Design And Development Of Fixture With Cantilever Beam For Intermediate Gear Box

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Abstract **- The steel industry involves various production methods and processes for steel manufacturing and end products. This in turn is done with the help of heavy duty industrial machines and equipment. Various components including powerful gearboxes are used in these machines for ensuring a smooth power transmission. Industrial gearboxes used in the steel industry provide high torque with high reduction ratios. They are available in a range of different sizes, specifications and configurations to suit the different needs of the industry. Intermediate gear box of conscast stand is one of the gear boxes which drive the roller of stand. As the service conditions at continuous casting department not favorable to equipment like gear boxes, the maintenance of these gear boxes is toughest task. The damaged gear boxes along with conscast stands are being repaired at Central Machine Shop. Our project work involves study the existing procedure of repair of gear box. Analyze the existing process and suggest improved method of repairing the gear box slashing both time and man-hours consumption. This was achieved by design and manufacturing a fixture which can separate both halves of gearbox casing within minutes using a 100 tones hydraulic jack.**

keywords **- Conscast stands, hydraulic jack. Intermediate gear box fixture.**

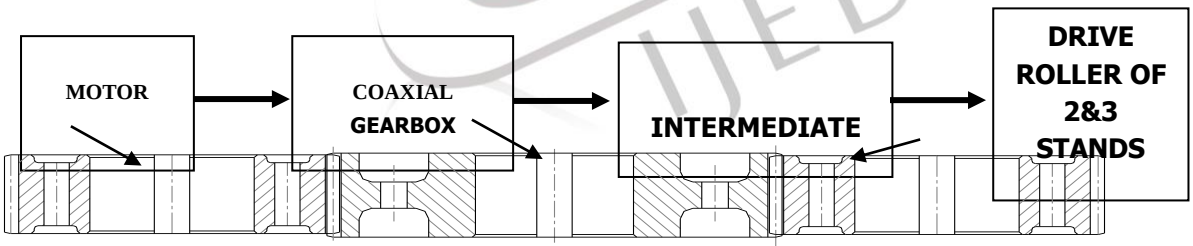
I.INTRODUCTION

Gears A gear is a kind of machine element in which teeth are cut around cylindrical or cone shaped surfaces with equal spacing. By meshing a pair of these elements, they are used to transmit rotations and forces from the driving shaft to the driven shaft. Gears can be classified by shape as involute, cycloidal and trochoidal gears. Also, they can be classified by shaft positions as parallel shaft gears, intersecting shaft gears, and non-parallel and non-intersecting shaft gears.

Hydraulic system A hydraulic drive system is a quasi-hydrostatic drive or transmission system that uses pressurized hydraulic fluid to power hydraulic machinery. The term hydrostatic refers to the transfer of energy from pressure differences, not from the kinetic energy of the flow.

Hydraulic Jack. : A jack, screw jack or jackscrew is a mechanical device used as a lifting device to lift heavy loads or to apply great forces

II. Introduction to intermediate gear box (IGB)



The IGB is only a power transfer unit; it does not either reduce or increase speed. The IGB consists of input gear, intermediate gear and an output gear. The output gear is mounted on a hollow out put shaft, which is having internal splines. These splines are matched with the bottom roller external splines.

Input gear **Intermediate Gear** **Output Gear**

Specification:

Reduction Ratio : 1:1
No. of Stages : 2
Power transmitted : 30 KW
Input : Z1=50; m=10
Intermediate : Z2=70; m=10
Output : Z3 = 50; m=10
RPM : 1
No. of gear boxes installed : 48
Type of casing : Split
Material of Casing : Fabricated steel structure
Type of Bearings mounted on shafts : Deep groove Ball bearing No.6244-2nos

on each shaft

Type of Oil seals mounted on O/P : A type size 220-250-16 (4 nos).

Type of Oil seals mounted on I/P : A type size 220-255-18 (3 nos).

***Steel handling process*:** The liquid steel shall be collected in liquid steel ladles (each capacity 150 Tons) from converter. After completion of the rinsing at Inert gas rinsing station, the 150Tons steel teaming ladle is sent to ladle distribution bay by ladle transfer car by 200+63/20 Tons EOT crane and placed over a Lift & Turn stand of the casting machine ready for casting. The frame of Lift and Turn stand is in its lower most position for receiving of steel ladle.

The below ff1 and 2 shoes the concast stand are a part for handling steel process component. After lowering the ladle on the stand properly, mounting of the hydraulic cylinder of the ladle on the stand slide gate is performed. After this the stand operator who operates mechanism of the stand from +16.15m platform lift the stand frames with the ladle on it to the upper position and then rotates the frame to transfer the ladle into the casting position.

