VOLUME 7	PAVEMENT DESIGN AND MAINTENANCE
SECTION 2	PAVEMENT DESIGN AND CONSTRUCTION

PART 1

HD 24/96

TRAFFIC ASSESSMENT

SUMMARY

This Part sets out the method for the calculation of traffic loading for the design of road pavements. Charts are provided for easy determination of the number of standard axles for use in the pavement design standard HD 26 (DMRB 7.2.3).

INSTRUCTIONS FOR USE

1. Remove HD 24/94 and archive as appropriate.
2. Insert HD 24/96
3. Remove Volume 7 Contents Sheet dated January 1996 and insert sheet dated February 1996.
4. Archive this sheet as appropriate.

VOLUME 7
PAVEMENT DESIGN AND MAINTENANCE

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Part 2 HD 35/95 Technical Information

Section 2 Pavement Design and Construction

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Part 3 HD 26/94 Pavement Design
[Incorporating Amendment No. 1 dated March 1995 and Amendment No. 2 dated February 1996]

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THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
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THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

DESIGN MANUAL FOR ROADS AND BRIDGES

Volume 7 : Pavement Design and Maintenance

Traffic Assessment

This Part sets out the method for the calculation of traffic loading for the design of road pavements. Charts are provided for easy determination of the number of standard axles for use in the pavement design standard HD 26 (DMRB 7.2.3).

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REGISTRATION OF AMENDMENTS

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VOLUME 7 PAVEMENT DESIGN AND MAINTENANCE

SECTION 2 PAVEMENT DESIGN AND CONSTRUCTION

PART 1

HD 24/96

TRAFFIC ASSESSMENT

Contents

Chapter

1 INTRODUCTION

General

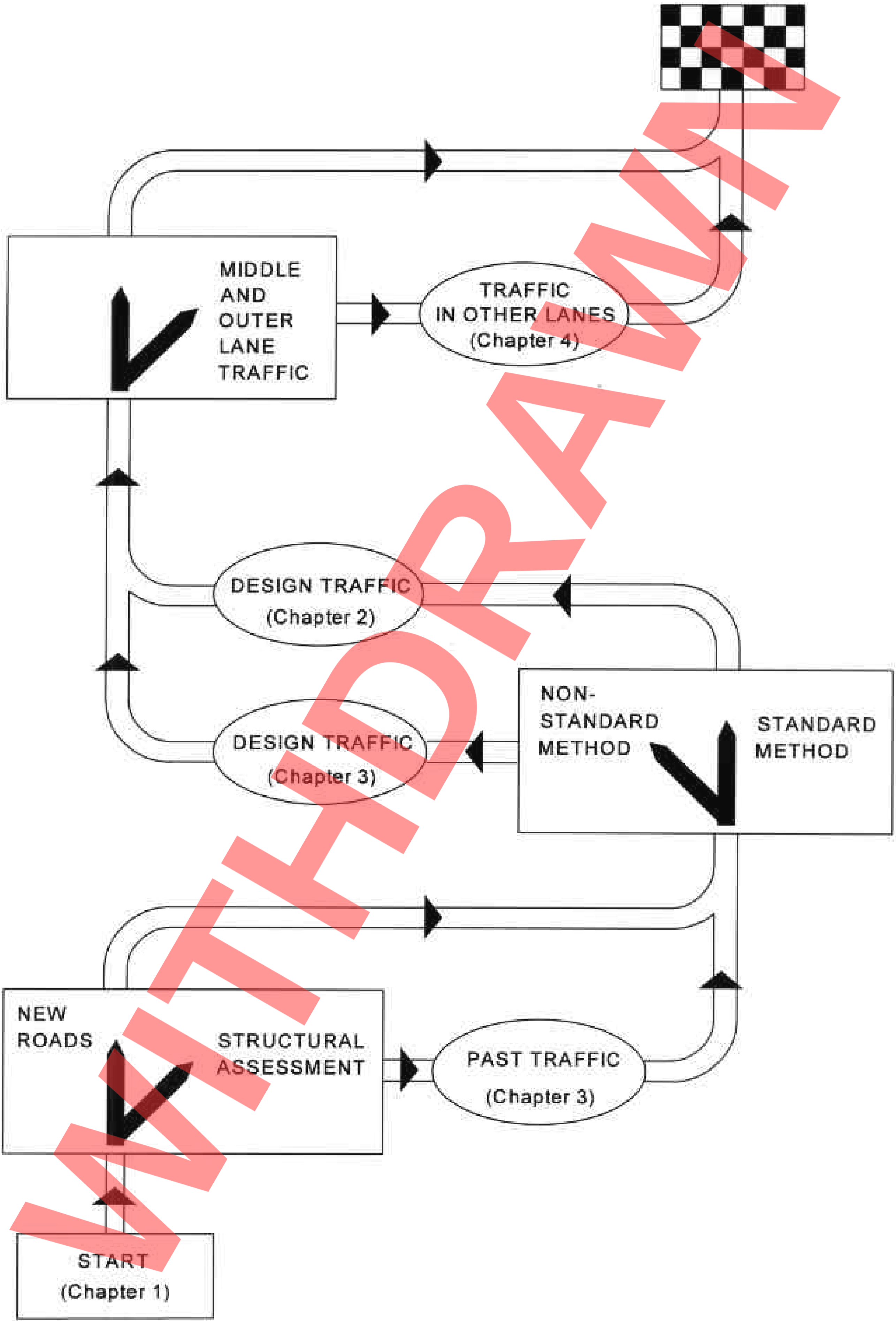
1.1 This Part covers the estimation of design traffic for new roads and the calculation of past and future traffic for the maintenance of existing roads. Two methods are presented for traffic calculation.

a) The **Standard Method,** is simple and is used in the design of new roads.

b) The **Structural Assessment and Maintenance Method** is primarily used in structural assessment and in maintenance design but can be used for new roads in exceptional circumstances, where non-standard traffic exists.

Implementation

1.2 This Part shall be used forthwith on all schemes for the construction, improvement and maintenance of trunk roads including motorways, currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay. Design organisations should confirm its application to particular schemes with the Overseeing Organisation.


