Strength of Materials

1. Preliminaries

Presentation of course

 Strength of materials

 Wytrzymałość materiałów

 Сопротивление материалов

 Résistance des matériaux

 Festigkeitlehre

 Hållfasthetslära

 材料力学

SM is about the resistance
of materials
(and structures)
against
external environmental
actions
(forces, deformations,
temperatures etc.)
which may lead to
the loss of
load bearing capacity

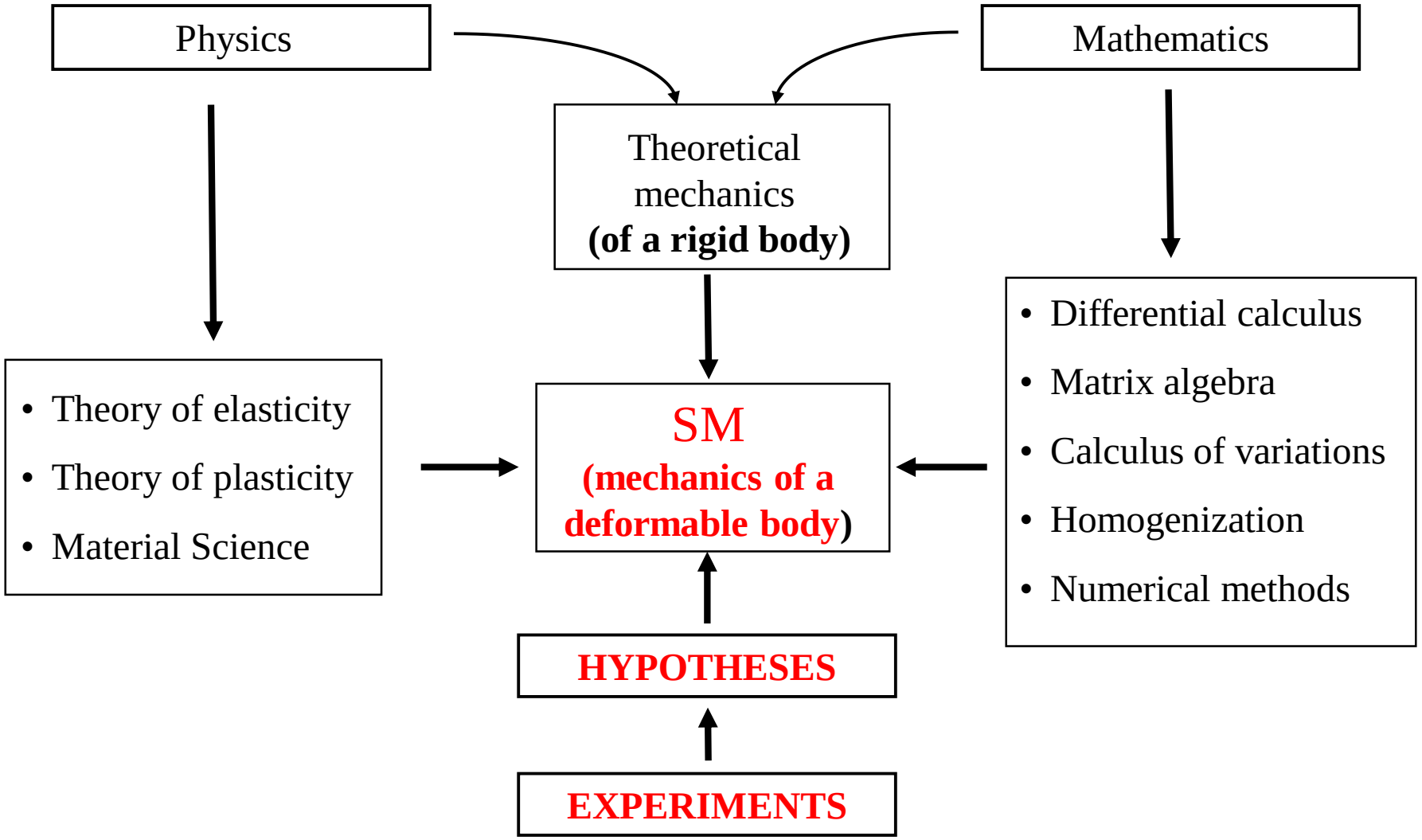
What the strength of materials is?

