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RESEARCH ARTICLE

Seismic detection and analysis method of concrete structures in building construction based on BIM technology

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ABSTRACT
To promote the development of BIM technology in the field of identification and reinforcement of existing buildings, this paper takes concrete structures as the research object, refers to the current building seismic identification standards, and develops a BIM-based seismic identification system for concrete structures. The research establishes a corresponding data integration platform for the existing concrete frame structure system. Through the secondary development of Revit software, the computer can automatically extract building information and automatically generate a BIM model for seismic identification. The study shows that the program can provide efficient and accurate calculation results in the seismic qualification of concrete frame structures. The seismic test of the concrete structure of the existing building shows that the concrete strength of some components of the building is lower than C20, and the spacing of stirrups in the densified area of some beam components is greater than 100 mm. The seismic structural measures of the building do not meet the requirements. However, the measures and the calculation index follow the relevant regulations. And the calculated values of all programs are highly consistent with the manual calculation results. it can providing a new idea for local earthquake prevention.

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KEYWORDS
BIM; concrete structure; earthquake resistance; detection; architecture

Introduction

In China, there are many existing buildings, the new construction area is large every year, and the land area available for real estate development is less and less (Sing, Love, and Liu 2019). As the development of China's engineering construction moves towards the third stage of maintenance and modernization, the appraisal, reinforcement, and reconstruction of buildings will receive further attention and development (Bong and Rahman 2022). During the long-term use of building structures, due to the natural environment or human factors, material ageing and structural damage will occur, which in turn will affect the durability of the structure and the bearing capacity of components. (Lee, Kim, and Kim 2021). In addition, as people continue to reflect and pay attention to the environment and survival issues, the concept of sustainable development has become more and more popular, and the construction industry must also take a sustainable development path that is in harmony with resources and the natural environment (Santos, Andrade, and Pereira 2019). The construction of new buildings needs to consume a lot of non-renewable resources, and the service life of existing buildings can be extended by employing maintenance and reinforcement, which is in line with the goals of resource protection and the requirements of sustainable development strategies. Repairing and transforming old buildings instead of blindly demolishing them reduces the emission of construction waste and preserves the memory of the city while protecting the ecology. Therefore, the reinforcement and renovation of old buildings have important economic and cultural significance and

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meet the requirements of resources and environmental protection (GhaffarianHoseini et al. 2019; Piaia et al. 2021;Silva and De Brito 2019). Before the reinforcement and renovation of existing buildings, structural inspection and identification are required first. However, at present, structural design software is used for analysis, and the identification work is completed by manual calculation and statistics, which is time-consuming and labor-intensive. In addition, considering that there are few schemes for seismic testing of concrete structures at present (Das et al. 2019). Therefore, it is of great practical significance to develop a set of engineering software with simple operation and accurate calculation to assist engineering practitioners to complete the seismic detection and identification of concrete structures during construction more quickly and efficiently. And Building Information Modeling (Building Information Modeling, BIM) is widely used in the field of construction (Liu et al. 2019), and this model is used to model existing buildings in the research. In addition, there are many buildings that are not concrete structures, such as ancient buildings such as wood and stone, that also require seismic testing. This method can also be used after improvement based on relevant building types to provide technical support for earthquake resistance and earthquake resistance.

Literature review

With the gradual reduction of available real estate land, how to improve the service life of existing buildings has become a key area of concern for researchers and practitioners in the relevant industry. Before this, the detection of these buildings was considered an essential step (Rosti et al. 2021). Miao et al. (2021) focused on pixel-level multi-category monitoring of building earthquake damage and developed a new method based on computer vision techniques. A new method based on computer vision techniques was developed. The results demonstrate the accuracy of vision-based methods for damage detection and the great potential of estimating the seismic damage status of RC components. Liu and Zhang (2019) developed an automated damage detection tool based on convolutional neural networks, which was used to detect the post-earthquake state of concentrically braced frame structures. The training results on the simulated dataset show that the tool can show high accuracy in the detection of braced buckling damage. Further research results demonstrate that the tool also has the potential to be used in practice. The unscented Kalman filtering method was optimized by Gaviria et al. to evaluate the impact of earthquakes on the displacement and structural properties of multi-story buildings. The results show that the method can successfully evaluate the dynamic properties of multi-storey buildings, and the results also demonstrate its effectiveness in reinforced concrete structures and damage diagnosis (Gaviria and Montejo 2021). Wu et al. (2021) paid attention to the study of earthquakes in super-tall buildings. They used an impulse response function to capture this effect. Seismic environmental noise interferometry is used in this method, and the experimental results show that this method is applicable in the structural health monitoring and hazard assessment of super high-rise buildings. Ierimonti, Venanzi, and Ubertini (2021) focused on reinforced concrete industrial buildings in earthquake-hazard zones. They developed a system to enable rapid post-earthquake damage assessment. The data was acquired using a bidirectional accelerometer, which was used to identify damage to the building. The conclusion of the study shows that seismic monitoring data combined with pre-assessed warning states can be used for post-earthquake diagnosis of building structures.

