Urban Road Construction Traffic Safety Assessment Based on Equivalent Follow-Up Distance Fde Evaluation

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Keywords: Equivalent Car-Pass Distance, Road Construction, Traffic Safety

Abstract: At Present, the Construction of Urban Roads in China Has Entered a Period of Rapid Development. Many Cities Are Planning, Constructing and Improving Urban Road Transportation Systems One after Another. Long-Term and Large-Scale Road Construction Will Bring a Series of Urban Road Traffic Problems. According to the Changing Characteristics of Traffic Flow Characteristics of Construction Roads, This Paper Analyzes the Characteristics and Causes of Traffic Safety, and Finally Proposes the Concept of Equivalent Follow-Up Distance, and Establishes a Traffic Safety Assessment System Based on Fde Evaluation.

1. Introduction

The Construction of Urban Roads Will Inevitably Occupy the Passage Space, Change the Road Traffic Environment, and Force Traffic Participants and Vehicles to Adjust Their Traffic Characteristics to Adapt to Changes in Traffic Capacity and Safety Requirements, Which Will Have a Huge Negative Impact on the Normal Operation of Urban Traffic [1]. Influences. China's Cities Are in the Process of Scale Expansion and Endogenous Function Improvement. Occupation of Tunnel Construction Takes Place, and Scientific Safety Assessment Methods Are Needed to Ensure Urban Traffic Safety [2]. from the Perspective of Driving, This Paper Establishes a Relatively Reasonable Driving Safety Evaluation System Based on Fde, Which is Used to Evaluate the Traffic Safety Risks Brought by Road Construction [3].

2. Analysis of Traffic Flow Characteristics in Urban Road Construction Area

During the urban road construction enclosure, the road environment changes and the traffic flow operation status changes accordingly [4]. In order to quantitatively determine the changes of the traffic flow parameters under the influence of the construction enclosure, the traffic investigation is used to obtain the traffic flow in the construction enclosure area [5]. The measured data of the parameters, data compilation, statistics, analysis, assessment of the specific impact of urban road construction enclosure on traffic flow, to provide data support for improving the road environment during urban road construction.

2.1 Vehicle Following Behaviour

During the construction enclosure, due to the occupation of road resources, the reduction of the number of lanes and the width of the lane caused traffic congestion, the traffic density on the lane increased, and the distance between the heads gradually became smaller. The vehicles traveling in the area were affected by the speed of the preceding vehicles. Car-following behaviour, road traffic flowing in this state is restrictive, delayed and transitive [6].

2.1.1 Constraint

In a group of vehicles, the driver follows the preceding vehicle, which is “following the requirements”. The front car restricts the speed of the rear car. The rear car speed cannot be longer than the front car, that is, the “vehicle speed condition”; and the rear car and the front car need to maintain a relatively safe distance. When the current car brakes, the rear car driver has enough Time

  DOI: 10.25236/iwass.2019.287

to react, that is, “pitch conditions.”

2.1.2 Delay (Also Called Hysteresis)

It can be seen from the constraint that after the current running state of the car changes, the running state of the rear car also changes, but the change of the two does not occur at the same time, but the rear car lags behind the preceding car. Assuming that the driver's reaction time is T, the current car's operating state changes at t, and the rear car can make a corresponding change at t+T.

2.1.3 Transitive

When the operating state of the first car changes, its deceleration (or acceleration) effect will continue to be transmitted backwards one by one, and the running state of the vehicle on the road will change all the time, that is, the transferability of the vehicle following.

2.2 Vehicle Lane Change Behaviour in Construction Sections

When the urban road construction enclosure occupies the main dry road of the city, the vehicle's running streamline changes, and the lane change behaviour will inevitably occur. The lane change of the vehicle in the construction enclosure area is shown in Figure 1. The construction enclosure area includes the construction upstream section, the construction section and the downstream section of the construction.

