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Finite Element Method study applied to Containerless Extrusion Die Design

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***Abstract*: The paper work effort has been made to study related open die extrusion where die design factor extrusion strains varied die included angle, maximum and minimum pressure study with respect to corresponding strain values and optimum die angles to noted experimentally.**

***Keywords*: Die Design, included angles, Strain values**

1. Introduction

Metal forming is derived into large group, includes wide range of manufacturing process. Containerless extrusion basically one type of extrusion where billet extruded without container or there is lot of clearance gap between the container and billet. Where extrusion force required for extrusion in terms of direct extrusion, varies with ram travels Initially the billets get compressed to the size of container before getting extruded. Where static friction exists between billet and container. The CAE stress analysis carried with version Ansys 19.0 for this study. Where half section of die applying with axisymmetric loading reduces to simple two-dimensional problems.

2. Literature Survey

Process where the materials subjected to compression, the forced flow through a confined suitably shaped opening called the die. Metals made to flow through a die to desire shape properties, results product. To produce hollow and solid product most of the case extrusion process used. The product obtained by this process is compressive in nature. The complexity jobs can also be achieved. where by tools store the desired geometry and impart pressure on the deforming the tool and material interface.

Before the die entry the product in identical straight rod. The die has Varity in entry side shape, if the die shape in tubular form at entry side mean hollow components can be produced like machining and casting. Process generally used to create fixed cross-sectional profile for die design most of the case material used as steel materials or aluminum alloys.

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3. Materials and heat Treatment Process of Dies

There is no single type of test that's the consensus choice as most important for composites, especially given the variety of purposes for testing and intended applications. To perform general purpose of testing composites material properties useful in design and analysis areas.

High Speed steel: Having a huge amount of tungsten, chromium and highly alloyed in nature. Where the hardness retained to around 900° C. At the high cutting speed these materials retain their hardness without effecting the temperature.

Tool steel: In machining and forming operation at high speed temperature these steels are used. These steels have good mechanical properties and mostly used for producing dies. Some mechanical properties as follows high thermal stability and good toughness. Hardness. Red hardness can achieve at high temperature. Cost is economical as compare to steel.

Hardening: Hard structure can obtain in steel by using this process. Critical Temperature these steel ranges from 650° C to 670°C.

4. Finite element analysis application in Die Design

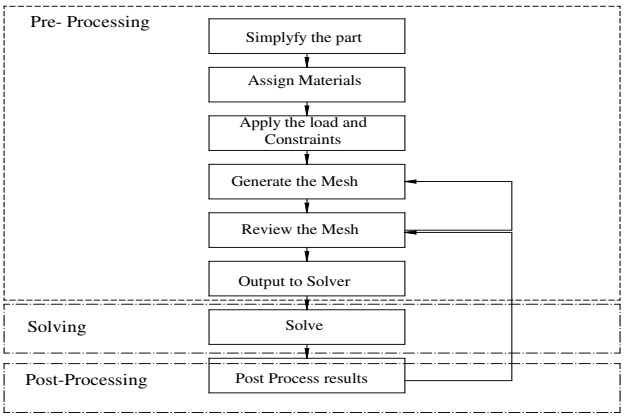

Fig.1 FEM Analysis flow Chart

In particular the FEM can be systematically programmed to accommodate complex and difficult problems such as non-homogeneous materials, on-linear stress strain behavior and complicated boundary conditions. This FEM is applied to wide range of boundary value problems n engineering. In boundary value problems, a solution is sought in the region of the body, while on the boundaries or edges of the region, values of dependent variables or their derivatives are prescribed.

There are three major types of boundary value problems

- Equilibrium or steady state problems,
- Eigen values problems.
- Propagation or transient problems.

Propagation or transient problems are time dependent problems. This type of problem arises, for example, whenever we are interested in finding the response of a body under time varying loads, in the area of solid mechanics and sudden heating or cooling in the field of heat transfer. Discretization of a given domain into a collection of prescribed finite elements. Derivation of element equations for all typical elements in the mesh. Assembly of the element equations to obtain the equations of the whole problems. Apply the boundary condition of the problem. Solution of the assembled equations. Post processing of the results.

