IEA ECBCS Annex 36: Retrofitting in Educational Buildings –
Energy Concept Adviser for Technical Retrofit Measures

SUBTASK A

Overview of Retrofitting Measures

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Energy Concept Advisor for Technical Retrofit Measures

Chapter 2

Building Envelope

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2.4. Overcladding systems

2.4.1. Introduction

Overcladding system is often the most logical solution to achieve a range of sensible improvements to the thermal performance of the external envelope of buildings,. It is best suited to be used in a comprehensive rehabilitation scheme, including windows and doors replacement and the installation of new heating and ventilation systems.
Overcladding system, in its generic form, is a composite one consisting of three key components:
Insulant (see chapter on Insulant materials and systems)
Fixing or framework
A variety of fixing are used:

- Mechanical fixing - metal or timber batten/rail system or framework and mechanical anchors or dowels
- Chemical fixing - various adhesives
- Mechanical and chemical fixing - a combination of the above fixings, eg chemical anchors.

Finish
There are two generic finishes:

- Wet render - polymer and fibre-reinforced cementitious renders (PMCR), polymeric coatings, insulating renders and cementitious renders
- Dry cladding - rigid boards, panels and tiling in a variety of materials.

2.4.2. Selecting overcladding systems

Overcladding system is appropriate for refurbishment projects when

- The external walls are poorly insulated
- The external walls are deteriorating or insufficiently weather tight, leading to damp, draught and heat losses.
- Wall cavities are bridged or blocked, limiting the possibility for cavity fill insulation.
- The use of internal lining insulation would be too disruptive, would alter critical internal dimensions or make room sizes too small.

General factors to consider in application of overcladding systems:

- overcladding system will involve alteration in various details of the building such as at windows, doors and where services punctuate the external envelope;
- the planning authority should be consulted for all overcladding system refurbishment projects. Overcladding system may not be appropriate where its application may alter the appearance of a sensitive or historic building.

2.4.3. Overcladding systems available

The following generic systems are available to choose from:

- Wet render systems
- Dry cladding systems
- Bespoke overcladding systems

Wet render and dry cladding systems are often proprietary products, developed and tested with third party accreditation for use in particular situations. Bespoke systems are designed by

architects or others for particular projects and combine all the elements of proprietary systems.

Advantages of overcladding system	Drawbacks of overcladding system
✓ Improves thermal performances	⇒ Overcladding system finishes are not as robust as solid construction; without attention, damage can lead to dampness and weathering problems
✓ Improves air tightness	
✓ Transfers the dew point outside the structural wall element	
✓ May contribute to improve sound insulation	⇒ Critical detailing requires knowledgeable design and care during installation
✓ Optimises use of thermal mass	
✓ Is relatively easy to install, leading to faster construction	⇒ Approved installers must be used for proprietary systems
✓ Ease of quality control as insulation coverage is clearly visible	⇒ Guarantees are only provided if a proprietary system is used, otherwise performance becomes the designer liability
✓ Renews ageing exterior facades	
✓ Contributes to eliminate internal problems: damp, condensation and mould growth, when accompanied by controlled ventilation	⇒ Small project demand the same level of technical support from system manufacturers as larger projects, hence they are relatively more expensive
✓ Avoids internal building works and can be installed during occupancy	⇒ Overcladding system is not suitable where an existing substrate is structurally unsound or cannot be repaired
✓ Increases life expectancy of buildings	
✓ Limits disruption to the fabric of the building	
✓ Does not reduce the size of the rooms	⇒ Overcladding system may not be suitable for listed or sensitive historic buildings
✓ Lowers maintenance costs	

2.4.4. Wet render systems

There is a wide range of wet render systems on the market. As insulation and fixing components are common to most systems, the component that distinguishes a high performance wet system from a low-performance wet system is the thickness and quality of the render. Wet render system consists of:

- Insulant
- Adhesive mortar and/or mechanically fixings, eg mushroom-headed dowels; fixing materials include polypropylene, nylon, stainless steel and plated steel
- Profiles and edgings in galvanised steel, stainless steel, plastic or aluminium, used on corners, at damp-proof course (DPC) level, window reveals, verges and copings
- Base-coat render, incorporating a glass fibre, plastic or metal mesh
- Top coat render with or without a finish

2.4.5. Use of wet render systems

Traditional render and PMCRs can be used on both low rise and high rise buildings. Polymer helps to make the render more workable on site, and in higher quantities provides weather protection and elastic flexibility in the render. Thin polymeric coatings can be used on both low-rise and high- rise buildings. The reduced weight of the render can be found to be advantageous in high-rise buildings. Polymeric coatings are relatively new on the market.

2.4.6. Critical detailing - Wet render systems

For wet systems, there are standard details and methods of application that must be followed according to manufacturers' recommendations. Particular care should be taken in the following areas:

- Fire spread and fire barriers - all systems must meet the current standards and regulations. Note that in multi-storey buildings, unless mineral wool insulation is used, fire breaks will be required in the overcladding system to prevent the spread of flame externally.
- Fixings to substrate - must take into account the nature and condition of the substrate, dead and imposed loads (wind pressure and dynamic suction), corrosion of fixings, and the movement of the system, with or isolated from, the building fabric.
- Render specification - to ensure weather protection, resistance to cracking, durability, aesthetic requirements, resistance to dirt and algae and to fulfil maintenance requirements.
- Specification of PMCR - the quantity of polymer used may vary considerably and the specifier should seek assurance from the manufacturer that the render is suitable for a specific application.
- Racking of renders and differential movement - cementitious-based renders must have movement or expansion joints in accordance with manufacturers' recommendations.
- Movement joints in the existing structure - Overcladding system will need joints at the same location
- Day-work joint - should be specified in the render system.
- Work on site - precautions should be taken to minimise particle spread from rasping of polystyrene insulation.
- Air leakage - must be prevented through the construction by correct detailing to avoid heat loss.
- Sealing of joints - must prevent water ingress into the system.
- Bi-metallic corrosion - must be avoided by correct specification
- DPC detailing - in existing and new buildings must not be compromised by insulation cover.
- Existing and new services - designers and installers need to resolve how to treat, for example, down pipes, gutters, gas mains, phone lines and aerials.

2.4.7. Dry cladding systems

Many dry cladding systems are available. They use a variety of supporting frameworks fixed back to the substrate or building structure. A cladding material is fixed to the framework based on standard cladding technology. Dry cladding systems consist of:

Insulant

Independently fixed to the substrate with a mechanical or adhesive fixing, or partially retained by the framework. Quilt material can reduce the risk of thermal bridging forming a tight fit around the framework.

Support framework or cladding fixing system

Support framework are constructed of treated timber, steel or aluminium. An adjustable framework ensures a true plane can be achieved over an uneven substrate. A stand-off framework or cross battening allows a continuous layer of insulation to the substrate, minimising thermal bridging. Spans can be mounted over substrate areas where fixings cannot be obtained. Frameworks members, their size, frequency and strength of fixing to substrate

are designed to withstand wind-loadings in accordance with manufacturers' recommendations. Supports will accommodate the insulation and a ventilated cavity behind rainscreen cladding.
Ventilated cavity
Most dry cladding systems incorporate a ventilation cavity between the cladding and the insulation to ensure that any moisture penetrating the cladding through the joints or migrating from inside the building is carried away
Cladding materials and fixing
Many cladding materials are available, including resin-impregnated laminates, highly compressed mineral wool, fibre-reinforced calcium silicate, aluminium panels and clay tiles. It is possible to have open joints to form a rainscreen cladding, or sealed joints for a fully sealed system. A wide range of colours and textures are available. Cladding fixings include nails, screws, rivets or partial secret fixing using adhesives. Pressed profiles, trims and cover/edge retention strips can add to the decorative effect of a panellised cladding system

2.4.7.1. Use of dry cladding system

Dry cladding system is particularly useful where fixings are restricted to particular areas of the building. Dry cladding is not used frequently on low rise buildings, where the cost can be prohibitive. Moreover the necessity to avoid possible damages of the system at the lower levels of the building suggests the use of different insulation methods for low rise buildings.

