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Design and Analysis of Pressure Die Casting for Door Handle

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ABSTRACT
Die casting is a metal casting operation that is specified by forcing molten metal under elevated pressure into a mould cavity. The mould cavity is build using two hardened tool steel dies which have been machined into shape and work closely to an injection mould during the process. While casting, a hot- or cold-chamber machine is used as requirement. While the using of round shaped aluminum door handles it detect that while opening the door whole load is concentrated on two screws which develop in tearing the area where handle is fastened, came in observation that if fastened screw get teared it looks odd . I have redesigned the Door handle maintaining its aesthetic appearance and design to overcome the said identified problem.

KEYWORDS: *casting, die, cavity etc*

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I. INTRODUCTION

Die casting is a metal casting operation that is specified by forcing molten metal under elevated pressure into a mould cavity. The mould cavity is build using two hardened tool steel dies which have been machined into shape and work closely to an injection mould during the process. While casting, a hot- or cold-chamber machine is used as requirement.

The casting appliances and the metal dies shows large capital costs and this tends to curb the process to high-volume production. Die casting is a process for manufacturing and producing metal parts. It is adept by blasting molten metal under high pressure into reusable metal dies The term “die casting” is also used to describe the finished part.The two prime types of die casting activity are hot-chamberand cold-chamber die casting. Two sorts of die casting include:

1. Hot chamber system.
2. Cold chamber system

- Low-pressure die casting
- Vacuum die casting
- Squeeze die casting
- Semi-solid die casting

II. OBJECTIVES

The main objective of the study is to design the pressure die casting tool to produce good quality component economically. Also:-

- Change of design to achieve equally distributed load.
- Reduction of material.
- To maintain aesthetic appearance good..
- Make conceptual design of die.
- Design calculations.

III. MODEL STUDY AND MODELLING OF COMPONENT

Model study includes study of model for what to be modified. Examine the criticality of component.

Proper design of component.

Component is modeled using the software SOLIDWORK.

Volume of Component – 1.126 e-005 Cu M

Area of Component – 12000 sq. mm.

Figure No. 1 3D model of Pressure Die Casting for Door Handle

Following Figure shows the Drafting of Pressure Die Casting for Door Handle all Dimensions are in mm.

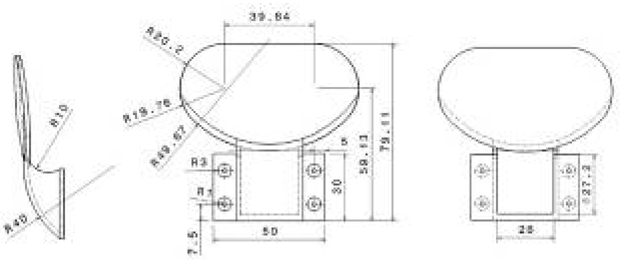


Figure No. 2 Drafting of Pressure Die Casting for Door Handle

IV. MACHINE SELECTION

Machine selection for creating any casting is be based on clamping force and operating stroke, length of shot stroke, maxi. shot pressure, maxi. die opening and die size, max. & min. die height, clearance between beams, over-all size and price.

Clamping force is not necessary the deciding factor in the selection of a die a casting machine. Die dimensions must be considered. The machine having tonnage for casting a part is insufficient platen area or tie-rod spacing for the die, or the opening stroke may not be sufficient for ejection of casting.

Another factor is the cost of the equipment, which must be payoff in the cost of operation. The cost of off-line equipment for die casting machine is typically proportionate with the dimensions of the machine.

Specification of HMT die casting machines:-

Model No.		DC 60	DC 120	DC 180	H-250-D	H 400-D	H – 660-D
Locking force	tones	80	120	180	250	400	660
Injection force adjustable (with intensifier)	tones	11.3	13	22.3	38	43	63
Hydraulic ejection force	tone	4	6	10	15	22	34
Die mounting plates H x V	mm	530 x 530	555 x 600	680 x 690	800 x 830	920 x 980	1130 x 1190
Space between tie bar	mm	330 x 330	380 x 410	450 x 430	500 x 550	580 x 640	720 x 780
Tie bar diameter	mm	60	65	80	100	120	150
Max. Die height	mm	400	400	600	750	750	880
Min. Die height	mm	150	150	200	225	200	350
Die opening force	mm	350	375	460	500	600	630
Injection plunger stroke	mm	250	275	300	350	400	600
Ejector stroke adjustable	mm	60	65	100	100	145	150
Free cycle time	sec	3	3.2	3.5	5.5	7	8
Motor capacity	kW	7.5	11	18.5	22.4	22.4	44.7
Machine area	M	4 x 1.1	4 x 1.25	5.0 x 1.3	5.9 x 1.6	6.1 x 1.65	7.2 x 2.1
Machine weight	tones	3.6	4	5.5	10	12.5	20
Capacity of oil tank	ltr	300	350	400	550	550	1000

Table No. 1 Specification of HMT die casting machines.

