FINITE ELEMENT ANALYSIS OF PROGRESSIVE DIE

[1]Vrushabh Mahaveer Ghosarwade, [2] Chandradharappa

[1] PG student, Department of mechanical engineering, UBDTCE, Davangere, KARNATAKA, INDIA.

[2] Professor, Department of mechanical engineering, UBDTCE, Davangere, KARNATAKA, INDIA.

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Abstract - Progressive die performs two or more operations at different stages in every time the ram descends. The stock strip advance through a series of stations that perform one or more die operation on work pieces stripe must move from first through each succeeding stations to produce a complete work piece. The distance from one station to the next must be same that is station to station distance is also same as the advance distance. Stripe moves in order to relocate at each successive station when establishing sequence of operations for progressive dies. Pearling operation must be placed first advantage should be take of any required holes in work piece for piloting irregularly placed punches should be avoided by punching out a portion of blank at one station and finishing it at another. The operation that required for bending and forming must be done in lateral stations.

The project aims at stress analysis and linear elastic fracture mechanics (LEFM) analysis of progressive die set. for blanking piercing bending of Caster wheel bracket the location of probable fracture is decided after first doing the stress analysis of die block by fem. after deciding the location of fracture the fracture is modeled on the bases of LEFM by creating singularity element around crack front and solve in fem.

Key Words: *Progressive die, FEA, Ansys.,LEFM Analysis of crack*

1. INTRODUCTION

1.1 Progressive die

Progressive die is set of assembled die in which one or more sheet metal cutting operation can be carried out at a time, in this process each tool is subsequently loaded in a sequence as per the required operation.

Industries involved in sheet metal manufacturing shear cutting methods are widely used for high and low cost production. Shear cutting process is more advantages over the other conventional metal or sheet metal cutting operation. Sheet metal cutting operation is common in most of the processing steps involved in sheet metal industries, and increased knowledge in this process will help to improve the process and help in increase the production range of industry [1]. The strong anxiety was to improve the quality as well as the volume of product in minimum cost of inventory, further more advance technology also applied to improve quality of product and the tool life[2]. Sheets with 0.2 to 20 mm thickness and higher are processed in industries depending on the requirement of customer or consumer or application. In spite of this type of sheet metal used, a longer punch and die life was consider in the improvement of the quality of product and productivity of process. Improving die and punch life was also useful in the blanking of precision parts in high quantities [3].

The press tool is a metal forming machine tool, basically designed for sheet metal operation by applying hydraulic force or mechanical force. The metal is formed to the desired shape and size as per the requirement of the consumer. In press tools are basically intended for the mass production of the component without removal of the chips as involved in the machining operation.

Now a day's sheet metal component are widely used in the day today life its ranging from household electrical component to big industries such as TV, camera, electrical ovens, computer as well as in automotive parts, aviation industries to reduce the cost as well as reduce the weight of the component and increase the performance of the product. The present application of the computer aided design along with use of EDM , CNC Machines are used in the punch and die and other elements of press tool making operation

