Preliminary Building Envelope, Structural and Space Optimization Study
Canadian Chancery,
Nairobi, Kenya

Final Submission
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rdh
Rounthwaite Dick & Hadley Architects Inc.

in association with:

ARUP
London, UK - Toronto, CAN - Gabarone, Botswana

TRIAD ARCHITECTS
Nairobi, Kenya

HOWARD HUMPHREYS (EAST AFRICA) LTD.
Nairobi, Kenya

PINCHIN ENVIROMENTAL LTD.
Mississauga, CAN

YMR PARTNERSHIP QUANTITY SURVEYORS
Nairobi, Kenya

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Executive Summary

1. Background

Rounthwaite Dick & Hadley Architects Inc. have been commissioned by Foreign Affairs and International Trade Canada to provide a preliminary architectural and engineering study of the Canadian Chancery in Nairobi, Kenya.

Terms of Reference for the study were provided in the Statement of Work of the Request for Proposal ARP-NROBI-AESVC-10122/B (August 11, 2011), the statement of Work for Structural Evaluation (December 19, 2011), and the Statement of Work for Physical Security (January 13, 2012).

2. Organization of the Report

This report is organized in seven parts in accordance with its principal objectives:

Part 1: Building Condition Report
Part 2: Mould Related Issues
Part 3: Space Optimization Requirements
Part 4: Building Envelope Upgrade Requirements
Part 5: Structural Assessment
Part 6: Project Phasing Plan
Part 7: Conceptual (indicative) Construction Cost Estimate

3. Conclusions and Recommendations Summary

3.1 Building Conditions – Architectural

Hundreds of concrete shrinkage cracks mar the exterior appearance of the building. These are not considered to be structurally significant and, to-date, have only been a minor source of water infiltration.

The roofing assembly incorporates muliple deficiences. Water infiltration adjacent to roof drains is evident at virtually all roof terraces. Replacement of the roofing is recommended.

Exterior walls are uninsulated, roof assemblies are only minimally insulated and, curtainwall and windows are not double-glazed. In order to upgrade exterior aesthetics and to improve energy performance recommendations include re-cladding of the building with an insulated rainscreen assembly, and reglazing with sealed insulating units. Skylights are leaking and require major refurbishment or replacement. The building interiors, including partitions, doors and frames, wall finishes, ceilings, and millwork are in very good condition in general.

Carpet flooring requires wholesale replacement.

Parking garage water proofing repair is required at cracks in the concrete slab.

3.2 Building Conditions – Structural

The structural elements of the building are in generally sound condition; however, large cracks exist in several areas including a large horizontal crack at the underside of the second floor at the northwest corner and large cracks in the third floor edge beam at the front facade.

Cracks in the reinforced concrete structure are also evident in the parking level floor slab, the basement retaining walls, the sub-basement shear walls. These cracks are not of concern with respect to structural integrity but should be repaired, particularly where water infiltration is occurring (or can be anticipated); i.e. at the underside of the second floor slab at the northwest corner, at the third floor edge beam at the front façade, at the basement retaining wall adjacent to the swimming pool, and at the parking level slab.

3.3 Building Conditions – Mechanical

The building HVAC systems appear to have been designed in accordance with the National Building Code, ASHRAE, SMACNA, and NFPA. The systems appear to have been installed to a reasonable standard of quality but there are very significant concerns with the original commissioning of the systems. Many areas of the building are routinely too cold, too warm, lack adequate air circulation, and lack appropriate control.

Recommendations for the HVAC system include:

- Checking and calibration of temperature sensors.
- Long term monitoring of chilled water temperatures at air handling units.
- Provision of a ducted return air system from each floor level to the air handling units
- Rebalancing of the hydronic system.
- Rebalancing of the air distribution system.
- Review of control sequences in the Building Automation System.
- Inspection of VAV unit dampers and controls.

In order to safeguard air quality, building debris should be removed from the bottom of return air shafts, storage should be removed from the mechanical plant room (which currently functions as a return air plenum), the washer/dryer should be removed from the mechanical plant room or direct exhaust should be provided, and the return air path should be separated from the elevator machine room.

Plumbing and drainage systems are generally in good condition; however, there is no water treatment system, chemical testing of borehole water should be provided, and the non-functioning solar hot water system requires re-commissioning.

The septic tank system is currently overflowing and sewage is contaminating the adjacent floodplain and river. A sewage treatment system is recommended.

3.4 Building Conditions – Electrical

Several deficiencies were noted in the building's electrical systems:

- The switchgear does not have waterproof guards to protect it from discharge of the sprinkler system.
- Battery pack emergency lights in the switchgear room should be re-wired.
- Illumination in the transformer room is inadequate.
- The transformer temperature alarm should be reconfigured to extend to a

remote monitored location such as the main guard house and to provide a signal which is distinct from the fire alarm system.

- Receptacles over wash basins should be replaced with GFCI outlets.
- PVC conduit should be removed and replaced with steel conduit.
- Loose cables should be enclosed in steel conduit.
- Wallwash downlights should be rotated to wash the walls.
- The dimming system in Meeting Room 118 is not functioning.
- The central lighting control system is functionally problematic and difficult to use.
- The indicators for the security air lock monitoring system should be relocated to a monitored location.
- The lighting protection and grounding system should be tested annually.
- The fuel line to the generators day tank is leaking.
- Aload bank connection should be provided for the generator to permit running at full load at intervals to prolong the generator's life expectancy.
- A central on line double conversion UPS should be provided to remove the requirement of maintenance of local UPS's at workstations.

3.5 Building Conditions – Fire Protection

The sprinkler system appears to be in good working order and is tested quarterly. Nonetheless, it is important to provide a tamper switch at the isolation valve at the pipe connection from the swimming pool. It is also recommended that sprinkler piping be painted red for identification.

The clean agent (dry) fire suppression system in the 2nd floor server room should be tested regularly.

The Edwards fire alarm system is apparently functioning despite annunciation of "fault" status. It is noted that there is apparently no Edwards agent in Kenya nor companies which are familiar with Edwards products. Regular testing and maintenance visits by overseas Edwards personnel should be organized or the control panel and devices should be replaced with locally – supported products as part of the retrofit program.

3.6 Building Conditions – Vertical Transportation

No deficiencies were observed in respect of the single exiting hydraulic elevator; however, it has been reported that the elevator does not reliably re-set automatically following power interruptions.

3.7 Building Conditions – Building Grounds

The building grounds are in general very well maintained and beautifully landscaped. There are, however, problems associated with the ramp to the immigration area and the ramp to the swimming pool. Neither has been designed to meet barrier free requirements of CSA B651-04 or the National Building Code in respect of requirements for floor surface, handrails, guardrails, and intermediate landings. In addition, concrete walls of the immigration ramp are marred by the same extensive cracking as the main building walls and, at both ramps, the floors have settled differentially from upstand walls and retaining walls.

3.8 Mould Related Issues

Isolated locations of mould growth were identified by the Indoor Air Quality Investigation dated November 16, 2009. Our review indicates that this is not a widespread problem but, rather, is limited to a few areas of water infiltration including a burst pipe flood event in March 2004.

3.9 Space Optimization Requirements

DFAIT intend that there will be interior alterations to the Ground, Second, and Third Floor levels of the Chancery to accommodate approximately 34 new employees. The existing exterior immigration waiting area is to be enclosed and the existing exterior reception area is to be enclosed.

Our study concludes that there are no exceptional or extenuating factors which would preclude the alterations program. There will be no significant impact on existing exiting or life safety provisions. There is sufficient spare capacity in the existing electrical systems. There is sufficient capacity in the existing HVAC plant to accommodate the increase in occupancy when the proposed improvements to glazing, insulation of exterior walls, and insulation of the roof areas are also considered. (Please refer to Item (3.10 below.)

3.10 Architectural Building Envelope Upgrades

Architectural building envelope improvements are proposed to incorporate the following elements:

- Replacement of the existing single-glazing of windows and curtainwall with hermetically sealed double glazed units.
- Provision of insulation and vapour retarder to the exterior side of existing uninsulated exterior walls.
- Provision of a lightweight exterior cladding, such as fibre cement panels, at all exposed façade surfaces.
- Replacement of the existing exterior plaster soffits at overhangs with ventilating grillage.
- Replacement of the existing flat inverted roof assemblies with a conventional roofing system incorporating higher insulation values and drainage slopes.
- Replacement of existing flashings and copings at roof curbs and parpets with new flashings and copings.

The improvements are intended to substantially improve thermal performance and weatherability. In addition they are intended to improve exterior aesthetics by concealing the existing stains and multitude of cracks in the exterior walls.

3.11 Physical Security Upgrades

Proposed improvements to the physical security aspects of the building involve the window and curtainwall assemblies and address the building envelope's resilience against bomb-blast threats as well as forced entry resistance.

Proposed physical security improvements include the following principal elements:

- Replacement of the north eastern lobby curtain wall framing and glazing, including new structural steel reinforcement.
- Replacement of existing ribbon windows at the third floor northeast eleva-

tion and the provision of steel plate to the block knee walls below the windows.

- Replacement of the vertical strip windows at the two stairwells at the northeast elevation including glazing, framing and new doors.
- Replacement of the existing glazing at all other exterior facades (northwest, southwest and southeast elevations). Existing aluminum window frames at these locations are proposed to be maintained.
- Improvement to force protection at the lower portion of the northeast curtainwall through the provision of a new security fence or, alternately, the provision of a layer of internal secondary glazing.
- Provision of anti-shatter film to internal glazed partitions.
- Replacement of skylight glazing and framing.

3.12 Structural Assessment

A structural assessment has been carried out to evaluate the building performance in respect of the National Building Code of Canada 2010. More particularly, this analysis is in consideration of the Chancery as a post-disaster facility capable of continuing operations immediately following an earthquake. Gravity loads and lateral loads were analyzed.

The building has capacity to resist the relevant gravity loads with the exception of one area on each floor level, from the basement to the roof. These areas require either strengthening or limitation of imposed loads. The areas are identified in Section 5.7.1.

The building will require structural strengthening retrofit work to meet the Immediate Occupancy requirements of NBCC 2010.

A preliminary scope of the retrofit work is illustrated in Sections 5.8.1, 5.8.2, and 5.8.3. This involves:

- Shear Walls and Cores: Thickening of concrete walls and addition of concrete boundary elements.
- Diaphragms: Provision of steel drag plates between lateral elements.
- Foundations: Enlarging the footings and installation of micropiles, rock anchors, or helical screw anchors.

It must be noted that the retrofit work is potentially disruptive to ongoing Chancery operations, particularly, work associated with exit stair shafts. It is recommended that future analysis will include a Probabilistic Seismic Hazard Assessment, a Site Geotechnical Investigation, and Non-Linear Time History Analysis. These will be valuable for refining design parameters for the detailed design of the retrofit, and for assessing design options as required to define the least disruptive design solutions.

3.13 Project Phasing

A preliminary phasing plan for the retrofit and fit-up work has been developed. This involves 10 successive stages and a project duration of 24 months.

The phasing plan involves the following assumptions:

- Chancery operations will be ongoing throughout the construction stages and no functions will be relocated off-site.
- Temporary security and life safety work will be provided to permit safe on-going occupancy.
- A tolerance for noise intrusion will be required. The most disruptive activities will be scheduled for nights and weekends but it is impractical to suggest that the work can be performed within a 24 month timeframe without major ongoing construction activity during normal work-day hours.

Significant abbreviation of the 24-month construction timeframe can only be achieved if a significant proportion of Chancery functions is temporarily located offsite.

3.14 Conceptual (Indicative) Construction Cost Estimate

A conceptual (indicative) construction cost estimate has been provided in Part 7 of the report. This breaks out the major cost components into the following groupings:

7.1 Rectification of Deficiencies
7.2 Mould Abatement
7.3 Space Optimization Requirements
7.4 Building Envelope Upgrade Requirements
7.5 Seismic Upgrade Requirements
7.6 Program Total

Part 1
Building Condition Report for
Canadian Chancery Nairobi, Kenya
Limuru Road, Gigiri, Nairobi

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Part 1. Building Condition Report

1.1 Executive Summary

1.1.1 Introduction

The building Condition Report identifies deficiencies in the Chancery's assemblies, buildings and systems. Findings are based on visual observations made in May, June and November, 2012 and from discussions with the building operators and users.

Previous structural test reports were reviewed and new structural investigations were carried out. These, however, are not extensively addressed in the Building Condition Report but, rather, are reviewed in Part 5 – Structural Assessment of this report.

1.1.2 Site Description

The Chancery site is located in Gigiri, a suburban, primarily diplomatic enclave in Nairobi. The property is located on the west side of Limuru Road, a major suburban arterial. The site is a steeply sloping ravine property. The Thigiri River and its narrow alluvial plain are on the west side of the property. These are part of a natural reserve known as the Gigiri forest. Properties to the immediate north and south of the Chancery are currently undeveloped steeply sloping woodland. The Rwanda High Commission occupies a nearby site to the north. The extensive grounds of the Kenya Technical Teachers College face the Chancery on the east side of Limuru Road.

The Chancery building, occupies a gross floor area of 4076 am. The current site area totals 20,234 sm. The newly acquired property on the south side of the chancery has an area of 11,393 sm.

1.1.3 Construction Details

The Chancery building consists of 3 floors above grade, a basement level which accommodates CBS parking, workshops, storage, and the Canada Club, and a sub-basement level which accommodates mechanical equipment, electrical equipment and storage.

The building structure is composed of cast-in-place reinforced concrete slabs, columns, shafts and shear walls which are founded on spread footings. Exterior walls above grade are non-structural cast-in-place reinforced concrete with a cementitous coating.

Due to the sloping contours of the site, the basement and sub-basement levels are above grade on the southwest side. The basement and sub-basement walls on the northeast, northwest, and southeast sides of the building are retaining walls.
Distinctive features of the building include a terraced massing, large radius corners, and deep projecting overhangs.

1.1.4 Previous Repairs and Upgrades

Previous repairs and upgrades at the Chancery have included a re-working of the roof assemblies, replacement of basement light fittings, replacement of a number of exterior light fittings, the provision of a thatched roof shade structure on the swimming pool deck, replacement of carpet in limited areas, various minor interior alterations, pipe repair work, and replacement of the parking garage doors.

1.1.5 Significant and Urgent Work

The Report Summary Tables classify recommendations for rectification of deficiencies into Short, Medium and Long Term categories. It is recommended, nonetheless, that all work items be organized into a single phased work program. This is recommended with an overriding perception that costs will be minimized and disruption to occupants will be minimized if all work items are planned on a sequential area-by-area basis rather than a needs basis. Rectification of building deficiencies should be integrated with building envelope, physical security, structural, and fit-up work.

1.1.6 Cost Analysis

Line item costs estimates are provided on the BCR Report Summary Tables. For a comprehensive summary of cost estimates please refer to Part-7 – Conceptual (Indicative) Construction Cost Estimate.

1.2 Specific Property Information

The building was constructed over the Years 2000 to 2003. There have been no significant additions or changes of use.

The building was originally designed for 111 staff members. As reported by the acting MCO, the building now serves a fluctuation complement of 150 to 170 occupants.

1.3 Building Structure

1.3.1 Overview

Please refer to the following Report Summary Table for the Building Structure. Cracks in reinforced concrete and masonry are identified as well as other structural deficiencies. It must be noted that these are not considered to be of concern with respect to the structural integrity of the building.

Repair of cracks and other cited deficiencies are recommended at locations where water infiltration is presently occurring and where water infiltration may be anticipated. These locations include the underside of the second floor slab at the north-west corner (at gridline 7 between grids D and E), at the third floor edge beam at the front façade, at the basement retaining wall adjacent to the swimming pool, and at the parking level slab.

For an analysis of structural conditions please refer to Part 5 – Structural Assessment.

