



INSTRUCTION MANUAL

DIRECT AND INVERTED PENDULUMS

Models DP and RP

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Tel. : 1.450.465.1113 • 1.877.ROCTEST (Canada, USA) • 33 (1) 64.06.40.80 (Europe) • www.roctest.com • www.telemac.com

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NOTE : This Instruction Manual covers general principals as to the installation of pendulums. Different parts and setups may be selected by the client, which may differ from those presented herein. This instruction Manual should be read accordingly.

1 APPLICATIONS

Direct and inverted pendulums are designed to accurately measure the relative internal horizontal displacement of points along a true vertical line. The applications of the pendulum include the following.

- Monitoring of movements within dams, dam foundations, nuclear power stations, viaducts and bridge piers
- Monitoring of structural and foundation movements in buildings
- In addition, it is a reference for surveying monitoring method.

The instrument has especially significant place in the field of dam monitoring to detect sliding or overturning of blocks.

2 DIRECT PENDULUM

2.1 DESCRIPTION

The direct pendulum is comprised of a wire suspended from the upper point and a reading station fixed to the structure at the lower point. The wire is tensioned by a suspended weight submerged in a damper tank.

2.2 INSTALLATION

The maximum length of a pendulum shall not, in general, exceed 60 M. If the height of the structure to be monitored is superior to this value, it is recommended to install several pendulums in series.

While defining project, one must take into consideration overall dimension of the pendulum parts.

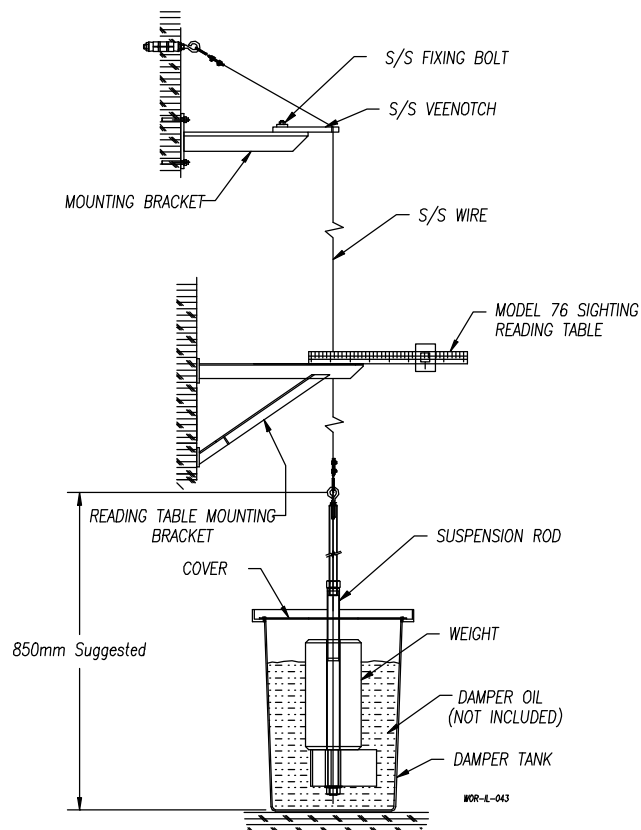
The reading table shall be oriented in such a manner to follow the greatest expected displacement.

The verticality of the well or borehole shall be sufficient to permit the free movement of the vertical wire in all directions.

The complete installation shall be protected from the winds, air currents, and from the fall of water which may impair the stability of the vertical wire.

These steps shall be followed:

- Set in place the wire anchoring device.
- With the use of a plumb-line passing through the Veenotch of the wire centering bracket, positioning of the centering bracket in such a manner that the wire will pass in the center of the cylindrical hole (well or borehole). If the direction of maximum amplitude is approximately known, the wire could be offset by half an amplitude, in the opposite direction of the expected displacement.
- Position and set brackets in relation to the plumb-line wire.
- Set in place and position the reading table (please refer to the instruction manual of the latter for installation details).
- Install the wire and the bottom weight (take into account that elastic elongation of the wire is approximately 2 mm per meter).
- Position the bottom oil tank (used to damp oscillation of the wire) in such a way that the bottom weight will not touch the tank wall or bottom. Fill tank with oil after stabilization of the weight position.

