



Guidelines for setting speed limits

H Ribbens

February 1986

Technical Report **RV/19**

**NATIONAL INSTITUTE FOR TRANSPORT AND ROAD RESEARCH, CSIR, SOUTH AFRICA
NASIONALE INSTITUUT VIR VERVOER- EN PADNAVORSING, WNNR, SUID-AFRIKA**

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Original by D J W Wium

Revised by H Ribbens

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SYNOPSIS

A method is described for setting the speed limit for a particular road section. Several speed limits based on different criteria are described for each of nine traffic and road factors. The most appropriate speed limit for each relevant factor is selected, and the lowest of them is used to set the speed limit for the road section.

The factors to be considered concern aspects such as the 85th percentile speed, accident rate, stopping sight-distance, pedestrian and pedal cycle movements, parking and loading manoeuvres, access to bounding properties, intersections, width of road without central median and clear roadside area.

The method should result in greater uniformity in speed limits for similar circumstances as set by different authorities.

SINOPSIS

'n Metode vir die vasstelling van die spoedperk vir 'n besondere padseksie word bespreek. Verskeie spoedperke gebaseer op verskillende kriteria word vir elk van nege verkeers- en padfaktore beskryf. Die toepaslikste spoedperk vir elke betrokke faktor word gekies en die laagste daarvan word gebruik om die spoedperk vir die padseksie vas te stel.

Die faktore wat oorweeg moet word, het betrekking op aspekte soos die 85ste-persentiel-spoed, ongelukskoers, stopsigafstand, voetganger- en trapfietsbewegings, parkeer- en oplaaimaneuvers, toegang tot aangrensende eiendomme, kruisings, breedte van pad sonder mediaan-eiland en oop padkantgebied.

Die metode behoort beter eenvormigheid in spoedperke vir soortelyke omstandighede soos vasgestel deur verskillende owerhede, tot gevolg te hê.

GUIDELINES FOR SETTING SPEED LIMITS

P R E F A C E

The original report was prepared following a request by the National Road Safety Council for guidelines for setting speed limits. Because it was considered that the speed limit should be based on other factors in addition to the prevailing speed, a literature study was made of the methods used in some overseas countries and a draft report on the subject was prepared. This report was studied and modified with regard to technical, human factor and law enforcement aspects by the following group of engineers and traffic officers: Messrs A R Berrange, T L Kruger, T C Mackey, H J O'Brien, R G Phillips and the late Messrs S Dorfman and D J W Wium. This report was published as Technical Report RF/4A/75.

In October 1981 the CSIR Steering Committee for Safety Research resolved that this report should be revised to incorporate warrants for speed limits of 70 and 90 km/h. The Committee agreed that, as an interim measure, Report RF/4A/75 be revised and reprinted as Report RF/6/83. The available members of the original working committee as well as other persons representing the organizations who participated in the drafting of RF/4A/75 were invited to assist with the revision. The following people participated:

R Fieldwick	(Chairman). Head of Safety Engineering Group, National Institute for Transport and Road Research, CSIR.
D Jones	Chief Traffic and Licensing Officer, Town Council of Benoni.
T C Mackey	Senior Engineer, Planning, Department of Transport.
H J O'Brien	Chief Traffic Officer, Town Council of Sandton.
A J Papenfus	Engineer, Planning Section, Transvaal Roads Department.
J Sampson	Assistant Chief: Road Planning and Traffic Engineer, City of Johannesburg.
H Ribbens	Assistant Head of Safety Engineering Group, National Institute for Transport and Road Research, CSIR.

The working group expressed concern at the widespread practice of the law enforcement authorities' reluctance to prosecute and convict drivers travelling at a speed less than 10 km/h above the speed limit. It was felt that this fact was known by drivers and that they adjusted their speed accordingly. Speed measurements on a variety of roads tended to support this view. As a consequence, the majority of the working group recommended that the speed limit should be based on the 50th percentile speed, rather than the 85th, in an endeavour to get drivers to travel at a safe speed. The Republic's poor accident rate was an important factor when formulating this recommendation. However, both the Committee of State Road Authorities and the Committee of Urban Transport Authorities recommended that the 85th percentile speed be used.

The working group also ranked in order of importance

- i) the factors which are used in determining the speed limit and
- ii) the proposed percentage of cases each factor should be the critical one.

The accident rate was deemed to be the most important factor and should be the critical factor in 40 per cent of the cases. The details of approximately sixty sites where the speed limit had been changed in accordance with RF/4A/75 were examined, and the values of the factors were modified to achieve more closely the suggested percentage of cases. It should be noted that only slight changes were required in most instances.

CONTENTS

Page

PREFACE

1.	INTRODUCTION	1
2.	CONSTRAINTS ON APPLICATION	4
3.	THE METHOD	4
4.	LENGTH OF ROAD SECTION	5
5.	FACTORS TO BE CONSIDERED	6
5.1	85th Percentile speed of traffic	7
5.2	Accident rate	8
5.3	Stopping sight distance	9
5.4	Pedestrians and pedal cyclists	9
5.5	Parking and loading manoeuvres	9
5.6	Access to bounding properties	9
5.7	Intersections and pedestrian crossings	11
5.8	Width of road without central median	11
5.9	Clear roadside area	11
6.	SETTING OF SPEED LIMIT	11
7.	POSTING OF SPEED LIMITS	12
8.	CONCLUSION	12
9.	ACKNOWLEDGEMENT	13
	REFERENCES	13
	APPENDIX A	15
	APPENDIX B	19
	APPENDIX C	20
	APPENDIX D	23
	APPENDIX E	25

