

Gathering21

Construction Innovations
for Future Generations

Enhancing asset management for Offshore lighthouses using BIM integrated sensor analysis

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1. Background
2. Case Studies
3. Lighthouse Asset Management with BIM
4. Next Steps





3D



Modelling

4D



Scheduling

5D



Budgeting

6D



Sustainability

7D



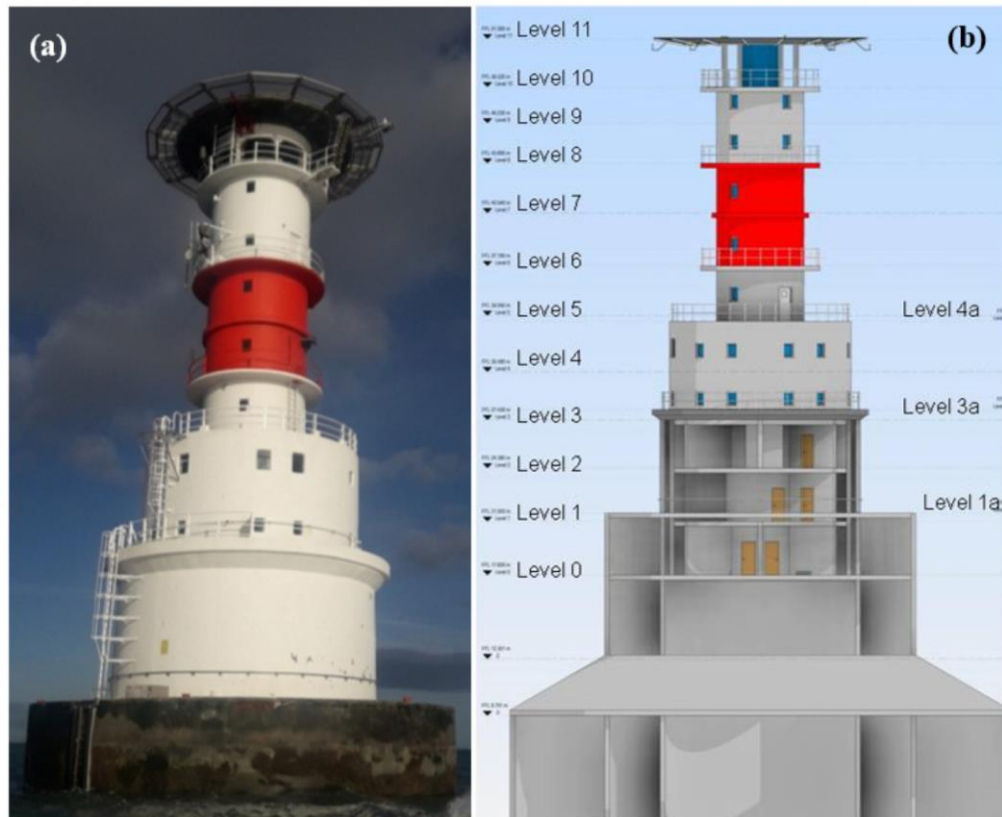
Facility Management



BIM in Facilities Management



Credit: <https://8dbim.weebly.com/6d.html>





2. Case Study Applications

SHM and Damage Detection

SHM & Sensors

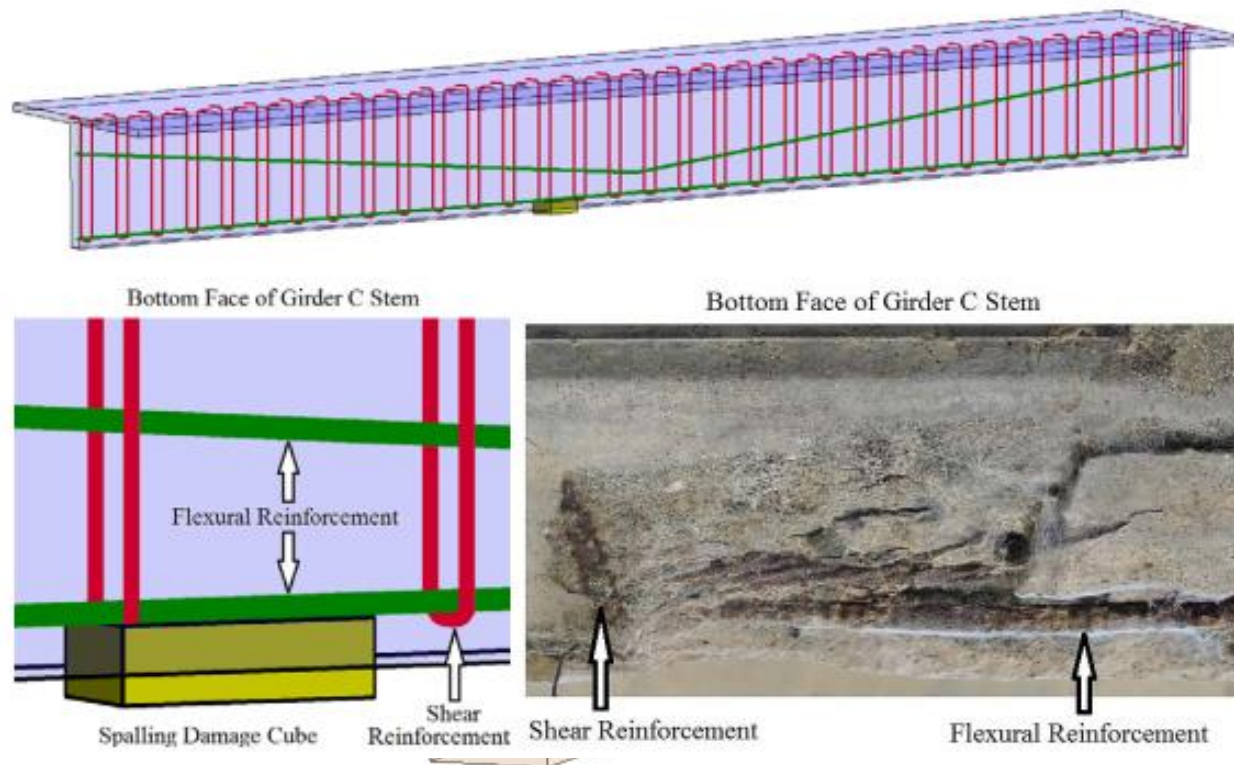
Building Management & Sensors

IFC Schema



Case Study Applications – SHM and Damage Detections

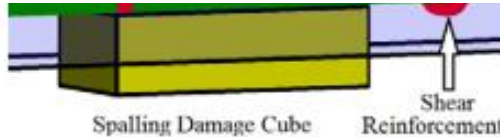
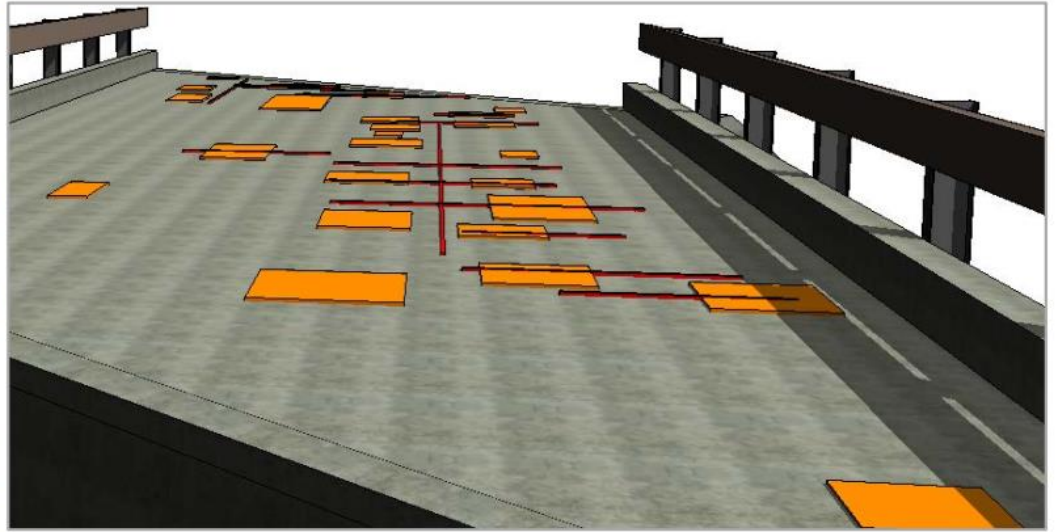
McGuire BM. *Using building information modeling to track and assess the structural condition of bridges* (Doctoral dissertation, Colorado State University. Libraries).





Case Study Applications – SHM and Damage Detections

McGuire BM. *Using building information modeling to track and assess the structural condition of bridges* (Doctoral dissertation, Colorado State University. Libraries).