Production data of HMT die casting machine :-

Production Data		DC - 80							DC - 120							
Plunger dia.	mm	35	40	45	50	55			35	40	50	60	65			
Shot capacity for Alumn	kgs	0.43	0.56	0.71	0.88	1.06			0.5	0.6	1.0	1.4	1.8			
Max. Injection pressure	kg/cm	1200	920	730	590	490			1352	1035	662	460	400			
Nominal casting area at above pressure	cm2	66	87	110	135	163			88	115	181	260	300			
Production Data		**DC - 180**							**H – 250 - D**							
Plunger dia.	mm	40	50	60	70	80	85		40	45	50	55	60	70	80	85
Shot capacity for Alumn	kgs	0.7	1.1	1.6	2.1	2.7	3.0		0.8	1.0	1.2	1.5	1.8	2.4	3.2	3.6
Max. Injection pressure	kg/cm	1790	1145	795	585	590	400		3025	2390	1935	1600	1345	985	755	670
Nominal casting area at above pressure	cm2	100	157	225	307	406	450		82	104	128	156	185	233	331	373
Production Data		**H – 400 - D**							**H – 660 - D**							
Plunger dia.	mm	50	60	70	80	90	100	110	40	45	50	55	60	70	8-	85
Shot capacity for Alumn	kgs	1.4	2.0	2.8	3.6	4.6	5.7	6.8	0.8	1.0	1.2	1.5	1.8	2.4	3.2	3.6
Max. Injection pressure	kg/cm	2090	1520	1115	855	675	540	450	3025	2390	1935	1600	1345	985	755	630
Nominal casting area at above pressure	cm2	182	263	358	467	592	733	885	200	285	390	510	650	800	965	1150

SHOT WEIGHT = PLUNGER AREA X PLUNGER STROKE X 0.75 FILLING RATIO X * 2.5 (Density of liquid Aluminum)
* for Zinc alloys multiple by 2.5
for Magnesium alloys multiple by 0.65
for Copper base alloys multiple by 3.2

Table No. 2 Production data of HMT die casting machine

V. DESIGN CALCULATIONS

Volume of Component – 1.126 e-005 Cu M

Area of Component – 12000 sq. mm

1. Calculation of opening force: -

$$\text{Opening force (Fo)} = \frac{Ac \times Pc}{100}$$

Where:
Ac = Area of component X 1.45 sq cm
1.45 = Area of feed system x Area of overflows
Pc = Cavity pressure/Technical Part
It will considered as 400 bar to 600 bar

Ac = 12000 x 1.45

17400 sq. mm

174 sq. cm

$$\text{(Fo)} = \frac{174 \times 60}{100}$$

$$\boxed{\text{Fo} = 1044 \text{ Tons}}$$

2. Calculation of Closing Force :-
Closing Force = Factor of safety + Opening force

$$\text{Closing Force} = \frac{20 \times 1044}{100} + 1044$$

= 1252.8 Tons

From machine specification, machine will be selected by projected area of component,

Our component projected area is 174 sq. cm which is under machine area range.

