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Northern Sydney Central Coast Health

Mona Vale Hospital

Facade Inspection Report

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1 Executive Summary

Arup Facade Engineering was engaged by Northern Sydney Central Coast Health to undertake an inspection of the main building (northern, southern, eastern, and western wings) and tower at Mona Vale Hospital, NSW.

Tim Womack, Felipe Flores, Liam O'Hehir and Dorji Chavara of Arup Facade Engineering undertook the inspections between the 20th July and 9th of August 2010.

The investigation included visual inspections, borescope investigations, representative hammer tap surveys, and hand-pressure tests of windows and sunshade elements to determine the overall integrity. The facades were primarily accessed using industrial rope access techniques (abseiling) to allow a close up inspection of the facade elements. A cherry picker was also used to assess areas of the north wing facades.

The investigations find:

Brick Walls & Brick Infill Panels:

- Brick ties and fixings suffering from a degree of surface corrosion.
- Deteriorated mortar joints have resulted in exposed brick ties and misalignment/loss of structural integrity of the brickwork.
- Disengaged brick ties and piers.
- Repaired sections of brickwork.
- Discoloured portions of brickwork.
- Cracked brickwork in some locations due to corroded window fixings.
- Eroded brickwork in some locations.

Windows & Louvres:

- Some louvres show extensive impact damage.
- All louvres are marked with pitted edges and have a mild level of surface corrosion.
- Loose and detached louvres due to corroded fixings.
- Detachment of louvre/window fixings, however the structure appears to be stable.
- Window frames all suffer from a mild level of surface corrosion but some joints are marked with pitted joints.
- Components of the hinges (aluminium rivets and barrel pins) are all suffering from corrosion despite being replaced. Some replaced hinges have missing screws.
- Missing fly screen protection in some windows.
- Remedial sealant application was noticed on the majority of the windows.

- Curtain wall stairs shows excessive movement when lateral force is applied by hand.
- The aluminium hinges and trims along the tower curtain wall are in very poor condition.
- Some areas of the tower wall curtain wall have triple hinges only fixed on two hinges.

Sunshades:

- All sunshades suffer from a mild level of surface corrosion.
- Some louvres and sunshades have suffered from impact damage. The louvres in some cases are loose possible as a result.
- Missing louvre elements have been noticed in some areas.
- Mild level of surface corrosions noticed on both internal and external sunshade fixings.
- Majority of the sunshades, though not operable, appear to currently be structurally stable.
- Mid span fixings of the sunshade systems are fixed onto brickwork panels which are generally in a very poor condition as described above.

Rendered Beams & Columns:

- Render loss noticed in a few locations and the exposed areas appear to be smooth.
- Majority of the render appears to be pinned however some areas have been pinned at render joints which are not appropriate.
- Render on the south wing does not appear to be pinned.
- Cracking was noticed in some areas.
- The majority of the rendered beams and columns present a high level of drumminess.

Roof Areas:

- Patched areas noticed on the Nurolite (it should be noted that this is known to contain asbestos) waterproof membrane.
- Lower roof of the western elevation of the northern wing has significant water pooling present.
- Bimetallic corrosion present in many areas of the sheeting on the western wing
- Damaged parapet capping and displaced flashings were noticed on the western wings. Displaced and damaged flashings noticed in some areas of the lower roof of the western wing.
- Localised detachment of Klip-lok roof sheeting.

- Corrosion of exhaust ducting, patched areas around ducting, and gutters experiencing both water pooling and corrosion noticed on the western wing.
- Surface corrosion and paint de-lamination was present on the RHS beams on the main tower.
- Severe edge corrosion (possibly bi-metallic) and paint de-lamination of the roof of the main tower.

Plant Room & Metal cladding:

- Expanded mesh and the structural beams on the underside of the metallic sheet cladding appear to be in poor condition.
- The structural beams have suffered from an extensive amount of surface corrosion especially on the bottom flange.
- The mild steel edge fixings used with the expanded mesh appear to have suffered from extensive surface corrosion as a result the mesh appears to be loose and sagging.
- Mosaic-tiled areas are drummy and some have completely detached. The surface of the exposed concrete areas appears to be smooth.

Reinforced Concrete Retaining Wall:

- Concrete retaining wall and reinforced concrete balustrades are suffering from corrosion of the reinforcement. As a result concrete spalling is evident.
- The steel balustrade appears to have suffered from extensive corrosion.
- Bubbling and pealing of the painted finish.

Tiled Facade:

- Cracked corners noticed on some tiles, with some showing cracking of the gloss finish.
- Sealant cracking noticed.
- Concrete beam beneath the tiled facade appears to be patched.
- Cracked mosaic-tiles were noticed.

Miscellaneous:

- Missing and damaged fascia on the northern wing
- Structural RHS members on the eastern elevation of the northern wing awning appear to be corroding.
- Air condition support brackets and fixings appear to be severely corroding.
- Rainwater pipe corrosion and failed ducting fittings.
- Incorrectly installed (missing structural bracket) air condition system.
- Corroding light fitting systems.

Mona Vale hospital building facade is approximately 50 years old and is in a generally poor condition. Nearly all the areas of the main building facade require remedial/refurbishment works to be undertaken. These works can be broadly grouped into four refurbishment options which prolong the extended life of the building. These are as follows:

Stabilisation:

- This option would be the most economical option and could extend the lifespan of the building by a further 2 years.
- As this option does not address the underlying causes of failure it hence offers the shortest residual life, and thus periodic inspections would need to be carried out at least every year.
- Facade types in need of stabilisation include:
    - All the facade types accept the "Brick walls & Brick Infill Panels".

Conservation:

- This option is a low level intermediate approach to facade refurbishment and could extend the lifespan of the building by a further 5 years.
- Facade types in need of conservation include (excluding monitoring and associated works as a result):
    - Rendered Beams & Columns
    - Miscellaneous

Restoration:

- Works associated with this approach will restore the facade elements back to their original functional state. These works will further increase the residual lifespan of the building by approximately 10 years.
- Facade types in need of restoration include (excluding monitoring and associated works as a result):
    - Brick walls & Brick Infill Panels
    - Windows and Louvres
    - Sunshades
    - Roof Areas: Minor works to include falls for water drainage.
    - Plant Room & Metal Cladding: Minor works to replace the tiled cladding.

Replacement:

- This option of works offers the highest level of performance improvement and durability and the life span.
- A holistic replacement strategy would be to replace the facade in their entirety with a panelised curtain wall system which could incorporate elements such as sunshades.

It should be noted from the above that the "Brick walls & Brick Infill Panels" which are in need of urgent attention need to be completely replaced (outer skin). As a result for example if only a two year extension of life span is pursued then the restoration works outlined for the brickwork along with the stabilisation works would need to be done together. Likewise for the conservation options.

