International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-8, Issue-6, November 2021
https://doi.org/10.55524/ijirem.2021.8.6.62
www.ijirem.org

The Consequences of a Large Number of Light Truck Vehicle

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ABSTRACT
Aerodynamics is dominated by the outer design of the vehicle and extra internal components, such as the deflector connected. It is widely known that in the Indian Subcontinent a large number of light trucks without any aerodynamic characteristics are produced and operated. The main purpose of this study is therefore to assess the effect of aerodynamic devices or railways on light-duty vehicles in Pakistan and Bangladesh. The research consisted of computer modelling, production of quick physical models and wind tunnel testing, as well as CFD analysis. Nevertheless, there are a dangerous number of light trucks in the Indian sub-continent, mostly in India, Bangladesh and Pakistan that operate by changing an arrangement truck for Bedford J. The drag forces of each model were examined and matched. The results indicate that aerodynamically competent deflectors may increase the aerodynamic drag by up to 22% for most locally produced Pakistani and Bangladeshi vehicles. The aerodynamic fitting may reduce fuel consumption by 12% by altering the deflectors.

Keywords
Aerodynamic, Deflectors, Drag Coefficient, Drag Force, Light Truck.

1. INTRODUCTION
With the exception of a few areas, such as hydrogen power train production, electric cars, and hybrid innovation, there has been little progress in the automobile industry in recent years. The vast majority of vehicles are still powered by petroleum derivatives. In order to increase gasoline costs and environmental awareness, automotive organizations are attempting to design more environmentally friendly vehicles while also improving existing innovation. When designing a vehicle, one of the most important factors to consider is drag power. One of the methods for reducing the drag power of a vehicle is to create an aerodynamic exterior form for it. A vehicle with a lower drag coefficient (CD) would need less gasoline in order to overcome the drag force. Large commercial vehicles, in contrast to regular passenger vehicles, are inefficient because of their non-aerodynamic body design[1].

In comparison to other vehicles, a large commercial truck has a drag coefficient of about 0.90. In order to compensate for the huge frontal regions, the drag force is increased and the body shape is faked. An estimated 42 liters of gasoline are used by an overweight truck travelling at 110 kilometers per hour on the highway. This fuel consumption rate is several times higher than that of a typical city vehicle. Weight drag takes on a significant role, accounting for 80 percent of the total drag of a large commercial vehicle. At 110 km/h, aerodynamic drag caused by a small pickup truck contributes for about 78 - 82 percent of full motion safety, depending on the vehicle. As a result, just as the removal of greenhouse gas emissions improves performance, the reduction of aerodynamic drag improves performance even more. On the odd event that an exterior structure, such as the truck's front deflectors, is ineffective, it will increase the amount of fuel used to a critical level [2].

Bangladesh produces about 10 percent of the total number of enlisted motor vehicles produced worldwide each year. According to the Bangladesh Road Transport Authority, the total number of registered cars in Bangladesh in 2016 exceeded 2.5 million, an increase over 2015. It is estimated that about one thousand enlisted trucks are present in Bangladesh, representing almost 7 percent of all vehicles. In Bangladesh, the vehicles are usually changed at the request of the owner or proprietors. In general, the ornamentation attached to the vehicle has a combination of epigraphic formulas, poetry, monotonous instances, and figural pictures, depending on the design. As a result, the richer the vehicle's owner, the greater the number of decorations that are added to the vehicle's outside. Because of the chain decorations that bind the truck's front guard together, the modified vehicle is often referred to as the "jingle truck," and it creates quite a stir whenever it goes out. In a similar vein, this kind of vehicle may be seen in Pakistan as well as in a few regions of India[3].

In thecustomized vehicle, the basic problem is that the external trimmings that are connected to its body will produce the drag coefficient, and thus more fuel will be required in order to combat the drag power. An average business vehicle travels about 135,000 kilometers each year. Despite the fact that the vehicle is in an un-aerodynamic condition, half of the gasoline is applied when the truck is travelling at a speed of 85 km/h in order to overcome the drag force. Consider the following example: even a small percentage of the reduction will contribute to fuel savings and a reduction in ozone-depleting emission of chemicals. It will be essential to see a reduction in drag power. Therefore, the primary goal of this study is to assess the drag measure generated by these redirectors when they are employed in light vehicles that are built and operated in an exploratory and numerical inquiry in the Indian subcontinent, particularly in Bangladesh and Pakistan. A redirector, on the other hand, is often called upon to test and examine a fuel-saving aerodynamic construction.

