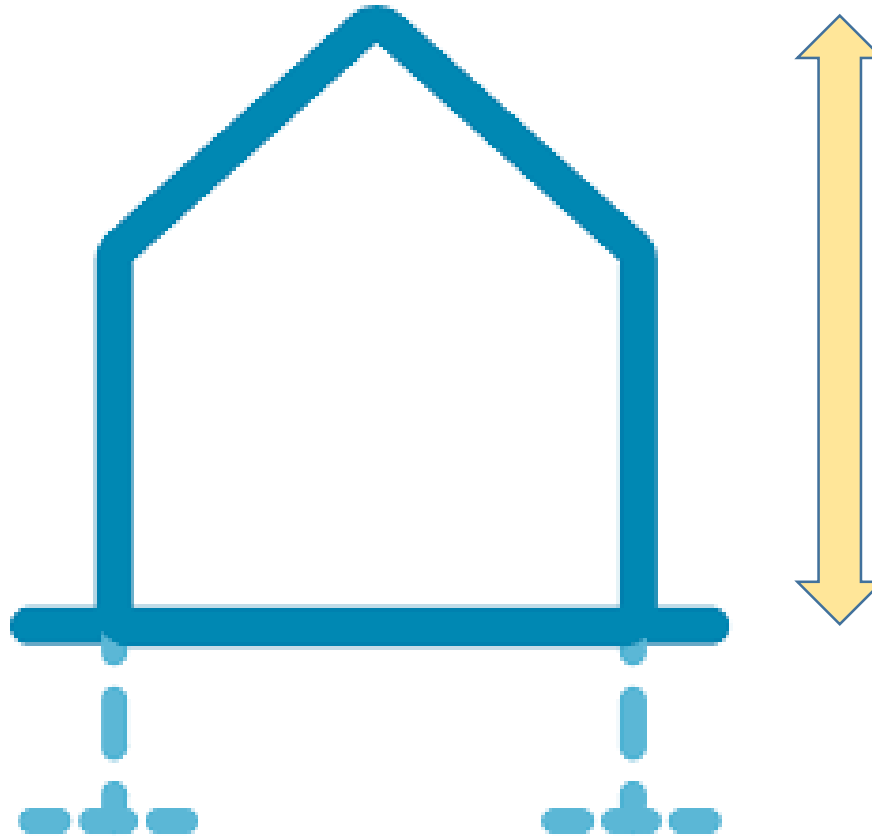


Superstructure 7: Fundamentals of Construction Technology



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📄	Name	Modified	Modified By
📁	Class Materials		Alan Nantel
📄	ACBA4001 Assignment 1 - brief.docx	October 14	Oliver James Macki...
📄	ACBA4001 Assignment 1...		
📄	Assignment 1.docx		
📄	Borehole Log to print for		
📄	Construction Management		
📄	CPD Presentation.pptx		
📄	EXAMPLE-Site-Investigati		
📄	FOUNDATIONS1.pptx		
📄			

General > Superstructure Lectures

📄	Name	Modified	Modified By
📄	Fundamentals Con Tech Superstructure 1.pdf	November 10	Gavin Traylor
📄	Fundamentals Con Tech Superstructure 2.pdf	6 days ago	Gavin Traylor
▶	Wk 01 Superstructure - Introduction.mp4	6 days ago	Gavin Traylor
▶	Wk 01a Superstructure - Walls.mp4	6 days ago	Gavin Traylor
▶	Wk 02 Superstructure Walls Openings.mp4	6 days ago	Gavin Traylor
▶	Wk 02a Superstructure - Building Regs.mp4	6 days ago	Gavin Traylor

Fundamentals of Construction Technology (ACBA4001)

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**Fundamentals of Construction Technology (ACBA4001)**
PUBLISHED ACBA4001 (2019-20) 14 items in 2 sections

LISTS

COLLECTION

FIND LISTS

REPORTS

EDIT

LIST SENT

NEW SECTION

ADD ITEMS

Essential reading (4)

Material which is an essential part of the course and students are expected to draw on as a core part of their learning. Must be available from the library and should be available online.

	BOOK Construction technology. 1, House construction Riley, Mike., Cotgrave, Alison., Third edition., Basingstoke, Hampshire :, Palgrave Macmillan, 2013., Total Pages vii, 382 pages, 8 pages of unnumbered plates : Essential Complete Check holdings	11
	BOOK Construction technology : industrial and commercial building. 2 Riley, Mike., Cotgrave, Alison., 3rd edition., Basingstoke :, Palgrave Macmillan, 2014., Total Pages 427 p. : Essential Complete Check holdings	8
	BOOK Building construction handbook Chudley, R., Greeno, Roger., 8th ed. , Oxford ;, Butterworth-Heinemann, 2010., Total Pages xi, 828 p. : Essential Complete Check holdings	6
	BOOK Architectural technology [electronic resource] Emmitt, Stephen., 2nd ed., Hoboken, N.J. :, Wiley-Blackwell, 2012., Total Pages 1 online resource (265 p.) Essential Complete Check availability	2

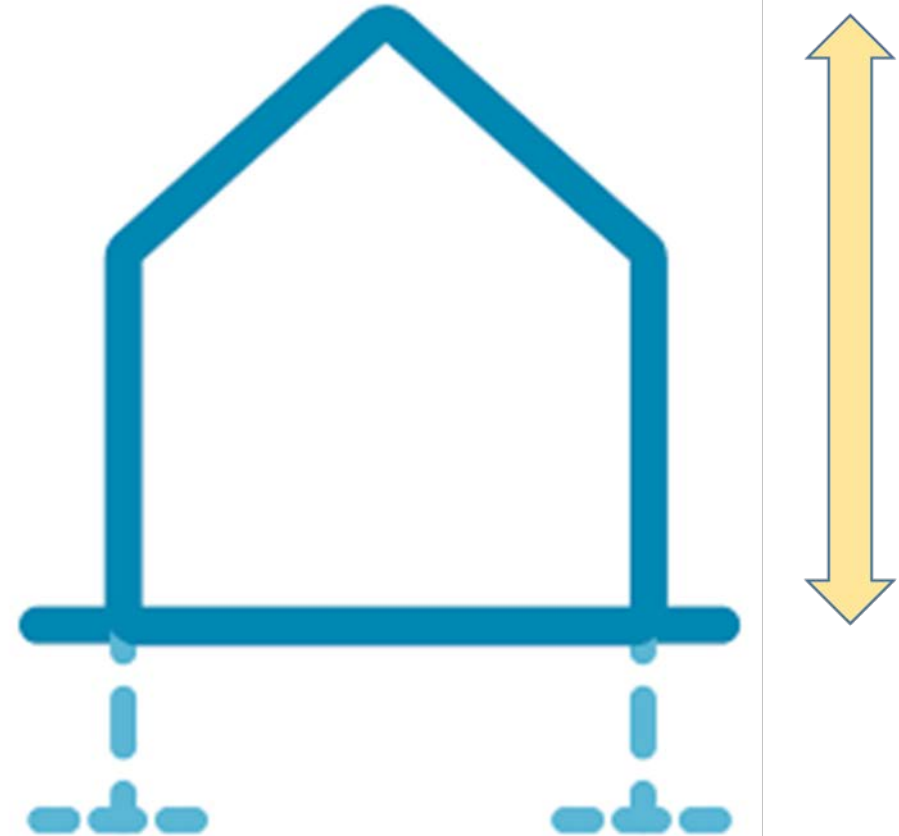
Further reading (10)

ACBA 4001
FUNDAMENTALS OF CONSTRUCTION
TECHNOLOGY: LEVEL 4

Superstructure Week 7:

Off Site Construction:

Offsite Ready Series







KNOWLEDGE FOR CHANGE

1 Offsite fundamentals

Slides by Dr Mila Duncheva and Carola Calcagno, Edinburgh Napier University

Funded by



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MOBIE
Ministry of Building
Innovation and Education

CITY OF GLASGOW
COLLEGE

CWIC
Canolfan Arloesi Adelladwaith Cymru
Construction Wales Innovation Centre

CONSTRUCTION
SCOTLAND
INNOVATION
CENTRE

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1.0 Introduction and Glossary

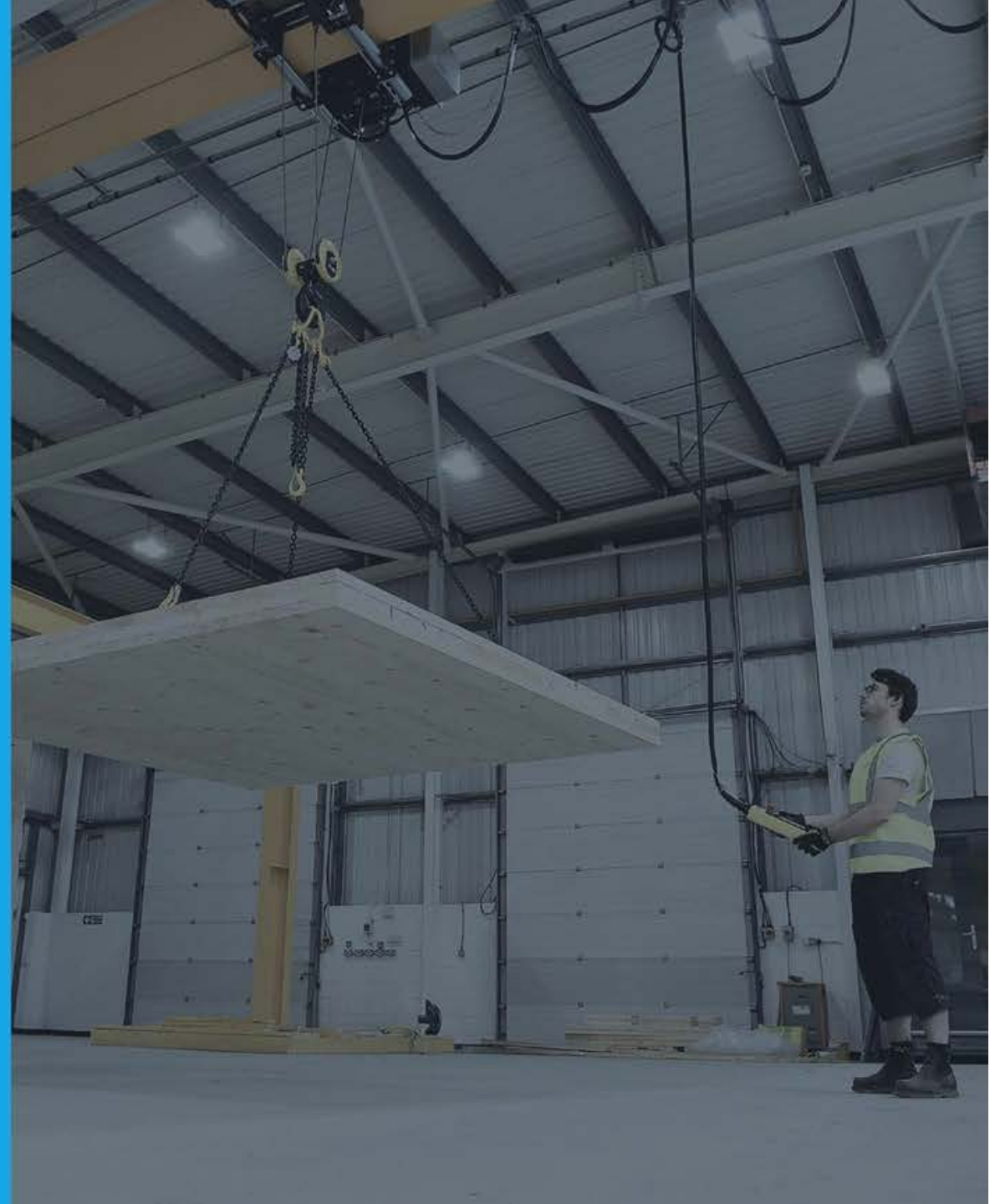




Image courtesy
of CCG OSM



Image courtesy of
Laing O'Rourke

“There is real confusion in terms of terminology with terms such as modular, offsite, prefabrication, modern methods of construction, volumetric and panelised all being used.”

House of Lords 2018

- **Large variety of terminologies:** *‘offsite’, ‘Off-Site Manufacturing (OSM)’, ‘Modern Methods of Construction (MMC)’, ‘smart’, ‘Industrialised Building System (IBS)’, ‘pre-fabrication’, etc.*
- **Lack of consistency** in the use of offsite systems classifications



Modern Methods of Construction (MMC)

Modern methods of construction (MMC) are all the approaches that aim to optimise the construction process to obtain better products in less time

- Business efficiency
- Quality
- Customer satisfaction
- Environmental performance sustainability
- Predictability of delivery timescale

MMC include but are not limited to offsite construction



CATEGORY
DEFINITION



1

Pre-manufacturing
(3D primary structural
systems)



2

Pre-manufacturing
(2D primary structural
systems)



3

Pre-manufacturing
components (non-systemised
primary structure)



4

Additive manufacturing
(structural and non-structural)



5

Pre-manufacturing
(non structural assemblies
& sub-assemblies)



6

Traditional building product
led site labour reduction /
productivity improvements



7

Site process led site labour
reduction / productivity /
assurance improvements

Offsite construction

Offsite is a construction method that adds substantial value to a product via the manufacture and pre-assembly of components, elements or modules in a factory, before installation into their final location.

Image courtesy of Offsite
Awards - Mott MacDonald



MMC

Process improvement

Additive
manufacture

Traditional
building
product led
efficiency
improvement

Site process
led efficiency
improvement

Pre-manufacturing	Non-systemised primary structure	Sub-assemblies and components	2D	Varying levels of enhancement
			3D	
	Non-structural assemblies	Panelised	Open	
	2D primary structural systems		Closed	
	Non-structural assemblies	Volumetric	Pods	
	3D primary structural systems		Modules	

Offsite

Factory production

Design for
Manufacture
and
Assembly
(DfMA)

DfMA +
Disassembly
(DfMA+D)

Flying
factories

Other definitions

Design for Manufacture and Assembly (DfMA): the concept of designing products and systems that are tailored for ease of manufacture, transport and assembly

- Understand the supply chain
- Component-based design

DfMA+ Disassembly (DfMA+D): targets efficiency also in the maintenance and end-of-life stages

- Considerations for de-construction, re-use and recycling

Other definitions

Flying factories: onsite or near-site temporary factories

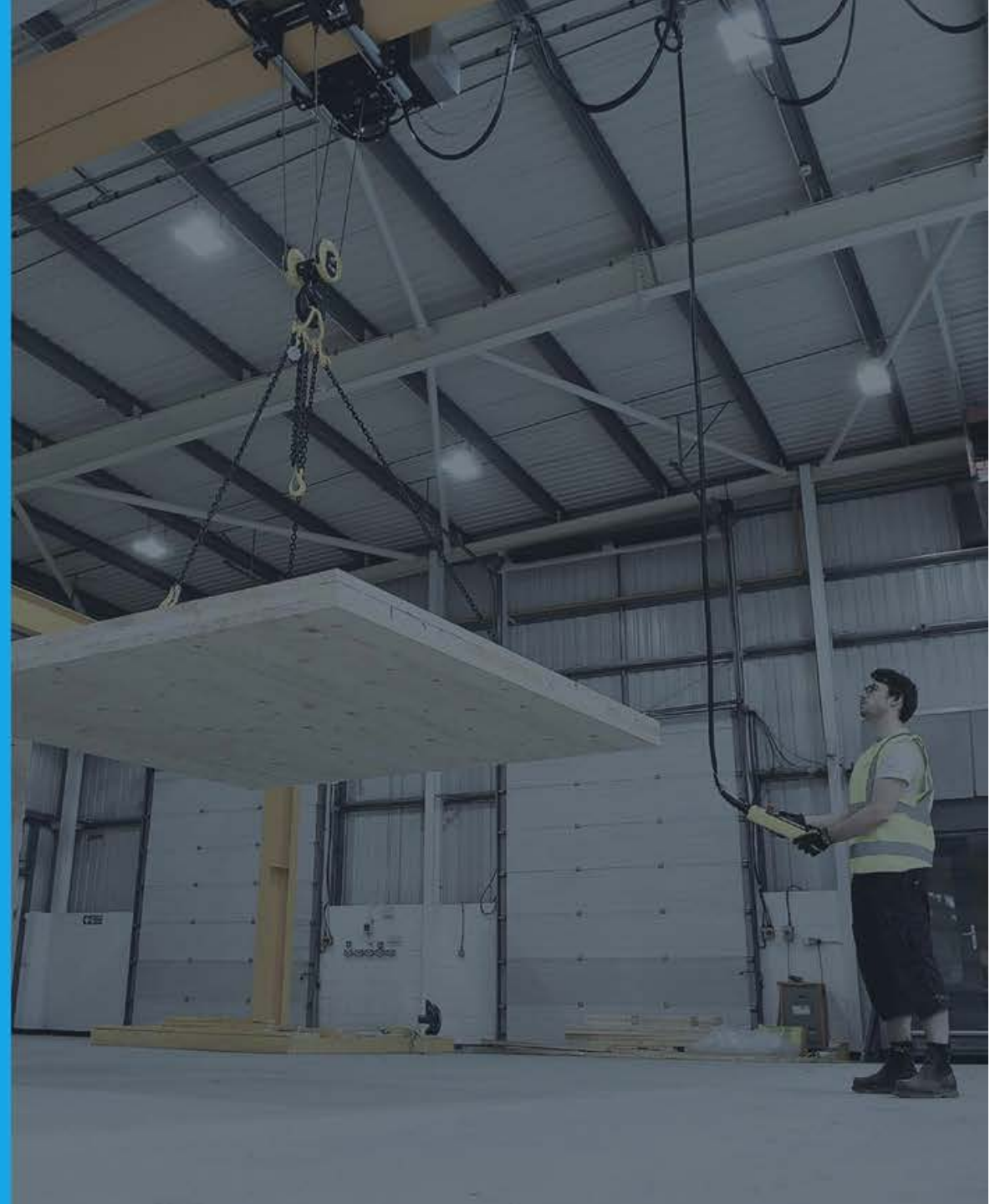
Smart construction: approaches that make full use of digital technologies and industrialised manufacturing techniques to improve productivity, minimise whole life cost, improve sustainability and maximise user benefits

Regional differences:

Industrialised Building System (IBS) in Asia and Australia

Modular in North America

1.1 Appreciation of how buildings are constructed



Four main categories of offsite construction:

Panelised systems



Volumetric systems



Can be made out of any typical construction material: concrete, steel, timber or hybrid

Sub-assemblies and components



Hybrid systems



Panelised systems

Planar unit which may or may not have a structural function

- **Open:** usually when non-insulated with only the structural elements and if applicable sheeting on one side
- **Closed:** include insulation, sheeting on both sides and a service zone; can be furtherly enhanced with the addition of internal lining, external cladding, windows and doors and services
- **SIPs** (Structural Insulated Panels): variation of closed panels; solid insulation 'sandwiched' with two layers of OSB.

Volumetric systems

They represent three-dimensional units that enclose usable space.

- Typically are fully finished internally and can also be finished externally
- Can also be non-structural – **pods**: used for bathrooms, plant rooms and roof-top services

Image courtesy of Offsite
Awards - Peter Dann



Sub-assemblies and components

Pre-manufactured elements that don't fall in the previous categories

- Stairs
- Doors
- Windows
- I-joists
- Steel elements



Hybrid systems

Generic term covering a wide variety of construction techniques, particularly where different systems and/or materials are used in combination to fulfil a specific function



Benefits and drivers

the factory environment provides a cleaner and safer place of work. The production is more efficient and performance are enhanced, with consequent reductions in costs.

the factory environment guarantees higher quality, more predictable product behaviour, better performance and little defects, with consequent higher customer satisfaction.



the optimised use of materials and the opportunity to carry some operations at the same time allows for time savings and reduction of waste. Additionally, the use of BIM and automation ensures flexibility.



