OVERLAY DESIGN METHOD BASED ON VISUAL PAVEMENT DISTRESS

by

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

Charlottesville, Virginia

May 1978
VHTRC 78-R26

1418

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ABSTRACT

A method for designing the thickness of overlays for bituminous concrete pavements in Virginia is described. In this method the thickness is calculated by rating the amount and severity of observed pavement distress and determining the total accumulated traffic. Ratings for the amount and severity of each type of pavement distress are tabulated in the report, and a chart for calculating the accumulated traffic from the daily traffic counts of different classifications of vehicles is given.

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Maintenance Rating of Pavement

The types of distress that affect the maintenance rating, MR, of a pavement are given in Table 1. Each type is rated by the amount and severity of its occurrence as shown in Table 2.

Table 1

Types of Distress Affecting MR Value

Types of Distress	Notation
Longitudinal Cracking	LC
Alligator Cracking	AC
Rutting	Ru
Pushing	Pu
Ravelling	Ra
Patching	Pa

Table 2

Rating of Distress

Amount of Distress	Rating Factor		
	Not Severe	Severe	Very Severe
No Distress	0	0	0
Distress rarely observed	1	2	3
Distress occasionally observed	2	4	6
Distress frequently observed	3	6	9

The degree of severity is not defined in this report; however, it is noted that on interstate pavements none of the types of distress are rated as being severe.

With the rating factors given in Table 2, the maintenance rating of each pavement is obtained as

$$MR = 92.6 - 2.4(LC) - 2.3(AC) - 1.0(Ru) - 1.0(Pu) - 0.9(Ra) - 2.3(Pa) \quad (1)$$

Pa is rated by the extent of damage only and is classified as being not severe.

The method of determining the maintenance rating is applied as follows. An inspection trip over an interstate highway results in the rating values in Table 3, which reflect the rating numbers assigned in Table 2.

Table 3

Illustrative Data for Rating a Pavement

Type of Distress	Amount	Severity	Rating
Longitudinal cracks (LC)	Frequent	Not severe	3
Alligator cracks (AC)	Frequent	Not severe	3
Rutting (Ru)	Occasional	Not severe	2
Pushing (Pu)	None	—	0
Ravelling (Ra)	None	—	0
Patching (Pa)	None	—	0

Then, by the use of equation 1 the MR is obtained as

$$MR = 92.6 - 2.4x3 - 2.3x3 - 1.0x2 = 76.5$$

Overlays applied to provide structural strength are recommended for the maintenance rating values given in Table 4. These recommended values are based on AASHTO Road Test results.

Table 4

Maintenance Rating Values for Overlays

Road Classification	Rating
Interstate Roads	83 or less
Arterial Roads	71 or less
Primary Roads	60 or less
Low Primary & Secondary Roads	36 or less

Thus an overlay would be justified for a pavement with an MR = 76.5, if the pavement is on the interstate system, but would not be justified if the pavement were on the arterial system.

Thickness of Overlay

The required thickness of an overlay is dependent on the durability of the asphaltic concrete mix as affected by the age, hardening, and stripping of asphalt. An overlay made from a well-designed mix and properly constructed could perform satisfactorily for 10 to 15 years without surface rejuvenation. For determining the thickness of the overlay, a service life of 12 years is recommended for use. The procedure is as follows.

1. Determine the accumulated traffic in terms of the 18-kip (8,160 kg) equivalents that the pavement has carried from the date of construction to the date of the proposed overlay, irrespective of any previous overlay. Use Figure 1 to convert the traffic count into 18-kip (8,160 kg) equivalents.

2. Determine the accumulated traffic in terms of the 18-kip (8,160 kg) equivalents the pavement will carry in the 12 years after the overlay.

