Design Manual for Roads and Bridges

Road Layout
Appraisal

CA 185
Vehicle speed measurement

(formerly TA 22/81)

Revision 0

Summary
This document contains the requirements for the measurement of vehicle speeds and for determining 85th percentile speeds on existing all-purpose trunk roads.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

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Release notes

Version	Date	Details of amendments
0	Nov 2019	CA 185 replaces TA 22/81. This full document has been re-written to make it compliant with the new Highways England drafting rules.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes TA 22/81, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This document provides requirements and advice on:

1) the measurement of vehicle speeds on existing all-purpose trunk roads; and
2) how to calculate 85th percentile speeds.

The primary purpose of this document is to provide a consistent approach to measuring and calculating 85th percentile speeds. It describes methods that are to be used when obtaining speed data using manual or automatic measurement methods.

The data derived using this document can be used where existing vehicle speeds are necessary to set the basis for design. Such schemes can include the setting of speed limits, minor improvements to existing roads and altering or designing new priority junctions, accesses or signal controlled junctions.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 1.N] apply to this document.

Abbreviations

Abbreviations

Abbreviation	Definition
kph	kilometres per hour

Terms and definitions

Terms

Term	Definition
All motor vehicle types	All the types of motor vehicles observed during an individual speed measurement period.
Free flow traffic	A condition where a driver is able to drive at a speed of their own choice, unimpeded by factors such as: 1) the proximity of other vehicles in front; 2) non-permanent obstructions to the road layout such as roadworks, or a broken down vehicle; or 3) adverse weather. NOTE: Examples of adverse weather are snow, ice, fog and torrential rain.
Individual speed measurement period	A period of time during which vehicle speeds are continuously measured at a specific location.
Journey speed	The effective speed of a vehicle relative to how long it has taken to travel between two points.
Spot speed	The instantaneous speed of a vehicle measured at a particular point.
85th percentile speed	The speed at and below which 85% of vehicles within a measurement sample are travelling.

1. Scope

Aspects covered

1.1 This document shall be used for the measurement of vehicle speeds and for determining 85th percentile speeds on existing all-purpose trunk roads.

NOTE *This document is not applicable to motorways.*

Implementation

1.2 This document shall be implemented forthwith on all schemes involving the measurement of vehicle speeds and the determination of 85th percentile speeds on the Overseeing Organisations' all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 1.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 1.N] shall be followed in respect of activities covered by this document.

2. Vehicle speed measurement

Spot speed and journey speed measurements

Speed limits

2.1 When speed limits are to be determined based on speed measurement, one of the following methods shall be used:

1) spot speed measurements of cars only; or
2) spot speed measurements of all motor vehicle types with a conversion factor applied.

NOTE 1 Section 3 of this document includes the conversion factor to be applied when calculating 85th percentile speeds for the purpose of determining speed limits based on spot speed measurements of all motor vehicle types.

NOTE 2 Department for Transport Circular 01/2013 (DfT Circular 01/2013 [Ref 1.I]) provides advice on setting speed limits.

Traffic signal installations

2.2 When design parameters for traffic signal installations are to be determined based on speed measurement, spot speed measurements of all motor vehicle types shall be used.

2.2.1 Spot speed measurements on the approach to proposed, upgraded and existing traffic signal installations should be taken between 150 and 200 metres back from the existing/proposed stop line but as close to 160 metres as practicable.

2.2.2 Spot speed measurements on the approach to proposed, upgraded and existing traffic signal installations should be taken where there are no parked vehicles within 100 metres of the measurement point.

2.2.3 Spot speed measurements on the approach to existing signal controlled junctions should be taken:

1) when traffic flows are between 20% to 40% of the maximum capacity of the junction; and
2) only during a green phase where no queues are present.

Other scheme types

2.3 When design parameters for anything other than speed limits and traffic signal installations are to be determined based on speed measurement, journey speeds of all motor vehicle types shall be used.

NOTE Journey speed measurements are used for highway schemes such as new priority junctions/direct access and minor improvements to existing roads etc.

2.4 Measurements for journey speed shall be taken on the approaches to the scheme extents.

NOTE Measuring journey speeds on the approaches to the scheme extents can be achieved by matching registration numbers at the time of passing the two points.

Free flow conditions

2.5 All speed measurements (spot and journey speed) shall be undertaken in free flow conditions where vehicles are unlikely to be accelerating or braking, unless the measurements are to be taken in connection with changes to an existing feature that naturally impacts the free flow of traffic.

NOTE 1 Examples of where the road geometry can cause vehicles to slow down and speed up (or accelerate/brake) include isolated sharp bends, gradients and road narrowings.

NOTE 2 Improvements to an existing junction is an example of where speed measurements can be taken in conditions that are not entirely free flow.

