SMART GUARD: A MODEL FOR ENHANCING THE SAFETY OF A MOTOR CYCLE CRASH GUARD

Deepak Eldho Babu, Rubin Kuriakose Jacob, Rakesh M B, Nidhin Kunjachan and Midhun Sunny

Department of Mechanical Engineering, M A College of Engineering, Kothamangalam, Kerala, India

INTRODUCTION

Road accidents are one of the major causes of death in the world. In India, the most common mode of transportation is two wheelers. As a result, majority of the accidents involve a two wheeler. The safety of a two wheel driver is hence very necessary. Most of the people in India buy a two wheeler as they cannot afford a four wheeler. Hence, we need to implement a safety device that can be fitted to the motorcycles that will not be too expensive and it will provide reasonable protection to the rider. One of the most commonly used safety devices is a crash guard. But, currently there is no standardised crash guard. Some are long and some are short. Short ones can cause the leg of the rider to get trapped during a fall. Long ones make it difficult to manœuvre through congested traffic and also take more space while parking. These are definitely limitations and these are necessarily what we want to eliminate. Hence, we have modified the crash guard to make it smart. A sensor will sense the particular angle of fall and our crash guard will extend only during the time of fall. All the other times, the crash guard will remain in a desirable compact position. We have incorporated sensors, actuators and other electronic components along with the mechanical parts.

Failed Designs and Reasons for Failure

In our attempt to come to a solution that would eliminate the drawbacks of conventional crash guards, we tried a few designs before finalising on the current one.

Here, we will be mentioning the ones that did not work out.

Theoretical Mechanism

In the theoretical mechanism, we incorporate the properties of gravity and friction. The idea is to have a shaft within a hollow shaft. The inner shaft will remain locked because of the friction present between the two. It will extend outwards only when the angle of tilt of the motorcycle exceeds the angle of friction i.e. the gravitational force will overcome the friction force and the inner shaft will move outwards only during the time of fall. We dropped this idea as it is practically very difficult to get such high machining and also the reaction time for this mechanism will be large.

Gear and Thread Mechanism

The next idea that came across was to use a gear that would extend the crash guard at the required time. For this, it was planned to cut outer thread on the inner shaft and an inner thread on the outer shaft. The gear would drive the shaft to move by the threading action up to the required length. This idea was also discarded because to reduce the reaction time, we would need to use a high RPM motor. But, such high RPM motors will fail during high impact loads. Instead if we use powerful motors, the weight, cost and reaction time will increase. Moreover, there is a higher chance of failure at the threads.
Toggle Clamp Mechanism
In this mechanism, we planned of using a toggle clamp. A toggle clamp is basically a tool used to fix the work piece. It basically is a 4 bar mechanism with concept of infinite Mechanical advantage incorporated in it. The handle is moved to lock the system. We planned of making a big toggle clamp which will fit our purpose. Also, we thought of using a torsion spring which would give us the required reaction time when it is unlocked. The idea was generated by analysing the working of a traditional rat trap. Once a small input is received, the twisted torsion spring will tend to come to its low energy state. This spring is coupled to the toggle clamp. As a result, the toggle clamp will extend come to its locked position. But, the fabrication of a large toggle clamp is difficult and it will considerably increase the weight of the model. Also, minor vibrations like those that occur when a motorcycle falls in a gutter, can unlock the spring leading to early ejection of the crash guard. The space consumed by this model is also high

Chosen Design
After the failure of the above designs, we could zero in on our current design.

Overview of the Design
After a particular angle of tilt of the motorcycle, the motorcycle will fall. We take this angle as the input for a gyro sensor. We have a microcontroller that reads the gyro reading and initiates a linear actuator. We have a spring which is compressed by a shaft. The shaft is the crash guard and hence it is now in compact position. This is locked in place using a lock. When the linear actuator initiates, this lock is unlocked and as a result, the shaft will extend out because of the spring. This position is maintained by using a lock to lock it. The haft can be manually pushed back after the fall.

Two Dimensional Drawing
The two dimensional figure shows the dimensions and the major components of the model. The electronic circuit part is not shown.

Three Dimensional Figure
The three dimensional figure gives a better understanding into the model. The electronic circuit part is not shown.

Analysis Using Ansys Design Software
Analysis of the prototype that we made was conducted on ANSYS platform and results were obtained which ensured the safety of the product against normal load condition. The stress analysis of the prototype was the major concern. Stress analysis and deformation analysis showed the following results.

Stress Analysis
Stress analysis of the prototype indicated that there is a chance of failure at the middle of the prototype. This can be overcome by increasing the thickness of the separator at the middle. There is also stress concentration at the clamp provided to support the smart guard. This can be reduced by providing proper thickness to the clamp. The most susceptible point of failure is the taper lock and the bolt. This was found to be safe indicating that the design works successfully.

Deformation Analysis
From the analysis it was found that the most deforming area is the area of impact. But the maximum deformation is only 5.3 mm for an axial force of 10,000 Newton. Deformation was found to be lower at the middle indicating minimum bending of the prototype. By using a material of improved fatigue strength the deformation of the model can be further reduced and better results can be obtained.

CONCLUSION
The suggested model of crash guard can be fitted in motorcycles for improved safety and better parking space utilisation. It extends to its full length only at the time of fall. The reaction time of the model was found to be very small indicating the mechanism works effectively. From the analysis of the prototype it was found that the effectiveness of the model can be improved by using a material of high fatigue strength, increasing the thickness of the separator placed at the middle, improving the thickness of the supporting clamp. The further scope of the project includes,

- Analysis to calculate the angle of fall at different speeds to increase the effectiveness of sensors.
- Study of using different material composites for crash guard.
- Conduct failure test using different materials at different conditions.
- Further reduction in the size of the model.
Reference


How to cite this article: