VW Embedment Jointmeter

52632244

SLOPE INDICATOR
12123 Harbour Reach Drive
Mukilteo, Washington, USA, 98275
Tel: 425-493-6200 Fax: 425-493-6250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

Contents

Introduction

About Embedment Jointmeters

VW embedment joinmeters are used to monitor openings of joints between lifts or sections in mass concrete.

The jointmeter consists of a socket, which is embedded in the first lift, and a vibrating wire transducer, which is embedded in an adjacent lift. The two parts of the jointmeter are connected by the transducer shaft, which is threaded into the socket. As the joint opens, the shaft is pulled out. As the joint closes, the shaft is pushed in. The vibrating wire element returns a signal that is proportional to the position of the shaft. The drawing below shows the various components of the jointmeter.

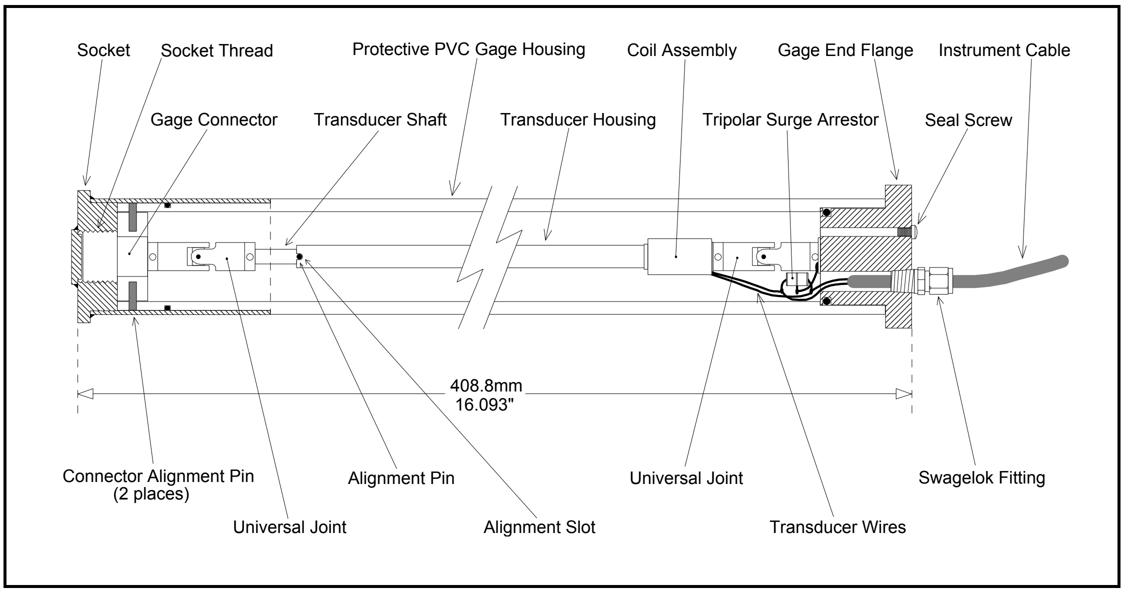


Figure 1 - Vibrating Wire Embedment Jointmeter

Testing the Jointmeter

Warning: In your testing, do not extend the shaft beyond the range of the transducer. Also, do not turn twist or turn the transducer connector or shaft independently of the transducer body.

Check the jointmeter for proper operation by connecting it to a readout. See Section 3 for readout instructions. The readout will display about 2000 (hz^2/1000) when the threaded connector is pulled out approximately 3 mm (0.125").

Resistance between the transducer leads should be approximately 180 Ω, ±10 Ω. Remember to add cable resistance (22 AWG stranded copper leads are approximately 14.7Ω/1000' or 48.5Ω/km. Multiply by 2 for both directions). You should measure approximately 3000 ohms at 25° between the green and white wire, and more than 2 megohms between any conductor and the shield .

Installation

Overview

Installation involves two steps:

1. Installing the socket.
2. Installing the transducer.

Installing the Socket

The socket is installed in the first lift of concrete, as shown in the drawing below. The protective socket plug has a 1/4-20 thread which can be used to bolt the socket to the forms. The socket could also be welded to rebar or tied in place with wire. No matter what fixing method you choose, keep these two points in mind:

1. The socket must be plugged during concreting and the plug must be removable.
2. The open face of the socket must be approximately flush with the finished face of the concrete.

