FINAL PAPER :: SP 2021

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Q1: Why Ruling gradient is termed as design gradient and how do you compare Ruling gradient with Limiting Gradient and Exceptional gradient?

Ruling Gradient. The gradient, which is usually adopted while making the alignment of the road, is known as the ruling gradient. The ruling gradient is used for designing the road because it gives maximum safety at minimum cost.

1. Ruling gradient

The gradient usually adopted while making the road alignment is called the ruling gradient. It is the maximum gradient within which the designer attempts to design the vertical profile of a road. It is also known as design gradient. As per IRC, the recommended value of ruling gradient for plain or rolling terrain is 1 in 30 or 3.3 %.

2. Limiting gradient

The gradient steeper than the ruling gradient, which may be used for a limited Road length, is called limiting gradient or maximum gradient. It is used where the topography of place compels adopting a steeper gradient than the ruling gradient to minimize the cost of road construction

3. Exceptional gradient

The gradient steeper than the limiting gradient which may be used in a short length of the road, only in an extraordinary situation is called exponential gradient. This type of gradient is adopted only in a very difficult situation and for a short length not exceeding 100 m at a stretch. As per IRC, the recommended value of Exceptional gradient for plain or rolling terrain is 1 in 15 or 6.7 %.

Q2: Discuss the adverse effects of improperly designed valley curve?

Valley Curve

When two grades meet at the valley (sag) and the curve will have convexity downwards, the curve is simply referred as the valley (sag) curve.

As in the case of horizontal curves, the different types of curves according to geometrical configuration are:

1. Circular
2. Quadratic parabola
3. Cubic parabola and other forms of transition curves

V curve or sag curves are vertical curves with convexity downwards. They formed when two gradients meet in any of the following four ways:

1. When a descending gradient meets another descending gradient.
2. When a descending gradient meets a flat gradient.
3. And When a descending gradient meets an ascending gradient.
4. When an ascending gradient meets another ascending gradient

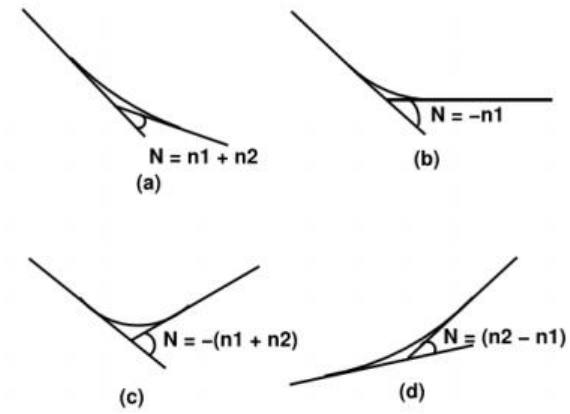
Design Considerations

As compared to the design of summit curve, valleyy curve requires more consideration. During day time the visibility in valley curves not hindered but during night time the only source of visibility becomes headlight in the absence of street lights. And in V curves, the centrifugal force generated by the vehicle moving along a valleyy curve acts downwards along with the weight of the vehicle and this adds to the stress induced in the spring of the vehicle which causes jerking of the vehicle and discomfort to the passengers.

Thus, the most important things to consider during design are:

- Impact and jerking free movement of vehicles at design speed
- Availability of stopping sight distance under headlight of vehicles during night driving

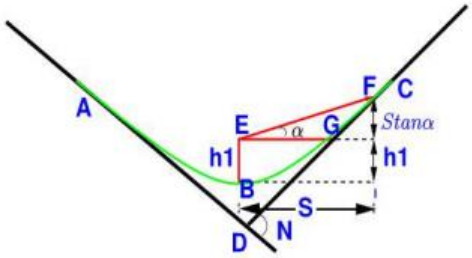
The best shape for a valley curve is transition curve. Some prefer to use the circular curve or quadratic parabola or combined circular spiral curve but mostly cubic parabola generally preferred in vertical valley curves. It made fully translational by providing two similar transition curves of equal length. It is set by cubic parabola $y = bx3$ where $b = 2N / 3L2$



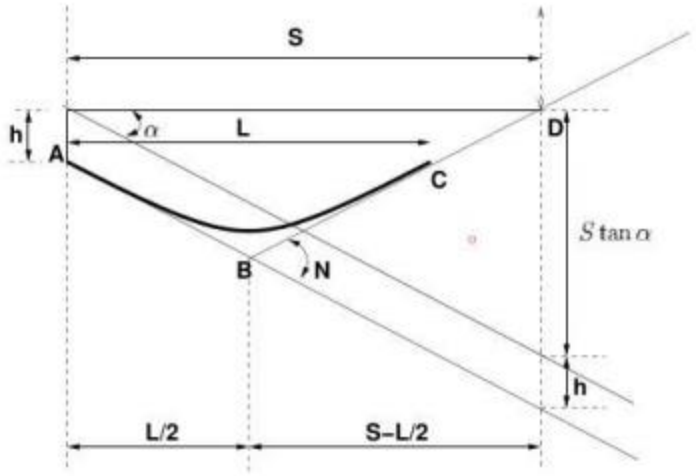
Length Of The Valley Curve

The valley curves made fully transitional by providing two similar transition curves of equal length The 2N 3 The length of the valley transition curve transitional curve set out by a cubic parabola y = bx where b = 2 3L is designed based on two criteria:

