

# ***STATE OF FLORIDA***



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## **THE EFFECTIVENESS OF KEYWAYS IN LONGITUDINAL JOINTS OF CONCRETE PAVEMENTS**

**FL/DOT/SMO/98-419**

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**STATE MATERIALS OFFICE**

**FLORIDA DEPARTMENT OF TRANSPORTATION  
STATE MATERIALS OFFICE  
PAVEMENT EVALUATION SECTION**

STUDY FL/DOT/SMO/98-419

**THE EFFECTIVENESS OF KEYWAYS IN  
LONGITUDINAL JOINTS OF CONCRETE PAVEMENTS**

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## **INTRODUCTION**

The main objective of this study was to evaluate the load transfer efficiency for longitudinal joints with and without keyways. In order to satisfy that objective, test sections were built as part of a newly constructed concrete pavement on SR 9A in Jacksonville, Florida. The pavement cross section consisted of 318 mm (12.5 inches) of concrete on top of 152 mm (6 inches) of granular base materials. The embankment/ subgrade thickness was 1219 mm (48 inches). The test sections had two lanes and shoulders. The distance between the joints tested and the free edge was 22 feet. Figure 1 shows typical keyway and non-keyway joints. Keyway and non-keyway joints had number 4 tie bars with a spacing of about 14 inches in compliance with the FDOT Jointed Plain Concrete Pavement Design Manual. The slip form paver used to construct the pavement had a mechanical device to insert tie bars automatically. It should be emphasized that the test results in this report represent joint performance of newly constructed roadway prior to the application of any traffic. The joints performance may change due to the repeated traffic applications in the future.

## **DATA COLLECTION**

After finishing the construction of the experimental sections and prior to opening the pavement to regular traffic, deflection measurements were collected on 20 slabs with Keyway joints and 20 slabs without Keyway joints. All deflection measurements were performed with the Florida Department of Transportation (FDOT) Falling Weight Deflectometer (FWD). The standard 550 Kpa which corresponds to the standard axle load was used in all FWD testing. Testing was done at two locations of every test slab. As shown in Figure 2, one of the testing location was near the centers of the slabs while the other was near the corners of the slabs. The

deflection testing was performed twice at all locations. Once in the early morning (a.m.) and a second time late in the afternoon (p.m.). The difference in temperature between the two testing times was 30E F. The above testing combinations resulted in eight data sets as shown in Table 1.

## **DATA ANALYSIS**

After collecting all the necessary data, the deflection measurements were normalized to reflect the standard load of 565 Kpa. The analysis was then performed in three steps. The first step consisted of calculating the load transfer efficiency across the longitudinal joints at each test location. The following simple equation was utilized in these calculations:

$$E = (P5 / P1) * 100 \dots\dots\dots(1)$$

Where:

- E: The efficiency of load transfer across the joint.
- P5: Deflection from sensor # 5 (see Figure 1).
- P1: Deflection from sensor # 1 (see Figure 1).

The second step in the analysis consisted of plotting the deflections for keyway versus non-keyway joints. Statistical analysis was then performed in the final step of the analysis. The following sections describe these steps in detail.

## **LOAD TRANSFER EFFICIENCY**

Equation 1 was utilized in calculating the load transfer efficiencies at all locations. Table 2 shows the standard deviation, average, highest, and lowest load transfer efficiency values for each data set. It is clear from Table 2 that all data sets had on the average high load transfer efficiencies which is expected for a newly constructed pavement section.

## **DEFLECTION PLOTS**

The deflection measurements from sensors number 1 and 5 were plotted for various testing conditions to visually compare the deflections from keyway and non-keyway joints. Figures 3 and 4 show how most deflection measurements obtained at mid slabs were lower for the keyway joints. On the other hand, Figures 5 and 6 show no particular trends for the deflections at corner locations.

## **STATISTICAL ANALYSIS**

The statistical analysis consisted of performing the t-test on the various data sets to determine the effectiveness of keyway joints. The analysis was first performed on the load transfer efficiency of keyway versus non-keyway joints. Similar analysis was later performed on the deflection measurements from sensors 1 and 5. The following sections summarize the findings from this analysis.

### **Effect of Keyways on Load Transfer Efficiency**

The load transfer efficiency of keyway joints were compared to the non-keyway joints statistically. Table 3 shows the results from the t-test including the critical and calculated t values. The calculated t values must be higher than the critical values in order to conclude that the data sets compared are different. It is clear from Table 3 that regardless of testing conditions (time of day or testing location), Keyway and non-keyway joints provided similar load transfer efficiency.

### **Effect of Testing Time on Load Transfer Efficiency**

The t-test was also performed to determine if testing time (a.m. vs p.m.) Would affect load transfer efficiency. The results from the analysis are summarized in Table 4. It is clear from Table 4 that in two out of the four cases, the efficiency of load transfer was affected by the

testing time. In all four cases, the load transfer efficiencies were less when tested in the afternoon. However, only in two cases the differences were significant statistically. The reduction in load transfer efficiency is most likely due to the curling of the slabs.

### **Effect of Testing Location on Load Transfer Efficiency**

Another factor that might influence the load transfer efficiency is the location of testing. The t-test was performed to compare the load transfer efficiency at the two testing locations. Table 5 summarizes those results which indicate that in three out of the four cases, the testing location affected the load transfer efficiency. These load transfer efficiencies are normally higher at mid slabs than at the corners of the slabs.

### **Effect of Keyways on Deflection Measurements**

The final factor that was examined in this study was the effect of Keyways on the deflection measurements from sensors 1 and 5. Table 6 shows the average deflection values for various testing conditions. It is clear from Table 6 that average deflection measurements for keyway joints were less than those for non-keyway joints. The percentages of reduction in deflection were higher than 10 percent for all mid slab testing locations. The t-test was performed on the deflection measurements to determine if the differences were significant statistically. Table 7 summarizes the results from the t-test. Keyway joints resulted in statistically less deflection measurements for all mid slabs testing conditions. Keyways were not as effective in reducing deflections at corner locations.

Although deflection measurements at mid slabs of keyway joints were about 10 to 15 percent less than the deflections at non-keyway joints, these percentages are far less than the fluctuations in deflection measurements due to testing at different time of the day. As shown in

Table 8, the p.m. deflections can be about 40 percent less than the a.m. deflections. Therefore, the relatively smaller 10 to 15 percent reduction in deflection due to keyway joints may not be as effective in increasing the service life of the pavement especially that no real reduction was achieved at the weaker corner locations.

Additional analysis was performed on FWD deflection measurements at the heavier loads of 750 KPa and 900 KPa. Keyways seem to offer more friction at longitudinal joints which can result in reducing deflections due to heavy loading. As shown in Table 9, keyways were significantly more effective in reducing deflection due to the heavier loads only in the a.m. hours and slightly less effective in the p.m. hours. The reduction in deflections at keyway joints was as high as 20 percent due to the heavy load of 900 KPa which corresponds to a 29,000 lbs axle.

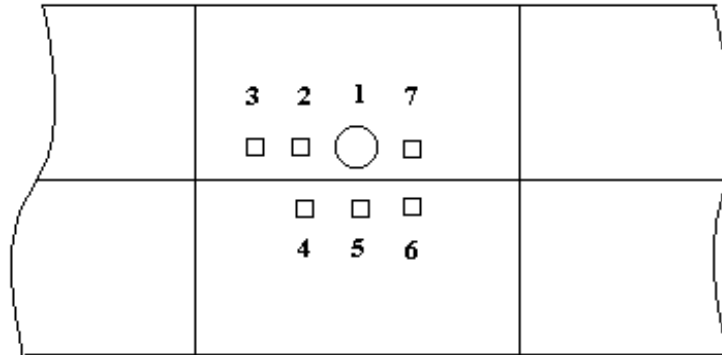
## **CONCLUSIONS**

The main objective of this study was to evaluate the effectiveness of longitudinal joints in concrete pavements with and without keyways. All tests were performed on newly constructed pavement before opening to traffic. The State Materials Office will continue performing FWD testing and condition evaluation of the sections with and without keyways to determine the effect of traffic on the performance of joints. The following conclusions can be drawn based on the testing and analysis performed up to date:

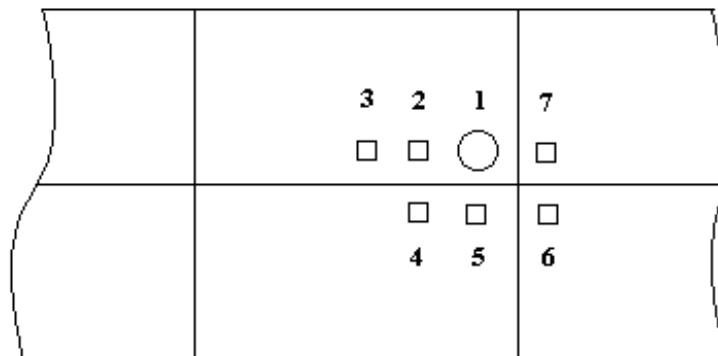
- a. The statistical analysis performed indicated that keyway and non-keyway joints provided statistically similar load transfer efficiencies.
- b. Load transfer efficiency will vary in some cases due to temperature fluctuations. The curling of the slabs may have caused those variations.