OFFSITE LEVEL 1
SUB - ASSEMBLIES



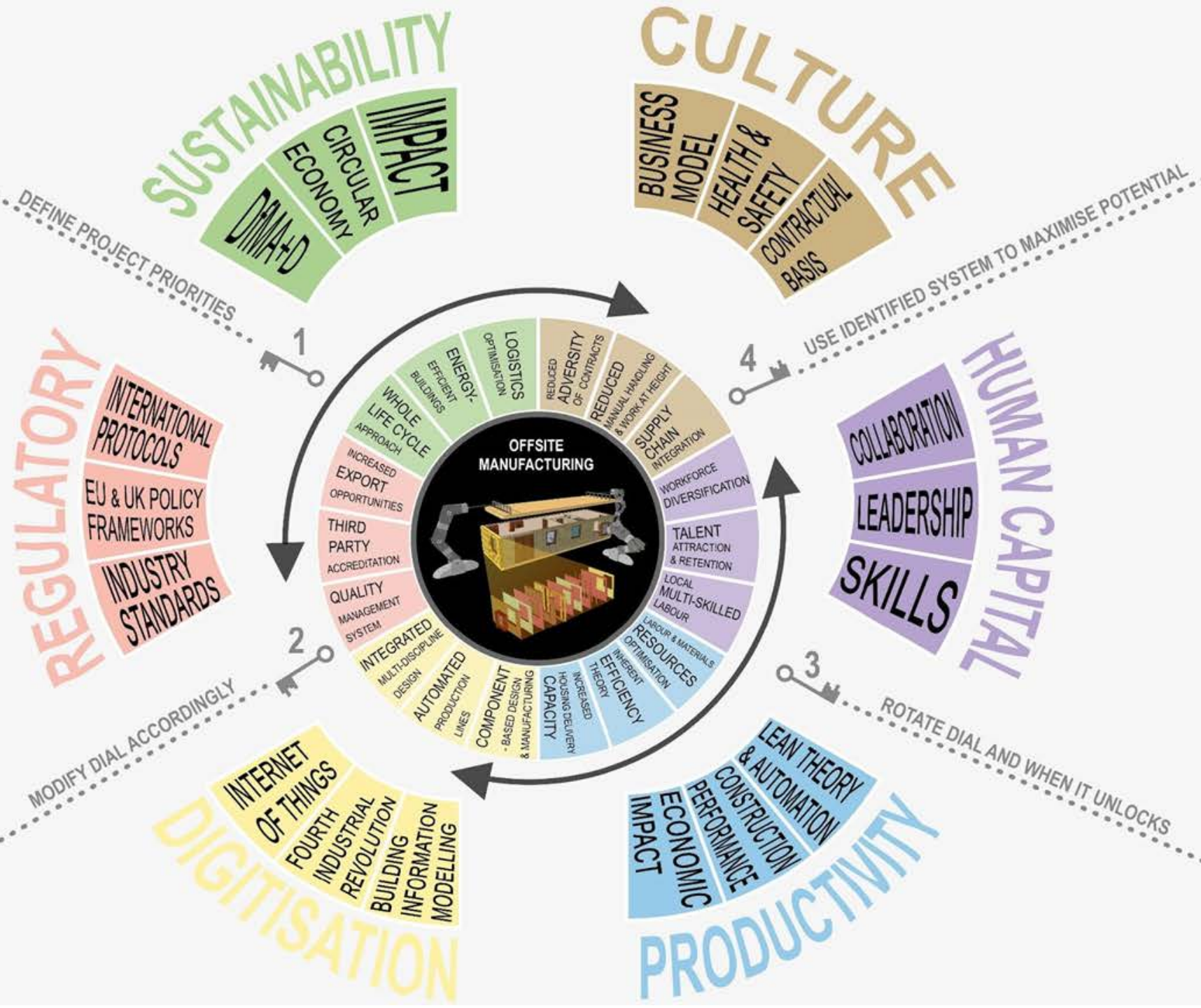
OFFSITE LEVEL 4
VOLUMETRIC



OFFSITE LEVEL 2
ENHANCED PANELS



OFFSITE LEVEL 3
HYBRID



Challenges and risks

The adoption of an offsite approach requires a change in culture that is still facing resistance.

- Transformations: project management, scheduling
- Investment decisions need to be more informed
- Onsite risks: remote areas access, manufacture at fault
- Meta skills: attention to detail, effective communication

YOU CAN BE THIS CHANGE!!!

Building types

Residential

The market **demand for housing** encourages the use of offsite construction for faster and more efficient delivery.

Due to the **different form** that residential buildings can assume, from **single-family** homes to **apartment blocks**, **different offsite systems** can be applied depending on the **size** and **environmental** performance that need to be obtained.

For example, **volumetric systems** are best suited when a high level of **repeatability** is required. They can be also used as **service pods**.

Residential low rise

Riverford Gardens

- CCG + MAST Architects
- Glasgow
- panelised system
- enhanced environmental and energy performance
- 156 homes:
 - 10 one-bedroom flats
 - 94 two-bedroom flats
 - 12 three-bedroom semi-detached homes
 - 40 four-bedroom terraced villas

Image courtesy of CCG
(Scotland) Ltd



Residential mid rise

Yoker

- CCG + MAST Architects
- Glasgow
- CLT
- tallest timber building in Scotland
- structural timber award winner 2018
- 42 apartments
- reduced erection/construction time, reduced material wastage, inherent air tightness and thermal properties

Image courtesy of CCG
(Scotland) Ltd

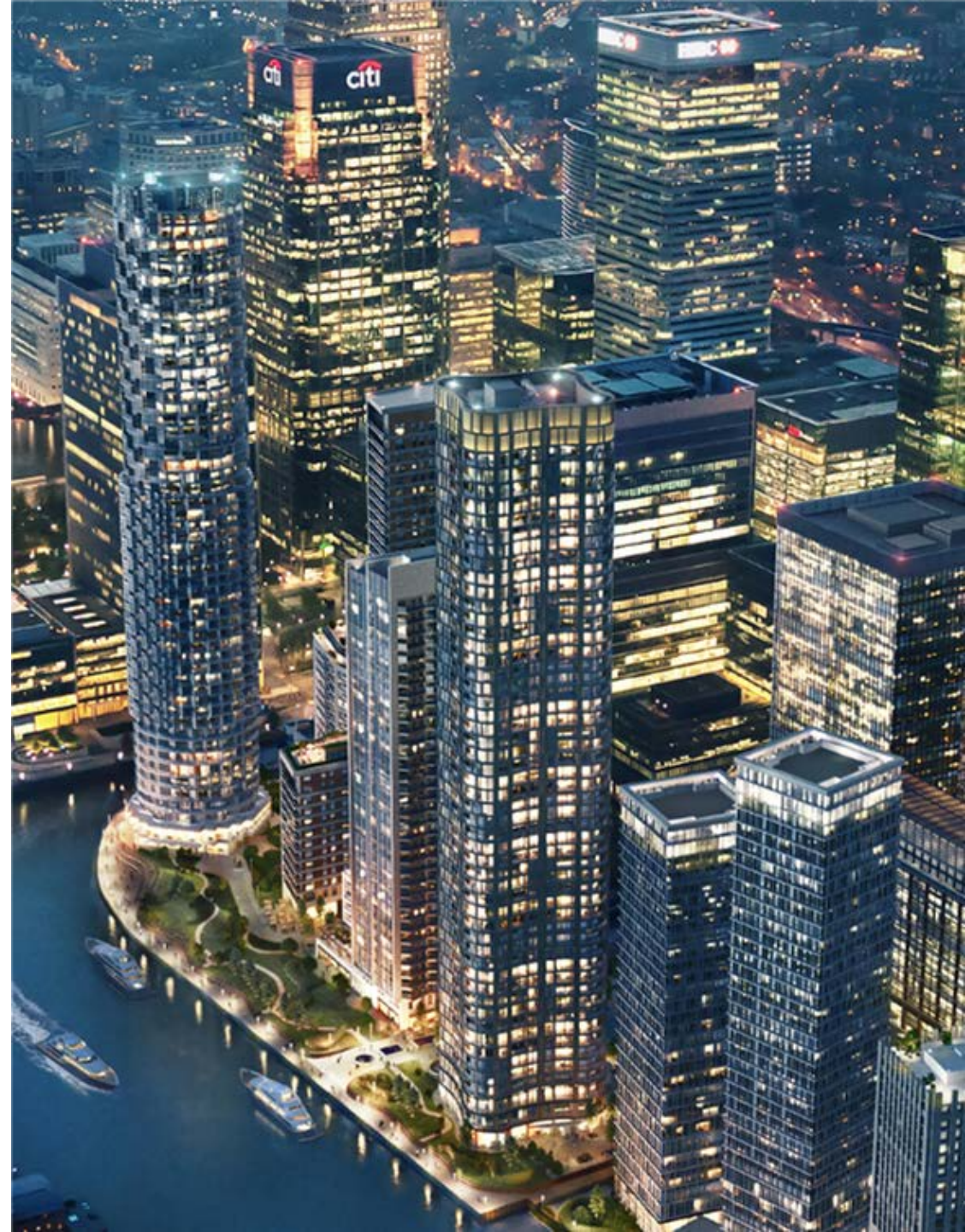


Residential high rise

Wood Wharf

Canary Wharf's new district, Wood Wharf, has been designed to provide a new residential led, mixed use, waterside community defined by the quality of its public spaces, the diversity of its land uses and activities, and its exemplary architecture.

Image courtesy of
Canary Wharf Contractors

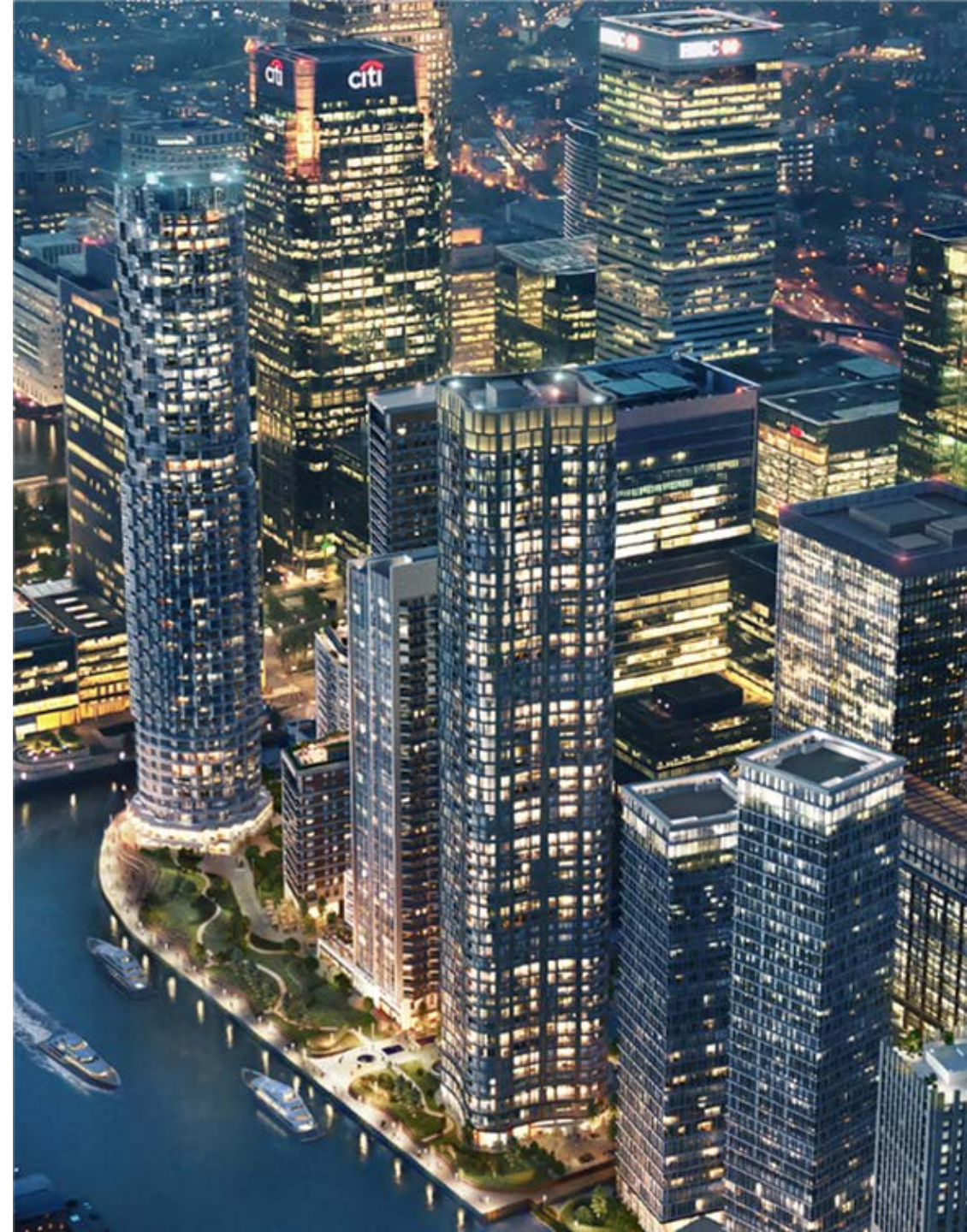


The masterplan, designed by [Allies and Morrison Architects](#), creates a strong and complementary mix of uses, providing over 3,300 new homes, nearly 2 million sq ft of high quality commercial office space, and a further 490,000 sq ft of shops, restaurants and community uses.

The buildings use a combination of [precast panels](#) by Laing O'Rourke and volumetric steel [bathroom pods](#).

Completion of the project is expected in [2023](#).

Image courtesy of
Canary Wharf Contractors



Non-residential

Non-residential buildings include offices, prisons, hospitals, and educational facilities, and typically have a high degree of repeatability ideal for offsite.

Additionally, the necessity for reduced time onsite frequently leads to the application of systems with higher levels of enhancement.

Offsite MEP systems are frequently applied, especially in hospitals, and can be easily integrated into existing buildings as well.

University of Nottingham building

Image courtesy of
Offsite Awards - SIP
Build UK





Velindre Cancer Centre – Post-graduate office building



Kindly provided by Wernick Buildings, Wales via CWIC

Retrofit

Due to the reduced amount of work to be complete onsite, offsite construction systems are well-suited for working with existing buildings, also known as retrofit.

During construction, these offer the benefits of reduced disruption to the surrounding area and continuation of operations as early as possible, due to the rapid onsite installation times.

Retrofit

Howden Hall Road, Edinburgh

- the house was reconfigured and turned back to front to create a new South/West facing open plan living, dining and kitchen area
- energy rating improvement: new modern high specification windows, additional insulation to the fabric (cavity wall, loft top up and under floor), energy saving measures (LED light bulbs, solar PV array and wood burning stove)
- new contemporary panelised sunroom
- innovative cantilevered glass box with glulam structure



Image courtesy of Prof Robert Hairstans

Infrastructure

A variety of offsite solutions can be applied in infrastructure, more frequently with the creation of bespoke systems and hybrid forms, due to the size of the construction.

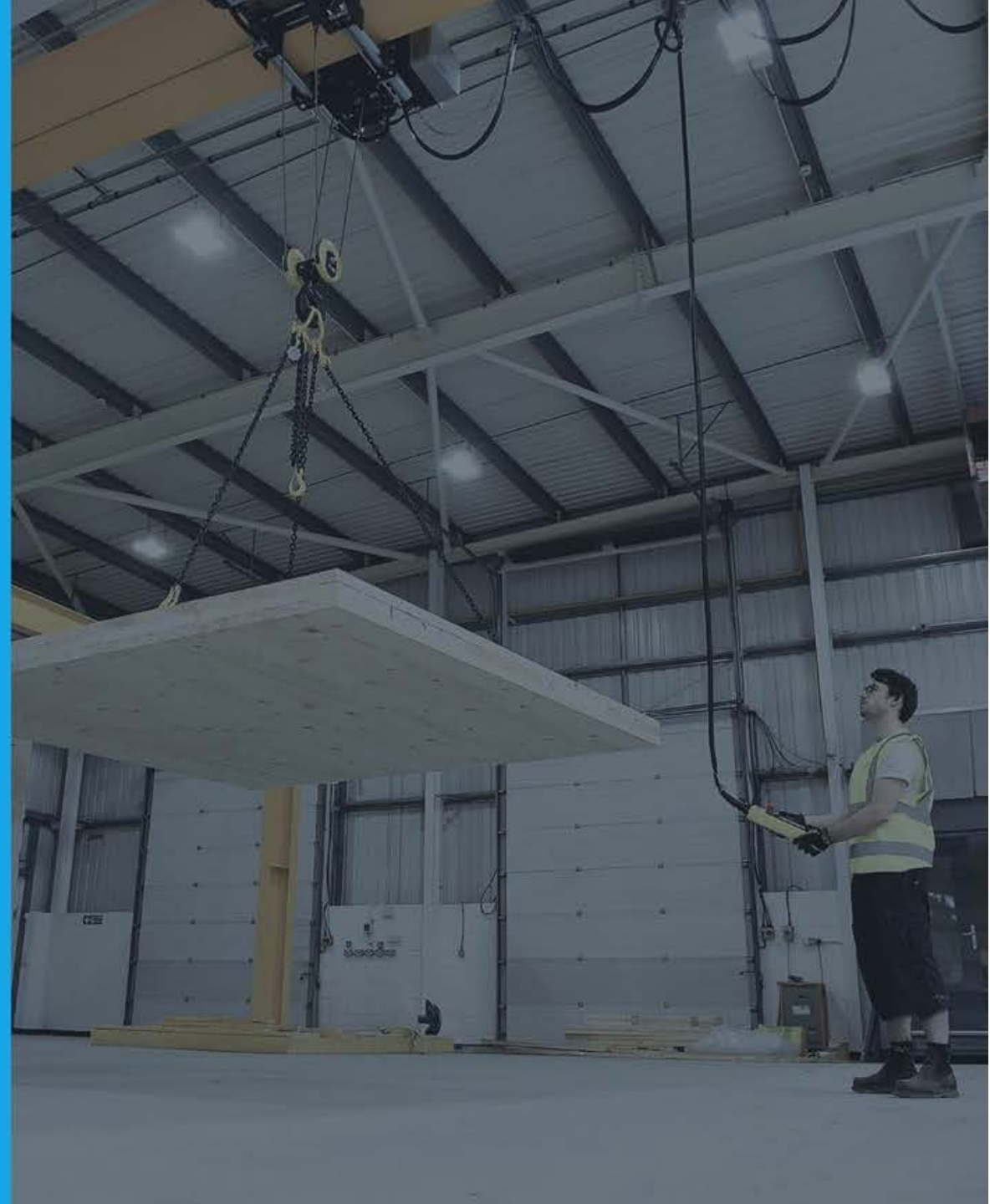
Infrastructures include bridges, roads, airports and train stations, which are constructed using mainly offsite steel and concrete elements.

Due to the scale of investment offsite construction can have a significant impact on the project parameters, and according to WPI economics use of offsite construction methods could reduce costs by 25% and time by 30%.

Image courtesy of
Offsite Awards -
COWI



1.2 Impact onsite if manufacturing is at fault



Possible issues

- **Dimensions** of the product do not meet specification
- **Floor slab or foundation** has not been constructed within the acceptable tolerances
- **Materials** used in manufacturing are different to those specified
- **Misaligned** connections for mains electricity and water
- **Thermal performance** is lower than required by the project

If discovered onsite, these issues will be costly to remediate as offsite products may need to be sent back to the factory.