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Structure	Columns	Basement Parking Columns L/7, E/7, F/7, G/7	Radial Cracks seen emanating from columns. The cracks looked like to be from flexural stresses.					1.1	BS-7, BS-8, BS-9, BS-10
Structure	Parapets / Façade	Building Exterior	Cracks seen on the parapet wall / façade. This was common observation all-round the structure. Diagonal cracks observed originating from the bottom window corners, radiating away from the window at 3rd floor level. The wall with the windows, sit on a cantilevered floor slab. Most probably the cantilevered slab deflection exceeded the allowable deflection for the wall finishes (plaster) to take without cracking.					1.2	BS-11
Structure	Foundation Walls	Electrical Room, Sub Basement	Cracks seen on retaining wall on Grid N/7-8. This was a common occurrence on all the retaining walls.					1.3.1	BS-4
		Men's Changing Room, Basement	Cracks seen on tile of retaining wall on Grid 4/D					1.3.2	BS-12
Structure	Shear Walls	Sub-Basement shear walls	Vertical cracks similar to those on the retaining walls observed.					1.4	N/A
Structure	Floor Slabs	Basement	Many cracks seen on the basement floor. This could be due to load of heavy cars / vehicles on slab (most of the vehicles were 4 wheel drive). On car park 22, near grid line E wall, major cracks seen					1.5.1	BS-1 BS-2
		Basement Electrical Room & Sub-basement Electrical Room	Large cracks on slab directly under heavy transformer (3.1 tonnes service load) on slab. Cracks seen underneath this slab from the lower level.					1.5.2	BS-5 BS-6
		Sub-basement Storage Area	Cracks seen on slab soffit directly below the wash bay. Efflorescence visible at the cracks. It appears water is penetrating through the slab from the wash bay / parking. It appears that the water proofing adopted during construction is not fully effective.					1.5.3	BS-13

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
		At all water points	Efflorescence was visible at the slab soffit directly below all exterior water points at the terraces. The water proofing provided during construction did not appear to be fully effective. At some locations, the water points have been permanently removed / blocked due to this water penetration through the slab issue.					1.5.4	N/A
		Slab directly below masonry partition walls	From the sub- basement, continuous cracks were visible running across the building directly under the masonry partition walls.					1.5.5	N/A
Structure	Masonry Wall	Sub-basement and basement, junctions between masonry and concrete wall / columns	Vertical Cracks on the junctions where concrete wall meet masonry walls. This may be due to differential thermal movements at the interface between the concrete and the masonry. It appears the keyed jointing between the concrete and the masonry does not fully dissipate the thermal stresses at the materials' interface. At the sub-basement slab-on-grade, the cracks from the concrete / masonry interface extended into the floor slab. Where a floor contraction /construction joint was provided at the same location as the wall material interface, the wall cracks were disappearing into the floor joints without cracking the slab-on-grade.					1.6.1	BS-15 BS-16
		Sub-basement Electrical Room,	Vertical Cracks on wall. This was a common observation on all retaining walls.					1.6.2	BS-17 BS-18
Structure	Swimming Pool	Sub-basement slab soffit	Heavy Efflorescence and paint pilling-off on retaining wall next to the swimming pool. It appears there is water proofing issues on this wall.					1.7	BS-3 BS-14
Structure	Roof		Access to the roof was denied. The Commission officials promised to take measurements / photos of the equipment on the roof but that was not accomplished.						

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Structure	Dimensions	Building length, width, storey heights, grid lines and structural elements sizes.	All measurements were as per the structural drawings						
Structure	Dimensions	Building length, width, storey heights, grid lines and structural elements sizes.	All measurements were as per the structural drawings						

1.4 Building Envelope

1.4.1 Exterior Walls

The exterior appearance of the building is marred by hundreds of small and hairline cracks in exterior walls. In addition black stains are prevalent at the tops of wall areas and at crack locations.

The wall assemblies consist of windload bearing cast-in-place reinforced concrete with a white cementitious coating which has a trade name of "Glitterlite". Due consideration was given as to whether the cracks exist solely in the coating or whether the cracks penetrate the thickness of the concrete walls. We have concluded that the cracks, in general, extend through the thickness of the reinforced concrete. This conclusion is based on the following factors:

- Sounding of the walls near the cracks indicates that the coating has not debonded from the walls. The coating, in fact, appears very securely bonded to the walls.
- Previous core samples indicate that the cracks which were thus examined do extend through the concrete thickness. Certain of these cores have not been infilled. It was visually confirmed by the study team that the cracks at the core locations did extend through the thickness of the concrete.
- Joseph Gathi, Maintenance and Operations Supervisor, has advised that he was present on the construction site when the cracks first appeared. He has advised the study team that the cracks appeared shortly after the formwork was stripped. This strongly suggests that the cracks are shrinkage cracks which developed as the concrete cured.
- The structural details indicate that the 200 mm thick walls are reinforced with a single wythe of reinforcing such that the concrete cover has a thickness of 90 to 95 mm over the reinforcing. This great depth of cover is believed to have contributed to the conditions that would have led to shrinkage cracking during the cure period.
- Mr. Gathi also advised that a few trial repairs were made and that the cracks recurred after the repairs. The study team examined the repairs and noted that the concrete had been routed out on both sides of the crack, infilled with grout, and re-coated. The recurrence of the cracks strongly indicates that they extend, at least, a significant depth into the concrete. The crack recurrence also strongly suggests that expansion and contraction forces alternately close and open them. The walls are fully exposed to solar and thermal conditions which, through the course of 24 hours, cycle the walls through significant temperature variations and, thus, to the related expansion and contraction forces.

We have considered an idea that the coating could be chipped off the face of the concrete and re-applied with a much tighter spacing of control joints. This idea could be tested. We have concluded, however, in the absence of such a test that the cracks would recur. This, we believe, would be due to the crack depth and the presence of the thermal stresses.

We have concluded that a new lightweight facing material such as fibre cement of metal paneling is needed to provide a long term solution.

It must be noted that the crack problem is considered an aesthetic matter primarily.

They occur predominantly in the face of the overhangs which are a secondary construction. The true exterior walls are considered to be the walls which are inboard of the overhang walls. It is noted that water infiltration through cracks is apparently occurring at a few isolated locations only. Nonetheless, we believe the problem should be rectified as water penetration into the depth of the cracks will contribute to rust formation on the reinforcing steel and, as rusting steel expands in volume, the cracks will increase in size and spalling of the concrete will occur.

The black staining of the concrete at the upper part of walls in apparently due to the fact that the existing roof copings are flush to wall surfaces and do not incorporate a drip. Rain – wetted wall surfaces absorb dust and airborne pollutants and support microbial growth, producing the stains. Cracks in the walls similarly serve to collect dust and pollutants and the resulting stains exaggerate the visual presence of the cracks.

1.4.2 Roof Assemblies

The originally constructed roof assemblies consisted of a ceramic tile finish, laid on a mortar bed, overtop of rigid insulation, and a 2-ply modified bitumen roofing membrane. Due to problems associated with the original construction the ceramic tile was removed and replaced with stone ballast laid overtop of a scrim fabric, overtop of the insulation.

We have noted that in this “inverted” roof assembly the waterproof membrane was laid on a flat slab with no slopes to drain. We have observed, too, that rainwater saturates the insulation and stone strata and is not finding its way to the roof drains.

It also appears that the roofing membrane is not well bonded to roof drains. Water staining is apparent at the underside of the roof slabs adjacent to the drains.

It is also apparent that membrane flashings at curbs and parapets are not, in general, bonded to the roof membrane. Where stone and insulation were lifted adjacent to curbs it appeared that long cuts had been made in the membrane, perhaps at the time of the repair work, and that no attempt had been made to seal the joint or establish a watertight continuity between the roof membrane and the membrane flashings.

The roof areas are only minimally insulated with 40 mm of extruded polystyrene insulation. Due to the equatorial location of the Chancery the roof is considered to be a principal source of heat gain and of the cooling load imposed on the building’s systems. We propose that increased insulation values be incorporated in roof reconstruction. This will serve to offset heat gains associated with a future increased occupant and equipment load and will serve to control future energy costs.

It was also noted that copings at roof parapets consist of thin, tapered-profile, cast-in-place concrete. These were cast without control joints and are riddled with hairline shrinkage cracks.

The proposed new roofing assembly consists of the following components:

- A concrete screed laid on the roof slab to produce positive slopes to drain; this will require raising of the parapets and analysis to determine if the additional load can be safely supported. Alternately, tapered roof insulation should be provided.

- Minimum 100 mm of rigid insulation (average thickness) with a thermal resistance rating in the order of R24.
- Coverboard and 2-ply modified bitumen membrane.
- New 2-ply modified bitumen flashings at curbs and parapets.
- Replacement of stone ballast as a decorative treatment.
- New parapet copings incorporating a drip (or flush if impervious coping and cladding materials are provided).
- Fall restraint anchors should be provided where maintenance access is required for servicing of condensers and similar items.
- Removal and reinstallation of lightining protection will be required at the parapets.

The 2-ply modified bitumen roofing system is recommended as it is durable and resistant to mechanical damage, it requires only a moderate level of workmanship skill, and as it is relatively commonplace in Kenya.

1.4.3 Exterior Windows and Curtainwall

Exterior windows and curtainwall consist of 15 mm tinted single glazing in a commercial aluminum curtainwall system. Although no identifying labels were found, the curtainwall frames are assumed to be manufactured by Kawneer as this is the only manufacturer known to us that still produces a glazing spline (or ”nose”) that is dimensioned for single-glazing.

The windows and curtainwall appeared to be in good condition and did not exhibit evidence of water infiltration or excessive condensation.

As part of a program of upgrading thermal resistance and improving physical security it is recommended that some of the framing will be replaced and that all of the glazing will be replaced with insulating double-glazed units. Please refer to Part 4 of this report.

1.4.4 Skylights

The skylights over the Multipurpose Area and Immigration Waiting Area are very low-sloped and have apparently not been installed in a weathertight manner and have leaked excessively. They have been covered with Perspex (or similar) synthetic glazing material in order to control leakage. This prevented a more detailed review of existing conditions.

The skylight frames appear to be Kawneer 2000 Series as originally specified. This system is designed for sealed double-glazed units but appears to have been adapted, apparently unsuccessfully, for single glazing.

More detailed examination is warranted at a later stage of the work. Our preliminary recommendation is that the glazing should be replaced with sealed double-glazed insulating units under the direction of a trained installer in order that weather seals, gaskets, and flashings will prevent the recurrence of water infiltration. Replacement of the skylight framing should also be seriously considered. This is ain view of physical security considerations as well as the desirability of creating increased glazing slope. The preliminary recommendations for new glazing is an 8mm heat strengthened outer lite, air space, and 12.76mm heat strengthened laminated inner lite(minimum) as required to address physical security concerns. Alternately, replacement of the skylights with a clerestory assembly should be considered.

Report Summary Table									
Category	**Item**	**Location**	**Observation**	**Recommendation**	**Type**	**Term**	**Est. Cost (KShs.)**	**Ref. Section**	**Photo**
Building Envelope	Roof Assembly	Roof over Basement, Ground Floor, 2nd Floor, 3rd Floor	The roof assembly consists of river stone ballast on a scrim fabric, on 40mm extruded polystyrene insulation, on a 2-ply modified bitumen membrane which has been laid on a flat structural concrete slab. There is no drainage slope; rainwater is retained within the insulation and stone strata.	Remove the existing roof assembly. Create drainage slope with screed or tapered insulation. Provide new insulation with minimum average R-20 thermal resistance. Provide new cap sheet and roofing membrane. Replace stone ballast.	B/U	Medium		4.1	BE-1
Building Envelope	Rain water drainage to the roof	Roof over Basement, Ground Floor, 2nd Floor, 3rd Floor	The drain has a flubora head and below the head there are perforations to facilitate drainage into the rain water leaders.	Replace roof drains with type to suit new roof assembly.	B/U	Medium		4.6	BE-2
Building Envelope	Roof Flashings	All roof levels	Membrane flashings are not continuous with the roofing membrane. Cuts in the membrane appear to have been made at some time in the past when the ceramic tile finish was removed from the flat roof areas. Ceramic tile remains as a decorative finish over the membrane flashings but is broken or absent in numerous locations.	Remove all flashings and install new membrane flashings and metal flashings in conjunction with the recommended roofing work.	B/U	Medium		N/A	N/A
Building Envelope	Coping	Top of the building external walling	The coping is gatherings dust and when it rains water drips on the wall with dirt. This stains the wall and creates a medium which enables algae to thrive. This has stained top of wall and parapets giving the building a black stain caused by algae.	Remove the existing cast-in-place concrete copings. Provide new copings incorporating a drip or an alternative method to prevent wall-staining.	B/U	Medium		4.3	BE-3 BE-4
Building Envelope	Roof anchors and Cleaning cradle	All roof areas	No fall-arrest anchors have been provided for the safety of personnel performing maintenance on the roof areas. Upper wall surfaces cannot be easily accessed for cleaning.	Provide a system of fall-arrest roof anchors. Design the system to accommodate a bosun's chair or swingstage	B/U	Medium		4.1	N/A

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Building Envelope	Sky Light glass roof	2nd floor level	The glass roof originally done is leaking and the Building Maintenance team has fixed a Perspex covering making the sky light untidy and in-efficient in lighting the room below.	Remove the old assembly and the current Perspex modification and install a new assembly which is clear and has solar and UV filters.	B/U	Medium		4.5	BE-5
Building Envelope	Windows	Entire Building	Windows and curtainwall are comprised of a capped aluminum curtainwall system with tinted 15mm laminated single-glazing.	Windows and curtainwall are to be upgraded for security and thermal performance in accordance with Part 4 of this study.	B/U	Medium		4.5	BE-2 BE-7 BE-8
Building Envelope	External Finishes	External Wall facing	All external walls of the building are faced with a white cementitious coating (“Glitterlite”). This is well bonded to the reinforced concrete substrate. Control joints are spaced apart very widely and this may have contributed to the development of the hundreds of fine cracks that are visible on the walls; ie. Some of the cracks may be superficial. As evidenced, however, by previous coring and previous re-coating trials it is believed that the majority of the cracks are not superficial and that they cyclically widen and tighten with diurnal solar and thermal conditions.	Re-facing of the external walls of the building is required to restore the building aesthetics and prestigious image.	B/U	Medium		4.3	BE-9 BE-10

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Building Envelope	Cracks through the external walls	External façade	As referenced above, hundreds of fine cracks are evident on the external walls. Previous cores indicate that the cracks thus examined penetrate the full thickness of the 200mm thick reinforced concrete walls. It is reported that the cracks appeared immediately after or soon after the stripping of the original formwork; this strongly suggests that the cracks are shrinkage cracks, which formed as the concrete cured. This observation is further supported by review of the wall construction. The single wythe of reinforcing indicates that there is approximately 90-95mm of concrete cover over the reinforcing. This great depth is believed to have contributed to shrinkage crack development and/or crack development due to thermally induced stresses.	Provide a new rainscreen cladding in the form of lightweight panels such as fibre cement, aluminum, or composite aluminum	B/U			4.3	BE-10 BE-11
Building Envelope	Exterior ramps	External areas	There are cracks which have formed on the corners of this window. Further observation revealed that the cracks continue to extend probably because of possible deflection of the down stand beam above. Rainwater infiltration to the interior rooms is evident.	Structural rectification is apparently required.	B/U	Short		4.3	BE-12

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Building Grounds	Exterior ramps	External areas	Two exterior ramps are of concern in respect of NBC barrier-free requirements. The ramp between the north guardpost and the Immigration loggia requires two intermediate landings in order that there will not be more than 9m between landings. Handrails are also absent. The ramp between the south guardpost and the swimming pool deck / Canadian Club entrance does not meet NBC requirements in respect of slope, landings, guardrails, and handrails. This is not currently considered a concern as an alternate barrier-free path of travel exists from the basement parking area to the Canadian Club. This path will not exist when the parking area is converted to office uses.	Complete redesign and reconstruction of the ramps are required to meet NBC requirements.	B/U	Medium		4.7	BG-1
Building Grounds	Over flowing Septic tank	Back area	The septic tank is overflowing. The septic tank may not be sufficient to handle waste water from the building. Overflow effluent contaminates the adjacent river and floodplain.	The septic system should be upgraded with a treatment plan which meets the occupation and environmental requirements.	ENV	Short		10.1	BG-3
Building Grounds	Boundary wall	Along Limuru road	The wall from observation is stable and does not show signs of weaknesses	General cleaning of the elevation both inside and outside to improve on the facing.	B/U	Medium		10.2	BG-4
Building Grounds	External boundary wall along the river.	Wall along the river	This is a palisade fence. The grounds slopes toward the river making the wall not to be expected to offer physical protection to the building, however as a palisade fence it is secure.	N/A				10.3	BG-5

1.5 Building Interior

1.5.1 Flooring

It is apparent that broadloom carpet throughout the building has not been properly adhered to the concrete slab. It is in a badly rippled and worn condition in approximately one-third of the floor area. It should be replaced throughout the building in conjunction with new fit-up work. Consideration should be given to a commercial carpet tile for the replacement work. Ceramic tile has been proposed by the occupants and this is in consideration of the red iron-rich dust which is routinely tracked into the building. As open office configurations are proposed to predominate in the fit-up program, broadloom carpet or carpet tile are recommended for noise absorption. The provision of entrance mats or grillage is recommended for the Chancery and Immigration entrances.

