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| Reference Source no. |             |
| Project number       | 956850      |
| Date of issue        | 13 May 2010 |
| Security Code        |             |

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## Review of Renovation Solutions

ROBUST Project: WP5.2

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## **Summary**

### **Review of Renovation Solutions**

ROBUST Project: WP5.2

**Author(s):** Israel Adetunji

**Reviewer(s):**

**Date of issue:** 13 May 2010

**Version no:**

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This report provided an overview of renovation solutions for residential, commercial and industrial buildings. These solutions were collated in a matrix to form the basis of the development of sustainability tool within WP 5 of the ROBUST project.

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## Review of Renovation Solutions

### 1. Introduction

A large proportion of the existing roofs and walls of industrial, commercial and residential buildings stock both in the UK and all over Europe constructed in the 1960's through to the 1990's have reached or near the end of their functional life. The majority of these are poorly insulated and need upgrading to modern standard.

There are many options available when it comes to refurbishing a building. It is a general wisdom that each refurbishment project is unique and solutions are bespoke. As a result, the act of refurbishment is generally perceived to be complex. In reality, the differences in the variety of these refurbishment options are subtle. Against this background, this document overviews the broad spectrum of solutions along with indication of cost. It presents a matrix of these solutions. This matrix provides the basis for the sustainability tool within WP 5.

### 2. Refurbishment Solutions

This section provides an overview of refurbishment solutions, which are broadly grouped into:

- Over painting
- Over cladding
- Over roofing
- Re-cladding
- Re-roofing
- Roof top extension

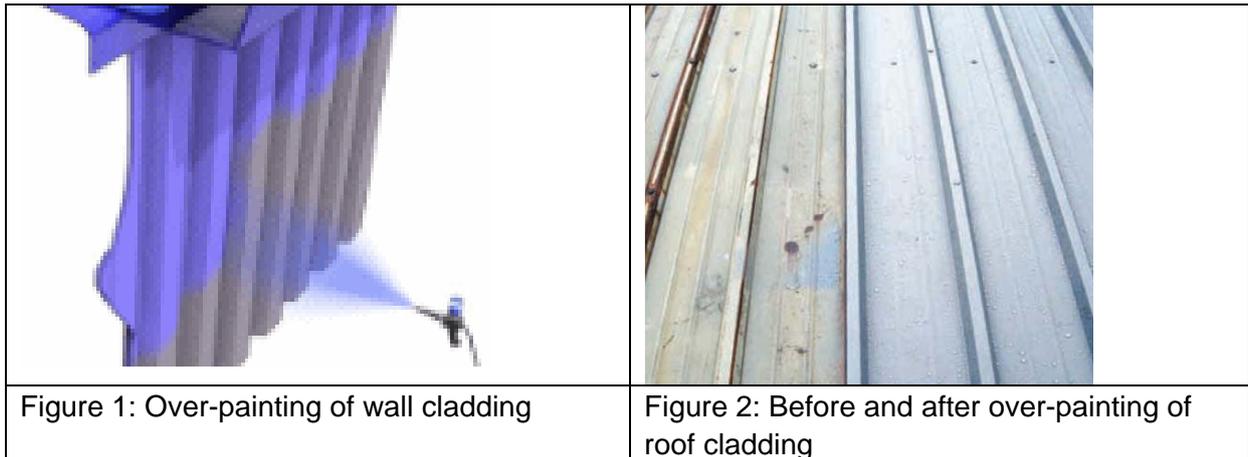
#### 2.1 Over-painting of existing cladding

Over painting of an existing cladding may be required for aesthetic or to extend the life of the building. Pre-finished steel provides an inherently flexible and adaptable surface that can be over-painted at any point during its lifetime. The process of over-painting is quick and can be carried out with minimal disruption to the activities within a building.

##### Steps:

- Inspection and assessment to identify an appropriate solution.
- Surface preparation – in most cases a wash down of the area to be recoated and removal of any loose paint using abrasives. Any areas of bare metal must be spot treated with an appropriate primer before application of the topcoat.
- Recoating operation – two coats of an approved coating system applied by spray or roller application on the required thickness specified by the manufacturer.
- Inspection – important to ensure that the technical requirements of the paint manufacturer have been fulfilled such as paint thickness. Most guarantees for recoating are insistent on this inspection.

Choosing the right coating for over-painting is important. Using a high performance, water-based paint considerably reduces the amount of Volatile Organic Compounds (VOCs) liberated during the over painting operation compared with conventional solvent based paint.



