

# Development of Innovative Road Safety Elements

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**Abstract:** To improve overall safety and reduce the number of accidents there must be an introduction of innovative road safety elements. The innovative road safety elements will increase efficiency. Nowadays engineers are busy finding the economic way of construction and innovative measures will help in reducing the cost of safety elements. The main objective of this research paper is to find cost-efficient and long-lasting road safety elements. This research paper also involves helping the safety elements to reduce maintenance costs. This paper will also deal with the safe approach system for roads. The road safety elements like Kerbs, Crash barriers, Footpath paver blocks or bricks, Drainage lines on both sides of roads, and sign boards will be made of waste or recycled plastics. The plastics will be modified in the desired shape and color as per the requirements. This innovative way of making road safety elements will help in reducing costs. This research will deal with avoiding time-to-time maintenance which will reduce the cost of maintenance and also increase efficiency. The adaptation of innovative road safety elements will restrict the increase of plastics in broad areas as the waste plastics in large will be used for this purpose. This will be nature-friendly and cost-effective. The implementation of a safe approach system in schools and other institutions will help to guide the public which will reduce accidents on roads.

**Keywords:** Road Safety Elements, Safe Approach System, Plastics, Economic, Long Lasting, Sustainable.

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## I. INTRODUCTION

Road safety is paramount to ensuring the well-being of all road users. Unfortunately, poor road conditions contribute significantly to accidents globally. Crumbling infrastructure, lack of proper signage, and poorly maintained roads increase the risk of accidents manifold. These hazards are particularly pronounced in developing regions where limited resources hinder regular maintenance and upgrades. Potholes, uneven surfaces, and inadequate lighting pose serious threats, especially during adverse weather conditions or at night [1]. Moreover, poorly designed intersections and narrow lanes amplify the likelihood of collisions, endangering motorists, pedestrians, and cyclists alike.

Addressing road safety requires a multi-faceted approach that encompasses infrastructure improvements, rigorous enforcement of traffic regulations, and public awareness campaigns. Investing in road maintenance and upgrades not only enhances safety but also promotes smoother traffic flow, reducing congestion and travel time. Strengthening law enforcement to penalize reckless driving and ensuring adherence to speed limits can mitigate the risks posed by poor road conditions [2]. Additionally, educating the public about safe driving practices and pedestrian awareness fosters a culture of responsibility and mutual respect among road users. By prioritizing road safety initiatives, communities can significantly reduce the incidence of accidents and safeguard lives.

According to a publication from the Indian Institute of Technology Kharagpur, "India is currently experiencing an unprecedented rise in the rate of motorization and a transitional state of economic growth." The Government of India's Ministry of Road Transport & Highways (MORTH) reports that between 1970 and 2012, there were 4.3 times as many traffic accidents, resulting in 9.5 times as many fatalities and 7.3 times as many injuries. Even though the government has set aside a sizeable sum of money for road construction, road traffic accidents and fatalities cause India to lose more than 3% of its annual GDP. These straightforward figures indicate a possible risk to public health in addition to giving some indication of the state of road traffic safety in India.

2017 World Health Organization "A bold goal to cut traffic-related fatalities and injuries by 50% by 2020 is part of the 2030 Agenda for Sustainable Development. Governments must move quickly to accelerate their efforts to achieve Sustainable Development Goals, even though they have made significant progress during the Decade of Action in enacting and enforcing new road safety laws on risks like speeding, redesigning roads with protective infrastructure like sidewalks, and ensuring that vehicles are equipped with life-saving technologies.

To do this, governments will need to uphold the promises they have made time and time again using a variety of policy tools and overcome obstacles, most notably fatalism—the false belief that traffic accidents are unavoidable and that nothing can be done to prevent them. Another innovative approach involves the implementation of road markings, kerbs, crash barriers, and footpaths which will be designed and made of plastics with the same strength and more durable and considering economy [3]. In Chennai, India, creative tactics for creating plastic roadways have already been put into practice. My invention is based on the use of plastic pavement tiles, road kerbs, sidewalks, medians, and crash barriers. Using the same concept, I have included the usage of plastic garbage as a component of road safety. This will save costs and be better for the environment.

Moreover, innovative road design and engineering solutions, such as roundabouts, traffic calming measures, and pedestrian-friendly infrastructure, are being implemented to create safer environments for

all road users. These designs prioritize safety by reducing vehicle speeds, minimizing conflicts between different modes of transportation, and improving visibility at intersections.

