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PAVEMENT DEFLECTION MEASUREMENT - DYNAMIC

Phase IV
Final Report

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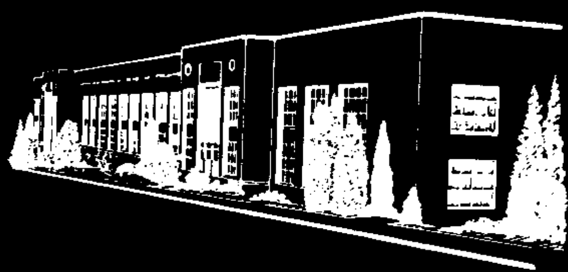

WASHINGTON STATE UNIVERSITY
COLLEGE OF ENGINEERING
RESEARCH DIVISION

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Study was conducted in cooperation with U. S. Department of Transportation, Federal Highway Administration

16. Abstract

Tests were conducted on various pavements to investigate the correlation between measurements obtained using the Impulse Index Computer and pavement condition as determined by other means. Benkelman Beam deflection measurements and Impulse Index measurements are compared along with Washington State Pavement Rating System results. Effect of temperature on the apparent Impulse Index is evaluated.

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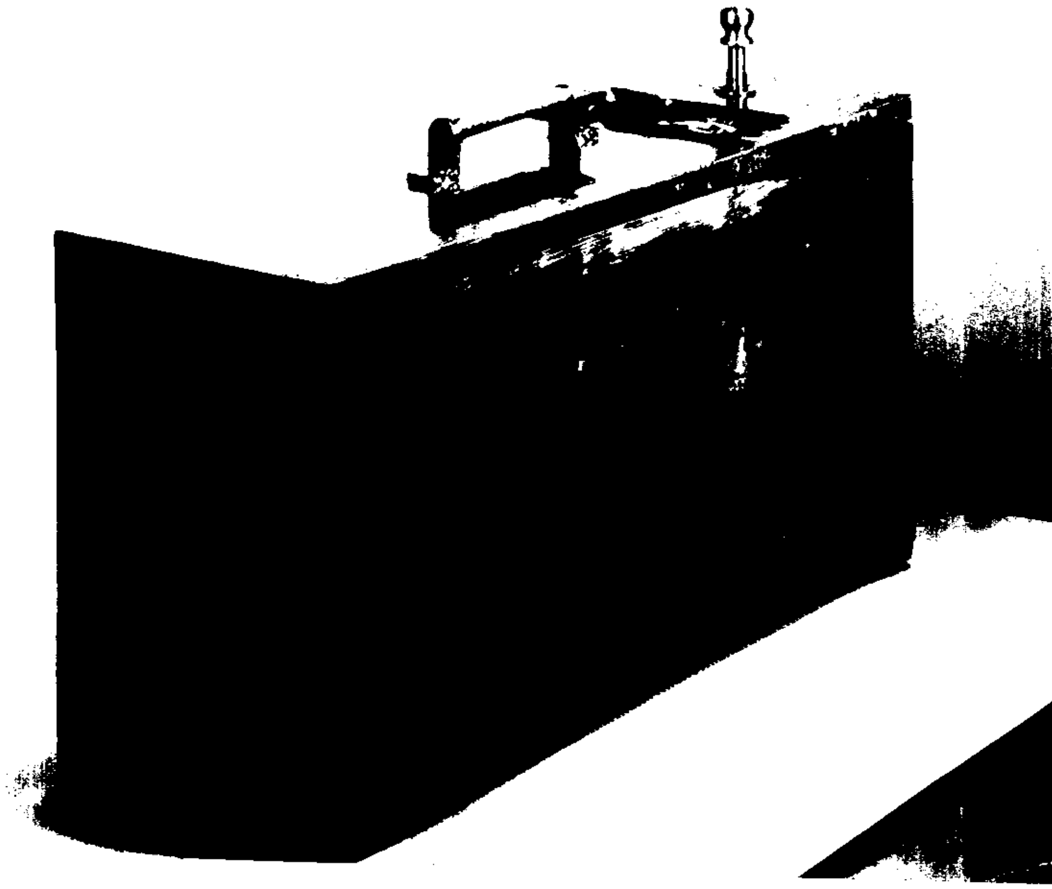


THE IMPULSE INDEX COMPUTER

Figure i

Summary and Conclusions

Only a limited amount of data relevant to impulse testing of pavements had been collected previous to the program reported on here. The Impulse Index data had appeared encouraging, but was not sufficiently extensive to be conclusive. The purpose of this phase of the program was to acquire sufficient data so that the degree of validity of the Impulse Index as a measure of pavement condition could be established.

The initial part of this program was devoted to determining the degree of repeatability of the measurements. A modification was made in the transducer to pavement interface which significantly improved the repeatability of the data. The modifications to the equipment and the resulting repeatability are reported in detail in Chapter II.

Pavements of various construction in various parts of the State of Washington and in a wide range of physical conditions were selected for comparative tests. Approximately 200 Benkelman Beam deflection measurements were made and compared with Impulse Index measurements. Two Impulse Index Computers were used and their results are compared with each other as well as with Benkelman Beam results. In addition, the results of the latest Washington State Pavement Rating System for evaluating defects was compared where this information was available.

Detailed descriptions of the comparative tests and the results are given in Chapter III.

A brief summary of results obtained on various pavements using the Benkelman Beam and the Impulse Index with the improved interface is presented in Figure ii. The degree of correlation between the two methods is readily apparent from the Figure. With the exception of an unexplained discrepancy at Site 7, the results of the two systems are in substantial agreement.

Additional tests were performed to determine the effect of pavement non-uniformity on the acquired results. It was determined that measureable differences exist in some pavements from one position to another only 10 or 20 inches removed.

The effects of pavement temperature were also determined and a correction curve is included in Chapter IV.

In the course of conducting these tests, the greater ease of using the Impulse Index Computer compared to other devices became readily apparent. The speed with which the tests can be performed means that the problem with traffic is reduced significantly.

Each measurement requires only seconds of time and the equipment is hand carried. Being transportable in any vehicle and requiring no set up time reduces the time lost in transit between test sites.

It appears that the Impulse Index Computer can be a valuable tool in uniform evaluation of pavement condition, assisting in reducing the time required for evaluation.

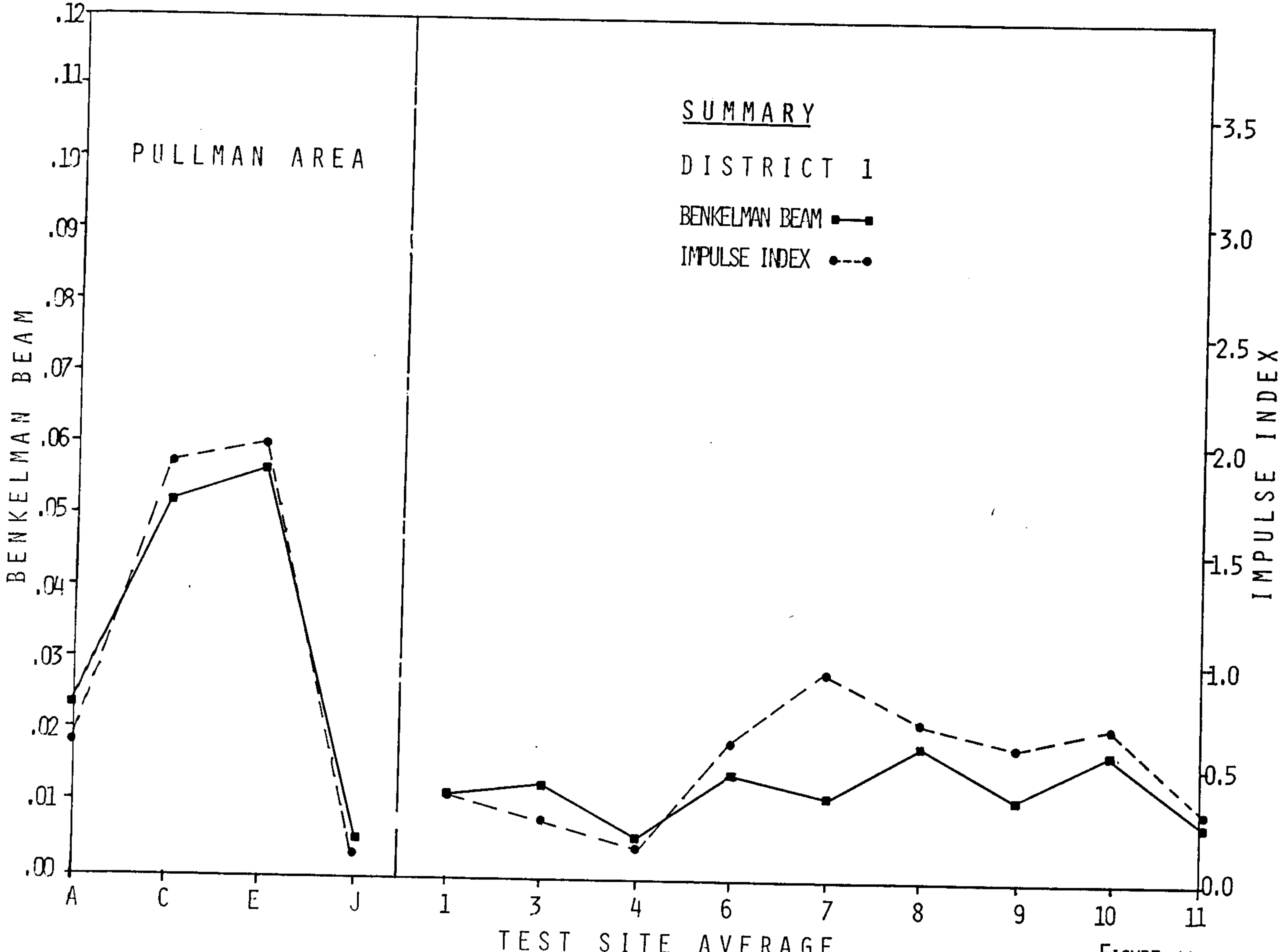
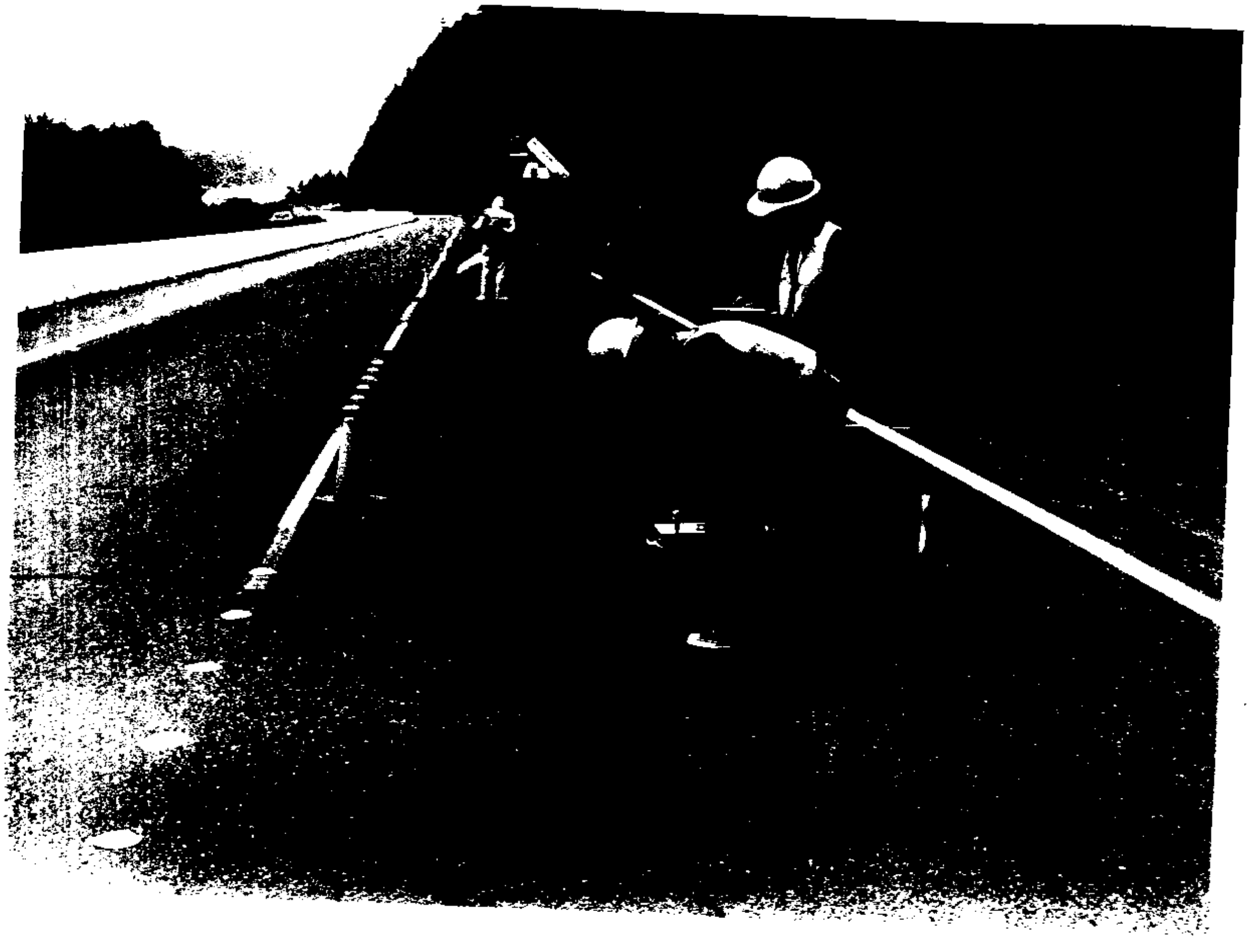

PULLMAN AREA
SUMMARY
DISTRICT 1
BENKELMAN BEAM
IMPULSE INDEX
BENKELMAN BEAM
IMPULSE INDEX
TEST SITE AVERAGE
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
A
C
E
J
1
3
4
6
7
8
9
10
11

FIGURE ii



The Impulse Index, in the foreground, following the Benkelman Beam crew from District 1 on US 20.

Figure iii

Recommendations

Before being released for use, a construction prototype should be built to ensure ruggedness, reliability and optimization of design. Digital readouts, autoranging, improved stability and lighter weight should be incorporated in the prototype.

If work is to be continued on the design of a vehicle to automatically acquire Impulse Index data, the interface may have to be again re-designed because the present design may not take the physical abuse of being slapped on the pavement repeatedly.

Chapter I "Introduction and Review of Previous Work on Impulse Index Pavement Evaluation"

Objective of Phase IV - Pavement Deflection Measurement-Dynamic

Only a limited amount of Impulse Index data had been accumulated under previous phases of this project. The purpose of Phase IV was to acquire sufficient data so that the degree of validity of the Impulse Index as a measure of pavement condition could be established. Correlation of the Impulse Index with pavement condition as determined by other means, such as the Benkelman Beam, was to be determined.

Previous Phases

Previous work at Washington State University leading to the development of the Impulse Index Computer has been described in the following publications:

1) "Pavement Deflection Measurement-Dynamic, A Feasibility Study" by F. W. Brands and J. C. Cook, Washington State University College of Engineering Publication H-32, June 1970
2) "Pavement Deflection Measurement-Dynamic, Phase II" by F. W. Brands and J. C. Cook, Washington State University College of Engineering Publication H-35, June 1971
3) "Pavement Deflection Measurement-Dynamic, Phase III, WSU Impulse Index Computer, Section I" by F. W. Brands and J. C. Cook, Washington State University College of Engineering Publication H-37, August 1972
4) "Pavement Deflection Measurement-Dynamic, Phase III, WSU Impulse Index Computer, Section II" by F. W. Brands and J. C. Cook, Washing-

ton State University College of Engineering Publication H-38, August 1972.

Each of these publications was the result of work supported by the Washington State Highway Commission in cooperation with the U.S. Department of Transportation, Federal Highway Administration. For the benefit of the reader who may be unfamiliar with these reports, a brief summary will be presented here.

The objective of the program was to develop a method of pavement testing which would be sufficiently fast, accurate and economical so that the entire system of state highways can be monitored at intervals and provide a uniformly based evaluation of the pavement condition. Such an evaluation is a valuable aid in the management of a highway system, being especially helpful in establishing the priorities and need for maintenance. Previously existing methods were too cumbersome, costly, slow and hazardous for widespread use.

Pavement Linearity and the Impulse Driving Function

In the initial phase of this program, a number of new concepts for evaluating pavement condition were explored and their qualities compared with those of existing techniques. Results of the explorations revealed several important matters relevant to the problems of pavement testing. Tests performed at Washington State University and elsewhere (5) indicate that the structural parameters of pavements are sufficiently linear over a broad enough range so that the energy or force used in testing need not always be as great as previously accepted methods have used. The direct consequence of this reasonable linearity is that pavement testing equipment need not intrinsically be large and heavy.

(5) Numbers refer to references in bibliography.

The advantages of the use of an impulse driving function rather than a steady-state sinusoid for system excitation are also reported.

The Impulse Index

Tests were conducted on various pavements using an impulse of energy for system excitation. Various characteristics of the response of the pavement to such excitation were examined for correlation of parameters with known pavement condition. The final product of the research was the development of a system using a hammer blow for excitation and two accelerometers placed on the pavement surface.

One accelerometer is placed as near to the point of impact as possible and the second accelerometer is positioned a fixed distance away. Eighteen inches was found to be a convenient and suitable distance. The output from each accelerometer is electronically processed so that its absolute magnitude is determined and then integrated with respect to time. Designating the resulting quantity as R and the unprocessed output of the accelerometer as a,

$$R = \int |a| dt$$

This quantity R from each accelerometer can be used for plotting a profile of the pavement response basin loosely referred to as a deflection profile under impulse loading.

For convenience, the quantity from the accelerometer nearest the hammer has been designated as R_1 and the quantity from the second accelerometer is designated R_2. A relation was developed which reduces the profile information into a single number, designated the "Impulse Index."

Experiments on flexible pavements indicated that the attenuation of energy propagated through better pavements was less than that for poorer pavements. The ratio of R_1/R_2 provides a form of measure of this attenuation. It was also determined that poorer pavements yielded higher values of R_1 than did better pavements. Taking both of these observations into consideration, the Impulse Index is generated as

$$\text{Impulse Index} = \frac{R_1}{R_2} \times R_1 = \frac{(R_1)^2}{R_2}$$

High values of Impulse Index correspond to weakened pavement and low values correspond to sound pavement.

A limited amount of data was accumulated to demonstrate the usefulness of the Impulse Index as an indicator of pavement condition.

The Hand-Carried Impulse Index Computer (Suitcase)

To assist in the further experimentation and to facilitate the acquisition of additional test data, two battery-operated, portable, suitcase-sized instruments were assembled, incorporating the impulse hammer, transducers, electronics and readout meters. Unless otherwise specified, these are the instruments which were used to acquire the Impulse Index data presented in this report. As explained in Chapter II, "Repeatability Improvement," one of these instruments was modified during this phase of the program in order to achieve improved repeatability.

The Vehicle

Because of the short time required for each Impulse Index measurement, it is possible to build a special vehicle which will obtain the necessary data while the vehicle remains in motion. It is anticipated that when such a vehicle is fully developed the data will be automatically acquired and recorded on magnetic tape as the vehicle is driven on the highway, facilitating the rapid logging of the condition of the entire highway system at planned intervals of time. Such a logging system will be a valuable aid in the management of highway maintenance, providing an accurate log of the state of deterioration as well as the rate of deterioration for every increment of highway pavement. Being on magnetic tape, the data would be easily handled in short time with great flexibility of format and at extremely low cost using modern computer data-processing methods.

Sections of pavement, for example, could be easily categorized according to their relative condition, and all sections whose condition is worse than a threshold criteria could be identified, thereby rapidly providing the information necessary for documenting budgetary requirements and establishing priorities and work schedules.

The capability to present documentary evidence of the rate of deterioration of a highway would greatly strengthen requests for the funding necessary for prudent maintenance and management decisions.

Chapter II "Repeatability Improvement with the Impulse Index Computer"

Limited previous work with the Impulse Index Computer had indicated that the degree of repeatability of the readings was less than optimum. When the Impulse Index Computer was placed on the pavement and measurements made, the reading obtained would repeat fairly well. However, if the instrument were picked up and returned to the same spot in between each measurement, the readings would often be sufficiently different to cause concern. If sufficient numbers of readings were taken, the average value yielded a figure that appeared to correlate well with pavement condition as determined by other means. An effort therefore was made to determine the degree of the spread in the data, its significance and its cause and cure. Many factors were suspected and examined before the problem was isolated and corrected.

The Electronics

The possibility of erratic operation of the electronics was checked. When the instrument was not moved sufficiently to displace the position of the transducers, the readings were repeatable. Careful examination and testing of all the circuits indicated that the electronics were not responsible for the spread in the readings. One of the two units does have a relay with exposed contacts which it is found necessary to clean from time to time. Some of the components are plug-ins and these must be firmly seated. These matters were kept under surveillance and were not responsible for the spread in the readings.

The Hammer Face

Variations resulting from the non-uniformity of the pavement surface at the point of impact of the hammer were investigated. If the hammer struck an anomolous peak of small area, part of the energy would be dissipated in crushing the rock peak instead of being transmitted through the pavement. The shape of the pulse of energy is also modified by the crushing action. To investigate these effects, tests were conducted using a bare-faced hammer and a hammer with a firm rubber pad of 1/8" thickness. The first test consisted of marking the outline of the base of the suitcase at four positions on asphalt paving. Designating the positions by numbers one through four, an Impulse Index Computer with a bare-faced hammer (brass) was placed on position 1. Three readings were taken without moving the instrument. The device was then lifted and returned to the same position and three more readings were taken. The device was once more lifted and replaced for three more readings. Nine readings therefore were taken at each of four positions on the pavement. The average value and the standard deviation of the Impulse Index readings for each of the four positions were determined. The standard deviation then was computed as a percentage of the average value for each position.

A one-eighth-inch-thick neoprene pad was then cemented to the hammer face and the entire test repeated. Data are shown in Table A-II-1 and a graphical display of the standard deviation as a percent of the average value for each location is diagrammed in Fig. II-1. It should be noticed from the graph that the rubber pad effected only a very small decrease in the percent standard deviation.

BARE HAMMER AND RUBBER PAD COMPARISONS

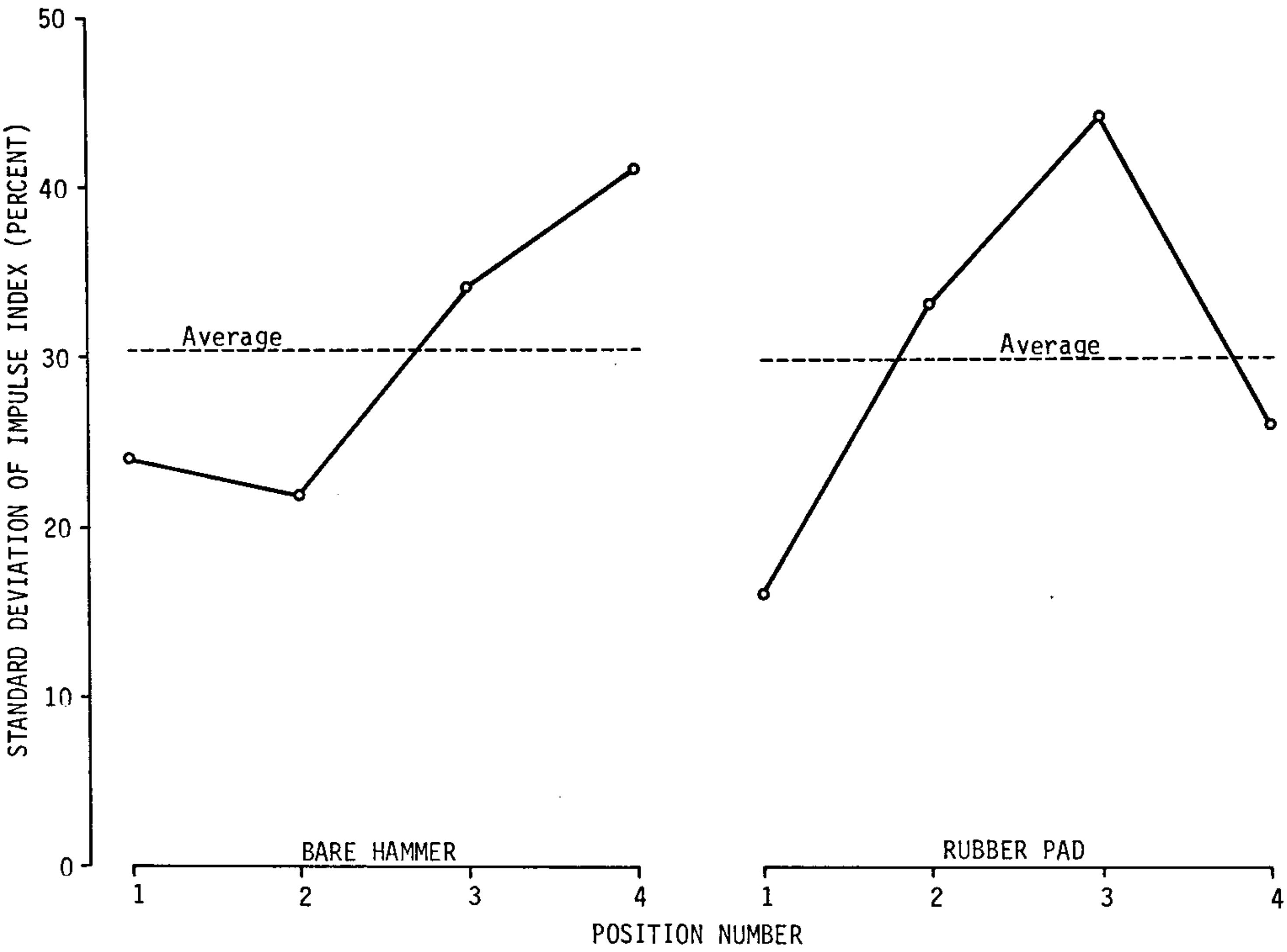


Figure II-1

A second series of tests was conducted on SR 127 between Colfax and Dusty at several locations designated by milepost number. In each of these measurements the hammer was struck only once on any given spot in order to preclude the possibility of the hammer blow altering the fine structure of the surface and therefore altering the next reading. A bare hammer and a rubber-faced hammer were interchanged on the unit. Three readings were made at approximately one-foot intervals in each of the two wheel tracks and in the lane center for one lane using each of the two hammers.

Table A-II-2 lists the data obtained. Figs. II-2 through II-5 are displays of R_1 and R_2 showing the average of the three measurements as well as the spread of the data. Figs. II-6 through II-9 are displays of the Impulse Index showing the average of three measurements as well as the spread.

In evaluating this set of data, it should be pointed out that this stretch of pavement gives other indications of lack of uniformity and some of the spread in the data is probably due to genuine differences in the pavement rather than lack of repeatability of the measurements. Additional information relevant to anomalies in pavements is reported in Chapter 4, "Temperature Effects and Pavement Non-uniformity." At any rate, the results are inconclusive as to the benefit or lack of benefit accrued by the addition of the rubber pad on the hammer face.

Oscilloscope Traces

Additional tests were made comparing photographs of the oscilloscope display of the accelerometer output with and without the rubber pad on the hammer. Fig. II-10 shows the comparative outputs. No significant differences are apparent.

R_1 and R_2
BARE HAMMER AND RUBBER PAD COMPARISONS
SR 127 MP38.1

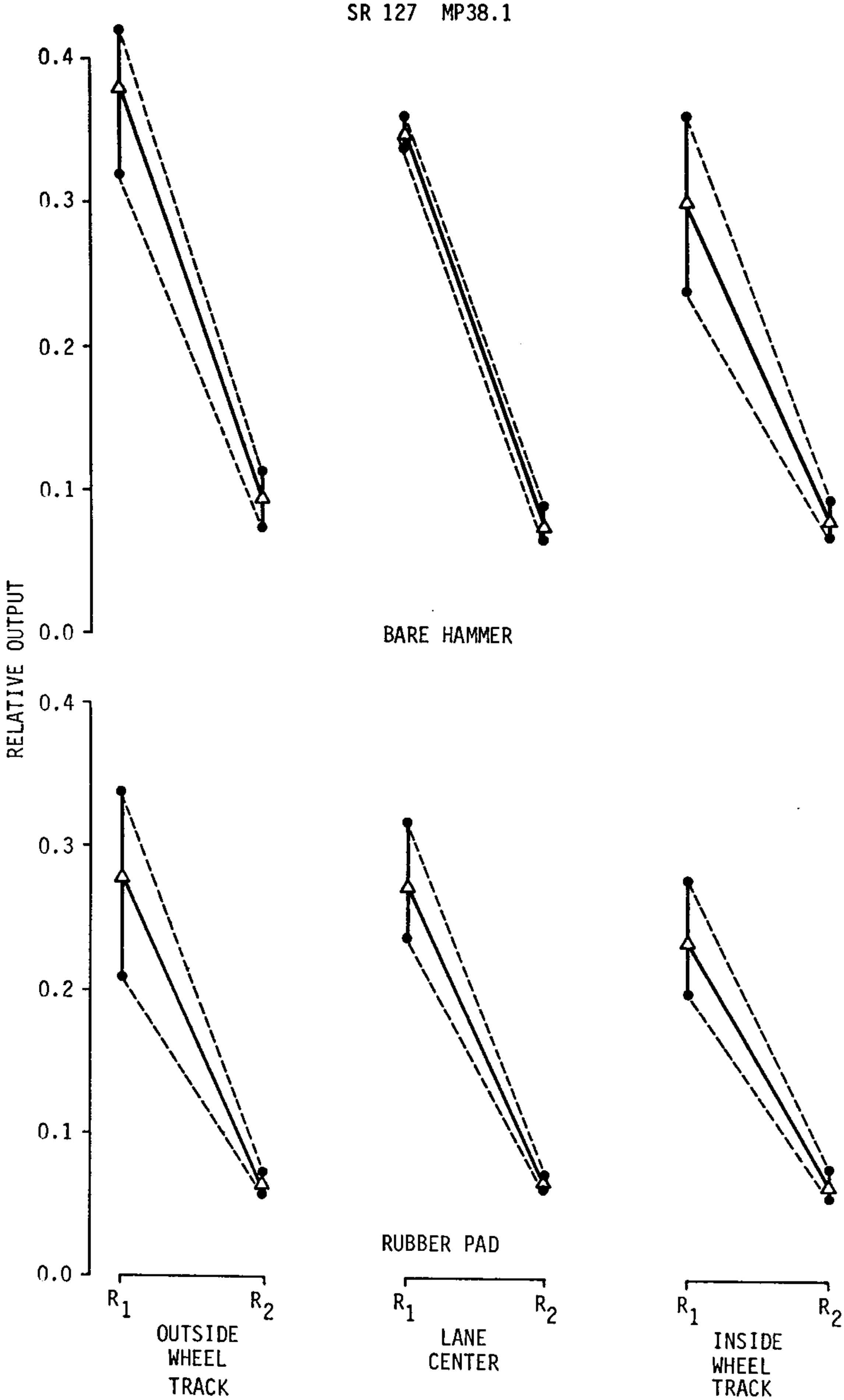


Figure II-2

R_1 and R_2
BARE HAMMER AND RUBBER PAD COMPARISONS

SR 127 MP36.3

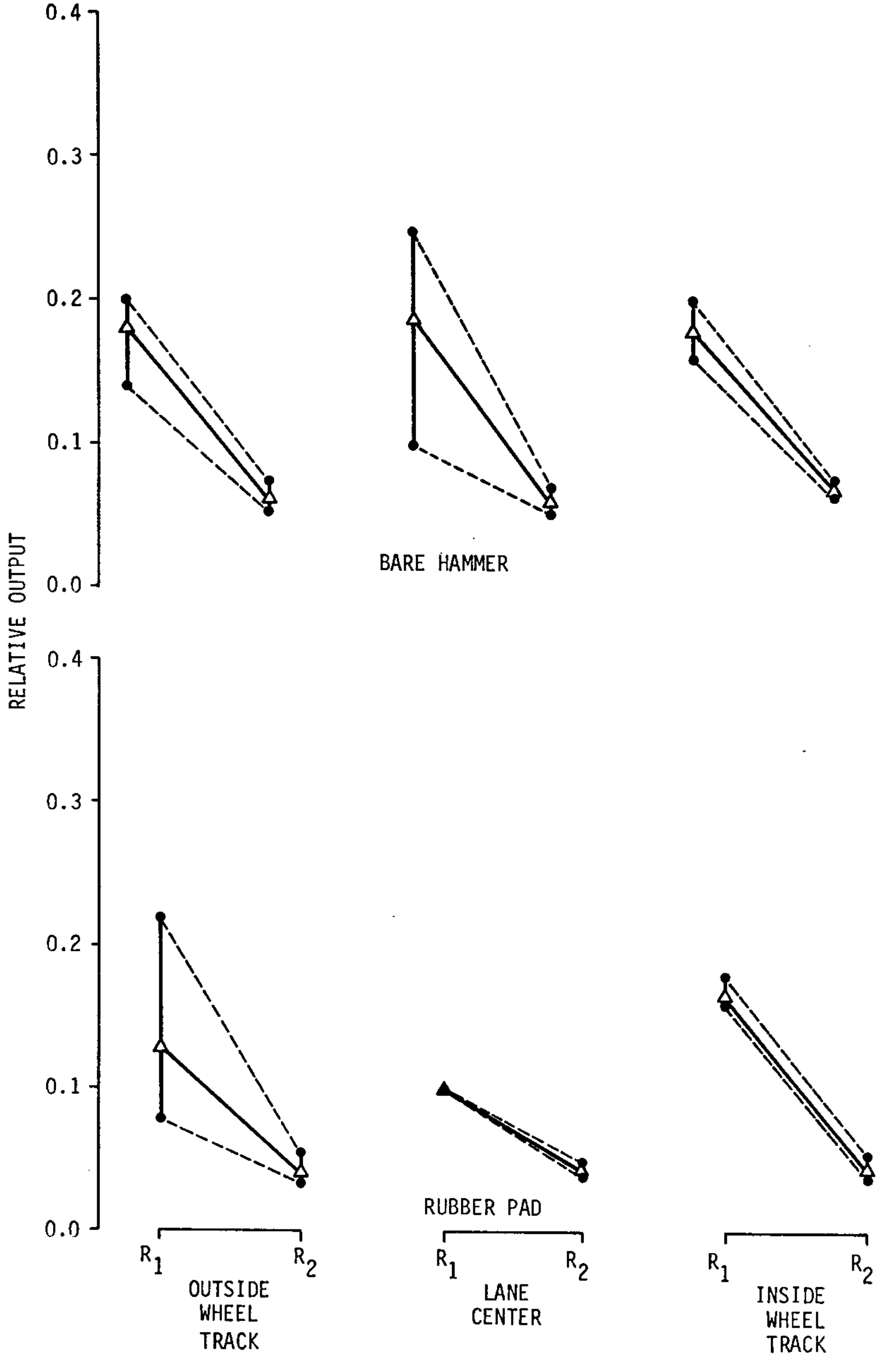


Figure II-3

R_1 and R_2

BARE HAMMER AND RUBBER PAD COMPARISONS

SR 127 MP33.6

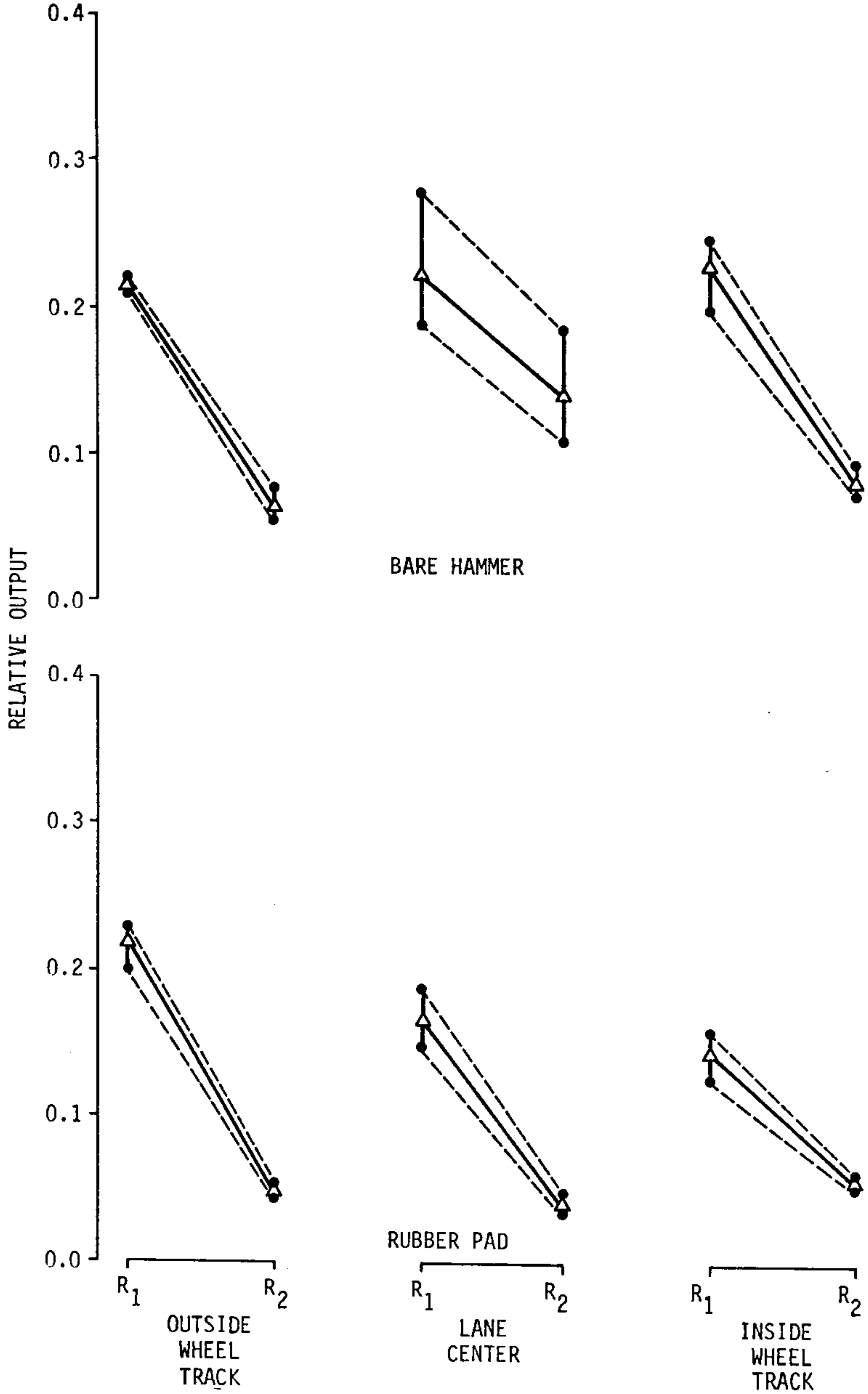


Figure II-4

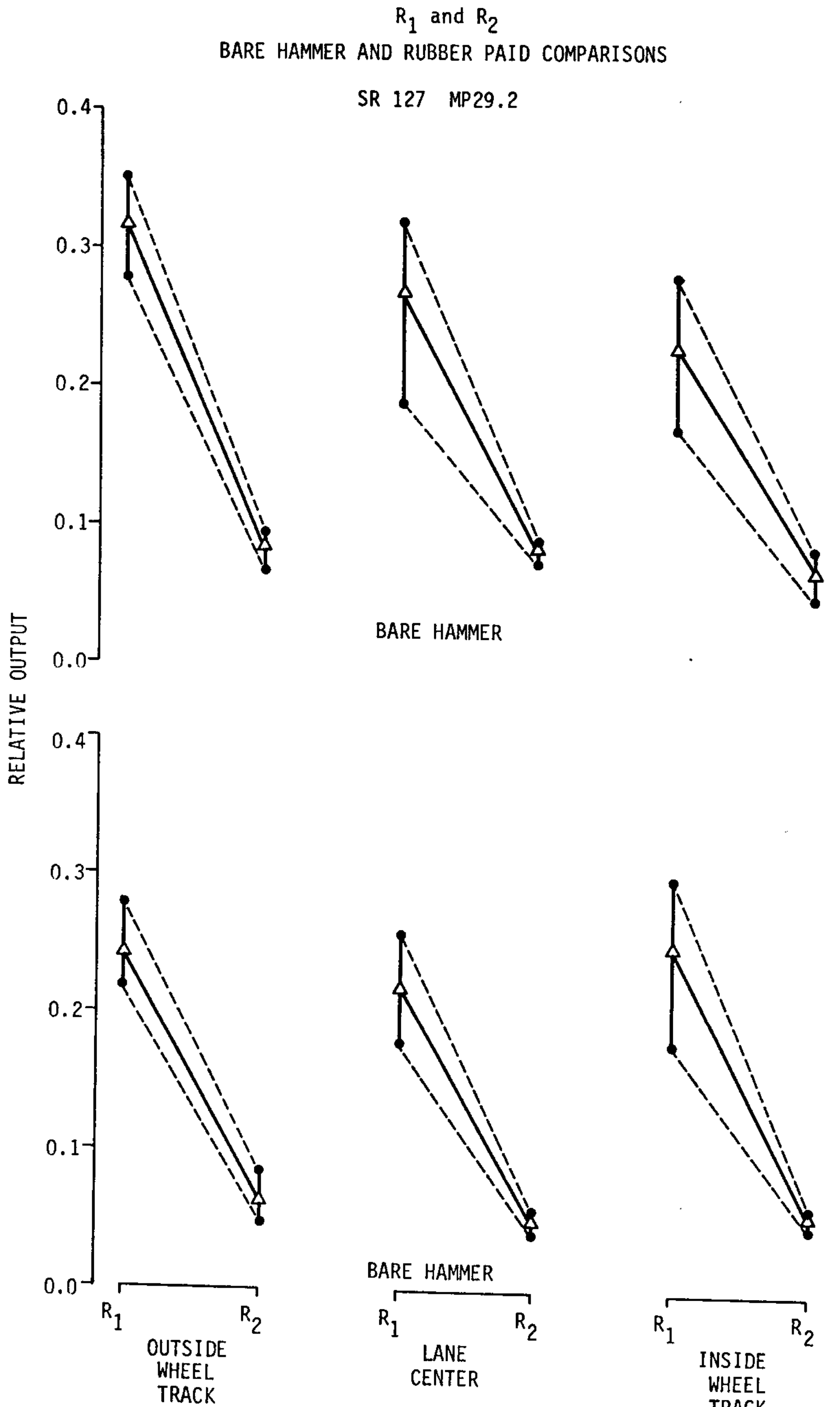

R1 and R2
BARE HAMMER AND RUBBER PAID COMPARISONS
SR 127 MP29.2
0.4
0.3
0.2
0.1
0.0
BARE HAMMER
RELATIVE OUTPUT
0.4
0.3
0.2
0.1
0.0
BARE HAMMER
R1
R2
OUTSIDE WHEEL TRACK
R1
R2
LANE CENTER
R1
R2
INSIDE WHEEL TRACK

Figure II-5

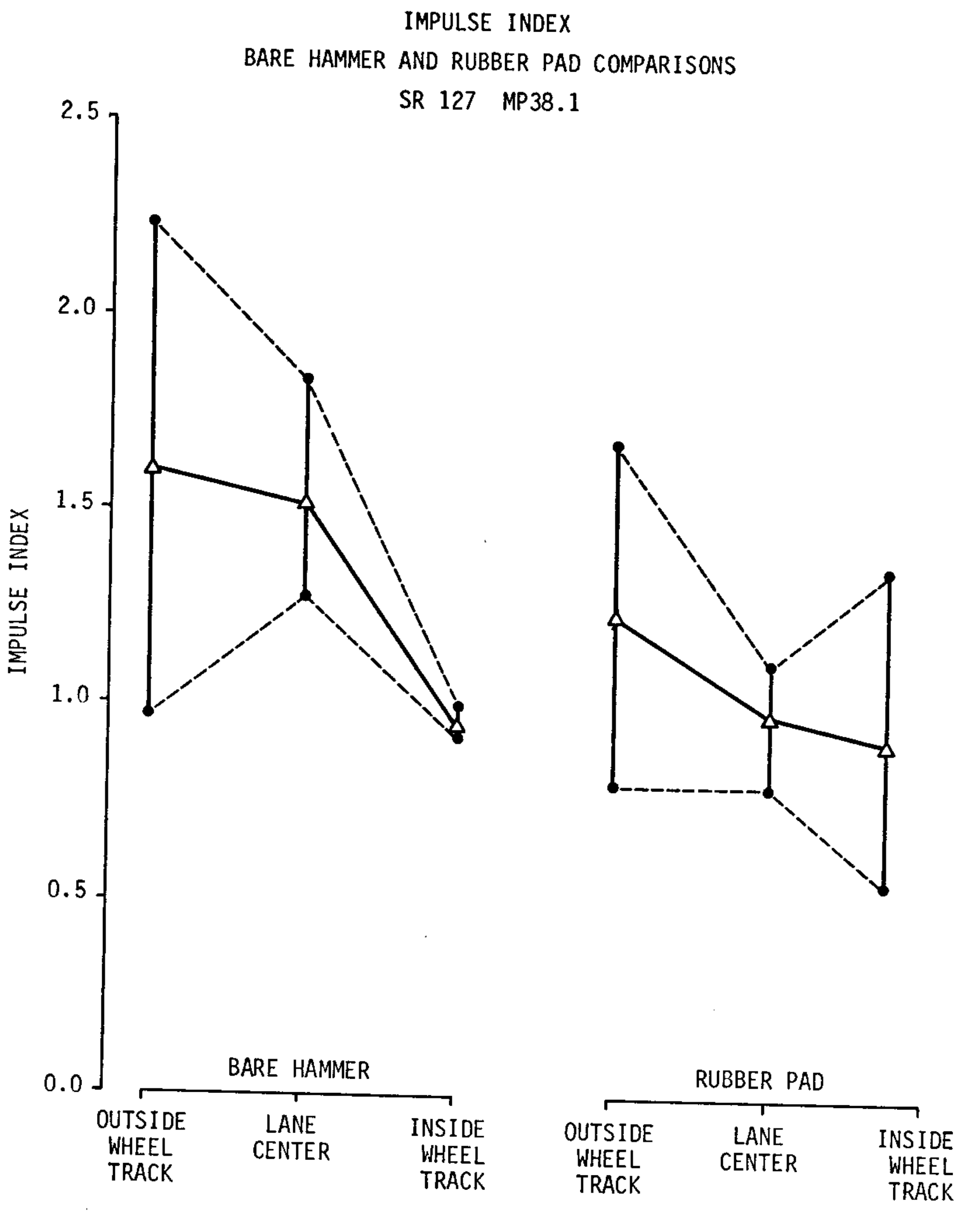

IMPULSE INDEX
BARE HAMMER AND RUBBER PAD COMPARISONS
SR 127 MP38.1
2.5
2.0
1.5
1.0
0.5
0.0
IMPULSE INDEX
BARE HAMMER
RUBBER PAD
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK

Figure II-6

IMPULSE INDEX
BARE HAMMER AND RUBBER PAD COMPARISONS
SR 127 MP36.3

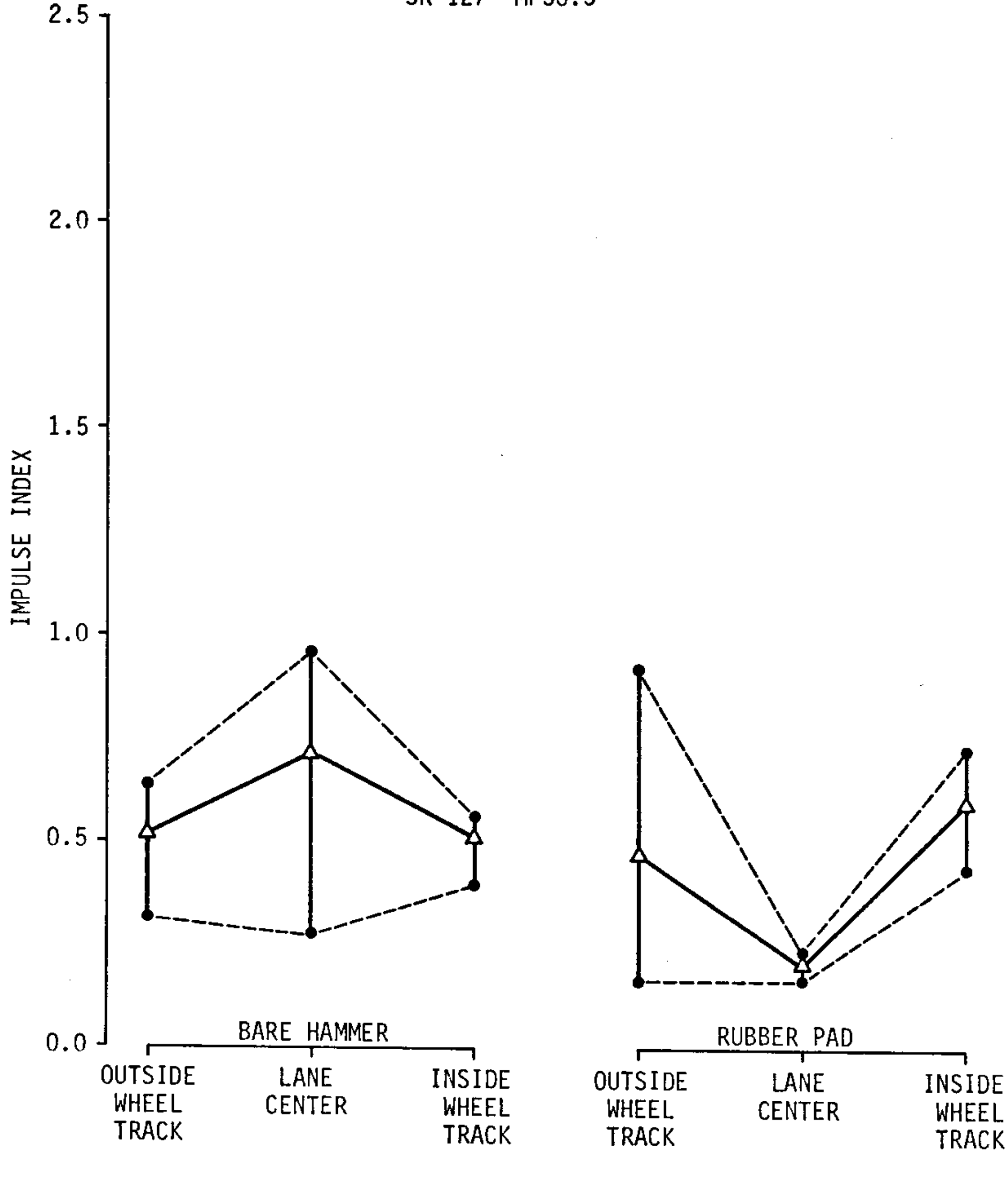


Figure II-7

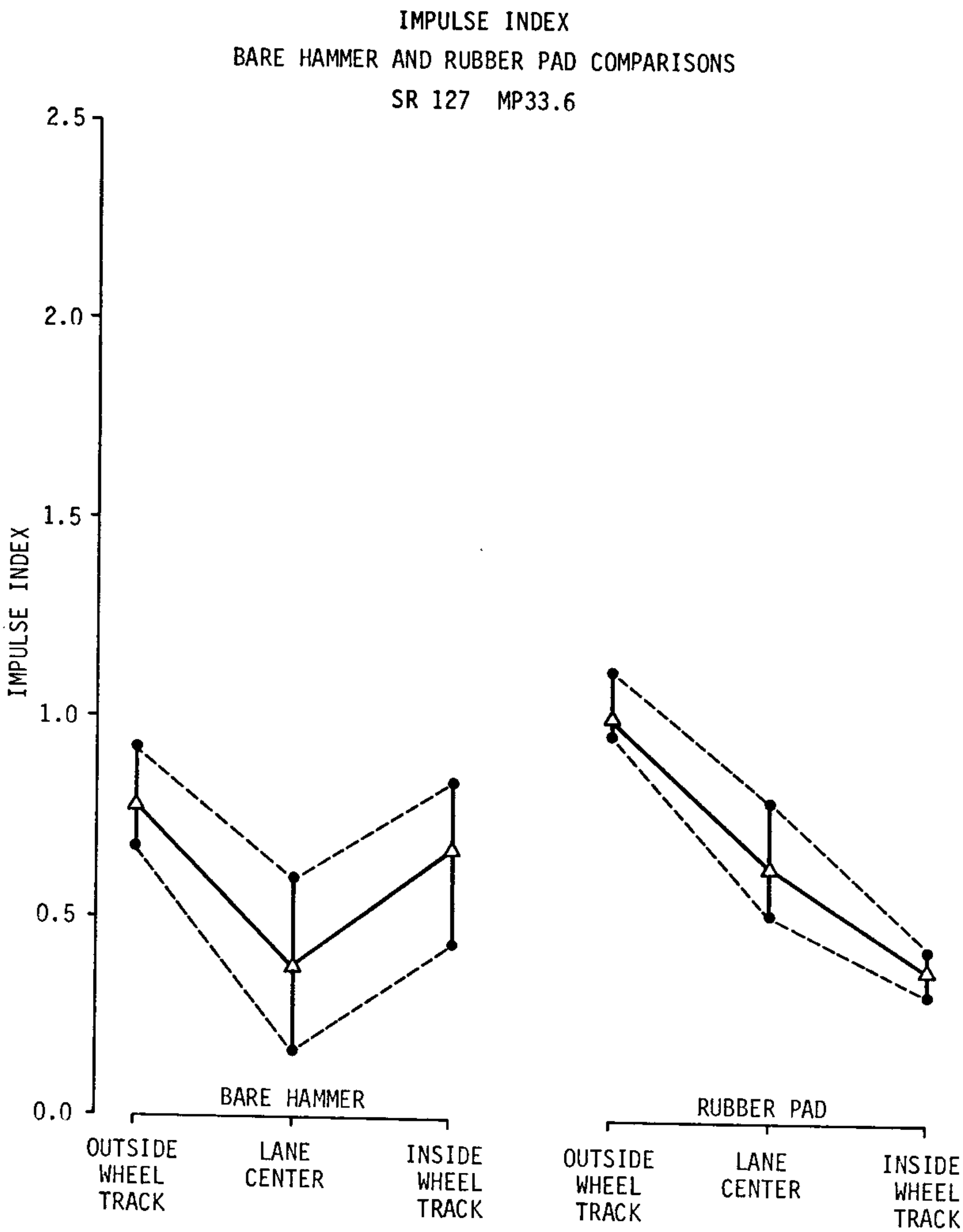

IMPULSE INDEX
BARE HAMMER AND RUBBER PAD COMPARISONS
SR 127 MP33.6
2.5
2.0
1.5
1.0
0.5
0.0
IMPULSE INDEX
BARE HAMMER
RUBBER PAD
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK

