A RESEARCH PAPER ON IMPROVEMENT AND DEVELOPMENT OF GEARBOX IN THREE WHEELER VEHICLE

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Abstract: - This Study investigated the method of improvement and development for the gearbox of three wheelers four stroke diesel engine by analysis through field complaints, observation and finding root cause of gearbox failure. As the problem arises gear box failure. After some time running of vehicles, excessive play occurs between parts needle bearing and cluster gear, which disturbs the alignment at cluster gear with the gearbox of diesel engine. Deep improvement aiming at describing the influence of method and processed improvement to maintain bearing position wrt. main housing of gear box. Needle bearing pressing mandrill special tool outer diameter decreased to maintain bearing position wrt. Bore depth in main center housing. Also ball bearing pressing special tool modified. While pressing with cluster gear references are changed from outer ring to inner ring of a ball bearing. The impact of development reflects on performances and engine smooth gear shifting.

Keywords: - Cluster Gear, Needle Bearing, Speed Gear, Ball bearing, GB Assy., NRB Bearing, Three Wheeler

I. INTRODUCTION

ATUL AUTO LIMITED is leading Three-wheeler manufacturing industry in India. Vehicles manufactured in industry are Diesel Paxx and cargo vehicles with FE and RE engine. CI engines are heavy with high CR in comparison of SI engines. Atul Auto Limited had recently launched their new model of Atul Gem Premium Cargo Dz. After some period of time the problem of gearbox failure is reported. Literally more and more vehicles are on the road and problems reports are also increased [1].
Gear box is a part of Diesel Engine which is mounted outside of Main Engine body. The power transmission in diesel engine takes from the

Piston - Crank Shaft –Clutch - Cluster Gear - Speed Gear -Idler Gear - Reverse Gear -Differential Hub - Rear Axle.
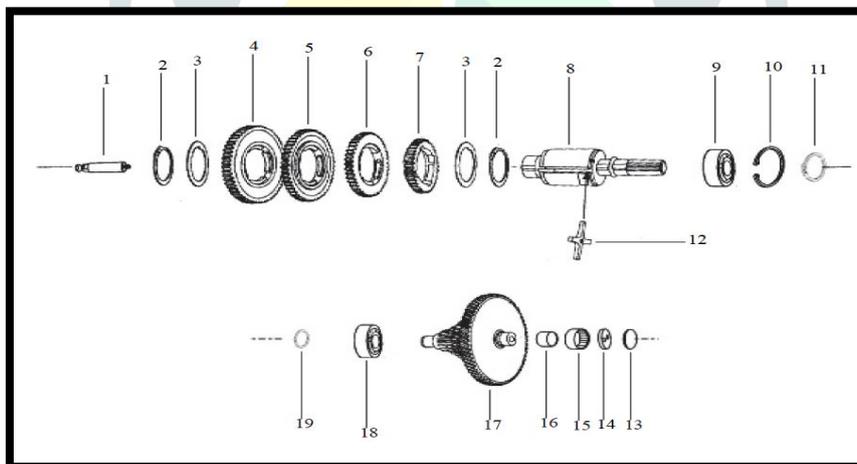

Fig 1.1 Dismantling Gear Box

Amid ignition, control is delivered in third stroke i.e. Power stroke. The power is exchanged to cylinder and through interfacing pole, control is stream to wrench shaft. Wrench shaft is the principle part of motor. Grasp is associated on the pole end of wrench. The power is transmitted to Cluster Gear. Group Gear is mounted on Gear box principle body through Needle Bearing. The power is exchanged from Cluster Gear to the primary Speed Gears, which is worked by stem as appeared in Figure. Advance the power is transmitted to differential center point and after that to Rear Axle.

The proper analysis and process improvements is needed to increase the gearbox lifespan and vehicle sustainability in competitive market. The following field complaints are noted while vehicle on road testing.
1) Cluster gear needle bearing failure.
2) Cluster gear needle bush bore oval/damage.
3) Main housing damage/crack due to cluster gear.
4) ES cover crack/damage due to cluster gear.
5) Cluster gear ball bearing failure.

2. OBSERVATION

Above all problems arises due to needle bearing failure. After some running of vehicle excessive play occurs between needle bearing & cluster gear & This will disturb alignment of cluster gear. Moving component bearing disappointment investigation, tends to Rolling Contact Fatigue (RCF) happens because of the aftereffect of cyclic pressure created amid task and instrument that include in worrying disappointment of moving component bearing [1]. Load analysis, oil pressure, gear working, gear wear pattern, washer thickness, needle bearing overhanging, over load analysis etc. were the possibilities to find the failure of gearbox and prevent for failure [2].

