

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 gradually improves the energy-saving, consumption reduction and aesthetic quality index that must be achieved, the external wall insulation and decoration engineering as an important part of the construction envelope structure will directly affect every aspect of buildings, such as energy saving effect, utilization safety and appearance. At present, some projects still have some construction problems, such as non-standard base treatment, rough insulation layer pasting process and delayed quality control, which will cause the insulation system to fall off, crack in walls and water leakage. Not only does this hinder the usability of buildings, but it also increases maintenance post construction. To that end, a thorough study of the major construction technology points for external wall insulation and decoration engineering may provide an essential foundation for the implementation of scientific operational procedures and relevant research into effective technical optimization methods to promote standardized construction technologies in the construction sector while also 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

You need to do a full detection of the wall base before starting construction, in which you have to check for various defects such as hollowing, cracking and looseness of the wall surface. For the protruding part on concrete, masonry wall after grinding or chisel work, the flatness deviation of the surface should not exceed 4 mm. As for the holes and gaps on the wall surface, these are treated by "cleaning - wetting - filling". Step 1: Brush the holes to remove dust and debris. Line up a brush with nylon bristles horizontally. Then, moisten the base layer; In the final step, stubble holes layer by layer with 1:3 cement mortar not exceeding 30 mm in thickness. Filled the subsequent layer to

prevent the hollowing of the insulation layer caused by insufficient filling in waiting for putting a previous layer ^[1]. After cleaning up the base treatment for interface is required. If the base wall is made of concrete, the interface agent can be a liquid (liquid exchanger), which enhances material properties by providing lubrication during stabilization. For concrete walls, cement based interface agent is more effective and for aerated concrete block walls polymer dedicated interface agent is better match. Mix The interface agent (according to the product instructions), stirring time shall not be less than 3 minutes, and there should be no particles. Mixed interface agent is strictly limited to be used within specified time, otherwise it will fail. The interface agent using a controlled thickness (normally 0.5 to 1 mm) is applied with a roller or brush. In application, cover the base surface evenly without missing spots or sagging. For the application of gaps and holes on the base surface (difficult features) increase number of applications so that there is an adequate penetration in both surfaces for interface agent ^[2]. In summary, it is a special resin to be cured through interface agent application for at least 24 hours at certain strength, Do not allow rainfall erosion or external force impact in the curing period. The next construction step can then be carried out, when the surface of the interface agent is dry and it has no powdering.

2.2 Insulation Board Pasting and Anchor Fixing

The types of insulation boards must be used according to design requirements. When arriving at the site, check whether the finished appearance quality and performance have met the standard; thickness deviation of less than ± 2 mm, surface flatness deviation 2 mm, no missing corners or fractures. Insulation boards should be pre-treated before pasting For extruded polystyrene boards (XPS), the surface of the board should be roughened and the roughening depth is controlled to be between 0.5 and 1 mm to improve the bonding strength between the board and bonding mortar. Only Clean board surface: In the case of molded polystyrene boards (EPS), dust from the board surface should be removed ^[3]. The preparation of bonding mortar is required to follow strictly according to the instructions on the product, using mechanical stirring for 5-8 minutes. Allow to stand for 3-5 minutes before stirring again a second time, checking that it is homogenous and workable. Ensure the consistency of bonding mortar is controlled at 60~80 mm, as excessive or insufficient consistency should not be failed. In pasting construction, dot-frame bonding mode or full bonding mode can be used. Dot-frame bonding is suitable for walls with good base flatness, the application area of adhesive mortar not less than 40% of the board area, frame edge holds a width no less than 50 mm and intermediate bonding points (diameter 100mm, spacing 200mm) securely formed. The full bonding method applies to exterior walls with a large base flatness deviation or height more than 20 m, making sure that the bonding mortar on the back of the board is completely uniformed and there are no missing areas. Paste the bottom of the exterior wall with boards to the top in a horizontal way. Boards should be staggered on adjacent boards, with at least a 100 mm staggered width to do not form continuous joints Fix the board within 2 mm of flatness by using a straightedge to test the board surface during paste. It is suggested that 5 to 10 mm of gap should be left in-between board joints, for later filling of the gap ^[4]. Anchor fixing operations can be performed after a board pasting and 24 hours cure. The type of anchors is selected according to the insulation layer thickness and wall material. For walls in concrete, expansion bolt type anchors are most commonly utilized with plastic expansion anchors being best for masonry walls. The anchoring depth of the anchors should conform to design requirements and shall not be less than 50 mm for concrete walls and 60 mm for masonry walls.

