



# CLAY BRICK: END OF LIFE CYCLE



## Contents

Intro	03
Life cycle assessment	04
Refurbishment & Retrofitting	05
Reuse & recycling	06
- Performance considerations	06
- The reuse process	10
Down cycling	12
Traditional methods of manufacture	12
Weathering tips for new brickwork	13



# INTRODUCTION

Bricks are durable and therefore sustainable and reusable; the vast majority will last for at least 150 years. Historically the brick industry has been cautious about advocating the reuse of brick, due to the uncertainties around the product performance. However with the increasing impacts of the climate and biodiversity emergency, the industry has committed to developing understanding of the important End of Life cycle stage.

Compared to other cladding systems, such as timber, masonry construction has a strong advantage at the End of Life cycle stage because bricks are more easily refurbished, reused and recycled.

The main focus of this document is the practical consideration of the reuse and recycling stage. For completeness, the refurbishment, retrofitting and downcycling stages are also included. However, these stages are not explored in detail, due to them either being part of a wider design decision or the down cycling process already being well understood.

As well as a sustainability motivation, the appeal of using reclaimed bricks is that they may have developed a particular aesthetic character, being fully matured and weathered.



# LIFE CYCLE ASSESSMENT

For the built environment, life cycle refers to a product or building over the course of its whole life including its design, construction, operation, and disposal. Considering the full life cycle of a building can ensure that all aspects are properly considered, rather than just a single element such as the cost of construction or the operational CO<sub>2</sub> emissions.

Life Cycle Assessment (LCA) is a method for evaluating the environmental load of processes and products during their life cycle. An LCA attempts to identify the environmental effects during all stages of its life and produces a figure (or several figures) that represent the total environmental load. In a full LCA, the energy and materials used, along with waste and pollutants produced as a consequence of a product or activity are quantified.

The term 'cradle-to-grave' is an approach for defining the boundaries of an embodied energy assessment which involves measuring or estimating the total energy consumed through the entire life cycle of a building or product. In terms of life cycle costs, whole-life costs consider all those that are associated with the life of a building, from inception to construction, occupation and operation, and disposal.

## End of life potential

The UK construction industry is one of the largest consumers of resources, and a significant proportion of landfill waste comes from the construction and demolition of buildings. As well as ensuring that waste is minimised during construction, it is important that the potential of buildings and their components is maximised at the end of the building life.

End of life (EOL) refers to the final stages of a product or material's phase of use. The treatment and disposal of construction materials once they have reached their end of life is an increasingly important issue as steps are taken to try and handle them in as efficient a way as possible that minimises waste, carbon emissions and the use of landfill sites.

For buildings, it is useful to approach the assessment in terms of the severity of the intervention; starting with refurbishment and then retro fitting. For construction products it may help to consider maintaining the highest value of the product, through reuse, recycling and then down cycling.



# REFURBISHMENT & RETRO FITTING

## Refurbishment

Refurbishment can offer a sustainable approach to refreshing buildings without the disruption and waste of demolition. Compared to other construction systems, masonry construction is well suited to refurbishment and there are well established methods in place for alterations, conversions and extensions.

Low rise residential masonry construction is particularly well suited to refurbishment, which means that housing stock can be altered with the changing demands. It should be noted that refurbishing a building that is not 'fit for purpose' due to structural stability or fire safety is unlikely to be the most sustainable solution in the long term.



Shrewsbury Flaxmill Maltings - Built 1797. Historic England.



Internal brickwork repair and replacement. Historic England.

## Retrofitting

Retrofitting can give buildings a new lease of life, updating them by adding features they did not have when they were constructed. The UK has a housing stock of around 20m properties and is the oldest in Europe. The UK builds around 250k homes per year and it is thought that 2/3 of the housing we will occupy in 2050 have already been constructed. Retro fitting will be an important part of ensuring that the overall energy efficiency of the housing stock is improved to achieve the net zero CO<sub>2</sub> emission target by 2050.

Retrofitting is mostly used in relation to the installation of new building systems, such as heating systems, but it can also refer to the fabric of a building, for example, retrofitting insulation or double glazing. Brick manufacturers have developed a number of systems that can be used to overclad existing solid wall masonry buildings. It is important that a holistic approach is taken, including ventilation, air permeability and heating.



