Pavement Analysis and Design

TE-503A /TE-503

Lecture-7
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Traffic Analysis

To design a highway pavement, it is necessary to predict the number of repetitions of each axle load group during the design period. Information on initial traffic can be obtained from field measurements that has traffic characteristics similar to those of the project in question.

The initial daily traffic is in two directions over all traffic lanes and must be multiplied by the directional and lane distribution factors to obtain the initial traffic on the design lane.

The traffic to be used for design is the average traffic during the design period, so the initial traffic must be multiplied by a growth factor.

Traffic Analysis

If n_i is the total number of load repetitions to be used in design for the *ith* load group, then

$$n_i = (n_0)_i(G)(D)(L)(365)(Y)$$

in which

$(n_o)_i$ is the initial number of repetitions per day for the *ith* load group,

***G* is the growth factor,**

***D* is the directional distribution factor, which is usually assumed to be 0.5 unless the traffic in two directions is different,**

***L* is the lane distribution factor which varies with the volume of traffic and the number of lanes and**

***Y* is the design period in years.**

Traffic Analysis

If the design is based on the equivalent 18-kip single-axle load, then the initial number of repetitions per day for the *ith* load group can be computed from

$$(n_0)_i = (p_i F_i)(\mathrm{ADT})_0(T)(A)$$

in which

p_i is the percentage of total repetitions for the *ith* load group,
F_i is the equivalent axle load factor (EALF) for the *ith* load group,
$(\mathrm{ADT})_o$ is the average daily traffic at the start of the design period,
T is the percentage of trucks in the ADT, and
A is the average number of axles per truck.

Traffic Analysis

The above two equations and summing over all load groups, the equivalent axle load for the design lane is

$$\text{ESAL} = \left(\sum_{i=1}^{m} p_i F_i\right)(\text{ADT})_0(T)(A)(G)(D)(L)(365)(Y)$$

In computing ESAL, it is convenient to combine the first and fourth terms in the above equation to form a new term called the truck factor:

$$T_f = \left(\sum_{i=1}^{m} p_i F_i\right)(A)$$

***T_f* is the number of 18-kip single-axle load applications per truck. Thus, the above equation becomes:**

$$\text{ESAL} = (\text{ADT})_0(T)(T_f)(G)(D)(L)(365)(Y)$$

Traffic Analysis-Average Daily Truck Traffic

The minimum traffic information required for a pavement design is the average daily truck traffic (ADTT) at the start of the design period. The ADTT may be expressed as a percentage of ADT or as an actual value.

This information can be obtained from the actual traffic counts on the existing roadway where the pavement is to be constructed or on nearby highways with similar travel patterns.

Traffic volume maps showing the ADT, sometimes with the percentage of trucks, on various roadways within a given area may also be used, although they are far less accurate than the actual counts.

Traffic Analysis-Average Daily Truck Traffic

The traffic counts must be adjusted for daily (weekday versus weekend) and seasonal (summer versus winter) variations to obtain the annual average daily traffic (AADT).

Traffic is the most important factor in pavement design. Every effort should be made to collect actual data on the project.

Traffic Analysis-Truck factor

A single truck factor can be applied to all trucks, or separate truck factors can be used for different classes of trucks. The latter case should be considered if the growth factors for different types of trucks are not the same.

Table 6.11 shows the computation of truck factors for trucks with five or more axles on a flexible pavement. The equivalent factors are based on an *SN* of 5 and a p_t of 2.5 and can be obtained from Table 6.4.

The sum of ESALs for all trucks weighed divided by the number of trucks weighed gives the truck factor.

Traffic Analysis-Truck factor

TABLE 6.11 Computation of Truck Factor for Trucks with Five or More Axles

Axle load (lb)	EALF	Number of axles	ESAL
Single Axles			
Under 3000	0.0002	0	0.000
3000–6999	0.0050	1	0.005
7000–7999	0.0320	6	0.192
8000–11,999	0.0870	144	12.528
12,000–15,999	0.3600	16	5.760
16,000–29,999	5.3890	1	5.389
Tandem Axles			
Under 6000	0.0100	0	0.000
6000–11,999	0.0100	14	0.140
12,000–17,999	0.0440	21	0.924
18,000–23,999	0.1480	44	6.512
24,000–29,999	0.4260	42	17.892
30,000–32,000	0.7530	44	33.132
32,001–32,500	0.8850	21	18.585
32,501–33,999	1.0020	101	101.202
34,000–35,999	1.2300	43	52.890
ESALs for all trucks weighed			255.151

$$\text{Truck factor} = \frac{\text{18-kip ESALs for all trucks weighed}}{\text{Number of trucks weighed}} = \frac{255.151}{165} = 1.5464$$

