Design and Fabrication of Prototype of over Speed Controlling system

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Abstract- *Many accidents are at least partially caused because of rash driving. This can happen due to many reasons: poor judgment on the part of the driver, poor driving by the driver. Once the driver has lost control it is very difficult to drive the vehicle. To avoid rash driving and to prevent losing of valuable property we need some safety systems in the vehicles. We can make this true by controlling the speed of the vehicle using sensors and other mechanical arrangements and this can bring the vehicle to the intended course. This simple system provides safety, and avoids rash driving in highly populated regions.*

Speed control is in the need of the hour due to the increased rate of accidents reported in our day-to-day life. During 2011, in India a whole of 4, 97,686 road accidents were reported which is a result of lack of speed control and violating the road rules. Road accidents can be prevented by adopting measures such as Traffic management, improving quality of road infrastructure and safer vehicles. The existing techniques still doesn't able to reduce the number of accidents.

Hence there is a need to implement Intelligent Speed Adaptation (ISA) in which vehicles speed can be automatically controlled by various limit techniques which are based on zones, highway, traffic density etc.

I. INTRODUCTION

Nowadays people are driving very fast, accidents are occurring frequently, we lost our valuable life by making small mistake while driving (zone wise, hills area, highways). So in order to avoid such kind of accidents and to alert the drivers about the speed limits in such kind of places the highway department have placed the signboards. But sometimes it may to possible to view that kind of signboards and there is a chance for accident. So to intimate the driver about the speed limit at zones and to detect crash automatically is done by means of using **over speed indication system** technology.

In India mostly 65 km/hr. limit for high ways and below 80km/hr. limit for express highways. This developed system is applicable for any speed limit which can be set or controlled as per the roads. In this project, the proposed methodology is suggested that one such kind of speed control system based lane speed for highway.

II. THEORETICAL BACKGROUND

Accident Avoidance systems in a four wheeler is a cocktail of several technological marvels.

1. Emergency Brake Assist (EBA)

In an emergency, many people do not depress the brake pedal hard enough. EBA senses an emergency braking situation and helps the driver to reduce speed in the shortest distance possible.

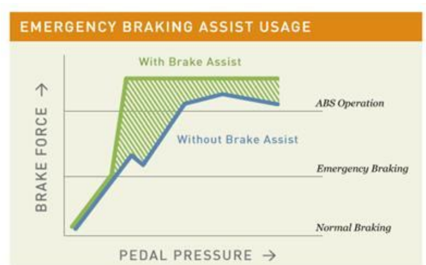

Fig No: 1.1 Emergency Brake Assist (EBA)

2. Dynamic Stability and traction Control (DSTC)

DSTC makes driving on twisty and slippery road conditions safer, by using sensors to detect whether any of the wheels is losing traction. DSTC has the ability to cut power in a flash, helping the car to regain its grip. If in any case the car shows a tendency to skid the system automatically slows the particular wheels to help maintain control.

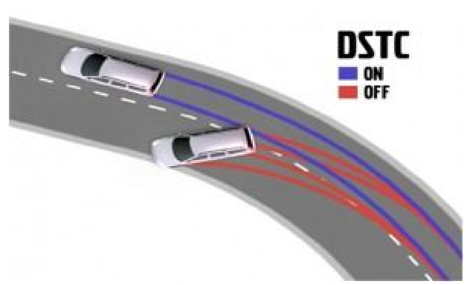

Fig No: 2.1 Dynamic Stability and traction Control (DSTC)

3. Electronic Brake Distribution (EBD)

EBD makes sure that the braking forces of the car are distributed between the front and the rear brakes in order to optimize braking efficiency.

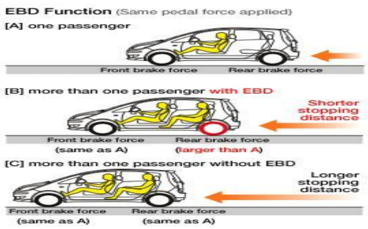

Fig No: 3.1 Electronic Brake Distributions (EBD)

4. Anti-Lock braking system (ABS)

With ABS you can brake as hard as you can and steer yourself to safety without the fear of wheels locking up and skidding.