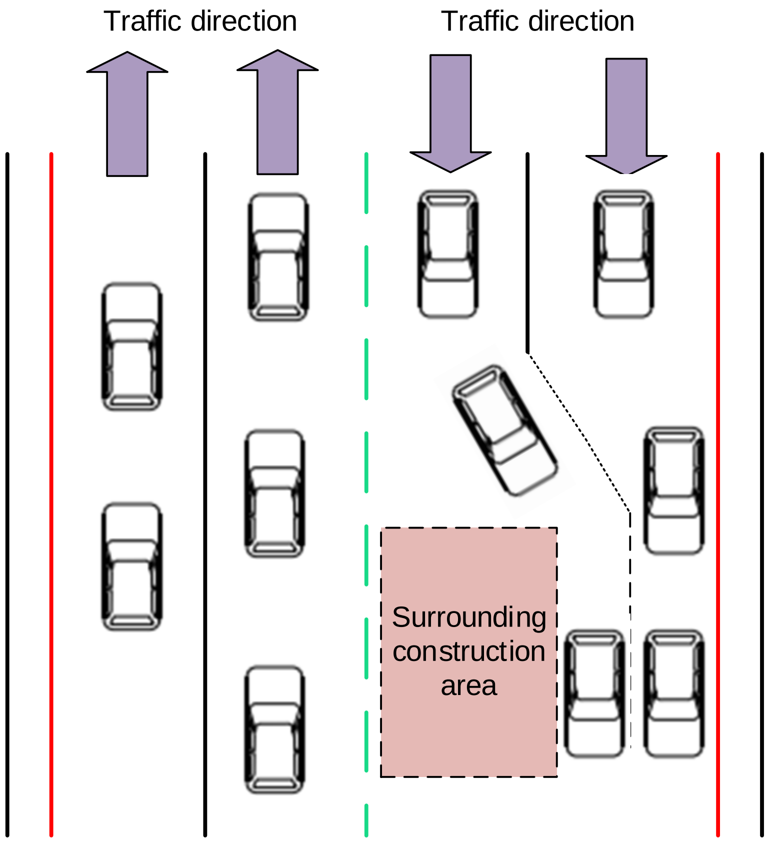

Fig.1 Schematic Diagram of Lane Change in Construction Enclosure Area.

2.2.1 Lane Change Features

Vehicle lane change on road sections in the construction area is mandatory, and it must be the first warning sign in the construction area.

The lane change behaviour is completed between the new lane change points. The lane change behaviour has the following three characteristics:

Vehicles traveling on the road occupied by the construction enclosure will only change lanes, while vehicles on the lanes where the construction enclosure is not occupied do not need to change lanes, so vehicles traveling on open roads have priority access;

When the traffic volume in the construction area is small, the vehicles traveling in the upstream section of the construction may change the behaviour in advance without restriction;

When the traffic volume in the construction area is large, due to the large disturbance, the vehicles that need to change lanes have no chance to change lanes in the upstream section of the construction, and gradually approach the construction enclosure. At the latest lane change point, the vehicles will be forced to change lanes. Vehicles in the open lane need to slow down or stop to ensure safe driving [7].

2.2.2 Impact on Traffic Flow

When the vehicle passes through the construction section, the road becomes narrower, the speed of the vehicle decreases, the traffic density increases, the lane change behaviour of the vehicle in the bottleneck section and the interference of the non-motor vehicle or the opposite vehicle form a traffic conflict in the construction area [8]. The traffic conflicts in the construction area are mainly divided into three types: the confluence conflicts occurring in the upstream sections of the construction, the passage conflicts of the construction sections, and the diversion conflicts of the downstream sections of the construction.

3. Road Construction Safety Analysis

The road traffic system is a dynamic coupling system consisting of five elements: people, vehicles, roads, environment and management. The movement of people and vehicles in the road and environment constitutes road traffic. Taking the highway operation area as the research object, the “person” includes the driver, the passenger, the pedestrian and the construction personnel; the “vehicle” mainly refers to the motor vehicle, including the car, the bus and the truck; the “road” mainly refers to the expressway; “Environment” includes traffic volume, traffic composition, roadside natural environment, artificial environment, etc. “Management” mainly focuses on construction management, ie management of people, vehicles, roads, environment, etc., including maintenance safety facilities, traffic organization and traffic control. Road traffic safety is based on the dynamic balance of the “people, vehicles, roads, environment and management” system. Any change in the elements of the system will have an impact on the entire road traffic. The occurrence of road traffic accidents is the uncoordinated system during the movement. Or caused by imbalance.

