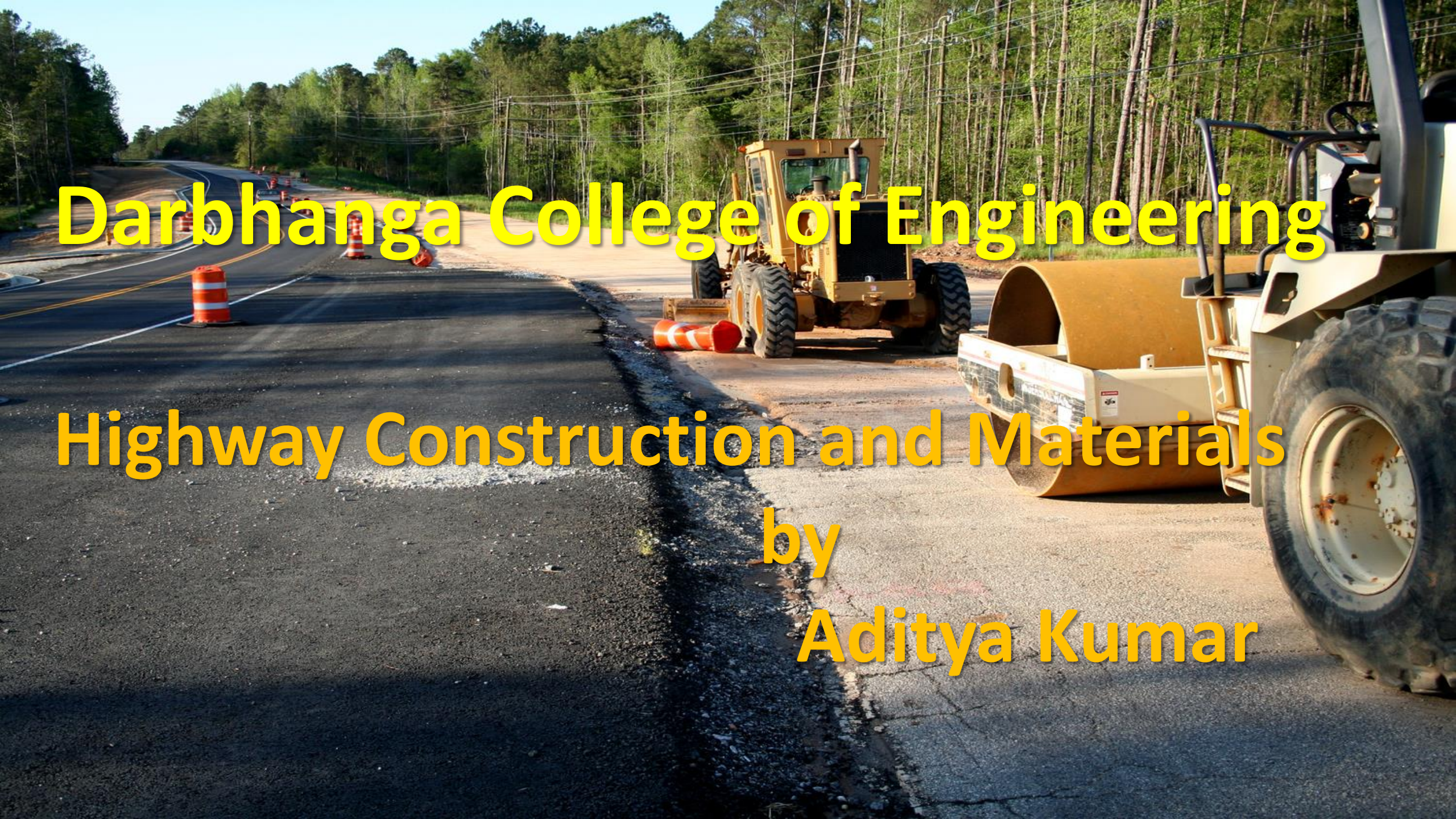
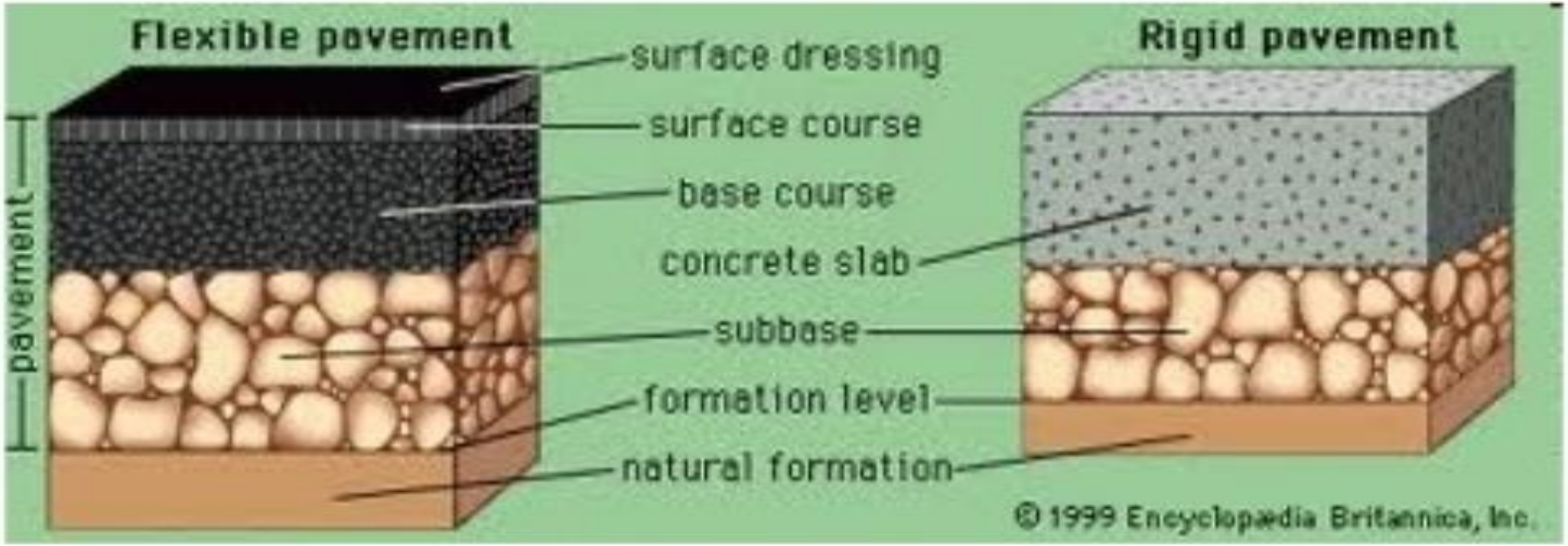

