



Budapest University of Technology and Economics

Department of Mechanics, Materials and Structures
English courses
General course /2017
Fundamentals of Structures

András Draskóczy
Lecture no. 1:

Introduction
Aims of the course
Building design problems
Loads and effects acting on loadbearing structures of buildings

Introduction

Our subject:

FUNDAMENTALS OF STRUCTURES

Lecturers: Dr. András Draskóczy, Dr. András Sipos

Department: DEPARTMENT OF MECHANICS, MATERIALS AND
STRUCTURES

Building K 2nd floor door no. 61.

Topics schedule and requirements are available on the website of the
Department at:

[www.szt.bme.hu/Downloads/English_courses/Fundamentals of
Structures/2017](http://www.szt.bme.hu/Downloads/English_courses/Fundamentals_of_Structures/2017)

Weekly reception hours are communicated on the homepage and at the
entrance of the Department

András Draskóczy: Thursdays 14.00-15.00 pm.

Use also the online Q&A platform piazza (piazza.com)!

Aims of the course

- review some of the most important topics of *kinematics* and *statics*
- acquire *general overview about problems of architectural and structural design and construction* through *site visits* at:
 - an existing building,
 - a material testing laboratory,
 - a construction site,
 - an architectural design buro anddiscussing the experiences gained at the above visits
- making *preparatory steps in numerical problem solution in the field of kinematics and statics*: resultant and equilibration of coplanar forces
- help to decide definitively to continue studies in architectural (or civil) engineering*

Problems related to building design

Main **components** of buildings

Spaces

(main) functional spaces

services for

circulation

socials activities

installations

Constructions

building constructions

loadbearing constructions

installations

Main **design characteristics** of the components

Connections

Form and dimensions

Connections

Form and dimensions

Materials

Main **design requirements**

Functionality

Human comfort

Functionality

Safety

Economics

Aesthetics

Aesthetics

Unity of function, construction and form

Questions about way of fulfilment of requirements

Way of handling of local conditions?

Characteristics of the natural and built environment, local building prescriptions, culture, climate, orientation, slope, underground conditions

Materials (products, constructions) to use?

Availability of local materials, economic, functional and aesthetical considerations

Aesthetics?

Way of handling of the general architectural *requirement of the unity of function, structures and form*

Materials, forms and styling, colours, surface structures to apply?

Economic considerations: prize/performance rate?

Safety considerations: Safe use? Danger of slip, air pollution etc.

Numerical verification of safety against rupture and collapse of the loadbearing structures

