# Correlation of the Road Rater and the Dynatest Falling Weight Deflectometer

Final Report
for
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DISCLAIMER

The contents of this report reflect the views of the authors and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute a standard, specification or regulation.

ABSTRACT

The Falling Weight Deflectometer (FWD) has become the "standard" for deflection testing of pavements. Iowa has used a Road Rater since 1976 to obtain deflection information. A correlation between the Road Rater and the FWD was needed if Iowa was going to continue with the Road Rater.

Comparative deflection testing was done using a Road Rater Model 400 and a Dynatest 8000 FWD on 26 pavement sections. The SHRP contractor, Braun Intertec Pavement, Inc., provided the FWD testing. The $r^2$ for the linear correlations ranged from 0.90 to 0.99 for the different pavement types and sensor locations.

## INTRODUCTION

The most widely used equipment for pavement deflection testing is the Falling Weight Deflectometer. All the pavement testing done for the Strategic Highway Research Program (SHRP) is with the FWD. Testing, evaluation, and design recommendations from the SHRP study will likely be based on the use of FWD.

The Iowa Department of Transportation has been using the Model 400 Road Rater since 1976. Overlay design procedures, research evaluations, and the pavement management system use and are based on the Road Rater system. To use the SHRP products, a correlation between the FWD and the Road Rater is needed.

## OBJECTIVE

The objective of the study was to correlate the Falling Weight Deflectometer and the Road Rater on the range of pavement sections in the state.

## TESTING

Comparative testing on 26 pavement sections was done with the SHRP contractor, Braun Intertec Pavement, Inc., and their Dynatest Model 8000 (Appendix A). The FWD followed the Road Rater on 22 of the sites and tested in the same locations. Four sites were SHRP sites and the Road Rater followed the FWD during testing. The testing was at the 1/4-point for the SHRP sites and at the outside wheel path for the other 22 locations. Testing on PCC pavement was at mid-panel.

The FWD tested each SHRP site with four drops per height setting. Forces generated were 9,000; 12,000; and 16,000 pounds. Two drops per height setting were used on the other sites. Forces generated were 5,500; 9,000; 12,000; and 16,000 pounds.

The FWD has seven velocity transducers extending ahead of the load point. Sensor spacing was 0, 8, 12, 18, 24, 36, and 60 inches from the load source.

The Road rater tested the PCC and composite pavements with a 2000 pound load (68 mils @ 30 Hz). Full depth asphalt pavements were tested at 1185 pounds (58 mils @ 25 Hz) and at 30 Hz.

Four velocity sensors were used on the Road Rater. The spacing was 0, 12, 24, and 36 inches from the load. The sensors extend backward from the load source. This configuration put the #2 through #4 sensors 180° from the FWD #2 through #7 sensors.

TEST RESULTS

Linear correlations were performed on data from the sensors at the 0-, 12-, 24-, and 36-inch spacing with the 9000 pound FWD setting (Appendix B). The 9000 pound setting was chosen because it is the wheel loading used for design. Correlations were not run at the heavier loadings, but if checked would likely be lower. The $r^2$ ranged from 0.90 to 0.99 for the dif-

ferent pavement types and sensor locations. The general linear correlation equation is: FWD = x *(R.R.)+C.

Table I contains the information developed for each pavement type and sensor spacing.

Further analysis of the data will be done when SHRP has released the FWD products.

## SUMMARY AND CONCLUSIONS

Based on the results of this study, the summary and conclusions are as follows:

1. The Road Rater at a 2000 pound load and the Dynatest at a 9000 pound force have a very strong correlation for deflections on both PCC and composite pavement. For full depth AC pavement an equally strong correlation was found between the Road Rater at 1185 pounds and the Dynatest at 9000 pounds.

