SOIL INSTRUMENTS

Perimetric Joint Meter Assembly

User Manual

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Section 1 : Introduction

This instruction manual describes the techniques required for the installation and reading of the acoustic (Vibrating Wire) Perimetric Jointmeter.

It is essential that the equipment covered by this manual should be installed and operated by competent and suitably qualified personnel.

The techniques described are intended to serve as a general guide and will vary to suit particular site conditions.

Section 2 : General Information

The Soil Instruments acoustic (Vibrating Wire) Perimetric Joint Meter has been designed specifically for use on concrete-faced dams to measure movement across the perimetric joint between the concrete face and plinth, either perpendicular or parallel to the perimetric joint, in the plane of the concrete face or normal to it. However, the system is suitable for any application where remote monitoring of the differential movement in three dimensions of adjacent concrete blocks is necessary.

Section 3 : Installation Techniques

3.01 Preliminary Tests

Upon receipt of the instrument, the Jointmeter should be immediately checked for proper operation (including the thermistor, if included). This shall be done after removal of the PVC protective cap. To avoid twisting the piston rod pressing in plugger must be used to remove force of the piston from the PVC cap while unscrewing it. Due to the strength of the main spring this operation is advised to be carried out by two individuals. When the protective PVC cap is removed the piston rod will be pushed out by the main spring. The jointmeter is ready for preliminary test as follows.

Connect the gauge leads to the readout unit. The reading (in Period x 10^7 units) shall be within a band of 3500 to 3800. The reading stability shall be within +/- 1 digit when the Jointmeter is in stationary, vibration free environment. Pushing in the piston rod by a few millimetres will change the reading which shall return to its original value when the piston rod returns under main spring force.

A swivel ball joint between piston rod and Transducer spring protects the wire from damage due to rotation of the piston rod. As the ball joint is not entirely friction free rotation of the piston rod may cause the wire to twist slightly before the ball rotates in the socket. This twist in the wire will result in a change in reading. In severe cases the wire which has torsional stresses added to pure tensile stresses will give a distorted signal.

Check the transducer by pushing the piston rod into the Jointmeter body in small steps. At each step a steady reading and clear ring of audio signal indicates a torsion free wire. Push the rod in completely i.e. full range. If the audio signal becomes dull with erratic reading during this check the wire is under torsion stress. These can be cleared by assisting the ball to rotate in its socket by gently tapping the instrument with a soft object. Repeat the check again and ensure that the transducer gives clear steady signal throughout the range before it is installed.

3.02 Installing the Gauges

The relative position of the jointmeter mounting bracket and the reaction (target) plate mounting bracket will determine the limits of movement of each instrument and its initial setting. Once the direction of movement and initial setting has been decided for each installation point fixing of mounting and support brackets for jointmeter and the reaction (target) plate frames can be proceeded with.

Accurately mark out on the concrete face at the required construction joint the centres and axes of movement (parallel, perpendicular, normal) ensuring that all are precisely parallel, etc to the joint, making due allowances for the expected range of movement, type and dimensions of the gauges, joint width, reaction (target) plate dimensions etc.

Drill suitable holes for the jointmeter mounting and support brackets. Bolt these firmly to the concrete face with the expanding masonry bolts supplied, bedding into epoxy resin as necessary for intimate contact, ensuring perpendicularity of the jointmeter to the reaction plate. Follow a similar procedure to mount the respective reaction (target) plate bracket.

When no shrink grout or similar epoxy resin used is fully cured the mounting brackets for jointmeter and reaction (target) plates are rigidly fixed to concrete. Smooth polished stainless steel reaction plate is now assembled to the bracket with four screws. Perimetric jointmeter can now be mounted on the fixed brackets. In order to check the initial setting obtains a pre-installation base reading No. by connecting a readout to the jointmeter with piston rod fully out of the body. Pass the jointmeter through the support bracket U bolt and the mounting bracket piston rod facing the reaction (target) plate. Push the piston rod against the reaction (target) plate and screw the nut on nose mounting thread of the jointmeter. Fully tighten the nut. The jointmeter piston rod semi-spherical head is in firm contact with polished stainless steel reaction (target) plate.

