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## The Octagon, Pavilion Gardens, Buxton

### Report on Inspection of Exposed Octagon Eaves Structure

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## ⋇ STRUCTURES ∠ GEOMETRICS ♦ SUSTAINABILITY ♦ INFRASTRUCTURE

#### 1 Introduction

Potential structural defects had been identified around the eaves of the Octagon structure at the Pavilion Gardens in Buxton. In order to investigate this, a contract was let to expose the structure over a representative length of eaves in order that the underlying structure and fabric could be surveyed and assessed.

Marsh Brothers Engineering Services Ltd were employed to open up a section of the eaves. In January 2015 an access scaffold was erected outside the southwest facade of the Octagon. The first few courses of slate were removed, the eaves board and soffit board removed and sections of the gutter taken down with the underlying structure being exposed. This permitted an inspection to be made of the underlying structure.

On 15 January 2015 we visited site and made our inspection. In addition to the access from the external scaffold we were able to make a limited internal inspection from an internal, existing high level platform to the south of the stage within the Octagon.

### 2 Description of Existing Structure

The Octagon was built in 1876 to the designs of Buxton architect Robert Rippon Duke. The building abuts the Pavilion Gardens structures built a few years earlier. It is octagonal in plan. It has a central dome springing off an internal octagonal faceted ring beam which is supported on eight paired columns and an outer pitched roof finishing on an outer octagon. The outside of the outer octagon is supported on external columns outside the windows.

The columns are all in cast iron. The inner columns of each of the internal paired columns supporting the top of the pitched roof and the base of the dome being are in two lengths with a splice at half height. Running from the outer of the internal columns to the external columns on the hips of the octagon are eight wrought iron lattice trusses. These are fabricated from angle chords with overlapping diagonal flat internals forming a lattice truss. These radial lattice trusses are supported on the outer corners of the octagon on cast iron columns with a cast iron decorative haunch at the connection. The tops of the external columns of the octagon are joined with a ring beam with intermediate cast iron columns (three or four depending upon the elevation) to support the large timber windows forming the sides of the octagon. The eaves beam is formed from a pair of wrought iron angles riveted to a wrought iron plate laid flat and bolted to the tops of the cast iron columns round the perimeter.

The cast iron gutter discharges via short stubs of special cast iron sections into the corner external columns which have hollow cores and act as downpipes.

The timber rafters are supported on the inner octagon lattice truss ring beam under the dome, on one intermediate lattice girder purlin and on the outer wrought iron eaves beam.

On the east and west faces of the octagon there are larger spans between the external columns (due to the link to the foyer on the east side and the stage on the west side). On these two

elevations the angle and plate horizontal girder is replaced with a lattice girder of similar form to the purlins and radial beams.

The roof is boarded on the soffit with 140x25 tongue and grooved boards nailed to the underside of the rafters

#### 3 Observations

- On the exposed southwest eaves there has been extensive corrosion presumably as a result of the gutter leaking. The wrought iron horizontal girder has severe corrosion throughout its length. This, coupled with past removal of sections of the flat web plate, has resulted in almost total destruction of this member over significant lengths. In the original condition the 220x55 softwood rafters would have been birds-mouthed over a timber plate sitting on the outer section of the eaves girder. However, in order to support the ends of the rafters over the south west elevation eaves where the girder has been severely compromised, short lengths of steel rsj's have been installed between the tops of the columns supporting the cut back rafter ends via a short softwood splice on fixed to the side of the top of the cast iron columns with multiple narrow shims. The outer angle chord of the horizontal eaves truss has come totally detached from the southwest corner column.
- The principal radial lattice truss rafters are supported on the outside corner cast iron columns via decorative cast iron haunches bolted to the underside of the lattice rafter truss. The haunch sits on a corbel which is part of the cast iron column. The end of the top of the lattice member appears to be bolted through into the face of the columns with two bolts. On the column that could be seen one of the bolts between truss end and column was missing. The cast iron haunch had a fracture through the top of the haunch against the underside of the truss.
- There were indications that the column at the corner between the southwest and western elevations may have moved out by 10-20mm as evidenced by the lack of fit of the now detached front angle of the horizontal eaves girder and a possible small gap between window frame and back of column.
- The external cast iron columns were noted has having some corrosion on their internal faces against the outside of the timber windows. The paintwork is coming off in some places. However the no significant loss of metal was noted in the columns were they could be seen.
- The lattice truss in the east elevation spanning over the Octagon reception could not be inspected close up but could be seen to be likely to be suffering corrosion with the paired angles forming the bottom chord being forced apart by corrosion of the internal diagonals and the touching faces of the angles. Plates have been added to both top and bottom chords – this looks like a probable later remedial work rather than original construction.

