

Visual Survey of 'The Keep', 571 Oxford Road, Reading  
Berkshire

Report: 1902/R01

November 2013

Client : Open Hand Open Spaces Ltd.

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## 1.0 Brief and Scope of Work

MLDE were commissioned by OHOS Ltd. to carry out a visual structural survey of 'The Keep', Oxford Road, Reading, Berkshire whom currently occupy the majority of the building and provide studio space for local artists.

The inspection of the building consisted of a visual review of the external elevations from ground level and an internal visual review of the structural fabric from each floor and roof terrace.

No opening up works or trial pits took place and as such some elements remained hidden and therefore some defects may not have been identified or disclosed.

The survey consists of a visual review of the primary structure only and where services, secondary members, and non-structural elements are commented upon, these comments should be assumed to have been made in passing only, and have not been fully inspected.

The survey was carried out in dry overcast conditions on the 27<sup>th</sup> November 2013. The report has been produced for the private use of OHOS Ltd. and cannot be sold or copied to a third party without the written permission of MLDE.

The report should be considered as a first stage report, further limited invasive investigation works will need to be carried out prior to producing a Tender package if the project were to proceed forward. The information yielded from this report will highlight further items to be reviewed and considered in more detail at an appropriate point in time. This initial visual investigation, in combination with detailed knowledge of other Cardwell Keep buildings, does allow a reasonably well defined broad heading list of the likely repairs which will need to be carried out to refurbish the building to be compiled.

## 2.0 Overview

The building is one of nine such structures in the UK that was designed at the War Office by Major H C Seddon, of the Royal Engineers, for the army. It is believed that this structure was constructed in 1877 and consists of red brick external walls with decorated local horizontal relief banding courses (yellow stock brick), with limestone dressings to windows and corbel stones. The main building wall stands directly onto the edge of Oxford street and has a matching arched brick entrance wing wall to the west side with twin wrought iron gates for personnel and vehicles access purposes (photographs 1 & 2). To the side and rear of the property is a small garden and a tarmac car park area (3) which is surrounded and contained by a brick perimeter wall which is believed to be owned by others.

Internally the upper floors consist of cast insitu concrete slabs spanning onto wrought iron beams supported by cast iron columns. It is believed that the wrought iron beams and

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cast iron columns were a standard pattern used throughout the country for the Cardwell Keep Buildings. Specification details of the believed standard components are being investigated with the Government Records office at the moment. From MLDE experience of other Keep Structures, the components standard to this type of building were well manufactured using good quality materials.

The plan form of the different buildings around the country were based on the pattern of using load bearing external walls of brick or stone to suit the local vernacular, with a central vertical core structure consisting of four segmental cast iron columns of differing diameter to suit the number of floors in the building, and radiating out from these columns a standard pattern of wrought iron beams.

It is believed that these buildings were used as lightweight store and office type facilities. This is borne out by the fact that originally there were no large lifts or heavy hoists in the building which could be used to move goods around the three floor structure. There were only two cantilever tread stair cases contained within two diagonally opposing stair towers at the external corners. A small dumb waiter lift (4) with very limited capacity is contained within the central zone of one of the stair tower enclosures to move small volume parcels between the floors. It is believed that some storage of rifles and rifle bullet ordinance were stored within the building.

A brief review of the historic allowances made for different occupancy was gauged for reference and consideration. The Dorman Long & Co. Handbook from 1895 suggests that the imposed design loads for floors within Office Buildings should be 80 lb/ft<sup>2</sup>, which equates to 3.8 kN/m<sup>2</sup>.

The current applied loads for light art studio work probably equates to an applied loading which is similar to light office use where the design loading would be 2.5 kN/m<sup>2</sup> which would need to be uplifted by 1.0kN/m<sup>2</sup> to cover for the insertion of light weight partitions.

The building is likely to originally have had a minimum working floor design capacity of about 3.8 kN/m<sup>2</sup> ( this will need to be confirmed by calculation at a later stage ) and the current applied loading is likely to be around 3.5 kN/m<sup>2</sup>. Therefore from a basic position the structural fabric of the building needs to be kept in reasonable order to be serviceable for studio or light office use.

The visual inspection started at roof level. The parapet brick wall at this level was recorded as 328mm thick. Some of the brickwork is weathered and crumbling (5 &6) but generally the overall condition is quite good when considering the age and the limited amount of previous repair. The brickwork needs limited re-pointing with an appropriate and approved matching lime mortar mix (7).

In some areas where re-pointing has taken place in the past, an inappropriate cement based mortar has been used. Most of the previous re-pointing was reasonably well executed from a workmanship point of view and whilst still in good order should be left in place as removing it may cause damage to the bricks. Loose or decayed areas should be repaired with a well matched lime mortar.

