International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 7, Issue 3 (March 2018), PP. 01-05

Handling and Finishing Of lineRollers in Steel Melt Shop

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ABSTRACT: An integrated steel plant has all the functions for primary steel production:

- Iron making (conversion of ore to liquid iron),
- Steel making (conversion of pig iron to steel),
- Bloom casting (production of large blocks of steel),
- Roughing rolling/billet rolling (reducing size of blocks)
- Product rolling (finished shapes).

The project is about repair technology of HFL roller widely used in steel melting shop where bloom casting takes place. Liquid steel from LD converter is shifted to continuous casting machine for producing blooms. Roller tables convey these blooms to Bloom Storage Yard (BSY). The roller tables are fitted with rollers. And these are known as Handling and Finishing Line Rollers (HFL). These rollers are exposed to very high temperatures. Hence failures of these rollers are frequent.

There are 84sets of rollers (i.e. 336 Rollers) installed in Steel Melt Shop at Continuous Casting Department. Each set contains 1 Drive & 3 Non Drive Rollers. Failure of these rollers leads to hindrance in production. The project work deals with repair of rollers & improving the existing process of repair at Central Machine Shop / Engineering Shops and Foundry Dept.

The project work high lights the failures & suggests the repair technology of roller by surfacing (built up by welding process), Re-machining built up portion, replacement of bearings after observing failures, repair or replacement of gear wheel, and a significant use of 2 measuring instruments to conserve time.

KEYWORDS : Bloom casting, Bloom Storage Yard, Product rolling, Roughing rolling, Steel making,

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Date of Submission: 12-03-2018 Date of acceptance: 27-03-2018

I. INTRODUCTION

There are two ends in a HFL roller. They are the drive & non-drive ends. Dismantling of roller involves various stages. There are 5 parts connected to a roller at drive end. They are spur gear, bearing, circlips, sleeve and through cover. The gear is removed by applying force through 315T horizontal forcing hydraulic press. The same process removes the bearing or by oxy acetylene gas cutting and circlips are removed by using circlip plier.

Failure analysis of components:

1. ROLLER:

- Worn out of roller bearing seat due to spalling.
- Wear out of through cover due to abrasive action.
- Thermal wear on surface of roller due to travelling of hot blooms over it.

Shearing of roller at the neck on drive side before bearing seat due to severe shock loads/failure of bearings.

2. GEAR WHEEL

3. BEARINGS

4. CIRCLIPS: - a) Breakage of circlip due to heavy axial load.

b) Deflection / deformation of circlip due to thermal stresses.

5. DISTANCE SLEEVE: -

Crushing of sleeve between gear & bearing due to sliding of any one of them.

6. THROUGH COVERS: -

Wear out of bore due to rubbing against roller. Function of the equipment:

The function of Handling and Finishing rollers (HFL Rollers) is to convey the casted hot blooms after gas cutting at Gega Gas Cutting Machine to Bloom Storage Yard. Any breakdown of these rollers will stop the production of blooms casting which in turn effect the liquid steel production. In order to improve availability of equipment the rollers to be ready for immediate replacement.
The damaged rollers of roller table are being sent to Central Machine Shop for carrying out necessary repairs.

II. PLANNING OF REPAIR IN ROLLER COMPONENTS:

ROLLER: -
1. To be replaced with new if roller body surface is 30% damaged by etched out surface.
2. To be sent for Thermit welding for joining a bar in place of sheared off portion. This roller is then machined to size as per drawing.
3.Applying bearing retainer (e.g. Loctite 642) on bearing seats on roller before mounting bearings, if the wear out is within 0.10mm in diameter.
4. Built up of worn-out surfaces of roller by welding technique known as Surfacing. This roller is then machined to specified dimensions as per drawing.
This portion of repair will be discussed elaborately in this project.

GEAR WHEEL: -
1. Spur gear can be reutilized if wear out of teeth is within 15% at the pitch circle diameter of gear as set by Plant Design Department of VSP.
2.Replace the gear if pitting observed over a length of entire flank.

BEARINGS: -
Any failure observed as per the list mentioned in Failure Analysis, it is deemed that bearing should be replaced with new.