Polished “Blue Pearl” granite tile is existing in principal entrance and reception areas and honed finish material has apparently been installed in stairwells. Entrance and reception areas are prone to be wetted by incoming pedestrian traffic and remain hazardous for slips and falls despite the application of a slip resistant sealer. It is recommended that the polished granite tile be replaced with a more slip resistant material at locations near the Chancery entrance. We have also considered the possibility of “roughening” the existing granite by shotblast or grinding; in our experience this has not produced aesthetically acceptable results.

1.5.2 Partitions and Wall Finishes

Partitions and Wall Finishes throughout the Chancery are in very good condition. Except for stairwell, washroom, service room and like occupancies, most partitions are demountable type by SMED. These include wood-framed glazed partitions and opaque vinyl covered partitions. Serious consideration may be given to re-use of the demountable partitions in the fit-up work. It is assumed that the vinyl wall covering will need to be replaced in association with partition relocations.

Ceramic tile finishes in washrooms and change rooms are in good condition.

Minor cracking has been observed in isolated locations in gypsum board and concrete block walls. This appears to be related to differential deflection of floor slabs and/or settlement of the slab-on-grade. The defects are considered to be minor aesthetic concerns and do not require significant attention.

1.5.3 Ceiling Finishes

Existing ceilings are, in general, acoustic tile or painted gypsum board. They are in very good condition throughout the building except in isolated locations; i.e. one location of sagging tee bar suspension has been observed and some minor staining is evident adjacent to previous pipe leaks and/or water infiltration. A concern has been raised by the occupants that replacement acoustic tile has been difficult to source. For the fit-up work acoustic tile can be re-used but it is suggested that a significant floor area, such as the third floor will have a new material in order that a quantity of the existing material can be stored for maintenance purposes.

1.5.4 Millwork

Millwork for vanities, counters, and like items are in very good condition except for minor wear and tear associated with 9-10 years of use. Kitchen counters should be provided with knee spaces in accordance with barrier free standards.

1.5.5 Accessories

Washroom accessories and partitions are in good condition. Grab bars in washrooms have not been installed in positions as specified by the National Building Code and should be reinstalled.

1.5.6 Equipment

The Blue Giant dock leveler is inoperational and requires service by a trained technician.

The washer/dryer is at the end of its service life. The dryer currently exhausts to the open volume of the sub-basement mechanical room. It should be relocated and separately vented as the mechanical room serves as a return air plenum.

1.5.7 Mechanical Room Storage

The sub-basement mechanical room is used for furniture storage and for miscellaneous items such as Christmas decorations. It is recommended that these materials be moved to a designated storage room. As the volume of the mechanical room serves as a return air plenum the presence of dust-collecting and combustible materials should be avoided.

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Building Interior	Cracks on the block walls at the basements	Internal wall partitions	From sight the ladder cracks may have resulted due to slab deflection and do not have any structural concern.	Remediation would involve reconstruction of the upper part of the block walls in order to provide a larger flexible deflection joint. This is not recommended, however, as the cracks are a minor aesthetic concern for areas which are not aesthetically important.	B/U	N/A		5.1	BE-13
Building Interior	Broadloom carpet	Ground, 2nd & 3rd Floors	Broadloom carpet throughout the building is worn and is badly rippled at approximately one-third of the carpeted areas. The rippling is apparently due to inadequate adhesion between the carpet and the substrate.	Replace existing carpet with new. Consider ceramic tile finish in leeu of carpet, particularly with respect to the red (iron-rich) dust which is routinely tracked into the building.	B/I	Medium		5.2	
Building Interior	Water damage	Corridor 110	The south wall of this area (adjacent to mechanical shaft) is wet, the drywall appears partially impregnated, and the wallcovering is peeling away. The source of the moisture is most likely to be a minor pipe leak.	Investigate and repair source of leakage; repair drywall and finish.	B/I	Short		5.3	
Building Interior	Dock leveller	Loading Dock	The dock leveller is inoperational	Provide investigation and repair by experienced mechanic.				5.4	
Building Interior	Cracked drywall	Room 315	A fine crack exists in the drywall at the north wall of the room; this telegraphs through the wallcovering. This most likely results from slab deflection and compression of the stud framing.	Rebuild wall to incorporate a nested stud deflection joint.	B/I	Medium		5.5	
Building Interior	Sagging acoustic tile ceiling	MSR Room	The tee bar suspension is sagging at one location within the room.	Install additional wire hanger(s).	B/I	Medium		5.6	

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Building Interior	Polished granite slip resistance	Room 100, 101, 104-107, 109-118, 124, 125, 127-130	These rooms have a polished granite floor finish which, in its natural state, does not meet the slip resistance requirements for the NBC for barrier-free paths of travel. The condition has been improved through the use of a clear sealer which has slip resistance characteristics. Unfortunately, this shows a traffic pattern, requires regular re-application, and remains slippery when wet.	Regular re-application of a slip-resistant sealer, ideally a product that provides greater slip resistance when the surface is wet.	H/S	Short		5.7	
Building Interior	Grab bars	Washrooms B009, B012, 104, 105, 230, and 329	Grab bars are not located in accordance with NBC.	Remove and reposition existing grab bars.	H/S	Medium		5.8	
Building Interior	Kitchen counters	Rooms 119, 223, 318	Counters in these kitchens/coffee stations do not have barrier-free knee spaces in accordance with the BCR Appendix D.	Re-design kitchens to meet barrier-free requirements in concert with future office alterations.	H/S	Medium		5.9	
Building Interior	Appliances	Mechanical Room SB006	Washer and Dryer are near the end of their service life.	Replace with new.	O/R	Medium		5.10	
Building Interior	Mechanical Room Storage	Mechanical Room SB006	Furniture and other combustible items are currently being stored in the Sub-Basement Mechanical Room. As the volume of the room functions as a return air plenum, the room should not be used for storage.	Remove stored materials from mechanical room. If storage space is required, construct new storage room with non-combustible materials; provide room exhaust and sprinklers in accordance with NBC.	O/R	Short		5.11	

1.6 Mechanical Systems

1.6.1 Introduction

The building mechanical systems appear to have been designed to National Building Code & industry best practices (ASHRAE and SMACNA, NFPA). Overall the systems appear to have been installed to a reasonable standard of quality, though there are some specific remedial actions recommended and required below.

There are some issues arising from this utilization of differing standards to the Kenyan norm; specifically a local unfamiliarity with some of the installations which can hamper maintenance. Other issues arise from the building being designed to one set of standards but being forced to utilize equipment designed to a different set of standards. A good example of this is sprinkler coverage of electrical switch rooms as the 415V equipment therein is not designed for installation in a sprinklered location. Mitigating measures for this are discussed in the electrical report.

It should be noted that all observations are based on information & readings taken from sensors and gauges mounted on the existing equipment. Some of these readings appear inconsistent with building performance and, to the extent that the instrumentation is not correctly calibrated, may be erroneous. We have noted where observed readings suggest instrumentation failure or poor calibration within this report.

1.6.2 HVAC System Overview

The HVAC system consists of several zoned air handling units located in a central plant room. The main units for the Chancery (AHU-2, AHU-3 and AHU-4) are variable volume systems, while AHU-1 serving the Canada Club is constant volume type. Ref M1/1 & M1/2. It should be noted that variable volume systems are uncommon in Nairobi. The overall system as-installed appears to be generally in good condition and to meet the requirements of the Chancery; all of the concerns raised appear to be related to the final commissioning of the system and the unavailability of local technical expertise to rectify this.

1.6.3 Central Plant Observations

The central plant for the Chancery consists of four Trane air handling units with cooling provided by two air-cooled chillers (TRANE TRTAB212), which use R134a refrigerant. The air handling units are zoned as follows: AHU-1 is dedicated to the Canadian club; AHU 2 serves the south perimeter zone; AHU-3 serves the internal zone, and AHU-4 the north perimeter zone. AHUs are fitted with Siemens VFDs and VAV terminal units have been provided to allow variable air flow in each zone. The overall central plant installation has been installed to a good standard and is regularly maintained.

The chillers are located in a dedicated room which is ventilated by wall-mounted louvres to promote heat rejection and ventilation of this space. The installation appeared to comply with manufacturer's recommendations for minimum clearances, and no damage to the chiller was observed. Ref M7/1 & M7/2. Each chiller has two cooling circuits for redundancy, and it was noted that one compressor was displaying a stopped error.
The supply & return chilled water temperatures at each AHU were measured during

the May 2012 visit and have been tabulated below:

	May 2012 Visit		
	CHW in (dC)	CHW out (dC)	Delta T (dC)
AHU 1 (Canada Club	16.5	18.5	2
AHU 2 (South)	12.5	12.5	0
AHU 3 (Central)	13.0	14.4	1.5
AHU 4 (North)	12.0	13.5	1.5

Table 1 Temperature Measurements at Air Handling Units (May 2012)

There are concerns with the May 2012 set of data, as the readings were taken around midday on a cool day (mid 20s), the lack of temperature increase across the chilled water coil of AHU-2 suggests a sensor malfunction. Air flow through this unit was observed and did not bypass the coil, thus heat transfer from this coil would have resulted, but the sensors do not pick up the subsequent temperature difference. As a result, we recommend that the sensors on this coil be checked and recalibrated. Second, the high temperatures at AHU-1 suggested one of two things: that either these temperature sensors are poorly calibrated, or that there is damage or water saturation of the insulation on the chilled water pipe to AHU-1. To get a better sense of where the problem lies, a second site visit was conducted in October 2012 where both AHU water and air temperatures (summarized in Table 2, below) and chilled water supply and return temperatures (summarized in Table 3) were measured.

	October 2012 Visit				
	CHW in (dC)	CHW out (dC)	Delta T (dC)	Supply Air (dC)	Return Air (dC)
AHU 1 (Canada Club	12.6	13.9	1.3	16.1	22.5
AHU 2 (South)	8.3	9.7	1.4	16.1	24.2
AHU 3 (Central)	12.4	13.9	1.5	20	24.2
AHU 4 (North)	13	17	4	18.9	22.6

Table 2 Temperature Measurements at Air Handling Units (Oct 2012)

Comparing these two sets of readings, the temperature sensors appear to be poorly calibrated and input from the maintenance staff suggested that this conclusion agreed with their experience. On the second visit, chilled water supply and return temperatures were also measured at each chiller (per Table 3).

	October 2012 Visit	
	CHWS (dC)	CHWR (dC)
Chiller 1	7	13
Chiller 2	10	13

Table 2 Temperature Measurements at Chillers (October 2012)

Measured temperatures at chiller 1 are consistent with the scheduled performance, while chiller 2 was out of service. This indicates that we recommend that the hydronic system be rebalanced to provide each coil with adequate chilled water. Further, the sensors at each AHU should be tested and recalibrated and the insulation on the chilled water lines should be inspected in more detail to identify damaged insulation, which may also be present. Both of these tasks can be completed by the maintenance team.

1.6.4 Air Distribution Observations

Air distribution from the central plantroom is via galvanised steel supply air ducts and builders work plenum shafts for return; the plantroom itself (which appeared to be clean) is used as part of the return air path. Building debris was observed at the bottom of the two return air shafts, indicating a need for cleaning of this area. One return route (from north side) is routed across the lift motor room housing the hydraulic pump and equipment, and this is not recommended as the hydraulic pump is a point source of pollution and can negatively affect air quality in the building.

It was also noted that the plantroom itself, which was generously sized, was being used as storage for various miscellaneous Chancery storage including office furniture and Christmas decorations, which had gathered dust. The entire plant room was being used as a return plenum and thus this is another source of contamination for air quality. Best practice is to avoid storage in any return plenum. Of most concern is the combination washing machine / dryer in the plant room without a dedicated exhaust to the outdoors. By NBC, a direct exhaust from the washer/ dryer is required, and discharge of the exhaust into what is effectively a return air plenum is unacceptable. A dedicated exhaust duct to the outdoors for the dryer is thus strongly recommended. It was noted that the filters in the AHUs appeared to be clean and no indication of low air quality was observed. However during the proposed retrofit, the above issues should be remedied, either by relocating all storage and non-HVAC equipment from the plant room, and by dedicated return air ductwork from the return air shafts directly to the air handling units. Ref M2/1, M2/2, M2/3, M2/4, M3/3.

We noted that the ducts entering the plant room have Fire Dampers operated by fusible links, which thus maintain to maintain the integrity of the air shaft fire separation; this complies with NBC and no action is required regarding these dampers at this time, beyond regular maintenance and inspection per manufacturer's recommendations. Ref M3/1 & M3/2.

During the building walk-through, several issues with air distribution and general temperature control were noted. For example, on the top floor, Offices 325 and 327 were noted to be very cold, and this issue was confirmed by the occupants; Office 323 was very warm and there was poor air circulation; offices 330 and 331 had poor air circulation and a local split unit had been installed to assist thermal comfort. In addition, some diffusers (such as in Office 323) were noisy, indicating excessively high air velocity due to poor balancing of the system. It was also reported that individual controls in the offices had no apparent effect on temperature or ventilation, indicating a fundamental problem with the HVAC controls. Similar complaints of overheating offices adjacent to overcooled ones were reported throughout the building. Ref. M6/2.

The unbalanced thermal comfort is indicative of poor system balancing, and discussions with the maintenance staff indicate that balancing was performed prior to the installation of partitions and with no load in the building. When partitions were put in to create individual offices, the system was not rebalanced and thus offices where a diffuser happened to be placed would be cooled, and where no diffuser was present would be overheating, which is in line with observations. To resolve this, we recommend that the system be re-commissioned in conjunction with the interior retrofit. This will include testing, adjusting and balancing of the HVAC ducts and hydronic distribution systems, review of control sequences in the building automation system, inspection of VAV unit dampers and controls, and testing and recalibration of individual equipment sensors.

1.6.5 Terminal Units

The poor balancing of the system includes poor balancing of terminal units and thus these units should be included in the re-commissioning during the retrofit.
Regarding the temporary split units, these should no longer be required once the re-commissioning is complete and can thus be either re-purposed or stored in case of future need. It should be noted that the refrigerant type in these units could not be determined in our walk-through and if containing CFC's these should be de-commissioned and properly disposed of.