2.3 Precise Paving and Sealing Treatment of the Decorative Surface Layer

Early construction: decorative surface layer needs to adjust the decorative material, retesting of base treatment, line marking and positioning before. However, after the decorative material arrives, their appearance quality, dimensional deviation and performance should be checked to verify whether it is uniform in color with no damage to the surface layer or not exceeding the dimensional deviation specification. If exterior wall tiles are used, water absorption and frost resistance must also be tested; otherwise, materials with performance below the standard may fall off or free up stones in the future. Re-inspection of base treatment: to check the flatness and strength of anti-crack

mortar rendering base layer, base flatness deviation can not be greater than 3 mm, there shall be no hollowing and cracking on the surface. First of all, the base layer must not contain blemishes [5]. Before constructing, the base surface should be marked with horizontal and vertical control lines by the layout design of the decorative surface layer. If the height of the decorative surface layer is 500 mm, horizontal control lines should be set with a maximum spacing of 500 mm; if it is > 500 mm, its corresponding value should not exceed 600 mm according to the width of the decorative surface layer. Mark the control lines for door and window openings, wall corners and other parts at the same time. While marking the lines, it should be calibrated with the level and a theodolite, because if you mark straight control lines then there will be positioning references for paving later on. The paving decorative surface layer should choose the reasonable construction process based on material. Use Professional China Exterior Wall Tile Paving Factory For exterior wall tile paving, a special outer wall tile adhesive should be selected. Mix the adhesive and apply to the base surface (or back of tiles) in a thickness ranging from 3 up to 5 mm after thoroughly mixing the adhesive according to manufacturer guidelines. While paving, positioning is done as per the control lines and 2 to 3 mm gap is left between tiles. You may choose to use a rubber mallet, which is better for tapping the tiles while paving so that they can bond well with the adhesive. Simultaneously, a level should be applied to verify the tile flatness and correct the position of tiles in order to eliminate height differences. The dry-hanging method is required for stone decorative panels when constructing. Install keel, the use of material and specification meets the design requirements. Ensure that the horizontal and vertical deviations of keel during installation are less than 1 mm/m, when the keel is fixed, stone panels must be installed, and hangers will connect them with the keel as shown in figure 21 using stainless steel hangers with no more than 600 mm hanger spacing. In the course of installation panel position is also adjusted to get straight panel joints and gaps that are not uneven [6]. Spray sealing treatment afterwards through decorative surface layer obvious wear. The sealants you need to choose for the sealing material should be neutral silicone weather resistant sealant. Dust and debris in the gaps should be removed before sealing, while on both sides of the gap cleaned with a solvent-free cleaning agent as well as clean and dry. A special caulking gun needs to be used during sealant installation for a gap-free injection of the sealant. Ensuring that the sealant joints are full and flat at the time of injection, compliance with design requirements for width and thickness of sealant joints, generally not less than 5mm in width and not to be less than 3 mm in thickness. Sealant is then applied and allowed to cure until hardened. Do not have rain scouring or external force effect on sealant joints in the curing period.

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

Selection of the material depends on climatic condition and design requirement of a project. Newly-developed integrated panels such as inorganic resin board composite insulation core materials and metal-faced sandwich insulation panels are prioritized; these products possess high thermal performance (thermal conductivity $\leq 0.035 \text{ W}/(\text{m} \cdot \text{K})$), as well as strong decorative properties where no material was less than 0.4 MPa compressive strength, and the passing criterion for frost resistance is that the number of freeze-thaw cycles should be higher than 25 [7]. Special quality verification should be conducted after the materials arrive at site. In addition to regular appearance boring inspection, the sample should be taken and tested on the thickness deviation of the insulation core material as well as pulling off of decorative layer etc., check for thermal performance test reports attached by manufacturer in order to avoid use of inferior goods. The construction adaptation process should be modified according to the properties of the composite components under investigation. If the integrated panels are with metal-faced surface, reservation for installation slots for connecting pieces shall be pre-designed beforehand on both panel edges, while the depth of slot shall completely be controlled between 5 mm and 8 mm, and width should match with those of corresponding connecting pieces. Dedicated interface treatment agent is applied to the base

interface of inorganic resin integrated panels; The coating thickness is 0.3~0.5 mm.

