



Monitor
with
Confidence

Vibrating Wire Joint Meter Manual

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REVISION HISTORY

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D	Operation and Temperature Correction section updates: Rc and Ri changed to Lc and Li to match calibration sheets, units of linear calibration factor changed to [mm/B-unit], typo in corrected linear displacement example removed. Revision History added. List of Equations added.	2019-Sep-16	MP	QR

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1 INTRODUCTION

Joint meters are mainly used to measure the opening of joints. Joint meters have most range in expansion.

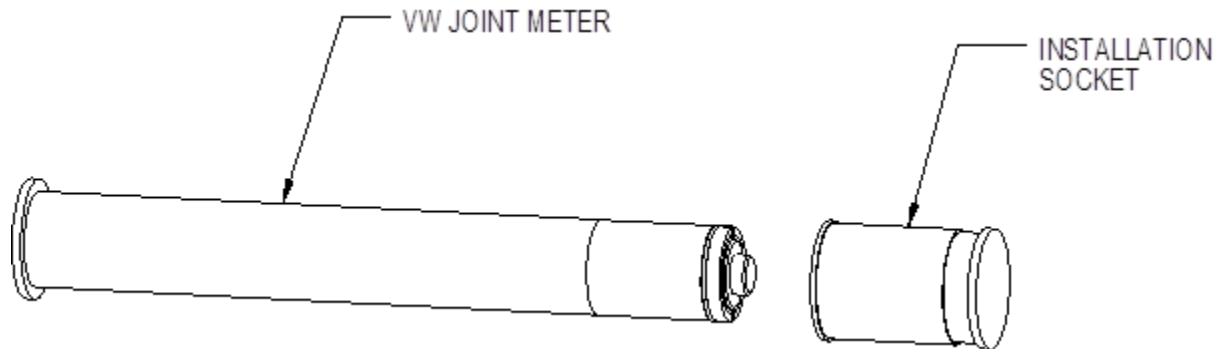


FIGURE 1-1 VIBRATING WIRE JOINT METER

The shipment will consist of the Vibrating Wire Joint Meter and the installation socket. Contact RST if the shipment is missing either item.

2 SAFETY



CAUTION: Do NOT PULL ON THE END OF THE JOINT METER. ENSURE THE PINS ARE SEATED IN THE SLOTS LOCATED IN THE END OF THE PVC HOUSING. THE PINS ARE TO PREVENT TWISTING THE SENSOR WHEN TURNING THE JOINT METER INTO THE INSTALLATION SOCKET.

THE SENSOR WILL BE DAMAGED IF THE PIN IS NOT SEATED IN THE SLOT WHEN TURNING THE VIBRATING WIRE JOINT METER.

3 INSTALLATION

3.1 INSTALLATION OF SOCKET

Connect the joint meter to a data logger to verify the instrument is functioning correctly prior to installing the joint meter.

A stainless-steel installation socket is provided with the joint meter to simplify the installation. The installation socket is installed into the form on one side of the joint. The vibrating wire joint meter is installed onto the other side of the joint.

- 1 Record the serial number and site location for each vibrating wire joint meter.
- 2 Drill a 6 mm hole at approximately 6 inches (150 mm) below the top of the lift, in the form at the predetermined joint meter location.