2. The Road Rater should be able to predict peak FWD deflections at 0, 12, 24, and 36 inches from the load.

Table I
Correlation Data

| | PCC Sections | | | | Composite Sections | | | | AC Sections | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | C | $r^2$ | Std. Error | X | C | $r^2$ | Std. Error | X | C | $r^2$ | Std. Error |
| Sensor 1 | 3.745 | 0.83 | 0.92 | 0.62 | 4.890 | 0.83 | 0.96 | 1.11 | 11.830 | -3.89 | 0.92 | 4.23 |
| Sensor 2 | 3.822 | 0.67 | 0.91 | 0.60 | 4.034 | 0.64 | 0.99 | 0.35 | 8.918 | -1.30 | 0.96 | 1.07 |
| Sensor 3 | 3.850 | 0.63 | 0.90 | 0.53 | 3.803 | 0.86 | 0.98 | 0.41 | 7.622 | -0.51 | 0.96 | 0.52 |
| Sensor 4 | 4.056 | 0.48 | 0.91 | 0.39 | 3.816 | 0.86 | 0.96 | 0.41 | 6.116 | 0.189 | 0.92 | 0.35 |

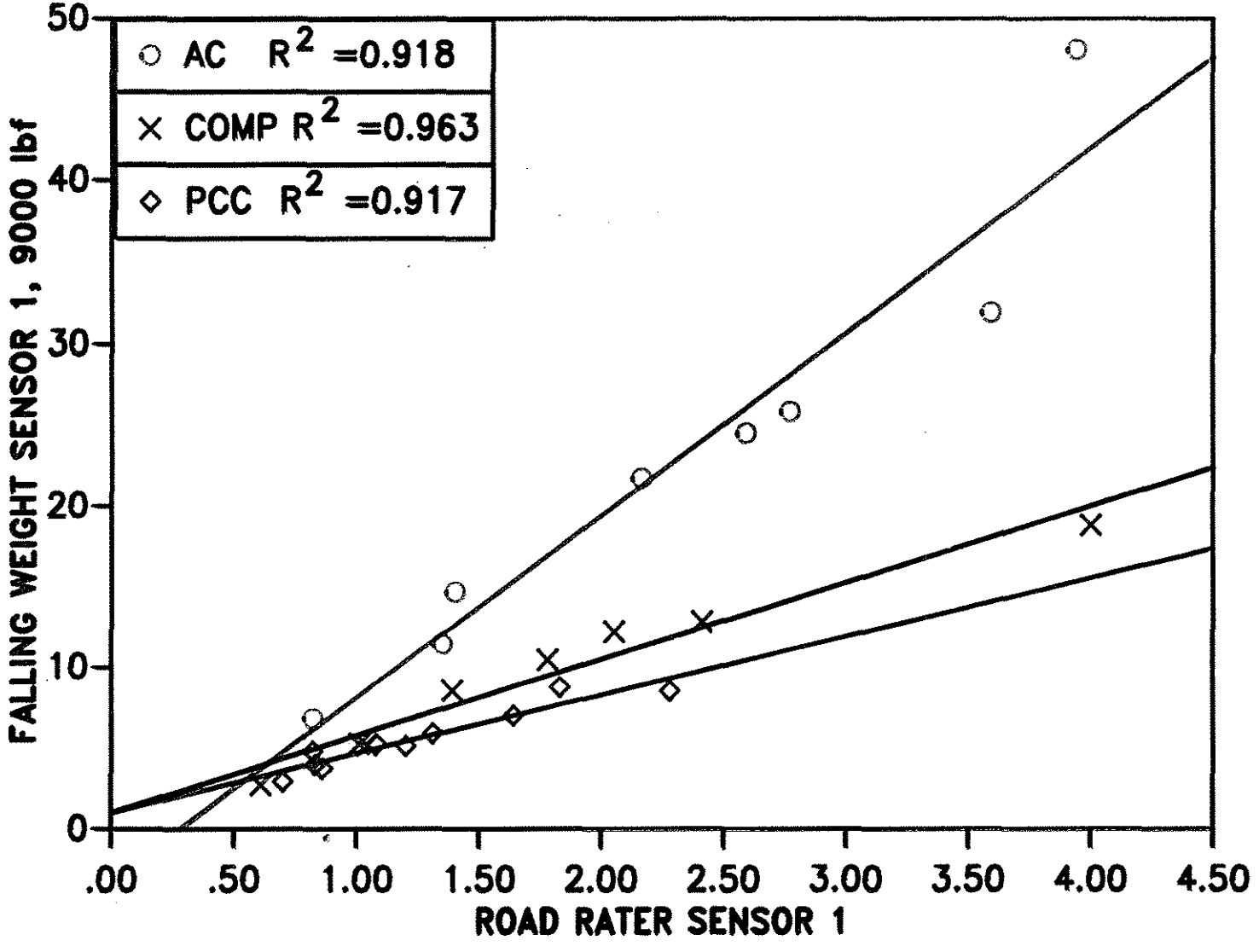
# Appendix A

# Appendix A
## Testing Summary

| County | Route | Location BMP | Location EMP | Structural Rating | Subgrade K | Structure | Test Date | Pave. Temp. | Road Rater Deflections (Mils) Sensor #1 | Sensor #2 | Sensor #3 | Sensor #4 | Dynatest Deflections (Mils) Sensor #1 | Sensor #3 | Sensor #5 | Sensor #6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 224 | 8.53 | 10.53 | 2.21 | 174 | 1960: 2.5" AC, 6" RSB, 4" SAS | 6-28-91 | 91 | 3.59 | 2.35 | 1.34 | 0.86 | 32.60 | 19.07 | 9.61 | 5.35 |
| 85 | 221 | 0.00 | 2.00 | 2.63 | 220 | 1949: Built-up SC, 6" RSB | 6-27-91 | 108 | 3.94 | 1.7 | 0.8 | 0.55 | 50.10 | 15.70 | 5.27 | 2.98 |
| 64 | 330 | 31.44 | 33.44 | 3.38 | 149 | 1977: 3.0" AC; 1961: 2" AC, 6" RSB, 6" SAS | 6-28-91 | 107 | 2.77 | 1.86 | 1.12 | 0.74 | 26.03 | 15.11 | 8.01 | 4.71 |