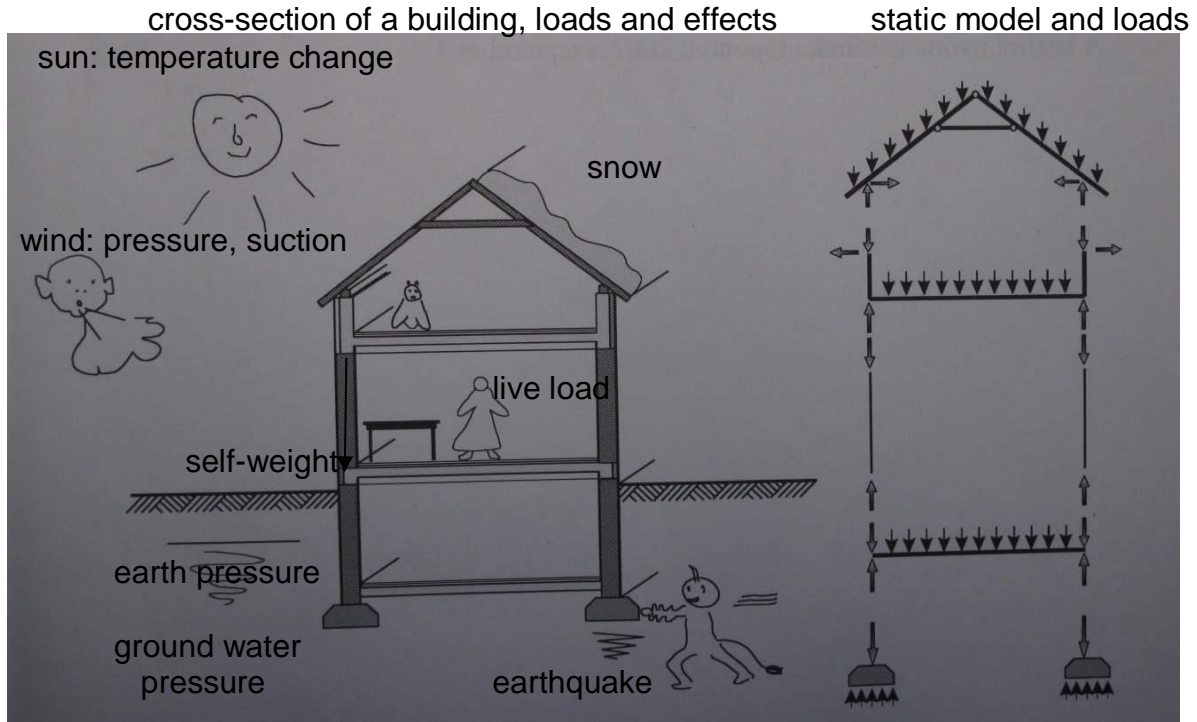
The need of a *design team*

<u>Parts of buildings</u>	<u>the designer of the parts</u>
The house as a whole composition of building constructions	architect, the chef of the design team
Installations Piping (water, waste water, heating)	building mechanical engineer
Electric supply, informatics	electric and informatics engineer
<i>Loadbearing structures</i>	<i>civil or structural engineer</i>
.....
Furnishing	architect of the interior
Surroundings of the building	garden architect

Most of the *safety requirements* refer to the *loadbearing structures*

Safety against	Requirement
<i>rupture and collapse</i> : adequate	<i>bearing capacity</i> of the members of the loadbearing structure
<i>buckling, overturning, sliding</i> :	<i>stability</i> of the loadbearing structure and of all of the structural members
<i>corrosion or fatigue failure</i>	<i>durability</i> of the structural materials:
<i>fire collapse</i> :	<i>fire resistance</i> of the structural members

Buildings and loads



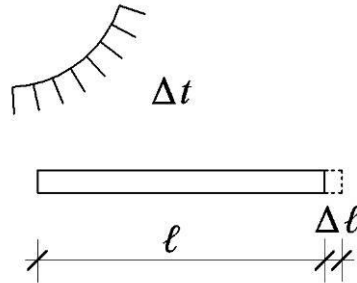
Loads and effects

According to present international terminology, loads are also effects

According to traditional terminology:

Examples for **effects** are:

- *temperature effects*: that give rise to volume (length) changes:



$$\Delta l = \alpha l \Delta t \text{ (mm)}$$

where Δl means elongation (contraction) (mm)

α : linear coefficient of thermal expansion of the material ($1/^\circ\text{C}$)

(For example for concrete: $\alpha_{\text{concrete}} = 10^{-5} 1/^\circ\text{C}$)

l : length of a linear member (mm)

Δt : temperature change ($^\circ\text{C}$)

- *corrosion effects*: for example oxidation of steel

-*aging*, for example plastics become more brittle with time
brittle behaviour: rigid rupture without previous deformation

Loads according to traditional meaning of the word **are forces** that are acting onto the structure

Definition of forces

2nd law of Newton:

$$F=ma$$

Where: m stands for mass (kg)

a means acceleration (m/sec^2)

unit of forces: $1 \text{ kgm}/\text{sec}^2 = 1 \text{ N}$ (Newton)

The most commonly known kind of acceleration is caused by the

gravitational attraction of the Earth: $g = 9,81 \text{ m}/\text{sec}^2$

Self-weight of masses:

$$G=mg \text{ (N)}$$

The selfweight of 1 kg mass is: $G = 1 \cdot 9,81 \approx 10 \text{kgm/sec}^2 = 10 \text{ N}$

The most commonly used *unit of forces* (loads) is 1 kN= 1000 N

A frequent case of occurrence of 1 kN is the appr. weight of 1 thick man:

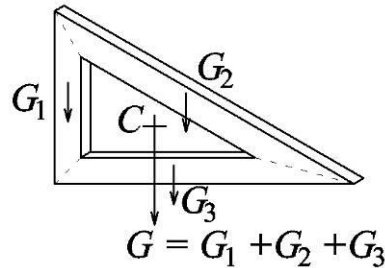
C: centre of gravity
(point of application)



$G \approx 1 \text{ kN}$

The vector character of forces

The selfweight G is an **idealization**, the resultant of a distributed parallel force system: the sum of the weights of the elementary parts of a body (mass), acting in vertical direction and passing through the *centre of gravity* (C) of the body. The self-weight of a set-square for example:

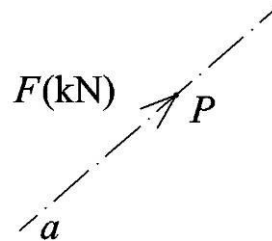


The self-weight G as an idealized resultant force is called a **concentrated force**.

