AN EVALUATION OF THE EFFECTIVENESS OF S-5 SCRATCH COURSES

by

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(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

Charlottesville, Virginia

November 1976
VHTRC 77-R27

SUMMARY

A study was made of the practice of "scratching" the surface course of several new construction projects in Virginia. It was found that sections with the surface course placed in one lift produced a road roughness value of about 3 in./mile higher than comparable sections which had the surface course split. Conversely, the single lift surface course sections had almost 2% average lower void contents than the scratched sections. It is concluded that the better riding quality cannot be justified economically when the decrease in durability caused by the lower density is considered.

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INTRODUCTION

The Virginia Department of Highways & Transportation's Road and Bridge Specifications state that "Bituminous concrete surface courses shall be placed in layers not exceeding an application rate of 200 pounds per square yard, unless otherwise specified." No mention is made of a minimum thickness nor of placing a surface course in two lifts. However, in some areas it has become a practice on new construction to request the contractor to "scratch" with 60 to 80 psy and come back with a final lift to obtain the specified rate of application. The intent of this practice is to get a smoother riding surface than may be obtained with a single lift. However, basic knowledge of bituminous concrete would indicate that this practice of laying thinner lifts would also tend to reduce the density of the mat.

PURPOSE

The intent of this study was to determine if splitting the surface course (scratching) on new construction projects affects the riding quality and density of this course. Further, a quantitative estimate of the degree of any effects was sought so that a sound engineering decision on the value of scratching could be made.

APPROACH

Initially, it was anticipated that seven or eight projects would be sought for inclusion in this study. On each project, comparison test sections were to be placed where the only variable would be the number of lifts to achieve the final application rate.

In order to determine if there would be real differences in surface roughness between the scratched and unscratched sections, each section was made a minimum of one mile long, and road roughness measurements were made by the Materials Division both before the initial and after the final S-5 applications.

In evaluating the other property, density, twenty tests were taken on each section to gain an indication of the influence of lift thickness. These tests were conducted with a nuclear gauge by the Research Council, and were performed in addition to the normal construction density tests.

RESULTS

As mentioned above seven or eight projects were sought, but because of the declining economy and resultant construction delays, as well as research priority changes, the study was terminated after tests on five projects. The consistency of the results indicates that this was likely a statistically significant number of projects from which to draw conclusions.

Projects

The five projects on which full thickness vs. scratched sections were compared all had 165 psy applications of S-5 mix. The projects were:

1.	Rte. 29	Gretna Bypass	Pittsylvania County
2.	Rte. 23	—	Lee County
3.	Rte. 15	Remington Bypass	Fauquier County
4.	Rte. 15	Brandy Bypass	Culpeper County
5.	Rte. 460	Blackstone Bypass	Nottoway County

Roughness

Each of the sections consisted of both traffic and passing lanes and thus were two lane miles long. In some instances there were large differences in the final roughness values for the passing and traffic lanes in the same section. To try to normalize these differences, which appear random and are assumed attributable to the contractor, base roughness, and/or laying procedures, averages of the traffic and passing lane roughnesses for each section were compared.

To minimize the effect of the vehicle in the road roughness measurements a control section on a nearby one-mile section of highway not under construction was tested prior to each roughness measurement. The measurements gave reasonably consistent values for the base and the surface courses. Table 1 shows the roughness data on the

base (B-3) and final surface courses (S-5) for each project, corrected to a temperature of 70°F as recommended by McGhee.[1]

TABLE 1

Average Road Roughness Data
(in./mile)

Project	Mix	Full Thickness	Scratched	Difference
Rte. 29 Gretna Bypass	B-3	45.6	44.0	
	S-5	34.2	28.6	5.6
	Difference	11.4	15.4	
Rte. 23 Lee County	B-3	89.1	99.8	
	S-5	39.4	34.8	4.6
	Difference	49.7	65.0	
Rte. 15 Remington Bypass	B-3	42.7	48.7	
	S-5	29.4	27.2	2.2
	Difference	13.3	21.5	
Rte. 15 Brandy Station Bypass	B-3	37.8	38.0	
	S-5	32.8	33.5	-0.7
	Difference	5.0	4.5	
Rte. 460 Blackstone Bypass	B-3	56.2	55.8	
	S-5	40.8	37.0	3.8
	Difference	15.4	19.2	
Average				3.1

As can be seen from the data in Table 1, the roughness of the base varied considerably, but the roughness of the surface course was relatively consistent. It is somewhat surprising that even on the roughest base course (Rte. 23), the final riding surface was relatively smooth.