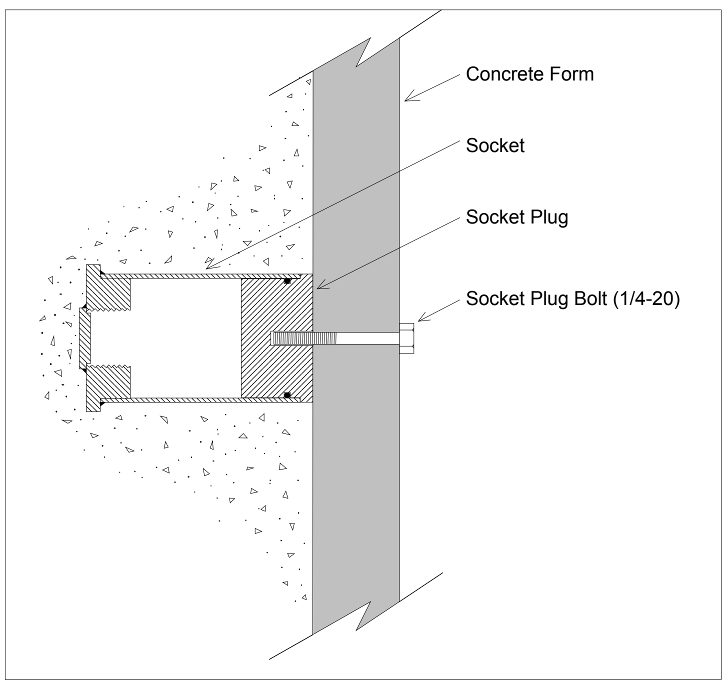


Figure 2 - Socket Installation

Installing the transducer

1. After the forms have been stripped and the socket is exposed, remove the plug. See Figure 2. Clean the socket thoroughly, then apply a light coat of grease on its surfaces.
2. Check that the pins in the connector are in the slots in the plastic housing. Then push the jointmeter into the socket. See Figure 1.
3. Remove the seal screw from the cable end flange. See Figure 1.
4. Place a small amount of epoxy or thread locking compound on the threads of the transducer connector. Then push the transducer into the socket until it stops. While applying an inward pressure, rotate the transducer in a clockwise direction until the connection is snug in the socket thread. Note: If the stiff direct burial cable is being used, the cable bundle or reel should also be rotated to avoid crimping the cable.
5. Secure the transducer body and cable in position for placing concrete. Connect your readout, as explained in "Taking Readings." Pull the transducer outwards until you see a reading of about 3000-3500 (Hz^2 / 1000). This sets the transducer at approximately 25% of its range in tension to allow for some closing of the joint. Remember that the transducer must not be rotated as you move it.
6. After setting the position of the transducer, wrap 2-3 layers of electrical tape around the transducer tube immediately adjacent to the socket to hold the transducer at this reading while the concrete is being placed. If the transducer has to be removed from the socket, it should be pushed back in until the pins catch and then rotated counter-clockwise until it comes loose.
7. Re-install the 10-32 x 3/8" seal screw into the transducer end flange.

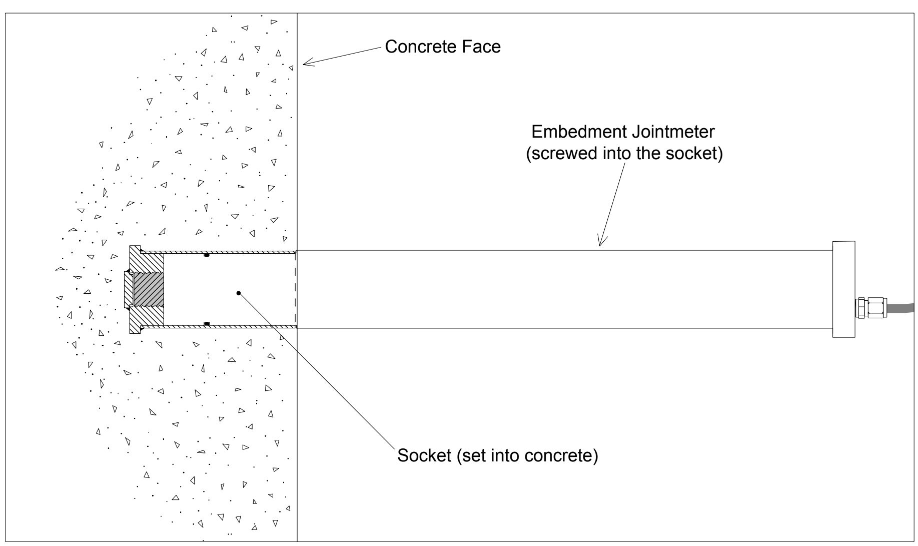


Figure 3 - Embedment Jointmeter Installation

Cable Installation

The cable should be routed to minimize the possibility of damage due to moving equipment, debris or other causes.

