

ENHANCING SAFETY OF TWO-WHEELER VEHICLES USING ENCLOSED BODY WITH ACTUATING BALANCING MECHANISM

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Abstract— In modern world, two-wheeler vehicles have been a significant mode of transportation, especially in developing countries like India. But it is also one of the most vulnerable form of transportation, safety wise. There aren't many safety features or devices or even other vehicular systems developed for two-wheeler Rider's safety other than helmet and leg guard and safety clothing, which general population avoid to use, as compared to cars. In order to improve safety standards of two wheelers, some passive safety features that have proved to be very vital in case of cars must be developed for two wheelers too, like occupant's safety cell, crumple zones, restraining systems etc. but all of which can't be used in conventional two wheelers due to structural restrictions and hence a new concept of vehicle as part of future mobility must be developed.

Keywords— safety cell developments, indigenous development of balancing mechanism, details of simulations done in order to meet the ARAI legal requirements.

1. INTRODUCTION

In developing countries like India, the no. of two wheeler vehicle account for more than 70% of vehicles on road and it has been proved to be a very cost effective as well as quicker mode of transportation in modern traffic. But it can't be denied that two-wheeler vehicles are amongst the lowest level of chain in terms of size and safety. Research shows that Two-wheeler riders are among the most vulnerable ones during accidents which cause major disability or even fatality.

Keeping in mind the scope of future mobility and the safety improvements required in present day two wheelers, development of new class or concept of two wheelers is must that will overcome all the

structural restriction in current two wheelers that will not only bring the safety conditions at par with cars but also improve comfort and convenience of riders during longer commute. Also due to increase in readiness of customers to buy second or third mode of transport, new concept vehicle will be a marketable option in nearer future.

The main motto of the design will be to implement structural changes in order to incorporate as many passive safety features in two wheelers as cars that have been proved vital during accidents to save occupants.

Different norms will be followed to design and develop the said concept vehicle as per the guidelines/requirements of ARAI and other Indian Standards like for structural strength testing as well as restraining system and many such criteria.

2. SAFETY GAPS

The average fatality rate in road accidents of two-wheeler riders being more than 400[1] per day, the safety aspects for this mode of transportation must be examined and assessed to provide better solution and reduce fatality. It is found that drivers are more prone to injuries than pillion riders [2]. While most rider's faces head injury commonly, but research shows that legs and torso are also equally prone to injuries and permanent damages. The only safety measure for two-wheeler riders is helmet and safety clothing doesn't provide much benefit other than soft tissue's protection. Further it is assessed that helmet while being safe, must have to meet certain pre-requirements like Crash-Proof ratings, proper fastening and a full-frontal gear for better protection of head [3].

While some researches show that helmet are not very effective in many conditions and in a country with hot and humid weather and where regulations

are not very strictly followed it is discovered that helmet while being compulsory is being avoided by users due to many reasons or are worn only in presence of police or in fear of penalties [4]. Certain research revealed that in case of helmet usage patients have been diagnosed with Tentorial hematoma which in case of severity may result in death [5;6]

Researchers around the world has developed and tested various safety devices and concepts which will lead to more enhanced safety of two-wheeler riders. It is seen and concurred that in order to save rider from accidental impact from flying over and causing severe head and chest injuries which many times lead to fatalities, the occupant must be prevented from ejection from the vehicle and for that the conventional 3-point seat belt is best option to be employed but due to structural limitations it cannot be used yet. Further leg protectors are also deemed very useful as they protect legs and thorax which would be injured in many accidental cases. [7;8]

Active safety systems are very much developed for conventional cars and are slowly finding their use in two wheelers and use of stability control and ABS will have huge impact on safety of vehicles to avoid accidents [9]. But it is deemed necessary to have passive safety systems for better occupant's protection and it is noted by many researches that new concept vehicle like BMW C1[10] and CLEVER [11] has huge advantage by their side as they use various systems conventionally used only for cars, like roll-cage structure, crumple zones, collapsible steering, Airbags, restraining system and seats with torso and head support which improves safety at par with conventional cars.

