ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 7, January 2014

Analysis of Progressive Dies

V. S. BHAJANTRI[1], G. B. KAPASHI[2], S. C. BAJANTRI[3]
[1]Assistant Professor, Dept. Of Mech. Engg., SCET, Belgaum-591156
[2]Assistant Professor, Dept. Of Mech. Engg., SCET, Belgaum-591156
[3]Assistant Professor, Dept. Of Mech. Engg., SCET, Belgaum-591156

Abstract*— the aim is to reduce the cost of the progressive dies without compromising on the quality of output. Using the optimum resources possible in designing the progressive dies frame can effect this reduction in the cost of the progressive dies. One way of doing it will be optimizing the volume of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material. In this project work an industrial application project consisting of mass minimization of the progressive dies is considered. This progressive dies has to compensate the stresses acting on the tools, top, middle & bottom plates and to fulfill certain critical constraints. The deformation of the frame with constant thickness is described by the plain stress state equation for linear elasticity. COSMOS is the commercial software that has been used for this analysis which uses finite element method for solution. The methodology followed in this work is comparison of stresses induced in the machine for different thickness used construction of frame of the progressive dies. These stresses are compared to yield stress and considering minimum factor of safety 2.0, the thickness of frame of the progressive dies selected to reduce the volume of material utilized for building the structure and hence to reduce the cost of the machine.

Index Terms— **Production. Dies, Tools, Production Time.**

I. INTRODUCTION

A. *What is a progressive die?*

Progressive die is a kind of assembled die where in more than one operation can be done at a time. This progressive die is applicable mainly on sheet metal operations, where in all the tools are previously loaded in a sequence as per the operation requirements.

Progressive die can perform many operation compared to other dies and also it can able to eliminate the loading & unloading time which results in faster production rate.

B. OBJECTIVES

Since progressive dies initial implementation cost is very high, so by analyzing it thermally & structurally decision making of implementation of this die becomes easy.

By the analysis of progressive die we can suggests the changes that can be done in tooling material and the die itself to improve the productivity. This can be done by knowing the stress acting on each part of die as well as on tools which are used in die.

Another main objective of this project is we can also calculate increase in productivity in progressive die than normal compound die, this can be done by comparing the time taken in operation of a sheet metal between progressive die and normal die.

C. ADVANTAGES AND DISSADVANTAGES OF PROGRESSIVE DIE

1) Advantages of progressive die

- Progressive die can operate more than operation at a time in sequence which eliminates the idle time in a sheet metal working.
- Progressive die can produce parts in batch as well as in mass which increases the productivity by large value compared to normal die.
- Progressive dies reduces the man power by operating in continuous sequence.
- In progressive dies quality parts are produced continuously.
- It also eliminates the idle time, loading & unloading time in operation.

2) Disadvantages of progressive die

- Since progressive dies initial cost is very high it rarely used in small scale industries.
- Since progressive dies produce parts in batch as well as in mass production it is not used variable production.
- Even though it reduces manpower still it need a program and a supervisor.

D. APPLICATIONS

- Progressive dies are mainly used in automobiles.
- In domestic appliance progressive dies are used.
- In aircrafts also progressive dies are effectively used.
- In many commercial products progressive dies are used.
- In boilers and some storing devices progressive dies are used.
- In many electronic products progressive dies are used.
- In case of some security devices also progressive dies are used.

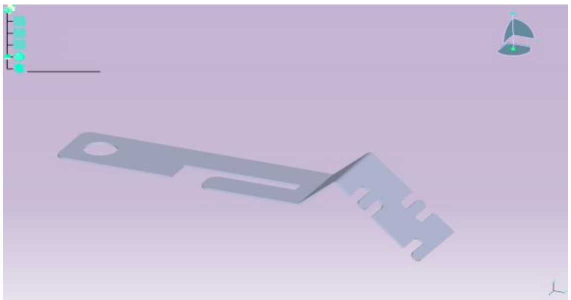

Fig 1 final product of progressive die

II. TRANSIENT DYNAMIC ANALYSIS

Transient dynamic analysis also called as time-history analysis, is a technique used to determine the dynamic response of a structure under the action of any general time-dependent loads. This type of analysis is used to determine the time-varying displacements, strains, stresses, and forces in structure as it responds to and combination of static, transient, and harmonic loads. The time scale of the loading is such that the inertia or damping effects are considered to be important.