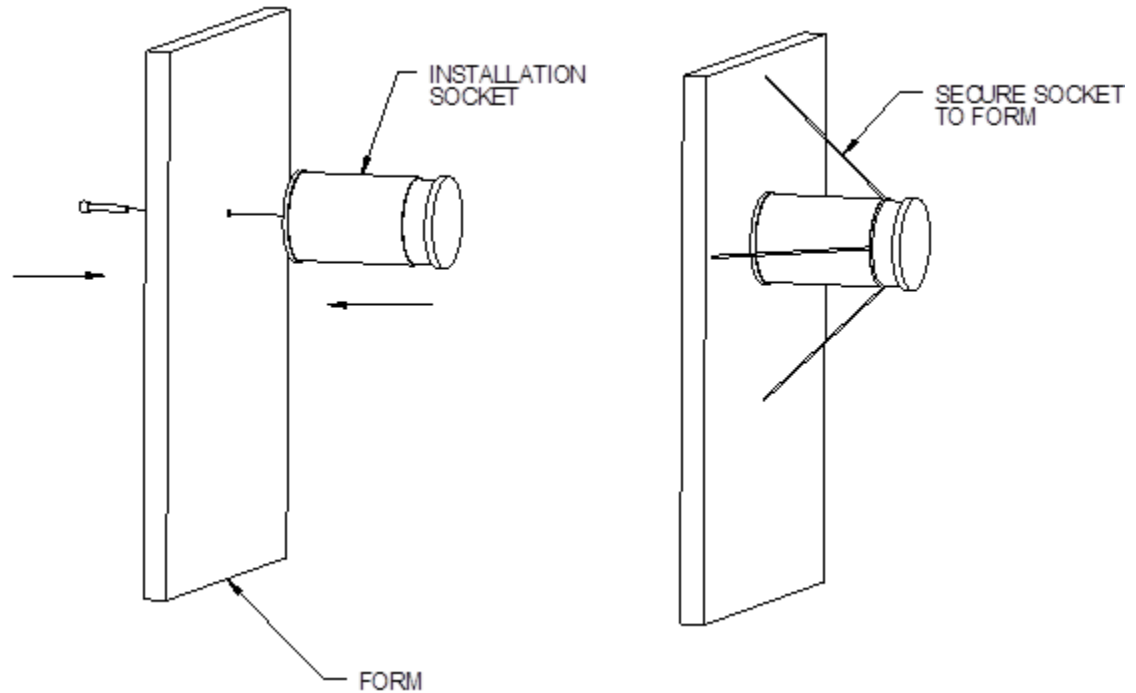


FIGURE 3-1 **INSTALLATION OF THE INSTALLATION SOCKET**

- 3 Apply a layer of grease, or similar lubricant, to the PVC plug to prevent the lift material from bonding to the plug.
- 4 Bolt the installation socket to the form using the hold drilled in Step 2.
- 5 Weld an additional anchor onto the socket to prevent it from being pulled out during form removal should forms be removed at an early stage.
- 6 A recess should be provided adjacent to the socket if the cable leads are to be run in the block in which the socket is embedded. Cable not less than 3 feet can be coiled.
- 7 Remove the form and PVC plug.
- 8 Re-install the PVC plug.
- 9 Begin pouring the next lift.

