# PROGRESS REPORT NO. 1

# BITUMINOUS CONCRETE OVERLAY STUDIES

by

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Virginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia
Department of Highways and the University of Virginia)

Charlottesville, Virginia

September 1971
VHRC 71-R7

## SUMMARY

Deflection tests conducted on eight sections of primary highway, both before and after asphaltic concrete resurfacings, were analyzed as a study of the utility of such tests in the design of overlays.

The application of tentative traffic and allowable deflection criteria showed that seven of the eight projects had deflections reduced to a satisfactory level by overlays of from 125 to 220 psy. It is likely that maintenance engineers would find deflection tests useful as decision making tools where the underlying pavement structure is unknown or of questionable quality. Other uses could include the definition of weight limits where unusual traffic or weather conditions prevail.

It is recommended that the Research Council, in cooperation with the Maintenance Division, proceed with the development of an overlay design procedure which would include well defined traffic and structural parameters.

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## INTRODUCTION

Early in 1970 studies of the application of dynaflect deflection tests to flexible pavement maintenance operations were initiated as a cooperative undertaking of the Research Council and the Virginia Department of Highways' Maintenance Division.

The studies were undertaken with the hope that procedures could be developed whereby maintenance personnel could utilize deflection test results as decision making tools. The decision of whether or not to overlay a given section of roadway is based on many factors, such as pavement condition, traffic, availability of funds, etc. Because of these many considerations, it was not anticipated that deflection tests would play a role in the routine selection of resurfacing sites, but would be used to optimize the use of available funds within previously chosen sites. For example, portions of the roadway where deflection tests indicate a structural weakness could receive a heavy overlay while structurally sound portions would have a reduced application. Other possibilities include the use of deflection tests to determine whether an overlay is sufficient to restore pavement serviceability or if more drastic measures, such as scarifying and remixing, are indicated.

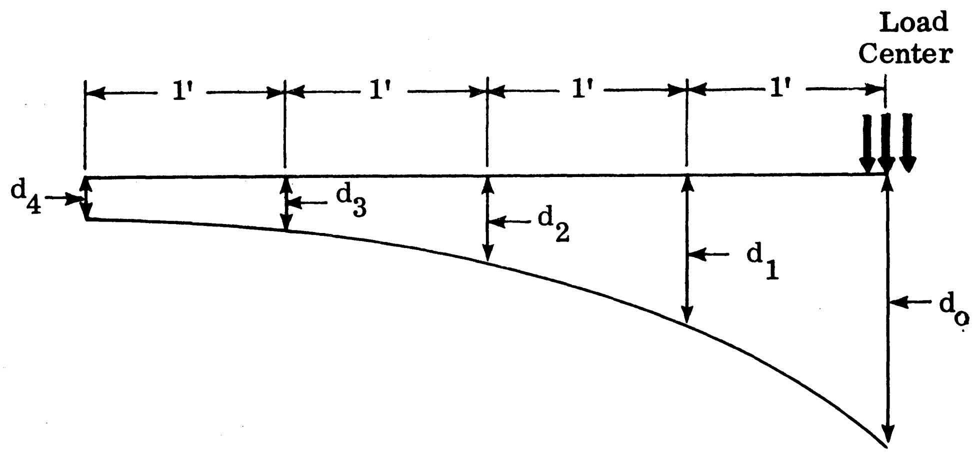
The studies began when P. F. Cecchini, Assistant State Maintenance Engineer, selected for testing eight sections of primary highway scheduled for resurfacing during the summer of 1970. The sites chosen all were in the resilient soil area of the central piedmont, none had been constructed or reconstructed in recent years, and all were in relatively poor condition (cracking, distortions, etc. were prevalent). The site descriptions listed in Table A-1 (appended) include information furnished by the Lynchburg District Office concerning the pavement components and history.

## APPROACH

### Deflections

Dynaflect deflection tests were conducted at 500 ft. intervals in the outer wheel paths of all test sites. Tests were run in both lanes of two-lane roads and in the traffic lanes of the one divided highway. Series of tests were conducted before the overlays were applied (spring and summer of 1970) and after their application (fall of 1970 and spring of 1971). As discussed below, some adjustments in overlay quantities resulted from the initial tests.

The dynaflect method provides for deflection measurements directly at the point of load application and at distances of one, two, three, and four feet from that point. The plot of all five deflections defines the deflection basin as shown in Figure 1. Recent studies(1) have shown that the shape of the deflection basin may be of more importance than the maximum deflection. As a means of interpreting the shape of the basin a bending factor, or a "spreadability", has been defined and is also shown in Figure 1. This factor is the ratio of the average deflection to the maximum, expressed as a percentage. An increase in the factor indicates an ability of the pavement to spread the load over a wider area. Thus, a 65 spreadability indicates a much stiffer pavement than does a 45. The use of the spreadability value in assessing pavement condition will be discussed later in this report.




$$\text{Spreadability} = \frac{d_o + d_1 + d_2 + d_3 + d_4}{5\,d_o} \times 100$$

Figure 1. Dynaflect deflection basin.

Representative (one lane) deflection results are plotted in Figures A-1 through A-8, appended, for each of the projects. The values given on the vertical scale are the maximum deflections ($d_o$) while those on the horizontal scale represent the distances from the beginning of the test site. The deflection results shown are the values obtained both before and after the overlays were applied, spring 1970 and spring 1971, respectively.

## Overlay Adjustments

Following the initial series of deflection tests, P. F. Cecchini and the author discussed the test results and agreed on the adjustments in the overlay application rate indicated in Table 1. Since the test sites were under maintenance contract at the time, efforts were made to stay within the contract quantities so that costly overruns could be avoided. For this reason, most adjustments consisted of increasing the overlay rate through a portion of a test site while decreasing the rate through the rest of the site. Rates of application were arbitrarily determined using only the general guideline that where deflections were highest, the rate should be highest. In several instances, no changes in the scheduled rates were recommended. These were where either the deflections were uniformly low so that no increases appeared necessary, or where deflections were excessively high and variable so that an increased overlay could not be expected to increase pavement performance and might be a wasteful step. Project 1 was seen as having this latter characteristic. In one case (project 3), the deflections were low enough that a slight decrease in rate throughout the project was recommended.

TABLE 1

ADJUSTED OVERLAY RATES

| Project (Section) | From | To | Sched. Overlay (psy) | Average Deflection ($d_o$, 1/1000 in.) | Adjusted Overlay (psy) |
|---|---|---|---|---|---|
| 1 | Throughout | | 150 | 2.304 | 150 |
| 2A | 1.5 mi. W. Charlotte CL | Route 1114 | 150 | 1.443 | 135 |
| 2B | Charlotte CL | 1.5 mi. W. | 150 | 2.103 | 200 |
| 3A | (Concrete) | | 150 | 0.919 | 135 |
| 3B | (Macadam) | | 150 | 1.316 | 135 |
| 4 | Throughout | | 125 | 1.227 | 125 |
| 5A | Route 658 | 1.3 mi. S. | 150 | 1.268 | 135 |
| 5B | 1.3 mi. S. Rte. 658 | Route 96 | 150 | 1.825 | 200 |
| 6A | Route 635 | 2.8 mi. S. | 150 | 1.359 | 135 |
| 6B | 2.8 mi. S. Rte. 658 | Route 751 | 150 | 2.074 | 220 |
| 7 | Throughout | | 150 | 1.887 | 150 |
| 8A | 3.01 mi. W. Rte. 24 | 5.01 mi. W. Rte. 24 | 150 | 1.330 | 135 |
| 8B | 0.75 mi. W. Rte. 24 | 3.01 mi. W. Rte. 24 | 150 | 2.070 | 200 |

## DISCUSSION OF RESULTS

### Reduction of Deflections

That the objective of reduced deflections was accomplished on all the projects is seen by reference again to Figures A-1 through A-8, where the average deflection was always reduced by the overlay. Now, the question of what deflection can be tolerated while maintaining acceptable overlay performance naturally arises.