Solutions

To prevent these issues it is critical to embed meta skills in offsite construction:

- Accuracy
- Adaptability
- Effective and ongoing communication
- Process improvement

Solutions

A fully integrated Building Information Model can help to ensure that there are no discrepancies and clashes between the offsite and onsite components of the project

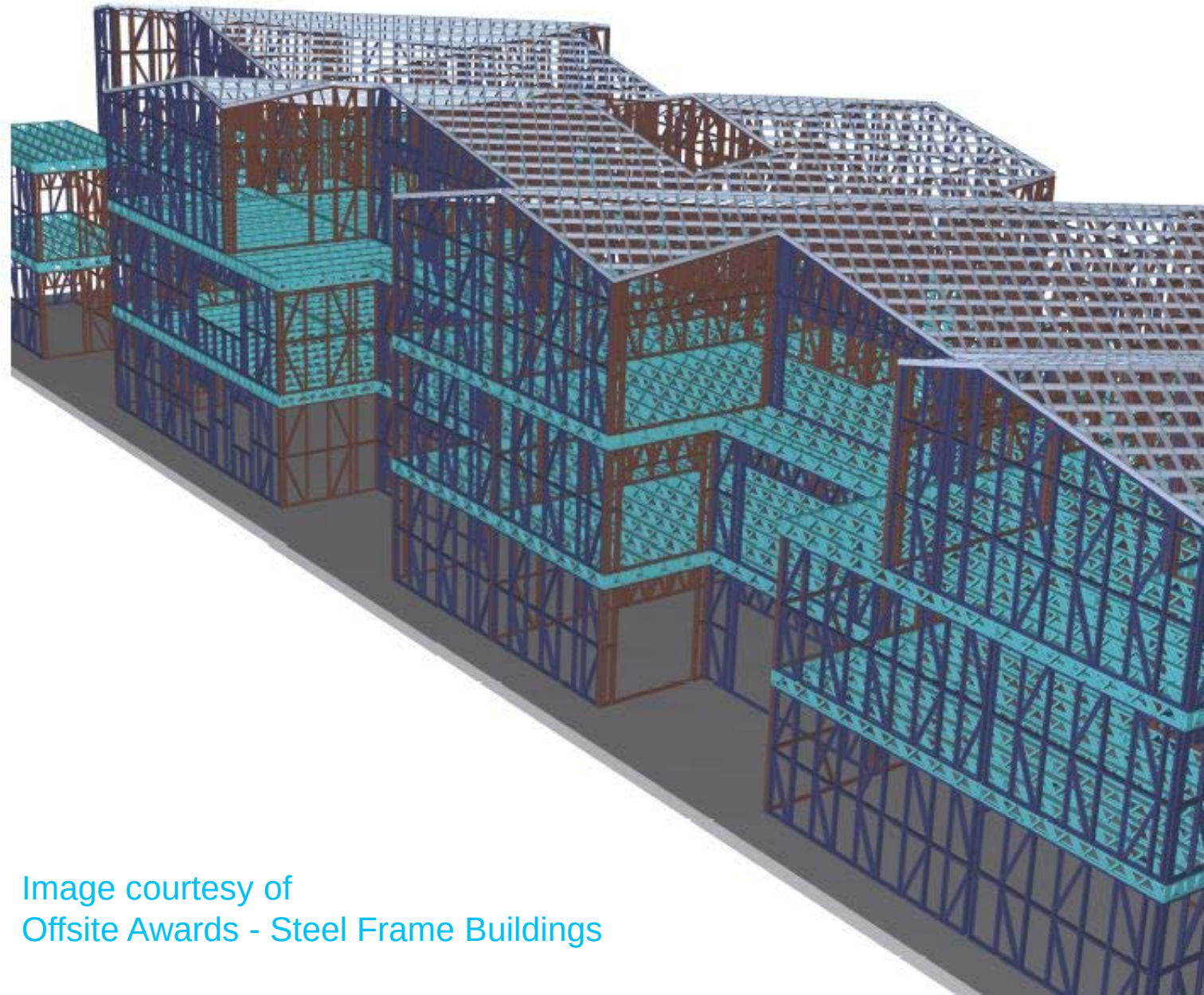
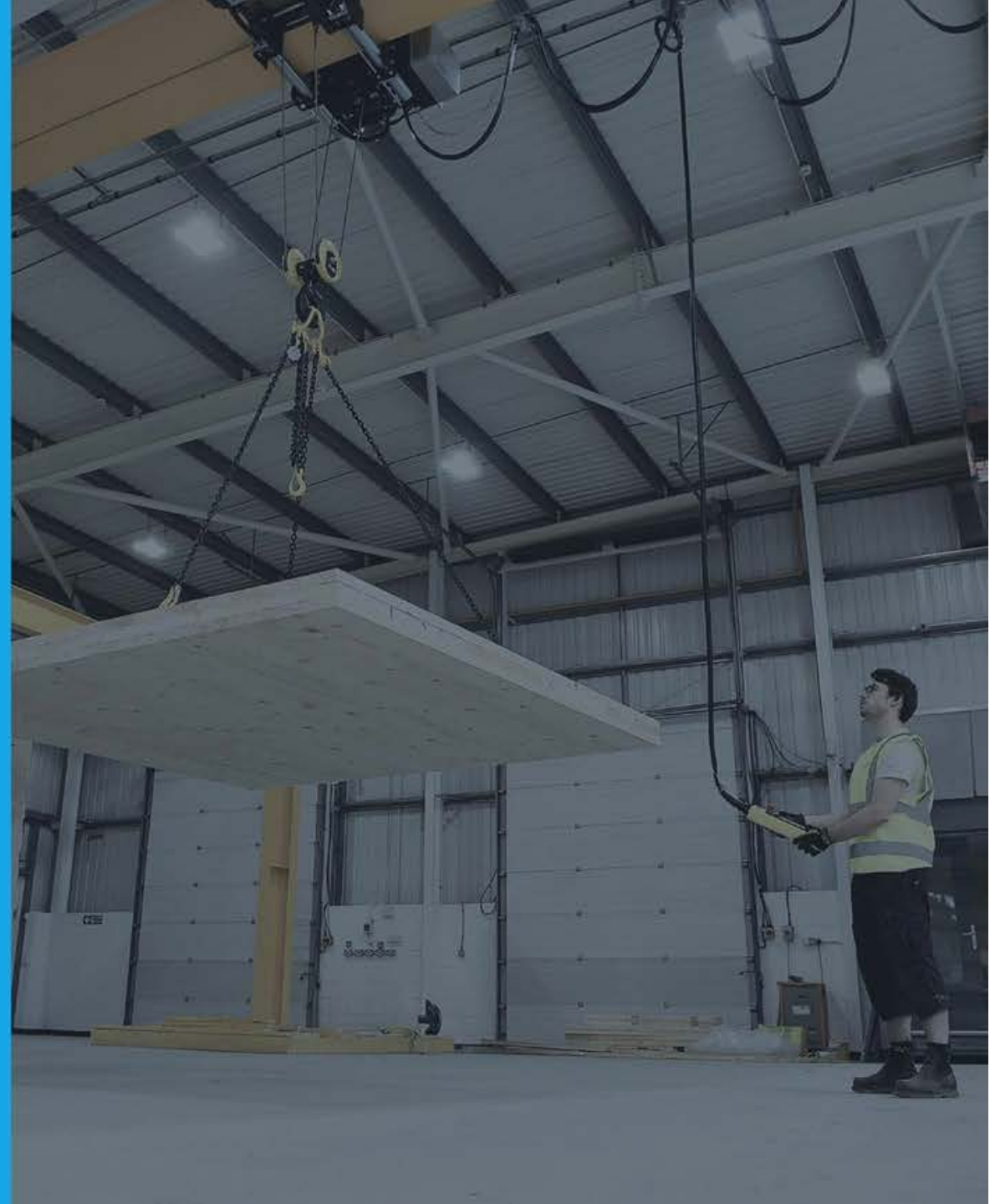


Image courtesy of
Offsite Awards - Steel Frame Buildings

1.3 Lean methodologies



Lean principles

Lean is a process improvement strategy centred around achieving customer requirements in a resource-efficient way.

5 process principles:

- Customer value
- Value chain
- Make the value flow
- Pull
- Perfection

+ eliminate process wastes: transportation, inventory, motion, waiting, over-production, over-processing, defects, skills misuse.



Lean tools

5S: it should be carried out by the people who use the work space to ensure usability; consists of 5 steps: sort, set, shine, standardise, sustain.

Visual management: involves easy to understand representations of work in progress, the status of each part of the work against the target dates, any challenges and how they are being resolved.

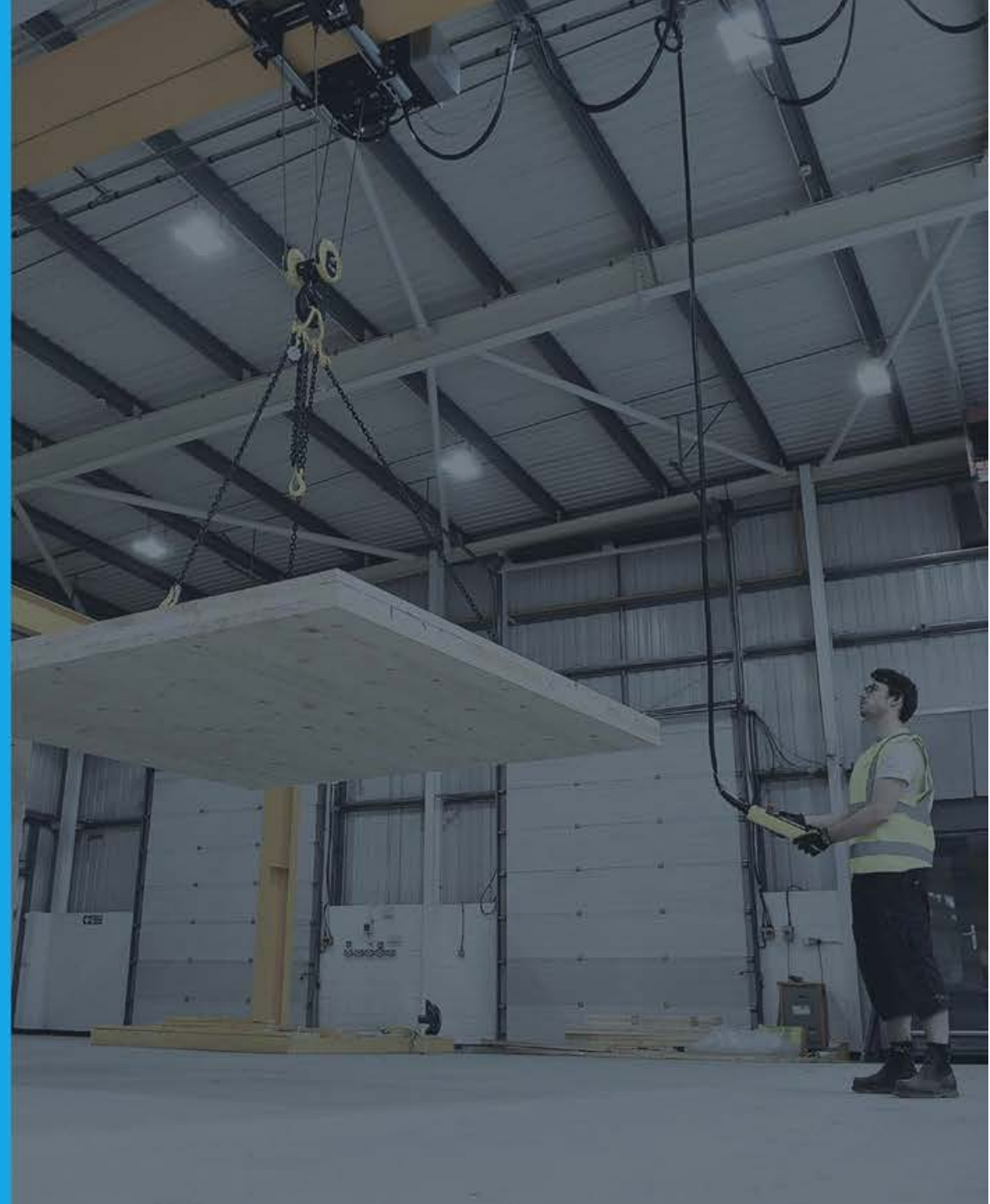
Process improvement: enabling resource-efficient organisational processes to reduce lead-in-times.





Lean planning whiteboard at Lindbäcks Bygg, Sweden (image courtesy of Duncheva, M. 2017)

1.4 Manufacturing processes



Offsite manufacture

Creation of elements in a factory environment provides opportunities for:

- consistency of process
- independence from adverse weather conditions
- improved efficiency
- reduced materials waste

Image courtesy of
Offsite Awards -
Dandara Group



Offsite manufacture

Key concepts:

- production control
- tolerances
- Just in Time (JIT)
- right first time

The manufacturing processes are typically enhanced by:

- lean techniques
- automation
- quality assurance
- safety management

Image courtesy of
Offsite Awards -
Dandara Group



Mass customisation

Important to achieving efficiencies in offsite projects is mass customisation, the combination of standard systems with varying assembly options to provide choice to the client whilst maintaining manufacturing process control.

Image courtesy of the
Construction Scotland
Innovation Centre



Levels of automation



Manual: performed by a human operator manually with a minimum of tools.



Mechanised: the worker employs mechanical assistance in performing an operation.

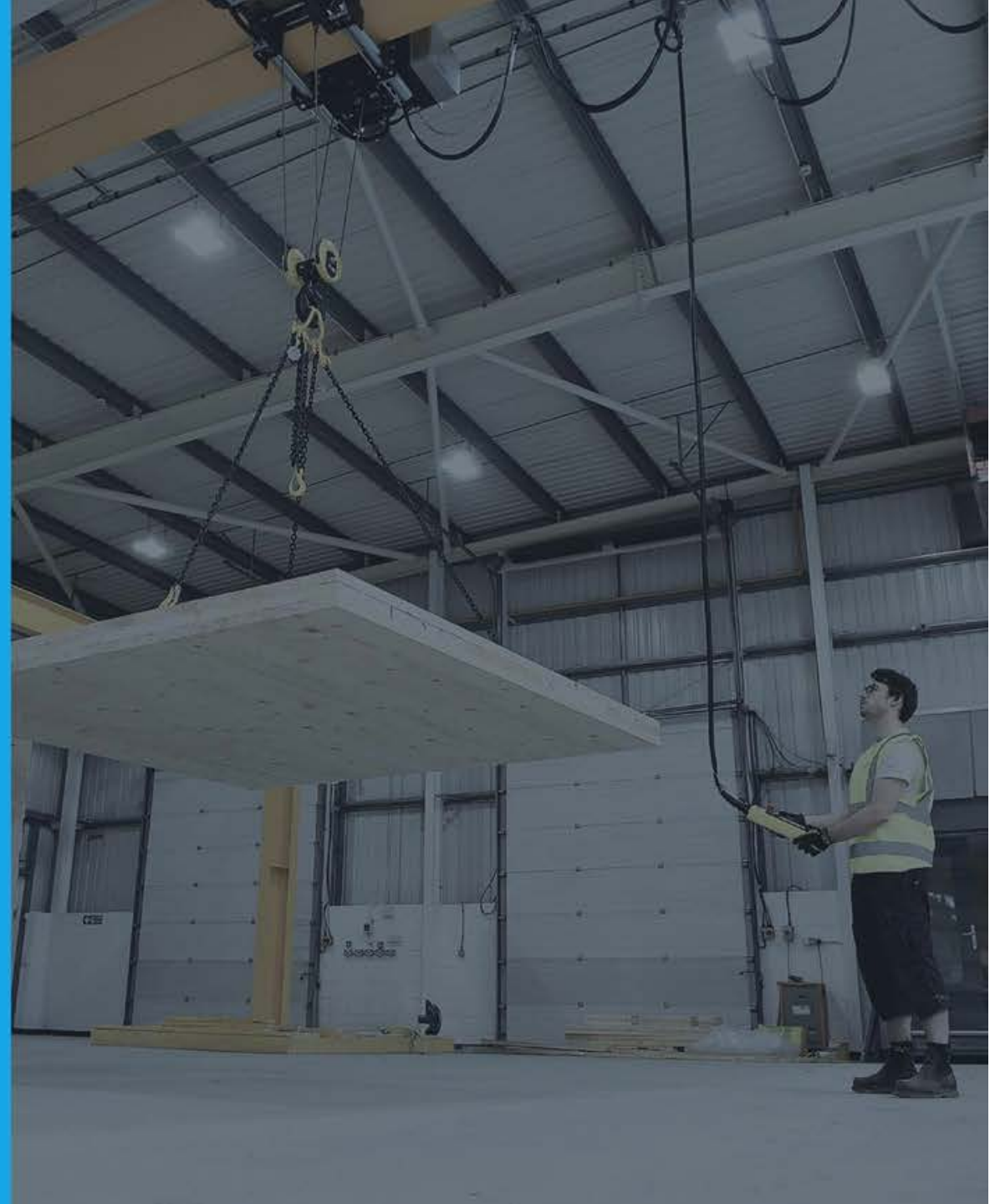


Semi-automated: a fixed program machine executes a sequence of operations and a human operator completes the task



Automated: under programmable control, a machine may execute a sequence of operations, without needing input from a human operator.

1.5 Order of sequence





RIBA Plan of Work 2020

Stage Boundaries:

Stages 0-4 will generally be undertaken one after the other.

Stages 4 and 5 will overlap in the **Project Programme** for most projects.

Stage 5 commences when the contractor takes possession of the site and finishes at **Practical Completion**.

Stage 6 starts with the handover of the building to the client immediately after **Practical Completion** and finishes at the end of the **Defects Liability Period**.

Stage 7 starts concurrently with Stage 6 and lasts for the life of the building.

Planning Note:

Planning Applications are generally submitted at the end of Stage 3 and should only be submitted earlier when the threshold of information required has been met. If a **Planning Application** is made during Stage 3, a mid-stage gateway should be determined and it should be clear to the project team which tasks and deliverables will be required. See Overview guidance.

Procurement:

The RIBA Plan of Work is procurement neutral – See Overview guidance for a detailed description of how each stage might be adjusted to accommodate the requirements of the Procurement Strategy.

ER Employer's Requirements
CP Contractor's Proposals

The RIBA Plan of Work organises the process of briefing, designing, delivering, maintaining, operating and using a building into eight stages. It is a framework for all disciplines on construction projects and should be used solely as guidance for the preparation of detailed professional services and building contracts.

	0	1	2	3	4	5	6	7
	Strategic Definition	Preparation and Briefing	Concept Design	Spatial Coordination	Technical Design	Manufacturing and Construction	Handover	Use
	Projects span from Stage 1 to Stage 6; the outcome of Stage 0 may be the decision to initiate a project and Stage 7 covers the ongoing use of the building.							
Stage Outcome at the end of the stage	The best means of achieving the Client Requirements confirmed If the outcome determines that a building is the best means of achieving the Client Requirements , the client proceeds to Stage 1	Project Brief approved by the client and confirmed that it can be accommodated on the site	Architectural Concept approved by the client and aligned to the Project Brief The brief remains "live" during Stage 2 and is derogated in response to the Architectural Concept	Architectural and engineering information Spatially Coordinated	All design information required to manufacture and construct the project completed Stage 4 will overlap with Stage 5 on most projects	Manufacturing, construction and Commissioning completed There is no design work in Stage 5 other than responding to Site Queries	Building handed over, Aftercare initiated and Building Contract concluded	Building used operated and maintained efficiently Stage 7 starts concurrently with Stage 6 and lasts for the life of the building
Core Tasks during the stage	Prepare Client Requirements Develop Business Case for feasible options including review of Project Risks and Project Budget Ratify option that best delivers Client Requirements Review Feedback from previous projects Undertake Site Appraisals See RIBA Plan of Work 2020 Overview for detailed guidance on Project Strategies	Prepare Project Brief including Project Outcomes and Sustainability Outcomes , Quality Aspirations and Spatial Requirements Undertake Feasibility Studies Agree Project Budget Source Site Information including Site Surveys Prepare Project Programme Prepare Project Execution Plan	Prepare Architectural Concept incorporating Strategic Engineering requirements and aligned to Cost Plan , Project Strategies and Outline Specification Agree Project Brief Derogations Undertake Design Reviews with client and Project Stakeholders Prepare stage Design Programme	Undertake Design Studies , Engineering Analysis and Cost Exercises to test Architectural Concept resulting in Spatially Coordinated design aligned to updated Cost Plan , Project Strategies and Outline Specification Initiate Change Control Procedures Prepare stage Design Programme Specialist subcontractor designs are prepared and reviewed during Stage 4	Develop architectural and engineering technical design Prepare and coordinate design team Building Systems information Prepare and integrate specialist subcontractor Building Systems information Prepare stage Design Programme Specialist subcontractor designs are prepared and reviewed during Stage 4	Finalise Site Logistics Manufacture Building Systems and construct building Monitor progress against Construction Programme Inspect Construction Quality Resolve Site Queries as required Undertake Commissioning of building Prepare Building Manual	Hand over building in line with Plan for Use Strategy Undertake review of Project Performance Undertake seasonal Commissioning Rectify defects Complete initial Aftercare tasks including light touch Post Occupancy Evaluation	Implement Facilities Management and Asset Management Undertake Post Occupancy Evaluation of building performance in use Verify Project Outcomes including Sustainability Outcomes Adaptation of a building (at the end of its useful life) triggers a new Stage 0
Core Statutory Processes during the stage:	Strategic appraisal of Planning considerations Planning Building Regulations Health and Safety (CDM)	Source pre-application Planning Advice Initiate collation of health and safety Pre-construction Information	Obtain pre-application Planning Advice Agree route to Building Regulations compliance Option: submit outline Planning Application	Review design against Building Regulations Prepare and submit Planning Application See Planning Note for guidance on submitting a Planning Application earlier than at end of Stage 3	Submit Building Regulations Application Discharge pre-commencement Planning Conditions Prepare Construction Phase Plan Submit form F10 to HSE if applicable	Carry out Construction Phase Plan Comply with Planning Conditions related to construction	Comply with Planning Conditions as required	Comply with Planning Conditions as required
Procurement Route	Traditional Design & Build 1 Stage Design & Build 2 Stage Management Contract Construction Management Contractor-led	Appoint client team	Appoint design team	ER CP Appoint contractor	ER CP Appoint contractor	ER CP Appoint contractor	ER CP Appoint contractor	ER CP Appoint contractor
Information Exchanges at the end of the stage	Client Requirements Business Case	Project Brief Feasibility Studies Site Information Project Budget Project Programme Procurement Strategy Responsibility Matrix Information Requirements	Project Brief Derogations Signed off Stage Report Project Strategies Outline Specification Cost Plan	Signed off Stage Report Project Strategies Updated Outline Specification Updated Cost Plan Planning Application	Manufacturing Information Construction Information Final Specifications Residual Project Strategies Building Regulations Application	Building Manual including Health and Safety File and Fire Safety Information Practical Completion certificate including Defects List Asset Information If Verified Construction Information is required verification tasks must be defined	Feedback on Project Performance Final Certificate Feedback from light touch Post Occupancy Evaluation	Feedback from Post Occupancy Evaluation Updated Building Manual including Health and Safety File and Fire Safety Information as necessary