Road traffic accidents are a leading source of death and disability across the globe. Traffic accidents are expected to be the third largest cause of disability adjusted life years (DALYs) globally by 2020, and the second major cause of DALYs in fast motorizing nations by 2050, according to estimates. According to the World Health Organization, road traffic accidents will overtake cancer as the third biggest cause of death in the not-too-distant future. Pedestrian accidents are becoming an increasingly difficult problem for public health trauma and road safety experts all around the globe to solve. Every year, an estimated 1.2 million pedestrians are killed and 50 million are injured on the roads, with more than 85 percent of the fatalities and injuries occurring in poor nations. Unfortunately, it is projected that the number of pedestrians killed or injured on the roads would rise by 65 percent in the next ten years. Pedestrian accidents are linked with significant morbidity, death, and economic costs, yet there has been little published research on the subject on a global scale, particularly when compared to studies of vehicle occupants in motion [4].

Unfortunately, significant changes in the nature of the world's LTVs vary from automobiles in three important ways: they have more mass and rigidity than automobiles, and their bumpers are considerable higher from ground. The arrangement of a pedestrian tangled accident is altered as a result of these variables. It is more often than not for pedestrians to be vaulted over than run over by a striking LTV, contrary to popular perception. This means that the bumpers and the upper part and front of the LTVs were directly liable for the damages to the pedestrian's head and legs whenever they crash with them. LTVs have higher bonnets, which causes the initial contact on the upper thigh and pelvis is so much more painful, and the frequency of injuries to vulnerable areas like as the head, chest, and stomach is twice as large as it is with vehicles [7].

The size and weight of the vehicle are the most important factors in determining the severity of injuries sustained in motor vehicle accidents. According to a recent study conducted in the U.S, a spike in the quantity of SUVs and pickups commercial trucks was related with a spike in pedestrian fatalities as well as an increase in the intensity of injuries. A research conducted out in the Abu Dhabi revealed that pedestrians were significantly more likely as occupants in a regular car to die in a crash with a passenger vehicle. It has been anticipated that the different governmental of the fleet of cars expanded the number annual road fatalities by 1 percent inside the Great Britain between 2001 and 2002, according to the National Road Safety Partnership. This percentage rise corresponds to an increase of roughly 40 more fatalities. LTVs are also more frequently than automobiles to be engaged in rear-end collisions involving children who are walking. Every year more than seven thousanddamages and two hundred fatalities occur as a consequence of back over accidents, with more than 60% of those injuries and deaths occurring in children under the age of five or people over the age of 70[8].

Systematic evaluations of controlled studies are exceedingly unusual, and the essential knowledge is lacking in this discipline. Although randomized experiments are difficult, impossible, or immoral to execute for many concerns in this discipline, in many situations observational studies offer the only information source. Several concerns concerning pedestrian collisions may be resolved by the use of corpses and mannequins in experimental research. However, because to the complex nature of the accident, several critical biomechanical components, including such vehicle-pedestrian contact, are impossible to be examined in such laboratory tests. In order to acquire a better understanding of how improvements in vehicle design effect pedestrian injuries, in-depth analyses of real-world incidents are necessary. In addition, all available dummy and carcass studies demonstrate that LTV produce more serious injuries and fatalities to pedestrians as opposed to vehicles, according to the study. Real-world crash data is in desperate need of being compiled in a more thorough manner. Retrospective cohort studies performed in this region have shown that accidents with LTVs are associated with a higher incidence of serious pedestrian injury and death when compared to incidents with passenger vehicles[9].

It is the researchers' objective with this conceptual to identify all relevant information and to discover and highlight any changes in pedestrian damage outcomes in collisions involving LTVs as compared to interactions with conventional passenger cars. While a limited number of additional studies have indicated the influence of LTVs affecting pedestrian accidents, there's been no systematic reviews to explore the effect of LTVs on the consequences of pedestrian collisions. Because reviews are detailed, they provide as a far more solid basis for judgement than other forms of research. We think that this comprehensive review will aid in the identification of the dangers presented by LTVs to vulnerable road users and pedestrians. In order to reduce the number of fatalities among vulnerable road users, policymakers in the automobile sector and the government will be able to make the required design modifications to LTVs[10].

2.DISCUSSION

2.1.1 Experimentation with Models

An entirely redesigned Bedford J truck built on a one-tenth scale served as the basis for the pattern vehicle. Two deflectors were used to better replicate the method used by the vehicles from Bangladesh and Pakistan. In addition, an aerodynamic molded deflector was created to limit the amount of drag power generated when the pattern truck model was connected to it. To complement the benchmark truck platform, all model deflectors were designed to be one-tenth the full size of the truck platform itself.

