Basic knowledge

Statics

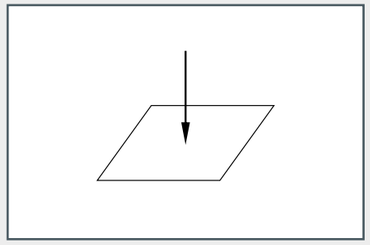
Statics is the study of the effect of forces on rigid bodies, which are in equilibrium. Two forces are in equilibrium when they are equal, in opposing directions, and have the same line of action. In statics, a body is considered rigid when deformations, caused by acting forces, are negligibly small compared to the dimensions of the body.

The main task of static analysis is to determine the equilibrium of the forces applied on a body or a mechanical system. Building on the axioms of mechanics, rigid-body mechanics deals with the equivalence and equilibrium of force systems, centre-of-gravity calculations, internal forces, and moments in beams and trusses along with problems on friction. Generally, the field looks at supporting structures that are at rest and that must remain at rest owing to their function. Material properties are not considered in statics; these are covered by strength of materials.

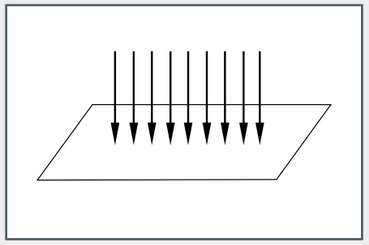
Basic terms of statics

Force, as the cause of motion changes and/or deformations, is described by its magnitude, the position of the line of action, and direction along the line of action. Forces are divided according to different criteria:

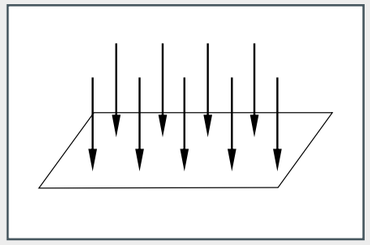
Division by dimension



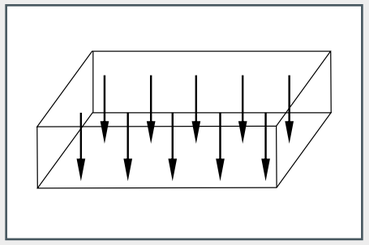
Point force:
only acts on a point
(idealisation in mechanics)



Linear force/line load:
continuously distributed force along a line
(idealisation in mechanics)



Area force:
affects only a specific area or is applied as a compressive load (water pressure on a dam, load of snow on a roof)

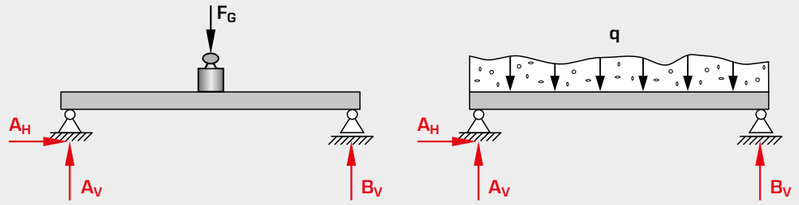


Volume force:
acts spatially distributed over the volume of a body (weight, magnetic and electrical forces)

Division by origin

Physical force or active force (F, q): acts in the normal direction on a body (e.g. weight, wind pressure and snow).

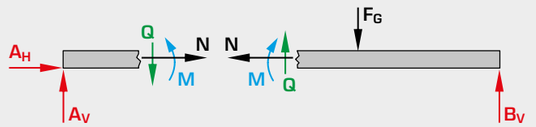
Reaction force or constraining force (A_V, A_H, B_V): acts in the opposite direction to the physical force and causes the body to remain in equilibrium (e.g. normal force F_N, support force and adhesive force).



Division in the system

Internal force: obtained by notionally cutting the body. This force acts between the parts of a body or system (normal force **N,** shear force **Q** and bending moment **M**).

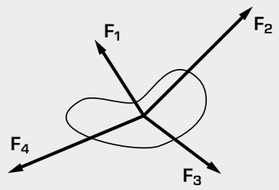
External force: acts on a body from the outside (e.g. weight, wind pressure, snow load, adhesive force and support force)



F_G weight, **q** snow load, **A** and **B** support forces, **index V** vertical forces, **index H** horizontal forces,
N normal force, **Q** shear force, **M** bending moment

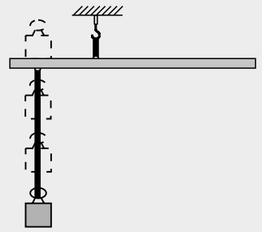
Axioms of statics

Axiom of inertia:
Every body remains in a state of rest or uniform rectilinear motion unless it is compelled to change this state by the forces acting on it.

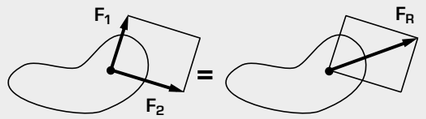


$\sum F = 0$

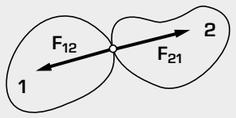
Axiom of displacement:
Two forces that are equal, have the same line of action and are in the same direction but different points of action, exert the same action on a rigid body, i.e. they are equivalent. In other words, the force vector can be displaced along the line of action.



Axiom of the parallelogram:
The action of two forces with a common point of action is equivalent to the action of a single force, whose vector is given as a diagonal in a parallelogram and which has the same point of action as the forces.



Axiom of reaction:
If a body exerts a force on a second body (action), this causes the second body to also exert a force on the first body (reaction), which is equal to the first force in magnitude and line of action, but which is in the opposite direction.



$F_{12} = F_{21}$