

6. Loads of the body

Loads of the body is a complex of external actions onto the body and internal processes in the body which cause existence of **deformations** and **stresses** in the body.

deformation
stress

The loads can be divided as follows:

- a) **force loads** – the deformation of the body is caused by the *prescribed* external forces acting onto the body (isolated forces [N], line forces [N/m], area forces [N/m²], volume forces [N/m³], or couples of forces [Nm]; their magnitudes are pre-defined);
- b) **deformation loads** – deformation of the body is the primary (controlled) quantity (e.g. a wheel fastened on a shaft by interference, tightening a screw, prescribed deflection of a beam); external forces are initiated as a consequence of this deformation and they are not previously known;
- c) **volume loads** – deformation of the body is caused by volume changes in some parts of the body; these changes can be a consequence of temperature changes (temperature loads) or of phase transformations in the material structure.

force loads

Problem 402

Problem 405

Example 418

Problem 409

Real load is usually combination of the above types, e.g. temperature changes in a body with restricted deformations - combination of temperature and deformation loads, etc.

Problem 406

Under certain circumstances (e.g. non-homogeneous phase transformations, local exceeding of yield stress) stresses or deformations need not vanish even when the body is unloaded again; **then residual stresses occur in the body**. Residual stresses can be caused by technological processes (welding, hardening etc.) or by the assembly of the structure (pre-stressed components). It is very difficult to evaluate the residual stresses in the body because they depend not only on the actual loads of the body but on all the **history of the loads**, i.e. on all the previous loads which have acted on the body.

Loading of the body is always a **process proceeding in time**, which can consist of the following loading states of the body:

1. **Unloaded (stress-free) state** – it is the initial state of the body at the very beginning of the loading process.
2. **Production state** – it is a state in which some stresses can occur, caused by technological processes in production (welding, hardening, cold moulding etc.).
3. **Assemblage state** – state in which, in addition to the above stresses, also stresses caused by assembling can occur (prestressed screws, forcing a wheel on a shaft with interference).
4. **Operation (working) state** – one of the set of loading states caused by the operation of the body (structure) during its lifetime. Some of these states can be prescribed for the structure by its operation instructions (pressure test of a pipeline, load test of a bridge etc.).
5. **Transition state** – state in which the body (structure)
 - is not able to subserve the required functions, but it is possible to restore its functionality by a repair or another intervention (replacement of the damaged component part),

- is able to continue subserving only some of the required function,
 - is able to continue subserving its function only with worse technical parameters than prescribed in technical specifications (efficiency, economy, fuel consumption, safety of operation, allowable load, user comfort etc.)
6. **Limit state** – the body (structure) must be set out of operation because it is not able to subserve the required functions.

In computational evaluation, no difference is made between transition and limit states mostly, because the sorting of the states depends on other than only mechanical criteria (e.g. economy) and limit state of a body (e.g. piston rod) can be transition state of the whole structure (the functionality of the motor can be restored by replacement of the broken piston rod). Therefore all the transition and limit state will be denoted as limit states below.

Checking
questions