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STRUCTURAL ENGINEERS REPORT

ON

ELSHAM TOP CHALK BARN

ELSHAM WOLDS

LINCOLNSHIRE

DN20 0NX

March 2013

Job No. 19-8220

## STRUCTURAL ENGINEERS REPORT ON ELSHAM TOP CHALK BARN, ELSHAM WOLDS, LINCOLNSHIRE, DN20 0NX

### 1.0 INTRODUCTION

1.1 On the instructions of Emma Stafford we visited the site known as Elsham Top Chalk Barn, Elsham Wolds, Lincolnshire, DN20 0NX on 28<sup>th</sup> of February 2019.

1.2 We were commissioned to carry out a structural inspection of the above barn as part of a proposed planning application for conversion into habitable accommodation.

1.3 At this stage we have not had sight of any details relating to the original construction, or any subsequent maintenance works. Likewise, we have not seen any details of the proposed conversions.

1.4 Our comments are therefore based solely upon the visual evidence available at the time of our visit in order to comment upon the structural integrity of the barn. It is, however, understood that this report will be included within a planning application for the proposed conversion.

1.5 The barn is a 'L' shaped two-storey structure built in predominantly stone walls supporting a hipped slate covered roof.

1.6 There are indications of a possible lean-to structure that has been removed or where works have been included construction of a buttressing brick wall. Temporary supports include the provision of timber props located under the arches along the eastern elevation, and there is an area of fencing to restrict access to part of the Western elevation where previous failure of the stone is evident. There are no indications of when these works were undertaken.

1.7 The barn occupies a relatively level plot surrounded by open farmland, with a predominantly grassed courtyard formed with the adjoining detached brick barns. There is various vegetation forming hedgerows and along the access roads, but these are generally some distance from the barn.

- 1.8 The brick single-storey barns forming the perimeter of the remaining yard are excluded from this report.
- 1.9 This report is confined to the structural aspects as detailed above. This report does not constitute a full building survey and excludes certain items such as those listed below:
- The decorative condition of the properties
  - The condition of the properties with respect to dampness, dry rot, timber infestation and the like
  - The condition of services
  - The condition of roof, floor, wall and ceiling coverings
  - The location of the site, its value and other aspects such as searches and boundaries, etc.
- 1.10 At this stage we have not undertaken any testing of materials, monitoring, breaking out or longterm investigation. No inspection has been made of timber or other parts which were covered, unexposed or inaccessible, and no comment can be made on the condition or quality of such materials.

## 2.0 EXTERNAL OBSERVATIONS

### 2.1 SOUTHERN ELEVATION

The roof exhibits a degree of rippling and undulation, presumably relating to the internal supports. From the weathering and algae growth on the slates, however, the movement appears to be long-standing. Isolated slates are missing and there are several areas where there is some dislodging. This includes the area at the eaves and the gutter, where sections of the wall are exposed. Here there is also limited vegetation growth.

The main elevation remains reasonably vertical with little significant rotational movement, particularly through the more westerly end. There is an element of rotation and bowing towards eastern section, although this is only in the region of 20 mm in a 600mm spirit level. It is made visually more onerous by the bowing relative to the first floor. At this point there is weathering to the stonework and indications of limited cracking damage extending up to the deteriorating timber framework associated with the first floor opening. Here there is dislodging of the brickwork of the arch, and the stone immediately either side of the opening, but no major stepped cracking or fractures suggestive of more recent foundation movement.

Through the timber work to the door and window openings there is further deterioration and a small degree of movement through the stone arches over the opening. This has been made more onerous by weathering to the stone finish, although again there is no major signs of stepped cracking or fractures.

Around the near central main arched opening the door frame has again suffered from some timber deterioration, but through the stone arch over there is little evidence of dislodging. Some staining and erosion of the stones has occurred below the gutter line, as a direct result of failure of the rainwater goods. This is, however, reasonably limited.

