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Architectural Technician

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# An Appraisal Of 4D BIM Technologies For Safety Planning and Site Safety for Temporary Works Design at the Construction Stage

# An Appraisal Of 4D BIM Technologies For Safety Planning and Site Safety for Temporary Works Design at the Construction Stage

The focus of this presentation is the application and appraisal of **Building Information Modelling** to **health and safety** and **risk management** on the construction site with an emphasis on **temporary works design.**

This includes a appraisal of BIM application and integration, for **visualisation, planning, health, safety and risk assessments** of construction projects, an appraisal of a **case study** and as well as other associated works.

In addition, a **survey** was conducted to gauge responses from participants and evaluate solutions to crucial issues in industry with an overall conclusion.

# Contents



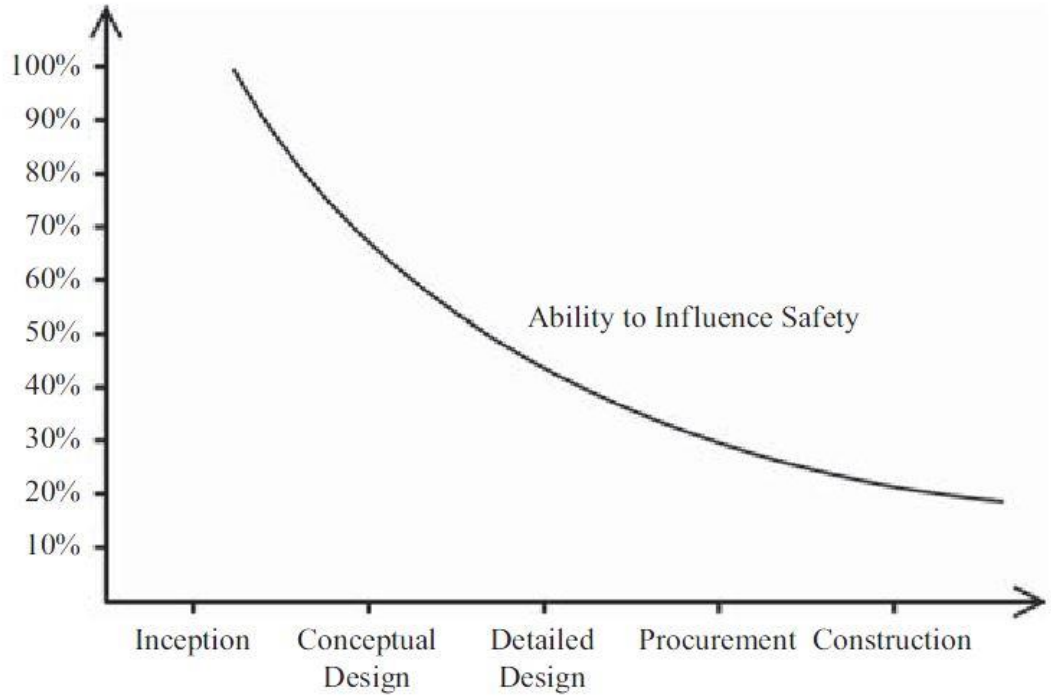
# Building Information Modelling Dimensions

**In general terms, there is a broad consensus that the following dimensions can be included in a model:**

- 2D. Two-dimensional graphical information.
- 3D. Three dimensional graphical information.
- 4D. Time and programme information.
- 5D. Cost estimation information.
- 6D. Sustainability & energy consumption.
- 7D. Facilities management information.

- 8D. Incorporating safety information

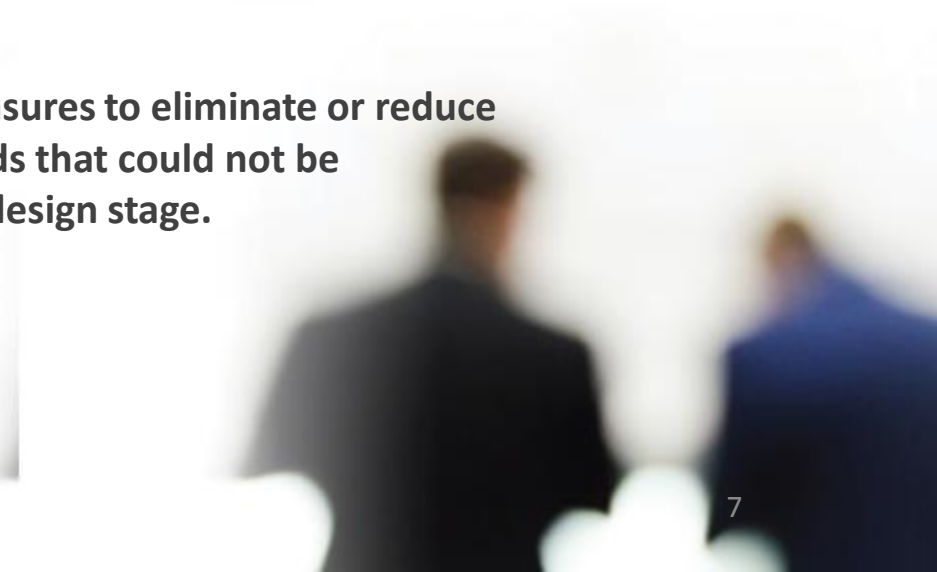
## Utilising BIM for risk management: Accident prevention through design (PTD)

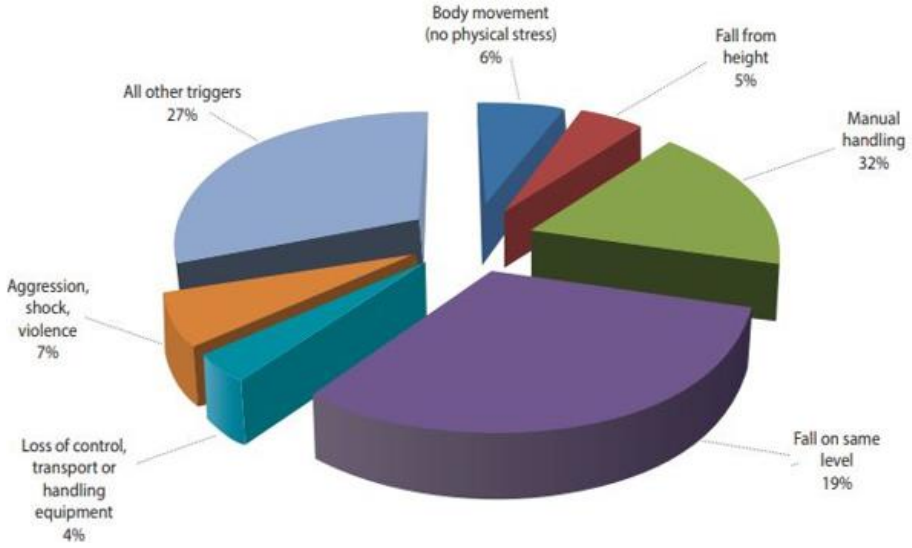



*Project Schedule Vs Safety Influence Curve*

The key feature of this process is the input of site safety knowledge into design decisions.
The type of knowledge that is critical to a successful safety implementation in design include:

- **Construction methods of design elements and the risks faced by workers on site in the process of building the elements.**
- **Safe design suggestions for making design changes or incorporating safety devices in the design.**
- **On-site safety measures to eliminate or reduce the risks for hazards that could not be eliminated at the design stage.**





