RURAL ROADS
Classification of Highways

Primary System
Expressways
National Highways (NH)

Secondary System
State Highways (SH)
Major District Roads (MDR)

Rural Roads
Other District Roads (ODR)
Village Roads (VR)
1) Why Roads are required?
   a) Providing good road network is very essential for development of Country.
   b) Social, economic and educational development of villages greatly depend on accessibility.
   c) Benefit farmers/villagers and transportation of agricultural products.
   d) Building good quality rural roads is a particular skill in itself, requires proper planning, supervision, good workmanship, the selection of the correct technology and work methods.
2) Why **codes** are prepared/needed?

- To have **uniform** system of adoption.

3) What are the rural roads codes to be followed?

- Rural Roads Manual IRC **SP:20 – 2002**.
SURVEY, PLANNING, DESIGNING AND ESTIMATION:

a) **Project for Rural Connectivity** to provide all weather access should be prepared Gram Panchayat wise after conducting reconnaissance survey.

b) The roads selected must connect one or more important roads to take the products of the areas to the *nearby market*.

c) Based on the topographical survey and longitudinal sections, the *embankment height* of the road should be finalized and estimate prepared accordingly.

d) **Side drains** should be provided along the road side keeping shoulders after the road slope.
e) Demarcation on the land proposed for road should be made with the help of the concerned revenue authorities and **boundary pillars fixed at 30-50 meter intervals** preferably.

f) Road should be planned and designed so as to have minimum number of curves and the **total number of curves in one kilometer should generally be less than 6.**

f) **Cross drainage works** should be properly designed and form part of the estimate and constructed simultaneously for the durability and all weather access. For more details, **design and specification should follow the “Specifications for Rural Roads” issued by MoRD.**
**Alignment**: The direction of the centre line of the road.

**Carriageway**: Portion of the *roadway intended* for the movement of vehicles.

**Camber**: The carriageway camber consists of a straight line cross-fall from the centre line to the shoulders. In curves super-elevation to be maintained sloping from outer curve to inner curve.

**Centre line**: A theoretical line along its longitudinal axis *dividing the road* equally in two parts.

**Crown**: The highest point of the road, located on the centre line when the surface is shaped with a camber.

**Sub-grade**: The existing natural soils on which the road pavement is placed.

**Road formation**: The surface of the sub-grade in its final form after completion of the earthwork.

**Gravel course**: The top layer of a gravel road. Also referred to as a surface course or gravel wearing course.
- **Roadway**: The area normally used by the traffic, consisting of the carriageway and shoulders.

- **Shoulders**: The point at which the side slope of the ditch and the carriageway intersect.

- **Side drain**: The drainage channel along the shoulders of the road which collects run-off water from the carriageway and which prevents water from the surrounding terrain from reaching the road surface.

- **Side slope**: The portion of the side drain from the shoulder break point to the ditch invert (side drain)

- **Drainage Culvert**: A drainage structure allowing water to pass under the road pavement to be discharged on the lower side of the road.
Road Composition

Base

Black Topping

Sub Grade

500mm

Sub Base

450

Sub Grade

Embankment

Ground Level
Typical Road Profile

**Typical Road Profile**

- **Shoulders**
- **BT. Surface**
- **Base**
  - Close Graded Granular Sub-Base (CBR ≥ 30%)  \( R_c ≥ 98\% \)
  - Coarse Graded GSB (CBR ≥ 30%)  \( R_c ≥ 98\% \)
- **Sub-Grade** (CBR ≥ 10%)
  - M.D.D. ≥ 1.75 g/cc  \( 500 \text{ MM} \)
  - Relative Compaction (R.C) ≥ 97%  
- **Embankment**
  - M.D.D. ≥ 1.52 g/cc  \( \text{upto 3M Height} \)
  - Relative Compaction ≥ 95%
  - M.D.D. ≥ 1.60 g/cc  \( \text{above 3M Height} \)
  - Free Swell Index <50%, LL <70% and PI<45%
(a) Road in straight (tangent section)

