BIM BETTER BUILDING PROCESS. BUILDING BETTER PERFORMANCE.

CASE STUDY:

University of Canterbury Structural Engineering Laboratory

DOMINION CONSTRUCTORS LTD

assemble™

BIM ACCELERATION COMMITTEE

BRANZ Funded from the Building Research Levy

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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Photos courtesy of Dominion Constructors and the University of Canterbury

WHAT IS BIM?

Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of a built asset – everything from bridges to buildings. A building information model is a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.

The key principle is that BIM is not any single act or process. It is not creating a 3D model in isolation from others or utilising computer-based fabrication. It involves being aware of the information needs of others as you undertake your part of the process.

"Elementary dear BIM"

The construction of the University of Canterbury's specialist Structural Engineering Laboratory demonstrates how BIM can be applied at specific stages of construction to determine specific building elements. It shows that BIM can add value to projects, large or small.

The Canterbury earthquakes highlighted the need for a seismic testing facility for large built structures to ensure that people can escape safely from them in the event of a quake, and to make them readily repairable so they can be back in use as quickly as possible.

The University of Canterbury (UC) College of Engineering decided to construct a purpose-built facility with strong floor and walls for earthquake testing building prototypes. It comprises a 2 metre deep, concrete 500m² floor and L-shaped concrete walls 1.6 metres thick and 9 metres high. Around 1.5 kilometres of steel is used in the reinforcing.

The Structural Engineering Laboratory is designed to test large chunks of full size structures at a loading rate and pace that simulates a real earthquake. Thousands of anchors are built into the floor and walls so that structures can be bolted on to them. The walls stay rigid and hydraulic rams push the structures from side to side to measure their resilience.

It is a very complex building with a very specific use that called for exact coordination.

On this project BIM wasn't used in the design phase, however, the contractor Dominion Constructors saw the benefit of using BIM to give proof of design, inform fabrication and help execute a number of processes in the construction phase. So the path was chosen to create a virtual mock-up of the floor and walls to test buildability, alignment with procurement of materials and to inform quality assurance and quality control throughout construction. Assemble was engaged to lead the BIM modelling process.

"In my 20 years in the industry I've never seen something of this scale before, in terms of the sheer volume of engineering involved – the job was unique in its brief and function."

ANDREW DICKINSON, BIM TECHNICIAN, ASSEMBLE

PROJECT DETAILS

DURATION
March 2015 to April 2016

PROJECT PARTNERS
Client: University of Canterbury
Client project manager: TPO The Project Office
Main contractor: Dominion Constructors
Design and BIM technician: Assemble
Structural engineers: Aurecon
Concrete supply: Firth
Reinforcing: Reoco Reinforcing
Couplers and post tensioning: Contech
Architect: Warren and Mahoney Architects

BIM USES
The New Zealand BIM Handbook Appendix D defines 21 distinct BIM Uses. For this project the primary BIM Uses are:

Design authoring
3D coordination
Phase planning
Construction system design

The process

The strong floor and walls of the Structural Engineering Laboratory were modelled in Revit. “Design Authoring” was used to establish a 3D model and provide the basis for deeper coordination. Through the BIM process of 3D coordination, and employing other BIM Uses “Phase Planning” and “Construction System Design”, Assemble tested the engineering design.

The 3D model enabled the design to be analysed for the buildability of this highly specialised facility and was used to virtually replicate all the stages of construction, which also assisted with planning on site.

Assemble modelled to a Level of Development (LOD) 300 – 400. This is because the model had to be accurate for fabrication. BIM processes were used to digitally represent integral elements of the floor and walls in 3D, including the reinforcing and coupler assemblies.

Assemble carried out coordination, working closely with Dominion Constructor’s team – three people were dedicated to this job, with specialists called in at times, as required.

Dominion Constructors had to upskill their subcontractors on site in the use of BIM 360 Viewer on mobile devices to instruct and guide their work.

“We were modelling for fabrication. BIM ensured we got the detail right.”