Darbhanga College of Engineering
Highway Construction and Materials
by
Aditya Kumar

Types of pavements



Difference between flexible and rigid pavement

Flexible pavement	Rigid Pavement
➢ Load is transfer by grain to grain.	➢ Load transfer is not exists.
➢ Low strength.	➢ High strength.
➢ Low life Span.	➢ Life span is more.
➢ High maintenance cost.	➢ Low Maintenance cost.
➢ Rolling of surface is needed.	➢ Rolling of surface is not needed.
➢ Damaged by oils and certain chemicals.	➢ No damage by oils and greases.

EMBANKMENT

Functions of embankments

- To keep the subgrade adequately above the HFL or ground water level
- To prevent damage to pavement due to surface water from adjoining land
- To reduce the possible damage to pavement layers due to capillary water
- To maintain the vertical alignment

EMBANKMENT

Design elements

- Height
- Fill material
- Settlement
- Stability of foundation and
- Stability of slopes

Site clearance

- Clearing
- Grubbing
- Stripping

Equipment's

Materials

- Soil
- Morrum
- Gravel
- Flyash
- Local available materials

Tests

- Sieve Analysis
- Consistency limits
- MDD & OMC
- Deleterious constituents
- Shear strength
- Consolidation
- CBR

Unsuitable Material

- Materials from swamps, marshes and bogs
- Peat, log, slump and perishable material

  OL, OI, OH or Peat
- Materials in a frozen condition
- Clay having LL > 70 and PI > 45
- Material with salts
- Size of coarse material > 75 mm

