Report Number CDOH-P&R-R&SS-72-6

styrofoam highway insulation on colorado mountain passes

Robert L. Hayden
Herbert N. Swanson
Planning and Research Division
Colorado Division of Highways
4201 E. Arkansas Avenue
Denver, Colorado 80222

March 1972

FINAL REPORT

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STYROFOAM HIGHWAY INSULATION
ON
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ABSTRACT

Styrofoam "HI" has been found to be effective in eliminating frost heaving on Colorado's mountain passes. The cost of installing two inch thick Styrofoam is approximately $1000 per hundred feet of two lane roadway when installation is done by maintenance forces and excavation and replacement of materials is necessary.

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STYROFOAM HIGHWAY INSULATION ON COLORADO'S MOUNTAIN PASSES

INTRODUCTION

Frost heaving has long been a problem on Colorado's mountain passes, where air freezing indices of approximately 2000°F days are encountered during the winter season.(1) Heaving of as much as six inches has occurred in some locations, and when it reaches this magnitude, safety to traffic is endangered and snow removal operations are impeded. Subexcavation and backfilling with granular material had been tried as a corrective measure, but met with only limited success.

Since other states and local governments had reported successful results with Dow Styrofoam "HI" Highway Insulation, it was decided to try this material in Colorado. Two locations were chosen where heaving had been found to be particularly severe: Vail Pass in central Colorado and Wolf Creek Pass in the southwestern part of the State.

A detailed analysis of the mechanics of frost heaving is beyond the scope of this report. Instead, the results have simply been presented in hope they will be of value to other agencies interested in doing further work along this line.

VAIL PASS TEST SITE

The Styrofoam test section on Vail Pass is located on U. S. Highway 6 approximately two miles west of Wheeler Junction. The insulated section is 200 feet long. It is shown in cross section in Figure 1 on the following page.

(1) The air freezing index for one day is the difference between the average temperature for that day and 32°F. If the average temperature is above 32°, the index is assumed to be zero for that day. The index for an entire season is determined by adding together the indices for all the days in the season.

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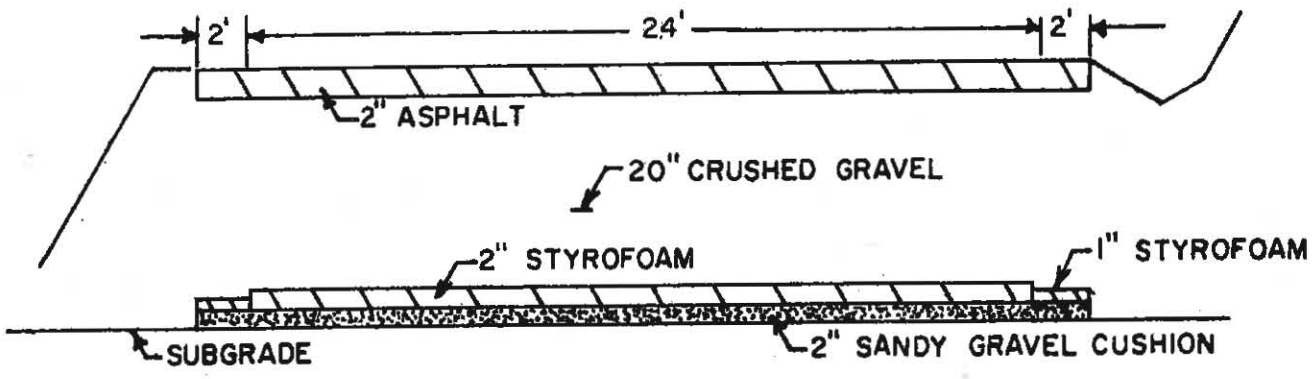

FIGURE 1

Installation was completed in August 1970 by Colorado Division of Highways maintenance personnel. The asphalt pavement and base were removed to a depth of 24 inches below the original pavement level. The exposed material consisted of a rocky clay having a moisture content of 5.5% and below the clay was a fine sand with 14.8% moisture.