2.1.2 Wind Tunnel Examination

This investigation was carried out at the RMIT commercial wind tunnel. The tunnel is a closed return circuit wind burrow with a turntable, which allows for the recreation of cross-wind effects. The tunnel's maximum speed is about 145 kilometers per hour. The rectangular test segment has dimensions of 3 meters wide, 2 meters high, and 9 meters long, with a cross-sectional area of 6 square meters. The corridor is 3 meters wide, 2 meters high, and 9 meters long. In the finer intricacies of this wind passage, it may be discovered. In the past, the passage was aligned with an ellipsoidal head pitot-static cylinder (located at the section of the test segment) that had been modified by the National Physical Laboratory (NPL) and connected with the Baratron pressure sensor developed by MKS Instruments, USA, through adaptable tubing to the examination and speeds inside the wind tunnel.

The truck model was linked to the JR3 multi-hub load cell manufactured by JR3, Inc. in the United States via a mounting sting. The sensor was utilized continuously to measure each of the three powers (drag, lift, and side powers), and three minutes were allotted for each power measurement (yaw, twist, and roll). Initially, the aerodynamic forces under a spectrum of wind speeds (40-100 km/h) at a zero-yaw angle were measured for the pattern truck without any external attachments in order to perform the gauge correlation (i.e. deflector). The estimations were obtained at that moment by combining the Bangladeshi, Pakistani, and aerodynamic redirectors on the benchmark truck. Each information arrangement was reported for 10 seconds in a typical fashion, with a 20 Hz repetition to ensure that there was

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little electrical interference. A variety of information collections were acquired at each of the speeds tried, and it was discovered that the median value was lower than the mean in terms of the number of potential errors in the information received from the basic experiment.

In this article, just the drag force (D) data and associated dimensionless drag coefficient (CD) are addressed. The following formulation was utilized in the creation of the CD:

$$C_D = \frac{D}{½ \rho V^2 A}$$

For some truck designs, the CD is included as a velocity component at the 0o yaw position. The outcome shows that the ordinary vehicle has a CD estimate of about 0.47 that is almost stable. According to this research, the truck CD values fall anywhere between 0.41 and 0.51 depending on the aerodynamic approach used by the front redirector. Among all other configurations tested, the benchmark truck with the aerodynamic deflector added had the lowest CD admiration of any of the other configurations.

For the purpose of taking into account the liquid stream around the simulations, a computational Fluid Dynamics (CFD) study was conducted. Despite the fact that the truck's state is not entirely symmetrical, it is possible to observe that the vortices are very turbulent in the area nearest to the rear section. This is especially true in the region closest to the rear segment. Vortices eventually merge into a few vortices with opposing bearing pivots and vortices extending out along the downstream, with the quality becoming more delicate as one travels farther downstream in the flow.

Following the investigation, it was discovered that the oncoming stream is separated in two locations at the front of the vehicle, one of which is located at the very top and one which is located at the very bottom of the truck body. Additionally, the upper stream district is divided into two different locations in the stream arrangement above the deflector as well. One is to the cold earth region, which builds the vortices for the body to avoid between the bottom floor and the truck body throughout the state, and the other is to the warm earth area. The velocity stream for the gauge model became more rapid at the top edge area of the frame, and the hole between the front truck and the trailer body caused a low-pressure zone to form in the vicinity of the hole.

Because of the state of the truck and trailer body at that point, the stream continues downstream and creates enormous vortices in the process. After cutting the Bangladeshi model truck's bonnet and top of the body, the wind currents swiftly travel through the vehicle. Following the installation of the fairing at the front of the truck body, it is responsible for constructing the weight drag of the whole truck body. It seems to be discovered in the form of delivering greater weight transport than the other three variations for the Pakistani type truck similar process, which is more than the other three types combined. The Aerodynamic form truck also has an excellent streamline stream attached super surface, which is seen in this image. In addition, as the incoming wind stream tracks closer to the surface, more air is supplied into the trailer hole from the truck's main body and downstream of the trailer, causing the disturbing impact of the local stream to be more noticeable.

As compared to the gauge model, the truck model, which was arranged individually for the Bangladeshi and Pakistani redirector structures, showed a drag power increase of between 14 percent and 22 percent, according to the results. This finding demonstrates that the extra fairings that have been changed in Bangladeshi and Pakistani redirectors offer greater drag power than the original fairings. When compared to the pattern model, the aerodynamic fairing shows a reduction in drag forces of 12 percent, which is significant.