Rezaei, Bulle, and Lesage (2019) combined Life Cycle Assessment (LCA) and BIM and used it in the early and detailed building design stages. The results of the research show that when the scheme is used in a specific project, the evaluation results of the software can help architects to carry out an environmental assessment of the relevant architectural design, and then select more suitable materials as a specific method to improve the sustainability of the building., reduce the energy consumption in subsequent maintenance and renovation work, and reduce the impact of construction and consumables on the environment. Based on BIM models and artificial intelligence, the research of Musella et al. (2021) developed a scheme for digitizing, inspecting, and evaluating existing buildings. They extended the application range of the method to allow it to detect existing masonry and concrete buildings. The results showed that the method has superior performance compared with existing solutions, it has a faster detection speed and can provide more accurate detection results. Also concerned about the energy consumption of buildings, Najjar et al. (2019) integrated LCA, BIM, and mathematical optimization programming to help residential building envelopes select appropriate building components. The conclusion of the study shows that the components selected after the evaluation can effectively reduce the energy use cost of the building. Tan et al. (2019) focused on the limitations of the use of BIM models in prefabricated building assessments and introduced interpretive structural models. The scheme can be well adapted to China's building construction requirements, and a corresponding three-level strategy has been formulated to promote the application of BIM. Research conclusions show that the optimized model is usable in the current scenario. Kazado, Kavgic, and Eskicioglu (2019) describe several schemes that integrate building sensor technology and BIM processes. These solutions can be used to monitor energy consumption in buildings and improve the efficiency of facility management. The research conclusions show that the scheme can effectively support the above demands and can be used in practical scenarios.

To sum up, there are existing solutions for building detection, and BIM models are also widely used in the construction industry. However, it can also be seen that the current research plan for seismic detection of concrete structures in building construction using BIM models is not perfect. Therefore, this study mainly focuses on the above-mentioned perspectives. It also provides new research ideas for seismic detection of various types of buildings.

Seismic detection of concrete structures based on BIM technology

BIM model creation of existing buildings

The seismic identification procedure proposed in the study is based on the current building seismic identification standards and other relevant specifications, combined with BIM and good data management technology and developed by modern software engineering ideas. The design is based on the actual appraisal process, combined with the actual investigation of the project, and the business operation process of the seismic appraisal of the existing building is summarized in Figure 1.

As shown in Figure 1, the research first collects the relevant technical data of the project; then formulates the testing plan and inspects the instruments; then conducts on-site testing and collects data, mainly from the aspects of the number of floors and axis dimensions of the building, material strength, force transmission path, structural connection, etc. Check the structure and integrity of the building; then analyze and process the on-site test data according to relevant specifications, eliminate abnormal data, and conduct supplementary testing if necessary; finally, evaluate the comprehensive seismic capacity, and propose corresponding reinforcement and reconstruction suggestions. and issue a test report. The research creates a BIM model to assist the seismic detection of concrete structures. The BIM model creation of existing buildings mainly includes two parts: geometric model creation and reinforcement model generation.