- c. The efficiencies of load transfer at mid slabs are higher than the corners of the slabs. The lower load transfer at the corners may be due to the absence of tie bars in the immediate vicinity of transverse joints.
- d. Deflection measurements taken at early morning and mid afternoon differ significantly especially at the corner locations due to induced slabs curling.
- e. Using keyway joints resulted in reducing the deflection measurements at the standard 565 KPa FWD load for mid slab test locations only. However, deflections at keyway as well as non-keyway joints were very low making such reduction insignificant.
- f. Keyway joints were more effective in reducing deflections of the heavy 900 KPa FWD load during the a.m. testing time and less effective during the p.m. testing time.
- g. Although keyway joints did not increase the load transfer efficiency of longitudinal joints, they resulted in reducing the deflection of concrete slabs. The continuous monitoring of the test sections with and without keyways will show if the reduction in deflection will result in extending the service life of the pavement.





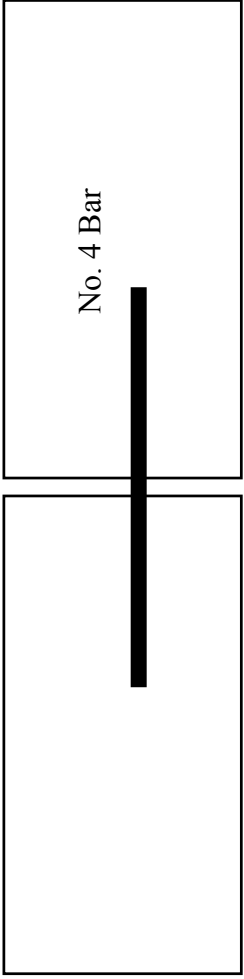
Mid Slab Testing.



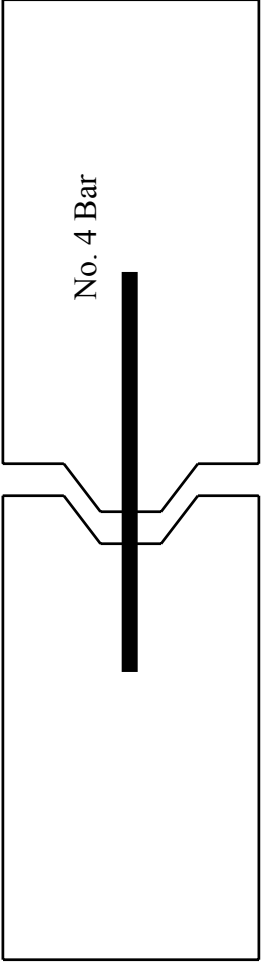
Corner Slab Testing.

- 1: FWD Loading Plate and Sensor 1 Location.  
 2 Through 7: Locations of Other Sensors.  
 All Sensors Are At 305 mm (12") Spacing.

Figure 1. FWD Testing Arrangements of Concrete Slabs.



