TECHNICAL METHODS
FOR HIGHWAYS

TMH 4

GEOMETRIC DESIGN STANDARDS FOR RURAL TWO-LANE TWO-WAY ROADS

SEPTEMBER 1978

ISBN 0 7988 1396 2

TMH 4 UDC 625.711.2:625.72

Pretoria, South Africa 1978

Published in September 1978 by the
National Institute for Transport and Road Research
of the
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
P.O. Box 395,
Pretoria,
0001 South Africa

Reprinted 1979

*Printed in the
Republic of South Africa
by Graphic Arts, CSIR*

GAcsir 94H3169*878

PREFACE

TECHNICAL MEASURES FOR HIGHWAYS (TMH) is a new series complementing the TECHNICAL RECOMMENDATIONS FOR HIGHWAYS (TRH) series. The TRH's are intended as guides for the practising engineer and leave room for engineering judgement to be used. The new TMH's are more in the nature of manuals for engineers, prescribing methods to be used in various road design and construction procedures. It is hoped that the use of these manuals will produce uniform results throughout the country.

The TMH series is also printed and distributed by the National Institute for Transport and Road Research (NITRR) on behalf of the Committee for State Road Authorities (CSRA). Any comments on or queries about the present document should be addressed to the Director, National Institute for Transport and Road Research, CSIR, P.O. Box 395, Pretoria, 0001.

SYNOPSIS

This document gives geometric (as opposed to structural) design standards for factors such as design speed, sight distances, superelevation and alignment. The standards are intended for use by engineers in the design of rural two-lane two-way roads and they should help to standardize the geometric design of such roads throughout the Republic.

CONTENTS

LIST OF TABLES

INTRODUCTION

Geometric road design deals with the dimensions of those road features such as alignment, grades, widths, sight distance, clearances and slopes as distinct from structural design which deals with such features as thickness, composition of materials and load-carrying capacity.

These standards are intended as a general guide.

Design level of service

The design level of service should be Level of Service B in the design year. In mountainous terrain the design level of service should be Level of Service C. Usually the design year is 20 years from the date of completion of construction.

Design speed

A design speed appropriate to the conditions should be selected. For arterial roads the normal design speed should be preferably not less than 100 km/h and for collector roads, preferably not less than 80 km/h.

Sight distance

Normal sight distances shall be as shown in Table I. Criteria for measuring sight distances, both vertical and horizontal shall be:

for passing sight distances: height of eye 1,05 m and height of object 1,30 m;

for stopping sight distances: height of eye 1,05 m and height of object 0,15 m.

All sight distances are measured along the centre line of the road and it is assumed that both the eye and the object are located 1,8 m to the left of the centre line. The sight distances in Table I are those required on an essentially level road and particular allowance should be made for the increase in sight distance required for vehicles on steeper down-grades.

Alignment

Alignment should be commensurate with the topography and with existing and probable future traffic. The sudden introduction of short-radius curves should

TABLE I

Sight distances

Design speed (km/h)	MINIMUM SIGHT DISTANCES (metres)	
	Passing	Stopping
120	800	210
110	740	180
100	680	155
90	620	135
80	560	115
70	490	95
60	420	80
50	350	65
40	280	50

be avoided at the ends of long tangents or in between existing large-radius curves.

The minimum radii of horizontal curves for given design speeds shall be as shown in Table II for the situation where there is no obstruction interfering with the line of sight on the inside of the curve. Where such obstructions occur, steps should be taken to ensure that the required sight distance is achieved. Normally the lane on the inside of the curve is critical in this respect, but it should be borne in mind that the lane on the outside of the curve could be critical in the case of vehicles moving downhill.

TABLE II

Minimum radii of horizontal curves

DESIGN SPEED (km/h)	40	50	60	70	80	90	100	110	120
RADIUS (m)	50	80	110	160	210	270	350	430	530

Grades

The desirable maximum sustained grades are as shown in Table III. An effort should be made not to exceed 12 per cent as an absolute maximum grade. The fact that traffic volume has a major influence on the economic acceptability of grades with regard to vehicle operating, construction and other costs should be taken into account.

TABLE III

Desirable maximum sustained grades

DESIGN SPEED (km/h)	DESIRABLE MAXIMUM SUSTAINED GRADE
100	6%
80	7%
60	8%

Climbing lanes*

A climbing lane should be considered where the critical length of grade is exceeded.

Superelevation

The maximum superelevation shall be 10 per cent.

Camber and crossfall

Surfaced roads should have a 2 per cent camber and the shoulders should have a crossfall of 2 - 4 per cent. Gravel roads should have a 3 per cent camber.

