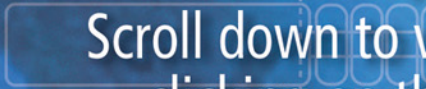




TYPES OF MANDRELS



REGULAR (RR): Universal Flexing
For standard tube & pipe



CLOSE PITCH (CP): Universal Flexing
For thinwall tubes



BRUTE: Single Plane Flexing
For large diameter tubes & pipe



JEWEL MANDREL: Universal Flexing
For very thinwall tubes



PLUG: For heavy wall tube

Welcome to the Wall Chart.

Scroll down to view the chart or go to a specific topic by clicking on the corresponding page icon on the left

OR

click on the button of another piece of literature you'd like to view.

Capabilities
Brochure



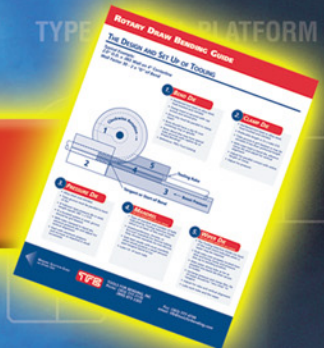
Tooling and
Techniques Guide



Tube and Pipe
Bending Manual



Wall Chart



www.toolsforbending.com

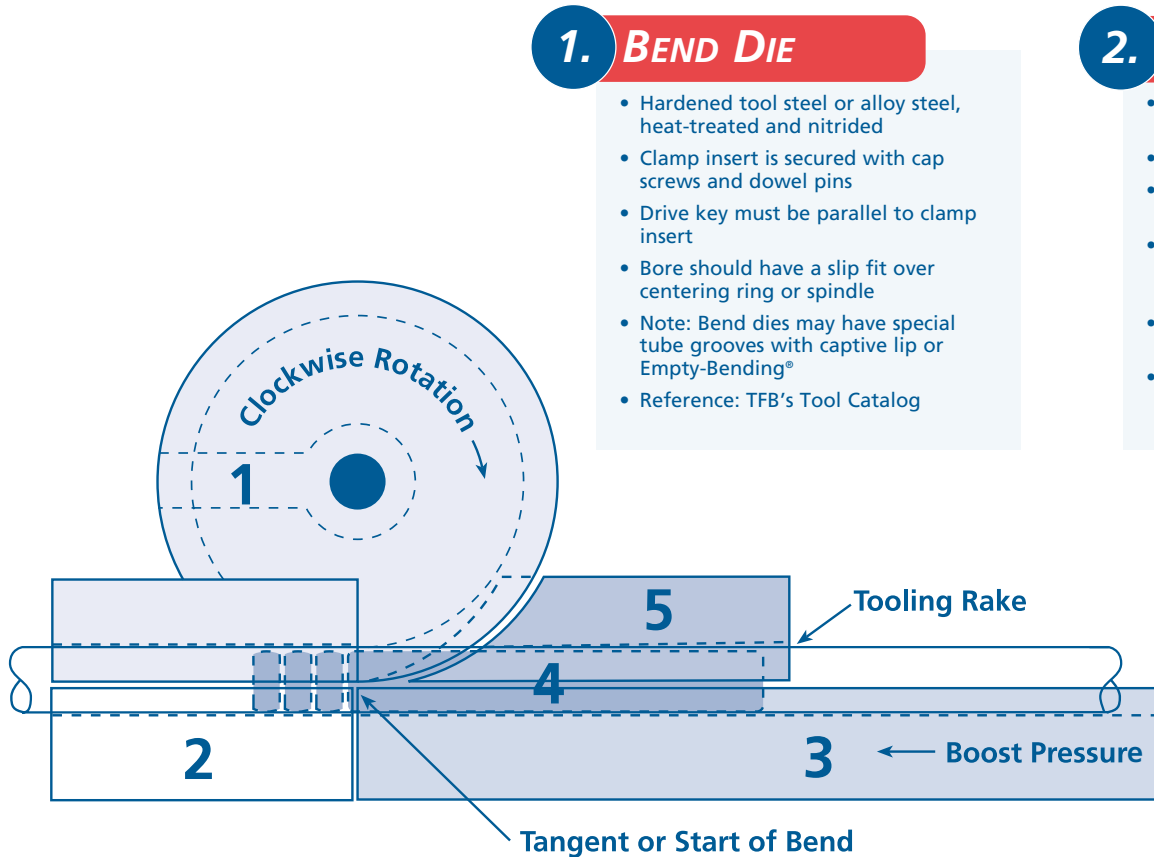
ROTARY DRAW BENDING GUIDE

THE DESIGN AND SET UP OF TOOLING

Typical Example:

