International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 08 Aug. 2025, pp: 943-947 www.ijaem.net ISSN: 2395-5252

Analysis of the Current Situation of Speed Limit Problem in Highway Tunnels and Tunnel Groups

Zhang Mengping[1]
(1. College of Traffic and Transportation, Chongqing Jiaotong University,Chongqing, China)

Date of Submission: 25-08-2025 Date of Acceptance: 05-09-2025

ABSTRACT: With the development of the economic base in our country, the expressway network in our country has been further improved. Not only has the highway network between cities been further expanded and extended, but in order to better promote poverty alleviation work, for the poor villages in remote areas such as mountainous areas to develop agricultural sales, tourism resources and other poverty alleviation projects, highways have been extended to the mountains. Tunnelling is undoubtedly the best solution to shorten the formation of transportation and improve transportation efficiency. By studying the determining basis of speed limit value and the driver speed selection basis, we can find out a better speed limit value and make a plan to improve the safety of high-speed transportation and reduce people's property health loss.

KEYWORDS: High speed limit, Speed limit in tunnel, Driver speed selection, Speed limit optimization.

I. INTRODUCTION

With the development of our country's economic foundation, our country's highway network has been further improved. Not only has the highway network between cities been further expanded and extended, but also in order to better promote poverty alleviation, open up agricultural product sales channels for poor villages in remote areas such as mountainous areas, and develop tourism resources and other poverty alleviation projects, the expressway has been extended to the mountains. Excavating tunnels is undoubtedly the best solution to shorten the formation of transportation and improve transportation efficiency. For a long time, with the increase in the number of high-speed tunnels, traffic safety issues in tunnels have gradually entered the public eye. At present, the speed limit problem of tunnels is the most direct and effective way to solve this problem.

According to the statistics of the Ministry of Transport, by the end of 2023, the total mileage of highways in the country has reached 5.44 million kilometers, of which 184,000 kilometers are highways, and the number of highway tunnels is also increasing, with a total of 24,850 and 26,784,300 meters. According to "The Road Traffic Safety Law of the People's Republic of China", the maximum speed limit of highways in Chinese mainland is 120km/h and the minimum speed is 60km/h.

Considering the speed limit in different lanes, the speed limit in the left lane (passenger car) is 100-120km/h and the speed limit in the right lane (passenger and van) is 60-100km/h when the two-lane section is considered. In the three-lane section, the speed limit is 100-120km/h in the left lane, 90-100km/h in the middle lane, and 60-100km/h in the right lane. The speed limit for highway tunnel sections is generally 80km/h[1].

According to the clear provisions of the "Highway Tunnel Design Code" (JTGD70/2-2014), tunnels are divided into four categories according to the length of individual tunnels: short tunnels, medium tunnels, long tunnels, and ultra-long tunnels, and the specific length is shown in Table 1. Although this specification classifies single tunnels, it does not clearly define tunnel groups[2].

At present, the state has not released an official definition of tunnel groups, and a summary of the existing literature finds that the definition of tunnel groups mainly has four definition dimensions: one is based on the visual characteristics of the driver; second, based on three aspects: fire protection, ventilation and lighting; third, based on the relative spacing of tunnels; Fourth, based on disaster prevention control. From the perspective of the driver's vision, when the length of the connection section between adjacent tunnels does not exceed 1000m, it can be called a tunnel group. From the perspective of fire

International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 08 Aug. 2025, pp: 943-947 www.ijaem.net ISSN: 2395-5252

protection, ventilation and lighting, adjacent tunnels can be defined as two tunnels with a tunnel spacing of more than 250m, continuous tunnels can be defined as two tunnels with a tunnel spacing of more than 250m and no more than 1000m, and adjacent tunnels and continuous tunnels are collectively referred to as tunnel groups. From the perspective of relative tunnel spacing, when the relative tunnel spacing is less than 1, it can be regarded as two tunnels belonging to the same tunnel group[3].