Traffic Analysis-Growth factor

One simple way to project the growth factor is to assume a yearly rate of traffic growth and use the average traffic at the start and end of the design period as the design traffic:

$$G = \frac{1}{2}[1 + (1 + r)^{Y}]$$

The Portland Cement Association (1984) applies the traffic at the middle of the design period as the design traffic:

$$G = (1 + r)^{0.5Y}$$

Table 6.12 shows the growth factors for 20- and 40-year design periods based on the above equation.

Traffic Analysis-Growth factor

TABLE 6.12 Traffic Growth Factors

Annual growth rate (%)	20-Year design period	40-Year design period
1.0	1.1	1.2
1.5	1.2	1.3
2.0	1.2	1.5
2.5	1.3	1.6
3.0	1.3	1.8
3.5	1.4	2.0
4.0	1.5	2.2
4.5	1.6	2.4
5.0	1.6	2.7
5.5	1.7	2.9
6.0	1.8	3.2

Source. After PCA (1984).

Traffic Analysis-Growth factor

The Asphalt Institute (AI, 1981a) and the AASHTO design guide (AASHTO, 1986) recommend the use of traffic over the entire design period to determine the total growth factor, as indicated by

$$\text{Total growth factor} = (G)(Y) = \frac{(1+r)^{Y} - 1}{r}$$

Table 6.13 shows the total growth factor, which is the growth factor multiplied by the design period, as recommended by the Asphalt Institute. The same factor is used in the AASHTO design guide.

Traffic Analysis-Growth factor

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Source. After AI (1981a).

Traffic Analysis-Growth factor

If the growth rate is not uniform, different growth rates should be used for different load groups or types of vehicles. To determine the annual growth rate, the following factors should be considered:

1. Attracted or diverted traffic due to the improvement of existing pavement

2. Normal traffic growth due to the increased number and usage of motor vehicles

3. Generated traffic due to motor vehicle trips that would not have been made if the new facility had not been constructed

4. Development traffic due to changes in land use as a result of the new facility

Traffic Analysis-Growth factor-Numerical problem

For an annual growth rate of 3.5% and a design period of 30 years, compute the growth factors by all the three approaches.

$$G = \frac{1}{2}[1 + (1 + r)^Y]$$

$$G = (1 + r)^{0.5Y}$$

$$\text{Total growth factor} = (G)(Y) = \frac{(1 + r)^Y - 1}{r}$$

Traffic Analysis-Lane Distribution Factor

TABLE 6.14 Truck Distribution for Multiple-Lane Highways

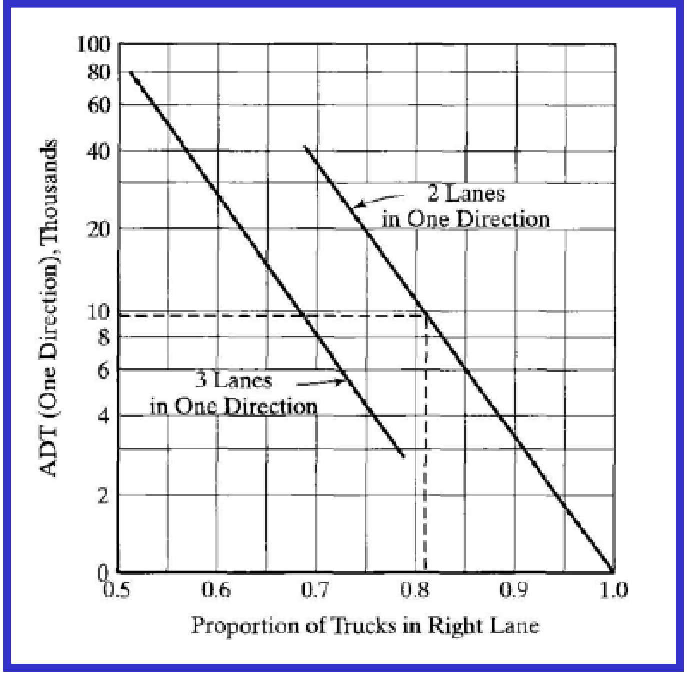
One-way ADT	Two lanes in each direction		Three or more lanes in each direction		
	Inner	Outer	Inner[a]	Center	Outer
2000	6	94	6	12	82
4000	12	88	6	18	76
6000	15	85	7	21	72
8000	18	82	7	23	70
10,000	19	81	7	25	68
15,000	23	77	7	28	65
20,000	25	75	7	30	63
25,000	27	73	7	32	61
30,000	28	72	8	33	59
35,000	30	70	8	34	58
40,000	31	69	8	35	57
50,000	33	67	8	37	55
60,000	34	66	8	39	53
70,000	—	—	8	40	52
80,000	—	—	8	41	51
100,000	—	—	9	42	49

