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LONGITUDINAL WEDGE JOINT STUDY

A FINAL REPORT

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by

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16. Abstract

This report describes the results of a five-year study undertaken to develop a technique for producing more durable longitudinal construction joints in bituminous pavements. The construction procedure evaluated involves forming the joint between adjoining lanes as two overlapping wedges. The wedge joint is formed by a steel plate attached to the paver screed which produces a 3:1 sloped face at the edge of the first bituminous mat placed.

The effectiveness of the wedge joint was measured by the extent to which this procedure was able to eliminate a "density gradient" across the joint. Nuclear density testing and coring were undertaken to determine the uniformity of the density across the joint and hence, the nature of the density gradient.

Density measurements were taken across the wedge joint and compared to the standard longitudinal center joint. These measurements indicate that the wedge joint has a more uniform density across the joint and has a higher average density than the standard joint. The wedge joint eliminates the density gradient and hence, lowers the potential for joint deterioration.

By eliminating the vertical edge, the wedge joint eliminates the vertical dropoff and offers a safer condition to the motorist when making lane changes in construction areas.

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IMPLEMENTATION STATEMENT

As a result of the findings of this study, a decision has been made to adopt the wedge joint technique as the Department's standard procedure for constructing longitudinal joints in bituminous pavements. The standard specifications are currently being revised to reflect that decision. A master change order is also being drafted to incorporate the use of this technique on ongoing projects.

Implementation of the wedge joint technique should be relatively straightforward since many contractors and Department personnel are familiar with its use.

TABLE OF CONTENTS

LIST OF FIGURES

PART ONE: INTRODUCTION

1.1 Objective

This report describes the results of a five-year study undertaken to develop a technique for producing more durable longitudinal construction joints in bituminous pavements. The construction procedure evaluated involves forming the joint between adjoining lanes as two overlapping wedges. This "wedge joint" is formed by a steel plate attached to the paver screed which produces a 3:1 sloped face at the edge of the first bituminous mat placed.

1.2 Background

1.2.1 Joint Durability

In placing bituminous concrete, it is often impossible to pave the full width of the pavement in a single pass. This is particularly true in the case of the resurfacing and rehabilitation work which now constitutes the primary focus of the Department's capital program. As a practical necessity then, most bituminous pavements contain longitudinal construction joints.

As is well-known, these construction joints can be the weak link in the chain which subsequently causes an otherwise sound pavement to deteriorate. The typical stages of distress of longitudinal joints include an initial separation, the ingress of water and incompressibles, and finally, cracking and ravelling.

There is no truly effective means of repairing distressed longitudinal joints. Figure 1 shows a photograph of typical longitudinal joint distress on a major highway (Route I-295) in the vicinity of Trenton. As noted in the photograph, the Department has undertaken some rather costly repair measures in an attempt to correct the severe joint distress. This repair strategy involves sawing out the pavement on either side of the joint, excavating the bituminous material, and

Figure 1

TYPICAL LONGITUDINAL JOINT

DISTRESS AND REPAIR.

installing a replacement inlay. Whether or not these expensive remedial measures will provide a long-term solution remains to be determined.

One procedure for minimizing joint distress is to require that the two adjoining mats both be hot enough during construction so as to permit adequate compaction. In an attempt to avoid these so-called "cold" longitudinal construction joints, New Jersey's specifications limit the length of a bituminous mat which may be placed before bringing the paver back to place the subsequent lane to 1500 feet. This method clearly has not been successful in the elimination of cold joints and subsequent joint deterioration. Indeed, due to New Jersey's high prevailing traffic volumes, it is often impossible to enforce this limitation on resurfacing work.

1.2.2 Safety Considerations

In the lane-at-a-time paving typically used on resurfacing projects, there is obviously a height differential between the newly placed mat and the adjoining pavement. This vertical "step-off" can pose a hazard to traffic travelling through the construction area, especially if lane changes are required.

A recent (unpublished) national survey of highway engineers (Ref.1) indicated that thirty to forty percent of the respondents were of the opinion that the step-off was "somewhat" or "extremely" hazardous to compact cars and motorcycles.

States have employed a variety of measures to deal with this perceived safety problem, including prohibiting step-offs, limiting their height, the use of special signing, and limiting the time within which the adjacent lane must be paved. New Jersey's typical practice is to minimize the use of lane-to-lane changes in the construction work zone and to require that the joining lanes be paved the same day. However, depending on project conditions, exceptions to this policy do occur (e.g., on Maintenance resurfacing projects).

1.2.3 Proposed Solution

Beginning in 1982, the New Jersey Department of Transportation began experimenting with improved longitudinal joint construction techniques. Based on a literature review, the most promising technique was the use of the so-called "wedge" joint. One of the first agencies to form joints using overlapping wedges was the Arizona DOT. In the Arizona work, the joint was formed by a sloping shoe attached to the paving machine. This shoe produced a wedge which tapered from 2" to zero over a 1 foot length. After compacting the face of the wedge with a pneumatic-tired roller, the adjoining lane was paved to form the finished joint.

In adapting this wedge joint for trials in New Jersey, two modifications were made. The first was to use a steeper sloping face (3:1 vs. 6:1) to reduce the potential for ravelling and second, to supplement the use of the wedge joint with infrared heating.

Supplemental heating of longitudinal joints has been used with at least some success with conventional vertical butt joints (see, e.g., Ref. 2). It was postulated that such supplemental heating could be used with particular effectiveness with the wedge joint by softening the wedge immediately before placement of the second (overlapping) mat, thereby providing a denser, more homogeneous joint.

PART TWO: RESEARCH METHODOLOGY

The primary measure used to gauge the effectiveness of the wedge technique was the extent to which this procedure was able to eliminate a "density gradient" across the joint.

The significance of such joint density gradients was pointed out by Foster (Ref. 2). In a 1964 paper, Foster presented the results of density tests on cores taken from variously constructed longitudinal joints. One of the primary findings of that study was that in poor-performing (cold) joints, there is a low density zone at the joint in the lane first paved (i.e., the "unconfined" joint edge) and a high density zone in the adjoining lane (the "confined" edge). Foster concluded that elimination of this differential was the basic problem in constructing a durable longitudinal joint. He theorized that this differential density was a major factor permitting the initial opening of the joint and the subsequent inevitable process of distress.

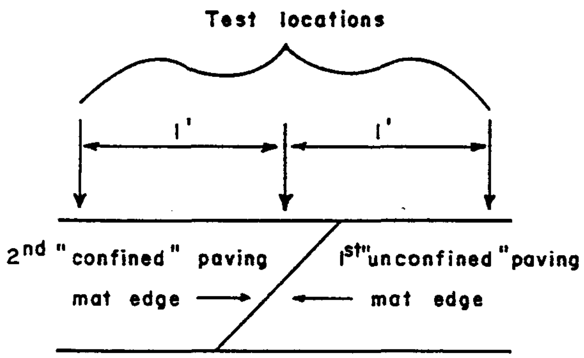
As noted above, Foster's research made comparisons only between various types of conventional butt joints. By virtue of its geometry alone, it was expected that the wedge joint technique would provide a more monolithic, better-performing joint. Simply, by eliminating the vertical shear plane in the conventional butt joint, the finished joint should be more resistant to opening due to the effects of traffic or temperature changes.

To test this assumption, a program of nuclear gauge testing and supplemental coring was undertaken to determine the uniformity of density across the joint and hence, the nature of any density gradient. As shown in Figure 2, at a given location, those density measurements were taken directly over the joint and one foot on either side.

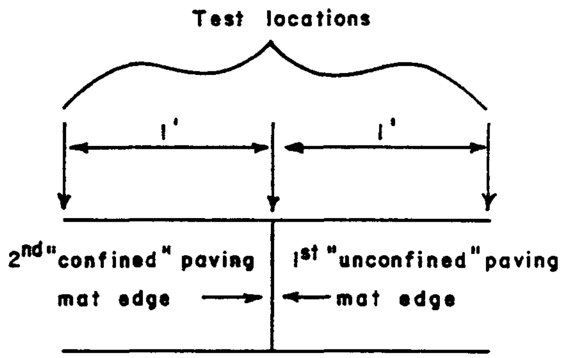
This program of density testing was performed on five resurfacing projects and one new bituminous concrete pavement. On three of those projects, a control section consisting of the conventional butt joint was incorporated to provide a specific basis of comparison to the wedge joint.

No formal testing was performed to determine the relative safety advantage of the wedge joint as compared to the conventional vertical joint. That the wedge joint does, in fact, possess such an advantage seemed intuitively obvious.

Figure 2: DENSITY TEST LAYOUT



A. Wedge Joint



B. Conventional Joint

PART THREE: JOINT CONSTRUCTION TECHNIQUES/EQUIPMENT

3.1 Conventional Butt Joint Construction

Figure 3 shows the sequence of operations involved in the construction of a typical New Jersey "butt" type joint. After placing the first bituminous mat, the subsequent lane overlaps the first lane by 2 to 4 inches (Figure 3a). The overlapped material is pushed back with a lute, creating a bump (Figure 3b). Rolling in the first lane overlaps the subsequent lane by about 6 inches (Figure 3c). In the subsequent lane, the roller pinches the material into the joint (Figure 3d).

