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Research Paper

Reduction of cost in castings by the method of radiographic test

T. Soundharya [1], N.V. Dhandapani [2]

[1]*Assistant professor, karpagam college of Engineering, Coimbatore.*
[2]*Professor, karpagam college of Engineering, Coimbatore.*

Abstract

Foundry in developing nations endures from low quality and low output due to the incidence of defects that may occupy single or multiple causes. Hence casting is a process of uncertainty. It is not an easy task, since casting is a complex process and has connections among various process and operations. Casting defects can negatively impact the bottom line of a foundry. Here an attempt is made cost cutback of castings in radiographic test. There are many defects which can be identified through radiographic test and these defects are reduced or remedied by means of welding. This study focuses about the cost reduction of castings by means of "Total quality management tools".

Keywords: *Casting Defects, Radiographic Test, Cost Reduction, Total Quality Management Techniques.*

1. Introduction

Metal casting would be a simple and multifaceted one. From a very elementary view, molten metal just stuff a mould and let it solidify, structure as a cast component. However, different metal casting processes will have their own reward and benefits in corresponds to their specific alloy. But top promoters insist fault-free castings on scheduled time. Since casting is not a one single process, it involves complex associations among various parameters and operations linked to metal composition, design procedures, melting, pouring, shake-out, fettling and machining. This is one frequent problem foundries are finding it not easy to meet up.

Fig. 1: 18"600 Bonnet

Fig. 2: 30"300 Body

2. Problem Description

Casting defects are those kinds that create a insufficiency or flaw to quality specification forced by design and service requirements. The castings defects are generally thermal defects and defect by appearance. A shrinkage defect begins due to inadequate feed metal as the metal solidifies. Cracks can appear in die castings from a number of causes Such as Shrinkage of the casting within the die, Undercuts or damage in die cavities, thermal imbalances, insufficient draft in section etc. so such defects results in low quality products and higher production cost.

3. Literature Survey

Rajesh Rajkolhe, J. G. [1] Khan diversified casting defects and their origin causes of occurrence and also provided a right guideline to quality control department to sort out casting defects which will help them to investigate defects that are not needed. C. M. Choudhari, B. E. Narkhede, S. K. Mahajan [2] suggested an intellectual method and simulation for reducing casting defects using casting software.

Sunil Chaudhari, Hemant Thakkar [3] reviewed the works of several researchers and attempted to get procedural solution for minimizing various casting defects and qualified the whole method of casting manufacturing. Ganesh G. Patil and K. H. Inamdar [4] presented a review on use of Artificial neural network (ANN) for the casting processes better than the other techniques such as design of experiment (DOE), inspection method, casting simulation, cause-effect diagram, genetic algorithm, fuzzy logic. Achamyeleh A. Kassie, Samuel B. Assfaw [5] studied four process parameters like Sand – binder ratio, Mould permeability, Pouring Temperature and De-oxidant amount in three levels and the relative influence of each factor on the casting defect/porosity/ was determined. Statistical Analysis method was suggested as a tool to optimizing the process parameters. B.R. Jadhav, Santosh J Jadhav [6] used quality control methodology to detect the defect reduction by controlling alloy composition and pouring temperature. Rallabandi srinivasu, g. Satyanarayana reddy, srikanth reddy rikkula [7] used statistical process control tools in order to improve quality and productivity of product or process. K. Siekanski etal [8] used a quality control tool to examine the casting defects and improve the quality of casting product. Ishikawa diagram and Pareto chart are used for data analysis. Xiaoli Li and SK Tso [9] used x-ray inspection processed by traditional method and wavelet technique to facilitate automatic detection of internal defects. Mr.Siddalingswami, S.Hiremath [10] presented a review on literature of different methods adopted by many foundries to reduce the percent of rejection by using a Casting simulation software and Various casting quality improvement techniques such as; Product Process Search analysis (PPS) and Inspection methods.

4. Methodology

A. Radiographic Test

One of the techniques used for the exposing of interior defects in castings is radiographic testing, a best non-destructive methods for discover internal defects, such as shrinkage and inclusions.

In this method, a casting radiated through an x-ray tube. Iridium and Cobalt would be a radiation source. In this process, a part radiation absorbed by casting and the remaining portion exposed to the radiographic film. Thicker materials absorb more radiation and film got lesser degree of radiation leaving a lighter appearance. More radiation penetrated in less dense area correlates a difference in darkness on the film. Area encloses hole, crack or inclusion will be reflects a dark area.

