PORTFOLIO

From BIM to Digital Twins:

Engineering Innovation and
Smart Construction Solutions

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CONTENTS

Graduation Project: Shanghai Lin'gang Modern Logistics Warehouse Center

1. Project Profile

Key Parameters: 22.4m-height structure with dual-layer warehouse and office mezzanines. Dedicated vertical circulation system for heavy vehicles.

Critical Objectives: Integrated storage-office spatial configuration. Direct second-level loading platform access for 40-ton trucks.

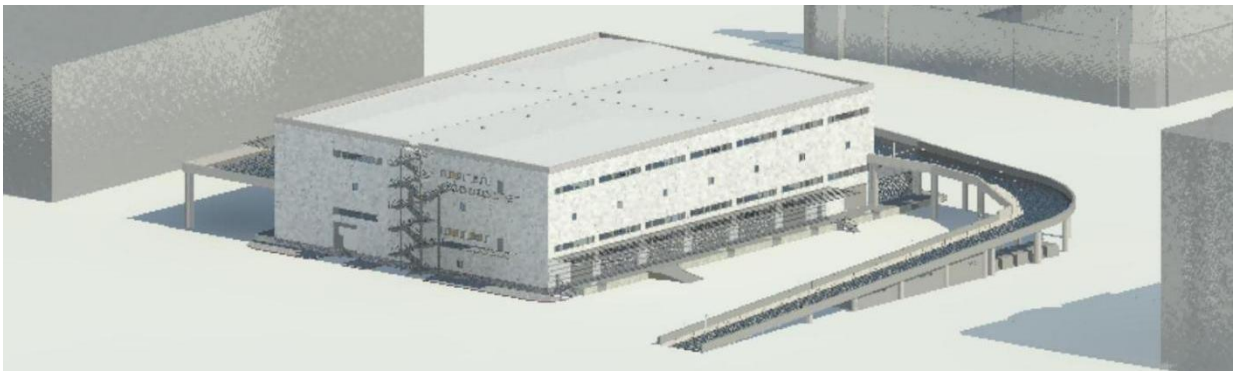
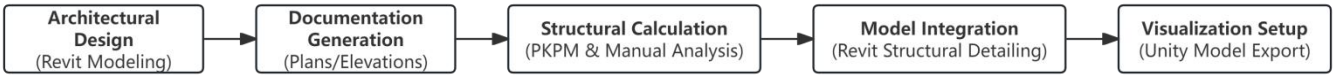


Figure 1. Shanghai Lin'gang Modern Logistics Warehouse Center

2. Methodology: BIM-Driven Forward Design

Architectural-structural coordination via model-centric workflow.



3. Technical Implementation Highlights

3.1 Architectural Design Optimization

Performance-Based Modeling: Solar analysis-driven spatial planning.

Logistics Simulation: 8% gradient ramp & Minimum turning radius feasibility optimization.

Loading Bay Optimization: Balancing maneuverability constraints and operational throughput.

3.2 Structural Verification

Primary System: Cast-in-situ reinforced concrete frame (12×12m grid).

L2 Floor Innovation: Waffle slab + composite steel deck.

Load Validation: PKPM global analysis & Manual spot-checks (critical joints).

3.3 Digital Delivery

BIM Documentation: 24×A1 drawings + auto-generated 3D details.

