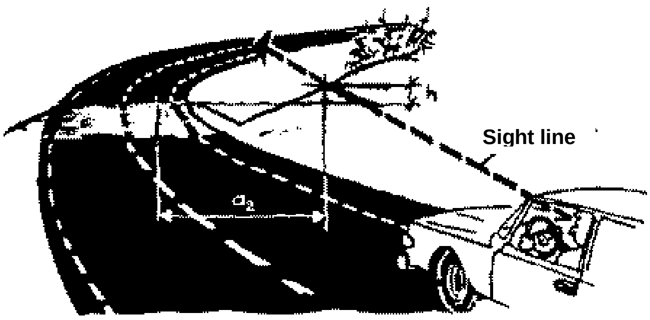
HIGHWAY DESIGN REPORT

Appendix 5

Proposed Amendment and Changes in Existing Guidelines



June 2000

SWEROAD

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1 Alignment

1.1 Turkish guidelines and practices

During the work with black spot analysis and safety audits of existing and planned roads, it was noticed that the vertical curve radii on existing roads in Turkey often were quite small. In the discussion in October 1999, the Turkish guidelines for horizontal and vertical curve radii were reviewed and compared with the Swedish guidelines. It was found that the Turkish radii generally are smaller than the requirements for low standard in the Swedish guidelines.

In the following tables the requirements for Swedish 2-lane rural roads are compared with the requirements for Turkish First Class 2-lane rural roads. (In the Turkish guidelines the radii for vertical curves are in degree of curve. The corresponding radii have been rounded to the nearest 50 meter value)

Design Speed	Sweden		Turkey
km/h	High standard	Low standard	-
60	-	**-**	**150**
70	300	**200**	**200**
80	400	**300**	**250**
100	600	**500**	**400**

Comparison between Swedish and Turkish requirements for minimum horizontal curve radii (m)

Design Speed	Sweden		Turkey	
km/h	High standard	Low standard	High standard	Low standard
60	-	**-**	**1 000**	850
70	3 000	**1 800**	**1 650**	1 150
80	5 000	**3 000**	**2 500**	1 500
100	11 000	**7 000**	**6 100**	3 200

Comparison between Swedish and Turkish requirements for minimum vertical crest curve radii (m)

Design Speed	Sweden		Turkey	
km/h	High standard	Low standard	High standard	Low standard
60	-	**-**	**900**	850
70	2 500	**1 800**	**1 250**	1 100
80	3 500	**2 500**	**1 700**	1 300
100	5 500	**4 500**	**2 900**	2 000

Comparison between Swedish and Turkish requirements for minimum vertical sag curve radii (m)

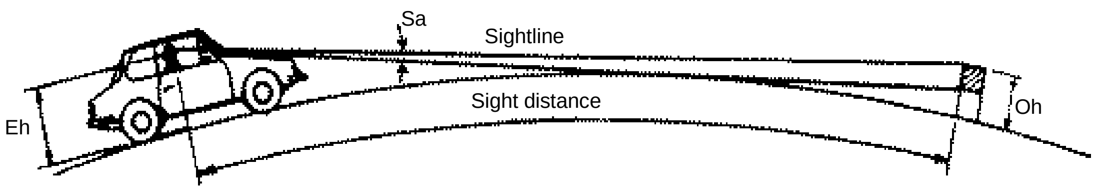
1.2 Proposal

It is suggested that the requirements are revised for the following parameters:

- sight distances,
- horizontal curve radii,
- vertical crest curve radii,
- vertical sag curve radii.

1.2.1 Sight distances

Stopping sight
Minimum requirements for horizontal and vertical curve radii are primarily based on stopping sight distances.



Definition of stopping sight distance

It is suggested that the stopping sight distances are revised and specified for different standard levels to be used for different classes of state roads. In the following table, a suggestion for revised stopping sight distances for horizontal roads is given. For up-grades, the required stopping distances are shorter and for down-grades they are longer.

Design speed	Standard level		
km/h	High	Fair	Low
50	70	50	35
70	110	100	85
90	165	150	135
110	235	215	195

Suggested stopping sight distances (m)

Passing sight
Passing sight distances are depending on driver behavior when overtaking. The passing sight distances in the Swedish guidelines are shown in the table below. It is suggested that these values are used in Turkey.

