



## **Design Considerations**







A guide to designing with  
Sto facade systems

// I know the price of success: //

dedication, hard work,  
and an unremitting devotion  
to the things you want to see happen

*Frank Lloyd Wright, 1867–1959*

# Contents

	<b>1. Introduction</b>	<b>4</b>
	A Brief History of the Wall	4
	Wall Construction Methods	6
	<b>2. Thermal Performance</b>	<b>10</b>
	Condensation Risk	11
	Thermal Bridging	12
	The Solution: External Wall Insulation Systems	13
	Part L - The Conservation of Fuel and Power	14
	<b>3. Fire Performance</b>	<b>16</b>
	Firebreaks in the Insulation	19
	<b>4. Wind Loading</b>	<b>22</b>
	<b>5. Building Physics</b>	<b>24</b>
	Accommodating Building Movement in Facades	24
	Managing Movement	26
	Product Warranty	29
	<b>6. Sustainability</b>	<b>30</b>
	Choice of Insulation Materials	32
	Sustainability Measures for Existing Stock	34
	Green Deal	35
	Sustainability Measures for New Build	36
	Code for Sustainable Homes	38
	BREEAM	40
	PassivHaus	41
	Environmental Product Declaration Certificate	42
	Waste Packaging Disposal	43
	<b>7. Colour, Texture &amp; Material</b>	<b>44</b>
	Light & Colour Perception	44
	The StoColor System	45
	Colour Variations	46
	Colours & Thermal Gain	47
	Colour Fade, Lightfastness & Chalking	48
	Texture & Finish Selection	52
	Material Selection	54
	What Should Render Withstand?	55
	Renderers: Technical Characteristics	56
	<b>8. Best Practice</b>	<b>58</b>

# Introduction: A Brief History of the Wall

Building components have changed and evolved over the centuries, but the basic elements have remained the same: walls, floors and roofs. This brochure is all about the wall element.

The physical properties of walls have remained fairly constant throughout time. Their principal functions were to protect from the elements and act as a defence against other humans.

Buildings evolved from simple timber structures incorporating wattle and daub, into sophisticated stone structures, with defence their primary concern. Moving forward in time, buildings became more complex timber structures and eventually, the modern brick and masonry developments of today.



### Cavity wall construction

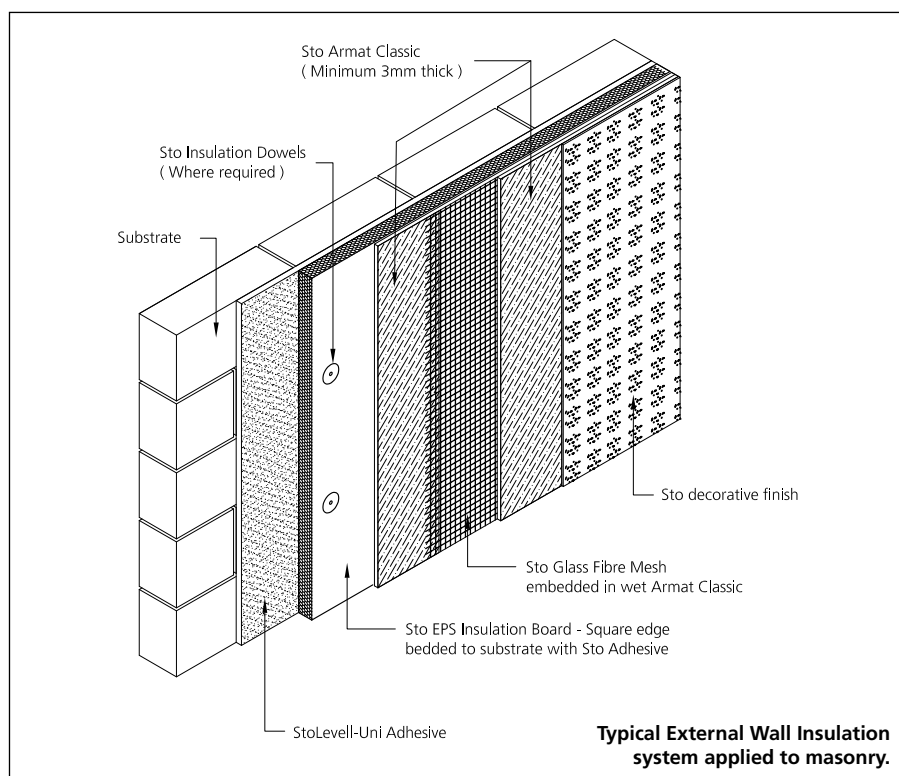
Cavity walls were not an invention of the 20th Century. In fact, there is evidence of cavity structures from as far back as the Iron Age. An example of this is the Scottish Broch (an ancient stone roundhouse) as well as certain Greek and Roman structures. Archaeologists assume this approach to building was predominantly for the purposes of reducing rain penetration. This type of structure was abandoned for many centuries as simpler, more cost-effective structures superseded them.

As society became more complex and prosperous, the cavity was reinvented and enhanced. The modern equivalent was to build two masonry leaves side by side, a set distance apart but carefully tied together. The leaves act together structurally, but separately in terms of moisture penetration. As long as the cavity is kept clear, the inner leaf should

remain dry. Even when the outer leaf is saturated, water will run down the cavity face of the outer leaf.

As well as considering the passage of water from the external environment, the air inside a building also contains moisture. In temperate climates, the air in the interior environment usually contains more moisture than the outside air. The UK is one such example. Moisture vapour will tend to migrate outwards, through the construction. A cavity can be beneficial in the removal of this type of moisture.

Cavity wall construction enjoyed resurgence from the 1920s due to improved construction standards for structural integrity and moisture penetration. Lower costs and speed of construction are also likely to have contributed to its popularity. Constructing two skins of masonry separated by a



The Design Considerations brochure attempts to address the main issues that may arise when specifying Sto facade systems and also explain some of the origins of the technical requirements.

Sto has tried and tested products and systems to meet the requirements of various organisations, be it the NHBC, Building Regulations or TRADA.

If you require further advice or information, please contact Sto Technical Services.

cavity was far cheaper than a solid, double thickness brickwork wall. Whatever the reasons, good thermal performance was not considered to be significant at that time.

## Insulated cavities

The oil crisis of the early 1970s highlighted a need to mitigate spiralling fuel costs. One of the best ways to do this was to improve the thermal efficiency of our homes and workplaces. For cavity wall construction, this higher thermal performance was met by adding insulation into an increased cavity width.

In the 1990s, this method of insulation became a Building Regulations requirement. The Regulations permit cavity walls to be constructed with cavities fully filled with thermal insulation. Where a cavity is only partially filled, the residual cavity must be a minimum of 50mm wide.

## External wall insulation (EWI)

EWI is the most effective, long term solution to improving the thermal performance and weather protection of buildings. It is an appropriate insulation method for both solid wall and cavity wall construction. Sto EWI systems are suited for direct application onto the outer masonry leaf. By insulating the outer leaf, the entire construction becomes warm and dry.

Raising the temperature of the building fabric moves the dew point of the wall safely away from the interior. In doing so, there is far less risk of condensation and associated mould growth. This helps to reduce maintenance on the through-wall construction by making it more thermally stable.

An additional benefit of EWI is the freedom to choose the thickness of insulation to achieve better thermal performance. Increasingly stringent Building Regulations necessitate increased insulation thicknesses. Placing the insulation on the exterior of the building maximises interior living space and rental values. Whether new build or renovation, EWI offers an attractive, thermally efficient and protective outer layer maintaining a building's value.

# Wall Construction Methods



### Framed structures

There are a number of key factors to consider when specifying a cladding system for a framed structure. Building Regulations require insulation or sheathing to be separated from the external wall cladding in framed structures. They must be separated by a drained and/or vented cavity with a breather membrane on the inside of the cavity. If the free cavity is over 50mm wide the breather membrane is not required.

Insulated carrier systems can be used as the backing for render onto framed

buildings. Direct application of insulated cladding to the frame is not permitted by the NHBC. Sto render is acrylic-based and flexible, therefore less likely to crack than a traditional sand and cement render. Sto render is highly resistant to rain and moisture, whilst remaining vapour permeable and makes for an excellent protective layer.

### Prefabricated structures

Prefabricated structures must also comply with the requirements for cavities as outlined in this section, despite their variety of manufacture.

A North American study highlighted the serious decay caused by water ingress into timber framed structures. The UK's National House-Builders Council (NHBC) used this research as a basis for their stance on framed construction.

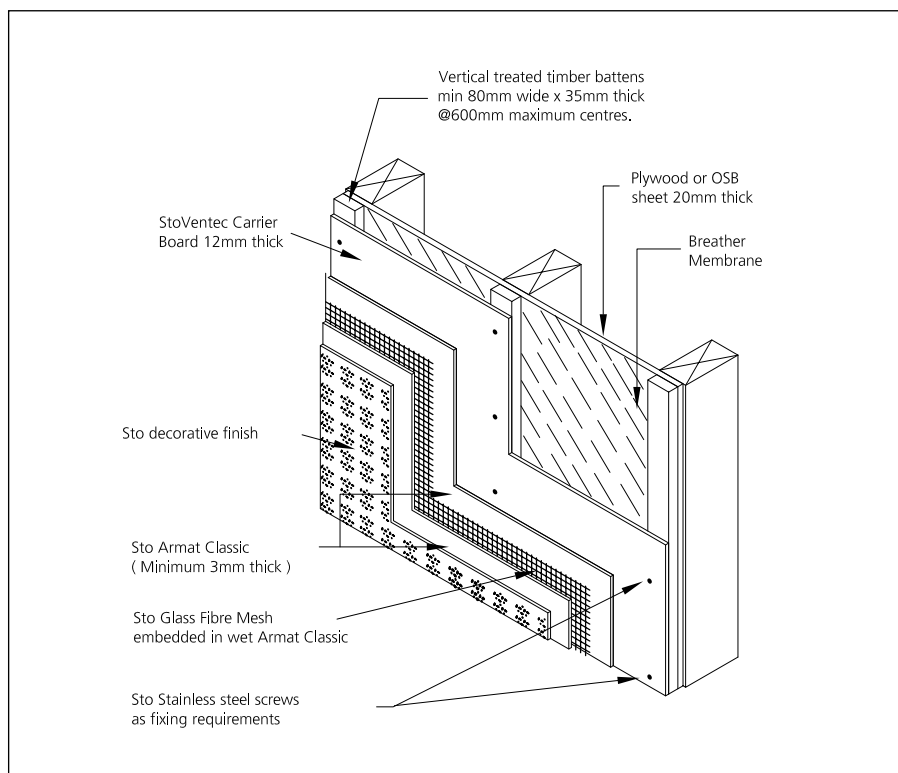
They decided that insulated cladding systems should not be fixed directly onto timber or steel framed constructions. The NHBC insist on a cavity between the frame and the cladding. This acts as a second line of defence to prevent moisture tracking back into the frame.

In the case of timber frame or steel framed construction, the NHBC requirements for a drained and vented cavity are set out in the **NHBC Standards Chapter 6.2**. The requirement is for a drained cavity of at least 15mm, although it is not necessary for the cavity to be ventilated.

### Render onto carrier board

The guidelines change slightly when render is applied to a carrier board before being fixed to a framed structure. It is possible to fix the carrier board to timber battens on the sheathing to create a cavity. If the battens are placed vertically, it is straightforward to ventilate this cavity and drain it at the base. The thermal insulation required fits within the frame studs, or further inboard of the frame, such as behind the cavity.

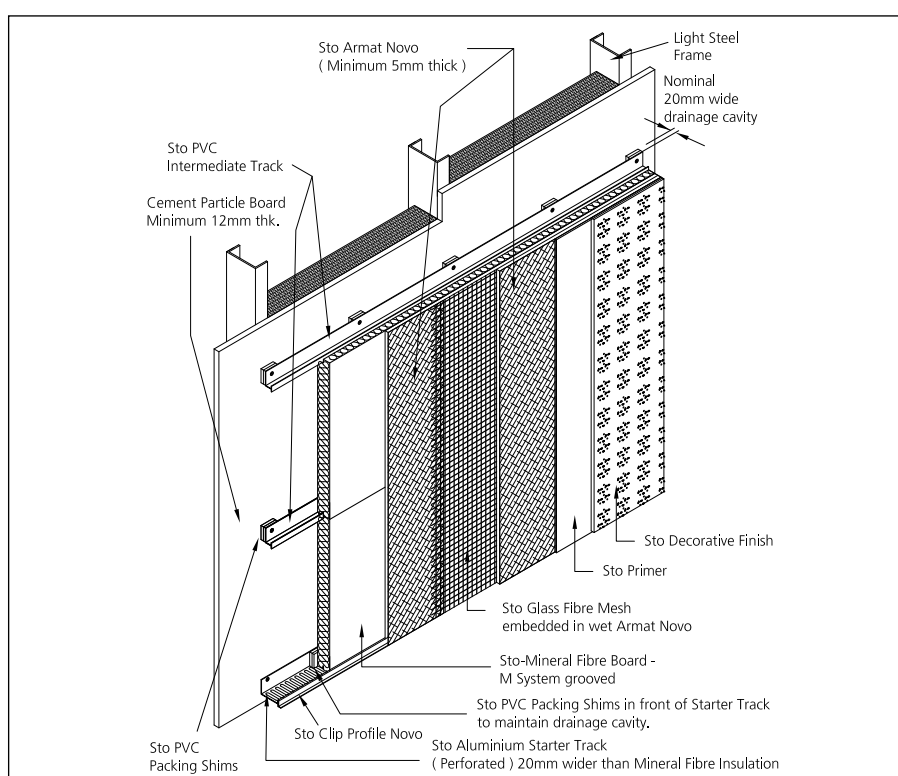
Sto have NHBC approved details for the StoRender Flex system onto StoVentec render carrier boards. A 35mm wide cavity is created using vertical battens.



### Render onto insulation

Sto render can be applied directly to the insulation boards. Here, the cavity can only be provided between the back of the insulation and the inner leaf or frame. The insulation's effectiveness may be reduced by the existence of a cavity on the "warm" side of the insulation. If the cavity is ventilated, this effect will be significant, but for a drained cavity the effect will be minimal.

The NHBC approved details for the StoTherm Mineral and Classic M systems have a 20mm drained cavity. There are two fixing methods that can be used to create the cavity: Packing shims and screws behind rails, or the innovative Sto-Rotofix Plus helical fixing.