3.2 Wedge Joint Construction

As shown in Figure 4, the longitudinal wedge joint consists of two overlapping wedges. The (3:1) inclined face of the joint is formed in the first bituminous mat placed by a sloping steel plate (Figure 5) which is attached to the inside corner of the paver screed extension. A typical wedge plate installation is shown in Figure 6. The plate is mounted about 3/8 to 1/2 inch above the existing pavement. The specific dimensions of the wedge joint plate and the attachment details vary with paver models.

After the initial mat is placed using the wedge forming plate, the mat is rolled to the top of the unconfined edge. In this operation, the roller should not extend more than 2 inches past the top of the unconfined edge (Figure 7). The inclined face of the wedge edge should not be compacted: Leaving the unconfined edge in an uncompacted state permits a more homogeneous bond with the second mat, thereby providing a denser finished joint. The appearance of the unconfined wedge edge and the rolling operation are shown in Figures 8 and 9.

When the second paving mat is placed, an infrared heater attached to the side of the paver heats the unconfined joint edge. This preheating and softening

Figure 3

CONSTRUCTION OF TYPICAL BUTT JOINT

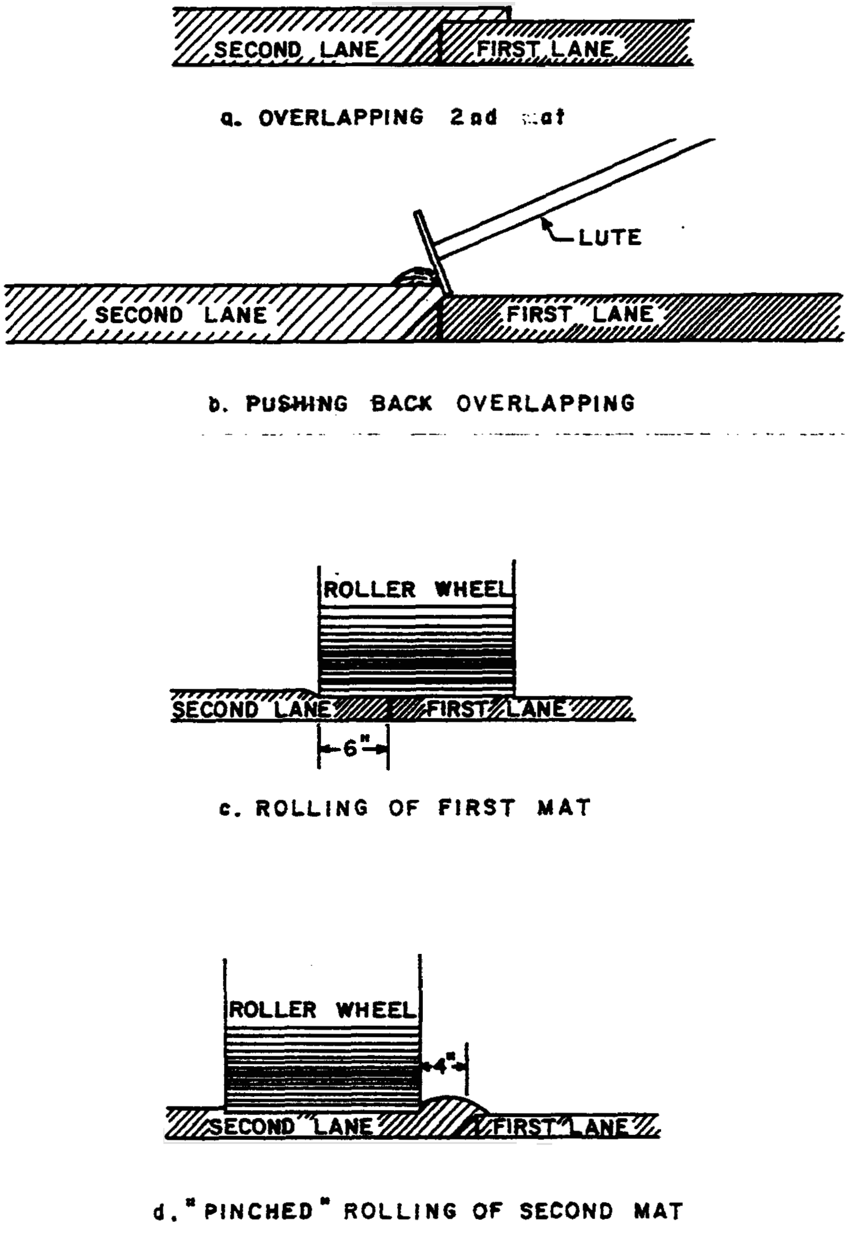
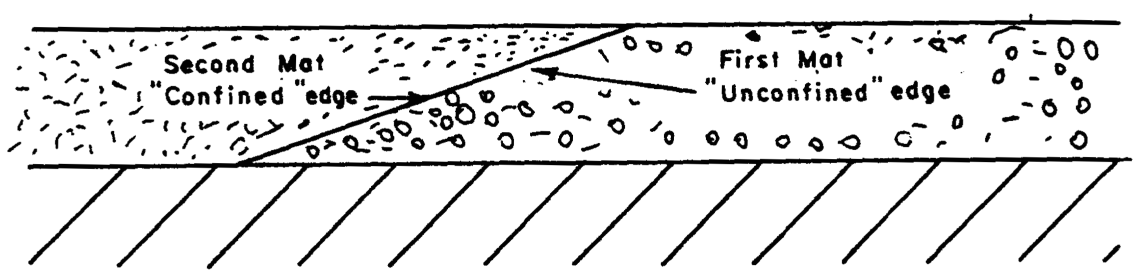