| 6 | 287 | 0.00 | 1.93 | 3.80 | 87 | 1974: 4.5" AC; 1955: Built-up SC, 6" RSB | 6-24-91 | 110 | 2.59 | 2.01 | 1.25 | 0.84 | 25.22 | 16.35 | 9.65 | 5.66 |
| 85 | 210 | 16.00 | 18.00 | 4.12 | 165 | 1978: 3" AC; 1965: 3" AC; 1956: 2" AC, 6" RSB, 6" SAS | 6-27-91 | 110 | 2.16 | 1.52 | 0.98 | 0.62 | 22.42 | 12.50 | 6.92 | 4.15 |
| 6 | 218 | 146.15 | 147.11 | 5.61 | 208 | 1974: 3" AC; 1960: 1.5" AC, 12" ATB, 4" GSB | 6-24-91 | 105 | 1.40 | 0.96 | 0.55 | 0.38 | 14.81 | 7.63 | 4.07 | 2.58 |
| 52 | 965 | 101.00 | 103.00 | 5.89 | 148 | 1971: 3" AC; 1958: 4.5" AC, 12" RSB, 4" GSB | 6-24-91 | 103 | 1.35 | 1.05 | 0.83 | 0.65 | 11.22 | 6.41 | 4.91 | 3.90 |
| 50 | 117 | 15.43 | 17.43 | 7.73 | 138 | 1978: 3" AC; 1958: 3" AC, 7" SCS, 6" SAS | 6-28-91 | 82 | 0.82 | 0.69 | 0.56 | 0.43 | 6.67 | 5.11 | 4.11 | 3.19 |
| 6 | 131 | 4.52 | 6.52 | 2.21 | 63 | 1971: 2" AC; 1952: 3.5" AC; 1927: 7" PCC | 6-24-91 | 96 | 4.00 | 3.35 | 2.58 | 1.89 | 19.24 | 13.99 | 10.38 | 7.67 |
| 85 | 69 | 122.00 | 124.00 | 3.28 | 157 | 1958: 3" AC; 1931: 7" PCC | 6-27-91 | 106 | 2.41 | 1.84 | 1.56 | 1.25 | 12.92 | 8.20 | 6.65 | 5.52 |
| 40 | 69 | 143.00 | 145.00 | 3.43 | 118 | 1966: 3" AC; 1931: 7" PCC | 6-27-91 | 98 | 2.05 | 1.81 | 1.62 | 1.33 | 12.30 | 7.73 | 7.22 | 6.23 |
| 64 | 330 | 20.21 | 22.00 | 4.34 | 177 | 1985: 2" AC; 1952: 3" AC; 1937: 7.5" PCC | 6-28-91 | 111 | 1.78 | 1.40 | 1.22 | 0.98 | 10.45 | 6.78 | 6.11 | 5.22 |
| 8 | 30W | 139.00 | 141.00 | 4.78 | 176 | 1973: 3" AC; 1956: 3" AC; 1930: 7" PCC | 6-27-91 | 111 | 1.39 | 1.20 | 1.07 | 0.90 | 8.55 | 5.61 | 5.03 | 4.38 |
| 85 | 65 | 102.10 | 104.10 | 5.46 | 177 | 1979: 2" AC; 1965: 3" AC; 1938: 7.5" PCC | 6-27-91 | 104 | 1.04 | 0.98 | 0.87 | 0.73 | 5.20 | 4.64 | 4.25 | 3.71 |
