3283

THE INFLUENCE OF THICKNESS ON DENSITY OF AN I-2 BITUMINOUS MIX

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

Charlottesville, Virginia

March 1978
VHTRC 78-R47

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INTRODUCTION

It is generally assumed that the density attainable on a particular bituminous concrete mat is dependent in part upon the thickness at which the mat is placed. The validity of this statement, except in the case of unusually thick mats, rests on two reasons. First, unless the mat is at least twice as thick as the largest particle in the mix, there is insufficient room for the rollers to reorient the larger aggregate and produce a mix of optimum density. Second, as the thickness increases, the heat retention also increases and a longer time is available for rolling.

The relationship between temperature retention and thickness has been researched in Colorado[1,2] and verified in Virginia;[3] however, little or no experimental field data have been reported on the influence of thickness on density as a function of particle size.

PURPOSE

This study was initiated on a resurfacing schedule to see if a relationship could be developed between density and thickness. Specifically, three sections were laid with I-2 mix; one at an application rate of 135 $lb.yd.^2$ (1.4"), a second at 150 $lb.yd.^2$ (1.6"), and a third at 165 $lb.yd.^2$ (1.8").

It was realized that no general conclusions would be forthcoming from a single experiment, but it was hoped that a study of this brevity could shed some light on poential relationships and indicate what, if any, problems might be encountered.

STUDY SITE

A two-mile section of Route 58 just west of Volney in Grayson County was selected as the study site, and the testing was begun on October 4, 1977.

OBSERVATIONS

There was concern as to how two conditions noted during the experiments would affect the results. First, the cross section of the road, while not considered to be poor, had some rutting in the wheel paths which would certainly affect the thickness of the bituminous mat across the road. When thin applications such as 135 lb.yd.^{2} (1.4") of I-2 are used, it is a general principle that a minimum thickness be laid on the crown and the application rate over the rest of the lane be averaged. This procedure means that the wheel paths may get twice the thickness applied at the crown, or centerline. Intuitively, this variation in thickness would create variations in the density between wheel paths and centerline.

The second condition causing concern was that at times the mat moved under compaction. It appeared that when the temperature of the mat decreased to about 210°F, the mat tended to crawl under the roller, irrespective of the number of passes applied and the mode of the roller, whether vibratory or static. When this movement began, nuclear densities, which were used for density control, stopped increasing. Because of this condition a high percentage of compaction was not anticipated.

RESULTS

Table 1 shows the average core thickness, the average and standard deviation of percent compaction, the number and mode of roller passes, and the average roughness for each section.

It can be seen that the average core thickness closely approximates the calculated thickness (indicated under Purpose) for each application rate, which indicates that even with a variable cross section, the contractor can do an excellent job of controlling the average thickness.

Table 1 also shows that in spite of the movement the mat underwent, the percent compaction values were very good. The overall percent compaction for the three sections was 93.5, which is about 1% higher than is expected under the new maintenance density specification.[4] However, the overall standard deviation of 1.56% was a little higher than is expected. The cause of this high standard deviation was that the 165 lb.yd.^{2} (1.8") section, primarily because of the variability in the thickness of the mat, had a standard deviation of 1.71%.

TABLE 1

AVERAGE DATA FOR EACH SECTION

Rate, lb.yd.^{2}	Avg. Core Thickness	Percent Compaction $\bar{X}$	σ	No. Passes	Roughness in./mi.
135	1.5"	94.0	0.98	3 vib.	105
150	1.6"	94.3	1.22	5 static	97
165	1.8"	92.2	1.71	3 vib.	83
Overall		93.5	1.56		

The expected trend between thickness and percent compaction was not found on this study, as is evidenced by the average values. There did appear to be a trend between the standard deviation of percent compaction and thickness, but no reason can be found for this trend and it is likely due to experimental error.

If a closer look is taken at the individual values as plotted in Figure 1, it appears that for the 165 lb.yd.^{2} (1.8") section only there is a trend between thickness and density. However, no relationship is apparent when all data points are considered.

Looking at Table 1 again, it appears that about 3 vibratory passes are equivalent to about 5 static passes, which is consistent with findings in previous research.

Lastly, it appears that although density was not a function of the thickness, riding quality was. Table 1 shows that the 165 lb.yd.^{2} (1.8") application was appreciably smoother than the next thickness mat, which in turn was smoother than the thinnest application. These results were not entirely unexpected.

