Design and Analysis of Punch and Die Process by Using Ansys with Non Linear Materials

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Abstract: **Punching is a forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. Punching is applicable to a wide variety of materials that come in sheet form, including sheet metal, paper, vulcanized fibre and some forms of plastic sheet. The deflection between FEA simulation and experiment test results still exist which affects the quality and accuracy of the results. Addressing it has become more challenging due to more stringent demands on simulation processes. It is becoming necessary to very rapidly identify sources of unnatural deflection for diagnostic and intervention purposes. The problem include the less efficient design for die and punch, limited die and punch for complex shape, and the unknown displacement control for round shape bending process of sheet metal. For methodology, a blanking experiment and holes is done to show result. Comparison between the results of experiment to measure nonlinear material analysis to see the stress and strain graph as per the penetration of punch is applied to simulate of sheet metal. Characteristics of sheet metal such as thickness are observed during the simulation analysis. in addition, designs are proposed for round shape for 1,2 and 3 mm sheet metal. A data sheet containing the displacement control of the press machine is developed from the simulation. Investigation by either evaluating other designs of its components or by extending its application to other problems**

Keywords: **Punch and Die Process, Non Linear Materials**

1. Introduction of punch and die

A. Punching

Punching is a forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. Punching is applicable to a wide variety of materials that come in sheet form, including sheet metal, paper, vulcanized fibre and some forms of plastic sheet. The punch often passes through the work into a die. A scrap slug from the hole is deposited into the die in the process. Depending on the material being punched this slug may be recycled and reused or discarded.

Punching is often the cheapest method for creating holes in sheet materials in medium to high production volumes. When a specially shaped punch is used to create multiple usable parts from a sheet of material the process is known as blanking. In metal forging applications the work is often punched while hot, and this is called hot punching. Slugging is the operation of punching in which punch is stopped as soon as the metal

fracture is complete and metal is not removed but held in hole

1) Die Forming

Fig. 1. Progressive Die with Scrap Strip and Stampings

B. Die Components

The main components for die tool sets are:

- Die block – This is the main part that all the other parts are attached to.
- Punch plate – This part holds and supports the different punches in place.
- Blank punch – This part along with the blank die produces the blanked part.
- Pierce punch – This part along with the pierce die removes parts from the blanked finished part.
- Stripper plate – This is used to hold the material down on the blank/pierce die and strip the material off the punches.
- Pilot – This will help to place the sheet accurately for the next stage of operation.
- Guide, back gauge, or finger stop – These parts are all used to make sure that the material being worked on always goes in the same position, within the die, as the last one.
- Setting (stop) block – This part is used to control the depth that the punch goes into the die.
- Blanking dies – See blanking punch
- Pierce die – See pierce punch.
- Shank – used to hold in the presses. it should be aligned and situated at the center of gravity of the plate.

C. Sheet Metal Cutting (Shearing)

- Sheet thickness: 0.005-0.25 inches
- Tolerance: ±0.1 inches (±0.005 inches feasible)
- Surface finish: 250-1000 μin (125-2000 μin feasible)

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D. Blanking

Blanking is a cutting process in which a piece of sheet metal is removed from a larger piece of stock by applying a great enough shearing force. In this process, the piece removed, called the blank, is not scrap but rather the desired part. Blanking can be used to cutout parts in almost any 2D shape, but is most commonly used to cut work pieces with simple geometries that will be further shaped in subsequent processes. Often times multiple sheets are blanked in a single operation. Final parts that are produced using blanking include gears, jewelry, and watch or clock components. Blanked parts typically require secondary finishing smoothing out burrs along the bottom edge. The blanking process requires a blanking press, sheet metal stock, blanking punch, and blanking die. The sheet metal stock is placed over the die in the blanking press. The die, instead of having a cavity, has a cutout in the shape of the desired part and must be custom made unless a standard shape is being formed. Above the sheet, resides the blanking punch which is a tool in the shape of the desired part.
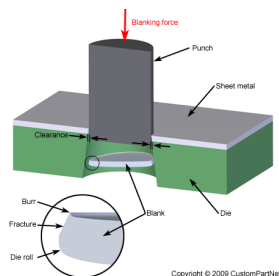

Fig. 2. Blanking

E. Fine blanking

Fine blanking is a specialized type of blanking in which the blank is sheared from the sheet stock by applying 3 separate forces. This technique produces a part with better flatness, a smoother edge with minimal burrs, and tolerances as tight as ±0.0003. As a result, high quality parts can be blanked that do not require any secondary operations. However, the additional equipment and tooling does add to the initial cost and makes fine blanking better suited to high volume production. Parts made with fine blanking include automotive parts, electronic components, cutlery, and power tools.
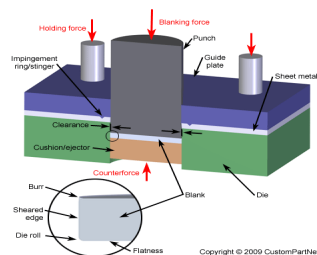

Fig. 3. Fine blanking

Most of the equipment and setup for fine blanking is similar to conventional blanking. The sheet stock is still placed over a blanking die inside a hydraulic press and a blanking punch will impact the sheet to remove the blank. As mentioned above, this is done by the application of 3 forces. The first is a downward holding force applied to the top of the sheet. A clamping system holds a guide plate tightly against the sheet and is held in place with an impingement ring, sometimes called a stinger, that surrounds the perimeter of the blanking location. The second force is applied underneath the sheet, directly opposite the punch, by a "cushion". This cushion provides a counterforce during the blanking process and later ejects the blank. These two forces reduce bending of the sheet and improve the flatness of the blank.