1.6.6 Local Exhaust Systems

As noted in the electrical report, the extract fan in the clean power room was out of service and requires repair. It was also noted that the washroom extract fan in the Canada Club was noisy and requiring servicing. It was also noted that there was no makeup air supply to the washrooms; this could be accommodated by adding door grilles to the doors or by increasing the undercut to the doors to facilitate air transfer.

Mechanical ventilation is provided in the carpark via a soffit-hung Trane AHU. This system is adequate but would require complete replacement should this level be fully enclosed and converted to another purpose.

The extract system for the Canada Club kitchen runs through the carpark. It should be noted that kitchens require exhaust per NBC and best practice, and thus if the car park is re-purposed, this duct will have to be relocated and cannot simply be removed.

1.6.7 Stair Pressurization System

The main staircase is provided with pressurizations fans. There do not appear to be any code requirements for same and we recommend that during the proposed renovation works that the requirement for same be rationalized and if deemed superfluous decommissioned and removed.

1.6.8 Generator Exhaust Flue

We understand that the generator exhaust stack was inverted in the past to due to staff complaints relating to the original discharge location. We recommend that this be rectified during the renovation works.

1.6.9 Plumbing

Overall the plumbing (hot & cold water) system appears to be in good working order and no issues were reported by maintenance staff. The incoming potable water is from the Nairobi City Water and Sewage Company (NCW&SC), but is not considered suitable for drinking as it is stored in the same storage tank as the water from the borehole on the Chancery property. It is not clear from the documentation available or from the site visit what material this underground tank is made from. There is neither any filtration nor any treatment system for either supply, though as mentioned, water from NCW&SC is normally treated at source, although the quality of this treatment is likely to be variable. There is need for regular chemical testing of borehole water. To be carried out Ref M7/3. A suitable water treatment should be provided for the municipal and bore hole water supply.

Sections of domestic water pipework is in galvanized steel and we recommend that were accessible this should be replaced with copper.

It was noted that there is Solar Hot Water system, but it was reported that this was non- functional. As solar water heating is an excellent energy conservation measure in this region, we strongly recommend that this is repaired and re-commissioned to allow its use. Ref M5/4.

The sewage treatment system did not appear to be functioning well: the collection pit was overflowing at the time of the visit, allowing raw sewage to run down the slope and into the local stream. Ref M6/3. Whilst a soak-away system could be installed to mitigate this overflow, provision of a small sewage treatment system would significantly better at protecting the local watershed from contamination. Arup can provide assistance on the procurement of such a system in future stage of design.

1.6.10 Swimming Pool

The swimming pool appeared to be in good working order and no concerns were raised by maintenance staff. The pool water is circulated continuously through a filtration system located in the pool plant room. Ref M5/1. The pool water is heated by means of solar panels located on the roof over second floor and an electric booster heater located in the plant room. Ref M5/2 & M5/3.However, during the site inspection, the floor in the swimming plant was noted to be wet, an indication there could be leakage at some section of pipework, and this problem could possibly be rectified as part of normal maintenance works. According to maintenance staff, the swimming pool is used or available for use by staff on a daily basis and there is regular monitoring of water quality by a dedicated pool attendant.

1.6.11 Conclusions and Recommendations

The following maintenance activities are recommended to be undertaken by the maintenance team at the Chancery:

- Checking and calibration of temperature sensors, and replacement where necessary
- Long-term monitoring of chilled water temperatures at AHUs
- Correct minor issues with exhaust fans and for washrooms and UPS rooms.
- Maintenance to the existing septic treatment system

The following additional tasks are more intensive and recommended to be included in the retrofit scope of work.

- Mechanical plant room should not be used as a return air plenum. Return air ductwork should be ducted directly to the air handling units. There would appear to be sufficient space in the mechanical riser and the plant room to facilitate this.
- Mechanical plant room should not be used as a storage room. Extraneous materials stored in the mechanical plant room should be relocated to a suitable storage area or alternatively partition off an area within the plant room to provide storage space.
- Washer drier should be relocated to a more suitable space and fitted with a suitable exhaust in accordance with NBC requirements.
- Thermal issues will need to be addressed based on proposed internal room layouts, relocating and/or adding VAV boxes and supply diffusers as appropriate, relocating/adding temperature sensors in suitable positions to suit the proposed room layouts.
- BMS system to be rationalized and the associated sequence of controls and calibration of temperature sensors. System to be validated using measured data versus data measured on the program and confirming percentage open of VAV boxes etc.
- Rationalize the requirement for pressurization fans to the staircase and decommission and remove if deemed superfluous.
- Carry out remedial works to generator exhaust stack to eliminate inversion issues and ensure discharge location does not give rise to complaints from staff.
- Rebalancing of hydronic system
- Rebalancing of air distribution systems
- Re-commissioning of solar hot water system
- Replacement of the septic tank system with a larger system or with a new sewage treatment plant to meet demand. Note due consideration to be given to maintenance/training requirements for a new treatment plant.
- Provision of new water treatment system for municipal and bore hole water supply

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	HVAC Cooling System	Basement Plant Room	The HVAC cooling system comprises of 2 Chillers (York) complete with chilled water pumps and distribution pipework. Chilled water is pumped to the Air handling units 1-5. The chillers generally appear to be in good working condition, though circuit one of chiller one was indicating "compressor stopped" condition.	Check Circuit 1 at next service.	B/U	Short	Not applicable - to be handled by in-house maintenance team		MS-21
Mechanical	Refrigerants	Basement Plant Room to serve the Chillers and various locations to serve condensing units for split type air conditioners.	Chilled water system utilizes R134a. The refrigerant used by the split air conditioning units was not indicated on the label at the outdoor unit and could not be confirmed by users at the time of site visit.	Check supply information to ensure refrigerant in split units is acceptable type. Note that recommissioning central plant to achieve full design efficiency should make the split units redundant.	ENV	Short	In-house team to investigate: ultimately defect will be addressed by upgrades elsewhere in HVAC systems.		MS-10
Mechanical	Air Handling Units (AHU) 01-05	Basement Mechanical Room for AHU 01-04 and Car park for AHU 05.	The air handling units (Manufacturer: TRANE) are supplied with outdoor fresh air and return air from the building in pre-determined quantities. Cooling of the fresh air is achieved by conveying the air over cooling coil containing chilled water. The air handling units appeared to be in good working condition, though for AHU 2, there was no significant difference noted between the temperature of return water and that of supply water, giving indication there was no load on this AHU.	Maintenance logs/records should be attached in the vicinity of the AHU plants and Chillers for ease of tracking and reference. Correct proportionate mixing of return air and supply air to be confirmed and regulated for each AHU, depending on demand.	B/U	Short	Not applicable - to be handled by in-house maintenance team		MS-2
Mechanical	Extract Fans	Various locations within building to serve washrooms, Electrical / UPS room, Kitchen	Toilet extract fans were operational. However, significant noise levels were noted at some extract grilles, possibly due to high air velocities. It was noted that there was no grille in the door to allow makeup air to enter easily. The extract fan serving the electrical UPS room was not operational at the time of site visit. The extract fan for the kitchen is no longer in use.	Check cause of excessive noise levels at extract grilles in toilet areas; measure air flow. Install door mounted air transfer grilles, or more simply, undercut the doors by 1". Repair defective fan to UPS room.	B/U	Short	300,000		N/A
Mechanical	Supply Air Ducts	Various locations within building	Supply air ducts are in galvanized mild steel ductwork insulated with mineral wool	None	B/I	N/A	N/A		N/A

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	Return Air Ducts	Basement Mechanical Room, Service Ducts, ceiling plenums	Some portion of the return air duct is in galvanized mild steel. However, the ceiling plenums in the office areas, service ducts and basement room effectively serve as part of the return air duct. The sections of duct work in galvanized steel are in good condition. However, the use of the basement plant room as a store due to it's generous size compromises its use as a return air plenum. The various items of furniture stored therein gather dust etc which is introduced into the return air system. Similarly the routing of the return air through the hydraulic lift motor room risks collecting smells and pollutants associated with hydraulic plant. The service shafts had builders debris inside, indicating they are not cleaned. Finally it was noted that a washing machine was being used in the mechanical plantroom- thus injecting humid, detergent laden air into the return air system.	Whilst there is no clear code violation with this configuration, and the pollutants and dust pickup is upstream of the AHU filters, it is unlikely that this arrangement does anything to improve air quality in the building. Our recommendation is to segregate the return air route by: 1/ installing a ceiling in the LMR over which the return air can pass, isolating to from the lift motor. 2/ Splitting the main mechanical plant room into separate dedicated storage areas and removing the washing machine and all non-HVAC equipment. 3/ cleaning and sealing the builderswork ducts with epoxy paint or similar.	B/U & ENV	Short	Check report for builder's work		MS-3 MS-4 MS-5 MS-6
Mechanical	Supply air and exhaust Grilles	Various locations within building	Supply grilles and return grilles are generally in good condition. There was little or no air supply in some supply registers in the office areas. It was noted that balancing of the air system was carried out before fit-out (partitioning) was complete.	The complete system should be re-balanced; if the cellular office layouts are being altered this should be done after the changes. Central air handling systems do require rebalancing after all but the most minor changes in partition layouts.	B/I	Medium	150,000.00		N/A
Mechanical	Toilet Extract Grilles	Toilet Areas	However, some dust was noted to have accumulated at the extract grilles in toilet areas. Excessive vibration noted in some grilles	Cleaning of extract grilles in toilet areas required	B/I	Short	Not applicable - to be handled by in-house maintenance team		N/A
Mechanical	Ductwork Insulation	Supply air duct and sections of return air duct	Ductwork insulation is in mineral wool. The insulation is generally in good condition	None		N/A			N/A

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	HVAC Controls / Building Management System	Basement Mechanical Room with sensors in the various locations served by the AHUs.	The cooling system is controlled by thermal sensors and variable air volume dampers connected to the controllers of the various air handling units and computerized building management system. The building management system for HVAC system is operational, though the apparent lack of balanced air flow in some offices gives indication of some shortcomings.	Recommission the individual thermostat units and ensure they are controlling the VAV box. Ensure the thermostats controlling the VAV box is in the same room as the supply air grilles.	B/I	Medium	500,000		N/A
Mechanical	Supply fans	Various locations including car park, generator room, fire escape stair wells.	Car park ventilation system comprises supply air fan, ductwork and grilles. The existing car park ventilation arrangement appears adequate. However, the suitability of the system should be reviewed if there is change in use for this area. The stair case pressurization and supply fan for stand-by generator room appear to be in good condition.	Remove the (disused) extract duct system from the kitchen hood in the Canada club as part of any change of use of the carpark.	B/I	N/A	N/A		N/A
Mechanical	Water Supply	Chancery building	The Chancery building receives water from two sources:- Nairobi City Water & Sewerage Company and Onsite borehole. There is no treatment system for borehole water, though staff have been cautioned not to use tap water for drinking purposes	Carry out analysis of borehole water and check if there is need to install any water treatment system to eliminate any corrosive effect on pipework and other equipment. Add notices in all bathrooms and kitchens warning the tap water is not potable; consider putting a local UV water purification unit at kitchen locations and installing a third "potable water" faucet.	B/I	N/A	500,000.00		MS-23
Mechanical	Domestic Water Booster Pumps	Pump Room	The pumping system comprises of 2 No. duty and stand-by automatic horizontal multistage pumps (Grundfos) complete with pressure switch and pressure vessels. The pumps are in good working condition and no concerns were noted from the users.	None	B/I	N/A	N/A		N/A

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	Sanitary Fixtures and accessories (comprising water closets, wash hand basins, hand dryers, mirrors, etc)	Various wet areas within building	Sanitary fixtures appear to be in good condition	Existing routine maintenance programme for pipework should be encouraged. However, maintenance logs should be used for ease of tracking.	B/I	N/A	N/A		N/A
Mechanical	Internal Drainage pipework	Various wet areas and basement pump-room	The UPVC drainage pipework is generally in good condition. There were no reports of leakage / blockage.	Existing routine maintenance programme for pipework should be encouraged. However, maintenance logs should be used for ease of tracking.	B/I	N/A	Not applicable - to be handled by in-house maintenance team		N/A
Mechanical	Septic Tank	Located next to site boundary fronting the river	Septic tank is underground masonry type. Capacity of septic tank could not be confirmed at the time of site visit as the drawings could not be traced. Sewage effluent was noted to be overflowing the manhole for the soak pit. There is no treatment for the sewage.	In short term check cause of overflow and rectify. A second tank in series would increase capacity and improve filtration. Considering the effluent will reach the local stream, provision of a sewage treatment plant should be considered.	B/I & ENV	Short	10,000,000.00		MS-20
Mechanical	Swimming Pool Circulation Pump	Swimming Pool Plant Room	One circulation pump (Type: Onga). Pumps appear to be in good working condition and no concerns were raised by users.	None	B/I	N/A	N/A		N/A
Mechanical	Swimming Pool Water Circulation Pipework	Swimming Pool Plant Room	Pipework for swimming pool water circulation system is in UPVC. At the time of the site visit, some water had pooled on the floor, giving indication of possible leakage from the pipework	Inspect the pipework to find out cause of leakage and rectify	B/I	Short	Not applicable - to be handled by in-house maintenance team		N/A
Mechanical	Swimming Pool Booster Water Heater	Swimming Pool Plant Room	Water heater is made from mild steel and has a series of electric heater elements. Water heater is in good condition, but coupling between the heater and pipework was noted to have rusted externally	Replace the rusted union coupling	B/I	Short	5,000		MS-16

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	Domestic Water Solar water heating	Roof over third floor	System comprises 6 No. thermosiphonic solar water heaters (Type: SOLARHART) complete with panels, cylinders complete with in-built heater elements. The users reported that the thermosiphonic system does not appear to function optimally and they have to perennially make use of the electric heater elements. No maintenance records were on hand.	Organise inspection,. Servicing & recommissioning of the system by a Solahart approved contractor.	B/I	Short	50,000.00		MS-18
Mechanical	Cold Water Distribution Pipework	Various wet areas and basement pump-room	Cold water distribution pipework is made from copper and galvanized mild steel in some areas. Pipework generally in good condition, though some leaks were noted in the mechanical plant room (See Picture 6.	Investigate cause of leakage and replace any damaged pipework sections	B/I	N/A	Not applicable - to be handled by in-house maintenance team		N/A
Mechanical	Pipework Insulation	Chilled water and hot water service pipework	The hot water and chilled water insulation is in mineral wool. For the most part, the insulation is in good condition. However, the integrity of the insulation has deteriorated in some areas.	Remove any damaged sections of the insulation and re-install.	B/I	N/A	Not applicable - to be handled by in-house maintenance team		N/A
Mechanical	Diesel Fuel Tank	Next to car park	The diesel tank is enclosed by masonry housing. Tank is well vented and in good condition	None	B/I	N/A	N/A		N/A
Mechanical	Swimming Pool Solar Water Heating	Roof over second floor	The solar water heating system for swimming pool comprises of plastic panels. Forced water is distributed to the panels and back to the pump via pipework. No maintenance records were on hand.	Carry out regular maintenance. Maintenance logs/records should be prepared for ease of tracking and reference	B/I	Short	Not applicable - to be handled by in-house maintenance team		MS-17
Mechanical	Fire Sprinkler Pumps	Pump Room	The pumping system comprises of 2 No. duty and stand-by electric fire pumps (Make: Patterson) and jockey pump (Make: Grundfos). Pumps appear to be in good working condition and no concerns were raised by users.	None	B/I	N/A	N/A		MS-11
Mechanical	Fire Sprinkler Pipework	Pump Room	Water from the swimming pool is available for the sprinkler system in the event of emergency. The pipe link has failed previously and been replaced in a new location; the tamper valve needs to be extended and recommissioned to the new connection position.	Extend cable to tamper valve; recommission.	B/I	Short	To be handled by service contractor for fire systems (within the budget for maintenace of fire equipment)		MS-14

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Mechanical	External Fire Hydrant	Site. Pipework Connected to fire pumps in the basement and Fire brigade Breeching inlet Hydrants distributed externally	Fire hydrant appears to be in good condition and there is evidence of regular maintenance checks	None	B/I	N/A	N/A		MS-19
Mechanical	Hose reel System	Various locations within building	Hose reel appear to be in good condition. There was evidence of regular maintenance (Quarterly).	None	B/I	N/A	N/A		ES-16
Mechanical	Portable Fire Extinguishers	Various locations within building	Fire Extinguishers appear to be in good condition. There was evidence of regular maintenance checks (Quarterly).	None	B/I	N/A	N/A		MS-24
Mechanical	Wet Sprinkler pipework & Sprayers	Entire Building	The wet sprinkler system covers virtually all areas in the building including electrical rooms i.e. transformer room, switch room, Generator room. In the event of discharge in these areas, there is high probability the equipment will be damaged beyond repair	CHC to consider installing dry fire suppression system in electrical rooms and server room	B/I	Medium	20,000,000.00		N/A

1.7 Electrical Systems

1.7.1 Introduction

It should be noted that the building electrical systems are designed to Canadian Federal Codes (specifically CSA 22.1) as appropriate for overall construction to National Building Code. However the local electrical supply is 415/240v 50Hz derived from previous British electrical standards (IEE wiring regulations). The majority of equipment is designed to British Standard but configured to meet Canadian code. This yields some hybrid situations yet overall the electrical installations appear safe with only minor modifications recommended to reduce some specific hazards.

