The use of aluminium

ALCOA AUSTRALIA

Ninth of a series dealing with methods of working, handling and applying aluminium.

BENDING

Bending, one of the most common operations in sheet metalwork, is widely used for the manufacture of such simple shapes as pans, boxes, ductwork, channels and angles. The same or similar equipment that is used for bending steel and other metals can, in most cases, also be used for bending aluminium. Most principles of bending also apply to such complementary operations as flanging, beading, curling, crimping and lock seaming, for which special machines are frequently used.

ALLOY AND TEMPER SELECTION

All aluminium alloys are suitable for bending, but for best results it is important to select the alloy and temper which have the best bending characteristics for the desired purpose.

Suggested bend radii for 90° cold bends in aluminium sheet and plate are given in Table 1. Aluminium alloy sheet capable of 180° bend over zero radius is listed in Table 2.

High-strength alloys in the non-heat-treated category, as well as the heat-treated alloys, work-harden more rapidly than some of the widely used softer alloys, such as A1100 and A3003. For stronger alloys, it is usually advisable to choose a larger bend radius than for the same gauge of a softer alloy.

In addition to alloy selection, proper temper selection is important. For instance, when using alloys such as A1100, A3003 and A5052, care must be taken to select the temper that best answers the requirements for design strength and minimum bend radius. Severe bending may require the annealed (–O) temper, while less severe operations can often be performed satisfactorily in one of the harder tempers. Heat-treatable alloys in the fully heat-treated tempers usually require large bend radii, whereas in the annealed condition they can be bent over a very small radius.

The sheet to be bent must be in a good, smooth condition to ensure best results. Heavy ragged burrs along the edges, or deep gouges and scratches, such as scriber marks, can be starting points for fractures. Any obvious roughness on the edge where critical bends are to be made should be removed with a file or emery cloth.

Local heating along the bend line is sometimes employed to avoid fractures. Heating is particularly useful when bending plate. It is also useful where a smaller bend radius must be chosen than that recommended for the particular material.

The maximum temperature that can be used without serious loss of mechanical properties is 300° to 400°F. for nonheat-treated material.

SPRING-BACK

The problem of spring-back is encountered in most bending operations. Spring-back represents the partial return of the metal, after bending, in the direction of its original shape. To compensate for spring-back, the metal should be bent beyond the angle that is ulimately desired.

EQUIPMENT

The equipment found in most modern sheet metal shops can be readily used for bending aluminium alloy sheet.

For simple shapes, folding brakes (bar folders) are used with the same techniques as for other metals. The bend radius is controlled by the blade location. The mechanical or hydraulic power brake, with proper tooling, will produce a wide variety of shapes. The tools most commonly used are V-dies with punches of suitable radii.

For a limited quantity of relatively thin metal parts, a rubber die is frequently used. In this process, a block of rubber is restrained in a steel channel section. As the metal is forced into the rubber, it assumes the shape of the punch. This method is sometimes used in forming multiple beads or embosses.

Beaded or half-rounded edges are often made with edging, beading or curling rolls. Usually these rolls are specifically designed for the requirements of the job and are made in pairs so that the female roll fits the driven shaft.

The recommended minimum inside bend radius for beaded or half-rounded edges is twice the metal thickness. However, with some of the stronger alloys and harder tempers, a slightly larger bend radius may have to be used.

Power hammers are often used to smooth out irregularities remaining from previous operations, as well as to "set" the final shape. Power hammers also can be useful in stretching the metal to form parts with double curvature or crown. This is a slow operation requiring considerable skill.

Curved surfaces and complete cylinders are usually bent to the desired shape in plate and sheet bending rolls. When producing cylindrical segments on pyramid roll benders, the fabricator will encounter the problem of a flat section that is roughly equal in size to the distance between the lower front and back roll.

TOOLS

Figs. 1 and 2 show a number of the most commonly used tools for bending. They should be smooth and free from rough edges and gouges which might scratch the sheet or be the cause of fractures.

Pressure pads are frequenly used to control the forming of aluminium sheet. Such pads help to reduce spring-back by giving a sharper bend to the formed part, which at the same time is brought closer to its final shape than would be possible without a pressure pad. A pressure pad under the bottom tool will also eject the finished part, eliminating the need of prying the part out of the bottom die. Sometimes pressure pads are used both on the top and the bottom tool, especially where it is desirable to eliminate spring-back almost completely.

SURFACE PROTECTION

The light coat of oil that is sometimes found on aluminium sheet for protection of the metal is often sufficient as a lubricant for brake-forming operations. On the other hand, if the sheet is dry, it is advisable to apply a light oil on the working faces of the tools and along the bend lines of the metal to prevent scoring and pickup.

TABLE 1

Approximate Radii[1] for 90° Cold Bend. Sheet and Plate alloys in common use.

