

Stretch Forming 101

Introduction

Stretch forming is a metal forming process that simultaneously stretches and bends a selected material over a machined form, called a die, to form a part with one or several different curve radii. This process produces perfectly curved parts with smooth, wrinkle-free contours.

The aerospace industry initially invented the stretch forming presses used to form aluminum aircraft parts to reduce weight to improve fuel efficiency. Today they are used worldwide across industries such as automotive for body and frame components, architecture to create curved structural elements, and rail car industry for structure frame components.

The Stretch Forming Process

Metals have a fundamental mechanical property called elasticity: their ability to return to their original size and shape after being stretched by an applied load, but only up to a limit. If a sufficient load is applied, the material reaches its elastic limit or yield point, where it will permanently deform. Elasticity and yield point properties are different for each material. These properties are essential factors to consider when stretch forming.

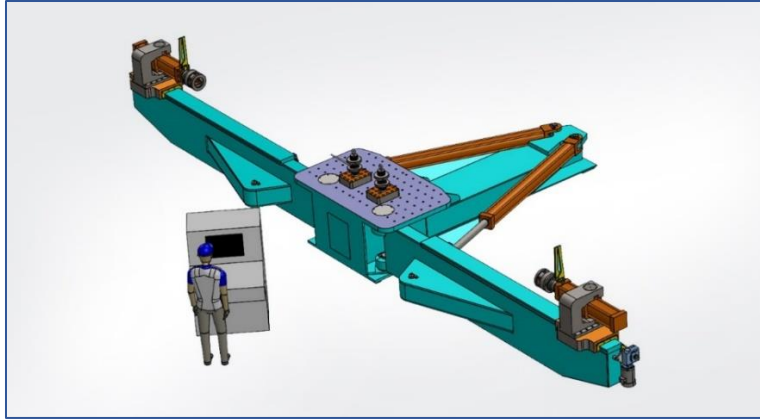
Like a rubber band, when a metal part is stretched, but the yield point is not exceeded, it will return to its original length when the pulling load is released. If sufficient force is applied to exceed the yield point, the part will be permanently lengthened or formed to the desired curve if formed over a die. This loaded state where the tension applied exceeds the yield point but does not break the part is a semi-plastic loading zone where stretch forming occurs.

The variety of materials with properties suitable for this forming process include stainless steel, clad metals, nickel, aluminum, brass and titanium alloys, and other heat-resistant and refractory metals. In some cases, parts formed using these materials are difficult or impossible to form by other methods.

Swing Arm Stretch Wrap V- Press

One of the basic Stretch Forming Presses is the Swing Arm Stretch Wrap V-Press. The machine frame has a table for mounting the die. Two arms (or carriage beams) support a positionable carriage equipped with a hydraulic tension cylinder and gripping jaw. During the stretch forming process, each end of the part blank is inserted into a gripper jaw. The hydraulic tension cylinders then stretch the part beyond the material's yield point.

The arms then swing back on pin joints to wrap the part around the die while maintaining the forming tension load. When the wrapping is completed, the stretch force is released, gripper jaws are opened, and the formed part is removed.



Swing Arm Stretch Wrap V-Press

Today's Stretch Wrap Forming Press is designed using FEA. Major machine components are fabricated, stress relieved, and accurately machined to provide rigid support for the forming process. A PLC-based CNC control is typically used for set-up, controlling manual functions for loading/unloading, forming, and controlling the programmed automatic forming cycles.

Modern Stretch Press controls provide yield point detection, pre-stretch control, force or position control during forming, and post stretch control. They can also be equipped with software to create part-forming programs, which provide consistent and repeatable forming cycles for quality parts production, reduces set-up time, and increased press efficiency.

Properly equipped V-Presses can be used to form Sheet Metal, Extrusions, and Brake-Formed Profile parts. The part length and cross-section dictate the size and the tonnage required to stretch form a part. Typical V-Presses range in sizes starting at 5 tons up to 150 tons, but higher tonnages are possible.

Sheet Metal Stretch Forming

Sheet Presses are used to form large size sheet stock into contoured shapes. They are typically used in the Aerospace Industry to form the parts that make up an aircraft's skin but are not limited to this industry.

The basic Sheet Press has a Die Table located at the centerline of the press and hydraulic cylinders to provide lifting force for forming. Long Beams on both sides of the table each support two carriages. The carriages intern supports the yoke, which supports the jawline on each side of the Die Table. Each carriage is driven by a hydraulic cylinder that moves the jawline into or away from the Die Table.

To operate, opposite edges of the sheet are load into the opposing Jawlines and gripped. The Jaws are moved away from the Die Table to tension the sheet. The die mounted to the Die table is driven up into the sheet while the Jaws maintain the forming tension. The sheet stretches as it wraps the die to form the part. After forming, the Jaws move in to remove the sheet tension and then open for part removal.

A CNC control via a PLC provides the manual as well as automatic control of the forming process. With a program loaded with the press in auto mode, the control moves the jawlines and die table to their load position. The operator loads the sheet stock and closes the Jaws to clamp the sheet. When the run button is pressed, the slack is taken out of the sheet. A pre-stretch is applied to the sheet, then forming occurs, followed by a post-stretch. Then the sheet tension is unloaded, and the jaws open and retract for part unloading.

