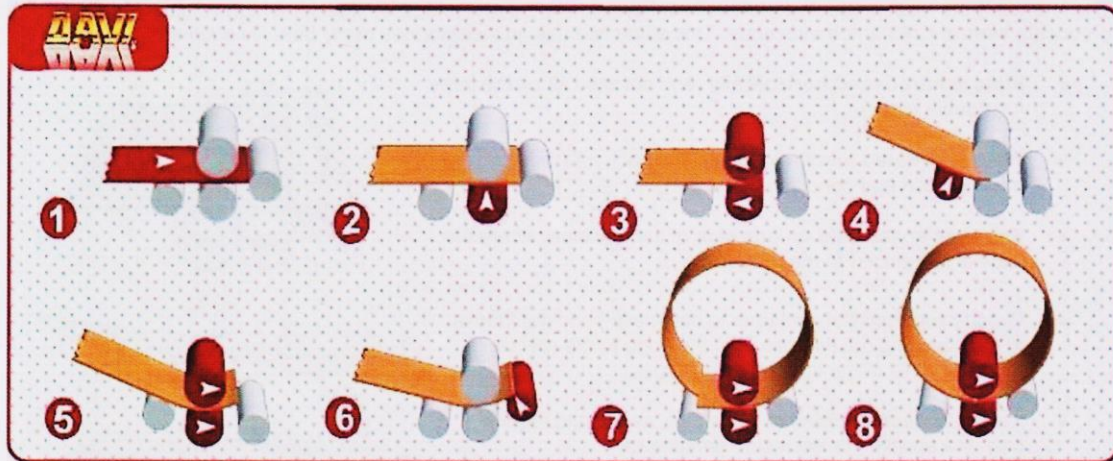


## The Four Roll Bending process



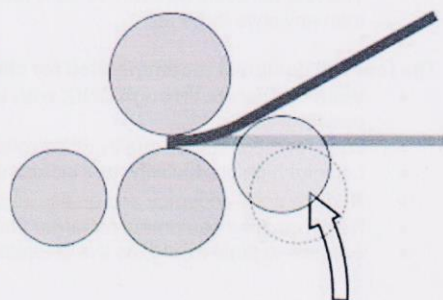
1. Plate alignment and squaring positively against the back roll.
2. Plate pinching (on DAVI, at a pre-set, safe, pressure).
3. Plate is moved as far back as possible between the top and bottom rolls, for the very minimal flat-end.
4. Side roll is moved up, to bend the edge of the plate (pre-bending position).
5. The rolls rotate, to feed the plate, to round the entire leading edge.
6. Inverting the side rolls (down the front roll; up the rear roll).
7. Rotate the rolls, feeding the plate to roll the entire plate length to the required diameter.
8. Pre-bending the trailing edge is an automatic end-of-process feature, continuing feeding the plate forward.

### PREBENDING (Flat-end)

What influences the flat-end of a rolled can? The flat-end (pre-bending) depends almost solely by the load that can be generated on the lower clamping roll.

The length of the flat-end does NOT depend by the side bending roll distance from the clamping spot, or large or narrow geometry of the side bending rolls, compared to the center of the machine (the axis of the two clamping rolls).

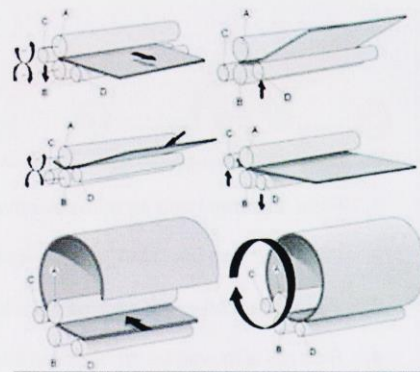
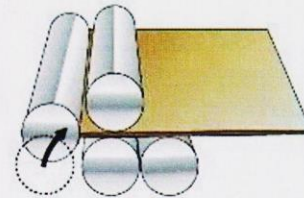
The more load that can be applied on the bottom clamping roll, no matter how far the side bending roll would raise to bend the plate, the shorter the flat-end (best pre-bending).



## THE BENEFIT OF THE FOUR ROLLS DESIGN - THE CONCEPT

The four roll is the most productive plate roll configuration in the market today, ideal for a high volume of parts to be produced, even in CNC automatic mode. This advanced design incorporates many benefits such as:

- **Plate is introduced horizontally** (and not tilted as on the three roll double pinch).
- **Plate is squared instantly** against the back roll (reducing risk of a mis-matched end condition of the part).
- **Requires space only on one side** of the machine, where the plate is introduced to the machine.
- **Greatly reduced flat-end** (due to better pre-bending) thanks to the clamping roll that can take the edge to the precise tangent points of the top and bottom rolls.
- It is the **fastest machine to roll a can**, as it would require only one position for each side bending roll.
- **The entire cylinder can be finished in only one pass** (within a suitable capacity), including pre-bending of the edges
  - No need to pre-bend both ends before starting to roll the entire cylinder, as required with a 3 roll.
  - Pre-bending of the trailing edge is performed while the plate meets the top and side roll as an "automatic" feature
  - No need to remove, turn and re-insert the plate as on a 3 roll single pinch (asymmetric).
- **The most suitable for CNC operation**, as the plate is under a better control, clamped between the top and bottom rolls, until the part is finished (slippage and position shifts are virtually eliminated).
- The four roll could be even **50-80% faster and more productive** than any style three roll.



