Unified Car Wheel Opener

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Abstract— Automotive maintenance is one of the major parameters for keeping its life span, it includes mainly change of the punctured tires, has been always a difficult task, every automotive manufacturer provide tool such as the L wrench and jack, but still using these tools require skilled person. Therefore, it is crucial to have a tool that should designed ergonomically, easy to handle, light weight, require small space and can perform similar task in one time. Unified wheel opener is a special purpose tool use to open/close all the nuts of a wheel at one time with the less efforts. Although various methods were used for opening the wheel, but they required a lot of effort. The main objective of the project is to develop a single tool with the multiple mechanisms which can be used during the assembling/dismantling of the wheels in automobile.

Key words: Changing Of Punctured Tires, Designed Ergonomically, Easy to Handle, Light Weight, Small Space

I. INTRODUCTION

Engineering in general, and Mechanical engineering in particular, ideals with a wide spectrum of the products, ranging from large and complex systems comprising of numerous elements down to a single component. Apart from being a physical object, a product can also be service that requires the application of the engineering knowledge, skills and devices to be useful to society. A service falls under the category of a system in that it is carried out to with the help of personal, facilities and procedures. The service offered by an automobile maintenance and repair garage would be a typical example from mechanical engineering. Even computer software's could be treated as an engineering knowledge and skills. In the following the term product when used alone denotes the object to be designed and made with the help of engineering knowledge and skills. In the following term product when used alone. Irrespective of the whether it is a large system, a simple machine, a component or a service. Specific reference to design of the computer software is not attempted in the following although many of the generalities apply to it also.

A general understanding of the nature of the product is a prerequisite for designing it. A complex product can be subdivided into sub-assemblies or the subsystems, components etc. frequently the planning, layout and design of a complex multi element product is an interdisciplinary but even non-engineering ones.

It is always preferable that our work should easy and fast. But easy and fast working requires some technical skills to work efficiency and properly. In our daily life we face many problems where we need a lot of effort and time to do that specific work. A little but important work we do often is the opening a tyre of a vehicle. It is a fact that a huge effort is required to a single nut of a car wheel and it will become a tedious task to open the wheel in extreme atmospheric conditions. It also creates problem when we are in hurry.

II. MATERIAL SELECTION

The selection of a material for a particular application is governed by the working conditions to which it will be subjected, ease of the manufacturing and the cost considerations, pure metals find few applications in pure condition and secondly. They generally have poor strength in pure form. Various desired and special properties can be achieved by addition of different materials to form alloys. Alloys comprises of a base of the metal and one or more alloying elements. The typical properties associated with working conditions are tenacity elasticity toughness and hardness, toughness and typical properties associated with the manufacturing process can be determined by testing example-tensile test resistance to abrasions by hardness test toughness by impact test and other special properties like fatigue and creep test.

A. Engineering Material for Product Design

All physical objects are made out of some material substances or other, Mother nature has own set of the building material for the objects of her creation, living or non-living over the millennia, man has observed and adapted many of these for making objects of his inventions and design. For engineering purposes, we now use a very wide spectrum of materials. These generally fall under the following categories-

Materials as found in nature used only very minor preparations such as the cutting to the size, sun drying, mixing with water some examples are coal, wood and stones.

Natural materials that are modified/refined before used through some physical, chemical, or the thermal processes that improves their utilizations.

B. Selection Criteria

The designer selects the materials of construction for this product is based on several criteria such as the its cost, the desirable properties that it should possesses its availability, the preferred manufacturing processes that are to be employed etc. The overall economy is influenced by all these factors. In special cases, essentially and/ or urgency of the need for the product can superseded the economic considerations. The main criteria for the material selection are discussed below:

1) Cost of the Material

The amount of raw materials, their composition, quality, any special heat treatment that is required etc. Influenced the unit cost of the materials. The unit cost of materials. The unit cost generally depends also on the quantity of raw material that is purchased in a single slot. Special steel materials, for example, cost much more in the market when purchased in small quantities from a retailer than in bulk directly from the steel mill/stockyard.

2) Manufacturing Process

Facilities for shaping and treating the selected materials into the finished product or components must be available for economic production. Otherwise, the production cost grows

up. for example, the selection of forged alloy steel for a connecting rod design necessarily assumes that a suitable forging facility is available along with the necessary dies and other accessories. If the alloy is of a rare quality, then facilities for its heat treatment might not be available.

3) Gear Materials

The materials of the most of the gears used for the transmitting reasonable torque and speed mainly need to be mechanically strong in shear and bending, sufficiently tough and resistant to wear, fatigue and chemical degradation.

However, the material for any gear is selected based on,

1) The working condition that is power, speed and torque be transmitted.
2) Working environment, that is temperature, vibration, chemical etc.
3) Ease of manufacturer
4) Overall cost of the material and manufacturer

The materials generally used for the making the gears are,

1) Ferrous metals- for high loads
2) Grey cast iron- preferred for reasonable strength and wear resistance, ease of casting and machining and low cost.
3) Forged and rolled high carbon steels and alloy steels (Ni-Cr, Mo etc.) which are either fully hardened or surface hardened for use under high stresses and speed.
4) A Nonferrous metals-for high load
5) Aluminium, bronze and brass are used for making gears having fine teeth and working at very light load example, in equipment's toys etc. or against hard steel mating gears.
6) Aluminium alloys like aluminium, bronze, Zinc-Al alloys etc.
7) Nonmetals-widely used for light load, non-precision and noiseless operations.
8) Polymers (plastics); both thermoplastic and thermosetting type and various composites (metals, wood dust or ceramic powders dispersed in thermosetting plastics).