Steel casting begins on the command of casting in-charge/ Charge-man. The slide gate of the casting ladle is opened by the casters standing at 16.15m level. Tundish is filled with steel up to the working level that is 150 to 250mm from the top. This level is maintained by the regulating the slide gate opening. After the tundish is filled to half its height tundish stopper is opened.

When withdrawal rolls are switched on mould oscillation mechanism starts automatically. After the machine is switched it's working with in 2-3 minutes, from the start of casting. Once the casting is stabilized tundish is lifted and submerged nozzle is introduced with the help of holder in all four strands simultaneously after closing the metal from tundish to mould. As soon as submerged nozzle is introduced metal flow will be resumed into the mould by regulating the stopper rod. The caster maintains the level of liquid steel in mould with in 100-150mm from the top end of mould.

Once casting is stabilized passes the stopper control from manual mode to auto mode.

***Withdrawal roll stands**:*

These are the roll stands, which withdraw the blooms from the Continuous casting machine. The CCM have 4 strands. In each strand there are 4 stands, TK1, TK2, TK3 and TK4. In which TK1 is the four-roll stand, consists of two bottom rollers and two top rollers. The main purpose of the TK1 stand is to hold the Dummy bar before casting and with draw it while casting starts, and guide the bloom.

Fig:1

Fig:2

III.PROBLEM IDENTIFICATION;

In the gear box following failures are observed regularly. To rapier the work lot of time and man power is consuming their by it is effecting the production process.

***Commonly observed Failure pattern**:*

1. Seizure of bearings
2. Jammed rotation
3. Oil/grease leakage
4. Wear out of bearing seats of all shafts
5. Wear out of oil seal seats of output and input shafts
6. Wear out of through covers at bore
7. Shearing of retainer ring screws
8. Torn out of oil seal inner lip and or expiry of shelf life
9. Deformed casing
10. Damaged fasteners

IV.EXISTING PROCESS OF REPAIR

The damaged intermediate gear boxes along with TK stands are being sent to CMS/ES&F for carrying out necessary repair. Sequence of repair process as follows

***Dismantling Activity**.*

1. Dismounting of IGB from the TK Stand
2. Unbolting of all fasteners of gear box casing
3. Separation of top casing from bottom
4. Dismounting of Input, Intermediate and Output shaft assemblies from the bottom casing.

5. Dismantling of all components from Input, Intermediate and Output shafts.

Remedial action

1. Thorough cleaning of all components including casing halves
2. Visual inspection for damage to components
3. Reclamation plan if the damaged parts are repairable

E.g. Worn out of output and input shafts at oil seat and bearing seat area can be reclaimed by surfacing and machining

4. Decision making for parts that can be replaced by new.

E.g. a) Worn out of output shaft internal splines need replacement of shaft with new.

b) Replacement of gears if teeth were worn -out, cracked, sheared and bent

c) Consumables like oil seals and bearings to be replaced with new as they are irreparable.

Assembling

1. Assembling of input, output and intermediate shafts, replacing damaged components with new or repaired parts
2. Mounting of all three internals on bottom casing of gear box.
3. Positioning of blind and through covers along with rubber cords to arrest lubricant leakage.
4. Mounting of top casing on bottom casing. Clamping both halves of casing by bolting.
5. Checking proper mating of both casing parts
6. Inspection of gear box for free rotation of shafts and lubricant leak
7. Deliver the gear box for fixing it to TK Stand.
8.

Analysis of Existing process of Repair

Our team studied the existing process of repair. We found the work force is not facing any difficulty in carrying out each and every activity except in the process of dismantling upper casing from the lower casing.

The following reasons are attributed for difficulty in dismantling.

1. The ambient temperature at work environment of this gear box is high. This makes the lubricant evaporate and the gear box internals get jammed in the casing due temperature rise
2. Due to thermal stresses the blind and through covers struck up with casing
3. The halves of casing seize at mating surface causing difficulty to separate both due to evaporation of lubricant as well as hardening of flange sealant

Due to above reasons the dismantling activity is consuming lot of energy manpower man-hours, time and discourage workmen for doing the job. This also causes fatigue to employees.

V. PROPOSED METHODS TO SOLVE IDENTIFIED PROBLEMS

1. Improvement in gear box lubrication system to maintain working temperature below 70^0C
2. Replace gear box with chain-sprocket mechanism
3. Apply anti seize compound to facilitate easy dismantling of gear box
4. Mechanize dismantling system of gear box by developing specialized tools/tackles for easy dismantling of gear box within shortest possible time.

