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Strategic Considerations for Enhancing Civil Defense Systems in Subways and Underground Utility Tunnels Amid Evolving National Defense Mobilization Needs

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Abstract

This paper is set against the backdrop of new national defense mobilization circumstances, and by reviewing and summarizing the functions of subways and underground utility tunnels during wartime, along with the characteristics of domestic and international subway and utility tunnel projects, it analyzes their critical roles in personnel shelter, evacuation, and pipeline protection. The paper discusses the construction of the civil air defense protection system, innovatively proposing some suggestions that may serve as references and examples for the development of civil defense systems in the urban subway and underground utility tunnels sectors in China.

Keywords

National Defense Mobilization, Civil Air Defense Engineering, Rail Transit Engineering, Underground Utility Tunnels

1. Introduction

National defense mobilization, generally referring to war mobilization, is the activity in which a state or political group transitions all or part of various societal sectors from a peacetime to wartime state to maintain and enhance military capabilities in response to war or other military crises, simply referred to as mobilization. Mobilization covers a wide range of areas, including: armed forces mobilization, political mobilization, economic mobilization, civil air defense, transportation mobilization, equipment mobilization, technological mobilization, and information mobilization.

In response to a severe international situation, in 2023, national defense mobilization offices were successively established in Yunnan, Jiangxi, Jiangsu, Gansu, Beijing, Fujian, Sichuan, Hubei, Hebei, Shanghai, and other places. This was not a coincidence but a preventive measure taken to protect the homeland, maintain national unity, and safeguard territorial integrity.

According to publicly available data, with economic development and the progression of urbanization, the proportion of civil air defense projects involving subway stations, interval tunnels, and utility tunnels has significantly increased. Despite the critical nature of subways and utility tunnels in the civil air defense protection system, research on this topic is scarce in China, making such studies highly necessary.

2. Overview

2.1 Subways

A convenient and fast mode of transportation in modern life, the role of subways as civil air defense works is relatively unfamiliar to most people. However, subways as civil defense facilities are not new; they played a significant role in air raid defense during World War I and World War II, protecting countless civilians from air raid damages. Urban subway projects serve primarily as transportation operations in peacetime and have a large internal space, but in wartime, they take on the role of evacuation routes and emergency personnel shelters, playing a crucial role in the urban civil air defense system.

Figure 1. Subway Station Concourse and Platform Levels

2.2 Underground Utility Tunnels

Important urban infrastructure buried underground, these tunnels house various types of municipal pipelines such as power cables, communication cables, water supply and drainage pipes, and reclaimed water pipes. Underground utility tunnels make intensive use of underground space, divided into multiple functional compartments, effectively addressing issues like "road zippers" and "aerial spider webs," thus enhancing urban quality and resilience. Like subways, these utility tunnels are a vital part of modern civil defense engineering, serving as crucial infrastructure and "lifelines" for city operations during both peace and war times.

Figure 2. Power Compartment and Integrated Compartment of the Underground Utility Tunnel Project

3. The Role of Subways and Underground Utility Tunnels in Warfare

3.1 Subway Shelter Function

Most of the Moscow Metro lines are deep-buried tunnel designs, comprising 9 lines with a total length of over 300 kilometers, including one circular line. Most of the Moscow Metro routes are built more than 50 meters below the surface. In emergencies, these subways can quickly be converted to protective shelters, capable of sheltering up to 3.5 million people. Nearly seventy percent of Russia’s population can be accommodated in its underground spaces [1][2].

Figure 3. Evacuation of Sheltered Personnel in Subway Tunnel

The Kyiv Metro in Ukraine, built after the Moscow and Saint Petersburg systems during the Soviet era, consists of three intersecting subway lines covering most of the Kyiv city area. There are a total of 54 stations, most of which are underground, with some stations as deep as 105 meters. These stations, exceeding 100 meters in depth, were initially constructed as air-raid shelters during the Soviet era and were converted into metro stations after World War II. They serve to ensure emergency shelter for people, safe transport, relocation, temporary storage, and transportation of materials in the event of air raids and secondary urban disasters [2].

North Korea, given its national economic scale and population size, does not have the need or capability to build a metro system under normal circumstances. However, based on national defense needs, the North Korean government has constructed what is currently the world's deepest subway system, the Pyongyang Metro, with an average depth of about 100 meters and reaching depths up to 200 meters. Apart from its regular rail transport functions, the underground passages are equipped with heavy-duty safety doors, and some tunnels serve military purposes and emergency sheltering. According to Japanese and South Korean media reports, the Pyongyang Metro system not only functions as a means of transport but also effectively provides emergency evacuation for the city's population, capable of moving everyone underground within three hours.