**The four roll design is recommended for clients who:**

- **Wish to operate through CNC, with less dependence on operator skills**
- Look for more steady quality of the rolled products.
- Look for high productivity, and increased profits.
- Require good accuracy and quality improvements.
- Need handling equipment for larger plates, who are also concerned for production or safety reasons.
- Are new to plate rolling, as it is the easiest plate roll to operate.

## PERFORMANCE AND GENERAL TECHNICAL SPECIFICATIONS

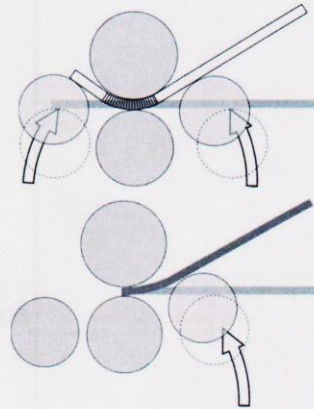
### Capacities\*

**Working in Standard "Rolling" Mode; capacities:**

Width of plate	Yield point	UTS Strength	Internal diameter	Plate thickness
4000 mm	260 Mpa	400 Mpa	5250 mm	155 mm
4000 mm	260 Mpa	400 Mpa	1580 mm	120 mm
4000 mm	360 Mpa	500 Mpa	5250 mm	135 mm
4000 mm	360 Mpa	500 Mpa	1580 mm	108 mm

**Working in Pre-bending Mode; capacities:**

Width of plate	Yield point	UTS Strength	Internal diameter	Plate thickness
4000 mm	260 Mpa	400 Mpa	5250 mm	140 mm
4000 mm	260 Mpa	400 Mpa	1580 mm	110 mm
4000 mm	360 Mpa	500 Mpa	5250 mm	110 mm
4000 mm	360 Mpa	500 Mpa	1580 mm	98 mm



**Cone Rolling capacity:**

- Step-bending (press / bumping method)
- Continuous rolling:

up to even 100% of the pre-bending capacity, depending on the cone geometry (the most used process on thicker plates)

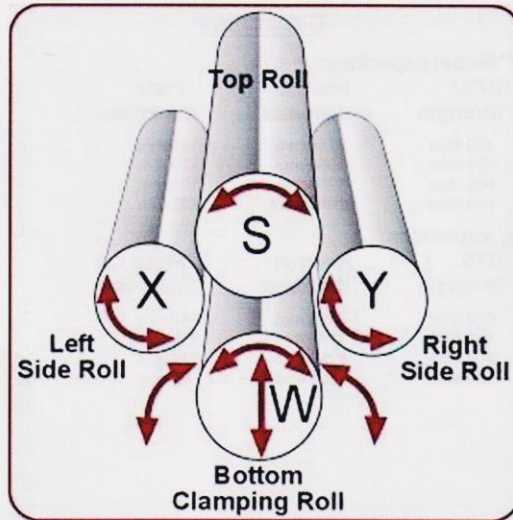
depending on the cone geometry (in some cases, even up to 75% of the pre-bending capacity)

(\*) Capacities in mild steel, formed in multiple passes. Clamping rolls are crowned for a medium thickness, and not for the maximum. Crowning for a specific application, is free of charge. Shimming is common to reduce or compensate the concave defect (canoeing) or the convex effect (hour-glass), when rolling thin plates, due to the physical rolls deflection. Thickness lighter than 1/3 of the machine capacity could be more affected by deflection. Davi can offer the Exclusive, Patented, optional "HDC" (Hydraulic Davi Crowning) to adjust and compensate for a part of the deflection of the clamping rolls (details available in the Optional section of this quote).



