

## Toggle Clamps: Everything You Need to Know



### Toggle Clamps. What are they and where they're the used?

Our goal in this article is to give you an overview of toggle clamps. We'll discuss clamping requirements and applications, the various types of toggle clamps, their basic mechanics and working principles and things to consider when selecting a toggle clamp as the hold-down devices for your jig and fixture designs.

In this article we will take a closer look at:

1. Introduction to Toggle Clamps
2. Toggle Clamp Requirements & Applications
3. Types of Toggle Clamps
  - > Vertical Toggle Clamp
  - > Horizontal Toggle Clamps
  - > Plunger or Push/Pull Toggle Clamps
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  - > Hook & Latch Toggle Clamps
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4. Basic Mechanics of Toggle Clamp
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## Introduction To Toggle Clamps

Hold-down clamps are used on [jigs and fixtures](#) in many industrial applications to tightly hold workpieces during machining processes or to position and hold parts while performing other mechanical tasks.

While many types of clamps are used in jigs and fixtures, the most commonly used are toggle clamps. They are available in manually, pneumatically and hydraulically operated versions and come in a wide variety of configurations, sizes, and holding capacities.

Regardless of how they are operated, the primary features of [toggle clamps](#) are that they lock in position securely, are quick acting and can be quickly turned on or off by an operator.

Toggle clamps consist of a handle to operate (if manually operated), a clamping arm to reach the workpiece, a linkage system to increase the applied force, and a base for mounting to a workbench or fixture. The handle is operated which moves the clamping arm to hold the work piece. The required clamping force is achieved and exerted on the workpiece holding the workpiece firmly and positively.

Once activated, toggle clamps are locked and prevent movement of the workpiece until the handle is released.

## Toggle Clamp Requirements & Applications

[Workpieces need to be held in a specific position](#) using a specific amount of force in the shortest period of time. Once the workpiece is clamped, the machining or other processing is usually carried out.

This means that the following tasks are fulfilled using the clamping products:

- > Quick clamping
- > Secure holding
- > High clamping forces are used in a variety of space requirements
- > Distortion-free clamping of the workpiece
- > Good accessibility to the workpiece

Workpieces are clamped in nearly all applications in a manufacturing environment. In the metalworking industry, reliable clamping is a basic requirement for **drilling, welding, bending, grinding, testing and assembling**. Additional applications that use clamping products are:

- > Automotive industry
- > Aerospace industry
- > Medical industry
- > Electrical industry
- > Woodworking industry
- > Plastics industry
- > Textile industry

## Types of Toggle Clamps

Toggle Clamps are defined by their action. The most common types of toggle clamps include vertical, horizontal, plunger, swing, push-pull, hook and latch, cam action and plier action. Some types of toggle clamps are available in both manual and [powered versions](#).

### Vertical Toggle Clamp

The most common toggle clamp is a [vertical or vertical action toggle clamp](#). Vertical toggle clamps are characterized by a bar that swings down and clamps vertically onto the workpiece. The handle, in its closed status, is in a vertical or upright position.

### Horizontal Toggle Clamp

The most common variation on the vertical toggle clamp is the [horizontal or horizontal action toggle clamp](#). Horizontal toggle clamps apply holding force in the same downward direction, but the handle is, in its closed setting, in a horizontal position. This allows use of a toggle clamp with a low profile where more clearance is needed above the clamp or where you need the operator's hand to be away from the clamp during operation.

### Plunger or Push/Pull Toggle Clamp

[Plunger or push/pull action clamps](#) incorporate a sliding plunger to apply the clamping force in a direct, straight-line direction. On push/pull clamps, the toggle action moves and locks the plunger in either the pushing or pulling direction. The clamping action is particularly useful in situations where you require the clamp to push forward to apply the force or pull forward to apply the force. This has the advantage that, when the clamp is mounted vertically with the handle in the back position, it will stop components from falling forward since the handle is behind the component in the lock position.