3. Calculation of Gate area:-

$$\text{Gate area (Ag)}= \frac{Qg}{Vg}$$

Where:
Qg = Discharge of material through gate
Vg= Gate Speed

$$Qg= \frac{\text{Volume of component x 1.30}}{\text{Filling time}}$$

The filling time is taken as average value

$$Qg= \frac{0.0000126 \text{ x } 1.30}{0.1}$$

Qg= 0.00014638 cu m
Qg= 146.38 cu cm/sec
Vg= 50 m/sec
Vg= 5000 cm/sec

$$Ag= \frac{146.38}{5000}$$

= 0.0292 mm
= 0.0292 x 100
= 2.92 sq. mm

Round of 3 sq. mm

4. Thickness of gate = S/3
Tg = 2/3
Tg =0.667mm
Tg = 1 mm
Where,
S= Area of wall Thickness

5. Width of Gate,
Wg = Ag/Tg
Where,
Ag= Area of gate.
Tg= Thickness of gate.
Wg = 3/1
= 3 mm

6. Length of Gate Tg = 2 to 3 times of Wg
= 2 x 3
Tg= 6mm

7. Area of Runner, Ar = 1.25 x Ag
= 1.25 x 3
= 3.75

Ar = 4 mm

8. Runner depth, Tr = $\sqrt{Ar/1.6}$

= 4/1.6

= $\sqrt{1.58}$mm

= 2mm

9. Width of runner, Wr= Ar/Tr
= 4/2
= 2mm

10. Length of Runner, Lr = 2 x Wr
= 2 x 2
= 4 mm

11. Ejector pin calculation

Ejector area = 4% of component area

Ac= 1200 x 4/ 100

Ac= 480sq. mm

Consider ejector pin dia as 8mm

Area, A (Ejection pin) = πr^2
= $\pi \times 4^2$
= 50.26 sq. mm

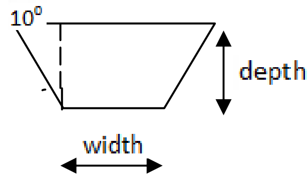
No. of ejection pin = Area (ejection)/ Area (ejection pin)
= 480/50.26
= 9.55
= 10 pins

12. Over flow calculation: -
Taken as 30% of component volume = 30 x 14.63/100
= 4.389
= 5 cu cm

Consider over flow = 3

Volume of single over flow = 5/3
= 1.66 cu cm
= 1.66 x 1000
= 1666.66 cu mm

By theoretical way

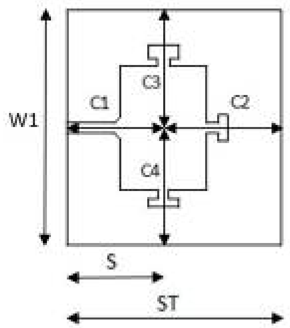


Depth = 3 x thickness
= 3 x 2
= 6 mm

Width = 2 x depth
= 2 x 6
= 12 mm

Length = 2 x width
= 2 x 12
= 24 mm.

Cavity Insert



Take, where, C1=30 , Distance from center line

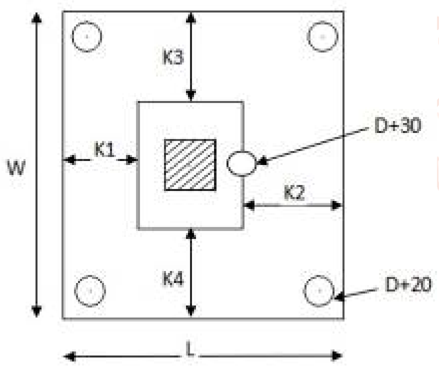
C2=30 , Distance from center line C3=50 , Distance from center line

C4=50 , Distance from center line
S = C1+75
= 30+75
= 105 mm

W1 = C3+C4+120
= 50+50+120
= 220 mm

ST = S+C2+60
= 105+30+60
= 195 mm.

Core Insert



Take,
K1 = 80 , K3 = 100
K2 = 80 , K4 = 100
L = K1+S1+K2
L = 80+95+80
L = 255 mm
W = K3+W1+K4
W = 100+220+100
W = 420 mm

VI. ANALYSIS

The following figure shows various analysis of Door Handle carried out in ANSYS software.

