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DESIGN AND SIMULATION OF DIFFERENT PROGRESSIVE TOOLS

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Abstract – Sheet metal is just metal formed into thin and flat pieces. it's one among the elemental forms utilized in metalworking, and may be cut and bent into a spread of various shapes. Countless everyday objects are constructed of the fabric . Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces thicker than 9 mm (0.35 in) are considered plate. Design of sheet dies could also be an outsized division of tool engineering, utilized in varying degree in manufacturing industries like automobile, electronic, house hold wares and in furniture.

Key Words: sheet metal, dies, thickness

1. INTRODUCTION

Sheet metal is simply metal formed into thin and flat pieces. it's one of the basic forms utilized in metalworking, and should be cut and bent into a selection of varied shapes. Countless everyday objects are constructed of the fabric . Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces thicker than 9 mm (0.35 in)are considered plate.

Sheet metal processing

The staple for sheet manufacturing processes is that the output of the rolling process. Typically, sheets of metal are sold as flat, rectangular sheets of ordinary size. If the sheets are thin and really long, they'll be within the sort of rolls. Therefore the primary step in any sheet process is to chop the right shape and sized 'blank' from larger sheet

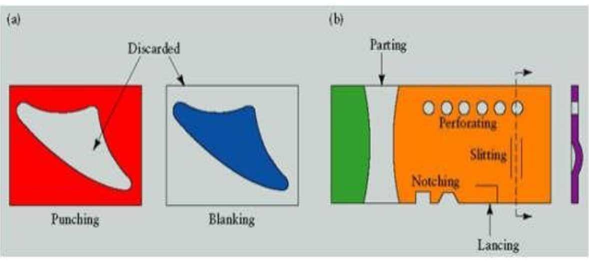


Fig.1.Shearing Operations: Punching, Blanking and perforating

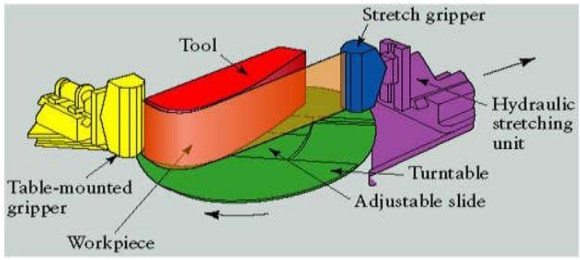


Fig.2.Common Die-Bending Operations Various Bending Operations

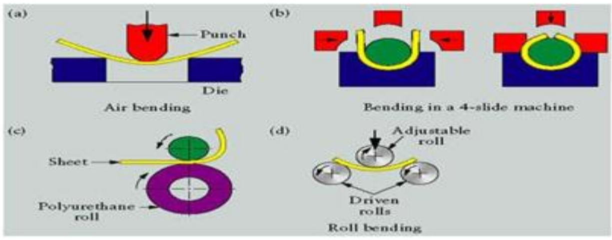


Fig.3: Schematic illustration of a stretch-forming process.

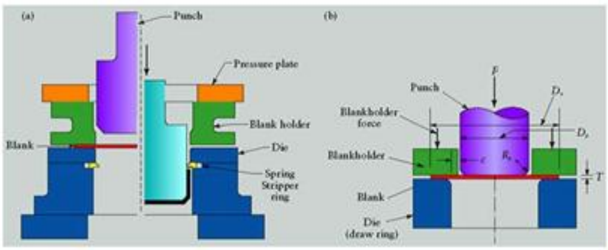


Fig.4. Schematic of the Drawing process.

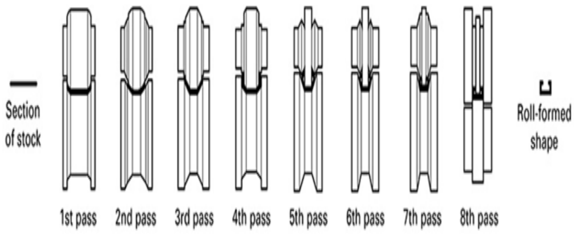


Fig.5.Eight roll sequence for the roll forming of a box channel

Finishing processes

Material properties, geometry of the starting material, and therefore the geometry of the specified final product play important roles in determining the simplest process.