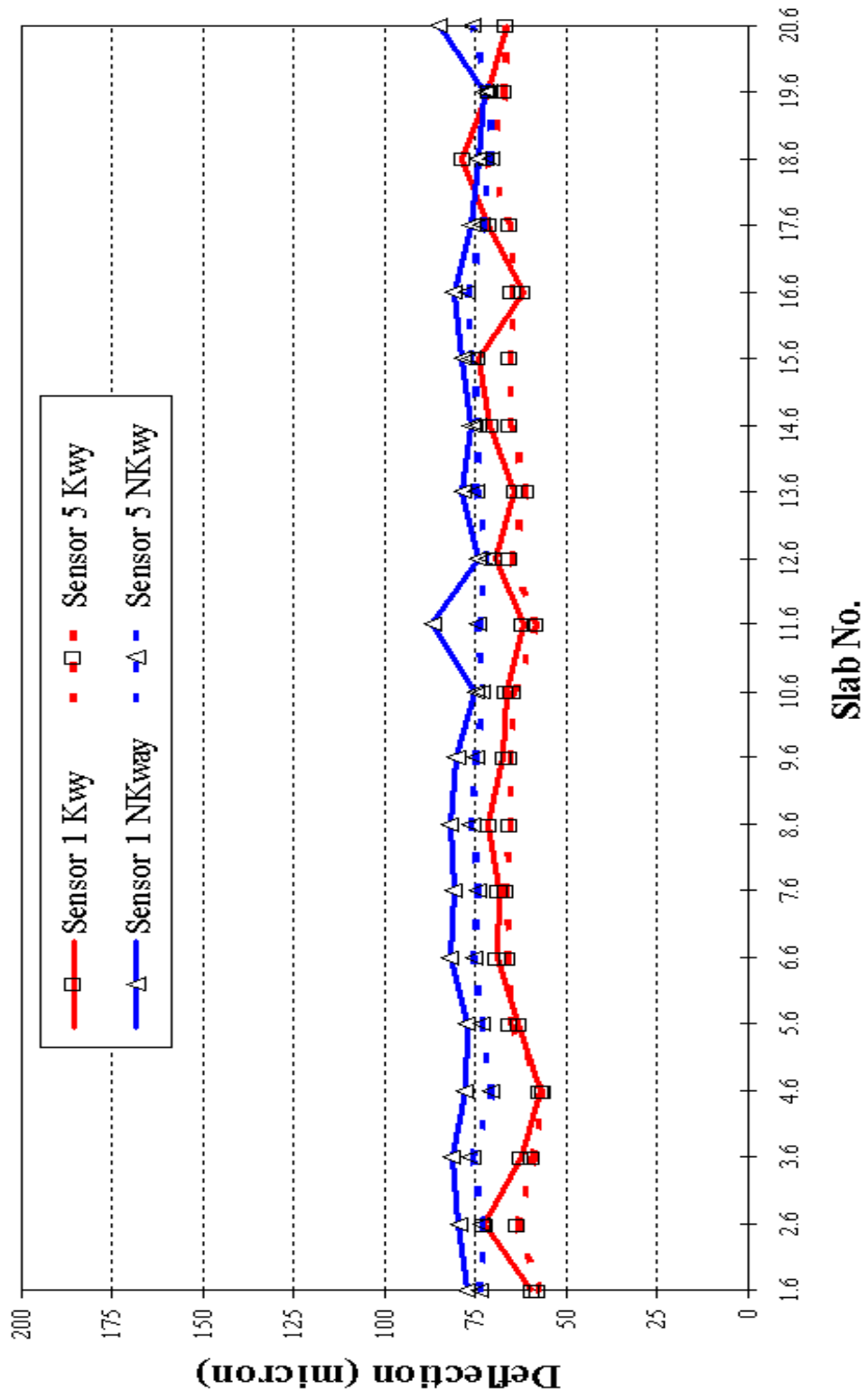
Non-Keyway Joint



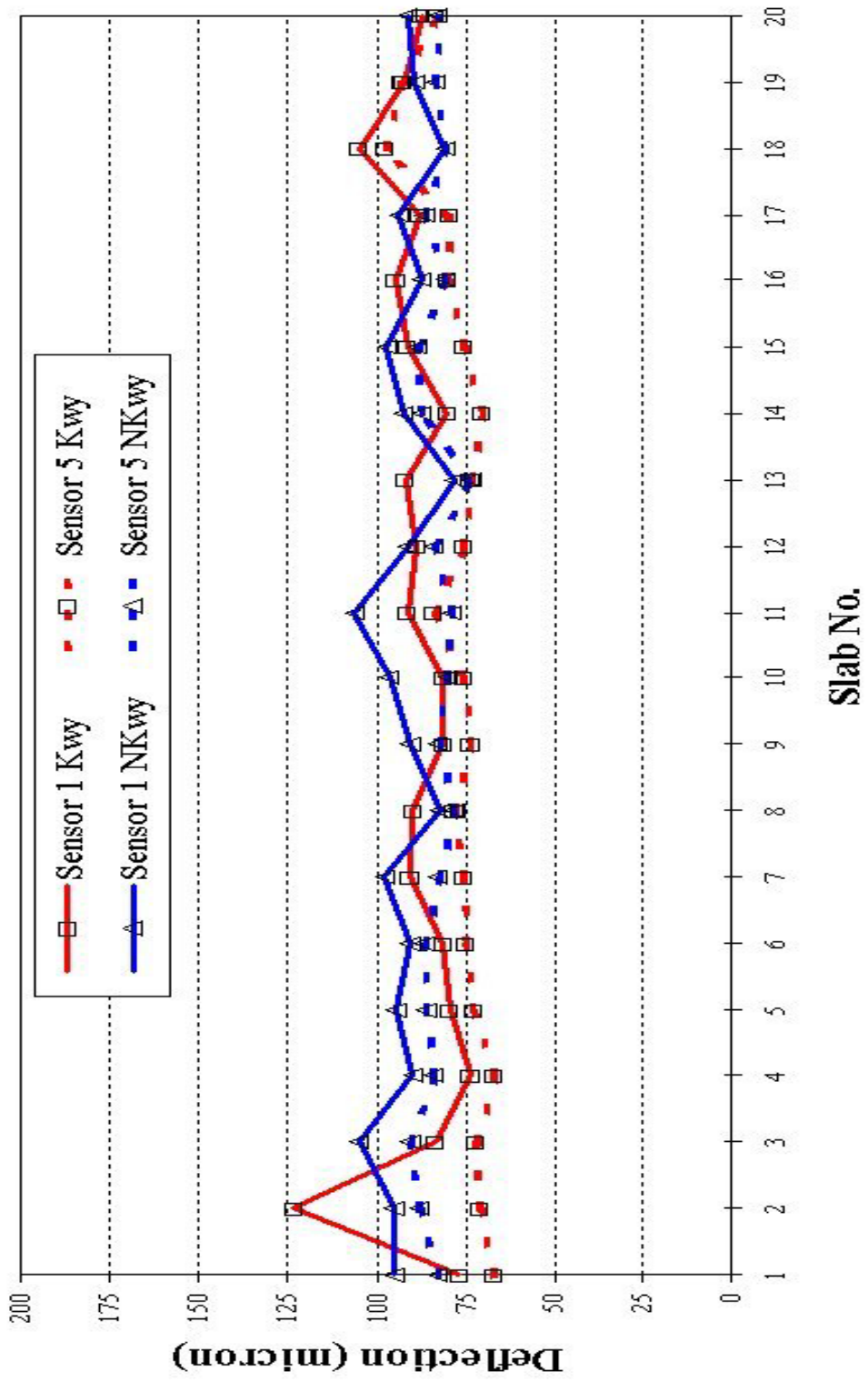
Keyway Joint

Figure 2. Typical Keyway and Non-Keyway Joints.

**Figure 3. Deflection Measurements At Mid Slabs AM.**



**Figure 4. Deflection Measurements At Mid Slabs PM.**



**Figure 5. Deflection Measurement At Corners AM.**

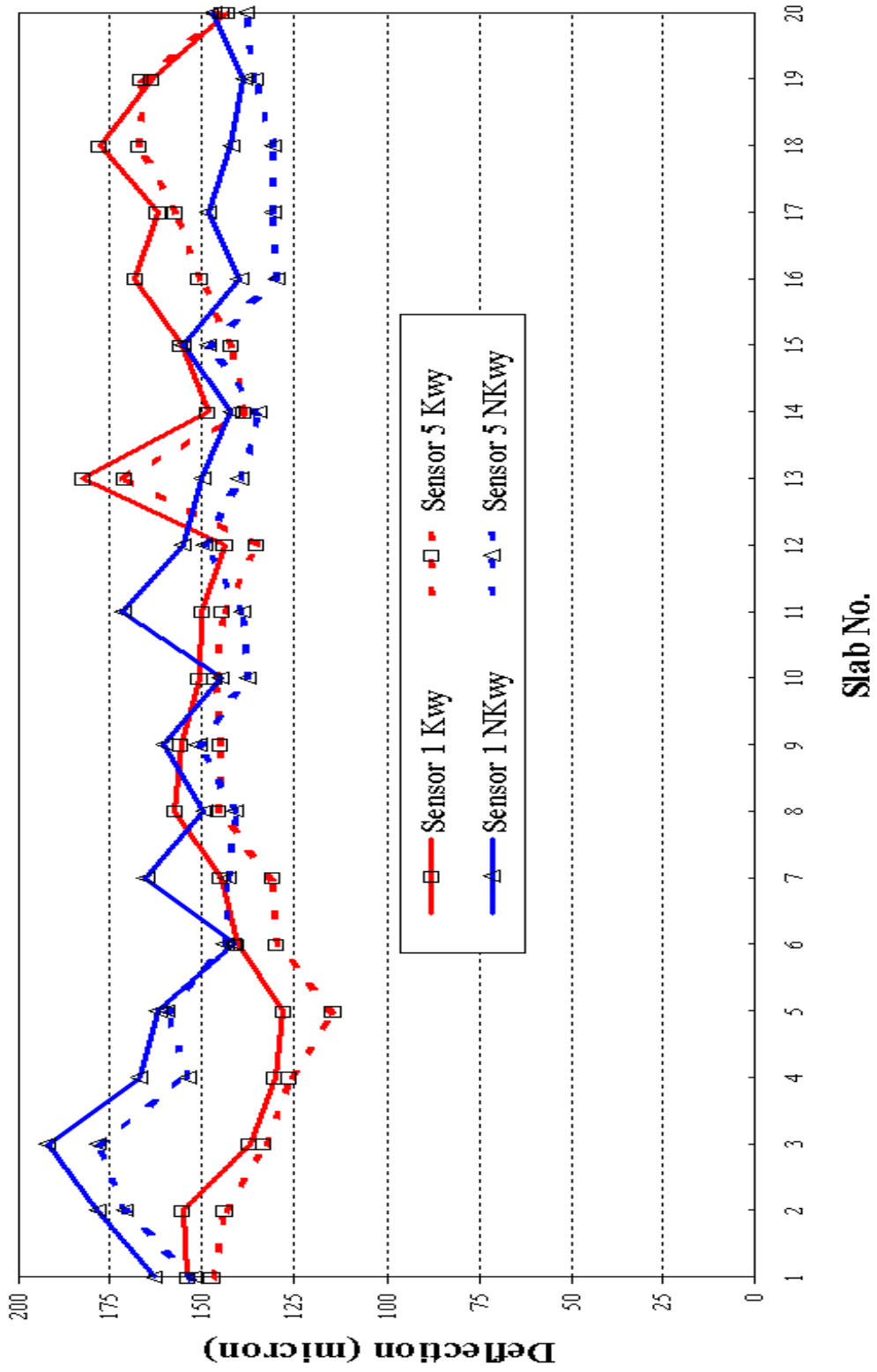


Figure 6. Deflection Measurements At Corners PM.