***Unity* Visualization(Figure 2)**:Truck transit animation & Physics-enabled FPV/Aerial navigation.

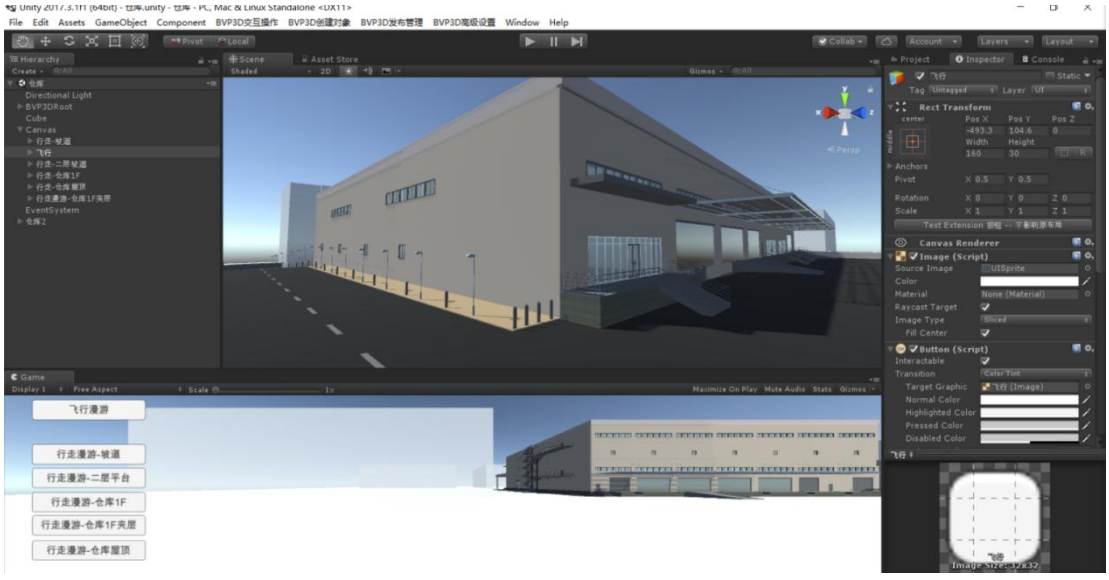


Figure 2. Unity development process page

Project Experience: Qiantan Plot 21 Project

(Aug 2020 – Mar 2023 | BIM Engineer & Engineering technician)

1.Project Profile

Location: East of Jiyang Rd, West of Dongyu Rd, Pudong, Shanghai

Scope: 608,784m^2 mixed-use complex (378,460m^2 aboveground + 230,324m^2 basement)

Structures: 2 commercial towers (195m & 159m), 4 residential towers (150m), Podium (30.95-35.5m)

Figure 3. Qiantan Plot 21 Project

2.Core Contributions

BIM Implementation & Innovation: Supported the BIM lead in delivering LOD 400 architectural and structural models and routine applications such as 4D construction sequencing. Took the lead in developing innovative BIM applications to showcase project-specific highlights.

Workflow Transformation: Implemented parametric modeling for multi-connection sump pit detailing, automating 2D detailing workflows and reducing design time from 5 days to 0.5 hours. Enabled real-time design modifications during fast-track construction by integrating parametric design principles.(Figure 4)

Carbon Intelligence & Green Optimization: Calculated embodied carbon from BIM quantities, predicted and monitored emission risks of key materials in real-time. Reduced transport emissions by 28% via logistics algorithms and increased recycled aggregates in concrete to ~30%, selecting materials with lower carbon footprints.

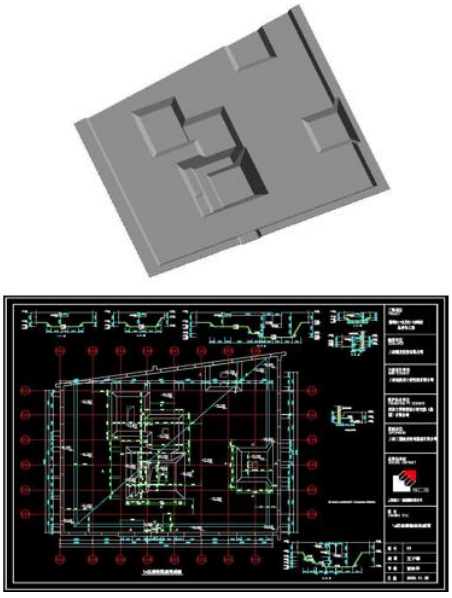


Figure 4. Concrete cushion model & Drawings via parametric detailing

Project Experience: Huaxin New City Project

(Mar 2023 – Ongoing | BIM Manager)

1. Project Profile

Location: West of Zhejiang North Rd, North of Hai'ning Rd, Jing'an, Shanghai

Scope: 551,391m² mixed-use development (390,872m^2 aboveground + 160,519m^2 basement)

Structures: 2 commercial towers (320m & 156m), 3 residential towers (147m), Podium (23.75m)

Figure 5. Huaxin New City Project

2. Core Contributions

Project BIM Management: Led full-cycle BIM implementation, coordinating architectural & structural, MEP and steel structure teams. Delivered multi-LOD parametric models for detailing and clash coordination, reducing field rework by over 30%.

BIM-Driven Detailing Reuse: Adapted and refined deepened detailing workflows from Qiantan 21 project across disciplines, enabling rapid, accurate model delivery.

Model-Based Quantity Extraction: Utilized BIM models to generate precise quantities for procurement and cost estimation, including paintable basement pipelines, self-leveling floor materials, and scenario-based take-offs.

Mechanical Design & Simulation: Led BIM-based mechanical design and Finite Element Analysis simulation of the self-climbing core platform, optimizing structural stability and anchorage. Produced 3D models and animated sequences to support site assembly.

Settlement & Inclination Monitoring: Integrated real-time sensor data into BIM for predictive deformation analysis, enabling early warnings and timely construction sequence adjustments.(Figure 6)

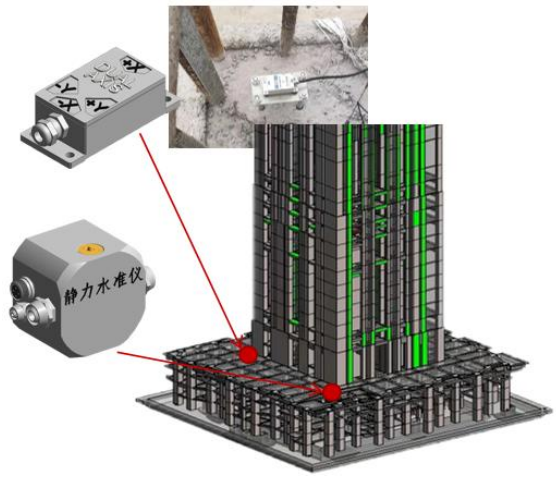


Figure 6. Installation of Static Level and Tilt Sensor in Huaxing New City Project.

