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

The urbanization process in China continues to advance, and the scale of construction engineering continues to expand. Whether high-rise residential and commercial buildings, industrial plants, or large public facilities, construction projects have come to demand ever higher performance from core materials. The application level of concrete pouring construction technology is directly related to project construction quality and structural service life, because it is one of the most important components for building structures. In recent years, performance requirements for concrete structures in civil engineering have been gradually strengthened. It is of great practical significance to study the characteristics and application essentials of concrete pouring construction technology based on the existing industry status quo, sort out scientific and reasonable construction strategies, improve the overall quality of construction engineering construction activities, and promote technological upgrading in the field of construction.

2. Characteristics of Concrete Pouring Construction Technology in Construction Engineering

2.1 High Integrity Requirement, Tight Process Connection

Concrete structure is the main load-bearing carrier of the building body. The load-bearing capacity and deformation resistance of the building structure are directly related to the integrity of key components such as frame columns, shear walls, and beam slabs. Concrete pouring operations should make sure strict construction continuity based on this particular characteristic. After sudden equipment failure or due to inadequate raw material supply, if concrete pouring is interrupted for a duration longer than its initial setting time the layer at the interface between the old and new concretes will become significantly weak [1]. The more complex the repair method selected (scabbling, rebar planting reinforcement, waterstop setting, etc.), the less costeffective it becomes, and it will be difficult to return the original mechanical properties of the structure. In addition, pouring concrete has a very strong relationship with the preceding steps of supporting the formwork and tying the rebar. As the quality of concrete after forming is directly influenced by factors like stability, verticality, and leakage performance etc from formwork. When there are gaps between formwork joints it will allow leaking of cement slurry, therefore causing serious quality defects like honeycombs and pitted surfaces. If the spacing control of rebar installation or the thickness of cover does not meet the design specifications, it will directly destroy the collaborative load-bearing mechanism between steel and concrete and reduce the overall load-bearing capacity of joints

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structure. Thus, it is necessary to take strict acceptance of the quality of formwork installation and rebar layout before pouring construction. It is also necessary to achieve the real-time monitoring of formwork deformation and rebar displacement status during the pouring process, in order to ensure that all processes can be connected perfectly, thus giving reliable guarantee for structure reliability.

2.2 Strong Environmental Sensitivity, Significantly Affected by External Conditions

Concrete setting and the hardening process is primarily a physical and chemical reaction. This process is very vulnerable to external environment factors (temp, humidity, wind) When applied into real construction, it is very likely to create new quality problems if technical parameters are not adjusted. Considering the influence of temperature, as long as the daily average temperature exceeds 30°C in a high-temperature environment, the water evaporation rate in concrete mixing will accelerate rapidly and easily result in excessive loss of slump and also produce surface drying shrinkage cracking. Additionally, if surface water evaporates rapidly after pouring is completed, it will lead to slow growth of surface strength of the concrete, which in turn affects the normal conduct of subsequent processes. Whenever the average daily temperatures are lower than 5°C, the hydration reaction rate of concrete will slow down significantly and the setting time will be extended accordingly). When the temperature decreases below 0°C, the water inside of concrete will freeze and upon freezing it will expand that can break cement paste structure which leads to non-reversible reduction in concrete quality. In extreme cases, it will also lead to freeze-thaw damage [2]. In addition, when construction are in the rainy season, raindrops will wash to directly dilute a part of concrete mixture which leads groundwater: cement ratio changes to adverse shorten even damage the concrete strength; Hot and windy weather can make surface moisture evaporate rapid then lead to risks appear like cracks. So, when carrying out concrete pouring construction, it is necessary to closely pay attention to the changes of weather and consider special contingencies according to different environments so as to reduce the overlap 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 a very important link to ensure the quality of concrete pouring. It needs systematic work from three key dimensions: technology, material, and equipment to find and eliminate potential risks in advance, laying a solid foundation for the subsequent pouring operations. First, technical preparation. Technical preparation, in broad strokes, includes clarity on construction standards and enhancements to operational procedures that deter construction deviations based on ambiguous technical disclosures [3]. According to the actual situation of the project, the construction unit should organize technical personnel to study the design drawings carefully, master key parameters such as concrete strength grade, impermeability grade and durability requirements accurately, and compile special construction schemes. It must cover the pouring sequence, layer thickness, method of vibration, curing measures and emergency plans as well. In addition, for special construction conditions, so that whether the scheme reliable is also necessary to do hydration heat calculation and crack control verification. Second, material preparation. The preparation of materials should be promoted according to the principle of qualified quality and stable supply, so that the performance of concrete mixture can meet the design requirements. The construction enterprise should strictly inspect the following raw materials: cement needs to check related qualifications and perform strength and stability test on dissimilar batches; sand and aggregate requires testing of indicators such as gradation, mud content, etc. particle size must correspond with structure requirements; admixture needs to check product certificates, dosage must follow the mix proportion like rule stringently; mixing water Shall comply with relevant standard specifications. Third, equipment preparation. Preparation of equipment: We must ensure that the performance and quantity of all kinds of construction equipment can fully meet the needs of pouring operation [4]. The enterprise should calibrate the metering system, clean the mixing drum, and check the operating status of the motor and transmission system for mixing equipment; implement inspection for tank seal repair (seal drag testing), ship interior cleaning ((level indicator)), reasonable arrangement of vehicle number according to distance between mixing plant and construction site, setting up retarder adding device if necessary for transportation equipment; carry out stability, integrity and applicability of pour vibration equipment Check to ensure that sufficient devices can be equipped with spare parts during pouring process as well as at least 1~2 generator should also be disposed in advance to avoid pouring stops due to unequip failure.

