Hughes & Salvidge Ltd
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DEMOLITION OF BUILDING 62 BOLDREWOOD CAMPUS

UNIVERSITY OF SOUTHAMPTON

Particular Risk Assessment

and

Outline Method Statement

Commercial-in-Confidence

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1.0 INTRODUCTION

Building 62 consist of 3 sections, a central block with internal courtyard, 6 storeys high on the north side and 7 storeys high to the south to accommodate the fall in ground level. To the west, there is a 6 storey extension, whilst to the east there is a further 2 storey block, linked to the main building by two 1 and 2 storey buildings.

The roof across the top two storeys of the central block is of steel frame construction. It appears the frames contain a series of Vierendeel trusses, which suggests that vertical self-weight loads and horizontal movements due to thermal changes are being transferred to the perimeter walls.

The first 5 storeys of the main block and all the adjoining annexes are of the same form of precast concrete construction. The concrete elements consist of precast concrete beams supported by precast concrete columns, complete with small spurs and pinned half joints.

Each column section is connected to the subsequent one using a series of steel dowels. The floors are constructed using grids of precast beams in sets of four. Each grid is linked by a series of precast "planks". Each floor is covered with a thin *in situ* concrete topping. Stability of the building is assumed to be provided by two pairs of shear walls in the south-west and north-east corners.

The building has a linked basement on two levels in accordance with the sloping ground level. There is an *in situ* concrete ground floor slab, with *in situ* concrete retaining walls to the perimeter. Foundations are based upon a traditional pile cap arrangement.

2.0 STRUCTURAL RISK APPRAISAL

Demolition of building 62 raises the possibility of premature collapse of sections of the structure due to the nature of the construction. It appears the central block has only two points of fixity, so that the building can respond to thermal changes along each elevation. Hence, it is essential that any demolition sequence continues to preserve the existing fixity and articulation of the building until final removal of the adjacent sections on either side of the shear walls.

The *in-situ* topping to the concrete floors provides stiffness to the structure in the horizontal plane. Removal of the composite floor "slabs" will result in a loss of rigidity and possible flexure of the main precast column elements within the structure. This may result in partial collapse of a section of the building if the precast columns are exposed to flexural forces outside their design limits. It is unlikely that the dowel joints between individual column sections would be able to withstand any significant level of flexural action.

Any lateral movement of the external frame could precipitate localized failure within a bay due to the method of fixity between the floor beams and the external frame. The buildings pre-disposition to differential lateral movement between floors was clearly apparent along the north elevation during a site inspection on 24 March 2010.

It also seems there is a global lateral shift of the south-east corner of the main building to the east due to thermal movements. It appears these movements have in turn affected the south end of the two-storey building across the entrance foyer to the south east corner. Hence, there is a potential risk that a local failure during demolition could generate a more widespread progressive collapse along and across the entire structure.

The visual inspection also indicated that structural stiffness and reinforcement levels in the precast beams are relatively low compared to modern standards.. Several beams in the entrance foyer contain numerous flexural cracks throughout the span, suggesting that initial sagging deflections have continued to creep over the past 40 years.

In the basement areas of the building, several precast columns spurs display structural cracks initiating from the corners of the half joints. It appears these sections are already experiencing considerable forces beyond their design capacity and there may be other sections in a similar or worse state currently concealed within the fabric of the main building.

Furthermore, it should be remembered that limit state design rules for concrete buildings were not introduced until 1972. The new approach recognised the potential deficiencies in designing to elastic state codes for shear forces and radically revised the levels of shear reinforcement. Accordingly all beams, columns and half-joints in particular are liable to fail suddenly as their shear capacity is likely to be limited.

Due to the nature of the structure, it is therefore recommended that, with the exception of the steel framed roof section and the entrance foyer area adjacent to the new-build, any demolition of the building be conducted remotely. Accordingly, a total exclusion zone should be established and maintained throughout the demolition process.

The stability of the steel framed roof section requires particular consideration to ensure it is fully secured by appropriate advance temporary works, as controlled dismantling is necessary prior to commencing structural demolition of the concrete frames. Similarly, control measures in the form of temporary screens and structural propping need to be evaluated in detail to enable separation and controlled dismantling of the existing entrance and foyer area, prior to demolition of the remainder of the 2-storey block.

The specific structural hazards and risks for the demolition work are identified in Table 1, in accordance with the Health & Safety requirements of the CDM Regulations, 2007. The particular risks identified here represent special areas of concern in addition to the general risks associated with demolition and the close proximity of an occupied building. Control measures for general risks during the demolition process, including all soft stripping activities, are covered in Hughes & Salvidge Health & Safety Plan and supplementary Risk Assessments.

3.0 OUTLINE METHOD STATEMENT

The proposed demolition techniques and sequence of working are based upon the need to control the particular structural risks identified above. The works would be conducted in a series of discrete phases to ensure the structural stability of the remaining parts of the building and safety of the work force are maintained at all times. Phases 2 & 3 are mutually exclusive, so that work can be undertaken at the same time in these areas. Phase 4 would not commence until both phases 2 & 3 have been completed.

Phase 1: Preliminaries

- Complete all asbestos removal and soft strip operations.
- Ensure all services disconnected or diverted.
- Verify location and presence of shear walls at south-west & north-east corners of main building. Conduct floor by floor visual survey of building frame to assess the structural significance of any cracks, deflections or lateral movements.
- Determine whether 2-storey block has a fixed point, such as *in situ* concrete staircase or shear walls. Hence, determine nature & extent of temporary works to protect adjoining new building.
- Examine monitoring records to determine whether thermal response of building confirms the shear walls are effective in controlling building movements.
- Investigate structural arrangement and connections between steel frame across roof of concrete building. Hence, determine temporary works required to enable controlled dismantling of steelwork prior to demolition of main building.
- Secure boundary fencing and define access & egress points for plant and demolition debris.
- Establish limits of total exclusion zone for each phase of the demolition works.

