Version 1.1 Oct 2012

GXM100 SERIES

MAGNETIC EXTENSOMETER SETTLEMENT SYSTEM

INSTRUCTION MANUAL

GEOSENSE

CONTENTS

1.0 INTRODUCTION

This manual is intended for all users of Geosense **GXM-100 Series** and provides information on their installation and operation.

It is VITAL that personnel responsible for the installation and use of the GXM-100 Series READ and UNDERSTAND the manual, prior to working with the equipment.

1.1 General Description

The **GXM-100 Series**, is a magnetic extensometer that is installed into boreholes or fills, to **monitor settlement or heave**, that may occur due to different civil/ geotechnical engineering activates, such as:

- Embankment Construction
- Mining
- Tunnelling

Data obtained from this instrumentation will highlight the settlement or **heave** in the ground, but will also highlight the zones in which the highest **settlement/ heave** is occurring. This aids in the design of structures, when construction is undertaken.

Particular features of the Geosense **GXM-100 Series** are:-

Reliable long term performance.
Rugged; suitable for demanding environments..

The magnetic targets and heavy duty access tubing are particularly suitable for the demanding environment found within the civil and geotechnical engineering industries.

The Geosense range of **GXM-100 Series** are supplied in various configurations to suit varying installation environments and techniques.

1.2 Theory of Operation

The **GXM-100 Series** system comprises of a reed switch probe, a steel measuring tape, a tape reel with built-in buzzer and a series of magnetic targets located along the length of a access tube.

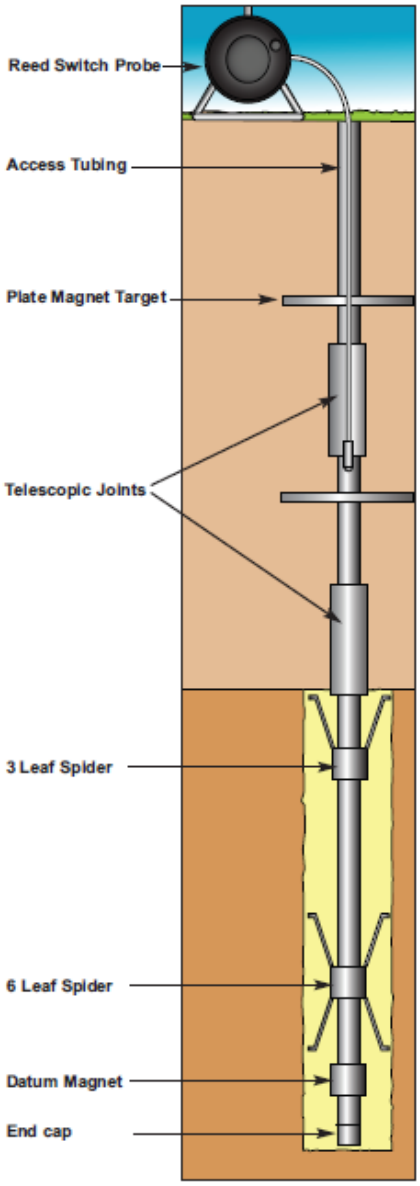
As the probe passes through a magnetic field the internal reed switch closes, activating the audible buzzer and light, so that the location of the magnetic target can be identified by measuring to the nearest millimetre on the graduated tape.

For borehole installations the magnetic targets are located in position by means of leaf spring legs attached to the targets which are known as “Spider Magnets” and are available in either three or six leaf versions. Boreholes are then backfilled with grout to create the bond between the existing ground and the targets.

Where targets are placed into fill then plate magnets are used which provides a large surface area of contact with the surrounding fill material.

As the surrounding soil moves down (or up) as settlement and heave occurs, so the position of the magnetic target moves accordingly.

The bottom magnetic target, known as the datum magnet, is located within stable ground and the depth of each magnetic target is referenced to this datum. The amount of settlement or heave is determined by comparing the current location of each magnetic target to its initial position, with reference to the datum.



1.3 Components

GXM-100 comprise of the following components:-

Access Tubing: Allows the reed switch probe to be lowered so measurements of the magnetic target position can be taken. 33mm OD x 25mm (1”) ID with flush threads.

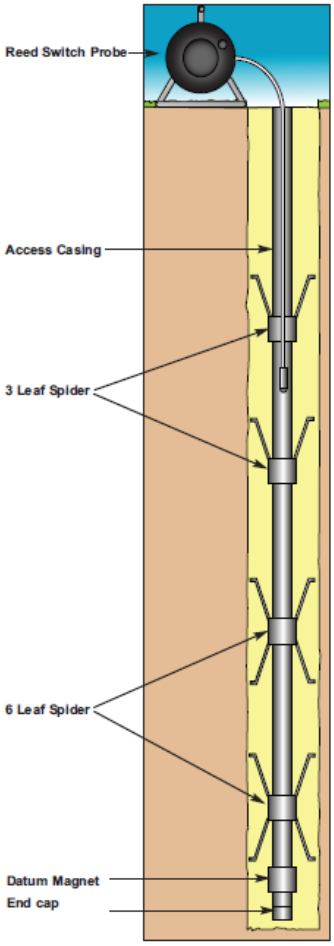
Telescopic section: To be used when settlement is expected to exceed 2-3% and at interface zones, typically between soft ground and fill material.

Datum Magnets: Fixed in place on the bottom section of the access tubing in stable ground, ‘beyond the zone of expected movement’.