Figure 4

CROSS SECTION OF WEDGE JOINT



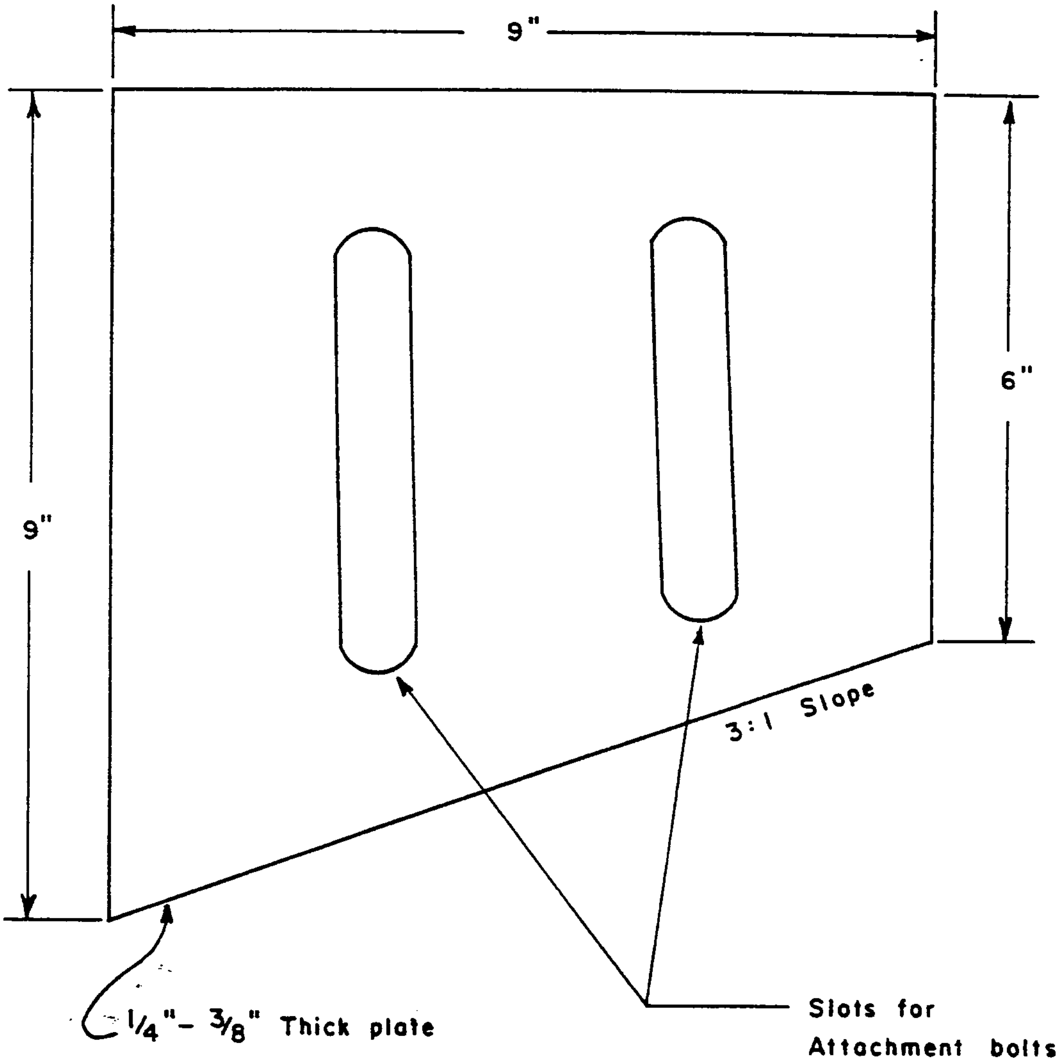


Figure 5

TYPICAL WEDGE PLATE DESIGN

Figure 6

Typical Attachment at Wedge

Plate to Paver

Figure 7

COMPACTION PROCEDURE AT UNCONFINED WEDGE EDGE

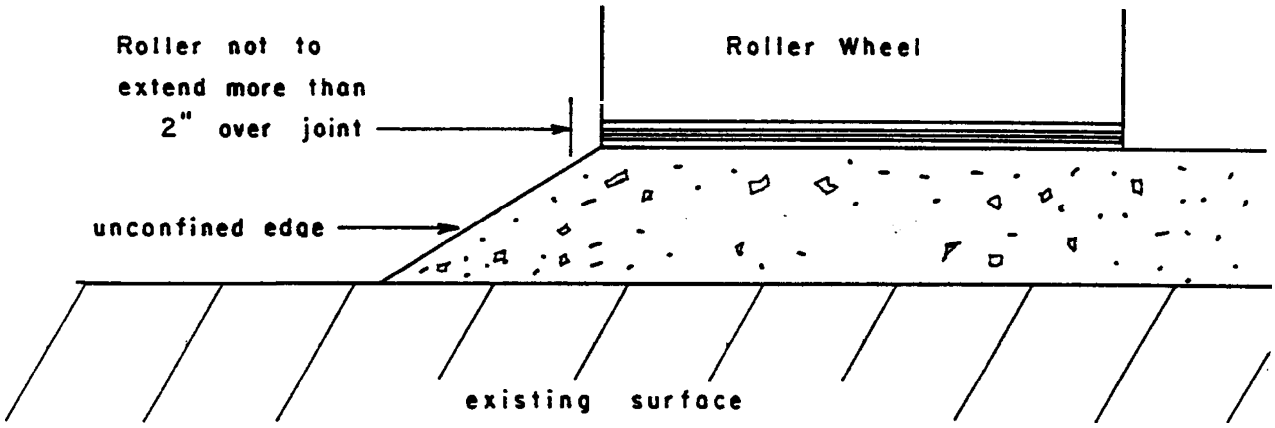


Figure 8
Initial (Unconfined) Wedge Edge

Figure 9
Rolling the mat at the Wedge edge.

of the joint edge and the adjoining mat is designed to provide a more monolithic joint and to increase the achievable density across the joint. (The heating equipment is described in Section 3.3.)

The second paving mat overlaps the first by 2 to 3 inches (Figure 10a). This overlapped material is pushed back with a lute 3 to 4 feet from the edge of the second mat (Figure 10b). No special rolling is necessary for the completed wedge joint.

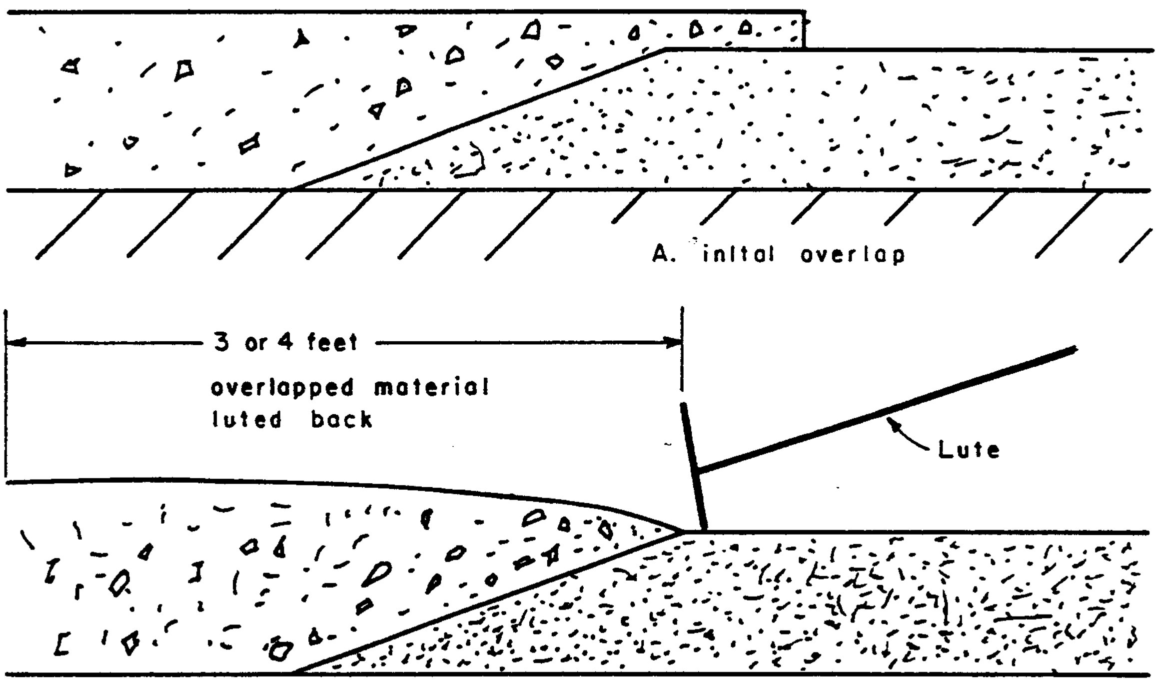
3.3 Infrared Heater

The infrared heater is designed to heat the surface of the unconfined wedge edge to a depth of about 1½ inches. The heater is mounted on the paver in front of the screed with a height of about 2 inches above the previously-placed mat.

The typical heater and mounting are shown in Figure 11. The heater consists of four ribbon burners which are mounted in a rectangular stainless steel box (15 inches wide x 76 inches long x 4 inches deep). The heater is suspended from the paver with a pair of support pipes. The heater is fueled by a LP vapor withdrawal cylinder. The manufacturer furnishes the heater ready to mount with all necessary hoses, regulators, and electrical connections.

Figure 10

PLACING SECOND MAT TO FORM FINISHED WEDGE JOINT



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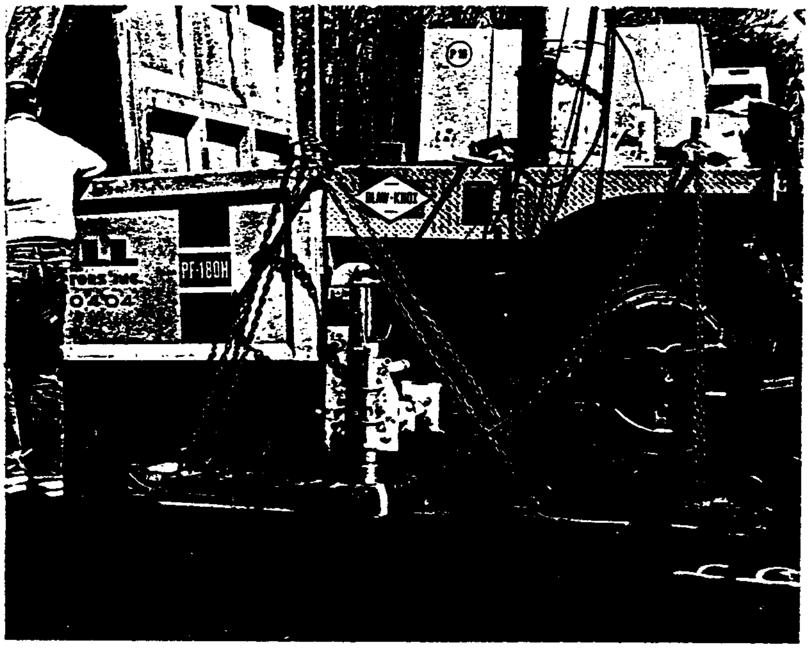


Figure II

Typical Heater Mounting

PART FOUR: RESULTS AND ANALYSIS

4.1 Nature of the Experiment

The testing program consisted of making density measurements across the joints on each of three projects where both the wedge joint and conventional joint were used (the "controlled experiments") and testing on three other projects where only the wedge or butt joint was employed (the "uncontrolled experiments").

