



External insulation
for dwellings



energy saving trust®

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The Energy Saving Trust would like to acknowledge the valued advice and contributions of Gale & Snowden Architects as well as the Insulated Render and Cladding Association (INCA) and INCA members. All diagrams courtesy of Gale & Snowden Architects.

Cover image: Lymm Water Tower, Cheshire: Architect and building owner – Ellis Williams.
System designer – Alumasc Exterior Building Products Ltd. Installer – Pegasus Externals Ltd.

1 Introduction and definitions

Introduction

This guide describes the external insulation systems – i.e. those with insulation on the outside of the main wall – available to architects, specifiers and builders. It covers both renovation of residential dwellings and new build, high-rise and low-rise – and includes a number of examples. Advice is provided on system selection, overall construction costs, critical detailing, durability and maintenance.

Home energy use is responsible for 27 per cent of UK carbon dioxide (CO₂) emissions, which contribute to climate change. By following the Energy Saving Trust's best practice standards, new build and refurbished housing will be more energy efficient, reducing emissions, saving energy and money, as well as protecting the environment.

There are many different types of external wall insulation system and they vary in quality and application. Choosing an appropriate system can be a daunting task. Many homes, flats and tower blocks are refurbished just 20 or 30 years after construction. External insulation is often the logical choice for improving the thermal performance and external façade of the building, especially for high-rise. In some cases, it may be the only practical method of achieving significant thermal upgrading.

When combating long-term problems such as internal damp, water ingress and air infiltration (leading to heat loss), this may be the only realistic option. It is best employed in a comprehensive rehabilitation scheme, including window and door replacement and the installation of new heating and ventilation systems. In new developments, external wall insulation can increase energy efficiency and lead to economic benefits.

Building regulations around the UK set requirements for new and existing homes (see box). If in any doubt, contact the local building control department.

Definitions

External insulation

In its generic form, this is a composite system consisting of three key components:

- **Insulant** – providing the thermal insulation.
- **Fixings or framework** – securely fixing the system to the substrate.
- **Finish** – a protective layer providing weather protection and a finish (often including accessories that offer further protection and connection to elements of the building such as windows and doors).

Insulants

These can be broken down into the following categories:

- **Mineral fibre** – quilt or rigid slab.
- **Closed cell foam** – rigid panels, e.g. polyisocyanurate, urethane or phenolic.
- **Expanded pentane blown polystyrene** – rigid panel.
- **Extruded polystyrene** – rigid panel, used below the damp proof course.
- **Others** – plant-based (e.g. cork, cellulose, woodfibre, reed matting, hemp) or cellular glass.

Fixings

- **Mechanical** – metal or timber batten/rail system or framework and mechanical anchors or dowels.
- **Chemical** – various adhesives.
- **Mechanical and chemical** – a combination, e.g. chemical anchors.

Finishes

There are two generic finishes:

- **Wet render** – these may be cementitious renders, polymer and fibre-reinforced cementitious renders, polymeric coatings or insulating renders.
- **Dry cladding** – rigid boards, panels and tiling in a variety of materials.

Regulations

Guidance provided within this document should be considered in conjunction with the relevant building regulations. These regulations vary across the UK, therefore the building control body should be consulted for individual standards. Where applicable all aspects of national building regulations should be met.

The following documents detail the building regulations applicable for existing dwellings in each part of the UK:

England and Wales

The Building Regulations 2000, Conservation of fuel and power, are detailed in Approved Document L1B – Work in existing dwellings (2006 Edition).

Scotland

Section 6: Energy, of the Domestic Technical Handbook on possible ways of complying with the Building (Scotland) Regulations 2004.

Northern Ireland

Building Regulations (Northern Ireland) 1994, are detailed in Technical booklet F, Conservation of fuel and power (December 1998) – Currently under revision.

3 External insulation systems



Figure 1 The University of East London's Design and Engineering Campus, by Edward Cullinan Architects
(Photo courtesy of weber building solutions)

Thermal improvements are most cost-effective as part of a package of remedial and refurbishment works. Where walls have a high U-value, insulation should be considered when replacing windows and adding loft insulation, in order to avoid exacerbating condensation and mould problems in the dwelling. This can be applied as:

- Cavity fill insulation.
- Internal lining insulation.
- External insulation.

External insulation is appropriate for refurbishment where:

- External walls are poorly insulated.
- External walls are deteriorating or are insufficiently weather-tight, causing damp, draughts and heat loss.
- Wall cavities are bridged or blocked, making them unsuitable for cavity fill insulation.
- The external appearance needs updating as part of a rehabilitation scheme for high-rise or system-built housing.
- Installing internal lining insulation would be disruptive, would alter critical internal dimensions or make room sizes too small.

Other factors

The application of external insulation will involve alterations to a number of building details. These include eaves overhangs, gable ends, windows, doors and places where services puncture the external envelope. Robust details for junctions are available for most typical construction types. For more information visit www.est.org.uk/housingbuildings/calculators/robustdetails

The planning authority should be consulted for all refurbishment projects involving external insulation. It may not be an appropriate option if it alters the appearance of a sensitive or historic building.

Table 1 Comparison of different wall insulation methods in refurbishment projects

Insulation methods	Insulated cavity wall	Internal lining	External insulation
Upgraded external appearance	No	No	***
Potential for thermal improvement	**	*	***
Occupation during installation	Possible	No	Possible
Structural protection	* (see note)	No	***
Installation cost comparison	£	££	£££
* not good			
*** good			
£ less expensive			
£££ more expensive			
Note: some injection foam systems are designed to provide structural stability when wall ties have corroded			

External insulation systems

External insulation for high-rise dwellings

External insulation is frequently used on high-rise dwellings to:

- Increase energy efficiency.
- Protect the fabric of the building.
- Improve the appearance.
- Improve comfort levels for occupants.

Although installation costs may be relatively high, external insulation has the potential to achieve significant energy savings and is the solution that causes least disruption to residents. It is particularly appropriate in high-rise structures with thermal bridging problems (where there is an exposed concrete frame, for example). Strategic guidance is available in GPG80 – see 'Further information'.

External insulation and new build

While external insulation is frequently employed in refurbishment, it is not often chosen for new build in the UK – unlike the practice in continental Europe and further afield. There are, however, many benefits to be gained, especially where cladding or render is used for the exterior finish.

- High levels of insulation can be achieved without increasing the overall size of the structure (for larger cavities or to compensate for reduced room sizes due to internal lining).
- Simplified wall construction and reduced construction costs through the use of solid load-bearing walls, since there is no need for a cavity.
- Simplified construction detailing, avoiding thermal bridging and air leakage (particularly around openings and at wall-to-floor junctions).
- Maximum benefit from the thermal mass of the wall construction, floors and internal partitions. The 'insulation blanket' around the walls of the building helps to level out internal temperature fluctuations.
- Faster construction speeds.

External insulation protects the structure of the building from the weather and external/internal temperature differentials. The dew-point, where vapour from inside the building is likely to condense, is further towards the outside and away from critical structural or load-bearing wall elements.