Picture of DAVI 4 ROLL with capacity of 3.000 x 166 mm

## TECHNICAL DATA



### ROLLS

Number of rolls:	4						
Rolls Length:	4250 mm						
Rolls diameter:	<table border="0" style="margin-left: 20px;"> <tr> <td>Top roll</td> <td>1100 mm less deflecting thanks to PSG technology</td> </tr> <tr> <td>Bottom roll</td> <td>1000 mm</td> </tr> <tr> <td>Side rolls</td> <td>850 mm</td> </tr> </table>	Top roll	1100 mm less deflecting thanks to PSG technology	Bottom roll	1000 mm	Side rolls	850 mm
Top roll	1100 mm less deflecting thanks to PSG technology						
Bottom roll	1000 mm						
Side rolls	850 mm						
Smallest possible diameter:	1210 mm						
Rolls material:	High tensile, forged, heat treated, tested & certified Chromium Molybdenum Manganese Alloy steel						
Heat treated rolls resistance:	R = 850 - 1050 N/mm <sup>2</sup> , depending on the Heat Treatment						
Heat treated rolls hardness:	HR Rockwell C 22-30, depending on the Heat Treatment						
Rolls induction, surface Hardened (on request):	induction, up to 48-62 HR Rockwell C, depending on application and materials (In case of Hot Rolling, and to prevent localized overloads, rolls are not suggested to be hardened more than approx. 22-30 HRC, as harder surface, more fragile, may be affected by fissures or cracks)						
Crowning:	2 clamping rolls (top and bottom) crowned to compensate for deflection. Customized crowing available on request.						

### DRIVE

Powered rolls:	2 (the top and the bottom clamping rolls)
Drive system:	2 <u>independent hydro-motors</u> (one hydro-motor for each powered roll) directly splined on the rolls shafts
Rolling speed up to max.:	<u>5 mt./min (20ft./min)</u> High Efficiency Technology
Rolls Peripheral Speed Compensation	Automatic, by the hydraulic system, without any power loss.

## ELECTRIC

Installed power:	HP 280 Power Saving Technology
Power supply:	415 Volts, 3 phases, 50 Hertz (Others available upon request)
CNC	DAVI CNC (different options are available, as detailed later on this quote)
Side Rolls Position gauge	4 Digital displays, on graphic screen, with an accuracy of 0,1 mm
Bottom Roll Position gauge	2 Digital displays, on graphic screen, with an accuracy of 0,1 mm

## MOVEMENTS

Rolls Guiding:	"Planetary Guides" (Friction-Free, Mill-Scale-Proof, Lubrication-Less). Exclusive Patented
Rolls movement:	Hydraulic, by mean of chromium plated largely dimensioned Hydraulic Cylinders, protected by overload protection system.
Side Rolls Tilting for cone bending:	Hydraulic powered, electronically controlled, in "cone" direction, up to more than 100 mm (the most, ever!), on 3 mt machines and wider, to help on rolling cones, easier, even with great angles
Bottom Clamping Roll Tilting for cone bending:	Hydraulic powered, electronically controlled, in "Counter-Cone" direction, to help for cone bending, to clamp the plate only at its longer round edge, speeding-up its rotation
Side Rolls "Counter-Cone" tilting to correct defects:	Hydraulic powered, electronically controlled, in "Counter-Cone" direction, up to more than 100 mm (the most, ever!), on 3 mt machines and wider, to correct cans with different diameters at the two ends
Plate Clamping pressure:	Managed by the operator, on the console screen, <u>pre-settable</u> to be optimized for any thickness. Electronically selected and (safely) monitored by the CNC.
Drop-end Tilting:	Hydraulic, to "release" the top roll front frame, to allow to tilt it
Top roll Tilting:	Hydraulic, to allow the "machine opening" to remove closed shapes

## BEARINGS

Type of Bearing on all rolls:	self-aligning spherical roller bearings
Top roll Housing:	Exclusive DAVI self-aligning "stress-free" Top Roll Bearing Housing (tiltable): absorbing any top roll deflection, tilting, out-of-axis situation, without any problem (other brands in the market have rigid, fixed roll housing, stress-affected by every physical roll deflection)

## **MAIN COMPONENTS** (top class Brands)

Self-Aligning Rolls Bearings: **SKF, INA, FAG, RKB**

Rolls: **Vienna, Nuova Ofar, Lucchini, Saarschmide SDF Italy (Thyssen-Krupp),**

Hydraulic Motors: **Sai, Samhydraulic, Riva Calzoni,**

Transmission Drives: **Brevini, Trasmital Bonfiglioli, RR, Roll-Star, Reggiana Riduttori**

CNC: **DAVI (\*awarded by NASA with "Certificate of Appreciation") & Apple iPad**

PLC: **B&R**

Position Sensors / transducers: **Gefran, Opkon**

Electric Components: **Siemens, Heidenhain, Moeller, Phoenix, Rockwell, Schneider, Allen Bradley, Telemecanique**

Electric Motors: **Seipee, Motovario, Electro Adda Drive, Siemens, ABB, Leroy-Sommer,**

Hydraulic Pumps: **Marzocchi, Casappa, Parker, Vickers**

Hydraulic Electro-Valves: **Rexroth, Parker, Duplomatic, Vickers**

Hydraulic Valves: **Rexroth , Sun, Oil Control, Hydraforce**

Hoses: **Techno-Hose,**

Cylinders Gaskets: **Merkel, Busak+Shamban, Polypac-Trelleborg, Dowty**

(or equivalent, also depending on availability)

## MACHINE PRICE SUMMARY

Item	Description	Unit Price
------	-------------	------------

### 1) MCB X-42 - DAVI Basic machine

### 2) Air/Oil Cooler

Keeps consistent the performance, when intensively used in hot weather environment.  
Water Coolers, can be quoted upon request. Cold water or chiller to be supplied by the Buyer.

