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Analysis and Optimization of Die Failure

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***Abstract*:- The die fatigue life is determined by the design of metal-formed product and die, forming process configuration, die stress and the entire metal-forming system. In the metal formed industries die is an important tool for fabrication of metal formed product. At the same time failure of tool steel take place because of many numbers of causes and insufficient material selection criteria. Main objective is to select the most preferable material for Die Block. For the hardness test, tensile test and Impact test is done. By that test we get the appropriate results.**

INTRODUCTION

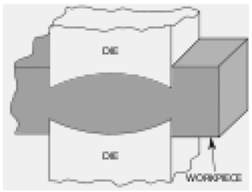
Tools and dies must also be produced with the proper size and shape after hardening so that excessive finishing work is not required. Heat- treatment distortion must be controlled, and surface chemistries must not be altered. Because of the careful balance that must be maintained in heat treatment, control of the heat- treatment process is one of the most critical steps in producing successful tools and dies. In addition to controlling the heat-treatment process, tool and die design and steel selection are integral factors in achieving tool and die integrity.

COMPANY PROFILE

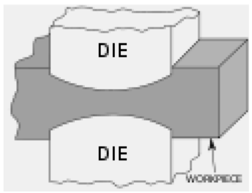
Steel & Industrial Forgings Limited (SIFL) is an AS 9100:2016 certified, Public Sector Undertaking fully owned by Government of Kerala. Incorporated in 1983 and Started commercial production in 1986, SIFL rapidly forged ahead to become a name to reckon with. We are masters in Titanium and Special alloy forgings. Untiring efforts of three decades has saddled SIFL firmly in the Forging Industry of India and abroad with best ratings for its products and services. Forgings with exquisite designs and shapes, flawless forms and contours, broad bands and spectra of metals like ALLOY STEEL, SUPER ALLOYS, ALUMINIUM and
TITANIUM. All in wide range of weights and unmatched quality have made SIFL the most sought after forging company in the country for critical components

FORGING

Forging is a manufacturing process involving the shaping of metal using localized compressive forces. The blows are delivered with a hammer (often a power hammer) or a die. Forging is often classified according to the temperature at which it is performed: cold forging (a type of cold working), warm forging, or hot forging (a type of hot working). For the latter two, the metal is heated, usually in a forge. Forged parts can range in weight from less than a kilogram to hundreds of metric tons. Forging has been done by smiths for millennia; the traditional products were kitchenware, hardware, hand tools, edged weapons, cymbals, and jewelers. Since the Industrial Revolution, forged parts are widely used in mechanisms and machines wherever a component requires high strength; such **forgings** usually require further processing (such as machining) to achieve a finished part. Today, forging is a major worldwide industry.



Edging



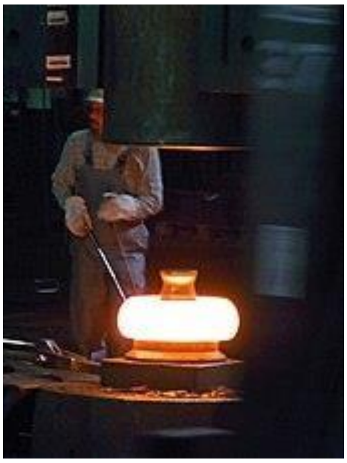
Fullering

PROCESSES

There are many different kinds of forging processes available; however, they can be grouped into three main classes.

- Drawn out: length increases, cross-section decreases
- Upset: length decreases, cross-section increases
- Squeezed in closed compression dies: produces multidirectional flow

Common forging processes include: roll forging, swaging, cogging, open-die forging, impression-die forging, press forging, automatic hot forging and upsetting.



Forging

DESIGN OF FORGING AND TOOLING

Forging dies are usually made of high- alloy or tool steel. Dies must be impact and wear-resistant, maintain strength at high temperatures, and have the ability to withstand cycles of rapid heating and cooling. In order to produce a better, more economical die the following standards are maintained:

- The dies part along a single, flat plane whenever possible. If not, the parting plane follows the contour of the part.
- The parting surface is a plane through the center of the forging and not near an upper or lower edge.
- Adequate draft is provided; usually at least 3° for aluminum and 5° to 7° for steel.
- Generous fillets and radii are used.
- Ribs are low and wide.
- The various sections are balanced to avoid extreme difference in metal flow.
- Full advantage is taken of fiber flow lines.
- Dimensional tolerances are not closer than necessary.

MATERIALS AND APPLICATIONS

Forging of steel

Depending on the forming temperature steel forging can be divided into:

- Hot forging of steel
- Forging temperatures above the recrystallization temperature between 950–1250 °C
- Good formability
- Low forming forces
- Constant tensile strength of the work pieces
- Warm forging of steel
- Forging temperatures between 750– 950 °C
- Less or no scaling at the work piece surface
- Narrower tolerances achievable than in hot forging
- Limited formability and higher forming forces than for hot forging
- Lower forming forces than in cold forming
- Cold forging of steel
- Forging temperatures at room conditions, self-heating up to 150 °C due to the forming energy
- Narrowest tolerances achievable
- No scaling at work piece surface
- Increase of strength and decrease of ductility due to strain hardening
- Low formability and high forming forces are necessary

Forging of aluminum

 Aluminum forging is performed at a temperature range between 350–550 °C

 Forging temperatures above 550 °C are too close to the solidus temperature of the alloys and lead in conjunction with varying effective strains to unfavorable work piece surfaces and potentially to a partial melting as well as fold formation.