MIDDLE
AND
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LANE
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STANDARD
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NEW
ROADS
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(Chapter 1)

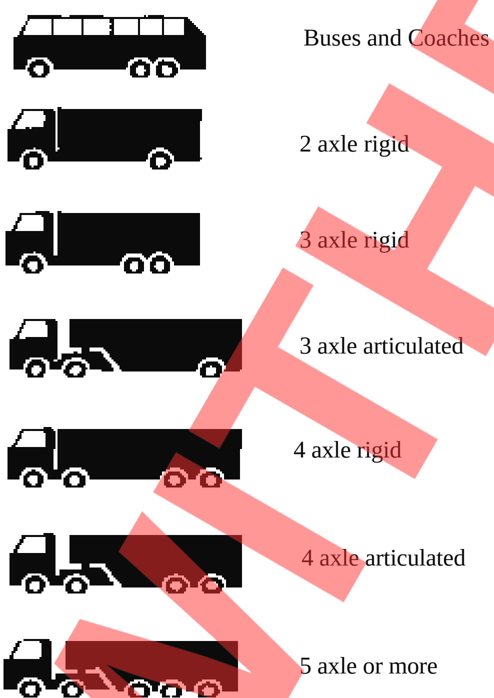
2 STANDARD METHOD

2.1 This method shall be used in the design of new roads. If it is considered inappropriate for any reason then further advice must be sought from the Overseeing Organisation.

2.2 It incorporates the latest research on wear and a traffic growth estimation based on the National Road Traffic Forecast (NRTF, 1989).

Vehicle Classifications

2.3 The flow of commercial vehicles has to be established to determine the cumulative design traffic. Commercial vehicles are defined as those over 15kN unladen vehicle weight. By comparison, the structural damage caused by lighter traffic is negligible. The following are the commercial vehicle classifications used (as defined in the COBA manual - COBA 9, 1981). For classifications in Scotland refer to STEAM.



2.4 A simplification is the grouping together into the categories OGV1 and OGV2, ie:-

Buses and Coaches	=	PSV
2 axle rigid 3 axle rigid 3 axle articulated	=	OGV 1
4 axle rigid 4 axle articulated 5 axle or more	=	OGV2

where: PSV = Public Service Vehicle
OGV = Other Goods Vehicle

Note: The classification shown is the same as that in COBA 9 (1981). This classification is used throughout this Part, and will be revised in due course should the classification change.

Traffic Flow

2.5 For new road schemes, the traffic flow shall be determined from traffic studies using the principles described in the Traffic Appraisal Manual (TAM, 1984). For Scotland, the principles are set out in STEAM (1986). Where traffic studies indicate that the flow at opening is not a suitable base for forecasting flows over the life of the scheme (e.g. because of construction of an adjacent link after a few years), an adjustment must be made to reflect this situation.

2.6 For maintenance design or for re-alignment, a classified count shall be carried out over a 12, 16 or 24 hour period. This must be converted to an average annual daily flow (AADF) using the principles given in COBA. (In Scotland use NESA (1986)).

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2.7 The total flow of commercial vehicles per day (cv/d) in one direction at opening (or at present for the case of maintenance design) and the proportion in the OGV2 category are required in determining cumulative design traffic.

Example

Count data converted to AADF (see 2.6). (COBA 9 classification)

Buses and Coaches	32	PSV
2 axle Rigid	249	OGV1
3 axle Rigid	29	"
3 axle Articulated	8	"
4 axle Rigid	30	OGV2
4 axle Articulated	62	"
5 or more axle	47	"

Total Flow	457 cv/d
Total OGV2 Flow	139 cv/d
Percentage OGV2	30%

2.8 If the traffic flow obtained is a 2-way flow, then allowance shall be made for the directional split. This is assumed to be 50:50 unless traffic counts or studies show a significant directional bias.

Cumulative Design Traffic

2.9 Either Figure 2.1 or 2.2 shall be used to obtain the design traffic for fully flexible (20 year) designs and for flexible composite pavements depending on whether the road is dual or single carriageway. Either Figure 2.3 or 2.4 shall be used for rigid, rigid composite and fully flexible (40 year) designs. Use thinner lines on graph for the higher percentages of OGV2. In each case the design traffic is expressed in millions of standard axles (msa) in one direction. Interpolation is permissible. A minimum design traffic of 1 msa shall be assumed on very lightly trafficked roads.

2.10 The msa values used in Figures 2.1 to 2.4 include adjustment to give the left hand lane traffic for use in design charts in HD 26 (DMRB 7.2.3). The curved shape of the relationships in Figures 2.2 and 2.4 is due to the increased proportion of traffic taken by the outer lane(s) of a dual carriageway at high vehicle flows.

Assumptions

2.11 The high growth prediction from NRTF is used. Average growth rates have been taken for PSV + OGV1 and for OGV2. The proportional flow increase i.e. average design life flow divided by flow at opening, is calculated assuming that the year of opening is 1995.

2.12 Whole life cost considerations show that it is economically best to design all roads to have a 40 year life, but that the first stage for flexible and flexible composite pavements should be normally a 20 year design to critical conditions, following which major maintenance would be carried out. However, in certain circumstances where design traffic is heavy in relation to the capacity of the layout, and in all cases where whole life costing is required to be taken into account, a thicker 40 year fully flexible design may prove to be an economic alternative and should be included as a permitted option. Therefore the structural design assumes a life of 20 years for flexible composite pavements, 20 or 40 years for fully flexible pavements, and 40 years for rigid and rigid composite pavements.