| 85 | 30 | 152.00 | 154.00 | 5.80 | 136 | 1985: 3" AC; 1964: 10" PCC, 4" GSB | 6-28-91 | 79 | 1.01 | 0.91 | 0.79 | 0.66 | 5.06 | 4.49 | 3.99 | 3.42 |
| 77 | 355 | SHRP 190609 | | 7.73 | 164 | 1989: 4" AC; 1965: 10" PCC, 4" GSB | 10-19-89 | 47 | 0.61 | 0.58 | 0.52 | 0.43 | 2.72 | 2.39 | 2.17 | 1.89 |
| 6 | 201 | 2.77 | 4.77 | 2.72 | 65 | 1959: 7" PCC | 6-24-91 | 99 | 2.28 | 2.10 | 1.79 | 1.38 | 8.55 | 7.90 | 6.78 | 5.56 |
| 8 | 210 | 11.85 | 13.85 | 3.27 | 86 | 1967: 7" PCC | 6-27-91 | 110 | 1.83 | 1.68 | 1.4 | 1.09 | 8.80 | 8.10 | 6.93 | 5.60 |
| 40 | 17 | 44.92 | 46.92 | 3.57 | 116 | 1979: 7.5" PCC | 6-27-91 | 93 | 1.64 | 1.49 | 1.25 | 0.97 | 6.93 | 6.29 | 5.32 | 4.19 |
| 6 | 21 | 59.49 | 61.49 | 4.27 | 145 | 1979: 8" PCC | 6-24-91 | 92 | 1.31 | 1.20 | 1.01 | 0.81 | 5.90 | 5.41 | 4.73 | 3.85 |
| 8 | 30W | 137.00 | 139.00 | 4.68 | 148 | 1964: 10" PCC, 4" GSB | 6-27-91 | 108 | 1.20 | 1.11 | 0.98 | 0.82 | 5.15 | 4.96 | 4.51 | 3.94 |
| 50 | 14 | 77.10 | 79.10 | 5.15 | 153 | 1989: 9.5" PCC | 6-28-91 | 84 | 1.08 | 1.00 | 0.90 | 0.78 | 5.04 | 4.76 | 4.33 | 3.78 |
| 77 | 355 | SHRP 190602 | | 6.05 | 158 | 1965: 10" PCC, 4" GSB | 7-11-89 | 98 | 0.86 | 0.81 | 0.71 | 0.59 | 3.60 | 3.30 | 2.92 | 2.52 |
| 40 | 20 | SHRP 193055 | | 6.20 | 162 | 1969: 10" PCC, 4" GSB | 7-13-89 | 94 | 0.83 | 0.78 | 0.67 | 0.54 | 3.86 | 3.47 | 3.05 | 2.66 |
| 40 | 20W | 134.32 | 136.10 | 6.38 | 161 | 1986: 9" PCC, 4" CTB | 6-27-91 | 88 | 0.82 | 0.77 | 0.69 | 0.58 | 4.60 | 4.28 | 3.77 | 3.17 |
| 35 | 35N | SHRP 195046 | | 7.46 | 181 | 1975: 8" CRC, 4" CTB | 7-14-89 | 82 | 0.70 | 0.65 | 0.54 | 0.41 | 2.87 | 2.52 | 2.16 | 1.81 |

