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STRUCTURAL REPORT

of

ABERDARON MILL

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4962/RVW/R2

24 May 2017

Mr.Geraint Jones
Bryn Gwynt
Anelog
Aberdaron
Gwynedd
LL53 8BT

ABERDARON : THE MILL

1.00 AUTHORITY AND BRIEF

1.01 We were commissioned by Mr.Geraint Jones to prepare a Structural Report of The Mill, Aberdaron. The proposal is to renovate the building and restore it as a Working Mill.

2.00 INSPECTION

2.01 An inspection of the Mill was made on 7 April 2017.

3.00 GENERAL DESCRIPTION

3.01 For orientation purposes the main road is to the north-west side of the Mill.

3.02 The building is Grade II Listed.

3.03 For ease of reporting the main building is divided into three units as Area A, Area B and Area C. There is also a Stable Block attached to the north-east face and a small Store Room extended from the Stable.

3.04 Area A is of the Mill Range running from north-west to south-east and approximately 6 metres wide by 10 metres long and of two-storey height. The slate clad roof is pitched with trusses taking support of the south-west and north-east external walls.

3.05 Area B is the Dresser Range which extends about 5 metres south-west from Area A (Mill Range) and of two-storey. The width of Area B varies from 3.3 metres at its south-west gable to 4 metres at Area A. The pitched slated roof trusses take support off the north-west wall and the dividing wall between Areas B and C.

3.06 Area C is located to the south of Areas A and B and has a partial first floor and houses the Corn Dryer Oven. It is 7 metres long and 5.5 metres wide.

3.07 The Stable is approximately 5 metres long by 5.5 metres wide with the attached Store 4 metres by 2.5 metres.

4.00 OBSERVATIONS (the numbers in brackets refer to the record photographs in Appendix B)

4.01 **South-East Elevation (Area A) – External** (1)

4.01.1 This gable elevation is of coursed random rounded stonework with a 2 metre wide door opening with a timber lintel, situated within the north-east half of the gable. Located centrally within the gable pediment is a window opening.

The timber lintel over the door is of robust section and shows no sign of deflection and can therefore be retained

4.01.2 The horizontal and vertical alignment of the wall is relatively true up to eaves height but the gable pediment tends to bow inward with maximum movement occurring to the north-east side of the window head.

4.01.3 The timber lintels above the window opening have suffered some erosion and appear to be very shallow for their span (2).

It is considered that these shallow lintels should be replaced with treated hardwood. In order to replace these lintels the small section of stonework above will require dismantling and rebuilding. This will also enable the bowed section of wall to be re-aligned. Any dismantling of the stonework will necessitate record photographs, numbering of the facing stones in order that they can be rebuilt to accord with its Listed status.

4.01.4 The lower 1.6 metres of wall has been re-pointed but above this the stonework generally is in need of re-pointing.

4.02 **South-East Elevation (Area C) – External** (3)

4.02.1 This wall is constructed of large coursed random rounded stones with its vertical and horizontal alignment true. The wall has some localised re-pointing but is generally in need of re-pointing throughout.

4.02.2 There is evidence of previous ivy penetration (4) just below the roof line and some live ivy growth towards the north-east end of this wall (5).

The ivy has generally been killed off but their roots and tendrils have penetrated the wall particularly along the top of the wall. These will need to be removed which may mean dislodging and re-bedding some of the upper stones. Ivy can be very destructive to stonework and any remaining live ivy should be removed and killed off. Initially ivy will not generally harm the masonry and acts as a protective barrier from the elements and pollutants. However, progressively the roots, stems and tendrils enter the stone joints and grow and expand within the wall, displacing areas of masonry. Subsequent open joints allow water ingress and further deterioration. Suckers and tendrils will also contribute to surface decay, especially of mortar, by the secretion of

acids. In these cases the ivy growth must be removed, which will result in disturbance of mortar within the joints and will require raking out and re-pointing. The main ivy stems should be cut at the base of the root, removing a length of at least 300 mm. This cuts off the water supply to the plant. The roots should be sprayed immediately after cutting with an herbicide. Once the main root has been cut, secondary roots may attempt to burrow invasively into the weaker areas of the wall fabric to access moisture naturally present in the wall. Immediate spraying will prevent this. The ivy can take up to two years to die back.