Research Project: Digital Twin Applications

(Aug 2024 – May 2025 | Independent BIM-to-UE5 Development)

1. Project Profile

Executed two distinct digital twin developments using Unreal Engine 5, both integrating BIM models with real-time simulation:

Underwater Data Center (Zhuhai, Guangdong): A high-complexity build involving millimeter-precision LOD 400+ modeling of the capsule, GIS-based seabed terrain integration, and UE5-based marine simulation with fluid dynamics and real-time material systems. Simulated operational workflows for installation and maintenance via a shore-connected service lane.(Figure 7)

Figure 7. Overall Rendering of the Underwater Data Center Digital Twin Project.

Pingnan Stormwater Detention Tank: Developed an interactive digital twin focused on construction-phase safety monitoring. Integrated live and simulated data from diaphragm wall inclination, supporting beam axial force, and pile settlement sensors. Delivered dashboards and predictive charts to support real-time risk assessment and decision-making.(Figure 8)

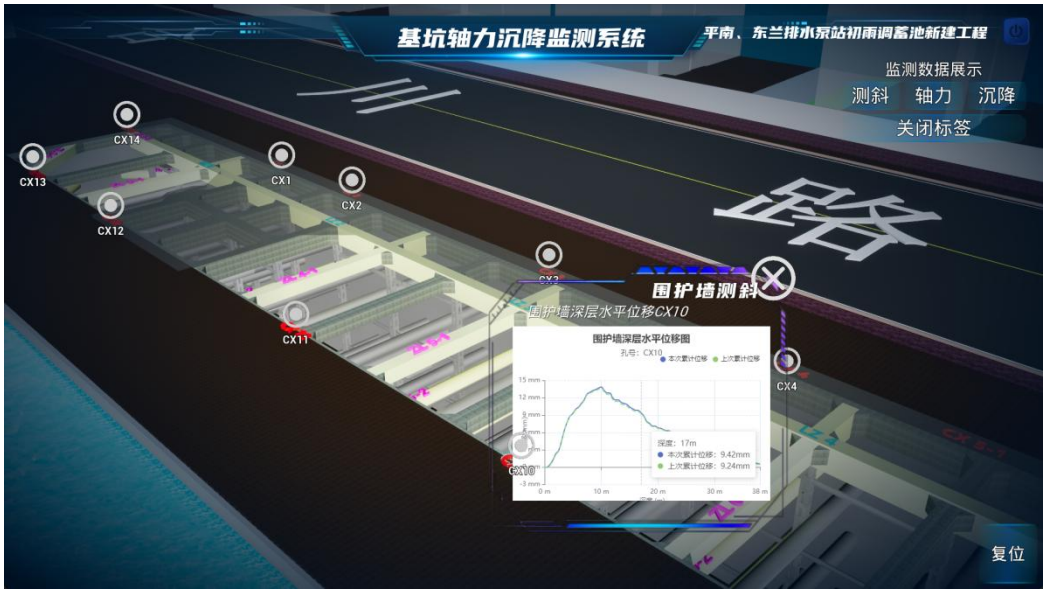


Figure 8. Digital Twin Monitoring of Diaphragm Wall Inclination in the Pingnan Project.

2. Core Contributions

Independently delivered the complete pipeline—from Revit modeling to fully interactive UE5 environments. Applied advanced real-time rendering, environmental simulation, and workflow sequencing for accurate planning. Integrated IoT and sensor data into both projects for live visualization, environmental monitoring, and predictive analytics, with scalable frameworks for future device connections.

Construction Machinery Design Support: Reinforced Concrete Core Steel Platforms

(BIM-Aided Detailing & Visualization)

1. Overview

For the reinforced concrete core construction, two large-scale mechanical systems were deployed: the integral climbing steel platform for superstructure construction and the integral descending steel platform for deconstruction.

Both machines share a structural composition of:

Top Section: Integrated steel working platform.

Bottom Section: Full-coverage supporting framework.

Middle Section: Multi-layer truss assembly.

These sections are connected via vertical steel columns.

2. Functional Principles

- **Integral Climbing Steel Platform (Construction Phase, Figure 9)**

Designed to remain fixed at a designated height during reinforced concrete core construction, with the top platform accommodating key construction equipment such as a placing boom, two luffing tower cranes, and a construction hoist.