Appendix B

# ROAD RATER VS. FALLING WEIGHT



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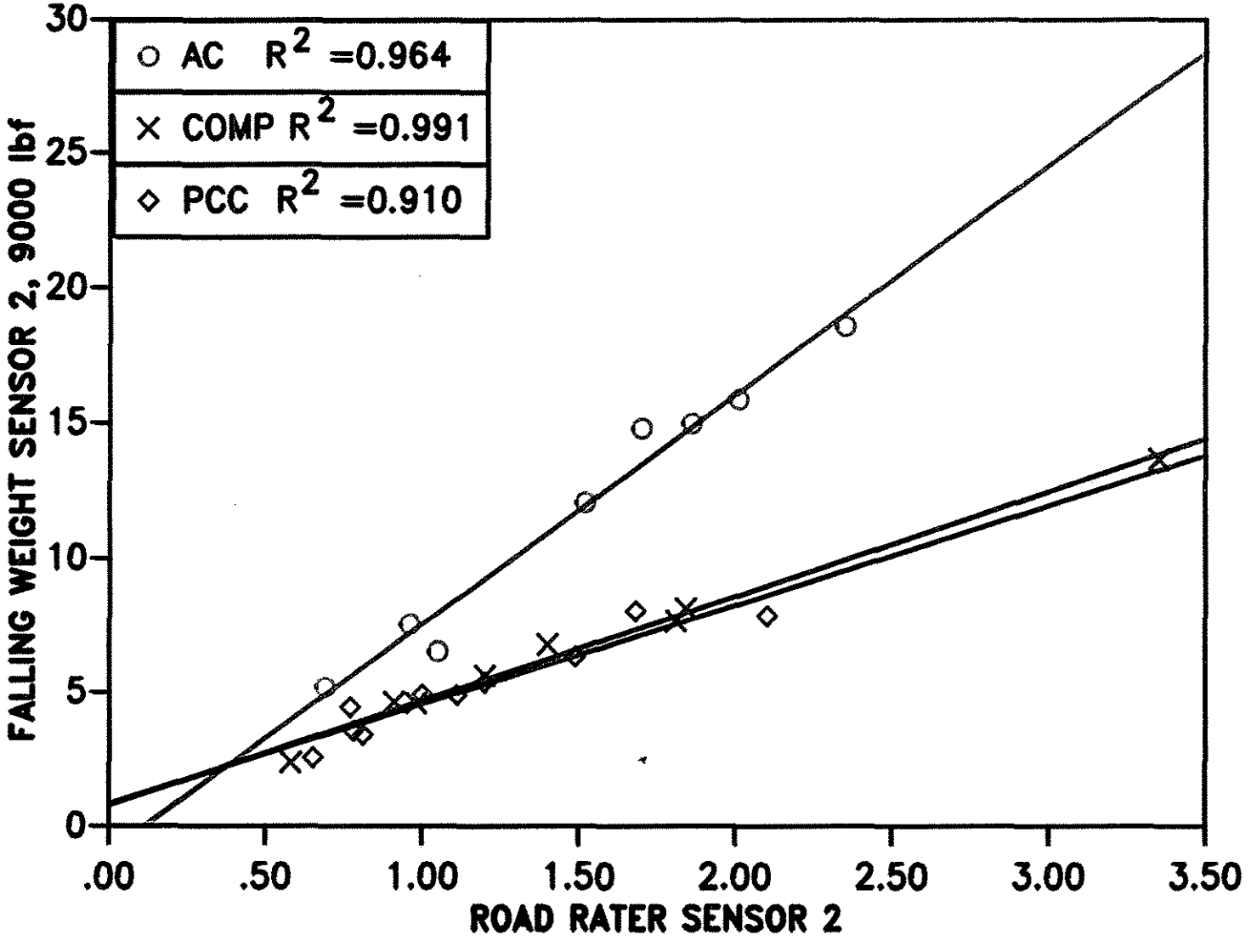

