GUIDELINES FOR SPRING HIGHWAY USE RESTRICTIONS

Research, Development, and Technology

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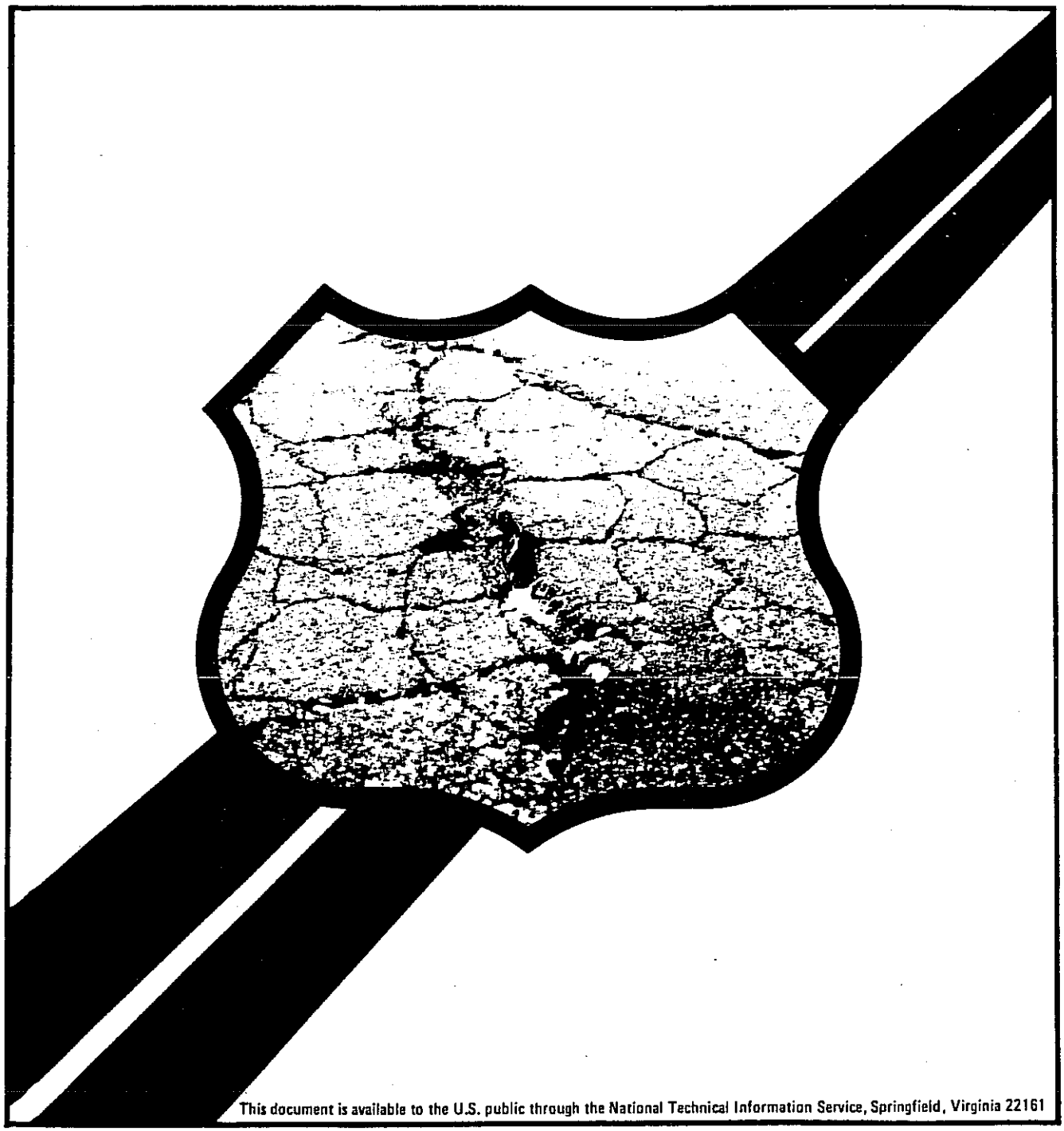
Report No:
FHWA-TS-87-209

U.S. Department of Transportation
Federal Highway Administration

Video Supplement
January 1987



FOREWORD

This Tech Share report supplements the video tape "Guidelines for Spring Highway Use Restrictions." This report provides guidelines for where to apply load restrictions, the amount of the load restrictions to apply, and when to apply and remove load restrictions.