Validation and selection of solution

All the mentioned solutions to tackle the problem are carefully studied and interacted with experienced VSP engineers. The outcome of this is mentioned below.

1. Existing system provided with water jacket in the casing for cooling the gear box with chilled water circulation in addition to liquid lubricant for lubricating internal components. These gear boxes frequently failed due to failure of water jacket mainly due to formation of holes by corrosion. Hence we found no further study is necessary in this regard.
2. Chain drive mechanism has its own limitations at high temperature environment like lubrication, frequent adjustment for tension. Therefore it is not advisable.
3. Applying anti seize compound definitely helps in dismantling gear box but entrapment of this compound between race ways of bearings will damage the bearings. Preventing the same during assembly not possible.
4. As process of dismantling is being done by manually, this includes driving of two or more wedges at parting plane to separate both casings by heavy hammering on wedges. This can be avoided by designing a fixture with combination of hydraulic jacking mechanism.

Hence we decided to develop a fixture with combination of jack for mechanizing the activity of dismantling the gear box to avoid laborious process involving lot of manpower.

VI. DEVELOPMENT OF FIXTURE

The drawings of intermediate gear box including component drawings obtained from SMS department.

Considering the spatial constraints of gear box a base frame was made and a hook is welded to the frame to lock the gear box on base with tie bar inserted through casing wings and hook.One square bar inserted through hollow output shaft and a hydraulic jack of capacity 100T placed between base frame and square bar. The jack operated and casing lifted from bottom casing. The following table-1shows pressure gauge readings and corresponding load applied for dismantling four no. of Gear boxes.

Table:1 Hydraulic pressure gauge reading

Identification no. of IGB	Pressure gauge reading (P in kg/cm^2)	Load applied in Tones (L= A*P/1000 T) A= Cross sectional area of piston
SMS-907/20	331	51T

SMS-907/21	408	63T
SMS-907/22	242	37T
SMS-907/23	388	60T

It is clear from the data that maximum load applied is 63T.As there is only 100T jack above 63T in CMS; we selected this jack for the unit.

a) The fabricated fixture contains the following parts assembled together shown in fig:3

1. Base frame
2. Supporting column with braces
3. cantilever
4. fulcrum pin
5. Jack support base
6. Hook
7. Tie bar
8. Circular support over cantilever
9. Packing pad for hollow shaft

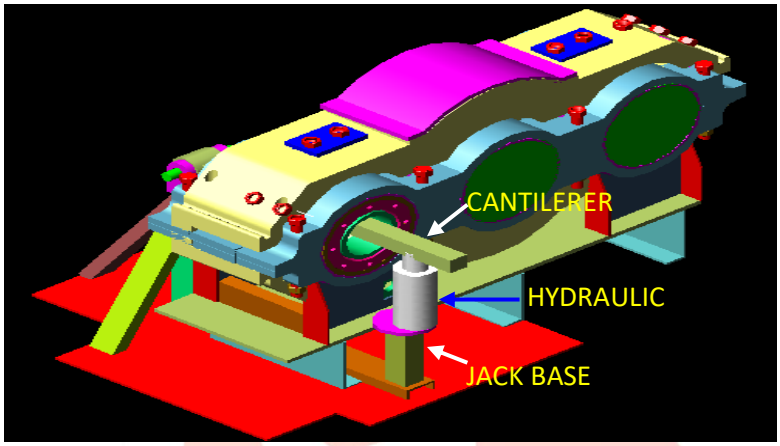


Fig:3 Animation of fixture developed

b) Hydraulic Jack

The jacking system consists of double acting (oil return) jack of lightweight design, working at high pressure. The jack is provided with collar threading to fit flange for mounting. Return line relief valve is provided on cylinder set at 100 kg/cm2 which is shown in fig:4

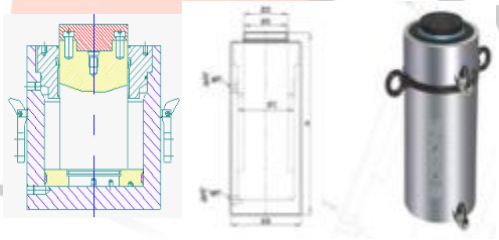


Fig:4 Parts in the hydraulic jack

Specifications

Capacity	: 100T
Stroke	: 125mm
Effective area	: 154 cm2
Working pressure	: 637 kg/cm2
Oil capacity	: 4715 cc
Acting	: Double acting
Return	: Oil return

c) Hydraulic Power Pack

Fig:5 System showing hydraulic power pack

An electric motor driven hydraulic power pack of ship capacity supplies pressurized oil to the jacks. The power pack is of mobile type with two wheels. The top plate of the power pack is removable for maintenance. Manifold with valves, motor & motor starter, are mounted on the top plate it is shown in fig-5

