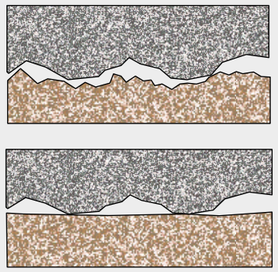
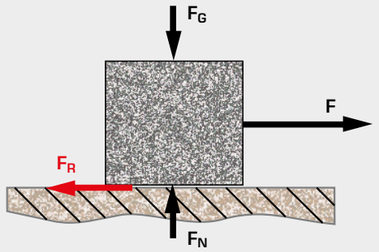
Basic knowledge

Static and kinetic friction

While in statics, we study idealised bodies excluding frictional forces, in the study of static and kinetic friction, we investigate real solid bodies. Friction occurs in all solid bodies that are in contact and that are moved against each other. The cause of the occurring forces is, among other things, the surface roughness, which causes the surfaces to interlock.



Top two solid bodies, both with high surface roughness; bottom one solid body with high surface roughness and one body with low surface roughness



F_G weight, F_R frictional force, F_N normal force, **F** external force, for example tensile force

Coulomb's law of friction states that the frictional force is proportional to the normal force.

The proportionality factor **μ** depends on the materials pairing of the bodies and is called the coefficient of friction.

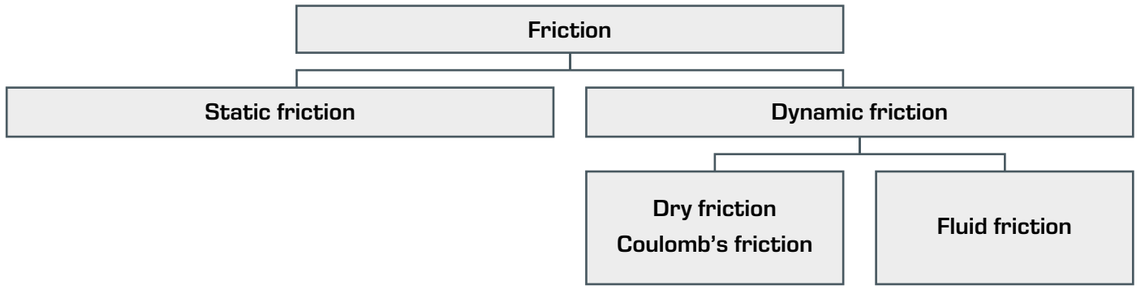
$F_R = \mu \cdot F_N$

Typical values for the coefficient of friction μ

Materials pairing	Coefficient of friction μ
steel on steel	0,1 bis 0,4
steel on teflon	0,04
aluminium on aluminium	1,1 bis 1,7
wood on wood	0,3

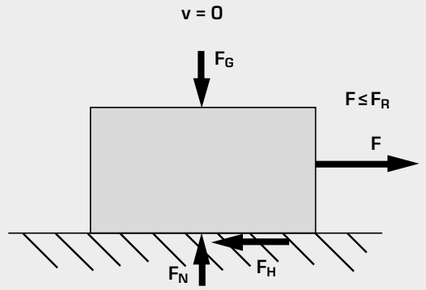
Types of friction

We differentiate between two types of friction: **static friction,** where there is no movement of the bodies relative to each other and **dynamic friction,** where the surfaces move relative to each other. The roughness of the surfaces is described by the coefficient of friction μ_S, for static and μ_K, for dynamic friction.



Static friction

Static friction is present if displacing forces are acting on both bodies, but the bodies have not started to move relative to each other yet. This is why we also talk about static friction that has to be overcome if we want to move a body. Static friction is a reaction force; in statically determinate systems, it can be determined from the equilibrium conditions.



The body adheres to its under-layer

F_G weight, F_H force of static friction, F_N normal force, **F** external force, **v** velocity

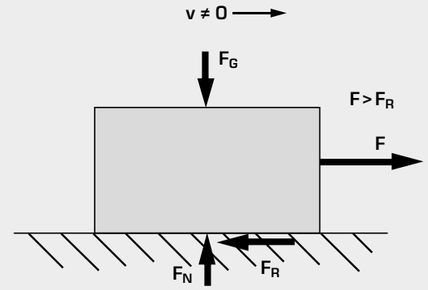
$F \leq F_{Hmax}$ $\quad F_{Hmax} = \mu_S \cdot F_N$

F_{Hmax} maximum force of static friction, μ_S coefficient of static friction, F_N normal force, **F** external force

The proportionality constant is called the coefficient of static friction μ_S. It depends on the material and the surface characteristics of the respective body. Whenever the applied force exceeds the maximum static friction, a body begins to slide.

Dynamic friction

Dynamic friction occurs when a body moves along another and in contact with it, i.e. it actually rubs against it. Dynamic friction increases with the roughnesses of the bodies' surfaces and the pressure applied between the bodies. The dynamic friction force is a physical force (active force) and proportional to the normal force F_N.



The body slides over its underlayer

F_G weight, F_R force of dynamic friction, F_N normal force, **F** external force, **v** velocity

$F > F_R$ $\quad F_R = \mu_K \cdot F_N$

F_R force of dynamic friction, μ_K coefficient of dynamic friction, F_N normal force, **F** external force

When calculating friction: the coefficient of dynamic friction μ_K is generally smaller than the coefficient of static friction μ_S.