Load-bearing during work phase: Supported by multiple corbels at the bottom section.

Lifting phase: Hydraulic jacks at the top bear on the core walls and, in conjunction with the bottom corbels, enable upward climbing.

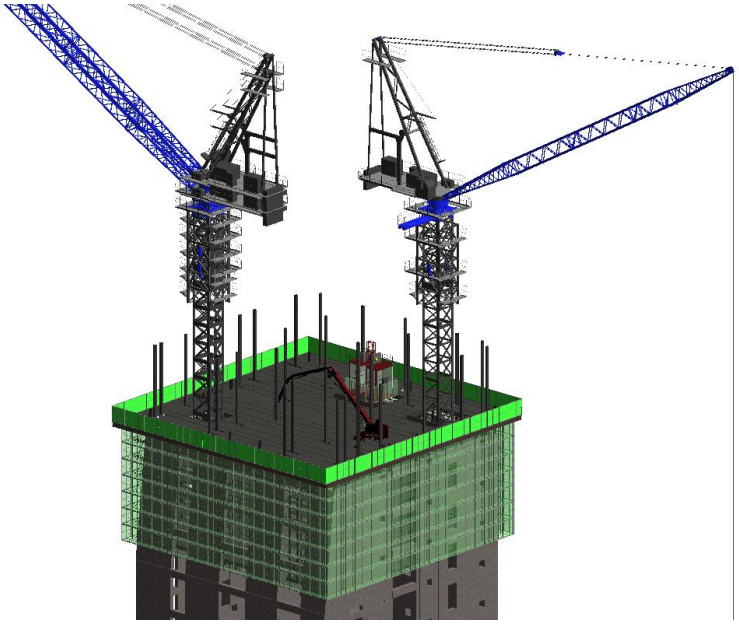


Figure 9. Design Model of the Integral Climbing Steel Platform

- **Integral Descending Steel Platform (Deconstruction Phase, Figure 10)**

Top structure replaced with a cable-stayed system.

Load-bearing during work phase: Supported by multiple corbels at the bottom section.

Lowering phase: After completing one floor's demolition, winches retract cables to lower the top guide rails onto the wall tops for load transfer, then release the bottom corbels to drop the entire platform. Alternating cycles of cable adjustment and base release achieve progressive lowering for dismantling.

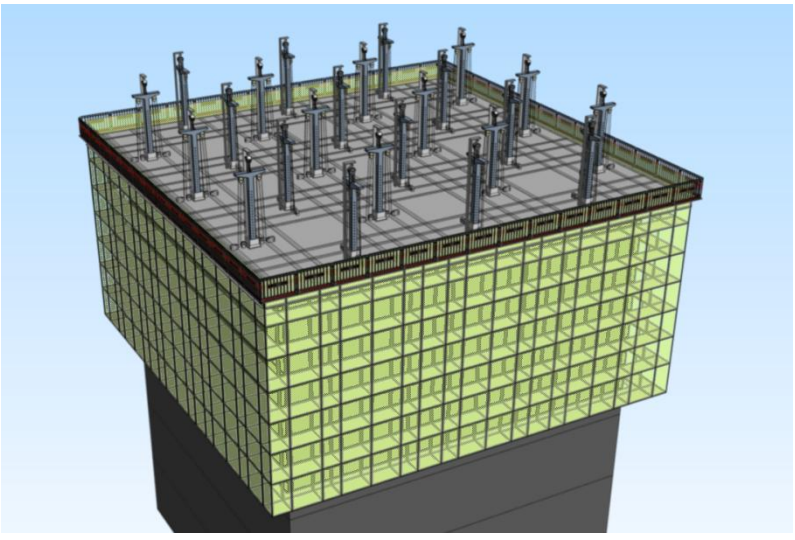


Figure 10. Design Model of the Integral Descending Steel Platform

3. BIM-Driven Design Support

Throughout the mechanical design process for both platforms, provided continuous BIM-based visualization and coordination:

Modeled all structural and mechanical components in 3D with parametric precision.

Simulated climbing/descending sequences to verify spatial clearances, load paths, and mechanical feasibility.

Supported iterative design upgrades by quickly producing visual alternatives for engineering review.

Delivered final as-built BIM models used for on-site installation guidance and operation training.

Construction Machinery Design Support: Specialized Platforms and Protective System

(BIM-Aided Visualization & Design Iteration)

1. Modular Shield Wall System

A modular exterior shielding system designed to replace traditional scaffolding safety nets for high-rise construction. The shield wall is suspended from the building facade, serving as both a dust and noise barrier. (Figure 11)

Modular Design: Panels are fabricated in standard modules for rapid assembly, disassembly, and transportation.

Dust-Tight Connections: Both ends of each panel are fitted with retractable soft curtains, enabling corner sealing and dust containment between adjoining panels.

Operational Advantages: Improves environmental protection performance while reducing scaffold erection time and cost.

