STAINLESS STEEL FABRICATION

FABTECH International

Presented by: SPECIALTY STEEL INDUSTRY of
NORTH AMERICA

Cutting, Mechanical Shearing

- More force and heavier equipment will be required to shear stainless steel compared to carbon steel
- Carbon steel 0.4 inches
- Ferritic stainless steel 0.3 inches
- Austenitic stainless steel 0.2 inches

Cutting, Mechanical Shearing

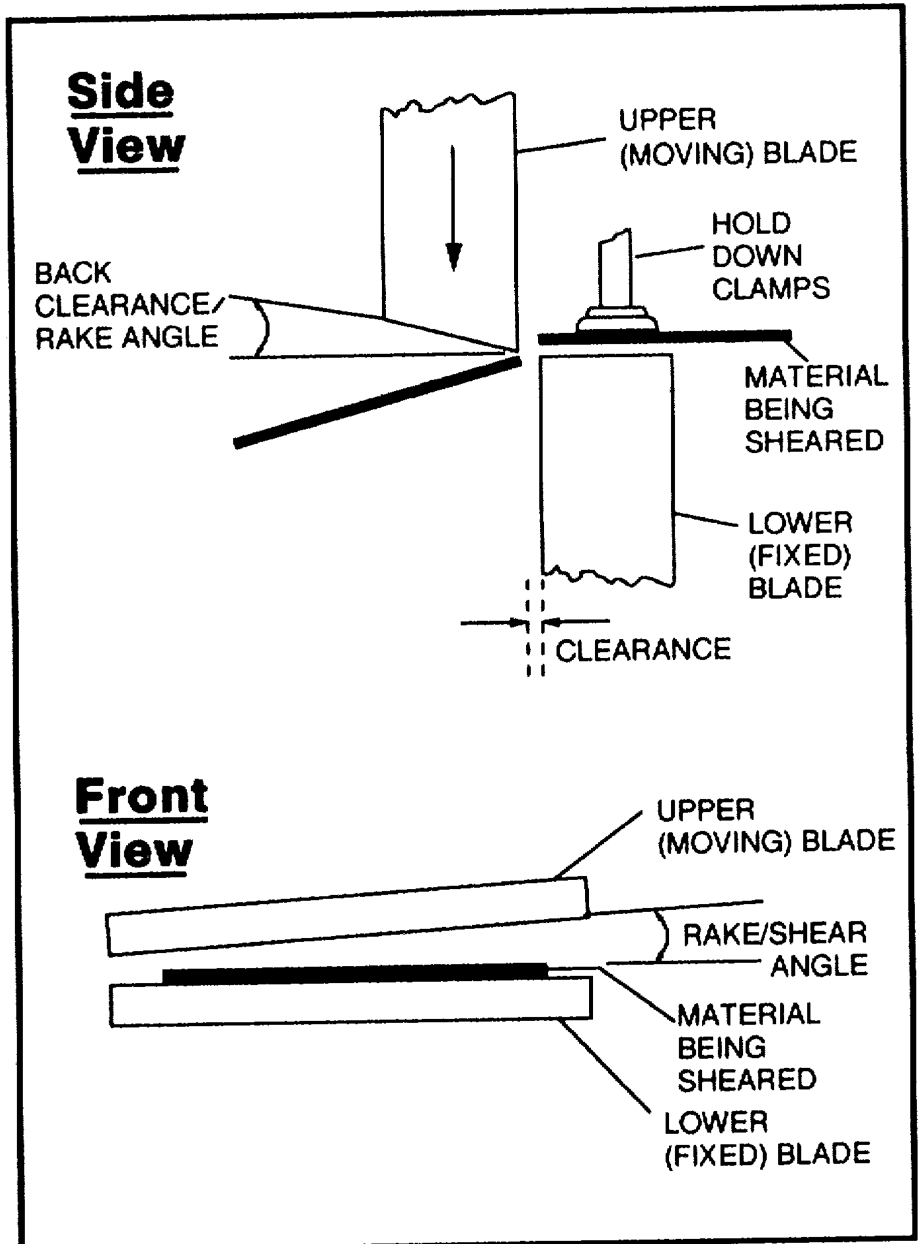
- Austenitic stainless steels are characterized by high ductility (hence greater resistance to fracture)
- The clearance setting of the blades is, therefore important
- For shearing thin gauge sheet a clearance of 0.001 to 0.002 in. is suggested
- Proper clearance is present if about 40 % of the metal thickness is burnished at the top side