#### 4 Discussion

Severe corrosion has clearly has totally destroyed the horizontal wrought iron eaves girder. Past remedial works have attempted to address the support of the rafter ends by introducing steel joists in lengths between the columns. The remedial works are not satisfactory as the steel joists are supported on multiple steel shims which are themselves now corroding. The steel joists are not properly attached to the columns so do not provide any effective ties between the columns. The connections between the cut back rafters and the steel joists is not satisfactory. The eaves fabricated girder performs the function of supporting the rafters at the eaves (and the gutter) as well as tying together the tops of the external elevation columns. The girder on the southwest elevation is clearly corroded well beyond repair. Whilst the historic repairs with the steel joists does support the roof they are not well fixed and this is not a satisfactory condition.

The one principle radial lattice truss to column connection that could be seen had three defects: the lattice truss has had some corrosion noted in the end angle which bolts to the back of the column; of the two bolts to the column one was missing; the cast iron haunch had a fracture at its top which is bolted to the bottom chord of the lattice truss. The fracture and the missing bolt may be a result of the possible small outward movement of the column on the corner between the southwest and west elevations.

The lattice truss supporting the roof over the Octagon Reception appeared to have suffered corrosion but the extent of this could not be determined. However the presence of full width top and bottom flange plates may indicate that this is a long standing defect that has had past remedial work.

#### 5 Recommendations

The eaves girder must be replaced in a form that not only supports the roof but ties the column tops together. It is considered likely that this will be needed on all elevations.

This could be done by replicating the original construction of creating a new horizontal girder from angles and plate with some additional stiffening to support the rafters over the longer spans. The original material was wrought iron but this is not readily available now. Some form of pure iron may be possible but mild steel is likely to be the most available and practical material to use.

The principal radial lattice truss connection to the external column needs attention. On the column which was inspected the haunch is fractured. This could be repaired by splicing a new piece across the fracture. It looks likely that the angles forming the end plate of the lattice truss will need to be strengthened and now bolts inserted through into the back of the column. It isn't known if these defects will be on other radial truss to column connections. The other seven will need to be inspected to check this.

It is probable that the lattice truss supporting the eaves over the Octagon Reception is in a poor condition. The most practical repair will probably be to replicate the construction and replace the whole truss.

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The external columns do appear to have suffered some corrosion on their back faces where they are in contact with the timber window frames and the paint work is in poor condition but overall there did not appear to be an excessive loss of material that would give rise to any structural concerns. The columns should be blast cleaned back to sound metal, inspected and repainted.

## 6 Photographs



Photo 1: The Octagon Building showing South West elevation with scaffolding for opening up.



Photo 2: South elevation



Photo 3: South West corner soffit showing original soffit and adjacent new soffit.



Photo 4: North West end of opening up showing top of column.



Photo 5: Corroded eaves ring beam wrought iron angles and extremely corroded web plate and recent UB's supporting rafter ends.



Photo 6: South West corner column showing hip lattice truss end.

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Photo 7: Column 2 to eaves ring beam junction.



Photo 8: Column 2 to eaves ring beam junction.



Photo 9: Column 2 showing original gutter support plate.



Photo 10: Internal view of Octagon.



Photo 11: CI haunch connection of hip lattice beam to Column 1.



Photo 12: Crack in haunch.



Photo 13: Suspect lattice truss to East elevation over Octagon reception.

### 7 Sketches