Figure 4. Subway Station Used as an Emergency Shelter for Personnel Protection

3.2 Development of Rail Transit in China

According to official statistics from the Ministry of Transport: As of January 2024, 31 provinces (autonomous regions, municipalities directly under the Central Government) and the Xinjiang Production and Construction Corps have a total of 308 urban rail transit lines in operation across 55 cities, covering a total operational mileage of 10,205.6 kilometers. These lines collectively operated 3.42 million train trips and served a passenger volume of 2.66 billion, with 1.59 billion entries recorded[3]. The cities ranked in the top 20 in terms of subway operation and construction mileage are highlighted in a diagram. In megacities like Beijing and Shanghai, daily passenger flow often exceeds ten million. Given the massive volume of passengers, subway travel has become the mainstream mode of transportation and a fundamental guarantee for urban operation.

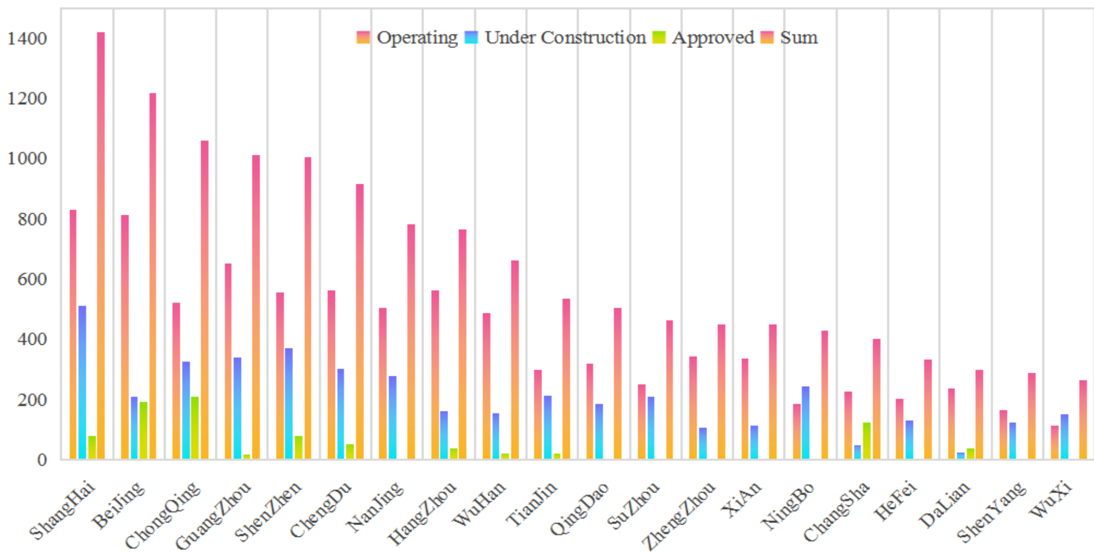


Figure 5. Top 20 Chinese Cities by Operational and Under-Construction Subway Length as of January 2024

3.3 Protective Function of Subway Civil Defense Engineering

Under the complex international circumstances of the 1960s and 1970s, including nuclear threats from the US and the USSR, China constructed a large number of tunnels and air-raid shelters as part of its civil defense efforts. When the first subway line in China—Beijing Subway Line 1—was constructed in 1965, it was already designed with wartime functions in mind, marking the beginning of China's subway civil defense engineering.

Subway civil defense engineering utilizes existing subway stations and interval structures, and adds protective measures to entrances, ventilation shafts, and other openings. By converting these features from peacetime to wartime use, they achieve a protective purpose, typically comprising a single subway station and an interval as one protective unit[9]. Subway stations also reserve civil defense connections to facilitate interconnectivity with surrounding civil defense structures. Under the current standards, subway civil defense engineering is designed to resist conventional weapons at levels 5 or 6 and nuclear weapons at levels 5 or 6, with chemical resistance classified as type C or D.

Figure 6. Protective Equipment for Track Areas and Wartime Entrances and Exits at Subway Stations

Subway projects are deeply buried underground, making them natural shelters. The main structure of these projects is designed to withstand nuclear weapons, missiles, and biochemical weapons. By improving protective facilities at weak points and openings, these structures meet the required resistance for civil defense. Additionally, with self-sufficient systems for air, water, and electricity within the protective units, these subways function effectively as civil defense shelters. In wartime, as long as the power supply is secured and operational safety is ensured, the subway can quickly evacuate and transport personnel while maintaining limited operation. Even if trains are not running, evacuation and transport can still be accomplished via track flatcars and on foot. If evacuation is hindered by threats, people can seek emergency shelter at nearby stations, which can transform their large spaces into emergency shelter areas. This not only addresses the shortage of urban shelter spaces but also solves the temporary shelter needs of the floating population during wartime. Stations' large spaces can also store essential supplies, addressing food needs during sheltering periods. This allows subway projects to transition from peacetime to wartime without significant adjustments, effectively embodying the civil defense construction policy of "long-term preparation, focus on construction, and integration of peacetime and wartime functions."

3.4 Underground Utility Tunnel Civil Defense Engineering: "Lifeline" Protection

In 1958, the first underground utility tunnel in China was constructed beneath Tiananmen Square in Beijing, housing electricity, telecommunications, and heating pipelines. Subsequently, substantial utility tunnel projects were developed in cities such as Shanghai, Tianjin, and Guangzhou. In July 2015, to enhance the quality of new urbanization, the State Council deployed measures to advance the construction of urban underground utility tunnels, marking a period of rapid development for utility tunnels in China.