from Wikipedia:

Strength of materials, also called **mechanics of materials**, is a subject which deals with the behavior of solid objects subject to stresses and strains

Strength of materials is a basis of an engineering knowledge, containing basic formulas and solutions for the most common simple cases

Roots of strength of materials (SoM)



Scope of the first semester of SoM

Statics of simple bar structures:
- trusses
- simple beams
- beams (more complicated but without an exaggeration)
- slant beams
- continuous beams
- frames
- arches
- combined structures

Cross-sectional characteristics

Mechanics of continua
- displacement
- deformation and strain
- stress
- constitutive relations

What our goals are?

1. Skill at determination of internal forces in structural elements
2. Determination of safety coefficients for structures' service

The first goal will be realized by learning statics
The best part of the first semester will be devoted to the static calculations
This matter is so important that the ability will be refined later on during a structural mechanics course

The second goal includes not only strength aspect but also necessary structural stability and stiffness
This matter is much more complex and will be studied starting with the continuum mechanics at the end of the first semester and during the whole second semester

Educational aids

Basic textbook in English will be:

V. D. da Silva, Mechanics and Strength of Materials, Springer, 2006

Other optional books:

J. Case, H. Chilver, C. T. F. Ross, Strength of Materials and Structures, Arnold co-ed. J.Wiley&Sons, New York, Toronto, 1999

S.Timoshenko, Strength of Materials, Van Nostrand Co., 2nd 1940, available at any Open Course Ware (OCW) resources provided by UK or US universities

F. Frey, Analyse des structures et milieux continus, vol. I , II et III, Presses Polytech. et Univ. Romandes, Lausanne 2011

Basic textbook in Polish:
Please look at the web site http://limba.wil.pk.edu.pl/zwm

Definitions

Modeling scheme

Idealization of:

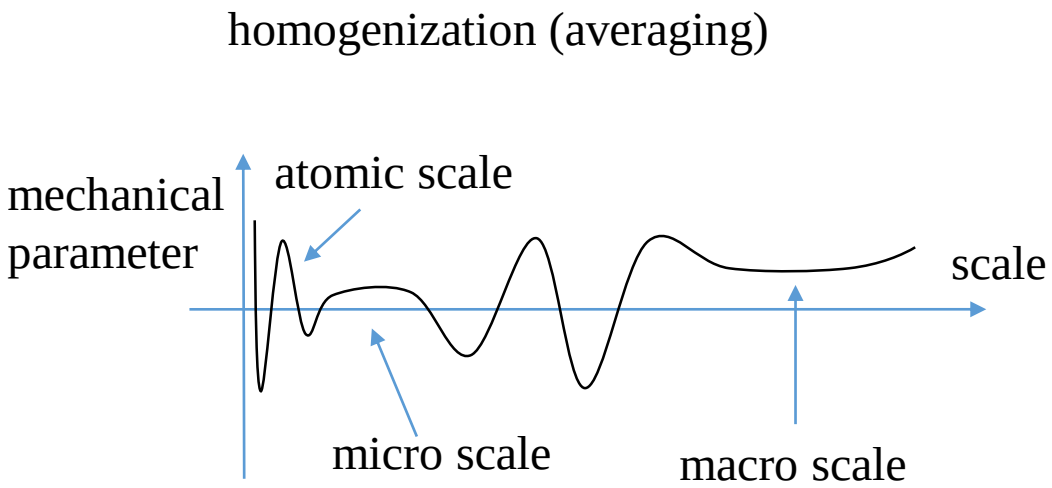
Material

Loadings
- Permanent versus movable
- Constant versus variable in time (static versus dynamic)

Structure geometry
- Bulk structures (H ~ L~B)
- Surface structures (H«L~B)
- Bar structures (L»H~B)

Material

Structural materials:
- steel
- aluminum
- concrete
- (reinforced concrete)
- wood
- soil



Representative element volume (REV) – continuum mechanics (mechanics of continua)
- metals: 1 mm
- wood: 1 cm
- concrete: 10 cm
- soil: ??? (from 1 cm to several meters)

Mechanical loadings

External surface forces

Surface distributed force ***p*** [N/m^2]