Spalling Damage Cube

Shear Reinforcement



Shear Reinforcement

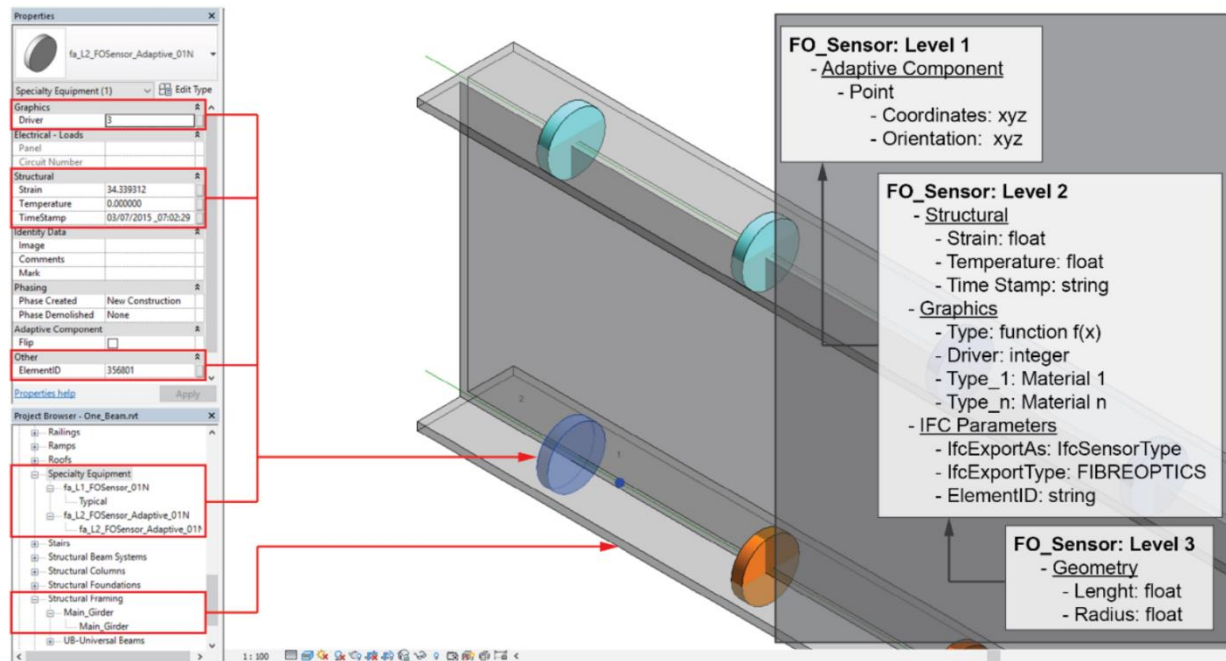
Flexural Reinforcement



Case Study Applications – SHM and live Sensors

Structural Performance Monitoring Using a Dynamic Data-Driven BIM Environment

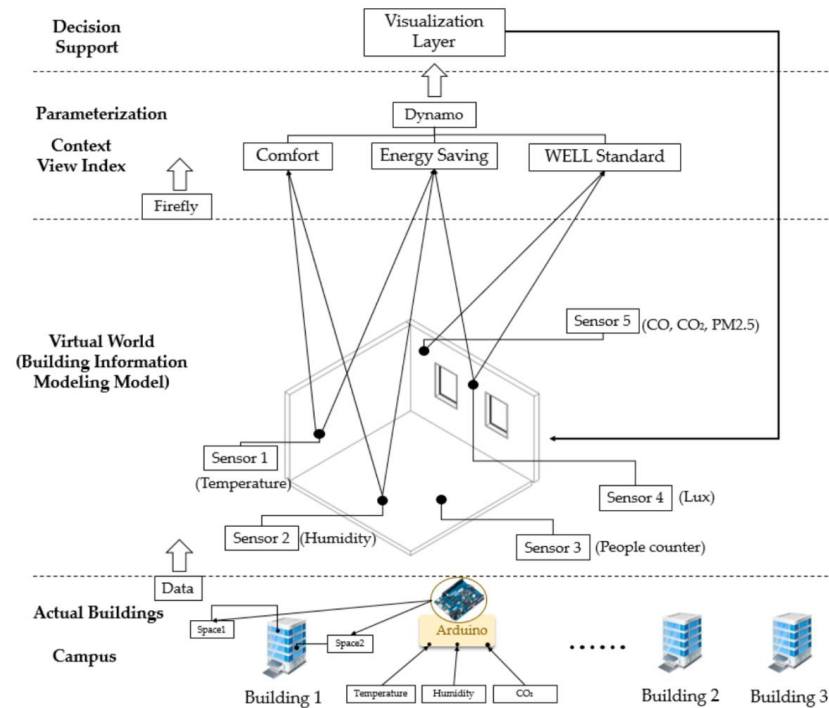
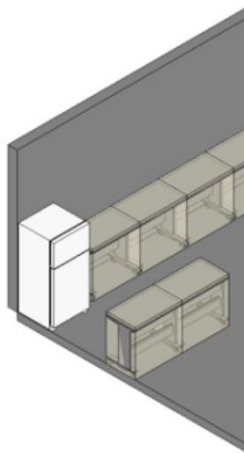
Juan Manuel Davila Delgado, Liam J. utler, ; Ioannis Brilakis, M.ASCE; Mohammed Z. E. B. Elshafie, and Campbell R. Middleton





Case Study Applications – Building Environmental Sensors

Chang, K.-M.; Dzung, R.-J.; Wu, Y.-J. An Automated IoT Visualization BIM Platform for Decision Support in Facilities Management. *Appl. Sci.* **2018**, *8*, 1086.



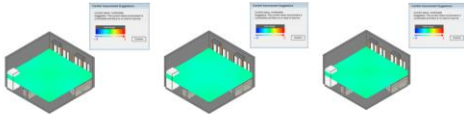


Case Study Applications - Building Environmental Sensors

Chang, K.-M.; Dzeng, R.-J.; Wu, Y.-J. An Automated IoT Visualization BIM Platform for Decision Support in Facilities Management. *Appl. Sci.* **2018**, *8*, 1086.