### Swing Clamps

[Swing clamps](#) are easy-to-use options for fixture building and other applications. They provide quick swing-and-clamp movement for increased productivity. Some manual swing clamps feature an enclosed cam track that can clamp and toggle-lock in the pull-down closed position. They also feature a detent that holds the clamp in the open position in order to prevent unwanted movement.

### Hook and Latch Toggle Clamps

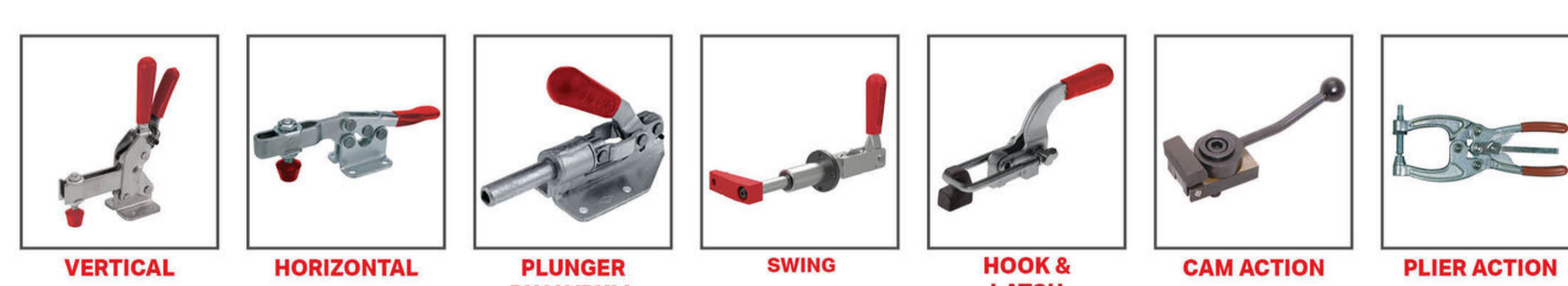
[Hook and latch toggle clamps](#) are most often used to pull components together. There are two types of hook and latch toggle clamps, U-bolt and Single Bolt. Hook and latch toggle clamps are often used to retain or hold lids onto items or when using injection molds which hinge. The mold halves are often held together with hook and latch toggle clamps. Hook and latch toggle clamps are also used for securing doors and are ideal in any application where you need to pull two separate items or components together.

### Cam Action Toggle Clamps

One of the challenges of using Toggle Clamps is that they normally require the component thickness to be consistent. Toggle clamps don't like variation. There are different methods to adjust for variation, but the most straight forward solution is to use a [cam action toggle clamp](#). A cam action toggle clamp works on a cam which allows for component variation of, typically, one to three millimeters. Cam action toggle clamps work with a handle that moves across a counter and then locks the component into position as opposed to a linkage system that is used in other types of toggle clamps.

### Plier Action Toggle Clamps

The least common type of toggle clamp is the [plier action toggle clamp](#). Plier action toggle clamps are hand tools that act in a squeezing motion to pull components together. They are often used in fabrication processes although they can also be found in the automotive industry. Plier action toggle clamps are flexible with the option of making custom jaws to match the shape of your workpiece precisely.



## Basic Mechanics of Toggle Clamps

Now that we have presented the different types of [toggle clamps](#), we will present their working principles. Understanding the working principles of toggle clamps is important to avoid any irritating inconveniences of using a clamp and increase operator comfort.

Because it is easy to use, toggle clamps are a leading clamping option. A toggle clamp has a linkage that applies a powerful clamping force but requires little effort to lock or unlock. Typically, this is accomplished thru a geometric trick. This directs the force into the base while not opposing the lock or unlock action. While toggle clamps have a variety of designs, the operational principle is usually the same. The working principles include:

### Pin Connections

It starts with the pin connection that avoids movement in different directions but allows rotation. As a result, no action can be transmitted to the pin connection which would cause the part to move.