B. Quality Control Tools

An aspect of quality assurance process engages number of activities in measurement and detection of the inconsistency in the characteristics of output attributable to the production system and hold close corrective responses. Seven basic quality tools each uses a set of graphical techniques will helpful in troubleshooting issues related to quality are listed below.

1) Flow Chart
2) Check Sheet
3) Cause-and-Effect/ Ishikawa diagram /Fishbone diagram
4) Pareto charts
5) Control Chart
6) Histogram
7) Scatter Diagram

In this work histogram, check sheet, and Pareto charts are used to analyze the problem.

Check sheet:

Check sheet, an ordered, organized form for collecting and analyzing data. It is used for a wide diversity of function. Here it employed for collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, etc.

Histogram:

Histogram, a bar graph used to present frequency data. Histograms give an easy way to assess the contribution of data over different categories.

- Define the Categories of Data.
- Gather Data and arrange them into the categories.
- Count the Data in each category.
- Draw the Diagram for each category on the x-Axis. The diagram will be in the form of bars which will be as high as the value for the category.

Pareto Chart:

Pareto Charts assist to apply the 80/20 rule of Joseph Juran under the statement 80% of the problems are the result of 20% of the occurrences. A Pareto Chart identifies the 20 percent root causes of problem.

Steps in making Pareto Charts:

- Characterize the number of categories.
- Class the data into the Categories and find out the rate of incidence of each category.
- Finally bring together the group in descending order

Table 1: Defect analysis: R0 & R1 defect

Sl no	Item	Heat No	RT No	DEFECTS (R0)					Total Rods	DEFECTS (R1)				SLAG	Total Rods
				CA/CB/CC	D	SD	E	slag		CA/CB/CC	D	SD	E		
1	36" 150 Body	4245	EC1130	423		30			453	39					39
2	36" 150 Body	4280	EC021	15					15						
3	36" 150 Body	4275	ECC020	160					160						
4	12"2500 Body	4296	ECS518						0		30				30
5	24"300 Body	4141	EC1118	145	55				200						295
6	12"2500 B/W Body	4295	ECS517		20				166						
7	30"150 Bonnet	4154-2	EC1094	632		46			678	26					26
8	20"150 GTV B/W Body	4213	EC1114						241						
9	20"600 Plug Body	4273	EC1131	179					179						
10	20"600 Plug Body	4268	EC1124	266		40			306						0
11	30"150 Bonnet	4154	EC1099	733					733						0
12	30" 150 Body	4145	ECS513	262	104	15			381						0
13	20"600	4237	EC1120						20						
14	24"300 Body	3957	EC1016	335					365						
15	24"300 Bonnet	4231	EC1116	207					207						0
16	16"900 Body	4221	EC1127						0						0
17	16"900 Body	4221	EC1128						0						0
18	36" 150 Body	3920-3	ECR127						0	191					191
19	30" 150 Body	3857	ECC018	425					425						0
20	24"300 SCV B/W Body	4252	EC1122	312	100				412						0
21	18"600 Body	4120	EC1108	92					92						0
22	10"*8 300CL EW Body	4205	EC1098	111					111						0
23	24"300 Body	4159	EC1101	37					37						0
24	30" 150 Body	4145	ECS513						0						0
25	24"300 Bonnet	4131	EC1103	101					101						0
26	24"300 Body	4153-2	EC1104	40					40						0
27	30" 150 Body	3853	ECI278	240					240						0
28	24"300 Body	4108	EC1086	334	47				381		1				1
29	30"150 Bonnet	3839	ECS491						0	89	40				129
30	30" 150 Body	3858	ECI279	20		75			95						0

Where,

RO - Radiographic test -1
R1 - Radiographic test - 2
CA/CB / CC- shrinkage
SD -surface defect
D - Crack
E - Chaplet