The waterproof asphalt roof covering is laid over the notionally pitched (from the middle) insitu concrete roof slab, the material is traditionally dressed up and into the brick parapet walls joint. Generally the asphalt membrane is in quite good order with only a few tears or cracks and probably dates from the late 1970's (8&9). In a limited number of places the upstand has pulled out from the parapet wall (10) and needs repairing. However, the long term function of the waterproof membrane and concrete roof slab has been very severely compromised by the insertion of numerous eye bolt fixings (11 & 12) installed into the concrete roof slab to secure the scaffolding down to the roof.

It is likely that a completely new and intact membrane will need to be installed as the probability of being able to provide a durable and reliable long term repair at each eye bolt location is unlikely. The eye bolts will need to be removed from the supporting concrete roof slab and the damaged areas carefully repaired in an appropriate manner.

The Bathstone parapet copings in some localised places have weathered and fractured. Loose fragments should be removed as a safety precaution. Some areas of stonework will need to be repaired with a carefully matched suitable bed of Bathstone. In general terms the stone parapet copings are in quite good order, some limited piecing in of replacement stone will be required and some filling of weathered joints is necessary with a suitably well engineered durable lime mortar mix. In general terms the stonework and stone corbels have, through good initial detailing, weathered very well and, apart from a small percentage of stones which have cracked as a result of fissures and weakness, are in good order.

Upon the roof there is a small room formed from 9" brick walls with a monopitch 7" thick concrete slab roof over (13). The concrete slab is constructed from unreinforced concrete and is now badly fractured (14) and is in an unsafe condition. It has been propped with small timber sections in an adhoc manner. General access to this space must be excluded. Any clearing of the space should only take place by a competent builder after first installing a suitably designed internal scaffold or air bag system, which should also be designed to facilitate the replacement of the roof structure once Listed Building Consent is gained for the works.

Externally the parapet above this room could be seen to have some weathered joints. Very limited internal inspection of the small room revealed that the roof slab is spanning over corroded wrought iron beams (15) built into the external parapet wall. The corroding bearings of the beam can be seen to be expanding, the expansion forces are jacking the masonry apart.

The corner towers (North-East and South-West) could only be partly visually reviewed from the roof and ground level as the installed crash deck obscures inspection, and therefore they could not be comprehensively looked at and will need to be revisited in more detail at a later date, in order to schedule the actual repairs (16 & 17). However, an understanding of the typical condition of the tower structures was gained.

The highly exposed upper top 1.2m sections of the corner towers are in a deteriorated condition (18, 19, 20 & 21) and need extensive deep repointing due to being heavily weathered. Some localised removal of embedded iron elements is needed, and repair of the surrounding damaged areas required (22 & 23). There are some signs of slight amounts of instability of the corbelled corner sections of each tower, these are likely to need to be upgraded with stainless steel ties from corner to corner with external pattress plates.

The stone work to the towers is generally in a good condition. However, a few elements are cracked and fractured and need repair or replacement (24,25,26, 27, 28 &29).

Large segmental cast iron water tanks completely fill the internal tower volume, these are present in the top of each tower (30 & 31). These originally would have been roofed over with a weather proofed timber structure, which are now not present (32 & 33). Due to the level of weathering present within the surrounding structure, the timber structures have probably been missing for the last thirty years.

There is a small gap between the tank side and the brick structure. The brick walls are in a weathered condition and need to be repaired (34, 35, 36 & 37). In order to do so, the tank structures will need to be removed. This will also facilitate the repair/upgrading of the supporting concrete slabs below the tanks. It is believed that the tanks and surrounding structure have been exposed to the elements for about thirty years.

It is strongly suggested that the tank structures are not replaced back into the tower voids for practical and financial reasons. The tank structures are bolted and riveted together and it is unlikely that they can be taken apart without being damaged. It is potentially quite dangerous to try to lift such heavy and brittle objects out of the towers in one piece. It might be possible to reform and reuse one tank somewhere in the grounds as a grey water recycling vessel which would preserve the Listed fabric on site. The tower voids could be re-roofed and converted into usable space. The south-west tower which does not contain the circulation stair to roof level could create a very serviceable double height cube space.

The floor plates of the building were originally open plan spaces, secondary modern lightweight fabric floor to ceiling partitions have been installed to subdivide the floor plates into small artist studios. The roof and floor plates are supported by four cast iron columns which are arranged in a square formation within the space. These carry through a grillage of wrought iron beams which subdivide concrete plates into nine pieces.