CIRCLIPS: -
There is no repair procedure for this, so they should be replaced with new if old is in damaged condition.

DISTANCE SLEEVE: -
To be replaced with new if crushed.

THROUGH COVERS: -
Even though surfacing and subsequent machining can repair it, it is not viable. So these to be replaced with new. Repair technique: Surfacing by process of welding
Whatever the causes of wear facing of surfaces by welding has been accepted as a solution to the problem and can reduce maintenance costs to the minimum. Weld metal with the correct metallurgical properties for the type of service encountered can be deposited where it is most needed and only where it is needed. In many instances may even be worthwhile economically to face new components before use, thus putting a protective layer on the part and obtain longer life at higher efficiency.

Pre weld preparation:
Thorough cleaning of surfaces to be welded from dust, rust and foreign particles
Remove oil and grease on surfaces to be welded by heating.

III. METAL DEPOSITION ON WORN OUT SURFACES BY WELDING PROCESS:

Welding process: Metal Arc Welding
In arc welding processes, the heat is generated by an electric arc between base metal and a consumable electrode. In this work heat is generated for melting the faying surfaces of the base metal to develop a weld joint. In this process electrode movement is manually controlled hence it is termed as manual metal arc welding. This process is extensively used for depositing weld metal because it is easy to deposit the molten weld metal at right place where it is required and it doesn't need separate shielding.
Welding electrode: Flux coated stick electrode 4mm (AWS CODE 7018)
Power source : Welding Transformer
Welding current : 160Amps
Deposit metal on worn out surface layer by layer around the cylindrical shape. The first layer of weld is called Route Run. If the route run is free of cracks then whole weld is free of cracks.
Measure the diameter of built up surface. Check for requirement of one more layer or not. Sent the roller for necessary machining to machining section after post weld preparation.

Post Weld Preparation:
Chipping the weld surface with chipping hammer.
Clean the weld surface with wire brush.

Process Improvement
Machining Activity

Re-machining bearing seats as per tolerance limits i.e. 150k6.
Re-machining Circlip groove at NDE of each roller.
During Assembly after Repair and Maintenance about 20% of the rollers were rejected for the following mentioned deviations:

1. About 2% of the rollers were rejected because of the deviation in the length of bearing seat
2. About 18% of rollers were rejected because of the deviation in the position of Circlip groove.

As rejection rate (18%) is very high we have to avoid for more productivity as well meeting the breakdown requirement within the specified time schedule.
We decided to study the metrological aspects of measurement during both machining and inspection.

The Position of Circlip is determined by the following vital parameters: -

1. Length of the bearing seat should be 73.0 and 73.10
2. The Width of the Circlip Groove Should fall between 4.15 and 4.30
3. The Depth of the Circlip Groove should be in the following range 2.4 and 2.6

Design of position gauge [(1)]

1. The form of GO gauges should exactly coincide with the form of the opposed (mating) parts.
2. GO gauges are complex gauges which enable several related dimensions to be checked simultaneously.
3. In inspection, GO gauges must always be put into conditions of maximum impassability.
4. NO GO gauges are gauges for checking a single element of feature.
5. In inspection, NO GO gauges must always be put into conditions of maximum pass ability.

Assuming a work tolerance of 10%, a position gauge has been designed to check for the position of the Circlip Groove.

Design of Ring Gauge

Go gauge NO GO gauge

d = diameter of the roller shaft
Assuming a work tolerance of 2%, a ring gauge has been designed to check for the diameter of the bearing seat. The following are the dimensions of the ring gauge.

IV. MODIFIED METHOD

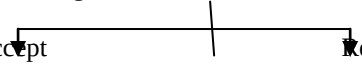
A go-no gauge (or go/no-go) refers to an inspection tool used to check a work piece against its allowed tolerances.[(2)]

A go/no-go gauge is an integral part of the quality process that is used in the manufacturing industry to ensure interchange ability of parts between processes or even between different manufacturers. It does not return a size or actual measurement in the conventional sense, but instead returns a state, which is either acceptable (the part is within tolerance and may be used) or unacceptable (the part must be rejected).

