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Research on Civil Engineering Software for Engineering Computation

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Abstract: Learning how to compute and simulate civil engineering processes is the necessary task for civil engineers, instructors, and learners. In general, with the continuous improvement of computer technology, the computing software promotes the reform of engineering industry. In general, the software can handle complex models with ease and accuracy. Therefore compared to traditional manual calculations, computerized software can avoid errors in data acquisition and calculation. Therefore, many problems in civil engineering have been improved. China is also strongly supporting and promoting the modern computing software usages into education, which further encourages BIM-based computing. In this research we propose to analyze civil engineering computing software implementation based on the experiment of BIM Glodon software. We use the Glodon GCL 2013 for empirical experiment for the engineering drawings and related quantities of components of civil engineering computing. This article presents the BIM Glodon Software makes advanced specific operations for civil engineering computing such as construction drawing, steel metering, and computing. The article reviews the related studies that are considered as valuable resources to software research and development, shows many scholars have also conducted in-depth research in computing development. According to our research result, we recommend that the development companies need to focus on upgrading their software to be more consumer friendly, cost effective.

Keywords: Engineering Cost, Engineering Software Glodon, Computation

1. Introduction

In general, there must be a lot of data to deal with in every civil engineering computing, which will take up a lot of time by manual calculation alone, and it is easy to produce artificial calculation errors [1].

In China, engineers usually use civil engineering computing software to evaluate the overall cost of the projects. The civil engineering computing includes the all computing for the road, water, drainage and flood control engineering and transportation [2]. In recent years, engineering computing has continued to develop. Practically, the software can handle complex models with ease and accuracy. Compared to traditional manual calculations, computerized software can avoid errors in data acquisition

and calculation. If there are only some approximations in more complex structures or models, this cannot guarantee the quality of the construction project. The engineering cost has gone through decades of development, and its management methods have evolved with the changes of the times. We all know that one of the core indicators of engineering construction management is engineering cost. The engineering cost management includes two basic tasks: one is the statistics of the quantity of construction project; the other is the cost accounting of construction project [3]. The engineering quantity of traditional engineering cost is generally calculated based on the two-dimensional design drawings. However, in recent years, in construction, the quality of projects started to use 3-dimentional design drawings and it can be calculated in a variety of ways. First, the cost will use outcomes and management efforts; secondly,

it needs to check these results and display them in a 3-dimensional model. Also, give the exact results of the project, and the results can also be displayed on the labeling map of the engineering dedicated to improving their inspection. Finally, computing software can still store the calculation results to facilitate employee queries.

2. Research Background of Software Based Civil Engineering Computation

With the popularity of calculation software, the engineering construction industry has basically replaced manual calculation. The basic reason is that the professional requirements of the calculation are relatively low when software calculation is used. In addition, the efficiency of the calculation is greatly improved, and the margin of error is relatively low.

2.1. Research Status of Civil Engineering Computation Software

The information-based development of engineering cost industry has also witnessed an evolution process of calculation of engineering cost from manual drawing, 2D computer-aided calculation in the 1990s to the 3D modeling calculation at the beginning of the 21st century and further to an engineering cost management phase with core BIM technologies [4].

Various software like SJMS, THS WARE, Revit, Glodon, Lubansoft and PMS all can realize the high-quality cost management of engineering projects, effectively improve the working efficiency, reduce the error rate of cost treatment and achieve highly efficient information fusion and sharing. Glodon software and BIM Revit software have been popular among the vast number of engineering cost users by virtue of their powerful parametric modeling and visualization functions. Meanwhile, they have further accelerated the development of construction industry in an effective combination with other technologies. In this study, Ganglin C-01 Phase II high-standard plant was modeled for the calculation of its engineering quantities based on Glodon BIM civil engineering quantity calculation platform GTJ2018 and Revit software, followed by a comparative analysis of the calculation results [4]. As early as the 1960s-70s, such as the United States, the United Kingdom had begun to enable computers to calculate engineering costs. The main application was to calculate prices for the government and enterprises. With the gradual maturation and development of software applications, the related concepts such as building information models are also proposed at the end of the last century, exampled by the BIM ArchiCAD software developed by Graphisoft, helping the calculation of planes to a three-dimensional view [5-6].

In addition to software research and development, many scholars have also conducted in-depth research in standard computing development. Artificial intelligence is a branch of computer science, involved in the research, design, and application of intelligent computer. Traditional methods for modeling and optimizing complex structure systems require huge amounts of computing resources, and artificial-intelligence-based solutions can often provide valuable alternatives for efficiently solving problems in the civil engineering [7]. The traditional hand-drawn drawings and CAD drawings are impossible to store component information in detail, so it will consume about 50%-80% of the time of cost engineer when statistic engineering quantities [10]. Until now we can model in the relevant cost software based on CAD drawings, and the work efficiency has certainly improved, but facing the increasing higher modern buildings and the more complex body, the statistics of engineering quantity are still cumbersome under such development trend, which is related to inaccurate and incomplete modeling information to a large extent [11].