In the creation of the geometric model, the level and grid need to be generated first. The axis dimension and storey height of the site are measured and stored in the database after the data integration module calculates and estimates. By reading the elevation and grid data in the database, calling the API of Revit can realize the automatic generation of the elevation and grid. The second is to create a construction type. Most of the concrete structural members are circular or rectangular sections, and family files of Revit metric conventional models can be used. Next is to create the building entity. Due to many building components, sampling is often used for testing in engineering, which makes the component information integrated into the database in the early-stage incomplete, and it is impossible to create a complete 3D model. In response to this problem, the research proposes two solutions. In the first solution, the user can design the interactive interface in the information integration module, and save the section, material, reinforcement, and other information as an independent attribute library, allowing the user to input the positioning axis of the undetected component and specify the attribute. In the second scheme, the user can select a certain floor and set it as the standard floor according to the construction layout, other floors can be obtained by copying the

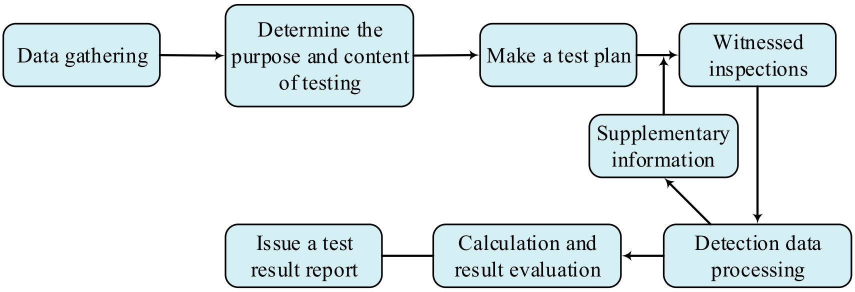

Figure 1. Flow chart of seismic appraisal of existing buildings.

standard floor, and finally, the floor can be assembled according to the actual project to generate a complete 3D solid model. Finally, the BIM structure information is attached. The parameter list defined by Revit itself is insufficient for creating a complete engineering information model, so the study makes up for this deficiency by creating shared parameters, which can write the structural information into the model while generating the instance.

In the process of rebar model generation, the research writes the rebar information of the existing building as component parameters and generates solid rebar by reading the rebar parameters of the selected elements. The concrete reinforcement model construction process mainly includes three parts: selection of reinforcement expression mode, calculation of reinforcement location point coordinates and generation of reinforcement solid model. First, you need to select the reinforcement representation mode. In BIM technology, there are two main modes of rebar expression: one is the flat method to express the rebar, and the other is the solid expression of the rebar. Considering the advantages and disadvantages of the two expression methods, the study chooses the method of expressing steel bars by solid. The second is the calculation of the coordinates of the positioning point of the reinforcement. Before arranging steel bars in Revit, it is necessary to calculate the position coordinates of longitudinal bars, stirrups, and other steel bars according to the position and section size of the components. The program has written the reinforcement information when creating the component instance, and the reinforcement information can be obtained by reading the parameters of the frame selection or clicking the component, to realize the calculation of the coordinates and the generation of the reinforcement. The last step is to generate the reinforcement solid model. When using the Revit API function to create a rebar entity, parameters such as rebar style, rebar type, rebar hook type, host element, rebar direction vector, rebar line array, and rebar hook direction need to be passed in. The type and direction of reinforcement and reinforcement hooks can be obtained by reading the parameters of the host element, but the reinforcement line array is unknown. Therefore, when the coordinate value of the reinforcing bar positioning point is calculated, the reinforcing bar line array should also be generated.

Seismic identification of concrete frame structures

After the BIM model of the existing building is created, the research expands the function of Revit according to the ‘Building Seismic Appraisal Standard’ to realize the seismic appraisal of the existing building of the concrete structure and export the appraisal report. The items that need to be identified include three parts: seismic identification of concrete structures, identification of seismic measures, and verification of seismic bearing capacity.

The seismic identification method of concrete structures in the study uses the method of grading and classification to identify existing buildings. Classification refers to the use of two-level evaluation methods. Mainly combined with the structural impact to carry out a comprehensive evaluation. Classification means that different identification requirements are adopted according to different subsequent use years. The specific method of seismic identification of concrete frame structure is shown in Figure 2.

The first-level appraisal is based on the different structural appraisal requirements proposed by the structure according to the fortification standard, the site category, and the building category. The second-level appraisal is mainly based on the seismic bearing capacity check. It can be evaluated by calculating the comprehensive seismic capacity index of the floor; it can also be calculated according to the formula (1) according to the method of ‘Code for Seismic Design of Buildings’.

$$S \leq R/\gamma_{Ra} \tag{1}$$

In formula (1), it Srepresents the design value of internal force combination, represents the design value $R$of bearing capacity, $\gamma_{Ra}$and represents the bearing capacity adjustment coefficient of seismic appraisal.