2.0" O.D. x .065 Wall on 4" Centerline

Wall Factor 30 - 2 x "D" of Bend



1. BEND DIE

- Hardened tool steel or alloy steel, heat-treated and nitrided
- Clamp insert is secured with cap screws and dowel pins
- Drive key must be parallel to clamp insert
- Bore should have a slip fit over centering ring or spindle
- Note: Bend dies may have special tube grooves with captive lip or Empty-Bending®
- Reference: TFB's Tool Catalog

2. CLAMP DIE

- Hardened tool steel or alloy steel, heat-treated and nitrided
- Preferable length is $3\frac{1}{2}$ x tube O.D.
- Tube groove is grit blasted or may be serrated if less than preferred length
- With tube held in bend die, advance clamp die and adjust for vertical alignment
- Adjust for parallel contact with entire length of clamp
- Adjust for pressure

3. PRESSURE DIE

- Alloy steel and nitrided
- Tube groove must be parallel to back of die
- If follower type pressure die is used, length equals $180^\circ + 2$ O.D.
- If a boosted system is used, groove should be grit blasted
- With tube clamped to bend die, advance pressure die and adjust for vertical alignment
- Start with minimum pressure and increase as required in small increments

4. MANDREL

FOR TIGHT RADIUS AND/OR THIN WALL BENDING

- Type of mandrel and number of balls indicated by Tooling Selection Guide which is on back of this wall chart.
- Aluminum/bronze, chrome, or Kro-Lon® mandrels for ferrous tubing. Only chrome mandrels for non-ferrous
- Gain best results with most mandrels when shank projects a small amount past tangent (bend & try)
- Lube I.D. of each tube

5. WIPER DIE

FOR TIGHT RADIUS AND/OR THIN WALL BENDING

- The Tooling Selection Guide (on back of this wall chart) indicates when a wiper may be required
- Push tube over properly located mandrel and bring clamp and pressure dies up to bending position
- Slide wiper along tube as far as possible into bend die then secure to holder
- Unclamp pressure and clamp dies, tip of wiper should be "very close" to tangent
- Adjust for rake and vertical alignment
- Lube each tube and the wiper

MANDREL SELECTION GUIDE
ON OTHER SIDE



TOOLS FOR BENDING, INC
PHONE: (303) 777-7170
(800) 873-3305

FAX: (303) 777-4749
email: tfb@toolsforbending.com

CORRECTIONS FOR POORLY BENT TUBES

After the initial tooling set-up has been made, study the bent part to determine what tools to adjust to make a better bend. Keep in mind the basic bending principle of stretching the material on the outside radius of bend and compressing the material on the inside of bend. Make only one adjustment for each trial bend unless the second adjustment is very obviously needed. Avoid the tendency to first increase pressure die force rather than adjust the wiper die or mandrel location. Start with a clean, deburred and lubed tube with the elongation properties sufficient to produce the bend.

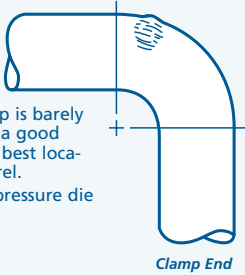
Note: There are certainly other corrections that could be made for the following problems. These illustrations are a few examples of how to “read” a bend and improve the tooling set-up.

1. PROBLEM

Hump at end of bend.

CORRECTION

- 1) Adjust mandrel slightly back from tangent until hump is barely visible. This is also a good system to find the best location for the mandrel.
- 2) Increase force on pressure die assist.



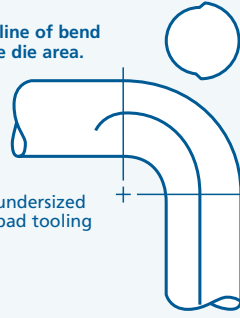
Clamp End

2. PROBLEM

Tool marks on centerline of bend in clamp and pressure die area.

CORRECTION

- 1) Reduce pressure and clamp die forces.
- 2) Oversized tube or undersized tube groove from bad tooling source.