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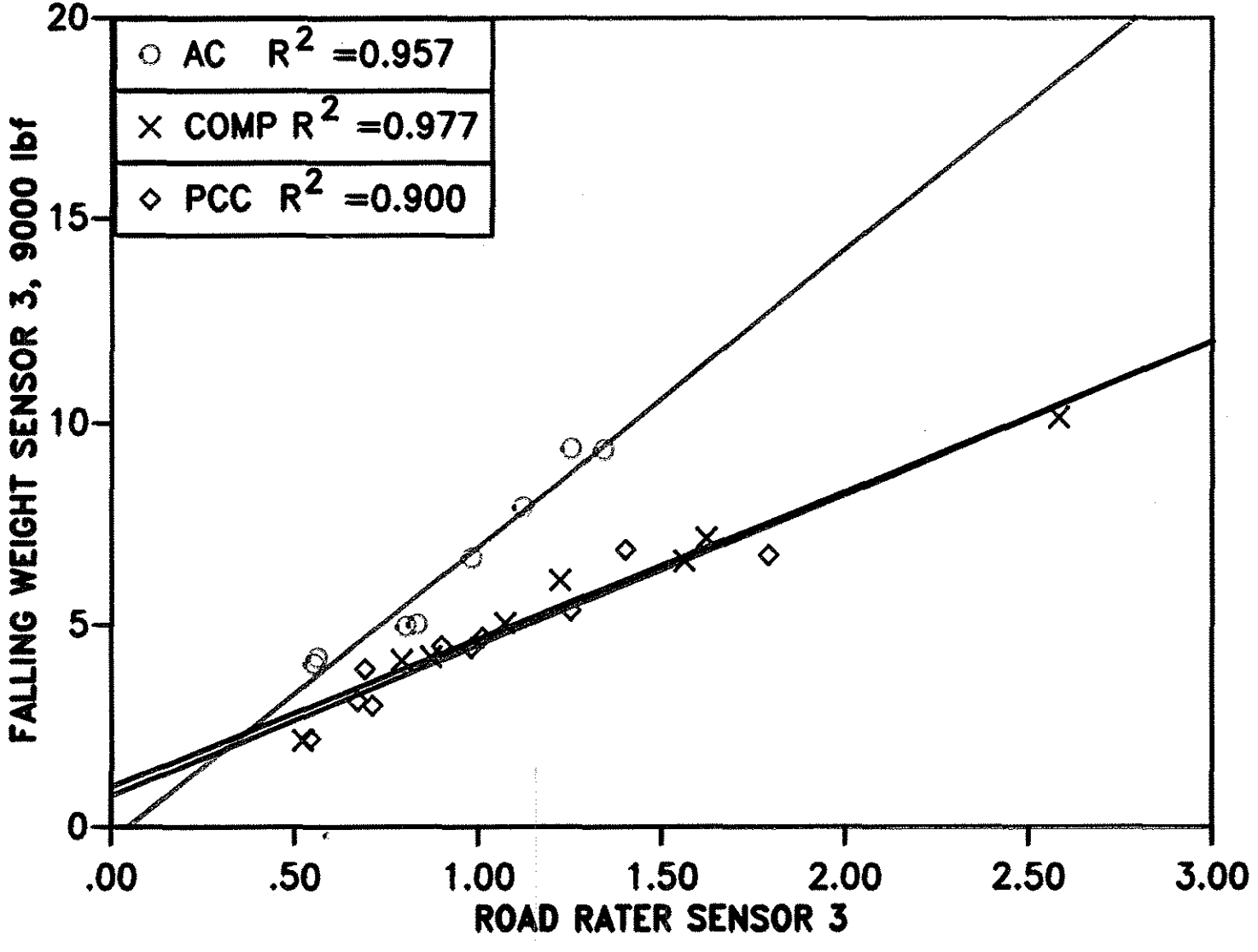