This study was conducted as part of the Federal Highway Administration's Rural Technical Assistance Program.

Additional copies of the report can be obtained from the National Technical Information Service, Springfield, Virginia 22161.

R. J. Betsold
Director, Office of Implementation
Federal Highway Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-TS-87-209		

4. Title and Subtitle	5. Report Date
Guidelines for Spring Highway Use Restrictions	January 1987
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s)	
Joe P. Mahoney, Mary S. Rutherford, R. Gary Hicks	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Washington State Transportation Center and the University of Washington Department of Civil Engineering Seattle, Washington 98195	11. Contract or Grant No. WSDOT Y-28U Task 28
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Video supplement
Federal Highway Administration Office of Implementation (HRT-10) 6300 Georgetown Pike McLean, Virginia 22101-2296	14. Sponsoring Agency Code RTAP Project #23

15. Supplementary Notes

FHWA Contract Manager: Charles W. Niessner

16. Abstract

This report is a supplement to the video presentation "Guidelines for Spring Highway Use Restrictions." Air temperature based criteria (thawing index) were developed which can be used to estimate when to apply and remove load restrictions. This supplement provides guidelines for where to apply load restrictions, the amount of the load restrictions to apply, and when to apply and remove load restrictions. Example calculations and a blank data collection sheet are also included.

17. Key Words	18. Distribution Statement
Load restrictions, frost, thaw, tire, axle, spring thaw, thaw weakening	No restrictions. This document is available to the public through the National Technical Information Service Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	15	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

INTRODUCTION

In some areas that have cold weather, damage can occur to pavements during the thawing periods (normally during the spring, but thawing can also occur during the winter months). To prevent potholes and cracks from forming, two possibilities exist:

1. apply truck load restrictions during the thawing (or critical) period; and

2. change the pavement structure to prevent or reduce damage.

Due to budget constraints, for many of the agencies faced with this problem the only choice is Item (1) above.

Until studies were recently completed by the Washington State Transportation Center in cooperation with the Washington State Department of Transportation, Oregon State University, the Federal Highway Administration, and numerous state, city and county agencies, few straightforward procedures existed which could be used to determine the amount of load restrictions needed, when to apply them and when to remove them. Therefore, a need existed to develop guidelines [1] to help local agencies handle this serious problem. The following pages describe a method to help local agencies more effectively apply load restrictions and can be used in conjunction with the associated videotape.

THE PROBLEM

Frost action in soils can cause several damaging effects. A commonly known effect is frost heave. Less information is available on an equally serious problem, loss in pavement strength. This loss in strength occurs during the thaw period (usually late winter or early spring) when moisture increases in the pavement layers. This effect is similar to the effects of a rising groundwater table or infiltration of moisture through a porous pavement surfacing or shoulder. Whatever the cause, if the amount of moisture is above the amount the pavement was designed for, the strength (or stiffness) of the pavement layers will be reduced.

Most of the currently used pavement design methods are based on studies of pavement behavior. The strength of a subgrade is usually estimated at the time when moisture and density are at equilibrium after soaking for several days (e.g., the CBR test). Design methods based on this procedure cannot account for unfavorable subgrade conditions caused by thaw periods or unusually high water tables, unless these conditions were present when the strength studies were conducted. This is because the design methods are based on the average subgrade conditions present throughout most of the pavement's life.

The damage to a pavement structure is directly related to the amount and frequency of the load applied. This was clearly demonstrated at the AASHO Road Test [2]. A majority of the state DOTs use the AASHTO Interim Guide for Design of Pavement Structures [3] for designing their pavement thicknesses. In designing a specific pavement using this method the traffic is changed to equivalent 18,000 lb. single axle loads for a given design period and for known or assumed materials. Any lowering of material strength or increase in the number of equivalent 18,000 lb. single axle loads reduces the life of the pavement. Thus, the method of reducing loads when the strength of the pavement materials is reduced is a reasonable way to maintain the design life and general serviceability of the pavement. Hence, there is a need for load restrictions during critical pavement periods.

