ANTHONY-JOHNSON
Consulting Engineer Ltd

Site Address:

PulverToft Barns,
Pulvertoft House
Gedney Broadgate

Site Survey:

The site comprises two individual barns, serviced by an entrance off a public highway. Both barns are noted as being suitably dis-used, with one containing ageing farm implements.

The barns are set to land that contains made ground with boundaries to the rear and side of the site, separating the land from adjacent fields and a neighbouring property.

It is proposed that the larger barn be converted for residential use. The purpose of this survey is to therefore determine the suitability of the structure for conversion.

Survey to Main Barn:

The man barn comprises a purpose built grain storage structure, similar in principle to a portal framed barn in that it is designed to resist sway and spread induced by wind and snow respectively through moment resisting connections at eaves. Cladding to the structure is hung to side elevations and propped to the roof all via a series of purlins, transferring loads back into the main portal style frames, contained within the interior of the structure.

External overview:

The main barn is formed of corrugated cement sheets, running vertical to all elevations and corrugated cement sheets to the head running up from eaves to apex. To each end of the barn is set a steel roller shutter door, providing a weather tight finish and access for large farm machinery. The majority of the exterior was found to be in good overall condition. Vertical deviation to main elevations was not noted and the ridge line was found to remain straight and run true throughout.



Image 11.0: Side elevation of Main Barn (rear)

Likely the result of high winds, damage has occurred to the corrugated cement sheeting to one gable end with the sheet having clearly failed and been torn off, exposing the underlying steel framing.



Image 12.0: Rear elevation with failed cladding

The barn is set to a concrete base with concrete plinths clearly evident to the perimeter.

A large quantity of husks, deposited to the side elevation of the structure are indicative of its former use as a grain store.

Interior overview:

Internally, the structure is formed of purpose made lightweight steel truss Portal frames, set at 4 m centres with steel purlins formed from rolled steel angles, set at 1 m centres to the head of the trusses.



Image 13.0: Internal view of the structure

Trusses clearly form sway frames with increasing depth when running from apex to eaves such that at the eaves there is sufficient lever arm to resist the bending moment induced by sway. The same is noted to vertical elevations with depth of trusses increasing toward the eaves, thus forming a haunch member.



Image 14.0: Haunches formed through deepening structural elements toward eaves.

Bracing is evident within the roofline such that sway along the axis of the building is transferred via compression and tension in the bracing members to the corner return of the structure, where cross-bracing and horizontal bracing ensure that it is transferred as tensile and compressive forces down to foundations.



Image 15.0: Bracing to end of structure.

The internal floor is finished with a concrete slab, sub-divided into bays for the intentional introduction of expansion joints between pours. These are noted as being set so as to control cracking within the finished floor. Deterioration in the concrete is clearly not evident and is reflective of a structure that has been suitably formed. A drainage gully to the rear elevation of the structure indicates the overall depth of concrete as being in the region of 500 mm. This in of itself implies a structure set to suitable foundations.



Image 16.0: Internal view of finished floor, with concrete divided into bays through introduction of expansion joints.

Discussion:

Findings of the survey indicate the following:

Structural elements are noted as being slender. On this basis, it is considered that purlins are restrained by the existing cement sheet cladding, reducing the effective length of these elements so that the full strength of the structural steel is achieved. Purlins provide the same to trusses, which are again considered slender in nature.

Unlike portal framed buildings, formed of solid structural steel elements, frames in this instance have been built up through the combination of individual thin walled elements to form trusses, which have then been combined to form portals. These form suitably light weight primary structural elements for the sole purpose of supporting the building over, resisting sway via deep haunches at eaves level. As such, the portal frames require both purlins and rigid cladding as a means to restrain them against buckling about the minor axis.

The reduction in depth of frame trusses at ground support level indicate that they have been designed as pinned bases, hence no moment resistance may be assumed in resisting sway at the base of the structure.

The profiled nature of the cladding gives rise to a structure that sheds wind loads at eaves level, allowing for an aero-dynamic eaves that does not attract significant thrust from wind loading. This coupled with the height to width and height to depth ratios of the building all point to a building where wind loading to vertical side elevations is low. By contrast, the presence of cross bracing and steel purlins all point to a building in which both purlins and bracing transfer wind loads applied to gable end back into foundations, thus removing sway from the building.

Conclusion:

Based upon the findings of the survey, it is considered that the building is suitable for the formation of a residential dwelling unit internal to the existing frame. The recommendation is based upon the premise that the existing structural elements will only be employed as a means to support a rigid external weatherproof finish capable of providing plate action to the internal structural elements.

Thin walled steel truss frames are noted as being inadequate for the addition of further loads and as such, the inclusion of a first floor internal to the structure would require additional supporting members, likely formed of stud walling.

Given the lack of moment resisting connections to the base of the structure, catenary action within the frame is unlikely in the event of a fire and stability against inward rotation is likely provided by the fire resistant cement cladding, with its major axis proffering sufficient compressive strength to allow for arching. On this basis, sufficient protection to the steel elements should be provided as part of the design process. Cladding should similarly be chosen on the basis of providing plate action through fixity back to structural elements, so as to provide lateral restraint to purlins about their minor axis thus preventing both torsion and lateral torsional buckling of members.

Given prior use of the existing structure, it is considered that the internal finished floor is likely formed to a suitable thickness of concrete for the inclusion of internal partitions. External examination indicates that it will proffer support to stud walls with first floor over.

Openings within the external cladding will require the addition of elements such that loads from self weight, wind and snow would be transferred suitably across the new opening.