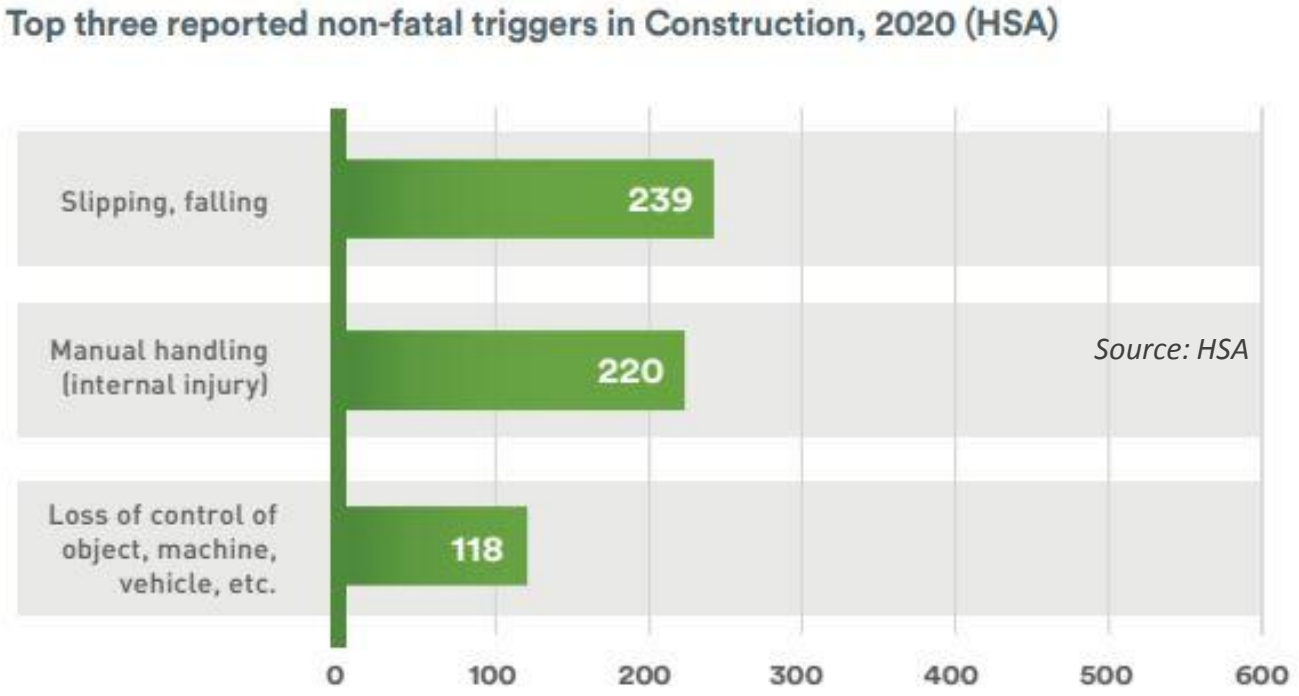

# Construction accident statistics: HSA

- Construction deaths in Ireland increased by **140%** in 2019, rising from **five to 12,** according to statistics from the **Health and Safety Authority.**
- **Falls from heights are** the primary cause of construction worker deaths.
- Fatalities are more common in **small construction companies** with fewer than 10 employees.

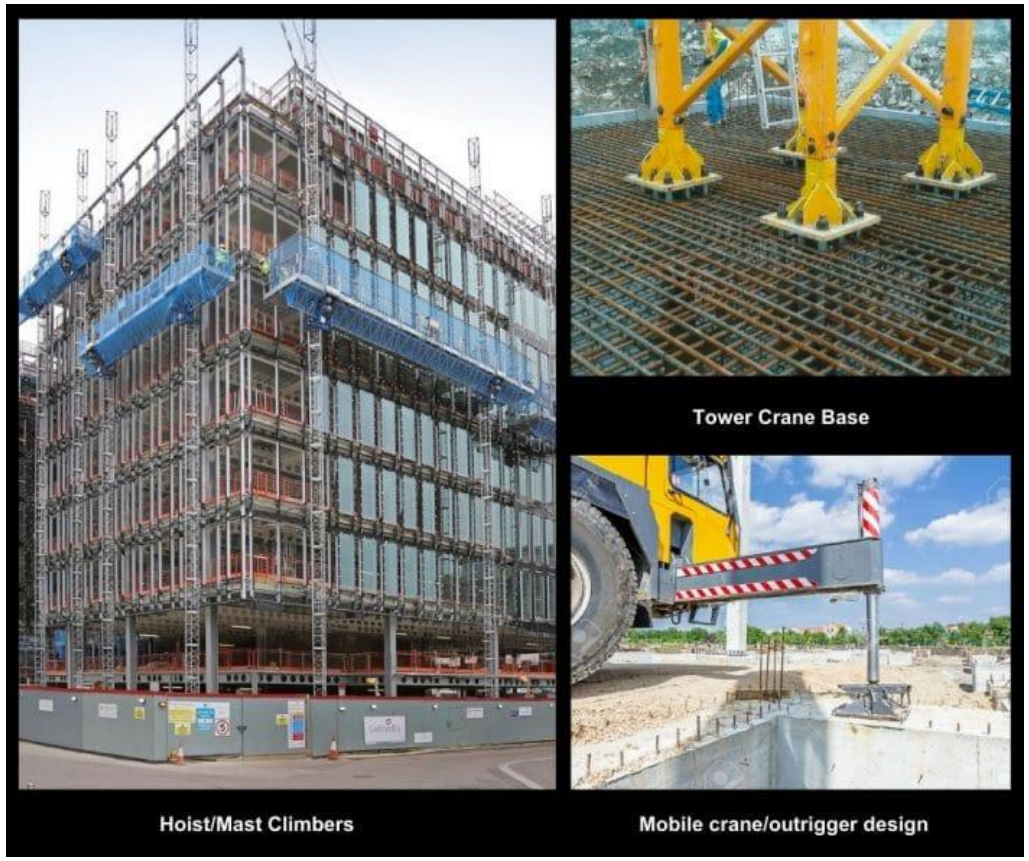
## Construction accidents statistics: Ireland

- The construction sector accounts for **28% of fatalities in the workplace** in 2020 so far, which is the highest rate reported in the last number of years.
- In comparison to previous years, the sector accounted for 25% of fatalities in 2019; 13% in 2018 and 13% in 2017.
- In 2019, HSA reported most construction fatalities were related to falls from heights.