Compaction Requirements

- Not less than 95 percent relative to MDD

Density Requirements

Sl. No	Type of work	For NH/SH/MDR	For Rural Roads
1	Embankment upto 3 m height, not subjected to extensive flooding	Not less than 15.2 kN/m^3	Not less than 14.4 kN/m^3
2	Embankment of any height subject to long period of inundation	Not less than 16.0 kN/m^3	Not less than 15.2 kN/m^3

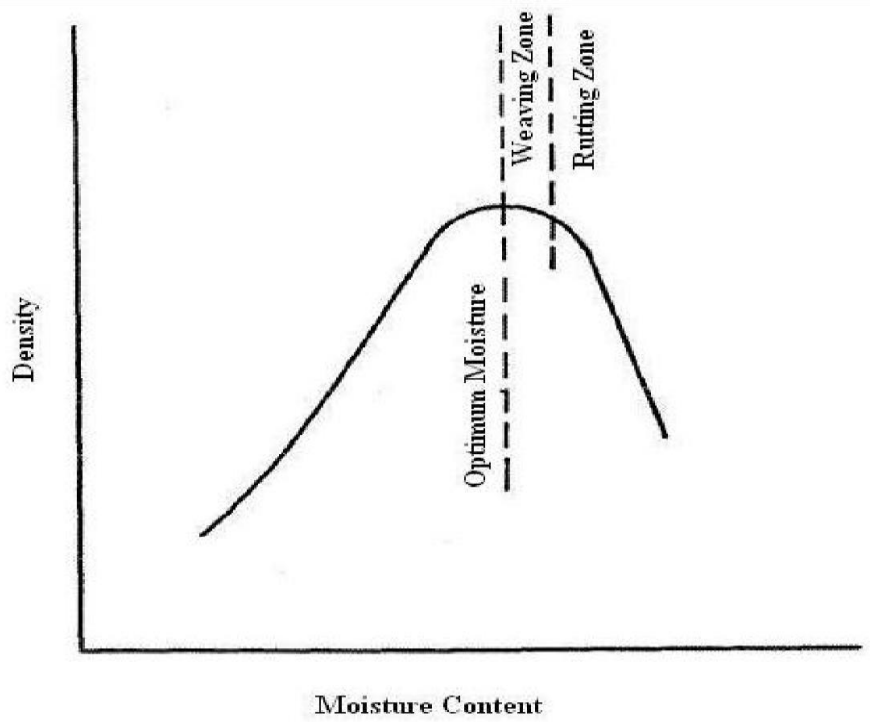
- Additional vegetation removal
  - To provide adequate sight distance
  - To improve the landscape
  - To remove decayed or dead trees
  - To remove obstructions to drainage
  - To permit access to and use of borrow pits
- Preliminary operations
  - Clearing
  - Salvage
  - Waste disposal
  - Stripping of top soil
  - Compaction of original ground
  - Embankment height

Placing of fill material

- Successive layers
- Not more than 250 mm
- Foot length + 50 mm (sheepsfoot roller)
- Required moisture content
- Adjustment in borrow area
- Adjustment while construction
- Water sprinklers, graders, barrows and mixers
- Drying
- -2 OMC +1

Compaction

- Increase in strength
- Reduce compressibility
- Reduction in moisture variation
- Reduction in erodability



Sheep foot roller

- As the name indicates, this type of roller consists of a drum having many round or rectangular shaped protrusions or "**feet**" on it. These rollers are also called **tamping rollers**.
- The **thickness of compacting layer is kept about 5 cm more than the length of each foot.**

Pneumatic tyre roller

- This type of roller consists of a heavily loaded wagon with several rows of four to six closely spaced tyres. This is also called rubber tyre roller.
- It provided uniform pressure throughout the width.
- 2 factors governing the amount of compaction are as follow
  - Tyre pressure
  - Area of contact
- Tyre pressure may be upto about **7 kg/cm**
- The gross weight of the roller is about 6 to 10 tonnes which can be increased to 25 tonnes by ballasting with steel section or other means.
- The maximum density can be achieved by **8 passes** of the roller. The optimum speed of roller is between **6 to 24 km/h**

VIBRATORY ROLLERS

- This type of roller is fitted with one or two smooth surfaced steel wheels 0.9 m to 1.5 m in diameter and 1.2 m to 1.8 m wide.
- Self propelled vibratory rollers are now available weighing from **4 to 6 tonnes**.
- Vibrations are generated by the rotation of an eccentric shaft inside.
- A vibratory roller is used for compacting granular base courses. It is sometimes used for asphaltic concrete work.