Systems available

Three generic types are available:

- Wet render systems.
- Dry cladding systems.
- Bespoke external insulation systems.

Wet render and dry cladding systems are often proprietary products with third-party accreditation (such as technical approvals from The British Board of Agrément, or BRE Certification Ltd) for use in specific situations. They are normally guaranteed when installed by the manufacturer's approved contractors. Bespoke systems are designed for particular projects and combine the elements of proprietary systems. They often incorporate dry cladding and the specification should be drawn up with the advice of appropriate experts, e.g. in timber technology.



Figure 2 Skywood House, Middlesex, by Foster and Partners
(photo courtesy of Sto Limited)

Advantages

External insulation:

- Protects the fabric of the building.
- Improves thermal performance.
- Ensures consistent U-values.
- Reduces thermal bridging, thereby minimising condensation and heat loss.
- Reduces thermal stress on the structure or substrate.
- Transfers the dew-point outside the structural wall element.
- Improves the airtightness of the construction, reducing draughts and heat loss.
- Maximises the effect of thermal mass, reducing internal temperature fluctuations.
- May contribute to improvements in sound insulation as part of general refurbishment, e.g. where windows are being replaced.
- Is available in a wide range of finishes and colours.
- Is relatively easy to install, leading to faster construction.
- Makes quality control easier as the insulation coverage is clearly visible.
- May be independently tested and certified for use in particular situations.
- May be covered by a guarantee where proprietary systems are installed by an approved contractor.

In new build applications, external insulation:

- Simplifies construction, particularly in terms of avoiding thermal bridging and achieving airtightness.
- Saves capital and running costs, as smaller heating systems can be used.
- Achieves high levels of insulation without increasing the size of the structure.
- Reduces labour and materials costs, leading to a good value construction.
- Usually eliminates the need for a vapour barrier, as the dew-point is transferred outside the structure.

In refurbishment applications, these systems:

- Bring major aesthetic improvements.
- Improve property values, by extending the life of the building, and modernising its appearance.
- Renew ageing exteriors.
- Lower maintenance costs.
- Limit disruption to interior décor and occupants.
- Can strengthen the existing structure.
- Increase life expectancy.
- Can help upgrade the property to a mortgageable standard.
- Avoid internal building works.
- Can be installed while occupants remain in residence.
- Do not reduce the size of rooms.
- Permit the installation of higher levels of insulation.
- Help to eliminate problems of damp, condensation and mould growth (when accompanied by controlled ventilation).
- Can mitigate the cost of replacing old render (with insulating render systems there is no need to chip off the old render, which would normally be necessary when replacing with render alone).
- Eliminate the need for extensive re-pointing, thus saving money.

Drawbacks

External insulation may sometimes have disadvantages:

- Finishes tend not to be as robust as solid construction; damage could lead to damp ingress and weathering problems.
- Critical details require knowledgeable design and careful installation.
- Construction costs can appear to be high compared to traditional construction in new build.
- Approved installers must be used for proprietary systems.
- Guarantees are only provided for proprietary systems.
- Small projects are relatively more expensive as they demand the same level of technical support from system manufacturers as larger ones.
- External insulation is not suitable if the existing substrate is structurally unsound or cannot be repaired.
- This technology may not be suitable for listed or sensitive historic buildings.

4 Wet render systems

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

- Insulant.
- Adhesive mortar and/or mechanical fixings (mechanical fixings may include mushroom-headed dowels; fixing materials include polypropylene, nylon, stainless 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.
- A base-coat render, incorporating a glass fibre, plastic or metal mesh.
- A top-coat render, with or without a finish.

INCA categorises wet render systems in the following way:

Traditional render (thick render)

- Two or three coat cementitious render to BS 5262.
- Factory batched – may contain polymers.
- Total thickness – 16-25mm over insulant.

Polymer-modified cementitious render (PMCR)

- Fibre-reinforced.
- Applied in one or two coats.
- Total thickness – 6-12mm over insulant.
- Can have a polymeric top coat.

Polymeric coating (thick render)

- Polymer-modified cementitious or cement-free base coat.
- Base coat – 4-10mm over insulant.
- Can have polymeric top coat.
- Synthetic textured finish – 1.5-4mm.

It should be noted that some systems can fall between these generic categories depending on the characteristics of the top and base coats.

Insulating render

- Air-based insulant in a traditional (thick) render.
- Total thickness – 25-80mm.
- Gives a relatively small increase in thermal performance.

Using wet render systems

Traditional render and polymer-modified cementitious render can be used in both low-rise and high-rise applications. Polymer helps to make the render more workable on site and, in larger quantities, provides weather protection and elastic flexibility. Polymer-modified cementitious systems have been used in the UK since the early 1980s.

Thin polymeric coatings can be used on both low-rise and high-rise buildings. The reduced weight may be advantageous in high-rise. These coatings do not need movement joints unless the building substrate has them.

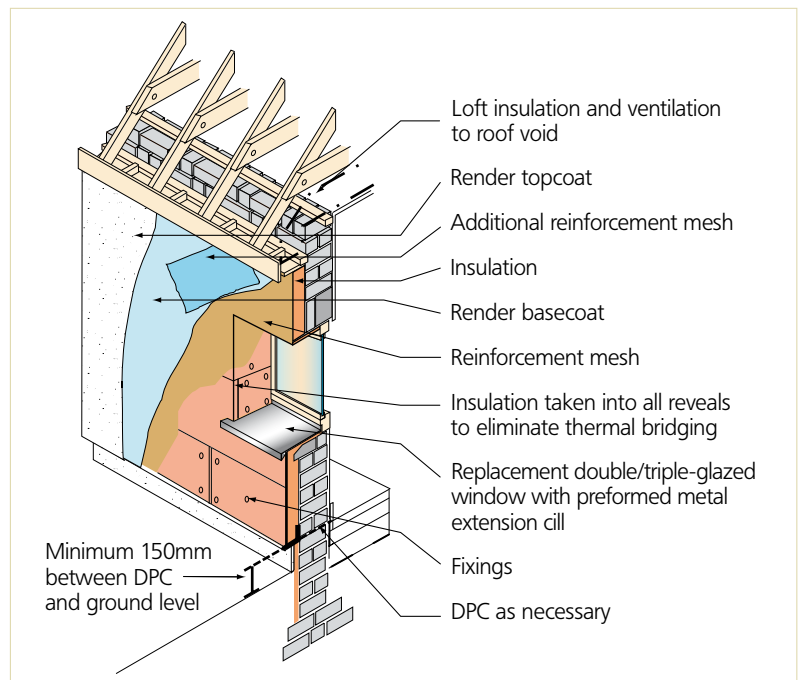


Figure 3 Diagram of a typical wet render system applied to an existing solid masonry wall