THE GUIDELINES

Local and state highway agencies have a wide variety of practices for applying load restrictions before the "spring thaw." Truck load enforcement programs adopted by the various

agencies differ widely in terms of the load limits applied, the forms the restrictions take and their implementation. The decision to close or open a highway or street is largely determined by experience and sometimes political pressure. There is very little information to help in decision making, especially for secondary and lower category highways, even though these types of highways form a large part of county and city road systems. Local governments generally have low to modest maintenance budgets and normally cannot afford to overlay the pavements after spring thaw damage. Therefore, a need exists for criteria for determining truck weight restrictions during the spring thaw.

The following guidelines are based on the literature review, the survey of current practice, and the analysis conducted in the previously mentioned studies [1]:

1. where to apply load restrictions,
2. the amount of the load restrictions to apply, and
3. when to apply and remove load restrictions.

The guidelines are general and must be applied with judgment, since the nature of the problem is site specific.

GUIDELINES FOR WHERE TO APPLY LOAD RESTRICTIONS

Criteria that should be considered in selecting pavements for load restrictions include

1. surface thickness,
2. type of subgrade,
3. local experience relating to observed moisture and pavement distress, and
4. surface deflections.

If the surface thickness of a pavement is about two inches or less and in an area where the Freezing Index (FI) (see definition in the Example, page 5) is greater than 400°F-days (i.e., a modest depth of freezing), then load restrictions should be considered.

Pavements on fine-grained subgrades such as silts and clays (Unified Soil classifications ML, MH, CL and CH) are candidates for load restrictions. Again, the depth of ground freezing is important.

Local experience, such as observed site drainage, is significant in determining the need for load restrictions. Items such as poor drainage from side ditches, available ground water, high winter precipitation, and snow removal policies should be considered. For example, pavement in cold but dry locations probably will not need any type of restriction. Observation of pavement distress, such as fatigue (alligator) cracking and rutting, may also determine the need for load restrictions. If these distress types primarily occur during the spring thaw, load restrictions are needed if options such as strengthening the overall pavement structure are not possible (or appropriate). Various nondestructive pavement response measures such as surface deflection can help define the potential pavement weakening during the thaw period; however, the experience of agency personnel should be used as much as possible.

Finally, study results concluded that pavement sections which have surface deflections 45 to 50 percent higher during the spring thaw than during the summer are candidates for load restrictions. However, site specific conditions can significantly alter the deflection threshold. For example, a relatively "weak" pavement section may have relatively high summer deflections. Thus its spring thaw deflections, although less than the threshold level of 45 to 50 percent, may still require load reductions. Surface deflection increases of less than 45 percent result in load reductions of about 25 to 30 percent or less.

GUIDELINES FOR LOAD RESTRICTION AMOUNT

The load reductions used by the agencies interviewed in the study ranged from about 20 to 60 percent. The average load reduction for seven locations (grouped state areas) was approximately 44 percent. This suggests that reducing the load on individual axles (or tires) by about 40 to 50 percent reduces the associated pavement response to levels that prevent or reduce the resulting pavement distress to acceptable levels.

The study results showed that as the load reduction percentage is increased the associated pavement life is increased. As shown in Table 1, potential pavement life increases are dependent on load reductions (starting with a load reduction of 20 percent). Thus, if the 44 percent load reduction level is used (average of the seven grouped state areas previously noted), this results in a potential improvement in pavement life of about 90 percent.

However, the necessary level of load reduction is not as simple as the preceding numbers suggest. For example, many thin or generally weak pavement structures need high levels of load reduction during the spring thaw period to prevent significant pavement damage (i.e., small or even modest levels of load reduction will not prevent significant pavement damage).

If load restrictions are to be used, a minimum load reduction of 20 percent appears to be needed. Load reductions greater than 60 percent appear to be excessive. Further, general national practice is to use load reductions ranging from 40 to 50 percent. The analysis performed in the study confirmed this range of load reduction.

GUIDELINES FOR WHEN TO APPLY LOAD RESTRICTIONS

A primary activity of the study was to develop guidelines on when to apply and remove load restrictions. These guidelines are based on air temperature data that are easy to obtain from local weather stations or site specific high-low recording thermometers.

