INSTALLATION REPORT — THICK LIFT BITUMINOUS BASE
Construction and Materials Phase

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INTRODUCTION

During the 1970 construction season, the Basic Construction Company of Newport News, laid a 9-inch bituminous concrete base course in a single lift directly on an unimproved subgrade on a section of Route 31 just southwest of Williamsburg, as specified by the Virginia Department of Highways. This construction technique, which had been used in many other areas but was new in Virginia, was attempted to determine its advantages and disadvantages.

The purpose of this report is to summarize only the construction and materials features of the project.

SPECIAL EQUIPMENT AND TECHNIQUES

In order that the compacted lift be 9 inches thick, the uncompacted layer had to be about 10 inches thick. Placement of the material at this thickness required the procurement of a special paver since most conventional pavers cannot lay over five to six inches. The contractor obtained a Blaw-Knox rubber tired paver to do the job. For compaction, in addition to the contractor's conventional 3-wheel breakdown and tandem finish rollers, two experimental vibratory rollers — a Vibroplus CC-40 and a Raygo Rustler — and a rubber tired roller were used. The rollers used on each of the experimental sections are shown in Table 1 (all tables and figures attached).

As will be seen later, the mix retained a very high temperature for an extended period of time. This prevented the rollers from getting on the pavement for about two hours except "pinch" the joint when paving adjacent to an existing lane. It was found that this delayed initial rolling produced fewer waves and thus an apparently smoother pavement. Also, the rollers had to stay about a foot from an unsupported edge until just prior to completing rolling to minimize lateral pushing of the mat. However, since the adjacent lane was laid the same day, the joint was sufficiently hot to allow adequate compaction later in the day.

Because of the simplicity of construction, the only major lead time required was for the placing of the curb and gutter. The motor grader stayed only about 200 feet in front of the paving operation and the entire subgrade compaction and base course placement moved very smoothly even though many manholes were encountered.

TEMPERATURE MEASUREMENTS

Temperatures were monitored on the 9-inch bituminous concrete lift on 4 sections. The measurements were made at 3 depth positions: (1) the interface of the subgrade and bottom of the bituminous layer, (2) the middle of the bituminous layer, and (3) at one-quarter of the total depth from the surface of the layer.

A thermoelectric Multimite was used with 20-gage thermocouples to make the temperature measurements. The thermocouples were inserted in the bituminous concrete after the paver passed and temperatures were taken at intervals until rolling was completed.

Examination of the temperature data for the 4 sections,(see Figures 1-4), shows the similarity of the curves, however, there were slight differences in the initial temperatures, which was to be expected. On all sections, there was very little heat loss during the first hour after the paver passed. After 2 hours sections 1, 2, 3, and 4 still maintained average temperatures of 211°F, 215°F, 217° and 226°F respectively.

The average temperatures of 1.5 and 3.0 inch lifts of bituminous concrete were measured in the fall of 1969 on other projects. These measurements showed that the average temperature of a 3.0 inch lift dropped to 210°F in approximately 20 minutes and the average temperature of a 1.5 inch lift dropped to 210°F in 5-15 minutes. The results for the present project thus illustrate that the 9-inch bituminous concrete layer retains heat much longer than do the 1.5- and 3.0-inch layers.

DENSITY MEASUREMENTS

One of the main concerns in placing the thick lift was the distribution of the density through the layer. Although, because of the high heat retention, many agencies had reportedly attained uniformly high densities throughout applications placed as thick as 18 inches, in Virginia it was still a case of "seeing is believing".

After the first roller pattern (Section 1) had been established and the maximum density achieved with the conventional rollers, nuclear direct transmission tests were made at 2, 4, 6, and 8 inches. These results as well as nuclear depth tests on other test sections are shown in Table 2. These results provided a very strong indication that uniform densities can be achieved throughout the depth of the lift.

To substantiate these nuclear depth results, density tests were run on cores from several sections, which had been sawed into thirds. These results, shown in Table 3, show conclusively that uniformly high densities can be achieved in thick lift bituminous concrete. In fact, these results add substance to previous findings that the density is more easily achievable as the lift thickness increases.

ROLLER PATTERNS

From the research standpoint, one of the most valuable aspects of the thick lift project was the opportunity to combine it with the continuing compaction study to determine what effect different rollers, primarily vibratory, would have on bituminous concrete compaction when used on a 9-inch lift.