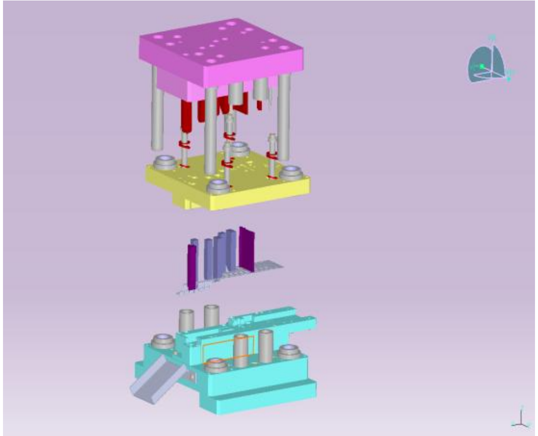

Fig 2. Dissembled view of progressive die

III. COSMOSXPRESS

COSMOS press offers an easy-to-use first pass stress analysis tool for Solid Works users. COSMOS press can help you reduce cost and time-to-market by testing your designs on the computer instead of expensive and time-consuming field tests. For example, you may want to examine the effects of a force applied to the faucet. COSMOS press simulates the design cycle and provides stress results. It also shows critical areas and safety levels at various regions in the faucet. Based on these results, you can strengthen unsafe regions and remove material from overdesigned areas. COSMOS press uses the same design analysis technology that COSMOS/Works uses to perform stress analysis. More advanced analysis capabilities are available within the COSMOS/Works line of products. The wizard interface of COSMOS press guides you through a five step process to specify material, restraints, loads, run the analysis, and view the results. The accuracy of the results of the analysis depend on material properties, restraints, and loads. For results to be valid, the specified material properties must accurately represent the part material, and the restraints and loads must accurately represent the part working conditions. COSMOS press supports the analysis of solid, single-bodied parts only. It does not support the analysis of assemblies, surface models, or multimode parts.

A. Assigning Material

The response of the part depends on the material it is made of. COSMOS press must know the elastic properties of the material of your part. You can pick a material from the material library provided with COSMOS press or you can input material properties manually. Materials can be isotropic, orthotropic, or anisotropic. COSMOS press supports isotropic materials only. To assign material from the material library:

1. On the Material tab, click Define.
   The Material dialog box appears.
2. Under Select material source, do the following
   Make sure that Library files are selected.
   1. Select the desired material. COSMOS press displays the properties of the selected material in the table to the right.
   2. Yield strength (SIGYLD) is not defined for some materials in the material library. SIGYLD is used to calculate factor of safety

   3. Under Material model, select Units for displaying the material properties.

   4. Click OK. The program assigns the selected material to the part and a check mark appears on the Material tab.

   5. Click Next. The Restraint tab appears.

   To define material properties:
   1. On the Material tab, click Define. The Material dialog box appears.

   2. Under Select material source, click Input and type a name for the material.

   3. Under Material model, select Units. Make sure to select the unit system before you type the numerical values of the desired properties.

3. In the properties table, enter values under the Value column. You can define the following properties:
   • EX (Modulus of elasticity).
   • NUXY (Poisson's ratio). If you do not define NUXY, COSMOS press assumes a value of 0.
   • SIGYLD (Yield Strength). Used only to calculate factors of safety.
   • DENS (Mass density). Used to include mass properties of the part in the report file only.

4. Click OK.
   COSMOS press
   assigns the specified material properties to the part, and a check mark appears on the Material tab. 6. Click Next. The Restraint tab appears. Once a material has been assigned to the part, Edit appears instead of Define.

B. Applying Restraints

On the Restraint tab, you define restraints. Each restraint can contain multiple faces. The restrained faces are constrained in all directions. You must at least restrain one face of the part to avoid analysis failure due to rigid body motion. To apply restraints to the model:

1. Click Next to continue.

2. Type a name for the restraint or accept the default name. We recommend that you use meaningful names for the restraints.

3. In the graphics area, click a face to restrain. To select additional faces, hold down the Ctrl key while you click the faces.

4. Click Show symbol to view the restraint.

5. Click Next. A check mark appears on the Restraint tab and a list of the restraints appears. Click the appropriate button to Add, Edit, or Delete a restraint.

6. Click Next. The Load tab appears.

C. Applying Loads

On the Load tab, you apply force and pressure loads to faces of the model

1) Forces

You can apply multiple forces to a single face or to multiple faces.

To apply a force load:

1. Click Next to continue.
2. Select Force and click Next.
3. Type a name for the force or accept the default name.
4. In the graphics area, click the desired face and click next. To select multiple faces, hold down the Ctrl key while you click the faces.
5. Select: • Normal to each selected face to apply the force in the direction normal to each selected face. or • Normal to a reference plane to apply the force to a selected reference plane. If you select this option, you need to select a reference plane in the Feature Manager design tree. 6. Select the force units first, then type the force value. The specified force value is applied to each face.