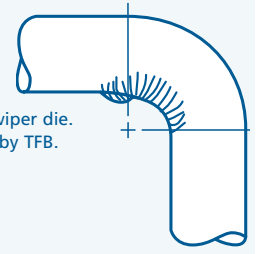
Clamp End

3. PROBLEM

Wrinkling throughout bend, even extending into wiper die area.

CORRECTION

- 1) Advance wiper die closer to tangent.
- 2) Decrease rake of wiper die.
- 3) Recut worn wiper by TFB.



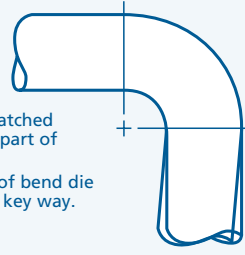
Clamp End

4. PROBLEM

Bad mark at start of bend and over bend for 90°.

CORRECTION

- 1) Removeable clamping portion of bend die not matched properly to round part of bend die.
- 2) Clamping portion of bend die not parallel to the key way.



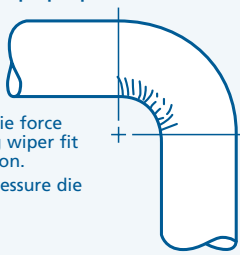
Clamp End

5. PROBLEM

Wrinkles throughout bend area with wiper and mandrel in known proper position.

CORRECTION

- 1) Check for under-sized mandrel.
- 2) Increase pressure die force only after checking wiper fit and mandrel location.
- 3) Reduce force on pressure die advance.



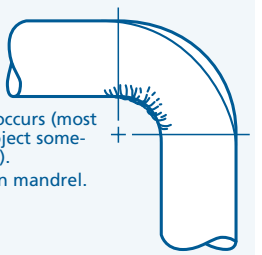
Clamp End

6. PROBLEM

Excessive collapse with or without wrinkling throughout entire bend.

CORRECTION

- 1) Advance mandrel toward tangency until slight hump occurs (most mandrels must project somewhat past tangent).
- 2) Need more balls on mandrel.



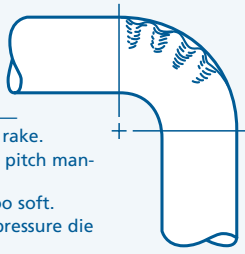
Clamp End

7. PROBLEM

Mandrel ball humps.

CORRECTION

- 1) Too much drag on tube; back off pressure die force — increase wiper die rake.
- 2) May require closer pitch mandrel ball assembly.
- 3) Tubing material too soft.
- 4) Increase force on pressure die assist.



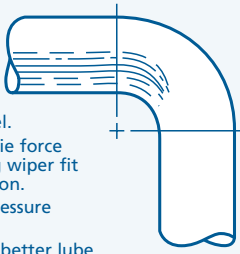
Clamp End

8. PROBLEM

Deep scratches throughout the bend and in wiper die area.

CORRECTION

- 1) Increase rake.
- 2) Check for undersized mandrel.
- 3) Increase pressure die force only after checking wiper fit and mandrel location.
- 4) Reduce force on pressure die advance.
- 5) Use more and/or a better lube.
- 6) Recut galled tube groove at TFB.



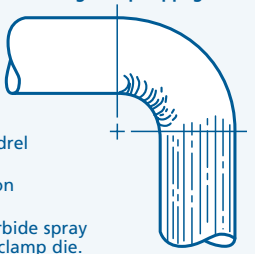
Clamp End

9. PROBLEM

Heavy wrinkles through bend area only and linear scratches in grip area indicating clamp slippage.

CORRECTION

- 1) Reduce pressure die force.
- 2) Check location (and lube) of mandrel and wiper die.
- 3) Increase pressure on clamp die.
- 4) Use serrated or carbide spray in tube groove of clamp die.



Clamp End

TOOLING SELECTION GUIDE

$$\text{"D" of Bend} = \frac{\text{centerline radius}}{\text{tube outside diameter}}$$

$$(2.0 \text{ C.L.R.} \div 1.0" \text{ O.D.} = 2 \times D)$$

$$(2.0" \text{ O.D.} \div .032 = 62.5 \text{ W. F.})$$

$$\text{Wall Factor} = \frac{\text{tube outside diameter}}{\text{wall of tube}}$$

