TECHNICAL NOTE No. 45
June 1992
Revised August 2003

Masonry Walls

Historical Note
Mud and fieldstone are the earliest walling materials met within buildings that remain in use today. Both have continued in use throughout recorded time into the beginning of this century. A limited amount of rubble stonework is still built today and there are a few people living who can give first-hand accounts of buildings with mud. Construction in these materials is necessarily massive and openings are small, giving buildings of these types very high qualities of thermal insulation.

Mud:
Mud is found in use in three forms: monolithic; in courses bonded with straw; and as unbaked bricks. The material is strong and perfectly stable as long as it is kept reasonably dry and for this reason it was always lime washed. The walls however require some moisture to keep their binding and can fail if too dry. Insertion of damp proof courses are not recommended for mud walls for this reason. A number of vernacular buildings across Northern Ireland have mud walls. Sometimes these may have been patched or built up by stone or brick and can be hard to recognise before work starts.

Mud was also used as a binder in rubble stone construction, when it was often mixed with lime.

Rubble Stone:
Rubble stonework is found in all regions but shales and sandstones are the most suitable. Both these types of stone can be split along the bedding planes giving shapes that can be knit tightly together. The quality of rubble stonework varies widely. The best has the stones selected in size to form a consistent pattern throughout, with special stones set to bind the corners and other weak points.

However carefully executed though, such stonework was rarely built to be seen. To make buildings weathertight and waterproof, the mortar which was squashed out of the joints as the work proceeded was plastered our over the face and then given a wash of lime or burnt earth. The best stones would be used to face the work, with the poorer material thrown in with generous supplies of mortar to level up the core. Lintels were either single large stones or a series of timbers. Attempts at arching are very rare in this type of construction because of the way in which the walls are made up. The enlargement of openings or breaking out new openings can be a very hazardous and destructive operation. Problems can sometimes result from the settlement of the core material away from the face work over time.

Bricks:
Earth burnt to form bricks, is a technique dating from Roman times, but brickwork earlier than 1700 is rare in Ulster. Prior to the transport revolution of the 19th century extensive use of brick was generally related to distinct regions where raw materials were available. The use of brick in most areas was sparse and generally confined to

dressing window and door openings or the construction of flues and chimneys. To escape tax the size of bricks gradually increased so that by the mid-19th century the usual depth of a brick course had reached 80 mm. Decorative brickwork is rare until the late 19th century when cheap transport made available a wide variety of imported bricks. In earlier buildings it is unusual to find anything but the most basic English and Flemish bond work**.** Another 19th century development is the use of yellow fireclays from the Lagan Valley in chimneys across the region, this was held to be much superior to local varieties.

When coal became widely available brick making was concentrated into industrial centres; previously bricks were made on site from locally dug clay. Because of the difficulties and expense of manufacture a place was found for every brick whatever its faults, the worst unburnt or deformed examples being built into internal partitions. During the 18 th century it became accepted practice to bond masonry walls by making use of horizontal timbers built in as the work progressed. Unfortunately these provide free passage for fungal and beetle attack linking every element of the building.

Ashlar:
Fully dressed stonework (ashlar) is the 'Rolls Royce' of masonry work. Very few local quarries produced material of a sufficiently consistent grain (freestone) for it to be used in this way with the result that ashlar is relatively rare in Northern Ireland. Where it is found the stone used has often been imported.

Mortar: (see technical note 37)
Stone and brick used for habitable buildings requires mortar. The simplest material was earth but the greater number of buildings that survive in use were built with a mortar using burnt limestone. These mixes of lime with earth or sand were used primarily to form a bedding for the unevenly shaped stones or bricks providing stability and keeping the weather out. Some superior work made use of hydraulic limes which, because of their silica and alumina content formed a chemical set through their entire depth. These are the forerunners of the modern proprietary cements. Most construction work made use of lime slaked from local limestone which in this region is quite pure or 'fat'. These limes harden where they are in contact with the air (carbonate) they have little have little chemical setting action. Historical mortars however seem to have had some chemical setting properties due to impurities such as ash in their production. . During the 19th century more complex mixes were developed using crushed furnace ash (so called black mortar) and similar bonding materials having a greater structural strength than pure lime.

A revolution in mortar mixes followed the development of Portland Cement about 1830. The material was designed to have a complete chemical setting quality and a structural strength up to five times that on any other known material. It was not long before it was discovered that Portland Cement mixed with a filler like sand or gravel and possibly reinforced with steel rods could be the principal building material, taking the place of both brick and stone, in the form of ferro concrete.

