The Module of Rebar Modeling for Chinese Building Standard Detailing Drawings by BIM-based Methods

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Abstract –
    Reinforcement engineering is one of the most important parts in projects of large reinforced concrete structures. Its quality directly affects the quality of the whole structure. As a matter of fact, many difficulties in rebar engineering remain to be solved, owing to its complexity and variability. Fortunately, the emerging BIM technology can overcome most of the difficulties. To efficiently build up a rebar model of a structure based on the Revit$^@$ software, this study carried out a module for rebar modeling using the Revit$^@$ API and the C# programming language. This module can establish the rebar part of structural elements, according to two-dimensional drawings of a structure. In addition, the module can provide an interface that is easy to be used for those who are not familiar with the standard detailing drawings. Simultaneously, this module generates a database regarding the rebar modeling, which can be further utilized in a future.

Keywords –
    BIM; Rebar; Revit$^@$ API; Secondary development

1   Introduction

    Reinforcement engineering is one of the most important parts in projects of large reinforced concrete structures. Determining the costs of it is essential for the whole project. In addition, its quality directly affects the quality of the whole structure. Owing to its complexity and variability, many difficulties in rebar engineering remain to be solved. Fortunately, the emerging BIM technology can overcome most of the difficulties.

    Building Information Modeling (BIM), as a new concept and technology, has been widely used by construction industries in the world since it was introduced. It can transform 2D drawings to a 3D model of a building structure. Because this 3D model allows for modifications to be made to the building's design during the stage of audit or construction, the amount of time and money needed to incorporate the changes is also reduced. In addition, the 3D model can provide 3D reviews, which can help constructors getting through the details of 2D drawings especially for the plan of reinforcement.

    Many research studies have shown that the use of BIM technology for reinforcement engineering can provide satisfactory results. For example, Aram et al. (2011) mentioned that making use of BIM technology can improve productivity of the reinforcement in supply chains. Porwal and Hewage (2012) reported that if BIM technology can be used reasonably, it can reduce the loss of rebar. Pratoom and Tangwiboonpanich (2016) pointed out that the quantity of rebar resulting from the use of traditional methods is 17.76% more than that resulting from the use of BIM-based methods. Meanwhile, the application of BIM in China is just beginning, compared with the developed countries. How to take advantage of BIM technology has become the rising issues of the construction industry in China.

    One of the issues nowadays is the deficiency in rebar modeling when using BIM software. For example, Cho et al. (2014) mentioned that a detailed structural model built by using Tekla$^@$ cannot interface directly with some other software tools for structural design, such as ETAB$^@$ and ADAPT$^@$, while Revit$^@$ Structure can. As a result, Revit$^@$ Structure was used in their study to interface with ADAPT$^@$. Still, the details of rebars for structural design needed to be improved, when building up the frame models by means of Revit$^@$ Structure. Shao (2017) developed a plug-in using Revit Extensions 2014$^@$ to carry out the modeling of rebar in beams, columns, slabs, walls and so on.

    The Revit$^@$ software is the most popular BIM software used by companies for design and construction in China. However, its functions for rebar modeling are limited. A series of tedious settings are required for the drawings of rebar when using Revit$^@$. The lack of the proper functions in the software not only affects the working performance of the designers, but also hinders the application of BIM technology in the reinforcement engineering.

This study proposed a module using the Revit[@] API and the C# programming language for rebar modeling. The module provides an interface that is easy to be used especially for those who are not familiar with the standard detailing drawings. This module includes the modeling of columns initially, but it can be extended to the modeling of beams, slabs, and walls in a future. This module can help to build rebar model efficiently and can promote BIM application in reinforcement engineering.