The identification of seismic measures mainly includes four aspects: specification translation, information extraction of the BIM model, calculation of relevant parameters, and identification of seismic measures of components. The first is canonical translation. Since specifications are usually written text, they need to be compiled into computer language. The research defines three classes of A_Code, B_Code and C_Code in the program, which correspond to the A, B, and C types of buildings in the specification respectively. Then, the seismic structure requirements of various buildings are translated into functions and written into the corresponding classes. The axial compression ratio check calculation of the column needs to know the axial force design value of the column, which should be carried out when the seismic

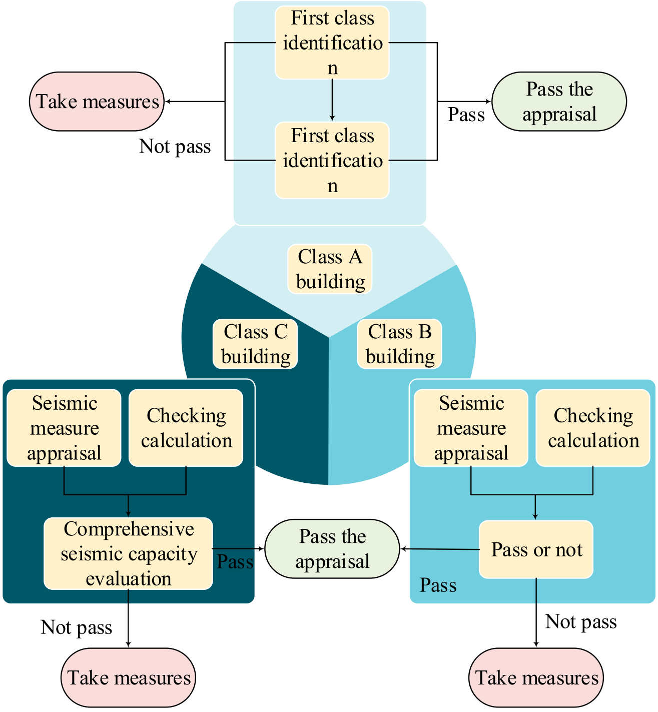

Figure 2. Seismic appraisal method of concrete frame structure.

bearing capacity of the member is checked. The second is BIM model information extraction. The Revit API provides element filters, which can be used to obtain elements that meet the conditions. The related attributes of elements can be obtained through the Element.get_Parameter function. In addition, the 'Standards for Seismic Appraisal of Buildings' has clear requirements on the total reinforcement ratio of longitudinal reinforcement of frame corner columns. Therefore, before the identification of seismic structural measures, it is necessary to distinguish corner columns from general columns. Determine the connection between the column and the beam, and then distinguish the corner column. Then there is the relevant parameter calculation. When reviewing structural measures, attribute parameters such as section and steel bar diameter can be directly obtained and used; however, some parameters need to be calculated to obtain, including the ratio of concrete compression zone height to effective height and volume hoop ratio. Because the 'Standards for Seismic Appraisal of Buildings' stipulates that the relative compression zone height of the existing frame beams should not be greater than 0.25 for the first grade, and 0.35 for the second and third grades. The formula for calculating the height of the relative compression zone is shown in formula (2).

$$\xi = \frac{x}{h_0} = \frac{A_s f_y - A_s' f_y'}{\alpha_1 f_c b h_0} \tag{2}$$

In formula (2), $A_s$and $A'$are the areas of the tensile and compression steel bars, respectively, which are $\alpha_1$equivalent to the coefficients of the rectangular stress diagram, and $h_0$are the effective height of the section. In addition, the 'Standards for Seismic Appraisal of Buildings' also put forward specific requirements for the volume hoop ratio in the densified area of column stirrups. The volume hoop ratio of the column stirrup densification area can be calculated according to formula (3).

