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Research on the development of integrated model of rural planning, design and construction based on BIM technology

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Abstract In order to better promote the strategy of rural revitalisation, this paper proposes an integrated model of rural planning, design and construction integrating BIM technology. Firstly, the BIM technology is systematically described, and the rural planning and design based on BIM technology is constructed from the four dimensions of infrastructure, agricultural industry, service facilities and rural landscape. In addition, the design of the construction integration model based on BIM technology is completed by integrating the local advantages of good natural resources around the countryside. Combined with the research dataset, the model of this paper is empirically analysed. Compared with point 2 (37.14%) and point 3 (23.76%), point 1 (79.52%) is more significant in the area of high visibility of rural buildings, similarly, the technology can be expanded to agricultural industry planning, service facilities planning, rural landscape planning and other areas, the construction integration model based on BIM technology greatly improves the implementability of the design scheme, and also makes construction The reduction of building energy consumption has reached 16.01%, which accelerates the pace of rural planning, design and construction, and is of great strategic significance for the sustainable development of rural economy.

Index Terms BIM technology, rural planning and design, construction integration model, sustainable development

I. Introduction

Rural planning and design refers to the process of rational utilization and integrated planning of rural land resources, natural environment, population, industry, infrastructure, cultural heritage and so on [1]. In recent years, with the increase of national investment in rural construction, rural planning and design has made remarkable progress. On the one hand, the planning and design concepts are constantly updated, focusing on the organic combination of ecological protection, cultural heritage and industrial development, and striving to protect the rural landscape while promoting the sustainable development of rural economy. On the other hand, the planning and design means are also increasingly rich, with the help of modern information technology and big data analysis, realizing the precise configuration and efficient use of rural resources [2], [3].

Building Information Modeling (BIM) technology has a development history of more than twenty years since its birth, and has experienced a development process in the domestic construction industry from building forward design, construction management to the application of the whole life cycle of the building. In recent years, the application of BIM technology has gradually matured, forming specialized BIM application solutions for different industries. Building information modeling is an engineering data model based on three-dimensional digital technology that integrates all kinds of information related to construction projects and supports an integrated management environment for construction projects [4], [5]. From the trend of development, the information technology in building design has developed from computer-aided building design to information-based building design, and the application of BIM technology is conducive to the implementation of rural planning and design and design and construction integration to improve the quality and duration of rural buildings, and to provide a reference for solving the many challenges faced in the current rural development [6], [7].

The innovation of this paper lies in the perfect integration of BIM technology into the integration of rural planning design and construction, so that the construction efficiency and quality can be guaranteed. Based on the characteristics and functions of BIM technology, a BIM technology-driven rural planning design and construction integration model study is proposed. Rural planning and design is a design work encompassing multiple dimensions, accordingly, the rural planning and design based on BIM technology is constructed from the four dimensions of infrastructure, agricultural industry, service facilities, and rural landscape. The construction integration model based on BIM technology is constructed to optimise the construction aspects of rural planning. Take a certain countryside as the research background, with the help of the model in this paper to carry on the example analysis.