Figure II-8

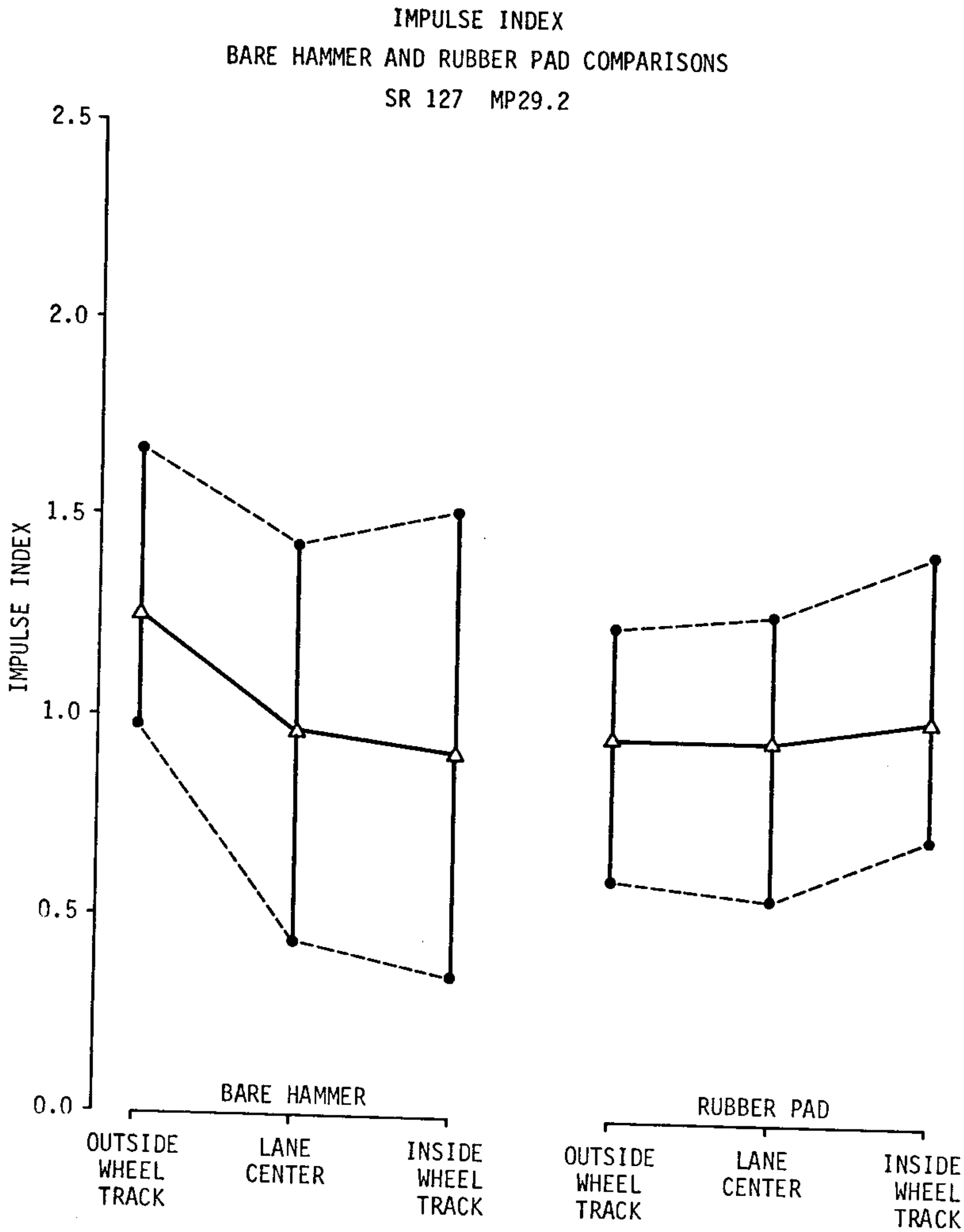
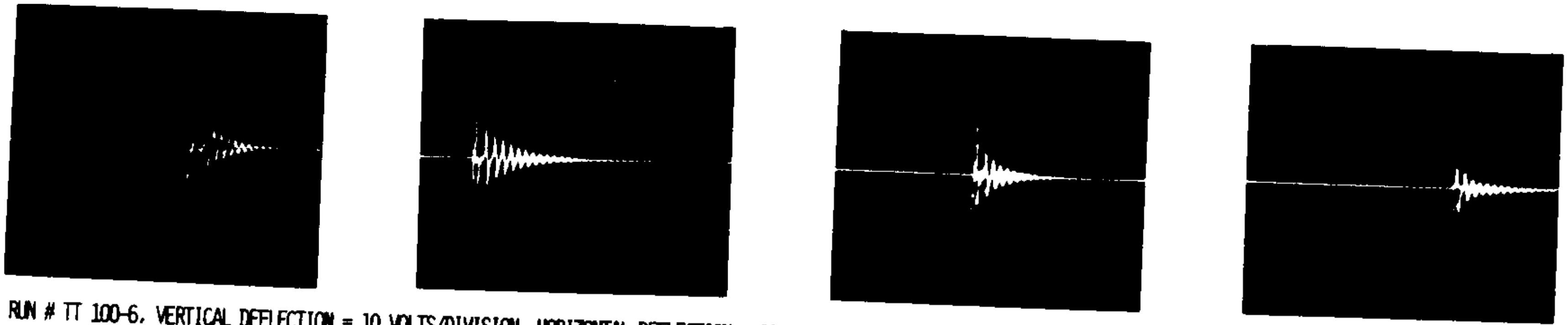

IMPULSE INDEX
BARE HAMMER AND RUBBER PAD COMPARISONS
SR 127 MP29.2
2.5
2.0
1.5
1.0
0.5
0.0
IMPULSE INDEX
BARE HAMMER
RUBBER PAD
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK
OUTSIDE WHEEL TRACK
LANE CENTER
INSIDE WHEEL TRACK

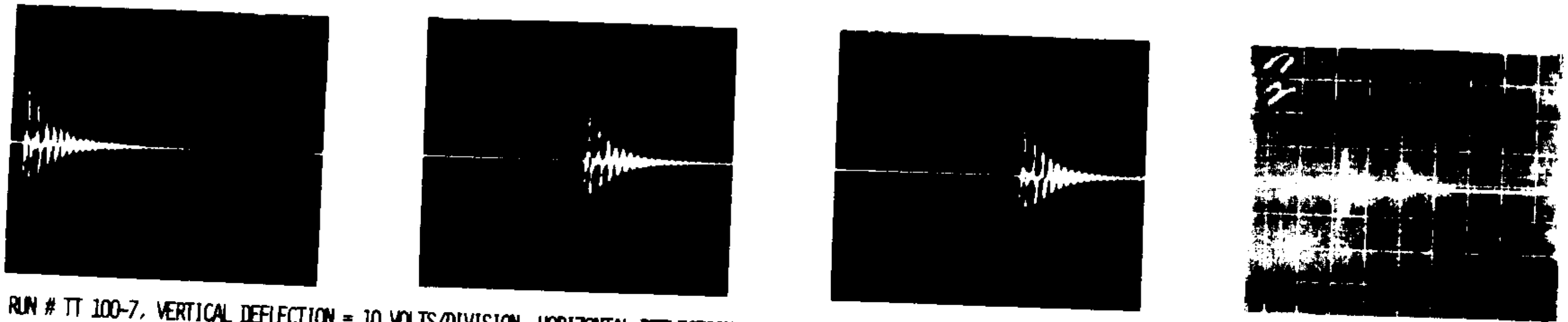
Figure II-9

BARE HAMMER AND RUBBER PAD OSCILLOGRAPH TRACINGS

4 INCHES | 6 INCHES | 8 INCHES | 12 INCHES



RUN # TT 100-6, VERTICAL DEFLECTION = 10 VOLTS/DIVISION, HORIZONTAL DEFLECTION = 10 MILLISECONDS/DIVISION, BRASS FOOTED TRANSDUCER R-3, BARE HAMMER,
DATE = FEB. 21, 1974

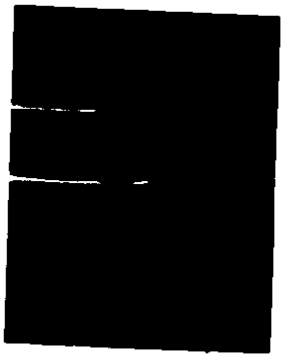


RUN # TT 100-7, VERTICAL DEFLECTION = 10 VOLTS/DIVISION, HORIZONTAL DEFLECTION = 10 MILLISECONDS/DIVISION, RUBBER PAD ON HAMMER, BRASS FOOTED TRANSDUCER R-3,
DATE = FEB. 21, 1974

Figure II-10

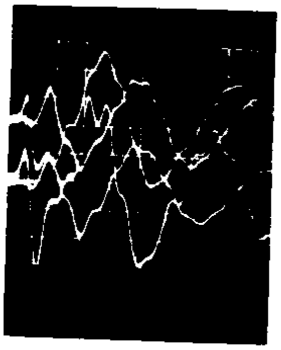
PROPAGATION OF WAVE THROUGH PAVEMENT

FRAME #2



0.1 Miliseconds/Division
1.0 Volts/Division

FRAME #3

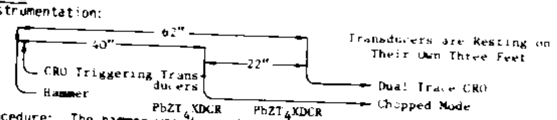


0.5 Miliseconds/Division
2.0 Volts/Division

TEST #1 Purpose: To Measure the Velocity of Propogation of a Wave in Pavement

Frame #2

Instrumentation:



Procedure: The hammer was dropped and the triggering transducer triggered the sweep of CRO memory scope (Tek 564B) without erasing, the two transducers ($PbZT_4$ standing on own three feet) were interchanged in position and the hammer was dropped again. Four traces were then on the memory CRO and a photo was taken (Frame #2).

Conclusion: The transducers behaved almost identically. The wave shape changed as it propogated along the pavement. The propogation time can be approximated from the picture.

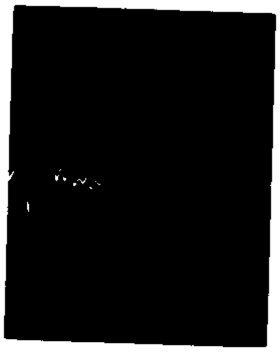
Frame #3

The same test was run with the intermediate transducer moved two inches toward the hammer and the scope settings changed as indicated under the photograph. The conclusion was essentially the same.

FRAME #4

0.2 Miliseconds/Division
0.1 Volts/Division

FRAME #5



0.5 Miliseconds/Division
0.1 Volts/Division

TEST #2 Purpose: To Achieve a Better Description of the Wave Shape Making Use of an Endevco Accelerometer

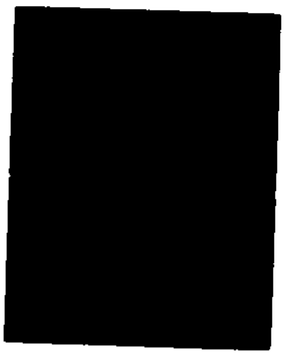
Frame #4

Instrumentation: Endevco Accelerometer 2217 mounted on stud and screwed into nut cemented to the pavement. Accelerometer drives a 100 megaohms ‖ 100 picofarads amplifier (The gain was unknown but substantial for the test). The hammer was located five feet from the accelerometer.

Frame #5

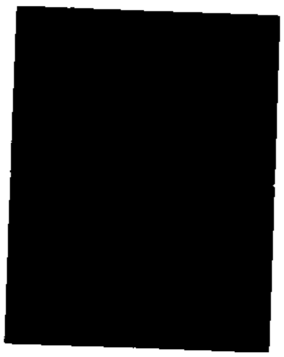
The same test was run for Frame #5 but the horizontal time scale was changed as indicated under the photograph.

FRAME #6



0.1 Miliseconds/Division
0.5 Volts/Division

FRAME #7



0.2 Miliseconds/Division
0.5 Volts/Division

FRAME #8

0.5 Miliseconds/Division
0.5 Volts/Division

TEST #3 (Frames #6, #7 and #8)

Instrumentation: Same as for Test #2 except the hammer was located 34 inches from the accelerometer.

Notes:

Frame #6: 0.1 Miliseconds/Div. To observe detail of leading edge of wave.

Frame #7: 0.2 Miliseconds/Div. It is not known why the vertical signal was smaller than that on Frame #6. The only thing that should have changed was the time base. Separate hammer blows were used however.

Frame #8: Amplitude was uc and slightly higher than in Frame #6.

Figure II-11

The Interface Problem

The accelerometers are attached to the suitcase with some positional freedom so that when the suitcase is placed on the pavement the accelerometers are also on the pavement and essentially uncoupled from the case. This is to prevent energy from propagating through the case to the transducers. It was observed that, if only one transducer were lifted and replaced but with the rest of the instrument not moved, the reading from that transducer would deviate from previous readings, but the reading from the unmoved transducer would not vary nearly as much. Hence it appeared that something about the transducer to pavement interface was responsible for the lack of repeatability. The configuration in use for this interface consisted of three short legs with dull points in contact with the pavement. The legs support a triangular base plate on which is secured the accelerometer. A series of tests was devised to attempt to cure this problem.

It was found that, by mounting a transducer on a stud screwed into a nut cemented to the pavement surface, the improvement in repeatability was very great.

Cementing the transducer to the pavement is not compatible with portability, but it certainly verified the location of the problem. A transducer cemented to the pavement was therefore used as a comparative device or control to examine other interface configurations. This control transducer was connected to one channel of the Impulse Index Computer, and another transducer with various interface configurations was connected to the other channel. In each case the value of $\int|a|dt$ was recorded for repeated hammer impacts. Detailed accounting of the various tests and configurations is given in the following section.

Comparative Interface Tests

Tests were run comparing various methods of cell anchorage on the pavement surface. Cell T-1 was anchored to the pavement surface by screwing its central stud into a nut epoxyed to the surface. This cell was used as a standard. Cell T-2 (or cell T-3 as noted) was located at a constant radial distance of eleven inches from the hammer and its method of anchorage and contact with the pavement surface was modified for each test.

Test #1:

Cell T-2, with its triangular base plate attached, was placed on the pavement surface, making contact through three legs. The hammer was dropped, output recorded, and the cell was rotated about its central axis through an angle of fifteen degrees. The hammer was dropped again and the procedure repeated for the data collection.

Test #2:

Cell T2 was used again, and the same procedure was used as in Test #1, except the cell was picked up without rotation and placed in the same location.

Test #3:

Cell T-3 was placed on the pavement surface, making contact through a sandbag glued to its triangular base plate. The sandbag was filled with spherical glass bead sand. The hammer was dropped while the cell remained in the same position and the readings were taken.

Test #4:

Cell T-3 was used again and the same procedure was used as in Test #3, except the cell was picked up and relocated after each hammer drop.

CELL ANCHORAGE TESTS

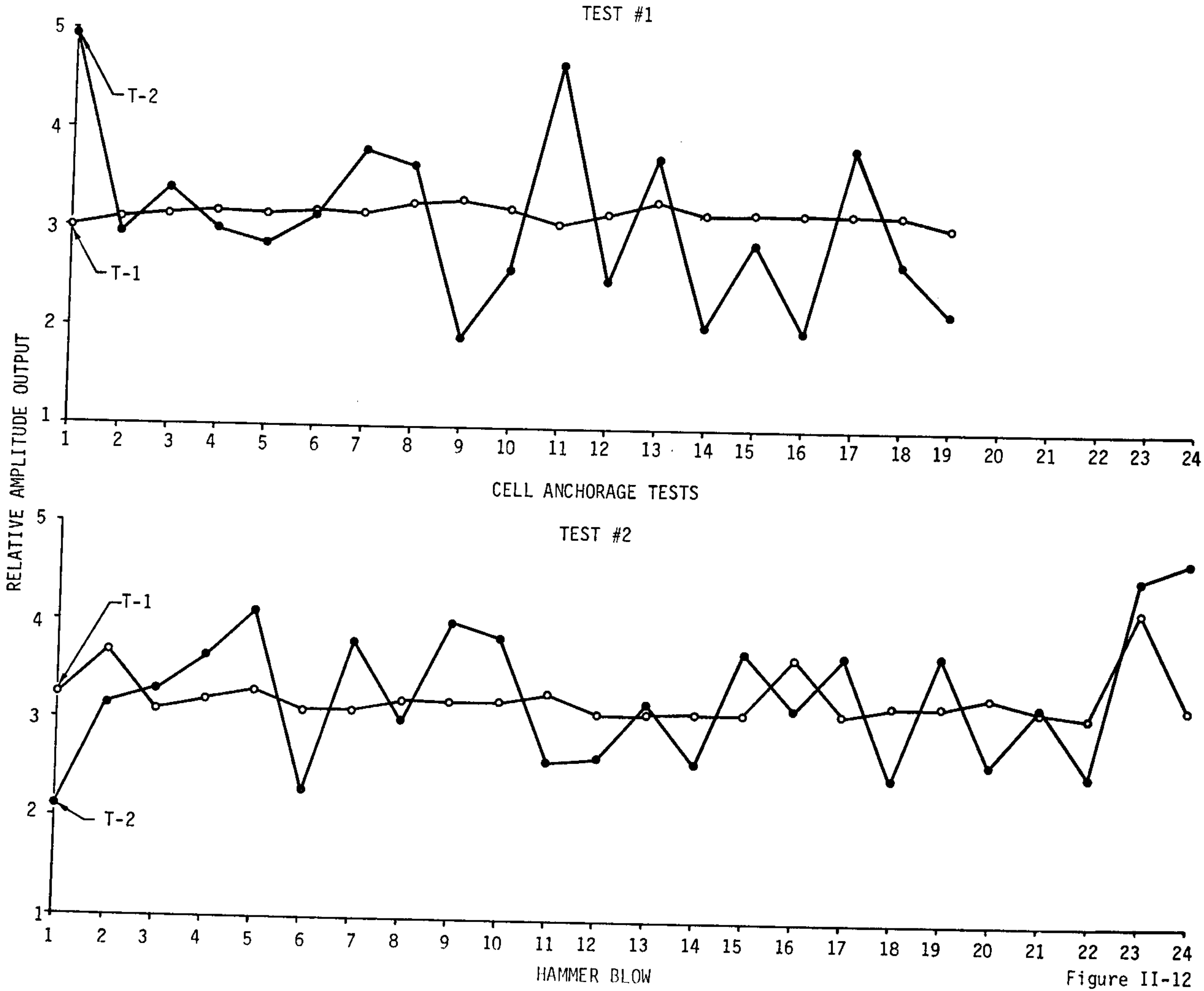


Figure II-12

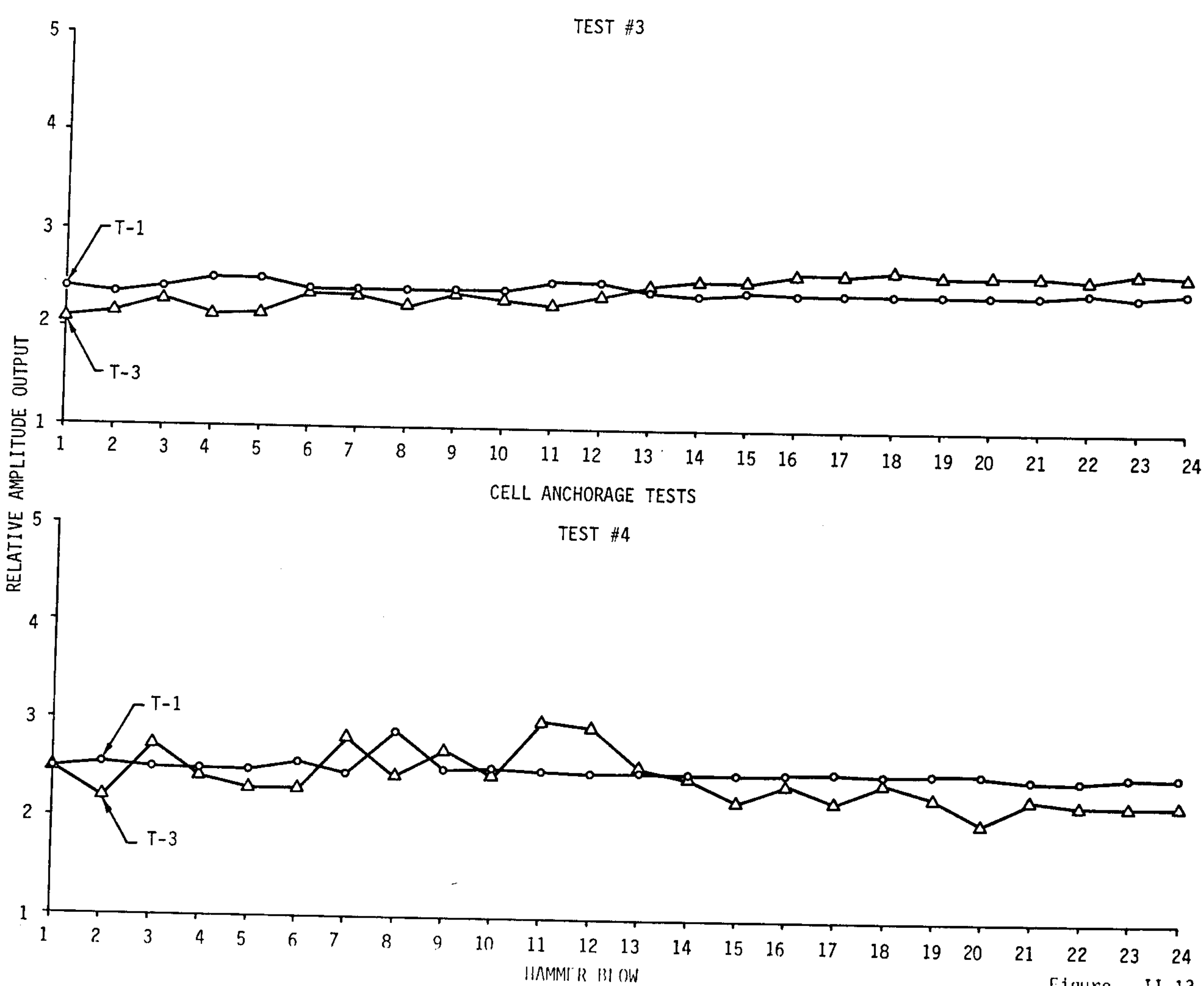

TEST #3
T-1
T-3
RELATIVE AMPLITUDE OUTPUT
CELL ANCHORAGE TESTS
TEST #4
T-1
T-3
HAMMER BLOW

Figure II-13

Test #5:

Cell T-3 was used again and the same procedure was used as in Test #3, except the cell was picked up and rotated about its central axis after each hammer drop.

Test #6:

Cell T-3 was used again and the same procedure was used as in Test #5, except the sandbag contact was soaked in water prior to the test.

Another set of six tests was run comparing various methods of cell anchorage on the pavement surface. Cell R-3 was anchored to the pavement surface by screwing its central stud into a nut epoxyed to the surface. This cell was used as a standard. Cell T-2 was located at a constant radial distance of seventeen inches from the hammer and its method of anchorage and contact with the pavement surface was modified for each test.

Test #7:

Cell T-2, with its triangular base plate attached, was placed on the pavement surface, making contact through a central leg. A ten-pound weight was placed over the cell, applying pressure to the leg contact point. The hammer was dropped twelve times while the cell remained in the same position and readings were taken.

Test #8:

Cell T-2 was used again and the same procedure was used as in Test #7, except the cell was picked up and relocated after each hammer drop.

Test #9:

Cell T-2, with its triangular base plate attached, was placed on the pavement surface, making contact through three legs. Tension was then applied through three symmetric leaf springs securing the cell to

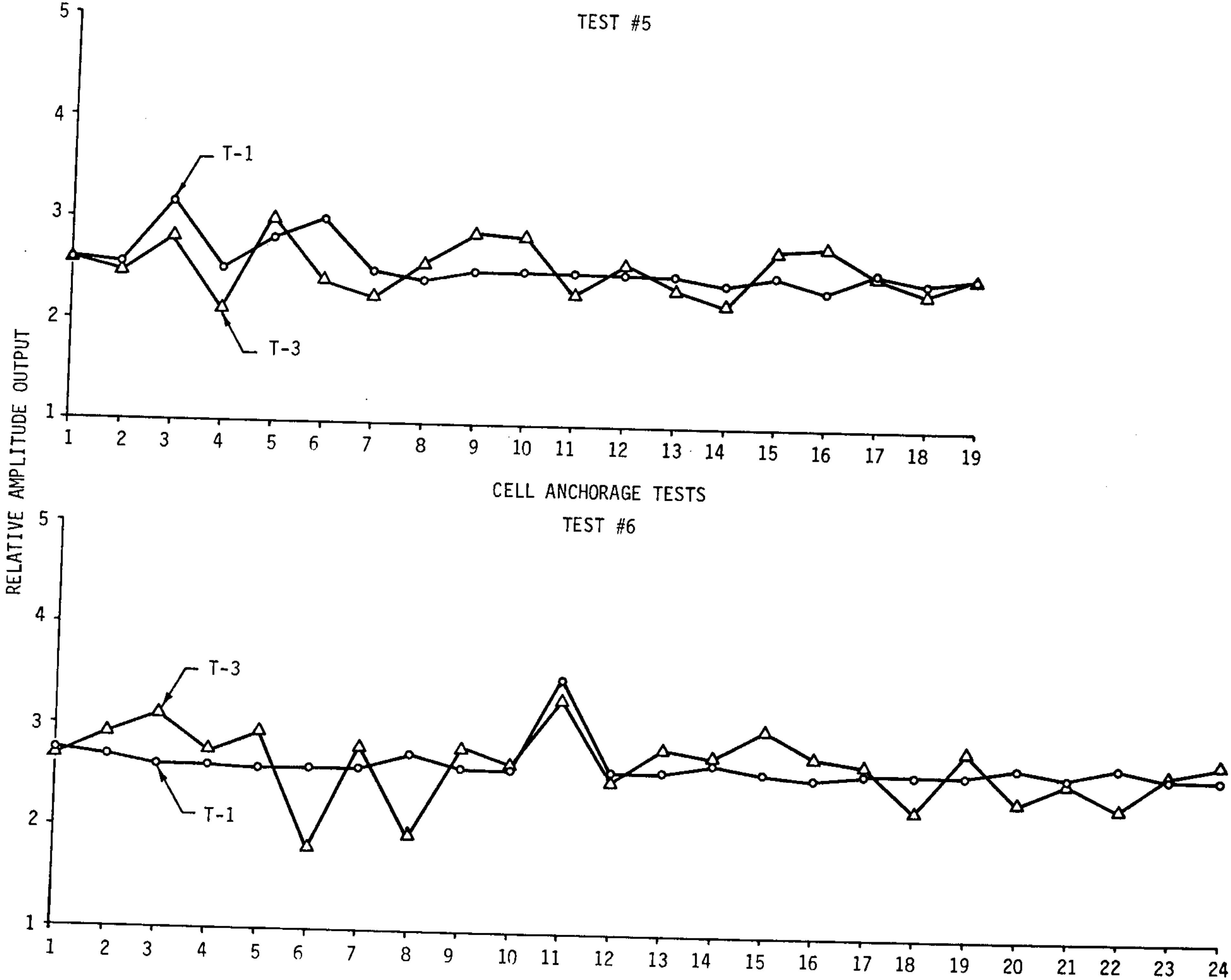

TEST #5
T-1
T-3
RELATIVE AMPLITUDE OUTPUT
CELL ANCHORAGE TESTS
TEST #6
T-3
T-1
HAMMER BLOW

Figure II-14

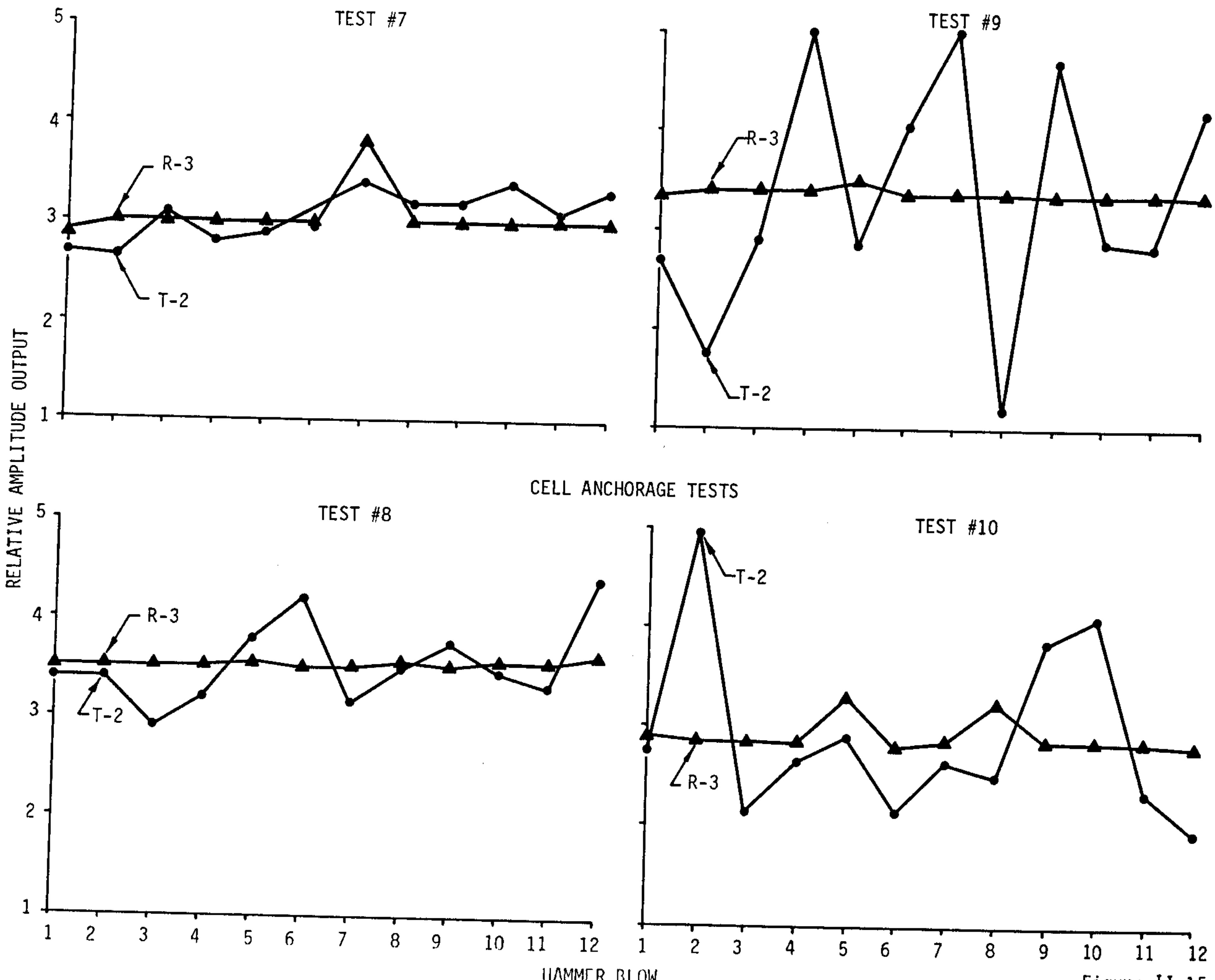

CELL ANCHORAGE TESTS
TEST #7
TEST #9
TEST #8
TEST #10
R-3
T-2
RELATIVE AMPLITUDE OUTPUT
HAMMER BLOW
1
2
3
4
5
6
7
8
9
10
11
12

Figure II-15

the pavement surface. The cell was picked up and relocated after each hammer drop.

Test #10:

Cell T-2 was used again and the same procedure was used as in Test #9, except the cell made contact through a central leg.

Test #11:

Cell T-2 was used again and the same procedure was used as in Test #10, except the triangular base plate was removed.

Test #12:

Cell T-2, with its triangular base plate removed, was placed on the pavement surface, making direct contact through the cell bottom. The cell was picked up and relocated after each hammer drop.

Three additional tests were run comparing various methods of cell anchorage on the pavement surface. Cell R-3 was anchored to the pavement surface by screwing its central stud into a nut epoxyed to the surface. This cell was used as a standard. In Tests #14 and #15, cell T-2, with its triangular base place attached, was placed on the pavement surface, making contact through three legs. Cell T-8 was mounted on a triangular base plate constructed with three 3/8" steel ball bearings. The balls were fastened to the plate by 0.15" O.D. wires epoxyed to the balls and secured to the base plate. The balls there therefore loose, but captive.

Test #13:

Cell T-8, with steel ball contact points, was placed on the pavement surface eleven inches from the hammer. The cell was picked up and relocated after each hammer drop.

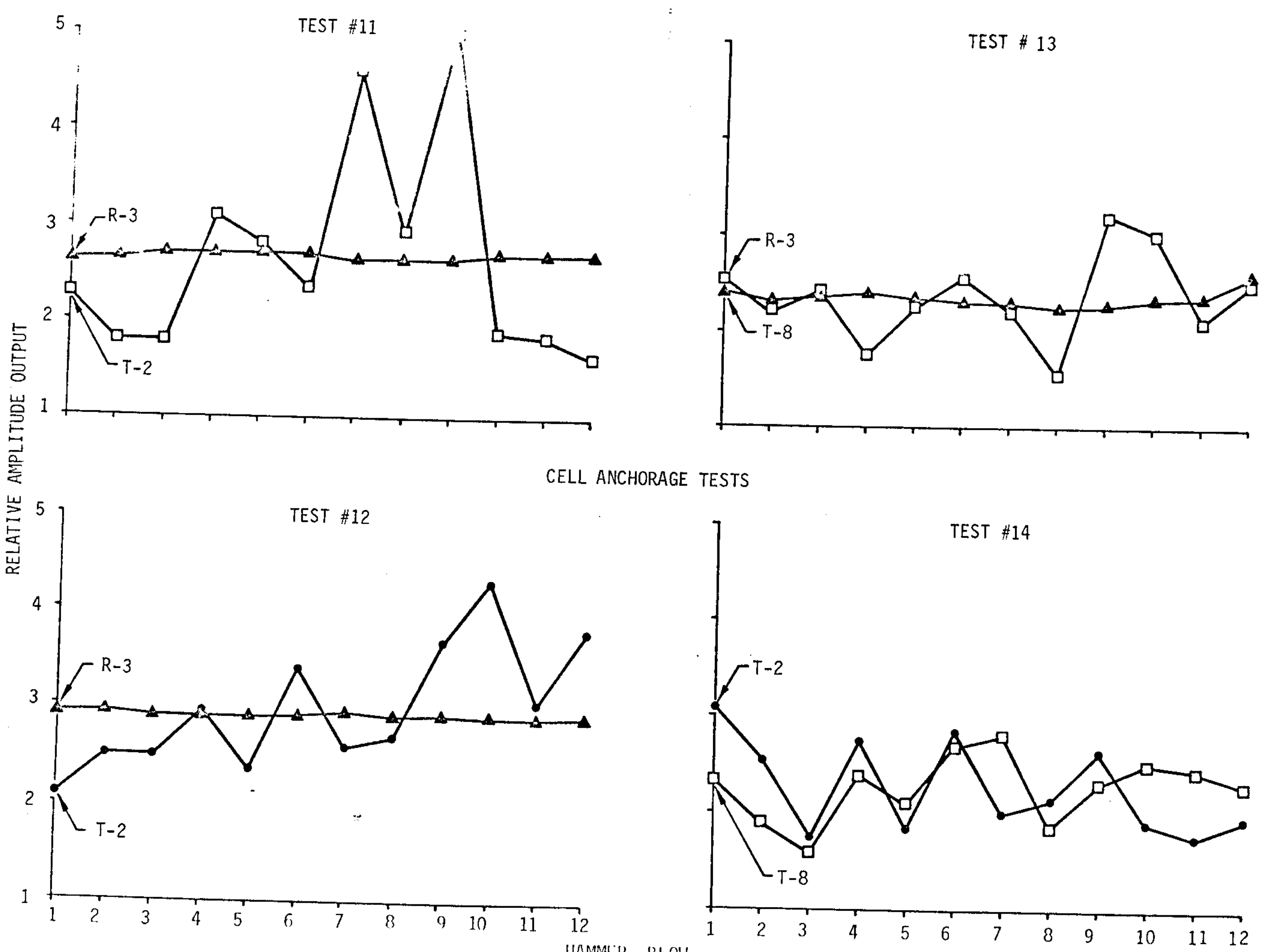

CELL ANCHORAGE TESTS
TEST #11
TEST # 13
TEST #12
TEST #14
RELATIVE AMPLITUDE OUTPUT
HAMMER BLOW
R-3
T-2
T-8
1
2
3
4
5
6
7
8
9
10
11
12

Figure II-16

Test #14:

Cell T-8, with steel ball contact points, was placed on the smooth pavement surface eleven inches from the hammer. Cell T-2, with its triangular base plate, was placed on the pavement surface nineteen inches from the hammer, making contact through three legs. Cell T-8 was picked up and relocated after each hammer drop.

Test #15:

Cells T-8 and T-2 were used again and the same procedure was used as in Test #14, except the pavement surface was rough.

CELL ANCHORAGE TESTS

TEST #15

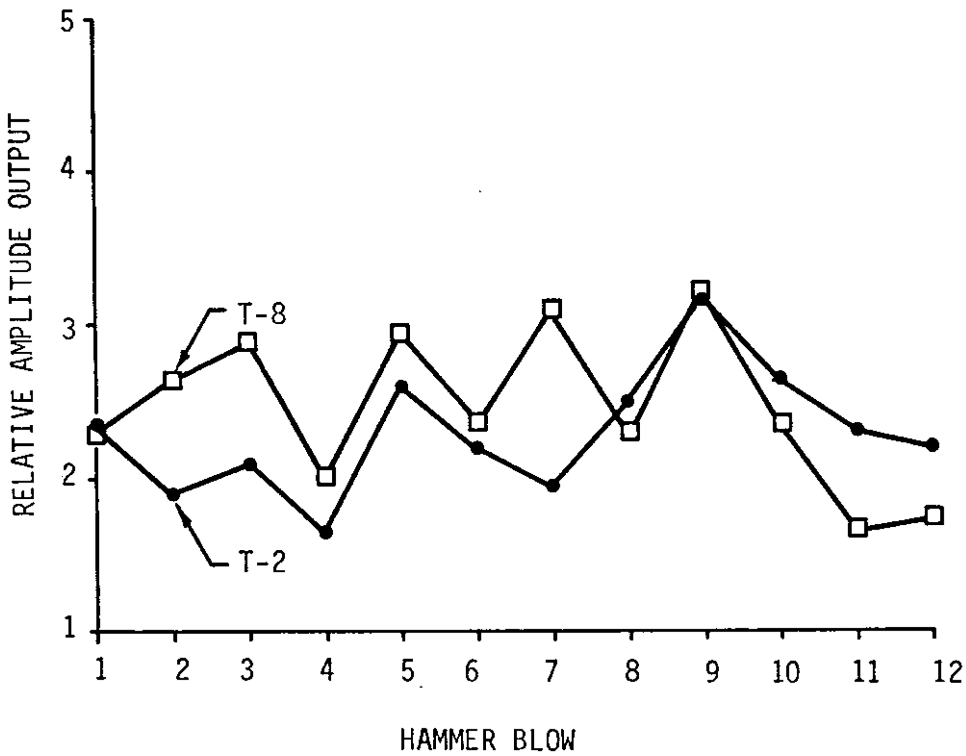


Figure II-17

The Hydrostatic Interface

The foregoing experimentation led to the design of a transducer to pavement interface which would make contact with a significant area of the pavement and yet not be affected by irregularities of the surface. An incompressible liquid in a sealed cell was used to provide intimate contact with the pavement surface and hence achieve good energy transfer from the pavement to the liquid. The vertical walls of the cell were made rigid to preclude loss of energy in the walls. The bottom face of the cell is a flexible rubber diaphragm. The transducer is flexibly coupled to the top of the cell so that energy transmitted from the pavement through the bottom diaphragm is then transmitted through the non-compressible liquid and thence to the transducer. This interface proved to give the repeatability which had been sought. Initial examinations of the waveform from the transducer showed that the output was unduly rich in high frequencies. These high frequencies did not correlate with pavement condition and so a low-pass filter was added to remove them.

It should be pointed out that a single-pole low-pass filter with 20 db of attenuation per decade behaves approximately as an integrator. The resulting signal from the accelerometer therefore is now approximately integrated before the magnitude is taken and it is integrated again. The channel output R then becomes

$$R \approx \int \left| \int a\,dt \right| dt = \int |\text{velocity}|\,dt$$

which is more closely related to total displacement than the result obtained without the filter.

Final Repeatability Tests

To determine the degree of repeatability achievable with this improved interface, one of the Impulse Index Computers (unit no.1) was equipped with the hydrostatic interfaces, and the other unit (unit no. 2) was left with the original tripod legs for the interface.

Five positions on a pavement were marked and designated A through E so that the instrument could be returned to the same position after being moved. The tripod unit was placed on position A and a single measurement made. R_1, R_2 and the Impulse Index were recorded. The instrument then was moved to positions B, C, D and E.

The measurements then were repeated with the hydrostatic unit, then again with the tripod, then again with the hydrostatic and so on alternately until each unit had measured each position twenty times. The data recorded appear in Tables A-II-3 and A-II-4. Graphical comparisons of the readings are displayed in Figs. II-18 to II-32.

R_1, R_2 and I^2 for each position is graphed separately so that actual differences in the pavement from one position to another do not mask the instrument repeatability.

The greatly improved repeatability of the hydrostatic interface is readily apparent from the graphs. If all of the values for a certain position obtained using the tripod are averaged, and likewise all of the values for the same position using the hydrostatic interface are averaged, the two average values are fairly close. One can conclude that the units therefore are measuring essentially the same quantity. The spread of the values obtained with the hydrostatic unit is much smaller than the tripod data, indicating better measurement repeatability.

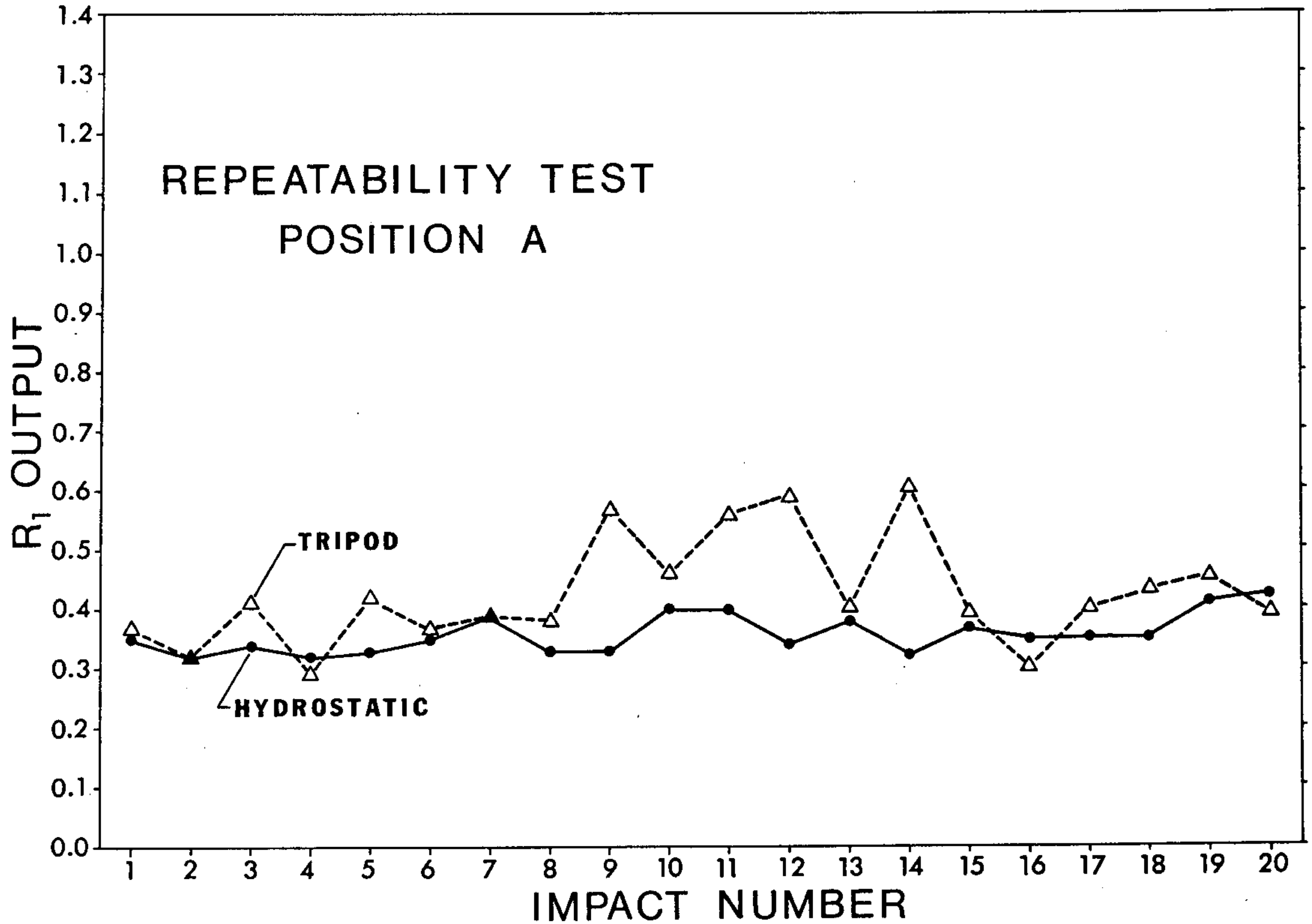

REPEATABILITY TEST
POSITION A
TRIPOD
HYDROSTATIC
R1 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-18

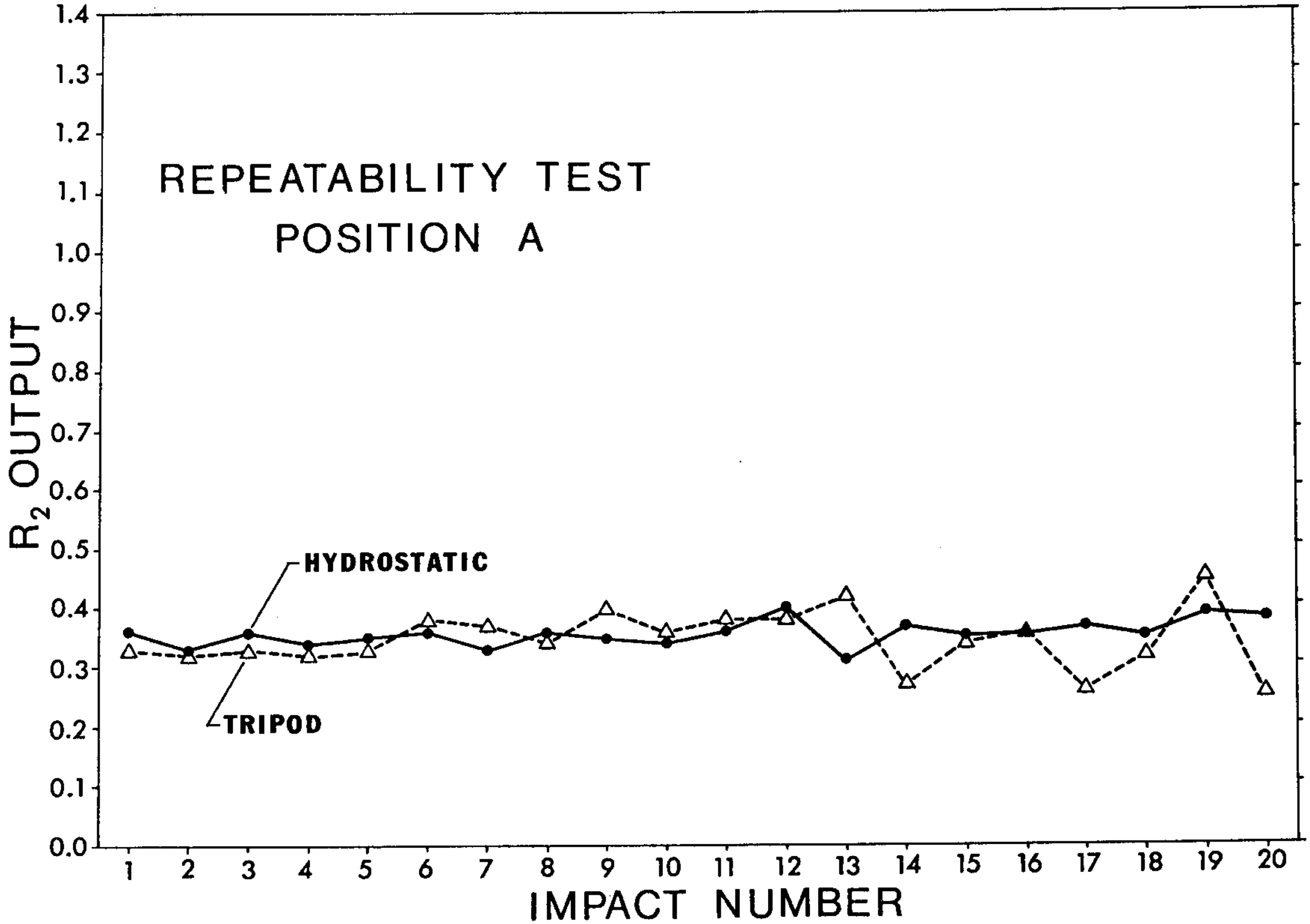

REPEATABILITY TEST
POSITION A
HYDROSTATIC
TRIPOD
R_2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-19

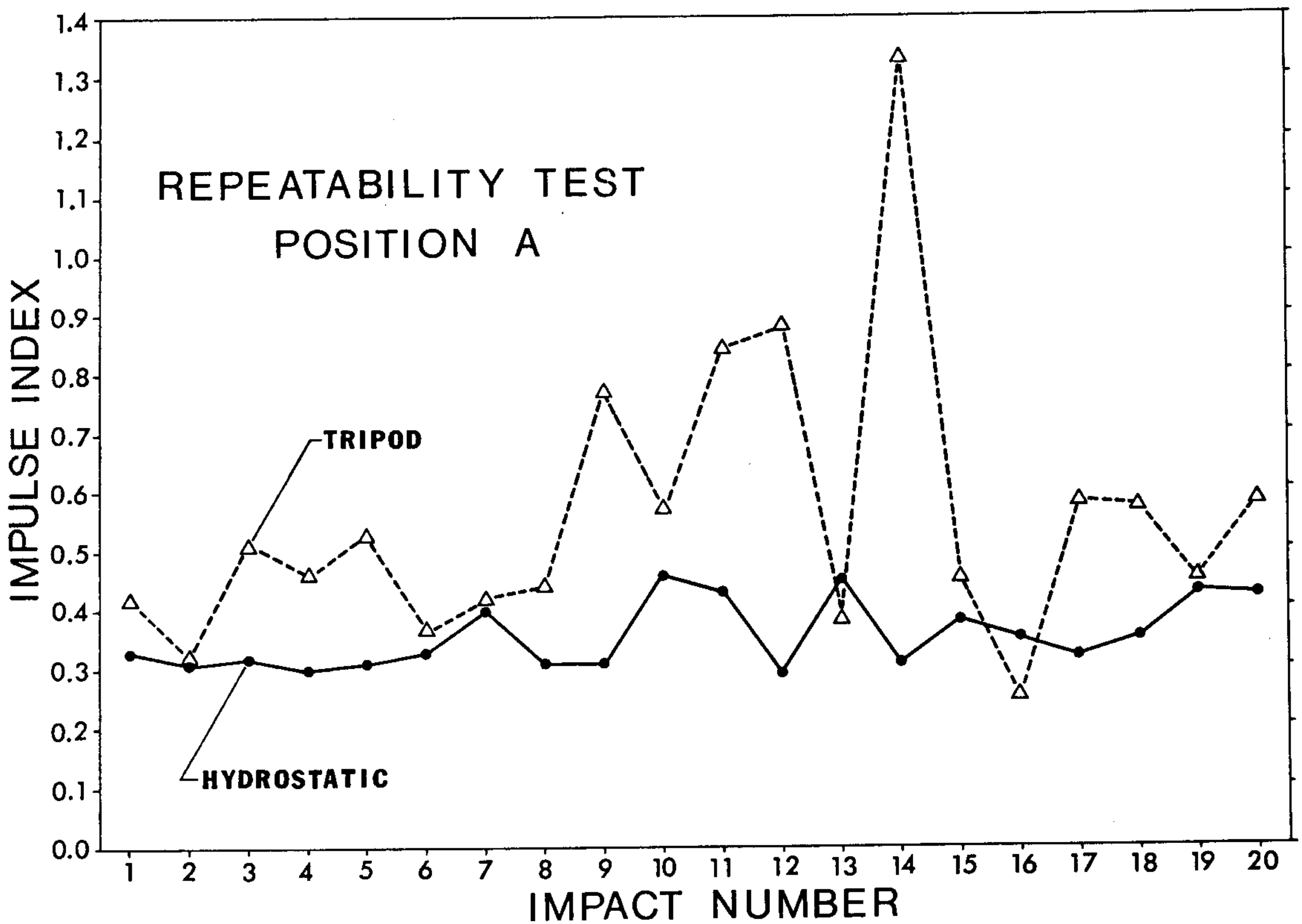

REPEATABILITY TEST
POSITION A
TRIPOD
HYDROSTATIC
IMPULSE INDEX
IMPACT NUMBER
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure II-20