State: open window

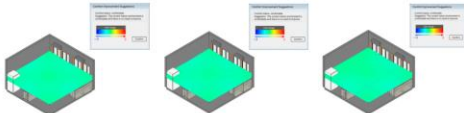
- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| • Time: 5:39:20 p.m. | • Time: 5:51:20 p.m. | • Time: 6:09:20 p.m. |
| • Average temperature: 22.6 °C | • Average temperature: 22.4 °C | • Average temperature: 22.4 °C |
| • Average humidity: 62.7% | • Average humidity: 62.7% | • Average humidity: 62.3% |
| • PMV: -0.257 | • PMV: -0.307 | • PMV: -0.309 |



(a)

State: closed window

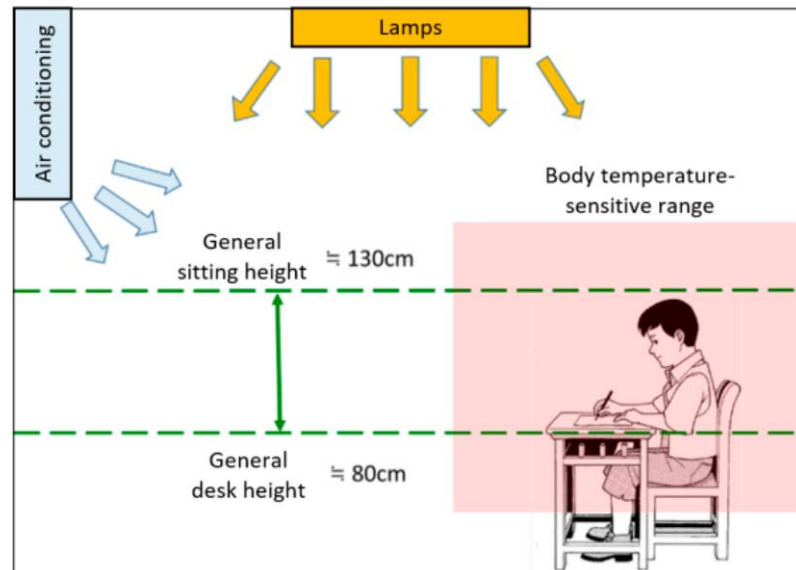
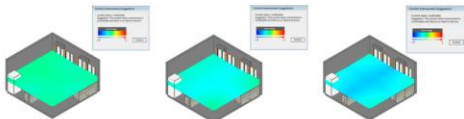
- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| • Time: 6:11:20 p.m. | • Time: 6:25:20 p.m. | • Time: 6:39:20 p.m. |
| • Average temperature: 22.4 °C | • Average temperature: 22.6 °C | • Average temperature: 22.7 °C |
| • Average humidity: 62.6% | • Average humidity: 61.6% | • Average humidity: 61.3% |
| • PMV: -0.307 | • PMV: -0.263 | • PMV: -0.24 |



