

# Study on Direct Waterproof Construction of Basement Roof in Planting Area

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**Abstract:** By analyzing the drainage and waterproof mechanism of basement roof and the permeable performance requirement of planting soil found that direct waterproof construction at concrete constructional layer will not only save construction cost and shorten construction period, but also eliminate potential quality trouble between waterproof layer and structure layer.

**Keywords:** Basement, construction, drainage, layer, shaping, waterproof.

## 1. INTRODUCTION

Traditional waterproof construction of basement roof is to set sloping layer and leveling layer between structural roof and waterproof layer, which form certain drainage slope above waterproof layer to realize roof drainage. As to sloping basement roof of building in planting area, if the design of waterproof constructional layer is improper, it may not only influence project cost and construction period, but also produce hidden danger of quality. As is shown in Fig. (1), traditional waterproof constructional layer of basement roof is designed with light concrete sloping layer, and in the meantime, in order to meet requirements on paving of coiled material waterproof layer, leveling layer is set. With 50m drainage length as an example, sloping of light concrete needs to heighten 250+30mm at most, and with 20mm leveling layer, the thickness added between constructional layer and waterproof layer reaches 300mm.

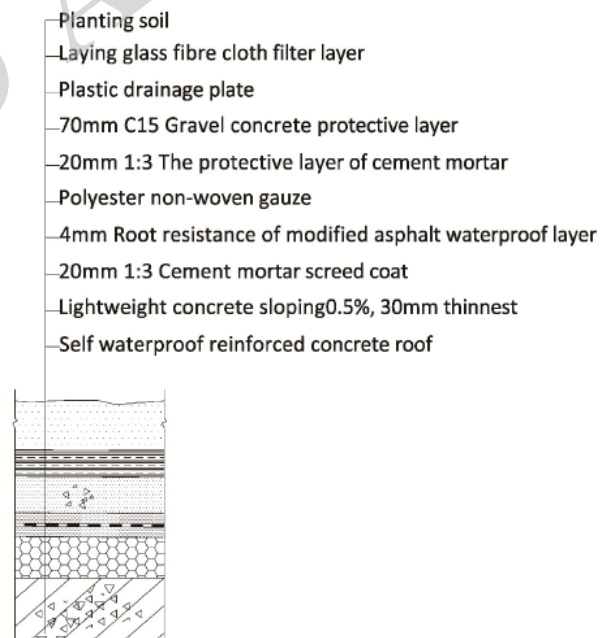
In accordance with such design, main problems concerning traditional waterproof construction of basement roof in planting area include: multi-layer wet construction process of sloping layer and leveling layer etc. may influence waterproof quality of waterproof layer, thus increasing flake, swelling and other hidden dangers; sloping layer and leveling layer consume project cost, thus increasing project cost; sloping layer and leveling layer occupy project time, and increase project period; sloping layer and leveling layer occupy earthing space, reduce earthing thickness and restrict planting conditions of lager trees. Main reasons resulting in the above problems are one-sided understandings on roof drainage and waterproof mechanism and permeable performance requirement of planting soil.

## 2. ANALYSIS OF DRAINAGE AND WATERPROOF MECHANISM OF BASEMENT ROOF

### 2.1. Analysis of Relation between Drainage and Waterproof Performances on Basement Roof

Traditional waterproof layer construction is in accordance with design theory of "drainage first while waterproofing

second and combination of drainage and waterproofing". Set sloping layer on reinforced concrete constructional layer, as is shown in Fig. (1). In order to meet requirements of paving of coiled material waterproof layer on flatness, set 1:3 cement mortar leveling layer with thickness of 20 on sloping layer. The purpose of such design is to firstly reduce the pressure of waterproof layer through drainage to improve waterproof ability [1].



**Fig. (1).** The basement waterproof roof planting area of traditional hierarchical structure.

However, earthing layer on basement roof certainly has definite water content due to need for green planting. Therefore, the waterproof requirement of basement roof in planting area is all-weather, long-term and rigid, but it has no direct relation with drainage capacity. No matter how great the drainage capacity is, waterproof ability of waterproof may meet requirement on waterproof performance.

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## 2.2. Analysis of Permeability and Drainage Mechanism of Planting Soil on Basement Roof

The area occupied by basement roof in planting area forms impermeable layer, hindering activity of water and soil, influencing survival and growth of green planting. In order to ensure permeability of planting soil layer, drainage layer shall be set between protective layer and earthing layer above waterproof layer of basement roof to meet the requirement on green planting. Permeability and drainage construction mechanism of basement roof is: firstly, free water in planting soil respectively permeates down vertically and permeates to the side with lower waterhead horizontally under the action of gravity and waterhead; then, free water permeating into drainage layer is drained to blind drain outside basement under the action of waterhead, and then is drained to drainage system in the community and permeates underground. Drainage structure mechanism of basement roof is shown in Fig. (2).