As shown previously in Table 1, eight roller patterns were established starting with the conventional rollers on the control section (Section1). The next 3 roller patterns used the Vibroplus CC-40 at low, medium, and high amplitudes, respectively for the breakdown, and then used the same roller operating as a static roller for finishing. Section 5, which was constructed about a month after the other sections, used a reverse sequence to that of the control section; that is, the tandem roller was used as the breakdown and the 3-wheel roller was used as the finish. This was done because the contractor had found that a smoother operation could be obtained by using only the tandem roller for both breakdown and finishing. As a corollary to this sequence it was decided to put the 3-wheel roller on after the tandem to see if an appreciable density increase occurred. Sections 6 and 7 were rolled with the Raygo Rustler at the low and high vibratory frequencies for breakdown, and then with the same roller in a static mode for finishing. The last section was placed in an attempt to determine the effect of a rubber tired roller under the given conditions.

Figures 5 through 12 show the roller patterns established on each section. It is seen (Figure 5) that 13 passes with the conventional rollers produced a density of 139.0 pcf. Figures 6 and 7 show the same density achieved after about 7 passes and 5 passes with the CC-40 at low and medium amplitudes respectively. Figure 8 shows that 4 passes with the CC-40 at the highest amplitude slightly exceeded the maximum density (after 13 passes) with the conventional rollers and ultimately reached a significantly higher density of 141.3 pcf.

Figure 9 shows that by using the lighter tandem roller as a breakdown, a density comparable to that achieved with the 3-wheel as breakdown can be reached in slightly more passes. Incidentally, when used for finishing, the 3-wheel roller did increase the density appreciably over that of the tandem indicating that a 3-wheel roller should be used as the breakdown and not the finish roller. Figure 10 shows the same general trend as Figure 8 in that the Raygo at the highest frequency produced densities comparable to those of the conventional rollers in many fewer passes — in this case about 6 — and ultimately produced significantly higher densities. At the lower frequency, the Raygo roller (Figure 11) required about 12 passes to reach the maximum density attained with the conventional rollers.

Figure 12 shows the roller pattern established using the rubber tired roller as an intermediate roller. The great drop in density after 2 passes with the rubber tired roller is believed to be due to the irregular surface caused by the roller and was not a decrease in the density of the material itself. It can be seen that a great increase in density occurred after 2 passes with the Raygo roller vibrating at a high frequency. This increase was partially due to the reverse of the above effect; i.e., the surface became much smoother. Any advantages due to the rubber tired roller are not obvious from the roller pattern.

CONCLUSIONS

Conclusions that may be drawn from the project are:

1. High densities can be obtained uniformly from top to bottom of a 9-inch lift.
2. Some special precautions should be taken in rolling lifts of this thickness.
3. Vibratory rollers can reduce the number of passes required to reach maximum density as much as one-half to two thirds that required by conventional rollers.
4. Average temperatures remain very high even as long as 2 hours after the lift has been placed.
5. Construction time can be reduced appreciably.

RECOMMENDATIONS

It is recommended that the Virginia Department of Highways specifications be revised to allow contractors to lay bituminous base course as thick as 6 inches compacted in order to take full advantage of paving machines, to speed up construction, and to allow retention of rolling temperatures for a longer period.

TABLE 1

Rollers Used on Experimental Sections

Section	1 (Control)	2	3	4	5	6	7	8
Breakdown	3-wheel	CC-40 low	CC-40 med.	CC-40 high	Tandem	Raygo low	Raygo high	Raygo static
Intermediate	xxx	xxx	xxx	xxx	xxx	xxx	xxx	Rubber tired
Finish	Tandem	CC-40 static	CC-40 static	CC-40 static	3-wheel	Raygo static	Raygo static	Raygo high

TABLE 2

Average Nuclear Depth Density Results by Section, PCF

Depth \ Section	1	2	3	4	5	6	7	8
2"	142.3	139.4	140.5	141.4	142.0	141.2	139.1	141.5
4"	142.9	141.4	143.1	142.9	142.5	143.2	140.2	143.2
6"	144.4	140.4	143.5	143.4	143.3	144.3	141.5	142.8
8"	144.5	141.0	142.5	144.1	142.8	143.2	140.7	141.2

TABLE 3

Average Conventional Density Results by Sections, Percent Compaction

Density \ Section	1	2	3	4	8
Top	95.7	95.9	95.7	97.3	93.2
Middle	96.3	96.7	96.1	96.9	97.1
Bottom	93.9	93.3	94.5	95.8	96.5