RIBA Plan of Work 2020

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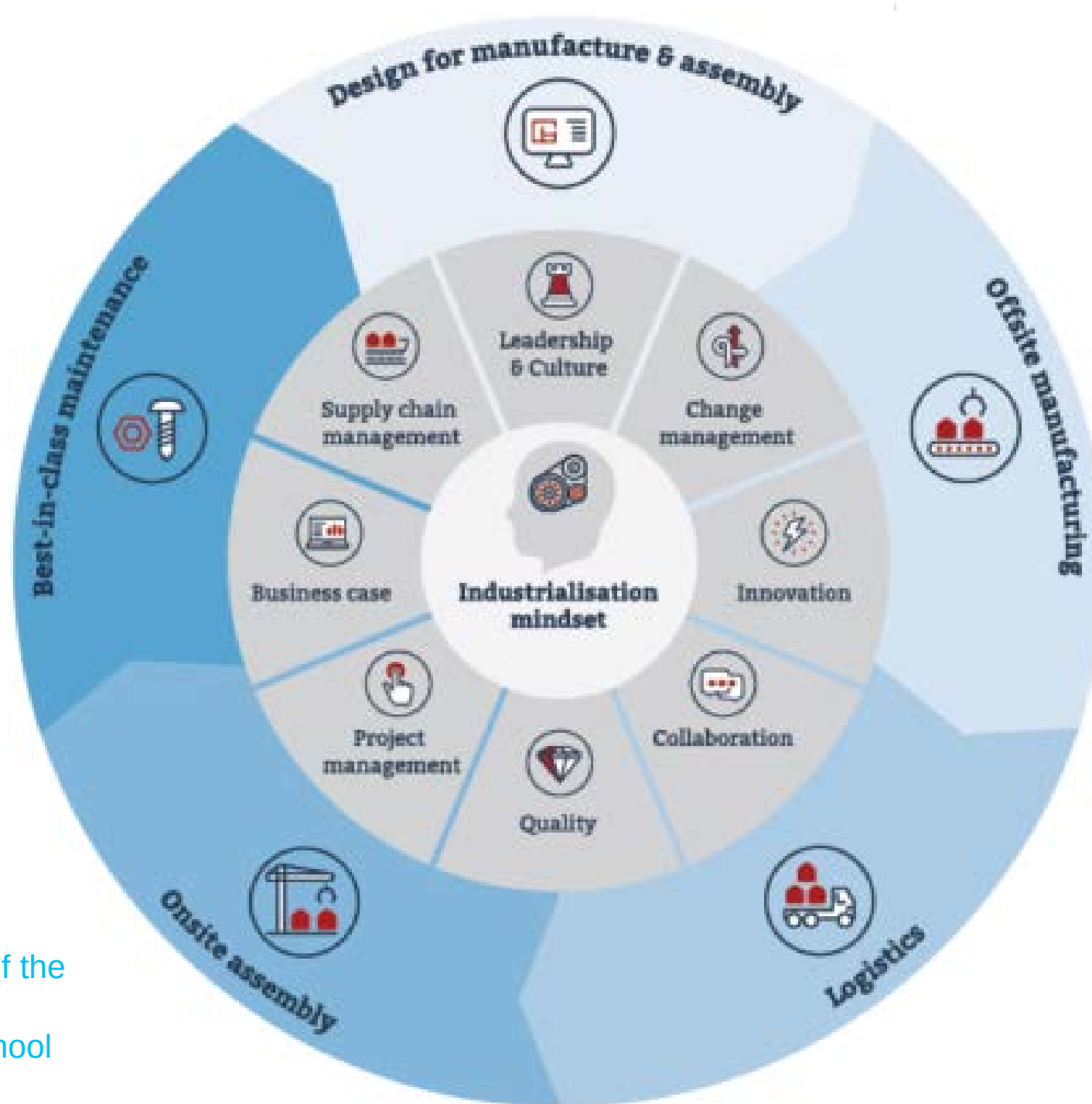


Image courtesy of the
Supply Chain
Sustainability School

Design considerations

The design process for offsite construction systems is often referred to as 'front-loaded'.

When designing according to DfMA principles the following aspects should be considered :

- Manufacturing process and standard sizing limitations
- Dimensional tolerances of the chosen offsite system
- Transportation restrictions
- Assembly process
- Supply chain
- Manufacturing capacity
- Site-specific restrictions

Manufacture

is the creation of elements in a factory environment, before being transported and assembled on site. The factory provides a controlled environment with some inherent benefits, such as consistency of process, independence from adverse weather conditions, improved efficiency and reduced waste.

Image courtesy
of CCG OSM



Logistics

Logistics can be defined as the point of connection between onsite and offsite activities.

This function is mainly about coordination and integration of multiple activities.

Image courtesy of
Carbon Dynamic



Onsite assembly

Assembly refers to the placement of offsite products in their designated location onsite and connection with the remaining structure.

Depending on the level of enhancement that is reached in the factory, assembly varies from the location of fully fitted volumetric elements that need little additional work, to the installation of open panels or sub-assemblies that need to be completed with internal/external linings, windows and doors and MEP services.

Image courtesy of Eurban

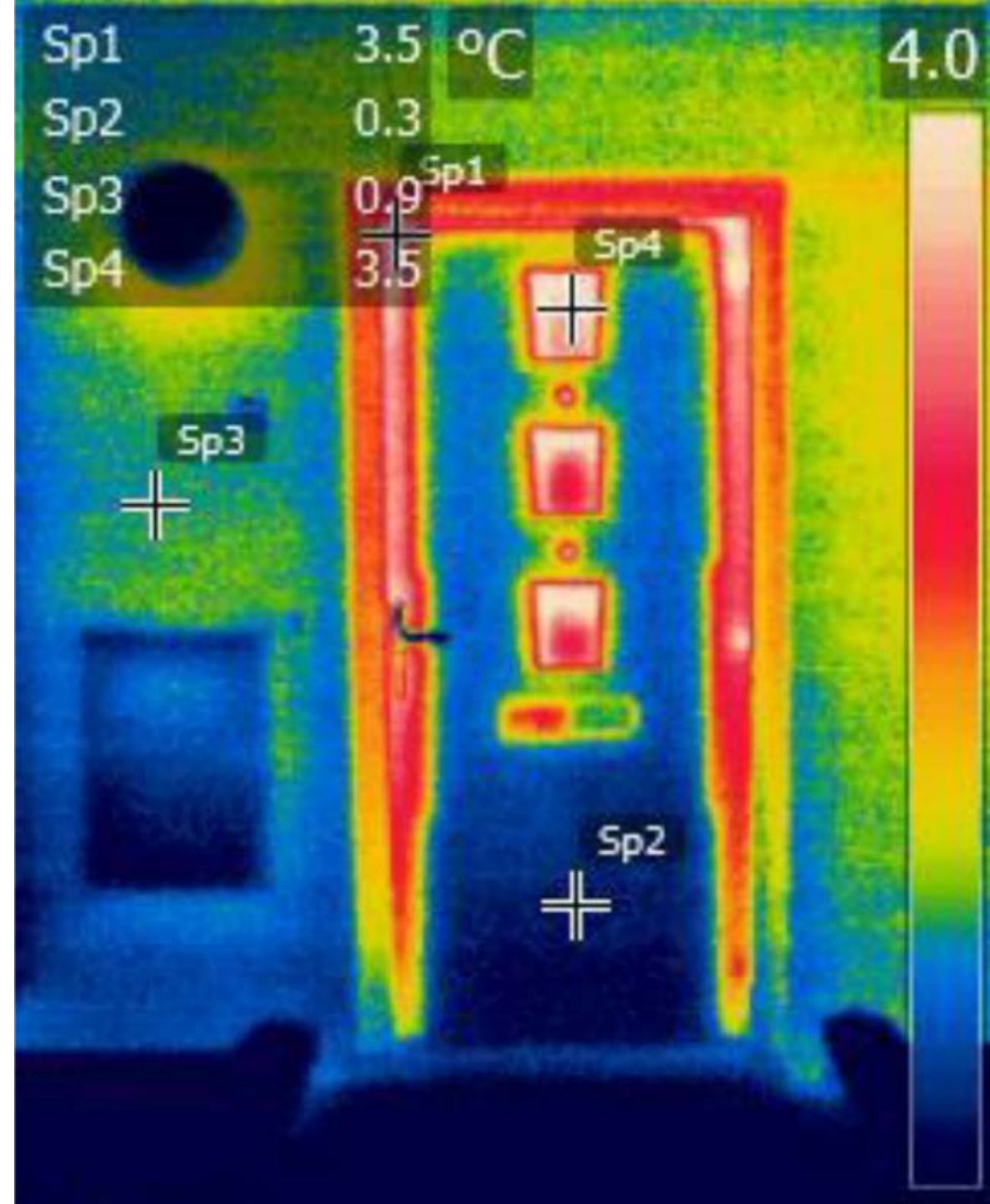


Design for maintenance

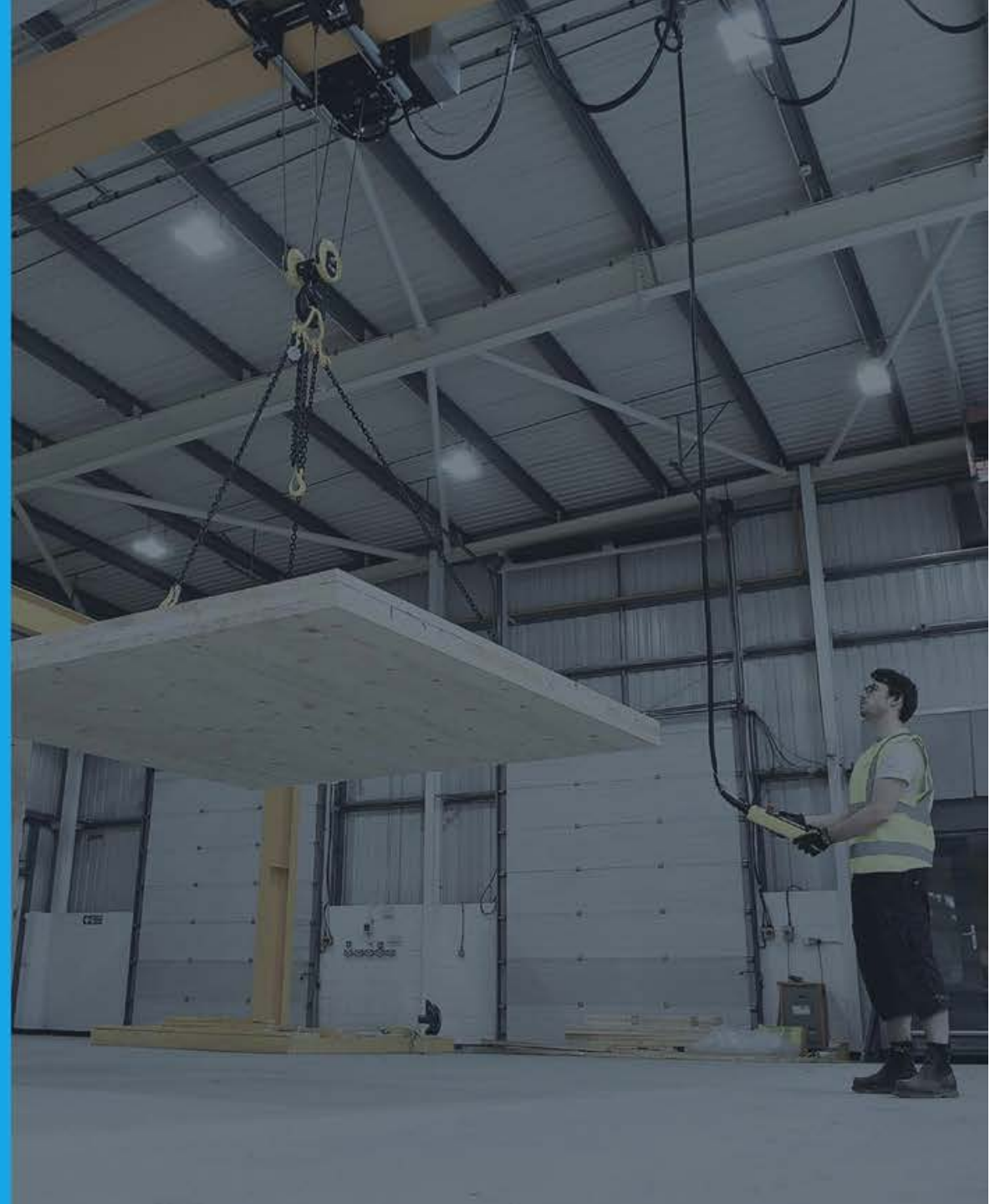
The production of building elements in a factory environment guarantees a higher level of performance and consequent ease of maintenance.

Thanks to the accurate design and the support of monitoring technologies, it's possible to predict the behaviour of the building and plan repairs and maintenance accurately.

Image courtesy of
Scottish Energy Centre



1.6 Quality assurance

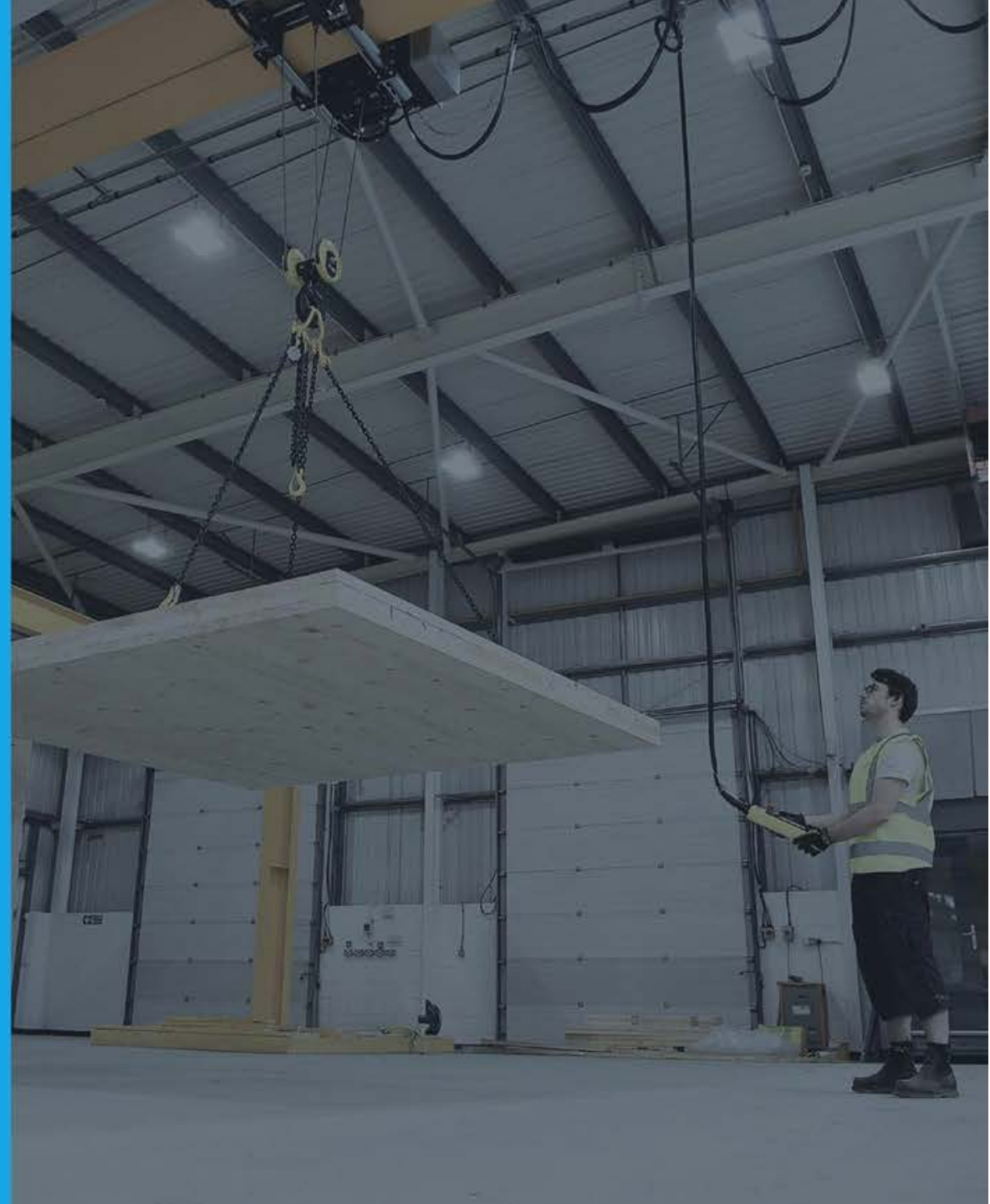


Quality assurance is integral to manufacturing environments and offsite manufacturers tend to comply with ISO 9001 Quality Management Systems, as well as other industry-specific standards and accreditations.

In addition, materials regulated by a harmonised European Standard need to have a CE mark to demonstrate compliance with the relevant manufacturing standards.