For urban construction, the concentrated arrangement of utility tunnels effectively utilizes underground space, conserves urban land, and reduces the need for poles, inspection wells, and other traditional pipeline installation structures, thereby enhancing the cityscape. Moreover, the utility tunnel system greatly facilitates the maintenance and repair of contained pipelines. Should any pipeline within a tunnel encounter issues, maintenance can be performed through designated access points without the need to excavate the road surface. This allows for maintenance and repairs to be conducted within the tunnel, enabling faster restoration of city services like electricity, gas, and telecommunications. Additionally, the underground structure's resistance to seismic events increases urban safety resilience.

Figure 7. Protective Equipment for Entrances, Exits, and Emergency Exits in Underground Utility Tunnels

The various pipelines within the utility tunnels are vital for the normal functioning of the city and can become targets during enemy airstrikes. Damage to these tunnels could lead to urban paralysis, communication failures, and disruptions in energy supply, adversely affecting civilian life and national war potential. Effectively protecting the essential pipelines within utility tunnels during wartime underscores their inclusion in the civil air defense system. In times of war, when facing air raids, protective measures such as sealing openings and forming a complete defense system can safeguard the operation of tunnel pipelines, thus preventing complete urban paralysis and creating conditions for rapid repairs to preserve wartime potential.

3.5 Steel Usage Analysis in Subway Stations and Underground Utility Tunnel Civil Defense Engineering

Subway stations and underground utility tunnels are designed for normal loads with high overall rigidity. The structures' walls, columns, and beams are thick and wide, buried deeply, and have high load-bearing capacities. They can meet certain protection levels with little or no additional reinforcement of steel and concrete.

The steel reinforcement requirement is minimal or unnecessary to achieve a resistance of 0.05 MPa. Furthermore, subway stations, subway interval tunnels, and underground utility tunnels are generally located under roads, covered by a layer of soil. Concrete road surfaces, asphalt, and stone cushion layers also provide significant protection against projectiles.

Table 1. Steel Requirement for Certain Projects in a City

Project Name	Normal Load (t)	Wartime 0.05 MPa Overpressure (t)	Reinforcement Increase (t)
XX Lake RoadUtility Tunnel	504	499	-5
XX Avenue Utility Tunnel	421	438	17
XX Subway Station	2056	2024	-32

During the construction of a subway in a Chinese city, to verify the protective performance of subway stations and tunnels against nuclear weapons and to further research and improve the engineering, a scaled model tunnel with a ratio of 1:15 and a full-scale model of 1:1 were built at a nuclear test site. After enduring seven nuclear explosions, the protective effectiveness of the engineering was proven. There was minimal internal vibration, and it provided protection against early nuclear radiation. Even during a surface nuclear explosion, the subway's wave-damping and ventilation systems remained largely intact, ensuring the safety of biological entities inside.