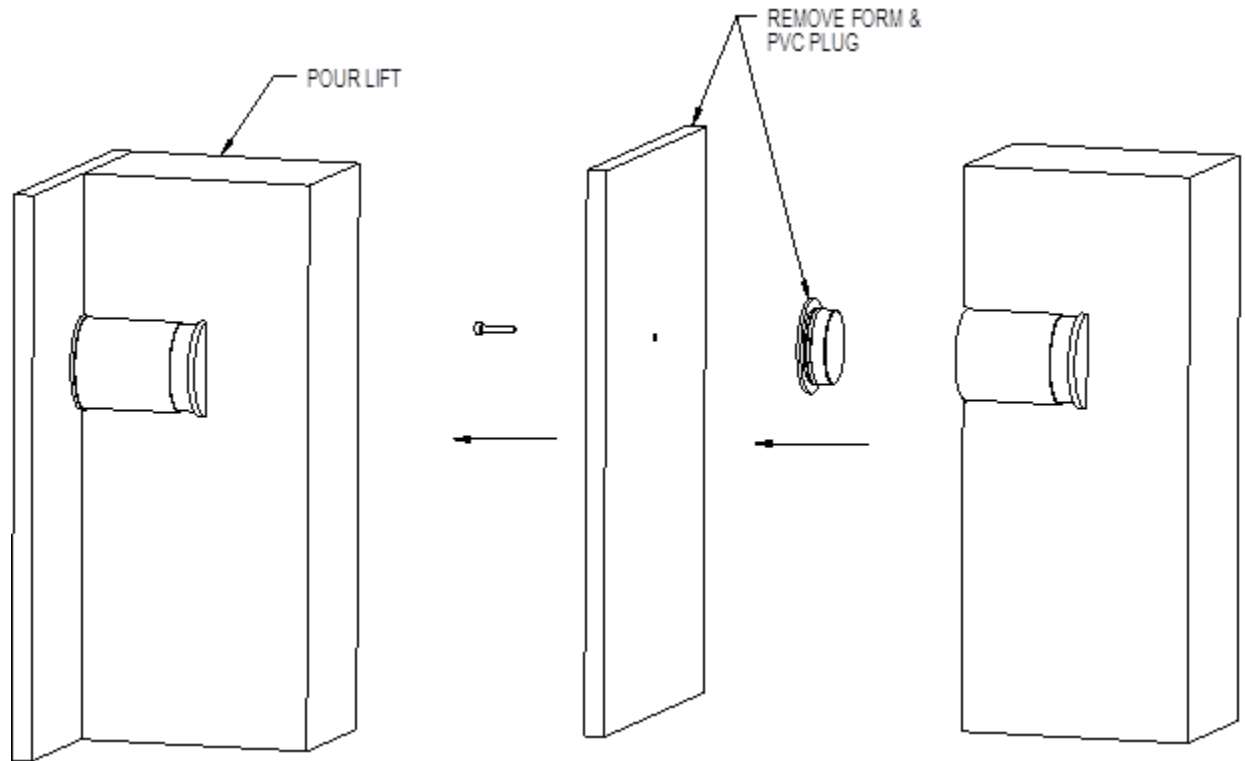


FIGURE 3-2 POUR LIFT

3.2 INSTALLATION OF JOINT METER

- 1 Remove the PVC plug in the socket when the adjacent lift reaches the elevation in which the joint meter itself is to be embedded and has set.
- 2 Loosen the sealing screw near the cable exit on the vibrating wire joint meter.
- 3 Thread the joint meter into the installed socket.



CAUTION: DO NOT PULL ON THE END OF THE JOINT METER. ENSURE THE PINS ARE SEATED IN THE SLOTS LOCATED IN THE END OF THE PVC HOUSING. THE PINS ARE TO PREVENT TWISTING THE SENSOR WHEN TURNING THE JOINT METER INTO THE INSTALLATION SOCKET.

THE SENSOR WILL BE DAMAGED IF THE PIN IS NOT SEATED IN THE SLOT WHEN TURNING THE VIBRATING WIRE JOINT METER.