A two inch thick sandy gravel cushion was placed on the subgrade and the Styrofoam was placed on the cushion. The Styrofoam was then covered with 20 inches of crushed gravel, care being taken not to damage or move the Styrofoam. The test section was finished with a two inch layer of asphalt pavement. The construction procedure is shown in Figures 2 through 5.

While the Styrofoam was being installed, provision was made for the later insertion of temperature sensing probes. Three sections of plastic tubing were placed with one end beneath the centerline of the roadway and the other end running out to the ditch. The ends beneath the centerline were located, respectively, immediately above the Styrofoam, immediately below the Styrofoam, and one foot below the Styrofoam. Bacharach Instrument Company #14-0068 Tempscribes were placed in a shelter box mounted on a pole several feet from the roadway. The Tempscribe probes were inserted into the plastic tubing so that the temperature could be read at the three depths beneath the centerline.

VAIL PASS TEST SITE
Styrofoam Highway Insulation

Figure 2

2 Inch Sandy Gravel Cushion on Top of Subgrade prior to placement of Styrofoam Insulation.

Figure 3

Hand Placement of Insulation on 2 Inch Cushion of Sandy Gravel.

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VAIL PASS TEST SITE
Styrofoam Highway Insulation

Figure 4

Insulation In Place Before Application of Crushed Gravel.

Figure 5

Dumping Crushed Gravel Followed by Blade Working Material on to Styrofoam.

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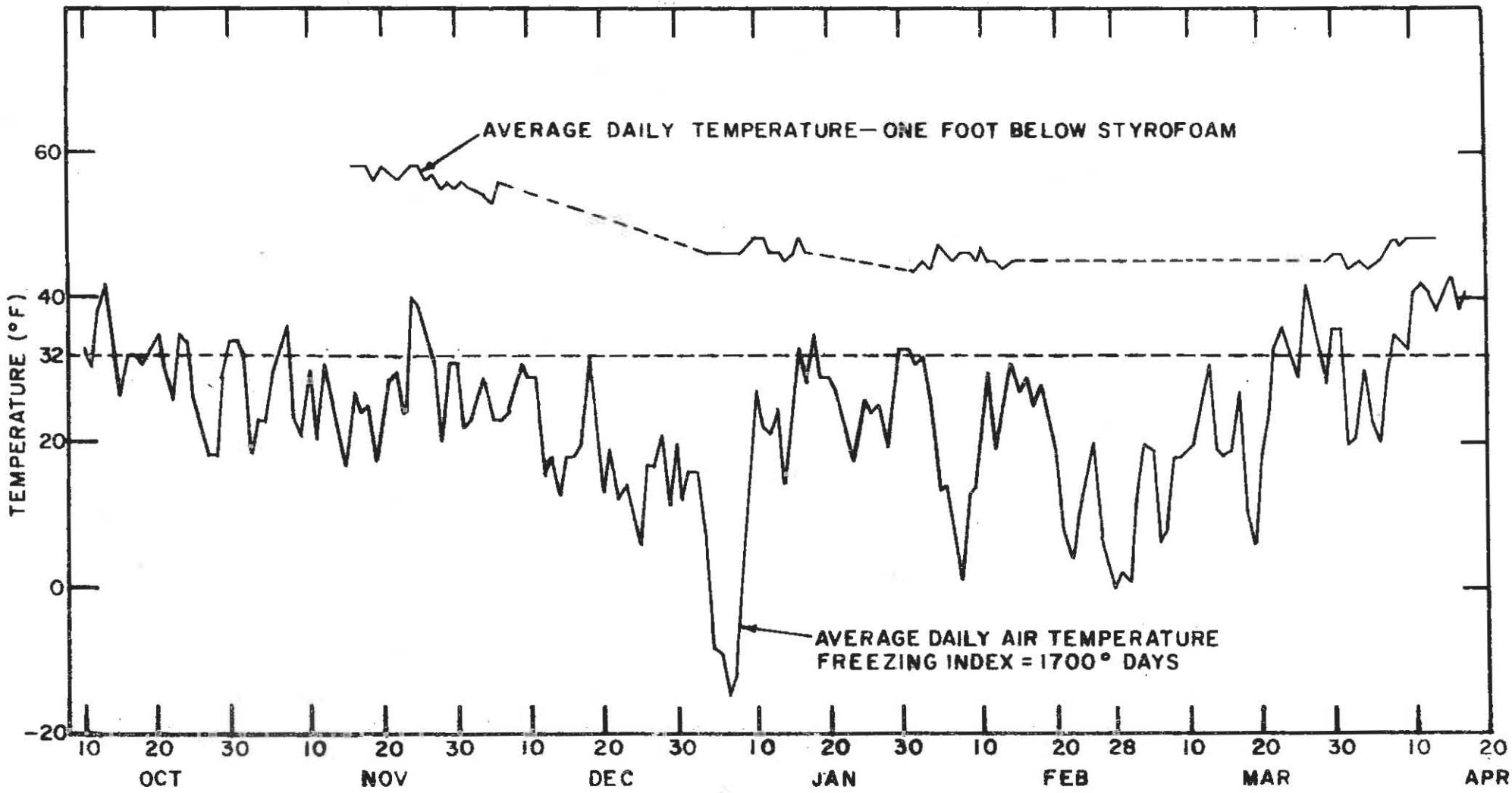