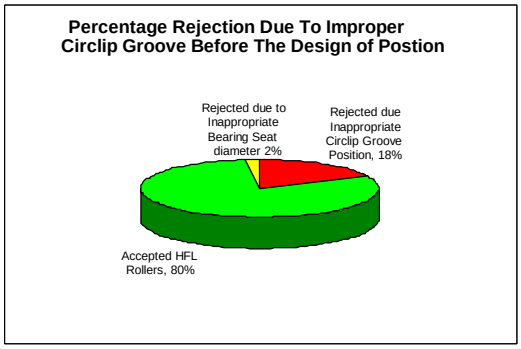
They are well suited for use in the production area of the factory as they require little skill or interpretation to use effectively and have few, if any, moving parts to be damaged in the often hostile production environment. [(3)]

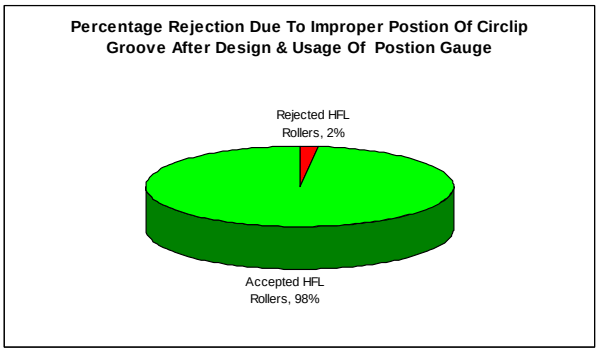
V. FIGURES AND TABLES

Measuring the dimensions of ends of the roller using gauges.



This is single stage measurement because the position gauge is replica of the assembly concerned and there is no need to measure physically and there is no need to verify the drawing.





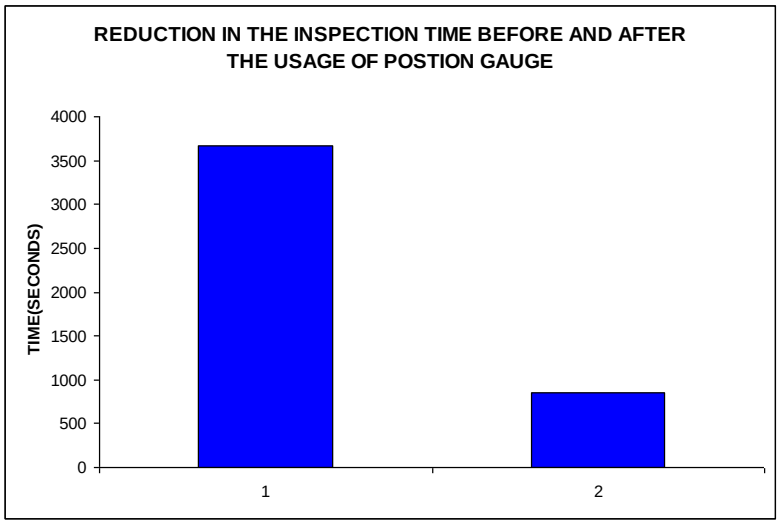
Further the time taken to inspect the position of the Circlip Groove on the Non Drive End (NDE) once is 22.90seconds.

Since about 160 rollers are repaired in CMS every year and every repaired roller is inspected for the position of Circlip groove, the time taken only for inspection is 3664 seconds (1.01 HOURS).

When the position gauge was used, time taken to inspect the position of the Circlip Groove on the Non Drive End(NDE) once, is 5.0seconds.

Therefore, time taken to inspect 160 repaired rollers is 848 seconds (0.235 HOURS)

The Position Gauge decreases the Inspection Time by nearly 89%



The Position of Circlip is determined by the following vital parameters: -

-Length of the bearing seat should be 73.0+0.100

-The Width of the Circlip Groove should fall between 4.0+0.150 and 4.0+0.300.

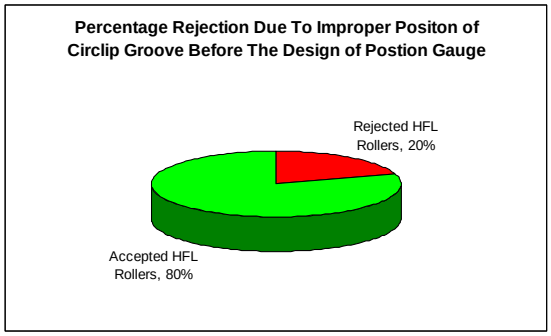
-The Depth of the Circlip Groove should be in the following range 2.50+0.00 to2.50-0.100.