2. PROGRESSIVE DIE

2.1 3D model of Progressive Die and Component

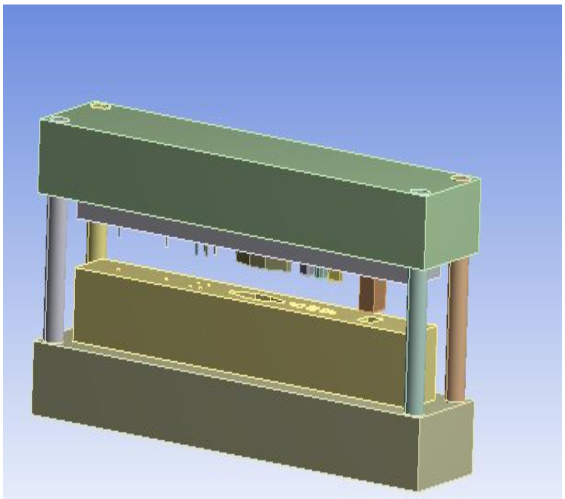

Fig 1. 3D Model of progressive die

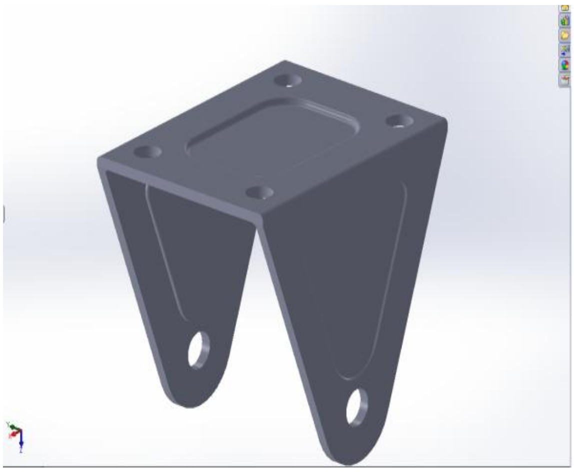

Fig 2. 3D Model of component

2.2. 2D Drawings of Progressive Die and Component

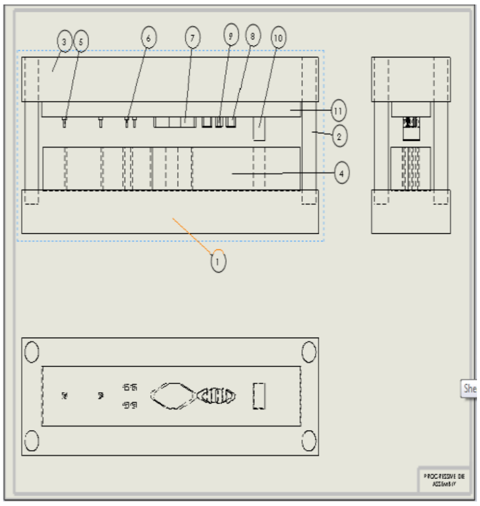

Fig 3. 2D Drawing of progressive die

ITEM NO.	PART NUMBER	QTY.
1	Bottom plate2	1
2	Guide rod	4
3	Top plate	1
4	Die	1
5	Punch 10mm	2
6	Punch 8.5mm	4
7	Side punch	1
8	Triangular punch	2
9	Rectangular punch	1
10	Bending single tool	1
11	Top shoe	1

Table 1. Bill of material

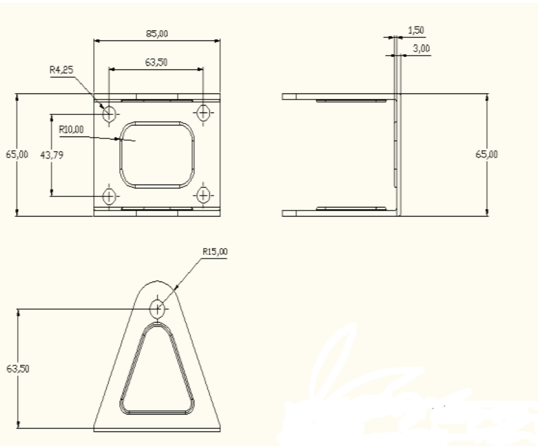

Fig 4. 2D Drawings of the component

Table 2. Material properties of component

Details	Specification
Material	0.2% carbon steel
Thickness	3 mm
Shear strength	300 N/mm^2
Tensile strength	420 N/mm^2

3.ANALYSIS BY ANSYS

3.1 Punch of diameter 8.5mm

For the punch material used is structural steel and the stresses calculated from the punches should not be exceed yield stress of the material in order to avoid the failure of the component.

