Recent Advances in BIM in Geotechnics

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ABSTRACT

The use of Building Information Modelling (BIM) is becoming more widespread throughout the various sectors, and professions of the UK construction industry, however, in its "*National BIM Report 2016*", the National Building Specification (NBS) concluded that BIM was still a) "*Far from embracing all parts of the supply chain*" and b) "*Not reaching the O&M phase of the building*".

Of course a positive step was taken when in April 2016 central Government departments required collaborative 3D Level 2 BIM. However we still need more clients and the operators of constructed assets to follow the initiative, if we are going to improve upon the NBS's findings.

This paper examines two recent advances in BIM in the field of geotechnics. The first case study relates to the sharing of site generated data, that is gathered electronically on site, processed and then uploaded to the BIM model, all automatically. In this way the stakeholders are seeing the object attributes updated in the integrated model in real time as the work is done. The advantages of this process include the obvious savings in time and effort, avoiding mistakes, self-certification and the manifest openness that supports collaboration.

The second case study relates to how monitoring data can be accessed from the BIM model. Whilst strictly not an "object" in BIM terminology, this information is important to the construction team during the building of the asset and surely to the operator and maintainer too. The monitoring database provides a way of all parties being able to interrogate the same data both in real time and historically. This information truly spans the gap between design, construction and the O&M phase, and has the potential to break down some of the traditional gaps.

Both advances support the wider uptake of BIM and its continuing development. More importantly, both give further impetus to the changing landscape of construction procurement.

If we are to continue to improve the efficiency and effectiveness of the construction industry we must learn to collaborate and digitalise. The author believes that BIM has the power to deliver this, almost by default, encouraging and cajoling the parties to act in this way.

INTRODUCTION

There are many of us involved in the construction industry that want it to change and modernise. Much has been said and written on the necessity to collaborate and use digital tools far more [PAS1192 series]; but the reality is that progress is painfully slow and largely because of poor returns, commitment towards research and development is scant. However, some are seeing that by adopting BIM those professionals working in the sector might be pushed or incentivised into a better way of working. The implementation of BIM requires a change in traditional processes and relationships. The very fragmented nature of our industry makes this collaborative method of working a challenge, but one that the author hopes BIM will make inevitable. Viewed in this way the adoption of BIM should be seen as an enabler. Used properly, contractually [CIC: 2013] and collaboratively it is a tool that should:

- Enable better information flows through improved technology.
- Enable better decision making during design and construction.
- Enable the full construction team to participate effectively in the process and;
- Enable the end user to better understand and manage their asset.

BRIEF INTRODUCTION TO KELLER

Keller is the world's largest geotechnical specialist. It has operations in over 40 countries and employs 10,000 people. It's UK operation makes up one of the leading companies in the market and offers a full range of foundation and ground improvement solutions. Most of the work that Keller does is design and build and normally through a subcontract with the Principal Contractor (as a tier two supplier to the ultimate client). Keller works in all sectors of the construction industry from housing, commercial, infrastructure and utilities. Because of the nature of what it does, the company often has involvement with architects, design consultants, cost consultants, housebuilders, clients and contractors. In many ways its position as a design-build tier two has required the business to collaborate across the industry for many years. This means that Keller, and companies like it, have a unique perspective when it comes to the adoption of BIM.

1.0 DATA DROP PROJECT

The subsurface realm is complex and heterogeneous. The performance of soils is self-evidently highly variable and difficult to predict with precision and natural and man-made obstacles add to the ground-related risks.

Currently, relevant geotechnical information is limited, if it is included at all, in commonly used BIM models, and ground conditions, the foundation system applied, and the execution of geotechnical works have minimal or no impact on the entire planning, construction and investment process. This is a clear contrast to the lessons learned since ground problems are one of the major causes of project delay, and when they occur they are normally difficult to handle and expensive to rectify. Therefore geo-related data, such as geological, hydrogeological and geotechnical objects and properties, should be considered as a vital and integral part of extended and future-looking BIM models.

From the geotechnical engineer's perspective, an un-federated BIM model (let's call it a GeoBIM model) would improve the understanding of how any geotechnical solutions "fits" the ground. Not just through a 3D representation of what is being installed, but how the foundation relates to the geographical strata that is either known about or postulated. Resistances, or pressures, or torques that have been used during the installation of the foundation are also important parameters to have captured in the objects within a GeoBIM model to aid understanding of the underlying conditions and to validate the design assumptions that have had to be made.

