HK CIC

DfMA & MiC from Prototype Demonstrations to Delivery at Scale

Aurélie CLERAUX – Head of Modular Construction, Innovation and Digital Transformation

BOUYGUES BATIMENT INTERNATIONAL

Shared innovation

Bouygues Organisation

More than 15 subsidiaries including

And many more: AWE, BYTHAI, Americaribe…

World context

- Increase of world population: need to deliver housing quickly
- Lack of Productivity in the construction industry
- Lack of skilled labour
- New market players in the modular construction sector

MODULAR CONSTRUCTION is THE solution

TO BUILD QUICKER, BETTER, CHEAPER, SAFER, GREENER

A MAJOR INNOVATION EXPLAINED IN 5 POINTS

FASTER

By industrialising and building offsite around 50% of a project, it removes any loss of time on site due to poor environmental or weather conditions.

BETTER

Each module is manufactured under strict quality control and checks.
Each unit is entirely pre finished with fit-out and façade treatment.
All defects are managed prior to handover to site which ensures lower maintenance cost during the lifecycle of the building.

COST EFFECTIVE

Increased productivity and design optimisation from the start significantly reduces the need for large teams on site. A shorter construction programme means a quicker handover, leading to earlier revenues and reduced financial costs.

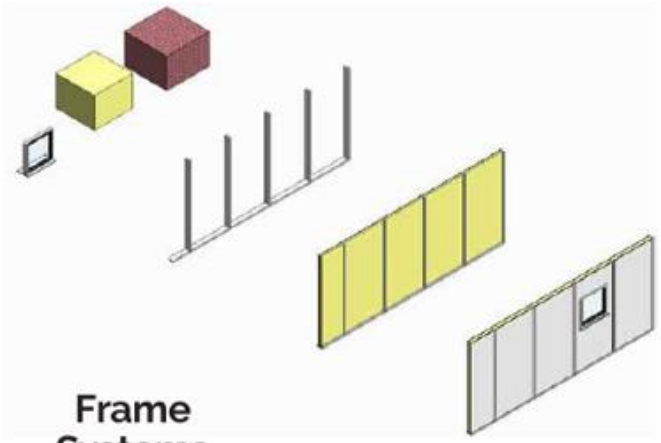
SAFER

Health and Safety is our number one priority and Modular Solutions provides a more protected working environment for our teams, reducing occupational health risks and risks from working at height.

GREENER

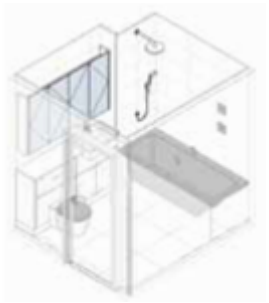
Waste is reduced on site by 70%. Traffic and disruption to local residents is also reduced with less deliveries, less noise and dust.

Panelised to volumetric



Frame Systems

Panel Systems



Pods

Volumetric

FEASABILITY

Working closely with our clients, we explore the true possibilities of the project. We analyse the affordability, programme, finance viability as well as the transportation and logistics and advise on the best layout and modules structure.

DESIGN & PRE-CONSTRUCTION

The design process is developed with our in-house engineering team and the architect, to optimise the modular design and coordination of trades.

MANU-FACTURING

Each unit is manufactured in a quality controlled factory environment. Once completed, the module is transported for the installation of internal and external finishes.

INSTALLATION

It is then ready to be assembled to the site, where it is stacked as per the sequencing programme and to form its structure.

FEASIBILITY

— Working closely with our clients, we explore the true possibilities of the project.

— We analyse the affordability, programme, finance viability as well as the transportation and logistics and advise on the best layout and modules structure.

FEASIBILITY AND DESIGN

Depending on site location, project type, site constraints, and transportation limitations, we provide a bespoke service of in-house technical & patented solutions.