1. Comfort criteria; that allowable rate of change of centrifugal acceleration limited to a comfortable 3 level of about 0.6m/sec.
2. Safety criteria; that is the driver should have adequate headlight sight distance at any part of the country.



For, L > S



Q3: Differentiate between Passive Control, Semi Control and Active Control?

Passive Control and Active Control?

Active vibration control is a technique for reducing unwanted vibration by using some kind of sensor to measure the motion or force or acceleration or other parameter of thing that is vibrating and a powered actuator to generate a force to resist the unwanted motion. There is some kind of know how to reduce the unwanted action.Passive vibration control does not use any sensors or actuators and does not consume any power, however mechanical components are used to absorb unwanted vibrations such as spring blades, shock absorber, air cushion...Concerning the field of application of these techniques it is very vast that goes from the bicycle, to the scooter, to the car, to the transport vehicle in general and to the mechanical machine of transformation and manufacturing

Semi Control

Semi control imposes only some rules or restrictions on driver which he/she is supposed to follow and they do generally follow because of the geometry and shape of control measures. These helps in reducing the conflict points by directing vehicle in a specific lane or direction.

Q5: why is it desirable to have, as far as possible, a uniform gauge for the railway network of a country?

In rail transport, track gauge or track gage is the spacing of the rails on a railway track and is measured between the inner faces of the load-bearing rails.

All vehicles on a rail network must have running gear that is compatible with the track gauge, and in the earliest days of railways the selection of a proposed railway's gauge was a key issue. As the dominant parameter determining interoperability, it is still frequently used as a descriptor of a route or network.

In some places there is a distinction between the nominal gauge and the actual gauge, due to divergence of track components from the nominal. Railway engineers use a device, like a caliper, to measure the actual gauge, and this device is also referred to as a track gauge.

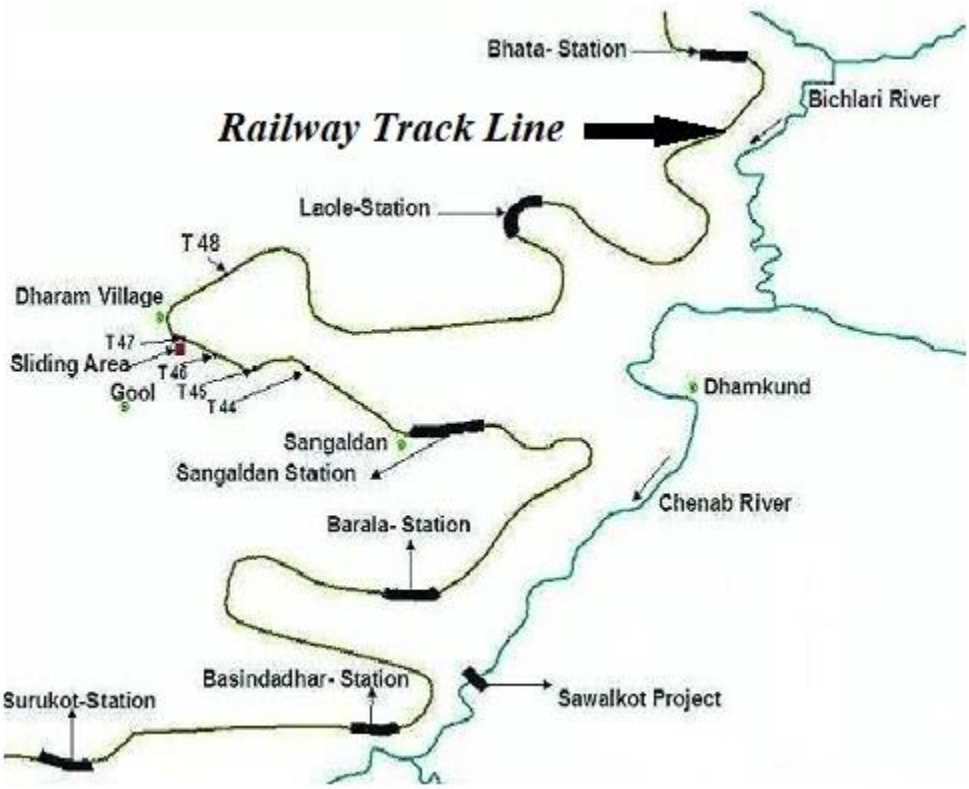
The terms *structure gauge* and *loading gauge*, both widely used, have little connection with track gauge. Both refer to two-dimensional cross-section profiles, surrounding the track and vehicles running on it. The structure gauge specifies the outline into which new or altered structures (bridges, lineside equipment etc.) must not encroach. The loading gauge is the corresponding envelope within which rail vehicles and their loads must be contained. If an exceptional load or a new type of vehicle is being assessed to run, it is required to conform to the route's loading gauge. Conformance ensures that traffic will not collide with lineside structures.

