Horizontal and vertical coordination

Coverage:

- the driver’s view
- safety considerations
- aesthetic considerations
- bad design form
- good design form
- drainage considerations
The driver’s view

- Need to look at the road design form in three dimensions
- Even if you meet the horizontal and vertical standards the road can be unsafe if the alignments are not co-ordinated
- Coordination will minimise any poor aesthetic and safety issues
- The road is constantly changing and drivers see a foreshortened view
- This can and does mask curve elements which may become a hazard to the driver
- A vertical curve should be contained within a horizontal curve
- In urban situations it is often difficult to achieve coordination of horizontal and vertical alignments due to many constraints.

The optical illusion

Optical illusion – Combination of horizontal and vertical curves

Horizontal curve + Sag vertical curve = Horizontal curve radius seems larger than in reality

Horizontal curve + Crest vertical curve = Horizontal curve radius seems smaller than in reality
Self-explaining roads

Visual cues can be given to drivers
- Line of trees, power poles etc. can indicate an intersection ahead
- Line of trees or vegetation can indicate horizontal curvature

Self-explaining roads through landscaping

Which way does the road go?
A very satisfactory appearance results when vertical and horizontal curves coincide.

Keep the vertical curve within the horizontal curve.

General design form

Keep the horizontal and vertical in phase.
Safety considerations

• The start of the horizontal curve should precede the start of the vertical curve

• The design speed of the horizontal and vertical should be of the same order

• Sharp horizontal curves should not be at or near a crest vertical curve or at the end of a down grade

Safety considerations

• Reverse horizontal curves should not occur at a crest vertical curve

• Location of a crest vertical curve or sharp horizontal curve at or near a road intersection is undesirable as intersection is hidden behind a crest

• Pavement narrowing /raised medians should not be combined with horizontal and vertical curves except where adequate prior visibility is provided.
Safety considerations

- Hidden dips may reduce overall safety and should be avoided

- Lateral shifts in the alignment on crests can lead to confusion

Aesthetic considerations

- Most pleasing appearance is achieved when the horizontal and vertical curves fit the terrain

- Sag vertical curve should be located on a horizontal curve rather than on the straight close to the start of the horizontal curve

- A short vertical curve on a long straight has a poor appearance

Example with the appearance of a dip in the road
Aesthetic considerations

• A short straight grade line between sag or crest curves looks unsightly

• Long straight flat grades make it difficult for drivers to judge the distance and speed of approaching vehicles. Adding a large curve provides a driver with a better perspective to judge speed and distance

• A disjointed effect occurs where the start of the horizontal curve is obscured by an intervening crest while the continuation of the road is visible in the distance

• A curve which is visible at the end of a long straight can appear much sharper than it is in reality. A radius as large as economically possible should be used.

Examples of poor coordination (Fig 6.8)

Both examples have visually poor alignment with unrelated horizontal and vertical curves and broken backed horizontal curves.

A short movement in one plane should not be placed within a large movement in the other.
Safety affected by hidden dip grading

A road that is not well fitted to the terrain
Dual carriageway tends to magnify the discontinuities

Integration of road and landscape
Good alignment coordination

Examples (Fig 6.10)

- Long horizontal curves are preferable (> 600 m length) to short curves providing overtaking opportunities are not reduced.

- Series of short horizontal curves can have a poor appearance.
**Vertical curves**

Long vertical curves are preferable to short curves. However, long crest curves can limit overtaking opportunities.

- Long sag curves look much better than short curves as they appear to show a kink

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**Good coordination examples**

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Summary

- Coordination of horizontal and vertical alignments is to ensure horizontal curvature is not hidden; it is a basic geometric design principle, a key safety factor and defines the look of a road.
- Drivers react to horizontal curvature, and often will NOT react and reduce speed when sight distance is restricted by vertical curvature.
- When a horizontal curve is combined with a crest vertical curve, the horizontal curve must start before the vertical curve, to allow drivers to perceive the horizontal curve and make appropriate speed adjustment.

Conclusion

- Do not under-estimate the need for the coordination of the horizontal and vertical.
- Consider the driver’s point of view
- Need to combine horizontal and vertical correctly
- Coordination can make the road much safer, improve appearance and reduce ongoing maintenance
- Need to balance conflicting demands
- Design as much an art as a science

The computer is only as good as the designer using it!
QUESTIONS?

SHAPING OUR TRANSPORT FUTURE