II. Overview

(1) Rural planning and design based on BIM technology

Rural planning and design, as an important part of rural revitalization strategy, is of great significance in promoting rural development, improving rural environment and enhancing the quality of life of rural residents. Literature [8] constructed a building information model using geographic information system (GIS) technology and building information technology (BIM) theory, and applied it to urban and rural planning, and also proposed the concept of urban-rural integration. Literature [9] pointed out the importance of rural landscape planning and design, and after analyzing the difference between BIM and traditional landscape design software, it proposed a rural landscape planning and design strategy based on BIM in order to better improve the living standard of rural residents. Literature [10] systematically reviewed the literature on the application of building information modeling (BIM) in the design and planning of rural settlements in China, and analyzed that the knowledge management capability and simulation modeling capability of BIM can effectively provide information support and knowledge assistance for the entire design and planning stage of rural settlements in China, so as to achieve the optimization of the environment of rural settlements, improvement of living comfort, collision detection, disaster prevention and mitigation, and reduction of expenditures, expenditure reduction and other purposes. Literature [11] attempted to modify Building Information Modeling (BIM) from a rural perspective and apply it to rural infrastructure (RI) projects with the aim of overcoming the instability in terms of barriers faced in RI projects, and the study provides reference value for urban and rural planning and design. Literature [12] takes the problems and requirements of rural habitat planning as an entry point, proposes the strategy of applying BIM technology in rural natural environmental protection, rural industrial development planning and rural infrastructure construction, and takes Leaping Village as an example to conduct empirical analysis, and the results verify the effectiveness of the proposed strategy, which to a certain extent promotes the rural revitalization and the construction of new socialist countryside. Literature [13] takes the historical rural residence in Bursa, Turkey as a real case to explore the application effect of the proposed knowledge-embedded H-BIM method in vernacular architecture, and the results of the study show that the proposed H-BIM method can effectively protect the historical vernacular architecture and provide technical support for the rural planning and design. Literature [14] tries to introduce BIM technology in the construction of leisure agriculture landscape project to visualize the designer's creativity and intention, which in turn improves people's living experience, and the study promotes the self-recovery ability of urban ecosystem to a certain extent, which provides reference significance for urban and rural planning and design.

(2) Construction integration based on BIM technology

The long-term strict separation of design and construction has brought many problems to modern project management. In recent years, the rapid development of building information modeling (BIM) has brought new ideas to solve the problem. Literature [15] constructed an integrated evaluation system for green port construction based on BIM technology, and the results of empirical analysis showed that the model can accurately, effectively and reliably evaluate the effect of integrated green port construction, which further improves the sustainable development level of green port construction. Literature [16] highlights the importance of effective risk management for the successful implementation of modular integrated construction projects and proposes the direction of risk management for modular integrated construction based on Building Information Modeling (BIM), in order to provide a useful reference for its future practice and improvement in the industry. Literature [17] indicated that GIS can be utilized to manage the information resources of construction projects, and pointed out that GIS can complement the functions of BIM to a certain extent, and a systematic construction platform can be developed based on GIS and BIM technologies, which is of great significance in overcoming the deficiencies of construction applications. Literature [18] summarizes the trends and challenges of the integrated application of BIM and related technologies in the whole life cycle of construction from the aspects of management, technology and promotion, in order to provide reference value for the risks and challenges faced by the industry in the future. Literature [19] pointed out the influencing factors of construction progress management under the traditional mode, proposed a construction progress management method based on BIM model and BIM5D software, and verified the validity of the proposed method through the analysis of practical application, which can monitor the construction quality and safety issues in time. Literature [20] examines the application effect of BIM technology in assembled buildings from several aspects of the design stage, construction assembly stage, operation and maintenance stage, and the application analysis of related software, aiming to improve the development of high efficiency, high quality, and high precision of assembled projects, and providing new ideas for the development of assembled buildings. Literature [21] systematically reviewed the trends and opportunities of Building Information Modeling-GIS integration in the architectural, engineering, and construction industries from the perspective of spatio-temporal statistics, and proposed the hypothesis that BIM-GIS integration can be more comprehensively applied through the life cycle of AEC projects. Literature [22] designed a BIM platform supporting Radio Frequency Identification Devices (RFID) and applied it to the construction of assembled houses, and experimentally proved the feasibility of the proposed platform, which can effectively solve the schedule delay problem encountered in the construction of assembled houses, reduce the risk of prefabricated house construction, and improve schedule performance.