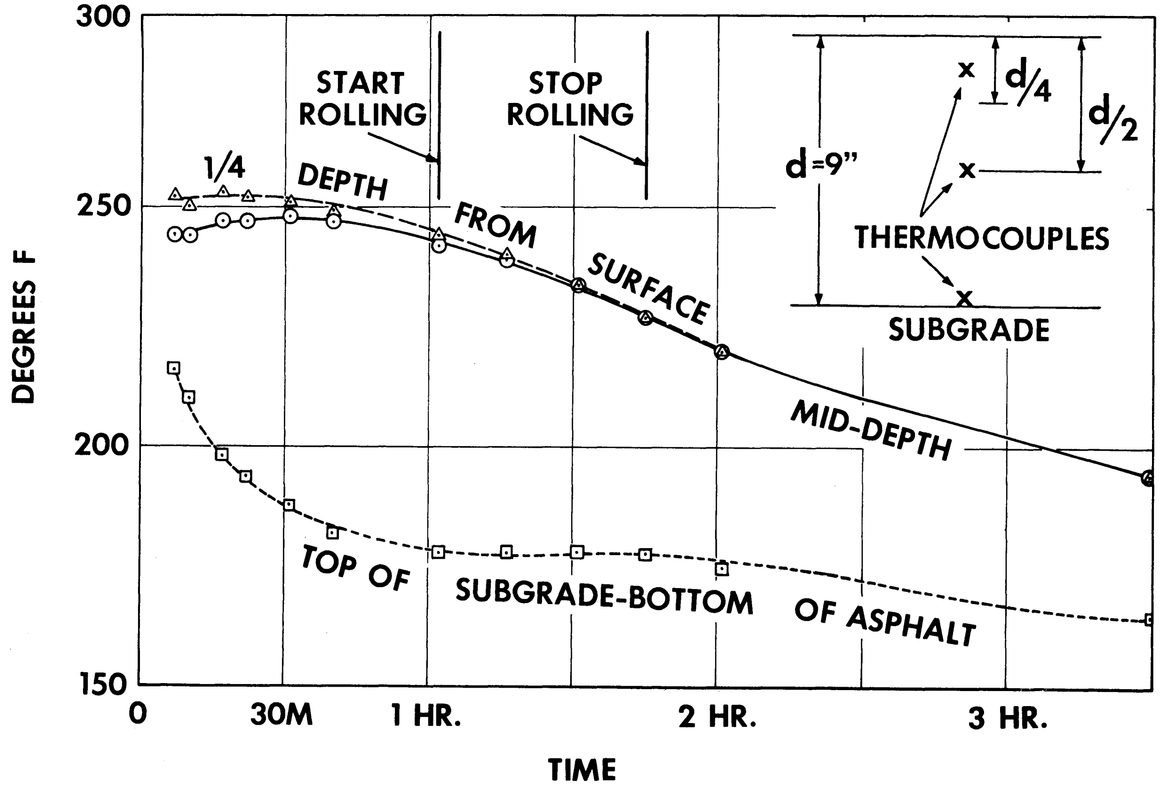

Figure 1. Deep lift temperature-time curves — Section 1.