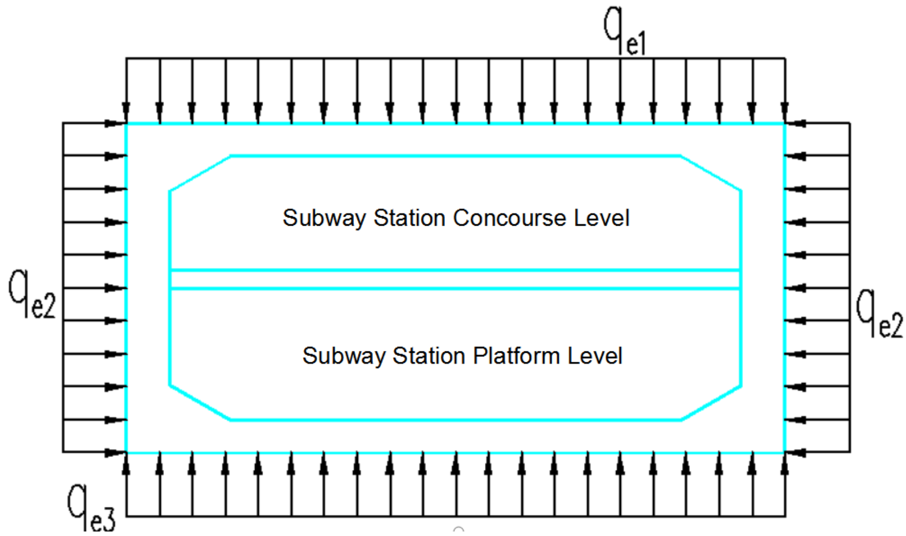


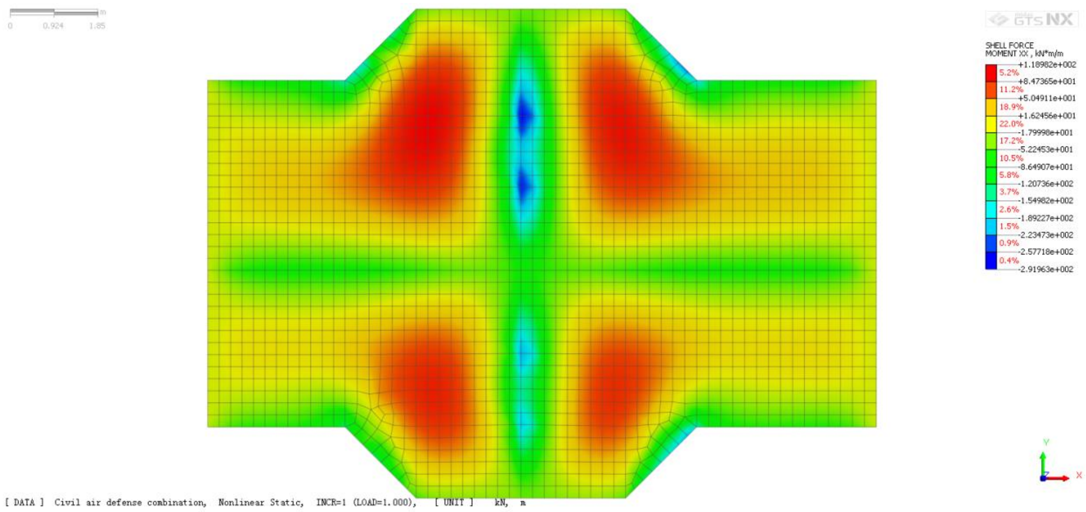
Figure 8. Schematic of Weapon Explosion Load Effects on a Standard Two-Level Subway Station (Cross-Section)

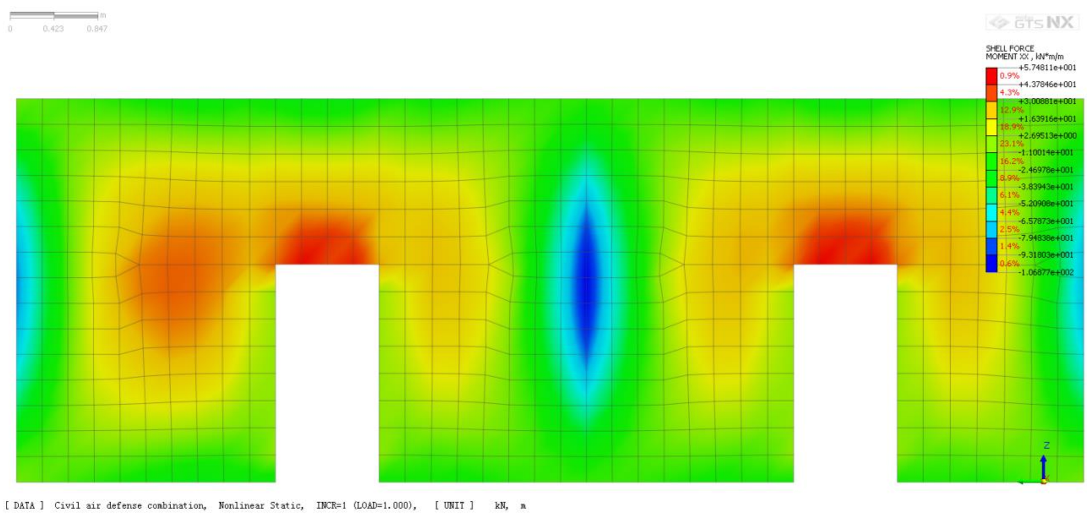
3.6 Stress Analysis of Utility Tunnel Civil Defense Engineering under Nuclear Level 6 and Conventional Level 6 Loads

In balancing protective functionality and construction costs, most civil defense projects do not consider direct hits by conventional weapons. However, since the Gulf War, a trend has emerged of targeting enemy military command capabilities and war potentials directly from the source. Throughout the entire war cycle, air forces aim to precisely destroy key military targets such as enemy radar stations, military airports, ground-based missile launch bases, as well as critical infrastructure like communications, electricity, and water supply.

The structure of underground utility tunnels is analyzed using three-dimensional simulation calculations. The equivalent static load method is employed, and an elastoplastic work stress analysis is conducted based on the degree of freedom system. Under Nuclear Level 6 and Conventional Level 6 load conditions, stress analysis calculations are performed for the roof, side walls, floor, civil defense door frames, and open walls. Following the internal force calculations, reinforcement is adjusted and compared. Under civil defense conditions, the total reinforcement in the underground utility tunnels increases by approximately 1.5-3.0%, with no changes to other engineering quantities, similar to calculations for subway stations.

In the context of modern high-tech warfare, the subway projects serving as wartime transportation channels for personnel and materials, and the utility tunnel civil defense projects acting as urban "lifelines," are increasingly empowered to withstand damage from nuclear and conventional weapons. This capability is becoming a trend due to the critical role these structures play in urban defense and resilience.