In some cases both Canadian and local Kenyan (UK-derived) electrical terminology is used in this report to avoid any potential confusion.

1.7.2 Incoming Electrical Supply & Standby Generation

The incoming electrical supply enters at 11kV from Kenya Power Lighting Co Ltd. Utility metering appears to be via wifi connection. Ref E3/2. It is terminated for main building isolation and protection into a GEC-Alsthom Oil switch rated at 12kv which although old (1998) is in reasonable condition. The supply then enters an Emirates transformer rated at 1MVA with a plated manufacture date of 2002. Ref E3/1.The transformer is owned and maintained by Kenya Power Lighting Co Ltd. The oil in the transformer is clean and the transformer is in good condition. Outgoing electrical supply is 415v three-phase four wire 50Hz as standard in Kenya.

There were no reports of adverse incidents due to power supply. Assessing the generator run-time suggest that power supply is relatively ok for the region.
The power quality can be divided into categories such as short interruptions, sags, swells, transients, noise, flicker, harmonic distortion and frequency variations. To assess power quality in more detail a certain set of measurements would have to be completed with power analyzer. These could be performed at a later stage, after the space planning exercise is complete.

Mission is utilizing small UPS-es (650VA) at each work station to counter any above mentioned power issues. Given the presence of both the generator providing full back-up to the facility and the local UPS-es at every work station, it is considered that overall power quality is good at present and have been good (both judged by local rather than western standards) for the life of the building. However, local UPS-es are expensive to maintain and (depending on the type used) may not provide additional power quality for the computers or IT equipment they are supporting. Therefore consideration should be given to replace them with central UPS system. Larger UPS unit will be less expensive to maintain, thus reducing the maintenance budget for the Mission and providing better power quality.

Most of the outlets backed-up with local UPS-es are fed from a harmonic mitigating transformer. That transformer could be replaced with central on-line double conversion UPS. In this case the risers for clean power would be switched over to UPS. Some adjustments would have to be made with respect to the MSR (telephone server) room and DCC (computer server) to prevent a central UPS feeding another UPS (server internal UPS). Two circuits for the 30amp twist lock receptacles in the MSR and DCC server rooms need to be relocated to the nearest regular power panel.

The feeder from the distribution panel to the UPS room would have to be replaced as it does not have a neutral conductor since harmonic mitigating transformer is a delta/wye hookup.

The feeder cabling between the switch and transformer, and from the transformer onto the electrical switchroom is installed in a trench and is tidy and in good order. Lighting within the electrical intake room is via “wellglass” explosion proof luminaires with compact fluorescent lamps. Ref E3/4. These give limited output yet and are of a higher grade of protection than justified for a transformer room. Replacing these with fluorescent fixtures- industrial weatherproof IP54 (wrap around diffuser) twin 4’- would give more appropriate illuminance with no negative impact.

There is an alarm system present which monitors transformer temperature etc. Ref E3/3 It was noted that the alarm indication for this is also located within the room which is unmanned. It was also noted that the bell matched that used by the fire alarm system, which is a code violation: non-life safety alarms should be differentiated. Accordingly one solution could be to extend the alarm circuit to a remote, monitored location and change it to utilize a buzzer or other signal clearly different from the fire alarm. However, given that the transformer is owned by local utility, this action would have to be coordinated with Kenya Power Lighting Co Ltd. Other option would be to simply remove this alarm (since the transformer is rated for outdoor use and the room is ventilated), however that would also have to be approved by Kenya Power Lighting Co Ltd.

The generator room is exceptionally clean for a room of this type. The generator is a Cummins USA unit rated at 895kW standby, 805kW prime. Ref E2/1 & E2/3. The run time indicated is 1,600hours which is commensurate with the good condition of the machine. Ref E2/2. Maintenance records indicate it is maintained quarterly. Overall the room is correct for purpose with dedicated ventilation, fire alarm and day tank complete with low fuel indication.
The generator is configured as 100% backup rather than life safety and the changeover arrangement is for the entire building rather than splitting life safety and other systems on different changeover switches as required by Canadian code. However as critical systems (Fire alarm, emergency lighting) have dedicated local battery backup considering this the systems would appear to meet the intent of the codes. Ref E2/4.

The fuel pipe to the daytank from external connection is run across the ceiling of the electrical switchroom and was leaking at the time of the inspection. Ref E5/4. It is suggested that this is repaired immediately.
As a side note, the capacity of both the main incoming supply and the standby generator are considerably in excess of the maximum demand recorded by the utility meter. This however is not surprising given that calculated demand load as per code is always substantially bigger than the actual demand load recorded after the building is commissioned. Review of some of the electrical data provided indicates a maximum demand of around 220kW, though this would have to be confirmed.

Given the overall satisfactory state of the installation and the fact that he generator is functioning properly, it is recommended that the generator arrangement remains as is, until such time the age or failure of the generator would prompt for replacement.

Ideally, diesel engines should be run at least 60% to 75% of their maximum rated load. Short periods of low load running are permissible providing the set is brought up to full load, or close to full load on a regular basis.

Internal glazing and carbon buildup is due to prolonged periods of running at low speeds or low loads. Running an engine under low loads causes low cylinder pressures and consequent poor piston ring sealing since this relies on the gas pressure to force them against the oil film on the bores to form the seal. Low cylinder pressures cause poor combustion which leads to soot formation and unburnt fuel residues which clogs and gums piston rings; that causes a further drop in sealing efficiency and exacerbates the initial low pressure. Glazing occurs when hot combustion gases blow past the now poorly-sealing piston rings, causing the lubricating oil on the cylinder walls to 'flash burn', creating an enamel-like glaze which smooths the bore and removes the effect of the intricate pattern of honing marks machined into the bore surface which are there to hold oil and return it to the crankcase via the scraper ring.

Hard carbon also forms from poor combustion and this is highly abrasive and scrapes the honing marks on the bores leading to bore polishing, which then leads to increased oil consumption (blue smoking) and yet further loss of pressure, since the oil film trapped in the honing marks is intended to maintain the piston seal and pressures.

Unburnt fuel then leaks past the piston rings and contaminates the lubricating oil. Poor combustion causes the injectors to become clogged with soot, causing further deterioration in combustion and black smoking.

The problem is increased further with the formation of acids in the engine oil caused by condensed water and combustion by-products which would normally boil off at higher temperatures. This acidic build-up in the lubricating oil causes slow but ultimately damaging wear to bearing surfaces.

This cycle of degradation could mean that the engine can become irreversibly damaged and may not start at all and will no longer be able to reach full power when required.

Under-loaded running inevitably causes not only white smoke from unburnt fuel but over time will be joined by blue smoke of burnt lubricating oil leaking past the damaged piston rings, and black smoke caused by damaged injectors. This pollution is normally unacceptable to the authorities and neighbors.

That is why we would suggest for a connection for load bank to be added, rated at 850kW. Load bank would enable running the generator under full load from time to time, as well as testing under full load (normally required once a year).

1.7.3 Electrical Distribution & Power

The main switchroom is clean and tidy. As noted above there is a diesel fuel line running through here that is leaking; this should be repaired immediately.

It was noted that the switchroom was sprinklered generally in compliance with Canadian codes, but the switchgear cubicles did not have sprinkler guards, which are not typically available for standard 415v assemblies (The British derived 415v electrical code would prohibit installation of sprinklers in electrical rooms). Whilst the system as supplied broadly meets with Canadian Electrical code there is an inherent hazard in this hybrid code type of set-up. Mitigating options could be:

- Custom fabrication and installation of drip guards
- Removal of sprinklers from the room & replacement with dry-extinguishing system
- Relocation of sprinklers to corners of room to prevent water being directed onto switchgear (possibly sprinkler heads could be guarded too & upgrade of fire detection system (there is no smoke detection in this room at present)
- Provision of dry powder automatic extinguishers within the panels themselves.

We would suggest that drip guards are installed as most cost effective and practical solution.
In addition, as good engineering practice we would suggest for smoke detectors to be installed in the switchroom to alert to early appearance of fire.

The switchgear itself is ABB and in good condition, though it is understood that there were issues with the original automatic changeover system which necessitated replacement with a Terasaki changeover section. Ref E1/1 & E1/2. The original ABB section remains in situ. The system SLDs installed in the premises have not been updated showing this new section. It is important that as-built information is maintained accurately. The switchboard assembly is rated at 1200Amps.

Emergency lights of the self-contained battery pack type have been retrofitted to the room, however they have been connected to the regular lighting circuit, meaning they are activated when the lights are switched off. The circuits should be rewired with an un-switched feed so they only activate in the event of main supply failure.

There is a harmonic mitigating transformer in the clean power room. As already suggested, this transformer should be replaced with central UPS.
It should be noted that in general from utility figures power quality is reasonable with good power factor (>0.95) and acceptable harmonics (<4%). The transformer is a Mirus unit (Mississauga, ON) manufactured in 2002. The local ventilation is out of service leading to the room being too warm though not unacceptably so. We would suggest that ventilation system is repaired to bring the temperature in the room to more satisfactory levels. If harmonic mitigating transformer is replaced with a central UPS, new air-conditioning unit should be installed.

Final electrical distribution is tidy and generally installed to applicable 415v local codes. Distribution Panels are ABB manufacture using MCBs, and are of 4, 8, 13 & 16amp TP outgoing way configurations. Ref E4/1 & E4/2. Socket outlets are 240v UK square pin 13amp pattern but generally installed on radial circuits. Ref E1/3 & E1/4. It was noted that receptacles (socket outlets) are installed over wash basins in several locations; ideally these should be removed but as there are no alternate receptacles in these washrooms they should be replaced with GFCI (RCD) protected socket outlets or left as is but corresponding circuits protected by 10mA RCD breaker.

Overall electrical labeling is satisfactory although it was not checked whether this has been maintained with any subsequent alterations.

Wiring above the ceiling is generally drawn into a system of conduits; the conduit is a mix of steel and PVC with steel predominating. There are also some cables present clipped loosely; the sheath appears to be PVC without any fire rating. As the ceiling is used as a return air plenum the PVC conduit should be removed and additional steel conduit installed so that all cables are enclosed. In talking with local electrical contractors, galvanized steel conduits in sizes of 25/32/38mm are available in Kenya with proper accessories and junction boxes and can be installed as required.

1.7.4 Lighting Systems

Lighting systems throughout employ energy efficient sources, a mix of linear and compact fluorescent. Overall the lighting systems are adequate and no wholesale upgrade is recommended, though there are specific defects which could be addressed.

In the ground floor meeting room (118) the wall wash downlights were actually installed backwards, i.e. they are angled in to the room. It should be a simple job to rotate them in the ceiling to orientate correctly. It would be worth maintenance staff checking for this throughout, it is evident with this model which way the light should be directed, however it is a reasonable common installation mistake to assume lights should be directed inwards as some sort of performance spotlight rather than aimed at the wall for ambient lighting.
In the same room the lighting is dimmable and this system does not function. It is probably simpler to remove this functionality and replace it with four scene controller.

It was noted that there is a central lighting control system present which is reported to be problematic. It is a relay-based system controlling circuits and has various profiles - Day/ Night/ Weekend which are difficult to use. The solution may be to replace the central system with a local room-based control system, though it should be noted that the presence detector & override switch commonly seen in Canadian buildings is not a readily available 240v product. During the retrofit it should be possible to fit the wall switch & ceiling sensor combinations that are used to give this functionality in 240v markets. Other option would be to replace the current system with a DALI or DALI related control system, c/w occupancy sensors and daylighting sensors. This would however entail replacement of electronic ballasts in most of the fixtures, however the result would be a modern, energy efficient, scalable, flexible, highly controllable and easily maintainable lighting control system.

Emergency exit signs are installed throughout and comply with Canadian codes and also local standards, utilizing commonly available equipment (Crompton & Chloride-Bardic). Both the Canadian standard red “EXIT” word and green pictograms are used; the EXIT signs should be replaced with current NBC green running man pictogram by replacing the lens and/or sticker only. Ref E5/1.

Emergency lighting appears to be generally via self-contained emergency fixtures, ie with integral battery packs. This follows local practice but would also comply with Canadian code.

External lighting is also in good functional condition; poles are 10-12’ (USS, Ontario) with flat glass fixtures. The maintenance staff advised that these were originally supplied at 347v and transformed down, but due to problems with this system they were successfully retrofitted with 240v 50Hz control gear. Ref E5/2.

1.7.5 Miscellaneous Systems

Note that security systems were not included within the scope of the survey. One security related system that was noted is the security airlock monitoring system; the indicators for these (blue & red lights) are currently in a non-monitored location. These should be relocated or additional repeater indicators extended to the security office (or other suitable monitored location).

1.7.6 Lightning Protection & Grounding

A full lightning protection system is provided to CSA standards, which appears to be complete and in good order.

The building is grounded via an earth electrode array which is marshalled at the main earth bar. The lightning protection ground as also correctly bonded here. The system appears to be in good condition though there is no evidence of periodic testing. It is recommended that a test be carried out annually.