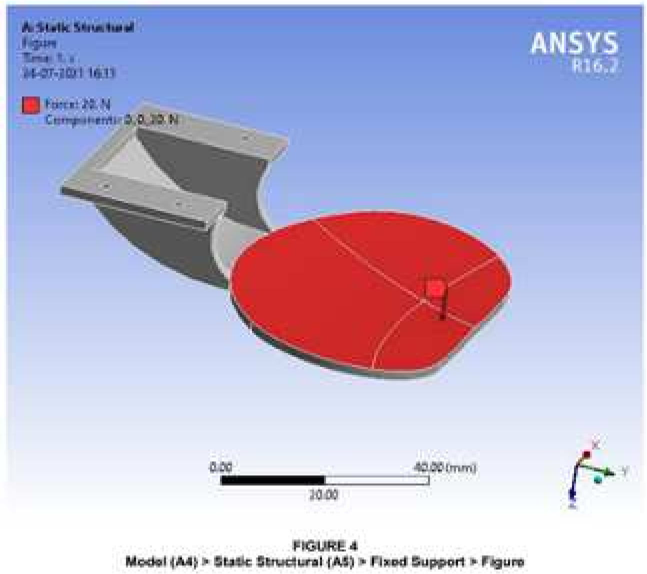


Figure No. 3 Force Analysis of Door Handle

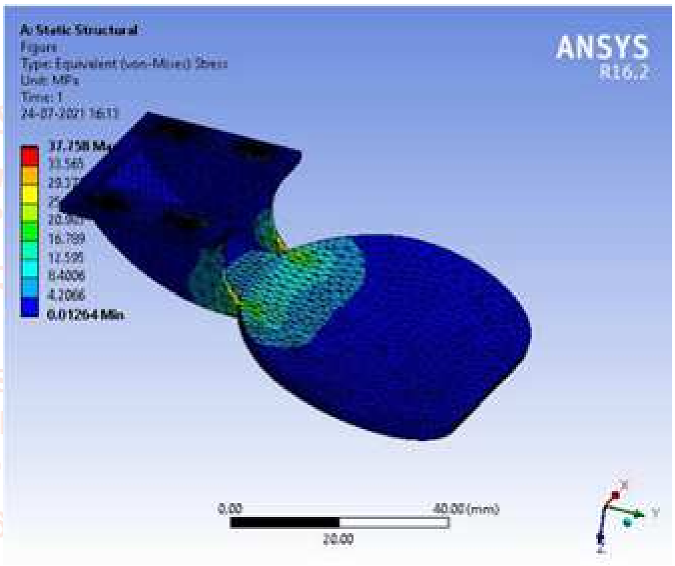


Figure No. 4 Stress Analysis of Door Handle

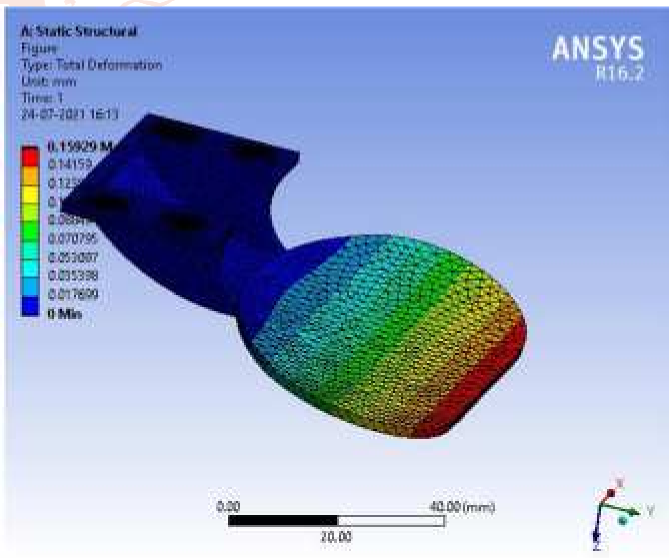


Figure No. 5 Total Deformation Analysis of Door Handle

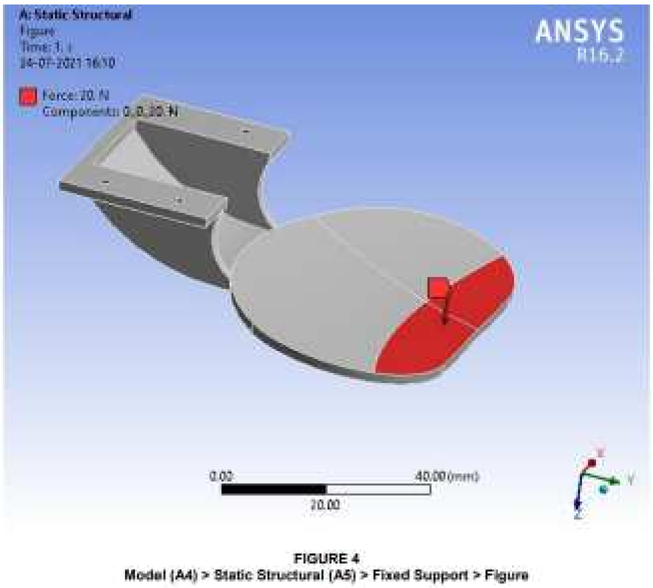


Figure No. 6 Partial Structure Force Analysis of Door Handle

VII. TOOL ASSEMBLY

Tool assembly is done in modeling software, includes the fixing of extracted core and cavity inserts into the Die, after assembly 3D models are converted into the 2D drawings for manufacturing process