3. The percentage ratio of the traffic after the overlay to the traffic before the overlay is

$$\frac{\text{18-kip (8,160 kg) after the overlay}}{\text{18-kip (8,160 kg) before the overlay}} \times 100.$$

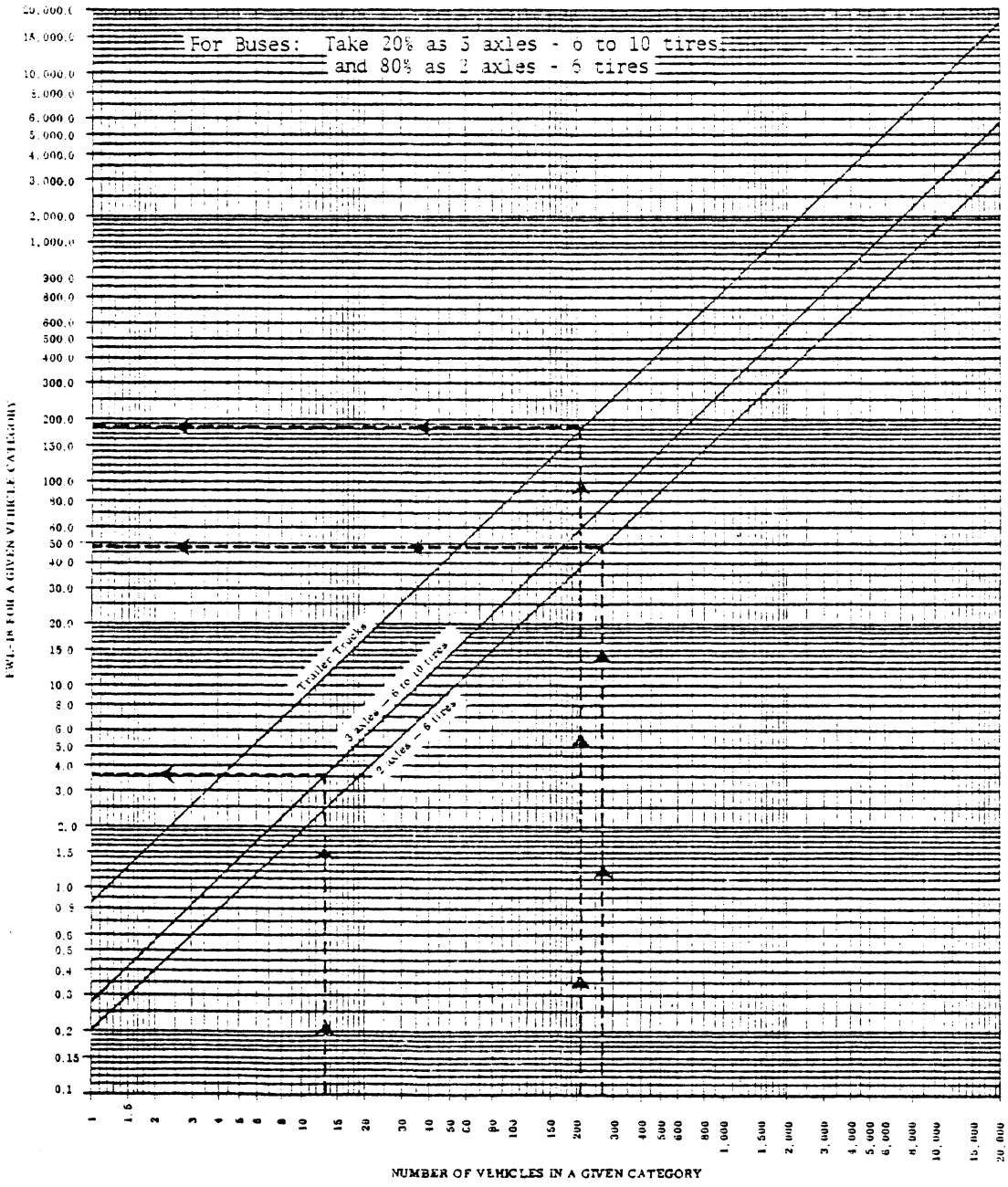

Figure 1. Determination of 18-kip equivalent from traffic count. (Conversion unit: 18-kip = 8,160 kg)

4. From Figure 2 determine the thickness of the overlay for the percentage ratio of the estimated traffic after the overlay to the traffic before the overlay.

