

2.4 Gradient

Gradient is the rate of rise or fall along the length of the road with respect to the horizontal. It is expressed as a ratio of 1 in x (1 vertical unit to x horizontal units). The gradient is also expressed as percentages such as n%, the slope being n vertical units to 100 horizontal units

Types of gradient

- a) Ruling Gradient
- b) Limiting Gradient
- c) Exceptional Gradient
- d) Minimum Gradient

Ruling gradient

The ruling gradient or the design gradient is the maximum gradient with which the designer attempts to design the vertical profile of the road. This depends on the terrain, length of the grade, speed, pulling power of the vehicle and the presence of the horizontal curve. In plain terrain, it may be possible to provide at gradients, but in hilly terrain it is not economical and sometimes not possible also.

The IRC has recommended ruling gradient values of

- a) 1 in 30 on plain and rolling terrain
- b) 1 in 20 on mountainous terrain
- c) 1 in 16.7 on steep terrain.

Limiting gradient

Where topography of a place compels adopting steeper gradient than the ruling gradient, 'limiting gradient' is used in view of enormous increase in cost in constructing roads with gentler gradients. However, the length of continuous grade line steeper than ruling gradient should be limited. On rolling terrain and on hill roads, it may be frequently necessary to exceed ruling gradient and adopt limiting gradient, but care should be taken to separate such stretches of steep gradients by providing either a level road or a road with easier grade.

Exceptional gradient

In some extra ordinary situations, it may be unavoidable to provide still steeper gradients than limiting gradient at least for short stretches and in such cases the steeper gradient up to 'exceptional gradient' may be provided. However, the exceptional gradient should be strictly limited only for short stretches not exceeding about 100 m at a stretch.

Minimum gradient

This is important only at locations where surface drainage is important. Camber will take care of the lateral drainage. But the longitudinal drainage along the side drains requires some slope for smooth flow of water.

The road with zero gradient passing through level land and open side drains are provided with a gradient of 1 in 400. A minimum of 1 in 500 may be sufficient to drain water in concrete drains or gutter, on inferior surface of drains 1 in 200 or 0.5%, on kutchra open drains steeper slope up to 1 in 100 or 1 % may be provided

Gradient for roads in different terrains

Type of Terrain	Ruling Gradient	Limiting Gradient	Exceptional Gradient
Plain or Rolling	3.3 %, 1 in 30	5 %, 1 in 20	6.7 %, 1 in 15
Mountainous terrain and steep terrain having elevation more than 3000 m above the mean sea level	5 %, 1 in 20	6 %, 1 in 16.7	7 %, 1 in 14.3
Steep terrain up to 3000 m height above mean sea level	6 %, 1 in 16.7	7 %, 1 in 14.3	8 %, 1 in 12.5