Lecture 1
INTRODUCTION

Mechanics of materials is a branch of applied mechanics that deals with the behavior of solid bodies subjected to various types of loading. This field of study is known by several names, including "strength of materials" and "mechanics of deformable bodies".

Strength of materials is based upon the laws and theorems of theoretical mechanics. However, in theoretical mechanics solids are conventionally considered as absolutely rigid bodies that is as bodies undergoing no change in shape under the action of loads applied to them. Experimental observations show, however, that all solids deform when subjected to forces. External forces (loads) acting on a solid produce internal forces, which resist the external ones. Thus, for instance, if external forces stretch a solid, the internal forces will resist the stretching, there will act forces of mutual attraction between individual particles of the solid. As external forces increase so do internal forces. However, the internal forces in each material can increase only to a certain limit characteristic of this material. The external forces may be so large that the internal forces in a body of given dimensions will not be able to balance them and the body will fracture. In order for structural members and machine parts to sustain the loads acting on them without fracture and appreciable deformations they must be made of a proper material and have the necessary dimensions. These dimensions of structural members are determined by calculations with making use of equations of strength of materials.

PROBLEMS OF STRENGTH OF MATERIALS

For various types of loading strength of materials establishes mathematical relations between external forces, geometric proportions of structural members, the resulting elastic (i.e. internal) forces and deformations.

These relations and the strength characteristics of materials are used to determine the required dimensions of structural members.

In establishing these relations certain assumptions and limitations are made. These assumptions and limitations are necessary because it is impossible to cover all the features of the phenomenon under study as a whole.

GENERAL ASSUMPTIONS

First of all, the material of which the structures are made is considered to be continuous, homogeneous at all points of the body and having the same properties in all directions. The latter property of the materials is called isotropy. Indeed, some structural materials such as cast metals possess high homogeneity (cast iron is an exception in this case). The more homogeneous the material and the more alike its properties in different directions, the closer is the agreement between theoretical and experimental results. In strength of materials experiment and theory are closely interrelated; all theoretical assumptions and conclusions are verified in practice and after their validity is confirmed they are accepted for use.

Strength of materials, as a rule, deals with only those problems of the behavior of bodies under the action of external forces in which the deformations are small compared to the dimensions of the body. This makes it possible to neglect the changes (produced by deformations) in the position of the forces acting on the body.

Strength of materials deals with only simple-shaped bodies. These are bars, plates, and thin-walled shells.

A bar is a body whose length is considerably greater than the transverse dimensions which are of the same order of magnitude. The axis of the bar may be curved or straight line. A bar with a straight axis may be called rod, shaft, beam, and column depending on its purpose.

A plate and a thin-walled shell are bodies whose thickness is considerably smaller than the other two dimensions. Strength of materials deals mainly with bars.

BASIC TYPES OF LOADING

Loading of structural members may be very complex. However, this complex loading can be always represented as consisting of a small number of basic types of loading. Basic types of loading studied in strength of materials are: tension, compression, shear, torsion, bending.

WORDS AND WORD COMBINATIONS

to apply ..... применять, прилагать, прикладывать
appreciable ..... заметный, ощутимый; поддающийся определению, оценке
to assume ..... допускать, предполагать
assumption ..... предположение, допущение
axis (pl. axes) ..... ось
bar ..... брус
basic ..... основной
beam ..... балка
behavior ..... поведение; тех. режим работы
bending ..... изгиб
calculation ..... расчет, вычисление
to cast ..... тех. отливать, лить (металлы)
column ..... колонна , столбик, стойка
compared to ..... по сравнению с
in comparison with ..... по сравнению с
compression ..... сжатие
to confirm ..... подтверждать
to consider ..... рассматривать, обсуждать; учитывать, принять во внимание; полагать, считать
considerable ..... значительный
to consist ..... состоять (из чего-либо of)
continuity ..... непрерывность
continuous ..... непрерывный, сплошной
conventional ..... условный; общепринятый
to cover ..... здесь охватывать
curve ..... кривая линия
curved ..... искривленный, кривой
to deal (dealt, dealt) ..... иметь дело (с кем-л. - with); решать (вопрос, проблему; with)
to decrease ..... уменьшать(ся), убывать