Design speed	Standard level		
km/h	High	Fair	Low
70	700	500	350
90	900	700	500

Suggested passing sight distances (m)

As an example, the requirement for 900 meters passing sight at 90 km/h means that about 85 percent of the drivers can be expected to overtake a passenger car as well as a heavy vehicle.

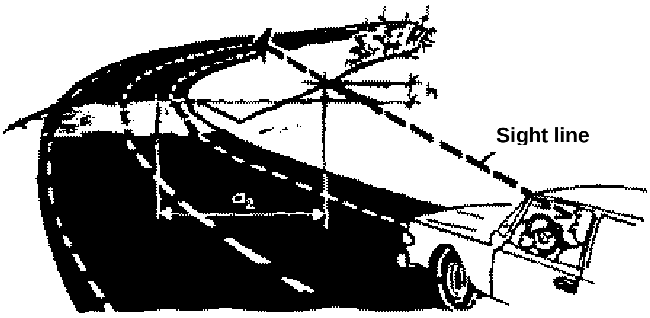
1.2.2 Horizontal curve radii

The minimum requirement for horizontal curves is to allow stopping sight distances. It is suggested that the minimum horizontal radii are revised and specified for different standard levels to be used for different classes of state roads. In the following table, a suggestion for revised minimum horizontal radii is given.

Design speed km/h	Standard level		
	High	Fair	Low
50	140	110	90
70	300	250	200
90	500	450	400
110	800	700	600

Suggested minimum radii (m) for horizontal curves

To create opportunities to overtake on roads with many curves, some of the curves must be designed to allow passing sight distance. The available sight distance is depending on the shape of the road side area and the combination of horizontal and vertical alignments. The principle is shown in the figure below. A separate calculation must be made for each curve.



Available sight in combined horizontal and vertical curve

1.2.3 Vertical curve radii

Vertical crest curves
Vertical crest curves should be designed to allow stopping sight distances. It is suggested that the minimum vertical crest radii are revised and specified for different standard levels to be used for different classes of state roads. In the following table, a suggestion for revised minimum vertical crest radii is given.

Design speed km/h	Standard level		
	High	Fair	Low
50	1200	600	400
70	3000	2300	1800
90	7000	6000	5000
110	16000	13000	11000

Suggested minimum radii (m) for vertical crest curves

Vertical sag curves
Vertical sag curves longer than the stopping sight distance should be designed to allow stopping sight. Short vertical sag curves should be designed for convenient driving. It is suggested that the minimum vertical sag radii are revised and specified for different standard levels to be used for different classes of state roads. In the following tables, a suggestion for revised minimum vertical sag radii is given.

Design speed km/h	Standard level		
	High	Fair	Low
50	1 200	1 000	900
70	3 500	3 000	2 500
90	4 500	4 000	3 500
110	6 500	6 000	5 500

Suggested minimum radii (m) for long vertical sag curves

Design speed km/h	Standard level		
	High	Fair	Low
50	600	500	400
70	1 000	850	750
90	1 550	1 400	1 250
110	2 200	2 000	1 900

Suggested minimum radii (m) for short vertical sag curves

2 Standard intersections

2.1 Turkish guidelines and practices

It is not clear if there is an adopted national standard for intersection types in Turkey. The intersection types in the intersection guideline (Kavşak Tipleri) seem to be examples of possible design and not standard types. Some of the currently planned intersection types are not suitable from a safety point of view, neither the basic design nor the details. One example is the so-called rotary intersections with often too wide lanes inviting to high speeds.

On existing roads there is a very great diversity of intersection types. The intersection areas are often too large and the lanes too wide because the traffic islands, if used, are generally too small. Many intersections also have small intersection angles. Since road markings generally are missing, it is often not clear how to drive in many intersections.

Consequently, a set of standard intersections should be worked out, including the details which are important to safety.

2.2 Proposal

The following amendments and changes are proposed:

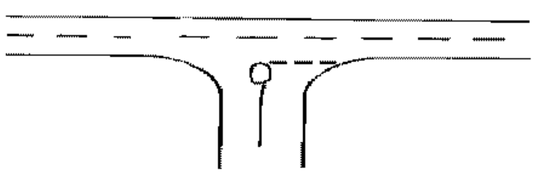
- systematic use of standard intersections,
- restrictive use of right turn lanes,
- longer widenings for extra lanes.

