Poisson's Ratio

Poisson's ratio (ν), named after Siméon Poisson, is the ratio, when a sample object is stretched, of the contraction or transverse strain (perpendicular to the applied load), to the extension or axial strain (in the direction of the applied load).

When a material is compressed in one direction, it usually tends to expand in the other two directions perpendicular to the direction of compression. This phenomenon is called the Poisson effect. Poisson's ratio ν (nu) is a measure of the Poisson effect. The Poisson ratio is the ratio of the fraction (or percent) of expansion divided by the fraction (or percent) of compression, for small values of these changes.

Conversely, if the material is stretched rather than compressed, it usually tends to contract in the directions transverse to the direction of stretching. Again, the Poisson ratio will be the ratio of relative contraction to relative stretching, and will have the same value as above. In certain rare cases, a material will actually shrink in the transverse direction when compressed (or expand when stretched) which will yield a negative value of the Poisson ratio.

The Poisson's ratio of a stable, isotropic, linear elastic material cannot be less than −1.0 nor greater than 0.5 due to the requirement that the elastic modulus, the shear modulus and bulk modulus have positive values. Most materials have Poisson's ratio values ranging between 0.0 and 0.5. A perfectly incompressible material deformed elastically at small strains would have a Poisson's ratio of exactly 0.5. Most steels and rigid polymers when used within their design limits (before yield) exhibit values of about 0.3, increasing to 0.5 for post-yield deformation (which occurs largely at constant volume.) Rubber has a Poisson ratio of nearly 0.5. Cork's Poisson ratio is close to 0: showing very little lateral expansion when compressed. Some materials, mostly polymer foams, have a negative Poisson's ratio; if these auxetic materials are stretched in one direction, they become thicker in perpendicular directions. Anisotropic materials can have Poisson ratios above 0.5 in some directions.

Assuming that the material is stretched or compressed along the axial direction (the x axis in the diagram):

$$ \nu = -\frac{d\varepsilon_\mathrm{trans}}{d\varepsilon_\mathrm{axial}} = -\frac{d\varepsilon_\mathrm{y}}{d\varepsilon_\mathrm{x}}= -\frac{d\varepsilon_\mathrm{z}}{d\varepsilon_\mathrm{x}} $$

where

- ν is the resulting Poisson's ratio,
- $\varepsilon_\mathrm{trans}$ is transverse strain (negative for axial tension (stretching), positive for axial compression)
- $\varepsilon_\mathrm{axial}$ is axial strain (positive for axial tension, negative for axial compression).

참고

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