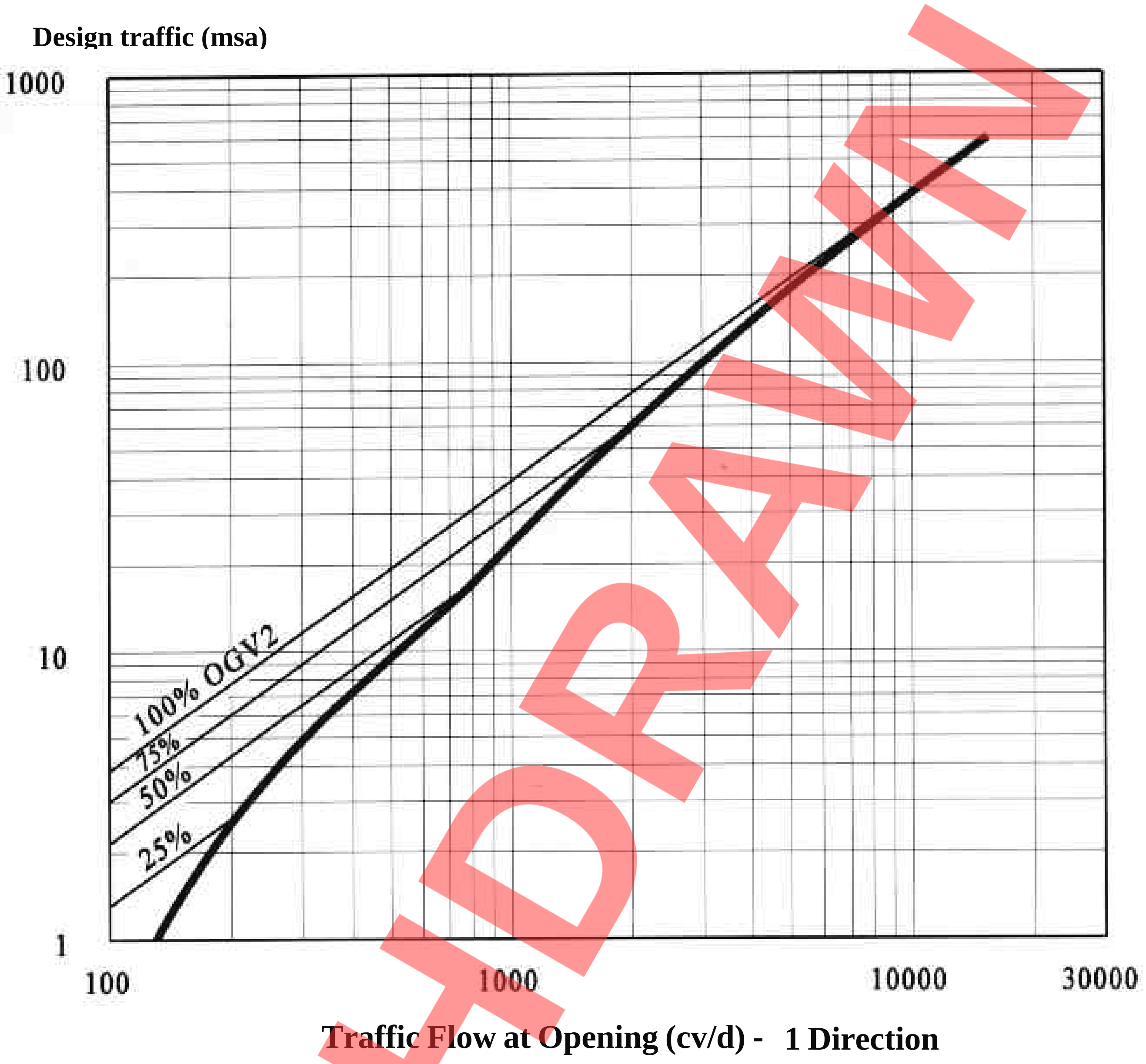

FIGURE 2.1 Design Traffic for Flexible (20 year life) and Flexible Composite Pavements - Single Carriageway