Table 2.1 Parts of gearbox and its function.

Part No.	Part Name:	Function
1.	Stem Gear Operator	It helps us to transfer the drive motion to linear gear assemblies
2.	External Circlip	To prevent gears run out from gear shaft
3.	Shoulder Ring	To absorb vibration from gear
4.	Speed Gear 1st	High torque & Less Speed
5.	Speed Gear 2nd	More torque & Low Speed
6.	Speed Gear 3rd	Low torque & More Speed
7.	Speed Gear 4th	Less Torque & High Speed
8.	Main Shaft	mounting of speed gears
9.	Ball Bearing	To revolve with less friction and body prevent body from vibration
10.	Internal Circlip	Speed Gear Locker
11.	External Circlip	To prevent gears run out from gear shaft
12.	Cross	Gear Shifter from 1-2-3-4.
13.	Shim Bush	Prevent direct body contact
14.	Washer (4 mm)	create more clearance B/w. cluster gear face & washer
15.	Needle Bearing	To revolve with less friction and body prevent body from vibration
16.	Inner Ring	To prevent cluster gear direct contact to body
17.	Cluster Gear	Power transmission from clutch to speed gear
18.	Ball Bearing	To prevent the body side cover fracture through vibration and jerk, free to revolve
19.	External Circlip	Protects the ball bearing from fall out.

3. ROOT CAUSE

Due to uneven forces and stress developed at certain needle rollers of needle bearing, scratches are generated and worn out the needle bearing. Due to these the scratches worn out materials and will fall between needle rollers and the cluster head. Due to this the more peeling of material happens and the bearing fails. The failure of needle bearing jams the cluster in the body. As torque is high and rpm is more the cluster gear will unstable and digs more teeth of main speed gear.

1) Less clearance between washer & Cluster gear face, dimension 23.4mm was not maintained in ES cover.
2) In All most failure cluster gear face rubbing with washer & metal chips enter in bearing & get failed.
3) NRB already displaced during assembly time.
4) Manufacturing defect in housing plant.
5) Vibration and axial play of cluster when power transmitted from cutch to cluster gear.

4. DIMENSION OF NRB

Inner diameter without roller: - 22.53 mm
Inner diameter with roller: - 22.21 mm
Outer diameter of NRB Shell: - 28.04 mm
Inner cage f NRB shell: - 15.90 mm
Total height of NRB: - 16.17 mm

By strategies for thorough and deliberate examination concerning the base materials, process media, surface morphologies, little scale an area pieces and even organization circumstances, primary drivers of this failure were settled, separated instruments were discussed, and proper countermeasures were proposed [2].

5. ACTION TAKEN

All problems arise due to needle bearing failure. After some running of vehicle excessive play occurs between needle bearing & cluster gear & this will disturb alignment of cluster gear. The clearance between cluster gear and needle gear is needed to decrease so that the friction between rolling needle bearing and cluster shaft. The increase in friction with increase in wear and tear of rollers of needle bearing.

1) Engine side cover Dim. 22.9 – Corrected.
2) Washer thickness changed from **4.0mm** to **3.5mm** to create more clearance B/w. cluster gear face & washer.
3) Needle bearing pressing mandrill OD decreased to maintain bearing position wrt. Bore depth in main center housing.
4) Ball bearing pressing tool modified, while pressing on cluster gear reference changed from Outer ring to Inner ring of ball bearing (Because of closer tolerance b/w Cluster gear & Inner ring, compare to outer ring & ES cover).
5) CMM program modified to cover up all critical dim. Related to GB assy. For Main center housing, Engine side cover & Gearbox cover.
6) Cut off no.: **MCG70RMC8B1350033, GB No.: P 1066 B 13.**

6. MODIFIED PARTS

1) NRB PUSHER MODIFIED: NRB pusher butting face diameter was 39.5 which is modified to 28.5 mm parallel to bore diameter. Before modifying chances to face resting on MS Housing. Rib and bearing position could be up side, after modifying bearing position always maintain wrt. to bore depth.