(b) Road in curve
GEOMETRIC DESIGN

- Horizontal Profile
- Vertical Profile
- Treatment for intersections

As Per IRC SP:20:2002
<table>
<thead>
<tr>
<th>Terrain</th>
<th>Distance, m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plain and Rolling</strong></td>
<td></td>
</tr>
<tr>
<td>Open Areas</td>
<td></td>
</tr>
<tr>
<td>Width between Building lines</td>
<td>25 / 30*</td>
</tr>
<tr>
<td>Width between Control lines</td>
<td>35</td>
</tr>
<tr>
<td>Built-up Areas</td>
<td></td>
</tr>
<tr>
<td>Distance between Building line and Road Boundary (setback)</td>
<td>3 – 5</td>
</tr>
<tr>
<td><strong>Mountainous and Steep</strong></td>
<td></td>
</tr>
<tr>
<td>Distance between Building line and Road Boundary (setback)</td>
<td>3 - 5</td>
</tr>
<tr>
<td></td>
<td>NORMAL</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Open in Plain and Rolling</td>
<td>15</td>
</tr>
<tr>
<td>Built-up in Plain and Rolling</td>
<td>15</td>
</tr>
<tr>
<td>Open in Mountainous &amp; Steep</td>
<td>12</td>
</tr>
<tr>
<td>Built up in Mountainous &amp; Steep</td>
<td>12</td>
</tr>
</tbody>
</table>
ROAD WIDTH

- Plain and Rolling – 7.5 m
- Mountainous and Steep – 6 m
- If Projected Traffic < 100 motorized vehicles and when Traffic is not likely to increase, the roadway width may be restricted to 6 m
- Roadway Width at Culvert (Plain and Rolling) – 7.5 m
- Roadway Width of Culvert in Mountainous or Steep Terrain – 6 m
- Roadway Width at Bridges – 5.5 m (4.25 m)
Carriageway Width = 3.75 m

When Traffic Intensity < 100 motor vehicles/day, width may be restricted to 3 m
## Recommended Camber

<table>
<thead>
<tr>
<th>Type of Pavement</th>
<th>Camber (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid pavement</td>
<td>2.0 to 2.5</td>
</tr>
<tr>
<td>Thin Bituminous Pavement</td>
<td>3.0 to 3.5</td>
</tr>
<tr>
<td>WBM and Gravel Road</td>
<td>3.5 to 4.0</td>
</tr>
<tr>
<td>Earthen Road</td>
<td>4.0 to 5.0</td>
</tr>
</tbody>
</table>
OTHER GEOMETRICS

- Side Slopes in Embankment in Silty/Sandy/Gravelly Soil – 2:1
- Embankment in Clay/Clayey Silt – 2.5:1 to 3:1
- Camber
  - WBM or Gravel Road – 3.5 to 4%
  - Thin Bituminous Surface – 3 to 3.5 %
- Camber for Shoulder – Min. 4% (Generally 1% more than the camber for pavement)
## Design Speed for Rural Roads

<table>
<thead>
<tr>
<th>Terrain</th>
<th>Design Speed, Kmph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ruling</td>
</tr>
<tr>
<td>Plain</td>
<td>50</td>
</tr>
<tr>
<td>Rolling</td>
<td>40</td>
</tr>
<tr>
<td>Mountainous</td>
<td>25</td>
</tr>
<tr>
<td>Steep</td>
<td>25</td>
</tr>
</tbody>
</table>
OTHER PARAMETERS IN HORIZONTAL ALIGNMENT

- Sight Distance
  - Stopping Distance
  - Intermediate Sight Distance
  - Overtaking Sight Distance
- Radius of Horizontal Curve
- Transition Curves
- Super Elevation
- Widening at curves.
VERTICAL ALIGNMENT

- Design of Gradients
  + Ruling
  + Limiting
  + Exceptional
- Design of Vertical Curves
  + Summit Curve
  + Valley Curve
- Design of Hairpin Bends
OTHER REQUIREMENTS

- Lateral Clearance
- Vertical Clearance
- Intersection with Other Roads
- Road Appurtenances
# REVIEW OF GEOMETRIC DESIGN STANDARDS FOR RURAL ROADS IN PLAINS

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>As per IRC:SP:20 (Rural Roads Manual)</th>
<th>Amendments proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Classification</td>
<td>(a) Other District Roads (b) Village Roads</td>
<td></td>
</tr>
</tbody>
</table>
| 2  | Carriageway width                   | 3.75m but can be reduced to 3.00m where traffic less than 100 motorised vehicle per day.                                                                                                                                              | (a) Through Roads : 3.75 m  
(b) Link Roads* : 3.00 m  
* If a link road carries traffic more than 100 motorised vehicles per day, the carriageway width will be 3.75 m. |                      |
| 3  | Roadway width minimum               | ODR and VR : 7.5 m for traffic more than 100 motorised vehicles per day  
6.0 m for traffic less than 100 motorised vehicles per day                                                                                                                                                                          | (a) Through Roads : 7.5 m  
(b) Link Roads : 6.0 m |                      |
|    | Notes                               | (i) The widths indicated are for roads in straight. These are to be increased on horizontal curves.                                                                                                                                  | (i) For curves see item 4 below.  
(ii) Provide passing places at suitable locations on link roads if formation 5.0 m or less.                                                                                                                                          |                     |
### Review of Geometric Design Standards for Rural Roads in Plains