F. Punching

Punching is a cutting process in which material is removed from a piece of sheet metal by applying a great enough shearing force. Punching is very similar to blanking except that the removed material, called the slug, is scrap and leaves behind the desired internal feature in the sheet, such as a hole or slot. Punching can be used to produce holes and cutouts of various shapes and sizes. The most common punched holes are simple geometric shapes (circle, square, rectangle, etc.) or combinations thereof. The edges of these punched features will have some burrs from being sheared but are of fairly good quality. Secondary finishing operations are typically performed to attain smoother edge

The punching process requires a punch press, sheet metal stock, punch, and die. The sheet metal stock is positioned between the punch and die inside the punch press. The die, located underneath the sheet, has a cutout in the shape of the desired feature. Above the sheet, the press holds the punch, which is a tool in the shape of the desired feature. Punches and dies of standard shapes are typically used, but custom tooling can be made for punching complex shapes.
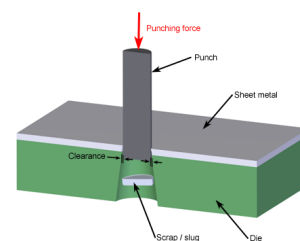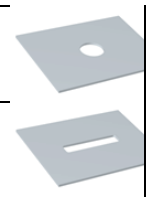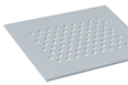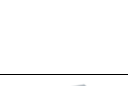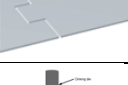

Fig. 4. Punching

A typical punching operation is one in which a cylindrical punch tool pierces the sheet metal, forming a single hole. However, a variety of operations are possible to form different features. These operations include the following:

Piercing - The typical punching operation, in which a cylindrical punch pierces a hole into the sheet.	
Slotting - A punching operation that forms rectangular holes in the sheet. Sometimes described as piercing despite the different shape.	

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Perforating - Punching a close arrangement of a large number of holes in a single operation.	
Notching - Punching the edge of a sheet, forming a notch in the shape of a portion of the punch.	
Nibbling - Punching a series of small overlapping slits or holes along a path to cutout a larger contoured shape. This eliminates the need for a custom punch and die but will require secondary operations to improve the accuracy and finish of the feature.	
Lancing - Creating a partial cut in the sheet, so that no material is removed. The material is left attached to be bent and form a shape, such as a tab, vent, or louver.	
Slitting - Cutting straight lines in the sheet. No scrap material is produced.	
Parting - Separating a part from the remaining sheet, by punching away the material between parts.	
Cutoff - Separating a part from the remaining sheet, without producing any scrap. The punch will produce a cut line that may be straight, angled, or curved.	
Dinking - A specialized form of piercing used for punching soft metals. A hollow punch, called a dinking die, with beveled, sharpened edges presses the sheet into a block of wood or soft metal.	

2. Project background

The project is expected to design and analysis the die and punch for sheet metal on piercing and shape bending. The sheet metal bending is a major process in many sectors of industry. However, the evolution of die design and ultimate tryout has been a slow, cautious process based on the trial-and-error and the experiences of skilled workers. Because of its low cost and generally good strength and formability characteristics, Mild steel is the most commonly used sheet metal. The cross-sectional ratio of width to thickness of the sheet metal and the pitch are important for in-plane bending conditions. The bending experiment is carried out and some experimental results such as beating force, bending radius and strain distribution are experimentally examined.

A. Problem Statement

The problems of the current project are:
i. The design for die and punch are less efficient.
ii. Limited die and punch for complex shape.
iii. The displacement controls for bending process of sheet metal are unknown.

B. Project objective

- Experiment and analysis of punching and piecing on sheet metal characteristics
- Design and simulate of and punch for sheet metal on round bending.

- Develop of round shape bend Data Sheet Reference for sheet metal.

3. Literature review

A critical literature review within a specific field or interest of research is one of the most essential activities in the process of research. In order to produce a more productive literature review, it is recommendable to include whole process of selecting resources, reading and writing about previous research studies chosen which includes the discussion about the drawing methods or techniques which are applied to the modal to achieve maximum efficiency and save time. In addition, this section also includes argument of the designs of die to find out which design provides the best performance. Besides that, the manufacturing process and parameters are also discussed. Vital information is transferred from external source into this section such as the intermit, reference book, and scientific journals edited by well known professors around the world. Hence, this section acts as a platform for the whole research to support and define each action performed during analysis and experiment.

A. Sheet metal processes

Sheet metal parts are light weight and can have versatile shape due to its low cost and generally good strength and formability characteristics. Thus, low-carbon steel is the most commonly used sheet metal (Bruce et al., 2004). Many Sheet Metal Forming processes are used to produce parts and shapes and there is usually more than one method of manufacturing a sheet metal from a given material. The broad categories of processing methods for materials are as followed:

- *Roll forming:* Long parts with constant complex cross-section.
- *Stretch forming:* Large parts with shallow contours that is suitable for low quantity production.
- *Drawing:* Shallow or deep parts with relatively simple shapes for high production rates.
- *Stamping:* includes punching, Flanking, embossing, bending, flanging, and coining.
- *Spinning:* Small or large axi-symmetric parts with good surface finish and low tooling cost (Kalpakjian and Schmid., 2001).

B. Shearing

- Perforating - punching a number of holes in a sheet.
- Parting- shearing the sheet into two or more pieces.
- Notching - removing pieces from edges.
- Lancing - leaving a tab without removing any material (Kalpakjian and Schmid., 2001).

C. Sheet Metal Bending

Sheet metal bending imparts stiffness to the part by increasing its moment of inertia. For example, the flanges, beads, and seams increase the stiffness of structure without adding any weight. The terminology used in bending of sheet

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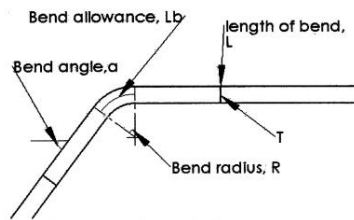
or plate is shown in Figure 5. (Giudice et al., 2006).

Fig. 5. Bending Terminology

From the figure above, the bend allowance, Lb is the length of the neutral axis in the bend. The position of Lb depends on the radius and the bend angle according to the formula below:

Lba(R+kT)

e= l/((2RIT)+1)

D. Engineering Design

Engineering design is known as the process of devising a system, component, or process to meet desired needs. It is a decision-making process in which basic sciences, mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objective and criteria, synthesis, analysis, construction, testing, and evaluation (Hyman. 1998).