SMOOTH WHEELED ROLLER

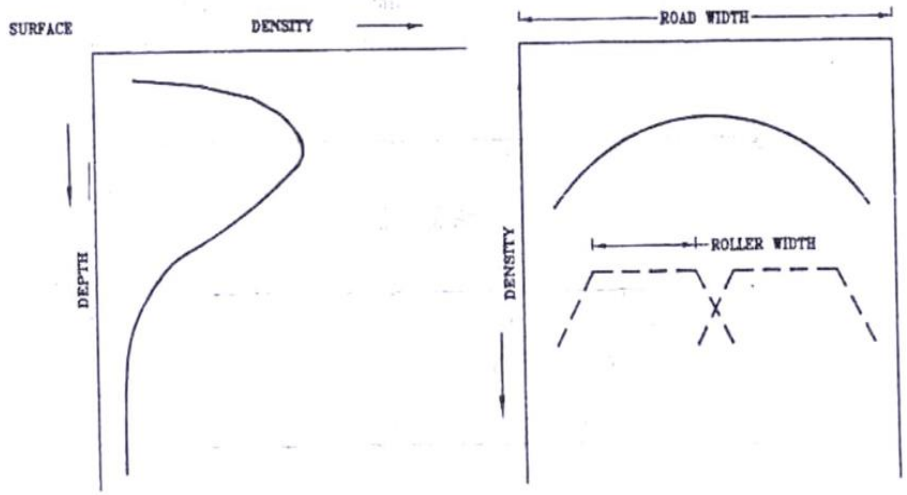
- This type of roller consists of a large steel drum in front and one or two wheels or drum on the rear end.
- Depending upon the number of wheels on the rear, it can be of following two types:
- Tandem rollers (having one wheel at rear and one wheel in front)
- Three wheeled rollers (having two wheel at rear and one in front)

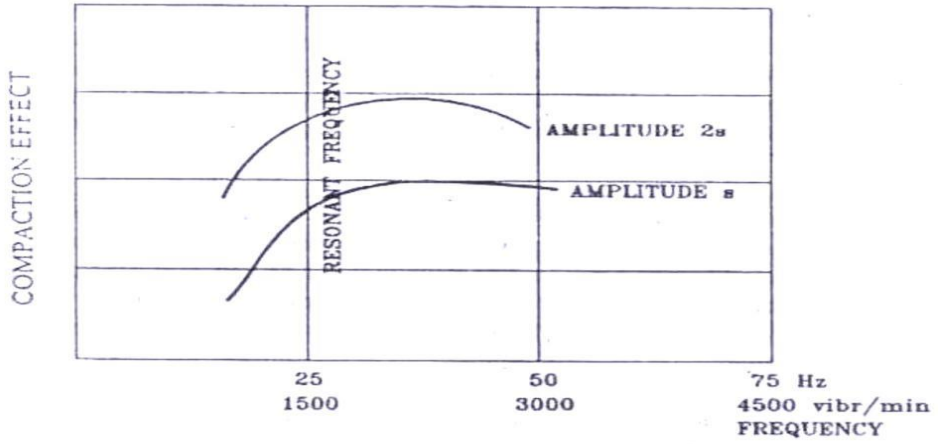
- The **weight of tandem roller** varies from **2 to 8 tonnes** and that of **two wheeled roller** varies from **8 to 10 tonnes.**
- The **ground pressure** exerted by tandem rollers is about **10 to 17 kg/cm^2**
- The **optimum working speed has found to be 3 to 6 km/h** and about **8 passes are adequate for compacting 20 cm layer**.