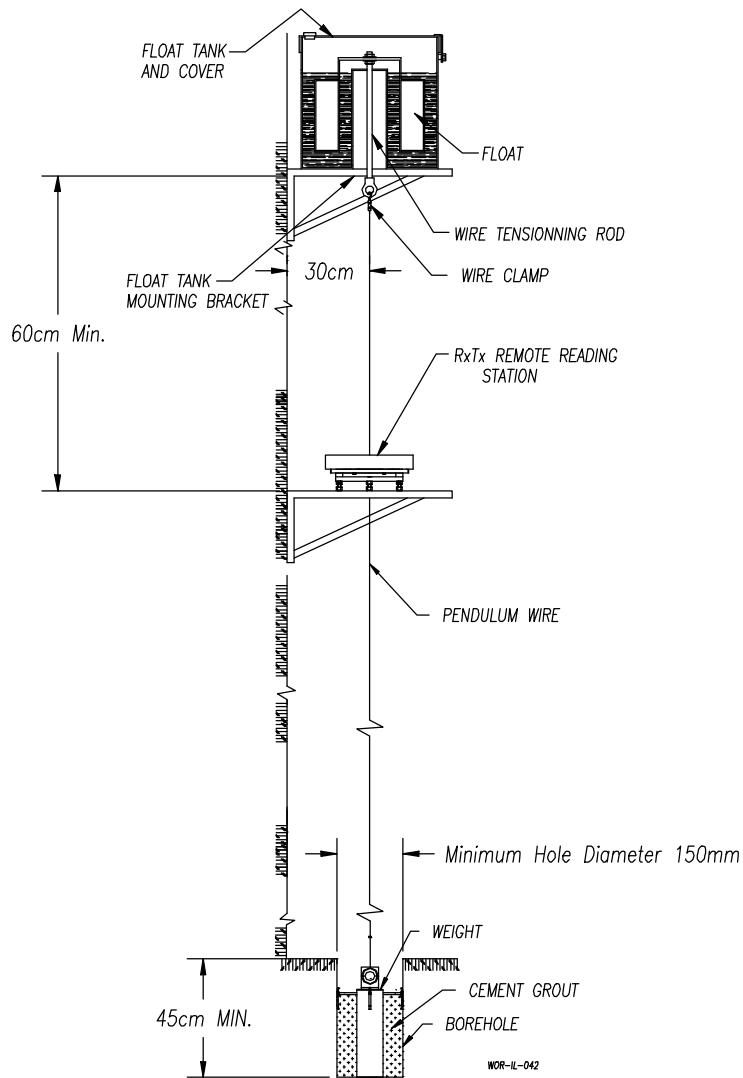


Direct Pendulum - Typical Installation with a Mechanical Reading Station

3 INVERTED PENDULUMS

3.1 DESCRIPTION

The fixed end of the inverted pendulum is grouted at the lower point of the system. The wire is tensioned vertically by a float. When anchored in a fixed point in foundation, it measures absolute displacement of points along the wire.