## 1. Introduction



### Ventilation performance of cavities

A fully ventilated cavity provides the most reliable means of removing moisture within the cavity. The air movement removes moisture vapour that has migrated from the internal environment. It also encourages evaporation of any water and promotes drying of the cavity.

A vented cavity will have less capacity than a ventilated cavity to remove excess moisture. Its performance depends on two main areas:

- the vapour resistance of all materials to the cold side of the cavity, and
- the size of the openings between the cavity and the external environment

Larger openings with lower resistance improve the rate of moisture removal. The removal of moisture in a vented cavity may also be increased by using a wider cavity. This improves the air circulation by convection, due to the lower frictional forces to resist air movement.

Drain openings (or weep holes) do not necessarily count as ventilation. They cannot be considered ventilation if they appear in open vertical joints in the outer leaf of a cavity wall.

The following classifications are taken from BS 5250:2002 – 'Code of Practice for control of condensation in buildings'.

- A vented air space is a cavity or void that has openings to the outside air. The openings are placed so as to allow some limited, but not necessarily through, movement of air.
- A ventilated air space is also a cavity or void that has openings to the outside air. The openings are placed to promote through movement of air.
- An unventilated air space is one in which there is no express provision of air flow though it (BS EN 6946 classification).



### Cavity widths – TRADA recommendations

The Timber Research & Development Association (TRADA) is a centre of excellence for the specification and use of timber products. They recommend that timber framed buildings have a ventilated cavity between the insulated/sheathed timber frame and the exterior render cladding.

TRADA offer two recommendations for cavity widths depending on the system:

- Backed systems (where deleterious material cannot fill the void) – A cavity of 25mm minimum
- Unbacked systems (i.e. traditional render onto metal lath without a breather membrane) – A cavity of 50mm

TRADA takes its guidance from its own experience and BS5250 – 'Code of Practice for the control of condensation in buildings'.



### Cavity widths – NHBC recommendations

The guidance from the NHBC Standards Chapter 6.2 compares closely to the TRADA recommendations:

- Backed systems (where deleterious material cannot fill the void) – A cavity of 20mm minimum
- Unbacked systems (i.e. traditional render onto metal lath without a breather membrane) – A cavity of 40mm

Depending on the size of the building, firebreaks may be required within the created cavities. This issue is addressed in the section on **Fire Performance** (p16).



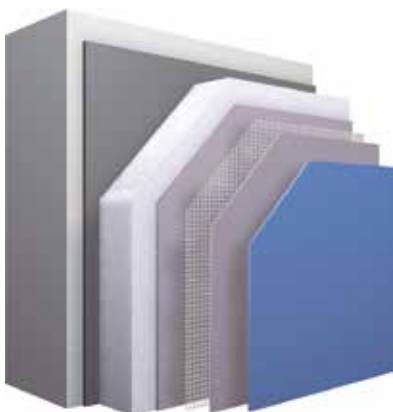
# Thermal Performance

All building materials have the ability to transfer heat, some more so than others. There are two main material categories when considering heat transference:

- **Heat conductors** are materials with high thermal conductivity that allow heat to pass through with little resistance, such as metals.
- **Thermal insulators** are materials with low thermal conductivity that are resistant to heat transference. Most non-metal materials are thermal insulators to some degree. Expanded Polystyrene and mineral wool products are both good examples of thermal insulators.

### Measuring Thermal Performance:

- **$\lambda$  (Lambda) Value** – The unit of measure for thermal conductivity in materials is known as the Lambda value ( $W/(m.K)$ ).
- **U Value** – Heat loss through materials is known as 'Thermal Transmittance', which is measured in  $W/m^2K$ . This is also known as the U value. Typically a section  $1m^2$  is tested which goes through the building. The amount of heat lost through that section is measured and a U value given. The lower the U Value, the better the material's insulating properties.



### Air tightness

The thermal performance of a building owes more to just the insulating properties of the materials used. Whether or not the building is air tight can have a considerable effect on ambient temperature. A draughty, leaky house will undermine efforts to insulate as heat will escape through the gaps.

Unless otherwise stated, the airtightness of buildings should be a minimum of  $10m^3/(h.m^2)$  at 50 Pascals. Super insulated building standards require far a more stringent figure. PassivHaus, for example, requires a minimum of  $1m^3/(h.m^2)$  at 50 Pascals, best practice being  $0.6m^3/(h.m^2)$ .

Part L of the Building Regulations (Conservation of fuel and power) details the air tightness requirements for building:

- Part L1A: Dwellings (New build)
- Part L1B: Dwellings (Refurb)
- Part L2A: Non-domestic buildings (New build)
- Part L2B: Non-domestic buildings (Refurb)

Through a greater awareness of environmental issues, specifically the impact of wasting heat energy, we are increasingly conscious of the benefits of conserving energy, both to the planet and our own well-being.



## Condensation Risk

Depending on the climatic conditions, there is calculable movement of moisture within the building envelope. It is important to understand and predict how the wall construction will behave in terms of moisture vapour movement. Failure to do so could risk condensation within the wall, known as 'interstitial condensation'.

In order to calculate the condensation risk, the vapour resistivity of each material layer within the wall must be known. By using this information and assuming environmental conditions for the site<sup>1</sup>, you can predict the risk of condensation<sup>2</sup>.

Air can hold varying amounts of moisture as a vapour, increasing or decreasing with temperature changes (see diagram). It is this moisture which, given the right circumstances, can condense within the wall itself. This can lead to problems of varying severity, most notably within timber and light steel gauge buildings.

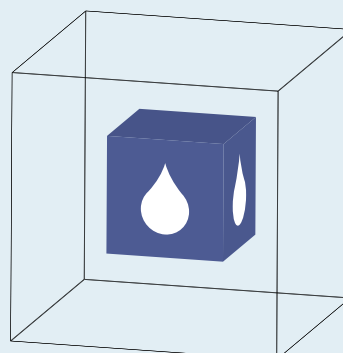


<sup>1</sup> Relative humidity and temperature inside/outside

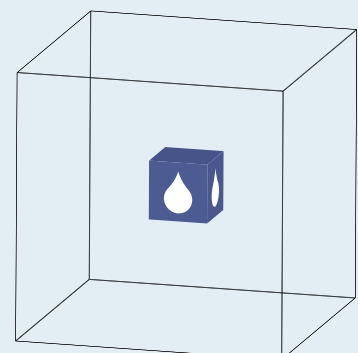
<sup>2</sup> Conversion from vapour to liquid

### Relative humidity

The maximum possible water content in air at different temperatures in g/m<sup>3</sup>



+20°C = 17.3 g



0°C = 4.8 g

The above illustration demonstrates how much water vapour (in grams) will condense from a cubic metre of air if the temperature of that air is lowered by 20°C. This temperature difference is a typical temperature gradient which can be experienced within winter conditions in the UK across a building element.





# Thermal Bridging

Thermal bridging is a phenomenon where heat can be lost through material 'bridges'. Where components with higher thermal conductivity penetrate or partially penetrate the insulating layer of the building, heat can be lost.

Examples of thermal bridging can be seen in concrete lintels or edge beams. Both can penetrate the inner leaf of a cavity wall, bypassing the insulation in the cavity. Even mortar joints within a brickwork facade will create a thermal bridge, allowing greater heat losses.

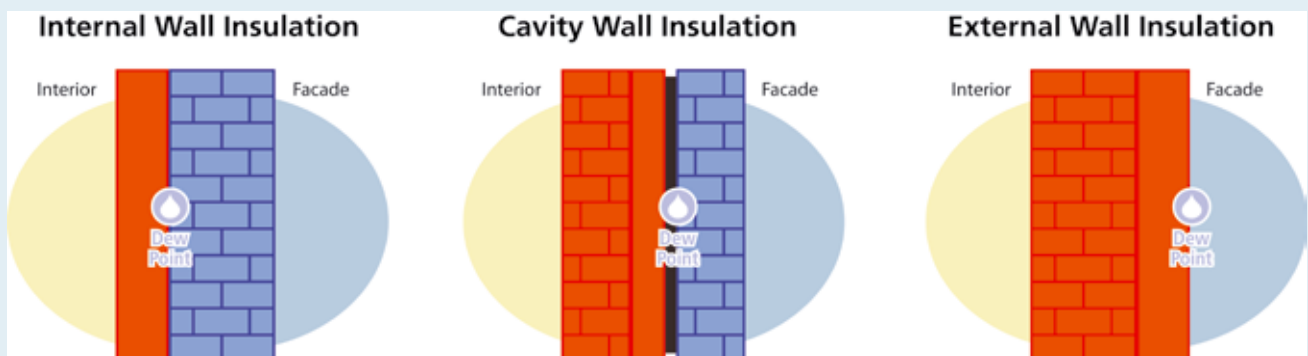
Buildings are often complex structures that have to perform numerous functions. When designing and constructing a building, numerous opportunities for cold bridges arise. The number and complexity of material interfaces could have a significant impact on the overall thermal efficiency of the building. Correct detailing at the design stage will remove the potential inefficiencies thermal bridges introduce.



**A thermal image of a residential home showing heat loss within the building. The cooler the colour, the less heat it being lost through the walls.**



## The solution: External Wall Insulation Systems



The temperature at which condensation would normally start to form within the wall construction or on internal surfaces.

Thermally insulating the exterior of the structural fabric of the wall makes good technical sense on a number of levels. The building is figuratively wrapped in a thick, well insulated and protective blanket.

The worst effects of thermal bridging are nullified and the detailing to achieve high thermal performance is greatly simplified. When combined with high performance render finishes, the insulation layer keeps the structural fabric of the wall warm and dry. This further improves its own thermal performance.

The use of insulation on the outside of the wall also makes sense from a condensation point of view. It ensures the wall is kept 'warm' for the majority of its thickness from inside to out.

This maintains the building fabric's temperature above the 'dew point', effectively dealing with mould growth and other environmental issues.

External wall insulation makes practical sense for both lightweight and heavyweight construction. For lightweight building construction the input of heating energy has an immediate effect on the internal environment. EWI protects the fabric of the building and reduces the heating requirement. On heavy, dense, construction the building envelope may be used as a "storage heater", ensuring a constant climate. EWI helps to keep the majority of the heat stored, making for a far more economical and ecological solution.

Sto has years of experience in this field and has developed solutions to provide for the most thermally efficient building constructions.

The pinnacle of this design know-how is well demonstrated in the Sto solution for Passivhaus construction. This standard of building design demands the highest levels of insulation, which result in buildings that generally do not require heating, other than body heat and electric lighting.

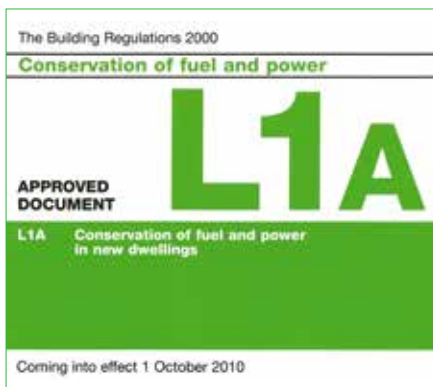
Sto are one of a very few systems that have achieved the Passivhaus standard and been awarded the coveted certification from the Passivhaus Institute.



# Part L – The Conservation of Fuel and Power

Under the Climate Change Act 2008, the UK has committed to legally binding reduction targets for greenhouse gas emissions. Carbon emissions must be reduced by at least 34% (relative to 1990 levels) by 2020 and at least 80% by 2050. Around 45% of UK CO<sub>2</sub> emissions come from buildings (27% from homes and 18% from non-domestic). Carbon emissions occur principally through heating and cooling, lighting and other fixed systems – all energy uses covered by the Building Regulations.

Reducing the emissions from housing stock is considered to be crucial in meeting the agreed reduction targets. The Government has announced that all new build homes in the UK should conform to Zero Carbon standards from 2016. In a similar way, all new non-domestic buildings must achieve Zero Carbon status from 2019. Options for changes to the Regulations in 2013 have been developed



as an interim step towards achieving Zero Carbon standards.

The Building Regulations 2002 set out minimum standards for building design and construction. The Regulations are supported by guidance from Approved Document Part L, relating to the conservation of fuel and power. Part L is the main tool used to push better standards of thermal performance in buildings and reduce carbon emissions. It offers best practice approaches to energy efficiency. Revisions to Part L occurred in 2006 and 2010. Each revision intended to go further towards meeting carbon emission targets.

### Methodologies, Standards and terms in Part L

**National Calculation Methodology**  
Energy use in a building is a complex interaction between the building

fabric and the heating, cooling and lighting systems. Therefore the Building Regulations are also supported by the National Calculation Methodology, used to calculate building energy performance for compliance. For domestic dwellings, these are known as the Standard Assessment Procedure (SAP). For non-domestic buildings, they are known as the Simplified Building Energy Model (SBEM) or approved dynamic simulation modelling.

### Fabric Energy Efficiency (FEE)

Consultation proposals relating to new homes include a recommendation that they should comply with a mandatory minimum fabric performance standard. Known as the Target Fabric Energy Efficiency (TFEE) standard, this is in addition to the mandatory carbon emissions standard (TER)<sup>1</sup>.

The TFEE standard proposes the same





methodology put forward by the Zero Carbon Hub task group. The Code for Sustainable Homes (the Code) also adopted this methodology.

The Fabric Energy Efficiency (FEE) methodology considers the space heating and cooling demand of a dwelling. The Dwelling Fabric Energy Efficiency (DFEE) is affected by:

- The building fabric U-values
- Thermal bridging
- Air permeability
- Thermal mass
- Features affecting light and solar gain

FEE is measured in  $\text{KWh/m}^2/\text{yr}$ . As it is a performance standard, different combinations of fabric specification can be used to reach a particular level.

<sup>1</sup>(TER) Target ( $\text{CO}_2$ ) Emission Rate

### External Wall Insulation and Part L

The use of Sto External Wall Insulation systems will lead to improved U-values and minimise thermal bridging. Some systems can incorporate breathable wet applied membranes that can contribute to the reduction in air leakage. Buildings incorporating Sto EWI solutions will make compliance with FEE targets considerably easier to attain.

If provided with relevant data, Sto can provide specific U-value and condensation risk calculations for general, through the wall situations. Please contact your local Technical Consultant or Sto Technical Services to arrange for a project specific calculation.

## The principal changes to be introduced in 2013

Approved Document Part L is updated on a three year cycle. The latest revisions to Part L are planned to come in to force in early 2013 and the proposals for the changes are out for consultation now.