4.02.3 The lintel above the west door opening has suffered erosion and the stones immediately above the lintel are loose (6).

The erosion of the timber has resulted in crushing of the timber at the bearings. The lintel will need to be replaced with hardwood and the loose stonework immediately above re-bedded.

4.03 **South-East Elevation (Stable Block) – External** (7)

4.03.1 Some of the facing stones to this wall have fractured and fragmented from weathering (8 & 9).

There is little that can be done to prevent further fragmentation and erosion of the stones, however, it is suggested that the worst affected be replaced with new.

4.03.2 At the south-west end of this wall there is a door opening with a failed timber lintel, which has caused displacement of the stonework immediately above (10).

The lintel will need to be replaced with treated hardwood of similar size and the collapsed stonework above the lintel re-built.

4.04 **South-West Elevation (Area C) – External** (11)

4.04.1 This gable elevation houses a boarded-up central door within the gable pediment served by the remains of steps leading up to the door. The wall is constructed of coursed random stonework with its horizontal and vertical alignment true with no evidence of cracking.

4.04.2 The door opening has a timber lintel with a shallow brick arched lintel immediately above supported by a curved metal plate which has corroded and laminated (12).

The rusted plate will need to be removed as it will continue to expand and displace stonework. The alignment of the brick arch is uneven and the metal plate may have been inserted to offer support. Alternatively the laminating of the metal may have caused the misalignment. The removal of the plate will necessitate the dismantling of the brick arch and the small amount of stonework above and its subsequent rebuild. The brick arch and stonework can be rebuilt re-using the existing materials but it would be preferable to omit the metal plate. If the plate is to be replaced it is recommended that stainless steel be adopted to prevent any future rusting.

4.05 **South-West Elevation (Area B) – External** (14)

4.05.1 This gable wall is of coursed random angular stone with a door opening adjacent to Area C with a stone lintel. There is a ground floor window opening between the door and west corner and a first floor opening centrally.

4.05.2 The vertical and horizontal alignment of the wall is relatively true but there is an indication of a vertical crack running up to roof level, above the south-east bearing of the door lintel (15). There is also an indication of slight cracking above the south-east bearing of the first floor window opening which has previously been re-pointed (16).

The cracking may suggest possible shearing of the stone lintel at its south-east bearing or alternatively outward movement of the south-east wall. The crack will have weakened the wall and it is recommended that stitching anchors are incorporated as shown on drawing 4962/03.

4.06 **North-West Elevation (Area C) – External** (17)

4.06.1 There is slight outward bulging toward the base of this wall but is generally free of cracks but in need of re-pointing particularly near the base of the wall.

4.07 **North-West Elevation (Areas A) – External**

4.07.1 The wall to Area A forms a gable and is constructed of random stonework. There is a vertical butt joint between Areas A and B. There is a low level opening which housed the axle of the waterwheel to pass into the building and a high level window within the gable.

4.07.2 There is outward bulging of the stone wall towards the north-east end of the gable. This bulging starts about 1.2 metres above ground, extending up to roof level and 2.5 metres from the north corner.

The bulging of the stonework suggests that the bond between the inner skin of the wall and outer face has failed leaving the outer skin of stonework unrestrained. It is recommended that the bulging stonework is consolidated with the inclusion of cintec anchors as shown on drawing 4962/03.

4.07.3 There is slight hairline cracking above the north-east bearing of the first floor window.

This cracking is not considered to be of structural significance and more likely to be due to thermal movement.

4.07.4 Generally this section of wall from base up to the cill level of the first floor window is in need of repointing throughout.

4.07.5 Towards the north corner there is evidence of re-pointed vertical and diagonal cracking (18). There is also slight vertical and diagonal cracking within the stonework at about 1 metre from the corner then running diagonally at about 45 degrees up towards the buried steel beam (19).

