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IMPLEMENTATION OF LEAN SIX SIGMA PRINCIPLES IN A SAND CASTING FOUNDRY OF GUJARAT

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ABSTRCT

Gujarat is a famous for producing cast component using sand casting processes. In Gujarat Rajkot, Bhavnagar, Ankleshwar, Vadodara, Ahmedabad are major district for sand casting component. Mainly Rajkot is a hub for casting a automobile component. In LSS application we tried to improve the productivity and waste elimination from the foundry sector. During pouring of liquid metal some portion of metal is solidified before pouring so we design a new ladle system with locking system. So author prepared a LSS model to implement LSS in sand casting foundry of Gujarat and improve the ladle capacity.

Keywords: LEAN SIX SIGMA, Foundry, Gujarat.

KAMANI FOUNDRY: IMPLEMENTATION OF LSS MODEL

STEP 1: Introduction about the Company

M/s. Kamani foundry, was established in 1969 by late shri. Khimjibhai kamani, started with the main objective of providing engineering and industrial products. Since the inception of their establishment, they have been striving to offer the highest level of satisfaction to their esteemed clients through the media of their quality products. Mr. Pragjibhai kamani and Mr. Amit kamani are the directors of kamani foundry., has considerable expertise in dealing with all sorts of industrial products ranging from fg 200 to fg 260 grades of grey cast iron casting. This foundry situated in AJI, G.I.D.C., PHASE – II, N' ROAD, RAJKOT – 360 003

STEP 2: Identify the scope of LSS application

Yes.

Step 3: VSM of the process

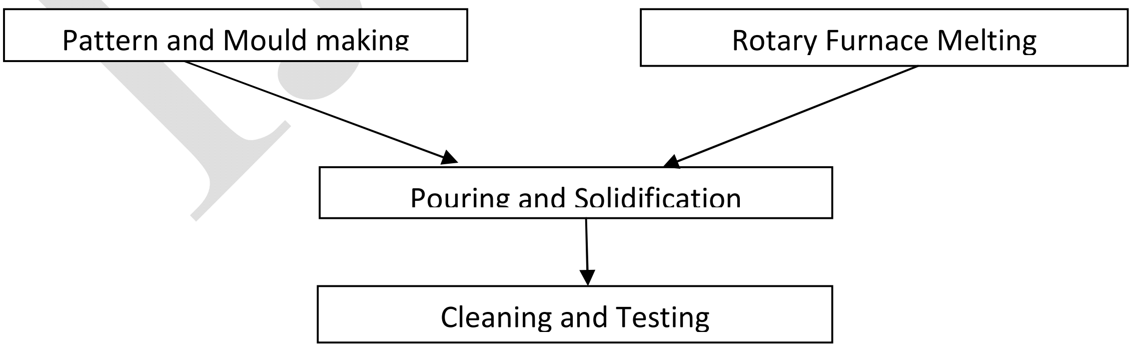

Fig 1.1: Mapping the processes in Kamani Foundry, Rajkot

Step 4: checking feasibility of applying LSS tools and techniques

By referring to the map developed in the previous steps of the AUTHOR lists the tools and techniques that could be applied to overcome wastages and rejection rates under each process. With this map in hand, the AUTHOR convenes a meeting of supervisors and operators to discuss about the feasibility of applying the tools and techniques specified under each process. During this meeting, the feasibility of applying these tools and techniques is discussed. Particularly the capability of operators in applying the chosen tools and techniques and practical benefits of applying them in reality were considered to decide the feasibility of applying LSS tools. After considering these factors, four tools and techniques were removed from the consideration. Now AUTHOR consults the top management about adopting the tools and techniques to overcome occurrence of wastes and defectives under each process. The management agrees to allow the application of all tools and techniques except one. That tool is removed from the consideration.

Step 5: Deciding the team and area of applying LSS

Under this step, the AUTHOR examines the stage of applying LSS. After studying the waste level and rejection rate, the AUTHOR decides to apply LSS in pattern making area. Subsequently the AUTHOR invites supervisors and operators who are interested to involve in applying LSS in the pattern making area. In response to this invitation, one supervisors and six operators volunteer to become team members of LSS. The AUTHOR interviews these team members. The AUTHOR develops confidence that, it is possible to apply LSS in the patter making area and overcome the occurrence of wastes and rejection of the patterns. The AUTHOR informs the top management about the formation of this LSS team. The management approves the formation of this LSS team and carrying out the subsequent steps.

- **Project number:1**
- **Project Title: Quality Improvement in Melting and solidification**
- **Team Leader : Darshana Kishorbhai Dave**
- **Team Members: Mr. (M.D .1.) Mr. Pragjibhai Kamani and (M.D.2) Mr. Amit Kamani**
- **Project Duration: 4 Months**

Step 6: ***Imparting training and education***

The AUTHOR studies the chosen LSS tools and techniques by referring to the case studies reported by the researchers and practitioners. After gathering this knowledge, the AUTHOR designs training modules on these chosen LSS tools and techniques. By making use of these training modules, the AUTHOR trains the team members to apply the chosen LSS tools and techniques in practice.