Phase 2: Two Storey Block

- Isolate personnel access from new building and erect temporary works to southern boundary of two storey block.
- Carefully break out roof sections from south east bays, situated at top of current access ramp and entrance foyer. Use remotely controlled light weight Brokk machine and leave supporting concrete frames intact.
- Check stability and any lateral movements of the northern part of the two storey block on a daily basis and at specific stages in the removal of the southern sections of the building
- Demolish access ramp to permit access and create hard standing area for crane.
- Selectively cut & lift out precast beams from roof level, followed by supporting precast column sections from southern boundary.
- Repeat above demolition process for first floor area with Brokk machine.
- Cut & lift remaining main floor beams and columns across southern boundary with new building.
- Demolish remainder of southern single storey connection to south east corner of main building.
- Confirm boundaries of total exclusion zone around isolated structure.

- Demolish remaining northern section of the two storey block, including single storey link to north east corner of main building, using concrete pulveriser.

Phase 3: Steel Frame Roof

- Remove all roofing material, expose structural steel frames and connections to top level of main concrete building.
- Install any temporary works required to permit controlled dismantling of Vierendeel trusses and maintain stability of remaining sections.
- Site crane along northern boundary of building and commence cut & lift operations above north-west extension, working towards main quadrangle.
- Continue cut and lift operations across northern half of main building.
- Re-site the crane along southern boundary and complete cut and lift operations across south half of building.

Phase 4: Main Building

- Establish total exclusion zone around perimeter of entire building.
- Locate long-reach machine with pulveriser attachment to north of north-west extension.
- Commence systematic removal of north-west corner of building, working eastwards towards the shear walls in the north-east corner.
- Remove one floor level at a time in each bay, working in a stepped manner across northern elevation.
- Cease demolition operations one bay before the shear walls in the north-east corner.
- Re-locate long reach machine to the west side of the building and repeat similar sequence of floor removal in a stepped manner, working along the west wing towards the shear walls in the south west corner.
- Cease demolition one bay before the shear walls in the south-west corner.
- Re-locate long reach machine south of the south-east corner and commence similar demolition procedure, working towards the south-west corner.
- Continue demolition of entire south-west corner, including the shear walls.
- Re-locate long-reach machine to the east side and proceed along east wing in a similar manner, removing the entire north-east corner containing the shear walls.
- Break-out floor areas above basement section, with machines working outside building perimeter to avoid premature collapse under the weight of the demolition plant.
- Breakout retaining walls, basement ground slabs and foundations.
- Backfill voids with hardcore as required.

Table 1. Identification of Particular Hazards and Assessment of Risks during Deconstruction of Building 62

Element	Hazard	Potential Risks			Control Measures	Residual Risk
		Type	Probability	Severity		
Internal fabric and fittings	Large volume of lightweight plastics, metals and hazardous materials. .	Materials become airborne, causing environmental pollution across site. .	Very High	Very High	Complete removal of asbestos and bio-hazardous material in advance. All soft stripping activities to take place within fully enclosed building.	Low
Steel Framed "Roof" Section	Working at height with restricted visibility. Complex three dimensional structure.	Entrapment or overturning of remote high-reach machine. Localized instability & uncontrolled partial collapse of steel structure.	Medium	Very High	Remove steel "roof" section by conventional cut and lift techniques. Provide temporary propping as necessary to ensure stability of remaining sections at all times.	Low
	Working at height within "danger area"	Injury to personnel	High	Very High	Appropriate PPE & control measures to be applied in accordance with standard Hughes & Salvidge risk assessments	Low
"Connection" to new building	Pin-jointed precast concrete frame. . .	Uncontrolled collapse onto occupied building	Medium	Very High	Isolate structure from new building. • Remove floor slabs by remotely operated demolition plant. • Prop precast frames to prevent collapse onto new building. • Apply temporary protective screens to vulnerable areas of adjacent building. • Cut and lift members out in predetermined sequence.	Low
Floor beams and in situ slab.	Stability of structural frame relies upon in-plane rigidity created by floor "slab".	Uncontrolled collapse of adjacent beams and column sections .	High	Very High	• Demolition to be conducted remotely using high reach demolition plant. • Total exclusion zone to be established around building perimeter to protect workforce and the public.	Low

Table 1. Continued

Element	Hazard	Potential Risks			Control Measures	Residual Risk
		Type	Probability	Severity		
Precast concrete frame	Pin jointed construction within structural frames.	Partial uncontrolled collapse.	Medium	Very High	• Ensure full sight line maintained using stepped approach to demolition • Stand-off demolition machine from side elevation. • Remove floors one at a time to avoid excessive loading from debris.	Low
	Pinned and grouted structure.	Partial or complete collapse due to over loading of pinned joints.	High	Very High	• Work in a pre-determined sequence towards shear walls. • Maintain total exclusion zone around building perimeter. • Clear all demolition debris from floors as it arises.	Low
	Heavy structural sections. Jointed sections permit sway movements.	Falling sections cause failure of precast sections below. Flexural collapse of column sections and progressive collapse across bays.	Medium High	High Very High	Pulverize structural elements in situ and reduce in size prior to lifting clear of the building. Maintain shear walls within building and commence demolition from “free ends” working towards points of fixity at each level.	Low Low
Basement	Hollow voids Retaining walls	Overturning of machines into voids. Collapse of walls if heavy machines too close to rear face after floors removed.	Medium Medium	High High	Fill any basement sections with compacted arisings, prior to tracking across with machines. Stand off machines at least 3m from back of walls until basement void is backfilled.	Low Low