

Investigation of Vehicle Rear Under Run Protection Device (RUPD) Using Aluminium Foam

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Abstract. Whenever the passenger cars meet with accidents with the heavy duty truck from rear, it will tend to penetrate under the truck bed called truck trailer under-ride crash. This is responsible for the thousands of accidents, causing severe injuries and spot death. This is mostly due to the lack of effective guarding system. The Present paper gives an importance on energy absorption mechanism of a Rear under Run Protection Device (RUPD) under crash effect of the truck. The aim of the study is to replace Steel RUPD with aluminum foam, which promises an improvement of vehicle crashworthiness as well as to reduce weight of the vehicle. The aluminum foam is selected due to the high specific strength and specific stiffness. This inborn character makes it a promising candidate in the modern lightweight structures in the automotive engineering which can contribute to the improvement of mileage in addition to safety of the occupants.

Keywords: Truck trailer, energy absorption, aluminum foam, safety.

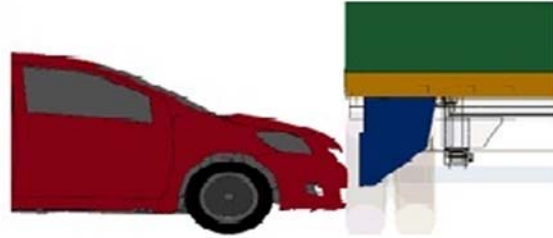
1. Introduction

The basic principle of an under ride protector for tractor-trailers or straight trucks is to prevent small passenger cars from going underneath these heavy vehicles. Due to high ground clearance of the heavy vehicles and the low height of a small vehicle's rear bumper, there is an existing of a large incompatibility between them when they will be collided. During the time of a collision, the bumper of the small car does not make contact with any part of the heavy vehicle, therefore may not utilizing the vehicle's crashworthiness of the components which are shown in Figure 1.1. Instead of, during the collision situation, the car could be completely passes underneath the heavy vehicle which is the term "underride" originates. The warp of the passenger compartment could be observed when the A-pillars come into contact with the bottom part of the trailer or the truck. At this point, disturbance is detected and the passenger compartment is completely distorted. In many cases, the collisions frequently result in severe occupant damage or fatal accident.





Fig(1.1) Inequality between passenger vehicle bumper and trailer



Fig(1.2)-Eliminated inequality of bumper and with an under ride protector



Figure 1.2: The Car Impact with Rear End of Truck

This type of collision can occur from the front, side or rear configuration when investigating the crash from the heavy vehicle's point of view. The car can pass underneath the bumper at the front, the trailer or the box of the straight truck at the side, or the back of the trailer or box at the rear. Guards can be installed in these areas to eliminate the under ride effect of the small vehicles and to improve the interaction between the vehicles. This research investigates and outlines the principles of side under ride protection devices to eliminate the incompatibility between the large trucks and small vehicles

2. Literature Survey

There has been a significant amount of statistics and surveys conducted over the years recording the occurrence of passenger vehicle to heavy vehicle collisions

Table 1. Recent Trends: Accidents on Indian Roads – 2015.

Parameter	2014	2015	% Change
Total accidents in the country	4,89,400	5,01,423	2.5
Total number of Persons Killed in the country	1,39,671	1,46,133	4.6
Total number of persons Injured in the country	4,93,474	5,00,279	1.4
Accident Severity*	28.5	29.1	2.1

2.1 Ten Important Rules to be followed for a Road Safety

2.1.1 A good starting point are the ten Golden Rules for road safety published by the International Federation of Automobile Clubs (FIA). These rules are in support of the United Nations' Decade of Action for Road Safety aimed at reducing road deaths around the world.

2.1.2 Buckle up. Drivers and passengers should always wear a seatbelt. In South Africa it is also the law that any child under the age of three is in a properly secure car seat. Wearing a seatbelt greatly reduces the chance of death or serious injury in crashes.

2.1.3 Respect the rules of the road. Road rules are there for everyone, and there to promote safety. Ignoring the rules of the road is selfish and puts other drivers and risk.

2.1.4 Obey the speed limit. Cars are made of metal, pedestrians and children are not.

2.1.5 Check your tyres. Worn tyres are extremely dangerous and can cause severe damage if they burst. Always check your tyres for wear, and the correct inflation, including the spare.

2.1.6 Drive sober. Driving drunk is extremely dangerous and illegal. If you are driving drunk you are a danger on the roads.

2.1.7 Protect your children. All children should be seated and buckled up. Younger children should be seated in car or booster seats and secured properly for the journey, no matter how short it is.

2.1.8 Pay attention. Distracted driving leads to less focus on the road and is extremely dangerous. Put your cellphone away and focus on the road ahead. No call or text message is more important than your life or the lives of your passengers and other road users.

2.1.9 Stop when you are tired. Driving while tired has been compared to driving while drunk. If you are tired, stop and rest. The AA advises all motorists to stop and rest every two hours or 200km.