STEEL

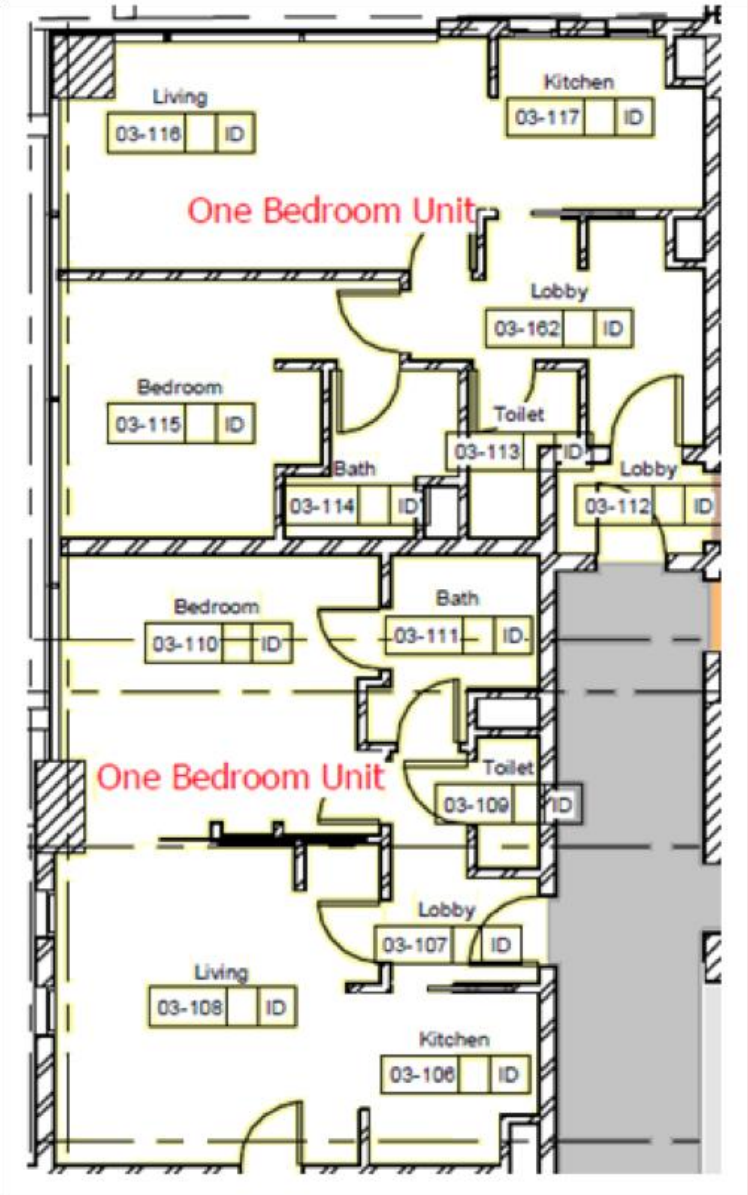
HYBRID

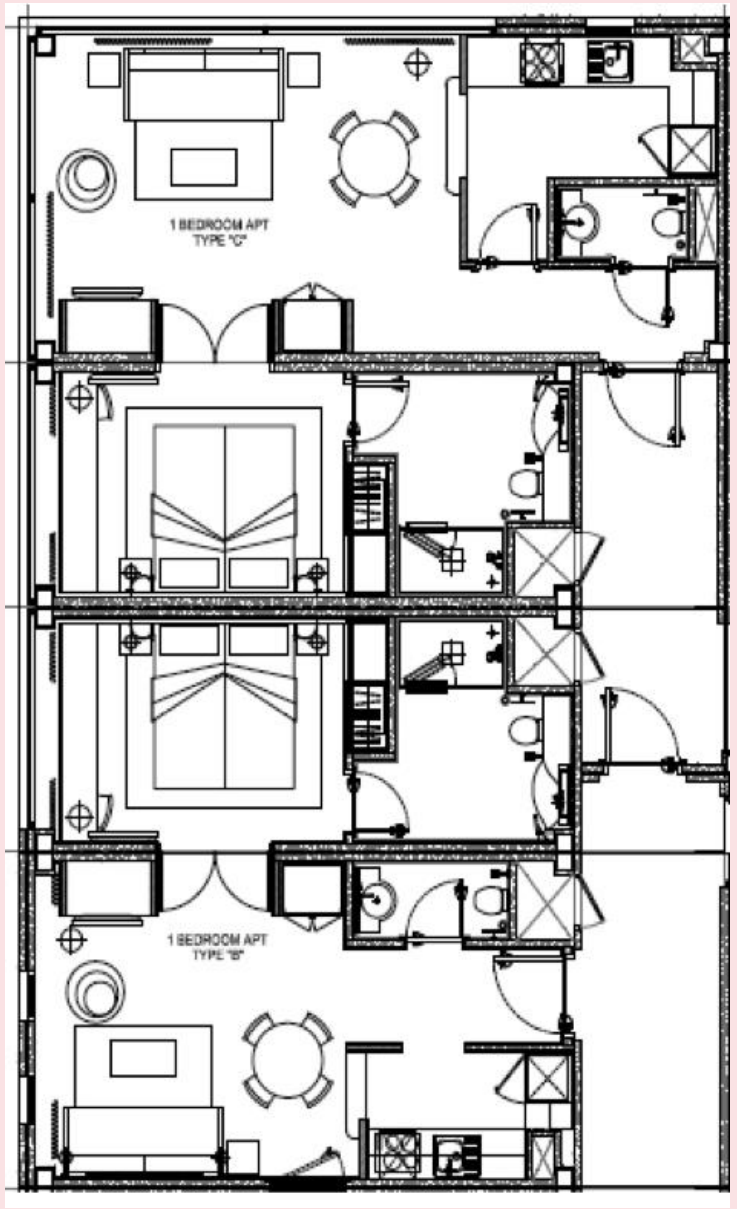
CONCRETE

DESIGN AND PRE CONSTRUCTION

— The design process is developed with our in-house engineering team and the architect, to optimise the modular design and coordination of trades.

EXAMPLE OF MODULARISATION





MANU-FACTURING

— Each unit is manufactured in a quality controlled factory environment.

— Once completed, the module is transported for the installation of internal and external finishes.

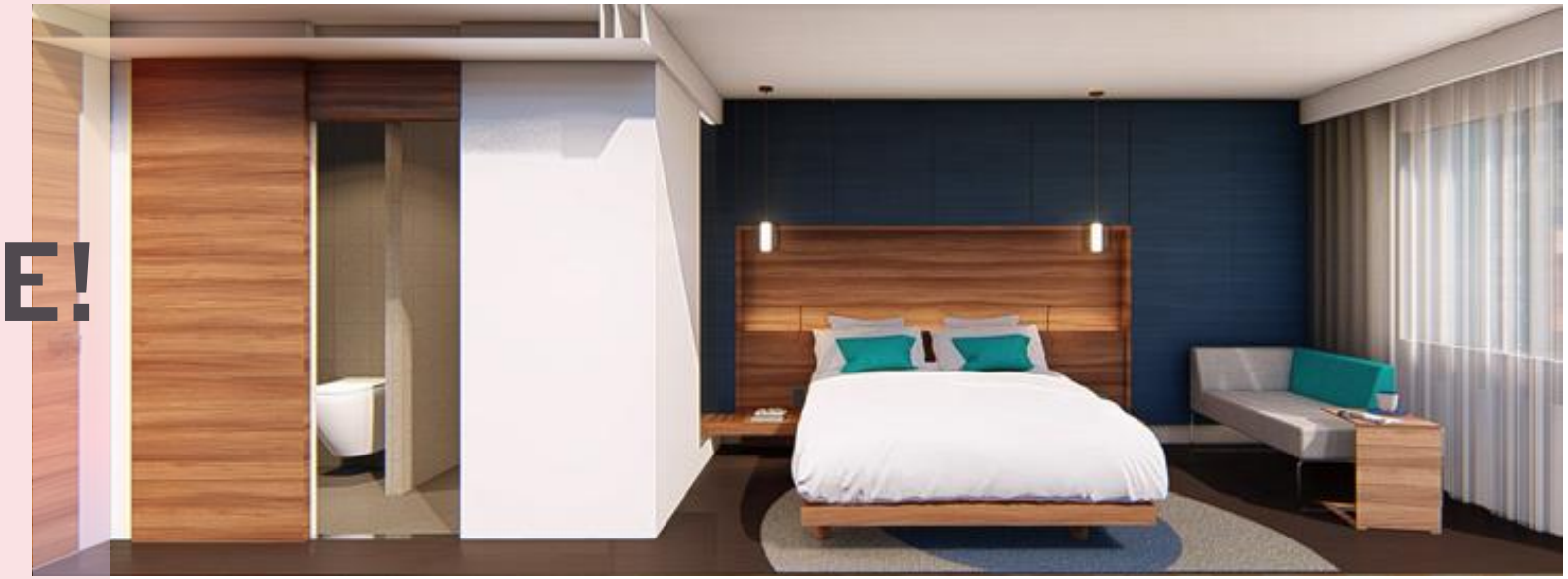
MANUFACTURING IN OUR DEDICATED YARD

INSTALLATION

— It is then ready to be assembled to the site, where it is stacked as per the sequencing programme and to form its structure.