NOTE 3 *In urban environments such as residential streets where persistent parking is typical, it would not be possible to undertake speed measurements in entirely free-flow conditions. In this particular scenario, the persistent parking can be considered a feature that naturally impacts the free flow of traffic and therefore equivalent to free-flow conditions.*

2.5.1 All speed measurements should be taken in dry weather conditions.

Minimum number of vehicles speeds to be recorded

2.6 A minimum of 200 vehicles speeds shall be recorded during each individual speed measurement period.

2.6.1 As many vehicles speeds as practicable should be recorded during each individual speed measurement period.

2.6.2 Similar numbers of vehicles speeds should be recorded as part of each individual speed measurement period and for each direction of travel in the case of two-way roads.

Speed measurement frequency and timing

2.7 Spot speed and journey speed measurements shall comprise a minimum of two individual speed measurement periods, undertaken on different days of the week, and at different times of the day.

2.8 On two-way roads, the individual speed measurement periods shall include separate measurements taken for both directions of traffic flow.

2.8.1 The minimum two individual speed measurement periods should be undertaken in different months and at least one month apart from each other, or in a neutral month if the former is not feasible.

2.8.2 Speed measurements should be undertaken outside of peak traffic flow periods.

NOTE 1 *Non-peak periods are typically between 10am and noon and 2pm and 4pm. In some cases these times need to be varied to take account of site specific circumstance e.g. if a school is nearby that closes at 3pm.*

NOTE 2 *A neutral month is a month that is not impacted by seasonal variation in traffic flows. Typical neutral months are April, May, June, September and October.*

2.9 Speed measurements shall not be undertaken during a local event that can result in traffic flows and speeds that are atypical for the road in question.

NOTE *Local events can include market days, local holidays, fetes and race meetings etc. It can also include situations where traffic is diverted along the route in question due to road works occurring on other parts of the network.*

2.10 Speed measurements shall not be undertaken at weekends.

2.11 Speed measurements on rural roads shall not be undertaken on bank holidays.

2.11.1 Speed measurements on urban roads should not be undertaken on bank holidays.

2.12 Where there is a difference in the 85th percentile speeds derived from the individual speed measurements periods, the higher value shall be used in the subsequent design.

Speed measurement methods

2.13 Speed measurements shall be undertaken using either manual or automatic methods.

NOTE *A variety of manual and automated methods of speed measurement are available, including:*

1) handheld radar speedometers (manual);

2) radar traffic classifiers (automated);

3) pneumatic tubes (automated);

4) inductive loops (automated).

Automatic speed measurement methods

2.14 When installing and operating automatic speed measurement equipment, the manufacturer's installation and operating instructions shall be followed.

NOTE *Automated speed measurements can reduce the risk of errors, provide greater volumes of data and reduce the risk of the results being artificially skewed (as a result of a the presence of a surveyor influencing driver behaviour); however, equipment such as inductive loops and pneumatic tubes can not always fully distinguish between different vehicle types due to classification being based on axle spacing. In this situation a correction factor can be applied (refer to Section 3: 85th percentile speed calculation)*

2.14.1 Vehicle speed measurement tools should be checked for accuracy prior to a survey being undertaken.

NOTE *A vehicle fitted with a calibrated speedometer can be used on site for a broad check of the accuracy of the readings given by the vehicle speed measurement tools being used.*

Manual speed measurement methods

2.15 For dual carriageway roads, speed measurements using manual methods shall be conducted on the same side of the road as the flow of traffic that is being surveyed.

2.15.1 For single carriageway roads, speed measurements using manual methods should be conducted on the same side of the carriageway as the flow of traffic that is being surveyed.

2.15.2 For manual speed measurements, as many of the vehicles that pass during a particular survey period should be recorded as possible.

2.15.3 A minimum of two surveyors should be utilised when undertaking manual speed measurements.

NOTE 1 *The use of a minimum of two surveyors (one taking readings and the other recording them) allows for a greater proportion of all passing vehicles to be recorded, if not all of them. It also helps to reduce errors and produce a more robust data set.*

NOTE 2 *A sampling method can be used if traffic flows are too high to allow all or most vehicles to be surveyed using manual methods.*

2.16 Any sampling technique used for manual methods of speed measurement shall be unbiased.

NOTE 1 *A unbiased sampling technique needs to be representative of the overall vehicle speeds during the survey period. A method that looks to record the vehicle speed of every 'x' number of vehicles where 'x' can provide sufficient time to measure and record the data could be used.*

NOTE 2 *On dual carriageways, surveys can be completed for specific lanes at a time to reduce the risk of vehicles being missed when trying to measure vehicle speeds across multiple lanes at the same time. The results of these individual lane surveys can then be added together to provide a set of results for the carriageway as a whole.*

2.16.1 When undertaking manual speed measurements, surveyors and their equipment (such as a vehicle) should not be located in a position that impacts the speed or flow of vehicles.