FIGURE 6
VAIL PASS TEST SITE
WINTER 1970-1971

The Tempscribe charts were changed every two weeks by the maintenance crew that worked on the pass, and the results were sent directly to the Colorado Division of Highways central office in Denver.

Difficulty was encountered with the Tempscribes. The ones reading immediately above and immediately below the Styrofoam appeared to have gotten out of calibration, and unfortunately, this was not realized until the end of the freezing season when all data was available for analysis. The clock drive mechanism also malfunctioned sometimes during extremely cold weather, and it is likely that the maintenance crew forgot to wind the clocks occasionally. The average daily air temperature and the average daily temperature one foot below the Styrofoam are plotted in Figure 6. The difference between the daily high and low temperature one foot below the insulation never varied by more than one or two degrees.

The Styrofoam placed on Vail Pass was effective in reducing frost heaving to a negligible level. The 200 foot long test section had been located over an area 50 feet long that had heaved severely in previous years. The only problems encountered was severe heaving at the ends of the section. This probably would have been prevented by constructing 25 foot long transition sections of one inch thick Styrofoam at both ends.

WOLF CREEK PASS TEST SITE

The Styrofoam test section on Wolf Creek Pass is located on U. S. Highway 160, approximately one-half mile west of the summit. The insulated section is 150 feet long and is shown in Figure 7.

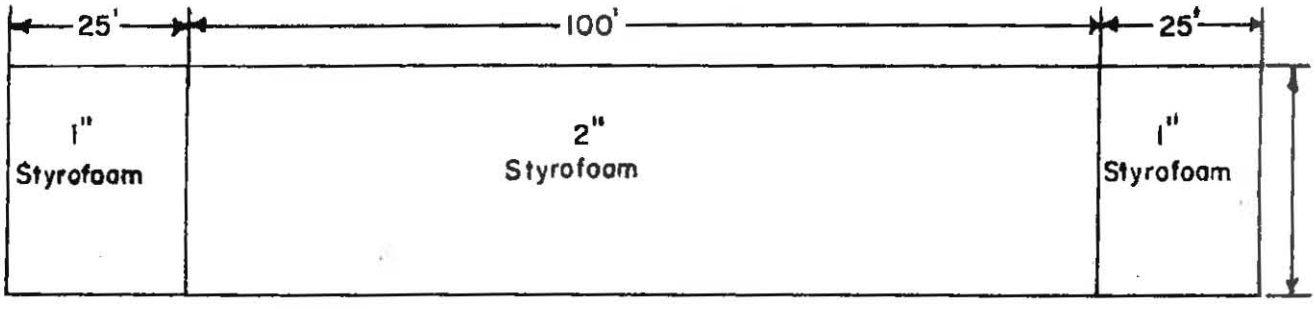

FIGURE 7

Installation was done in August 1970 by Colorado Division of Highways maintenance personnel. The pavement and base course were excavated to a depth of 15 inches. Deeper excavation was done in three locations to obtain a soil profile. The following profile was obtained.