The amount of gasoline required is determined by the length of the drag effects. As the drag rises, the fuel consumption increases as well, almost instantly. As a result of the non-aerodynamic structure of such trucks, which are common in Bangladesh and Pakistan, the lateral reliability of the vehicle can be compromised as the vehicle's gravity focal point shifts and the total lift is reduced due to the troubling effect of the stream flowing over the roof during operation. Wind commotion and dirt are also attested to by the truck deflectors' complex exterior systems, which further contribute to the affidavit's credibility. The increase in operating expenses will also be a result of the increase in fuel consumption, which will further hasten the deterioration of air quality. In addition, the increasing use of gasoline places an extra burden on the preservation of the nation's vitality and economy. Since 2014, the globe has used more than 1.3 trillion gallons of petroleum and diesel each year, enough to power several million vehicles and trucks across the world. An analysis conducted by Snyder discovered that it is possible to save $30 million per year in fuel use in the United States by reducing demand by as low as 1 percent (which equates to just 0.1 L/100 km for a typical car).

We identified one of its most important benefits of our research to be the extensive search technique, which encompassed multiple internet databases. A considerable number of papers were produced as a consequence of our search strategy. The reason for this is largely connected to the fact that filtering by research type is only practicable for randomized controlled trials. The initial check of identified articles to discover relevant research cut the number of possible relevant publications to a reasonable quantity that were further reduced by subsequent filtering. However, but it wasn't always possible to assess relevance from abstractions, and this has proved to be a thing and arduous task. For reviews, we are presented with the same obstacles and considerable hurdles. We were unable to identify any Margin crash research from less-developed countries in our search. Due to funding limits and a conflict of objectives, spite of the fact that swiftly developing nations have bigger challenges associated to rapid mobility in their particular countries, there is a shortage of research done within those countries to explore vehicle crash-related concerns. As a consequence, we would be unable to discover any eligible research from impoverished countries that fulfilled our inclusion requirement. Studies from these countries are expected to be published on journals who are not classified and thus do not release in English. Given the hurdles connected with receiving science funding in such governments, there is substantially less research done in such countries. A considerable percentage of the studies included in our review of the literature originated in Germany. Several big datasets, including those maintained more by National Transportation Safety Board, as well as consumer and insurance sector databases relating to health care are employed in our present research, which we feel offers considerable benefits. The Crashworthiness Database Server is a countrywide subset of a statistical population of light passenger cars that is used to measure crashworthiness. As a consequence, the sample populations employed in this study preserve enough variability to be indicative of the entire population. Furthermore, datasets that were employed in the study all function as a connected network, with common protocols for case registrations, accident investigations of damage causation, as well as biomechanics causality, among other things. Apart from that, we have incorporated studies from Australia, Germany, and the Holland in our assessment.

3. CONCLUSIONS

There are numerous nations, particularly in Bangladesh and Pakistan, where a significant number of trucks are produced without consideration for their aerodynamics. According to the results, aerodynamically efficient deflectors are not feasible in the majority of locally manufactured Bangladeshi and Pakistani light vehicles because they would increase their aerodynamic drag by up to 22 percent. The elimination of aerodynamically designed letters will not only reduce fuel consumption but would also result in a significant reduction in greenhouse gas emissions. With just a little modification to these new conventional cars, these nations will see a substantial increase in their economic output.

The findings of a recent European study involving numerical simulations and experimental testing, which included a full-scale test with a pedestrian dummy, indicate that an energy-absorbing front end (and changing the shape of the front end) and side of LTVs and other heavy vehicles can reduce up to 90 percent of injuries to the head and lower extremities at impact velocities of up to 40 km/h. Vehicles equipped with peripheral airbags as well as energy-absorbing framework, in our opinion, would provide greater protection to susceptible road employers from the impact of LTVs than they now do. An example of such a notion is an energy fascinating bumper system composed of a foam-type mastic such as polyurethane, polypropylene, or a comparable substance.

To date, bumper systems for low-velocity vehicles (LTVs) are primarily intended to prevent or limit physical damage to expensive components of the vehicle and, as a result, to reduce insurance costs associated with replacing parts of the vehicle in crashes by merely protecting the hood, trunk, grill, fuel, exhaust, and cooling system in low-velocity crashes, as opposed to protecting the entire vehicle. Now is the moment to consider both the lowering of insurance costs in accidents and the use of effective technologies and materials that may minimize the impact of LTV crashes on vulnerable road users who are at risk of injury. Road users across the world deserve improved and safer road conditions. With the ever-increasing rates of obesity throughout the globe, it is imperative that pedestrians' rights to utilize roads safely, both as a mode of transportation and as a recreational activity, are protected. The front design of LTVs, the energy-absorbing qualities of the bumper and the top surface of the LTVs' front, and road engineering (traffic calming) may all be improved to make them safer for pedestrians.

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