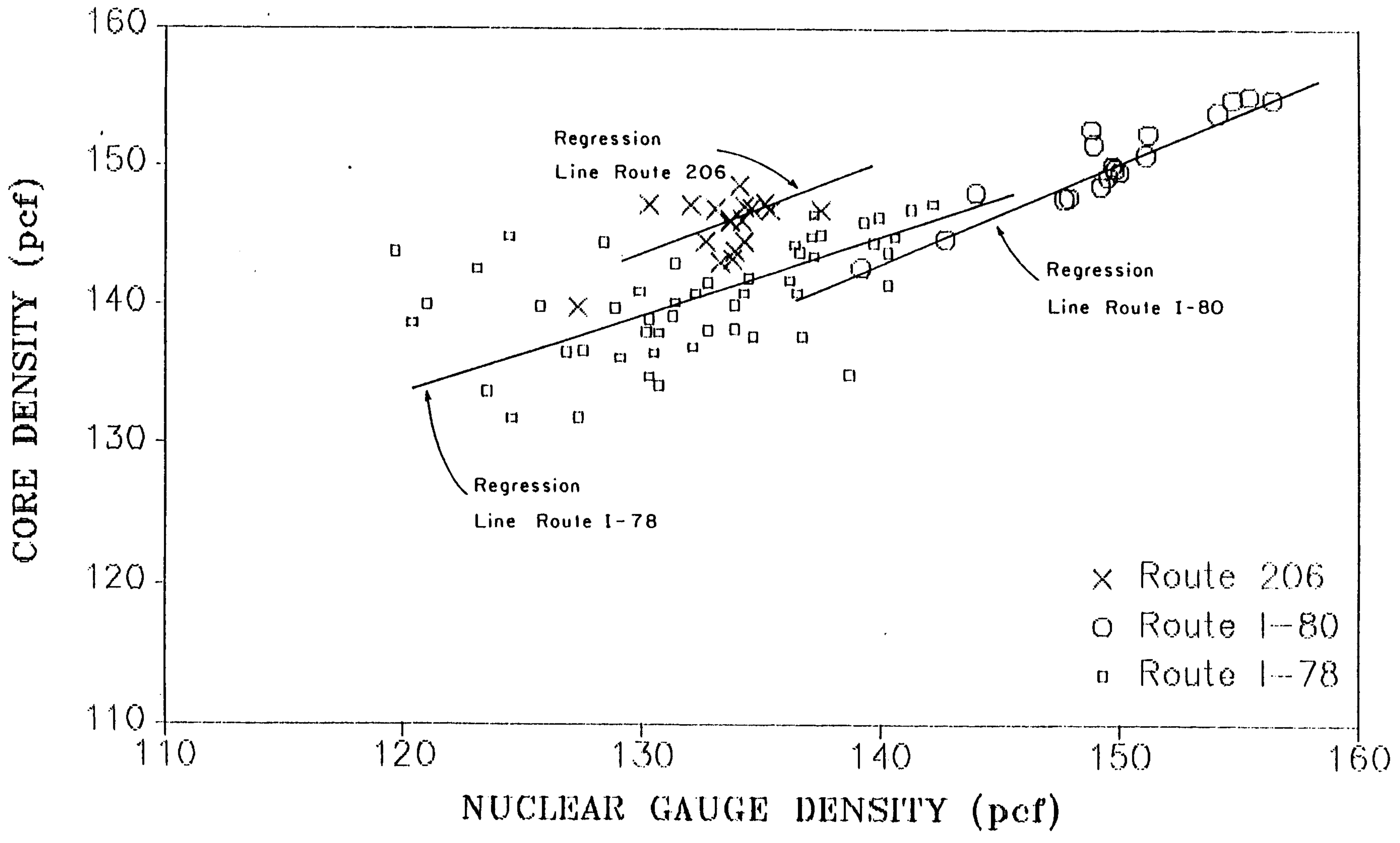
On each project, from 5 to 17 test locations were selected for density measurements. The nuclear testing was done with a Troxler Model 3411 B gauge.

4.2 Comparison of Nuclear and Core Densities

In this research, primary reliance was made on measurements with a nuclear density gauge because of its obvious advantages in performing measurements during construction. To provide a check on the reliability and accuracy of the nuclear measurements, a program of coring was undertaken to determine the bulk density (Designation NJDOT B-9) of the pavement in the locations tested with the nuclear gauge. The results of those comparative density determinations are plotted in Figure 12.

The plotted data displays the general type of trend expected for the two types of determinations, indicating a generally good relationship between the field and laboratory measurements (i.e., coefficients of determination (R^2) up to .87). However, in one particular case — a series of seven measurements taken over the centerline of the butt joint on the Route 78 project — the core densities were distinctly different (higher) than the nuclear measurements. A traditional statistical outlier test indicates that this data does not follow the pattern shown for the remainder of the data. We cannot definitively determine whether in this

Figure 12
COMPARATIVE DENSITY DETERMINATIONS
Nuclear and Core Densities



instance it was the nuclear gauge or the core measurements which were in error. Apart from this one anomalous situation then, the basic conclusion to be drawn from Figure 12 is that the various kinds of density determinations in this study were consistent and hence a reasonable basis for decision.

4.3 Controlled Experiments

4.3.1 Route US 40 & 322, Section 2D, Atlantic County

In July 1984, the wedge joint technique was used in constructing all of the longitudinal joints in the 1½" thick top course on this resurfacing project, except for a 300 foot control section. In the control section, the joint between the inside and outside eastbound lanes in front of Inteleplex Inc. was constructed using the conventional technique.

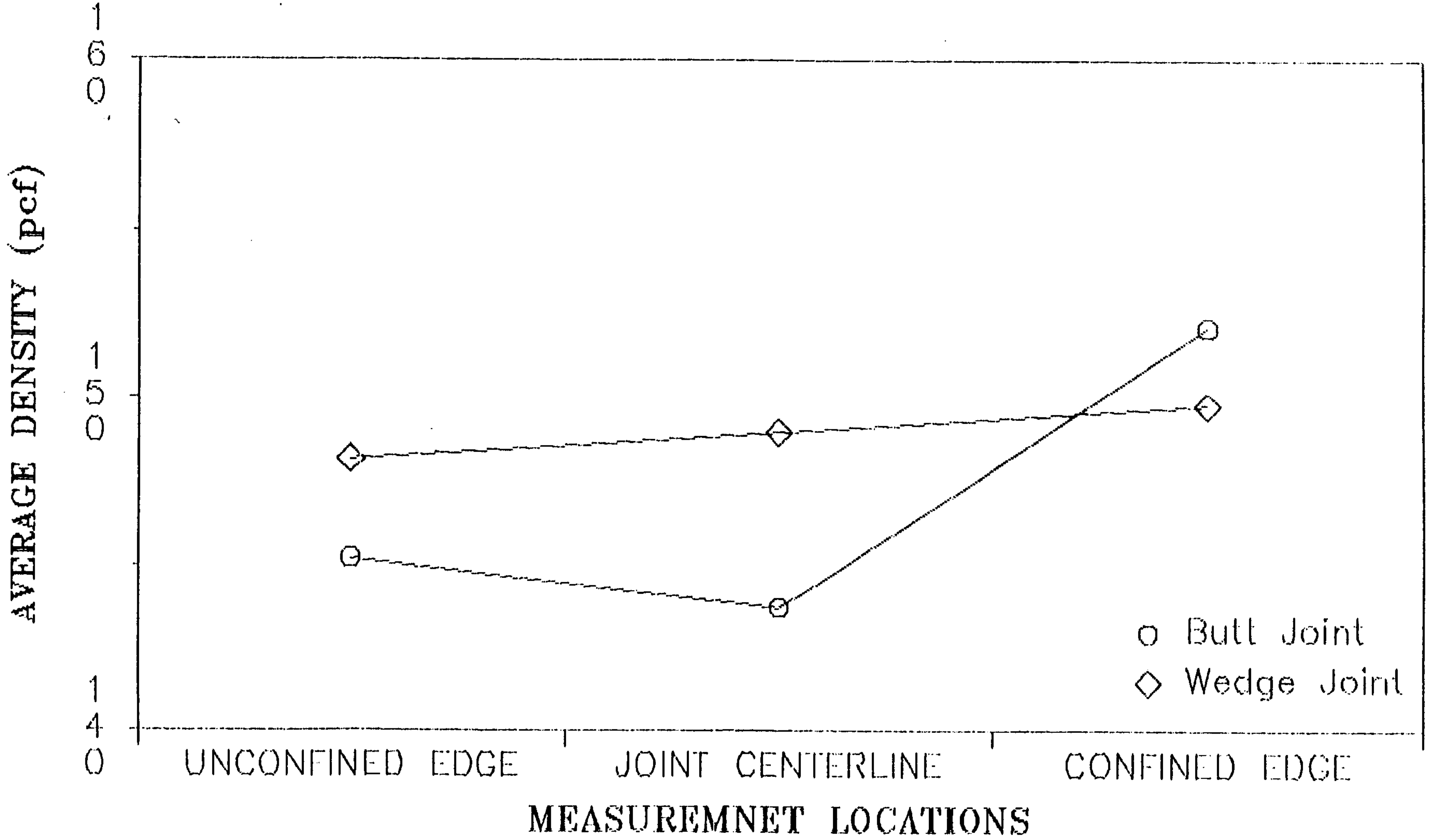
Density data for the wedge and butt joints are presented in Appendix Tables A1 and A2 and Figure 13. Examination of the plotted data indicates that the wedge joint technique was successful in achieving the goal of a generally higher, more uniform density. A statistical analysis of the differences in means confirms that there is no significant difference in density across the wedge joint on this project.

The butt joint density data displays the typical density gradient pattern reported in the literature, with the density measurements in the first paving mat and those directly over the joint being significantly less than that achieved in the second paving mat.