Presses

- Mechanical Press **-** The ram is actuated employing a flywheel. Stroke motion isn't uniform.
- Hydraulic Press **-** Longer strokes than mechanical presses, and develop full force throughout the stroke. Stroke motion is of uniform speed, especially adapted to deep drawing operations.

Dies and Punches

• Simple- single operation with one stroke
• Compound- two operations with one stroke
• Combination- two operations at two stations
• Progressive- two or more operations at two or more stations with each press stroke, creates what's called a strip development

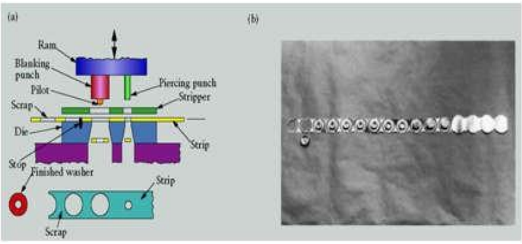


Fig 5 Progressive dies Punches

1. MATERIALS

Stainless steel

The three commonest chrome steel grades available in sheet are 304, 316, and 410.

Grade 304 is that the commonest of the three grades. It offers good corrosion resistance while maintaining formability and weldability. Available finishes are #2B, #3, and #4. Note that grade 303 isn't available in sheet form.

Grade 316 offers more corrosion resistance and strength at elevated temperatures than 304. it's commonly used for pumps, valves, chemical equipment, and marine applications. Available finishes are #2B, #3, and #4.

Grade 410 may be a heat treatable chrome steel , but doesn't offer nearly as good corrosion resistance. it's commonly utilized in cutlery. the sole available finish is dull.

2. Aluminium

The four commonest aluminium grades available as sheet are 1100-H14, 3003-H14, 5052-H32, and 6061-T6.

Grade 1100-H14 is commercially pure aluminium, so it's highly chemical and weather resistant. it's ductile enough for deep drawing and weldable, but low strength. it's commonly utilized in chemical processing equipment, light reflectors.

Grade 3003-H14 is stronger than 1100, while maintaining an equivalent formability and low cost. it's corrosion resistant and weldable. it's often utilized in stampings, spun and drawn parts, mail boxes, cabinets, tanks, and fan blades.

Grade 5052-H32 is far stronger than 3003 while still maintaining good formability. It maintains high corrosion resistance and weld ability. Common applications include electronic chassis, tanks, and pressure vessels.

Grade 6061-T6 may be a common heat-treated structural aluminium alloy. It's weldable, corrosion resistant, and stronger than 5052, but not as formable. Note that it loses a number of its strength when welded. It's utilized in modern aircraft structures, generally replacing the older 2024-T4 alloy.

Gauge

The sheet gauge (sometimes spelled gage) indicates the quality thickness of sheet for a selected material. for many materials, because the gauge number increases, the fabric thickness decreases.

Sheet thickness gauges for steel are supported the load of steel, allowing more efficient calculation of the value of fabric used. the load of steel per sq ft per inch of thickness is 41.82lb (18.96kg), this is often referred to as the Manufacturers' Standard Gage for Sheet Steel. For other materials, like aluminium and brass, the thicknesses are going to be different.

DESIGN OF SHEET DIES INTRODUCTION

Design of sheet dies may be a large division of tool engineering, utilized in varying degree in manufacturing industries like automobile, electronic, house hold wares and in furniture.

There is little question that accuracy achieved by the new ideas in design and construction applied by the press tool designer, coupled latest development made in related fields made more productive, durable and economical.

These are

 The concept of "Flexible Blank Holder" has given the scope to regulate the flow of the fabric during a better way.

 Hardened and toughened new martial & heat treatment process made the planning easy.