Table 2: Radiographic test – 1

Welding defect	CA/CB/CC	D	SD	E	Slag
Welding rods	11649	1380	277	0	0

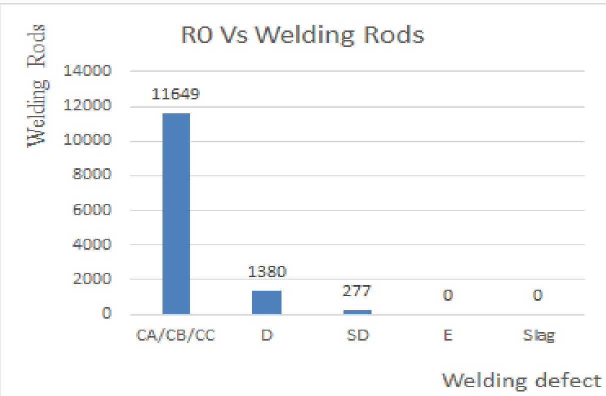

Fig. 3: R0 vs. welding rods

Table 3: Radiographic test – 2

Welding defect	CA/CB/CC	D	SD	E	Slag
Welding rods	1797	301	0	0	290

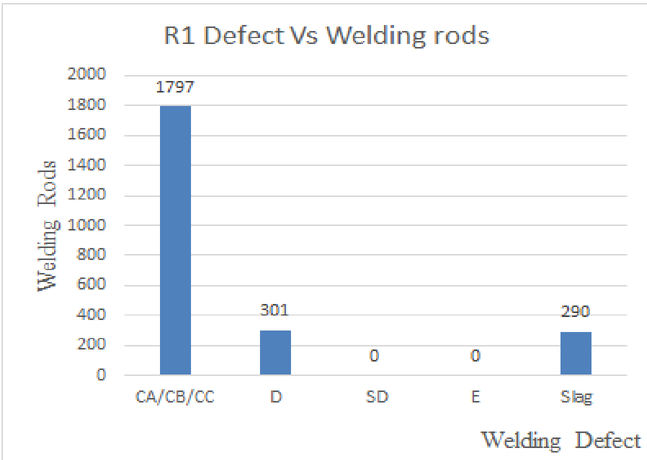

Fig. 4: R1 vs. welding rods

Table 4: Radiographic test – 3

Welding defect	CA/CB/CC	D	SD	E	Slag
Welding rods	153	30	0	0	29

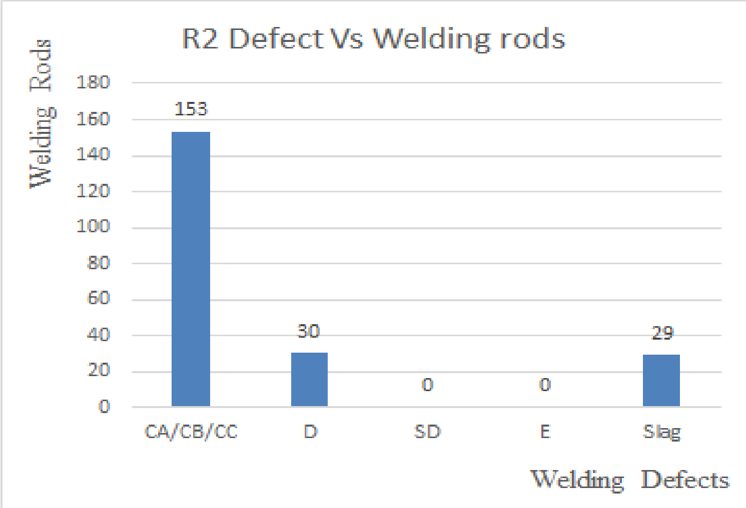

Fig. 5: R2 vs. welding rods

Table 5: Reduction of welding rods

Sl no	Item	Heat No	RT No	DEFECTS (R0)					Total Rods	25%	25% Reduction	50%	50% Reduction	75%	75% Reduction	Rate
				CA/CB/CC	D	SD	E	slag								
1	36" 150 Body	4245	EC1130	423		30			453	113.25	339.75	226.5	226.5	339.75	113.25	2265
2	36" 150 Body	4280	EC021	15					15	3.75	11.25	7.5	7.5	11.25	3.75	75
3	36" 150 Body	4275	ECC020	160					160	40	120	80	80	120	40	800
4	12"2500 Body	4296	ECS518						0	0	0	0	0	0	0	0
5	24"300 Body	4141	EC1118	145	55				200	50	150	100	100	150	50	1000
6	12"2500 B/W Body	4295	ECS517		20				166	41.5	124.5	83	83	124.5	41.5	830
7	30"150 Bonnet	4154-2	EC1094	632		46			678	169.5	508.5	339	339	508.5	169.5	3390
8	0"150 GTV B/W Bod	4213	EC1114						241	60.25	180.75	120.5	120.5	180.75	60.25	1205
9	20"600 Plug Body	4273	EC1131	179					179	44.75	134.25	89.5	89.5	134.25	44.75	895
10	20"600 Plug Body	4268	EC1124	266		40			306	76.5	229.5	153	153	229.5	76.5	1530
11	30"150 Bonnet	4154	EC1099	733					733	183.25	549.75	366.5	366.5	549.75	183.25	3665
12	30" 150 Body	4145	ECS513	262	104	15			381	95.25	285.75	190.5	190.5	285.75	95.25	1905
13	20"600	4237	EC1120						20	5	15	10	10	15	5	100
14	24"300 Body	3957	EC1016	335					365	91.25	273.75	182.5	182.5	273.75	91.25	1825
