

Study on Considerations for Bicycle and Pedestrian Passage in Municipal Road and Bridge Design

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Abstract: Modern urban construction development actively promotes the concept of green travel, where cycling and walking have become primary low-carbon and environmentally friendly transportation modes, occupying an important position in the urban transportation system. However, some cities inadequately consider bicycles and pedestrians in municipal road and bridge design, leading to restricted passage space for non-motorized vehicles and pedestrians, causing safety issues and poor travel experiences. This paper will focus on the field of municipal road and bridge design, point out the considerations and problems regarding bicycle and pedestrian passage in such designs, propose scientific and reasonable design optimization strategies, and provide a strong reference for the sustainable development of urban transportation systems.

1. Introduction

Municipal roads and bridges are core components of the urban transportation network, and their design quality is closely related to urban traffic operation efficiency. Against the backdrop of actively promoting green travel concepts, cycling and walking have become low-carbon and environmentally friendly travel modes, widely recognized by people. In the vast majority of large and medium-sized cities in China, cycling and walking have become popular. But honestly, some municipal road and bridge designs still prioritize motor vehicle passage needs, with insufficient consideration for bicycles and pedestrians, limiting the active promotion of green travel modes. So, in-depth exploration of bicycle and pedestrian passage paths in municipal road and bridge design is of significant practical importance.

2. Considerations for Bicycle and Pedestrian Passage in Municipal Road and Bridge Design

2.1 Spatial Path Planning

Spatial path planning of bicycles and pedestrians in municipal road and bridge design is a process that must comply with the principle of safety and comfort, so it can only establish a multi-dimensional collaborative passage system based on road functional positioning. The independence of the passage path is the basic principle among such procedures. Physical separation facilities shall be set up between vehicular lanes and bicycle lanes in municipal engineering construction units, and physical separation facilities shall also be established between pedestrian walkways to ensure cyclists' safety. At the same time, at a number of design nodes such as bridge intersections and approach ramp slopes, turning radii and gradient design were combined into the optimization process. However, where land is scarce it can be selected to work on a mode share board design for motor and non-motorized lanes whereby surface markings will distinguish their path and the choice of construction materials will prevent encroachment by motor vehicles in passage channels.

2.2 Safety Protection

Municipal road and bridge design in bicycle pedestrian passage system safety protection, need build enhance a thing multi-dimensional protection system. Continuous guardrails or green belt design to separate the lanes of motor vehicles (motor vehicle lane), certain non-motorized vehicles

(non-motorized vehicle lane), and pedestrian walkway will be focused on in some aspects of the design. And the guardrail is higher than 1.2m, and there are high baffles at the bottom of the guardrail to prevent children from climbing or objects from rolling out along with it. Anti-skid paving and vibrating markings should be set up at speed change areas such as bridge approach slopes and tunnel entrances/exits. When slope elevation is over 2.5%, anti-slip grooves should be provided. The pedestrian walkway should be longitudinally inclined, and a double-layer handrail placed at key nodes. All bridges and connecting roads should additionally be furnished with suitable and uniform lighting facilities to prevent glare and shadows in addition to making it feasible for the users - of footpaths/cycle paths/roads including pedestrians/cyclists (as the case may be) at evening time. It should also maintain a consistent, level passage path across the entire route of travel avoiding any steep grades and abrupt turns. Intersections should be zero-level difference transitions and tactile paving systems and tactile warning tiles. Pedestrian walkways and lanes can be further separated to minimize pedestrian-vehicle mixing interference where bridge deck width permits.

2.3 Environmental Integration

Municipal road and bridge design should give full play to the importance of bicycle and pedestrian passage systems, and deeply integrate their planning into the urban ecological humanistic environment. In terms of ecology, green permeability should be expanded. Ecological corridors would be formed to selective native weather-resistant plants. Install vertical greening modules on the outside of bridge piers, use rainwater collection systems to automatically irrigate vertical greening modules, and form dynamic ecological landscapes [5]. Permeable paving materials have the application rate is greater than 70%, with a certain proportion of sunken green space design enables hard road surface rainwater storage and regulation function, to maintain the regional hydrological cycle. Regional genes can be implanted on the level of cultural expression. Some of which would be traditional architectural elements that could also translate into the modern world. Prioritize the use of environmentally friendly building materials like recycled aggregate concrete and bamboo-steel composites that impart thoughts on sustainable development through material texture. Social and cultural integration should provide rich shared interactive areas that turn transportation functions into moments of positive social interaction, enabling enhanced community cohesion.