The backlog of deflection-performance data in Virginia has application to relatively heavy duty pavements with high traffic volumes and is of little value in the evaluation of the thin, lightly traveled pavements presently under consideration. On the other hand, there has developed, over a number of years, a rule of thumb that Benkelman beam deflections in excess of 0.035 in. (.00125 in. dynaflect) are undesirable. At the same time, there is general agreement that tolerable deflection levels should be established with due consideration for traffic volumes and for pavement characteristics. For a fixed deflection level, increasing the volume of heavy wheel loads will cause more rapid pavement deterioration. Similarly, for fixed traffic conditions a pavement will tolerate, and be subjected to, lower deflections as its rigidity is increased.[2]

The pavements under consideration, with the exception of project no. 3, are lightly traveled and very flexible so that a higher deflection level may be tolerated. Benkelman[3] offers the following guidelines, which have been translated to terms of dynaflect deflection:

| Traffic Classification | Tolerable Deflection (1/1000 in.) |
|---|---|
| light | 2.00 |
| medium | 1.50 |
| heavy | 1.00 |

While the traffic classifications are not well defined, Benkelman[3] indicates that when traffic exceeds 1,000 or more vehicles per lane, including 10 percent trucks and buses, the design Benkelman beam deflections should not exceed 0.030 to 0.050 in. (0.0010 to 0.0018 in. dynaflect). For this reason, a truck and bus count of less than 100 per lane per day was considered as light traffic for the purposes of the present study. Also, for the present study truck and bus counts from 100 to 500 and in excess of 500 per lane per day were considered as medium and heavy, respectively. Clearly, 18-kip equivalency values would be more meaningful than T. T. & B. counts, but these are costly to determine and may not be justified for purposes other than original design.

In Table 2 the deflections are tabulated and compared to the tolerable values established above. Note that in most cases the average deflection was below or close to the tolerable level before the overlay was provided. This probably accounts for the relative longevity of most of the projects which had not been resurfaced for from 6 to 13 years (some surface treated sections had never received an asphaltic concrete overlay). After the resurfacings, only one project (no. 1) had an average deflection greater than the allowable. Again the substantial decrease in average deflection is evident.

TABLE 2

DEFLECTION DATA

| Project No. | T. T. & B. | Allowable Deflection (1/1000 in.) | Average Deflection (d , 1/1,000 in.) | | Standard Deviation | | % Exceeding Allowable Deflection | |
|---|---|---|---|---|---|---|---|---|
| | | | Before Overlay | After Overlay | Before Overlay | After Overlay | Before Overlay | After Overlay |
| 1 | 25 | 2.000 | 2.304 | 2.122 | 0.908 | 0.869 | 63 | 56 |
| 2A | 25 | 2.000 | 1.443 | 0.960 | 0.481 | 0.377 | 12 | 0 |
| 2B | 25 | 2.000 | 2.103 | 1.037 | 0.572 | 0.230 | 57 | 0 |
| 3A | 240 | 1.500 | 0.919 | 0.853 | 0.297 | 0.194 | 3 | 0 |
| 3B | 240 | 1.500 | 1.316 | 1.268 | 0.500 | 0.229 | 36 | 16 |
| 4 | 110 | 2.000 | 1.227 | 1.028 | 0.294 | 0.244 | 0.4 | 0 |
| 5A | 80 | 2.000 | 1.268 | 1.217 | 0.389 | 0.379 | 3 | 2 |
| 5B | 80 | 2.000 | 1.825 | 1.491 | 0.682 | 0.444 | 40 | 13 |
| 6A | 20 | 2.000 | 1.359 | 1.165 | 0.330 | 0.360 | 13 | 1 |
| 6B | 20 | 2.000 | 2.074 | 1.315 | 0.590 | 0.234 | 55 | 0.2 |
| 7 | 120 | 2.000 | 1.887 | 1.249 | 0.834 | 0.447 | 45 | 5 |
| 8A | 105 | 2.000 | 1.330 | 1.017 | 0.332 | 0.266 | 2 | 0 |
| 8B | 105 | 2.000 | 2.070 | 1.696 | 0.584 | 0.439 | 56 | 25 |

From the relatively limited number of projects studied, it is hard to determine a pattern of average deflection reduction as related to overlay thickness. For example, reductions of from 7.9 to 33.8 percent resulted from 125-150 psy (1.1 to 1.4 inches) overlays while those resulting from the 200-220 psy (1.8 to 2.0 inches) applications ranged from 18.1 to 31.7 percent. Average reductions were 20.1 percent and 21.7 percent for the light and heavy applications, respectively. Benkelman[3] points out that in other states overlay effectiveness per inch reduced as the thickness was increased. He cites one example where a 1 inch overlay caused a 29 percent reduction, while the values for 3 and 6 inch applications were 42 and 54 percent, respectively.

The average deflection, however, is only partly descriptive of the ability of a pavement to carry prevailing traffic. Since in any case 50 percent of the deflections are above the average, it is necessary to consider both the average and the variability of a set of deflection data. By doing this, the possibility of having the average equal to the allowable and thus permitting half the pavement to fail early is avoided.

Statistical analyses of deflection data from the study pavements resulted in the standard deviations shown in Table 2. Again the analyses apply to pavement conditions both before and after the resurfacings. As can be seen, the resurfacings have caused a substantial reduction in variability in nearly every case. This reduced variability may be of more importance than that of reduced average deflection, and probably is the result of the overlays having a more pronounced strengthening effect in very weak pavement areas.

If the measured deflections, in light of their variability, are compared with the allowable it can be seen, also in Table 2, that before resurfacing most of the projects had a significant percentage of excessive deflections. After the resurfacing, most projects showed deflections reduced to where few if any exceeded the allowable. Since it is often not practical to reduce all deflections below the allowable, it is usual practice to permit some percentage to exceed this level. California[2] permits 20% of their deflections to exceed the allowable, arguing that it is not economically feasible to correct all weak support conditions. It is recognized that isolated areas might require additional maintenance at an early date after resurfacing. If the projects in the present study are viewed in this way, it can be concluded that all projects except no. 1 and the B section of project 8 have been sufficiently strengthened by the overlay operations.

While strengthening has been significant, it is impossible to assign an expected life to the resurfacings because it is presently impractical to accurately assess the traffic conditions. Other studies currently under way in the Pavement Section would permit the estimation of 18-kip equivalency ratings from the routinely available traffic counts on primary highways.

## Effective Overlay Thickness

Vaswani[1] has developed a method for pavement evaluation based on theoretical concepts and on the characteristics of the measured deflection basin mentioned earlier. Using this method, the pavement thickness index (equivalent asphaltic concrete thickness) and the modulus of elasticity of the supporting subgrade soils can be estimated.