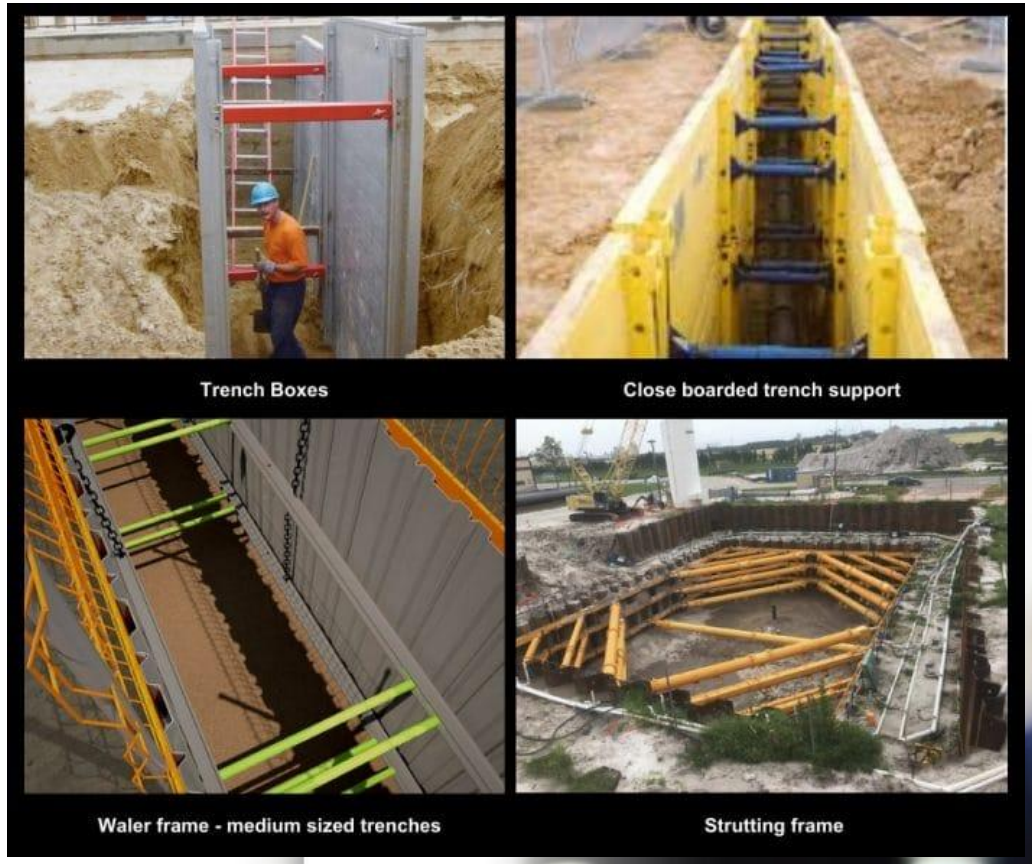
# Construction accidents statistics




*Source: HSA*




## Risks associated with temporary works



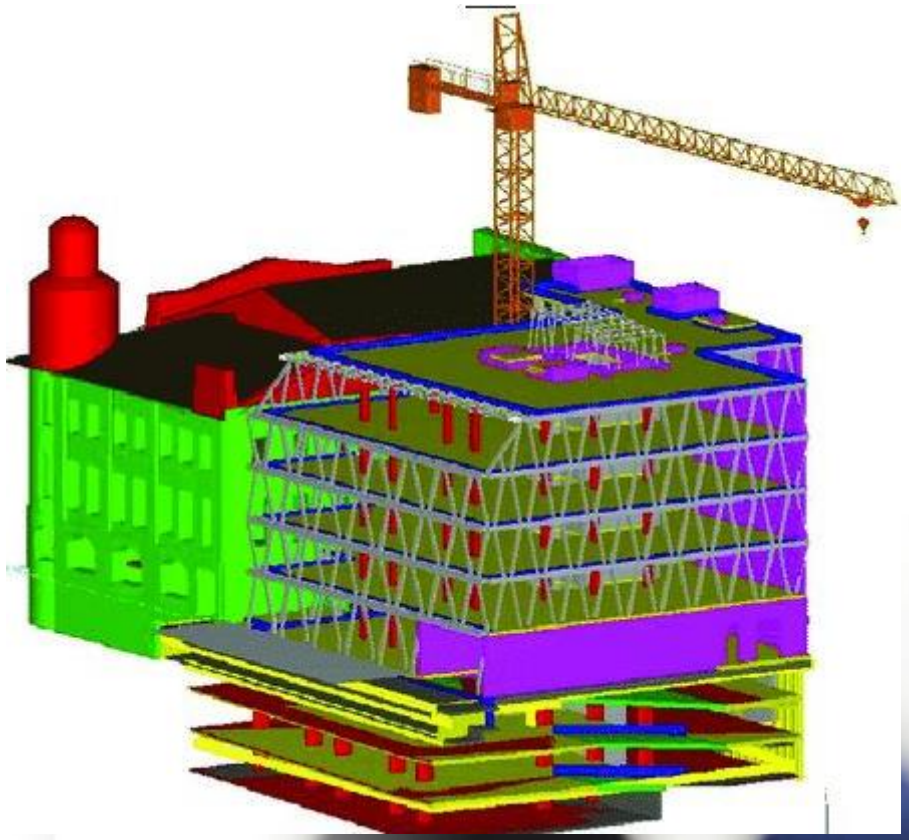
# Risks associated with temporary works

Crane collapse,
London, July 2020

*Image source: Benefits, Obstacles and Problems of Practical BIM Implementation, (Procedia Engineering)*

## Crane Information Modelling (CIM)

- Multiple hazards can arise regarding cranes when in use. Most involve large lift systems like tower cranes and mobile cranes.
- Nevertheless hazards do exist with all types of systems as well as overhead cranes and with all aspects of ongoing crane management procedures.
- Analysis of overhead crane accidents reveals **three common safety hazards** that every company using overhead lift systems should be aware of to keep operatives safe. The three most common hazards involving overhead cranes include **electrical hazards, overloading**, and **materials falling/slipping** from overhead hoists.



## Crane Management Plan using a 4D BIM application

A Crane Information Model (CIM) is developed based on several requirements

- **Firstly**, a CIM is intended to be an extension of current BIM systems. This means that elements, and spaces within CIM should be parametrically driven. This will allow a CIM to be easily modified and collaboratively shared.

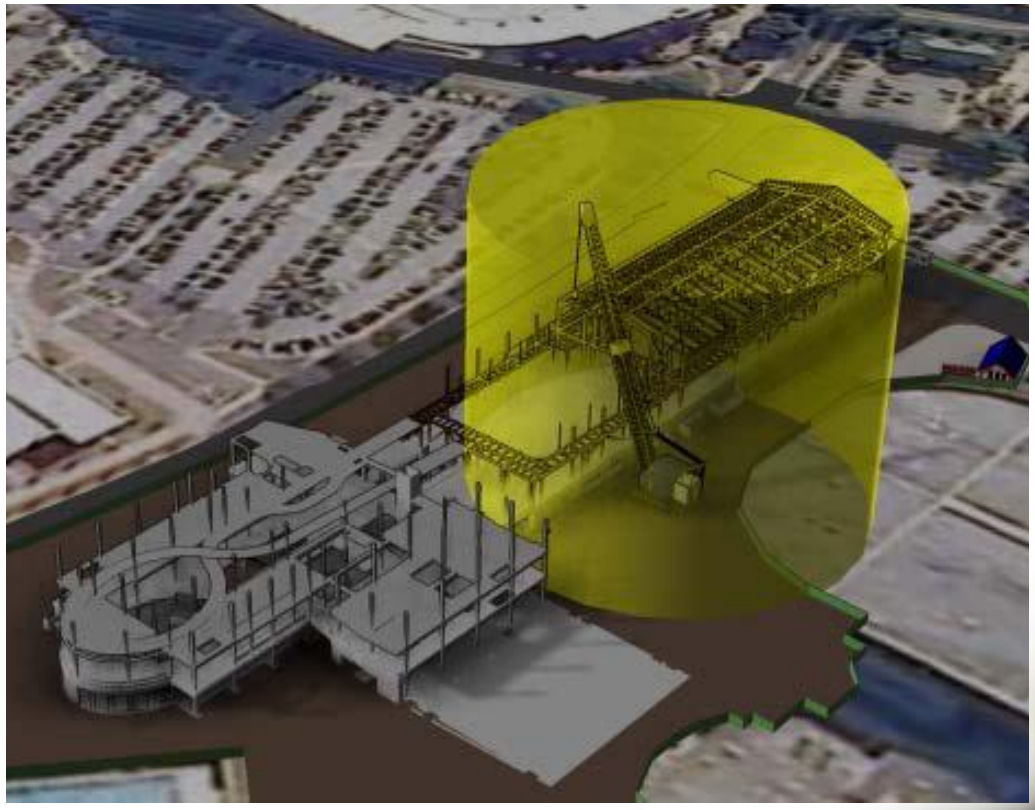
- **Secondly,** the CIM is intended to be a repository of crane information. Hence, the relevant crane information should incorporate not only the crane geometry, but the load charts as well.

