## Local On-Sample Strain Measurement (Hall Effect or LVDT)

The GDS Hall Effect or LVDT Local Strain Transducers provide on-sample small strain measurements of axial and radial strain. 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.

| Key Features: | Benefits to the User: |
|---|---|
| Accurate determination of soil stiffness: | 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. |
| Axial and radial deformation measured directly on the triaxial test specimen: | Removes bedding errors or “end effects”. |
| Small strain measurement: | Recent work has demonstrated 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. |
| Measurement is taken in the middle third of the sample which is less restrained than the end zones: | Therefore, it is highly desirable that radial and axial deformations are measured locally in this region if realistic deformation moduli are to be found. |

### Technical Specification:

| | Hall Effect | LVDT |
|---|---|---|
| **Range:** | +/- 3.0mm | +/-2.5mm or +/-5.0mm |
| **Resolution (using 16 bit data acquisition):** | +/- 3.0mm = <0.1µm | +/- 2.5m m = <0.1µm , +/- 5.0m m = <0.2µm |
| **Accuracy:** | +/-0.2% FRO over 4mm range, +/-0.3% FRO over 5mm range and +/- 0.4% FRO over 6mm range | 0.1% FRO |
| **Radial caliper weight (based on a 70mm caliper):** | 46g | 74g |
| **Axial apparatus weight (1 off):** | 16g | 26g |
| **Transducer weight (1 off):** | 5g | 20g |
| **Maximum rated pressure:** | Up to 2000kPa | Low pressure version for use in water up to 3500kPa<br>High pressure version for use in non-conducting oil up to 200MPa |
| **Operates Within Temperature Range:** | +10°C to +40°C | -20°C to +60°C |





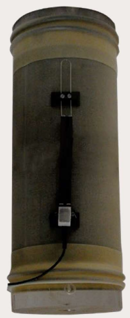

Fig 1. Axial Hall Efffect

## The Hall Effect Axial Strain Transducer

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).

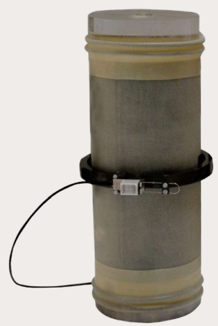

Fig 2. Radial Hall Efffect

## The Hall Effect Radial Strain Transducer

As shown in Fig. 2, 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.

| Key Features: | Benefits to the User: |
|---|---|
| Light compact semiconductor chip: | The Hall Effect semiconductor chip is very light, has compact assembly and is compensated against changes in ambient temperature and changes in DC voltage supply. |
| +/- 1V DC Voltage Output: | Can be connected directly to any standard data acquisition system. |

## The Hall Effect deformation transducer – explanation of the principle of operation

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 Chris Clayton and his colleagues at the University of Surrey where they have been used successfully for over ten years.