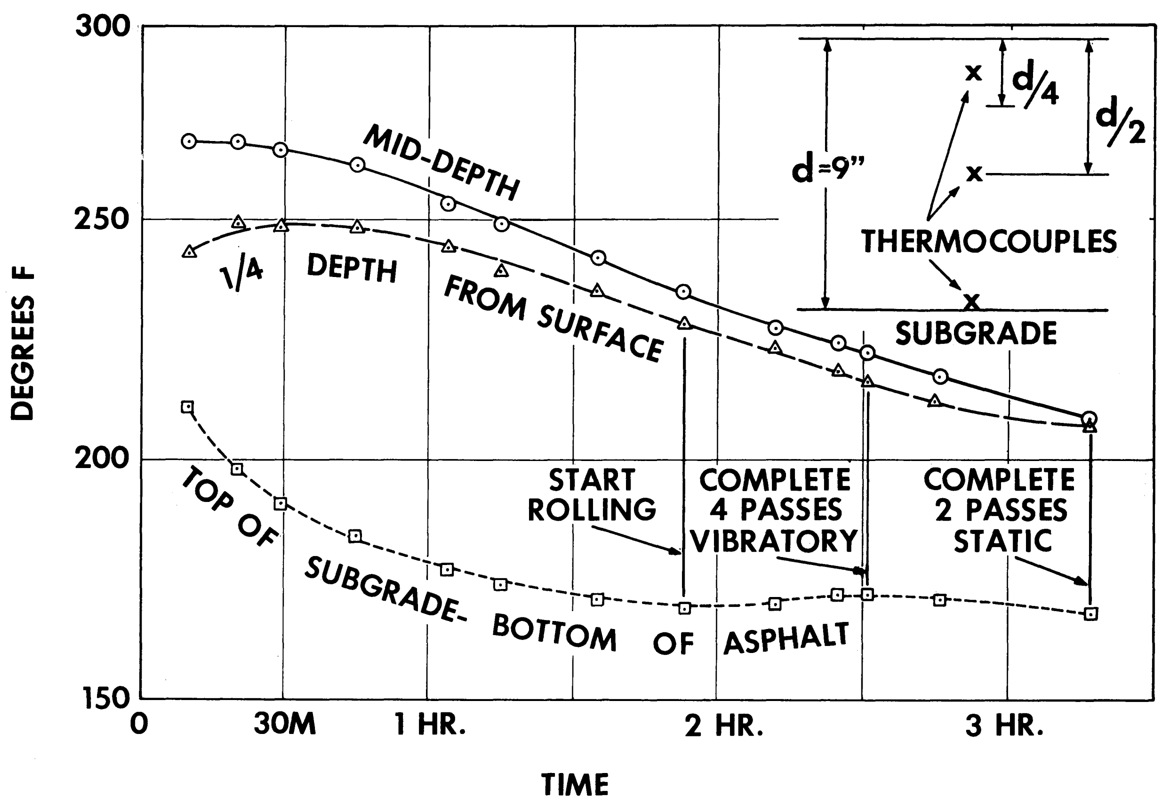

Figure 2. Deep lift temperature-time curves — Section 2.

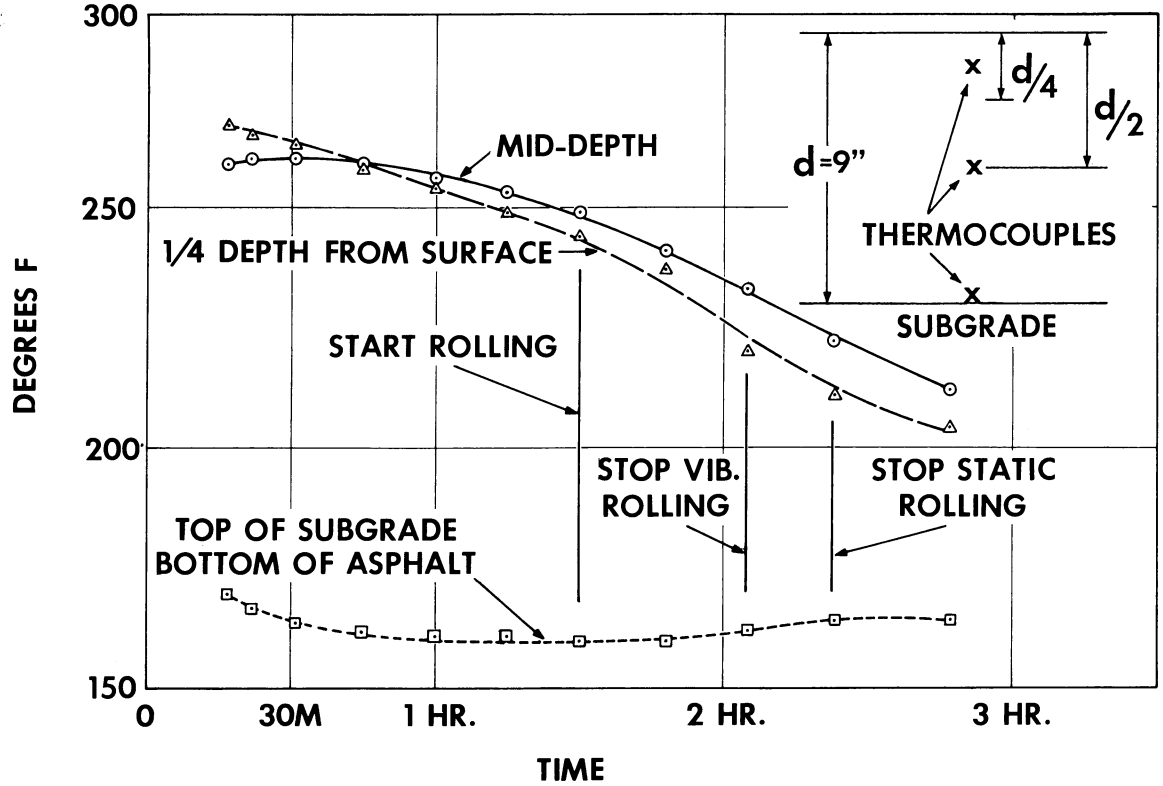

Figure 3. Deep lift temperature-time curves — Section 3.

