Analysis of Construction Risks and Discussion on Safety Supervision in Building Engineering

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Abstract: This paper addresses the frequent occurrence of risks such as deep foundation pit collapse, high-formwork instability, and electric shock from temporary electricity use in building engineering construction. It analyzes the specific manifestations of these three types of risks, discusses corresponding risk mitigation countermeasures from the aspects of scheme optimization, process control, and equipment configuration, and also studies three types of safety supervision strategies: specialized scheme review, on-site inspection, and standing supervision for hazardous and major works. Bycarding (teasing out) the synergistic logic between risks, countermeasures, and supervision, a closed-loop management approach of "risk identification - countermeasure implementation - supervision guarantee" is proposed. This solves the problems of fragmented risk control and unfocused supervisory measures in traditional construction, achieving the effects of enhancing construction safety reliability and reducing accident rates, thereby providing practical reference for safety management in building engineering construction.

1. Introduction

Currently, with the expanding scale and increasing technical complexity of building engineering construction, the proportion of hazardous and major works such as deep foundation pits and high-formwork has risen, consequently increasing the difficulty of construction risk prevention and control. In actual construction, safety accidents often occur due to incomplete risk identification, ineffective implementation of countermeasures, and inadequate supervisory control, leading not only to casualties and economic losses but also affecting project progress. Based on this, in-depth analysis of the core causes of construction risks, matching them with targeted countermeasures, and strengthening the supervisory and safeguarding role of safety supervision are of great significance for building a scientific construction safety management system and promoting high-quality and safe construction in building engineering.

2. Construction Risks in Building Engineering

2.1 Problems Associated with Collapse Risk in Deep Foundation Pit Construction

During the design stage, some projects fail to optimize the support scheme based on geological survey data, merely applying generic templates, leading to inappropriate selection of support structures. Furthermore, insufficient consideration of the surrounding environmental impact results in deviations in load calculations for the support structure, sowing the seeds for collapse hazards. During the construction stage, violations of regulations are prominent: over-excavation frequently occurs in pursuit of progress, with excavation depths exceeding design requirements by 0.5-1m, compromising the stability of the pit slope soil; quality control during support structure construction is lax, with issues like broken piles during row pile casting and insufficient grouting of soil nails, reducing the overall strength of the support; dewatering systems operate unstably due to pump failures or pipe blockages, causing the groundwater level to rise, increasing the water content of the

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slope soil, and reducing its shear strength [1]. During the monitoring stage, monitoring frequency is insufficient, or monitoring points are sparsely placed, failing to capture slope displacement changes promptly; some monitoring data is falsified, concealing the true situation of excessive displacement, missing the optimal time for rectifying hidden dangers, ultimately leading to collapse accidents.

2.2 Problems Associated with Instability Risk of High-Formwork Support Systems

At the scheme level, some specialized schemes lack depth in preparation, failing to specify detailed parameters for frame erection or to verify the frame's load-bearing capacity against construction loads, rendering the scheme lacking guidance; some schemes, although reviewed by experts, are not adjusted according to the expert opinions during construction and are executed as per the original plan, leading to a disconnect between the scheme and reality [2]. During the erection process, the quality of frame components is substandard: upright pipes have insufficient wall thickness, ledger pipe couplers have breaking strength below standard, directly reducing the overall stability of the frame; erection personnel violate regulations: upright spacing exceeds scheme requirements, ledgers are missing, upright foundations are not hardened, causing uneven stress distribution on the frame. In terms of load control, layered pouring requirements for concrete are not followed, with single-pour thickness exceeding 50cm, causing the frame to bear excessive load instantly; additionally, materials like steel bars and formwork are illegally stacked on the frame, exceeding its design load limit, exacerbating frame deformation, ultimately leading to instability and collapse.

2.3 Problems Associated with Electric Shock Risk from Temporary Electricity Use

In terms of wiring layout, violations are common: temporary power lines are not protected by conduits as required by codes, laid directly on the ground or scaffolding, easily leading to insulation damage due to crushing or abrasion; lines crossing roads lack protective sleeves, easily causing line breakage from vehicle traffic; lines of different voltage levels are laid mixed together without maintaining safe distances, posing risks of leakage between lines [3]. In terms of equipment configuration, distribution box setup is non-standard: the requirement for "three-level distribution, two-level protection" is not met, some distribution boxes lack residual current devices (RCDs), or the RCDs have excessive trip currents or are faulty and not replaced; power tool management is chaotic: regular insulation tests are not conducted, tools with damaged insulation or exposed wire connections continue to be used, creating leakage hazards. In terms of environmental adaptation, no specific protective measures are taken in damp environments: distribution boxes lack rain and moisture protection, internal dampness causes short circuits and leakage; workers' personal protective equipment is inadequate: failure to wear insulated gloves and shoes as required, operating power tools barefoot on damp ground, increasing the probability of electric shock; simultaneously, emergency measures are lacking: no emergency tools like insulating rods or gloves are available on-site, preventing timely power cut-off and rescue after an electric shock accident, worsening the consequences.