3.03 Initial Setting - Base Reading Ni.

Initial setting of the Triaxial Jointmeter is achieved by assembling it to pre-fixed mounting brackets facing the reaction plate. When fully assembled the reading will correspond to the position of the piston at a point on its full scale deflection. This can be calculated as follows:

- Obtain the gauge constant of the Jointmeter from its Calibration Certificate.
- Obtain the pre-installation zero reading.
- Note the current reading with a Vibrating Wire readout in Period x 10^7 units.
- Substitute the values in the formula given in the Calibration Certificate.

Example

Gauge Constant K : 80.1028
Pre-installation Test N_o : 4166
Initial Setting N_i : 5028

Position of piston

$$\text{rod at initial setting} = 80.1028 \left(\frac{10^7}{4146^2} - \frac{10^7}{5028} \right)$$

$$= 14.91\text{mm}$$

The Jointmeter is set at 14.91mm of its full scale span. This method can be used to check the initial setting of each Jointmeter.

Having finally locked it in position a note of initial zero/reference reading Ni must be recorded on the installation sheet of each Jointmeter. All subsequent readings from the Jointmeter will represent linear movement of the structure from the time of initial setting.

Good installation practice requires making a note of date, time, atmospheric conditions, temperature, pressure and detail of readout equipment used.

Having completed the installation and recorded initial reading, cables can be routed through the ducts and tubes to a junction box according to procedure described below.

3.04 Cabling and Terminal Units

It is possible to use a portable readout or data logger to take readings from Jointmeters individually at the installation point. But it is often more convenient to extend the transducer cables to a central location. Because vibrating wire transducers have an output signal in frequency rather than current or voltage, slight variations in cable resistance have no detrimental effect on gauge readings. Consequently, splicing has no effect on instrument performance allowing cables to be spliced and routed to junction boxes and then connected to multi conductor cables for transmission to a central location

3.05 Cable Jointing with 3M Splice Kit

Thoroughly scrape all wax and dirt from each cable end for approx. 150mm. Prepare the cable ends as shown. Stagger the individual conductor connections.

Use crimped connectors to join the conductors. Ensure Electrical continuity of outer armour/screen is re-established across joint. Use the electrical insulation tape to wrap the connectors. Stretch the tape to half its original width and apply one layer half lapped over connector area only. Do not wrap the tape beyond the pencilled area.

Trim the ends of the mould with a sharp knife to suit the diameter of the cable. Hold the mould halves in place centred over the splice. Snap both halves together and fit the pouring spouts in the holes. Ensure that both seams are completely snapped together. Tape the ends of the mould body to form a seal.

Mix the resin thoroughly and maintaining the mould in a level position, spouts uppermost, pour the resin through one spout until both spouts are completely filled. When the resin has solidified and cooled remove the spouts.

NOTE: **In cold weather (below 15 degrees C) the resin becomes very viscous. It is therefore advisable to keep the resin in a warm place prior to mixing. Mix the compound until its temperature starts to rise, this decreases the viscosity.**

3.06 Terminal Units

The cables are normally terminated in multi-channel terminal units. The cables enter through waterproof glands. The terminal units have a hinged cover secured by two screws.

Unscrew and open the hinged cover. Unscrew the four fixing screws holding the terminal panel and carefully remove it without straining the connecting leads.

Prepare the cables by stripping and cutting back 20 mm approx. of the outer insulation and armour/screen. Remove the insulation and strip back 5 mm of the conductor insulation.

Slacken the entry glands and insert the cables. Make connections to the contact blocks. The earth leads from transducers are not normally connected at the terminal units but leave sufficient lengths available to allow this to be done retrospectively should site conditions require it. Then tighten the glands to grip the cables.

Replace the terminal panel and secure. Connect the readout unit to each instrument in turn to check connections.

Section 4 : Data Reduction

Each Soil Instruments Limited Vibrating Wire Jointmeter is calibrated and comes with a standard Calibration Certificate giving the Gauge constant and temperature at the time of calibration. A sample Calibration Certificate is included in this manual as Appendix 'A'. Calibration is carried out by pushing in the piston rod to full range while it is coupled to a micrometer. Slip gauges can also be used for this purpose by wedging them between the piston rod and the reaction plate. Readings are taken at full range displacement, a number of intermediate points and at zero extension. The gauge factor is then calculated using the expression given in the Calibration Certificate specimen.