Thus, a combination of pavement components (crushed stone, stabilized soil, etc.) can be expressed as equivalent to some thickness of bituminous concrete underlain by a subgrade having a given strength.

The application of this approach to the study pavements is indicated in Table 3. Spreadabilities were computed from average deflection data utilizing all five sensors (Figure 1). Thickness indices were determined for all test sections (Reference 1, Figures 5 and 11), both before and after resurfacing. Similarly, both before and after subgrade moduli were determined.

Thickness indices ranged from 3.2 to 7.0 (old concrete pavement overlain by old plant mix) before the resurfacings, and from 4.4 to 8.3 (old concrete, etc.) afterwards. By comparison of the before and after thickness indices for a given project, the indicated increase in the thickness index was determined. This indicated increase was, in turn, compared to the actual overlay thickness to determine the effectiveness of the overlay. The table shows that when all projects and subsections were evaluated in this manner, the overlay effectiveness ranged from 50 to 158 percent, with an average of 110 percent. Average effective increases in thickness index were 1.5 and 1.7 for the 125-150 psy and the 200-220 psy applications,respectively.

Variations in overlay effectiveness were very likely due to variations in subgrade quality as reflected in the subgrade moduli (Table 3). Note that project 1 had the lowest subgrade modulus and the least effective overlay. This finding supports the position, long held by highway engineers, that when subgrades are very weak an overlay is insufficient and that subgrade strengthening is indicated. On this project, the overlay was only 50 percent effective with 56 percent of the deflections exceeding the allowable after the overlay. While only observations of performance will indicate the true adequacy of the overlay, it is likely that the project will perform poorly. Since the project was surface treated, a suitable temporary alternative to reconstruction might have been to renew the surface treatment. This would have permitted a higher tolerable deflection with better prospects for long service.

Other projects (nos. 2 and 5 for example) showed significant differences in the before and after subgrade moduli. These differences probably were largely due to changes in the subgrade moisture conditions between the 1970 and 1971 tests. It is likely that a decrease in modulus indicates an increase in subgrade moisture content while an increased modulus suggests subgrade drying. Deflections naturally are influenced by changes in subgrade support and should be evaluated when the support is in a minimum condition, because they are maximum at that time.

## TABLE 3

## STRUCTURAL DATA

| Description | | Deflection $d_o$ Average (1/1,000 in.) | | | Spreadability (Averages) | | Indicated Thickness Index | | | | | Subgrade Mod. (psi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project No. | Overlay Rate, psy | Before | After | Reduction, % | Before | After | Before | After | Indicated Increase | Actual Increase, in. | Overlay Effect, % | Before | After |
| 1 | 150 | 2.304 | 2.122 | 7.9 | 51 | 53 | 4.1 | 4.8 | 0.7 | 1.4 | 50 | 4,000 | 3,900 |
| 2A | 135 | 1.443 | 0.960 | 33.5 | 49 | 55 | 4.7 | 6.4 | 1.7 | 1.2 | 142 | 7,000 | 8,500 |
| 2B | 200 | 2.103 | 1.037 | 31.7 | 49 | 56 | 4.0 | 6.2 | 2.2 | 1.8 | 122 | 4.600 | 7,500 |
| 3A | 135 | 0.919 | 0.853 | 7.2 | 54 | 63 | 6.4 | 8.3 | 1.9 | 1.2 | 158 | 9,000 | 7,200 |
| 3B | 135 | 1.316 | 1.268 | 3.7 | 62 | 69 | 7.0 | 8.3 | 1.3 | 1.2 | 108 | 4,800 | 4,100 |
| 4 | 125 | 1.227 | 1.028 | 16.2 | 47 | 54 | 4.3 | 6.0 | 1.7 | 1.1 | 154 | 9,700 | 8,100 |
| 5A | 135 | 1.268 | 1.217 | 11.8 | 49 | 59 | 4.8 | 6.6 | 1.8 | 1.2 | 150 | 8,200 | 5,500 |
| 5B | 200 | 1.825 | 1.491 | 18.3 | 45 | 53 | 3.5 | 5.1 | 1.6 | 1.8 | 89 | 6,300 | 5,300 |
| 6A | 135 | 1.359 | 1.165 | 14.3 | 47 | 50 | 4.0 | 5.0 | 1.0 | 1.2 | 83 | 8,500 | 8,200 |
| 6B | 220 | 2.074 | 1.315 | 18.5 | 44 | 49 | 3.2 | 4.8 | 1.6 | 2.0 | 80 | 5,800 | 7,800 |
| 7 | 150 | 1.887 | 1.249 | 33.8 | 47 | 54 | 3.8 | 5.7 | 1.9 | 1.4 | 136 | 6,000 | 6,300 |
| 8A | 135 | 1.330 | 1.017 | 23.5 | 46 | 50 | 4.1 | 5.3 | 1.2 | 1.2 | 100 | 9,000 | 9,700 |
| 8B | 200 | 2.070 | 1.696 | 18.1 | 45 | 49 | 3.2 | 4.4 | 1.2 | 1.8 | 67 | 5,500 | 5,800 |

## Pavement Condition

All eight of the projects were inspected after the overlays had been in service approximately one year. In general, the first year's performance has been excellent with only two of the projects and subsections showing distress. These were:

(a) Project No. 1

The project has a few isolated longitudinal cracks that appear to be load related. This is not surprising, since deflections were highest on this project and the overlay was least effective.

(b) Project No. 4

The project has numerous random cracks of various sizes and forms. Most do not appear to be load related, but to reflect from the underlying badly cracked and patched pavement. The thinnest overlay (125 psy) was used on this project which had the lowest deflection with the exception of project no. 3. The project was expected to perform better than it has.

The only other noticeable features on any of the projects was a small amount of stripping in the wheelpaths of projects 6 and 7 and reflection cracks from the old concrete underlying project no. 3.

## CONCLUSIONS

The study reported herein was of the nature of a feasibility study so that all the possible areas of research have not yet been examined thoroughly. For example, a study of resurfaced sections in comparison with unresurfaced control sections and a study of traffic estimation methods will be discussed in a second progress report.

While at present few firm conclusions can be offered, the following appear to be at least partially supported by the data presented.

1. Deflections can be significantly reduced by asphaltic concrete overlays. The use of thicker mats in high deflection areas tends to produce a leveling effect throughout a project.

2. Deflection variability is significantly reduced by resurfacing, which suggests that high deflection areas are more markedly affected by an overlay.

3. However, where very high deflections result from weak subgrade soils, an overlay is less effective and may in certain cases be inadvisable.

4. As measured by the deflection reduction, overlay effectiveness per inch of thickness is reduced as the thickness is increased.

## RECOMMENDATION

The preliminary studies reported have given ample evidence that overlay design could be a fruitful area of further research. While it is recognized that its application in some cases would be overshadowed by financial and other considerations, a systematic overlay design procedure clearly could be useful as a maintenance tool. Among other uses of such a tool could be the quantitative establishment of temporary weight restrictions where unusual traffic or moisture conditions prevail.

