UNIVERSITY OF GONDAR

INSTITUTEOF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEEREING

RAILWAY & TUNNEL CONSTRUCTION
(CoTM 4203)
Chapter Two: Railway Line and Sub Grade

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Railway Line

- ✓ **Proper surveying is required for construction of new railway line between two places.**
- ✓ **Several stages are involved to propose suitable alignment for new railway**

Railway Line

Railway line surveying should consider the following stages.

- Validation of new railway line construction
- Marking of tentative alignments
- Reconnaissance survey
- Selection of good alignments
- Preliminary survey of alignments
- Final alignment survey
- Final survey report

Viability of New Railway line Construction

When there is a demand for new railway, it is important to justify the viability of the line by considering:

- The total people living in the area
- The population habits, living standards and economic condition
- The number of bridges, culverts and tunnels
- The number of industries in the line
- The presence of agricultural, natural and industrial resources.
- The presence of religious places, business centers and markets

Marking of Tentative Alignments

When marking is done the following should be considered:

- The alignment marked should be as short as possible
- It should pass through less valuable lands
- It should not pass through high value lands like center of cities and valuable structures
- The alignment should be marked on ridge lines to eliminate the earth filling cost
- If there is valley or depressions then it is better to avoid
- The alignment should be as straight as possible
- The alignment should not pass through religious places, temples, churches, mosques, burial grounds
- The alignment should cross the river perpendicularly

Reconnaissance Survey

The next stage is reconnaissance Survey:

1. By using compass find lines of alignments
2. The area 100 meter radius is studied
3. Presence of water table level is determined
4. Perform soil survey
5. Count the number of bridges and culverts
6. Count the number of crossing points like rivers and roads
7. Count the number of curves along the alignment
8. Determine the slope of ground
9. Observe construction materials availability and its transportation methods
10. Observe availability of labor and places for camp
11. Record rainfall and discharge by the river of past 10 years
12. If the alignment passed through a private property or land, record its details of owner. Then the owner will receive compensation from the government
13. An index map is prepared for all the alignments with their details.

Selection of Good Alignments

A good alignment:

- Is always short and economical
- Can generate considerable amount of revenue
- Consists minimum number of bridges or culverts in its way
- Earth filling is as minimum as possible
- Alignments consisting vertical curves are eliminated
- Construction material and labor availability is as near as possible.
- Connect all the important areas in that region
- Location of stations should be easily reachable for passengers

Final Survey report

When final survey alignment is completed then a report is prepared for the final alignment and submitted to approval.

The report includes:

1. Project introduction
2. Necessity of project
3. Justification of final alignment
4. Details of final alignment like its length, area, number of bridges, culverts, crossings
5. Estimation sheet
6. Specification details
7. Revenue expected
8. Recommendation of project

Maps

The following maps are prepared:

1. Map of the area through which alignment will pass
2. Route survey map
3. Longitudinal section of alignment
4. Cross section of alignment
5. Station yards map
6. Drawings of culverts, bridges, tunnels to be constructed along the alignment
7. Drawings of station yards buildings

Railway Subgrade

- The subgrade is a platform upon which the track structure is constructed.
- Railway subgrade insures the track quality reaches its standard of the safe and comfortable running of trains.
- So it is very important substructure component which has a significant influence on track performance and maintenance.

The railway subgrade should fulfil the following functions

- Enable passenger and fright trains to run safely at design speed
- Support the heavy axle loads imposed by freight trains
- Minimize future track maintenance cost

Cont…

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Cont…

These functions can be achieved by:

- ✓ Limiting settlements of the original ground and consolidation within the embankment filling
- ✓ Provide an arrangement that will be stable under the imposed railway loading and weight of the earthworks
- ✓ Ensuring that the condition of the formation does not deteriorate during its working life.

Geotechnical Analysis of Subgrade

Before constructing new railway lines, a geotechnical investigation is performed and it should indicate:

- Whether materials are available on site or will require fill to be imported
- Where weak ground requires treatment before filling
- The measures necessary to ensure the stability of earthwork slops in the long term
- Where cuttings require particular drainage or protective measures
- The appropriate type of plant to be used for cut and fill operations

Geotechnical Classification of Soils

- A general knowledge of the basic parameters of the mechanical behavior of the ground soil is essential.
- The classifications are based on characteristics of:
  - ✓Granulometric grade
  - ✓Attrberg limits (liquidity, plastic and shrinkage limits)
  - ✓CBR index

Classification of Railway Subgrade

The mechanical behavior of the subgrade is classified as followed:

- Low settlements and very good support of train loads. This subgrade designated as S_3.
- Medium settlements and withstands train loads. This subgrade designated as S_2.
- Large settlements and less satisfactory support of loads. This subgrade designated as S1.
- Extensive settlements and poor performance in withstand loads. This subgrade designated as S_o.