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Electrical	Lighting	Groundfloor Meeting Room	Wall wash downlights installed in reverse (shining into room) and also non functional, possibly intentionally to avoid glare.	Rotate lights to correct orientation (facing walls) and re-lamp.	B/I	Short	In-house team		N/A
Electrical	Security	Level 3	Warning lights (duress and both doors open) for airlock doors are in non-monitored location.	Extend repeaters of the two lamps to monitored location; or put interface and connect to telecoms system for remote/ mobile warning	H/S	Short	In House team or DFAIT security contractor?		N/A
Electrical/ Mechanical	Sprinklers	Ground/ B1	Sprinkler heads located in main switchroom, generator room, telecoms room. No smoke detectors in a switchroom	We suggest that drip guards on electrical equipment are installed as most cost effective and practical solution. In addition, as good engineering practice we would suggest for smoke detectors to be installed in the switchroom to alert to early appearance of fire.	B/I	Medium			ES-2
Electrical	Power (receptacles)	Various	Receptacles (Socket outlets) located in close proximity to wash basins.	Remove & blank off or replace with GFI (RCD) protected type or protect with RCD breaker.	H/S	Short	100,000.00		N/A
Electrical	Lighting	Main Utility Transformer Room	Explosion proof "wellglass" type fixtures installed. Excessive specification also provides insufficient illumination.	Replace with regular sealed (IP44) plantroom type of fixture- 4' fluorescent with wireguard .	B/U	Medium	40,000.00		ES-12
Electrical	Alarm System	Main Utility Transformer Room	Bells & strobe for alarm system located over control panel in same transformer room: non monitored location. Also bell is same type (and presumably sound) as fire alarm bell which is not advisable.	Extend to new position; replace bell with device dissimilar to Fire Alarm warning, OR remove the alarm. Coordinate with Kenya Power Lighting Co Ltd.	O/R	Medium	100,000.00		ES-11

Report Summary Table									
Category	**Item**	**Location**	**Observation**	**Recommendation**	**Type**	**Term**	**Est. Cost (KShs.)**	**Ref. Section**	**Photo**
Electrical	Generator	Generator room	Although the generator is generally in excellent condition, it is considerably oversized.	Add connection for load bank rated at full generator load. Include in maintenance procedures for load bank to be rented at least semi-annualy (preferably quarterly) and for generator to be run at full load for at least 8 hours each time.	B/U	Medium			ES-5
Electrical	Generator	Generator room	Fuel pipe to filling point traverses electrical switchroom (below) and is leaking.	To be repaired immediately.	O/R ENV	Short			ES-5
Electrical	General	Switchroom	Single Line Diagram mounted on wall is out of date. Self-contained emergency light is connected to switch line on lighting circuit so comes on when light switch is switched off; will degrade battery quickly.	Update and replace SLD. Rewire emergency light to unswitched electrical supply (switchfeed).	B/U	Short	15,000.00		N/A
Electrical	*Local UPS-es*	*Throughout building*	*Local UPS-es providing back-up power and (depending on the type) may not be addressing possible power quality issues.*	*Replace harmonic mitigating transformer with central UPS. Remove local UPs-es.*	*B/U*	*Medium*			*N/A*

1.8 Life Safety, Fire Detection and Fire Suppression System

1.8.1 Fire Suppression

The entire building appears to be sprinklered in compliance with NBC. It should be noted that while the electrical rooms are correctly sprinklered, we observed that the electrical equipment did not appear to be suitable for a sprinklered environment and this should be checked by the maintenance staff with the vendor.

It was reported that the sprinkler system has not suffered from any leaks in the last 18 months, and that the system is tested quarterly. The fire pump room appeared clean and well-kept and the equipment in good working order. Ref M4/1, M4/2 & M4/3.

The sprinkler system is fed from the main underground storage tank that receives water from the municipal water supply and from an onsite bore hole. There is a secondary feed from the swimming pool to allow pool water be used in the sprinkler system in the event of loss of supply from the municipal water supply and/or the bore hole not being able to meet demand in a fire situation.

It was reported that the pipe from the swimming pool broke at some stage and was replaced by a new pipe including an isolation valve in new location. However, the tamper switch was not moved to the new valve location and thus no tamper switch is present on the relocated pipe. The reason the tamper switch was not relocated was because the cable was too short to do so. The replacement or extension of this cable and installation of the tamper switch should be flagged as a high priority maintenance item. Ref M4/4.

Generally the sprinkler pipework appears to be in good condition. In many cases is painted to match the surrounding walls/ ceiling rather than being painted red for clear identification, but this is still compliant with relevant codes. Ref M6/1 & E
Hand held fire extinguishers & hose-reels are provided. Ref M7/4 &E 4/4.

It was reported that the server room on Level 3 is protected by a clean agent (dry) system. This system was not tested or inspected during our site walk-through and it should be confirmed that regular testing and maintenance is occurring per manufacturer's recommendations. Due to the difficulties in maintaining these systems locally we recommend that during the proposed building upgrades that the clean agent system be decommissioned and the sprinkler system extended into cover this area.

1.8.2 Fire Alarm System

An Edwards fire alarm system is installed, comprising smoke & heat detectors, callpoints and bells as audible warning. The system is in "fault" status though apparently functional; the fault arose when several devices were replaced and the maintenance teams report there is no Edwards agent in Kenya nor any local companies familiar with this product. Ref E4/3.

Further investigation should be considered as the fault may have been caused because non-Edwards (wrong) devices were installed. Since the devices for this FA system are readily available in North America, they should be shipped from Canada and installed during future retrofit. If the system goes to normal after the retrofit, then there would be no need to change the panel and the devices.

As part of any retrofit, if necessary an Edwards service technician should be flown from the location closest to Nairobi to re-commission the system after the space planning exercise is complete. We would suggest that existing Edwards EST-3 system remains in place and to be regularly maintained by the technicians certified by Edwards.

In addition, based on our assessment of the extent of space planning exercise, additional fire alarm zones may not be required. However, that needs to be confirmed during the design stage as any additional fire alarm zones would need to be accommodated by the existing fire alarm panel. Ref E4/4.

1.8.3 Conclusions and Recommendations

The following maintenance activities are recommended to be undertaken by the maintenance team at the Chancery for the life safety, fire detection and fire suppression systems:

- Replacement of tamper switch cable and re-installation of tamper switch on sprinkler piping at the earliest opportunity.

The following additional tasks are more intensive and recommended to be included in the retrofit scope of work.

- Decommission and removal of the clean agent fire suppression system serving the server room on level 3.

1.9 Vertical Transportation Systems

The single hydraulic elevator is in good condition. Normal wear and tear of cab finishes is evident. The occupants have reported that elevator power does not consistently re-set automatically following a power failure. The power transfer and UPS systems should be checked and rectified by trained technicians.
Return air is currently conducted through the elevator machine room to the return air plenum of the sub-basement mechanical room. The return air should be separated from the machine room to avoid air contamination.

1.10 Building Grounds

Ramps currently lead from the guardposts to the pool deck area and to the Immigration Waiting Area. These do not have landings, handrails, guard rails, and floor surfaces in accordance with CSA B651-04 Accessible Design for the Built Environment or with the National Building Code of Canada. In addition the floor surfaces have settled significantly in relation to adjacent upstand walls and retaining walls. The ramps require major reconstruction to meet code requirements.

Pavements, curbs, boundary walls, and fences are in very good condition.

As referenced in the mechanical section, the septic system is apparently blocked and is overflowing onto the ground surface. This contributes to the pollution of the Thigiri River watershed. A sewage treatment system should be considered.

1.11 Summary Cost Analysis

Please refer to Part 7 – Conceptual Indicative Construction Cost Estimate.

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Sitework	Driveways and Culverts		No major defects noted					8.1	N/A
Sitework	Parking lots, Curbs, Guards		No major defects noted					8.2	N/A
Sitework	Sidewalks	Ramp at Immigration Office	Floor of ramp separating from ramp wall. The ramp floor rests on backfill between the retaining walls. The backfill varies in depth with the minimum at the immigration waiting area and the maximum at the entrance gate. The ramp floor differential movement is maximum at the entrance gate and minimum at the immigration waiting area. The ramp floor movement appeared to be due to differential settlement of the backfill.					8.3.1	BS-21
		Ramp Wall at Immigration Office	Cracks on ramp wall where openings are located. It appeared as if the lamp recesses / openings were added later.					8.3.2	BS-19 BS-20
Sitework	Fencing, Handrails	Ramp wall capping at Immigration Office	A continuous crack between the wall capping and the ramp wall was observed. It appeared the capping and the wall were of different material and there were differential thermal movements at the material interface causing the cracking.					8.4	BS-22
Sitework	Retaining Walls	Retaining wall near tennis court	Vertical cracks seen on retaining wall, The walk-way floor separating from wall. At some areas, a vertical and horizontal movement of more than 20 mm observed. The walkway is placed adjacent to a steep slope. It appeared there were slope stability and settlement concerns.					8.5	BS-23 BS-24
Sitework	Drainage away from building		No drainage problem noted					8.6	N/A

Report Summary Table

Category	Item	Location	Observation	Recommendation	Type	Term	Est. Cost (KShs.)	Ref. Section	Photo
Sitework	Building Exterior	Exterior	Many cracks seen all over the building that are not aesthetically pleasing					8.7.1	BS-25 BS-26 BS-27 BS-28
		Exterior	Spalling of wall as well as cracks seen where generator was previously located. Wall appears charred. May be as a result of vibration forces and high temperatures created by generator.					8.7.2	BS-29

1.12 Building Condition Report Appendices

Appendix A – Sources of Data Contact Information

Drawing, specifications, Indoor Air Quality Report, and geotechnical report on Evaluation of Surface Fault Displacement were provided by:

Christian Richer
Senior Project Manager
Capital Project Delivery Division (ARPA)
Foreign Affairs Canada
125 Sussex Drive, Ottawa, K1A 0G2

General information on existing operations and conditions was provided by the following High Commission Staff:

Sylvia Lawrie
Management and Consular (D/MCO Property)

Jonathan Boisseau
DMCO Consular

Sylvain Dulong
First Secretary, Management

Joseph Gathi
Maintenance and Operations Supervisor

Canadian High Commission
Limuru Road, Gigiri
P.O. Box 1013, 00621, Nairobi, Kenya

Appendix B – digital Images

S-1: Cracks on Basement floor slab

S-2: Cracks on Basement floor slab

S-3: Spalling on slab soffit below swimming pool

S-4: Vertical Crack on Retaining wall in sub-basement Electrical RoomCracks on Basement floor slab

S-5: Vertical Crack on Slab soffit in sub-basement Electrical Room

S-6: Crack on Floor Slab in Basement Electrical Transformer Room

S-7: Radial Cracks of Floor Slab in Basement Columns

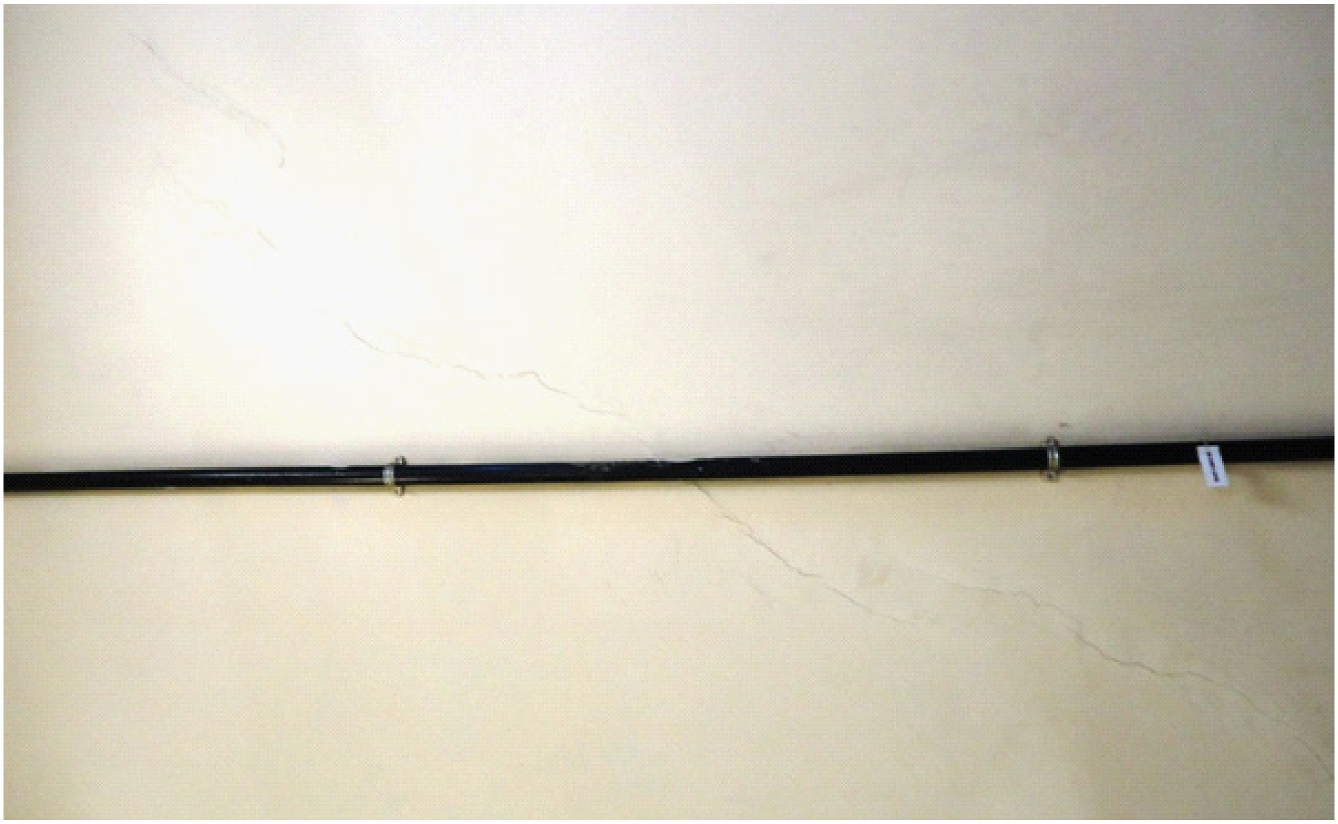
S-8: Radial Cracks on Floor Slab in Basement Columns

S-9: Radial Cracks on Floor Slab in Basement Columns

S-10: Radial Cracks on Floor Slab in Basement Columns


S-11: Vertical Cracks on Parapet Walls


S-12: Vertical Cracks on Basement Men's Locker Room



S-13: Cracks on Slab soffit on Sub-Basement Storage Area

S-14: Efflourescence in pump room beloiw swimming pool

S-15: Crack on junction between masonry wall and concrete

S-16: Crack on junction between masonry wall and concrete

S-17: Cracks on masonry wall

S-18: Crack on masonry wall


S-19: Cracks on ramp wall


S-20: Cracks on ramp wall

S-21: Seperation of ramp wall from floor

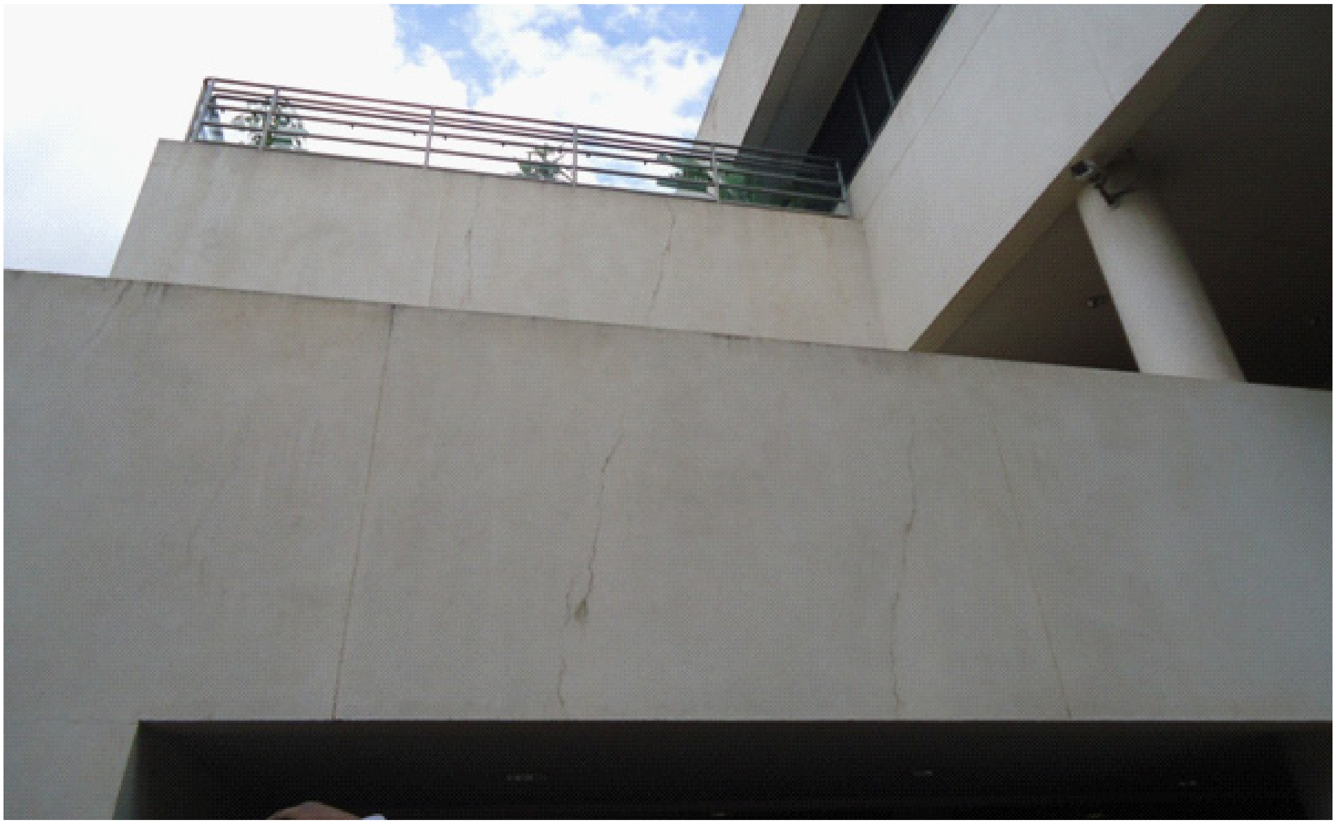
S-22: Seperation of wall capping from wall

