*Table 200.06*
**Grade Standards**

| *Rural Design Speed (kph)* | *Level %* | *Rolling %* | *Mountainous %* |
|---|---|---|---|
| 60 | 5 | 6 | 8 |
| 70 | 5 | 6 | 7 |
| 80 | 4 | 5 | 7 |
| 90 | 4 | 5 | 6 |
| 100 | 3 | 4 | 6 |
| 110 | 3 | 4 | 5 |
| 120 | 3 | 4 | 5 |
| 130 | 3 | 4 | 4 |
| ***Urban Roadway Type*** | | ***Desirable Maximum %*** | ***Absolute Maximum %*** |
| Freeway | | 3 | 4 |
| Expressway | | 3 | 4 |
| Ramps | | 4 | 6 |
| Arterial (Main Rd) | | 2 | 3 |
| Frontage Road | | 2 | 3 |
| Sector Roads | | 2 | 3 |

## 204.04 VERTICAL CURVES

Parabolic vertical curves are used in roadway design per Figure 200.06.

Figures 200.07 and 200.08 will be used to obtain vertical curves lengths. For design speeds greater than 65 kph, the minimum vertical curve length should be 120 m. For 50 kph design speed, it should be 60 m.

Flat vertical curves may develop poor drainage in the level section. Adjusting the edge grade or shortening the vertical curve may be required.

Design of these long vertical curves should be avoided because many drivers will not pass on curves over 1 km long, despite adequate sight distance. It may be more economical to construct passing lanes than to obtain passing sight distance by using a long vertical curve.

## 204.05 LONG SUSTAINED GRADES

The maximum grade guideline is not sufficient to insure uniform roadway operation. The uphill grade length must be considered because it has a major effect on operational speed, capacity, level of service, and contributes to heavy truck delays. Figure 200.09 shows the speed reduction in kph for an assumed typical heavy truck of 180 kg/kW as a function of grade length and upgrade percent. Generally, a truck speed reduction of up to 15 kph does not significantly impact roadway capacity.

Consideration should be given to adding lanes where the truck speed reduction is greater than 15 kph and there is a significant reduction in level-of-service when moving from the approach segment to the grade. On two lane roadways, a climbing lane should be considered when, in addition to the above criteria, the upgrade traffic flow is in excess of 200 vehicles per hour and the truck factor is in excess of ten percent. Decision sight distance should be provided at climbing lane drops on expressways.

## 204.06 STRUCTURE GRADE LINE

**Structure Depth -** The depth to span ratio for a structure is dependent on many factors. Use a structure depth to span ratio of 0.04 to 0.045 for preliminary design purposes.

**Falsework Allowance -** To establish the grade of a structure constructed with a falsework opening, allowance must be made for the falsework depth. The minimum vertical falsework clearance over primary and secondary roadways shall be 4.8 m. The minimum vertical falsework clearance over local roadways shall be 4.5 m.

**Bridge Deck Drainage -** Vertical alignment design requires special consideration of structure drainage. Zero gradients and sag vertical curves should be avoided on bridges. Parapets collect large amounts of debris and smaller bridge deck drains or scuppers have a higher potential for clogging. The minimum desirable longitudinal slope for bridge deck drainage is 0.2 percent. Where vertical curves on bridges cannot be avoided, the elevations should be checked to provide a minimum effective longitudinal grade of 0.5 percent, and not extend more than 15 m either side of the sag or crest point.