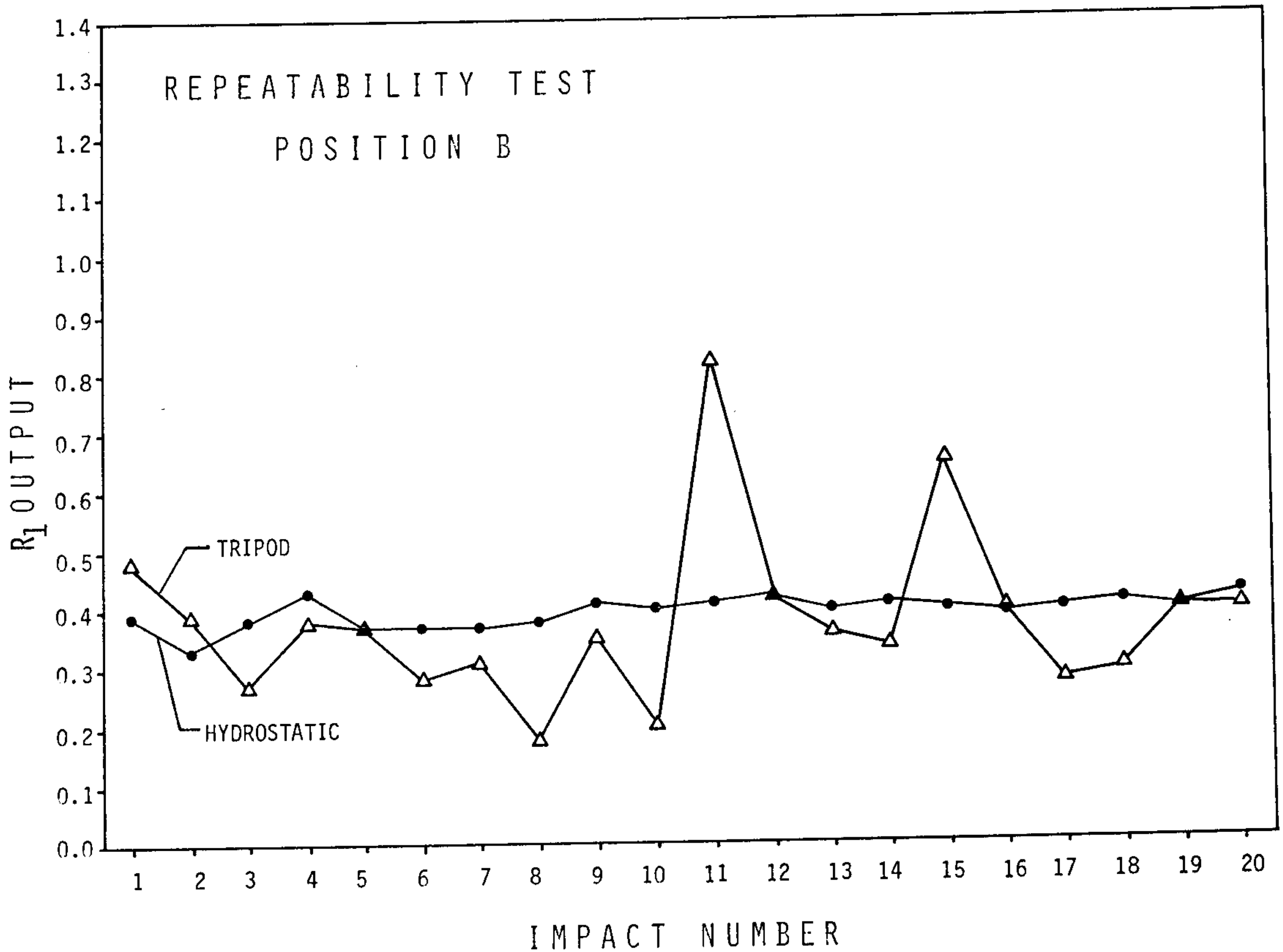

REPEATABILITY TEST
POSITION B
TRIPOD
HYDROSTATIC
R_1 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-21

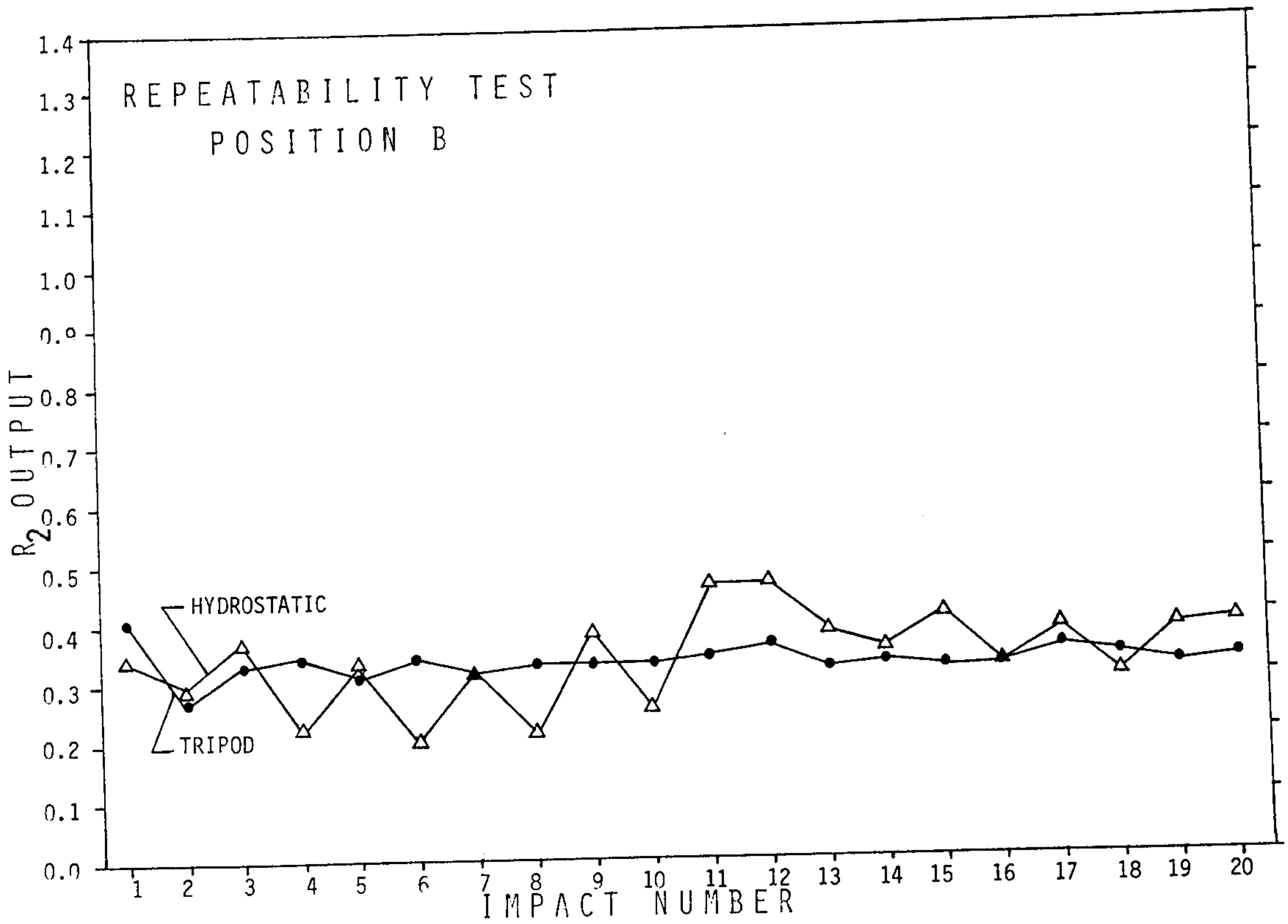

REPEATABILITY TEST
POSITION B
HYDROSTATIC
TRIPOD
R_2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-22

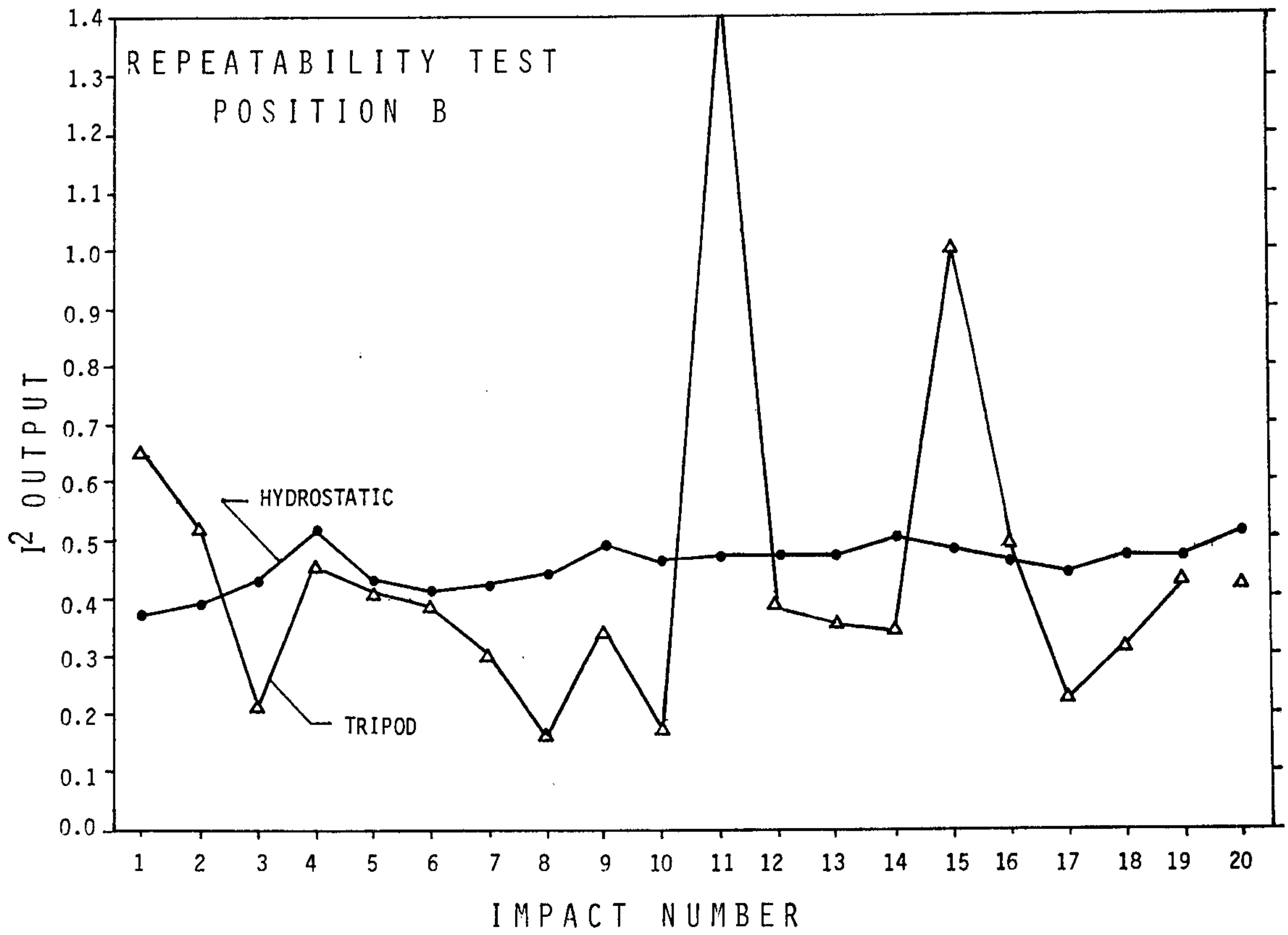

REPEATABILITY TEST
POSITION B
HYDROSTATIC
TRIPOD
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I^2 OUTPUT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-23

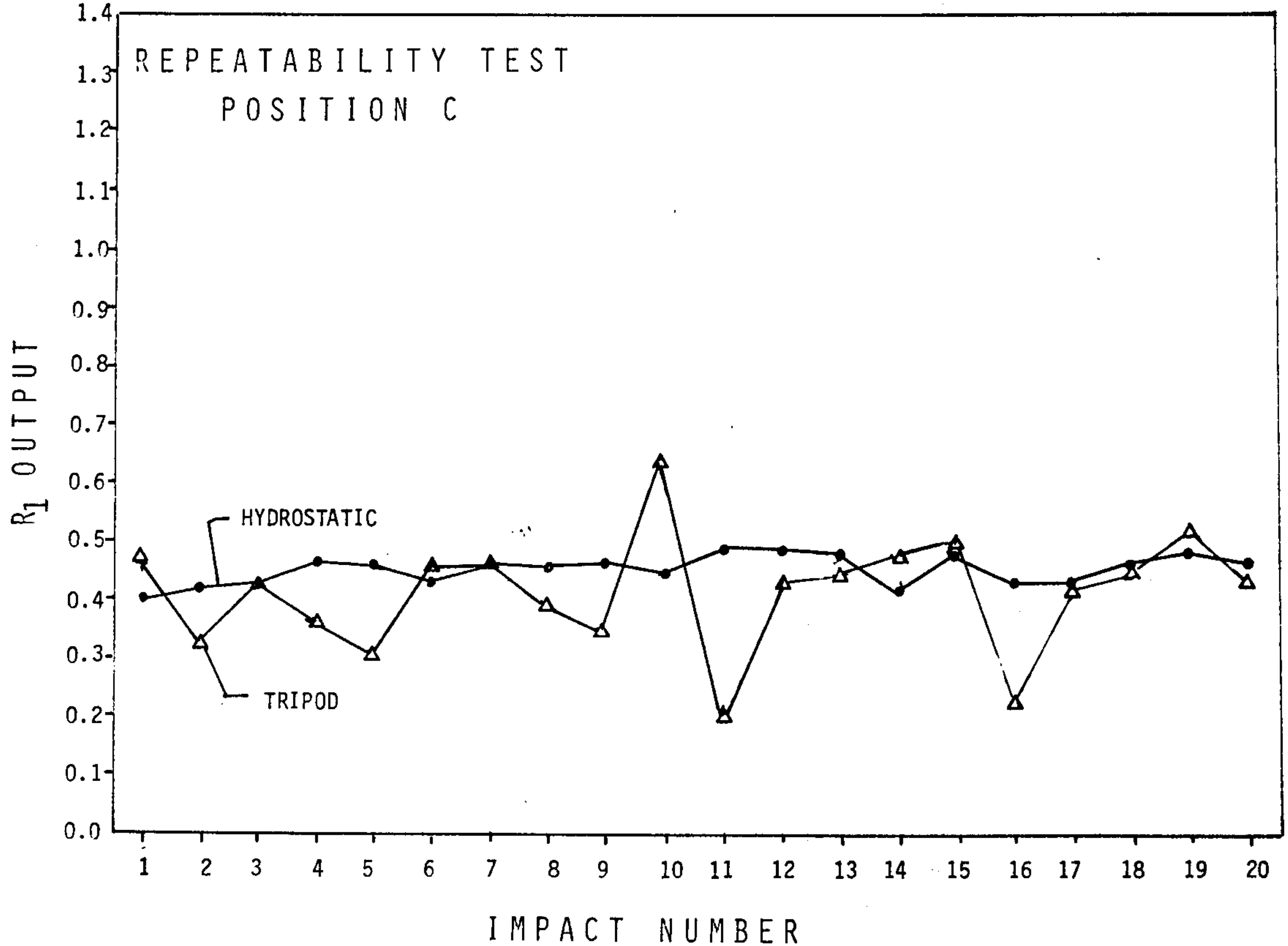

REPEATABILITY TEST
POSITION C
HYDROSTATIC
TRIPOD
R_1 OUTPUT
IMPACT NUMBER
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure II-24

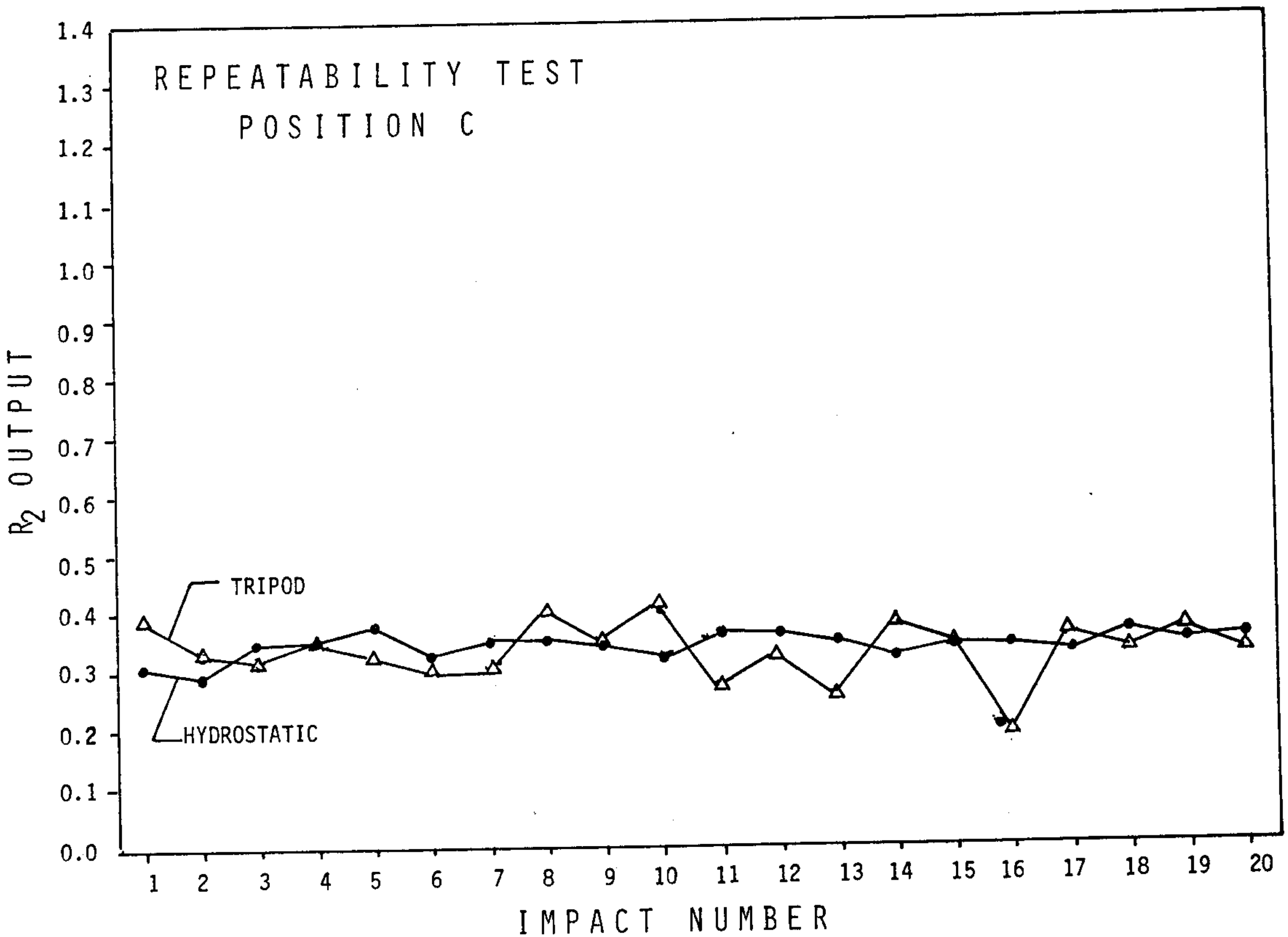

REPEATABILITY TEST
POSITION C
TRIPOD
HYDROSTATIC
R_2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-25

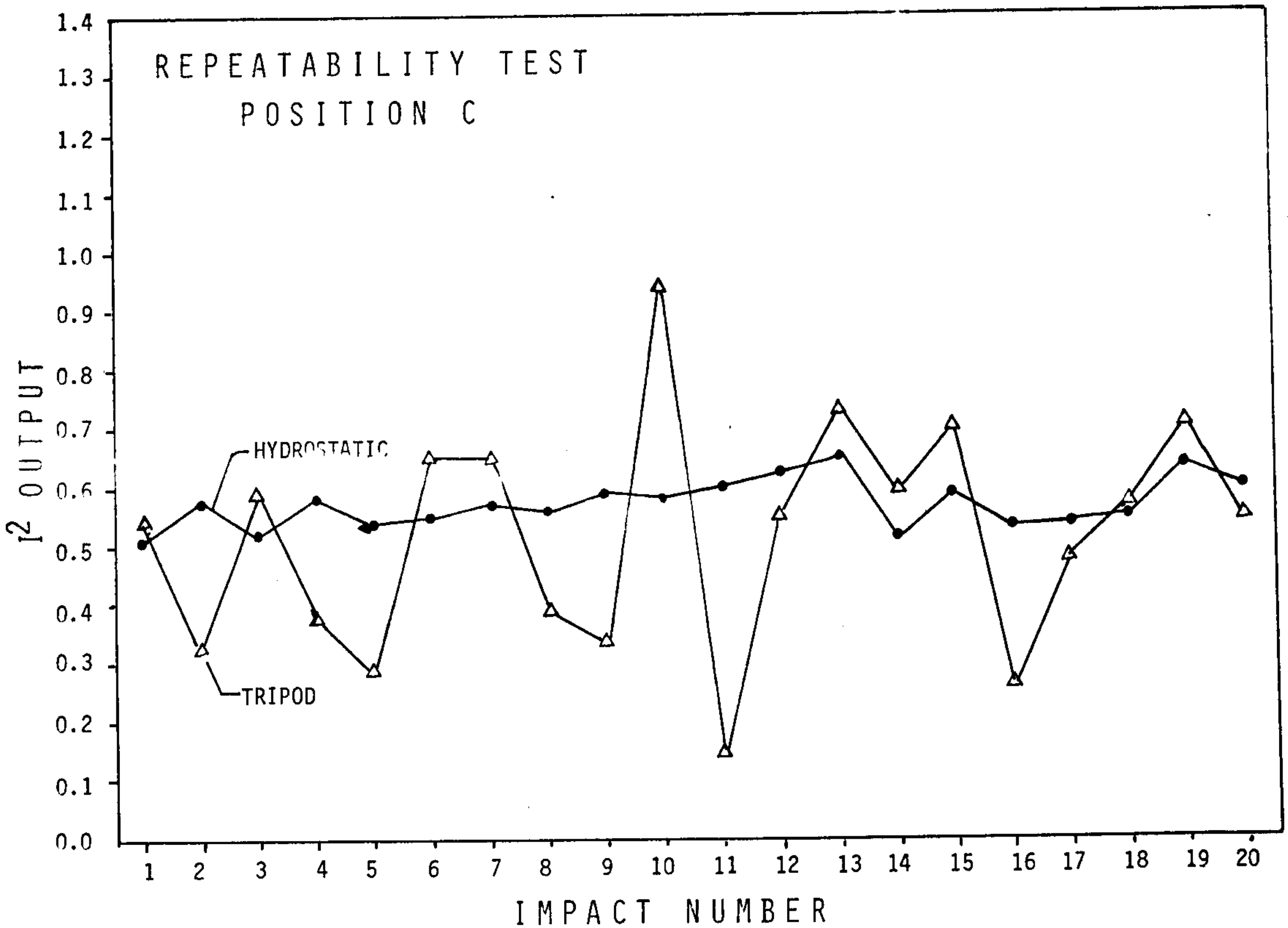

REPEATABILITY TEST
POSITION C
HYDROSTATIC
TRIPOD
I^2 OUTPUT
IMPACT NUMBER
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure II-26

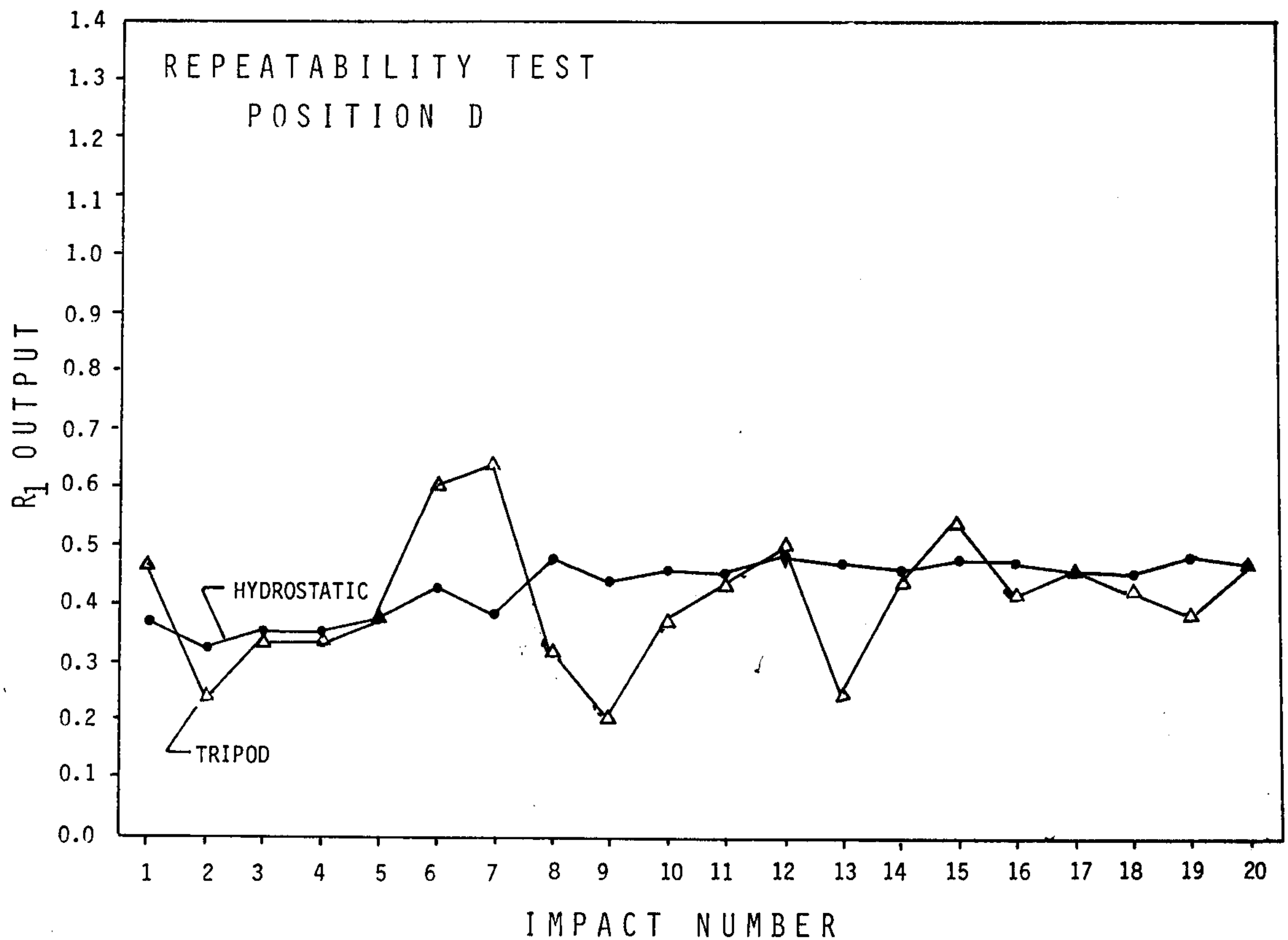

REPEATABILITY TEST
POSITION D
HYDROSTATIC
TRIPOD
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
R1 OUTPUT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-27

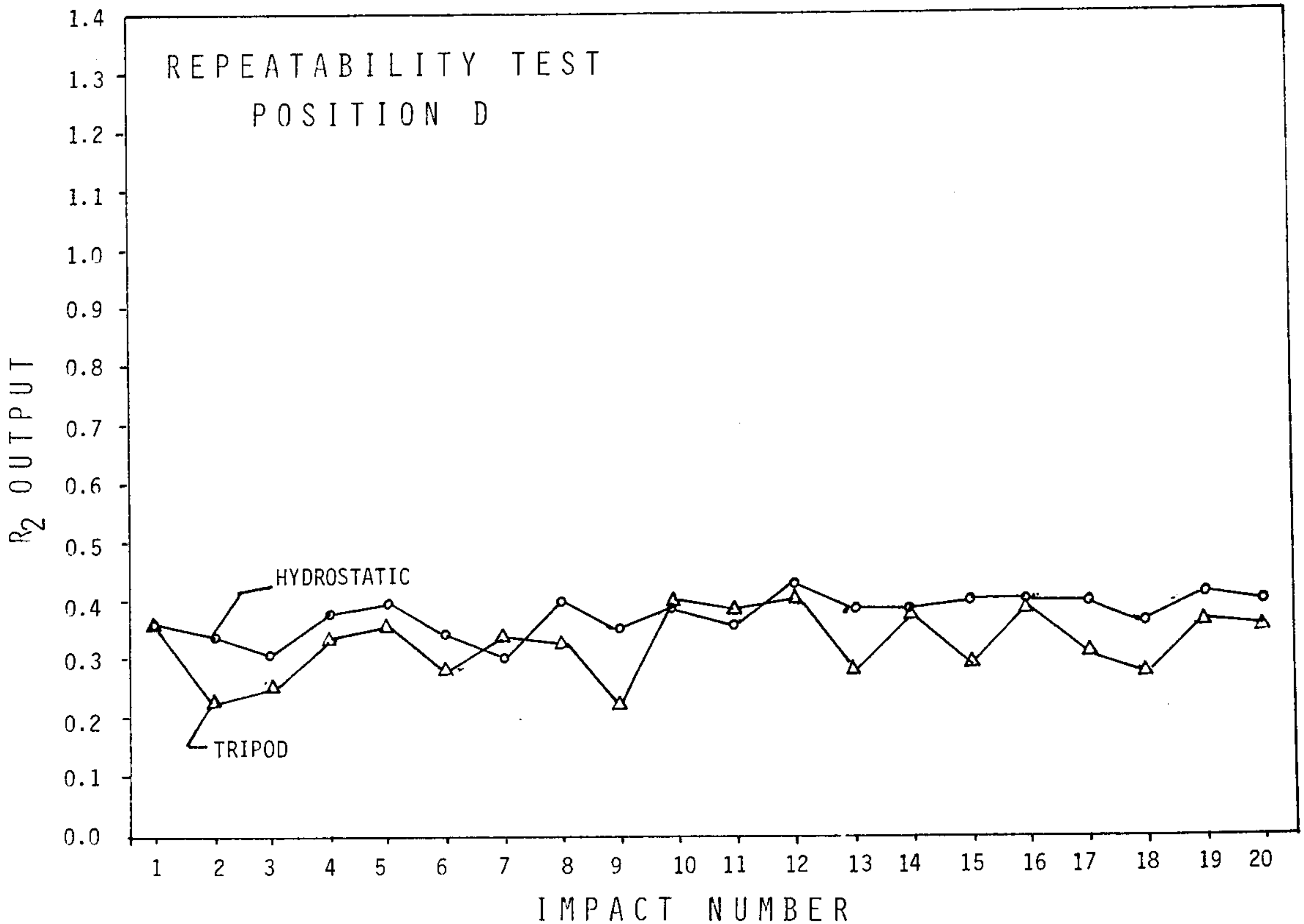

REPEATABILITY TEST
POSITION D
HYDROSTATIC
TRIPOD
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
R2 OUTPUT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-28

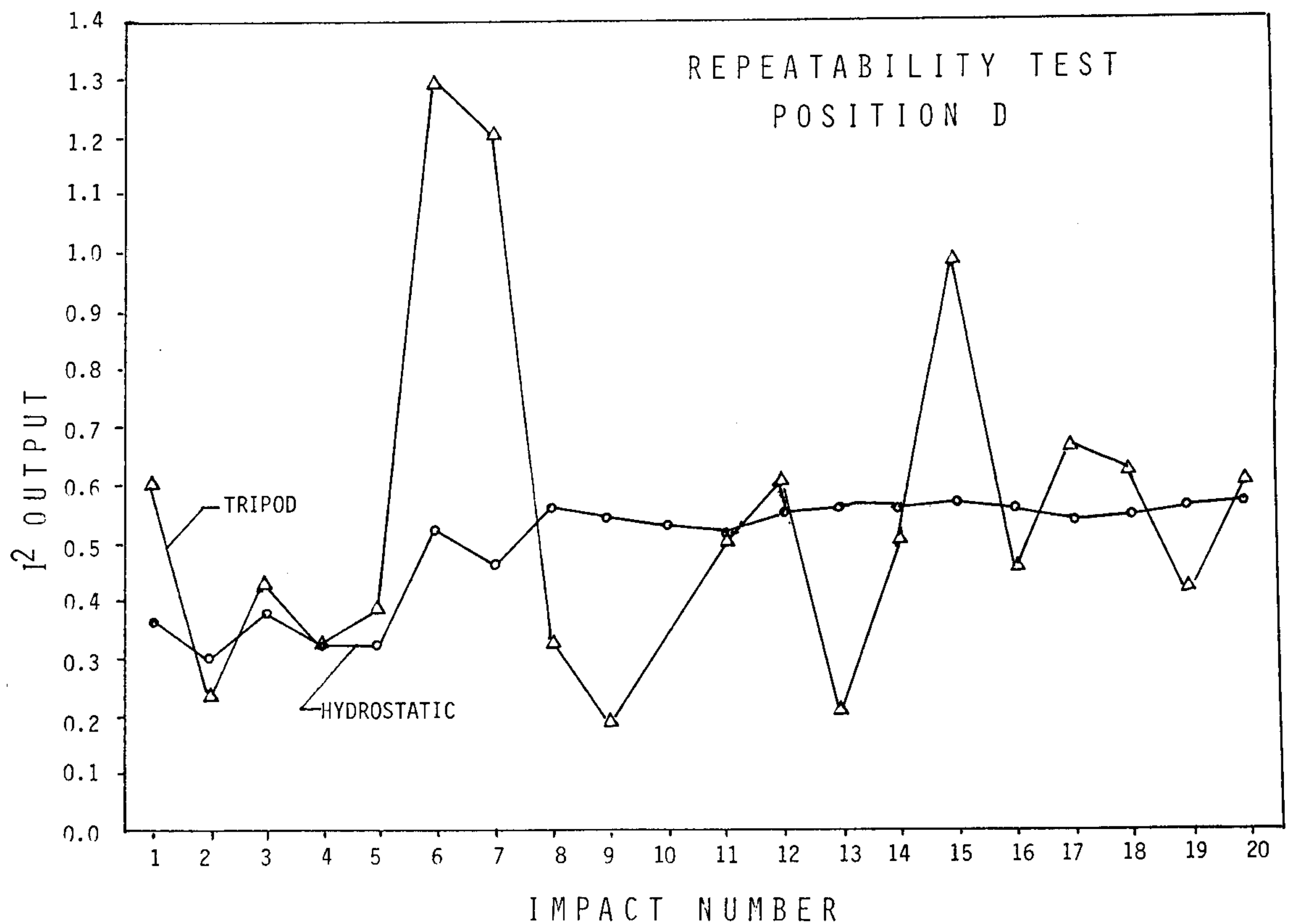

REPEATABILITY TEST
POSITION D
I2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
TRIPOD
HYDROSTATIC
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
IMPACT NUMBER

Figure II-29

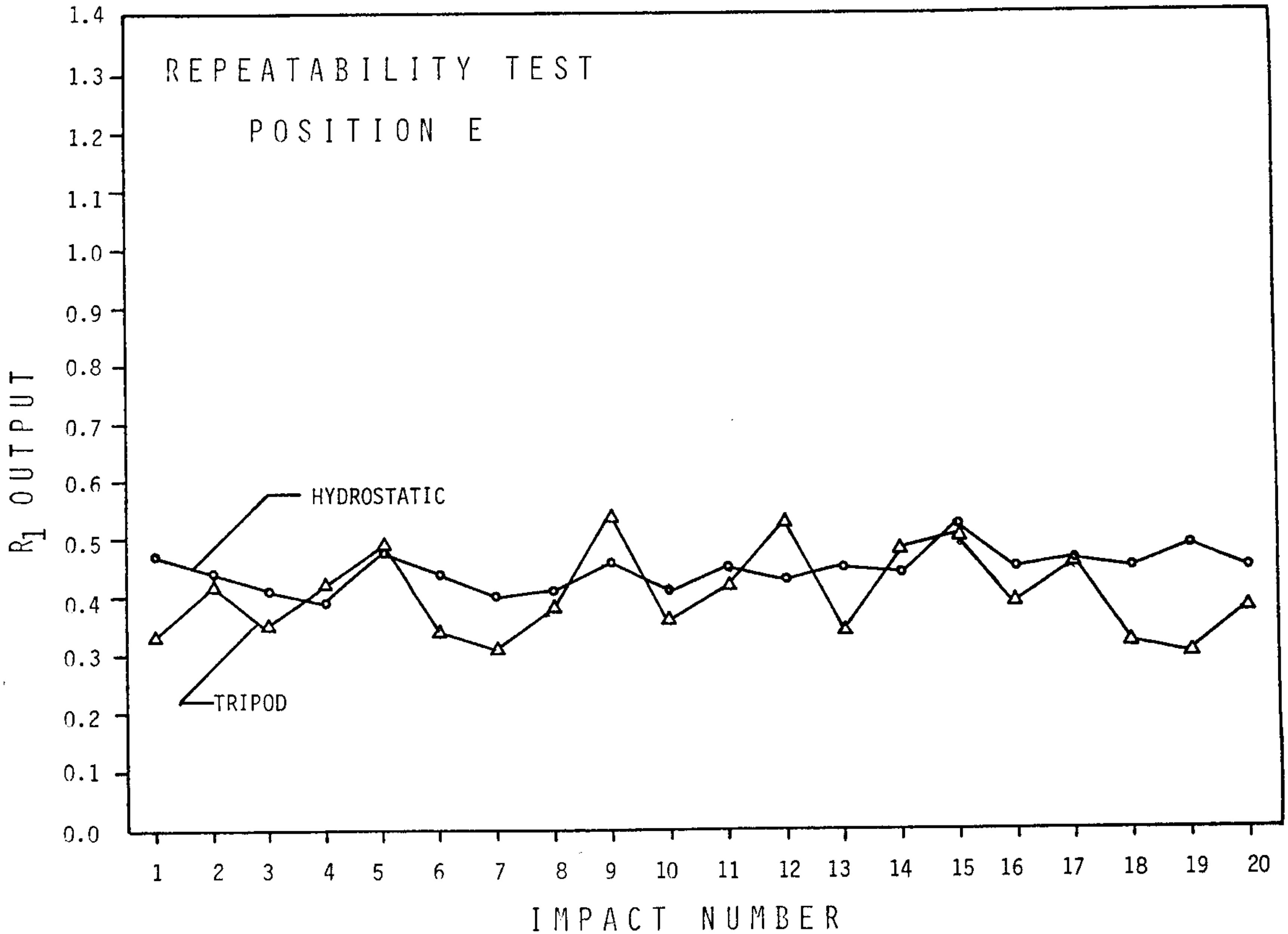

REPEATABILITY TEST
POSITION E
HYDROSTATIC
TRIPOD
R1 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-30

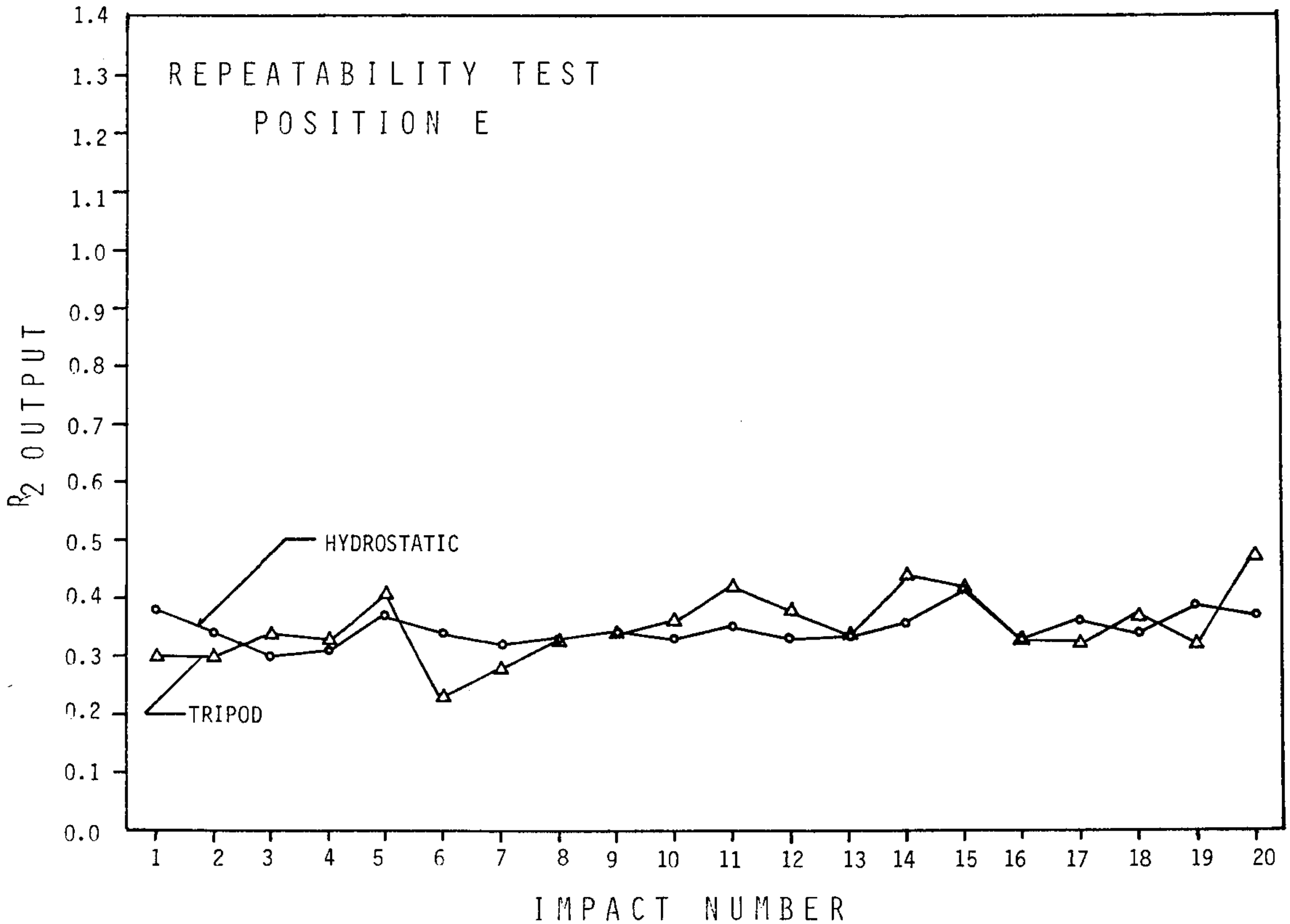

REPEATABILITY TEST
POSITION E
HYDROSTATIC
TRIPOD
R2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-31

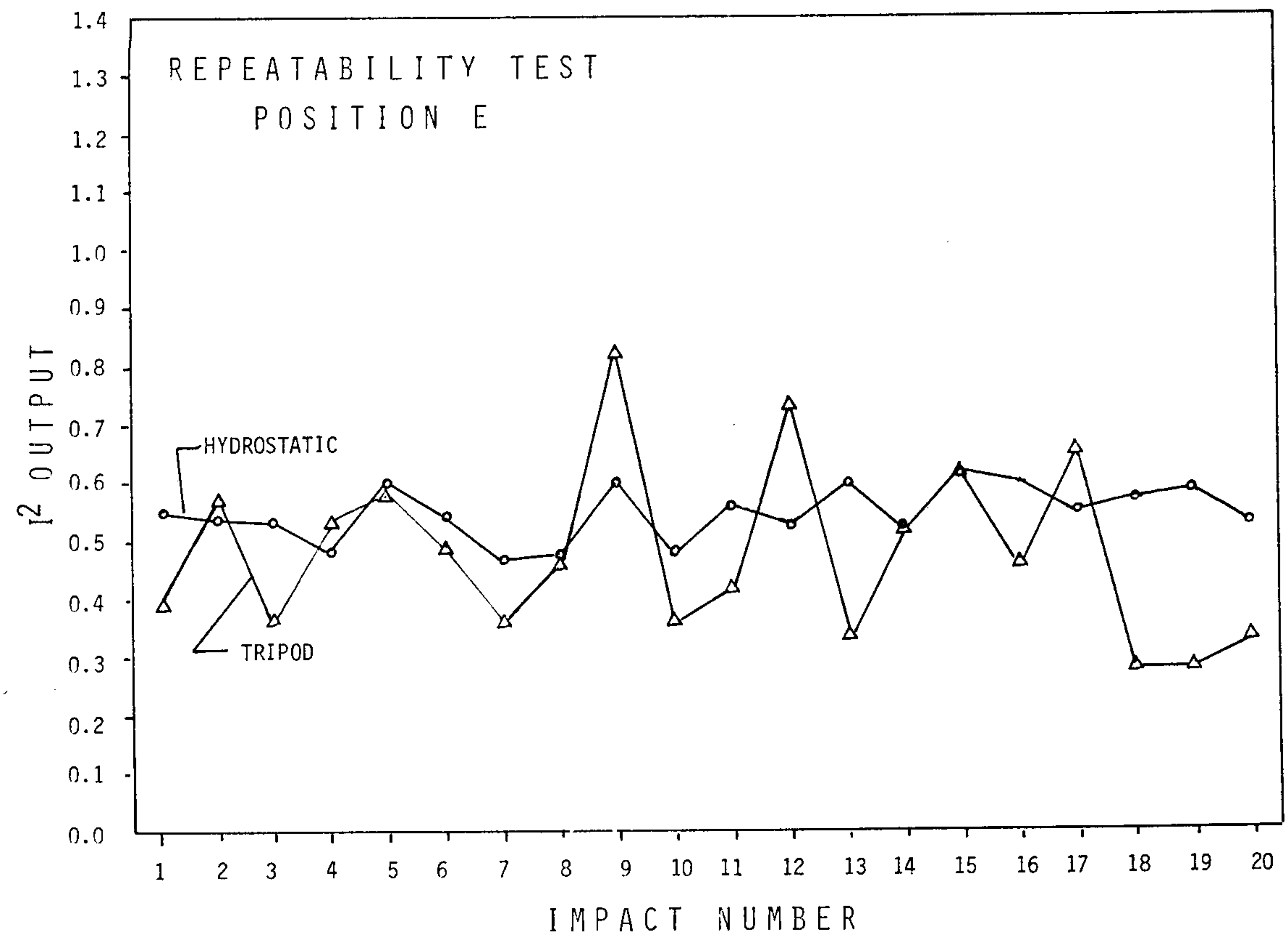

REPEATABILITY TEST
POSITION E
HYDROSTATIC
TRIPOD
I^2 OUTPUT
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
IMPACT NUMBER

Figure II-32

Chapter III "Comparisons of Impulse Index Data with Benkelman Beam Data"

Several different sets of tests were conducted for the purpose of comparing Impulse Index measurements with Benkelman Beam measurements. Some of these tests were conducted prior to the development of the hydrostatic interface and others were conducted after this development. This chapter shows comparisons of measurements made with the Benkelman Beam, with two separate tripod interfaced Impulse Index Computers and with a hydrostatic interfaced Impulse Index Computer.

Test Sites

Numerous test sites were selected including a broad variety of pavements widely separated geographically in the state of Washington. In the eastern part of the state, in the region around the city of Pullman, the following test sites were chosen and are designated throughout this chapter as indicated below.

Site A: Westbound lane, SW Crestview, 425' west of Grand Ave. - City of Pullman
0.25' Asphaltic Concrete (AC), 0.25' Crushed Surfacing Top Course (CSTC), 0.67' Gravel Base (GB)

Site B_1: US 195 (prior to SW bypass) vertical deformation fill area, milepost 22.8
0.25-0.5' AC, .35' CSTC, 0.21'AC, 0.17' CSTC, 0.17' GB, 0.5' Ballast, 0.17' CSTC

Site B_2: US 195, milepost 23, west of Pullman CBD
Section same as B_1, except 0.25' only AC wearing surface.

Site C: Intersection of parking lot entrance with approach road to new Pullman High School
3" permanent vertical deformation; 0.17'AC, 0.5' GB

Site D: Rear entry approach road - new Pullman High School
0.1' light bituminous surface treatment, 0.5' GB

Site E: Larry Street extension - main access road to High School
0.17' AC, 0.5' GB

Site F: Taxiway, Pullman-Moscow Airport, west end, north edge
0.33' Type A surf., 0.17' Type C Leveling Course, 1.42' Type A base

Site G: Taxiway, Pullman-Moscow Airport, east end, north edge
0.17' Type A surf., 0.17' Type C Leveling Course, 1.08' Type A Base Course

Site H: Taxiway, Pullman-Moscow Airport, east end, left center of pavement
0.33' Type A surf., 0.25' Type C Leveling Course, 1.02' Type A Base Course

Site I: No site designated as Site I

Site J: North Grand, 1000 Block, Pullman
0.5' nonreinforced PCC, 1.0' GB

Site K: US 195 north of Colfax, Sta. 250, northbound, right lane
0.15' Class B AC, 0.10' Class B Leveling Course, 0.25' CSTC 0.50' PCC, 0.25' CSTC, 0.75' CSBC, 0.25' CSBC

In the western part of the state, in Highway District 1, nine additional sites were used as described later in this chapter. These sites were selected because the District 1 personnel were conducting Benkelman Beam tests on these locations for other purposes and it was convenient to accompany them with the Impulse Index Computers and to monitor the exact pavement locations within minutes of the Benkelman Beam measurement.

Analysis of Pullman Area Tests

The first Pullman area Benkelman Beam comparison tests for this study were conducted in June of 1974 prior to the development of the hydrostatic interface. The equipment used included two Impulse Index Computers, both equipped with tripod interfaces; two Benkelman Beam sets, and a truck with 15,000 lbs on the rear set of dual tires. Tire pressure was 80 psi. The procedure used is described below:

After blocking traffic from the lane to be used and posting signs, a series of distance guide lines were marked on the pavement at 20-foot intervals. The truck was parked with its rear wheels on the guide line and the two Benkelman Beam sets with buzzers were positioned with their contact points between the dual wheels. In this manner, a Benkelman Beam measurement was made for each wheel track simultaneously. The truck was driven slowly twenty feet away and the pavement rebound recorded from the Benkelman Beam dials. The exact position of the contact point of each Benkelman Beam then was marked on the pavement before moving the beam to the next location.

Each of the two Impulse Index Computers then was used at each of the marked positions. In order to take into account all directions of azimuth of the deflection basin, eight Impulse Index measurements were made for each location, rotating the instrument 45° between each measurement and with the hammer positioned on the pavement directly over where the Benkelman Beam contact point had been. There were a very few deviations from this procedure where the locations were so close to the pavement edge that measurements at certain azimuths could not be made or would have been meaningless.

The entire procedure then was repeated for each 20-foot interval marked. A separate crew was used for each Benkelman Beam and for each Impulse Index computer. The Benkelman Beam data for the Pullman area test sites are reproduced in Table A-III-1. The corresponding Impulse Index data are reproduced in Tables A-III-2 and A-III-3. For comparison of the measurements, the average value of the Benkelman Beam deflection for each wheel track is displayed on the same chart as the average value of the Impulse Index for the same site as obtained independently from each instrument. The Impulse Index obtained from each of the two units is averaged separately in order to provide a comparison between the two units as well as with the Benkelman Beam.

Fig. III-1	Compares the average Benkelman Beam measurement for each site with the average Impulse Index measurement as obtained from unit 1 in the right-hand wheel track.
Fig. III-2	Compares the data from the same instruments as Fig. III-1 but for the left-hand wheel track.
Figs. III-3 and III-4	Are similar to III-1 and III-2 except the Impulse Index was obtained from unit 2.
Figs. III-5 and III-6	Illustrate the comparison of the average data from the two Impulse Index computers.