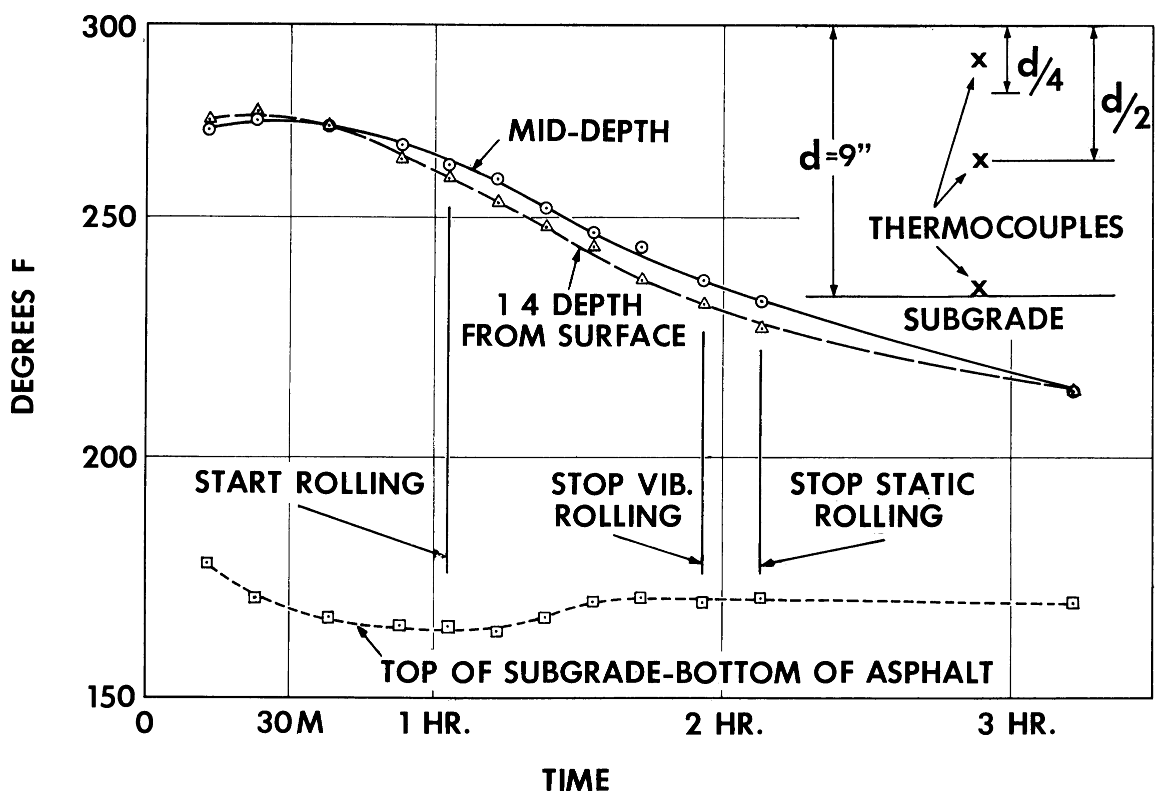

Figure 4. Deep lift temperature-time curves — Section 4.

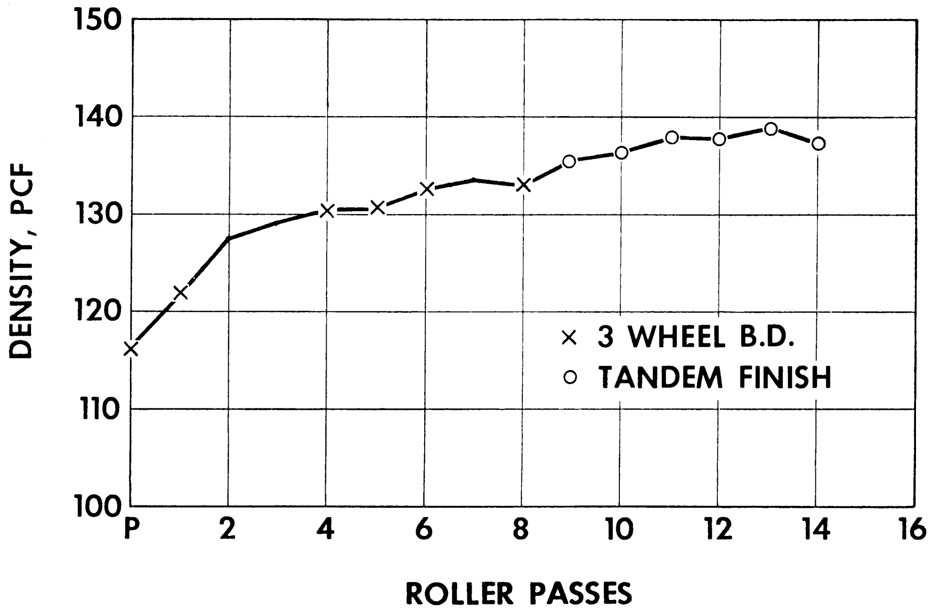

Figure 5. Roller pattern on section 1 — using conventional rollers.