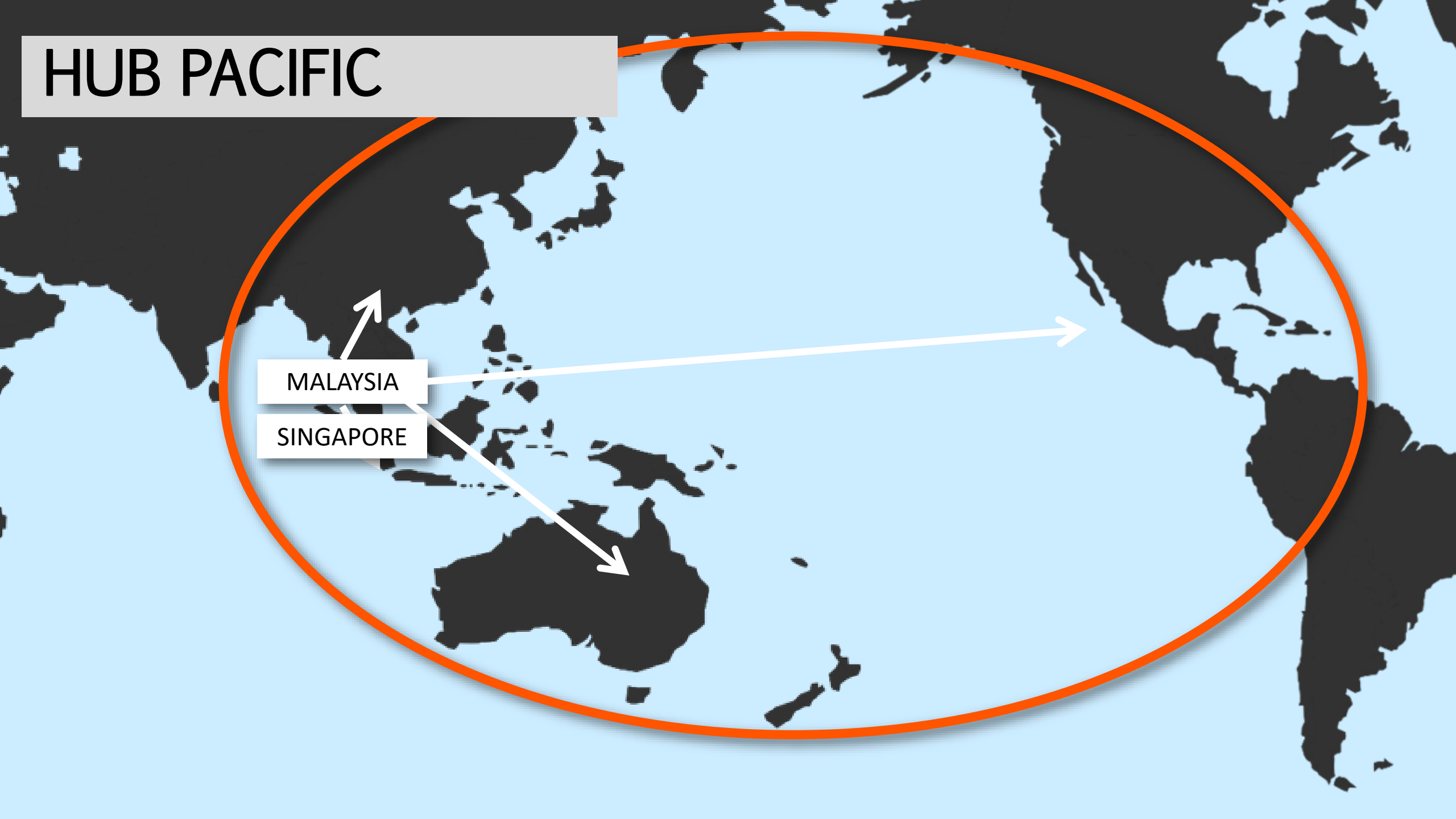
INSTALLATION AND TRANSPORTATION FROM 2.5M WIDE...

UP TO 4.5M WIDE!



HUB ATLANTIC

HUB PACIFIC



COUNTRY SPECIFIC

A PRODUCT APPROACH WITH TURNKEY SOLUTIONS

50+ BOUYGUES REFERENCES

HOTELS

Citizen M Shoreditch — London, 2016
Hotel Crowne Plaza — Singapore, 2016

RESIDENTIAL

Clement Canopy — Singapore, 2018
Woodleigh Lane – Singapore, 2021
Serangoon Avenue 1 – Singapore, 2021
Peruma – Singapore, 2021

STUDENT HOUSING

Canterbury Riverside – UK, 2021
Victoire Daubie — La Verrière, 2016
Crous — Reims, 2016
Crous — Arras, 2015
Oniris — Nantes, 2015
Heinlex – Saint-Nazaire, 2015
Djinn – Le Bourget du Lac, 2014

MILITARY HOUSING

Catalpa — 30+ projects in France, 2016/2018

EDUCATION

Collège – Clisson
Lycée Du Sud Loire – Clisson
Campus Valrose – Nice
National Skills Academy For Construction – London
BCA Academy – Singapore, 2021

ADMINISTRATION

Base Logistique – Saint-Priest
Maison Des Associations (bât A) – Saint-Nazaire

HEALTHCARE

Nursing Home – Singapore, 2017

OFFICES

Zac De La Fontaine (Ilot HI) – Orléans

PRISON

Prison D'orbe – Genève

SOCIAL HOUSING

Alexandra House YMCA Croydon – London, 2012

288 modules

CROWNE PLAZA EXTENSION
A FIVE STAR HOTEL / Singapore

- 243 hotel rooms
- 288 modules
- 10 storey hotel next to Changi Airport
- Gross Floor Area: 10,000 m2
- 17 month programme
- Module type: steel
- Completed in July 2016

276 modules

WOODLAND CRESCENT
Nursing home/ Singapore

- 243 beds
- 276 modules
- 2 storeys podium built in-situ
- Gross Floor Area: 9,000 m2
- 15 month programme
- Module type: hybrid steel / concrete
- Completed in 2017
- Weight of one module: between 10 and 15 tons

CLEMENT CANOPY
SINGAPORE

Located close to Singapore city centre, Clement Canopy is an iconic project for the city.

