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Vehicle Level Total Drivetrain Backlash Measurement

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Abstract

This paper studies the methodology of measurement of Drive train Backlash of the Vehicle including gearbox and rear axle at vehicle level. Many attempts have been made by the engineers to measure the Backlash of the system. Some conventional methods includes the use of dial gauge indicator, filler gauge etc., but all the methods are either time consuming or required a skilled worker to do the work. The method explained in this paper is an innovative technique of measurement of backlash of the Light Commercial and Passenger vehicle consisting of manual gear box and rear axle at vehicle level of the system. i.e. measurement of the backlash without disassembling the gearbox and rear axle.

Keywords- *Backlash, gear mashing, helix angle, Drive train, Run-out, innovative method.*

I. INTRODUCTION

Backlash is a term, associated with the gears. It can be defined as the gap between the two teeth of the gears, when they are in mesh condition. It can also be defined as increase in the width between the teeth of the gear 1 as compare to the decrease in tooth thickness of the gear 2 so as to develop gap between the teeth. This phenomenon is shown in figure.1

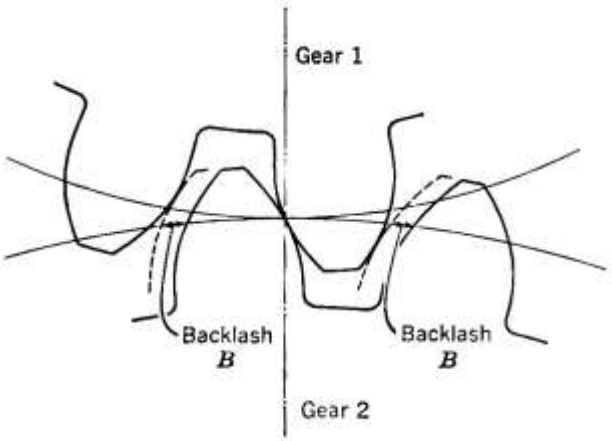

Figure 1. Gear backlash.

II. IMPORTANCE OF GEAR BACKLASH

Backlash of gear is the inherent property of all gear drive. As it is well known fact that none of the two gears can be made equal due to variation in manufacturing process and due to human errors some amount of backlash presents in all gear drive. The general purpose of backlash is to prevent gears from jamming and making contact on both sides of their teeth simultaneously.

A small amount of backlash is also desirable to provide for lubricant space and differential expansion between the gear components and the housing. Any error in machining which tends to increase the possibility of jamming makes it necessary to increase the amount of backlash by at least as much as the errors. Consequently, the smaller the amount of backlash, the more accurate must be the machining of the gears. Run-out of both gears, errors in profile, pitch, tooth thickness, helix angle and center distance all are factors to consider in the specification of the amount of backlash.

On the other hand, excessive backlash is objectionable, particularly if the drive is frequently reversing or if there is an overrunning load. The amount of backlash must not be excessive for the requirements of the job, but it should be sufficient so that machining costs are not higher than necessary. Due to least backlash jamming, rubbing and heat generation takes place between the systems. Due to excessive backlash noise and vibration in the system generates and also impact forces come on the gear tooth so as to increases the chances of gear wear and tear.

III. INNOVATIVE METHOD USED FOR MEASURING THE BACKLASH

In this method the use of Digital Inclinometer have been done for measuring gear backlash. Digital inclinometer is a digital surface level indicator, which shows the deviation of the test surface with respect to absolute plane surface in degrees

Figure 2. Gear backlash reading.

3.1. Causes of gear backlash

1) If there would be variation in center distance between the two shafts of a drive then the backlash will present in the system.
2) Due to wear and tear of the gear tooth during running backlash comes in seen.
3) Due to gear run-out during running of the gear drive, backlash comes in to system.

3.2. Gear box backlash Measurement

Figure-3 shows the methodology of measurement of gearbox backlash. The concepts explained as, for measuring the backlash or free play between the gears, it's a fundamental law that, one mating gears should be fixed or restricted against motion and another gear should be free. Hence if we will see the construction arrangement of a 4 of 5 speeds manual gear box then during engine off condition and in neutral position of the gear box, the lay shaft gears are fixed with clutch shaft gear and drive shaft gears are free to rotate on its own shaft. As soon as we select the gears the drive shaft gear fixed with lay shaft gears for proving drive but it is free on its shaft.