The steel beam has probably corroded within the wall which will expand and cause cracking and displacement of stone. The steelwork should therefore be removed. However, it is considered that the cracking is caused by the bulging of the stonework as described in clause 4.07.2. The vertical cracking will have weakened the wall and it is recommended that stitching anchors are incorporated as shown on drawing 4962/03.

4.08 **North-West Elevation (Area B) – External**

4.08.1 This wall is constructed of coursed random stonework with a full height vertical joint to Area A. There is a window opening at mid height adjacent to Area A.

4.08.2 There is a window opening at mid height adjacent to Area A with a stone lintel which has minimal bearing to its north-east side with signs of slippage. There is vertical cracking within the stonework above this bearing running up to roof (20). The inner lintel to this opening is of timber which has suffered erosion (21)

Either additional support should be provided within this opening such as a substantial hardwood frame or the replacement of the stone lintel should be considered. The internal lintel is near to failure and may be contributing the defects evident and should be replaced.

4.08.3 Below the north-east side of this window there is a butt joint with loose stonework towards the base which will require re-pointing.

4.08.4 The wall from the west corner to the window is in sound condition with very little re-pointing necessary apart from where the cracking and loose stonework occurs.

4.09 **North-East Elevation (Area A) – External** (22)

4.09.1 There is considerable ivy growth to this wall with tree growth at the south corner immediately adjacent to the wall.

The ivy should be cut back and killed as described in clause 4.02.2. As the tree matures the roots can cause major damage to the stonework and therefore the tree should be cut back and the roots removed. However due to its close proximity to the wall damage could occur by grubbing out the roots. It suggested that the tree be cut down to its base and eco-plugs inserted to kill off the stump and roots.

4.09.2 The wall is of random stonework and there is a significant vertical crack located 850 mm from the north corner extending from external ground level to roof (23 & 24).

The crack is 20 to 25 mm wide and suggests outward movement in a north-westerly direction. The cause of this movement is not clear and could be due to a number of factors which may become evident when the site is cleared of vegetation and works commence on site. The wall will require stitching anchors as shown on drawing 4962/03.

4.09.3 There is a window opening within this wall near the south corner. It would appear that the wall is leaning outward just south-east of the window (25)

Internally there is a truss bearing on this leaning wall which has been modified by cutting out the collar and bottom ties. With the omission of the triangulation a horizontal thrust is exerted from the truss rafters onto the wall which has caused the outward movement to occur. The collar tie and bottom boom of the truss should be reinstated.

4.10 North-West Wall (Stable Block)

4.10.1 This wall is retaining for almost full height and could not be viewed due to vegetation growth.

There are shrubs and vegetation growing along the top of the wall which can only be detrimental to the wall fabric. All vegetation should therefore be removed.

4.11 North-East Wall – External (Stable Block)

4.11.1 This wall could not be viewed due to ivy growth to the gable pediment and lack of access internally.

4.12 Internal (Area A) – Ground Floor

4.12.1 The first floor joists span north-west to south-east and are of varying size ranging from 75 by 175 deep to 100 by 120 deep. The south-east joists take support off a 130 by 300 deep timber cross beam but due to large notches within the top of the beam its effective depth has been reduced to 180 mm. This beam has twisted and rotated in a southerly-easterly direction. North-west of this beam is a more robust cross beam, 250 x 280 mm deep, running north-east to south-west supporting a lower level first floor. There are tenon joints under the beam located about 700 mm from either end which suggest that there may have been posts supporting the beam (26)

4.12.2 The lower level first floor to the north west has 75 x 175 deep joists at 400 centres spanning north-west to south-east taking support off the main timber beam.

4.12.3 Due to water penetration near the north-east wall some of the timbers have rotted and failed (27). There is localised erosion to a number of the joists to the south-west side with at least 4 no which should be replaced.

4.12.4 The external walls are of random stonework. The north-east wall is in a poor state and bulging inward noticeably in places (28).