Example

Traffic at opening	1250 cv/d
OGV2	20%
Cumulative Design Traffic =	31 msa

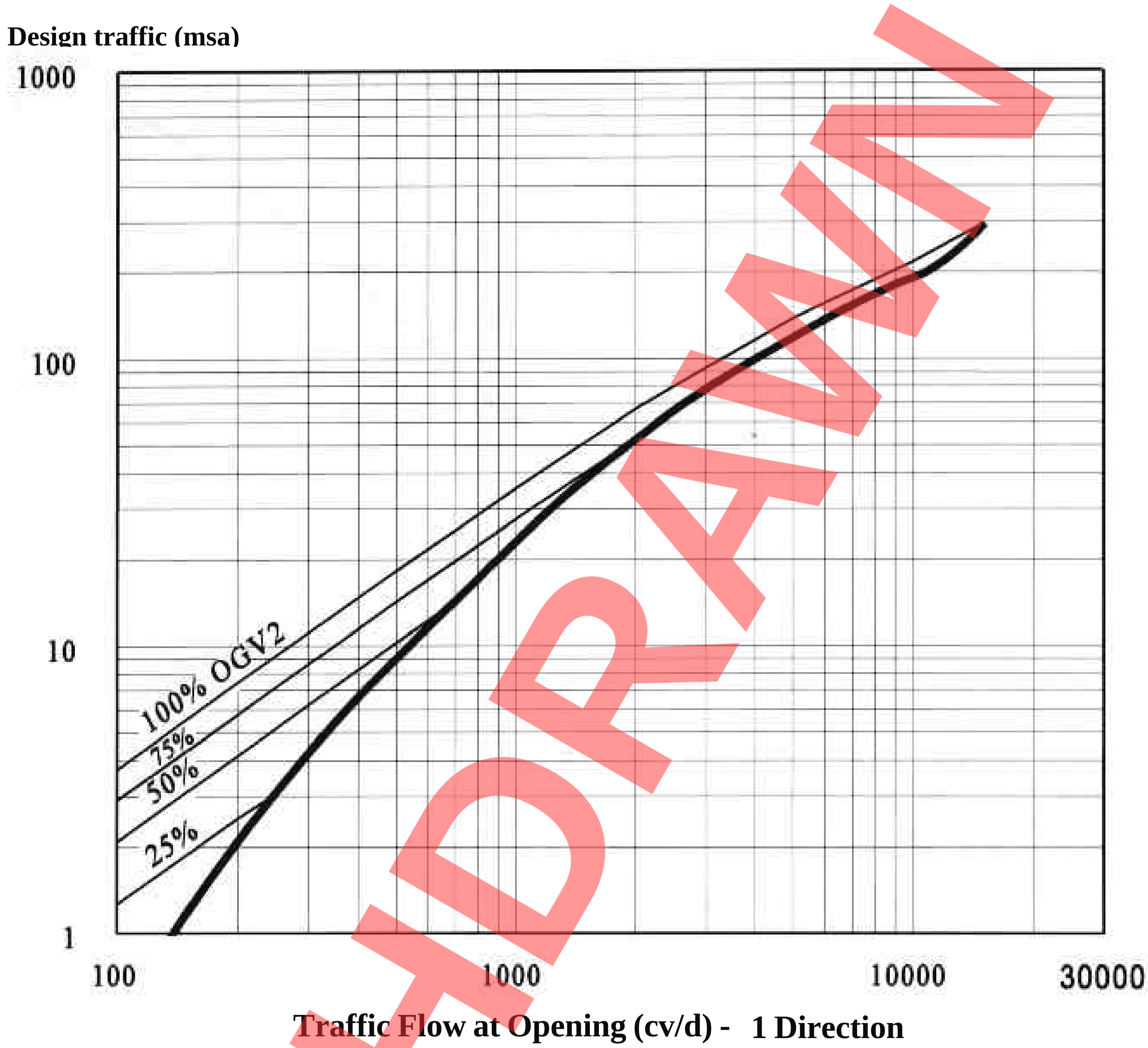

FIGURE 2.2 **Design Traffic for Flexible (20 year life) and Flexible Composite Pavements - Dual Carriageway**

Example

Traffic at opening	1250 cv/d
OGV2	20%

Cumulative Design Traffic : 30 msa

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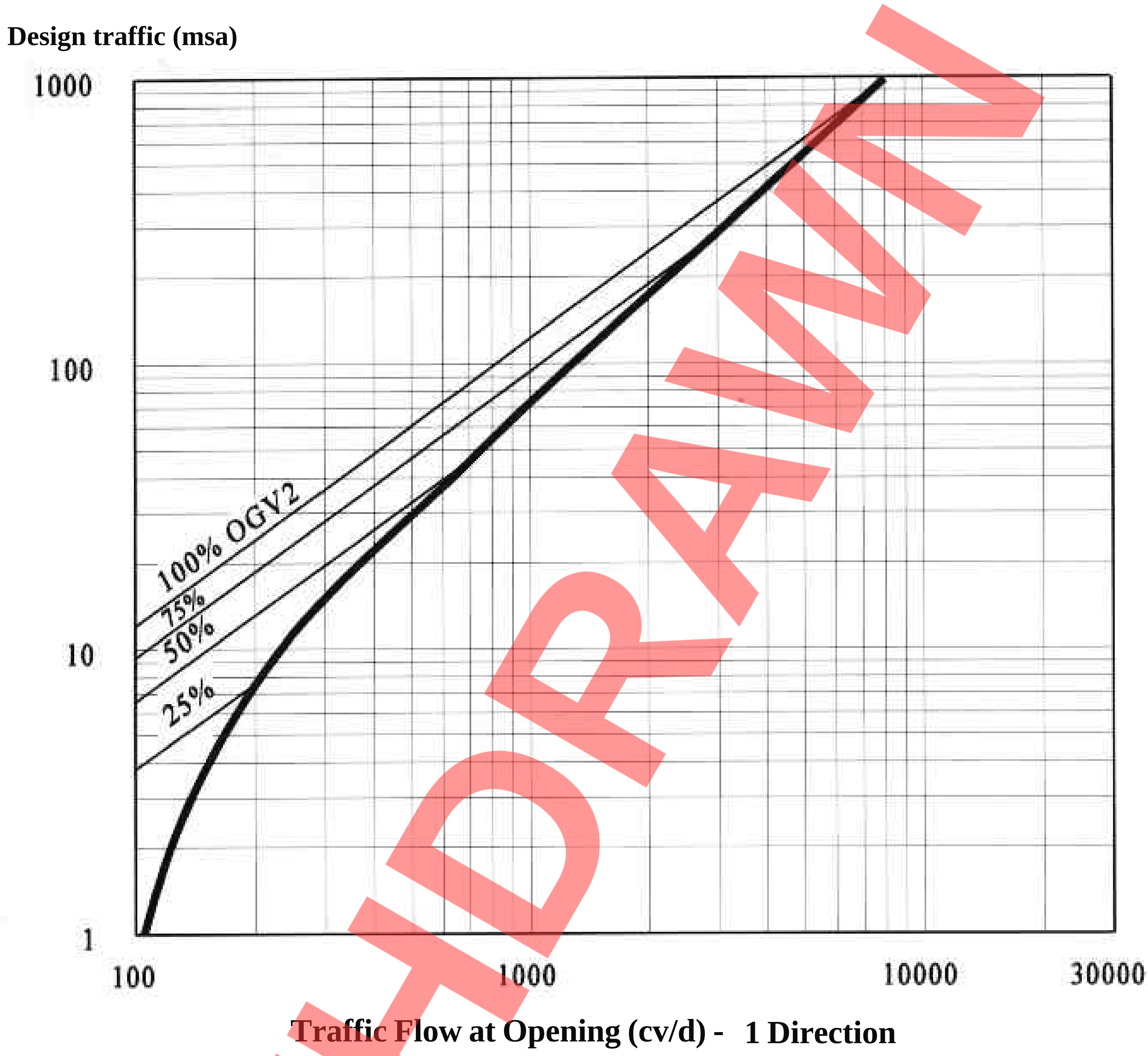

FIGURE 2.3 Design Traffic for Rigid, Rigid Composite and Flexible (40 year life) Pavements - Single Carriageway