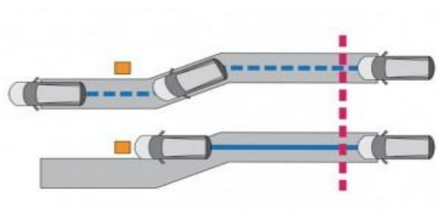

Fig No: 4.1 Anti-Lock braking System (ABS)

III. PROBLEM DEFINITION & SOLUTION

The above systems as applied to automobiles are extremely costly as they compulsorily need a computer for their implementation and in most of the cases GPS is mandatory. More over all these systems are singular problem oriented, hence there is a need of a cost effective low end technology or device that can perform the function of over-speed indication –alarm-and brake control with minimal use of high end technology, suitable for low budget commercial vehicles.

Solution

The Over speed indication and accident prevention system is a answer to the above problems where in the following features have been incorporated;

1. Over speed sensing using a simple centrifuge and inductive proximity sensor
2. Over-speed indication using flashing LED or hooter.
3. Braking –using Disk brake to ensure optimal braking force and minimum braking distance.
4. Electromagnetic actuation using solenoid .making the operation fully automatic.
5. Braking (Nature similar to the anti-lock braking) ie, intermittent and gradual braking.
6. Power regulation of the prime mover (in our case of model ---Single phase variable speed motor) to avoid power loss and excessive brake wear.

IV. CONSTRUCTION AND WORKING

Construction:

The Over-speed indication and accident prevention system comprises of the following:

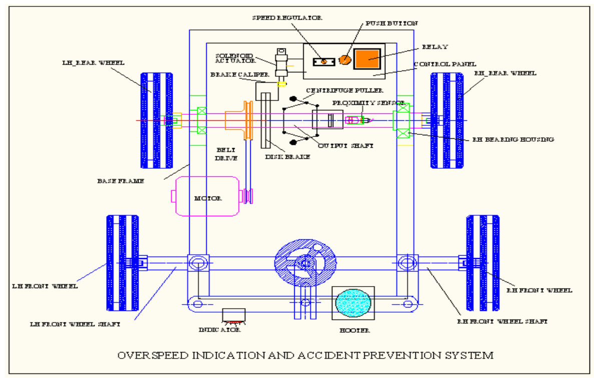

Fig No: 4.1 Construction of Over –Speed Indication and accident prevention system

a) Chasis or Frame: The Chasis or frame is fabricated structure that carries the entire system; rear wheel shaft is the driver shaft, that carries the reduction pulley driven by motor using a open belt drive. The end carries the steering mechanism in form of Ackerman steering with the central steering wheel controls the steering angle using the slotted lever arrangement.
b) Motor: Motor is the prime mover; it is single phase AC motor 50 watt, 0 to 6000 rpm variable speed. Motor speed is regulated using electronic speed regulator.
c) Over speed Sensing mechanism : The over speed sensing mechanism is a mechanical linkage based on the bob-weight type centrifugal, only that is used to vary the proximal distance between the probe and the sensor which is inductive type.
d) Braking Mechanism: The braking mechanism uses a Disk brake and brake caliper arrangement. The Disk brake is used with the view to maximize the braking and ensure safety.

Working:

System starts with motor starting. Motor speed controlled by electronic speed regulator. As speed increases the dead weight of the centrifuge governor fly's out making the probe to slide back; at over speed level the resultant gap between probe of the slider and the proximity sensor exceeds the permissible limit, which makes the relay to operate and consequently the following actions take place.

1. Visual over speed indicator in the form of over speed indication lamp lights.
2. Audio over speed indicator in the form of over speed indication hooter goes ON.
3. Braking mechanism is actuated to operate the shoe brake cam linear actuator mechanism.

V. DESIGN OF PROTOTYPE

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy & efficiency.

Hence a careful design approach has to be adopted. The total design work has been split up into two parts;

- System design
- Mechanical Design.

