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RECTIFICATION OF DEFECTS IN CYLINDER FRAME CASTING

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Abstract— Casting is a process which carries risk of failures occurrence during all the process of accomplishment of the finished product. Hence necessary action should be taken while manufacturing of cast product so that defect free parts are obtained. Mostly casting defects are concerned with process parameters. Even in completely controlled process, defects in casting are observed and hence casting process is also known as process of uncertainty which challenges the explanation about the cause of casting defects.The objective of the project is to rectify the errors associated with casting of the cylinder frame.

Index Terms— Casting, Casting defecs,Inspection, Poldi test,D P test, , Remedial measures

1.INTRODUCTION

The Metal casting is the one of the direct method of manufacturing the desired geometry of components. it is also known as near net shape process. The Autokast Ltd is casting industry, which produce different castings for customer needs. The cylinder frame is the one of the product of Autokast Ltd. Cylinder frame is an integral part of the machines which houses the engine cylinders and associated engine structures such as coolant passages, intake and exhaust passages, ports and crankcase. Cylinder frame used machines such as tractors,Power tillers etc.

The aim of our project is to rectify the defects associated with cylinder frame and to suggest remedial measures to rectify it. Casting process is based on the property of a liquid to take up the shape of a vessel containing it. When molten metal solidifies it takes the shape of a mould but not exactly the same because there is reduction of volume due to shrinkage. In order to compensate for shrinkage of metal, suitable provisions is to be provided. Thus casting is one of the most versatile forms of mechanical process for production, because there is no limit to size, shape and intricacy of the articles that can be produced by casting.

The major target of this project is to identify the root causes of the defects formed and to rectify it, at minimum cost. We think this attempt will reduce the chances of failures during production. This project have important role in attaining quality of the product. An attempt is made to modify the physical and dimensional constraints to eradicate uneven distribution of molten metal, usage of pre heated cores all of which are described in detail in this report.

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2 LITERATURE REVIEW

2.1 CASTING

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process.

Mostly casting defects are concerned with process parameters. Hence one has to control the process parameter to achieve zero defect parts. For controlling process parameter it is essential to have knowledge about effect of process parameter on casting and their influence on defect. Number of researchers has worked for defect minimisation through process improvement using various tools. A brief review discussed further.

Narayanswamy and Natrajan [1] reviewed various casting defects. They categorise defects into filling related defects (FRD), shape related defects (SRD), thermal defects (TD) and defects by appearance. The monthly percentage of rejection due to these defects is varying from 12.86 % to 15.01 %. The filling related defects are further classified as sand inclusion, rough surface, scabbing, blow holes, chill blow, clay ball hole, sand fusion, and pin holes. Sand related defects are also further classified as mould lift, mould broken, and shift, leakage. The defects by appearance are categorized as DBS blast core missing, swelling, and no core. Out of these defects the filling related defects are to be given importance for the analysis and it is mainly due to the quality of sand. The shape related defects, defects by appearance and thermal defects are due to various factors in mould making process and melting process. Using the modern method and suitable techniques, it is really a boon for the foundry sector to produce quality casting to satisfy the customer requirement. They concluded that quality of castings depends on quality of sand, method of operation, quality of molten metal and environmental conditions etc.

Dr. Shivappa D.N [2] studied TSB castings revealed that the contribution of the four prominent defects in casting rejections are sand drop, blow hole, mismatch, and oversize.

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It was noticed that these defects are frequently occurring at particular locations. Systematic analysis were carried out to understand the reasons for defects occurrence and the reasons identified are; the causes of sand drop were found due to improper cleaning of mould in the areas around chills and mould interface, sleeve, and breaker core. Blow holes occurrence around long member is due to failure to connect flow off in the gating design. The mismatch of castings is due to lack of locators and improper setting of cores. Casting oversize is due to mould lift and mould bulging. Remedial measures identified to overcome the above defects are; (i) Sand drop: proper cleaning of the mould before closing, ensure that sand don't enter into the sleeve, replace no bake core with shell core, provide pads at bottom face, and modified the loose piece design to avoid core crushing. (ii) Blow hole: modification of gating system; flow offs are to be directly connected on top surface of long member. (iii) Mismatch: provided six locators for proper setting of cores - three are of metallic and three are self-locators. (iv) Over size: clamp the moulds properly to withstand the pouring pressure. Production trials were carried out in the foundry for four months period by incorporating the above remedial measures and validated. Outcome of the results showed substantial reduction in rejection of castings.

Sarath and Rathish [3] suggested new approach to produce sound Fg260 gray iron casting by computer simulation through experimental validation in a cast iron foundry. The casting process is simulated by using finite element simulation software and results were compared. A simple rectangular plate casting dimension 200*100*15 mm is produced with different combination of riser dimensions. To improve the yield and minimise defect, cylindrical riser of hemispherical bottom width h/d=1.3was considered. Ansys simulation software was used to compute solidification time and selection of optimal riser dimensions. It was proven by researchers that hemispherical bottom riser consumes 16-17 % less metal than standard cylindrical side riser. Experimental verification was also done to validate results obtained by simulation.

