097.13 DPWH
04-11-2011

Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Manila

APR 08 2011

DEPARTMENT ORDER)
No. 22)
Series of 2011 04-11-11)
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SUBJECT: **Minimum Pavement Thickness and Width of National Roads**

In line with the Department's thrust of upgrading the design standards of national roads and in order to avoid the early deterioration of pavement due to uncontrolled overloading, the guidelines on the design of pavement thickness and width of national roads are hereby prescribed:

A. Pavement Thickness

1. Portland Cement Concrete Pavement (PCCP)

a) For new road construction, rehabilitation or upgrading, the minimum thickness of the pavement shall be 280 mm. However, a thickness of less than 280 mm., but in no case less than 230 mm., may be adopted if the Cumulative Equivalent Single Axle Load (CESAL) is not more than 7.0×10^6. The procedure for calculating the CESAL is hereto attached as Annex A.

b) For pavement rehabilitation using the crack and seat method, a minimum thickness of 260 mm. shall be adopted for the new pavement that will be constructed on top of the deteriorated concrete pavement.

c) For pavement reblocking, the thickness of the new pavement shall be the same as the replaced blocks.

2. Asphalt Pavement

a) For overlaying works, the minimum thickness of the overlay shall be 50 mm.

b) On grounds of economy, pavement thickness of more than 50 mm. shall be considered only if the cost of the asphalt pavement of such thickness is less than the cost of a 230 mm. thick PCCP.

In both pavement types, the thickness of pavement shall be verified from pavement design analysis using the AASHTO method as contained in the DPWH Design Guidelines, Criteria and Standards considering the latest Annual Average Daily Traffic (AADT) and axle loading.

B. Pavement Width

1. In new construction, the minimum width of the carriageway shall be 6.70 meters.

2. In rehabilitation or upgrading works involving a length of at least 500 meters, the minimum width of the carriageway to be adopted shall be 6.70 meters, provided that such works will not require right-of-way acquisition.

This Order shall take effect immediately.

ROGELIO L. SINGSON
Secretary

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Department Order No. 22
Series of 2011

ANNEX A

PROCEDURE IN COMPUTING THE CUMULATIVE EQUIVALENT SINGLE AXLE LOAD (CESAL)

1. Determine the Design Traffic for each vehicle type.

$$\text{Design Traffic} = P_i \left[\frac{(1+i)^n - 1}{i} \right] 365$$

Where:

P_i = Annual Average Daily Traffic
i = Traffic Growth Rate
N = Design Life Period (20 yrs. for PCCP and 10 yrs. for ACP)

2. Determine the Traffic Equivalence Factor (EF) for each vehicle type.

The damaging effect per pass to a pavement by a type of axle relative to the damage per pass of a standard axle load (usually the 8,200 kg. single-axle load) is expressed as *equivalence factor* (EF). The EF for each axle is calculated using the following formula.

$$EF = \left[\frac{axleload(tons)}{8.2} \right]^4$$

Then, determine the EF for each vehicle type.

$$EF = \Sigma \left[\frac{axleload(tons)}{8.2} \right]^4$$

Note: When the road section being designed has data based on actual traffic and axle load surveys, the corresponding Equivalent Factors (EF), as contained in the CY 2010 Summary Traffic Data issued by the Planning Service, shall be used.

3. Compute the Cumulative Equivalent Single Axle Load (CESAL) for each vehicle type.

$$\text{CESAL} = (\text{Design Traffic} \times D_D \times D_L)\ EF$$

Where:

D_D = Directional distribution factor, which is generally 50%
D_L = Lane Distribution Factor

The D_L factor may be calculated using Table 1.

Table 1. Lane Distribution Factor

Number of lanes in each direction	Percentage of 18-tons ESAL in design lane
1	100
2	80 – 100
3	60 – 80
4	50 – 75

4. Add the CESAL for all vehicle types.

EXAMPLE CALCULATION OF CESAL

I. DATA

Given the AADT of a road for one direction as follows:

Truck Type	AADT (one-direction)
2 – axle	40
3 – axle	20
4 – axle	7

A traffic growth rate of 4%[1] and a design period of 20 years are assumed.

II. SOLUTION

1. Determine the Design Traffic for each truck type.

a) 2 – axle trucks = $40 \left[\frac{(1+0.04)^{20}-1}{0.04}\right] 365 = 434{,}760$

b) 3 – axle trucks = $20 \left[\frac{(1+0.04)^{20}-1}{0.04}\right] 365 = 217{,}380$

c) 4 – axle trucks = $7 \left[\frac{(1+0.04)^{20}-1}{0.04}\right] 365 = 76{,}083$

[1] Whenever available, the traffic growth rate based on historical data shall be used.

2. Determine the equivalence factor (EF) for each axle and truck type.

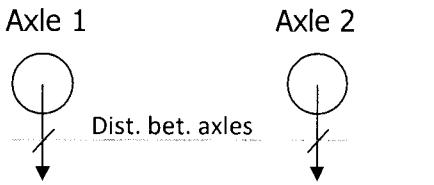
The table on GVW and maximum allowable axle load prescribed under RA 8794 as shown will be used in calculating the EF of each truck type.

