Institute of Transport Economics
Norwegian Centre for Transport Research

ENGLISH Summary

Road alignment and road safety

A synthesis of knowledge

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This report summarises knowledge about the relationship between road alignment and road safety. This relationship is complex, because alignment is a multidimensional design element. In general, if one element of alignment is changed, this will result in changes in other elements. The summary of knowledge is based on studies that developed multivariate accident prediction models including at least two elements of alignment. Whenever possible, the relationship between an element of alignment and the number of accidents has been expressed as a functional relationship. A total of 15 elements of alignment were included.

The alignment of a road defines its curvature in space. A distinction is normally made between horizontal and vertical alignment. There is much more research about horizontal alignment than about vertical alignment. Although elements of alignment are closely related to each other, most research has focused on a single or a few elements of alignment. This study aimed at summarising knowledge for as many elements of alignment as possible.

Alignment parameters included in study

The following alignment parameters have been included:

1. Radius of horizontal curves
2. Deflection angle of horizontal curves
3. Length of horizontal curves
4. Super-elevation in horizontal curves
5. Variation of super-elevation in horizontal curves
6. Existence and length of spiral transition curves
7. Length of straight section ahead of a horizontal curve
8. Radius of neighbouring curves
9. Number of neighbouring curves
10. Vertical grade ahead of a horizontal curve
11. Horizontal curves located in crest or sag vertical curves
12. Algebraic difference in vertical grades
13. Vertical grades in general (absolute grade)
14. Length of vertical grades
15. Sight distance
16. Stop sight distance at crest vertical curves

Most studies focus on just one or two of these elements and very few studies have included more than three.

Functional relationships

The relationship between each alignment parameter and the number of accidents has been summarised as a functional relationship whenever possible. An example of such a relationship is shown in Figure S.1.

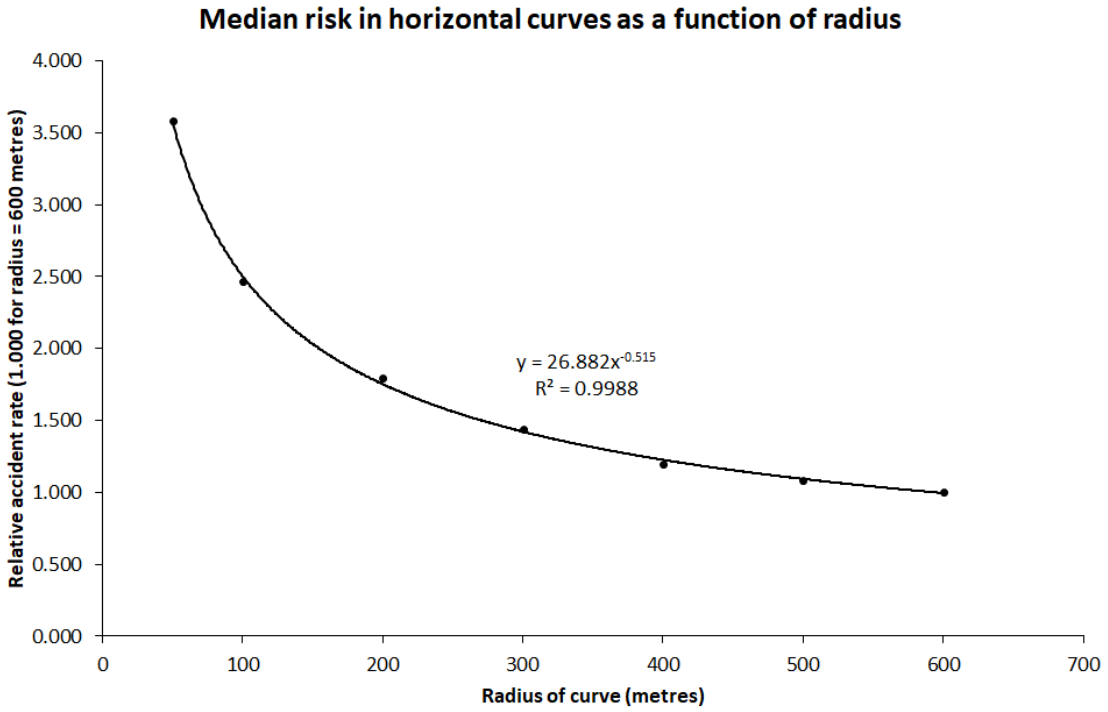

Figure S.1: Relationship between horizontal curve radius and the relative number of accidents.

The functional relationship shown in figure S.1 is based on 46 functional relationships derived from the primary studies. It shows the median values of relative risk estimated in these studies. The median value is representative, in that half of estimates show a smaller increase in risk, half show a larger increase in risk.

Risks associated with alignment parameters

Table S.1 shows the relative risks associated with each alignment parameter included in the study.

Table S.1: Risks associated with alignment parameters.

Alignment parameter	Safest value	Relative number of accidents	Least safe value	Relative number of accidents
Radius of horizontal curve	600 m	1.00	50 m	3.58
Deflection angle of horizontal curve	30 degrees	1.00	100 degrees	2.52
Length of horizontal curve	50 m	1.00	600 m	5.86
Super-elevation in horizontal curve (#)	10 %	1.00	0 %	1.21
Variation of super-elevation in curve (#)	0 %	1.00	10 %	1.21
Existence of spiral transition curve (#)	Yes	1.00	No	1.12
Increasing length of spiral transition curve (#)	10 m	1.00	0 m	1.02
Length of straight section ahead of curve	0.1 km	1.00	1.0 km	1.38
Radius of neighbouring curve	50 m	1.00	600 m	1.11
Number of curves ahead of a curve (#)	5	1.00	0	1.41
Upward grade before horizontal curve (#)	0 %	1.00	1 %	1.45
Downward grade before horizontal curve (#)	0 %	1.00	1 %	1.56
Horizontal curve in crest vertical curve	No	1.00	Yes	1.91
Horizontal curve in sag vertical curve	No	1.00	Yes	2.08
Vertical grade in general (absolute value)	0 %	1.00	7 %	1.30
Length of vertical grade	0.1 km	1.00	1.0 km	8.72
Sight distance	227 m	1.00	45 m	1.58
Stop sight in crest vertical curves	Adequate	1.00	Too short	1.99

(#) This result is based on a Norwegian study

Compound measures of alignment – alignment classes and design consistency

In some studies, roads have been classified according to the quality of their alignment. The most common classification uses three classes: poor, medium and good. A summary of studies using this classification found that by going from poor to medium, accident rate can, on the average, be reduced by 15 %. Going from medium to good may reduce accident rate by 17 %. Going from poor to good may reduce accident rate by 28 %.