GUIDELINES FOR SETTING SPEED LIMITS

Original by D J W Wium

Revised by H Ribbens

1. INTRODUCTION

The purpose of speed limits is to reduce the number or severity of accidents, or both, and to provide for the smooth and efficient passage of all types of traffic. Although obedience to speed limits can be imposed through speed limit enforcement involving controls and fines, voluntary compliance can be achieved to a large extent if the drivers of vehicles understand the need for a specific limit on particular roads. The application of lower speed limits is not always necessarily the solution and environmental changes such as narrower lanes, and so on could have the desired effect of slowing down traffic. The general speed limits for urban and rural areas, as proclaimed in the provincial ordinances, cannot cater for all the widely varying circumstances which occur in these two types of area. Provision is made in the ordinances for speed limits other than the general ones by means of appropriate signing to allow for the setting of "realistic" speed limits to suit the prevailing circumstances along a road. Use of the provision can result in the more effective use of speed limits as a safety measure, although it is important that variations in the speed limit along a specific road be kept to an absolute minimum so as not to confuse the drivers of motor vehicles unduly.

Very limited guidance is given to authorities on how speed limits should, be determined. The South African Road Traffic Signs Manual¹ states merely that the exact value of the speed limit should be the safe speed for the type of alignment, surface condition and traffic volume of a particular road section and, where necessary, should be determined by an actual speed measurement. A

study of methods for speed limit determination used in overseas countries has shown that techniques vary considerably in England, Australia, New Zealand, Canada and amongst the different states of the USA and it would seem there is no unanimity on the criteria to be used.

Most authorities in the United States², replying to an enquiry reported there, stated that they used the 85th percentile speed as the basic factor in assessing the speed limit; physical conditions of the roadway, roadside development and accident experience were also considered, but only in a subjective manner. A method described by the Traffic Institute of Northwestern University³ uses more objective criteria to adjust the prevailing speed parameter by giving consideration to ten other factors. The Federal Highway Administration⁴, however, intends to conduct a nationwide survey on criteria used in the setting of speed limits soon. This will be followed by comprehensive research studies to validate existing criteria and to develop objective criteria for treating factors usually considered in setting speed limits. In Canada⁵, provinces rely on the 85th percentile speed or the 10 mph "pace speed" for establishing speed limits. Some jurisdictions, however, have carried the procedure further, considering other factors such as distance between intersections, number of driveways per mile, pedestrian activity, etc.

In Great Britain⁶ the Ministry of Transport introduced new criteria for determining appropriate speed limits for specific lengths of road. These are much more precise than the criteria used before since they take into account local conditions such as speed of traffic, character of road environment, traffic composition, character of road and casualty rates.

In Victoria, Australia⁷, general speed limits of 100 km/h in rural areas and 60 km/h in urban areas have been set traditionally with an allowance for relatively minor speed zone amendments. Speed zone speeds were based on an indication of the perceived safe operating speed by the majority of drivers (which is the 85th percentile speed) plus a calculated speed zone index. This

provided a measure of the abutting land use and other roadway and roadside development characteristics which could be compared with a predetermined scale of index values established from past practice and experience. More recently the index has not been used for defining the speed zones and the more general abutting land use criteria have been the determinant of the appropriate speed limit. In this context the speed zones are no more than general limits applicable to different areas rather than the accepted speed zone concept of setting the speed of different road sections compatible with varying roadway, traffic or adjacent land use characteristics.

New Zealand⁸ uses a rating system for the setting of speed limits which allocates units to the various components. Three basic considerations are acknowledged which affect the choice of speed limit for a road, viz:

- a) development alongside the roadway e.g. buildings, recreation areas and side roads
- b) roadway adequacy e.g. pedestrians, cyclists, parking, geometry, traffic control, use etc.
- c) existing operating characteristics e.g. existing speeds, accident history, etc.

After a study of these methods, it was concluded that they could be improved and made more appropriate to conditions in the Republic of South Africa, as described in a report on speed limit criteria⁹.

The purpose of this document is to describe a method which would assist the many different authorities in the Republic of South Africa to set speed limits which would not only suit the prevailing circumstances along a road but also result in the setting of the same limit for similar circumstances by different authorities.

This method of setting the speed limit requires the consideration of several factors in terms of certain criteria, some very similar to those being used in Great Britain and those recommended by the Traffic Institute of Northwestern University³, so that the lowest limit for the most critical conditions can be selected.

2. CONSTRAINTS ON APPLICATION

Road authorities which have separate departments responsible for signing and for speed control, are reminded that such departments should collaborate closely to ensure that adequate enforcement and speed control will be maintained on road sections signed with speed limits differing from the general limits.

It is generally recognised that a higher limit rigidly enforced will produce safer travel and smoother traffic flow than a lower limit inadequately enforced.

The mere erection of a sign may not change the traffic speed pattern.

Road authorities are also reminded that accidents may be reduced by the removal or modification of hazards along a given section.

After any change in the circumstances along a section, the speed limit should be re-assessed.

In the application of this method, priority should be given to those roads which have a poor accident record.

3. METHOD

The method consists of three steps. The first step requires that the length of the particular road section for which the speed limit has to be set, i.e. its terminals, be determined.

The second step consists of considering a number of traffic and road factors, one or more of which may limit the speed of vehicles along the particular road section. The factors are given in Appendix A and for each of them two or more speed limits are given, depending on the circumstances prevailing along the road section. The method requires the selection of the most appropriate description under each applicable factor, with its corresponding speed limit. The speed limit for the road section is then determined by comparing the different speed limits thus obtained and selecting the lowest one or the second lowest if the lowest figure is considered unnecessarily restrictive.

