Traffic Safety Strategy Highway Design

Principles
for
Selection of Intersection Type

February 2000

SweRoad
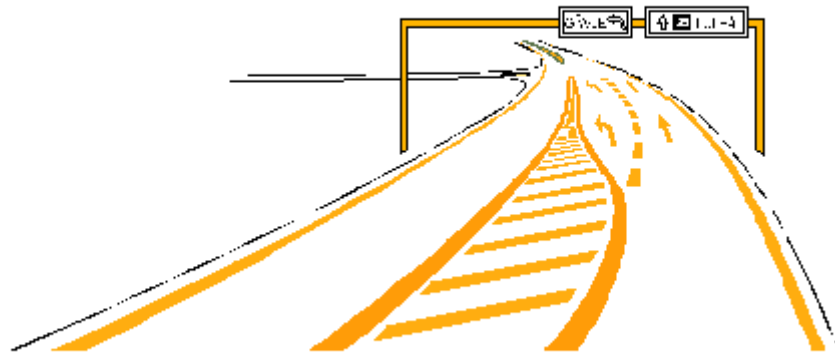
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1   Introduction

1.1   Purpose

The purpose with this report is to

- describe a model for selection of intersection type
- propose measures to adapt the model to Turkish conditions

The objective should be to eventually incorporate a model for selection of intersection type into new comprehensive Turkish design guidelines. To work out new design guidelines is however a long procedure. Awaiting new guidelines it is suggested that the proposed model is adapted to Turkish conditions. This should mainly be done by establishing *preliminary selection criteria* for each step and a *set of type intersections* for each intersection category.

1.2   Definitions

At-grade intersections can be classified into two main categories depending on if the main road traffic is controlled or not.

- **Priority intersection**
  At-grade intersection with **priority for the main road traffic** and control of secondary road traffic only**.**
  Priority intersections can be divided into different types depending on

- **Control intersection**
  At-grade intersection with **control of the main road traffic** as well as secondary road traffic.
  There are two types of control intersections: *signalized intersection* and *roundabouts*

1.3   Contents

Generally the selection of intersection type should be made from a socioeconomic point of view where e.g. construction costs, accident costs, environmental costs and travel time costs are considered.

However, for some cases the selection can be based on experiences from other similar intersections. Thus it is not always necessary to make a socioeconomic calculation considering all possible types of intersections. The traffic safety aspect is suggested to be the primary criteria. Thus the safety should first be checked to meet the requirements. Other effects should then be checked to be acceptable.

In this report the following is presented:

- Proposal for a procedure for the selection of at-grade intersection type

- Examples based on Swedish selection criteria

- Suggestions for continued work to revise the model and to adapt it to Turkish conditions

2 Proposed selection model

2.1 Model overview

2.1.1 General description

The model is divided into three steps with a number of selection criteria. The criteria are based on **road and traffic conditions** concerning type of road, location and traffic, **standard requirements** concerning safety, speed and delays and experiences of **safety and capacity performances** of different intersection types.

The model is based on the following assumptions concerning different types of at-grade intersections:

− The traffic volumes may be too high to be operated by an at-grade intersection and for certain road e.g. national motorways at-grade intersections are not accepted.
− Priority intersections are safe and give sufficient capacity for certain traffic volumes and speed limits.
− If a priority intersection is not sufficient for safety and capacity the main road traffic must also be controlled. This might not be accepted.
− Depending on location, traffic conditions and speed limits different types of priority or control intersection should be selected.

The selection model shows a **suggested procedure** illustrated with selection criteria based mainly on Swedish experiences of intersections on 2-lane roads. The selection model must to be useful in Turkey be completed with selection criteria based on Turkish intersection types and accident and capacity data.

2.1.2 Required data

Road and traffic conditions
Road classification and location
The acceptability of at-grade intersections and/or traffic control measures (stop or yield control) should be related to the road function. For some important roads at-grade intersections or traffic control measures might not be accepted in some cases.

The acceptability of at-grade intersections and/or traffic control measures should also be depending on whether the road is located in a rural, sub-urban or urban area.

Traffic conditions
Traffic data is needed mainly on daily traffic volumes on the primary and secondary road. For detailed capacity control and design traffic data is also needed on hourly traffic and turning traffic.