Masonry Repair

Today there are very few local commercial quarries producing building stone and none of these are suitable for fine ashlar work. Clay bricks are made outside Dungannon but their appearance is quite different from earlier bricks made here so that matching material often has to be imported or salvaged. Pure lime either hydrated or in putty form is available in the this area and is recommended for repair work.

Faults and Repair

(a) Ground Settlement:
Symptom: Deformation and cracking, generally orientated vertically; sometimes outward
leaning walls.

Repair: Most settlement takes place early in the life of a building. If this is the case it may be
sufficient to replace any fractured lintels or other structural members and then grout the cracks. Old settlement patterns are unlikely to be the cause of further movement or structural collapse. If the settlement is new or progressive the course must be located – the local water table may have been altered by new building work nearby, or a drain may have been fractured. After dealing with the cause it may be necessary to provide new foundations by underpinning the old foundations with additional structural support.

(b) Damp:
Symptom: Discoloration: paper not staying on the wall; appearance of powdery or crystalline
deposits on the wall face; frost damage to brick, stone or mortar.

Repair: The position of the damp will be a good guide to its origin – failures of the roof; rainwater drainage and external plasters are dealt with in other sections. Ground damp can be counteracted in two ways:

I Piping water away before it reaches the structure. This will involve a trench around the building, piped to falls together with manholes and catch pits for maintenance, and the excavation back-filled with stones.

ii. Making the wall itself resistant to damp. If the ground level is high and cannot be reduced then the wall must be 'tanked'. This means that the wall is excavated and protected by a waterproof membrane, which itself is protected from puncture by a second skin of masonry and then back-filled.

If ground levels relate correctly to the walls, ie, are below the level of the floor and damp is showing at the lower part, then it may be necessary to provide a horizontal barrier within the wall. However the necessity of this should be carefully assessed before embarking on potentially costly remedial works. Ensure that the cause of the problem is isolated – don't confuse condensation (which can commonly occur in this area in modern moisture rich and draught proofed houses) with rising damp. Repairs in recent times may have exacerbated the problem by applying a dense coating outside and inside and to the floor. It may be possible to replace paint for example with a more breathable alternative or to reduce the problem by opening up blocked vents. Bear in mind that most historic buildings were designed to avoid moisture problems. What has changed and can it be reversed?

If a Damp proof course is felt to be necessary the most common methods are:

i. To cut through the thickness of the wall and insert an impervious sheet, usually copper. This method is only suitable for walls with continuous horizontal mortar bed joints, eg, brick or ashlar stonework.

ii. To inject the wall with a chemical which prevents water movement. In solid rubble masonry walls the core often contains voids and decayed mortar which will result in an uneven distribution of the chemical. To avoid this, the wall should be prepared by

washing out the loose material at the base of the wall and then grouting to fill the voids. The grout should be of similar strength to the original mortar. The chemical is then expected to form an even and continuous barrier. This method is uncertain in its coverage and operatives normally require the removal of a meter of plaster on the interior and its replacement with hard cement render to avoid bridging. This will also disguise any failure of coverage. The method also requires holes to be drilled at regular intervals and may be visually unacceptable in certain historic buildings.

iii. To prevent capillary action in the wall by electro-osmosis. This type of installation is specialist work. The wall is prepared by stripping the plaster to a height of about 1 m. A continuous metal strip is then fastened to the masonry and the surface made good. The long term effectiveness of such systems have been questioned but they have the advantage of causing less disruption to the historic fabric of the wall.

Damp higher up the wall can sometimes be related to flues no longer in use. Flues on external walls reduce the effective thickness of the walls and where there is no protection at the head of the stack considerable amounts of water can drive in. This may not dry out because there is no air movement. This problem can often be cured by fitting ventilating caps at the top of the stack which prevent rain entering but allow air to circulate. Lower down in the flue fit a ventilator so that air can move through the length of the flue.

In walls where weather exposure is severe and a very dense stone or brick has been used, the wind will sometimes force rainwater right through the full thickness of the wall. The simplest cure is to render the outer face but if this is not possible, for appearance reasons, specialist advice is necessary.

(c) Ferro Concrete or Reinforced Concrete:

The most frequent cause of failure is corrosion of the reinforcement. Poor compaction when originally placed will cause later decay. Contained chemical impurities, possibly introduced from the sand or aggregate, or added intentionally at the time of construction to increase plasticity in the mix, or to make possible work in frosty weather, are another cause.