In Appendix B a recording form is given on which to encircle the most appropriate speed limit for each factor; the lowest and next lowest limits can then be seen at a glance. Appendix E at the back of the report consists of a perforated summary sheet of Appendices A and B. This summary sheet can be removed from the report and duplicated for field use.

In the third step, the length of the road section must be checked to see whether it complies with the recommended minimum lengths for different speed limits and to adjust the length of the section accordingly.

Follow-up accident and other studies should be carried out to determine the effect of any change in speed limits along road sections.

4. LENGTH OF ROAD SECTION

The length of the road section for which a speed limit is to be set must be such that the speed limit will be as appropriate as possible over the full length of the section. To meet this objective it is essential that the circumstances under the various traffic and road factors remain fairly uniform over the full length of the section. When the circumstances change or when they differ over a sufficiently long length, it will obviously be necessary to set a

different speed limit for the new circumstances. The need for near uniformity of circumstances will be met when only short lengths of section are considered but there must obviously be a minimum length of section because too many variations in the speed limit along a road may confuse drivers.

The minimum length of the road section to which the speed limit is to apply will depend on the level of the limit. The minimum lengths given in Table 1 are recommended. Where there is a need for a speed limit over lengths shorter than the recommended minimum lengths, the use of advisory speeds should be considered.

Where it is necessary to set the speed limit at a value more than two steps below the limit on the preceding road section, it is recommended that one or more intermediate or transition speed limit(s) be introduced. Transition lengths of 0,2 km should be allowed for transition speed limits of 80 and 100 km/h and lengths of 0,1 km for speed limits of 50, 60 or 70 km/h.

Table 1: Minimum length of road to which a speed limit shall apply

Speed limit (km/h)	Absolute minimum length (km)	Desirable minimum length (km)
40	0,3	1,0
50	0,4	1,5
60	0,5	2,0
70	0,7	2,5
80	0,8	3,0
90	0,9	4,0
100	1,0	5,0
110	1,2	6,5
120	1,5	8,5

5. FACTORS TO BE CONSIDERED

The following brief explanatory notes must be read in conjunction with the criteria given in Appendix A. Although many other factors can also be taken into account it is obviously necessary to limit

the number of factors for practical purposes and for easy application. Differential speed limits for day and night time have also been an issue of discussion during the revision of the report. However, no conclusion was reached and this aspect needs further investigation. Finally, since speed deceleration at roadworks and different methods of speed control are already covered in Section 4 of the South African Road Traffic Signs Manual¹ this aspect is not dealt with in this report.

Factors which apply over very short distances should rather be the subject of an advisory speed displayed in conjunction with a warning sign. Similarly, circumstances which prevail for relatively short periods in the day should not be the main consideration.

5.1 85th Percentile speed of traffic

It is important for speed limits to be accepted by drivers as reasonable restrictions. It has been shown that if the speed limit is posted higher than the 85th percentile, the average speed of traffic increases, as does the total number of accidents. The death/injury accidents remain unchanged. If the speed limit is posted at the 85th percentile, the average speed of traffic remains unchanged but the dispersion of speeds decreases. The severity of accidents is reduced but the total number of accidents remains unchanged. Setting the speed limit below the 85th percentile results in a still smaller dispersion of speed, a reduction in the average speed, and a reduction in both the number and severity of accidents¹⁰.

Many South African drivers believe that they can drive up to 10 km/h faster than the posted speed limit before they are prosecuted. An analysis by the working group of various speed distributions indicated that the mean speed (50th percentile speed of traffic) is usually between 8 and 12 km/h slower than the 85th percentile speed of traffic. The 50th percentile speed on a particular road was regarded by most members of the working group as a good guide to determine the appropriate speed for the road.

This conclusion was not shared by all members, who preferred to use the 85th percentile speed. No differentiation is made between urban and rural conditions. However, both the Committee of State Road Authorities and the Committee of Urban Transport Authorities recommended that the 85th percentile speed be used.

A method for determining the 85th percentile speed is described in Appendix C.

5.2 Accident rates (equivalent accident number)

The accident rate for a given road section is possibly the only objective measure of the accident risk on it. Since risk is relative, the accident rate must be compared with the average rates for other roads of a similar character. For the purpose of setting speed limits the accident rate must be based on reliable accident and traffic data, collected for a sufficiently long period to provide an adequate sample size. In calculating the accident rate the sample size of distance travelled should be at least 5 million vehicle km; this is obtained by multiplying the average daily traffic volume by the length of the section by the number of days.

The rate to be used is the number of equivalent accidents per million vehicle kilometres travelled over that particular road section. This procedure automatically gives greater weight to the more severe accidents. A weighting is assigned to each accident category i.e. fatal, injury and damage only. The weightings recommended in Technical Manual K21¹¹ are suggested for use. An example of how to determine the number of equivalent accidents per 1 million vehicle kilometres travelled is given in Appendix D.

These values may be higher than those which a community can achieve or has achieved. It is strongly recommended that existing speed limits which are accepted by the community should never be raised because a road has a better safety record than the rates given in Appendix A.

5.3 Stopping sight distance

In the design of the alignment (curves and gradients) of the road it is customary to select or prescribe the design speed of a road. Stopping sight distance is the distance a driver must be able to see ahead to stop in safety as illustrated in Figure 1. Over crests it is measured from an eye height of 1,05 m to an object height of 0,15 m and on curves it is measured from an eye height of 1,05 m, to an object height of 0,15 m, over an obstruction 0,6 m high¹². All sight distances are measured along the centre line of the road.

