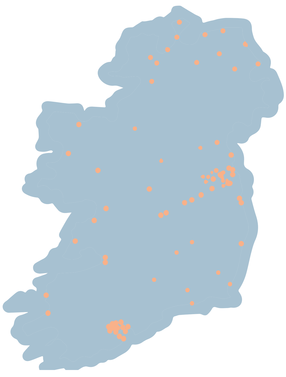
# An investigation of the technological challenges in upgrading Ireland's unused industrial buildings for emergency residential accommodation

Ireland's Industrial Estates



345 Industrial Estates in Ireland



82 industrial zoned sites in Dublin

## Precedent work

### StartBlok Riekerhaven



- Student Housing
- Amsterdam, Netherlands
- Completed works in July, 2016
- Architects: HVDN Architects
- Home to 560 residents.
- 463 Studio apartments
- 42 two-person apartments
- 6 three-person apartments
- Re-cycled shipping containers repurposed as homes for students and refugees

### Prefab Shelter Solutions



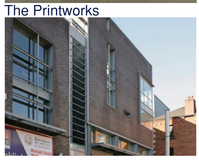
- Emergency accomodation
- San Francisco, California
- Completed works in 2021
- Architects: Mike Bullman
- Area: 2136m2 with 200 beds
- Portal Frame steel structure
- Pre-fabricated roof and wall panels

### Sinergia Cowork Palermo



- Offices
- Montevideo, Uruguay
- Year : 2014
- Architects: Emilio Magnone, Marcos Guiponi
- 32 offices and 4 rental meeting rooms within the envelope of the portal frame
- Use of completely removable lightweight structures, made through metal beams and Structural Insulated Panels walls

### The Printworks



- Housing
- Dublin, Ireland
- Completed works in 1995
- Architects: Derek Tynan
- 10 Apartments, retail and office units, and a private courtyard.

## Tolka Valley

- Covering more than 550,000 m2
- Consisting of more than 220 units
- Occupancy of building ranging from warehouses to factories and coffee shops and schools.
- Located 4km from Dublin
- Access to Luas and Dublin Bus
- Currently 12 buildings listed for sale for more than 6 months