2.1.10. Be courteous and considerate. Everyone wants to be somewhere, and get there as quickly as possible. Respect other drivers who also have a right to be on the road with you

2.2 Standards and Regulations

The guard must have a minimum cross section height of at least 100mm at any point on the device itself and must comply with very specific strength tests. At location P1, the guard must resist a force of 50,000N on either the left or right side. At location P2, the guard must hold a force of 50,000N and at location P3, it must resist a force of 100,000N on either the right or left side. During these tests, the maximum allowable deflection of the guard is 125mm. In addition to the load tests, the guard must meet energy absorption guidelines.

The guard is required to absorb by plastic deformation at least 5650J of energy within the allowable 125mm of deformation at location shows these locations along with basic dimensions of the guards.

3. Design of Truck under run Device

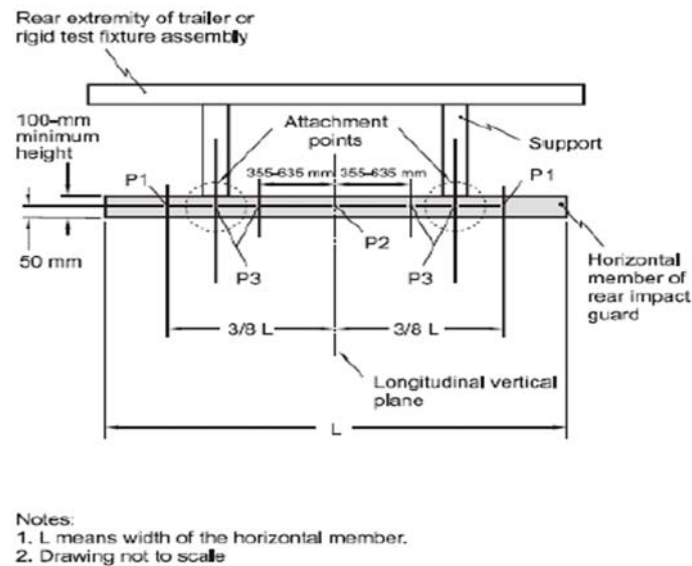


Figure (3.1) - Design of Truck under run Device

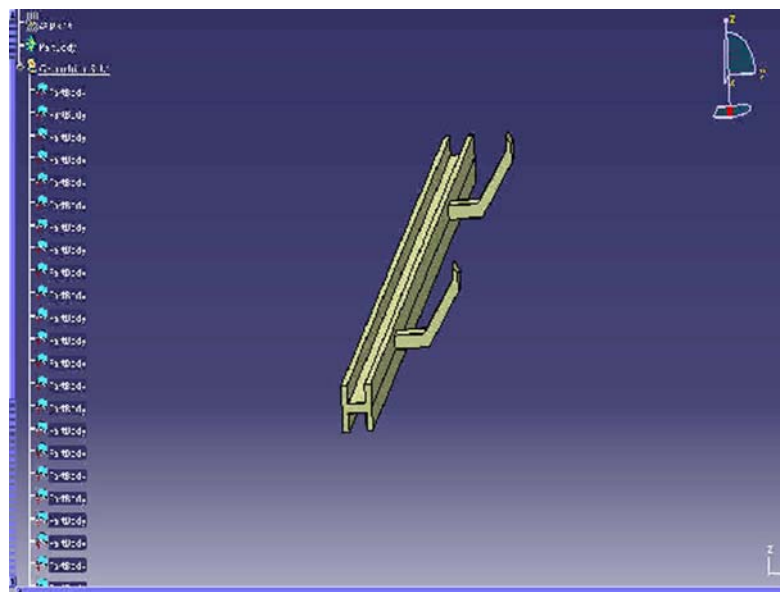


Figure (3.2) - RUPD with I-Section Beam

The load tests require that Location P1 and P2 be tested with a force of 50,000N. Location P3 is exempt from the tests. Instead, an additional test is done which consists of a “Uniform Load Test Force Application Device”. This device must have a height of 203mm and a width that is larger than the distance between the outside edges of the outer supports of the guards. During testing, the center of the device must be aligned with the center axis of the guard and must be guided to prevent rotation. The displacement rate of the application device is 90mm/min and the guard must hold the force with a maximum deflection of 125mm. The force applied with

this device is 350,000N and the guard is required to absorb 20,000J of energy by plastic deformation. If the manufacturer decides to forgo the energy absorption requirement, the guard must be tested with a force of 700,000N. If the guard is symmetrical, it may be tested only on one side, with half of the required force. The ground clearance of the guard must be at maximum of 560mm from the ground and must be measured before and after the tests to pass the regulation

