

COMMENTS ON LINSEED OIL TREATMENTS OF CONCRETE

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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INTRODUCTION

Studies by the Research Council and numerous other agencies, as well as experience covering almost forty years, clearly indicate that concrete with good resistance to scaling caused by deicer salts is achievable when the water-cement ratio is kept to 0.45 or less, the air entrainment is proper for the size of aggregates used, and the mixture is properly consolidated. Studies and experience over the same period have indicated that these factors are not consistently given the needed attention. Thus numerous treatments of pavement surfaces with water repellents to prevent deicer scalings have been developed, tested, and, for the most part, discarded as ineffective. These treatments vary widely in cost.

By far the most satisfactory such treatment in terms of the cost/benefit ratio is the application of linseed oil. The Guide to Durable Concrete prepared by Committee 201 of the American Concrete Institute states:

Most studies indicate that linseed oil is the best choice when both effectiveness and cost are considered. A mixture of 50 percent boiled linseed oil and 50 percent mineral spirits is normally used. It should be put on in two applications when the concrete surface is dry and clean. For estimating purposes, a coverage of 40 sq yd (33 sq m) per gallon for the first application and 65 sq yd (54 sq m) per gallon for the second application may be assumed. However, experience has shown that because of varying porosities of different concretes, the actual application rate should be determined from a test strip on each pavement. Applications which are too light or too heavy are to be avoided; both are ineffective in preventing scaling and the latter also adversely affects skid resistance. A linseed oil treatment should provide temporary protection (for 1 to 3 years), after which another application may be made if needed. (1)

RESEARCH COUNCIL REPORTS

The results of the Research Council's studies of linseed oil and other treatments are contained in five reports: references 2, 3, 4, 5, and 6.

These reports cover laboratory work, controlled applications to a pavement on I-64 east of Richmond and a bridge deck east of Charlottesville, and an evaluation of skid resistance on three sections of interstate treated with linseed oil. The Council has not conducted research on linseed oil since the early 1970's but has kept informed on the technology through the Transportation Research Board, American Concrete Institute, etc.

The major emphasis of these studies was on new construction rather than retreatment. There is no question but that linseed oil is the most cost-effective way of delaying the onset of scaling for concrete that has insufficient air or other scale-resisting properties. There is also sufficient evidence to conclude that the onset of scaling is most evident in the first several years and that with maturity of the concrete there is an increase in its resistance to scaling.

In the first of the above listed Council reports it was concluded that "This project has not progressed sufficiently to provide information on the need for retreatment, but the literature reviewed indicates the necessity for periodic retreatment."⁽²⁾

In the summary of studies on I-64 east of Richmond, the statement made is: "The air void characteristics are such that scaling is unlikely in either the treated or untreated sections."⁽²⁾ This has been borne out since the pavement is free of scaling and has not been retreated.

The ACI guideline suggests that initial protection lasts 1-3 years and that the concrete should be retreated, if needed.⁽¹⁾ The question is, "When is retreatment needed?" Two observations that can be documented are available for this determination.

1. Is there evidence of scaling during the 1st or 2nd year?
2. Is the air void system adequate (spacing factor, \bar{L} , determined by ASTM C457 equal to or less than 0.0080 in.)?

The decision not to retreat can be made if the answer to the first question is no. If the answer is yes, then measurement of the air content on a core or two would indicate the probability that retreatment would be effective.

When retreating concrete it is probable that one coat is sufficient. In any case, the ACI guideline suggests that a test strip should be used to establish the ability of the concrete to absorb one or two applications.

Thus, on the basis of protecting concrete it would be reasonable to conclude that general retreating or the initial treatment of pavements that are two or more years old with linseed oil should be discontinued. Where scaling is noted during the first two years, retreatment might be considered. In such cases, the air void parameters should be determined. Prior to any treatment, a test strip should be applied to the most representative area. If a retreatment or an initial treatment of an old pavement is warranted, a single-coat application may be sufficient.

The precautions recommended in the preceding paragraph have two purposes:

1. to determine if there is a need for a linseed oil treatment and
2. to prevent the creation of a slippery pavement.