4.3.2 Route NJ 10, Section 2G & 3G, Morris Plains

In July 1986 the wedge joint technique was used to construct the longitudinal joint in the 2" thick top course on this resurfacing project, except for an approximately 500 foot test section where the conventional butt joint was

Figure 13
COMPARATIVE JOINT DENSITY MEASUREMENTS
Route 40 & 322 Section 2D



installed for comparison purposes. The control section was located in the eastbound roadway between the railroad bridge and the Route 53 bridge.

Density results for the wedge and butt joints are shown in Tables A3 and A4 and Figure 14.

The plotted density data for this project indicates that the wedge joint provided greater, more uniform density. The average density at the confined joint edge was statistically higher than at the other two transverse test locations. It is doubtful whether this statistically significant difference (amounting to approximately 4 pcf) is an important difference in terms of joint performance.

Examination of Figure 14 clearly indicates a very marked density gradient in the conventional butt joint, with the density directly over the joint being significantly lower than that attained in either of the adjoining paving mats.

4.3.3 Route I-78, Sections 6F &7F, Warren County

In May 1986, the wedge joint technique was used in constructing the joints in the top course and two lifts of binder from Station 369 + 00 (Bloomsbury Rd.) to Station 432 + 00 (Asbury Rd.) except for a 300 foot butt joint control section. The control section was located between Stations 387 + 00 and 390 + 00 in the outside and center westbound lanes. The top course was 2" thick and each of the two binder courses were 3" thick and variable.

Density results for the wedge and butt joints are shown in Tables A5 and A6 and Figure 15.

Examination of the plotted data indicates the wedge joint results on this project were similar to those observed on Route 10, with the wedge joint displaying approximately equal densities in the first paving mat and over the centerline of the joint, but somewhat higher densities in the second (confined) paving mat.

Figure 14
COMPARATIVE JOINT DENSITY MEASUREMENTS
Route 10 Section 2G & 3G

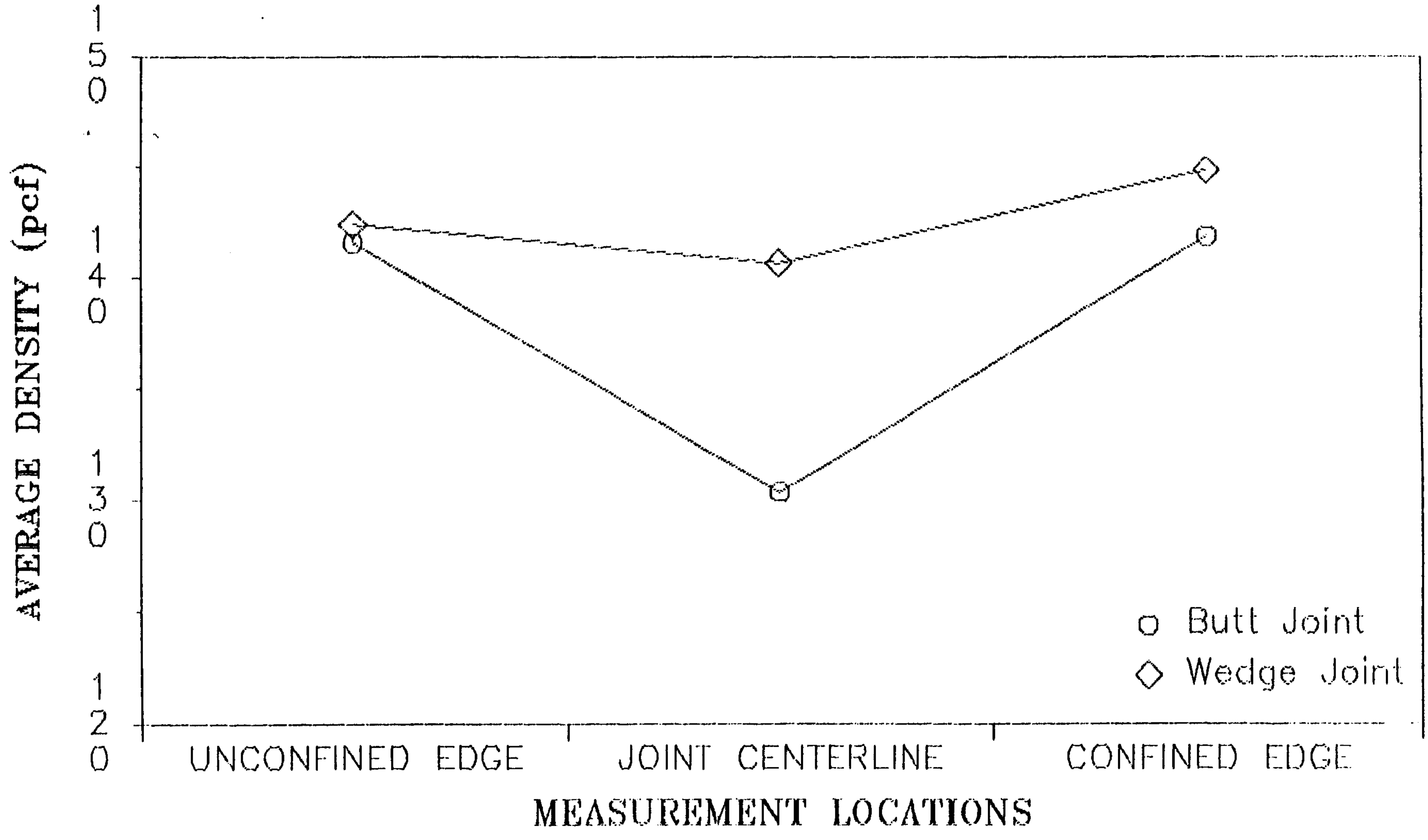
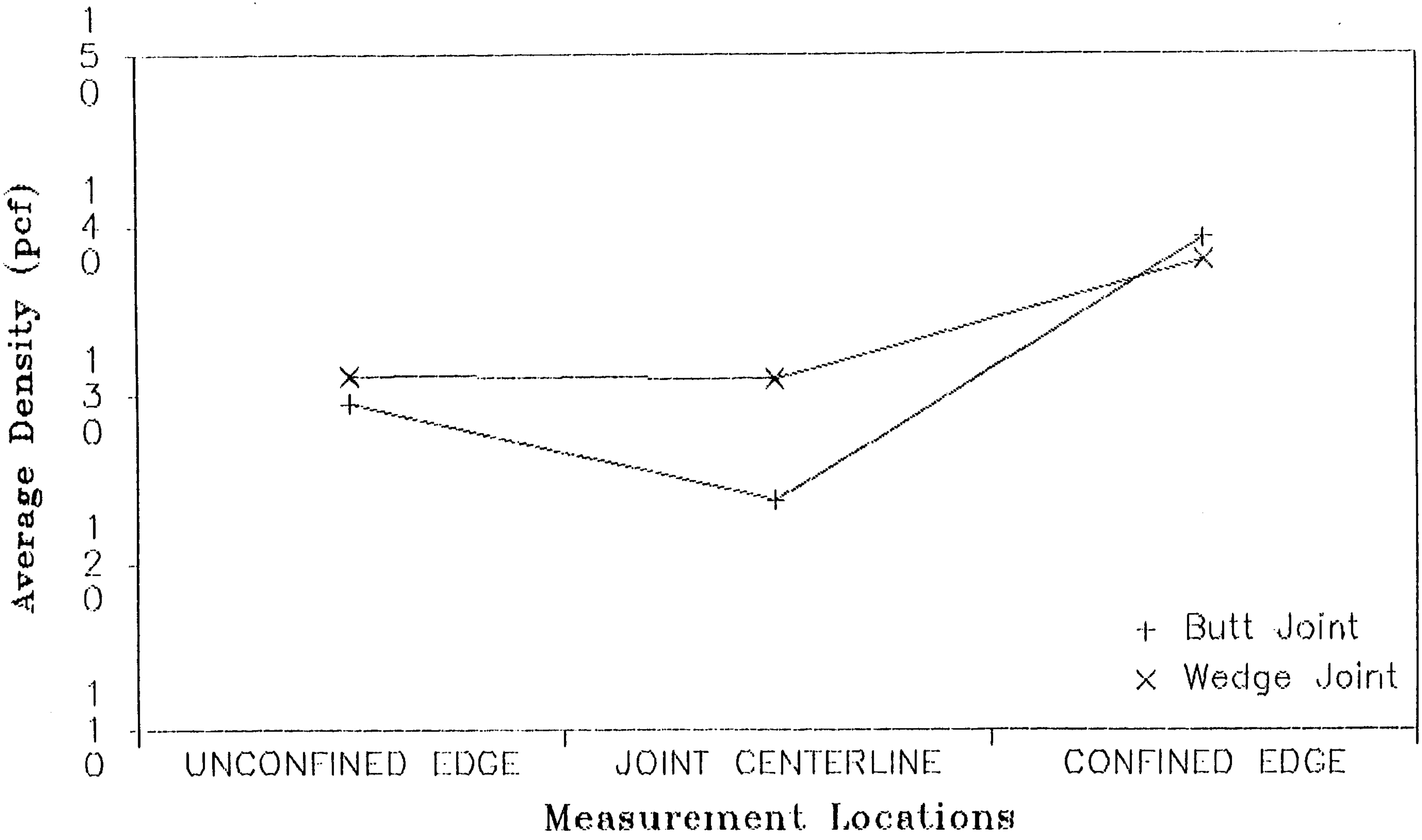


Figure 15
COMPARATIVE JOINT DENSITY MEASUREMENTS
Route I-78, Section 6F & 7F



Here again, the butt joint displayed a pronounced density gradient, with the density measurements directly over the joint being the lowest.