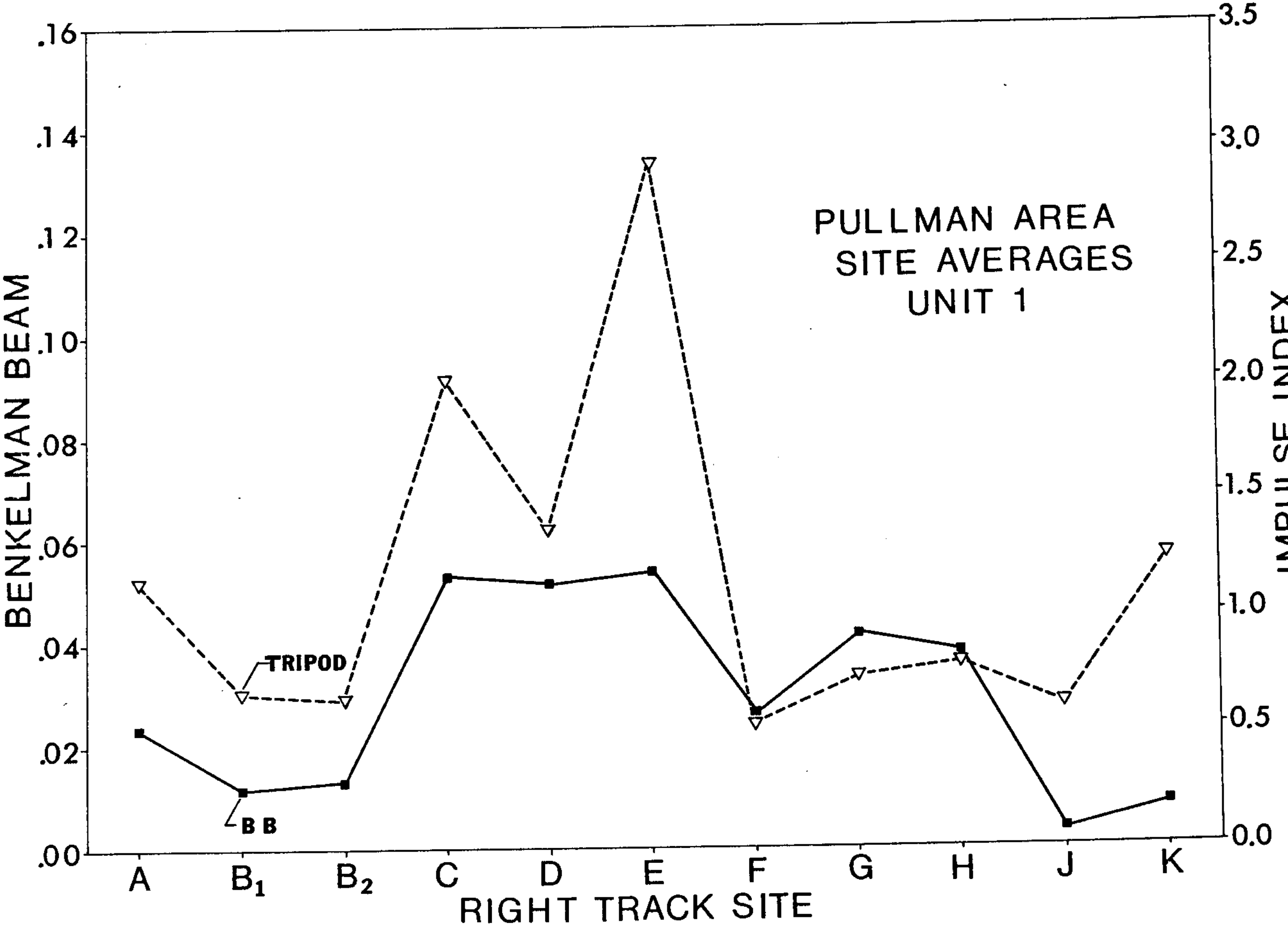

PULLMAN AREA
SITE AVERAGES
UNIT 1
BENKELMAN BEAM
IMPULSE INDEX
RIGHT TRACK SITE
TRIPOD
B B
A
B1
B2
C
D
E
F
G
H
J
K
.00
.02
.04
.06
.08
.10
.12
.14
.16
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

Figure III-1

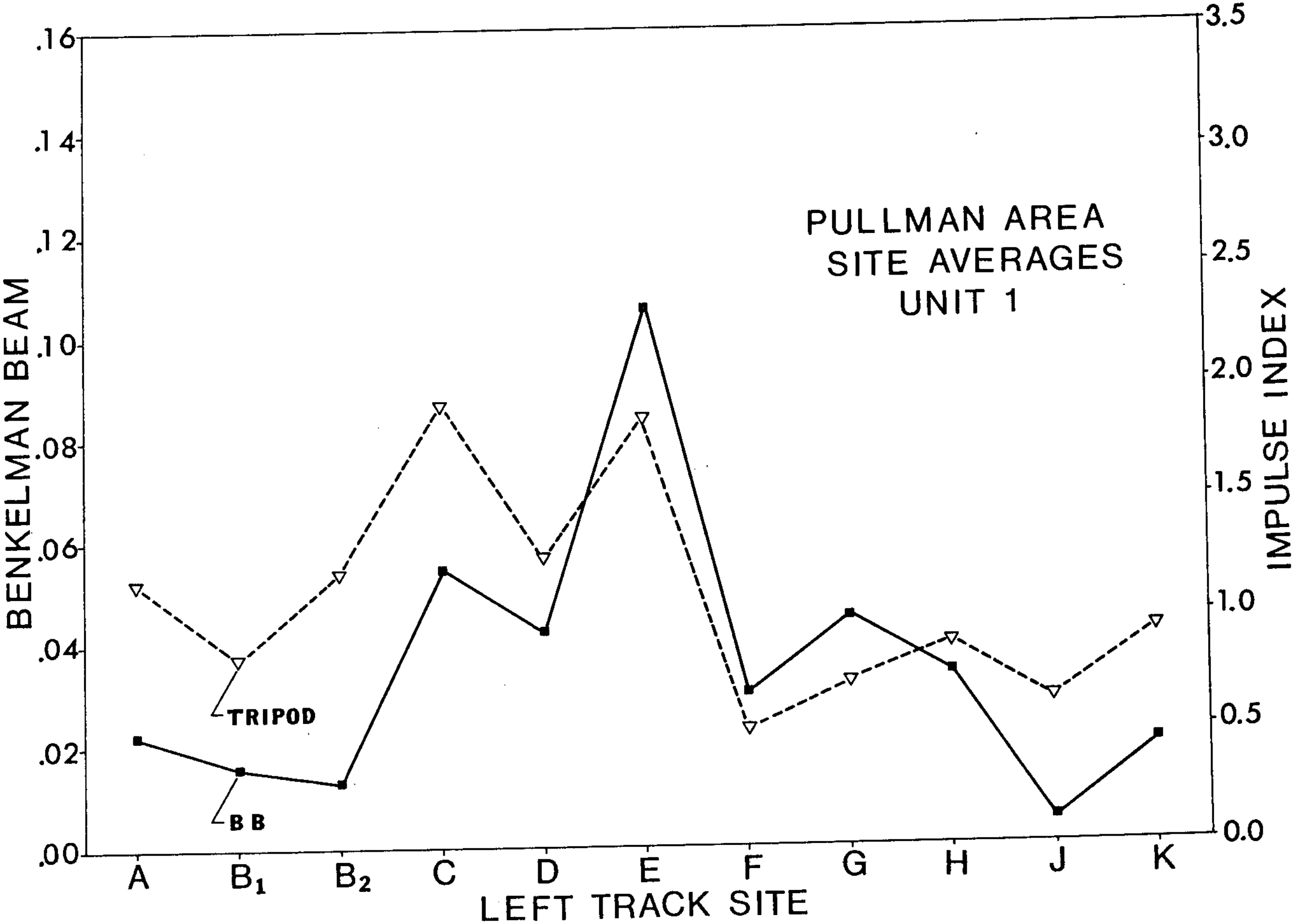

PULLMAN AREA
SITE AVERAGES
UNIT 1
BENKELMAN BEAM
.16
.14
.12
.10
.08
.06
.04
.02
.00
IMPULSE INDEX
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
TRIPOD
B B
A
B_1
B_2
C
D
E
F
G
H
J
K
LEFT TRACK SITE

Figure III-2

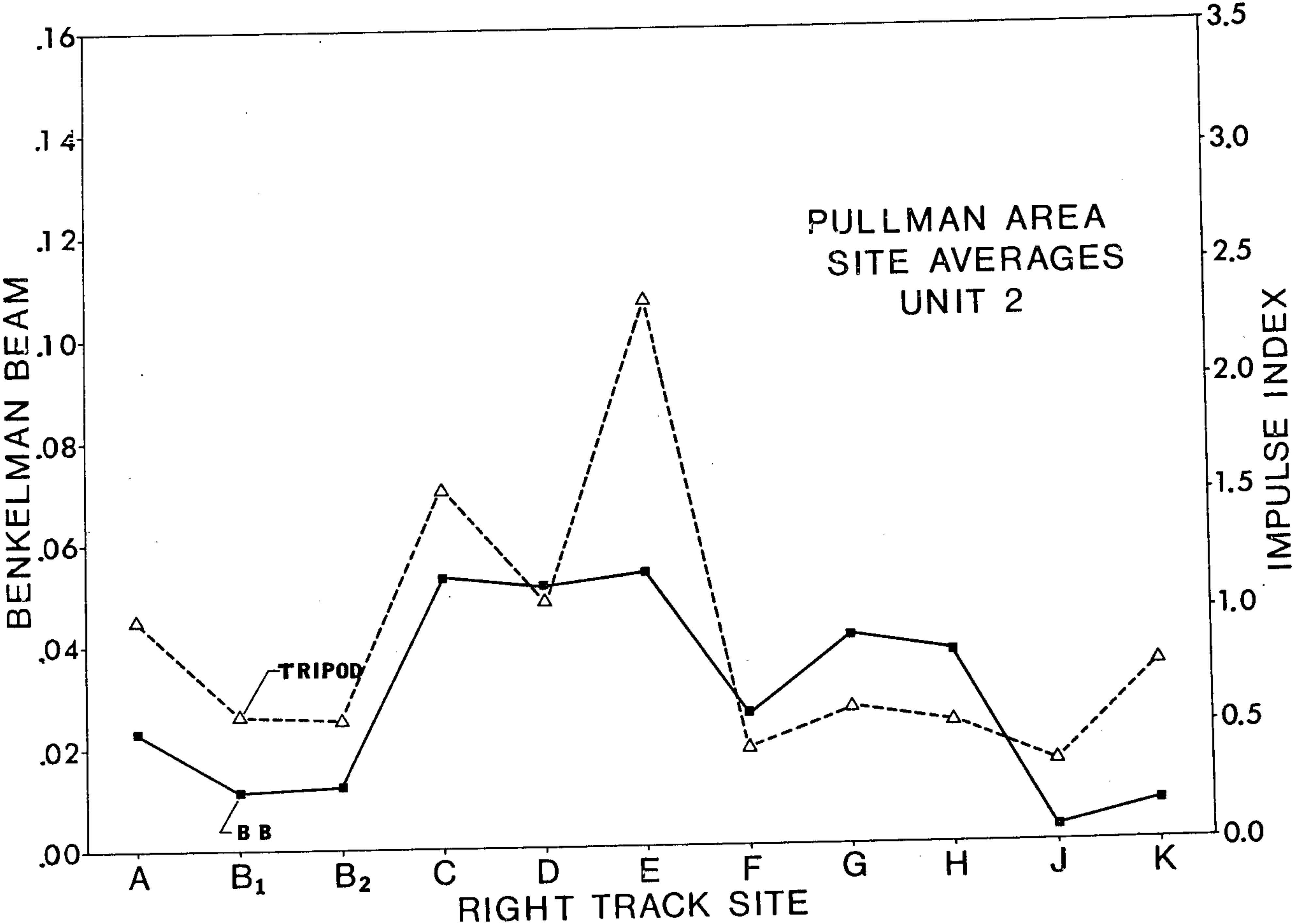

PULLMAN AREA
SITE AVERAGES
UNIT 2
BENKELMAN BEAM
.16
.14
.12
.10
.08
.06
.04
.02
.00
IMPULSE INDEX
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
TRIPOD
B B
A
B1
B2
C
D
E
F
G
H
J
K
RIGHT TRACK SITE

Figure III-3

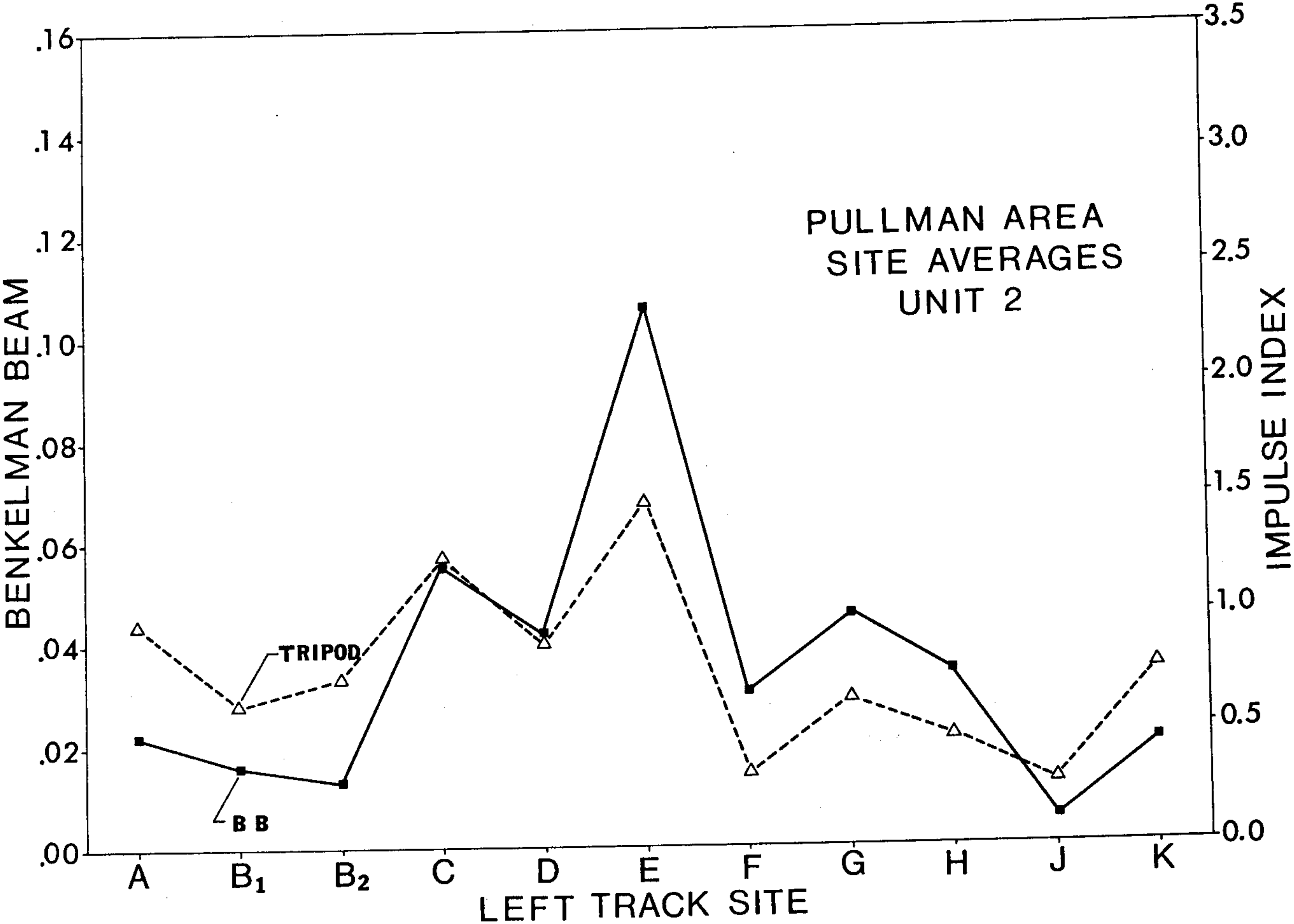

PULLMAN AREA
SITE AVERAGES
UNIT 2
BENKELMAN BEAM
IMPULSE INDEX
LEFT TRACK SITE
TRIPOD
B B
.16
.14
.12
.10
.08
.06
.04
.02
.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
A
B1
B2
C
D
E
F
G
H
J
K

Figure III-4

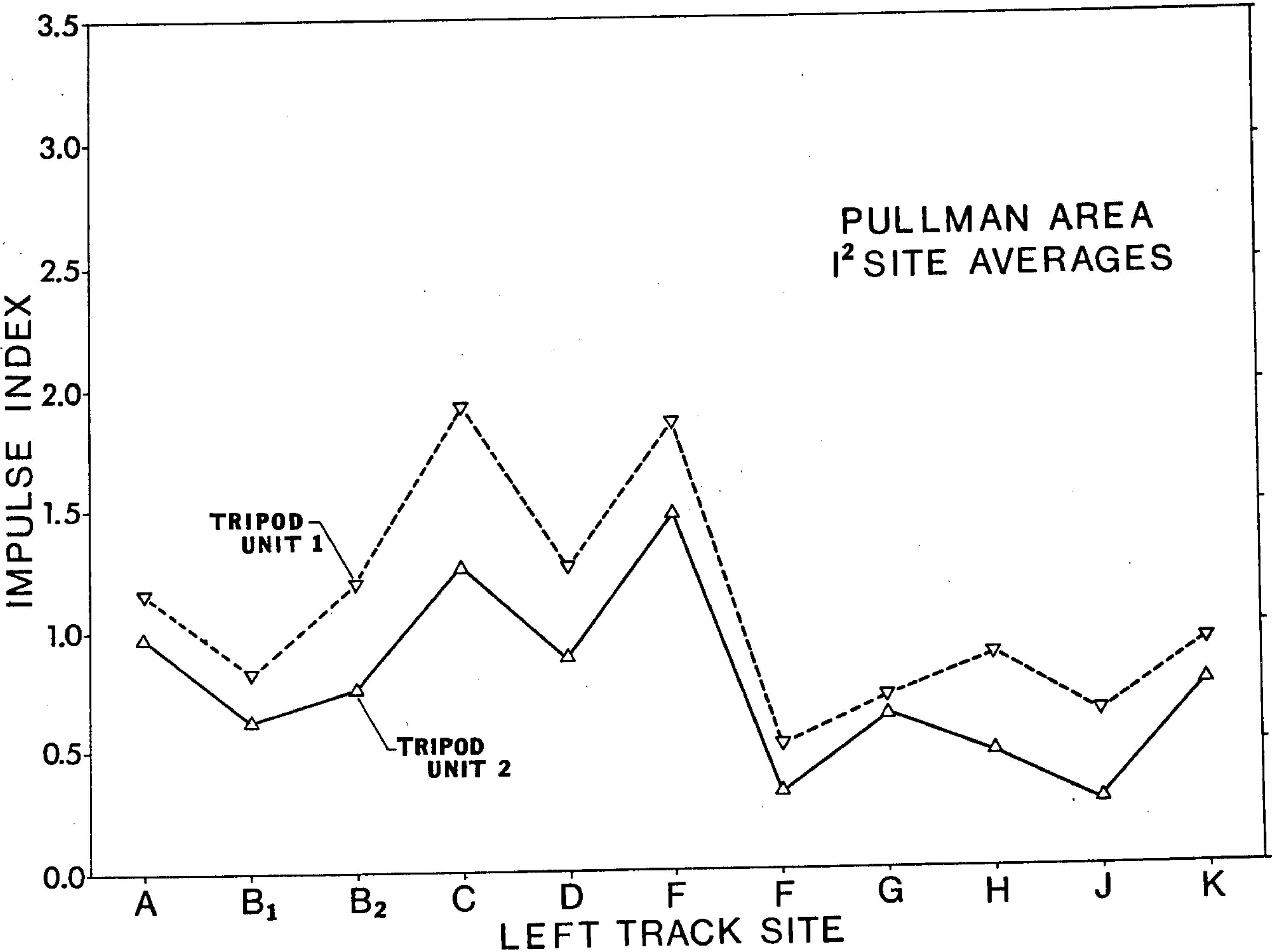

PULLMAN AREA
I² SITE AVERAGES
IMPULSE INDEX
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
TRIPOD UNIT 1
TRIPOD UNIT 2
A
B1
B2
C
D
F
F
G
H
J
K
LEFT TRACK SITE

Figure III-5

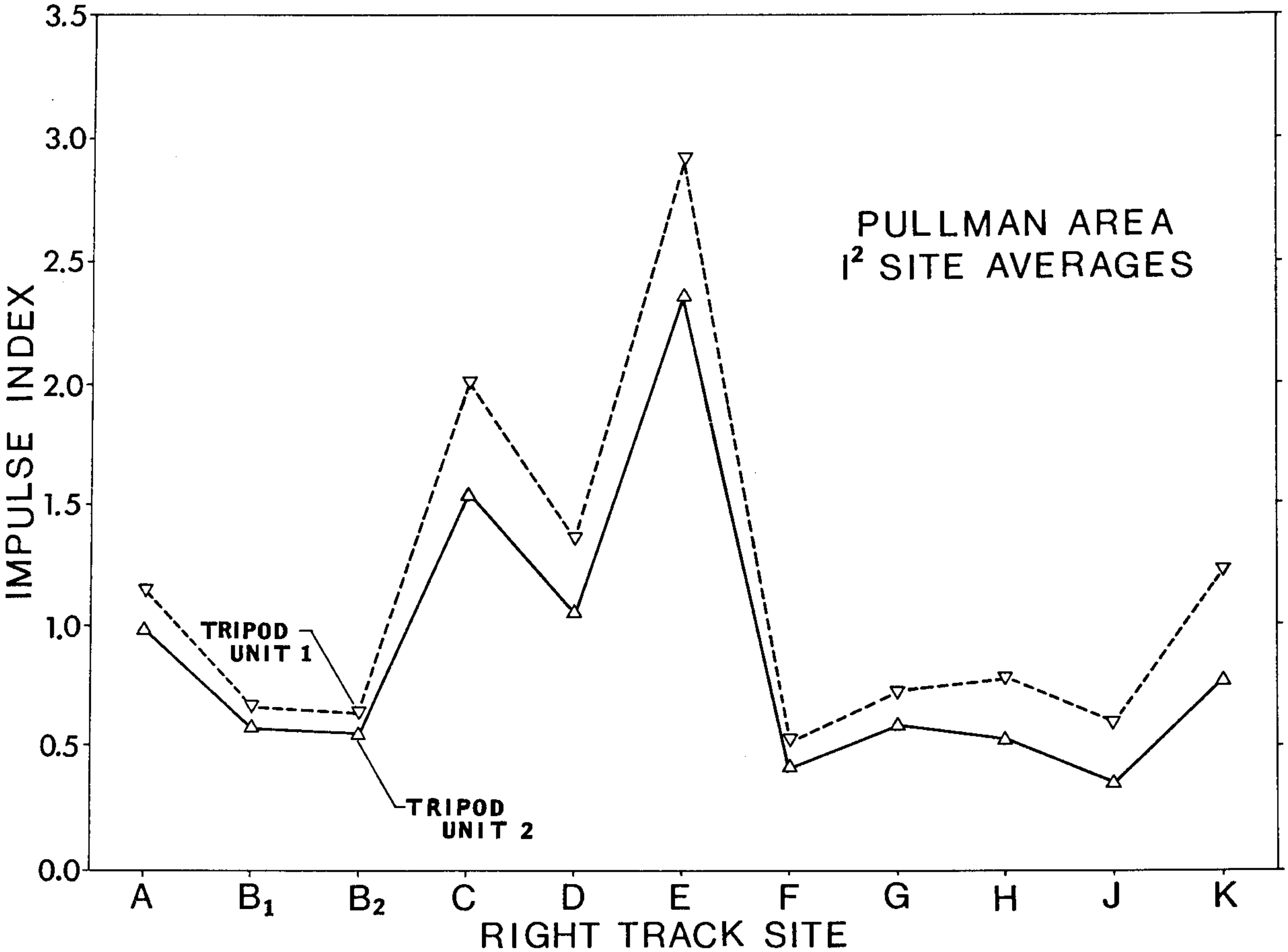

PULLMAN AREA
I^2 SITE AVERAGES
IMPULSE INDEX
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
TRIPOD UNIT 1
TRIPOD UNIT 2
A
B_1
B_2
C
D
E
F
G
H
J
K
RIGHT TRACK SITE

Figure III-6

District 1 Sites

Nine sites located in Skagit and Snohomish counties in the western part of the state of Washington were selected for additional tests to compare Impulse Index measurements with Benkelman Beam measurements. These particular sites were selected because the District 1 personnel were already scheduled to make Benkelman Beam tests at those sites under a program designed to determine future load limits under freeze-thaw conditions. The sites are identified by number and are described as follows:

Site 1: State Route (SR) 20, Milepost (MP) 6, Eastbound Lane (EBL), South of Anacortes
0.35' Asphaltic Concrete (AC), 0.40' Cement Treated Base (CTB), 0.25' Sand (S)

Site 3: SR 20, MP 18.6, WBL, West of Lyman
0.35' Resurfacing (RS), 0.30' AC, 0.35' SRB, 0.8' SSGB

Site 4: SR 20, MP 21, WBL, East of Lyman
0.5' RS, 0.35' AC, 0.65' SRB, 0.5' SSGB

Site 6: SR 9, MP 27, SBL, South of Arlington
0.25' AC, 0.25' Crushed Surfacing Top Course (CSTC), 0.6' GB, 0.7' SSGB

Site 7: SR 9, MP 17, SBL, South of Marysville Jct.
0.40' AC, 0.20' CSTC, 0.90' SSGB, 0.70' SSB

Site 8: SR 204, MP 1.1, WBL, East of Everett
0.40' AC, 0.60' SGB, 0.80' SSB

Site 9: SR 9, MP 13, SBL, South of SR 204 Jct.
0.45' AC, 0.15' CSTC, 0.50' SGB, 0.7' GB

Site 10: SR 2, MP 10, EBL, East of Snohomish

0.40' AC, 0.10' CSTC, 1.0' SGB, 0.5' SSG

Site 11: SR 2, MP 19, EBL, West of Sultan

0.9' AC (5 layers), 0.10' CSTC, 0.20' SSGB, 1.0' SGB


SKAGIT COUNTY
ISLAND COUNTY
SNOHOMISH COUNTY
SKAGIT CO.
SNOHOMISH CO.
KING CO.
JEFFERSON CO.
KITSAP CO.
VENDOVI I.
JACK I.
SAMISH BAY
SAMISH
GUEMES I.
GUEMES
GUEMES CHANNEL
SADDLEBAG I.
HAT I.
ANACORTES
PADILLA BAY
BURROWS BAY
LAKE CAMPBELL
PASS L.
STATE PARK
DEWEY
CORNET
HOPE I.
SIMILK BAY
FIDALGO
WHITNEY
FREDONIA
LA CONNER
SWINOMISH INDIAN RES.
GOAT I.
IKA I.
SKAGIT BAY
BLANCHARD
EDISON
BOW
ALLEN
SAMISH R.
BURLINGTON
STERLING
SEDRO WOOLLEY
RIVER
PRAIRIE
THORNWOOD
SOUTH FORK NOOKSACK RIV
LYMAN
HAMILTON
CONCRETE
LAKE SHANNON
LOWER BAKER DAM
BIRDSVIEW
VAN HORN
FABER
PINNEY CR.
SAUK
CLEAR LAKE
BEAVER LAKE
RIVERSIDE
MT. VERNON
BIG ROCK
BIG LAKE
MONTBORNE
DAY CR.
DAY L.
DEVILS L.
CONWAY
EPHLICK
LAKE McMURRAY
McMURRAY
LAKE CAVANAUGH
CREEK
OAK HARBOR
CRESCENT HARBOR
SAN JUAN DE FUCA
PENN COVE
COUPEVILLE
MADRONA BEACH
CAMANO
UTSALADY
TERRYS COR.
E STANWOOD
STANWOOD
NORMAN
STILLAGUAMISH R.
SILVANA
PILCHUCK
BRYANT
NORTH FORK
CICERO
OSO
RIVER
HAZEL
FORTSON
TRAFTON
ARLINGTON
BOULDER R.
ENGLISH
LAKE GOODWIN
EDGECOMB
SISCO
SOUTH
KEYSTONE
FORT CASEY
SARATOGA
PORT SUSAN
TULALIP INDIAN RESERVATION
TULALIP
BABY I. HEIGHTS
GREEN BANK
MABANA
PASSAGE
HOLMES HARBOR
LANGLEY
FREELAND
BAY VIEW
AUSTIN
USELESS BAY
CLINTON
COLUMBIA BEACH
GEDNEY I.
PORT GARDNER
EVERETT
MARYSVILLE
GETCHELL
HARTFORD
LAKE
MACHIAS
GRANITE FALLS
SURREY
FORK ROBE
STILLAGUAMISH
GOLD BASIN
LAKE ROESIGER
SULTAN
LAKE CHAPLAIN
THREE LAKES
SNOHOMISH
INLET PUGET SOUND
MAXWELTON
GLENDALE
POSSESSION
MUKILTEO
MOSHER
SILVER L.
MARTHA L.
POSSESSION SOUND
MEADOWDALE
EDMONDS
RICHMOND BEACH
CATHCART
MALTBY
MONROE
SULTAN
STARTUP
GOLDBAR
SKYKOMISH RIVER
BOTHELL
WOODINVILLE
HOLLYWOOD
DUVALL
NOVELTY
LAKE JOY
STILLWATER
NORTH FORK
SOUTH FORK
TOLT R.
DAM
SHILSHOLE BAY
WEST PT
KIRKLAND
REDMOND
MP73
MP76.2
2
3
4
5
6
7
9
10
11
12
13

ꟷ gure III-7

Analysis of District 1 Tests

The District 1 tests were conducted on August 19 and 20 of 1974. At each test site, nine locations were marked off at 25-foot intervals. One Benkelman Beam set was used and it was operated by the crew from District 1. The pointer of the beam was projected through the space between the dual wheels of the truck to a point four feet ahead of the axle centerline. The truck was driven slowly ahead and the maximum deflection recorded. The position on the pavement of the pointer of the Benkelman Beam was marked before the beam was moved. The truck provided a rear axle load of 15,000 pounds.

One of the Impulse Index Computers had just been equipped with the newly developed hydrostatic interfaces. The other unit retained its tripod interfaces. As was done in the previous tests, eight Impulse Index measurements were made with each of the two instruments at each test position. The instrument was rotated 45° between each measurement and positioned so that the hammer would impact at the point where the tip of the Benkelman Beam had rested.

The resulting Benkelman Beam data are reproduced in Table A-III-4. Impulse Index measurements obtained with the tripod unit are reproduced in Table A-III-5. Impulse Index measurements obtained with the hydrostatic unit are reproduced in Table A-III-6. Figs. III-8 through III-16 are graphs illustrating comparisons for each of the nine positions. The eight Impulse Index readings taken at each test position are averaged separately for each instrument and graphed along with the Benkelman Beam reading for each position. A separate graph is presented for each test site.

It can be observed from these graphs that the Benkelman Beam measurement and the Impulse Index obtained using the hydrostatic interface correlate fairly well on a point-by-point basis. Because of the spread in the data obtained with the tripod interface unit, the correlation is not as good from this unit.

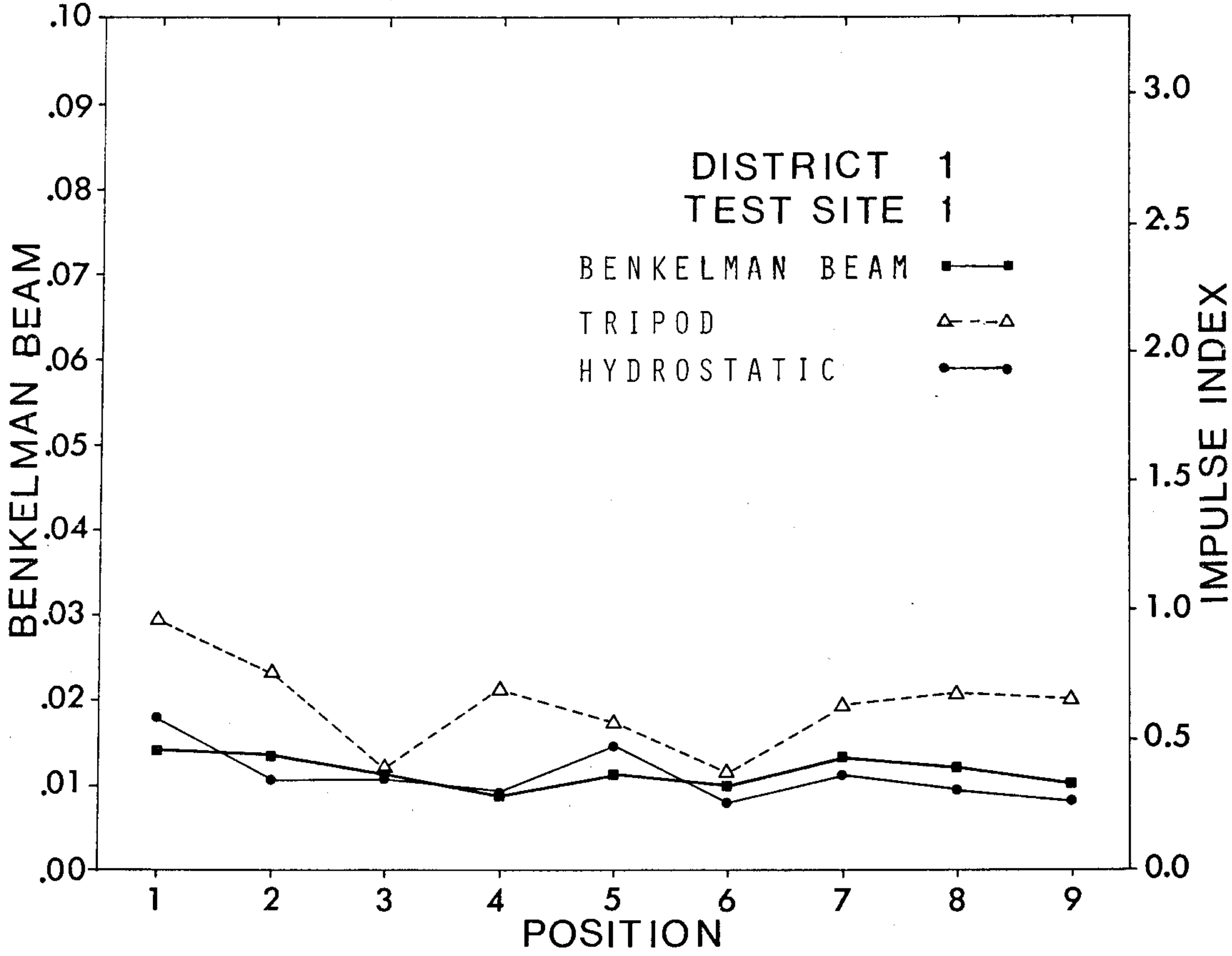

DISTRICT 1
TEST SITE 1
BENKELMAN BEAM
TRIPOD
HYDROSTATIC
BENKELMAN BEAM
IMPULSE INDEX
POSITION
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9

Figure III-8

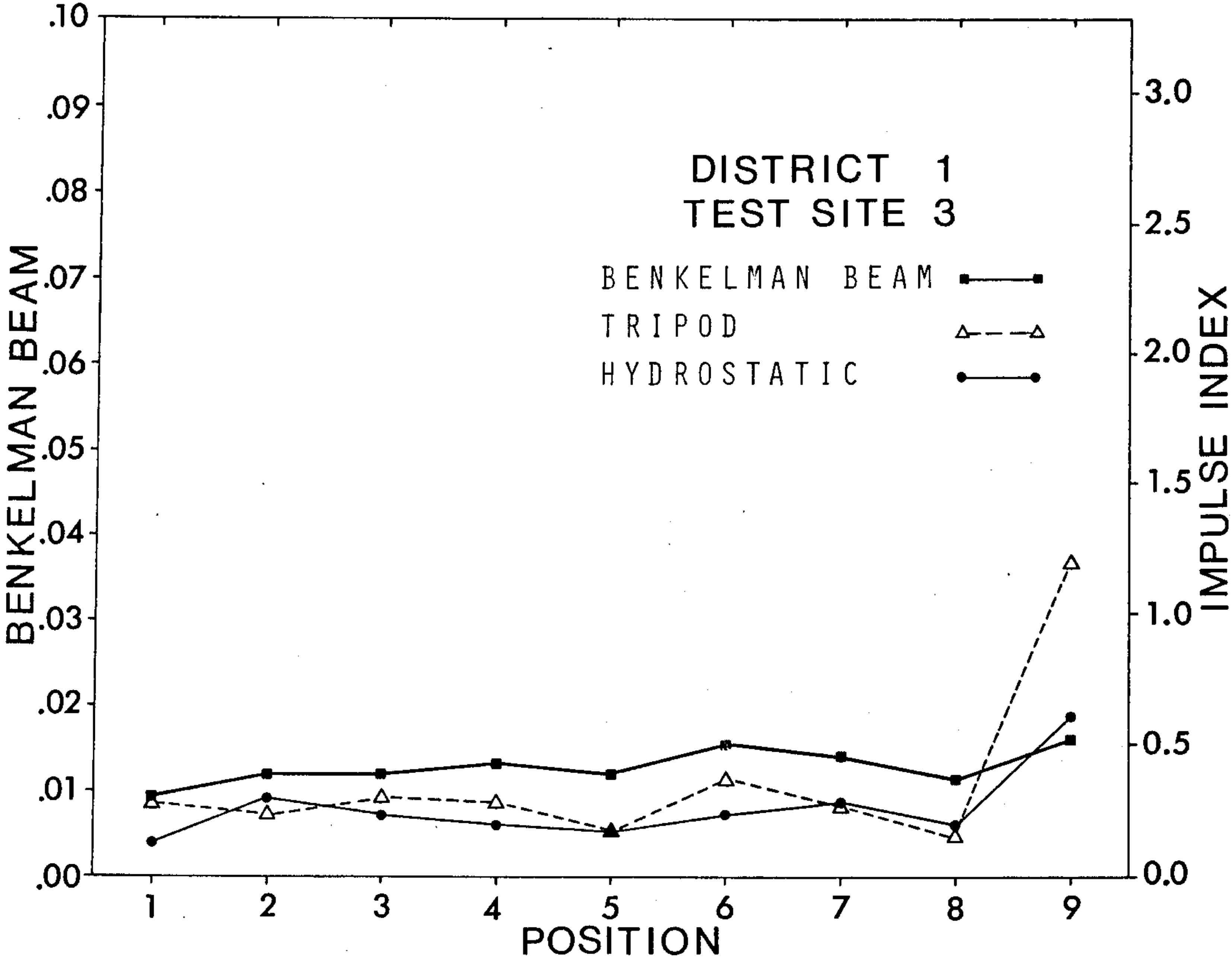

DISTRICT 1
TEST SITE 3
BENKELMAN BEAM
TRIPOD
HYDROSTATIC
BENKELMAN BEAM
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.00
IMPULSE INDEX
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
POSITION

Figure III-9

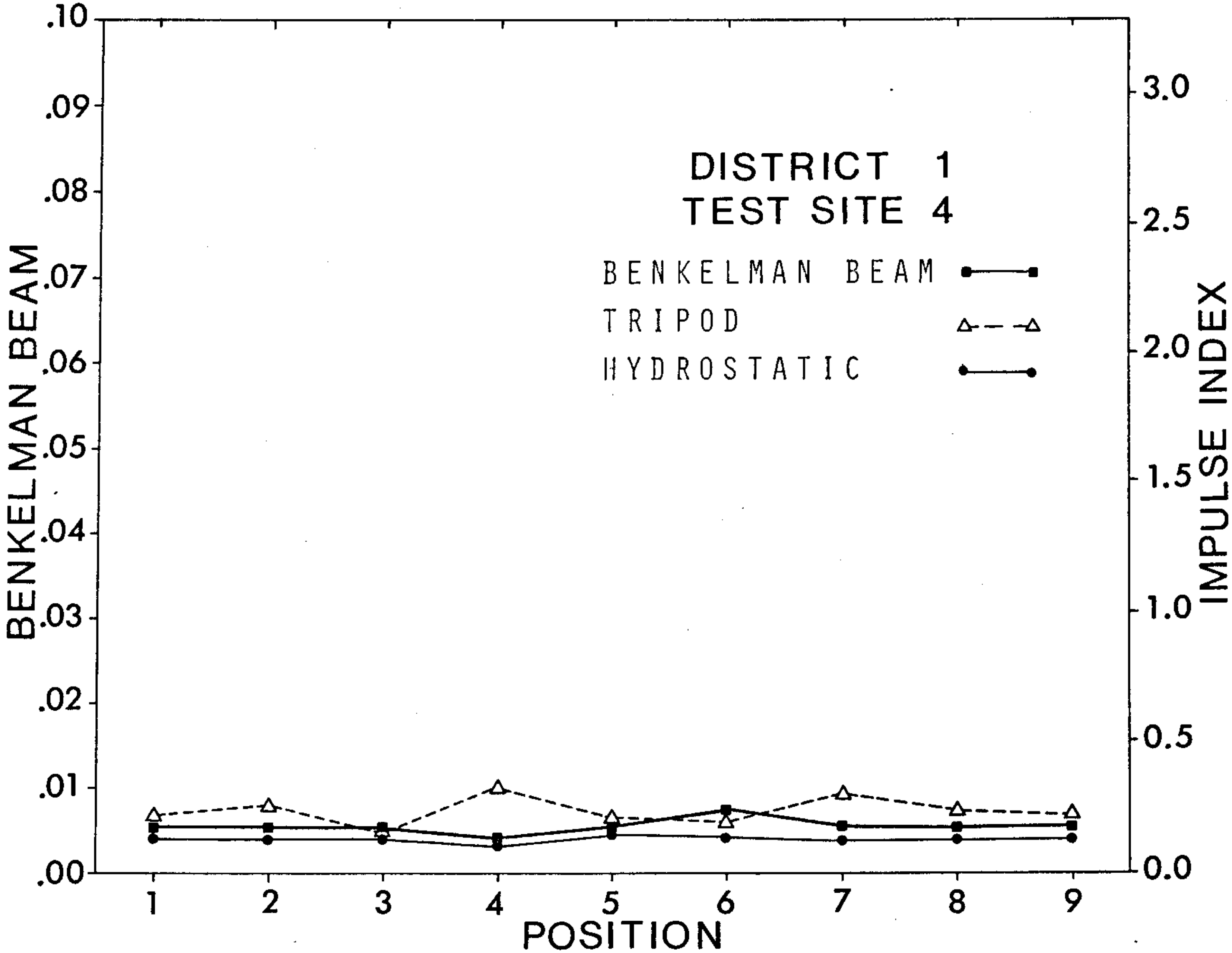


Figure III-10

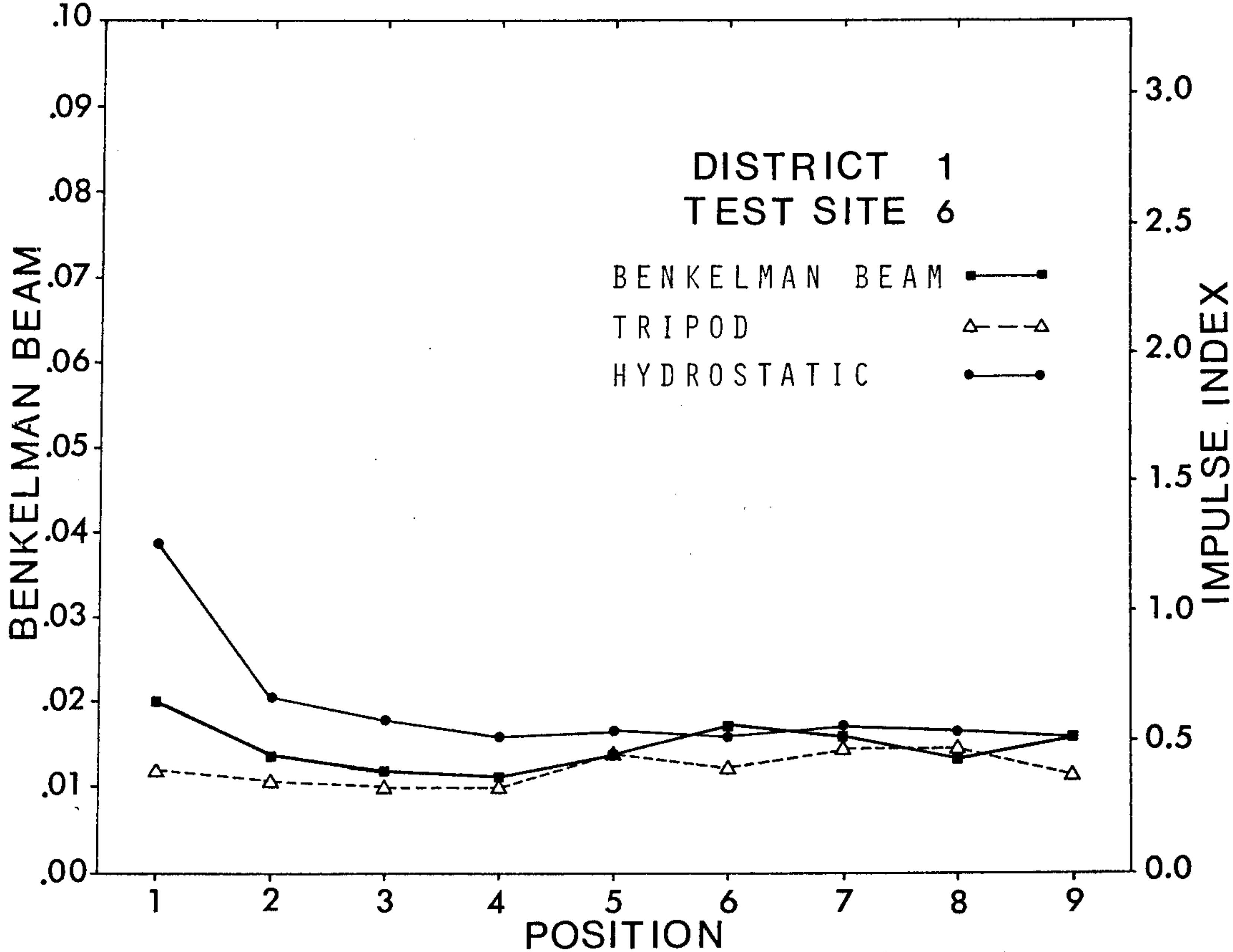


Figure III-11

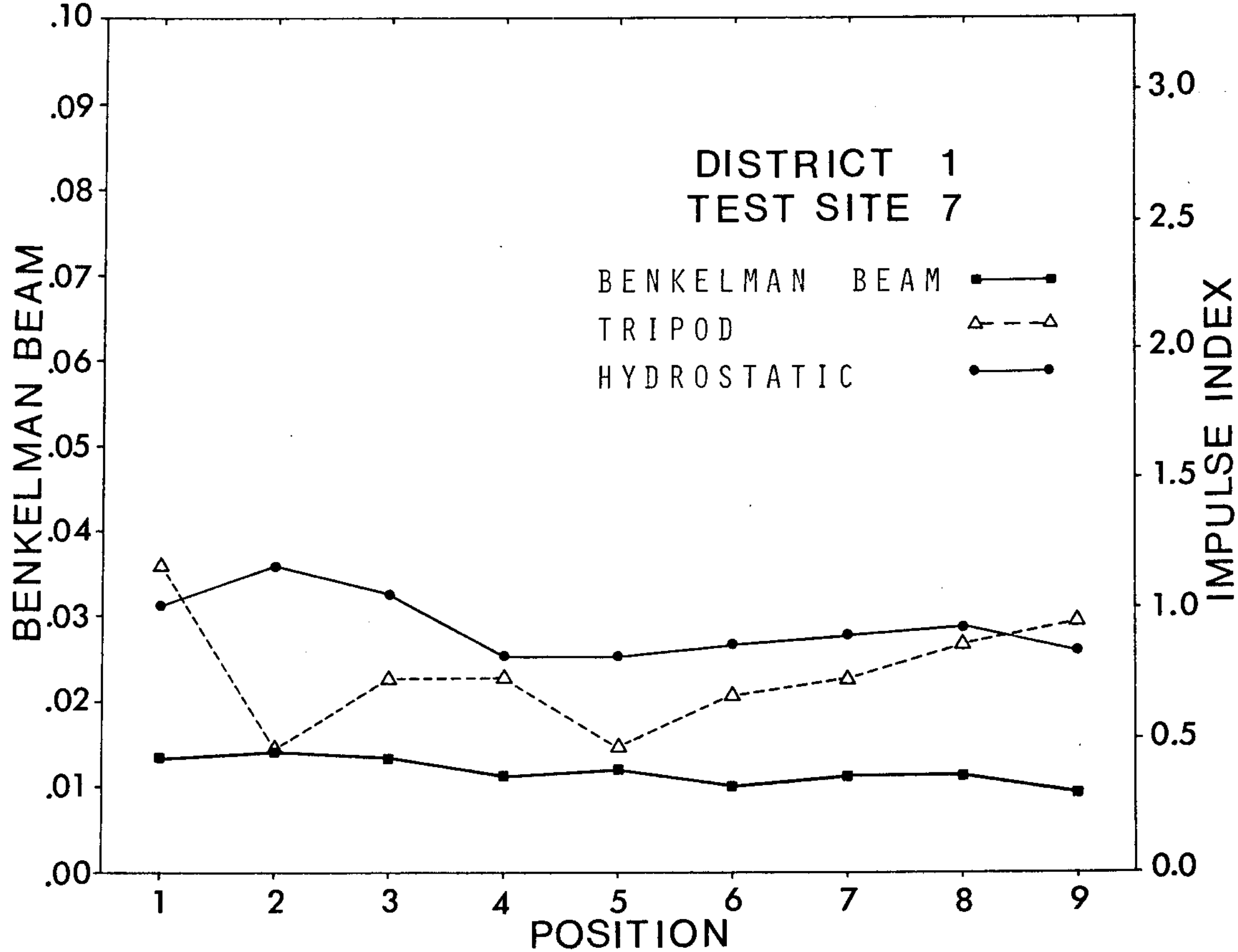


Figure III-12

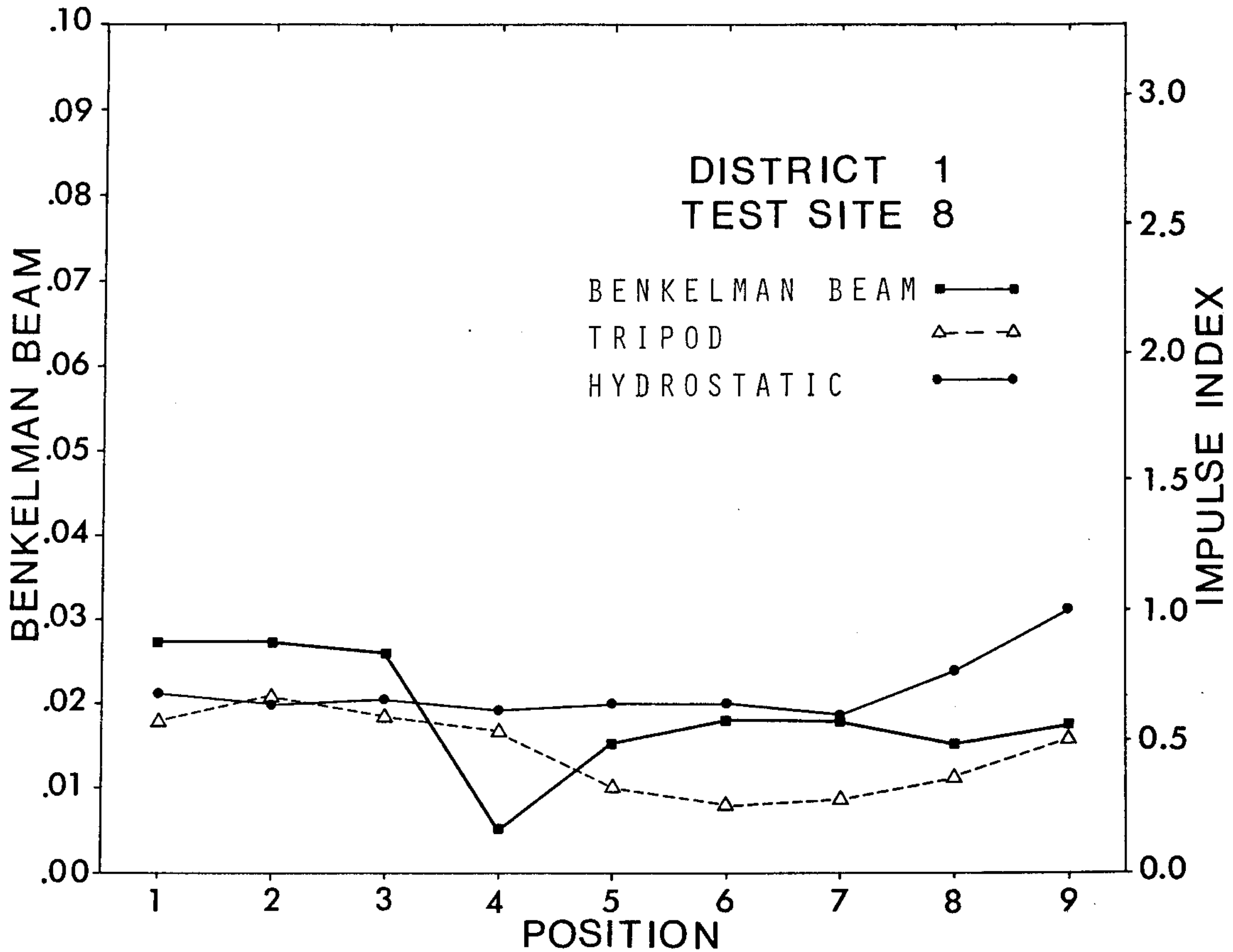


Figure III-13

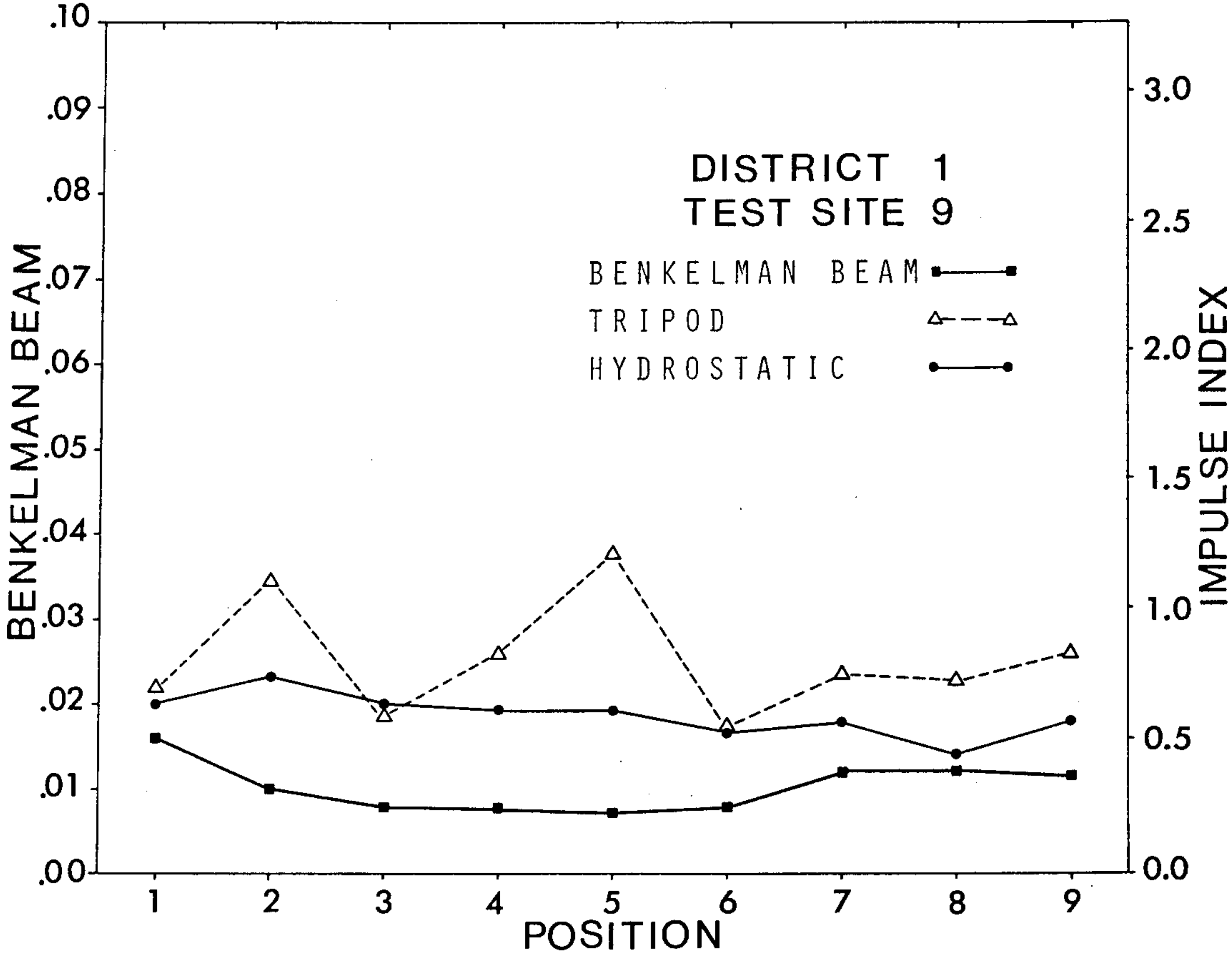


Figure III-14

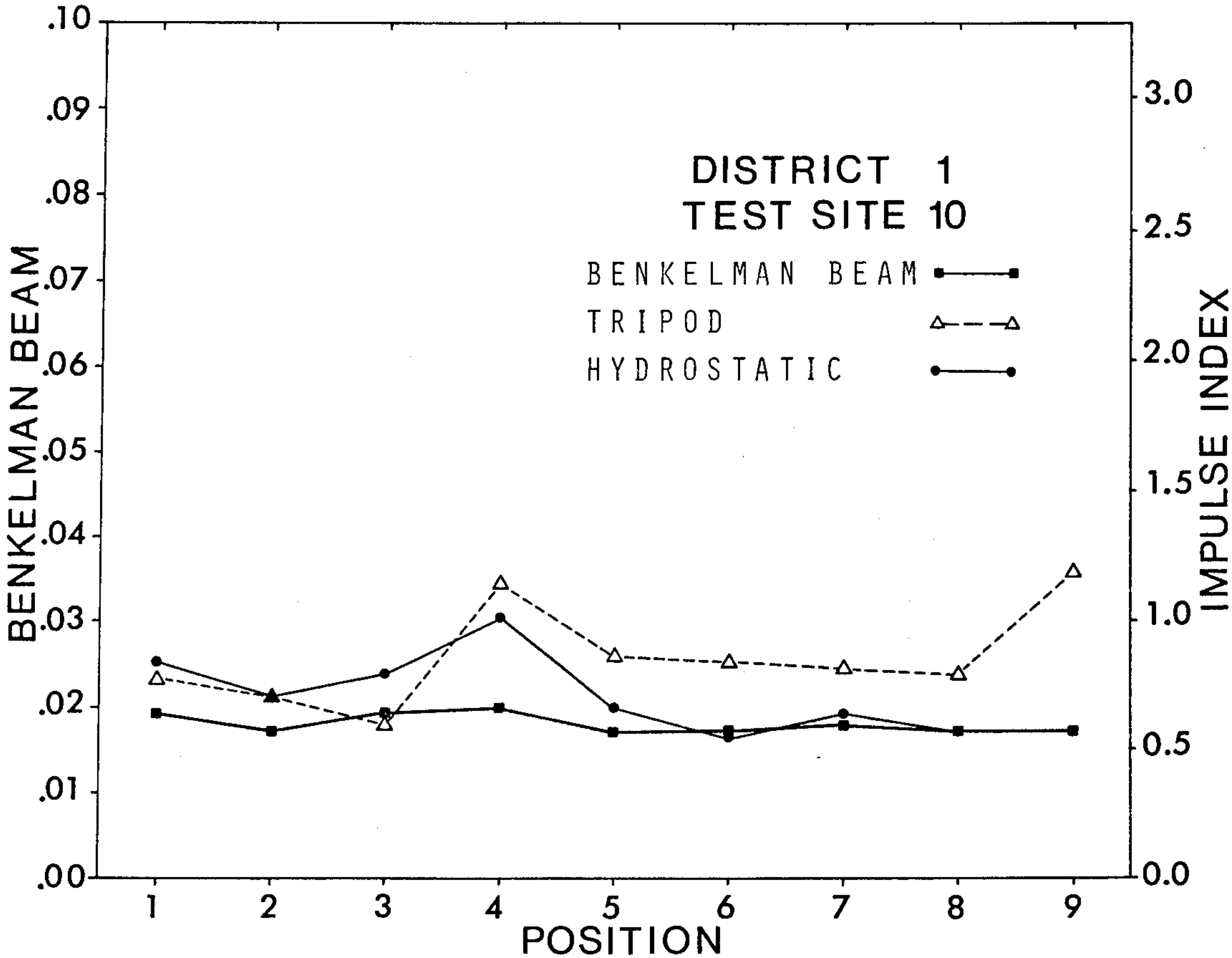


Figure III-15

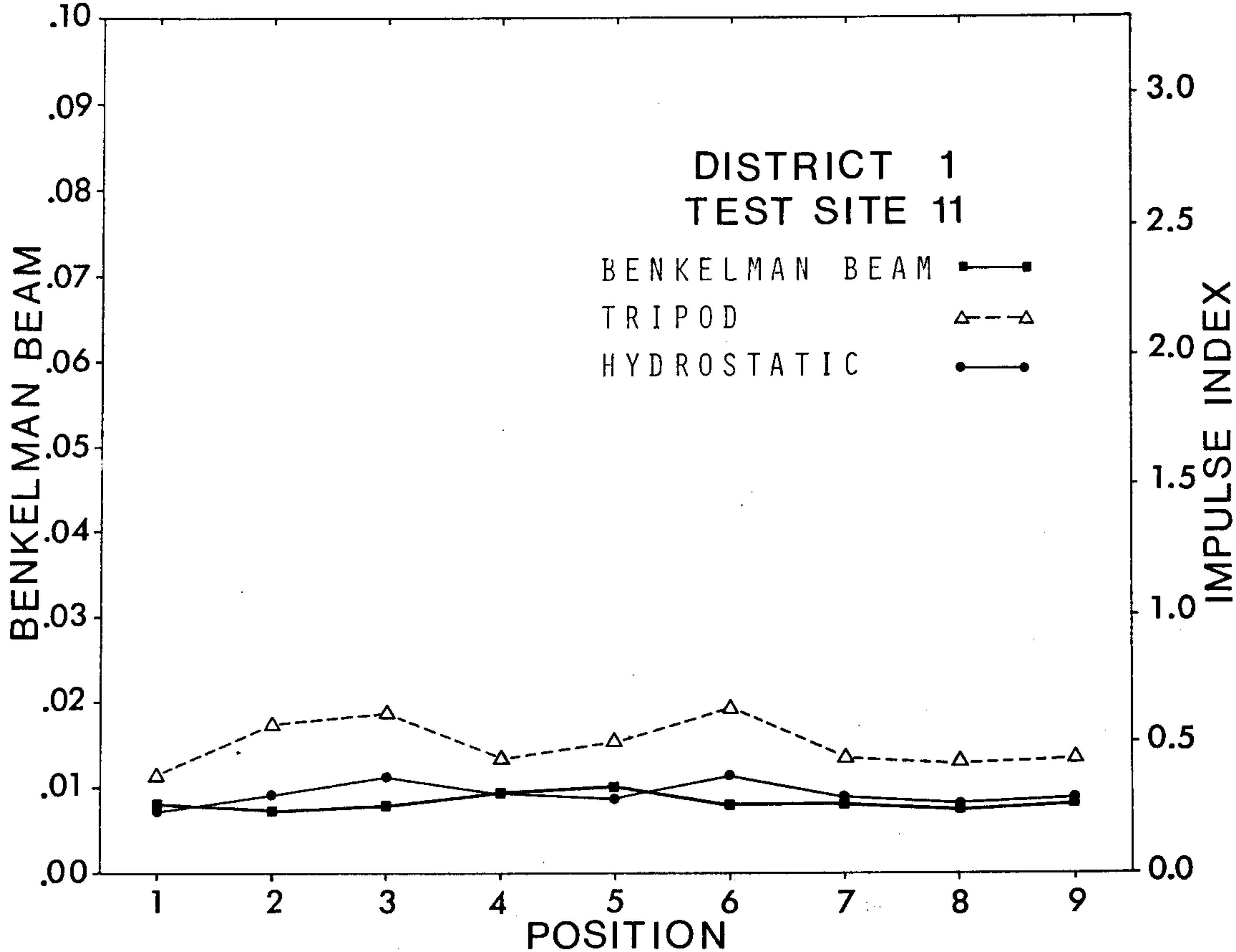


Figure III-16

Hydrostatic Unit in Pullman Area

The hydrostatic interfaced unit was then taken to the sites in the vicinity of Pullman which had been previously measured and which were easily accessible without blocking traffic. The painted markings were still visible and sites A, C, E and J were measured.

