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Enhancing Road Safety Through Rolling Barrier Systems

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Abstract - *The Rolling Barrier (RB) system is an innovative longitudinal barrier that can be effectively implemented on curved road segments, ramps, medians, and entrance/exit ramps in parking structures. In 2015, Maharashtra, India, recorded 63,805 traffic accidents, with 54.2% involving collisions with longitudinal barriers. These incidents could be significantly reduced by installing safer barrier systems. A small Korean manufacturing company developed the RB, a novel design featuring continuous pipes encased in urethane rings, aimed at improving traffic safety.*

This study evaluates the RB's effectiveness in crash cushioning, directional vehicle correction, and required structural strength. Experimental tests were conducted using a 1.3-ton passenger car and a 3.5-ton truck on curved road sections. Results showed that vehicles maintained a parallel trajectory with the RB post-impact, with no structural failure observed during crashes. Further strength and safety performance tests were carried out using an 8-ton truck and a 1.3-ton car. The RB met the standards outlined in the Ministry of Construction and Transportation's "Guidelines for Installation and Management of Road Safety Facilities." Comparative analysis confirmed the RB's superior crash absorption and structural performance over conventional barriers.

Key Words: Rolling, Barrier, Road, parking, Construction

1.INTRODUCTION *(Size 11 , cambria font)*

In 2015, the state of Maharashtra, India, recorded 63,805 road traffic accidents, with a striking 54.2% involving collisions with longitudinal barriers. This statistic highlights the urgent need for improved traffic safety measures, particularly in high-risk areas such as curved roads, medians, ramps, and parking garage exits. Traditional guardrails, while essential, have limitations in terms of energy absorption and vehicle redirection, especially during high-impact collisions.

To address these challenges, a Korean company introduced the Rolling Barrier (RB) system—an innovative longitudinal barrier composed of rotating urethane rings mounted on continuous steel pipes. This design not only cushions impact but also redirects vehicles, helping prevent secondary collisions or further roadway departure. The RB is particularly suited for deployment in complex traffic environments like curved road sections and exit ramps, where the risk of vehicle loss-of-control is high.

This study aims to evaluate the effectiveness of the RB in terms of crash energy absorption, vehicle redirection, and structural integrity. Controlled crash tests were conducted using a 1.3-ton passenger car and a 3.5-ton truck at curved road sections. Results showed that, post-impact, vehicles ran parallel to the RB, indicating successful redirection without structural failure. Additional performance tests using an 8-ton truck and compliance evaluations for passenger protection confirmed that the RB meets the standards set by the Ministry of Construction and Transportation's "Guidelines for Installation and Management of Road Safety Facilities."

Mathematical modelling was also employed to compare the RB with conventional barriers, focusing on crash cushioning and structural strength requirements. The findings confirm that the RB offers significant improvements in impact mitigation and passenger safety. The emergence of such innovative systems marks a pivotal advancement in road safety technology, emphasizing the need for ongoing development in barrier design to reduce fatalities and improve highway infrastructure resilience.

Importance of Road Barriers and the Purpose of Street and Highway Construction

Purpose of Street and Highway Construction

The primary objectives of constructing streets and highways are to:

- Ensure the certification and provision of safe and reliable transportation systems.
- Facilitate the efficient movement of individuals, goods, and materials across regions.

Common Road Incidents
Roadways are often the site of various incidents, including car crashes, vehicle collisions, and other accidents. These occurrences highlight the inherent risks of vehicular travel and the need for robust safety measures.

Need for Protective Equipment
To mitigate the risks associated with road travel, the installation of defensive infrastructure is critical. This includes equipment such as road safety fences and barriers, which are essential in preventing and reducing the severity of accidents.

Role of Road Safety Fences
Road safety fences are designed to:

- Prevent vehicles from accessing restricted or dangerous areas.
- Provide a simple yet highly effective means of improving road safety for both motorists and pedestrians.

Applications of Road Safety Barriers
Road safety barriers are used in a wide range of contexts, including:

- Accident-prone zones.
- Temporary traffic redirection or control during construction activities.
- Police checkpoints or barricades.

Varieties of Road Barriers
Barriers come in various shapes, sizes, and weights, each tailored to suit specific scenarios. Their designs are customized to address particular safety requirements, ranging from high-impact zones to temporary installations.

Versatility of Road Safety Barriers
These barriers serve multiple functions, such as:

- Preventing unauthorized access to sensitive areas.
- Containing vehicles in hazardous conditions.
- Enhancing overall safety across different environments, including highways, urban roads, and work zones.

Efficiency of Road Safety Measures
Road safety barriers significantly contribute to:

- Reducing the severity of vehicular impacts.
- Preventing injuries and fatalities.
- Supporting overall traffic management and incident control efforts.

Customization for Specific Needs
Different types of barriers are engineered to fulfill specific safety roles. Selecting the appropriate barrier type for a given application ensures maximum performance and protection.

Collaborative Role in Safety Infrastructure
Effective road safety requires a multifaceted approach. The integration of road safety barriers with other protective elements—such as signage, lighting, and road markings—forms a comprehensive safety system that enhances the resilience and functionality of transportation networks.

