Discussion on Construction Technologies for Exterior Wall Insulation and Decoration Engineering in Building Construction

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Abstract: To enhance the overall quality and long-term performance of exterior wall insulation and decoration engineering in building construction, this paper investigates the construction technologies and optimization approaches in this field, considering challenges such as difficulties in construction quality control, low efficiency of traditional processes, and insufficient system stability. It elaborates on the operational procedures of three core construction stages: base treatment and interface agent application, insulation board pasting and anchor fixing, as well as decorative surface layer paving and sealing. Additionally, it proposes technical optimization methods from three aspects: the selection of new materials, the optimization of process parameters, and the introduction of real-time monitoring techniques. By systematically sorting out the key technical points at each stage and clarifying suitable solutions for different construction scenarios, common issues in traditional construction such as base hollowing, insufficient adhesion of the insulation layer, and sealing failure of the decorative surface layer are addressed, achieving the goals of improving construction efficiency and enhancing the stability and durability of the insulation and decoration system, thereby providing technical references for similar engineering projects.

1. Introduction

As the building industry continuously raises its requirements for energy conservation, consumption reduction, and aesthetic quality, exterior wall insulation and decoration engineering, as a crucial component of building envelope structures, directly influences the energy-saving effect, usage safety, and aesthetic appeal of buildings. Currently, some projects still encounter problems during construction, such as non-standard base treatment, rough insulation layer pasting processes, and delayed quality control, which can lead to potential hazards like insulation system detachment, wall cracking, and water leakage. These issues not only impair building functionality but also increase post-construction maintenance costs. Against this backdrop, an in-depth exploration of the key construction technology points for exterior wall insulation and decoration engineering, the establishment of scientific operational procedures, and the research into effective technical optimization approaches are of great significance for promoting standardized construction technologies in the industry and ensuring project quality.

2. Construction Technologies for Exterior Wall Insulation and Decoration Engineering in Building Construction

2.1 Base Treatment and Uniform Interface Agent Application

Before construction, a comprehensive inspection of the base wall is necessary, focusing on identifying defects such as hollowing, cracking, and looseness on the wall surface. For protruding parts on concrete or masonry walls, an angle grinder or chisel should be used for grinding or chiseling to ensure that the wall surface flatness deviation does not exceed 4 mm. Regarding holes and gaps on the wall surface, they should be treated following the "cleaning - wetting - filling" process. First, use a brush to remove dust and debris from the holes. Then, wet the base layer, and finally, fill the holes layer by layer with a 1:3 cement mortar, with each layer not exceeding 30 mm

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in thickness. Wait for the previous layer to set before filling the next layer to prevent subsequent insulation layer hollowing due to inadequate filling [1]. After base cleaning, interface treatment is required. The choice of interface agent depends on the material of the base wall. For concrete walls, a cement-based interface agent is preferred, while for aerated concrete block walls, a dedicated polymer interface agent is suitable. Before applying the interface agent, it should be mixed according to the product instructions, with a stirring time of no less than 3 minutes to ensure uniformity without particles. The mixed interface agent should be used within the specified time to prevent failure due to prolonged storage. The interface agent can be applied using a roller or brush, with a controlled thickness generally ranging from 0.5 to 1 mm. During application, ensure uniform coverage of the base surface without missing spots or sagging. For gaps and holes on the base surface, increase the number of application times to ensure adequate penetration of the interface agent [2]. After interface agent application, it should be cured to the specified strength, generally for no less than 24 hours. During the curing period, avoid rain erosion or external force impacts. Only when the interface agent surface is dry and free of powdering can the next construction process be carried out.