- The general fabric performance will be improved by 8% in domestic dwellings over the existing standards. Current worst case allowed is  $0.3\text{W/m}^2\text{K}$ .
- Non domestic properties are targeted for an improvement of 24% over current standards

### The Approved Document has two phases:

1. The first phase (October 2012) deals with consequential improvements to existing properties. This ties in with the launch of the **Green Deal** (see page 35), the Government's upcoming initiative to encourage homeowners to take out energy saving home improvements at no upfront cost. The homeowner will have to adopt certain energy saving measures when they make significant alterations to their home.
2. The second phase (April 2013) constitutes the main changes to the existing Building Regulations.



## Fire Performance

Fire considerations for construction have always been important and the Building Regulations reflect this. Following a fire within a multi-storey block of flats in Scotland (c.1999), the Building Regulations underwent review. Since then, attention has been focused on the spread of fire and the specific contribution of cladding systems.

### Cladding systems and leap-frogging

One of the key mechanisms of fire spread described in the publication was fire 'leap-frogging' from window to window. This phenomenon quickly spreads fire upwards from the original source. When this happens, combustible cladding on the facade can ignite, fuelling the spread of fire. This process can continue with each additional window and storey, adding to the fire load.

The results of the publication's findings set new regulations regarding cladding systems:

*'Cladding specified on a multi-storey building must not 'appreciably accelerate' the rate at which fire will spread up the building.'*



### Building Regulations Part B Fire Safety: Approved Document 2006 Edition

Fire performance requirements are described in detail in the Building Regulations and associated Approved Documents. An overriding principle of fire management is one of containment. If a fire develops, it must not rapidly spread through the internal rooms or across the building facade.

The regulations are split into many parts when evaluating fire performance across the United Kingdom. The sections are listed here:

- For England and Wales certified systems must meet the requirements of Approved Documents (AD) B Volume 1, section B4 (domestic dwellings) or ADB Volume 2, section B4 (non-domestic buildings).
- For Scotland Approved Document B4 applies (section 12) as does Part 2 (Fire) of the Technical Handbooks for domestic or non-domestic regulations.
- For Northern Ireland Technical Booklet E (Fire safety), section 4 applies.

**External fire spread is covered under Approved Document part B4 of the Building Regulations (Part D10 in Scotland).**



### Testing cladding systems

Full scale fire testing takes cognisance of time, flame development, temperature and physical damage. Material choice is not the only consideration that needs to be thought through when testing. The design of the system itself can also affect the spread of flame.

Fire tests are conducted under strictly controlled conditions. A void is constructed at the base of the test rig. This is where the fire is initially lit and mimics an open window for the purposes of the test. Around this void, a complete multi-storey elevation is constructed from the test system. Observations are made throughout the test, but a key criterion is that the system remains attached. A pass or fail is awarded after a full examination of the test rig.

The majority of cladding systems are inevitably combustible to some degree. Cladding systems must allow enough time for the emergency services to evacuate inhabitants and gain control of the fire. How long the system withstands the fire is a key factor in the test.



### The fire performance of buildings in the UK

#### England, Wales and Northern Ireland:

Regulation B4 requires the external walls of a building to adequately “resist the spread of fire”. The functional requirements are given in the Approved Documents.

In any building<sup>1</sup>, the cladding system and materials must conform or exceed the regulation for limited combustibility<sup>2</sup>. Alternatively, the wall construction must meet the provisions of BR135<sup>3</sup>. External facing surfaces of buildings (<18m) must demonstrate compliance with British and European regulations for surface spread of flame. In Britain, Class 0 (BS476 parts 6/7) and in Europe, Euro Class B-S3, D2.

#### Scotland:

External cladding systems used above 18m must be completely non-combustible, or meet the provisions of BR135. These requirements also apply to any buildings which are less than 1m from a boundary, regardless of building height.

<sup>1</sup> Different regulations apply to buildings exceeding 18m in height and/or are less than 1m from a boundary.

<sup>2</sup> Regulation B4 - Section 12, Approved Document. Limited combustibility is defined in Regulation B4, Appendix A, Table A7

<sup>3</sup> BR135: ‘Fire performance of external thermal insulation for walls of multi-storey buildings’



### 3. Fire Performance

#### Materials of limited combustibility

Expanded Polystyrene (EPS) is a thermoplastic insulation and will inevitably melt in a fire. It is vital that EPS of 'limited combustibility' is used. Sto only use high quality EPS incorporating a fire retardant, which does not contribute to the fire load. All insulating materials from Sto conform to Regulation B4 and are either non-combustible or of limited combustibility.

When specifying EPS, full depth firebreaks are required to resist the progress of fire across the face of the building. This is an additional precautionary measure to further inhibit the spread of flame.

EPS systems can be tested on full-scale fire tests (BS 8414) to monitor the reaction to fire of the composite system. The system can only be specified for high rise projects if it meets the provisions of BR135 during testing.



#### Building Research Establishment (BRE) and Loss Prevention Standards (LPS)

BRE Global is an independent, third party approvals organisation offering certification of products and services. Their Loss Prevention Certification Board (LPCB) assesses and certifies fire systems against standards such as BS, EN and LPS. These standards were developed in co-operation with manufacturers and insurers. Approved systems are listed in the 'Red Book'.

**LPS 1581<sup>1</sup>** – An LPCB standard for non-load-bearing external wall insulation and render fixed to a solid substrate. Fire testing follows the BS 8414 part 1 methodology.

**LPS 1582** – An accredited third-party approval for non-load-bearing EWI with render applied to lightweight steel frame. Fire testing follows the BS 8414 part 2 methodology.

**BR135<sup>2</sup>** – A guidance document from the BRE providing performance criteria and a classification methodology, defined in BS 8414 Parts 1 and 2. It also includes guidance on the fire performance and design principles of EWI.

<sup>1</sup> Formerly LPS 1181, part 4

<sup>2</sup> BR135: 'Fire performance of external thermal insulation for walls of multi-storey buildings'





## Firebreaks in the Insulation

Firebreaks are used to prevent the rapid progress of fire spreading up the outside of a multi-storey building unchecked. They act as non-combustible, time delay buffers between areas where combustible materials or cavities may exist.

Firebreaks are usually mineral fibre, a minimum of 100mm high and run the complete perimeter of a building. As part of the Sto system, standard 200mm Lamella boards are often used.

Normally, firebreaks must be fully adhered to ensure a good bond and to act as a smoke/flame barrier. Exceptions to this will be on to sheathing boards with breather membranes. The mineral fibre firebreak is mounted onto secure adjustable stainless rails. In this scenario, it utilises an intumescent strip to block drainage holes in the event of fire.

Firebreaks should be installed at every floor level after the second storey and correspond with all vertical fire compartments. However, some Fire Officers may require breaks to be installed at every floor level.

The Building Regulations require the installation of cavity barriers at positions of compartment walls and floors. This stops the passage of fire via cavities created behind the insulation either by design or otherwise. This is also a requirement at window openings where cavities may allow fire up behind the back of the system.

Although systems that incorporate mineral fibre Insulation are non-combustible, cavity barriers may still be required if the insulation is spaced/shimmed from the wall, creating a cavity.



**We must consider all the requirements for fire control on a building, including:**

1. Continuous horizontal firebreaks are normally required after the 2nd storey / beginning of 3rd storey, and every storey thereafter.
2. Vertical firebreaks may be required to provide fire compartmentalisation between adjoining rooms. The requirement and location of these firebreaks should meet Fire Officer / Building Control specifications.
3. Cavity firebreaks are needed to close the cavity at all openings such as windows and doors. This is a requirement for mechanically fixed systems, where the method of fixing creates a cavity.



### 3. Fire Performance

#### Dealing with Cavities

Possible solutions when detailing the closure of cavities could include:

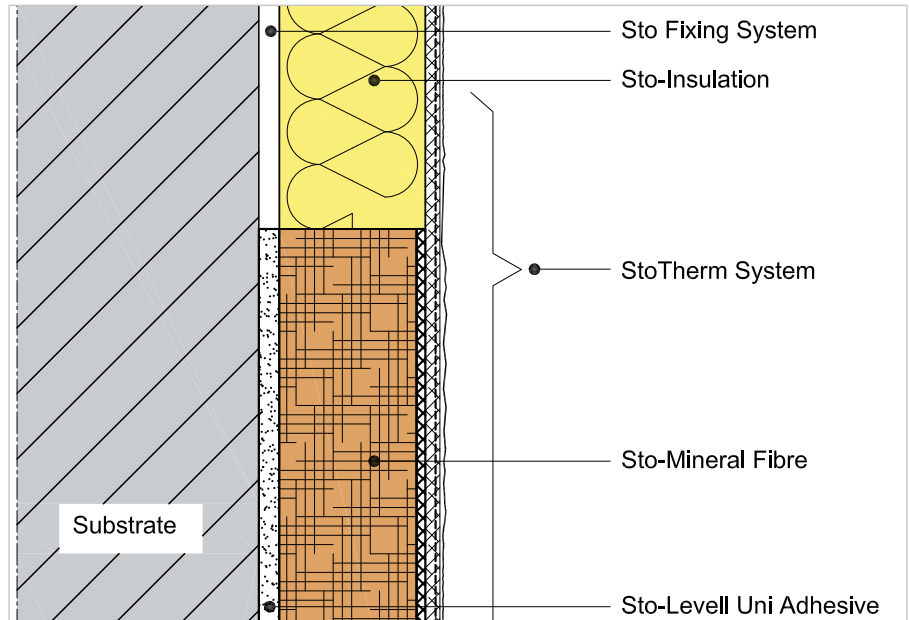
- Window frames (dependent upon the window type and its position)
- Mineral fibre (Minimum 100mm thick)
- Timber (Minimum 38mm thick)
- Other proprietary cavity fire closures.

#### Vented Cavities

The use of firebreaks in vented cavities is even more important. Vented cavities create a ready chimney for fire to rapidly progress unhindered and unseen.

In vented cavity situations, there is often not one standard solution that fits all conditions. Usually the solutions will comprise of a combination of perforated stainless steel angles and intumescent strips.

System specific details for dealing with cavities and vented cavities are available on request.



#### Fixings

The BRE guide BR135<sup>1</sup> recommends that mechanical fixings should be used to support the firebreak. The recommendation is for stainless steel fixings through the mesh to support the render.

**Partial fire break detail for a StoTherm external wall insulation system. Please note additional fixings will be required**

It is important to note that metal fixings will act as a cold bridge on the surface. They may have a visual impact in certain weather conditions and as the facade ages.

The provision and specification of fixings required for Fire Safety will ultimately be decided by the Building Control Officer. Early consultation in the design process is therefore vital.

<sup>1</sup> These are BRE guidance recommendations. This is one route to showing compliance. Other possible options to meet the requirements include physical testing.





### Full Scale testing

Sto has invested heavily in full scale fire tests. This process ensures the supply of high quality systems that perform well in a fire situation. The result is a wealth of test information for use in specifying a proven system in relation to fire.

The individual BS 8414 test reports are also available from Sto along with calorific tests on each system component. Please contact our technical services department if you require this test data.



StoTherm Vario fire test: 2010



## Glossary of Fire Testing Standards and Test Methods

### BR 135: (Annex A)

Fire performance of external thermal insulation for walls of multi-storey buildings with masonry construction (including performance and classification method of BS8414-1).

### BR 135: (Annex B)

Performance criteria and classification method for BS 8414-2 given in BRE Digest 501 for buildings supported by a structural steel frame.

### BS 476 Part 6

Fire tests on building materials and structures. Method of test for fire propagation for products.

### BS 476 Part 7

Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.

### BS 8414 Part 1

Fire performance of external cladding systems. Test methods for non-load bearing external cladding systems applied to the face of masonry building substrates.

### BS 8414 Part 2

Fire performance of external cladding systems. Test methods for non-load bearing external cladding systems applied to the face of structural steel framed building substrates.

### BS EN 13501-1

Fire classification of construction products and building elements. Classification using data from reaction to fire tests.

### BS EN 13823

Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item (SBI).

### BS EN ISO 1182

Reaction to fire tests for building products. Non-combustibility test.

### BS EN ISO 1716

Reaction to fire tests for building products. Determination of the heat of combustion.

### BS EN ISO 11925-2

Reaction to fire tests. Ignition of building products subjected to direct impingement of flame. Single-flame source test.

### LPS 1581 issue 2

Formerly LPS 1181 part 4, a Loss Prevention Certification Board (LPCB) third party accreditation standard for non-load-bearing external thermal insulation composite systems applied to a masonry based substrate.

### LPS 1582 Issue 1

A Loss Prevention Certification Board (LPCB) third party accreditation standard covering non-load bearing external thermal insulated cladding systems with render finishes fixed to and supported by a structural steel frame.



# Wind Loading

Wind load is often the largest force applied to the facade of the building. Buildings will endure both positive pressure and negative suction loads simultaneously. Wind loads can vary dramatically due to location, building shape, size, and proximity to other buildings or topographical features. In extreme circumstances this can lead to either a building being blown over, or facade fragments being torn off.

To accommodate such variations in imposed loads, building components or systems must be designed to accommodate extremes. Accurate and detailed wind loading data is therefore critical to the successful design of all Sto EWI and rainscreen specifications. It is of particular importance to those projects relying on mechanical fixings to support the system. Due to the complexity of these calculations, a qualified Structural Engineer is usually employed to undertake them. Most manufacturers will give standard windloading values for their systems. Due to increased safety factors now required by the BBA, it is vital that wind loads are matched against system performance.

### The importance of fixings

Depending on the system chosen, a specific fixing pattern is designated for each project. Each will require a specific number of fixings based upon the wind loading calculations. These are directly related to the substrate pull out capacity.

Not adhering strictly to the specification for the actual substrate may result in system failures. To ensure system integrity, it is imperative that the correct numbers, types and spacing of fixings are installed. With the increased popularity of rainscreen cladding, a detailed



subconstruction can be economically designed by Sto to meet specific requirements. Our Ventec Glass and Render systems with integral bracketary and support rails are two examples offering economical design.

### Normal zones and Rim zones

The wind load on a building can be further divided into Normal Zones and Rim Zones. A Normal Zone is typically within the middle of a facade where the wind load is at its lowest value. A Rim Zone is where the load is at its highest and is typically at corners and edges of buildings. The Rim Zones can be graduated.

In the absence of accurate wind load data, worst-case loading must be assumed for all zones. Generally wind suction loads are around 1-2KN/m<sup>2</sup>. Ideally, an accurate wind load calculation will be produced for each project to ensure safe construction. Once known, the number and spacing of each fixing should be calculated in accordance with BS 6399 Part 2: 1997.