(b)

State: air conditioning on

- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| • Time: 6:41:20 p.m. | • Time: 6:57:20 p.m. | • Time: 7:11:20 p.m. |
| • Average temperature: 22.8 °C | • Average temperature: 21.8 °C | • Average temperature: 21.1 °C |
| • Average humidity: 61.2% | • Average humidity: 59% | • Average humidity: 57.3% |
| • PMV: -0.215 | • PMV: -0.488 | • PMV: -0.676 |

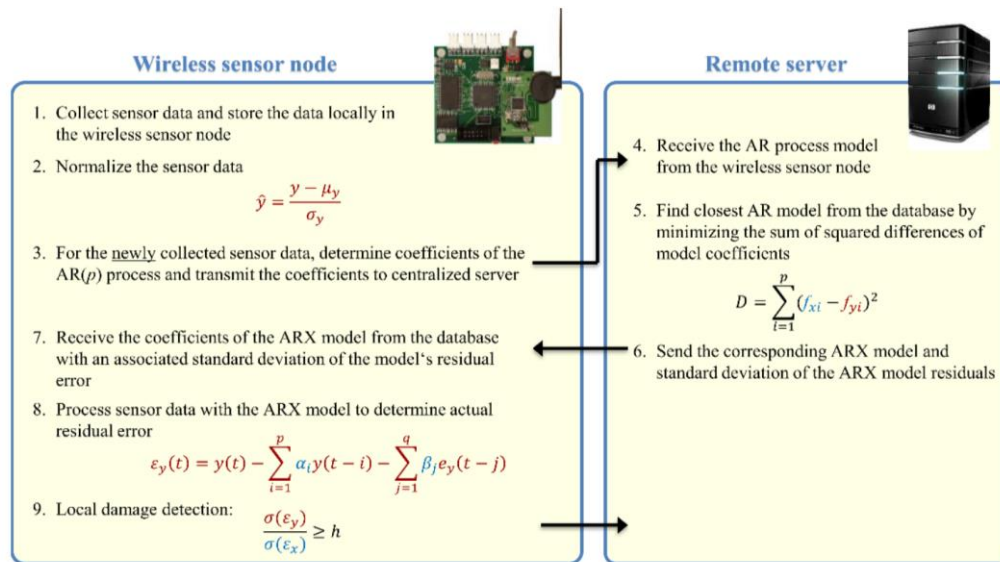




Case Study Applications – SHM and Live Sensors

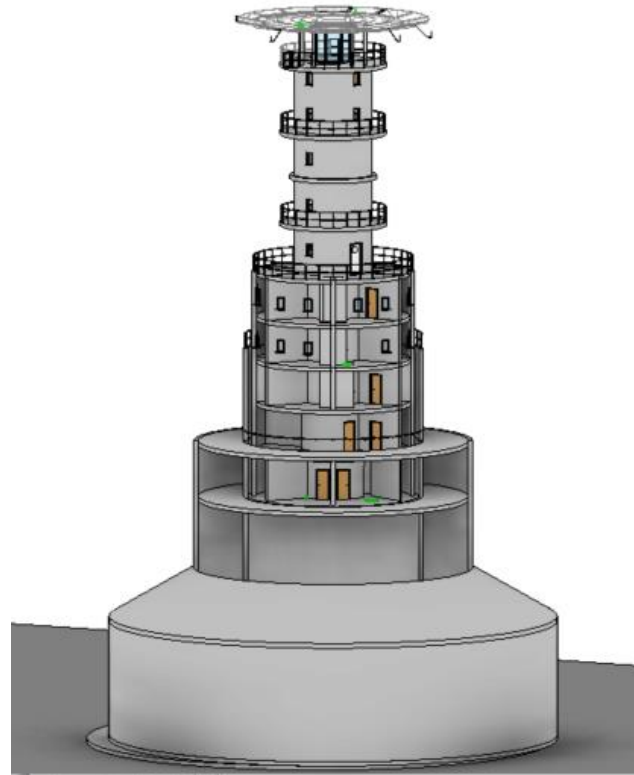
IFC Schema Extension

Theiler MI, Dragos KO, Smarsly K. BIM-based design of structural health monitoring systems. In Proceedings of the 11th International Workshop on Structural Health Monitoring, Stanford, CA, USA 2017 Sep 12 (Vol. 12).