Because of the improved repeatability of the device, only four readings were made at each test point, with 90° rotation between measurements. These data are presented in Table A-III-7 and are graphed in Figures III-17 through III-20.

Summary of Benkelman Beam Comparisons

Because of anomalies in the pavement structure, monitoring of a single point on a pavement does not give an adequate measure of the pavement condition. Many points must be measured, as will be shown in Chapter 4. To compare the overall results of the two methods of determining pavement condition, all of the Benkelman Beam measurements made at each test site were averaged and all of the Impulse Index readings obtained for each test site were averaged for each instrument.

The resulting graph of the data shown in Fig. III-20 indicates the degree of correlation.

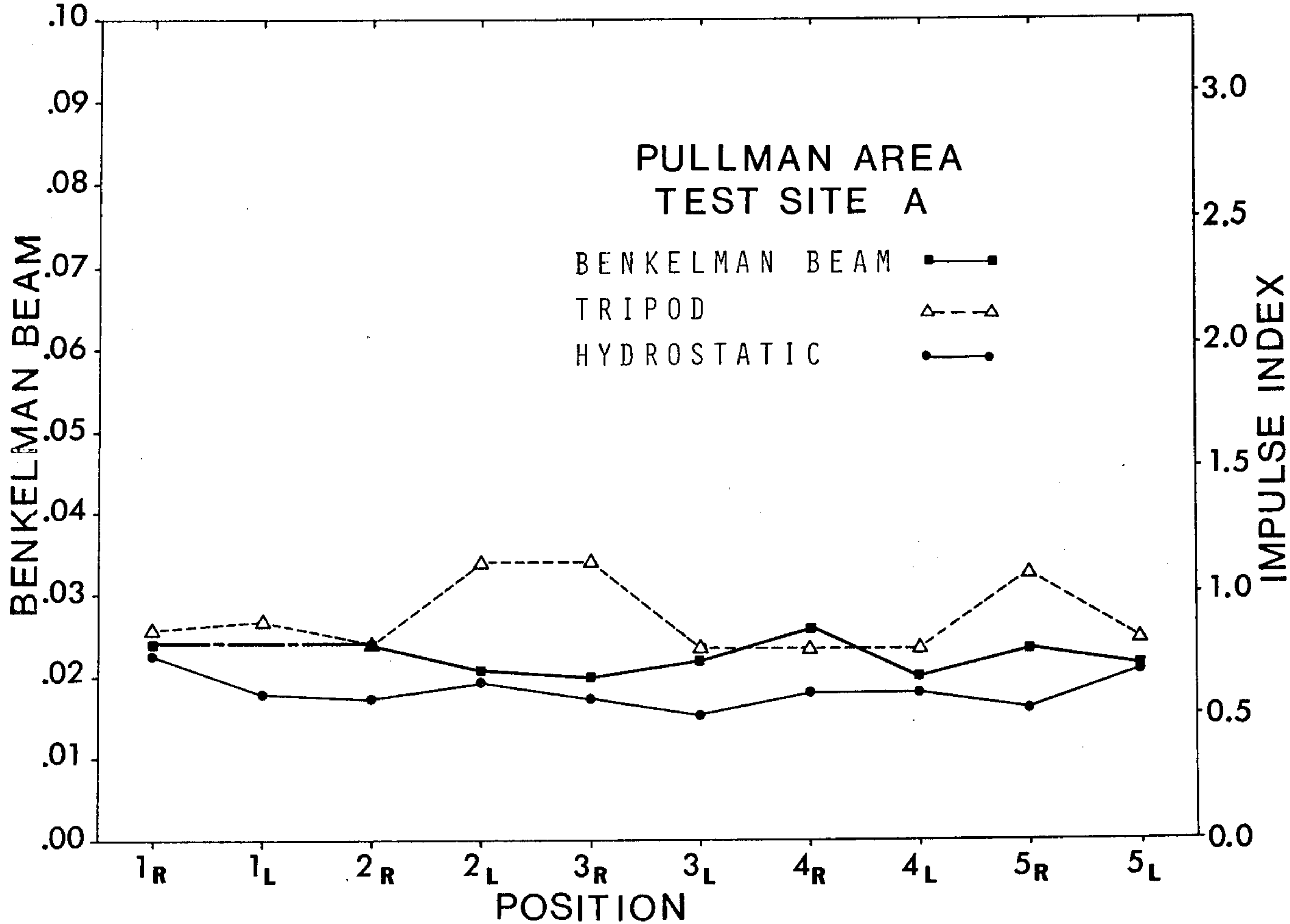


Figure III-17

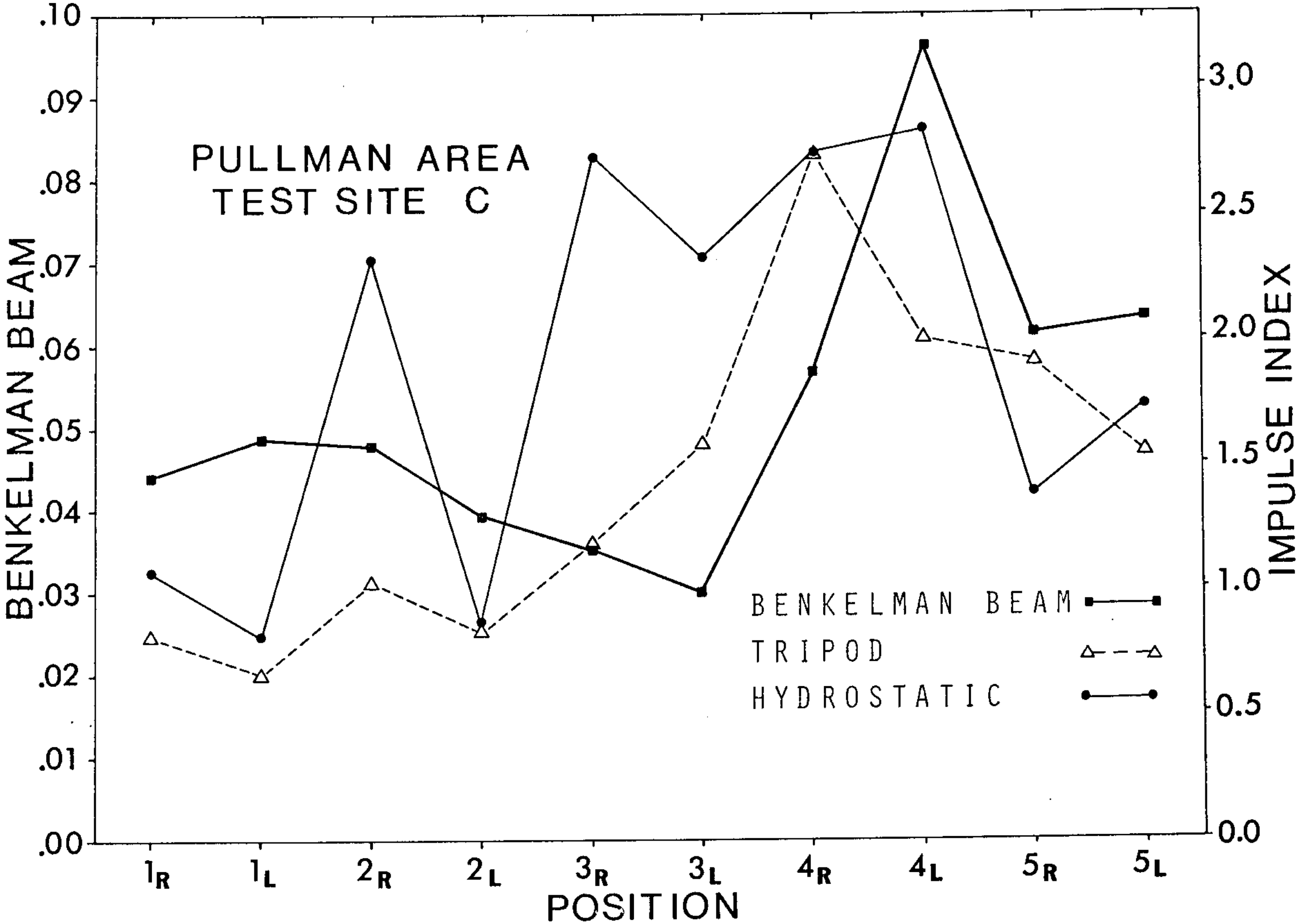


Figure III-18

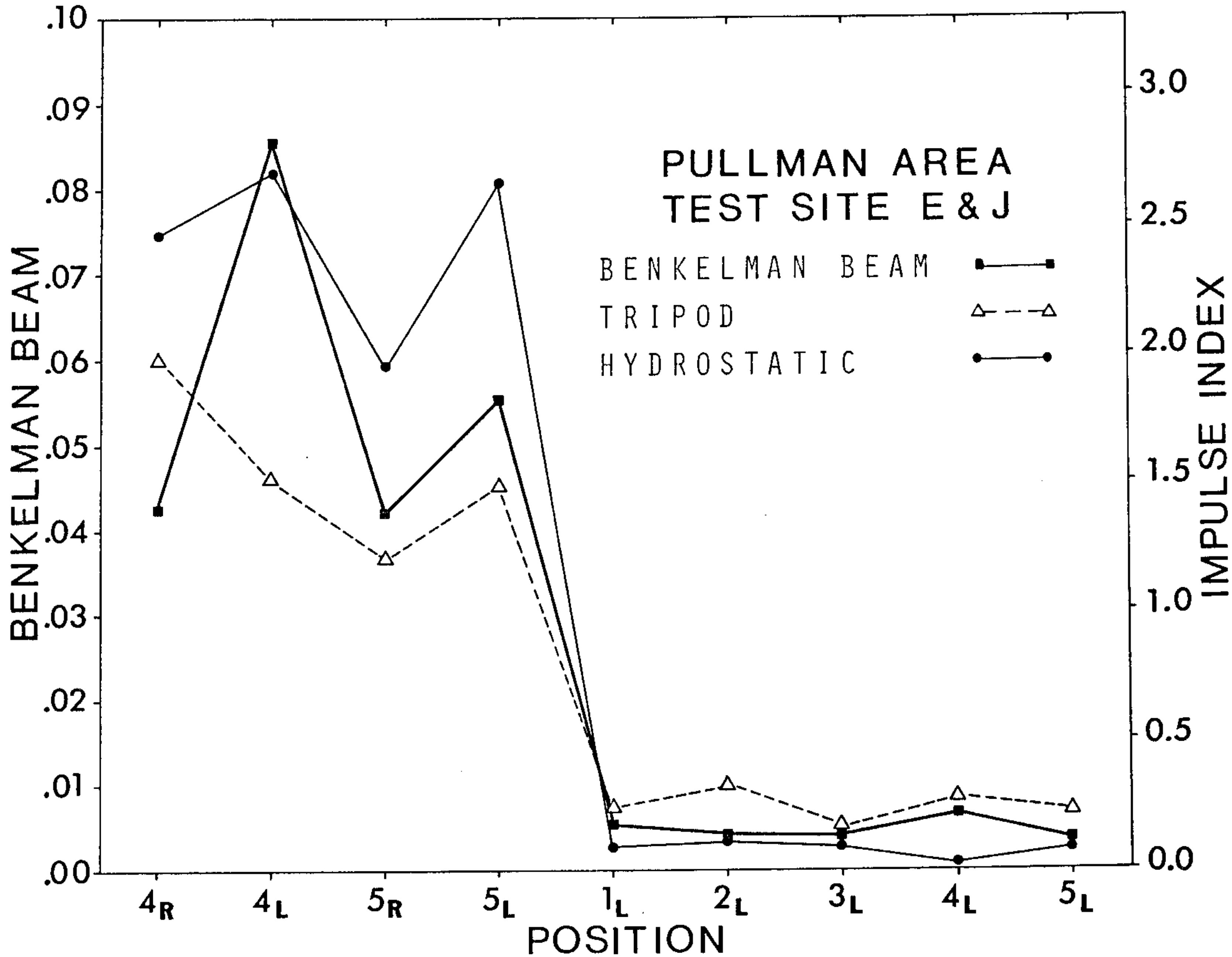


Figure III-19

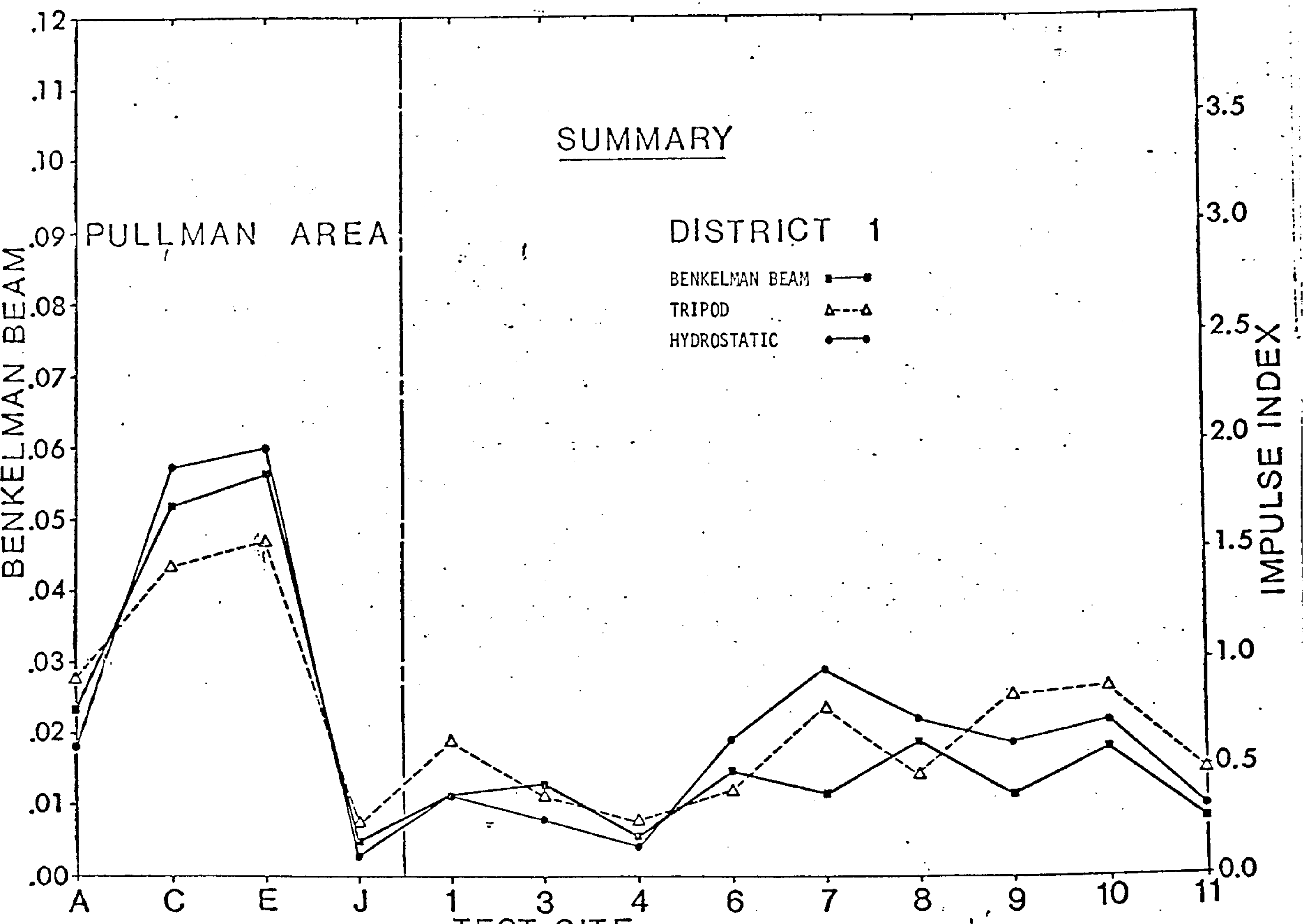


FIGURE III-20

Comparisons with Washington Pavement Rating System

The Washington Pavement Rating System involves an on-site inspection of the selected length of pavement by a trained team of evaluators. One rating is given for visible defects and another rating is given for the quality of the ride. After the Benkelman Beam and Impulse Index tests were completed, the record of the most recent Washington Pavement Rating team was acquired. The rating team had rated the pavement in segments one mile in length. The mile long segment that included the sites measured with the Benkelman Beam and the Impulse Index were used for comparison. Only the rating based on defects was used.

Both the Benkelman Beam and the Impulse Index give low readings for good pavement and high readings for poor pavement. The Washington Pavement Rating system yields the reverse, giving low readings for poor pavements and high readings for good pavements. For purposes of comparison, an inverted scale from 0 to 100 is superimposed on the Benkelman Beam and Impulse Index comparison graph for District 1 and the defect rating for each site is plotted. The comparative data is presented in Figure III-21. Some degree of correlation does exist. It does seem that the spread of W.P.R.S. readings from a low of 25 to a high of 75 may be somewhat wide ranging for the pavements tested, and would require some additional interpretation rather than a simple equating with the Benkelman Beam deflections and the Impulse Index for the corresponding points.

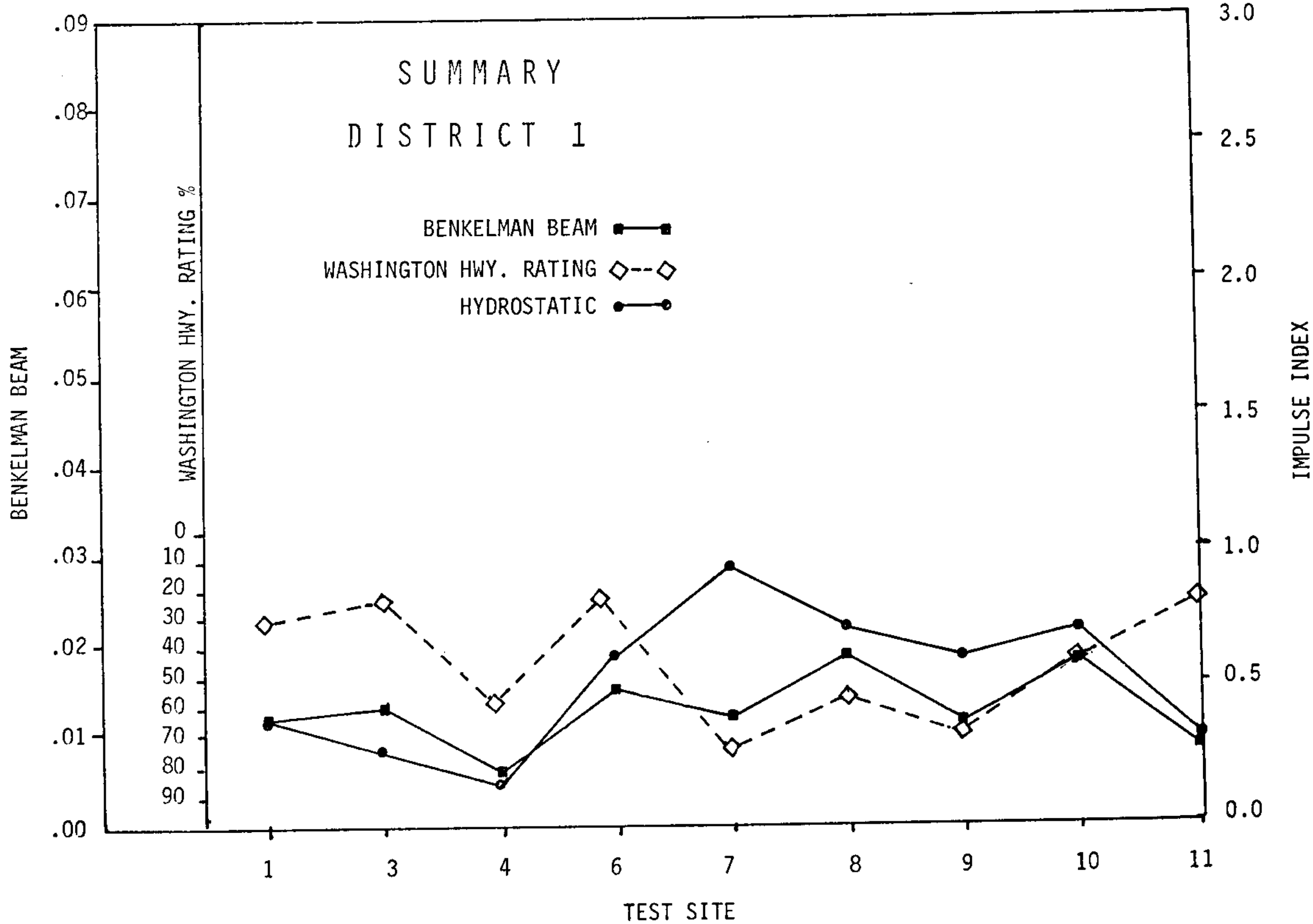


Figure III-21

Chapter IV "Temperature Effects and Pavement Non-uniformity"

Up to this time the significance of the exact pavement location when comparing measurement techniques was not known. Is one square foot of pavement identical to the next? Until the instrument repeatability problem was overcome, it was difficult to determine the small differences of different locations because so many readings were required. The variation in the readings masked the actual differences unless the pavement variations were large. The effects of pavement temperature on the measurements were also masked by the large spread of the readings.

The improved repeatability achieved using the hydrostatic interface permitted meaningful tests to be made so that these two problems could be attacked.

Two categories of data are employed for the development of this chapter. The first category is the data initially taken to determine the repeatability of the Impulse Index measurement using the hydrostatic interface and appearing in this report at Table A-II-3. The test procedure used to acquire the data of Table A-II-3 is described in Chapter II.

The second category of data was considered too voluminous to include with this report. It will be referred to as the "Two-Day Temperature Data" and is available to interested parties for reproduction and handling costs. The "Two-Day Temperature Data" was acquired in the following manner.

Three convenient locations on asphalt paving of different construction were selected. The primary purpose of the test was to determine the effect of temperature variations on R_1, R_2 and on the Impulse Index measurement. Some information on pavement non-uniformity was also obtained from the test results. The three locations are identified and described as follows:

"Engineering Labs": A service road paved with 2 1/2" AC and 10" GB.

"Airport Taxiway": 0.33' type A surface, 0.17' type C leveling course, 1.42' type A base.

"M.P. 20, U.S. 195": Lane center 0.25' ACP, 0.06' resurfacing, 0.17' bituminous mix, 0.83' crushed stone.

At each of these locations, the outline of the base of the Impulse Index Computer was painted at five positions, identified by numbers 1 through 5 and separated by only a short distance. The idea was to monitor these locations at two-hour intervals for two days during late summer when the nights are cool and afternoons are hot. Air temperatures were measured in the shade two feet above the pavement. Many variables exist when measuring air temperature because the air over the pavement is heated by the pavement but a breeze can bring in cooler air from the adjoining fields. Pavement temperature was measured with a mercury thermometer inserted in a hole drilled in the pavement. The hole was 2" deep and 1/2" in diameter. The hole was filled with mineral oil. The temperatures used in the following analysis are pavement temperatures unless otherwise stated. Data from the hydrostatic interface unit only are presented here, although similar data were acquired for the tripod interface unit. The results from the two units are generally similar except for the larger spread of data from the tripod unit.

<u>Table A-II-3 Data</u>

The five positions identified in Table A-II-3 as A, B, C, D, E were side by side on the pavement, with each position covering an area of 10" x 30" to accommodate the Impulse Index Computer. The total area involved for all five positions is then a rectangle 50" by 30".

The data of Table A-II-3 can be used to determine some information regarding non-uniformity of the pavement. Twenty measurements were made with each instrument on each of the locations recording R_1, R_2 and the Impulse Index. The average of the 20 readings from the hydrostatic unit only was determined for each location for each quantity and the results are plotted in Fig. IV-1.

The construction of this pavement is recorded as 2 1/2" AC with 10" GB. It is of interest to note from the graph that measurable variation existed from one of these positions to the next. The lowest Impulse Index appeared on position A with an average value of 0.36. Only 20 inches away, the average value is 0.57.

<u>Two-Day Temperature Data</u>

Four measurements were made on five closely spaced positions at each of the three locations every two hours with each instrument. Only the data from the hydrostatic interface unit will be used here. The average of the four readings of the Impulse Index for each of the positions is displayed graphically in Figs. IV-2 through IV-7 for the entire two-day test sequence.

Referring first to Fig. IV-2, note that for the first test of the day (4:00 a.m.) at the Engineering Lab location the Impulse Index for position 1 was measured as 0.62 and is the lowest of these five positions.

PAVEMENT NON-UNIFORMITY

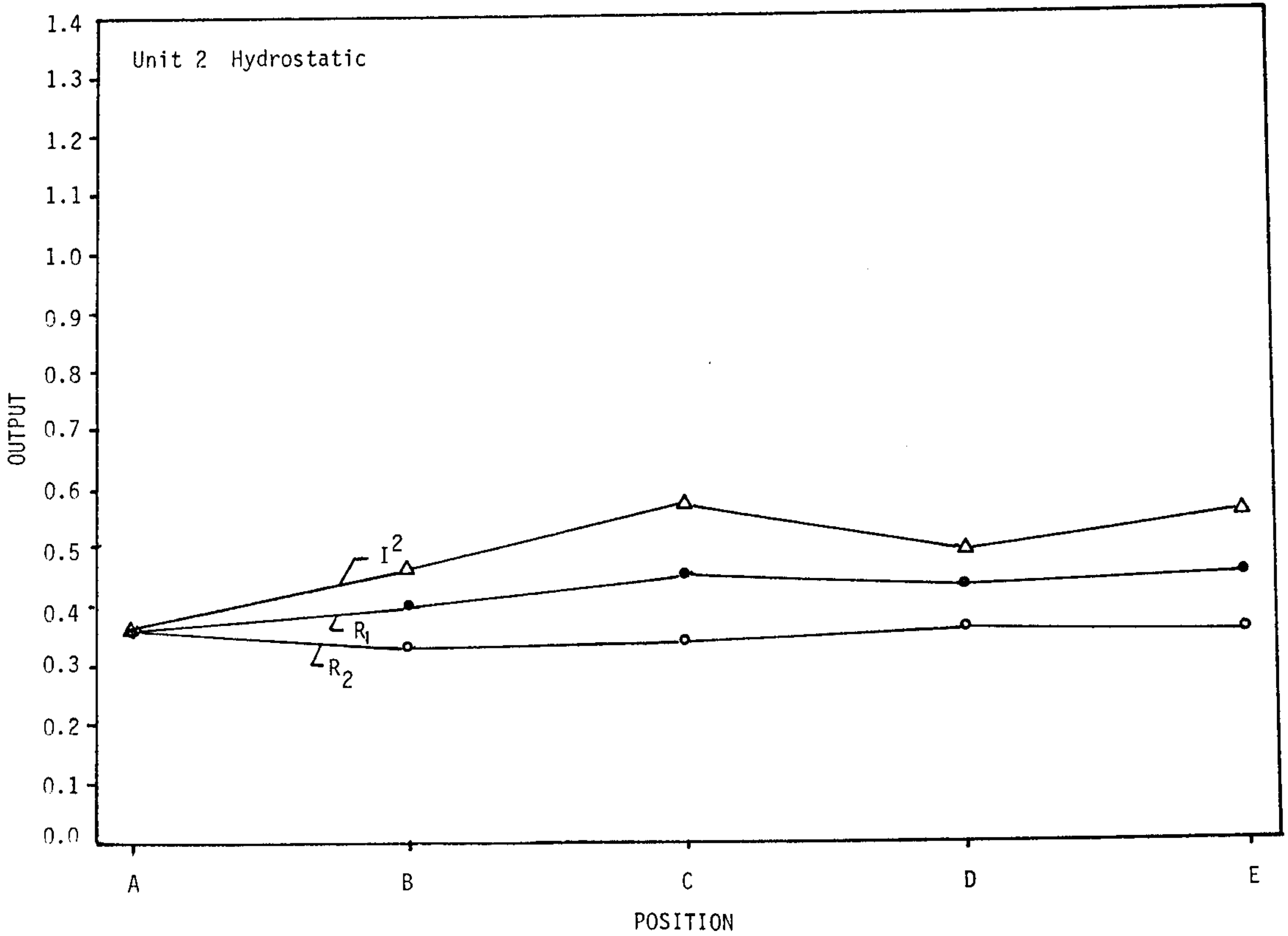


Figure IV-1

Position 2 was measured as .79 and was the highest of these five. As the day progressed and the temperature changed, the Impulse Index reading changed also. Throughout the day as the readings changed with temperature, the relative order of the five positions remained fairly much the same. Because of the sequence in which the data were acquired, it does not seem likely that this could be attributable to anything other than the pavement at position 1 is measurably different from the pavement of position 2 and so forth. The sequence of measurement was to take a single measurement at position 1, then position 2, 3, 4 and 6, then return to 1 and repeat the cycle until each position was measured four times with the instrument moved in between each reading. Figure IV-3 is the same location on the next day and it can be seen that the pattern repeats, with position 1 being again the lowest, except for one point.

Figures IV-4 and 5 appear incomplete. This is because the deflection went out of range of the instrument during the hotter part of the days. A more sophisticated range changing method can and should be incorporated in the device to preclude this condition. The location was near the edge of the end of the Pullman-Moscow airport taxiway. This is a small airport and this part of the taxiway receives no heavy traffic. Figures IV-6 and -7 present data from U.S. 195 at milepost 20. This pavement is fairly old and heavy with two major layers. The individuality of each position is again apparent from the graph.

PAVEMENT NON-UNIFORMITY

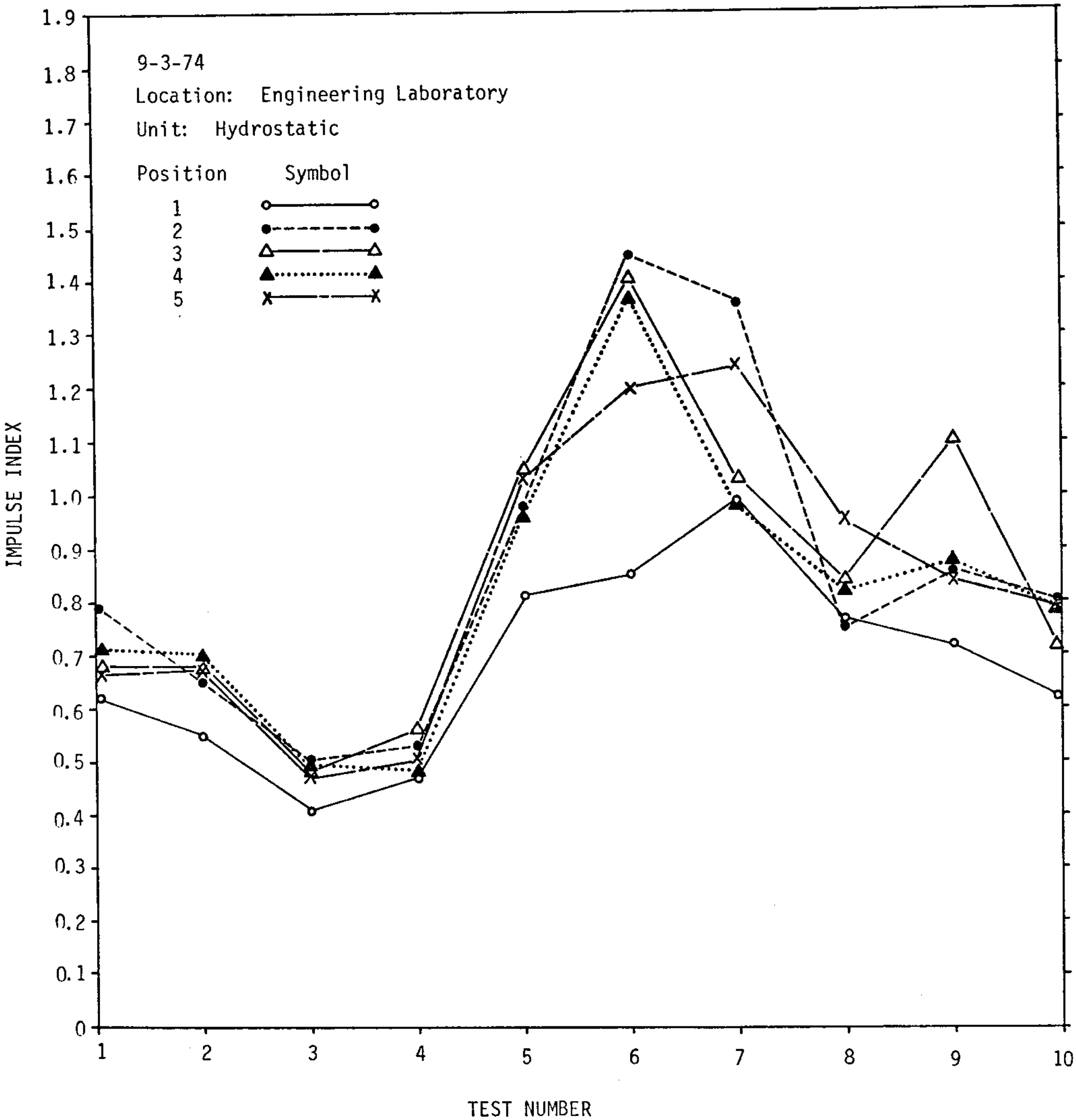


Figure IV-2

PAVEMENT NON-UNIFORMITY

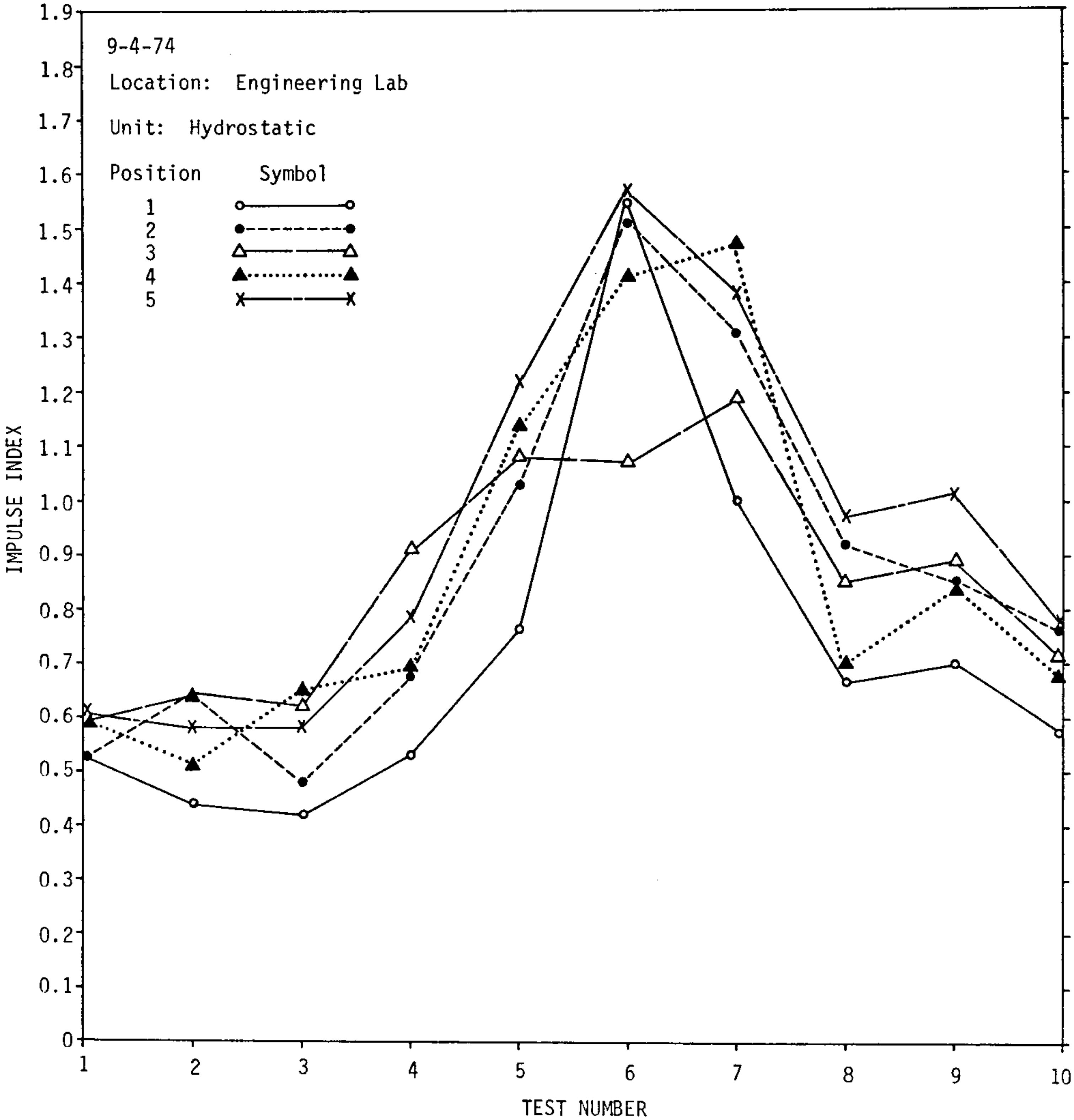


Figure IV-3

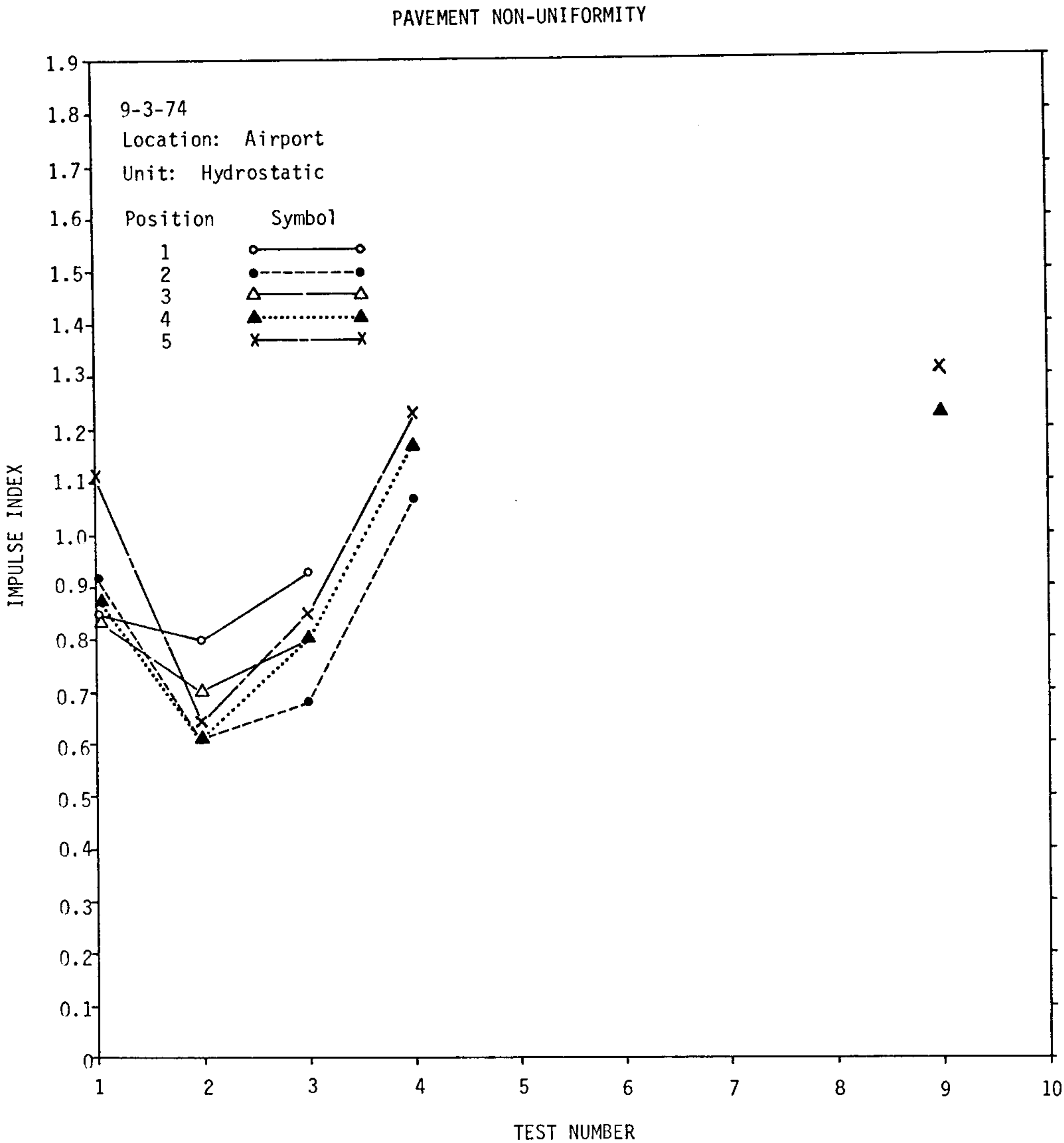

PAVEMENT NON-UNIFORMITY
9-3-74
Location: Airport
Unit: Hydrostatic
Position
Symbol
1
2
3
4
5
IMPULSE INDEX
TEST NUMBER
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
1
2
3
4
5
6
7
8
9
10

Figure IV-4

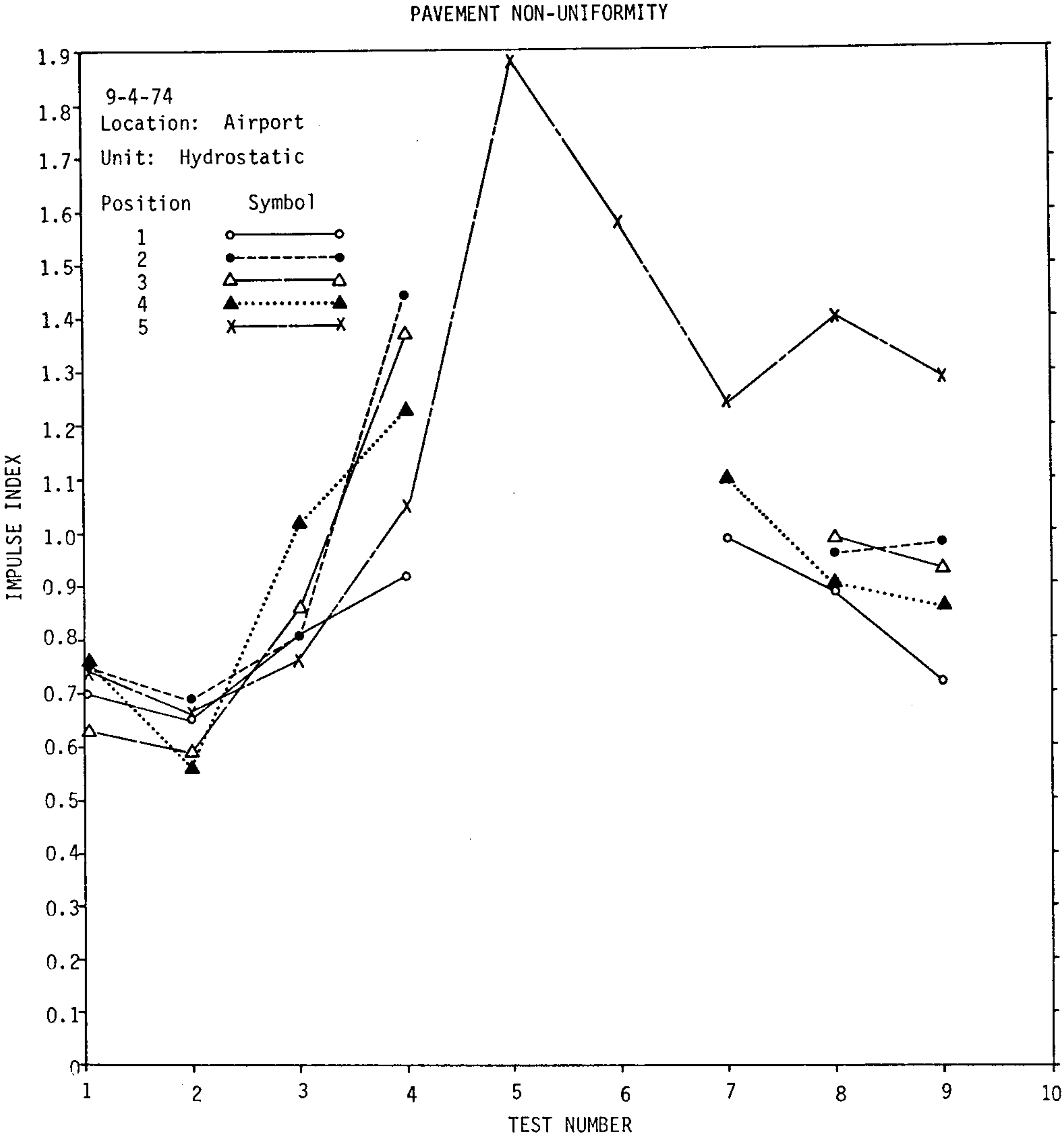

PAVEMENT NON-UNIFORMITY
9-4-74
Location: Airport
Unit: Hydrostatic
Position
Symbol
1
2
3
4
5
IMPULSE INDEX
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
TEST NUMBER

Figure IV-5

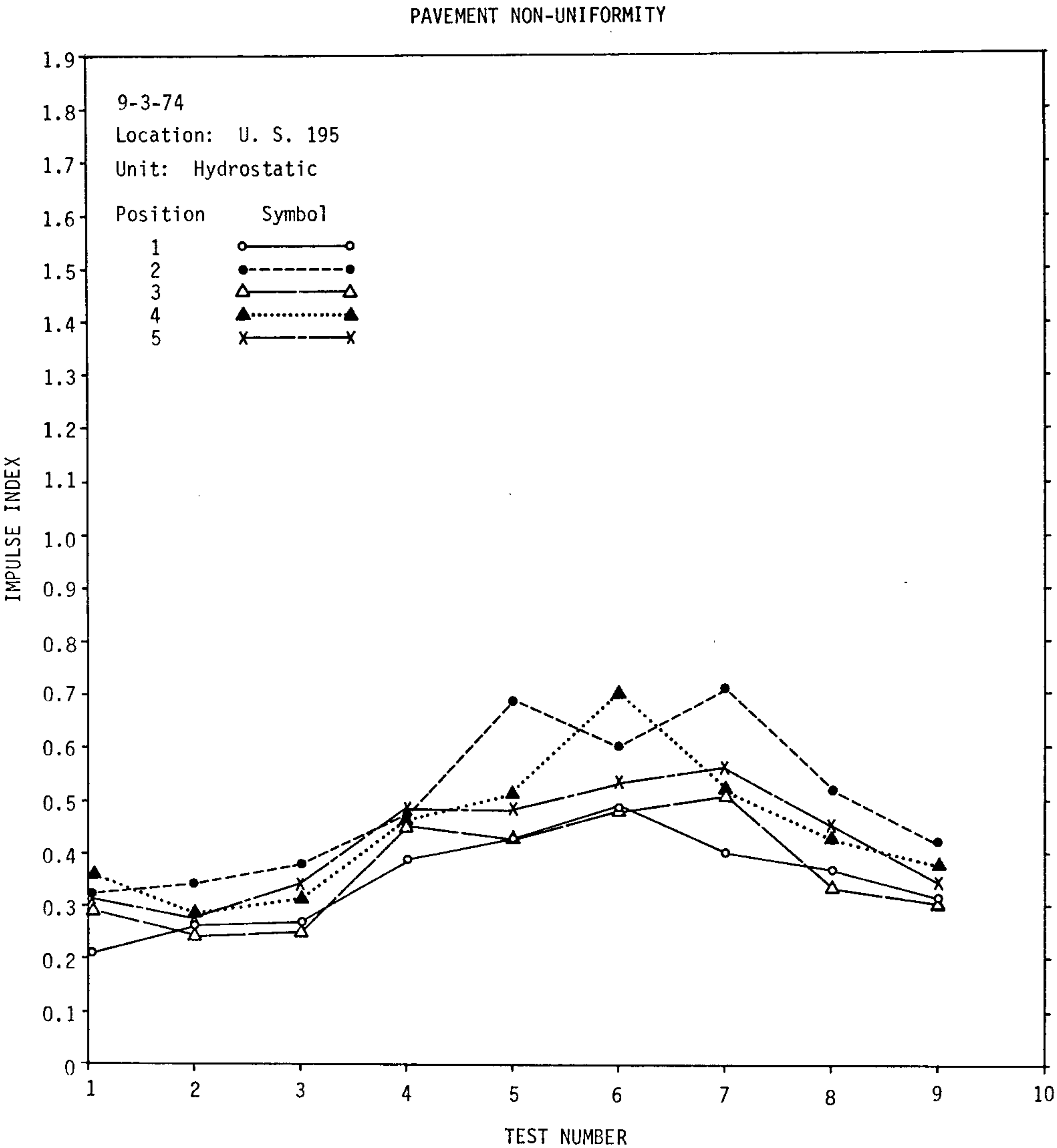

PAVEMENT NON-UNIFORMITY
9-3-74
Location: U. S. 195
Unit: Hydrostatic
Position
Symbol
1
2
3
4
5
IMPULSE INDEX
TEST NUMBER
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
1
2
3
4
5
6
7
8
9
10

Figure IV-6

PAVEMENT NON-UNIFORMITY

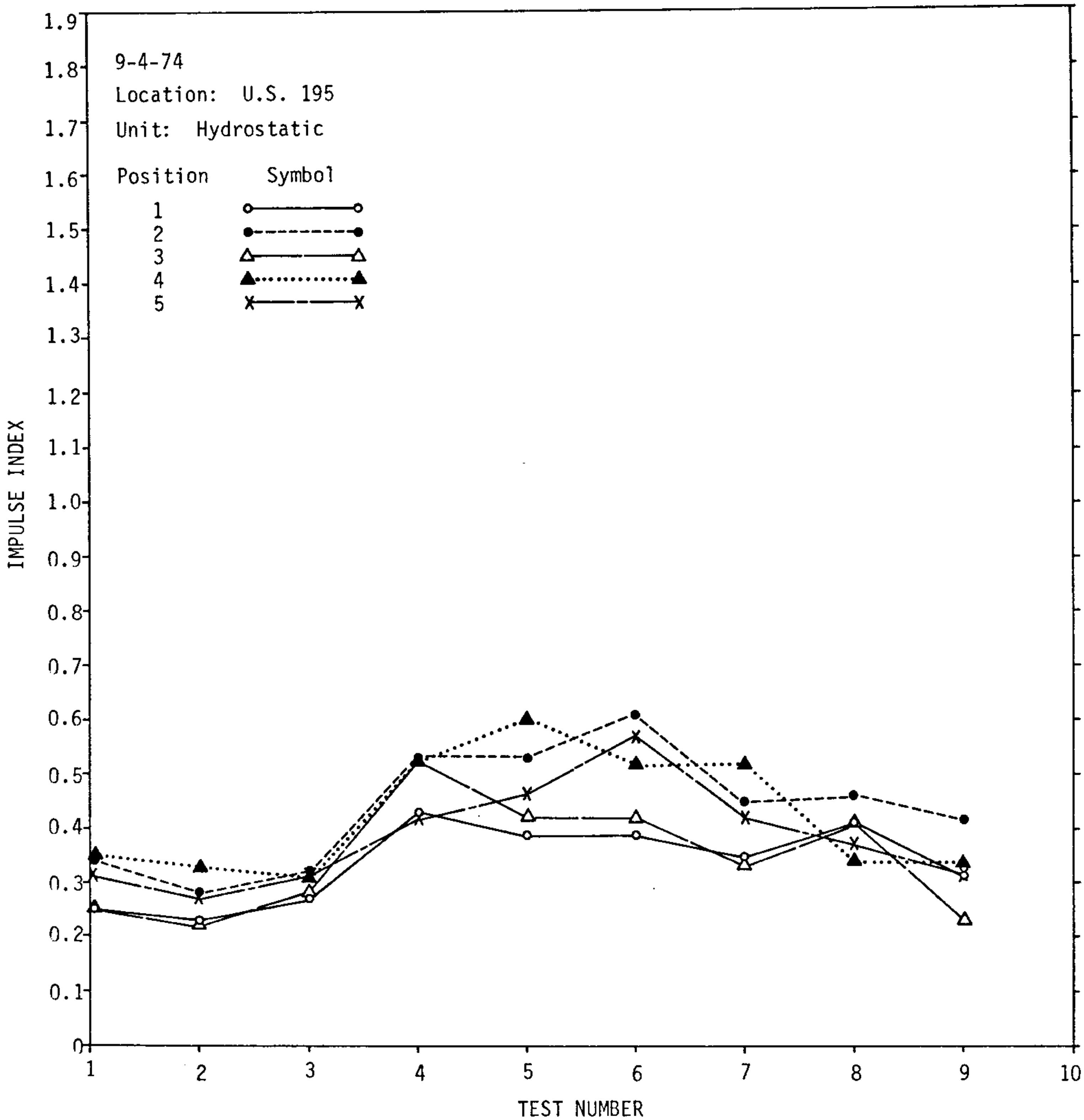


Figure IV-7

Temperature Characteristics

To determine effects of temperature variations on the measurements, the measurements from all five positions are all averaged together, giving an average of 20 measurements for each parameter of the three locations repeated at two-hour intervals. Figure IV-8 is a graph of R_1, R_2, the Impulse Index and the pavement temperature for a two-day sequence for the Engineering Lab location. The horizontal axis is test series number, or essentially the time of day. Figures IV-9 and-10 are similar but for the other two locations.