## 2.2 Over roofing and over cladding systems

### 2.2.1 Built-up system for over roofing and over cladding of wall

In this application existing inner sheet/ panels remains and new steel bracket, mineral wool insulation and outer steel liner are applied. This form of over-cladding is ideal for many refurbishment applications but it is important to recognise and address the need for including a vapour check or perhaps a breather paper to avoid the problem of interstitial condensation. Old buildings and the construction details they employed, were by their nature very 'leaky' with air and vapour movement not controlled. Over-cladding or over-sheeting will generally require the introduction of a vapour control layer (VC) above the internal sheet and below the insulation.

The refurbishment of roofs with existing roof-lights can be a problem, and generally the client would have to accept a reduced level of light through the roof-light as a result of the introduction of a VC. Cutting and sealing the VC around every rooflight could overcome this but can add considerably to the overall cost.

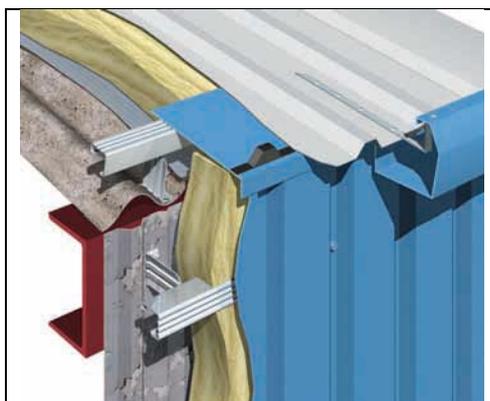


Figure 3: Build up system showing over roofing and wall over cladding of asbestos sheet

#### Solution

- Suitable for over-roofing and over-cladding of any existing roof/wall material.
- Retains the old roof cladding for use as a liner.
- Causes minimal disruption inside the building.
- Uses support brackets attached over the old sheeting into the purlins to provide an insulation space with minimal cold-bridging.
- New insulation is added to comply with current building regulations.
- Finally, the external top sheet is installed.

## 2.2.2 Composite panels for roofs and walls

There are various types of composite panels ranging from flat, micro-ribbed and profiled panels. Two types of insulations are PUR/PIR and Rockwool. The later is used where improved fire performance is required. The system offers a fast and economical means of over-cladding an existing wall or roof, with minimal disruption.

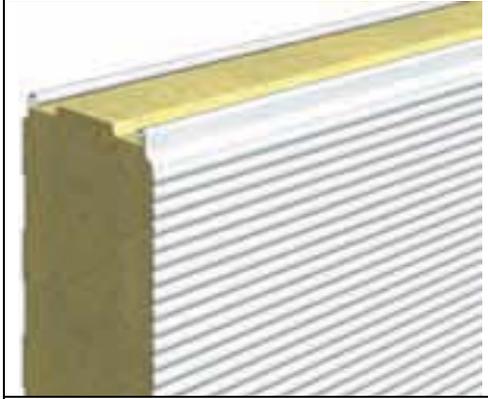


Figure 4: Composite panel with Rockwool insulation

### Solution

- Existing roof or wall panel remains and, steel bracket and composite panel attached.
- Composite wall panels incorporate factory sealed, weather-tested tongue and groove side lap joints.
- Single roof panels can span up to 3.5 meters, depending upon local loading conditions.
- A range of flashings, fasteners, sealants and flute fillers are available to match composite roof panels.
- Integrated windows, doors and louvres are available for all architectural wall systems.

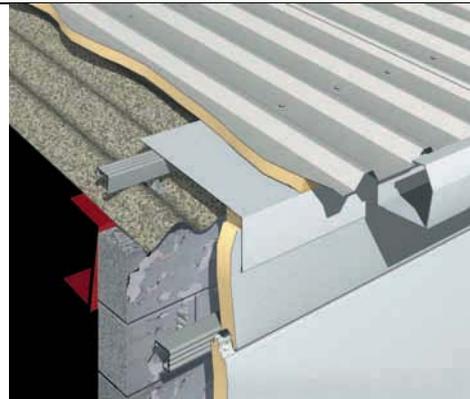


Figure 5: Over roofing of asbestos sheet and over cladding of brick using Corus Composite PUR panel



Figure 6: Over roofing of tired steel sheet and over cladding of brick using Kingspan Composite PUR panel

## 2.3 Architectural over-cladding systems for wall

### 2.3.1 Flat and trapezoidal profile over-cladding

This option is effectively the same as build-up system (section 2.2); except that flat and other elaborate profiles are used for over cladding of walls.

#### Solution

- Offers the option for a wide plank profile to be used to create a flat façade. Alternatively, a profiled top sheet can be introduced to create light and shade lines.
- Interesting architectural features can also be incorporated.
- Allows the new cladding to be installed onto a spacer system, fixed back to the existing structure. Insulation can also be installed to upgrade thermal performance.
- Provides a system which insulates and protects the old building and an option for the façade to be designed to reflect corporate image and identity.