In order to calculate the wind loads and the location of rim zones, the following information is required:

- Plan of building with dimensions.
- Elevations of building with dimensions.
- Regional location
- Built environment (whether in town or rural setting)
- Height above sea level
- System to be used (cavity will make a difference)
- Surface finish (whether rough or smooth)
- Location and size of any significant openings in the building
- Location plan of all adjacent buildings
- Height of all adjacent buildings

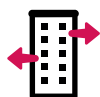
The following table gives fixing configurations and requirements for given wind loads. If in doubt, consult with your local Sto Technical Consultant for further advice.

System	Fixing requirement	Safe wind load <sup>note 1</sup>
<b>StoTherm Classic M</b>	Horizontal pvc intermediate rail fixed at max. 300mm centres with vertical 'T' splines	1.1
	Intermediate rail fixed both horizontally and vertically at max. 300mm centres	1.96
	Intermediate rail fixed both horizontally and vertically at max. 300mm centres plus centre dowel through each board or foam adhesive injected through centre	2.65
<b>StoTherm Classic M (Sto-Rotofix Plus) using EPS K90 (20Kg/m³)</b>	4 Rotofix Plus fixings per m²	1.5 <sup>(note 2)</sup>
	6 Rotofix Plus fixings per m²	2.5 <sup>(note 2)</sup>
	Specified number of Rotofix Plus fixings per m²	>2.5
<b>StoTherm Classic K</b>	Sto Levell Uni adhesive with no dowels (after full strength development )	10.68
	Sto Levell Uni with 2 supplementary dowels/board before adhesive gains strength	1
	Sto Turbofix adhesive with no dowels after 2 hours	>3.6
<b>StoTherm Mineral M</b>	Horizontal pvc intermediate rail fixed at max. 300mm centres with vertical 'T' splines	0.83
	Intermediate rail fixed horizontally at max. 300mm centres plus centre dowel through each board	1.6
<b>StoTherm Mineral K</b>	Sto Levell Uni with additional dowels at a rate of at least 8 per m²	4.51
	Sto Levell Uni with additional dowels at a rate of 8 per m² before adhesive gains strength	1.84
<b>StoTherm Mineral Lamella</b>	Sto Levell Uni with no dowels after full strength development of adhesive	11.11
<b>StoTherm Mineral M (Sto-Rotofix Plus)</b>	8 Rotofix Plus fixings per m²	1.51 <sup>(note 3)</sup>
	Specified number of Rotofix Plus fixings per m²	>1.51 <sup>(note 3)</sup>
<b>StoVentec rainscreen</b>	T profiles spaced @ 600mm spacing max.	1.1
	Wall brackets spaced @ 1200mm spacing max.	
	Vertical spacing of Ventec board fixing screws @ 234mm max.	
	T profiles spaced @ 600mm spacing max.	1.6
	Wall brackets spaced @ 1200mm spacing max.	
	Vertical spacing of Ventec board fixing screws @ 117mm max.	
	T profiles spaced @ 400mm spacing max.	2.2
	Wall brackets spaced @ 1200mm spacing max.	
	Vertical spacing of Ventec board fixing screws @ 117mm max.	
	T profiles spaced @ 400mm spacing max.	2.6
	Wall brackets spaced @ 800mm spacing max.	
	Vertical spacing of Ventec board fixing screws @ 117mm max.	

<sup>note 1</sup> (Factor of Safety 3) All figures are –ve suction loads in KN/m²

<sup>note 2</sup> (Factor of Safety 1.5) All figures are –ve suction loads in KN/m². The pull-out testing of fixings to substrate must be evaluated in accordance with BBA certificate and the lowest figure used.

<sup>note 3</sup> (Factor of Safety 2.25) All figures are –ve suction loads in KN/m².



# Accommodating building movement in facades

Movement in construction materials is a common and often unavoidable consequence of some of the following factors:

- **Type 1: Deflection under load**

Elements of a construction deflect/bend under its own weight (dead loads) and imposed loads e.g. people, furniture (live loads).

- **Type 2: Moisture movement**

Caused by materials shrinking upon drying and expanding upon taking up moisture, (shrinkage/expansion forces).

- **Type 3: Thermal movement**

Materials expand upon heating and contract upon cooling. Generally associated with metal components such as steel, aluminium and copper.

- **Type 4: Shearing forces**

Differential settlement within the foundations of a building. They will lead to some form of vertical separation of the facade. Can also be caused by differential expansion of materials.

- **Type 5: Bending Movement**

Arises from the deflection of a facade under wind loading.

As a consequence of these forces materials can crack, compress or stretch, depending on their inherent properties. Where this could result in a visible or physical defect in the building, this is unlikely to be desirable. Therefore the building needs to be designed to accommodate this potential movement.

Different materials and methods of construction will lead to differing types of movement. These factors will dictate the magnitude of that movement and the resulting solutions.



### Methods of Construction

Although Sto thin coat renders can provide a seamless finish, it is not always possible. Sto has undertaken extensive system testing and our recommendations are backed up by real test data. The provision of movement joints in a facade will be determined by the substrate and type of system chosen. The materials and construction details will dictate the requirement for the number and position of movement joints in the facade.



### Self-supporting masonry

This is where no structural frame exists. Blockwork and/or brickwork are supported by a foundation, i.e. all floors and the roof are supported by the masonry.

Movement within the masonry will occur as a result of the masonry expanding or contracting. Such movement is due to changes in moisture or temperature. Uncontrolled shrinkage of masonry can lead to cracking of the wall, including any finishes applied onto it. Shrinkage of masonry during the drying out process is dealt with by including contraction or shrinkage joints along the wall. Typically, this would result in joints at intervals no greater than 6 metres, but this can vary.

For more specific advice on shrinkage joints in concrete masonry, please contact either the manufacturer or the Concrete Block Association:

[www.cba-blocks.org.uk](http://www.cba-blocks.org.uk)



### Structural frame with infill panels

Where concrete or steel framed structures have infill panels of masonry or sheathing boards. The same movement principles apply to masonry infill panels as to self-supporting masonry. However, the masonry will be supported at each floor level by a beam, not by the masonry below. The beam is likely to deflect (sag) when loads are imposed upon it. Because of this, a movement joint (deflection joint) will usually be required. The joints typically appear between the underside of the beam and the top of the infill panel. This is commonly called a 'soft joint'. The level of deflection should be specified by the building engineer, and will determine the approach to accommodating this movement.

An infill panel of studs and sheathing boards will impose a dead load significantly less than a masonry panel. However, a horizontal joint below the beam is still often required. This connection allows vertical movement but restrains the frame laterally, commonly referred to as a 'deflection head detail'.



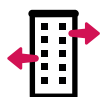
### Timber frame

Timber framed construction shares some similarities with self-supporting masonry. The timber frame is erected onto a foundation slab and provides the structural support for all floors and the roof. However, timber has very different properties to masonry in relation to thermal movement and shrinkage.

Timber is a good insulant and relatively unaffected by thermal movement, but it can be prone to other forms of movement, particularly shrinkage, during the drying out period. The shrinkage from drying is across the grain rather than along the length, so very little shrinkage occurs in vertical studs. Cross grain shrinkage can be significant, depending on initial moisture content of the wood and moisture gains during construction.

Poor construction may also lead to movement through settlement of the timber frame under compression. Any movement in a timber frame is concentrated at each floor level where the timbers are in a horizontal orientation and subjected to compression by the greatest weight. Little movement occurs in the main wall areas between floors. Cladding systems used in conjunction with timber frames must allow for potentially significant shrinkage movement at floor levels. This normally means a separation joint, which can be open or sealed, depending upon the wall design.





# Managing Movement

Sto render systems are robust enough to be attached to substrates with differential movement, but great care must be taken. If undue stress is placed upon the system it could deform and possibly fail.

Sto external wall insulation systems (StoTherm) are available as adhesive fix ('K') systems or mechanical fix ('M') systems.

### StoTherm K Systems

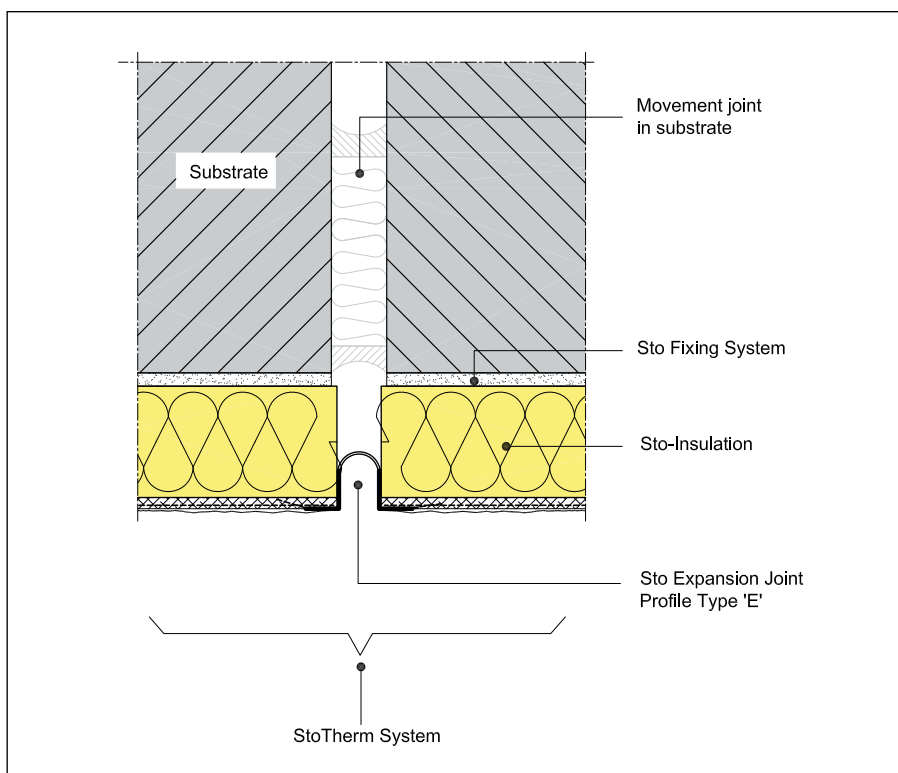
K systems are connected directly to the substrate with adhesive. As the substrate moves, so will the insulation. Any movement joints in the substrate must be mirrored through the system, including all deflection movement.

Usually adhesively fixed systems require movement joints mirroring those of the substrate to avoid surface blemishes. In certain situations it may be possible to realise a seamless facade across movement joints using an adhesive system if the insulation is locally debonded from the background on either side of the joint.

Always seek advice from a Sto Technical Consultant when seeking seamless facades with a K system.

Independent test data shows that:

- Direct fix systems are unable to accommodate compression in excess of 6mm.
- By debonding the insulation using Sto-Rotofix Plus, a seamless facade can be achieved accommodating up to 22mm in compression.



### StoTherm M Systems

Due to the nature of their manufacture and assembly, mechanical systems can tolerate far more movement than adhesive systems. The insulation boards are smaller (500mm x 500mm rather than 1000mm x 500mm). They connect to the substrate by either PVC rails or the unique Sto-Rotofix Plus system. With non-rigid connections between the components, each connection permits a small degree of movement.

A mechanical system only partially connects the render layers to the substrate. The fixings are also designed to accommodate expansion and contraction. These factors combined means that StoTherm M systems have a far higher capacity to deal with movement within the substrate. StoTherm M Systems can even be taken over contraction joints, unbroken, irrespective of the anticipated movement.

Sto has conducted extensive movement stress testing at the University of Dortmund, and their results are quite conclusive. Under specific conditions, it is possible for StoTherm 'M' systems to be continued across some building movement joints.

The type, direction and degree of anticipated movement must be confirmed by the system designer. The amount of movement due to compression is limited to 15mm where PVC rails are used to hold the insulation. A Sto-Rotofix Plus specification allows up to 19mm of compression.

In cases where the movement cannot be accommodated, the movement joint must be mirrored through the StoTherm M System. Local solutions may be possible, so where movement exceeds guidelines refer to your Sto Technical Consultant or contact the technical department for an approved detail.

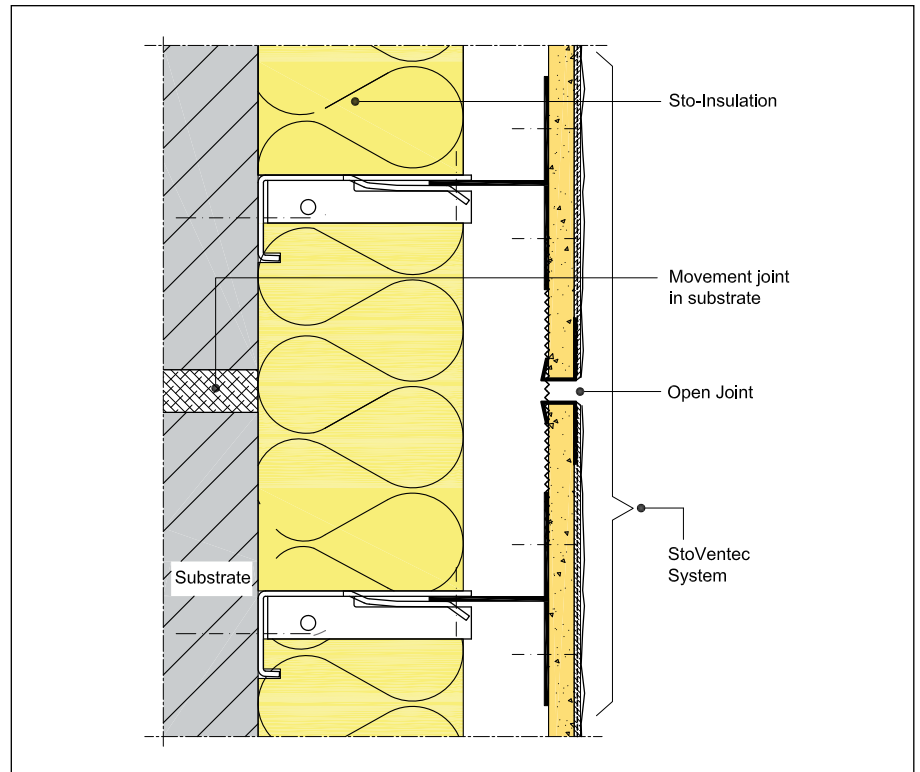


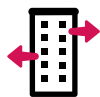


### StoVentec Render Carrier Board

Timber framed construction can suffer from shrinkage across the grain and compression under load at floor levels. Sto has engineered systems and products to cope with such issues.