This wall is retaining and the bulging indicates parting of the inner and outer faces of the wall. It is recommended that the wall is consolidated with anchors as shown on drawing 4962/04. On completion of the anchoring the wall is to be re-pointed throughout with lime mortar.

4.12.5 There is a vertical crack within the north-west wall located about 850 mm from the inner face of the north-east wall (29)

4.13 **Internal (Area A) – First Floor** (for location of trusses refer to drawing 4962/02)

4.13.1 Access to the south-east end could not be made due to the unsafe nature of the floor but there is a truss (Truss 1) located just south-east of the main first floor beam comprising rafter, bottom tie and two diagonals (30). The truss appears to be in sound condition as viewed from the north-west with a slight split in the south-east rafter at the diagonal connection. There is a high level horizontal member supporting a beam and this has eroded and will require replacing (32).

4.13.2 Truss 2 has had its low level collar tie removed (33 & 34) and bottom tie cut away (35).

The removal of the collar tie and bottom tie will create a horizontal thrust at the rafter supports. As the south-west bearing of the truss rests on the south-east wall of Area B this will act as a buttress to resist the force. The north-east bearing, however, has no resistance and has caused the outward movement of the north-east wall as described in clause 4.09.3. The collar tie and bottom boom should be reinstated.

4.13.3 There are areas of missing slates which has allowed water penetration but generally the timbers appear to be in reasonable condition but there are some rafters which will require replacing.

4.13.4 Within the north-west wall there is a significant vertical crack which starts about 850 mm from the inner face of the north-east wall running up to the underside of the purlin (36).

There is outward movement of the north corner with vertical cracking evident to both the north-west and north-east walls. As stated previously the cause of this movement is not clear but the horizontal thrust from the roof truss will add to the movement. It is recommended that the corner be stitched as shown on drawing 4962/03.

4.14 **Internal (Area B) – Ground Floor**

4.14.1 Within this area the 70 x 150 first floor joists span north-west to south-east. There is a timber platform towards the north corner supporting machinery and constructed of robust softwood beam and column sections. The 260 x 280 mm deep beam built into the north-west wall (37) has suffered rot at its bearing (38).

A small metal bracket appears to have been added to provide support but has rusted and is ineffective. The end of this beam will need to be cut back and spliced or alternatively cut away from the wall and a new column inserted internally to support the beam end. This may require a foundation.

4.14.2 The walls within this room appear generally sound albeit some are hidden from view. There is, however, a vertical crack in the north-west wall (39) running from ground level to a height of about 1.2 metres and located 2.6 metres from the inner face of the south-west wall.

4.14.3 The timber lintel above the window opening within the north-west wall has partially failed and there is displacement of the stonework above (40).

The lintel will need to be replaced and the collapsed stonework above rebuilt.

4.15 Internal (Area B) – First Floor

4.15.1 Located centrally there is a collar tie truss (Truss 3) (41) and a similar truss (Truss 4) (42) about 600 mm from Area A. The trusses have bolted connections and are of softwood which suggests that they are replacements. The timbers appear sound and there is no displacement of the joints.

Whilst the timbers appear sound there may be rot where they are built into the external stone walls and these will need to be checked by opening-up the bearings for examination. This will apply to all truss bearings.

4.15.2 The walls generally appear to be reasonable condition but there is a vertical crack in the north-west wall located about 3 metres from the south-west wall (43).

The cracking is in a similar location to the ground floor crack described in 4.14.2. The collar tie truss will exert a horizontal thrust at the top of the wall but the cracking is unlikely to be due to this force. It is more likely to be thermal movement of the masonry and not considered to be structural. The crack should be raked out and re-pointed with lime mortar.

4.16 Internal (Area C) – Ground Floor

4.16.1 This north-east wall of this room has the vaulted brick hopper walls of the Grain Dryer (44) held in place by a large timber beam at first floor level. The remaining perimeter walls are of random stonework. The stone walls are generally sound and free of cracking but the north-west wall is in need of re-pointing (45).