4.4 Uncontrolled Experiments

4.4.1 Route I-80, Section 4BB, Paterson

In July 1985, the wedge joint technique was used in constructing all of the joints in the 2" top course in this resurfacing project. No butt joint control section was provided.

The density results are presented in Table A6 and Figure 16. On this project, the wedge technique again succeeded in eliminating the joint density gradient: A statistical analysis indicates that there is no significant difference in density across the finished wedge joint.

4.4.2 Route US 206, Sections 6B, 5A, 4B, and 3B, Red Lion

In May 1984, the wedge joint was used in constructing all the longitudinal joints in the 2" top course of this resurfacing project. Supplemental (infrared) heating was not used in constructing the wedge joints on this project.

The density results are presented in Table A7 and Figure 17. As shown in Figure 17, the finished wedge joint displayed no statistically significant density gradient across the joint.

4.4.3 Route NJ 55, Section 12A and 13C, Sewell

In an attempt to shed light on the previously described anomally between certain of the Route 78 nuclear and core densities, a density testing program was undertaken on the Route 55 project. At the time of testing, portions of this project were under construction and other parts had been open to

Figure 16
JOINT DENSITY MEASUREMENTS
Route I-80, Section 4BB

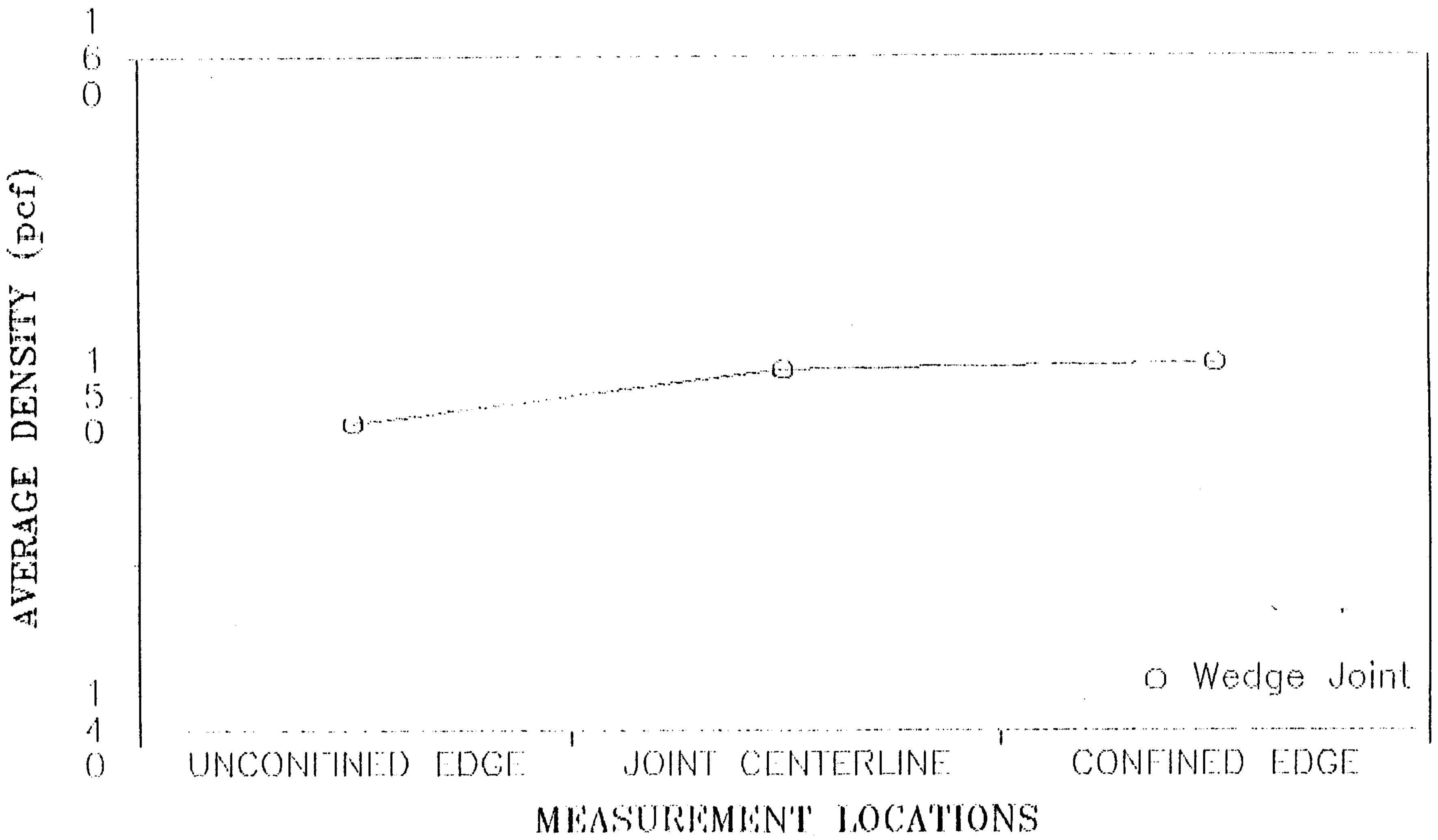


Figure 17
JOINT DENSITY MEASUREMENTS
Route 206, Section 6B,5A,4B,&3B

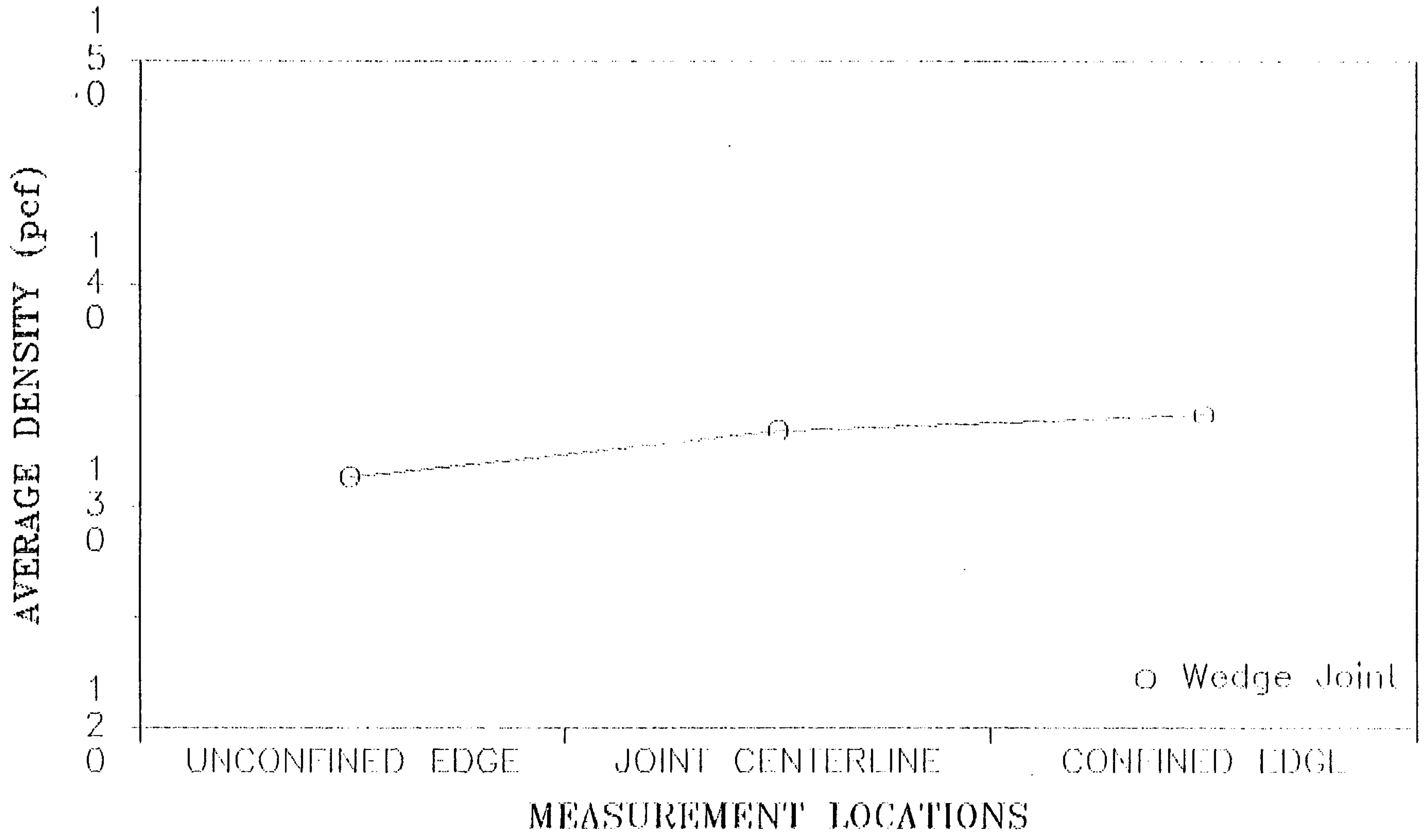
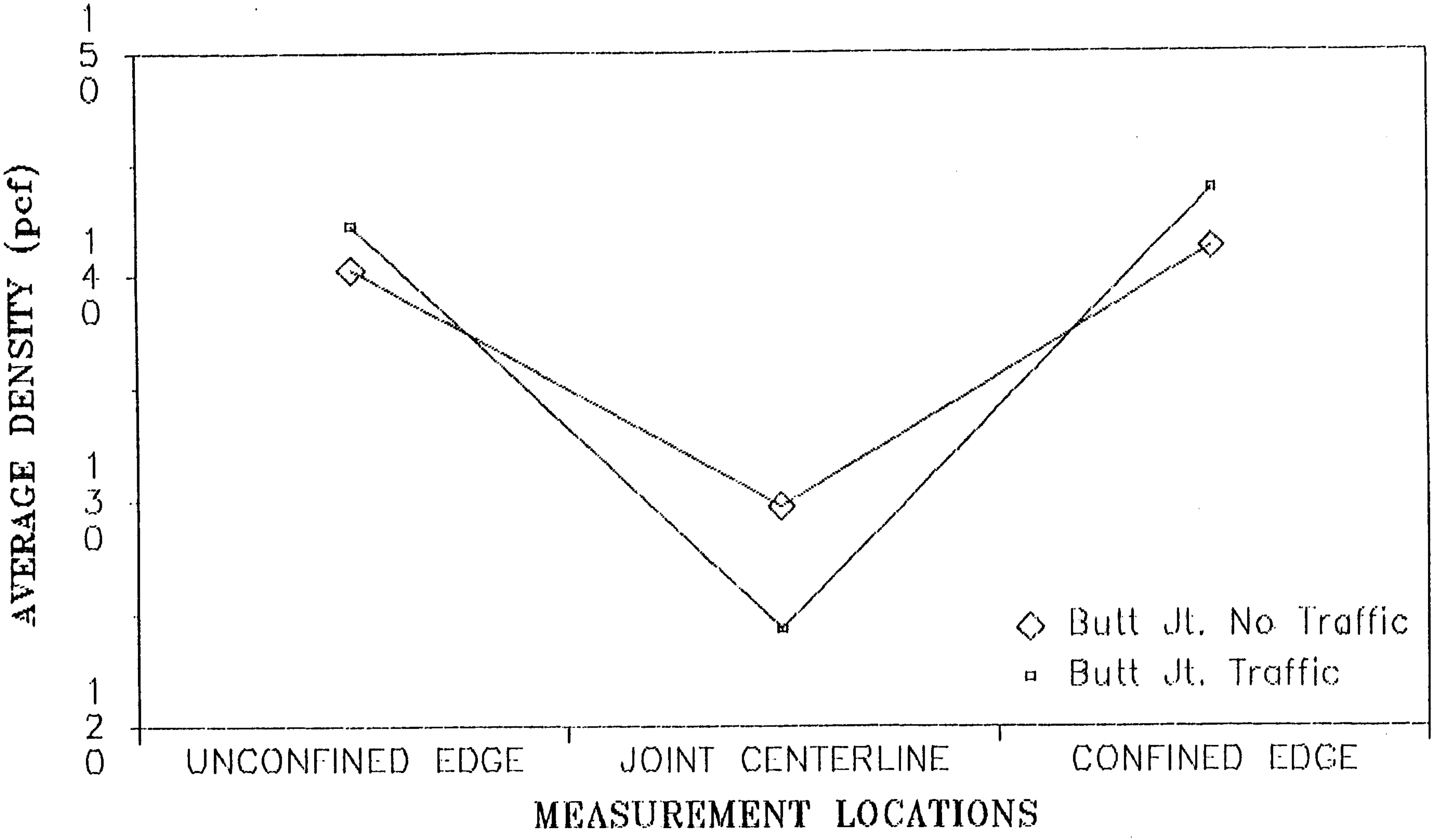


Figure 18
COMPARATIVE JOINT DENSITY MEASUREMNETS
Route 55, Section 12A & 13C



traffic for approximately six months. Since the cores on the Route 78 project were taken after the project had been opened to traffic, the basic objective of the Route 55 testing was to determine whether consolidation under traffic might have been a factor. The density results are presented in Table A8 and Figure 18.

As it turns out, the Route 55 data did not help in resolving this situation. However, the Route 55 data was instructive on a fundamental point: The as-constructed joint density gradients are apparently not reduced under traffic. As indicated in Figure 18, both the newly constructed and in-service portions of the Route 55 project displayed nearly identical, pronounced joint density gradients.

4.5 Costs

The costs associated with the use of the wedge joint technique have been estimated on the basis of information supplied by New Jersey contractors, resident engineers, and an infrared heater supplier.

The purchase price of the infrared heater reportedly ranges from $1,000 to $4,000, depending on the size of the heater and number of burners (BTU rating). The total cost of acquiring and installing the wedge joint plate, the heater mounting, and propane tank is approximately $650.

The daily operating cost of the heater is insignificant. For example, the Route 3 Section 2J project required only about $10 of propane (30 pounds) per day for each 1,000 tons of bituminous concrete placed in a 2 inch thick overlay.

PART FIVE: SUMMARY AND CONCLUSIONS

This report describes an evaluation of a construction procedure that involves forming the longitudinal joint between adjoining bituminous paving mats as two overlapping wedges. This "wedge" joint is formed by a steel plate attached to the paver screed which produces an approximately 3:1 sloped face at the edge of the first bituminous mat placed. As the subsequent paving mat overlaps the wedge edge, an infrared heater heats and softens the previously placed mat edge to increase the achievable density at the joint.

