INSTRUCTION MANUAL

VIBRATING WIRE TYPE
STRAIN METER MODEL SME- 2025

SENSORS & MEASUREMENTS ENTERPRISES
WORKCUMOFFICE:- A-65(1)TALKATORA INDUSTRIAL ESTATE TALKATORA, LUCKNOW-226011 INDIA.
TELEFAX:-0522-2661617.MOB.+91-9415101236,+91-9838562636
email. smeprajapati@gmail.com/smegeotech@gmail.com
website: www.smegeotech.com

OPERATING / INSTALLATION PROCEDURE OF STRAIN METER

1) Introduction

The strain meter is suitable for embedment in soil or concrete or for surface mounting by wielding on steel structures. It is designed to with stand the ingress of water and the hostile environment found at large construction sites. The strain meter is ideally for measurement of strain in Dams, bridges, underground cavities, mines, tunnels, steel structures and other areas of application where strain measurement is required. The positive sign indicates compressive strain and the negative sign indicates tensile strain.

2) Application

The SME vibrating wire strain meter is the electrical strain meter of choice as its frequency output is immune to external noise, it is able to tolerate wet wiring common in geotechnical applications and it is capable of transmission of signals to long distances. It has applications of positive or negative strain measurement in soil, concrete mass or steel structure including:-

- Measurement of strain in concrete, rock and steel constructions.
- Determining and monitoring of stress distribution in concrete or masonry dam.
- Study of stress distributions in the supporting ribs of underground cavities and tunnels.
- Testing of wye sections.
- Long term analysis of stress distribution in wyes sections, enclosing concrete and the rock over burden.
- Monitoring of stresses in pressure shafts.
- Long term analysis of stress distribution in, pressure shafts enclosing concrete and the rock over burden.
- Measurement and monitoring of strain and consequently stress in steel structure.

3) Vibrating Wire Strain Meter

a. Operating principle

The vibrating wire strain meter basically consists of a magnetic, high tensile strength stretched wire, one end of which is anchored and the other end is displaced proportionally to the variation in strain. Any change in the strain, directly effects the tension of the wire, resulting in a corresponding change in frequency of vibration of the wire.

The wire is plucked by a coil magnet, proportionate to the tension in the wire, it resonates at a frequency.

To summarize, any variation in strain causes the strain meter to deflect. This change in tension in the wire thus affecting the frequency of vibration of the wire when it is vibrating at its natural frequency. The strain is proportional to the square of the frequency and the read out unit is able to display this directly in µ strains.

b. General description

The SME model 2030 strain meter has a range of ±1500 u strains and the SME model 2040 has a range of ±1000 u strains. Each strain meter is individually temperature compensated thus eliminating the necessity of a thermistor for strain correction due to temperature induced frequency changes. A thermistor may be provided in case it is also necessary to independently monitor the temperature.

The SME model 2030 has a gage length of 150 mm and the model 2040 also has a gage length of 150mm.

c. Cable connection:

The two leads from the coil magnet are brought in the cable joint housing through the 2 core cable. The 'O' ring is provided for proper sealing the magnet coil assembly. A cable joint housing and cable gland is provided for the cable connection.

d. Spiders for strain rosettes

SME manufactures spiders for five position strain rosettes. The spider is precision machined to the specified angles. The strain meter is screwed on to the spider at the correct angular positions with the help of long screw & spacer.

The SME Model 2030 five position spider permits precise and accurate installation in a concrete Dam or structure of four strain meters at angles of 0°, 45°, 90°,135° in one plane and one strain meter at right angles to this plane.

e. No stress strain container

The strain meter is designed to respond to change in dimensions of the concrete in which it is embedded, whether the deformation is due to stress, creep, temperature change, moisture change or chemical growth of the concrete. The main purpose of the strain meter, however, is to determine stress although indirectly. Change in stress is revealed simple by multiplying the measured strain by the modulus of elasticity. But for stress which develops over a long period of time, account must be taken of changes in modules of elasticity and or deformation due to creep and to all causes other than stress.