Example

Thus, for an interstate highway pavement that was built in 1967 and had a maintenance rating of 76.5 in 1977, an overlay would be justified. Having determined the need for an overlay the thickness of the overlay could be calculated as outlined below.

1. Determination of the daily traffic in 18-kip equivalents.

   From the average daily traffic volume records (the average daily traffic volumes on interstate, arterial and primary routes are published by the Department for each year) the ADT obtained for 1976 and the 18-kip equivalents are given in Table 5. Figure 1 is used to convert the traffic count to 18-kip equivalents.

Table 5

ADT Counts and 18-kip Equivalents

Vehicle Type*	ADT	18-kip Equivalents (From Figure 1)
2 axle - 6 tire	320	58
3 axle - 10 tire	50	14
Trailer Trucks	2,850	2,500
Buses (Assume 20% of 3 axle and 80% of 2 axle vehicles)	40	6
Total		2,578

For-four lane highway
**Design Traffic = 2,578 x 0.5 x 0.8 = 1,031 18-kip.

*Cars and 2 axle - 4 tire vehicles are not considered, because their damaging effect on the pavement is almost negligible.

**The Traffic and Safety Division reported traffic counts include both directions of travel. One-half the reported traffic is assumed to travel in each direction and 80% of the truck traffic is assumed to use the outside (design) lane.

