Research on Roof Waterproofing Construction Technology and Quality Control in Construction Engineering

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Keywords: roof waterproofing; construction technology; quality control; whole-lifecycle man agement

Abstract: Roof leakage is a common quality problem in construction engineering projects that has plagued construction projects for a long time. Such a situation is not only detrimental to the functionality and structural integrity of the structure but also escalates post-construction maintenance costs. The research object of this paper is the roof waterproofing construction in construction engineering. Systematic analysis of the characteristics and application scenarios of roof waterproofing construction technology is carried out according to the Technical Code for Roof Engineering (GB 50345-2012), and it proposes in detail the key process and technical points of roof waterproofing construction in construction engineering, as well as multi-dimensional quality control measures. We hope to offer practical references that help solve roof leakage problems and improve the service life of waterproof works, so as to facilitate the quality improvement of construction engineering.

1. Introduction

The roof is a predominant enclosing structure within the construction engineering field and serves to protect against external environmental influences like rainwater, snow loads, and ultraviolet radiation during both its construction and operational life. Waterproofing performance is the fundamental object to ensure the roof service. With the development of construction technology, in recent years, due to the diversification of building forms and diversifying climatic conditions, roof leakage problems frequently. This results not only in damage to interior decoration and equipment failure, but may also cause structural safety hazards such as steel bar corrosion and concrete carbonation, which seriously affect the service life of buildings and the comfort of occupants. Hence, the research on roof waterproof construction technologies and quality control in construction engineering has a significant effect on promoting the overall improvement of roof waterproof project quality.

2. Characteristics and Applicable Scenarios of Roof Waterproofing Construction Technologies

2.1 Characteristics of Roof Waterproofing Construction Technologies

For roof waterproofing construction technologies, the various material properties, construction adaptability, and in-service stability characteristics can vastly differ depending on these technology types.

The rolled sheet waterproofing technology has advantages in core mechanical properties and durability. The materials have great tensile and deformation resistance, allowing them to respond to structural stresses arising from changes in the roof environment. Flexible laying can also be gained in construction practice, though hard standardised process compliance must be used. Nevertheless, this technology has relatively demanding requirements for the flatness of the base layer. A smooth base surface is crucial to achieving good bonding effects.

The integrity and flexibility of coating waterproofing technology. When the coating executed, it could create a seamless waterproof membrane. It calls for huge adaptability and works great as an elaborate base layer. The construction tools are straightforward and easy to use as there is no need

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of elaborate cutting processes involved. However, this technology is heavily affected by the environment. Temperature and humidity have a direct effect on the film-forming property and drying speed of industrial paint, so construction must be carried out under appropriate environmental conditions.

Among these, rigid waterproofing technology is known for its durability and affordability. The materials serve both structural load-bearing and waterproofing roles, adhering tightly to the foundation layer. With easily obtainable and affordable raw materials, the construction process flows naturally with existing building structure methods without requiring specialized professional equipment. On the other hand, rigid materials are naturally brittle with poor deformability. They are susceptible to cracking due to temperature variations or structural fluctuations and hence need the auxiliary usage of pliable substances.

Composite waterproofing technology is only characterized by complementary advantages, high reliability. It achieves a multilayered protect system by combining different kinds of waterproofing technologies, which integrates the advantages of several techniques. These waterproofing layers include two or more making sure the overall waterproofing effect could still be maintained in case one of many fails. The construction process of this technology is more complicated, and the compatibility between different materials and the quality of connection between various processes must be strictly controlled, so the construction period is relatively longer.

2.2 Applicable Scenarios of Roof Waterproofing Construction Technologies

Identification of roof waterproofing construction technologies should be made under conditions analysis of functional requirements for buildings (structures), environmental conditions, and cost budgets.

Rolled sheet waterproofing technology is applicable to high demand of waterproof durability and construction efficiency roof, especially the large-area roof with regular base layers shape. Long exposure of its deformed resistance can achieve long-term stable waterproof construction in regions with large temperature difference. Attention should also be given to roofs which require certain external loads.

For roofs with complex shapes of base layers and lots of node structures, coating waterproofing technology is more applicable. Through the application of coating, it can cover special structural parts flexibly, avoiding weak waterproofing points at nodes. This campus roof technology can reduce construction costs and simplify the process for roofs with small construction areas or those in need of localized waterproofing rehabilitation. In wet surroundings, the adhesion and waterproof qualities of several sorts of coatings materials are additionally very good.

The rigid waterproofing technology is suitable for situations where there are requirements for the strength of the waterproof layer, a limited budget and relatively stable roof environment. It can act as a protective shield for the roof structural or waterproof layer. It can obtain some basic waterproofing functions at a low cost in areas where leakage risk is not high, and it is also suitable for projects that have great integration with traditional construction processes.