BIM Role: Provided detailed 3D modeling of panel modules and connection interfaces; simulated installation sequences and corner sealing performance for design validation.

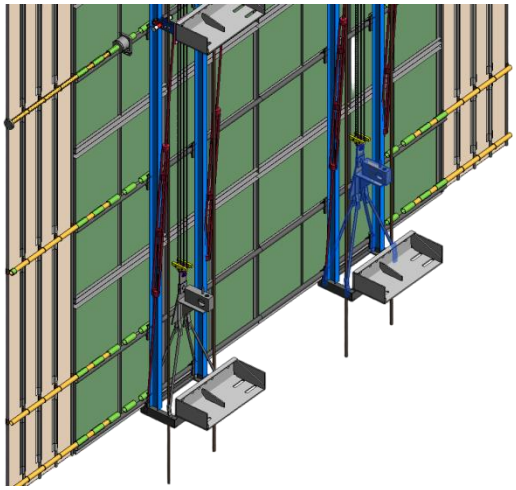


Figure 11. Design Model of the Modular Sheild Wall System

2. Self-Climbing Elevator Shaft Platform for Formwork Installation

Designed for confined 2.4m x 2.4m elevator shafts, this platform enables efficient installation and removal of internal steel formwork.

Two-Level Configuration: Consists of a top platform (equipped with an overhead steel frame for formwork hoisting) and a bottom platform, connected by a central lifting column.

Mechanical Drive: An electric motor mounted beneath the top platform powers vertical climbing.

Support Mechanism: Both platforms feature four-sided, eight-point corbel supports, which alternate to achieve safe and stable climbing.

BIM Role: Delivered precise 3D models of the platform structure and moving components; simulated climbing sequences for spatial clearance checks; optimized the design for rapid and safe formwork handling within restricted shaft dimensions. (Figure 12)

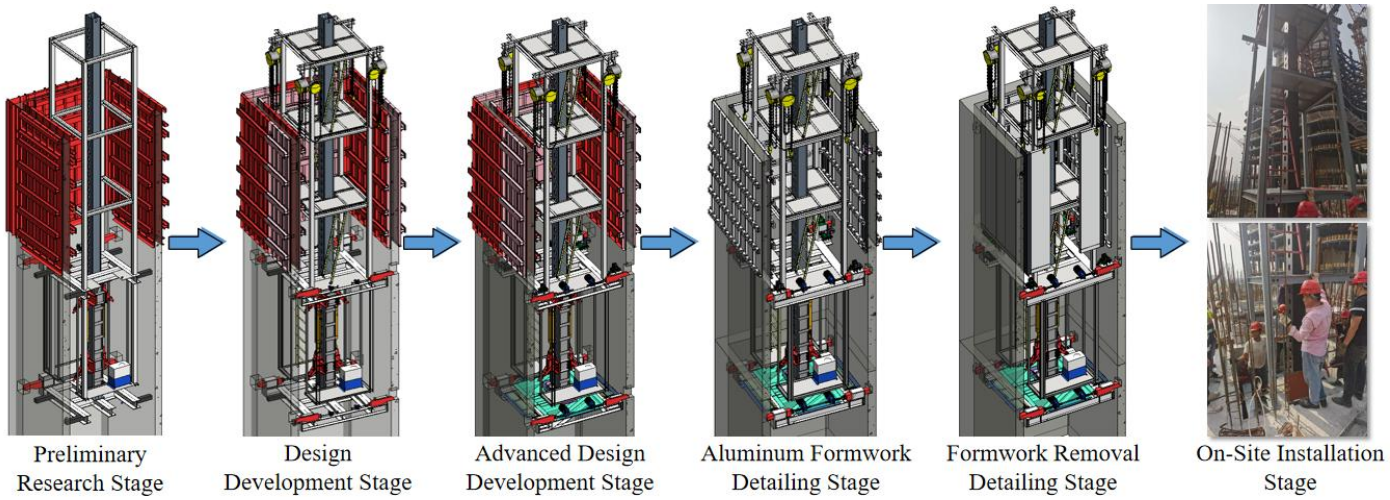


Figure 12. BIM iteration deepening and upgrading of self-climbing elevator shaft platform.

3. Self-Climbing Elevator Shaft Platform with Integrated Placing Boom (Prototype Only)

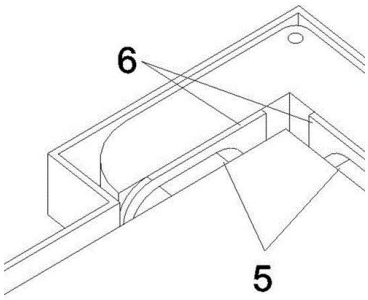
A functional extension of the Self-Climbing Elevator Shaft Platform, incorporating a concrete placing boom mounted at the top and internal pump lines for in-shaft concreting.