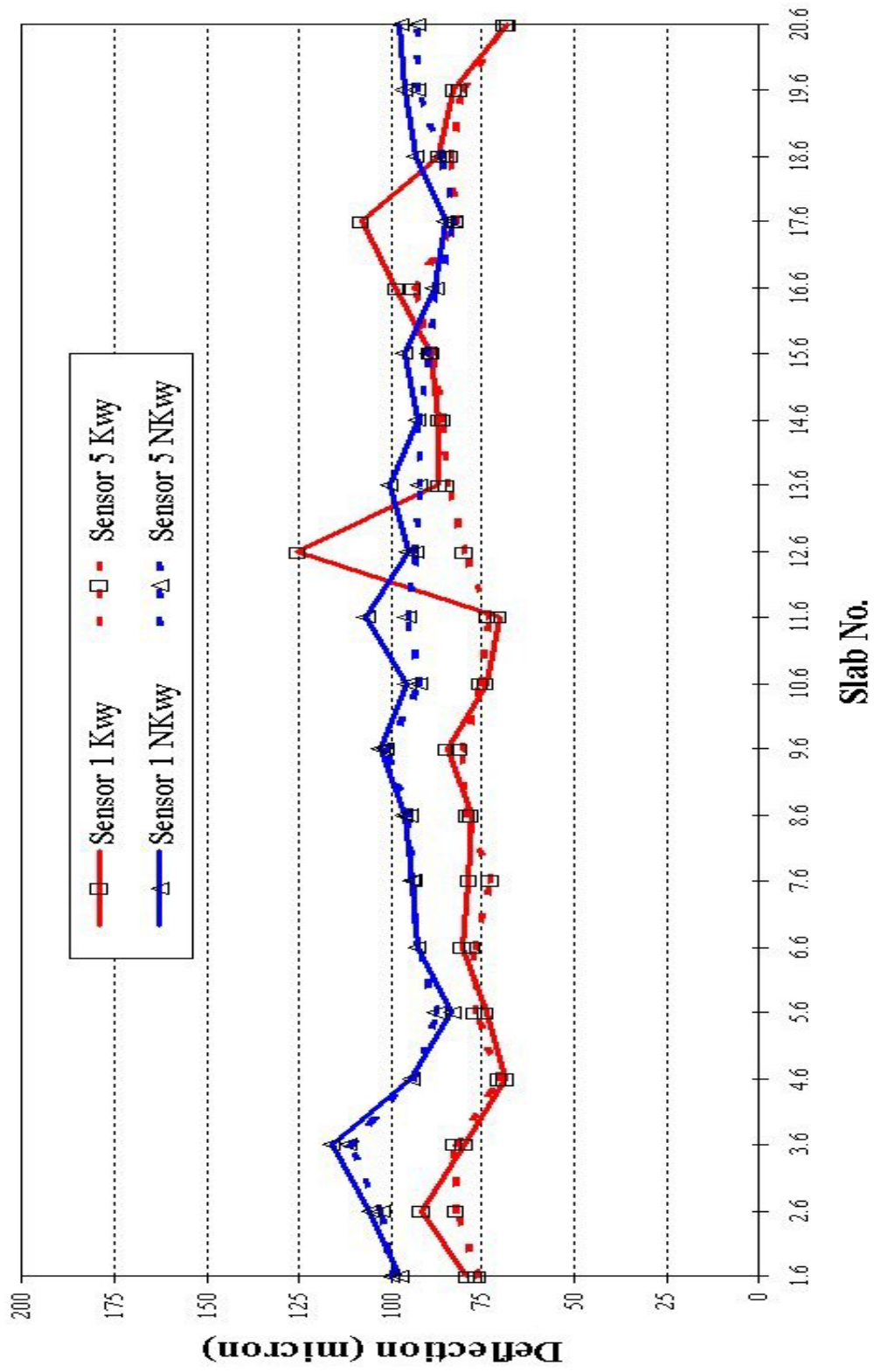


Table 1. The Eight Data Sets Included in The Study.

Data Set #	Joint Type	Testing Time	Loading Location
1	Keyway	A.M.	Mid Slab
2	Keyway	A.M.	Corner
3	Keyway	P.M.	Mid Slab
4	Keyway	P.M.	Corner
5	Non-Keyway	A.M.	Mid Slab
6	Non-Keyway	A.M.	Corner
7	Non-Keyway	P.M.	Mid Slab
8	Non-Keyway	P.M.	Corner

Table 2. Descriptive Statistics of Load Transfer Efficiencies for Various Data Sets.

Data Set #	Highest Value	Average Value	Lowest Value	Standard Deviation
1	100	95	64	9
2	100	94	89	3
3	100	95	88	4
4	100	87	58	9
5	100	97	90	3
6	100	93	81	4
7	99	94	86	3
8	100	91	75	6



Table 3. Results from T-Test Analysis on Keyway Versus Non-Keyway Joints Under Different Loading Conditions.

Testing Time	Testing Location	$t_{critical}$	$t_{calculated}$	Results
A.M.	Mid Slab	2.02	1.06	Equal
A.M.	Corner	2.02	.75	Equal
P.M.	Mid Slab	2.02	.88	Equal
P.M.	Corner	2.02	1.43	Equal

Table 4. Results from T-Test Analysis on The Effect of Testing Time (a.m. Versus p.m.) On Load Transfer Efficiency.

Joint Type	Testing Location	$t_{critical}$	$t_{calculated}$	Results
Keyway	Mid Slab	2.02	.05	Equal
Keyway	Corner	2.02	3.36	Different
Non-Keyway	Mid Slab	2.02	3.12	Different
Non-Keyway	Corner	2.02	1.72	Equal

Table 5. Results from The T-Test Analysis on The Effect of Testing Location On Load Transfer Efficiency.

Joint Type	Testing Time	$t_{critical}$	$t_{calculated}$	Results
Keyway	A.M.	2.02	0.6	Equal
Keyway	P.M.	2.02	3.56	Different
Non-Keyway	A.M.	2.02	3.02	Different
Non-Keyway	P.M.	2.02	2.25	Different

Table 6. Average deflection Measurements from Sensors 1 and 5.

Testing Location	Testing Time	Sensor # 1			Sensor # 5		
		Keyway	Non-Keyway	Percentage Difference	Keyway	Non-Keyway	Percentage Difference
Corner	A. M.	153	156	1.9%	144	146	1.3%
Mid Slab	A. M.	85	96	11.5%	80	94	14.5%
Corner	P. M.	89	92	3.2%	77	83	7.2%
Mid Slab	P. M.	67	79	15.2%	64	74	13.5%

Table 7. T-Test Results on Deflections from Keyway Versus Non-Keyway Joints Under Different Testing Conditions.

Testing Time	Testing Location	Sensor #	$t_{critical}$	$t_{calculated}$	Results
A.M.	Mid Slab	1	2.02	3.38	Different
A.M.	Mid Slab	5	2.02	7.14	Different
P.M.	Mid Slab	1	2.02	7.9	Different
P.M.	Mid Slab	5	2.02	8.9	Different
A.M.	Corner	1	2.02	.74	Equal
A.M.	Corner	5	2.02	.34	Equal
P.M.	Corner	1	2.02	1.26	Equal
P.M.	Corner	5	2.02	3.24	Different

Table 8. Percentages Change in Average deflection Measurements from Sensors 1 and 5 Due to Testing at A. M. Versus P.M.

Testing Location	Sensor # 1		Sensor # 5	
	Keyway	Non-Keyway	Keyway	Non-Keyway
Corner	42%	41%	46%	43%
Mid Slab	21%	18%	20%	21%

Table 9. Percentage Reduction in Deflection Measurements Due To The Addition of Keyways  
At Various FWD Loads.