As shown in Table 2, thermal analyses performed in the study resulted in two possible times for applying load restrictions. Both were based on a Thawing Index (TI) (see Example, page 6) calculated using a 29°F air temperature datum (not the normal 32°F) and are a function of total pavement thickness. (An air temperature

TABLE 1

Pavement Load Reduction (%)	Pavement Life Increases (%)
20	62
30	78
40	88
50	95

TABLE 2

Pavement Structure	BST/Asphalt Concrete Thickness (inches)	Base Course Thickness (inches)	Thawing Index (°F-days) Should Level	Must Level
• Thin	2 inches or less	6 inches or less	10	40
• Thick	Greater than 2 inches	Greater than 6 inches	25	50

datum of 29 ° F is used to account for bituminous pavement surface heating effects since the pavement surface is about 32°F when the air temperature is about 29°F.)

Should Level

The "should" load restriction application time occurs after thin pavements accumulate a Thawing Index of 10°F-days and thick pavements accumulate a Thawing Index of 25°F-days following the start of the thawing period (see Table 2). This is used to estimate thaw to the bottom of the base course.

Must Level

The "must" load restriction application time occurs after thin pavements accumulate a Thawing Index of 40°F-days and thick pavements accumulate a Thawing Index of 50°F-days following the start of the thawing period. This is used to estimate thaw to approximately four inches below the bottom of the base course.

Discussion

The above criteria are best suited for use during the start of the spring thaw period (generally late February to April). A different condition exists for mid-winter thawing cases. First, the sun angle is lower during a mid-winter thaw than the sun angle calculated in the analysis, so that a higher base temperature (such as 31°F) is needed for calculating the Thawing Index for mid-winter. Second, for most areas, the percent of cloud cover is higher during mid-winter.

The temperature based Thawing Index criteria are best applied to fine-grained soils. The analysis performed in the study showed more consistent results for this soil type than for coarse-grained soils. An example of how to use this criterion is shown in the Example on page 6.

GUIDELINES FOR DURATION OF LOAD RESTRICTIONS

The literature review, interviews, and the structural and thermal analyses showed that the length of the load restriction period should approximate the time required to achieve complete thawing. (This assumption should be verified by those agencies which use these guidelines.)

An equation is used to estimate the time required for complete thawing to occur (hence the length of load restrictions) and is based on a Thawing Index criterion. The Thawing Index is estimated from a regression equation whose independent variable is the Freezing Index. The equation selected is

Thawing Index = 4.15 + 0.26 (Freezing Index)

An approximate solution is

Thawing Index $\simeq$ 0.3 (Freezing Index)

An example of how to calculate the Freezing Index and Thawing Index for a "typical" pavement and location is shown in the Example on page 6.

The above criterion for duration of load restrictions results in a restriction period of about two to four weeks for areas with Freezing Indexes of 400°F-days and about six to eight weeks for areas with Freezing Indexes of 2,000°F-days.

EXAMPLE OF DATA COLLECTION AND ESTIMATION OF START AND DURATION FOR IMPOSING LOAD RESTRICTIONS

Location:
- Mansfield, Washington (central Washington state)
- Winter of 1985-1986
- Pavement section typically restricted during spring thawing
- 2 inches bituminous surfacing
- 6 inches granular base
- Silty subgrade

High and low daily temperatures were collected daily throughout the freezing and thawing period to calculate freezing index, based on 32°, and thawing index based on 29°F (Table 3).

CALCULATING THE FREEZING INDEX

The freezing index is a measure of the amount and duration of temperature differences during the freezing period. The freezing index is calculated using the following equation:

$$FI = \Sigma (32 - T)$$

where:

Σ = the sum of

T = average daily temperature = $1/2 (T_H + T_L)$ in °F,

T_H = maximum daily temperature (°F), and

T_L = minimum daily temperature (°F).

The temperature data collected for Mansfield to identify the freezing period and the freezing index are shown in Table 3.

STEPS:

1. When T becomes less than or equal to 32°F for several days, the freezing season begins. The freezing season for 1985 began on November 9.