GROSS VEHICLE WEIGHT (GVW) PER RA 8794

Truck Type	Code	GVW (kg)
2 – axle	1 – 1	16,880
3 – axle	1 – 2	27,250
4 – axle	11 – 2	30,380

Maximum allowable axle load = 13,500 kg.

a) In a 2 – axle truck, the load distribution[2] for each axle is as shown in the figure below.



Truck Code 1 – 1

0.2(GVW) = 3.38 tons

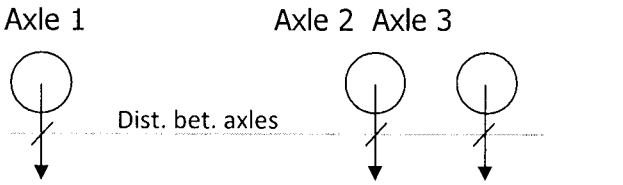
0.8(GVW) = 13.5 tons

The EF for a 2 – axle truck is then computed as follows:

$$EF_{2\ axle} = \left[\frac{3.38}{8.2}\right]^4 + \left[\frac{13.5}{8.2}\right]^4 = 7.38$$

b) In a 3 – axle truck, the load distribution for each axle is as shown in the figure below.

Truck Code 1 – 2



0.2(GVW) = 5.45 tons

0.4(GVW) = 10.9 tons

0.4(GVW) = 10.9 tons

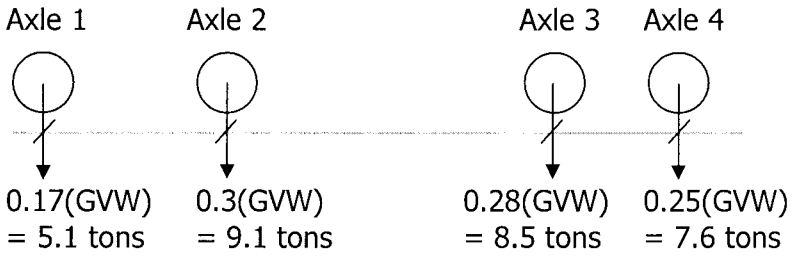
[2] The axle load distribution factors for each vehicle type is shown in Annex B.

The EF for a 3 – axle truck is then computed as follows:

$$EF_{3\ axle} = \left[\frac{5.45}{8.2}\right]^4 + \left[\frac{10.9}{8.2}\right]^4 + \left[\frac{10.9}{8.2}\right]^4 = 6.44$$

c) In a 4 – axle truck, the load distribution for each axle is as shown in the figure below.

Truck/Trailer Code 11 – 2



The EF for a 4 – axle truck is then computed as follows:

$$EF_{4\ axle} = \left[\frac{5.1}{8.2}\right]^4 + \left[\frac{9.1}{8.2}\right]^4 + \left[\frac{8.5}{8.2}\right]^4 + \left[\frac{7.6}{8.2}\right]^4 = 3.56$$

3. Compute for CESAL for all vehicle types.

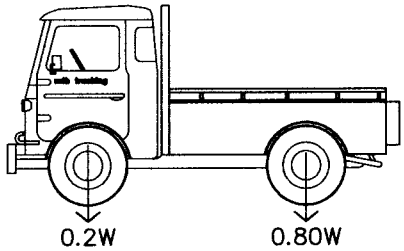
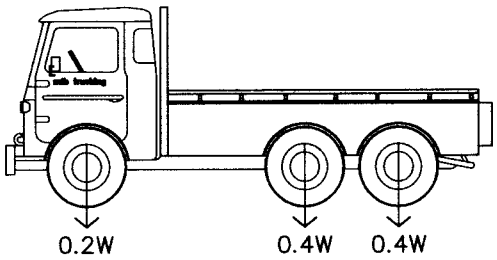
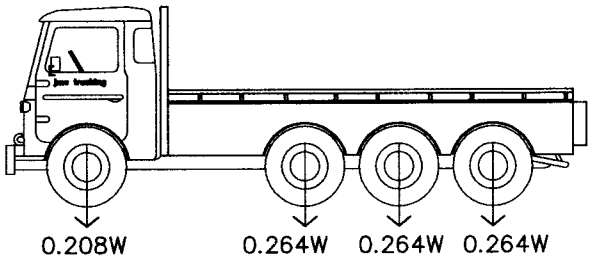
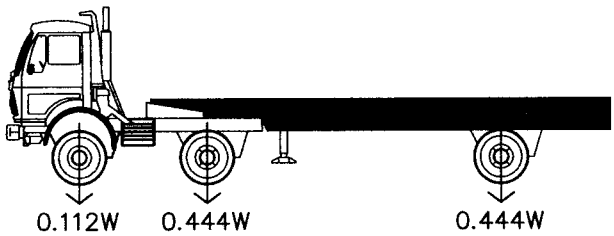
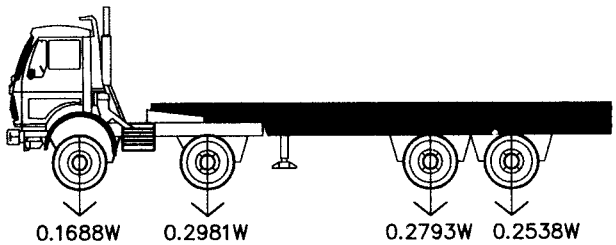
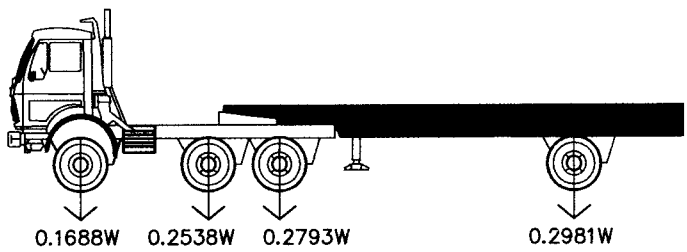
$$CESAL\ (W_{18}) = (434{,}760 \times 7.38) + (217{,}380 \times 6.44) + (76{,}083 \times 3.56)$$

