

# *Analysis and Countermeasures of Several Problems in Urban Road Engineering Design*

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**Abstract:** Road engineering plays an important role in the construction of urban infrastructure, which is the foundation to support various municipal facilities. It has a direct impact on the efficiency of transportation and the safety of public travel. The continuous progress of China's urban construction has greatly promoted the significant improvement of the quality of road engineering. However, there are still some unreasonable problems in the actual road engineering design, which cause potential hazards. In order to better play the important role of road engineering design, it is necessary to study the problems, analyze the specific causes, and find ways to solve the problem of poor road engineering design in combination with the actual research results, so as to improve the quality of road engineering design. At present, the number of cars used by Chinese residents is increasing, and the demand for urban roads is also increasing. In view of the many problems existing in urban transportation, the design and planning of urban roads should be highly consistent with the concept of sustainable development of road traffic in China, and more scientific and reasonable. The purpose of this study is to conduct in-depth analysis and research on the problems existing in urban road traffic design, and find out effective solutions to the problems.

Nowadays, with the rapid development of the national economy, people's living standards have improved significantly, and with it, the expansion of urban scale and the number of people have increased significantly, and the number of private cars has increased significantly[1]. The construction of many roads can no longer meet the people's growing consumption demand. At the same time, the road traffic system is very important to the national economy, not only an important means of rational allocation of resources and macroeconomic control, but also plays a vital role in land development, urban planning and economic layout, and the quality of road engineering design in urban infrastructure construction directly affects the overall development of the city. Strengthening the quality of road engineering design is the key to solving the current road traffic problems. Through sufficient preliminary research and survey work, combined with innovative modernization concepts, the contradiction between engineering design and actual needs is solved, so as to better meet the needs of the development of the times [2].

## 1. Classify urban roads and analyze the nature of urban roads based on different functions.

As urbanization continues to accelerate and the development of transportation motorization continues to grow, the strict classification of urban roads has become more and more critical. In the urban road network, roads are divided into four different levels, namely expressways, trunk roads, secondary roads, and branch roads, according to their location and function in the transportation system, as well as the degree of impact on surrounding service functions [3].

Expressway is a key road in the city that is used to provide a large number of long-distance, rapid transportation services. It is necessary to adopt a central separation belt and strictly control the entrances and exits in the road design, control the distance and form between the entrances and exits, and equip traffic safety facilities and management facilities to ensure smooth and continuous traffic. The number of lanes set up in one direction should not be less than

On both sides of the expressway, it is not appropriate to set up entrances and exits of public buildings that can attract a large amount of traffic and pedestrian flow.

Trunk roads play the role of the backbone of the urban road network, and its role is to connect the main districts of the city, and the traffic function is the leading. It is recommended to set up separation measures for motorized and non-motorized lanes, and reasonably control the spacing of intersections. It is not advisable to set up entrances and exits of public buildings with a large number of vehicles and people on the main roads.

The urban road network is composed of trunk roads and secondary trunk roads, and the secondary trunk roads mainly play the function of collecting and distributing traffic, and also have certain service functions.

Branch roads are connected with internal roads such as secondary trunk roads, residential areas, industrial areas, and traffic facilities, with the main purpose of solving local traffic and service function as the guidance.

Urban road design needs to focus on safety, efficiency, smoothness, environmental protection and economy, and at the same time must reflect the unique characteristics and functional needs of the city. The functional classification of roads includes traffic, life, commercial and landscape, and there are also differences in the design of roads with different functions.

**Traffic roads:** Traffic roads refer to roads designed to meet the needs of motor vehicle transportation, mainly responsible for urban traffic flow and connecting external traffic, which is characterized by fast speed, many vehicles, and wide roadways; The road alignment is suitable for fast driving, and it is required to avoid the installation of a large number of public buildings along the road that attract people, such as urban highways and arterial roads. When designing this type of road, special consideration should be given to the predominance of motorized lanes and the hierarchical design to meet the needs of high-risk traffic.

**Living Roads** Living roads are roads specially set up to meet the needs of urban residents for shopping, socializing, playing, resting and other activities, mainly for walking and bicycle traffic, with fewer motor vehicles. On both sides of the road, there are life service facilities and public buildings and residential buildings with a large flow of people, which have better public transportation service conditions. The living road can be divided into the main road and the secondary road, the former reflects the nature and characteristics of the city, and is the city's landscape avenue. Such as commercial streets, main roads in residential areas. Another important part of the urban transport system is the subsistence feeder road, which includes the various roads in the city as well as the road network within the community. When planning road design, it is necessary to fully consider the appropriate road width allocation.

