Co-planar inc.

Design Considerations And Recommendations

Co-planar Stamped Part Design Standards

General Nomenclature

- Break or Breakout

  A characteristic of a stamped cut is break or breakout. The area of the blank-out where the substrate breaks as opposed to the area of the blank-out which is cut or sheared. This break-out surface is rough and not well-defined.

- Burr

  A characteristic of a stamped cut is burr, unwanted material remaining on the burr-side of the part below the breakout of the sub-strate. Burrs may be horizontal (protruding into a cut opening) or vertical (adding to the thickness of the substrate).

- Burr-side of the substrate, cut or part

  The burr-side of a cut (or burr-side of the part) is the side of the substrate opposite the side the punch entered.

- Die-side of the substrate, cut or part

  (Please refer to Burr-side description.)

- Punch-to-die clearance

  The amount of space between the punch and the die. Clearance is generally expressed as a percentage of the substrate thickness which will be cut. Since the punch-to-die clearance is equal on all sides of the punch, the term total clearance designates the dimensional differ-ence between the punch and the die (or 2x clearance on one side of the punch and die).

- Punch-side of the substrate, cut or part

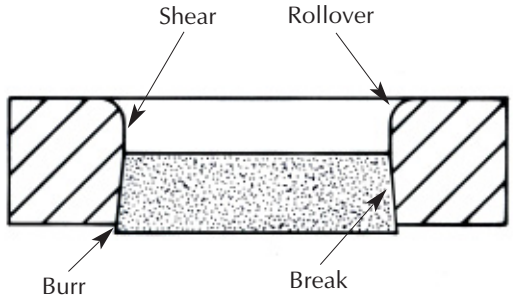
  The punch-side of the cut is the side of the substrate that the punch has entered. The punch-side of the part will generally include a rollover condition leading into the cut.

- Rollover

  A characteristic of a stamped cut is rollover. When cutting into a substrate, the punch will compress the material immediately adjacent to it. This compression remains in the substrate and is observed as a radius lead-ing into the cut. This radius is also termed rollover or lead-in and identifies the punch-side of the part.

- Shear

  A characteristic of a stamped cut is shear. The area of the blank-out where the substrate has been cut by the punch. The sheared portion of the blank-out is well-defined, consistent in size and smooth.



Stamping Conditions and Guidelines

Punch-to-Die Cutting Clearance

When cutting or blanking through any material there exists a direct relationship to the thickness of

the material being cut and the clearance between the punch (the part that goes through the material) and the die (that which supports the remaining material and accepts the slug which has been cut away).

While optimal cutting clearance is material alloy dependent, for most fine stamping operations Co-planar uses 5% cutting clearance. Stamping tools designed with 5% cutting clearance will provide a clean, burr-free cut, 60 to 80% shear length and minimal top surface rollover or lead-in. The downside to cutting clearances this tight is increased tool wear.

In normal stamping operations we may elect to design a stamping tool with more punch-to-die clearance. For these applications, design standards dictate 7 to 12% total punch-to-die clearance. Increasing the clearance will yield longer press runs before the stamping tool requires servicing or sharpening. For these applications, the customer is not as concerned with slightly increased burring, reduced shear length inside the cuts and more roll-over or lead-in. Instead, this customer is focused on maximum quantities of parts stamped in a very short period of time. Non-typical applications may call for increased clearances (beyond 12%), but this is reserved for specialized applications.

Burnishing or Shaving

A normal stamping cut (through a substrate) will provide an opening in the material with four characteristics:

- A sheared (straight) portion of the cut wall (punch-side of the part)
- A breakout portion of the cut wall
- A lead-in or radius edge leading into the cut
- A burr (die-side or burr-side of the part)

When the customer needs a very straight, extremely consistent opening through the material, Co-planar will design a burnishing or shear station into the stamping tool. In this operation the opening is first cut undersized using normal punch-to-die clearance. The opening is then re-cut, removing very little material and using extremely tight (1 to 2% total) punch-to-die clearance.

The resultant opening will provide the following characteristics:

- The entire wall of the opening will be sheared
- Minimal, if any, breakout
- Minimal lead-in
- Very fine, if any, burr

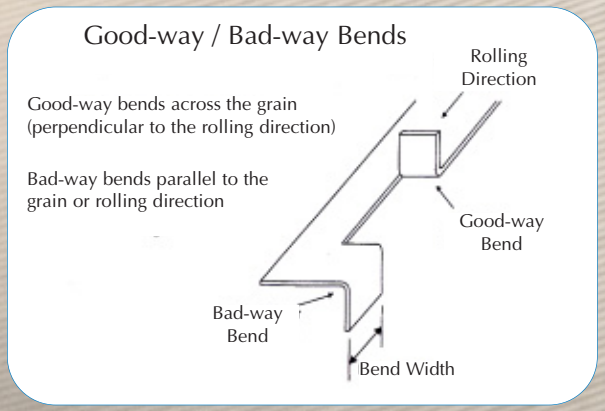
While the results of shaving a cut are significant, there are downsides to this operation. For example, the opportunity for slug marks to appear on the finished part is greatly increased. This is due to the difficulty in keeping the scrap produced by the shaving operation separated from the remaining substrate. Another aspect of incorporating a shaving operation into a stamping tool is increased downtime due to excessive wear of the cutting components.