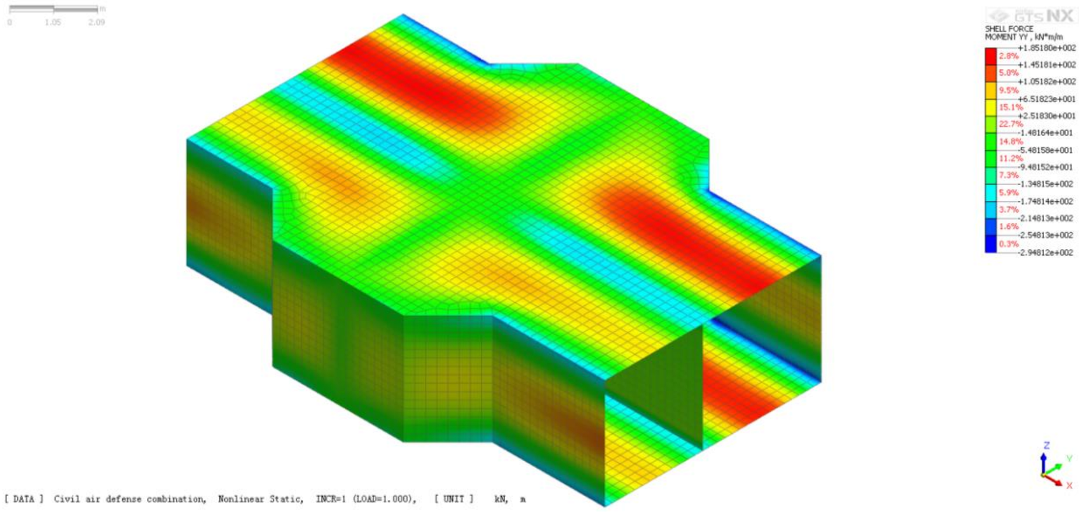


Figure 9. Three-Dimensional Stress Analysis of the Top Slab and Open Walls in an Underground Utility Tunnel

4. Reflections and Suggestions on Domestic Civil Defense Engineering Construction

In accordance with the principle of coordinating with economic construction and integrating with urban development, although recent years have seen some effects from the construction of civil defense engineering in conjunction with subways and Utility tunnels in China, the continuous evolution of warfare methods and intensity under modern war conditions demands increasingly higher civil defense capabilities from all countries. Considering the various issues, difficulties, and bottlenecks encountered in the development and utilization of urban underground spaces domestically, the following suggestions are proposed:

4.1 Accelerate Legislation, Strengthen Legislative Integration, and Reinforce Top-Level Design

Countries like the United States, United Kingdom, Germany, France, and Japan have led in legal research and legislation regarding the development and utilization of urban underground spaces, rail transit projects, utility tunnels (common trenches), and civil defense projects. These countries offer valuable references and insights.

Drawing from the legislative practices of these countries and based on Article 345 of the "Civil Code of the People's Republic of China," it is suggested to integrate the contents related to urban underground spaces from laws such as the "Civil Code of the People's Republic of China," the "Urban and Rural Planning Law of the People's Republic of China," the "Land Management Law of the People's Republic of China," the "Civil Air Defense Law of the People's Republic of China," the "Fire Protection Law of the People's Republic of China," and the "Regulations on the Development and Utilization of Urban Underground Spaces" into a unified, comprehensive, and distinctly Chinese "Urban Underground Space Law."

It is recommended that a national-level specialized urban underground space management department be established, with corresponding departments set up at the provincial and city levels to oversee the entire process of urban underground space development and utilization. Important targets (including vital pipelines) should be managed in a categorized and hierarchical manner, with rational layout and focused protection. Depending on the characteristics of these targets, comprehensive protective measures should be implemented, such as relocating underground, evacuating and transferring, emergency reinforcement, concealment and camouflage, alternative detours, and emergency repairs. These measures aim to achieve systematic protection construction tasks that incorporate key construction, system protection, regional joint defense, and both soft and hard defenses. For projects that affect the basic operational capabilities of cities, it is suggested that during the project approval stage, the service range, the extent of wartime damage, and the difficulty of restoration be used as criteria for approval levels[4].

4.2 Strengthen Research and Update Design Standards Promptly

The pace of weapon technology evolution in modern warfare is rapid, and yet scientific research related to civil defense, as a component of the national defense system, is significantly lagging. Insights from recent conflicts such as the Gulf War, Kosovo War, Syrian War, and the Russia-Ukraine conflict underscore the importance of enhancing research on the damage effects of modern air strike weapons on civil defense structures. Scientific and technological research targeted at civil defense protective systems is fundamental to ensuring that subsequent engineering designs and constructions meet protection efficacy requirements. Many existing standards and norms related to civil defense are outdated and have not been revised to meet modern requirements.

Firstly, government and industry authorities should support research institutions in intensifying relevant studies to produce valuable scientific outcomes, such as the timely update of related standards and norms. Research institutions should also dedicate efforts to study research topics, advancing the development of new protective materials and equipment, and adopting new materials, new processes, and intelligent solutions to significantly address current issues of cumbersome protective equipment and suboptimal protection efficacy.

