

**SNOW AND ICE CONTROL
BY PAVEMENT HEATING**

A PROGRESS REPORT

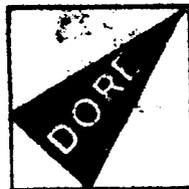
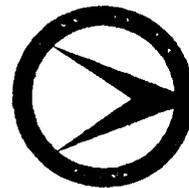
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The intent of this report is to summarize the progress which the Division of Research and Evaluation of the New Jersey Department of Transportation has made in the field of snow and ice control by means of a heated pavement.

Prior work by the Department of Transportation resulted in the construction of two electrically heated pavements both of which utilized copper sheathed, mineral insulated resistance wires. The first of these was installed in 1961 on the approach to a drawbridge on the Route 1 and 9 truck route. This installation was later abandoned due to dislodgement of the heating cables. The second installation was built in 1964 on two ramps and the bridge deck at the Route U.S. 46 and 17 interchange and is still operating successfully.

Our present research has been primarily concerned with finding a more economical source of heat energy in place of conventional organic fuels or electricity. Toward this goal we have concentrated on the possibility of using the heat available in the earth, either below or adjacent to roads and bridges. At a depth of ten feet the soil temperature averages 50°F with a seasonal variation of $\pm 7^\circ\text{F}$ with the minimum occurring in March or April. At deeper depths the temperature gradually increases with depth and exhibits even less seasonal variation.

In order to investigate the feasibility of utilizing the heat source and to study other factors related to pavement heating, we have designed and prepared plans and specifications for the construction of an experimental test installation.

The test area will be located in a parking lot adjacent to a recent addition to the Transportation Department Building in Trenton, New Jersey. This area will consist of two parallel sections of pavement, each 13 feet wide and 123 feet long. One section will be constructed of 9 inch thick slabs of Portland Cement Concrete and the other will be a heavy duty Bituminous Concrete pavement.

Each of these sections will be divided into four panels, each approximately 30 feet long, for a total of eight test panels. Each test panel will contain various heating elements and will be completely independent of the other panels.

Pipes will be embedded in the concrete of Panels #1, #2, #3, #4, #5, and #6 at a depth of 2 inches and 4 inches. These pipes will be spaced at 6 inch, 12 inch and 18 inch intervals in each panel, however, the pipe diameter will vary from 3/4" to 1" to 1-1/4" in the various panels.

All pipes will be standard weight, wrought iron except in Panel #3 where a PVC plastic pipe will be embedded in the Portland Cement Concrete slab. This design should permit us to evaluate the many variables associated with an embedded pipe type heated pavement and to find the best combination of pipe size, spacing and material for any given condition.

In addition there will be two panels (#7 and #8) which will contain vinyl insulated, electric resistance wires, designed to dissipate 20, 40, and 60 watts/ft.² These sections will serve as a reference standard for the other panels during snow conditions. Furthermore, there will be a 2 inch layer of insulation directly below part of the electrical heated Portland Cement Concrete slab, in order to test the effectiveness of insulation in reducing downward heat losses.

Prior to the pavement construction, a 90 foot length of the subgrade, below the test area, will be excavated to a depth of 13 feet. Into this pit will be placed 6000 linear feet of 1-1/4" wrought iron pipe constructed in five layers with a 2 foot separation between each layer. As each layer of pipe is placed the pit will be backfilled and compacted.

This network of pipes will be the means by which we can tap the heat available in the earth. By circulating a water-ethylene glycol solution through these pipes and then to the pipes embedded in the pavement, it should be possible to transfer sufficient heat from the earth, for snow melting purposes.

To increase the amount of heat available, this system would be operated during the summer months thus transferring heat from the hot pavements to the earth below.

Unfortunately, during the period between summer and snow season, much of the heat may be lost to the surrounding earth or to the atmosphere. To reduce this heat loss, we have provided for an 8 inch layer of a polystyrene insulation above and enclosing part of the buried network of pipes. This same type insulation has previously been used beneath roads to prevent frost penetration below the subbase.

Future research with our experimental system may involve the use of a heat pump. This device is capable of extracting heat from a source and discharging this heat at a higher more useful temperature. The heat pump could be utilized by any of the following means.

1. Heat might be extracted from the atmosphere and transferred by means of a liquid to the heating pipes embedded in a roadway.
2. Heat might be extracted from the atmosphere and then transferred by a liquid, via the buried pipes, for storage in the earth. This method offers the advantage of using a small heat pump, which would gradually replenish the heat in the storage volume.
3. The heat pump could use the earth as a heat source utilizing the buried pipes as the heat exchanger. This method may be useful if the temperature of the earth is not sufficiently high for snow melting purposes.
4. A heat pump, using either the atmosphere or earth as a source, could supply heat for storage, utilizing the heat of fusion of an appropriate liquid. Such a system offers the advantage of storing large amounts of heat in relatively small volumes.