Secondly it should be also noted that the works outlined in conservation include stabilisation and likewise restoration including both stabilisation and conservation.

Based on our visual inspection and assessment we have also highlighted areas of the façade requiring immediate and imminent attention as shown on drawings included in Appendix A. These drawings exclude windows, louvres and sunshades.

- The red areas represent portions of the building envelope that require immediate attention.
- The yellow areas represent the portion of the building envelope that requires attention in the short term (3-5 years). It should be noted that no guarantee on the location of these yellow areas can be given as we do not purport to have discovered or seen hidden defects or every structural condition in existence.
- The green areas represent portions of the building envelope that, from observations, appear to be in fair condition and would require normal levels of maintenance and ongoing monitoring. These areas appear to have had remedial works recently done.

2 Introduction

Arup Facade Engineering was engaged by Northern Sydney Central Coast Health to undertake an inspection of the main building (northern, southern, eastern, and western wings) and the main tower at Mona Vale Hospital, NSW.

The scope of works is set out in our letter dated 19 May 2010 and acceptance confirmed by your purchase order No. 1268713 dated 25 June 2010.

The inspection of the facades was commissioned by the client with the intention of understanding the condition assessment of the existing facades of the main building. The aim of this investigation is to determine appropriate strategies for remediating defects found.

At present temporary fencing and exclusion zones are currently present the western wing, and portions of the perimeter of the northern wing.

For this report our agreed scope of services, is summarised as follows:

- Understand the constraints imposed by the existing construction, facade and the site.
- Indentify remedial solutions that may improve durability and extend life of the building facade.
- Improve building comfort of the main building for both the patients and hospital staff.
- Identify the most cost effective solutions to remediate any current facade defects.
- Ultimately identify the highest total value solutions.

The purpose of this investigation is therefore to attempt to identify the mechanisms of deterioration, and to provide advice as to appropriate means to remedy identified issues, or to recommend further investigations if required.

In order to assist in our investigation the following documents were obtained from Colin Frame (Northern Sydney Central Coast Health):

1. Original facade elevation drawings
2. Facade Report (Windows) by Integrated Consulting Group (24/11/2009)
3. Facade Report conducted by Atkinson Capital Insight (29/09/2003)
4. Facade Report conducted by the NSW Public Works Department (12/07/1987)

2.1 Façade Description

The main building of Mona Vale Hospital is split into four main wings and a main central tower as shown in Figure 1 below.

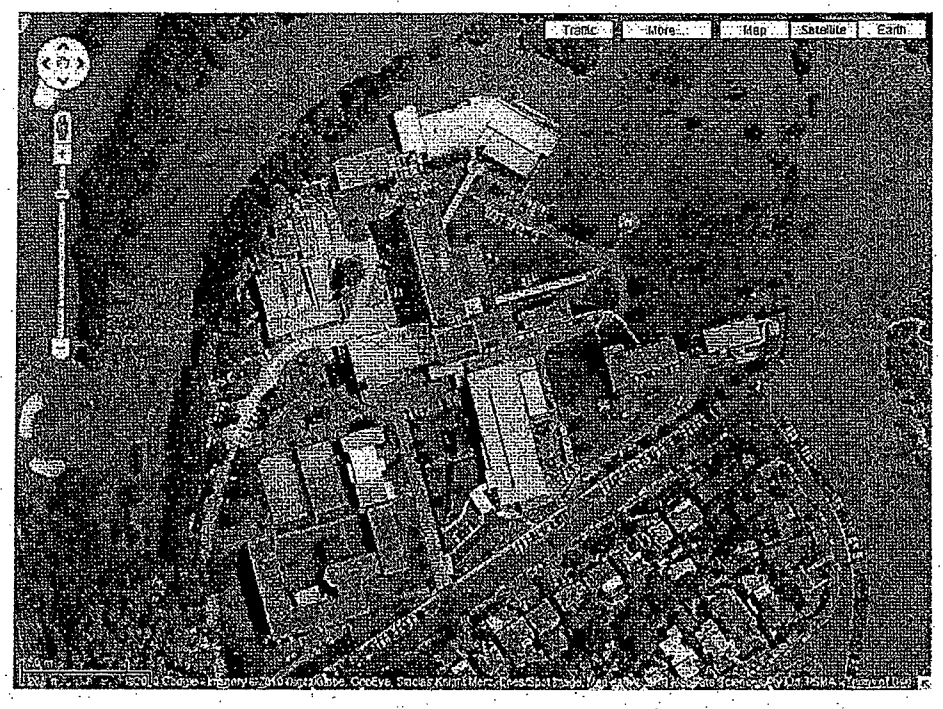

Figure 1: Site Map (courtesy Google Maps)

The building structure consists of a reinforced concrete frame, using concrete slabs and columns.

The building facade consists of the following main components:

Brick Walls & Infill Panels:
The majority of the brick infill panels consist of cavity brickwork incorporating a metal flashing at the base. Some areas of the building are continuously infilled from slab to slab with cavity brickwork also.

Glazing & Fixed Louvres:
The glazing generally consists of fixed panes and single glazed "hoper" aluminium sashes fixed to an aluminium system. This includes aluminium sub-sills, sub-heads formed of paired angles, and jambs. Aluminium framed windows are fixed to the concrete slabs, columns and brick infill panels

All louvred panels are integrated to the aluminium system and also fixed to the concrete columns and slab.

It is apparent that some glazed areas on the eastern elevation of the northern wing were replaced with a completely new window system in recent years.

Sunshades

A series of aluminium framed sunshade blades are fixed to the western elevation of the northern wing. The aluminium frame supporting aluminium blades are fixed to the concrete slab and brick infill panels.

3 Inspection

3.1 General

The inspection was undertaken by Tim Womack, Felipe Flores, Liam O'Hehir and Dorji Chavara of Arup Facade Engineering over four days between the 20th of July and the 9th of August 2010.

The investigation included visual inspections, borescope investigations within brick wall cavities, representative hammer tap surveys, and hand-pressure tests of windows and sunshade elements to determine their overall integrity.

The facades were primarily accessed using industrial rope access techniques (abseiling) to allow a close up inspection of the facade elements. A cherry picker was also used to assess areas of the north wing facades.

Original facade drawings were made available to us by Colin Frame. These drawings were used for annotation purposes. Digital photos were also taken to record our inspection findings.

3.2 Limitations

The works are limited to those described above. This report has been prepared for Northern Sydney Central Coast Health, and shall not be relied upon by any third party. No responsibility is undertaken to any third party in the use of this report.