## Crane Information Model (CIM)

**BIM** can facilitate the automation of Crane Lifting Plan requirements by using the following:

- **The site boundary**
- **Counter-jib clearance**
- **Crane coverage**
- **Load capacity**

*Image source: Azhar S, Behringer A, (McWhorter School of Building Science, Auburn University US)*



Crane swing work zone (crane management plan)

Alan Farrell

## Crane Information Model (CIM)

### Crane Management Plan using a 4D BIM application

An efficient crane management plan in place can identify swing radius of the site cranes and ensure **safe distances** from any power lines and nearby temporary and permanent structures and **identify what personnel** will be utilizing crane at a certain instance of time.

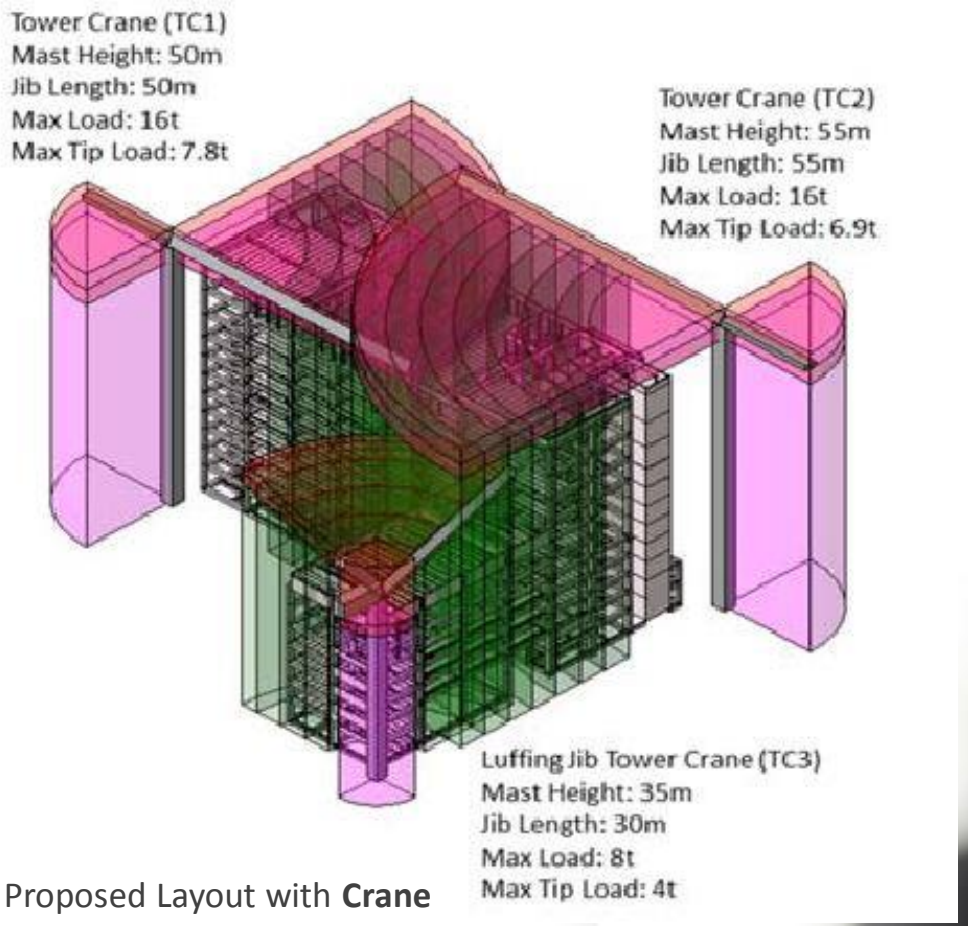
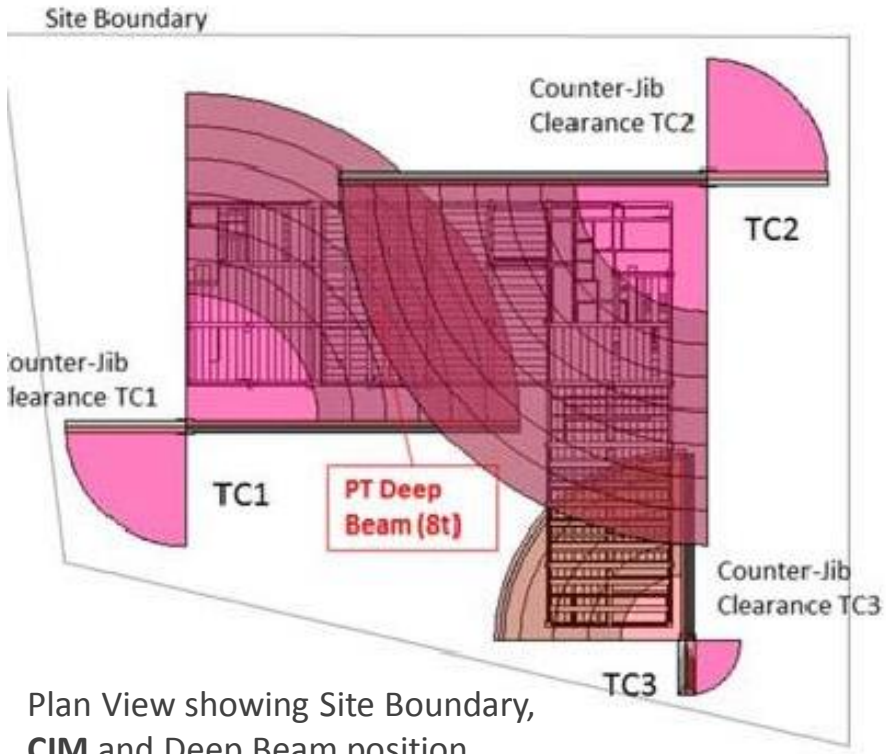



*Image source: Justin K. W. Yeoh (National University of Singapore)*

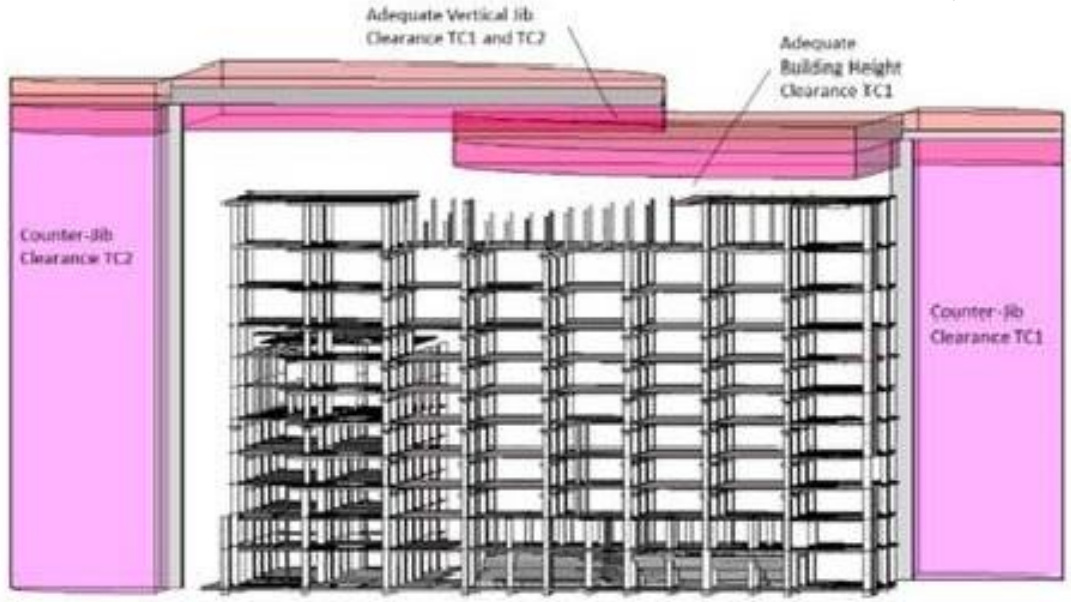
Proposed Layout with **Crane Information Model**