## 2. Road Design Principles [4]

Security matters. The safety of urban road engineering directly maintains the safety of citizens' lives and property. Designers must keep their mission in mind during the road design process. In the design, it is necessary to match the design speed and use the running speed for inspection, and modify the linear design on the basis of the running speed test. At the same time, it is necessary to consider the design of road entrances and exits and intersections, analyze and evaluate road capacity and service level, and determine the road structure form according to traffic function and traffic volume. In addition, supporting traffic safety facilities should be designed, in accordance with the provisions of CJJ37-2012 of the Code for Urban Road Engineering Design [3], as shown in Table 1 below. Road design should comply with the technical specifications of urban roads. Only in this way can the quality of road construction be fundamentally ensured.

Table 1: Main technical indicators of urban roads at different levels

Catalogue Categories	Design speed (km/h)	Design years( years )	Number of two- way motorized lanes(bar)	Lane width(m)	Separator	cross section form
Fast Road	100,80,60	20	$\geq 4$	3.75	Must set	Two, four road
Main Road	60,50,40	20	$\geq 4$	3.73,3.5	Should set	Second, third, and fourth panel roads
Secondary trunk	50,40,30	15	$\geq 2$	3.5	settable	Single, two, three pieces of road
Branch roads	40,30,20	15~20	2	3.5	Not set	Single width road

### 2.1 Economic Principles

The economic principles cover a wide range, which requires both effective control of road construction costs and the reduction of people's transportation costs to avoid unnecessary waste of resources. Designers need to conduct in-depth analysis of the nature and flow direction of the road in accordance with economic principles, and reasonably plan the road route to ensure smooth traffic. On the premise of ensuring the function and quality of road traffic, it is necessary to fully consider the consumption and occupation of road construction resources, and reduce unnecessary consumption as much as possible [4].

### 2.2 Design principles of low-carbon and green urban roads

As an important part of urban infrastructure, roads play an extremely important role in people's daily work and life, and directly affect people's social activities. The principle of urban road design is to improve the natural environment and create a livable living space to meet the diverse needs of citizens by improving the natural environment in a scientific and rational way [5]. The urban road system is not only a key component of the national emergency rescue system, but also an infrastructure for urban safety management and major natural disaster prevention, so the relevant construction design is very important. Urban road planning and design should follow green and humanistic principles. In the green design of urban roads, it is necessary to consider the recycling of rainwater, and adopt the rainwater engineering design of low-impact development mode to achieve the goals of conservation and early forestry construction. We choose environmentally friendly and renewable materials, and focus on saving construction money, while striving to achieve a balance between quality and cost. In order to achieve the goal of green design of urban circular roads, it is necessary to adopt energy-saving design strategies on the basis of fully satisfying and improving road

traffic functions to meet the requirements of urban road construction environment and energy-saving indicators, and then realize the economy of power supply and distribution system [6].

### **3. Analysis of the main problems existing in urban road design [7]**

#### **3.1 Insufficient investigation leads to unreasonable planning and design.**

Road planning in urban construction planning is very important, and urban planners often detach themselves from reality, do not conduct field visits, have insufficient understanding of the actual situation of urban roads, and rely too much on personal experience when designing urban roads. The resulting design scheme is not very feasible. It is not possible to meet the demand for transportation, let alone achieve safe, comfortable and efficient transportation. At present, many cities are in the critical stage of industrial restructuring. If the road traffic design cannot be synchronized with the urban development process, it will not only bring inconvenience to citizens, but also may have an impact on the prosperity and development of the city. At the same time, it can also have a negative impact on the image of the city [8].

Road design is an important part of road construction, and it is the premise of municipal road construction and transportation network expansion. Define the horizontal, longitudinal and cross-sectional design of the line, accurately determine the location of the line, and lay a solid foundation for road traffic engineering. Some designers fail to take into account the relevance of the road traffic network to the overall urban planning when carrying out the design work, resulting in the disharmony between the road design results and the urban transportation network. It has a direct impact on the rationality of urban road layout, and has an impact on the safety and stability of traffic operation, resulting in an increase in traffic risk coefficient.

