IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

APPLICATION OF DIFFERENT THERMOPLASTIC GEARS IN THE GEARBOX OF MOPED

Amarjeet R. Gupta[1]

[1]*Student, Mechanical Department, DMIETR Sawangi Mehghe Wardha, Maharashtra, India,*

amarjeetrzg@gmail.com

Abstract

The gearbox is one of the inherent components in any automotive system and comprises approximately 30% cost of the total cost of the automobile. Plastic gears also open new opportunities for more efficient transmissions in many products along with reduced drive drive-cost, weight, noise and wear. Along with this the gearbox is a heavy component of the automobile.

To reduce drive cost, noise and weight by replacing metallic gears with thermoplastic gears in the gearbox of identified low power moped is the objective of this work.

Initially the material is identified among heavy engineering plastics for manufacturing of gear. The material selected is tested in test laboratory and gears are manufactured using hobbing process with the same accuracy and specifications as that of metallic gears of the gearbox.

Index Terms: *Plastic gear, Material for plastic gear, Plastic gear design, Plastic gear in moped, Necessity of plastic gear*

1. INTRODUCTION

Plastic gears are continuing to displace metal gears in a widening arena of applications. Their unique characteristics are also being enhanced with new developments, both in material sand processing. In this regard, plastics contrast somewhat dramatically with metals, in that the latter materials and processes are essentially fully developed and, therefore, are in a relatively static state of development.

Plastic gears can be produced by Hobbing or shaping, similarly to metal gears or alternatively by moulding. The moulding process itself is considerably more economical means of production. Therefore, a more in-depth treatment of this process will be presented in this section.

1.1 Current Aspect1

Following are the examples, where plastic gears are successfully replace with metal gear **:**

When Maytag engineers designed their new washer transmission around plastic gears, they effectively eliminated the noise of steel gears. They also saved 13 pounds and did away with 42 parts compared with a previous metal gearbox. Gears injection-moulded from unfilled and Fibreglass-reinforced Celcon® acetal copolymer maintain their strength and tight tolerances even in an oil-bath transmission. They also demonstrate the long-term durability essential in an appliance expected to have a long service life.

Hewlett-Packard and molder UFE took plastic gears to new standards of manufacturing quality in the DeskJet 660 color printer . Acetal copolymer cluster gears were specified to comply with the high-quality standards of AGMA (American Gear Manufacturers Association) Quality Class Q9. The accuracy was necessary for precise paper movement to prevent **"banding"** - obvious skipped lines or overprinting. For 48-pitch gears, 1.25 inches in diameter, AGMA Class Q9 denotes Total Cumulative Error (TCE) of just 0.0015 inch, and Tooth-To-Tooth (TTT) error of 0.00071 inch.(fig 1)

To improve the reliability of the "World Washer" manufactured in several countries, Whirlpool Corporation introduced a splined clutch or "splutch," containing a spline and gears moulded in Acetal copolymer. The low-wear epicyclic gear assembly lasts four-times(fig 1)

FIG 1

FIG 2

1.2 NEED OF PLASTIC GEAR 2

At present there is a trend for reducing weight and increase efficiency. We know gears are so important in our daily life. although it's not so visible. All automobiles including transports vehicles and plenty of other household equipments use gears. If gears are not present it would have been difficult for us to carry our routine. Various developments along the ages have come to a point where nothing new can be created. In search of betterment research is still carried out for determining advancement in pre existing facts. Gears are having application in various fields. For example- wristwatch, automobile, power-drive equipments, heavy machines, work part transfer machines. Various industries are carrying out various research works for substitutions of plastic gears.

Using plastic gears in place of metal gears reduces weight and also reduces power consumption and increases efficiency.

2. INDUSTRIAL APPLICATION OF PLASTIC GEAR2

The other applications of plastic gears are:

- Light duty works machines like lathes, grinding machines and milling machines use plastic gears.
- Automotive gasoline tank level. Gears applicable motors, wiper systems, turbo and variable induction system gears.
- Automotive motor fan.
- Lift gates.
- Seating and tracking headlight to break actuator. Electronic throttle bodies and turbo controls. CD ROM, printers.
- Washing machines.
- Gear pumps, geometer.
- Damper drives in control valve.
- Actuator in fluid devices.
- Power screws that shape control surface on small aircraft.
- Gyro and steering control in military applications.
- Small petrol engine gears, like "Oil pump gears, cam gears, lawn-mower and chain-saw applications

