DESIGN AND ANALYSIS OF MOULD FOR MUDGUARD OF BIKE

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Abstract: The machining process of the mold is mostly emphasized but few consider the integration of the design guidelines with molding analysis. The main consideration in part design is to comply with market demands, such as aesthetics, function, laws, and regulations. Mold design considers the manufacturing cost of each component such as sliding blocks, ejection systems, two- or three-plate mold, etc. Therefore, in order to design good parts and molds, many detailed and complicated theories and mechanisms must be considered.

Index Terms **– Mould, Analysis, Design, Ejector,**

I. INTRODUCTION

Injection molding has been the most popular method for making plastic product due to high efficiency and manufacturability. The injection molding machine includes main for stage for production of plastic parts: filling and packing Stage, cooling stage and ejection stage. Among these stage cooling stage is a very important one because it mainly the productivity, quality and total efficiency of the machine. The cooling stage taken 70% time of cycle time. The appropriate design of cooling channel reduces cooling time, increases the productivity and minimizes undesired defect such as sink marks, differential shrinkage, thermal residual stress and war page. The cooling phase, heat transfer between the molten materials inside the cavity and the cooling fluid flow in the cooling channel inside the mold. The rate of heat exchange is very important and directly related to the time taken by the cooling phase. So it is important to understand and optimize the cooling channel design to optimize the rate of heat transfer in an injection molding process.

The optimizing convectional cooling channels (straight-drilled cooling lines) and finding architecture for injection mold cooling channel (conformal cooling channel). The optimize the configuration of the cooling system in the terms of shape, size and location of cooling line. The cooling layout conformal cooling channel the conform to the mold cavity surface and examines the effectiveness of the cooling system.

The design of injection mold is highly interactive and manual process involving substantial knowledge of multiple areas, such as mold design features, mold making processes, molding equipment and part design, all of which are highly coupled to each other. The main challenge is to design and produce a mold that is straightforward to manufacture, while providing uniform filling and cooling of plastic parts. At the same time the tool has to be strong enough to withstand millions of cyclic internal loads from injection pressures and external clamp pressures, in order to assure the target part‟s reproducibility.

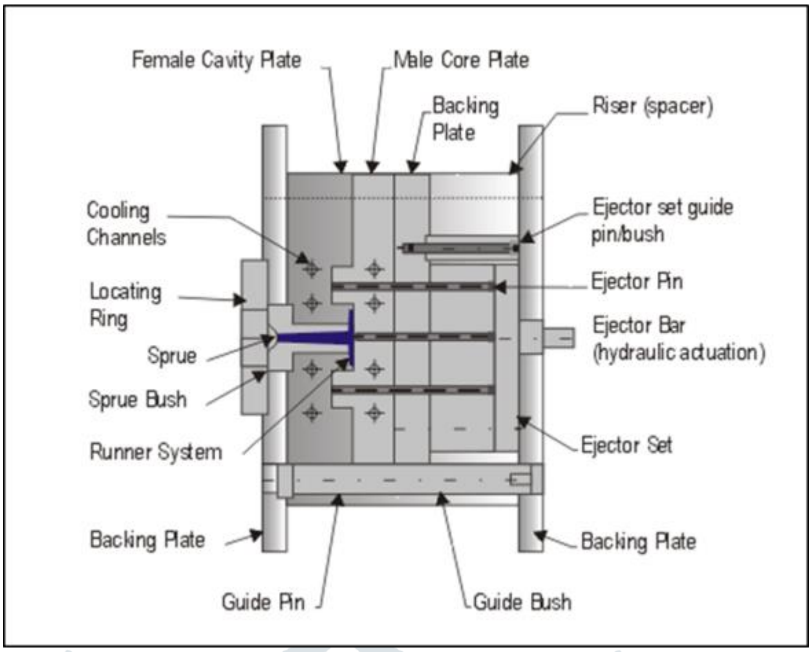

Fig.1- Mould Detail

Mould componants :

1. Insert

Inserts are the small parts or subparts of core or cavity.