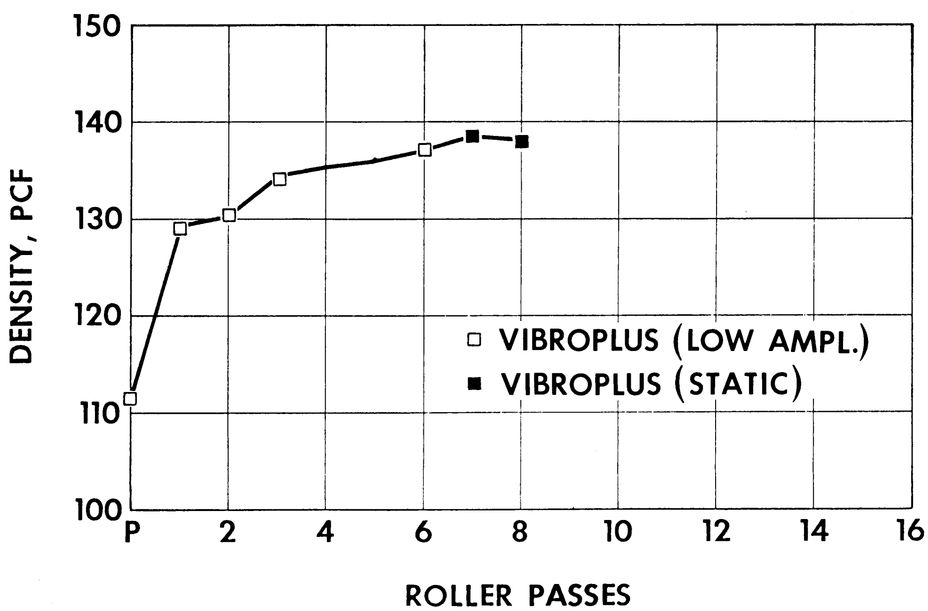

Figure 6. Roller pattern using CC-40, low amplitude.

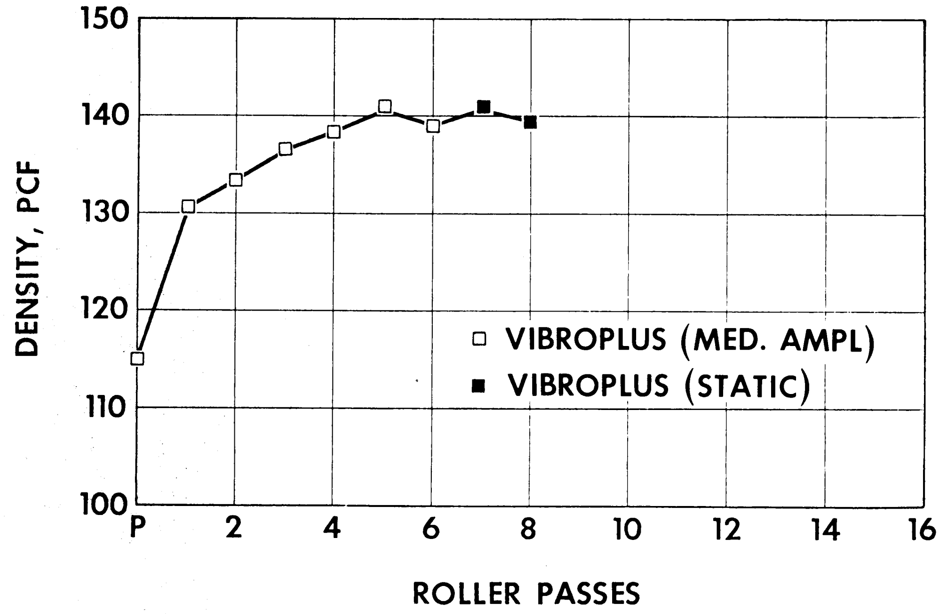

Figure 7 Roller pattern using CC-40, medium amplitude.