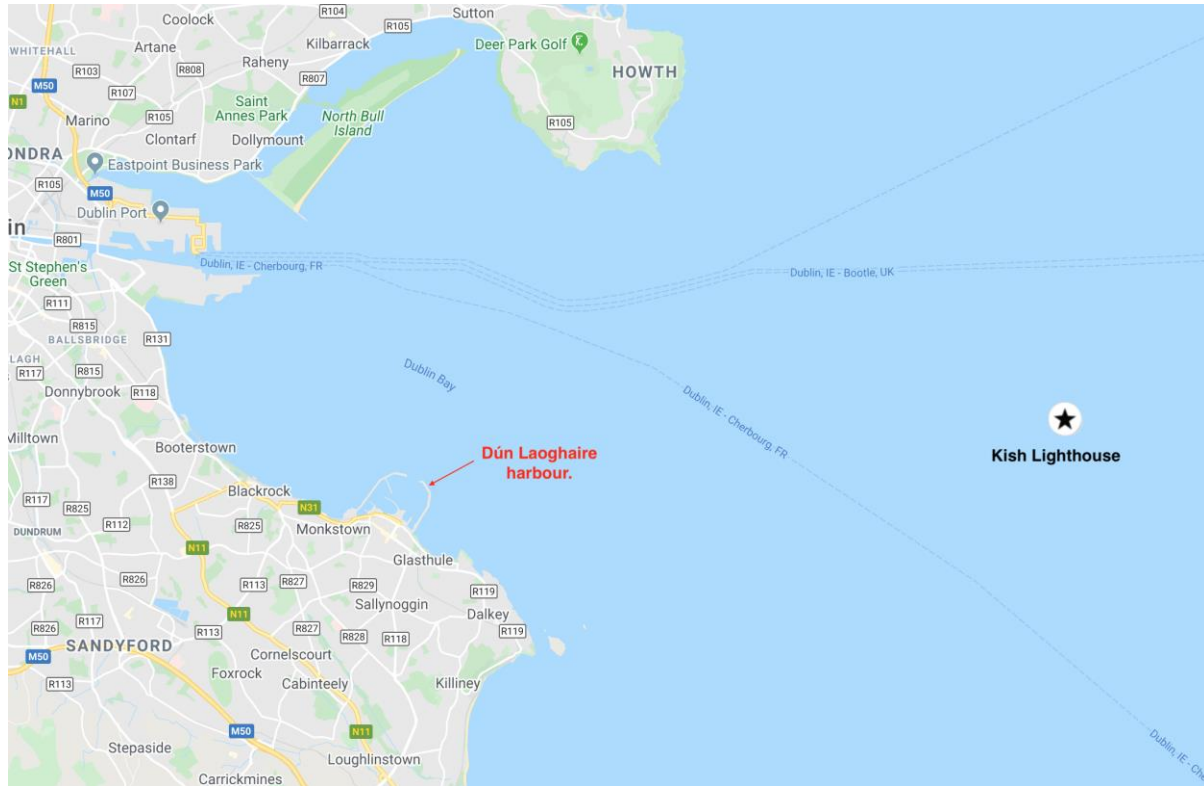


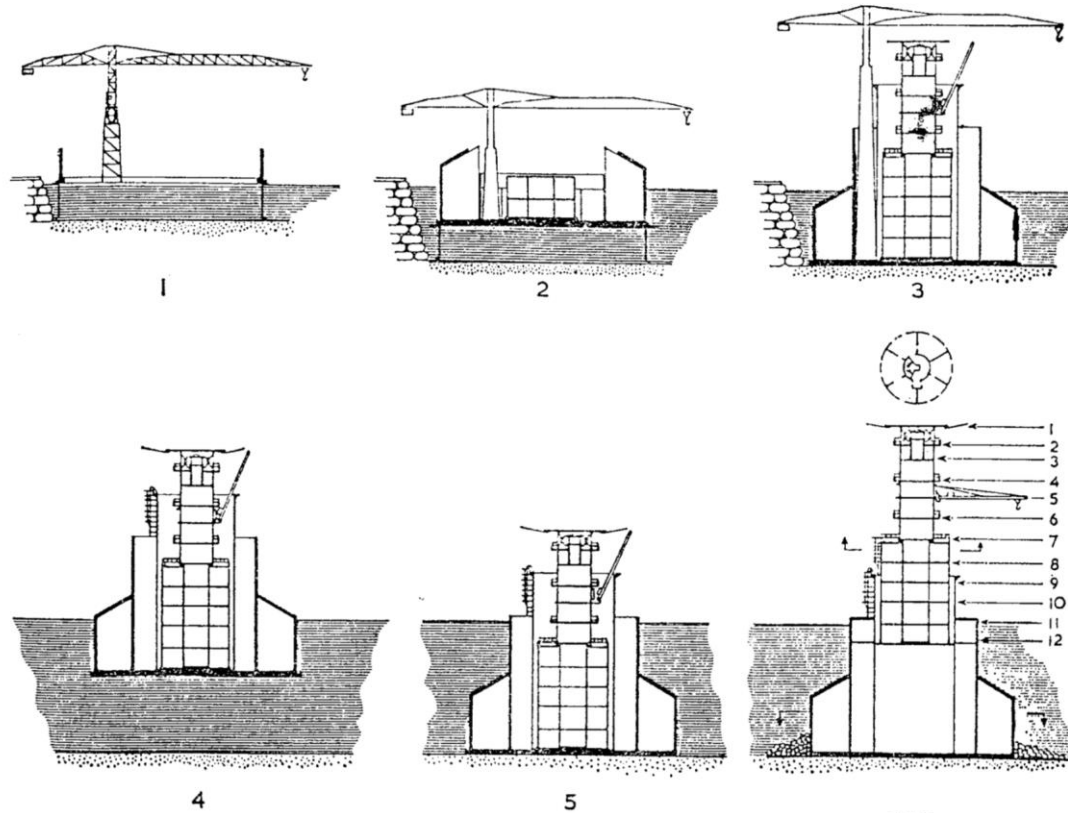
3. Lighthouse Asset Management with BIM





Kish lighthouse







Kish lighthouse – Damage Detection & Visualisation

Table 10 Severity rating - colours assigned

Colour	Description	Severity Rating
Blue	Blue	1
Green	Green	2
Yellow	Yellow	3
Orange	Orange	4
Red	Red	5