5.4 Pedestrians and pedal cyclists

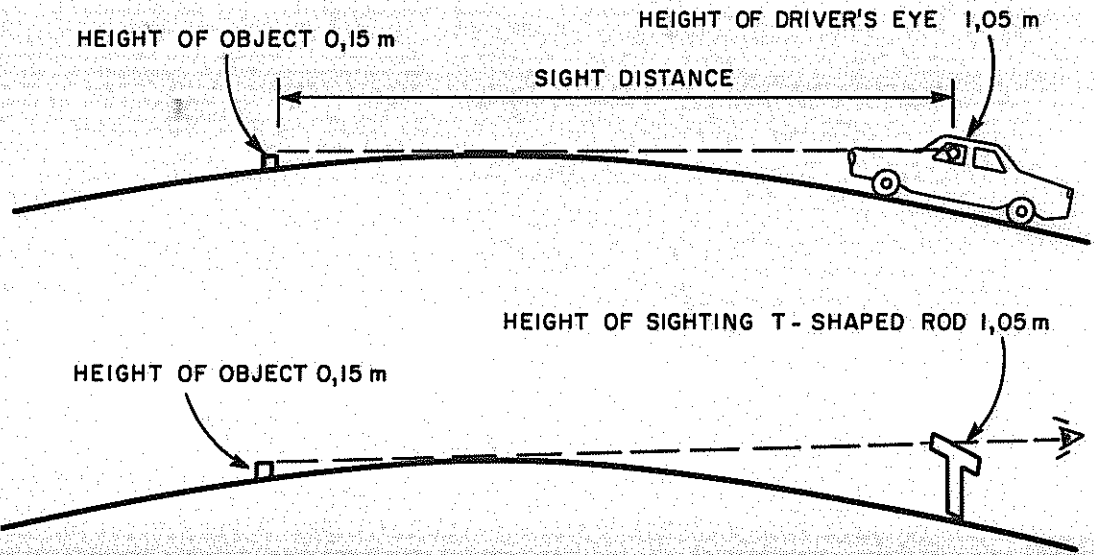
The maximum speed limit must be related to the number of pedestrians crossing the road and also to the facilities provided for their safety, such as a central refuge, an uncontrolled midblock crossing or a signal-controlled midblock crossing. This criterion requires that the number of pedestrians crossing the road over a 150 m length be counted over at least four hours during an average day. It may be noted that high pedestrian volumes at intersections may warrant traffic signal control in terms of the South African Road Traffic Signs Manual¹ and hence the appropriate speed control determined by criteria under the intersection factor in par. 5.7.

5.5 Parking and loading manoeuvres

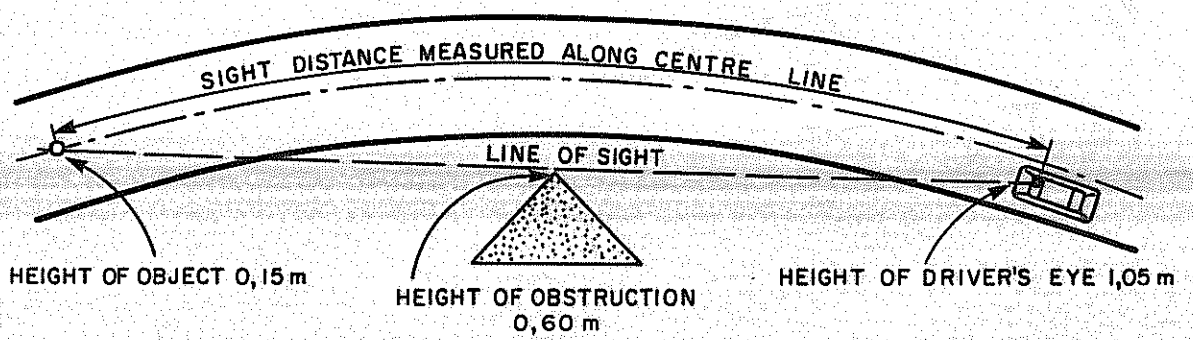
The disruptive manoeuvres of parking and loading along the road in the central business district, commercial subcentres and along some isolated sections of road in rural areas require the speed limit to be set according to the number of manoeuvres.

5.6 Access to bounding properties

The speed limit is related to the frequency of access to bounding properties which have been developed.



ON VERTICAL CURVES



ON HORIZONTAL CURVES

FIGURE 1
STOPPING SIGHT DISTANCES

5.7 Intersections and pedestrian crossings

This factor applies mainly in the transition zone between built-up and rural areas. The frequency of crossroads and their controls and the visibility of the traffic controls are the main criteria.

5.8 Width of road without central median

The width of the road is a factor that becomes increasingly important as the speed of vehicles increases, especially on two-lane roads with traffic flows in opposite directions. The travelled way is defined as that portion intended for the movement of vehicles, and excludes the shoulders.

5.9 Clear roadside area

The proximity of fixed objects to the edge of the travelled way has an influence on the severity of accidents and consequently speeds must be limited where there are numerous fixed objects, unprotected by guardrails, close to the road. Only fixed objects likely to produce injury to persons or damage to vehicles when hit need be considered.