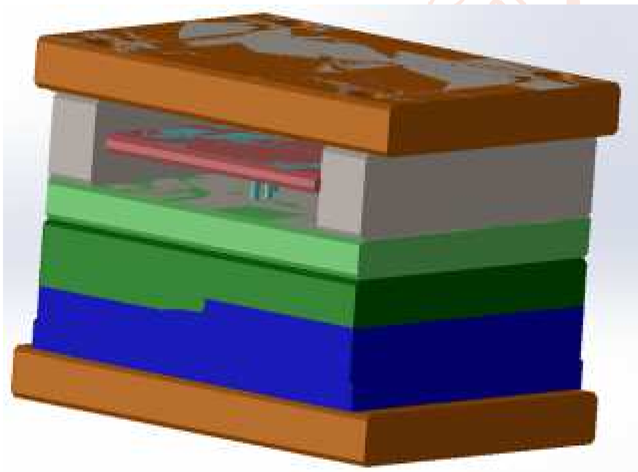


Figure No. 7 3D View Assembly for Pressure Die Casting of Door Handle

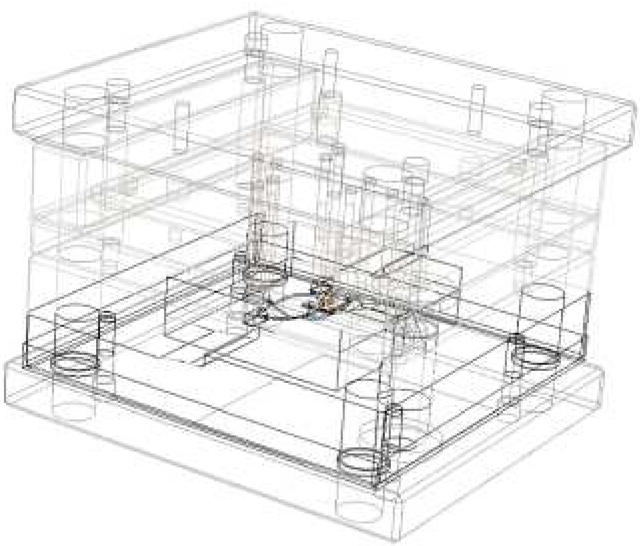


Figure No. 8 Wireframe View Assembly for Pressure Die Casting of Door Handle

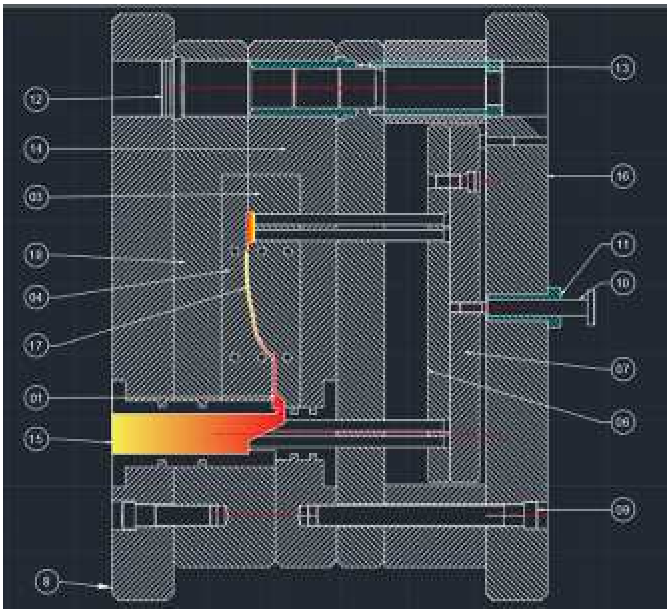


Figure No. 9 Ballooning of Pressure Die Casting of Door Handle

18	Cavity bk Plate	01			
17	Component	01			
16	Top plate	01		EN-8MS	
15	Diffuser				
14	Core Bk Plate	01		EN-8MS	
13	GUIDE BUSH	03	Ø31XØ28X45	EN-31	
12	GUIDE PILLAR	03	Ø31XØ28X108	EN-31	
11	EJECTOR GU. BUSH	04	Ø24X42	EN-31	
10	EJECTOR GU. PILLAR	04	Ø24X94	EN-8MS	
09	SUPPORT PILLAR	04	Ø18X76	EN-31	
08	BOTTOM PLATE	01	246X246X27	C-45	
07	EJECTOR BK PLATE	01	110X246X17	C-45	
06	EJECTOR PLATE	01	118X246X19	C-45	
05	SPRUE BUSH	01	Ø38X93	P-20	
04	CAVITY HOLDER	01	196X246X36	C-45	
03	CORE HOLDER	01	196X246X36	C-45	
02	EJECTOR PIN	04	Ø4X125	STD	
01	CAVITY INSERT	01	80X160X28	O.S	
	PART NAME	QTY	SIZE	MATERIAL	REMARKS

Figure No. 10 Bill of Material of Assembly of Pressure Die Casting of Door Handle

VIII. CONCLUSION

In this project, we carried out the Design and Analysis of Pressure Die Casting for Door Handle. The complete pressure die tool is designed for fabricating Door Handle by using solid work. All the results viz. Stress analysis, deformation analysis are analyzed by using ANSYS software. And also we have design the pressure Die casting tool assembly for Door Handle by considering standard design consideration and it has not shown any error in the analysis.

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