3.1 Characteristics of Traffic Accidents

There are few studies on urban construction projects involving traffic accidents in urban construction projects. The main characteristics of traffic accidents in the construction areas of Europe, the United States and Japan are as follows:

(1)Accidents occur in the construction area. On different types of road sections, the traffic accidents in the construction area are the most, while the accidents near the termination area are relatively few.

(2)There are many rear-end accidents in the construction work area. The rear-end collision occurred mainly because of the reduced speed of driving. However, the time and distance required for different driving speeds are different, so that the driving vehicles maintain substantially the same speed through the construction area, which can greatly improve the traffic safety of the construction area. The speed limit setting also considers the vehicle composition type. To avoid excessive speed differences.

(3)Different types of accidents depend on the operation area of the construction area at different locations. The closer the vehicle is to the construction area, the more the vehicle scraping and rear-end collisions occur. When the vehicle passes through the construction area, the number of vehicle scraping and rear-end collisions decreases, while the vehicle and the road are out. The number of accidents in which solids are scratched or collided increases.

3.2 Causes of Traffic Accidents

In the construction process of urban construction projects, the following three types of traffic accidents are generally caused:

(1) Linear changes in the road

When the driving vehicle enters the construction work area, the vehicle in the closed lane needs to change the original driving route and wrap to the open lane, which will seriously affect the driving speed and smooth flow of the open lane vehicle. At the same time, due to road enclosures, section reconstruction, lane changes and other reasons, the road will change linearly, resulting in poor line-of-sight, bumps, overturning, etc., thus increasing safety risks.

(2) changes in the surrounding environment

During the construction period, there will be entry and exit of construction workers and construction vehicles in the construction area. Their access will bring some interference to the normal traffic. At the same time, the implementation of the closed road will affect the lateral clearance of the road. The operation has an impact.

(3) Traffic sign markings are improperly set

In order to ensure the smoothness and safety of traffic in the construction area, it is usually necessary to set up a management facility that can guide traffic safety before the upstream transition section of the road construction area. However, due to the improper setting of traffic signs and marking lines, the driving cannot be promptly and promptly reminded. The personnel caused the driver to drive into the construction area by mistake, or failed to take effective lane change or avoidance measures in time, resulting in a traffic accident. The setting of traffic signs and markings enables the driver to know the accuracy of the road traffic in the construction area in advance and guide the operation of the vehicles in the construction area.

According to the characteristics of the above accidents, the traffic accidents in the construction area should be reduced. The following aspects should be considered: Set the corresponding isolation fence and anti-collision facilities according to the actual situation of the construction section; Reasonably set the speed limit standard and arrange the corresponding limit Speed marking line; as far as possible to separate people and vehicles to ensure the safety of pedestrians and vehicles.

4. Establishment of Traffic Safety Assessment System Based on Fde Evaluation

4.1 Evaluation Index System Establishment Principle

For comprehensive evaluation, we must first select some physical parameters such as physical quantity that can comprehensively and scientifically reflect the safety of dangerous roads. The contents of the traffic operation environment in the dangerous road are complicated. The following principles should be followed to establish the evaluation index system.

4.1.1 Scientific Principles

The selection of evaluation indicators must ensure that the traffic conditions of the dangerous roads can be fully and accurately reflected, and at the same time ensure that the formulas and concepts adopted are accurate, and the symbols of the traffic parameters are in line with industry norms. The selection of indicators should also avoid duplication. On the basis of science, the relationship between indicators and the whole should be correctly reflected.