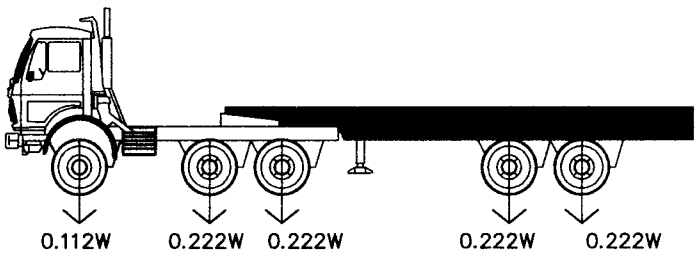
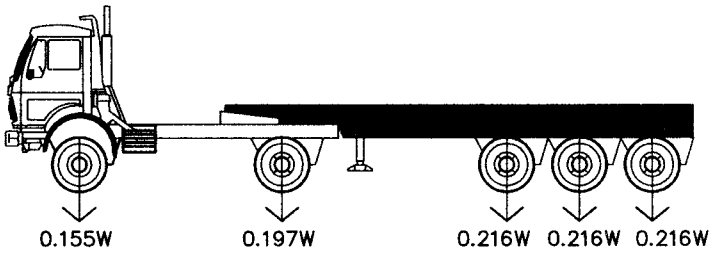
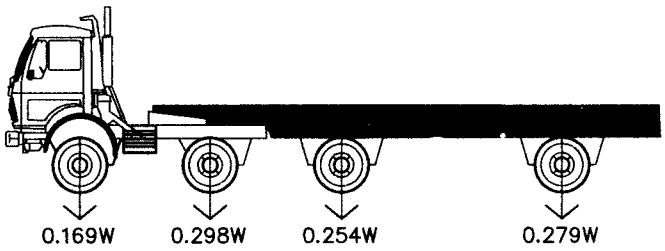
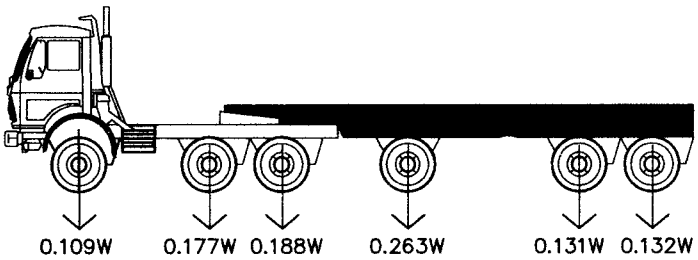
$$= 4{,}879{,}311.48$$

Say 4.9×10^6

In the example shown, if a PCCP is used, the thickness of the pavement may be less than 280 cm since the calculated CESAL is less than 7.0×10^6. The actual thickness shall be computed based on AASHTO guidelines, but should not be less than 230 mm.

ANNEX B
AXLE LOAD DISTRIBUTION FACTORS

CODE	DESCRIPTION	LOAD DISTRIBUTION
1-1	TRUCK (2 AXLE)	
1-2	TRUCK w/ TANDEM AXLE (3 AXLE)	
1-3	TRUCK W/ TRIDEM AXLE (4 AXLE)	
11-1	TRUCK SEMI TRAILER (3 AXLE)	
11-2	TRUCK SEMI - TRAILER (4 AXLE)	
12-1	TRUCK SEMI TRAILER (4 AXLE)	

CODE	DESCRIPTION	LOAD DISTRIBUTION
12-2	TRUCK SEMI TRAILER (5 AXLE)	
11-3	TRUCK SEMI-TRAILER (5 AXLE)	
11-11	TRUCK TRAILER (4 AXLE)	
12-12	TRUCK TRAILER (6 AXLE)	
12-3	TRUCK SEMI - TRAILER (6 AXLE)