Table-1: Application of plastic gears

Industry	Application	Resins	Design Consideration
Automotive	Actuators	Nylon	Switch Components
Automotive	Scooter gear box	Nylon	Small Transmission gear
Fluid Handling	Gear Pump	PPS,PEEK,LCP	Chemical Resistance
Industrial	Cam shaft driving system gear drive	Nylon	Small Engine
Power Tool	Cordless screw driver	Nylon	Mechanical Strength, Impact resistance

2.1 Advantage And Disadvantage Of Plastic Gear Over Metallic Gear2

ADVANTAGES

Among the characteristics responsible for the large increase in plastic gear usage, the following are probably the most significant reasons:

- Cost effectiveness of the injection-moulding process.
- Elimination of machining operations; capability of fabrication with inserts and integral designs.
- Low density, lightweight, low inertia. Uniformity of parts.
- Capability to absorb shock and vibration as a result of elastic compliance.
- Ability to operate with minimum or no lubrication, due to inherent lubrication.
- Relatively low coefficient of friction.
- Corrosion-resistance; elimination of plating, or protective coatings.
- Quietness of operation.
- Tolerances often less critical than for metal gears. due in part to their greater resilience.
- Consistency with trend to greater use of plastic housings and other components. One step production; no preliminary or secondary operations.
- Reduction in the overall lubrication of the gears.

DISADVANTAGES

- Less load-carrying capacity, due to lower maximum allowable stress; the greater compliance of plastic gears may also produce stress concentrations.
- Plastic gears cannot generally be moulded to the same accuracy as high-precision machined metal gears.
- Plastic gears are subject to greater dimensional instabilities, due to their larger coefficient of thermal expansion and moisture absorption.
- Reduced ability to operate at elevated temperatures; as an approximate figure, operation is limited to less than 120°C. Also, limited cold temperature operations. Initial high mould cost in developing correct tooth form and dimensions.
- Can be negatively affected by certain chemicals and even some lubricants.
- Improper moulding tools and process can produce residual internal stresses at the tooth roots. Resulting in over stressing and or distortion with aging.

3. METHEDOLOGY3

1) For the appliance engineer, plastic gears are a powerful means to cut cost, weight, noise and wear. They also open new opportunities for smaller, more efficient drives. What are the payoffs when using plastic gears in place of metal? The questions are timely as more engineers turn to plastics gears in higher-power, high-precision applications.

(a) Initially Gears are design for same power transmission as that of present metallic Gears. Using same conventional design procedure.

(b) Gears are modeled using PRO-E software and tested for displacement ,strain and stress and are Simulated Using cad modelling and FEM , analysis of the plastic gear and its material will be done. In addition ,its an efficient design tool by which designers can perform parameter design studies by considering various design cases of loding, motion etc can be analyzing and choosing the optimum design.

2) By taking into consideration the varios method s of plastic gear manufacturing. Gears are manufactured using Hobbing process by different thermoplastic materials viz. cast nylon, NylonDOS2 etc. As per the objective of our project we will carried out the experimentation and testing of the replaced metal gear by plastic gear under different running condition

and speed.We are going to make analysis and measurement of the following components.

3.1 VIBRATION ANALYSIS3

In this Vibrations are measured for metallic as well as non-metallic Gears and compared it among them.Noise measurement by Digital noise Meter and analyzed. Likewise vibration measurement and the noise of Gearbox are measured and compared critically among them.

3.2 HEAT GENERATION MEASUREMENT3

In this Heat generated during power transmission is measured by digital temp. Meter in both metallic as well as non-metallic Gears and Heat generated as well as dissipated is analysed. Heat generated as well as dissipated is analyzed. After making all the analysis and measurement we will make the comparative study in the various dimensional, physical, analytical and economical sections . Finally Gears are tested for their life using actual testing on the road and performance is checked and compared with metallic gear.And by taking out its result, which we will help us to make our conclusion that, Is it any advancement to use the plastic gear in sunny moped or not?

4. EXPERIMENTATION4

4.1 Technical Specification Of Sunny Moped4

The Bajaj Sunny is India's first **Scooterette**. It has a **60cc** engine, which takes it to a maximum speed of **50kph**. It has the capacity to carry a maximum load of **120kg**, hence it is highly recommended for riding alone or carrying a small pillion rider. With an automatic gearbox, it makes riding a pleasure. Like most scooterettes , the Sunny is targeted at teenagers who are eligible to get a driving license for ungeared two wheelers at 16 years of age.