 The latest machining process made the complex designs made easy, like wire cut, EDM, Profile Grinding.

Four factors are essential contributions to first-class presswork are

• Good operation planning
• Excellent tool design
• Accurate tool design
• Knowledge press setting

Design of any Press Tool involves the subsequent Steps

1. Determination of force (Press Tonnage) required for the operation
2. Selection of Press for requisite force, work piece size and shape
3. Determination of shut height of the tool

4. Computing die thickness, and margins (minimum cross-section)

4. Drawing Strip Layouts and comparing Material utilization

6. Design of locating Elements

7. Selection of Locating Elements

8. Selection of Hardware

9. Drawing die plan and selection of pillar die set

10. Deciding punch length and mounting

11. Finding Centre of Pressure and Checking scrap Disposal

12. Drawing Details

TYPES OF PRESS TOOLS

Press tools are commonly utilized in hydraulic and mechanical presses to supply components at a high productivity rate. Generally press tools are categorized by the kinds of operation performed using the tool, like blanking, piercing, bending, forming, forging, trimming etc. The press tool also will be speciopified as blanking tool, piercing tool, bending tool etc.

CLASSIFICATION OF PRESS TOOLS

Press tools are classified into:

STAGE TOOLS

Blanking tool

When a component is produced with one single punch and die were the whole profile is cut in single stoke is named Blanking tool.

Piercing Tool

Piercing involves cutting of unpolluted holes with resulting scrape slug. The operation is usually called piercing, generally the term piercing is employed to explain die cut holes no matter size and shape. Piecing is performed during a press with the die. the piercing tool is employed to pierce the holes as secondary tool like after bending of component etc.

Cut off tool

Cut off operations are those during which strip of suitable width is move lengthen single. cut-off tools can produce many parts. the specified length of strip are often stop for bending and forming operation using this tool.

Parting off tool

Parting off is an operation involve two stop operations to supply blank from the strip. During parting some scrape is produced. Therefore parting is that the next best method for cutting blanks. it's used when blanks won't rest perfectly. it's almost like stop operation except the cut is in double line. this is often finished components with two straight surfaces and two profile surfaces

Trimming tool

When cups and shells are drawn from flat sheet the sting is left wavy and irregular, thanks to uneven flow of metal. This irregular edge is trimmed during a trimming die. Shown is flanged shell, also because the trimmed ring faraway from round the edge. While alittle amount of fabric is faraway from the side of a component in trimming tool.

Shaving tool

Shaving removes alittle amount of fabric round the edges of a previously blanked stampings or piercing. A straight, smooth edge is provided and thus shaving is usually performed on instrument parts, watch and clock parts and therefore the like. Shaving is accomplished in shaving tools especially designed for the aim .

Bending tool

Bending tools apply simple bends to stampings. an easy bend is completed during which the road of bend is straight. One or more bends could also be involved, and bending tools are an outsized important class of pres tools.

Forming tool

Forming tools apply more complex forms to figure pieces. the road of bend is curved rather than straight and therefore the metal is subjected to plastic flow or deformation.

Drawing tool

Drawing tools transform flat sheets of metal into cups, shells or other drawn shapes by subjecting the fabric to severe plastic deformation. Shown in fig may be a rather deep shell that has been drawn from a flat sheet.

This type of Press tools are wont to perform just one particular operation.

Progressive tool

Progressive tool differs from the stage tool by the subsequent aspect, In progressive tool the ultimate component is obtained by progressing the sheet or strip in many stages. In each and each stages the component will get its shape stage by stage the complete shape are going to be obtained at the ultimate stage.

Compound tool

The compound tool differs from progressive and stage tool by the arrangement of punch and die. it's a inverted tool were blanking and piercing takes place during a single stage and also blanking punch will act as piercing die.