• There are some cases where, some areas of core are cavity may get damage during continuous assembly and disassembly of mould during plastic injection process.

• If such area gets damage then whole mould will be of no use and it will cause a big time as well and money loss.

• Hence such areas of core or cavity are converted in small parts which are designed of same dimensions as mentioned on core or cavity and then are inserted into that core and cavity.

2. Side core

If there are holes or hollow parts in mould then we have to give cylindrical solid part in that section so that plastic will not flow over there and hollow part will be created.

But we have to ensure that this cylindrical shape part is detached from mould when plastic is solidified so that it will not break the final product during removal process.

Hence side cores are used to create hollow parts or holes in the mould which detach itself from core or cavity during opening of the mould to remove part from cavity easily. There are mainly 3 types of side cores:

- Finger pin operated side core
- Pneumatic side core
- Hydraulic side core

3. Finger pin side core:

In finer pin side core mechanism, we use one rod which has been inserted in body which slides on given path on core or cavity. Rod is inserted in angle such that when core moves apart from cavity it travels back and detach itself from product and when mould assembly is engaged it get attached to the mould to ensure proper positioning for hole or hollow part of product.

4. Hydraulic side core:

Its operation is same as finger pin operated side core nut the difference is we use fluid to move body front and back during assembly and disassembly of mould.

5. Sprue Bushing:

The primary functions are to seal tightly against the nozzle of the injection barrel of the molding machine and to allow molten plastic to flow from the barrel into the mold. There is a tapered hole in the middle of the sprue bushing and that is where the plastic flows through the bushing. The hole is tapered to allow the plastic, after it solidifies, to be removed easily to prepare for the next cycle.

5. Runner

The molten plastic is directed to the cavity images through channels that are machined into the faces of the A and B plates. These channels allow plastic to run along them, so they are referred to as runners. To save material and cycle time, many molds are built with hot runner systems A runner shaped as full round is ideal case. This is because a circular cross section creates equal pressure in all directions on the plastic molecules, while a non-circular section causes unequal pressure

6. Ejector Pins

When the mold opens, the finished part is pushed out by a number of ejector pins shaped like flat headed pins. The ejector will pushes out the products from the mold after cooling phase.

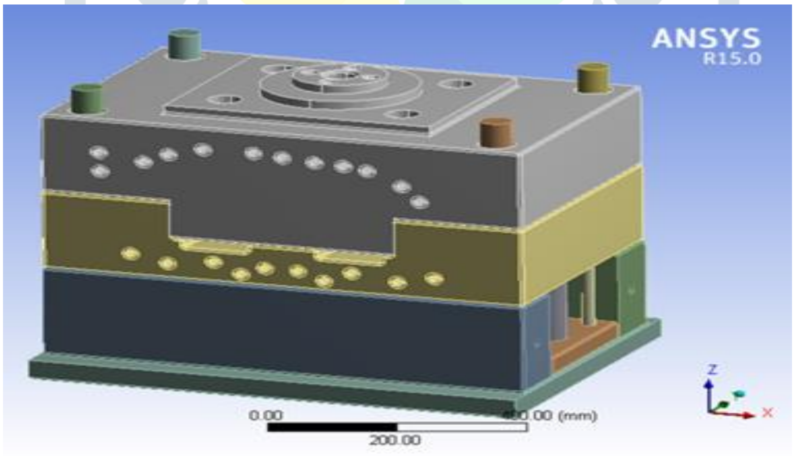

Fig 2- Mould Assembly

II. LITERATURE REVIEW

How to Make Injection Molds (G. Menges): In this paper he said that Golden rule for part design, that is, ensure even distribution of wall thickness. Relationship between part thickness and flowing length. Dimension specification of radius, fillets, and chamfer angles. Design principle for ribs and bosses. Relationship between draft allowance and mold opening.