#### **3.2 Initial design is not prioritized.**

The preliminary design and general budget estimate are the basis for determining the investment amount of the construction project, preparing the fixed asset investment plan, the project bidding and bidding, and the project audit, which plays a central role in the preliminary review of the government investment project and is of great significance for ensuring the scientific decision-making and scientific construction of the construction project. However, due to various reasons, the initial design was not paid enough attention, resulting in the failure of the subsequent design plan to be implemented smoothly, and eventually the preliminary design had to be revised, resulting in a huge waste of time, manpower, and financial resources [9].

#### **3.3 Insufficient cross-sectional design**

The cross-sectional form and components of urban roads are influenced by a variety of factors, including the size of the city, the width of the red line, the volume of traffic, the type of vehicle, the design speed, the geographical location, the drainage mode, the location of the structure, and the intersection form of the intersecting roads. The common cross-sectional layout is in three forms: single-width road, double-width road and four-width road. According to traffic management regulations, the cross-sectional composition and width of urban roads should take into account the functional and technical level of the road, the design traffic flow, the environment along the route, and the traffic organization and management [3].

The cross-sectional design of the road is to integrate the various functions of the road on the road section, and its layout directly affects the traffic capacity of the road, which plays an increasingly important role in providing comfortable, safe and convenient traffic conditions for road users.

The shortcomings of the general cross-sectional design are mainly manifested in the following aspects: first, the lack of sufficient analysis of urban road functions. According to the size of its traffic volume, the road alignment can be determined by the maximum slope of each highway, the geometric alignment and the longitudinal cross-sectional alignment of each bridge and culvert and route connection relationship; If there is no detailed planning, the road does not consider the various characteristics of the locomotive and the conditions of the surrounding land when planning the transportation network, but only focuses on the design and operation of the road, then it is easy to cause various traffic congestion and traffic problems. In order to overcome this situation, it is necessary to give full play to the capacity and conditions of the road, in terms of planning the structure and traffic of the road. Secondly, there is the problem of insufficient width of the roadside strip. Roadside strips are typically made up of sidewalks, green belts, and facility belts. The width of the sidewalk does not take into account the flow rate during peak hours and the capacity of the 1m wide crosswalk, which makes it difficult to meet the demand for pedestrian traffic. The setting of road service facilities needs to consider the overall planning, including guardrails, lamp beads, signs, garbage cans, mailboxes and other facilities should be coordinated with each other to form a complete package. The wiring harness of the facility is less than 0.5cm and the width of the green belt is less than 1.5cm, resulting in the congestion of pedestrian space and the inability to meet their needs. According to the requirements of the current pavement design code, the service life of the asphalt concrete pavement is usually about 6 years, and the service life of the cement concrete pavement can be as long as twenty or thirty years. However, many pavements experience structural failure in less than five years. This phenomenon may be related to factors such as excessive emphasis on economy and neglect of technology in engineering design.

### **3.4 The intersection design is unreasonable**

As an important part of the road network, the intersection of urban roads has the function of connecting roads and helps to guide the merging and diversion of vehicles. Although the space occupied by the intersection is limited, if it is not properly designed, it will affect the overall traffic capacity of the road, and even the traffic capacity of the surrounding related roads, which may lead to traffic accidents.

### **3.5 Urban road traffic design lacks awareness of energy conservation and emission reduction**

Due to the intensification of resource consumption and the increasing damage to the environment, the urgent issues to be solved are to save energy and reduce emissions. Nowadays, China is actively advocating green environmental protection, energy conservation and emission reduction, and promoting urban green road traffic planning to a new height by refining urban road traffic classification standards and dividing buses, bicycles, and pedestrian lanes, realizing the organic combination of green transportation and humanization, and improving the comfort of green transportation [10].

### **3.6 The "human-centered" design principle cannot be fully reflected.**

It is important to focus on the principle of "people-centric" road design, which puts pedestrian safety first. In the design of the road, the traffic needs of pedestrians should be considered, including the installation of pedestrian overpasses, human crossings, road guardrails, traffic lanes, traffic barriers and other facilities, and the addition of anti-glare facilities to improve road safety. If the road design is not standardized and lacks humanity, it will not meet the needs of the public. Therefore, designers should continue to learn from the advanced experience at home and abroad, scientifically

and rationally, systematically and perfectly design road safety facilities, so as to fundamentally ensure the safety of people's travel, and truly realize the people-oriented design concept.