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.

In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely,

- Designed Parts
- Parts purchased

For designed parts detached design is done & distinctions thus obtained are compared to next highest dimensions which are readily available in market. This amplifies the assembly as well as postproduction servicing work. The various tolerances on the works are specified. The process charts are prepared and passed on to the manufacturing stage.

The parts which are to be purchased directly are selected from various catalogues & specified so that anybody can purchase the same from the retail shop with given specifications.

1. Prime Mover Selection

Motor is a Single phase AC motor, Power 75 watt, Speed is continuously variable from 0 to 8500 rpm. The speed of motor is variated by means of an electronic speed variator. Motor is a commutator motor i.e., the current to motor is supplied to motor by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed variator; thereby the speed is also is changes. Motor is foot mounted and is bolted to the motor base plate welded to the base frame of the indexer table.

Note: The above motor is selected with the view that the input power of the motor when varied will vary the motor speed and torque, just as in case of engine where in torque and speed can be varied by pressing the accelerator pedal, in our case the electronic speed variator resembles the accelerator.

2. Design of Belt Drive

Selection of an open belt drive using V-belt:
Reduction ratio = 5
Planning 1st stage reduction;
Motor pulley (ϕ D1) =20mm
Main shaft pulley (ϕ D2) =100mm

Input Data:

Input power = 0.075kw
Input speed =1000 rpm
Center distance = 210 mm
Max belt speed = 1600 m/min = 26.67 m/sec
Groove angle (2β) = 40^0
Coefficient of friction = 0.25
Between belt and pulley
Allowable tensile stress = 8 N/mm^2

Selection of belt section:

Ref. Manufacturers Catalogue
Table No: 2.1

C/s symbol	Usual load of drive (KW)	Nominal top width (w)in mm	Nominal thickness (t)mm	Weight per meter kgf
FZ	0.03 - 0.15	6	4	0.05

$$\sin\alpha = \frac{O_2M}{O_1O_2} = \frac{R_2R_1}{x} = \frac{D_2 - D_1}{2x}$$

$\alpha = \frac{100-20}{2\times210}$

α = 10.98⁰

Angle of lap on smaller pulley; i.e.; motor puller;

θ = 180 - 2 α

= 180 - 2(10.98)

θ = 158.04^0

θ = 2.75

Now;

Mass of belt /meter length =0.05 kgf

⇒ Centrifugal Tension (Tc) = Mv^2

∴ Tc = $0.05\ (26.67)^2$

Tc = 35.56 N

Max.Tension in the Belt (T) = f_{all} × Area

= 8 x 20

=**160N/mm²**

a) Tension in Tight side of belt
b) T_1 = T - Tc

= 160 - 35.56

T_1 = 124.4 N

b) Tension in slack side of belt = T_2

$= 2.3\log\left(\frac{T_1}{T_2}\right) = \theta \times \mu \times cosec\beta$

= 0.25 x 2.8 x cosec 20

$\log\frac{T_1}{T_2} = 0.86$

$= \frac{T_1}{T_2} = 7.75$

T_2 = 16 N

Power Transmitting Capacity of Belt;

P = (T_2 - T_2) v

= (124.24 - 16) 26.67

P= 3.13 Kw

⇒ Belt can safely transmit 0.075 Kw power

Selection of Belt

Selection of belt 'FZ 6 x 600' from std manufacturers catalogue

MAKE: HELICORD

Result Table

Table No: 2.2

1.	Belt selected	FZ 6 x 600
2.	Tight side Tension	T_1 =124.24 N
3.	Slack side Tension	T_2 = 16 N
4.	Motor pulley diameter. (ϕ D_1)	D_1 =20 MM
5.	Pulley (a) diameter (ϕD_2)	D_2 =100MM

3. Design of Input Shaft

Motor Torque

$$P = \frac{2\pi nT}{60}$$

$$T = \frac{60 \times 60}{2 \times \pi \times 6000}$$

$T = 0.095\ Nm$

Power is transmitted from the motor shaft to the input shaft of drive by means of an open belt drive,

Motor pulley diameter = 20 mm

Input shaft pulley diameter = 110 mm

Reduction ratio = 5

Input shaft speed = 6000/5 = 1200 rpm

Torque at Input shaft = 5 ×0.095 = 0.475 Nm

T_{Design} = 2 ×T =0.95 Nm. FOS =2

= 0.95 KN-mm

Selection of input shaft material

Ref: PSG Design Data.