Mold-Making Handbook (K. Stoeckhert): From this wa know how Ribs to be provided in mould. Fillets to be provided and their variation. Boss preparation.Giving Draft Angle.

Wong C. T et. al: In this paper,the analysis, simulation, mold flow provides sufficient information result, such as fill time, injection pressure and pressure drop. The analysis also helps to reduce defect of plastic in actual injection such as sink marks, air traps, and over packing and reduce time and cost. The analysis simulation, mold flow provides sufficient information results such as fill time and that also help in reduce the time of mould set up time in the machine cycle time.

III. Problem specification:

The injection exerts high pressure and under high temperature. The design of the die cavity for the critical since cavity has to withstand the high temperatures and pressures. In this work the die cavity for the cap is analyzed by using a finite element package ansys 16. So the deformation of the cavity plate stress caused is found out and analyses.

Also, the positioning of ejectors pins , selection finger side core is important.

IV. METHODOLOGY

- ❖ Material Selection.
- ❖ Gathering information related to product material.
- ❖ Calculating the necessary size and design of core and cavity on CAD software.
- ❖ Calculating the required dimension of sprue gate, support pillar, guide pillars, ejection guide pillars, ejection pins.
- ❖ Design and analysis of base plate, ejector plate, ejector back plate on CAD software.
- ❖ Providing insert, providing air vents, providing side cores and their removal mechanism.
- ❖ Providing ejector pins, providing multi-directional cooling lines.
- ❖ Analysis of whole mould and anlysis of cooling lines pattern.

V. MATERIAL SELECTION

Table 1.1 Material selection

Materials	Composition of elements
C45	C= 45% Mn= 0.5-0.9
MS	C= 0.05-0.25%
EN31	C= 0.92-4% Si= 0.10% Mn= 0.30%
20MnCr5	Mn= 0.2% Cr= 0.5%
P20	C= 0.35-0.40%

Signif

1. **C45:** It is medium carbon steel offering moderate resistance. It is not capable of through hardening but can be case hardened as per need. Used for manufacturing Top Plate, bottom Plate, ejector plate, ejector back plate etc.
2. **P20:** It is low alloy steel that have good toughness at moderate levels. Mainly used in plastic injection mould cavities and die castings. P20 is used since it gains a crack free and pores free surface after finishing and polishing operation. Because of this property the plastic product obtained gets good surface finish and also is crack free.
3. **EN31:** High quality carbon steel with high degree of hardness. Also possesses good abrasion resistance & compressive strength. This material is through hardened during its use in process. This increases its strength. This is used in manufacturing guide pillars and support pillars, return spring pillars, ejector pins.
4. **20MnCr5:** This material is also through hardened during its usage. It is also used in manufacturing guide pillars, support pillars, return spring pillers, ejector pins .

VI. Calculations:

1. Support Pillars.

Material for Support Pillar: - EN31

$S_{yt} = 567.33$ N/mm^2

$S_{Shear} = 0.5\ S_{yt} = 283.665$ N/mm^2 …….Ref. V.B.Bhandari (Section 4.4 Page No-81)

Shear Stress = S_{Shear}/ F.O.S …….Ref. V.B.Bhandari (Section 4.2 Page No-77)
= 141.8325 N/mm^2 …….[F.O.S =2 Ref. V.B.Bhandari (Section 4.2 Page No-78)

Shear Stress = Force/ Shear Area

$Force^2 = (Mass*9.81)^2 + (Tonnage*9.81)^2$
Area = $3.14/4*(d^2)$

Form Above calculation we get $s_{support}$

But we can’t take only one support pillar, they need to be well distributed over the midline of the mould as the machine tonnage is applied over the central portion.

Considering 10, 11 or 12 number of supports as per space and diameter of material available.