2.2.1 Systematic use of standard intersections

The road design should be adapted to the capabilities and expectations of the road users. The drivers respond to the expected situation rather than to the actual situation. If there is a difference between the two, for example, due to design standards, the driver's decision can be delayed or wrong resulting in an accident. Consequently, the geometric design should be consistent with what the drivers are expecting and willing to accept. The use of standard type intersection is one way to meet this requirement.

A systematic use of type intersections is therefore suggested. A set of such intersections proven to be safe should be worked out and used in all new projects. The standard intersections should be based on a limited number of type intersections adapted to different planning conditions (traffic volumes, number of legs etc.). The following type intersections are suggested (see appendix 1):

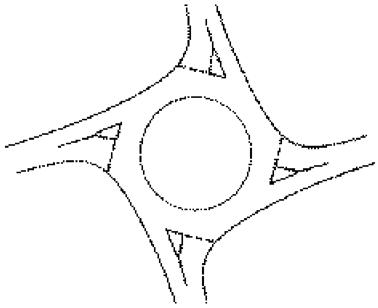
Priority intersections



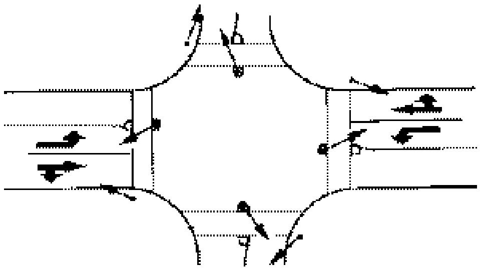
Type I
Traffic island only in the secondary road

Type II
Traffic islands in primary and secondary road

Control intersections



Roundabout



Signalized intersection

In the elaboration of standard intersections, the details below should be considered.

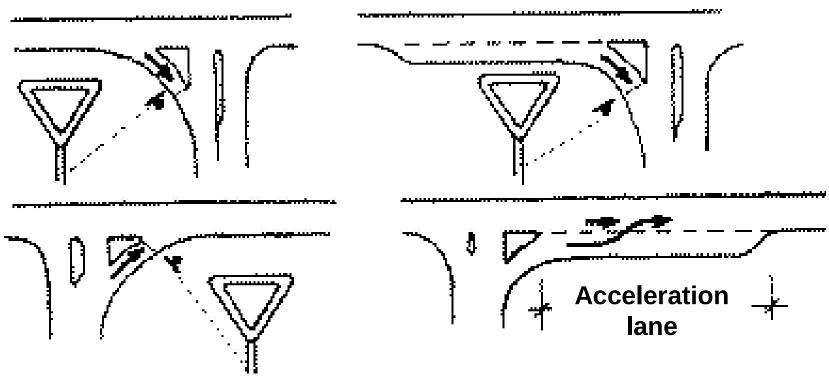
2.2.2 Restrictive use of right-turn lanes

Right-turn lanes should generally not be used in small priority intersections. They can be used, for example, if the turning traffic volume is high or if both intersecting roads have the same importance.

Safety
Experiences show that from a safety point of view there are no major advantages with right-turn lanes. Right-turn **off** lanes can create safety problems for slow vehicles and bicycles. Right-turn **on** lanes can increase safety at high traffic volumes.

Capacity
From a capacity point of view, right-turn **off** lanes are seldom needed. Right-turn **on** lanes are only needed where traffic volumes are close to the maximum capacity. Delays with and without left-turn lanes can be calculated using different Capacity Manuals.

Design
The right turning traffic should always yield if there is no separate acceleration lane. There should always be a directional traffic island, raised or painted, see figure below.