Select 3 faces and specify a 50 lb force, COSMOSXpress applies a total force of 150 lbs (50 lbs on each face).

7. Click Show symbol to make sure that the load is applied in the desired direction. Click Flip direction to reverse the direction of the force.
8. Click Next. The force list box lists the defined force. A check mark appears on the Load tab. Click the appropriate button to Add, Edit, or Delete a force.
9. Click Next. The Analyze tab appears.

2) Pressure

You can apply multiple pressures to a single face or to multiple faces. COSMOSXpress applies pressure loads normal to each face. To apply a pressure:

1. Click Next to continue.
2. Select Pressure and click next.
3. Type a name for the pressure, or accept the default name.
4. In the graphics area, click the desired face and click Next.
5. Select the pressure units, then type the pressure value.
6. Click Show symbol to make sure that the load is applied in the desired direction. Click Flip direction to reverse the direction of the pressure.
7. Click Next. The pressure list box lists the defined pressure. A check mark appears on the Load tab. Click the appropriate button to Add, Edit, or Delete a pressure.
8. Click Next. The Analyze tab appears.

D. Analyzing the Part

COSMOS press prepares the model for analysis and then it calculates displacements, strains, and stresses. When the existing results do not belong to the current geometry, material, restraints, or loads, an Update button appears in the lower left corner of the COSMOS press window. Click Update to re-analyze the model and calculate the new results.

To analyze the part:

1. Read the displayed information and click Next.
2. Select: Yes (recommended) to accept the default mesh settings (default element size and tolerance values) or No, I want to change the settings to change the default mesh settings.
3. Click Next. If you choose to change the default settings, type in the desired values, or drag the slider. The default tolerance is 5% of the specified element size. Click Next. For a more accurate solution, drag the slider towards the right (finer). For a quick estimate, drag the slider to the left (coarser).
4. Click Run.

When analysis is completed, a check mark appears on the Analyze tab, and the Results tab appears. If COSMOS press fails to mesh the part, you will receive a message. Try to analyze again using one or more of the following options: If the part is complex, suppress small fillets and other features that are not significant for analysis. Use a smaller element size of about 80% of the previous one. Use a larger tolerance of up to 30% of the element size. The default tolerance is 5% of the element size. COSMOS/Works provides additional tools to deal with mesh failure. Viewing the Results After completing the analysis, you can view results. A check mark on the Results tab indicates that results exist and are available to view for the current geometry, material, restraints, and loads. When the existing results do not belong to the current geometry, material, restraints, or loads, an Update button appears in the lower left corner of the COSMOS press window. Click Update to re-analyze the model and calculate the new results. Although COSMOS press calculates displacements, strains, and stresses, it only allows you to view stresses. The first screen of the Results tab displays the minimum factor of safety among all locations in the part. Standard engineering codes usually require a factor of safety of 1.5 or larger. For a given minimum factor of safety, COSMOS press plots possible safe and unsafe areas in blue and red, respectively.

1) How to assess the safety of your design?

1. To view regions of the model with a factor of safety less than a given value, type this value in the box and click Show Me. COSMOS press displays regions of the model with factors of safety less than the specified value in red (unsafe regions) and regions with higher factors of safety in blue (safe regions).
2. To view more results, click Next

2) How to view the stress distribution in the model?

1. Click Show me the stress distribution in the model.

2. Click Next. The equivalent stress (von Misses stress) plot is generated.

3. Click any of the following:

- Play to animate the stress plot.
- Stop to stop the animation.
- Save to save the animation to a separate file.

3) How to view the deformed shape of the model?

1. Click Show me the deformed shape of the model.
2. Click Next. The deformed shape plot is generated.
3. Click any of the following:

- Play to animate the deformed shape plot.
- Stop to stop the animation.
- Save to save the animation to a separate file.

Table 1. Difference between Geometric Model & Finite Element Model

GEOMETRIC MODEL	FINITE ELEMENT MODEL
1) These models are the building blocks for creation of finite element model.	1) These models are the key properties for formation of results & analysis.
2) These models will not provide a solution, as they are just models.	2) These give the solution as nodes & elements define them.
3) They are not necessary when the finite element model is created i.e. after the meshing has been completed the geometric model can be deleted.	3) These models cannot be deleted as in the case of a geometric model because these models are needed to obtain a solution.
4) Presence of geometric model is helpful in applying the boundary conditions & the forces on the lines, areas & volumes that define the model.	4) It is a tedious process to select each node & element to apply the loads or boundary conditions on the model.
5) Deletion of geometric model drastically reduces the database (db) file size & helps in the transfer of data through net from one place to another.	5) the finite element model is the least requirement for any data transfer & hence the space occupied by it is justified.
6) E.g.:- key points, lines, areas & volumes.	6) E.g.: - nodes & elements.