Example

Traffic at opening	1250 cv/d
OGV2	20%

Cumulative Design Traffic = 92 msa

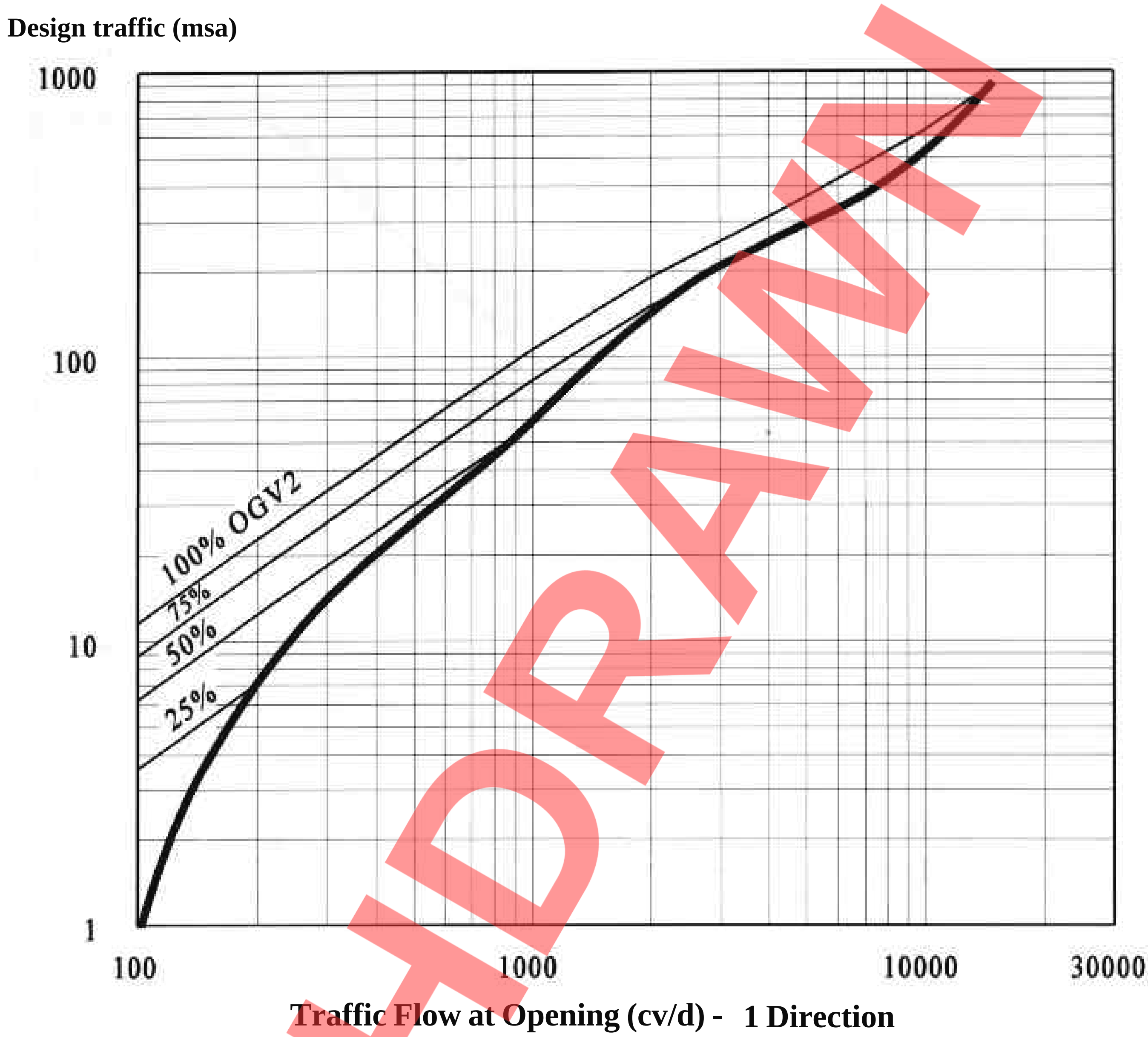

FIGURE 2.4 Design Traffic for Rigid, Rigid Composite and Flexible (40 year life) Pavements - Dual Carriageway

Example

Traffic at opening	1250 cv/d
OGV2	20%

Cumulative Design Traffic = 80 msa

3 STRUCTURAL ASSESSMENT AND MAINTENANCE METHOD

3.1 This method is primarily intended for use in structural assessment and in the design of maintenance measures. Prior approval **must** therefore be obtained from the Overseeing Organisation before using this method for new roads.

3.2 It caters for both the assessment of past traffic and the prediction of future design traffic. It allows a more detailed assessment than the standard method for new roads by permitting the use of appropriate wear factors, growth rates and design period, although the values pertaining to the standard case are highlighted. The msa values given by the charts in Chapter 2 include a cut-off line that ensures that pavements are not designed thinner than has proved historically acceptable. The method described in this chapter does not contain a similar restraint, so that use of the two chapters will not always produce comparative msa value.

Traffic Flow (F)

3.3 The best estimate of present one-way traffic flow (AADF), or traffic flow at opening in the case of new road design, shall be obtained. For existing roads this will take the form of a classified count, converted to AADF using the principles in COBA. (In Scotland use NESA). The flow of vehicles in each class shall be entered in a table such as Table 3. 1. In most instances it is sufficient to combine the traffic into the same two categories, PSV + OGV 1 and OGV2, as in the standard method.

Design Period (Y)

3.4 The number of years over which traffic is to be assessed shall be selected. For past traffic, this will generally be the number of years since opening. For future design traffic this will generally be either 20 or 40 years depending on construction type and period required (see paragraph 2.12).

3.5 The National Road Traffic Forecast (NRTF, 1989), predicts future trends, giving both upper and lower estimates. For conservative design, the upper estimate can reasonably be taken. However, the NRTF is a national estimate and may not necessarily apply to any given road.

3.6 Past growth, where known from traffic counts, can also be used to give an indication of future trends in a particular situation, but only where data over at least 10 year period are available, since averaging over a shorter period may give misleading results.

Growth Factor (G)

3.7 For each class or category of vehicle a 'growth factor' shall be calculated which is dependent on the selected design period and the growth rate. It represents the proportional difference between the average vehicle flow over the entire design period and the present flow (or flow at opening). The growth factor for future traffic may be found by using Figure 3. 1.

3.8 The NRTF growth lines shown for PSV+OGV1 and for OGV2 (the bold lines on Figure 3. 1) shall be used unless specific alternative data are available. If actual growth rates are known for a specific group of vehicles, then use that rate in Figure 3. 1. Also, see Note, Paragraph 2.4.

3. 9 If past traffic is being calculated, the growth factor applicable is given in Figure 3.2. As in Figure 3. 1, average lines are shown for PSV + OGV I and OGV2 which represent national trends. Use these lines unless actual growth rates are known for a specific group of vehicles, then use that rate in Figure 3.2.