An economic way of construction involves various strategies aimed at minimizing costs while maintaining quality and efficiency throughout the building process. One approach is to prioritize the use of locally sourced materials. By sourcing materials from nearby suppliers, transportation costs are reduced, and the environmental impact associated with long-distance transportation is minimized [4].

Additionally, effective project management and planning are essential for controlling costs and avoiding delays. They improve communication among stakeholders and identify potential cost-saving opportunities. Moreover, regular monitoring and evaluation of the construction process can help identify areas for improvement and ensure that the project stays within budget [5].

#### Aim of the study

**Enhancement of Safety:** Reducing accident rates and raising overall road safety can be accomplished by installing impact-resistant, durable, and highly visible road barriers [6][7].

**Sustainability:** Using recycled plastic in road elements can help reduce the amount of plastic trash generated [5].

**Cost-effectiveness:** When designed and installed correctly, plastic elements can be more economical because they are long-lasting and low-maintenance.

**Environmental Impact:** Converting plastic trash into parts for road safety, lessens the quantity of plastic waste that ends up in landfills [7].

**Durability and Extended Life:** Plastic parts utilized in traffic safety precautions are more resistant to weathering and corrosion.

**Innovative Technologies:** Ongoing materials science and engineering research and development continuously improve the strength, durability, and adaptability of plastic-based road safety components [1].

## II. OBJECTIVES

- To use recycled plastic as road safety elements.
- To enhance the quality and standard of road safety elements.
- To reduce the cost of safety elements.
- To make long-term planning for maintenance, repair, and replacement easier.
- To encourage citizens about the safe system approach.

## III. THEORITICAL BACKGROUND

A wide range of strategies are used in novel plastic road safety components to increase road safety using materials derived from plastic. These elements are diverse and constantly evolving. With ongoing studies in technological integration, design, and materials aimed at steadily raising road safety precautions, the realm of plastic road safety element innovation is broadened. Durability, affordability, and environmental sustainability are key elements that affect how these features are created.

### *Crash Barriers*

The Vani-Warora Highway in Vidarbha, Maharashtra, has the first 200-meter-long bamboo crash barrier in the world, called Bahu Balli, which was put in place in March 2023. Creosote oil is applied to the Bambusa Balcooa barrier before it is constructed. It was tested at Central Building Research Institute (CBRI) and National Automotive Test Tracks (NATRAX) in Pithampur, Indore, two government-run facilities.



Nitin Gadkari  
@nitin\_gadkari

An extraordinary accomplishment towards achieving #AatmanirbharBharat has been made with the development of the world's first 200-meter-long Bamboo Crash Barrier, which has been installed on the Vani-Warora Highway.



Figure 1: Bamboo Crash Barriers

## The Plastic Roads

An Indian scientist named Rajagopalan Vasudevan came up with the concept of utilizing discarded plastic to build roads. This is composed of a plastic waste-infused asphalt mixture. Road construction using plastics may create a new avenue for post-consumer plastic recycling.



Figure 2: The Plastic Road of Chennai

### *Paver Blocks*

Paver blocks are a porous type of block made by combining varied proportions of tiny stone shards, cement and sand, and other elements. The most significant component in the manufacturing of paver blocks is an automatic paver block-making machine with a high production capacity.



Figure 3: Paver Blocks for footpath Kerb

### *Kerb*

A raised or edged structure, a road kerb is usually composed of stone, concrete, or other sturdy materials. Its main function is to keep cars from straying off the road; however, it may also be used to divide or demarcate two neighbouring lanes.

Kerbs help to regulate and facilitate drainage. These mark the edge of the pavement.



Figure 4: Road Kerb

#### Road Side Drainage

Side gutters are an effective way to remove surface water since they are usually built parallel to the road. Because they collect drained-off water, they are essential to keeping the road surface dry. Although these gutters are reasonably priced, their deep ditches may make them look unattractive. Draining water from the road and its surroundings is the main goal of a road drainage system. Dewatering and drainage are the two components of the road drainage system. "Dewatering" refers to the process of eliminating precipitation from the road's surface.



Figure 5: Road Side Drainage

#### IV. METHODS

Since the globe produced two million tonnes of plastic in the 1950s, the amount produced has expanded tremendously. Global output reached 460 million tons in 2019; by 2050, it is predicted to have doubled. Plastic is used in a wide range of applications, such as food packaging, home appliances, medical devices, and construction, which is the main factor driving this rise [3].