#### **4. Discussion on improvement measures for urban road design**

##### **4.1 Down-to-earth, focus on the future, and control comprehensively.**

When carrying out road design work, we should pay attention to long-term planning and move forward pragmatically. Before carrying out road engineering design, it is necessary to fully understand the situation of the planned road section, including ground environment investigation, geological survey, planning discussion and personnel preparation. In the actual design process of road engineering, it is necessary to carry out the work in strict accordance with the relevant national specifications. The design process should be based on the overall situation, pay attention to details, and carry out on-site planning in combination with the actual situation [11].

Before you start your design work, you should look at your surroundings from a holistic perspective. In the initial stage of infrastructure construction, the relevant institutions and construction departments must carry out sufficient demonstration work. During the actual construction process, the necessary preparations should be carried out in advance, such as providing the necessary conditions for the future laying of pipelines, so as to avoid the need for follow-up renovation work after the road is completed. During the construction process, it is necessary to ensure close cooperation between various departments in the period before and after to avoid the waste of resources.

##### **4.2 Enhance environmental awareness**

In the current municipal greening, road greening occupies an important position, becoming a key component of municipal roads, and occupies a large proportion. In recent years, traffic pollution has become increasingly serious due to a significant increase in per capita car ownership. In order to cope with this situation, there is an urgent need to solve it through road greening. The green spaces of the city streets are also an important part of the urban landscape. With the rapid development of urban road construction in China, in order to better play the function of road greening and ensure driving safety, it is necessary to unify technical regulations and coordinate with municipal facilities to meet the needs of urban modernization.

##### **4.3 Respect for history and pay attention to characteristics**

Urban road landscape and image design should fully reflect the unique characteristics of the city to avoid the formation of homogenization. Taking Kunming, Yunnan Province as an example, the city is known as the "Spring City", so its urban road design should have a distinctive "Spring City" characteristic, fully demonstrate the unique charm of the "Flower City", and skillfully integrate the local cultural characteristics. Integrating the profound historical culture, ethnic culture, ecological civilization, Buddhist culture, as well as the traditional and culturally diverse characteristics of towns and cities into urban construction, it gives unique and valuable life to the artistic creation of urban road traffic [12].

##### **4.4 Improve road transverse and longitudinal section design**

###### **4.4.1 Road plane design**

Various factors, such as socio-economic, physical geography and technical conditions, will affect



the route location of highways and urban roads. The mission of the designer is to seek to design the most economical engineering route that meets certain technical standards and meets traffic needs on the basis of in-depth research and collection of a large amount of data. The general design process is to first determine the plane, followed by elevation measurements and cross-sectional measurements; After obtaining the ground line and related information, the longitudinal and cross-sectional design is carried out to consider the vertical and horizontal elements as much as possible. Graphic design is one of the key points of road engineering design. In practice, this part of design planning is often overlooked by designers, and the quality of road plane design depends on the rationality of the design and strict adherence to the design specifications, guiding standards, and consideration of the actual situation of the urban route and the surrounding area.

#### **4.4.2 Cross-sectional design**

The elements to be considered in cross-sectional design are very complex, usually including motorized lanes, sidewalks, non-motorized lanes and curbs. It is a design element that must be considered in road planning and design. The design scheme needs to consider the overall, scientific, applicability and other factors to ensure that the lanes covered by the cross-sectional design are reasonable. In this process, special consideration needs to be given to factors such as allowable speed and flow, and the land needs to be fully utilized so that the width of the single lane is reasonably designed and used. After considering the current traffic situation and in-depth analysis of potential factors, the original number of lanes should be reasonably adjusted according to factors such as road base, design width and proportion of supporting facilities. Full consideration must be given to the harmony of the design and the guarantee of optimization. In the design, more attention should be paid to environmental protection, safety and humanized design, and the layout of the green structure and separation zone should be optimized.

