USBR Settlement Probe

50801099

This equipment should be installed, maintained, and operated by technically qualified personnel. Any errors or omissions in data, or the interpretation of data, are not the responsibility of Slope Indicator Company. The information herein is subject to change without notification.

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Introduction

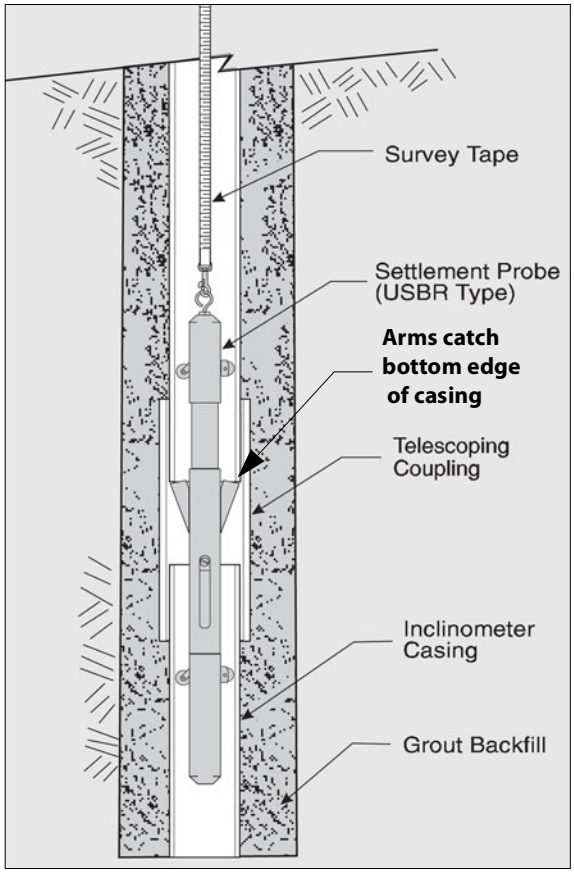
Overview

The USBR settlement probe is used to monitor settlement of inclinometer casing that is installed with telescoping couplings or telescoping sections. The probe is equipped with spring-loaded arms that are used to detect the bottom edge of each length of casing and wheels that keep the probe centered in the casing.

To make settlement measurements, the operator connects a survey tape to the probe, and extends the probe to its full length, allowing the spring-loaded arms to emerge. Next, the operator inserts the probe in the casing, lowers it to the approximate depth of the first coupling, and pulls up so that the extended arms catch on the bottom edge of the casing, as shown in the drawing below. The operator refers to the survey tape and notes the depth of the probe in his notebook.

The operator then continues the survey, repeating these actions at each telescoping coupling. When the probe strikes the bottom of the casing, it collapses, retracting the spring-loaded arms. The operator can then retrieve the probe.

Settlements are calculated by comparing subsequent measurements to the initial set of measurements. Changes in depth indicate settlement.



Extending the Arms

To make measurements, you must extend the arms.

1. Hold the probe by its top wheels.
2. Place the bottom of the probe on the ground.
3. Press the release lever and pull the top of the probe upwards. (The release lever is the edge of an arm.)
4. The arms extend.

Retracting the Arms

To withdraw the probe from the casing, you must retract the arms. Try this now so that you will be familiar with the required action.

1. Lift the probe about 2 cm from the ground.
2. Let the probe drop.
3. The probe collapses and the arms retract.

It takes very little force to collapse the probe and retract the arms. The weight of the upper section is usually enough. However, it is good practice to work the mechanism a few times before conducting a survey. Also, it is good practice to flush any debris from the bottom of the casing.

Making Measurements

Set Up

1. Check that you have the field notebook for recording depths. You may have prepared the notebook by entering the depth of each coupling.
2. Connect the survey tape to the probe.
3. Extend the arms of the probe.
4. Work the mechanism a few times, retracting and extending the arms to be sure that the mechanism operates smoothly.

Making Measurements

1. Insert the probe in the casing.
2. Lower the probe to the depth of the first telescoping coupling.
3. Pull up on the survey tape so that the extended arms catch the bottom edge of the casing.
4. Hold the probe in that position, refer to the survey tape, and write the depth in your notebook.
5. Lower the probe to the depth of the next telescoping coupling, pull up to catch the arms on the casing, and write the depth in your notebook
6. Continue until you have noted depths for each length of casing.
7. When you have completed the last measurement, lower the probe to the bottom. Release tension on the survey tape to allow the probe to collapse.
8. Retrieve the probe. If the arms are still extended, repeat the step above until the arms retract.

Calculating Settlement

Field Data

In the field, depth measurements are referenced to the top of the casing. The table below shows the measured depths at five telescoping couplings, one of which is near the bottom of the casing. Couplings were set to allow the maximum of 0.5 feet of settlement. Set 1 represents the initial set of readings.

For simplicity, we refer to measurement locations as "coupling 1" and so on. However, the measurement actually refers to the distance from the bottom edge of the casing at coupling 1 to the top of the casing.