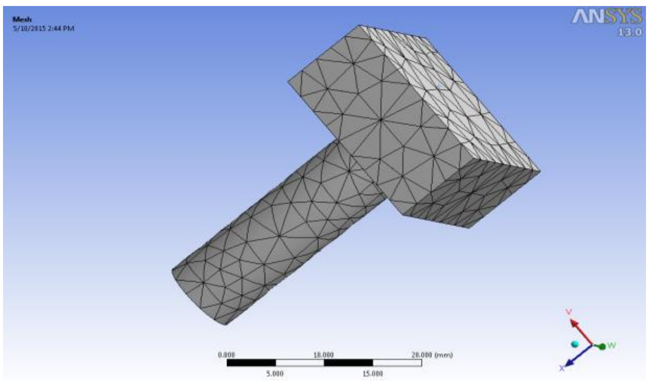

Fig 5.Meshed model of punch of diameter 8.5mm

For meshing the punch of 8.5mm diameter we used solid 185 element, the upper square section of the punch is fixed to the punch holding plate and the nature of the load acting on the punch is compressive load.

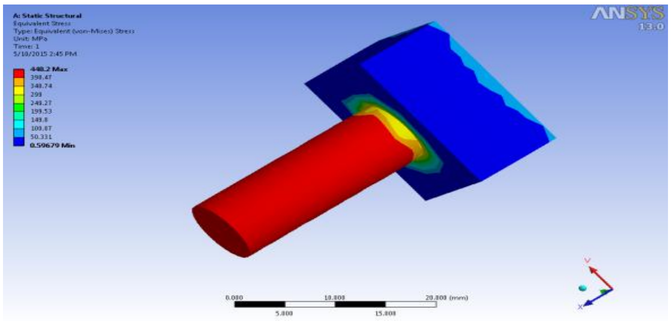

Fig 6. Von-mises stress on the punch of dia 8.5mm

The minimum stress acting on the punch is 0.596 N/mm^2 and the maximum stress is 448 N/mm^2.

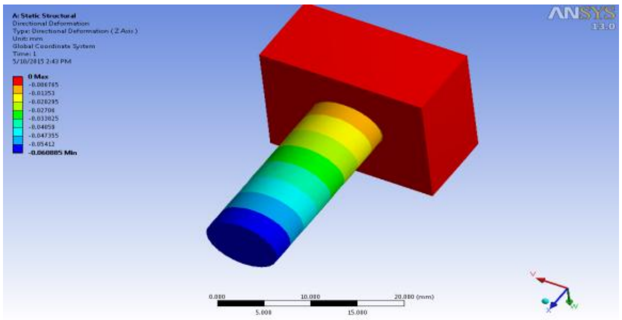

Fig 7. Directional deformation of punch of dia 8.5mm

The directional deformation of the punch of diameter 8.5 mm, the minimum deformation is 0.0600 mm.

3.2 Punch of diameter 10mm

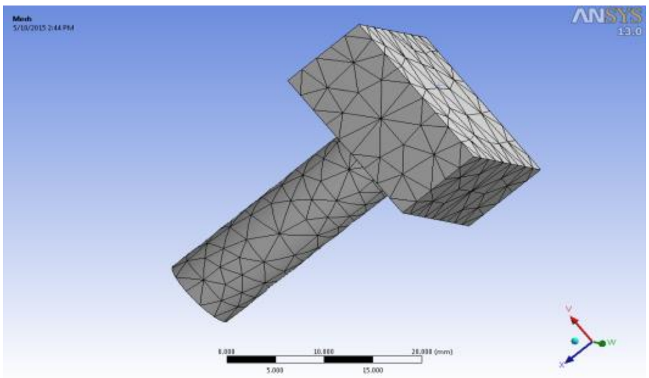

Fig 8.Meshed model of punch of dia 10mm

Element used for meshing is solid 185 for punch of diameter 10mm, the upper part of tool is fixed to tool holder plate and load acting on the tool is compressive load.