Table No. 2 Technical Specification Of Sunny Moped

ENGINE	TWO STROKE/PETROL
TRANSMISSION	AUTOMATIC
ENGINE DISPLACEMENT	59.86 CC
TACHOMETER	NO
MAX. POWER	2.8 hp AT 6000 RPM
GROUND CLEARANCE	100mm
IGNITION	ELECTRONIC
DRY WEIGHT	63 Kg
FUEL TANK CAPACITY	3.5 lit
BATTERY	12 V
F/R SUSPENSION	LEADING LINK WITH COIL SPRING
R/R SUSPENTION	HYDRAULIC DAMPER WITH COAXIAL SPRING
MAX, SPEED	50 Kph
FRONT TYRE SIZE	2.75 X 10 Pr
REAR TYRE SIZE	2.75 X 10 Pr
WHEEL BASE	1,165 mm

4.2 THE VARIOUS DIMENSIONS OF REPLACED GEAR OF BAJAJ SUNNY4

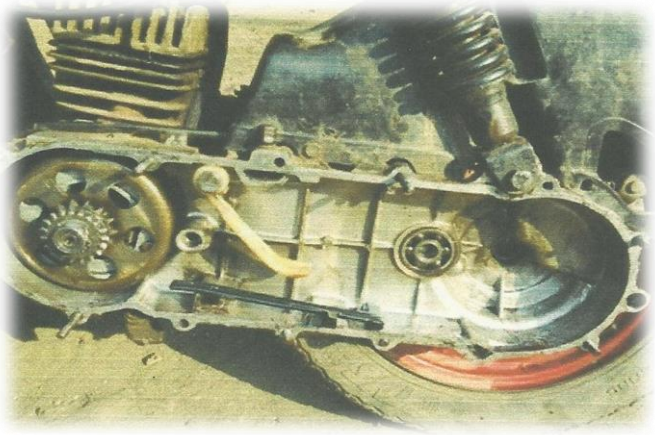
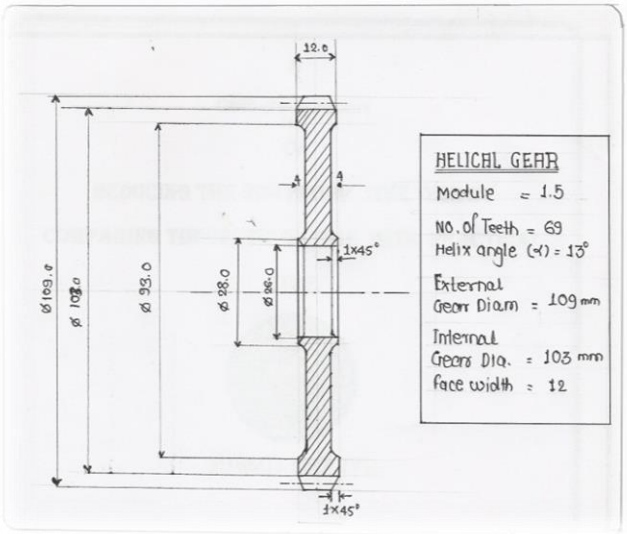


FIG. NO. 3 Gear box of sunny moped



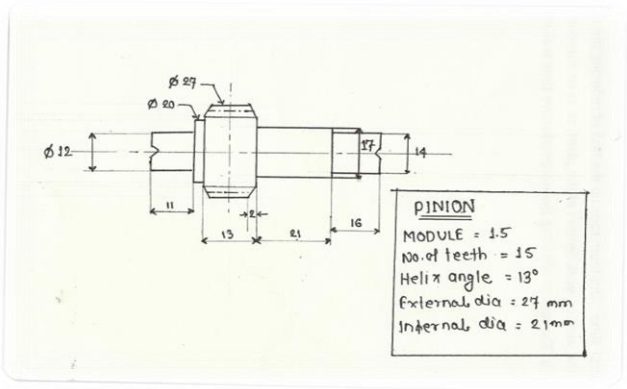


FIG. NO. 4 Dimensions of gears

4.3 DESIGN PROCEDURE FOR PLASTIC GEAR4

4.3.1 ANALYTICAL DESIGN

THEORETICAL CALCULATIONS

Under this section we will go through the theoretical analysis of the gear and pinion i.e will find the values of different forces and load which would act on the gear as per the collected and measured dimensions.

