

# Toggle clamps

Toggle clamps offer effective solutions if it is a matter of clamping or positioning a workpiece economically and above all quickly.

Toggle clamps work according to the knee-lever principle and can be operated with very little expenditure of force.

Locking or self-restriction is guaranteed if the dead centre position (alignment of the three points of the joint) is exceeded.

Toggle clamps represent an optimal solution in drilling, welding, grinding and inspection fixtures, etc. In the timber industry as well, extreme deformations are avoided by using toggle clamps when bonding or building up fragile sheets, for example, because the clamping force is controllable.

## Principle of the knee lever



It is generally known that a person can support himself against a wall to shift a heavy piece of furniture. If the person has bent his knees and tries to move the furniture with the force of his legs, this is associated with the expenditure of considerable force.

However, if the person has his legs in the position as shown in the picture above, and presses on the knee joint from above with a force, the move is much easier to achieve.

As soon as the 3 points of the joint A, B and C are in a line (knees straightened), it is no longer possible for the piece of furniture to be pressed back by a counterforce.

This principle is used with the toggle clamps.

## Operating method:

1. Position before clamping
2. Dead centre position (points of the joint in a line)
3. By exceeding the dead centre safe clamping is absolutely guaranteed (self-restriction)

## Calculating the clamping force

### Calculation variables

A: Distance between the centres (mm)

B: Distance to the point of force application (mm)

D: Diameter of the axle bolt (mm)

F<sub>H</sub>: Hand force (N)

F<sub>1</sub>: Force on the point of the joint (N)

F<sub>sp</sub>: Clamping force (N)

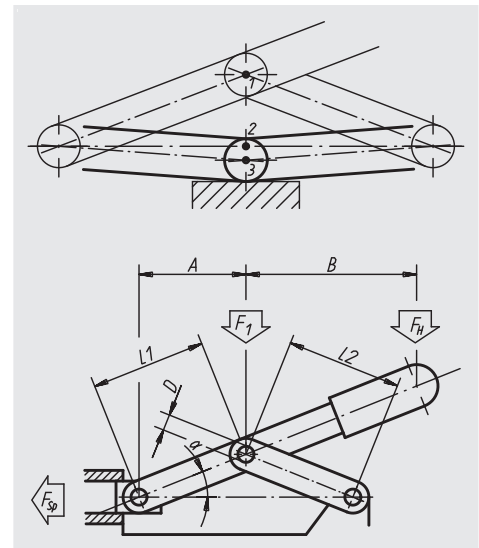
L<sub>1</sub>, L<sub>2</sub>: Length of the lever arm (mm)

α: Inclination angle of the lever (degrees)

β: Friction angle in the joints (degrees)

δ: Angle of repose at the connecting rod (degrees)

μ: Coefficient of friction = 0,1 => δ 5,73°



$$F_{sp} = \frac{F_1}{2} \left[ \frac{1}{\tan(\alpha + \beta)} - \tan \delta \right]; F_1 = \frac{F_H \cdot (A + B)}{A}; \beta = \arcsin \left( \frac{2D}{L_1 + L_2} \cdot \mu \right)$$

Very high clamping forces can be achieved with toggle clamps. The full potential force cannot be used. Adhering to the holding forces F recommended in the catalogue, however, to guarantee a long life for the toggle clamps.

Therefore the clamping force must be tuned to the retention force, which can be done by setting the pressure screw.