Existing Building



Assemblies of God Church



Community Centre



Dublin bus-stop



Luas station

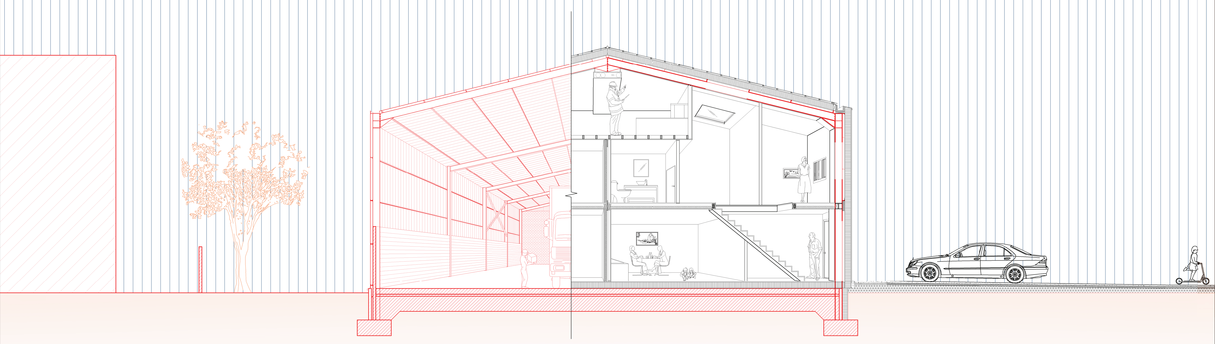


15,840 People can be housed Tolka Valley industrial Estate

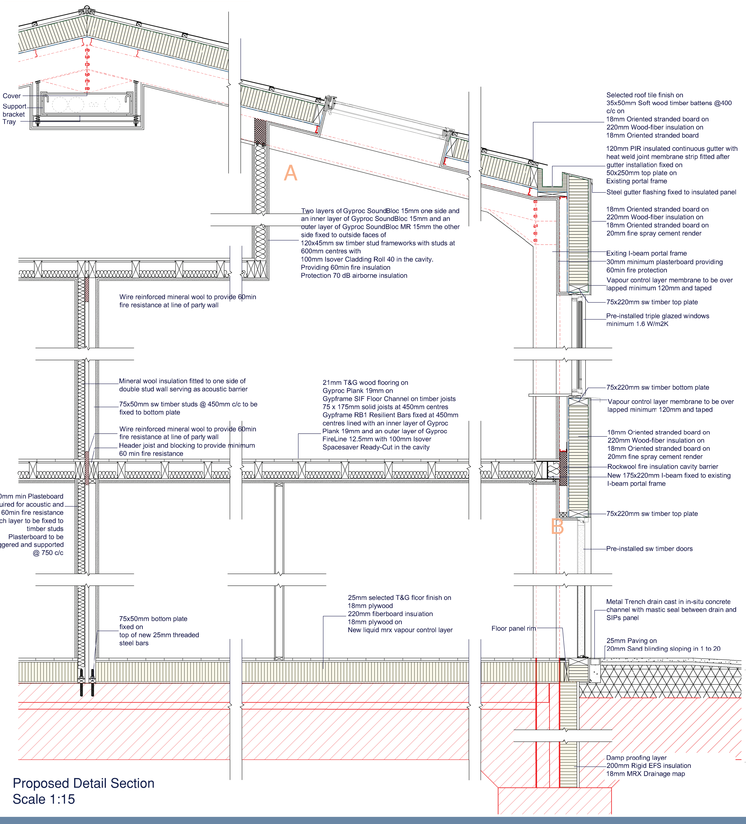
8,000 People per hectare

864 People can be housed in the currently available listed buildings

108,000 ton Co2 Saved if applied to every building in Tolka Valley

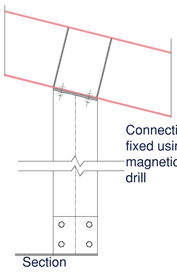


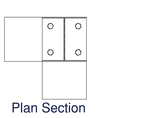
## Detail Construction



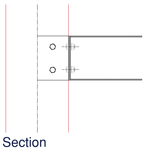

Proposed Detail Section
Scale 1:15

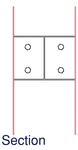
## Proprietary steel connections

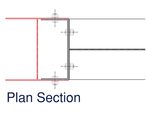



A I-beam Hanger Detail

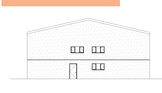



B First floor I-beam connection Detail

## Elevations





South Elevation

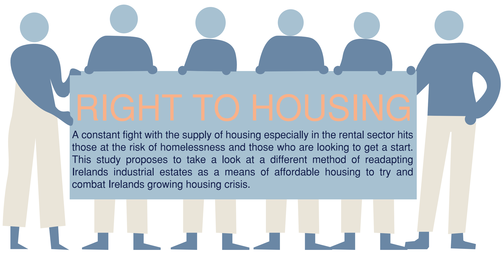


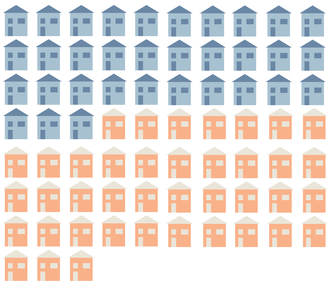
West Elevation



East Elevation

# Introduction and Motivation



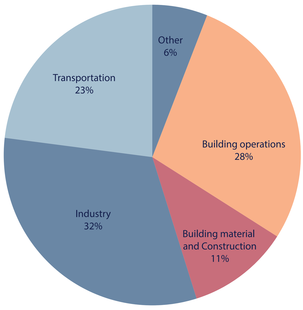



33,000 Proposed houses to be built every year for the rest of the decade compared to the predicted 73,000 needed to unwind the housing crisis

The governement set housing goal is to construct 29,000 homes in 2022 with a further 33,000 homes each year for the rest of the decade. According to Initiative Ireland, a finance company, i is predicted that a total of 48,000 houses are needed to be built in 2023 with a further 73,000 houses for he next five years to unwind the current housing crisis.

"THE GREENEST BUILDING IS THE ONE ALREADY BUILT"

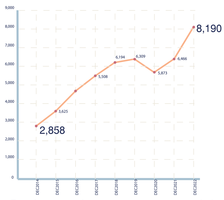
What is adaptive re-use?
Adaptive reuse is the repurposing of existing buildings with the goal of conserving its architectural and cultural heritage.