2. Guide Pillars

Material=20MnCr5

$S_{yt} = 1150$MPa
$\sigma_{comp} = S_{yt}/FOS$
$\sigma_{comp} = 1150/2$
$\sigma_{comp} = 575$MPa

σ_{comp} = Force/Area
$Force^2 = (Mass*9.81)^2 + (Tonnage*9.81)^2$
Area = 3.14/4*(d^2)
Numbers of guide pillars = 4
Calculate the diameter of guide pillar

3. Ejector guide pillars.

Material for Ejector Guide pillars :- EN31

S_{yt} = 567.33 N/mm^2

No. of guide pillars = 4

Compressive Stress = S_{yt} / F.O.S …….Ref. V.B.Bhandari (Section 4.2 Page No-77)
= 283.665 N/mm^2

Compressive Stress = Force/ Area

Force= (Weight + 2*Tonnage Force)*9.81

Area = 3.14/4*(d^2)

Form Above calculation we get d

4. Ejector pins.

Material for Ejector pins: - EN31

S_{yt} = 567.33 N/mm^2

No. of guide pillars = 4

Compressive Stress = S_{yt} / F.O.S …….Ref. V.B.Bhandari (Section 4.2 Page No-77)
= 283.665 N/mm^2

Compressive Stress = Force/ Area

Force= (Tonnage Force)*9.81

Area = 3.14/4*(d^2)

Form Above calculation we get d.

VII. ANALYSIS OF MOULD

Finite element method has become one of the most widely used techniques, for analyzing mechanical loading characteristics in modern engineering components. Traditional analysis techniques can only be satisfactorily applied to a range of conventional component shapes and specific loading conditions. Unfortunately, the majority of engineering loading situations are not simple and straight forward therefore the traditional techniques often need to be modified and compromised to suit situations for which they were not intend. The uncertainty thus created, commonly leads to the designer applying excessively high factor of safety to the mechanical loads and so to over design components by specifying either unnecessarily bulky cross section or high quality materials, inevitably the cost of the product is adversely affected.

Finite element method is one of the numerical methods that process certain characteristics that take advantage of special facilities, offered by the high speed computers. In particular the finite element method can be systematically programmed to accommodate such complex and difficult

Problems as non-homogeneous materials, nonlinear stress strain behavior and complicated

Boundary conditions.

VIII. FEA PROCEDURE:

The basic steps involved in the FEA are:

1. Modeling, discretization of the given domain using finite elements of different types, shapes and orders.
2. Approximation of field variables over each element domain.
3. Element matrix generation.
4. Imposition of boundary and constraint conditions.
5. Solution of global matrix equations.
6. Post processing of the result.