BIM Role: Modeled the placing boom integration and internal routing of pump lines; simulated operational reach within the elevator shaft. The concept remained at the prototype stage and was not implemented on site.

Invention Patent

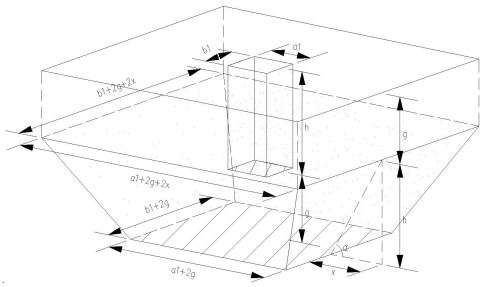
1. **Monitoring Method for Temporary Openings in Construction Sites Enabled by BIM Technology (基于 BIM 技术的施工现场临时洞口的监测方法)**
Chinese Patent No. 202110899612.9

A BIM-based method to monitor temporary openings (such as vents or access points) on construction sites. This method employs BIM models to capture and track the status of these openings in real time, enhancing safety supervision and ensuring that temporary structures maintain compliance throughout construction.



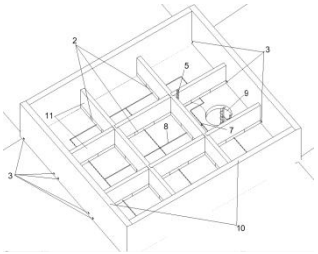
2. **Method for Modeling Multi-Connection Sump Pit Using BIM Technology (一种基于 BIM 技术的多联集水井建图方法)**
Chinese Patent No. 202110847145.5

A BIM-driven approach to modeling multi-junction sump pits. This method automates the creation and detailing of interconnected catchment wells within the BIM environment, significantly improving accuracy and reducing manual modeling time.



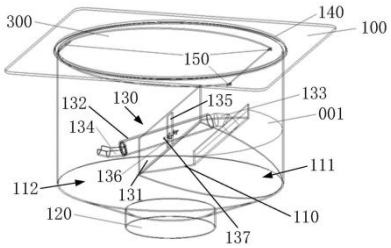
3. **Irrigation System for Sloped Roofs with Soil Cover (一种斜屋面覆土建筑的浇灌系统)**
Chinese Patent No. 202211560163.6

An irrigation smart system designed specifically for sloped roofs that are covered with soil. The system integrates controlled water distribution channels applicable for green roof applications, optimizing irrigation efficiency and promoting vegetation growth.



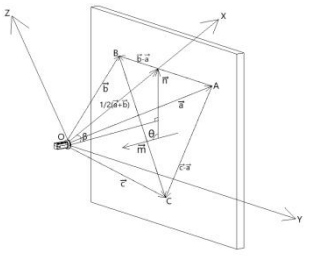
4. **Self-Sedimenting Capillary Floor Drain (一种自沉淀过滤毛细地漏)**
Chinese Patent No. 202211560167.4

A novel floor drain system that employs capillary action to enable self-sedimenting filtration. Designed to separate and retain sediments at the drain inlet, the system enhances drainage efficiency while reducing clogging and maintenance frequency.



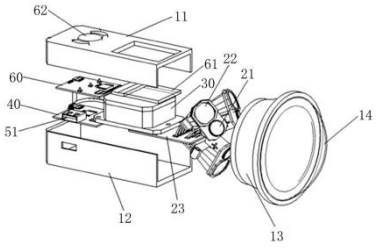
5. **Wall Verticality Measurement Method Based on Vector Computation and Laser (一种基于矢量计算的墙面激光测垂方法)**
Chinese Patent No. 202211120084.3

A method combining vector calculations with laser-based measurements to determine the vertical alignment of wall surfaces. Utilizing BIM platforms, this method enhances accuracy in detecting plumbness deviations in real-world walls and supports precise quality control during construction.

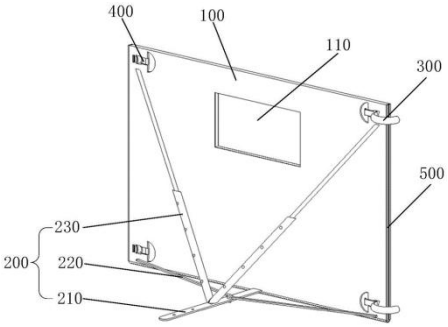


6. **Wall Verticality Laser Measurement Instrument (一种墙面激光测垂仪)**
Chinese Patent No. 202310030508.5

An instrument specifically created to measure the plumbness (vertical alignment) of wall surfaces using laser technology. Intended for high-precision verticality assessments on construction sites, offering faster and more accurate readings compared to manual methods.