It is recommended that efforts proceed toward the development of an overlay design procedure to be used by maintenance engineers. Since much of the background for such a procedure has been developed here and in other Research Council studies, it is believed that a completed procedure could be developed in from one to two years. The studies would give particular emphasis to low traffic primary highways and might encompass the following:

1. The definition of realistic tolerable deflections based on pavement characteristics and on prevailing traffic conditions.
2. The refinement of thickness index concepts for application to the determination of overlay thickness.
3. The development of guidelines indicating whether a pavement should be resurfaced, reconstructed, or continued in service as is or with reduced wheel loads.

## ACKNOWLEDGEMENTS

The cooperation and encouragement of P. F. Cecchini, assistant state maintenance engineer, in the conduct of this study is gratefully acknowledged. Also acknowledged are J. H. Phillips, district engineer, H. C. Chryssikos, assistant district engineer, and the maintenance personnel in the Lynchburg District who provided background information and assisted in the field testing. Dr. N. K. Vaswani, R. W. Gunn and G. V. Leake of the Council staff are to be commended for their varied contributions to the conduct of the study.

## REFERENCES


1. Vaswani, N. K., "A Method for Evaluating the Structural Performance of Subgrades and/or the Overlying Flexible Pavements," Interim Report No. 3, Virginia Highway Research Council, February 1971.

2. Zube, Ernest, and Raymond Forsyth, "Flexible Pavement Maintenance Requirements as Determined by Deflection Measurement", HRB Record No. 129, January 1966.

3. Benkelman, A. C., "General Discussion", HRB Record No. 129, January 1966.

# APPENDIX

TABLE A-1

PROJECT DESCRIPTIONS

Description of Pavement Cross Section and Overlays

#1 — Route 40 — Charlotte County

From: WCL Phenix
To : Rte. 672

Typical Section —

18 ft. Pavement Width
6" to 10" Topsoil Base
Surface Treated

Additional Pavement Overlays —

None — No records available.

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#2 — Route 40 — Campbell County

From: Charlotte County
To : Route 1114

Typical Section —

20 ft. Pavement Width
6" to 10" Topsoil Base
Surface Treated

Additional Pavement Overlays —

In 1951, this section was reworked by breaking up the old surface treatment, adding crusher run stone and mixing with a Seaman's mixer. A seal was then applied. State forces then placed a mixed-in-place treatment with a motor-paver. Since that time several seal treatments have been applied as needed. No other records are available on this section.

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#3 — Route 501 — Halifax

From: SCL Halifax
To : Int. Rte. 129

Typical Section, South Bound Lane —

20 ft. Pavement Width
8" Portland Cement Concrete Base

Additional Pavement Overlays —

This section was surface treated prior to 1949. In 1950 100 psy of H-2 bituminous concrete binder was added because pavement cross section was very rough. In 1957, this section had 150 psy of F-1 modified bituminous concrete applied.

#3 — cont'd.

Typical Section, North Bound Lane —

22 ft. Pavement Width
10" W.B. Macadam Base
Surface Treated
Built in 1949

Additional Pavement Overlays —

In 1950, 100 psy of H-2 bituminous concrete binder was applied. This section was very rough due to increased traffic loads as this is a dual highway location now. In 1957, this section had an application of 150 psy of F-1 modified bituminous concrete applied.

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#4 — Route 501 — Halifax County

From: Rte. 603 (Volens)
To : 3.6 Mi. South

Typical Section —

20 ft. Pavement Width
6" to 8" Topsoil for Base
Surface Treated

Additional Pavement Overlays —

Prior to 1961, this section had only surface treatment applied. In 1961, H-2 bituminous concrete binder was used to build up curves to meet standards. The section was overlayed at this time with 155 psy of I-3 bituminous concrete surface. This work in 1961 was done under Plant Mix Schedule No. 310-61.

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#5 — Route 501 — Halifax County

From: Rte. 658
To : Rte. 96

Typical Section —

20 ft. Pavement Width
Topsoil Base (Depth unknown)
Surface Treated

Additional Pavement Overlays —

In 1957, this section had an application of F-1 modified bituminous concrete surface applied at the rate of 150 psy.

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#6 — Route 151 — Nelson County

From: Rte. 635
To : Rte. 751

Typical Section —

20 ft. Pavement Width
Topsoil Base (Depth unknown)
Surface Treated

Additional Pavement Overlays —

None — No records available.

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#7 — Route 60 — Amherst County

From: Rte. 715
To : 1.0 Mi. E. Rte. 635

Typical Section —

20 ft. Pavement Width
Either 6" or 8" W. B. Macadam Base
Surface Treated — Approximately 150 psy of plant mix, about 1960.

Additional Pavement Overlays —

Surface treatment possible prior to 1964. In 1964, this section had 150 psy of I-3 bituminous concrete added. This was done under Plant Mix Schedule #304-64.

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#8 — Route 60 — Buckingham County

From: 0.8 Mi. W. Rte. 24
To : 5.01 Mi. West

Typical Section —

20 ft. Pavement Width
Topsoil Base (Depth unknown)

Additional Pavement Overlays —

Prior to 1962, this section possibly had some seal treatments done by state forces or let on surface treatment schedules. In 1962, this section had 150 psy of I-3 bituminous concrete applied under Plant Mix Schedule No. 307-62.

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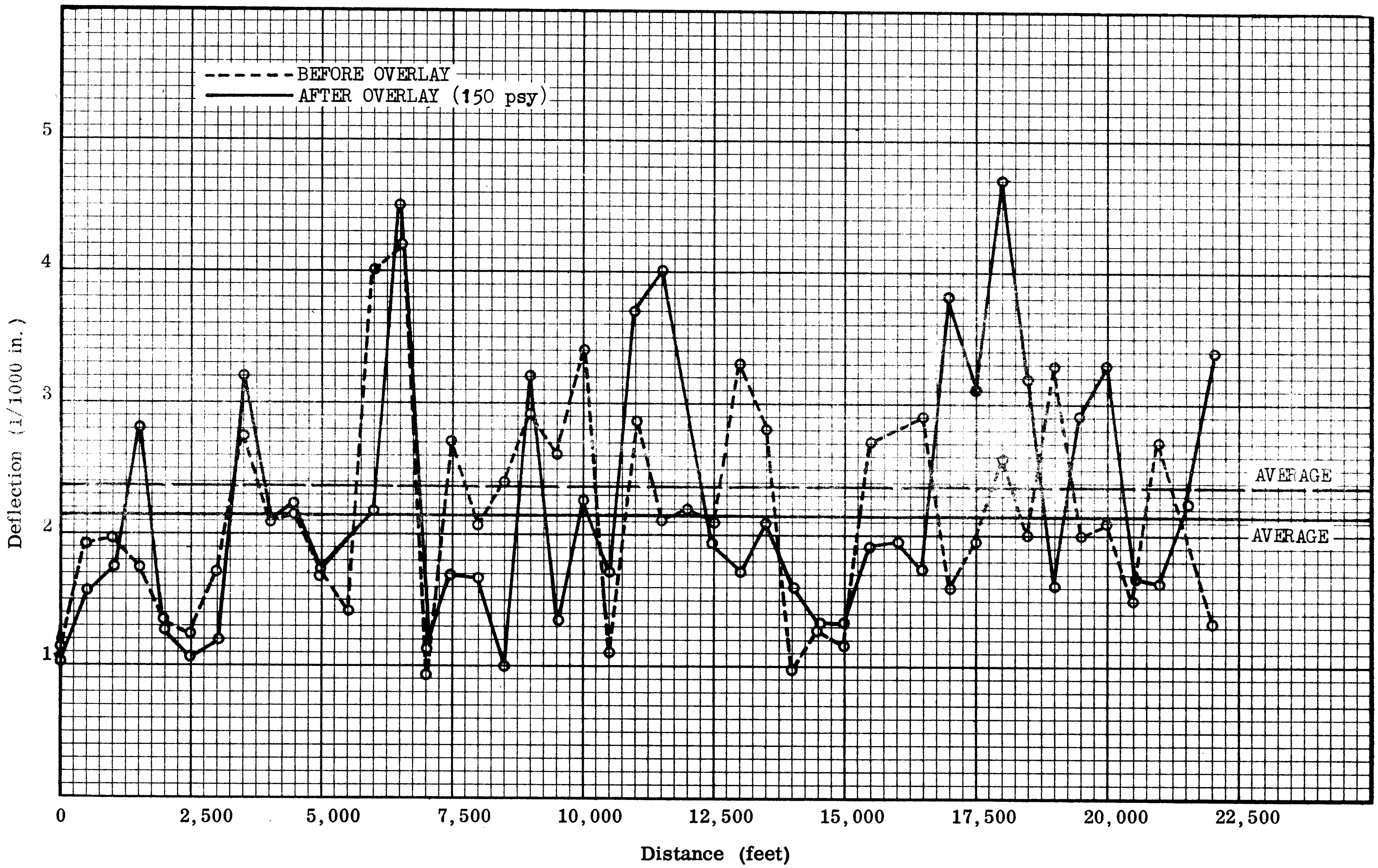