Superelevation attainment length

Superelevation attainment length is that distance over which the slope of the outer edge of any lane differs from that of the inner edge of that same lane. The superelevation attainment length is considered to consist of two components, namely

(i) the camber run-off length, C, and

(ii) the superelevation development length, L.

* Subject to research

For a particular design speed and therefore a constant relative slope factor, s

$$C = \frac{w.f.s}{100} \text{ and } L = \frac{w.e.s}{100}$$

where w = lane width in metres

f = normal camber or crossfall (%)

e = rate of superelevation (%)

s = relative slope factor

Hence C = D.f and L = D.e
where D = run-off factor $= \frac{w.s}{100}$

The variation of 's' relative to the design speed is shown in Table IV.

TABLE IV

Variation of relative slope factor with design speed

DESIGN SPEED (km/h)	40	50	60	70	80	90	100	110	120
s	140	155	170	185	200	215	230	245	260

Normal practice should be to have two-thirds of the required superelevation at the beginning or end of the curve, but moderate adjustments could be made to the location of the superelevation attainment length to allow the control points to fall on staked points. It is necessary to adjust design superelevation attainment length, curves at changes in the gradient of pavement edges and warping of pavements for smooth driving, surface drainage and appearance.

Cross-sections and cross-section elements

On surfaced roads, lane widths should be 3,4 to 3,7 m and usable shoulder widths should be 1,5 to 2,5 m with, where required, an additional 0,5 to 0,6 m for rounding of the shoulder and the erection of guide blocks or guard-rails.

Fill slopes

Fill slopes shall not be steeper than 1 vertical to 1,5 horizontal. Flatter slopes may be justified for specific types of material or for reasons of safety.

Cut slopes

In rock cuts the rock quality and formation shall determine the slope ratio which should not be steeper than 1 vertical to 0,25 horizontal.

In earth cuts the steepest slope should be 1 vertical to 1 horizontal but, if plant growth is to be established, this slope should not be steeper than 1 vertical to 1,5 horizontal.

In sand the steepest slope shall be 1 vertical to 2 horizontal.

Inside slopes

The inside slope from the shoulder breakpoint to the invert of an open side-drain in a cutting shall not be steeper than 1 vertical to 2 horizontal, but should ideally be 1 vertical to 4 horizontal.

Side-drains

An open side-drain in a cutting should have a maximum depth of 0,25 m below the shoulder breakpoint and a maximum depth equal to the thickness of the pavement design layers.

Vertical clearance

The minimum vertical clearance across the width of the roadbed shall be 5,1 m.

Horizontal clearance

Where the road passes underneath a structure, the minimum width between abutments — in the case of a structure with jackspans, between piers — shall be 17,2 m except in the case of less important roads where no future widening is anticipated; in this case the minimum clearance shall be 13,0 m.

The minimum width between guard-rails on structures shall be the width of the roadway.

Culverts for agricultural purposes

The dimensions for agricultural culverts are dictated by the type of animal and implements for which they are required.

Recovery areas*

Recovery areas promote safety by providing areas for manoeuvring in emergencies and are recommended. Where warranted such recovery areas should be up to 9 m wide from the edge of the carriageway and minimum side slopes should ideally be 1 vertical to 4 to 6 horizontal.

Verge width

A verge between the road reserve fence and the top of cut or toe of fill is required for services, drainage along the toe of the fill, catchwater drains, maintenance operations, stock corridor, etc.

The minimum verge width should be 5 m, with an ideal width of 7,5 m next to cuts, and next to fills higher than 4 m.

Road reserve widths

The road reserve width should not be less than that required for all the cross-section elements and appropriate verges. Additional width may be necessary to accommodate deep cuts and high fills.

Intersections

Sight distance at intersections should be based on an eye height of 1,05 m and on an object height of 1,30 m.

A stop intersection should make provision for suitable shoulder sight distances.

A yield intersection should make provision for both suitable shoulder sight distances and yield condition sight triangles. The land covered by the latter sight triangle should ideally be acquired and incorporated into the road reserve.

A single radius of 15 m should be employed between the edges of the carriageways of the intersecting roads unless there is a motivation for using a three-centred curve based on the SU + T wheel track.

Guard-rails*

There are tentative indications that guard-rails may not be economically or otherwise justified on fills which are less than 4 m in height and which have slopes of less than 1 vertical to 2 horizontal. On higher fills guard-rails should be provided. More liberal use of guard-rails in mist belt areas may be warranted as demarcation lines.

Guard-rails should not be erected closer than 2 m from the edge of the carriageway.

* Subject to research