"It takes an estimated sixty-five years for an energy-efficient new building to recapture the amount of energy lost in demolishing an existing building"
-(Coulson, et al. 2017)



14.6 GT of Co2 emitted each year from the construction industry




People accessing emergency accomodation has tripled since 2104 to 8,190

## Objectives

- To determine if it is effective to readapt Irelands Industrial warehouses for emergency accomodation.
- To create a proposed layout which complies with building regulations.
- To determine a suitable methodology for the internal construction.
- To analyse the carbon impact of a modular insulated panels retrofit of the industrial warehouse in comparison to a traditional cavity block construction.

## Aim

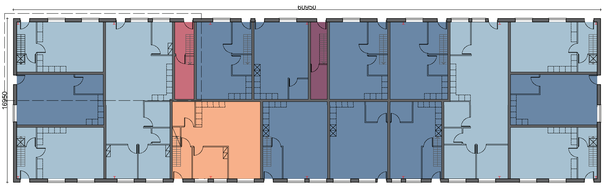
- The primary aim of this dissertation is to demonstrate the technological and environmental feasibility of Ireland's steel portal frame warehouses as a potential alternative for emergency housing.

## Methodology

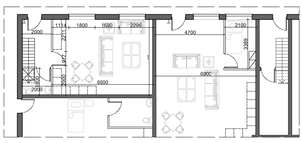
- To analyse current building regulations in regards to housing and residential development.
- To analyse the technology of retrofit of portal frame buildings and investigating key junctions of the building
- To conduct an LCA of the embodied carbon of the existing building and its demolition.
- To investigate which is the most common building typology for new construction in Ireland and conduct a comparative study of the LCA between the proposed retrofit building and the most common building typology.

# Proposed Plans

Plant Room Access
Plant Room Access
Studio Apartment
2 Bedroom Apartment
1 Bedroom Apartment
3 Bedroom Apartment




Proposed Ground Floor Plan
1:150 Scale



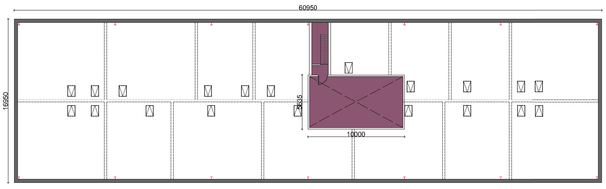
Proposed Layout Plan
1:100 Scale

Minimum overall apartment floor areas

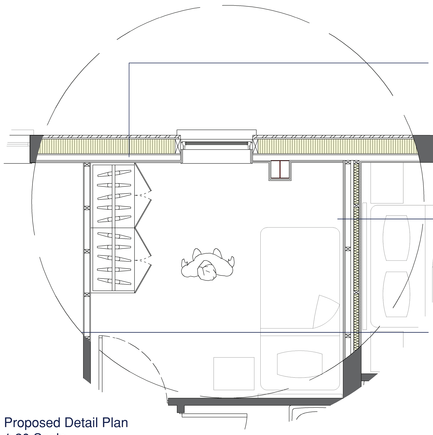
| | |
|---|---|
| Studio | 40 sq m |
| One Bedroom | 45 sq m |
| Two Bedroom | 73 sq m |
| Three Bedroom | 90 sq m |




Proposed First Floor Plan
1:150 Scale




Proposed Second Floor Plant Room Plan
1:150 Scale



18mm OSB board
220 mm fibre board insulation
18mm OSB board
12mm fiber cement board
18mm Lime render with mesh to manufacturer specification

15mm plasterboard
15mm plasterboard
75x50mm stud wall with mineral wool insulation fitted to one side
75x50mm timber stud wall
15mm plasterboard
15mm plasterboard

12.5mm plasterboard
50x25mm timb stud wall
12.5mm plasterboard

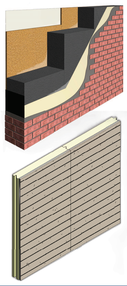
Proposed Detail Plan
1:20 Scale

# Prefabricated Insulated Panels

## RC Panel

Dutch company provides cheap and effective solutions to achieve Netherlands goal of neutral energy consumption on all buildings.