$$\rho_v = \frac{n_1 A_{s1} l_1 + n_2 A_{s2} l_2}{A_{cor} s} \tag{3}$$

In Equation (3), s represents the spacing of the stirrup densification area, A_{cor}represents the core area of the column section, l_1, $n_1$and A_{s1}represents the length of the stirrup in the b direction, the number of limbs and the cross-sectional area of a single root l_2, n_2 and A_{s2} represents the length of the stirrup in the h direction, and the limb number and cross-sectional area of a single root. In the appraisal of seismic measures for construction, the structural requirements of the structure vary according to the seismic fortification intensity, fortification type, site type and seismic grade of the building. Therefore, it is necessary to obtain the relevant seismic design parameters entered by the user before proceeding with the review. By passing these seismic design parameters and component attribute parameters obtained or calculated from the database into the corresponding functions, the review of structural measures can be realized, mainly including structural system, material strength, component section size, reinforcement configuration and so on.

In the process of seismic bearing capacity checking, two parts, load application and structural calculation and analysis, are mainly concerned. In engineering analysis, it is first necessary to define different load cases according to the actual project or the way the load acts on the structure, mainly including dead load, live load, seismic action, wind load, snow load, etc. When carrying out structural analysis, load combination should be carried out to obtain the internal force distribution under the most unfavorable situation of the structure. To evaluate the bearing capacity of a component, it is necessary to determine two factors, the effect S and the resistance R. The internal force of the component under each working condition and load combination is determined through static analysis, dynamic analysis, and load effect combination. Before further evaluation, it needs to be determined. The bearing capacity of the component. According to the stress characteristics of beams and columns in the frame structure, the axial compression and flexural bearing capacities of the columns and the flexural and shear bearing capacities of the beams are mainly calculated.

Calculation example of seismic identification program of concrete frame structure

To verify and check the application effect of the detection and identification program, this part adopts an actual project to evaluate the application effect of the platform. The project selected by the research institute is in S city. The main body of the building is a five-story reinforced concrete frame structure, and the aggregate use of the building is the office. The main building is 33.2 m long and 14.3 m wide. The height of the first floor is 3.6 m, and the height of the second floor to the fifth floor is 3.3 m. The plan view of the standard floor frame structure of the building is shown in Figure 3.

The original design structure of the building has a safety level of Class II, the site category is Class II, the building's seismic fortification category is Class C, the seismic level of the frame structure is Class III, the seismic fortification intensity is 7 degrees, and the basic seismic acceleration design value is 0.10 g. The design earthquake grouping is the first group. The concrete structures tested in this project were randomly selected from the construction site. The field inspection data is entered into the software and the data is

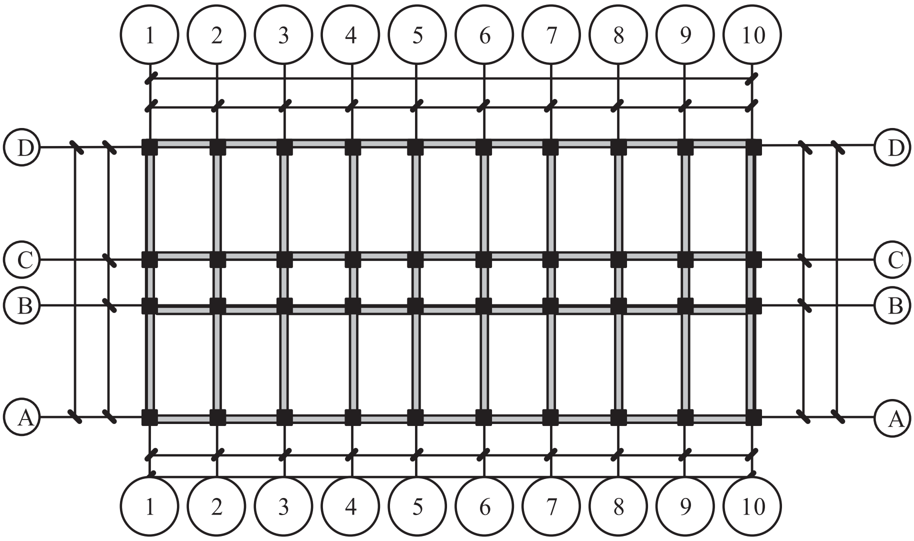

Figure 3. Standard floor frame structure plan.

