Application of Concrete Pouring Construction Technology in Construction Engineering

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Abstract: In the construction engineering system, concrete pouring construction technology is a core link determining structural safety, stability, and durability. Its application quality is directly related to the overall construction effectiveness of the project. With modern architecture developing towards high-rise, large-span, and complex structures, higher requirements are placed on the precision and standardization of concrete pouring technology. This article analyzes the characteristics of concrete pouring construction technology and proposes specific applications of this technology. It aims to provide technical reference for concrete pouring construction in engineering projects, ensuring the quality of the engineering structure meets standards.

1. Introduction

With the continuous advancement of China's urbanization process, the scale of construction engineering continues to expand. From high-rise residential buildings and commercial complexes to industrial plants and large public facilities, various construction projects have increasingly strict performance requirements for core materials. As a key component of building structures, the application level of concrete pouring construction technology is directly related to project construction quality and structural service life. Currently, the performance requirements for concrete structures in construction engineering are becoming increasingly stringent. Based on this industry status quo, in-depth research on the characteristics and application essentials of concrete pouring construction technology, and sorting out scientific and reasonable construction strategies, are of great practical significance for improving the overall quality of construction engineering and promoting technological upgrading in the construction industry.

2. Characteristics of Concrete Pouring Construction Technology in Construction Engineering

2.1 High Integrity Requirement, Tight Process Connection

Concrete structures are the core load-bearing carriers of the building main body. The integrity of key components such as frame columns, shear walls, and beam slabs directly determines the load-bearing capacity and deformation resistance of the building structure. Based on this characteristic, concrete pouring operations must strictly ensure construction continuity. If pouring is interrupted for a time exceeding the initial setting time of concrete due to sudden equipment failure or insufficient raw material supply, a significant weak layer will form at the interface between the old and new concrete[1]. Even if complex repair methods such as scabbling, rebar planting reinforcement, and setting waterstops are used, it will not only significantly increase construction costs but also make it difficult to fully restore the structure's original mechanical properties. Furthermore, the connection between concrete pouring and the preceding processes of formwork support and rebar tying is particularly tight. The flatness, verticality, and sealing performance of the formwork directly affect the appearance quality and structural accuracy of the concrete after forming. If gaps exist at formwork joints, it can easily cause concrete slurry leakage, leading to quality defects such as honeycombs and pitted surfaces. If the spacing control of rebar installation or the cover thickness does not comply with design specifications, it will directly disrupt the collaborative load-bearing mechanism between steel and concrete, weakening the overall

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load-bearing capacity of the structure. Therefore, before pouring construction, the quality of formwork installation and rebar layout must be strictly accepted. During the pouring process, it is also necessary to monitor in real-time formwork deformation and rebar displacement status to ensure seamless connection of all processes, providing reliable guarantee for structural integrity.

2.2 Strong Environmental Sensitivity, Significantly Affected by External Conditions

The setting and hardening process of concrete is essentially the result of the combined action of physical and chemical changes. This process is extremely sensitive to external environmental factors such as temperature, humidity, and wind. In actual construction, if technical parameters are not adjusted based on environmental conditions, it is very prone to cause various quality problems. From the perspective of temperature impact, when the daily average temperature exceeds 30°C in a high-temperature environment, the water evaporation rate in the concrete mixture will significantly accelerate, not only easily causing excessive loss of slump but also potentially leading to surface drying shrinkage cracks. Moreover, after pouring is completed, if surface water is lost quickly, it will directly cause slow surface strength growth of the concrete, adversely affecting the normal progress of subsequent processes. When the daily average temperature is below 5°C, the hydration reaction rate of concrete will significantly slow down, and the setting time will correspondingly lengthen). If the temperature further drops below 0°C, the water inside the concrete will freeze and expand, thereby damaging the cement paste structure, ultimately leading to a permanent decrease in concrete strength. In severe cases, it can also cause freeze-thaw damage[2]. Additionally, during construction in the rainy season, rainwater can directly dilute the concrete mixture, altering its original water-to-binder ratio, which adversely affects concrete strength; windy weather can accelerate the evaporation of surface moisture from the concrete, significantly increasing the risk of surface cracks. Therefore, during concrete pouring construction, it is necessary to closely monitor weather changes and formulate special contingency plans for different environmental conditions to minimize the interference of environmental factors on pouring quality.