4.16.2 The first floor joists are generally 75 x 175 deep at 450 centres spanning south-west to north-east albeit the two joists nearest the south-east wall are 75 x 125. The joists are supported by the beam alongside the Grain Dryer.

4.61.3 Within the north-east brick wall there are three openings with the central opening having a brick arched lintel over (46) whilst the north-west opening has a timber lintel (47) which has suffered from beetle attack and rot and is probably the cause of the partial failure of the wall above this. The south-east opening pointed brick arch lintel serving an oven (48)

The defective timber lintel should be replaced.

4.17 Internal (Area C) – First Floor

4.17.1 Access was not gained into this room as the door was sealed with boarding and metal sheeting. However the inside could be viewed from an opening within the door.

4.17.2 There are 2 timber collar tie trusses (Trusses 5 & 6) supporting purlins and rafters, which appear to be replacement timbers and from what could be seen seemed to be in good condition (49).

4.17.3 The timber first floor ceases at the grain dryer and beyond this is a void which would have been floored with tiles (50).

4.17.4 At the north corner a large section of the north-east wall has collapsed (51).

The collapsed wall will need to be rebuilt re-using the existing stones.

4.18 **Internal - (Stable Block)**

4.18.1 Access was not gained internally to the stable block due to extensive vegetation growth but what could be seen of the north-west and north-east walls internally suggested that they were in reasonable condition (52 & 53). The floor is cobbled.

4.18.2 The single storey building has a central softwood collar tie truss supporting timber purlins (54).

4.18.3 The north wall appears damp which is not surprising as it is retaining for its full height.

4.18.4 There appears to be some bulging of the south-west wall internally starting at mid point of the room extending to the north-west wall and from ground level to a height of about 2 metres.

It is recommended that consolidation anchors be inserted to tie the inner and outer skins of the stone wall as shown on drawings 4962/03.

4.19 **Internal – (Store)**

4.19.1 The store is located to the north-east of the Stable and of single storey construction. Access was not possible due to vegetation and brambles both internally and externally (55). No comments can therefore be offered with regard to the Store.

5.00 CINTEC ANCHORS

5.01 Cintec anchors have been specified for the stitching and consolidation of the stonework. This type of anchor comprises a stainless steel hollow tube or square section surrounded by a fabric sock. The stonework is cored and the anchor inserted. Grout is injected through the centre tube, which returns between the outer face of the hollow section and the fabric sock and expands into voids and fissures within the wall. The outer core of stonework is retained and used as a plug to seal the end of the anchor. A specialist contractor approved by Cintec International must install the anchors. The main contractor is to provide scaffolding for the works together with power and water supply.

6.00 SUMMARY

6.01 Generally the external stone fabric of the buildings are sound, apart from the collapsed stonework internally to Area C. There are, howver, localised areas of bulging stonework requiring consolidation anchors and some vertical cracks in need of stitching anchors as shown on drawings 4962/03 and 04.

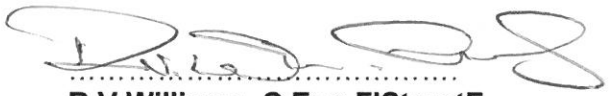
6.02 Truss 2 has had its bottom tie cut away and the collar tie removed resulting in outward movement of the north-east wall of Area A. The truss should be repaired with the bottom tie reinstated by splicing.

6.03 All vegetation should be cleared from the site and trees in close proximity cut down and killed off and all ivy removed and killed.

6.04 There are localised areas of damp penetration, through missing slates, which have caused rot to some timbers internally which should be replaced or spliced as required.

6.05 There are a number of defective timber lintels which have caused displacement of stonework above which will need to be replaced and the stonework re-bedded.

6.06 All repairs must accord with Cadw's requirements as it is a Listed building.



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APPENDIX A

Drawing 4962/01 : Ground Floor Plan

Drawing 4962/02 : First Floor Plan

Drawing 4962/03 : Elevations Showing Anchors

Drawing 4962/04 : Section A – A Showing Anchors