C. Size or Major Dimension's

The dimensional features that are used to express or specify the gears are;

For spur gears and worm wheel-

Number of teeth (z)

Module (m)

Helix angle if any (θ)

Width (b)

For example, pitch circle diameter (PCD) = $\frac{mZ}{\cos\theta}$

For worm

*number of start

*module helix angle length

Gear geometry

Some geometrical features also need to be mentioned while specifying gears such as,

*Pressure angle

*Addendum and Dedendum

III. DESIGN PROCEDURE

All engineering activities necessarily begin with some ideas with some ideas with high or low innovative content, translated into the definite plans for their realization in the form of products. This is the essence of design engineering. The ultimate success depends on a thorough consideration of how the product will be made and used as well as on the attention to existing or for a most innovative one. This is applicable equally for a minor redesign of a phases of the product cycle can influences the design is therefore essential. The product cycle can be better understood.

A. The Challenge of Design Engineering

The present-day industry bases economy is founded on the consumption of as many different products as possible by as much as the number of users as possible. It serves as an engine driving technology. The number put manufacturing under pressure; the number as well as the variety put greater pressure on design engineering. This is manifested by

Short time available for design, development and testing of the product before it reaches the users.

Demands from the users for affordable cost combined with the high quality of performance and appearance.

Increasing number of competitions who can supply a product of equivalent value. On one side, the scientific cooperation and exchange of information have become international. On the other side, industrial activities and communications network have globalized. Given the present-day ease of access to the technology, major breakthrough in product innovation and design are not really essential for the industries to produce and prosper.

B. Design parameter of gears

Since from the calculation we know that the center of distance(a)=5 cm

We know that

1) Module of gear(m)

$$m=\frac{2a}{z1+z2}$$

We are using the gears of same no of teeth so z1=z2=z

After simplification

$$M=\frac{a}{z}$$

According to this relation module is proportional to z

By hit and trial method,

If z=20, m=2.5

if z=25, m=2.5

For the simple design we consider

z=20 and m=2.5

Design procedure For Gear and Pinion

Torque required for one nut = 80 N-m

Total torque required = 4*80 N-m

= 320N-m

Let input torque = 30N-m

Maximum tangential force on pinion (Wt) = $2 * \frac{Ti}{Dp}$

= $2*30*\frac{1000}{25}$

= 2400N

2) Diametral pitch (Dp)

Ratio of no. of the teeth to the pitch circle diameter,

$$Dp = \frac{Np}{pcd}$$

$$Dp = \frac{20}{1.9685}$$

Dp = 10.16 inch

3) Circular pitch (Cp)

The distance from a point on one tooth to the corresponding point on the adjacent, measured on the pitch circle.

$$Cp = \frac{3.1416}{Dp}$$

$$Cp = \frac{3.1416}{10.16}$$

Cp = 0.3092 inch or 7.854 mm

4) Addendum (a)

The radial distance from the pitch circle to the top of the tooth.

$$a = \frac{1}{Dp}$$

$$a = \frac{1}{10.16}$$

a = 0.0984 inch or 2.5mm

5) Whole depth (Wd)

The full length of the tooth

$$wd = \frac{2.157}{10.16}$$

wd = 0.2123 inch or 5.6250 mm

6) Dedendum (d)

The radial distance from the pitch circle to the bottom of the tooth.

d = wd-a

d = 5.6250-2.5

d = 3.125mm

Radius of the tooth profile

$$R = \frac{3}{4} * Cp$$

$$R = \frac{3}{4} * 7.854$$

R = 5.89mm

7) Chordal thickness (ct)

Ct = PD sin(90/N)

Ct = 50*sin (90/20)

Ct = 3.923mm

Bending stress

$$\text{Bending stress} = \frac{W*3.142}{mby}$$

Where,

W is the tangential load

Pd is the diametral pitch

b is the face width

Y is the Lewis form factor

m is the module

80*10*3 = w*50

w = 1600N

b is the face width=25mm

Y is the Lewis form factor

m is the module =2.5mm

$$\text{Bending stress} = \frac{1600*3.142}{2.5*25*0.320}$$

$$\text{Bending stress} = 251.32 \frac{N}{mm*mm}$$

$$\text{Shear stress} = \frac{Load}{Area}$$

$$\text{Shear stress} = \frac{2w}{b*m*3.142}$$

$$\text{Shear stress} = \frac{2*1600}{25*2.5*3.142}$$

$$\text{Shear stress} = 16.297 \frac{N}{mm*mm}$$

$$\text{Deflection} = \frac{wl\text{^}3}{3EI}$$

L = H = Tooth height = 2.25*module = 5.625mm

or L = addendum + dedendum = 2.5+3.125 = 5.625mm

deflection = $3.51*10^{-3}$

IV. CONCLUSION & FUTURE SCOPE

4 in 1 nut remover has been successfully designed fusion 360 and pro E selecting the suitable material for gear and pinion calculation were performed. With calculations Factor of safety of gear pairs is higher than that of design FOS the design of the gear pair is safe. For validation finite element, stimulation will be performed for better optimized result. In future product assembly will be manufactured and tested. Cost as well as size of the apparatus should be less so that it can be economical and easy to carry a along with in the situation. The automation of the equipment can also be used if required in any assembly line of the industries.

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