### 2.2 SOUTH WEST GABLE

The stonework appears reasonably true with only a limited degree of rotation relative to the foundations. The coursing does not exhibit major out of level moment nor is this

significant stepped cracking or fractures. At the lower level there is some weathering to the individual bricks of the plinth and through the main body of the wall possible evidence of previous buildings having been demolished. These include timber members built within the wall, which have deteriorated, and pockets within the stone. Generally in the stonework around the damage, or where there has been localised repair, there is little to suggest significant recent movement.

The hipped end of the roof exhibits notable deformation within the hip lines towards the eaves and there are areas of ill-fitting tiles at eaves level. Through the main body the finish the deflection as the region of 75 mm, although the weathering and discolouration suggests that this movement is not recent in origin.

### 2.3 NORTHERN ELEVATION OF WESTERN WING

The roof reflects the general undulation noted previously, and there are areas of ill-fitting and missing slates. Some patch repairs have been carried out, albeit on an ad hoc basis, with subsequent movement of the finish. Here the deformation is in region of 75 mm with the weathering suggesting that it is not recent in origin.

At the return with the Western gable there is untidy detailing to both the lower brickwork and the stone, with indications that previous patch repairs have been carried out. There is cracking of the stonework and opening up within the repairs, although the weathering suggests this is not that recent. No major stepped cracking continues towards the 'bricked in' ground floor opening and the general stonework at the return is reasonably true.

Approximately 4 m in from the return there is a remnant of an original stone return which has subsequently extended in brickwork. It is not clear if this was formed as a buttress, or as some part of a building that was subsequently removed. At the interface between this buttress and the main wall there is little of significance.

The main stonework appears reasonably level and true, albeit with some undulation consistent with the materials used. Where the large arched opening has been 'bricked in' there is little at the interface between the brickwork and the stone to suggest a recent

problem. There is slight discrepancy along the joint between the two materials presumably relating to historic movement of the older construction. No significant cracking damage then runs through the return up to the Northern wing and again the main wall is relatively true.

There are tree stumps evidence against the wall consistent with wild sown vegetation but little to suggest that this has had significant effect on the structure. Patch repairs have been carried out at eaves level, albeit in a relatively poor manner, and there are several sections of shattered stonework. At the return with the Northern wing there is open jointing at higher level with localised failure of the stonework at the return itself. This is relatively limited and does not continue as major cracking through the original stone wall.

#### 2.4 WESTERN ELEVATION OF NORTHERN WING.

The roof finish ripples notably, presumably relating to the internal walls or associated trusses. There are several areas of ill-fitting slates particularly around the eaves, with failure of some rainwater goods. Through the main body of the roof finish, however, the mortar does not appear to be that recent from the general weathering and discolouration.

At the return with the Western wing there is displacement of some stonework and area of long-term patch repair at the higher level. Here it would appear that the original stone has been replaced with a more modern stone finish prior to treatment of the external face. The dislodging is relatively limited but will require some localised repair.

The wall near the return is reasonable to and this extends up beyond the opening into the open ground floor area. Rotation then continues from ground level, but it is difficult to completely evaluate due to the severe weathering that has occurred to the stone face over the lower section. At higher level there is no major cracking damage and the degree of bowing remains limited, although some movement has occurred towards the eaves between the first floor openings. Generally this has not been reflected by major cracking damage other than shattering the stones consistent with the failure of the rainwater goods.

Approximately midway along the elevation there has been collapse of the external face of the stone wall to reveal a construction with apparent rubble infill. Extensive previous repairs are refacing of the wall were carried out in the area of the collapse with new stone introduced on the external face. This includes the area of collapse where there are remnants of the newer stone within the rubble. Close access to the section of wall was not considered appropriate but the wall in the vicinity has rotated out was relative foundations. This is probably only in the region of 75 mm overall and is not reflected by other major structural movement.

To the southern end of the collapse there is section of brick repair at low-level and timber deterioration around the openings and backing lintels to the frame. The stone repairs appear to have taken account of previous deformation of the wall as a is little cracking visible within the newer stone finish. Some untidy detailing has occurred around the adjoining openings probably due to the weathering and shattering of the external face of the stonework locally to those openings.

Within the area of the collapse we note timber members built within the wall which have suffered from significant deterioration. These include the lintel over the ground floor opening, and the framework and threshold member to the first floor opening above.