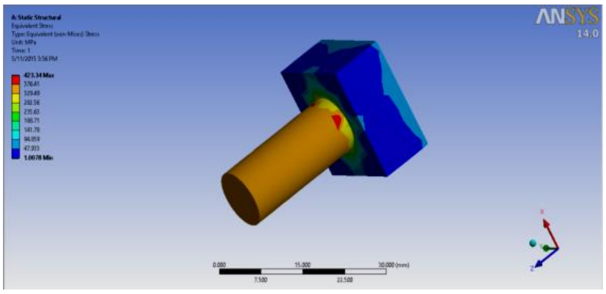

Fig 9. Von mises stress on punch of dia 10mm

The maximum stress acting on punch of diameter 10mm is 423N/mm^2 and the minimum stress acting is 1.008N/mm^2.

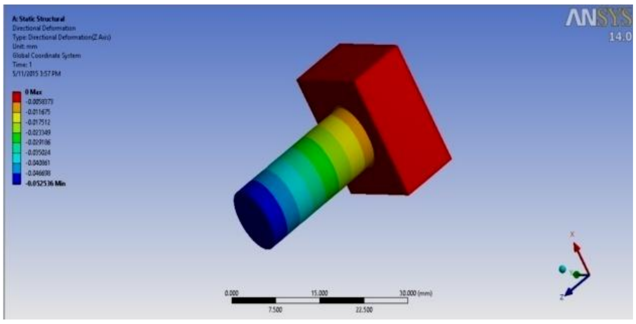

Fig 10. Directional deformation of punch of dia 10mm

The directional deformation of diameter 10mm is as shown above the maximum deformation is zero because the upper part of the punch is fixed no deformation the minimum deformation is 0.0525mm.

3.3 Blanking tool

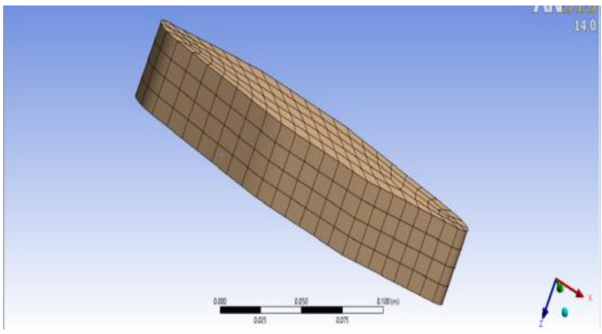

Fig11.Meshed model of blanking tool

Element used for the meshing is solid 185 for blanking tool, upper part fixed to the punch holding plate and compressive load act on the tool.

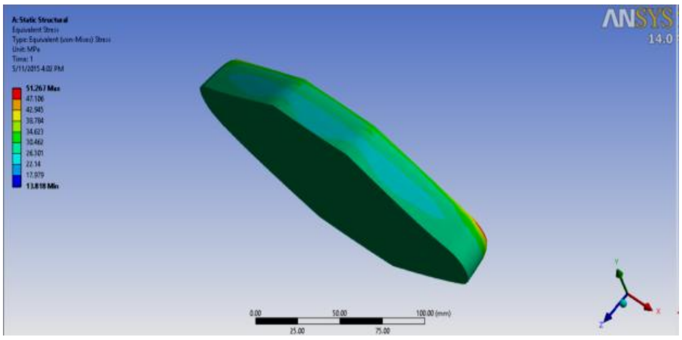

Fig 12. Von mises stress on the blanking tool

The von-mises stress distribution on the blanking tool is shown above the maximum stress is 51.26 N/mm^2 and the minimum stress acting on tool is 13.181 N/mm^2.

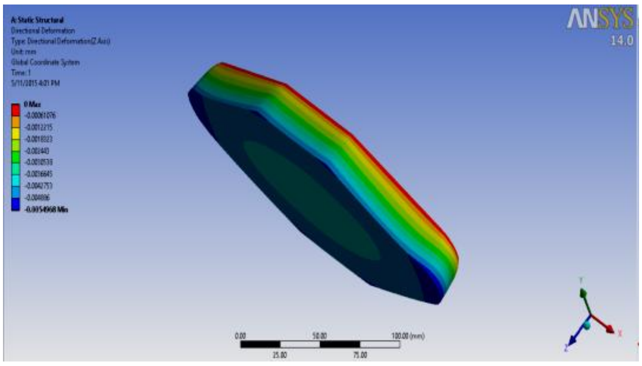

Fig 13. Directional deformation of blanking tool

Directional deformation of blanking tool is shown above the minimum deformation is 0.0054968 mm.