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>New Construction</td>
</tr>
<tr>
<td>4.</td>
<td>Widening at Curves</td>
<td>Widening of Pavement and Roadway</td>
<td>Widening of Pavement and Roadway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upto 20 m radius – 0.9 m</td>
<td>Upto 20 m radius – 0.9 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21 – 60 m radius – 0.6 m</td>
<td>21 – 60 m radius – 0.6 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 60 m radius - Nil</td>
<td>More than 60 m radius - Nil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Existing Roads (Tolerances that can be considered)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For existing roads, widening of pavement and roadway can wait unless there is evidence of safety hazard.</td>
</tr>
<tr>
<td>5.</td>
<td>Width of Bridges</td>
<td>5.5 m</td>
<td>Clear width between kerbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.25 m where traffic less than 100 motorized vehicles per day</td>
<td>Through roads : 5.5 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Link roads : 4.25 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Notes:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(i) If the link road carries traffic more than 100 motorised vehicles per day, the width of bridge may be 5.5 m.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) The design of bridge where width is kept as 4.25 m should be such as can be widened easily later.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(iii) Cautionary sign posts of narrow bridge should be provided on all bridges having width as 4.25 m.</td>
</tr>
<tr>
<td>6.</td>
<td>Roadway width of culverts and causeways</td>
<td>7.5 m</td>
<td>(a) Through Roads : 7.5 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(b) Link Roads : 6.0 m</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Notes</td>
</tr>
<tr>
<td></td>
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<td>(i) The widths indicated are for roads in straight. These are to be increased on horizontal curves.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For existing culverts, widening may be undertaken at the time of replacing the old and dilapidated/distressed culverts and causeways unless there is evidence of safety hazard.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Need to provide cautionary sign posts</td>
</tr>
</tbody>
</table>
# Review of Geometric Design Standards for Rural Roads in Plains

As per IRCSP:20

Applicable for both Through roads and Link roads

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Minimum radius of horizontal curves</td>
<td>As per IRCSP:20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plain Terrain</td>
<td>Rolling Terrain</td>
</tr>
<tr>
<td>(i) ODR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruling</td>
<td></td>
<td>90 m</td>
<td>60 m</td>
</tr>
<tr>
<td>Absolute Minimum</td>
<td></td>
<td>60 m</td>
<td>45 m</td>
</tr>
<tr>
<td>(ii) VR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruling</td>
<td></td>
<td>90 m</td>
<td>60 m</td>
</tr>
<tr>
<td>Absolute Minimum</td>
<td></td>
<td>60 m</td>
<td>45 m</td>
</tr>
</tbody>
</table>

Applicable for both Through roads and Link roads

<table>
<thead>
<tr>
<th></th>
<th>New Construction</th>
<th>Existing Roads (Tolerances that can be considered)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plain Terrain</td>
<td>Rolling Terrain</td>
</tr>
<tr>
<td>Ruling</td>
<td>90 m</td>
<td>60 m</td>
</tr>
<tr>
<td>Minimum</td>
<td>60 m</td>
<td>45 m</td>
</tr>
<tr>
<td>Exceptional</td>
<td>40 m</td>
<td>35 m</td>
</tr>
</tbody>
</table>

Need to provide cautionary sign posts where these requirements are not met due to constraints of land acquisition.

(i) Through roads

For existing roads, the horizontal geometry up to absolute minimum may be considered acceptable unless there is evidence of site-specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.

(ii) Link roads

For existing roads, the existing horizontal geometry may be considered acceptable unless there is evidence of site-specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.