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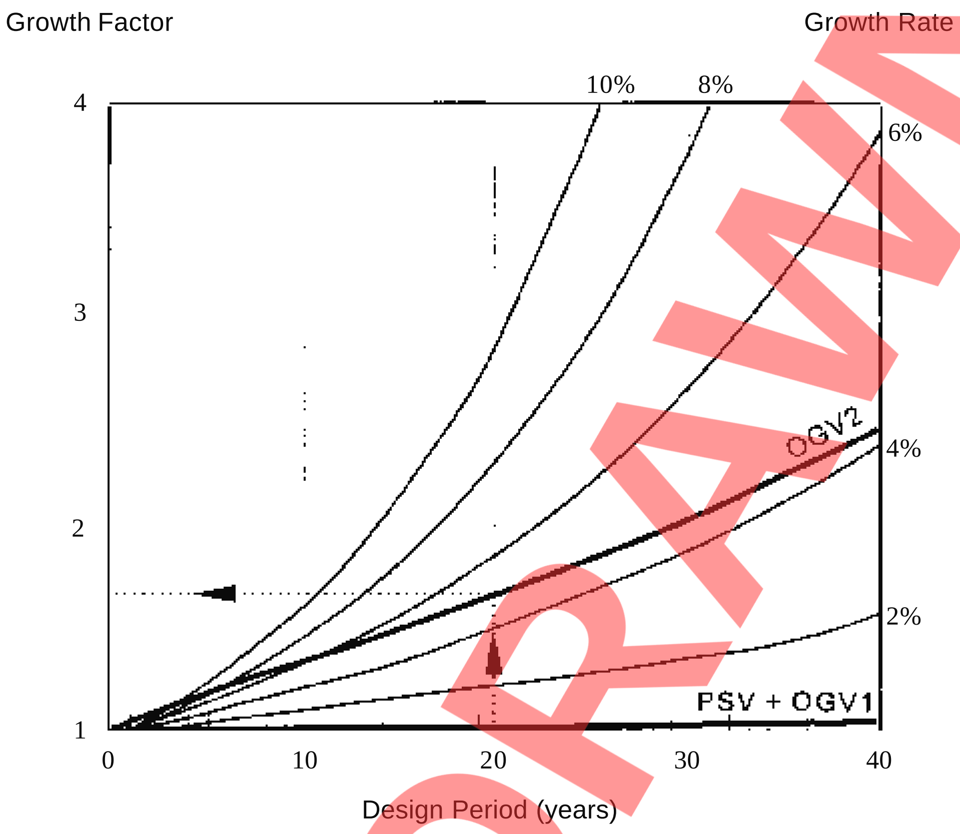

FIGURE 3.1 Derivation of Growth Factor

Example

Considering OGV2
Design Period 20 years
Growth Factor 1.66

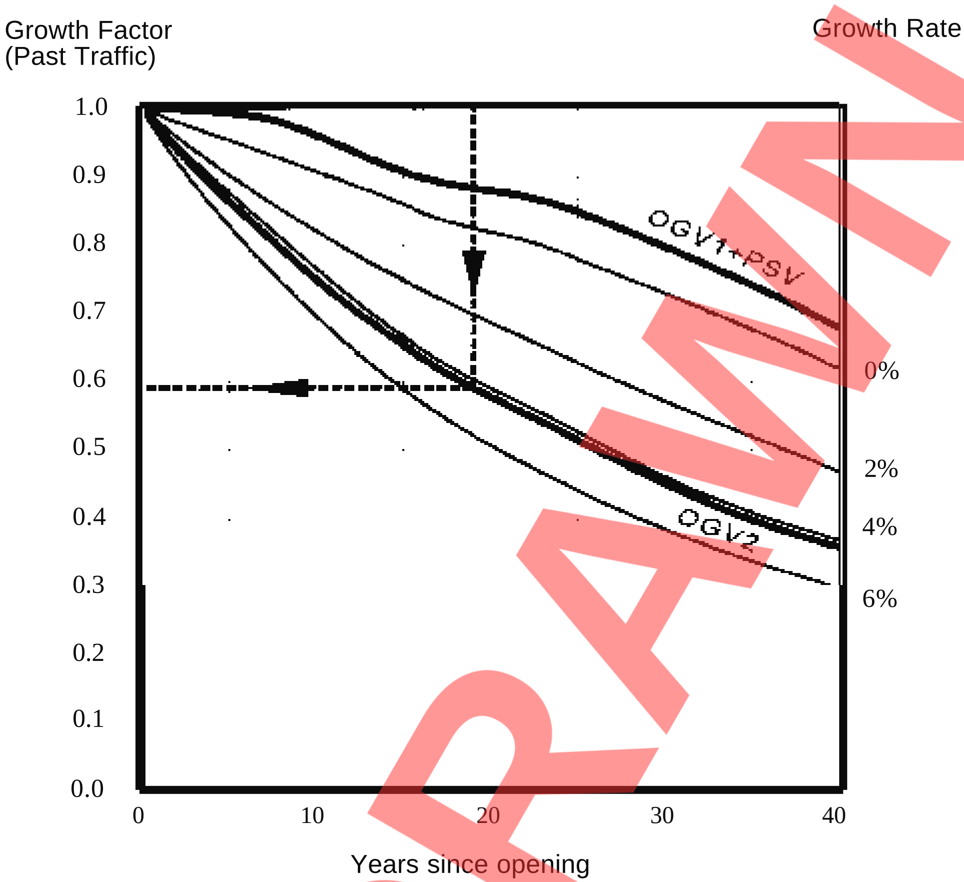

FIGURE 3.2 Derivation of Growth Factor for Past Traffic

Example

Considering OGV2
Time since Opening 19 years
Growth Factor 0.59

Vehicle Class/Category	AADF (F)	Design Period (Y)	Growth Factor (G)	Wear Factor (W)	Cumulative Traffic (T)*
either					
Buses & Coaches (PSV)				1.3	
OGV1					
2 axle rigid				0.34	
3 axle rigid				1.7	
3 axle articulated				0.65	
OGV2					
4 axle rigid				3.0	
4 axle articulated				2.6	
5 axle articulated				3.5	
or					
OGV1 + PSV				0.6	
OGV2				3.0	
Total cv/d			TOTAL (all lanes)		msa
			% in Left Hand Lane (P)		
			DESIGN TRAFFIC (= P x TOTAL/ I 00)		msa

* T = 365.F.Y.G.W.10-6 msa

TABLE 3.1 : Structural Assessment and Maintenance Method

3.10 If a series of past traffic counts is available it is preferable to use these to calculate mean vehicle flows for each class between count dates. Under such circumstances a growth factor for past traffic is unnecessary and therefore effectively becomes 1.0. The growth factor should be recorded in column G of a table such as Table 3. 1.