No detailed calculations or quantitative assessments of the adequacy or compliance of the building to current design codes or the Building Code of Australia (BCA) were carried out as part of this survey, nor was any physical materials testing carried out or enquiries made of statutory authorities in connection with the building. No statistical analysis was undertaken in the determination of trends noted.

Note that while all reasonable effort was made to access all areas of each façade, some areas were difficult to closely access. These locations are typically located at the very top of each façade, where cantilevered roof slabs exist and rope angles are tight and hence lateral manoeuvres are difficult. In these locations we attempted to visually identify defective brickwork and windows at the edges of every bay.

Whilst this report is based on a reasonably detailed visual inspection of the facades of the building shown to us and described in this report, we do not purport to have discovered or seen hidden defects or every structural condition in existence and such this should not be inferred from the descriptions or photographs forming this report.

The inspection has been made with only representative removal of any parts of the facade and has been limited to areas where reasonable and safe access is available.

Arup's services do not extend to advising on asbestos and Arup shall have no liability for any claims arising out of or in connection with asbestos.

4 Findings

The following sections describe the general condition and defects found during our investigation. Referenced photographs considered to be particularly relevant taken during the visual inspections are tabulated in Appendix B.

4.1 Brick Walls & Brick Infill Panels

These areas include the infill panels bounded by windows, columns, and slabs, and the full height brick panels at the end of each wing. In each case the panels include double skin cavity construction.

4.1.1 Brick Ties

Borescope investigation (Fig B1-1) within the brick cavity revealed that a significant portion of the brick ties suffer from varying degrees of surface corrosion (Fig B1-3 – B1-7), and fixing corrosion (Fig B1-5). During the inspections brick ties were often visible through eroded mortar joints (Fig B1-2).

The investigations also showed that the brickwork piers are often disengaged from the external brickwork skin (Fig B1-8), with ties only apparent to the pier in several locations. In some locations, brick ties appear to have become disengaged, or were never engaged, from the brick wall's outer skin (Fig B1-3, and B1-6).

4.1.2 Brickwork

The corrosion of the fixings and support brackets of the windows in some areas have resulted in the fracture of some of the brickwork in locations throughout the building (Fig B1-9 – B1-11).

Poor connection between both outer and inner skins of the brickwork (possibly due to disengaged brick ties and piers) have resulted in significant wall peeling and displacement of the outer skin (Fig B1-12 – B1-17) on a top panel on the western elevation of the northern wing, and the end of the panel on the western wing.

The mortar joints of the brickwork in most areas are severely deteriorated and in some areas the lack of mortar bedding has resulted in the misalignment of brick joints (Fig B1-18). Brickwork in low lying areas adjacent to the northern wing car park has experienced significant sideways displacement of bricks (Fig B1-19 and B1-20).

Brickwork discoloration is evident in some sections possibly due to boiler soot (Atkinson Capital Insight Report Date 29/09/2003) (Fig B1-21). Previous localised repairs to mortar joints with silicone are also present on the western wing (Fig B1-22). Some areas of the bricks on the western wing have also suffered extensive surface erosion (fretting) (Fig B1-23 and B1-24).

The lack of mortar bedding in some areas have resulted in the loss of structural integrity (Fig B1-25, B1-27, B1-29 and B1-30), and bricks can be physically removed by hand (Fig B1-26). Repaired sections of brickworks have been noticed on the northern wing (Fig B1-31).

4.2 Windows & Louvres

The fixed awning and double-hung type windows and louvres that exist at Mona Vale Hospital comprise glass and aluminium materials and are typically constructed by fixing the frame into the masonry brickwork, and concrete columns and slabs.

The joints between the windows sub frame and rough opening are then usually filled with sealant.

4.2.1 Typical

Some of the aluminium louvres have suffered extensive impact damage (Figure B2-1). Nearly all of them are extensively marked with pitted edges (Figure B2-2).

Corroded louvre fixings have resulted in some louvre blades being detached and loose (Figure B2-2).

In general the louvre blades all suffer from a mild level of surface corrosion (Figure B2-3 – B2-4).

At some locations the louvre/window fixings have detached from the supporting concrete structure (Figure B2-3 – B2-4). However the frame work appears to be structurally sound.

The mild steel fixings used to affix the frame work onto the structure appear to be suffering from a mild level of surface corrosion (Fig B2-5).

Most of the aluminium framed windows suffer from a mild level of surface corrosion (Figure B2.6 – B2-7). Some framing joints are marked with pitted joints (Figure B2-7).

Most of the aluminium rivets and barrel pins of the hinges are suffering from corrosion despite being replaced (Figure B2-8 and B2-9). In some cases hinge screws are also missing (Figure 2-10).

The eastern elevation of the northern wing has sash windows which appear to be new, however the framing appears to be sagging (B2-11).

The glazing films on some glazing panes in the northern wing also appear to be in very poor condition (Figure B2-12 and B2-13). In the same location some window joints have suffered from extreme corrosion and are loose (Figure B2-14) or have completely detached (Figure B2-15).

At the same location some window sections no longer have a functional fly screen protection (Fig 2-16).

The majority of windows have had some form of 'remedial' sealant applied to presumably address extensive water penetration issues over the years.

4.2.2 Fire Stair Curtain Wall

The curtain wall to the fire stairs on the west facade of the western wing shows excessive movement when lateral force is applied by hand (Fig B2-17 and B2-18). This is especially evident in the top side possibly due to the placement of a stabilisation bracket only at the landing (Fig B2-19).

Most of the aluminium beads, trims and hinges are in poor condition and no longer perform well. Displaced trims and beads are often visible in typical areas.

4.2.3 Tower Curtain Wall

Most of the aluminium hinges and trims are in poor condition and no longer perform well (Fig B2-23 – B2-28). The hinges appear to be corroding in most areas, and in some areas the hinges have been removed and the windows have been permanently fixed to the window frame (Fig B2-23 – B-26).

Some areas of the tower curtain wall appear to have triple hinged sashes only held by two hinges (Fig B2-27 – B2-28).

Extensive 'remedial' sealant applications also exist across the tower curtain wall interfaces.

4.3 Sunshades

Sunshades exist on the northern wing of the main building. All sunshades suffer from a mild level of surface corrosion (Fig B3-1 –B3-13). Some louvres and trims which form part of the sunshade systems have experienced impact damage (Fig B3-1) and are loose (Fig B3-1, B3-2 and B3-3). In some cases the louvre elements of the sunshade system are completely missing (Figure B3-4).

The fixings (pins) of the sunshades systems have also experienced a mild level of surface corrosion both externally (Fig B3-5 – B3-9) and internally (Fig B3-10 and B3-11). However, the majority of the sunshades, though not operable, appear to currently be structurally stable (Fig B3-12).

The mild steel fixings on the sunshades appear to be suffering from extensive corrosion (Fig B3-13).