1.7 Codes and standards



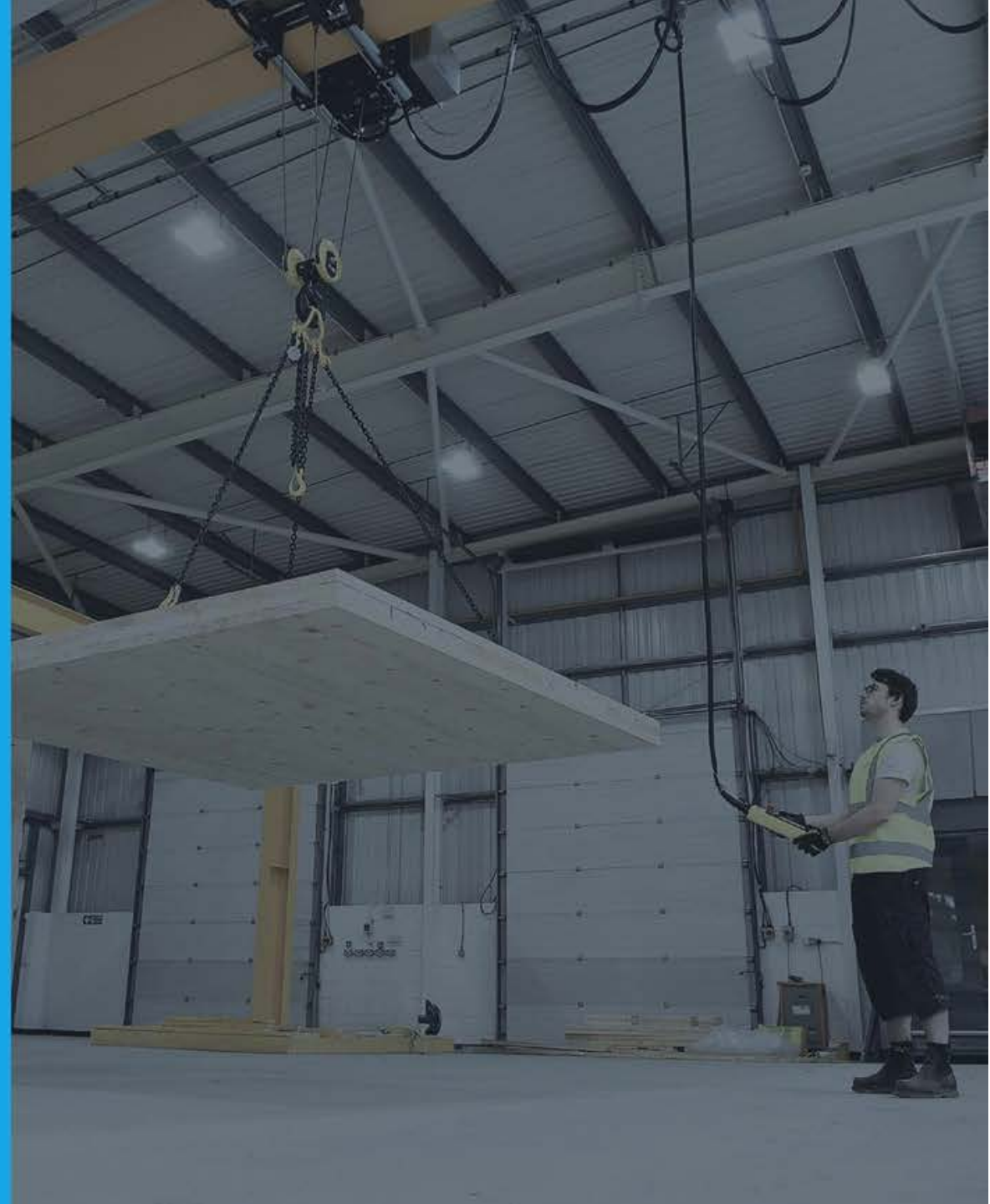


Standards and regulations

Not all standards are suitable for the offsite approach and many of the applicable ones are out of date.

1. ISO 45001: occupational health and safety management.
2. BS EN ISO 14001:2015: specifies requirements for an environmental management system.
3. BREEAM: environmental assessment method and rating system for buildings.
4. BS EN ISO 19650-1: Organization and digitization of information about buildings and civil engineering works, including building information modelling.
5. RIBA Plan of Work: identifies the key stages of project development.
6. ISO BS 10007:2017 – Quality management systems guidelines for configuration management.
7. BS 5606:1990 – Guide to accuracy in building.
8. BS EN 1090-1:2009 – Steel and aluminium structures.

1.8 Full range of materials and systems



Steel



- particularly suitable for large-scale projects where large spans need to be covered
- 'dry' method: results in a clean work environment and a quick onsite assembly



- transportation can become a challenge
- components cannot be easily modified
- steel has a high thermal conductivity: detail design and insulation installation need to be particularly accurate to avoid thermal bridging



- corrosion is a risk

Concrete



- removes the need for 'wet' construction with associated curing times
- opportunity for buildings with special security and durability requirements (prisons, infrastructures, etc)



- components are heavy: associated health and safety risks
- usually includes only the concrete structure; the remaining work needs to be arranged and synchronised on site



- Transportation issues; remote locations can become a barrier

Timber



- high environmental credentials (e.g. carbon capture)
- good thermal performance and air-tightness

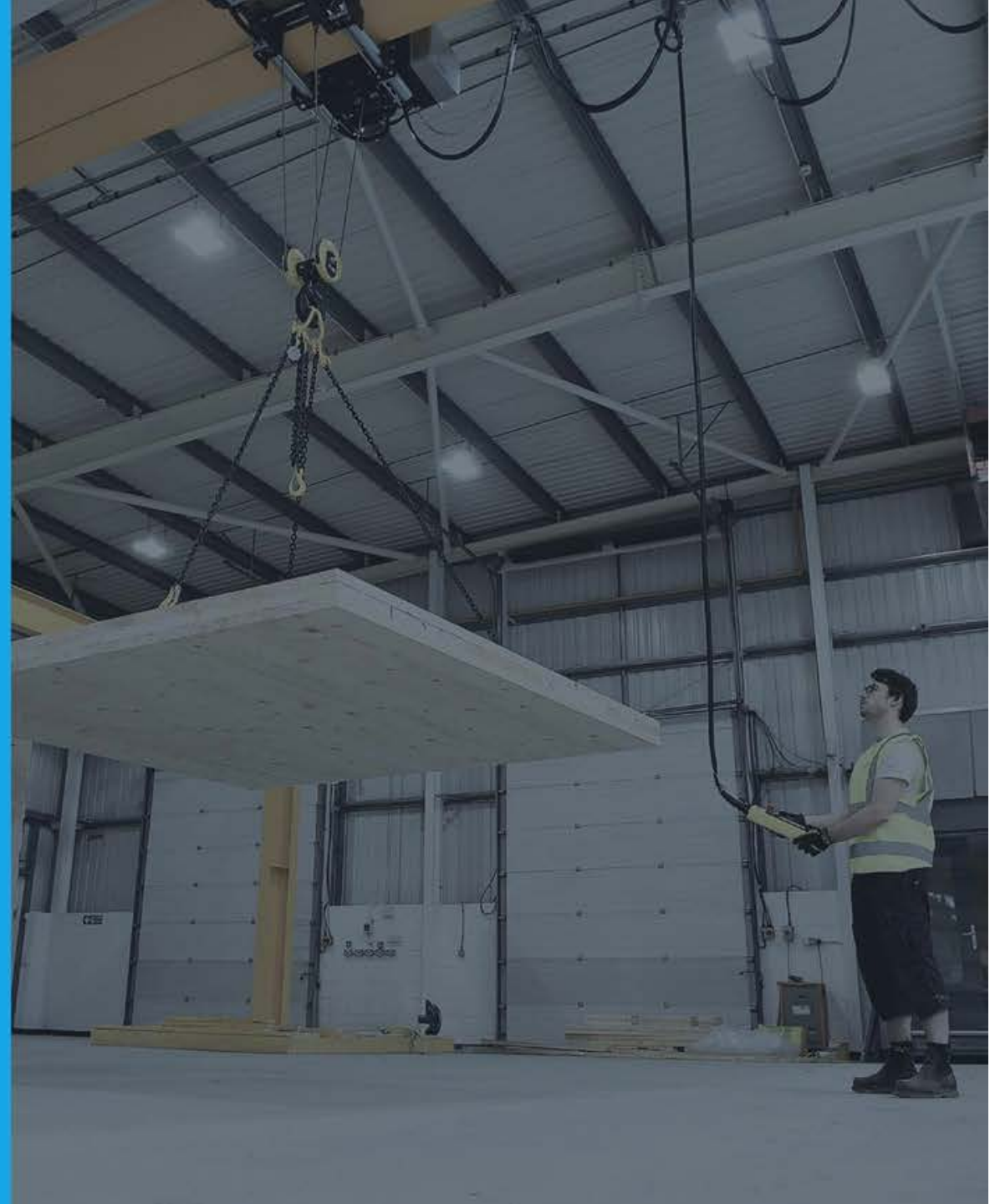


- special attention needs to be taken when designing with timber, because of its natural properties, which can result in differential movement due to changes in its moisture content



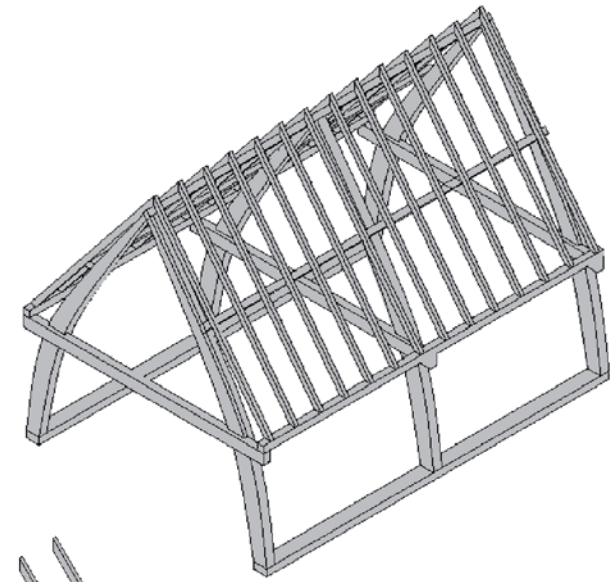
- fire regulations prescribing the use of non-combustible materials can be a barrier

History of offsite construction



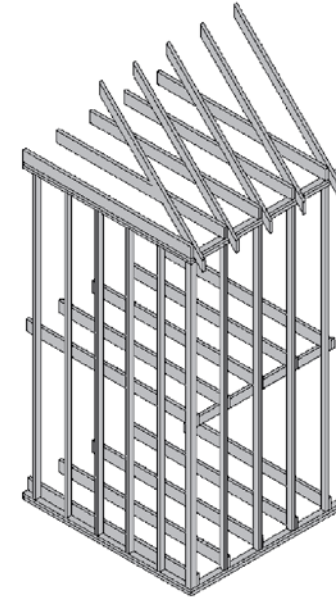
Middle Ages

Cruck frame: Carpenters would often assemble the frames of buildings in their yards to ensure that all the elements fitted together. The frames were then marked and dismantled to be transported to the site and reassembled.



19th Century

Timber balloon frame: With the North American population rapidly expanding, the pressure to build new homes resulted in the invention of 'Balloon Frame Construction', a 2- or 3-storey high vertical timber frame that supports the roof and floor joists.



Timber platform frame: Platform frame derives from the balloon frame and is built floor-by-floor, with single-storey vertical frames supporting the floor and upper structure.

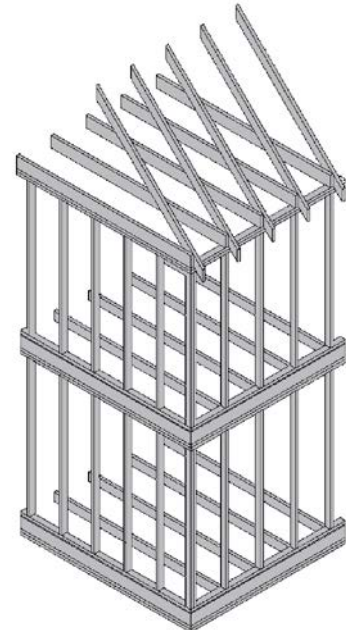
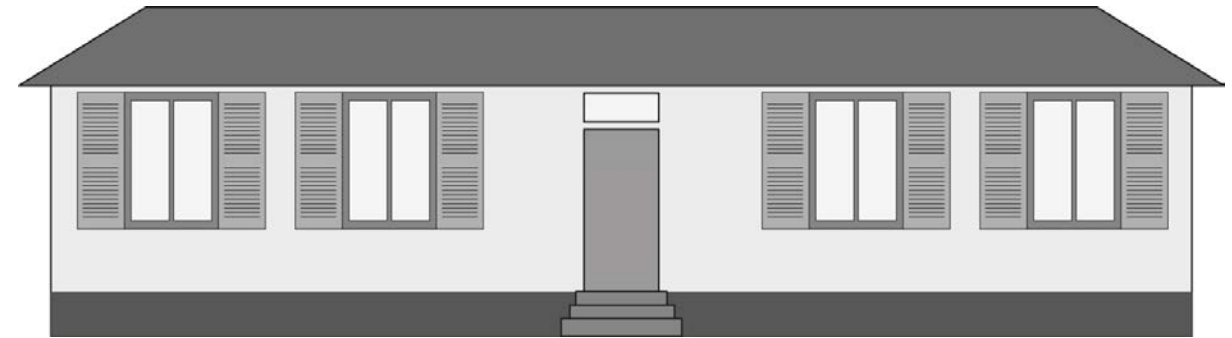


Image courtesy of
Prof Robert Hairstans

Before the World Wars

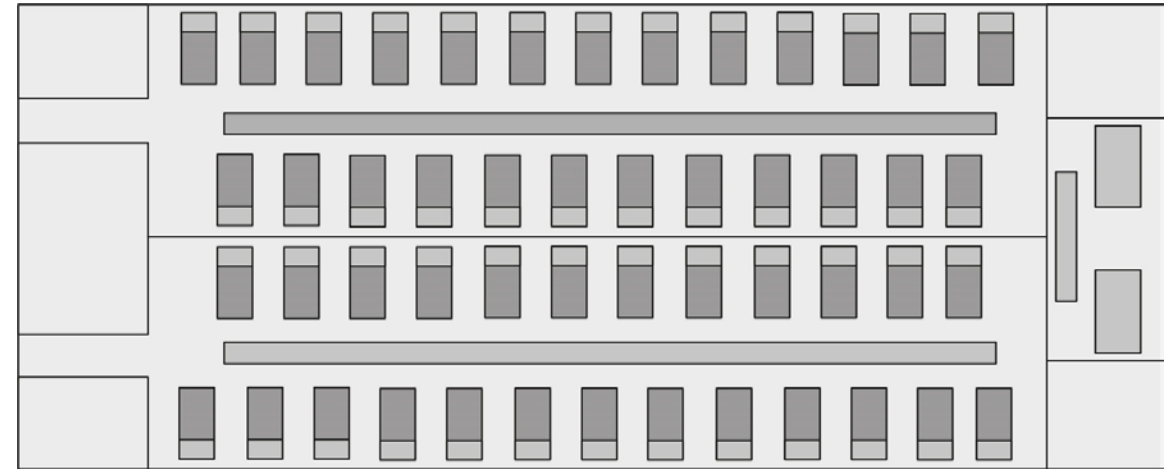
Manning Cottage: Due to colonial expansion, it became necessary for buildings to be produced, packaged and dispatched in large quantities to all corners of the world. John Manning, a London carpenter and builder, embraced the key concepts of offsite construction by producing the Manning cottage, a timber house that was standardised for efficiency and designed to facilitate transport and assembly by unskilled workers.



Historic building
illustrations Image courtesy
of Carola Calcagno

Before the World Wars

Renkioi Hospital: During the Crimean War, British engineer Isambard Kingdom Brunel designed and constructed the Renkioi Hospital on the coast of Dardanelles, Turkey. The timber frame structure was designed and produced in the UK, flat-packed, shipped and assembled onsite by unskilled workers in under 6 months.



Before the World Wars

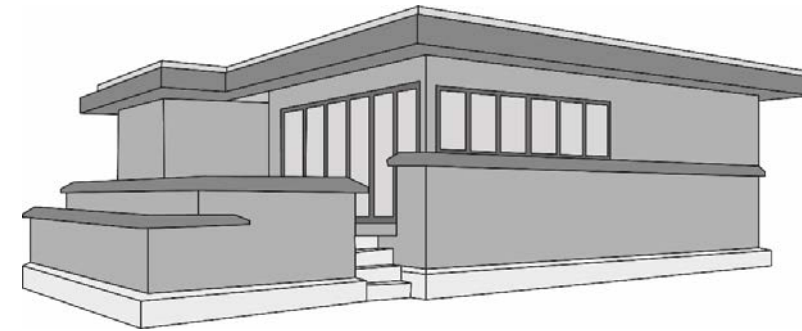
Eldon Street: Liverpool city engineer J.A. Brodie experimented with concrete wall panels and floor slabs, which were pre-cast for rapid onsite installation. These were first applied in the house on Eldon street in 1903. Trade unions opposed the idea heavily and UK pre-cast panel production did not advance much further at the time.



House type-based prefabrication: Architect F.L. Wright realized 7 houses, in partnership with the developer Arthur Richards, in order to make well-designed housing more affordable and accessible.

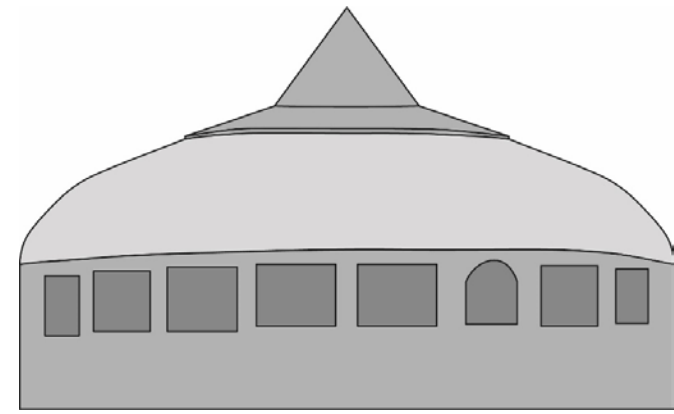
The Richards Company's pre-cut lumber were sold via a car dealership-like model, shipped and assembled in the field, allowing for more a precise structure.

WWI material shortage marked the decline of this project.

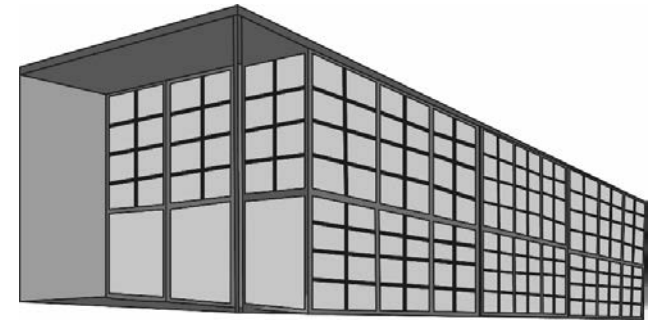


Post WWII

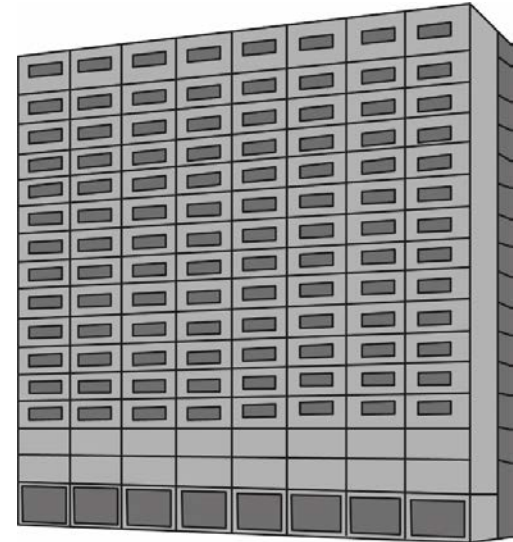
Dymaxion House – B. Fuller: self-sufficient single family dwelling that could be mass produced and flat-packaged. The house was to be constructed in aluminium and provided with wind turbines and water cisterns.



Eames House – C.&R. Eames: built for the Case Study House Program which focused on the use of new material and technologies developed during WWII. The project makes use of prefabricated materials.

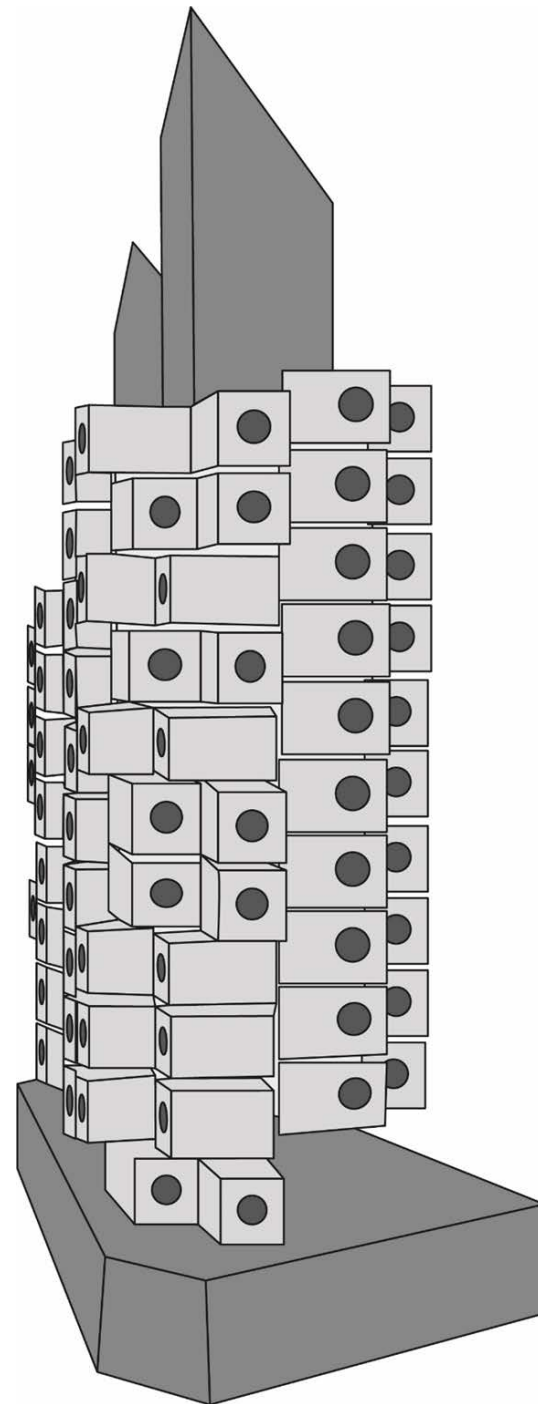


Camus pre-cast panelised systems: patented in 1948 the system was produced around the globe and developed in different forms. Camus system with a steel frame was extensively used in high-rise UK residential construction.