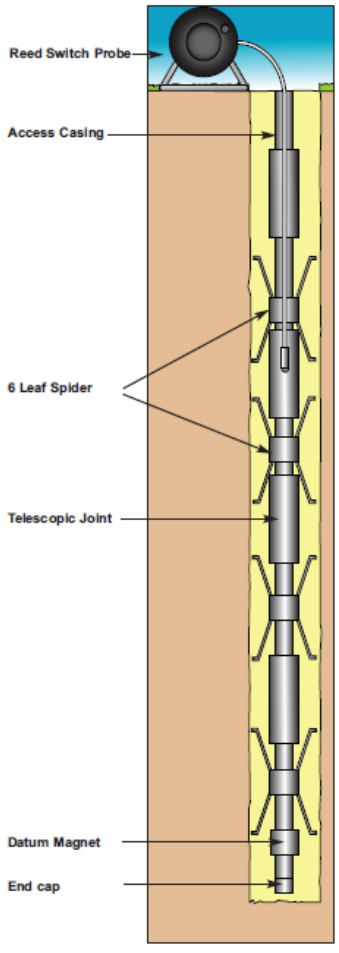
3 Leaf Spider Magnet: Can be installed using a placing tool after the access tubing and datum magnet are installed to full depth.

6 Leaf Spider Magnet: The legs are compressed for installation, held onto the access tubing and installed. The legs are then released when the magnetic target is located at the required depth and any temporary drill casing has been removed (see installation).

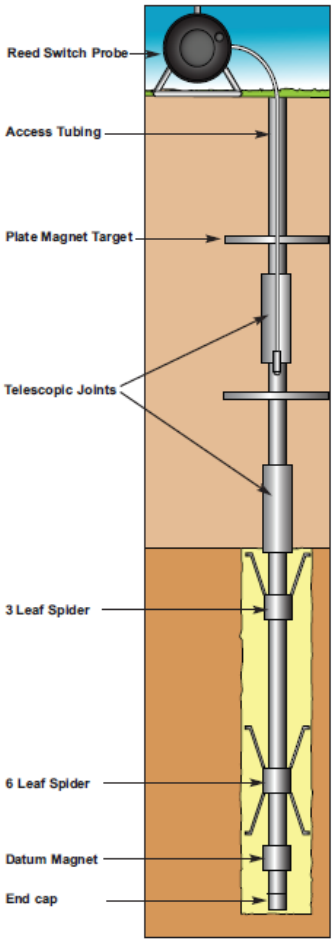
Plate magnet: Used in fill to provide a large surface area contact to the surrounding soil.



GXM-100



GXM-100T



GXM-100P

2.0 DELIVERY

This section should be read by all users of Geosense **GXM-100 Series** magnetic extensometers.

2.1 Packaging

GXM-100 Series is packed for transportation to site. Packaging is suitably robust to allow normal handling by transportation companies. Inappropriate handling techniques may cause damage to the packaging and the enclosed equipment. The packaging should be carefully inspected upon delivery and any damage MUST be reported to both the transportation company and Geosense.

2.2 Handling

Whilst they are a robust devices, **GXM-100 Series** are precision measuring instruments. They and their associated equipment should always be handled with care during transportation, storage and installation.

Once the shipment has been inspected, it is recommended that **GXM-100 Series** remain in their original packaging for storage or transportation.

2.3 Inspection

It is important to check all the equipment in the shipment as soon as possible after taking delivery and well before installation is to be carried out. Check that all the components detailed on the documents are included in the shipment. Check that the equipment has not been physically damaged.

2.4 Storage

All equipment should be stored in an environment that is protected from direct sunlight. Storage areas should be free from rodents.

No other special requirements are needed for medium or long-term storage.

3.0 INSTALLATION

This section of the manual is intended for all users of Geosene **GXM-100 Series** magnetic extensometers and is intended to provide guidance with respect to their installation.

It must be remembered that no two installations will be the same and it is inevitable that some 'fine tuning' of the following procedures will be required to suit specific site conditions.

It is VITAL that personnel responsible for the installation and use of the GXM-100 Series Magnetic Extensometer READ and UNDERSTAND the manual, prior to working with the equipment.

****

As stated before, it is vital to check all the equipment in the shipment soon after taking delivery and well before installation is to be carried out. Check that all components that are detailed on the shipping documents are included.

3.1 BASE Readings

IT IS ESSENTIAL TO TAKE BASE READINGS OF THE DATUM MAGNET WHEN INSTALLATION IS COMPLETE.

IT IS ALSO RECOMMENDED TO TAKE THREE SETS OF READINGS FROM DIFFERENT PASSES THROUGH THE ACCESS TUBING AND AVERAGE FOR EACH MAGNETIC TARGET.

3.2 Getting started

Ensure that all the necessary equipment is laid out on clean ground and the number of items needed for installation are checked. Check that all equipment provided is not damaged and is clean.

Prior to installation of the **GXM-100 Series** it is essential to establish and confirm details of the installation to be carried out. Some of the main considerations are, listed below :-

1. Depth of installation, together with datum magnet & magnetic target depths

2. Labelling of release cords (for 6 leaf spiders only)

3. Borehole Identification

Boreholes that require the **GXM-100 Series** to be installed in them should be clearly identified and a labelling/ marking scheme should be established with the client.