(d) Mud:

The worst enemy of this material is damp. A relatively constant low level of damp is good for the cohesion of the walling material. Water will be constantly taken up and then given off according to weather conditions; this is called ‘breathing’. When the water level reaches saturation this cohesion breaks down.

The outer lime shield may have failed, and this will lead to the gradual erosion of the wall face but if quantities of water enter the core from either the head or the foot of the wall then the problem must be treated urgently or a total collapse of that section of wall must eventually be expected.

(e) Stone:

Local weather conditions caused repeated wetting and drying, and atmospheric pollution are severe enemies of all stones. The incorrect bedding of sedimentary stonework can result in the total breakdown of individual stones. Iron, built in as ties or cramps, rusts and swells eventually bursting the stonework open. Where the stone itself is extremely durable for example basalt and granite the problems are found at the joints. All these decay patterns are aggravated by frost.

Basic structural damage to stonework often results from impact or explosions. Ill considered structural alterations can provide the initial weakness, for example the creation of large ground floor shop fronts and clear sales areas cutting lateral stability to a minimum or perhaps the creation of rooms in a roof space causing the essential structural tie members to be severed.

(f) Brickwork:
Behaves in a similar way to stone. The bricks themselves can be broken down by chemicals present in the clay at the firing or from adjacent building materials. Poor firing is another problem. When bricks were expensive every brick possible was found a job in the structure often in cross walls and flues where they were not originally seen.

(g) Pointing:
See also Technical Note No:37
The general principle of pointing is that the joint should be weaker than the brick or stone with
which it is used. In this way it is the joint which decays and not the masonry face. Consequently it is necessary after a period of time to renew mortar joints. The frequency of renewal will depend very much on the quality of the work and the weather conditions. There are many examples of work upwards of two centuries old which are perfectly sound. It must also be remembered that older buildings do not have specially designed joints to accommodate thermal movements. It is in fact the flexibility of the relatively weak mortar beds which provides the necessary movement, and this must not be inhibited by bad repairs.

Repointing is a job which, if it is to have any life and be at all effective, must be carefully done. The joint must be cut back square to an even depth. It must not be feathered off at the ends into old work. Just before repointing flush out to clear all loose material; this will ensure that the new mortar has a good grip and does not suffer from too much suction. Work must start at the top of the wall, and the new mortar must be well rammed in. The finished joint must not project beyond the face of the adjoining masonry. The strength of the new mortar must always be matched to the original work and it should never be stronger than the stone or brick from which the walls are built. Any mortar used in historic work should be of the range – 1:3 lime to sand, hydraulic lime mixes are recommended for exposed conditions (see note 37). Guaged cement lime sand mixes have been accepted by EHS to repair historic buildings in Northern Ireland. Traditional lime/sand mixes are much more appropriate for the long term conservation of these buildings and there has been an increase in availability of the material and the skills to use it in recent years. Sand cement mixes have proven to be detrimental to historic buildings and will not be accepted by this agency.

Notes on the Preparation of Contract Specifications

Identify the areas to be worked on, and for this photographs can sometimes be as valuable as drawings. Describe the types of work necessary in each area, ie, repointing; individual stones or bricks to be cut out and replaced; parts of the walling to be taken down and rebuilt; location and size of ties, pins, blockbonding, ring beams, underpinning, etc. What materials from cutting out or demolition should be set aside for reuse and any cleaning or other preparation which must be carried out. Describe replacement materials whether they are to be new or second-hand and in this context it may be necessary to say from where they can be obtained. Limes, cements, sands, aggregates and mortar mixes should be included with descriptions of colouring, sizing, etc. Indicate how these should be stored and protected before use. Describe damp-proofing courses and chemical dressings, and any pinning or other reinforcing techniques to be employed. Describe the required quality and appearance of the

finished product, any bond pattern or finish to the joints that is particularly required and name any sample areas that must be approved before the general work proceeds.

Further Reading

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Ashlar and dressed stone:
Ashurst J.,Dimes F.G., Conservation of Building and Decorative Stone, Butterworth Heinemann, Oxford, 1999.
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Mortar

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Notes on the repair of masonry structures, EHS Belfast, 2002
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TAN1 Preparation and Use of Lime Mortars,Historic Scotland, Edinburugh,1995.

Technical References

Building Regulations Northern Ireland – Technical Booklet C Site preparation and resistance to moisture,1994.

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