3.11 Figure 3.2 includes a correction due to a considerable change in average wear factor in the past. The NRTF lines in Figure 3.1 also include the predicted changes in average wear due to changes in vehicle distribution within categories.

Wear Factor (W)

3.12 The road wear caused by an axle increases significantly with increasing load. Thus, a doubling of load will lead to a much higher increase in wear. It approximates to a fourth power law, where the road wear is assumed to be proportional to the fourth power of the axle load, ie:-

$$\text{Wear/axle} \quad \alpha \quad L^4$$
(L = axle load)

3.13 Each vehicle is related to a 'standard axle', which is defined in the TRRL report LR833 (1978) as that exerting or applying a force of 80kN. Each vehicle may then be said to equate in its damaging power to a certain number of equivalent standard axles by using the fourth power law. This number is termed the wear factor of that vehicle.

3.14 Approximate national average wear factors for the various vehicle classes are as follows (RR138 1988):-

Buses & Coaches	1.3
2 axle rigid	.34
3 axle rigid	1.7
3 axle articulated	.65
4 axle rigid	3.0
4 axle articulated	2.6
5 axle or more	3.5

By comparison the wear factor of a private car is negligible.

3.15 Weighted average wear factors are assumed for the categories PSV + OGV1 and OGV2 of 0. 6 and 3.0 respectively, based on the proportion of vehicles in each class (Transport Statistics of Great Britain, 1992).

3.16 These wear factors are shown in Table 3. 1, and shall be used in all cases unless reliable data clearly reveals a divergence from these national average figures.

Cumulative Design Traffic (T)

3.17 The cumulative design traffic in each class or category shall be calculated using the following equation:-

$$T = 365.F.Y.G.W.10^{-6} \text{ msa}$$

where:-
T = Design Traffic (msa)
F = Present Traffic Flow (AADF
Y =) Design Period (Years)
G = Growth Factor
W = Wear Factor

The total design traffic is the sum of the cumulative traffic in each class or category.

Proportion in Left hand Lane (P)

3.18 For dual carriageway design, the proportion of vehicles in the most heavily trafficked lane (i.e. left hand lane) is required. This is given, approximately, by Figure 3.3. It the design charts in HD 26 (DMRB 7.2.3) are to be used, it is always the traffic in the left hand lane which is required, and Figure 3.3 shall be used to determine it, based on the traffic flow at opening. For flows greater than 30,000 cv/d, a proportion of 50% shall be taken.

3.19 Tables 3.2 to 3.4 are three examples of the use of the Structural Assessment and Maintenance Method.

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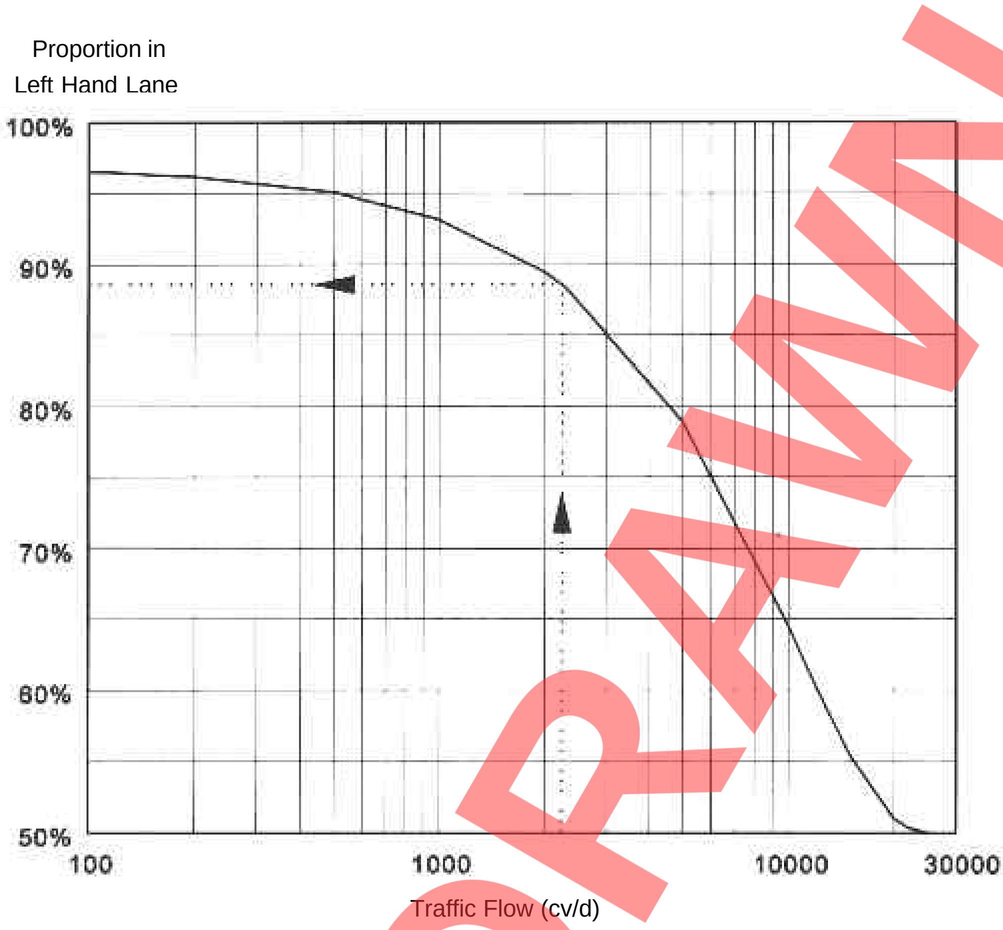