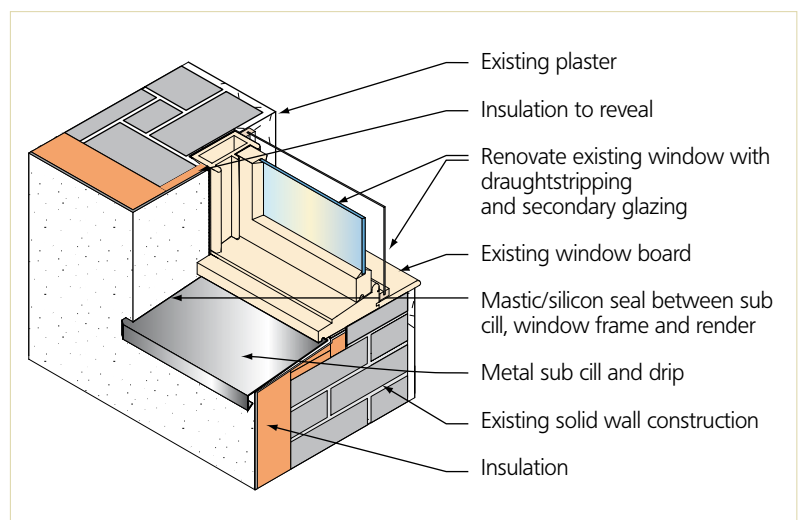


Figure 4 Refurbishment window reveal detail

5 Critical detailing – wet render systems

Standard details and methods of application must be followed, in accordance with manufacturers' recommendations. Particular care should be taken in regard to the following.

Fire spread and fire barriers

All systems must meet current standards and regulations. In multi-storey buildings firebreaks will be required in the external insulation system to prevent the spread of flame externally.

Fixings to the substrate

These must take into account a number of factors including: the nature and condition of the substrate; the dead and imposed loads (wind pressure and dynamic suction); potential corrosion; and the movement of the system with, or isolated from, the building fabric.

Thermal bridging

Particular care is needed for insulation detailing at junctions including: window and door reveals; eaves; verges; and the ground. Attention must also be paid to the fixing of details to substrate, particularly in refurbishment projects (e.g. details around balconies, handrails and signs).

Render specification

This should ensure the required weather protection, resistance to cracking, durability, aesthetics, resistance to dirt and algae, and also satisfy maintenance requirements.

Polymer-modified cementitious render

The quantity of polymer varies considerably between systems. The specifier should check with the manufacturer that the render is suitable for the specific application.

Racking of renders and differential movement

Cementitious renders must accommodate movement or else have expansion joints, in accordance with manufacturers' recommendations. As the provision and design of movement joints varies with the system, manufacturers' specifications must be used.

Movement joints in the existing structure

External insulation will usually need joints at the same locations. Joints that effectively separate two structurally independent parts of a building may not be bridged under any circumstances.

Day-work joints

These should be specified in the render system.

Work on site

Particle spread from rasping of polystyrene insulation should be minimised: these are not biodegradable and may present a hazard or annoyance to occupants and users of the area.

Air leakage

Correct detailing will prevent this.

Sealing of joints

This must be carried out effectively in order to prevent water ingress into the system.

Bi-metallic corrosion

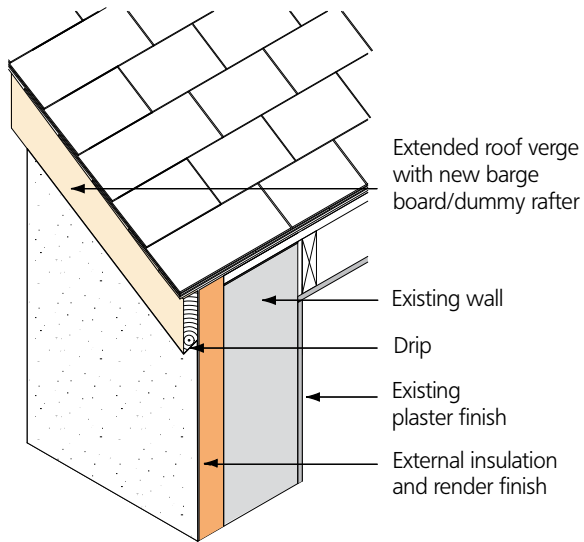
Correct specification will ensure this does not occur.

DPC detailing

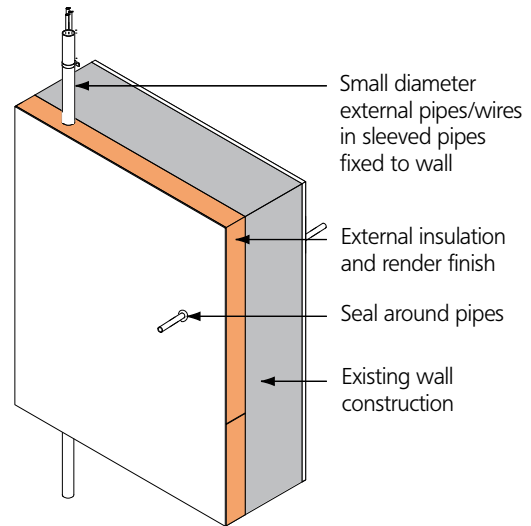
The DPC must not be compromised by being covered with insulation. Refer to manufacturers' details.

Services

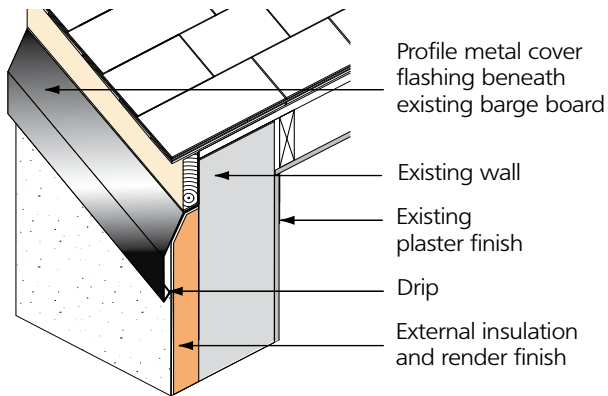
Designers and installers must decide how to treat, for example, down pipes, gutters, gas mains, phone lines and aerials.



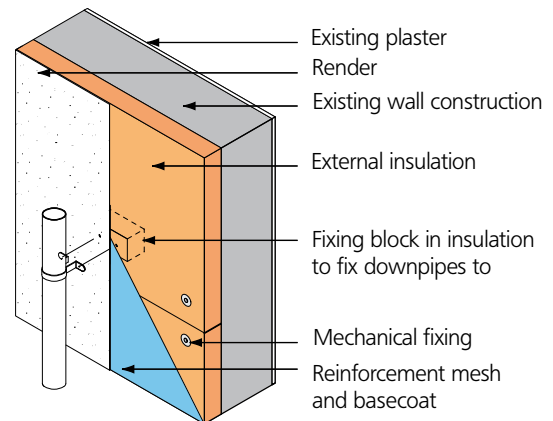
Refurbishment verge detail



Refurbishment detail showing inclusion of services in external insulation system



Alternative refurbishment verge detail



Detail showing a fixing through external insulation system

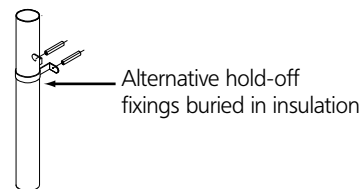


Figure 5 Selected details for wet render systems

6 Dry cladding systems

Dry cladding systems use a variety of supporting frameworks fixed to the substrate or building structure. The cladding material is fixed to the framework using standard technologies. Dry cladding systems consist of:

- The insulant, fixed to the substrate in a similar way to wet systems.
- A supporting framework or cladding fixing system.
- A ventilated cavity.
- Cladding material and fixings.