IV. ANALYSIS

A. *ANALYSIS OF PROGRESSIVE DIE PARTS*

The following is the details for analyzing the 3 parts of progressive dies

4.1.1) Steel, high strength 4340
4.1.2) modulus of elasticity= 210000000000 n/m2
4.1.3) density =7.8g/cc
4.1.4) poi=0.29
4.1.5) uts=1550
4.1.6) pressure 100 kgf/cm2 tools
4.1.7) plate 200kn

Working stress

4.1.8) top plate = 276n/mm2
4.1.9) mid plate = 356n/mm2
4.1.10) bottom plate = 183n/mm2

4.1.1) ANALYSIS OF TOP PLATE (max stress= 2.761e^008) (N/m^2)

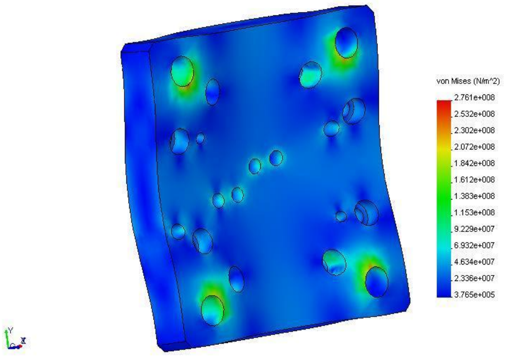

Fig 4.1.1) Top plate

4.1.2) ANALYSIS OF MIDDLE PLATE (max stress= 3.569e^008) (N/m^2)

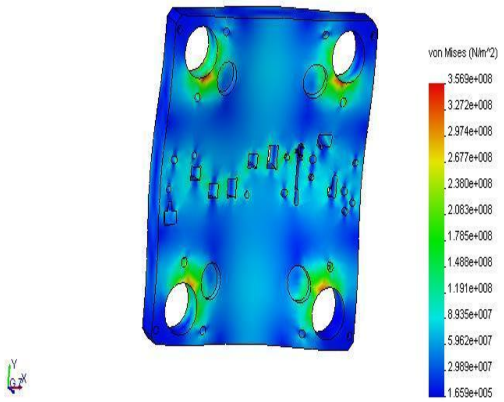

Fig 4.1.2) Middle plate

4.1.3) ANALYSIS OF BOTTOM PLATE (max stress= 1.835e^008) (N/m^2)

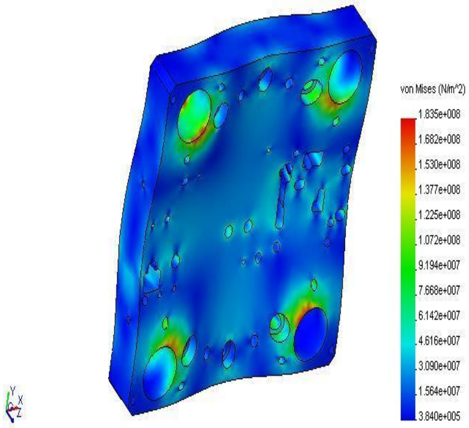

Fig 4.1.3) bottom plate

B. ANALYSIS OF PROGRESSIVE DIE TOOLS

4.2.1) The following is the details for analyzing the tools of progressive die

4.2.1) Steel, high strength 4340
4.2.2) modulus of elasticity= 210000000000 n/m2
4.2.3) density =7.8g/cc
4.2.4) poi=0.29
4.2.5) uts=1550
4.2.6) pressure 100 kgf/cm2 tools
4.2.7) plate 200kn

Working stress

4.2.8) top plate = 276n/mm2
4.2.9) mid plate = 356n/mm2
4.2.10) bottom plate = 183n/mm2

4.2.1) Analysis of forming punch 01 (max stress= 1.345e^008)(N/m^2)

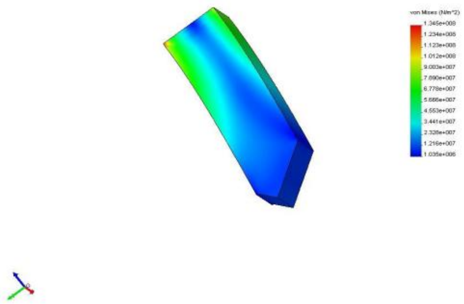

Fig 4.2.1) forming punch 01

4.2.2) Analysis of forming punch 02 (max stress= 1.180e^008) (N/m^2)