Step 7: Defining the problem

Under this step, the AUTHOR discusses with the LSS team members to choose the problem. The LSS team members inform that the occurrence of high level of wastes and rejection rate is due to the inappropriate shrinkage allowance assigned during the designing of patterns. Thus this problem was defined and the project charter was developed by the AUTHOR and LSS team members. This project charter is shown in Figure 1.2.

- *Date of starting the project:* July 1, 2014
- *Date of completing the project:* September 3, 2014
- *Project deliverables:* Waste elimination and zero defect in melting and solidification.

LSS Project

Project number: 1

Project title: Quality improvement in Cupola charging, melting and solidification (QII PM)

Team leader: DARSHANA DAVE

- *Team members*: **Mr. (M.D .1.) Mr. Pragjibhai Kamani and (M.D.2) Mr. Amit Kamani**
- *Problem definition*: Assigning inappropriate method leads to the occurrence of higher wastes and rejecti solidification.

Project duration: 3 months

Fig. 1.2: Project charter

Implementation of Six Sigma (D-M-A-I-C) Methodology

Identify the Problem in Kamani Foundry ,Rajkot: Develop a new ladle system design with zero solidification

Step 8: Measuring the performance

While executing this stage, under the direction of the AUTHOR, the team members assess the waste level under seven categories that occurred due to the mistake in giving proper shrinkage allowance in the patterns. These seven categories are, Over production, Defects, Delay, Unnecessary motion, Transportation, Inappropriate Processing and Unnecessary Inventory. Subsequently, the number of castings rejected due to the existence of this problem in the foundry is determined by the LSS team members.

Depends upon the end use of ladle can be classified in to three categories: 1. Casting ladle (to pour molten metal in to mould);2.Transfer ladle(Torpedo ladles to transfer the molten metal from source of melting to automatic pouring unit as in continuous casting process) and 3 . Treatment ladle (used as mixing of various elements to obtain metallurgical properties or to convert C.I. to ductile iron) . In transfer Ladle Refractory lining materials like precast firebricks or refractory concretes are used to avoid melting of steel ladle shell. Ladles can also classified according to hand operated ladle, overhead crane operated ladle and special purpose wheel car used in steel plant.

General design of ladle is vertical cone while tapered cone type shell gives more strength and rigidity. In small scale foundries drum ladle is made up of horizontal cylinder which is suspended between two carriers or bogies. Furthermore ladle is either open or dome shaped with removable covered lid to reduces drop down of heat/temperature of molten metal to avoid solidification of molten metal in ladle itself. In small ladle ceramic coating is used if required.

In large scale industry, medium and large ladles operated through shafts on an overhead crane by means of worm gear type gearbox which is operated either by large hand wheel or an electric motor. Figure 1.3 shows a pouring of molten metal through overhead crane and ladle.

Fig. 1.3: Pouring of molten metal through overhead crane and ladle

Step 9: Analyse the problem

The AUTHOR and LSS team members carry out the Why-why analysis to determine the cause of occurrence of the defined problem. Figure 1.4 shows a present ladle locking design. When handle in down position than rod of gearing system goes to up position .When rod of gearing system goes to up than also rod of lock goes to up position .When rod of lock goes to in up position then metal goes to outside of the ladle i.e. in molding box. But when lock is closed than some part of metal stick on mouth of hole show in figure. Some part of metal are wasted, and this wasted metal goes again in furnace.1kg-1.5kg metal are wasted per ladle. Use of old design ladle, very large times are consumed and low productivity. More man power is required. More electricity is required for old locking system of ladle. One advantage of old locking system of ladle is that only reciprocating motion is required, so life of locking system is more.