- Available for new and retrofit construction
- rigid fibreglass, oriented strand board, graphite-infused expanded polystyrene and another sheet of rigid fibreglass and selected finish
- Window and door installed in the insulation layer
- Facade panel seams are then sealed using a sealent product creating an airtight fit



- The panel consisted of a 40mm mineral internal layer with a 12mm cement fibre board to the inside and outside of the 234mm cellulose insulation, a vapour barrier fitted to the outer cement board and an 18mm cavity was left between the panel and the finish.



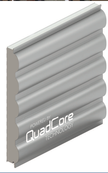
## SIPKits

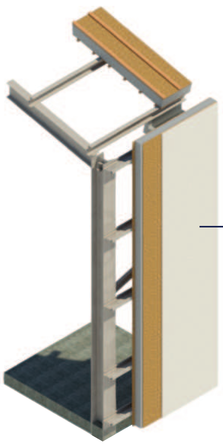
- It consists of a dense foam polystyrene sheet pressurized between two weatherproof OSB boards.
- u-Value of 0.12 w/m2K



## Kingspan

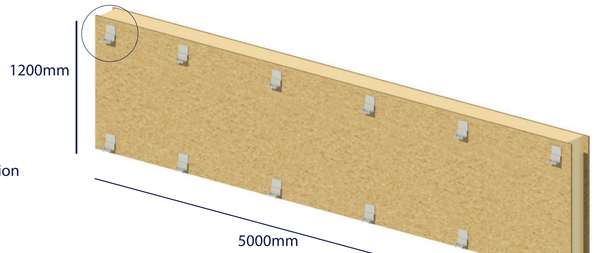
- Overall thickness of 138 can achieve a u-Value of 0.17 W/m2 K
- Wall Panel is manufactured with a HCFC, CFC and HFC free QuadCore insulation core.

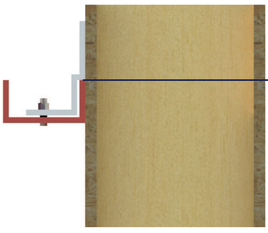


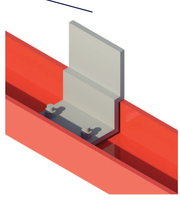
18mm Oriented stranded board
220mm Wood-fiber insulation
18mm Oriented stranded board
Fiber glass mesh
Render primer
20mm fine spray cement render

Connection Point



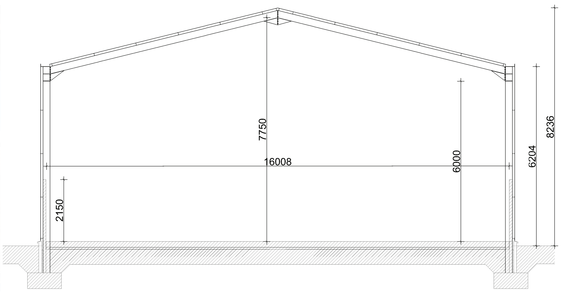
New SIPs lowered on the existing C-channel and fixed from inside