III. Rural planning design and construction modelling incorporating BIM technology

III. A. Introduction to BIM technology

III. A. 1) Concept of BIM

Building Information Modelling (BIM), abbreviated as BIM, is the most important information management tool in the construction industry [23], [24]. Building refers to the real-life physical space, Information refers to the data and information contained in the physical space structure, which is the core of the BIM technology. Modelling is the carrier of data and information, which is the foundation of the BIM technology. The focus of BIM is not on the software itself, nor just creating the model. The focus of BIM is on 'information sharing'. The focus of BIM is not on the software itself, nor is it just about creating a model, the focus of BIM is on 'information sharing', the 3D model referred to in BIM technology is not simply a spatial figure formed by geometric elements, but a data model that contains information about a solid object [25], [26]. With the continuous superposition of data information, 3DBIM can be expanded to 4D, 5D, nD. superimposed on the time parameters of the 3D model forms a 4D model, which can be used to dynamically simulate the construction process, 5D BIM is the cost of costs into the model, the project-related financial data can be more three-dimensional image of the display.

III. A. 2) Characteristics of BIM technology

BIM is a technology that digitally presents and manages physical building objects and their functional characteristics through information data models. A well-stored and standardised digital model of a building can link the construction data and information resources generated by various processes such as building design, production and use, and it is a comprehensive description of the construction process and physical characteristics of the construction products and most of these data should be effectively used by all the participants of the construction project. effectively used by all participants in the construction project. It has the following 5 major features:

(1) Visualisation is a significant difference of BIM technology compared with traditional 2D technology, BIM changes the traditional expression of point-line-plane geometry, and displays the spatial entity in the form of 3D simulation model.

(2) Coordination is one of the important features of BIM technology, which is the technical basis for the change of the way of work of the participating units of the project. In the whole process of project construction, all the parties involved in the construction are always coordinating and cooperating with each other.

(3) The simulation of BIM can simulate various scenarios in the real environment in the virtual space, which can help designers to achieve simulation design for the functional requirements of the building.

(4) The design optimisation feature of BIM can effectively avoid the design obstacles brought about by the limitations of designers and untimely communication of information, and realise the timely optimisation of the scheme, while the related information in the BIM model can be updated in real time, which greatly improves the design efficiency and quality of the project planning scheme.

III. A. 3) BIM-related software

BIM software types and main application scope as shown in Table 1, according to the type of software can be broadly divided into modelling software, structural analysis software, visualisation software, performance analysis software, cost management software and so on.

Table 1: BIM software type and main application range

Software type	Major software	Main application
Core modeling software	Revit series software Bentley ArchiCAD	Architectural design, structural design Meter and equipment installation Plant design Architectural design
Structural analysis software	PKPM	Structural design analysis
Visualization software	3DS Max, Artlantis, AccuRender, Lightscape	Model scene presentation
Model integrated collision check software	Autodesk Navisworks, Glodon, Luban Software, BIM drawing review software	Pipeline comprehensive program optimization, Collision detection
Cost management software	Luban Software and Guanglian Software	Engineering cost analysis and management

III. A. 4) Introduction to BIM functionality

Traditional 3D technology conveys only visual information such as colour, shape, etc., and the model does not incorporate more building information data, while the biggest feature of BIM technology is the integration of building data and information, which integrates 2D paper data and electronic data and information to form a BIM shared database as shown in Figure 1.