The vector character of concentrated forces

means further idealization, that is a generalized force in the space can be defined by the following data:

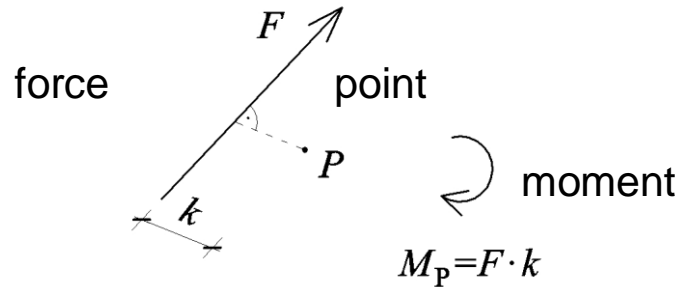
1. point of application (P)
2. line of action (a)
3. direction (arrow head)
4. magnitude F (kN)



The vector character of forces is exploited by determining the resultant of planar or spatial force systems and by equilibration problems, and will be practiced during this course and in the subject Statics.

The effect of a force F will not change by shifting the force along its line of action.

The moment of a force



The moment of a force F with respect to a point P is $M = Fk$ (kNm)
where k is the distance of point P from the line of action of the force F , called also *lever arm*.

The *sense* (direction) of a moment is indicated by an arrow head on the sign (semicircle) of the moment.

The effect of a moment M will not change by shifting the moment parallel to its plane in any position in the space.

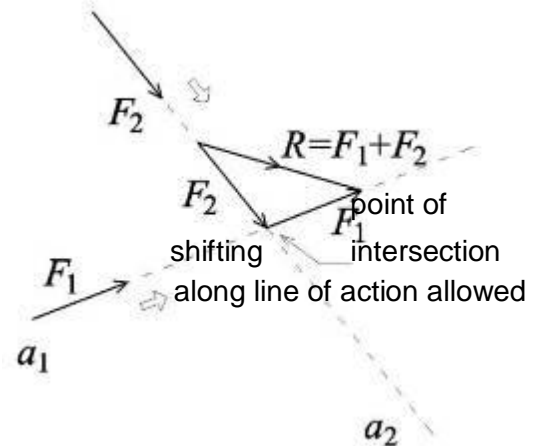
The summation of forces in the plane: the resultant force, the couple

Geometrical (graphical) method:

Use of *force scale*:

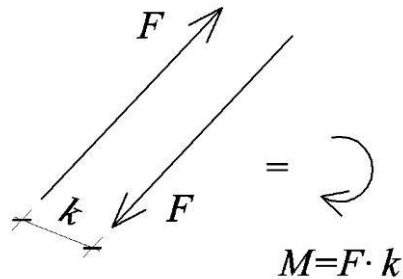
1 kN \equiv 1 cm

F_1 and F_2 lie in the same plane



The couple

The resultant of two parallel forces F of equal magnitude, opposite direction and distance k is a moment $M=Fk$. The two forces are called a *couple*.



Classification of loads according to *distribution*

Concentrated load (a)

Distributed *planar* (or coplanar) loads

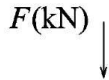
uniformly distributed load (b)

triangular (linearly variable) (c)

general (d)

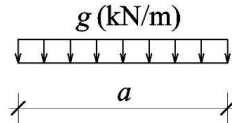
Examples for planar loads:

a)



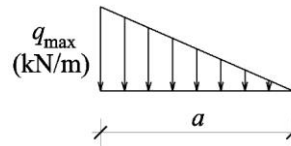
concentrated load

b)



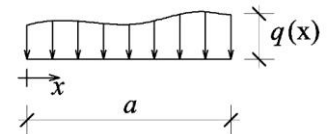
uniformly distributed load

c)



triangular load

d)

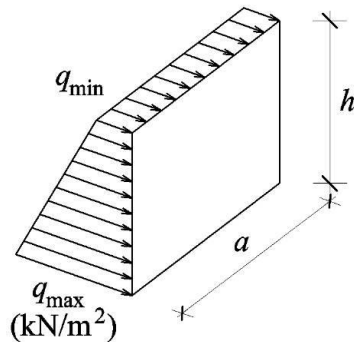


general distributed load

Spatial load system

Examples:

earth pressure



uniformly distributed
gravity forces acting on a surface
(self-weight of a floor construction or
live load intensity on a floor)