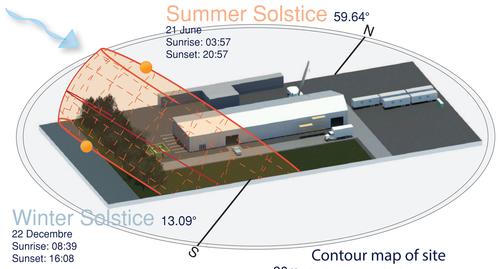


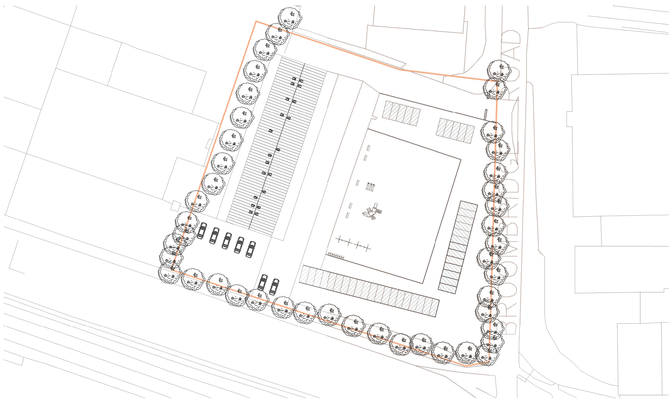
# Case Study



Existing Section 1:50 Scale

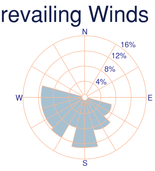


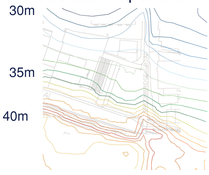



Proposed Site plan

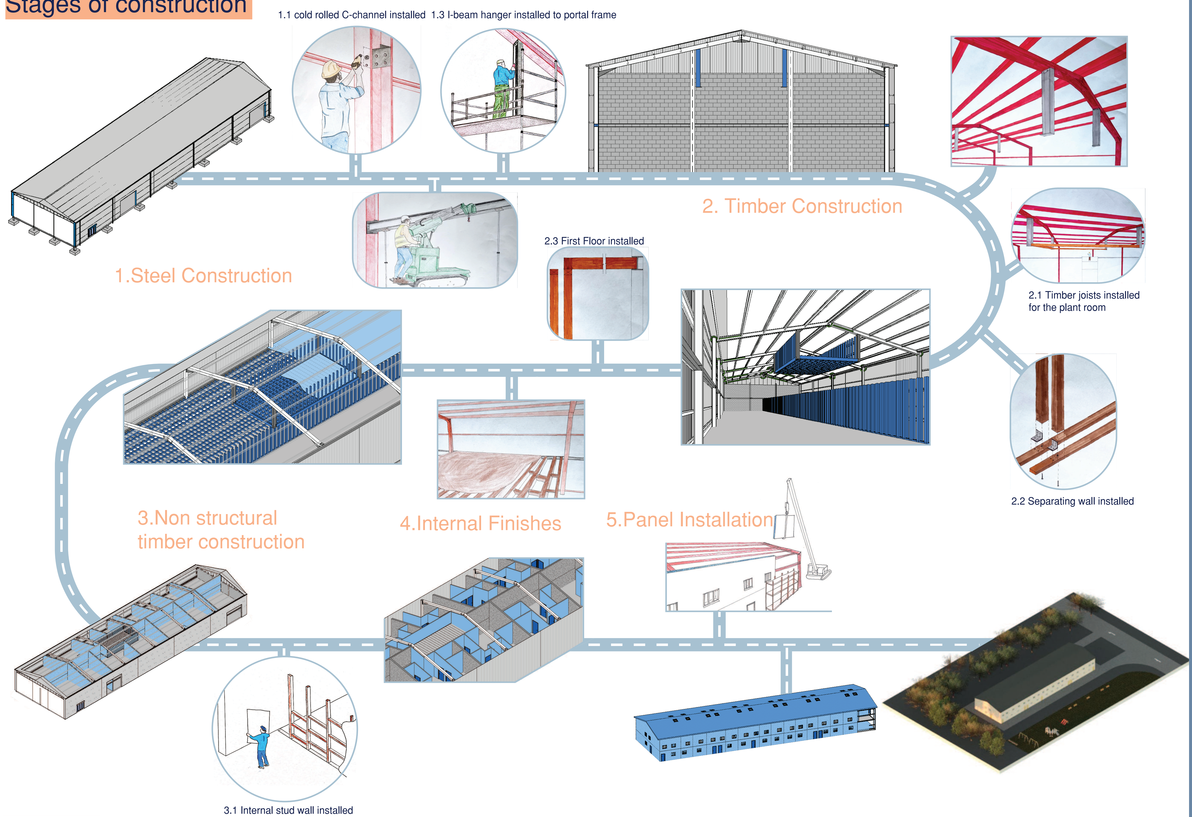
## Prevailing Winds sw




## Contour map of site

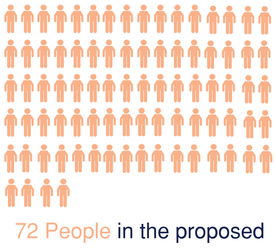



# Stages of construction




# Results

| No. | Housing Type | No. of people |
|---|---|---|
| 9 | Studio | 12 |
| 8 | One Bedroom | 16 |
| 4 | Two Bedroom | 14 |
| 6 | Three Bedroom | 30 |



72 People in the proposed apartment scheme

| Material | Layer Dimension | Quantity |
|---|---|---|
| OSB | 18 | 1012(m2) |
| Wood Fibre board | 220 | 1012(m2) |
| Render Finish | 20 | 1012(m2) |
| Kingspan Quadcore Panels | 20 | 1012(m2) |
| Concrete Hollow Block | 100 | 1012(m2) |
| PIR Insulation | 140 | 1012(m2) |
| Selected Brick finish | 102.5 | 1012(m2) |

## What is LCA?

- Life cycle assessment is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a building.