E. Designing for Manufacturability

Manufacturability is regarded as the art and science of designing a product so that it is easy to manufacture. Manufacturability starts from earliest stages of the design concept phase to the assembly stage. Besides that, the manufacturing engineer must always be a part of the design and development process. The problem or potential problems regarding manufacturing process must be found and corrected before the design is finalized and drawings are released. Manufacturability also includes materials. For standard materials, standard parts and standard hardware. means standard cost and procurement lead times. As a conclusion, it is the product design that determines the cost of manufacture, lie improved methods including process and tooling have minimum impact on the product (Tanner, 1991).

F. Finite Element Analysis

Finite Element Analysis (F.E.A) is a powerful technique used for solving complicated mathematical problem of engineering and physics such as structural analysis, heat transfer, fluid flow, mass transport and electromagnetic potential. Modem F.E.A. generated 'by computer software allows engineer to subject a computer model of structure to various loads to determine how it will react. It also enables designs to be quickly modeled, analyzed, changed, checked for feasibility and structural integrity, redesigned or discarded if they do not work (Chew, 1995).

4. Simulation methodology

In This project, the piercing and shape process is carried out by using the punch and die methods. As we read in chapter 1 and 2 punches and dying process most useful in sheet metal bending process. Now in this project I here consider, sheet metal or a piece sheet undergoing piercing and punching process. The punch and die of sheet is carried out by these steps:

1. Consider a concepts of the sheet with had punching process over it is performed
2. Create a punch as the sheets form
3. Create a die as the sheet form
4. Assembly together
5. Covert file to fea software
6. Perform the simulation process over it
7. Find results of stress and strain over the sheet and punch
8. Change the material
9. Change the thickness to compared

In this project, I here consider 3 different materials and 3 different thickness sheets to compare the stress and strain of the sheet while in process of punch and die.

5. Creating modeling

A. Modeling software CATIA

CATIA V5 is the main answer for item achievement. It tends to all assembling associations. CATIA can be connected to a wide assortment of businesses, from aviation, car, and modern hardware, to gadgets, shipbuilding, plant outline, and shopper products. Today, CATIA is utilized to outline anything from a plane to adornments and attire. With the power and useful range to address the total item advancement process, CATIA bolsters item building, from beginning particular to item in-benefit, in a completely coordinated way. It encourages reuse of item plan information and abbreviates improvement cycles, helping undertakings to quicken their reaction to advertise needs.
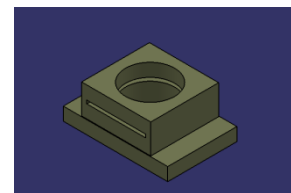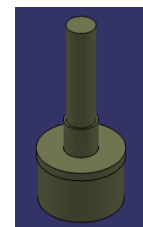
1) Modeling procedure.

B1 Die

Fig. 6. Die

B2 Punch

Fig. 7. Punch

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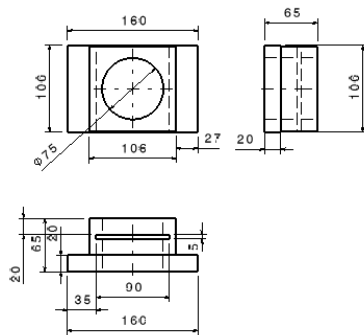
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B. Drafting
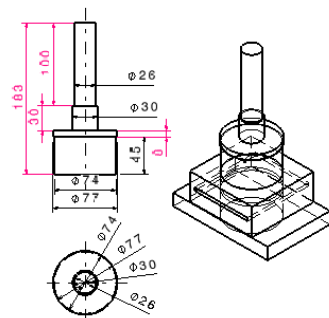

Fig. 8. Drafting of die

Fig. 9. Drafting of punch

Discussion about the design and we are going to discuss about procedure and analysis results in next chapter.

6. Introduction of Ansys

Ansys a product of Ansys inc. Is a world's leading, widely distributed and popular commercial cae package. It is widely used by designers/analysis in industries such as aerospace, automotive, manufacturing, nuclear, electronics, biomedical, and much more. Ansys provides simulation solution that enables designers to simulate design performance directly on the desktop. In this way, it provides fast efficient and cost efficient product development from design concept stage to performance validation stage of product development cycle.

A. Project Objectives

After complete of this chapter,
- The basic concept and general working of Fea
- Understand the advantage and limitations of fea
- Understanding the analysis type
- Understanding important terms and definition of fea

The finite element analysis (fea) is computing technique that is used to obtain approximately. Solution to boundary valve problems. It uses a numerical method called finite element method(fem).in fea involves the computer model of a design that is loaded and analysed for specific results, much as stress, deformation, deflection, natural frequencies, mode shapes, temperatures distribution and soon.

B. Fea Software

There is a variety of commercial fea software package available in the market. Every cae software provides various modules for various analysis requirements. Depending on your requirement, you can select a required module for your analysis. Some firms use one or more cae software and other develop customised version of the commercial software to meet their requirement.

1) Advantage And Limitations Of Fea Software

Following are some of the advantage and laminations of fea software.

2) Advantage
- It reduces the amount of prototype testing, thereby saving the cost and time.
- The finite elements modelling and analysis are performed in the preprocessor and solution phases which if done manually would consume a lot of time and in some cases, might be impossible to perform.
- It helps optimise a design
- It is used to simulate the designs that are not suitable for prototype testing.
- Its helps you create more reliable, high quality, and competitive designs.

3) Limitations
- It does not provide exact solutions
- Fea package are costly
- An inexperienced user can deliver incorrect answer, upon which expensive decision will be based
- Results give solutions but not remedies
- Feature such as bolts, welded joints, and so on cannot be accommodated to model. This may lead to approximation and errors in the results.
- For more accurate results, more hard disk space, ram, and time are required.

4) Starting Ansys Workbench 19.0

The workbench windows help streamline an entire project to be carried out in ansys Workbench 19.0. In this window, one can create, manage, and view the workflow of the entire project create by using standard analysis system. The workbench windows mainly consist of the menu bar, standard toolbar, the toolbar windows, project schematic windows, and the status bar.