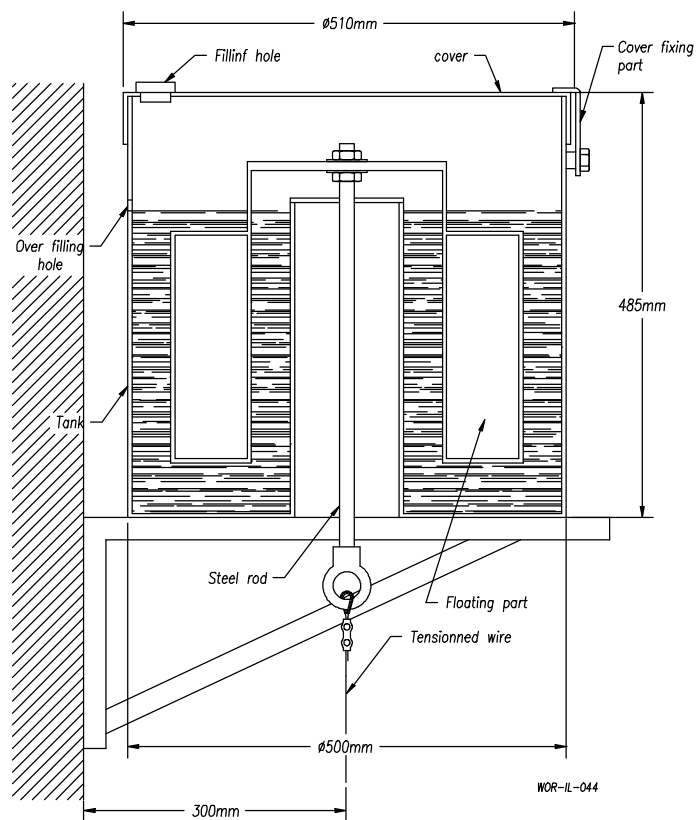


Inverted Pendulum - Typical Installation with a RxTx electrical reading station

3.2 INSTALLATION

The installation method is identical to the direct pendulum installation; the setting in place of a plumb-line wire passing through a vee-notch will permit to set with precision the brackets of the reading table and support of the water tank and float. Other techniques can be followed to set parts in place.

When installing the wire of the pendulum and the water tank, special care shall be taken in order to completely immerse the float without allowing it to enter in contact with the tank wall, bottom or cover.



Inversed Pendulum - Float Tank - Details

4 READINGS

The monitoring of the wire position for both direct and indirect pendulums can be done manually and/or electrically with a remote readout unit. The method of reading depends upon the concept of monitoring, the expected values of movements, and the accuracy required.

This instruction manual should be read in conjunction with those related to these reading devices.

4.1 MANUAL READINGS

4.1.1 SIGHTING READING TABLE MODEL 76

To take a reading with a mechanical reading table the operator aligns the cursors on the left and right scales with their respective sights and with the pendulum wire. The positions of the cursors are read directly off the scale and the cursor vernier. The readings are converted to wire displacement values using the charts provided with each reading station.

SPECIFICATIONS - Sighting reading table Model 76	
Measuring range:	±15 mm
Resolution:	0.1 mm
Accuracy:	0.5 mm
Reading station components:	Stainless steel table (includes scales, cursors, sights and chart for evaluating wire position)

4.1.2 MECHANICAL READING TABLE MODEL RT-IP50

Readings are taken by means of a digital micrometer. Four reference pins are used to section respectively the depth micrometer in the X and Y axes. Measurements are made by bringing the depth micrometer anvil in contact with the pendulum wire, in reference to the fixed pin.

SPECIFICATIONS - Mechanical reading table Model RT-IP50	
Measurement range:	- X-axis : ±35 mm (plus ±19 mm due to adjusting slots) - Y-axis : ±35 mm
Resolution of standard micrometer:	About 0.001 mm
Accuracy of standard micrometer:	About 0.01 mm
Dimension:	254 x 152 x 50 mm
Material:	Adjustable base and measuring plate: zinc-plated steel. Pins: stainless steel.
Measurement:	Two orthogonal horizontal directions

4.1.3 OPTICAL COORDINOSCOPE MODEL MVR

The setup consists of a reference base permanently installed at the reading point. The coordinoscope is then installed on its reference section respectively at X and Y axes on the base frame. Measurements are taken by focusing or aiming the lense at the pendulum wire and by reading the current lateral displacement on the vernier.

SPECIFICATIONS - Optical coordinoscope MODEL MVR	
Measuring range:	400 mm
Accuracy:	0.02 mm
Focal range:	±50 mm
Overall dimension:	500 x 500 mm

4.2 REMOTE ELCTRICAL READING

4.2.1 MODEL RXTX ELECTRICAL REMOTE READING STATION

Please refer to specific instruction manual.

4.2.2 MODEL PI-30 INDUCTION REMOTE READING STATION

Please refer to specific instruction manual.

5 MAINTENANCE

Pendulums do not require much in term of routine maintenance. The user should always make sure that:

- The wire is always free to move i.e. that it is not stuck by a debris,
- The wire is always protected against wind,
- The liquid level in the tank is appropriate;
- Each part of the whole system remains well anchored to the structure.