Need to provide cautionary sign posts.
## REVIEW OF GEOMETRIC DESIGN STANDARDS FOR RURAL ROADS IN PLAINS

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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>New Construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plain Terrain</td>
<td>Rolling Terrain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ruling Gradient</td>
<td>3.3 % 3.3 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limiting Gradient</td>
<td>5 % 5 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exceptional Gradient*</td>
<td>8 % 10 %</td>
</tr>
<tr>
<td>8.</td>
<td>Longitudinal gradients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For existing roads, the existing vertical curves upto limiting gradient may be considered acceptable. Gradients steeper than limiting gradient but upto exceptional gradient in short stretches could also be considered acceptable unless there is evidence of site-specific problem. Need to provide cautionary sign posts.</td>
</tr>
</tbody>
</table>

*Length of exceptional gradient not to exceed 200m at a stretch. Successive stretches to be separated by a minimum length of 100 m with gradient ruling or gentler*
PAVEMENT DESIGN
OBJECTIVES OF PAVEMENT DESIGN

- To provide a stable surface under the wheel loads.
- To provide good riding surface.
- To have durability.
- To have cost effectiveness.
REQUIREMENTS OF PAVEMENTS

- Better load dispersion.
- To limit elastic deformation.
- To arrest capillarity.
Subgrade
Sub-base course
Base course
Wearing course
ENVIRONMENTAL CONSIDERATIONS

◊ Location of Subgrade w.r.t. Water Table
◊ Height of Embankment – Slope Stability
◊ Settlement of Embankment
◊ Settlement of Embankment Foundation
Principal Criterion – Vertical Compressive Strain – Rutting on Pavement Surface

Traffic
- Commercial Vehicles of Laden Weight more than 3 t
- Existing Traffic Volume & Rate of Growth for Upgradation

For New Construction – Anticipated Traffic, Needs Estimation
- If Adequate data not Available, assume 6% Growth Rate
- Design life 10 years.
Subgrade strength parameter is evaluated in terms of 4-day soaked CBR, except in areas with annual rainfall less than 500 mm and where the water table is too deep.

Traffic parameter is evaluated in terms of number of Commercial Vehicles Per Day (CVPD).

Design Curves A, B, C, D for different categories of traffic namely 0-15, 15-45, 45-150 and 150-450 CVPD.

Type of surface is given as matrix with rainfall and traffic intensity parameters.
DESIGN CATALOGUE AS PER IRC SP 20
DESIGN CRITERIA

For Unpaved Roads

- Serviceability over the design life is limited to 2, when rehabilitation will be due with or without overlay.
- Allowable rut depth under a 3 m straight edge is generally not more than 50 mm.

For Paved Roads

- The thickness of Flexible Pavement (Paved) is based on structural number recommended by AASHTO for Low Volume Roads at 50% reliability level.
300 mm of soil just beneath the pavement crust is treated as subgrade.

Sub-grade to be compacted in two layers to 100% MDD achieved by Standard Proctor Test. Minimum dry density is $16.5 \text{ k N/m}^3$.

During soil survey depth fluctuation of ground water table need to be recorded.
The following 4 methods are available for the estimation of sub-grade CBR:

- By IS Soil classification.
- By using nomogram.
- By empirical formulae.
- By conducting actual CBR.

Typical presumption design CBR Values

<table>
<thead>
<tr>
<th>Description of Subgrade Soil</th>
<th>IS Soil Classification</th>
<th>Typical Soaked CBR Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Plastic Clays and Silts</td>
<td>CH, MH</td>
<td>* 2-3</td>
</tr>
<tr>
<td>Silty Clays and Sandy Clays</td>
<td>ML, MI, CL, CI</td>
<td>4-5</td>
</tr>
<tr>
<td>Clayey Sands and Silty Sands</td>
<td>SC, SM</td>
<td>6-10</td>
</tr>
</tbody>
</table>
The in-situ sub-grade strength of an existing road will be determined in terms of CBR value on re-moulded to the insitu density at the field equilibrium moisture content, after the recession of the rainy season.

If the above is not possible 4 days soaked CBR is taken, as design CBR.

CBR can be determined by using Dynamic Cone Penetrometer (DCP).
<table>
<thead>
<tr>
<th>Quality of Sub-grade</th>
<th>Class</th>
<th>Range (CBR%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor</td>
<td>$S_1$</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>$S_2$</td>
<td>3 – 4</td>
</tr>
<tr>
<td>Fair</td>
<td>$S_3$</td>
<td>5 – 6</td>
</tr>
<tr>
<td>Good</td>
<td>$S_4$</td>
<td>7 – 9</td>
</tr>
<tr>
<td>Very Good</td>
<td>$S_5$</td>
<td>10 – 15</td>
</tr>
</tbody>
</table>

* Where the CBR of sub-grade soil is less than 2, the economic feasibility of replacing 300 mm sub-grade with suitable soil needs to be explored and, if found feasible, the pavement should then be designed based on the CBR value of the improved sub-grade. Alternatively, a capping layer of thickness not less than 100 mm of modified soil (with CBR not less than 10) should be provided.
Adequate provision of Cross Drainage Structures as per requirement is a must.