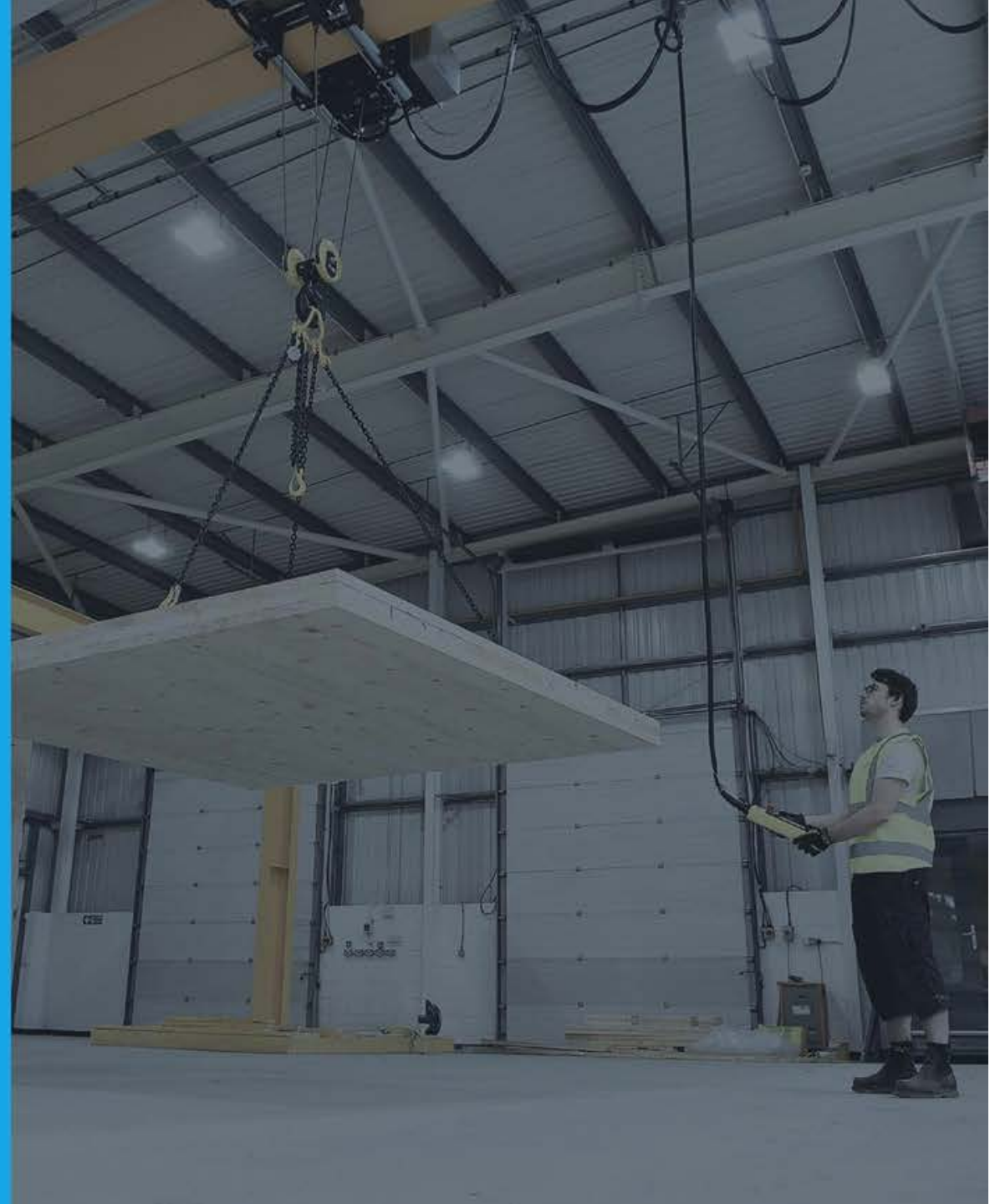


Post WWII

Nakagin Capsule Tower – K. Kurokawa:
created to house traveling business men;
represents the first example of capsule
architecture. Each module can be plugged in
to the central core and replaced/exchanged.
All pieces of the pods were manufactured in
a factory then transported to the site by truck.



Summary



Offsite construction

Offsite is a construction method that adds substantial value to a product via the manufacture and pre-assembly of components, elements or modules in a factory, before installation into their final location.

Image courtesy of
Offsite Awards - Mott
MacDonald



Four main categories of offsite construction:

Panelised systems



Volumetric systems



Can be made out of any typical construction material: concrete, steel, timber or hybrid

Sub-assemblies and components



Hybrid systems



Benefits

the factory environment provides a cleaner and safer place of work. The production is more efficient and performance are enhanced, with consequent reductions in costs.

the factory environment guarantees higher quality, more predictable product behaviour, better performance and little defects, with consequent higher customer satisfaction.



the optimised use of materials and the opportunity to carry some operations at the same time allows for time savings and reduction of waste. Additionally, the use of BIM and automation ensures flexibility.

Applications
of offsite
construction
include all
construction
sectors



Image courtesy of CCG (Scotland) Ltd

Image courtesy of
Offsite Awards -
COWI



Offsite order of sequence

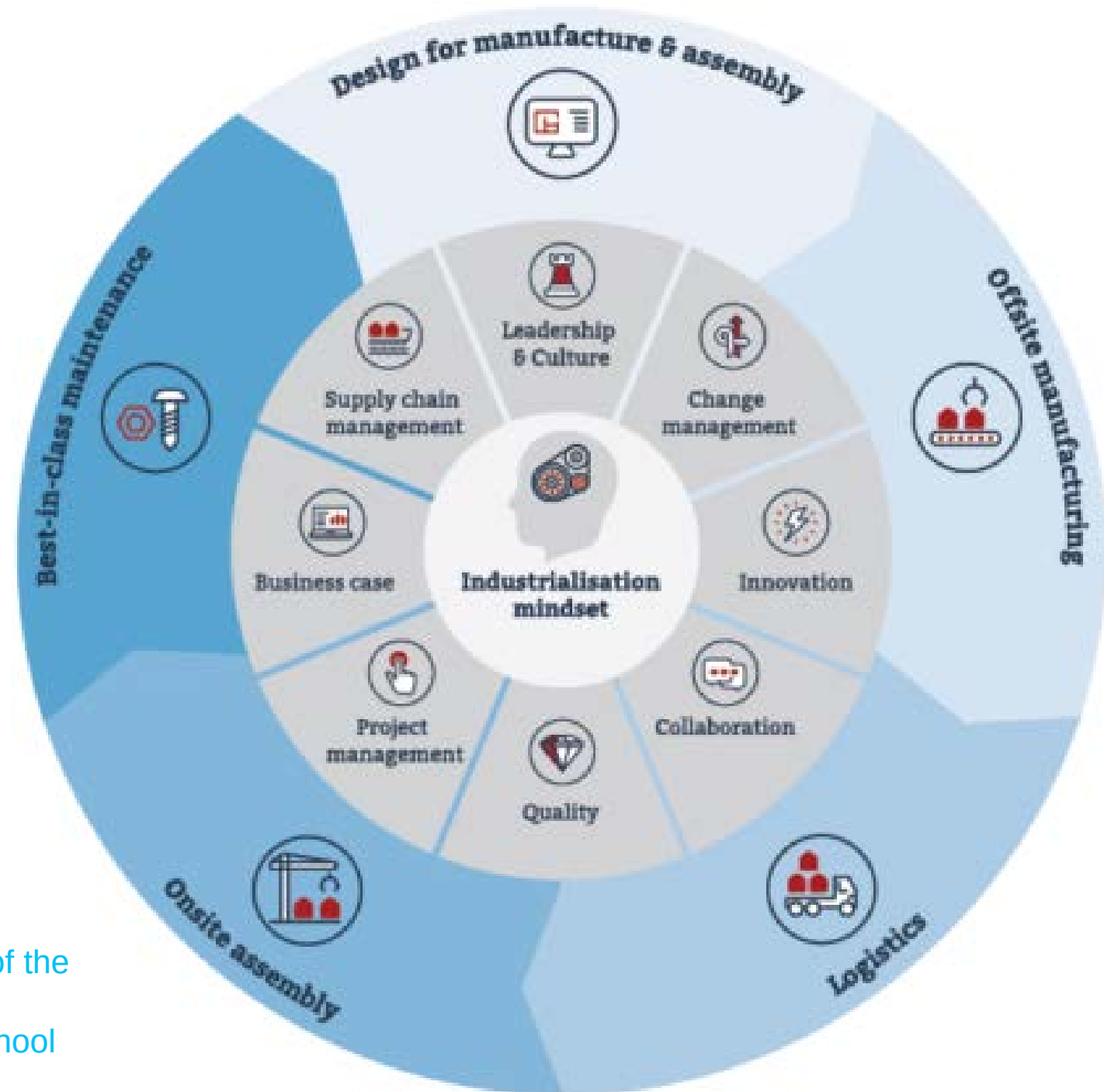


Image courtesy of the
Supply Chain
Sustainability School

Questions?

Dr Mila Duncheva,
Edinburgh Napier University

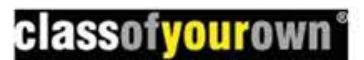




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Assessment 2

Submission
deadline:

22nd January 2021

Module Learning Outcomes (from module syllabus)

- Identify the different types of substructure available for a range of low-rise building systems and techniques used in their production.
- Define and produce annotated sketches that illustrate a broad range of common constructional forms, demonstrating understanding of their potential defect and repair needs.



APPENDIX GA36a

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:		Student ID number:	
Programme:	Construction Portfolio		
Module:	Fundamentals of Construction Technology		
Module code:	ACBA4001	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Gavin Traylor	Internal Verifier:	Allan Nantel
Assignment Title:	New Build Dwelling: Technical report with drawings	Word count (or equivalent):	2,500 words (or equivalent)
Submission deadline:	Friday 22 nd January	Return date of provisional marks & written feedback:	Within 20 working days
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

- Identify the different types of substructure available for a range of low-rise building systems and techniques used in their production.
- Define and produce annotated sketches that illustrate a broad range of common constructional forms, demonstrating understanding of their potential defect and repair needs.

Assessment 2

Submission
deadline:

22nd January 2021

New Build Dwelling: Technical report with drawings (weighting 100%)

Scenario:

You have been approached by Miss A Client who has received planning consent for her single, two storey detached domestic building. [See attached floor plans and elevations].

It is to be built on a level but reclaimed site, which prior to advanced ground works had been used as agricultural land. There is a retaining wall structure to the south of the site and the Ground Investigation report suggests a suitable raft foundation be constructed for the property.

The building is a timber framed construction where the inner skin of the 'cavity wall' is 140mm thick insulated C16 timber frame. The outer skin consists of stack bonded facing brick work and blockwork with a smooth render finish. Additional PIR insulation is contained within the cavity to improve the thermal performance. There is to be an insulated ground floor with underfloor heating in the screed with upper floors to be traditional solid timber with tongue and groove softwood flooring.

Windows and external doors are to be powder coated aluminium with triple-glazed units.

Roof structure is to be trussed rafters with a metal profile sheeting finish installed on OSB sheathing boards.

The client has asked you to prepare a technical report that addresses some of the construction details required as they are unfamiliar with timber frame construction. Your technical report should be graphical and contain the tasks highlighted below:

Assessment 2

Submission
deadline:

22nd January 2021

*The following tasks are allocated a percentage to emphasise the suggested **time** you should spend on each individual task. Marks will be allocated against the set Marking Criteria indicated on page 5.*

1. Produce **neatly drawn, proportionate and suitably annotated sections and sketches** that illustrate the materials and methods for the detailing of the following building elements and construction inter-faces. Ensure that detailing shows how the design will meet the current **Building Regulations for a domestic new-build**:

The Ground floor Construction, detailing and junctions with external walls. (20%)

The First floor Construction, detailing, junctions with external walls and restraints. (20%)

Eaves detailing and roof covering – indicating appropriate weathering, fixing and laps. (20%)

The main roof **structure**. Construction, detailing and fixing. (20%)

2. Given the specified roof structure and finish describe the advantages and disadvantages of such a method. Give an example of an alternative method of construction and describe what advantages or disadvantages that it may have. (10%)

3. Appropriate ventilation can play an important part of the design of a domestic building and is even more critical when considering a timber framed construction. Clearly describe the causes and sources of condensation, and the detrimental effects of condensation upon building fabric. (5%)

Using neat, annotated, proportional sketches where necessary, describe the appropriate methods of ventilation that will reduce condensation within this proposed building. (5%)

Assessment 2

Guidance specific to this assessment:

Submission
deadline:

22nd January 2021

Engagement with Literature Skills

Where techniques are suggested in the report make reference to the sources such as the Building Regulations and Good Practice. Use sources such as the CIS.

Knowledge and Understanding Skills

Demonstrate your understanding of the methods and techniques. This will be assessed by the depth and awareness of a professional context within this scenario.

Cognitive and Intellectual Skills

Demonstrate your knowledge and skills and present the work in a coherent and professional manner. This will also be assessed by the quality of your evaluation and conclusions.

Practical Skills

This will be assessed via the scenario and how your knowledge has been applied.

Transferable Skills for Life and Professional Practice

The report and drawings should be presented in a professional manner with all work clearly labelled and cross-referenced.

STUDENT FEEDBACK FORM		
This section details the extent to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.		
Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	10	
2. Knowledge and Understanding Skills	25	
3. Cognitive and Intellectual Skills	25	
4. Practical Application Skills	25	
5. Transferable Skills for Life and Professional Practice	15	
Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate) Up to 1 week late (10% loss) Over 1 week late (20% loss)	%

Assessment 2

Submission
deadline:

22nd January 2021



FRONT VIEW



FRONT VIEW

Your sketches not images

1. Produce neatly drawn, proportionate and suitably annotated sections and sketches that illustrate the materials and methods for the detailing of the following building elements and construction interfaces. Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build:

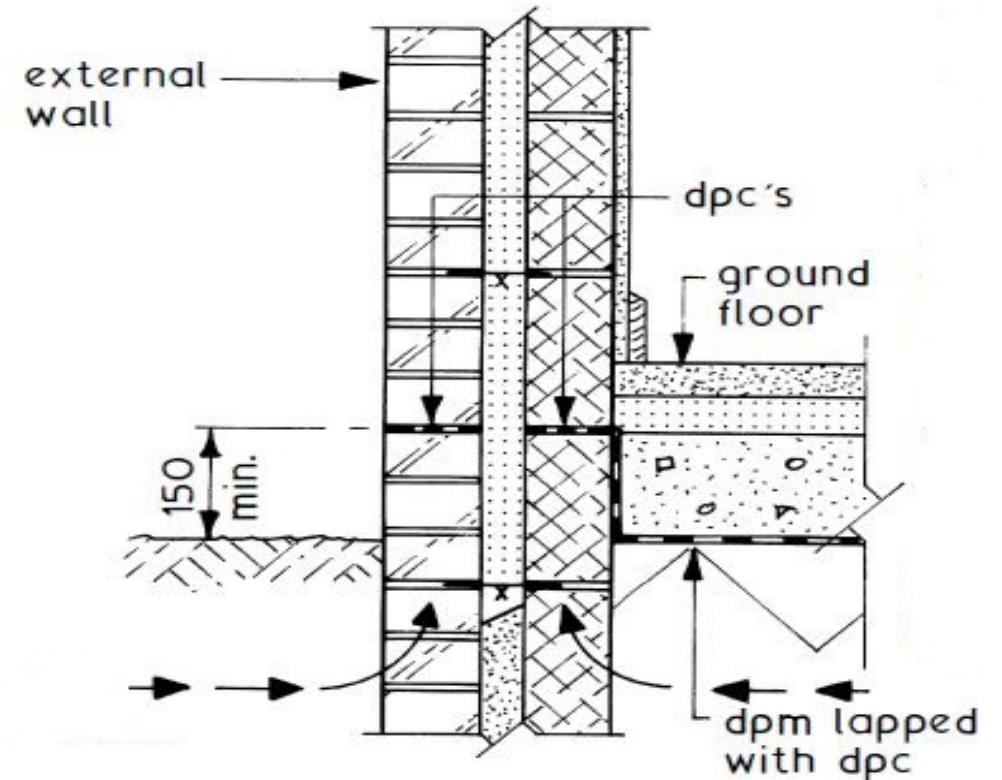
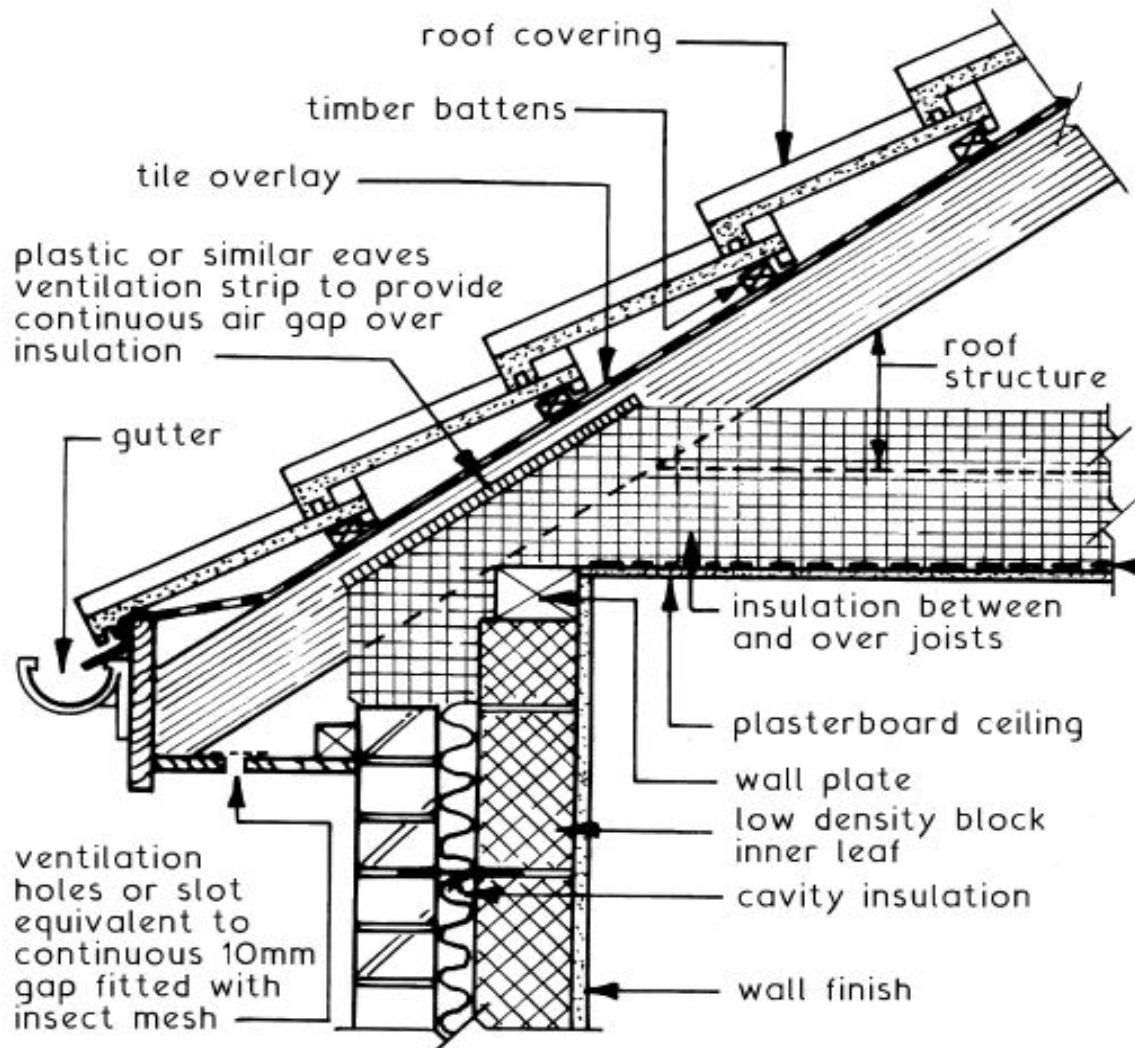
The Ground floor Construction, detailing and junctions with external walls. (20%)