2   Method

Revit[@] API provides certain functions that can access the graphical and parameter data of a building
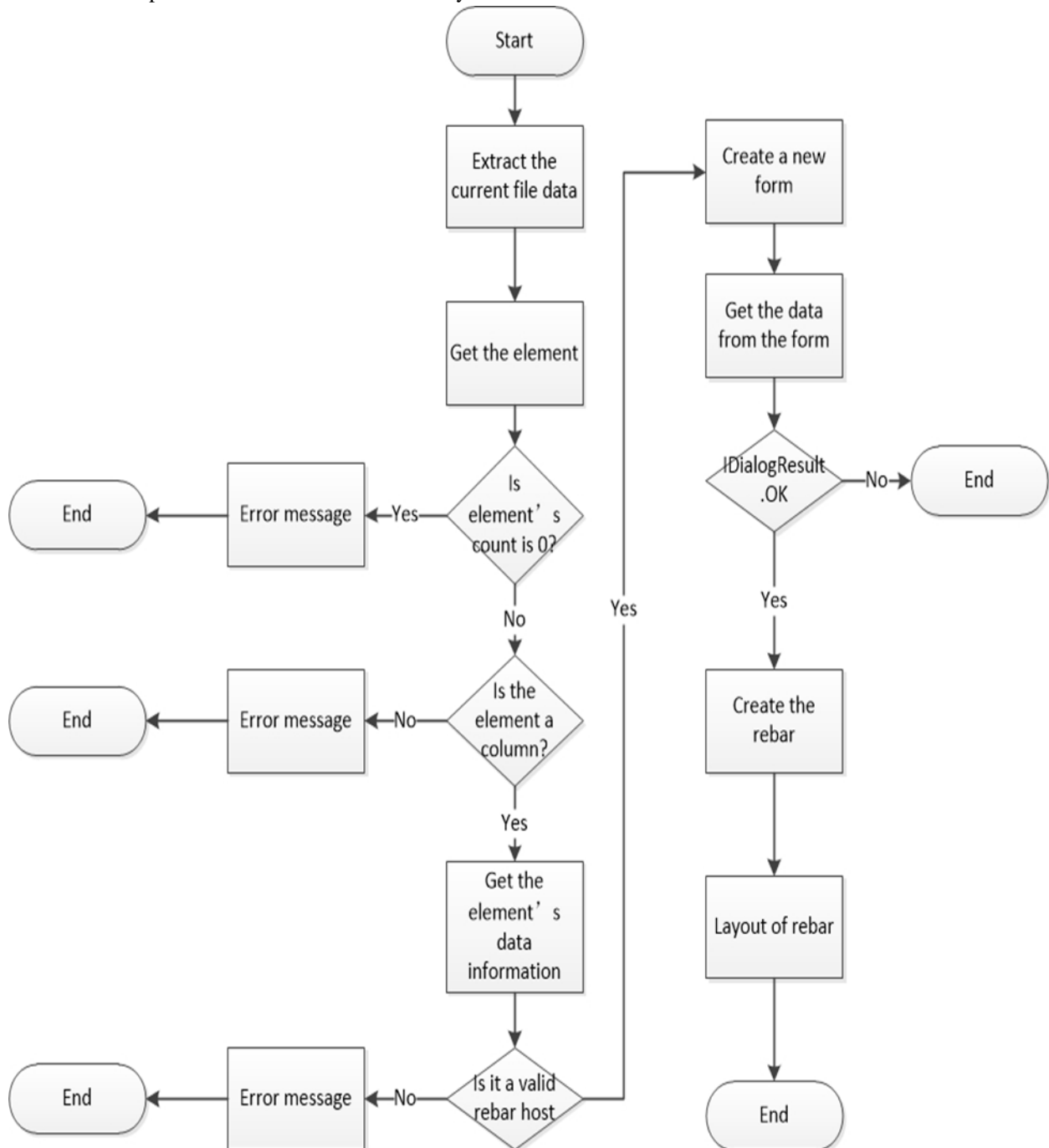
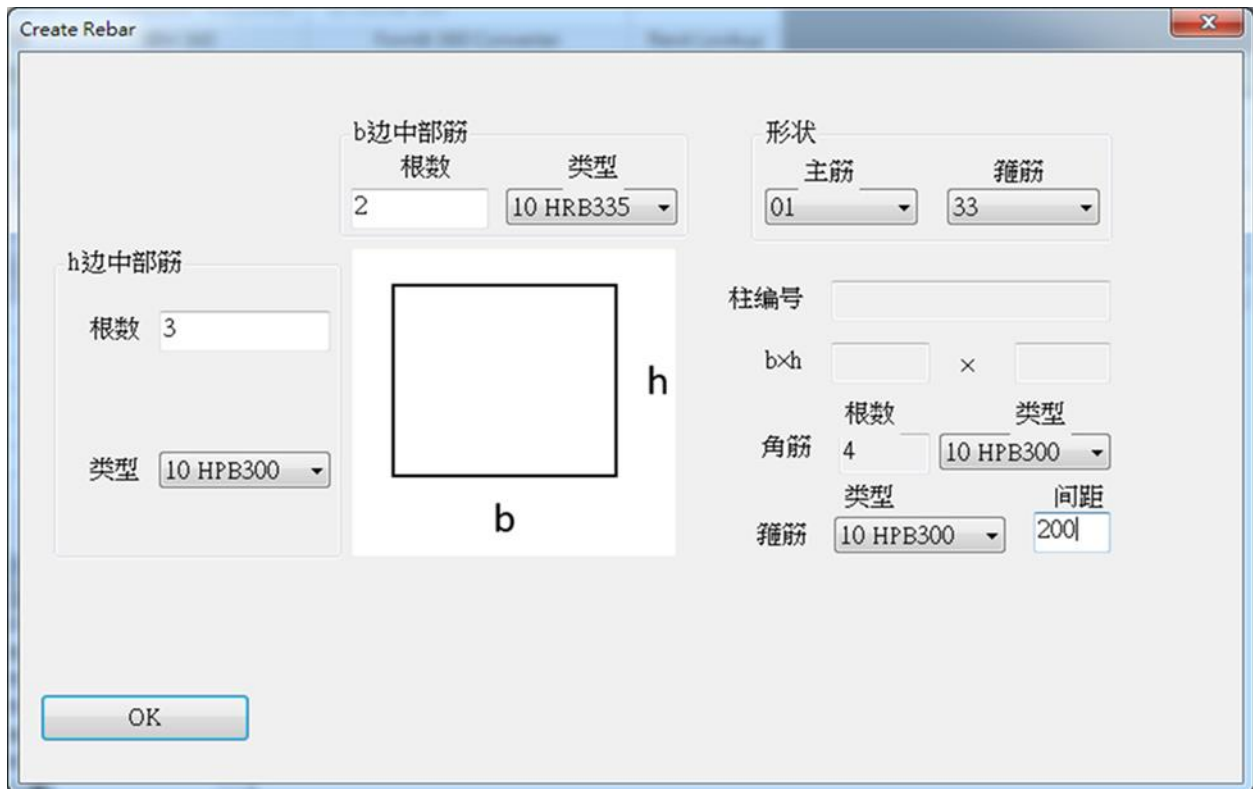Figure 1. The flow chart of main program.