2.2. Research Status in China

China started using computer-aided cost analysis later than the international community. Since software development has matured in China the focus of experts and scholars is to enhance software calculation efficiency.

Since the first introduction of computer-aided engineering costs in the 1970s, the development of computer technology has been widely popular in my country's engineering cost field, to improve the efficiency and accuracy of engineering costs, most companies' computer calculations are used when making bidding, and it has covered the whole process of construction management, such as pre-settlement. Domestic project cost-related software has also gradually developed mature and also has played different cost management roles in all phases of construction management.

China is also strongly supporting and promoting the introduction of prefabrication methods into all sectors of the AEC industry, which further encourages BIM-based workflows [8]. Besides software industries marketing BIM tools, the Chinese government has emerged as a major force promoting BIM adoption in China recently [8], with a guideline by the Ministry of housing and Urban-Rural Development aiming ambitiously for a national BIM adoption rate of 90% by the year 2020 [9]. The combination of BIM technology and engineering quantity is compared, and it is considered that the software strength on BIM design software is more obvious, but is not for other categories.

About the application of domestic engineering cost software, the main content involved in the preparation of the budget and summarizes relevant forms, query engineering-related resource data; software to government management ports can conduct project audits, system management, summary resources information, etc.

Value of GICD product refers to the true "BIM + smart" design software, open up the upstream and downstream data of structure design, which can bring revolutionary quality and efficiency improvement for engineers [11].

According to domestic research, experts explore the application problem of calculation software in China construction projects; some experts combine the advantages

of design software, explore the docking problem of the calculation software and design software so that the design software provides a strong basis for the calculation software. After extensive studies, a comprehensive evaluation of the software especially of the calculation software is lacking [4-9]. Experts prefer to open the software channel, eliminate software barriers, improve the accuracy and efficiency of engineering calculations by simplifying plug-in mode.

3. Analysis of Civil Engineering Computing

Although software development is increasing, there are still some problems in practice, such as "trusted calculation problems" and calculating scope issues. For barriers found during this software, many solutions have now been implemented, such as unified information through the industry, providing users with high quality training, regular and irregular. The goal is to improve automation, intelligence, databases to support comprehensive management.

3.1. Analysis of Civil Engineering Software Based Computing, Its Significance

At present, domestic cost software involves several types such as engineering kit software, graphics automatic calculation software, and steel dosage software, in which graphic calculation software is the most core part, because only in the case of ensuring accurate engineering calculation. It also affects the calculation of the amount, so the three-dimensional calculation method can solve the problem of low efficiency and high accuracy.

The importance of three-dimensional calculation software in engineering management is that the software generated and handmade calculations efficiency ratio was four to one.

To enhance the above significance, due to the comprehensive impact of many cost issues such as people, materials, and machinery, engineers usually tend to use civil engineering computing software to compute all costs and related things [12]. The usability and accuracy of engineering computing software has a good reputation in the civil engineering industry. BIM technology still a novelty in the Chinese design and construction process [8, 13].

The significance also presents the implementation of each stage of civil engineering is inseparable from the total computing budget such as feasibility study, evaluation, preparation, the project settlement. In general, engineers in China usually use civil engineering cost software to evaluate the overall cost of the project [14]. In addition, civil engineering computing work practices and processes are still in the process of being clarified and established [15].

3.2. Analysis of Principles of Civil Engineering Quantity Computation

The engineering quantity is an important piece of information to prepare the construction drawing budget. Quantity computation is concerned with cost and financial management of construction projects to enhance the design process through the logical use of cost and budget parameters to sustain viable links relating price, utility, forms which assists in attaining the employer's objectives within the predetermined budget [16-17].

During the calculation of the engineering quantity, the following principles should usually follow the below rules.

The engineering quantity calculation rules should be consistent. When calculating the project according to the construction drawing, it must be measured in strict accordance with the list and quota calculation rules.

The measurement caliber is uniform. For example. measurements made in the Guangdong Province should apply to that of Hunan province's operations and quote. The engineering amount ought to be calculated in a certain order. For instance, strip members ought to be calculated in left and right order. When calculating the engineering quantity according to the construction drawing, some of the partial items listed, and the measurement unit must be calculated with the calculation unit specified in the corresponding quota. In addition to the flat venue in the earthwork, other excavations filling outscores are calculated in cubic meters. According to the construction drawing and regional quota, the name of the partial item is listed in the order of the quota.

