



A Review Paper on Safety of Third Row Occupant in The Event of Vehicle Crash

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Abstract:

Exceptional advancement in the various fields of science and technologies in the 20th century lead us to today's more elegant life. One of the major contributors to this advancement is the high speed road transfer facilities. Increased running speed and density of vehicle on roadways are causing large number of accident which leads to large number of deaths and serious injuries. According to Global report on road safety 2013, Over 1,37,000 people were killed in Indian road accidents in 2013 alone, that is more than the number of people killed in all Indian wars put together. This scenario is not much different in the other part of the world too. This large number of road fatalities is always being concern for the every government of the world and has encouraged them to mandate considerable safety feature in the every vehicle manufactured. Dynamic vehicle market has also become a motivational source for the vehicle manufacturer to meet the requirement set by testing agencies like ENCAP to get maximum star rating for safety which gives them an edge over the competitor.

Keywords: Third row occupant, NHTSA, IIHS ENCAP.

I. INTRODUCTION

Considering the mandatory requirement stated by different automotive safety authorities and star rating requirement by testing agencies a lot of work is done on the safety concern of the first and the second row occupant safety during last six decades. The work done not only covers the vehicle structural development but also includes the work done on the restraint system like airbag, seat, seat belt, steering system, dashboard and trims in the interior of the vehicle. This lot of work done has resulted in availability of design process and commercially viable effective design solutions to meet the first row and second row occupant safety requirements. But not much advancement and concern over the safety of third row occupant is seen due to the less use of the third row of the special utility vehicle and the vans. One more reason could be the inclination of the designer towards the design philosophy that more the distance between the occupant and the impact point lesser will be the severity of the occupant injuries. However some work definitely done on the third row occupant protection in case of crash event like vehicle rollover which imposes almost similar risk of occupant ejection and injuries irrespective of the row in which occupant is seating. The most common solution implemented is extension of inflatable curtain airbag to cover up the head of the third row occupant. But not much research is done on the safety of third row occupant in case of the frontal impact and rear impact. Recent study carried by the NHTSA shows the concern over the safety of the third row adult occupant in case of the Frontal impact. Moreover, the study also shows that in case of the rear impact third row occupant faces the fatal injuries. Thus work undertaken for this project focuses on the evaluation of the safety of third row occupant in the event of frontal as well as the rear crash for belted as well as the unbelted occupant. Work is not constrained to the front facing seat but also extended to side

facing seats which are becoming more popular in the country like India. Thus Evaluation of the side facing third row occupant is done frontal and rear impact for both belted and unbelted conditions.

II.OBJECTIVES

- A. Study the safety of third row occupant with belted and unbelted conditions for Frontal Crash scenarios
- B. Study the safety of third row occupant with belted and unbelted conditions for Rear Crash scenarios.

III.LITERATURE REVIEW

With more vehicles being designed with third-row seats, some consumers are concerned with the safety implications of seating people usually children closer to the vehicle's rear, where they could be more vulnerable during a rear crash. Because of limited data, there is no clear-cut picture regarding third-row-seat safety. Reliable accident data are thin, partly because third rows are often unoccupied. Also, without evidence of a problem, automakers are not required to conduct rear-crash tests with dummies. Although third-row passengers are closer to the impact point in rear collisions, they are farther from that point in front collisions, which are more common and usually more harmful. The biggest danger to third-row passengers in a rear-ender is posed when the passenger is an adult and sitting in a seat with an inadequate head restraint and no three-point seat belt. Still, there's a growing trend for smaller vehicles to offer a third row. Those third-row seats tend to be very close to the tailgate, which means there's little crush space available in the event of a severe rear-end impact. Again, though, the relative rarity of high-speed rear-enders and the low occupancy rate of third-row seats means