Figure A-1. Deflections before and after overlay, Project 1.

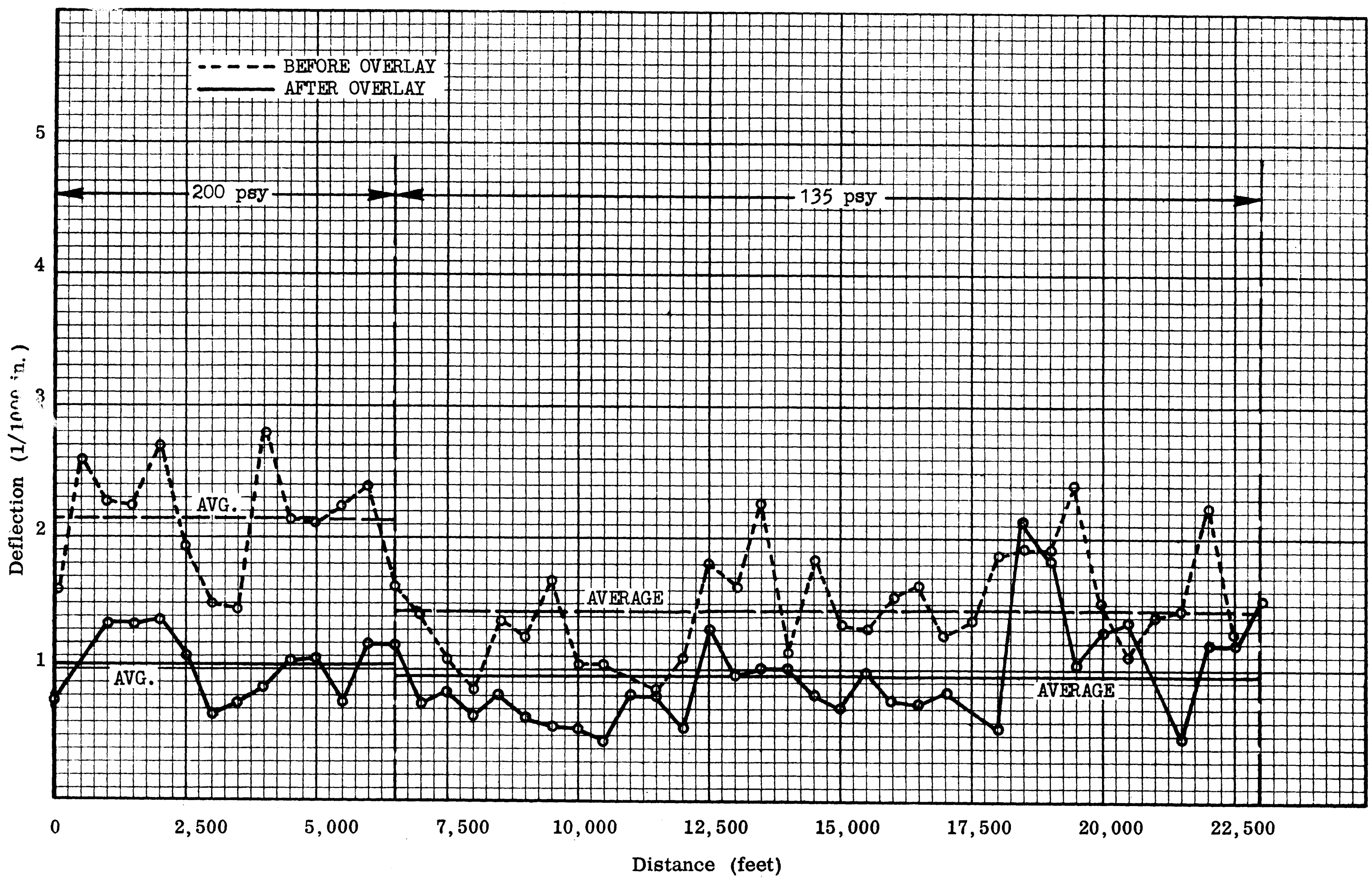


Figure A-2. Deflections before and after overlay, Project 2.