Cutting, Mechanical Shearing

- A good clearance guide is to use a clearance of 5% of the metal thickness @ 16 gauge (0.62 in.) and heavier, and 3% of the metal thickness below 16 gauge
- To counter the shearing force required with austenitic stainless steel, the hold down pressure on the clamps may have to be increased

Cutting, Mechanical Shearing

- The higher power required can to some extent be countered by altering the rake/shear angle
- A rake of 1in 40 is a shear angle of approximately 1 1/2 degrees
- Small rake/shear angles require higher power, but cause less distortion
- Larger rake/shear angles reduce the power but require higher hold down pressure
- BLADES MUST BE SHARP


Side View
UPPER (MOVING) BLADE
HOLD DOWN CLAMPS
BACK CLEARANCE/ RAKE ANGLE
MATERIAL BEING SHEARED
LOWER (FIXED) BLADE
CLEARANCE
Front View
UPPER (MOVING) BLADE
RAKE/SHEAR ANGLE
MATERIAL BEING SHEARED
LOWER (FIXED) BLADE

Cutting, Circle Shearing

- It is important to set circular knives to correct horizontal and vertical clearance
- A good guide is a clearance of 8% of the thickness
- Less vertical clearance in relation to the thickness is required for hard material
- Knives are generally overlapped to cut all the way through the metal up to about 0.045 inches

Cutting, Circle Shearing

- Knife speed for circular shearing is on the order of 60 to 150 sfp
- For stainless below 17 gauge (0.058 in.) the highest speed can be used, lowering the speed for for heavier gauges
- Knives deteriorate with metal pickup, this can be minimized by using a lubricant

Cutting, Sawing

- High speed steel blades are suggested for all types of sawing of stainless steel
- Austenitic stainless are more difficult to cut due to their tendency to work harden
- Cutting must be initiated without any riding of the saw on the work and keep a positive pressure
- No pressure, drag or slip, should occur on the return stroke

Blanking

- Blanking stainless steel required more force (for an equal thickness) than for carbon steel
- Clearance is important. For the thinnest gauges a minimum clearance of 0.001 in. per side is suggested. For thicker materials the clearance per side should be 5-10%of the material thickness.
- For Plate (over 3/16 in.) the clearance per side may be increased to 15%

Punching

- While similar to blanking, the holes are usually smaller and often discarded, thus the angular shear edges are placed on the punch
- In austenitic stainless steel, circular holes should have a minimum diameter of twice the thickness of the material and the minimum distance between adjacent holes should be 1/2 the hole diameter