that there is precious little data on which to make a safety judgment. When buying a vehicle with three rows, look for one that has side-curtain air bags that reach all the way back there. Children too big for child seats need lap-and-shoulder belts and head restraints that reach at least as high as the top of their ears [1] Keeping people safe in cars has been a priority for decades now, but most of the focus has been on protecting the driver and front passenger. Since those are the seats most frequently occupied places in a Vehicle. The basic laws of physics mean that any vehicle occupant has the greatest risk of injury when the initial point of impact is closest to them. Since frontal collisions are the most common type of crash, representing about 50 percent of all passenger vehicle occupant deaths in 2007 according to the Insurance Institute for Highway Safety (IIHS), rear-seat passengers in general have less of a risk of injury during a frontal collision simply because they are more likely to be further away from the initial point of impact. However, this does not hold true for all age groups. A 2005 NHTSA study assessed the risk of serious injury and death to occupants seated in the front seat versus the rear seat, in a frontal impact. This study showed that restrained occupants younger than age 50 had less risk Side-impact collisions and rollover accidents are another concern to rear-seat passengers. In 2007, 28 percent of car and truck occupants died in a side impact collision. The statistics on rollover collisions are more disturbing, as they have a higher rate of death: In 2007, 35 percent of rollovers resulted in a fatality. These rates are beginning to decrease as more automakers include side airbags that not only extend to the third row but also offer added rollover protection. Neck injuries, including whiplash, are the most common serious injury reported in rear-end collisions. When seated in the rear, while restrained occupants older than 50 were better off in the front seat because the airbag afforded them greater protection. [2] Plus, third-row occupants are at greater risk than second-row occupants in rear-end and side-impact collisions, because they're closer to the rear of the vehicle in a rear impact and are even less likely to have side airbags to protect them. Currently, only about 55 percent of vehicles with third-row seating have side airbags that cover all three rows. But, even if a vehicle does have three-row side curtain airbags, they may not extend down far enough to protect children. [2] While Small cars and SUV's represent opposite ends of the spectrum in size, small cars and sport-utility vehicles pose the highest risk of death in a collision. In a study of 2004 accident data, the NHTSA found that the highest incidence of fatality was in compact cars, followed by compact pickups, then midsize SUVs. [2] Automakers are also going to greater lengths to ensure their small cars perform well in crash tests, though a crash test rating is only comparable to a group of cars of similar size and weight. In other words, the federal government's four-star rating of the compact Scion xD does not make it as safe as the midsize Volkswagen Jetta, which also received four stars. [2] When it comes to SUVs, it's important to keep in mind that rear-seat passengers are not necessarily safer just because they are in a larger, heavier vehicle. A recent study by the Partners for Child Passenger Safety published in the medical journal Pediatrics found that children ranging from infants to age 15 were no safer in SUVs than they were riding in cars, due to the increased risk of rollovers in SUVs. In addition, a child seated in the third row is not necessarily safer in a frontal collision than a child in the second row. [2] A 2005 study by Transport Canada (the Canadian equivalent of the NHTSA)

showed that youngsters are likely to face the same forces in a frontal collision regardless of whether they are seated in the second or third row of the vehicle. The study, which involved a crash test dummy representing a 6-year-old seated in a booster seat in the second and third rows, found equally elevated forces in both rows. Since rear-seat passengers are less likely to have safety features like airbags, three-point seatbelts with pretensioners and adjustable head restraints to protect them, they are at greater risk in these types of collisions. And if they happen to be riding in a small car or SUV, the risk is even higher. [2] With the increasing number of entries in the small-car segment, more of these vehicles are likely to carry rear-seat passengers. Because these small cars are generally in the entry-level segment, many of them lack the safety features that are standard on larger, more expensive vehicles. One study published by the Society of Automotive Engineers (SAE) indicated that the standard three-point design would be more effective if the design were reversed for rear-seat occupants meaning a belt that goes over the right shoulder and buckles by the left hip for LH-side rear occupants, the opposite of what is typically found in vehicles today. [2] Researchers found this design improved the seatbelt geometry for a wider range of occupants, increasing its protective benefits as well as making it more comfortable for occupants. This so-called "reversed shoulder belt geometry" was used on some BMWs from the late 1980s to the late 1990s. The practice was discontinued when BMW began phasing in three-point belts for the rear center passenger. This is particularly a concern in small and midsize SUVs, where the third-row seatback is usually much closer to the rear window than in full-size SUVs. In an informal survey of vehicles with three rows, distances between the third row and the rear window ranged from 8 to 33 inches, with the smaller SUVs generally having the shortest distances. Is 8 inches or even 1 foot enough space? It depends not only on the strength of the seatback, but on the other safety features built into the vehicle. [2] There were 2.3 million rear collisions in 2000, according to the latest-available federal statistics. That was 21.7% of all crashes. There were 2,980 fatal rear-end wrecks in 2000, 6.2% of all fatal collisions. The worst thing about a rear-ender might be the driver's helplessness. A rear-end collision is one you don't control. Somebody drives into you while you're sitting at a light or something. When a minivan with a third-row occupant is hit from behind, the occupant is killed half the time (50%), according to a Ford Motor analysis. Fortunately, third rows are infrequently occupied just 1% to 2% of the time, according to accident statistics. [3] In a rear crash, the seat back regardless of which row acts as the restraint system, just as the safety belt and air bag do in a front crash. If a seat back is so rigid that it stays upright in a violent rear-ender, the stiff seat slams its passenger forward at the moment of impact. Then the passenger snaps backward against the stiff seat as the struck vehicle halts. Severe whiplash can result. [3] If, on the other hand, the seat is so yielding that it'll absorb lots of the crash force, the seat back bends far enough backward that the passenger could fly out into whatever's behind solid glass or a tailgate or even an intruding vehicle in a severe crash, in the case of third-row seats. [3] The bounce-back from a yielding seat also can cause whiplash. Plus, it takes close to 3 feet of space for a yielding seat to lay back fully. A third row gets that much space only in big SUVs. The sweet spot is somewhere between very stiff and fully yielding, but nobody's quite sure where. There's no generally accepted crash-test dummy to measure rear impact