S-23: Seperation of Retaining wall from floor

S-24: Seperation of Two Retaining walls

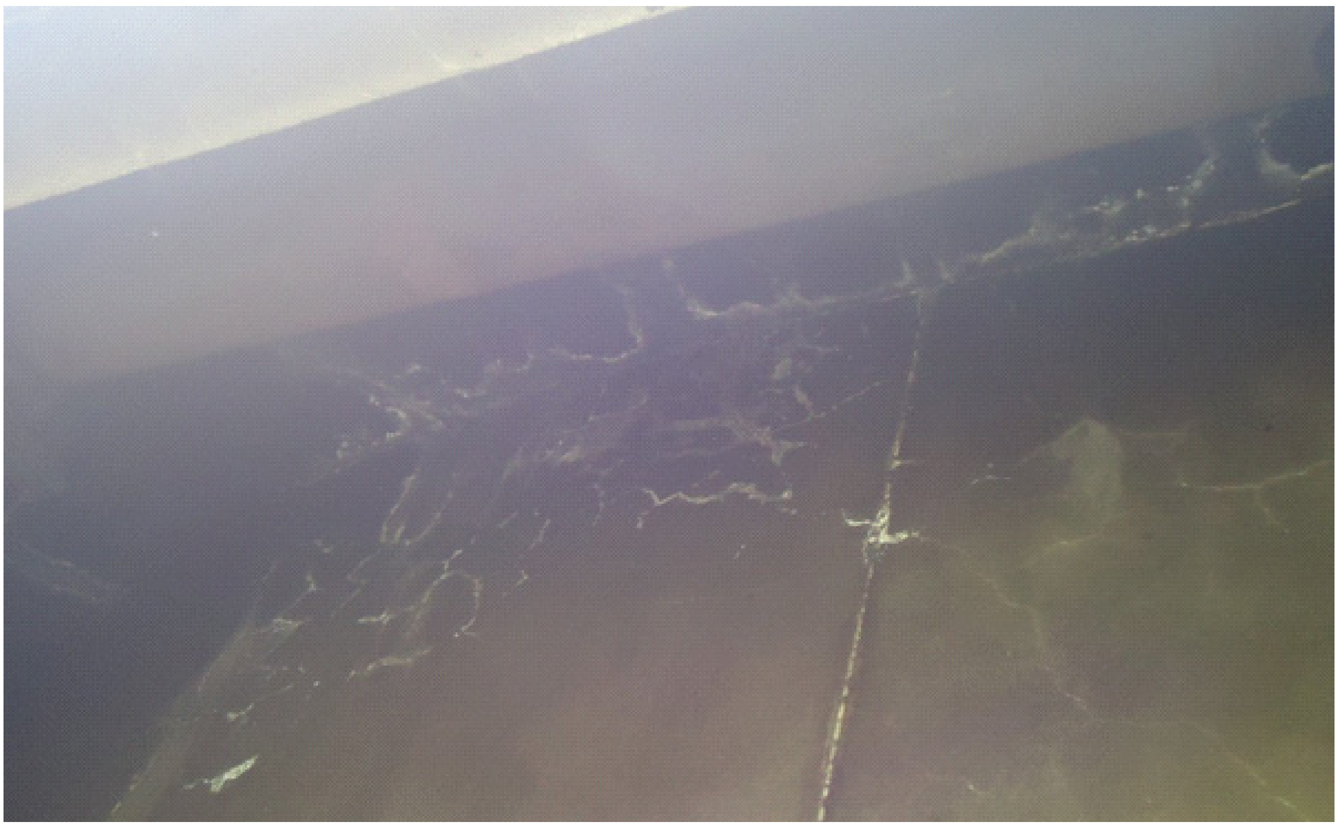
S-25: Cracks on Exterior walls

S-26: Crack on Exterior walls



S-27: Cracks on exterior walls

S-28: Cracks on exterior walls



S-29: Spalling of wall and cracking at previous location of generator

BE-1: Exposed Insulation

BE-2: Existing Roof Drain to be raised

BE-3: Wall without copping drip

BE-4: Wall without copping drip

BE-5: Sky light, damaged glass roof assembly which requires replacement

BE-6: Sky light

BE-7: Window Frame

BE-8: Window glazing from outside

BE-9: External Elevation finishes which require upgrading

BE-10: Cracks on top of the wall finish

BE-11: Diagonal cracks on the wall which require rectification

BE-12: Cracks on the edges of the windows with structural concerns

BE-13: Crack on the block work at the basement

BE-14: Soffits with cracked

BG-1: Access to the public area

BG-2: Aluminum Glass Curtain Wall from Limuru Road

BG-3: Overflowing septic at the back area

BG-4: Boundary wall along Limuru road

BG-5: Boundary wall at the back along the river

MS-1: AHU #2; VFD

MS-2: AHU #2; Return Air intake

MS-3: Washing Machine in AHU Room

MS-4: Storage in AHU Room

MS-5: Storage in AHU Room

MS-6: Debris in Return Air Shaft

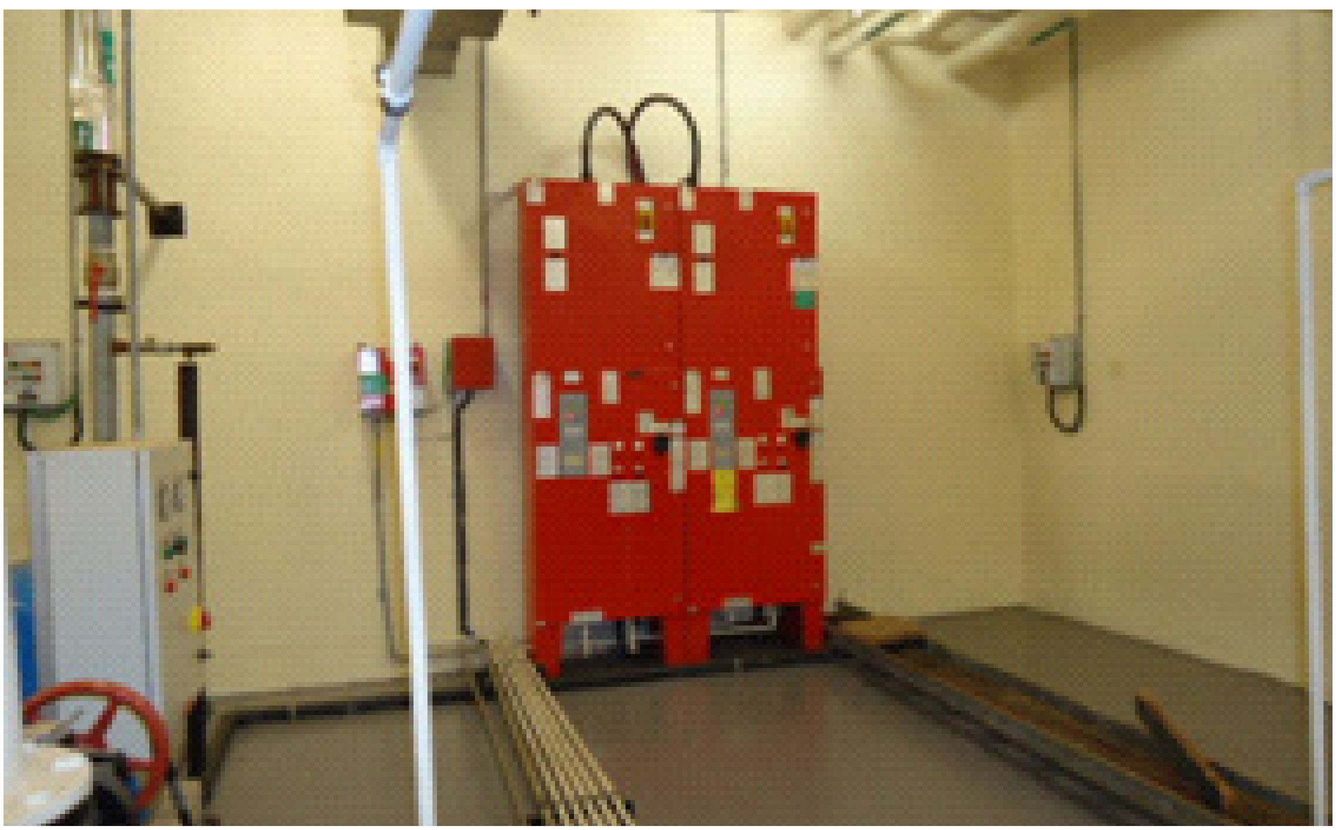
MS-7: Return Air Route with Fire Damper over Elevator Machine Room

MS-8: Return Air Route with Fire Damper over Elevator Machine Room (view from Elevator Machine Room)


MS-9: Debris in Return Air Shaft (hole from electrical cupboard with broken fan)

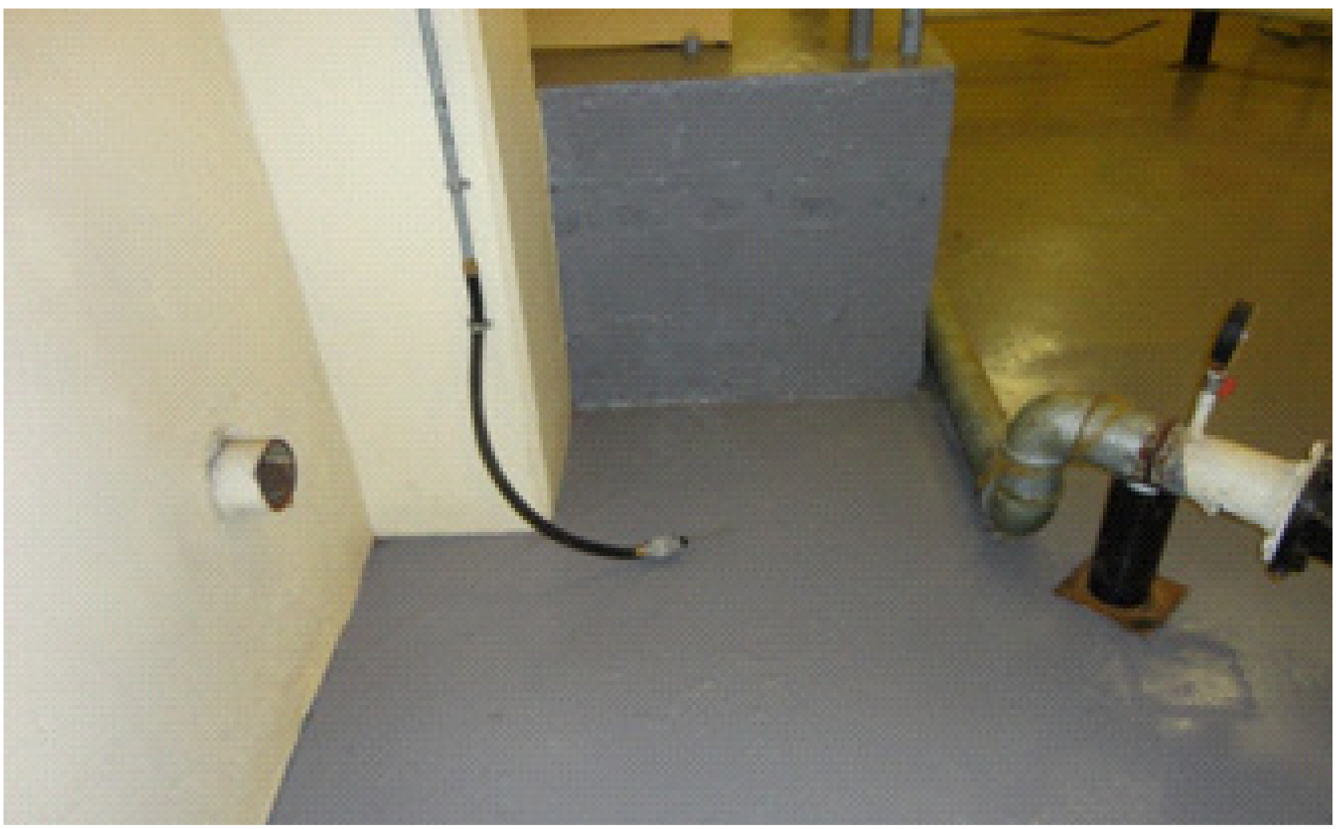
MS-10: Condenser Unit for Split Air-conditioner