3.2 Pouring Sequence and Layering/Segmentation Control

The order of concrete pouring, together with layering and segmentation control are critical links which determine the integrity and compactness of a structure. To avoid quality hazards such as cold joints and cracks in concrete, the pouring scheme must be targeted according to structure type and project scale. When formulating the pouring sequence, construction enterprises should take "low first and high later, inside first and outside then, primary components priority followed by secondary components" as the basic principle; at the same time consider structural stress characteristics of performance objective design arrangement for construction operation convenience to ensure concrete pouring uniform and orderly avoid locally due to stress imbalanced deformation [5]. Layered pouring is the main way to make sure the compactness of concrete. Formwork layer thickness according to the effective action depth of the vibration equipment to stay out of days, if there is not enough thick fodder failure and impact construction efficiency phenomenon. Meanwhile, construction personnel must control the interval time between upper and lower layer pouring strictly, which shall be less than the initial setting time of concrete (for ordinary concrete is generally 2-3 hours). If the interval time is longer than the initial setting time, it should be treated as per construction joint standard: hammering the surface of the already poured concrete to remove loose stone and surface laitance, then wash and moisture, adding a 10-20mm thick cement mortar of matched proportion, pouring new concrete on top to prevent gap between old and new concrete. In addition, pouring into the segment is primarily applicable to large-area and large-volume concrete projects. The theory to effectively reduce the single pouring volume, avoid hydration heat accumulation, and at the same time help with construction equipment scheduling and pouring quality control by reasonably dividing pouring segments [6]. It should comprehensively consider factors such as the initial setting time of concrete and transportation capacity, so that a pouring segment can be completed before the initial setting of concrete;Structural stress characteristics, segment joints should avoid key stress-bearing parts such as midspan locations of beams and column nodes (in this case, it is preferable to be set within the 1/3 span range of secondary relative structures or at door/window openings in shear walls), and temperature stress control. Typically, each segment-length for large volume concrete does not exceed 20m (800-1000mm wide strip reserved between segments after pouring). 28 days after the pouring of concrete has ended, (or according to design scope) compensating shrinkage concrete shall be poured with expanding agent and strength grade higher than that of original structure.