When a link has a pin connection on each end, the force at a single end that is not along the line results in a movement around the other end. Since both sides cannot support the movement, the entire system is out of equilibrium. Thus, two-pin link systems in equilibrium can have forces along the line between each connection.

The trick behind toggle principle is simple. The clamp structure is made from an array of two-pin links. In the clamped position, the links are properly aligned and the clamping force is straight along the links and you can lock the clamp.

The handle of the toggle clamp is also well-arranged. The clamping and unclamping motion is perpendicular to the clamping force. Since this force is directed along the links, locking or unlocking the toggle does not require any force.

### Linkage Arrangement

#### > Crank-Slider Mechanism

In this working principle, the clamping arm is held to slide back and forth. The handle of toggle clamps pivots around a point that is part of its base. It has a link that attaches the clamping arm to the handle.

In the arrangement of a crank-slider mechanism, the pins in the handle, the link and the clamp arm align horizontally in the clamped position. The force from the clamp is directed along the links. The handle is pushed straight down in the clamped position.

This arrangement can be modified to lock in both open and closed position. This can be accomplished when the pins in the connecting link and handle are far apart. The link will line up along a horizontal line, but it will also resist the force from the clamp arm. The release action will be perpendicular to the clamping force. But instead of compression, the handle will be in tension while the other links remain in compression.

#### > Rotating Clamp

Another arrangement is the clamp arm that swings around a pivot point. It doesn't slide in a straight line. Circular motion around a point is tangential to a curved path. It is always perpendicular to the center of rotation.

In the clamped position, the link that connects the handle and clamp arm is held in line with the handle and fixed point. While it puts force in line with the clamping force, the force is primarily directed thru the links to the point where the handle rotates.

#### > Over Clamp

A crank-slider mechanism and a rotating clamp are subject to potential manufacturing tolerance issues and vibration that can lead to improper alignment. Because of that, the force will release the clamp and can result in potential system failure.

The system is susceptible to these problems because the clamping force is high and the release force is low. Even if a small percentage of clamping force goes toward the lock, release can happen. Toggles are designed to over-clamp and the locking position is beyond the industry standards.

## Things To Consider When Selecting a Toggle Clamp

Used as a workholding device, a toggle clamp is perfect for securing objects in place. Typically, a toggle clamp comes with a handle, a lever system, and a securing bar. While the securing bar ensures that the objects won't move, the lever system applies enough pressure on the object to keep the workpiece steady for work.

Generally, clamp selection depends upon the type of workpiece processing. Although a vertical clamp may be a better choice than a horizontal clamp, a low-profile, horizontal toggle clamp is a good solution for low height locations.

When selecting a toggle clamp, the following should be considered:

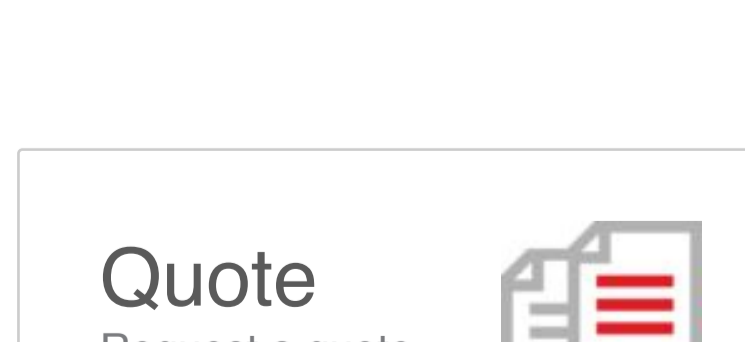
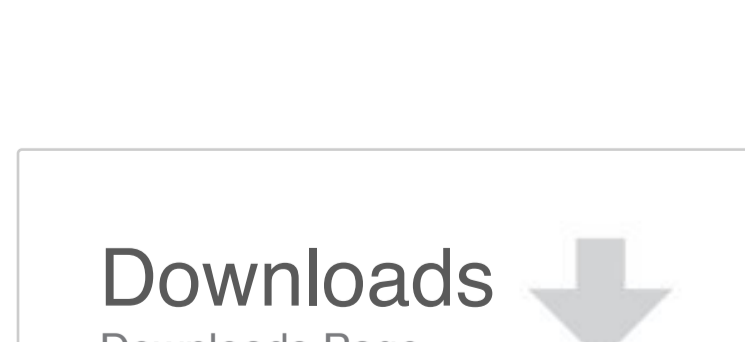
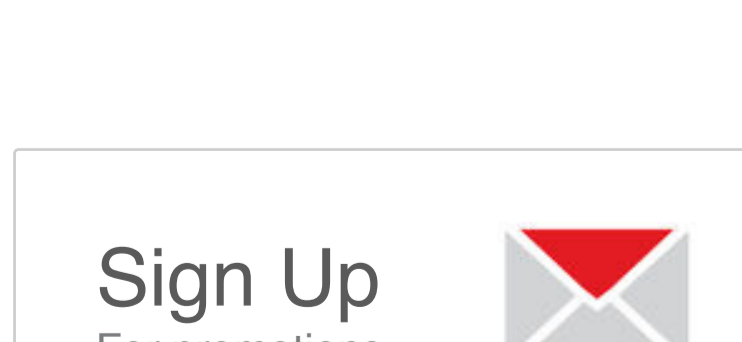
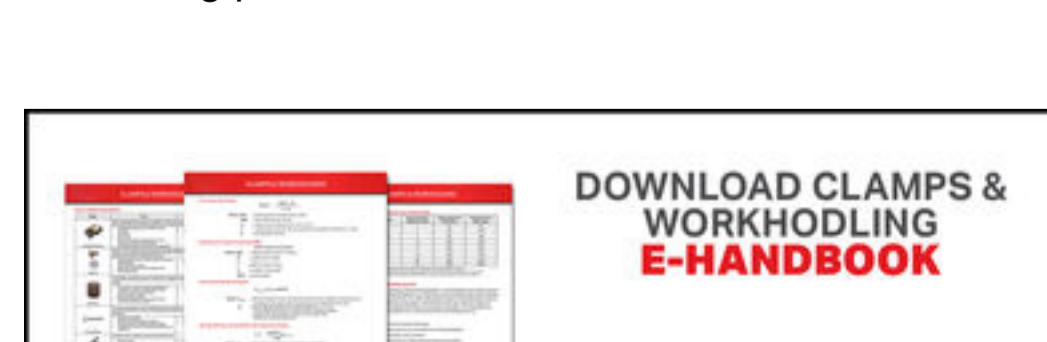
- > Workpiece Size and Shape of the
- > Consistency of Workpiece Thickness
- > Required Holding Capacity
- > Required Exerting Force
- > Strength and Practicality
- > Operator Position Relative to the Fixture
- > Frequency of Operation
- > Cycle Time and Sequence of Operation
- > Alternative Pneumatic or Hydraulic Clamping Solutions
- > Clamp Materials and Prevailing Manufacturing Environment

## Summary

Workpieces are clamped in nearly all applications in a manufacturing environment. In the metalworking industry, reliable clamping is a basic requirement for **drilling, welding, bending, grinding, testing and assembling**. The automotive, aerospace, medical, electrical, woodworking plastics and textile industries also use toggle clamping solutions extensively in their manufacturing process applications.

In this article we discussed [clamping requirements and applications](#), the [various types of toggle clamps](#), their [basic mechanics and working principles](#) and [things to consider when selecting a toggle clamp](#) as a hold-down device for your jig and fixture designs.

Toggle clamps are an excellent choice on production lines where workpieces need to be held securely and removed quickly. Since one of their key features is that they can be quickly turned on or off by an operator, toggle clamps are often used in repetitive manufacturing processes.


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