It is often desirable to measure separately the deformation due to all causes other than stress. This is done by installing a "no stress strain meter" which is exposed to the same conditions as the surrounding concrete except as to stress. The SME model 2040 no stress strain container is a two walled hollow cylinder with a dimension of 400 mm Φ X 600 mm height. The welded leak proof container has an outer wall of 2 mm thick mild steel and an inner wall of 1 mm thick copper. The gap between the walls is 50 mm. The purpose of the gap is to prevent true stress from acting on the strain meter which is installed inside the container. The strain meter therefore only reads deflection which takes place in the concrete due to autogenous growth of the concrete.

4) Installation procedure

a) Preparation of the sensor before installation.

Check the working of the sensors as follows:

- The coil resistance measured by the digital Multimeter should lie between 110-130 ohm.
- Connect the sensor to the readout unit model 2460-P. The initial offset reading lie between 700-900 Hz. for both the models.
- This initial reading on the indicator should be stable. A crude but a simple and very effective method of checking whether the sensor is responding to changes in strain is as follows:
- Press the two ends of the strain meter gently between the fore fingers and verify that the strain reading on the indicator increases. Pulling the ends gently will decrease the strain reading.
- This change in reading ensures that the deformation produced by straining the strain meter is transmitted to the vibrating wire sensing element.

b) Connect the required length of cable to the sensor as suggested in the operating manual of cable jointing.
c) Check the working of the sensor again following the procedure described above.

CAUTION: The strain meter is a delicate and sensitive instrument. It should be handled with care. Twisting it or applying too much force on it may result in a zero shift or even permanently damaging it.

d) Cable should be marked at every 5 m by the use of stainless steel tags after jointing the cable tied by stainless steel wire stamped with appropriate strain meter numbers.

5) Embedment procedure of strain meter in group a concrete dam

I) When strain meters have to be installed in groups of up to a maximum of 5 sensors, a more elaborate arrangement is necessary to assume the correct installation in the limited time available before the mass concrete begins to set in, therefore, the alignment of the strain meters has to be expedited and simplified. This is done by mounting the strain meters on a spider which correctly orients them and keeps them in position while the concrete is filled in the trench manually. The installation procedure is different in details from that of mounting individual strain meters.

II) At any particular chainage where the group of strain meters have to be installed, raise the level of the dam to the requisite elevation. Mark the positions on the concreted surface where the strain meters have to be installed. Raise the level of the concrete by around 75 cm leaving trenches of around 1 m wide X 2 m at the marked positions to take the strain rosette and the no stress strain container. Level off the bed with the level protractor.

III) Place the spider assembled with the strain meters and the no stress strain container inside the trench. As SME convention, the spider is placed away from the vertical shaft and the no stress strain container is placed closer to the vertical shaft. This helps in properly placing the cable and also identifying it.

IV) Before placing the no stress strain container inside the trench, it should be first checked for leakage. The no stress strain container should be anchored to the previously laid concrete by stay wires and anchors such that it does not lift up during the filling up of the trench with concrete.

V) It is important to install the strain meters quickly such that the concrete around the sensors is essentially the same as that in the rest of the dam.

VI) As a first step, the rossets are fixed / grouted at the correct location and the correct distance in the dam and leave it for 4/5 hours so that rosset is properly jammed.

VII) Now mount the strain meters one by one to rosset as given in the figure 1.2 with the help of mounting screws and spacers provided with strain meter. Take 2 core cable of strain meter and rout through flexible pipe up to the small junction box provided in between the rosset & no stress strain container.