When viewed from the northern end the area of newer stonework relative to the collapse can clearly be seen to have bowed outwards relative to the main wall line. It is not clear this is due to historic movement or continued failure of structure. The wall leading towards the northern end continues to rotate relative to the foundations into the main body of the structure, and there is bowing of this stone with evidence of delamination around the more northern door casements. This does not extend to the brickwork or newer stone to the northern section, where the wall is more vertical, albeit leaning into the plane of the structure by around 50-75 mm.

The principal damage through this northern section relates to erosion of the stone and some shattering of the faces, albeit relatively localised. Poor quality patch repairs have been carried out around the first floor openings and there is deterioration within the timber frames. This includes some limited shattering of the arch over the openings, and the stonework in the immediate vicinity. There is, however, bowing of the stone into the plane

of the roof with some deformation at the eaves. The area of damage remains relatively limited, however.

At the return with the northern gable the coursing is more level and true, but we would note repairs having been undertaken at the lower level then extending through the stonework of the first floor. The return above first floor level has been rebuilt in brickwork, presumably as historic repair, only for the cracking to have reopened. Some of the damage is associated with shattering of the stones and spalling of the external faces, with little to the main body of the structure away from the gable itself.

## 2.5 NORTHERN ELEVATION

Substantial alterations have been carried out through the elevation with the central section having been rebuilt in brickwork over an exposed steel beam which is orientated about its weak axis. This beam is exposed on the soffit and brick edge with notable deflection and rusting through the web.

The brickwork below the beam appears to take account of displacement of the lower stonework with stepping back into the line of the beam by around 50 mm. Through the brickwork itself there is no major stepped cracking or fractures, but there is some damage through the retained lowest stonework at the return with the Western side. Here snapping of the stones extends as separation through poor quality mortar repairs within what is effectively a very limited buttressing return.

At the return with the main eastern elevation there is clear separation of the stonework, with structural cracking running the full height suggestive of delamination of the stonework relative to the core. Patch repairs have been carried out only for the cracking to return to a width of more than 50 mm where spalling has occurred. The eastern return has rotated substantially relative to ground level, where we would note a rainwater downpipe discharging directly on to the ground. This movement is probably more than 100mm across the height of the wall, being more onerous around the cracking and first floor level.

## 2.6 EASTERN ELEVATION

The general undulation of the roof reflects that noted previously, with the rippling probably coinciding with the internal walls or trusses. Generally within the finish there are no major areas of dislodged or missing tiles, with the weathering suggesting that the moment is probably long-standing.

At the southern end a series of timber props have been provided to the underside of the arches associated with the open area of barn. The wall is reasonably true at the return with the southern elevation but there is bowing above the arch with rotational movement of the stonework outwards across the central section. Here there has been replacement of the external stone finish with the newer stone, although there is no major cracking damage within the finish to suggest an active problem.

At the interface of the newer stone with the original materials there is no major separation, but we would highlight the poor condition to a number of areas of the stone including the arches. The degree of bowing probably exceeds 100mm and we presume that the timbers were installed as a propping mechanism while previous repairs were carried out. A plaque on the wall indicates that the barn was subject to some repairs around 1930. It is. This presumably included rebuilding of the arches over the first floor timber frames.

Above the end arch towards the centre of the building there is cracking damage running through the stonework from the lower level, but not extending through the repairs. Further shattering and cracking of the stone extends down to the arch although here there is no timber buttressing. Patch repairs were carried out to the stone around the downpipe in the immediate vicinity, with little evidence of reopening of the damage in what is more true section of the wall. This continues beyond the infilled brick opening through to the more central openings, before further significant rotation and bowing was noted.

Through the area immediately adjacent to the central window opening there is severe rotation and bowing of the stonework such that it is probably more than 150 mm out of true. There is spalling of the stone in this general area, although no major cracking damage visible through the mortar joints suggestive of recent movement. The rotation extends across most of the remainder of the elevation, with further severe bowing around

first floor level by probably more than 150 – 200 mm. This is not reflected by major cracking damage but there are areas of shattering and weathering of the stone.