Combination tool

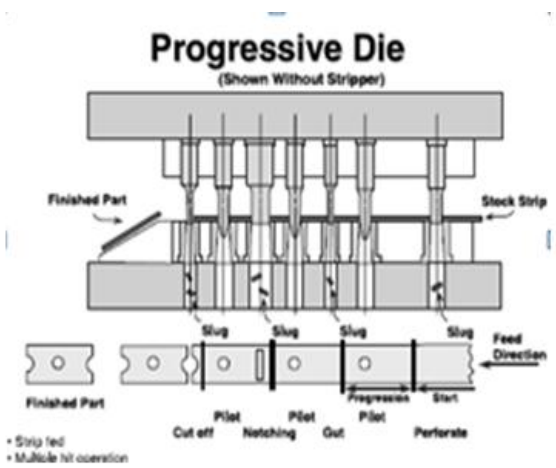
In combination tool two or more operations are going to be performed simultaneously like bending and trimming takes place during a single stage. together tool two or more operations like forming, drawing, extruding, embossing could also be combined on the component with various cutting operations like blanking, piercing, broaching and stop takes place.

PROGRESSIVE TOOL DESIGN

Progressive dies provide an efficient thanks to convert raw coil stock into a finished product with minimal handling. As material feeds from station to station within the die, it progressively works into a completed part.

Progressive dies usually run from right to left. The part material feeds one progression for every press cycle. Early stations typically perforate holes that function pilots to locate the stock strip in later stations.

There are many variations of progressive die designs. the planning shown here illustrates some common operations and terminology related to progressive dies.



Progressive stamping may be a metalworking method which will encompass punching, coining, bending and a number of other ways of modifying metal staple, combined with an automatic feeding system.

He feeding system pushes a strip of metal (as it unrolls from a coil) through all of the stations of a progressive stamping die. Each station performs one or more operations until a finished part is formed. The ultimate station may be a cutoff operation, which separates the finished part from the carrying web. The carrying web, alongside metal that's punched away in previous operations, is treated as rubbish.

The progressive stamping die is placed into a reciprocating stamping press. Because the press moves up, the highest die moves with it, which allows the fabric to feed. When the press moves down, the die closes and performs the stamping operation. With each stroke of the press, a completed part is far away from the die.

Since additional work is completed in each "station" of the die, it's important that the strip be advanced very precisely in order that it aligns within a couple of thousandths of an in. because it moves from station to station. Bullet shaped or conical "pilots" enter previously pierced round holes within the strip to assure this alignment since the feeding mechanism usually cannot provide the required precision in feed length.

Progressive stamping also can be produced on transfer presses. These are presses that transfer the components from one station to subsequent with the utilization of mechanical "fingers". For mass productions of stamped part which do require complicated in press operations, it's always advisable to use a progressive press. one among the benefits of this sort of press is that the production cycle time. Depending upon the part, productions can easily run overflow 800 parts/minute. one among the disadvantages of this sort of press is that it's not suitable for top precision deep drawing which is when the depth of the stamping exceeds the diameter of the part. When necessary, this process is performed upon a transfer press, which runs at slower speeds, and believes the mechanical fingers to carry the component in situ during the whole forming cycle. within the case of the progressive press, only a part of the forming cycle are often guided by spring loaded sleeves or similar, which end in concentricity issues and non uniform material thickness. Other disadvantages of progressive presses compared to transfer presses are: increased staple input required to transfer parts, tools are far more expensive because they're made in blocks (see fig. 1) with little or no independent regulation per station; impossibility to perform processes within the press that need the part leave the strip (example beading, necking, flange curling, thread rolling, rotary stamping ect).

The dies are usually made from alloy steel to face up to the high shock loading involved, retain the required sharp leading edge , and resist the abrasive forces involved.

The cost is decided by the amount of features, which determine what tooling will got to be used. it's advised to stay the features as simple as possible to stay the value of tooling to a minimum. Features that are approximate produce a drag because it's going to not provide enough clearance for the punch, which could end in another station. It also can be problematic to possess narrow cuts and protrusions.

Applications

An excellent example of the merchandise of a progressive die is that the lid of a beverage can. The pull tab is formed in one progressive stamping process and therefore the lid & assembly is formed in another, the pull tab simultaneously feeding at a right angle into the lid & assembly process.