4. Tools

The following is a list of tools typically used during the installation of **GXM-100 Series**

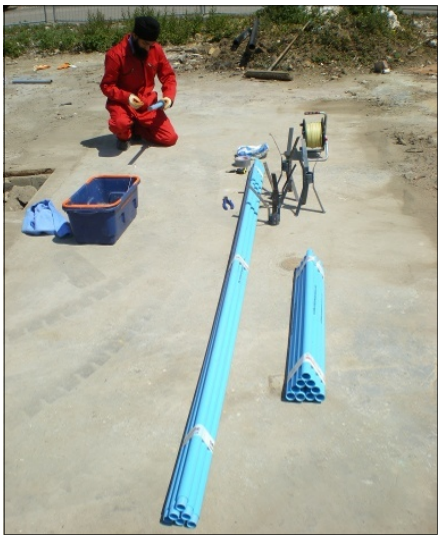
- Tape Measure
- Wire Cutters
- PVC solvent cleaner
- PVC solvent cement
- Pozidrive Screw Driver
- Identification Labels
- Permanent Maker Pen
- Support Wire or Chord
- Wire Grips
- Allen Key
- Paper / Masking Tape
- Installation tool (3 leaf spiders only)
- Support Clamp

5. Extensometer Components:-

- Access Tube (flush coupled)
- Datum Magnet (s)
- Spider Magnet (s)
- Plate Magnet (s)
- Reed switch probe

3.3 Installation - GXM100

1. Check the bore hole to ensure that the full depth is clear and free of obstructions Ensure that the base of the borehole is in solid ground and 'beyond the range of expected movement'



2. Lay out all the equipment that is supplied, ensuring that the quantity is correct for the installation to be carried out.

3. Where necessary, apply cleaning solvent to a clean cloth.

4. Clean both threads of the access tube.

   Ensure this is done throughout the installation.

3.3 Installation - GXM100 contd...

5. Apply PVC solvent cement to the male end of the bottom plug or cap.

6. Screw in the bottom plug or push a bottom cap on to the lowest length of the access tube.

7. Using a tape measure, measure 500mm from the bottom of the first access tube and mark with a permanent marker.

8. Slide the datum magnet onto the access tube to the location marked.

9. Secure the datum magnet in position, with self tapping screws. DO NOT OVER TIGHTEN. Apply glue also, if required.

3.3 Installation - GXM100 contd...

10. Lower the first part of access tube, complete with datum magnet into the borehole and support with a clamp.

Ensure access tubing is firmly held in place so that the casing will not drop into the borehole. This can be held manually supported or by using a clamp

11. Apply the PVC solvent cement to the male thread of the access tubing.

12. Screw both ends together (rotating only the upper section) and lower into borehole.

    Repeat for all sections to full installation depth.

3.3 Installation - GXM100 contd...

INSTALLATION OF '3 LEAF' SPIDER MAGNETS

13. Once all the tubing has been installed into the borehole, place the three leaf magnet over the access tube.

14. Place the installation tool over the top of the access tube. The weight of the installation tool will push the 3 leaf spider magnet down into the borehole.

15. Lower the installation tool to advance the three leaf magnet to the required depth, This can be checked using the graduated tape measure attached to the placing tool.

For more precise positioning, use the reed switch probe inside the access tube to set the target level and use the tool to carefully lower the magnetic target until the reed switch is activated.

Repeat for all 3 leaf spider magnets.

3.3 Installation - GXM100 contd...

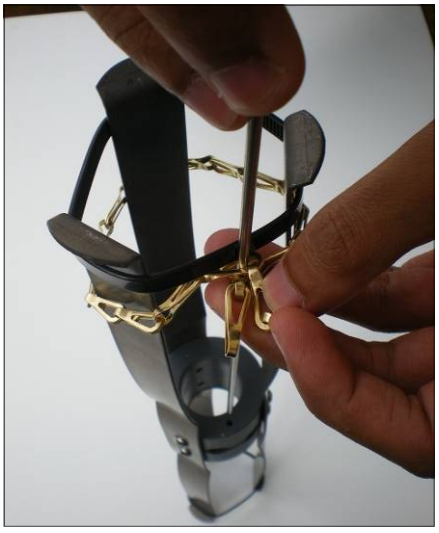
INSTALLATION OF 6 LEAF SPIDER MAGNETS

The installation of ‘6 leaf’ spider magnets differs from the 3 leaf type as the legs are compressed for installation and released when the magnet is in position at its specified depth.

Commonly, the spider magnet is temporally and loosely attached to the access tubing and installed together with the tubing.

16. The 6 leaf spider magnet comes with their legs compressed together with cable ties.

17. Cut the supplied chain to length so that it easily fits around the closed spider legs (plus some loose links)



18. Wrap the retaining chain around one end of the legs and push the release pin through two links to secure the chain in position.

3.3 Installation - GXM100 contd...

19. Push the release pin down and through the hole in the body of the magnetic target and into two links on the retaining chain at the other and of the spider magnet.

20. Once the retaining chains and pin have been located, cut the cable ties.

TAKE CARE NOT TO RELEASE THE SPRINGS AS ACCIDENTAL RELEASE COULD CAUSE INJURY

21. Where steel cable is supplied to release the spider legs, feed the steel support cable through the top eye of the release pin attached to the spider magnet and the wire grips. Feed through the wire grip twice and tighten the grip screws.

3.3 Installation - GXM100 contd...

21. Calculate the required length of the steel wire (from the target to the ground level + say 1m). Cut cable lengths for each spider and attach a label or mark to the top of the wire(s) to identify spider magnet elevations.

22. Alternatively, use nylon chord tied securely to the release pins and marked with an identifying code at the upper end (knots in the chord are often used).