Testing Location	Testing Time	Sensor # 1			Sensor # 5		
		565 KPa	750 KPa	900 KPa	565 KPa	750 KPa	900 KPa
Corner	A. M.	1.9%	2.6%	9.6%	1.3%	1.9%	10.8%
Mid Slab	A. M.	11.5%	13.7%	19.8%	14.5%	14.3%	20.1%
Corner	P. M.	3.2%	5.5%	2.7%	7.2%	7.8%	6%
Mid Slab	P. M.	15.2%	12%	11.3%	13.5%	12.7%	10.7%

## **APPENDIX**



## APPENDIX

### Falling Weight Deflectometer

AM	Keyways	Position	0.2	550, 750 & 900 kPa .....	A1-3
	Non-keyway		0.2	550, 750 & 900 kPa .....	A4-6
AM	Keyways	Position	0.6	550, 750 & 900 kPa .....	A7-9
	Non-keyway		0.6	550, 750 & 900 kPa .....	A10-12
PM	Keyways	Position	0.2	550, 750 & 900 kPa .....	A13-15
	Non-keyway		0.2	550, 750 & 900 kPa .....	A16-18
PM	Keyways	Position	0.6	550, 750 & 900 kPa .....	A19-21
	Non-keyway		0.6	550, 750 & 900 kPa .....	A22-24

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.2)**

Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	551	158	132	67	135	151	133	134	96%
2	538	163	137	114	136	151	134	142	93%
3	542	143	122	104	139	139	121	136	97%
4	537	137	118	98	121	133	115	125	97%
5	543	133	113	95	110	119	108	115	89%
6	539	147	128	108	131	136	119	137	93%
7	539	152	130	110	127	137	123	136	90%
8	537	166	143	120	140	153	140	145	92%
9	533	165	136	112	135	154	136	135	93%
10	532	160	139	115	140	156	142	142	98%
11	527	161	136	113	138	155	142	135	96%
12	532	153	132	110	134	144	133	139	94%
13	532	194	165	139	146	182	160	153	94%
14	537	156	134	114	134	146	132	131	94%
15	528	167	145	123	147	152	142	150	91%
16	532	179	157	133	155	160	149	162	89%
17	520	176	154	129	163	171	155	163	97%
18	524	192	166	140	180	180	160	179	94%
19	529	175	149	125	152	178	158	149	100%
20	519	156	132	112	146	157	137	146	100%

HIGH	551	194	166	140	180	182	160	179	100%
LOW	519	133	113	67	110	119	108	115	89%
AVERAGE	534	162	138	114	140	153	137	143	94%
STDEV	8	16	14	16	15	16	15	14	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.2)**

Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	742	216	180	14	183	207	181	183	96%
2	747	223	187	159	186	202	182	195	91%
3	750	196	169	144	194	192	167	188	98%
4	744	192	162	136	172	184	160	172	96%
5	750	185	155	129	152	164	149	158	89%
6	743	204	175	148	183	187	164	188	92%
7	743	209	177	149	177	188	170	188	90%
8	744	234	199	168	196	214	194	204	91%
9	740	223	185	151	185	211	182	184	95%
10	739	223	190	159	196	214	194	197	96%
11	729	222	186	156	190	212	195	185	95%
12	736	212	180	153	184	196	182	190	92%
13	736	261	222	187	203	244	216	212	93%
14	740	215	184	156	184	201	180	179	93%
15	731	230	199	169	202	207	193	207	90%
16	731	247	214	182	214	217	202	222	88%
17	715	240	209	177	221	232	209	223	97%
18	714	264	226	191	244	248	218	244	94%
19	731	240	204	171	211	240	216	205	100%
20	718	217	184	156	204	220	192	205	100%

HIGH	750	264	226	191	244	248	218	244	100%
LOW	714	185	155	14	152	164	149	158	88%
AVERAGE	736	223	189	153	194	209	187	196	94%
STDEV	11	21	19	36	20	21	19	20	3%

**FALLING WEIGHT DEFLECTOMETER**  
**SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.2)**  
**Deflection (microns)**  
**Sensor No.**

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	910	263	217	182	227	251	217	223	95%
2	918	409	228	195	226	243	220	236	59%
3	925	240	206	175	237	236	203	232	98%
4	915	234	198	165	206	225	194	210	96%
5	920	226	188	158	186	200	180	194	88%
6	917	437	214	181	224	230	201	232	53%
7	914	253	215	181	214	228	207	230	90%
8	913	285	243	205	240	262	235	249	92%
9	908	266	221	183	224	253	222	223	95%
10	909	274	232	194	238	261	237	241	95%
11	900	268	224	186	232	255	235	224	95%
12	909	260	220	186	223	240	220	232	92%
13	906	312	265	223	243	289	256	256	93%
14	907	261	223	189	222	243	218	218	93%
15	907	286	243	206	244	253	235	254	88%
16	891	299	257	218	260	263	243	268	88%
17	902	299	255	215	271	286	256	275	96%
18	896	328	281	237	301	307	272	304	94%
19	914	296	250	209	261	290	264	253	100%
20	900	268	226	190	253	272	238	252	100%

HIGH	925	437	281	237	301	307	272	304	100%
LOW	891	226	188	158	186	200	180	194	53%
AVERAGE	909	288	230	194	237	254	228	240	90%
STDEV	8	53	23	20	25	26	24	25	12%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	529	174	151	132	158	163	150	166	94%
2	523	193	164	141	156	185	168	155	96%
3	525	207	180	158	152	192	173	150	93%
4	527	179	155	132	157	165	156	155	92%
5	524	175	148	125	148	172	153	137	98%
6	524	153	134	116	145	155	143	142	100%
7	522	179	155	134	145	155	149	150	87%
8	525	161	141	121	137	152	136	138	94%
9	527	172	150	128	147	162	149	138	94%
10	525	156	135	116	143	148	137	144	95%
11	528	184	161	138	147	149	137	155	81%
12	528	166	144	123	156	160	145	153	96%
13	520	163	143	123	138	152	138	141	93%
14	522	154	137	118	143	146	140	138	95%
15	525	167	145	123	140	160	142	149	96%
16	524	151	131	112	138	140	129	138	93%
17	521	161	135	114	124	142	132	124	88%
18	525	153	131	112	133	141	129	134	92%
19	523	150	130	111	130	147	132	134	100%
20	521	160	140	120	143	150	138	145	100%

HIGH	529	207	180	158	158	192	173	166	100%
LOW	520	150	130	111	124	140	129	124	81%
AVERAGE	524	168	146	125	144	157	144	144	94%
STDEV	3	15	13	12	9	14	12	10	5%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	730	238	208	181	218	222	205	228	93%
2	724	265	223	193	216	255	230	216	96%
3	715	280	243	212	209	257	234	209	92%
4	730	247	213	180	217	229	216	213	93%
5	724	238	200	170	201	235	207	188	99%
6	727	214	187	160	201	216	197	197	100%
7	724	246	212	182	202	215	204	208	87%
8	727	223	194	166	189	210	188	190	94%
9	727	236	205	176	204	222	205	191	94%
10	723	215	186	161	199	205	189	198	95%
11	728	256	224	191	205	209	195	216	82%
12	724	229	197	170	215	221	200	211	97%
13	724	228	198	171	190	210	195	195	92%
14	723	212	187	159	197	200	190	192	94%
15	731	232	201	171	196	222	197	208	96%
16	728	211	180	154	192	195	179	191	92%
17	719	219	184	156	170	196	181	172	89%
18	726	212	179	157	184	197	179	186	93%
19	723	206	180	154	180	205	181	184	100%
20	720	222	191	164	198	207	190	200	100%

HIGH	731	280	243	212	218	257	234	228	100%
LOW	715	206	179	154	170	195	179	172	82%
AVERAGE	725	231	200	171	199	216	198	200	94%
STDEV	4	20	17	15	13	17	15	14	4%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	917	298	259	224	272	278	255	285	93%
2	946	335	286	246	279	326	293	280	97%
3	937	357	308	270	270	325	291	272	91%
4	947	317	272	230	279	293	277	275	92%
5	942	300	252	214	256	295	258	242	98%
6	946	276	238	205	257	278	253	253	100%
7	944	314	270	232	261	275	263	267	88%
8	946	288	249	214	242	270	243	244	94%
9	945	301	261	224	261	284	261	244	94%
10	945	399	237	205	257	262	242	255	66%
11	945	328	285	244	263	268	249	276	82%
12	940	294	252	217	276	284	255	271	97%
13	940	295	255	220	245	271	254	252	92%
14	937	269	234	200	251	254	239	244	94%
15	944	297	256	218	250	282	250	267	95%
16	936	394	227	195	132	247	228	243	63%
17	936	278	233	196	217	252	230	221	91%
18	938	269	229	197	234	251	226	236	93%
19	938	266	232	198	229	261	234	236	100%
20	935	283	243	207	254	262	242	255	100%