5) Project schematic windows

The project schematics windows help manage an entire project. It displays the workflow of entire analysis project. To add an analysis system to the project schematic windows, drag the analysis system from toolbox windows and drop into the green coloured box displayed in the project schematic windows.
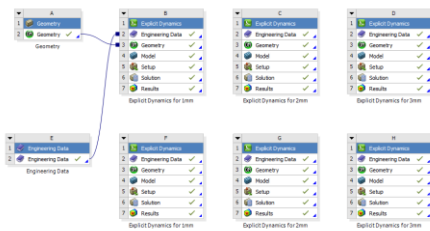
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Fig. 10. Imported into Project Schematic

6) Component of the System

An item that is added from the toolbox window to the project schematic windows is known as a system and the constituent elements of the system are known as cells. Each cell of a system plays an important role in carrying out a project and are discussed next. The engineering data cell is used to define the material to used in the analysis. To define the materials, double click on the engineering data cell, the workbench corresponding to this the engineering data cell will e displayed. Engineering cell-double click-click on the shell system (engineering data book)-select general materials in the outline of the engineering data sources- select materials in the outline of general materials
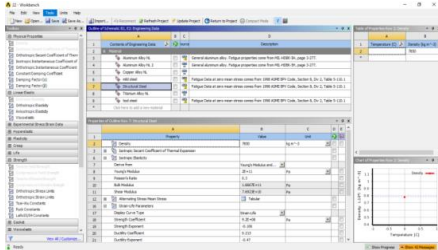

Fig. 11. The engineering data workspace

Tool steel

Density	7.83e-006 kg mm^-3

Compressive Ultimate Strength

Compressive Ultimate Strength MPa
2000

Compressive Yield Strength

Compressive Yield Strength MPa
1800

Tensile Yield Strength

Tensile Yield Strength MPa
1800

Tensile Ultimate Strength

Tensile Ultimate Strength MPa
2000

Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.07e+005	0.3	1.725e+005	79615

Mild steel

Density	7.85e-006 kg mm^-3

Compressive Ultimate Strength

Compressive Ultimate Strength MPa
780

Compressive Yield Strength

Compressive Yield Strength MPa
430

Tensile Yield Strength

Tensile Yield Strength MPa
430

Tensile Ultimate Strength MPa
780

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.05e+005	0.3	1.7083e+005	78846

Copper Alloy NL 2

Density	8.3e-006 kg mm^-3
Specific Heat	8.75e+005 mJ kg^-1 C^-1

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

Aluminum Alloy NL

Density	2.77e-006 kg mm^-3
Specific Heat	8.75e+005 mJ kg^-1 C^-1

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	71000	0.33	69608	26692

The geometry cell is used to create, edit or import the geometry that is used for analysis. To create a geometry for analysis, double click on geometry cell, the design modeller windows will be displayed.
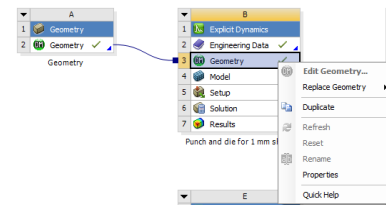

Fig. 12. The menu displayed on right clicking on the geometry cell

The new geometry option in the menu is used to get into design modeller windows, where you can create geometry or import the geometry from the existing geometry file create in another cad software packages. The model cell will be displayed for mechanical analysis system and is used to discredited geometry into small elements, apply boundary and load conditions, solve the analysis, and so on. The mesh cell will be displayed for fluid flow analysis and is used to mesh the geometry, on double clicking on this cell, the meshing windows

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will be displayed. In other words, this cell is associated with the meshing windows.

The setup cell is used to define the boundary conditions of an analysis system, such as loads and constraints. This cell is also associated with the mechanical workspace. The solution cell is used to solve the analysis problem based on the conditions defined in the cells above the solution cell. The cell is also associated with the mechanical workspace. The results cell is used to display the results of the analysis in the user specified formats; this cell is also associated with the mechanical workspace.

7. Explicit analysis

A. Project Objective

In this project, we will be able to define total deformation and stress, etc.

- Create the Explicit analysis system
- Apply different types of materials
- Applying of boundary conditions
- Apply a different type of constraints
- Apply different loads
- Generate the results as per required
- Generate project reports

In this project, we imported the geometry of the component show the dimensions for the component with respect to the load applications. The material to be applied on the model is stainless steel. Next, you will run the analysis under two conditions and evaluate the total deformation, directional deformation, equivalent stress, maximum principal stress, and minimum principal stress.
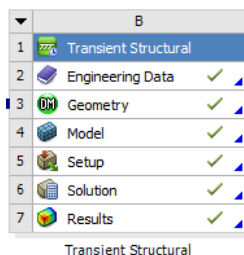

Fig. 13. The explicit analysis Added to the project Schematic
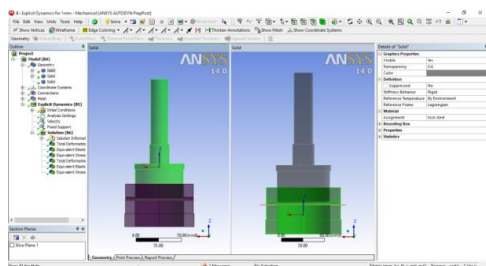

Fig. 14. The Mechanical Window

As discussed in previous chapters, analysis can be carried out in three major steps: pre-processing, solution, and post-processing. The tools required to carry out these steps are discussed next.

B. Project overview

- Start a new project and create the model.
- Generate the mesh.
- Set the boundary and loading _conditions.
- Solve the model.
- Duplicate the existing analysis system.
- Interpret results.
- Save the project.

1) Starting a new project and creating the model

The first step is to start a new project in the workbench window.

- Start Ansys workbench.
- Choose the save button from the standard toolbar; the save as dialog box is displayed.
- Double-click on Explicit in the toolbox window; the Explicit analysis system is added in the project schematic window.
- Rename the Explicit analysis system (if).
- In the analysis system, double-click on the geometry cell; the design modeler window along with the Ansys workbench dialog box is displayed.