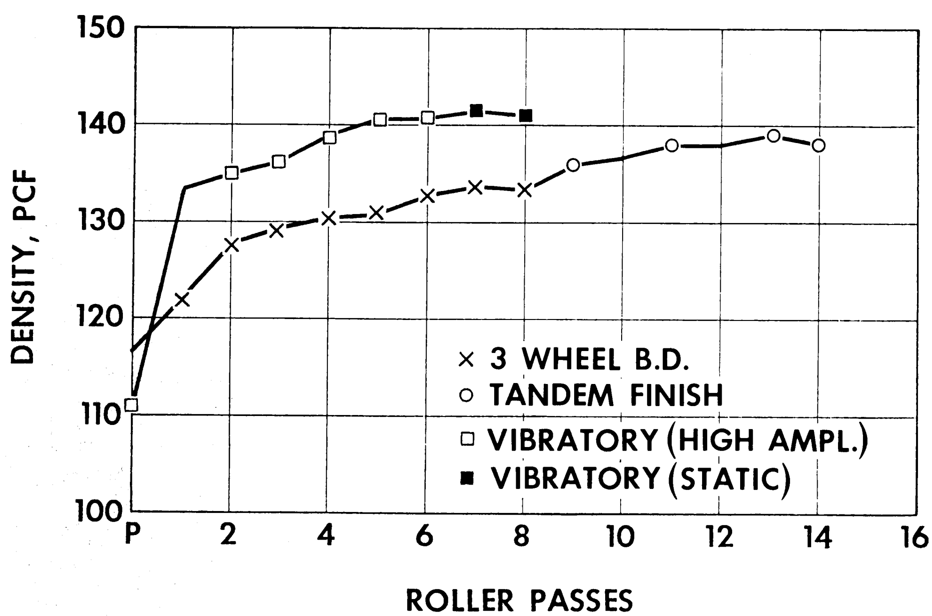

Figure 8. Roller patterns of the CC-40 as compared to the conventional rollers.

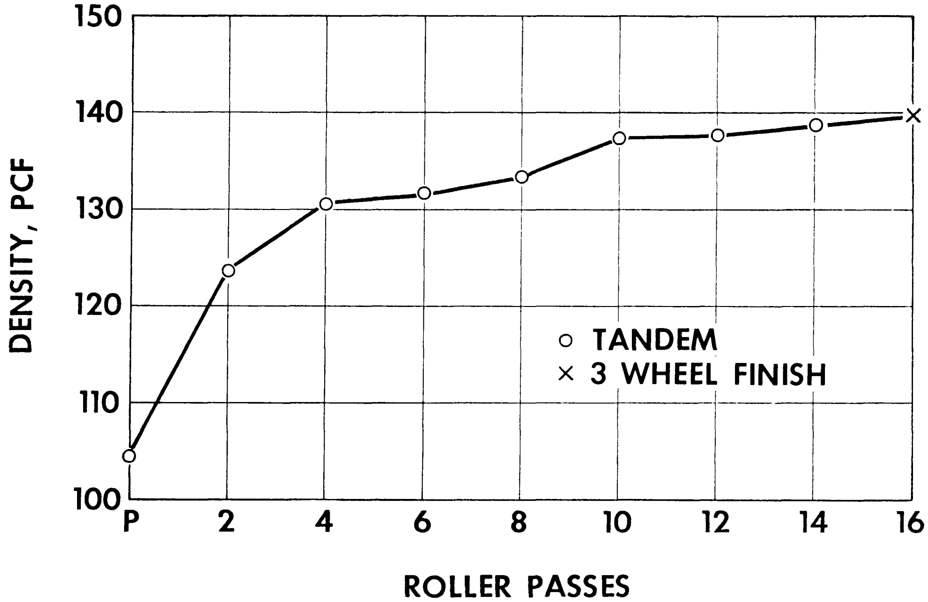

Figure 9. Roller pattern using conventional rollers in reverse sequence.