The suspended concrete floor slabs have been cast directly on top of the wrought iron floor beams (38), around the cast iron columns bases/heads and onto the perimeter brickwork. The arched form of the slabs was created by using strips of wood as a temporary bottom shutter. The concrete floor slabs appear to have a thickness of about 125mm. In 1878 the use of site cast concrete within buildings was a very uncommon occurrence and was considered an advanced development for that age.

The concrete sections are formed from totally unreinforced material. The concrete is of a dense good quality with some lightweight clinker aggregate (39). The aggregate seems to be limited to a maximum size of 10mm and generally would seem to equate to a 30N concrete such as C30/10. The structural function of the slab depends solely on the intactness and soundness of the section.

There are some significant cracks visible to the underside of the slabs other than the casting and restraint joints which are present over the iron beam lines, especially on the first floor slab and to a lesser degree on the roof slab.

The painted underside of the suspended concrete vaulted roof slab is visible, supported from the original grid of wrought iron beams spanning to the external 450mm thick brick walls. The central portion of the roof slab has been upgraded in the last twenty years by the insertion of some secondary transverse and longitudinal steel and blockwork splitter structures (40).

The iron and steel elements have been intumescently painted to upgrade their fire performance.

There is evidence of significant water ingress through the roof slab (41 & 42) into the building fabric, that has clearly been taking place over a prolonged period of time. The water has seeped through the failing and punctured asphalt roof water proofing, especially due to the installation of the scaffold fixings through the roof slab, which have resulted in water penetration. There has also been water ingress around pipe penetrations and through wall areas where water run off is concentrated towards the façade.

The water ingress has resulted in some corrosion of the wrought iron beam bearings to varying degrees of severity. Surface corrosion is evident and varies from minor surface pitting to the initial onset of local delamination of the body material of the members at their ends (43 & 44).

The full extent of the degradation and condition of the wrought iron and cast iron members will require further investigation by ultra sonic NDT techniques to confirm their quality and soundness.

The segmental circular cast iron columns with flared and buttressed heads decrease in diameter as the number of floors to be supported reduces. Further information of the wall thickness of the columns and the material type for the specified cast iron needs to be gained in further elements of inspection works. In some locations the cast iron columns have been drilled to allow the local fixing of services. This practice must be stopped as cast iron structures are inherently brittle and potentially could cause a catastrophic failure of a column.

There are numerous cracks visible to the underside of the concrete roof slab (45), signifying that the slabs are in a weakened and degraded condition. The formation of cracks will also mean that the rate of degradation of the slabs will accelerate. It must be remembered that the roof and floor slabs have a general thickness of only 125mm and are totally unreinforced.

Some local investigation will be required to ascertain the bearing condition of the roof slab and floor slabs at the chamfered corner sections of the building, experience of other

Keep structures has shown some places where roof and floor slabs have very limited bearings at the supports in some local areas.

The floor slabs appear in general terms, apart from the first floor slab, to be in reasonable order, being constructed from what appears to be sound concrete with some lightweight aggregates. The unreinforced slabs have developed top joints/cracks along the supporting beam lines (46). There are a few areas of local damage that will need some limited repair.

The design service capacity of the supporting structure of the slabs will need to be calculated and reviewed against the applied loading. Further detailed analytical works will need to be carried out in order to consider the theoretical strength of the structure and the level of decay and corrosion which has taken place at each location. The Keep buildings were very efficiently designed by the War Office staff and could be considered for 1877 as "state of the art construction", prefabricated cast iron columns (47) (Pre Tay Bridge Disaster 1879), wrought iron beams and un-reinforced insitu cast concrete slabs.

Some localised differential movement of the masonry and the concrete floor slabs is apparent from the cracks present but in overall terms the stability of the walls appears to be very good.

There are a variety of small cracks in the walls caused by the expansion forces associated with the corrosion jacking of the iron beams at the bearings. The extent of the corrosion within the embedded ferrous elements needs to be investigated in more detail. A percentage of the beams will need to be repaired at the bearings.

The external walls would benefit from the non-breathable paint being removed which would allow the elements to breath more effectively which in turn will reduce their background moisture content levels and hence improve the life expectancy of the embedded iron structure.

Some of the repairs and their nature need to be balanced with the scheme development as it progresses in detail, and when actual calculations are carried out to prove the adequacy and robustness of the structure for the intended future life cycle. The magnitude and type of repairs needed for the property will depend significantly on the period set to next maintenance. In some elements such as the wrought iron beams, if a twenty five year future life were required then not all of the beam bearings would need attention, whereas if a 99 year future life was required then all beam bearings will need upgrading and careful repair and treatment in order to achieve the proposed service life.