2) Generating the mesh

After the model is created in the design modeler window, you need to generate the mesh for the model in the mechanical window.
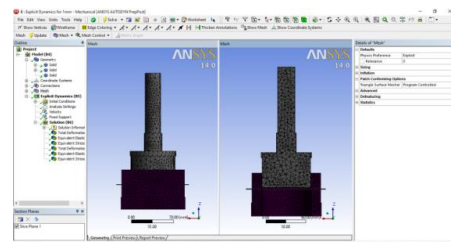

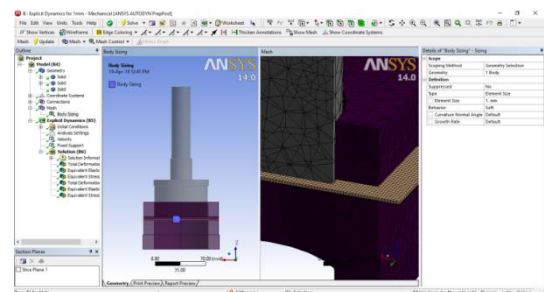Fig. 15. Mesh generated with default mesh controls

Fig. 16. Mesh for punch, sheet and die

Expand the statistics node in the details of "mesh" window to display the total number of elements created. On doing so, you will find that the total number of elements.

3) Specifying the boundary conditions

After you mesh the model, it is required to specify the boundary and loading conditions.

- In the mechanical window, select the Explicit node from the tree outline; the details of "Explicit structural" window is displayed along with the

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environment contextual toolbar.

- Go to environment contextual toolbar- select connection in outline- click on the contact region and select required suitable face for friction contact.
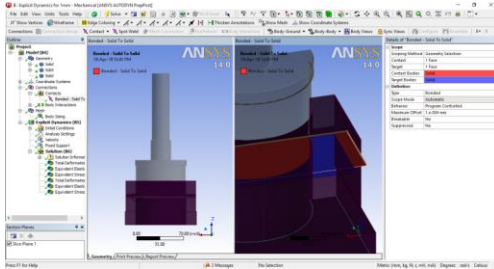

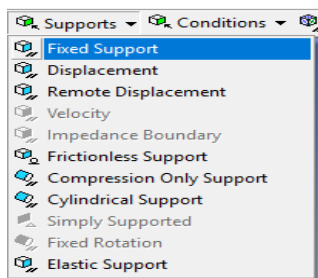Fig. 17. Contact region

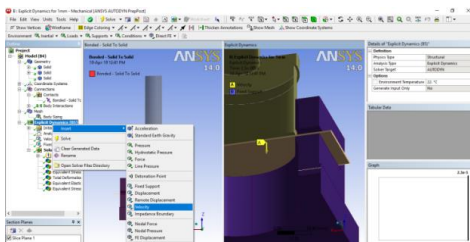Fig. 18. Choosing the fixed support tool from the supports drop-down
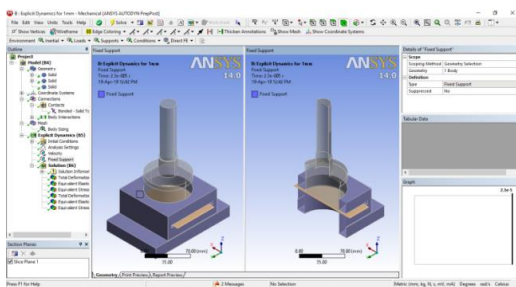

Fig. 19. The loads drop-down
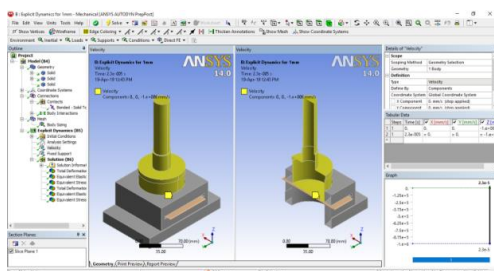

Fig. 20. Fixed support

Fig. 21. Velocity

4) Solving the Fe model and analyzing the results

After the boundary and load conditions are specified for the model, you need to solve the analysis. After solving, you will get the total and directional deformations due to the given condition. Also, you will get equivalent stress, maximum principal, and minimum principal stresses.

- Choose the total tool from the deformation drop-down of the solution contextual toolbar; total deformation is added under the solution node.
- Choose the equivalent (von-misses) tool from the stress drop-down in the solution contextual toolbar;

The equivalent or von-misses stress is the criteria by which the effect of all the directional stresses acting at a point is considered 1" his helps in finding out whether the model will fail or bear the stress at that particular point.

8. Results from ANSYS

A. Aluminum Alloy

1. Material: Aluminum Alloy for Sheet with Thickness 1 Mm
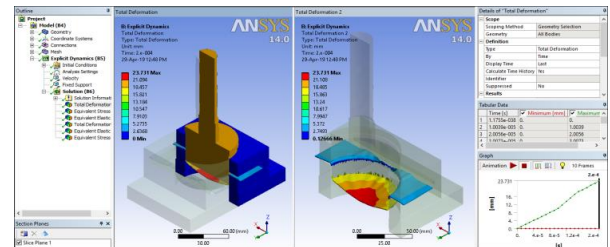

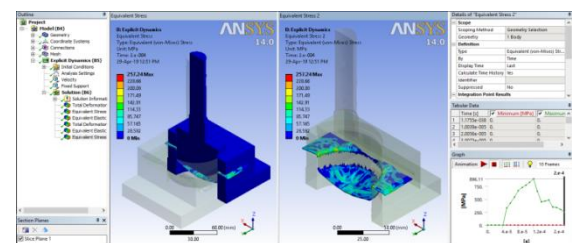Fig. 22. Aluminum alloy values of total deformation
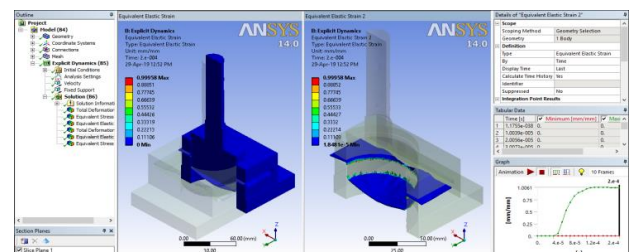