With all of that in mind Keller decided in March 2016 to move towards an environment where first it could use a GeoBIM model for its own purposes to validate and check its own work, but hopefully also move towards a way of linking or federating this with the overall Project BIM Model.

It is already possible to plot ground information such as boreholes into a GeoBIM model, particularly if the "AGS" electronic data format is used [ICE:2016]. However, obtaining and then manually entering the as-built data, is a time consuming and frankly boring process. Engineers become overly involved in the administration and cease doing what they have trained and are paid to do; engineer.

So Keller decided that both to improve its internal processes and to encourage the uptake of BIM, that this dataflow needed to be automated, meaning that site construction data would flow into the BIM model directly. In the future this will be common place, but presently a lot of manual site records are distilled and entered into the model by manual keying in.

1.1 PROCESS

Many of the rigs and items of equipment used in the geotechnical sector already have on-board computers controlling the process and recording installation data [ICE 2016]. The data drop project essentially takes this source data, collected during construction, and pushes it into the Autodesk Revit Project BIM Model for all the other project stakeholders to view.

Fig 1.1. Typical on-board rig computer

The philosophy has been to meet the requirements of BIM Level 2 using Keller's existing systems as far as possible. K2 software fulfils this requirement perfectly as it is tailored to link databanks that would otherwise operate independently.

The process requires the use of an application to application interface program (API) to take the data from the site computer, into a sharepoint environment and then beyond into Revit [See Fig 1.2].

The process executes on a schedule and moves data from the site (via mobile links) into the Keller repository first, then into the BIM model. Selected data and specifically object attributes are moved into the model, but all the source information is permanently maintained (and archived) in the Keller server.

The Keller database provides a secure electronic data input into the system drawing from several different types of instrumentation and sources. This repository hosts the master input data. This is a rich data environment and so can be portioned as necessary, by client or by project for example.

A simple search within the SharePoint site allows the user to interrogate the rig instrumentation database retrieving construction information for a specific project, product, rig and shift. This is cross-checked against the design intent and any discrepancies between the as built record and design intent are flagged within the system requiring an engineer to check it.

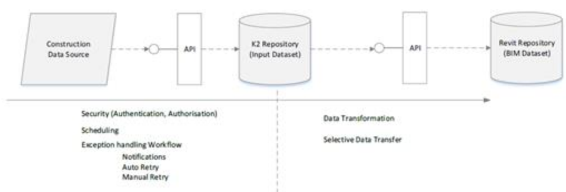

Fig 1.2. API Logic

The next step is that selected data is sourced from the repository and published to the BIM model. The data that is chosen could be selected by the client or other stakeholders. The application provides data transformation and translation services to ensure that it is mapped correctly to the objects and the attributes are then assigned into the Revit model.

The overall system processes are orchestrated using K2 removing human intervention and bureaucracy. This also allows automatic scheduling, provides notification to the users and allows system-human task creation. An example of a BIM model automatically populated with site data is included in figure 1.3.

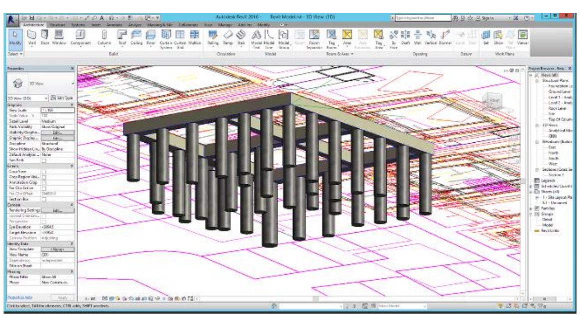

Fig 1.3. The Populated Revit Model

In addition to populating the model, using the construction data, the application automatically populates the daily report sheet issued to the client on the site itself. This additional step removes any manual input from the site team whilst improving the accuracy of this task.

2.0 BIM AS A GATEWAY TO MONITORING DATA

The second advance is in the use of monitoring data. Monitoring and the instrumentation of either existing infrastructure that might be affected by construction, or the monitoring of the new works, or the collection of data relating to the environment is now common place and increasing in popularity.

The traditional linear approach of procurement is being challenged by BIM and situations are being created where all parties have to share from a common information pool. But breaking through the barriers of the parties protecting their own interests, or not freeing up the data into the model, remains a challenge and this is where Keller has made some important headway.

It is not unheard of that in some traditional arrangements, monitoring is carried out (procured) separately by the client, by the Principal Contractor and possibly some of the sub-contractors too. Data is not typically shared freely and when it is it can be conflicting, unsurprisingly.