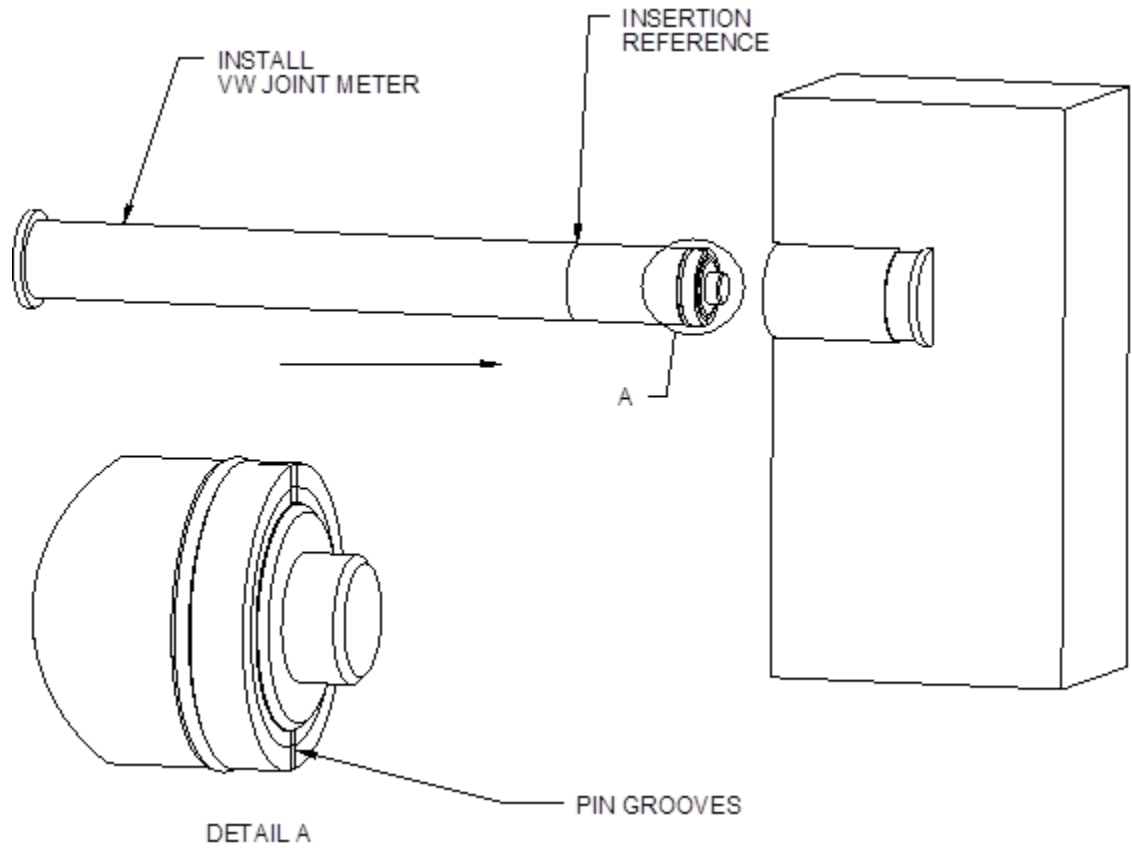


FIGURE 3-3 **INSTALLATION OF THE JOINT METER**

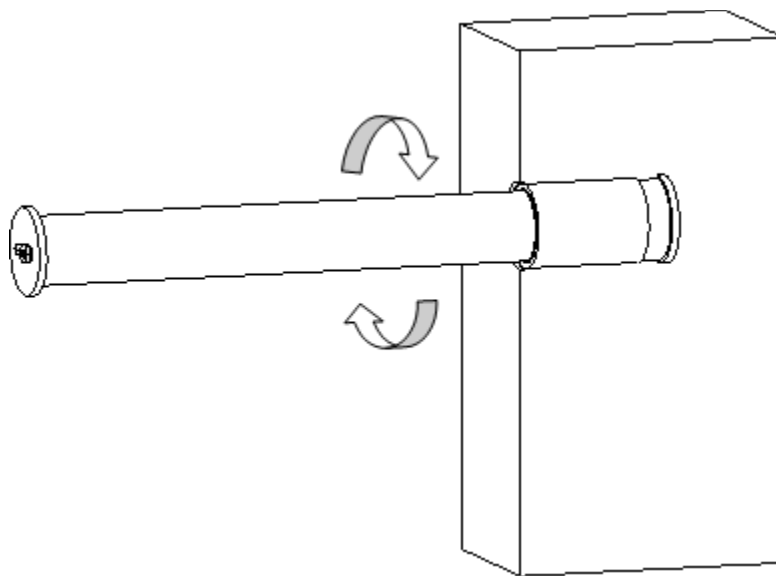


FIGURE 3-4 **TIGHTENING THE SEALING SCREW**

- 4 Tighten the sealing screw.

- 5 Provide a conduit to protect the cable when pouring the next lift. It is recommended to run the cable vertically to the gallery and then horizontally if necessary.
- 6 Pull the gage out approximately 10–15% of its range in tension to allow for slight compression of the gage. Use a RST VW2106 Vibrating Wire Readout to ensure the gage has only been pulled out approximately 10–15%.

The gage should not be rotated after pulling it from the socket. Wrap 2 – 3 layers of electrical tape around the gage tube and the socket. The tape should hold the gage at this reading while the concrete is being placed.



NOTE: THE GAGE SHOULD NOT BE ROTATED AFTER PULLING IT FROM THE SOCKET. WRAP 2 – 3 LAYERS OF ELECTRICAL TAPE AROUND THE GAGE TUBE AND THE SOCKET. THE TAPE SHOULD HOLD THE GAGE AT THIS READING WHILE THE CONCRETE IS BEING PLACED.



CAUTION: THE GAGE MUST BE PUSHED BACK IN IF IT HAS TO BE REMOVED FROM THE SOCKET. PUSH THE GAGE UNTIL THE PINS CATCH AND THEN ROTATE IT COUNTER-CLOCKWISE UNTIL IT COMES LOOSE.

- 7 Complete the lift and allow it to set.
- 8 Connect a RST VW2106 Vibrating Wire Readout to the joint meter and take initial readings. Match the readings with the instructions serial number and site location.

4 OPERATION

After the installation is complete, initial readings can be recorded by using an RST Vibrating Wire Readout or Data Logger. Make the electrical connections according to the instructions supplied with the readout and be sure to record relative site information to provide a unique identifier for the data. When referenced with the instrument's initial readings, subsequent readings will provide actual deformation, according to Equation 1:

$$\text{Subsequent reading} - \text{Initial reading} = \text{Deformation}$$

EQUATION 1 ACTUAL DEFORMATION

The readouts will output the displacement in B-units ($\text{Hz}^2 \times 10^{-3}$) and the calibration factor, supplied with each calibration sheet, may be used to convert to linear displacement units. The readouts also output the temperature in °C. If an Ohmmeter is used directly on the green and white wires, then Appendix B may be used to convert to °C.