TABLE 1.CLASSIFICATION OF HIGHWAY TUNNELLENGTHS

Classify	Extra-Long Tunnel	Long Tunnel	Middle Tunnel	Short Tunnel
Length	L>3000	1000＜L≤3000	500＜L≤1000	L≤500

II. THE MAIN BASIS FOR SPEED LIMITS

The accidents that often occur in highway tunnel sections mainly include rear-end collisions, rollovers, collisions with fixed objects, and scratches, of which rear-end collisions are the most common accidents. Relevant studies show that the main causes of accidents are the changes in the speed of vehicles entering and exiting the tunnel and the changes in the driver's visual characteristics, and the influence of other factors such as weather causes and road conditions at the time of the accident is relatively small.

2.1 MAIN BASIS

There are two feasible solutions for determining the maximum speed limit in the world, one is directly determined according to the design speed of the highway; the other is determined according to the speed of 85%. The selection of speed limit values in our country is clearly stipulated in accordance with the Code for the Setting of Highway Traffic Signs and Marking Lines (JTG D82-2009), and the actual operating speed or design speed is used as the speed limit value according to the actual road conditions. However, in the academic world, most scholars believe that 85% is the speed limit value, which is more appropriate. Considering the complexity of the tunnel environment, the speed limit must take into account various factors that may have an impact, so it is necessary to reduce the speed of 85% of the vehicle accordingly.

For the minimum speed limit, the tunnel section is not clearly specified, usually 15% as the minimum speed limit. However, the speed of large vehicles is relatively low, resulting in a large difference between the 15% speed of mixed flow and the 15% speed of small cars, and the minimum speed limit should be appropriately increased on the basis of the 15% speed of mixed flow, but not more than 15% of the speed of small cars[4].

TABLE 2. CHANGE OF VISUAL DISTANCE WITH SPEED

Operating speed （km/h） Recognition distance (m)	Warning signs	Ban signs	Indication signs
40	272	336	435
60	239	307	411
80	212	276	374
100	179	239	326

2.2 INFLUENCING FACTORS

(1) Visual characteristics. In the process of driving the vehicle, the driver needs to receive and process complex road information through the cooperation of multiple senses, of which 80% of the information comes from vision and is closely related to speed. For static vision, the driver's naked vision or corrected visual acuity is more than 4.9, and the

International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 08 Aug. 2025, pp: 943-947 www.ijaem.net ISSN: 2395-5252

static vision directly determines the running speed of the vehicle and is directly proportional to it. Under normal circumstances, the dynamic visual acuity will decrease by 10%-20% compared with the static visual acuity, and the visual distance will continue to shorten as the moving visual acuity decreases with the increase of vehicle speed, as shown in Table 2. The visual field is also divided into static and moving vision. The driver's field of vision belongs to the dynamic field of vision during driving, which will change with the increase of vehicle speed, which is inversely proportional to the vehicle speed as shown in Table 3, and the gaze point continues to move forward. According to the provisions of the "Highway Traffic Signs and Marking Setting Specifications", the speed reaches 120km/h and the visual distance is 250m; The speed reaches 100km/h, and the visual distance is 210m; The speed reaches 80km/h and the visual distance is 170m. When drivers pass through tunnels, they will experience the "black hole effect" and "white hole effect", and drivers need time to adapt to changes in external brightness stimuli. The "black hole effect" will cause the driver to receive light stimuli from 1000 lux to 100 lux, and the pupil will cause a short "blindness" phenomenon in order to adapt to light changes, which generally takes a long time, about 25-30 minutes to fully adapt; The "white hole effect" often only takes a few seconds to a minute to adapt. The alternation of light stimuli can cause visual fatigue for the driver, which can affect the driving speed.

TABLE 3. THE RELATIONSHIP BETWEEN VISUAL FIELD, FIXATION POINT AND SPEED

Speed(km/h)	visual field	Gaze point(m)
40	90-100	180
60	75	330
80	60	420
90	40	540

(2) Driver's reaction characteristics. The reaction characteristics are relatively complex, and the reaction time of the driver increases with the increase of vehicle speed. Generally speaking, when the speed reaches 40km/h, the screening time of the driver is about 0.6 seconds; The speed reaches 80km/h and the response time is about 1.3 seconds. Combined with the visual characteristics of the driver mentioned above, the combined result in a longer reaction time than usual.

