Exploration of Waterproof and Anti-seepage Construction Technology in Building Engineering Construction

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Abstract: This study examines the waterproofing and anti-seepage construction technologies for four key parts of building engineering: basements, roofs, exterior walls, and bathrooms. It analyzes the operational essentials and applicable scenarios of each technology, and summarizes four application strategies: developing specialized plans according to the specific location, strengthening material acceptance, controlling key nodes, and implementing water ponding tests. The role of the synergy between technology and strategy in preventing engineering leakage is elaborated. The research aims to address the problems of non-standard application of waterproofing technology and frequent potential leakage hazards in building engineering. The results indicate that scientifically selecting waterproofing technologies combined with targeted application strategies can effectively enhance the waterproofing quality of projects, improve the overall level of waterproofing construction in the industry, and promote the development of building engineering towards greater durability and reliability.

1. Introduction

Leakage is a common quality issue in building engineering, affecting not only the building's functionality and service life but also potentially causing structural safety hazards. Currently, within the industry, some projects face problems such as mismatched waterproofing technology selection for specific location needs, inadequate construction control, and lax material quality control, leading to frequent issues like basement water seepage, roof leakage, and exterior wall infiltration. As the requirements for building waterproofing performance continue to increase, there is an urgent need to systematically explore waterproofing and anti-seepage technologies suitable for different locations, as well as application strategies to ensure the implementation of these technologies. Based on this, in-depth research on waterproof and anti-seepage construction technologies and application strategies in building engineering is of significant practical importance for reducing leakage problems and improving building engineering quality.

2. Building Waterproof and Anti-seepage Construction Technology

2.1 Basement Base Slab Sheet Membrane Waterproofing Construction Technology

During the base course preparation stage, after the base slab concrete is poured, use a grinding machine to clean surface laitance and debris; check the flatness of the base course with a 2m straightedge, with deviations needing to be controlled within 3mm; repair base course cracks with epoxy resin mortar, and proceed with subsequent construction only after drying, to avoid voids under the membrane caused by an uneven base course. Apply a base course primer selected to match the membrane, such as a polymer-modified asphalt primer, using a roller for even application with a thickness controlled around 0.5mm; allow it to dry statically for no less than 4 hours (judged by the "finger touch method") to prevent the primer from affecting membrane adhesion if not dry.

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Perform membrane laying using the hot-melt method: unfold and lay the membrane flat on the base course, heat the bottom surface of the membrane with a torch until the surface melts, then slowly roll it forward; the membrane overlap width must reach 100mm, with extra heating at overlap areas to ensure firm bonding; use a roller during laying to expel internal air and avoid voids. Strengthen node treatment: pre-lay a 500mm wide additional membrane layer at internal and external corners, ensuring it is compacted and tightly adhered before large-area membrane laying; at the junction between the base slab and wall slab, the membrane must extend upwards by 300mm and overlap with the wall slab waterproofing membrane to form a continuous waterproofing system, effectively resisting groundwater penetration.

2.2 Roof Polyurethane Coating Waterproofing Construction Technology

Carry out base course pre-treatment: the roof concrete base course must be cleaned, free of dust and oil stains; use a moisture content meter to check the base course moisture content, which must be controlled within 9%; if exceeded, lay a breathable film for ventilation and drying; level depressions in the base course with cement mortar, with flatness deviation not exceeding 3mm, to prevent uneven coating thickness. Apply a primer: choose polyurethane primer material, mix thoroughly according to ratio, and apply evenly on the base course with a brush to a thickness of 1.5mm; allow it to cure statically for generally 4-6 hours; after curing, a uniform film should form on the base course surface without missed spots or exposed substrate. Apply polyurethane coating in layers: after the primer cures, start applying the first coat, controlling the thickness to 0.8mm, using a roller in the sequence of "vertical surfaces first then horizontal, high points first then low"; after the first coat dries, apply the second coat, 1.0mm thick, in a direction perpendicular to the first to ensure even coverage; if the roof waterproofing grade requires it, a third coat can be added, with the total thickness needing to reach over 2.0mm. Perform node enhancement: at nodes like roof gutters, eaves, and pipe penetrations, first lay a fabric reinforcement material, then apply the coating; the fabric must be laid flat without wrinkles, and the coating must completely cover the fabric to form a reinforced waterproof layer, preventing leakage at node locations.