[a] Combined inner one or more lanes.

Source. After Darter et al. (1985).

Traffic Analysis-Lane Distribution Factor

Based on the data in Table 6.14, the Portland Cement Association (PCA, 1984) developed a chart for determining the proportion of trucks in the design lane, as shown in Figure.



Traffic Analysis-Lane Distribution Factor

The Asphalt Institute (AI, 1981a) combines the directional and lane distribution factors (DxL) and determines the percentage of total truck traffic in the design lane by Table 6.15.

A comparison of Table 6.15 and Figure indicates that the lane distribution factors by the Asphalt Institute are about the same as those by PCA for an ADT of 3000 in one direction.

TABLE 6.15 Percentage of Total Truck Traffic in Design Lane

Number of traffic lanes in two directions	Percentage of trucks in design lane
2	50
4	45 (35–48)[a]
6 or more	40 (25–48)[a]

[a] Probable range.

Source. After AI (1981a).

Traffic Analysis-Lane Distribution Factor

The lane distribution factors recommended by the AASHTO design guide are shown in Table 6.16.

Note that the percentage in Table 6.15 is based on total traffic, but the percentage in Table 6.16 is based on the traffic in one direction.

TABLE 6.16 Lane Distribution Factor

No. of lanes in each direction	Percentage of 18-kip ESAL in design lane
1	100
2	80–100
3	60–80
4	50–75

Source. After AASHTO (1986).

Traffic Analysis-ESAL-Numerical problem

A two-lane major rural highway has an ADT of 4000 during the first year of traffic, 25 % trucks, 4% annual growth rate and 50% on the design lane. If T_f = 0.38, compute the ESAL for a design period of 20 years.

$$\text{Total growth factor} = (G)(Y) = \frac{(1 + r)^Y - 1}{r}$$

$$\text{ESAL} = (\text{ADT})_0(T)(T_f)(G)(D)(L)(365)(Y)$$

Traffic Analysis-ESAL-Numerical problem

An eight-lane divided highway is to be constructed on a new alignment. Traffic volume forecasts indicate that the AADT in both direction during the first year will be 12,000 with following vehicle mix:

Passenger cars (1,000 lb/axle)=50%

2-axle SU trucks (6,000lb/axle)=33%

3-axle SU trucks (10,000lb/axle)=17%

The vehicle is expected to remain the same throughout the design life. Expected annual traffic growth rate is 4%. Determine ESAL for 20 year design period.

$$\text{ESAL} = (\text{ADT})_0(T)(T_f)(G)(D)(L)(365)(Y)$$

Traffic Analysis-ESAL-Numerical problem

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Source. After AI (1981a).

Traffic Analysis-ESAL-Numerical problem

TABLE 6.16 Lane Distribution Factor

No. of lanes in each direction	Percentage of 18-kip ESAL in design lane
1	100
2	80–100
3	60–80
4	50–75

Source. After AASHTO (1986).

Traffic Analysis-ESAL-Numerical problem

A pavement is subjected to the single axle loads as shown. Determine the ESAL for a design period of 20 years using AI's equivalent load factors and equivalent load factors equation. Take D=0.5, L=0.9, SN=5, p_t=2.5, Growth factor=4%.

Axle load (kip)	Number per day	Axle load (kip)	Number per day	Axle load (kip)	Number per day
12	200.0	20	47.2	28	2.9
14	117.4	22	21.4	30	1.2
16	84.5	24	12.9	32	0.7
18	61.4	26	6.1	34	0.3

Traffic Analysis-ESAL-Numerical problem

$$ESAL = (ADT)_0(T)(T_f)(G)(D)(L)(365)(Y)$$

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Source. After AI (1981a).