6. SETTING THE SPEED LIMIT

Once the different factors in Appendix A have been considered and the limits for those which are relevant have been selected according to the prevailing circumstances, the next step consists in setting the speed limit in the way mentioned in paragraph 3. To recap, it is recommended that the lowest limit which applied in respect of any of the factors be selected as the speed limit to apply over the road section irrespective of what the limit for the other circumstances or factors are, or the second lowest figure may be selected if the lowest figure is considered unnecessarily restrictive. In exceptional circumstances a lower speed limit may be set if there are other factors not included in the considerations which warrant it, such as roads which are slippery under wet conditions.

7. POSTING OF SPEED LIMITS

The posting of speed limits along road sections with speed limits which differ from the general limits is very important¹³. Although detailed discussion is outside the scope of this document, the following points are made:

- a) Signs should be provided wherever there is a change in the ruling speed limit.
- b) Repeat signs should be provided on all surfaced roads in rural areas and on all urban roads where limits above or below the blanket speed limit are posted.
- c) The size of signs and repeater signs is of utmost importance. Although the South African Road Traffic Signs Manual¹ recommends that a sign, 610 mm in diameter is used where a speed limit of between 40 and 60 km/h is sign-posted, a sign size of 914 mm in diameter is recommended in areas where the smaller sign would not be very obvious to the driver, e.g. through commercial areas, on roads with sharp horizontal and vertical curvature, etc.
- d) Advisory speed signs are desirable in all cases where hazard signs are posted.

8. CONCLUSION

The method described here for setting the speed limit for a particular road section should result in greater uniformity in speed limits for similar circumstances, and consequently in greater acceptance by drivers of speed limits as a road safety measure. The criteria values must be considered as provisional until such time as there is a need for them to be revised following additional experience with the implementation of this method of setting speed limits.

9. ACKNOWLEDGEMENT

The original surveys which formed the basis for this method were funded by the National Road Safety Council and by Southern African road authorities.

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APPENDIX A

SCHEDULE FOR SPEED LIMIT CRITERIA

Max. speed limit

1. 85th Percentile speed of traffic

Where the 85th percentile speed is as follows:

a)	below 45 km/h	40 km/h
b)	between 45 and 55 km/h	50 km/h
c)	between 55 and 65 km/h	60 km/h
d)	between 65 and 75 km/h	70 km/h
e)	between 75 and 85 km/h	80 km/h
f)	between 85 and 95 km/h	90 km/h
g)	between 95 and 105 km/h	100 km/h
h)	between 105 and 115 km/h	110 km/h
i)	above 115 km/h	120 km/h

2. Accident rates (equivalent accident number)

- a) On urban road sections for which the equivalent number of accidents per million vehicle kilometres is as follows:

Equivalent accidents per 10⁶ veh. km

i)	70 or more	40 km/h
ii)	35 - 70	50 km/h
iii)	20 - 35	60 km/h
iv)	14 - 20	70 km/h
v)	10 - 14	80 km/h
vi)	7 - 10	90 km/h
vii)	4 - 7	100 km/h

- b) On rural road sections for which the number of accidents per million vehicle kilometres is as follows:

Equivalent accidents per 10⁶ veh. km

i)	8 or more	60 km/h
ii)	6 - 8	70 km/h
iii)	4 - 6	80 km/h
iv)	2 - 4	90 km/h
v)	1 - 2	100 km/h
vi)	0,5 - 1	110 km/h
vii)	0,5 or less	120 km/h

3. Stopping sight distance¹⁴

On a section of road which has a series of three or more curves or crests, the appropriate speed limit may be determined from Figure 2.

