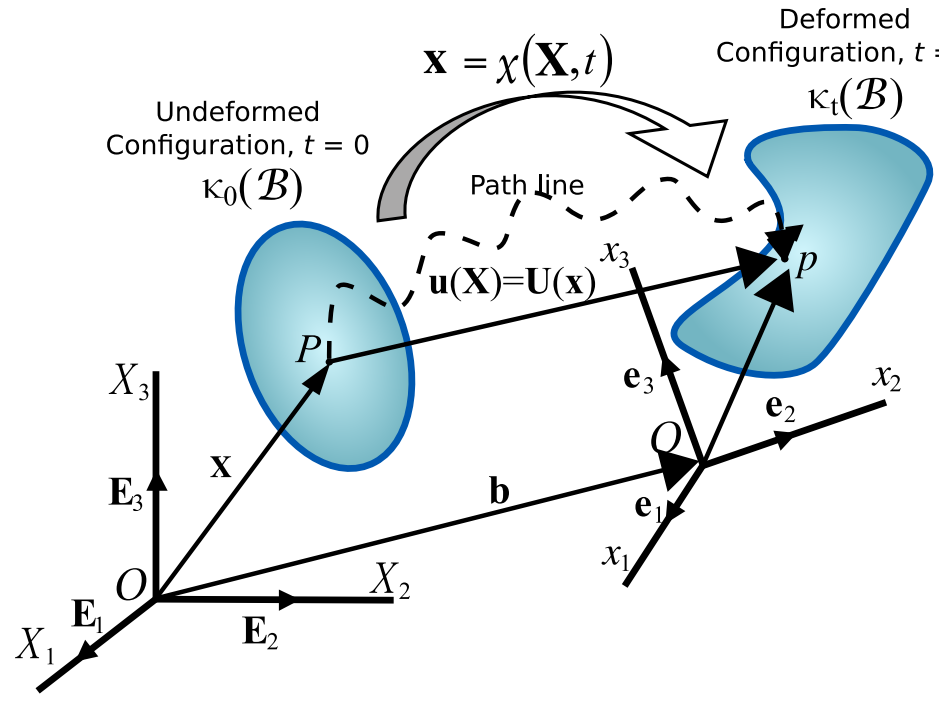
Deformations and Strain

Topics



Ref:
http://commons.wikimedia.org/wiki/File:Displacement_of_a_continuum.svg

1. Deformation Gradients
2. Polar Decompositions
3. Rotation Matrices
4. Finite Element Mapping
5. Small Scale Strains
6. Green & Almansi Strains
7. Principal Strains & Invariants
8. Hydrostatic & Deviatoric Strains
9. Velocity Gradients
10. True Strain
11. Material Derivative
12. Special Topics

Summary

This section gets to the heart of what Continuum Mechanics is all about - dealing with large displacements and deformations of objects. The ultimate goal is often the determination of the stress, strength, fatigue, and fracture properties of an object or material. However, all these objectives begin with the same first step - quantifying the object's displacements and deformations.

Displacements are not usually the focus of attention. In fact, the term rigid body

displacement implies this because it refers to the situation where the object moves, but does not stretch or deform in any way. Such behavior does not generate stress. It can, however, seriously complicate the more important objective of determining deformations.

The term deformation refers to the much more interesting and complex situation of material bending, twisting, stretching, etc. All of these deformation modes generate stress. The challenge is to separate the displacements from the deformations, and to quantify each.

It turns out that deformations are closely related to the gradient of the displacement field. Since gradients quantify rate of change w.r.t. position, it makes sense that if the displacements at all points on an object are the same, then it is undergoing rigid body displacement and there is no change in displacements and therefore no strains, stresses, fatigue, etc.

The main complication to the above effort is... rotations. Rigid body rotations are a subset of rigid body displacements that complicate the whole process and can appear (incorrectly) as strains if they are not treated properly.

Hooke's Law

Table of Contents

Deformation Gradients