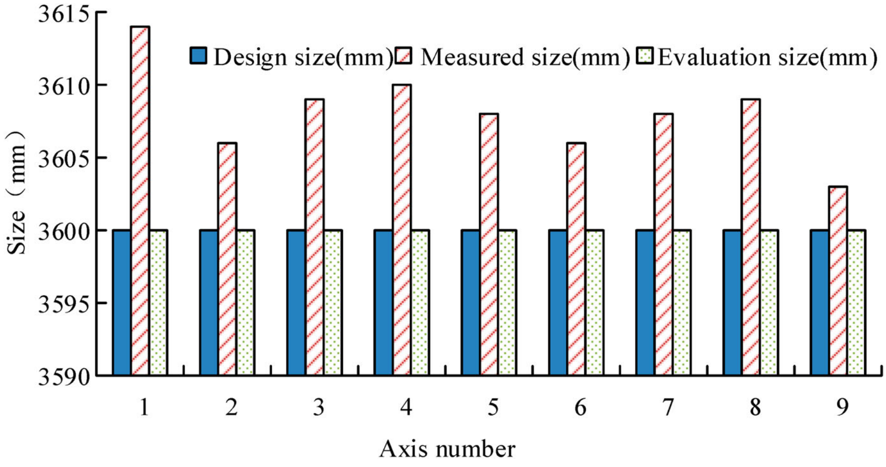

Figure 4. Sampling test results of the concrete column and beam members.

reviewed for compliance. The review results showed that the ratio of the height to the diameter of the compressive core sample was 1.01, which basically met the 1.00 specified in the 'Technical Specification for Testing Concrete Strength by Drilling Core Method'. In addition, the sample number, error and precise digits of the construction section and protective layer thickness detection data all meet the requirements of the specification, and subsequent analysis and processing can be carried out. After calculation by the program, the average value of concrete compressive strength of the frame column and frame beam core sample is 29.3 MPa, the standard deviation of the sample is 3.8 MPa, the upper limit value of the estimated interval is 24.1 MPa, the lower limit value is 20.6 MPa, Take the upper limit value of 24.1 MPa as the estimated value of the strength of the test batch of concrete. The research tests the reinforcement of concrete members, and the process is mainly to check the number of reinforcements and the spacing of stirrups in the construction of concrete columns and beams. The derived calculation results are shown in Figure 4.

According to Figure 4, among the 9 randomly selected samples, the maximum gap between the measured size and the designed size is 14 mm, and the minimum gap is 3 mm. According to the specific requirements in 'Technical Specifications for Testing Concrete Strength by Drilling Core Method', the above error sizes are all within a reasonable range, so the data can be input into the program for subsequent calculations. In addition, the data obtained by random extraction also include the frame beam section size, the steel bar detector to detect the frame column steel bar configuration, etc., Form Table 1.

According to Table 1, the design value and the actual value of the frame column reinforcement configuration also show a small gap. Among them, the difference between the stirrups in the non-encrypted area and

Table 1. Reinforcement detector detects reinforcement configuration of the frame column.

		Main reinforcement configuration		Stirrup in non-encrypted area (mm)		Thickened stirrup (mm)	
		B to one side (root)		Diameter, spacing		Diameter, spacing	
Floor	Component number	Design	Measure with instruments	Design	Measure with instruments	Design	Measure with instruments
1	2XB	3HRB40016	3 root	φ8@200	@201	φ8@100	@105
	3XD	3HRB40016	3 root	φ8@200	@207	φ8@100	@103
2	2XA	3HRB40016	3 root	φ8@200	@209	φ8@100	@106
	2XB	3HRB40016	3 root	φ8@200	@205	φ8@100	@96
3	1XB	3HRB40016	3 root	φ8@200	@208	φ8@100	@107
	2XA	3HRB40016	3 root	φ8@200	@209	φ8@100	@102
4	1XD	3HRB40016	3 root	φ8@200	@207	φ8@100	@106
	2XB	3HRB40016	3 root	φ8@200	@201	φ8@100	@108
5	3XC	3HRB40016	3 root	φ8@200	@205	φ8@100	@109
	2XD	3 HRB400 16	3 roots	φ8@200	@208	φ8@100	@108