2.3 Waterproofing Technology for Joints in Exterior Wall Prefabricated Components

Prepare the structure: before prefabricated wall panels leave the factory, pre-form tongue-and-groove joints at the joint locations, with a groove depth of 20mm; during installation, adjust verticality to ensure tight butting of the grooves; after installation, clean debris and dust from the joints, blow clean with compressed air to avoid impurities affecting sealing effectiveness. Apply waterstop tape: choose water-expanding waterstop tape, 50mm wide, and apply it to the external groove of the joint; before application, apply adhesive to the groove surface; after applying the tape, press firmly by hand to ensure close contact with the wall panel, without bubbles or edges lifting; the waterstop tape must be placed continuously without breaks, forming the first waterproofing barrier [1]. Inject polyurethane sealant: 24 hours after tape application, begin injecting sealant; choose high-elasticity polyurethane sealant, mix the main agent and curing agent according to ratio before injection, and stir evenly; use a specialized injection gun to inject from one end of the joint to the other; the sealant width must reach 15mm, thickness not less than 10mm; ensure the sealant fills the joint completely without voids during injection; after injection, use a spatula to level the sealant surface flush with the wall panel surface. Conduct quality inspection: after the sealant cures, check if the seal is continuous and full, without cracking or detachment; use a water spray test to check the joint's waterproofing effectiveness, observing the indoor side for any water seepage, ensuring reliable joint waterproofing.

2.4 Bathroom Polymer Cement-Based Waterproof Coating Construction Technology

Perform base course grinding and cleaning: grind the bathroom floor concrete base course with an angle grinder to remove surface protrusions and sharp debris; sweep away dust after grinding; fill gaps around pipe penetrations and floor drains densely with waterproof mortar, grind level after drying to avoid leaks from gaps. Moisten the base course: 1 hour before applying the waterproof coating, spray water onto the base course with a sprayer so the surface is moist but without standing water; moistening enhances the bond between the coating and the base course, preventing coating cracking. Apply the waterproof coating in layers: mix the first coat thoroughly according to ratio, apply with a brush to a thickness of 0.5mm, along the length of the bathroom; after the first coat dries, apply the second coat with the same mix ratio, along the width direction, also 0.5mm thick; the two coats provide cross coverage ensuring no missed spots; the coating must cover the entire bathroom floor and extend up the surrounding walls to a height of no less than 1800mm, connecting with the wall tile waterproof layer [2]. Strengthen node treatment: at floor drains and pipe penetrations, first apply a coat of waterproof coating, then lay a 200mm wide fiberglass mesh for reinforcement; the mesh must be laid flat without wrinkles, then apply another coat of waterproof coating ensuring the mesh is completely covered; the coating at pipe penetrations must extend upwards 100mm, bonding tightly with the pipe surface to form an enhanced waterproof layer at the node, preventing water ingress.

3. Application Strategies for Waterproof and Anti-seepage Construction Technology in Building Engineering

3.1 Develop Specialized Waterproofing Plans According to Location

Conduct location-specific water seepage risk assessment: collect project geological survey reports and building usage functions, analyze seepage risk levels for basements, roofs, exterior walls, and bathrooms separately, categorizing into high, medium, and low-risk areas. Determine key technical parameters: set waterproofing grade as Level I for high-risk areas, requiring two waterproofing barriers; set Level II for medium-risk areas, with one barrier; simultaneously, select materials based on location characteristics, prioritizing cement-based coatings for damp areas and weather-resistant polyurethane coatings for exposed areas. Prepare specialized plans: the plans should specify material types, construction techniques, node treatment methods, and include detailed node drawings [3]. Review and confirm: plans must be jointly reviewed by the technical responsible person and the supervising engineer, focusing on the rationality of the risk assessment and parameter matching; after approval, conduct briefings for construction teams to ensure accurate implementation.