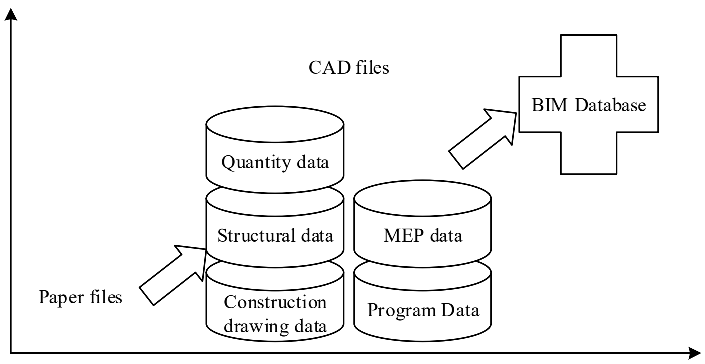

Figure 1: Schematic diagram of the BIM technical data integration

The main modelling software used in this paper is Autodesk Revit 2016.The use of families in Revit software helps to better data management and modification, which is the basis of all the elements.The types of Revit's elements mainly include datum elements, model elements and view elements. These three types of elements include a variety of different families, and the basic framework structure of Revit elements is shown in Figure 2. According to the needs of the designer, different parameter variables are assigned to the elements, and by modifying the family attribute parameters to meet the diverse requirements of model design, a series of model elements such as axis network elevation, walls, beams and columns, reinforcement bars, doors, windows, floor slabs, roofs, staircases, curtain walls and other model elements are created, and the terrain model of the site is created through the geographic information parameters.

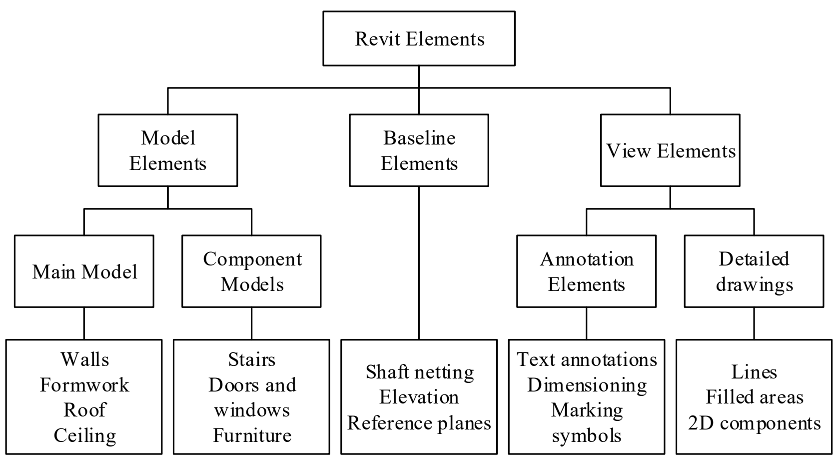

Figure 2: The basic framework structure of the Revit element

III. B. Rural planning design based on BIM technology

The formation process of the rural planning and design programme makes full use of the characteristics of BIM technology to ensure the scientific rationality of the whole planning and design process. Because the whole master planning and design programme is large in length, the following four important contents are introduced from the infrastructure planning programme, agricultural industry planning programme, service facilities planning programme and rural landscape planning programme, in order to fully prove that the planning and design based on BIM technology is more scientifically sound and more in line with the actual situation of the project area.

III. B. 1) Infrastructure planning programme

According to the status quo information and relevant norms, combined with the real-life three-dimensional model and infrastructure BIM model, the infrastructure of the project area for systematic analysis and planning, the project area without 10KV cable trench within the lot, allowing low-voltage cables buried directly. In principle, the medium and low voltage power lines are laid in the ground by cable trench, if the current situation is difficult to implement underground, except for the main roads and squares and other landscapes in the area need to be laid underground, you can consider the local overhead poles and roads along the road regular erection. Lighting power supply should be from the power distribution room of the power load centre, unified management. The source of domestic water supply in the project area is urban water supply the source of domestic water supply in the project area is urban water supply. According to the limitation of site conditions and the principle of ecological protection, the road system of the project area does not carry the function of large-sized motor vehicles, but mainly connects various attractions with rural roads and walking trails.

III. B. 2) Agro-Industrial Planning Program

The agricultural industry as a whole shows the layout of “front flowers and consequences”. Front of the mountain agricultural planning to plant economic foliage forest, woody flowers and seasonal flowers mainly, not only can produce its own economic income, but also can be used as a science and cultural and creative display area, sports and fitness recreation area, comprehensive service center of the natural landscape for tourists to sightseeing excursions. The back of the mountain and Jinyun Mountain Nature Reserve adjacent to the current planting of loquat, rice, citrus and other economic crops, planning in principle to retain the existing crops, the distribution of scattered crops transplanted together, moderately expanding the scale and varieties of improvement. Under the premise of ensuring basic agricultural production, some research centers, processing workshops and agricultural experience projects are moderately planned. In addition, on the basis of ensuring the transportation needs of agricultural production, two main excursion routes (picking experience route and sightseeing experience route) are planned according to the needs of agricultural tourism and the characteristics of industrial distribution.