0.0 feet - 0.25 feet	Asphalt pavement
0.25 feet - 0.50 feet	Crushed gravel
0.50 feet - 1.5 feet	Pit run gravel
1.5 feet - 3.5 feet	Yellow sandy clay
3.5 feet - 7.5 feet	Blue gray sandy clay
7.5 feet	Hard rock

Two inches of sand was placed on the subgrade, followed by the Styrofoam, four more inches of sand, four inches of crushed gravel, and three inches of asphalt pavement. A section through the two inch Styrofoam area is shown in Figure 8.

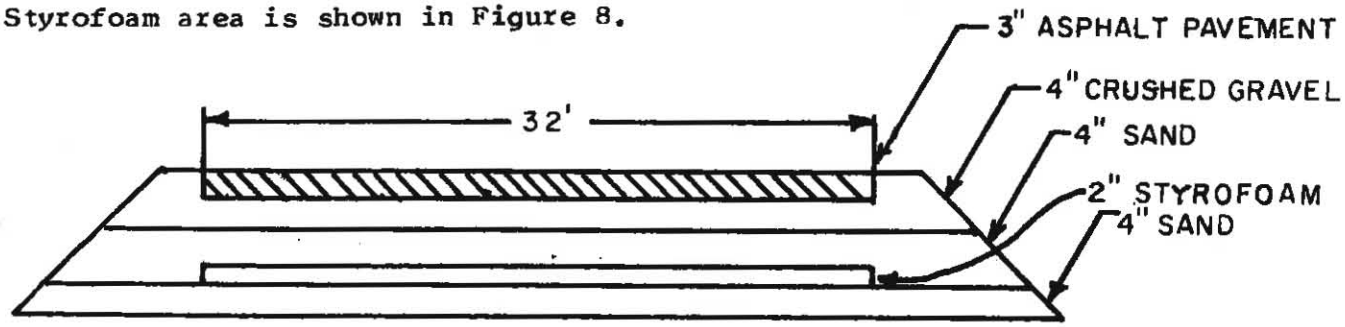

FIGURE 8
WOLF CREEK PASS CROSS SECTION

As was done at the Vail Pass test site, plastic tubing was installed for the insertion of Tempscribe probes. The probes were placed beneath the center of the two inch Styrofoam and located nine feet from the centerline of the roadway. Probe depths were immediately above the Styrofoam, immediately below, and one foot below. Better luck was experienced with the clock drive mechanisms on Wolf Creek Pass. The results are shown in Figure 9.