2.2 Insulation Board Pasting and Anchor Fixing

The selection of insulation boards should comply with design requirements. Upon arrival at the site, their appearance quality and performance should be inspected to ensure that the board thickness deviation does not exceed ±2 mm, the board surface flatness deviation does not exceed 2 mm, and there are no missing corners or fractures. Before pasting, the insulation boards should be pre-treated. For extruded polystyrene boards (XPS), a roughening treatment should be carried out on the board surface, with a roughening depth controlled between 0.5 and 1 mm to enhance the adhesion between the board and the bonding mortar. For molded polystyrene boards (EPS), dust on the board surface should be removed to ensure cleanliness [3]. The preparation of bonding mortar should strictly follow the product instructions, using mechanical stirring for 5 to 8 minutes. After stirring, let it stand for 3 to 5 minutes and then stir again for a second time to ensure uniformity and workability. The consistency of the bonding mortar should be controlled between 60 and 80 mm to avoid difficulties in application due to excessive consistency or reduced bonding strength due to insufficient consistency. During pasting construction, the dot-frame bonding method or full bonding method can be adopted. The dot-frame bonding method is suitable for walls with good base flatness, with a bonding mortar application area of no less than 40% of the board area, a frame edge width of no less than 50 mm, and intermediate bonding points with a diameter of no less than 100 mm and a spacing of no more than 200 mm. The full bonding method is suitable for exterior walls with a large base flatness deviation or a height exceeding 20 m, ensuring uniform coverage of the bonding mortar on the back of the board without missing bonding areas. When pasting the boards, start from the bottom of the exterior wall and proceed upwards in a horizontal manner. Adjacent boards should be staggered, with a staggered width of no less than 100 mm to avoid forming continuous joints. During board pasting, use a straightedge to check the board surface flatness and adjust the board position to ensure that the board surface flatness deviation does not exceed 2 mm. A gap of 5 to 10 mm should be reserved at board joints for subsequent gap filling [4]. After board pasting and 24 hours of curing, anchor fixing operations can be carried out. The choice of anchors depends on the thickness of the insulation layer and the wall material. For concrete walls, expansion bolt-type anchors are preferred, while for masonry walls, plastic expansion anchors are suitable. The effective anchoring depth of the anchors should meet design requirements, with no less than 50 mm for concrete walls and no less than 60 mm for masonry walls.

2.3 Precise Paving and Sealing Treatment of the Decorative Surface Layer

Before decorative surface layer construction, preliminary preparations should be made, including the selection of decorative materials, re-inspection of base treatment, and line marking and positioning. After the arrival of decorative materials, their appearance quality, dimensional deviation, and performance should be inspected to ensure uniform color, no damage, and compliance with dimensional deviation specifications. For exterior wall tiles, indicators such as

water absorption and frost resistance should be tested to prevent later detachment or efflorescence due to substandard material performance. The re-inspection of base treatment should check the flatness and strength of the anti-crack mortar rendering base layer, with a base flatness deviation of no more than 3 mm and no hollowing or cracking on the surface. If there are defects in the base layer, they should be repaired first [5]. Before construction, according to the layout design of the decorative surface layer, horizontal and vertical control lines should be marked on the base surface. Horizontal control lines should be set at intervals of no more than 500 mm based on the height of the decorative surface layer, and vertical control lines should be set at intervals of no more than 600 mm based on the width of the decorative surface layer. At the same time, control lines for door and window openings, wall corners, and other parts should be marked. When marking the lines, a level and a theodolite should be used for calibration to ensure straight and accurate control lines, providing positioning references for subsequent paving. The paving of the decorative surface layer should select appropriate construction processes according to the material type. For exterior wall tile paving, a dedicated tile adhesive should be used. The adhesive should be mixed according to the product instructions, and after thorough mixing, it should be applied to the base surface or the back of the tiles with a thickness controlled between 3 and 5 mm. During paving, positioning should be carried out according to the control lines, with a gap of 2 to 3 mm reserved between tiles. A rubber mallet should be used to gently tap the tiles during paving to ensure tight adhesion between the tiles and the adhesive. At the same time, a level should be used to check the tile flatness and adjust the tile position to avoid height differences. For stone decorative panels, the dry-hanging method should be adopted for construction. First, install the keel frame, with the material and specifications of the keel meeting design requirements. During installation, ensure that the horizontal and vertical deviations of the keel do not exceed 1 mm/m. After the keel is fixed, install the stone panels, which should be connected to the keel using stainless steel hangers with a hanger spacing of no more than 600 mm. During installation, adjust the panel position to ensure straight panel joints and uniform gaps [6]. After paving the decorative surface layer, sealing treatment should be carried out. Neutral silicone weather-resistant sealant should be selected as the sealing material. Before sealing, dust and debris in the gaps should be removed, and the surfaces on both sides of the gaps should be cleaned with a solvent-free cleaning agent to ensure cleanliness and dryness. During sealant application, a dedicated caulking gun should be used to evenly inject the sealant into the gaps. During injection, ensure that the sealant joints are full and the surface is flat, with the width and thickness of the sealant joints meeting design requirements, generally no less than 5 mm in width and no less than 3 mm in thickness. After sealant application, it should be cured until solidification. During the curing period, avoid rain erosion or external force contact to prevent deformation of the sealant joints.