Where the timber frames were visible there is deterioration to the timber and some apparent delineation of this external face through to the rubble fill, with the movement continuing to exceed 150 mm in places. Towards the Northern return this rotation and bowing reduces significantly, but there is further damage at the return, particularly within the stonework at the higher level. Here the movement is consistent with the cracking referred to previously.

### 3.0 INTERNAL OBSERVATIONS

#### 3.1 FIRST FLOOR LEVEL

##### 3.1.1 NORTHERN ROOM

The roof is constructed with rafters spanning on to mid height purlins, which in turn are supported by King post trusses at approximately 3 m centres. The trusses bearing into the walls or sit on timber packers above the timber lintels to the main openings. Generally within the roofline there is little other than isolated light ingress, although there is staining to timbers and indications of possible infestation. At some of the bearings of the trusses within the external wall there is light penetration, although this remains reasonably limited.

The main eastern elevation is reasonably true although there is movement to reflect the major bowing noted externally. Along the concrete and stone 'plinth' with the timber floor there is some cracking damage and evidence of patch repairs, but generally within the wall there is no major evidence of recent structural damage.

At the return with the Northern elevation there is an area of brick repair, and the floor has dropped noticeably down towards that corner. At the interface between the brick repair and the stonework there is separation cracking of more than 15 mm, possibly extending through to the outer stone finish. Cracking damage runs parallel with the repair and has resulted in some spalling of the joints. The cracking extends through the brickwork return with the Northern elevation where again there is clear evidence of separation along the butt joint between the two materials. The brickwork to the Northern elevation does not exhibit major rotational movement, but there is further significant damage along the return with the Western side.

Here the brickwork returns and is bonded into the stone without their being significant separation. However, only some 300 mm further away from the return there is a significant vertical crack running down to low-level and extending the full width of the wall. This crack includes some debonding and stepping along its route, and has a width in excess of 15 mm. Further slight cracking extends through the stonework in the immediate vicinity and there is clear evidence of movement within the floor down towards this northern end.

Cracking then runs diagonally up to meet the initial opening through the Western elevation, following a new diagonal pattern to higher level. The wall has rotated into the plane of the room across the eaves, being more onerous between the openings. Here the rotation at eaves level relative to the first floor probably exceeds 75-100 mm in places, although generally it is not reflected by major stepped cracking or fractures.

There is isolated damage and separation between the timber boarding and the perimeter cementitious upstand, but generally the movement is not reflected by cracking damage. There is significant deflection within some of the timber members built above the window openings, particularly where they support the trusses, but this movement does not appear to be recent in origin.

The internal wall is solid brickwork which extends up to main side elevations at both ends. Against the Western elevation there is limited separation at the butt joint, but more significant movement has occurred along eastern end. Here there is full width separation between the internal wall and the eastern elevation such that the separation crack probably exceeds 40 mm. It is consistent along the full height of the wall and has reopened following previous poor quality pointing.

### 3.1.2 SOUTHERN END OF NORTHERN WING

The roof has been substantially altered and strengthened presumably during the historic repairs. This has included new purlins and boarding below the original finish, with additional timber members inserted as the rafter sections to the trusses. Through the boarding there is little to suggest major damage, although this boarding is clearly a substantial depth below the original roofline, as indicated in the open section to the southern end. This means an inspection of the underside of the roof is not practical.

The floor exhibits various adulation presumably associated with the manner of support. This includes dropping of around 15 mm between the likely supports, although within the general timber boarding there is little of major significance. Within the visible stonework along the eastern elevation there is some bowing near to floor level and irregularities

within the cementitious plinth. Generally, however, there is only limited movement associated with the bearing of the timber trusses within the external walls and deflection of the timbers.

There is cracking to the edge of one of the openings towards the southern end, with slight displacement of the stonework, although this is relatively limited. Untidy detailing and some loose stonework were noted around the openings, but the degree of deformation noted externally has not been fully reflected within the rough stone finish. Where there is rotation it is probably less than 75 mm across the height of the wall.

