

Common technical risks contractors face when constructing mushroom slab systems, their causes and preventive measures

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KEYWORDS

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ABSTRACT

Contractors executing mushroom slab structural works often encounter various risks that affect construction progress, quality and cost. This paper analyzes the causes of these risks and proposes several preventive measures for contractors.

1. Introduction

A mushroom slab is a type of flat reinforced concrete slab without beams, directly supported by columns. At the junction between the column and the slab, the slab is usually thickened or flared, forming a shape similar to a mushroom cap.

Thanks to this structural configuration, buildings using mushroom slabs can optimize story height and create more open interior spaces.

Currently, there are no specific standards or codes governing the construction and acceptance of this type of slab. Therefore, contractors may face various technical risks during construction. It is essential for contractors to have sufficient expertise to avoid undesirable consequences.

2. Objective Identification

In mushroom slab construction, all contractors aim to achieve: On-time project completion, assured construction quality, labor safety, environmental hygiene, cost efficiency.

Therefore, risk management is crucial to prevent delays, quality issues, cost overruns, and safety incidents.

3. Risk Identification

3.1. Advantages, Disadvantages, and Construction Procedure

3.1.1. Advantages and Disadvantages of Mushroom Slabs

a. Advantages

- The most significant advantage is reducing floor-to-floor height compared to other slab systems, helping optimize façade and finishing costs.
- Requires less material and reduces the volume of concrete due to its structural efficiency.
- Flat slab system shortens construction time and reduces costs.
- Can span up to 20 m, commonly effective within 8–12 m spans.

- Loads are distributed in two directions, reducing overall structural weight.
- When combined with columns and shear walls, it can improve seismic resistance.

b. Disadvantages

- Requires high precision in both design and construction, especially at column-head regions.
- Flat soffit makes it more difficult to arrange MEP systems without early planning.
- Not always suitable for structures with heavy concentrated loads at mid-span.

3.1.2. Construction Procedure

- Formwork installation
- Installation of bottom reinforcement at column head
- Installation of bottom slab reinforcement
- Installation of top slab and column-head reinforcement
- Concrete casting
- Concrete curing

3.2. Common Technical Risks

Typical technical risks encountered in mushroom slab construction include:

- Punching shear failure at column–slab connections
- Excessive cracking and deflection
- Formwork settlement or collapse during concreting
- Incorrect reinforcement placement and insufficient cover thickness
- Inadequate formwork load-bearing capacity
- Differential column settlement affecting slab performance
- Water leakage in roof slabs and wet areas
- Honeycombing or surface defects after formwork removal
- Lack of coordination between design and construction

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4. Causes of Technical Risks

4.1. General Causes

4.1.1. Errors in Design and Method Planning

- Incorrect calculation of construction loads for formwork, leading to insufficient load capacity

4.1.2. Errors in Concrete Mixing

- Use of admixtures without reducing water content
- Use of contaminated sand or water leading to delayed setting or surface defects (e.g.)

4.1.3. Errors During Construction

- Failure to follow proper procedures, causing defects such as honeycombing, cracking, or collapse
- Insufficient bracing in formwork systems
- Lack of protective measures during unexpected rain

4.1.4. Management Failures

- Lack of regular safety inspections
- Poor monitoring of construction progress and conditions
- Inadequate review of construction methods

4.2. Specific Causes for Each Type of Failure

4.2.1. Punching Shear Failure at Column–Slab Connection

- Insufficient shear reinforcement
- Incorrect slab thickness due to elevation errors
- Concrete strength not meeting design requirements

4.2.2. Cracking and Excessive Deflection

- Poor ground compaction under formwork at ground level, causing settlement
- Incorrect formwork design or insufficient stiffness
- Poor curing and shrinkage effects
- Excess water in concrete mix leading to delayed setting

4.2.3. Formwork Collapse or Settlement

- Concrete poured in heaps, causing localized overloading
- Lack of monitoring and reinforcement of weak supports during casting
- Failure to comply with multi-level shoring requirements (e.g., 2.5-story rule)



Figure 1. Third-level reshoring after removal of mushroom slab formwork.

4.2.4. Incorrect Reinforcement Position and Insufficient Concrete Cover

- Column head reinforcement may sink, and bottom reinforcement may not be properly supported due to careless workmanship, lack of spacers, and foot traffic during concrete casting.

4.2.5. Insufficient Formwork Load-Bearing Capacity

- Mushroom slabs typically have large thicknesses and spans, requiring a robust shoring system.
- Attempts to reduce costs by using insufficient supports or removing props too early may lead to inadequate load-bearing capacity and potential collapse of formwork and shoring.

4.2.6. Differential Column Settlement

- When foundations settle unevenly, cracks can rapidly develop at column–slab connections because the slab is directly supported by the columns.

4.2.7. Water Leakage (Especially Roof Slabs and Wet Areas)

- Flat slabs with large spans are prone to cracking, which can lead to water leakage.
- Improper waterproofing procedures also contribute to leakage issues.