The Cross drainage and longitudinal drainage are to be integrated for effective drainage management.

Shoulders will increase the life of the pavement and therefore are to be properly made as per the provisions made in the code.
GRAVEL ROAD
WBM with gravel
MARK OUT OF THE ROAD
CONSTRUCTION MATERIAL

1) Soil:
- The only material that can be used for the sub-grade is natural soil.
- All soils are composed of sand, silt and clay in varying proportions;
- the proportions of the material and their properties affect their stability under load. An ideal road material is one in which all these are present in proper proportions so as to obtain the maximum stability.
- An intimate and compact mixture of the following will make a stabilized soil:
  - Sand--- 70 to 85 %,
  - Silt-------10 to 20 %,
  - Clay-------5 to 10 %,
- It will be usually sufficient to have 70 % sand and 30% clay and silt.
2) Gravel:

Gravel roads are a layer of compacted gravel (or crushed rock) graded from fines to pebbles, containing binding stuff (clay) in the fines. Sandy and gravel material should meet the grading requirement. The size and grading of the gravels should vary from 53mm at the bottom to 75 mui at the top. If grading is not possible, the following proportions may be taken:

- 25 mm to 20 mm 15%
- 20 mm to 6mm 75%
- Below 6 mm 10%

Washed gravel is devoid of the fines needed to bind the material, and will require the admixture of pulverized clay, about 5 to 10% to act as a binder or alternatively, the proportion of fines passing a 75 micron mesh should be about 10 to 15 percent and sufficient to fill the voids in the gravel. The sand content in the fines should be at least twice as great as the clay content.
3) **Moorum:**

Moorum for road should be in crystal form, strong and hard. The soil content in it should be negligible. The clods of moorum should not be more than 3cm.

4) **WBM:**

**Grade II:** 100mm thick of 63-45mm graded size coarse aggregate (metal) properly consolidated to 75mm thick.

**Grade III:** 100mm thick of 53-22.40mm graded size coarse aggregate (metal) properly consolidated to 75mm thick.

5) **Black topping:** 20mm thick cold or hot mix with tack coat and seal coat.
CONSTRUCTION

a) Alignment:

The alignment of road should be decided to minimise the distance,

- as far as possible on higher elevation and
- the cutting of trees is minimal.
- It should be ensured that there is no hindrance to electricity, telephone and water lines.

The existing alignment should also be examined and if it is convenient, technically fit and economical then it should be used.
STRIP PLAN
(Alignment)
SETTING OF ALIGNMENT
CONSTRUCTION

b) Earthen embankment (sub-grade):

- The proper preparation of earthen embankment i.e. sub-grade for any road is of utmost importance before the road structure (pavement) is laid over it. Unless the foundation is hard and firm and properly shaped, the resulting road will be bad and will remain bad. Special attention must be given to the compaction of the sub-grade and its drainage.

- The soil should be excavated from both the sides of the road, if land is available and suitable in such a way, so that the pits after excavation of soil are linked with each other and side drains are formed.

- The borrow pit should be at least 1.5 meter away from toe of the embankment and the depth of borrow pit should not be more than 0.75 meter.
Compaction of earthen embankment:

- All large clods should be broken up in the borrow pits and no clods larger than a man’s fist should be brought on the embankment. Ramming is not enough for crushing the large clods completely, which can be done effectively only by 8/10 ton rollers. Each layer should be rolled well until all clods are flattened. Any roots, grass, jungle or other rubbish should not be buried in the embankment with the earth.

- The organization of filling, spreading and rolling should be such that newly deposited fill is spread and rolled smooth immediately in order to minimize the loss of moisture.

- Generally the depth of loose soil for compaction should not exceed 15 to 23 cm. If more material is to be compacted it should be done in layers. Rolling should commence at the edges and progress towards the center. Each pass of the roller should be uniformly overlapping not less than one-third of the track made in the preceding pass.
Compaction of earthen embankment:

- The required density of earthen embankment and gravel layer is not possible without use of power roller; therefore, for compaction of earthen embankment to achieve the required density, power roller should be used.
Laying gravel/ Moorum:

- Gravel roads are generally built in two courses, foundation course and surface course. A thickness of about 15 cm after compaction is required for light traffic and about 30 cm after compaction is required for heavy traffic.

- Moorum roads are generally built in one course and thickness of about 20 cm after compaction is required for light traffic.