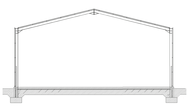

A1-A3 Product Stage
1. A1 Raw Material Extraction
2. A2 Transport to Manufacturing Site
3. A3 Manufacturing

A4-A5 Construction Stage
4. A4 Transport to Construction Site
5. A5 Installation and Assembly

B1-B5 Use Stage
6. B1 Use
7. B2 Maintanance
8. B3 Repair
9. B4 Replacement
10. B5 Refurbishment

C1-C4 End of life Stage
11. C1 Deconstruction and demolition
12. C2 Transport
13. C3 Waste processing
14. C4 Disposal

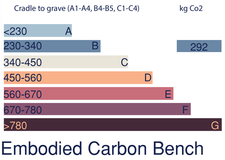
## Existing Building



Existing Construction

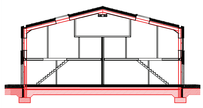



Embodied Carbon By life cycle-stage

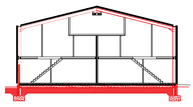



Embodied Carbon Bench Mark

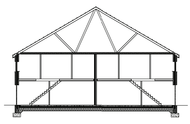
## Building Typology



Sip Panel Construction



Kingspan Panel Construction



Cavity Block Construction

## U-Value Calculation

| Material | Layer Thickness (mm) | Thermal conductivity (W/m-1K-1) | Thermal Resistance (m2K/W-1) | Specific Heat Capacity (J/kg-1K-1) | Density (kg/m-3) |
|---|---|---|---|---|---|
| External Surface | | | 0.040 | | |
| Concrete Block | 100 | 0.600 | 0.111 | 840 | 1850 |
| PIR Insulation board | 150 | 0.025 | 5.200 | 1400 | 30 |
| Air Cavity | 50 | 0.278 | 0.180 | - | - |
| Brickwork | 102.5 | 0.770 | 0.133 | 1000 | 1790 |
| Internal Surface | | | 0.130 | | |

| Core Thickness (mm) | 45 | 54 | 60 | 70 | 74 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|
| Overall Thickness (mm) | 83 | 92 | 98 | 108 | 112 | 118 | 128 | 138 |
| U-Value (W/m2K) | 0.39 | 0.32 | 0.28 | 0.24 | 0.23 | 0.21 | 0.18 | 0.17 |
| Weight (kg/m2) | 11.1 | 11.5 | 11.7 | 12.1 | 12.3 | 12.5 | 12.9 | 13.2 |

| Material | Layer Thickness (mm) | Thermal conductivity (W/m-1K-1) | Thermal Resistance (m2K/W-1) | Specific Heat Capacity (J/kg-1K-1) | Density (kg/m-3) |
|---|---|---|---|---|---|
| External Surface | | | 0.040 | | |
| OSB | 18 | 0.130 | 0.138 | 1000 | 600 |
| Wood Fibre Board | 220 | 0.042 | 5.238 | 2000 | 270 |
| OSB | 18 | 0.130 | 0.138 | 1000 | 600 |
| Render | 20 | 1.000 | 0.020 | 1000 | 1800 |
| Internal Surface | | | 0.130 | | |

U-Value : 0.17 W/m2 K

U-Value : 0.17 W/m2 K

U-Value : 0.17 W/m2 K

## Embodied Carbon Benchmark (A1 to C4)

<230 A — 33kg Co2 e/m2 by SIPs construction
43kg Co2 e/m2 by Kingspan panel construction
205kg Co2 e/m2 by Cavity Block Construction

230-340 B — 292kg Co2 e/m2 by Existing Construction

340-450 C

450-560 D

560-670 E

670-780 F

>780 G

One Click LCA