3. Application of Concrete Pouring Construction Technology in Construction Engineering

3.1 Pre-construction Preparation

Pre-construction preparation is the basic link to ensure the quality of concrete pouring. It requires systematic work from three core dimensions: technology, materials, and equipment, to identify and eliminate potential risks in advance, laying a good foundation for subsequent pouring operations. First, technical preparation. The core of technical preparation lies in clarifying construction standards and operating procedures to prevent construction deviations caused by unclear technical disclosures. The construction unit should organize technical personnel to thoroughly study the design drawings, accurately grasp key parameters such as concrete strength grade, impermeability grade, and durability requirements, and compile special construction schemes based on the actual situation of the project[3]. The scheme needs to comprehensively cover the pouring sequence, layer thickness, vibration method, curing measures, and emergency plans. For special construction scenarios, it is also necessary to conduct hydration heat calculation and crack control verification to ensure the scheme is both scientific and feasible. Second, material preparation. Material preparation needs to advance around the principle of qualified quality and stable supply, ensuring the performance of the concrete mixture meets design requirements. The construction enterprise must implement strict inspection of various raw materials: cement requires inspection of relevant qualification certificates and batch testing of its strength and stability; sand and aggregate require testing of indicators such as gradation and mud content, and the particle size must match the structural requirements; admixtures require inspection of product certificates, and their dosage must strictly follow the mix proportion requirements; mixing water must comply with relevant standard specifications. Third, equipment preparation. Equipment preparation needs to ensure that various construction equipment is in good performance and sufficient quantity to meet the needs of pouring operations[4]. For mixing equipment, the enterprise needs to calibrate the metering system, clean the mixing drum, and check the operating status of the motor and transmission system; for transportation equipment, it is necessary to check the tank seal, clean residual concrete inside the tank, reasonably arrange the number of vehicles based on the distance between the mixing plant and the construction site, and set up a retarder adding device if necessary; for pouring and vibration equipment, it is necessary to check its stability, integrity, and applicability, equip enough devices and spare parts, and simultaneously prepare emergency equipment such as generators to avoid pouring interruptions due to equipment failure.

3.2 Pouring Sequence and Layering/Segmentation Control

The arrangement of the concrete pouring sequence and the control of layering and segmentation are key links determining the integrity and compactness of the structure. Targeted pouring schemes need to be formulated based on the structural type and project scale to avoid quality hazards such as cold joints and cracks. In planning the pouring sequence, construction enterprises need to follow the basic principle of "from low to high, from inside to outside, and from primary to secondary components," while also considering the structural stress characteristics and construction operation convenience, ensuring the concrete pouring process is uniform and orderly, and avoiding structural deformation due to stress imbalance[5]. Layered pouring is the core means to ensure concrete compactness. The layer thickness needs to be set reasonably based on the effective action depth of the vibration equipment, avoiding both insufficient vibration due to excessive layer thickness and reduced construction efficiency due to overly thin layers. At the same time, construction personnel must strictly control the interval time between pouring upper and lower layers of concrete, ensuring it is less than the initial setting time of concrete (usually 2-3 hours for ordinary concrete). If the interval time exceeds the initial setting time, it needs to be treated according to the construction joint standard: scabble the surface of the already poured concrete, remove loose stones and surface laitance, water and moisten it, then lay a 10-20mm thick cement mortar of the same mix ratio, before pouring new concrete to ensure tight bonding between old and new concrete. Furthermore, segmented pouring is mainly suitable for large-area and large-volume concrete projects. By reasonably dividing pouring segments, the single pouring volume can be reduced, the risk of hydration heat accumulation can be lowered, and simultaneously facilitating construction equipment scheduling and pouring quality control[6]. When dividing segments, it is necessary to comprehensively consider the initial setting time of concrete and transportation capacity, ensuring that a single pouring segment can be completed before the initial setting of concrete; the structural stress characteristics, segment joints should avoid key stress-bearing parts such as the mid-span of beams and column nodes, preferably set within the 1/3 span range of secondary beams or at door/window openings in shear walls; and temperature stress control. The segment length for large-volume concrete usually does not exceed 20m, and an 800-1000mm wide post-pouring strip needs to be reserved between segments. After the concrete pouring is completed for 28 days (or as required by the design), compensating shrinkage concrete with a strength grade higher than the original structure (mixed with expanding agent) is used for pouring.