Specific shrinkage figures should be obtained from the timber frame manufacturer. Allowances must also be made for an increase in moisture during the construction phase. Movement joints (or anticipated movement areas) must be reflected through the StoVentec Render Carrier Board and the coating. Usually, this also applies when the StoVentec Render Carrier Board is used as part of a StoVentec rainscreen facade. It is sometimes possible to slightly offset the position of a horizontal joint within the rainscreen system from the position of a horizontal joint within the substrate. Details are available to minimise the impact of such movement joints.



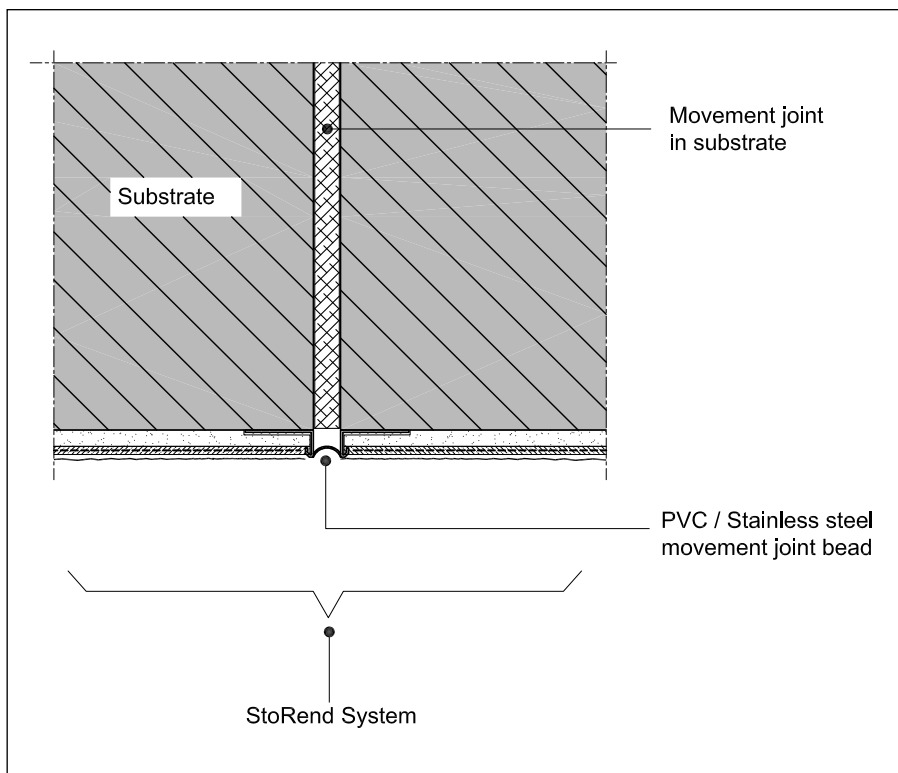


### StoRend Systems

The StoRend family of render systems are known for their quality and set the industry standard. The systems are designed to provide a combination of levelling and unparalleled flexibility onto solid masonry or concrete backgrounds.

These render only systems can accommodate movement in a variety of ways. Increasing levels of flexibility are achieved through varying combinations of cement-free, highly flexible reinforcing coats, glass fibre mesh and 'in-the-mix' fibres.

The mineralic levelling coats are factory produced using carefully graded aggregates for maximum quality and uniform consistency. These products can be further improved by the addition of fibres into the mix, helping to prevent shrinkage, cracking and crazing normally associated with these types of traditional renders. The additional use of a synthetic, cement free reinforcing/intermediate coat brings further benefits. StoArmat Classic combines with Sto acrylic topcoats such as Stolit to provide a highly flexible, durable and weather-proof facade.



Most render-only systems cannot be used to bridge across movement joints. StoRend Flex Cote bucks this trend. With careful detailing and proper installation, StoRend Flex Cote can be used in certain situations. The system can be continued unbroken over a contraction joint to bridge masonry shrinkage joints. This detail<sup>1</sup> is subject to maximum shrinkage of 6mm per joint (i.e. 3mm on each side of the joint). For this to be a viable option, it is imperative that the system designer confirms the expected shrinkage.

<sup>1</sup> SRFC\_13 & SRFC\_13\_2 (correct August 2012)

Movement within the building envelope can be highly varied. It is recommended that the implications of such movement are discussed at the earliest possible stage. Please contact your local Technical Consultant or Sto Technical services to arrange for a project-specific discussion.



# Product Warranty

## Product Warranty

Renders have long been considered high-risk materials. Cracking, spalling, colour fading, poor weather protection and high maintenance requirements were commonplace problems which specifiers had to anticipate. Sto has proven that this no longer needs to be the case.

Sto has been in the render business for over 150 years. Since 1955, over 450 million m<sup>2</sup> of our cement free external wall insulation systems have been applied worldwide. We offer unparalleled experience, knowledge and expertise in designing and manufacturing quality solutions. Our products and systems have stood the test of time in even the harshest environments.

Our standard product warranty offers the security that our products are of the highest quality and free of defects. This does not affect your statutory rights.



## Duration

The duration of this Warranty (the "Warranty Period") shall be: 5 years from the date of purchase for Sto facade products.

## Warranty

Sto warrants that during the warranty period the goods shall be:

- Of satisfactory quality to meet the needs of the specification.
- Of a standard which is appropriate for the purposes for which they have been and are to be used.

## Sto service

As part of the warranty offering, the following commitments are made:

- The warranty carries no cost to the customer.
- Lists of registered applicators are available from Sto to apply products under the warranty conditions.
- Free technical support is available for the investigation of warranty claims.
- Advice is available regarding the provision of a latent defects and insolvency insurance for longer terms of warranty. Please contact Sto for information.

Sto Ltd. recommends the use of Sto Registered Applicators to the specifier and contractor for the installation of our systems. These applicator companies have previously sent representatives to our workshops and undergone thorough system installation training. They are independent parties and legally separate from the Sto group. It is the responsibility of the Sto Registered Applicator to ensure the installation is in accordance with our method statement and specification. The use of Sto Registered Applicators does not infer or imply any warranty with regard to workmanship. Sto Ltd. will of course investigate and offer advice on any quality issues brought to us as a result of use of our material and associated product warranty.



# Sustainability

Sto leads in the field of sustainability in modern construction, through raw material selection, recycling of packaging and embracing new technologies. Together, these factors improve our system designs and help us towards our sustainability targets.

Our mission, 'Building with conscience', means far more than the sustainability of our manufacturing processes, but also our relationships with staff, customers and other key stakeholders.

For us to sustain our business we need to be mindful of the changing needs of society in a wider context. 'Building with conscience', is at the heart of everything we do, and will continue to shape our approach to business in the future.

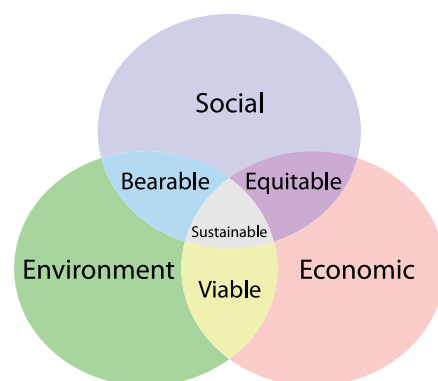


Fig. 1 – Motivating factors concerning sustainability.

## What constitutes sustainability within construction?

"Is it sustainable?" is a frequently asked question amongst the construction industry. Without an official industry definition, the answer can often be down to a loose interpretation.

Before a product or system can be considered sustainable, a full cradle to grave study needs to be conducted. This critical assessment of a product must consider all stages from manufacture, use, demolition and recycling across its lifespan.

## Sustainability – The Sto definition

There are many interpretations of the word sustainable and how it relates to our industry. To seek clarity we have considered this matter carefully. In lieu of an official industry definition, we have developed our own stance on the issue of sustainability.

The short-term needs of commerce and the community have to be balanced against longer term issues such as energy consumption and environmental concerns. At Sto we define sustainability as:

*'The point at which the needs of Social, Environmental and Economic factors intersect for a mutually beneficial outcome' (see Fig. 1)*

Consumption is the very nature of development and it is the impact of our consumption habits which concerns us. Our aim is that all consumption leads to long term improvements in social, environmental and economic spheres.



Below: Underhill House, the UK's first certified Passivhaus



### Our commitment to sustainability

In 2002 our StoTherm external wall insulation systems underwent a rigorous cradle to grave study by PE Europe, independent leaders in life cycle engineering. The goal was to assess the energy payback of StoTherm systems across their entire lifecycle. The conclusion of the report was extremely encouraging. StoTherm systems clearly demonstrated a significant energy payback during their lifespan. According to PE Europe, StoTherm systems are sustainable: energy payback happens within a few years compared to an assumed 40 year lifespan.

Sto is committed to sustainable manufacture and we continue to back up our claims with scientific studies. All elements of the product lifecycle are considered when manufacturing all of our products.

### Some of our sustainability credentials

Our core business focus is on developing systems which actively contribute to the long term environmental benefit of society. Examples of this are:

- EN ISO 14001:2004 accredited
- Signed up to the U.N. Global Compact Voluntary Business Initiative (2009)
- The first global manufacturer to remove VOCs from all water-based coatings long before any regulatory requirement
- Our products contain up to 96% recycled materials
- Removal of an estimated 150 million tons of CO<sub>2</sub> since 1960 through EWI installations



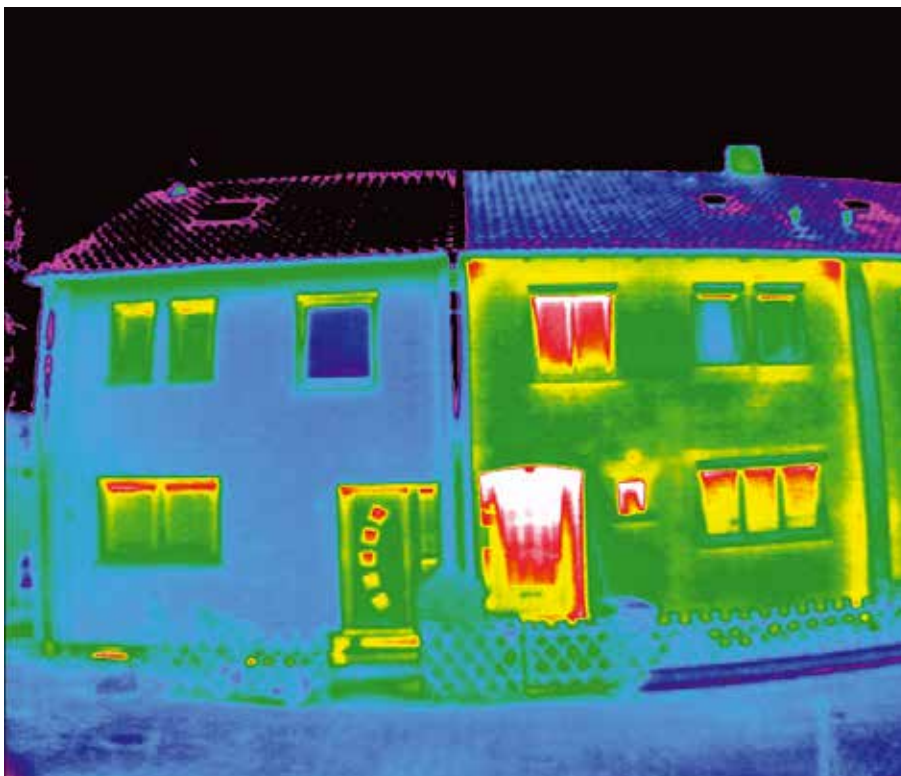


## Choice of insulation materials

PE Europe assessed the performance of our most widely used insulating materials against:

- Global warming potential
- Acidification potential
- Eutrophication
- Ozone formation

The systems showed minor variations throughout the essential categories noted above over a 40 year life cycle. Taking into account the full cradle to grave study, 'pay-back' was restricted to just a few years. With respect to global warming, 216 tonnes of carbon dioxide are typically saved by insulating a standard sized house (assuming a 40 year life cycle).



Thermal image showing a well insulated house (left) next to a poorly insulated home (right)



**What are Governments doing about sustainability?**

Having recognised that environmental concerns were a global issue, the United Nations General Assembly convened the Brundtland Commission in 1983. The commission was created to address:

“...the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development.”

According to the commission, sustainable development is:

“... [a] reconciliation of effective environmental protection and the conservation of resources with economic development...”

**UK sustainability measures**

The UK Government has committed to meet the demands of the Kyoto Protocol (1997) on climate change. Prime Minister David Cameron stated that his vision was to create the “...Greenest Government ever...”, arguably setting the most ambitious carbon reduction targets of any EU government. As part of this, he has backed a number of carbon reduction schemes as part of the Home Energy Saving Programme (HESP).



# Sustainability Measures for Existing Stock

Buildings in general account for 40% of annual carbon emissions within the UK. The vast majority of buildings which will exist in 2050 have already been built. Therefore, the majority of carbon reductions are likely to come from refitting homes with more energy efficient technologies.

To generate interest in energy efficiency measures, a number of grant schemes have been launched under the HESP umbrella:

- The Carbon Emissions Energy Target (CERT)
- The Community Energy Savings Programme (CESP)
- The Energy Company Obligation (ECO)

The Government is hoping that building and home owners will be able to afford such improvements due to savings on energy bills and motivated to do so by becoming more environmentally aware. Such thoughts have led to the announcement of the Green Deal.



## Green Deal

The Green Deal is the most ambitious Government energy saving programme to date. Funds will be made available for building owners to improve the energy efficiency of their properties.

### How is the Green Deal funded?

The Green Deal allows home owners to benefit from energy saving measures without the need for upfront costs. The home owner receives a loan from a Green Deal Provider (GDP), who attaches a loan repayment to their utility bill paid for by the energy saving measures.



### What is 'The Golden Rule'?

The Green Deal is to be privately financed as a form of loan. The loan is tied to the house (not the occupier) and connected to the utility bill.

All Green Deal measures will be repaid via the energy providers as part of the monthly utility bill. All measures need to be paid back within a 25 year period<sup>1</sup>. The intention is that the amount you save per month through more efficient homes will cover the loan repayments. This principle has been labelled the 'Golden Rule'. The Golden Rule is in place to ensure that utility bills do not increase as part of the energy efficiencies. This is because the Government is keen to make Green deal participation as widespread as possible.

The occupier will not see any monthly reduction in their bills as the amount should stay the same. The only difference being that the money saved on more efficient homes will be used to pay off the loan. In real terms, people will not see a reduction in their monthly bills until the loan has been repaid. The shorter term benefit for occupiers is they are safeguarding themselves against sudden spikes in fuel costs.