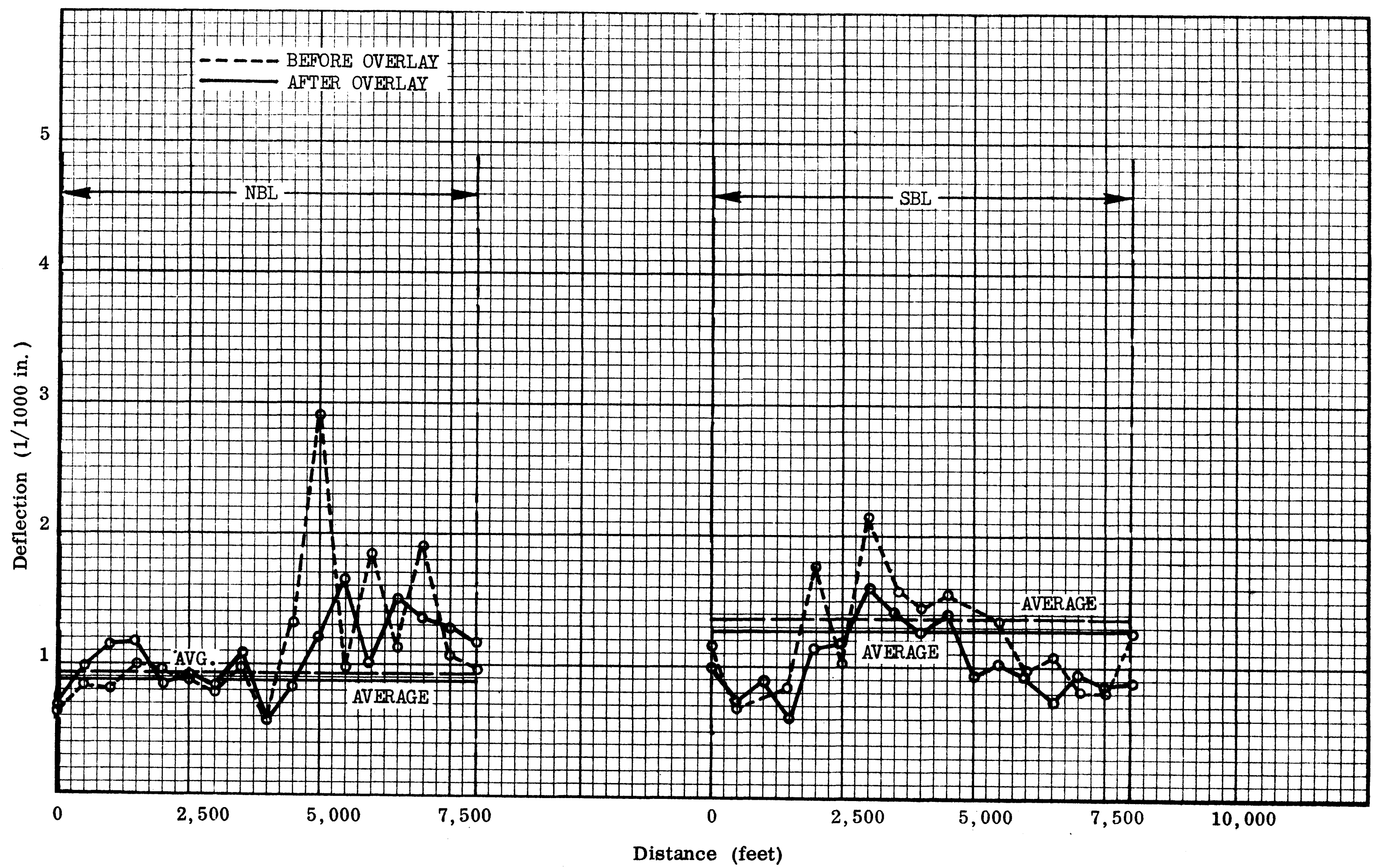


Figure A-3. Deflections before and after overlay, Project 3.

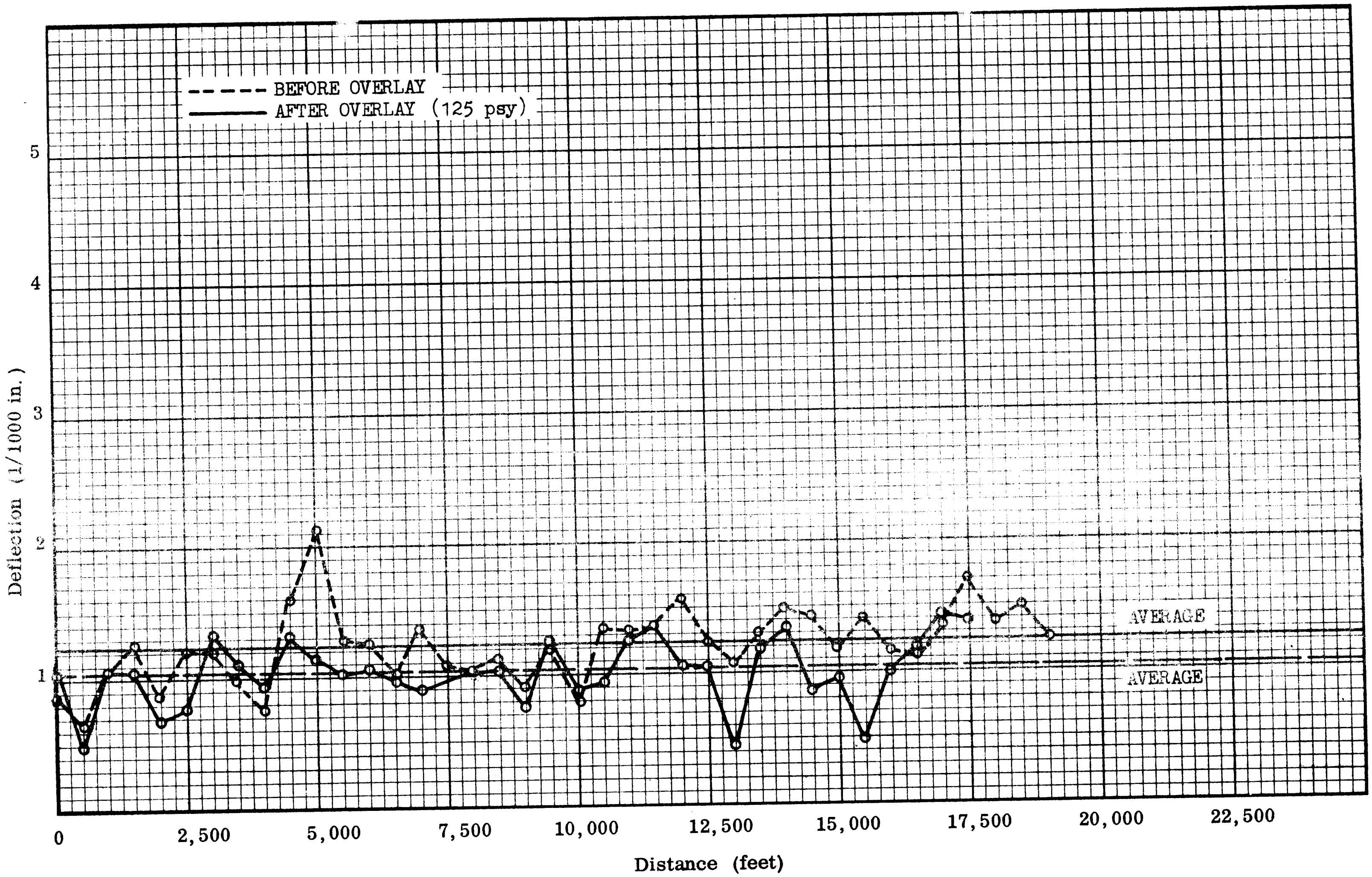


Figure A-4. Deflections before and after overlay, Project 4.