3.4 Bending

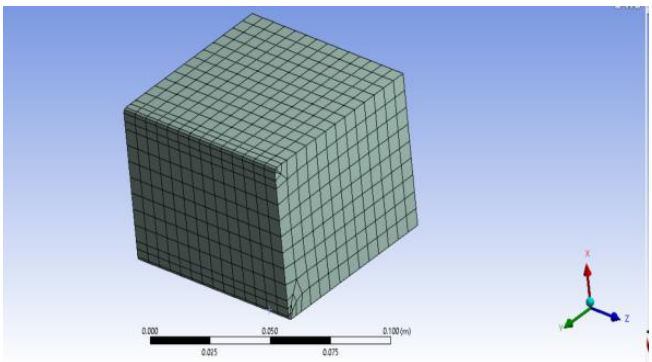

Fig 14. Meshing of bending tool

Element used for the meshing is the solid 185, bending tool used to obtain the bend shapes at an angle of 90^0.

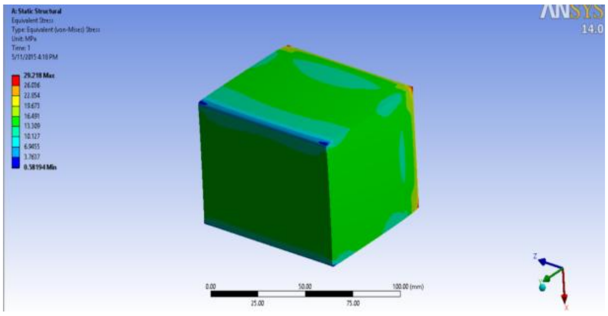

Fig 15. Von mises stress on bending tool

Von mises stress distribution on the bending tool shown above where minimum stress is 0.58194 N/mm² and the maximum stress acting on the tool is 29.218N/mm².

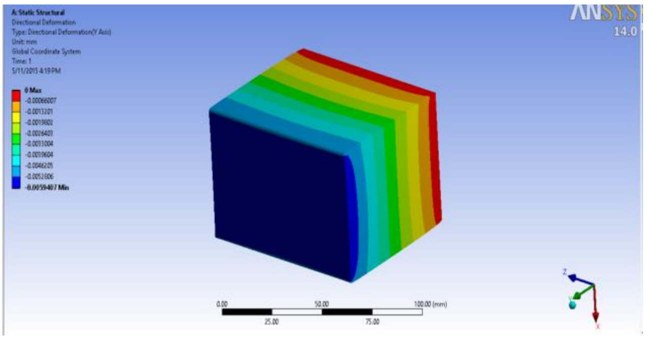

Fig.16. Directional deformation of bending tool

The directional deformation of the bending tool shown above the minimum deformation is the tool is 0.0059mm.