3.2 Optimization of Process Parameters for Insulation Layer Pasting

The bonding mortar ratio should no longer be a fixed value, which must be adjusted dynamically according to the humidity of the base and the ambient temperature. As seen in studies above, when ambient temperature is 15-25 °C, relative humidity is 60%-70%, the mass ratio of cement to sand should be keep at level of 1:3 and polymer emulsion dosages provide to be about 8%-10% of the cement mass. When the temperature is lower than 10 °C, it is necessary to increase the proportion of emulsion to 12% to 15% and add proper type antifreeze. It was recommended to extend the stirring time for 8–10 min in order to obtain the workability and bonding strength of mortar [8]. Parameter optimization of pasting pressure. A dedicated pressure roller is used in place of manual pressing, with a roller diameter of 80 to 100 mm and applied pressure between 0.2 and 0.3 MPa. Roll the roller on the board 2-3 times at a steady speed to make sure the bonding mortar fullness is over 95 %, and do not cause hollowing because of uneven pressure. Also, the parameters of curing conditions should be explained. Determination of curing time after paste according to ambient temperature and humidity. 24 hours for curing required when the temperature keeps in 20 – 25 °C. When the temperature drops below 5 °C, it is necessary to cover with thermal insulation quilts and extend the curing time of 48 hours. Be sure to keep ambient humidity no lower than 60% from the age of your curing time.

3.3 Introduction of Real-time Monitoring Techniques for Construction Quality

In the base treatment process, flatness monitoring points should be arranged appropriately with a density of one point per 50 m². The flatness data of the base layer should be measured in real-time using a high-precision laser leveling instrument (measurement accuracy ± 0.1 mm/m). If a local deviation larger than 3 mm is detected, it should be immediately flagged and grinded so that the accumulation of deviations does not affect downstream processes [9]. Real-time monitoring equipment for bonding force shall be adopted in the insulation layer pasting process. For this, we take 3 randomly selected boards from each batch of pasted insulation boards and use tensile sensors at the center and four corners on the board. The sensor range is 0-5 kN/ with an accuracy of 0.01 kN, which can be used to monitor the change in bonding force in real time within 1 h, 6 h and 24 h after pasting. If the monitored value is below 0.15 MPa, to analyze the causes and take proper corrective measures immediately. Humidity monitors should be incorporated in the anti-crack mortar rendering stage. If required, bury monitoring probes 2 to 3 mm into the mortar layer (one probe /10 m²), and according to monitor the internal humidity of the mortar in real-time ensuring that during curing the humidity be held between 70~80%.

4. Conclusion

The above research shows that the quality control of exterior wall insulation and decoration engineering construction in building construction process needs refining operation and technical optimization at each stage. Base treatment must strictly follow defect identification + repair process, wherein interface agents can be used that are appropriate to the base material and that will control evenness which sets up successive construction. The pasting of the insulation board is should be pre-treated and process parameters controlled, the arrangement of mechanical anchor fixing can reasonably arrange according to the wall material and height, so as to ensure its bonding strength, thus ensuring that: The stability of each layer is even higher. The paving of decorative surface layer should reinforce the guiding base and later sealing treatment to meet appearance effects with waterproof. The integrated materials for insulation and decoration can simplify the construction process. Dynamically adjusting on Insulation Layer Pasting process parameters, can adapt to different environment, it will solve the problems of mortar cracking、the insufficiency of bonding force. Recent advancements in real-time monitoring methods can help to alert any issues and address quality problems before, which otherwise will be remedied only after an event.

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