Cont…

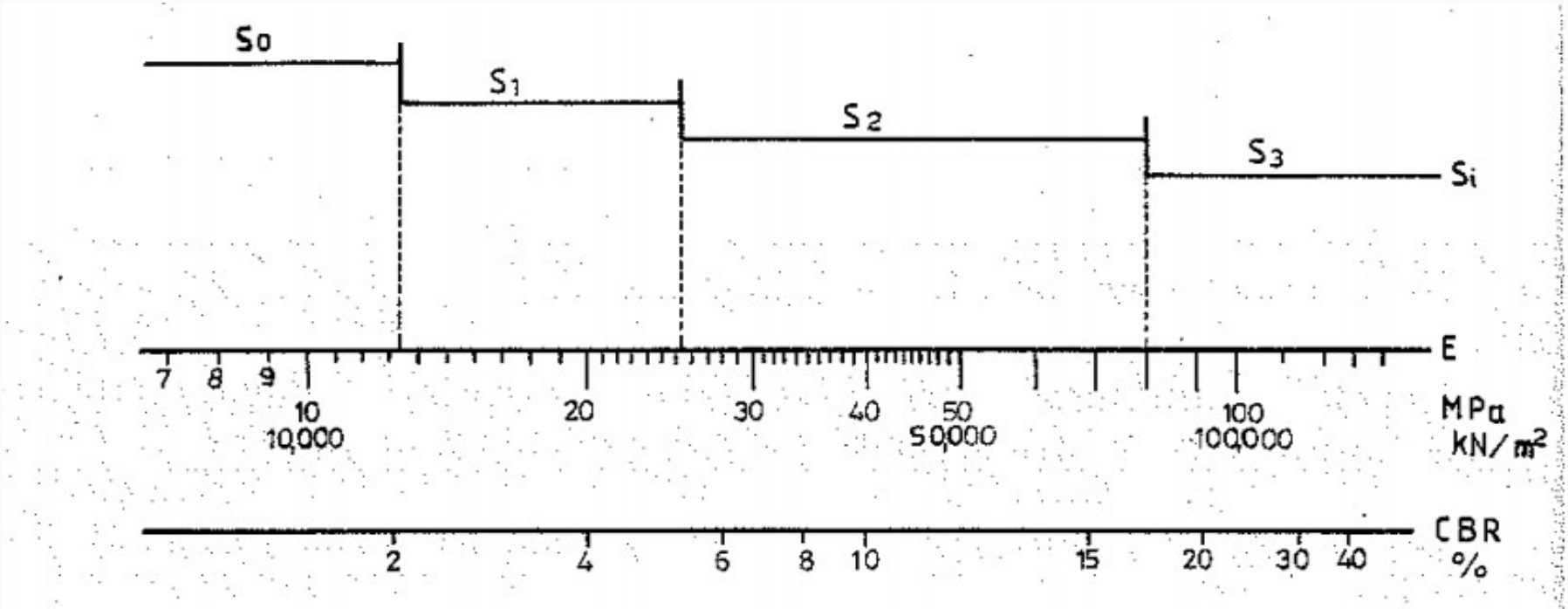
- Soils of category So are unsuitable to support the track properly because they are:
  - Inhomogeneous
  - Change their characteristics through time
  - Allow penetration of stones in to the subgrade
- Organic soils should be avoided or replaced by appropriate soil materials.

Mechanical Characteristics of Subgrade

- The role of subgrade is to withstand train loads.
- In order to withstand loads properly, the subgrade should have the required mechanical properties.
- The modulus of elasticity of subgrade determines its carrying capacity.

Cont…

Modulus of elasticity and CBR index for various subgrade soil.



Formation Layer

- If subgrade soil used is classified S1 or S2, it is advisable to place a top layer composed of a better quality sol material
- This layer is termed as the formation layer.
- The formation layer should be more compact than the base.
- The thickness of the formation layer is defined as a function of the sub grade quality.

Cont…

Use of formation layer leads to a substantial improvement in the subgrade behavior only if the following requirements are meet:

- The base material should have a low water content, otherwise the base soil particles will penetrate the formation layers, destroying the transvers slope.

- The formation layer should be homogeneous and free of local concentrations of fine grained materials.

Geotextiles in Railway subgrade

- Railway subgrades of medium, bad or very bad quality can be improved through the use of geotextiles.
- Geotextiles are permeable geomembranes consisting of polyester fibers.

There are two large geotextile classes:

1. woven geotextiles: composed of two perpendicular fiber layers
2. Non woven geotextiles: the fibers are laid randomly

Cont…

Geotextiles have a large deformability.