Composite waterproofing technology mainly applies to roofs that have high-demand requirements for waterproof reliability. Where waterproofing grades are stringent and the environment is harsh, a multi-layered protective system can provide even greater waterproofing safety. It suggests stable overall functionality through the synthesis of technologies, so it is also applicable for roofs that need to meet multiple functional requirements [1].

3. Key Processes and Technical Points of Roof Waterproofing Construction in Construction Engineering

3.1 Key Processes of Roof Waterproofing Construction in Construction Engineering

This work can be divided into five stages of construction: "pre-construction preparation - base layer treatment - core waterproofing construction - protective layer construction - acceptance inspection", where each phase is interrelated and inseparable.

The pre-construction preparation stage is primarily concerned with materials and conditions for construction. This includes performing quality checks on waterproofing materials during the work process to make sure that their performance adheres to design requirements. At the same time, it is necessary to clean up the construction area, prepare tools and equipment, draw up a detailed construction plan to clarify the standard of operation and personnel arrangement in each stage.

Base layer treatment is one of the important practices used for waterproofing construction. The surface has to be cleaned as much debris so that there is no contamination. The base layer must be repaired to a flat, solid, dry layer before building the waterproof layer. Poor base layer treatment can directly contribute to application incompatibility between a waterproofing layer and base layer (due to lack of bonding) leading to leakage problems post-construction.

The core waterproofing construction is the main process that determines the waterproofing effect. The construction processes for waterproofing should be performed step by step and according to the types of waterproofing technology being selected (rolled sheet, coating, rigid or composite waterproofing type), so that laying or coating the waterproof layer should always be done uniformly and completely. In particular, focus on the connection treatment between parts to prevent problems such as missed laying, missed coating, or loose connections and ensure the integrity and tightness of the waterproof layer.

The outer protective layer construction is designed to protect the waterproof layer from exterior damage. This should be done immediately after waterproof layer is finished and accepted. Based on the usage requirements of the roof, select appropriate protective layer materials, and lay/pour them as required by the standards to ensure that the bonding between protective layer and waterproof layer is solid. And, it should also have certain strength and durability to improve the service life of waterproof layer.

Acceptance and inspection are the last stage of waterproofing construction. It is necessary to inspect the overall waterproofing project, pay attention to whether the waterproof layer is qualified and whether the quality of protective layer construction meets the requirements. Waterproofing effects also need to be validated from closed water test methods. Issues identified must be rectified immediately until the project passes the acceptance, which means that roof waterproofing project is designed to regulation [2].

3.2 Technical Points of Roof Waterproofing Construction in Construction Engineering

The technical points of roof waterproofing construction should be detailed implementation throughout the whole process, according to the provisions of material control and specific operation details.

When selecting materials, the quality and performance of them shall be checked again to confirm that they conform to construction requirements before use. In addition, the compatibility of different materials can not be ignored, otherwise it will cause due to material compatibility problems and affect waterproofing effect.

The technical points of base layer treatment lie at keeping the exact base layer state. It is important to verify if both typical standards of dryness as well as flatness are fulfilled by using professional methods on the base layer. As for flaws like cracks on the base layer, suitable repair materials and processes ought to be used to guarantee that there is a seamless connection between the repaired part and also adjacent locations without any pattern or visible gaps in height. On the other hand, clean up the base layer surface thoroughly, remove grease stains, floating dust and other substances that will affect bonding.

The technical points of core waterproofing construction are different according to the technology type, but they all need strict observance for operational norms. When laying rolled sheet waterproofing, it is important to control the force and speed, ensuring that they are flat in use and that lap joints should be treated according to specifications. In the case of coating waterproofing, it is necessary to control the thickness and number of applications so that a uniform film formation can be guaranteed without any sagging or coating missed. In the case of rigid waterproofing, a special attention should be paid to the proportions of materials and pouring processes that ensure

the density of concrete or mortar. In composite waterproofing, the contact between different water-proof layers is optimal for tightness.

It will not only recommend proper precautions during construction but also node treatment for waterproofing. Places such as roof internal and external corners, pipe roots, drainage tubes are susceptibility to become potential leakage points. This requires that, in the construction stage, some strengthened treatment measures must be taken to increase the number of layers or optimize sealing methods so as to guarantee node parts' waterproof layer thickness and tightness. Simultaneously, the treatment of the protective layer at nodes must also be considered to avoid damage caused by insufficient protection.

Also, construction environment control is an important technical point. While in the construction phase, environmental factors like temperature, humidity and wind speed should be monitored closely. The waterproofing construction shall not be carried out under unfavorable environmental conditions and the establishment of the construction rhythm and construction technology shall be adjusted with this factor. Specific cold, rainy days and high-temperature or low temperature environment will affect the construction quality of waterproof layer, so construction time should be reasonably arranged to ensure construction under conditions that can meet the needs of environmental [3].