Alloy and Temper	Radii for various thicknesses expressed in terms of thickness "t"							
	1/64 inch	1/32 inch	1/16 inch	1/8 inch	3/16 inch	1/4 inch	3/8 inch	1/2 inch
A1100-O	0	0	0	0	0	0	0	1t-2t
A1100-H14	0	0	0	0	0-1t	0-1t	0-1t	2t-3t
A1100-18	0-1t	½t-1½t	1t-2t	1½t-3t	2t-4t	2t-4t	3t-5t	3t-6t
A3003-O	0	0	0	0	0	0	0	1t-2t
A3003-H14	0	0	0	0-1t	0-1t	½t-1½t	1t-2½t	1½t-3t
A5005-O	0	0	0	0	0	0	0	1t-2t
A5005-H14	0	0	0	0-1t	0-1t	½t-1½t	1t-2½t	1½t-3t
A5005-H34	0	0	0	0-1t	0-1t	½t-1½t	1t-2½t	1½t-3t
A5052-O	0	0	0-1t	0-1t	0-1t	0-1t	½t-1½t	1t-2t
A5052-H34	0	0	½t-1½t	1½t-2½t	1½t-2½t	2t-3t	2t-3t	2½t-3½t
B5083-H321	—	—	½t-1t	½t-1½t	1t-2t	1t-2t	1½t-2t	2t-3t
B5083-H323	—	—	1t-2t	1½t-3t	1½t-3½t	2t-4t	—	—
C5154-O	0	0-1t	0-1t	0-1t	0-1t	½t-1½t	1t-1½t	1t-2t
C5154-H32	0	0-1t	½t-1½t	½t-1½t	1t-2t	1½t-3t	2t-4t	2½t-5t
C5154-H34	0-1t	0-1t	½t-1½t	1½t-2t½	1½t-3t	2t-4t	2½t-4½t	3t-5t

[1]Minimum permissible radius over which sheet or plate may be bent varies with nature of forming operation, type of forming equipment, and design and conditions of tools. Minimum working radius for a given material or hardest alloy and temper for a given radius can be ascertained only by actual trial under contemplated conditions of fabrication.

Fig. 1 — Typical brake tools.

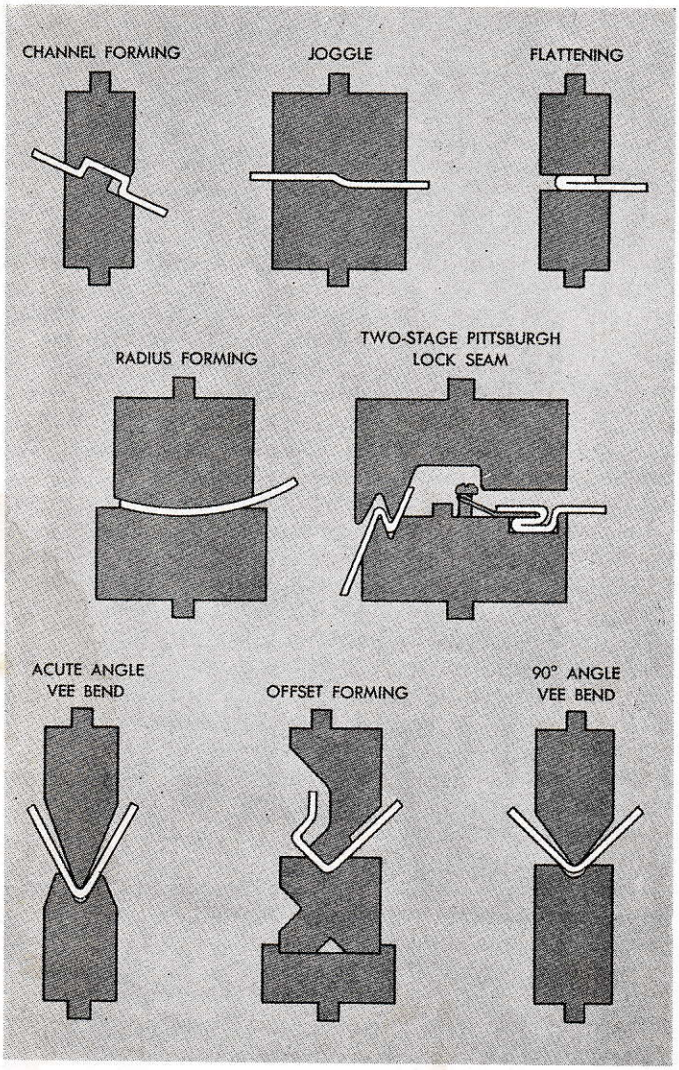

TABLE 2

180° Bends over a Zero Radius

	1/64 inch	1/32 inch	1/16 inch	1/8 inch
A1100-O	X	X	X	X
A1100-H14	X	X	X	
A3003-O	X	X	X	X
A3003-H14	X	X	X	
A5005-O	X	X	X	X
A5005-H14	X	X	X	
A5005-H34	X	X		
A5052-O	X	X	X	X
A5052-H34	X			
C5154-O	X	X	X	
C5154-H32	X	X		

Fig. 2 — Typical brake tools used with rubber pad.