DESIGN AND DEVELOPMENT OF SMART SPEED BREAKER (SSB)

Suchir Patil, Mithun Das, Shivaprasad, Vikram Singh, Ravi Kumar

Mechanical Engineering Department BTI, VTU INDIA

Abstract: Planning and development of speed breaker will provide ease in driving as well as ease to traffic police. The simple design of SSB constitutes spiral torsion spring, sensors and a set of gears. As the vehicle moves by, the sensors determine the speed and are compared with a set value. If the speed is more, the vehicles feel the bump else the SSB moves down due to actuation of gears hence providing smoother drive.

Keywords: Spiral torsion spring, Sensors, Ramp, Microcontroller

I. INTRODUCTION

The problem faced in traffic by the traffic police and people has inspired the idea of SSB. It is not just the speed breaker but a kind of automated traffic control system. It constitutes sensors, a set of gears, springs and ramp made of honeycomb structure. The objective of this design is to control the traffic and make people follow the traffic rules with ease.

The first set of sensors is placed before the SSB. These sensors determine the speed of the moving vehicle. The speed limit is set by the traffic police. This predefined speed is compared with the vehicle speed. If vehicle speed is less than the predefined speed, then the vehicle pushes the SSB down without the feel of bump and hence moves in a smoother way. If speed of vehicle is more than predefined speed, the ratchet is actuated, locks the movement of SSB and thus the bump is felt to the vehicle.

The SSB lets the traffic only in one direction hence reducing traffic jam problems and rash driving. In multilane roads, the SSB is placed separately on each lane to regulate the speed.

II. PLANNING

2.1. Idea

The rapid increase in traffic, irregular standards of speed breaker, work load on traffic police, problems of ground clearance and unease to people driving has inspired to conceive the idea of SSB. The above factors have made the traffic system in India unmanageable.

The speed breaker should not only help in reducing speed, but also control the traffic and provide smoother drive to people. It should make people follow the traffic rules subconsciously. The design should be simple and easy to maintain.

2.2 Challenges

- In a single road with bidirectional traffic distinguished by a white or yellow line, people move haywire overtaking each other and causing jams and accidents.
- For smaller humps, people do not bother to cross over it at a higher speed while bigger humps touches the vehicle chassis and may cause damage to it.
- In multilane, the lanes are distinguished based on speed and load of vehicle; however no one follows it which causes problems in smoother movement of traffic.

2.3 SSB Constraints for Design

- Limit the speed of Vehicle
- Provide smoother movement
- Allow only unidirectional traffic
- Cause no problem of ground clearance

III. CONCEPT DESIGN

3.1 Preliminary Design

The concept of SSB has been designed to include
- Ramp
- Compound gearing
- Ratchet Pawl
- Sensor actuating Pawl
- Sensor actuating locking mechanism

Ramp takes the load of vehicles and it is reliable to design using honeycomb structure as it can take maximum compressive load.

Ratchet is compounded with spur gear and Pawl is attached to the actuator. Sensors are placed aside the road and controls the actuator based on comparison of speeds. The preliminary concept is shown in the figure below (Fig.1).

Fig.1 Preliminary concept
3.2. Working
As the car moves past the first set of sensors (Laser: Emitter and Receiver kept opposite), the signal gets disturbed and when second set of sensors gets disrupted the speed is calculated based on the known distance between sensors and calculated time from built-in microcontroller timer. Predefined speed set by traffic police is stored in microcontroller and is compared with the vehicle speed. If the speed exceeds the defined value, the actuator actuates the pawl locking the gear movement and thus the vehicles feel the bump. If the vehicle speed is less than the defined value, then no actuation takes place and the ramp is moved down with vehicle force. As the front wheel moves down the ramp, it locks the ramp down till the rear part goes past the final set of sensors; thus preventing damage to the chassis. The SSB concept is shown below (Fig.2).