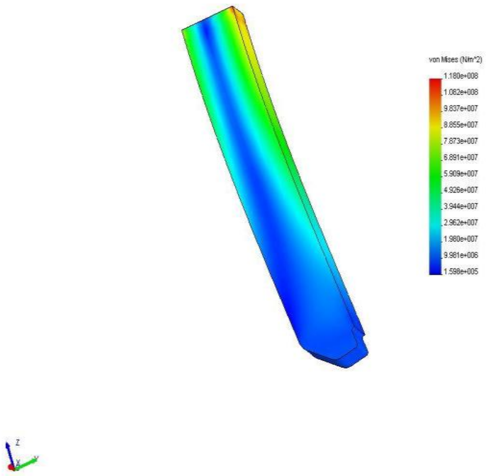

Fig 4.2.2) forming punch 02

4.2.3) Analysis of forming punch 03 (max stress= 8.744e^007) (N/m^2)

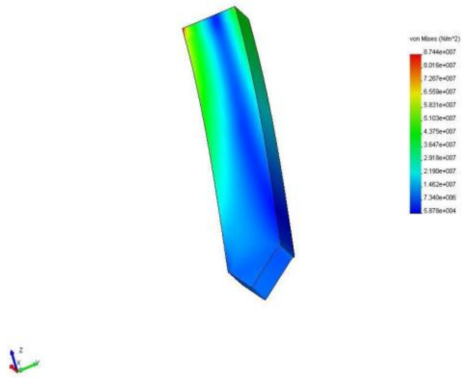

Fig 4.2.3) forming punch 03

4.2.4) Analysis of forming punch 04 (max stress= 9.269e^007) (N/m^2)

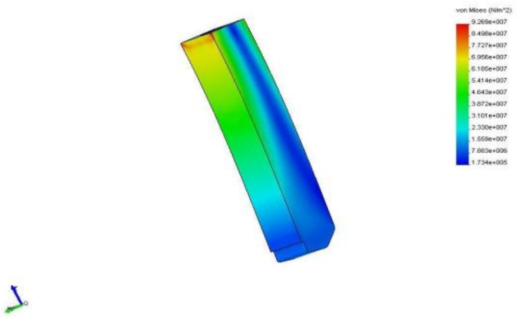

Fig 4.2.4) forming punch 04

4.2.5) Analysis of forming punch 05 (max stress= 3.764e^008)(N/m^2)

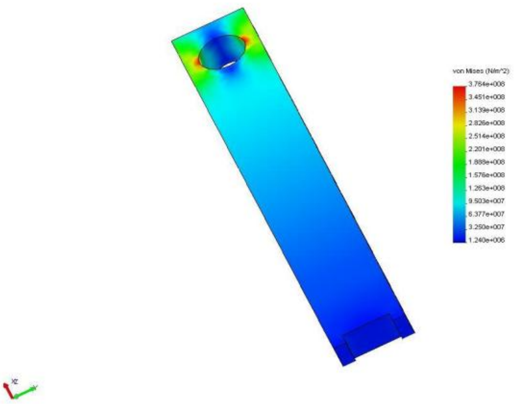

Fig 4.2.5) forming punch 05

4.2.6) Analysis of forming punch 06 (max stress= 2.162e^008)(N/m^2)

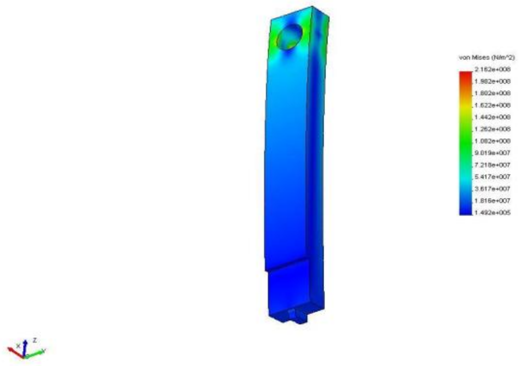

Fig 4.2.6) forming punch 06

4.2.7) Analysis of forming punch 07 (max stress= 4.270e^007) (N/m^2)