III. B. 3) Service Facilities Planning Program

After a full investigation of the project area and combining the results of professional collaboration with the BIM collaboration platform, a few snack kiosks are constructed at the same time to satisfy the dining needs of the public tourists in the park, and the food and beverage should be with local local characteristics. The visitor service center and the flower supermarket at the entrance can be used by tourists to select special souvenir commodities related to the flower theme. In addition, it is recommended that all ecological flush-free toilets be used in the park, with the natural absorption method of fecal matter treatment, rather than chemical cleaning of toilets or centralized pipeline treatment. The toilets should be built with a service radius of 300 meters, and be located in places with frequent visitor activities and more secluded terrain, with signage.

III. B. 4) Rural Landscape Planning Program

Combined with the topography of the planning area, landscape viewpoints and the characteristics of each landscape node, the planning area landscape node is summarized as the natural world of fifteen scenes. The project includes: plant science museum, insect kingdom, elf kingdom, cultural and creative base, colorful terraces, garden farms, national medical hall, ancient exploration, plant research center, Jinyu Academy, bird forest garden, firefly valley, love valley, fisherman's paradise, beibei memory culture wall. To enhance the image of the planning area, highlight the characteristics of the planning area as the goal, in accordance with the principle of people-oriented, landscape diversification, shaping the colorful style, creating a unique waterfront landscape in the planning area. Retain the existing style of rural areas in the area, repair damaged and old buildings and original landscapes with native materials, and appropriately increase greening at corners and courtyards and three-dimensional plant landscapes such as hedges and flower walls. In addition, it is necessary to combine the seasons and the growing status of crops to create agricultural production landscapes that are different and distinctive in all seasons.

III. C. Construction integration model based on BIM technology

III. C. 1) 3D Design Modeling

The modeling software used to build the architectural BIM model of this project is Revit Architecture, and the structural BIM model is built using Revit Structure. The center file is created before modeling, and the head of the BIM team divides the permissions of each profession on the collaborative management platform and stipulates the work content of each profession. In modeling, is first analyze the design drawings, understand the design concept and design content of the case project, simulate the modeling process of each design stage in the design and construction integration. In the scheme design stage, the overall framework of the building is determined, the project area is divided, the preliminary design model is created, and then the preliminary design model is gradually deepened to the construction drawing design model according to the requirements of the design content.

III. C. 2) Model checking and collision detection

Since this project provides a set of design drawings before the model is built, when the model is checked after the design model is built by each specialty, the model completeness review is completed based on the comparison of the drawings and model information. It realizes the review of single-specialty design model and deepening design within the specialty. For collision detection, the collision detection of integrated pipelines of electrical, HVAC, water supply and drainage majors is carried out first, and then the collision detection of integrated pipelines of electromechanical majors and BIM models of building structure majors is carried out. A total of 288 structural conflicts and 564 E&E conflicts were found in the project. The collision detection results are displayed in the form of reports, and by exporting the reports, the location of the conflict and the collision situation is clear, and the collision problems and solutions can be visualized without opening the software.

III. C. 3) Integrated pipeline optimization

After integrating the collision on the model, the collision results are still analyzed, and for the collision between pipeline and structure and between pipeline and pipeline, the pipeline is deepened according to the principle of pipeline integrated collaborative deepening, and the deepening contents are recorded and uploaded to the collaborative management platform in a timely manner during the deepening process. Under the condition of meeting the design requirements, the pipeline layout is carried out, and the layout plan is simulated and deepened. When multiple solutions are proposed for pipeline problems, it is necessary to simulate and compare and analyze the multiple solutions to choose the optimal comprehensive pipeline layout plan.