The traffic growth during the *expected service life* of the planned intersection must be considered. The service life varies depending on type of project. For small projects in urban areas it should be shorter than for e.g. large projects in rural areas. The official project life for state roads in Turkey is 20 years.

Standard requirements
Safety
Safety is suggested to be the primary selection criterion. The basic safety requirements for intersections, defined as e.g. the accepted number of expected accidents or injured, must therefore be established.

Speed
Both the safety level and the capacity of different intersection types are depending on the speed limit on the primary road. The speed limit for the main road must thus be decided. The requirements for speed can be based on road classification and location.

Capacity
In addition to safety the capacity or delays is an important selection criterion. Capacity requirements, defined as e.g. level of service (e.g. according to HCM) or load factor (actual traffic volume / maximum traffic volume) for intersections should thus be established

2.1.3 Selection criteria

Step	Selection criteria
I. Applicability of at-grad intersection	- Road classification - Capacity
II. Selection of intersection category	
II a. Applicability of priority intersection	- Safety - Capacity
II b. Acceptance of control intersection	- Road classification and location
III. Selection of intersection type	
III a. Priority intersection type	- Safety
III b. Control intersection type	- Road classification and location - Safety - Traffic distribution - Economic study
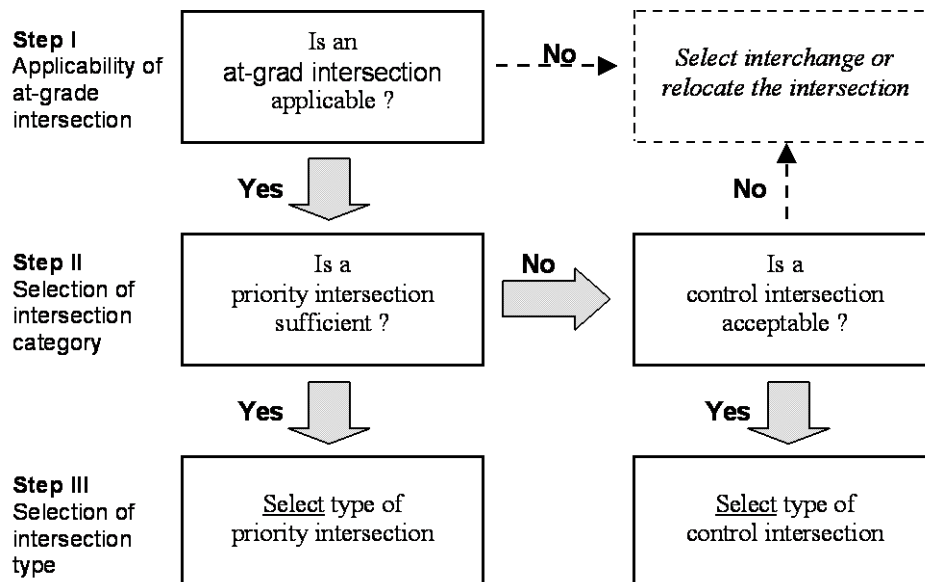
Intersection selection model

2.2 Step I. Applicability of at-grade intersection

Check if an at-grade intersection is applicable is made in two steps.

- Is an at-grade intersection acceptable on this kind of road
- Is the capacity of an at-grade intersection sufficient?

Road classification

At-grade intersections can generally be accepted on all roads except motorways. However. for intersections between some important roads the ambition could be to avoid at-grade intersections. Based on a functional road classification a table showing the acceptance of at-grade intersections can be worked out. An example on such a table is shown below.

	Intersecting/adjoining road			
Main Road	*State road type I*	*State road type II*	*Provincial road type I and II*	*Village, municipality and forest roads*
State road, type I	No	Yes / No	Yes	Yes
State road, type II		Yes	Yes	Yes
Provincial road, type I and II			Yes	Yes

Example of table for acceptance of at-grade intersections

Safety

The traffic volumes an at-grade intersection can handle with reasonable delay depend on many factors. Thus the first check if an at-grade intersection is sufficient will be a rather rough estimate. It can be done by using a diagram where the traffic volumes on the primary and secondary road are considered.