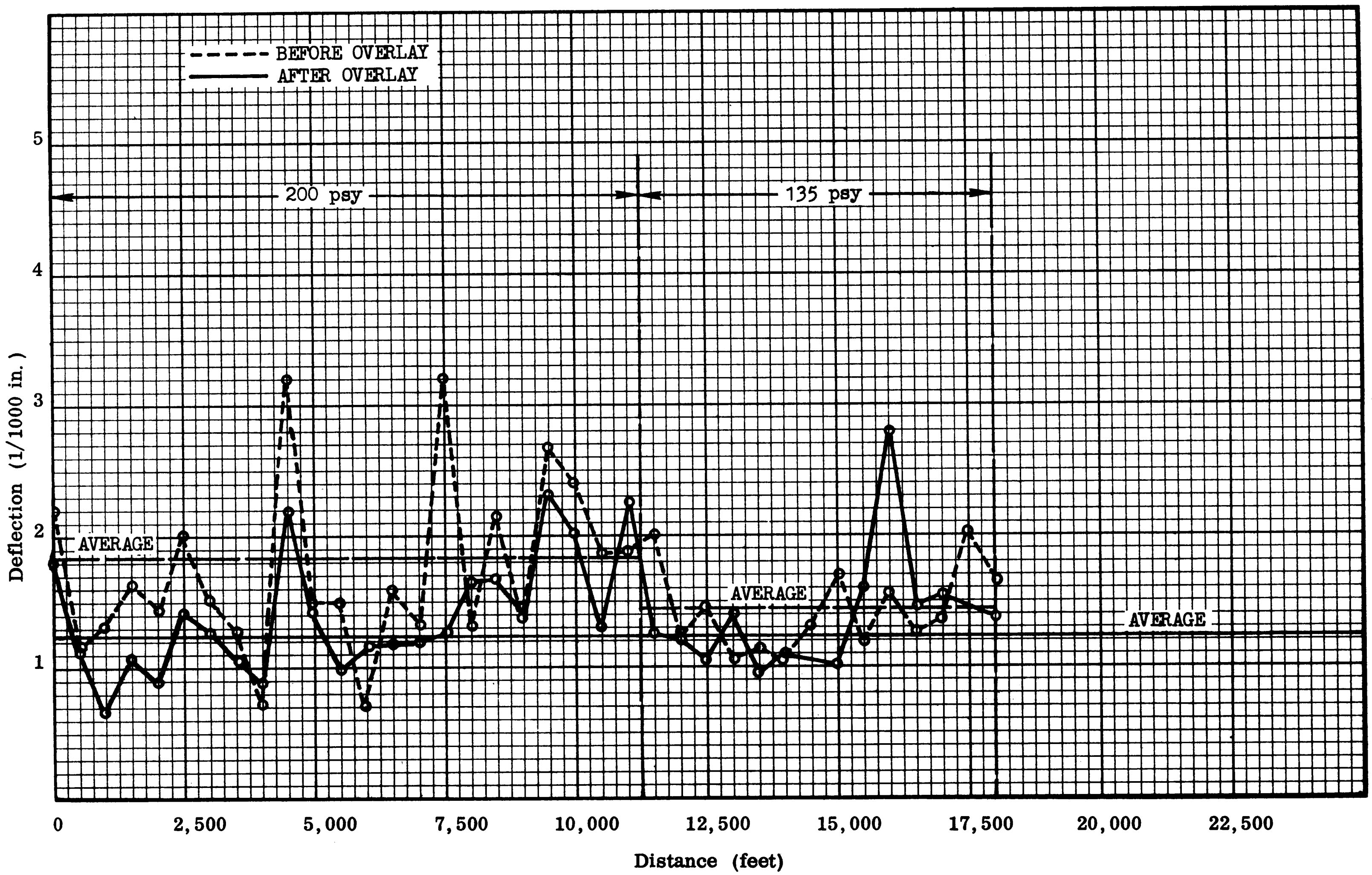


Figure A-5. Deflections before and after overlay, Project 5.

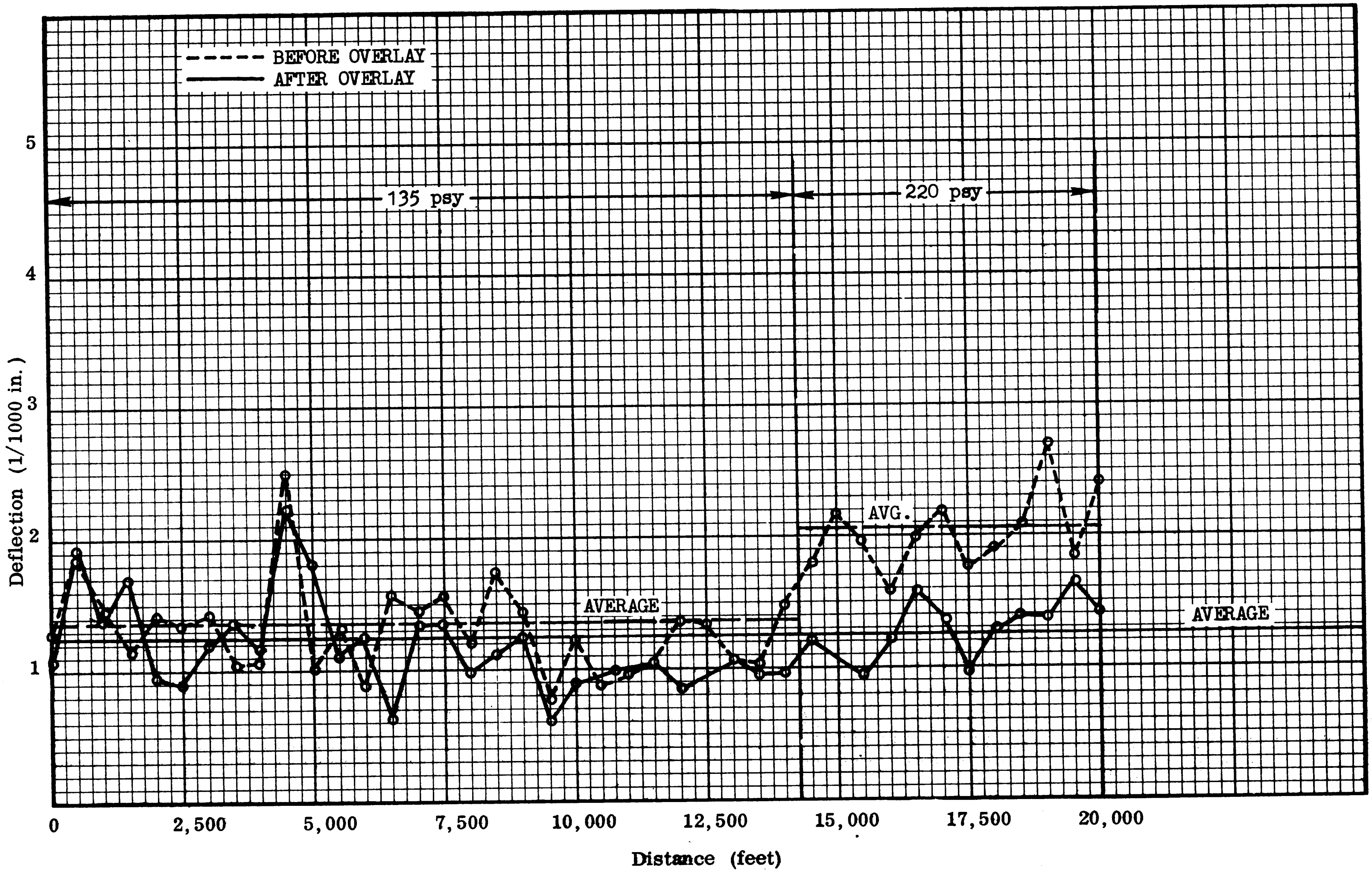


Figure A-6. Deflections before and after overlay, Project 6.