Table 11 Sample output of existing damage, its location and severity

Floor	Type of Damage	Location	Severity	Severity rating
Floor No.0	Surface Deposition	All radical walls except SW wall	A medium to long-term durability issue	5

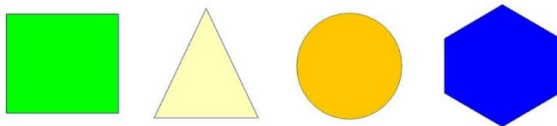
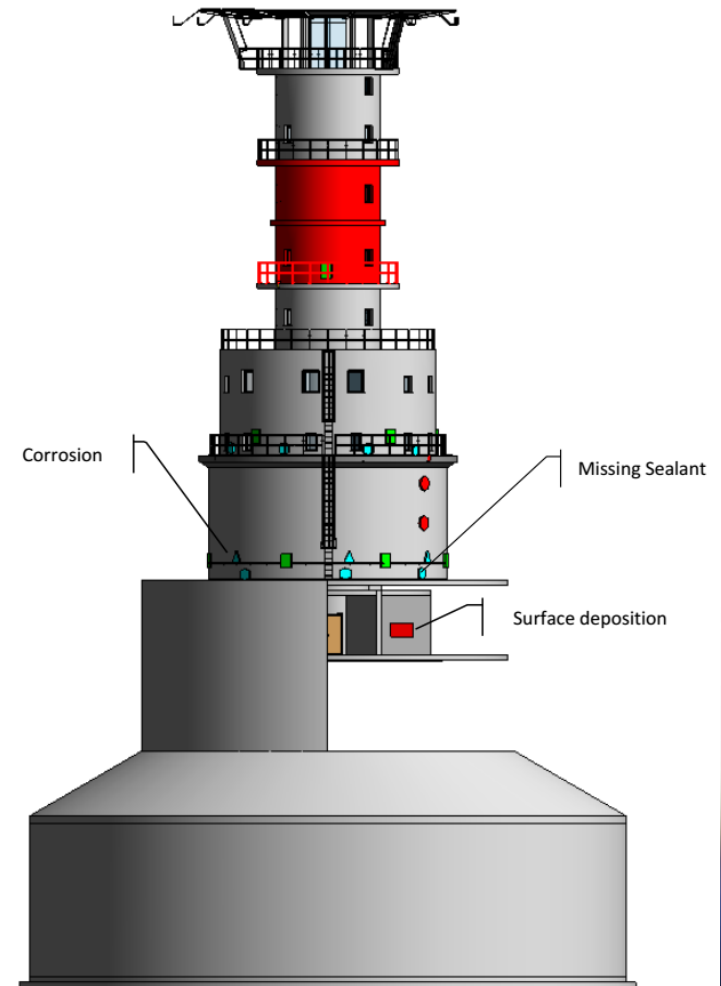
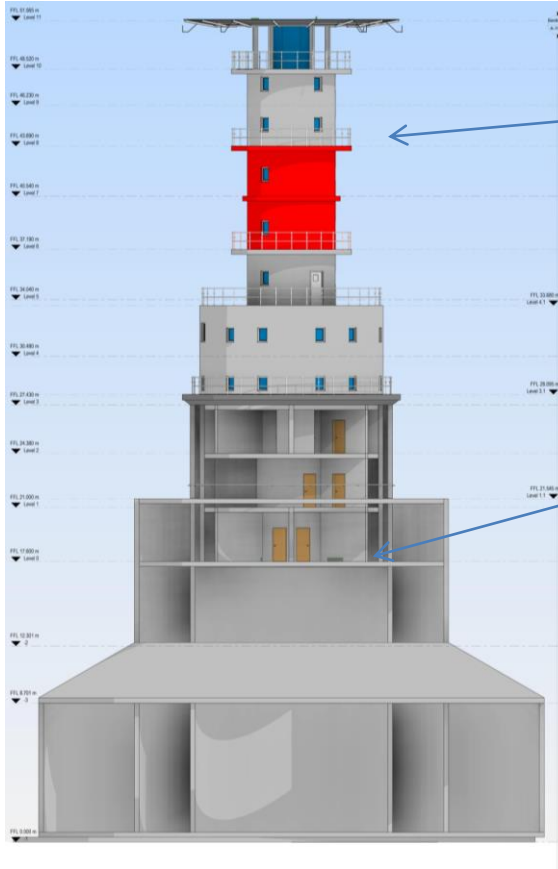


Figure 19 Damages and assigned shapes (from left to right): Surface deposition, corrosion, cracking and missing sealant