Hard to treat homes may require more expensive solutions that will not be paid back within the 25 years. To stay within the Golden Rule, it is likely such measures will be subsidised. There are hints that grants will be made available through schemes such as ECO.

### Hard to treat homes – Solid Wall Construction

Earlier schemes have enabled huge numbers of people to secure funds for cavity wall and loft insulation. Not all homes can benefit from these options, especially hard to treat homes such as those with solid wall construction. External Wall Insulation is ideal for hard to treat homes. It is one of the few remaining measures which can have a significant impact on heat loss of a building. Due to the comparative expense of external wall insulation it has not been widely adopted by home owners to date. Green Deal and ECO are set to make external wall insulation far more attractive to landlords and home owners.

<sup>1</sup> Correct at publication date





# Sustainability Measures for New Build

The UK Government has committed to reducing carbon emissions by 80% of 1990 levels by 2050. To facilitate this, a staged development plan of reducing carbon emissions from UK homes and buildings began in 2006.

### Zero Carbon Road Map

The grand aim was to achieve zero carbon for all new homes built by 2016. A road map of changes to Part L of the Building Regulations was created to facilitate this. How to achieve Zero Carbon has been an on-going debate since it was first announced and specifically how it is to be funded.

The original Zero Carbon definition – New Homes (2009):

*“...one whose carbon dioxide emission is zero or negative across the year. This includes energy regulated by Building Regulations and other energy used in the home.”*

The Minister of State John Healey MP, Aug 2009



Originally, all energy consumed during the lifecycle of the building had to be considered, including all domestic appliances. Building A Greener Future (July 2007) highlighted all new homes built from 2016 must take into account:

- Emissions from space heating, ventilation, hot water and fixed lighting
- Expected energy use from appliances
- Exports and imports of energy from the development (and directly connected energy installations) to and from centralised energy networks
- The building will have net zero carbon emissions over the course of a year
- The present consultation retains the approach of looking at net emissions (including from appliances) over the course of a year

It proposes that, to meet the zero carbon homes standard, homes should:

- Be built with high levels of energy efficiency
- Achieve at least a minimum level of carbon reductions through a combination of energy efficiency, onsite energy supply and/or directly connected low carbon or renewable heat
- Choose from a range of (mainly offsite) solutions for tackling the remaining emissions

These proposals were socially and environmentally viable, but they were not economically viable. They were ultimately unsustainable as homebuyers will not pay a premium for green measures. The term Zero Carbon required a strategic rethink.



### **Budget announcement on Zero Carbon New Homes (2011)**

The Government has been forced to rethink their roadmap to Zero Carbon, largely due to funding difficulties. As part of this, the definition of Zero Carbon is being reconsidered as is the 2016 deadline. It is likely that the 2016 deadline will be extended to 2018 or 2019. In the 2011 Budget announcement, details of the 2016 zero carbon new homes policy have been clarified. Only the emissions covered by Building Regulations (heating, fixed lighting, hot water and building services) are to be considered. Therefore, emissions from plug-in electrical appliances and cooking no longer form part of the Zero Carbon requirement. This change in stance was based upon recommendations from the Zero Carbon Hub's Task Group. This latest announcement is sure to divide opinion between sustainable bodies and the construction industry.



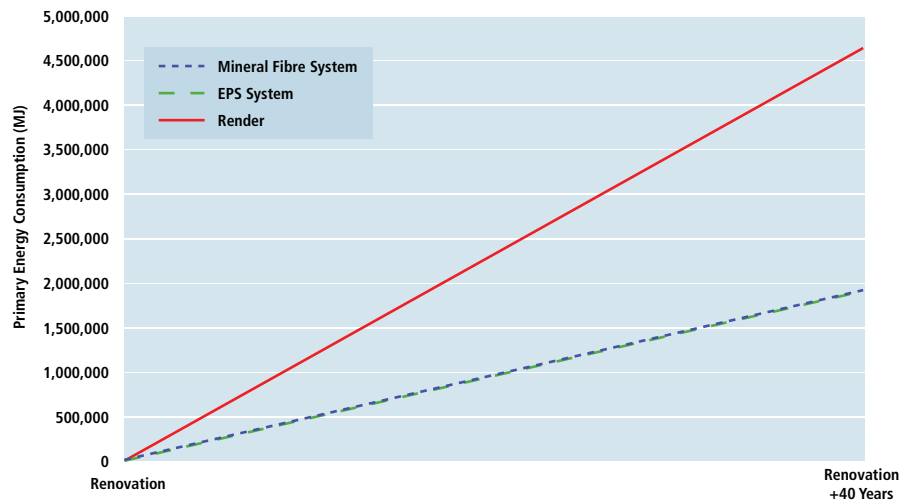




# Code for Sustainable Homes

The Code for Sustainable Homes (The Code) is the UK Government's national sustainability standard for new homes. The Code has exerted an increasing influence on the way buildings are designed and built in the UK since 2006. The code has the ambitious target of evaluating the sustainability of new buildings. It is gradually driving design to the point where new buildings are Zero Carbon by 2016 (2019).

Within England, the Code replaces the EcoHomes scheme, also developed by the BRE.



**On a scale of 40 years it is impossible to show graphically the difference between the three facade systems compared to the primary energy use of the existing building.**

### Scoring methodology

The Code for Sustainable Homes is not a design solution. More so, it is a guide on how a development should perform against selected criteria.

The Code measures the sustainability of a new home, rating the whole home as a complete package. There are 6 levels of the Code, level 1 being the least sustainable and level 6 the most sustainable. Before its redefinition, Zero Carbon was associated with level 6 of the Code.

The code evaluates a building on the basis of a points system. The total number of points achieved by the building will dictate which level of the code it meets. Points are awarded for performance against a set of nine separate criteria. The technical performance of the building, quality of life issues such as daylight, waste management and ecology are all considered. There are set standards for minimum energy and water use at each level.



### Application of the Code

The Code is not a Building Regulation, so applications of the code levels are not uniform in the UK. Public sector housing authorities are stating that all housing projects should conform to Level 4 from April 2010. Private housing developments are more likely to be required to achieve Level 3.

There is an area of debate on how best to achieve Level 4 of the Code. One argument is that Level 4 can be achieved solely by focussing on the exterior fabric of the building. A counter argument is that it is necessary to use micro-generation technology to accumulate sufficient points.

Unlike Building Regulations, the Code does not specify how the total points should be achieved. There is flexibility for developers to make their own choices.

### How the Code is influencing design

There is no doubt that the dramatic improvement in the energy efficiency of the building is challenging – meeting that challenge is not impossible, but traditional methods of construction are having to be re-evaluated.

A significant part of this re-evaluation focuses on the external envelope of the building. More specifically, how to achieve U Values far in advance of those required a decade ago.

Traditional cavity wall brick and block construction is struggling to meet the challenge. House builders are forced to look at alternatives unfamiliar to the UK market.



Two recent experimental projects<sup>1</sup> by major UK house builders give an indication of what houses may look like in 2016+. Both use solid walls with External Wall Insulation finished in render. With the redefinition of Zero Carbon, it is unlikely we'll see much "Eco-bling" on our future homes. Factors such as wind turbines have a minimal impact upon the sustainability of a home. The real savings are through more efficient use of energy and reducing consumption.

<sup>1</sup> The Barratt Green House and the Miller Zero project



# BREEAM - Building Research Establishment Environmental Assessment Method



The BRE Environmental Assessment Method (BREEAM) is a widely used guideline for assessing sustainability within building design.

BREEAM addresses wide-ranging environmental and sustainability issues. It enables developers and designers to provide environmental credentials for their buildings. In simple terms, their criterion establishes the need for:

- Reduced energy costs
- Lower energy and water consumption rates
- Improved social benefits attributed to newly built homes



## Aims of BREEAM

The main aims of BREEAM are to:

- Encourage demand for environmentally sustainable buildings
- Reduce the environmental impact of developments
- Provide a credible 'environmental label' for developments

## BREEAM Environmental Ratings

The assessment method has been used to provide an environmental measure of thousands of typical construction types. These ratings are detailed in BRE's 'Green Guide to Specification', which can be accessed from the BRE website.

Specifiers can use the ratings to assist in the design decisions needed to arrive at a sustainable construction solution. The ratings are used to classify materials when assessing building construction against the Code for Sustainable Homes.

All Sto EWI systems are categorised as class 'A' systems. This demonstrates the importance of the system as a whole and not just the individual insulation type used.

## What is the Green Guide?

The Green Guide was created by the BRE to act as a reference point for specifiers. It also offers an accredited environmental rating for buildings by assessing and scoring the environmental impact of individual materials. Ratings are set out from A+ (most favourable) to E (least favourable).

Sto's insulation material ratings as part of our EWI systems are as follows:

- Expanded Polystyrene (EPS): A+
- Mineral Fibre: A
- Lamella: A

## PassivHaus

In Germany and increasingly in the UK, the PassivHaus method of construction offers the designer another approach to sustainability. PassivHaus designs meet Level 4 of the Code for Sustainable Homes – without relying on microgeneration to achieve that result.

StoTherm Classic has been optimised to meet PassivHaus standards and has received certification from the PassivHaus Institute.

A major advantage of any PassivHaus is the incredibly low energy consumption and running costs. The costs of building such a house are declining, and currently stand at around 5-8% above those for a low-energy house.

The key criterion for a PassivHaus is the annual heating requirement, which must be below 15 kW/h per m<sup>2</sup>. As a comparison, the annual energy consumption of a typical home predating 1980 is more than 220 kW/h per m<sup>2</sup>. The long term potential of PassivHaus is making it an increasingly popular and understood methodology in the UK.







## Environmental Product Declaration Certificates (EPDs)

### Environmental Product Declaration certificates – EPDs

Sto has attained EPDs for all its essential mineral based render products. We are one of the first global manufacturers to achieve this and it signifies our commitment to sustainability. As soon as appropriate testing regimes for synthetically bound products have been agreed, these shall also be tested.





## Waste packaging disposal

The iconic yellow Sto pail has become a recognisable artefact across thousands of work sites globally. The ergonomic design and bold colouring is as much a part of our brand as the Sto logo.

We are often asked how we deal with the thousands of plastic pails and other packaging materials that are distributed to our customers across the country. As a company committed to protection of the environment, we ensure that our packaging materials are recyclable and the amount used is the minimum possible for safe handling and transportation.

Under the Producer Responsibility Obligations (Packaging Waste) Regulations (GB & NI) and the Waste Management (Packaging) Regulations (Eire), the Environmental Protection Agencies have a duty to monitor the compliance of businesses with the regulations. Most businesses with an annual turnover of more than £2m and handle more than 50 tonnes of packaging in a year have to comply with the Environmental Agencies, while others join a compliance scheme that takes on legal and associated administration tasks.

As a member of such a scheme, Sto provides evidence that our packaging is recycled when it becomes waste. The weight and constituents of every pail, carton or bag is recorded by us and audited by the compliance scheme managers.

Companies that actually recycle waste packaging are licensed by the Environment Agencies to produce and sell Packaging Recycling Notes (PRNs) and these represent evidence that a quantity of waste packaging material has been recycled or recovered. For every tonne of waste that is recycled, a PRN may be



issued. To complete the circle, the user of our products has a responsibility under the Site Waste Management Plans Regulations to ensure that the packaging is disposed of properly and that it will be delivered or collected by a local waste processor.

PRNs are purchased on our behalf by our compliance scheme managers to meet our obligations under the regulations and by purchasing PRNs we are fully compliant with the regulations and underwriting the cost of our packaging being recycled.

As demand for PRNs rises and falls, so does the price we have to pay. They have a value as a commodity and the PRN is the only evidence that is accepted by the Environment Agencies of a business's compliance with the regulations.



# Light & Colour Perception



This section discusses colour theory, texture and material within the built environment. It focuses on the StColor System and the technical and aesthetic considerations when specifying colour within architecture.

All matter and energy is colourless. Light would also be colourless had we not evolved a means of colour perception: retinas within the eye.

Visible light is a form of electromagnetic radiation that is read by cone receptors in the retina and interpreted by the brain as colour. Different colours are caused by different wavelengths of light being reflected from different materials. For example, a red object reflects red wavelengths, while a purple object reflects both blue and red wavelengths.

White objects reflect 100% of light and black objects absorb 100% of light.

### Natural and Artificial Light

White light can be split into different colours via a prism. Colours appear most naturally under a strong white light source. It is considered 'pure', combining the full, visible, monochromatic colour spectrum (rainbow colours).

Artificial light sources often have a colour bias, such as yellow. Without the full colour spectrum available with white light, not all colours can be absorbed or reflected, directly affecting the quality of colour perception. A particular colour tone may look significantly different in sunlight compared to interior lighting.

A prime example is when a facade wall penetrates into an atrium. The wall will appear different under the natural light from outside compared to the artificial light inside.

### Quality of Light

The time of day and how light is dispersed can have an effect on colour perception. Two elevations of an identical colour can appear different due to shading, texture and cross lighting.

It is important to understand how light will play across a building throughout the day. For example, a facade elevation is likely to appear more blue in the morning and more red in the evening.

Understanding the effects of light in this way gives the designer a better understanding of the colours that will work for each site



# The StoColor System

Developed in the year 2000, the StoColor System is a colour range engineered for architecture. The system complements our various render products from a technical and aesthetic point of view. Colorimetric and system-theoretical considerations are not given pride of place.

The StoColor System has over 800 colours, providing a clear, systematic approach to colour design and a sound foundation for creative concepts.

## Functionality of the StoColor System

- Quick and easy to understand thanks to a clear, logical construction.
- Reliable application of design through a harmonic, finely nuanced selection of colours for exterior and interior use.
- Ergonomic, perception-oriented presentation media (e.g. fans, charts) for all phases of colour design.
- Sto Technical Consultants are available to offer advice on colour and product choice to ensure optimum durability.

Please consult the StoColor System file for a full explanation of the system structure. Certain performance products are not available in the full range.

To view the full StoColor System, visit [www.sto.co.uk](http://www.sto.co.uk)



### Level 1.

#### The human colour perception range

Human perception is primarily able to distinguish the colours yellow, orange, red, violet, blue and green. This forms the starting point of the StoColor System.



### Level 2.

#### The colour wheel - 24 basic colours

The 6 primary perception areas are each mixed out into 4 further colour levels. The result is the 24-part colour wheel that forms the basis of the StoColor System.