The iron work which supports the second and third floor concrete slabs appears to be in marginally better condition than the roof slab and first floor slab levels.

At ground floor level four two feet square stone columns support the main cast iron columns. The capitals to these stone columns which also pick up the wrought iron first floor beams have extensive horizontal cracking which would indicate that some advanced and advancing corrosion jacking of the iron work is taking place (48, 49, 50,

51 and 52). These capitals and the incoming beams will need to have extensive repair and upgrading in due course.

The brick walls at ground floor level are quite damp and damaged, the extent of which has been compounded by the application of cement render (53 & 54). The render needs to be removed and the walls allowed to breathe properly.

Parts of the ground floor has painted hardwood flooring which when cleaned up would be quite serviceable. The other parts of the ground floor are a combination of concrete and setts and need to be lifted and relaid.

The cantilever sandstone landings and treads are degraded, and would benefit from local dressing by a stone mason to remove slip and trip hazards.

The currently unglazed verandah structure (55) needs to have the iron structure refurbished and repainted, the elements within the walls are likely to need upgrading and once carried out the glass replaced and new lead flashings appended.

The gate structure needs some minor brickwork repairs. However, the hinge plates need refixing into brickwork once repaired (57 & 58). The gates will need wire brushing back to black metal and then repainting.

The railings to the two small enclosed spaces against the front of the building also need refurbishment (59).

The cast iron rainwater goods need to be completely replaced through the building on a like for like basis and at ground level suitable soakaways need to be formed (60,61,62).

The Asbestos Register for the Building was not present on site during the inspection and should be carefully reviewed prior to any opening up works or modification to elements. If the document is not readily available then a Type 3 survey should take place and a new Register Produced.

### 3.0 Summary and Conclusion

The Cardwell Keep structures in general terms are simple robust well built buildings. The Listed Reading Keep primary structure is in overall terms in quite good order apart from a few items which after one hundred and thirty years of use and little previous investment now requires some attention. The main load bearing walls are not showing any signs of any foundation movement and appear to be well founded.

The pointing and brickwork is in need of some localised repair/repointing and isolated brick replacement, especially in the more exposed parts of the elevations around the tops of the two towers and the roof parapets.

The stone detailing, corbels, lintels and cills are generally in a very good condition with little in the way of weathering in overall terms. A few corbels and lintels are broken/fractured and will need to be repaired.

The walls are in fairly good condition except where they contain embedded ferrous metal elements which are corroding. The corrosion jacking of the metal is splitting the brickwork. The areas of the building where water has been allowed into the fabric for the past three decades are starting to corrode, especially the wrought iron floor beam bearings to the more exposed elevation and localised wet areas.

The residual strength of the iron members will need to be carefully checked by an Engineer during the conversion works and repairs carried out as necessary. It is likely that the bearings of the wrought iron floor beams will need some enhancement and modification in general terms on the third floor and ground floor locations, some other localised repairs of the iron work is likely to be needed. These works and other items will need to be covered by an approved Listed Building Application.

The cast insitu vaulted unreinforced concrete floor slabs seem in general terms in reasonable order for their age, they have naturally created their own movement joints along the tops of the supporting wrought iron beams, these cracks are not of any real structural significance. There are in some limited places a few cracks which are not in beam locations and these need to be carefully repaired to a well detailed engineering specification. The first floor structure has a significant number of cracks which are off beam lines and will need to be repaired.

It is believed there could be a detailing weakness in the concrete slab construction at roof level in the corner zones. In some other Keep Structures the concrete roof floor slab does not have a direct vertical bearing on the brick outside walls in the corner zones. A small slab modification or upgrade corner trimmer needs to be designed to support this area if found to be similar to other Keep Structures.

The first and second floor slabs from experience do not appear to have the same problem and seem to have been cast with intermittent concrete fingers which extend into the core of the brickwall and again will need to be confirmed by some minor invasive investigations.

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The future structural reliability of the thin brittle unreinforced concrete floor slabs at all levels needs to be managed by sensible and appropriate use, which avoid heavy or sharp dynamic type loading.

The windows and doors within the building need to be completely refurbished, most windows will need to be fully re-glazed as the panes have either been damaged or replaced with perspex.

The content of this report should be considered as an initial guide to assist in the formulation of a Budget Cost Plan for any refurbishment of the building.

Further more detailed work needs to be carried out as the scheme enters the detailed design phase. It is important that the design adjustments and re-development of the building is carried out in a sympathetic manner. Useful and valuable information gained from reviewing and working on other Cardwell Keep buildings has been used in the formulation of the content of this report.

## Appendix A - Record Photographs

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