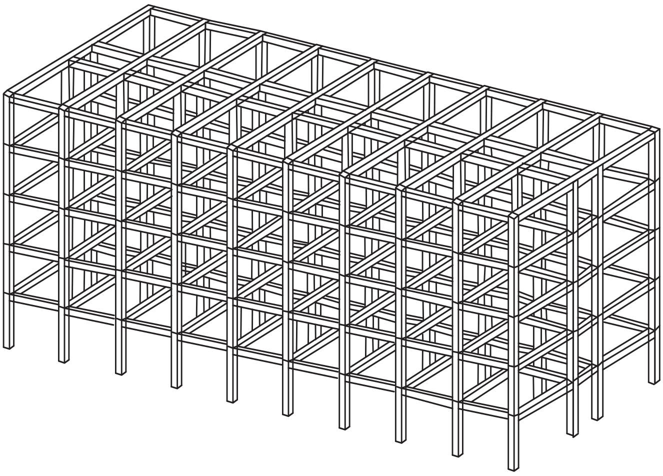

Figure 5. Schematic diagram of three-dimensional building model.

the difference between the thickened stirrups is between 1 and 9 mm, which are all within a reasonable error range. Next, edit the 3D model of the building according to the actual engineering and on-site inspection results, Form Figure 5.

Form Figure 5, the bottom first layer is the standard layer, and the three layers above are copied and modified based on the standard layer. Among them, the longitudinal reinforcement grade is HRB400, the diameter is 18 mm, the number of B and H sides is 3, the stirrup grade is HPB300, the stirrup diameter is 8, the non-encrypted stirrup spacing is 201 mm, the length of the stirrup encryption area is 1055 mm, and the stirrup diameter is 8. The spacing between the reinforcement areas is 105 mm, and the concrete strength is 28.7 MPa. After the model is established, the seismic measures of the building are first identified. According to the results of the program operation, the review details of the seismic measures of the building are shown in Table 2.

Combined with the on-site testing data and program identification results, the concrete strength of some components of the building is lower than C20, and the spacing of stirrups in the densified area of some beam components is greater than the 100 mm required by the specification, so the seismic structural measures do

Table 2. Seismic measures review results.

Identification content		Identification result	Appraisal conclusion
Total height of house		16.8m	Satisfy
Seismic grade		three-level	Satisfy
Concrete strength		Partially lower than C20	Unsatisfied
Frame column	Column section	Section width is 400 mm and Ho/b is 7.	Satisfy
	Steel bar configuration	The reinforcement ratio of longitudinal reinforcement shall be at least 0.9%.	Satisfy
		8mm	Satisfy
		100mm $< 16 \times 8$	Satisfy
		Greater than 0.6	Satisfy
Frame beam	Beam section	The minimum section width of the beam is 250 mm.	Satisfy
		The aspect ratio is 2.	Satisfy
		The ratio of clear span to cross-section height shall be at least 6.	Satisfy
	Steel bar configuration	Less than 2.50%	Satisfy
		The minimum longitudinal reinforcement of frame beam is 2HRB40016.	Satisfy
		Part of the beam encryption area stirrup spacing is greater than 100 mm.	Unsatisfied
		8mm	Satisfy

Table 3. Component control internal force statistics table.

Component number	Type	Position	Axial force p (kN)	Shear force V2 (kN)	Shear force V 3 (kN)	Twist moment T (kN m)	M2 bending moment (kN·m)	M2 bending moment (kN·m)
234852	Concrete-rectangle-column	I end(234336)	−505.516	18.977	−24.944	−0.925	−43.648	34.61
234860	Concrete-rectangle-column	I end(234352)	−776.011	46.502	−31.5	−0.965	−55.117	81.583
234862	Concrete-rectangle-column	I end(234356)	−780.031	46.118	−31.591	−0.974	−55.299	80.649
236626	Concrete-rectangular canal	I end(234340)	11.761	−76.734	−0.022	0.259	−0.052	−75.344
236628	Concrete-rectangular canal	I end(234336)	12.392	−41.131	−0.092	−0.364	−0.191	41.129
236631	Concrete-rectangular canal	I end(234352)	9.543	−41.226	−0.11	0.242	−0.203	36.211

Table 4. Statistics of ratio of bearing capacity to internal force.