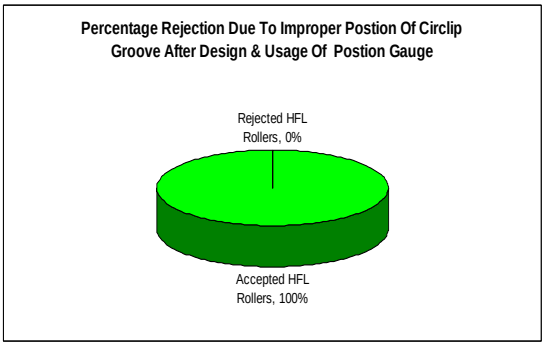
If there is a deviation in any one or more of the above mentioned parameters then HFL roller will be rejected as the Circlip position is altered and assembly is not possible. (5)

Assuming a work tolerance of 10%, a position gauge has been designed to check for the position of the Circlip Groove.

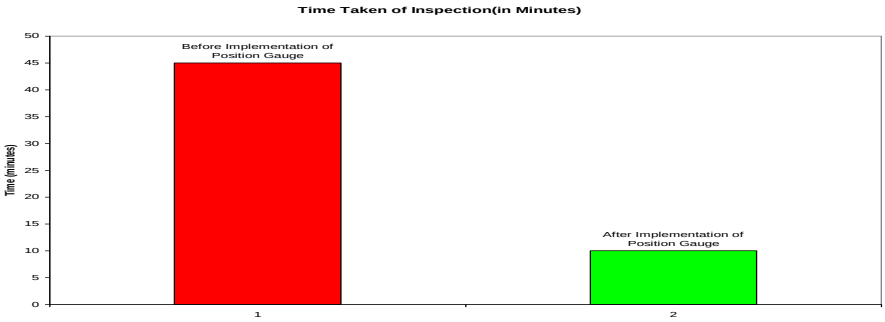
ADVANTAGES AFTER THE DESIGN OF POSITION GAUGE:

1) Phenomenal Decrease in Rejection Rate.





2) Decrease in Inspection time. With Vernier Calipers it took about 23 seconds to check the positional dimensions of Circlip Groove. With Position Gauge It took only 5 seconds to check the positional dimensions of Circlip Groove. Consequently the inspection time decreases to about 10minutes, which is lesser than 45 minutes



As the rejection rate is very high (20%) the inspection of the position of the Circlip groove should done accurately during machining of the roller itself. The parameters that determine the position of the Circlip groove are measured with the help of Vernier Callipers. From the above it can be observed that the mean time taken for the inspection of position of Circlip groove is about 22.9 seconds. Taking into consideration that there are about 56 HFL rollers for one Continuous Casting Machine, it approximately takes 22 minutes to inspect once. As the inspection process is conducted twice, the time taken for the whole inspection process is about 45 minutes. (6)

VI. CONCLUSION

The project work dealt with repair activity of HFL roller and bottlenecks in the process of repair are addressed with suitable remedial measures like:

- Design of circlip position gauge which reduces rejection rate during machining.
- Design of ring gauge which is used to check the diameters of roller shaft, which prevents rejection.
- Improvement in welding process during built up of worn-out surfaces so that quality of roller enhanced.
- Detail study of bearing failure conducted and most of them related to insufficient lubrication. Hence site engineers were advised to improve lubrication system.
- Detail study of gear failure was conducted and a table was formulated to identify the type of failure.
- The built up process more economical when compared with the other process
  Even though above suggested points enhanced the life of roller there is further scope for improvement. Those are mentioned below.
- Bearing fit on roller to be increased to "m6" from "k6" as spalling of bearing observed on many rollers.
- Water cooling system to be improved so that thermal failure of bearings and thermal wear of roller can be avoided effectively.

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Lokesh Tadisetti.“ Handling and Finishing Of Rollers in Steel Melt Shop” International Refereed Journal of Engineering and Science (IRJES), vol. 07, no. 03, 2018, pp. 01–05.