Pg No: 1.10 & 1.12.0 1.17

Designation	Ultimate Tensile Strength N/mm2	Yield strength N/mm2
EN 24 (40 N; 2 cr 1 Mo 28)	720	600

Using ASME code of design;

Allowable shear stress;

Fs_{all} is given stress;

Fs_{all} = 0.30 syt = 0.30 ×600

=180 N/mm²

Fs_{all} = 0.18 ×Sult = 0.18 ×720

= 130 N/mm²

Considering minimum of the above values;

fs_{all} = 130 N/mm²

As we are providing dimples for locking on shaft;

Reducing above value by 25%.

⇒ fs_{all} = 0.75 ×130

= 97.5 N/mm²

a) Considering pure torsional load;

$$T_{design} = \frac{\pi}{16} F_{sall} \times d^3$$

$$d^3 = \frac{16 \times 0.95 \times 10^3}{\pi \times 97.5}$$

d = 7mm

selecting minimum diameter of spindle = 16 mm from ease of construction because the standard pulley has a pilot bore of 12.5 mm in as cast condition, and a bore of minimum 16 mm for keyway slotting operation.

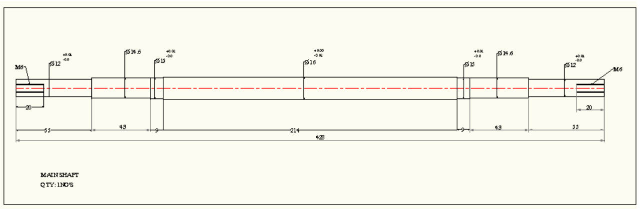

Fig No: 3.1 Shaft

4. Design of Bearings:

I. Design (selection of LH-wheel shaft bearing)

In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance ; hence we shall first select an appropriate ball bearing first select an appropriate ball bearing first taking into consideration convenience of mounting the planetary pins and then we shall check for the actual life of ball bearing .

Ball Bearing Selection: Series 60

Table No: 4.1

ISI NO	Brg Basic Design No (SKF)	D	D1	D	D2	B	Basic capacity	
							C kgf	Co Kgf
15A C02	6002	15	17	32	30	9	2550	4400

P = X Fr + Yfa.

Where;

P=Equivalent dynamic load (N)

X=Radial load constant

Fr= Radial load (H)

Y = Axial load contact

Fa = Axial load (N)

In our case;

Radial load F_R= T1 +T2=

$F_a = 0$

P= 140.4 N

⇒L= $(C/p)^p$

Considering 4000 working hours

$$L = \frac{60 \times n \times L \times h}{10^6} = 336\,mrev$$

$$336 = \left(\frac{C}{140.4}\right)^3$$

$$\boldsymbol{C = 976N}$$

AS; required dynamic of bearing is less than the rated dynamic capacity of bearing;

⇒ Bearing is safe.

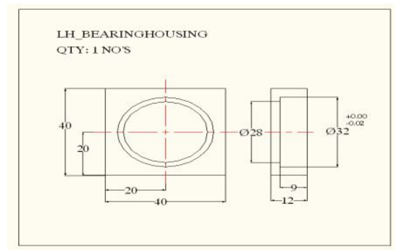

Fig No: 4.2 Bearing Housing

b) Design (selection of RH-wheel shaft bearing)

In selection of ball bearing the main governing factor is the system design of the drive ie; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing first select an appropriate ball bearing first taking into consideration convenience of mounting the planetary pins and then we shall check for the actual life of ball bearing.