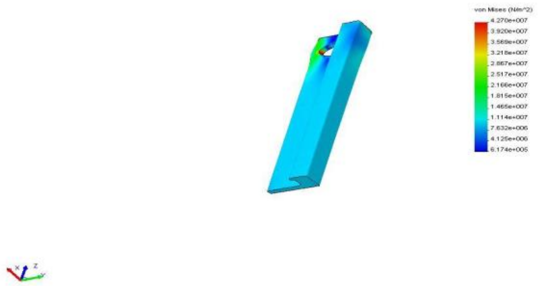

Fig 4.2.7) forming punch 07

4.2.8) Analysis of forming punch 08 (max stress= 1.550e^008)(N/m^2)

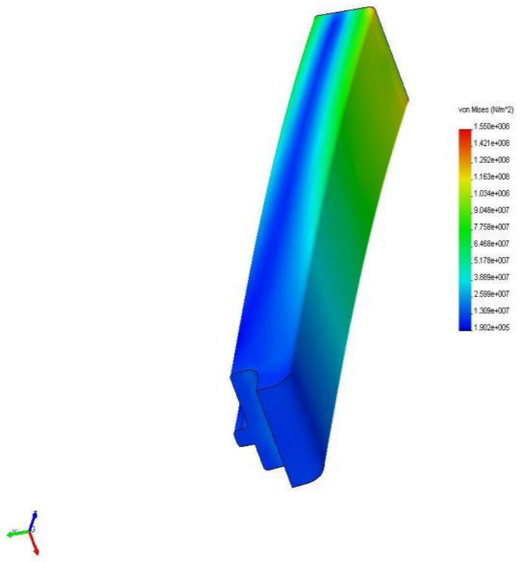

Fig 4.2.8) forming punch 08

4.2.9) Analysis of forming punch 09 (max stress= 4.540e^008)(N/m^2)

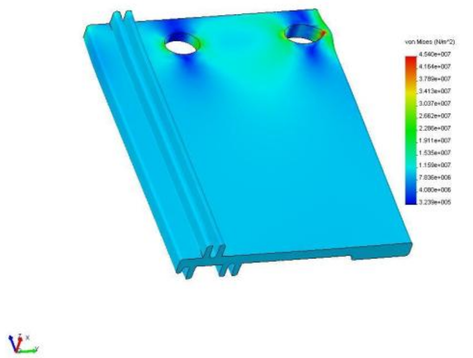

Fig 4.2.9) forming punch 09

4.2.10) Analysis of forming punch 10 (max stress= 2.437e^007)(N/m^2)

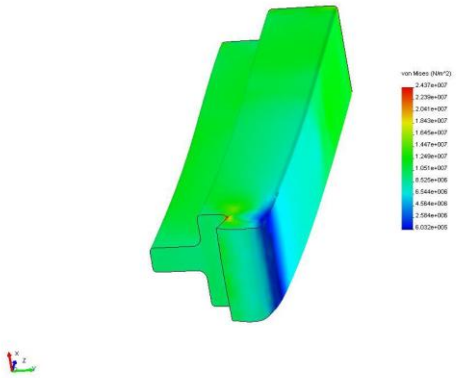

Fig 4.2.10) forming punch 10

4.2.11) Analysis of forming punch 11 (max stress= 1.209e^008)(N/m^2)

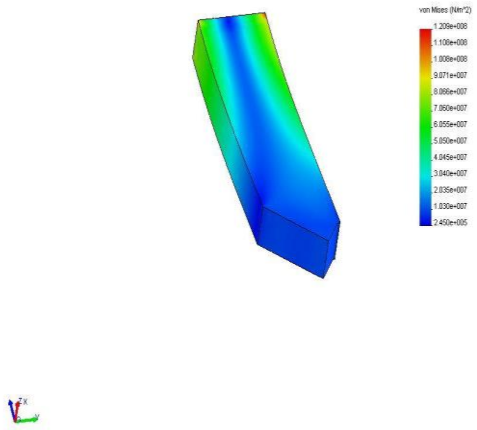

Fig 4.2.11) forming punch11

4.2.12) Analysis of forming punch 12 (max stress= 1.098e^008)(N/m^2)

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 7, January 2014

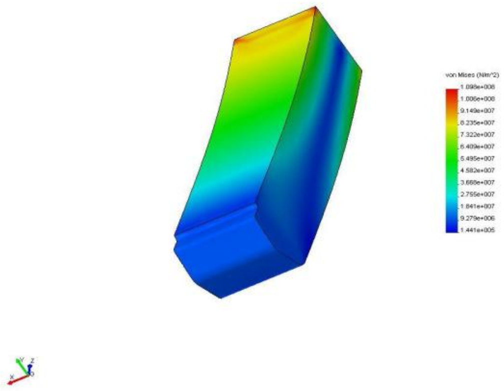

Fig 4.2.12) forming punch12

4.2.13) Analysis of forming punch 13 (max stress= 8.236e^007)(N/m^2)