Figure 2. The user interface of column

information model. Besides, it can create, modify, and delete the structural elements in the model. Moreover, it can create plug-ins that can enhance the user's interface and automate the repetitive tasks. The C# programming language is the other tool used in this study, which is easy to learn for a beginner. Using the Revit[@] API and the C# programming language, this study developed a module for rebar modeling. The steps of generating the rebar model in the component are roughly divided into: 1. Extract the current file data; 2. select the main body of the rebar; 3. ensure the type of the element; 4. define the rebar generation element; 5. restrict the rebar to the main body. Shown in Figure 1 is the flow chart of the main program in the module for creating rebar.

The brief introduction of the module follows. Firstly, the elements of a structure are established by means of Revit[@]. Once the desired element is selected for the arrangement of rebar, one can run the module. Shown in Figure 2 is the user interface in which the parameters related to the rebar can be assigned in the interface of the module. After clicking the "OK" button, the rebar are arranged in the element as planned.
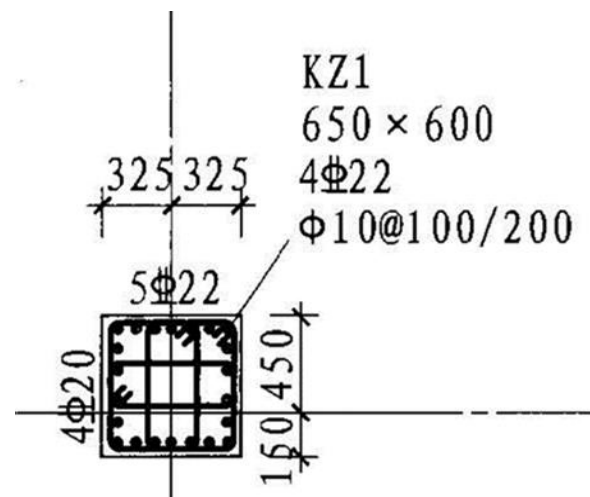
Figure 3. The tagging of column in the standard detailing drawings. （From B16G101-1[7]）

3 Results

Taking the element of column as an example, the parameters consist of the quantity, the number, the type, and the shape of the main bar, and the type, the spacing, and the shape of the stirrup as well.

At the left of the interface in the Figure 2, a user can input the quantity and choose the type of the main bar of
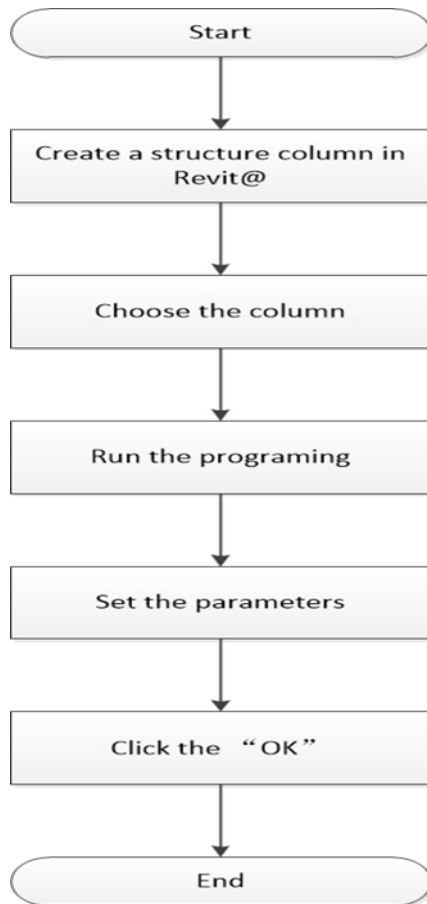

Figure 4. The rebar modelling for column

Figure 5. The flow chart of using the module

the "h" side. At the upper middle of the interface, a user can input the quantity and choose the type of the main bar of the "b" side. The lower middle of the interface shows the simple schematic diagram of column. At the upper right of the interface, a user can choose the shape of the main bar and stirrup. At the lower right of the interface, the serial number and the size of the column respectively show in the first and second lines. The third line gives the type of the main corner bars and the fourth line gives the type and the spacing of the stirrups. The user interface is like the standard alters as shown in the Figure 3. Shown in the Figure 4 is the rebar modeling resulting from the Figure 2. The flow chart of using the module is shown in Figure 5.

4   Conclusions

Currently, lots of BIM software for rebar modeling is deficient. Particularly, some of them cannot satisfy the needs of Chinese users, when using the Chinese building standard detailing drawings. This study developed a module for rebar modeling using the Revit[@] API and the C# programming language. Revit[@] is a convenient and popular BIM tool that can efficiently build up a rebar model of a structure. Compared to other BIM software，this module can result in a user interface that allows users to easily use the Chinese building standard design drawings. Even when one is not familiar with the standards, the module can be employed to create rebar modeling resulting from 2D construction drawings.

In the next study, the programing not only will finish the modeling of beams, slabs, and walls modeling, but also will create a database related with the model. People can use this module to build a detailed rebar modeling. The database will store all data about the rebar, such as quantity, type, shape, length, etc. Users can generate multi-purpose quality take-off reports extracted from the database, to promote BIM application in reinforcement engineering.

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