2.4.7.2. Critical detailing - dry cladding systems

As for wet systems, methods of application and system detailing should be according to manufacturers' recommendations. Particular care should be taken in the following areas: *Fire spread and fire barriers* - all systems must meet current standards and regulations.
Fixing to substrate - must take into account the nature and condition of the substrate, dead and imposed loads (wind, pressure and dynamic suction), movement of system with or isolated from the building. *Thermal bridging* - prevention by the use of a stand-off framework or cross-battening and ensuring the insulation is fitted tightly around the framework.
Maintenance of ventilation behind rainscreen cladding - by correct configuration of the supporting framework, correct fixings and retention of the insulation material and provision of permanent ventilation openings and non perforated cavity barriers. Bird and insect barrier or mesh should be added. *Air leakage* - must be prevented through the construction by correct detailing to avoid heat loss. *Existing and new services* - designers and installers need to resolve how to treat down pipes, gutters, gas mains, phone lines and aerials.

2.4.8. Bespoke overcladding system design

Designed individually by architects and designers, such a system tends to be simply detailed, allowing a non-specialist building contractor to construct it. The potential for bespoke overcladding system design mainly lies in dry cladding. A typical design may incorporate a rainscreen onto a substrate such as single blockwork, employing simple timber framing technology.

2.4.8.1. Critical detailing and watchpoints for bespoke overcladding systems

As for dry systems, the design should consider: water ingress - maintain a ventilated cavity; dynamic suction and imposed loads; fire protection - incorporate cavity barriers and prevent

surface spread of flame; maintenance and durability - suitable specification of cladding material and ease of replacement.

2.4.9. Selecting a system

2.4.9.1. Factors affecting the choice of a system

The main aspect to check in choice of a system is the suitability for the proposed application, for this purpose proprietary systems should be tested and accredited for use in a particular situation. The design and type of fixing and strength of the system have to fit the requirements for wind loading resistance. The condition of substrate can influence the choice of system, according to the type of fixing and framework available. The performance of insulation influences thickness to be achieved. Mouldability and flexibility of the system is required to form or fit around external features on a façade. Incorporation of fire barriers and prevention of fire spread can affect fire performance evaluation. Vapour permeability have to be checked in order to ensure the correct dew point position in the construction. Buildability and ease of construction evaluation may prevent problems on site and increase speed construction for a cost-effective solution. Ease of access itself may affect cost of supply and installation. Maintenance requirement have to be evaluated in order to ensure longevity and low long-term costs. Rough costs of different systems can be indicated as follows: wet traditional, insulated and PMCR renders present the lower cost per square meter, wet polymeric coating and dry bespoke design have medium costs and dry cladding systems present the higher costs per square meter (up to 3 times the cheapest one).
Systems described above present advantages and drawbacks. The following table suggest some of the possible of them in order to facilitate the choice of the system suitable for different situation.

	Advantages	**Drawbacks**
Dry cladding systems	• Panels can be removed easily for inspection or for replacing • A dry system with a ventilated cavity may be more appropriate where driving rain and high exposure levels are a problem • Vapour permeability is maintained where a ventilated cavity is used • Faster construction than wet systems • Fixing system or framework can provide some degree of stability or span over problem areas • Can be applied in freezing conditions • Manufacturers technical service available	• High performance dry system can be relatively expensive compared with high-performance wet render systems • Supervision is required for correct installation of insulation to ensure reduction in thermal bridging and maintenance of ventilated cavity • Thermal bridging may arise unless carefully designed out • High quality control required on site • High performance dry system can be relatively expensive compared with high-performance wet render systems