3.3 Concrete Vibration Technology

The main purpose of concrete vibration is to remove air bubbles from the mixture, facilitate a compact forming of the concrete, and thus increase its strength and durability. Depending on the type of structure and pouring situation, appropriate vibration equipment should be selected:Internal vibrators are mainly applicable to vertical or block structures such as beams, columns, walls and large volume concrete. Common models are φ30mm, φ50mm and φ70mm corresponding to densely reinforced areas, ordinary beam/column pouring and large-volume concrete construction. While choosing the vibrator head diameter works as an important point, for it should not be more than 1/3 of distance between two rebars to be able to smoothly inserted into a gap of rebar; Surface vibrators are used for horizontal structures (like floor slabs and ground surfaces). Of these, special bidirectional vibrators used to generate vibration effects display more uniform performance. Keep the vibration plate close to the concrete surface during use, so that there will be no gaps, resulting in vibration failure; External vibrators are used for vibrating thin-walled components and structures where the rebar density is too high to insert an internal vibrator. Configuration criterion is one unit for 1-2m² formwork, vibration frequency limit at 200-300Hz. The vibration is conveyed out to the concrete inner from formwork for compaction consequences [7]. The operation of vibration shall adhere to the principles of inserting quickly, withdrawing slowly, distributing evenly and vibrating moderately. At the same time, during vibration, prevents vibrator head colliding with rebars, precast concrete parts on site and embedded parts to avoid rebar displacement, deformed formwork or pieces falling off. Second, vibration quality control needs to integrate process inspection and post-hoc testing: In the middle of the order, quality inspectors need to check realtime the spacing of vibration points and time duration, vibrator insertion depth and whether rebars or formwork are displaced or deformed from vibration at any point in time, if problems are found being adjusted immediately. At the same time, slump is to be checked minimum once for every 100m of placed concrete. If it exceeds ±20mm, the mixing plant must be informed immediately for adjustment to avoid insufficient compaction because of too small slump or segregation caused by too large slump. 24 hours after the completion of concrete pouring, relevant personnel are required to carry out post-hoc testing, focusing on checking whether defects such as honeycombs, pitted surfaces, voids, or cracks exist in the surface: For honeycombs and pitted surfaces, loose concrete must be removed in the defective area cleany washed with water then repaired with cement mortar of the same mixture ratio; for voids, loosly adhered concrete must be removed not less than 100mm deep implants steel mesh then repair fine aggregate concrete one grade higher strength with punching.

3.4 Concrete Pouring Technology for Special Parts

The design of structural beams and columns needs targeted pouring technical schemes for parts in the construction engineering with complex structure, high stress indexes, large volume concrete required post-pouring strips thin-walled components require the same. Beam-column joints are the stress concentration area of a frame structure, leading to dense reinforcement and narrow space which is easy to cause insufficient compaction during vibration: first optimize rebar layout, leave about 50mm for pouring, for diameter ≥25mm mechanical connections need to be used in construction, this can greatly shorten the anchorage length of bar ends; then use concrete same as column strength corresponding grade with aggregate size of 5-20mm mixed pumped admixture by great effect on fluidity; finally use 30mm vibrator multi-angle vibration construction plus external vibrators designed installation location needs attention when too dense reinforcement. Hydration heat is a main contributor to thermal cracks in large-scale concrete, which needs control from three aspects of mix proportion, pouring and curing. Cement contentShould use low-heat cement,And sloped layered pouring, being cured for not less than 14 days [8]. Pours need to be standardized as well for post-pour strips. Choose a location where the stress is small, which should be 800-1000mm wide and set waterstop strips; the settlement post-pouring strips shall be poured 28 days after the main structure is topped out; temperature post-pouring strips shall be constructed at least 28 days after the original concrete is poured; before pouring, clean and scabble, moisten it for 24h and lay mortars without coarse aggregate of 10-20mm thick on it and use compensating shrinkage concrete one grade higher with dense vibration. Curing time: not less than 28days. Now if you really want to have a thin-wall component, you need reinforced shuttering and refined pouring. Formwork: Steel Formwork ≥3mm or Bamboo plywood ≥18mm; support vertical pole spacing ≤1.2m + Cross Bracing; Concrete Fine aggregate 5-15mm, pumping agent and retarder in use. Layered pouring thickness of 200-300mm, speed of 0.5-1m/h; Vibration External vibrators +30 mm internal vibrators to do combination vibration+ Bicking method used for mortar+ Cure for 14 days (sprinkling water 2-3 times daily).

4. Conclusion

As the core technology of the construction engineering system, concrete pouring construction technology is a key element determining the overall efficiency of project construction. Through the clarification of this technology characteristics, construction enterprises should reasonably use this technology from pre-construction preparation. Pouring sequence and layered/segmented control, concrete vibration operation and special parts pouring treatment continuously improve the quality of concrete pouring construction. In the continuous deepening trend of intelligence and greening in construction industry, construction engineering practitioners should actively adapt to the development trend of industry technology, constantly learn new technologies and updated specifications in practice, accumulate experience continuously and optimize skills continuously.

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