The point of most interest was the difference between the roughnesses on the full thicknesses as compared to those on the scratched sections (column 5). On four of the five projects the scratch course was smoother than the full thickness application. On one project (Rte. 15 Brandy Station Bypass), although numerically the full thickness section was smoother than the scratched section (0.7 in./mile difference), the reality there was no statistically significant difference between the two. It is interesting to note that the roughness on the B-3 was only about 38 in./mile, the lowest of that on the bases tested. This fact probably contributed to the small roughness difference between the B-3 and S-5 and may have over shadowed any value of scratching. The average difference between the two methods of placing the surface course was 3.1 in./mile in favor of scratching.

Density

The average results of 20 density tests on the surface course of each section are shown in Table 2. These results support the widely held belief that lower densities are obtained with thinner lifts. The reason is twofold. First, because of the influence of aggregate size, compaction is more difficult in thin lifts. But more important is the much higher rate of cooling in the thinner lifts, which allows a shorter time in which to obtain compaction.

TABLE 2

Density Data

Project	Full Thickness		Scratched		Difference	
	PCF	Voids %	PCF	Voids %	PCF	Voids %
Rte. 29 Gretna Bypass	124.6	10.0	123.8	10.5	-0.8	0.5
Rte. 23 Lee County	133.7	11.0	131.8	12.3	-1.9	1.3
Rte. 15 Remington Bypass	132.2	9.0	128.0	11.9	-4.2	2.9
Rte. 15 Brandy Station Bypass	134.0	10.0	132.2	11.2	-1.8	1.2
Rte. 460 Blackstone Bypass	139.4	9.0	135.0	11.9	-4.4	2.9
Average					-2.6	1.8

is more difficult in thin lifts. But more important is the much higher rate of cooling in the thinner lifts, which allows a shorter time in which to obtain compaction.

On every project the scratched section had lower densities and consequently higher voids than the full thickness sections, although the differences on the Rte. 29 Gretna Bypass are not statistically significant. The average differences between methods of paving were 2.6 pcf and 1.8% for density and voids respectively.

Quantitative Estimate

As mentioned under Purpose, it was the intent of the study to estimate quantitatively the degree to which road roughness and density were affected by scratching so that an objective engineering decision could be made as to when, if ever, this practice should be employed.

It is conceded that many, if not most, engineers are particularly concerned with the riding quality of new pavements. This is to be expected since other than aesthetics, the only sensitivities affected are the feel of the road. However, from a technological standpoint density should be of more concern than roughness to the engineer because it directly affects durability. In the range of 8% to 12% voids a decrease of 2% voids can increase the life of a pavement by about 2 years. As can be imagined, this fact has very important economic implications.

The indications from Tables 1 and 2 are that scratching with a surface course will improve the road roughness by about 3 in./mile and increase the voids in the mix almost 2%. It is the author's belief that a change in roughness of 3 in./mile cannot be determined subjectively, i.e. by the "seat of the pants," and that an improvement of 3 in./mile cannot offset the economic effect of having to overlay the pavement 2 years sooner than otherwise would be necessary.

SCRATCHING ADVANTAGES

There are at least two situations in which scratching may be advisable, as noted below.

1. When the mix to be used for scratching is much more economical than the final surface course. This situation occurs in the western part of the state where limestone can be used for the scratch course and non-polishing aggregates are reserved for the final lift.

2. When the base thickness does not meet the design called for and must be increased, or when spots occur where construction has caused some very unusual roughness. In both cases, scratching should be considered in spot situations and should not be carried through the whole project. As indicated for Rte. 23, Table 1, full thickness placement can produce nearly as smooth a riding surface as scratching, even when a rough base exists.

CONCLUSIONS

1. Scratching with a surface course will improve the roughness results by about 3 in./mile, a degree that cannot be determined subjectively.

2. Scratching with a surface course will result in an increase in the void content of the mix of about 2%.

3. The lower roughness value of 3 in./mile does not balance the 2% loss of density caused by scratching, considering the economic consequences of the latter.

ACKNOWLEDGEMENTS

The cooperation of the Materials Division in obtaining the road roughness data is gratefully acknowledged; J. P. Bassett's team of G. T. Llewellyn and G. C. Keso were extremely cooperative.

The assistance of the following inspectors was invaluable in ascertaining that the limits of the test sections were paved as required.

W. L. Rodgers	Blackstone Bypass
W. P. Salyer and D. R. Browning	Rte. 23
W. L. Jones	Remington Bypass
D. D. Baine	Brandy Station Bypass
C. L. Burnett	Gretna Bypass