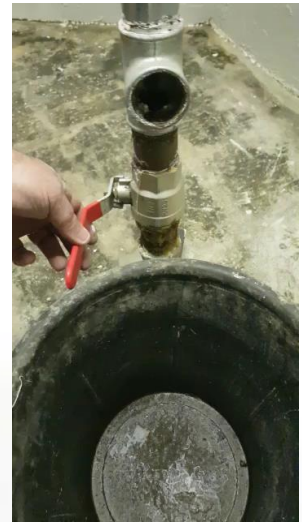


Kish lighthouse – Structural Issues



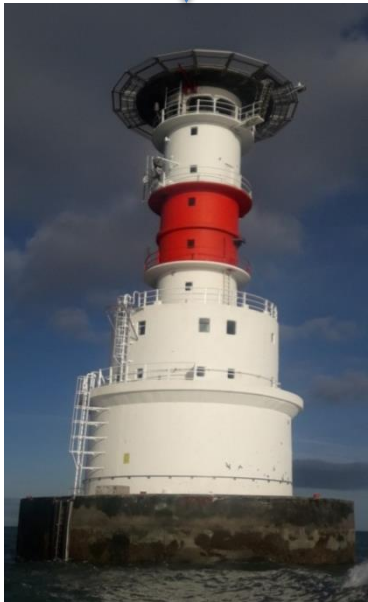
Rocking about annulus or Base

Pressure Signal



Environmental
Sensors

Wind
Wave
Tides
Temp

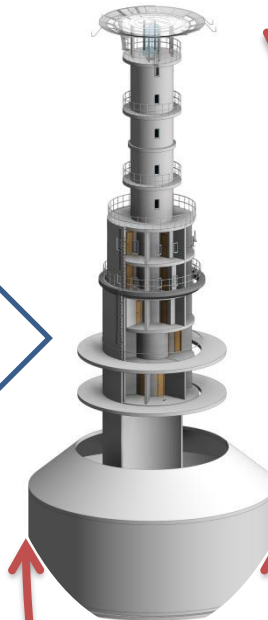


Building Sensors

Pressure
Vibration
Cracking

Database
Storage

DYNAMO



Virtual Sensors

Dynamic BIM

Key Schedules

IFC Interoperability

SHM Analysis

Damage Visualisation

Design Life Extension

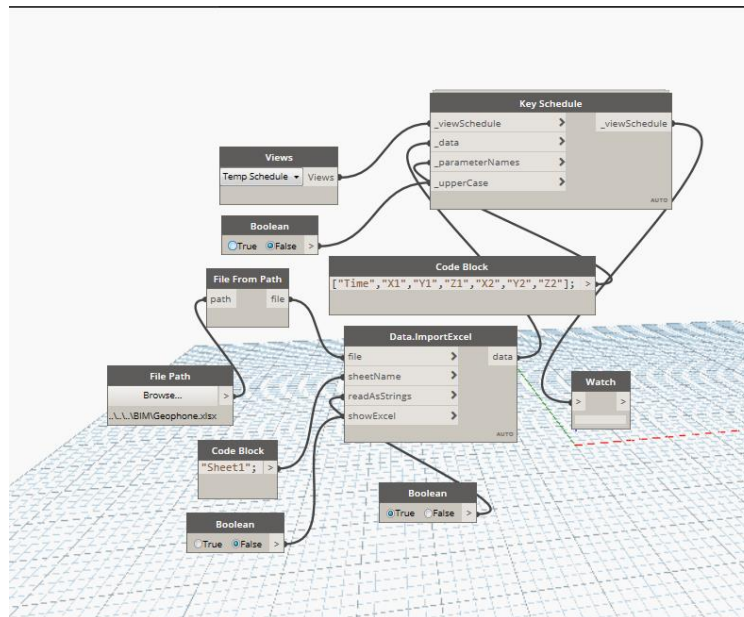
Maintenance Planning



Dynamo – Graphical programming interface that enables automation, integration and processing of data within the BIM environment

