Research on Application Technology of High Performance Concrete in Hospital Building Construction

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Abstract: With the increasing requirements for structural safety and durability in the medical construction industry, high-performance concrete has become the preferred material in hospital building construction because of its excellent performance. Firstly, this paper summarizes the definition of high performance concrete and its importance in medical buildings, then analyzes the application of high performance concrete in hospital infrastructure, structural components and special environment (such as operating room, radiology department), and makes in-depth research on the key technologies such as mixing, transportation, formwork support, formwork removal, pouring and maintenance in the construction process, so as to provide scientific guidance for the application of high performance concrete in medical buildings, so as to improve the engineering quality, prolong the service life and reduce the maintenance cost.
***Keywords*:** hospital building construction,high performance concrete,application of construction technology

1. Introduction

In the field of modern architecture, as a basic building material, the performance of concrete directly affects the quality and service life of buildings. Especially in hospital construction, due to the particularity of hospital buildings, the performance requirements of concrete are more stringent. Because of its excellent mechanical properties, durability and workability, high-performance concrete has become an indispensable key material in hospital construction. This paper will conduct an in-depth exploration of the application technology of high-performance concrete in hospital building construction, analyze its advantages in actual construction and possible technical problems, and propose corresponding solutions.

2. Overview of high-performance concrete

The so-called high-performance concrete is actually a kind of concrete with excellent performance in terms of workability, durability, strength and volume stability. Its characteristics are mainly manifested in several aspects: high strength, high durability, high chemical corrosion resistance and high wear resistance. For example, the compressive strength of this kind of concrete can usually reach more than 80 megapascals (MPa), and even as high as 150MPa in some cases, which far exceeds the strength standard of ordinary concrete. Besides, the durability of high-performance concrete is one of its core advantages, which can effectively resist the influence of harsh environmental factors such as chloride ion penetration, freeze-thaw cycle and so on. The development and application of high-performance concrete is based on the improvement and optimization of the performance deficiency of traditional concrete. Through fine material selection, strict mix design and advanced construction technology, it ensures that the performance indexes of concrete in hospital buildings meet or even exceed the design requirements. The use of this kind of concrete not only improves the overall quality of hospital buildings, but also prolongs its service life and reduces maintenance costs [1].

3. Application of high performance concrete in hospital building construction

3.1 Applications in infrastructure

In the construction of modern hospital infrastructure, the application examples of high-performance concrete are extensive and diverse, especially in supporting large-scale infrastructure, underground engineering and special facilities. For example, when building the foundation of large medical equipment, high-performance concrete can ensure the stable operation and long-term use of these critical equipment due to its excellent high strength, high durability and excellent volumetric stability. In addition, underground parking lots and radiation protection structures in hospitals are also important areas for high-performance concrete applications. This concrete material can effectively block radiation, and at the same time, it has the ability to resist groundwater and chemical erosion. During the construction of a well-known tertiary hospital, specially prepared high-performance concrete was specially used in the underground structure, and its impermeability grade reached

P12, which was two grades higher than that of conventional concrete, thus providing a solid guarantee for the long-term safety of the underground structure. Furthermore, hospital sewage treatment facilities and waste treatment systems also need to rely on high-performance concrete. These facilities are often subject to harsh environmental conditions, where the corrosion resistance and durability of high-performance concrete are fully demonstrated, effectively reducing the cost and impact on hospital operations due to frequent repairs or replacements. In short, the application of high-performance concrete in hospital infrastructure not only improves the quality and life of the project, but also provides a solid material foundation for the efficient and safe operation of the hospital, fully reflecting the role of scientific and technological progress in promoting infrastructure construction.

3.2 Applications in structural members

In hospital buildings, the application strategy of high performance concrete in structural members is particularly important. Since hospital buildings usually contain a large number of critical structures, such as load-bearing walls, floor slabs, columns, and basement waterproofing structures, these all require concrete to have high strength, high durability, and good workability. For example, the use of high-performance concrete can improve the compressive strength of the columns, allowing them to withstand greater loads and ensure the stability of the building. At the same time, due to the particularity of hospitals, areas such as operating rooms and intensive care units have extremely high requirements for the seismic performance of structures. The use of high-performance concrete can effectively improve the structural safety performance of these key areas.

In practical applications, it may be necessary to adjust the mix ratio of concrete and add an appropriate amount of superplasticizer or air entraining agent to improve the rheological properties of concrete and make it easier to pour into structural members with complex shapes. For example, during the construction process of a hospital, high-performance concrete was used, and by optimizing the mix ratio, crack-free construction was successfully achieved in the basement structure, which significantly improved the waterproof performance and structural durability of the basement. In addition, for prestressed concrete members, high-performance concrete can ensure the effective transmission of prestressed tendons and reduce the prestressed loss caused by concrete cracking. In the design stage, the early strength and late strength of concrete should be accurately calculated in combination with the structural analysis model to ensure the quality and efficiency of prestressed construction [2].

3.3 Application in special environments (such as operating room, radiology department)

In the design and construction of hospital buildings, the application of high-performance concrete is particularly important for some special functional areas, such as operating rooms and radiology departments. As the key place for operation and treatment in hospitals, the cleanliness of the operating room is directly related to the success of the operation and the health and safety of patients. Therefore, the compactness and impermeability of high-performance concrete are crucial characteristics for operating rooms. These properties can effectively prevent the growth of bacteria and structural leakage, thus maintaining a sterile environment and avoiding secondary infection to patients due to environmental deterioration. In addition, high-performance concrete also has the advantages of low shrinkage and high durability, which helps to reduce the maintenance requirements due to structural deformation, ensures that the operating room can operate stably for a long time, and provides patients with a safe and reliable treatment environment.

