Notes on Fluid Mechanics

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1 Shear

Definition 1.1. *A **fluid** is any material that is unable to prevent the deformation caused by shear stress.*

Consider a shear testing device consisting of two plates with a small piece of material between them. We apply a force F continuously on the upper plate. The shear stress τ is defined as the amount of force per unit area,

$$\tau = \frac{F}{A} \tag{1}$$

where A is the area of the plate in contact with the fluid.

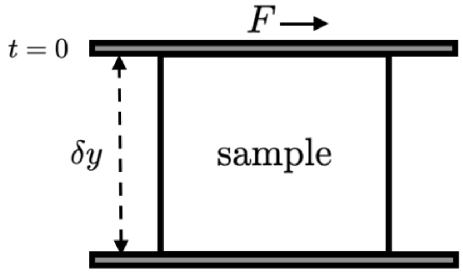

Figure 1: A shear testing device (depicted in 2D).

1.1 Shear in solids

Consider the sample in our shear testing device is a solid, Fig 1.1 shows the deformation after time t'. For any given shear τ, the shear deformation is finite in solids. We can define a new quantity, shear strain λ, to measure this deformation:

$$\lambda = \frac{\Delta x}{\delta y} \tag{2}$$

*Corrections to me@vgg.cz.

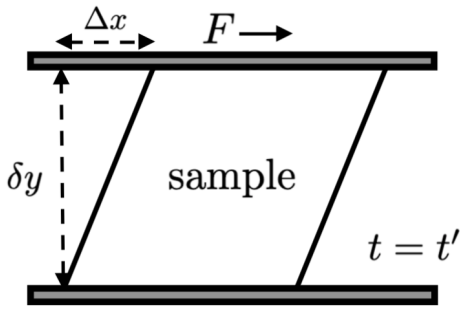

Figure 2: Shear deformation at time t' for a solid.

We can derive the relationship between shear stress and strain experimentally. In fact, it turns out they are related linearly. We call the constant of proportionality the Shear Modulus, G, and it is dependent on the material.

$$\tau = G\lambda \tag{3}$$

1.2 Shear in fluids

$t = t_1 \quad t = t_2$