Singh and Kumar [4] analysed defects of check valve namely cold shut, scab and shrinkage. Reduction of causes of these defects like pouring temperature, permeability, mould hardness and sand particles optimised through taguchi's method. In their work l9 orthogonal array is used for the trial purpose. The response of the s/n ratio, contribution of different process parameters and relation between s/n ratio and the levels of different process parameters is studied and analyzed to obtain optimum process parameters. After implementation various experiments and testing techniques they concluded that the optimum value of pouring temperature is 13400 c, permeability is 150(no) , sand particle size is 42 AFS and mould hardness number is 91.132 .

Mane V.V [5] carried out casting defect analysis by using techniques like cause-effect diagrams, design of experiments, if-then rules and artificial neural network. Researcher describes 3-step approach to casting defect identification, analysis and rectification. The defects are classified in terms of their appearance, size, location, consistency and discovery stage and inspection method. This helps in correct identification of defects. For defect analysis, the possible causes are grouped into design, material and process parameters. The effect of suspected cause parameters on casting quality is ascertained through simulation. Based on the results and their interpretation, the optimal values are determined to eliminate defects.

2.2 CASTING DEFECTS

Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameter. Even in completely controlled process, defect in casting are observed and hence casting process is also known as process of uncertainty which challenges the explanation about the cause of casting defects. In order to identify the casting defect and problem related to casting, the study is aimed in the research work. This will be beneficial in enhancing the yield of casting. Beside this, standardization (optimization) of process parameter for entire cycle of manufacturing of the critical part is intended in the proposed work.

This study aims to finding different defects in casting, analysis of defect and providing their remedies with their causes. This paper also aims to provide correct guideline to quality control department to find casting defects and will help them to analyse defects which are not desired.

Casting is a process which carries risk of failure occurrence during all the process of accomplishment of the finished product. Hence necessary action should be taken while manufacturing of cast product so that defect free parts are obtained. Mostly casting defects are concerned with process parameters. Hence one has to control the process parameter to achieve zero defect parts. For controlling process parameter one must have knowledge about effect of process parameter on casting and their influence on defect. To obtain this all knowledge about casting defect, their causes, and defect remedies one has to be analyse casting defects. Casting defect analysis is the process of finding root causes of occurrence of defects in the rejection of casting and taking necessary step to reduce the defects and to improve the casting yield. In this review paper an attempt has been made to provide all casting related defect with their causes and remedies. During the process of casting, there is always a chance where defect will occur. Minor defect can be adjusted easily but high rejected rates could lead to

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significant change at high cost. Therefore it is essential for die caster to have knowledge on the type of defect and be able to identify the exact root cause, and their remedies.

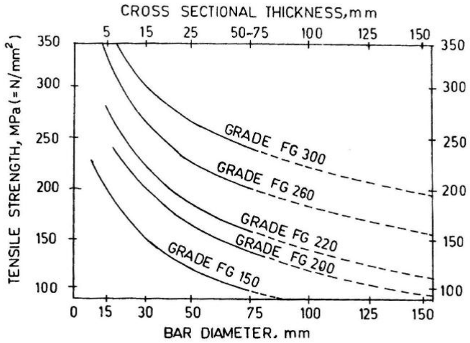

Fig 2:1 Variation Of Tensile Strength And Cross Sectional Thickness Of Grey Cast Iron

Grade (*see* IS 4843)	Tensile Strength *Min* MPa (N/mm²)	Brinell Hardness HBW
(1)	(2)	(3)
FG 150	150	130 to 180
FG 200	200	160 to 220
FG 220	220	180 to 220
FG 260	260	180 to 230
FG 300	300	180 to 230
FG 350	350	207 to 241
FG 400	400	207 to 270

Fig 2:2 Mechanical Test Requirements

3. Design Analysis Of Kamco Cylinder Frame

Table 3:1 Details of the existing design.