23. Carefully calculate the position of each magnetic target on each length of tube. Mark the access tubes to establish their installation sequence and then mark the position of each target on the tubes.

24. Using a 'water degradable' tape (masking or paper tape), form a ring around the tube, just above the target position. This is to locate the upper edge of the target body.

25. Slide the appropriate target up the access tube until it butts up against the tape ring. Then using further degradable tape, secure the target in place to prevent it sliding down the tube during placing

3.3 Installation - GXM100 contd...

26. Alternatively, secure the spider magnet to the access tube using Denso tape (grease tape) above and below the spider magnet.

27. Arrange the assembled tubes and targets in sequence, making sure that the chords or wires can be run to the borehole un-hindered.

28. Loosely attach the grouting tremie pipe to the lowest end of the access tube. And begin lowering the assembly into the borehole.

ENSURE THAT THE END OF THE RELEASE WIRES / CHORDS ARE OUTSIDE THE BOREHOLE AND DO NOT GET CAUGHT ON ANYTHING THAT COULD CAUSE EARLY RELEASE

3.3 Installation - GXM100 contd...

29. At the next joint in the tube, add glue to the 'male' threads only.

30. Select and fit the next length of access tube, complete with any attached magnetic targets. Rotate only the upper tube and take care not to tangle the pin release wire / chord.

31. Carefully lower the tube and tremie pipe into the borehole and repeat for all subsequent tube lengths. Where spider targets are to be located close to tube joints, they may need to finally located in position during the installation.

32. When all the access tubes have been installed, cut the tube to the required level and push (don't glue) the top cap into place and attach the release chord / wire, in a coil, to the top of the tube.

33. Backfill the borehole with Bentonite / Cement grout as specified by the Engineer (see section 7.0). Hold the extensometer access tube down and pull on the tremie pipe to disconnect the two. Slowly and carefully withdraw the tremie pipe as the grout is placed, taking care that the bottom of the pipe is not raised above the top of the grout column.

3.3 Installation - GXM100 contd...

31. Allow the drillers to pull the drill casing (if used) so that the bottom of the casing is above the deepest target. Identify the release pin chord / wire attached to the deepest target and pull it to release its legs. As the pin is pulled, the legs spring out to engage with the borehole walls to hold the target in place as the grout hardens. The release of the legs can be felt through chord / wire and it is important that both sets of legs are released. In most circumstances the pin can be removed from the borehole but sometimes the lower pins get tangled with the chords / wires from the higher targets.

IF THE PINS GET SNAGGED AFTER RELEASING THE LEGS OF THEIR PARTICULAR TARGETS, DO NOT ATTEMPT TO DRAG THEM OUT OF THE BOREHOLE, AS THIS COULD DISLODGE OR CAUSE PREMATURE RELEASE OF HIGHER TARGETS.

Often, when all the spiders target legs have been released, all the pins and chords can be removed from the borehole without the use of force.

If they do not come easily, cut the chords and abandon them in the borehole. They will have no effect on the performance of the instrument.

32. Pull the drill casing (if any) up to a level just above the next magnet. Release the next target as described above.

33. Repeat sequentially for all the targets.

34. As the grout hardens it may sink and need to be topped up. In many cases a security cover would be fixed over the access tube to protect it from damage.

35. Base readings would be recorded when the grout has hardened.

3.4 Installation - GXM100T

The **GXM100T** is essentially the same as the Standard GXM100 as described in the previous section of this manual, but incorporates Telescopic sections of access tubing for installation at locations where the expected settlement is estimated to be larger than 2 - 3%.

In practice the Telescopic sections would be used to absorb compressive movement of the tubes. Typically, installations in very soft ground would require Telescopic sections at regular intervals. If fill material is to be place over soft ground and an extensometer is to be extended up through the fill, the zone of maximum compression is commonly the interface between the existing ground and the fill. At this interface, the risk of tubing shear is greatest as the fill material will 'grip' the tube which will then be forced downwards as the sub-strata consolidate. Here the inclusion of a Telescopic joint would be used to absorb this compressive movement.

Each standard Telescoping section is 1m long and can absorb 800mm of compressive movement. However, they can be supplied in any length, to suit particular applications.

They comprise of two lengths of the standard 33mm access tubes which are held within a 42mm sleeve by shear pins. Each section is supplied with threaded, flush couplings to connect directly to the standard tubing.

If the axial load on the access tube exceeds the strength of the shear pins, the pins will shear and allow the access tube to telescope inwards.

INSTALLING TELESCOPIC SECTIONS

Where Telescopic sections are to be used, the spider Magnetic Targets MUST be fitted to the access tubing BEFORE installation into the borehole and their legs released by pins and chords / wires.

Telescopic Sections are connected to the access tubing in the same way as the standard tubing. The joints in the 33mm tubing are 'Glued and Screwed' at the required location.

Where headroom permits, these joints can be pre-assembled onto the standard access tube and lowered into borehole as required. The shear pins are of sufficient strength to support most installations without installations but it is better to fill deep boreholes with water prior to installation.

3.5 Installation - GXM100P

The **GXM100P** is very similar, in principle, to the Standard GXM100 as described in previous sections of this manual, but incorporates plate magnets that are installed in fill material as an embankment is being constructed. The larger surface area of the plate magnet provides a more representative sample of the settlement that is occurring in the fill.

These are often incorporated into a settlement system that is used to measure the compression within an embankment.

The Datum Target is installed is commonly installed at the interface between the original ground and the fill material.