HIGH	947	399	308	270	279	326	293	285	100%
LOW	917	266	227	195	132	247	226	221	63%
AVERAGE	940	308	254	218	249	276	252	256	91%
STDEV	7	38	22	20	32	22	19	17	10%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	545	82	78	71	79	79	77	79	96%
2.6	575	90	81	76	79	81	82	80	90%
3.6	545	83	78	71	86	86	80	82	100%
4.6	548	71	68	62	71	73	69	69	100%
5.6	558	75	76	71	74	78	77	74	100%
6.6	534	85	81	74	77	82	77	84	96%
7.6	534	83	81	74	76	77	77	80	93%
8.6	545	81	79	74	81	82	80	80	100%
9.6	537	89	85	76	84	85	82	88	96%
10.6	536	78	75	69	78	80	77	79	100%
11.6	531	75	72	69	77	78	76	239	100%
12.6	525	135	87	78	84	86	85	89	64%
13.6	529	93	89	82	89	90	90	89	97%
14.6	532	92	89	82	89	91	90	89	99%
15.6	531	95	93	87	92	94	93	94	99%
16.6	524	106	103	92	99	101	99	103	95%
17.6	522	117	99	92	87	89	90	95	76%
18.6	540	91	86	78	88	88	88	86	97%
19.6	527	89	85	78	82	87	85	84	100%
20.6	526	73	70	60	75	74	73	69	100%

HIGH	575	135	103	92	99	101	99	239	100%
LOW	522	71	68	60	71	73	69	69	64%
AVERAGE	537	89	83	76	82	84	82	92	95%
STDEV	13	15	9	8	7	7	8	36	9%



**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	750	113	106	99	108	109	106	108	96%
2.6	744	122	114	107	111	115	113	111	94%
3.6	750	116	107	98	119	119	110	113	100%
4.6	759	98	90	83	97	97	93	93	99%
5.6	743	109	105	99	101	108	106	103	99%
6.6	739	119	111	101	108	112	106	114	94%
7.6	737	117	112	101	106	107	107	113	91%
8.6	753	115	110	102	113	115	111	110	100%
9.6	740	124	117	104	115	117	113	121	94%
10.6	742	111	104	94	108	111	107	109	100%
11.6	735	106	101	95	106	108	106	365	100%
12.6	727	126	120	109	115	118	118	122	94%
13.6	735	132	124	115	124	124	125	124	94%
14.6	737	127	121	112	123	125	122	123	98%
15.6	738	133	128	118	126	129	128	127	97%
16.6	728	147	141	127	137	139	135	142	95%
17.6	705	152	135	127	119	122	121	130	80%
18.6	728	126	118	109	123	123	121	121	98%
19.6	731	125	118	110	116	121	120	117	100%
20.6	730	102	96	85	102	103	100	96	100%

HIGH	759	152	141	127	137	139	135	365	100%
LOW	705	98	90	83	97	97	93	93	80%
AVERAGE	738	121	114	105	114	116	113	128	96%
STDEV	12	14	13	12	10	10	10	57	5%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	929	161	131	120	134	134	130	132	83%
2.6	916	139	137	129	135	138	138	136	99%
3.6	921	142	131	120	145	145	133	138	100%
4.6	927	119	111	102	118	119	115	113	100%
5.6	918	133	127	119	123	130	127	124	98%
6.6	909	145	135	124	133	137	130	138	94%
7.6	905	144	135	124	128	130	130	136	90%
8.6	922	141	133	125	137	139	134	134	99%
9.6	913	154	144	128	140	144	141	148	94%
10.6	913	137	127	114	135	135	132	134	99%
11.6	906	131	122	115	128	131	128	349	100%
12.6	901	155	147	134	140	145	143	151	94%
13.6	904	163	151	140	152	155	151	151	95%
14.6	912	156	148	137	150	152	150	149	97%
15.6	1245	157	148	138	149	151	150	150	96%
16.6	921	183	174	159	170	174	167	176	95%
17.6	887	179	170	160	149	151	153	164	84%
18.6	904	155	146	135	152	153	151	150	99%
19.6	912	155	146	135	143	149	148	144	100%
20.6	915	127	118	108	128	129	126	120	100%

HIGH	1245	183	174	160	170	174	167	349	100%
LOW	887	119	111	102	118	119	115	113	83%
AVERAGE	929	149	139	128	139	142	139	152	96%
STDEV	75	16	16	15	12	12	13	49	5%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	530	104	102	92	105	106	105	101	100%
2.6	531	112	106	98	107	109	106	107	97%
3.6	528	124	117	108	118	119	117	120	96%
4.6	527	101	97	90	100	101	99	95	100%
5.6	530	89	86	81	90	93	90	85	100%
6.6	530	99	97	89	96	99	97	96	100%
7.6	529	100	103	94	98	101	99	103	100%
8.6	527	103	99	91	100	102	100	98	99%
9.6	531	109	103	96	105	108	107	102	99%
10.6	526	103	98	92	96	99	102	98	96%
11.6	523	115	111	101	101	103	103	110	90%
12.6	531	101	98	89	97	99	96	97	98%
13.6	519	109	103	96	98	100	98	102	92%
14.6	525	100	96	89	97	100	99	95	100%
15.6	523	104	100	94	96	97	96	98	93%
16.6	524	95	91	86	91	95	93	90	100%
17.6	527	91	87	81	87	89	89	86	98%
18.6	523	101	98	90	92	93	92	97	92%
19.6	528	103	99	92	96	99	98	96	100%
20.6	523	105	101	94	99	100	99	100	100%

HIGH	531	124	117	108	118	119	117	120	100%
LOW	519	89	86	81	87	89	89	85	90%
AVERAGE	527	103	100	92	98	101	99	99	97%
STDEV	3	8	7	6	7	7	6	8	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	734	147	139	128	145	147	144	139	100%
2.6	733	153	145	135	146	148	145	144	97%
3.6	732	167	157	146	159	160	157	160	96%
4.6	728	139	132	124	137	139	136	130	100%
5.6	732	123	118	111	125	129	125	117	100%
6.6	733	137	133	124	133	136	133	131	99%
7.6	710	142	143	137	136	139	137	142	98%
8.6	731	144	135	125	138	139	138	134	97%
9.6	728	142	135	126	139	141	141	136	99%
10.6	728	142	135	127	131	136	138	135	96%
11.6	725	156	149	138	139	140	140	149	90%
12.6	730	139	133	123	134	135	130	134	97%
13.6	710	151	141	132	135	138	135	141	91%
14.6	727	139	130	123	134	136	135	130	98%
15.6	723	144	137	129	133	133	133	136	92%
16.6	725	132	126	120	128	131	129	124	99%
17.6	730	127	120	112	121	124	122	120	98%
18.6	728	140	133	124	127	127	126	132	91%
19.6	728	143	137	128	131	135	135	134	100%
20.6	726	144	139	128	137	137	135	138	100%

HIGH	734	167	157	146	159	160	157	160	100%
LOW	710	123	118	111	121	124	122	117	90%
AVERAGE	727	143	136	127	135	138	136	135	97%
STDEV	7	10	9	8	8	8	8	10	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**AM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	956	188	177	163	185	186	183	178	99%
2.6	957	195	184	171	186	188	186	184	96%
3.6	955	213	200	184	202	201	198	204	94%
4.6	949	176	169	158	175	178	174	166	100%
5.6	951	158	150	141	160	165	159	150	100%
6.6	951	177	170	158	169	175	170	168	99%
7.6	926	187	182	166	173	177	173	181	95%
8.6	950	185	172	159	175	177	175	170	96%
9.6	948	182	173	161	177	180	179	172	99%
10.6	948	183	174	163	168	174	177	173	95%
11.6	943	198	190	176	178	179	178	190	90%
12.6	945	177	171	158	170	172	167	170	97%
13.6	922	193	183	166	173	177	172	174	92%
14.6	946	176	166	157	170	174	172	166	99%
15.6	940	185	176	165	170	170	168	173	92%
16.6	940	167	160	151	163	166	164	156	99%
17.6	945	164	154	143	155	159	156	153	97%
18.6	943	178	171	158	162	163	162	169	92%
19.6	946	182	175	163	168	172	172	171	100%
20.6	944	184	176	163	175	175	172	174	100%

