



# Exploration of Civil Air Defense Basement Structure Design Content and Common Problems

Xiaohan Zhang

Shanghai Underground Space Design and Research Institute Co., Ltd, Shanghai, China.

**How to cite this paper:** Xiaohan Zhang. (2023) Exploration of Civil Air Defense Basement Structure Design Content and Common Problems. *Engineering Advances*, 3(3), 246-249. DOI: 10.26855/ea.2023.06.018

**Received:** May 31, 2023

**Accepted:** June 29, 2023

**Published:** July 27, 2023

\***Corresponding author:** Xiaohan Zhang, Shanghai Underground Space Design and Research Institute Co., Ltd, Shanghai, China.

## Abstract

In recent years, the development momentum of China's construction field is good, and various construction projects are increasing, creating a good living space environment for people. In order to meet the needs of wartime, the construction of civil air defense basement is very necessary. Compared with the general construction engineering projects, the construction requirements of civil air defense basement are higher, in terms of technical application standards are obviously higher than ordinary buildings, especially in structural design has more requirements, in the actual civil air defense basement structure design process, often appear a variety of problems, seriously affect the functional role of civil air defense basement, not conducive to the development of civil air defense engineering. The continuous acceleration of urbanization process has made the development space of urban ground buildings smaller and smaller, underground buildings have begun to be paid attention to underground construction projects must involve basement structures, the safety of basement structures is directly related to the quality and safety of the entire building, and the civil air defense basement structure introduced in this article has higher requirements than ordinary basement building structures. This article analyzes this and puts forward several simple points, which should be seriously solved to ensure the function of the civil air defense basement.

## Keywords

Civil air defense basement, structural design, features, principle, issue

## Introduction

The basement of civil air defense (hereinafter referred to as "civil air defense") is a kind of civil air defense fortification, including external walls, buffer walls, explosion-proof doors, closed walls and protective walls. Civil air defense basement engineering is an indispensable part of construction projects, which can not only be used as temporary bunkers for civil air defense, wartime air defense command centers, communication centers, concealment stations, etc.; It can also meet people's daily life needs, and is an indispensable lifeline project for urban disaster resistance and mitigation. The design of the civil air defense basement plays a very important role in the quality of the entire project construction; If the plan is not qualified, the quality of civil air defense basement construction cannot be discussed. Therefore, this paper studies the design content of civil air defense basement structure, common problems in the design process and their solutions, which is of great significance to strengthen the design of civil air defense basement engineering structure.

## 1. Civil air defense basement structure design features

### 1.1 Complex structural design

Civil air defense basement has higher requirements for quality and structure, as far as the general building structure is concerned, its structural design work also presents complex characteristics, and the civil air defense basement structure

design work is more complicated. The main reason for the situation is due to the functional role of the civil air defense basement, which not only needs to assume the role of general construction projects, but also needs to meet wartime needs, and has certain protection capabilities to withstand stronger shocks and loads. Under normal circumstances, in the structural design of conventional buildings, in the design of the bearing capacity of components, it is only necessary to ensure that the bearing capacity can exceed the maximum load of the building, which can meet the general architectural design requirements. However, this design concept is not applicable in the structural design of civil air defense basements, on this basis, it is also necessary to consider the vibration and load impact generated by various strategic weapons, and the structure of civil air defense basements needs to be stronger and more knotted [1]. The complexity of the design is at a glance.

## 1.2 Structural design criteria for multiplicity

The construction of civil air defense basement is a means of prevention, the current world situation is relatively peaceful, in a long-term state of peace, it is necessary to plan ahead and prepare for wartime, but if the construction of civil air defense basement is only to meet the needs of wartime, it will cause serious waste of resources, especially in the current state of urban space shortage, improving the utilization rate of urban space is of great significance. In order to make the important role of the civil air defense basement fully played, so in the civil air defense basement structure design process, it is necessary to ensure that the civil air defense basement meets multiple standards, in addition to the basic attributes of civil air defense, but also need to have conventional building functions. Based on this, in the need to use superimposed design, carry out civil air defense basement structure design work, such civil air defense basement can meet the current urban development needs, can effectively improve urban space utilization, for the development of the city is of great significance. For example, in terms of space design, it is necessary to analyze the carrying capacity of the civil air defense basement, consider the maximum number of personnel that the civil air defense basement can accommodate in wartime, and also consider the functional role of the civil air defense basement in peacetime. This structural design feature brings great difficulty to the design work, designers need to consider multiple standards, the incidence of design problems has increased significantly, and it needs to attract great attention to design [2].