1. A 0.6m deep, 50mm diameter hole is formed in the existing ground using an auger or pipe or bar, to accept the lowest 0.5m of access tube, below the Datum Target.

   The pipe is lowered into the hole and the ground is 'tamped' around the pipe to close the ground around it.
   In rock or hard ground the hole would be cored and backfilled with a contentious grout.

   The Datum Target would be installed at (or just below) the existing ground level. The Datum Target can be either a standard Datum Target (see right) or a Plate Mounted target (see right).

2. As filling continues, additional tube is added and care must be taken to ensure that the access tube is not damaged and that it remains vertical. When the fill reaches the elevation of the next Target, the area around the access tube must be made level and compacted.

3.5 Installation - GXM100P contd..

3. Once the fill has been levelled and compacted , the plate magnet is placed over the access tube.

4. Check that the plate is level. If not, remove the plate and compact the fill until it is level. Then re-fit the plate.

5. Selected fill would be placed around and over the plate and compacted using only hand tools.

TAKE CARE NOT TO MOVE OR DAMAGE THE ACCESS TUBING
COMPACTION AROUND THE TARGETS AND TUBING SHOULD BE CARRIED OUT BY HAND

6. As the fill is placed, add tubing, taking care to clean, glue and screw the joints.

3.5 Installation - GXM100P contd...

7. Telescoping joints may be required within the fill, if it is at all compressible.

8. At regular intervals, check that the access tubes are vertical.

Readings can be taken at any time after installation.

Obviously, since the stability of neither the top of the pipe nor the Datum Target can be guaranteed as they may be moving, the actual elevation of the top of the access tube MUST be recorded at the same time as EVERY monitoring operation.

INSTALLATION COMPETE FOR GXM100P

3.6 Installation - GXM100 C

The **GXM100 C** is same as the GXM100 P as described in the last section of this manual, but incorporates 'CROSS ARM' magnetic targets that are installed in fill material as an embankment is being constructed. The long length of the 'Cross Arm' provides even more contact with the fill and some Engineers consider that this will better register the behaviour of the fill, rather than the material close to the vertical access tube.

These, too, are incorporated into settlement systems that are used to measure the compression within an embankment.

The Datum Target is installed is commonly installed at the interface between the original ground and the fill material.

1. As with the plate system, a 0.6m deep, 50mm diameter hole is formed in the existing ground using an auger or pipe or bar, to accept the lowest 0.5m of access tube, below the Datum Target.

   The pipe is lowered into the hole and the ground is 'tamped' around the pipe to close the ground around it. In rock or hard ground the hole would be cored and backfilled with a contentious grout.

   The Datum Target would be installed at (or just below) the existing ground level. The Datum Target can be either a standard Datum Target (see right) or a Plate Mounted target (see right).

2. As filling continues, additional tube is added and care must be taken to ensure that the access tube is not damaged and that it remains vertical. When the fill reaches the elevation of the next Target, the area around the access tube must be made level and compacted.

3. The Cross Arms are installed in or on compacted material in a similar manner to the Plate Targets.

4.0 DATA

4.1 Taking readings

TO ENSURE CONSISTENT READINGS MAINTAIN THE SAME PROCEDURE EVERY TIME READINGS ARE TAKEN.

WHEREVER POSSIBLE USE THE SAME REED SWITCH PROBE. IF DIFFERENT PROBES ARE USED ALWAYS TAKE BASE READINGS WITH EACH PROBE AND COMPARE DATA. APPLY ANY OFFSET TO LATER READINGS

1. Where necessary, switch on reed switch probe. Some instruments do not have on/off switches.

2. Lower probe to bottom of access tubing. As the probe passes past each magnetic target the buzzer will sound several times.

3. Once the probe has reached the bottom of the access tube slowly raise it.

   As the probe passes through a single magnetic target, ONE, TWO or THREE sounds could be heard.

4.0 DATA

4.1 Taking readings contd….

Please Remember …….It is ABSOLUTELY VITAL that the same procedure is adopted for ALL monitoring operations on the same instrument.

There are more than one methods that can be employed to gather data from Magnetic Extensometers. The aim is to accurately determine the distance between the targets and the top of the access tube (or other upper reference mark). Below is ONE tried and tested procedure….

The level of the target is defined as the reading on the Reed Switch Probe tape when the buzzer FIRST sounds as it enters a Targets magnetic field, FROM BELOW.

Once the probe is below the Datum Target, slowly raise it until a 'buzz' or 'bleep' is heard from the reel.

STOP !

Slowly lower the probe again to just below the point where the sound stops.

<u>Slowly</u> raise it until it sounds again.

STOP !

Repeat until the level at which the sound starts can be accurately read form the tape. This value should be recorded.

Repeat for ALL other Targets … remembering to only use the FIRST sound as the probe RISES into the magnetic field of each Target.

4.2 Data Reduction

Readings taken from the **GXM100 Series** are taken from the top of the access tube, to indicate the depth of the probe. Therefore the site readings are referenced to the top of the access tubing and not the datum magnet.

The data in the table below show reading sets recorded from 1 instrument over 6 months:

Magnet Number	Collected Readings					
	01-Dec	01-Jan	01-Feb	01-Mar	01-Apr	01-May
5	19.244	19.245	19.245	19.246	19.245	19.244
4	21.785	21.791	21.793	21.797	21.796	21.796
3	23.990	24.000	24.003	24.009	24.010	24.011
2	30.698	30.711	30.714	30.721	30.723	30.726
1	35.430	35.445	35.449	35.457	35.459	35.462
Datum Magnet	40.755	40.772	40.777	40.786	40.789	40.792

Initially, the readings have to be inverted so that they show the distance between the individual targets and the datum magnet, not the top of the access tube. The data is inverted because the datum magnet is considered to be the fixed point, unlike the top of the access tube which may move as the sub-strata moves.