3.3 Concrete Vibration Technology

The core goal of concrete vibration is to expel air bubbles from the mixture, promote the dense forming of concrete, and thereby enhance its strength and durability. For different structural types and pouring scenarios, suitable vibration equipment needs to be selected: Internal vibrators are mainly suitable for vertical or massive structures such as beams, columns, walls, and large-volume concrete. Common models include φ30mm, φ50mm, and φ70mm, corresponding to densely reinforced areas, ordinary beam/column pouring, and large-volume concrete construction, respectively. During selection, note that the vibrator head diameter should not exceed 1/3 of the rebar spacing to ensure it can be smoothly inserted into the rebar gaps; Surface vibrators are suitable for flat structures such as floor slabs and ground surfaces. Among them, bidirectional vibrators provide more uniform vibration effects. During use, ensure the vibration plate is in close contact with the concrete surface to avoid vibration failure due to gaps; External vibrators are suitable for thin-walled components and structures where rebar is too dense for internal vibrator insertion. The configuration standard is one unit per 1-2m² of formwork, with vibration frequency controlled at 200-300Hz. Vibration is transmitted to the concrete interior through the formwork to achieve compaction effects[7]. Vibration operation must strictly follow the principles of quick insertion and slow withdrawal, uniform point distribution, and moderate vibration. Simultaneously, during vibration, avoid the vibrator head colliding with rebars, formwork, and embedded parts to prevent rebar displacement, formwork deformation, or embedded part detachment. Furthermore, vibration quality control requires combining process inspection and post-hoc testing: During the process, quality inspectors need to check in real-time the vibration point spacing, vibration time, vibrator insertion depth, and whether rebars or formwork have displaced or deformed due to vibration, adjusting promptly if problems are found. Simultaneously, slump needs to be tested at least once per 100m³ of concrete poured. If the deviation exceeds ±20mm, the mixing plant must be notified immediately for adjustment to prevent insufficient compaction due to too small slump or segregation caused by too large slump. 24 hours after concrete pouring is completed, relevant personnel need to conduct post-hoc testing, focusing on checking whether defects such as honeycombs, pitted surfaces, voids, or cracks exist on the surface: For honeycombs and pitted surfaces, loosely adhered concrete in the defective area needs to be removed, rinsed clean with water, and repaired with cement mortar of the same mix ratio; for voids, loosely adhered concrete with a depth of not less than 100mm needs to be removed, steel mesh implanted, and then repaired by pouring with fine aggregate concrete of one grade higher strength.

3.4 Concrete Pouring Technology for Special Parts

Special parts in construction engineering such as beam-column joints, large-volume concrete, post-pouring strips, and thin-walled components require targeted pouring technical schemes due to their complex structure, high stress requirements, and great construction difficulty. Beam-column joints, as the core stress-bearing area of the frame, have dense reinforcement and narrow space, easily leading to insufficient vibration compaction: First, optimize rebar layout, reserving a pouring channel of not less than 50mm; for rebars with diameter ≥25mm, use mechanical connections to shorten the anchorage length; then use concrete of the same strength grade as the column, with aggregate size of 5-20mm and added pumping agent to improve fluidity; finally, use a φ30mm vibrator for multi-angle vibration, supplemented by external vibrators in extremely dense rebar areas. Large-volume concrete is prone to thermal cracks due to hydration heat, requiring control from multiple dimensions of mix proportion, pouring, and curing. The mix proportion should use low-heat cement, employ sloped layered pouring, and cure for not less than 14 days[8]. Post-pouring strips need standardized setting and pouring. The location should be chosen where stress is relatively small, with a width of 800-1000mm and equipped with a waterstop; settlement post-pouring strips should be poured 28 days after the main structure is topped out; temperature post-pouring strips should be constructed 28 days after the original concrete is poured; before pouring, clean and scabble, moisten for 24h, lay 10-20mm of mortar without coarse aggregate, use compensating shrinkage concrete of one higher grade for dense vibration, and cure for not less than 28 days. Thin-walled components require strengthened formwork and controlled pouring. Formwork should use steel formwork ≥3mm or bamboo plywood ≥18mm, support vertical pole spacing ≤1.2m with cross bracing; concrete should use fine aggregate of 5-15mm, with pumping agent and retarder added, layered pouring thickness of 200-300mm, speed of 0.5-1m/h; use a combination of external and φ30mm internal vibrators for vibration, cure for 14 days and sprinkle water 2-3 times daily.

4. Conclusion

Concrete pouring construction technology, as a core component of the construction engineering system, is a key link determining the overall effectiveness of project construction. Based on clarifying the characteristics of this technology, construction enterprises need to reasonably apply this technology from aspects such as pre-construction preparation, pouring sequence and layered/segmented control, concrete vibration operation, and pouring treatment of special parts, continuously improving the quality of concrete pouring construction. As the construction industry's trend towards intelligence and greening continues to deepen, construction engineering practitioners need to actively adapt to industry technology development trends, continuously learn new technologies and updated specifications, and constantly accumulate experience and optimize skills in practice.

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