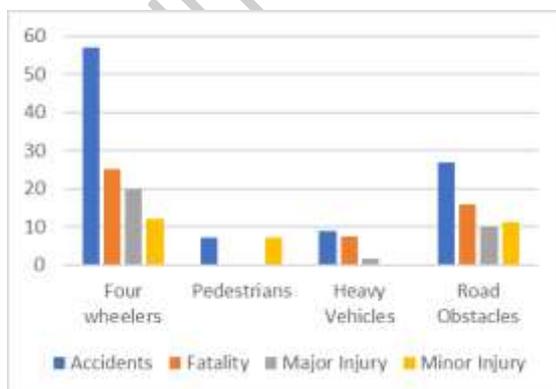


Fig: 1 Accident Analysis of Two-Wheeler

3. DESIGN AND ANALYSIS OF CONCEPT VEHICLE.

Above mentioned safety gaps show that a structural roll cage is necessary which can adhere to various automotive standards, and in order to provide safety as comparable to cars, structural changes are must which can be developed in new concept vehicle. The roll cage so designed is keeping in mind the types of damages riders tend to face during accidental conditions. And structural analysis is done using static analysis method on ANSYS software. Some details of which are as follows:

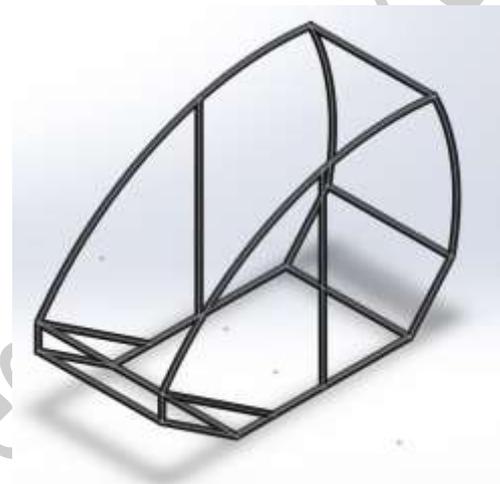


Fig 2: Prototype Design

Analysis of prototype design 1 is done by static load testing. Loads were given as point load and at magnitudes that will imitate impact force of about 40kmph. The output of the test very well adheres to AIS-098 standard requirements. The output reports can be seen as follows in terms of deformation as follows:

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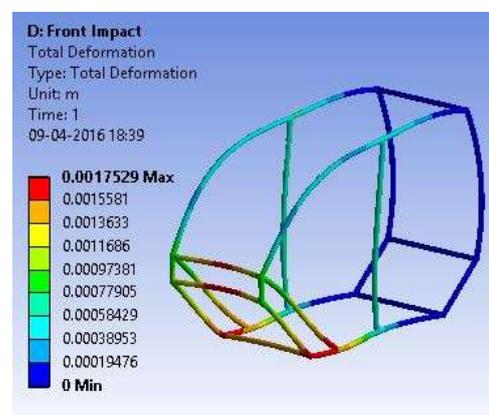


Fig 3: Deformation Report of Front Impact.

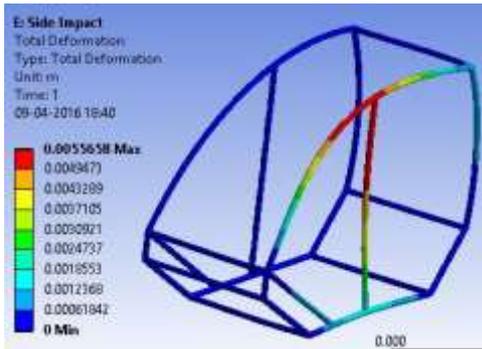


Fig 4: Deformation Report of Side Impact.

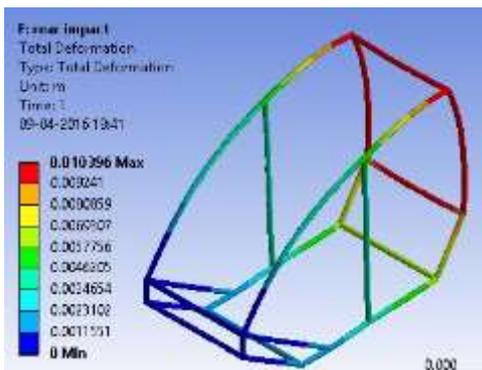


Fig 5: Deformation Report of Rear Impact.

