Research on Design Technology of Safety Facilities in Highway Traffic Engineering

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Abstract—In highway traffic, setting up the necessary traffic safety facilities can provide a guarantee for the safe driving of vehicles. To a certain extent, proper and reasonable setting of traffic safety facilities is an important indicator to measure the safety design of highway traffic engineering. In order to do a good job in highway traffic safety from the source, people gradually pay attention to how to improve the rationality of the design of highway traffic safety facilities. As people pay more attention to highway traffic safety facilities, their design technology has become an important research content to effectively avoid safety problems in highway traffic design, construction and operation, and reduce the high cost of subsequent upgrades. This paper takes the design technology of highway traffic engineering safety facilities as the research object, and analyzes the main structure of highway traffic road safety facilities and the main causes of safety problems on the side of highway traffic roads. On this basis, with the main purpose of effectively avoiding road traffic safety accidents and guaranteeing road traffic safety, targeted safety protection measures are provided. From the aspects of guardrail design technology, visual illusion deceleration marking design technology, warning signs and other aspects, research and discussion are carried out to provide a reference for effectively improving the overall level of traffic safety facilities design.

1. INTRODUCTION
With the development of economy and the progress of society, the construction of highway traffic engineering in our country continues to develop and grow, and has made great achievements. My country has basically completed the construction of a highway traffic network, with all highways running east-west and running north-south. At present, my country's economic development is at a critical stage of improving quality and increasing gear shifts, ushering in new features and new normal of economic development. Highway transportation is the foundation of national economic and social development. Therefore, under the current new normal situation, highway transportation presents new characteristics.

Highway traffic engineering is affected by many factors during the construction process, including the natural environment, engineering investment, and service concepts. In the design process of many highway traffic projects, due to the lack of consideration of the road user experience, especially the lack of roadside design concepts and methods, the safety and comfort of road traffic engineering are not paid enough attention, resulting in road accidents caused by roadside safety issues getting more serious. Relevant statistics show that in major traffic accidents with more than 3 deaths, most of them are caused by the loss of control after the driving vehicle collides with the side of the highway. From the outer edge of the lane to the boundary of the red line of the road belongs to the range of the roadside.
Highway traffic accidents are characterized by serious hazards and frequent occurrences, which seriously threaten the lives and property safety of highway traffic participants. At present, roadside safety protection design is an important part of improving road safety performance. Only take a positive attitude, pay attention to roadside safety issues, study the safety facilities design of highway traffic engineering, fully apply innovative safety facilities design techniques in the construction practice of highway traffic engineering, reduce the number of highway traffic accidents at the source, and reduce or avoid the severity of road traffic accidents.

2. ANALYSIS OF THE CURRENT SITUATION OF HIGHWAY TRAFFIC SAFETY FACILITIES

2.1. Definition and analysis of roadside accidents

2.1.1. Definition of roadside accidents. Roadside accidents are caused by vehicles driving away from the traffic lane, intruding into the shoulders or areas other than the shoulders, colliding with guardrails, pedestrians, vehicles, sign posts, and other dangerous objects, falling into cliffs, and crossing opposite lanes accident. In the absence of collision with other vehicles, roadside accidents are usually bicycle accidents. The statistics of roadside accidents for different forms are shown in Figure 1.

![Figure 1. Distribution of roadside accidents in different forms](image1)

As can be seen from the data in the figure, there are many types of accidents involving pedestrians, stationary vehicles and ditches, accounting for more than 10% of the total, and the total accounts for about half of the total number of roadside accidents. The proportion of roadside accidents that hit the retaining wall is also relatively high, all reaching more than 5%.

2.1.2. Causes of roadside accidents. From the perspective of traffic engineering, it is necessary to analyze the causes of traffic accidents from the aspects of people, vehicles, roads, and environment. Roadside accidents are caused by vehicles exceeding safety distances. The design of roadside safety distances in various countries is shown in Figure 2.

![Figure 2. Roadside safety distances in various countries (cm)](image2)
The causes of vehicle-side accidents include driver's inattention or fatigue driving, driving after taking medicine or drinking, and speeding; Failure of vehicle parts; The road has low anti-skid performance, insufficient sight distance, incomplete safety facilities, etc.; bad weather such as rain and snow cause the road to be too slippery, with low visibility and poor visibility.

Highway traffic engineering protection measures are aimed at road accident engineering sections that affect driving safety, and road traffic engineering measures are adopted for remediation. An analysis of the reasons for vehicles entering the road from the perspective of traffic engineering facilities will help us study such road traffic safety issues and eliminate potential safety hazards. The main specific reasons include: unreasonable guardrail setting; roadside clear area not up to standard; improper handling of road shoulders, slopes and gullies; failure to set up various signs and markings reasonably; not cooperating with various traffic safety facilities.