3. Common Problems in Bicycle and Pedestrian Passage Design of Municipal Road and Bridge Engineering

3.1 Unreasonable Space Allocation

The unreasonable space allocation for bicycle and pedestrian passage in municipal road and bridge engineering design has become a more prominent problem. There are absolutely no bike lanes on some roads and bridges, or the planning was done terribly shy of your bike lane even more so. In some of the busiest sections, bike lane width can barely accommodate a bicycle going through— This results to traffic congestion if a cyclist makes a brief stop or give way ^[1]. Moreover, certain municipal designs for roads + bridges have further muddled the waters between pedestrian and bicycle passage space. As pedestrians, you have to avoid money and high-speed bicycles while walking, otherwise we will face a collision. Cyclists must also brake and change lanes, further reducing the efficiency of passage. From the spatial layout point of view, some municipal roads and bridges in bicycle and pedestrian passage area design is not organic; Different obstacles could also stop pedestrian walkways and eventually lead pedestrians to run an additional pathway (including a long travel distance and time cost). Moreover, in certain road and bridge works projects of the slow-traffic space are also not properly covered due to cater for certain groups like the elderly, children and persons with disabilities. Not only does this design flaw shrink the crowd, but it also adds to the growing disorder in how space is used.

3.2 Signal Control Needs Optimization

Some traffic lights on the roads and bridges are not scientifically timed now. Bikes and pedestrians still have to wait out red lights for long periods, even during low traffic volume times. This unreasonable timing actually greatly affects the passing efficiency of bicycles and pedestrians, wasting their time. In peak hour, the green light time is less than 15 seconds, leading a large amount bikes and pedestrian to be unable to pass through the intersection in one signal cycle; they flow into the middle of intersection which disturbs traffic order and increases safety hazard. At the same time, in some road and bridge designs, intersection traffic lights do not take full account of the passage characteristics of bicycles and pedestrians. Other vehicles blocking Pedestrian Passage Intersections that lack dedicated bike traffic signals are problematic as bicycles must obey motor vehicle signals, which puts cyclists in a dangerous position. There is much to be desired when it comes to the intelligence of signal triggering mechanisms. Intersections typically operate on a fixed timing plan, lacking the ability to perceive and responded to pedestrian and bicycle flows in real time. While some grade-separated crossing facilities provide pedestrian-vehicle separation, issues such as unclear signal indications and prolonged waiting times reduce facility usage rates, resulting in widespread infractions.

3.3 Insufficient Accessibility Facilities

Municipal road and bridge engineering bicycle pedestrian passage design mainly exists the lack of accessible facilities. In terms of the bicycle passage, some roads and bridges lack uninterrupted standardized bike lanes throughout. In places, the bicycle lanes are taken up by parked motor vehicles or have an inadequate separation from the motor vehicle lanes, causing cyclists to frequently dodge the motor vehicles — with serious safety implications. Bicycle lanes at intersections have no marked guides nor areas to smoothly connect lanes, which causes people on bikes to lose direction when turning. Even more often, accessibility facilities are insufficient to pass by foot. The ramp design in some urban road and bridge municipal projects does not comply with the standards required to practice, that is not functional for persons with disabilities passage. While some municipal road and bridge tactile paving is treated as "decoration," it does not provide functional benefits. During the installation process, problems such as a sudden stop affected by abnormal obstacles, unreasonable detour planning and even being blocked by fixed or temporary objects like street light poles, distribution boxes and shared bicycles occurred ^[2]. This can turn into a trap and is misleading for people with sight problems.

3.4 Traffic Organization Needs Improvement

Municipal road and bridge construction in the implementation of bicycle and pedestrian passage design projects There is a problem that needs to be improved. Regarding path planning, bicycles and pedestrians are mixed together; not only does it cause passage efficiency to be reduced, but also increasing the potential of collision risk, which threaten the safety of passers-by and cyclists. Crossing facilities: There are still some cases where bicycles and pedestrians share a facility, but their needs have not been completely taken into account in design. Part of road and bridge construction projects have relatively complete slow-traffic systems that are designed on the bridge itself but there is a lack of linkages to surrounding roads, communities or public transportation terminals. This decentralized traffic organization lowers the throughput of the slow-traffic system and frustrates the construction of a continuous, friendly travel network. Moreover, some roads and bridges does not have physical separation between bicycle lanes and pedestrian walkways but only lines to divide functions, making it harder to enforce the prohibition of motor vehicle encroachment or non-motorized vehicle border crossing. Issues such as inadequate lighting at night and lack of warning signs make nighttime crossings more dangerous.

4. Optimization Strategies for Bicycle and Pedestrian Passage Design in Municipal Roads and Bridges

4.1 Implementing Spatial Separation and Functional Optimization

Strategies of spatial separation and functional optimization should be used to optimize the design of bicycle and pedestrian passage in municipal roads and bridges. During the spatial separation step, independent bicycle lanes and pedestrian express ways ought to be created sensibly as indicated by pedestrian motion stream data. There are also physical separation methods for new road and bridge projects: avoid mutual disturbance by setting green belts or guardrails of different heights between bicycle and pedestrian spaces. Bicycle lanes and the pedestrian walkways set on both sides of wide urban arterial road bridges separated in middle by green belts. Functional optimization: optimization of the guidance and comfort in the facilities; improvement at the systemic level across passage. In this way, there must be an uninterrupted, consistent guiding method; colours and textures should guide visually impaired persons which must act as guides to everyone whom can predict the walkicies very clearly. Rest seats must be installed in the pedestrian areas and away from the corridor space so that stationary spectators do not block the passage of people. In zones or areas with heavy traffic stream and the potential for conflict, a type of smart sensing systems can be piloted. It can be a sound and light warning device, information screen, etc. Provide users with dynamic safety reminders of real-time traffic flow.