The insulant

This may be 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 by forming a tight fit around the framework.

Supporting frameworks or cladding fixing systems

These will be made of treated timber, steel or aluminium. An adjustable framework enables a true plane to be constructed over an uneven substrate. With a stand-off framework or cross-battening, a continuous layer of insulation can be applied to the substrate, minimising thermal bridging.

These systems can span over substrate areas where fixings cannot be anchored. The size and frequency of framework members, as well as the strength of fixing to the substrate, must be designed to withstand wind-loadings in accordance with manufacturers' recommendations. The frameworks enclose the insulation and, usually, a ventilated cavity behind rainscreen cladding.

Ventilated cavity

Most dry cladding systems incorporate a ventilation cavity between the cladding and the insulation. This ensures that any moisture penetrating the cladding through the joints, or migrating from inside the building, is carried away.

Cladding materials and fixings

Commonly available cladding materials include: resin-impregnated laminates; highly compressed mineral wool; fibre-reinforced calcium silicate aluminium panels; clay tiles and recycled glass granulate suitable for seamless thin coat render. A rainscreen cladding will have open joints, while a fully sealed system will have sealed joints. A wide range of colours and textures are available.

Cladding fixings include nails, screws and rivets. Partial secret-fixing uses adhesives. Pressed profiles, trims and cover/edge retention strips can be added to enhance the decorative effect of a panel cladding system.

Using dry cladding systems

Dry cladding is particularly useful where fixings have to be restricted to particular areas of the building. Access can be gained for periodic checks and maintenance work, which often proves necessary on high-rise buildings. Dry cladding is seldom used on low-rise dwellings as the cost can be prohibitive.

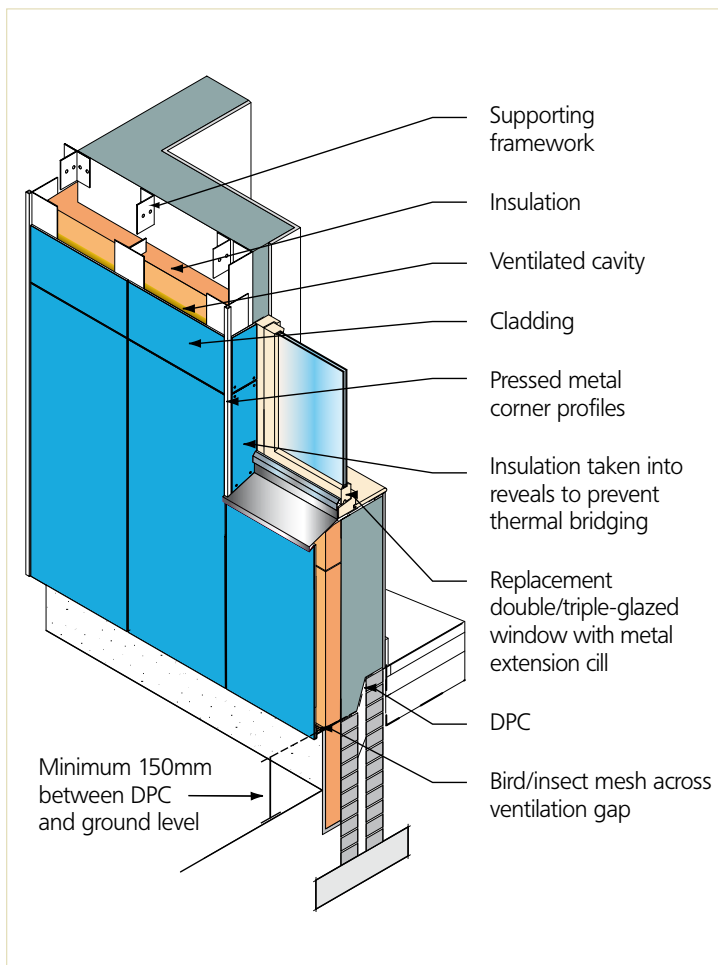


Figure 6 Diagram of a typical dry cladding system

7 Critical detailing – dry cladding systems

Application methods and system detailing should follow manufacturers' recommendations. Particular care should be taken in the following areas.

Fire spread and fire barriers

Systems must meet current standards and regulations. Fire protection measures include the provision of a strip of non-combustible insulation, the introduction of a cavity barrier and the prevention of surface spread of flame.

Fixings to the substrate

Factors that must be taken into account include: the nature and condition of the substrate; dead and imposed loads (wind pressure and dynamic suction); movement of the system with, or isolated from, the building.

Thermal bridging

The use of a stand-off framework or crossbattening will help prevent this. The insulation should be fitted tightly around the framework.

Movement

An allowance needs to be made at all cladding joints in accordance with manufacturers' details.

DPC

The DPC detailing must not be compromised by covering it with insulation.

Maintaining ventilation behind the rainscreen cladding

This can be achieved by correct configuration of the supporting framework, correct fixing and retention of the insulation material, together with the provision of permanent ventilation gaps above and below the cladding, window openings and non-perforated cavity barriers. Bird and insect barriers or mesh should be added.

Air leakage

Correct detailing will prevent this.

Bi-metallic corrosion

Correct specification will ensure this does not occur.

Compatibility

Ensuring that boards and metal support frameworks can be used together may mean employing an isolating material foam tape.

Services

Designers and installers must decide how to treat down pipes, pipes, gutters, gas mains, phone lines and aerials.

Concealed fixings

Metal cladding panels are available that hook on to provide a totally secret fixing.