3. Countermeasures for Construction Risks in Building Engineering

3.1 Countermeasures for Deep Foundation Pit Collapse Risk

During the scheme preparation and review stage, prepare a specialized scheme before construction based on the geological survey report, clarifying the support type, dewatering method, and excavation layer thickness; the scheme must be reviewed by 5 or more experts, focusing on verifying support structure strength calculations and dewatering effect predictions; after expert approval, submit to the supervision unit for approval; construction is prohibited without approval. During support structure construction, strictly follow the scheme: control pile diameter deviation ≤50mm and pile position deviation ≤100mm during row pile construction, use bored cast-in-situ pile technology to ensure pile integrity; during soil nailing wall construction, control soil nail drilling depth deviation ≤50mm, maintain grouting pressure between 0.3-0.5MPa to ensure sufficient grouting [4]. During process monitoring and control, set up one displacement monitoring point every 20m around the pit, use a total station to monitor slope displacement daily, keeping daily displacement within 3mm; operate the dewatering system 24h, assign personnel to check pump status every 2h, ensuring the groundwater level remains stable at 0.5-1m below the excavation level; strictly prohibit over-excavation, complete the blinding layer construction within 24h after reaching the design level; if excessive displacement or water level rise is detected, stop work immediately, reinforce with sandbag backfilling or additional temporary supports, and resume work only after stabilization.

3.2 Countermeasures for High-Formwork Frame Instability Risk

During the technical briefing stage, before erection, the technical responsible person conducts a specialized briefing for the erection team, clarifying based on construction drawings and the scheme: upright foundation treatment, upright spacing ≤1.2m, ledger step distance ≤1.5m, kickboard distance from ground ≤200mm; after the briefing, have team members sign for confirmation, ensuring everyone understands the erection requirements. During erection control, use qualified frame components; have a quality inspector supervise the entire erection process, checking if uprights are vertical, ledgers are horizontal, and nodes are locked; immediately demand rectification if upright spacing exceeds limits or ledgers are missing [5]. During acceptance for use, after erection is complete, conduct joint acceptance by the project manager, technical responsible person, and supervising engineer; use a torque wrench to check coupler tightness, use a level to check frame flatness; only allow use after signing the "High-Formwork Acceptance Record" upon passing acceptance; strictly prohibit working on the frame without passing acceptance. During concrete pouring monitoring, pour in layers according to the scheme, with each layer thickness ≤50cm, control pouring speed ≤2m³/h; assign dedicated personnel to observe frame deformation; if abnormal noises or displacement are detected, stop pouring immediately, evacuate personnel, and resume only after investigation and reinforcement.

3.3 Countermeasures for Temporary Electricity Electric Shock Risk

During the wiring standardization stage, use insulated conductors for temporary power lines; when overhead, height ≥2.5m; when crossing roads, protect with steel pipes; when buried, depth ≥0.7m with markings; separate lines of different voltage levels, spacing ≥0.3m; strictly prohibit unauthorized connections; after wiring, have an electrician inspect and approve before energizing [6]. During equipment configuration stage, set up distribution boxes according to "three-level distribution, two-level protection": main distribution box, sub-distribution box, and switch box in sequence, each device corresponding to an independent switch box; install RCDs in switch boxes, with operating current ≤30mA and break time ≤0.1s; distribution boxes must be rain and dust proof, installed in dry, ventilated locations, 1.3-1.5m above ground. During inspection and maintenance stage, electricians daily check line insulation and distribution box RCDs; perform quarterly insulation tests on power tools; immediately stop use and repair upon finding damaged insulation or faulty protectors; strictly prohibit using faulty equipment. During environmental protection stage, when working in damp environments, use additional waterproof conduits for lines; workers must wear insulated gloves and shoes; equip the site with emergency tools like insulating rods and gloves;

in case of electric shock, cut power first before rescue to avoid secondary injury, effectively reducing electric shock risk.