Electrical Noise

Cables should be routed as far away as possible from sources of electrical interference such as power lines, generators, motors, transformers, arc welders, etc.

Never route cables or bury them alongside AC power lines. The instrument cables will pick up the 50 or 60 Hz (or other frequency) noise from the power cable and will likely make it difficult to obtain stable readings.

Initial Readings

Initial readings must be taken just before placing the second lift of concrete. The transducer should be in place and ready for the pour. Take readings again after the second lift of concrete has cured.

Taking Readings

Introduction

These instructions tell how to take readings with Slope Indicator's portable readouts. Instructions for reading VW sensors with a Campbell Scientific CR10 can be found at www.slopeindicator.com. Go to Support - Tech Notes and click on the link titled "CR10-VW Sensors."

Reading with the VW Data Recorder

1. Connect signal cable to the Data Recorder.

Binding Posts	Wire Colors	
VW	Orange	Red
VW	White & Orange	Black
TEMP	Blue	White
TEMP	White & Blue	Green
SHIELD	Shield	Shield

2. Choose Hz^2 + Thermistor.
3. Select the 1400-3500 Hz range.
4. The recorder shows a VW reading as $Hz^2/1000$ and a temperature reading in degrees C.

Reading with the VWP Indicator

1. Connect signal cable to the VWP Indicator's jumper cable, as shown in the tables below.
2. Select the 1.4-3.5 kHz range with the Sweep key.
3. Select Hz^2 with the Data key. The VWP Indicator cannot read thermistors.

Standard Jumper 52611950

Connect alligator clips as shown below:

Clips	Wire Colors		Function
Red	Orange	Red	VW
Red	White & Orange	Black	VW

Universal Jumper 52611957

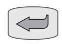
This cable has a bare-wire adapter (BWA):

BWA	Wire Colors		Function
6	White & Orange	Black	VW
8	Orange	Red	VW
10	Shield	Shield	Shield

Reading with the DataMate MP

The DataMate MP allows you to choose engineering units for your readings. See the DataMate MP manual for directions on programming. Here we tell how to use the DataMate MP's manula mode.

Manual Mode

1. Connect the DataMate to the sensor (see connection table below).
2. Switch on. Press  (Manual Mode).
3. Scroll through the list to find "Vibrating Wire Hz^2 & Thermistor."
4. Press  to excite the sensor and display a reading of both the VW element and the thermistor.

Connections

The DataMate jumper cable has a universal connector that connects directly to a universal terminal box or to signal cables that are terminated with a universal connector. A bare-wire adapter (BWA) is also supplied with the DataMate. It allows connection to wires of the signal cable as shown below:

Terminals on BWA or Terminal Box	Wire Colors		Function
5	Blue	White	Temp
6	White & Orange	Black	VW
7	White & Blue	Green	Temp
8	Orange	Red	VW
10	Shield	Shield	Shield

Data Reduction

Deformation Calculation

Use the equation below to convert readings to deformation. Readings are assumed to be digits representing $Hz^2/1000$.

Deformation = (Current Reading - Initial Reading) x Calibration Factor x Conversion Factor

or

$$D = (R_1 - R_0) \times C \times F$$

Where:
R_1 = Current Reading.
R_0 = Initial Reading.
C = Calibration Factor.
F = Factor for engineering unit conversion from the table below.

From→ **To↓**	Inches	Feet	Millimeters	Centimeters	Meters
Inches	1	12	0.03937	0.3937	39.37
Feet	0.0833	1	0.003281	0.03281	3.281
Millimeters	25.4	304.8	1	10	1000
Centimeters	2.54	30.48	0.10	1	100
Meters	0.0254	0.3048	0.001	0.01	1

Table 1: Engineering Units Conversion Multipliers

Example

Assume that R_0 = 3150, R_1 = 6000, and C = 0.00356 mm per digit (digits represent $Hz^2/1000$).

The deformation change is:

$$D = (6000 - 3150) \times 0.00356 = +10.146 \text{ mm}$$

Note that an increase in reading indicates increased extension.