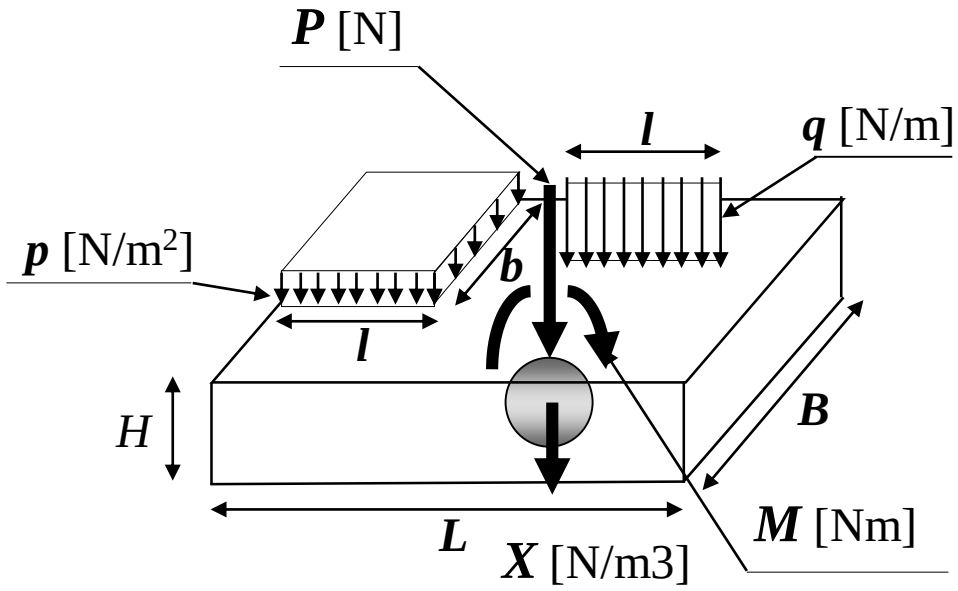
Line distributed force ***q*** [N/m]

Point force ***P*** [N]

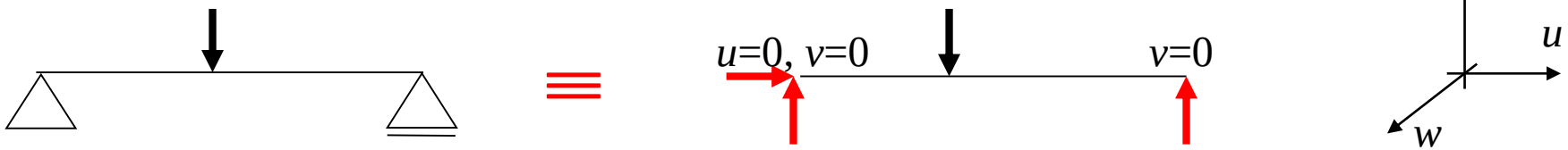
Point moment ***M*** [Nm]

External volume forces

(gravitational forces, inertia forces, electromagnetic forces etc.) ***X*** [N/m3]



Displacements ***u****(u,v,w)* [m] (e.g. supports, forced shift of structural members)

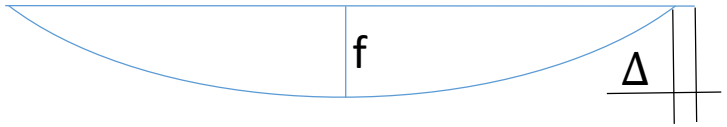


Basic assumptions

Ass. 1: Material continuum
The material is smeared (diffused) in the element volume

Ass. 2: Static equilibrium
any structure is in static equilibrium (it means that any part of structure is in static equilibrium)

Ass. 3: Solidification principle
usually, the civil structures are very stiff, so in static calculations we can neglect an influence of the deformations onto static values
(ex.: f = 1/150 -> rel. error of the span length = 0.1 %, 1/250 -> 0.038 %, 1/500 -> 0.01 %)



Ass. 4: Superposition principle
(additivity of results) linear homogeneous equations

$$f(x) = \alpha x \;\rightarrow\; f(kx) = kf(x), \qquad f(\Sigma x_i) = \Sigma f(x_i)$$

Thank you for your attention!