In a collaborative way of working this monitoring service would only be procured once, for the project; for everyone, but access to the information has to be open and transparent with all parties having the same unfettered access. The BIM model provides a perfect way of achieving this.

However, monitoring data can be difficult to handle. First it often needs processing, and there are various ways that the data can be presented, graphical representation is an obvious way, but more innovative techniques such as heat mapping can be more easily read. Secondly the amount of data is problematic. Monitoring could on some jobs last decades and if, as is the case with some instruments, data is being read and logged every minute, then the database soon swells. If this were all to be stored directly within the BIM model then it would be quickly become unwieldy.

So the solution that Getec (a Keller subsidiary) has arrived at is to write a plug in to the Revit standard menu that allows the user to access the I&M database through interaction with the model.

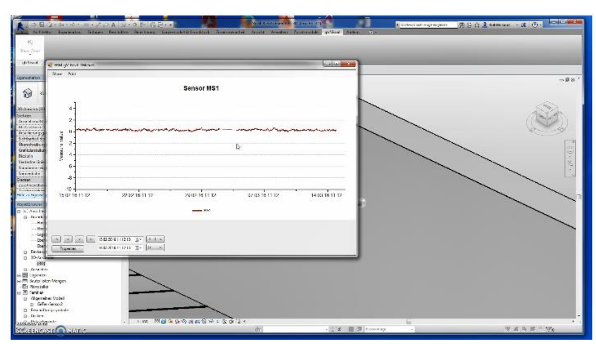

Fig 2.1 I&M through Revit

The user can navigate through the model in the usual way. Sensors and instruments are drawn into the model like any other piece of hardware and each of them is an object in the 3D model with useful attributes that can be used throughout the construction and the O&M phase.

When the user wants to see the monitoring information one or more of the sensors is selected and access to the monitoring database is activated. This allows the I&M information to be presented with the full functionality of the I&M software running behind the BIM model.

If access to this data is to be restricted, then this is easy to arrange. The sensors and instruments would be visible in the model, but the link to the I&M software would be only available to those that are authorised.

One issue to address is who owns the data. Permissions can be allocated, but one could argue that ultimately the client pays for the data whether he sees or uses it or not. Surely, any client would want the benefit of monitoring data pre, during and post construction? This opens up the opportunity for the BIM model to be truly used as envisaged, from concept, through design, into construction and finally in the O&M phase. Perhaps the offer of I&M data that can be used for many years after the building is commissioned could move some clients to embrace the benefits of BIM after construction.

In this scenario, the model could not only be used for the fabric of the building or piece of infrastructure, but the monitoring data could be extended to cover heating and lighting performance, air conditioning systems, or for maintenance, condition based monitoring tools. Whilst these are recognised virtues of other asset management systems the potential for overlap is obvious.

This approach of providing a “live” BIM model rather than just a record of what has been built at handover, supports the Governments Soft Landings philosophy [BSRIA:2009] and is perhaps the holy grail for BIM in the future.

CONCLUSIONS

Most commentators concur that wide adoption of BIM in the construction industry is inevitable. It is a question of when, not if. In addition to the obvious digital progress, the author also hopes that BIM will be the enabler or the catalyst for change towards a more collaborative industry too.

The value of data is undervalued. The cost of collecting and collating data is often expensive and time consuming. With the data drop solution, real time and accurate data, direct from the construction site, can now be sent directly to the BIM model without any human processing.

Our industry is fragmented. The Department for Business, Innovation & Skills in 2013 identified that on a typical medium sized project (£20M) up to seventy sub-contractors can be involved, but we can use BIM to present an opportunity to assemble a supply chain that can get involved earlier in the asset life cycle, and stay around for longer too. The use of BIM requires tier two contractors working within the project team to coordinate the way in which the information contained and associated with the model is created and managed.

Keller’s commitment to BIM and in particular its focus on transparent solutions is a good example of how the tier twos are responding. Contrary to some findings, many subcontractors are ready and are wanting to fully engage with BIM. But for this to happen it needs the commitment from the clients and also the tier one contractors.

Keller would like to think that with the I&M data so obviously being relevant to all the stakeholders and the phases of a construction project then this might present a further reason for clients to think again about deploying BIM on their scheme.

Our industry is still in search of the cultural shift that will see us working in collaboration. We should collectively take the opportunity now to make BIM the catalyst to that change.

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