(3) Vehicle factors. The stability of the vehicle can be maintained at a stable level under the premise of not being stimulated by external stimuli, and the stability of driving will be affected by external stimuli, and the driver will usually maintain stable driving behavior by reducing the speed. The braking performance of the vehicle will change with the change of power, and the temperature of the brake pads will increase due to frequent braking, which will reduce the friction of the brake pads and directly affect the braking effect. In the face of complex traffic conditions in tunnels, reasonable speed selection is the best way to reduce traffic accidents.

(4) Road factor. There are three types of road design: straight line, circular curve, and gentle curve. Relevant data show that the tunnel section is a straight line, which can easily cause fatigue driving of drivers and produce the psychology of rushing out of the tunnel, thus unconsciously affecting the speed. Although the curve tunnel will reduce the visual impact of the "black hole effect" and "white hole effect" on the driver, it will also narrow the driver's field of vision and shorten the visual distance, thereby affecting the vehicle speed. The building materials of tunnel pavement are generally asphalt and cement concrete, according to different tunnel lengths, different building materials will be selected when building tunnels, generally speaking, medium and long tunnels choose cement concrete, short tunnels choose asphalt materials. The pavement material of our country's highways generally chooses asphalt materials, which will cause changes in vehicle driving stability due to the sudden change of pavement materials at the junction of tunnel sections and non-tunnel sections, which will have an impact on speed.

To sum up, the main role of speed limit is to ensure driving safety in the tunnel section, and

International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 08 Aug. 2025, pp: 943-947 www.ijaem.net ISSN: 2395-5252

the speed limit is greatly affected by the visual characteristics of the driver, and other influencing factors such as vehicle factors and road factors will have a secondary impact.

III. THE BASISFOR SPEED SELECTION

Driving a vehicle requires the driver to have a good visual level, a certain psychological quality, and the most important thing is to be able to make appropriate driving decisions based on real-time road conditions and corresponding road traffic norms. There are many factors that can affect the speed choice of drivers, and according to the special situation of the tunnel section, it is mainly divided into the following types:

(1) Traffic composition. Through data investigation, there are obvious differences in the traffic composition of different lanes in the tunnel section. Comparing the two dimensions of 150m and 50m in front of the tunnel entrance, the traffic composition of the fast lane and the slow lane is relatively simple, and the traffic composition of the driving lane is relatively complex. Relevant studies have shown that the traffic accident rate of tunnel sections is correlated with the mixing rate of large vehicles, and when the mixing rate reaches 20%-80%, road safety will be greatly reduced. When the vehicle drives to the entrance of the tunnel, the driver faces the problem of changing the traffic composition, and needs to predict the speed according to the current traffic conditions on the road to maintain stable driving behavior [5].

(2) Traffic. With the increase in traffic volume, the degree of influence between different vehicles increases, and at the same time, it affects the driver's choice of speed when entering the tunnel. In the state of free flow of road traffic, the traffic volume is relatively small, and the interference of other vehicles to the driver is small, and the driver can freely choose the speed of entering the tunnel, and the speed is relatively high. In a steady flow state, the traffic volume increases, the interference between vehicles also increases, and a certain queuing phenomenon begins to appear, the speed of entering the tunnel is limited, and the driver chooses a lower speed to enter the tunnel; In the saturated flow state, the traffic volume reaches the maximum capacity of the road, and all vehicles need to drive at a constant speed according to the corresponding traffic speed, and the vehicle speed is further reduced.

(3) Natural. Rain can affect the speed of vehicles on basic sections of the highway, with light rain reducing vehicle driving speed by 3%-13% and heavy rain reducing driving speed by 3%-16%. At the same time, light rain will reduce road capacity by 4%-10%, and heavy rain will reduce the value by 10%-30%. For the tunnel section, rainfall cannot directly affect the road conditions in the tunnel, but it will form a dry and wet junction between the basic road section and the tunnel section, resulting in the difference in dynamic friction factors between the front and rear road surfaces, which can easily cause wheel slippage, resulting in the driver reducing the speed when entering the tunnel. The impact of foggy weather on vehicle speed is mainly reflected by affecting the visual distance of the driver. Meteorology, road visibility is less than 1km, which is considered fog. The moisture and water vapor brought by foggy weather will also reduce the dynamic friction coefficient of the road surface. According to the above, the driving speed of the driver will affect the visual distance, the visibility in foggy weather is reduced, and the visual distance of the driver is greatly shortened. Ice and snow weather mainly affects the speed of the vehicle by reducing the anti-skid performance of the road surface. Relevant research data show that the anti-skid performance of ice and snow pavement is reduced to 1/6 of that of dry pavement. Drivers are forced to reduce their speed for the purpose of safe driving.