Fig 1.2 Before modifying NRB Pusher   Fig 1.3 After modifying NBR Pusher

2) ES COVER ASSY. ON MS HSG: Ball bearing pusher modified. While assy. of engine side cover on main center housing, hammering required on ball bearing to fix on cluster gear. Before hammering reference was outer ring of bearing with possibility to create excess play between inner ring and outer ring. After hammering reference started on inner ring of bearing and now no load coming on ball or outer ring of bearing while assy.
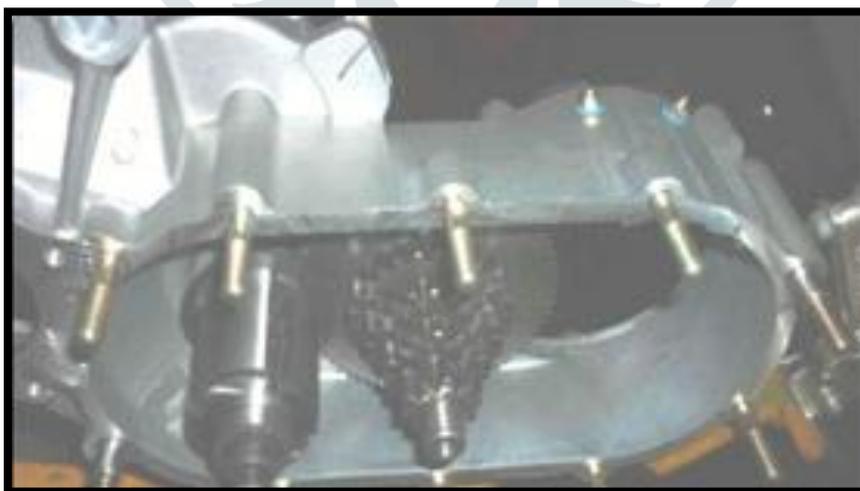

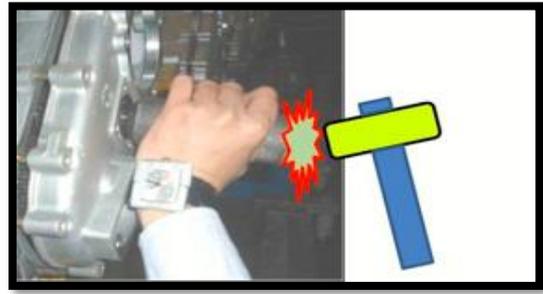Fig 1.4 Main Shaft ES Cover

Fig 1.5 ES Cover Assembly

Fig 1.6 Hammering Reference on inner ring of bearing

3) NRB Pusher modified: NRB Pusher modified, before the pusher butting diameter was 38 mm which is modified after to 28.0 mm diameter with clearance of -0.15 to +0.20 mm.
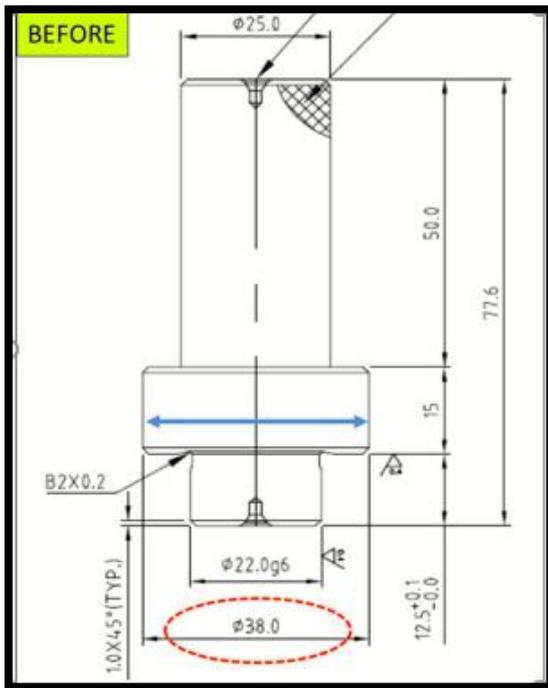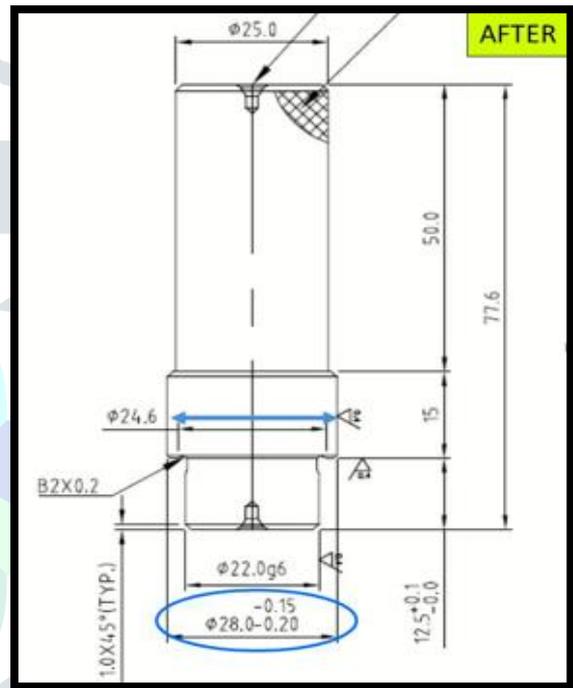