The figure below shows an example of such a diagram based on experiences from the UK (Roads and Traffic in Urban Areas, 1987).
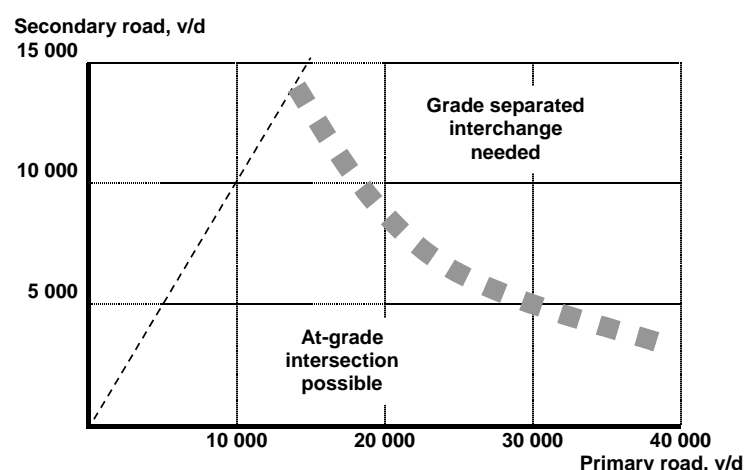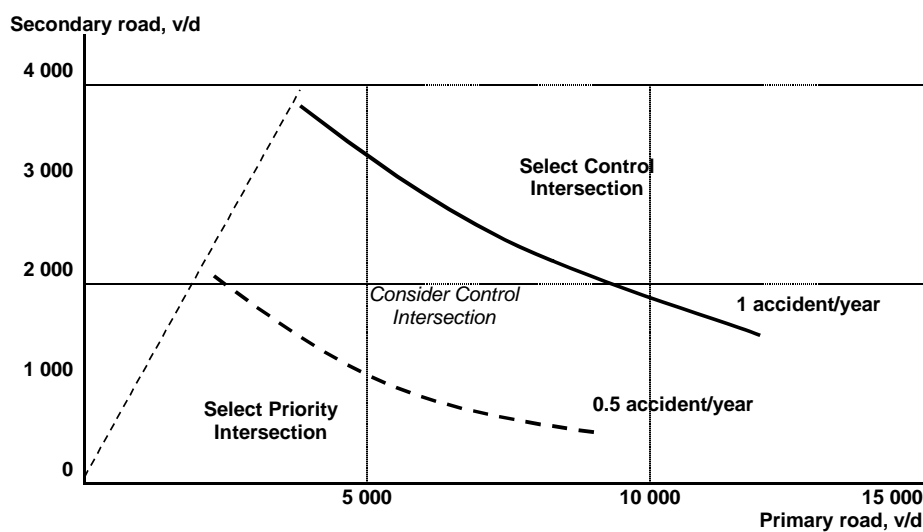

Example on a diagram for checking the capacity of an at-grade intersection

2.3   Step II a. Applicability of priority intersection

Safety

The safety requirement for intersections can be defined as an interval with a <u>desired level</u> that ought to be satisfied and a <u>definite level</u> that must be satisfied. If the expected number of accidents does not exceed the desired level a priority intersection should be selected. If it exceeds the definite level a control intersection should be selected. Between the defined levels a control intersection should be considered.

The selection can be made using diagrams with the relation between the safety levels and the traffic volumes on the primary and secondary roads. Below a diagram is shown for a 3-leg intersection (T-intersection) with 70 km/h speed limit on the main road based on Swedish accident statistics.
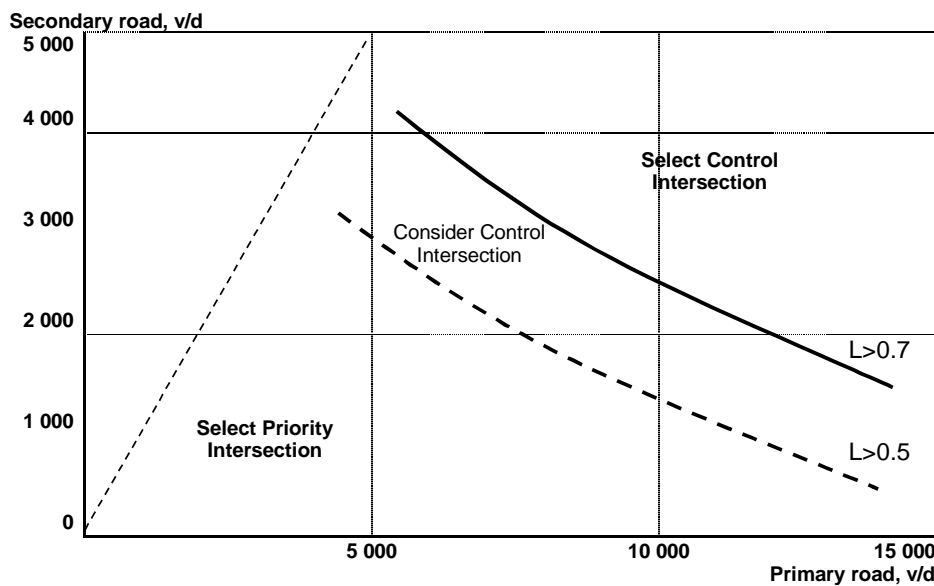
Example on diagram for safety estimation of priority intersections

