Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 11, November-2019

Optimization of Stress Distribution Over Sheet Metal Forming using Structural Analysis Method

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***Abstruct*:- The sheet metal stress distribution case study is carried out and tried to validate result with post-processing software. The different CAD modelling sample is used to check how the stress generates and deformation occurs in the forming component which is design and developed of simple geometric shape mainly circle, rectangle, hexagonal, and combination of all. The output result is obtained from total deformation and maximum stress generation. The sheet metal material used is "Structural steel" this material used in various automotive industries for car body manufacturing, seating etc, Force is applied in the form of pressure in structural analysis for the achieving optimize the result. The basic software used are CATIA for modelling and Ansys is use for post-processing analysis method.**

Key words: Sheet metal, forming result, Geometric shape cad model, post-processing method CATIA, & Ansys.

INTRODUCTION:

The sheet metal tooling technology is having a very wide range production application in the various sectors like Automotive, Defence, Medical, Aviation, Energy generation plant and many more. The product quality is so precise that it can easily use any were for the specific application. The sheet metal consists of the number of operations to obtain the desired accurate shape of the final product. When it comes to the material then there are numbers of material are developed in metallurgy for the specific application. Sheet metal forming non-cutting operation like drawing, bending, and some other processes. The common failures encountered during sheet metal forming, wrinkling, puckering, and shape distortion factors. They are generally characterized by a high ratio of surface area to thickness. Sheet metal forming operations are so diverse in type, extent and rate that no single test provides an accurate indication of the formability.

In other words, the same sheet metal can have good or bad formability depending upon the components of the forming system. It is interesting to contrast this to a typical mechanical property of sheet metal which is dependent on the sheet metal only rather than on the system conditions such as sheet thickness, process conditions, surface finish, sheet metal properties etc.

So, many researchers have done the formability and analysis of sheet metals of different materials. [1] Kalyani Abhinav, Prof. K. Annamalai showed in the paper the different loading condition and their behaviour over the steel and the deformation values for different in term of graph and post-processing method. [2] Woojong Kang and Seong S Cheon Showed the couple residual stress in stamping. The residual stress level on the real product. High residual stresses at the wall region near the weld beads are detected. [3] Mr. Sachin S. Kaurase, Prof. M. P. Chopad showed about the sheet metal analysis of bending using material say Structural steel, Aluminum alloy, Magnesium alloy. [4] Shirish Ghimire, Yogesh Emeerith, Rohit Ghosh, Sushovan Ghosh they discuss the sheet metal analysis while image 120 º die. After removal of the tool, the final directional deformation on the metal sheet for a 90 º die is 8.0578 mm and that when using a 120 º die is 5.1489 mm[5] Sumit Katare, Prof.Sanjay Goyal, discussed about the bending analysis. We have analyses above result the Duranickle alloy Material are best for using sheet metal plate bending, Duranickle material having maximum strain at the low value of load and it has a larger deformation that‟s whyDuranickle material is the best material as per comparison study.

The experiment setup is carried out with the two different software CATIA and Ansys. The sheet metal is the structural steel and the workpiece is 250x1500mm in CAD model. The thickness is 1 mm density 7860 kg/m3 yield strength is 420Mpa the experiment carried out with the 4 different sheet metal forming design just by using simple geometric shape. Falt sheet, circle profile, hexagonal profile, rectangle profile and combination of all the geometrics as below.