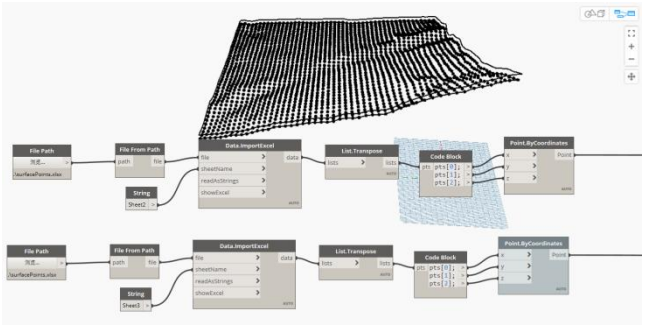


7. **Multi-Functional Guardrail and Its Usage Method**
(一种多功能护栏及其使用方法)
Chinese Patent No. 202310347355.7



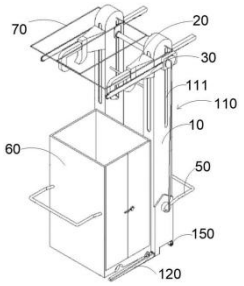
A versatile guardrail system designed for dual purposes: directing and controlling pedestrian flow during evacuation scenarios, and serving as a water-blocking barrier on uneven ground surfaces. The guardrails can be interconnected at various angles to form flexible layouts, and their modular design allows for quick disassembly and compact storage when not in use.

8. **Adaptive Skin Modeling Method on Terrain Surface Based on Dynamo and Revit**
(基于 Dynamo 和 Revit 的地形曲面上自适应表皮建模方法)
Chinese Patent No. 202310399129.3



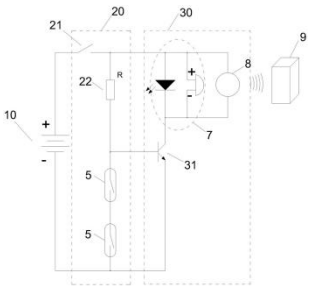
A modeling method that leverages Dynamo (visual scripting for Revit) combined with Revit's API to adaptively generate building skins (facades or surface structures) on complex terrain surfaces. This method enables flexible surface modeling that conforms to topoFigureic variations, improving design adaptability and efficiency.

9. **Integrated Cable-Tray Dismantling and Recovery Machine**
(一种电缆桥架拆除回收一体机)
Chinese Patent No. 202310738599.8



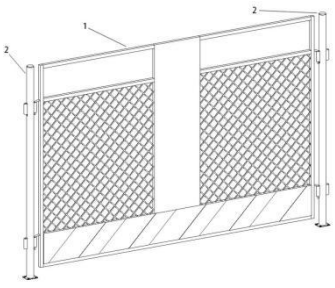
A mechanized system that combines dismantling and material recovery functions for cable trays on construction sites. The device automates the safe detachment of cable tray segments, collects recovered metal components, and reduces manual labor and on-site waste handling. Designed to improve efficiency during renovation or dismantling works and to streamline recycling logistics.

10. **Safety Protection System for Construction Sites**
(一种用于施工现场的安全防护系统)
Chinese Patent No. 202110899613.3



An integrated safety-protection solution tailored for construction environments. The system likely combines physical protective devices, sensor-based monitoring, and alerting mechanisms to prevent accidents and enforce safety zones. It aims to provide continuous site protection, automated hazard detection, and rapid response support for on-site personnel.

11. **Monitoring Circuit and Intelligent Guardrail Upright Post**
(一种监测电路及智能护栏立杆)
Chinese Patent No. 202110899621.8



A monitoring circuit designed to be integrated with guardrail upright posts, enabling the posts to report status information (e.g., connection integrity, impact events, tilt). The invention supports smarter safety barriers that can detect anomalies, feed data into site monitoring systems, and trigger maintenance or emergency procedures.

Published Paper

Paper: *The Deepening Design Technology and Application of Multi-Sump Based on BIM Technology*
Authors: Zhou Zhenquan, Wang Zirui
Published in: Building Construction (China), Issue 9, 2022
Affiliation: Shanghai Construction No.1 (Group) Co., Ltd., Shanghai 200120, China

Abstract:
This paper addresses the inefficiency and inflexibility of traditional deepening design methods for collecting wells. It proposes a BIM-based multi-sump deepening design technology that streamlines data processing and drawing tasks, eliminates manual errors, and allows for rapid adaptation to design changes and temporary construction optimizations. By adopting this digital approach, the process delivers more accurate drawings and data to guide on-site construction, significantly reducing the workload of technical staff and improving design efficiency.