3.2 Strengthen Incoming Inspection of Waterproofing Materials

Preparation stage for inspection: first, establish a material inspection standard manual clarifying testing indicators for different materials: thickness deviation of waterproof membranes must be controlled within 5%, heat resistance must reach no sliding or flowing at 70°C; solid content of waterproof coatings must be no less than 65%, tensile strength no less than 1.8MPa; simultaneously prepare testing tools and contact qualified third-party testing agencies [4]. Appearance check stage: upon material arrival, inspectors check the appearance batch by batch; waterproof membranes must be free of cracks, holes, and damaged edges; waterproof coatings must be free of stratification and sedimentation; measure membrane thickness with a thickness gauge, randomly select 3 rolls per batch, measure 5 points per roll, calculate average deviation, and mark immediately if exceeding 5%. Performance testing stage: sample materials from each batch according to specifications: 1 group per 1000 rolls for membranes, 1 group per 50 tons for coatings; send to third-party agencies for testing key indicators including heat resistance and tensile strength; testing cycle is generally 3 to 5 days [5]. Result determination stage: after test reports are issued, qualified materials are stored in warehouse categorized by specification, and material ledgers are established; for unqualified materials, issue an immediate notice for removal, take photos for evidence, contact suppliers for return or replacement, strictly prohibiting unqualified materials from entering the construction process.

3.3 Enhanced Control of Key Node Waterproofing

Pilot sample stage: before construction, select representative nodes to create pilot samples; sample construction must strictly follow the plan: pipe penetration nodes require added fiberglass mesh reinforcement, width not less than 200mm; exterior wall joints require applied waterstop tape, width not less than 50mm; after sample completion, organize acceptance; the technical responsible person and supervising engineer check the setting of additional layers and sealant filling; after acceptance, use as the construction standard and organize team observation and learning [6]. Standing supervision stage: during node construction, assign dedicated quality inspectors for standing supervision, recording the entire construction process: when laying additional layers at internal/external corners, check if the overlap width reaches 500mm; during sealant application, check if the sealant thickness reaches 10mm and if it is continuous and full; immediately stop and rectify upon finding operational deviations. Process inspection stage: use specialized tools to check quality: manually press pipe penetration nodes to check bonding firmness; use sealant detectors to check the density of joint nodes; inspection frequency is sampling 1 out of every 10 nodes; immediately rework upon finding problems [7]. Acceptance confirmation stage: after all node construction is completed, conduct specialized acceptance; after passing, fill out the node acceptance record form, signed by the standing supervisor and supervising engineer; nodes that fail acceptance cannot proceed to the next process.

3.4 Implement Water Ponding Tests for Waterproofing Engineering

Test preparation stage: before the test, clean the waterproofing layer surface, block drainage outlets, and set up water level observation points; prepare water storage facilities for basements and bathrooms, and water spraying equipment for roofs [8]. Test implementation stage: conduct 24-hour water ponding tests for basements and bathrooms, with water depth not less than 20mm; observe the water level every 2 hours during the test, simultaneously checking the ceiling below and walls for dampness; conduct 2-hour water spray tests for roofs, with spray pipe spacing set at 2m, water pressure controlled at 0.3MPa; during spraying, check roof joints and gutters for water accumulation or leakage. Leakage handling stage: mark leakage points and analyze causes: joint leakage is often due to insufficient sealant, requiring removal of old sealant and refilling to a thickness not less than 10mm; pipe penetration leakage is often due to poor adhesion, requiring removal of old coating, reapplication, and adding fiberglass mesh reinforcement [9]. Re-inspection confirmation stage: after rectification, re-conduct water ponding or spray tests; basements and bathrooms still require 24-hour ponding, roofs require 2-hour spraying, until no leakage; after passing the test, fill out the test record, jointly signed by the construction and supervision units, serving as the basis for waterproofing engineering acceptance.

4. Conclusion

The above analysis shows that waterproof and anti-seepage construction in building engineering requires both "technology adaptation" and "strategy guarantee". Different locations require targeted waterproofing technologies: basement base slabs are suitable for sheet membrane waterproofing, roofs for coating waterproofing, joints in exterior wall prefabricated components require a combination of structural and material waterproofing, and bathrooms are best suited for polymer cement-based waterproof coatings; each technology must strictly follow operational procedures to be effective. Developing specialized plans according to location ensures technology matches needs, strengthening material acceptance controls quality at the source, controlling key nodes eliminates leakage risks, and implementing water ponding tests verifies waterproofing effectiveness. The combination of these forms a complete waterproofing control system, effectively solving the problems of blind technology application and extensive control in traditional waterproofing construction, thereby enhancing the reliability of engineering waterproofing.

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