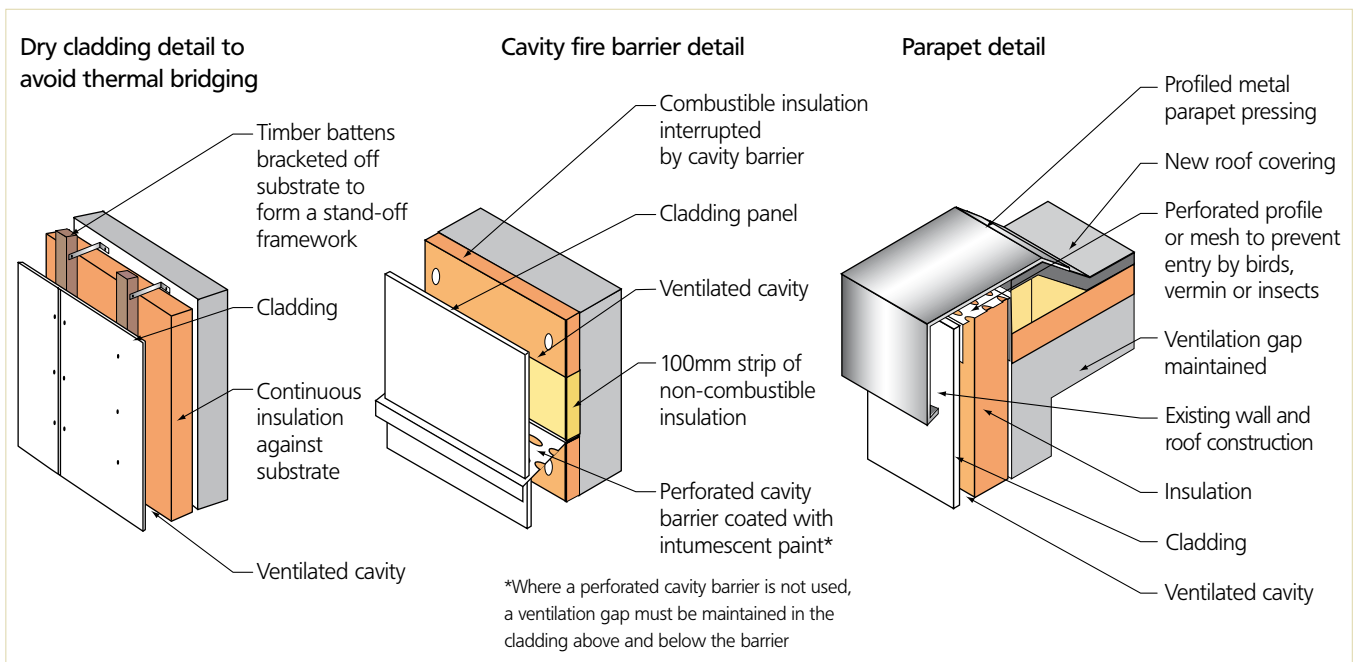


Figure 7 Selected details for dry cladding systems

8 Bespoke systems



Figure 8 Bespoke system using unseasoned oak cladding, by Gale and Snowden Architects
(Photo courtesy of Clive Boursnell)

Designed by architects and designers for individual projects, bespoke systems tend to have simple detailing, allowing a non-specialist building contractor to construct them.

A typical design may consist of a rainscreen fastened onto a substrate such as single blockwork with simple timber-framing technology. It should be noted that a guarantee will not normally be available: reliance will most likely have to be placed on the designer's professional indemnity insurance. It is therefore best undertaken by those with expertise in this area.

Figure 8 illustrates the use of unseasoned oak weatherboard as an external cladding.

Critical detailing and watchpoints

As for dry cladding systems, the design should consider:

- The prevention of water ingress by a ventilated cavity.
- Dynamic suction and imposed loads.
- Fire protection – the design should incorporate cavity barriers and prevent surface spread of flame.
- Maintenance and durability – suitable cladding materials should be chosen and ease of replacement taken into account.

An example of a bespoke design

The design in Figure 9 shows blockwork providing internal thermal mass. Timber studwork and a sheathing material create a 250mm cavity filled with loose cellulose insulation.

If solid timber studwork is used, it can be bracketed off the blockwork to avoid thermal bridging. Alternatively, lightweight composite I-beams of low thermal conductivity can be used. The whole construction is vapour permeable and airtight.

A ventilated cavity and unseasoned oak weatherboarding act as the rainscreen. This architect-designed system demonstrates how insulation can be used externally and how it is possible to use environmentally sustainable materials.

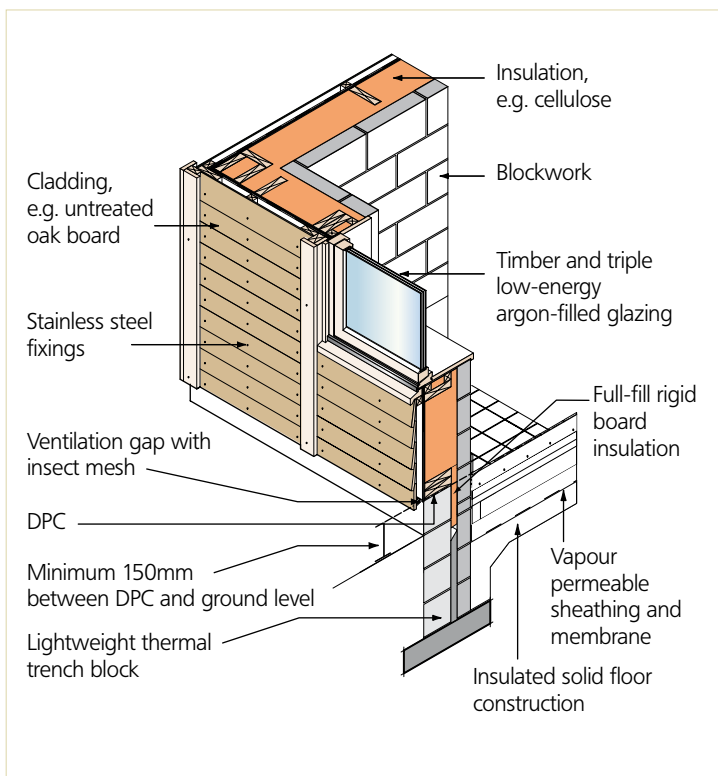


Figure 9 Diagram of a new build bespoke external insulation system

9 Energy Saving Trust standards and environmental criteria

The external cladding or render is generally the major cost item in any system, so it is logical to maximise the amount of insulation in order to maximise the benefit.

There are three Energy Saving Trust performance standards for new housing and these are set at different levels:

- Good practice – represents an improvement on building regulations. The maximum permitted U-value is 0.30W/m²K.
- Best practice – represents a readily achievable higher and is suitable for all general housing. The maximum permitted U-value is 0.25W/m²K.
- Advanced – suitable for extremely energy efficient exemplar housing requiring specialist design and construction input. This is based on the European PassivHaus standard (www.passivhaus.de). The maximum permitted U-value is 0.15W/m²K.

The good practice and best practice standards use a 'whole house' Dwelling Emissions Rate (DER) approach: this considers the overall carbon dioxide

emissions in a very similar way to the 2006 building regulations in England and Wales (Part L1A) and Northern Ireland (Technical Booklet F). This allows specifiers to 'trade off' the performance of one construction element against others and consequently there is no single U-value that can be stated for walls.

Full details of these standards can be found by visiting www.est.org.uk/housingbuildings/standards

For existing dwellings which are being externally insulated, the Energy Saving Trust best practice performance standard sets a limit U-value of 0.3W/m²K. Figure 10 shows how the U-value can be achieved with different insulation types of varying thicknesses. It also shows the insulation thickness necessary at reveals to limit thermal bridging.

The U-values quoted are only applicable to the exact element construction described. Contact the manufacturer of the selected insulation material to discuss the technical requirements and assess the potential for interstitial condensation for the specific building prior to commencing work.