Keywords: BIM; collecting well; deepening design; parameterization

数 字 建 造 DIGITAL CONSTRUCTION

基于BIM的多联集水井深化设计技术

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摘要：针对传统集水井深化设计方法工作量大、不便于修改的情况，提出了基于BIM的多联集水井深化设计技术，简化了数据处理及绘图的工作内容，避免了传统深化设计时的人工误差，并能较快地响应设计变更调整，满足施工临时优化需要。通过这种数字化深化设计技术，可以得到更精准的图纸和数据，用于指导施工，减少技术人员的工作量，提高深化设计的工作效率。

关键词：BIM；集水井；深化设计；参数化

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Deepening Design Technology of BIM-based Multi-catchment Wells

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Abstract: In response to the traditional catchment well deepening design method with large workload and inconvenient modification, the deepening design technology of BIM-based multi-catchment well is proposed, which simplifies the work content of data processing and drawing, avoids the manual error in traditional deepening design, and can respond to design change adjustment faster to meet the need of temporary construction optimization. Through this digital deepening design technology, more accurate drawings and data can be obtained for guiding construction, reducing the workload of technicians and improving the efficiency of deepening design.

Keywords: BIM; catchment well; deepening design; parameterization

在垂直电梯的电梯间底部，需预留足够空间以加装轿厢缓冲器、导轨、对重等元件[1]。而建筑领域对于电梯间底部所形成的电梯井的施工较为复杂，需在最底层大底板面向下开挖后，以一定角度平整开挖面再浇筑混凝土垫层，在垫层上设置支架并铺设钢筋，在集水井位置处设置模板后浇筑，形成具有一定深度的电梯井。

在电梯井附近通常会设置集水井，收集产生的余水。建筑层高较高时，需多部电梯同时运作，电梯井之间的间距较小。另外，考虑建筑功能，还需设置大小、深度不同的其他功能的井坑，此处统称为集水井。工程中常见的情况是在较小范围内有多个集水井存在，且其放坡面互有影响，故将其区域所包含的多个集水井统称为多联集水井。

1　存在的问题

在传统多联集水井深化设计中，先要根据技术要求和布置原则手动计算，定下放坡角度，确定底面放坡边线；再根据混凝土底板厚度、集水井挖深和放坡角度，使用三角函数确定顶面放坡边线的位置，并在平面图中进行绘制，得到最初深化设计图；此外，技术人员需考虑现场施工的可行性，对多个集水井之间叠合位置进行二次深化设计，将挖土坡度和平台标高进行合理排布和规划，绘制“土方开挖面放坡图”和“垫层完成面放坡图”；技术人员在得到上述2张放坡图后，需通过手动计算和空间想象力绘制对应位置的剖面详图。在实际工程中，设计和施工工作同步进行。设计时并非所有节点均能面面俱到，较多图纸问题在实际使用时才发现，加上业主修改方案、设计院频繁更新等，都对深化设计工作造成了较大的负担[2]。

由于施工中需持续提交对应版本图纸进行多方会审，较多节点无法在设计院发送蓝图后再进行深化设计，需使用先行版本的图纸进行深化设计，其间任何变更均会导致该节点深化设计内容需重新制作，传统深化设计方法在此过程中会产生相当大的计算量，且产生的数据较多，在计算及绘图中均易造成人工误差，影响施工质量[3]。

2　基于BIM的多联集水井深化设计技术

为了提高深化设计工作质量和效率，尝试引入数字化施工的BIM技术解决上述问题，通过BIM技术的参数族、三维可视化等特点，在深化设计过程中，在遇到设计变更

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确定了多联集水井深化设计原则后，继续布置其余集
包含的6个集水井构件参数族，将其设置为不同
使其在调整参数时互不影响，将完成赋值的集
导入到项目中，放置于1a区对应位置上，形成
深化设计图，并可进行放坡线的输出（图3）。
水井参数族模型相交时在交界处会形成线段，

模型图像及数据内容的比例与各公司轻量化平台的预设方式相关，用户无法自主控制模型需要展示的内容，只能通过平台预设展示涵盖一定预设内容的模型。

在对大量平台及软件进行对比测试后，发现Fuzor软件及其移动端轻量化应用软件Fuzor Mobile具有独特的存储与展示方式，能够较好地满足BIM部门与施工技术部门对
zor Mobile根据用户在Fuzor软件中预设
，读取其包含信息，对内容进行展示。
目的现场管理来说较为实用，且轻量化
件的体量较小，便于查看，其包含的标
能对于其他轻量化平台也更为实用，其
轻量化平台中也较优，能较好地满足项
的需求，减轻操作人员的负荷（图5）。

（b）模型中对施工问题的标注

阶段发现问题时通过Fuzor Mobile标注

轻量化方法较好地将各部门进行了串
节点处重复工作的情况，有效提高工作
携及无需网络即可进行轻量化内容查看
准确收集井标记现场问题所在，提高了
的工作效率与问题收集、反馈的效率。

中的应用对比研究，实现了基于BIM的
设计技术在集水井深化设计功能下的简
有效减少了技术人员的工作量，缩短约
该方法避免了传统深化设计过程中可能
提高了深化设计成果精度，相比传统深
法还能获得三维模型，可用于指导现场
不仅能在较短的时间内提供更多、更精
能在发生设计变更时快速响应调整。

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图2　集水井参数族各边的参数示意