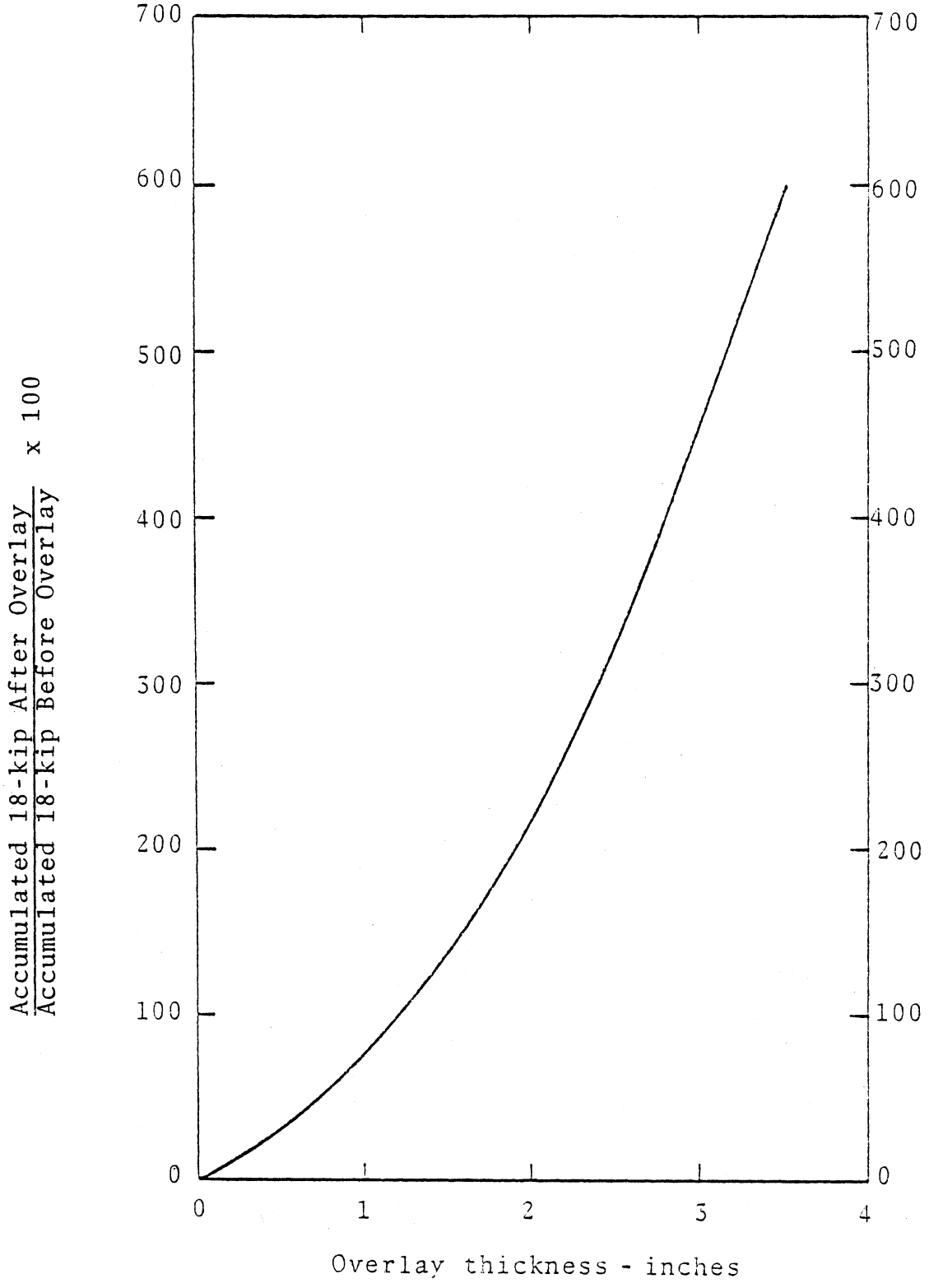

Figure 2. Overlay thickness versus traffic carrying capacity. Conversion units: 18-kip = 8,160 kg
1 inch = 2.5 cm

2. Determination of the accumulated traffic before the overlay.

This could be determined from the traffic record or it can be estimated on the assumption that the traffic has increased at the rate of 5% a year (the national standard). Table 6 has been developed to show (a) the growth rate for each year for a 20-year period (the ADT after 9 years = 1.47 x ADT during the first year) and (b) the accumulated traffic for each year for a 20-year period (the accumulated traffic after 9 years = 4,016 x ADT during the first year).

Table 6

Growth Rate and Accumulated Traffic
Assuming 5 Percent Growth

Period of Traffic in Years	Growth Rate	Accumulated Traffic Rate
1	1	365
2	1.05	748
3	1.10	1,149
4	1.16	1,572
5	1.22	2,017
6	1.27	2,480
7	1.34	2,969
8	1.40	3,480
9	1.47	4,016
10	1.54	4,578
11	1.62	5,169
12	1.70	5,789
13	1.78	6,438
14	1.87	7,120
15	1.97	7,839
16	2.07	8,595
17	2.17	9,387
18	2.28	10,219
19	2.39	11,091
20	2.51	12,007

In the above example the accumulated traffic on the road in 1977 at the end of 11 years of service

$$= \frac{\text{Design daily traffic in 1977} \times \text{accumulated traffic rate}}{\text{Growth Rate}}$$

$$= \frac{1{,}031 \times 5{,}169}{1.62} = 3.29 \text{ million 18-kip}$$

3. Determination of the estimated traffic for the life of the overlay.

   Assuming that the life of the bituminous mix in the overlay will be 12 years, the projected traffic during this 12-year period would be

   = Design daily traffic in 1977 x accumulated traffic rate for 12 years,

   = 1,031 x 5, 789

   = 5.97 million 18-kip

4. Design of overlay thickness.

   Ratio of two traffics

   $$= \frac{\text{Accumulated 18-kip (8,160 kg) after the overlay}}{\text{Accumulated 18-kip (8,160 kg) before the overlay}} \times$$

   $$= \frac{5.97}{3.29} \times 100 = 180 \text{ percent.}$$

From Figure 2 the design thickness of an overlay for this ratio is 1.75 inches (4.5 cm).