Insulation type	Typical thermal conductivity (W/mK)	External wall insulation						Reveal insulation thickness
		Insulation thickness						Thickness (mm) to achieve best practice R-value of 0.5m ² K/W
		40mm	60mm	80mm	100mm	120mm	140mm	
U-values achieved								
Phenolic	0.022	0.44	0.32	0.25	0.21	0.18	0.16	12
Polyisocyanurate and polyurethane	0.023	0.45	0.33	0.26	0.22	0.19	0.16	12
Expanded polystyrene and mineral wool (slab)	0.038	0.65	0.49	0.39	0.33	0.28	0.25	19
Cellular glass and woodfibre	0.040	0.67	0.51	0.41	0.34	0.30	0.26	20

■ Worse than best practice in refurbishment
 ■ Achieves best practice in refurbishment

Figure 10 U-values and thicknesses for different insulation types based on common construction details. Figures are based on 20mm lightweight plaster, 220mm brick, insulation (with four 10mm² fixings per m² – conductivity of fixings 50W/mK), 20mm sand and cement render.

Environmental effects of manufacture and installation

The main environmental impact of any building is the energy used by occupants to run the building during its lifespan known as 'operational energy'. However it is also important to consider the impacts from construction materials which include embodied energy, mineral extraction and the use of ozone-depleting chemicals.

Embodied energy is the energy used during the manufacture, maintenance and replacement of the components that constitute the building during its lifespan. In older buildings operational energy has traditionally represented the major impact. As the energy efficiency standards of modern buildings have been raised the importance of embodied energy has increased.

Where the selection of products and materials directly affect the operational energy, the most efficient option should be selected. For those looking to maximise environmental benefit, or where products are very similar in terms of operational performance, then these other aspects should also be taken into consideration.

Further information about the environmental impact of building materials, including embodied energy, mineral extraction and the use of ozone-depleting chemicals or green house gases, can be found in the Green Guide to Housing Specification (BR390).

Also see 'Insulation materials chart – thermal properties and environmental ratings' (CE71) for further information.



Lymm Water Tower, Cheshire
Architect and building owner – Ellis Williams. System designer – Alumasc Exterior Building Products Ltd.
Installer – Pegasus Externals Ltd.

Table 2 Environmental rating for different external insulation systems

Element type	Element	Insulation groups A B C	Summary rating	Climate change	Fossil fuel depletion	Ozone depletion	Freight transport	Human toxicity	Waste disposal	Water extraction	Acid deposition	Ecotoxicity	Eutrophication	Summer smog	Minerals extraction	Typical replacement interval	Recycled input	Recyclability	Recycled currently	Recycling energy
Bespoke timber clad	Local timber cladding, timber framework	Any – A B or C	A	A	A	A	A	A	A	A	A	A	A	C	A	30	C	A	B	A
Dry cladding systems	Aluminium/plastic board, aluminium framework	Any – A B or C	B	B	A	A	A	C	A	B	A	A	A	A	A	40	A	B	A	B
	Aluminium/plastic board, steel framework	A rating	A	A	A	A	A	B	A	A	A	A	A	A	A	40	B	B	A	B
		B or C rating	B	B	B	B	A	C	A	A	B	B	B	A	A	40	B	B	A	B
	Epoxy resin laminate board, aluminium framework	Any – A B or C	C	C	C	A	A	B	B	B	C	A	A	C	A	30	C	C	B	C
	Fibre cement board, aluminium framework	A or B rating	A	A	A	A	A	B	A	C	A	A	A	A	A	40	A	B	A	A
		C rating	B	B	B	A	A	B	A	C	B	A	A	A	A	40	A	A	A	A
Terracotta rainscreen cladding, aluminium framework	A rating	A	A	A	A	A	B	A	B	A	A	A	A	A	30	A	B	A	B	
	B or C rating	B	B	A	C	A	C	A	B	A	B	C	A	A	30	B	B	A	B	
Insulating render	Insulating lime render	n/a	C	B	B	A	C	A	C	A	A	A	A	A	C	30	C	A	A	A
Polymer-modified cementitious render	Polymer-modified render, render glass wool mesh	A or B rating	A	A	A	A	A	A	B	B	A	A	A	A	B	25	C	A	A	A
		C rating	B	B	B	A	A	A	A	B	B	A	A	A	B	25	C	A	A	A
Polymeric coating	Polymeric coating, glass wool mesh	A or B rating	B	B	B	A	A	B	A	A	B	A	A	B	A	20	C	C	C	C
		C rating	C	B	C	C	A	C	A	A	B	C	C	A	A	20	C	C	C	C
Traditional render	Sand/cement render, glass wool mesh	Any – A B or C	A	A	A	A	A	A	B	C	A	A	A	A	C	30	C	A	A	A

This table shows the (A, B, C) environmental rating for different external insulation systems. Ratings are awarded against the issues described above as A, B or C, indicating the best third, middle, or worst third of the list of systems examined.

This data is reproduced by courtesy of the BRE's Centre for Sustainable Construction. The information is part of the Green Guide to Housing Specification (BR 390) available from the BRE Bookshop (see Contact information for details).

Group A Expanded polystyrene, glass wool, mineral wool, recycled cellulose.

Group B Corkboard, foamed glass, polyurethane (ZODP).

Group C Extruded polystyrene (ZODP).

Any use of insulation that does not have ZODP rating will automatically receive a 'C' summary rating.

The issues rated in table 2 are briefly defined as follows.

- Climate change – global warming gases.
- Fossil fuel depletion – coal, oil and gas consumption.
- Ozone depletion – gases which destroy the ozone layer.
- Freight transport – distance and mass of freight moved.
- Human toxicity – pollutants which are toxic to humans.
- Waste disposal – material sent to landfill or incineration.
- Water extraction – mains, surface and ground water consumption.
- Acid deposition – gases which cause acid rain, etc.
- Ecotoxicity – pollutants which are toxic to the ecosystem.
- Eutrophication – water pollutants which promote algal blooms, etc.
- Summer smog – air pollutants which cause respiratory problems.
- Minerals extraction – metal ores, minerals and aggregates mined.

10 System selection

Factors affecting the choice of system

- The proposed application – have the proprietary systems been tested and accredited by a third party for use in this situation?
- The proposed location – will the system meet the exposure ratings given in BS 8104, 'Code of practice for assessing exposure of walls to wind-driven rain'?
- Wind-loading – are the design and type of the fixings, and the overall strength of the system, sufficient?
- Condition of the substrate – are the framework and the fixings suitable?
- Performance of the insulation – what thickness of insulation is to be achieved?
- Quality and range of finishes, textures and colours – these have to suit the aesthetics of the scheme?
- Mouldability and flexibility of system – can the materials be formed or fitted around external features on a façade?
- Fire performance – fire barriers and prevention of fire spread issues have to be resolved.
- Vapour permeability – will the system provide the correct dew-point position?
- Availability of a company guarantee – this should be offered by manufacturers when installed by an approved contractor.
- Quality assurance – are the manufacturers and installers BSI registered under ISO 9001 or 9002 for the design, manufacture and supply of their systems?
- Buildability – how easy is the construction method?
- Speed of construction – this will help achieve a more cost-effective solution.
- Cost of supply and installation – this can be affected by ease of access.
- Maintenance requirements – this will impact on longevity and long-term costs.