Ball Bearing Selection: Series 60

Table No: 4.2

ISI NO	Brg Basic Design No (SKF)	D	D1	D	D2	B	Basic capacity	
							C kgf	Co Kgf
15A C02	6002	15	17	32	30	9	2550	4400

P = X Fr + Yfa.

Where;

P=Equivalent dynamic load (N)

X=Radial load constant

Fr= Radial load (H)

Y = Axial load contact

Fa = Axial load (N)

In our case;

Radial load F_R= T1 +T2=

$F_a = 0$

P= 140.4 N

⇒L= (C/p) ^{p}

Considering 4000 working hours

$$L = \frac{60 \times n \times L \times h}{10^6} = 336\, mrev$$

$$336 = \left(\frac{C}{140.4}\right)^3$$

$$\boldsymbol{C = 976N}$$

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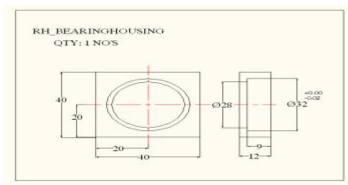

Fig No.4.3 Bearing Housing

5. Design of Governor:

Here the approach is to select the spring directly as per geometrical constrains and calculate the mass of the centrifugal bob weights to deflect the spring according to requirements of the governor set-up.

Assuming minimum cut off speed for model = 60 kmph

Wheel diameter = 300 mm

Hence speed of wheel shaft =1060 rpm

Radial speed = ω = 111 rad/sec

According to the Geometry of setup the spring used in the governor setup is mounted on the wheel shaft, hence minimum diameter = 16 mm, assuming rod diameter = 1.2 mm and no. of turns to be 10, both end ground, free length = 20mm.

The function of the spring is to maintain the gap between the sensor and the probe below 3mm, hence in order to cut-off to occur the spring has to be deflected by at least 4mm.

Hence specifications of spring selected:

Type: Helical compression spring:

End condition: Both end ground

Rod dia. = 1.2 mm

Inner diameter of spring = 16mm

Outside diameter of spring = 18.4

Mean coil dia. = 17.2

Free length = 20mm

No of turns = 10mm

Hence solid length = 12mm

Maximum deflection possible = 8 mm

Spring index =15

Maximum permissible stress = 420 N/mm^2

Modulus of rigidity = 84 KN/mm^2

$$Fs = \frac{K \times 8 \times W \times C}{\pi d^2}$$

$$420 = \frac{1.123 \times 8 \times W \times 15}{\pi \times 1.2^2}$$

$$\boldsymbol{W = 14.09N}$$

This is the load in the axial direction to be applied by the flying bob weight as centrifugal force, so also the fiction in linkages and shaft sliding bearing has to be overcome by the mass system hence; the load is taken to be 2 times required.

W= 2 ×14.09 = 28.18

W = mω^{2}r----------This is because two bob-weights are used.

m = 28.18 / ω^{2}r

m =28.18 / 111^2 ×0.025 = 0.092 N

m = (0.092 /9.81) ×1000 =9.4 gms

Hence the profile of bob weight selected is as follows:

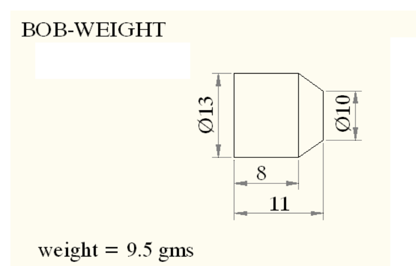

Fig No: 5.1 Bob

1) **Design of Link**:

The link that is subjected to direct tensile load in the form of pull = 28.18 N

The cross sectional area of link is 10 ×2 mm^2

Material Selection:-

Ref:-PSG Design Data

(1.10&12 1.17)

Table No: 5.1

Material Designation	Tensile Strength N/mm^2	Yeild Strength N/mm^2
C40	600	380

a) Check for failure of connecting rod under direct tensile load

Now,

Ft = Load /Area

Ft act = 28.18/20

=1.409 N/mm^2

As $Ft_{act} < Ft_{all}$

The link is safe under tensile load

b) Check for failure of link under direct tensile load at the eye end

This is the portion where the lever pin fits, the cross sectional area at this point is 10×2 -4×2=12 mm^2

Now, Ft = Load /Area

Ft act = 28.18/12=2.34/mm^2

As Ft act< Ft all

The link is safe under tensile load

6. Design of Brake Disk Hub: -

Brake disk hub can be considered to be a hollow shaft subjected to torsional load.