## 2. Civil air defense basement structure design principles

The structural design of civil air defense basements should follow the following principles, specifically: (1) In the process of carrying out the structural design of civil air defense basements, the characteristics of civil air defense basements should be fully considered for both peacetime and wartime use, and the building design should take into account the principle of meeting daily use and wartime needs at the same time, and meet the difference in load between wartime and daily use, so as to ensure that the civil air defense basement can meet the actual multi-faceted bearing demand standards. (2) Due to the characteristics of the use of civil air defense basements, the structural strength of the building should be considered in the structural design process, that is, adhere to the principle that the structural design meets the strength testing standards. In the design of the civil air defense basement wall structure, the ductility ratio of each component in the building should be determined, and the relationship between the protective sealing demand of the building and the deformation limit should be paid attention to in time. (3) Since the civil air defense basement plays a role in preventing the destruction of nuclear weapons or other conventional weapons during wartime, this requires that the strength design parameters should be used as the benchmark for the force consequences under the strongest damage situation in the design process of the civil air defense basement to ensure that the destructive power of weapons in wartime cannot cause damage to the civil air defense basement. (4) The coordinated processing of the resistance design of various parts in the civil air defense basement building plays a particularly prominent role in the design of the civil air defense basement structure. This requires that in the process of civil air defense basement structure design, the resistance coordination of various components should be dealt with in a timely manner to strengthen the unity of design standards, to prevent problems such as shortening the service life of buildings caused by incongruous design of various components.

## 3. Common problems and solutions to civil air defense basement structure design

Through the above analysis, it can be seen that the design work of the civil air defense basement has the characteristics of complexity and multiple standards, the design is very difficult, the design staff needs to consider the problem in many aspects, and any factors are ignored. It may bring various design problems and affect the functional role of the civil air defense basement. In fact, in the civil air defense basement structure design process, often appear a variety of problems, can also be called design common problems, in order to create a high-quality civil air defense basement, to promote the development of China's civil air defense cause [3]. It is necessary to eliminate the impact of design factors on the civil air defense basement, the design department should focus on a variety of common design problems, plan-

ning and design process, the use of efficient civil air defense basement structure design, to create a qualified civil air defense basement. Common design problems mainly include the following aspects:

### 3.1 Design problems and solutions of anti-collapse scaffolding beam stirrups at the entrance and exit positions

The main role of the civil air defense basement is to meet the needs of wartime, provide people with a safe place, and avoid casualties caused by various weapons of destruction. In the civil air defense basement, the work of the design of the entrance and exit positions is very important, the installation of anti-collapse scaffolding can improve the safety of entrances and exits, avoid the risk of collapse caused by vibration, and is an effective means to improve the safety of civil air defense basements. From the design point of view, the anti-collapse scaffolding roof needs to bear a large load after the construction is completed, of which these loads mainly come from two aspects, first, when the house collapses, various building structures will produce a large load on it, and the way of this load is usually at a vertical angle. Second, the explosive produces a horizontal shock wave at the moment of explosion. In the process of civil air defense basement anti-collapse scaffolding design, many designers do not consider the problem comprehensively, stirrup design has problems, mainly manifested in the spacing design of stirrups, often appear scaffolding beam stirrups between the  $\geq 150\text{mm}$  and stirrup encryption area spacing is greater than 5 times the diameter of longitudinal ribs, this stirrup design has obvious problems, will reduce the function of the anti-collapse scaffolding to bear the load, not conducive to the important functional role of the civil air defense basement. In the design of the anti-collapse scaffold, it is necessary to analyze the rationality of the stirrup spacing, combine the design specifications and actual engineering function requirements, reduce the stirrup spacing, improve the load bearing capacity of the anti-collapse scaffold, ensure that the quality of the civil air defense basement can meet the needs of wartime, and realize the construction of high-quality civil air defense projects [4].

