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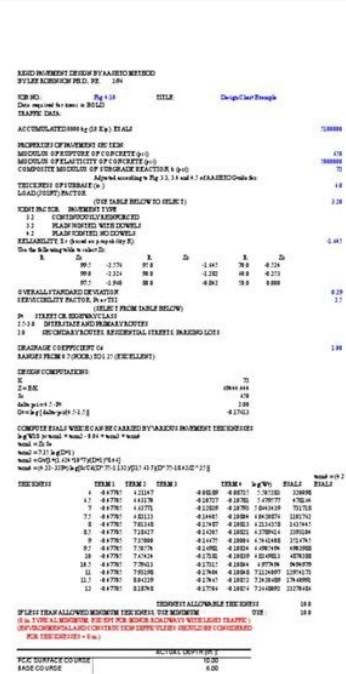
Halcrow CALCULATION SHEET		No.	No.						
Project Document 1	Ref:	Date:	Page:						
Subject: Road Pavement Design Calculations	Ref:	Date:	Page:						
Method used: AASHTO Guide for design of Pavements, Standard 1993 Pavement Design Method									
1) Equivalent Single Axle Load (ESAL): As per the AASHTO Guide for design of Pavements, Standard 1993, Method C, Concrete Pavement, 17th July 2004, Michigan Legal Soil. Actual truck load are as follows:									
<table border="1"> <tr><td>Single axle</td><td>12000 kg (12,000 lbs)</td></tr> <tr><td>Double axle</td><td>15000 kg (25,000 lbs)</td></tr> <tr><td>Tandem axle</td><td>18000 kg (39,000 lbs)</td></tr> </table> <p>The Traffic analysis period shall be 20 years</p>				Single axle	12000 kg (12,000 lbs)	Double axle	15000 kg (25,000 lbs)	Tandem axle	18000 kg (39,000 lbs)
Single axle	12000 kg (12,000 lbs)								
Double axle	15000 kg (25,000 lbs)								
Tandem axle	18000 kg (39,000 lbs)								
2) Soil Resilient Modulus, M _s :									
As per the soil report the three type of soil encountered in the area: <input checked="" type="checkbox"/> Dense Sand <input type="checkbox"/> Medium Sand <input type="checkbox"/> Silt <p>Except for the other material found in the area is generally expected to be suitable for pavement foundation after compaction and providing mat capping on the sides for the foundation. If the soil is not suitable for the foundation, it will be required that may be a combination of geotextiles and geogrids placed under the foundation. It is also required that which selected fill will be place to provide a stable foundation.</p>									
Subgrade soil Resilient Modulus: M = 750 to 3000 kN/m² (CR)									
Page 1 of 1									

AASTHO Flexible Pavement Design Method

Design considerations for the AASHTO Flexible Pavement Design

The following factors are considered in the pavement thickness design.

- Pavement performance
- Traffic
- Roadbed soils (subgrade material)
- Materials of construction
- Environment



EXAMPLE NO: 4.3

A flexible pavement is constructed with 4 in. of hot mix asphalt wearing surface, 8 in. of aggregate-bituminous base and 8 in. of crushed stone sub-base. The subgrade has a soil resilient modulus of 10,000 psi and M_1 and M_2 are equal to 1.0 for the materials in the pavement structures. The overall standard deviation is 0.5, the initial PSI is 4.5 and the TSI is 2.5. Daily traffic has 1080 20-kips single axles, 400 24-kip single axles, and 680 40-kip tandem axles. How many years would you estimate this pavement would last if you wanted to be 90% confident that your estimate was not too high, and if you wanted to be 99% confident that your estimate was not too high?

Solution:

Given Data:

$$\begin{array}{lll} D_1 = 4 \text{ inch} & D_2 = 8 \text{ inch} & D_3 = 8 \text{ inch} \\ M_s = 10,000 \text{ psi} & M_1 = M_2 = 1.0 & S_e = 0.5 \\ \Delta \text{PSI} = 4.5 & \Delta \text{PSI} = 2.0 & \text{TSI} = 2.5 \end{array}$$

Loads:

$$\begin{aligned} \text{Single Axle} &= 1080 \text{ 20 kip} \\ \text{Single Axle} &= 400 \text{ 24 kip} \\ \text{Tandem Axle} &= 680 \text{ 40-kip} \end{aligned}$$

Design Size =?

$$R = 90\% \quad (b), \quad 99\%$$

$$SN = a_1 D_1 + a_2 D_2 M_2 + a_3 D_3 M_3 \quad \dots \quad (1)$$

Putting values in Eqn. (1)

$$SN = (0.44)(4) + (0.30)(8)(1) + (0.11)(8)(1) = 5.039 = 5$$

Equivalency factor From Table 4.2 and 4.3

$$20 \text{ kip single axle equivalent} = 1.51$$

$$24 \text{ kip single axle equivalent} = 3.03$$

$$40 \text{ kip tandem axle equivalent} = 2.08$$

Thus: total daily 18 kip ESAL

FLEXIBLE PAVEMENT THICKNESS DESIGN AASHTO METHOD

Example

Determine the thickness of the surface, base and subbase layers using the following design parameters:

Equivalent Single Axle Load (ESAL) = 2×10^6
Initial Present Serviceability Index, $PSI_i = 4.5$
Terminal Present Serviceability Index, $PSI_t = 2.5$
Resilient modulus of asphalt concrete, $M_{Ri} = 450,000$ psi
CBR of crushed stone base = 100%
CBR of gravel subbase = 22%
CBR of subgrade = 6%
Exposure to moisture = 30% of the time
Quality of drainage: Surface layer – Good
Base layer – Fair
Subbase layer – Fairly poor
Reliability, $R = 99\%$
Standard deviation, $S_o = 0.35$

Solution

(1) Design Serviceability Loss, ΔPSI

$$\Delta PSI = PSI_i - PSI_t = 4.5 - 2.5 = 2.0$$

(2) Resilient Modulus

Subgrade : $M_{Rg} = 6,800$ psi (Figure 16-4 Appendix A-4, with CBR = 6%)
Subbase : $M_{Rb} = 13,300$ psi (Figure 16-16, Appendix A-10, with CBR = 22%)
Base : $M_{Rc} = 30,000$ psi (Figure 16-15, Appendix A-9, with CBR = 100%)

(3) Structural Number

(Use nomograph in Figure 16-11, Appendix A-5)

Surface : $SN_1 = 3.2$ (with $R = 99\%$, $S = 0.35$, $ESAL = 2 \times 10^6$, and $M_{Rg} = 30 \times 10^3$)
Base : $SN_2 = 4.2$ (with $R = 99\%$, $S = 0.35$, $ESAL = 2 \times 10^6$, and $M_{Rb} = 13 \times 10^3$)
Subbase : $SN_3 = 5.2$ (with $R = 99\%$, $S = 0.35$, $ESAL = 2 \times 10^6$, and $M_{Rc} = 6.8 \times 10^3$)

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