The First floor Construction, detailing, junctions with external walls and restraints. (20%)

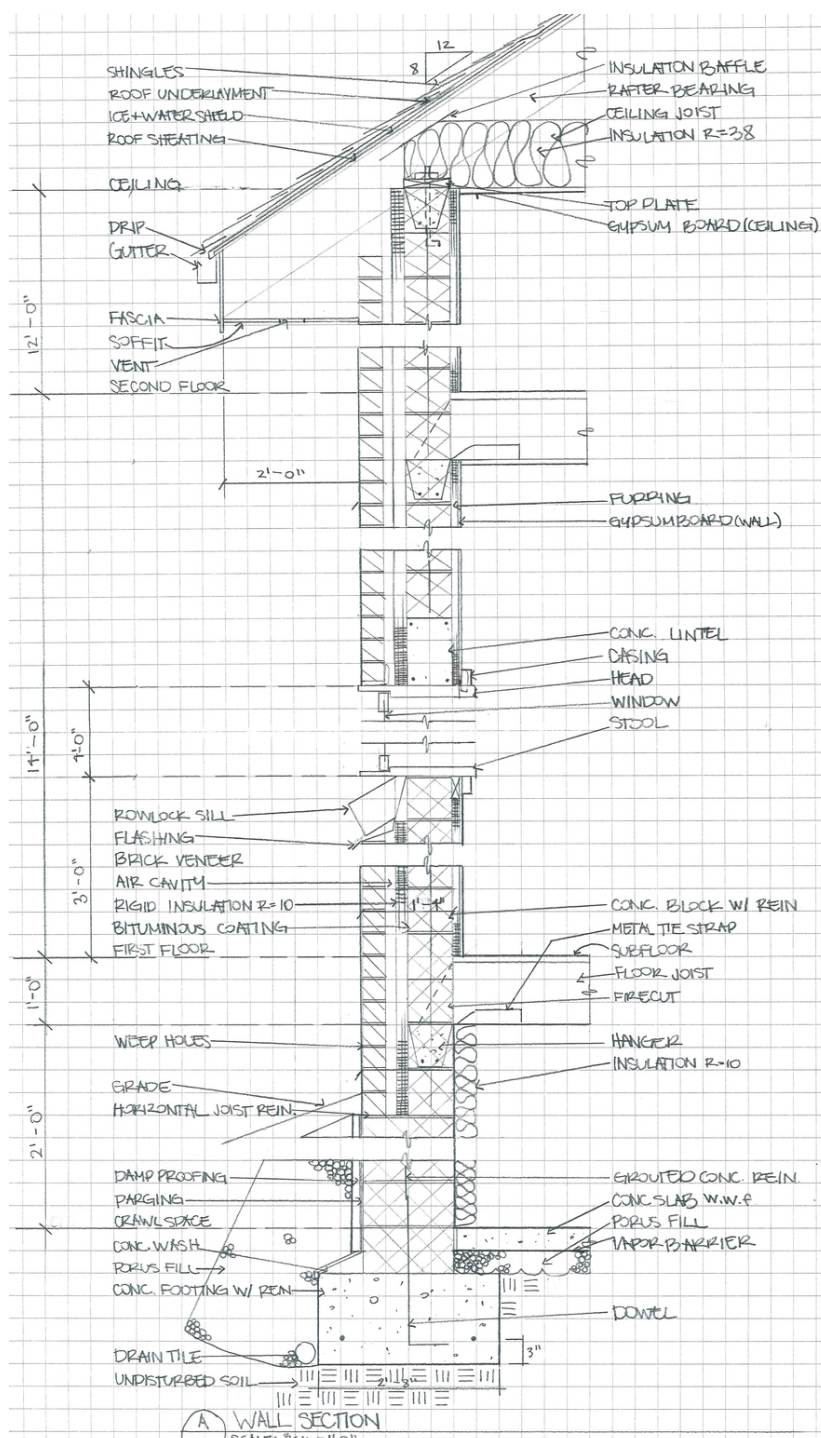
Eaves detailing and roof covering – indicating appropriate weathering, fixing and laps. (20%)

The main roof **structure**. Construction, detailing and fixing. (20%)

Your sketches not images

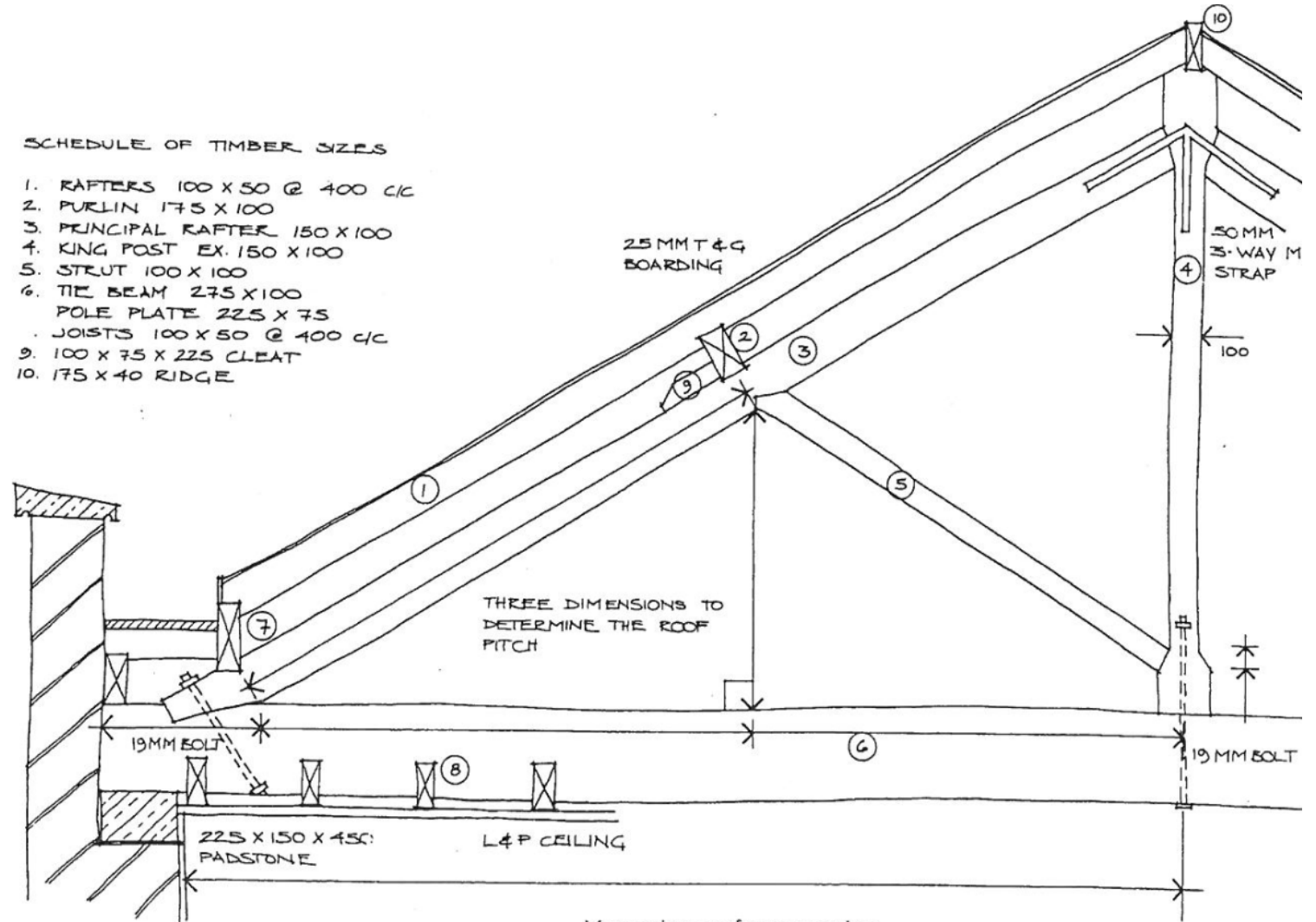


sketches not images



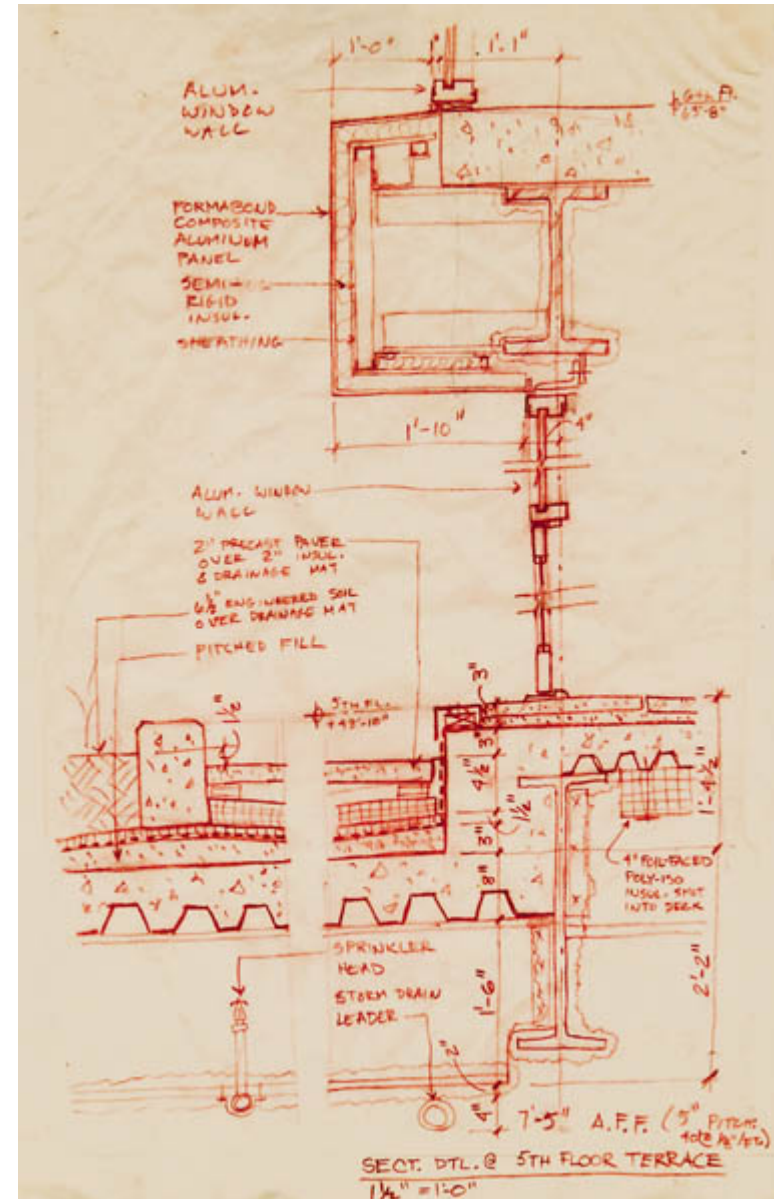
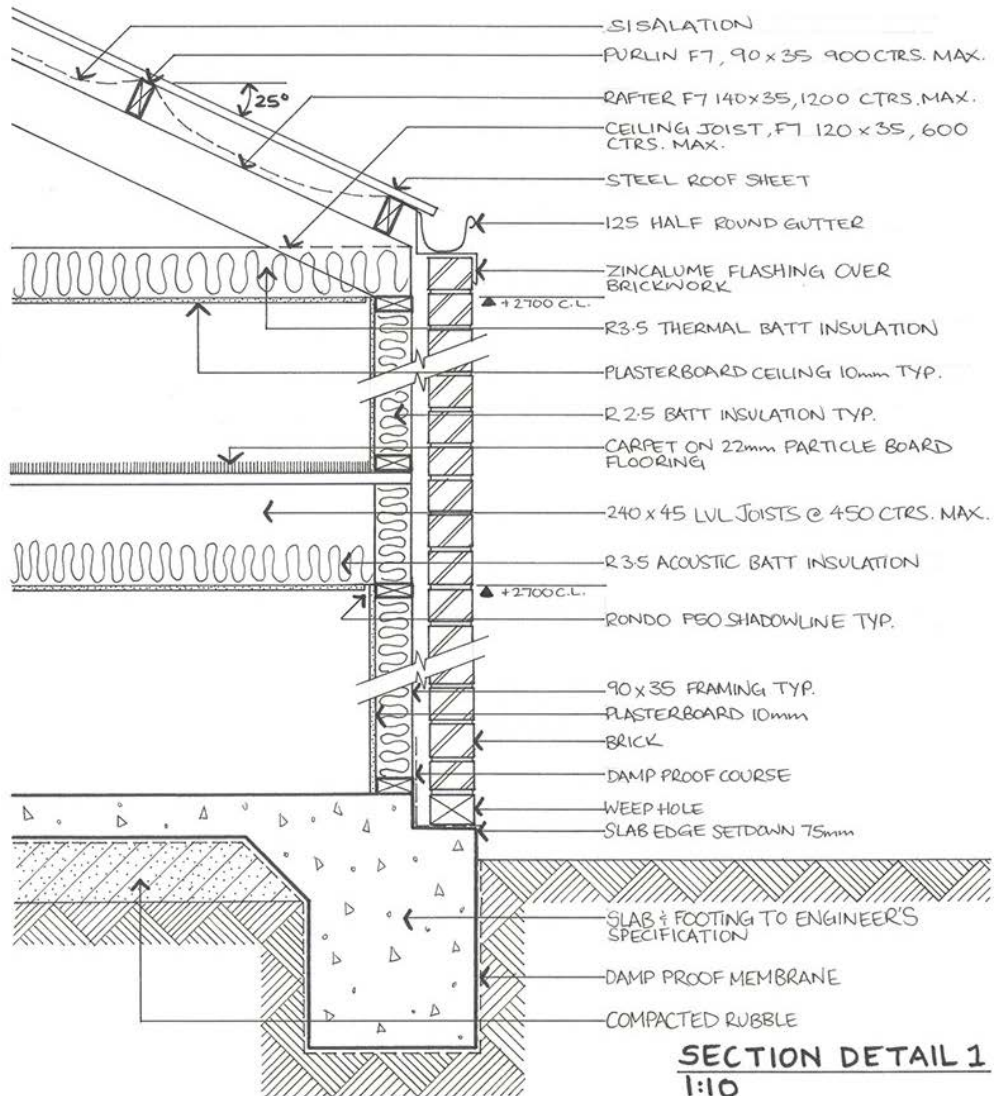
SCHEDULE OF TIMBER SIZES

1. RAFTERS 100 X 50 @ 400 C/C
2. PURLIN 175 X 100
3. PRINCIPAL RAFTER 150 X 100
4. KING POST EX. 150 X 100
5. STRUT 100 X 100
6. TIE BEAM 275 X 100
POLE PLATE 225 X 75
JOISTS 100 X 50 @ 400 C/C
9. 100 X 75 X 225 CLEAT
10. 175 X 40 RIDGE

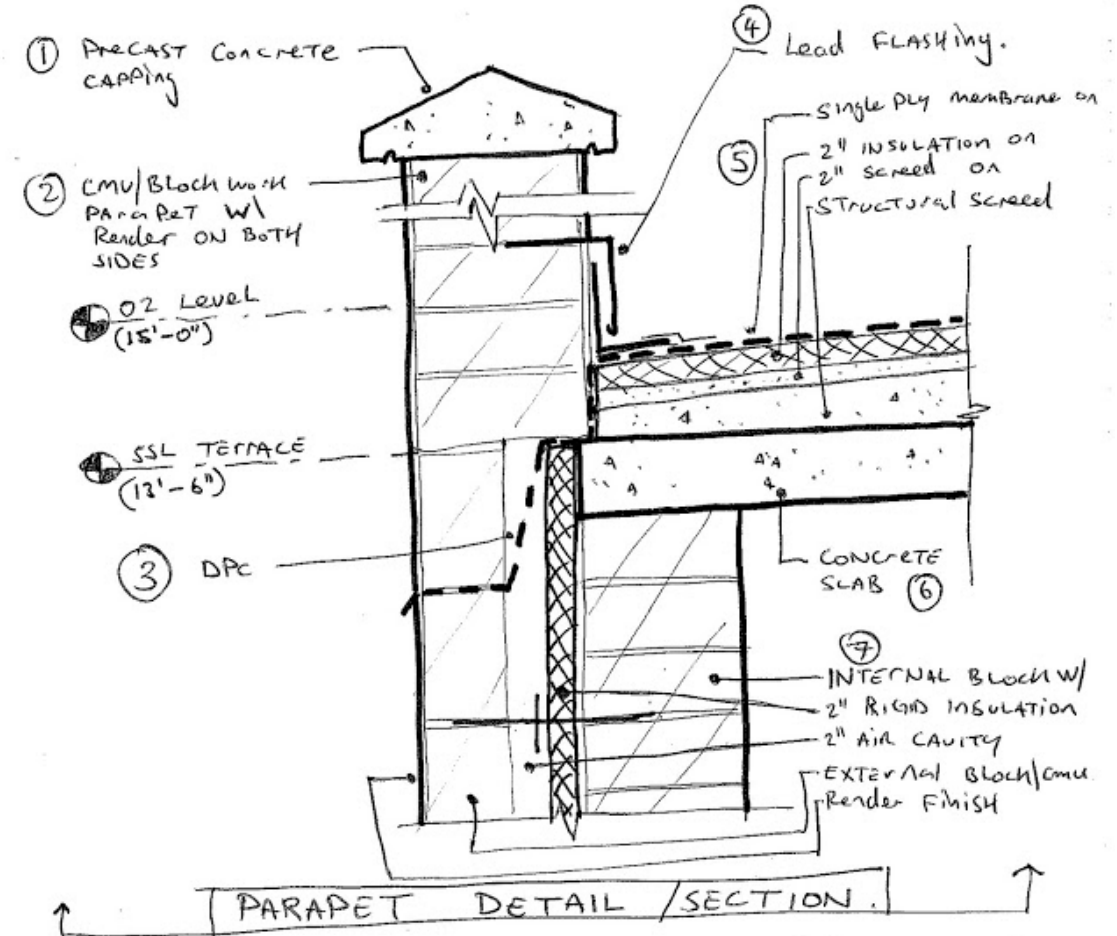
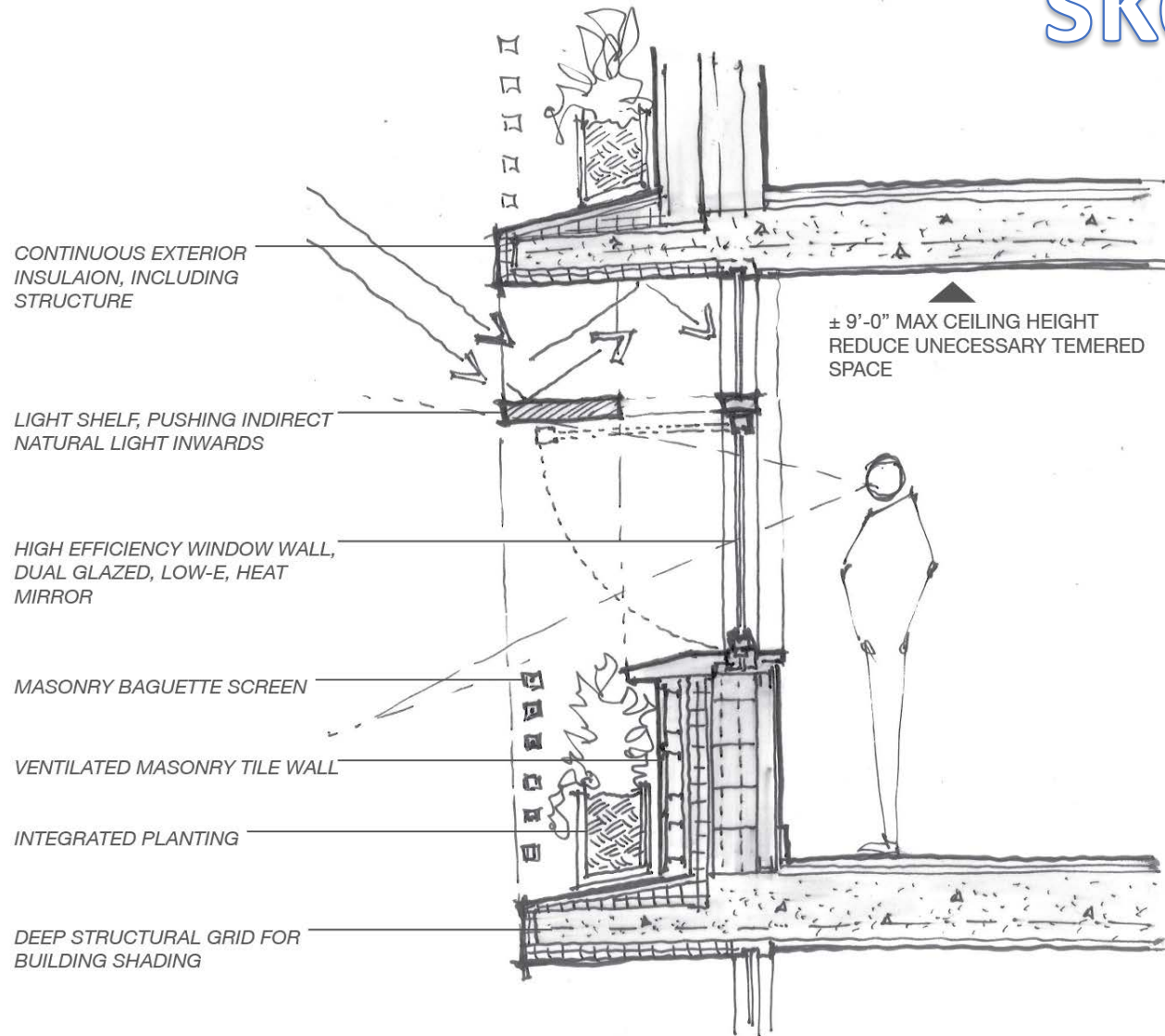