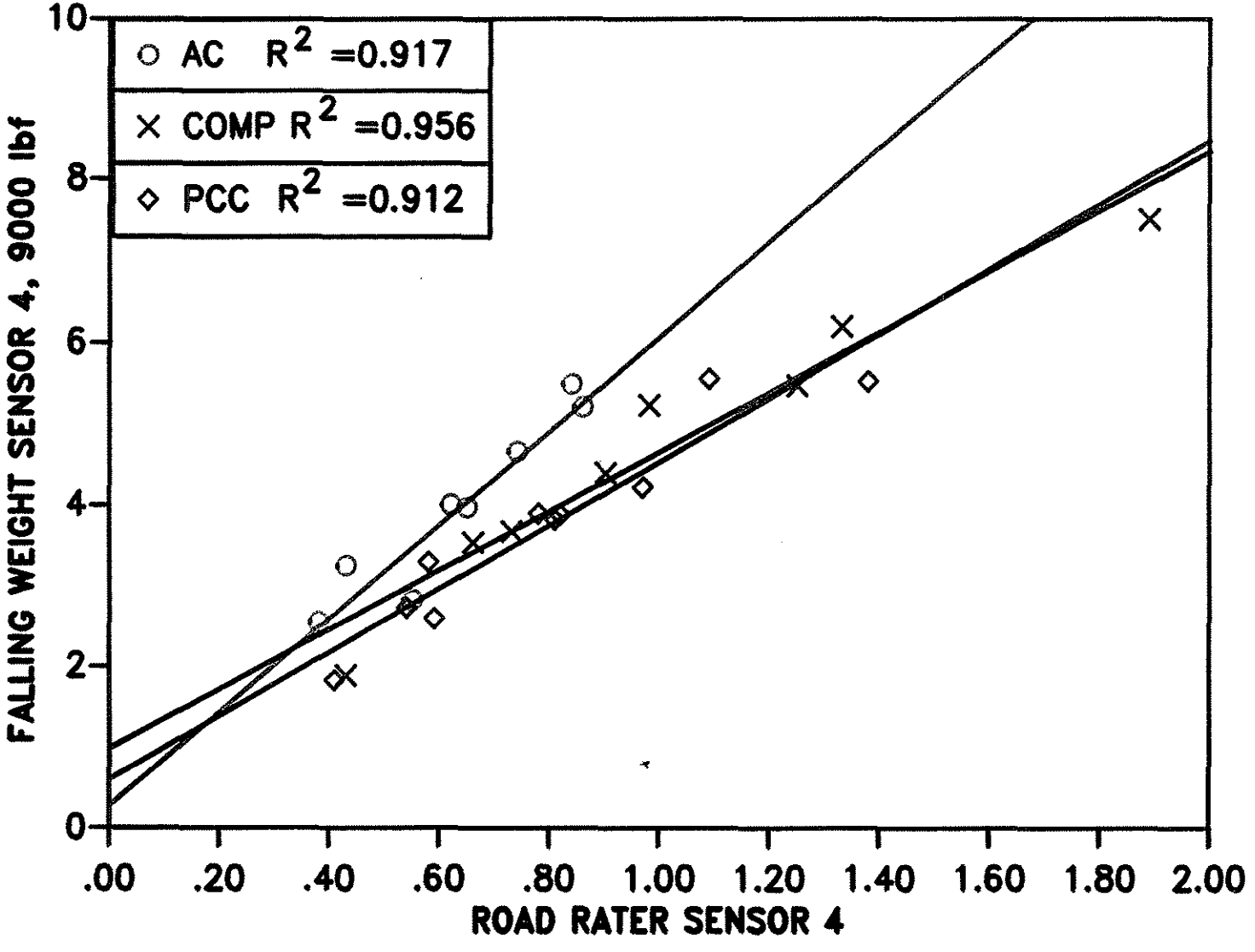
# ROAD RATER VS. FALLING WEIGHT