forces, and no universal rear-crash test to measure seat safety. [3] NHTSA requires a seat back to withstand 3,300 inch-pounds of force, a measure of pressure equivalent to what 3,300 pounds could exert at the end of a one-inch lever, or 1 pound could exert at the end a 3,300-inch lever, or any combination of those that multiplies to 3,300.[3] NHTSA's official position on its long-running process: "There is genuine debate in the technical literature regarding the risks and benefits of more-rigid seat backs vs. those that yield, and we must ensure that any changes to the standard are cost-beneficial without producing other safety problems. NHTSA intends to issue a proposed upgrade to the seat back standard this summer." [3] The agency, in separate actions, is toughening head-restraint regulations and fuel-system strength rules before revising the seat standards. Proper head restraints will minimize whiplash threats posed by stiffer seats, NHTSA believes. And fuel systems that must not leak after 50-mph rear-enders, instead of 30-mph now, will minimize fires, dangerous to people trapped inside because of flimsy seats. [3] The National Highway Transportation Safety Administration does not conduct rear-crash tests with dummies to simulate the effects on third-row seat occupants, said an agency spokesman, Tim Hurd, and has no immediate plans to do so. The agency already ranks vehicles with one to five stars for front and side safety and for rollover resistance. [4] Mr. Hurd said the agency did not consider a rear crash test necessary because the probability of someone's being hurt in the third row was very low. "Hardly anyone sits back there, and rear crashes tend to be at low speeds," he said. [4] Nor does the Insurance Institute for Highway Safety, a group financed by the insurance industry, currently conduct crash tests for third-row safety. [4] As the number of vehicles with third rows grows, the probability of passengers being injured is likely to increase, too, just as the incidence of S.U.V. rollovers grew as those vehicles became more common. [4] Safety experts say the most effective air bags are those that provide head protection, like side-curtain bags or sausage-shape bags that inflate out of the roof. The seat does come with three-point belts, but they don't have pre-tensioners that pull the belts tight in a crash. For 2004, the Dodge Durango, which has long offered a third-row seat, adds a side-curtain bag that covers the third row. The Chrysler Pacifica wagon also has such a bag. [4] Volvo, which bases many of its safety features on a database of 25,000 actual crashes, has packed its new utility wagon, the XC90, with third-row safety features including a curtain bag. The XC90 has been designed so the forward-facing third row sits a foot away from the back window and on top of the rear axle. The axle is made of steel, not aluminum, providing better protection to occupants in a rear side-collision. "Even at 5 miles per hour, a child could be thrown out the back window," said a Volvo spokesman, Dan Johnston. "We've taken the position that if we offer third rows then we have to design them for safety." [4] In typical models, third-row seats offer up to five inches less headroom for passengers than the average headroom available in front seats. In some cases the seats are so tightly fitted that consumer groups wonder if passengers could more easily be injured in collisions that cause the rear of the vehicle to crumple. [5] Hard data on the safety of third rows are scant. Most crash-testing focuses on front impacts because they are the most deadly type. Concern about side impacts, also particularly deadly when large SUVs and trucks hit lower-riding cars, also grew following the rise in SUV popularity over the past decade. Rear-end collisions haven't gotten as much attention in part because