Component number	Type	Nu/N (2 direction-axial compression)	Nu/N (2 direction-eccentric compression)	Nu/N (3 direction-axial compression)	Nu/N (3 direction-eccentric compression)
234852	Concrete-rectangle-column	43.029	1.452	43.66	4.032
234860	Concrete-rectangle-column	33.168	1.43	33.674	2.794
234862	Concrete-rectangle-column	12.098	2.538	12.275	2.72
236626	Concrete-rectangular canal	9.424	2.121	9.562	2.111
236628	Concrete-rectangular canal	41.224	1.462	41.828	1.96
236631	Concrete-rectangular canal	27.426	1.077	27.828	1.87

not meet the requirements. The next step is to check the seismic bearing capacity of the structure. The statistical data of the component control internal force obtained by the program calculation are shown in Table 3.

Form Table 3, the statistical data of the construction control internal force obtained by the program calculation, according to the ‘technical specification for testing the strength of concrete by the drilling core method’, this value meets the relevant requirements, and the value calculated by the program is consistent with the value calculated by hand. Finally, the seismic bearing capacity check is carried out, first of all, the results of the ratio of the bearing capacity of each member to the internal force, Form Table 4.

Form Table 4, the program check calculation results of the ratio of the bearing capacity to the internal force of some components are shown, indicating that the bearing capacity of the main bearing components of the building meets the requirements of the seismic code. To verify the correctness of the program calculation, the research also used manual hand calculation for comparison. The results showed the consistency of the results of the manual calculation and the program calculation, which further verified that the program calculation has high accuracy. The second step is to make statistics on the seismic bearing capacity of the building. The statistical data are shown in Table 5.

It can be seen from Table 5 that, after calculation by the program, the parameters of the building’s seismic bearing capacity meet the relevant provisions in the ‘Building Seismic Appraisal Standards’. Similarly, the study compared the results with the parameters calculated by manual hand and obtained a highly consistent conclusion, which proved the validity and high accuracy of the program calculation.

Table 5. Checking results of seismic bearing capacity.

Component number	Type	Axial compression ratio	Column bearing capacity	Destructional forms	Appraisal conclusion
234852	Concrete-rectangle-column	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
234860	Concrete-rectangle-column	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
234862	Concrete-rectangle-column	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
235786	Concrete-rectangle-column	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
236626	Concrete-rectangular canal	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
236628	Concrete-rectangular canal	Satisfy	Satisfy	Suitable reinforcement failure	Checking calculation is qualified
236631	Concrete-rectangular canal	Satisfy	Satisfy _	Suitable reinforcement failure	Checking calculation is qualified
236633	Concrete-rectangular canal	Satisfy _	Satisfy _	Suitable reinforcement failure	Checking calculation is qualified

Conclusion

China has many existing buildings, so the research on existing building inspection and appraisal procedures is of great practical significance and has social and economic benefits. Based on 'Building Seismic Appraisal Standards' and combined with BIM technology, the research aims to improve the accuracy and efficiency of testing and appraisal, develop the seismic appraisal software for concrete frame structures, and integrate the seismic appraisal software referring to the latest research results of existing building testing and appraisal. The software is adopted in the seismic identification of existing buildings. The research successfully carried out rapid modeling and used the software to check the seismic bearing capacity of the building. During the data collection process, the gap between the design value and the actual value of the frame column reinforcement configuration is between 1mm-9 mm, which meets the relevant error standards, so the data is used in subsequent calculations. Combined with the on-site test data and program identification results, the concrete strength of some components of the building is lower than C20, and the spacing of stirrups in the densified area of some beam components is greater than the minimum value required by the code, so it does not meet the requirements of the 'Building Seismic Identification Standard' for the 7-degree zone C in Class building regulations. The seismic bearing capacity of the building can meet the requirements of the relevant codes according to the program calculation results of the control internal force of the components, the ratio of the bearing capacity of each component to the internal force, and the seismic bearing capacity of the building. However, due to the limited time, the software still has many shortcomings. For example, the existing building structures are of various types, and the research is only conducted on the existing concrete frame structure. To realize the automation of the existing building inspection and identification, it is necessary to improve the structure and the type of evaluation object. When conducting seismic analysis, the study did not take into account the reduction in yield strength after corrosion of the reinforcement, and further research and improvement are needed in future studies.

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