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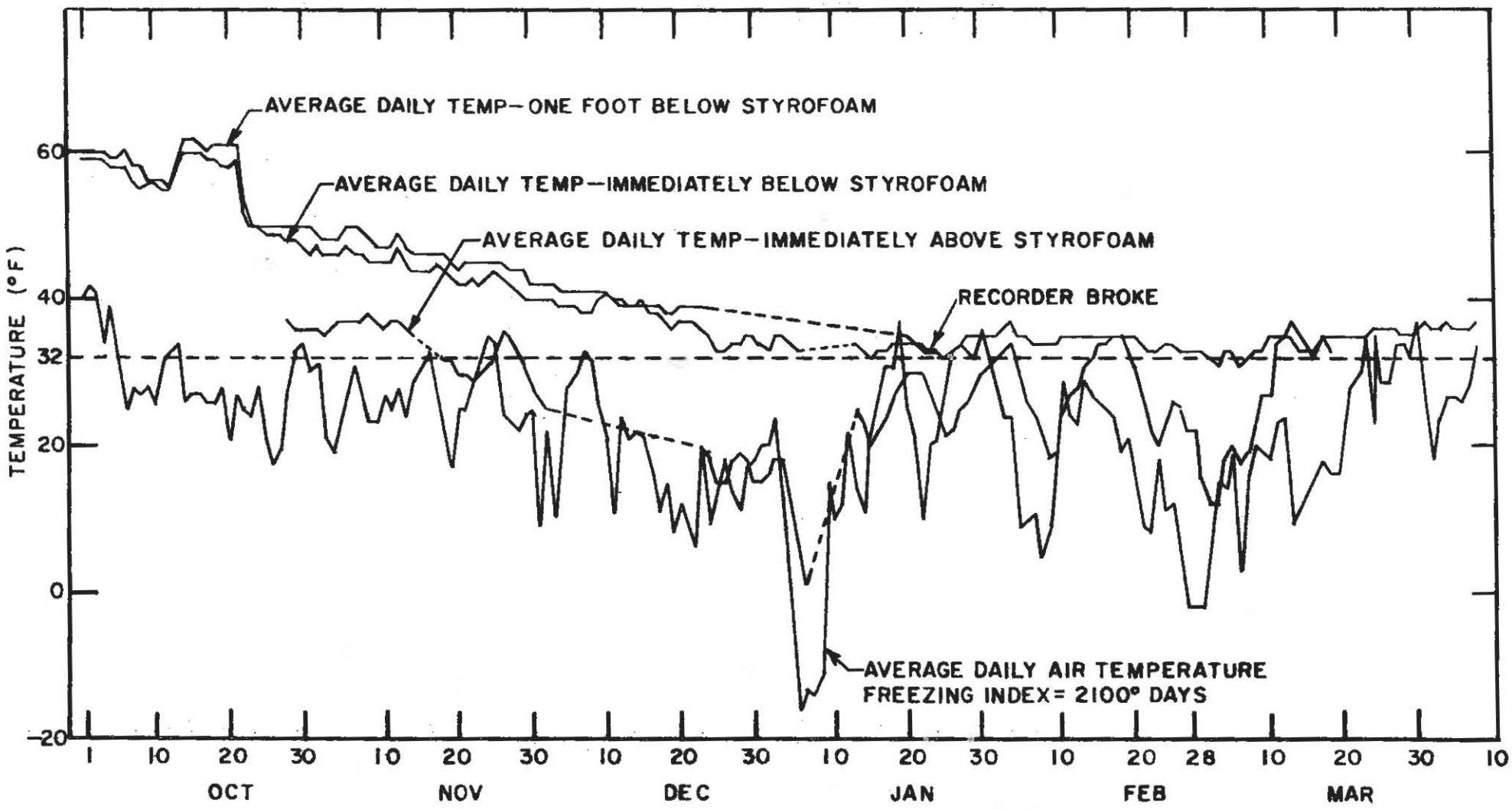

FIGURE 9
WOLF CREEK PASS TEST SITE
WINTER 1970–1971

The Styrofoam insulation on Wolf Creek Pass was very effective in reducing frost heaving. Elevations had been taken at the test location during the winter before installation and heaving of as much as six inches was found. After installation, heaves were less than one-half inch. The 25 foot long transition of one inch Styrofoam at the east end solved the problem encountered on Vail Pass where no transition was used. Some heaving was found at the west end, apparently because the test section was not long enough to cover the entire area where the most severe heaving had been encountered.

CONCLUSIONS

Styrofoam "HI" is effective in reducing frost heaving to an insignificant amount on Colorado's mountain passes. It can be used as an alternative to subexcavation and backfilling with granular material at the discretion of the engineer.

For a winter season with a freezing index of approximately 2100 degree days, and assuming at least one foot of cover over the insulation, two inches of Styrofoam appear to be adequate to prevent freezing of the subgrade. This design is probably adequate for any highway in Colorado below the 12,000 foot altitude.

A 25 foot transition zone of one inch thick Styrofoam should be included at both ends of a Styrofoam installation, and care should be taken that the transition runs beyond the area where the most severe heaving has been encountered.

During periods of snowfall when the temperature is near freezing, snow is apt to accumulate on the insulated sections before it begins to stick to the rest of the road. Also, snow and ice melt somewhat more slowly from insulated areas. Preferential icing of insulated sections has not been found to be a problem, probably because of Colorado's low humidity.

LIST OF FIGURES