2. The average daily temperature is equal to

   T = 1/2(column 3 + column 4)

   On November 13, for example:

   T = 1/2(35 + 7) = 21°F

3. The freezing degree-days per day (column 6) is equal to

   Daily FI = 32 - T (from column 5)

   For November 13, for example:

   Daily FI = (32 - 21) = 11°F-days

4. The Freezing Index is the accumulation of daily freezing degree days from the start of freezing

   FI = Σ (32 - T) from the start of freezing

For November 13, for example:

$FI = (3 + 7 + 9 + 8 + 11) = 38$°F-days

5. The end of the freezing season is near for pavements when the average daily air temperatures (column 5) in spring go above 29°F for several days, causing thawing of the pavement to begin. The thawing season for Mansfield during 1986 began on February 24 (refer to Table 3). The freezing index for the entire freezing season from November 9 to February 23 was

$FI = \Sigma (32 - T)$

$FI = (3 + 7 + 9 + 8 + \ldots +$
24 (February 21) +
18 (February 22) +
10 (February 23))

FI = 1375°F-days

A review of the temperature data in Table 3 shows that four thawing periods occurred during January and February. Three of these periods were followed by freezing periods, thus canceling any cumulative thawing effects (approximately) and reducing the cumulative freezing effects as well.

ESTIMATING THE TIME TO PLACE LOAD RESTRICTIONS

The pavement consists of 2 inches of asphalt concrete on 6 inches of aggregate base. This is classified as a thin pavement. The "should" level for placing load restrictions for thin pavements is

TI_{29} should restrict = 10°F-days

The thawing season starts on February 24.

TI_{29} = 9 (February 24) +
14 (February 25)

= 23°F-days

The load restrictions should be placed by February 26.

TI must restrict = 40°F-days

The "must" level for restricting a thin pavement is

TI_{29} = 9 (February 24) +
14 (February 25) +
11 (February 26) +
7 (February 27)

= 41°F-days

The load restrictions must be placed by February 28.

The earlier thaw period (January 31 to February 7) could have been used to start load restrictions. However, this would have been somewhat premature since this period was followed by more freezing weather. As with any criterion, judgment must be used. For this location (Mansfield, Washington), the normal thaw period starts during the last week of February or the first week of March.

ESTIMATING THE LENGTH OF LOAD RESTRICTIONS

The duration may be estimated in days or in thawing degree-days. It is better to estimate the duration of the thawing period using the thawing index based on 29°F.

To estimate the number of thawing degree days required for the restricted period the equation is:

$TI_{29} = 4.154 + 0.259$ (FI)

TI_{29} = 4.154 + 0.259 (1375°F-days)

= 360°F-days

On March 28, the TI_{29} (column 9) is 347°F-days

On March 29, the TI_{29} is 368°F-days

Therefore, the load restrictions should be removed by about March 30.

The simpler approximate equation for the thawing degree-days required for the restricted period which may be used in place of the above equation is:

$$TI_{29} = 0.3\ (FI)$$

$$TI_{29} = 0.3\ (1375°F\text{-days})$$

$$= 412°F\text{-days}$$

On March 31, the TI_{29} is equal to 412°F-days. Therefore, the load restrictions should be removed by April 1.

Day	Month/ Year	Measured Daily Air Temperature (° F)		Average Daily Air Temperature, (°F)	Daily Freezing Index = 32° F - Avg. Daily Temp. (see note) (° F - days)	Sum of Daily Freezing Index (°F-days)	Daily Thawing Index = Avg. Daily Temp. - 29° F. (see note) (° F - days)	Sum of Daily Thawing Index (°F-days)
		High	Low	$\left(\frac{\text{High} + \text{Low}}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
1	Nov., '85	43	24	34				
2	" "	51	29	40				
3	" "	55	26	40				
4	" "	60	35	48				
5	" "	50	30	40				
6	" "	50	30	40				
7	" "	54	25	40				
8	" "	50	18	34				
9	" "	45	13	29	3	3		
10	" "	40	10	25	7	10		
11	" "	35	11	23	9	19		
12	" "	40	8	24	8	27		
13	" "	35	7	21	11	38		
14	" "	33	4	18	14	52		
15	" "	30	4	17	15	67		
16	" "	32	7	20	12	79		
17	" "	26	5	16	16	95		
18	" "	35	10	22	10	105		
19	" "	20	-6	7	25	130		
20	" "	16	-6	5	27	157		
21	" "	14	-4	5	27	184		
22	" "	14	0	7	25	209		
23	" "	12	-8	2	30	239		
24	" "	11	-8	2	30	269		
25	" "	10	-12	-1	33	302		
26	" "	10	-8	1	31	333		
27	" "	16	-8	4	28	361		
28	" "	13	-8	2	30	391		
29	" "	11	-8	2	30	421		
30	" "	27	-8	10	22	443		

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

Figure A-1. Worksheet for Bituminous Surfaced Pavements.