List the metering formulas and units. According to the list quota requirements, the calculation formulas of each part are calculated according to the partial items, and when calculating the engineering quantity, it can be calculated according to the form of the table.

Label the clear calculation site, write a clear calculation step to facilitate post-review.

Summarize the computing of projects. After calculating all partial items, look up the corresponding quota in the quantity column, the subsequent and integrated unit prices are included in the total cost.

3.3. Analysis of Basic Characteristics of Civil Engineering Quality Computation

The definition of the engineering amount refers to the number of objects and is the specific amount of each component of the various partial items expressed by the metering unit or the natural unit.

Metering units are generally cubic meters, square meters, rice, tons, and natural units refer to the number of natural properties of objects. When the length and width of the object are not a fixed value, it is often measured in cubic meters. When there is a fixed value in the length-width-height of the object, the other two are variables, often in square meters. When there are two fixed values in the length-width-height of the object, the other is a variable often as a meter unit. Rebar, steel structure, metal construction, pre-buried iron parts, are based on measurement units.

From a macro perspective, there is a development course of domestic and foreign engineering cost management, the civil engineering computing method reform in China mainly has two processes, respectively, and the preliminary application phase of the software and the wide application

phase of the engineering cost. All professional engineering calculations are based on knowledge. The construction drawings of civil engineering projects are relatively installed. Singing profiles are complete, and all components will be displayed on the drawings. It is more intuitive, but the structural construction details will be large, and small mistakes are easy to make.

4. Analysis of Software of Civil Engineering Computation

4.1. The Current Status in Software Penetration in Market

The civil engineering computing software is software that has emerged in the construction industry. The development process of civil construction model software has changed from manual calculation to software calculation to today's graphic calculation. Traditional calculations are effective, but it is time-consuming. The software version is completed in 3 simple steps, a simple project to modeling to calculating. Manpower is spent on the modeling links throughout the project and the software takes care of the rest. This allows for flexible statistics. Handmade calculative engineering volume often occurs low-level errors such as decimation, decimal point misplacements, and the review is very difficult.

The civil engineering computing software is a professional software, which is not like a general software with a lot of users, so the price is often not. With the current chance of computer technology, the project software has also had a long-term development. Some excellent software can disclose the cost of people from heavy manual labor, efficiency. It has been upgraded, enhances the level of the civil and construction industry. However, due to various reasons, such as the factors in development, development ideas, market positioning, the situation is not optimistic. After more than ten years of development, there have been several top monopoly brands. For instance, the BIM software developed by Graphisoft company, ArchiCad is a software tool for architects working in the architecture-engineering-construction (AEC) industry for designing buildings from the conceptual phase all through to the construction phase. BIM software enables architects to work in a Building Information Modeling/Management environment. Archicad of BIM works on two platforms of MacOS and Windows, with no significant differences between them [6].

In three decades of software development, China has come a long way. Svil series software developed by Guanglian Series software, Luban Software, Shenzhen Tsinghua Seville are all CAD platform-based and some have import and export options on models. In addition to the more well-known software, there is some less popular software, such as Gold Installation Software, Hongye Installing Software, and Counting Installation Software.

These have been developed by certain regional quotas, so the applicability is not wide, and mainly selects mainstream software for comparative analysis.

4.2. Glodon: Glodon BIM Civil Engineering Platform GTJ2021

Compared to 2D design mode which is mostly adopted in the traditional building design, Glodon GTJ establishes spatial building models by combining the drawings [4]. Glodon BIM GGJ2013 is very convenient when computing the amount of steel the engineering cost, and after calculating the steel bars in the beams, plates and columns, the software presents we the three dimensional layout of the steel bars, the model visualizes and displays the position of the steel accurately. The stairs steel bars in Glodon Software are relatively cumbersome.

4.3. Luban: LUBAN Master (Civil Engineering), LUBAN (Reinforcement)

Luban's model software is one of the earliest company in the industry [4]. Their software was made earlier allowing them to grow their software to be more professional, functional, comprehensive, and flexible. Although their software is prone to crashing unless the source file is a genuine CAD file, they have a better reputation than their main competitor Glodon.

The biggest difference between Luban and other software is that it's a civil construction and steel bars are separate. The civil engineering reinforcing model requires mutual guidance, the operation is more complex, the report is more general, and the amount is slightly inefficient compared to other software. In recent years, software updates have been poor, and their product functions and technologies have been slightly weak compared to other three-dimensional count software. Their claims attracted VIP clients when they started out but now everything is chaotic and the user's trust is low.

4.4. New Point BIM Quantity

The new point calculation software is based on a rudimentary project. Compared to other brands, it is easier to get started and it has many advantages to its predecessors. This software also uses its platform so there's no need to install extra CAD software. There is also much convenience to the new software like not needing to split drawings, which gives it a major advantage to others such as Glodon.