Field Data					
Coupling	Set 1	Set 2	Set 3	Set 4	Set 5
4	8.00	8.00	8.00	8.00	8.00
3	18.50	18.40	18.40	18.40	18.30
2	29.00	28.90	28.80	28.80	28.70
1	39.50	39.40	39.30	39.20	39.10
Bottom	50.00	49.90	49.80	49.70	49.60

The values in this table show that vertical movements are occuring, but in the wrong direction. The top seems to be stable and the casing at the other depths seems to be moving upwards. The reason: we have been using the top of the casing as the reference. In fact, the bottom of the casing is stable and the casing at other depths is really moving downwards.

Note: If the bottom of the casing is not stable, you must survey the elevation of the top of the casing each time a set of readings is taken, and then add or subtract offsets obtained from the survey.

Converting Readings

Before we can calculate settlement, we must convert readings so that they show the distance from the bottom rather than from the top.

To convert the readings, subtract the depth at each coupling from the depth at the bottom.

The table at right shows set 1 with the readings converted.

Coupling	Set 1
4	42.00
3	31.50
2	21.00
1	10.50
Bottom	0.00

Calculating Settlement

The data summary below shows the initial reading, current magnet elevations, and changes, referenced to the datum magnet.

The Current" column holds readings converted to show the distance from the bottom. The "Change" column is the difference between the current reading and the initial reading (current - initial). A negative value indicates settlement.

Data Summary									
Coupling	Set 1	Set 2		Set 3		Set 4		Set 5	
	Initial	Current	Change	Current	Change	Current	Change	Current	Change
4	42.00	41.90	-0.10	41.80	-0.20	41.70	-0.30	41.60	-0.40
3	31.50	31.50	0.00	31.40	-0.10	31.30	-0.20	31.30	-0.20
2	21.00	21.00	0.00	21.00	0.00	20.90	-0.10	20.90	-0.10
1	10.50	10.50	0.00	10.50	0.00	10.50	0.00	10.50	0.00
Bottom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

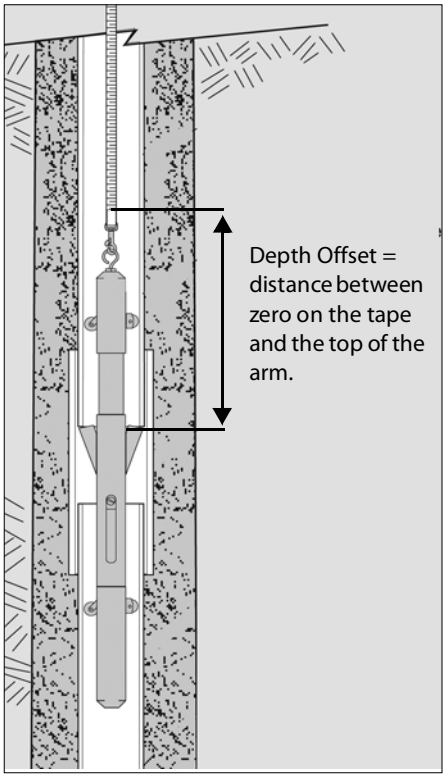
Depth Offset

The depth offset is the distance from the top of the extended arms and the zero on the survey tape. To determine the depth offset:

1. Connect the survey tape to the probe.
2. Extend the arms of the probe.
3. Measure the distance from the top edge of the arms to the zero on the survey tape. This is the depth offset.

The true depth of the casing is the depth measurement obtained from the survey tape plus the depth offset.

For example, if the depth measurement as read from the tape is 8.5 feet, and the depth offset is 2 feet, then the true depth of the bottom edge of the casing is 10.5 feet.



Elevation

Settlement is often expressed in terms of elevation.

1. Use an optical survey to establishes the initial elevation of the top of the casing.
2. Use the settlement probe to establish the elevation of each length of casing.

In the example below, the top of the casing was established to be 500 feet above sea level. Tape depth is the depth of the casing at each coupling, as measured with the survey tape. The depth offset was established at 2 feet. True depth was found by adding the depth offset to the tape depth. Elevation was found by subtracting the true depth from 500, the elevation of the top of the casing.

Table of Elevation: Surveyed Top of Casing = 500 feet above sea level				
Coupling	Tape Depth	Depth Offset	True Depth	Elevation
4	8.00	2	10	490.00
3	18.50	2	20.50	479.50
2	29.00	2	31.00	469.00
1	39.50	2	42.50	458.00
Bottom	50	2	52.00	448.00

Calculating Settlement as Elevation

1. Calculate the initial elevation of the casing at each coupling, as shown above.
2. Obtain tape depths as usual. It is not necessary to add depth offsets.
3. Convert tape depths so that readings are referenced to the bottom.

The table below shows the initial set and two subsequent sets. The reading column contains coverted readings (referenced to bottom). The change column contains changes from the intial reading. The elevation column contains the new elevation.

Data Summary								
Coupling	Set 1 (Initial)		Set 2			Set 3		
	Reading	Elevation	Reading	Change	Elevation	Reading	Change	Elevation
4	42.00	490.00	41.90	-0.10	489.90	41.80	-0.20	489.80
3	31.50	479.50	31.50	0.00	479.50	31.40	-0.10	479.40
2	21.00	469.00	21.00	0.00	469.00	21.00	0.00	469.00
1	10.50	458.00	10.50	0.00	458.00	10.50	0.00	458.00
Bottom	0.00	448.00	0.00	0.00	448.00	0.00	0.00	448.00