Day	Month/ Year	Measured Daily Air Temperature (° F)		Average Daily Air Temperature, (°F)	Daily Freezing Index = 32° F - Avg. Daily Temp. (see note) (° F - days)	Sum of Daily Freezing Index (°F-days)	Daily Thawing Index = Avg. Daily Temp. - 29° F. (see note) (° F - days)	Sum of Daily Thawing Index (°F-days)
		High	Low	$\left(\frac{\text{High} + \text{Low}}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
1	Dec., '85	17	-8	4	28	471		
2	" "	8	-8	0	32	503		
3	" "	18	2	10	22	525		
4	" "	24	8	16	16	541		
5	" "	34	12	23	9	550		
6	" "	34	12	23	9	559		
7	" "	34	16	25	7	566		
8	" "	34	14	24	8	574		
9	" "	34	20	27	5	579		
10	" "	26	12	19	13	592		
11	" "	20	2	11	21	613		
12	" "	22	12	17	15	628		
13	" "	26	-4	11	21	649		
14	" "	23	-3	10	22	671		
15	" "	22	-2	10	22	693		
16	" "	20	-3	8	24	717		
17	" "	20	2	11	21	738		
18	" "	30	2	16	16	754		
19	" "	25	10	18	14	768		
20	" "	28	18	23	9	777		
21	" "	26	18	22	10	787		
22	" "	24	14	19	13	800		
23	" "	24	18	21	11	811		
24	" "	22	16	19	13	824		
25	" "	22	14	18	14	838		
26	" "	21	12	16	16	854		
27	" "	21	14	18	14	868		
28	" "	18	14	16	16	884		
29	" "	20	12	16	16	900		
30	" "	20	12	16	16	916		
31	" "	20	10	15	17	933		

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

Figure A-1. Worksheet for Bituminous Surfaced Pavements (cont.).

Day	Month/ Year	Measured Daily Air Temperature (° F)		Average Daily Air Temperature, (°F)	Daily Freezing Index = 32° F - Avg. Daily Temp. (see note) (° F - days)	Sum of Daily Freezing Index (°F-days)	Daily Thawing Index = Avg. Daily Temp. - 29° F. (see note) (° F - days)	Sum of Daily Thawing Index (°F-days)
		High	Low	$\left(\frac{\text{High} + \text{Low}}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
1	Jan., '86	27	5	16	16	949		
2	" "	34	0	17	15	964		
3	" "	26	6	16	16	980		
4	" "	28	9	18	14	994		
5	" "	28	9	18	14	1008		
6	" "	30	12	21	11	1019		
7	" "	26	8	17	15	1034		
8	" "	30	10	20	12	1046		
9	" "	40	16	28	4	1050		
10	" "	37	28	32	0	1050	3	3
11	" "	39	20	30	2	1052	1	4
12	" "	34	16	25	7	1059	-4	0
13	" "	32	10	21	11	1070		
14	" "	18	18	18	14	1084		
15	" "	26	14	20	12	1096		
16	" "	27	20	24	8	1104		
17	" "	36	26	31	1	1105	2	2
18	" "	46	30	38	-6	1099	9	11
19	" "	40	30	35	-3	1096	6	17
20	" "	40	21	30	2	1098	1	18
21	" "	40	21	30	2	1100	1	19
22	" "	40	12	26	6	1106	-3	16
23	" "	34	22	28	4	1110	-1	15
24	" "	41	20	30	2	1112	1	16
25	" "	32	6	19	13	1125	-10	6
26	" "	26	6	16	16	1141	-13	--
27	" "	28	16	22	10	1151		
28	" "	31	24	28	4	1155		
29	" "	30	20	25	7	1162		
30	" "	34	24	29	3	1165	0	0
31	" "	38	30	34	-2	1163	5	5