Figure 7: Over cladding of existing industrial block work



Figure 8: Over cladding of existing residential concrete wall using cassette panels

### 2.3.2 Composite flat panel system

The flat panel façade systems are fully interchangeable and can be used to refurbish or 'reface' conventional brick, stone or concrete walls or existing panel-based cladding systems. The façade panels can either be fixed to a new lightweight supporting steelwork structure, which is fixed to the existing walls, or can be fabricated to a size which will suit the existing supporting steelwork, after removal of the old panels. The latter is often considered where the original panel system may have failed or where refurbishment is required for cosmetic purposes.

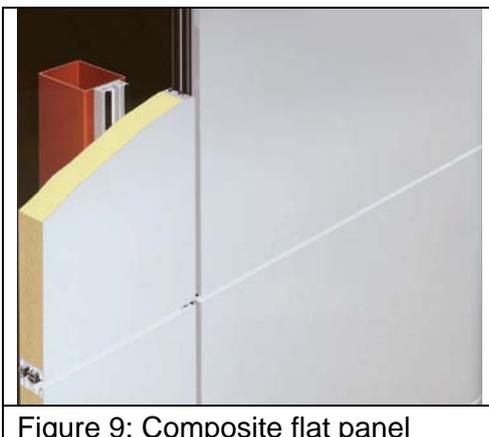


Figure 9: Composite flat panel

#### Solution

- Manufactured to the highest standards.
- Can be used as over cladding on existing walls or as strip and re-cladding solutions
- Offers outstanding levels of thermal and acoustic performance.
- Fully engineered joints to all four edges to ensure a neat, watertight detail.
- Generally manufactured to bespoke dimensions in all axes so particularly well suited to combining with existing structures.

### 2.3.3 Rainscreen cladding

This solution is similar to flat panel systems, but without the need for edge sealing strips. The systems are attached over, and spaced away from, the external face of the existing façade. As the name suggests, the system provides the building with a degree of weather screening from the prevailing elements. Rainscreen systems allow the façade to breathe and enable the introduction of additional insulation within the newly formed cavity. This system will improve the thermal performance of the façade and reduce the ingress of water through permeable construction methods. It will also enable the building to be visually transformed by the use of flat panels manufactured from pre-finished steel.

#### Solution

- Ideally suited for the refurbishment and over cladding of the façades of commercial buildings suffering from the ingress of water.
- Panels are factory-produced for the specific application and are available in a wide range of prefinished steel products.
- Panels are easily attached to the structure via a pre-formed sub-structure.
- Provides a ventilated cavity which can accommodate additional insulation.

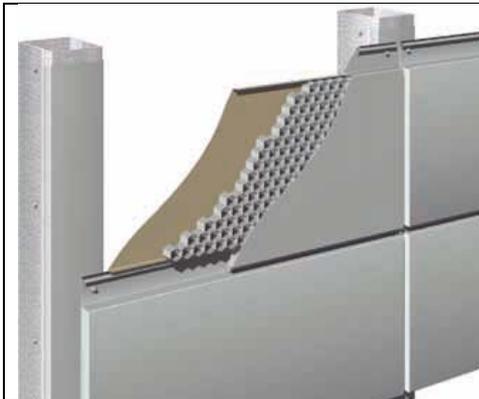


Figure 10: Stratascreen panel with honeycomb core



Figure 11: Stratascreen panel with PUR/PIR core

### 2.3.4 Brick slips and tiles systems for wall

Brick slips and tiles systems are sometimes used for refurbishment of residential and commercial buildings to combine the aesthetic beauty of traditional brickwork with the construction benefit of a fast track approach. The system comprises of an innovative natural clay slip tiles inserted into a proprietary steel backing section. The system is capable of being fixed to a wide range of old and tired substructures including timber, steel, concrete and traditional masonry.

#### Solutions:

- Ideal for over-cladding of residential and commercial buildings
- A broad range of colours, textures, sizes and pattern are possible
- Brick slips with closed cell insulation e.g. PUR/PIR and backing sheet and sub-frame
- Tile system on composite panel with PUR/PIR and sub-frame
- Tile system on composite panel with Rockwool and sub-frame



Figure 12: Brick slips with closed cell insulation, backing sheet and sub-frame

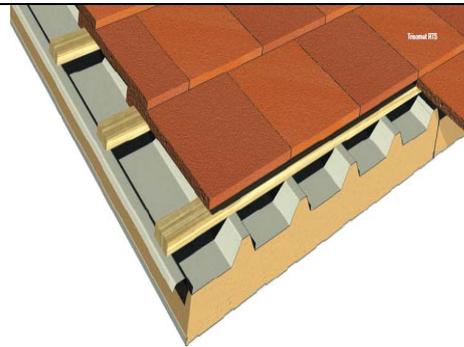


Figure 13: Tile system on Composite panels with PUR/PIR

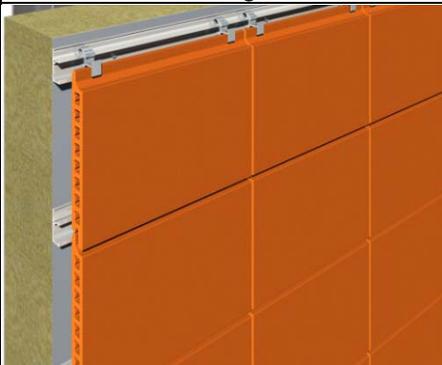


Figure 14: Tile system on Composite panels with Rockwool



Figure 15: Natural stone composite panels on aluminium frame

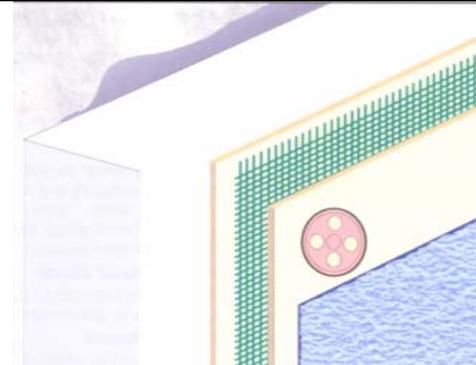
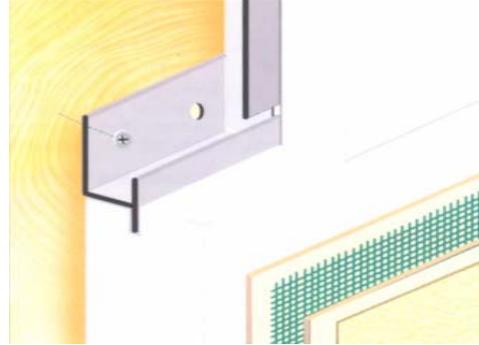
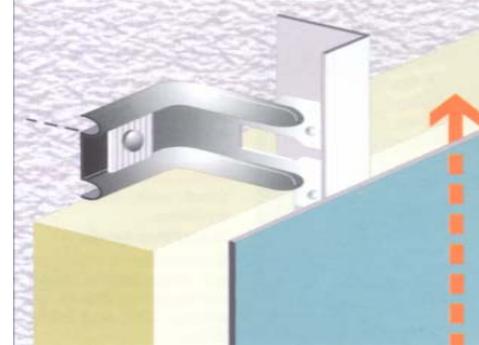
### 2.3.5 Insulated render systems

Insulated render systems find their applications in both residential and commercial buildings and are widely used in continental Europe. The main types of insulation used are:

- EPS (Expanded Polystyrene) rigid, flame retardant cellular, plastic insulation.
- Extruded, cellular plastic insulation extruded from polystyrene. Closed cell insulation.
- Rock wool (slab) non-combustible, highly vapour permeable, popular for multi-storey.
- Lamella Rock mineral wool.
- PIR (Polyisocyanurate) Cellular plastic foam.
- Phenolic Rigid cellular foam.

#### Solutions:

- Direct Applied Render Protected Systems (to masonry, concrete and panel backgrounds). Insulation applied directly to the substrate, render basecoat/s, reinforcement and finish (cementitious or synthetic). See figure 16 -17.
- Rail Supported, Render Protected Systems. A mechanically fixed system supported by rails fixed to the substrate, comprising insulation, render reinforcement and finish. See figure 18.
- Rail Applied Ventilated Rainscreen Systems. These systems use mechanically fixed steel or aluminium rails, rock fibre slab insulation and rain screen cladding against weather (fig. 19).

|  |   |
|--|---|
|            |            |
| <p>Figure 16: Rockwool render protected systems on a multi-storey residential building</p>   | <p>Figure 17: Direct applied render protected Systems (to Masonry and Panel Backgrounds).</p> |
|           |           |
| <p>Figure 18: Rail Supported, Render Protected Systems to Masonry and Panel Backgrounds.</p> | <p>Figure 19: Rail Applied Ventilated Rainscreen Cladding Systems.</p>                        |

## 2.4 Over roofing systems

### 2.4.1 Metal standing seam pitched over-roof

Metal standing seam systems are the industrial or commercial building equivalent to the copper or lead roof systems traditionally used on churches. They have no through fixings and no end laps to ensure total weather protection. The use of clip fixing and a standing seam profile allows for thermal movement of the full length sheets. The introduction of mini-rib stiffeners provides greater design strength, whilst maintaining the aesthetic appearance. The design is particularly suitable for aggressive weather conditions.

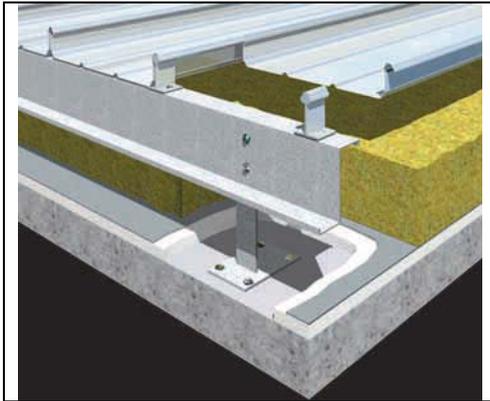


Figure 20: Standing seam pitched over-roofing

#### Solution

- No penetrative fixings and no end-laps ensure total weather protection.
- Offers a flexible and lightweight option for the refurbishment of failed roof cladding systems. In most cases can be installed on top of the existing roof.
- Offers an opportunity to enhance the building's thermal performance and change its appearance.
- By increasing the amount of insulation beneath the external sheet, higher U-values can be achieved.
- Provides an opportunity to be roll-formed on site in lengths of more than 120 meters.

### 2.4.2 Flat to pitch framed roof systems

Flat to pitch conversions completely transform the appearance of the building. In some cases, they are the only effective way of waterproofing the existing roof structure but do require a detailed structural survey to be carried out. This is to ensure that the existing roof structure or supporting walls are capable of withstanding the additional loads from the new structure.

#### Solution

- Lightweight cold form steel trusses placed over the existing flat roof. The trusses provide support for a new pitched metal roof. The lightweight structure does not impose a high dead load onto the existing roof, although during the design process this extra load has to be taken into account to ensure that the structure can accommodate it.
- Can incorporate additional habitable space within the new roof structure. This will depend upon the result of the structural survey and the layout of the existing services and access.
- Can be further insulated with low-density mineral wool or rock wool insulation on top of the old roof to improve u-values and reduce heat loss from the building.
- Several external sheets are possible. Standing seam system can be chosen, especially for low pitch. For a greater pitch, a simple, through-fix trapezoidal profile can be employed.
- Alternatively, composite panel can be used on the new roof structure



Figure 21: Flat to pitched roof truss system with steel liner

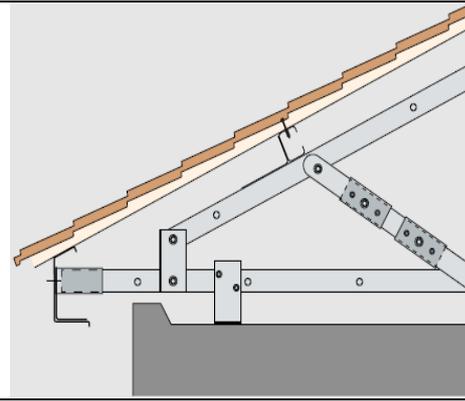


Figure 22: Flat to pitched truss system with composite steel tile panel (PUR/PIR)

### 2.4.3 Prefabricated roof system

Corus “Hi-Point” modular roofing system is a very good example of prefabricated roof systems using cold form lightweight steel. The system is ideal for new build and refurbishment projects.

#### Solution:

- Specifically suited to fast track building programmes,
- Attached hot rolled steel to connect to the existing roof to receive Hi Point modules
- Hi-Point components are either pre-assembled under factory controlled conditions then transported as complete units to site ready for craning into position or, where space allows, delivered as a kit of parts ready for assembly and installation.
- Hi-Point roof constructions are available as mono-pitch, duo-pitch and barrel-vault roofs
- Variety of insulations types and thickness can be used with virtually any finish such as steel single skin tapezodal profile, secret fix standing seam or composite panel



Figure 23: Hi-point with flat roof

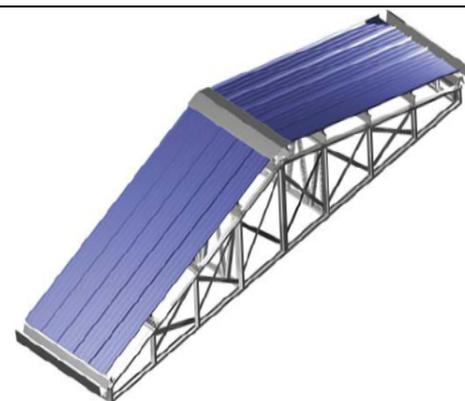


Figure 24: Hi-point as pitched roof



Figure 25: Hi-point with standing seam roof



Figure 26: Hi-point as barrel pitched roof

## 2.5 Strip and Re-cladding of wall and roof

Typically, over-cladding of roofs and walls of existing buildings is a cost effective form of refurbishment of industrial shed. However, there are occasions when a complete strip and re-clad is the most suitable options. For instance, old Industrial sheds were traditionally clad with asbestos cement sheeting. It is estimated that 1.5 million non-domestic buildings contain asbestos. Whilst over cladding is an option, it is increasingly becoming common a practice for most clients to remove the asbestos cladding and then re-clad. The reasons are to take advantage of the Government asbestos removal tax relief and low insurance rates.

### Solutions:

- Ideally suitable for industrial shed
- The two generic options are build up system and composite panels.
- Build up systems: stripped roof to the existing steel purlin and apply new inner steel skin, steel bracket, mineral wool insulation and outer steel skin
- Composite systems (PUR/PIR or rock wool insulation: stripped roof to the existing steel purlin and new composite panel applied