Figures IV-11, -12 and -13 are plots of R_1, R_2 and the Impulse Index for each location plotted against temperature. It can be seen that R_1 goes up with temperature fairly linearly, R_2 reaches its maximum value at 25° to 30°C, and the Impulse Index goes up with temperature somewhat non-linearly.

From these data, temperature normalization can be achieved depending on what temperature it is desired to use as normal.

To normalize the Impulse Index, a conversion can be used of the form

$$I_{T_1} = \frac{I_{T_2}}{\left[1 + C[T_2 - T_1]\, e^{K[T_2 - T_1]}\right]}$$

where I_{T_1} is the normalized Impulse Index at the desired temperature, T_1,

T_1 is the temperature to which it is desired to normalize the data,

TWO DAY VARIATIONS

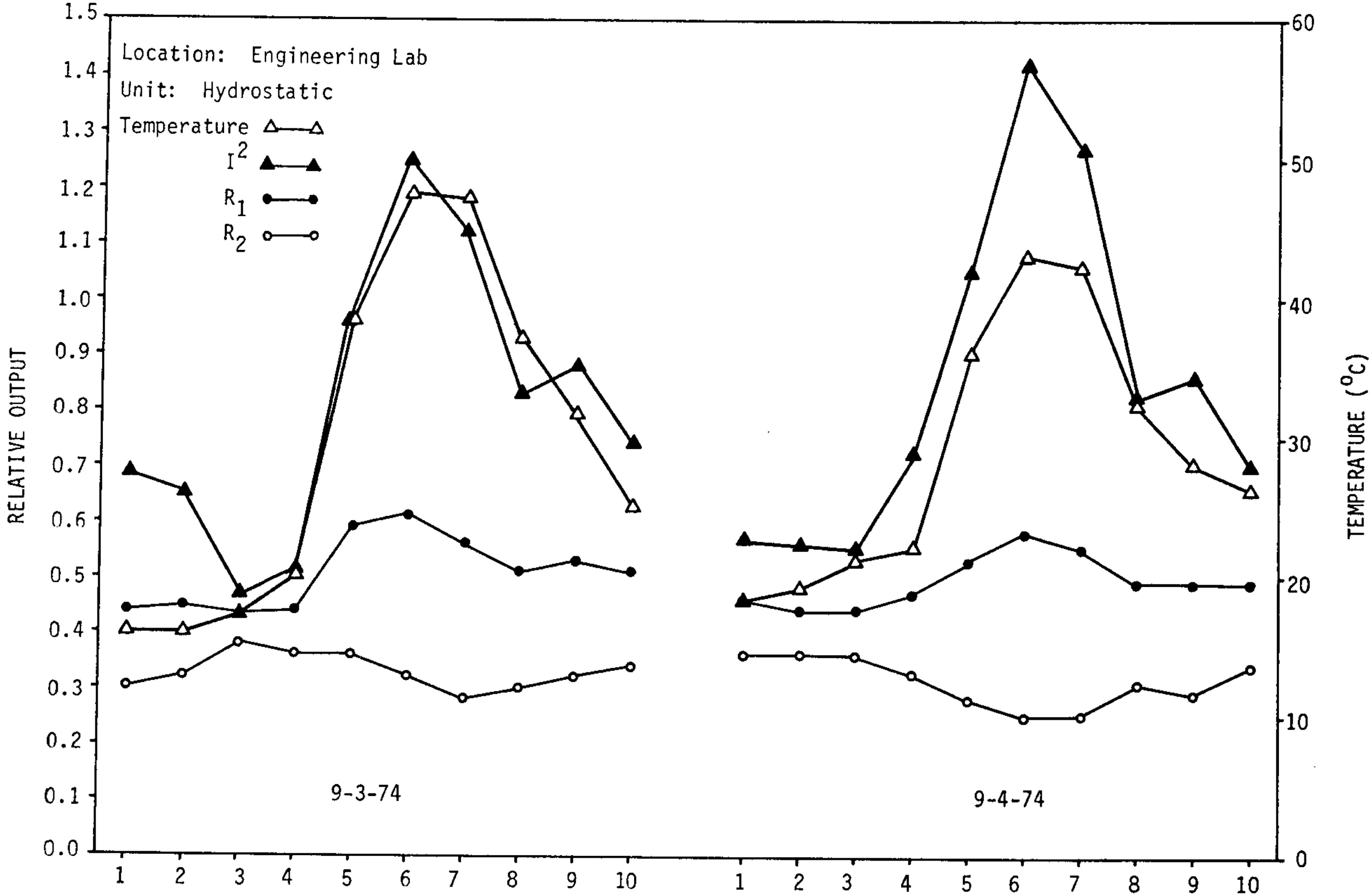


Figure IV-8

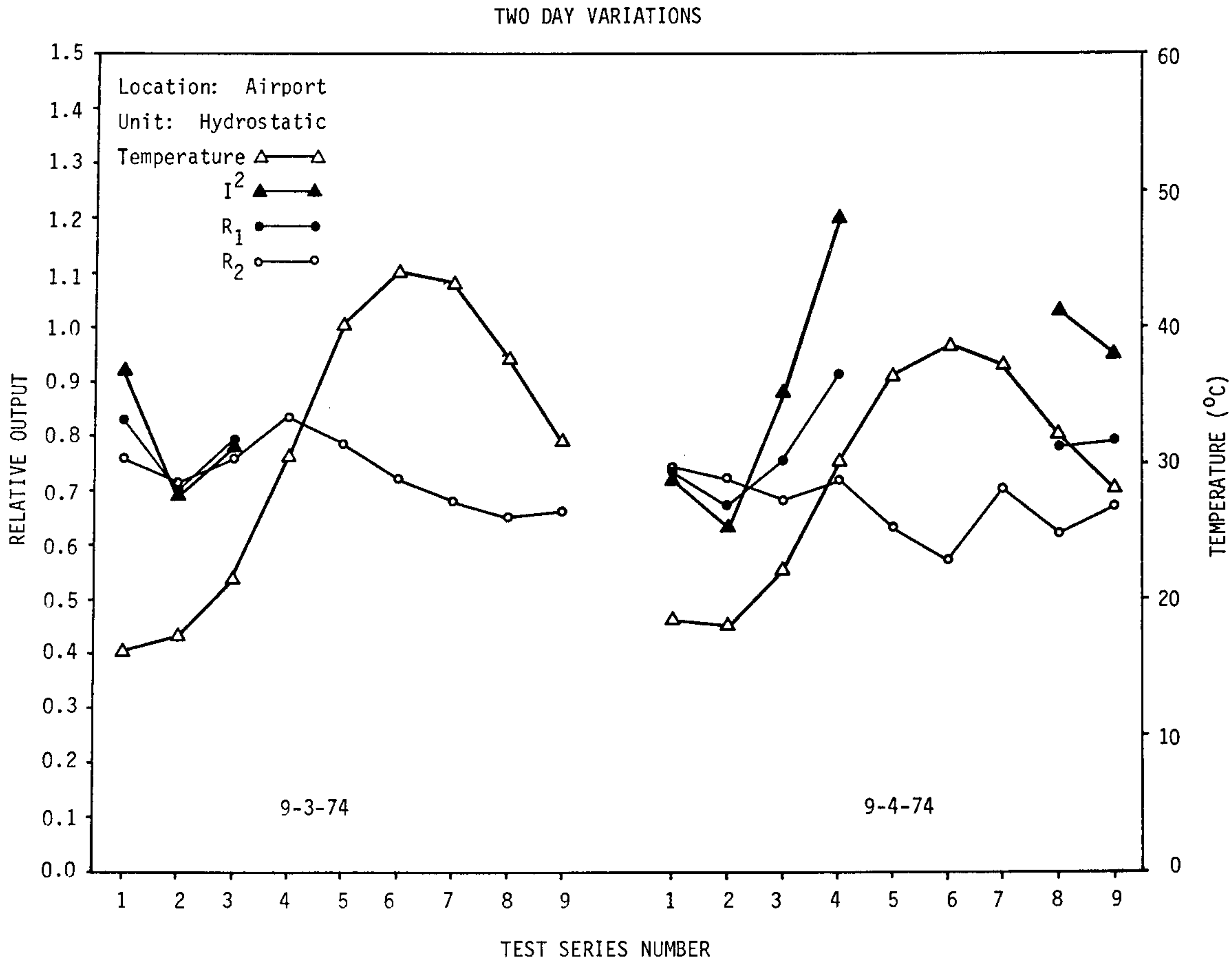

TWO DAY VARIATIONS
Location: Airport
Unit: Hydrostatic
Temperature
I2
R1
R2
RELATIVE OUTPUT
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
TEMPERATURE (°C)
60
50
40
30
20
10
0
9-3-74
9-4-74
1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9
TEST SERIES NUMBER

Figure IV-9

TWO DAY VARIATIONS

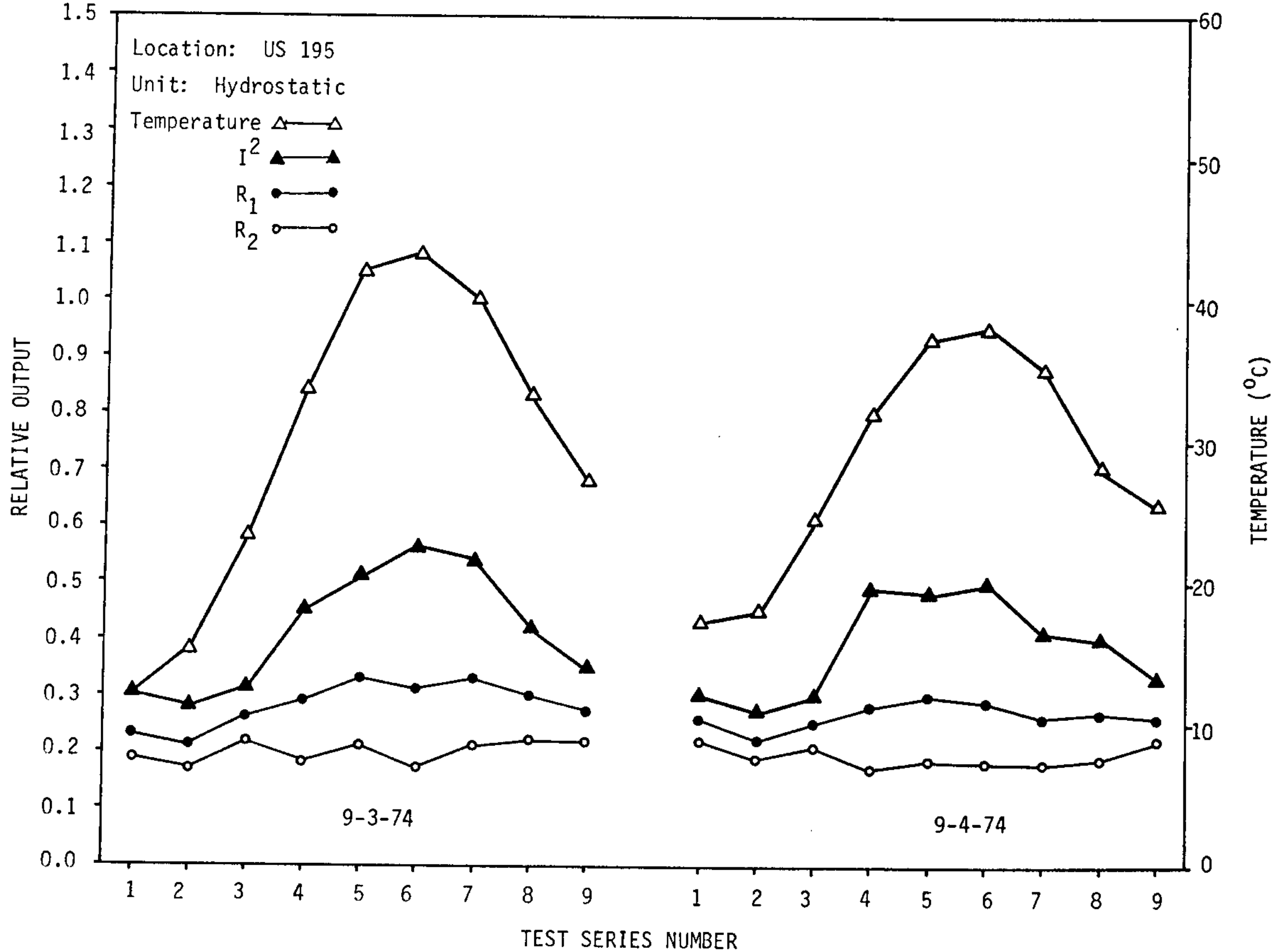


Figure IV-10

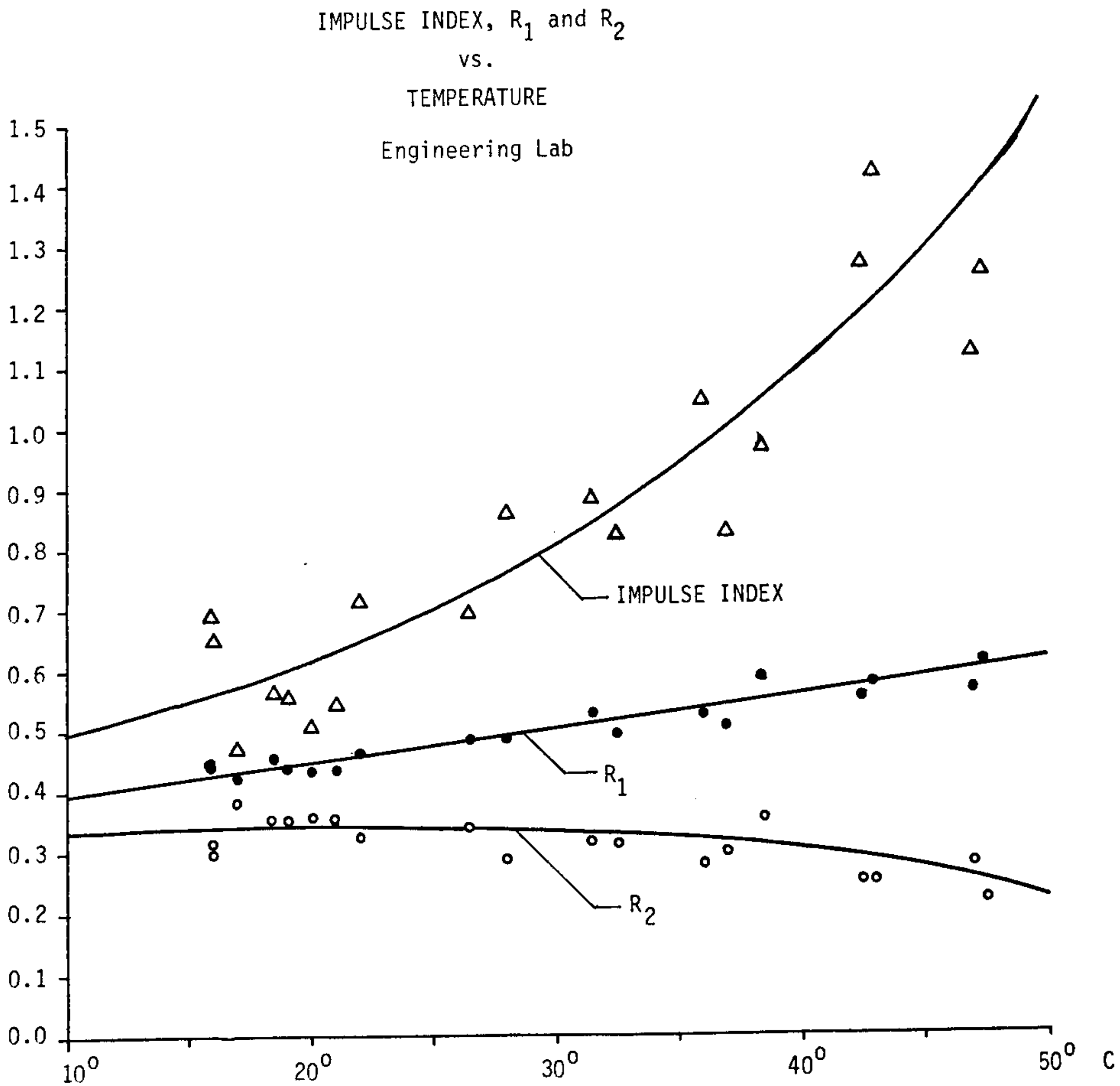

IMPULSE INDEX, R1 and R2
vs.
TEMPERATURE
Engineering Lab
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10°
20°
30°
40°
50° C
IMPULSE INDEX
R1
R2

Figure IV-11

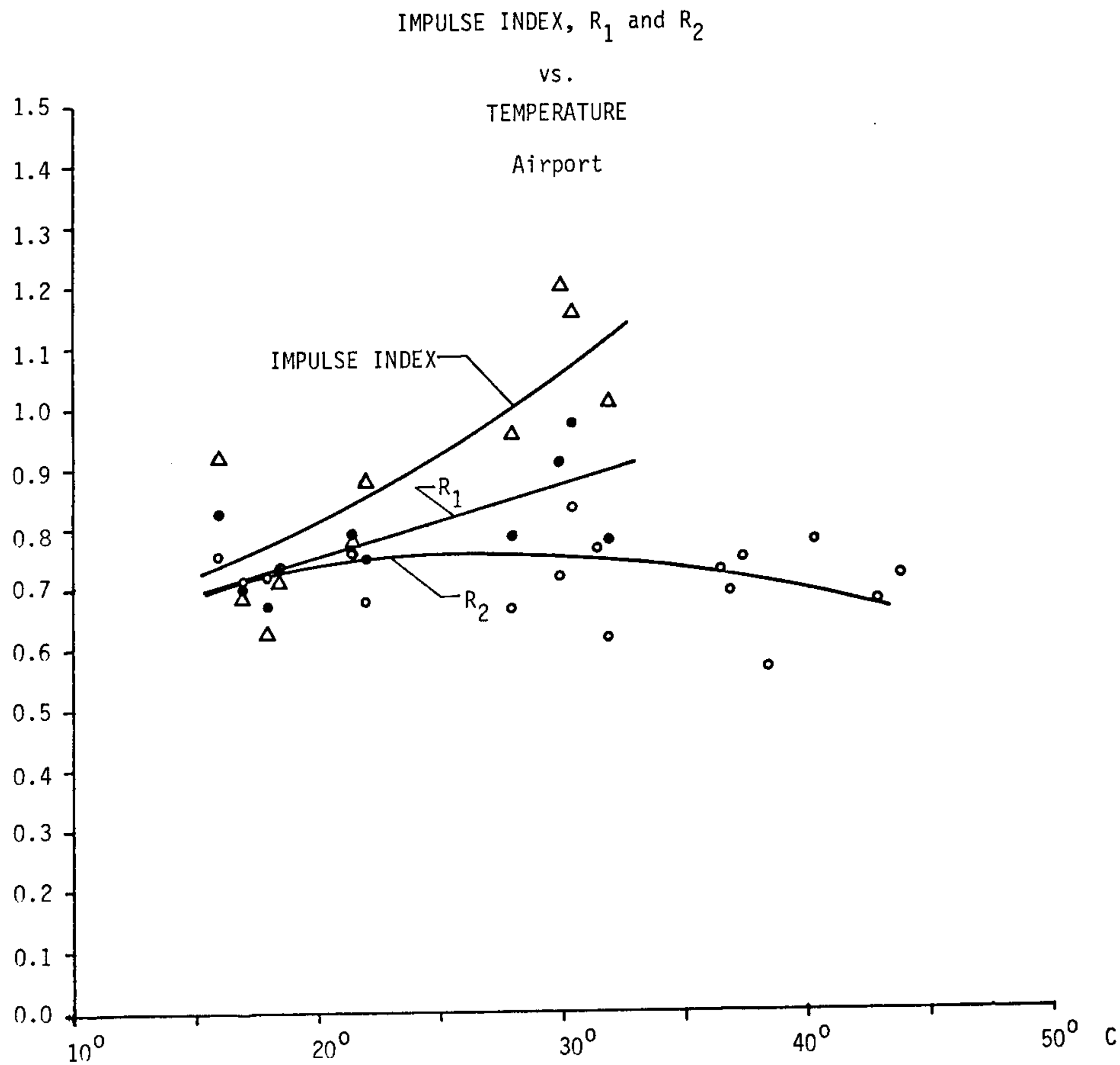

IMPULSE INDEX, R1 and R2
vs.
TEMPERATURE
Airport
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
IMPULSE INDEX
R1
R2
10°
20°
30°
40°
50° C

Figure IV-12

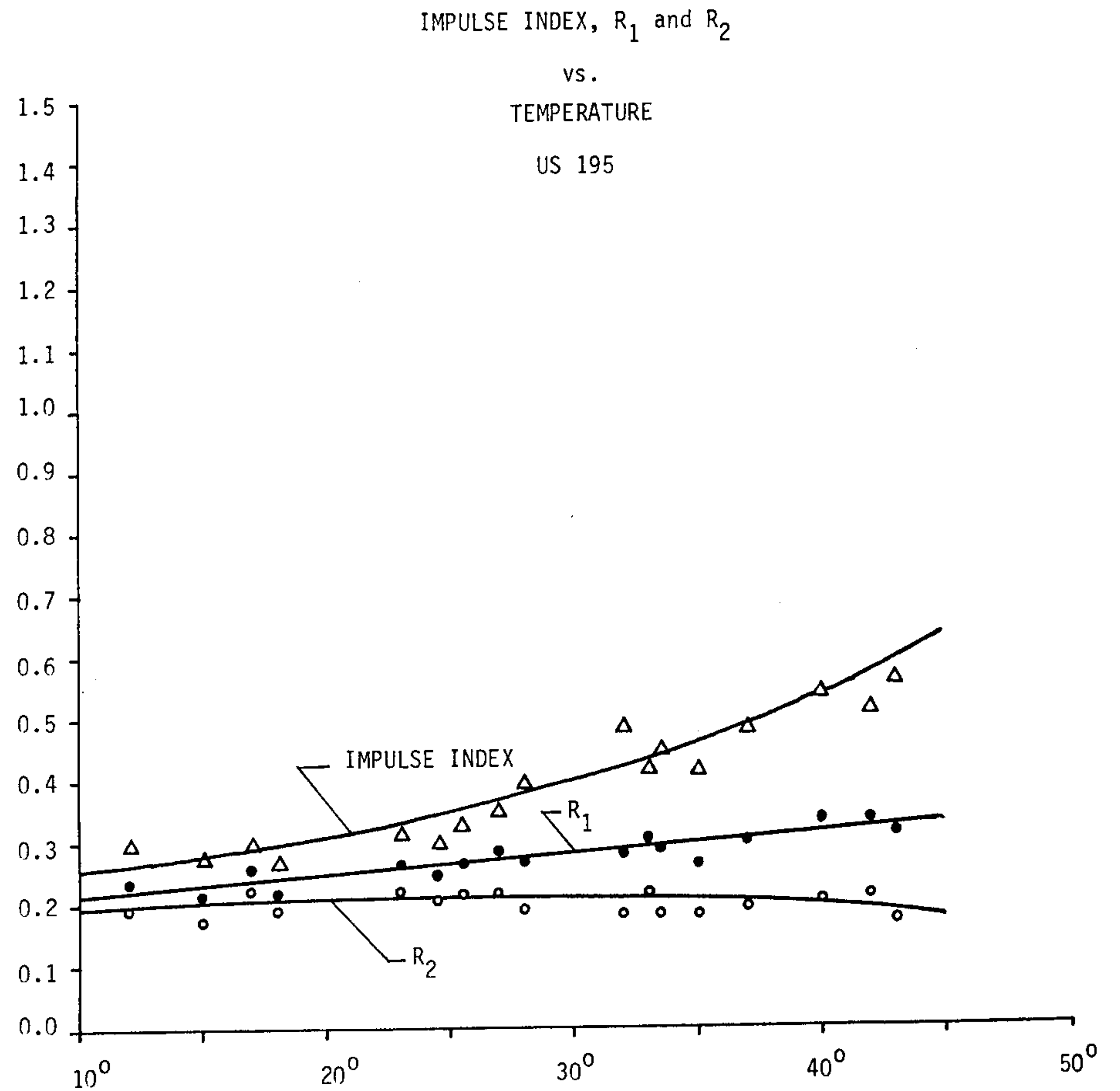

IMPULSE INDEX, R_1 and R_2
vs.
TEMPERATURE
US 195
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
IMPULSE INDEX
R_1
R_2
10^0
20^0
30^0
40^0
50^0 C

Figure IV-13

T_2 is the actual pavement temperature when the measurement is made,

e is the Naperian log base,

c and K are constants which can be determined from the curves of Fig. IV-11, -12, -13.

If T_1 is selected as 20^{o} C, the normalizing equation becomes

$$I_{20^{o}C} = \frac{I_T}{\left[1 + .024(T-20^{o})\ e^{.025(T-20^{o})}\right]}$$

A temperature correction curve based on this relation appears in Figure IV-14 and can be used to normalize readings from the hydrostatic unit to 20^{o}C. To use the curve, the Impulse Index taken at any pavement temperature from 0^{o}C to 40^{o}C should be divided by the correction factor obtained for that temperature from the chart.

TEMPERATURE CORRECTION CURVE

Plot of $\left[1 + .024(T-20^{\circ})\, e^{\,.025(T-20^{\circ})}\right]$

To use curve:

Divide Impulse Index as measured at any temperature by the correction factor for that temperature.

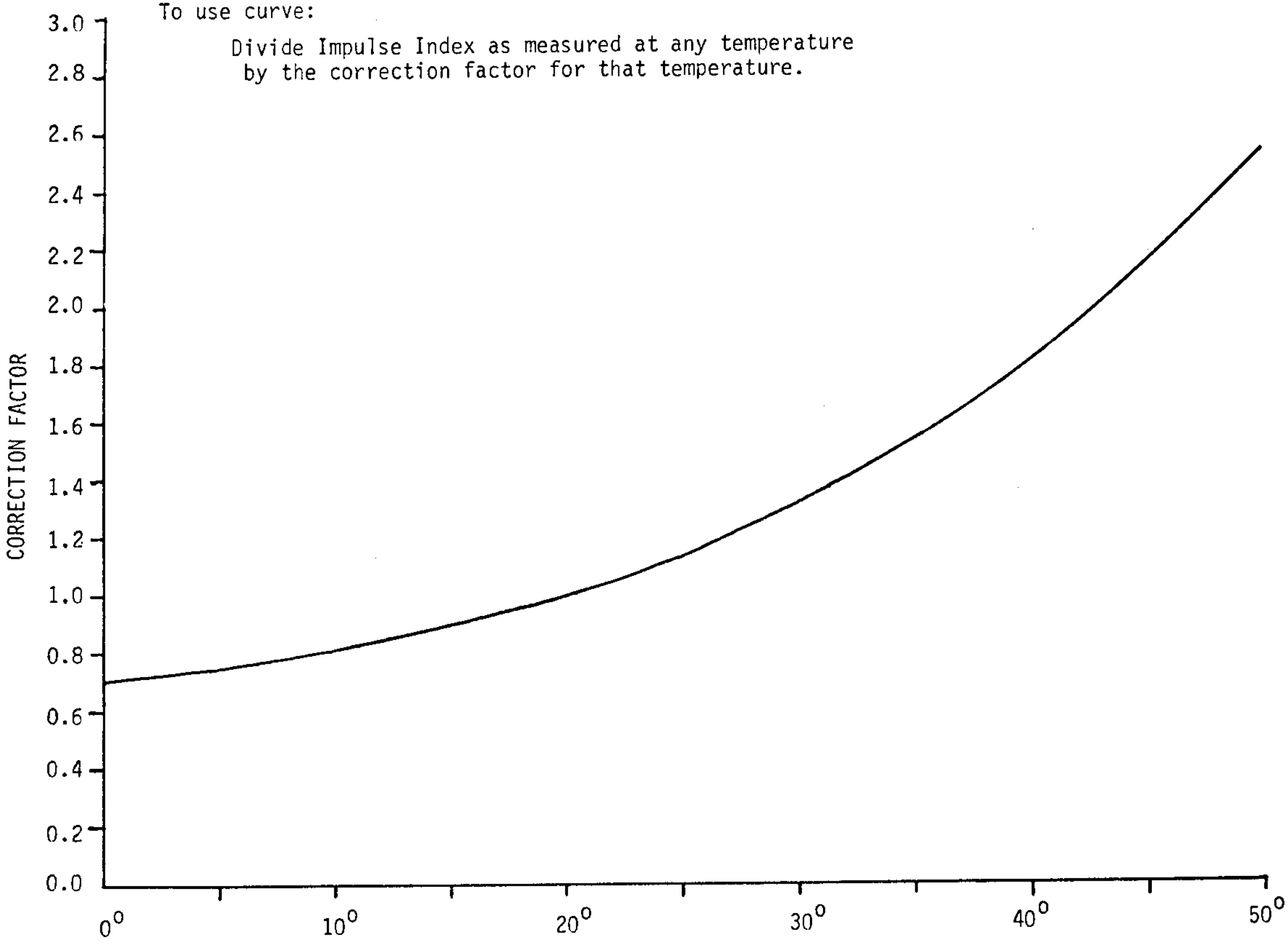


Figure IV-14

Chapter V - "Seasonal Variations"

Six test sites were selected to conduct measurements over a period of time in an effort to detect seasonal variations. The sites are designated by letters A, B, C, D, E, F, with recorded construction as follows:

Site A:	US 195, MP 20 0.25' ACP .06' resurfacing .17' bituminous mix .83' crushed stone	Core sample revealed both layers of pavement. Total pavement thickness 0.5'.
Site B:	US 195, MP 19 same construction as site A.	
Site C:	SR 27, MP 2.1 .06' resurfacing .50' crushed stone	Core sample revealed only a thin surface treatment.
Site D:	SR 27, MP 3.0 same construction as site C.	
Site E:	US 195, MP 24.3 .06' light bituminous surface treatment .33' crushed stone .67' base	Core sample revealed unrecorded 0.25' AC.
Site F:	US 195, MP 24.8 same construction as site E.	

A twenty-foot length of pavement was marked off with paint at each site. At two-week intervals 10 Impulse Index measurements were made with each instrument in the outside wheeltrack at each site. The exact points of measurement for each reading were random within the 20-foot length. Only the summary of results from the hydrostatic units are presented in Fig. V-1.

It can be observed from the graph that sites C and D displayed much greater variation than the other sites. Sites C and D have only a light surface coating with no asphalt concrete. The other sites, all on US 195, have heavier pavements and are much better behaved.

Tests on site F had to be terminated early because the road was torn up to accommodate a junction with new construction. The last reading (November 12, 1974) on site A is substantially lower than the previous readings because it had received a new asphalt overlay just the day before the last reading was taken. As would be expected, the overlay improved the indicated Impulse Index of the pavement.

There is an unexplained peak in the data taken on October 1, 1974. The temperature had shown a small peak but the recorded readings are higher than can be explained by temperature alone. An examination of the raw data has not revealed any clue as to the reason for this peak. Several suggested possibilities are:

1) Operator error in operating the unit or reading or recording the values.

2) Increased truck traffic due to the recently completed harvest or other commercial activity.

3) An effect on the pavement of a positive versus a negative time derivative of temperature, possibly affecting the gradient of temperature within the pavement and consequently its response.

4) Quite a variation usually exists between the lane center and the outside wheeltrack. The more or less random selection of the exact positions of the unit when making the measurements depended on the operator's identifying the outside wheeltrack. Perhaps the operator on October 1 was, for one reason or another, better able to identify the wheeltrack. At the time these tests were initiated, the significance of the exact pavement location was not established.

SEASONAL VARIATIONS

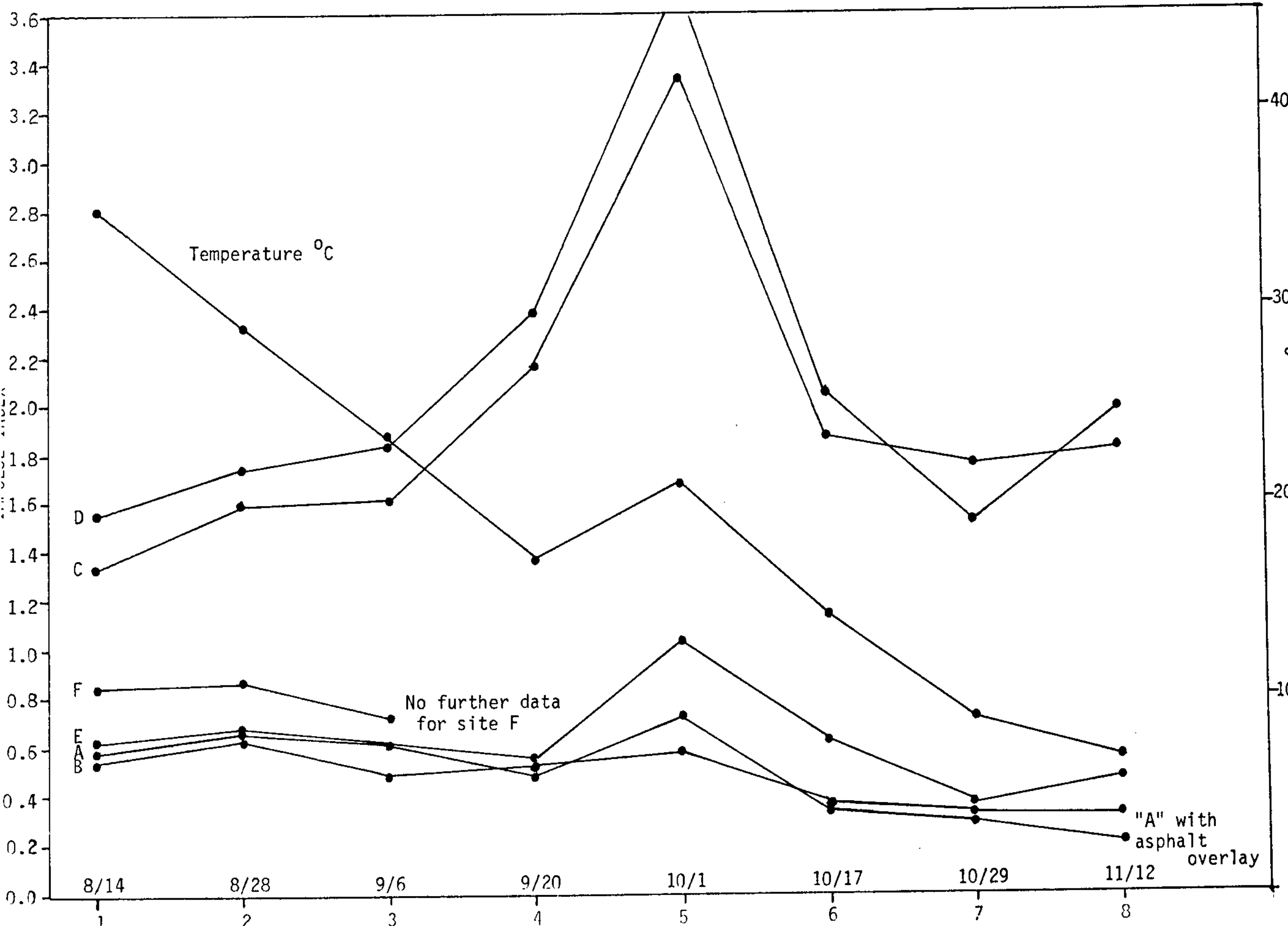


Figure V-1

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APPENDIX

TABLE A-II-1

REPEATABILITY TEST - COMPARISON OF BARE AND PADDED HAMMER

BARE HAMMER

POSITION 1

R_1	.34	.42	.37
R_2	.24	.24	.24
I^2	.47	.70	.56
PICK UP AND RESET			
R_1	.24	.36	.44
R_2	.2	.27	.32
I^2	.3	.48	.56
PICK UP AND RESET			
R_1	.28	.4	.44
R_2	.22	.3	.34
I^2	.34	.54	.54

AVERAGE I^2 = .499
STANDARD DEVIATION I^2 = .12
% STANDARD DEVIATION = 24%

POSITION 3

R_1	.36	.34	.48
R_2	.28	.32	.42
I^2	.45	.37	.56
PICK UP AND RESET			
R_1	.38	.35	.36
R_2	.3	.32	.34
I^2	.46	.38	.4
PICK UP AND RESET			
R_1	.2	.3	.32
R_2	.38	.38	.35
I^2	.13	.26	.3

AVERAGE I^2 = .368
STANDARD DEVIATION I^2 = .126
% STANDARD DEVIATION = 34%

POSITION 2

R_1	.3	.37	.44
R_2	.29	.37	.44
I^2	.31	.37	.44
PICK UP AND RESET			
R_1	.32	.36	.42
R_2	.2	.3	.34
I^2	.52	.44	.53
PICK UP AND RESET			
R_1	.38	.42	.42
R_2	.24	.27	.3
I^2	.59	.61	.62

AVERAGE I^2 = .492
STANDARD DEVIATION I^2 = .11
% STANDARD DEVIATION = 22%

POSITION 4

R_1	.22	.29	.28
R_2	.23	.31	.35
I^2	.2	.28	.24
PICK UP AND RESET			
R_1	.28	.38	.42
R_2	.16	.22	.24
I^2	.48	.7	.73
PICK UP AND RESET			
R_1	.42	.44	.5
R_2	.36	.3	.45
I^2	.53	.5	.56

AVERAGE I^2 = .469
STANDARD DEVIATION I^2 = .19
% STANDARD DEVIATION = 41%

TABLE A-II-1 (Continued)

1/8" PAD ON HAMMER

POSITION 1

R_1	.19	.25	.26
R_2	.18	.22	.2
I^2	.2	.28	.33
PICK UP AND RESET			
R_1	.24	.26	.28
R_2	.2	.22	.22
I^2	.28	.33	.33
PICK UP AND RESET			
R_1	.21	.27	.28
R_2	.19	.24	.27
I^2	.23	.3	.3

AVERAGE I^2 = .287

STANDARD DEVIATION I^2 = .046

% STANDARD DEVIATION = 16%

POSITION 3

R_1	.12	.28	.16
R_2	.12	.2	.13
I^2	.12	.36	.12
PICK UP AND RESET			
R_1	.14	.18	.18
R_2	.19	.24	.23
I^2	.1	.14	.16
PICK UP AND RESET			
R_2	.22	.25	.26
R_2	.24	.23	.24
I^2	.2	.22	.24

AVERAGE I^2 = .184

STANDARD DEVIATION I^2 = .0817

% STANDARD DEVIATION = 44%

POSITION 2

R_1	.16	.18	.21
R_2	.23	.24	.31
I^2	.12	.14	.15
PICK UP AND RESET			
R_1	.23	.28	.28
R_2	.2	.28	.33
I^2	.27	.28	.25
PICK UP AND RESET			
R_1	.22	.22	.14
R_2	.2	.26	.16
I^2	.23	.19	.12

AVERAGE I^2 = .194

STANDARD DEVIATION I^2 = .065

% STANDARD DEVIATION I^2 = 33 1/3%

POSITION 4

R_1	.2	.12	.18
R_2	.18	.16	.18
I^2	.22	.1	.18
PICK UP AND RESET			
R_1	.15	.19	.2
R_2	.11	.21	.2
I^2	.23	.18	.2
PICK UP AND RESET			
R_1	.22	.3	.27
R_2	.22	.3	.35
I^2	.22	.3	.22

AVERAGE I^2 = .206

STANDARD DEVIATION I^2 = .053

% STANDARD DEVIATION I^2 = 25.8%

TABLE A-II-2

REPEATABILITY - SR 127

		BARE HAMMER				1/8" PAD ON HAMMER		
	MP 38.1							
OUTSIDE WHEEL TRACK	R_1	.42	.32	.4	R_1	.21	.3	.34
	R_2	.075	.115	.1	R_2	.06	.075	.07
	I^2	2.24	.96	1.6	I^2	.8	1.2	1.68
LANE CENTER	R_1	.34	.34	.36	R_1	.32	.24	.27
	R_2	.09	.075	1.44	R_2	.065	.075	.075
	I^2	1.28	1.44	1.84	I^2	1.12	.80	1.04
INSIDE WHEEL TRACK	R_1	.24	.3	.36	R_1	.23	.2	.28
	R_2	.07	.095	.085	R_2	.065	.08	.06
	I^2	.92	1.00	.92	I^2	.80	.56	1.36
	MP 36.3							
OUTSIDE WHEEL TRACK	R_1	.18	.20	.14	R_1	.08	.1	.22
	R_2	.055	.075	.065	R_2	.035	.043	.055
	I^2	.64	.60	.32	I^2	.16	.32	.92
LANE CENTER	R_1	.25	.1	.22	R_1	.1	.1	.1
	R_2	.07	.053	.055	R_2	.045	.04	.05
	I^2	.96	.28	.88	I^2	.16	.24	.24
INSIDE WHEEL TRACK	R_1	.18	.2	.16	R_1	.18	.16	.16
	R_2	.065	.068	.078	R_2	.045	.04	.055
	I^2	.56	.56	.40	I^2	.72	.64	.44

TABLE A-II-2 (Continued)

Location		Bare Hammer			1/8" Pad on Hammer		
MP 33.6							
Outside Wheel Track	R_1	.21	.22	.22	.23	.22	.23
	R_2	.068	.058	.078	.05	.045	.055
	I^2	.72	.92	.68	1.12	.96	.96
Lane Center	R_1	.19	.28	.2	.15	.19	.16
	R_2	.185	.133	.11	.038	.045	.05
	I^2	.16	.60	.40	.60	.80	.52
Inside Wheel Track	R_1	.24	.25	.2	.16	.13	.16
	R_2	.075	.078	.095	.058	.058	.065
	I^2	.76	.84	.44	.44	.32	.40
MP 29.2							
Outside Wheel Track	R_1	.28	.35	.32	.22	.23	.28
	R_2	.095	.075	.093	.085	.05	.063
	I^2	.88	1.68	1.20	.60	1.04	1.24
Lane Center	R_1	.3	.19	.32	.18	.22	.26
	R_2	.09	.09	.075	.06	.045	.05
	I^2	1.00	.44	1.44	.56	1.04	1.28
Inside Wheel Track	R_1	.28	.24	.17	.3	.18	.28
	R_2	.05	.07	.085	.065	.05	.065
	I^2	1.52	.84	.36	1.44	.72	1.24

Table A-II-3

IMPULSE INDEX REPEATABILITY DATA

Hydrostatic Unit 1

	A	B	C	D	E	Pavement Temperature
Impact No. 1						
R_1	.35	.39	.40	.37	.47	+12°C
R_2	.36	.41	.31	.36	.38	
I^2	.33	.37	.51	.37	.55	
Impact No. 2						
R_1	.32	.33	.42	.32	.44	+12°C
R_2	.33	.27	.29	.34	.34	
I^2	.31	.39	.58	.30	.54	
Impact No. 3						
R_1	.34	.38	.43	.35	.41	+12.5°C
R_2	.36	.33	.34	.31	.30	
I^2	.32	.43	.52	.38	.53	
Impact No. 4						
R_1	.32	.43	.46	.35	.39	+13°C
R_2	.34	.34	.35	.38	.31	
I^2	.30	.52	.58	.32	.47	
Impact No. 5						
R_1	.33	.37	.46	.37	.48	+13°C
R_2	.35	.31	.38	.40	.37	
I^2	.31	.43	.54	.33	.60	
Impact No. 6						
R_1	.35	.37	.43	.43	.44	+13.5°C
R_2	.36	.34	.32	.34	.34	
I^2	.33	.41	.55	.52	.54	

TABLE A-II-3 (Continued)

Hydrostatic Unit 1

	A	B	C	D	E	Pavement Temperature
Impact No. 7						
R_1	.39	.37	.46	.38	.40	+13.5°C
R_2	.36	.32	.35	.30	.32	
I^2	.40	.42	.57	.46	.47	
Impact No. 8						
R_1	.33	.38	.45	.48	.41	+13.5°C
R_2	.35	.33	.35	.40	.33	
I^2	.31	.44	.56	.56	.48	
Impact No. 9						
R_1	.33	.41	.46	.44	.46	+14°C
R_2	.35	.33	.34	.35	.34	
I^2	.31	.49	.59	.54	.60	
Impact No. 10						
R_1	.40	.40	.44	.46	.41	+14.5°C
R_2	.34	.33	.32	.39	.33	
I^2	.46	.46	.58	.53	.48	
Impact No. 11						
R_1	.40	.41	.48	.45	.45	+14.5°C
R_2	.36	.34	.36	.36	.35	
I^2	.43	.47	.60	.52	.56	
Impact No. 12						
R_1	.34	.42	.48	.49	.43	+15°C
R_2	.40	.36	.36	.42	.33	
I^2	.29	.47	.62	.55	.53	

TABLE A-II-3 (Continued)

Hydrostatic Unit 1

	A	B	C	D	E	Pavement Temperature
Impact No. 13						
R_1	.38	.40	.48	.47	.45	+15.5°C
R_2	.31	.32	.35	.38	.33	
I^2	.45	.47	.65	.56	.60	
Impact No. 14						
R_1	.34	.41	.41	.46	.44	+15.8°C
R_2	.37	.33	.32	.38	.36	
I^2	.31	.50	.51	.55	.52	
Impact No. 15						
R_1	.37	.40	.47	.48	.52	+16°C
R_2	.35	.32	.35	.40	.42	
I^2	.38	.48	.59	.57	.62	
Impact No. 16						
R_1	.35	.39	.43	.47	.45	+16°C
R_2	.35	.32	.34	.40	.33	
I^2	.35	.46	.53	.55	.60	
Impact No. 17						
R_1	.35	.40	.43	.46	.46	+16°C
R_2	.37	.35	.33	.40	.36	
I^2	.32	.44	.54	.53	.55	
Impact No. 18						
R_1	.35	.41	.46	.45	.45	+16°C
R_2	.35	.34	.36	.36	.34	
I^2	.35	.47	.55	.54	.57	

TABLE A-II-3 (Continued)

Hydrostatic Unit 1

	A	B	C	D	E	Pavement Temperature
Impact No. 19						
R_1	.41	.40	.48	.49	.49	+16.5°C
R_2	.39	.32	.35	.41	.39	
I^2	.43	.47	.64	.56	.59	
Impact No. 20						
R_1	.41	.42	.46	.47	.45	+17°C
R_2	.38	.33	.35	.39	.37	
I^2	.42	.51	.59	.56	.53	

TABLE A-II-4

IMPLUSE INDEX REPEATABILITY DATA

Tripod Unit 2

	A	B	C	D	E	Pavement Temperature
Impact No. 1						
R_1	.37	.48	.47	.47	.33	+12°C
R_2	.33	.34	.39	.36	.30	
I^2	.42	.65	.55	.60	.38	
Impact No. 2						
R_1	.32	.39	.32	.23	.42	+12°C
R_2	.32	.29	.33	.23	.30	
I^2	.32	.52	.32	.23	.57	
Impact No. 3						
R_1	.41	.27	.44	.33	.35	+12°C
R_2	.33	.37	.32	.25	.34	
I^2	.51	.21	.59	.43	.36	
Impact No. 4						
R_1	.39	.38	.36	.33	.42	+12.5°C
R_2	.32	.22	.35	.34	.33	
I^2	.46	.45	.38	.32	.53	
Impact No. 5						
R_1	.42	.37	.30	.37	.49	+13°C
R_2	.33	.33	.33	.36	.41	
I^2	.53	.41	.29	.38	.58	
Impact No. 6						
R_1	.37	.28	.45	.60	.34	+13.5°C
R_2	.38	.20	.30	.28	.23	
I^2	.37	.38	.65	1.29	.49	

TABLE A-II-4 (Continued)

Tripod Unit 2

	A	B	C	D	E	Pavement Temperature
Impact No. 7						
R_1	.39	.31	.45	.64	.31	+13.5°C
R_2	.37	.32	.30	.34	.28	
I^2	.42	.30	.65	1.20	.36	
Impact No. 8						
R_1	.38	.18	.39	.32	.38	+13.5°C
R_2	.34	.21	.40	.33	.33	
I^2	.44	.16	.39	.33	.45	
Impact No. 9						
R_1	.57	.35	.34	.20	.54	+14°C
R_2	.40	.38	.35	.22	.34	
I^2	.77	.34	.33	.18	.83	
Impact No. 10						
R_1	.46	.20	.64	.37	.36	+14°C
R_2	.36	.25	.41	.40	.36	
I^2	.57	.17	.96	.34	.36	
Impact No. 11						
R_1	.56	.82	.19	.43	.42	+14.5°C
R_2	.38	.46	.27	.38	.42	
I^2	.84	1.46	.14	.49	.42	
Impact No. 12						
R_1	.59	.42	.43	.50	.53	+15°C
R_2	.38	.46	.33	.41	.38	
I^2	.88	.38	.55	.60	.73	

TABLE A-II-4 (Continued)

Tripod Unit 2

	A	B	C	D	E	Pavement Temperature
Impact No. 13						
R_1	.40	.36	.44	.24	.34	+15°C
R_2	.42	.38	.25	.28	.34	
I^2	.38	.35	.73	.21	.34	
Impact No. 14						
R_1	.60	.34	.47	.43	.48	+15.5°C
R_2	.27	.35	.38	.38	.44	
I^2	1.33	.34	.58	.49	.52	
Impact No. 15						
R_1	.39	.65	.50	.54	.51	+15.8°C
R_2	.34	.41	.35	.29	.42	
I^2	.45	1.00	.70	.98	.62	
Impact No. 16						
R_1	.30	.40	.22	.41	.39	+16°C
R_2	.36	.32	.19	.39	.33	
I^2	.25	.49	.26	.44	.46	
Impact No. 17						
R_1	.40	.28	.42	.46	.46	+16°C
R_2	.26	.38	.36	.31	.32	
I^2	.58	.22	.48	.66	.66	
Impact No. 18						
R_1	.43	.30	.44	.43	.32	+16°C
R_2	.32	.30	.34	.28	.37	
I^2	.57	.31	.56	.62	.28	

TABLE A-II-4 (Continued)

Tripod Unit 2

	A	B	C	D	E	Pavement Temperature
Impact No. 19						
R_1	.45	.40	.52	.38	.30	+16°C
R_2	.45	.38	.37	.36	.32	
I^2	.45	.43	.71	.40	.28	
Impact No. 20						
R_1	.39	.40	.43	.47	.38	+16.5°C
R_2	.25	.39	.33	.35	.47	
I^2	.58	.42	.54	.60	.33	

TABLE A-III-1

BENKELMAN BEAM DATA - PULLMAN AREA
REBOUND IN INCHES

Site	Position 1	2	3	4	5	6	7	8	9	10	Average
AR	.02425	.024	.020	.026	.0235	.020	.0205	.0268	.021	.0245	.0230
B_1R	.0159	.0083	.0135	.0114	.0085	.0110	.0077				.0109
B_2R	.0115	.0117	.0116	.0112							.0115
CR	.0440	.0480	.0352	.0567	.0610	.0750					.0533
DR	.0555	.0470									.0513
ER	.0490	.0520	.0870	.0426	.0420						.0545
FR	.0282	.0256	.0290	.0240	.0247						.0263
GR	.0377	.0437	.0384	.0390	.0440						.04056
HR	.0360	.0370	.0384	.0436	.0352						.03084
JR	.0030	.0030	.0034	.0035	.0039						.00336
KR	.0090	.0097	.0073	.0080	.0095						.0087
AL		.0209	.0231	.0203	.021	.0210	.0192	.0259	.0242	.0259	.0223
B_1L	.0195	.0180	.0135	.01625	.015	.0155	.0120				.0157
B_2L	.0120	.0120	.0140	.0120	.0125						.0125
CL	.0485	.0390	.030	.0960	.0630	.0540					.0551
DL	.0445	.0400									.4225
EL	.0725	.0825	.233	.0855	.0550						.1057
FL	.032	.029	.028	.031	.0278						.02956
GL	.040	.040	.044	.051	.051						.0452
HL	.036	.036	.036	.032	.032						.0344
JL	.0055	.004	.004	.0065	.0035						.0047
KL	.009	.009	.009	.009	.012						.0096

TABLE A-III-2

IMPULSE INDEX DATA - PULLMAN AREA

Unit 1									Average*
A1R x 4									
R_1	.46	.35	.30	.37	.36	.38	.57	.52	.414
R_2	.56	1.00	.53	.52	.80	.60	.80	.86	.177
I^2	.37	.73	.17	.27	.17	.25	.40	.32	1.040
A2L x 4									
R_1	.42	.36	.31	.31	.41	.34	.48	.31	.368
R_2	.77	.66	.70	.66	.65	.59	.67	.51	.163
I^2	.23	.20	.14	.15	.26	.20	.34	.20	.860
A2R x 4									
R_1	.42	.55	.51	.31	.30	.47	.48	.48	.440
R_2	.70	.80	.65	.52	.79	.76	.72	.78	.179
I^2	.26	.38	.36	.19	.12	.29	.31	.30	1.105
A3L x 4									
R_1	.31	.44	.24	.37	.31	.43	.30	.33	.341
R_2	.32	.26	.46	.84	.62	.68	.40	.36	.123
I^2	.30	.53	.13	.17	.16	.27	.23	.30	1.045
A3R x 4									
R_1	.44	.64	.43	.52	.38	.32	.45	.62	.475
R_2	.74	.90	.86	1.0	.58	.68	.77	.63	.193
I^2	.26	.45	.21	.27	.24	.15	.25	.59	1.210
A4L x 4									
R_1	.30	.38	.35	.47	.50	.52	.29	.39	.400
R_2	.66	.58	.42	.83	.90	.59	.60	.56	.161
I^2	.14	.25	.30	.27	.28	.46	.14	.27	1.055

*Note: The x4 gain position of the instrument increases the gain of channel 2 by a factor of 4. Hence, to normalize the data, the resulting R_2 reading must be divided by 4 and the Impulse Index multiplied by 4. This normalization has been performed only in the "average" readings in these tables.