15	24"300 Bonnet	4231	EC1116	207					207	51.75	155.25	103.5	103.5	155.25	51.75	1035
16	16"900 Body	4221	EC1127						0	0	0	0	0	0	0	0
17	16"900 Body	4221	EC1128						0	0	0	0	0	0	0	0
18	36" 150 Body	3920-3	ECR127						0	0	0	0	0	0	0	0
19	30" 150 Body	3857	ECC018	425					425	106.25	318.75	212.5	212.5	318.75	106.25	2125
20	4"300 SCV B/W Bod	4252	EC1122	312	100				412	103	309	206	206	309	103	2060
21	18"600 Body	4120	EC1108	92					92	23	69	46	46	69	23	460
22	0"*8 300CL EW Bod	4205	EC1098	111					111	27.75	83.25	55.5	55.5	83.25	27.75	555
23	24"300 Body	4159	EC1101	37					37	9.25	27.75	18.5	18.5	27.75	9.25	185
24	30" 150 Body	4145	ECS513						0	0	0	0	0	0	0	0
25	24"300 Bonnet	4131	EC1103	101					101	25.25	75.75	50.5	50.5	75.75	25.25	505
26	24"300 Body	4153-2	EC1104	40					40	10	30	20	20	30	10	200
27	30" 150 Body	3853	ECI278	240					240	60	180	120	120	180	60	1200
28	24"300 Body	4108	EC1086	334	47				381	95.25	285.75	190.5	190.5	285.75	95.25	1905
29	30"150 Bonnet	3839	ECS491						0	0	0	0	0	0	0	0
30	30" 150 Body	3858	ECI279	20		75			95	23.75	71.25	47.5	47.5	71.25	23.75	475

Table 6: 36"150 body welding rod reduction

Total rods	25% reduction rod	50% reduction rod	75% reduction rod
453	340	227	113

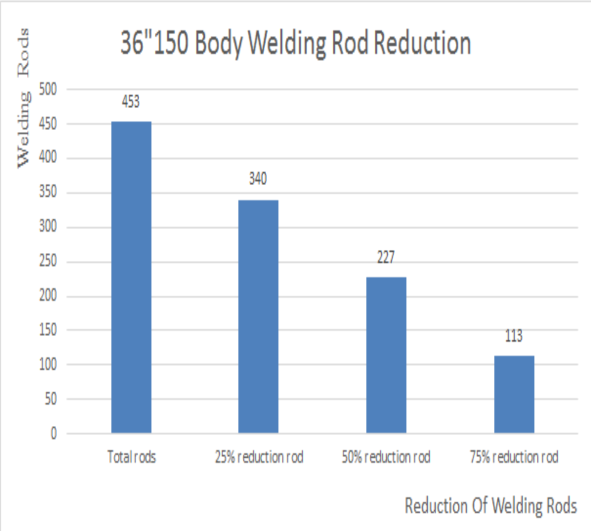

Fig. 6: welding rods vs. welding rod reduction

Table 7: Total no of welding rod reduction

Total rods	25% reduction rod	50% reduction rod	75% reduction rod
13743	10307	6872	3436

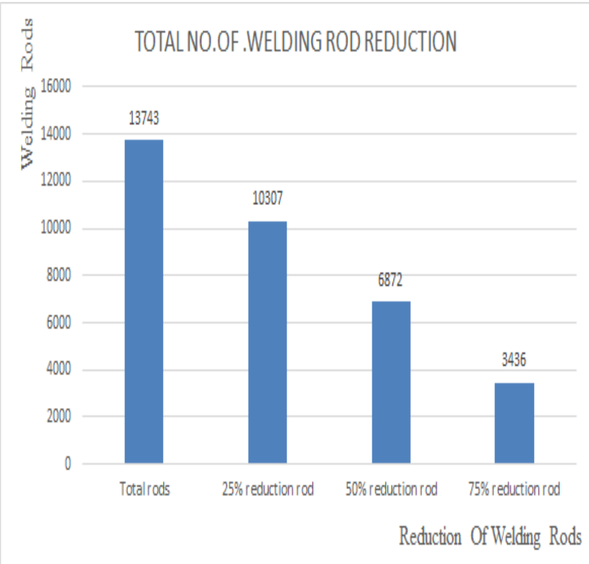

Fig. 7: Welding rod vs. reduction of welding rods

Table 8: cost reduction of welding rods

Total rods rate (Rs)	25% reduction rate (Rs)	50% reduction rate (Rs)	75% reduction rate (Rs)
274860	206145	137430	68715

