Linseed Oil for Protection of Concrete Surfaces

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THE PROBLEM of protecting concrete surfaces from the ravages of winter is as old as the use of concrete itself. In spite of its smooth, rock-hard appearance, small, almost microscopic pores exist in the top surface, through which moisture may enter.

When the atmospheric temperature is above the freezing point, this moisture evaporates rapidly as soon as drying conditions prevail and does no measurable damage to the surface.

At lower temperatures however water in the pores freezes and remains in the solid state until the temperature rises to permit thawing. Several freeze-thaw cycles may occur during an average winter day. Since water expands on freezing, the effect of repeated freeze-thaw cycles is to initiate scaling and later spalling of the top surface. This is particularly true for concrete less than four years old.

The problem is aggravated by the use of most de-icing agents, which react with concrete and markedly accelerate the deterioration process. Thirty-eight states in the snow belt as well as many counties, cities, townships, and villages within their borders now use salt for winter maintenance of highways, streets, and sidewalks. During the 1960–61 winter season an estimated two million tons of salt were used for this purpose. This total will increase in the next few years as the trend is toward the use of more salt and less sand and cinder abrasives. Less labor is required in spreading the salt, and there is not the subsequent problem of cleaning gutters and unblocking sewers.

However effective this use of salt may be in facilitating the safe movement of traffic through ice and snow, the problem of deterioration of concrete pavements which its use entails is a serious one indeed. The scaling and pitting which beset sections of concrete roads, bridge decks, parking ramps, curbs, sidewalks, and other concrete surfaces, often after a single winter, graphically point up a problem which urgently demands a solution.

Suggested Remedies

Air-Entrained Concrete. Prominent among the corrective measures suggested is the use of air-entrained concrete. This contains myriads of tiny air bubbles distributed more or less evenly throughout the mass, which help to inhibit scaling and spalling due to freeze-thaw cycles and the use of de-icing chemicals. Today practically all new concrete highway construction employs air-entrained concrete.

Whether even this, without added surface protection, can withstand the various disintegrating factors to which it is exposed during the winter is debatable. The average motorist may observe cases where sections of roadway, curbing, bridge deck, or parking ramp floor have failed. It is increasingly common to see sections of concrete road, particularly bridge decks, resurfaced with asphaltic black-top. This is, of course, a costly expedient and not necessarily a permanent solution. The black-top surface itself is subject to rutting, particularly in hot weather, and, unless extreme care is exercised in the original application, it may peel away from the concrete base.

While plausible explanations may be offered when air-entrained concrete fails in service, such as incorrect quantity of entrained air, improper formulation, inferior quality of aggregate, excessive trowelling of the top surface, etc., the fact remains that failures occur often enough to be a source of serious concern to highway maintenance engineers. While more vigilant inspection at the time of placing the concrete may obviate some of these difficulties, it would add to the cost and could not eliminate the ever-present possibility of human error.

Protective Coatings. A harmless, easily-applied, low-cost material, which can be applied in thin coats to seal the pores of the concrete and thus prevent the entrance of water and corrosive solutions, would appear to offer a practical means of correcting the trouble at its source. Various protective-coating substances have been suggested among them linseed oil, synthetic resins, silicates, and silicones. One major manufacturer of synthetic resins has recently undertaken an advertising campaign in national magazines to call public attention to the problem and to highlight the need for winter roadway protection.

The water-repellency characteristics of linseed oil films suggested many years ago its application for the purpose. The Portland Cement Association (1,2) and the Salt Institute (3) have pointed out the value of linseed oil as a protective coating for nonair-entrained concrete. Gonnerman (4) comments on the effectiveness of boiled linseed oil in protecting nonair-entrained concrete. A number of state, county, and municipal highway departments have used and are still using linseed oil for both types of concrete.

Increased usage of air-entrained concrete has diverted attention from the use of linseed oil for protective purposes. However, with more salt being used on roads each year, the subject seems worthy of reappraisal.

Economics of Linseed Oil Protection

Modern superhighways are expensive. Costs may vary from $1,000,000 per mile over flat rural terrain to more than $10,000,000 per mile within a large city. The price of the concrete paving alone is a substantial factor. It may vary from $5.50 per square yard in rural areas, reasonably adjacent to a supply of raw materials, to $13 per square yard on a bridge deck in a metropolitan area.