Q6: In the process of selecting a suitable alignment for a railway line, what factors and parameters are kept in view? What analysis is done to assess the economic viability of the alignment?

Factors in selection of good track alignment

Though the direct shortest route is the most economical but is rarely possible due to various practical difficulties such as intermediate obstructions, steep gradients within the shortest route, construction and

maintenance problems etc. Moreover, it may be necessary to deviate from the shortest route to connect obligatory points. (i.e. traffic generating points or places of importance).
An alignment, which is economical in the initial cost, may not prove most economical in maintenance or vehicle operation cost or both. It is also possible that shortest route may be costlier than other routes, when different alternatives are tried from construction point of view. Thus, it may be concluded that all the requirements cannot be fully justified simultaneously.



For satisfying most of the requirements, the following factors in selection of good alignment, require due consideration –

1. Obligatory or controlling points
2. Position, Amount and Type of Traffic
3. Gauge-Selection
4. Geometric Standards
5. Topography of the country
6. Economic Considerations
7. Other Consideration

Economic Considerations

Keeping in view the above factors, the alignment should be economical also. For this purpose, different alternatives of alignment keeping in view the basic purposes should be analysed from cost point of view, The best alignment would be one, which gives the maximum annual return (r) given by the formula –

$$r = \frac{Gross\ revenue\ (R) - Annual\ running\ expenses\ (E)}{Investment\ (I)}$$

$$r = \frac{R - E}{I}$$

This shows 'r' should be maximum which depends upon the proper selection of the route so as to include the advantages of traffic generating centres. The other way of increasing the annual returns is sound track construction which reduces the annual running expenses. So a suitable balance between the construction cost and operating expenses should be strack. The biggest item of expenditure is the maintenance of the track, so a reasonable economy in selection of materials and construction should be made.

Q7: Discuss the ways in which water can damage roads?

Excess moisture is the main factor behind most bearing capacity problems and road damage on low volume roads. An example of this is in the flow of groundwater under roads constructed on side sloping ground. This flow can be blocked if there is bedrock, frozen soil or impermeable materials near to the road surface, and thus cause water to flow towards the road structures increasing the moisture content and reducing bearing capacity. For this

reason road drainage systems need to work effectively over the whole life time of the pavement – and not just for a few years. Once the drainage is in order an economical and sustainable structural solution can be designed.

. High amounts of water under bituminous layers can cause high hydraulic pressures in the bottom of the bound layer when it is subjected to heavy traffic wheel loads. These effects act like pressure washes and break the bond between the bitumen and aggregate surfaces. If pavement is porous they can also lead to pumping.

Finally water has an influence on the components of bituminous materials and their bonds even without the addition of mechanical loading. The following physical processes have been identified as being caused by water:

1) molecular diffusion of water through the mixture components
2) the advective transport, i.e. “washing away”, of bituminous mastic due to the moving water flow through the connected macro-pores.
3) frost action

Mechanical processes identified as being caused by water damage are:

1) the occurrence of intense water pressure fields inside the mixture caused by traffic loads, and
2) “pumping action”.

In practice all of the physical material degradation processes interact with the mechanical processes to produce an overall water-mechanical damage in the mixture. Additionally the extensive use of deicing salts, together with freeze-thaw cycles, can cause severe damages to bituminous pavements.

Q8: Differentiate between V-shape, Rectangular and Trapezoidal side drains?

V-shape side drains

V-Shape drain is a surface water drainage drain to discharge rain water to nearest channel. It was made from precast concrete from factory. V-Shape drain is a surface water drainage drain to discharge rain water to nearest channel. ... It is used to channel storm water to the nearest monsoon drain.

Rectangular side drains

Our stainless-steel rectangular drains are adapted to various conditions of use (outlet, height, diameter and outflow). These very decorative systems make for a watertight drain thanks to the seal. The flap inside collects residues in order to avoid unpleasant odors. The full set contains 1 PVC drain, 1 inox grid and 1 pair of legs.

Trapezoidal side drains

Trapezoidal Channel is an open channel with a trapezoidal cross section where both sides have the same slope. The flow routing through a Channel Connection is described in Analysis of Connections. Parameters to specify: Length, Slope, Manning's n, Diameter/Base Width, Height, Side Slope