Density, force and stress

Engineering Fluid Mechanics

Dr. Kelly Kibler
Department of Civil, Environmental & Construction Engineering
University of Central Florida

Density

Density is ***mass per unit volume:***

$$\rho = \frac{\mathbf{M}}{L^3} = \frac{\mathbf{kg}}{\mathbf{m^3}} = \frac{\mathbf{lbm}}{\mathbf{ft^3}}$$

Density

Density is ***mass per unit volume:***

$$\rho = \frac{\mathbf{M}}{L^3} = \frac{\mathbf{kg}}{\mathbf{m^3}} = \frac{\mathbf{lbm}}{\mathbf{ft^3}}$$

Specific weight (γ) is the ***weight of a unit volume of a substance***:

$$\gamma = \rho g$$

where g is gravitational acceleration
in U.S. Customary units $g = 32.2\ ft/s^2$
in SI units $g = 9.81\ m/s^2$

Density and force

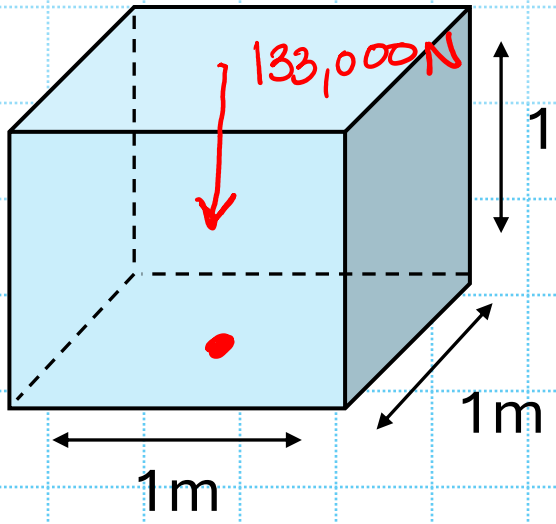
$$\rho_{Hg}@25^\circ C = 13,534 \frac{kg}{m^3}$$

$$\gamma_{Hg}@25^\circ C = \rho g = 13,534 \frac{kg}{m^3} \cdot 9.81 \frac{m}{s^2}$$

$$= 132,769 \left(\frac{kg \cdot m}{m^3 s^2}\right)\left(\frac{1N}{1 kg \cdot \frac{m}{s^2}}\right)$$

$$\gamma_{Hg} = 132,769 \frac{N}{m^3}$$

Density and force



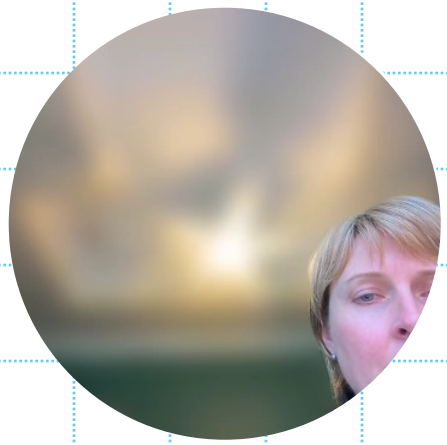
$$\sigma = \frac{F}{A} = \frac{132{,}769\ N}{1\ m^2}$$

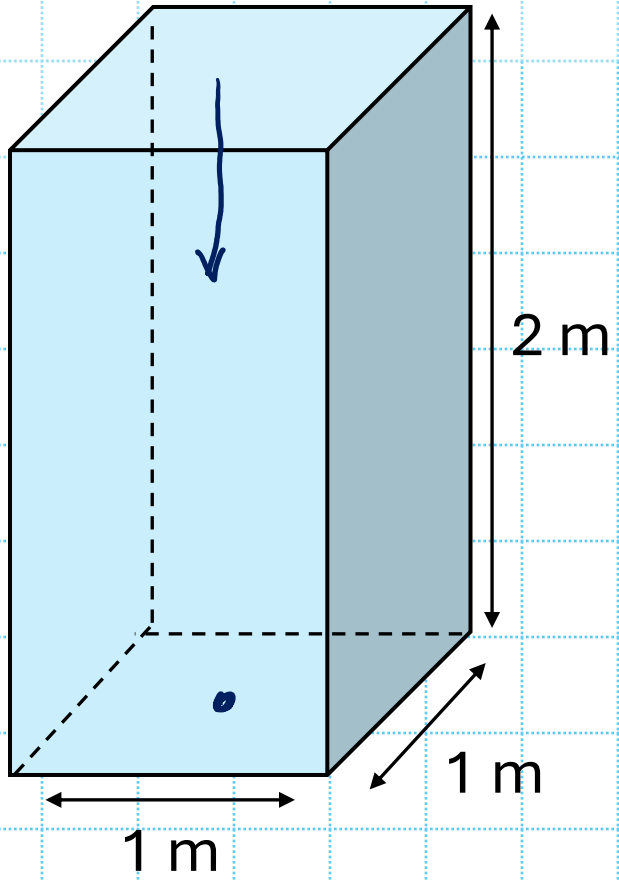
$$132{,}769\ \frac{N}{m^2} \rightarrow Pa$$

PRESSURE (P)

$$P = 132{,}769\ Pa$$

Density and force





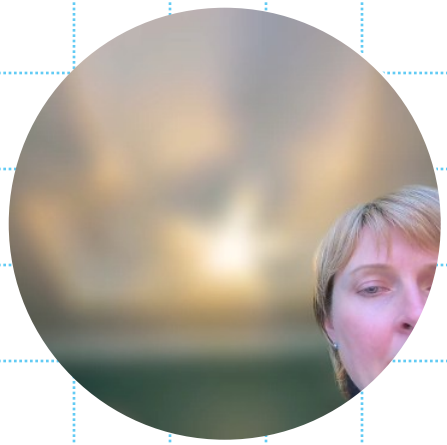
$$\gamma_{Hg} = 132{,}769 \frac{N}{m^3}$$

$$F = 132{,}769 \frac{N}{m^3} \cdot 2\,m^3$$

$$F = 265{,}537\,N$$

$$\sigma = \frac{F}{A} = 265{,}537 \frac{N}{m^2}$$

Density, force and stress



UCF College of Engineering and Computer Science
UNIVERSITY OF CENTRAL FLORIDA

Acknowledgement

This material is based upon work partially supported by the National Science Foundation under Grant# 2335802. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

UCF College of Engineering and Computer Science
UNIVERSITY OF CENTRAL FLORIDA

You are free

- to **Share** – to copy, distribute, display and perform the work
- to **Remix** – to make derivative works

Under the following conditions

- **Attribution** — You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).
- **Noncommercial** — You may not use this work for commercial purposes.
- **Share Alike** — If you alter, transform, or build upon this work, you may distribute the resulting work only under the same or similar license to this one.

UCF | College of Engineering and Computer Science

UNIVERSITY OF CENTRAL FLORIDA

THE END

Photo credit: Kelly Kibler, Volusia County, Florida