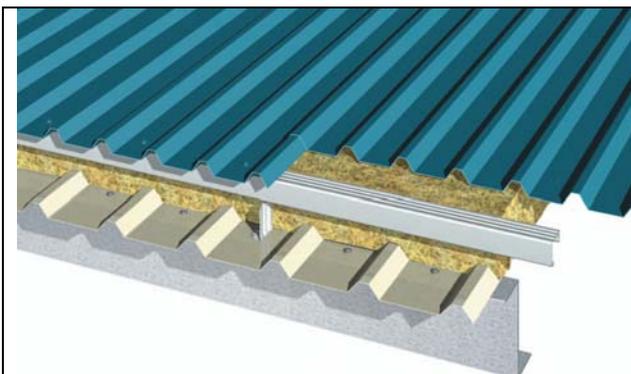


Figure 27: Build up roof systems with trapezoidal profile

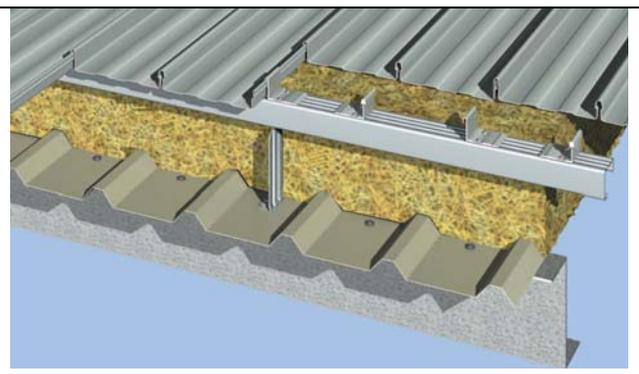


Figure 28: Build up roof systems with secret fix profile

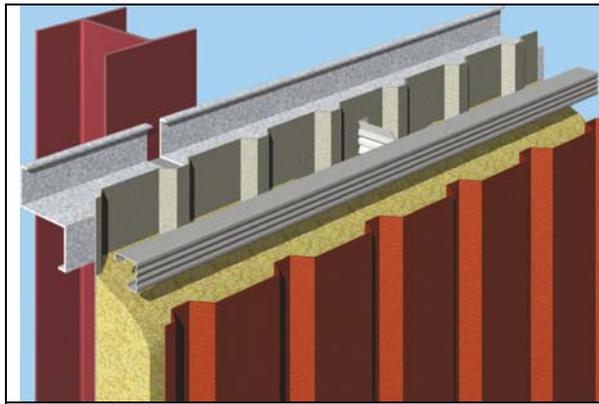


Figure 29: Build up wall systems with trapezoidal profile

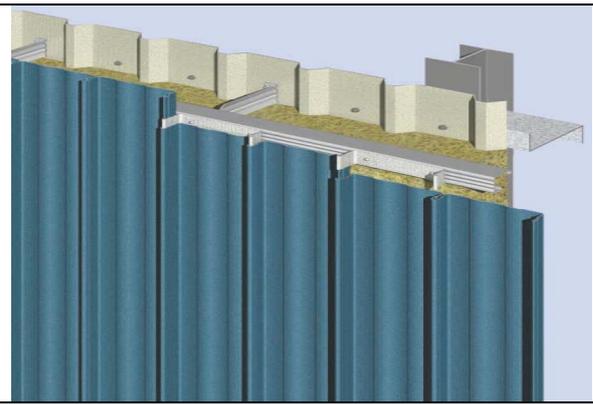


Figure 30: Build up wall systems with secret fix profile



Figure 31: Strip and re-sheet with composite PUR/PIR panel

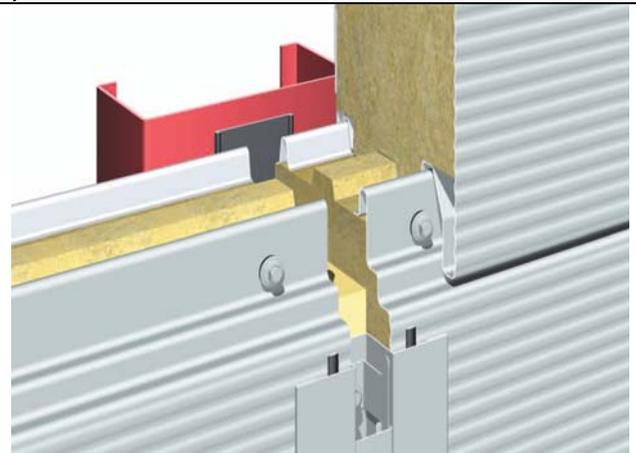


Figure 32: Composite system with rock wool insulation

## 2.6 Roof top extension/room in the roof

Roof top extension/room in the roof to provide additional space is an important element of residential building refurbishment. Depending on the complexity and span of the roof, the structural elements of roof top extension/room-in-the roof solution normally consists of a combination of several materials. The generic form are a combination of one or two of hot roll steel, timber and lightweight cold form steel sections. However, within the ROBUST project the main focus is steel. Therefore, the use of lightweight cold form steel sections either prefabricated into sub-frame modules or panelised trusses in the factory, or site assembled are considered for the walls and roof elements. The new floors are either lightweight cold form steel joists or composite decks.

### Solution:

- Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External steel purlin with insulation and fix through trapezoidal steel liner
- Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External steel purlin with insulation and secret fixed steel liner

- Steel trusses / steel modules insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External insulation, timber battens and concrete tiles.
- Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External insulation, timber battens and clay tiles.
- Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External composite insulated steel panels mimicking traditional slate, concrete or clay tiles pattern



Figure 33: Roof top extension



Figure 34: Construction phase



Figure 35: Attic Truss for habitable roof



Figure 36: Habitable roof construction phase

### 3. Matrix of cladding solutions for refurbishment

This matrix is developed based on the variety of refurbishment solutions described in Section 2.0 above.

**Table 1: Matrix of cladding solutions for refurbishment**

| Sectors     | Over -clad                      | Re-clad        |                | Over roof      | Roof-in-roof/ Roof top extension |
|-------------|---------------------------------|----------------|----------------|----------------|----------------------------------|
|             |                                 | wall           | Roof           |                |                                  |
| Industrial  | A1, A2, A3, A4                  | C1, C2, C3, C4 | D1, D2, D3, D4 | E1, E2, E3, E4 | -----                            |
| Commercial  | B1, B2, B3, B4, B5, B6, B7, B8, | -----          | -----          | F1, F2, F3     | -----                            |
| Residential | B9, B10, B11, B12,              | -----          | -----          |                | G1, G2, G3, G4, G5               |

**Table 2: Typical refurbishment solutions for industrial sheds**

| Solution   |                     | Description   | Reference  |             |
|------------|---------------------|---|--|-------------|
| INDUSTRIAL | Over cladding: wall | A1  | Build up systems: existing wall panels remains and steel bracket, mineral wool insulation and outer steel skin applied   | See fig. 1  |
|            |                     | A2  | Composite systems with PUR/PIR: existing wall panels remains and steel bracket, composite panel applied  | See fig. 3  |
|            |                     | A3  | Composite systems with Rockwool: existing wall panels remains and steel bracket, composite panel applied   | See fig. 5  |
|            |                     | A4  | Over painting of existing steel wall cladding  | See fig. 4  |
|            | Over roofing        | E1  | Build up systems: existing roof panels remains. Steel bracket, insulation and out steel skin applied   | See fig. 2  |
|            |                     | E2  | Composite systems with PUR/PIR: existing roof panels remains. Steel bracket, composite panel applied   | See fig. 3  |
|            |                     | E3  | Composite systems with Rockwool: existing roof panels remains. Steel bracket, composite panel applied  | See fig. 5  |
|            |                     | E4  | Over painting of existing steel roof cladding  | See fig. 4  |
|            | Re-cladding of wall | C1  | Build up systems: stripped wall to the existing steel purlin and apply new inner steel skin, steel bracket, mineral wool insulation and outer through fix trapezoidal steel skin | See fig. 29 |
|            |                     | C2  | Build up systems: stripped wall to the existing steel purlin and apply new inner steel skin, steel bracket, mineral wool insulation and outer secret fix steel skin              | See fig. 30 |
|            |                     | C3  | Composite systems with PUR/PIR: stripped wall to the existing steel purlin and apply new composite panel applied   | See fig. 31 |
|            |                     | C4  | Composite systems with Rockwool: stripped wall to the existing steel purlin and apply new composite panel applied  | See fig. 32 |
|            | Re-cladding of roof | D1  | Build up systems: stripped roof to the existing steel purlin and apply new inner steel skin, steel bracket, mineral wool insulation and outer through fix trapezoidal steel skin | See fig. 27 |
| D2         |                     | Build up systems: stripped roof to the existing steel purlin and apply new inner steel skin, steel bracket, mineral wool insulation and outer secret fix steel skin | See fig. 28  |             |
| D3         |                     | Composite systems with PUR/PIR: stripped roof to the existing steel purlin and apply new composite panel applied  | See fig. 31  |             |