In order to calculate the Inverted Data the measured depth is subtracted from the measured depth to the datum magnet …. as seen from the table below:-

Magnet Number	Collected & Inverted Readings											
	01-Dec	Inverted	01-Jan	Inverted	01-Feb	Inverted	01-Mar	Inverted	01-Apr	Inverted	01-May	Inverted
5	19.244	21.511	19.245	21.527	19.245	21.532	19.246	21.540	19.245	21.544	19.244	21.548
4	21.785	18.970	21.791	18.981	21.793	18.984	21.797	18.989	21.796	18.993	21.796	18.996
3	23.990	16.765	24.000	16.772	24.003	16.774	24.009	16.777	24.010	16.779	24.011	16.781
2	30.698	10.057	30.711	10.061	30.714	10.063	30.721	10.065	30.723	10.066	30.726	10.066
1	35.430	5.325	35.445	5.327	35.449	5.328	35.457	5.329	35.459	5.330	35.462	5.330
Datum Magnet	40.755	0.000	40.772	0.000	40.777	0.000	40.786	0.000	40.789	0.000	40.792	0.000

Measured depth of the Datum Target - each month
Measured depth of the Individual Targets - each month

If it is necessary to use the top of the access tubing as the reference because the datum magnet is not in stable ground, it is VITAL that the top of the access tube should be surveyed each time the instrument is read.

4.2 Data Reduction contd..

Settlement Calculations

Once the inverted values have been obtained as shown on the previous page, the calculation of settlement can be made. This calculation uses the first month's 'inverted' readings as the initial readings, subtracting the current month 'inverted' values to determine the 'change'. This 'change' is the actual movement of the magnetic targets and is, therefore, the movement that has occurred in that particular strata. Where the elevation of the Datum Magnet is known, this can be added to the 'inverted' values to obtain the actual elevation of each target (see table below). Since the elevation of the datum magnet is a constant, the 'change' can be calculated either with or without its inclusion.

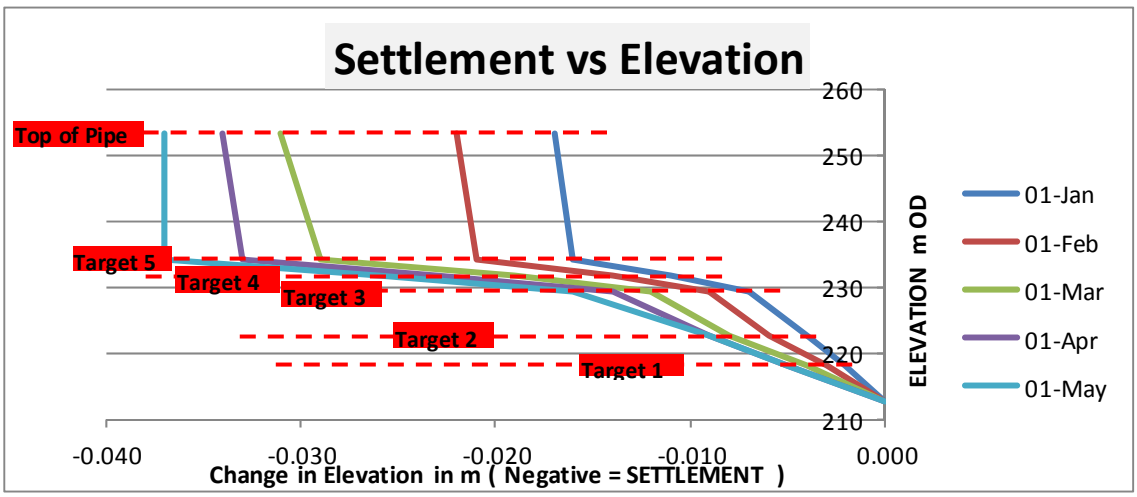
If the 'difference' is negative it indicates that the ground has experienced 'settlement', whereas a positive 'difference' indicated 'heave'.

Datum elevation = 212.672 m OD

Magnet Number	Calculated Movement											
	01-Dec		01-Jan		01-Feb		01-Mar		01-Apr		01-May	
	Initial		Current	Change	Current	Change	Current	Change	Current	Change	Current	Change
Top of pipe	253.427	0	253.444	-0.017	253.449	-0.022	253.458	-0.031	253.461	-0.034	253.464	-0.037
5	234.183	0	234.199	-0.016	234.204	-0.021	234.212	-0.029	234.216	-0.033	234.220	-0.037
4	231.642	0	231.653	-0.011	231.656	-0.014	231.661	-0.019	231.665	-0.023	231.668	-0.026
3	229.437	0	229.444	-0.007	229.446	-0.009	229.449	-0.012	229.451	-0.014	229.453	-0.016
2	222.729	0	222.733	-0.004	222.735	-0.006	222.737	-0.008	222.738	-0.009	222.738	-0.009
1	217.997	0	217.999	-0.002	218.000	-0.003	218.001	-0.004	218.002	-0.005	218.002	-0.005
Datum	212.672	0	212.672	0	212.672	0	212.672	0	212.672	0	212.672	0