they are rarely fatal, and their effect on third-row occupants is largely unstudied. [5] One reason third-row seats are more widely available is because higher gasoline prices have pushed consumers toward smaller, more fuel-efficient vehicles and car makers are trying to accommodate even those who have large families, participate in car pools or otherwise require space for more than five passengers.[5] Don't assume the largest, heaviest vehicles are safest. According to IIHS death statistics, once a vehicle is over 4000 pounds, additional weight does not significantly reduce the risk of fatalities in a multi-vehicle crash. Most large sport utility vehicles do not get top ratings in the NHTSA and IIHS frontal crash tests and many others have no crash test results. [6] A vehicle is classified as rolling over if it tips onto its side or roof at any time during the crash. The rollover may occur subsequent to a frontal or side impact with another vehicle or a fixed object. Many rollovers occur after a vehicle leaves the roadway and may lead to occupants being ejected from the vehicle, increasing the likelihood of a fatality. [9] A total of 7,229 passenger vehicle occupants died in rollover crashes in 2017. Twenty-seven percent of these did not involve any other impact. [9] Rollover crashes accounted for 45 percent of occupant deaths in SUVs and 41 percent in pickups in 2017, compared with 22 percent in cars.[9]

IV. FUTURE EFFORTS TO PROTECT REAR PASSENGERS

One possibility is Ford's inflatable safety belt. Engineers have developed a small, tube-like airbag that deploys from the seatbelt in the chest area. This sausage-shaped airbag deploys in both frontal and side impacts and can stay inflated for longer periods to protect during rollovers. It will be useful to prevent rib fractures and neck loads, especially in older passengers. [2] An equally important new safety feature is stability control, which is proving to help drivers avoid crashes in these larger vehicles that often have inferior handling compared to passenger cars. [6] Google's experiment with the fully 'autonomous' vehicle to more evolutionary changes, in which an 'autopilot' guides most driving decisions, and the 'Internet of things' enables cars to sense approaching objects, scooters, people and stop by themselves. In principle, removing the driver can eliminate accidents resulting from drunkenness, drug use, texting, falling asleep, jumping red lights, looking left while a headphone-wearing pedestrian walks into your way from the right, and other human errors [8] Road traffic crashes are predictable and can be prevented. Many countries have shown sharp reductions in the number of crashes and casualties by taking actions including:

- Raising awareness of, legislating and enforcing laws governing speed limits, alcohol impairment, seat-belt use, child restraints and safety helmets.
- Formulating and implementing transport and land-use policies that promote safer and more efficient trips; encouraging the use of safer modes of travel, such as public transport; and incorporating injury prevention measures into traffic management and road design.
- Making vehicles more protective and visible for occupants, pedestrians and cyclists; using daytime running lights, high-mounted brake lights and reflective materials on cycles, carts, rickshaws and other non-motorized forms of transport. [7]

V. DECADE OF ACTION FOR ROAD SAFETY 2011-2020

On March 2, 2010, the United Nations General Assembly unanimously passed a historic resolution (A/64/L.44/Rev.1) declaring 2011-2020 to be the Decade of Action for Road Safety. The Decade of Action will serve as an excellent framework in which all stakeholders government agencies, educational institutions, non-governmental organizations, corporations, and more can work together to improve road safety both locally and globally. The Decade of Action will be officially launched on May 11, 2011[10] The 2030 Agenda for Sustainable Development recognizes that road safety is a prerequisite to ensuring healthy lives, promoting well-being and making cities inclusive, safe, resilient and sustainable. The Decade of Action for Road Safety 2011–2020, officially proclaimed by the UN General Assembly in March 2010, seeks to save millions of lives by building road safety management capacity; improving the safety of road infrastructure; further developing the safety of vehicles; enhancing the behaviour of road users; and improving post-crash response. Guided by the Global Plan, the Decade of Action offers a framework for policy, practice and advocacy to help countries achieve the Sustainable Development Goals.[11]

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[9] <http://www.iihs.org/iihs/topics/t/general-statistics/fatality-facts/passenger-vehicles>

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VI. ANNUAL GLOBAL ROAD CRASH STATISTICS [7]

1. Nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day.
2. An additional 20-50 million are injured or disabled.
3. More than half of all road traffic deaths occur among young adults ages 15-44.
4. Road traffic crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally.
5. Road crashes are the leading cause of death among young people ages 15-29, and the second leading cause of death worldwide among young people ages 5-14.
6. Each year nearly 400,000 people under 25 die on the world's roads, on average over 1,000 a day.
7. Over 90% of all road fatalities occur in low and middle-income countries, which have less than half of the world's vehicles.
8. Road crashes cost USD \$518 billion globally, costing individual countries from 1-2% of their annual GDP. Road crashes cost low and middle-income countries USD \$65 billion annually, exceeding the total amount received in developmental assistance. Unless action is taken, road traffic injuries are predicted to become the fifth leading cause of death by 2030.

VII. REFERENCES

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