IX. ANALYSIS OF WHOLE MOULD

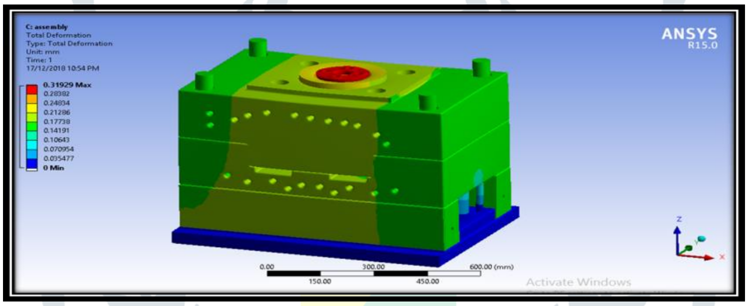

Fig.No.3- Deformation analysis of assembly

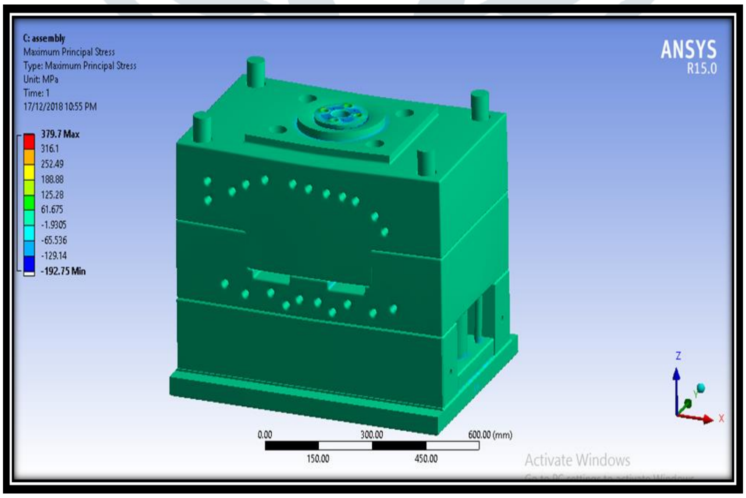

Fig.No.4- Stress analysis of assembly

Analysis of Whole Mould and Cooling Lines:

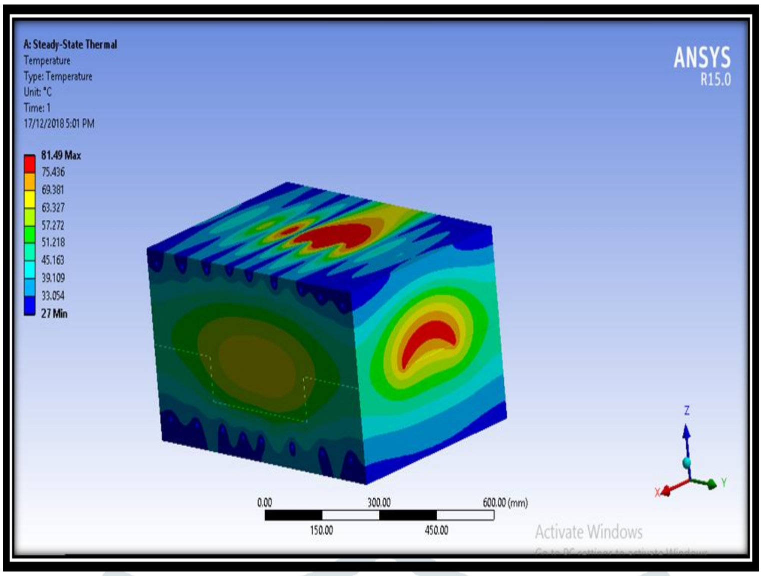

Fig.No.4- Thermal analysis of cooling line pattern 1

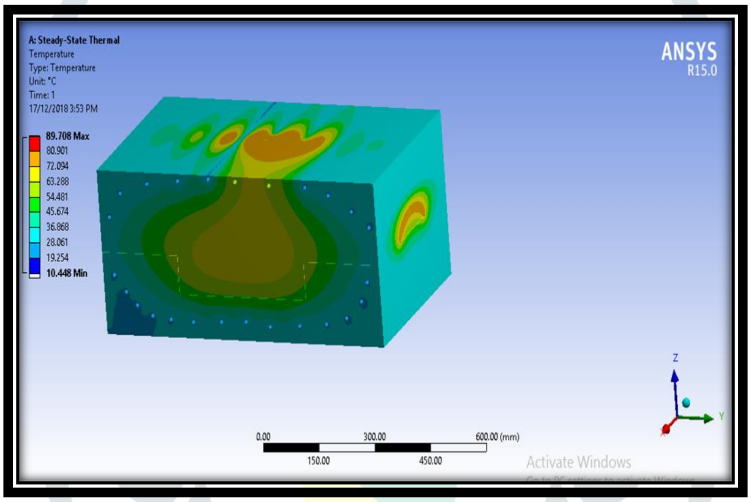

Fig.No.10- Thermal analysis of cooling line pattern 2

X. Result and Discussion:

1. Cooling patter analysis:

From the cooling pattern analysis we choose the cooling patter analysis 2 ethics maintain temperature of mould low an good.

2. Structural analysis:

From structural analysis of assembly we find the Deformation analysis and stress analysis which is both in limit.

XI. Conclusion:

From this paper we conclude that by consider above parameters we designing of the mould.

XII. REFERENCES:

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