The openings along the southern face have been partially filled with timber and brickwork to sill level. At the interface between this brickwork and the original stone there is no major separation cracking and the openings are reasonably true. No major stepped cracking or fractures were noted within the stonework, although there are small areas where the inner stones have delineated from the core of the wall. The rotation relative to the floor is less pronounced than noted elsewhere, albeit there is movement near to the window openings. Bowing then extends between openings, but the scale of movement is probably less than 100 mm overall.

The return with the southern elevation is reasonably true and within the stone there was little other than deterioration within the timber work around the opening. Separation cracking has occurred between internal wall and the external wall, with open joints in the stone where sections have spalled away. This cracking has been the subject of previous low quality repairs only to have reopened by around 10 mm, although there is little through the main body of the wall on either side of the separation to suggest a major progressive problem.

The upper section of the internal wall is of brickwork infill and a considerably lesser width to the general construction. Some minor cracking was noted through the brickwork, but this did not appear to be recent in origin. The floor is dished down towards the centre, but again there is no major damage within the boarding to suggest that the movement is recent.

### 3.1.3 LANDING AND STAIRS TO GROUND LEVEL

This area coincides with the principal collapse noted externally and there is some unevenness within the stone to the Western elevation and separation around the internal walls. Where low quality skim has been applied to the walls there is little to suggest major structural movement, but we would note significant deterioration within the timber work associated with the roof truss over.

Through the wall to low-level degree of bowing and is less pronounced but we would highlight substantial separation between the internal stair walls and the eastern elevation. This is tapered to a width in excess of 75 mm at approximately first floor level, which reflects the separation noted within the northern room.

The separation against the southern wall probably in the region of 20 mm but has not continued to a major disagree where poor quality render and pointing has previously been undertaken. Against the northern end, however, the separation is again more than 40 - 50 mm being tapered around first floor level. Through the finish at half landing level cracking does not continue to any significant degree nor is there major signs of movement through the finishes of that internal wall.

## 3.2 GROUND FLOOR LEVEL

### 3.2.1 NORTHERN STORE

The floor over consists of joists spanning on to substantial timber beams at approximately 3m centres. These in turn are supported on a central spreader and a series of timber props through to ground level. Some of these props have suffered from notable deterioration and there is clear rotation towards the eastern elevation of more than 10 mm in a 600mm spirit level. Some of the original props have been removed and the main floor beam is almost spanning the full width. From notches cut within these beams it would appear that the internal layout has been substantially changed in the past.

Around the return with the northern elevation the separation identified at high-level continues between the brickwork and the stone such there is a width in excess of 20 mm

in places. Through the main body of the stone wall of the eastern elevation there is lateral displacement towards the first floor of around 50-75 mm, with this being more onerous towards the centre to coincide with the substantial bowing noted externally. Here there is cracking running through the render and evidence of continued movement, with the wall probably in the region of 150 mm out of true across the full height. This extends through to the internal wall with the stairs, where separation extends from the first floor down through the stonework, some of which suggests movement following previous repairs.

Within the Western elevation, and around the area of the external collapse the wall has moved into the plane of the building in a similar manner to that noted externally. There is deterioration within timber members built within the walls and some spalling of the render finish. A substantial section of the internal wall at the northern end has been rebuilt in brickwork where it is relatively level and true. There is no major stepped cracking or fractures within the brickwork although there is separation at its interface with the stone features.

Through the northern elevation there is block work in filling to an original opening and a timber member built within the masonry. Through the general stonework there is no major cracking although there is continued movement of the return in the North West corner, to reflect that noted previously.

### 3.2.2 CENTRAL STABLE

The substantial floor beams have replaced with more modern construction with further central beam and timber posts. This remains reasonable true, although there is slight lean towards the eastern side. This is not reflected by a comparable amount within the eastern elevation although there is separation of the internal wall relative to the return. Here open joints in excess of 20 mm were noted although the weathering and discolouration suggest it is long-standing.

The degree of movement between the stairwell and the eastern elevation is more limited and generally through the stone and brick interface there is little that can be considered recent. There have been patch repairs, with mortar packing where the internal walls abut the external wall, but this has not reopened to any major degree. There is, however, open

jointing and spalling to the mortar along the internal face of the open section of floor. Here the fill has displaced, and the wall exhibits a degree of movement.