Material Selection:

Table No: 6.1

Designation	Ultimate Tensile strength N/mm^2	Yield strength N/mm^2
EN 24	800	680

As Per ASME Code;

$$F_{smax} = 108N/mm^2$$

$$T = \pi \times F_{sact} \times \left(\frac{D_o^4 - D_i^4}{D}\right)$$

$$0.95 \times 10^3 = \pi \times F_{sact} \times \left(\frac{26^4 - 16^4}{26}\right)$$

$$F_{sact} = 0.563N/mm^2$$

As; $fs_{act} < fs_{all}$

⇒ Hub is safe under torsional load

VI. RESULT

1. The normal person requires 4 to 5 seconds to apply brakes and up to 10 seconds to apply effectively but within this braking system brake apply within fraction of seconds automatically.

Without applying brake-

Table No: 6.1

Speed in (rpm)	Distance in (m)	Time taken in (secs)
60	4	6.71

With applying brake-

Table No: 6.2

Speed in (rpm)	Distance in (m)	Time taken in (secs)
60	4	7.85

VII. ADVANTAGES AND APPLICATIONS

Advantages:

- The over speed indication and accident prevention system offers the following advantages:
- The system eliminates the over-speeding which considerably reduces the chances of accidents due to over-speeding
- Ensures safety of the driver and or passengers as automatically speed is reduced.
- Reduces brake wear and tear as no need of excessive braking force to keep vehicle speed in control
- System components involve simple and cost effective components hence simple production.
- Low system cost as low level electronics is used.
- No computing /microprocessor involved keep the system cost effective.
- Can be easily implemented in both commercial LCV/MCV/HCV.
- Minimal space requirements .hence modifications in conventional system is reduced further increases the adaptability of system
- Visual indication in the form of indication lamp.
- Audio indication in the form of hooter increases operator vigilance and safety.

Applications:

- Small Cars
- SUV and commercial cars
- Medium to heavy duty transport vehicles
- Cargo trucks and Public transport vehicles etc.
- Material handling equipments.
- Automation.

VIII. CONCLUSION & FUTURESCOPE

This project presents architecture for automatic adaptation of the longitudinal speed control of a vehicle to the circumstances of the road which can help to decrease one of the major causes of fatalities: The excessive or inadequate vehicle speed. Our approach is based on a combination of different sensor technologies: The proposed on-board architecture is portable and easily adaptable to any commercial car with minimal modifications. By this system, our approach is to control the speed of vehicle at limiting road area to avoid the accidents. The accidents and rash driving can be reduced up to 80 % and can save many lives and many valuable properties.

In the empirical trials in our installations, the vehicle's speed was successfully changed as a result of the detection of the signals, increasing the driver's safety as shown in the results. The technology developed can assist human drivers in difficult road circumstances. By using this system, it can be reduced the rash driving within cities, within the regions of school zones, villages that are located at the highways and beside the highways.

Future Scope:

Lane Keeping Assist System (LKA)

The LKA uses camera to monitor the passing or dividing lane in the front and the system will give warning signal if the driver crosses the passing lane or enters into the opposite direction passing lane without giving or giving improper direction signal.

Low-Speed Following Mode (LSM) System

The LSM exploits mini-meter wave radar to detect the acceleration, deceleration and stopping of the front car to estimate the distance away from the front car, meanwhile he also controls the brake and the fuel systems to maintain his car within the safety range. If the front car experiences abnormal condition the system will blow alarm sound to warn the driver.

Cruise Control:

Cruise control (sometimes known as speed control or auto cruise) is a system that automatically controls the speed of a motor vehicle. The system takes over the throttle of the car to maintain a steady speed as set by the driver.

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