DESIGNING PROGRESSIVE DIES

The decision to supply a neighborhood progressively is typically determined by two factors: the quantity of production and therefore the complexity of the part. These two factors are instrumental within the design and construction of the tooling. it's important to deal with all factors which will contribute to the specified level of part quality, tool maintenance, and tooling life. Trade-offs are going to be necessary to succeed in most decisions, and every one will affect tooling costs.

PART ORIENTATION

The process begins with determining how the part are going to be run through the die. this is often governed by the features of the part and therefore the locations of the datum's and important tolerances. Then, the trade-offs begin.

Optimizing material usage may require rotating the part within the strip, which changes the grain direction of the steel within the part and thus can affect the strength of any forms within the part. Forming with the grain can cause cracking and fatiguing of the metal and make holding consistent form angles harder . Therefore, the shape are going to be much more vulnerable to problems related to the chemical makeup of every coil that's run.

For example, Figure 1shows a neighborhood for the pc industry that was rotated within the strip to protect against inconsistent form angles that would be caused by differences between coils. The part contained critical dimensions with 0.025-millimeter tolerances hooked in to the forms. Rotating the strip to make sure more consistent forms wasn't the foremost efficient use of fabric. During this case, however, part tolerances won out over optimizing material usage..

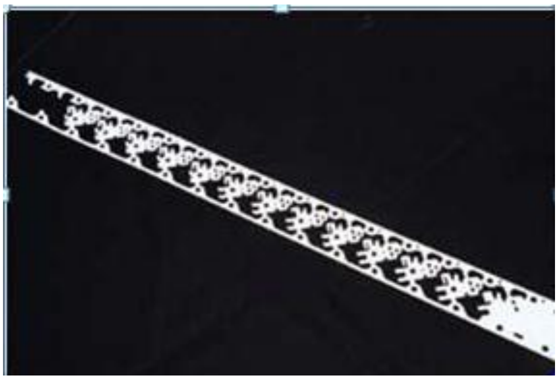


Figure 6: This part was rotated in the strip to maintain critical tolerances better .

Part configuration could provide a second motivation for rotating a neighborhood within the strip. If cam forming or piercing is required to form the part progressively, rotating the part could also be the simplest, and sometimes only, option because the cam and driver can take up a big amount of room. The part typically is rotated in order that the cams' functions are perpendicular to the coil. This provides the simplest and most accessible condition for the cams.

One such compromise is shown in Figure 2. The part is carried through with a ladder-style carrier, which adds material to the coil width because only two small areas are available for carrying the part. Also, due to the form and length of the forms, a big amount of lift is required . External stock lifters carrying the ladder strip work well in high-lift situations.

Figure 7: Compromises among excessive lift, material use, and tooling cost and complexity were necessary to form this part.

One final consideration for part orientation within the strip is that a neighborhood should be rotated in order that the feed is as short as possible. this is often very true for heavier materials and narrow coils. The slitting process can cause camber in coils which will make feeding difficult. A shorter progression feed runs faster and has less chance to cause feed problems. When a considerable difference between the length and width of the part exists, it's usually more cost- effective to create the tooling with the shorter lead.

CARRYING THE PART

Three basic options are available for carrying a neighborhood, although many variations of every can also be used. With in the most straightforward approach, parts are carried by the scrap between them. Excess material adequate to one to 2 material thicknesses per side is required for trimming. This method typically produces minimal scrap.

Certain part configurations are needed to use this method. When rotated and laid out end to finish , the parts must have enough usable area on both the leading and trailing edges of the progression (see Figure 3).

The second basic strip option, during which a neighborhood is carried on one side of the strip, is shown in Figure 4. This style is suitable for parts that need an excellent deal of forming on as many as three sides. It also improves accessibility if cam piercing or forming is required.

Figure 7: One side of the strip is used to carry this part through a progressive die.