### 3.2.3 SOUTHERN OPEN BARN AREA

Floor beams are again at approximately 3 m centres, and in this instance the original props appear to have been retained or replaced with new materials. These props are truer and generally at the bearing within the eastern elevation in particular there is little of major significance. The stone columns to the elevation appear reasonably true but there is rotation of the wall at was first floor level of around 25 mm. Slight displacement has occurred around the timber plate below the bearing of the timber beams. Within the arches of the eastern elevation there is some is slightly dislodging, and older cracking damage' but relative to the timber propping there is little to suggest significant recent movement. We would, however, note severe deterioration within parts of the timber plate where they are built within the elevation.

Along the return with the central stable there is cracking running vertically through the internal wall some 1 m in from the eastern elevation. This is the subject of notable discolouration and weathering to suggest it is not recent in origin. Patch repairs were carried out along a similar area of cracking towards the western side and there is open jointing with sections of the chalk fill that are loose. This again does not appear to be that recent, although it does reflect a pattern of movement and bowing of the wall outwards towards first floor level.

Around the opening through the Western elevation the bowing noted externally has been reflected by movement that is probably in excess of 50 mm. There are open joints within the mortar of the stonework as well as pockets where sections have come away. The amount of cracking within this stonework, however, remains limited and not suggestive of major recent movement.

Separation has occurred at the junction of the continuation of the Western elevation with the external southern wall, similar to that noted elsewhere. The scale of the movement is relatively minor in terms of rotation with both walls reasonably true. Cracking does run centrally through the southern elevation to low-level along a line of historic repair, but

other than limited apparent loose brickwork and stonework directly below the bearing of the first floor joists there is little to suggest an ongoing problem.

#### 3.2.4 WESTERN PROJECTION

This is a predominantly two-storey space with the roof constructed with rafters and purlins spanning between the main King post trusses. Within the roof finish there are some areas of light ingress and this is particularly onerous around one of the truss ends. Here there is staining of the timber work and possible infestation. Substantial sections of the walls have been covered in a plaster finish, and where this could be viewed from the limited first floor and ground floor the degree of cracking damage remains limited. There are sections that have spalled away, as well as some historic repairs, but generally these do not follow a pattern suggestive of major instability.

Separation cracking has occurred where the western wing meets the main northern section, reflecting the undulation noted externally, with open jointing running through to low-level in excess of 50 mm. Within the render within the immediate proximity the structural damage remains more limited, and it does not continue to any significant degree through the finishes at low-level

Where the main open is filled with brick there is no significant separation relative to the original stone wall nor cracking damage through the render finish. Generally this area of wall remains relatively vertical, and the degree of damage was limited.

There is a small section of first floor at the western end, but this was not considered accessible due to staining of the timbers and rot in the boarding. Our comments are therefore restricted from the access ladder. Separation has occurred along the returns between the western face and the main walls, and there is cracking running near centrally through the render directly below the truss line. This has a width around 5 mm with notable weathering along the edges. No major stepped cracking or fractures were noted, with a significant portion of the damage likely to relate to the ongoing weather penetration. The vertical cracking does not extend to any major degree through the finishes below the first floor, although there is continued separation between the returns of the stone walls.

Around the substantial opening through the southern elevation the stone arch has been retained with little through the render finish on either side. Some isolated spalling has occurred but there is no significant cracking or indications of recent movement through the main body of the wall. Isolated loose stones were noted around the opening, but the wall is otherwise reasonably true. There is staining of the wall at low-level indicative of dampness, and some algae growth. This is consistent with this form of wall.