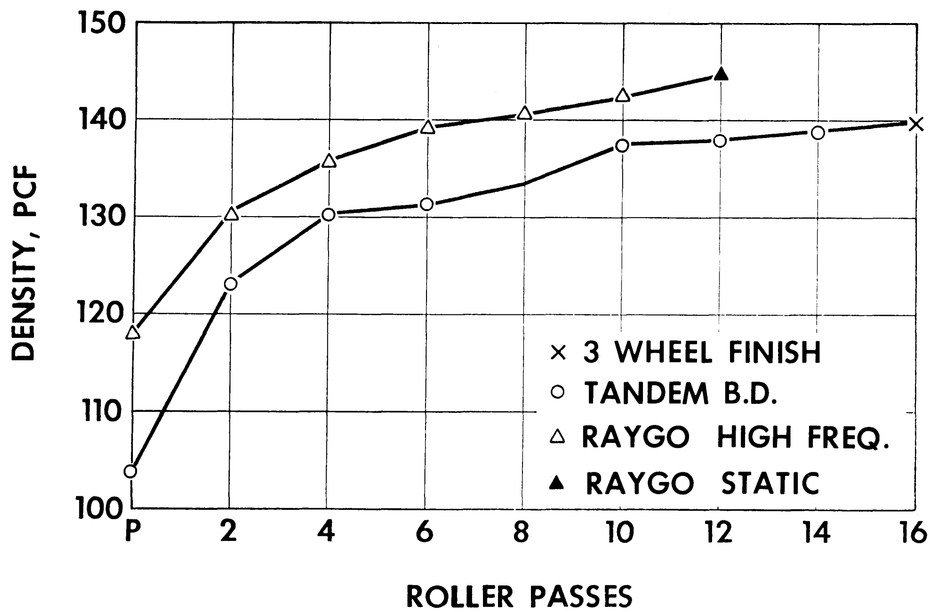

Figure 10. Roller patterns for the Raygo as compared to conventional rollers.

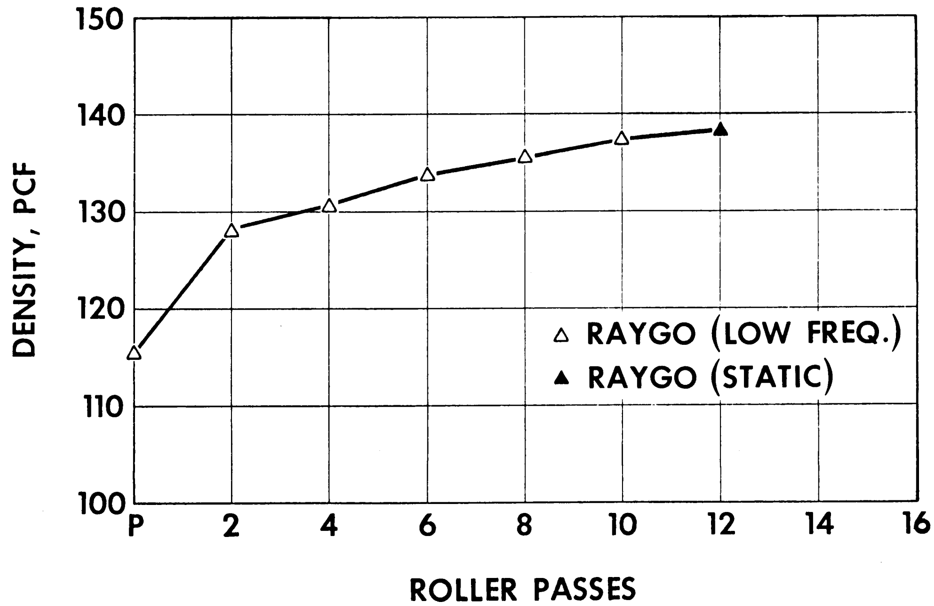

Figure 11. Roller pattern for Raygo roller, low amplitude.

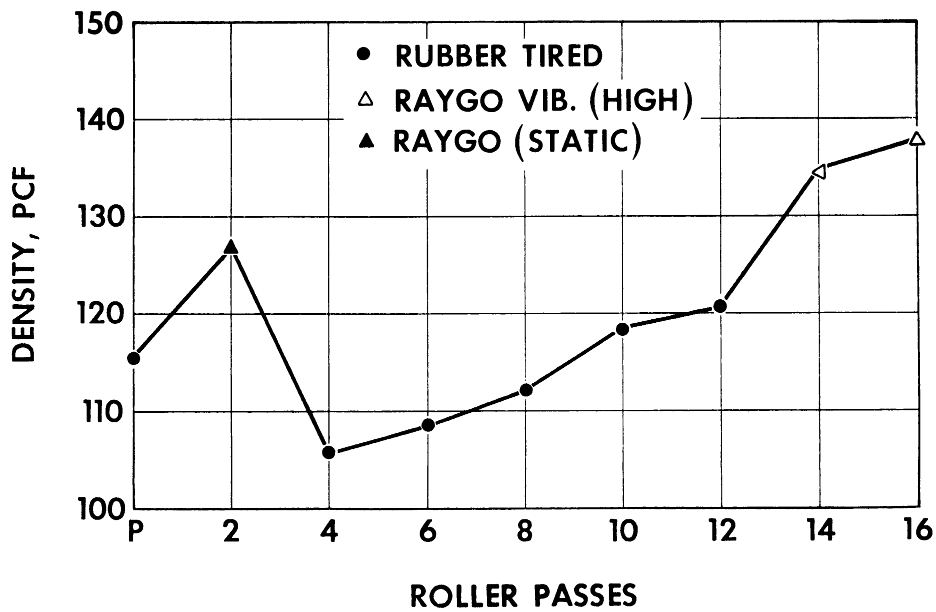

Figure 12. Roller pattern using a rubber tired roller.