5.The basic purpose FEM packages

The rapid advances made in computer hardware and software leads to significant developments in FEA software. Finite element programming has emerged as specialized discipline, which require knowledge and experience in the diverse area such as foundation of mechanics, numerical analysis and computational skills in the area of software technology, programming techniques, data structures, database management and computer graphics. Input: Physical modeling, geometry, material, loading and boundary conditions. Library: Elements, generation of equilibrium equations. Assembly and solution: construction and solution of structural system. Output Display of predicted displacement, stress and temperature.

6. Experimental Works

Force acting on the nodes, assumed as 600KN.Half portion of die acting 300KN due to symmetry. Load is split into 30KN acting on inner nodes and 15KNon the outer nodes. Force is acting on the die at entry side. The die material is homogeneous and isotropic. Heat flux, surface and gravity loads are absent. Young's modulus E=200Gpa, μ=0.33, Sy=2000MPa. Only the structural loads are considered.

Table 1 Steps for analysis of die without FOS

External diameter of die in (mm)				
60	70	80	85	86
Note: Ansys Macro used for analysis -without factory of safety				

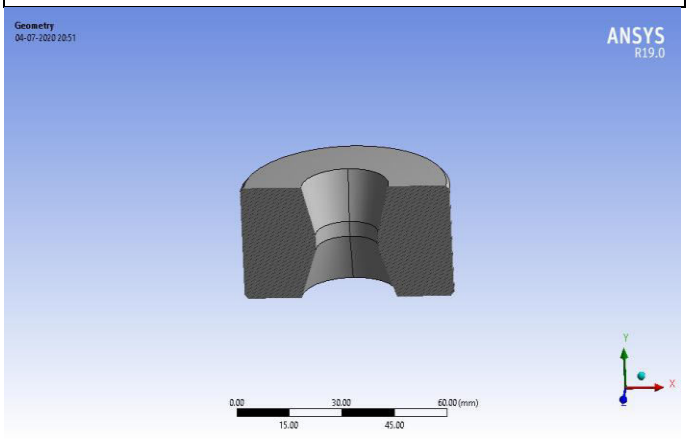

Fig 2. Die Geometry

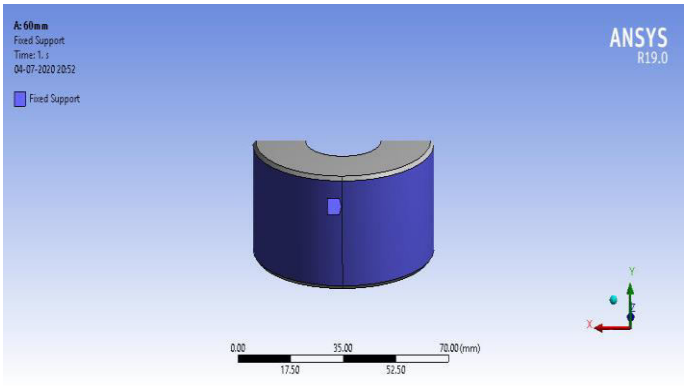

Fig 3. Fixed Supports applied for 60mm die

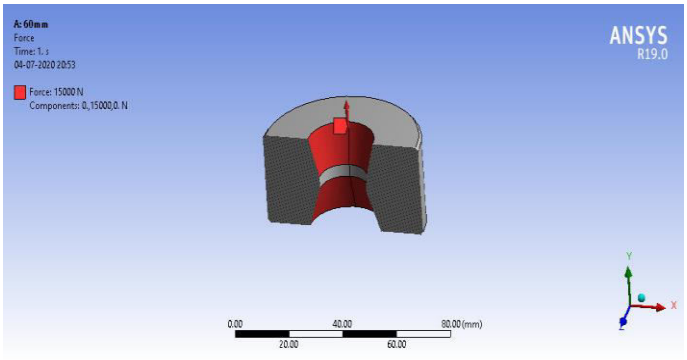

Fig 4. 15KN load applied to 60mm Die

Model generation: The ultimate purpose of a finite element analysis is to recreate mathematically the behavior of an actual engineering system. In other words, the analysis must be an accurate mathematical model of a physical prototype. In the broadest sense, this model comprises all the nodes, elements, material properties, real constants, boundary conditions, and other features that are used to represent the physical system.