4.3 Shortcomings in Civil Defense Construction

According to relevant research statistics, China has constructed over 720 million square meters of civil defense structures[6]. Despite the large scale of construction, the overall protection system is not comprehensive. This is reflected in: (1) Civil defense structures being generally scattered, isolated, and not interconnected, lacking a cohesive underground space protection network; (2) An unreasonable ratio of civil defense structure types, with a disproportionate amount of lower-grade civil defense constructions (such as second-class shelters and material storages) and low per capita shelter area standards (according to current design standards, the per capita shelter area is only 1 square meter per person, and for first-class personnel shelters, it is only 1.5 square meters per person)[7]; (3) Key civil defense projects such as civil defense command centers, medical rescue facilities, professional team facilities, and first-class personnel shelters are underrepresented in many cities, with this issue being quite prominent; (4) There are gaps in the construction of specialized civil defense projects like nuclear-biochemical monitoring centers and regional water supply stations.

To strengthen the interconnectivity between subways and other civil defense structures as well as military facilities, it is recommended that subways be considered as key urban civil defense evacuation routes from the planning stage, effectively integrating with surrounding plots along the route. Additionally, provisions for subsequent Transit-Oriented Development (TOD) and related facilities should be considered to maximize the resource functionality of subway station underground spaces, enhance the service quality and operational efficiency of urban rail systems, increase the commercial value around subway stations, and encourage integration with surrounding projects. By interconnecting with civil defense structures along subway routes, a comprehensive and accessible urban underground civil defense network can be formed, enhancing the overall resistance of the urban civil defense system against destruction.

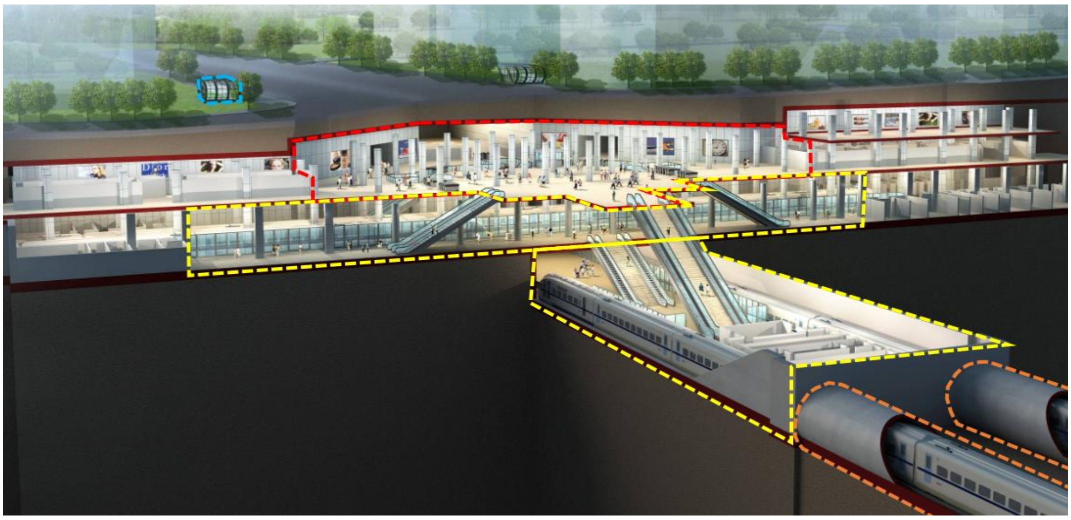


Figure 10. Defense Elements of Subway Stations (Red, Yellow: Wartime Personnel Shelter Areas + Supply Storage Areas; Blue: Wartime Personnel Entrances and Exits; Orange: Wartime Personnel Evacuation Areas + Supply Transit Passages)

4.4 Revision of Peacetime-Wartime Conversion Standards

Civil defense engineering transitions from peacetime to wartime in three stages: early conversion, pre-war conversion, and emergency conversion. China's standards for these conversions have not been updated for decades. The current systems involve numerous components for sealing and protective equipment, and the preparation time is too long, which does not meet the requirements for addressing the suddenness of modern aerial warfare attacks.

"Peacetime-Wartime Conversion Standards" refer to the standards ensuring that civil defense structures complete the procurement of materials and equipment, the processing of components, and the structural reinforcement measures such as sealing external entrances and exits within a specified timeframe before the conflict. This ensures that the civil defense structures are fully functional during wartime.