Alsop Fields, Sheffield. Mixed use development



Thermal upgrades with bronze aluminium cladding

# REUSE AND RECYCLING

Reuse involves dismantling and removing components so that they can be reused elsewhere. Generally, the value of the product is maximised by reuse in its original capacity. However recycling can be an option if reuse is not, allowing a building's products, components and materials to re-enter the supply chain. Masonry is particularly well suited for reuse and recycling, with old bricks being reused in new building facades, or recycled for less critical areas, if the performance cannot be guaranteed.

The following section develops the key requirements for reusing and recycling brickwork.



## PERFORMANCE CONSIDERATIONS

### Frost Resistance

Clay bricks are made from a great variety of natural clay deposits, which together with the firing characteristics during the manufacturing process, determine the frost resistance. With reclaimed bricks there can be difficulty in assessing frost resistance.

A sample of bricks can be subjected to a freeze thaw cycle test, but the results of this test cannot be extended to classify the whole consignment, as consistency cannot be fully known.

Assessing compressive strength and water absorption does not guarantee frost resistance. Strong and dense bricks of Engineering class are very often frost resistant, while others of lower strength and high water absorption can be equally frost resistant. To assume that because a brick is old it must have proven frost resistance is incorrect, depending on the previous application.

Before the early part of the 20th century, brick makers would have assessed bricks as they were drawn from the kiln. From the manufacturer's experience of the brick making material, the bricks would have been sorted on the basis of durability. Bricklayers, with their experience of locally available materials, would also have gained the ability to judge the relative frost resistance of bricks when selecting them for particular locations. They selected the bricks appropriate for the exposed external face of a wall and those adequate to use for protected inner walls.

# PERFORMANCE CONSIDERATIONS

## Frost Resistance

When a building is demolished, the bricks being reclaimed may become mixed up. Non-frost resistant bricks are only suitable for internal use and before the commonplace use of concrete blocks, such bricks were frequently used in buildings for internal walls. Often, they are lighter in colour and do not make a clear ringing sound if tapped against each other. These bricks are only suitable for reuse in an internal environment.

Unfortunately no Standard currently exists to state the method by which bricks should be reclaimed. The supplier should provide reliable assurance that reclaimed bricks have been taken exclusively from external walling. Only if it is certain that the bricks have been obtained from an exposed situation should they be treated as frost resistant.

Selecting new bricks with regard to frost resistance is more straightforward as they are classified in BS EN 771-1 into categories of frost resistance. The design standard PD 6697 explains which category of frost resistance is required in a specific exposure.

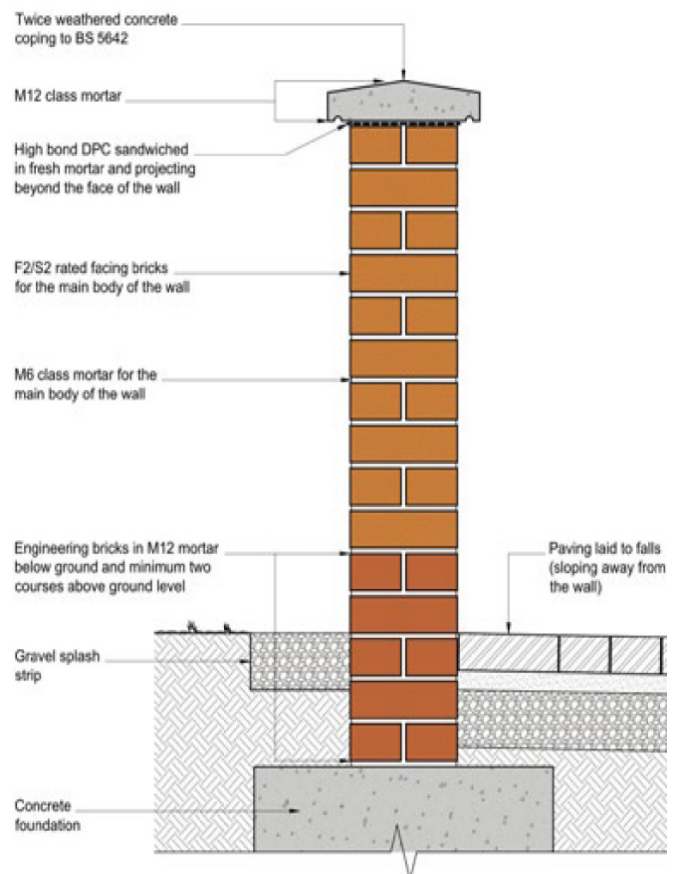
## Soluble Salts Content

Soluble salts can be present in reclaimed bricks for a number of reasons. They naturally occur in clay deposits or the bricks may have become contaminated during their service life, for example by salts leaching from ground water. Bricks may also be contaminated during reclamation or storage and there is no way of knowing the salt content of a reclaimed brick without lab testing.