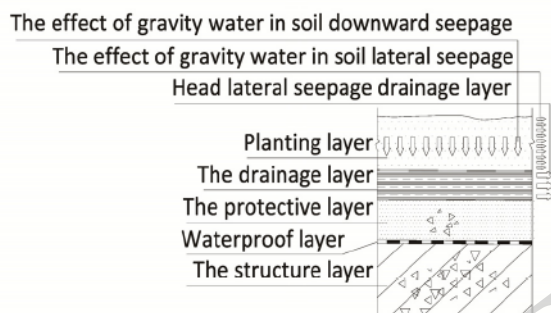


Fig. (2). The basement roof drainage structure mechanism.

## 3. DIRECT WATERPROOF CONSTRUCTION OF BASEMENT ROOF IN PLANTING AREA

### 3.1. Overview of Direct Waterproof Layer Structure of Basement Roof in Planting Area

Direct waterproof constructional layer of basement roof in planting area refers to hierarchy structure design that waterproof coiled materials etc. are directly paved on finished surface of primarily molding constructional layer, waiting for it to dry, which need a proper concrete smoothing technological process when pouring of basement roof concrete [2].

### 3.2. Main Functions of Direct Waterproof Constructional Layer of Basement Roof in Planting Area

In order to solve main problems concerning traditional waterproof construction of basement roof in planting area, according to analysis of relation between drainage and waterproofing performances on basement roof and permeability and drainage mechanisms of planting soil, it should be adopted in planting area that is direct waterproof constructional layer of basement roof, which directly pave waterproof layer and remove excessive layers between constructional layer and waterproof layer. It needs not only to ensure reliability of waterproof function, and in the meantime needs to realize permeability and drainage functions of soil planting layer, meeting requirements on green planting.

## 3.3. Advantages of Direct Waterproof Constructional Layer of Basement Roof in Planting Area

Compared with traditional waterproof constructional layer of basement roof, direct waterproof construction of roof obviously simplifies constructional layer. It not only reduces project cost, shortens project period and reduces restriction of natural climate on construction [3], but also removes hidden dangers resulting from sloping layer and leveling layer etc. multi-layer wet construction process, conforming to drainage and waterproofing mechanisms on basement roof, providing greater guarantee on waterproofing quality.

## 4. KEY POINTS OF DIRECT WATERPROOF CONSTRUCTION OF BASEMENT ROOF

### 4.1. Conformity to Permeability and Drainage Functions of Planting Soil on Basement Roof

Direct waterproof construction of basement roof is not to simply remove sloping layer and other related constructional layer, but to improve permeability function of planting soil in basement area through optimizing permeability and drainage structure under the condition of ensuring waterproofing function. In accordance with analysis of drainage mechanism of basement roof, means to realize the permeability and drainage capacity of planting soil of basement roof include setting of drainage slope and utilization of permeability of soil layer itself and thickness of drainage layer etc.

### 4.2. Key Points of Basement Roof Concrete Smoothing Process

Smoothing of basement roof concrete makes the surface flat and smooth. The main function is to meet paving requirement of waterproof layer, and in the meantime remove crazing, blistering and other flaws on waterproof concrete surface, ensuring anti-permeability performance of waterproof concrete.

#### 4.2.1. Control of Concrete Smoothing Time

The time of concrete smoothing directly influences quality of concrete smoothing. After concrete was pouring and vibrating, smoothing includes Leveling process and pressing smoothing process. Leveling process is also referred to as primary smoothing, and it shall be completed before initial setting of concrete. Initial setting means that concrete loses plasticity and is primarily molded, and use of vibrating bar and high frequency vibrator as well as process that external force changes interior shape and structure of concrete may produce damage to interior structure of the concrete. Pressing smoothing process is also referred to as secondary smoothing, too early or late operation time is unable to guarantee smoothing quality, and it shall be quickly finished within the time before final setting of concrete [4] so as not to damage interior structure of the concrete. As to secondary smoothing, it is conducted on concrete surface to press and level cement mortar, meeting requirement on paving of coiled material waterproof layer.