2288

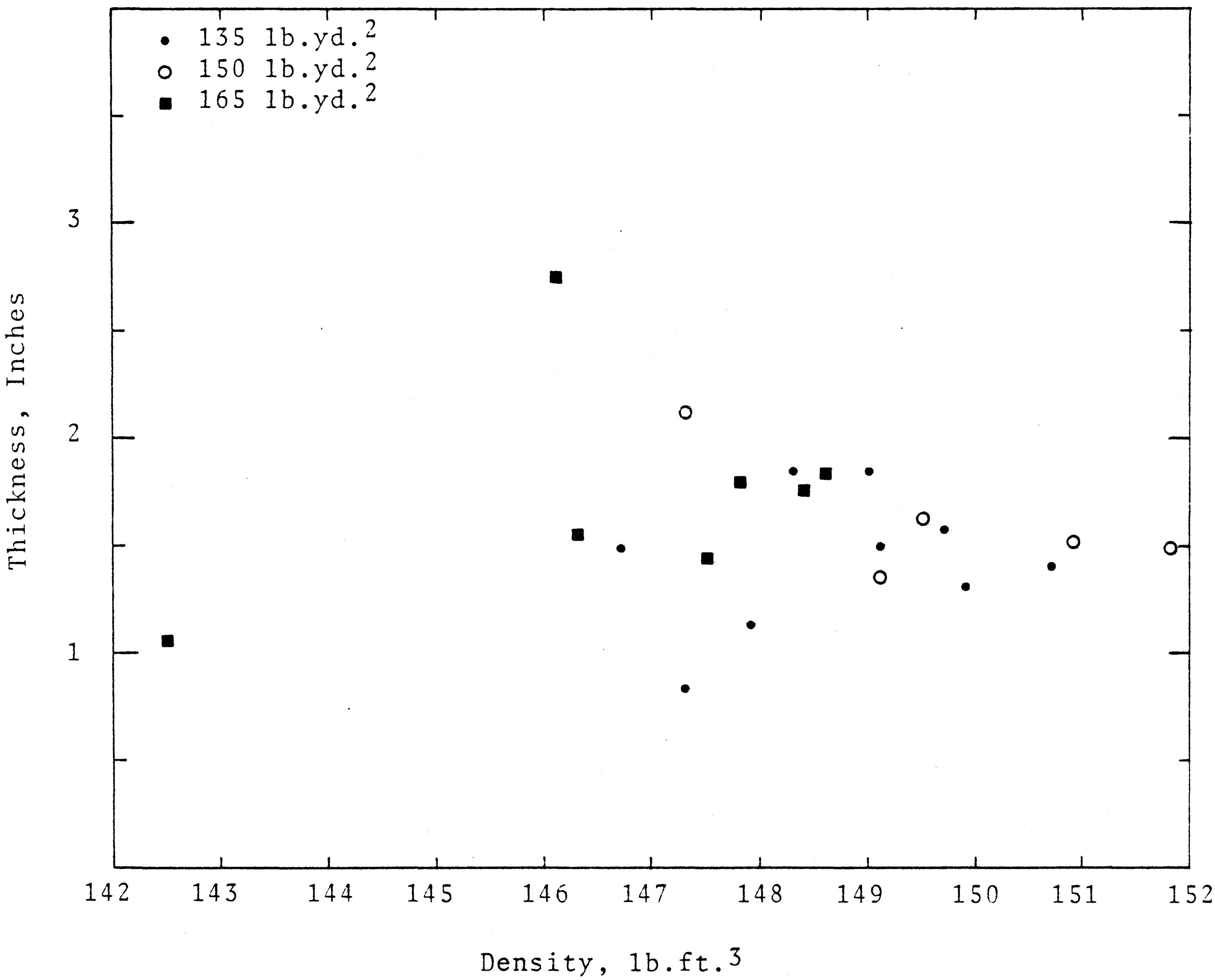

Figure 1. Relationship between thickness and density.

CONCLUSIONS

From this very limited study, it appears that the following conclusions are indicated.

1. Even when the road cross section is distorted, the contractor can do an excellent job of controlling the average application rate.

2. The percent compaction, while acceptably high, did not increase as the rate of application increased.

3. On this project about 3 vibratory roller passes were equivalent to about 5 static passes.

4. Riding quality appeared to be a function of thickness, with the 165 lb.yd.^{2} (1.8") section having the lowest roughness value. (This should not be considered a generalization since thick lift construction has shown a tendency to create a rougher ride than two more moderate lifts.)

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