4.LEFM APPROACH FOR CRAC PROPOGATION IN BLANKING TOOL

4.1 Modeled cracked blanking tool in ANSYS

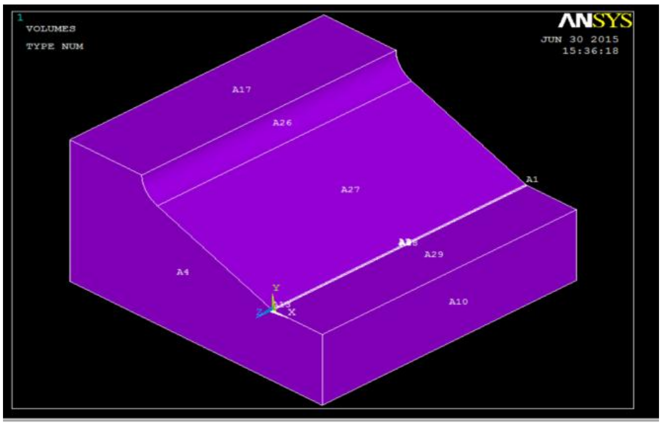

Fig 17. Cracked model of blanking tool

Due to the symmetry of the blanking tool we taken 1/4th of the component and crack is initiated at the corner of the blanking tool and is modeled in the ANSYS as shown above.

4.2 Meshed model of blanking tool

For meshing model we use the fine mesh and tetra shape meshing for whole model

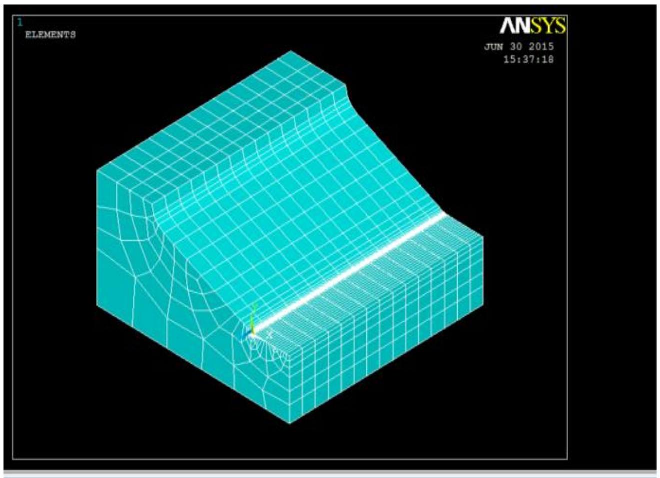

Fig 18. Meshed model

4.2.1 Singular mesh at crack tip to blanking tool

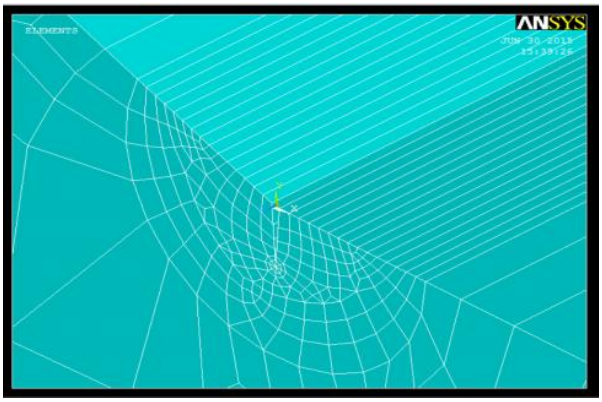

Fig 19. Singular mesh applied at crack tip

At the crack tip we use the singular type of mesh in that all the meshing lines are concentrate at the crack tip to obtain the crack tip deformation and stress concentration at the tip of the crack.

4.3 Applied boundary condition for the model

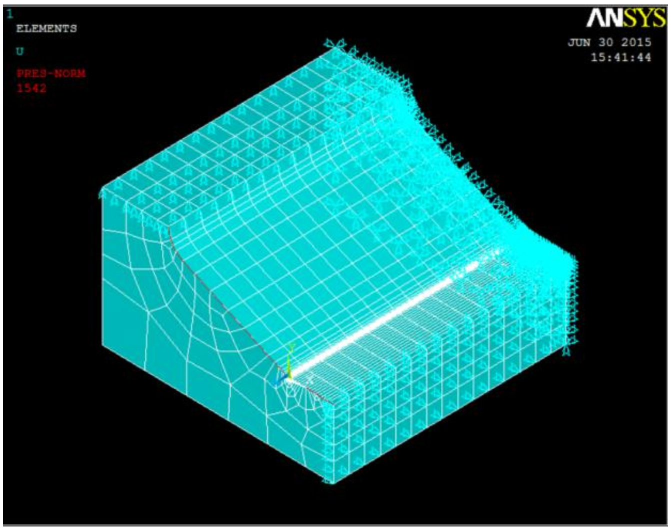

Fig 20. Applied boundary conditions for the model

Due to the symmetry of the component 1/4th of the component is taken as per the constrain we apply fixed support at back side and on the symmetric side of the tool and pressure applied on the edge of the tool. That is indicated as red line in above figure.