Factors affecting the choice of insulant

- The nature or form of insulant, its rigidity and workability (e.g. whether a panel, quilt or loose beads/fibres).
- Mouldability and flexibility, the ease of forming or fitting around external features.
- Degree of support required for the render or finish.
- Performance in fire.
- Chemical composition.
- Embodied energy content.
- Cost.

Factors affecting the detailing

- Strength of system for dead and imposed loads.
- Wind loading and resistance to suction.
- Nature of the substrate or structure – its strength, soundness and friability.
- Long-term performance of the finish.
- Thermal shock – differential movement between render and insulation due to rapid temperature changes.
- Freeze/thaw cycling.
- Heat and moisture cycling.
- Capillary water action.
- Corrosion of fixings and trims.
- Impact resistance.
- Fire spread; the incorporation of horizontal and vertical fire barriers; the use of appropriate fixings to prevent deformation of the cladding by fire.
- Vapour permeability and interstitial condensation.
- Dimensional variation as a function of temperature and humidity.
- Differential movement between materials – e.g. the amount of metal components in the render.
- Long-term maintenance care.

Durability and maintenance

External insulation is vulnerable to damage, particularly at ground floor level, therefore:

- Either avoid or strengthen external insulation where damage may occur.
- Provide additional reinforcement for wet render systems in vulnerable areas, such as on ground floor level, around entrances or near vehicular access.
- For dry systems, select toughened panels and stronger fixings for vulnerable areas.
- Tackle graffiti through the use of textures and colours, or a finish which can be safely over-painted.

Most wet render systems can be used in severe weather conditions. However, evidence of test results or a proven track record in these situations should be sought. Ease of maintenance will depend on the external finish or cladding used. Dry systems with smoother surfaces tend to need less maintenance than wet systems.

The frequency of maintenance also depends on the location, and the appearance required. North walls and those with reduced wind turbulence – those adjacent to other buildings, for example – may suffer from algal growth and the effects of pollution. External flues and fans will also cause a localised build-up of dirt. Maintenance work on wet render systems can vary from very occasional to regular overcoating with an acrylic or silicone paint finish.

Often the only deterioration is in the finish itself. It can develop a dirty or stained appearance; if this becomes aesthetically unacceptable, it will require maintenance. Some manufacturers recommend periodic pressure washing at 5-10 year intervals.

Key reminders

- Systems must conform to all current standards and regulations relating to fire.
- A proprietary system should have third party accreditation. The certificate should include details of the specific application under consideration.
- Contractors should be approved and trained by the system manufacturer. They should also have

an appropriate quality assurance scheme and be members of a relevant trade association.

- Ensure there is an appropriate insurance-backed guarantee available for the installed proprietary system.
- Check impact of specialist design and detailing to external façades in terms of costs.
- Conduct site-checks of workmanship in wet systems; ensure that corner and edge details are straight.
- Conduct site-checks of workmanship in dry systems; verify that insulation is installed correctly around frameworks without thermal bridging and that the ventilated cavity behind the rainscreen is not bridged.
- If driving rain is likely to be a problem, consider a dry system with a ventilated cavity.
- Avoid excessive hot and cold temperatures when applying wet renders as this can cause drying/curing problems. Polymeric coatings are particularly susceptible to problems at low temperatures as they may not coalesce (adhere together or 'film form').
- Do not use external insulation (dry or wet) in vulnerable areas unless it has additional protection, since it is prone to damage.
- Make sure adequate technical input is available for proprietary systems. Agree all details with system designers or specialists in advance of work on site.
- Establish the liability for system performance before specification.
- Plan for more maintenance than manufacturers suggest for both wet and dry systems. Some wet renders are prone to cracking, so establish what is an acceptable level of cracking for the proposed project. However, cement free polymer systems have a high degree of crack resistance..
- Do not apply external insulation if the existing structure is unsound.
- Take care with over-coating that additional paint layers do not compromise fire properties or vapour permeability.

Table 3 Comparison of different external insulation systems

	Advantages	Drawbacks
Wet render systems	<ul style="list-style-type: none"> • Different systems are available in a range of technical performances for varying situations. • Polymeric coatings (see page 7 for a description) do not need movement joints where they are not required in a substrate. • Manufacturers' technical service is available. 	<ul style="list-style-type: none"> • Renders cannot be applied in low temperatures, especially polymeric coatings. • It is not possible to inspect behind render after application without remedial works. • Mess on site may occur when rasping polystyrene. • High quality control required on site. • No agreed standards on polymer quality and content for PMCR (although they must meet third-party testing criteria).
Dry cladding systems	<ul style="list-style-type: none"> • 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. • Fixing system or framework can provide some degree of stability or span over problem areas. • Faster construction than wet systems. • Can be applied in freezing conditions. • Manufacturers' technical service is available. 	<ul style="list-style-type: none"> • High-performance dry systems can be relatively expensive compared with high-performance wet render systems. • Thermal bridging may arise unless carefully designed out. • Supervision is required for correct installation of insulation to ensure reduction in thermal bridging and maintenance of ventilated cavity. • High quality control required on site.
Bespoke external insulation	<ul style="list-style-type: none"> • Gives control of the composition and costs of individual materials as they are not part of a manufacturer's package. • Gives the opportunity to use sustainably 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 – e.g. weather boarding, stone, glass, terracotta and tile hanging. • Is of tailor-made design to suit the building and its context. 	<ul style="list-style-type: none"> • No guarantees are available. • No technical service is available from system manufacturers. • Guaranteed performance becomes designer's liability. • New designs are untested.

11 Examples – wet render systems

Refurbishment

Wet systems are often used in refurbishment programmes, where the overall strategy is to improve the energy efficiency, appearance and comfort levels of a building. Thick and thin render systems are both suitable for high rise properties. In areas where external insulation is vulnerable to impact damage, such as on the ground floor, it can be strengthened with additional reinforcing mesh or rigid panels. Alternatively, different insulation techniques may be used in these vulnerable areas instead of external insulation.

High rise

The tower-block refurbishment shown in Figure 11 uses a polymeric coating to give a high-performance, low-maintenance finish. It incorporates 100-150mm of polystyrene insulation with mineral wool firebreaks. The renovation included new double-glazed windows and doors, while the external balconies were converted into internal living spaces. Following the refurbishment, the previously under-sized heating system is now adequate and the problem of traffic noise has been reduced.

Low rise

The upgraded British Iron and Steel Federation (BISF) housing in Rugby (Figure 12) employs a thick polymer-modified cementitious render, over an insulation system. A render finish is used on the first floor and a rendered brick-lookalike at ground floor level. Additional features, including new porches, were fixed through the insulation system.



Figure 11 Example of a refurbished high-rise building – Moorfield, by Bristol City Council



Figure 12 Example of a refurbished low-rise building – BISF housing, by Rugby City Council

New build

External insulation can often simplify and speed new build construction. Higher levels of insulation can be achieved more easily than in traditional forms of construction. In the following examples, wet render systems using polymeric coatings were used.