The mid span fixings of the sunshade systems are fixed onto brickwork panels (Fig B3-14).

4.4 Rendered Beams & Columns

A large portion of a rendered column on the northern wing has suffered from a significant loss of column render (Fig B4-1 and B4-2). The majority of the remaining render has been pinned (Fig B4-1, B4-3 – B4-5), however a large portion of the render still suffers from drumminess. However the vertical and some horizontal pins have been incorrectly placed at render joints (Fig B4-1 and B4-4)

Some portions of the render present extensive surface cracking formations (Fig B4-4, B4-6 and B4-7).

Render detachment was also noticed on the south wing near the emergency ward; however this section of the render has not been pinned (Fig 4-8). It should also be noted that the exposed concrete appears to have a smooth surface on the south wing.

4.5 Roof Areas

The Nuralite waterproof membrane system on the northern wing roof has some patched areas (Fig B5-2). It should be noted that Nuralite is known to contain asbestos.

The lower roof of the western elevation of the northern wing has significant areas of water pooling present (Fig B5-3 and B5-4).

Bimetallic corrosion was present in many areas of the roof sheeting on the western wing (Fig B5-5 and B5-6).

The parapet capping on the western wing had both structural damage (Fig B5-7 and B5-8), and displaced flashing (Fig B5-8). While walking on the sheeting it was noticed there appeared to be localised detachment of the Klip-lok roof sheeting.

Other areas of concern on the roof sheeting of the western wing include surface corrosion of the exhaust ducting (Fig B5-9), patched areas around ducting (Fig B5-10), and gutters experiencing both water pooling and corrosion (Fig B5-11).

The lower roof of the northern elevation of the western wing had some areas which had both displaced and damaged flashings (Fig B5-12).

Surface corrosion and paint de-lamination was present on RHS beams on the main tower (Fig B5-13). Severe edge corrosion (possibly bi-metallic) and paint de-lamination on the roofing of the main tower was also present (Fig B5-14 and B5-15).

4.6 Plant Room & Metal Cladding

The metallic sheet cladding appears to be coated with polyurethane or similar coating and generally appears to be in good condition (Fig B6-1 and B6-2).

The expanded mesh and the structural beams on the underside of the metallic sheet cladding appear to be in poor condition. The mild steel edge fixings used with the expanded mesh appear to have suffered from extensive surface corrosion (Fig B6-4, B6-5, B6-8 and B6-9). The mesh in some areas appear to be loose, while in other areas the mesh appears to be sagging down due to the corroded edge fixings (Fig B6-3 and B6-4).

Most of the structural beams suffer from an extensive amount of surface corrosion especially on the bottom flange (Figure B6-5 and B-6).

Some of the mosaic-tiled areas are drummy, and in some locations (especially around the corroding beams) areas of the mosaic-tiles have completely detached from the substrate (Fig B6-5 and B-6). It should be noted that the exposed substrate also appears to have a smooth surface.

4.7 Reinforced Concrete Retaining Wall

Though not part of the facade of the main building the reinforced concrete retaining wall and reinforced concrete balustrades are suffering from corrosion of the reinforcement (Fig B7-1 and B7-2), resulting in concrete spalling in some areas (Fig B7-3 and B7-4).

Some elements of the steel balustrade have severely corroded (Fig B7-5). Other areas of concern are the bubbling and peeling of the painted finish.

4.8 Tiled Facade

Generally this area of the facade is in good condition (Fig B8-1), however some titles do show cracking of the gloss finish (Fig B8-2), and some tiles and sealant joints have cracking (Fig B8-3 and B8-4).

Patch work was present on the column beam beneath the tiled façade (Fig B8-5. The mosaic-tiles cladding the structural columns are cracked in some locations (Fig B8-6).

4.9 Miscellaneous

During the inspections other areas of concern have been noticed. These include missing (Fig B9-1 and B9-2) or damaged fascia (Fig B9-3 and B9-4) on the northern wing.

The structural elements (RHS) on the eastern elevation northern wing supporting the awning appear to be corroding (Fig B9-5 and B9-6).

Air conditioning support brackets and fixings on the northern wing appear to be severely corroding and in need of urgent attention (Fig B9-7).

Rainwater pipe corrosion (Figure B9-8) was also noticed and need to be addressed to prevent unnecessary water pooling and facade damage in the future.

Other items noticed include failed ducting fittings (Fig B9-9) on the northern wing, incorrectly installed (missing structural bracket) air condition system (Fig B9-10), and corroding light fitting systems on the roof (Fig B9-11). It should be noted that the air condition unit shown in Fig B9-10 has resulted in a permanently open window sash.

5 Discussion

The building facades at Mona Vale Hospital are generally in poor condition, with questionable remaining structural integrity in some locations. Work is required in many areas to mitigate current public liability risks associated with continued unmitigated deterioration and detachment of facade materials.

The following sections discuss the causes and prognosis for the defects found and considers options for remediation that generally adopt the following strategies:

1. Stabilisation – Minimising the risk of detachment or collapse by stabilising the facade. Generally this is the cheapest strategy, but does not address the underlying causes and hence often the shortest residual life.
2. Conservation – Applying measures to stabilise the facade and also increasing the durability of existing material. This potentially provides increased residual lifespan.
3. Restoration – Carrying out work that restores deteriorated components back to their original intended condition. This approach is typically relatively costly as it is labour intensive but provides a residual life span that matches that of the original construction.
4. Replacement – Complete removal of the existing components and replacement with appropriate alternatives. This is likely to result in the greatest improvement in performance and durability but is typically associated with the higher cost. Note that it may not be more expensive than restoration, depending on the extent of restoration and replacement options being considered.

Based on our visual inspection and assessment we have also highlighted areas of the façade requiring immediate and imminent attention as shown on drawings included in Appendix A. These drawings exclude windows, louvres and sunshades.

- The red areas represent portions of the building envelope that require immediate attention. This represents approximately 15% of the façade area
- The yellow areas represent the portion of the building envelope that requires attention in the short term (3-5 years). This represents approximately 60% of the façade area. It should be noted that no guarantee on the location of these yellow areas can be given as we do not purport to have discovered or seen hidden defects or every structural condition in existence.
- The green areas represent portions of the building envelope that, from observations, appear to be in fair condition and would require normal levels of maintenance and ongoing monitoring. These areas appear to have had remedial works recently done.

5.1 Brick walls & Brick Infill Panels

Cavity wall construction relies on the following attributes for overall system strength:

- Good quality bricks, held together by good quality mortar.
- Two skins of brick with a space (or cavity) between them.
- Effective ties at appropriate locations to tie the two skins together.
- Depending on the geometry of the panels (and whether the brick supports windows etc) brick piers may be required to stiffen the panels.

