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TOPIC: CURVES, HIGHWAY ,ALIGNMENT

NAME OF SUBJECT: TRAFFIC ENGINEERING

ASSIGNMENT: 04

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Q1:) Write a note on classification of vertical curves?

CLASSIFICATION OF VERTICAL CURVE:

Vertical curve are provided to change the slope in the road and may or may not be symmetrical. They are parabolic and not circular like horizontal curves. Identifying the proper grade and the safe passing sigh distance is the main design criterion of the vertical curve. Crest vertical curve the length should be enough to provide safe stopping sight distance and in sag vertical curve the length is important as it influences the factors such as headlight sight distance rider comfort and drainage requirement.

SAG CURVE:

Sag curve are those which change the alignment of the road from uphill to downhill.

CREST CURVE/SUMMIT CURVE:

Crest curve are those which change the alignment of the road from downhill to uphill. In designing crest vertical curves it is important that the grades not too high makes it difficult for the motorists to travel upon it.

DESIGN OF VERTICAL CURVE:

Summit curve are those curve which have convexity upwards. They are formed under the four following condition.

1. When a positive gradient meets an-other mild positive gradient.
2. When a positive gradient meets a level zero gradient.
3. When a positive gradient meets with a negative gradient.
4. When a negative gradient meets another steeper negative gradient.

DESIGN OF VERTICAL SAG CURVE:

Valley (sag) curve are those curve which have convexity downward. They are formed under the four following condition.

1. When a negative gradient meets another mild negative gradient.
2. When a negative gradient meets a level zero gradient.
3. When a negative gradient meets with a positive gradient.

4. When a positive gradient meets another steeper positive gradient.

Q:2) Discuss the principles of highway alignment?

ALIGNMENT:

The position or the layout of the central line of the highway on the ground is called the alignment.

REQUIREMENT FOR AN ALIGNMENT:

The alignment between two terminal station should be short and as far as possible be straight but due to some practical consideration deviation may be needed.

The alignment should be easy to construct and maintain. It should be easy for the operation of vehicles. So to the maximum extend easy gradient and curve should be provided.

The alignment should be economical and it can be considered so only when the initial cost maintenance cost and operating cost is minimum.

PRINCIPLE OF HIGHWAY ALIGNMENT:

1) The alignment of a highway is a three dimensional problems measures in x, y, and z coordinates. However highway design practice three dimensional design computation are cumbersome and what is perhaps more important the actual implementation and construction of a design based on three dimensional coordinates has historically been prohibitively difficult. As a consequence the three dimensional highway alignment problem is reduce to two dimensional alignment.
2) The vertical alignment is represented in a profile view which give the elevation of all point of measured along a constant elevation reference.
3) Aside from considering the alignment problem as two dimensional problem, one simplification is made instead of using x and z coordinates highway positioning and length are define as the distance along the highway usually measured along the centerline of the highway on a horizontal constant elevation plan from a specified point. This distance is measured in term of stations with each station consisting of 100ft of highway alignment distance.

4) The notation for stationing distance is such that a point on a highway 4250ft from a specified point of origin is said to be at station 42+50 ft that is 42 station and 50ft with the point of origin being at station 0+00. This station concept combined with the highway's alignment direction given in the plan view horizontal alignment and the elevation corresponding to stations given in the profile view vertical alignment gives a unique identification of all highway point in a manner that is virtually equivalent to using x, y, and z coordinates.

HIGHWAY HORIZONTAL ALIGNMENT:

1) Highway horizontal alignment in road design consists of straight section of road, known as tangent connected by circular horizontal curves.
2) It is the design of the road in the horizontal plane.
3) Consists of a series of tangents straight lines circular curves and transition curves.
4) Should provide safe travel at a uniform design speed.

HIGHWAY VERTICAL ALIGNMENT:

1) Highway vertical alignment is the longitudinal section.
2) It consist of straight grades joined by vertical curves.

3) Vertical alignment specifies the elevation of points along the road way.

Q:3) A 550-ft equal tangent sag vertical curve has the PVC at station 175 + 00 and elevation 1001 ft. The initial grade is -3.8%. and the final grade is +0.9%. Determine the stationing and elevation of the PVI, the PVT, and the lowest point on the curve?

SOLUTION:

Since the curves is equal tangent the PVI will be 275 ft or three station (measured in a horizontal plane) from the PVC and the PVT will be 550 ft or six station from the PVC. Therefore the stationing of the PVI and PVT is 173+00 and 176+00, respectively. For the elevation of the PVI and PVT it is known that a-3.8% grade can be equivalently written as -3.8ft/station (a 3.8 ft drop per 100 ft of horizontal distance). Since the PVI is three station from the PVC which is known to be at elevation 1001 ft, the elevation of the PVI is.

1001-3.8ft/station x (3 station)=989.6 ft

Similarly with the PVI at elevation 989.6 ft the elevation of the PVT is

989.6+0.9 ft /station x (3 station)= 992.3ft

It is clear from the values of the initial and final grades that the lowest point on the vertical curve will occur when the first derivative of the parabolic function is zero because the initial and final grades are opposite in sign. When initial and final grades are not opposite in sign the low (or high) point on the curve will not be where the first derivative is zero because the slope along the curve will never be zero. For example a sag curve with an initial grade of -2.0% and a final grade of -2.0% will have its lowest elevation at the PVT and the first derivative will not be zero at any point along the curve. However in our example problem the derivative will be equal to zero at the same point so the lowest point will occur when

$$dy/dx=2ax+b=0$$

$$b=G_1=-3.8$$

with G_1 in percent. (with L in station and G_1 and G_2 in percent)

$$a=0.9-(-3.8)/2(6)=0.285$$

Substituting for a and b gives

$$dy/dx=2(0.285)x+(-3.8)=0$$

x=5.25 stations

This gives the stationing of the low point at 175+25(5+25 stations from the PVC). For the elevation of the lowest point on the vertical curve the values of a, b, c (elevation of the PVC), and x are substituted into giving,

$$\mathbf{Y=0.285(5.25)^2+(-3.8)(5.25)+1001}$$

$$\mathbf{7.855-19.95+1001}$$

$$\mathbf{Y=988.905\ ft}$$