High rise

The luxury apartments shown in Figure 13 have 100mm of insulation fixed to a solid concrete wall. The polymeric render coating provided a finish without movement joints and achieved high performance levels in exposed conditions.

Low rise

A polymeric render coating was used for the architect-designed house shown in Figure 14, mainly for performance reasons. The external render continues the line of the internal finish over the edges of the wall to form the coping detail, with sharp angle/corner details, and is then allowed to 'disappear' into the ground, giving the wall a monolithic appearance.



Figure 13 Example of a new build high-rise building – Vogans Mill, London, by Michael Squires Associates



Figure 14 Example of a new build low-rise building – Crescent House, Wiltshire, by Foster and Partners

12 Examples – dry cladding systems



Figure 15 Example of a refurbished high-rise building – Woolwich, London, by Hunt Thompson



Figure 16 Example of a refurbished low-rise building

Refurbishment

In the UK, dry cladding systems are mainly used in commercial buildings. In the residential sector they may be used for refurbishment projects but rarely for new build.

High rise

The multi-storey refurbishment project in Woolwich (Figure 15) has a high-performance dry cladding system. It was chosen because:

- It allows cladding panels to be removed for periodic inspections of the building structure.
- A high-quality cladding system was needed for the severe weather rating.
- The ventilated cavity behind the rainscreen allowed the building to breathe, and excess moisture to be carried away.
- The system allowed a higher speed of construction.

The external walls on the ground and first floors are of cavity/brick construction to provide impact protection for vulnerable areas.

Low rise

The dry cladding refurbishment project shown in Figure 16 gave added protection to the structure as well as a renovated external envelope. If larger amounts of insulation had been installed, with consequently increased energy savings, the payback period for the project could have been greatly reduced.

13 Examples – a bespoke system and a listed building

A bespoke system

The architect-designed system on a Devon medical centre (Figure 17) consists of an internal blockwork wall, with timber battens and mineral wool insulation fixed to the outer face.

A ventilated cavity together with timber weather-boarding provides a rainscreen. The system was not used on the ground floor, which was constructed of rendered blockwork cavity construction to withstand impact damage. The system was carefully designed to ensure that vapour permeability through the construction was not a problem. This should always be checked by dew-point calculations.



Figure 17 Example of a new build bespoke system – Barnstaple, Devon, by Clive Jones & Associates

Listed buildings and conservation areas

There are special concerns about specifying external insulation for historically sensitive buildings. The local authority should be consulted at the earliest opportunity in all cases.

Certain wet render systems are appropriate, such as that used on the listed building shown in Figure 18.

A combination of recycled mineral material and polystyrene was used to form the complex mouldings which replicated features such as the rustication and the corning. The originals had deteriorated beyond repair.



Figure 18 Example of a refurbished listed building – Stanhope Gardens, London, by Chassay + Last Architects

14 Benefits of wider usage



EWI system supplied by weber building solutions,
architects: Goddard Manton, photography: Brauer Associates

There are a number of benefits to be gained from the wider application of external insulation systems, principally:

- Reduced global CO₂ production through increased energy efficiency in buildings.
- Reduced resource use through re-use of old buildings.
- Reduced resource use in new build. External insulation systems use less resources than some traditional construction methods.
- Improved building performance. This has a number of supplementary beneficial effects: previously under-sized heating systems may not now need renewal due to increased thermal performance of the building and lower heating demand; and the process of covering walls in poor condition with new insulation will increase airtightness and reduce heat loss.
- Improved health for occupants, through raised comfort levels in old buildings, and improved living conditions.
- Increased social benefits through the enhancement of the local environment and an increase in community pride.

Health and Safety

Always follow the safety advice provided by the material supplier regarding any precautions to take. This may be in the form of safety instructions on the packaging, material safety data sheets or other specific written safety instructions. For example, it is recommended that overalls, gloves, goggles and a face mask are worn at all times during installation of fibrous insulation to prevent irritation and inhalation of fibres.

15 Contact information

BRE

Available from BRE Bookshop at
www.brebookshop.com

Tel: 01344 40407

- BR 390. The Green Guide to Housing Specification.

British Standards Institution

Available from BSI at: www.bsi-global.com

Tel: 020 8996 9001

- BS 8104. Code of practice for assessing exposure of walls to wind-driven rain.
- BS 5262. Code of practice for external renderings.

Relevant organisations and websites

Insulated Render & Cladding Association (INCA)

INCA is the industry trade association offering specifiers technical advice related to:

- The process of insulated render and cladding.
- The selection of a system proven under UK climatic conditions.
- Matching a vetted contractor (generally with at least two years experience) to a project.

INCA provides a Latent Defects Insurance Scheme covering design, materials and workmanship for the refurbishment and new build of all building types. Only participating INCA installers can offer the Scheme on BBA or BRE Certified INCA systems.

Tel: 01428 654011

Email: incaassociation@aol.com

www.inca-ltd.org.uk



National Insulation Association

The National Insulation Association represents the manufacturers and installers of cavity wall and loft insulation and draught proofing and other innovative solutions. Both the National Insulation Association and its members are fully committed to maintaining and raising standards within the insulation industry.

3 Vimy Court, Vimy Road, Leighton Buzzard, LU7 1FG

Tel: 01525 383313

www.insulationassociation.org.uk



Further information

The Energy Saving Trust sets energy efficiency standards that go beyond building regulations, for use in the design, construction and refurbishment of homes. These standards provide an integrated package of measures covering fabric, ventilation, heating, lighting and hot water systems for all aspects of new build and renovation. Free resources including best practice guides, training seminars, technical advice and online tools are available to help meet these standards.

The following publications may also be of interest:

- Central heating system specifications (CHeSS – Year 2005) (CE51/GIL59)
- Whole house boiler sizing method for houses and flats (CE54)
- Energy efficient lighting (CE61/GPG199)
- Insulation materials chart – thermal properties and environmental ratings (CE71)
- Energy efficient refurbishment of existing housing (CE83/GPG155)
- Advanced insulation in housing refurbishment (CE97)
- Energy efficient refurbishment of existing housing – case studies (CE104/GPCS418)
- Energy efficient loft extensions (CE120)
- Energy efficient garage extensions (CE121)
- Energy efficient domestic extensions (CE122)
- Post-construction testing – a professionals guide to testing housing for energy efficiency (CE128/GIR64)
- Practical refurbishment guidance for solid-walled houses (CE184) (to be published)
- Improving air tightness in existing homes (CE137/GPG224)
- Refurbishment of high rise dwellings – a strategic guide for local authority managers (CE187/GPG80)

To obtain these free publications or for more information, call 0845 120 7799, email bestpractice@est.org.uk or visit www.est.org.uk/housingbuildings



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All technical information was produced by BRE on behalf of the Energy Saving Trust.

Printed on Revive Silk which contains 75% de-inked post consumer waste and a maximum of 25% mill broke.