'Change' in distance to the Datum Target (negative = settlement)
Actual elevation of each target with respect to fixed datum

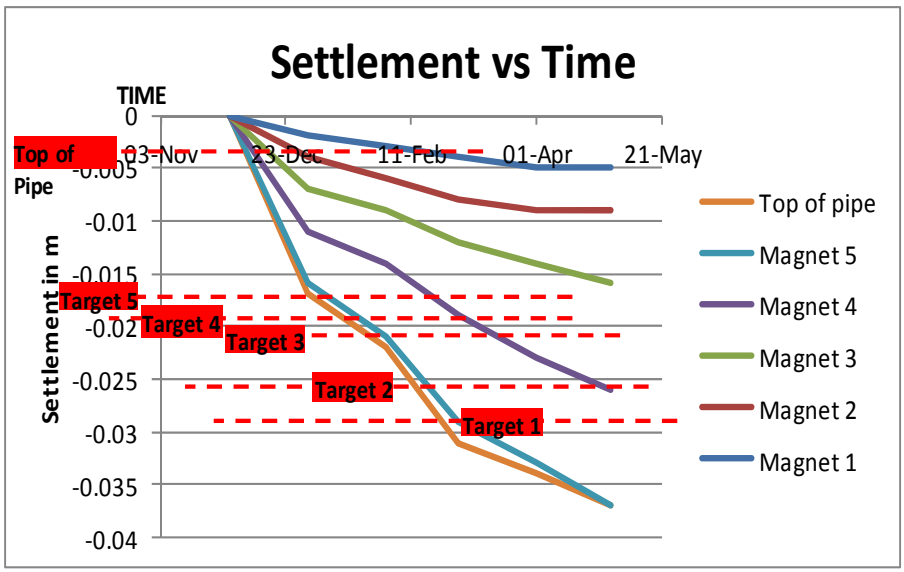
The 'change' (Settlement or Heave) values can then be presented in graphical formats to suit particular requirements. There are many formats that can be adopted. The graph below is just one such format.



In the previous graph, the settlement profile for each months
data is presented as a line which joins the change / elevation co-ordinates.

The negative ‘change’ values mean that the graph expands to the left as settlement increases. Some presentations change this value to positive to show the ’change’ as an increase to the right.

In the graph below, the settlement of each target is plotted against time.



5.0 GROUTING

THERE IS OFTEN CONFUSION REGARDING THE PURPOSE OF THE SPRUNG SPIDER LEGS. THEY ARE NOT, AS MANY PEOPLE THINK, TO KEY INTO THE SURROUNDING GROUND, THEY ARE ONLY THERE TO KEEP THE TARGET IN PLACE UNTIL THE GROUT HARDENS.
ONCE THE BOREHOLE IS GROUTED, THE LEGS BECOME REDUNDANT AND THE GROUT BECOMES THE CONNECTION BETWEEN THE MAGNETIC TARGET AND THE SURROUNDING GROUND.

Backfilling of boreholes and other excavations for extensometer installation often calls for the preparation and installation of a grout, which is to be specified by the engineer.

Grout should be mixed in a purpose designed grout mixer so as to ensure a complete mix. However, and only as a last resort, grout can be mixed in a large container using a high volume pump for circulating, mixing and placing the liquid.

Grout is used as either a sealing compound, a void filling material, or as a combination of both. Commonly the components and proportions of the mixture are designed to reflect the characteristics of the material into which it is to be placed. Where a specific design is not required, generalisations can be made with regard to the mix proportions.

Where the grout is to be used to backfill for a Magnetic Extensometer borehole, the commonly adopted mix proportions, by weight, would be :-

Grout Mix for Hard and Medium Soils		
Materials	Weight	Ratio by Weight
Portland cement	50 Kg (2 bags)	1
Bentonite	15 Kg	0.33
Water	125 Litres	2.5
Grout Mix for Soft Soils		
Materials	Weight	Ratio by Weight
Portland cement	50 Kg (2 bags)	1
Bentonite	20 Kg (as required)	0.4
Water	325 Litres	6.5

Other compounds can be added to the grout mixture to alter its characteristics:-

- Expanding agents are added to introduce small bubbles into a cement and water mix as it cures to prevent it from shrinking.
- Plasticisers can be added to a mixture to allow it to flow more freely through small bore pipe work.
- Fillers are added to provide weight and / or bulk to the mixture for use where grout may have a tendency to flow through the borehole walls.

6.0 MAINTENANCE

As the **GXM100 Series** access tubing and magnetic targets are installed within a borehole and grouted or within embankments it is a non-retrievable system and therefore maintenance free.

However the reed switch probe will require some basic maintenance including the following:-

- Status of the battery - change as required
- Cleanliness - always clean the probe, tape & reel after use
- When lowering and raising the probe make sure that the tape does not run over any sharp edges that may abrade the surface and shorten the life of the instrument.