NOTE *Surveyors at the side of a road with a radar device in clear view of approaching traffic can potentially artificially skew traffic speeds as motorists can slow down as a result. Surveyors situated in a vehicle away from the carriageway with their equipment positioned inconspicuously reduces this risk.*

3. 85th percentile speed calculation

3.1 85th percentile vehicle speeds shall be calculated where designs are to be based on measured vehicle speeds.

NOTE 1 85th percentile vehicle speeds can be calculated using a variety of methods, including:

1) built-in functions in spreadsheet software;

2) statistical formulae; and

3) listing out the measured speeds in ascending order and counting down from the highest value until 15% of the values have been passed (the value that is arrived at is the 85th percentile speed).

NOTE 2 The method of listing out the measured speeds in ascending order and counting down to establish the 85th percentile is only suitable for samples that include 200 or more vehicles.

3.1.1 Where speed measurements have been taken either partially or entirely in wet weather conditions, the following values should be added to each individual speed recorded in wet weather:

1) 8kph for dual carriageways; and

2) 4kph for single carriageways.

NOTE Wet weather conditions includes periods after rainfall when the road surface is still wet.

3.1.2 Equations 3.1.2a to 3.1.2d should be used to derive the 85th percentile speed when using the statistical formula method.

Equation 3.1.2a 85th percentile speed

$$p85 = m + s$$

where:

p 85	is the 85th percentile speed
m	is the mean of the measured vehicle speeds
s	is standard deviation of the measured vehicle speeds

Equation 3.1.2b Mean of the measured vehicle speeds

$$m = \frac{\sum v}{n}$$

where:

$\sum v$	is the sum of all measured vehicle speeds
n	is the number of measured vehicle speeds

Equation 3.1.2c Standard deviation of measured vehicle speeds

$$s = \sqrt{\frac{\sum (v-m)^2}{n-1}}$$

Equation 3.1.2d provides a useful relationship to assist in deriving $\sum (v-m)^2$

Equation 3.1.2d Additional formula for deriving the standard deviation of measured vehicle speeds

$$\sum (v-m)^2 = \sum v^2 - \frac{\left(\sum v\right)^2}{n}$$

NOTE 1 *The formula given in Equation 3.1.2a is based on the established shape of speed distributions, which are to all intents and purposes normal (Gaussian). For a normal distribution, the 85th percentile is 1.037 standard deviations above the mean.*

NOTE 2 *The value derived using Equation 3.1.2a is rounded to the nearest whole number.*

NOTE 3 *The standard deviation (s) is approximately one sixth of the mean (m). This relationship can be used as a quick check to determine if the standard deviation calculated using Equation 3.1.2c is likely to be correct.*

NOTE 4 *Figure 3.1.2N4 provides a worked example of how to calculate the 85th percentile speed using Equations 3.1.2a to 3.1.2d. In this example, a spot speed survey recorded the speeds of 200 vehicles. The sum of the 200 vehicle speeds equals 9,400 and the sum of the squares of the 200 vehicle speeds equals 450,810. Rounding to the closest whole number gives an 85th percentile speed of 54kph.*

Figure 3.1.2N4 Example of how to derive 85th percentile speed using equations 3.1.2a to 3.1.2d.

Step 1

$$m = \frac{\sum v}{n}$$

$$m = \frac{9{,}400}{200}$$

$$m = 47$$

Step 2

$$\sum (v-m)^2 = \sum v^2 - \frac{(\sum v)^2}{n}$$

$$\sum (v-m)^2 = 450{,}810 - \frac{9{,}400^2}{200}$$

$$\sum (v-m)^2 = 450{,}810 - 441{,}800$$

$$\sum (v-m)^2 = 9{,}010$$

Step 3

$$s = \sqrt{\frac{\sum (v-m)^2}{n-1}}$$

$$s = \sqrt{\frac{9{,}010}{200-1}}$$

$$s = \sqrt{45.28}$$

$$s = 6.73$$

Step 4

$$p85 = m + s \qquad p85 = 47 + 6.73 \qquad p85 = 53.73$$

3.2 For the setting of speed limits where the speeds of all motor vehicle types have been used, the following shall be added to the calculated 85th percentile speed for every 15% of heavy good vehicles in the sample:

1) 1kph for single carriageway roads; and
2) 2kph for dual carriageway roads.

NOTE *When speed measurements that include all motor vehicle types are used for the purpose of setting speed limits, it is necessary to adjust the calculated 85th percentage speed based on the percentage of heavy goods vehicles in the sample. The adjustment ensures that the resultant 85th percentile speed reflects that of cars only.*

4. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'

5. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	Department for Transport. DfT Circular 01/2013 , 'Setting local speed limits'

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