HIGH	957	213	200	184	202	201	198	204	100%
LOW	922	158	150	141	155	159	156	150	90%
AVERAGE	945	182	174	161	173	175	173	172	97%
STDEV	9	12	11	10	10	9	10	12	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	534	81	69	57	68	71	63	68	88%
2	528	132	74	62	69	76	72	73	58%
3	534	88	75	63	75	76	73	78	86%
4	524	79	68	58	69	72	69	70	91%
5	562	80	71	59	70	73	70	72	91%
6	561	82	72	61	74	75	72	73	91%
7	562	91	77	65	75	76	74	82	84%
8	557	91	75	62	78	79	72	78	87%
9	555	83	75	62	71	75	69	73	90%
10	555	83	73	62	74	77	70	74	93%
11	558	92	76	63	76	85	74	74	92%
12	551	91	75	65	75	77	68	75	85%
13	553	94	77	61	74	75	70	78	80%
14	559	81	68	58	65	71	65	68	88%
15	548	94	79	67	74	78	72	78	83%
16	556	96	81	66	78	81	73	82	84%
17	553	90	74	64	80	81	74	83	90%
18	553	107	97	83	98	100	90	103	93%
19	548	95	85	71	91	96	82	92	100%
20	530	93	81	70	85	89	80	87	96%

HIGH	562	132	97	83	98	100	90	103	100%
LOW	524	79	68	57	65	71	63	68	58%
AVERAGE	549	91	76	64	76	79	73	78	87%
STDEV	12	12	7	6	8	8	6	9	9%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	741	111	95	78	95	97	88	95	87%
2	729	126	102	86	95	104	99	101	83%
3	735	121	103	87	102	105	99	107	87%
4	726	109	93	81	96	100	96	98	92%
5	757	112	97	81	95	99	95	99	88%
6	762	113	97	83	100	102	98	101	90%
7	761	121	102	87	99	102	99	108	84%
8	753	123	102	85	105	106	96	106	86%
9	749	121	101	85	96	101	92	100	83%
10	751	120	99	83	99	104	96	101	87%
11	733	125	103	87	105	116	102	102	93%
12	747	123	103	88	101	105	93	104	85%
13	750	127	104	83	99	103	95	104	81%
14	755	110	92	78	89	95	87	92	86%
15	742	126	106	90	100	106	97	106	84%
16	752	130	107	90	106	109	99	111	84%
17	747	120	100	85	107	109	98	110	91%
18	725	147	129	109	130	133	119	139	90%
19	740	133	115	97	125	131	111	124	98%
20	723	121	108	94	119	120	107	118	99%

HIGH	762	147	129	109	130	133	119	139	99%
LOW	723	109	92	78	89	95	87	92	81%
AVERAGE	744	122	103	87	103	107	98	106	88%
STDEV	12	9	8	7	10	10	7	11	5%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	956	142	120	100	121	125	112	122	88%
2	942	325	129	111	121	133	127	131	41%
3	953	154	131	112	131	134	128	138	87%
4	942	140	119	102	123	127	123	126	91%
5	948	141	120	100	118	122	118	124	87%
6	950	142	121	103	126	127	122	127	89%
7	949	151	127	108	124	127	121	134	84%
8	945	152	128	106	130	132	119	131	87%
9	938	152	126	104	119	124	114	125	82%
10	942	151	122	102	124	129	122	126	85%
11	914	406	129	108	131	146	128	128	36%
12	937	154	129	110	127	131	117	131	85%
13	940	157	130	103	125	130	119	131	83%
14	945	136	116	98	111	120	108	114	88%
15	931	158	133	111	125	132	119	131	84%
16	938	161	134	112	133	136	122	139	84%
17	935	148	125	106	134	137	123	138	93%
18	951	183	159	135	158	160	147	172	87%
19	928	167	142	121	156	162	136	154	97%
20	909	156	134	114	149	148	135	146	95%

HIGH	956	406	159	135	158	162	147	172	97%
LOW	909	136	116	98	111	120	108	114	36%
AVERAGE	940	174	129	108	129	134	123	133	83%
STDEV	12	68	9	8	12	12	9	13	16%



**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	544	99	86	74	85	86	78	92	87%
2	541	99	86	77	88	92	83	93	93%
3	540	110	96	83	91	95	89	99	86%
4	545	93	82	72	86	87	81	87	94%
5	546	98	84	72	86	89	81	86	91%
6	543	94	84	75	88	90	80	89	96%
7	543	102	90	78	85	86	81	94	84%
8	545	85	79	71	78	81	75	82	95%
9	548	93	83	72	81	85	80	84	91%
10	549	99	85	73	82	82	78	87	83%
11	544	110	96	83	85	82	77	93	75%
12	544	95	84	73	87	87	81	90	92%
13	546	81	72	63	75	76	73	75	94%
14	548	95	85	74	84	90	83	88	95%
15	549	100	86	75	88	91	85	89	91%
16	542	91	82	72	81	84	80	86	92%
17	551	96	85	73	87	89	83	88	93%
18	542	84	74	63	80	84	75	86	100%
19	542	93	82	73	86	87	81	89	94%
20	543	95	84	74	81	86	81	87	91%

HIGH	551	110	96	83	91	95	89	99	100%
LOW	540	81	72	63	75	76	73	75	75%
AVERAGE	545	96	84	74	84	86	80	88	91%
STDEV	3	7	6	5	4	4	4	5	6%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	734	139	116	99	115	115	106	123	83%
2	735	134	116	103	119	125	112	125	93%
3	731	147	128	110	124	129	119	134	88%
4	732	126	111	96	117	117	108	118	93%
5	740	131	114	98	117	121	110	116	92%
6	736	126	113	99	119	122	110	121	97%
7	737	137	121	107	115	116	111	127	85%
8	736	117	107	96	107	110	102	111	94%
9	741	123	111	98	110	115	107	114	93%
10	741	133	115	98	113	114	106	118	86%
11	735	150	130	112	116	111	104	126	74%
12	738	131	114	99	118	119	110	123	91%
13	737	110	98	86	101	104	98	101	95%
14	740	130	116	102	114	122	112	121	94%
15	741	134	116	101	119	123	114	121	92%
16	733	129	112	98	110	114	108	117	88%
17	743	133	115	100	118	121	112	121	91%
18	732	113	101	87	108	111	103	111	98%
19	732	125	111	98	116	117	110	121	94%
20	736	129	114	100	110	116	110	116	90%

HIGH	743	150	130	112	124	129	119	134	98%
LOW	731	110	98	86	101	104	98	101	74%
AVERAGE	737	130	114	99	114	117	109	119	90%
STDEV	4	10	7	6	5	6	5	7	6%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.2)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1	921	342	143	122	143	142	129	152	42%
2	923	167	145	127	148	154	140	155	92%
3	920	340	156	135	152	159	147	164	47%
4	922	156	136	119	145	142	135	146	91%
5	925	165	142	123	146	152	137	145	92%
6	923	158	141	124	147	152	135	150	96%
7	923	220	149	129	141	144	136	156	65%
8	924	148	133	118	133	137	127	138	93%
9	925	154	140	120	137	142	133	142	92%
10	927	165	142	122	140	141	134	148	85%
11	922	187	163	141	144	139	128	156	74%
12	923	164	142	122	147	148	136	152	90%
13	924	139	122	107	127	130	122	127	94%
14	926	163	145	127	143	153	141	151	94%
15	927	166	144	125	147	153	141	151	92%
16	921	161	137	120	136	140	133	144	87%
17	928	165	141	123	145	149	137	149	90%
18	921	142	126	111	134	139	127	136	98%
19	919	156	136	121	145	145	135	150	93%
20	921	161	141	123	136	144	135	143	89%

HIGH	928	342	163	141	152	159	147	164	98%
LOW	919	139	122	107	127	130	122	127	42%
AVERAGE	923	181	141	123	142	145	134	148	85%
STDEV	2	57	9	7	6	7	6	8	16%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	535	63	60	53	59	61	61	61	97%
2.6	569	72	63	58	61	63	62	64	88%
3.6	533	66	62	55	62	63	62	64	95%
4.6	531	61	59	51	58	60	60	59	98%
5.6	559	64	63	57	63	66	63	68	100%
6.6	564	69	63	57	63	66	65	65	96%
7.6	560	69	67	59	67	67	66	66	97%
8.6	561	72	67	60	65	66	62	67	92%
9.6	558	68	64	58	65	66	63	67	97%
10.6	556	68	66	58	63	66	63	66	97%
11.6	547	64	60	53	62	60	58	62	94%
12.6	553	71	66	58	65	67	63	66	94%
13.6	558	65	61	54	60	62	60	61	95%
14.6	550	73	68	61	65	67	65	67	92%
15.6	552	76	70	62	67	67	65	70	88%
16.6	549	64	67	59	65	67	63	67	100%
17.6	570	71	66	60	62	65	63	65	92%
18.6	543	82	76	73	72	75	72	79	91%
19.6	551	73	68	61	67	69	66	68	95%
20.6	548	69	63	58	67	69	66	65	100%