7.0 TROUBLESHOOTING

If when lowering the reed switch probe down the access tube no sound is audible check the following:-

- That magnetic targets have been installed in the installation (check installation records)
- That the light is visible - if not then the battery should be checked

8.0 SPECIFICATION

GXM100 Magnetic Settlement System

Description	
Access Casing OD	33mm
Access Casing ID	25mm
Access Casing Length	1.5 or 3m
Access Casing Weight	0.6kg/m
Bottom Cap OD	33mm
Material	PVC
Magnetic Target	3 & 6 Leaf
Reed Switch Probe	30, 50, 100, 150, 200m
Installation Tool	30, 50, 100, 150, 200m

GXM100T Magnetic Settlement System

Description	
Access Casing OD	33mm
Access Casing ID	25mm
Access Casing Length	1.5 or 3m
Access Casing Weight	0.6kg/m
Bottom Cap OD	33mm
Access Tubing and Telescopic Sections	
Telescopic Section OD	42mm
Telescopic Section ID	35mm
Length	500mm
Range	200mm
Weight	0.55kg
Material	PVC
Accessories	
Spider Magnet	6 Leaf
Magnetic Target	43mm
Datum Target	43mm
Duct / Denzo Tape	10m
Read Switch Probe	30, 50, 100, 150, 200m

8.0 SPECIFICATION contd

GXM100P Magnetic Settlement System

Description	
Access Casing OD	33mm
Access Casing ID	25mm
Access Casing Length	1.5 or 3m
Access Casing Weight	0.6kg/m
Bottom Cap OD	33mm
Access Tubing and Telescopic Sections	
Telescopic Section OD	42mm
Telescopic Section ID	35mm
Length	500mm
Range	200mm
Weight	0.55kg
Material	PVC
Accessories	
Plate Magnet Target	33x300mm
Datum Target	33x60mm
Duct / Denzo Tape	10m
Read Switch Probe	30, 50, 100, 150, 200m

9.0 SPARE PARTS

The access tubing of **GEO-XM Series** magnetic settlement system (GXM100, GXM100T, GXM100P and GXM100C) is installed within non-recoverable environments (below ground) it is not serviceable nor does it contain any replaceable parts.

The reed switch probe which is used to measure the location of the magnetic targets has the following spare parts:-

Qty	Description
1	Spare probe & tape
1	9 volt battery
1	Reel
1	LED
1	Buzzer
2	Probe clips

10.0 RETURN OF GOODS

10.1 Returns procedure

If goods are to be returned for either service/repair or warranty, the customer should contact Geosense for a **Returns Authorisation Number,** request a **Returned Equipment Report Form QF034** and, prior to shipment. Numbers must be clearly marked on the outside of the shipment.

Complete the **Returned Equipment Report Form QF034**, including as much detail as possible, and enclose it with the returned goods and a copy of the form should be faxed or emailed in advance to the factory.

10.2 Chargeable Service or Repairs

Inspection & estimate

It is the policy of Geosense that an estimate is provided to the customer prior to any repair being carried out. A set charge for inspecting the equipment and providing an estimate is also chargeable.

10.3 Warranty Claim

(See Limited Warranty Conditions)

This covers defects which arise as a result of a failure in design or manufacturing. It is a condition of the warranty that the **GXM Series Magnetic Settlement System** must be installed and used in accordance with the manufacturer's instructions and has not been subject to misuse.

In order to make a warranty claim, contact Geosense and request a **Returned Equipment Report Form QF034.** Tick the warranty claim box and return the form with the goods as above. You will then be contacted and informed whether your warranty claim is valid.

10.4 Packaging and Carriage

All used goods shipped to the factory **must** be sealed inside a clean plastic bag and packed in a suitable carton. If the original packaging is not available, Geosense should be contacted for advice. Geosense will not be responsible for damage resulting from inadequate returns packaging or contamination under any circumstances.

10.5 Transport & Storage

All goods should be adequately packaged to prevent damage in transit or intermediate storage.

11.0 LIMITED WARRANTY

The manufacturer, warrants the **GEO-XM magnetic settlement system (GXM100, GXM100T,GXM100P and GXM100C)** manufactured by it, under normal use and service, to be free from defects in material and workmanship under the following terms and conditions:-

Sufficient site data has been provided to **Geosense** by the purchaser as regards the nature of the installation to allow **Geosense** to select the correct type and range of **GEO-XM magnetic settlement system (GXM100, GXM100T, GXM100P and GXM100C)** and other component parts.

The **GEO-XM magnetic settlement system (GXM100, GXM100T, GXM100P and GXM100C)** equipment shall be installed in accordance with the manufacturer's recommendations.

The equipment is warranted for 1 year from the date of shipment from the manufacturer to the purchaser.

The warranty is limited to replacement of part or parts which, are determined to be defective upon inspection at the factory. Shipment of defective part or parts to the factory shall be at the expense of the Purchaser. Return shipment of repaired/replaced part or parts covered by this warranty shall be at the expense of the Manufacturer.

Unauthorised alteration and/or repair by anyone which, causes failure of the unit or associated components will void this **LIMITED WARRANTY** in its entirety.

The Purchaser warrants through the purchase of the GEO-XM magnetic settlement system (GXM100, GXM100T, GXM100P and GXM100C) equipment that he is familiar with the equipment and its proper use. In no event shall the manufacturer be liable for any injury, loss or damage, direct or consequential, special, incidental, indirect or punitive, arising out of the use of or inability to use the equipment sold to the Purchaser by the Manufacturer.

The Purchaser assumes all risks and liability whatsoever in connection with the **GEO-XM magnetic settlement system (GXM100, GXM100T, GXM100P and GXM100C)** equipment from the time of delivery to Purchaser.

INSTALLATION NOTES

Geosense is a division of Marton Geotechnical Services Ltd

Geotechnical Centre . Rougham Industrial Estate . Rougham . Bury St Edmunds . Suffolk . IP30 9ND . England .

Tel: +44 (0) 1359 271167 . Fax: +44 (0) 1359 271168 . email: info@mgs.co.uk . www.mgsgeosense.co.uk