The primary measure of the effectiveness of the wedge joint was the extent to which this procedure was able to eliminate variations in density across the finished joint. Such density gradients have been described by others as the root cause of poor joint performance.

The results of the extensive program of field density testing undertaken in this study indicate that the wedge joint technique produces higher, more uniform density than the conventional butt joint technique. These observed improvements in density, combined with the elimination of the vertical shear plane in the conventional butt joint, suggest that the wedge joint procedure will provide a finished joint which is more resistant to opening under the effects of traffic and weathering.

In addition to improved performance, the wedge joint offers two other advantages. First, by eliminating the vertical edge, the wedge joint offers a safer condition for motorists when making lane changes in the resurfacing construction area. Second, use of the wedge joint with supplemental heating eliminates the need to pull back the paver to avoid "cold" joints, thereby providing the contractor with greater flexibility/production capability. This elimination of the pullback requirement also has the potential for improving the riding quality of the finished pavement by reducing the number of transverse joints in the surface course.

While this study of the effectiveness of the wedge joint procedure was limited to resurfacing projects, it is obvious that certain of the observed results are equally applicable — and the benefits equally desirable — on new construction. It is therefore recommended that the wedge joint with supplemental heating be adopted for use in constructing surface mixes (top and bottom layer) on both new bituminous pavement construction and resurfacings.

One point which is unsettled, however, is whether the supplemental heating should be required for bituminous mixtures <u>other</u> than surfacing mixes. Construction personnel have expressed the opinion that it may not be necessary, since base course joints have historically not been a factor in pavement distress. However, they agree that the safety feature of the wedge joint (i.e., elimination of the edge dropoff) is important for all mixes on resurfacing work. Under these circumstances, it is concluded that the wedge joint should also be used on base course construction on both new and overlay projects, except that the use of supplemental heating should be a contractor option. It is recommended that the merits of this approach be verified by Research as a part of the normal implementation process.

PART SIX: RECOMMENDATIONS

1. Specifications

It is recommended that the Department adopt the wedge joint technique as the standard method for constructing longitudinal joints in all bituminous paving. The specification changes necessary to implement this change in construction practices are presented in Appendix B.

2. Further Research

It is recommended that the merits of eliminating the use of supplemental heating in base course wedge joint construction be evaluated by Research as part of the implementation process.

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2. Foster, C. R. and Hudson, S. B., and Nelson, R. S., Constructing Longitudinal Joints in Hot-Mix Asphalt Pavements, Highway Research Board, Highway Research Record No. 51, Washington, DC 1964.