2.2. Common highway traffic safety structure

2.2.1. Highway traffic safety signs. Setting traffic signs in public transportation can help drivers understand the linear direction of the highway and the location of the edge of the highway; By understanding the traffic signs next to the highway, the driver can avoid blind spots during driving and increase driving safety. Setting up traffic signs in accident-prone areas can remind drivers to pay attention to the actual situation on both sides of the road, so that motor vehicles can safely pass through accident-prone areas to avoid traffic accidents.

2.2.2. Guardrail. In the process of highway traffic safety design, it is necessary to combine the design requirements and safety requirements to select the appropriate anti-collision guardrail to ensure traffic safety. In the design of safety facilities for highway traffic engineering, due to the variety of guardrails, you can choose guardrails with high safety, high reliability, economical benefits, and beautiful appearance. The guardrail serves as a major safety feature, but it cannot serve as a major obstacle. The collision prevention mechanism of the guardrail is to absorb the collision energy of the vehicle through the elastoplastic deformation, friction and displacement of the guardrail and the vehicle, thereby protecting the life safety of the driver and passengers. Using the deformation of the guardrail and the vehicle itself to prevent more serious injury accidents is a significant difference between the guardrail and other safety facilities. When setting up guardrails to prevent vehicles from colliding with other dangerous objects, the guardrails should be treated as dangerous objects. When setting up guardrails, it is necessary to consider the probability of accidents, the possibility of vehicles exiting the road, and the status of roadside obstacles. If the severity of accidents that are not roadside dangerous objects is greater than the severity of the accidents, the guardrails should be installed to avoid putting a lot of money on the roads where the probability of accidents is low.

2.2.3. Anti-collision barrel. Normally, anti-collision barrels are set at the entrance of the toll station to prevent cars from colliding with the facilities in the middle of the road, and must use striking colors to remind drivers. When designing the anti-collision barrel, high reflective strips should be arranged on the surface, so that the driver can notice the structure at the first time and slows down in advance.

3. DESIGN TECHNOLOGY OF SAFETY FACILITIES FOR HIGHWAY TRAFFIC ENGINEERING

3.1. Guardrail safety facilities design

The guardrail is an important part of the road safety facilities. Its line shape can induce the driver's sight, so that it can clearly see the road outline and the direction of travel. Reasonable setting of safety guardrails can reduce traffic accidents. Guardrails play an important role in the protection of uncontrolled vehicle collision accidents. The guardrail ensures the safety of passengers by absorbing vehicle collision energy and reduces the severity of the accident. The function of the guardrail is at the cost of the destruction or deformation of itself or the vehicle. When setting the roadside guardrail, both
positive and negative effects must be considered; The positive effect of guardrail protection can reduce the severity of accidents and the probability of accidents, while the negative effect has the opposite effect.

From the perspective of driving safety, the roadside guardrail itself is also an obstacle, so it should be as far away from the lane as possible when setting the guardrail. Set the guardrail as far away as possible from the driveway. It requires that the guardrail have enough deformation space to function properly. When selecting the form of the guardrail, it is necessary to consider the deformation of the guardrail during collision, and to ensure that the distance between the guardrail and the object should be sufficiently large when the vehicle collides with the object. The content of parapet design is shown in Figure 3.

Only when the wheels are all on the ground during a collision, and the vehicle suspension system has not been seriously deformed, can the guardrail exert its best protection effect. Therefore, the collision performance of the guardrail is obviously affected by the terrain conditions between the traffic lane and the guardrail; Two factors, curbs and side slopes, require special attention; Before the vehicle collides with the guardrail, the vehicle crosses the curb or the side slope of the road, which will cause two situations. Before the collision, the vehicle vacates and crosses the guardrail; The collision point between the vehicle and the guardrail is too low, and the front of the vehicle may be drilled into the guardrail, and a jam or trip may occur at the guardrail post. When the roadside guardrail cannot be parallel to the lane edge line, the end of the guardrail needs to be abducted for the transition of the roadside guardrail from the starting position to the protected obstacle. Figure 4 is a schematic diagram of the abduction process at the end of the guardrail.