Table 9: 36"150 body reduction of rate

	Total no.of.flim & Rods	Total Film rate	25% reduction	rate	50% reduction	rate	75% reduction	rate
RT Flim	17	4131	17	4131	17	4131	17	4131
Defect open	90.6	1812	67.95	1359	45.3	906	22.65	453
Welding rod	453	9060	339.75	6795	226.5	4530	113.25	2265
RT Flim	17	4131	17	4131	17	4131	17	4131
TOTAL rate	TOTAL Rate	19134	25% reduction	16416	50% reduction	13698	75% reduction	10980

Table 10: Total cost reduction

	Total no.of.flim & Rods	Total Film rate	25% reduction	rate	50% reduction	rate	75% reduction	rate
RT Flim	354	85900	354	85900	354	85900	354	85900
Defect open	2748.6	54972	2061.45	41229	1374.3	27486	687.15	13743
Welding rod	13743	274860	10307.25	206145	6871.5	137430	3435.75	68715
RT Flim	354	85900	354	85900	354	85900	354	85900
TOTAL rate		501632	25% reduction	419174	50% reduction	336716	75% reduction	254258

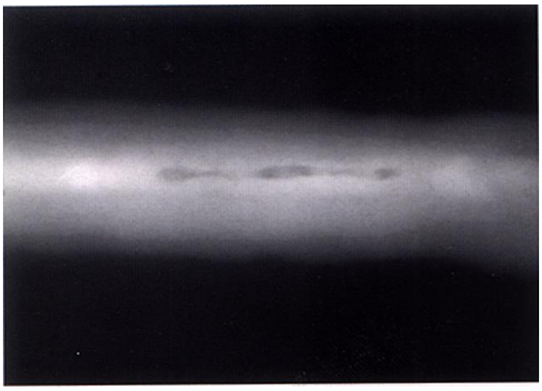

Fig. 3: Radiographic image of slag inclusion

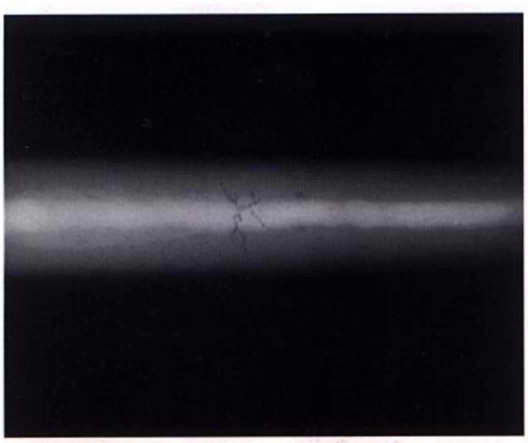

Fig. 4: crack defect radiographic image of crater crack

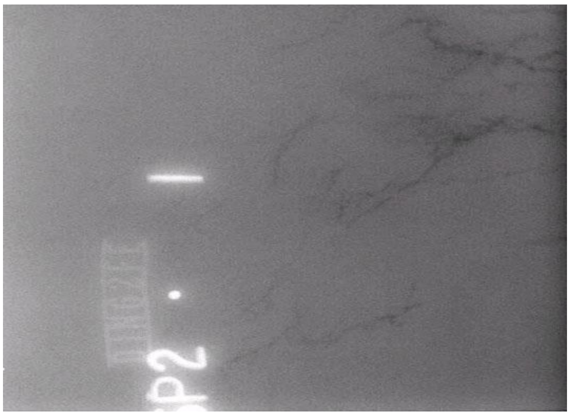

Fig. 5: Shrinkage defect in RT

5. Results and Discussion

In these paper different types of thermal related casting defects are studied and we found that the shrinkage is the major defect that occurs in the castings when it is tested under the radiographic test. By avoiding sharp corners, edges, early knockout and reducing the pouring rate, pouring time and by increasing metal pouring temperature we can avoid these defects.
The welding rods that are used to remove the defects and their costs and the radiographic films that are used and their costs has been estimated.

6. Conclusion

A defect like cracks and shrinkages plays a major threat in quality of casting. Shrinkages can be eliminated by using of chills at correct position for direct solidification and Proper pouring temperature rate. Correct composition, Use of fine sand grains can be the remedial measures to avoid cracks.
From our analysis we suggest that the pouring temperature of metal should be 1580 deg to 1630 deg Celsius for steel castings to avoid shrinkage defects. Our paper will definitely be helpful to increase the productivity and yield of the castings.

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