4. Quality Control Measures for Roof Waterproofing Construction in Construction Engi neering

4.1 Pre-event Prevention: Building a Solid Quality foundation

Quality control is to prevention in advance and the first step for roof waterproofing construction, and its purpose is to prevent quality risks from the source. It primarily deals with design optimization, material control, and workforce preparation.

An appropriate waterproofing grade and technical plan should be established according to the function of the building and environmental conditions in the design stage. For the details of waterproofing treatment measures for roof node structures, full consideration should be given to avoid inherent defects in the design will cause subsequent construction problems. At the same time, we need to ensure that the design plan is compatible with site construction conditions, and provide clear guidance for subsequent construction.

Material control should run through the whole process of "material arrival - storage - usage". After receiving materials on-site, qualification documents must be checked to determine whether their appearance and performance are in compliance with design standards to prevent unqualified materials from being put into construction. Storage: Appropriate protective measures should be applied according to the characteristics of the material, in order to prevent deterioration arising from temperature, humidity and light. Check whether the material is acceptable again before using and check if there will be any adverse effect on waterproofing.

A specialized construction team with professional qualification and construction experience should be selected for personnel preparation. Organized technical releases and training before construction to clarify construction norms, technical points, quality standards and norms so that the operators master the flow of the process have high understanding of quality requirements. Further, to avoid quality problems caused by nonstandard operations or unclear responsibilities, a job responsibility system should be established to clarify the quality control responsibilities of each position.

4.2 In-event Control: Strengthening Construction Process Supervision

To ensure the quality of roof waterproofing construction, it is important to control during event. To realize the dynamic supervision of whole construction process, it should include construction processes, operational norms and in-process inspections.

Process control must be based on the guide line of "not entering into next process until previous process passes inspection". Strict control of key processes such as base layer treatment, waterproof

layer construction and protective layer construction. Particular attention is paid to the audit of whether each process meets technical requirements, and the consistency of established processes (to prevent quality hazards caused by interruption errors such as shutting down improper process connection or skipping process). At the same time, attention must be paid to construction details on any node area and ensure their compliance with waterproofing norms.

Monitoring the operational norms is to monitor in real time whether on-site construction behaviors comply with technical plans and regulatory requirements during construction. Such as lap treatment during rolled sheet laying, thickness control of the coating applied, material proportioning and pouring processes for rigid waterproofing construction, etc. Non-standard actions will be corrected in time to ensure the construction process meets quality standards.

Under the in-process inspection, a periodic inspection mechanism should be set up to conduct sampling tests at regular intervals on construction quality. Make sure the waterproof layer bond is intact. This means checking that the bond/ glue remains tight and secured. Responses to problems found need to be acted on without delay in order not to allow follow-up and dissemination of quality issues.

Enhanced monitoring of the construction environment. Changes in the ambient temperature, humidity and wind speed should reasonably adjust construction rhythm to prevent some key process construction in adverse environment. Construction records should be kept, such as: construction parameters, material usage and quality inspection results and so on. They could provide a basis for the subsequent tracing of quality [4].

4.3 Post-event Acceptance: Completing Quality Closed-loop Management

Post-event acceptance is the ultimate step of quality control for roof waterproofing construction. Its substance is to check the project quality through comprehensive inspection and ensure that the waterproofing project meets design and regulatory requirements. At the same time a post-maintenance mechanism should be put in place to establish the long-term waterproofing effect of roof.

Quality inspection should be conducted during the acceptance phase, which includes not only the appearance quality inspection of waterproof layer and protective layer but also performance validation through professional testing methods (such as closed water test) to ensure waterproofing effect. Pay special attention to check the potential leakage hazard node area and connection area. Any outstanding quality problems found should be developed for rectification plan, and after the recheck until acceptance fully passes.

After acceptance, complete engineering archives (design documents, material qualification certificates, construction records, test reports, etc.) should be set up and archived to provide the basis for subsequent maintenance and quality tracing of the roof. In addition, a mechanism for post maintenance shall be established whereby the warranty obligations and validity of the roof waterproofing project must be clear. Users should establish an inspection plan, guiding daily maintenance such as cleaning the drainage system and checking the integrity of the waterproof layer to detect and deal with minor damage in a timely manner, preventing leakage problems from expanding and extending the service life of roof waterproofing engineering [5].

5. Conclusion

To sum up, roof waterproofing construction quality control is not a one-stage independent control but a whole-lifecycle systematic project of "pre-event prevention-in-event control-post-event acceptance." In the context of that, as construction enterprises set higher quality demand for engineering projects and green construction and intelligent monitoring technologies are being gradually applied in practice, roof waterproofing quality control also requires to keep with the times. This multi-dimensional quality control can ensure the long-term stability of roof waterproofing projects, which has laid a solid foundation for improving the overall quality and sustainable development of construction engineering.

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