Though initial setting and final setting times of cement or concrete can be specified or measured under standard condition, under the condition that mix proportion of concrete is

given, because of different temperatures, humidity, concrete transportation, pouring time and field climate or other operation conditions, initial setting and final setting times of each batch of concrete can't be precisely determined. Therefore, under site construction condition, concrete smoothing time may be controlled depending on representation of concrete at site. In case of summer or long transportation distance, retarder can be mixed to extend initial setting time. Secondary smoothing will be done, when interior concrete start to solidified and concrete start to return slurry, which is time that the workers do not fall into the concrete, and will leave footprints. Smoothing worker should grasp the time to remove bubble on concrete surface layer, remove concave, sand hole and other defects on the surface.

#### 4.2.2. Process of Concrete Molding Smoothing

Molding smoothing of constructional layer surface of concrete is the necessary precondition for meeting requirement of waterproof concrete on waterproof capacity and directly paving waterproof layer of coiled materials. Concrete molding smoothing may adopt manual molding smoothing or mechanical molding smoothing [5]. As to manual smoothing, sufficient personnel shall be assigned according to smoothing area to ensure completion of smoothing process within controlled smoothing time. In case of large area of basement roof, especially under high temperature in summer, concrete is condensed fast, and it is better to adopt mechanical operation with human assistance to improve efficiency of molding smoothing.

##### 1. Process flow of mechanical molding smoothing:

Setting of horizontal point – pouring of concrete – mechanical leveling (primary smoothing) – mechanical abrading (secondary smoothing)

##### 2. Process flow of manual molding smoothing:

Setting of horizontal point – pouring of concrete – manual leveling (primary smoothing) – manual abrading (secondary smoothing)

#### 4.3. Selection of Waterproof Layer of Basement Roof

In accordance with requirements in Technical Code for Waterproofing of Underground Works, waterproofing grade determines structure of waterproof layer [6].

Waterproof grade: waterproof standard is determined as functional requirement and importance of basement, and waterproofing grade of basement is divided into four levels. Requirements on waterproof standard from fourth level to primary level are raised level by level.

Waterproof concrete: in underground works by open cut method, as to basement with waterproofing grade from primary level to third level, the major structures shall select waterproof concrete; while as to basement with fourth-level waterproofing grade, the major structure is better to select waterproof concrete. Impermeable grade of waterproof concrete shall be determined as per buried depth of the basement.

Additional waterproof layer: in addition to selection of waterproof concrete as waterproofing of major structure, in accordance with different requirements on waterproofing

grade, corresponding additional waterproof layer shall be set. For instance, as to basement with primary waterproofing grade, one or two kinds of additional waterproof layer shall be selected. In consideration of economic requirement, construction requirement and reliability of waterproofing etc., floor, side plate and roof of the basement shall be made with distinction. For instance, it is better to select coiled material waterproof layer for basement roof, while waterproof coatings can be selected as additional waterproof layer for side plate.

#### 5. APPLICATION OF DIRECT WATERPROOF CONSTRUCTION IN CONCRETE CONSTRUCTIONAL LAYER IN WATERPROOF CONSTRUCTION OF BASEMENT ROOF

Design of original waterproof hierarchy structure of basement roof in planting area in certain residential community (as shown in Fig. 1) includes 10 constructional layers. It is optimized to 6 constructional layers upon design, and constructional layers from top to bottom respectively refer to: (1) planting soil; (2) two layers paved with glass wool cloth; (3) macadam permeability layer with thickness of 100; (4) C15 fine stone concrete protection layer with thickness of 40; (5) modified asphalt coiled material waterproof layer pasted with thickness  $\cong 4$ ; (6) surface smoothing of waterproof reinforced concrete roof. Refer to Fig. (3) Direct Waterproof constructional layer of Basement Roof in Planting Area for details. The community has been completed for many years, but there is no leakage on basement roof, and green plants grow well.

#### CONCLUSION

When application of direct waterproof construction of basement roof in planting area, individual buildings in different areas, with different forms and different requirements shall be different. In case of large rainfall and high requirement on drainage, backfill with good permeable performance shall be selected, with comprehensive utilization of vertical and lateral permeability capacity of earthing layer, water will be drained to blind drain outside the basement through drainage layer. When necessary, structure sloping and other structure schemes may be adopted to improve drainage capacity of drainage layer. In addition, thickness of planting soil can be increased through manual sloping, and make root system of green plants far away from drainage layer, and avoid root system of green plants being flooded, thus ensuring planting soil environment suitable for green plants. In conclusion, specifying structure mechanisms of waterproofing, permeability, drainage and green planting may solve problems concerning design of waterproof constructional layer.

#### CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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Declared none.

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