3. Optimization Approaches for Construction Technologies of Exterior Wall Insulation and Decoration Engineering in Building Construction

3.1 Selection of New Insulation and Decoration Integrated Materials

Material selection should be based on the project's climatic conditions and design requirements. Priority should be given to integrated panels such as inorganic resin board composite insulation core materials and metal-faced sandwich insulation panels, which combine high insulation performance (thermal conductivity ≤ 0.035 W/(m·K)) with strong decorative properties, ensuring a compressive strength of the material of no less than 0.4 MPa and no damage after 25 freeze-thaw cycles in terms of frost resistance [7]. After the materials arrive at the site, special quality verification should be carried out. In addition to routine appearance inspections, samples should be taken to test the thickness deviation of the insulation core material and the adhesion of the decorative layer, and the thermal performance test reports attached by the manufacturer should be checked to avoid using substandard products. According to the characteristics of the integrated materials, the construction adaptation process should be adjusted. For metal-faced integrated panels, installation slots for connecting pieces should be reserved in advance at the panel edges, with a slot depth controlled between 5 and 8 mm and a slot width matching the connecting pieces. For inorganic resin integrated

panels, a dedicated interface treatment agent should be applied to the base interface, with a coating thickness of 0.3 to 0.5 mm.

3.2 Optimization of Process Parameters for Insulation Layer Pasting

The proportion of bonding mortar should break away from traditional fixed ratios and be dynamically adjusted according to the base humidity and ambient temperature. For example, when the ambient temperature is between 15 and 25 °C and the relative humidity is between 60% and 70%, the mass ratio of cement to sand should be maintained at 1:3, and the polymer emulsion dosage should be 8% to 10% of the cement mass. If the temperature is below 10 °C, the emulsion dosage should be increased to 12% to 15%, and an appropriate amount of antifreeze should be added. The stirring time should be extended to 8 to 10 minutes to ensure the workability and bonding strength of the mortar [8]. The pasting pressure parameters should be optimized. A dedicated pressure roller should be used instead of manual pressing, with a pressure roller diameter of 80 to 100 mm and an applied pressure controlled between 0.2 and 0.3 MPa. The roller should be rolled horizontally along the board 2 to 3 times at a constant speed to achieve a bonding mortar fullness of over 95% and avoid hollowing due to uneven pressure. The curing condition parameters should be clarified. After pasting, the curing time should be determined according to the ambient temperature and humidity. When the temperature is between 20 and 25 °C, curing for 24 hours is sufficient. When the temperature is below 5 °C, measures such as covering with thermal insulation quilts should be taken, and the curing time should be extended to 48 hours. During the curing period, ensure that the ambient humidity is no less than 60%.

3.3 Introduction of Real-time Monitoring Techniques for Construction Quality

In the base treatment stage, flatness monitoring points should be arranged at a density of one point per 50 m2. A high-precision laser leveling instrument (measurement accuracy ±0.1 mm/m) should be used to collect real-time flatness data of the base layer. If a local deviation exceeding 3 mm is detected, it should be immediately marked and ground to avoid the accumulation of deviations affecting subsequent processes [9]. During the insulation layer pasting process, bonding force real-time monitoring equipment should be used. Randomly select 3 boards from each batch of pasted insulation boards and install tensile sensors at the center and four corners of the boards. The sensor range should be 0 to 5 kN with an accuracy of 0.01 kN to monitor the bonding force changes at 1 hour, 6 hours, and 24 hours after pasting in real time. If the monitored value is below 0.15 MPa, the reasons should be immediately analyzed and rectified. In the anti-crack mortar rendering stage, humidity monitors should be introduced. Bury monitoring probes 2 to 3 mm into the mortar layer, with one probe set per 10 m2, to monitor the internal humidity of the mortar during curing in real time, ensuring that the humidity is maintained between 70% and 80%.

4. Conclusion

The above research indicates that ensuring the construction quality of exterior wall insulation and decoration engineering in building construction relies on refined operations and technical optimizations at each stage. Base treatment should strictly follow the defect identification and repair process, and interface agent application should match the base material and control uniformity to lay a solid foundation for subsequent construction. Insulation board pasting should focus on material pre-treatment and process parameter control, and anchor fixing should be reasonably arranged according to the wall material and height to ensure the bonding strength and overall stability of the insulation layer. Decorative surface layer paving should strengthen preliminary positioning and later sealing treatment to ensure appearance effects and waterproof performance. The selection of insulation and decoration integrated materials can simplify the construction process and reduce process connection problems. Dynamically adjusting the process parameters of insulation layer pasting can adapt to different environmental conditions and solve problems such as mortar cracking and insufficient bonding force. The introduction of real-time monitoring techniques can enable early detection and rectification of quality problems, avoiding the limitations of

post-event remediation.

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