Figure 11. Rapid Conversion On/Off Protective Equipment for Subway Civil Defense Engineering

For rail transit and utility tunnel civil defense projects, which are distinct from conventional point-based, surface-based, and adjunct civil defense structures, the utility tunnels stretch narrowly under city roads. To accommodate the installation, maintenance, and operational needs of various pipelines, numerous feed inlets, personnel access points, maintenance openings, and ventilation outlets that connect to the outdoors must be established. It is recommended to use remotely controlled intelligent protective devices at these weak points to enhance the timeliness of conversions. Moreover, the volume of pipelines entering and exiting the underground utility tunnels far exceeds that of adjunct civil defense and subway civil defense projects. The difficulty of sealing these pipelines during pre-war conversion is significant; thus, it is advised that pipeline sealing measures be implemented effectively at once to ensure complete protective functionality.

Figure 12. Rapid Conversion Protective Sealing Components for Underground Utility Tunnels

4.5 Urgent Need to Establish and Integrate a Smart Civil Defense Management Platform

The overall goal of smart civil defense construction is to utilize cutting-edge information technology to automate civil defense command communications, program support decision processes, integrate control platforms, and intelligently manage components, thus optimizing resource allocation and integrating forces. This enhances the sharing of information between civil defense and military forces, providing a reliable system platform and information support for city-wide protection. To achieve smart civil defense construction, it is necessary to build a "military-civil fusion, unified management network" smart platform (central control center) to meet the real needs of modern warfare and civil air defense emergency preparedness. The platform should include the following components:

(1) A civil defense data visualization command platform;

(2) An integrated management system for civil defense projects;

(3) An IoT-based operational and maintenance system for civil defense projects;

(4) A civil defense alarm visualization management system;

(5) A wartime population evacuation system;

(6) A dynamic, map-based system for civil defense readiness data.

These initiatives will facilitate a more robust and responsive civil defense framework, enhancing the effectiveness and integration of civil defense capabilities in the face of modern threats.

4.6 Scientific Management, Regular Maintenance, and Classification Assessment of Existing Civil Defense Projects

Since the reform and opening up, due to rapid urban expansion, there has been insufficient emphasis on the maintenance of civil defense structures. Many civil defense facilities built in the last century have deteriorated due to neglect, losing their protective efficacy. Additionally, in some regions, there is a "build but don't manage" approach to civil defense projects, where the lack of post-construction maintenance severely affects their wartime protective efficacy.

Inadequate maintenance of civil defense projects during peacetime, such as unauthorized modifications to structures, damage to civil defense equipment channels, and deterioration of protective equipment and facilities (e.g., corrosion of metal parts, aging of sealing strips), can prevent these systems from effectively blocking shockwaves, toxins, and radioactive materials during wartime. It is crucial to implement and adhere to a maintenance management system for civil defense structures, regularly inspecting and maintaining them to keep them in good operational condition. Effective assessment and management of existing civil defense projects are essential, with targeted reinforcement and renovations based on classifications and assessments to restore their protective functions.

4.7 Strengthening Civil Air Defense Education and Steadily Advancing the Training and Construction of National Defense Mobilization Professional Teams

4.7.1 Education and Regular Drills

Since the self-defense counter-attack against Vietnam in 1979, China has not experienced war, and has been in a long period of peace. Civil defense structures are still crucial for protecting the lives and property of the populace, but there is a lack of education on civil defense, which also leads to a lack of emphasis on the construction of such projects. Current emergency training includes fire drills and earthquake disaster response, but civil air defense exercises are rare, typically limited to annual air raid siren tests on Air Defense Awareness Day.

4.7.2 Training and Building Professional Support Teams

Tailored civil air defense professional team building should be conducted based on the characteristics of different civil defense projects, such as subways,underground utility tunnels, civil defense basements, emergency stations, central hospitals, and supply depots. This will help advance the construction of community and mass civil air defense organizations. Due to the long period of peace, many have forgotten what war is like. While the nation is actively developing civil defense, the public seldom understands the purpose and methods of these constructions. In the event of war, relying solely on a limited number of civil defense professionals to calm and guide the massive populace to effectively take shelter and relocate to nearby civil defense structures is inadequate. Therefore, it is essential to strengthen the public's understanding of civil defense knowledge, integrate civil air defense concepts into the education system and cultural construction, and regularly conduct simulated drills for civil defense sheltering to maintain readiness and master the skills needed for wartime sheltering effectively.

Additionally, establishing and clarifying emergency plans for urban subway civil air defense and organizing pre-war conversion measures for city subways are necessary. A multi-faceted approach is essential to respond effectively to emergencies and to be well-prepared for potential conflicts.

Figure 13. First Domestic Full-Element Rail Transit Engineering Peacetime-Wartime Conversion Drill

5. Conclusion

Based on the discussions and summaries in the preceding sections, this paper innovatively proposes the following viewpoints:

(1) **Specific Pre-Setting for Civil Defense Functions in Subway Stations:** In addition to the conventional categories, protection levels, and chemical protection grades, subway stations (protection units) should have preset civil defense functions based on the actual characteristics of rail transit engineering defense subway stations.