Uses Nodes and Elements

Visually Orientated



External Sensors



Lidar Wind Sensor



Dublin bay buoy



Internet

python



Sensor Nodes

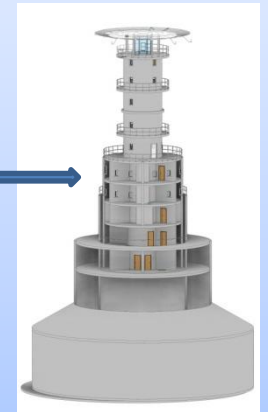


Sensor Network

BIM Environment



Remote Database



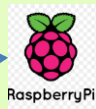
BIM



In-situ Wave Gauge



Pressure Sensor



RaspberryPi



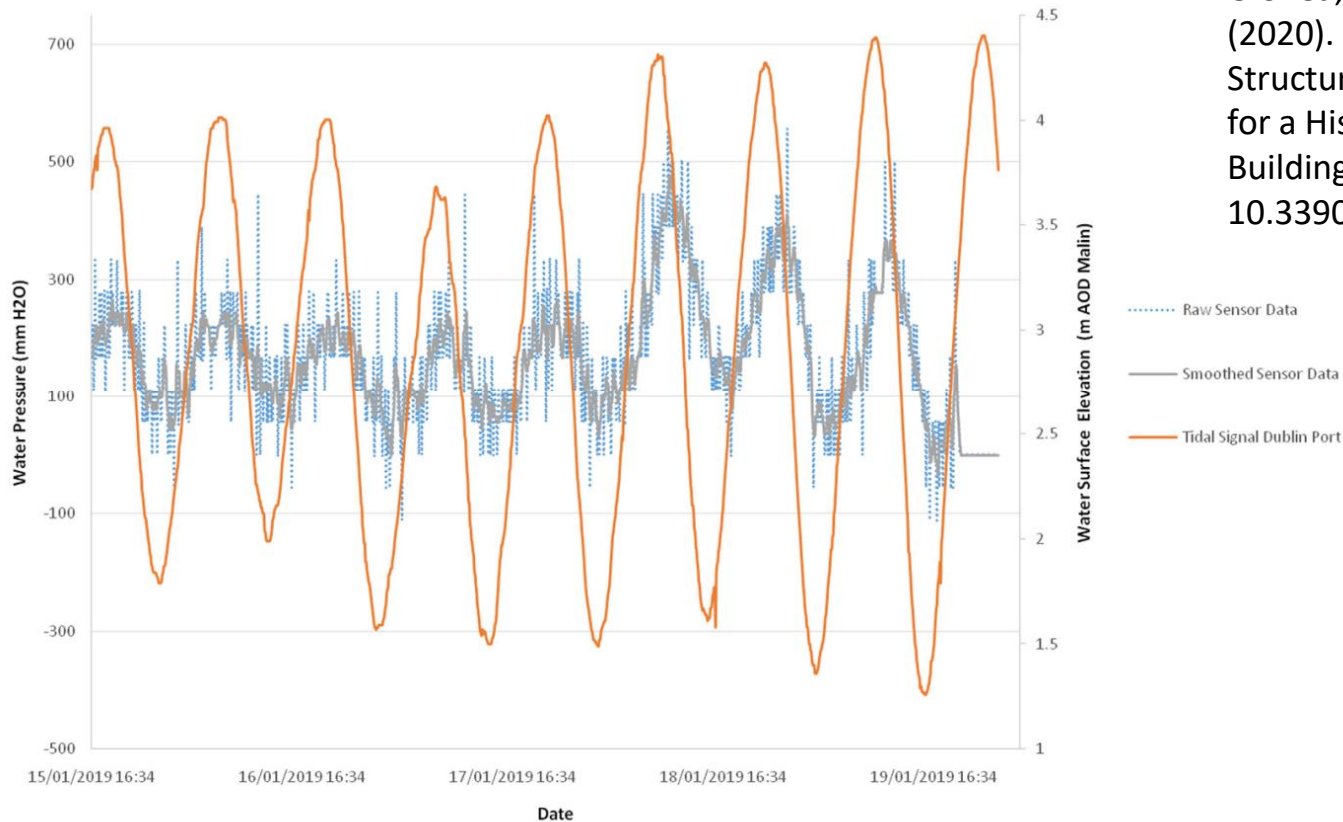
Accelerometer Sensors



Geophone Sensors



Pressure Signal Comparison with Water Surface at Dublin Port



O'Shea, Michael & Murphy, Jimmy.
(2020). Design of a BIM Integrated
Structural Health Monitoring System
for a Historic Offshore Lighthouse.
Buildings. 10. 131.
10.3390/buildings10070131.



4. Next Steps....

Add more sensors

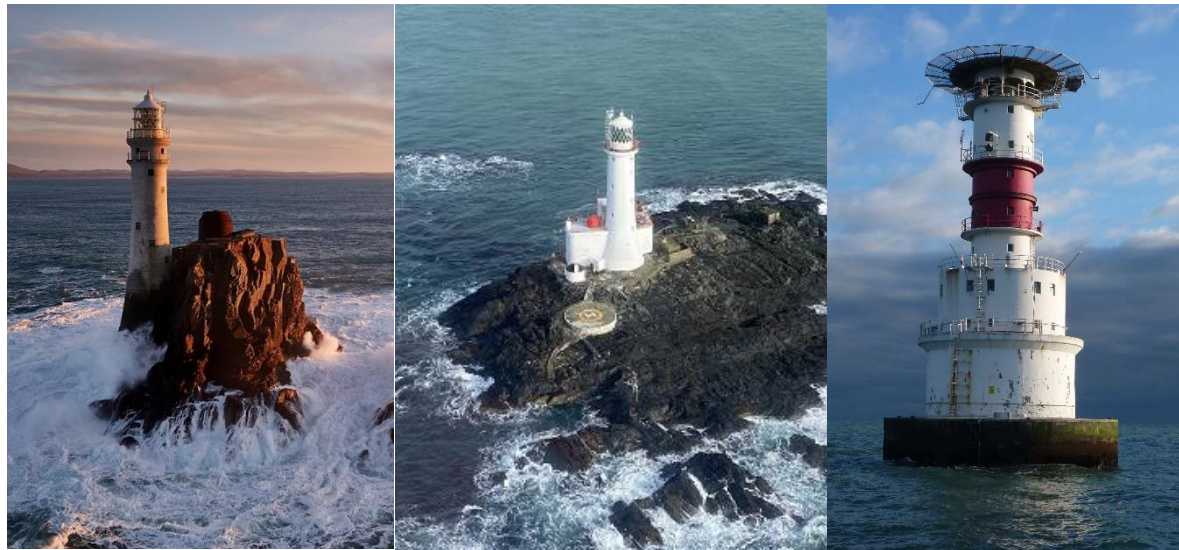
Decarbonising Lighthouses with BIM integrated analysis Kish, Fastnet and Tuskar

Humidity

Thermal performance

Energy Consumption

Renewable Sources

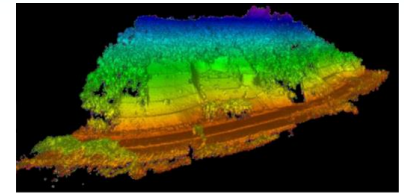




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GEOBIM – Monitoring Historic Retaining Structures



Geological Survey

Suirbhéireacht Gheolaíochta
Ireland | Éireann



INFRAWORKS

Gathering21

Construction Innovations
for Future Generations

CitA

Get in touch michaeloshea@ucc.ie

Thank you
for attending

A blurred background image showing the silhouettes of several people in business attire, likely at a conference or event, with some light bokeh effects.



Using the Model to undertake
3d Printing

Examining FOS for Stability

Scale model for tank testing



1:60 Scale



1:200 Scale