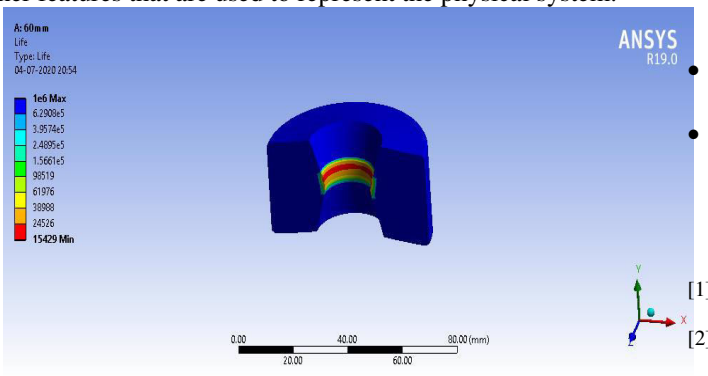

Fig 5. Fatigue Life for 60mm Die

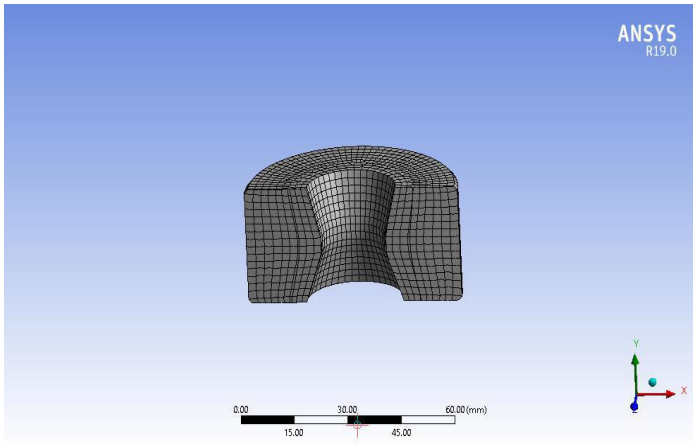

Fig 6. Mesh generation for 60mm diameter Die

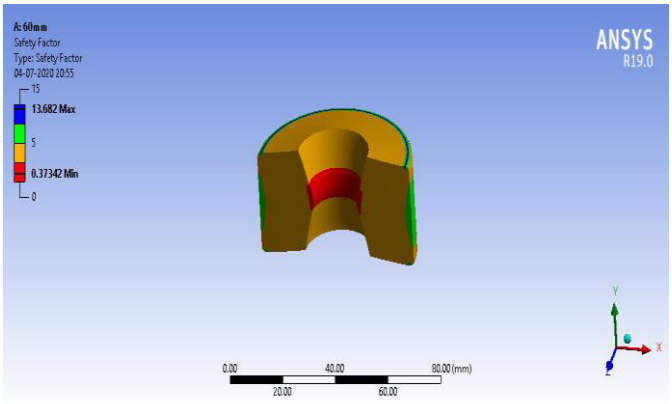

Fig 7. Factory Safety for 60mm diameter Die

7. Conclusion

From above Experimental results following conclusion were drawn.

- Development of Die design profile based on the round billet using mathematical countered die profile.
- The effective stress, effective strain rate and effective strain and fatigue deformation obtained with respect to material life and loading history.
- During mid-travel ram stroke on billet where maximum load occurs at die.
- It is noted that die length increases with increased in extrusion pressure, along with friction factory.

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