The report entitled "Skid Resistance of Linseed Oil Treated Pavements" contains the following two recommendations:

1. Prior to any linseed oil treatment, a close evaluation should be made of the surface condition and pavement skid resistance and the planned application amount decreased if necessary. Also, this evaluation should help determine what precautionary measures should be taken, such as when to let traffic back on the treated pavement or the use of "Slippery When Wet" signs, if the pavement gets wet after treatment.
2. With wet conditions (rain) the treated area should not be opened to traffic before 24 hours, unless skid tests indicate the pavement has sufficient skid resistance... Judgment will have to be used to determine if the pavement should be opened to traffic after the 24-hour period. Whenever possible, it would be desirable to run skid tests before making any decisions. (6)

These recommendations were based on data gathered on six test sites, four of which had not been previously treated. The two sites that had been treated had been opened to light traffic (875 AVD) for

one year. The previous treatment had been made prior to the road being opened to traffic and had been applied in two applications totaling 0.040 gal.yd.² Of the six test sites, these two were the only ones prejudged to have excellent absorptive characteristics. The other four surfaces were seven years old and were prejudged to have either good, fair, or poor absorption characteristics. Three of the six sites received two applications which, in effect, gave a total of nine test conditions. The prejudged and the observed absorption rates coincided in seven cases, whereas in the other two cases a pavement prejudged to have fair absorptive characteristics had a good observed absorption rate and one prejudged good had a fair absorption rate. The prejudgments were based on the apparent texture and cleanliness of the surface, with a poor rating indicating a worn, smooth surface with a heavy layer of road film, and an excellent rating indicating a well-textured, clean surface. This subjective rating was found to be a good indication of the amount of skid resistance that would be lost as a result of the linseed oil treatment, with a pavement rated poor losing the most.

Experience has demonstrated that the skid resistance problem created by a linseed oil treatment can be much more serious than the 1969 report indicated. During the summer of 1980 about seven miles of eleven-year-old concrete pavement in Albemarle County were treated with 0.025 gal./yd.² of linseed oil in both the traffic and the passing lanes. The oil did not penetrate well into the passing lane and to a much lesser degree into the surface of the traffic lane. While the skid resistance of the passing lane was lowered, it was considered to be safe for traffic traveling at reduced speed; however, that of the traffic lane was reduced to a nonsafe condition when wet, and the lane was closed every night in case precipitation occurred. After being restricted to daytime traffic for about a week with no noticeable improvement in skid resistance, the traffic lane was closed around-the-clock until it was found that the oil could be removed from the surface with a 2% solution of sodium hydroxide. This problem resulted from the surface texture in the traffic lane being quite smooth and unable to absorb the oil. The failure to foresee this problem lends support to the use of a test strip as advocated by others and cited earlier.

On the basis of the 1969 skid study and the 1980 experience in Albemarle County it is recommended that no linseed oil treated or retreated bridge or pavement surface be opened to traffic until skid tests have provided results indicating the pavement to have adequate skid resistance under wet conditions, or unless the surface exhibits excellent absorptive characteristics as evidenced by a change from an oily appearance to a dry appearance similar to that noted prior to the application of the linseed oil.

SUMMARY OF RECOMMENDATIONS

In light of the above, the following recommendations are made.

1. General retreatment or initial treatment with linseed oil of pavements two or more years old should be discontinued. However, new surfaces, particularly those in which the water-cement ratio is above 0.45, the air entrainment is not proper for the size of aggregates used, and the mixture is not properly consolidated, should receive a linseed oil treatment, even though recommendations 4 and 6 should be adhered to.
2. Where scaling of treated surfaces is noted during the first two years, treatment might be considered.
3. In such cases, the air void parameters should be considered.
4. Prior to any treatment, an application should be made on a test strip in the most representative area.
5. If a retreatment or an initial treatment of an old pavement is warranted, a single-coat application may be sufficient.
6. No linseed oil treated or retreated bridge or pavement surface is to be opened to traffic until skid tests have provided results which indicate the pavement will have adequate skid resistance under wet conditions, unless the surface demonstrates excellent absorptive characteristics which can be detected by a change from an oily appearance similar to that noted prior to the application of the linseed oil.

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