1	Name of casting	Cylinder frame
2	For product	KAMCO Ltd
3	Type of casting	Automobile
4	Material	Fg 260
5	Method of inspection	Visual and dimensional
6	Theoretical weight in kilograms	Liquid metal – 60 cast - 40
7	Pattern equipment	Split pattern + 5 core box + loose piece + gating piece
8	Pattern material	Aluminum
9	Core box material	Tb/tc
10	Number of cores	5
11	Method of moulding	HPL
12	Required moulding boxes	750 sq.
13	Method of pouring	Lip
14	Mould loading	Automatic
15	Pouring temperature in degree centigrade	1400-1420
16	Pouring time in seconds	10-15
17	Mould volume	0.43 m3
18	Metal sand ratio	1:16
19	Type of mould	Green sand
20	Type of core	PEPSET – cold box h25&h40
21	Moulding material	Mould – green sand Core – PEPSET
22	Consumption in kg	Mould – 675 Core – 40
23	Core drying	Flame heating
24	Sprue diameter	35
25	Runner size	16/30 x 50 + filter
26	Ingates size	30/31 x 4 – 3 Nos
27	Risers/sleeves	Flow offs – 11 Vents - 6
28	Maximum waiting time of ready mould in hours	1 hr
229	Time of keeping casting in sand in hours	2
30	Kind of fettling	Manual and shot blasting
31	Removing of gates and risers	Chipping and grinding

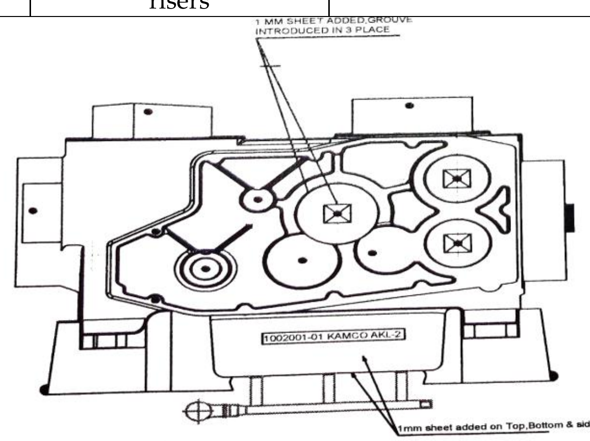

Fig 3:1 Sketch Of Cylinder Frame

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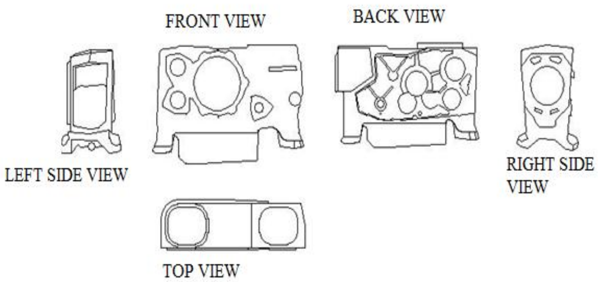

Fig 3:2 Drawing Of Cylinder Frame

4. TEST DETAILS

4.1 Poldi Test

The poldi hardness tester is one of the portable hardness testers. The indentation is obtained on the test surface by striking a blow on the ball which also produces indentation on the standard bar. The diameter of the indentation on the test surface and the standard bar are correlated in the manufacturer's table and the hardness number is measured in BHN.

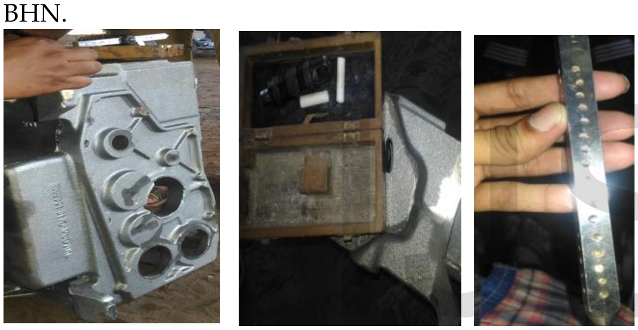

Fig 4:1 Poldi Hardness Testing

Test Result

Table 4:1 Composition Of Elements, Tensile value and Hardness value

CYLINDER FRAME TEST RESULT				
Sl No	Chemistry Of Material		Tensile Value UTM, (N/ mm²)	Hardness BHN
1	C Mn Si P S	3.1 0.6 1.6 0.1 0.12	260	176

Fg 260 grade cast iron is used for the production of cylinder frame casting and these composition of materials such as carbon, manganese, silicon etc are within the standard range of fg 260 cast iron. The required tensile strength of the cylinder frame casting is greater than or equal to 260. The tensile strength obtained for this composition is satisfactory from the test result while the required hardness test is greater than or equal to 180, but the obtained strength in the test is not satisfactory for the cylinder frame casting.

Table 4:2 Changed Composition Of Elements, Tensile value and Hardness value

CYLINDER FRAME TEST RESULT				
Sl No	Chemistry Of Material		Tensile Value UTM, (N/ mm²)	Hardness BHN
1	C Mn Si P S	3.62 0.6 2.18 0.08 0.09	291	186

When small amount of carbon and silica is added, then the amount the value of hardness in poldi test increases to the required rate. The tensile strength is obtained as 291 n/mm² and the hardness in BHN is obtained as 186 and both these values are within the required range. By increasing this element, the grade of the metal may change. The new amount of the carbon and silicon comes under the fg150 grade cast iron.