FIGURE 3.3 Traffic in Left Hand Lane - Dual Carriageways

Example

Traffic Flow 2300 cv/d

87 % in Left Hand Lane

Vehicle Class / Category	AADF (F)	Design Period (Y)	Growth Factor (G)	Wear Factor (W)	Cumulative Traffic (T)*
either					
Buses and Coaches (PSV)				1.3	
OGV1					
2 axle rigid				0.34	
3 axle rigid				1.70	
3 axle articulated				0.65	
OGV2					
4 axle rigid				3.0	
4 axle articulated				2.6	
5 axle articulated				3.5	
or					
OGV1 + PSV	820	12	1.0	0.6	2.2
OGV2	72	12	1.29	3.0	1.2
Total cv/d	892		TOTAL (all lanes)		3.4 msa
			% in Left Hand Lane (P)		95%
			DESIGN TRAFFIC (= P x TOTAL/100)		3.2 msa

*T = 365.F.Y.G.W.10^{6} msa
- 12 year design
- NRTF growth

Table 3.2 Structural Assessment and Maintenance Method (Example 1)

Vehicle Class / Category	AADF (F)	Design Period (Y)	Growth Factor (G)	Wear Factor (W)	Cumulative Traffic (T)*
either					
Buses and Coaches (PSV)	398	20	1.0	1.3	3.8
OGV1					
2 axle rigid	2084	20	1.0	0.34	5.2
3 axle rigid	196	20	1.0	1.70	2.4
3 axle articulated	95	20	1.0	0.65	0.5
OGV2					
4 axle rigid	209	20	1.5	3.0	9.2
4 axle articulated	912	20	1.5	2.6	36.0
5 axle articulated	743	20	1.5	3.5	28.5
or					
OGV1 + PSV				0.6	
OGV2				3.0	
Total cv/d	4637				

TOTAL (all lanes)	85.6 msa
% in Left Hand Lane (P)	79%
DESIGN TRAFFIC (= P x TOTAL/100)	67.6 msa

*$T = 365.F.Y.G.W.10^{6}$ msa

- 20 year design
- NRTF growth
- from accurate traffic breakdown

Table 3.3 Structural Assessment and Maintenance Method (Example 2)

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Vehicle Class / Category	AADF (F)	Design Period (Y)	Growth Factor (G)	Wear Factor (W)	Cumulative Traffic (T)*
either					
Buses and Coaches (PSV)	510	15	0.70	1.3	2.5
OGV1					
2 axle rigid	1831	15	0.70	0.34	1.5
3 axle rigid	162	15	0.70	1.70	1.1
3 axle articulated	79	15	0.70	0.65	0.2
OGV2					
4 axle rigid	150	15	0.70	3.0	1.7
4 axle articulated	718	15	0.60	2.6	7.2
5 axle articulated	601	15	0.70	3.5	8.1
or					
OGV1 + PSV				0.6	
OGV2				3.0	
Total cv/d	4051				

TOTAL (all lanes)	22.3 msa
% in Left Hand Lane (P)	82%
DESIGN TRAFFIC (= P x TOTAL/100)	18.3 msa

*T = 365.F.Y.G.W.10^{-6} msa

- Past traffic
- 15 years
- from recent count
- 3% past growth assumed

Table 3.4 Structural Assessment and Maintenance Method (Example 3)

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4. LANE DISTRIBUTION

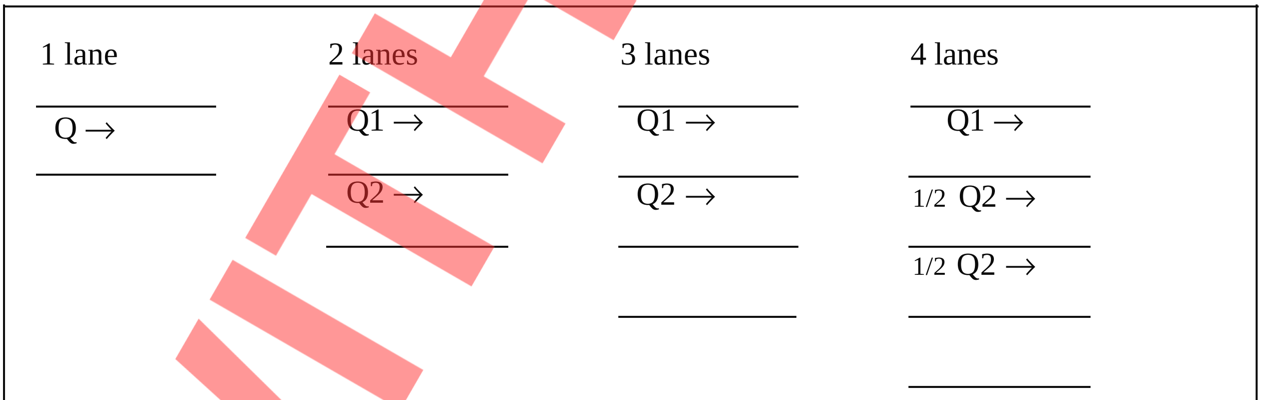
Standard Situation

4.1 For new road design, all lanes, including the hard shoulder, shall be constructed to the same specification, i.e. designed to carry the left hand lane traffic. The actual traffic in other lanes is not considered.

4.2 For maintenance purposes it is sometimes necessary to estimate the traffic in the other lanes separately. For 3 lane carriageways it shall be assumed that all commercial vehicles **not** in the left hand lane are taken by the middle lane, unless specific data indicates otherwise (see Figure 4. 1). For a 4 lane carriageway the number of commercial vehicles **not** in the left hand lane shall be assumed to be evenly distributed between the two middle lanes, unless specific data indicates otherwise. In each case, however, the outer lane shall be designed to carry the same traffic as the middle lane(s).

Non-standard Situations

4.3 The distribution of traffic between lanes can, under certain circumstances, vary considerably from the standard assumptions stated above. These will include lengths either side of junctions, for example where lanes leave and join a carriageway, or at traffic signals and roundabouts. This does not affect the design of new roads, the construction thickness of which is based on traffic distribution away from junctions. However, in the specific case of maintenance or widening work to areas around junctions, then consideration should be given to the effect of non-standard traffic distribution on design.



Q = total one way flow (commercial vehicles)
Q1 = left hand lane flow (= Q x P ÷ 100) - where P = Proportion (%) in Left Hand Lane
Q2 = remainder (= Q - Q1)

FIGURE 4.1 Design Traffic in Outer Lanes

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1992

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6 ENQUIRIES

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All technical enquiries or comments on this Part should be sent in writing as appropriate to:

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