4.1 TEMPERATURE CORRECTION

Temperature correction may not be necessary in many cases as the Vibrating Wire crack meter has a small coefficient of thermal expansion. Temperature corrections may be applied for maximum accuracy or when temperature fluctuations are greater than 10°C.

$$\text{Corrected Linear Displacement} = CF(L_c - L_i) + K(T_c - T_i)$$

EQUATION 2 LINEAR DISPLACEMENT

Enter the appropriate values into Equation 2 to calculate the displacement and convert the readings into linear units. All subsequent readings should be subtracted from the initial reading to calculate the distance the crack has opened, where:

L_c	Current reading	[B-unit]
L_i	Initial reading	[B-unit]
CF	Linear Calibration Factor, provided on the calibration sheet	[mm/B-unit]
T_c	Current temperature	[°C]
T_i	Initial temperature	[°C]
K	Temperature Factor, see Equation 3	[mm/°C]

Use Equation 3 to calculate K, the temperature correction factor:

$$K = CF[(L_c * M) + B]$$

EQUATION 3 TEMPERATURE CORRECTION FACTOR

L_c	Current reading	[B-unit]
M	Slope, see Table 4-1	[1/°C]
B	Constant, see Table 4-1	[B-unit/°C]
CF	Linear Calibration Factor, provided on the calibration sheet	[mm/B-unit]

TABLE 4-1 TEMPERATURE CORRECTION FACTOR

Stroke (mm)	25	50	100	150	200	300
Slope (M)	0.000310	0.000311	0.000399	0.000359	0.000306	0.000277
Constant (B)	-0.3186	-0.2758	-0.8128	-0.5579	-0.4498	-0.2495

Sample calculation:

Assuming the following measurements from a 150mm sensor:

L_c	3762	[B-unit]
L_i	4791	[B-unit]
CF	0.0291788	[mm/B-unit]
T_c	22.5	[°C]
T_i	13.3	[°C]
M	0.000359	[1/°C]
B	-0.5579	[B-unit/°C]

First, calculate the Temperature Correction Factor (Equation 3):

$$K = CF[(L_c * M) + B]$$

$$K = (0.0291788) * [(3762 * 0.000359) + (-0.5579)]$$

$$K = (0.0291788) * (0.792658)$$

$$K = 0.023129$$

Next, apply the Temperature Correction Factor to Equation 2 to find the Linear Displacement:

$$\text{Corrected Linear Displacement} = CF(L_c - L_i) + K(T_c - T_i)$$

$$\begin{aligned} \text{Corrected Linear Displacement} \\ = [(0.0291788) * (3762 - 4791)] + [(0.023129) * (22.5 - 13.3)] \end{aligned}$$

$$\text{Corrected Linear Displacement} = (-1029 * 0.0291788) + (0.023129 * 9.2)$$

$$\text{Corrected Linear Displacement} = (-30.02499) + (0.212785)$$

$$\text{Corrected Linear Displacement} = -29.8122\text{mm}$$

4.1.1 Thermistor Temperature Compensation

The following equation may be used to convert the measured thermistor resistance R (Ω) to temperature T (°C) to compensate for Temperature.

EQUATION 4 CONVERTING THERMAL RESISTANCE TO TEMPERATURE

$$T = \frac{1}{1.4051 * 10^{-3} + 2.369 * 10^{-4} * \ln(R) + 1.019 * 10^{-7} * (\ln(R))^3} - 273.2$$

Alternatively, the values may be looked up directly in Table 4-2.

TABLE 4-2 THERMISTOR RESISTANCE (Ω) VERSUS TEMPERATURE ($^{\circ}\text{C}$)

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	+30	525.4	+70	153.2	+110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.11	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	+1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342.2	83	107.9	123
77.99K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-35	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	282.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	56.92	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.	53	250.9	93	83.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	3000	25	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149
								55.6	150

5 SERVICE AND REPAIR

The product contains no user-serviceable parts. Contact RST for product service or repair not covered in this manual.