The new point software has the potential to be a competitor for Glodon with its effective software. However, the disadvantage of the new point software in civil engineering computation is that product recognition is low, the main users are in Jiangsu, Anhui, and Shandong in China, it is not a recommended software for major projects.

4.5. Svil: Svil 3rd Calculation for CAD

Svil's calculations software is based on the CAD platform and is a major player with a big market. It seems to be the most powerful, and proficient CAD designers using it to compare and contrast drawing. The usage to big projects is not perfect.

On the other hand, it is the hardest program to master. meticulous settings for using the software can be difficult to learn. In study, Svil's calculation software is suited for small-scale projects because modeling efficiency is relatively low and time-consuming for major projects. Also, the documentation is not complete for all the functions, especially the difficult ones.

Software such as Luban and Brownsville's software are merely plug-ins for CAD programs. This solution is cost-effective but it may produce risk piracy errors, crashes, and other problems that would risk the whole project.

5. Empirical Case Analysis

In order to make a clearer understanding of the application of the computing software in the civil industry, the actual operation is performed according to the specific engineering. BIM civil engineering computing model provides many advanced level functions such as intelligent identification of drawings, one-key importing of BIM design model, cloud collaboration.

In this paper, we use the Glodon GCL 2013 which is the latest version until the 2021 release for empirical experiment. In this experiment, a spatial models were established for this project using the Glodon platform GTJ2013, the engineering quantities of column, beam and slab were summarized and calculated, and the computing results were comparatively analyzed in the end.

5.1. Glodon GCL2013 Project Overview

The project name is XX dormitory. The location is in Longchuan, Guangdong. It is a no basement, 4 story building with 23, 84.11 square meters. The building design is to be 17.7 meters.

The author maps out the engineering plan with the Glodon Cube software and computing.

5.2. Application Examples in the Civil Construction

In this experiment, the first step is to enter engineering information on the Glodon software. This information includes structural types, layers, cornice height, indoor outer floor high, and floor information. We present detailed facade drawings in Glodon GCL2013 (Figure 1).
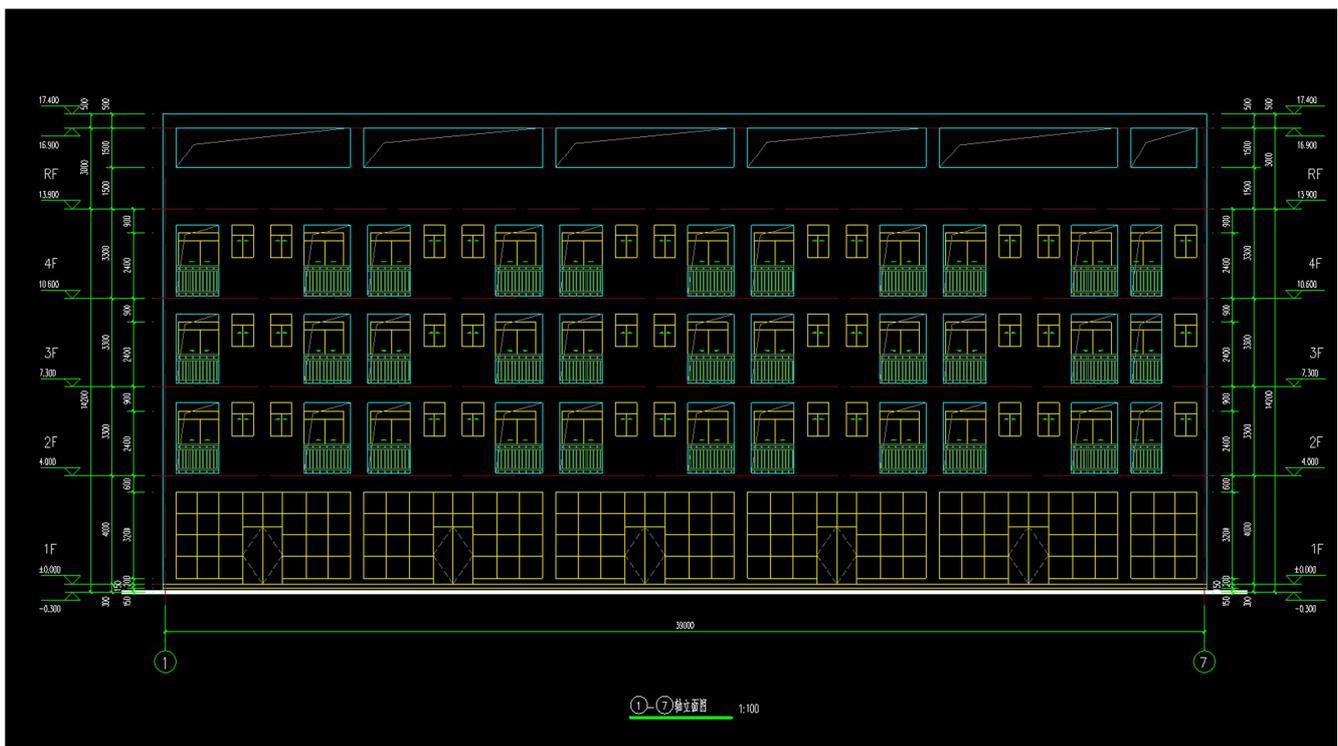

Figure 1. Façade, BIM GCL2013.