4.2 Optimizing Intelligent Signal Control

Bicycles as well as pedestrians are integral elements of the municipal road and bridge traffic system. However, optimizing their passage design and underlining intelligent signal-control are indeed the prerequisites for greater efficiency and added safety through traffic flows. Engineering construction units should unify the information interaction platform by integrating traffic signal systems, monitoring equipment and mobile terminals. Roadside sensors gather information about the flow, speed and location of bicycles and pedestrians in real-time which can then be uploaded to the platform. Mobile apps or smart wearables can provide real-time information to travelers on the status of traffic signals, road congestion, helping them in advance route planning ^[3]. Intelligent communication terminals should be installed at the key nodes of municipal road and bridge projects to give traffic instructions and safety reminders to cyclists and pedestrians. Like, we can build the traffic lights with voice prompt at all the crossings with automatic reminder in sound about to finish of green light then it will make traffic information communication more intuitional. In addition, municipal road and bridge construction units should vigorously implement humanized interactive communication design, create intelligent human-computer interaction system, optimize passage experience and security. Technologies like interactive traffic lights, or giant LED displays can be added that clearly count down time remaining on waiting, and passage status prompts for pedestrians and cyclists who are waiting. For Special Groups or high volume scenarios, designers should set request priority buttons. Based on a request, the system will reasonably consider it last in the next cycle and grant green light extension, which is also considered as humane.

4.3 Implementing Accessibility and Humanized Design

The optimization of bicycle and pedestrian passage design in urban roads and bridges should apply accessibility, humanized design thinking to establish an all-age-friendly passage space system based on continuous accessibility facilities through the whole line. Use anti-slip ramps for connecting bridges. Gentle slope transitions at height difference points -- they should not be steps or steep slopes that hinder vulnerable groups. Based on this, the design of compound should be actively popularized, and pedestrian passages can be more than 3 meters, walking paths and rest area should be divided clearly. Focus on humanized details is the essence through whole design process. Use a unified standard of Chinese-English bilingual comparison and international universal symbols on signs. Sign placement height should be at eye level for wheelchair users, and this requirement will require an upgrade from the traffic function of municipal roads to a service experience. You must establish an accessible, slow-traffic system that anyone can enjoy.

4.4 Optimizing Traffic Organization

Multi-dimensional traffic organization strategies should be implemented in the optimized design of bicycle and pedestrian passage systems in municipal roads and bridges to achieve synergistic improvement of safety and efficiency. For spatial layout, it is layer design concept. For Main streets, colored anti-skid pavement plus 3D markings could be used to clarify the borders of dedicated bike lanes which are physically separated from motor vehicle lanes by permeable concrete isolation belts [4]. Flexible facilities should be available with pedestrian passages to become separate spaces. Double-layer corridor systems should be used to achieve three-dimensional separation of pedestrians and vehicles in key areas. As far as the design of signal control optimization is concerned, engineering construction units should establish a composite control system based on inductive control and coordinated control. The plan assumes the implementation of geomagnetic sensors and video detectors at arterial road intersections to monitor bicycle flow in real-time, leading to short-term responses that result in dynamic regulation of green light duration. Comments: Establishing a standalone dedicated bicycle phase at larger intersections or mixed use squares, completely decoupled in time from the pedestrian crossing signal. We can use IoT to deploy sensors and warning devices at Points of Conflict. When risk of high-speed bicycle approach or collision with pedestrians is detected, both cyclists and pedestrians can be warned simultaneously via ground flashing warning lights (GFWLs) and sound alert devices to improve awareness on the part of both cyclists and pedestrians.

5. Conclusion

In summary, the proper planning for municipal road and bridge engineering bicycle, pedestrian pass patrol can meet people's positive green travel concepts in the new era. In design phase, the municipal road and bridge construction units should implement spatial separation optimization, intelligent signal control optimization, accessibility and humanization design, traffic organization optimization. This contributes to ease of city construction and the establishment of transportation planning and building oriented toward sustainability.

References

- [1] He Shiwei. Study on Considerations for Bicycle and Pedestrian Passage in Municipal Road and Bridge Design [J]. Architecture and Decoration, 2025(4):86-88.
- [2] Bao Wei. Research on the Impact of Urban Traffic Development on Municipal Road and Bridge Design and Countermeasures [J]. Real Estate Guide, 2025(13):156-158.
- [3] Peng Huiguang. Spatial Layout and Traffic Guidance Design of Municipal Roads and Bridges in High-Density Urban Areas [J]. Off-Road World, 2024(20):101-102.
- [4] Zhang Leilei. Research on Construction Technology of Subgrade and Pavement in Settlement Sections of Municipal Road and Bridge Engineering [J]. Computer Fan (Campus Edition), 2023(7):207-209.