Capacity

If a priority intersection should be selected or considered for safety reasons the capacity must be checked. This can be done in the same way as for safety. The capacity requirement (defined as level of service or load factor) can be defined as one <u>desired level</u> that ought to be satisfied and one <u>definite level</u> that must be satisfied.

The selection can be made using diagrams with the relation between the capacity levels and the traffic volumes on the primary and secondary roads. Below a diagram is shown for a 3-leg intersection (T-intersection) with 70 km/h speed limit on the main road based on Swedish accident statistics.

Example on diagram for capacity estimation of priority intersections
L = Load factor (actual traffic volume / maximum capacity)

2.4   Step II b. Acceptance of control intersection

Road classification and location

Traffic control measures (local speed limit and stop or yield control) might not be accepted on the primary road. The table below shows an example on the road standard requirements depending on road classification and location.

| | Road class | | |
Location	State road type I	State road type II	Provincial road type I and II
Rural	No	Yes / No	Yes
Sub-urban	Yes / No	Yes	Yes
Urban	Yes	Yes	Yes

Example of acceptance of traffic control measures for different road classes
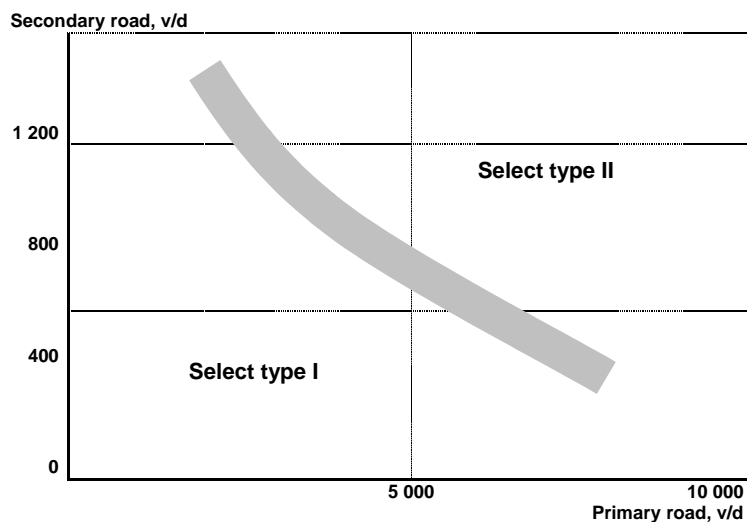
2.5   Step III a. Selection of priority intersection type

Available types:
- Type I   <u>without</u> traffic islands in the primary road
- Type II,   <u>with</u> traffic islands and left turn lane in primary road

Safety

The selection of priority intersection type is based on the safety performance only since a safe type I intersection generally also gives enough capacity. The selection can be made using the same kind of diagram as in earlier steps.

Example on diagram for selection of priority intersection type

2.6   Step III b. Selection of control intersection type

Available types:
- Roundabout
- Signalized intersection

Safety

According to recent studies roundabouts are found to be safer than signalized intersections. Roundabouts, but not signalized intersections, can also normally be accepted on roads and in locations where a control intersection is accepted. For safety reasons a roundabout should therefore be selected if not:

- the planning conditions are such that a signalized intersection ought to be selected
- a signalized intersection is socioeconomic favorable.

Planning conditions

A roundabout may not be possible depending on e.g. the available space or the alignment of the connecting roads. This can be checked by a preliminary lay-out of a roundabout with standard dimensions.

A signalized intersection should be considered if the intersection is part of a coordinated signal network or located in an area where signalized intersections are common and well known to the road users.