After the floor information is set, the shaft network and the first wall the door window, and the three-dimensional graphics of the first layer are drawn according to a layer.

There are some limitations for drawing walls, doors, and windows. Specifically, the window and window size shown on drawings often do not show. It is easy to repeat mistakes like clicking the export column instead of inserting. There are also cases where a door cannot be set in the middle of two windows.

According to the experiment to divide the corresponding floor, and we develop the grid, beam, plate, column and corresponding steel bars of each floor are separately identified and modeled (Figure 2). After the drawing is completed, the legality test of the main bars and the negative bars of the plate is carried out, and the special area of the reinforced steel is modified accordingly, and finally the preliminary layered model is drawn (Figure 3).

Since all building floors of this project are 4 floors, the

model is directly established by using Glodon BIM steel bar calculation software (Figure 4).

In the experiment, we do same process for each floor. The process to the floor layers is done based on filling in the corresponding floor markings according to the general description of the structural design and copy it to other floors (Figure 5).

After the each floor drawing is completed, the legality test of the main bars is carried out, and then the red area of the reinforced steel is modified accordingly, and final, we have a result from roof model, the roof layer plan model is drawn (Figure 6). The detailed drawing a layer is presented in Figure 7.
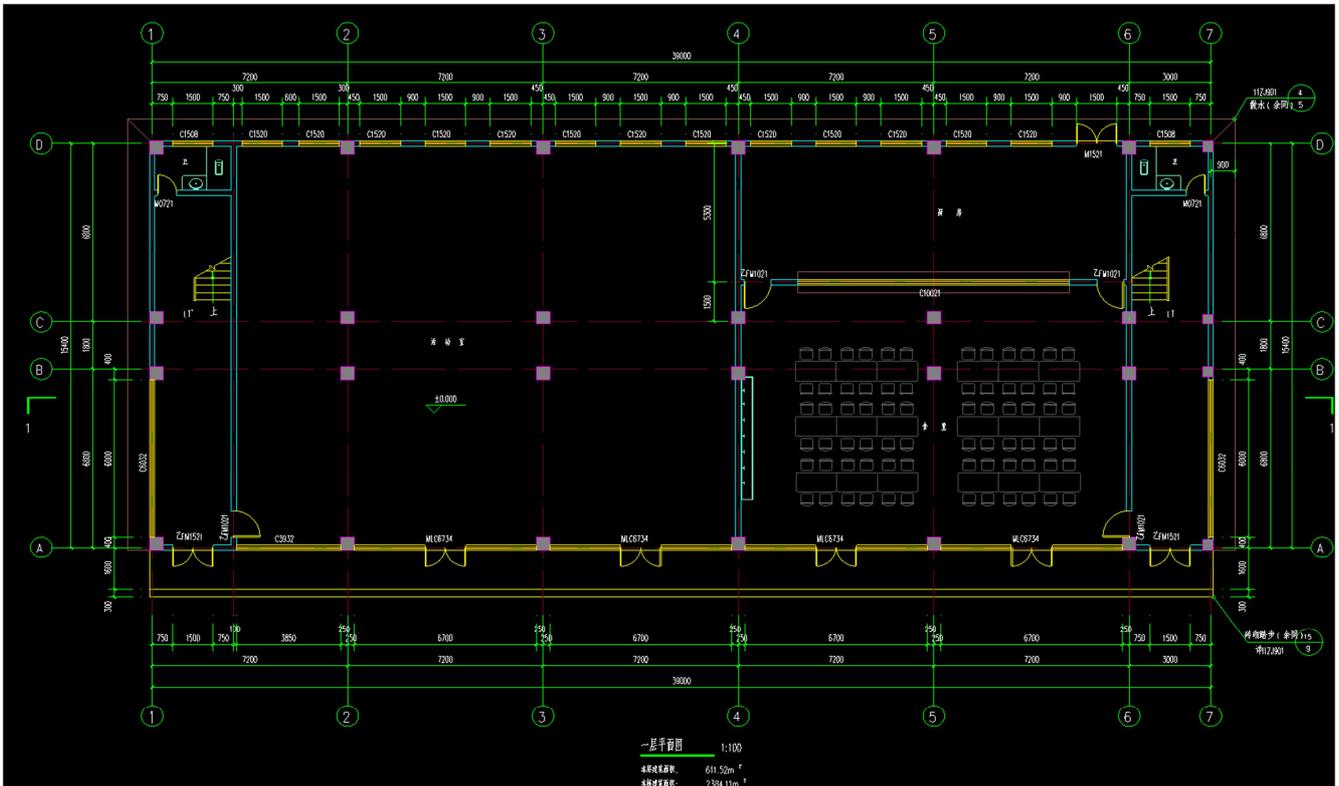
Figure 2. *Glodon BIM GCL2013 First floor plan.*
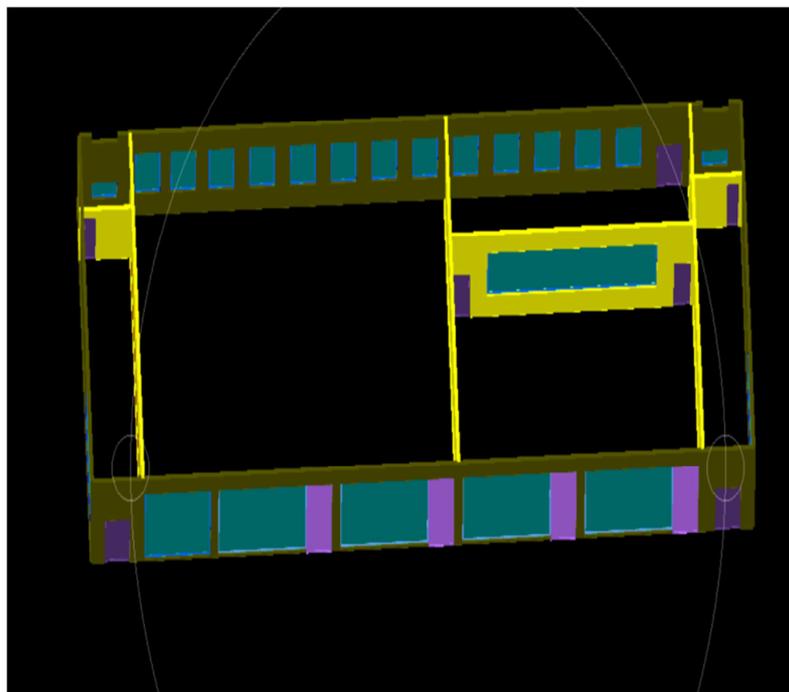
Figure 3. *Glodon BIM GCL2013 Glodon Draw a layered.*
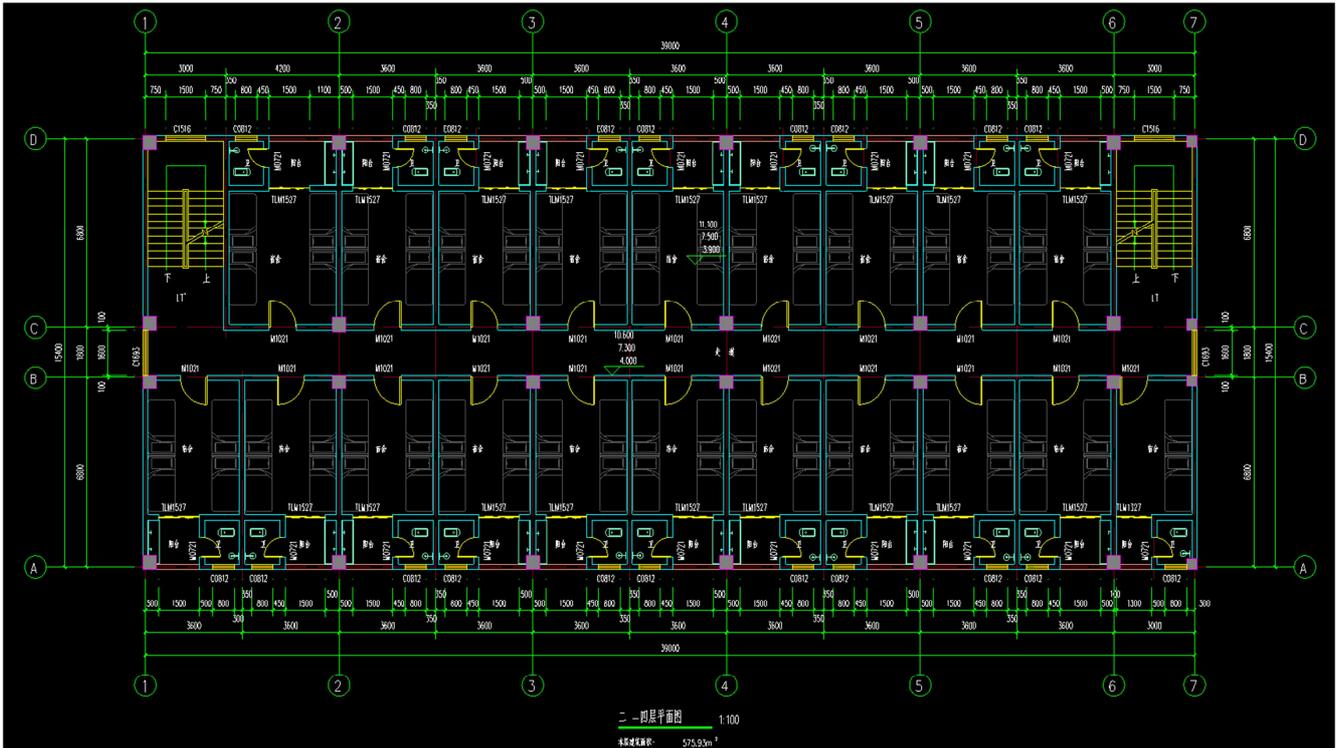
*Figure 4. Glodon BIM GCL2013, Two to four layers plan.*
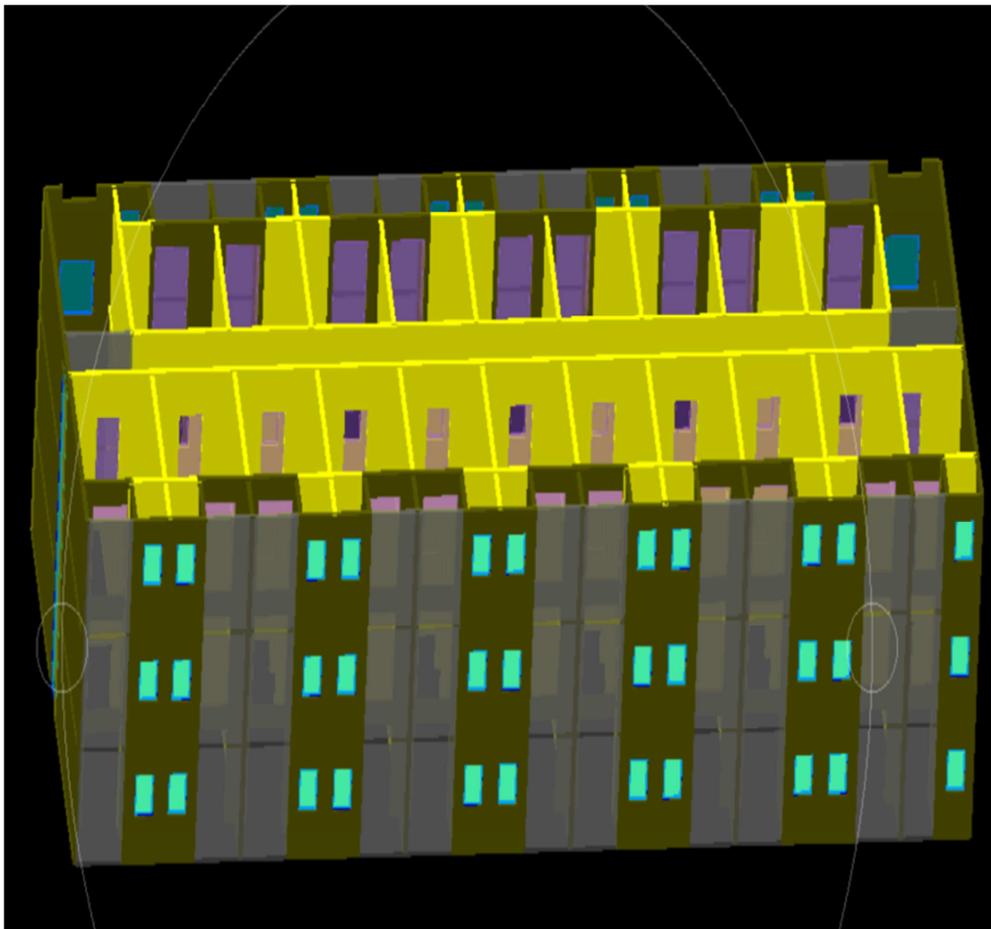