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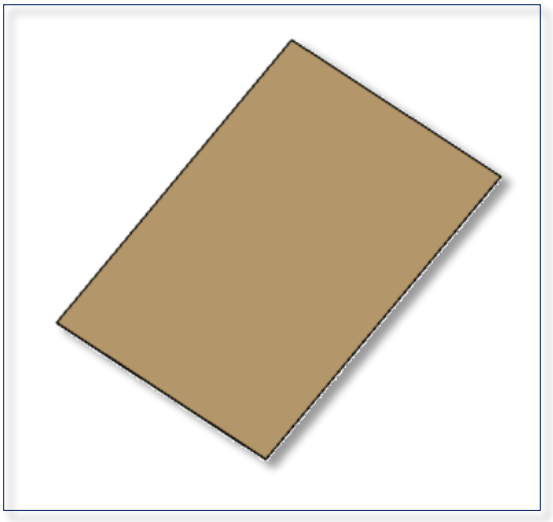
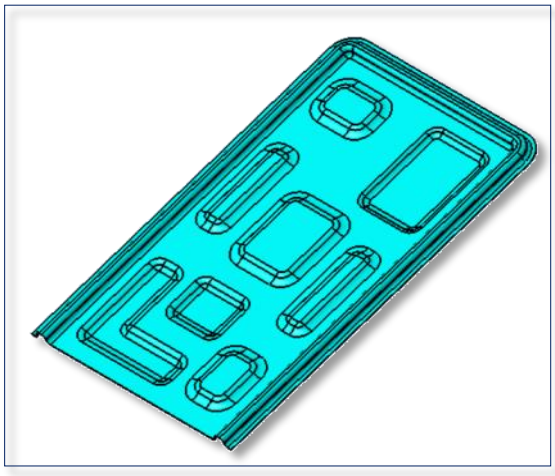


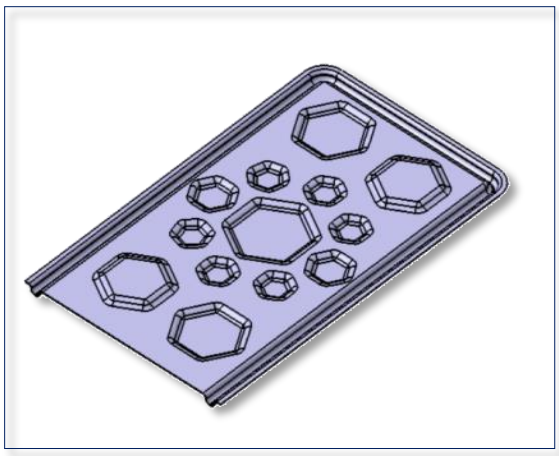
a. flat sheet no forming.

The falt sheet of 0.5 mm thick is shown in the above image in which there is no forming operation is done to reduce the stress concentration factor over the entire surface of the sheet metal.



b. rectangular shape forming sheet

The falt sheet of 0.5 mm thick is the shown in the above image in which there is forming operation is done to reduce the stress concentration factor over the entire surface of the sheet metal in simple rectangular shape is used.



c. Hexagonal forming sheet

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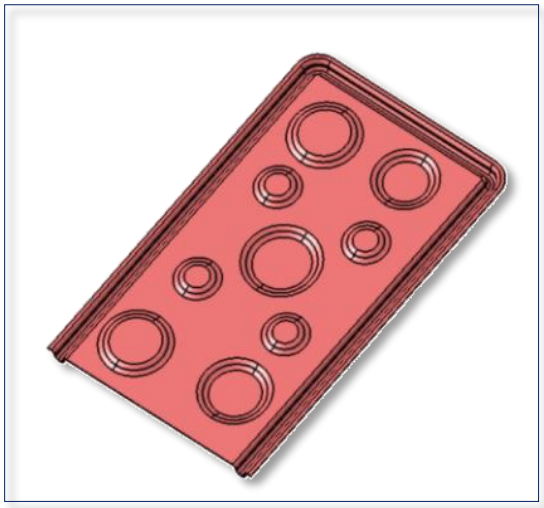
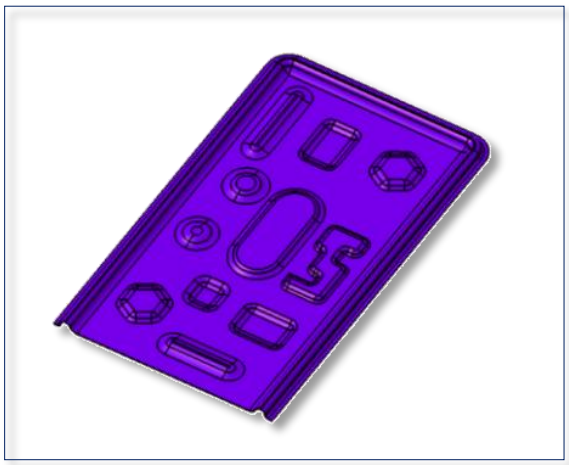
The falt sheet of 0.5 mm thick is the shown in the above image in which there is forming operation is done to reduce the stress concentration factor over the entire surface of the sheet metal in simple hexagonal (say honeycomb) shape is used.



d. Circlular forming sheet.