Signalized intersections can generally not be accepted for all road classes and locations. The following table shows an example on how the acceptance of signalized intersections can be determined.

Location	Road class		
	State road type I	State road type II	Provincial road type I and II
Rural	-	-	-
Suburban	-	S	S
Urban	S	S	S

Example of acceptance of signalized intersection for different road classes and locations.

Delays

For high traffic volumes on the primary road the delays are shorter in a signalized intersection than in roundabouts. Consequently a signalized intersection can give lower total socioeconomic costs. The diagram below shows for which traffic volumes signalized intersections should be considered from an economic point of view.
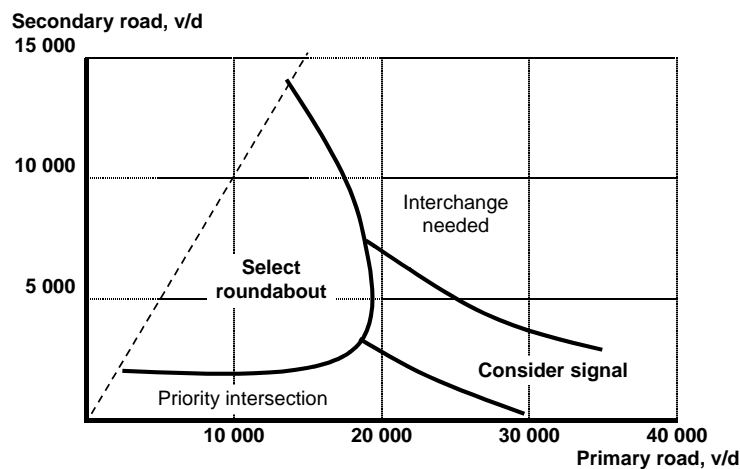
Example on diagram for when to select roundabout
and when to consider signalized intersection

Economic study

If a signalized intersection is considered due to planning conditions or traffic volumes a socioeconomic analysis should be made. This should include road construction and maintenance costs, accident costs, travel time costs, vehicle costs and environmental costs.

3 Examples

The following examples are based on for Turkey drafted suggestions concerning road classification and location. Other prerequisites (standard requirements, intersection types and safety and capacity performances) are based on Swedish conditions.

3.1 Example 1. 3-way intersection

Road and traffic data

Primary road:	State road, type II
Secondary road:	Provincial road, type II
Number of legs:	3
Location:	Rural
Traffic volumes:	Primary road 5 000 vehicles/day
	Secondary road 1 000 vehicle/day

Standard requirements

Safety requirement:	0.5 expected accidents per year
Speed limit:	70 km/h
Capacity requirement:	Load factor < 0.5

Step I. Applicability of at-grade intersection

Road classification

Main Road	Intersecting/adjoining road			
	State road type I	State road type II	Provincial road type I and II	Village, municipality and forest roads
State road, type I	No	Yes / No	Yes	Yes
State road, type II		Yes	Yes	Yes
Provincial road, type I and II			Yes	Yes

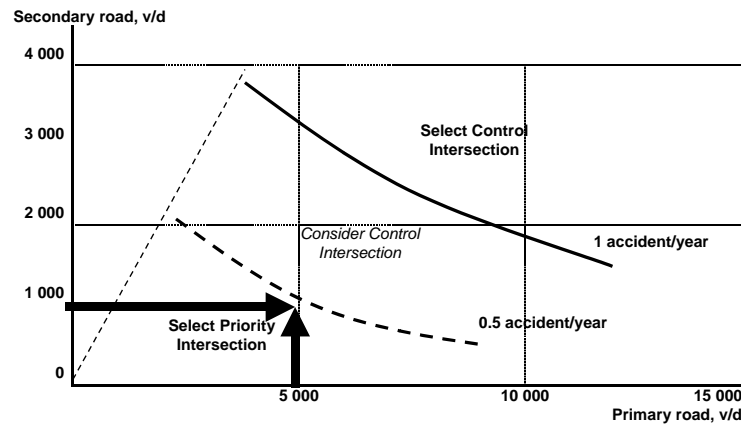An at-grade intersection can be accepted for this intersection!