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

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		High	Low	$\left(\frac{\text{High} + \text{Low}}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
1	Feb., '86	36	32	34	-2	1161	5	10
2	" "	40	26	33	-1	1160	4	14
3	" "	34	30	32	0	1160	3	17
4	" "	38	30	34	-2	1158	5	22
5	" "	37	27	32	0	1158	3	25
6	" "	36	25	30	2	1160	1	26
7	" "	40	18	29	3	1163	0	26
8	" "	32	10	21	11	1174	-8	18
9	" "	32	20	26	6	1180	-3	15
10	" "	28	16	22	10	1190	-7	8
11	" "	30	14	22	10	1200	-7	1
12	" "	32	15	24	8	1208	-5	--
13	" "	32	7	20	12	1220		
14	" "	29	11	20	12	1232		
15	" "	30	15	22	10	1242		
16	" "	29	12	20	12	1254		
17	" "	30	11	20	12	1266		
18	" "	29	15	22	10	1276		
19	" "	30	-8	11	21	1297		
20	" "	23	-10	6	26	1323		
21	" "	21	-6	8	24	1347		
22	" "	28	0	14	18	1365		
23	" "	34	10	22	10	1375		
24	" "	45	32	38	--	--	9	9
25	" "	48	38	43			14	23
26	" "	48	32	40			11	34
27	" "	48	24	36			7	41
28	" "	48	26	37			8	49

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

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		High	Low	$\left(\frac{\text{High} + \text{Low}}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
1	Mar., '86	43	25	34			5	54
2	" "	48	22	35			6	60
3	" "	40	20	30			1	61
4	" "	46	24	35			6	67
5	" "	47	21	34			5	72
6	" "	46	24	35			6	78
7	" "	47	29	38			9	87
8	" "	49	30	40			11	98
9	" "	50	30	40			11	109
10	" "	52	31	42			13	122
11	" "	40	33	36			7	129
12	" "	52	32	42			13	142
13	" "	52	25	38			9	151
14	" "	45	20	32			3	154
15	" "	53	26	40			11	165
16	" "	53	26	40			11	176
17	" "	54	26	40			11	187
18	" "	54	32	43			14	201
19	" "	56	31	44			15	216
20	" "	57	32	44			15	231
21	" "	62	35	48			19	250
22	" "	50	32	41			12	262
23	" "	47	34	40			11	273
24	" "	54	30	42			13	286
25	" "	50	30	40			11	297
26	" "	52	34	43			14	311
27	" "	52	36	44			15	326
28	" "	58	42	50			21	347
29	" "	58	41	50			21	368
30	" "	59	40	50			21	389
31	" "	60	43	52			23	412

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

Figure A-1. Worksheet for Bituminous Surfaced Pavements (cont.).

Day	Month/ Year	Measured Daily Air Temperature (° F)		Average Daily Air Temperature, (°F)	Daily Freezing Index = 32° F - Avg. Daily Temp. (see note) (° F - days)	Sum of Daily Freezing Index (°F-days)	Daily Thawing Index = Avg. Daily Temp. - 29° F. (see note) (° F - days)	Sum of Daily Thawing Index (°F-days)
		High	Low	$\left(\frac{High + Low}{2}\right)$				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9

Note: Calculate Daily Freezing Index starting at the beginning of the freezing season and accumulate throughout the normal freezing period. The air temperature datum for Freezing Index is 32°F and 29°F for Thawing Index. The Thawing Index period for much of the U.S. will start in late February to April.

Worksheet for Bituminous Surfaced Pavements.

REFERENCES

1. Rutherford, M.S., Mahoney, J.P., Hicks, R.G. and Rwebangera, T., "Guidelines for Spring Highway Use Restrictions," Final Report, Washington State Department of Transportation, Olympia, Washington, August 1985.

2. _____, "The AASHO Road Test, Report 5, Pavement Research," Special Report 61E, Highway Research Board, Washington, D.C., 1962.

3. _____, "AASHTO Interim Guide for Design of Pavement Structures - 1972," American Association of State Highway and Transportation Officials, Washington, D.C., 1981.

* U.S.Government Printing Office: 1987 0-181-763 (40185)