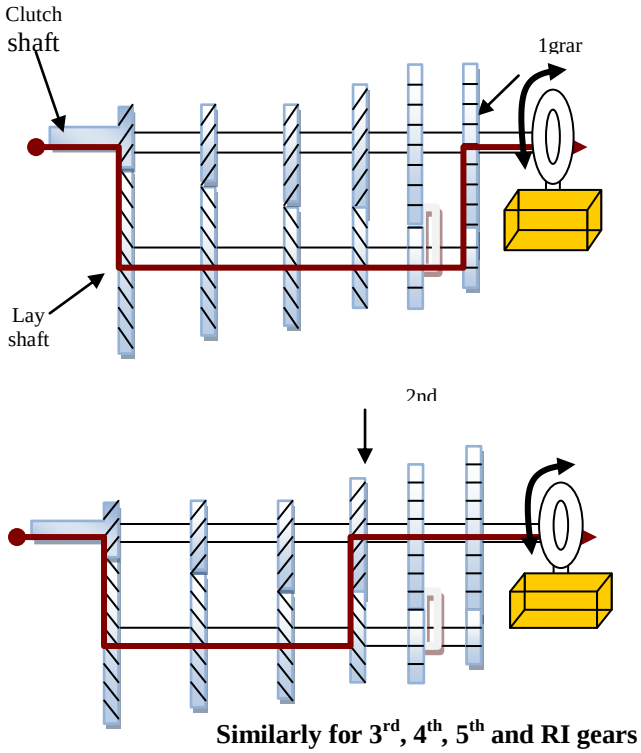

Figure 3. Gear box backlash measurement

For measuring gear box and rear axle backlash, we have to decouple the propeller shaft from its both side, i.e. form gear box coupling flange end and rear axle coupling flange and fix the bracket for placing inclinometer. Now after putting inclinometer we select the corresponding gear and give a to and fro motion to the coupling flange. Due to this to and fro motion, the inclinometer will give us the value of backlash between the corresponding gears. Table-1 shows the value of backlash of a 5 speed manual transmission gear box of a light commercial vehicle. Table 1 shows reading of backlash for each gear.

Table 1 : gear box backlash measurement readings

Gear	1	2	3	4
1st	1.4	1.3	1.3	1.3
2nd	1	0.8	1	1
3rd	1.1	1.1	1.1	1.1
4th	1.3	1.3	1.3	1.3
5th	5th gear speed directly coupled with clutch shaft			
RI	1.8	1.7	1.8	1.8

3.3. Rear axle backlash measurement

Similarly for rear axle backlash measurement same practice can be done by placing digital inclinometer at the rear axle coupling flange end and keeping both the wheels at the ground we can measure the backlash between crown wheel and pinion, Figure-4 and Figure-5. Figure-4 shows the backlash between the crown heel and pinion and figure - 6 shows the backlash of the system including crown wheel pinion, diff gears and splined shaft. Table-2

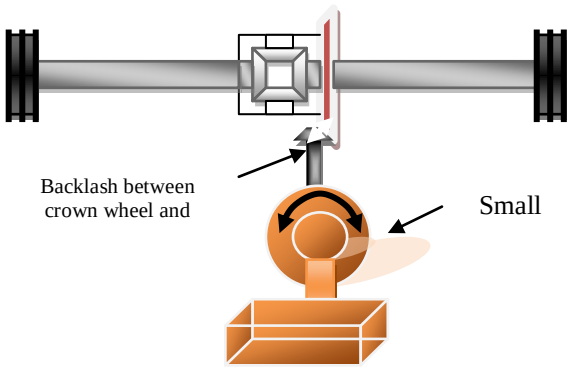

Figure 4. Backlash between crown wheel and pinion

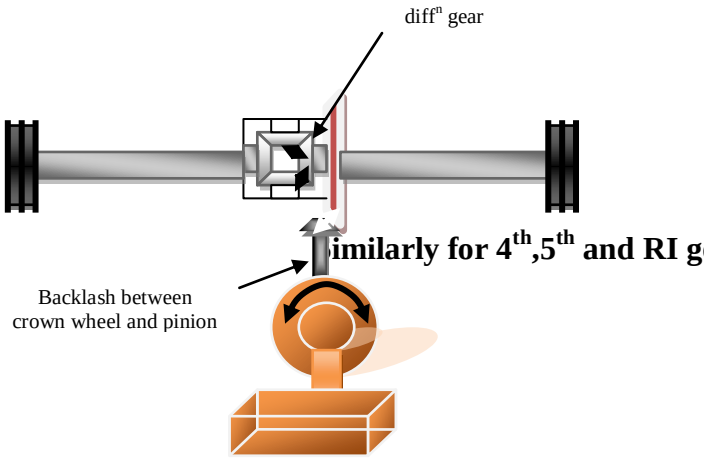

Figure 5. Overall system backlash

Table 2: Backlash value for some LCV.s

Rear Axle Backlash(degree)			
Vehicle	Between CW & Pinion	System Backlash	distance covered(kms)
LPT 712	1.9-2.2	4.2-4.9	51250
Eicher 10.95	1.6	4.3	48470
IVECO	0.9-1	4.0-4.4	47530

IV. RESULTS AND DISCUSSION INNOVATIVE

An innovative methodology for measurement of backlash is developed which is applicable to all types of vehicles like LCV.s and Passenger vehicle.

Total drive train backlash of the LPT-712 vehicle. We don't have backlash in 5th gear because in **5th gear the drive shaft is directly coupled with clutch shaft and which will not give any backlash.**

Previously we were thought of getting individual backlash between crown wheel and pinion and between diff gears and between splined shaft by first fixing bevel coupling flange end and one of the wheel and giving to and fro motion to the other wheel, but this is not possible and we can only get overall backlash of the system(rear axle).

V. CONCLUSION

The method developed is more user-friendly and cost saving in terms of money and time. The Method is unique and can be used for all types of vehicle. Backlash measurement with dial gauge indicator, we first need to drain out the oil and uncover the cover plate of gear box and rear axle but with the use of this method we need not to remove the cover plate and also not to drain-out the oil.

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