4.2. Temperature Correction

In most cases correction is not necessary because the jointmeter has a very small coefficient of thermal expansion. However, if temperature changes are extreme (>10° C), corrections may be applied. The temperature coefficient of the mass in which the Jointmeter is embedded should also be taken into account. By correcting the transducer reading for temperature changes, the deformation of the concrete mass may be distinguished. The following equation applies:

$$D_{corrected} = ((R_1 - R_0) \times C) + ((T_1 - T_0) \times K) + L_C$$

Where:
R_1 = Current Reading.
R_0 = Initial Reading.
C = Calibration Factor.
T_1 = Current Temperature.
T_0 = Initial Temperature.
K = Thermal Coefficient, as calculated below.
L_C = Correction for the expansion/contraction of the universal joints and flanges.

Calculating Thermal Coefficient K

K changes with the position of the transducer shaft. Use the following equation to calculate an appropriate value for K:

Thermal Coefficient = ((Reading in Digits x Multiplier) + Constant) x Calibration Factor

or

$$K = ((R1 \times M) + B) \times C$$

The table below provides values for M and B, which vary according to the stroke of the jointmeter.

Jointmeter stroke:	12 mm (0.5")	25 mm (1")	50 mm (2")	100mm (4")	150mm (6")
Multiplier M:	0.000295	0.000301	0.000330	0.000192	0.000216
Constant B:	1.724	0.911	0.415	0.669	0.491
Length of joints and flanges L:	226 mm (13.3")	221 mm (13.1")	162 mm (10.8")	146mm (5.75")	146mm (5.75")

Table 2: Thermal Coefficient Calculation Constants

Calculating L_C

LC is a correction for changes in the gauge length of the sensor due to expansion or contraction of the universal joints and flanges.

$$L_C = 17.3 \times 10^{-6} \times L \times (T_1 - T_0)$$

Where L is from Table 2 in millimeters or inches to match the Calibration Factor units.

Example

Consider the following example using a jointmeter with a 25 mm range.

$R_0 = 3150$
$R_1 = 6000$
$T_0 = 15.3° C$
$T_1 = 20.8° C$
C = 0.00356 mm/digit
K = ((6000 x 0.000295) + 0.911) x 0.00356 = 0.0095
L_C = 17.3 x 10-6 x 221 x (20.8 - 15.3) = 0.021

D =(6000 – 3150) x 0.00356 = 10.146 mm

$D_{corrected} = ((R1 - R_0) \times C) + ((T_1 - T_0) \times K) + LC$

$D_{corrected}$ = ((6000 - 3150) x 0.00356) + (20.8 - 15.3) x 0.0095) + 0.021

$D_{corrected}$ = (2850 x 0.00356) + (5.5 x 0.0095) + 0.021

$D_{corrected}$ = 10.146 + 0.052 + 0.021

$D_{corrected}$ = +10.219 mm

As can be seen from this example, the corrections for temperature change are very small and can usually be ignored.

Environmental Factors

Since the purpose of the jointmeter installation is to monitor site conditions, factors which may affect these conditions should always be observed and recorded. Seemingly minor effects may have a real influence on the behavior of the structure being monitored and may give an early indication of potential problems.

Some of these factors include, but are not limited to: blasting, rainfall, tidal levels, excavation and fill levels and sequences, traffic, temperature and barometric changes, changes in personnel, nearby construction activities, seasonal changes, etc.

Troubleshooting

After jointmeters are installed, they are usually inaccessible, so few remedial actions can be taken. Consult the following list of problems and possible solutions should difficulties arise.

Unstable Readings

- Are you using an appropriate sweep frequency?
- Is the transducer shaft of the Jointmeter positioned outside the specified range of the instrument? Note that when the transducer shaft is fully retracted with the alignment pin inside the alignment slot (Figure 1) the readings will likely be unstable because the vibrating wire is now out of range.
- Is there a source of electrical noise nearby? Possible sources of electrical noise are motors, generators, transformers, arc welders and antennas. Check that the shield drain wire is connected to ground whether using a portable readout or datalogger.

No Reading

- Is the cable cut or crushed? Check with an ohmmeter. Nominal resistance between the two transducer leads (usually red and black leads) is 180Ω, ±10. Remember to add cable resistance when checking (22 AWG stranded copper leads are approximately 14.7Ω/1000' or 48.5Ω/km). If the resistance is infinite, or very high (>1 megohm), a cut wire must be suspected. If the resistance reads very low (<100Ω) a short in the cable is likely. Splicing kits and instructions are available from the factory to repair broken or shorted cables.