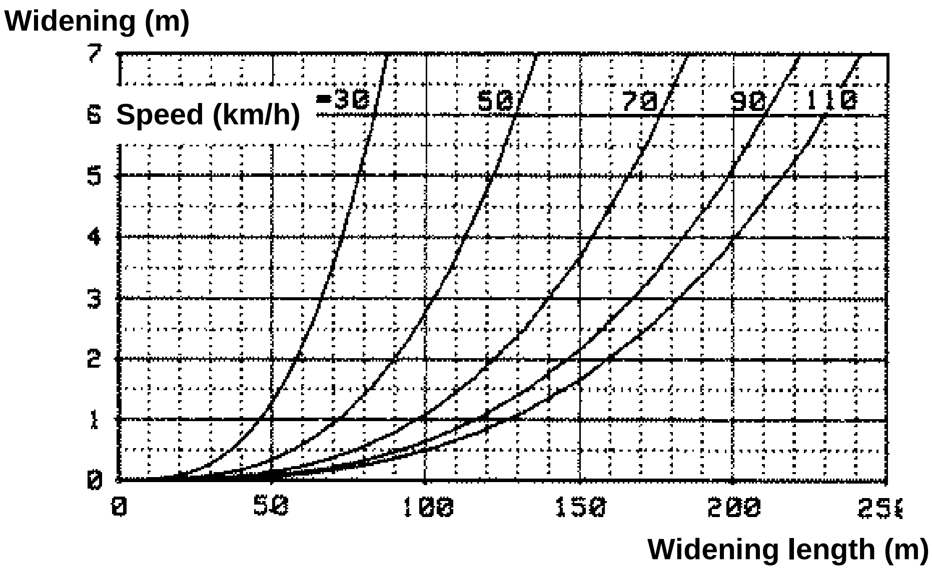
Design principles for right-turn lanes

2.2.3 Widening of roads for extra lanes

Widening width
The widening width is determined by the extra width needed in the intersection.

Example: Left-turn lane 3.5 m + road marking 0.3 m = 3.8 m
Symmetrical widening gives 1.9 m widening on each side.

Widening length
The widening length is determined to give convenient driving for the chosen design speed. The length can, for example, be determined by the following diagram from the Swedish guidelines.



Example of principle for determining widening length

Example: Needed widening: 1.9 m
Speed limit: 70 km/h
According to the diagram the needed widening length will be 120 m.

3 Climbing lanes

3.1 Turkish guidelines and practices

Climbing lanes do not primarily seem to be a design problem. New climbing lanes are designed according to “Design guidelines” based on the old AASHTO guidelines. The new AASHTO guidelines are translated to Turkish but not yet adopted.

3.2 Proposal

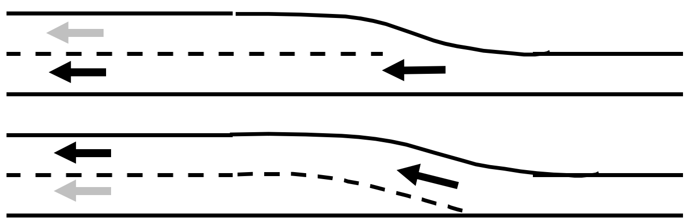
It is suggested that:

- AASHTO guidelines are revised and adapted to Turkish conditions.

In the revision, the attached summary of the Swedish guidelines for climbing lanes and the details below should be considered.

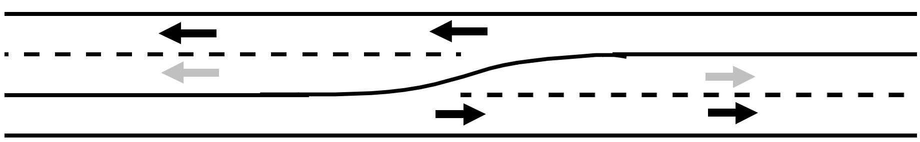
Termination of meeting climbing lanes over a crest
At terminations of meeting climbing lanes over crests, the transition lengths are often too short. However, this is a deviation from the existing guidelines and more an example of the need for changes in design practices than for changes in the guidelines.

Continuous lane at the beginning of climbing lanes
On existing climbing lanes in Turkey, normally the left lane is continuous, meaning that the traffic is led into the left lane. Even though it is called “climbing lane” the right lane ought to be considered as the normal lane and the left lane as a passing lane for overtaking. Hence, the right lane ought to be continuous.



Existing practice (upper) and suggested standard design (lower)

Another reason for this, is to make it possible to use the standard design where climbing lanes in both directions start at the same point.



Design of two climbing lanes starting at the same point