Figures B1-5 to B1-8 shows a distinct change in mortar composition between the outer and inner skin. The outer skins appear to be lighter in colour, which could indicate greater lime content. However the inner skin appears to be darker, indicating a cement rich mortar.

The choice of mortar variation could be attributed towards achieving the desired external aesthetic requirements (close colour matching between the brickwork and mortar).

The extremely poor and variable current condition of the brickwork panels are a result of either the high lime content (of the external skin) mortar used during initial construction, possibly combined with poor construction and QA measures employed with respect to the brick ties and brick piers.

This has resulted in the progressive erosion of the external mortar beds, in some cases to the point where the mortar no longer exists and bricks are simply stacked.

Correspondingly, where brick ties appear to have been originally installed correctly the effectiveness of the bond into the variably deteriorated mortar bed is now questionable.

There are also many locations where existing brick ties are ineffective due to never having had engagement in the outer skin, or have been bedded into piers that are not engaged into the outer skin (i.e. the piers are not physically 'interlocked' with the main panel).

Furthermore, the high porosity of the mortar together with the loss of the mortar is allowing increased salty aerosols (i.e. sea spray laden air) into the cavity. This is in turn causing corrosion of the existing ties.

In a few areas attempts (focussing solely on the mortar) have been made to reinstate the mortar to improve the condition. In our opinion this really only provides a cosmetic fix, although we acknowledge that it may also reduce the risk of individual bricks detaching from the panels.

Our concern with this approach is that it does not address the overall stability of the panel as a whole by providing additional tying to the inner skin.

The mild steel fixings and brackets used for attaching the window frames to the surrounding structure have also begun to corrode due to the salty environment. This corrosion results in significant volume expansions which have resulted in brickwork fracture in some areas. Any remedial options will need to address reinstatement of these fixings.

Options for remediation include:

1. **Stabilisation** – Given the very poor state of the brickwork we do not believe stabilisation alone is currently a viable option.
2. **Conservation** – Given the very poor state of the brickwork we do not believe conservation alone is currently a viable option.
3. **Restoration** – Restoration would involve removal and rebuilding of the outer skin while retaining the inner skin and providing additional brick ties. At the same time the condition and integrity of the inner skin can be assessed. In this option it may be possible to retain the existing bricks for re-use to minimise costs. Such work could be carried out from fixed or suspended scaffolds operating progressively around the building.
4. **Replacement** – Replacement could include removal of the outer skin and replacement with a framed cladding system, while retaining the inner skin. A system of steel studs, insulation, vapours barriers and external cladding (such as aluminium or steel panels) could be considered.

Another replacement strategy would be to consider a holistic replacement where brick panels and windows are replaced in their entirety with a panelised curtain wall system. This offers superior quality and durability, but at the expense of major disruption, possibly requiring staged shut-down of the building.

With any of the strategies, we recommend that a trial be carried out of the repair to establish methods and hence increase cost certainty of the final work. This will also aid in reducing construction stage technical risks.

5.2 Windows & Louvres

The fixed, awning, and double-hung windows and louvres are typically constructed by fixing the frame work into the masonry brickwork and concrete columns and slabs. Due to the extremely poor condition of the brickwork (discussed in section 5.1) in most areas of the main building the structural integrity of the window and louvre systems is of concern.

Detached window and louvre frames were noticed during the inspection. This could be associated with the fact that no sub-frame assembly was installed to allow for building movements.

Localised severe fixing and framing bracket corrosion was noticed during the inspection. The brick fracture noticed in the area could propagate in the future throughout the building if internal fixing and bracket corrosion noticed is consistent throughout the building.

To gain further insight into the structural integrity of the fixings and framing brackets it would be useful to select a few brickwork panels and completely remove the outer skin to visually inspect the window frame work and fixings.

Due to the close proximity to the beach front, the majority of the louvres and window framing exhibit extensive surface corrosion. The louvres and framing joints are marked with pitted edges.

The pitted joints highlight a further problem in that the condition of the internal fixings could also be affected.

The fixings have suffered from a large amount of corrosion and in some cases this has resulted in framing detachment at some joints, complete detachment of window components, and louvre detachment from the framing.

The detached elements of the framing highlight a potential hazard in the fact that during high wind loads, detachment of loose facade elements could become a public safety hazard.

The window panes affixed with hinges with missing or corroded screws and hinges, pose a potential safety hazard to the public.

The detached elements highlighted in some cases form part of the fall protection system (Fig B2-15) for those areas. These elements need to be urgently reattached to minimise risk of persons falling from height and the potential public liability issue.

The sagging of the aluminium framing of the eastern elevation of the northern wing is possibly due to the incorrect engineering sizing of the aluminium frame.

The fire stair curtain wall suffers from extensive moment when pushed by hand. There appears to be a 'remedial' stabilisation bracket on the landing, however none near the top side of the stair well. The engagement of the 'new' bracket to the curtain wall is suspect. To minimise public liability exposure this area needs to be immediately fenced off until an appropriate short term engineering solution can be implemented to stabilise the curtain wall system.

The curtain wall along the tower appears to be in extremely poor condition primarily due to corrosion and poor secondary construction ('remedial' works) methods employed.

Options for remediation include:

1. **Stabilisation** – Due to the corrosion of the hinge fixings and louvre fixings, stabilisation remedial solutions would involve the replacement of all hinge joints (barrel pins) with new stainless steel systems.

   In addition all the corroded and loose louvre blades fixings should be replaced with new anodised aluminium pop rivets. Missing fall protection elements of the window framing need to be reinstalled to minimise public liability claims.

   As part of the stabilisation works the excessive movement of the curtain wall along the stair well needs to be addressed, possibly through the addition of a stabilisation bracket near the top side of the stair.

   The displaced and damaged gaskets, trims and beads in the window and louvre frame systems need to be replaced. The adoption of this remedial solution would ensure that all the window/louvre frame systems will have a fresh seal from the natural elements.

   Stabilisation work could be carried out from fixed or suspended scaffolds operating progressively around the building.

2. **Conservation** – As above.

3. **Restoration** – Restoration works of the window/louvre systems could see all the window systems being restored into their original operational state.

   This could also incorporate the replacement of glass panes with deteriorating glazing films.

   The previously operable sashes that have been screw fixed shut could be fitted with stainless steel hinges to restore the original functionality of these sashes. These works like with the stabilisation and conservation approaches could be completed from fixed or suspended scaffolds which could operate around the building.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

4. **Replacement** – As most of the window systems are structurally sound (with the exception of fixing brackets), the performance improvement of the individual replacements may not justify the cost involved. However this is subject to essential works outlined in section 5.1 (restoration) and the above mentioned stabilisation works being carried out.