Plastics are now widely used in many aspects of modern life, providing affordability, convenience,

and variety. However, the manufacturing, usage, and disposal of these materials have a substantial negative impact on the environment due to their widespread use. Plastics hurt the environment in a variety of ecosystems, including marine and terrestrial ones, and their continued presence presents long-term problems for environmental sustainability.

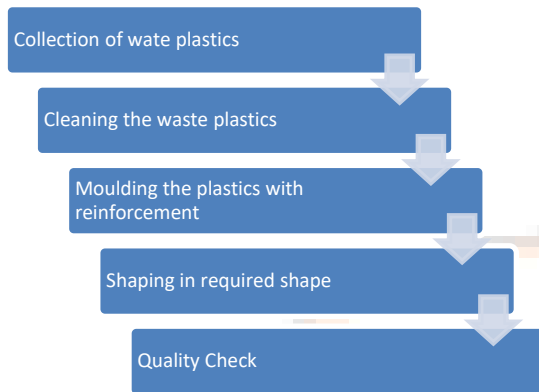
Making road safety elements from waste plastics presents a promising avenue for addressing both plastic pollution and road safety challenges. Several methods exist for utilizing waste plastics to manufacture road safety elements, each offering unique advantages in terms of sustainability, cost-effectiveness, and durability. Here are some methods commonly employed:

#### Plastic Recycling and Repurposing

- **Melting and Moulding:** Recycled plastic waste, such as polyethylene (PE) or polypropylene (PP), can be melted and shaped into a variety of traffic-calming and delineation components, such as speed bumps and traffic cones. Once the plastic has melted, it can be poured into moulds of any size or form, cooled, and solidified.
- **Extrusion:** Road dividers, bollards, and other long, continuous shapes can be made from shredded or granulated waste plastics by the use of extrusion methods. Before installation, the extruded plastic can be cut to the appropriate lengths and forms.
- **By injecting molten plastic under high pressure into pre-designed moulds,** injection moulding enables the creation of accurate and intricate road safety features, such as reflective road studs or sign components.

For the construction of bitumen roads wet method and dry method are adopted in which aggregates and plastics are mixed with bitumen and the bitumen is placed at 120 degrees Celsius so that the road shapes and settles. This will give the same stability and rigidity to the road and it will be economical, and long-lasting. More than that this is environmentally friendly.

## V. METHODOLOGY



The Waste plastics should be collected from different sources and stored at the collection warehouse. These plastics must contain foreign materials which should be removed. The fresh waste plastics that taken and heated to liquification. Then these plastics are placed in different shapes of road safety elements which are arranged with reinforcement. The reinforcement will provide tensile strength and will enhance the flexibility of structures. After coming to shape these will be placed in water to get cool.

The final process will be a quality check. In this, the elements are checked with various aspects to check the match. After passing the quality check only the elements will be installed.

## VI. RESULTS

Using plastic for road safety elements offers several benefits, contributing to both environmental sustainability and enhanced road safety. The following paragraphs outline these advantages:

Plastic road safety elements provide a sustainable solution to the growing problem of plastic waste pollution. By utilizing recycled plastics in the manufacturing process, these elements help divert plastic waste from landfills and oceans, reducing environmental degradation and conserving natural resources. Incorporating waste plastics into road safety products also promotes the principles of the circular economy, where materials are reused, recycled, and repurposed, thereby minimizing the need for virgin materials and reducing carbon emissions associated with plastic production [6].

Plastic road safety components are also resilient and long-lasting, which makes them ideal for surviving the rough conditions of highways and roads. Plastic-based safety elements are less prone to damage from moisture, chemicals, or severe temperatures, and are lightweight and corrosion-resistant when compared to traditional materials like metal or concrete. Because of their durability, road safety goods have a longer service life, which lowers the need for frequent maintenance and replacement and, ultimately, the lifecycle costs for municipalities and transportation agencies.

Road safety features made of plastic are versatile and adaptable in both installation and design. Reflective materials or vivid colours are frequently used in plastic-based safety goods to improve visibility both during the day and at night [6].

### *Crash Barriers*

Crash Barriers in innovation will be made of plastic with reinforcement which will be moulded at that desired quantity to get the same strength as RCC and Steel. This will be economical and easy to install and maintenance costs will be very low and eco-friendly.

### *Paver Blocks*

Paver Blocks are mostly seen on footpaths. These are made of Aggregates in different colours to look attractive. The plastic paver blocks will be cost-effective and we can make them in different colours. The maintenance cost be negligible and will be long lasting.