Figure 5. Glodon BIM GCL2013, Draw a layer.
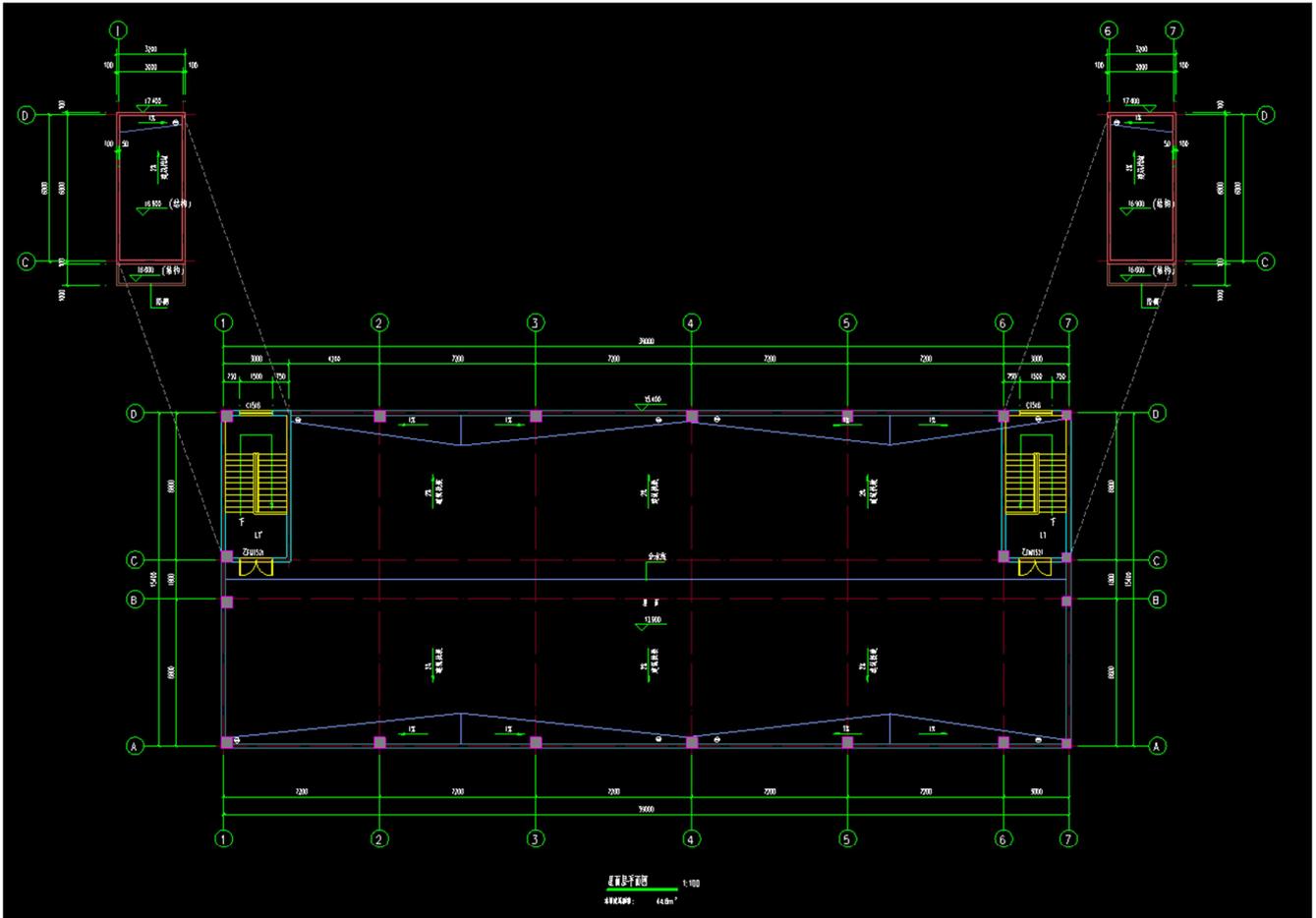
Figure 6. Glodon BIM GCL2013, Roof layer plan view.

Figure 7. Glodon BIM GCL2013, Draw a layer.

The software needs to be improved for it is very easy to stumble onto mistakes. Small discrepancies like this are easy to find with the Glodon software.

6. Conclusion

In this research, we analyze civil engineering computing software. We focus on the experiment of BIM Glodon software adoption. In fact, buildings such as high rises, high-level foundation pits, elevator well pits, complex exotic balconies, lines are too complex to be calculated via computer software due to their incalculable components amount. However, regarding the research, we present BIM Glodon software saves unnecessary troubles for cost personnel and improve the working efficiency for building complex components.

The civil engineering market has not saturated in this market, software is still a demand for this industry. The company that overcomes this challenge will have a high reward. There are companies currently working on this today but they have not had success. After the research and experiment, building components were respectively drawn using Glodon GTJ2013, the 3D model of this high standard plant was acquired, the civil engineering computing quantities of the components were calculated and comparatively analyzed. The development of BIM

technology is in line with the trend of social development.

According to the analysis, the development companies need to focus on upgrading their software to be more consumer friendly and cost effective. This will allow for the development and sales of their software.

Acknowledgements

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