### Level 3.

#### 5 colour rows of 24 basic colours

Each basic colour possesses 5 colour rows mixed out according to the principle of the same-colour triangle:

#### 1. Light clear colour row

Basic colour mixed to white

#### 2. Shade row 1

Basic colour mixed to grey

#### 3. Shade row 2

Basic colour mixed to grey

#### 4. Shadow row

A colour from the light clear row mixed with a colour from the dark clear row

#### 5. Dark clear colour row

Basic colour mixed to black

### Class 4 custom colours

Colours outside of the StoColor system are available on request, but as these colours have not been subject to the fade resistance testing, we are unable to guarantee the same level of lightfastness.



# Colour Variations

Sto renders feature a number of binders (acrylic, silicate and silicone resin). These binders each have different pigment carrying capacities. It is important to check that the desired colour is available in the chosen render. Our colour charts are coded to signify colour availability for a number of different products.

### Variations across different products

Matching colours from one product to another can prove difficult. Even if the tint ratio is identical, subtle variations in the hue/texture of fillers and aggregates can make an enormous difference to the 'perceived colour' of two products.

### Variations across identical products

Every effort is taken to ensure a consistent colour within the same product range. However, minor variances in tone can occur from one batch to the next due to small differences in natural aggregates. Finishing techniques used by multiple applicators can also have an effect on the perceived colour.

Product batches should never be mixed across a single elevation as even subtle differences can easily be seen. Where possible, material from the same batch should be used across the entire project. If this is not possible, application should be limited to the same batch per elevation or other natural breaks.



### Colour matching service

On request, Sto tinting teams can store colour swatches for projects. These can be used to make minor colour adjustments when ordering over multiple batches or product ranges. This is a more accurate way to colour match than relying on predefined tinting ratios.

### Overpainting

If a facade had significant colour variance across a rendered surface, often the only way to remedy the situation will be to overpaint the entire elevation with masonry paint (if appropriate).

### Re-application

If the colour variation is as a result of light or texture, then overpainting may not solve the problem. A total re-application of the topcoat may be necessary.

### Natural White

The visible texture in Sto finishing renders is the marble grain encapsulated within the material binder and fillers. This binder, as well as having different physical characteristics, has a slightly different white tone. For this reason we describe our white as 'natural white'.

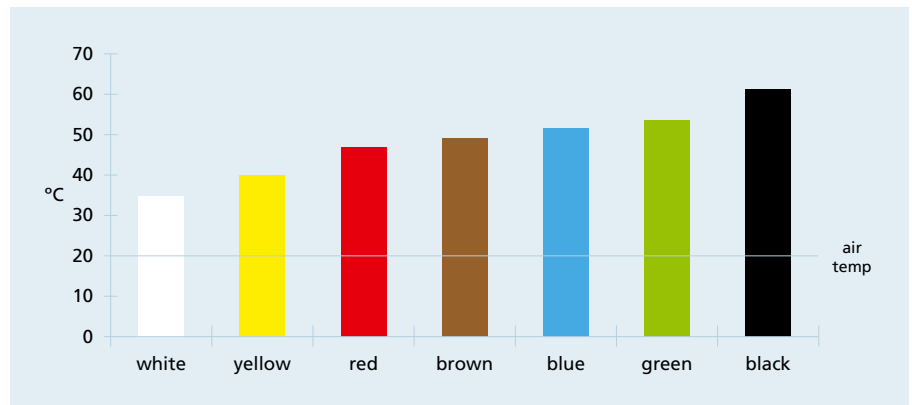
In certain materials it is possible to tint the finish to closely match a standard RAL white. It should be noted however, that this tone will never be a perfect match. It is also associated with a slightly increased cost. For this reason, site sample panels in the actual material are always recommended.





## Colours & Thermal Gain

The influence of colour is an important factor when considering the temperature of the render finish. Sto facade systems can be supplied in all 800 colours from the StoColor System, but in practice it is not advisable to have a dark, intense colour render with an external wall insulation system. The walls will heat up too much through thermal gain. The graph on the right shows different temperatures reached by different coloured walls at 20°C air temperature.



### Light Reflectance Values

All colours reflect light to a greater or lesser degree. This is represented in colour systems by Light Reflectance Values (LRV).

Measured using a spectrophotometer, LRV has a scale of 0-100, the higher the value, the more light is reflected. Absolute white has a value of 100 and absolute black has a value of 0, though manufactured whites and blacks rarely have absolute values. LRV helps specifiers to select colours suitable for their projects when considering heat gain.



### Use of dark colours

For external wall insulation systems, the use of dark colours can result in heat absorption within the render. This increases the risk of cracking and damage to the insulation. All colours with an LRV of less than 20% should be checked with our Technical Services department.

If very dark colours are required, alternative systems should be considered, such as the StoVentec insulated rainscreen cladding system. This system features a ventilated cavity, allowing for heat build-up to be easily dissipated.



### Use of intense, vivid colours

The dispersal of the pigment and aggregate in render products can be affected by the application method. Applying products of intense colour requires additional care. We recommend that renders with an LRV of less than 15% are overpainted to achieve a consistent appearance. We also recommend the same for C3 and C4 tinting categories of the StoColor System.

When overpainting, we recommend products with a high pigment carrying capacity such as StoColor Maxicryl. Our specifications will always state this recommendation and any deviation from this will invalidate the warranty.





# Colour Fade, Lightfastness & Chalking

Colour selection is often reliant on the designer's inspiration and local planning restrictions. But there is far more to consider when selecting colour.

Many manufacturers' colour charts show a wide range of colour tones, some surpassing the number offered by the StoColor System. Due to technical limitations, many thousands of colours are entirely unsuitable for exterior application. Some colours, such as vivid purples and pinks, lose their intensity under exposure to natural UV light. There are only a few pigments that keep their colour under the influence of sunlight long term.

The extent of colour fade depends upon a number of factors:

- Type and quality of pigment
- Binder composition
- Levels of UV exposure
- Type of substrate



### Weathering Effects

All pigmented materials run the risk of fading under exposure to heat, ultraviolet light, moisture and other weathering effects. Facades are particularly subject to environmental influences and natural wear and tear. Weathering will eventually lead to unavoidable changes of colour, sheen, texture and finish.

Other atmospheric influences, such as industrial pollution and microbiological contamination will also lead to an inevitable colour change.

### Binder and pigment durability

The colour stability of facade coatings is influenced by the pigments and the binders. UV light and exposure to weathering eventually degrade synthetic binders. Micro-cracks form, altering light refraction and making the colour shade of the binder appear 'grey'. Pigments are partially uncovered and exposure to UV light accelerates the colour change, worsening the issue.

### Sto Pigment Selection

In line with our commitment to quality, Sto only uses the highest grade, state-of-the-art pigments available. At times it is necessary to mix synthetic and mineralic pigments to achieve a certain colour and ensure acceptable lightfastness.



Classification (Fb-Code) of age-related colour changes. Source: BFS Guidelines No. 26			Colour pigments classed to their light fastness			
			Group 1	Group 2	Group 3	
			Very good light stability inorganic pigments	Good light stability organic and/ or inorganic pigments	Limited light stability organic and/or inorganic	
Coating material classed to binder	Class A	Facade Paint	Lacquer	A1	A2	A3
		Silicate paint	Acryl-Lacquer			
		Dispersion paint with a high resin content	PUR-Lacquer			
	Class B	Dispersion paint matt	Alkyd resin varnish	B1	B2	B3
		Silicone resin paint				
		Dispersion-silicate paint				
	Class C	Dispersion filling paint	Copolymer-resin paint	C1	C2	C3
		Lime paint, coloured	Epoxy resin lacquer			

Table showing classification of binders and pigments related to their durability on the facade over time. Three classes (A-C) refer to the resistance of the binder, where A is best and C worst. The pigments are divided into 3 groups (1-3), where 1 is best and 3 is worst for colour fastness. Code A1 relates to the best possible combination of binder and pigment. The ‘A’ stands for ‘barely visible chalking’. The ‘1’ stands for marginal colour change due to very light resistant inorganic pigments.

### Types of pigment

#### • Mineralic Pigments

Naturally occurring mineralic pigments provide the greatest lightfastness, but the colour range is limited by the metal compounds present in the ground where they are mined.

#### • Natural Pigments

Derived from vegetable or animal matter, but not used in facade applications as they do not hold colour intensity well enough.

#### • Synthetic Pigments

Advances in technology have allowed the production of synthetic pigments, allowing for bright colours with good lightfast qualities.

#### Pigment and colour dependent changes. Source: BFS Guidelines No. 26

Colour change	Group	Pigmentation
Hardly visible	A	Very good Lightfast inorganic pigments
Visible	B	Good Lightfast organic and/or inorganic pigments
Clearly visible	C	Limited Lightfast organic and/or inorganic pigments

Table assigning pigments to groups. The lightfast inorganic pigments belong to group A. They are very durable on the facade. Group B contains inorganic pigments and organic pigments which have good lightfastness. But after some time, a visible colour change can be seen. Pigments which are not colourfast are classed to group C. These are mainly organic pigments.



### Colourfastness 'Standards & Norms'

Although there are no regulations for colourfastness, there are many Norms and Standards. The following are some German norms:

- DIN 18363: Paint and varnish coatings
- DIN EN ISO 4618
- BFS-Merkblatt No. 25: Technical guidelines for judging colour match and colour variations

In the German technical guidelines, tinted facade coatings and varnishes are classed for expected colour changes. This classification depends on:

- The type of coating material
- The pigmentation of the coating

An assessment of time dependant colour changes is relative and it is not possible to define exactly.

The BFS guidelines describe the state of technology for painters and decorators. They serve as a technical authority for the Coatings and Lacquer industry for experts, planners and architects.

The technical guideline no. 26 gives guidance on colour changes which may appear after some time. This is dependent upon the type of project and any impacts on the coatings. The guideline describes a classification system which can be used as a forecast. It applies only to tints ex-factory and for colours which are produced with tinting systems of the corresponding producer.



### Chalking

Chalking is the result of weathering of the coating finish. Controlled chalking is sometimes desirable, since it is a self-cleaning process. Excessive chalking can only be remedied by extensive

preparation. For example, the removal of loose powdery pigment by scrubbing, wire brushing or sanding the surface. This should then be followed by the application of an appropriate primer.

#### Visible chalking of facade systems (without changes induced by pigments).

Source: BFS Guidelines No. 26

Visible chalking	Class	Examples
Hardly visible	A	Silicate paint Dispersion paint with high binder content
Visible	B	Dispersion paint, matt Silicone resin paint, matt Dispersion-silicate paint
Clearly visible	C	Dispersion filling paint Lime paint, coloured

This table classifies chalking of binders in facade systems. Class A means that there is nearly no degradation of the binder over a period of 3 to 4 years. When exposed to weathering, the surface tends to a low chalking and discoloration. Binders displaying considerably higher chalking are assigned to class B. Dispersion 'filling' paints and coloured lime paints tend to chalk more than silicate or dispersion paints with a high binder content.



### The importance of quality ingredients and composition

The composition of the facade coating has a considerable influence on the durability of the colour. The binder, pigment, fillers and additives (e.g. wetting agents, thickeners) all have an important role to play. The quality and quantity of each will have a significant effect in producing a technically and aesthetically robust facade coating.

The binder for the coating should be UV stable. In 'organic' water-based facade coatings, the binder content is a decisive factor for the colourfastness. Dispersion paints with high binder content and low pigment volume concentrations provide a much better binding of the pigments. Mineralic binders such as potassium water glass or sol/silicate exhibit the greatest UV resistance of all binders and are very weather resistant.

Light-coloured facade coatings tend more to chalking than dark-coloured coatings. The reason for this may be the photochemical reaction of the titanium dioxide which dominates in light colour shades. Different quantities of titanium dioxide and the type of binder used in the coating can produce huge differences in colour stability.



### Colour specification for Facades

Test standards for colour stability are fragmented. In order to provide reliable data for facade coatings, Sto performs long-term weathering tests. Two main types of test are conducted. The first involves natural exposure of pigments to the elements in three locations globally (Shanghai, Germany and Florida). These exposed weathering stations accurately test and record weathering effects over

decades. In addition, we subject each pigment to laboratory tests, putting them through artificial extremes of weathering. The pigments are subjected to intense UV exposure, hot and cold cycles as well as simulated rain. These tests simulate many years' worth of exposure condensed into just a few hours. Only the most stable of colours make it into the StoColor System, so you can be assured they are ideally suited for use in the built environment.





# Texture & Finish Selection

Choice of texture is more than just an aesthetic consideration. Heavier textures are more forgiving and make it easier to achieve a consistent surface. Fine textures, without skill and care, are more likely to show imperfections, such as bumps, depressions and trowel marks. We will always advise the system designer selects a Sto render aggregate size of 2mm or greater. Smaller aggregate sizes can be used, but greater levels of substrate preparation are required to minimize visible surface undulations.

By altering the aggregate size and grading a variety of textures can be created.



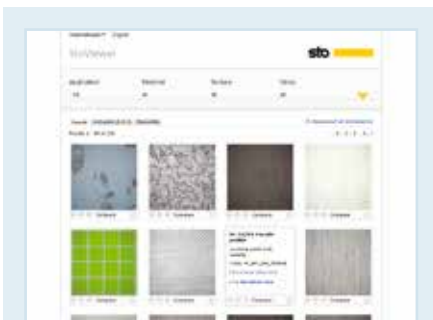
### Stippled (K)

A classic finish for synthetic renders. The even texture gives the finished substrate a flatter aspect compared to a smooth, floated surface which can highlight even minor trowel marks. The stippled texture can also help to promote effective water shedding in rainy weather.



### Freestyle (MP)

If a unique, bespoke finish is required, the very fine grading of MP finish renders give the scope for design flexibility. The material can be rubbed up to give a near smooth texture (subject to the practical limitations) or provide a variety of 'freestyle' textures for the facade.



Visit the StoViewer online to see different Sto materials and textures:

<http://goo.gl/avxJW>



### Rilled (R)

An attractive drag finish for synthetic renders with the appearance of a scratch plaster. The rilled texture helps to give the finished substrate a flatter, more even appearance.



### Natural Stone Aggregate

A durable, multi-coloured finish with a heavy texture and natural stone aggregate. Ideal for high impact areas and splash zones below the damp-proof course.





### Appraisal of Render Textures

With any wet formed, hand-applied material there will always be some surface irregularities. Aesthetic acceptability is subjective and the British Standard for rendering and plastering defines the limits of acceptability and the viewing conditions under which those assessments should be made.

We suggest that any assessment on the finish is undertaken in accordance with BS EN 13914-1:2005 (Design, Preparation and Application of External Rendering and Internal Plastering).