Power Pack Specifications:

Electric motor capacity : 5hp / 3ph / 1450 rpm
Direction control : By Hand Lever
Working pressure : 700 kg/cm2
Pump flow up to 120 Bar : 12.3ltrs/min
Pump flow above 120 Bar : 2.6 Liters /min
Test pressure : 700 kg/cm2
Tank capacity : 50 litres

VII RESULTS AND DISCUSSIONS

Modified Vs Existing dismantling process

Drive the wedges between parting surfaces of gear box by heavy hammering. Place, clamp and assemble the cantilever after placing the gear box on base frame of fixture. Jack the lever with hydraulic jack to separate both halves of the casing. Comparison parameters are in table -2

Table :2 Comparing existing process with modified process for disassemble of rear box

Parameter	Existing process	Modified process
Man power	3T+1W+1K+1CO	1T+1W+1K+1CO
Time consumed	16 hours	1hour
Man-hours	96	4
Tools /tackles	Wedges, sledgehammers Chisel, striking rods.	Hydraulic jack100T and Developed Fixture

T= Technician/Fitter; W = Welder ; K= Khalasi/Unskilled worker,
CO= Crane Operator

Repair time of IGB

Dismantling the gear box casing =16 hours: 6 manpower: 96 man-hours
Cleaning of all components and casing =16 hours: 2 manpower: 32 man-hours
Dismantling and assembling of output = 08 hours: 3 manpower: 24 man-hours
Dismantling and assembling of I/M = 08 hours: 2 manpower: 16 man-hours
Dismantling and assembling of Input = 08 hours: 3 manpower: 24 man-hours
Assembling of internals with casing =16 hours: 3 manpower: 48 man-hours
Total activity of repair =72 hours: 19 manpower: 240 man-hours
Repair time of IGB

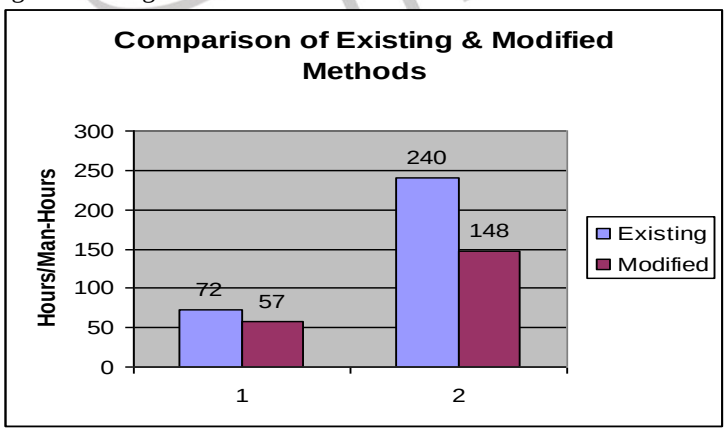
Before

Time=72 hours
Man-hours =240

After

Time = 57 hours
Man-Hours = 148

Graph-1: Graphically showing the existing method with modified method in terms of hours



Modified method effectively reduced repair time by 26% and Man-Hours by 38% which is shown in graph-1

Tangible Benefits:

1. Gear box life enhanced as the method of dismantling is smooth and does not cause distortion of casing due to avoidance of wild hammering
2. Less manpower
3. Less energy consumption
4. Less repair time

Intangible Benefits:

5. Reliability of equipment ensured
6. Quality of gear box improved
7. Less breakdowns
8. Employee satisfaction.
9. Ease in dismantling
10. Less fatigue.

VIII.CONCLUSION

The project work dealt with repair activity of Intermediate gear box and Development of Fixture with cantilever beam using hydraulic jack in the process of repair. The remedial action for preventing injury to workmen as well as damage to Gear box casing and other components in is addressed with modified procedure for dismantling Gear box Casing through specialized Fixture in combination with hydraulic jack. The salient features of this device are

- Holds the gear box intact on base frame to offer stability during process of dismantling.
- Introduction of jack base to prevent bending of base frame.
- Provision of fulcrum pin and bush to facilitate smooth lifting of cantilever beam at one end.
- Provision of circular plate and felt packing between cantilever and hollow shaft to prevent damage of shaft during jacking.

This type of activities always contributes for minimizing Mean time to repair and improves the availability of equipment for production thus improves productivity.

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