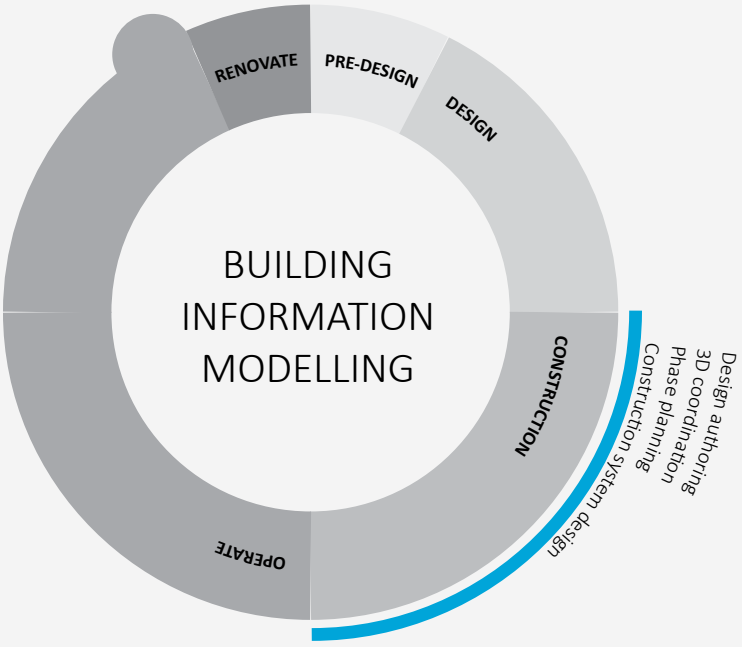
ANDREW DICKINSON, BIM TECHNICIAN, ASSEMBLE

WHAT IS A BIM USE?

“BIM Use – a unique task or procedure on a project which can benefit from the application and integration of BIM into that process.”

THE NEW ZEALAND BIM HANDBOOK.

THIS CASE STUDY HIGHLIGHTS THE VALUE OF USING BIM IN THE CONSTRUCTION STAGE OF THE PROJECT LIFE CYCLE.



Challenges and constraints

For the Structural Engineering Laboratory to function as it should, it was important to spread the force of simulated earthquakes over a wide area of concrete. The floor and walls were required to withstand 390kN+ loading to anchor points and bolts.

There is as much reinforcing in the base of this facility as in the foundation of New Zealand's tallest building, SkyTower. It took twelve hours to pour the concrete for this project, which required a massive continuous supply of concrete and precision planning and timing.

Within the concrete were more than 3600 couplers or anchor points that needed to be laid to a 2mm level of accuracy, along with steel trusses in the floor and 400 tonnes of steel reinforcing. All of this needed to be coordinated before being laid and built.

A lot of reinforcing and a lot of components had to fit in very tight spaces. It was important to visually map out clashes so they could be resolved early and remove uncertainties in the 2D drawings.

By embracing new technology the project team could see the end product in a 3D viewer before putting it together.

Results and benefits

BIM streamlined construction. The reason for using BIM was partly to do with some of the building elements having no tolerance, so the importance of accuracy and coordination was of high importance.

In some places in the floor there were four layers of reinforcing, in essence, it was a concrete layer cake. Using BIM to virtually build the floor, layer on layer, ensured that all of the components were perfectly aligned.

With so many cast-in components, BIM modelling came into its own… helping the project team avoid clashes between the reinforcing steel and couplers.

BIM assisted quality assurance as Dominion Constructors could QA each layer against the model as it happened. This ensured that every step was dimensionally correct. The accuracy of the BIM model proved to be invaluable in ensuring everything fitted first time.

"The key was the BIM model – it showed us where the clashes were that we had to go back and resolve."

ROB STEEL, SENIOR PROJECT MANAGER, DOMINION CONSTRUCTORS

"Testing the sequencing and buildability of the reinforcing in a virtual world meant that everything went together like a meccano set."

ROB STEEL, SENIOR PROJECT MANAGER, DOMINION CONSTRUCTORS

Project Manager Robert Steel says that avoiding clashes through BIM modelling saved weeks in lost production time. "We got it right first time so there was no rework and a lot less wastage than usually occurs on jobs done the traditional way without BIM. Labour was more efficient because the team could see how components fitted together in the model. All components were in place, on time."

The Structural Engineering Laboratory is now part of a network of earthquake research facilities throughout New Zealand, working in the national interest. It exposes UC students to modern testing techniques that provide first-hand experience of seismic loading on structures and soils in real-time and at a realistic scale.

Cost considerations

Development of the BIM model cost approximately $70,000 out of a total project budget of $10 million. Dominion Constructors estimate that the time and materials saved by using BIM, due to the high standard of construction and clash avoidance, would be worth double that, demonstrating how BIM provides a good return on investment.

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