New bricks are classified by three categories of soluble salts content defined in BS EN 771-1. Soluble salt content should be known in order to specify the mortar, as an incorrect specification can lead to deterioration by sulfate attack. This is a reaction involving a constituent of the cement and sulphate salts in solution. The result is crumbling and disintegrating of mortar joints. It is sensible to treat reclaimed bricks as Category S1, a higher level of salts than S2.

## Efflorescence

Similar to the above it is possible that reclaimed bricks will contain water soluble salts. To reduce the risk of efflorescence, reclaimed brickwork should follow the same design and workmanship standards as new brickwork.



Free standing wall . Durability and soluble salts category requirement

# PERFORMANCE CONSIDERATIONS

## Strength

For new brick production manufacturers are required to declare a compressive strength by testing a representative sample from bulk quantities. Units are tested to destruction so it would generally be impractical to adopt this method for reclaimed bricks. Therefore it is difficult to be certain about the strength of reclaimed bricks.

Modern bricks are manufactured to more consistent methods than those of former times, to achieve consistency of performance. Greater variation within the properties of a reclaimed material should be expected. However, for three-storey domestic construction it is unlikely that strength requirements would limit the use of reclaimed bricks.

## Water Absorption and flexural strength

For similar reasons to the performance properties above, water absorption and flexural strength of reclaimed bricks can be difficult to determine. However, these characteristics are unlikely to limit the application of reclaimed bricks in most types of low-rise residential construction.

## Movement Joints

Although the irreversible moisture movement that occurs during the life of clay bricks will generally have taken place in reclaimed bricks, brickwork built with them will still be subject to cyclic thermal movement. Therefore movement joints should be provided as recommended in PD 6697.



## Sizes

Before 1965 two standard heights were adopted in the 1920s by the Royal Institute of British Architects (RIBA): 2 5/8" (66.8mm) allowing four courses to rise 12" (305mm) and 2 7/8" (73mm) allowing four courses to rise 13" (330mm).

They became known as the Southern and Northern bricks respectively, based on common regional usage. Prior to 1904 when the RIBA initially adopted the Southern Brick Standard there were no standards, only popularly used sizes.

Up to as late as 1965 many bricks did not conform to the standards mentioned above. Where bricks are selected to match existing work, it is advisable to check the size of the chosen brick to establish nominal work size.



# PERFORMANCE CONSIDERATIONS

Reclaimed bricks tend to have greater size variability, which should be considered, as the bricklayer's craft skills will become of greater significance in attaining a satisfactory finish. Also check that there are sufficient supplies available to complete the work.

If using Imperial bricks with a standard metric concrete block inner skin, adjustable wall ties may be required to overcome the differences in bed joint alignment. When using reclaimed bricks of 1965 Imperial standard size in metric gauged brickwork - i.e. four courses to 300mm - horizontal bed joints will be thinner compared with when traditionally gauged (four courses to 12"). This will affect the overall appearance of the brickwork.

Reclaimed bricks may be used because it is assumed that new bricks are made in one size. Since the metric size was adopted in 1974, standard bricks have been made to conform to a British Standard metric size (215 x 102.5 x 65mm). It is slightly smaller than the former Imperial standard (8 5/8" x 4 1/8" x 2 5/8") (219 x 104.8 x 66.8mm).

However, most manufacturers make and hold in stock, bricks of various Imperial sizes. These can be used to course with existing Imperial dimensioned work, where the height of the unit is most important. The most common Imperial compatible bricks are 80mm, 73mm (2 7/8") 67mm (2 5/8") 50mm (2") high. The majority of these bricks are 215mm long and 102.5mm wide, but manufacturers can make any size required. A selection of standard specials is covered by BS 4729.

## Paving

To be used as paving, clay pavers must be fully frost resistant. Reclaimed pavers can be used with confidence, providing they have been previously laid in an area where they have been fully exposed to the weather. Great caution is advised when considering whether reclaimed walling bricks might be suitable for paving.