   However replacement could be considered simultaneously with the brickwork replacement strategy (outlined 5.1) which would see a panelised curtain wall system incorporating functionality of the old brickwork and window systems. This offers superior quality and durability, but at the expense of major disruption, possibly required staged shut-down of the building.

5.3 Sunshades

The sunshade facade elements, like the windows and louvres, also suffer from a mild level of surface corrosion. The louvre elements of the sunshade system are also detached from their framing member due to the corrosion of the fixings. As discussed in section 5.2 these loose areas need to be addressed to minimise public liability.

Structurally the sunshades appear to be stable, despite no longer being operable and suffering from surface corrosion both internally and externally. However, the mid span fixings of the sunshade systems are affixed to the brickwork panels which as previously mentioned are extremely poor structural condition.

At heavy wind loads these mid span fixings could fail due to the progressive erosion of the mortar bedding resulting in the brickwork being no longer structural.

The issues raised above with regards to the sunshades also need to be addressed urgently to minimise potential safety risks and public liability issues.

Options for sunshade remediation include:

1. **Stabilisation** – The associated louvre fixings could be replaced with new anodised aluminium pop rivets and stainless steel fixings.

   If panel by panel outer skin brickwork is the choice of remediation for the brickwork panels, then careful attention needs to be given to the mid-span fixings of the sunshade systems. These fixings transfer the proportional wind load of the systems back to the building structure through the outer skin.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

   An alternative solution would be the complete removal of the sunshade systems.

2. **Conservation** – Apart from the works mentioned under stabilisation, monitoring of the sunshade fixings would need to be conducted and appropriately replaced.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

3. **Restoration** – The majority of the sunshade systems are no longer operable. Restoration works would involve the above mentioned works, plus the restoration of the operable parts of the sunshade system. As the system is considerably old, the parts may no longer be available, and thus customised parts would need to be fabricated at an extra cost.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

4. **Replacement** – Integrated operable sunshade systems could be considered for the northern and western elevations of the main building if a panelised curtain wall system is opted for as outlined in section 5.1. This however is subject to the intended use of these areas internally.

5.4 Rendered Beams & Columns

The rendered areas appear to be drummy in most areas; however most areas appear to be in structurally stable due to the pinning. However, some pinning has occurred at render joints especially in the vertical direction. Pinning should be done keeping in mind appropriate edge distance from joint locations.

Overall whilst currently stable, these rendered areas should be further stabilised and repaired to prevent further deterioration which could eventually result in potential detachment and public liability.

Some cracking through the render possibly due to thermal movements and shrinkage is evident throughout. These areas over time may become an area of concern due to water penetration through the cracks. Thus these areas would need to be patched up to prevent potential structural corrosion of the reinforcement within the concrete beams and columns.

Two large portions of dislodged render were noticed. These areas are now potential water penetration path ways, and can eventually result in structural corrosion of the reinforced beams.

The exposed columns appear to be very smooth in appearance. Ideally the substrate should be rough to allow for greater surface area for the 'keying' of the outer render. The smooth areas could explain why despite pinning a significant portion of render still appears to be drummy.

Options for render remediation include:

1. **Stabilisation** – Cracked and spalling areas of render need to be patched, and repainted.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

2. **Conservation** – The above mentioned works along with pinning of drummy rendered areas. These areas also need to be continually monitored as to address any further cracking and drumminess.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building. Monitoring could be done through industrial rope access or with the aid of a cherry picker.

3. **Restoration** – The restoration of the rendered areas are not really appropriate as the render appears to be structurally sound and in relatively good condition. This is however subject to the above mentioned works being carried out.

4. **Replacement** – Replacement works do not need to be considered, if the above mentioned works are carried out, however these areas can be replaced or overclad during works outlined in section 5.1.

5.5 Roof Areas

The roofing areas of the south elevation appear to be in good condition (Fig B5-1). In general the roof areas of both the south and the east wings also appear to be in relatively good condition.

The localised circular pattern corrosion on the roof sheeting of the western wing indicates bimetallic corrosion. The non-compatible adjoining metals need to be separated to prevent further localised corrosion around the fittings.

The edge corrosion of the roof sheets of both the northern wing and the main tower need to be treated to prevent further corrosion damage.

The damaged parapet capping and displaced flashing provides pathways for water penetration into the substrate which in turn will result in corrosion and damage of the substrate. As a result these areas will need to be addressed to minimise secondary damage of the structure.

A mild level of surface corrosion was noticed on the structural RHS members on the main tower roof. To minimise the level of corrosion damage these areas will need to be treated for rust.

The pooling, corrosion and structural damage needs to be addressed to prevent further damage to both the internal finishes and facade elements.

Options for remediation include:

1. **Stabilisation** – Stabilisation works would involve the replacement of compatible fittings for roof sheeting to minimise bimetallic corrosion between fitting and roof sheet.

   The ends of the roof sheeting on the main roofs need to be replaced to prevent further corrosion.

   Remedial works should be carried out to repair the displaced and damaged parapet capping and flashings.

   Rust treatment to the RHS members on the main tower roof is also required. Apart from this rust treatment to the main tower roofing and the western wing roof needs to be done.

   Consideration should be given to the application of a compatible coating on to the Nurolite membrane on the northern wing. This would continue to prolong the life of the existing membrane. Prior to application small sectional patch work areas should be done to evaluate the bonding performance of the proposed water proof coating and the Nurolite membrane.

2. **Conservation** – As above
3. **Restoration** – Apart from the above mentioned works, water logging issues could also be addressed along with the restoration works to include falls for appropriate water drainage on all roof levels.
4. **Replacement** – The inspections did not highlight any need for roofing replacement, however this option could be considered in conjunction with replacement works specified in section 5.1.

5.6 Plant Room & Metal Cladding

In general the metal facade cladding on the main tower appeared to be good condition.

However, the structural beams below the metal cladding are in extremely poor condition due to corrosion. This is especially evident in the lower flanges of the members.

Due to the structural loads imposed on these members and the level of current corrosion urgent rust treatment works would need to be done on these members to minimise risk of failure and associated public liability issues.

Extremely corroded mild steel fixings were also noticed during the inspection. These fixings structurally hold up the horizontal expanded mesh. Due to the extensive corrosion of the mild steel fixings the expanding mesh is sagging severely in some areas. These fixings need to be urgently replaced to minimise the risk of detachment and public liability issues.

Drummy mosaic tiles were also noticed during the inspection. These tiles would eventually need to be replaced to minimise public liability due to possible detachment.

Options for remediation include:

1. **Stabilisation** – Due to the extremely corroded state of the structural beams below the metal cladding, rust treatment would need to be done to stabilise the corrosion rate of the beams.