The falt sheet of 0.5 mm thick is the shown in the above image in which there is forming operation is done to reduce the stress concentration factor over the entire surface of the sheet metal in simple circular profile shape is used.



d. combined shape forming sheet.

In this particular concept design, we have to use the combination of all the shape to accommodate the maximum surface are without tearing off the surface of the sheet metal and to reduce the stress generation value (please see in the results).

EXPERIMENT PROCEDURE

The experiment procedure is as fallow very firstly the falt sheet is subjected to the constant loading condition in of 80kg with the 5g loading condition the load is equally distributed over the surface area of the sheet to achieve an approximate result. The load is constant for all the sample and converted into force to get the compression results among all. The major part is allowing the analysis to get the result only if the boundary condition is fixed for all the sample then and then only we will come to know to end result. The structural sample is created in the CATIA V5 (student version) and for validation analysis, ANSYS 16.0 is used academic licence.

The boundary condition is given directly to the software where the material properties are defined the density plays the main role in the selection of material to perform the exact result along with the boundary condition.

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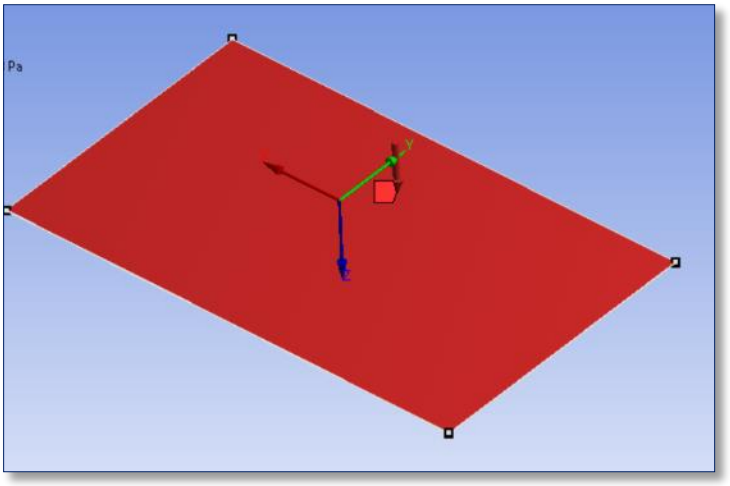

Pressure applied over the surface.

The abouve image showing the force is converted in pressure with respect to area and the magnitude of pressure is applied to the sheet same is use for rest of sample.

OBERVATIONS AND CONCLUSION:

In the table, we can see the details of the test performed on our sample. The value for the stress generation, strain and for total deformation is clearly mentioned under the loading condition for each profile of sheet metal, from the table we can see that stees value for flat sheet is highest and second highest is for hexagonal structure but, the value of total deformation in rectangular profile is more this is maybe due to more sharp edges to identify the exact result we need to check the result in the graph for better understanding.

OBSERVATION TABLE

SHEET FORMING	MATERIAL	THICKNESS	SURFACE AREA(mm2)	LOAD (Kg)	PRESSURE(Mpa)@ 5gCONDITION	STRESS($e10^{12}$)	STRAIN	TOTAL DEFORMATION
FLAT SHEET	STRUCTURAL STEEL	0.5 mm	37500	80	147150000	5.224	26.14	75.843
CIRCULAR PROFILE	STRUCTURAL STEEL	0.5 mm	42633.808	80	167295062.6	3.945	24.507	29.185
HEXAGONAL PROFILE	STRUCTURAL STEEL	0.5 mm	41848.326	80	164212831.2	4.715	24.594	25.081
RECTANGULAR PROFILE	STRUCTURAL STEEL	0.5 mm	42271.696	80	165874135.1	3.148	235.72	184.47
COMBINED PROFILE	STRUCTURAL STEEL	0.5 mm	42050.591	80	165006519.1	3.478	22.411	21.44