# Crane Information Model (CIM)

*Image source: Justin K. W. Yeoh (National University of Singapore)*




Plan View showing Site Boundary, **CIM** and Deep Beam position




Elevation View of **CIM**

Crane swing work zone

(crane management plan

# Optimising scaffolding for site safety

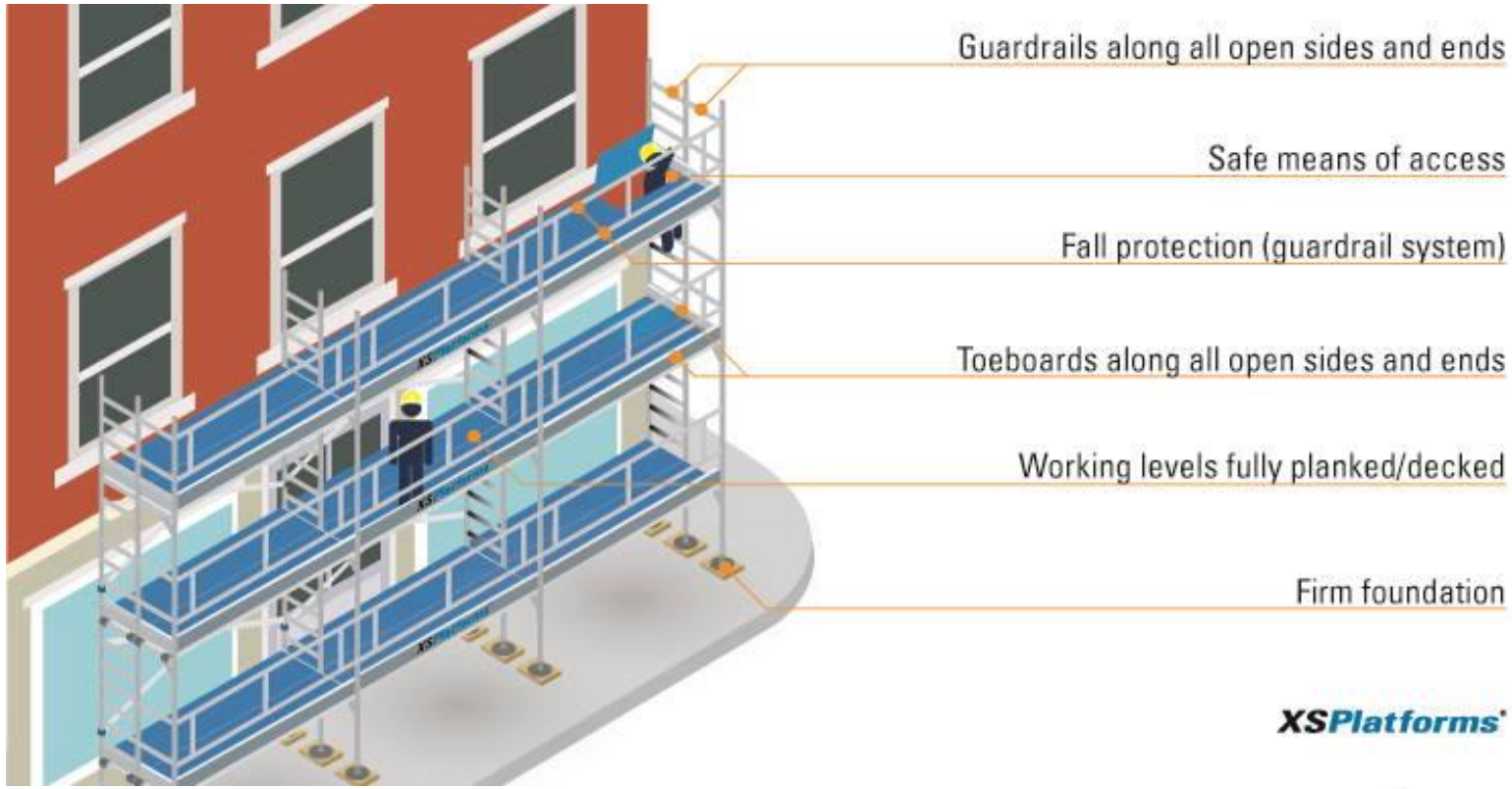


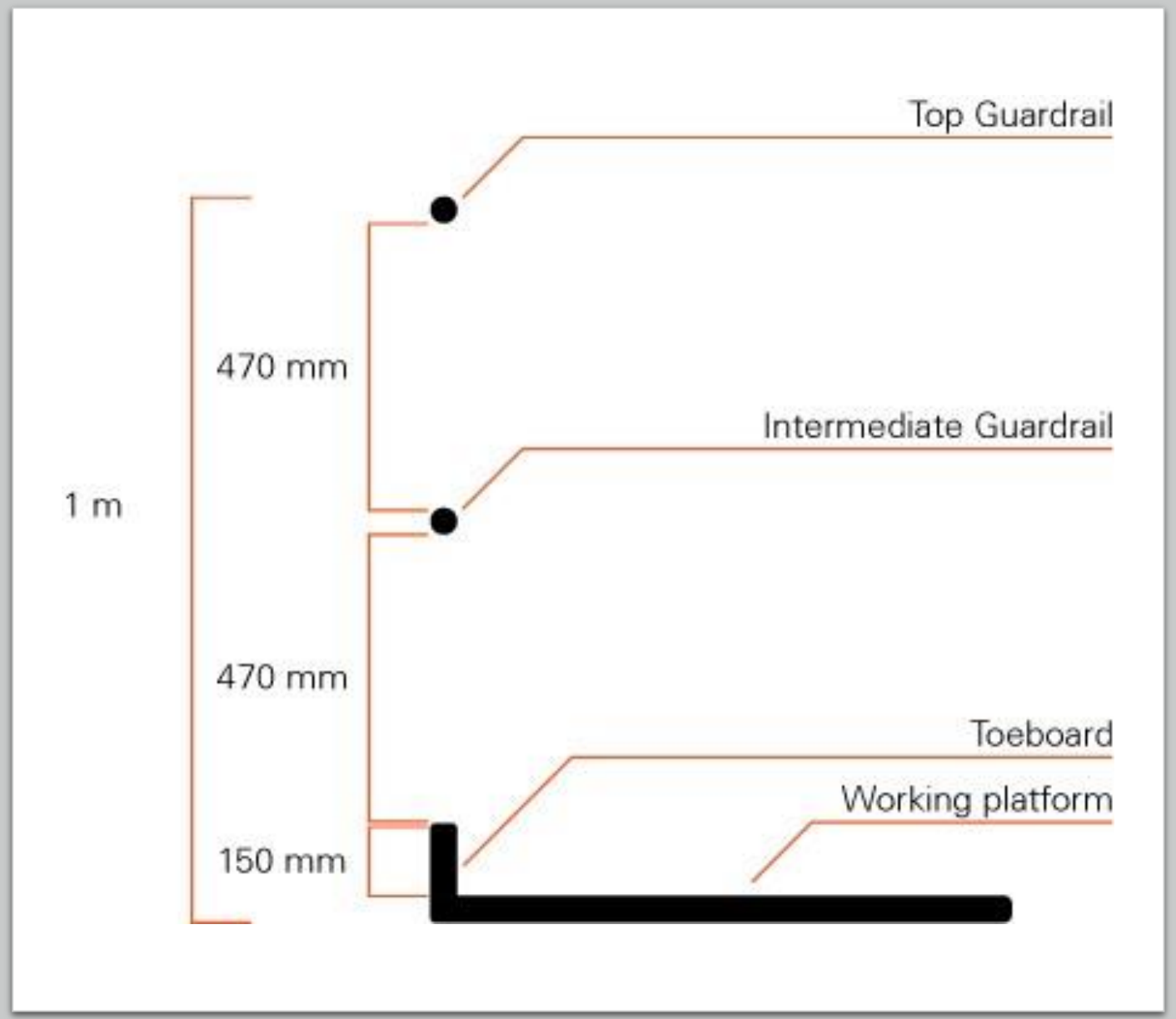

*Image source: xsplatforms.com*

# Optimising scaffolding for site safety

Guardrails on scaffolding

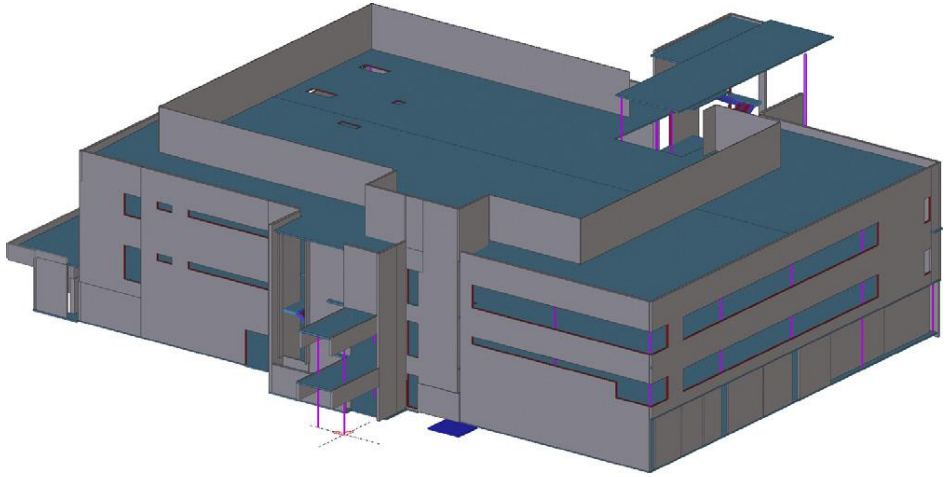
**The principal guardrail top surface needs to be at least 1 meter above the entire working area. Between the working area and the principal rail, intermediate