III. C. 4) Layout and Optimization of Support Brackets

It is necessary to pay attention to the design of integrated support hangers, for these parts of the BIM professional engineers communicate with the BIM person in charge and the design department in time to formulate the integrated support hanger program for the pipeline, so that compared with the different pipelines individually arranging pipeline supports, it can save the amount of electromechanical auxiliary materials, and at the same time, make the pipeline arrangement more neat and beautiful. After the collision detection is completed, make appropriate modifications to the support hangers, click Mechanical Analysis, and generate the mechanical analysis calculation of the support hangers.

III. C. 5) Optimization of pre-drilled holes

The model after integrated deepening design of pipelines is imported into Ruban BIM works, and the collision detection function of the software is utilized to check the collision conflicts between the electromechanical pipelines and the building structure model, and accurately locate the reserved holes by using the collision points. This project utilizes the building structure model and electromechanical model to check the reserved holes drawn at the design stage. In Luban BIM works software, according to the rules of hole checking, the model is checked for holes, and the results are viewed, and the holes are automatically generated for the integrated pipeline layout model, and the data of the holes are exported. According to the generated results of reserved holes, the management of reserved holes can be carried out to reduce rework in the later construction and avoid the loss of construction period. After calibration, it is found that in this case, according to the collision detection results, 42 new reserved holes are added, 6 reserved holes are deleted, and 25 reserved holes are modified. In the traditional mode, the designed reserved holes are very prone to deviations and errors and omissions in the actual construction process, leading to the lag of the installation project and the need to waste a lot of time reworking, resulting in the optimization of the construction on the project site is often done while working, and this approach obviously brings about delays in the construction period and cost increases. Based on the BIM technology of cavity optimization can be a perfect solution to this problem, deepen the processing of the model can be directly derived from the reserved holes positioning map, can directly guide the construction personnel to carry out the construction, can be realized completely according to the construction plan.

III. C. 6) Construction program simulation

According to the construction deepening model, the person in charge of each specialty carries out feasible analysis of the construction deployment within their own specialty, and further refines and perfects it. In the construction stage, the general contractor can simulate and analyze the configuration of manpower, materials and machines, working surfaces and construction processes at the construction site through the 4D model construction simulation to determine whether the space requirements for multi-disciplinary construction operations are met and optimize the construction plan. Before the construction of the project, the general contractor, according to the drawings and model analysis results, drew up the construction deployment of the project, the BIM team according to the deployment of the construction of the BIM model for the split, each object is given to the progress of information to complete the creation of the 4D model, through the construction simulation found that there are a number of construction organization problems in the part of the construction of the construction of the various construction conflicts are more, the BIM team needs to organize timely professional coordination meetings on the construction organization problems and interspersed with the flow of the construction. The BIM team needs to organize professional coordination meeting in time to discuss the construction organization problems and the interspersed running water construction plan, and come up with the deepening treatment plan to solve the problems, and the BIM team carries out the construction simulation on the deepening plan to judge the correctness and reasonableness of the deepening treatment plan.