### 3) Electronic Package to produce cones

- Electronic control software tilting of the side bending rolls (returns horizontal automatically).
- Electronic counter-tilting of the bottom clamping rolls, to help cone feeding.
- Guiding die (cone shoe or roller) in Hardened Tool-Alloy chromium Steel

### 4) DAVI "EASY-ROLL"

#### **"Self-Programming" CNC: DAVI " MCB EASY-ROLL"**

With Davi **Aided Program**, cylinders and other single radius shapes, could be programmed... **WITHOUT PROGRAMMING** ! Select a shape from the library; enter Width, Thickness, Radius and Material; the entire rolling Process is automatically calculated and built into a CNC Part Program, virtual, as ready to be optimized (according to the actual material) by the operator on the real plates in the machine, and saved in the CNC memory!

To roll a lot of identical plates, just press the "start" button. All the movements will be automatically performed by the CNC (as different materials change the diameters, manual corrections can be required, to improve the results).

It is suggested to roll in one pass automatic mode up to 60-70% of the prebending capacity (multiple passes parts can be eventually programmed in Editor mode).

Proven programs can be saved in memory, for future use.

#### **Programs:**

- **1000 Programs** capacity in memory (**50 steps** per program).

#### **Program mode:**

- **Editor** mode, writing the program through the Keyboard, step-by-step, by axis and positions through key-board;
- **Teach-In** mode, rolling the first piece and memorizing: the control repeats it, with the same movement and positions, on the rest of the batch.
- **Aided** mode, part program generated by the CNC

#### **Operating mode:**

- **Manual** mode
- **Semi automatic** mode (in MDI)
- **Automatic** mode



**Controlled axis:**

**9 axis :**

- X = Front bending roll - KX = Tilting of the front bending roll for cone process
- Y = Rear bending roll - KY = Tilting of the rear bending roll for cone process
- W = Bottom clamping roll - KW = Counter tilting of the bottom clamping roll to help on cone feeding
- P = Clamping Pressure control
- S = Rolls rotation to feed the plate
- O = Machine opening

**Unlimited additional Axis** can be added, upon request, at the time of the order, with additional price;  
Unlimited number of axis can be manually controlled through Joystick

**Features:**

- **Color graphic display screen 12"** with extended keyboard, 10 alpha-numerical program names, touch screen.
- 3D-Compact console (**Movable on wheels**)
- MULTIPORTS: **USB** ports for programs back-up, **Ethernet**
- Operating System **Windows 7 embedded**

*The Easy-Roll control also includes:*

- **ON-BOARD INFO DIAGNOSTICS** - Instantly available on the monitor: User's manual, Electric and Hydraulic Schematics, Parts Manual identifying consumable or spare parts, Capacity Charts of different material and steel grade, Listed Trouble Shooting, helping to find out possible problems, FAQ Frequent Asked Questions, to solve many doubts.
- **REMOTE TELE-SERVICE ON LINE** (by customer, on-demand): if allowed by the customer, using a simply and safe **Ethernet** connection the closest Authorized DAVI Service Center can provide **Remote Service**.
- **DIAMETER CORRECTION for single radius:** in case of deviation (for different Yield) Easy Roll **re-calculates** and suggests new, and "corrected" position of the side rolls, according to the **real** result on the **real** plate, to improve the result.
- **PLATE CUT DIMENSION:** on line for available templates (single radius)
- **AUTOMATIC MODE PRODUCTION REPORT:** total daily, weekly, monthly, annual reporting of production
- **DVD-Like ANIMATION** - An animation, trains to the correct sequence of movement on the part to roll, not to collide or interfere, after calculating the entire sequence.

Machine control and machine electrical - electronic components protected against welding spike. Tack welding/welding on our machine is NOT a problem



Note: the CNC control is supplied to manage and position the controlled axes of the machine within Davi's specified tolerances, but not how the material reacts to them. In fact, there are many variables including yield and tensile strength, material thickness, grain direction, cut dimensions, material handling practice and storage, and operator ability that affect the results of the finished product. These factors may require that adjustments must be made, manually by the operator, to meet required rolling tolerances, although the machine positions and sequences are consistently performed by the CNC.

**5) Packing**