Obsrvation table

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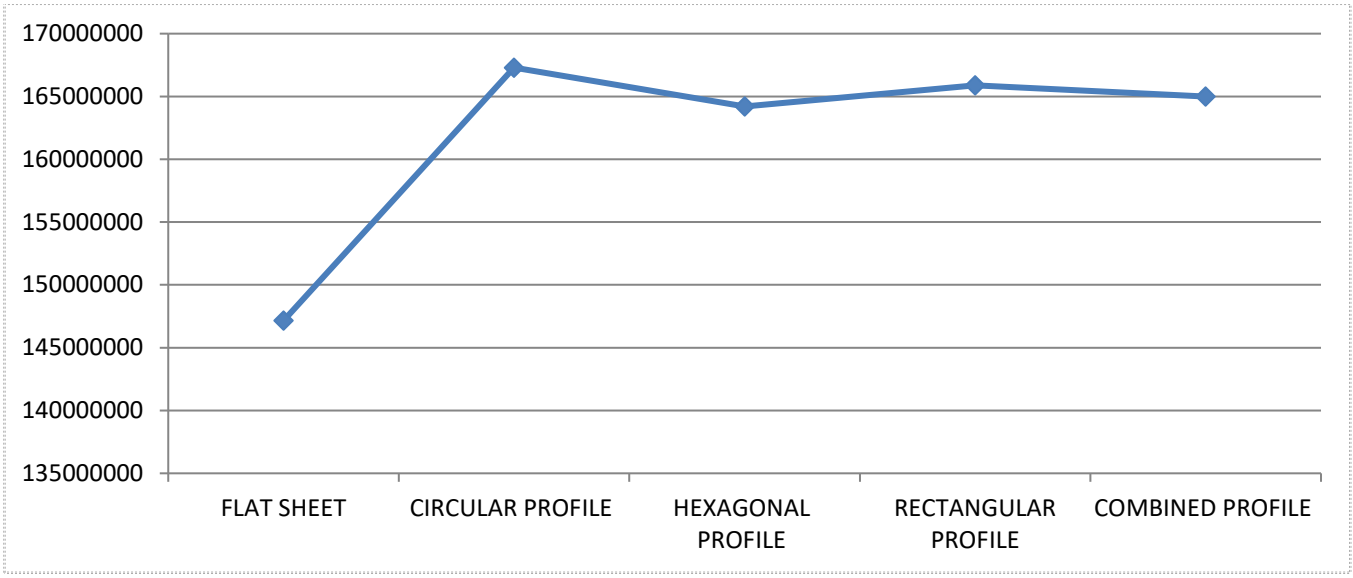
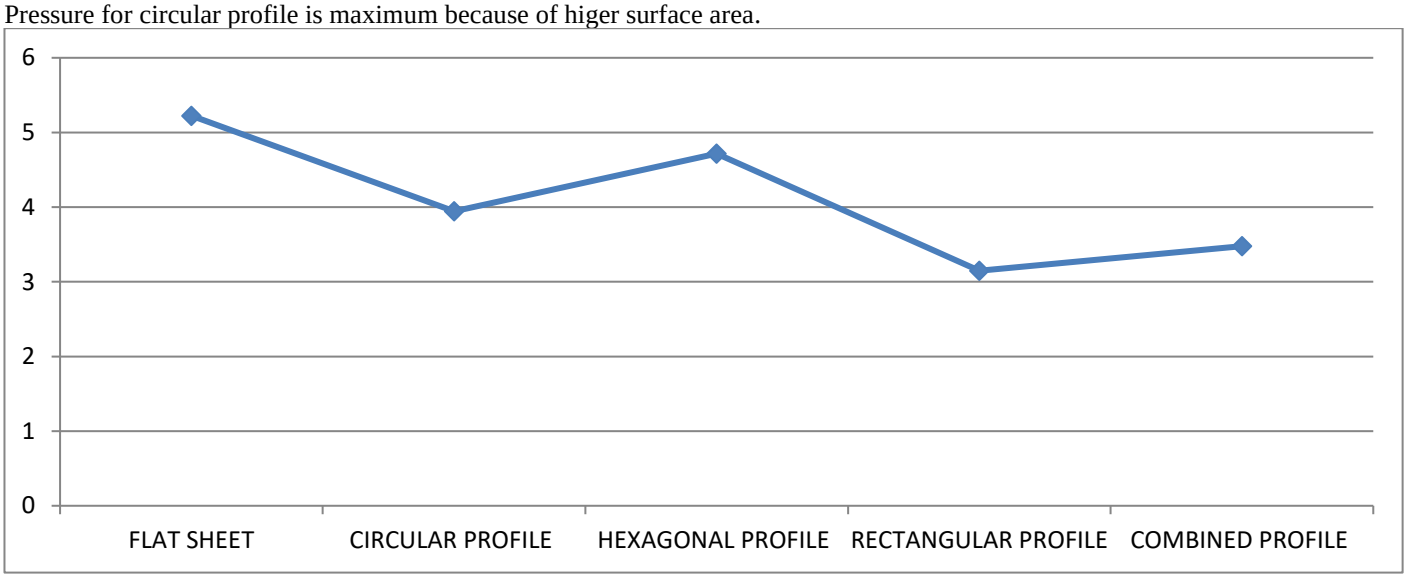