IV. Example analysis of the integration of rural planning, design and construction

IV. A. Example analysis of rural planning and design

IV. A. 1) Regional visualization application study

Through the relationship between buildings, the regional visibility can be calculated. Regional visibility is a scientific guide for the placement of fire prevention facilities, which play a decisive role in disaster prevention and mitigation. A county has a large area of high-density, low-rise building complexes, which are a major fire hazard because most of the housing structures are brick and wood and are old. Village streets and lanes are narrow, fire engines can not enter, so only additional fire prevention equipment and reasonable placement to play a preventive and mitigation effects. Due to the disorderly arrangement of village buildings, the main streets and lanes are irregular and long, the visualization degree of fire protection equipment plays a decisive role in disaster prevention and mitigation. By experimenting and comparing the different placement of fire protection equipment, the effective placement of fire protection equipment can be carried out, and the degree of visualization of the street area for the three test points is shown in Figure 3. The overall model of the street is input into the calculation software, and the three experimental points are identical except for the difference in placement location. Cells were made in units of each square meter, with the highest surrounding building as the set height, in order to calculate the visibility degree 3D data model. The calculation software was used to obtain the percentage of each unit area that had a direct view of the fire apparatus, referred to as the visibility percentage, by performing calculations on each cell. The percentage of visibility is divided into + equal parts, and displayed in different colors, in the evaluation process will be 0% ~ 30% set for the visibility of low regions, 40% ~ 70% set for the visibility of the region, 80% ~ 100% set for the visibility of high regions. Using the average possible human height of 1.72 meters as the reference plane, the degree of visibility of the three placement test sites was calculated separately. The areas of different colors were sorted and calculated to derive the test data of different locations, and the three experimental data were compared to draw relevant conclusions.

Facility visibility Area 1 Facility visibility Area 2 Facility visibility Area 3

Figure 3: The street area is visible to three test points

IV. A. 2) Analysis of research findings

Figure 4 shows the relative visualization degree of the three test points. the high visibility area of point 1 (79.52%) performs better than that of point 2 (37.14%) and point 3 (23.76%), and in the case of fire and other emergencies, the probability that residents and tourists can directly see the fire prevention equipment is the highest in the street, which can minimize the probability of fire spreading, and carry out the work of disaster prevention and mitigation effectively. Similarly, through the application of BIM technology, the regional visualization calculation can provide strong scientific support and reasonable suggestions for the planning of agricultural industry, service facilities, rural landscape planning, tour route arrangement and placement of disaster prevention and mitigation facilities in traditional villages.

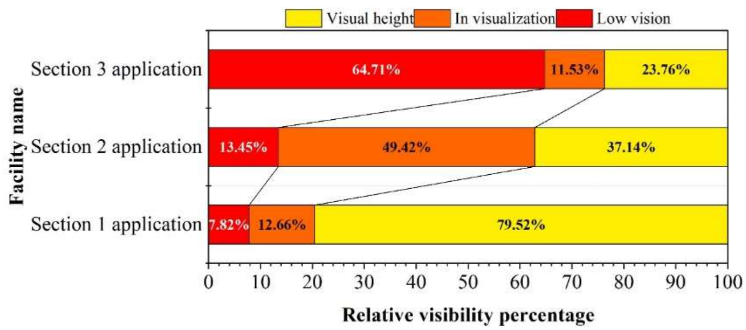

Figure 4: The relative visual degree of the test points in three

IV. B. Construction Integration Model Validation Analysis

IV. B. 1) Summary of works

Starting from the village arable land to break the distribution of fragmentation, increase the rate of construction land, ecological land and spatial planning in a reasonable and orderly manner, through the comprehensive remediation of planning and designers, we expect to solidly promote the rural construction land consolidation, integration, and do a good job of rural ecological protection of the key tasks, starting from the internal dynamics, vitality, and creativity, reorganization of the spatial environment, and help promote the revitalization of the countryside. The project for the village A, the village back of the mountains and water town, the village area of the natural environment is superior, strong local flavor, gathered “mountains, water, forests, fields, villages” multi-factors of natural resources, presenting a natural landscape surrounded by water, the village is based on the mountains and water, choose the water to live in the scattered form. The volume of villages is small in the north and large in the south, the layout is scattered, and the central village is insufficiently clustered. Villagers' residences are relatively free and scattered, and land use is not intensive.