4 Safety Supervision Strategies for Building Engineering Construction

4.1 Supervisory Review of Specialized Schemes

At the scheme receipt stage, when the construction unit submits specialized schemes for hazardous and major works like deep foundation pits and high-formwork, the supervision unit must check the scheme's completeness, confirming whether it includes core content such as basis of preparation, project overview, construction technology, safety measures, and emergency plans; return incomplete (documents) for supplementation to avoid affecting review accuracy due to missing items. During compliance verification stage, focus on checking whether the scheme has been signed and approved by the construction unit's technical responsible person, whether the hazardous and major works scheme has been reviewed by 5 or more qualified experts, whether the expert opinions are clear and have been implemented for rectification; schemes without signatures or expert review are directly deemed failed and strictly prohibited from proceeding to the next stage [7]. During technical rationality assessment stage, the supervising engineer, based on the project reality, verifies key parameters of the scheme: the deep foundation pit scheme requires review of the support structure strength calculation and whether the dewatering scheme matches the groundwater level; the high-formwork scheme requires review of whether the frame upright spacing and ledger step distance comply with the load-bearing capacity verification results; for unreasonable parameters, provide written modification opinions and require the construction unit to adjust and resubmit for review.

4.2 On-site Safety Inspection and Control

During inspection plan formulation stage, the supervision unit develops daily inspection plans based on project progress, clarifying inspection areas, frequency, and personnel, to avoid aimlessness in inspections. During key area inspection stage, conduct inspections using a combination of "look, check, test": inspection of deep foundation pit support requires looking for cracks on slopes, deformation of support structures; checking the operational status of dewatering system pumps, water level in observation wells; inspection of high-formwork frames requires looking for settlement of upright foundations, loosening of ledger couplers; spot-checking coupler tightness with a torque wrench; inspection of temporary electricity requires looking for whether lines are conduit-protected, whether distribution box RCDs are effective; testing whether protectors trip sensitively [8]. During hidden danger handling stage, upon finding general hidden dangers, immediately notify the construction unit orally for rectification, recording it in the "Safety Inspection Log"; upon finding major hidden dangers, immediately issue a "Work Suspension Order", requiring cessation of related operations and evacuation of personnel, while simultaneously reporting the situation to the client unit to prevent accident escalation. During rectification review stage, after the construction unit completes rectification, submit a "Rectification Reply Form" with before-and-after comparison photos; the supervising engineer must review on-site within 24h; if the review fails, continue rectification until requirements are met.

4.3 Standing Supervision for Hazardous and Major Works

During standing supervision preparation stage, 24h before construction of hazardous and major works, the supervision unit clarifies the standing supervisor, time, and content, delivers a "Standing Supervision Notice" to the construction unit informing them of the requirements, and prepares standing supervision record forms and measuring tools [9]. During process supervision stage, the standing supervisor must be present at the worksite throughout, supervising the construction process in real time: supervision of deep foundation pit excavation requires recording excavation layer thickness and sequence, immediately stopping and demanding rectification for violations like over-excavation or excavating before support is in place; supervision of high-formwork concrete pouring requires recording pouring layer thickness and speed, observing whether the frame has abnormal noises or displacement, immediately demanding adjustment upon detecting concentrated loads. During record organization stage, fill out the "Standing Supervision Record" in real time as required during standing supervision, content including construction time, location, personnel, parameters, problems found and handling; key steps must include data records; the record must be jointly signed and confirmed by the construction unit's quality inspector and the standing supervisor to ensure authenticity and traceability.

5. Conclusion

The above research indicates that construction safety in building engineering requires a risk-oriented approach, supported by countermeasures and guaranteed by supervision, with the synergy of these three forming a combined force for control. At the risk level, the core problems of the three types of risks—deep foundation pits, high-formwork, and temporary electricity—are concentrated in the three links of design, construction, and management, requiring targeted solutions. At the countermeasure level, risk resolution must run through the entire construction cycle, from scheme preparation to process execution to environmental adaptation, ensuring specific measures for each type of risk. At the supervision level, specialized scheme review controls the source, on-site inspections dynamically correct deviations, and standing supervision for hazardous and major works focuses on the critical, these three types of strategies can effectively supervise the implementation of countermeasures and prevent risks from turning into accidents. The combination of the three achieves full-chain control of construction risks, enhancing the safety level of building engineering construction.

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