# THE REUSE PROCESS

## Cleaning Off Mortar

Bricks of the Victorian Period and earlier centuries would normally be jointed in lime mortar which is easier to remove from the brick than modern Portland cement mortar. Nevertheless, good lime mortar can form a strong bond with the bricks. Removal needs patience and hard work with a heavy hammer and broad cold chisel for large lumps of mortar and a brick hammer (one with a replaceable hardened claw steel tip is useful) for dislodging smaller pieces.

Rubbing bricks on an abrasive grit stone may be useful for truing up some surfaces. The use of power tools is not advised as grinding wheels or discs and wire brushes are difficult to control, and scoring or polishing can easily disfigure a brick's surface.



## Chemical Cleaning

Proprietary, branded brick cleaning solutions are generally based on dilute hydrochloric acid and may be used to remove stubborn mortar or lime stains from the face of bricks. Care must be taken to wet the bricks first to reduce surface absorption and prevent penetration of the acid into the brick (see BDA 'Cleaning of Clay Brickwork' publication).

The use of hydrochloric acid, or any other chemical, is not recommended for the initial removal of solid mortar.

## Mortar

For restoration work it is generally best practice to use the same mortar mix as originally specified, which traditionally was hydraulic lime and sand mortar. If there is no need to use traditional lime mortar, then old bricks can be satisfactorily laid with Portland cement based sand mortars.

The particular mix of mortar should be chosen in relation to the exposure of the walling (or paving) in question and guidance on this selection is given in the BDA's 'Mortar for Brickwork' document.



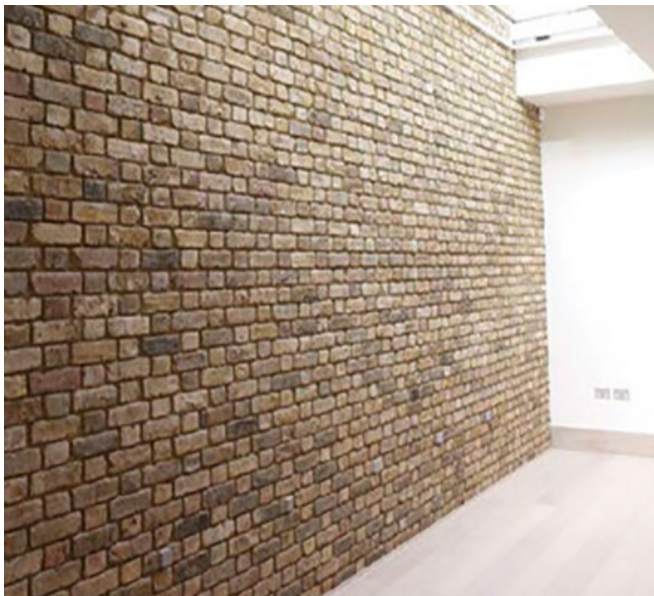
Sample panel prepared for repointing.

# THE REUSE PROCESS

## Matching Colour and Texture

Sometimes it is assumed that because a building is old, the only way to match a brick is by using one that is reclaimed. It is interesting to note that when Hampton Court and Kew Palace have bricks replaced, new bricks are specified, albeit made to the particular sizes and special shapes required. There are a number of specialist brick makers who focus on historic repair.

Currently in the UK there are over 4,000 types of brick made from many different types of clay. The colour and texture of clay bricks are essentially dependent on the manufacturing method and the firing characteristics of the clay. It is quite feasible that a suitable match can be found within these ranges.



## Stabilisation of internal brick surfaces

While the great majority of brick will easily reach 150 years life, not all older bricks are equally durable due to uneven firing. Bricks may also have damage due to external sources, such as gritting salt. Chemical pollution from decades in an industrial environment may have altered the matrix of the brick face. Testing should be thorough to confirm the reused brick is free of defects.

If the reused brick face is friable or starts to flake, the brickwork should be cleaned, preferably brushed with a stiff bristle brush (not a wire brush) to remove all debris. Following this, a lime wash can be applied which is binding, breathable, and non-invasive. A coat of properly applied lime wash is largely translucent, with the form and texture of the bricks still visible.

A modern alternative is a silane/siloxane based water repellent which still enables the brick to breathe, as it lines the pores of the brick rather than providing a coating. This is applied as a white cream, which dries clear, but does give an initial sheen. A small area should be tested and monitored before commencing extensive work.

## DOWN CYCLING

Downcycling is a secondary use not of the same value as the first. The majority of masonry from demolition sites is crushed and used as sub-base or fill for landscaping works.