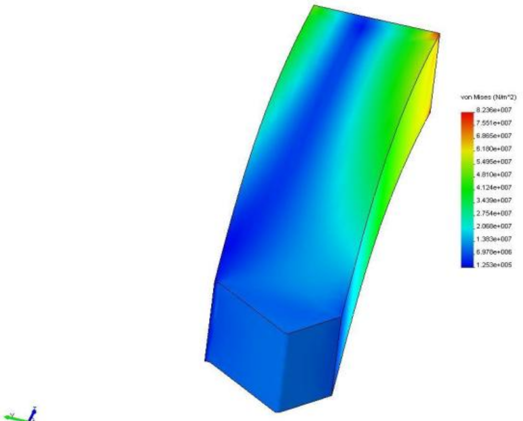

Fig 4.2.13) forming punch13

4.2.14) Analysis of forming punch 14 (max stress= 8.385e^007)(N/m^2)

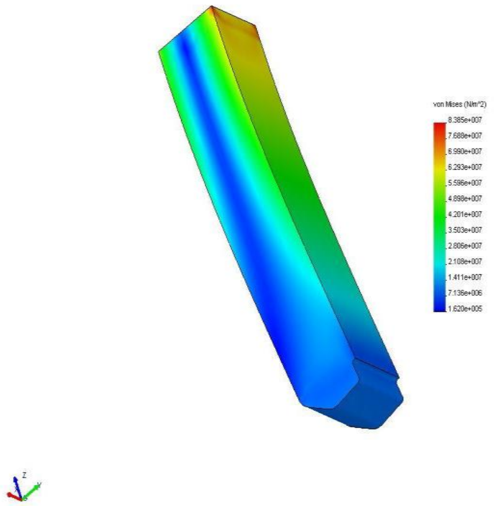

Fig 4.2.14) forming punch14

4.2.15) Analysis of forming punch 15 (max stress= 1.091e^008)(N/m^2)

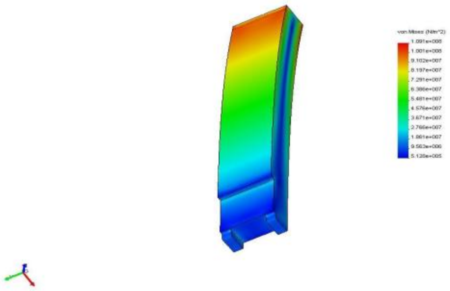

Fig 4.2.15) forming punch15

4.2.16) Analysis of forming punch 16 (max stress= 1.993e^007) (N/m^2)

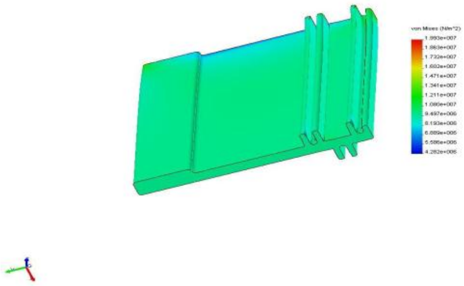

Fig 4.2.16) forming punch16

4.2.17) Analysis of forming punch 17 (max stress= 2.393e^007) (N/m^2)

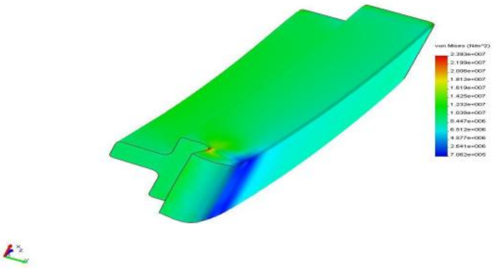

Fig 4.2.17) forming punch17

V. CALCULATION AND DISCUSSIONS

A. *PRODUCTION RATE*

NOTE-the following calculations were done based on the information’s collected from MSM HYDROPNEUMATIC INDUSTRY and only for 3 operation and by using only one tool for each operation. By referring MSM HYDROPNEUMATIC INDUSTRY work study following information were noted down.

OPERATIONS	OPERATION TIME (min/pc)	MATERIAL HANDLING TIME (min/pc)
Piercing	0.033	0.016
Blanking	0.033	0.016
Bending	0.005	0.033

1) CYCLE TIME

Cycle time can be calculated by using the equation **Tc= To+Th+Tth**------(1)

Where Tc = cycle time, To = operation time, Th = mtrl handling time, Tth = tool handling time.