IV. B. 2) Crash check analysis

After the later BIM design, we can find out the related problems in the 2D drawings more clearly, and avoid the phenomenon of “touching, omitting, missing” in the project as much as possible, avoiding reworking of the project and saving the construction cost to the maximum extent. The model of fire pipeline before optimization is shown in Fig. 5, and the model of fire pipeline after optimization is shown in Fig. 6. The fire pipeline of A and B gate opening is directly connected with the pipeline of the mainline tunnel, and it is found through the BIM model before the on-site construction that there exists a big difference in the height between the mainline tunnel and the ramp here, and the fire pipeline needs to pass through the lining of the tunnel in the mainline and be laid to the entrance of the ramp tunnel at the same time with a large depth, which requires large earth excavation, which makes it difficult to construct. A large amount of earth excavation is required, which is extremely difficult and unreasonable. Combined with the 3D BIM model, the design scheme is optimized, and the fire fighting pipe is introduced into the ramp from the side of the mainline tunnel, which greatly improves the implementability of the design scheme, and saves costs and human resources.

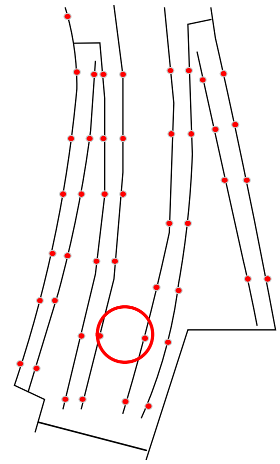

Figure 5: Pre-optimization model of fire pipe

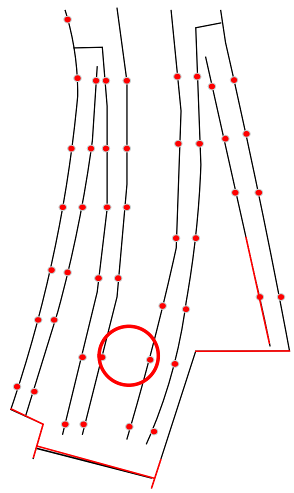

Figure 6: Fire pipeline optimization model

For rural buildings, the software PKPM-Energy is used to analyze the energy consumption of construction to analyze the energy-saving reduction of each index, and to generate a report on the thermal performance calculation of the envelope, a report on the calculation of the building load, and a report on the calculation of the building energy consumption, and the results of the calculation of the energy consumption of rural buildings are summarized as shown in Table 2. The software provides enclosure structure load defect analysis to help designers improve the thermal performance of the enclosure structure in a targeted manner. Demonstrate the calculation process of itemized energy consumption to help designers improve equipment selection. Through reasonable selection and optimization of the heating and air conditioning system, this project has reduced the system energy consumption by 16.01%.

Table 2: Calculation results of energy consumption in rural buildings

Type of energy consumption	Type of energy consumption		Reference building	
	Symbol	Numerical value/KJ	Symbol	Numerical value/KJ
Heating unit energy consumption kWh	E1	2211.37	E1	4116.06
Heating pump energy consumption kWh	E2	0	E2	0
Energy consumption of air conditioning unit kWh	E3	18121.73	E3	20119.16
Cooling water pump energy consumption kWh	E4	0	E4	0
Chilled water pump energy consumption kWh	E5	0	E5	0
Total annual energy consumption kWh	E6	20333.1	E6	24235.22
Energy consumption reduction	16.01%			

V. Conclusion

Combining the local advantages of good natural resources around the countryside, this project proposes an integrated model of countryside planning and construction based on BIM technology, and analyzes the model by example.

(1) In the application study of rural building area visualization, the high visibility area of point 1 (79.52%) performs better than that of point 2 (37.14%) and point 3 (23.76%), and the same technology can be applied to various aspects such as agricultural industry planning, service facility planning, rural landscape planning, and tour route arrangement.

(2) Combined with the 3D BIM model, the design scheme is optimized by introducing the fire fighting pipe from the main tunnel side to the ramp, which greatly improves the implementability of the design scheme and saves costs and human resources. In addition, it makes the reduction of system energy consumption reach 16.01%.

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