APPENDIX A

NUCLEAR DENSITY DATA

Table A1

Route U.S. 40 & 322
Section 2D

Nuclear Density Measurements

Top Course
Wedge Joint

Density-PCF

Location	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
1	152.1	148.8	150.5
2	150.0	147.2	147.1
3	150.1	147.2	148.0
4	149.2	150.1	149.0
5	148.3	150.6	151.2
6	145.7	150.2	153.1
7	148.5	148.4	150.2
8	146.7	148.8	149.0
9	146.0	147.5	149.9
10	145.3	151.0	149.8
Average	148.2	149.0	149.8

Table A2

Route U.S. 40 - 322
Section 2D

Nuclear Density Measurements

Top Course
Butt Joint

Density-PCF

Location	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
1	148.3	141.1	151.3
2	150.6	146.2	152.5
3	149.6	148.7	150.9
4	147.6	145.3	149.3
5	144.8	146.7	152.6
6	138.5	145.5	153.4
7	144.4	142.0	151.7
8	146.5	141.9	149.1
9	138.1	136.7	155.2
10	143.1	142.6	154.8
Average	145.2	143.7	152.1

Table A3

Route 10
Section 2G & 3G
Nuclear Density Measurements

July 1986 (Top Course)
Wedge Joint

Density PCF

Station	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
419 + 0	136.6	139.4	141.8
418 + 75	144.6	138.8	135.9
418 + 50	133.1	137.6	144.5
418 + 25	135.6	138.6	145.4
418 + 0	141.6	139.9	141.1
417 + 75	144.7	141.1	141.2
417 + 50	146.7	142.7	146.1
417 + 25	142.4	139.3	149.2
417 + 0	143.4	142.4	145.1
416 + 75	144.5	142.6	144.5
416 + 50	145.4	134.9	149.8
416 + 25	144.1	145.6	146.9
416 + 0	143.4	137.2	145.0
415 + 75	144.2	142.6	145.8
415 + 50	143.4	142.5	149.9
415 + 25	143.4	144.2	146.0
415 + 0	144.5	142.6	145.8
Average	142.4	140.7	144.9

Table A4

Route 10
Section 2G and 3G
Nuclear Density Measurements
July 1986 (Top Course)
Butt Joint

Density - PCF -

Station	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
0 + 0	138.8	125.8	140.1
0 + 25	141.6	128.2	142.6
0 + 50	143.4	130.0	141.1
0 + 75	142.7	128.3	141.2
1 + 0	143.1	137.2	144.9
1 + 25	143.5	130.0	141.8
1 + 50	137.6	122.2	141.6
1 + 75	140.6	133.4	139.1
2 + 0	143.1	137.4	143.2
2 + 25	140.0	129.0	141.5
2 + 50	141.6	121.6	141.5
2 + 75	140.3	129.9	140.5
3 + 0	142.0	137.0	143.2
3 + 25	142.0	137.4	143.8
3 + 50	143.5	127.9	142.6
Average	141.6	130.4	141.9

Table A5

Route I-78, Section 6F & 7F
Nuclear Density and Laboratory Bulk Density

May 1986 (Top Course) Density-PCF
Wedge Joint

Station	Nuclear Density Unconf.	Bulk Density Unconf.	Nuclear Density Over Jt.	Bulk Density Over Jt.	Nuclear Density Confined	Bulk Density Confined
410 + 0	130.3	134.8	134.7	137.7	140.6	144.9
409 + 75	130.7	134.2	133.9	138.3	138.7	135.0
409 + 50	132.3	140.9	129.9	141.0	140.3	141.5
409 + 25	134.3	140.9	130.3	139.0	137.1	144.9
409 + 0	136.5	140.9	136.7	137.7	139.9	146.3
408 + 75	132.8	141.6	130.7	138.0	137.2	146.5
408 + 50	127.5	136.7	128.9	139.8	134.5	142.0
408 + 25	130.5	136.5	124.5	131.8	136.6	143.8
408 + 0	130.2	138.1	132.8	138.2	137.2	143.5
407 + 75	127.3	131.9	128.4	144.5	137.5	145.1
Average	131.2	137.6	131.0	138.6	138.0	143.4
Station			Butt Joint			
389 + 75	131.4	143.0	129.1	136.2	136.2	141.8
389 + 50	131.4	140.2	119.7	143.8	139.3	146.0
389 + 25	120.4	138.7	124.4	144.9	142.2	147.3
389 + 0	126.8	136.6	121.0	140.0	140.3	143.8
388 + 75	133.9	140.0	123.1	142.6	141.3	146.9
388 + 50	131.3	139.2	123.5	133.7	139.7	144.5
388 + 25	132.2	137.0	125.7	139.9	136.4	144.3
Average	129.6	139.2	123.8	140.2	139.3	144.9

Table A6

Route I-80, Section 4BB
Nuclear Density and Laboratory Bulk Density

October 1985 (Top Course)

Wedge Joint
Density - PCF

Station	Nuclear Density Unconf.	Lab. Bulk Density Unconf.	Nuclear Density Over Jt.	Lab Bulk Density Over Jt.	Nuclear Density Confined	Lab. Bulk Density Confined
280 + 17	144.0	148.1	148.9	151.6	148.8	152.7
271 + 14	149.2	148.6	142.7	144.8	149.8	149.8
269 + 50	150.0	149.6	149.7	150.1	151.2	152.4
268 + 36	147.7	147.7	154.7	154.9	155.4	155.1
262 + 81	151.1	150.8	149.5	149.3	139.2	142.7
259 + 75	147.9	147.8	154.1	153.9	156.4	154.9
258 + 15	154.6	—	155.8	—	156.1	—
Average	149.2	148.8	150.8	150.8	151.0	151.3

Table A7

Route U.S. 206
Section 6B, 5A, 4B, & 3B

Nuclear Density and Laboratory Bulk Density
(No heat on Joint)
(Top Course) May 1984

Wedge Joint
Density - PCF

Location	Nuclear Density Unconf.	Lab. Bulk Density Unconf.	Nuclear Density Over Jt.	Lab. Bulk Density Over Jt.	Nuclear Density Confined	Lab. Bulk Density Confined
1	127.3	139.9	133.7	146.0	133.1	146.9
2	134.1	148.6	133.3	143.1	135.2	147.3
3	133.1	--	125.8	--	134.3	--
4	130.3	147.2	132.7	144.6	134.6	147.0
5	127.8	--	131.6	--	130.9	--
6	134.3	144.6	137.5	146.8	133.8	143.3
7	133.9	143.9	135.4	146.8	134.2	146.1
8	132.1	147.2	133.7	146.1	134.3	147.1
9	129.8	--	137.6	--	137.2	--
Average	131.4	145.2	133.5	145.6	134.2	146.3

APPENDIX B

RECOMMENDED WEDGE JOINT SPECIFICATION

Table A8

Route N.J. 55
Section 12A and 13C

Nuclear Density Butt Joint

October 1986

Unopened Section

Location	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
1	143.1	131.6	139.0
2	143.1	126.9	142.4
3	141.0	127.6	141.3
4	139.0	131.3	143.8
5	135.5	131.7	140.2
Average	140.3	129.8	141.3

Opened Section

Location	Nuclear Density Unconfined	Nuclear Density Over Joint	Nuclear Density Confined
1	142.5	121.8	140.8
2	141.1	125.4	144.2
3	141.8	129.5	143.4
4	143.4	115.6	145.3
5	142.9	128.8	145.3
Average	142.3	124.4	143.9

WEDGE JOINT SPECIFICATION

Section 404 - Bituminous Concrete Surface Course of the 1983 Standard Specification for Roads and Bridges, changed as follows:

404.08 Bituminous Concrete Paver (Insert between 3rd and 4th paragraph)

Bituminous concrete pavers shall be equipped with a sloped plate to produce a wedge edge at longitudinal joints. The sloped plate shall be attached to the paver screed extension.

The sloped plate shall produce a wedge edge having a face slope of 3:1. The plate shall be so constructed as to accommodate compacted mat thickness from 1-1/2 to 4 inches. The bottom of the sloped plate shall be mounted 3/8 to 1/2 inches above the existing pavement. The plate shall be interchangeable on either side of the screed. A typical plate attachment is shown in the plan details.

Bituminous pavers shall also be equipped with an infrared joint heater of at least 500,000 BTU/hr total capacity to heat the longitudinal edge of the previously placed mat to a surface temperature of 200^{o}F, or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately behind the joint heater. The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignite them with the forward movement of the paver. The joint heater shall heat an area of the previously placed wedge edge not less than 15 inches in width and 76 inches in length at one time. Heating shall immediately precede placement of the bituminous material.

404.15 Spreading and Finishing

(a) Longitudinal Joints (The 3rd through 5th paragraphs are deleted and replaced with the following:

The longitudinal wedge joint shall be formed between all abutting mats except that it shall be optional for paving the longitudinal joint between the lanes when paving in echelon.

The material being placed in the abutting lane shall be tightly crowded against the face of the previously placed lane. The paver shall be positioned so that in spreading, the material overlaps the top edge of the lane previously placed by 2 to 3 inches. The overlapped material shall be luted back onto the uncompacted mat and should be left sufficiently high to allow for compaction. To assure a true line, the paver shall closely follow the lines or markings placed along the joint for alignment purposes. The width and depth of the overlapped material shall be kept uniform at all times.

404.16 Compaction (Insert after 3rd paragraph)

When compacting the longitudinal edge of the first lanes placed using the wedge joint, the breakdown roller shall not extend more than 2 inches over the top of the sloped face of the wedge joint.

Section 304 - Bituminous-Stabilized Base Course of the 1983 Standard Specifications for Road and Bridge Construction is changed as follows:

304.04 Equipment

The equipment shall be specified in Section 404 except as follows:

The infrared joint heater will not be required.