   The fixings holding the expanded mesh have also suffered severe corrosion and needs to be replaced with stainless steel fittings. This would also address the sagging of the expanded mesh and minimise the public liability issues associated with this.

   Due to the drumminess of the tiled mosaic cladding, these areas would need to be regularly inspected, tap tested, and loose tiles removed.

   Such works could be carried out from fixed or suspended scaffolds operating progressively around the building.

2. **Conservation** – As above.

3. **Restoration** – In addition to the above works, the tiled mosaic cladding would need to be replaced to minimise public liability.

4. **Replacement** – In conjunction with the replacement works described in section 5.1, the replacement of the mosaic tiles and expanded mesh could be considered.

5.7 Reinforced Concrete Retaining Wall

Sections of the reinforced concrete retaining wall are suffering from advanced internal corroding of the reinforcing steel. The corrosion of the steel results in drastic volumetric expansion of the steel resulting in spalling of the concrete.

The spalled areas allow for more reinforcing steel to be exposed to natural elements and in turn the corrosion of the reinforcing steel at an increasing rate. In order to prevent structural failure of some parts of the retaining wall, the corroded steel sections would need to be treated for rust before carrying out localised concrete repairs.

It was also noticed that the steel balustrades were also extremely corroded. The exposed edges of the balustrade pose a significant H&S hazard (for infants and young children). This needs to be addressed to minimise potential risk of people falling and public liability issues.

It was also noticed the paint was bubbling and peeling in many areas. This is possibly due to the fact that the current paint finish was applied directly over the old paint finishes. The old paint should have been scraped off before a new coat was added.

Options for remediation include:

1. **Stabilisation** – The stabilisation works would involve rust treatment of the reinforcing bars in the concrete retaining wall and also on the steel balustrade.

   Apart from the above all the spalling concrete areas would need to be patched up and the entire retaining wall and balustrade repainted.

   Due to the extent of corrosion damage present on the retaining wall it would be necessary to continue monitoring the retaining wall to observe any further damage.

2. **Conservation** – As above.

3. **Restoration** – If the required stabilisation works are done promptly and results of the monitoring to follow do not yield any drastic corrosion growth rates restoration works are not deemed necessary.

4. **Replacement** – Due to the extent of the damage of the steel balustrades it would be advisable to replace these balustrades with stainless steel wire balustrade system.

5.8 Tiled Facade

The tiled facade section appears to be generally in good condition. Some tiles have shown signs of gloss cracking; however, these cracks do not pose any problem structurally.

The sealant joints however show some signs of deterioration (cracking). The sealant between the tiles is necessary to ensure that water penetration through the joints is minimised. Water penetration through the joints could result in the erosion of the bonding material between the tiled facade and the underlying substrate. As a result these sealant joints need to be addressed through the remedial works to minimise potential future deterioration and public liability due to a dislodged tile.

The cracks on the column beneath the tiled facade are possibly due to thermal movements and shrinkage. These areas over time may become an area of concern due to water penetration through the cracks. Thus these areas would need to be patched up to prevent structural corrosion of the reinforcing steel in the columns.

Options for remediation include:

1. **Stabilisation** – The cracked concrete areas below the tiled facade would need to be repaired.

   Works should involve the application of new sealant joints between the tiles.

   Such works could be carried out from fixed or suspended scaffolds operating progressively along the tiled facade.

2. **Conservation** – As above.

3. **Restoration** – If the required stabilisation works and conservation works are carried out in a suitable timeframe and ongoing monitoring of the façade does not yield any areas of concern, then restoration works are not deemed necessary.

4. **Replacement** – Along with the works specified in section 5.1 it may be advisable to replace the entire tiled facade to match the aesthetics of the new facade system.

5.9 Miscellaneous

A variety of miscellaneous observations were noted during the inspections. The missing and damaged fascia on the northern wing poses a significant concern as these exposed and damaged areas are pathways for water penetration into the substrate. Due to the porous nature of the concrete substrate, water penetration can result in the corrosion of reinforcing steel.

A severe level of surface corrosion was noticed on the structural RHS members on the eastern elevation of the northern wing. To minimise the level of corrosion damage these areas will need to be treated for rust.

A number of air conditioning units with extremely corroded brackets were noticed. Due to the weight of these units, these extremely corroded brackets need to be replaced to minimise risk associated with the falling from the facade and associated public liability issues.

Corroded rain water pipes were also noticed during the inspection, these pipes would also need to be replaced to prevent uncontrolled water flow, unnecessary water pooling, which could result in water penetration through some elements of the facade.

Failed exhaust fan fittings were noticed on the northern wing. As a result this fan's functionality is compromised and thus urgently needs to be fixed back on the support structure.

An air conditioning unit without structural brackets was noticed on the western wing. Due to the weight of this unit, the installation of a proper structural support system is required to minimise public liability.

Corroded light fixings were also noticed on the western roof. The level of corrosion was only mild and primarily on the surface.

Options for remediation include:

1. **Stabilisation** – The stabilisation works required on the variety of miscellaneous items picked up during the inspection include:
    - Replacement of the missing fascia on the western elevation of the northern wing.
    - Replacement of the damaged fascia on the western elevation of the northern wing.
    - Rust treatment of the structural RHS members on the eastern elevation of the northern wing.
    - Replacement of the structural members holding up the air conditioning unit on the northern wing (B9-7 and B-9-8).
    - Correct installation of air conditioning units on the western wing (Fig B9-10). It would also be advisable to remove the awning sash window and to replace it with a fixed sash window of an appropriate size to suit the air conditioning system.
    - Replacement of the corroded water drainage ducting.
    - Re-installation of the exhaust ducting on the northern wing.

2. **Conservation** – Apart from the above, the light fixing brackets on the roof of the western wing should be replaced with stainless steel / aluminium fixings as part of the conservation works.
3. **Restoration** – If the required stabilisation works and conservation works are carried out in a suitable timeframe and ongoing monitoring of the facade does not yield any areas of concern, then restoration works are not deemed necessary.
4. **Replacement** – Along with the major replacement works outlined in section 5.1 it would be advisable to incorporate new fascia, structural members, central air conditioning systems into the new system, and exhaust and ducting requirements of the hospital.

6 Conclusion & Recommendations

The Mona Vale hospital building facade is approximately 50 years old and is in a generally poor condition.

Based on our findings and the discussion presented in section 5 it is imperative that nearly all the areas of the main building facade require remedial / refurbishment works to be undertaken. Thus work will be required to mitigate the current public liability risks and to return the building envelope to a fair condition which can be economically maintained.