| Solution | Description   | Reference   |
|----------|---|-------------|
| D4       | Composite systems with Rockwool: stripped roof to the existing steel purlin and apply new composite panel applied | See fig. 32 |

**Table 3: Typical refurbishment solutions for commercial and residential buildings**

| Solution                 | Description         | Reference |  |             |
|--------------------------|---------------------|-----------|--|-------------|
| COMMERCIAL / RESIDENTIAL | Over cladding: wall | B1        | Build up systems: existing façade remains and steel-sub frame, mineral wool insulation and outer steel skin/cassette panels applied  | See fig. 8  |
|                          |                     | B2        | Composite flat panel systems with PUR/PIR: existing panels remains and steel sub-frame, composite panel applied  | See fig. 9  |
|                          |                     | B3        | Composite flat (or ribbed) panel systems with Rockwool: existing wall panels remains and steel sub-frame, composite panel applied  | See fig. 4  |
|                          |                     | B4        | Brick slips with PUR/PIR insulation and backing sheet and steel sub-frame  | See fig. 12 |
|                          |                     | B5        | Tile system on composite panel with PUR/PIR and steel sub-frame  | See fig. 13 |
|                          |                     | B6        | Tile system on composite panel with rock wool and steel sub-frame  | See fig. 14 |
|                          |                     | B7        | Stratascreen (honeycomb) metallic cladding system on U-sections with mineral wool between  | See fig. 10 |
|                          |                     | B8        | Stratascreen (PUR/PIR) metallic cladding system on U-sections with mineral wool between  | See fig. 11 |
|                          |                     | B9        | Direct applied insulated render on rock wool insulation  | See fig. 16 |
|                          |                     | B10       | Direct applied insulated render on EPS insulation  | See fig. 17 |
|                          |                     | B11       | Direct applied insulated render on PUR/PIR insulation  | See fig. 3  |
|                          |                     | B12       | Insulated render on EPS insulation, sheathing board on steel sub-frame   | See fig. 18 |
|                          | Over roofing        | F1        | Truss/modular roof systems: Convert existing flat roof to pitched roof – existing flat roof remains, add mineral wool insulation, steel frame (hot/cold form) and steel outer skin | See fig. 21 |
|                          |                     | F2        | Truss/modular roof systems: Convert existing flat roof to pitched roof – existing flat roof remains, add steel frame (hot/cold form) and Composite panel                           | See fig. 22 |
|                          |                     | F3        | Metal standing seam over roof solution: Add steel bracket, purlin and mineral wool insulation, clip fixing on top of purlin and a standing seam profile                            | See fig. 20 |

**Table 4: Typical roof top extension solutions for residential buildings**

| Solution    |                                       | Description | Reference   |             |
|-------------|---------------------------------------|-------------|---|-------------|
| RESIDENTIAL | Roof top extension / room in the roof | G1          | Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External steel purlin with insulation and through fix trapezoidal steel liner                         | See fig. 33 |
|             |                                       | G2          | Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External steel purlin with insulation and secret fixed steel liner                                    |             |
|             |                                       | G3          | Steel trusses / steel modules insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External insulation, timber battens and concrete tiles.  | See fig. 35 |
|             |                                       | G4          | Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External insulation, timber battens and clay tiles.   |             |
|             |                                       | G5          | Steel trusses / steel modules with insulation (mineral wool or PUR/PIR): Internal vapour barrier and double plasterboard. External composite insulated steel panels mimicking traditional slate, concrete or clay tiles pattern |             |

## Reference

**Steel cladding systems** (*Note: the majority of the information is found on the Corus website*):

- <http://www.corusgroup.com>
- <http://www.kingspan.com>

**Insulated render:**

- <http://www.inca-ltd.org.uk/>
- <http://www.wbs-ltd.co.uk/refurbishment.htm>

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