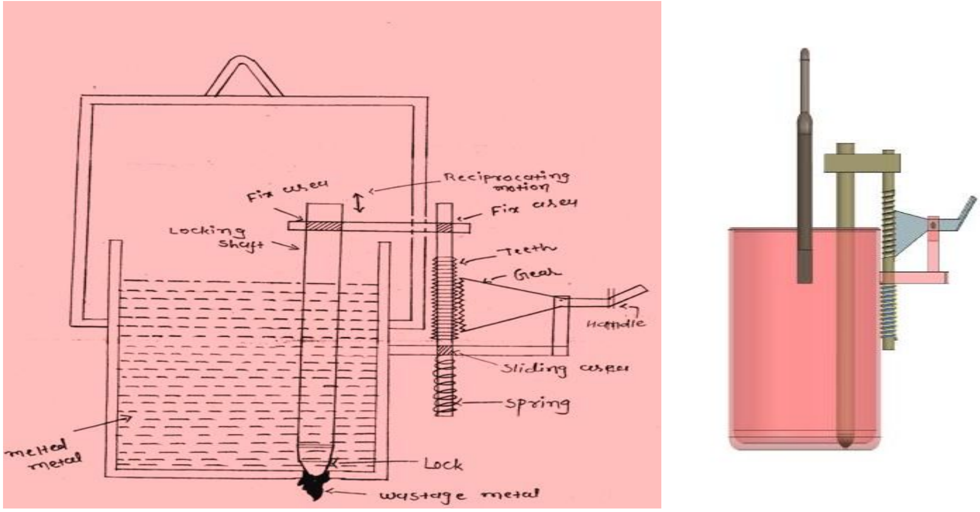

Fig. 1.4: Present ladle design

Step 10: Improve by providing solutions

Figure 1.5 shows a new design of locking system of ladle. When handle of reciprocating motion is goes to in upward position than rod of gearing system is goes in downward position. When rod of gearing system is goes in downward position than also rod of lock is goes to in downward position and then handle of rotating motion are used. When handle will rotate than lock goes on slide way so in figure and metal goes to outside of ladle i.e. in molding box. In last, when lock is closed then metal does not to go in outside of ladle so metal are not wastage. But in new ladle, metal are goes in inside of ladle Use of new locking system, very low times are consumed than old locking system. Productivity goes to high than old locking system. Low electricity are required than old locking system. More customer satisfaction than old locking system. One disadvantage of new locking system is that short life.

Advantages:

- High productivity.
- Low manpower is required.
- Low times are required than old locking system.Low electricity are required than old locking system**.**

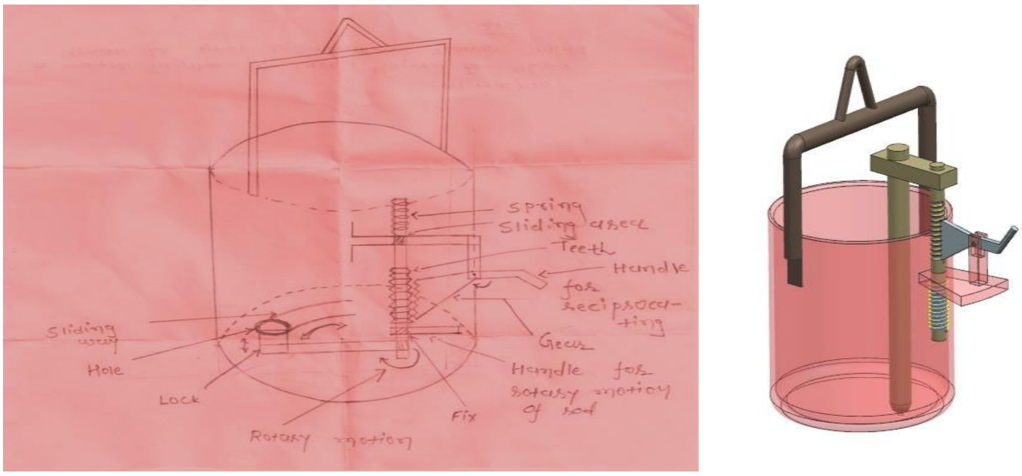

Fig. 1.5: Improved ladle design

Step 11: Implementing the solutions

With the improvement in ladle design we can reduce the solidification of molten metal in ladle by 15 to 20% per ladle and minimum 45 to 50 ladle required per shift , saving in thousands of rupees par ladle.

Step 12: Controlling the implementation of the system

The AUTHOR and LSS team members prepared an audit sheet to check the continuance of the system installed in the previous step. The AUTHOR and LSS team members conduct audit on the second Saturday of the month. When deviations are found, the AUTHOR and LSS team members take swift actions to restore the status queue.

Step 13: Assess the level of acquiring core-competencies

The AUTHOR appraises the top management about the implementation of solutions. The top management receives reports from different sections about the occurrence of wastes and rejection of castings. From these reports, the top management understands that, there has been nearly no wastages and rejections due to the installation of the system of LSS. The customer who receives the first consignment also informs that the quality of castings is superior in comparison to those are supplied by other foundries. These observations indicate that the application of LSS enables the foundry to acquire core-competencies.

DISCUSSION

AUTHOR found difficulty in step 5, 6 ,12 and 13 to implement LSS while stage 7 to 10 easy stages of LSS. Challenges involved in implementing LSS in foundries .Majority of foundry data not available and they are unable to give the necessary data because they have not much information related to lean and six sigma technology. Investors of small scale foundry industry are capable to accommodate LSS MODEL but they are afraid to shake their foundry secrets in researchers as well as common practitioners of same manufacturing component**.** With the improvement in ladle design we can reduce the solidification of molten metal in ladle by 15 to 20% per ladle and minimum 45 to 50 ladle required per shift , saving in thousands of rupees par ladle.

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