Number of teeth on gear =69
Number of teeth on pinion =15
Helix angle = 13°
External gear diameter =109mm
Internal gear diameter =103mm
Face width = 12mm
Given,

mn = 1.5mm, tg = 69, tp = 15, Ψ = 13°, b = 12mm, Pr = 2.8hp and N = 6000rmp

DESIGN POWER

Pd = Pr.kl.kw

kl = 1.25 and kw = 1.15 (kl for light shock and kw for conti. lubrication)

$Pd = 2.8 * 1.25 * 1.15$

= 3 kw

$vp = \frac{\pi Dp * Np}{1000 * 60}$

Dp = mt*tp

$= \frac{mn * tp}{\cos\Psi} = 23mm$

$vp = \frac{\pi * 23 * 6000}{60 * 1000} = 7.22m/s$

$ft = \frac{pd}{vp} = \frac{3 * 10 * 1000}{7.22} = 332.4N$

$y = 0.485 - \frac{2.87}{tf}$

$tf = \frac{tp}{Cos313} = 16$

y = 0.305

fb = so*cv*y*b*mn

$cv = \frac{6}{6+vp} = 0.453$

fb = 245*.453*.305*12*1.5

= 601.30N

fb > ft(safe)

$fd = ft + \frac{21vp(Ceb * cos213 + ft)}{21vp + \sqrt{Cebcos213 + ft}}$

eprob = 0.012mm, eper = 0.04mm

choose smaller valie i.e e = 0.012mm

fd = 1329.2N

$fw = \frac{k * b * Dp * Q}{Cos2\Psi}$

$Q = \frac{2tg}{tg+tp} = 1.642$

$Dp = \frac{mn * tg}{Cos13} = 106mm$

therefore,

fw = 2093kb

1329 = 2093kb

kb = 0.634

kb = .721

200BHN for gear

250BHN for pinion

fw = 1509N

feb = Seb*b*Y*mn

Seb = 350MPa

fen = 350*12*0.305*1.5

fen = 1921.5N

fen > fw, therefore design of gear is safe.

5. GEAR MANUFACTURING METHODS5

The various manufacturing techniques used for gear production are as follows:
a) Casting and injection moulding method
b) Gear forming method
c) Gear generation process

6. DEVICES USED FOR EXPERIMENTATION AND MEASUREMENT

The various devices used during the entire experiment for measurement and analysis are as follows:
1) Dial vernier calliper
2) Digital vernier calliper
3) Sound level meter
4) Digital tachometer
5) Vibration meter
6) Thermometer

CONCLUSION

Plastic Gears can be applicable in the gearbox of two wheeler moped. Plastic gear will be implemented in the gear box of Bajaj Sunny moped. And this can reduce the cost of vehicle.

REFERENCES

[1]. "Plastic Gearing For Small Engine Applications," Sae Technical Paper 2006-32-0038, 2006, Doi: 10.4271/2006-32-0038. By Kapelevich And Mc Namara
[2]. The Evolution Of Nylon Plastics In U.S. Automotive Applications," Sae Technical Paper 830284, 1983 Doi: 10.4271/830284. By J. Chruma
[3]. "Noise Reduction With Plastic Gears: A Case History For Diesel Engines," Sae Technical Paper 954149, 1995. By Calabrese A., Davoli P. And Quaranta
[4]. "Nylon Gears For Engine Timing Drives: Design And Experimental Tests," Sae Technical Paper 1993-25-0635, 1993. By Crippa G., Davoli, Gorla C. And Quaranta
[5]. "Element Of Workshop Technology" By S.K. Hajara Choudhury, A.K. Hajara Choudhury And Nirjhar Roy (Media Promoters And Publishers Pvt. Ltd.) Vol 1 And Vol 2
[6]. "Theory Of Machine" By R.S. Khurmi And J.K. Gupta (S. Chand Publication Chapter No.29, Helicle Gear Page No. 1066-1079)
[7]. "Effect Of Rotational Speed On The Performance Of Unreinforced And Glass Fibre Reinforced Nylon 6 Spur Gear" By S.Senthivalen And R. Gnanamoorthy
[8]. "Plastic Gear Case Study On Plastic Resines" By Zan Smith And Andy Ulrich
[9]. "Machine Design" By R.S. Khurmi And J.K.Gupta (S.Chand Publication ,Chap. No-29-Helical Gears , Pg No.-960-970)
[10]. "Production Engineering" By P.C. Sharma (S.Chand Publication Ch.No- 16-Gear Manufacturing, Pg.No.634-655)