Fig. 23. Aluminum alloy values of equivalent stress

Fig. 24. Aluminum alloy values of equivalent strain

B. Mild steel

1. Material: Mild steel with Sheet with Thickness 2 Mm

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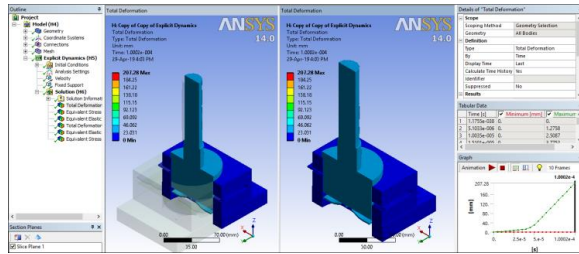**www.ijresm.com | ISSN (Online): 2581-5792**

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Fig. 25. Mild steel values of total deformation
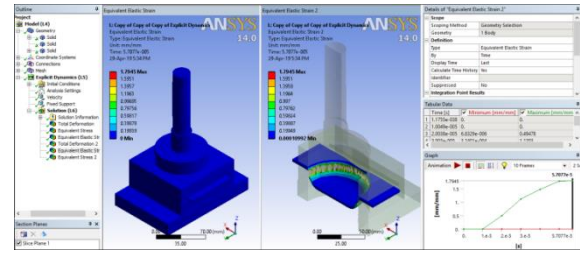
Fig. 30. Copper alloy values of equivalent strain
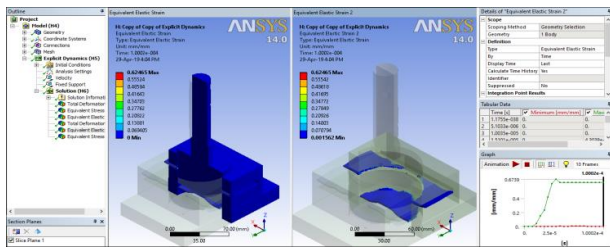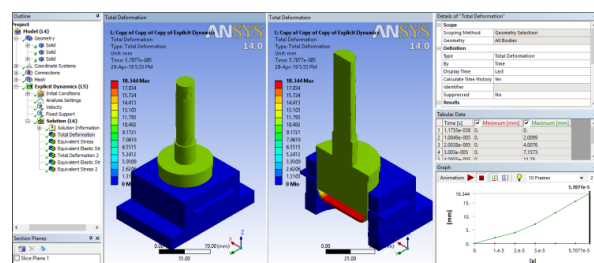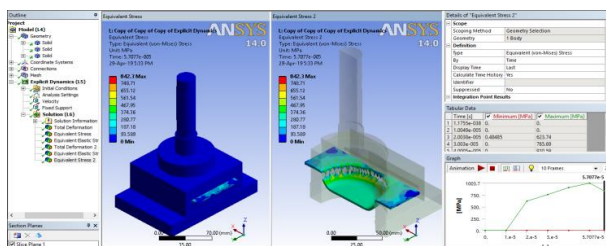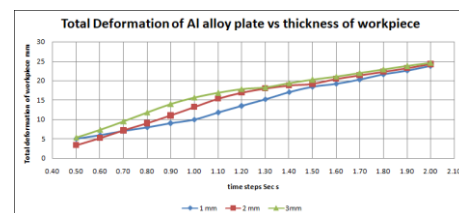

Fig. 26. mild steel values of equivalent stress

Total deformation is the total change of shape in a given working condition. You can view the total deformation induced in any component by using the total tool from the deformation drop-down in the solution contextual toolbar. Directional deformation is the total change of shape in a particular axis, due to given working conditions. You can view directional deformation by using the directional tool from the deformation drop-down in the solution contextual toolbar.

Fig. 27. Mild steel values of equivalent strain

The legend has colors arranged in a band from top to bottom. Depending upon the type of analysis and the parameters evaluated, each color will indicate a different value. A typical legend displayed when total deformation is selected from the tree outline. The blue color in the legend indicates the minimum value of total deformation. In this case, it displays 0 which means there is no deformation at that region. "0" means the time or step where the punch not yet contacted to sheet.
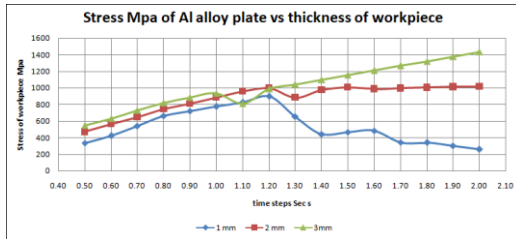
C. Copper alloy

1. Material: Copper alloy with Sheet with Thickness 3 Mm

Fig. 28. Copper alloy values of total deformation

Table 1
Total deformation, stress and strain for 1,2 and 3mm thickness work piece made-up of al alloy sheet

Al Alloy	Total Deformation for thickness			Stress mpa for thickness			Strain mm/mm for thickness		
Time Step	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm
0.50	5.0015	3.37	5.39	333.5	472.2	549	5.02e-02	0.31898	0.46158
0.60	6.0038	5.267	7.33	423.1	568	633	0.28666	0.6071	0.66683
0.70	7.001	7.158	9.51	543.3	648	727	0.5322	0.80056	0.85808
0.80	8.0002	8.981	11.8	661.1	744.6	818	0.69776	1.0154	0.92794
0.90	9.0001	10.96	14	723.8	809.8	887	0.82024	1.1397	1.1062
1.00	10.034	13.24	15.6	775.3	883.8	934	0.89134	1.1809	1.24
1.10	11.748	15.36	16.8	824.1	956.9	813	0.93156	1.2049	1.3346
1.20	13.468	16.89	17.9	896.1	997.6	988	0.96971	1.2599	1.3609
1.30	15.2	17.94	18.2	655.8	882.8	1043	0.99835	1.2515	1.3609
1.40	17.07	18.77	19.3	444.5	974.8	1099	1.0061	1.2572	1.42135
1.50	18.476	19.11	20.2	466.7	1007	1154	1.0036	1.2572	1.46025
1.60	19.238	20.43	21.1	485.6	987.4	1210	1.0021	1.28827	1.49915
1.70	20.287	21.36	22	346.1	995.2	1265	1.0035	1.30341	1.53805
1.80	21.572	22.3	22.9	339.1	1003	1321	1.0013	1.31855	1.57695
1.90	22.605	23.24	23.7	302	1011	1376	1.0004	1.3337	1.61585
2.00	23.731	24.18	24.6	257.2	1019	1432	0.99958	1.34884	1.65475

