129 Helpsheet

World Leaders in Computer Controlled Testing Systems for Geotechnical Engineers and Geologists

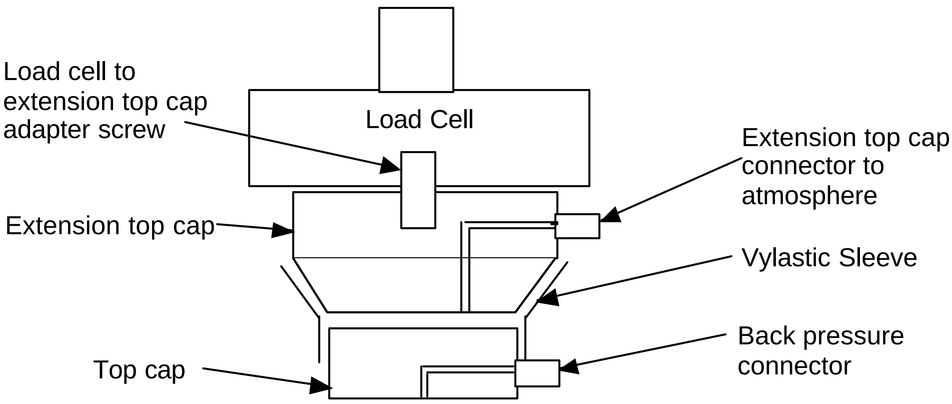
Hardware

Triaxial Testing Systems

Extension Testing – Explanation of the Forces Acting

1. Using the Extension Top Cap

The GDS triaxial extension device enables triaxial extension to be carried out as routinely as triaxial compression. The device prevents cell pressure from acting vertically on the top cap resting on the test specimen. This allows axial stress to be reduced below cell pressure.



Please refer to helpsheet #47 for practical information on using the device

2. Forces Acting on the System

The axial stress on a sample (measured in kN) using an internal load cell (which measures force independent of cell pressure) without using the extension device is:

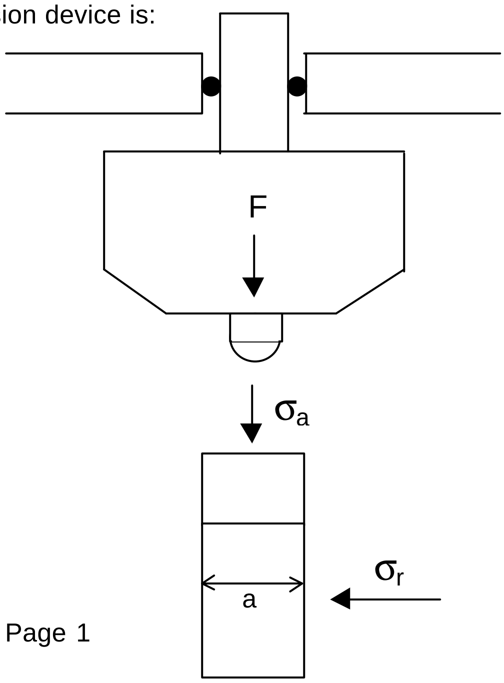
$$\sigma_a = \frac{F}{a} + \sigma_r$$

Where F is the force from the loadcell

a is the area of the sample

σ_a is the axial stress

σ_r is the radial stress

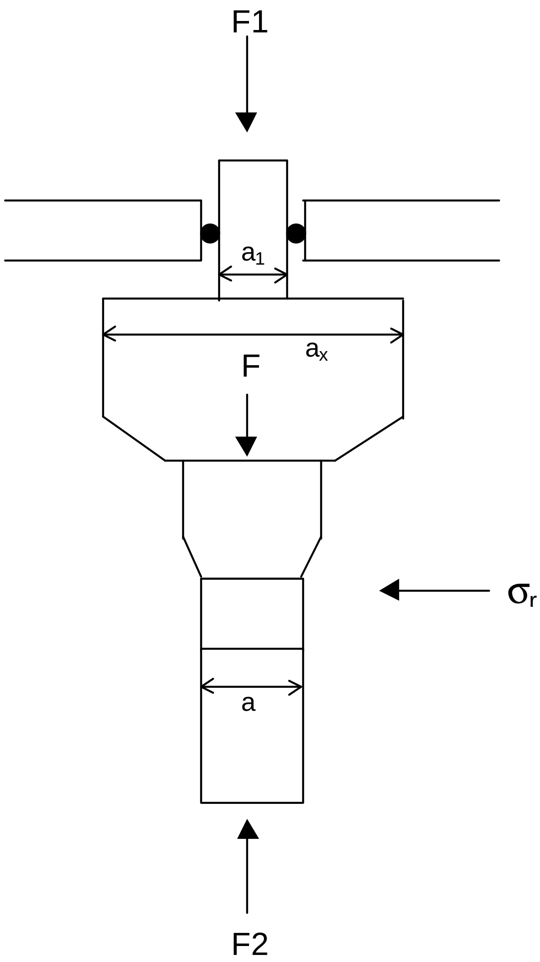


Using the extension top caps makes no difference to the forces acting on the sample. *The axial stress is calculated in exactly the same way as when using normal top caps.*

This is shown by the following diagram and mathematical proof:

Where:

F is the force measured by the loadcell
a_x is the area of the loadcell
a_1 is the area of the load ram
a is the area of the sample
σ_a is the axial stress
σ_r is the radial stress
σ_d is the deviator stress



By definition:

$$\sigma_a = \sigma_r + \sigma_d \text{ ....(1)}$$

$$\sigma_a = \frac{F_2}{a} \text{ ....(2)}$$

From the free body diagram:

$$F_1 = F + (a_1 \cdot \sigma_r) \text{ ....(3)}$$

$$F_1 + (a_x - a_1)\cdot\sigma_r = F_2 + (a_x - a)\cdot\sigma_r \text{ ......(4)}$$

simplifying (4) gives

$$F_1 - a_1 \cdot \sigma_r = F_2 - a\,.\sigma_r$$

Substituting F instead of F_1 using the relationship shown in (3) gives:

$$F = F_2 - a \cdot \sigma_r$$

but, from (2)

$$F_2 = a \cdot \sigma_a$$

therefore

$$F = a \cdot \sigma_a - a \cdot \sigma_r$$

Dividing by a gives:

$$\frac{F}{a} = s_a - s_r$$

Rearranging the equation:

$$s_a = \frac{F}{a} + s_r \text{ ....(5)}$$

Which is exactly the same as when not using the extension device.

EXAMPLE

Internal Load cell reading (F) = 0kN (this is the deviator force)
Cell pressure (s_r) = 500kPa

From (5), this results in an Axial Stress (s_a) of 500kPa. The specimen is in isotropic conditions, whether the extension device is fitted or not.