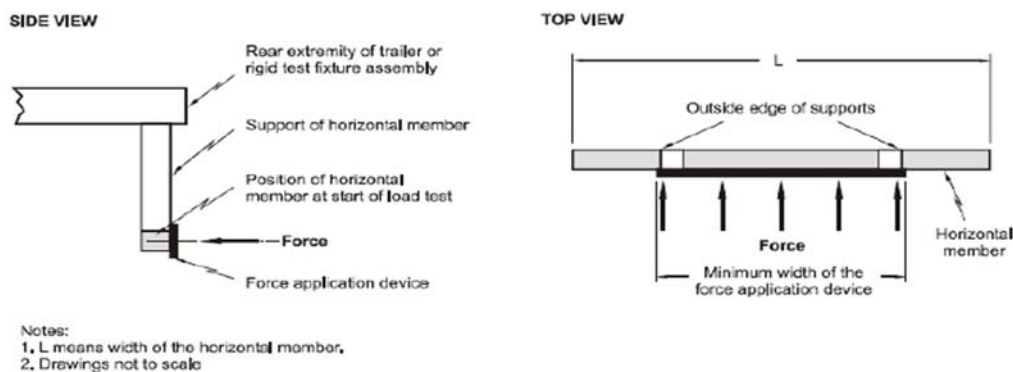


Figure : (3.3)-CMVSS Uniform Load Test Force Application Device

There are three different load cases (P1, P2, and P3) which have to be tested. The load is applied as a pressure on a specified area, one load at a time. Load area size is 200mmx100mm.

Applied pressures are $P1=12.5\text{bar}=12.5 \times 10^5\text{pa}$

$P2=25\text{bar}=25 \times 10^5\text{pa}$

$P3=12.5\text{bar}=12.5 \times 10^5\text{pa}$ applied outer, inner and middle areas respectively.

4. Results and Discussions

The computational results have found in ANSYS Explicit Dynamics Analysis, where the velocity of the vehicle increases with impact stress increases and corresponding deformation have found.

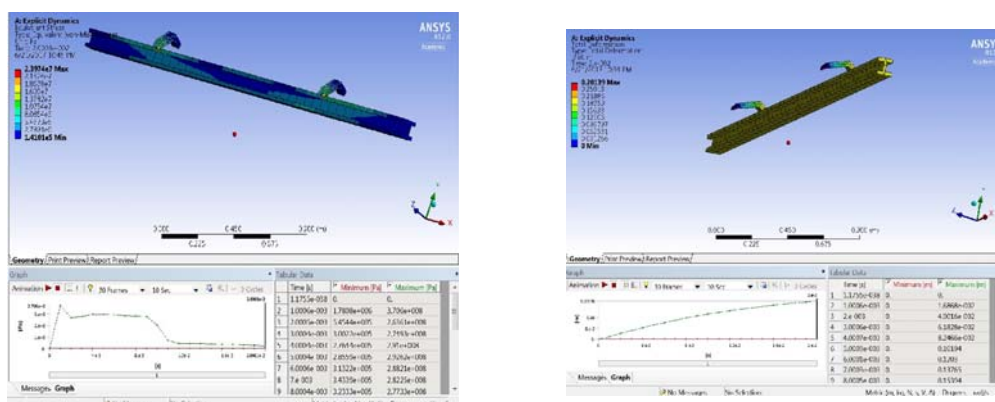


Figure: 4.1a) vonmises stress is 2.3974×10^7 Pa. at 50kmph Figure: 4.1b) Total Deformation is 0.28 m. at 50kmph

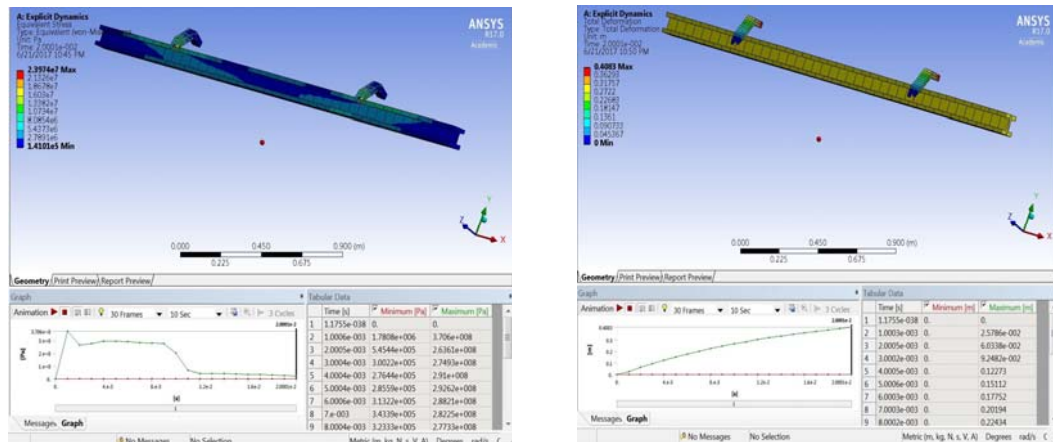


Table 2. Results of ANSYS Explicit Dynamic Analysis

S.No	Velocity (kmph)	VonMises Stress(pa)	displacement (m) Strain
1	50	2.3974e7 N/m ²	0.0515
2	60	2.371e7 N/m	0.0115

5. Conclusion

The energy absorbing RUPDs would help in minimizing the fatalities occurring due to vehicle under run and hence would increase the road safety. The RUPDs would also help in avoiding the damage to the heavy vehicles due to such an under run accident. The design proposed in this paper is helpful in minimizing the impact force during the accidental situations. The maximum velocity of impact would be withstand at 80 kmph based on the design parameters.

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7. References

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