- 505 luxury residential apartments
- 1,899 modules
- 40 storey tower
- Gross Floor Area: 46,000 m^2
- 36 month programme
- Module type: concrete
- Topping out in April 2018
- To be completed in April 2019

46,000 m^2


BLOCK 2
17-48

834 apartments

WOODLEIGH LANE RESIDENCES
Singapore

- 834 apartments
- 2,514 modules
- 7 x 14 – 15 storey blocks
- Gross Floor Area: 58,641 m2
- 33 month programme
- Module type: concrete
- To be completed in October 2020

613 appartments

SERANGOON North Avenue 1
Singapore

- 613 apartments
- 2,012 modules
- 5 x 15 storey blocks
- Gross Floor Area: 47,270 m2
- 30 month programme
- Module type: concrete
- To be completed in July 2020

356 appartments

PERUMAL
Singapore

- 356 apartments
- 842 modules
- 24 storey blocks
- Gross Floor Area: 16,161 m2
- 30 month programme
- Module type: concrete
- To be completed in June 2020

BCA ACADEMY PHASE 2 INTENSIFICATION WORKS
SINGAPORE

Institutional Development

- 7 storey Zero Energy Building (ZEB) constructed with Mass Engineering Timber (MET) system
- 16 storey Super Low Energy Building (SLEB) constructed with Advanced Precast System (APCS), Prefabricated Prefinished Volumetric Construction (PPVC) system, and Passive Displacement Ventilation (PDV) system
- Gross Floor Area: 21,800 m^2
- Fast track 18 months construction programme
- Module type: concrete – 156 modules
- To be completed in June 2021

Innovative Building

CANTERBURY
— UNITED KINGDOM

- Student accommodation
- 491 bedrooms
- 430 modules
- Gross Floor Area: 11,897 m^2
- Start of modules manufacturing 01/04/2020
- To be completed in September 2021

11,897 m^2

R&D and INNOVATION

For MODULAR CONSTRUCTION

Many challenges to tackle

Technical development

Structure
Fire
Acoustic
Thermal performance
Carbon
Air tightness

Digital Thread for Design for Manufacturing & Assembling… and Disassembling

Automatic, Generative design
Full coordination with BIM 3D, 4D and 5D
Automatic procurement, BOM
Methods of assembly

Smart Factory, 4.0

LEAN Manufacturing
Logistics & materials tracking
QA, QC, Safety, Activity monitoring