1.1) FOR NORMAL DIE

Since in normal die tool is already arranged that tool handling time becomes zero. That Tth= 0

Therefore equation (1) becomes **Tc= To+Th**

1.2) FOR PROGRESSIVE DIE

Since in progressive die material handling is made automatic so it is neglected. That is Tth=Th=0. Therefore equation (1) becomes **Tc= To**

Calculating cycle time for both the dies results are as followed.

OPERATIONS	NORMAL DIE (min/pc)	PROGRESSIVE DIE (min/pc)
Piercing	0.049	0.033
Blanking	0.049	0.033
Bending	0.083	0.05
Total cycle time	0.181	0.116

2) BATCH PRODUCTION

Batch production can be calculated by using the equation Tb=Tsu+Q(Tc)----(2) (min/cycle) where Tb = batch production time, Tsu = set up time, Q = number of parts taken foe each set of operation.

2.1) FOR NORMAL DIE

By referring the work study of industry it is found that set up time they taken as 10 sec that 0.166 min/pc

That is equation (2) becomes Tb=0.166+1000(Tc)

2.2) FOR PROGRESSIVE DIE

Since in progressive die set up time is not needed so it is taken as zero. That is Tsu=0

The following result can be plot after calculation.

For normal die batch production time Tb= 181.166 (min/cycle)

For progressive die batch production time Tb= 331.187 (min/cycle)

3) PRODUCTION RATE

Production rate can be calculated by using equation **Tp=Tb/Q**----(3)

Where Tp = production time.

For both the dies equation remains the same

After calculation results will be as followed

For normal die production time Tp= 0.18116 (min/1000pc)

For progressive die production time Tp= 0.116 (min/1000pc)

to calculate rate of production rate use the equation **Rp= 60/Tp** (min/hr)—(4)

Equation remains same for both the die

After calculation rate of production

For normal die Rp=331.187 (min/hr)

For progressive die Rp= 871.20 (min/hr)

4) NET INCREASE IN PRODUCTION RATE

BY COMPARING THE RATE OF PRODUCTION THAT IS (871.20-331.187) Rp=540.0 (min/hr)

5) RESULTS

By the results of above calculations

B. *INCREASE IN PRODUCTION RATE WITH RESPECT TO TIME*

1) FOR 1 HOUR

By the above calculations it is ahown that for 1 hour rate of production increased by **Rp= 540 (min/hr)**

2) FOR 1 BATCH

For 1 batch taking 8 hours production rate will be, **Rp=540*8=4320 (min/batch)**

3) FOR 1 DAY

For 1 day taking 3 batches then the production rate will be, **Rp= 4320*3= 12960 (min/day)**

4) FOR 1 MONTH

For 1 month if we consider an average of 30 days production rate will be, **Rp=12960*30=388,800 (min/month)**

5) FOR 1 YEAR

For a year by taking 12 months production rate will be, **Rp=388,800*12= 4,665,600 (min/annum)**

VI. CONCLUSION

6.1) By studying the applications, advantages of progressive dies we can conclude that progressive die can only used for batch and continues production.

6.2) By studying the types of software's used to analyze these dies I can conclude that stress amount that acts on the tools and the parts of progressive dies.

6.3) By calculating the increase in production rate I concluded the exam statistic benefit of over production by progressive dies.

6.4) By analyzing this die we can conclude progressive die has its initial cost very high but it can bring the revolution in the small scale industries if small scale industries install this die.

6.5) Progressive dies not only increases the production rate but also reduces man power.

6.6) Progressive dies also can bring quality and consistency in bringing quality by continues production.

REFERENCES

[1] Vince Adam & Abraham Askanazi "Building better product with Finite Element Analysis" Onward Press, first edition,1999.

[2] J.N Reddy "An introduction of finite element method" Tata McGraw Hills, 2ndedition (2001).

[3] en.wikipedia.org/wiki/progressive die.

[4] en.wikipedia.org/wiki/Finite Element Method

AUTHOR BIOGRAPHY

Mr. Vishnu S. Bhajantri is currently working as assistant professor in Dept. of Mechanical Engineering, Shaikh college of Engineering and technology, Belgaum, Karnataka, India. Two year teaching experience.

Mr. Ganapati B. Kapashi is currently working as assistant professor in Dept. of Mechanical Engineering, Shaikh college of Engineering and technology, Belgaum, Karnataka, India. Three Year industrial experience and two national conferences given.

Mr. Sunil C. Bajantri is currently working as assistant professor in Dept. of Mechanical Engineering, Shaikh college of Engineering and technology, Belgaum, Karnataka, India. One Year industrial experience and two year teaching experience.