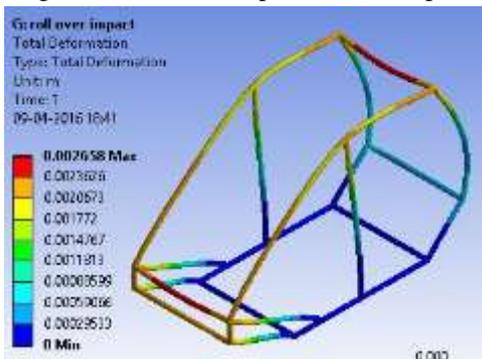


Fig 6: Deformation Report of Roll over Impact.

The enclosed body so designed is to provide complete weather proof protection to occupants, provide aerodynamic shape for improved fuel efficiency as well as to provide better aesthetics to the vehicle. The first prototype designed for the concept vehicle is heavily inspired by some concepts developed for e.g. BMW C1, and the famous CLEVER vehicle. The prototype 1 design is as follows:



Fig 7: Prototype 1 Body Design.

4. BALANCING MECHANISM

Normally two-wheeler riders will use gyroscopic effect of vehicle or legs for balancing the vehicle, but since the concept vehicle will have enclosed body, an external balancing mechanism has to be developed. For the new concept vehicle, external balancing mechanism are inspired from landing gears of an airplane, i.e. use of pneumatic cylinders in order to counter balance the vehicle by restricting the vehicle to fall on its side.



Fig 8: Balancing Mechanism (Lift position).



Fig 8.1: Balancing Mechanism (Land position).

Special mechanism is made indigenously to allow the motion of pneumatic cylinders in rotary motion and a roller wheel is attached just below the cylinder to contact with road surface, this will ensure smooth rolling effect and minimal reaction force from the road surface. The mechanism is such that when it is actuated, the pneumatic cylinders will fall downwards by rotating motion and thus will act as counter balance and when it is not necessary i.e. when gyroscopic effect of vehicle is good enough to balance the vehicle it will climb back to its original position.

The before mentioned pneumatic system uses air pressure of up-to 10bar that is created in an in-house compressor which will be battery operated and the whole system is automated, i.e. it will take inputs from various sensors such as vehicle speed sensor and gyro sensor. Also, manual bypass switch will be provided in order to manually operate the mechanism.

7. ADDITIONAL FEATURES OF CONCEPT VEHICLE.

Conventional two-wheeler vehicle as compared to conventional cars lack a lot of features and systems be it for safety or comfort, but by utilizing structural changes proposed in this paper, new features that are already in use in conventional cars can be implemented. Such features and systems are as follows along with their reasons:

1. Bucket Seat:

Two wheeler riders generally tend to complain about lack of back support or back-pain during longer journey, this feature will provide better comfort to the riders.

2. Seatbelt:

The most versatile and one of the most important safety feature of conventional car, by using bucket seat and an enclosed structure for two wheelers, seatbelts can be implemented and that will directly affect the safety concern of riders.

3. Air conditioning:

Another feature that will reduce the fatigue of riders especially in intense weather conditions, by implementing enclosed body, a/c system can be used.

4. Aerodynamic Body:

This will not only affect the aerodynamics of a rather open body vehicle, but will also lead to fuel savings and drastic improvement in aesthetics of vehicle.

5. Others:

Many passive and active safety systems can be further implemented like airbags, crumple zones, collapsible steering column etc. which will further add to crash-worthiness of the concept vehicle.

CONCLUSION.

The new proposed concept vehicle with enclosed body is specially designed for real world accident situations. Various safety and comfort features and systems used in conventional car can be implemented in two wheelers by doing some structural changes and that can lead to better safety standards of two wheelers that are one of the major modes of transportation in our country. In order to improve safety of two-wheeler riders, they must be restricted from ejection during accident, this shall be done using seat belts and enclosed body. The concept vehicle will adhere to all legal requirements of respective authorities.

The so-called design is backed by computerized as well as numerical simulations to ensure the safety of design as well as to optimize any potential flaw in the system, though real life performance has to be verified by real crash tests.

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