Factors affecting field compaction

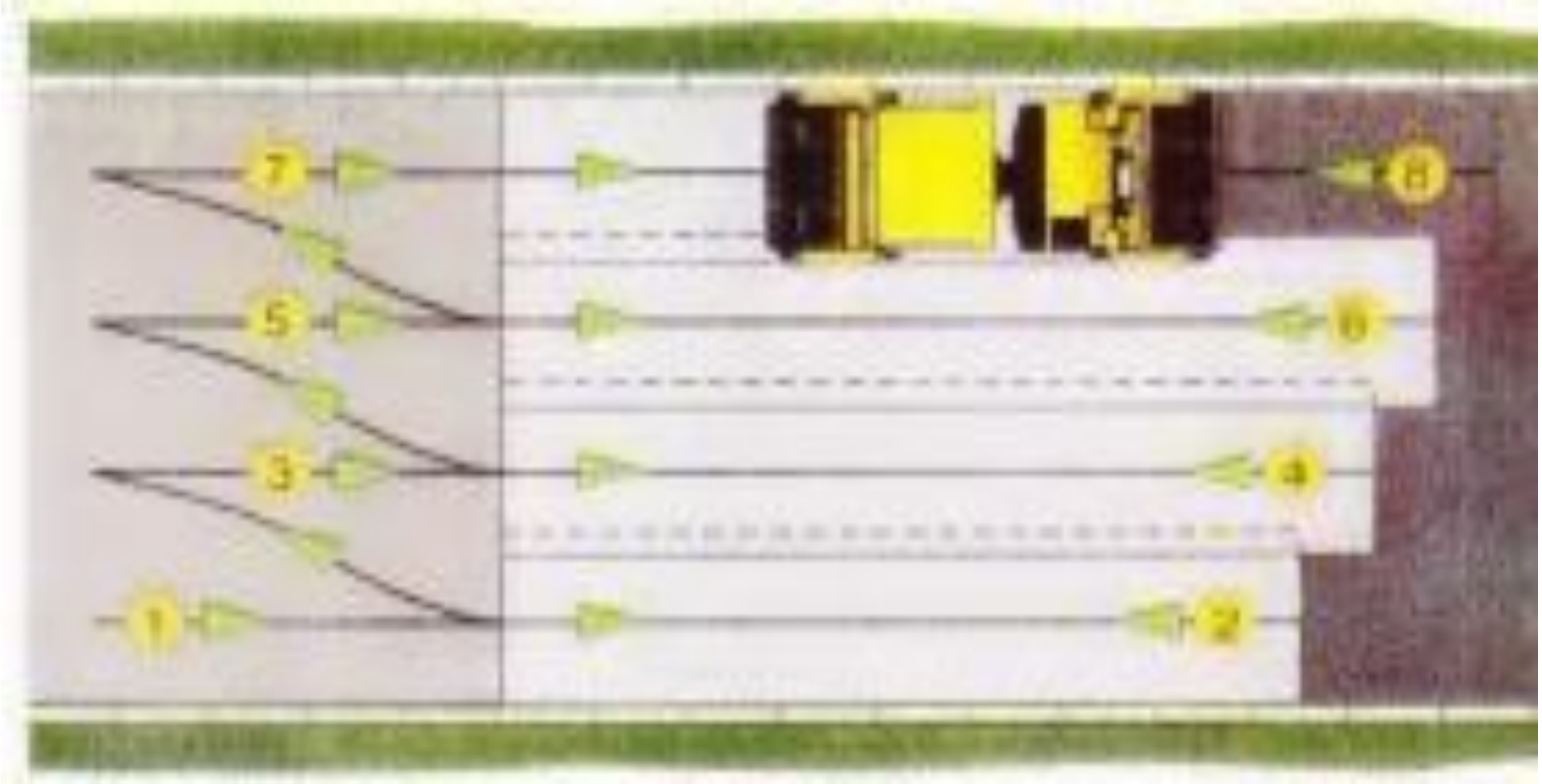
- Compactive effort
- MOISTURE CONTROL
- Soil type
- Thickness of lift
- Smooth Wheel Rollers
- 8 – 10 tonnes; 20 tonnes