- Every 15 to 20 cm. thick moorum/ gravel layer should be compacted with static smooth-wheeled roller of 8 to 10 ton weight for prescribed density at optimum moisture content by sprinkling water with trailer mounted water browser.
CONSOLIDATION
Camber:

- The road surface is normally shaped to fall away from the center line to either side. The camber is necessary to shed rain water and reduce the risk of passing vehicles colliding. The slope of the camber is called the cross fall. On sharp bends the road surface should fall directly from the outside of the bend to the inside which is called ‘super elevation’.

- Camber (cross slope) is necessary so that rain water does not stagnate on the road, in gravel/ moorum road **3.5% camber in low rainfall area** (Annual Rainfall less than 1000 mm) and **4% camber in high rainfall area** (Annual Rainfall more than 1000 mm) should be provided.

- Before the gravel road is opened to traffic, the surface should be lightly sanded with coarse sand/ quarry dust etc. so as to have a cover of 6 mm to 12 mm over the whole surface.
CAMBER CHECKING BY FIELD STAFF
Cross Drainage works:

- Structures for cross drainage should be constructed simultaneously after giving proper layout for the durability of the road and all weather access. Minimum earthen **cushion** (500mm) over the pipe for its safety should be ensured.

- For **side walls** (of RR masonry) of culvert/causeway, plastering is not required, pointing is sufficient. On top of the side walls, copping should be made for the durability of the culvert/causeway (preferably in CC).
Culverts:

In General 2-3 culverts may be required per KM length road depending on the topography.

Types of culverts:

1) Pipe Culverts
2) RCC slab culvert on masonry or PCC Abutment
3) RCC Box culvert
4) Vented Causeway
5) Submersible bridge
Design of Culverts:

1. Maximum Flood discharge to be calculated using empirical formulae

a. Dicken’s formula: \( Q = CM^{3/4} \)
   Where \( Q = m^3 /sec \)
   \( M = \) catchment area in sqm
   \( C = \) Constant – 11-14 where annual rainfall is 60-120cm
   14-19 when annual rainfall is more than 120cm
   Western Ghats – 22 adopted

b. Ryve’s Formula: \( Q = CM^{2/3/or 3/4} \)
   Where \( Q = m^3 /sec \)
   \( M = \) catchment area in sqm
   \( C = \) Constant – 6.8 for areas within 25kms of coast
   8.5 for areas between 25-160 kms of coast
   10 for limited areas near hills
2. Slope area method:

\[ Q = AV \]

- \( A \) is mean cross sectional area of flow (to be measured across the stream)
- \( V \) is velocity of flow
- \( V = \frac{1}{n} \left( \frac{R^2}{3S^{1/2}} \right) \)

\( V \) = velocity in m/sec
\( R \) is Hydraulic mean depth in m
\( S \) is slope of bed
\( n \) is coefficient of Rugosity depends upon surface and type of natural stream

3. Foundations:

To be decided based on scour depth.

\[ D = 0.473 \left( \frac{Q}{K_{st}} \right)^{1/3} \]

- \( D \) is depth
- \( Q \) is design discharge
- \( K \) is silt factor

Maximum scour depth:
- \( 2D \) for piers
- \( 1.27D \) for abutments
IMPORTANT QUALITY CONTROL TESTS ON SOILS

a) Liquid Limit and plastic Limit ; % of water content at which the soil enters liquid state.
   - IS: 2720 –part 5 at 2 tests per 3000 cum
   - Liquid limit < 70% and plasticity Index < 45%
   - Liquid limit < 40% and plasticity Index < 20% for earthwork around structures (for a distance of 2 times the height of abutment)

b) Compaction Properties (IS: 2720- part 7&8, standard Procter’s for low traffic and modified Procter’s for high traffic at 2 tests per 3000 cum for finding OMC and MDD

c) Field Moisture Content
   - IS: 2720-part2 at 1 test per 250 cum of soil

d) Field Density by Sand Replacement or Core cutter
   - Method at 1 test per 1000 square metres

e) Relative Compaction
   - = Field Dry Density / Max Dry Density (lab)
   - (95% for Embankment and 97% for sub Grade)
f) CBR (soaked & un soaked): CBR is the ratio of force per unit area required to penetrate a soil mass with a circular plunger 50 mm ø at the rate of 1.25 mm/minute to that required for corresponding penetration of a standard material.

g) Thickness of Embankment and Sub-grade

For Cement Concrete Roads:

a) Cement tests
   i) Initial setting time
   ii) final setting time
   iii) Compressive strength after 3 days, 7 days and 28 days.

b) Strength test on 70.6mm 1:3 cement mortar cubes to determine the grade of cement sand shall be as per IS:650
**Drainage**