R&D
INNOVATION
DIGITALISATION

Challenge 1

Technical Developments

Develop solutions without existing regulations for offsite construction

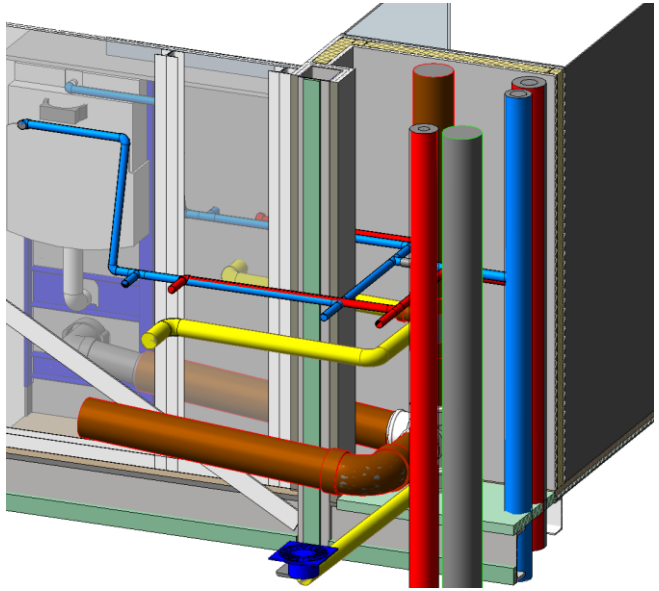
BOUYGUES BATIMENT INTERNATIONAL

MODULAR SOLUTIONS

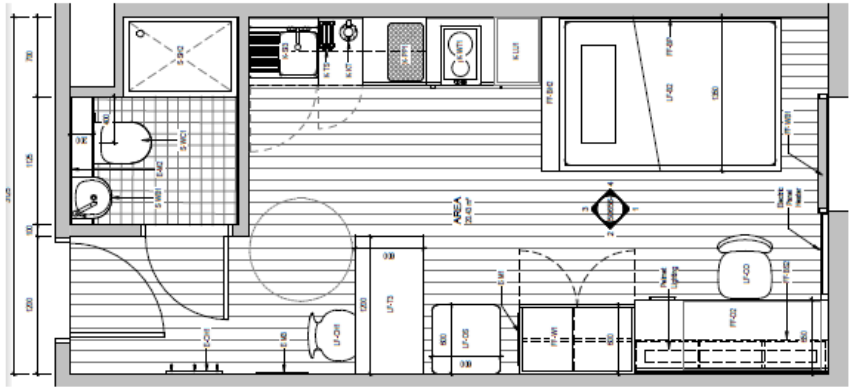
Shared **innovation**

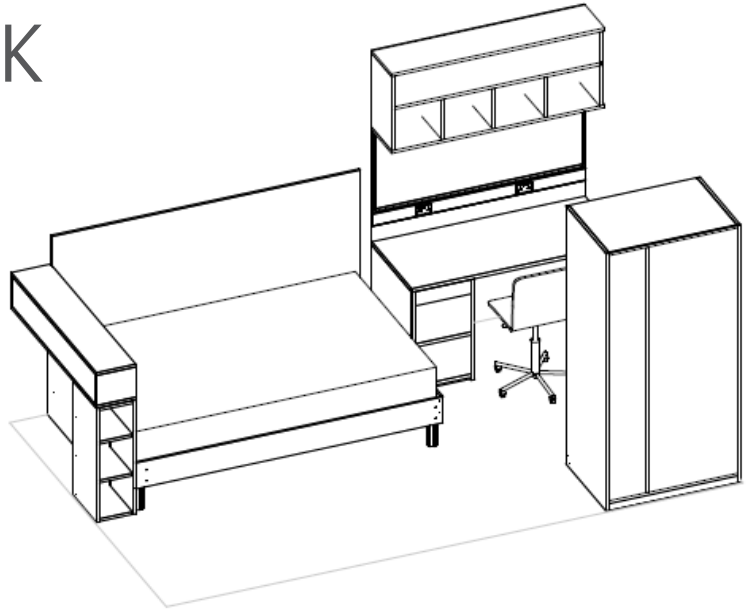
Technical developments

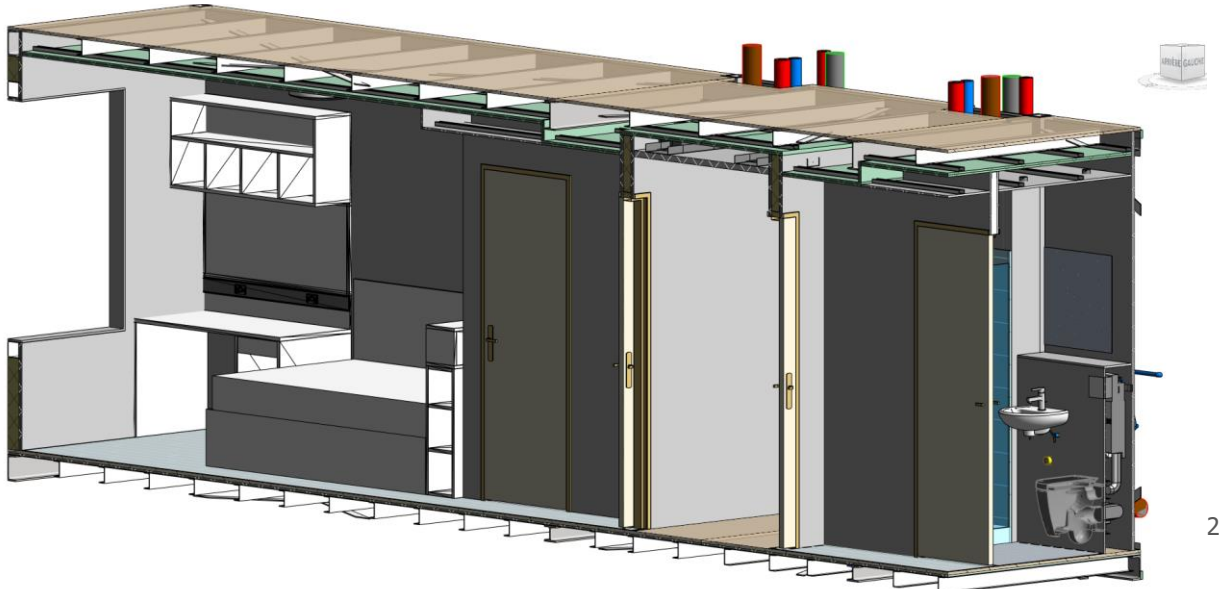
Example: Modular in the UK



Mock up studio





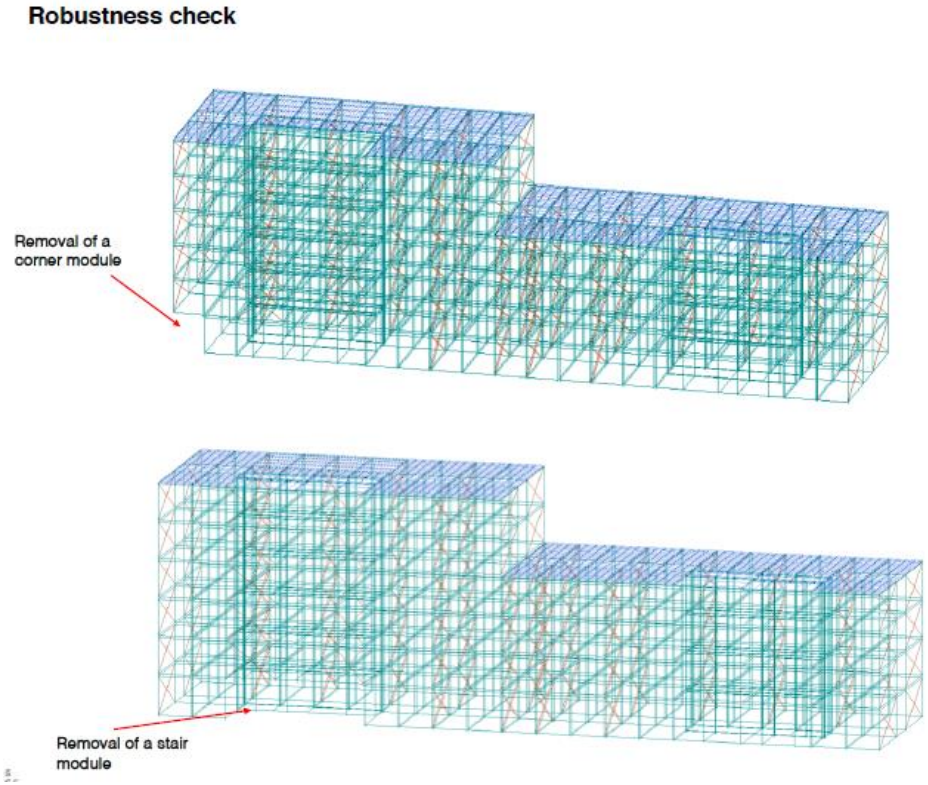


Technical developments

Compliance with local Standards:

- ➔ **Structure**
- ➔ Fire
- ➔ Acoustic
- ➔ Thermal
- ➔ Carbon

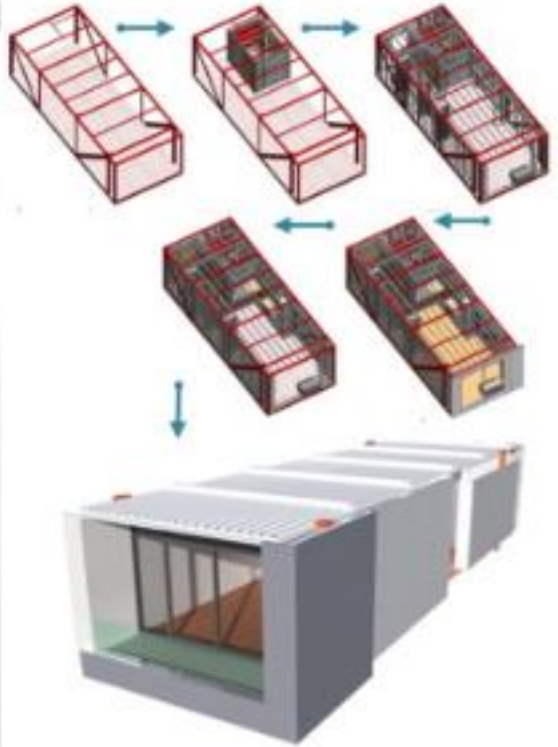
Robustness and disproportionnate collapse

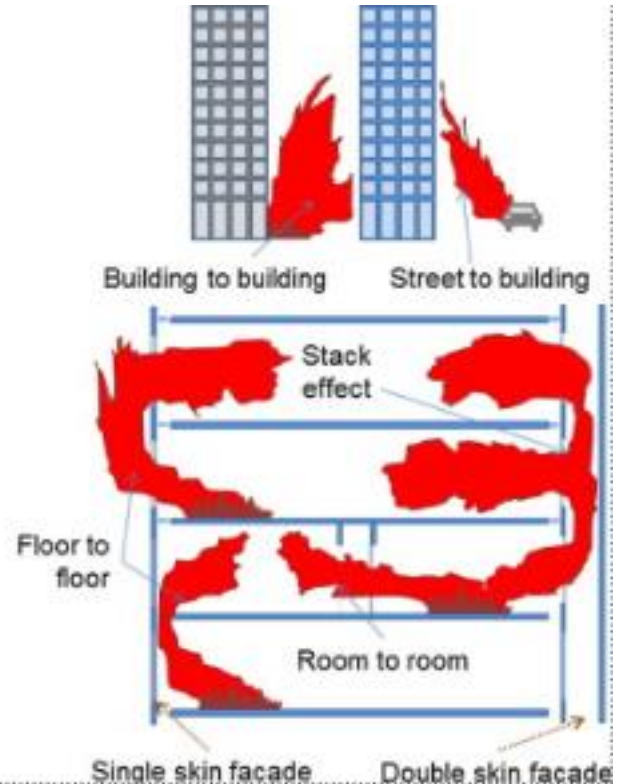


Technical developments

Compliance with local Standards:

- Structure
- **Fire**
- Acoustic
- Thermal
- Carbon



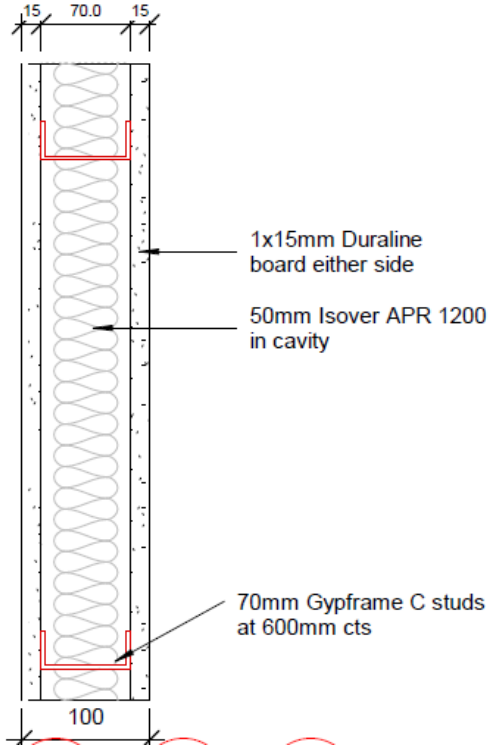


Technical developments

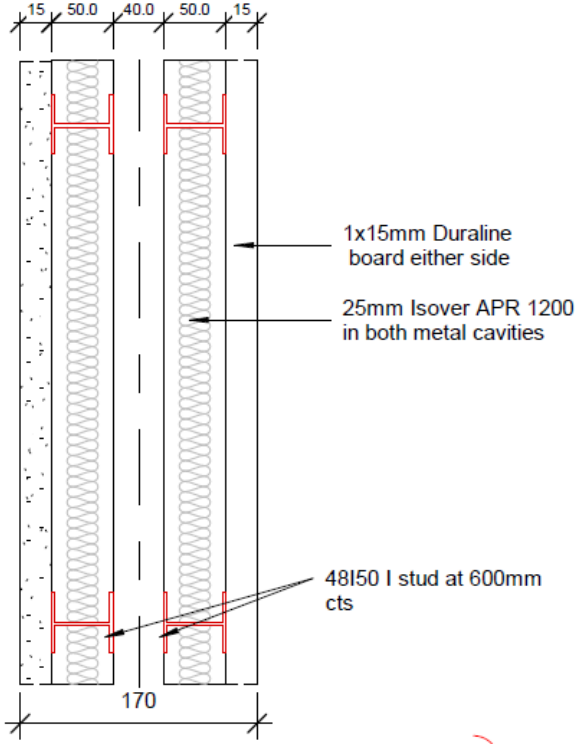
Compliance with local Standards:

- Structure
- Fire
- **Acoustic**
- Thermal
- Carbon

Standard partition



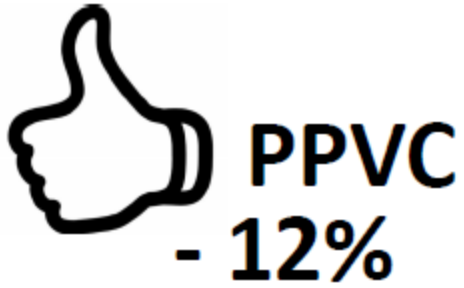
Modular partition

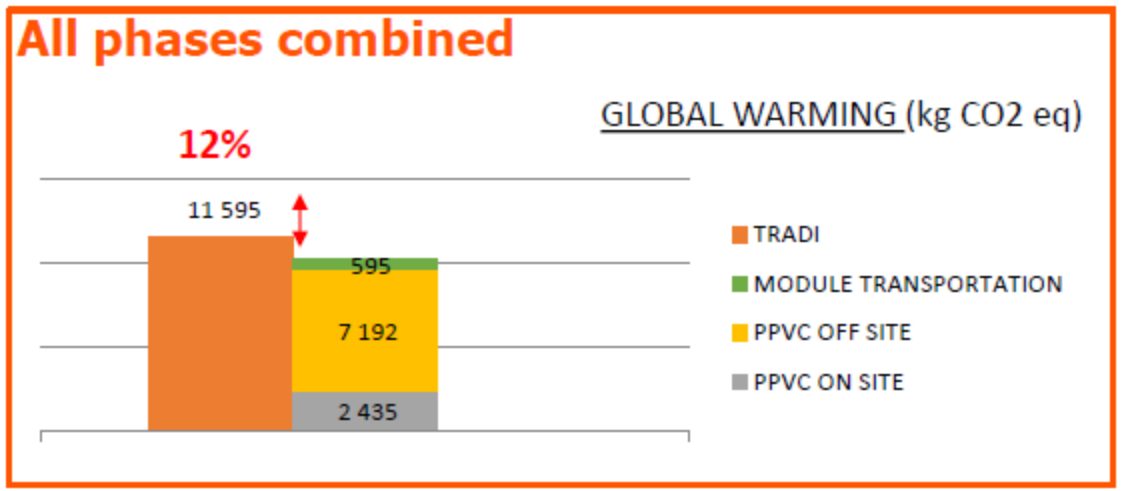


Technical developments

Compliance with local Standards:

