PAVEMENT TECHNOLOGY ADVISORY
-TEMPORARY LOAD LIMITS ON LOCAL ROADS-
PTA-D2

WHY SET LOAD LIMITS?

The 18,000-pound Equivalent Single Axle Load (ESAL) is a standard measure of the damage applied to a pavement by traffic loads. As such, a vehicle that applies 2 ESALs to the pavement does twice the damage as a vehicle that applies 1 ESAL. However, the damage caused by each vehicle is not a simple linear increase with the vehicle weight. A general rule is that a 10 percent increase in gross vehicle weight will result in twice the damage to the pavement. By that reasoning, a load limit reducing the allowable vehicle weight by 10 percent could conceivably reduce the rate of pavement damage by one-half, and thereby double the pavement life.

LOAD LIMIT LAWS

While load limits may be an attractive way to reduce damage and extend the life of a pavement, they should not be overly restrictive. Pavement managers not only must protect the roads and the tax dollars invested in them; they must also provide transportation facilities that meet the users' needs without undue inconvenience. Load limit laws are intended to balance these missions.

In Illinois, one such law allows temporary load limit reductions on local roads for up to 90 days in one calendar year. The reason for the law is that the roadbed can become extremely soft at certain times of the year, typically during the spring thaw. At such times, the pavement may be severely damaged by only a few passes of heavy trucks. Alternatively, the pavement may be adequate for heavier loading at other times of the year, and the reduced load limit may cause an undue inconvenience if left in place.

LOAD LIMIT EVALUATION

Two types of temporary load limits may be used: gross load or axle load. Gross load limits restrict the ***total*** weight of the truck, and axle load limits restrict the weight of each ***axle*** on the truck. The benefit of either load limit type can be evaluated by comparing the expected pavement damage under a temporary load limit reduction to the damage that would occur if no such reduction were imposed.

Example:

A local agency is considering a temporary load limit reduction on a section of roadway. The flexible pavement consists of 6 inches of crushed stone with a number of seal coats built up over the years. The local agency would like to know whether an 8,000-pound axle load limit or a 20,000-pound gross load limit will provide a greater benefit.

Step 1 - Determine traffic:

Data is collected to determine the average daily traffic and the breakdown of vehicle types. Assume that a traffic count at the location yielded the following results (passenger vehicles ignored):

Truck Type	Daily Traffic
2-Axle (6-tire)	5
3-Axle (Tandem)	5
5-Axle (Semi)	5

Step 2 - Calculate the damage under an 8,000-pound axle load limit:

Equivalency factors represent the number of ESAL applications per vehicle. To determine the total daily damage to the pavement, the equivalency factor for each truck type is multiplied by the daily traffic for that truck type, and the results are summed. The equivalency factors for trucks of each type having 8,000-pound axle loads are highlighted in Table 1 on Page 3 of this document.

Truck Type	Daily Traffic
2-Axle (6-tire)	5 x 0.060 = 0.30
3-Axle (Tandem)	5 x 0.071 = 0.36
5-Axle (Semi)	5 x 0.110 = 0.55
Total daily damage	1.21

Step 3 - Calculate the damage under a 20,000-pound gross load limit:

The same process used in Step 2 is employed to calculate the total daily damage under a 20,000-pound gross load limit. The equivalency factors for trucks of each type having 20,000-pound gross loads are highlighted in Table 2 on Page 3 of this document.

Truck Type	Daily Traffic
2-Axle (6-tire)	5 x 0.265 = 1.32
3-Axle (Tandem)	5 x 0.033 = 0.16
5-Axle (Semi)	5 x 0.008 = 0.04
Total daily damage	1.52

Step 4 - Calculate the damage under maximum legal load limits:

Equivalency factors for trucks carrying the maximum legal loads can be determined using Table 3 on Page 4 of this document, provided the designer knows the axle configuration and load distribution for the vehicle types. If only the gross vehicle weight is available, either the legal loading method, or the equal tire loading method *(see PTA-D1)* can be used to estimate the load distribution. Loading values that fall between the values listed in Table 3 can be estimated using linear interpolation.

For this example, assume that trucks of each type carrying the maximum legal load have the following load distributions.

Equivalency factor for 2-axle trucks:

1.00 + 1.00 = 2.00 ESALs/veh

Equivalency factor for 3-axle trucks:

0.810 + 1.00 = 1.81 ESALs/veh

Equivalency factor for 5-axle trucks:

0.810 + 0.810 + 0.06 = 1.68 ESALs/veh

The daily damage from trucks carrying the maximum legal load would be:

Truck Type	Daily Traffic
2-Axle (6-tire)	5 x 2.00 = 10.00
3-Axle (Tandem)	5 x 1.81 = 9.05
5-Axle (Semi)	5 x 1.68 = 8.40
Total daily damage	27.45

Step 5 - Compare the damage caused under the different load limits

In this case, the maximum legal load limits would result in about 20 times more daily damage than if an 8,000-pound axle limit or a 20,000-pound gross load limit were imposed (27.45 ESALs vs. 1.21 ESALs or 1.52 ESALs, respectively). The daily pavement damage under a 20,000-pound gross limit is about 26 percent greater than the damage under an 8,000-pound axle limit; therefore, the 8,000-pound axle limit would be the preferred alternative.