 Forging temperatures below 350 °C reduce formability by increasing the yield stress, which can lead to unfilled dies, cracking at the work piece surface and increased die forces

Due to the narrow temperature range and high thermal conductivity, aluminum forging can only be realized in a particular process window. To provide good forming conditions a homogeneous temperature distribution in the entire work piece is necessary. Therefore, the control of the tool temperature has a major influence to the process. For example, by optimizing the perform geometries the local effective strains can be influenced to reduce local overheating for a more homogeneous temperature distribution.[27]

Application of aluminum forged parts[edit]

High-strength aluminum alloys have the tensile strength of medium strong steel alloys while providing significant weight advantages. Therefore, aluminum forged parts are mainly used in aerospace, automotive industry and many other fields of engineering especially in those fields, where highest safety standards against failure by abuse, by shock or vibratory stresses are needed. Such parts are for example pistons, chassis parts, steering components and brake parts. Commonly used alloys are AlSi1MgMn (EN AW-6082) and AlZnMgCu1,5 (EN AW-7075). About 80% of all aluminum forged parts are made of AlSi1MgMn. The high- strength alloy AlZnMgCu1,5 is mainly used for aerospace applications.

EQUIPMENT

Hydraulic Drop Hammer

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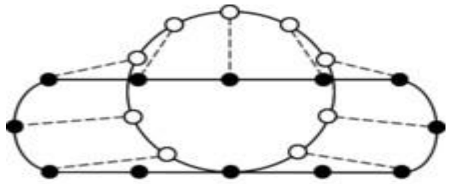

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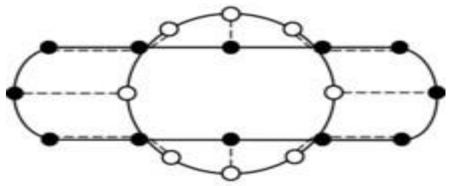

(b)

The most common type of forging equipment is the hammer and anvil. Principles behind the hammer and anvil are still used today in *drop- hammer* equipment. The principle behind the machine is simple: raise the hammer and drop it or propel it into the work piece, which rests on the anvil. The main variations between drop- hammers are in the way the hammer is powered; the most common being air and steam hammers. Drop-hammers usually operate in a vertical position. The main reason for this is excess energy (energy that isn't used to deform the work piece) that isn't released as heat or sound needs to be transmitted to the foundation. Moreover, a large machine base is needed to absorb the impacts.

Forging presses

A *forging press*, often just called a press, is used for press forging. There are two main types: mechanical and hydraulic presses. Mechanical presses function by using cams, cranks and/or toggles to produce a preset (a predetermined force at a certain location in the stroke) and reproducible stroke. Due to the nature of this type of system, different forces are available at different stroke positions

FACTORS TO CONSIDER FOR TOOL AND DIE FAILURES

A number of factors can be responsible for tool and die failures. They include:

1. Mechanical design. The design must be compatible with the steel grade selected, the procedures required to manufacture the tool or die, and the use of the tool or die.

2. Grade selection. The grade of steel selected must be compatible with the design chosen, the manufacturing processes used to produce the tool or die, and the intended service conditions and desired life.

3. Steel quality. The material must be macro structurally sound, free of harmful inclusions to the degree required for the application, and free of harmful surface defects.

4. Machining processes. The machining processes used to produce the tool or die must not alter the surface microstructure or surface finish and must not produce excessive residual stresses that will promote heat-treatment problems or service failures.

5. Heat-treatment operation. Heat treatment of tools and dies must produce the desired microstructure, hardness, toughness, and hardness at the surface and in the interior.

6. Grinding and finishing operations. Grinding and finishing operations must not impair the surface integrity of the component.

7. Tool and die setup. Alignment of tools and dies must be precise to prevent irregular, excessive stresses that will accelerate wear or cause cracking.

8. Tool and die operation. Overloading must be avoided during operation to ensure that the desired component life is achieved

Technical Specifications and Features

Load	10000KN
Rated energy	125000J
Slide and bolster size	(2400x1800)/(2400x1830) = 0.983mm
Slide stroke	400mm
Adjustment by wedge	25mm
Wedge shut height from fixed bolster	1025mm
Shut height from fixed bolster	1475mm
Fixed bolster thickness	200mm
Clearance between uprights	2500mm
Continuous speed	20min
Main motor power	55kw

CONCLUSION

We studied about analysis of die failure and Knowing more about why dies fail usually helps point the way for improvements in tool life especially if we learn from not only our own experiences, but also the experiences of others.

Dies fail for various reasons, including:

- Abrasive wear to out-of-tolerance conditions;
- Heat checking and spalling/accelerated wear out;
- Thermal softening and subsequent deformation of dies;
- Excessive ―benching‖ (hand grinding/polishing);
- Catastrophic failure (broken dies); and,
- Inaccurate dies that miss target dimensions

A major cause of die breakage is lack of sufficient die support, either at the sidewalls or due to improper match up with the supporting tools, such as bolsters, rams, die shoes, etc. Usually, die fracturing comes from a failure to adhere to fundamentals in tool support and die maintenance, as well as workpiece placement on the dies. Lack of proper preheating makes any fracture develop much faster — sometimes after just a few forgings.

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