Fig 1.7 NRB Pusher Before

Fig 1.8 NRB Pusher modified

4) Gap between cluster gear face and washer (NRB Side): Washer Thickness changed from 4mm to 3.5 mm. this will create more clearance between Washer and Cluster gear face at needle bearing end. The washer placed in housing of cluster of NRB side gap between cluster gear face and washer before was 4 mm thickness with minimum gap of 0.3 mm and maximum gap of 1.3 mm. After modified washer the thickness decreased to 3.5 mm with minimum gap 0.8 mm and maximum gap of 1.8 mm.
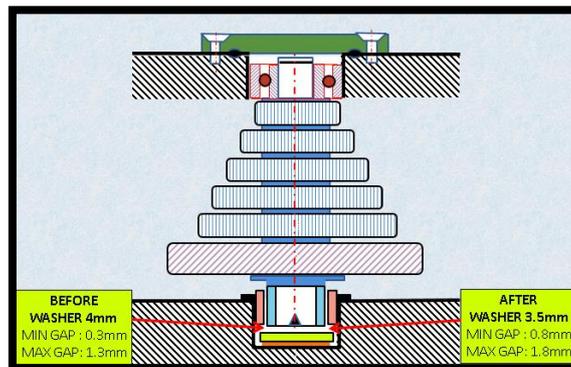

Fig 1.9 Cluster Gear Modified

5) ES cover Dimension corrected: ES COVER Dimension 22.9 (+0.1) corrected and modified up to 22.760 mm. It can be creating less clearance between washer and Cluster gear face at needle bearing end.

7. EFFECT OF MODIFICATION

Modification carried out on cluster gear and hardened shim in order to prevent failure of gearbox.

a) One step added at the support shaft diameter of 22 mm, Depth: - 1.5 mm
b) Cluster gear support end length increased to equalize with the length of the inner ring: 13 mm.
c) Shim diameter of 25.50 mm & Hardened 2 mm changed.

8. INSPECTION PROCEDURE FOR MODIFICATION

By pressing the needle bush in to a ring gauge of sufficient wall thickness to avoid distortion size of the truly round and cylindrical bore of gauge: 35.645 mm.
Plugging the bearing with: -

GO GAUGE: 28.621 mm
NO GO GAUGE: 28.673 mm

The above procedure is the only capable of ensuring adequate inspection possible executive press fit or the bush in the ring gauge may render the bush unfit for subsequent satisfactory use.

To avoid damage due to excessive press FIR the following procedure may be followed.

Ring gauge bore: - 34.695 mm
Go Gauge: - 28.621 mm
No Go Gauge: - 28.642 mm
Dynamic Capacity: - 1690 kg
Static Capacity: - 1620 kg
Limiting Speed: - 10500 rpm.

9. CONCLUSION

The current work thus establishes technical feasibility Modification carried out on cluster gear and hardened shim in order to prevent failure of gearbox. This continual improvement is done to improve product durability. There is no change in part number and special tool pusher for needle bush. Part interchangeability process is advised in the new vehicles. Process improvement circulars are on processed and modified gearbox Is taken place in premium vehicles.

For future investigations in Needle Roller Bearing Analysis it is recommended to simulate several parts, with different boundary conditions to fulfil more features of the software. For instance, other analysis like static analysis or a buckling analysis should be carried out. For comparison of analysis results and reports regarding to their accuracy the simulation must be simple structures recommendable. Ensuring ease and clear arranged control calculation with meaningful conclusions, further used as absolute values comparing the simulation results.

10. ACKNOWLEDGMENT

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