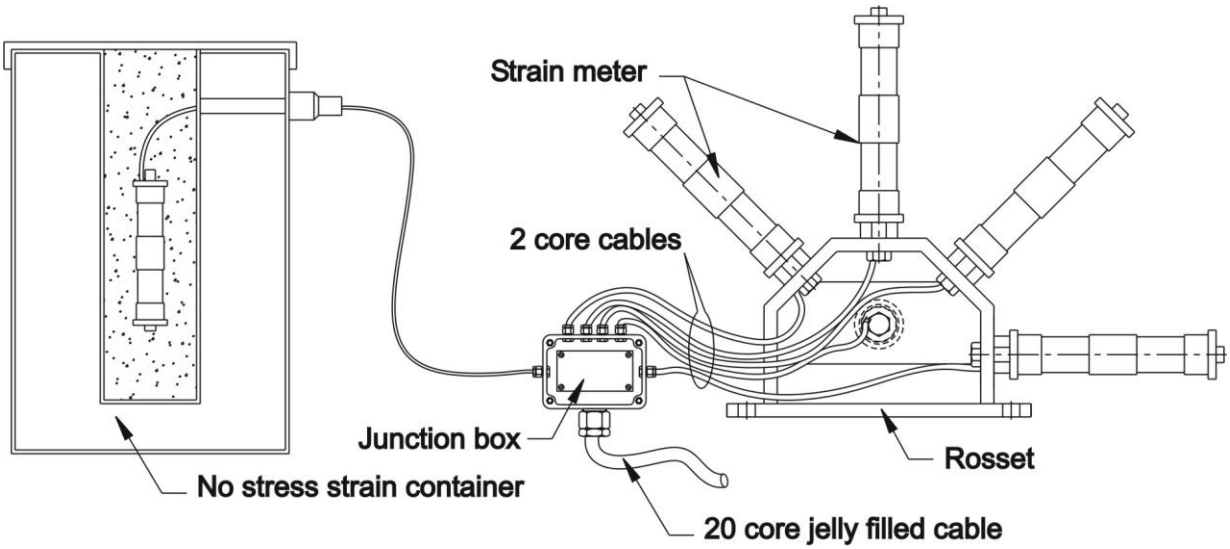
VIII) Check the angles, direction and depth of the strain meter spider and the strain meters mounted on the spider .A protractor level is most useful for this application. A plumb line and 60 cm wide angle protractor may be alternatively used to maintain the correct orientation, tie strings may be used as they make the fixing easier.

IX) Backfill by hand and shoveling, using the same concrete as the mass concrete used in the construction and hand puddle. When concrete is poured over the strain meters, take care not to move the strain meter rosette. Pour the concrete by hand until a 10 cm cushion is built up on top of each meter.

X) The no stress container should be checked for any leakage. This check is necessary to prevent concrete filling in between the walls of the container and making it useless for measurement of the strain in no stress conditions.

XI) Insert the strain meter into the container hole and fill the no stress container with sand /gravel. Route the cable up to the small junction box through PVC pipe.

Xll) Finish with light shallow vibrations up to the top of the lift.



6) Embedment procedure for separate single strain meter

The mounting of a single strain meter is usually done by embedding it near the top of a lift. The embedment procedure is described below:

i) At any particular chainage where single strain meters have to be installed, raise the level of the dam to around 25 cm below the requisite elevation. Mark the positions on the concreted surface where the strain meters have to be installed. Raise the level of the concrete by around 50 cm leaving trenches of around 1 m X 1 m at the marked positions.

ii) Backfill the trench to the level to provide a bed, in case the strain meter is to be mounted horizontally. For strain meter to be installed vertically or at an inclination, back fill to the level that the strain meter would be fully covered.

iii) For strain meter to be installed horizontally lay it in the correct position & direction. For strain meter to be installed vertically or diagonally, use an electric laboratory vibrator to make a hole for the meter in the correct position and direction. Insert the strain meter in to the hole.

iv) Check angles, direction and depth for this application.

v) Vibrate around a deeply embedded meter or hand puddle around a shallow meter.

vi) Continue back filling by hand and shoveling, using the same concrete as the mass concrete used in the construction and hand puddle. Pour the concrete by hand until a 10 cm cushion is built up on top of each meter.

vii) Finish with light shallow vibrations and protect the area with a light broad barrier. Mark with area with yellow painted metal stakes so that the strain meter installation is not damaged before the concrete sets in.