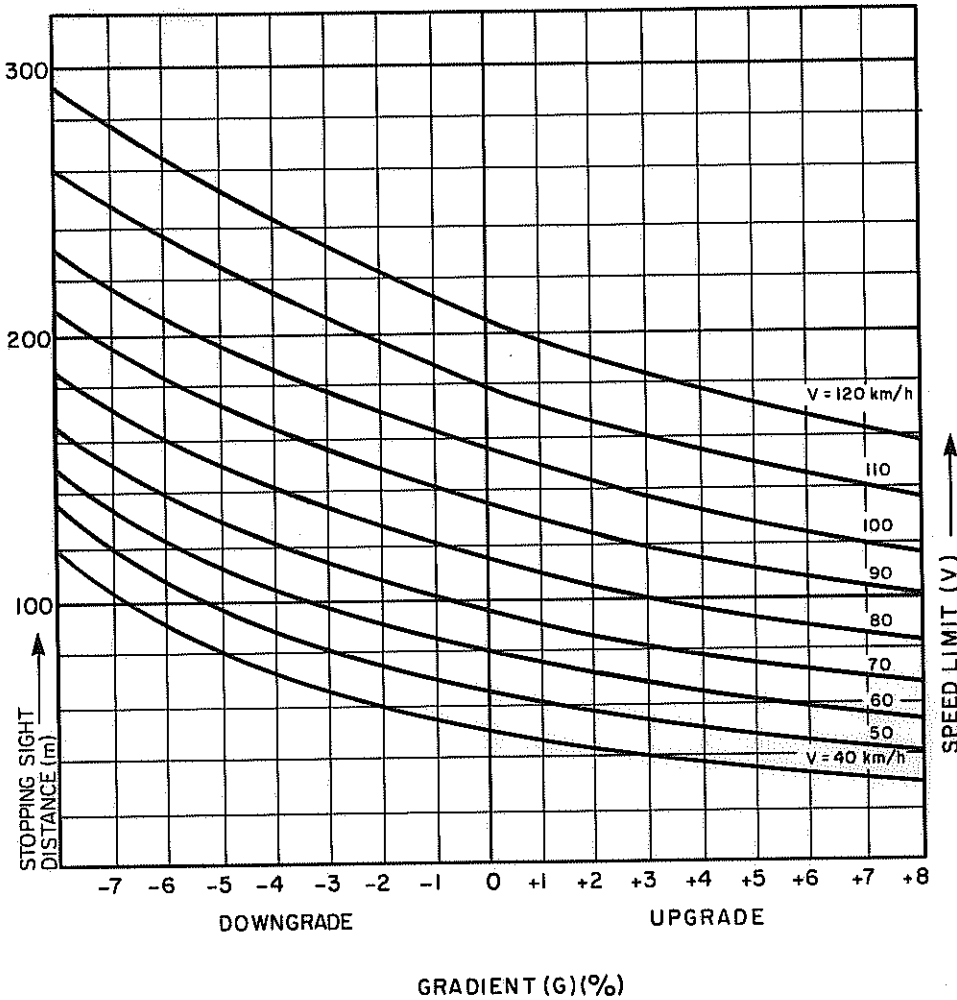


FIGURE 2
STOPPING SIGHT DISTANCE ON GRADE
Source TRH17

For example, on a section of road with curves with a safe stopping sight distance of 100 m on a 2 % downgrade, the speed limit would be 66 km/h, which would be rounded off to 70 km/h.

Note: Figure 1 explains how the stopping sight distance is measured on vertical and horizontal curves.

Max. speed limit

4. Pedestrians and cyclists

- a) In an urban area where during any four hours of an average day more than 500 pedestrians during the four hours cross a road over a 150 m length with:
- i) no central median or uncontrolled midblock crossing 40 km/h
 - ii) a central median or uncontrolled midblock crossing 50 km/h
 - iii) a signal-controlled midblock crossing 60 km/h
- b) In a rural area where during any four hours of an average day an isolated concentration of more than 200 pedestrians during the four hours cross over a 150 m length as follows:
- i) a road with no central median 70 km/h
 - ii) a road with a central median 80 km/h
- c) In areas where numerous pedestrians walk and pedal cyclists ride on the shoulders of a road
- i) in an urban area 60 km/h
 - ii) in a rural area 80 km/h

5. Parking and loading manoeuvres

- a) In an urban area where parking and loading manoeuvres along a kerb during any four hours of an average day:

	<u>4 Moving lanes or less</u>	<u>More than 4 moving lanes</u>
i) exceed 200 manoeuvres per hour per km	50 km/h	60 km/h
ii) range between 100 and 200 manoeuvres per hour per km	60 km/h	60 km/h

- b) In a rural area along an isolated section where more than 25 but less than 50 parking and loading manoeuvres per hour per km occur during any four hours of an average day along the carriageway 80 km/h

Max. speed limit

- c) In a rural area along an isolated section where more than 50 parking and loading manoeuvres per hour per km occur during any four hours of an average day along the carriageway 70 km/h
- 6. Access to bounding properties
Where access to residential and business properties is as follows:
 - a) directly from the road where the accesses are spaced at less than 50 m 60 km/h
 - b) directly from the road where the accesses are spaced at between 50 m and 100 m 70 km/h
 - c) directly from the road where the accesses are spaced more than 100 m apart N.A.
- 7. Intersections and pedestrian crossings
 - a) In an urban area where vehicles on the road in question are required to stop or yield for signs or traffic control signals at the following average spacing:
 - i) under 0,4 km 60 km/h
 - ii) between 0,4 km and 1,2 km 70 km/h
 - iii) over 1,2 km 80 km/h
- 8. Width of road without central median
 - a) less than 6 m in an urban area 50 km/h
 - b) less than 6 m in a rural area 80 km/h
- 9. Clear roadside area
 - a) On a road section in an urban area with more than 20 fixed objects (trees, poles, etc.) per km on one side :
 - i) less than 1 metre from the road edge 60 km/h
 - ii) between 1 and 2 m from the road edge 70 km/h
 - iii) between 2 and 3 m from the road edge 80 km/h
 - b) On a road section in a rural area with more than 10 fixed objects per km on one side:
 - i) less than 1 m from the road edge 70 km/h
 - ii) between 1 and 3 m from the road edge 80 km/h
 - iii) more than 3 m from the road edge 100 km/h
 - iv) more than 5 m from the road edge 120 km/h

APPENDIX B

RECORDING FORM FOR SPEED LIMITS AS SELECTED ACCORDING TO THE CRITERIA UNDER THE DIFFERENT FACTORS GIVEN IN APPENDIX A

<u>Factor</u>	<u>Appropriate speed limit</u>										
1. 85th Percentile speed of traffic	40	50	60	70	80	90	100	110	120	NA	
2. Accident rate	40	50	60	70	80	90	100	110	120	NA	
3. Stopping sight distance	40	50	60	70	80	90	100	110	120	NA	
4. Pedestrians and cyclists	40	50	60	70	80						NA
5. Parking and loading manoeuvres		50	60	70	80						NA
6. Access to bounding properties			60	70							NA
7. Intersections			60	70	80						NA
8. Width of road without central median		50			80						NA
9. Clear roadside area			60	70	80		100		120	NA	

NOTE: 1) Consider the criteria under the different factors described in Appendix A and encircle the most appropriate speed limit above for each applicable factor.

Where the conditions along the road section are outside the scope of the criteria and can not be applied, encircle the letters NA to indicate that the criteria are "not applicable".