To apply a protective coating of linseed oil would cost around 3¢ per square yard for materials. While application costs can vary, it has been estimated that this will not exceed an additional 3¢ per square yard when readily-available, efficient, spreading equipment is used.

Method of Application of Linseed Oil

Boiled linseed oil is preferred to raw oil because of its more rapid drying and film-forming characteristics. To decrease the viscosity and facilitate spreading it is customary to mix the oil with an equal volume of mineral spirits. The mixture may be applied "as is" or may be emulsified with water.

When the straight mixture is used, it is customary to apply two coats, the first at .025 gal. per sq. yd. When this has thoroughly dried, it is followed by a second coat applied at the rate of .015 gal. per sq. yd.

When the water emulsion is used, the emulsion must be prepared in advance and kept under agitation to avoid separation during use. Two coats are recommended, applied at a rate adjusted to give the same approximate amounts of oil per coat as those suggested above.

The Iowa State Highway Commission (5) suggests the following formula for the emulsion:

Boiled linseed oil	.054 gal.
Kerosene	.054 gal.
Soap powder	.030 lb.
Trisodium phosphate	.040 lb.
Water	.892 gal.

This is only one of many practical formulas and should not be construed as limiting the ingredients or proportions.

For roads it is customary to use an asphalt spreader to apply the oil or emulsion, as the case may be. When a spreader which previously contained asphaltic materials is used, care must be taken to remove all asphalt residues completely to avoid discoloring the pavement. For smaller areas, such as sidewalks, driveways, parking ramps, etc., a portable type of spray equipment may be used.

Local conditions usually dictate whether it is preferable to use the emulsion or the straight mixture. Each has advantages, the most important of which are listed below. With the emulsion, greater volume of fluid applied probably insures more complete coverage; where wind losses are

likely to be high, the relative oil loss is less. The straight mixture is easily prepared and may be purchased directly from the supplier. It can be used at lower temperatures. The emulsion dries slowly below 60°F. whereas the straight mixture can be applied at temperatures as low as 40°F.

Miscellaneous Uses

Linseed oil has been recommended for the preservation of concrete structures, such as dams, silos, etc. Mortar applied pneumatically to the surface of such structures may be preserved by the application of two coats of linseed oil (6). Garage floors and driveways around private homes, subject to attack by salt solutions dripped from the fenders and the underside of automobile bodies, may be protected by linseed oil treatment, preferably before the first winter after placement. The same considerations apply to concrete steps and walkways around residences, where rock salt is used for de-icing.

Recent Applications of Linseed Oil

ROADS

Illinois Toll Road. Three sections now under test, including a section of straight road and two curved sections at interchanges. Second winter.

Interstate 94. Section at the Minnesota-North Dakota boarder, Fargo-Moorehead. First winter.

Ontario, Canada, Department of Highways. Eighteen miles of Highway 40, near Rockville, Ontario. Second winter. Another comparable section of Highway 401 near Ottawa. First winter.

Mt. Lebanon Township, Pa. Fifteen miles of concrete streets and roadways. First winter.

BRIDGE DECKS

Illinois Toll Road. Bridge deck 5/8 of a mile in length at O'Hare Airport Interchange. Second winter.

Calumet Expressway. Bridge over Little Calumet River, south of Chicago. Northbound section in third winter. Southbound section in second winter.

SIDEWALKS

Montreal, Quebec, Canada, Department of Public Works. Linseed oil treatment specified on new installations, following two years of experimentation with several types of protective agents.

Mt. Lebanon Township, Pa. Linseed oil emulsion treatment specified for all sidewalks and curbs which will be exposed to various chlorides.

AIRPORTS

United States Air Force Academy, Colorado Springs, Colo. Concrete parking aprons of Peterson Field treated with linseed oil. Third winter.

PARKING RAMPS

Garrick Ramp, St. Paul, Minn. Second winter.

As of November 1960 these roads and bridge decks, which had passed through one or more winters, were in good condition.

The Garrick Parking Ramp in St. Paul, Minn., was also in excellent condition. A similar parking facility (Victory Ramp), not treated with linseed oil, showed severe scaling and spalling in some areas after one winter on the exposed upper deck where salt was used, also in areas where salt solutions were carried from the outside streets on auto tires and the undersides of auto bodies.

REFERENCES

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