4.1.2 Principle of Objectivity

The selected indicators should be able to objectively reflect the state of traffic operation, and at the same time ensure the accuracy of the data obtained and the comprehensiveness and reliability of the data source. The evaluation method must also ensure its objectiveness, without subjective assumptions.

4.1.3 The Principle of Integrity

The established evaluation index system should be able to reflect the system objectives, and reflect all the characteristics of the system through its various aspects, and can reflect its changing trend. The indicators are both connected and independent. The driving safety status is a complex system. It must reflect the characteristics of the traffic flow, and also reflect the driver's characteristics, tunnel environment, transportation facilities and other aspects to ensure its overall situation. Unity.

4.1.4 Nonlinear Principle

The traffic safety evaluation of the tunnel is not a simple linear problem, it is a relatively complicated system problem. Therefore, it is necessary to follow the nonlinear principle and optimize the index architecture through appropriate methods.

4.1.5 Principle of Practicality

The research on the safety evaluation of dangerous roads is to solve the practical problems in the operation management of tunnels. Therefore, in the selection of indicators, it is necessary to combine with practice to select common indicators or easy-to-obtain indicators in daily statistics so that they can be intuitively analyse the problem and lay the foundation for the possibility of subsequent countermeasures.

4.2 Equivalent Follow-Up Distance Fde Evaluation Parameter Calibration

This paper introduces the equivalent flow-off distance (FDE) as a comprehensive index to evaluate the possibility of vehicle collision before and after a certain moment:

$$FDE = \frac{v_L h - v_F t}{3.5} + \frac{{v_L}^2 - {v_F}^2}{254(f \pm g)} - L \tag{1}$$

formula: v_L --- Front car speed

v_F --- Rear car speed

h--- Headway distance

t--- Rear car driver's reaction time

f--- Road friction coefficient

g--- Road longitudinal slope

L--- Front car captain

The size of the FDE value mainly depends on the speed difference between the two cars. If the speed of the rear car is faster than the speed of the preceding car, the possibility of collision between the two cars is greater and the danger is greater. When FDE>0, it means that the two cars are driving safely, but the larger the value of FDE is, the more dangerous it is. The smaller the value of FDE is, the safer the driving is. The FDE<0 , indicating that there is a greater possibility of collision between the two vehicles, and there is a potential danger. The greater the absolute value, the greater the collision risk of the two vehicles.

Under normal circumstances, a driver's reaction time is 2.5s and the light in the highway tunnel is dim relative to the outside of the tunnel. Therefore, in the tunnel section, the lane in the 3s lane is taken, due to the relative closeness of the space. Dust and oil are easily left in the tunnel and are not easily removed, which also reduces the friction coefficient of the road surface in the tunnel. Under normal circumstances, the friction coefficient f of the road surface is 0.29-0.44, and the friction coefficient f of the road surface in the tunnel is 0.25-0.33. The longitudinal slope of the expressway is specified according to the design code of the traffic engineering. Usually set at 3% ~5%.

4.3 Road Section Driving Safety Evaluation Index Nf

Since it can only reflect the driving safety of a certain vehicle before and after a certain moment in the tunnel, in order to fully reflect the detection position of a section of a certain section of the road for a period of time (generally the driving safety inside), this paper proposes the road section safety evaluation index. The indicator formula is as follows:

$$NF = \sum_{i=1}^{N} FDE/N \tag{2}$$

Where: (the number of all vehicles passing through the section for a period of time) represents the average of all vehicle values over a period of time on a section of the road, used to evaluate the overall safety of the road segment.

5. Conclusion

With the acceleration of China's urbanization process, there are more and more urban new construction and reconstruction projects. The construction of urban projects is bound to have certain traffic impacts on surrounding roads, intersections and even road networks. Therefore, from the perspective of urban development and traffic management, It is very important to achieve urban development in a reasonable and orderly manner and to minimize the impact of development projects on traffic safety. This paper introduces the concept of equivalent follow-up distance FDE, and puts forward the road safety evaluation index NF, and establishes a traffic safety assessment system based on FDE evaluation, which provides reference and reference for the future traffic safety assessment of urban road construction projects.

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