They are used:

- To separate two consecutive layers of granular materials
- To reinforce a soil layer of insufficient mechanical strength
- For drainage

Cont…

Purposes of geotextiles

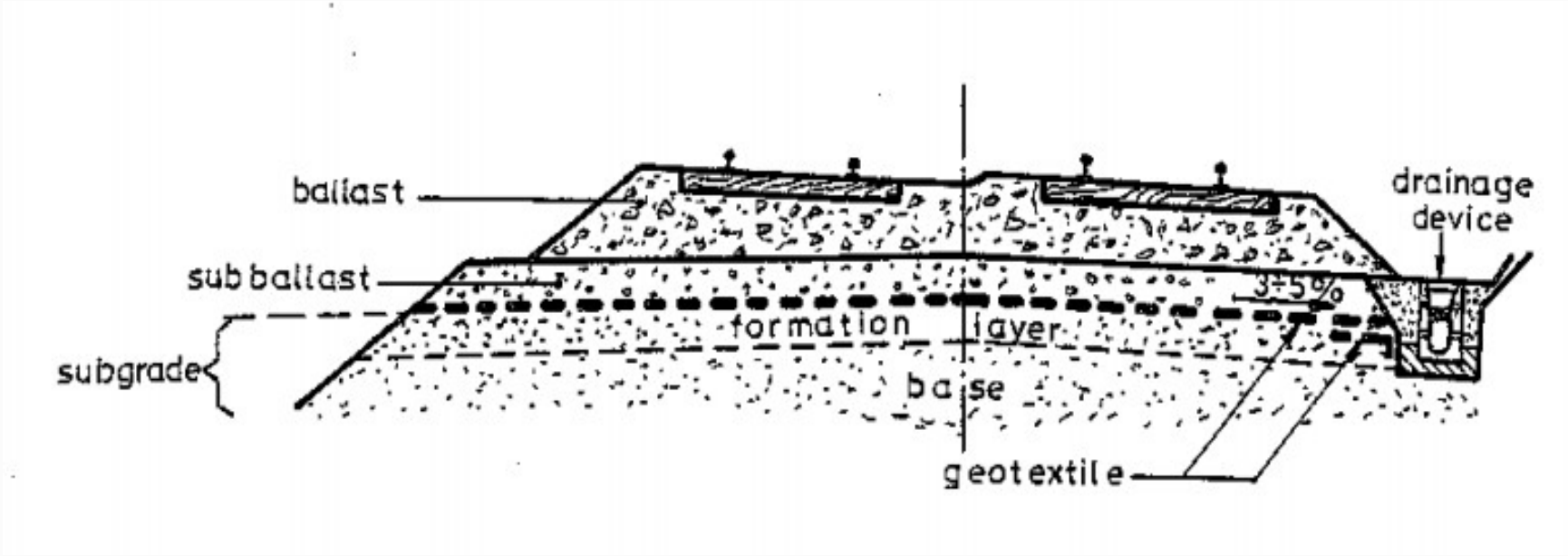
1. To facilitate proper and convenient laying of track support strength on the subgrade

2. To increase the mechanical resistance of the track support structure

3. They function as filters or as drains

Cont…

Proper laying of geotextile on railway subgrade.



Cont…

- They are commonly used to separate the gravel sub ballast from the subgrade soil material.
- The use of geotextiles reduce track maintenance expenses
- The geotextile installation expense is thus pay back very quickly

Railway Gauges

2.1. Type of gauges

2.2. Problems of multi-gauge system



Gauges

Definition:-

It is the clear distance between two parallel rails laid.



Types of gauges

1. ***Standard gauges (SG)*****-1435mm (66%) Uk, USA, CANADA, TURK, CHAINA…**
2. ***Broad gauges(BG)*****-1676mm(15%) –India ,Pakistan ,Brazil ,Argentina, Russia**
3. ***Meter gauge(MG)*****-1000 -1076mm mm(17%) – India, France, Argentina, Switzerland , Africa, Japan , Australia, New Zealand**
4. ***Narrow gauge(NG)*** **610-762mm**

Gauge Selection

1. Cost of construction

- ✓ Land components of earth work, proportional increase
- ✓ Bridges, marginal increase
- ✓ Buildings, signals
- ✓ Rolling stock, independent

2. Physical features of the country

- ✓ Gradient
- ✓ Curves
- ✓ Narrow gauge is more suitable to the above conditions

3. Traffic

- ✓ gauges (high volume and speed increase)
- ✓ Traction/signaling independent
- ✓ Operating cost per tone-km reduces with wider gauge

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Choice of a Gauge

- Forecasted travel demand and movement of goods by train -should be economical for construction and subsequent operation.
- Geometric standards are different for different gauges. Difficult terrain e.g. hilly, broken, restricted or marshy, poses much more problems in achieving these standards.
- National security requirements, area exploration and such like specific needs may dictate laying of a particular gauge track.

Multi gauge problems

- Inconvenience to passengers
- Change of plat forms
- Climbing or crossing forms
- Man power required for luggage transfer
- Hauling of luggage
- Tensions, regarding catching the link train
- Transfer during night time
- Transshipment of goods
- damage to goods, theft, storage facilities required, miss handling

Cont…

Non Uniformity in Gauge results:

- Unwanted delay and costs
- Increase cost of transportation, chances of theft, misplacement and damage.
- A station with two gauges requires two sets of equipment and facilities.



Thank You!