*Water* is the main contributor to the wear and damage of low-volume rural roads. The water can be in the form of ground water, surface water (streams and rivers) or rain and it can damage the road in several ways:

a) by washing away the soil (erosion and scouring),

b) by making the road body less resistant to traffic (i.e. weakening the load bearing capacity),

c) by depositing soils (silting) which may obstruct the passage of water.
wheel ruts preventing water from exiting the carriageway

original camber

base course

debri on shoulder preventing water from exiting the carriageway

damaged shoulder causing stagnant water
SOME ROADS FORMED IN NORTH EASTERN STATES UNDER MGNREGS
ARUNACHAL PRADESH
MIZORAM

CONSTRUCTION OF APPROACH ROAD TO BAWNGSUAR UNDER TLANGNUAM RD BLOCK (MGNREGS) (2009 - 2010)
MEGHALAYA
EFFECT OF CYCLONE AILA ON EMBACKMENT IN WEST BENGAL
Road Formation in Hill Slopes:

- Surface seal
- Road shoulder
- Side slope
- Catch water drain
- Side cut
- Side drain
- Culvert
- Stream
Hill Cutting in difficult terrain
Arunachal Pradesh
Side drains

Side drains collect water from the carriageway and surrounding areas and lead it to an exit point where it can be safely discharged. The side drains need sufficient capacity to collect all rainwater from the road carriageway and dispose of it quickly and in a controlled manner to minimise damage. Sides drains can be constructed in the forms either V-shaped, or as a trapezoidal shape.
A Road to the Forest of Madhya Pradesh
INTERNAL ROADS:
i) STONE/ BRICK KHARANJA:
a) The base under the Kharanja pavement must be properly levelled; hollow patches filled up and consolidated with hard core, cambered and cross-falls or longitudinal slopes given. There should be no soft spots present either in the base or the sub grade.
b) Looking to the drainage system and plinth level of houses on both the side of internal road, level of Kharanja should be kept. The moorum should be compacted with DURMUT by adding water in the moorum.
c) After laying 1:6 cement mortar on the moorum layer, the 3 inch thick floor stones/bricks in width i.e. 4.5 inch should be fixed in diamond shape and the joints should be filled up with 1:3 cement mortar.
d) Drain/Nala at proper elevation with proper slope should also be constructed simultaneously.
CEMENT CONCRETE ROAD:

a) The construction of **side drains** (Nala) should be as per availability of land.

- If sufficient land is not available for providing drains on either side, side drain at **one side** to be provided and the slope of the road to be maintained towards side drain.
- If land is not available for providing side drains on either side, the slope should be given from Centre of the road towards outer boundary.

b) The **top level** of the road should be decided based on the plinth level of the houses and drainage of the water from the houses.

c) It is very essential to have a **good solid foundation** of well consolidated and non-absorptive material under a concrete road. The load carrying capacity of a concrete road structure lies mainly in the structural rigidity of the slab and the uniformity of sub grade support. It is therefore necessary to prepare the base in such a way that the concrete slabs are supported as uniformly as possible.
CEMENT CONCRETE ROAD:

d) The base of concrete pavement should be **made smooth** before laying the concrete so as to reduce the co-efficient of friction between the concrete slab and the base

e) The base under the concrete pavement must be **properly levelled**.

  - **hollow patches** filled up and consolidated,
  - **cambered and cross-falls** or longitudinal slopes given.
  - **No soft spots** present either in the base or the sub grade.

f) The excavation for **drain** should also be carried out as per requirement.
that one woman and my own granny [fell and] fractured their legs at the ankle.
Construction Of CC Road And CC Drains In SC Localities In Gorgal Of Maghi GP In Nizamsagar Mandal

C/O C.C ROADS & C.C DRAINS IN SC WADA AT GUDAM UNDER M.G.NREGS.
h) **Cement concrete** by mixing in mechanical mixer should be laid on the surface of sub base after sprinkling water on it and it should be **compacted with vibrator**.

i) After every 4 meter length of concrete slab, 5 mm wide and 70 mm deep **Expansion & Contraction joint** should be given. This joint should be filled up with sand and bitumen.

j) As per requirement **drainage line** from house to CC Drain, PVC pipe of 100 to 150 mm diameter should be laid.

k) On both side of the concrete road, as per availability of land, 20 cm layer of moorum should be filled up.