Abrasive Cutting

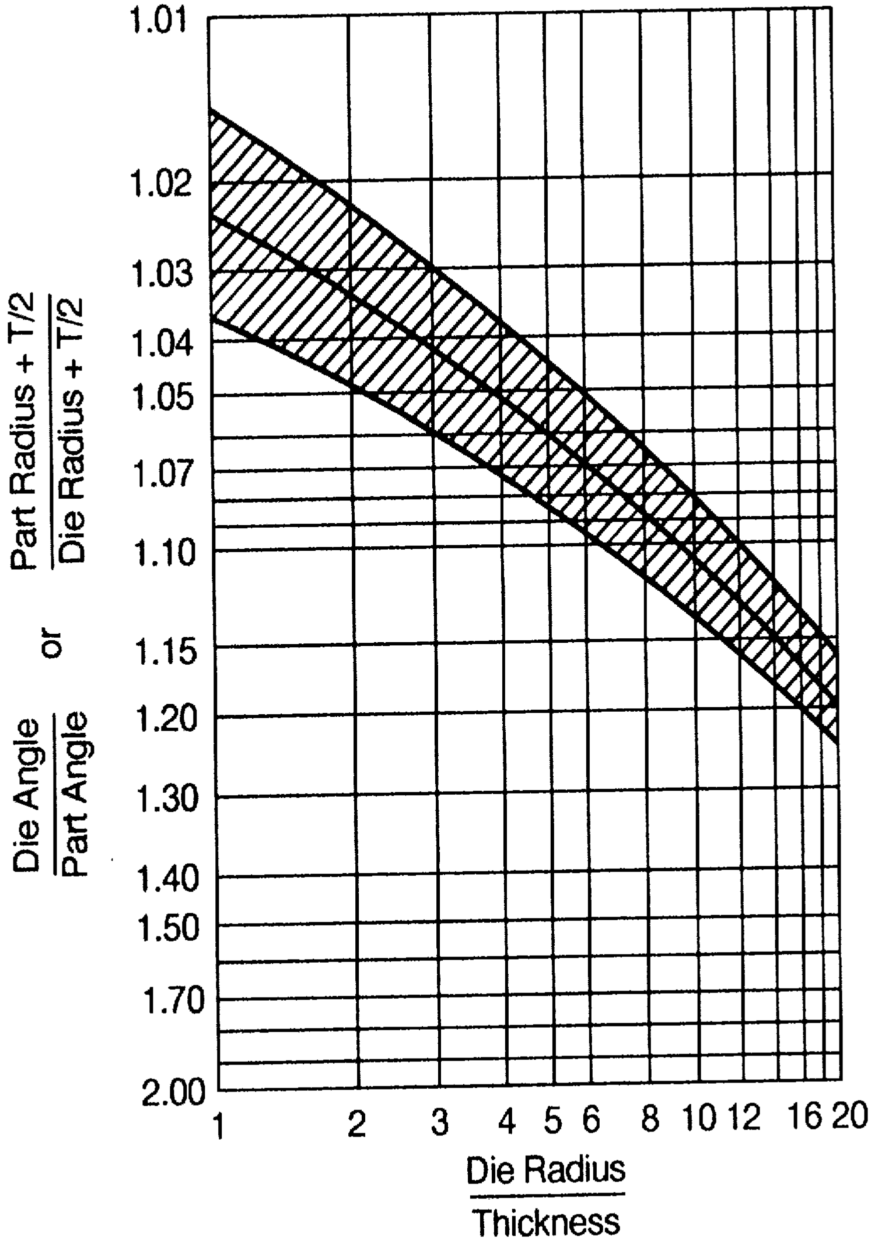
- Abrasive wheels, rotating at high speed can be used for straight line cutting of sheet and thin gauge plate and for cut-off operations on relative small sections
- Cut-off operations are usually done wet
- Straight line cutting is normally done dry
- Use uncontaminated vitrified or resinoid-bonded wheels
- DO NOT INDUCE OVER-HEATING

Bending - Springback

- When metal is bent, the outside of the bend is in tension and the inside edge is in compression
- If the bending force is not sufficient cause permanent plastic flow of the metal at either the outer or inner surfaces, the metal will return elastically to its original shape
- the force necessary to make a permanent bend depends on: the yield strength, work hardening characteristics, the desired angle and the thickness of the material

Bending - Springback

- Austenitic stainless steels, with their higher rates of work hardening, require more power than is required to bend carbon steel of equal thickness to the same angle
- Therefore stainless steel must be bent further than carbon steel to result in the same angle and there is more springback
- Springback increases with increasing ratio of bend radius to part thickness (small bend radius = less springback



Example

Using a thickness (T) of 0.100 in. and a die radius of 1.00 in.

$$\frac{\text{Die Radius}}{\text{T}} = 10$$

Then

$$\frac{\text{Die angle}}{\text{Part angle}} = \begin{matrix}1.12\\ \text{(on average)}\end{matrix}$$

If part angle is to be 90°, the part must be bent an average of 100.8°.

If the die angle is to be 90°, the part angle will be an average of 80.3°.