side protection shall be installed in the form of:**

- **One or more intermediate guardrails**
- **A frame of which the principal guardrail forms the top edge**
- **A fencing structure.**
- **The openings in the side protection may not be bigger than the diameter of a 470 mm sphere fitting through.**

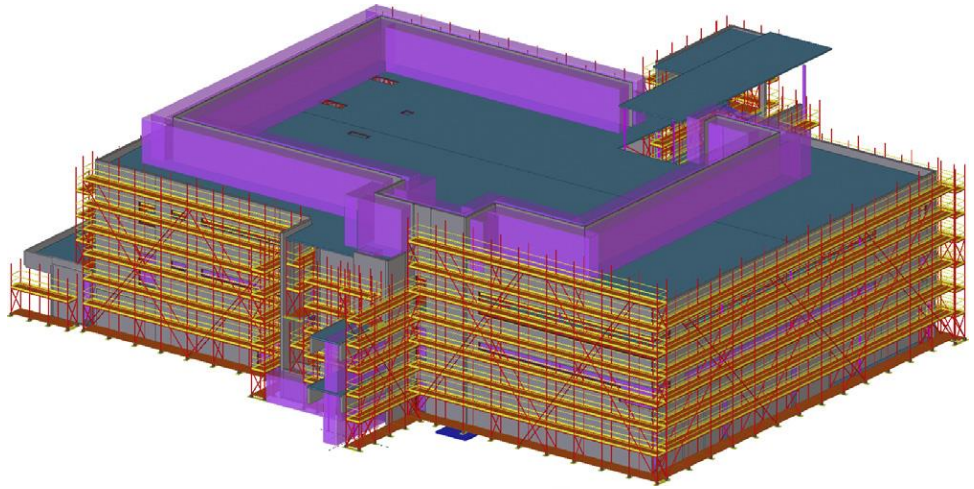



*Required dimensions for a guardrail system*

# Optimising scaffolding corner sequence design using BIM



Sequencing of scaffolding structural design



*Source: K. Kim, J. Teizer*

# Optimising scaffolding sequence design using BIM

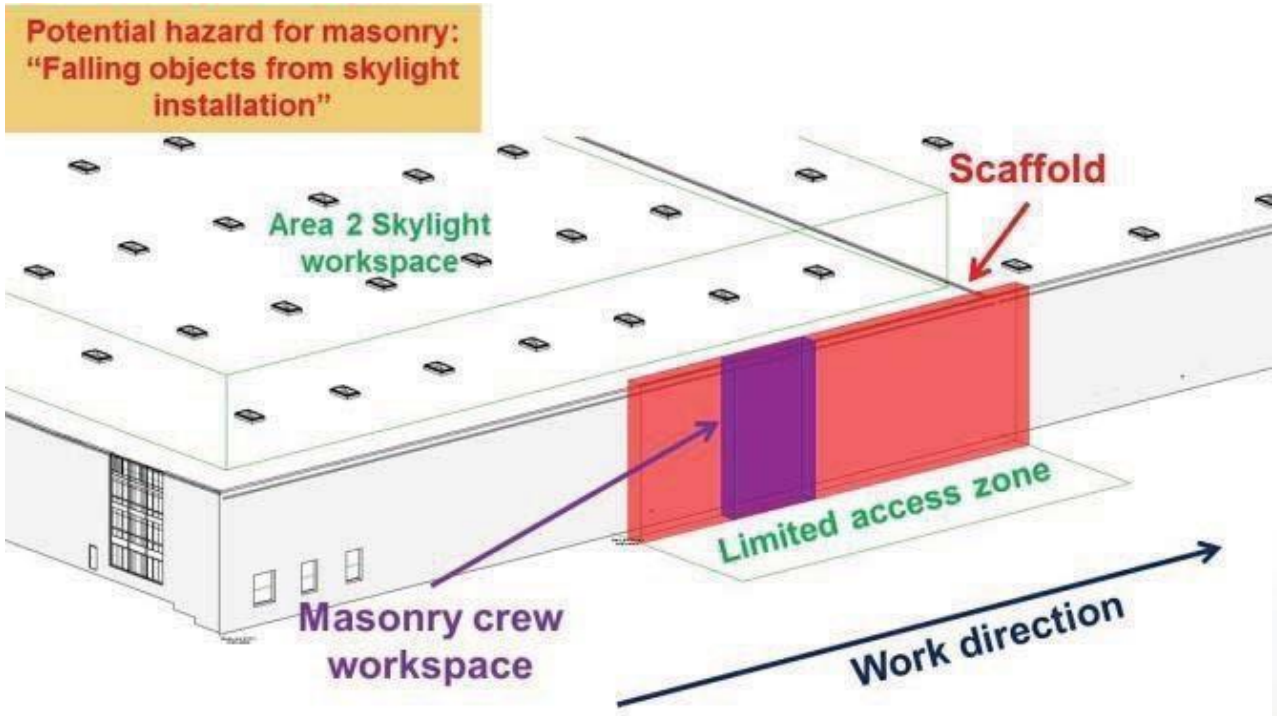
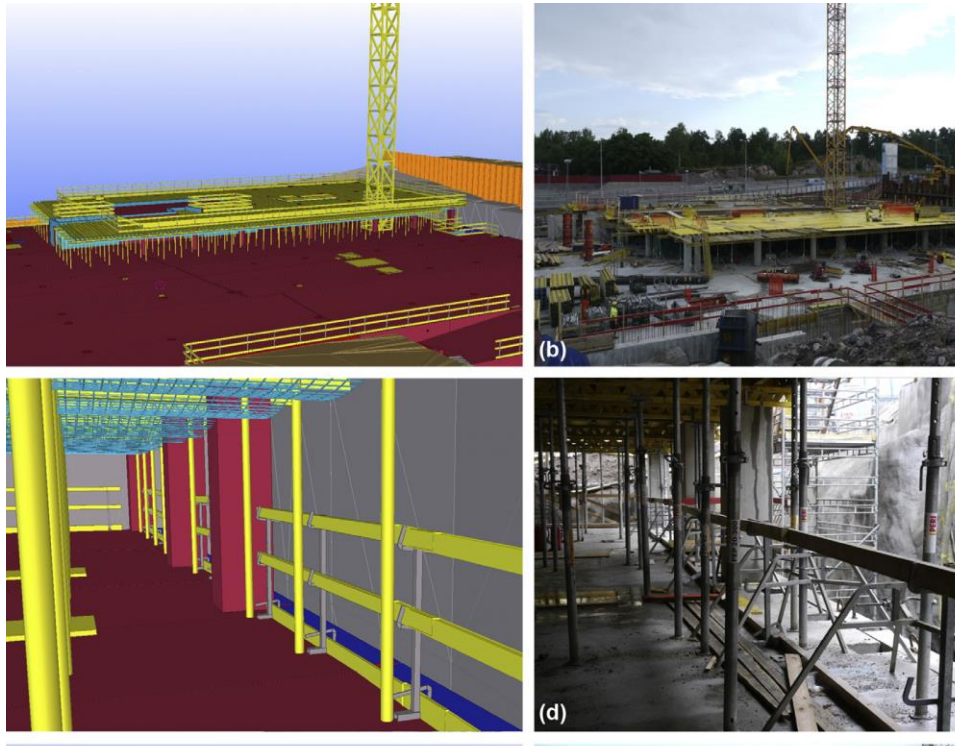