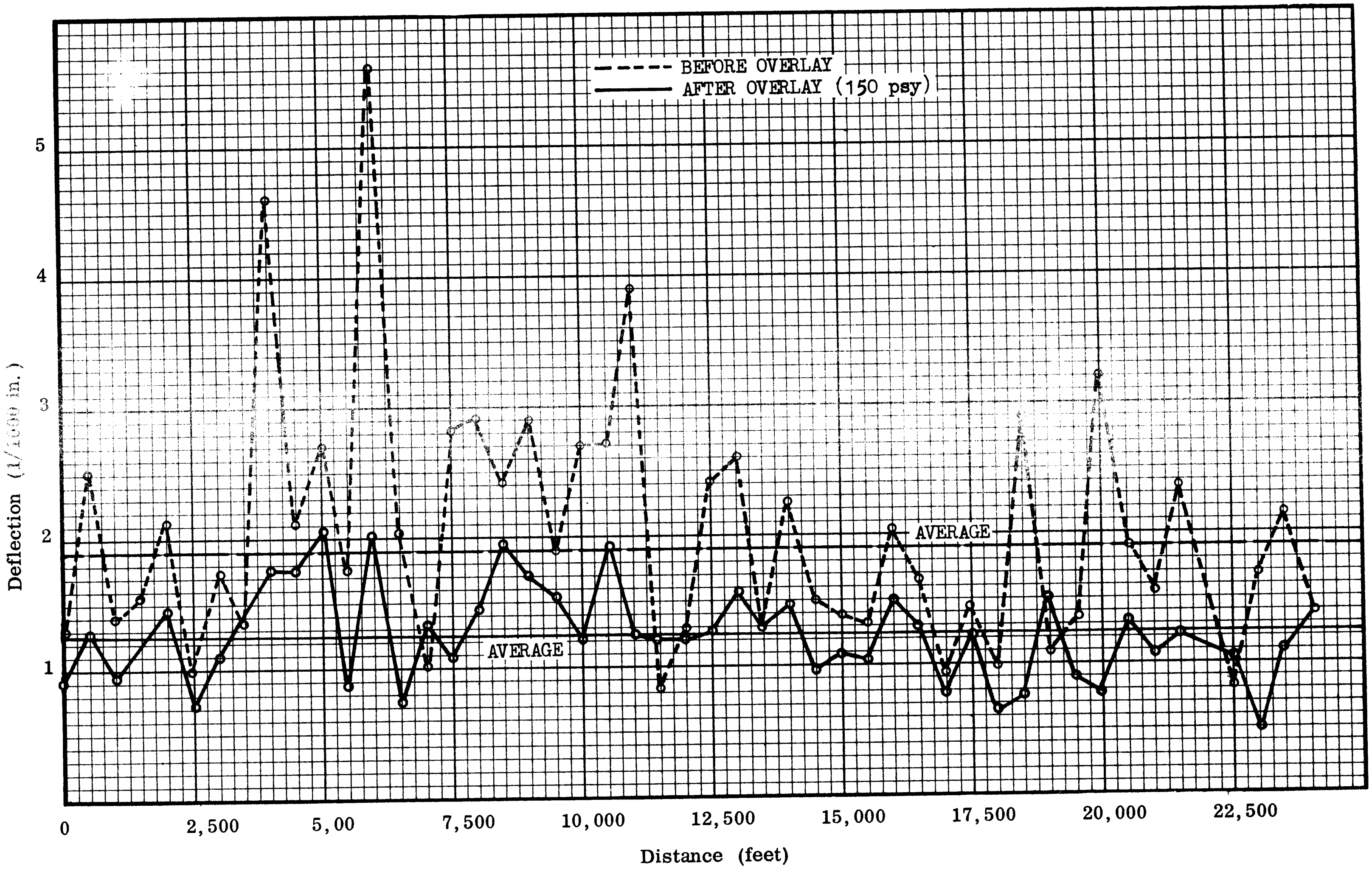


Figure A-7. Deflections before and after overlay, Project 7.

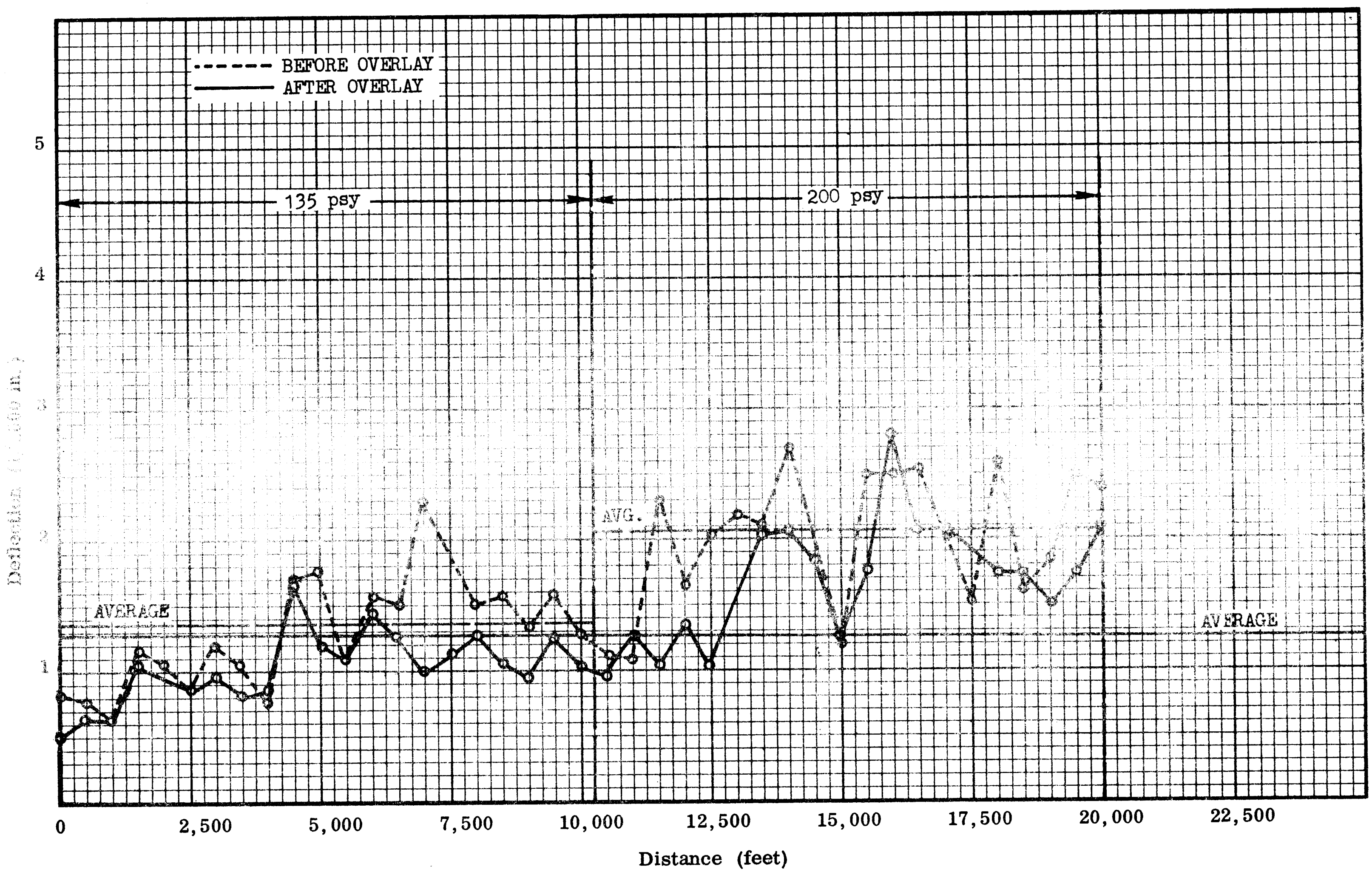


Figure A-8. Deflections before and after overlay, Project 8.