2) Set the speed limit at the lowest figure encircled above or at the second lowest figure if the lowest figure is considered unnecessarily restrictive.

APPENDIX C

DETERMINING THE 85TH PERCENTILE SPEED

The 85th percentile speed is the speed at or below which 85 per cent of the vehicles travel. The procedure for determining the 85th percentile speed is described in the following paragraphs.

Equipment

The measuring of vehicle speeds may be done by using one of several methods, e.g. mirror boxes and stopwatch, radar, timing instrument actuated by road sensors, etc. They must all be used in an unobtrusive way so that the measured speeds are those which drivers have chosen themselves.

Weather conditions

The speed measurements should be taken during periods of dry pavement conditions and clear weather with good visibility.

Time of day

As a general rule speed measurements should be taken during periods of average traffic volume. Where unusual flow distributions prevail, a traffic count of successive half-hours over at least twelve hours may be taken so that the times of average flows can be determined. It is recommended that the speed measurements at a representative site on the road section be made over five hours divided into at least two separate periods, e.g. three hours in the mid-morning (e.g. 09h00 to 12h00) and two hours in the early afternoon (e.g. 14h00 to 16h00). Speed measurements may be taken during periods of peak flow providing that traffic congestion does not unduly reduce traffic speed and that the volume of traffic does not make measurement impracticable.

Representative site

The speed measurements must be made at a site along the road section where the measured speeds will be representative of the whole road section. The site must be away from features which could cause drivers to vary or reduce their speeds. Where this is an existing limit posted, the measurement should be made after enforcement of the existing limit has been suspended for at least a week. If the limit is subsequently raised then a further 85th percentile determination should be made after the new limit has been in force for six months.

Measurements

The ideal is to measure the speeds of all vehicles during the five hours but if this is not possible because of high traffic volumes, the speeds of a representative sample of vehicles must be taken. For this purpose the speeds of at least 300 randomly selected vehicles must be measured and must be distributed as evenly as possible over the five hours. This can be accomplished in several ways, e.g. by one measurement every minute or by measuring fifteen successive vehicles at the start of every

fifteen minutes. The selection of vehicles for speed measurements must be done in a systematic manner to prevent any bias, e.g. every n-th vehicle or the n-th vehicle after predetermined time intervals. The actual speed measurements must be recorded successively and must be expressed to the nearest whole km/h.

Finding the 85th percentile

After the measurements have been completed, construct a frequency table consisting of three columns: the first column containing the speed arranged in ascending order in rows below each other; the second column containing the number of times each speed value was recorded; and in the third column the cumulative total (C.T.) by adding each number to the sum above it. The last number in the C.T. column is the total number of speeds being considered.

To find the 85th percentile, multiply the total number by 0,85 and find the row in which that number occurs in the C.T. column. The speed of that row is the 85th percentile speed.

An alternative method of obtaining the 85th percentile from the data in the frequency table is to express the figures in the C.T. column as percentages of the total number and then plotting them against the speed on graph paper. The 85th percentile speed can then be read off from the graph obtained when a smooth curve is drawn through the plotted points.

An example of the tabulation is given below :

<u>Speed (km/h)</u>	<u>Number of vehicles</u>	<u>Cumulative total (C.T. and percentage)</u>
1 - 69	135	135 (35 %)
70	25	160 (42 %)
71	33	193 (51 %)
72	21	214 (56 %)
73	37	251 (66 %)
74	20	271 (71 %)
75	23	294 (77 %)
76	17	311 (81 %)
77	9	320 (84 %)
78	12	332 (87 %)
79	15	347 (91 %)
80+	<u>36</u>	383 (100 %)
Total	383	

Note: The table has been shortened by grouping the lowest and the highest measurements together under "1-69" and "80+"

Steps to find the 85th percentile speed from the tabulation

- 1) Note that total number of speeds recorded in the table which is given by the last number in the C.T. column, viz. 383.
- 2) Multiply this number 383 by 0,85 giving a product of 325,5 which can be rounded off to the whole number 326.
- 3) Inspect the numbers in the C.T. column to find the row in which the cumulative total number is equal to or just larger than the number 326 found in the previous step, viz. the row with 332 in the C.T. column.
- 4) This number occurs in the row with speed 78 km/h in the first column and the 85th percentile speed is thus 78 km/h. The appropriate speed limit for this factor is thus 80 km/h.

APPENDIX D

DETERMINING THE EQUIVALENT ACCIDENT RATE PER 1 MILLION VEHICLE
KILOMETRES TRAVELLED

The equivalent accident rate takes into account accident severity when investigating a change to the speed limit along a road section with a poor accident record.

1. Determine the vehicle kilometres travelled on the relevant road section. (a sample of at least 5 million vehicle kilometres is required).

Example

Average daily traffic volume x length of road section x number of days over which accident data apply.

e.g. 21 600 vehicles x 1,7 km x 365 days

= 13,4 million vehicle kilometres.

2. a) Determine the number of accidents by severity on the road section for the corresponding period, multiply each severity type with the recommended weighted factor and sum.

Example

<u>Severity</u>	<u>No. of accidents</u>		<u>Weighting^x</u>		<u>Equivalent no of accidents</u>
Fatal	7	x	12	=	84
Injury	35	x	3	=	105
Damage only	179	x	1	=	<u>179</u>
				Total	368

^x Weighting recommended in Manual K21

3. Calculate the equivalent accident rate per million vehicle kilometres travelled

Example

$$\begin{aligned} \text{Equivalent accidents per} &= \frac{\text{Total equivalent no. of accidents}}{\text{Millions of vehicle km travelled}} \\ \text{million veh. km.} &= \frac{368}{13,4} \\ &= 27,6 \text{ equivalent no. of accidents/} \\ &\quad \text{million veh. km.} \end{aligned}$$

Therefore, the appropriate speed limit for this factor would be 60 km/h.