Research and Methodology

Aim

"The goal is to diminish the frequency and severity of accidents, minimize vehicle damage, and curtail injuries to the human body, ultimately working towards the paramount objective of saving lives from the scourge of accidents. as wrote in goal wise"

3.2 Problem Statement

- Why are barriers installed on sharp horizontal curves?
- What is the main drawback of barriers in mitigating collisions on these curves?
- What happens when a vehicle collides with a barrier on a sharp horizontal curve?
- Why does the loss of control post-collision lead to severe consequences?

- In what way does the current barrier system fall short in averting severe consequences during collisions on sharp horizontal curves?

3.3 Objective

- The primary aim is to lower the number of accidents.
- To alleviate the intensity or seriousness of accidents.
- To focused on minimizing harm and damage sustained by vehicles involved in accidents.
- To diminish injuries inflicted upon the human body during accidents.

3.4 Research work

- To secure and keep wild vehicles from going into the path of different Vehicles. Consequently, the road safety barriers are put on the middle of the road.
- To shield the vehicles from falling into a lope.
- The road safety barriers are ought to be set toward one side of the street if there is a drop of at least 5 meters close to the street
- To keep a crazy vehicle from slamming and hitting a street side object.
- Study for literature review survey
- Study of all design and all parameters,
- Barrier with controller descriptions
- Design and analysis by using tool
- Analysis result

3.6 Materials used in Rolling Barrier System

Urethane has emerged as the material of choice in numerous contemporary, performance-driven applications due to its exceptional physical and mechanical properties, setting it apart from other materials. Functioning as a type of synthetic rubber, urethane is characterized by its remarkable flexibility and malleability. Notably, it boasts a non-brittle nature combined with elasticity, making it a preferred material for various applications

3. CONCLUSIONS

As the rolling barrier activates the rolling friction when vehicles hit the barrier, the rolling barrier reduces severity of traffic accidents. After the rolling barrier was installed at two downgraded and curved roads sections in Busan, the accidents at the sections were reduced by more than 50% in a year.

The future scope of rolling barriers holds tremendous potential, and several key points highlight their evolving role in various applications:

1. Advanced Materials and Durability:
- Continued research in materials science is likely to yield stronger and more durable materials for rolling barriers, enhancing their ability to withstand diverse environmental conditions and impacts.

2. Incorporation of Smart Technologies:
- Integration with smart technologies, such as sensors, cameras, and connectivity, will likely become more prevalent. This enables real-time monitoring, data collection, and remote-control capabilities, contributing to improved safety and security measures.

3. Autonomous and Automated Systems:
- The development of autonomous rolling barrier systems has the potential to revolutionize transportation safety. Automated deployment and repositioning based on real-time data analysis can enhance efficiency and response times.

4. Adaptability to Various Environments:
- Future rolling barriers may be designed to adapt to different terrains, offering solutions for diverse settings, including urban areas, highways, construction sites, and events. This adaptability will increase their versatility and effectiveness.

5. Integration with Urban Planning:
- Urban planners may incorporate rolling barriers into city infrastructure, using them as flexible tools for managing traffic flow, creating temporary pedestrian zones, and responding to emergency situations.

6. Green and Sustainable Solutions:
- The use of eco-friendly materials and energy-efficient technologies may be explored to make rolling barriers more sustainable. This aligns with global efforts to create environmentally conscious infrastructure solutions.

7. Humanitarian and Disaster Response:
- Rolling barriers could play a crucial role in disaster-prone areas, aiding in quick and efficient evacuation procedures. Their mobility and adaptability make them valuable assets in emergency response scenarios.

8. International Standards and Regulations:
- As rolling barriers become more prevalent, the establishment of international standards and regulations may be necessary to ensure consistency, interoperability, and safety across different regions.

9. Cost-Effective Solutions:
- Innovations in manufacturing processes and materials may lead to more cost- effective production, making rolling barriers accessible for a wider range of applications and regions.

10. Public Awareness and Acceptance:
- Future developments should focus on increasing public awareness and acceptance of rolling barriers. Education campaigns and demonstrations can help dispel concerns and build trust in these innovative safety solutions.

The concept of a rolling barrier represents an innovative approach to safety and security, particularly in the context of transportation and infrastructure. As we conclude our exploration of rolling barriers, several key points emerge.

The potential to enhance the efficiency of emergency responses is a notable advantage of rolling barriers. The

ability to quickly deploy and reposition these barriers can facilitate rapid interventions during critical situations, thereby contributing to improved overall safety outcomes.

Moreover, the integration of smart technologies and automation further enhances the functionality of rolling barriers. From remote control capabilities to real-time monitoring and data collection, these features enable a proactive and data-driven approach to safety management.

Despite the promising aspects of rolling barriers, it is crucial to consider potential challenges such as maintenance requirements, cost-effectiveness, and public acceptance. Balancing these factors will be essential for the widespread adoption and success of rolling barrier systems.

In conclusion, the concept of rolling barriers represents a progressive step forward in safety and security infrastructure. As technology continues to advance, the refinement and widespread implementation of rolling barriers have the potential to significantly enhance our ability to protect lives and property in a variety of settings. Continued research, development, and collaboration across industries will be essential to fully unlock the benefits of rolling barriers and ensure their seamless integration into our evolving safety landscape.

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