Bending, Brake Press

- Brake press bending of stainless steel can be performed in the same way as bending carbon steel with allowances for the higher strength and greater springback
- Since stainless has a high ductility they can be bend to equally small bend radii, gauge for gauge, as carbon steel
- A good rule is to set up the brake forming procedure assuming the same forming pressure used for hot rolled carbon steel **four gauges** heavier

Bending, Roll Bending

- Again the same procedure can be used with stainless as with carbon steel (allowing for the increased power and springback - note: the increased springback can be offset by increasing the roll pressure)
- The minimum cylinder which can be made in stainless steel on a pyramid type bender is about twice the center roll diameter (1 1/2 times for low carbon steel)

Descaling Stainless Steel

- When stainless steel is heated an oxide scale will form on the surface
- Any such scale should be removed to restore the stainless steel to its optimum corrosion resistant condition
- Removal of the oxide scale is most commonly performed by using a pickling solution (10-15% nitric acid plus 1-3% hydrofluoric acid at 130 degrees F) or a pickling paste

Descaling Stainless Steel

- Blasting the scale off the surface is another method. Glass bead blasting is the preferred operation
- If grit or sand blasting is used BE CAREFUL to use NEW OR UNCONTAMINATED blasting media
- Flapper wheels or wire brushing can also be used BUT MADE SURE THE WHEEL OR BRUSH IS EITHER STAINLESS OR A -NON-CONTAMINATING MATERIAL

Care in the Shop

- Plates and heavy gauge sheet should be stored vertically and not dragged out of the racks or over one another
- Avoid iron contamination from forks or clamps
- Use wooden blocks to separate sheets
- Slings should be of synthetic material not chains
- Thin gauge or polished material should be handled with clean linen gloves

Rust Contamination

- Handling equipment should be dedicated for use only on stainless
- If separate handling is not practical, equipment must be cleaned after its use with carbon steel and before using it on stainless steel as iron from the carbon steel can contaminate the surface of the stainless and it (the carbon steel particles) WILL RUST

Stainless Steels are Not Difficult - Just Different

- Forming and fabricating practices used for carbon steel, galvanized steel, aluminum and copper are the same ones used for STAINLESS STEEL
- Require MORE power
- GREATER tendency to springback
- They will WORK HARDEN as they are worked

Bending, Roll Forming

- Stainless steel can be roll-formed readily in the annealed state (note: stainless is available in cold rolled tempers, such as 1/4 and 1/2 hard)
- Tempered stainless steel requires more passes

Sources of Contamination

- Any form of **<u>Carbon Steel</u>** such as iron fillings, weld splatter, grindings and all forms of embedded iron, such as from steel brushes, steel rolls or steel tool scratches
- **<u>Chlorides</u>** in any combination of Hydrochloric Acid (as metal cleaners), solder fluxes and masonry cleaners

Avoiding Contamination

- Prevent embedded iron:
  Store sheets and plates upright in racks Cover carbon steel work surfaces Non-steel guards on hooks, slings, forks etc.
- Preventing organic impairment:
  Grease, oils, crayon, paint, tape and other sticky deposits

Avoiding Contamination

- Apply surface protection
- Use clean tools
- NEVER use Steel brushes or STEEL WOOL
- NEVER shot blast with Steel Shot or media used on carbon steel

Removing Iron Contamination

- Mechanical cleaning
- Chemical cleaning
- ASTM A 967, Chemical Passivation Treatments

Welding Processes for Stainless Steel

- Shielded Metal Arc Welding: SMAW, covered electrodes, “stick”
- Gas Tungsten Arc Welding: GTAW, “TIG”
- Gas Metal Arc Welding: GMAW, “MIG”

Welding Processes NOT SUITABLE for Stainless Steel

- Oxyacetylene Welding
- Carbon Arc Welding

Cleaning of Stainless Steel

- Water wash or Ferroxyl test to detect iron
- Degreasing using nonchlorinated solvents followed by a “water break” test
- Pickling, controlled surface passivation, using a Nitric/Hydrofluoric acid bath
- Blasting with clean glass-beads
- Grinding and Electropolishing