- Structure
- Fire
- Acoustic
- Thermal
- **Carbon**



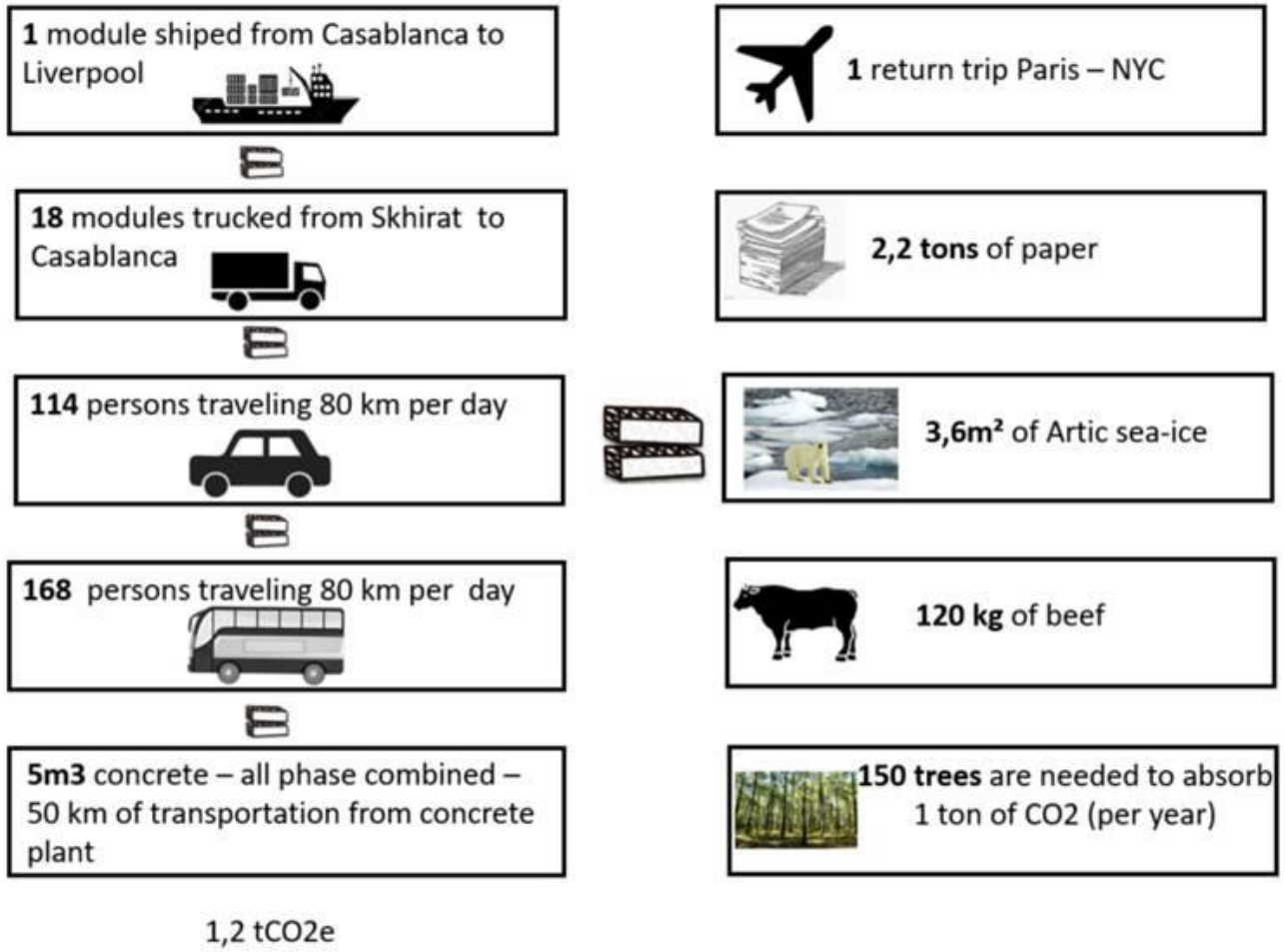


Comparison TRADI/PPVC
Tradi made of concrete VS hybrid PPVC

Technical developments

Compliance with local Standards:

- ➔ Structure
- ➔ Fire
- ➔ Acoustic
- ➔ Thermal
- ➔ **Carbon**



LCA done for a project based in Manchester

Technical developments

Compliance with local Standards:

- ➔ Structure
- ➔ Fire
- ➔ Acoustic
- ➔ Thermal
- ➔ Carbon

The Assurance Scheme comprises:
- Assessment and accreditation against best practice by Lloyd's Register EMEA.
- A 60 year durability assessment by BLP Insurance.
- A web based database comprising properties constructed under the BOPAS scheme with details of construction.

Accreditation undergoing:

- ➔ BOPAS

Technical developments

- Need for collaborative research works between government, universities, private companies (consultants, GC, architects)

- Let's NOT stop at R&D but let's make this become real through new regulations and guidelines, adapted to modular construction and offsite construction

Challenge 2

DfMA + D

Design for Manufacturing and Assembling and Disassembling

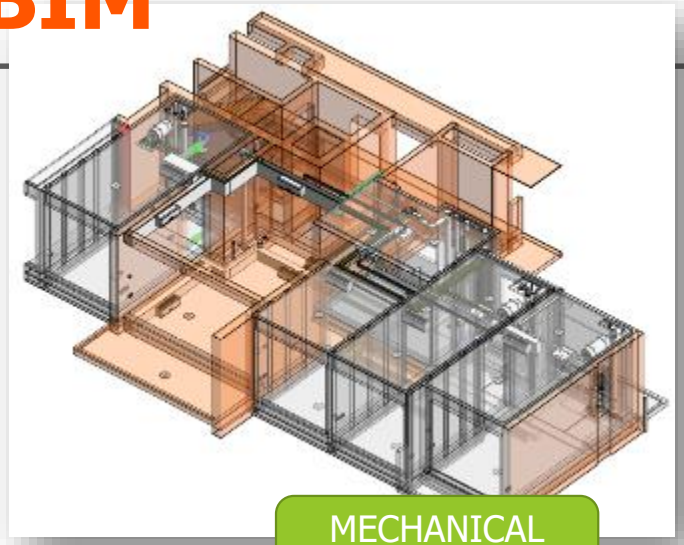
BOUYGUES BATIMENT INTERNATIONAL

MODULAR SOLUTIONS

Shared **innovation**

Today in BIM

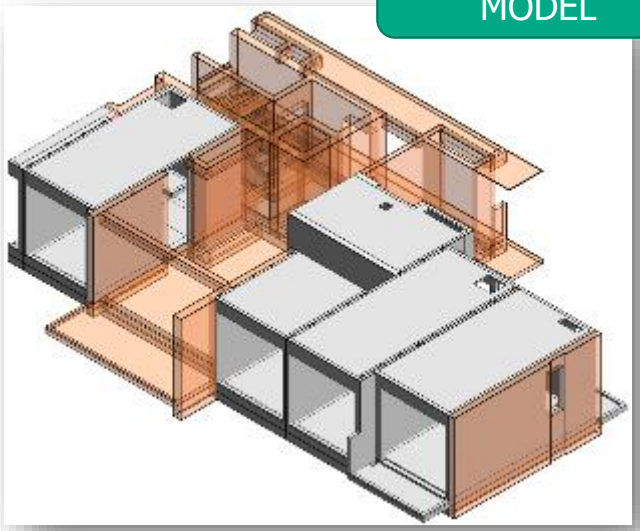
Design Teamwork
3 Disciplines to develop PPVC collaboratively