Capacity
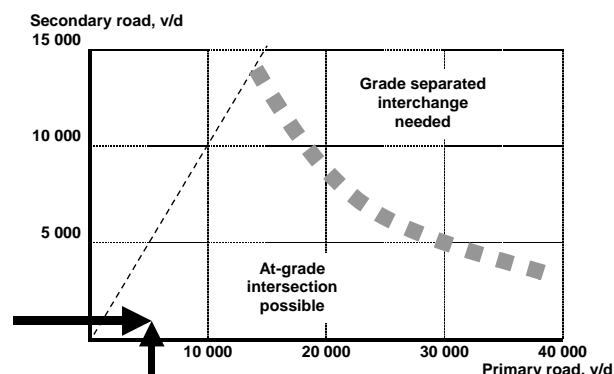
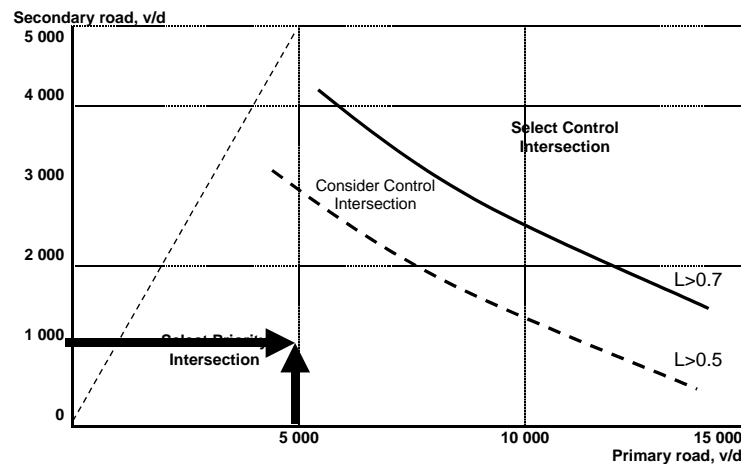The capacity of an at-grade intersection is quite sufficient!

Step II a. Applicability of priority intersection

Safety

The expected number of accidents is approximately 0.5 a year.
Priority intersection satisfies the safety requirement!

Capacity

The load factor is less then 0.5.
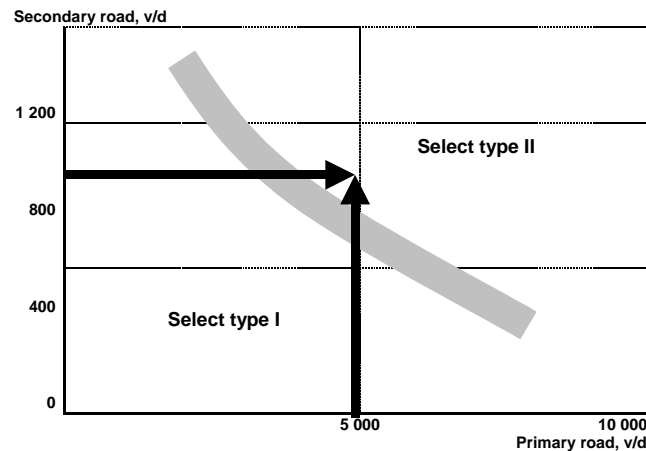Priority intersection satisfies the capacity requirement!

Priority intersection is selected since it is sufficient for both safety and capacity.

Step II b. Acceptance of control intersection

Since priority intersection is selected the check of acceptance of control intersection is not necessary.

Step III a. Selection of priority intersection type

Safety

Priority intersection type I, with separate left turn lane in the primary road, should be selected for safety reason.

4   Continued Work

4.1   Revision of the proposed selection model

The first step in the continued work should be to revise the proposed selection model. This should mainly be done in a working group in KGM with representatives from concerned departments. The objective should be to consider if the proposed model lay out is workable in Turkey and what could be changed or added. The working group should also consider and plan the adaptation to Turkish conditions.

The suggestion from the working group will be included in the final report which will be presented by the end of May 2000.

4.2   Adaptation to Turkish conditions

The second step should be to adapt the revised selection model to Turkish conditions. This must probably be made in steps. Some of the needed adaptations, e.g. to decide on which road classes and in which locations priority intersection can be accepted, can hopefully be made in a rather short period of time. Other adaptations such as working out selection criteria based on accident experiences will certainly take a long time.

A description of the work needed for the adaptation to Turkish conditions will be included in the final report. The main work, however, will be to establish a set of standard at-intersection and to work out selection criteria for these standard intersections.