to depend ..... зависеть (от on, upon)
to determine ..... определять, устанавливать
dimension ..... размер
equation ..... мат. уравнение
to establish ..... устанавливать, основывать, доказывать
external ..... внешний, наружный
feature ..... особенность, характерная черта
to fracture ..... ломать(ся)
homogeneity ..... однородность; гомогенность
homogeneous ..... однородный
however ..... однако, тем не менее, не смотря на; как бы ни
to increase ..... расти, возрастать; увеличивать(ся), повышать(ся)
internal ..... внутренний
isotropy ..... изотропия
length ..... длина
load ..... нагрузка
magnitude ..... величина
to make use ..... использовать, воспользоваться
mutual ..... взаимный
to neglect ..... пренебрегать, не обращать внимания
to observe ..... наблюдать, замечать; изучать
in order that ..... с тем, чтобы
in order to ..... для того, чтобы
phenomenon (pl. phenomena) ..... явление
plate ..... пластина
to possess ..... владеть, обладать
problem ..... мат. задача; проблема
property ..... свойство, качество
purpose ..... цель, назначение
relation ..... (обыкнов. pl.) отношение, соотношение, связь
to represent ..... представлять, изображать

to require ..... требовать, нуждаться
required ..... требуемый
rigid ..... жесткий, негнущийся, твердый
rod ..... стержень
shaft ..... тех. вал, ось
shape ..... форма; очертание, вид
shear ..... сдвиг
solid ..... твердый; крепкий, прочный; сплошной; целый
solid body ..... твердое тело
to solve a problem ..... решать задачу
straight ..... прямой
strength of materials ..... сопротивление материалов
to stretch ..... растягивать(ся), вытягивать(ся), натягивать(ся)
structural member ..... конструктивный элемент
to subject ..... подвергать (воздействию, влиянию)
to sustain ..... поддерживать; выдерживать; подвергаться, переносить, испытывать
tension ..... растяжение
thickness ..... толщина
thin-walled shell ..... тонкостенная оболочка
torsion ..... кручение
transverse ..... поперечный
to undergo (underwent, undergone) ..... подвергаться, испытывать, переносить
to use ..... употреблять, применять, пользоваться
validity ..... действительность, законность
various ..... различный, разный; разнообразные; (перед pl.) многие
to verify ..... проверять; подтверждать; удостоверять

Lecture 2

CLASSIFICATION OF EXTERNAL FORCES

External forces (loads) may act on machine and structural parts in different ways. According to the manner in which they are applied forces may be divided into body and surface forces. Among body forces is, for example, the gravity force (weight). Surface forces are divided into distributed and concentrated ones. Distributed forces are applied over an area or along a length.

The force distributed over an area is expressed in units of force per unit area (N/m^2 = Pa, MPa). A load distributed along a length is expressed in units of force per unit length (N/m, kN/m).

Concentrated forces act over a very small area. A concentrated force is considered to be applied at a point for the sake of simplicity; this simplification introduces no serious error in calculations, as a rule. Concentrated forces are measured in units of force (N, kN).

According to their nature of action loads are divided into static and dynamic ones. A static load is defined as a load, which increases slowly from zero to a certain maximum value and then remains constant or varies only slightly.

An example of dynamic loads is an impact load when the time duration of the load is a small fraction of a second. Dynamic loads also include periodic loads varying in time and inertia forces developed during vibration.

Materials resist these types of forces (static and dynamic) in different ways.

METHOD OF SECTIONS

External forces acting on a body deform it and give rise to internal resisting forces. The internal forces are determined by the method of sections. The idea of this method is as follows.

Consider a body, which is in a state of equilibrium under the action of forces P_1, P_2, P_3, P_4 (Fig.1).

Imagine the body cut through the section *a-a* and one of the two parts removed, say, the right-hand part. The remaining left-hand part will then be acted on by the external forces P_1 and P_2. In order for this part of the body to remain in equilibrium, it is necessary to apply internal forces over the entire section.