Traffic Analysis-ESAL-Numerical problem

Given that: Design life: 20 years, D=0.5, L=0.9, Average daily traffic=12,000, Growth rate=5%, Percentage of trucks=25%. Determine ESAL for the given loading:

Single axle load		Tandem axle load	
Axle load (kip)	Axles/1000 trucks	Axle load (kip)	Axles/1000 trucks
8	1200	14	220
10	240	17	200
14	200	23	180
18	160	28	200
20	60	34	15
22	15		
24	8		

Traffic Analysis-ESAL-Numerical problem

$$ESAL = (ADT)_0(T)(T_f)(G)(D)(L)(365)(Y)$$

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Source. After AI (1981a).

Traffic Analysis-ESAL-Numerical problem

Estimate the equivalent 18-kip single-axle load applications (ESAL) for a four-lane pavement (two lanes in each direction) of a rural interstate highway with a truck count of 1000 per day (including 2-axle, 4-tyre panel and pickup trucks), an annual growth rate of 5%, and a design life of 20 years.

Traffic Analysis-ESAL-Numerical problem

	Tru					
	Rural systems					
				Collectors		
Vehicle type	Interstate	Other Principal	Minor Arterial	Major	Minor	Range
Single-unit trucks						
2-axle, 4-tire	0.003	0.003	0.003	0.017	0.003	0.003–0.017
2-axle, 6-tire	0.21	0.25	0.28	0.41	0.19	0.19–0.41
3-axle or more	0.61	0.86	1.06	1.26	0.45	0.45–1.26
All single units	0.06	0.08	0.08	0.12	0.03	0.03–0.12
Tractor semitrailers						
4-axle or less	0.62	0.92	0.62	0.37	0.91	0.37–0.91
5-axle[b]	1.09	1.25	1.05	1.67	1.11	1.05–1.67
6-axle or more[b]	1.23	1.54	1.04	2.21	1.35	1.04–2.21
All multiple units	1.04	1.21	0.97	1.52	1.08	0.97–1.52
All trucks	0.52	0.38	0.21	0.30	0.12	0.12–0.52

a Compiled from data supplied by the Highway Statistics Division, U.S. Federal Highway Administration.
b Including full-trailer combinations in some states.
Source. After AI (1991).

Traffic Analysis-ESAL-Numerical problem

$$\text{ESAL} = (\text{ADT})_0(T)(T_f)(G)(D)(L)(365)(Y)$$

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

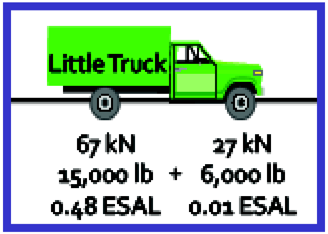
Source. After AI (1981a).

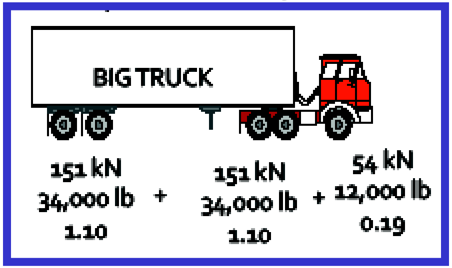
Traffic Analysis-ESAL-Numerical problem

A six-lane divided highway is to be constructed on a new alignment. Traffic volume forecasts indicate that the ADT in both direction during the first year will be 3,500 with following vehicle mix:

Little truck=5%

Big truck=30%





Expected annual traffic growth rate is 4%. Determine ESAL for initial year, 5, 10, 20 and 30 year design periods.

$$ESAL = (ADT)_0(T)(T_f)(G)(D)(L)(365)(Y)$$

Traffic Analysis-ESAL-Numerical problem

TABLE 6.13 Total Growth Factor

Design period (years)	Annual growth rate (%)							
	No growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Source. After AI (1981a).

Traffic Analysis-ESAL-Numerical problem

TABLE 6.16 Lane Distribution Factor

No. of lanes in each direction	Percentage of 18-kip ESAL in design lane
1	100
2	80–100
3	60–80
4	50–75

Source. After AASHTO (1986).

Assignment No. 5

Pavement Analysis and Design by Yang H. Huang

Chapter-6

Problems 6.1 to 6.10 (Pages 276-278)

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