As a hospital department that uses radioactive equipment for diagnosis and treatment, the radiology department puts forward different special requirements for high-performance concrete. Since radiation will be produced during X-ray or gamma-ray examination in radiology departments, concrete materials need to have certain radiation protection properties. By adding appropriate amounts of heavy metal oxides, such as lead oxide, to concrete, the ability of concrete to absorb X-rays and gamma rays can be significantly improved, thus effectively protecting medical personnel and patients from radiation damage. In addition, the equipment in the radiology department is usually heavy, which requires concrete not only to have good bearing capacity, but also to have high compressive strength to ensure stable installation and long-term use of the equipment. These characteristics of high-performance concrete can meet the strict requirements of radiology department for building structures, and ensure the normal operation of medical equipment and the safety of medical personnel.

4. High-performance concrete construction technology

4.1 Special requirements for concrete mixing and transportation

In hospital construction, concrete mixing and transportation are the key links to ensure the quality of high-performance concrete. Due to the extremely high requirements for uniformity and workability of high-performance concrete, mixing

time, mixing sequence, transportation time, and protective measures during transportation all require special attention. For example, the mixing time usually needs to be longer than ordinary concrete to ensure that the various components are well mixed, and it is generally recommended that the mixing time be no less than 180 seconds. At the same time, the principle of "dry-wet-dry-wet" should be followed during the stirring process to ensure the full progress of hydration reaction. During transportation, in order to prevent the initial setting or segregation of concrete, the time from the mixing station to the pouring point should be shortened as much as possible. Generally, it is required that the transportation time should not exceed 120 minutes. Furthermore, transport vehicles should be kept clean to avoid contamination of concrete performance [3].

4.2 Formwork support and formwork removal technology

In hospital building construction, formwork support and formwork removal technology is the key link to ensure the quality of high-performance concrete structure. The choice and support of formwork directly affect the forming quality of concrete, while the determination of formwork removal time is related to the early strength development of concrete. The formwork should have good flatness and stiffness to ensure the smooth finish of the concrete surface and the accuracy of the structural dimensions (such as in some high-standard medical facilities, the requirements for concrete surface flatness may reach millimeter level). At the same time, the convenience and safety of construction should be considered when the formwork is installed. For example, the use of quick-release formwork system can significantly improve the construction efficiency.

In terms of formwork removal technology, it is usually necessary to determine the optimal formwork removal time according to the hardening speed and design strength of concrete. For example, in the case of early strength concrete, the formwork may be safely removed within 24-48 hours after pouring. However, premature formwork removal may lead to damage to concrete structures. Therefore, the construction personnel should decide the formwork removal time according to the environmental conditions on site and the measured strength of concrete. In some special structures (such as prestressed concrete members), the formwork removal process may require the use of specialized tools and equipment to ensure that the prestressed state of the concrete is not damaged. In addition, BIM (Building Information Modeling) technology should be combined for simulation analysis in the process of formwork support and formwork removal, so as to predict possible problems and formulate solutions in advance. Through BIM technology, the installation and disassembly process of formwork can be accurately simulated, reducing rework caused by construction errors, thereby improving construction efficiency and quality.

To sum up, formwork support and formwork removal technology plays a vital role in high-performance concrete construction, and it is necessary to combine advanced construction methods and digital tools to ensure the structural safety and construction efficiency of hospital buildings.

4.3 Concrete pouring and curing technology

Concrete pouring is a key link in building construction, especially for high-performance concrete. During the pouring process, it is necessary to ensure the continuity of concrete and avoid construction joints to ensure the integrity of the structure. For example, in large hospital buildings, it is possible to encounter large areas, large volumes of concrete pouring, which requires precise pouring plans and rigorous construction organization. Maintenance technology is the key to ensure the full play of concrete performance. After initial setting, high-performance concrete should be moisturized and cured immediately to prevent strength decline or cracking caused by excessive evaporation of water. Usually, the curing period should last at least 7 days or even longer, and the specific time needs to be determined according to environmental conditions and concrete type. For example, spraying curing agents, covering moisturizing materials or using steam curing to maintain a wet environment on the concrete surface. In actual operation, temperature monitoring and control is also an important part of the curing process. Too high or too low temperature changes may lead to increased internal stress of concrete and trigger cracks. Therefore, large hospital buildings may need to take thermal insulation measures in winter and cooling treatment in summer to control the temperature rise rate and temperature difference of concrete [4].

In general, concrete pouring and curing technology is the key to realizing the advantages of high-performance concrete, which requires the construction team to have professional knowledge and experience, combined with advanced construction technology and scientific management methods, to ensure the long-term safety and durability of hospital buildings.

5. Conclusion

To sum up, in hospital building construction, the application of high-performance concrete not only improves the durability and safety of the structure, but also shows its unique advantages in meeting special environmental requirements. Through the discussion in this paper, we can see that the application of high-performance concrete in hospital infrastructure,

structural components and special environments such as operating rooms and radiology departments provides more reliable and lasting solutions for hospital buildings. In the future, with the progress of material science and the innovation of construction technology, the application of high-performance concrete in hospital building construction will be more widely used, providing strong support for building a safer and more comfortable medical environment.

References

[1] Gao Shan. Application of high-strength and high-performance concrete in architectural engineering construction [J]. Journal of Liaoning Communications College, 2021, 23 (04): 27-30.

[2] Chi Qigui. High strength and high performance concrete technology [J]. China Residential Facilities, 2021, (05): 99-100+57.

[3] Huang Tianyi. Research on improvement and application of high-performance concrete technology [J]. Housing and Real Estate, 2021, (06): 141-142.

[4] Mi Shaoxuan. Research on the application of high-performance concrete in buildings and bridges [J]. Building Technology Development, 2019, 46 (22): 71-72.