Figure 6: Plastic Paver Blocks

The paver blocks are also used to make roads in hilly areas that are getting heavy snowfall. During snowfall the road becomes slippery and driving

becomes almost scary. To come out of that problem paver blocks are placed as the top layer of the road which helps in gripping the tyre and enhancing safety.



Figure 7: Paver Block Road

### Kerb

The road kerbs need regular maintenance, cleaning and painting. To come out of this issue the plastic kerb will be provided which rarely needs maintenance. This will be made in different colours and no need to paint it again and again because it will never lose its colour.



Figure 8: Road Kerb

### Road Side Drainage

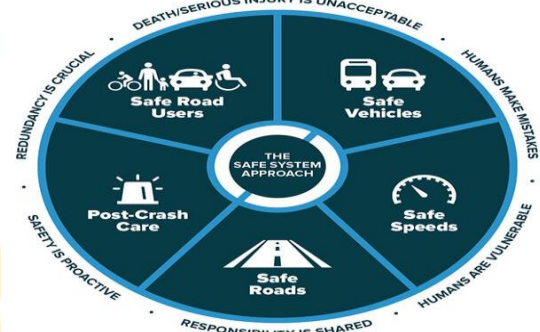
The roadside drainage is mostly made of RCC which is costly. The drainage made of plastic will be the replacement for this as it is effective, economical and lightweight which can be shifted from one site to another.



Figure 9: Drainage

## SAFE SYSTEM APPROACH

The Safe System Approach represents a holistic and proactive approach to road safety, aiming to eliminate fatalities and serious injuries on roads. At its core, this approach acknowledges that humans make mistakes and are vulnerable to the forces involved in crashes, and therefore, it focuses on creating forgiving road environments that can accommodate human error without resulting in severe consequences [3]. The Safe System Approach emphasizes the shared responsibility of road designers, policymakers, vehicle manufacturers, and road users in creating safe road systems.



Central to the Safe System Approach is the concept of forgiving infrastructure, which prioritizes road design and engineering measures that mitigate the severity of crashes. This includes measures such as roundabouts, median barriers, safe crossing points for pedestrians, and reducing vehicle speeds in high-risk areas [3]. By designing roads and intersections with safety as a primary consideration, the Safe System Approach aims to minimize the likelihood of crashes occurring and reduce the severity of injuries when crashes do occur.

Moreover, the Safe System Approach recognizes the importance of vehicle safety features and regulations in mitigating the consequences of crashes. This involves promoting the use of advanced safety technologies such as seat belts, airbags, electronic stability control, and autonomous emergency braking systems in vehicles [4]. Additionally, it advocates for stringent vehicle safety standards to ensure that vehicles are designed to withstand crashes and protect occupants from injury. By integrating vehicle safety with road design and user behaviour, the Safe System

Approach creates multiple layers of protection to prevent crashes and minimize their impact on road users.

To accomplish the ultimate aim of zero road fatalities and serious injuries, the Safe System Approach prioritizes the establishment of forgiving road conditions and fosters collaboration among stakeholders. In short, it represents a paradigm shift in the way that road safety thought is approached.

## VII. DISCUSSION

Keeping everyone safe on the roads requires a high priority on road safety. Regrettably, a major global contributing factor to accidents is bad road conditions. Furthermore, promoting safe driving behaviours and raising public awareness of pedestrians helps to cultivate a respectful and responsible culture among drivers. Autonomous vehicles have the potential to drastically lower the number of collisions by obeying traffic laws and keeping a safe distance from other cars [3].

Plastic waste is a growing environmental pollutant, accounting for 3.4% of global greenhouse gas emissions. By utilizing waste plastics in the manufacturing of road safety elements, these methods contribute to waste reduction, resource conservation, and the promotion of circular economy principles. Moreover, incorporating recycled plastics into road infrastructure enhances resilience, sustainability, and innovation in the transportation sector, ultimately contributing to safer and more sustainable road networks.

To improve road safety and solve the pollution caused by plastic waste, plastic road safety elements provide a long-lasting, adaptable, and sustainable solution. These components support resource efficiency and environmental conservation by using recycled plastics in manufacturing [7]. They are useful instruments for fostering safer driving conditions and lowering the number of accidents on roads and highways because of their robustness, adaptability, and visibility. Adopting plastic-based solutions for road safety is a win-win situation that helps drivers and the environment in equal measure.

The Safe System Approach is a road safety management approach that focuses on designing roads to prevent serious injuries and deaths. It's

based on the idea that people make mistakes and are vulnerable to injury in crashes, so the approach aims to eliminate the possibility of these happening. The Safe System Approach also prioritizes equitable solutions [6].

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