7) Cable laying

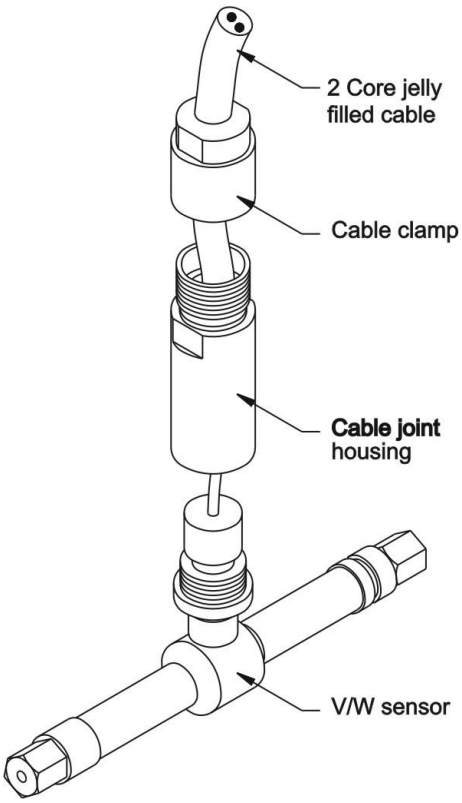
Very careful and skilled cabling is required in installation of the strain meter group as the sensor/cable joint and a large part of the cable is permanently embedded and no future access is available for any maintenance and corrective action.

As access galleries are available in concrete dams, the cable from the sensors is first routed to the gallery. These cables may be terminated in junction boxes inside the gallery. The data from the various sensors can then be taken or logged from the junction boxes with the help of a read out unit or data logger. Alternatively, if required, the signals from the junction boxes may be carried through multi core cables to any observation room outside the dam structure.

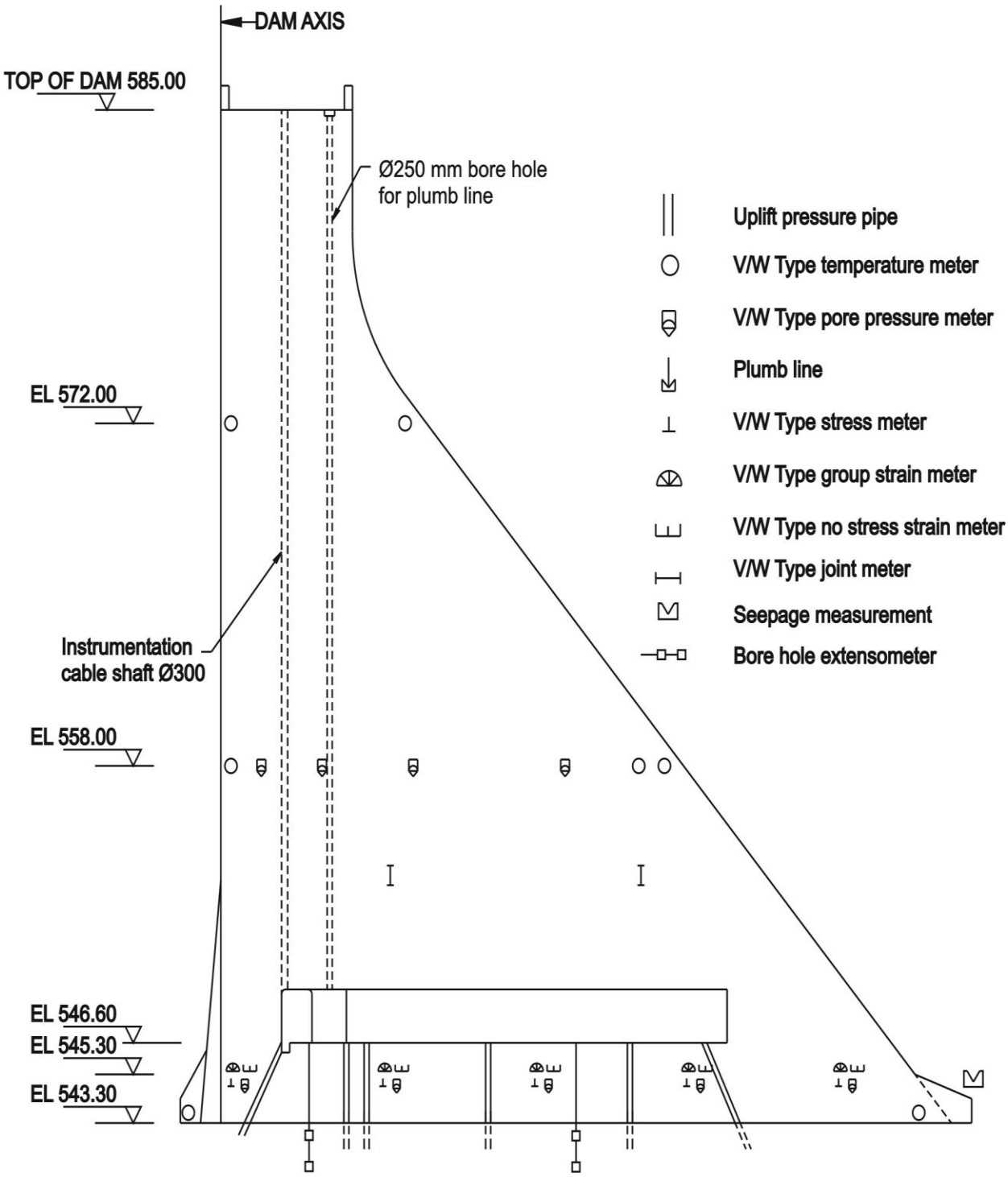
In a concrete dam, a number of strain meters along other sensors are installed at selected elevations at different cross sections.