Following the installation instructions the initial reference reading Ni is noted which indicates zero movement. Subsequent data obtained from the Jointmeter can be reduced to linear movement in millimetres by using the gauge constant in the equation given in the Calibration Certificate. An example of data reduction is as follows;

Gauge Constant: K mm: 120.4254

Reference Reading Ni: 6320
(Zero measurement)

Example 1: Subsequent Reading N_1: 4820

Equivalent Linear Movement: P = K x $\left(\frac{10^7}{N_1^2} - \frac{10^7}{N_1^2}\right)$

(Joint opening)

= - 21.685mm

Example 2: Subsequent Reading N_2: 6740

Equivalent Linear Movement: 120.4254 $\left(\frac{10^7}{\{6320\}^2} - \frac{10^7}{\{6740\}^2}\right)$

(Joint opening)

P = 3.6404mm

Note: A negative sign represents opening up of a joint and vice versa.

Section 5 : Temperature Correction

The transducer working elements are made primarily of steel and stainless steel and are affected by changing temperature to a certain predictable degree. In case of large temperature changes application of temperature correction will improve the accuracy of the measurements. The approximate temperature effect on the gauge is 0.0125mm per degree Celsius. Hence for a temperature increase of 10°C a transducer will indicate (0.0125 x 10) 0.125mm reduction in linear measurement. Correction is applied by adding 0.125mm to the result indicated by the transducer reading. A fall in temperature will result in a positive change in linear measurement which can be corrected accordingly. Physical dimensional changes due to temperature in the transducer and the structure on which it is mounted are of the order of 10^{-6}m/m/°C and can be neglected.

Section 6 : Environmental Factors

Since the purpose of the transducer 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 behaviour of the structure being monitored and may give an early indication of potential problems. Such factors include but are not limited to: blasting, rainfall, tidal levels, excavation and fill levels and sequences, site traffic, temperature and barometric changes, changes in personnel reading the instruments, nearby construction activities, seasonal changes, etc.

Section 7 : Troubleshooting

Maintenance and troubleshooting of vibrating wire Jointmeters is confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves are sealed and cannot be opened for inspection.

If a unit fails to read, the following steps should be taken:

1) Check the coil resistance. Nominal coil resistance is 130 ± 5○, plus cable resistance (for 22 gauge copper resistance is approximately 1○/15m). Check resistance across positive/negative and earth conductor.

2) If resistance is high or infinite, a severed cable must be suspected.

3) If the resistance is low or near zero, a short must be suspected.

4) If the resistance of coil is 130 ± 5○ and coil and earth is of a finite value (not infinite), then a leakage to earth is suspected due to damaged cable.

5) If resistances are within the nominal range and no reading is obtained the transducer is suspect and Soil Instruments should be consulted.

6) If all resistances are within nominal range and readings cannot be obtained on any transducer, the readout unit is suspect and Soil Instruments should be consulted.

7) If cuts and shorts are located, the cable can be spliced in accordance with recommended procedures.

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Appendix A. Typical Works Calibration Data Sheet

Soil Instruments

VIBRATING WIRE INSTRUMENT CALIBRATION CERTIFICATE

Instrument Type : VW JOINTMETER   Serial No : 50/208 /J

Range : 0 to 50 mm   Customer/Contract : Soil Instruments

WORKS CALIBRATION DATA

Date of Calibration : 05/06/89   Gauge Constant [mm].(K) = -121.1036

Ambient Temperature : 21°C   Calibrated By: Certified By:

Barometric Pressure : 1028 mbars

Works File No. : XXX

FIELD READINGS

	Readout displaying period x 10^7	Readout displaying frequency^2 x 10^{-3}
Routine Readings		
Indicated Change from reference setting:	$P = K\left(\frac{10^7}{Ni^2} - \frac{10^7}{N1^2}\right)$	$P = K(Ni - N1) \times 10^{-4}$
Gauge Constant (See Note 1)	$K = \frac{R}{\left(\frac{10^7}{No^2} - \frac{10^7}{Nr^2}\right)}$	$K = \frac{R}{(No - Nr)} \times 10^4$

Where R = Calibrated instrument range in millimetres

No,Nr= Initial and full scale calibration readings

Ni = Reference reading at initial setting

P = Indicated change in millimetres

K = Gauge Constant

N1 = Routine Reading displayed by readout

NOTE 1 The works gauge constant may be checked by user after recalibration by using the above formulae.

NOTE 2 For data on temperature and barometric pressure effects, refer to the users manual.

NOTE 3 Zero reading 'No' must be established by user on site on installation.

NOTE: BAROMETRIC PRESSURE DOES NOT AFFECT VW JOINTMETERS (TRIAXIAL)