The second basic strip option, in which a part is carried on one side of the strip, is shown in **Figure 4.** This style is suitable for parts that require a great deal of forming on as many as three sides. It also improves accessibility if cam piercing or forming is required.

Figure 8: The parts shown here are carried by the scrap between them, which also serves as stretch webs for the center draw.

Lifting the strip through the die can become harder when this carrier option is employed . A stock lifter on the sting of the strip isn't sufficient—lifters are needed within the center of the strip for balancing, or feeding the strip through the die can become a drag . If large or numerous flanges are to be formed down, achieving the right lift are often difficult.

This type of carrier can cause another feeding problem. Trimming an outsized quantity of fabric from one side of the coil can cause camber within the strip as stresses are released from the steel. The more progressions during a die, the greater risk of feed and pilot alignment problems caused by camber

Part configuration, stock material thickness, and the way narrow the carrier must be are all factors that influence whether camber becomes a drag . to stop camber, the coil width should be increased in order that the carrier side of the coil can also be trimmed. the extra trim releases stresses from the other side of the coil and balances the strip. Even with the extra trim, carrying the part on one side of the strip are often the foremost effective method to run a neighborhood from a cloth usage standpoint.

The third carrier option is that the ladder style. a number of the benefits of the ladder carrier were discussed earlier. These carriers work well with complex parts and with those requiring significant amounts of lift. Because this method allows a strip to feed easily, it is also often utilized in applications during which higher feed rates are needed.

The ladder carrier uses more material per part. Often, however, a neighborhood can't be produced progressively the other way. If production volumes are borderline to start with in terms of justifying progressive tooling, the added costs of the more complex progressive die and extra material waste may make producing the part through multiple operations a far better option.

STATIC ANALYSIS OF PISTON STEEL MATERIAL

Save catia model as .iges format

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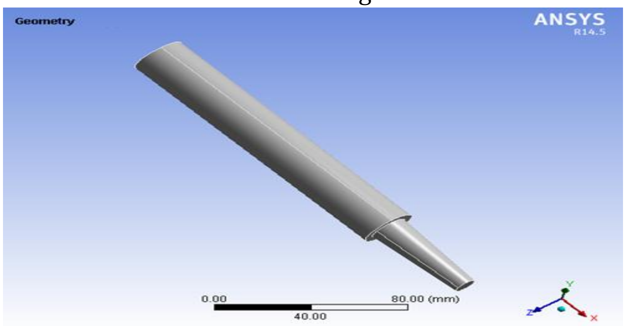
→→Select geometry → right click → import geometry → select browse →open part → ok

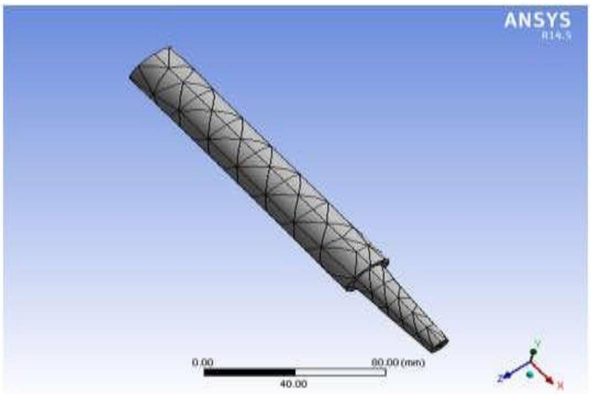
→select mesh on work bench → right click →edit



Double click on geometry → select MSBR → edit material Density-7810 kg/m^3, Young's modulus 200000 MPa , Passion ratio 0.33