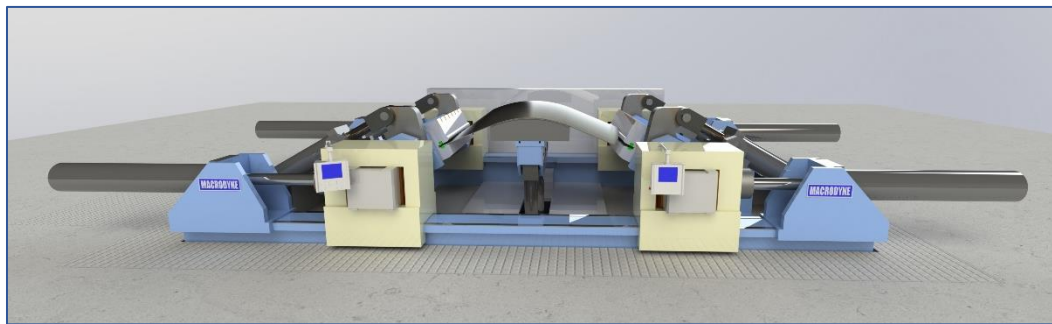
This Stretch Forming Process creates quality parts with no wrinkles, even stress distribution, minimum spring back, and a surface free of orange peel or Luder's lines.

Sheet Metal Press Types

There are three basic types of sheet metal press:

- **T- Press** (Transverse Press):

The main die table is perpendicular to the long-beams, parallel to the jawlines. Each jawline is fixed to the yoke. The carriages drive the yoke to move the jawline into or away from the Die Table. The yoke is equipped with a Swing movement, so the jaw can be pivoted up to 45–90 degrees, depending on the design.



T – Press (Transverse – the part's long axis parallel to the Jaws)

The Main Die Table for a T-Press is usually narrow to allow Bullnose forming leading edge parts. Die table saddles can be provided. Saddle fit over or mount to the side of the die table to support wide dies.

This press can be capable of drape, stretch wrap, or bullnose forming, depending on the design. For stretch warping, the PLC must control the die table loading based on the yoke swing position controlled by a tangency tracking device.

If equipped with a Bulldozer, the press can also do Stretch Draw forming.

- **L-Press** (Longitudinal Press):

The L-Press die table is parallel to the long-beams, perpendicular to the jawline. The jawline is equipped with tension control and curving, oscillation, and rotation motion. The carriages position the yokes to move the Jawlines into or away from the Die Table. The yoke is equipped with a Swing movement so the jaw can be pivoted up from the horizontal 0-45 degrees.

This press is mainly design for Stretch Wrap Forming.

This press can be supplied with auxiliary die tables for very long parts. These tables are synchronized to move up and down with the main die table.

If equipped with a bulldozer, it can also do stretch draw forming.

- **VTL-Press** (Versal Transverse/Longitudinal Press):

For VTL-press, the main die table rotates to position parallel or perpendicular to the jawline. The jawline is equipped with tension control and curving, oscillation, and rotation motions. The carriages position the Yokes to move the jawlines into or away from the Die Table for set-up or loading. The carriage can also angulate the yoke. The yoke is equipped with a swing movement so the jaw can be pivoted up from the horizontal 0-90 degrees based on design.

This press is designed to do drape, stretch wrap, and bullnose forming. If equipped with a bulldozer, it can also do Stretch Draw forming.

This press can be supplied with Auxiliary Die Tables for long parts. In this case, the tables are synchronized to move up and down with the Main Die Table. The supply of Auxiliary Die Tables eliminates the need for a rotating Main Die Table.

Stretch-Draw Press

This Stretch Forming Press is designed to draw form using mating dies while the sheet is in tension. The press is equipped with hydraulic cylinder driven upper and lower platens (tables) that support, position, and load the die. Both Jaws have curving, oscillation, rotation, lift, and tension control. The press is also capable of stretch forming.

Other Types of Stretch Forming Press Available

- **Stretch Straightener**

Designed to stretch, straighten and de-twist long bars and extrusions.

- **Rotary Draw**

This Stretch Press used a rotary table, a fixed and linear traveling tension jaw, and a wiper. The die and on the jaw are mounted to the rotary table. The table rotates to align the jaws for part loading. As the table rotates, the part wraps the die while the traveling jaw maintains part forming tension. If used, the wiper presses a wiping shoe that matches the part profile against the forming position.

This press is used to form extrusions, brake-formed profiles, and sheet metal parts.

Advantages and disadvantages of Stretch Forming

The main advantage of stretch forming is its ability to form complex shapes accurately while maintaining a parts dimensional cross section shape and quality finish.

As a cost-effective process, stretch forming uses less force than any other press forming method and can reduce material costs. Metal parts are created with a quality finish free of scuffs and or marking. The stretch forming process induces work hardening, which increases material strength while at the same time reducing residual stress to minimize spring back.

The stretch forming process is seldom suited to progressive or transfer operations. Although the process can create sharp contours and reentrant angles, it is best for forming shallow or nearly flat shapes.

Stretch forming uses bulldozing or joggling as a secondary operation to draw form, or indent, parts during or after forming. Punches are also used for providing the next process of locating holes.

For some sheet stretch wrapping applications, the forming cycle time must be slowed to maintain the material properties and surface finish. For this reason, it is not recommended for high volume

production. However, stretch-draw forming, which uses mating dies and other processes not covered by this paper, like quad axis forming, can be done as rapidly and automatically as conventional press operations.

Visit our Stretch Forming page to learn more about custom Stretch Forming Presses.

Contact us about your hydraulic press needs.