Forming Conditions and Guidelines

A common characteristic of most stamping tools is forming (or bending) the parts. Much consideration is necessary when designing forming stations that will produce reliable and consistent results in the finished part. An improperly designed forming application will cause inconsistent dimensional results and the possibility of failures due to metal fatigue in the finished part.

Good-way, Bad-way Bends

Parts are stamped from coiled strip materials. The grain of the material runs parallel with the length as opposed to perpendicular to the length of the material. When incorporating forming stations inside stamping tools, consideration must be given to the material grain.



- Good-way bends across the grain (perpendicular to the material edges) are strong, reliable dimensionally and will not separate the grain structure of the base material.

- Bad-way bends parallel to the grain (parallel to the material edges) tend to be weak, less reliable in terms of dimensional stability and will separate (orange-peel) the grain structure of the base material. Additionally, when pre-plated material is used, bad-way bends will tend to expose the base material through the plating.

Forming Radii

One of the most important aspects of manipulating material during a forming operation is to consider the bend radius the material is required to negotiate. If the bend radius is too small, relative to the substrate thickness, the formed material will yield (become weak, crack and or break).

If the bend radius is too large, relative to the substrate thickness, the intended form will not be dimensionally consistent. In general, consider 1.5 times the substrate thickness for a starting point when designing a formed part.

Whenever possible formed parts are to be dimensioned to the inside radius. This is the area of the bend that is controlled. The outside radius of the form is generally considered to be uncontrolled and dimensions to this area of the part will be required to incorporate a larger tolerance.

Form Tolerance

In general, 90° angled forms will require a ±3° tolerance. Depending on the application, the stamping tool design may incorporate cam or qualifying stations which will reduce the bending tolerance to ±0.5°.

Hole Deformation

To avoid deformation of cut features, keep all cuts three times (3x) material thickness from the area of the substrate to be formed. Features closer than 3x substrate thickness will become deformed as they get sucked into the adjacent bend.

Coining

Another common feature incorporated into stampings run by Co-planar is coining. In a coining operation a definite impression is pressed into the surface of the material. This impression may appear on the burr-side or punch-side of the part. Coined impressions are consistent in terms of dimensional outline and depth. The depth and overall outline do have design considerations in terms of how deep the impression may be compressed. Limitations exist regarding alloy, run speed, general part configuration, allowable distortion and surface dimensions.

Scoring

In order to facilitate one feature breaking free of another, score lines may be included in the part and stamping tool design.

In many applications, score lines allow a part to be separated from a carrier strip without the need for additional break free tooling. Once scored, the parts will separate the same way (usually one 90° bend) at the desired location. Scoring has streamlined many automated insertion applications.

Drawing

In a drawing application a continuous round, square or rectangular wall of material is formed perpendicular to the substrate. There are many applications that benefit from drawing material into a shell configuration. The design engineers at Co-planar will suggest drawing applications whenever the opportunity exists.

Riveting or Eyeleting

Joining two assemblies together in a manual, semi-automated or automated environment may help the customer avoid costs elsewhere in his operation.

Material Systems

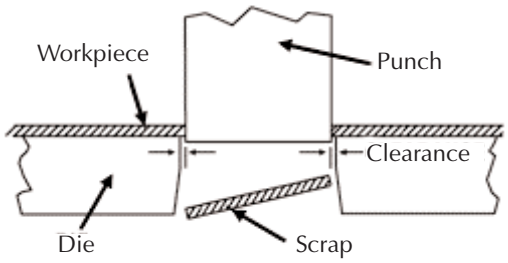
Co-planar is adept at stamping many different materials. We address customers' specific needs on an individual basis and will recommend material systems to meet or exceed customer expectations.

Some of the materials routinely processed by Co-planar include Copper, Copper Alloys (including Phos-Bronze, Brass, and Beryllium), Stainless Steel alloys, Steel alloys, Nickel alloys, PVC and Mylar.

Our material systems often include one or more of the following – dual gauge skived, dual gauge EB welded, dual gauge coined, milled, precious metal inlays, overlays and crush-bonded materials. We also employ a wide variety of pre and post-plated materials.

General Guidelines

- A burr equal to 10% of the substrate thickness is to be expected from any normal stamping operation.
- The smallest radius to be cut into a substrate should equal the thickness of that substrate.
- In most forming operations the smallest (inside) radius should be equal to 1.5 times the sub-strate thickness.
- Keep holes 3 times material thickness away from formed areas of the part.
- Most, if not all spring applications will include design considerations for the grain direction of the substrate.



Our Commitment

The design considerations herein presented are for general reference only, as there are exceptions to any rule. The customer's specific needs will be addressed on an individual basis. If it can be done, Co-planar will design and accomplish it. We are your source for...*Engineering Solutions.*

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