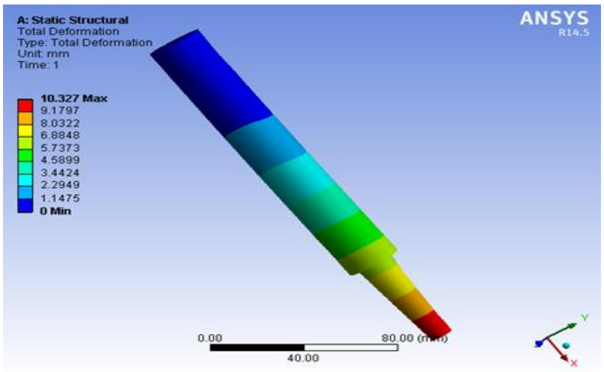
Select mesh on left side part tree → right click → generate mesh →

Meshed model

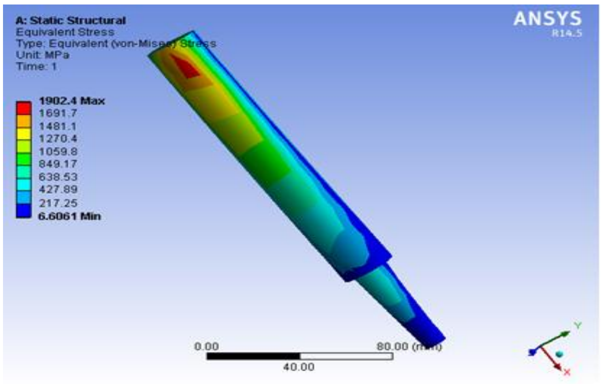


Select static structural right click → insert → select displacement area > pressure area also
Select solution right click → solve → ok
Solution right click → insert → deformation → total→
Solution right click → insert→ strain
Equivalent (von-misses) → Solution right click → insert → stress → equitant (von-mises) →Right click on deformation → evaluate all result

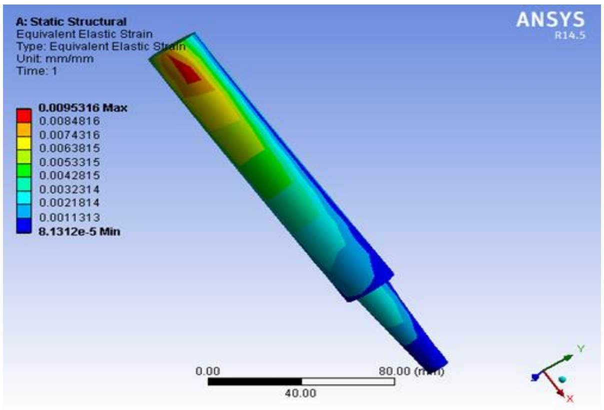
Total deformation



Stress

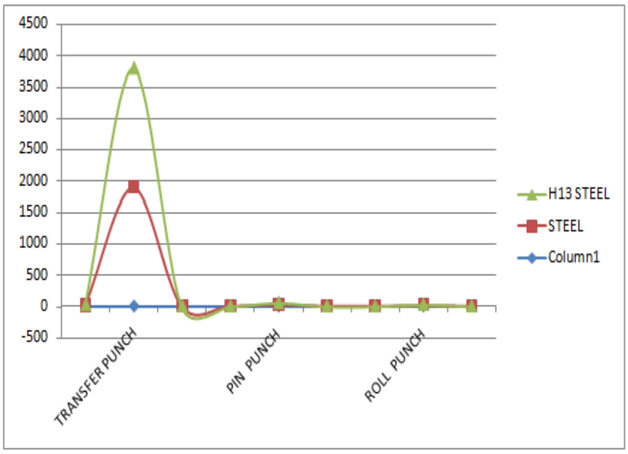


Strain



RESULTS

TOOL TYPE		STEEL	H13 STEEL
TRANSFER PUNCH	DOF	10.327	9.8354
	STRESS	1902.4	1902.4
	STRAIN	0.0095316	0.0090778
PIN PUNCH	DOF	0.011562	0.011011
	STRESS	28.518	28.518
	STRAIN	0.00014396	0.00013711
ROLL PUNCH	DOF	0.0083148	0.0079188
	STRESS	13.666	13.666
	STRAIN	7.0934E-5	6.7556E-5



CONCLUSIONS

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