**Options available**

***Sample Sizes***

38mm ✓ 50mm ✓
70mm ✓ 76mm ✓
100mm ✓ 150mm ✓
Custom ✓

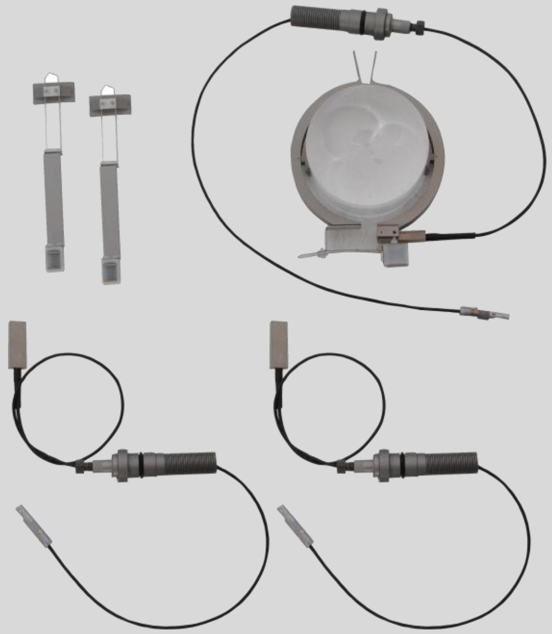
***Displacement Range***

+/-3.0mm ✓

***Pressure Range***

Up to 1700kPa ✓

# Hall Effect Local Strain Transducers



## What is it?

**The GDS Hall Effect Local Strain Transducers provide on-sample small strain measurements of axial and radial strains.** Accurate determination of soil stiffness is difficult to achieve in routine laboratory testing. Conventionally, stiffness of a triaxial test specimen is based on external measurements of displacement which include a number of extraneous movements. True soil strains can be masked by deflections which originate in the compliances of the loading system and load measuring system. Such equipment compliance errors add to a variety of sample bedding effects to give a poor definition of the stress-strain behaviour of the material under test, particularly over the small strain range. Most triaxial tests therefore tend to give apparent soil stiffnesses far lower than those inferred from field behaviour (Jardine, Symes & Burland, 1984).

## Why measure small strain?

Recent work has demonstrated the rather surprising finding that soils can be equally as brittle as rocks and that an understanding of their behaviour at levels of shear strain below 0.05% is very important. Indeed, K-zero for normally consolidated clays may reach peak strength in the triaxial apparatus at axial strains as low as 0.1%. Moreover, even when the behaviour is not brittle, the strains prior to yield are usually very small (loc. cit).

## Why measure locally on the specimen?

In the conventional triaxial test, surface friction arises between the unlubricated ends of the test specimen and the end platens of the test apparatus. The ends are therefore restrained laterally and hence vertically also. Accordingly, the test specimen deforms non-uniformly with a gradient of axial and radial deformation from zero at the ends to a maximum at the middle.

It is widely believed that triaxial test specimens with a height to diameter ratio of 2 have end zones which are more or less restrained while the middle third is more or less unrestrained. Therefore, it is highly desirable that radial and axial deformations are measured locally in this region if realistic deformation moduli are to be found.

The measurement of axial deformation based on the relative movement between the top cap and the base pedestal is subject to bedding errors. These errors arise because of the difficulty in providing perfectly plane, parallel and smooth ends on the triaxial test specimen. The top cap can rest on surface asperities of the test specimen or make contact imperfectly, perhaps on one edge of the specimen. Owing to this "point" loading effect, rapid deformation will occur during the early stages of triaxial compression until the top cap is properly bedded down.

***Technical specification***

- **Range =** +/- 3.0mm,
- **Resolution using 16 bit data acquisition +/- 3.0mm =** <0.1µm,
- **Accuracy =** +/-0.2% FRO over 4mm range, +/-0.3% FRO over 5mm range and +/- 0.4% FRO over 6mm range,
- **Radial Caliper Weight, 38mm caliper =** 24g, 70mm caliper = 46g,
- **Axial Apparatus Weight (1 off)** = 16g,
- **Transducer Weight (1 off encapsulated Hall Effect Chip)** = 5g.

## The axial strain measuring device

As shown in Fig. 1, a spring-mounted pendulum holds a magnet assembly. This is suspended from an upper pad fixed to the test specimen by pins and bonded to the membrane by adhesive. The spring allows relative motion between the fixing pad and the pendulum without the need to introduce a bearing. This is a very important feature of the device as it guarantees no slack in the system while ensuring that friction remains very low.

The lower part of the gauge consists of a metallic container holding the linear output Hall Effect semiconductor encapsulated in epoxy resin. This is mounted on the specimen by means of a pinned fixing pad (Clayton & Khatrush, 1986).

## The radial strain measuring device

As shown in Fig. 1, the device comprises a caliper similar to that originally designed by Bishop & Henkel (1962) and described in their book "The measurement of soil properties in the triaxial test". This type of caliper has been used for many years to indicate lateral deformation in the triaxial test.

The caliper is mounted on the test specimen by means of two diametrically opposed pads fixed to the test specimen by pins and bonded to the membrane by adhesive.

The Hall Effect transducer is positioned across the opening of the caliper where it measures the opening and closing of the jaws. Both the axial and radial devices are designed so that self-weight is partly counteracted by buoyant uplift.

**Fig 1: Radial and axial local strain transducers mounted directly on a triaxial test specimen**

## The Hall Effect deformation transducer – explanation of the principal

If a metallic or semiconductor plate, through which current is flowing, is placed in a magnetic field where flux lines are directed perpendicular to the plate and the current flow, the charge carriers will be deflected so that a voltage is produced across the plate in a direction normal to the current flow. This is known as the Hall Effect after E H Hall who discovered the effect in 1879. Hall Effect semiconductors are used widely to measure magnetic flux density. Linear versions of these devices are typically direct current (DC) energised and deliver a DC output which varies linearly with magnetic flux density over a specified range.

The devices have been applied to the measurement of local axial and radial deformation in the triaxial test. The work was pioneered by Dr C R I Clayton and his colleagues at the University of Surrey where they have been used successfully for over ten years.

***Why buy GDS Hall Effect Local Strain Transducers?***

- Axial and radial deformation measured directly on the triaxial test specimen.
- Light and compact assembly.
- The Hall Effect semiconductor chip is very light, remarkably small and is compensated against changes in ambient temperature and changes in DC voltage supply.
- High output, high resolution.
- Designed for use with the GDS data acquisition system.
- Proven performance over 10 years at the University of Surrey.

***References***

Bishop, A.W. & Henkel, D.J. (I 962). The measurement of soil properties in the triaxial test. Edward Arnold, London, Second Edition, 228p.

Clayton, C.R.I. & Khatrush, S.A. (1 986). A new device for measuring local axial strains on triaxial specimens. Geotechnique 36, No.4, 593-597.

Jardine, R.J., Symes M J. & Burland, J.B. (1 984). The measurement of soil stiffness in the triaxial apparatus. Geotechnique 34, No.3, 323-340.