3.3 Application in roads having bidirectional traffic distinguished by road paint.
The implantation of SSB on lanes allows the traffic to move in one lane. So people tend to follow their lanes which avoid overtaking and traffic jams. This concept is shown in Fig.3. Separate mini lane can be provided to the two wheelers to prevent intervention with the Light Motor Vehicle (LMV) thus maintaining smoother flow of traffic.

3.4 Application in Multilane road
Different speeds can be set in multilane for fast and slow moving vehicles. Also these SSB can be used to monitor and control the speed. The concept of multilane is shown in Fig 4.

IV. DETAIL DESIGN

4.1 Constraints
- Determination of total height of SSB: Survey of vehicles based on ground clearance is taken into account.
- Angle of inclination: The distance between the bumper and tier is considered.
- Width of SSB: The width of lane or SSB is designed considering automobile car standards.
- For design of ramp: Maximum car load experienced is factored.

4.2 Angle of Inclination
To illustrate, the minimum ground clearance of a sports car is considered to be approximately 10 cm. However, this is too low for a speed breaker and hence the height is set to 15 cm. To prevent the vehicle front bumper touching the SSB, the distance ‘x’ is considered as shown in Fig.5.

Typically, the ‘X’ ranges from 20 to 65 cm. For this design, approximately 60 cm is assumed.
Let angle of inclination be ‘$\Theta$’

Finding $\Theta$:

$$\theta = \tan^{-1} \left( \frac{10}{60} \right) = 9.5^\circ$$

Finding Y:

$$\tan(9.5^\circ) = \frac{Z}{Y}$$

$$Y = \frac{5}{\tan(9.5^\circ)} = 30$$

Hence $Y = 30\text{cm}$

Width of SSB is 250cm as per the automobile standards car specifications including tolerance.

### 4.3 Design of Ramp

Ramp is designed with static compressive load and material used is Aluminum 5052 (Hexcel Composites). Design is adopted from Hexcel Composites.

Ramp design due to bending load: The ramp is subjected to bending during locked position. Cantilever situation from Hexcel composites design formulae with end load of 3KN is considered.

- **Bending Stiffness:**
  $$D = \frac{E_{fc}h^2b}{2} = 308700 \text{Nm}^2$$

- **Shear Stiffness:**
  $$S = bhG_c = 39.06 \times 10^6 \text{N}$$

- **Deflection:**
  $$\delta = \frac{K_pP^3}{D} + \frac{K_pP}{S} = 0.0024\text{mm}$$

- **Facing Stress:**
  $$\sigma_f = \frac{M}{h tb} = 12.85 \text{MPa} \ll 150\text{MPa}$$

Hence design is safe since is less than yield strength

- **Core Stress:**
  $$\tau_c = \frac{F}{hb} = 0.0142 \text{MPa} \ll 3.0\text{MPa}$$

Hence design is safe and is less than core compressive yield strength.

### 4.4 Logic of Programming on Microcontroller

The initial flow chart for programming the microcontroller is shown in Fig. 8. The microcontroller used for the prototype is Arduino UNO Microcontroller.

As the vehicle moves, the interruption of first set of sensors triggers the timer, the interruption of second set of sensors stops the timer, the time and the known distance is used to calculate the speed of the vehicle. The calculated speed is compared with the predefined speed limit; if the vehicle speed is less than the limit,
then there is no actuation of pawl mechanism. The ramp gets locked as the vehicle passes parallel to the road. When vehicle moves past the third sensor, the lock of ramp is deactivated and the program starts again i.e. loops in for upcoming vehicles. If the speed is greater than the speed limit, the actuation of pawl takes place, the interruption of third sensors do not actuate any mechanism and program starts or goes under loop.

**CONCLUSION**

Our prototype design of SSB is reliable in controlling the traffic in a smart way thus preventing stress for people and traffic police. Accordingly, it can be optimized for real-time application considering the actual design standards.

**REFERENCES**