Fig. 29. Copper alloy values of equivalent stress

Graph 1 Total deformation for 1,2 and 3mm thickness work piece made-up of al alloy sheet

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Graph 1 stress for 1,2 and 3mm thickness work piece made-up of al alloy sheet
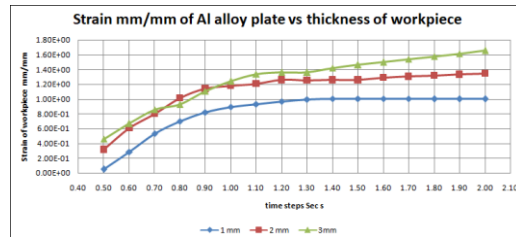
Graph 2 strain for 1,2 and 3mm thickness work piece made-up of al alloy sheet

Table 2
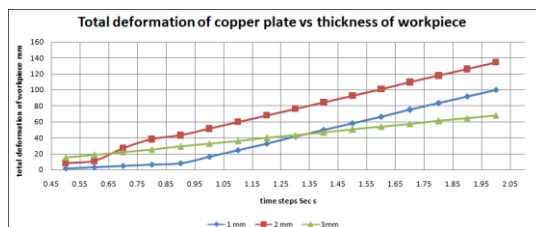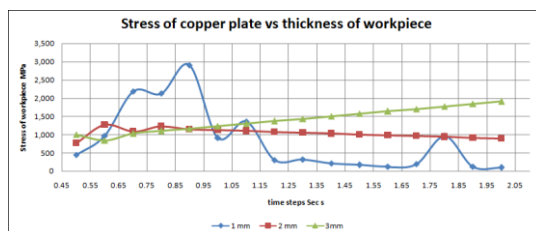total deformation, stress and strain for 1,2 and 3mm thickness work piece made-up of copper sheet
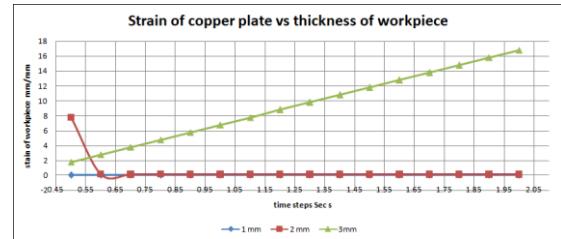
copper	Total Deformation mm for thickness			Stress mpa for thickness			Strain mm/mm for thickness		
Time Step	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm
0.50	1.4209	8.177	15.4	4457	772.09	1004	2.43e-02	77209	1.7787
0.60	3.1449	11.04	18.3	9670	1.28e+03	842	7.04e-02	1.28e+03	2.7787
0.70	4.8435	27.1	22.1	21877	1.09e+03	1032	0.13444	1.09e+03	3.7787
0.80	6.5507	38.03	25.6	21293	1.23e+03	1099	0.15502	1.23e+03	4.7787
0.90	8.2933	42.96	29.1	29075	1.15e+03	1167	0.18771	1.15e+03	5.7787
1.00	16.221	51.26	32.7	9185	1.13e+03	1234	0.18538	1.13e+03	6.7787
1.10	24.626	59.55	36.2	13614	1.10e+03	1302	0.18538	1.10e+03	7.7787
1.20	33.004	67.85	39.7	3058	1.08e+03	1369	0.18538	1.08e+03	8.7787
1.30	41.399	76.14	43.3	3227	1.06e+03	1437	0.18538	1.06e+03	9.7787
1.40	49.783	84.44	46.8	2170	1.03e+03	1504	0.18538	1.03e+03	10.7787
1.50	58.16	92.74	50.3	1717	1.01e+03	1572	0.18538	1.01e+03	11.7787
1.60	66.553	101	53.9	1196	9.86e+02	1639	0.18538	9.86e+02	12.7787
1.70	74.965	109.3	57.4	1986	9.62e+02	1707	0.18538	9.62e+02	13.7787
1.80	83.354	117.6	60.9	9580	9.39e+02	1774	0.18538	9.39e+02	14.7787
1.90	91.742	125.9	64.5	1206	9.15e+02	1842	0.18538	9.15e+02	15.7787
2.00	100.13	134.2	68	956.2	8.92e+02	1909	0.18538	8.92e+02	16.7787

Graph 3 total deformation for 1,2 and 3mm thickness work piece made-up of copper sheet
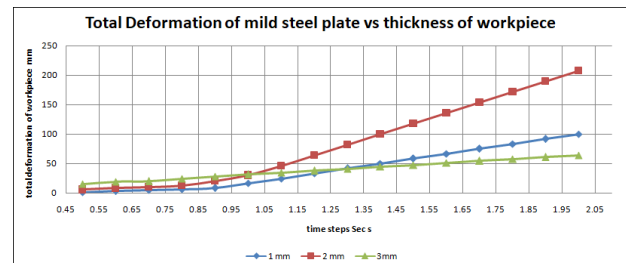

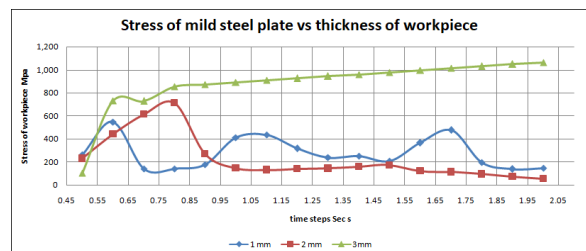Graph 4 stress for 1,2 and 3mm thickness work piece made-up of copper sheet