TABLE A-III-2 (Continued)

Unit 1									Average
A4R x 4									
R_1	.36	.37	.34	.35	.42	.23	.38	.33	.348
R_2	.97	.40	.64	.89	.50	.42	.60	.42	.151
I^2	.14	.34	.19	.14	.34	.13	.23	.26	.885
A5L x 4									
R_1	.41	.48	.29	.30	.27	.35	.29	.46	.356
R_2	.49	.58	.47	.47	.54	.62	.39	.60	.130
I^2	.34	.40	.18	.20	.14	.20	.22	.36	1.020
A5R x 4									
R_1	.31	.33	.42	.37	.33	.24	.40	.33	.341
R_2	.33	.74	.42	.56	.62	.43	.40	.53	.126
I^2	.30	.15	.42	.25	.18	.14	.40	.22	1.030
A6L x 4									
R_1	.38	.50	.30	.58	.34	.34	.45	.33	.403
R_2	.55	.80	.48	.61	.42	.44	.74	.56	.144
I^2	.26	.31	.19	.54	.27	.25	.28	.20	1.150
A6R x 4									
R_1	.36	.34	.49	.34	.34	.38	.48	.54	.409
R_2	.42	.59	.48	.52	.40	.51	.62	1.08	.144
I^2	.31	.20	.49	.23	.28	.28	.36	.27	1.210
A7L x 4									
R_1	.43	.37	.46	.54	.43	.31	.41	.33	.410
R_2	.53	.47	.48	.76	.52	.31	.45	.58	.128
I^2	.35	.30	.43	.38	.35	.30	.30	.19	1.300

TABLE A-III-2 (Continued)

Unit 1									Average
A7R x 4									
R_1	.32	.29	.30	.38	.51	.50	.31	.50	.389
R_2	.47	.68	.42	.55	.62	.70	.45	.61	.141
I^2	.22	.13	.22	.26	.42	.35	.22	.41	1.115
A8L x 4									
R_1	.41	.28	.43	.43	.48	.41	.55	.35	.418
R_2	.51	.47	.98	.50	.52	.70	.67	.78	.160
I^2	.36	.17	.20	.37	.45	.24	.45	.16	1.200
A8R x 4									
R_1	.37	.41	.62	.34	.48	.36	.30	.34	.403
R_2	.59	.52	.85	.52	.81	.47	.48	.54	.149
I^2	.23	.33	.45	.24	.29	.28	.19	.22	1.115
A9L x 4									
R_1	.54	.36	.28	.34	.52	.47	.48	.41	.425
R_2	1.01	1.00	.63	.66	.70	.89	.68	.56	.192
I^2	.29	.13	.13	.18	.38	.25	.34	.29	.995
A9R x 4									
R_1	.30	.36	.36	.37	.39	.38	.38	.34	.360
R_2	.50	.55	.83	.68	.66	.43	.52	.54	.147
I^2	.20	.25	.16	.20	.23	.34	.28	.22	.940
A10L x 4									
R_1	.34	.30	.34	.35	.58	.53	.42	.46	.415
R_2	.69	.85	.58	.42	.76	.82	1.10	.80	.188
I^2	.17	.13	.21	.30	.45	.34	.16	.26	1.010

TABLE A-III-2 (Continued)

Unit 1									Average
A10R x 4									
R_1	.50	.33	.32	.28	.23	.30	.35	.37	.335
R_2	.58	.54	.36	.44	.52	.30	.62	.41	.118
I^2	.42	.21	.29	.19	.10	.30	.20	.34	1.025
B1L x 4									
R_1	.27	.33	.26	.24	.34	.39	.32	.32	.309
R_2	.82	.75	.40	.44	.44	.52	.44	.47	.134
I^2	.10	.15	.17	.13	.22	.30	.23	.18	.740
B1R x 4									
R_1	.21	.21	.24	.32	.27	.20	.30	.28	.254
R_2	.41	.46	.27	.51	.44	.30	.30	.38	.096
I^2	.11	.10	.21	.20	.16	.13	.30	.20	.705
B2L x 4									
R_1	.25	.27	.26	.46	.21	.22	.29	.36	.290
R_2	.72	.56	.50	.60	.53	.40	.32	.70	.135
I^2	.09	.13	.14	.35	.09	.13	.26	.19	.690
B2R x 4									
R_1	.19	.21	.22	.20	.23	.20	.28	.18	.214
R_2	.47	.35	.39	.37	.40	.28	.50	.28	.095
I^2	.08	.13	.12	.12	.14	.15	.16	.12	.510
B3L x 4									
R_1	.24	.16	.26	.17	.22	.16	.33	.30	.230
R_2	.60	.26	.34	.30	.29	.28	.45	.31	.088
I^2	.10	.11	.21	.10	.14	.10	.24	.30	.650

TABLE A-III-2 (Continued)

Unit 1

									Average
B3R x 4									
R_1	.20	.30	.25	.20	.14	.17	.23	.20	.211
R_2	.32	.64	.40	.32	.28	.28	.34	.25	.088
I^2	.13	.14	.16	.14	.08	.10	.17	.16	.540
B4L x 4									
R_1	.28	.25	.20	.18	.28	.28	.34	.20	.251
R_2	.57	.30	.40	.37	.44	.45	.41	.34	.103
I^2	.14	.21	.10	.10	.18	.18	.29	.13	.665
B4R x 4									
R_1	.21	.21	.14	.11	.06	.16	.17	.18	.155
R_2	.34	.40	.26	.32	.28	.34	.23	.32	.077
I^2	.14	.12	.08	.05	.10	.08	.13	.11	.405
B5L x 4									
R_1	.34	.26	.27	.20	.33	.23	.20	.22	.256
R_2	.44	.43	.40	.52	.52	.26	.36	.30	.101
I^2	.26	.16	.19	.08	.22	.21	.12	.16	.700
B5R x 4									
R_1	.20	.18	.28	.30	.18	.23	.22	.17	.220
R_2	.33	.38	.63	.44	.31	.48	.32	.43	.103
I^2	.13	.09	.13	.20	.10	.11	.16	.08	.500
B6L x 4									
R_1	.22	.21	.26	.33	.22	.25	.21	.28	.248
R_2	.24	.31	.40	.42	.27	.41	.32	.30	.083
I^2	.20	.15	.19	.46	.19	.16	.14	.25	.870

TABLE A-III-2 (Continued)

Unit 1

									Average
B6R x 4									
R_1	.29	.27	.29	.21	.26	.18	.30	.22	.253
R_2	.34	.49	.40	.24	.36	.27	.38	.23	.081
I^2	.24	.15	.22	.18	.20	.13	.23	.22	.785
B7L x 4									
R_1	.30	.21	.31	.28	.25	.19	.25	.20	.249
R_2	.41	.29	.42	.44	.42	.33	.43	.24	.093
I^2	.18	.16	.23	.29	.16	.11	.16	.17	.730
B7R x 4									
R_1	.33	.33	.22	.26	.30	.23	.23	.27	.271
R_2	.49	.43	.34	.32	.30	.30	.24	.43	.089
I^2	.23	.26	.15	.21	.29	.19	.23	.18	.870
B8L x 1									
R_1	.48				.48	.53	.51	.38	.476
R_2	.30				.33	.38	.40	.26	.334
I^2	.75				.68	.70	.62	.51	.652
B8R x 1									
R_1	.39	.53	.33	.40	.50	.46	.28	.26	.394
R_2	.22	.23	.18	.21	.20	.25	.15	.15	.199
I^2	.66	1.22	.58	.70	1.25	.82	.48	.44	.769
B9L x 1									
R_1	.40				.35	.43	.35	.44	.3940
R_2	.30				.20	.13	.20	.22	.210
I^2	.50				.62	1.42	.56	.83	.786

TABLE A-III-2 (Continued)

Unit 1									Average
B9R x 1									
R_1	.37	.30	.34	.32	.30	.38	.34	.42	.344
R_2	.22	.24	.14	.18	.14	.16	.11	.22	.176
I^2	.97	.39	.76	.52	.60	.86	.91	.78	.724
B10L x 1									
R_1	.75				.38	.34	.46	.50	.486
R_2	.26				.30	.12	.17	.24	.218
I^2	2.163				.47	.86	1.25	.94	1.136
B10R x 1									
R_1	.32	.25	.39	.27	.31	.36	.34	.38	.328
R_2	.20	.14	.11	.15	.25	.26	.26	.23	.200
I^2	.52	.45	1.38	.48	.39	.48	.64	.62	.620
B11L x 1									
R_1	.53	.44	.40	.36	.46	.54	.65	.56	.493
R_2	.24	.11	.13	.18	.21	.24	.32	.18	.201
I^2	1.17	1.76	1.23	.72	.92	1.22	1.32	1.74	1.260
B11R x 4									
R_1	.33	.28	.31	.31	.34	.26	.35	.41	.280
R_2	.67	.98	1.0	.44	.60	.60	.78	1.0	.190
I^2	.16	.08	.10	.22	.20	.11	.16	.16	.595
B12L x 4		x 1							
R_1	.41	.54	.30	.40	.33	.32	.62	.65	.446
R_2	(.20) .80	.46	.18	.14	.18	.17	.24	.22	.299
I^2	(.84) .21	.63	.50	.99	.61	.56	1.60	1.92	.956

TABLE A-III-2 (Continued)

Unit 1

									Average
C1L x 4									
R_1	.41	.34	.26	.34	.35	.30	.30	.55	.356
R_2	.50	.60	.56	.63	.50	.55	.49	.53	.136
I^2	.34	.20	.12	.20	.25	.17	.20	.56	1.020
C1R x 4									
R_1	.39	.34	.49	.36	.41	.50	.44	.30	.404
R_2	.59	.53	.38	.46	.54	.44	.40	.54	.121
I^2	.26	.22	.60	.28	.31	.54	.48	.18	1.435
C2L x 4									
R_1	.26	.28	.58	.46	.42	.32	.48	.27	.384
R_2	.36	.76	.40	.45	.46	.56	.32	.36	.115
I^2	.19	.10	.80	.47	.38	.18	.67	.21	1.500
C2R x 4									
R_1	.27	.41	.44	.28	.30	.32	.33	.56	.364
R_2	.41	.38	.42	.60	.43	.52	.46	.51	.117
I^2	.19	.44	.46	.14	.21	.21	.24	.59	1.240
C3L x 4									
R_1	.56	.38	.38	.55	.61	.48	.48	.47	.489
R_2	.61	.50	.37	.46	.50	.58	.49	.66	.130
I^2	.50	.29	.39	.65	.71	.40	.46	.33	1.865
C3R x 4									
R_1	.48	.46	.51	.40	.52	.42	.43	.48	.463
R_2	.51	.60	.51	.35	.52	.42	.51	.44	.121
I^2	.43	.34	.50	.45	.51	.42	.37	.52	1.770

TABLE A-III-2 (Continued)

Unit 1

									Average
C4L x 4									
R_1	.43	.48	.57	.40	.38	.40	.46	.58	.463
R_2	.34	.37	.38	.33	.32	.45	.30	.46	.092
I^2	.53	.61	.82	.43	.44	.35	.66	.70	2.310
C4R x 4									
R_1	.58	.40	.70	.32	.46	.38	.34	.32	.438
R_2	.22	.35	.25	.43	.50	.37	.30	.27	.084
I^2	1.53	.44	1.96	.24	.42	.38	.37	.36	2.85
C5L x 4									
R_1	.42	.50	.29	.44	.51	.45	.45	.43	.436
R_2	.33	.37	.35	.40	.28	.26	.28	.37	.083
I^2	.53	.64	.23	.46	.87	.74	.69	.48	2.32
C5R x 4									
R_1	.46	.39	.45	.46	.46	.47	.45	.50	.455
R_2	.35	.33	.35	.28	.28	.26	.26	.32	.076
I^2	.60	.45	.55	.72	.70	.79	.72	.76	2.645
C6L x 4									
R_1	.38	.48	.33	.35	.28	.54	.42	.42	.400
R_2	.41	.50	.27	.30	.32	.32	.38	.45	.092
I^2	.35	.46	.41	.41	.25	.84	.45	.38	1.775
C6R x 4									
R_1	.33	.45	.26	.52	.35	.30	.45	.27	.366
R_2	.39	.47	.43	.45	.41	.43	.46	.39	.107
I^2	.27	.42	.16	.57	.30	.21	.45	.20	1.290

TABLE A-III-2 (Continued)

Unit 1									Average
D1L x 4									
R_1	.38	.32	.40	.41	.23	.58	.36	.47	.394
R_2	.78	.65	.56	.56	.46	.40	.40	.52	.135
I^2	.19	.16	.28	.30	.12	.79	.32	.27	1.215
D1R x 4									
R_1	.50	.32	.48	.31	.42	.35	.42	.30	.388
R_2	.56	.34	.48	.46	.36	.32	.33	.39	.101
I^2	.43	.30	.48	.21	.46	.38	.51	.34	1.555
D2L x 4									
R_1	.28	.39	.33	.41	.28	.30	.42	.27	.335
R_2	.48	.42	.51	.37	.43	.28	.40	.46	.105
I^2	.17	.37	.22	.44	.20	.31	.43	.16	1.150
D2R x 4									
R_1	.39	.30	.35	.30	.32	.34	.30	.35	.325
R_2	.40	.52	.43	.40	.44	.48	.38	.56	.113
I^2	.37	.17	.29	.23	.24	.24	.25	.22	1.005
E1L x 4									
R_1	.47	.53	.56	.53	.40	.39	.64	.56	.510
R_2	.37	.30	.39	.35	.36	.46	.30	.24	.087
I^2	.57	.88	.75	.77	.44	.24	1.37	1.31	3.165
E1R x 4									
R_1	.61	.52	.63	.47	.52	.70	.57	.46	.560
R_2	.63	.38	.46	.50	.76	.52	.58	.69	.141
I^2	.57	.69	.83	.44	.36	.89	.56	.30	2.320

TABLE A-III-2 (Continued)

Unit 1									Average
E2L x 4									
R_1	.59	.44	.41	.40	.38	.62	.40	.46	.463
R_2	.47	.38	.31	.47	.54	.42	.72	.41	.116
I^2	.71	.49	.52	.34	.27	.86	.22	.49	1.950
E2R x 4									
R_1	.54	.84	.62	.56	.44	1.+	.48	.52	.625
R_2	.50	.42	.36	.48	.61	.50	.49	.54	.122
I^2	.70	1.68	.99	.64	.32	2.0	.45	.49	3.635
E3L x 4									
R_1	.26	.25	.43	.34	.27	.36	.30	.33	.318
R_2	.83	.58	.65	.54	.36	.70	.68	.94	.165
I^2	.09	.11	.29	.22	.20	.18	.13	.12	.670
E3R x 4									
R_1	.59	.93	.44	.65	.48	.55	.50	.16	.538
R_2	.20	.23	.26	.22	.54	.52	.25	.24	.077
I^2	1.74	3.76	.70	1.92	.42	.58	.90	.12	5.070
E4L x 4									
R_1	.37	.49	.46	.45	.27	.33	.35	.50	.403
R_2	.36	.48	.67	.43	.45	.34	.47	.35	.111
I^2	.37	.49	.20	.46	.17	.32	.26	.70	1.485
E4R x 4									
R_1	.35	.30	.37	.39	.26	.41	.34	.38	.350
R_2	.23	.38	.35	.30	.27	.23	.35	.42	.079
I^2	.54	.23	.40	.48	.24	.66	.33	.34	1.610

TABLE A-III-2 (Continued)

Unit 1

									Average
E5L x 4									
R_1	.39	.44	.46	.32	.38	.32	.36	.27	.368
R_2	.32	.41	.43	.79	.41	.42	.48	.31	.112
I^2	.47	.47	.49	.13	.36	.24	.27	.24	1.335
E5R x 4									
R_1	.25	.25	.30	.26	.39	.26	.37	.27	.294
R_2	.35	.29	.30	.36	.30	.23	.44	.40	.083
I^2	.20	.22	.30	.20	.50	.32	.25	.20	1.095
F1L x 1									
R_1	.54	.46	.38	.40	.36	.48	.50	.59	.46
R_2	.92	.36	.34	.44	.53	.32	.60	.51	.50
I^2	.33	.54	.43	.35	.25	.68	.40	.65	.45
F1R x 1									
R_1	.73	.16	.40	.46	.32	.30	.39	.41	.40
R_2	.50	.40	.36	.43	.19	.37	.24	.35	.36
I^2	.99	.07	.44	.49	.53	.25	.43	.45	.46
F2L x 1									
R_1	.36	.40	.28	.44	.52	.43	.37	.42	.09
R_2	.67	.27	.20	.37	.50	.46	.32	.57	.42
I^2	.20	.58	.39	.51	.54	.60	.56	.25	.45
F2R x 1									
R_1	.20	.42	.50	.37	.35	.41	.52	.51	.41
R_2	.43	.54	.63	.38	.27	.39	.31	.34	.41
I^2	.10	.32	.38	.36	.43	.42	.82	.74	.45

TABLE A-III-2 (Continued)

Unit 1

									Average
F3L x 1									
R_1	.20	.31	.47	.68	.41	.37	.32	.44	.40
R_2	.25	.30	.35	.37	.30	.38	.34	.33	.33
I^2	.16	.32	.61	1.25	.54	.36	.31	.56	.51
F3R x 1									
R_1	.32	.24	.50	.25	.44	.58	.37	.30	.38
R_2	.21	.20	.21	.27	.33	.54	.39	.24	.30
I^2	.49	.30	1.19	.24	.55	.61	.35	.37	.51
F4L x 1									
R_1	.44	.31	.57	.63	.37	.32	.40	.59	.45
R_2	.48	.27	.34	.32	.32	.33	.36	.41	.35
I^2	.40	.35	.92	1.24	.43	.31	.43	.83	.61
F4R x 1									
R_1	.44	.62	.40	.55	.34	.36	.31	.37	.42
R_2	.31	.27	.60	.32	.32	.58	.33	.37	.39
I^2	.61	1.42	.27	.90	.36	.23	.29	.37	.56
F5L x 1									
R_1	.36	.32	.41	.34	.46	.32	.51	.30	.38
R_2	.34	.50	.48	.48	.56	.58	.43	.20	.45
I^2	.38	.21	.35	.24	.38	.17	.58	.46	.35
F5R x 1									
R_1	.38	.43	.47	.60	.56	.33	.35	.54	.46
R_2	.45	.31	.42	.53	.48	.35	.51	.36	.43
I^2	.32	.57	.50	.66	.64	.31	.24	.76	.50

TABLE A-III-2 (Continued)

Unit 1									Average
G1L x 1									
R_1	.46	.33	.51	.39	.50	.40	.42	.37	.42
R_2	.20	.21	.30	.24	.30	.22	.37	.38	.28
I^2	.94	.49	.81	.60	.80	.60	.46	.36	.63
G1R x 1									
R_1	.27	.40	.26	.36	.41	.34	.30	.33	.33
R_2	.14	.20	.17	.20	.12	.30	.19	.22	.19
I_2	.50	.73	.39	.61	1.40	.37	.46	.49	.62
G2L x 1									
R_1	.54	.37	.36	.33	.34	.44	.38	.38	.39
R_2	.31	.42	.44	.34	.30	.24	.19	.32	.32
I^2	.86	.33	.30	.32	.40	.76	.73	.44	.52
G2R x 1									
R_1	.34	.49	.43	.28	.32	.33	.35	.31	.36
R_2	.20	.20	.21	.26	.13	.35	.12	.34	.21
I^2	.56	1.20	.82	.29	.71	.66	.91	.64	.72
G3L x 1									
R_1	.45	.35	.39	.39	.31	.40	.42	.36	.38
R_2	.33	.17	.20	.13	.14	.17	.27	.46	.23
I^2	.57	.66	.75	.99	.63	.82	.62	.29	.67
G3R x 1									
R_1	.43	.50	.52	.37	.38	.33	.28	.31	.39
R_2	.42	.62	.28	.23	.18	.26	.18	.24	.30
I^2	.43	.99	.90	.58	.72	.42	.42	.41	.61

TABLE A-III-2 (Continued)

Unit 1									Average
G4L x 1									
R_1	.34	.49	.50	.36	.26	.27	.42	.54	.40
R_2	.10	.12	.19	.26	.21	.20	.16	.18	.18
I^2	.98	2.00	1.32	.48	.34	.36	.99	1.62	1.01
G4R x 1									
R_1	.30	.34	.41	.36	.30	.40	.44	.41	.37
R_2	.18	.18	.18	.17	.18	.17	.20	.35	.20
I^2	.50	.60	.86	.71	.47	.85	.88	.46	.67
G5L x 1									
R_1	.41	.36	.32	.39	.38	.32	.34	.31	.35
R_2	.24	.20	.24	.25	.21	.27	.27	.32	.25
I^2	.68	.65	.41	.58	.67	.38	.41	.31	.51
G5R x 1									
R_1	.44	.40	.32	.40	.35	.36	.38	.44	.39
R_2	.16	.15	.21	.22	.16	.22	.16	.20	.19
I^2	1.0	.96	.47	.68	.69	.54	.82	.90	.76
H1L x 1									
R_1	.45	.35	.27	.33	.32	.36	.46	.47	.38
R_2	.24	.14	.13	.13	.20	.20	.23	.18	.18
I^2	.80	.76	.52	.77	.50	.60	.83	1.23	.75
H1R x 1									
R_1	.40	.38	.25	.32	.37	.40	.32	.34	.35
R_2	.17	.22	.13	.20	.16	.14	.20	.20	.18
I^2	.85	.63	.46	.48	.80	.98	.48	.55	.65

TABLE A-III-2 (Continued)

Unit 1									Average
H2L x 1									
R_1	.34	.45	.38	.46	.44	.43	.26	.36	.39
R_2	.14	.24	.18	.20	.16	.16	.12	.12	.17
I^2	.75	.80	.75	.97	1.21	1.16	.53	.94	.89
H2R x 1									
R_1	.50	.35	.36	.40	.40	.30	.33	.41	.38
R_2	.18	.10	.15	.14	.13	.13	.16	.19	.15
I^2	1.39	1.23	.82	1.14	1.23	.65	.63	.83	.99
H3L x 1									
R_1	.31	.37	.36	.38	.40	.38	.30	.40	.36
R_2	.15	.12	.15	.16	.13	.12	.18	.12	.02
I^2	.62	.97	.76	.83	1.23	1.20	.47	1.33	.93
H3R x 1									
R_1	.45	.30	.37	.24	.49	.40	.30	.34	.36
R_2	.13	.26	.14	.24	.19	.42	.11	.11	.20
I^2	1.56	.35	.88	.24	1.26	.38	.75	.90	.79
H4L x 1									
R_1	.40	.37	.47	.30	.45	.31	.31	.44	.38
R_2	.18	.14	.21	.17	.20	.20	.15	.14	.17
I^2	.80	.90	.96	.51	.91	.48	.61	1.38	.82
H4R x 1									
R_1	.26	.20	.24	.30	.24	.30	.18	.24	.25
R_2	.10	.06	.09	.08	.08	.10	.11	.09	.09
I^2	.65	.59	.58	.99	.64	.75	.29	.58	.63

TABLE A-III-2 (Continued)

Unit 1									Average
H5L x 1									
R_1	.58	.32	.34	.34	.32	.32	.31	.30	.35
R_2	.19	.14	.14	.18	.17	.16	.18	.13	.16
I^2	1.77	.68	.75	.58	.58	.61	.50	.61	.76
H5R x 1									
R_1	.26	.32	.28	.29	.28	.32	.34	.29	.30
R_2	.13	.12	.12	.15	.12	.15	.11	.11	.13
I^2	.47	.75	.60	.53	.59	.61	.88	.67	.64
J1L x 1									
R_1	.34	.36	.36	.58	.52	.55	.39	.33	.43
R_2	.33	.63	.53	.64	.26	.36	.45	.35	.44
I^2	.35	.21	.25	.52	.86	.80	.34	.31	.46
J1R x 1									
R_1	.58	.28	.46	.42	.51	.35	.27	.61	.44
R_2	.40	.50	.36	.57	.63	.34	.24	.47	.44
I^2	.79	.30	.56	.30	.42	.36	.31	.76	.48
J2L x 1									
R_1	.64	.51	.40	.50	.60	.43	.65	.72	.56
R_2	.91	.78	.36	.59	.52	.44	.86	.50	.62
I^2	.45	.33	.43	.43	.66	.43	.48	1.04	.53
J2R x 1									
R_1	.57	.40	.35	.40	.29	.42	.63	.54	.45
R_2	.46	.39	.38	.37	.37	.46	.33	.34	.39
I^2	.68	.42	.32	.43	.22	.38	1.20	.82	.32

TABLE A-III-2 (Continued)

Unit 1

									Average
J3L x 1									
R_1	.43	.77	.37	.59	.34	.56	.58	.54	.52
R_2	.70	.51	.24	.44	.20	.73	.79	.50	.51
I^2	.27	1.16	.56	.75	.55	.42	.43	.48	.58
J3R x 1									
R_1	.65	.58	.64	.38	.60	.64	.74	.55	.60
R_2	.54	.47	.32	.52	.64	.52	.75	.61	.55
I^2	.75	.70	1.28	.28	.55	.76	.73	.49	.69
J4L x 1									
R_1	.52	.58	.55	.67	.63	.69	.46	.53	.58
R_2	.48	.40	.43	.42	.48	.63	.38	.58	.48
I^2	.54	.80	.67	1.07	.78	.73	.54	.49	.70
J4R x 1									
R_1	.71	.66	.43	.52	.37	.42	.56	.39	.51
R_2	.57	.58	.38	.54	.45	.36	.37	.63	.49
I^2	.85	.72	.46	.48	.31	.46	.81	.25	.54
J5L x 1									
R_1	.72	.59	.58	.67	.52	.54	.35	.52	.56
R_2	.43	.39	.56	.47	.64	.46	.39	.46	.48
I^2	1.21	.83	.59	.91	.42	.61	.31	.57	.68
J5R x 1									
R_1	.32	.56	.51	.74	.70	.52	.18	.61	.52
R_2	.26	.59	.48	.56	.55	.52	.48	.46	.49
I^2	.39	.51	.53	.94	.84	.51	.08	.77	.57

TABLE A-III-2 (Continued)

Unit 1									Average
K1L x 4									
R_1	.25	.30	.27	.40	.25	.32	.26	.28	.29
R_2	.28	.34	.35	.50	.36	.42	.37	.34	.09
I^2	.22	.26	.21	.32	.18	.24	.19	.23	.93
K1R x 4									
R_1	.25	.23	.22	.22	.35	.26	.28	.23	.26
R_2	.30	.35	.24	.30	.37	.24	.29	.30	.08
I^2	.21	.16	.22	.16	.32	.27	.27	.17	.89
K2L x 4									
R_1	.30	.24	.26	.23	.43	.28	.30	.34	.30
R_2	.32	.26	.45	.40	.38	.29	.34	.27	.09
I^2	.42	.23	.16	.16	.48	.27	.26	.41	1.20
K2R x 4									
R_1	.42	.32	.37	.24	.32	.35	.34	.29	.33
R_2	.28	.37	.44	.50	.24	.42	.27	.27	.09
I^2	.45	.29	.31	.12	.42	.10	.41	.30	1.20
K3L x 4									
R_1	.18	.21	.26	.18	.21	.24	.24	.24	.22
R_2	.21	.22	.22	.20	.28	.21	.22	.22	.056
I^2	.17	.20	.20	.18	.16	.27	.28	.19	.83
K3R x 4									
R_1	.40	.34	.46	.29	.33	.25	.28	.40	.34
R_2	.29	.29	.27	.31	.25	.39	.21	.27	.071
I^2	.52	.39	.73	.26	.41	.16	.38	.57	1.71

TABLE A-III-2 (Continued)

Unit 1

									Average
K4L x 4									
R_1	.17	.21	.19	.16	.21	.29	.24	.24	.21
R_2	.22	.28	.21	.24	.30	.33	.27	.28	.067
I^2	.15	.16	.17	.12	.15	.25	.22	.22	.72
K4R x 4									
R_1	.18	.26	.19	.28	.24	.19	.26	.25	.23
R_2	.32	.24	.28	.26	.25	.48	.27	.33	.076
I^2	.11	.28	.13	.30	.23	.08	.24	.20	.79
K5L x 4									
R_1	.20	.24	.21	.23	.16	.24	.22	.24	.22
R_2	.26	.25	.32	.38	.36	.26	.23	.39	.077
I^2	.16	.23	.13	.15	.08	.23	.21	.15	.67
K5R x 4									
R_1	.30	.26	.25	.30	.33	.36	.27	.21	.29
R_2	.24	.24	.31	.35	.29	.28	.30	.35	.074
I^2	.38	.27	.21	.25	.37	.45	.25	.13	1.16

TABLE A-III-3

IMPULSE INDEX DATA -PULLMAN AREA

Unit 2

A1L x 4	0°	45°	90°	135°	180°	225°	270°	315°	Average*
R_1	.48	.40	.35	.31	.27	.19	.27	.30	.32
R_2	.64	.35	.69	.56	.53	.32	.48	.52	.128
I^2	.36	.43	.18	.18	.14	.11	.15	.16	.86
A1R x 4									
R_1	.50	.29	.31	.36	.38	.20	.32	.34	.34
R_2	.70	.76	.51	.48	.64	.37	.58	.51	.136
I^2	.35	.11	.19	.28	.22	.11	.17	.23	.83
A2L x 4									
R_1	.48	.44	.31	.39	.30	.44	.37	.40	.39
R_2	.71	.55	.44	.51	.63	.65	.54	.52	.142
I^2	.33	.35	.23	.30	.14	.28	.26	.30	1.10
A2R x 4									
R_1	.37	.32	.30	.27	.44	.46	.34	.35	.36
R_2	.60	.61	.75	.54	.72	.88	.68	.50	.165
I^2	.23	.17	.12	.14	.27	.24	.16	.25	.79
A3L x 4									
R_1	.36	.24	.32	.28	.30	.28	.32	.39	.31
R_2	.66	.54	.64	.74	.38	.54	.60	.59	.147
I^2	.20	.22	.16	.11	.23	.14	.17	.26	.75
A3R x 4									
R_1	.35	.36	.45	.28	.42	.41	.48	.31	.38
R_2	.60	.33	.74	.67	.56	.62	.48	.60	.144
I^2	.20	.38	.28	.12	.31	.28	.48	.16	1.11

*Note: The x4 gain position of the instrument increases the gain of channel 2 by a factor of 4. Hence, to normalize the data, the resulting R_2 reading must be divided by 4 and the Impulse Index multiplied by 4. This normalization has been performed only in the "average" readings in these tables.

TABLE A-III-3 (Continued)

Unit 2

									Average
A4L									
R_1	.35	.26	.34	.22	.30	.41	.35	.31	.32
R_2	.67	.45	.46	.69	.46	.70	.52	.53	.140
I^2	.18	.16	.26	.08	.20	.24	.24	.18	.77
A5L x 4									
R_1	.32	.30	.30	.26	.29	.38	.38	.31	.32
R_2	.73	.42	.59	.47	.46	.45	.53	.68	.133
I^2	.15	.20	.15	.15	.20	.32	.28	.16	.81
A5R x 4									
R_1	.39	.37	.28	.23	.33	.39	.36	.32	.33
R_2	.50	.42	.30	.46	.48	.39	.43	.66	.114
I^2	.32	.33	.27	.12	.23	.39	.29	.16	1.06
A6L x 4									
R_1	.30	.27	.30	.36	.22	.37	.26	.35	.30
R_2	.40	.40	.52	.42	.57	.75	.50	.66	.132
I^2	.23	.19	.17	.30	.08	.18	.14	.18	.74
A6R x 4									
R_1	.43	.32	.41	.36	.35	.32	.37	.40	.37
R_2	.78	.78	.52	.45	.45	.48	.35	.53	.136
I^2	.23	.14	.32	.28	.27	.21	.38	.30	1.07
A7L x 4									
R_1	.35	.30	.28	.30	.48	.31	.40	.33	.34
R_2	.49	.30	.47	.40	.54	.33	.60	.53	.114
I^2	.24	.30	.17	.23	.42	.29	.26	.20	1.06

TABLE A-III-3 (Continued)

Unit 2									Average
A7R x 4									
R_1	.31	.37	.32	.40	.35	.35	.45	.29	.36
R_2	.58	.74	.45	.53	.43	.43	.50	.61	.133
I^2	.17	.20	.23	.31	.30	.27	.39	.13	1.00
A8L x 4									
R_1	.34	.35	.32	.34	.34	.40	.27	.41	.35
R_2	.82	.50	.46	.59	.52	.48	.38	.52	.133
I^2	.18	.24	.23	.20	.23	.32	.13	.31	.92
A8R x 4									
R_1	.30	.33	.24	.38	.39	.26	.29	.32	.31
R_2	.53	.46	.30	.45	.52	.30	.47	.39	.107
I^2	.16	.23	.20	.31	.28	.22	.17	.26	.92
A9L x 4									
R_1	.32	.37	.26	.35	.38	.31	.30	.40	.34
R_2	.55	.70	.41	.66	.56	.59	.46	.45	.137
I^2	.18	.20	.18	.18	.25	.16	.18	.34	.84
A9R x 4									
R_1	.33	.27	.38	.36	.26	.32	.28	.30	.31
R_2	.53	.37	.67	.46	.35	.60	.33	.41	.116
I^2	.20	.20	.22	.29	.19	.17	.23	.21	.86
A10L x 4									
R_1	.36	.32	.36	.44	.45	.31	.39	.53	.40
R_2	.39	.60	.56	.53	.48	.47	.69	.70	.138
I^2	.32	.17	.23	.36	.42	.20	.22	.39	1.16

TABLE A-III-3 (Continued)

Unit 2

									Average
A10R x 4									
R_1	.41	.30	.35	.27	.32	.35	.29	.24	.32
R_2	.62	.47	.61	.38	.41	.59	.70	.20	.124
I^2	.26	.18	.19	.20	.24	.20	.12	.27	.83
B1L x 4									
R_1	.26	.32	.24	.23	.29	.33	.22	.28	.27
R_2	.56	.48	.35	.38	.56	.42	.44	.44	.113
I^2	.12	.21	.17	.13	.16	.25	.10	.18	.66
B1R x 4									
R_1	.24	.32	.25	.20	.27	.22	.30	.24	.26
R_2	.42	.56	.29	.23	.47	.51	.35	.32	.099
I^2	.14	.18	.21	.16	.14	.09	.24	.16	.66
B2L x 4									
R_1	.34	.19	.24	.20	.20	.22	.22	.24	.23
R_2	.40	.32	.45	.33	.50	.33	.33	.40	.096
I^2	.09	.09	.18	.14	.15	.23	.08	.08	.52
B3L x 4									
R_1	.23	.20	.13	.18	.17	.17	.27	.21	.20
R_2	.44	.41	.29	.31	.31	.46	.36	.40	.093
I^2	.12	.1	.06	.10	.10	.06	.20	.10	.42
B3R x 4									
R_1	.20	.20	.16	.21	.21	.20	.28	.23	.21
R_2	.25	.34	.34	.27	.30	.38	.25	.38	.078
I^2	.17	.11	.07	.16	.14	.10	.30	.14	.60

TABLE A-III-3 (Continued)

Unit 2

									Average
B4L x 4									
R_1	.23	.14	.19	.23	.28	.27	.24	.24	.24
R_2	.44	.35	.41	.44	.33	.43	.41	.47	.103
I^2	.12	.16	.08	.13	.23	.17	.14	.12	.58
B4R x 4									
R_1	.18	.24	.16	.14	.21	.20	.14	.17	.18
R_2	.31	.44	.35	.26	.42	.30	.23	.30	.082
I^2	.10	.13	.08	.08	.10	.12	.08	.10	.40
B5L x 4									
R_1	.29	.32	.21	.17	.25	.23	.15	.26	.24
R_2	.63	.37	.27	.40	.42	.42	.36	.44	.103
I^2	.14	.27	.17	.07	.13	.12	.06	.15	.56
B5R x 4									
R_1	.22	.18	.17	.21	.21	.18	.30	.20	.21
R_2	.28	.30	.27	.32	.50	.20	.43	.74	.095
I^2	.16	.10	.10	.13	.08	.16	.20	.05	.49
B6L x 4									
R_1	.26	.23	.20	.20	.26	.21	.20	.20	.22
R_2	.32	.31	.24	.28	.26	.46	.34	.30	.078
I^2	.21	.16	.16	.14	.26	.10	.11	.13	.64
B6R x 4									
R_1	.19	.16	.17	.24	.28	.22	.18	.18	.20
R_2	.34	.32	.38	.37	.36	.43	.32	.26	.087
I^2	.10	.08	.08	.16	.23	.11	.10	.11	.49

TABLE A-III-3 (Continued)

Unit 2									Average
B7L x 4									
R_1	.20	.25	.20	.18	.21	.17	.32	.24	.22
R_2	.35	.50	.24	.35	.46	.35	.38	.33	.093
I^2	.12	.13	.18	.09	.10	.08	.25	.17	.56
B7R x 4									
R_1	.24	.27	.21	.25	.26	.33	.25	.24	.26
R_2	.45	.39	.34	.31	.61	.43	.41	.48	.107
I^2	.12	.20	.14	.20	.11	.24	.15	.12	.64
B8L x 1									
R_1	.49				.46	.33	.58	.45	.462
R_2	.27				.22	.22	.26	.27	.248
I^2	.84				.91	.49	1.29	.73	.852
B8R x 1									
R_1	.24	.16	.26	.38	.33	.32	.30	.30	.29
R_2	.24	.20	.15	.14	.14	.14	.14	.22	.17
I^2	.24	.13	.41	.91	.70	.60	.52	.38	.49
B9L x 1									
R_1	.51				.28	.27	.35	.40	.362
R_2	.24				.20	.18	.20	.22	.208
I^2	1.08				.70	.37	.57	.64	.672
B9R x 1									
R_1	.40	.37	.33	.42	.29	.30	.28	.22	.33
R_2	.17	.14	.18	.20	.22	.16	.12	.15	.17
I^2	.84	.86	.55	.84	.36	.50	.54	.28	.60

TABLE A-III-3 (Continued)

Unit 2									Average
B10L x 1									
R_1	.47				.58	.35	.27	.30	.394
R_2	.30				.17	.21	.24	.25	.234
I^2	.72				1.98	.51	.30	.33	.768
B10R x 1									
R_1	.28	.27	.30	.33	.38	.23	.26	.34	.30
R_2	.14	.15	.15	.18	.19	.20	.22	.27	.19
I^2	.51	.44	.54	.55	.66	.25	.28	.42	.46
B11L x 1									
R_1	.37	.28	.18	.24	.25	.23	.45	.30	.29
R_2	.20	.19	.16	.24	.37	.22	.14	.21	.22
I^2	.64	.36	.18	.24	.17	.22	1.45	.40	.46
B11R x 1									
R_1	.36	.30	.26	.39	.18	.31	.33	.14	.28
R_2	.24	.21	.18	.12	.13	.09	.20	.11	.16
I^2	.48	.40	.36	1.27	.20	.88	.50	.15	.53
B12L x 1									
R_1	.30	.58	.44	.29	.41	.37	.31	.21	.36
R_2	.24	.21	.20	.16	.18	.23	.16	.15	.19
I^2	.34	1.60	.90	.46	.81	.55	.53	.25	.68
C1L x 4									
R_1	.32	.31	.31	.28	.33	.24	.23	.31	.26
R_2	.48	.57	.55	.60	.45	.40	.42	.50	.124
I^2	.21	.18	.14	.18	.12	.12	.23	.13	.66

TABLE A-III-3 (Continued)

Unit 2

									Average
C1R x 4									
R_1	.27	.34	.32	.35	.38	.32	.26	.27	.31
R_2	.56	.56	.52	.37	.52	.60	.46	.42	.125
I^2	.13	.20	.20	.32	.27	.17	.14	.17	.80
C2L x 4									
R_1	.23	.25	.23	.31	.36	.28	.32	.26	.28
R_2	.46	.32	.39	.56	.38	.37	.32	.42	.101
I^2	.11	.19	.13	.17	.32	.22	.32	.17	.82
C2R x 4									
R_1	.28	.26	.26	.43	.28	.32	.31	.31	.31
R_2	.45	.41	.30	.31	.48	.45	.38	.33	.097
I^2	.17	.17	.23	.56	.16	.23	.25	.29	1.03
C3L x 4									
R_1	.37	.63	.49	.42	.48	.48	.38	.44	.46
R_2	.48	.56	.58	.46	.48	.58	.66	.65	.139
I^2	.30	.66	.40	.38	.48	.38	.23	.30	1.57
C3R x 4									
R_1	.39	.36	.33	.36	.30	.33	.34	.40	.35
R_2	.49	.54	.35	.46	.37	.34	.47	.40	.107
I^2	.30	.24	.30	.28	.24	.32	.26	.40	1.17
C4L x 4									
R_1	.33	.43	.35	.45	.37	.41	.40	.40	.39
R_2	.33	.25	.25	.29	.28	.25	.43	.42	.078
I^2	.33	.70	.47	.65	.46	.61	.36	.36	1.97

TABLE A-III-3 (Continued)

Unit 2									Average
C4R x 4									
R_1	.38	.38	.32	.56	.22	.22	.50	.45	.38
R_2	.14	.20	.23	.22	.42	.30	.26	.24	.063
I^2	.95	.70	.42	1.43	.12	.15	.88	.76	2.71
C5L x 4									
R_1	.37	.44	.48	.36	.40	.27	.30	.40	.38
R_2	.40	.36	.46	.40	.40	.27	.33	.33	.092
I^2	.33	.50	.49	.32	.40	.27	.27	.45	1.52
C5R x 4									
R_1	.42	.40	.45	.43	.34	.51	.30	.32	.40
R_2	.38	.40	.30	.32	.34	.32	.26	.30	.081
I^2	.44	.40	.60	.53	.34	.78	.34	.34	1.89
C6L x 4									
R_1	.44	.35	.47	.35	.35	.35	.35	.42	.39
R_2	.29	.35	.33	.35	.35	.42	.36	.35	.088
I^2	.62	.35	.64	.35	.35	.28	.34	.48	1.71
C6R x 4									
R_1	.25	.30	.26	.34	.29	.44	.25	.23	130
R_2	.34	.30	.38	.36	.32	.40	.30	.40	.09
I^2	.18	.30	.18	.30	.25	.47	.21	.14	1.02
D1L x 4									
R_1	.37	.25	.30	.22	.34	.44	.26	.33	.31
R_2	.36	.44	.36	.40	.53	.52	.36	.30	.102
I^2	.36	.14	.24	.12	.22	.37	.19	.34	.937

TABLE A-III-3 (Continued)

Unit 2									Average
D1R x 4									
R_1	.42	.28	.39	.43	.28	.33	.27	.24	.330
R_2	.50	.44	.50	.40	.44	.30	.35	.26	.100
I^2	.34	.18	.30	.45	.18	.36	.21	.21	1.115
D2L x 4									
R_1	.29	.23	.19	.33	.20	.37	.31	.25	.271
R_2	.33	.35	.51	.41	.46	.43	.58	.48	.111
I^2	.24	.15	.06	.26	.09	.31	.16	.12	.695
D2R x 4									
R_1	.28	.29	.28	.33	.32	.35	.26	.30	.301
R_2	.56	.56	.52	.49	.40	.35	.30	.38	.111
I^2	.14	.15	.15	.22	.26	.35	.23	.24	.870
E1L x 4									
R_1	.43	.36	.35	.45	.33	.32	.45	.42	.389
R_2	.36	.35	.42	.35	.44	.36	.37	.27	.091
I^2	.48	.36	.28	.54	.25	.28	.52	.60	1.655
E1R x 4									
R_1	.35	.35	.53	.36	.36	.48	.46	.52	.426
R_2	.48	.48	.40	.43	.51	.52	.46	.38	.114
I^2	.25	.26	.66	.30	.26	.44	.46	.68	1.655
E2L x 4									
R_1	.38	.27	.31	.35	.32	.28	.38	.38	.334
R_2	.40	.23	.24	.34	.25	.35	.56	.44	.088
I^2	.35	.31	.38	.36	.38	.22	.25	.31	1.28

TABLE A-III-3 (Continued)

Unit 2

									Average
E2R x 4									
R_1	.30	.41	.36	.39	.41	.49	.55	.43	.418
R_2	.36	.34	.44	.39	.44	.50	.65	.65	.118
I^2	.25	.47	.29	.39	.38	.46	.45	.28	1.485
E3L x 4									
R_1	.30	.35	.32	.28	.35	.36	.40	.26	.328
R_2	.71	.46	.44	.35	.38	.37	.42	.42	.111
I^2	.13	.26	.23	.23	.31	.35	.38	.16	1.025
E3R x 4									
R_1	.37	.46	.42	.43	.56	.36	.36	.63	.415
R_2	.37	.23	.17	.08	.18	.30	.16	.18	.052
I^2	.37	.86	.90	2.31	1.742	.42	.72	2.205	4.764
E4L x 4									
R_1	.39	.38	.30	.30	.25	.30	.40	.29	.326
R_2	.30	.26	.27	.26	.30	.30	.27	.25	.069
I^2	.48	.52	.32	.32	.20	.30	.55	.32	1.505
E4R x 4									
R_1	.27	.31	.40	.39	.33	.30	.41	.29	.338
R_2	.27	.17	.20	.27	.25	.23	.20	.23	.057
I^2	.27	.50	.77	.52	.40	.36	.75	.34	1.955
E5L x 4									
R_1	.30	.30	.37	.24	.28	.37	.35	.29	.313
R_2	.30	.31	.28	.20	.32	.25	.24	.19	.065
I^2	.30	.29	.48	.25	.24	.52	.48	.39	1.475

TABLE A-III-3 (Continued)

Unit 2

									Average
E5R x 4									
R_1	.36	.23	.19	.29	.31	.25	.24	.23	.263
R_2	.17	.21	.26	.27	.34	.25	.22	.23	.061
I^2	.67	.25	.14	.30	.28	.25	.26	.23	1.190
F1L x 1									
R_1	.45	.22	.34	.25	.24	.56	.29	.30	.33
R_2	.21	.28	.20	.14	.28	.31	.36	.46	.28
I^2	.87	.17	.50	.36	.20	.90	.22	.18	.43
F1R x 1									
R_1	.35	.43	.28	.30	.24	.32	.15	.35	.30
R_2	.19	.30	.30	.37	.24	.23	.20	.30	.27
I^2	.61	.59	.25	.25	.24	.42	.10	.38	.36
F2L x 1									
R_1	.20	.31	.26	.31	.30	.31	.16	.30	.27
R_2	.16	.28	.32	.17	.25	.22	.22	.32	.24
I^2	.23	.33	.20	.51	.35	.40	.12	.27	.30
F2R x 1									
R_1	.27	.13	.14	.39	.29	.21	.20	.24	.23
R_2	.27	.18	.21	.30	.34	.19	.18	.28	.24
I^2	.27	.10	.09	.47	.24	.22	.21	.18	.22
F3L x 1									
R_1	.17	.22	.25	.24	.18	.15	.14	.28	.20
R_2	.22	.21	.24	.21	.29	.20	.16	.20	.22
I^2	.14	.22	.25	.26	.11	.11	.12	.36	.20

TABLE A-III-3 (Continued)

Unit 2									Average
F3R x 1									
R_1	.37	.30	.26	.33	.48	.28	.24	.23	.31
R_2	.33	.16	.21	.33	.24	.33	.38	.16	.27
I^2	.41	.51	.30	.33	.88	.23	.15	.30	.39
F4L x 1									
R_1	.25	.14	.19	.30	.15	.25	.38	.24	.24
R_2	.23	.19	.23	.31	.22	.25	.27	.16	.23
I^2	.26	.10	.15	.26	.10	.25	.50	.30	.24
F4R x 1									
R_1	.44	.32	.33	.45	.32	.26	.22	.46	.35
R_2	.30	.20	.33	.33	.35	.29	.11	.27	.27
I^2	.58	.44	.33	.56	.28	.22	.38	.71	.44
F5L x 1									
R_1	.27	.28	.27	.15	.20	.23	.29	.15	.23
R_2	.16	.23	.23	.18	.20	.30	.29	.12	.21
I^2	.37	.30	.30	.13	.20	.17	.29	.18	.24
F5R x 1									
R_1	.28	.41	.34	.43	.39	.42	.32	.41	.38
R_2	.25	.24	.38	.29	.25	.24	.32	.25	.28
I^2	.30	.62	.30	.60	.56	.65	.32	.62	.50
G1L x 1									
R_1	.26	.27	.28	.23	.24	.34	.40	.30	.29
R_2	.16	.12	.22	.14	.24	.17	.18	.16	.17
I^2	.36	.48	.31	.32	.24	.59	.76	.51	.45

TABLE A-III-3 (Continued)

Unit 2									Average
G1R x 1									
R_1	.33	.20	.27	.25	.39	.42	.37	.41	.33
R_2	.17	.29	.27	.18	.33	.26	.25	.20	.24
I^2	.56	.12	.47	.30	.42	.58	.51	.73	.46
G2L x 1									
R_1	.40	.47	.26	.42	.26	.47	.36	.37	.38
R_2	.18	.25	.16	.20	.25	.21	.23	.25	.22
I^2	.77	.80	.38	.83	.25	.93	.52	.50	.62
G2R x 1									
R_1	.37	.20	.31	.32	.24	.25	.34	.33	.30
R_2	.20	.11	.15	.15	.16	.19	.12	.18	.16
I^2	.62	.29	.57	.58	.30	.31	.81	.56	.51
G3L x 1									
R_1	.25	.25	.33	.38	.37	.31	.34	.24	.31
R_2	.13	.13	.16	.19	.10	.12	.29	.13	.16
I^2	.38	.41	.58	.67	1.37	.68	.38	.36	.60
G3R x 1									
R_1	.31	.32	.28	.34	.37	.29	.30	.26	.31
R_2	.18	.16	.14	.14	.15	.14	.12	.21	.14
I^2	.46	.57	.47	.70	.82	.47	.56	.28	.54
G4L x 1									
R_1	.35	.25	.30	.28	.36	.34	.36	.33	.32
R_2	.10	.10	.16	.15	.20	.23	.12	.20	.16
I^2	1.23	.46	.49	.45	.58	.48	.89	.50	.64

TABLE A-III-3 (Continued)

Unit 2									Average
G4R x 1									
R_1	.39	.26	.32	.33	.30	.42	.27	.39	.34
R_2	.18	.23	.18	.18	.16	.19	.13	.14	.17
I^2	.75	.28	.51	.53	.50	.84	.46	.94	.60
G5L x 1									
R_1	.50	.35	.30	.27	.28	.33	.34	.45	.35
R_2	.16	.17	.15	.13	.20	.17	.16	.20	.17
I^2	1.56	.65	.50	.48	.36	.56	.61	.90	.70
G5R x 1									
R_1	.31	.27	.30	.28	.29	.20	.28	.40	.29
R_2	.11	.15	.08	.11	.15	.10	.11	.10	.11
I^2	.68	.44	.91	.57	.50	.34	.56	1.60	.70
H1L x 1									
R_1	.25	.23	.25	.30	.18	.26	.20	.28	.24
R_2	.15	.10	.11	.13	.18	.15	.23	.17	.15
I^2	.35	.42	.46	.57	.18	.41	.16	.42	.37
H1R x 1									
R_1	.26	.23	.21	.15	.26	.37	.25	.35	.26
R_2	.12	.15	.18	.12	.15	.18	.14	.18	.15
I^2	.48	.34	.23	.18	.40	.66	.39	.60	.41
H2L x 1									
R_1	.29	.33	.30	.20	.12	.17	.15	.11	.21
R_2	.16	.16	.12	.13	.10	.15	.06	.07	.12
I^2	.44	.60	.64	.26	.12	.18	.28	.14	.33