Aggregates from demolition may be reused in concrete production but use is restricted both by rules governing maximum percentages allowed and also by supply, since the amount of aggregate that can be recovered for this purpose is limited. Where aggregates are reused in concrete, new cement, the source of most of the embodied CO<sub>2</sub> emissions, will still be required.



## TRADITIONAL METHODS OF MANUFACTURE

Reclaimed bricks may be selected for aesthetic reasons, but they must be technically appropriate for new work. Many dealers supply reclaimed bricks graded by quality of appearance but cannot guarantee durability. In the absence of any specific assurance regarding the durability of particular reclaimed bricks, they should be used with caution.

Many specifiers choose reclaimed bricks in the mistaken belief that bricks of similar appearance are not available as newly manufactured materials. In particular, they are not aware that handmade bricks are still currently manufactured. Many tolerate the distressed state of reused brick, resulting from the process of reclamation, in the belief that there is no alternative.

Several companies continue to make handmade bricks, including traditional clamp fired, produced in exactly the same way as brick makers have done for centuries. Other companies have developed simulated handmade bricks, which look handmade but have been manufactured by modern machine methods.



# WEATHERING TIPS FOR BRICKS

Old brickwork often has a pleasing weathered appearance or natural patina, which gives the brickwork a mature character. New brickwork can sometimes contrast with established work, but there are methods available to match the appearance.

A traditional method was to apply a soot wash made by soaking a sack of soot in water and applying washes to the brick until the required degree of darkening had been achieved. Commercial wash preparations are available that perform the same function and advice can be obtained from English Heritage regarding their application. It is best not to darken the brickwork too much as the surface of new brickwork will darken naturally over time.



Commercial tints generally are both successful and long lasting prior to the natural aging process taking over. Brick tinting using modern materials is best carried out by specialist firms with previous experience. It is always advisable to test a small, discreet area or sample panel before starting more extensive work.

Another traditional method is to apply a solution of yogurt and water. This encourages an ecosystem to form on the wall surface and promotes the growth of lichens and mosses.



# REFERENCES AND FURTHER READING

EN 771-1, Specification for masonry units Part 1: Clay masonry units

BS EN 845-1, Specification for ancillary components for masonry – Part 1: Ties, tension straps, hangers and brackets

BS EN 845-2, Specification for ancillary components for masonry – Part 2: Lintels

BS EN 845-3, Specification for ancillary components for masonry – Part 3: Bed joint reinforcement of steel meshwork

BS EN 998-2, Specification for mortar for masonry – Part 2: Masonry mortar

BS EN 1990, Eurocode – Basis of structural design

BS EN 1996-1-1, Eurocode 6 – Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures

BS EN 1996-1-2, Eurocode 6 – Design of masonry structures. General rules. Structural fire design

BS EN 1996-2, Eurocode 6 – Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry

BS EN 1996-3, Eurocode 6 – Design of masonry structures. Simplified calculation methods for unreinforced masonry structures

PD 6697, Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2

BS 8000-3, Workmanship on building sites – Part 3: Code of practice for masonry

[brick.org.uk/about/our-members](http://brick.org.uk/about/our-members)

[brick.org.uk/admin/resources/cleaning-of-clay-brickwork.pdf](http://brick.org.uk/admin/resources/cleaning-of-clay-brickwork.pdf) Cleaning of brickwork

[brick.org.uk/admin/resources/whole-life-performance-of-clay-masonry-adrian-bown-2007.pdf](http://brick.org.uk/admin/resources/whole-life-performance-of-clay-masonry-adrian-bown-2007.pdf)

[brick.org.uk/admin/resources/brick-epd.pdf](http://brick.org.uk/admin/resources/brick-epd.pdf)

[brick.org.uk/sustainability-reports](http://brick.org.uk/sustainability-reports)



Telephone: 020 7323 7034  
Email: [brick@brick.org.uk](mailto:brick@brick.org.uk)  
[www.brick.org.uk](http://www.brick.org.uk)

The Building Centre  
26 Store Street  
London  
WC1E 7BT

Published by the Brick Development Association. The BDA are committed to providing impartial and authoritative information. We make every effort to ensure the accuracy and quality of information and guidance when it is published. However we can take no responsibility for the subsequent use of this information, nor for any errors or omissions it may contain.

Brick Development Association

[www.brick.org.uk](http://www.brick.org.uk)