Measuring roof construction.

sketches not images



sketches not images



The Building Regulations

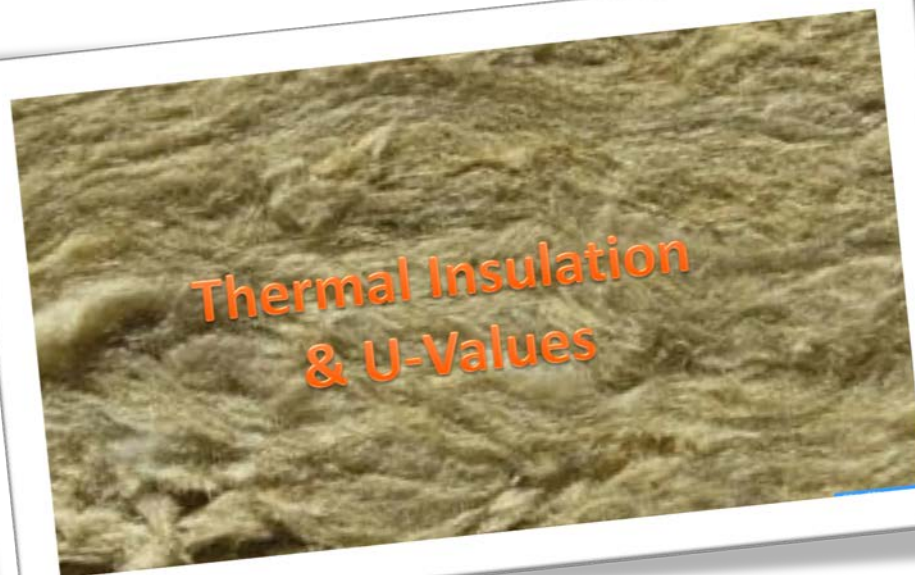
Access your individual products

► The Construction Information Service - CIS
The most comprehensive source of technical standards legislation and technical guidance for construction professionals



<https://www.vca.co.uk/superstructure/building-regs/mp4>

Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build:



Part L of the Building Regulations (Conservation of fuel and power) now prevents certain forms of construction by setting limiting standards (i.e. maximum U-values) for building elements.

It should be noted however that these are maximum permitted values, the specification for the notional domestic building referred to in Part L1A has considerably lower values, for example:

External wall: 0.18 W/m²K.

Floor: 0.13 W/m²K.

Roofs: 0.13 W/m²K.

Windows, roof windows, glazed rooflights and glazed doors: 1.4 W/m²K.

2. Given the specified roof structure and finish describe the **advantages** and **disadvantages** of such a method. Give an example of an **alternative method of construction** and describe what **advantages or disadvantages** that it may have. (10%)

Roof structure is to be trussed rafters with a metal profile sheeting finish installed on OSB sheathing boards.

Alternative type of roof structure and/ finish

Compare and contrast

Tables / Text / Drawings

3. Appropriate ventilation can play an important part of the design of a domestic building and is even more critical when considering a timber framed construction. Clearly describe the causes and sources of condensation, and the detrimental effects of condensation upon building fabric. (5%)

Using neat, annotated, proportional sketches where necessary, describe the appropriate methods of ventilation that will reduce condensation within this proposed building. (5%)



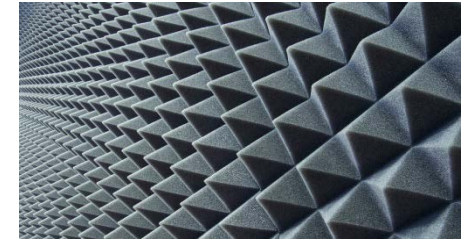
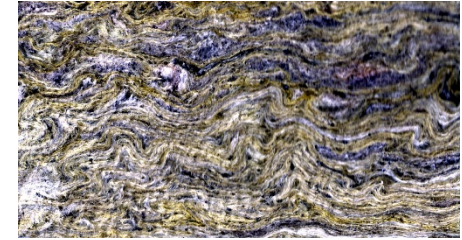
What is condensation and how can it be prevented.

Sketch section details

The use of buildings to house people, equipment and processes have resulted in the development of buildings that can control these internal environments with greater accuracy.

As well as protection and **enclosure** we can now consider:

- Thermal Insulation and temperature control
- Acoustic insulation
- Provision of Light (natural and artificial)
- Controls for humidity and ventilation
- Exclusion of contaminants.



Performance Requirements of the Building Fabric

What are the key drivers in providing a building that is suitable for the need?

- Structurally Stable
- Durability
- Thermal insulation
- Protection from weather and exclusion of moisture
- Acoustic performance
- Flexibility to change to changing needs
- Aesthetics
- Buildability
- Sustainability





Condensation is intrinsically linked to thermal performance, as the temperature reduction inside to outside through the building **enclosure** is a principal factor in its creation.

Key Terms

Types: Surface Condensation and Interstitial Condensation.

Surface Condensation is a familiar problem eg: humid air hitting a cold surface such as bathroom and kitchen windows.

Condensation can be damaging in extreme instances where it leads to residual dampness in plaster and other finishes, and can be the source of mould growth over time.

Interstitial Condensation – most serious type and causes the most problems in lightweight building enclosures where the condensation occurs within the constructional thickness.



Key Terms

Dew Point – The temperature at which saturation and condensation occurs. When water vapour in the humid air is cooled it eventually reaches a saturation temperature where the water vapour condenses into water droplets.

Relative Humidity - This is the relative wetness of a given volume of air. This is expressed as a % based on the amount of water vapour in the air relative to the amount of water vapour the air *could* carry.

e.g if the RH is 50% then the air's carrying capacity is at half.

If the air temperature is reduced to a where the RH is 100% - Dew point.

Examples:

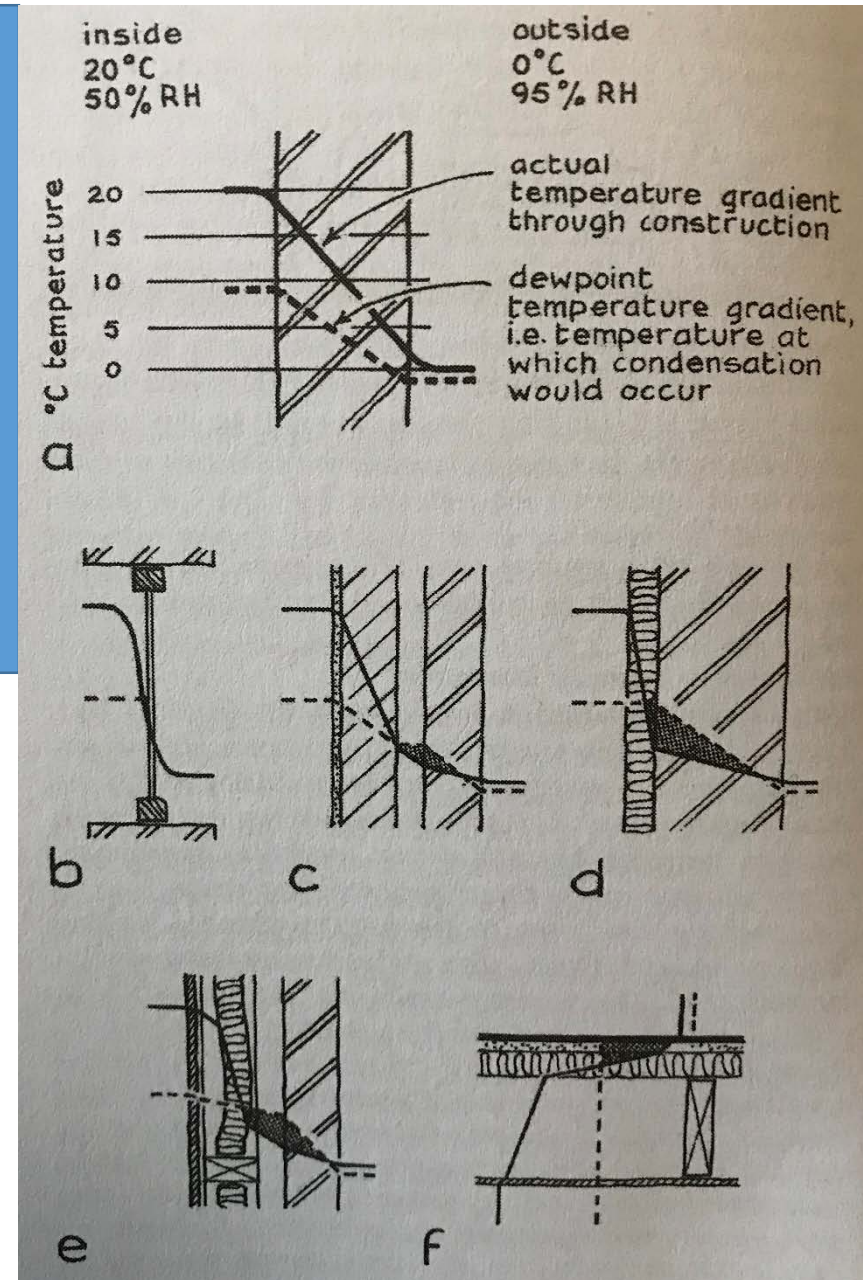
Domestic Internal temp 20 degs C and 50% RH

External Cold Winter 0 degs C and 95% RH

Note: The air outside has a higher RH than the inside only because it is colder – although it actually contains less water vapour.

Actual Temperature Gradient and Dew point Temperature Gradient
Basic Principles and Examples (a – f)

Interstitial Condensation occurs where the two gradients cross.



Preventing Condensation

Heating and Ventilation.

Improve the heating of the building and increase the ventilation. Heating on full with all the windows open? Ventilation is limited, but additional fans in kitchens and bathrooms will reduce the vapour content in the air. This will do little for the interstitial condensation.

Placing Insulation towards the Outside

This has the effect of making the gradient distortion a safer one, but is not always a practical solution. **(a)**

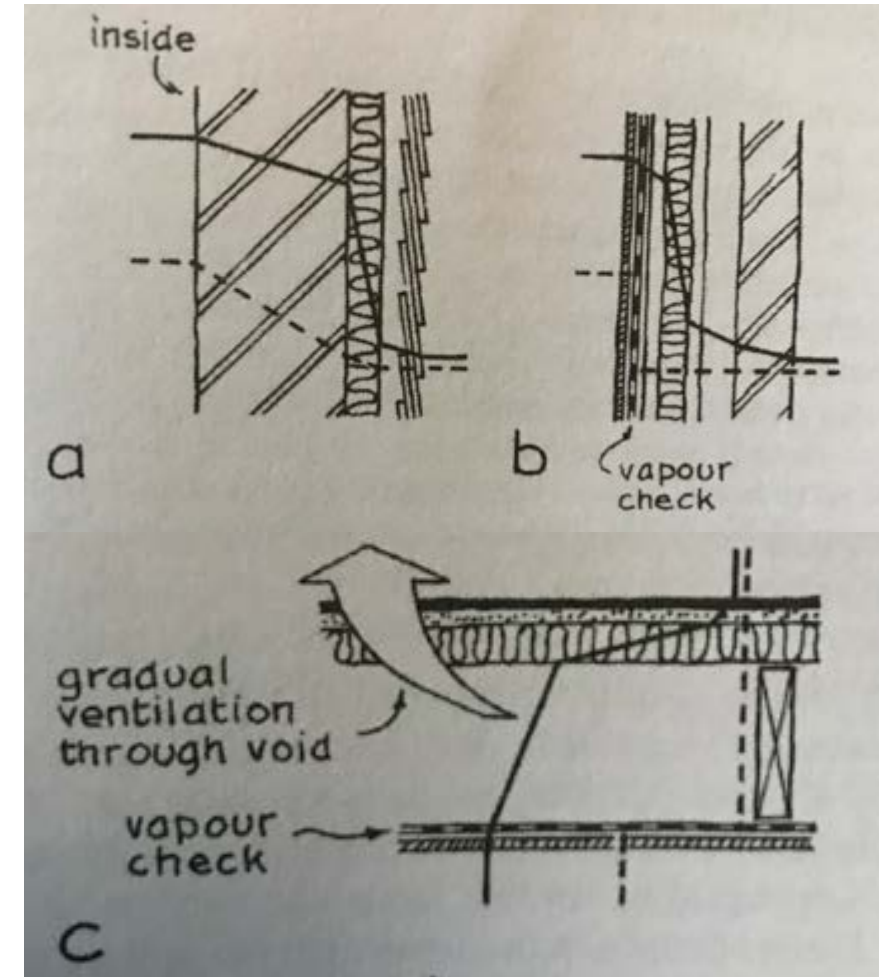
Vapour Checking

An effective vapour check can reduce the dew point gradient and makes the dew point in the enclosure the lower outside level. **(b)** Typically the positive vapour check can be a thin layer of plastic sheeting or metal foil.

Vapour Checking and Construction Ventilation

In an extreme case - flat roof timber construction **(c)** a vapour check is not enough. They can not be relied on 100% due to fixings etc.

The answer is to allow the construction some ventilation to the outside. Gradual through ventilation, (Soffit vents / eaves vents / airbricks) will carry any residual ventilation away. Vapour checking and gentle ventilation avoid condensation without significant heat loss.



Summary

Condensation is caused by warm moist air reaching cold places.
Precautions are:

- Improving heating and ventilation generally
- Possibly putting insulation to the outside
- Vapour checking **ON THE WARM SIDE** of the insulation
- Ventilating the Construction to the fresh air if there happens to be a vapour trapping membrane on the outside.

Further Reading:

Esmond Reid: 'Understanding Buildings'

Mike Riley: Alison Cotgrave: 'Construction Technology 1'

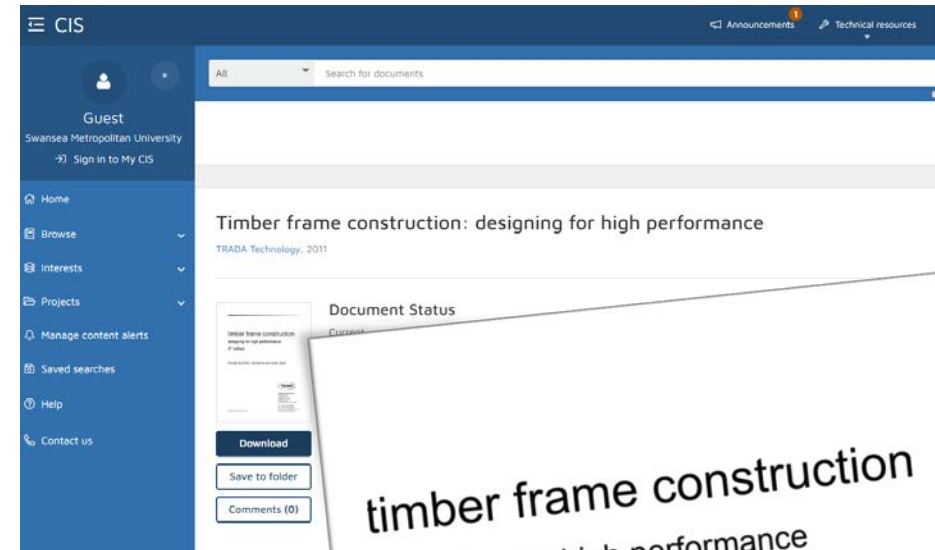
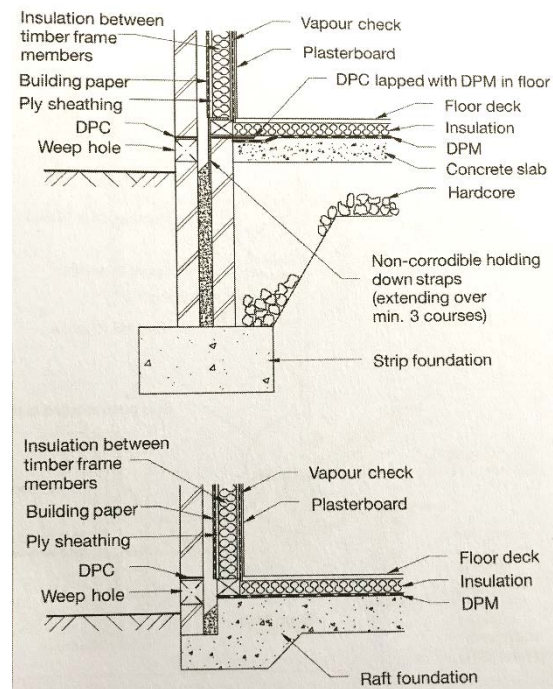
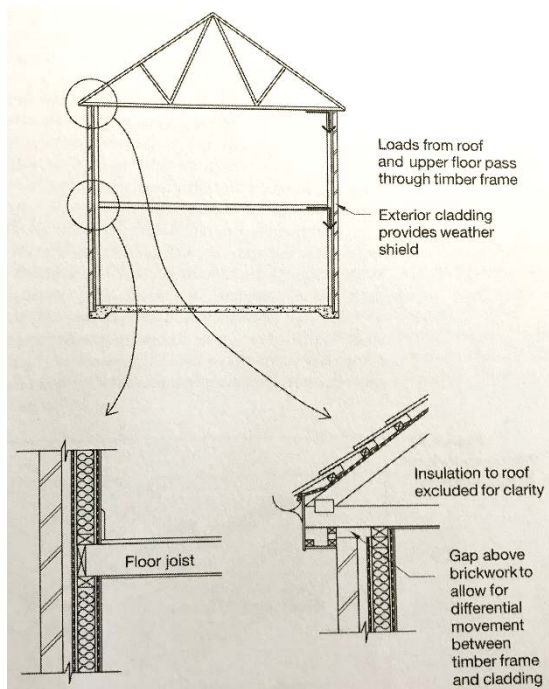
McMullans: 'Environmental Science in Building'

https://youtu.be/k_QXw1BCZ2A

Timber Frame Construction

Sources for Timber construction

<https://www.macmillanihe.com/companion/Riley-Construction-Technology-1/resources-zone/Chapter-07-Case-Study-2/>



timber frame construction
designing for high performance
5th edition

Revised by Robin Lancashire and Lewis Taylor



TRADA Technology Ltd
Chiltem House
Stocking Lane
Hughenden Valley
High Wycombe
Buckinghamshire HP14 4ND
tel: +44 (0)1494 569600
fax: +44 (0)1494 565487
email: information@trada.co.uk
website: www.trada.co.uk

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