Graph 5 strain for 1,2 and 3mm thickness work piece made-up of copper sheet

Table 1
Total deformation, stress and strain for 1, 2 and 3mm thickness work piece made-up of mild steel sheet
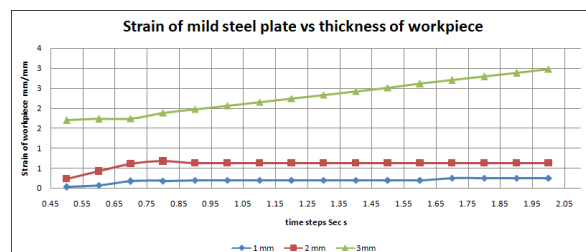
Mild Steel	Total Deformation mm for thickness			Stress mpa for thickness			Strain mm/mm for thickness		
Time Step	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm	1 Mm	2 Mm	3mm
0.50	1.4209	5.808	15.4	2655	22986	1029	2.88e-02	0.23494	1.6939
0.60	3.1449	8.199	19.5	5473	44098	731	7.07e-02	0.41923	1.7302
0.70	4.8435	10.54	19.8	14322	61525	728	0.16769	0.60742	1.734
0.80	6.5507	12.99	24.6	14222	71132	855	0.18471	0.6739	1.87775
0.90	8.2933	20.26	27.9	17667	27065	873	0.19146	0.62465	1.96877
1.00	16.221	30.13	31.2	4117	14703	890	0.20063	0.62465	2.05979
1.10	24.626	45.9	34.5	4358	13150	908	0.20063	0.62465	2.15081
1.20	33.004	63.78	37.8	3160	13959	925	0.20063	0.62465	2.24183
1.30	41.399	81.7	41.1	2386	14424	943	0.20063	0.62465	2.33285
1.40	49.783	99.7	44.4	2528	16074	960	0.20063	0.62465	2.42387
1.50	58.16	117.7	47.7	2109	17395	978	0.20063	0.62465	2.51489
1.60	66.553	135.6	51	3667	12224	995	0.20063	0.62465	2.60591
1.70	74.965	153.5	54.3	4755	8763.1	1012	0.2522	0.62465	2.69693
1.80	83.354	171.5	57.6	1951	10726	1030	0.2522	0.62465	2.78795
1.90	91.742	189.4	61	1383	9717.9	1047	0.2522	0.62465	2.87897
2.00	100.13	207.3	64.3	1457	13043	1065	0.2522	0.62465	2.96999

Graph 6 total deformation for 1,2 and 3mm thickness work piece made-up of mild steel sheet

Graph 7 stress for 1,2 and 3mm thickness work piece made-up of mild steel sheet

Graph 8 strain for 1,2 and 3mm thickness work piece made-up of mild steel sheet

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Table 4
Reaction force vs time steps for difference materials

Time Steps	Al Alloys	Copper Alloy	Mild Steel
		Force	
0.1	97.412	130.8375	170.466
0.2	111.28	78.5375	155.498
0.3	96.304	131.5425	170.992
0.4	97.523	131.0875	175.312
0.5	112.42	82.9425	124.01
0.6	111.3	85.5225	128.732
0.7	112.6	75.1775	85.946
0.8	97.48	131.725	174.552
0.9	112.11	76.765	121.784
1	113.77	96.495	104.536
1.1	110.16	91.6275	112.228
1.2	111.41	85.49	127.926
1.3	111.28	78.5375	155.498
1.4	96.302	131.1675	173.304
1.5	110.59	103.4775	162.872
1.6	102.44	91.4225	131.26
1.7	111.3	85.5225	128.732
1.8	96.811	128.2625	167.88
1.9	108.02	91.92	131.576
2	97.831	128.875	173.948
2.1	96.532	128.355	172.806
2.2	96.811	128.2625	167.88
2.3	96.312	131.4675	175.638
2.4	97.412	130.8375	170.466
2.5	112.6	75.1775	85.946
2.6	112.09	71.87	110.766
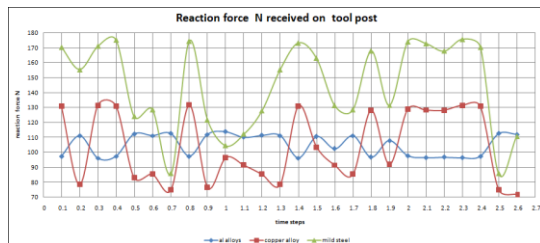
Graph 9 reaction force vs time steps For Difference Materials

9. Conclusion

From the above discussion, we can understand the punching and die process is very important in manufacture industries. The concept of above thesis is to find the stress and strain on the sheet when the punching tool is start pressing the sheet toward the die. As we can see in chapter 5, a simple design of sheet was consider which have piercing and shape forming feature.

The stress and strain graph and value are obtained by using one of fea software known as Ansys. In Ansys software, the die placed as fixed one and punch is moving as distance of 7 mm. the gap between punch and die is 3 mm and clearness of hole of punch and die is 1 mm in radius of hole.

Analysis was done, based on 3 different thickness of sheet like (1mm, 2mm and 3mm) with respective to material general used in industries like aluminum alloy, Mild steel (HCS) and Copper (cu).

After the simulation the deformation are same to all materials, but stress of HCS material is higher compare to other materials with thickness. And the stress of the single material with different thickness don't have much different in stress and strain. When it compare to same thickness with different material have greater impact over stress and strain. So, high density material give more resistance force when compares to lower density material (HCS<cu<AL).

10. Project scopes

For the main purpose of this research, the following scopes are created:

1. Collecting the data from various sources for reference and analysis for literature. The data collecting process is done manually or automated depending on the situation.
2. Develop the most efficient and simple design of the punch and die so that they are easy to manufacture; complex shape and sizes are not recommended.
3. The next scope is geometry measurement which involves the dimensions of a design including the length, width, thickness, height, angle between lines, diameter etc. The dimensions of the design of the die and punch are measured to form a 3-D view to get clearer picture.
4. Perform analysis by F.E.A and validation. Validation is the process of checking if something satisfies a certain criterion. Validation is important because it disallows data that cannot possibly be either true or real to be entered into a database or computer system.
5. Develop the methodology of the proposed design

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