*Image source: Kyungki K, (Automation in Construction)*

Hazard identification using workspaces and scaffolding spaces

# Rules based checking for construction site hazards




Comparison of BIM model and live situation

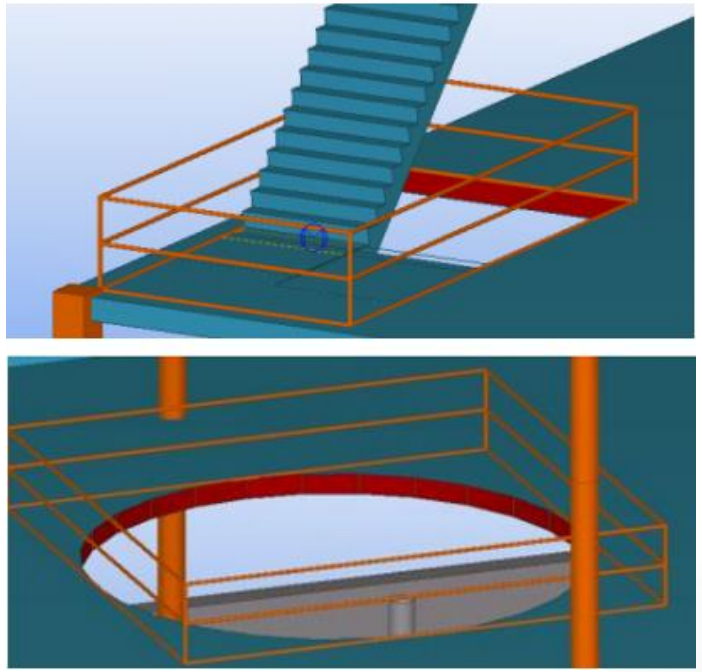


*Image source:*
*K. Kim, J. Teizer*

BIM software: Tekla Structures' ability to detect hazardous openings

Alan Farrell

# Rules based checking for construction site hazards

BIM and safety rules based identification of unsafe construction design factors

Safety rule……**Hazard**
*Accident type……**Fall***
*Accident subject……**Gap***
*Attributes……**Vertical***
*Parameter……**H=cm***
*Safety rules……**Safety Guards***
*Prevention measures……**Handrails***