Table 2. Civil Defense Function Settings and Judgment Standards for Subway Stations

No.	Civil Defense Function Station	Judgment Standards	Remarks
1	Wartime Regional Water Supply Station	(1) Subway station depth exceeds 40 meters, conditions allow for a water well; (2) Lowest point of the interval connecting channels exceeds 50 meters, conditions allow for a water well; (3) Distance to municipal water supply main pipeline is less than 300 meters; (4) Distance to a water source (reservoir, lake, water plant, spring, etc.) is less than 500 meters;	In cases where it is not feasible to set up a water well or main pipeline due to special reasons, an underground transportation corridor should be reserved between the subway station and the water source.
2	Wartime Materials Storage Station	(1) Unused space in subway and interval tunnels exceeds 4000 square meters; (2) Within a 500m radius of the station, there is a grain station or food storage base; (3) Within a 500m radius of the station, there are storage bases for clothing and other cold-weather gear; (4) Other emergency or wartime materials bases within a 1000m radius of the station;	If it is not feasible to set up a rail transport passage due to special reasons, a vehicle transport corridor should be reserved during the design phase.
3	High Resistance Station	(1) Shelter area of the station is buried deeper than 30 meters; (2) Station constructed using cut-and-cover method; (3) Overburden thickness exceeds 5 meters;	In the design phase, early involvement is required to preliminarily enhance the station's resistance level.
4	Energy Supply	(1) Distance to storage warehouses for fuel,	If it is not feasible to set up pipelines

	Station	coal, alcohol, etc., is less than 500 meters; (2) Distance to power stations, energy storage facilities is less than 500 meters;	simultaneously due to special reasons, a vehicle transport corridor should be reserved during the design phase.
5	Medical Rescue Station	(1) Distance to a civilian hospital is less than 200 meters; (2) Distance to rescue stations, central hospitals, and other wartime medical units is less than 300 meters; (3) Distance to a pharmaceutical storage base is less than 400 meters;	In cases where it is not feasible to connect directly due to special reasons, transportation and treatment corridors for wartime casualties should be reserved during the design phase.
6	Wartime Transportation Hub Station	(1) Subway station where three or more lines intersect; (2) Stations connected to train stations, airports, port terminals; (3) Stations involved in traffic mobilization by national defense mobilization authorities;	Related to the number of people remaining and evacuating in the urban area, data may be sensitive, thus treated vaguely.
7	Command and Communication Station	(1) Station near government institutions, major media centers; (2) Station near communication base stations, air raid alarm bases; (3) Station near sites requiring national defense mobilization command and communication;	Specific data may be sensitive, thus treated vaguely.

(2) **Calculation of Shelter Capacity at Subway Interchange Stations:** The method for calculating the number of people sheltered in subway interchange stations should consider factors such as station size, depth, and location. Design standards should increase the upper limit of the number of people, with an increment of 500-800 people per station for each additional interchange line.

(3) **Enhanced Protection Levels for Pre-Set Civil Defense Subway Stations and Underground Utility Tunnels:** Subway stations and underground utility tunnels with preset civil defense functions should have their conventional weapon resistance levels upgraded to Level 5 for conventional weapons in critical areas and Level 5 for nuclear weapons.

(4) **Intelligent Protective Equipment for Utility Tunnel Access Points:** Feed inlets, personnel entry/exit points, maintenance accesses, and ventilation openings in underground utility tunnels, which connect to the outdoors, should be equipped with remotely controllable intelligent protective devices to enhance the efficiency of conversion between peacetime and wartime operations.

(5) **Synchronized Sealing Measures for Subway Stations and Utility Tunnels:** The pipeline sealing measures for the entry and exit engineering of subway stations and underground utility tunnels should be implemented simultaneously to reduce the workload of peacetime to wartime conversion and ensure the completeness of protective functions.

These recommendations aim to enhance the effectiveness and readiness of civil defense structures, particularly in urban settings with significant reliance on subway systems and underground utility tunnels. By integrating these advanced standards and practices, cities can better prepare for potential emergencies and conflicts, ensuring a more robust defense posture.

6. Outlook

As the world landscape in 2024 exhibits complex and volatile characteristics, localized conflicts and regional instabilities are reminders that we do not live in an era of peace but in a peaceful country. In conflicts such as the Russia-Ukraine conflict, the Israeli-Palestinian conflict, the Iraq War, the Kosovo War, and the Syrian War, high-tech weapons such as precision-guided missiles, massive ordnance air blasts, and bunker busters were employed. However, reliable civil defense structures provided effective shelter for people and resources, significantly reducing casualties.

High-quality construction and scientific, efficient use of civil defense structures are crucial for responding to sudden wars and preserving wartime potential. The establishment of the National Defense Mobilization Office marks a new phase in the reform of our national defense system. It can effectively enhance the potential for national defense mobilization and strengthen national defense forces. This is necessary for national defense construction, is a critical foundation for maintaining national territorial integrity and economic development, and also brings new thoughts and challenges to the construction of the civil air defense protection system.

Continuing to build and innovate within the framework of civil defense will be essential in preparing for and mitigating the impacts of potential future conflicts, ensuring that civil defense efforts are not only maintained but are also adapted to meet the evolving demands of modern warfare and technological advancements.

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