8) Welding the strain meter to a steel structure:-

The mounting of the strain meter to a steel structure is a fairly simple operation. A dummy strain meter is provided for this purpose. In case of model 2020 strain meter, the length of the steel dummy strain meter is 150 mm.
Place the mounting blocks on a surface plate with the screws at the top and tighten the screws with an allen key. The faces of the dummy strain meters should coincide with the end faces of the mounting brackets. Take care that the bottom face of the mounting brackets sit flush with the surface plate and there is no wobble in the mounting blocks.
Clamp the assembly to the steel structure and weld the mounting brackets to the steel structure. Remove the dummy strain meter and insert the strain meter in position.
Route the cable properly to the location where readings have to be taken, taking care that it is suitably protected.



CAUTION: Great care should be taken while tightening the strain meter between the mounting brackets such that no torque or bending movement is applied across the length of the strain meter.



General installation places of strain meter in Dam

9) Observation Sheet:

Sl.#	Date	Sensor no. Group A	Sensor no. Group B	Sensor no. Group C	Sensor no. Group D	Sensor no. Group E	Sensor no. NSSM
		Location	Location	Location	Location	Location	Location
		E.L.	E.L.	E.L.	E.L.	E.L.	E.L.
		μ strains	μ strains	μ strains	μ strains	μ strains	μ strains
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							

10) Frequency of observation

The strain meter readings should be taken before installation and after embedment in the concrete. 1st reading of the strain meter should be taken 24 hours after setting of the concrete. Even though SME strain meter is temperature compensated, it is recommended to note the date, time and temperature while taking the initial readings of the strain meters.

Subsequent readings of strain should be taken every day for the first three days, on alternate days for the next three weeks and at appropriate intervals thereafter.

SENSORS & MEASUREMENTS ENTERPRISES
WORKCUMOFFICE:- A-65(1)TALKATORA INDUSTRIAL ESTATE TALKATORA, LUCKNOW-226011 INDIA.
TELEFAX:-0522-2661617.MOB.+91-9415101236,+91-9838562636
email. smeprajapati@gmail.com/smegeotech@gmail.com
website: www.smegeotech.com