Due to the variation in condition and functionality of the facade elements, four refurbishment options (which are described in section 5.1-5.9) could be pursed as illustrated in the table below:

	Period Inspections	Initial Costs	Value
Stabilisation	Frequent	Low	Low
Conservation	Moderate	Moderate	Low
Restoration	Moderate	Moderate to High	Moderate
Replacement	In-Frequent	High	High

*Given in increasing order of hierarchical risk

From the above table it can be seen that the Stabilisation works represent the bare minimum refurbishment which need to be undertaken to minimise the risk of detachment of facade elements.

This option would be the cheapest option, from a short term point of view. As this option does not address the underlying causes of the failure it hence offers the shortest residual life, and thus periodic inspections would need to be carried out at least every years. This option will not address the occupational comfort issues of both the hospital staff and its patients. It would be expected that remedial work would be required on a frequent basis to maintain the building elements and continued deterioration occurs.

The conservation works is a low level intermediate approach to facade refurbishment. These works generally increase the residual lifespan of the facade elements. However, periodic inspection would still need to occur approximately every 3 years. The initial costs required will be slightly more than the stabilisation works outlined however could be still considered as low when compared to the other options outlined. Similar to the stabilisation works, this option will minimise the public liability issues associated with the facade elements.

No significant improvement of the occupational comfort will result in adoption of conservation works. Reduced remedial works would be required on an ongoing basis at least for the short to medium term.

The restoration works outlined in the previous section will restore the facade elements back to their original functional state. These works will further increase the residual lifespan of the facade elements. But this in turn increases the initial costs associated with the repairs but will extend the time span between periodic inspections and further remedial work.

The final classification of works, replacement, offers the highest level of performance improvement and durability. However this sort of work is generally associated with a high level of initial cost. Periodic inspections will be the lowest of the four outlined options as the replacement elements can be selected to suit the environmental conditions present at the location and stringent QA measures can be enforced to minimise structural and aesthetic deterioration.

The new facade systems should be designed to maximise overall energy efficiency of the building. Thus when cost is considered over a longer time frame, based on the less frequent inspections required, the greater energy efficiency and the lower ongoing maintenance costs, this option in our opinion should be thoroughly investigated.

Based on our visual inspection and assessment we have also highlighted areas of the façade requiring immediate and imminent attention as shown on drawings included in Appendix A. These drawings exclude windows, louvres and sunshades.

- The red areas represent portions of the building envelope that require immediate attention. This represents approximately 15% of the façade area
- The yellow areas represent the portion of the building envelope that requires attention in the short term (up to ½ years). This represents approximately 60% of the façade area. It should be noted that no guarantee on the location of these areas can be given as we do not purport to have discovered or seen hidden defects or every structural condition in existence.
- The green areas represent portions of the building envelope that, from observations, appear to be in fair condition and would require normal levels of maintenance and ongoing monitoring. These areas appear to have had remedial works recently done.

If refurbishment is to be considered for the building then our limited observations of the structural elements of the building would appear to indicate that these elements are in fair to good condition and would support this refurbishment process without the structure requiring significant remedial work. This should be reviewed with a greater focus if refurbishment is considered and may include:

- Condition of structural elements
- Likely useful life of the structural elements

In addition it is worth considering if the facility is still functional and does it satisfy its intended use (i.e. as a hospital) with regard to is layout, internal condition, location of facilities, ability to be re-configured, adaptable etc.

7 Budget Estimates

Budget estimates have been sought from RM Watson (RMW), a specialist remedial building contractor with experience in the type of work recommended above.

These estimates are based on a combination of the stabilisation and conservation works discussed for windows/louvers. In addition, the red and yellow areas marked on drawings in Appendix A.

7.1 Contract Works

RMW have advised the following budget rates for the proposed immediate and imminent works:

7.1.1 Immediate Works

Façade areas requiring immediate attention are marked in red on elevation drawings included in Appendix A. In addition stabilisation and conservation works discussed for windows/louvers and sunshades are also included.

Brickwork

Demolish and rebuild brickwork using a combination of cherry picker and scaffold access [redacted]

Windows & Louvres

Time allowance per window to resecure, reseal, etc. $ [redacted]

Sunshades

Time allowance to install new fixings, angles, etc, to make sunshade blades and framing safe and secure as required $ [redacted]

Beams & Columns

Remove any loose render, make safe and paint wall behind to match colour of existing finish $ [redacted]

Plant Room

Treat and coat steel, refix mesh, prepare, reinforce and encapsulate tiles with a compatible membrane - $ 27,000.00 + GST

Concrete Retaining Wall

Break out, prepare and patch 750 litres of spalling concrete, prepare and coat concrete, prepare and paint rusting balustrade $ 62,000.00 + GST

Miscellaneous Works

Replace missing fascia, reinstall air conditioning units, replace corroded drainage $ [redacted]

TOTAL $ [redacted]

7.1.2 Imminent Works (3-5 years)

Façade areas requiring immediate attention are marked in yellow on elevation drawings included in Appendix A. In addition, stabilisation works discussed for the tiled façade.

Brickwork

Repoint remaining brickwork, install 5,000 Cintec ties using a combination of cherry picker and scaffold access [redacted]

Concrete Retaining Wall

Remove existing balustrade, patch concrete and install 4 strands of stainless steel wire per opening [redacted]

Nuralite Membrane

Install safety rails, remove capping, strip and dispose of asbestos roof membrane, lay 2 layer torch on membrane with new capping [redacted]

Tiled Façade

Cut out and reseal flexible joints $ [redacted]

TOTAL [redacted]

A preliminaries cost should be added to both stages of the works to cover site establishment, supervision, administration and safety.

The cost would depend on the duration of the works and the amount of work undertaken at the time. We believe that a figure equal to [redacted] would be a reasonable inclusion.

The figures listed above are based on the following assumptions:

- Programme estimate is 6 to 8 weeks for each of the North, East and West elevations of the northern wing, and 4 to 6 weeks for each of the North and South elevations of the western wing. Works to the plant room areas are included in this programme estimate.
- Allowance has been made for the possibility that the existing Nuralite membrane includes hazardous materials such as asbestos. This is currently a 'best guess' estimate as specialist contractors would need to provide further input on this.
- Project preliminaries can be reduced if all works were undertaken as one whole project rather than individual scopes. We believe that savings in the order of [redacted] may be achievable.
- A contingency of approximately [redacted] needs to also be included.
- It should be noted that the above costs do not include consultancy costs and fees (i.e. design, project management, superintendency). An extra [redacted] should be included for design and project management and [redacted] for superintendency.

We therefore recommend that the budgets listed above be put aside, to account for the works for both immediate and imminent works.

Please note that these figures are indicative of order of cost only, and if greater confidence of costs is required, these should be confirmed either by an experienced quantity surveyor or by formally calling for tenders based on a detailed works specification.