### 3.2 Door frame wall design problems and solutions

As mentioned above, the structural design of the civil air defense basement needs to implement multiple standards, and on the basis of meeting the needs of wartime, the practical function of the civil air defense basement should be increased, and the principle of combining war and peace should be followed to enhance the functional role of civil air defense basements. Based on the analysis of conventional building structure design, the design of the door frame wall usually needs to set up four retaining walls, which are located in 4 directions above and below, on this basis, the stress resistance of the retaining wall is calculated, and then a reasonable structural design is carried out to carry out the reinforcement of the retaining wall. However, from a wartime point of view, the functional role of the retaining wall has been improved, and it is an important defensive component in wartime, in addition to bearing the original load of the building, it also needs to resist external loads, including vibration and shock caused by various explosions [5]. However, in the actual retaining wall design process, many designers have ignored the combined force of the wall, resulting in the bearing capacity of the side wall to the left and right retaining wall bending moment and the top and bottom plate to the upper and lower retaining wall transmission moment bearing capacity is insufficient, can not achieve resistance coordination, the application of this design mode, will seriously weaken the function of the retaining wall, resulting in the important defense ability of the retaining wall can not be effectively played. In order to improve the rationality of the retaining wall design and fully implement the principle of combining war and peace, it is necessary to consider the problem from an overall perspective, and carry out the different design of the four retaining walls according to the different positions of the retaining walls, increase the current synergy, and improve the defense capability of the retaining walls as a whole.

### 3.3 Common problems and solutions in the design of civil air defense basement diffusion room

The diffusion chamber is an important part of the civil air defense basement, which belongs to a very critical content, the purpose of the diffusion room is to meet the needs of wartime wave elimination, explosives will produce a strong shock wave after the explosion. There will be a fatal threat to the personnel in the underground bunker, through the role of the diffusion chamber, the shock wave can be weakened, reduce or eliminate the threat of the shock wave to the personnel in the civil air defense basement, and ensure the safety of people's lives, based on the important role of the diffusion chamber, in the process of designing the structure of the civil air defense basement, we must focus on the design effect of the diffusion chamber, improve its quality, and ensure that the structure of the diffusion chamber can meet the needs of wartime. However, in the actual design link, the design of the diffusion chamber often has various problems [6], the value of the diffusion chamber is unreasonable, and the residual pressure design also has problems, can not meet the actual residual pressure requirements, the equivalent static load of various components of the diffusion chamber lacks comprehensive consideration and analysis, the important functional role of the diffusion chamber is seriously weakened, directly affecting the safety of the civil air defense basement, affected by these problems, the civil air de-

fense basement is difficult to meet the wartime needs. For these problems, the design department needs to pay attention to the strength of the wall between the shaft and the diffusion chamber and the structural components such as the roof, floor and exterior wall in contact with the soil of the diffusion chamber and ensure the comprehensiveness of the problem consideration, especially the load resistance of the diffusion chamber, which needs to be accurately calculated, combined with wartime construction standards, reasonable allocation of steel bars, the use of high-quality diffusion chambers, the elimination of explosion shock waves, and the civil air defense basement to play a miraculous effect in wartime.

#### 4. Conclusion

Civil air defense basement structure design is not a purely functional problem solving, but a very comprehensive design work involving a wide range of content. In order to do a good job in the design of civil air defense basement structure, designers must have a clear concept, be very familiar with atlases, relevant specifications and calculation formulas, and have professional knowledge of system design and relevant design experience, in order to lay a good foundation for civil air defense engineering to play the expected role. In the design process, the common problems in the design should be summarized at all times, and continuously improved and improved in practice, so as to ensure the quality of the civil air defense underground project. Civil air defense basement is a very important civil air defense project, in the civil air defense basement structure design process, must fully combine wartime needs and peacetime functional needs, to ensure that the role of civil air defense basement can be fully played, for the development of civil air defense to make positive contributions.

#### References

- [1] WU Wei. Design of main components of basement civil air defense structure [J]. Research on Urban Construction Theory (Electronic Edition), 2023(11): 91-93. DOI:10.19569/j.cnki.cn119313/tu.202311031.
- [2] Wang Limei. Key points of civil air defense basement structure design [J]. Engineering and Construction, 2021, 35(06): 1166-1167.
- [3] Lv Huiling. Analysis of common problems in civil air defense basement structure design [J]. Popular Standardization, 2020(23): 154-155.
- [4] LIN Yong. Research on civil air defense basement structure design content and countermeasures for common problems [J]. Sichuan Cement, 2022(12):111-113.
- [5] GAO Yuhua. Research on the design strategy of civil air defense engineering combined with wartime under the guidance of demand function [D]. Nanchang University, 2022. DOI:10.27232/d.cnki.gnchu.2022.001634.
- [6] Zhang Xiaohan. Conceptual design of air shock wave resistance for high-rise shear wall structures with attached civil air defense basement structures under nuclear explosion [J]. Engineering Technology Research, 2018(09):225-226. DOI: 10.19537/j.cnki.2096-2789.2018.09.108.