l) The **curing** of the road should be carried out for **15 days**.
DESIGN PARAMETERS OF CEMENT CONCRETE ROADS

a) Design Wheel load (5100 Kg) and Traffic Intensity

b) Temperature difference between top and bottom of CC pavement and mean daily and Annual temperature cycles

c) Characteristics of sub grade and sub-base

d) Foundation surface characteristics (very smooth, smooth and rough)

e) Design of slab thickness is based on critical stress condition on edges, corners and interiors
Concrete acts more like a bridge over the subgrade. Inch-for-inch much less pressure is placed on materials below concrete than asphalt pavements.
CC PAVEMENT DETAILS

- Slab Thickness
- Surface smoothness
- Longitudinal joint
- Transverse joint
- Surface Texture
- Concrete materials
- Dowel bars
- Tiebars
- Subgrade
- Subbase or base
Separation membrane as per 602.5 (plastic sheet 125 microns thick) being laid over sub-base/base
As per IS code the following waste materials may be used as binder for Rural Roads:

1) Fly ash
2) Iron and steel slag
3) Processed municipal waste
4) Rice husk ash
5) Marble slurry dust waste
6) Recycled concrete
7) Quarry waste and mine waste

Note:
CD WORK USING LOCAL STONES FOR WING WALLS
CD WORK – 2 VENT PIPE CULVERT
CD work with RCC Pipe
MAINTENANCE OF ROADS

- The maintenance work will be considered as a separate work with pre-measurements and post measurements.

- Maintenance of rural roads to avoid blockages and ensure they work properly, thus avoiding damage to the road which includes
  1. The clearing and cleaning of the different road elements,
  2. The carrying out of minor repairs and the creation of basic road protection measures,

This can be achieved by regular inspection of roads by the concerned officers.
Repairing Rills and Gullies

What: Fill in any rills or gullies in the road surface or shoulder caused by water flowing over the road, at the same time removing the cause of the erosion.

Why: So traffic can pass easily and damage to the road surface and road base is avoided.

To avoid the rill or gully being formed again, we guide the water away from the road by creating cross drains, diversion ditches and/or side drains. The material from the excavation of these drains can be used to fill the rills and gullies.

First we place the warning flags to let the road users know we are working here.

We fill in the rills and gullies with suitable material and stones.

When: Whenever rills or gullies are encountered.
Clearing Obstacles And Landslides

What: Remove any landslides or other obstacles (rocks, branches, etc.)

Why: So vehicles can pass easily and water does not flow over the road where it may cause damage

Whenever landslides or other obstacles are encountered, especially during the rainy season.
Clearing Side Drains

**What:** Remove any garbage, earth, stones, vegetation or other material from the side drains and other drainage ditches

**Why:** So water can flow freely through the side drains and does not flow over the road where it may cause damage

**When:** Before the rainy season starts and again during the rainy season if necessary.
Clearing Culverts

What: Remove any earth, stones, vegetation, garbage or other material from inside the culvert.

Why: So that water can flow freely through the culvert and does not flow over the road where it may cause damage.

When: Before the rainy season starts and again during the rainy season if necessary.
The culverts are covered by backfill with a depth at least equal to a quarter of the culvert diameter or minimum 500mm.
DO’s:

i) Sectioning and breaking of clods must be made as a **separate task** after separating from earth work and must be ensured in execution.

ii) **Proper berms** should be provided (minimum of 60cm or equal to height of formation) for the durability and safety of shoulder of the roads.

iii) Slopes must be **trimmed** with designed side slope as per the type of soil and preferably covered with top soil of the trench or borrow pit, which will have high percentage of vegetation.

iv) **Compaction** with power roller in layers at optimum moisture content should be done and monitored to ensure that the desired density of soil and granular material for construction of embankment/sub grade has been achieved.
DAMAGED CD WORK
మహర్షి వాస్తవానికి చేపా శివరాత్రితో కూడా కార్యాలయ వెండి కార్యాలయ మేలుమే సంచాలించా నేండు కుటుంబం జాతీయ భాషా బ్యాక్స్ ని ప్రాతిపదిత చేసాయి.
GULLY IN ROAD SURFACE
CUT IN THE ROAD SHOULDERS
Donot's:

i) Earthen roads become muddy in rainy season and dusty in summer. Such roads do not provide all weather access, therefore, should not be constructed under MGNREGA.

ii) If the work is being executed without proper levelling, without breaking of clods, without sectioning, this results in slipping of slopes, reducing of formation width and getting uneven riding surface.

iii) Power roller is a must for consolidation/compaction of embankment and surfacing, whereas, in most of the cases it is not being used in execution of RCP works. This results in the damage of road in a short time besides having uneven surface from the beginning affecting the durability of road.