SUMMARY SHEET OF CRITERIA FOR SETTING SPEED LIMITS ROAD SECTION DATE OF SURVEY
 Max. speed limit
 Max. speed limit

1. 85th Percentile speed of traffic

Where the 85th percentile speed is as follows:

- a) below 45 km/h
- b) between 45 and 55 km/h
- c) between 55 and 65 km/h
- d) between 65 and 75 km/h
- e) between 75 and 85 km/h
- f) between 85 and 95 km/h
- g) between 95 and 105 km/h
- h) between 105 and 115 km/h
- i) above 115 km/h

- 40 km/h
- 50 km/h
- 60 km/h
- 70 km/h
- 80 km/h
- 90 km/h
- 100 km/h
- 110 km/h
- 120 km/h

2. Accident rates (equivalent accident number)

a) On urban road sections for which the equivalent number of accidents per million vehicle kilometres is as follows:

Equivalent accidents per 10⁶ veh. km

- i) 70 or more
- ii) 35 - 70
- iii) 20 - 35
- iv) 14 - 20
- v) 10 - 14
- vi) 7 - 10
- vii) 4 - 7

- 40 km/h
- 50 km/h
- 60 km/h
- 70 km/h
- 80 km/h
- 90 km/h
- 100 km/h

b) On rural road sections for which the number of accidents per million vehicle kilometres is as follows:

Equivalent accidents per 10⁶ veh. km

- i) 8 or more
- ii) 6 - 8
- iii) 4 - 6
- iv) 2 - 4
- v) 1 - 2
- vi) 0,5 - 1
- vii) 0,5 or less

- 60 km/h
- 70 km/h
- 80 km/h
- 90 km/h
- 100 km/h
- 110 km/h
- 120 km/h

3. Stopping sight distance

Stopping sight distance =
 Gradient =
 Speed limit =

NOTE: Use Figures 1 and 2 for calculation

4. Pedestrians and cyclists

a) In an urban area where during any four hours of an average day more than 500 pedestrians during the four hours cross a road over a 150 m length with:

i) no central median or uncontrolled midblock crossing

40 km/h

ii) a central median or uncontrolled midblock crossing

50 km/h

iii) a signal-controlled midblock crossing

60 km/h

b) In a rural area where during any four hours of an average day an isolated concentration of more than 200 pedestrians during the four hours cross over a 150 m length as follows:

i) a road with no central median

70 km/h

ii) a road with a central median

80 km/h

c) In areas where numerous pedestrians walk and pedal cyclists ride on the shoulders of a road

i) in an urban area

60 km/h

ii) in a rural area

80 km/h

Max. speed limit

Max. speed limit

5. Parking and loading manoeuvres

a) In an urban area where parking and loading manoeuvres along a kerb during any four hours of an average day:

- i) exceed 200 manoeuvres per hour per km
- ii) range between 100 and 200 manoeuvres per hour per km

b) In a rural area along an isolated section where more than 25 but less than 50 parking and loading manoeuvres per hour per km occur during any four hours of an average day along the carriageway

c) In a rural area along an isolated section where more than 50 parking and loading manoeuvres per hour per km occur during any four hours of an average day along the carriageway

6. Access to abutting properties

Where access to residential and business properties is as follows:

- a) directly from the road where the accesses are spaced at less than 50 m
- b) directly from the road where the accesses are spaced at between 50 m and 100 m
- c) directly from the road where the accesses are spaced more than 100 m apart

7. Intersections and pedestrian crossings

a) In an urban area where vehicles on the road in question are required to stop or yield for signs or traffic control signals at the following average spacing:

- i) under 0,4 km
- ii) between 0,4 km and 1,2 km
- iii) over 1,2 km

8. Width of carriageway without central median

- a) less than 6 m in an urban area
- b) less than 6 m in a rural area

9. Clear roadside area

a) On a road section in an urban area with more than 20 fixed objects (trees, poles, etc.) per km on one side :

- i) less than 1 m from the road edge
- ii) between 1 and 2 m from the road edge
- iii) between 2 and 3 m from the road edge

b) On a road section in a rural area with more than 10 fixed objects per km on one side:

- i) less than 1 m from the road edge
- ii) between 1 and 3 m of the road edge
- iii) more than 3 m from the road edge
- iv) more than 5 m from the road edge

RECORDING FORM FOR SPEED LIMITS AS SELECTED ACCORDING TO THE CRITERIA

Factor	Appropriate speed limit									
1. 85th Percentile speed of traffic	40	50	60	70	80	90	100	110	120	NA
2. Accident rate	40	50	60	70	80	90	100	110	120	NA
3. Stopping sight distance	40	50	60	70	80	90	100	110	120	NA
4. Pedestrians and cyclists	40	50	60	70	80					NA
5. Parking and loading manoeuvres	50	60	70	80						NA
6. Access to bounding properties	60	70	80							NA
7. Intersections	60	70	80							NA
8. Width of road without central median			50							NA
9. Clear roadside area			60	70	80					NA

NOTE: Set the speed limit at the lowest figure encircled above or at the second lowest figure if the lowest figure is considered unnecessarily restrictive.

RECOMMENDED SPEED LIMIT km/h

- 60 km/h
- 70 km/h
- 80 km/h