TABLE A-III-3 (Continued)

Unit 2									Average
H2R x 1									
R_1	.30	.25	.27	.30	.31	.25	.28	.29	.28
R_2	.10	.13	.09	.12	.13	.22	.13	.12	.13
I^2	.73	.40	.67	.63	.62	.29	.52	.44	.54
H3L x 1									
R_1	.35	.23	.32	.33	.25	.28	.35	.21	.29
R_2	.08	.14	.14	.10	.12	.10	.08	.10	.11
I^2	1.53	.31	.61	.81	.44	.60	1.53	.35	.77
H3R x 1									
R_1	.28	.34	.25	.25	.26	.27	.28	.32	.28
R_2	.13	.12	.10	.17	.10	.10	.10	.15	.12
I^2	.48	.80	.47	.35	.62	.64	.67	.58	.58
H4L x 1									
R_1	.28	.15	.27	.11	.27	.23	.14	.20	.21
R_2	.15	.10	.14	.13	.14	.16	.10	.17	.14
I^2	.46	.24	.49	.10	.44	.30	.18	.23	.31
H4R x 1									
R_1	.18	.16	.17	.19	.21	.18	.20	.24	.19
R_2	.05	.08	.10	.10	.10	.08	.09	.10	.09
I^2	.43	.25	.23	.31	.40	.33	.35	.43	.34
H5L x 1									
R_1	.30	.24	.28	.25	.28	.12	.29	.13	.24
R_2	.15	.12	.13	.14	.13	.08	.17	.10	.13
I^2	.53	.38	.52	.39	.54	.16	.44	.14	.39

TABLE A-III-3 (Continued)

Unit 2									Average
H5R x 1									
R_1	.30	.30	.21	.32	.19	.24	.38	.19	.27
R_2	.13	.09	.10	.10	.09	.11	.12	.08	.10
I^2	.60	.82	.36	.76	.32	.44	.96	.34	.58
J1L x 1									
R_1	.17	.18	.24	.25	.25	.20	.16	.26	.21
R_2	.20	.30	.14	.24	.16	.11	.17	.30	.20
I^2	.13	.11	.35	.25	.36	.33	.14	.23	.24
J1R x 1									
R_1	.54	.40	.21	.28	.24	.30	.27	.47	.34
R_2	.43	.29	.27	.23	.26	.30	.20	.28	.28
I^2	.64	.52	.15	.30	.21	.30	.32	.73	.40
J2L x 1									
R_1	.29	.30	.33	.25	.34	.25	.28	.30	.29
R_2	.29	.34	.28	.23	.30	.19	.25	.23	.26
I^2	.29	.28	.37	.25	.38	.30	.29	.36	.32
J2R x 1									
R_1	.38	.18	.25	.31	.30	.32	.25	.43	.30
R_2	.32	.30	.28	.25	.25	.18	.17	.45	.28
I^2	.43	.11	.24	.37	.33	.52	.34	.39	.34
J3L x 1									
R_1	.16	.23	.20	.15	.21	.42	.16	.11	.21
R_2	.30	.39	.18	.24	.17	.37	.21	.11	.25
I^2	.09	.13	.22	.10	.24	.45	.12	.11	.18

TABLE A-III-3 (Continued)

Unit 2									Average
J3R x 1									
R_1	.42	.46	.51	.19	.21	.20	.27	.18	.31
R_2	.34	.41	.43	.28	.27	.20	.23	.23	.30
I^2	.49	.48	.57	.13	.16	.20	.31	.14	.31
J4L x 1									
R_1	.15	.14	.32	.38	.31	.20	.53	.18	.28
R_2	.23	.21	.25	.32	.20	.20	.68	.18	.28
I^2	.10	.09	.38	.42	.42	.20	.41	.18	.28
J4R x 1									
R_1	.26	.43	.40	.36	.40	.16	.21	.17	.30
R_2	.30	.46	.37	.44	.31	.23	.22	.26	.32
I^2	.23	.38	.42	.28	.46	.10	.19	.12	.27
J5L x 1									
R_1	.23	.24	.21	.24	.17	.20	.19	.51	.25
R_2	.28	.28	.28	.26	.31	.13	.28	.60	.30
I^2	.18	.20	.15	.21	.09	.28	.13	.42	.21
J5R x 1									
R_1	.28	.24	.19	.24	.22	.60	.53	.25	.32
R_2	.26	.24	.33	.30	.28	.48	.50	.24	.33
I^2	.30	.24	.10	.18	.17	.69	.54	.26	.31
K1L x 4									
R_1	.32	.34	.31	.24	.27	.25	.40	.34	.31
R_2	.43	.28	.27	.24	.27	.33	.32	.30	.08
I^2	.25	.38	.35	.24	.27	.18	.46	.36	1.25

TABLE A-III-3 (Continued)

Unit 2									Average
K1R x 4									
R_1	.22	.16	.18	.20	.19	.25	.22	.18	.20
R_2	.33	.26	.25	.15	.25	.11	.27	.16	.06
I^2	.15	.10	.14	.27	.14	.28	.18	.19	.73
K2L x 4									
R_1	.24	.22	.15	.23	.26	.17	.22	.25	.22
R_2	.20	.20	.22	.25	.23	.32	.26	.22	.06
I^2	.30	.24	.10	.21	.28	.08	.18	.27	.83
K2R x 4									
R_1	.31	.24	.26	.21	.21	.23	.24	.27	.25
R_2	.20	.31	.37	.21	.21	.20	.17	.23	.06
I^2	.45	.18	.18	.21	.21	.24	.30	.28	1.03
K3L x 4									
R_1	.15	.18	.20	.21	.15	.11	.20	.17	.17
R_2	.20	.25	.26	.24	.19	.21	.25	.17	.06
I^2	.11	.13	.15	.19	.10	.05	.15	.17	.53
K3R x 4									
R_1	.22	.18	.16	.17	.20	.15	.17	.25	.19
R_2	.27	.24	.17	.20	.27	.22	.20	.28	.06
I^2	.18	.13	.13	.15	.13	.10	.13	.22	.59
K4L x 4									
R_1	.13	.20	.13	.25	.13	.14	.15	.16	.16
R_2	.18	.15	.15	.22	.19	.13	.19	.16	.04
I^2	.10	.24	.11	.28	.09	.14	.12	.16	.62

TABLE A-III-3 (Continued)

Unit 2									Average
K4R x 4									
R_1	.22	.19	.16	.22	.21	.18	.20	.17	.19
R_2	.19	.24	.25	.17	.17	.43	.26	.20	.06
I^2	.23	.15	.10	.25	.24	.07	.15	.14	.67
K5L x 4									
R_1	.10	.12	.10	.17	.12	.10	.11	.18	.13
R_2	.15	.18	.16	.20	.16	.10	.20	.40	.05
I^2	.07	.08	.07	.13	.08	.10	.05	.08	.33
K5R x 4									
R_1	.18	.15	.18	.15	.16	.21	.19	.26	.19
R_2	.24	.19	.18	.15	.16	.23	.23	.34	.05
I^2	.14	.11	.18	.15	.16	.19	.14	.19	.63

TABLE A-III-4

BENKELMAN BEAM DATA - DISTRICT 1
MAXIMUM DEFLECTION IN INCHES

Site	Position 1	2	3	4	5	6	7	8	9	Average
1	.014	.013	.011	.009	.011	.010	.013	.012	.010	.0114
3	.009	.012	.012	.013	.012	.015	.014	.011	.016	.0127
4	.005	.005	.005	.004	.005	.007	.005	.005	.005	.0051
6	.020	.014	.012	.011	.014	.017	.016	.013	.016	.0148
7	.013	.014	.013	.011	.012	.010	.011	.011	.009	.0116
8	.027	.027	.026	.005	.015	.018	.018	.015	.017	.0187
9	.016	.010	.008	.008	.007	.008	.012	.012	.011	.0111
10	.019	.017	.019	.020	.017	.017	.018	.017	.017	.0179
11	.008	.007	.008	.009	.010	.008	.008	.007	.008	.0081

TABLE A-III-5

IMPULSE INDEX DATA - DISTRICT 1 - TRIPOD INTERFACE

Unit 2 - Site 1

	0°	45°	90°	135°	180°	225°	270°	315°	Average
Position 1 x 4									
R_1	.34	.21	.30	.42	.48	.33	.31	.33	
R_2	.58	.63	.68	.49	.45	.53	.84	.60	
I^2	.21	.16	.14	.35	.50	.22	.12	.18	.24
Position 2 x 4									
R_1	.57	.42	.31	.35	.27	.43	.32	.34	
R_2	.86	.87	.74	.76	.94	.71	.85	.74	
I^2	.39	.22	.14	.16	.08	.26	.13	.16	.19
Position 3 x 4									
R_1	.24	.29	.23	.35	.25	.33	.22	.25	
R_2	.61	.89	.99	>1	.80	.72	.71	.54	
I^2	.10	.10	.06		.08	.16	.07	.13	.10
Position 4 x 4									
R_1	.17	.33	.58	.22	.43	.32	.35	.31	
R_2	.57	.79	>1	.70	.51	.70	.60	.50	
I^2	.06	.15		.08	.36	.16	.22	.20	.176
Position 5 x 4									
R_1	.28	.34	.30	.19	.42	.24	.28	.25	
R_2	.41	.32	.96	.79	.84	.76	.60	.50	
I^2	.20	.36	.10	.05	.04	.08	.14	.14	.14
Position 6 x 4									
R_1	.28	.29	.26	.17	.23	.27	.36	.21	
R_2	.74	>1	.69	.88	.71	.48	.92	.58	
I^2	.11		.11	.04	.08	.08	.15	.08	.0925

TABLE A-III-5 (Continued)

Unit 2 - Site 1

Position 7 x 4

									Average
R_1	.36	.24	.44	.34	.34	.18	.17	.23	
R_2	.53	.59	.76	.44	.53	.68	.68	.55	
I^2	.26	.10	.22	.25	.23	.05	.05	.10	.16

Position 8 x 4

R_1	.34	.29	.33	.27	.23	.52	.21	.42	
R_2	.60	.63	.96	.57	.87	.84	.52	.60	
I^2	.20	.14	.12	.13	.06	.33	.09	.30	.17

Position 9 x 4

R_1	.43	.39	.37	.36	.33	.38	.41	.16	
R_2	.75	.73	.80	.88	.97	>1	>1	.54	
I^2	.25	.22	.18	.16	.12			.05	.163

TABLE A-III-5 (Continued)

Unit 2 - Site 4

									Average
Position 1 x 1									
R_1	.17	.11	.16	.27	.13	.16	.15	.19	
R_2	.10	.13	.20	.18	.07	.12	.11	.10	
I^2	.27	.09	.12	.37	.21	.20	.18	.30	.22
Position 2 x 1									
R_1	.23	.22	.18	.19	.11	.19	.19	.14	
R_2	.09	.11	.21	.11	.11	.12	.12	.14	
I^2	.47	.35	.16	.30	.11	.28	.28	.14	.26
Position 3 x 1									
R_1	.17	.15	.17	.21	.11	.10	.17	.14	
R_2	.16	.17	.15	.14	.12	.11	.15	.13	
I^2	.18	.13	.18	.30	.10	.09	.18	.15	.16
Position 4 x 1									
R_1	.32	.17	.18	.28	.16	.17	.18	.17	
R_2	.11	.10	.12	.13	.11	.17	.15	.13	
I^2	.85	.26	.25	.53	.20	.17	.22	.20	.33
Position 5 x 1									
R_1	.16	.20	.14	.24	.21	.10	.16	.12	
R_2	.12	.27	.11	.18	.14	.10	.09	.18	
I^2	.22	.26	.18	.30	.29	.10	.26	.08	.21
Position 6 x 1									
R_1	.12	.23	.20	.10	.08	.16	.15	.06	
R_2	.14	.26	.10	.14	.07	.06	.15	.09	
I^2	.10	.20	.33	.07	.09	.34	.15	.24	.19

TABLE A-III-5 (Continued)

Unit 2 - Site 4

									Average
Position 7 x 1									
R_1	.11	.33	.22	.16	.27	.16	.15	.13	
R_2	.08	.15	.12	.12	.10	.19	.14	.10	
I^2	.14	.66	.36	.20	.62	.13	.15	.15	.30
Position 8 x 1									
R_1	.17	.22	.20	.18	.10	.18	.17	.21	
R_2	.11	.19	.10	.10	.10	.16	.10	.17	
I^2	.22	.25	.35	.30	.10	.21	.26	.24	.24
Position 9 x 1									
R_1	.10	.27	.22	.13	.26	.07	.19	.11	
R_2	.16	.20	.18	.12	.11	.08	.19	.10	
I^2	.06	.33	.27	.13	.51	.05	.19	.13	.21

TABLE A-III-5 (Continued)

Unit 2 - Site 3

									Average
Position 1 x 1									
R_1	.10	.21	.37	.13	.24	.21	.14	.19	
R_2	.13	.17	.22	.15	.10	.11	.15	.14	
I^2	.08	.26	.57	.12	.50	.35	.13	.25	.28
Position 2 x 1									
R_1	.13	.23	.28	.12	.17	.37	.28	.15	
R_2	.14	.18	.25	.25	.21	.20	.32	.17	
I^2	.11	.29	.31	.06	.14	.64	.26	.13	.24
Position 3 x 1									
R_1	.18	.34	.24	.28	.12	.17	.24	.46	
R_2	.20	.29	.21	.30	.20	.11	.21	.26	
I^2	.16	.39	.26	.26	.08	.24	.28	.75	.30
Position 4 x 1									
R_1	.40	.30	.29	.22	.23	.18	.28	.15	
R_2	.20	.40	.31	.16	.20	.24	.30	.15	
I^2	.74	.23	.27	.27	.24	.14	.27	.15	.29
Position 5 x 1									
R_1	.22	.15	.12	.14	.13	.16	.36	.16	
R_2	.30	.19	.21	.32	.17	.20	.20	.24	
I^2	.17	.12	.07	.06	.10	.12	.63	.10	.17
Position 6 x 1									
R_1	.32	.29	.32	.15	.19	.31	.15	.52	
R_2	.22	.31	.18	.19	.27	.24	.20	.29	
I^2	.44	.27	.53	.25	.10	.40	.12	.92	.38

TABLE A-III-5 (Continued)

Unit 2 - Site 3

									Average
Position 7 x 1									
R_1	.26	.17	.29	.17	.22	.37	.36	.18	
R_2	.26	.17	.31	.16	.30	.24	.31	.25	
I^2	.26	.17	.28	.19	.17	.54	.41	.12	.27
Position 8 x 1									
R_1	.19	.21	.15	.42	.11	.10	.14	.20	
R_2	.22	.18	.27	.45	.18	.14	.16	.28	
I^2	.16	.24	.08	.38	.07	.08	.11	.14	.16
Position 9 x 1									
R_1	.36	.25	.40	.50	.27	.37	.28	.20	
R_2	.04	.02	.30	.20	.34	.25	.42	.05	
I^2	3.24	3.12	.50	1.25	.23	.51	.20	.54	1.2

TABLE A-III-5 (Continued)

Unit 2 - Site 6

									Average
Position 1 x 1									
R_1	.25	.34	.28	.32	.36	.23	.33	.36	
R_2	.28	.12	.35	.24	.27	.19	.07	.19	
I^2	.22	.80	.23	.42	.47	.26	1.6	.62	.40
Position 2 x 1									
R_1	.32	.30	.26	.30	.30	.32	.30	.17	
R_2	.32	.22	.24	.29	.29	.21	.18	.20	
I^2	.32	.40	.28	.31	.32	.45	.47	.14	.34
Position 3 x 1									
R_1	.17	.26	.29	.21	.26	.38	.35	.28	
R_2	.18	.16	.27	.16	.22	.32	.23	.26	
I^2	.16	.38	.30	.26	.30	.46	.51	.30	.33
Position 4 x 1									
R_1	.21	.19	.25	.28	.42	.23	.29	.35	
R_2	.18	.16	.19	.18	.38	.30	.28	.26	
I^2	.23	.23	.30	.41	.46	.18	.30	.47	.32
Position 5 x 1									
R_1	.14	.34	.25	.26	.34	.31	.35	.25	
R_2	.17	.15	.19	.21	.22	.14	.15	.14	
I^2	.12	.66	.32	.30	.48	.58	.70	.40	.45
Position 6 x 1									
R_1	.36	.30	.33	.39	.36	.40	.27	.24	
R_2	.27	.27	.26	.23	.30	.25	.23	.24	
I^2	.47	.33	.42	.35	.44	.60	.32	.24	.40

TABLE A-III-5 (Continued)

<u>Unit 2</u> - Site 6

									Average
Position 7 x 1									
R_1	.31	.15	.27	.33	.32	.40	.34	.31	
R_2	.23	.15	.30	.16	.12	.25	.16	.20	
I^2	.40	.15	.25	.60	.70	.60	.64	.46	.48
Position 8 x 1									
R_1	.32	.32	.35	.41	.34	.28	.37	.23	
R_2	.17	.23	.24	.25	.23	.16	.23	.28	
I^2	.57	.43	.47	.65	.48	.44	.56	.20	.48
Position 9 x 1									
R_1	.32	.31	.24	.34	.33	.29	.31	.27	
R_2	.20	.27	.27	.25	.30	.15	.25	.23	
I^2	.47	.35	.23	.45	.35	.52	.38	.31	.38

TABLE A-III-5 (Continued)

Unit 2 - Site 7

									Average
Position 1 x 1									
R_1	.36	.37	.35	.36	.32	.30	.34	.43	
R_2	.08	.17	.09	.10	.13	.18	.08	.10	
I^2	1.62	.73	1.36	1.29	.66	.45	1.44	1.84	1.17
Position 2 x 1									
R_1	.42	.22	.24	.26	.29	.27	.25	.24	
R_2	.18	.17	.16	.10	.20	.20	.11	.10	
I^2	.86	.26	.34	.58	.40	.36	.49	.46	.47
Position 3 x 1									
R_1	.37	.32	.23	.22	.38	.31	.34	.27	
R_2	.17	.08	.14	.12	.14	.14	.12	.08	
I^2	.71	.94	.33	.74	.94	.65	.85	.72	.74
Position 4 x 1									
R_1	.37	.57	.33	.33	.38	.30	.32	.26	
R_2	.22	.16	.18	.15	.20	.21	.13	.22	
I^2	.57	2.03	.54	.62	.68	.41	.67	.30	.73
Position 5 x 1									
R_1	.23	.23	.22	.25	.46	.17	.28	.28	
R_2	.18	.16	.13	.16	.21	.07	.10	.15	
I^2	.27	.30	.34	.35	.97	.32	.67	.50	.47
Position 6 x 1									
R_1	.36	.27	.20	.23	.28	.35	.42	.31	
R_2	.17	.11	.13	.16	.14	.21	.10	.12	
I^2	.70	.60	.29	.30	.50	.55	1.76	.74	.68

TABLE A-III-5 (Continued)

Unit 2 - Site 7

Position 7 x 1

									Average
R_1	.37	.39	.21	.31	.29	.31	.44	.31	
R_2	.17	.13	.14	.11	.12	.14	.18	.10	
I^2	.74	1.17	.29	.75	.60	.60	.94	.86	.74

Position 8 x 1

R_1	.32	.27	.44	.38	.27	.39	.38	.36	
R_2	.16	.09	.13	.13	.10	.19	.13	.16	
I^2	.58	.66	1.49	1.11	.60	.72	.97	.74	.86

Position 9 x 1

R_1	.42	.33	.38	.40	.33	.35	.36	.30	
R_2	.16	.18	.11	.08	.12	.13	.14	.20	
I^2	.96	.55	1.31	2.00	.77	.80	.82	.41	.95

TABLE A-III-5 (Continued)

Unit 2 - Site 8

Position 1 x 1									Average
R_1	.34	.35	.15	.32	.41	.23	.22	.30	
R_2	.13	.13	.09	.10	.14	.20	.20	.24	
I^2	.77	.81	.22	.90	1.18	.25	.24	.36	.59
Position 2 x 1									
R_1	.42	.33	.24	.36	.26	.28	.40	.35	
R_2	.16	.12	.11	.13	.11	.14	.22	.19	
I^2	1.00	.76	.45	.85	.52	.50	.64	.60	.67
Position 3 x 1									
R_1	.30	.42	.17	.23	.31	.44	.35	.39	
R_2	.14	.17	.10	.13	.13	.20	.19	.22	
I^2	.55	.92	.26	.35	.63	.86	.57	.64	.60
Position 4 x 1									
R_1	.36	.48	.23	.25	.40	.38	.43	.40	
R_2	.23	.37	.12	.21	.22	.26	.26	.24	
I^2	.52	.59	.39	.30	.72	.53	.68	.62	.54
Position 5 x 1									
R_1	.29	.13	.34	.32	.24	.12	.39	.14	
R_2	.22	.22	.21	.14	.34	.16	.20	.17	
I^2	.36	.08	.49	.66	.18	.10	.67	.12	.33
Position 6 x 1									
R_1	.34	.24	.15	.12	.13	.27	.31	.20	
R_2	.25	.26	.16	.12	.18	.18	.18	.16	
I^2	.44	.23	.14	.12	.10	.36	.50	.24	.27

TABLE A-III-5 (Continued)

Unit 2 - Site 8

									Average
Position 7 x 1									
R_1	.13	.27	.29	.26	.14	.26	.28	.36	
R_2	.17	.17	.17	.20	.13	.24	.27	.30	
I^2	.10	.39	.44	.31	.15	.27	.28	.42	.29
Position 8 x 1									
R_1	.37	.36	.18	.32	.36	.36	.34	.16	
R_2	.27	.28	.16	.39	.26	.21	.24	.21	
I^2	.49	.46	.20	.27	.48	.55	.45	.13	.38
Position 9 x 1									
R_1	.23	.35	.36	.29	.37	.37	.29	.48	
R_2	.17	.18	.23	.16	.24	.25	.25	.22	
I^2	.30	.58	.52	.45	.52	.52	.31	.95	.52

TABLE A-III-5 (Continued)

Unit 2 - Site 9

									Average
Position 1 x 1									
R_1	.48	.40	.20	.33	.29	.27	.31	.46	
R_2	.16	.13	.14	.12	.13	.19	.19	.20	
I^2	1.44	1.23	.28	.76	.56	.35	.46	.98	.72
Position 2 x 1									
R_1	.43	.55	.26	.43	.47	.44	.38	.28	
R_2	.13	.16	.14	.22	.12	.13	.23	.15	
I^2	1.42	1.89	.43	.81	1.84	1.49	.58	.47	1.12
Position 3 x 1									
R_1	.38	.19	.24	.34	.43	.33	.40	.36	
R_2	.18	.13	.20	.16	.18	.26	.14	.27	
I^2	.72	.27	.26	.68	.92	.40	.98	.46	.60
Position 4 x 1									
R_1	.47	.38	.30	.42	.17	.21	.45	.52	
R_2	.11	.14	.22	.20	.24	.13	.23	.18	
I^2	2.01	.88	.40	.80	.12	.31	.80	1.50	.85
Position 5 x 1									
R_1	.33	.71	.28	.35	.36	.41	.29	.30	
R_2	.11	.13	.10	.11	.14	.12	.08	.16	
I^2	.80	3.88	.65	.94	.84	1.40	.81	.50	1.23
Position 6 x 1									
R_1	.42	.23	.18	.24	.40	.36	.24	.20	
R_2	.13	.08	.09	.19	.23	.15	.14	.15	
I^2	1.35	.48	.31	.30	.68	.75	.38	.22	.56

TABLE A-III-5 (Continued)

Unit 2 - Site 9

									Average
Position 7 x 1									
R_1	.30	.38	.46	.28	.27	.27	.27	.30	
R_2	.15	.10	.11	.19	.21	.15	.18	.13	
I^2	.54	1.44	1.92	.39	.33	.44	.36	.57	.75
Position 8 x 1									
R_1	.63	.17	.33	.30	.24	.36	.26	.34	
R_2	.15	.08	.22	.16	.19	.16	.20	.17	
I^2	2.65	.27	.48	.51	.30	.72	.31	.61	.73
Position 9 x 1									
R_1	.35	.32	.47	.30	.32	.50	.31	.30	
R_2	.14	.20	.13	.14	.15	.14	.20	.17	
I^2	.76	.44	1.70	.53	.60	1.79	.44	.50	.85

TABLE A-III-5 (Continued)

Unit 2 - Site 10

									Average
Position 1 x 1									
R_1	.24	.27	.27	.28	.36	.22	.25	.25	
R_2	.10	.08	.08	.07	.07	.10	.10	.10	
I^2	.48	.73	.74	.89	1.85	.42	.56	.52	.77
Position 2 x 1									
R_1	.21	.43	.24	.23	.36	.31	.23	.28	
R_2	.12	.14	.06	.08	.13	.10	.10	.13	
I^2	.33	1.32	.63	.50	.93	.85	.45	.53	.69
Position 3 x 1									
R_1	.37	.23	.20	.26	.28	.30	.24	.27	
R_2	.11	.04	.08	.13	.18	.13	.12	.10	
I^2	.99	.82	.41	.49	.41	.50	.44	.62	.585
Position 4 x 1									
R_1	.43	.27	.41	.25	.35	.21	.19	.26	
R_2	.10	.10	.06	.09	.08	.06	.09	.10	
I^2	1.85	.59	2.8	.58	1.53	.56	.35	.82	1.14
Position 5 x 1									
R_1	.25	.27	.22	.33	.27	.27	.20	.26	
R_2	.15	.11	.07	.07	.10	.06	.06	.04	
I^2	.38	.55	.55	1.56	.62	.87	.50	1.69	.84
Position 6 x 4									
R_1	.33	.29	.24	.30	.41	.25	.26	.20	
R_2	.36	.66	.37	.69	.46	.26	.32	.34	
I^2	.30	.13	.16	.14	.37	.25	.21	.11	.835

TABLE A-III-5 (Continued)

Unit 2 - Site 10

									Average
Position 7 x 4									
R_1	.24	.24	.20	.21	.21	.22	.21	.27	
R_2	.25	.40	.28	.17	.24	.27	.18	.30	
I^2	.23	.15	.15	.25	.19	.18	.24	.24	.815
Position 8 x 4									
R_1	.28	.21	.25	.24	.30	.21	.20	.22	
R_2	.41	.33	.31	.23	.30	.38	.38	.18	
I^2	.19	.13	.20	.25	.30	.12	.11	.26	.78
Position 9 x 4									
R_1	.25	.23	.26	.40	.26	.27	.31	.29	
R_2	.42	.23	.22	.24	.31	.25	.37	.31	
I^2	.16	.23	.31	.60	.23	.28	.26	.27	1.17

TABLE A-III-5 (Continued)

Unit 2 - Site 11

									Average
Position 1 x 4									
R_1	.12	.15	.18	.13	.22	.11	.09	.11	
R_2	.36	.35	.23	.14	.29	.16	.18	.20	
I^2	.03	.06	.15	.11	.17	.08	.04	.06	.36
Position 2 x 4									
R_1	.17	.11	.14	.15	.16	.13	.15	.10	
R_2	.16	.10	.16	.16	.11	.15	.13	.10	
I^2	.19	.11	.11	.14	.19	.11	.16	.10	.56
Position 3 x 4									
R_1	.17	.17	.16	.10	.16	.17	.14	.13	
R_2	.15	.10	.12	.13	.15	.19	.18	.13	
I^2	.19	.23	.18	.08	.15	.15	.10	.13	.605
Position 4 x 4									
R_1	.15	.10	.10	.20	.12	.12	.12	.13	
R_2	.14	.13	.13	.19	.16	.18	.21	.13	
I^2	.16	.07	.08	.21	.08	.08	.06	.13	.435
Position 5 x 4									
R_1	.18	.12	.22	.16	.15	.13	.11	.14	
R_2	.18	.14	.23	.17	.28	.22	.21	.18	
I^2	.17	.10	.22	.16	.08	.08	.07	.10	.49
Position 6 x 4									
R_1	.17	.15	.17	.17	.18	.12	.15	.17	
R_2	.18	.13	.15	.18	.21	.16	.15	.19	
I^2	.17	.16	.20	.16	.15	.09	.15	.16	.62

TABLE A-III-5 (Continued)

Unit 2 - Site 11

									Average
Position 7 x 4									
R_1	.14	.12	.12	.19	.15	.13	.14	.12	
R_2	.18	.16	.18	.22	.22	.15	.24	.14	
I^2	.11	.09	.09	.17	.11	.11	.08	.10	.43
Position 8 x 4									
R_1	.14	.11	.10	.07	.15	.17	.14	.16	
R_2	.18	.21	.14	.17	.16	.17	.21	.24	
I^2	.11	.06	.08	.04	.15	.17	.16	.11	.41
Position 9 x 4									
R_1	.15	.15	.11	.14	.16	.13	.17	.11	
R_2	.16	.19	.14	.14	.25	.19	.18	.37	
I^2	.14	.11	.08	.14	.11	.09	.16	.04	.435

TABLE A-III-6

IMPULSE INDEX DATA - DISTRICT 1 - HYDROSTATIC INTERFACE

Hydrostatic Unit 1 - Site 1

	0°	45°	90°	135°	180°	225°	270°	315°	Average
Position 1									
R_1	.48	.33	.33	.33	.44	.38	.34	.43	
R_2	.26	.16	.22	.24	.24	.31	.22	.27	
I^2	.84	.63	.50	.45	.74	.45	.50	.63	.5925
Position 2									
R_1	.32	.27	.25	.33	.20	.23	.22	.32	
R_2	.19	.18	.30	.30	.14	.16	.18	.20	
I^2	.51	.40	.22	.35	.28	.33	.26	.48	.3538
Position 3									
R_1	.27	.27	.27	.19	.24	.26	.25	.20	
R_2	.22	.17	.14	.16	.19	.18	.19	.13	
I^2	.36	.41	.50	.23	.31	.37	.33	.31	.3525
Position 4									
R_1	.19	.25	.21	.24	.25	.21	.21	.21	
R_2	.12	.17	.19	.17	.14	.20	.17	.19	
I^2	.33	.38	.24	.34	.43	.23	.27	.22	.3050
Position 5									
R_1	.37	.34	.36	.35	.29	.33	.37	.29	
R_2	.26	.21	.40	.22	.20	.22	.20	.22	
I^2	.50	.55	.32	.56	.42	.51	.67	.37	.4875
Position 6									
R_1	.19	.25	.25	.25	.25	.23	.23	.21	
R_2	.19	.20	.20	.22	.15	.20	.23	.22	
I^2	.19	.31	.30	.27	.40	.27	.23	.20	.2713

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 1

									Average
Position 7									
R_1	.25	.30	.28	.26	.25	.26	.23	.15	
R_2	.14	.25	.16	.23	.13	.21	.16	.13	
I^2	.45	.37	.45	.30	.49	.31	.33	.19	.3613
Position 8									
R_1	.30	.24	.22	.25	.26	.25	.22	.16	
R_2	.22	.16	.17	.17	.20	.23	.16	.17	
I^2	.42	.36	.27	.39	.35	.27	.30	.16	.3150
Position 9									
R_1	.21	.17	.17	.22	.24	.23	.23	.18	
R_2	.16	.10	.15	.15	.18	.20	.22	.19	
I^2	.27	.30	.20	.32	.32	.25	.24	.18	.2600

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 3

									Average
Position 1									
R_1	.14	.16	.15	.15	.16	.16	.16	.17	
R_2	.20	.19	.19	.18	.19	.18	.18	.20	
I^2	.11	.15	.12	.14	.14	.15	.15	.16	.1400
Position 2									
R_1	.27	.26	.23	.25	.24	.26	.27	.28	
R_2	.27	.25	.17	.25	.24	.22	.22	.25	
I^2	.27	.27	.31	.27	.24	.33	.35	.32	.2950
Position 3									
R_1	.28	.24	.25	.25	.25	.25	.19	.22	
R_2	.27	.26	.28	.25	.26	.24	.19	.19	
I^2	.30	.23	.22	.25	.25	.27	.19	.26	.2463
Position 4									
R_1	.19	.21	.24	.22	.25	.25	.24	.23	
R_2	.23	.22	.30	.23	.26	.30	.30	.28	
I^2	.16	.21	.20	.22	.24	.22	.19	.19	.2038
Position 5									
R_1	.20	.20	.20	.20	.20	.23	.17	.18	
R_2	.27	.24	.22	.20	.20	.24	.20	.26	
I^2	.16	.17	.18	.20	.20	.22	.15	.14	.1775
Position 6									
R_1	.24	.27	.26	.27	.26	.22	.25	.27	
R_2	.32	.28	.25	.29	.29	.23	.27	.31	
I^2	.18	.26	.27	.26	.24	.22	.24	.24	.2388

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 3

									Average
Position 7									
R_1	.29	.27	.29	.31	.34	.29	.34	.32	
R_2	.30	.27	.34	.34	.38	.43	.36	.36	
I^2	.28	.26	.26	.27	.30	.20	.33	.28	.2725
Position 8									
R_1	.24	.24	.23	.23	.25	.25	.22	.25	
R_2	.35	.36	.30	.27	.28	.28	.28	.36	
I^2	.17	.16	.19	.20	.24	.24	.17	.19	.1950
Position 9									
R_1	.56	.46	.44	.36	.45	.50	.49	.50	
R_2	.26	.25	.51	.39	.45	.46	.61	.25	
I^2	1.2	.79	.35	.33	.44	.52	.38	.95	.6188

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 4

									Average
Position 1									
R_1	.12	.11	.10	.11	.10	.10	.10	.11	
R_2	.12	.10	.09	.10	.11	.10	.09	.11	
I^2	.14	.14	.14	.14	.10	.12	.14	.12	.1300
Position 2									
R_1	.12	.11	.10	.11	.11	.11	.10	.11	
R_2	.12	.08	.09	.09	.10	.10	.09	.10	
I^2	.14	.15	.12	.13	.13	.13	.13	.14	.1338
Position 3									
R_1	.11	.12	.10	.10	.10	.11	.10	.10	
R_2	.11	.11	.08	.08	.11	.10	.09	.10	
I^2	.13	.14	.14	.12	.10	.12	.13	.12	.1250
Position 4									
R_1	.12	.11	.11	.10	.11	.10	.11	.09	
R_2	.11	.11	.09	.10	.10	.11	.11	.10	
I^2	.13	.12	.14	.11	.12	.10	.12	.10	.1175
Position 5									
R_1	.15	.14	.14	.11	.13	.13	.11	.13	
R_2	.25	.10	.12	.10	.12	.11	.09	.13	
I^2	.10	.19	.18	.14	.15	.15	.16	.13	.1500
Position 6									
R_1	.13	.11	.13	.11	.11	.10	.10	.11	
R_2	.14	.10	.11	.12	.10	.09	.10	.10	
I^2	.12	.13	.17	.12	.14	.12	.12	.15	.1338

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 4

									Average
Position 7									
R_1	.13	.11	.10	.11	.10	.10	.11	.11	
R_2	.12	.13	.12	.11	.10	.10	.10	.10	
I^2	.14	.10	.11	.12	.11	.11	.14	.13	.1200
Position 8									
R_1	.13	.12	.10	.09	.11	.11	.12	.12	
R_2	.14	.11	.09	.09	.12	.10	.12	.10	
I^2	.13	.14	.13	.11	.11	.14	.13	.15	.1300
Position 9									
R_1	.13	.11	.11	.11	.11	.11	.10	.11	
R_2	.14	.11	.10	.11	.11	.10	.09	.12	
I^2	.12	.12	.14	.13	.13	.12	.14	.11	.1263

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 6

									Average
Position 1									
R_1	.61	.53	.47	.49	.60	.59	.71	.62	
R_2	.30	.36	.30	.24	.26	.24	.26	.23	
I^2	1.24	.75	.70	.91	1.38	1.45	1.93	1.67	1.25
Position 2									
R_1	.39	.41	.42	.36	.28	.44	.39	.40	
R_2	.22	.25	.26	.21	.16	.19	.23	.20	
I^2	.66	.63	.66	.59	.47	.94	.63	.76	.6675
Position 3									
R_1	.37	.36	.36	.36	.31	.40	.40	.39	
R_2	.21	.25	.24	.22	.18	.24	.22	.21	
I^2	.63	.50	.52	.58	.52	.64	.71	.67	.5963
Position 4									
R_1	.26	.38	.30	.32	.32	.33	.34	.29	
R_2	.19	.21	.20	.18	.18	.17	.18	.17	
I^2	.35	.66	.42	.56	.54	.63	.62	.48	.5325
Position 5									
R_1	.42	.40	.40	.30	.40	.39	.42	.33	
R_2	.25	.32	.29	.28	.27	.27	.27	.22	
I^2	.67	.46	.54	.52	.57	.54	.62	.49	.5513
Position 6									
R_1	.57	.52	.50	.55	.56	.48	.49	.54	
R_2	.54	.53	.54	.54	.53	.46	.47	.54	
I^2	.57	.50	.45	.55	.58	.48	.50	.52	.5188

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 6

									Average
Position 7									
R_1	.55	.56	.59	.60	.56	.57	.61	.60	
R_2	.60	.69	.59	.59	.55	.61	.54	.58	
I^2	.49	.45	.57	.60	.55	.52	.66	.60	.5550
Position 8									
R_1	.47	.57	.55	.41	.47	.41	.52	.49	
R_2	.42	.47	.48	.43	.46	.32	.39	.44	
I^2	.52	.66	.60	.39	.48	.50	.66	.52	.5413
Position 9									
R_1	.39	.53	.41	.51	.49	.50	.47	.50	
R_2	.39	.46	.47	.42	.40	.42	.46	.43	
I^2	.39	.59	.36	.59	.57	.57	.46	.57	.5125

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 7

									Average
Position 1									
R_1	.35	.35	.39	.43	.46	.41	.47	.44	
R_2	.13	.20	.20	.21	.14	.16	.15	.15	
I^2	.86	.58	.73	.82	1.51	.96	1.47	1.29	1.03
Position 2									
R_1	.46	.45	.45	.40	.38	.38	.44	.46	
R_2	.16	.19	.23	.19	.11	.12	.14	.13	
I^2	1.32	.94	.82	.82	1.31	1.2	1.38	1.63	1.18
Position 3									
R_1	.38	.36	.37	.39	.38	.38	.38	.39	
R_2	.15	.15	.20	.12	.10	.10	.13	.15	
I^2	.89	.80	.67	1.27	1.44	1.44	1.11	.93	1.07
Position 4									
R_1	.35	.33	.33	.36	.29	.36	.34	.29	
R_2	.12	.15	.20	.13	.10	.11	.11	.10	
I^2	.92	.67	.53	.92	.70	1.18	.92	.75	.82
Position 5									
R_1	.35	.35	.34	.38	.29	.34	.35	.34	
R_2	.14	.16	.17	.14	.10	.11	.12	.12	
I^2	.83	.72	.62	.95	.79	.97	.92	.83	.8288
Position 6									
R_1	.33	.28	.26	.26	.34	.35	.35	.35	
R_2	.12	.14	.13	.12	.12	.10	.10	.10	
I^2	.80	.53	.52	.56	.86	1.23	1.23	1.23	.87

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 7

									Average
Position 7									
R_1	.30	.29	.34	.34	.34	.36	.32	.35	
R_2	.13	.15	.21	.14	.10	.09	.09	.11	
I^2	.69	.51	.52	.76	1.16	1.44	1.14	1.11	.92
Position 8									
R_1	.34	.32	.30	.33	.32	.30	.33	.33	
R_2	.10	.14	.16	.13	.07	.08	.10	.10	
I^2	1.16	.67	.53	.78	1.46	.97	.95	.92	.93
Position 9									
R_1	.25	.26	.34	.34	.32	.35	.31	.34	
R_2	.10	.13	.15	.14	.08	.10	.11	.12	
I^2	.64	.50	.70	.77	1.28	1.23	.77	.86	.84

TABLE A-III-6 (Continued)

<u>Hydrostatic Unit 1</u> - Site 8

R_1	.43	.35	.39	.43	.36	.36	.41	.36	
R_2	.24	.20	.22	.23	.17	.19	.22	.20	
I^2	.71	.60	.69	.77	.72	.64	.73	.62	.6850
Position 2									
R_1	.45	.39	.34	.38	.36	.45	.41	.45	
R_2	.27	.26	.22	.22	.20	.24	.26	.26	
I^2	.71	.54	.52	.62	.60	.81	.63	.74	.6463
Position 3									
R_1	.38	.41	.43	.44	.41	.44	.44	.46	
R_2	.23	.25	.24	.25	.24	.26	.26	.28	
I^2	.59	.64	.71	.71	.64	.71	.71	.72	.6788
Position 4									
R_1	.25	.22	.23	.28	.25	.28	.30	.29	
R_2	.10	.11	.14	.12	.10	.07	.10	.10	
I^2	.56	.43	.37	.63	.59	.93	.83	.75	.6363
Position 5									
R_1	.33	.41	.41	.40	.39	.37	.43	.36	
R_2	.21	.25	.24	.20	.17	.22	.25	.26	
I^2	.50	.68	.67	.75	[illegible]	.61	.71	.48	.6525
Position 6									
R_1	.49	.41	.40	.40	[illegible]	.45	.49	.47	
R_2	.32	.26	.26	.25	[illegible]	.35	.26	.30	
I^2	.74	.61	.60	.63	[illegible]	.54	.85	.69	.6513

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 8

									Average
Position 7									
R_1	.38	.33	.37	.44	.39	.49	.44	.34	
R_2	.30	.23	.25	.29	.21	.26	.26	.23	
I^2	.47	.47	.55	.64	.70	.83	.71	.49	.6075
Position 8									
R_1	.45	.50	.46	.50	.52	.38	.48	.52	
R_2	.30	.29	.26	.34	.26	.25	.26	.26	
I^2	.66	.80	.76	.71	.95	.54	.80	.98	.7750
Position 9									
R_1	.49	.55	.51	.56	.58	.54	.60	.57	
R_2	.30	.29	.28	.31	.26	.27	.31	.30	
I^2	.76	.97	.88	.92	1.29	1.08	1.16	1.08	1.02

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 9

									Average
Position 1									
R_1	.45	.39	.39	.50	.45	.47	.43	.42	
R_2	.29	.27	.36	.29	.26	.26	.27	.24	
I^2	.67	.41	.40	.81	.76	.80	.64	.70	.6488
Position 2									
R_1	.36	.37	.36	.37	.34	.35	.31	.35	
R_2	.16	.18	.19	.15	.14	.14	.13	.14	
I^2	.73	.74	.63	.83	.77	.82	.70	.78	.7500
Position 3									
R_1	.35	.37	.30	.30	.24	.34	.37	.29	
R_2	.14	.16	.19	.15	.11	.12	.14	.10	
I^2	.79	.46	.45	.58	.50	.85	.88	.71	.6525
Position 4									
R_1	.37	.23	.26	.27	.26	.23	.23	.25	
R_2	.09	.11	.11	.10	.09	.07	.08	.09	
I^2	.70	.46	.58	.68	.70	.65	.57	.64	.6225
Position 5									
R_1	.23	.29	.30	.28	.26	.31	.25	.24	
R_2	.08	.10	.12	.11	.08	.11	.11	.13	
I^2	.56	.72	.70	.68	.64	.77	.54	.42	.6288
Position 6									
R_1	.30	.31	.31	.25	.31	.25	.27	.32	
R_2	.15	.16	.19	.13	.14	.15	.14	.14	
I^2	.56	.56	.47	.48	.70	.40	.46	.70	.5413

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 9

									Average
Position 7									
R_1	.38	.33	.36	.26	.27	.33	.36	.34	
R_2	.20	.21	.22	.18	.14	.16	.17	.18	
I^2	.57	.51	.57	.68	.48	.62	.73	.61	.5963
Position 8									
R_1	.30	.26	.34	.26	.28	.26	.30	.30	
R_2	.20	.18	.20	.17	.15	.17	.17	.20	
I^2	.43	.37	.55	.39	.51	.39	.50	.44	.4475
Position 9									
R_1	.30	.32	.33	.39	.32	.31	.37	.32	
R_2	.16	.21	.21	.21	.15	.15	.17	.17	
I^2	.54	.47	.49	.70	.63	.59	.74	.56	.5900

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 10

									Average
Position 1									
R_1	.42	.45	.43	.33	.49	.45	.36	.46	
R_2	.18	.20	.15	.16	.23	.30	.25	.25	
I^2	.89	.91	1.23	.63	.98	.66	.49	.78	.82
Position 2									
R_1	.29	.30	.39	.30	.30	.38	.50	.29	
R_2	.10	.14	.14	.11	.11	.23	.26	.22	
I^2	.75	.59	.98	.72	.72	.60	.88	.37	.7013
Position 3									
R_1	.46	.37	.40	.34	.40	.44	.34	.28	
R_2	.15	.14	.16	.19	.19	.24	.25	.14	
I^2	1.41	.92	.91	.59	.82	.74	.45	.51	.79
Position 4									
R_1	.42	.44	.40	.53	.43	.45	.30	.50	
R_2	.21	.14	.14	.19	.19	.23	.23	.20	
I^2	.77	1.38	.99	1.48	.89	.84	.40	1.25	1.00
Position 5									
R_1	.46	.40	.34	.33	.35	.28	.29	.30	
R_2	.19	.18	.14	.18	.13	.19	.22	.22	
I^2	.99	.86	.75	.59	.87	.41	.40	.40	.6588
Position 6									
R_1	.35	.30	.40	.39	.29	.25	.31	.32	
R_2	.22	.15	.17	.16	.18	.18	.33	.23	
I^2	.53	.55	.86	.90	.44	.34	.29	.44	.5438

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 10

									Average
Position 7									
R_1	.37	.36	.30	.37	.37	.28	.34	.38	
R_2	.20	.20	.12	.15	.18	.19	.26	.24	
I^2	.65	.63	.70	.84	.72	.40	.44	.58	.6200
Position 8									
R_1	.30	.37	.33	.30	.37	.34	.35	.33	
R_2	.16	.18	.16	.15	.17	.24	.27	.18	
I^2	.56	.68	.65	.53	.56	.48	.46	.59	.5638
Position 9									
R_1	.36	.36	.40	.38	.30	.30	.36	.34	
R_2	.20	.18	.18	.16	.18	.26	.36	.29	
I^2	.62	.67	.80	.82	.48	.34	.35	.40	.5600

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 11

									Average
Position 1									
R_1	.18	.15	.15	.15	.15	.16	.18	.17	
R_2	.11	.12	.14	.10	.10	.10	.12	.10	
I^2	.24	.20	.17	.24	.25	.26	.28	.28	.2400
Position 2									
R_1	.16	.17	.20	.20	.20	.20	.21	.18	
R_2	.08	.11	.11	.14	.15	.14	.14	.12	
I^2	.32	.26	.35	.31	.28	.29	.30	.27	.2975
Position 3									
R_1	.21	.20	.23	.20	.21	.26	.26	.23	
R_2	.10	.13	.13	.13	.15	.15	.17	.13	
I^2	.44	.30	.40	.29	.29	.43	.39	.40	.3675
Position 4									
R_1	.20	.22	.20	.19	.22	.19	.22	.20	
R_2	.15	.17	.15	.13	.09	.11	.18	.14	
I^2	.27	.28	.27	.27	.50	.32	.27	.31	.3100
Position 5									
R_1	.20	.20	.19	.21	.17	.20	.17	.16	
R_2	.14	.15	.15	.07	.15	.16	.14	.13	
I^2	.27	.27	.24	.56	.20	.26	.22	.20	.2775
Position 6									
R_1	.19	.19	.20	.26	.22	.21	.17	.23	
R_2	.07	.11	.14	.11	.12	.15	.13	.16	
I^2	.47	.31	.30	.55	.40	.28	.25	.32	.3600

TABLE A-III-6 (Continued)

Hydrostatic Unit 1 - Site 11

									Average
Position 7									
R_1	.17	.22	.19	.17	.19	.17	.20	.20	
R_2	.14	.12	.13	.10	.13	.16	.18	.14	
I^2	.23	.39	.29	.29	.28	.19	.24	.28	.2738
Position 8									
R_1	.15	.19	.24	.16	.19	.19	.19	.16	
R_2	.13	.13	.13	.09	.11	.14	.13	.10	
I^2	.18	.29	.30	.29	.29	.26	.29	.27	.2713
Position 9									
R_1	.16	.19	.17	.19	.19	.21	.17	.19	
R_2	.12	.12	.12	.09	.14	.16	.13	.13	
I^2	.22	.26	.26	.40	.26	.26	.24	.28	.2725

TABLE A-III-7

IMPULSE INDEX DATA - PULLMAN AREA

Hydrostatic Unit 1

	1	2	3	4	Average
A1R					
R_1	.47	.48	.46	.49	.475
R_2	.25	.32	.30	.29	.29
I^2	.82	.69	.67	.80	.745
A1L					
R_1	.45	.48	.48	.50	.478
R_2	.22	.43	.36	.39	.35
I^2	.62	.52	.60	.63	.593
A2R					
R_1	.33	.39	.33	.50	.388
R_2	.23	.25	.26	.30	.26
I^2	.47	.58	.41	.77	.558
A2L					
R_1	.54	.60	.55	.50	.548
R_2	.39	.51	.48	.50	.47
I^2	.73	.68	.60	.48	.623
A3R					
R_1	.42	.33	.34	.43	.380
R_2	.28	.24	.22	.25	.248
I^2	.59	.44	.51	.71	.563
A3L					
R_1	.42	.39	.33	.50	.410
R_2	.34	.30	.34	.33	.328
I^2	.49	.48	.32	.73	.505

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
A4R					
R_1	.40	.42	.41	.30	.383
R_2	.25	.30	.23	.21	.248
I^2	.60	.57	.70	.44	.578
A4L					
R_1	.39	.47	.44	.49	.448
R_2	.28	.39	.30	.35	.33
I^2	.53	.54	.30	.35	.58
A5R					
R_1	.40	.34	.42	.35	.378
R_2	.25	.28	.30	.23	.266
I^2	.60	.42	.56	.50	.52
A5L					
R_1	.52	.42	.46	.52	.480
R_2	.38	.29	.27	.34	.32
I^2	.67	.58	.73	.75	.682
C1R					
R_1	.62	.77	.56	.63	.645
R_2	.38	.46	.33	.35	.38
I^2	.94	1.29	.89	1.13	1.062
C1L					
R_1	.59	.60	.60	.62	.603
R_2	.37	.42	.36	.66	.452
I^2	.88	.82	.95	.56	.802

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
C2R					
R_1	.94	.83	.85	.69	.828
R_2	.25	.34	.32	.34	.312
I^2	3.53	2.03	2.26	1.40	2.305
C2L					
R_1	.52	.51	.48	.54	.513
R_2	.30	.29	.31	.30	.30
I^2	.87	.85	.71	.93	.84
C3R					
R_1	.82	.87	.74	.96	.848
R_2	.27	.26	.25	.29	.268
I^2	2.49	2.91	2.19	3.18	2.69
C3L					
R_1	1.02	.96	1.02	1.02	1.005
R_2	.46	.43	.44	.42	.438
I^2	2.261	2.14	2.37	2.48	2.313
C4R					
R_1	1.02	1.02	1.02	1.02	1.020
R_2	.39	.45	.37	.34	.388
I^2	2.67	2.31	2.81	3.06	2.71
C4L					
R_1	1.00	1.02	.97	1.02	1.003
R_2	.30	.38	.37	.40	.362
I^2	3.33	2.74	2.54	2.60	2.80

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
C5R					
R_1	.72	.69	.69	.69	.698
R_2	.39	.36	.33	.34	.356
I^2	1.33	1.32	1.44	1.40	1.372
C5L					
R_1	.86	.73	.80	.83	.805
R_2	.39	.36	.39	.37	.378
I^2	1.90	1.48	1.64	1.86	1.72
E2R					
R_1	.63	.69	.62	.68	.655
R_2	.28	.33	.33	.29	.308
I^2	1.42	1.44	1.16	1.59	1.402
E2L					
R_1	.75	.83	.90	.85	.833
R_2	.48	.46	.49	.45	.47
I^2	1.17	1.50	1.65	1.61	1.48
E3R					
R_1	1.11	1.04	1.02	.99	1.040
R_2	.25	.39	.19	.23	.266
I^2	4.93	2.77	5.48	4.26	4.36
E3L					
R_1	.97	.86	.89	.88	.900
R_2	.70	.57	.58	.57	.606
I^2	1.34	1.30	1.37	1.36	1.34

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
E4R					
R_1	.98	.78	.92	.74	.855
R_2	.29	.40	.29	.28	.316
I^2	3.31	1.52	2.92	1.96	2.43
E4L					
R_1	1.02	1.42	1.32	1.02	1.195
R_2	.55	.48	.68	.50	.552
I^2	1.89	4.20	2.56	2.08	2.68
E5R					
R_1	.86	.65	.89	.86	.815
R_2	.32	.44	.30	.40	.366
I^2	2.31	.92	2.64	1.85	1.93
E5L					
R_1	.99	.93	.92	.79	.908
R_2	.35	.29	.33	.25	.306
I^2	2.80	2.98	2.56	2.50	2.71
E1R					
R_1	.69	.66	.69	.80	.710
R_2	.30	.28	.29	.32	.298
I^2	1.59	1.56	1.64	2.00	1.70
E1L					
R_1	.83	.78	1.0	.99	.900
R_2	.33	.42	.43	.44	.406
I^2	2.09	1.45	2.33	2.23	2.02

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
E2R					
R_1	.74	.73	.62	.64	.683
R_2	.57	.31	.35	.26	.372
I^2	.96	1.72	1.10	1.58	1.34
E2L					
R_1	.81	.87	1.0	.90	.895
R_2	.47	.47	.47	.44	.462
I^2	1.40	1.61	2.13	1.84	1.74
J1L					
R_1	.12	.14	.10	.12	.120
R_2	.18	.29	.14	.16	.192
I^2	.08	.08	.08	.09	.082
J2L					
R_1	.15	.10	.11	.10	.115
R_2	.14	.12	.12	.13	.128
I^2	.16	.09	.11	.09	.112
J3L					
R_1	.10	.11	.10	.08	.098
R_2	.12	.16	.14	.13	.138
I^2	.09	.09	.09	.07	.085
J4L					
R_1	.10	.14	.12	.11	.118
R_2	.13	.18	.16	.19	.166
I^2	.10	.11	.10	.08	.098

TABLE A-III-7 (Continued)

Hydrostatic Unit 1

	1	2	3	4	Average
J5L					
R_1	.12	.11	.09	.13	.113
R_2	.17	.18	.13	.18	.166
I^2	.10	.09	.07	.10	.09