### Sample Panels

The best way to appraise colour and texture is for a sample panel to be constructed on site by the applicator in the specified material. The panel should be viewed under typical light conditions. This will ensure a quality standard for workmanship and colour against which the project can be benchmarked.

Sto supplies colour cards and overpainted samples as a means of assisting colour choice. Site samples will be provided by the chosen applicator, and should be a requirement of the contract.

### Extract from BS EN 13914-1:2005

Rendering on external walls should be reasonably consistent in texture, finish, colour and line. However, rendering cannot be expected to provide a perfect finish and the following should be observed.

- Some minor surface cracking and crazing is likely to occur but should not be unduly obtrusive.
- Some patches and daywork joints may be visible but should not be unduly obtrusive.
- Some tooling marks may be visible, but should not be unduly obtrusive.

### Lighting – General recommendations

The intensity and angle of illumination can have a critical effect on the appearance of a finished externally rendered surface. For this reason, normal working and acceptance conditions are limited to when lighting and viewing are from positions perpendicular to the surface.

### Glancing light conditions

If the surface is to be assessed under glancing light conditions this should be stated in the contract specification.

### Viewing conditions

When inspecting a finished externally rendered surface, it should be viewed in daylight, standing at ground level, from a generally accessible viewing position. Where possible it should be viewed at a distance of ten metres, with sunlight, if any, not falling on the surface in a glancing direction.

### Line

The line of the rendered surface will largely be determined by the line of the substrate.



## Material Selection

### Render components

Render consists of five basic components:

- Binder
- Pigments
- Filler
- Diluting agent
- Additives

Different combinations and quantities of these components produce renders of varying strengths and qualities. Of these elements, the binder has the greatest effect on a render's physical properties.

### Material choice

The choice of material will likely depend on the aesthetic the designer is seeking. That said, it is also important to consider anticipated levels of exposure to the elements. Such conditions vary depending on the location of the building and the surrounding environment.

Designers should account for site exposure conditions in accordance with BS EN 13914-1:2005 and BS 8104:1992. They must also ensure the wall construction and detailing is suitable for the given exposure. Sto can advise on suitable solutions to match construction types.



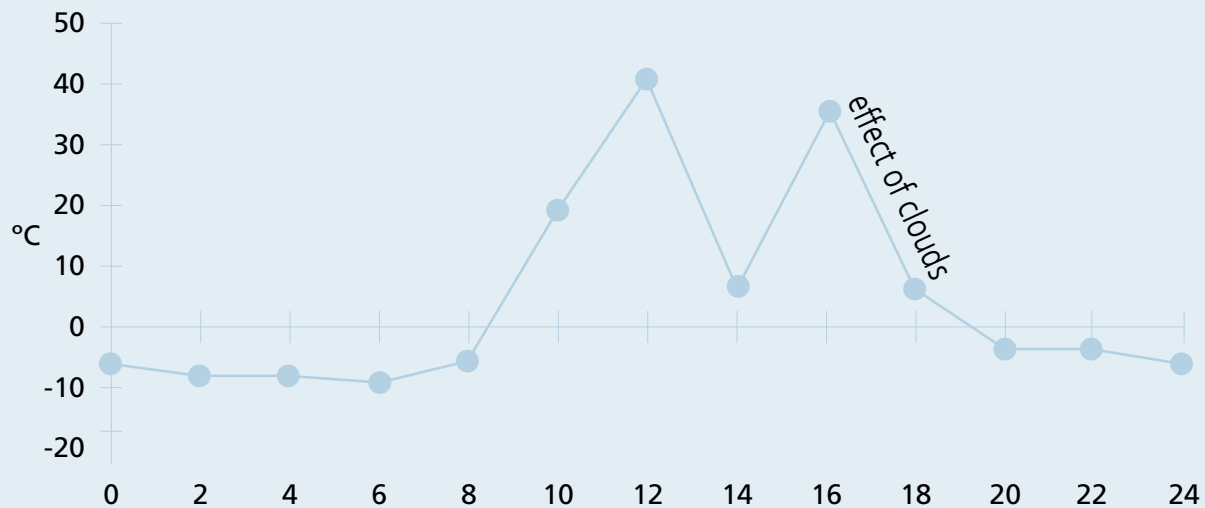
### Finish renders & technical design considerations

While primers and intermediate coats are important for the technical performance of a render system, the render finish has more criteria to satisfy. Finish renders must protect the wall structure as well as fulfil aesthetic demands.

When choosing a finish, it should not be less flexible than the materials beneath. The binder in the render finish must be compatible with the substrate and intermediate coats. If this is not observed, the system will eventually fail.



## What Should Render Withstand?



This chart shows the temperature of a typical building over a 24-hour cycle in Winter.

### Weather protection

A render must have a low water absorption coefficient to keep the substrate dry. It must also be vapour permeable to allow any moisture within the substrate to pass through the render (known as 'breathing').

The building envelope must withstand everything that the weather throws at it:

- Rain & snow
- Sunlight
- Cold & heat
- Dust & wind
- Chemical/mechanical corrosion
- Freeze-thaw
- Biological corrosion from fungus, algae and mildew

### Crack prevention and surface temperature

A render must be flexible enough to withstand the stresses caused by extreme temperatures or small structural movements without cracking.

The surface temperature of any substrate will fluctuate throughout the day and goes through a cycle of freeze-thaw conditions with the changing seasons. This continuous heating and cooling causes movement and expansion within the substrate. The walls have to be able to withstand these without the need for continuous repair.

### Resistance to dirt/algae

The render should be resistant to algae growth, even in polluted city areas.

### Ease of repair

All defects should be minor and easy to repair, keeping the render as maintenance free as possible.



# Renders: Technical characteristics

Not all renders provide the same benefits. Lime, cement and silicate products are breathable, but they fail in terms of cracking and weather resistance. This means that water can get inside the system and result in the system coming away from the wall.

Acrylic render, silicone render and Lotus-Effect® renders are the best types of render to choose in terms of technical characteristics.



### Acrylic resin render

Sto has been developing acrylic resin renders for over 50 years. In their most basic form, acrylic renders contain:

- Limestone or marble aggregates
- Synthetic resin binders
- Titanium dioxide fillers
- Pigments and enhancers (such as silicone emulsions)

Correct formulation of these constituents produce tough, clean, weather resistant coatings.

Acrylic resin renders are highly elastic, making them resistant to cracking. They have the best adhesion co-efficient and are easy to apply and texture. Acrylic renders offer the widest choice of colour and the best colour stability.

### Features & benefits

- Universally tintable in the 800 colours of the StoColor System
- Extremely low water absorption, reduces risk of surface damage
- Optimum substrate adhesion properties
- High elasticity/flexibility provides resistance to mechanical movement, minimising risks of cracks
- Exceptional colour stability following the drying process. Does not require an equalising coat.
- Can be applied with trowel or airless spray machine.



### Silicone resin render

Silicone resin renders combine the benefits of mineral binders with synthetic binder types. They have excellent water repellency, vapour permeability and good dirt resistance, but a limited colour choice.

StoSilco render has synthetic binder content between 6% and 10%. We use a silicone resin emulsion as a second binder part. Silicone resin has long-chained, 3-4 times reactive Poly-Siloxanes, building three-dimensional mesh structures into the render layer. It is this structure that is responsible for the long life and excellent physical properties of a real silicone resin coating.

### Features & benefits

- Tintable in the Earth Tones range of 493 colours from the StoColor System.
- Very good CO<sub>2</sub> and water vapour permeability, increasing the rate of moisture transfer and evaporation for a breathable wall.
- Highly water repellent, aiding in cleaner looking facades.
- Resistant to aggressive atmospheres, offering excellent weather protection.
- Resistance to algae and fungus growth, minimising associated risks.





#### Lotus-Effect® render

An innovation unique to Sto. StoLotusan is the only render on the market with the patented Lotus-Effect®. It demonstrates unbeatable water and dirt repellence, and provides the best natural protection against algae growth.

As StoLotusan cures, the surface forms a unique microstructure similar to that of the lotus leaf. This greatly reduces the surface contact of water and dirt particles. Every time it rains, the rainwater simply rolls off the facade, picking up loose dirt deposits as it goes.

#### Features & Benefits:

- Tintable in the Earth Tones range of 493 colours from the StoColor System.
- Water and loose dirt are unable to grip the surface, so the facade is cleaned every time it rains.
- Very good CO<sub>2</sub> and water vapour permeability, increasing the rate of moisture transfer and evaporation for a breathable wall.
- Provides the best natural resistance against algae and fungus.
- Excellent application properties with trowel or airless spray machine.



#### Lime based render

A low strength render with high water absorption and vapour permeability. It can only be applied to mineral substrates. Lime renders do not have the flexibility, durability and colour fastness required for today's market, usually limited to niche renovation projects.

#### Cement based render

Affordable, durable and offer excellent vapour permeability. Unfortunately, they lack flexibility, are prone to cracking and demonstrate poor colourfastness. They should only ever be applied to mineral substrates. With the proper additives, cement-based renders can provide weather protection.

#### Silicate based render

A mineralic render offering improved properties when compared directly to cement based renders. However, they lack flexibility and colour fastness is limited. Best suited to lime-based substrates.

#### Silicone Resin vs. Silicone Oil



If something is cheaper, there is normally a reason. For example, reduced titanium dioxide content leads to a more porous textured surface, duller in colour. Have a look at the image of two comparable products above. The finish on the right is a Sto finish.

The long life and excellent physical properties of silicone coatings come from the three dimensional molecular structure of the silicone resin binder.

But many silicone products on the market contain silicone oil. This is a short-chained, non-reactive, oligomeric siloxane that can only create 2-dimensional molecule chains.

While silicone oil and silicone emulsions can be added to provide some hydrophobic properties, it is only an additive and provides no binder properties. In fact, too much silicone oil can create an adhesive surface with a strong soiling tendency.

There is currently no industry standard definition for what constitutes a silicone render. Some brands claim to offer the same as Sto, but with less silicone content and oil used in place of resin binders, these products will in no way perform to the same standard.

#### Please note

Some water-borne/greasy deposits can cause staining on StoLotusan, especially over detailing that can cause water to regularly drip onto the rendered surface. It is therefore particularly important to ensure that cappings are used and that StoLotusan render is only applied at 150mm above ground level to avoid ground water splashing.



# Best Practice

There are some simple precautionary steps that can be taken to ensure the successful installation and longevity of the Sto system.

### Specification Stage

It is vital that a unique specification is issued by Sto for each project. Project requirements should be discussed with the Sto Technical Consultant to ensure all detailing issues are addressed.

Technology and practices change, so it is important to use the latest details and processes. The specification is used to generate a project-specific method statement for the system installation.

### Pre-start meetings

Before the contract starts, a meeting should be convened between Sto, the applicator, the architect and the main contractor. This provides an opportunity to review and ensure a thorough understanding of the project by all parties.

Access to the wall should be agreed before installation commences. This could include scaffolding, location of scaffold boards, scaffold ties and other methods, such as cherry pickers or mast climbers. Sample panels should be constructed and approved as part of the contract. Refer to these panels in the event of issues relating to workmanship, texture and colour.



### Substrate preparation

Sto renders are typically adhered to, or follow, the underlying substrate. To ensure successful application, it is important that the substrate is:

#### 1. Solid

The substrate needs to be consolidated, strong and able to support a render. Sto can supply many primers and systems to accommodate different substrates. Where there may be a concern, a site visit with a Sto Technical Consultant should be arranged.

#### 2. Clean

Remove all friable, loose or dusty materials, as these can affect the adhesion of renders to the substrate.

#### 3. Dry

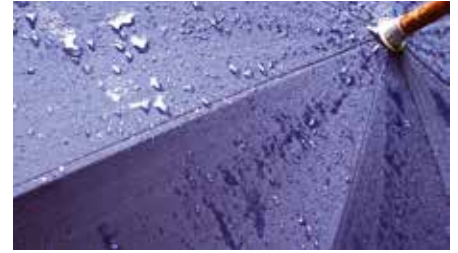
Application onto damp or wet substrates can cause adhesion problems for some renders. Some materials require a dry substrate, while others may benefit from predampening. Always refer to the product's Technical Data Sheet or speak to a Sto Technical Consultant.

#### 4. Load Bearing

The substrate must be capable of supporting the weight of the system. Ensure that systems reliant on mechanical fixings for support have adequate strength between the fixing and the substrate.

#### 5. Level

While some systems can accommodate small variations in the substrate, render only systems generally follow the underlying substrate and building line.



Below: A Sto advanced weathering chamber

### Weather protection during installation

The substrate needs to be kept dry, or allowed to dry, before applying the render to allow for proper adhesion.

Following application, acrylic renders should be protected from inclement weather to allow them to cure. As they cure by evaporation, the rate of curing can be affected by temperature, wind and relative humidity.

Cementitious and acrylic renders should not be applied in direct sunlight. Heat build-up in the wall can cause the product to dry too fast. This can make finishing difficult, and in the worst cases can result in cracking.

### Cold weather

Extreme cold will have a negative effect on render products. Both powder products and ready-mixed materials have water as a constituent part. Products that become frozen will be irreparably damaged and will need to be replaced.

It is important that paste materials are stored above 5°C. Powder products should be kept dry and off the ground and should not be allowed to freeze.

If uncured render is exposed to frost, the binder can be disturbed. Sto QS render technology enables renders to be applied in temperatures as low as 1°C. During the winter months, Sto will typically supply all acrylic base coats and top coats (where available) in QS technology as standard.

### Colour

Sto through-coloured renders are tinted for each project. A colour stick is supplied with every batch to check against the required colour.



### Algae growth

If render becomes saturated, has little direct sunlight, or is applied in an area of high vegetation, it can support algae growth. There are a number of measures that can be taken to minimise this:

- Have adequate cappings and cills to throw off as much water as possible.
- Hydrophobic and superhydrophobic renders such as StoSilco and StoLotusan help to shed water.
- Algicides can be applied to the walls on a seasonal/periodic basis. This will kill off the growth and improve the appearance of the wall.
- Walls can be overpainted with hydrophobic paints such as StoColor Silco or StoColor Lotusan following the algicidal treatment.

### Protection from incidental damage on-site

Renders, like most other facade materials, are liable to the vagaries of the site. To minimise damage from physical impact, dirt and other trades, we recommend that the final render coat is left as late as possible in the programme. Renders can be repaired or repainted but this is not always desirable. Whilst most dirt can be washed off, some very fine clays can become ingrained and lead to staining which can be difficult to remove.

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