#### **4.5 Design of road engineering intersection facilities**

The study found that the traffic capacity of highway intersections is half of the normal road section. In order to maximize the capacity of the intersection, a variety of facilities can be added to optimize the crossing design. There are many possible ways to do this, such as increasing the number of lanes at the intersection. By making appropriate local adjustments to highway intersections, vehicles can pass smoothly, thereby reducing the occurrence of traffic congestion. By setting up traffic lights at highway intersections, traffic flow can be better managed and traffic congestion can be reduced, ensuring that the traffic flow of the road is reasonably distributed, thereby improving the overall traffic operation efficiency. The optimization of traffic sign parameters at highway junctions aims to improve the ability of motorists to quickly identify sign information, so as to promote them to take safe driving measures. Properly designed intersection facilities can improve traffic efficiency and reduce the probability of traffic accidents. [13]

#### **4.6 Road drainage design**

After the completion of road construction, the drainage system design of the slope and road surface should be considered to ensure the smooth drainage of rainwater, reduce water damage, prolong the service life of the road surface and improve environmental friendliness. In the design of road drainage, it is necessary to comprehensively consider the factors of slope and pavement. Specifically, the slope drainage design should set up interception ditches at the top and bottom of the slope to ensure that rainwater can be smoothly discharged and avoid rainwater seeping into the road surface and causing degradation of the pavement material. In addition, drainage design is also required on the surface of

the slope to avoid the soaking of the slope by rainwater, which reduces the geomechanical properties and causes slope stability problems. In road design, in addition to setting up a drainage cross slope, a permeable pavement layer can also be considered. It can effectively promote the rapid discharge of rainwater through the permeable cement pavement layer, and realize the effectiveness of pavement drainage. In addition, the road drainage system can be connected to the sponge city, and the road rainwater can be stored in the sponge city transfer station, so that it can be used for urban greening, road cleaning and other purposes when needed, so as to realize the recycling of water resources. Road drainage design promotes sustainable urban development by harnessing the drainage and flood prevention capacity of sponge cities [14].

#### **4.7 Intermediate expansion joint design in urban road**

In the field of highway traffic engineering, expansion joint design is used to solve the problems of thermal expansion and contraction, earthquake, vibration and deformation caused by various factors such as temperature changes, earthquakes or land subsidence. The key objective is to ensure that the road can expand and contract freely under various conditions, thereby reducing the degree of deformation of the road [15].

#### **4.8 Follow the actual design in urban development**

The design scheme of urban road construction engineering must be combined with the needs of urban development, and integrate technical, economic and resource factors to ensure that the design is scientific and forward-looking. Design concepts must be updated at any time to incorporate advanced scientific concepts into practical work. In recent years, the concept of low-carbon has received extensive attention, and it is very important to introduce the concept of low-carbon in urban road planning, which directly affects the sustainable development of cities[16]. In recent years, more and more cities continue to expand in scale, the construction and development of future urban areas, inseparable from road traffic, how to coordinate the old and new urban areas, urban and rural areas and the surrounding cities between road design and traffic connection work, is also a problem to consider in traffic engineering design. The actual "people-oriented" of urban development, road design should establish the design concept of humanistic care, and incorporate many factors such as the will of the masses and the actual needs of urban development into the design considerations, and when designing, it is necessary not only to consider the future development direction and planning goals of the city, but also to avoid the occurrence of loopholes to modify and rebuild again, so as to reduce the impact of unfavorable factors on urban road traffic and promote the rapid development of the city.

#### **4.9 Increase the supervision of road traffic design in large cities.**

With the continuous growth of urban economy, the requirements for urban road traffic design are increasing day by day. Therefore, it is particularly urgent to pay more attention to urban road traffic design. Through an effective supervision mechanism, the occurrence of design errors can be effectively reduced, and the safety of road construction can be improved. This helps to reduce the probability of safety accidents, thereby further promoting the healthy development of the urban transportation system. In order to ensure traffic safety on urban roads, we must increase the supervision of road traffic construction and ensure that designers design according to standards to fully meet the needs of urban transportation development. Relevant departments must be aware of their responsibilities, conscientiously implement the supervision work, to ensure that there is no improper operation in the construction process, and at the same time pay attention to the design of



urban road greening, combine traffic function and aesthetics, and formulate a unique urban road construction plan.

## 5. Conclusion

Roads are the infrastructure of urban transportation and economic development, and the quality of road engineering design directly affects the travel safety of residents and social stability, and has important significance for national governance and people's livelihood security. With the acceleration of China's urbanization process, the urban traffic volume has increased significantly, and the scale of the road corresponding to the demand has been expanding. When carrying out specific work, designers must conduct a detailed analysis of the city's traffic flow, vehicle composition, topography, environment along the line and other factors to ensure the scientific and rational design of urban roads. [17]

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