"D" of bend Degree of bend		1 x D		1.50 x D		2 x D		2.50 x D		3 x D		3.5 x D	
		90°	180°	90°	180°	90°	180°	90°	180°	90°	180°	90°	180°
10	Ferrous Non-Ferrous	P P	P P	P P	P P	P P	P P						
* 20	Ferrous Non-Ferrous	RP-1 RP-1	RP-1 RP-2	RP-1 RP-2	RP-1 RP-2	RP-1 RP-2	RP-1 RP-2	P RP-1	P RP-1	P P	P P		
30	Ferrous Non-Ferrous	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-1 RP-2	RP-1 RP-2	P RP-1	P RP-1	P P	P P
40	Ferrous Non-Ferrous	RP-3 CP-4	RP-3 CP-4	RP-3 CP-4	RP-3 CP-4	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-1 RP-3	RP-1 RP-3	P RP-2	P RP-2
50	Ferrous Non-Ferrous	CP-4 CP-4	CP-4 CP-4	CP-3 CP-4	CP-3 CP-4	RP-3 CP-4	RP-3 CP-4	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	RP-2 RP-3	P RP-2	P RP-2
60	Ferrous Non-Ferrous	CP-4 CP-5	CP-4 CP-5	CP-4 CP-4	CP-4 CP-4	CP-4 CP-4	CP-4 CP-4	RP-3 CP-4	RP-3 CP-4	RP-3 RP-3	RP-3 RP-3	RP-1 RP-1	RP-1 RP-1
70	Ferrous Non-Ferrous	CP-5 UCP-6	CP-6 UCP-6	CP-5 UCP-6	CP-6 UCP-6	CP-4 CP-4	CP-5 CP-4	CP-4 CP-4	CP-4 CP-4	RP-3 CP-4	RP-4 CP-4	RP-1 RP-2	RP-1 RP-2
80	Ferrous Non-Ferrous	CP-5 UCP-6	CP-5 UCP-8	CP-5 UCP-6	CP-6 UCP-8	CP-4 UCP-5	CP-4 UCP-6	CP-4 CP-4	CP-4 CP-5	RP-3 CP-4	RP-3 CP-4	RP-1 RP-3	RP-1 RP-3
90	Ferrous Non-Ferrous	UCP-6 UCP-8	UCP-8 UCP-10	UCP-5 UCP-8	UCP-5 UCP-10	CP-4 UCP-6	CP-4 UCP-6	CP-4 UCP-6	CP-4 UCP-6	CP-4 CP-4	CP-4 CP-4	RP-3 RP-3	RP-3 RP-3
100	Ferrous Non-Ferrous	UCP-6 UCP-8	UCP-8 UCP-8	UCP-6 UCP-8	UCP-6 UCP-8	UCP-5 UCP-8	UCP-5 UCP-8	UCP-5 UCP-6	UCP-5 UCP-6	UCP-5 UCP-5	UCP-5 UCP-5	CP-4 CP-5	CP-4 CP-5
125	Ferrous Non-Ferrous			UCP-6 UCP-6	UCP-6 UCP-6	UCP-6 UCP-6	UCP-6 UCP-6	UCP-5 UCP-6	UCP-5 UCP-6	UCP-5 UCP-6	UCP-5 UCP-6	CP-4 CP-4	CP-4 CP-4
150	Ferrous Non-Ferrous	CAUTION:				UCP-8 UCP-8	UCP-8 UCP-8	UCP-6 UCP-8	UCP-6 UCP-8	UCP-6 UCP-6	UCP-6 UCP-6	CP-5 UCP-6	CP-5 UCP-6
175	Ferrous Non-Ferrous	BETTER CALL:						UCP-6 UCP-6	UCP-6 UCP-6	UCP-6 UCP-8	UCP-6 UCP-8	CP-6 UCP-8	CP-6 UCP-8
200	Ferrous Non-Ferrous					TOOLS FOR BENDING, INC.				UCP-6 UCP-6	UCP-6 UCP-6	CP-6 CP-6	CP-6 CP-6

KEY P-Plug or Empty-Bending
RP-Regular Pitch
CP-Close Pitch
UCP-Ultra Close Pitch
No. indicates suggested number of balls

NOTE 1. The Empty-Bending system (without a mandrel or wiper die) is recommended for applications above the dotted line.
2. A wiper die is recommended for applications below the dotted line.
3. "H" style, brute, chain link mandrel in regular pitch, close pitch, and ultra-close pitch.
4. All mandrels are available with lube holes and grooves and finished in chrome, Kro-Lon, AMPCO bronze.