- Vibratory Rollers
- Rolling speed 3 to 6 kmph
- Frequency 25 to 30 Hz
- **Amplitude 1.5 to 2 mm (soil)**





Rolling Pattern



Materials/Borrow pit

- From cutting for nearby sections of the road
- From excavation for improving sight distances
- By sectioning an adjacent waterway where necessary
- By excavating cuts to lead drainage water away from the road
- By excavating side drains and catch water drains
- From wasteland outside the roadland
- From humps above the general ground level within the roadland
- By excavating tanks
- From the land acquired temporarily outside the roadland
- From soil mounds resulting from the digging of wells

Borrow pit

- Should be rectangular in shape and parallel to road alignment
- Should be minimum 5 m away from toe
- Depth of cutting should check the imaginary line
- Should not be dug continuously
- Provide adequate drainage
- From cultivated land, top soil should be preserved
- Should not be dug within 800 m of town and village limits
- Preferably depth of digging shall be 30 cm
- Borrow pits on river side
- Borrow pits on landside

Filter Material

Sieve Designation	Class I	Class II	Class III
53 mm	-	-	100
45 mm	-	-	97-100
26.5 mm	-	100	-
22.4 mm	-	95-100	50-100
11.2 mm	100	48-100	20-60
5.6 mm	92-100	28-54	4-32
2.8 mm	83-100	20-35	0-10
1.4 mm	59-96	-	0-5
710 micron	35-80	6-18	-
355 micron	14-40	2-9	-
180 micron	3-15	-	-
90 micron	0-5	0-4	0-3

Embankment

Embankment

Embankment

Construction procedure of embankment

- Site clearance
- Dozer, excavator, grader, et.,
- Preserving top soil (if required)
- Identification and selection of material
- Dewatering
- Setting up construction limits
- Determining the compaction pattern (control section)
- Placing the Material
  - Fill to required thickness
  - **Drainage requirements**
- Moisture check
- Spreading
  - Grader
- Compaction
  - Rollers and plate vibrators
- Density check
- Acceptance
- Subsequent lift placement

Unsuitable Materials

- **Fly ash**
- Produced from coal based thermal power plants
- 90 million tonnes
- Utilization 13%
- **Types**
- Bottom ash
- Pond ash

Fly ash

- Bulk utilization in embankments
- Environmental protection
- Alternate to borrow soil
- Properties
  - Type of coal
  - Pulverization
  - Combustion techniques
  - Disposal systems

Typical Properties of Fly ash (Pond ash)

Parameter	Range
Specific Gravity	1.90 –2.55
Plasticity	Non-Plastic
Maximum Dry Density (gm/cc)	0.9 –1.6
Optimum Moisture Content (%)	38.0 – 18.0
Cohesion (kN/m^2)	Negligible
Angle of Internal Friction (φ)	30°- 40°
Coefficient of Consolidation C_v (cm^2/sec)	1.75×10^{-5} - 2.01×10^{-3}
Compression index C_c	0.05– 0.4
Permeability (cm/sec)	8×10^{-6} - 7×10^{-4}
Paritcle Size Distribution (% of materials)	
Clay size fraction	1 – 10
Silt size fraction	8 – 85
Sand size fraction	7 – 90
Gravel size fraction	0 – 10
Coefficient of Uniformity	3.1– 10.7

Construction Practice

- Clearing and Grubbing
- Stripping and storing of top soil
- Setting out limits
- Dewatering if any

- Preparation of Ground supporting embankment
  - Loosing and compaction
  - Drainage layers/Capillary cut off
  - Geotextiles
  - Bottom ash

Handling and transportation

- Transported to site
- Excess of moisture
  - Change of lifting areas
- Stockpiling
  - shall be avoided; if not
- Adequate moisture
- Protection cover
- » Polythene sheet
- » Earth cover

Spreading and compaction

- Provision of side cover with core
- Compaction
  - Small vibratory compactor – 100 – 150 mm
  - Medium weight roller – 250 mm
  - Vibratory rollers
- Up to 400 mm
- Initial two passes shall be without vibration
- Static roller
  - Not more than 200 mm
  - Cover soil maximum particle size 50 mm