

Dynamics: Conservation of Momentum

Cauchy Stress Principle (1827) – also formulated by Euler for perfect fluids

“Upon any imagined closed surface S there is a distribution of stress vectors $\vec{\tau}$ whose resultant and moment are equivalent to those of the actual forces of material continuity exerted by the material outside S upon that inside.”

Truesdell (1953): This principle *“has the simplicity of genius.”*

Conservation of Momentum – fundamental principle of dynamics

The rate of change ($\frac{d}{dt}$) of linear momentum of a material volume (W_t) is equal to the resultant force on the volume:

$$\frac{d}{dt} \int_{W_t} \rho \vec{u} dx = \int_{W_t} \rho \vec{f} dx + \int_S \vec{\tau} dS,$$

$S = \partial W_t =$ boundary of W_t ; $\vec{f} = \vec{f}(\vec{x}, t) =$ body force per unit mass.