#### 4.0 COMMENTS, RECOMMENDATIONS AND CONCLUSIONS

- 4.1 It is understood that the building was the subject of some repair and this presumably included the under drawing of part of the roof noted at first-floor level. A plaque on the eastern elevation refers to restoration and repairs being carried out during the 1980s, and we assume that these works also included replacement of the more obviously weathered stonework with the new stones noted extensively within the eastern and western elevations.
- 4.2 It is not clear whether the rebuilding of the northern face of the northern wing was carried out at the same time. There are, however, indications of movement of this section of the building presumably due to the limited buttressing provided by the openings, and debonding and delineation of the stonework. This is more onerous along the eastern return, where there is substantial cracking damage that will require stabilisation and repair works.
- 4.3 Along the eastern elevation we have highlighted the bowing which has occurred, particularly through the northern end. This bowing probably exceeds 150 mm although it is not reflected by major cracking either internally or externally. Notable sections of the stonework have suffered from shattering and erosion, but where the 1980s repairs were carried out there is little to suggest major subsequent damage of movement.
- 4.4 The eastern elevation generally reflects the bowing with distortion of the building towards the eastern side. At some of the openings there is apparent delineation between the external stone and the fill. Where erosion and shattering of the stones has occurred there is clear separation relative to the patch repairs, although the main concern is the section which is collapsed near to the centre of the elevation.
- 4.5 This collapse included a substantial area of the replacement of the external stone leaf during the 1980s. Some brick repairs were also carried out, but the stone face appears to have separated from the fill, presumably under wetting/freezing cycle. Either side of the area of collapse there are indications of further sections of the facing stone are loose and it is therefore probable that locally to this failure it will be necessary to carry out some extensive stabilisation of the stone fill.

- 4.6 The form of stabilisation is clearly subject to any alterations associated with the proposed conversion works. The stonework can be strengthened by the introduction of a grouted system injected through the joints of the stone into the fill material. This will more effectively tie the wall together across its width, and the introduction of additional ties could also be considered. If these could be provided through the northern end of the building, then this will greatly enhance the lateral stability of that section.
- 4.7 As a minimum we recommend that the stair walls and all other internal walls that currently exist within the building are tied through to the stonework using an appropriate masonry reinforcement system. If allowable external steel plates with tie rods through across the building would further strengthen these joints. Such repairs will substantially reduce the likelihood of further lateral deformation.
- 4.8 Within the open section of the barn the degree of movement and deformation remains limited. Where there is minor separation cracking at the interface between internal walls, or at the returns externally, this has not been reflected by major cracking damage. There is little evidence of instability within this two storey section, with the required repairs likely to fall within general construction detailing. The use of proprietary masonry reinforcement system to tie in the corner returns should be considered, although it is primarily precautionary in this area.
- 4.9 Within our general description of the building we have highlighted various areas of weather penetration, timber deterioration and likely damp related algae growth. These comments in no way constitute a report regarding such matters, however. As part of the refurbishment of the building it is strongly recommended the specialist advice is obtained with regards to dampness, timber infestation and rot. All treatment should be incorporated within the conversion and refurbishment works so that the long-term stability of the structure is not further compromised.
- 4.10 Inevitably as part of the conversion and alteration works it will be necessary to introduce or alter the existing openings. In carrying out this work it is recommended that the stone in the general area the openings is strengthened using the grouted and tie system referred to above. By ensuring that the fill material and stone walls are stabilised around

the openings it will be possible to carry out the alterations without the need for significant reconstruction.

- 4.11 It should be appreciated all our comments are based on a single visual inspection of the building without the benefit of any long-term assessment, investigations or testing of the materials used in the construction. We are therefore unable to categorically state that all movement observed within the building has ceased.
- 4.12 Within our comments we have made recommendations regarding the bulging of and bowing of the walls, as well as the clear evidence of failure to one section of the external stonework. Further significant stabilisation of the stone in the general area of the failure should be expected, and this may have to include localised reconstruction.
- 4.13 From the available visual evidence, however, it is our opinion that the barn is in an acceptably stable condition for accommodation within a sympathetic conversion to a domestic property. There will be some localised repairs and rebuilding works necessary due to the lack of long-term maintenance of the building. This is expected to be limited, and there is little visual evidence to suggest a requirement for extensive reconstruction works.

**R F DUDLEY**  
**B.ENG C.ENG M.I.C.E.**  
**For and on behalf of Dudley Consulting (Hull) Ltd**