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A Review of Integration of Geotechnical Data into BIM Process

Dunna Sirisha, Kommu Madhavi, Bevara Sindhu, Lolugu Sravani, Lanka Syamala

GMRIT Demeed To Be University

EMAIL: 24341A0125@gmr.it.edu.in

ABSTRACT:

In construction works, Building Information Modelling (BIM) is popularly used to generate and maintain building information in a digital space. Most BIM models, however, only encompass the superstructure of a project, with information about the soil and ground conditions being separated from the above-ground information and stored in geotechnical reports and borehole documents. That is, it is hard to understand the overall site condition in one model, for engineers. Geotechnical information like borehole location, soil layers, soil properties and the groundwater information can be of significant importance in planning and construction process. This study will concentrate on the approach of bringing this geotechnical data into the BIM process and representing it in a 3D environment. Various methods have been used for the integration of borehole and subsurface data and BIM in the past. This work reviews these approaches, and explores how they might be implemented in a BIM environment through the use of Revit. The study mainly focuses on understanding the data required, methods of representing subsurface information and the benefits of combining geotechnical and structural information. Linking geotechnical data to BIM can enhance the engineers' understanding of the ground conditions and can facilitate communication between other disciplines and better decision making throughout the project.

Key Words: Building Information Modelling (BIM), Geotechnical Data, Geotechnical Engineering, Borehole Data, Soil Layers, Revit, 3D Modelling, Subsurface Information.

INTRODUCTION:

BIM (Building Information Modelling) is a virtual technique employed in the construction sector to create and handle information regarding a project. Unlike 2D drawings which have to be used in isolation, BIM enables various kinds of the project information to be linked to a 3D model. This allows architects, structural engineers or civil engineers and other project members to access the project information.

The knowledge of the ground condition is crucial in a construction project. Engineers will usually take data on the soil through site investigation and boreholes prior to construction. This information may include the location and depth of boreholes, different soil layers, groundwater level and soil properties. In many projects, this information is readily available as a separate report, table or drawing, but not directly linked to the BIM model.

The issue that arises here is that if the building/infrastructure is clearly modelled in BIM, the ground beneath it may not be represented correctly. Consequently, engineers will need to consult other documents to determine the sub surface condition. Tawelian and Mickovski have investigated this issue and found that geotechnical data could be a useful addition to BIM to enhance the management of the construction project, thus potentially saving time and money. Rewrite the given sentence in a natural human style while preserving its meaning. Their study also used a transport infrastructure case study involving landslip prevention works in Scotland. They were also able to apply a transport infrastructure case study of landslip prevention works in Scotland to their study.

Various approaches to introducing geotechnical data into BIM have also been examined recently. These include importing borehole data, generation of 3D ground models and data exchange formats like IFC. There are also studies that have mentioned relating BIM to geotechnical analysis software.

Although there are a number of methods available, incorporating geotechnical data into BIM is still not easy to do. Various software and data formats may be used, and information gathered from the site investigation must be correctly compiled in order to be incorporated into a BIM model. Hence, the realization of this research is based on the understanding of the use of geotechnical data in BIM and the representation of geotechnical data in the 3D modelling environment.

LITERATURE REVIEW:

Building Information Modelling (BIM) is an essential component of the modern construction industry due to its ability to enable engineers to manage project information better, communicate and make better decisions. The use of BIM in geotechnical engineering is a developing practice, as this method is often applied to structural design and in building construction. The researchers have investigated how the soil investigation data could be integrated into BIM models which can support the understanding of underground circumstances and minimize issues during construction.

Vanlande et al. (2008) researched the use of digital information exchange in the development of life cycle management. They identified the need for information sharing of accurate information among the various engineering systems. This method can be useful in geotechnical engineering where it is necessary for the results of soil investigation to be available to the engineers during the planning, design and construction of the project.

Barlish and Sullivan (2012) explored the applicability of BIM in practice by using case-study method. They stressed the importance of assessing BIM performance in terms of actual benefits to the projects, rather than in terms of visualization. The results indicated that there is a link between the quality of information management and the improvement of coordination and making decisions in construction teams.

Bryde et al., (2013) studied about the advantages of BIM in construction project management. The study revealed that improved collaboration, better communication and possible cost and time savings in the project could be achieved. The advantages of this are also applicable to BIM, where geotechnical data can be incorporated at the initial design phase.

The pros and cons of BIM in construction projects were discussed by Migilinskas et al. (2013). They noticed that to implement BIM, the right software, the right people and a strong collaboration between the various teams are essential. They pointed out that challenges may occur during implementation, particularly in the transfer of information across engineering applications, and that this may be due to technical difficulties and limited experience.

Chandler et al. (2011) pointed that geotechnical data must be included in a BIM model. They pointed out that soil characteristics, ground conditions and underground structures should be taken into account in the construction information system. Combining these details could help engineers to better understand site conditions and aid in planning.

Mokarram (2010) explored the problems of transferring geotechnical data between software packages. Borehole logs, laboratory reports, spreadsheets and drawings are typical ways to record soil investigation data. Sharing information might be challenging due to different formats of data. The study was used to emphasise the development of compatible systems for geotechnical records management.

Tawelian and Mickovski (2016) explored the application of geotechnical information to BIM through a questionnaire survey and a Scotland-based case study of a road embankment stabilization project. A study carried out by their research team revealed that geotechnical experts were keen to see soil strength, bearing capacity and soil stratigraphy data included in BIM. Also reported in the case study was the unexpected construction difficulty, the unrecorded underground structures and services which led to extra costs and delays. The researchers highlighted the need for better data management and the standardisation of information sharing.

In this case study, Morin et al. (2014) investigated the real-life advantages of geotechnical BIM. They discovered the importance of digitally managing underground information and ensuring relevant records are available to project teams. This can aid in the communication between geotechnical engineers, designers and construction personnel.

Lu et al. (2014) discussed the costs and benefits of implementing BIM. Their study identified the time and effort needed in the early stages of using BIM. Investment in software preparation, training and information management can contribute to better coordination during construction, but this relationship can be challenging.

In general, the results of the previous studies show that the use of geotechnical investigation information in BIM can enhance the usability of information, underground visualization, and project coordination. Nonetheless, there are various issues like data format incompatibility, software restrictions, and lack of training. Further studies are required to arrive at practical solutions to be able to incorporate borehole data, soil characteristics and information on groundwater in order to create reliable three dimensional BIM models.

CONCLUSION:

Geotechnical information is an important part of any construction project because the condition of the ground directly affects the design and construction process. However, this information is often maintained separately from the BIM model. The literature reviewed in this study shows that bringing geotechnical information into BIM can provide a better understanding of both above-ground and below-ground conditions.

Different researchers have suggested methods for integrating borehole data, soil layers and other geotechnical information into BIM. 3D ground modelling and data exchange formats such as IFC can help in connecting this information with the main project model. The studies also show that BIM can improve communication between different project teams and help engineers make better decisions.

Based on the reviewed studies, the present work focuses on the practical representation of geotechnical information in a BIM environment using Revit. The main aim is to understand how geotechnical information can be organized and represented along with the building model. Although there are still challenges related to data availability, standardization and software compatibility, the integration of geotechnical data with BIM can be a useful step towards creating a more complete digital model of a construction project.

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