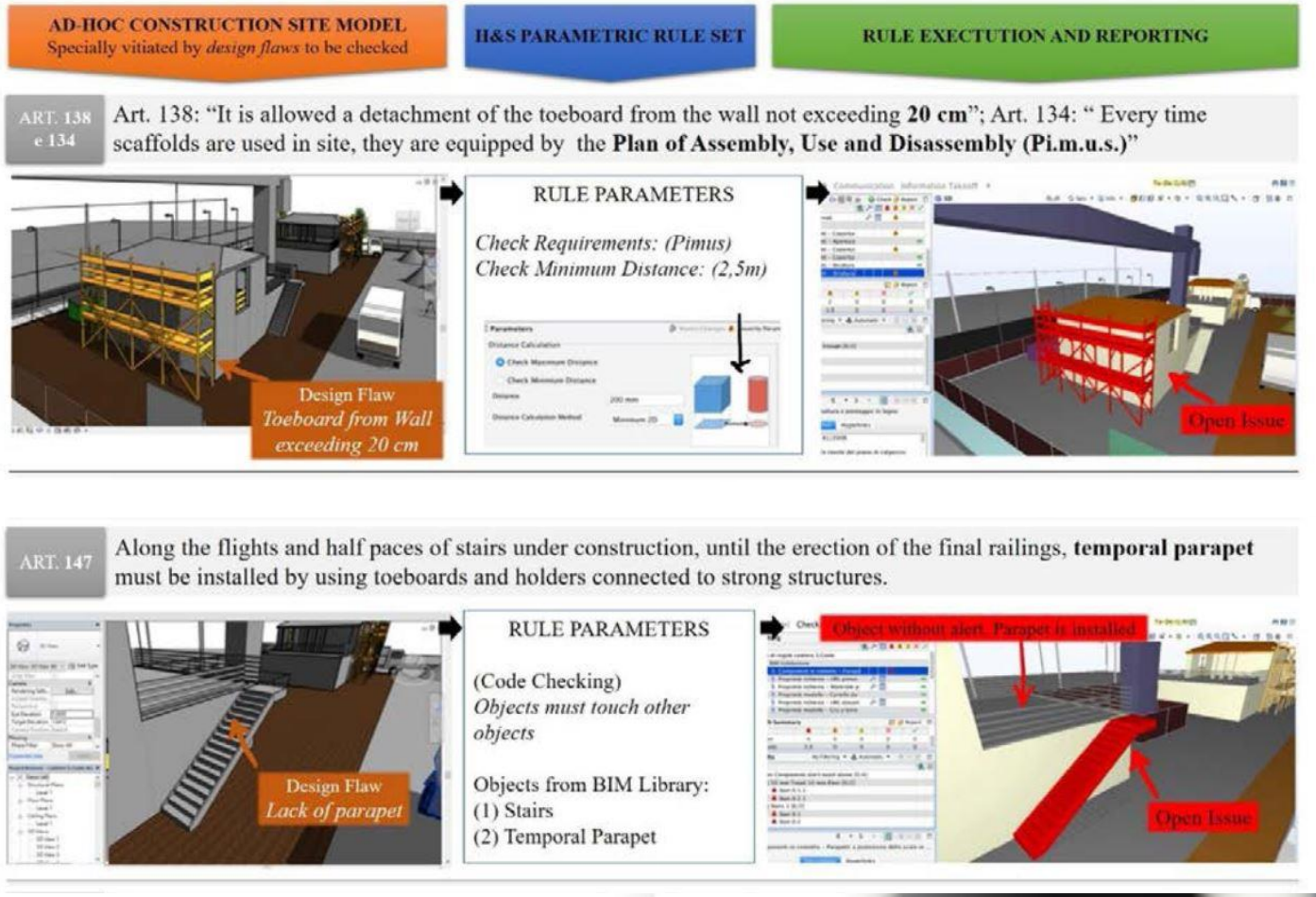



*Image source: Creative Construction Conference, June 2017, Primosten, Croatia*

*Case study (MGF Engineering)*

# Drax power station

**MGF** is an engineering company that provides specialist excavation safety & structural support solutions

*Image source: MGF Engineering*

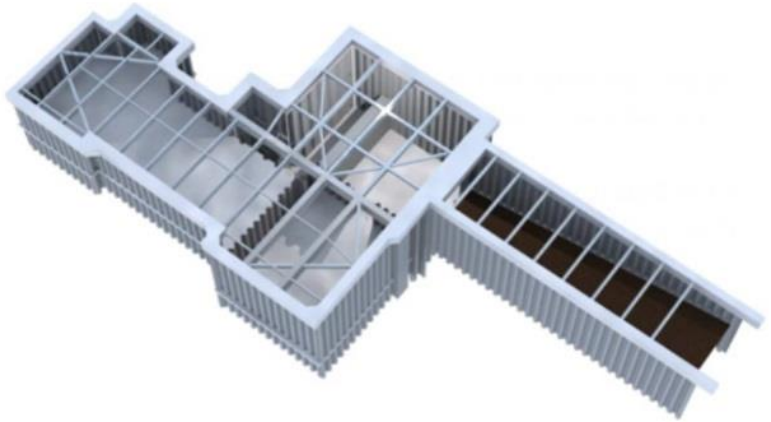
Cofferdam installation

**DRAX POWER STATION**
Project
**Ecostore Rail Unload Building**
Main Contractor
**Volker Ground Engineering**
Key Benefit
**Significant time savings in the installation process**

**MGF,** a UK based firm that provides excavation reinforcement for the construction industry and has pioneered the use of visualisation and 4D simulation to convey essential installation and a safe working environment.

*Case study (MGF Engineering)*

# Drax power station



Cofferdam BIM model and frame

Cofferdam installation

*Image source: MGF Engineering*

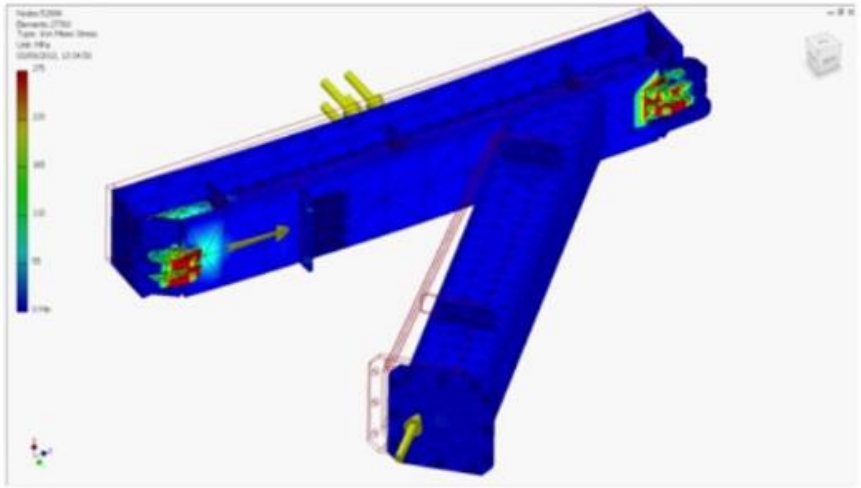
*Case study (MGF Engineering)*

# Drax power station

*Image source: MGF Engineering*

Cofferdam BIM model and frame

BIM model of structural element with loading calculations



# Survey data and analysis

An investigation for this research was conducted to gather information, gauge responses from participants and evaluate solutions to crucial issues in industry

# Survey data and analysis

**The questions put to participants:**

- From experience, are there any advantages/disadvantages by linking the temporary works 3D design model with the permanent works model from a safety and scheduling perspective?
- The management of site Health and Safety face a number of challenges. Which issues has the most priority in the industry?
- With the successful adoption of BIM, a new collaborative way of working and sharing of information is expected. Will this achievement experience an initial loss of productivity?
- What level is your familiarity of PAS 1192-6?
- How will the implementation of BIM affect the role of the Site Safety officer?

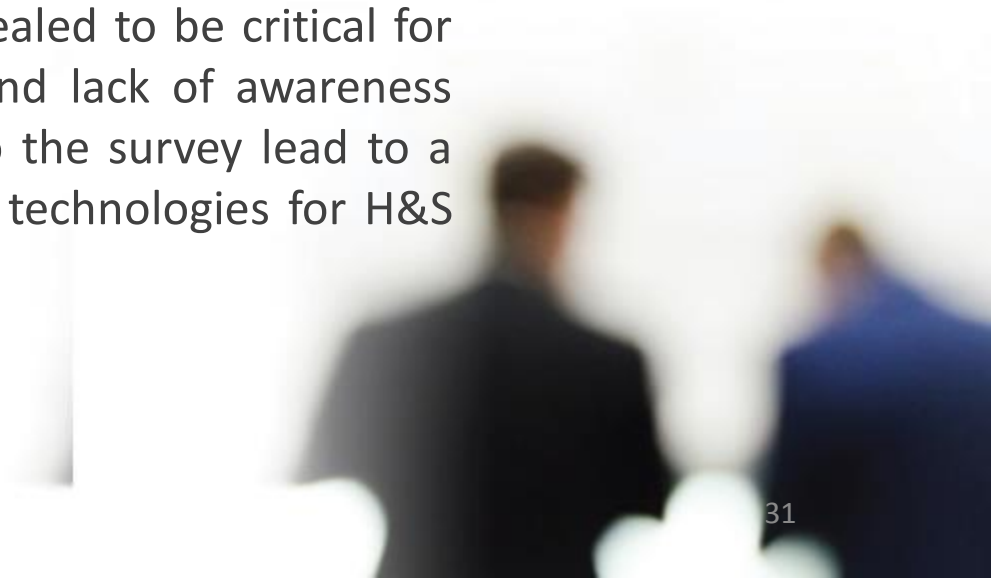
# Survey data analysis

- The application of BIM to a project has a significant influence on site safety due to an element of prediction in early concept and design.
- The highest priority was allocated to cultural attitudes toward safety, financial support and project timescales.
- The Health and Safety Officer it was determined to be a redefined one when BIM was applied to a project rather than a more traditional approach

# Conclusion

This research concludes that site safety can be significantly improved when level 2 BIM is applied to a construction project rather than a more traditional approach. An implementation of Health and safety is high on the agenda with responses to survey feedback encouraging.

A new approach to engage site operatives is revealed to be critical for site safety alertness and reduce complacency and lack of awareness that may manifest itself. The positive answers to the survey lead to a clear justification and indeed application of BIM technologies for H&S awareness for construction site personnel.



# Thank you!