4.4 K FOR CRACK LENGTH 0.1mm

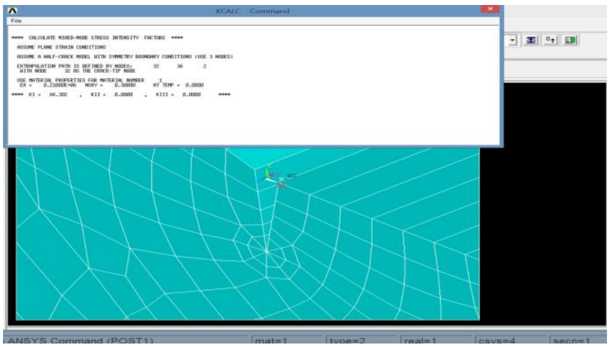

Fig 21. K for crack length of 0.1mm

Stress intensity factor (K) for 0.1mm is 66.302MPa$\sqrt{m}$.

4.5 K for crack length 0.15mm

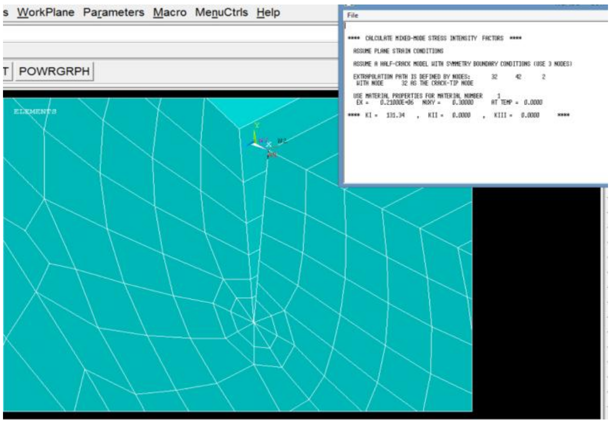

Fig 22. K for crack length 0.15mm

Stress intensity factor obtained for crack length 0.15mm is 131.34 MPa$\sqrt{m}$.

5. RESULT AND DISCUSSION

The following results are obtained by ANSYS and theoretical calculations for different components and results are compared.

Table3.Deformation results

COMPONENTS	ANSYS RESULTS	THEORETICAL RESULTS
	Deformation in mm	Deformation in mm
Punch of diameter 8.5mm	0.0608	0.055
Punch of diameter 10 mm	0.05253	0.0482
Blanking tool	0.00549	0.00508
Bending tool	0.00594	0.00618
Embossing rectangular punch	0.00579	0.00596
Embossing triangular punch	0.00630	0.00649

The results obtained from the manual calculations are closely matched with the results obtained from the ANSYS and the deformations obtained are very small.

Table 4. Stress intensity factors for different crack length

Crack length in mm	Stress intensity factor(K) MPa$\sqrt{m}$
0.1	66.302
0.15	131.34
0.2	151.84
0.25	184.59
0.3	196.56

6. CONCLUSIONS

1. Deformations obtained from the manual calculations are closely match with ANSYS results and are very small.
2. Maximum stress is more at the corner of the blanking punch hence crack initiation is more at the corner of the blanking punch.
3. At the corner of the blanking punch the crack is developed, LEFM model was created using singularity element for crack length 0.1, 0.15, 0.2……..,0.3mm.
4. Stress intensity fracture values obtained at various crack length are compared to the fracture toughness of the die and is low.

7. REFERENCES

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