Wet render systems	• Different systems are available in a range of technical performances for varying situations • Polymeric coatings do not need movement joints where they are not required in a substrate • Manufacturers' technical service available	• Renders cannot be applied in low temperatures, especially polymeric coatings • It is not possible to inspect behind render after application without remedial works • High quality control required on site • Mess on site may occur when rasping polystyrene
Bespoke systems	• Gives control of the composition and costs of individual materials as they are not part of a manufacturers' package • Gives the opportunity to use sustainability sourced products and materials • Gives the ability to design the system to allow vapour permeability through the wall construction • A wider variety of finishes can be used - eg weather boarding, stone, glass, terracotta and tile hanging • Is of tailor-made design to suit the building and its context	• No guarantee is available • No technical service is available from system manufacturers • Guaranteed performance becomes designer's liability • New designs are untested

2.4.10. Ventilated Roofs

This kind of system may be obtained by the use of an air layer of constant thickness placed between the covering elements and the below layers. This layer has the function to contribute to the control of the igrothermal characteristics of the roof through adequate air changes. This system comes adopted to the aim of:

- in the warm season: reducing the heat gains below the tiles through activation of convective flows, making comfortable the lving of the attic
- in the cold season: avoiding the humidity stagnation under the tiles, with consequent condensations that may deteriorate the insulating materials and the other structures of the cover.

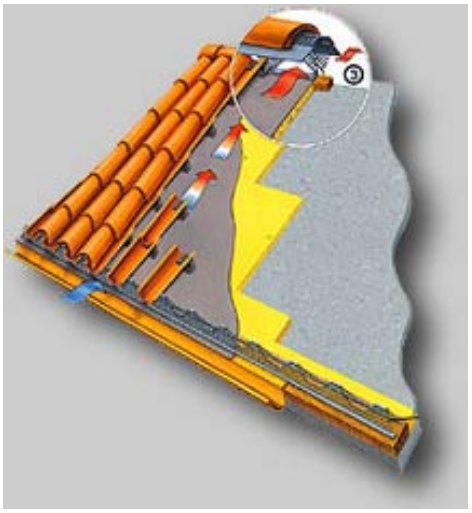
The discontinuous covers, regarding to the methodology of control of the igrothermal behavior of the structure, can be characterized and classified in the four following functional outlines:

- roof without insulating layer neither the ventilation one.
- roof without insulating layer, but equipped of the ventilation one.
- roof equipped with insulating layer, but lacking in the ventilation one (hot roof).
- roof equipped with insulating layer and the ventilation one too (cold roof).

From the igrothermal point of view the last type of cover is perhaps the one which gives the best guarantees of a satisfieing operation. The insulating layer allows to catch up the

demanded value of total thermal resistance while the ventilation layer contributes to regulating the igrothermal characteristics of the cover
The ventilated layer (always placed immediately over the insulating one) can be realized by means of the space attic or also obtained by means of an appropriate ventilated air layer of constant thickness, tilted, adjacent to the structural layer. There are several techological systems to obtained ventilated roof.

- Under-tile ventilation system: it consists in a ventilated preassembled panel which makes possible to put down the insulating material, the room of ventilation and the support for the cover mantle in one operation only. The ventilation room has the height of cm.4. The system includes the supply of one antisparrow grill and a ventilated overflow to realize in work.



- Ventilated/Anchorated roof: the system consists in one room of ventilation obtained by means of the application, on every channel between the tiles, of an element with functions of rise-spacer and, at the same time, anchorage of the tiles. The obtained interstice complies with the following technical prescription: ventilation surface not less than cmq./ml.600; absolute absence of horizontal fillets limiting the upward air flow of warm air. The direct contact of the cover with the ventilation interstice takes advantage of the overheating of the air increasing the outflow speed. This system adapted to install new or recovered tiles and it is equipped of an antisparrow grill in a position to let the warm air coming go out

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