IV. ANALYSIS OF THE RATIONALITY OF THE SPEED LIMIT SCHEME

At present, the speed limit standard for tunnel sections is 80km/h, but high-speed traffic accidents often occur in tunnel sections, and it has been proved that the speed limit of 80km/h can no longer meet the actual speed limit requirements of all tunnels. In 2018, a small car in the Yuling Tunnel collided with a traffic facility shortly after driving out of the tunnel due to the fatigue of the driver, and the second small car in the rear collided with the car in front because it could not dodge in time, resulting in a serious traffic accident in which 3 people were injured and 1 person died. The low traffic density of the Yuling Tunnel can easily cause drivers to increase speed and reduce safety [6].

At present, the detection of vehicle driving speed in tunnels mainly adopts the methods of interval speed measurement and single-point speed measurement. Interval speed measurement is to install sensors at the entrance and exit of the tunnel, record the vehicle's license plate information, full tunnel entry time, and complete tunnel exit time, upload it to the processor, and display the average speed of the vehicle through the tunnel by calculating the time of passing through the tunnel, combined with the length of the tunnel, and publish it. Single-point speed measurement is to install a

sensor somewhere in the tunnel to record the instantaneous speed of the vehicle as it passes the sensor, as the speed of the vehicle through the tunnel.

V. SPEED LIMIT OPTIMIZATION

According to relevant research, when the speed limit value is 70km/h, the probability of tunnel traffic accidents is the lowest, and when the speed limit value is 60km/h, the probability of accidents is the largest. When the speed limit value of the tunnel is large, due to the complex road environment in the tunnel, the driver cannot respond in time in case of emergencies, which is easy to cause rear-end collisions. Therefore, the size of the speed limit value cannot be generalized, and it is necessary to formulate different speed limit values based on factors such as real-time traffic composition, traffic volume, and natural environment. At the same time, the distance between the deceleration warning sign and the tunnel entrance can be increased, and the length of the buffer section of the vehicle speed can be increased, so that the driver can reduce the speed to the specified speed in time before entering the tunnel.

VI. CONCLUSION

This paper summarizes the current situation of speed limit in our country's high-speed tunnel sections and its unreasonableness. By analyzing the basis for determining the speed limit value and the speed selection of the driver, the method of formulating a reasonable tunnel speed limit value is found. Through research, it is found that if you want to reduce the accident rate of high-speed tunnel sections, you need not only to formulate a reasonable speed limit plan, but also to improve the basic literacy and common sense of drivers in order to avoid accidents to a greater extent.

REFERENCES

[1]. Li Hao, Wen Yuanyong. Research on the safety and speed limit setting methods and engineering plans of high-speed public road tunnels [J]. Construction technology development, 2020, 47(03): 136-138.
[2]. Fang Zhongquan. Research on Speed Limiting Technology for Tunnel Groups on Mountain Freeways [D]. Chang'an University, 2017.
[3]. Zhou Na. Research on Traffic Operation Environment Analysis and Evaluation of Expressway Tunnel Group [D]. Chang'an University, 2010.
[4]. Fu Yongguo. Rear-end collision accident in highway tunnel section[D]. Kunming Ligong University, 2019
[5]. Tang Zhengguang, Fu Yongguo, Dong Wenwu, et al. Analysis of vehicle speed characteristics in highway tunnel sections[J]. Journal of Chongqing Jiaotong University (Natural Science Edition),2020,39(06):25-32.
[6]. Tan Kunpeng. Research on variable speed limit method based on tunnel traffic density classification[D]. Chongqing Jiaotong University, 2022.
[7]. Shi Hongqian. Research on traffic accident index system and method of highway tunnel group[D]. Southwest Jiaotong University, 2009.
[8]. Gao Wei. Research on speed limit problem of long downhill tunnel group of mountain expressway[D]. Chongqing Jiaotong University, 2017.