4.2.8. Honeycombing or Blowouts at Slab Soffit after Formwork Removal

- Inadequate vibration leading to honeycombing
- Delayed spreading of concrete causing loss of surface workability and incomplete compaction
- Poorly sealed formwork joints leading to cement paste leakage and honeycombing at the slab soffit

5. Risk Prevention Measures

To minimize risks, contractors should implement the following measures:

- Design construction methods that fully consider construction loads and influencing factors; verify calculations to eliminate errors. Select appropriate construction methods and execution plans with reasonable scheduling and timing. Strictly comply with construction sequences and technical standards to reduce technical risks.
- Regularly inspect and improve the competence of site management and technical staff.
- Continuously collect, update, and report all technical issues encountered on site.
- Monitor weather forecasts to adjust schedules and prepare mitigation measures.

During Construction

a. Formwork Installation

- Carefully check the positioning, elevation, and dimensions of column heads to ensure the effective depth.
- Pay special attention to the shoring system:
 - Use base plates to distribute loads on the ground
 - Check bracing systems to ensure stability and sufficient load capacity
 - Ensure tight joints to prevent cement paste leakage
- Inspect and eliminate defective elements such as bent props, weak beams, or warped formwork panels.

b. Installation of Bottom Reinforcement at Column Head

- Ensure correct quantity, type, size, position, and concrete cover thickness.
- Avoid walking directly on reinforcement to prevent deformation and reduction of cover thickness.

c. Installation of Bottom Slab Reinforcement

- Ensure sufficient anchorage length of slab reinforcement into the column head.
- Ensure correct quantity, type, size, position, and concrete cover thickness.

d. Installation of Top Reinforcement (Slab and Column Head)

- In addition to checking type, quantity, diameter, and position, it is necessary to:
 - Verify the top elevation of the upper reinforcement layer
 - Control concrete cover thickness
 - Ensure correct slab thickness and final surface elevation after casting

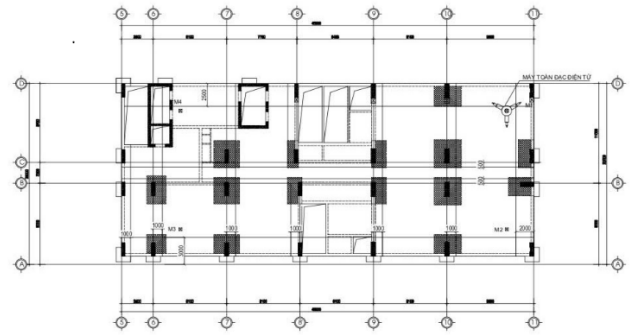


Figure 2. Layout Plan for Column Head Positioning – Ngoc Xanh Hotel Project.

- Due to multiple reinforcement layers, special attention must be paid to ensure that the concrete cover of the top slab reinforcement and the top column head reinforcement are consistent.

e. Concrete Casting

- Prior to casting, formwork and reinforcement must be inspected and approved in accordance with regulations.
- Control the quality of materials used in the concrete mix, paying attention to aggregate proportions and water content according to the approved mix design.
- Check concrete quality before casting:
 - Perform slump tests
 - Prepare concrete specimens as required
- Concrete placement and vibration must comply with **TCVN 4453** standards.
- During casting, concrete must be quickly spread evenly to avoid load concentration.
- Assign personnel to continuously monitor the formwork and shoring system during casting to promptly address any issues.
- Pay attention to the positioning of the stationary concrete pump:
 - Openings in the formwork should be prepared for anchoring and positioning the pump at each slab level.

f. Concrete Curing Process

- After casting, technical staff must instruct workers to carry out proper curing:
 - Maintain adequate moisture
 - Ensure sufficient curing duration
 - Apply protective covering when necessary
- Avoid any impact on the concrete structure during hardening; no mechanical loads should be applied to the slab during this period.

6. Conclusion

To successfully construct mushroom slab structures, contractors must develop detailed construction methods along with comprehensive risk management and prevention strategies.

Proper implementation of these measures will: improve the ability to complete projects on schedule, ensure construction quality, reduce costs, maintain labor safety, protect environmental conditions.

References

- [1]. Dinh Tuan Hai, Nguyen Huu Hue, *Risk Management in Construction*, Construction Publishing House, 2016.
- [2]. Le Anh Dung, Bui Manh Hung, *Risk Management in Construction Enterprises*, Construction Publishing House, 2015.
- [3]. Bui Manh Hung, *Formwork and Scaffolding in Construction*, Construction Publishing House, 2013.
- [4]. Do Dinh Duc, Le Kieu, *Construction Techniques – Volume 1*, Construction Publishing House, 2004.
- [5]. Vietnamese Standard TCVN 4453:1995 – Cast-in-place Concrete and Reinforced Concrete Structures – Code for Construction and Acceptance.
- [6]. Cu Huy Tinh, *Common Technical Risks for Contractors Using VRO Slabs and Preventive Measures*, Journal of Construction Materials, Vol. 15 No. 2, April 2025.
- [7]. CCI Construction Joint Stock Company, *Construction Method Statement for Mushroom Slab – Ngoc Xanh Project*, 2025.