HIGH	570	82	76	73	72	75	72	79	100%
LOW	531	61	59	51	58	60	58	59	88%
AVERAGE	552	69	65	58	64	66	63	66	95%
STDEV	11	5	4	5	3	4	3	4	4%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	738	89	83	74	81	85	83	85	96%
2.6	735	100	88	81	86	87	87	88	87%
3.6	733	93	86	78	87	88	87	88	95%
4.6	734	88	83	72	80	84	83	83	95%
5.6	754	91	87	77	87	90	87	90	99%
6.6	762	94	86	77	87	89	88	88	95%
7.6	756	96	89	81	90	92	89	89	96%
8.6	758	96	89	81	88	89	84	90	93%
9.6	754	95	88	79	87	90	87	89	95%
10.6	749	93	88	78	86	89	85	88	96%
11.6	741	88	82	72	80	82	78	84	93%
12.6	746	96	89	79	88	91	87	88	95%
13.6	753	91	83	74	82	85	82	83	93%
14.6	742	99	90	82	88	91	88	89	92%
15.6	747	103	93	84	90	92	88	95	89%
16.6	742	101	90	79	87	92	87	89	91%
17.6	729	95	89	81	85	88	87	88	93%
18.6	729	110	102	92	99	102	97	104	93%
19.6	744	98	91	83	90	93	90	92	95%
20.6	737	94	85	78	90	92	89	87	98%

HIGH	762	110	102	92	99	102	97	104	99%
LOW	729	88	82	72	80	82	78	83	87%
AVERAGE	744	96	88	79	87	90	87	89	94%
STDEV	10	5	4	5	4	4	4	5	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - KEYWAYS (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	955	115	106	96	105	108	107	108	94%
2.6	940	121	113	102	109	112	111	113	93%
3.6	951	120	111	100	111	112	110	113	93%
4.6	948	114	105	92	104	108	107	107	95%
5.6	943	117	108	97	108	112	107	112	96%
6.6	953	116	106	96	108	110	110	109	95%
7.6	949	123	112	99	111	116	111	112	94%
8.6	946	120	111	99	109	110	105	112	92%
9.6	943	121	108	98	109	112	107	111	93%
10.6	940	117	111	98	108	112	107	111	96%
11.6	928	111	101	89	100	102	98	106	92%
12.6	935	120	111	99	110	114	107	110	95%
13.6	941	112	103	92	102	106	102	103	95%
14.6	931	122	113	102	109	114	108	112	93%
15.6	937	127	117	106	113	115	108	117	91%
16.6	930	129	112	99	109	116	107	111	90%
17.6	909	117	111	100	106	109	108	110	93%
18.6	911	133	129	118	123	127	120	130	95%
19.6	932	122	114	103	113	117	112	114	96%
20.6	926	117	107	98	113	115	111	108	98%

HIGH	955	133	129	118	123	127	120	130	98%
LOW	909	111	101	89	100	102	98	103	90%
AVERAGE	937	120	110	99	109	112	108	111	94%
STDEV	13	5	6	6	5	5	4	5	2%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	547	80	78	71	74	76	75	78	95%
2.6	543	83	78	72	74	76	74	79	92%
3.6	544	85	77	71	79	79	77	81	93%
4.6	543	81	74	66	72	74	73	73	91%
5.6	546	80	75	69	74	76	73	74	95%
6.6	547	85	78	73	77	78	75	79	92%
7.6	546	84	79	72	77	77	76	80	92%
8.6	545	85	79	72	78	79	76	81	93%
9.6	545	83	77	70	76	78	76	79	94%
10.6	544	78	73	67	75	76	75	73	97%
11.6	545	90	84	76	76	77	76	84	86%
12.6	541	78	73	66	74	75	73	73	96%
13.6	550	81	76	70	76	77	76	75	95%
14.6	551	78	75	70	75	76	75	75	97%
15.6	550	81	76	69	77	78	76	76	96%
16.6	552	83	77	71	77	79	76	79	95%
17.6	543	79	74	67	75	76	74	74	96%
18.6	539	78	72	66	70	74	72	71	95%
19.6	539	76	77	66	74	75	73	73	99%
20.6	547	88	82	75	80	79	76	82	90%

HIGH	552	90	84	76	80	79	77	84	99%
LOW	539	76	72	66	70	74	72	71	86%
AVERAGE	545	82	77	70	76	77	75	77	94%
STDEV	4	4	3	3	2	2	1	4	3%

**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	734	109	105	96	99	103	100	104	94%
2.6	733	112	106	97	99	102	100	106	91%
3.6	735	114	104	95	106	106	103	108	93%
4.6	736	106	99	90	98	100	97	99	94%
5.6	736	106	100	92	99	103	98	100	97%
6.6	736	111	106	98	102	106	102	106	95%
7.6	725	116	105	96	104	105	102	108	91%
8.6	737	115	107	98	105	107	104	109	93%
9.6	739	112	104	95	101	105	102	106	94%
10.6	732	104	97	88	98	100	99	97	96%
11.6	737	123	113	102	102	105	103	113	85%
12.6	734	105	98	89	100	102	98	99	97%
13.6	739	109	102	94	101	104	102	101	95%
14.6	743	107	101	94	99	102	100	101	95%
15.6	744	111	103	94	104	105	103	104	95%
16.6	743	112	104	95	104	106	102	106	95%
17.6	735	106	99	90	100	103	99	100	97%
18.6	732	104	98	89	96	100	97	97	96%
19.6	732	106	105	88	99	101	98	98	95%
20.6	740	119	111	101	108	109	104	111	92%

HIGH	744	123	113	102	108	109	104	113	97%
LOW	725	104	97	88	96	100	97	97	85%
AVERAGE	736	110	103	94	101	104	101	104	94%
STDEV	5	5	4	4	3	3	2	5	3%



**FALLING WEIGHT DEFLECTOMETER  
SR 9A - Project No. 72002-3554 / WPI 2114721**

**PM DATA - NON-KEYWAY (position 0.6)**  
Deflection (microns)  
Sensor No.

Test date: January 9, 1998

Slab No.	Load (kPa)	1	2	3	4	5	6	7	Joint Efficiency (1 vs. 5)
1.6	922	135	130	116	124	127	123	129	94%
2.6	919	139	130	119	120	126	123	129	91%
3.6	926	141	129	118	130	132	127	132	94%
4.6	923	133	122	111	121	123	120	123	92%
5.6	922	133	125	114	124	126	121	124	95%
6.6	928	136	131	120	128	131	126	131	96%
7.6	907	143	131	119	128	130	126	134	91%
8.6	927	143	133	121	130	133	130	135	93%
9.6	927	139	129	116	126	131	127	130	94%
10.6	921	133	120	110	123	124	122	121	93%
11.6	921	152	140	127	126	130	127	141	86%
12.6	917	132	121	110	124	126	122	123	95%
13.6	923	136	127	116	126	129	126	126	95%
14.6	929	133	126	115	123	126	123	125	95%
15.6	929	136	129	116	129	130	127	129	96%
16.6	933	139	129	118	129	132	127	130	95%
17.6	922	131	121	111	124	126	122	124	96%
18.6	918	126	120	110	117	123	119	118	98%
19.6	921	135	130	109	121	124	122	121	92%
20.6	928	147	137	125	134	134	129	137	91%

HIGH	933	152	140	127	134	134	130	141	98%
LOW	907	126	120	109	117	123	119	118	86%
AVERAGE	923	137	128	116	125	128	124	128	94%
STDEV	6	6	5	5	4	3	3	6	3%