Preseeure Graph

Pressure for circular profile is maximum because of higer surface area.



Stress Graph

stress for flat sheet and then for hexagonal is maximum throughout the loading cycle deformation will obtained from the same result.

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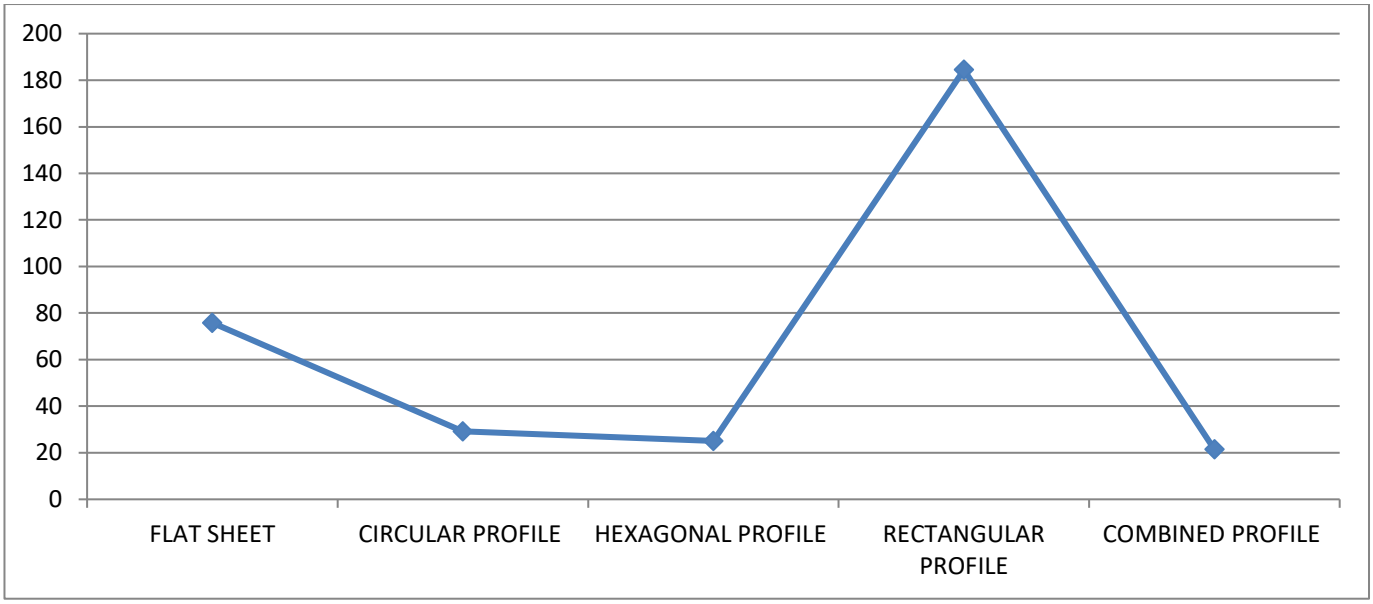

Total Deformation Graph

The material goes to maximum total deformation in a rectangular profile because of the small radius and the more sharp corners.

CONCLUSION:

Among all this design we can conclude that the best forming profile is combination of all geometric shape profile which having less stress, strain, and total deformation from the rest of the forming profile the reason is that individual simple geometric shape is having their own limitation but when then combine with each other the the design is optimize and good result outcome.

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