Note: An 8000-pound axle limit results in substantial differences in the allowable gross load, depending on the number of axles per truck. The allowable gross loads must not exceed any bridge load limits that exist on the roadway section.

The basic process outlined in the previous example can be followed in the same manner to compare other load limit alternatives. The maximum legal load limits for use in Step 4 may be found on the Illinois Department of Transportation (IDOT) Designated State Truck Route System map, available upon request by calling (217)782-6271.

For help in establishing load limits, customizing loadings for unique situations, or for additional information, please contact:

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Bureau of Materials and
Physical Research
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TABLE 1: AXLE LOAD EQUIVALENCY FACTORS FOR FLEXIBLE PAVEMENTS

AXLE LOAD, KIPS	2-AXLE TRUCK	3-AXLE TRUCK	5-AXLE TRUCK
8	0.060	0.071	0.110
10	0.150	0.180	0.280
12	0.330	0.390	0.620
14	0.650	0.770	1.220
16	1.180	1.400	2.210
18	2.000	-	-

TABLE 2: GROSS LOAD EQUIVALENCY FACTORS FOR FLEXIBLE PAVEMENTS

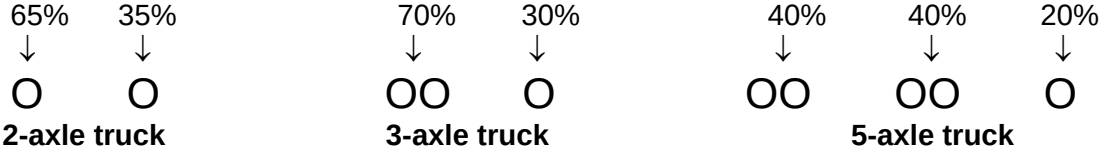
GROSS LOAD, KIPS	2-AXLE TRUCK	3-AXLE TRUCK	5-AXLE TRUCK
12	0.031	-	-
16	0.100	0.015	-
20	0.265	0.033	0.008
24	0.575	0.073	0.017
28	1.130	0.135	0.030
30	1.555	0.180	0.040
32	2.100	0.235	0.050
36	-	0.395	0.075
40	-	0.610	0.110
44	-	0.950	0.170
48	-	1.390	0.240
50	-	-	0.280
52	-	-	0.340
56	-	-	0.470
60	-	-	0.620
64	-	-	0.835
68	-	-	1.090
72	-	-	1.400
76	-	-	1.780
80	-	-	2.210

TABLE 3: EQUIVALENCY FACTORS FOR SPECIFIC AXLE TYPES

LOAD, KIPS	FLEXIBLE PAVEMENT AXLE TYPE		RIGID PAVEMENT AXLE TYPE	
	SINGLE	TANDEM	SINGLE	TANDEM
2	0.0002	0.0000	0.0002	0.0001
4	0.002	0.0003	0.002	0.0006
6	0.009	0.001	0.011	0.002
8	0.030	0.003	0.035	0.006
10	0.075	0.007	0.087	0.014
12	0.165	0.013	0.186	0.028
14	0.325	0.024	0.353	0.051
16	0.589	0.041	0.614	0.087
18	1.00	0.066	1.00	0.141
20	1.61	0.103	1.55	0.216
22	2.49	0.156	2.32	0.319
24	3.71	0.227	3.37	0.454
26	5.36	0.322	4.76	0.629
28	7.54	0.447	6.58	0.852
30	10.4	0.607	8.92	1.13
32	14.0	0.810	11.9	1.48
34	18.5	1.06	15.5	1.90
36	24.2	1.38	20.1	2.42
38	31.1	1.76	25.6	3.04

ASSUMPTIONS FOR TABLES

- Table 1 assumes the load is shifted to achieve an equal load distribution to each axle (e.g. the gross load is divided by the number of axles to find the axle load).
- Table 2 assumes the following load distributions, typical under normal loading:



2-axle truck **3-axle truck** **5-axle truck**

Note: Load distributions that differ significantly from these assumptions will have different associated equivalency factors. These can be determined individually if the situation arises. Contact the Pavement Technology Engineer for help.

- The equivalency factors in Tables 1 and 2 were compiled from the 1993 *AASHTO Guide for Design of Pavement Structures (AASHTO Guide)*, and are suitable for flexible pavements on the local roads system in Illinois. The values assume a pavement Structural Number (SN) of 1 and a terminal serviceability (p_t) of 2.0.
- The equivalency factors for Table 3 were compiled from the 1993 *AASHTO Guide*; SN = 1, T = 6, p_t = 2.0. The values are suitable for most flexible and rigid pavements on the local road system in Illinois. Table 3 can also be used for pavement design.
- The equivalency factors in all three tables apply to the roadway only, and do not apply to bridges or drainage structures.