3.2. Design technology of optical illusion deceleration marking

The optical illusion of obstacles mainly uses visual selectivity. Through single or continuous planar patterns, the human visual integrity is used to make it have a three-dimensional visual effect, which affects the use environment of the road, causing the driver’s attention and moderate tension. So as to guide its natural deceleration.
The types of highway lines generally include basic road sections, growing downhill, access ramps, interchanges, tunnels, etc. These sections require vehicles to drive at a reduced speed, but they still belong to the main line section of the expressway. The vehicles run at a higher speed and the continuity of traffic is strong. Setting a three-dimensional visual illusion visual deceleration marking may cause a sudden drop in speed and have a serious impact on subsequent traffic; The freeway entrance ramp is a buffer area where the divided traffic flows into the main line, and the speed of the vehicle should be continuously increased. Therefore, there is no need to set up a three-dimensional optical illusion visual deceleration marking; The exit ramp is a connecting section where the motor vehicle is separated from the main line of traffic and heading for the toll station. The speed of the vehicle should be gradually reduced, and a three-dimensional visual illusion visual deceleration marking can be set.

3.2.1. *Graphic Design.* Using the three-dimensional drawing method of the plane, the visual illusion effect has a blocking obstacle with a certain vertical height relative to the road horizontal plane, which makes the driver mistakenly think that an object is placed on the road ahead.

3.2.2. *Color design.* In the design of three-dimensional optical illusion visual deceleration markings, yellow and orange are characterized as warm, blue as cool, red as warning, and white as neutral. Take the half-hexagonal column as an example, as shown in Figure 5. The driver can observe one top and two sides of the half-sided hexagonal pyramid. The top surface is filled with yellow, and the left side is filled with white, and the right side is filled with red. Visually lift the top surface out of the flat figure, emphasizing the angle with the horizontal plane. At the same time, the white side is the brightest side, the yellow top side is the sub-bright side, and the dark red side is the shadow side, producing a visual light and shadow effect.

![Figure 5. Comparison of warm white and red colors](image)

3.2.3. *Pavement background collocation design.* The top line of the white bottom surface is lower than the top line of the deceleration marking graphic, and the driver is guided to use it as a reference, mistakenly thinking that the top surface of the white bottom surface is the road horizontal line, and the deceleration marking graphic beyond the range of the white background is vertically above the road level, Enhance the three-dimensional effect of the pattern; At the same time, the white ground and the black (gray) white of the asphalt pavement produce relatively high contrast, which can enhance the visual stimulation of the deceleration marking on the driver.

3.2.4. *Design technology of shock deceleration marking.* In road traffic, there are often sections with bad alignment and bad road conditions, but the road conditions after partial reconstruction or overhaul are better, resulting in a greater change in vehicle speed. Therefore, in consideration of driving safety, it is necessary to set deceleration markings on road sections where the road decelerates. Set a horizontal shock deceleration marking on the section before the starting point of the deceleration section, and use the marking to remind the driver to slow down ahead. Marking size and layout are shown in Figure 6.
3.3. **Highway traffic sign design**

Road traffic signs are the basic hardware for traffic organization and traffic management. They play an active role in prior control in preventing roadside accidents. Set road traffic signs on special sections of highways to remind drivers of current road conditions in advance, and remind drivers to control driving speed, so that vehicles can maintain a controllable driving state, greatly reduce vehicles rushing out of the road, and avoid traffic accidents. Taking the expressway as an example, it is a combination of various road alignments and structures. The expressway should set all kinds of signs reasonably according to the characteristics of the road alignment and structures of each road section. Therefore, the design of highway traffic signs is divided into two parts, the design of full-line road signs and special road traffic signs. Expressway traffic signs are based on the design of the two-stage construction drawings.

4. **Conclusion**

The installation of reasonable safety facilities on highways can reduce the severity of traffic accidents, and is extremely beneficial to eliminate various vertical and horizontal interference, and can effectively improve the service level of highways. To provide sight guidance to the driver and improve the road landscape. Therefore, when designing and setting up highway traffic safety facilities, design researchers need to fully consider traffic safety, guide drivers effectively and reduce accident losses: it is also necessary to fully consider the convenience and humanized experience in the use of highway traffic safety facilities. With the continuous increase in the number of cars and the mileage of highway traffic, people are gradually paying attention to the safety of highway traffic, especially paying more attention to the safety of mountain road traffic with complicated conditions. In some areas with complex terrain, due to the limitation of the terrain to a great extent, there are more dangerous road sections, and major highway traffic accidents often occur. This article discusses the highway traffic engineering facilities from the main reasons of highway traffic accidents, the basic status of highway traffic engineering safety facilities and other aspects. The article takes the problems existing in the existing road traffic safety facilities as the basic starting point, and takes the perfect safety facilities and reducing the number of accidents as the basic starting point. From the optical illusion deceleration marking design technology, guardrail safety facility design and highway traffic sign design, research on highway traffic safety facility design technology is carried out. Due to the many factors involved in the safety facilities of highway traffic engineering, its content is relatively extensive, and it is limited by the time, level and technical information of the research.
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