4.2. Dye Penetrant Test

Dye penetrant inspection also called liquid penetrant inspection or penetrant testing is a widely applied and low-cost inspection method used to locate surface-breaking defects in all non-porous materials.

Observation

Cracks can appear in die castings from a number of causes. Some cracks are very obvious and can easily be seen with the naked eye. Other cracks are very difficult to see without magnification. The highlighted area in figure is the part of the cylinder frame is the place where the oil is stored and this part should be completely crack free part. Any sort of cracks in this part will lead to the leakage of the oil which will leads to the complete rejection of the part.

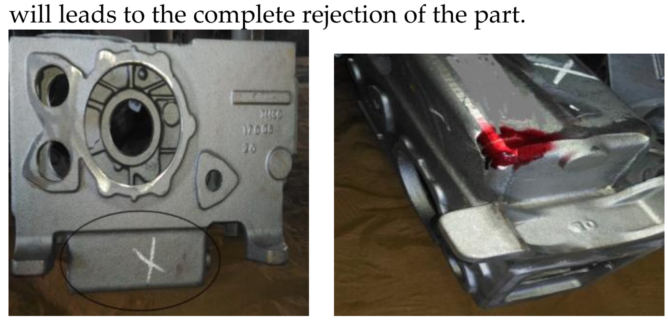

Fig 4:2Die Penetrant Testing

Suggestions

Reduce dry strength, add saw dust/ coal dust, avoid superheating of metal, use chills, provide feeders, correct composition, and reduce sharp corners. Applying these steps in casting will leads to defects free casting.

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4.3. Dimensional Checking With Gauge

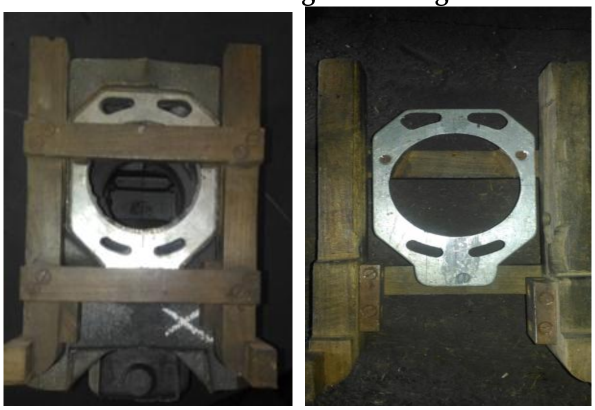

Fig 4:3 Test Using Gauge Special Gauge Used For Cylinder Frame

This gauge shown in figure is used for checking the dimensional accuracy of the cylinder frame. This gauge is specially designed for the cylinder frame casting. The over size or under size of the diameters of the holes in the cylinder frame can be easily checked by using this gauges.

Suggestions

- Check pattern mounting on match plate and rectify, correct dowel
- Use proper moulding box and closing pins

4.4 Visual Inspection

Fig 4:6 Visual Inspection: Sand Inclusion

Fig 4:4 Visual Inspection: Blow Hole

Visual inspection is the commonly used method used to check the defects in casting. The cylinder frame casting is a hollow frame with wall thickness 14 mm. Since the thickness is very small the inspections such as ultrasonic inspection, radiography etc cannot be done on it.

Suggestions

- Increase the strength of the cores. Use greater proportion of binder.
- Check moulds for pressure marks and, if necessary, insert pressure pads
- Carefully blow out mould cavities
- Check the moulding plant for uniform flask stripping and overhaul moulding plant as necessary
- Ensure uniform mould compaction, avoid over compacted sections clay bonded sand

For blow holes

- Make adequate provision for evacuation of air and gas from the mold cavity.
- Increase permeability of mold and cores.

Table 4:3 Test Result And Conclusions

Sl. No	Test Conducted	Problem Identified	Solution
1	Poldi Test	Strength	• Improve composition by adding small amount of carbon and silicon
2	Die Penetrant Test	Crack	• Avoid super heating of metal • Reduce sharp corners • Use chills
3	Test Using Gauges	Dimensional Error	• Check pattern mounting on match plate • Using moulding box and closing pins
4	Visual Inspection	Sand Inclusion	• increase core strength • Ensure uniform mould compaction, avoid over compacted sections clay bonded sand

5 CONCLUSION

The project was conducted on rectification of defects formed in the casting of cylinder frame at Autokast Ltd. We were able to learn in detail about the casting methods involved for the manufacturing of different castings. The data received was put in to good use through the computing skills that we were able to procure during our time here at the company. Casting defects cause a serious problem in foundry industry often leading to losses of raw materials and financial loss.

The main defects identified are crack, blow hole, sand inclusion, and shrinkage. The defect crack is due to lack of strength and it has been rectified by varying the composition of the elements and the solutions for the other defects are suggested.

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