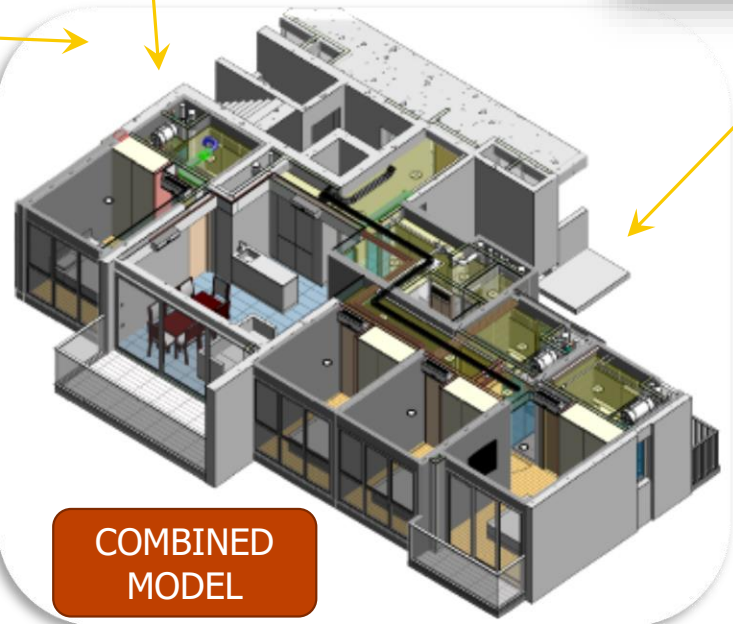


MECHANICAL SERVICES

ARCHITECTURAL FINISHES

STRUCTURAL MODEL





COMBINED MODEL

Tomorrow: Library of components

Challenge 3

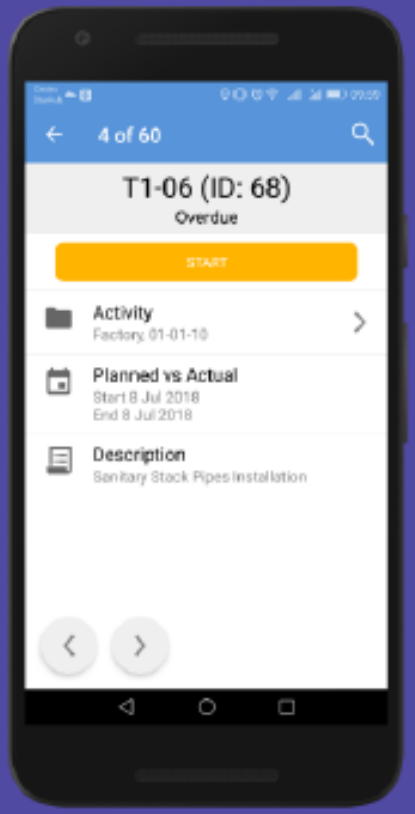
Smart Factory

BOUYGUES BATIMENT INTERNATIONAL

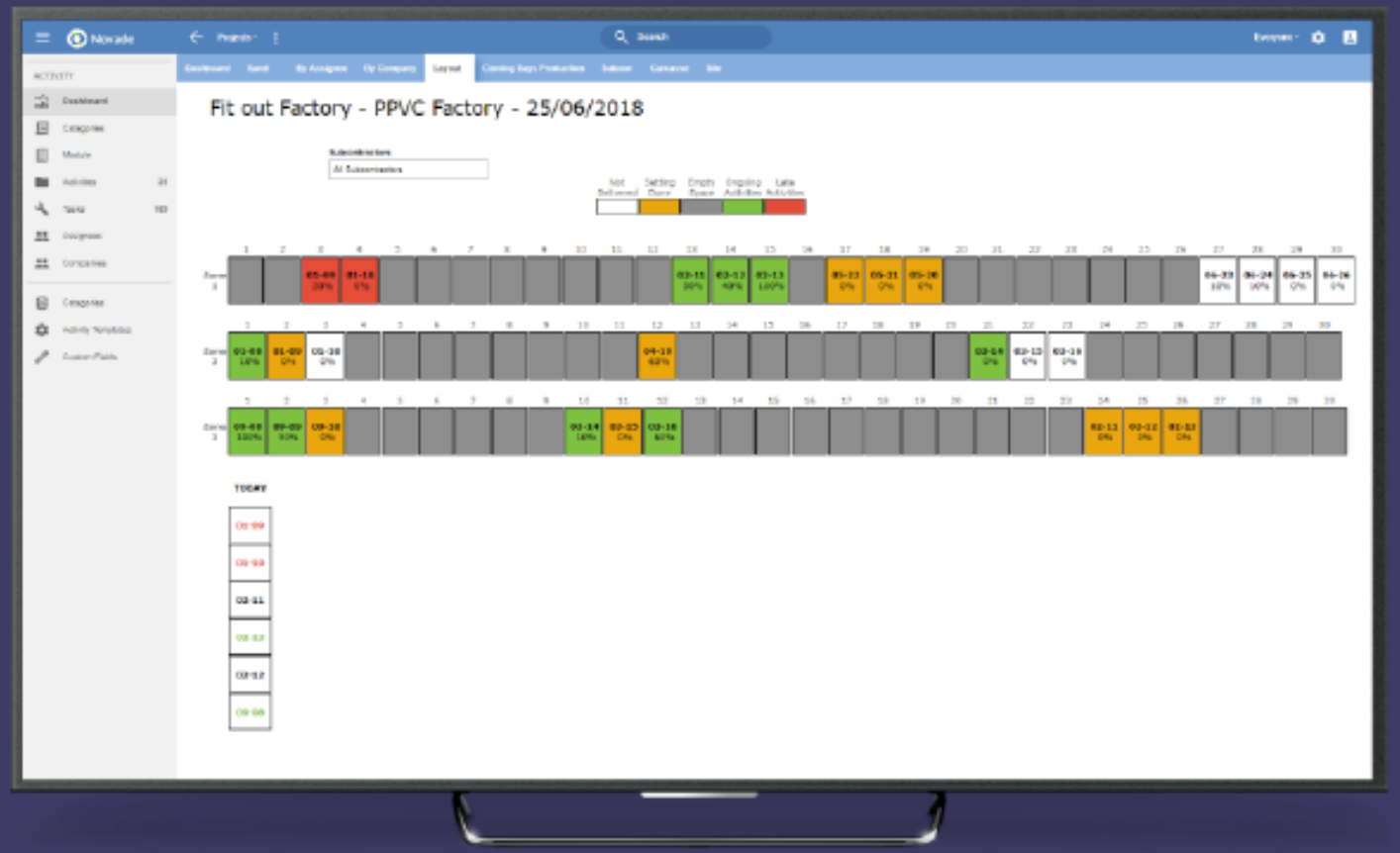
MODULAR SOLUTIONS

Shared **innovation**

REAL TIME MONITORING OF PRODUCTION



PER TASK, PER MODULE
START / STOP BUTTON



CENTRAL MONITORING PLATFORM

QUESTIONS ?

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MODULAR SOLUTIONS