MS-11: Fire Pump



MS-12: Fire Pump Control Panel

MS-13: Fire Pump Room



MS-14: Tamper switch at old valve position

MS-15: Swimming Pool Plant

MS-16: Pool Water Heater

MS-17: Solar Hot Water Panels

MS-18: Solar Hot Water Header

MS-19: Fire Hydrant

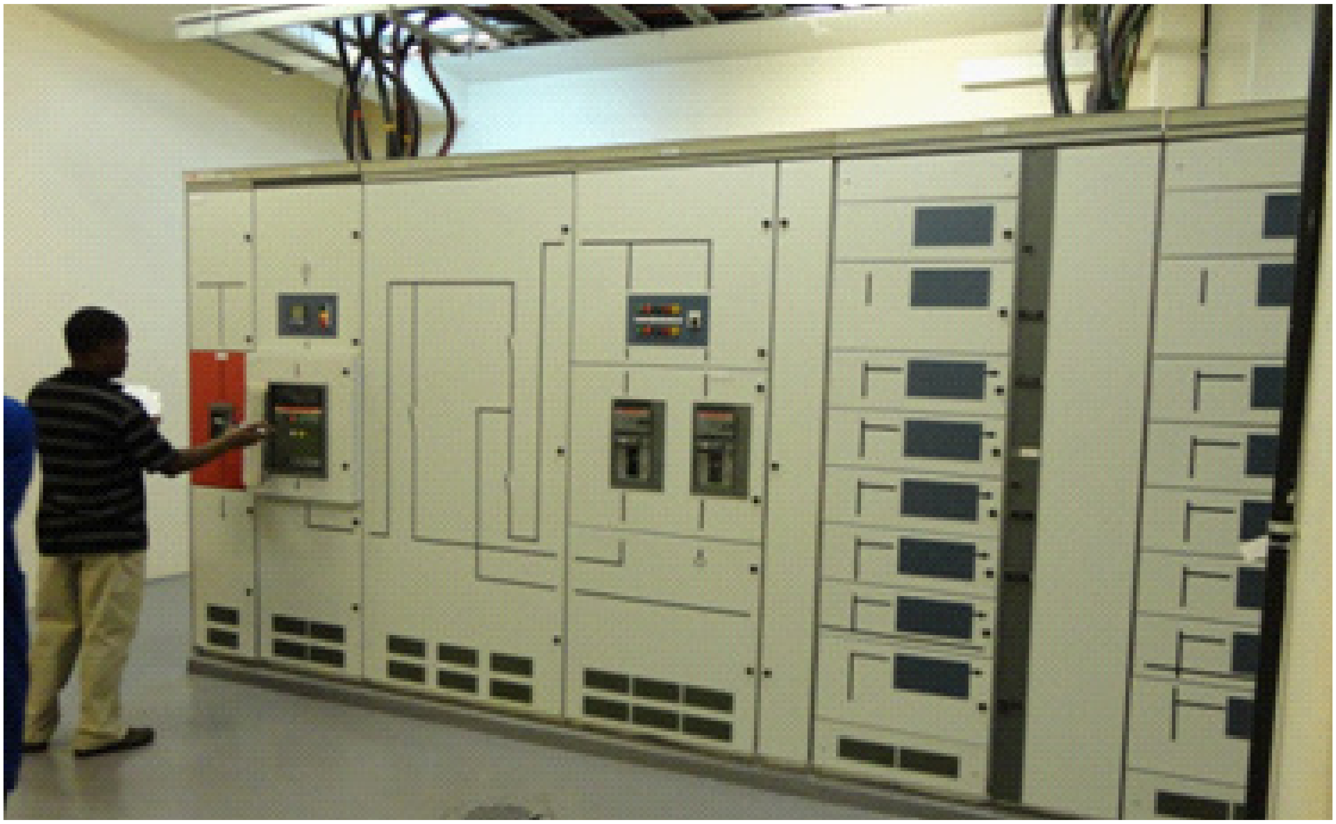
MS-20: Overflowing septic tank

MS-21: Chiller (at left) in plantroom

MS-22: Chilled water Manifold

MS-23: Water Cooler (drinking water)

MS-24: Fire Extinguisher



ES-1: Main Switchpanel

ES-2: Main Switchpanel, Additional Section

ES-3: Distribution Wiring to Socket (Receptacle), Blue Phase

ES-4: Distribution Wiring to Socket (Receptacle), Yellow Phase

ES-5: Stand-by Generator

ES-6: Generator Control Panel

ES-7: Generator Nameplate

ES-8: Fire Pump Disconnect

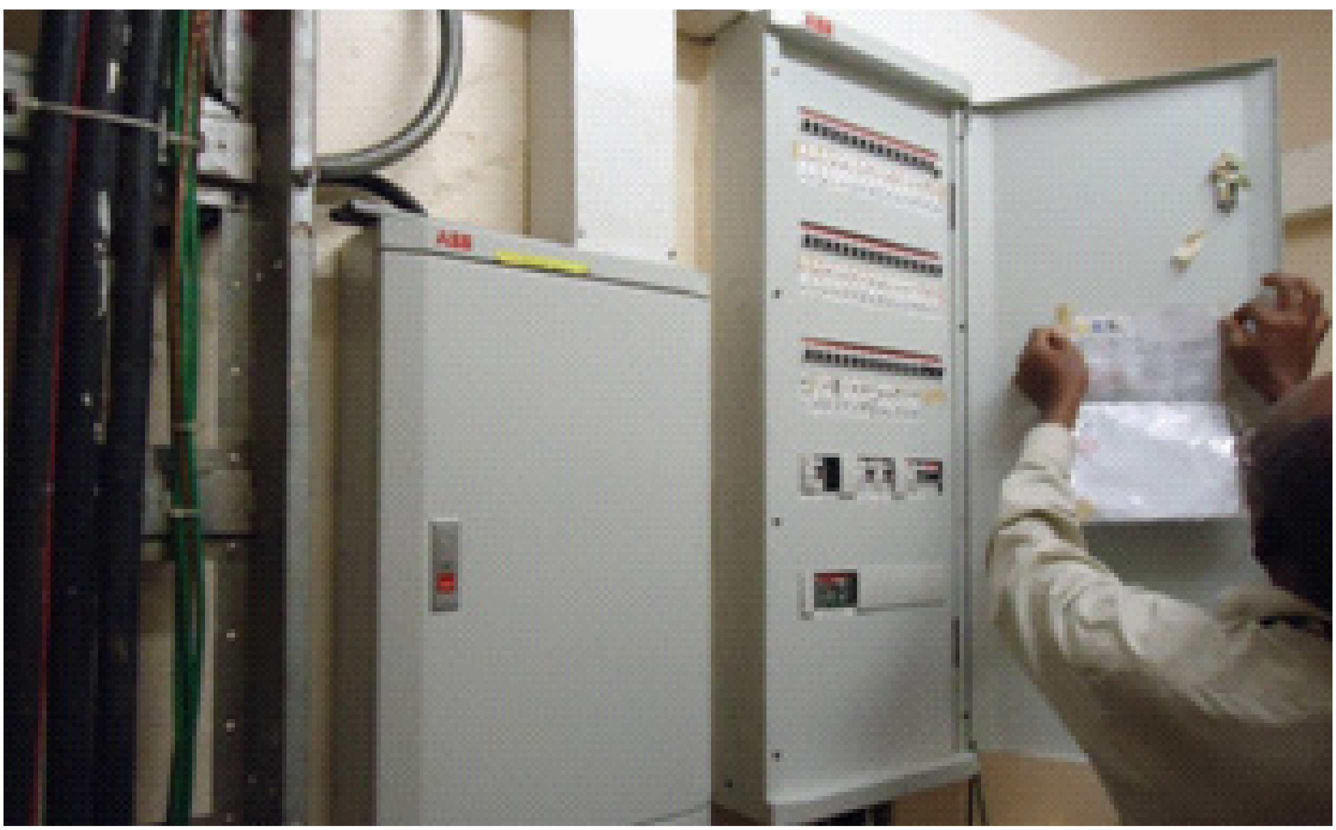
ES-9: Main Transformer

ES-10: Kenya Utility Metering

ES-11: Transformer Temperature Alarm and Bell

ES-12: Electrical Intake room (showing Wellglass-type light)

ES-13: Typical Distribution Panel



ES-14: Inside Distribution Panel

ES-15: Fire Alarm Panel

ES-16: Hose reel and Fire Alarm Callpoint

ES-17: Pictogram Exit Sign

ES-18:External Lighting Pole

ES-19: Elevator Hydraulic Machine

ES-20: Stand-by Generator Daytank

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Part 2
Mould Related Issues

Part 2. Mould Related Issues

2.1 Background

An Indoor Air Quality Investigation dated November 16, 2009 was prepared by Pinchin Environmental Ltd. and was provided to the consultants. Mr. Adam Crawford of Pinchin Environmental was consulted for the preparation of this report.

The IAQ Investigation cited isolated locations of mould growth. With the exception of office 316 and second floor area 206-211 test results did not indicate that mould growth which had been identified by visual observation and bulk tape – lift samples was impacting on airborne spore concentrations at the time of the investigation. The mould growth was identified on drywall finishes and on exterior walls below wallpaper in several locations throughout the building.

The IAQ Investigation states that the likely cause of the majority of the mould growth is:

a. The previous flooding episode in 2004, and/or
b. Water infiltration through the building exterior as a result of cracks and other deficiencies and/or
c. Condensation on exterior (un-insulated) wall surfaces being trapped below the wallpaper.

We are able to make the following further observations.

Lifting of sample areas of wallcovering did not reveal visible evidence of mould growth on exterior walls.

The building operator, Joseph Gathi, Maintenance and Operations Supervisor, advised that since original occupancy numerous areas of wallcovering on exterior walls have been removed and replaced. Mr. Gathi stated that mould growth was not encountered at these locations.

It appears evident that isolated locations of mould growth have developed due to water infiltration and the burst pipe flood event in March 2004.

There is no evidence to suggest that mould growth is widespread throughout the building. If condensation is currently being trapped on exterior wall surfaces below the wallpaper, this condition will be alleviated by the recommendation to provide insulation, vapour retarder, and new rainscreen cladding in accordance with Part A of this report. All vinyl wallpaper on exterior walls should be removed.

Should mould growth be visually evident at any locations in the course of the retrofit and fit-up program it should be removed in accordance with CSA 82 Mould Guidelines for the Canadian Construction Industry. We recommend a modest budget be established for mould removal.

Part 3
Space Optimization Requirements

Part 3. Space Optimization Requirements

3.1 Space Planning

Floor plans indicating existing layouts and floor plans indicating Preliminary Concept Blocking for the new fit-up have been provided by Foreign Affairs and International Trade Canada. These drawings are provided in Section 3.7.

The Concept Blocking drawings indicate major reorganization of spaces to accommodate an increased staff complement of 34 individuals as well as reorganization of functions. The staffing increment is shown to be accommodated on the existing three office floors by means of an enclosure of the Chancery Reception Area, the enclosure of the Immigration Waiting Area, the elimination of many enclosed offices and the substitution of open office workstations.

The proposed allocation of space is in general accordance with the principles cited by PWGSC Government of Canada Workplace 2.0 Fit-Up Standards, 2012.

3.2 Architectural Outline

Extensive demolition and removals work is required to remove partitions, remove floor finishes, and reconfigure ceilings.

Enclosure of the Chancery Reception and Immigration Waiting Areas can be achieved with commercial aluminum curtainwall and insulating double glazed units.

New partitions can largely be comprised of re-use of existing glazed and opaque demountable partitions. These demountable partitions were manufactured by SMED, a company which is no longer in existence. Haworth Canada, however, has delveloped products that con be used to modify, improve, reuse, and add to the existing SMED system. Secure partitions will be required for new interview booths and to suit new zone perimeters. New floor finishes primarily comprised of broadloom or carpet tile are required throughout all closed and open office areas.

Re-work to ceilings will be required wherever existing ceilings extend above partitions. New ceiling suspension should be specified to match existing. Acoustic ceiling tiles may be re-used but a significant supplementary quantity will be required.

A sound masking system should be considered for open office areas.

New millwork will be required for new Interview booths and miscellaneous locations including the retrofit of kitchens to meet barrier free requirements.

The capacity of exit doors and exit stairs has been checked and these are adequate to serve the additional occupant load.

The capacity of existing washroom fixtures has been checked and these are also considered adequate to serve the additional occupant load. It will be necessary, however, to calculate the ratios of male and female staff to determine if the facilities remain adequate for both genders.

The possibility of infilling the existing atrium has been considered. This would involve the construction of a new floor assembly at the Second Floor between gridlines 4 and 5, Fand J. This would create a supplementary provision for the accomodation of new positons within the Mission and it is work that could be readily coordinated with the adjacent curtain wall security upgrade. (Please refer to Section 4.2.2.) A seperate cost estimate has been provided in Part 7. This includes:

- New steel floor framing.
- A new floor assembly comprised of metal deck, concrete topping, and carpet flooring.
- New ceiling.
- Extension of the air distribution system.
- Extension of the sprinkler system.
- Extension of the electrical systems including power, data, communication, lighting, and fire alarm.

3.3 Structural Outline

It will be critical to integrate the fit-up design with the structural retrofit work which is outlined in Part 5 of this report. Shear walls, cores and shafts are required to be substantially thickened and concrete boundary elements will be added. These elements must be integrated with the planning of the floors and the detailing work.

The provision of a second elevator has been considered but is not currently shown on the Preliminary Concept Blocking drawings. If required, a location between gridlines K and L, 4 and 5 has been reviewed and is considered feasible for the construction of new shaft openings and an elevator hoistway.

3.4 Mechanical Outline

In general the new space plan includes an increase in the amount of open plan area through reducing the amount of cellular offices provided at present. This will assist with resolving some of the issues with respect to balancing and thermostatic control; however it is still recommended that the system be rebalanced and recommissioned after the new partition layout is completed to ensure that thermal comfort is maintained in this new configuration. The increased fresh air requirement for the additional proposed occupants (34 persons; 80.25 l/s, per ASHRAE 62.1 (2007)) is small enough that the air-handling units could be rebalanced to increase the fresh air ratio to meet this increased ventilation rate. The overall increase in building load due to the increased occupants is approximately 8.5kW (4.5kW occupant load, 3.5kW allowance for increased plug loads, and 0.5kW ventilation load), which is low relative to the reduced envelope gains due to the provision of improved insulation and tinted glazing. It would be prudent to carry this rebalancing and re-commissioning as a complete & thorough exercise on the building, as it requires attendance by expatriate technicians, and ensuring the system is correctly balanced and commissioned correctly should restore satisfactory operation. It appears there is sufficient capacity in the existing plant to accommodate the increase in occupancy, when the proposed improvements to the glazing and insulation of façades and roof are also considered.

The proposal includes enclosing two areas; the single level immigration waiting area and the main reception. The enclosed portion of main reception area will be approximately 50m2. This space opens to the southwest to the open main entry and has minimal external exposure, limited to the southeast wall, thus solar gains are minimal. Based on ASHRAE 62.1 (2007), the expected occupancy is 81 persons, requiring a total 333 l/s of outdoor air. The peak cooling load for this public space is estimated at 18kW (approximately (2.3kW envelope load, 2.5kW ventilation load, 12kW occupant load, 700W lighting and 500W misc/plug loads). Because of security concerns, the air to this space must be supplied and evacuated independently of the main air handlers serving the private space for Canadian Based and Locally Engaged Staff, thus a dedicated 20kW DX split air-conditioning unit, complete with mixing box for direct dedicated outdoor air supply and relief air, is recommended for this space.

The enclosed immigration area will be approximately 100m2 and has significantly more external exposure glass, though again limited to the southeast and southwest walls. This space also has a higher expected occupancy. Based on ASHRAE 62.1 (2007), the expected occupancy is 161 persons, requiring a total 665 l/s of outdoor air. The peak cooling load for this space is estimated at 37kW (approximately (5.5kW envelope load, 5kW ventilation load, 24kW occupant load, 1.4kW lighting and 1.1kW misc/plug loads). Because of security concerns, the air to this public space must again be supplied and evacuated independently of the main air handlers serving the private space for Canadian Based and Locally Engaged Staff, thus a dedicated 20kW DX split air-conditioning unit, complete with mixing box for direct dedicated outdoor air supply and relief air, is recommended for this space. There is also the potential for natural ventilation of this space during non-peak conditions. This could comprise openable windows in the glazing.

The space optimization re-planning has been designed to minimise the impact on plumbing services, though the coverage of sprinklers would need to be verified with the new plan, particularly within the newly enclosed areas. It is envisaged that any alterations would be minor and involve repositioning of a minimal amount of heads.

3.5 Electrical Outline

As there is considerable spare capacity built into the existing design, the extent of work to accommodate the fit-out would be restricted to repositioning of receptacles to suit new layouts. Some additional circuits could be run from local DPs to ensure the additional occupancy does not cause overloading of existing receptacle circuits.

For new open office areas a power and communications distribution strategy will need to be developed. It is anticipated that this will involve the provision of new furrings on perimeter walls, columns, and shear walls together with poke-through floor monuments fed from new conduits located at the underside of floor slabs. Power poles are considered unsightly and should be entirely avoided.

Similarly light fittings would be repositioned to suit the new layout, without requiring any significant modifications to the installation or large quantities of additional fixtures.
The position of all fire alarm callpoints, smoke/ heat detectors etc would have to be checked but again the requirements are likely to be lower in the open plan configuration.

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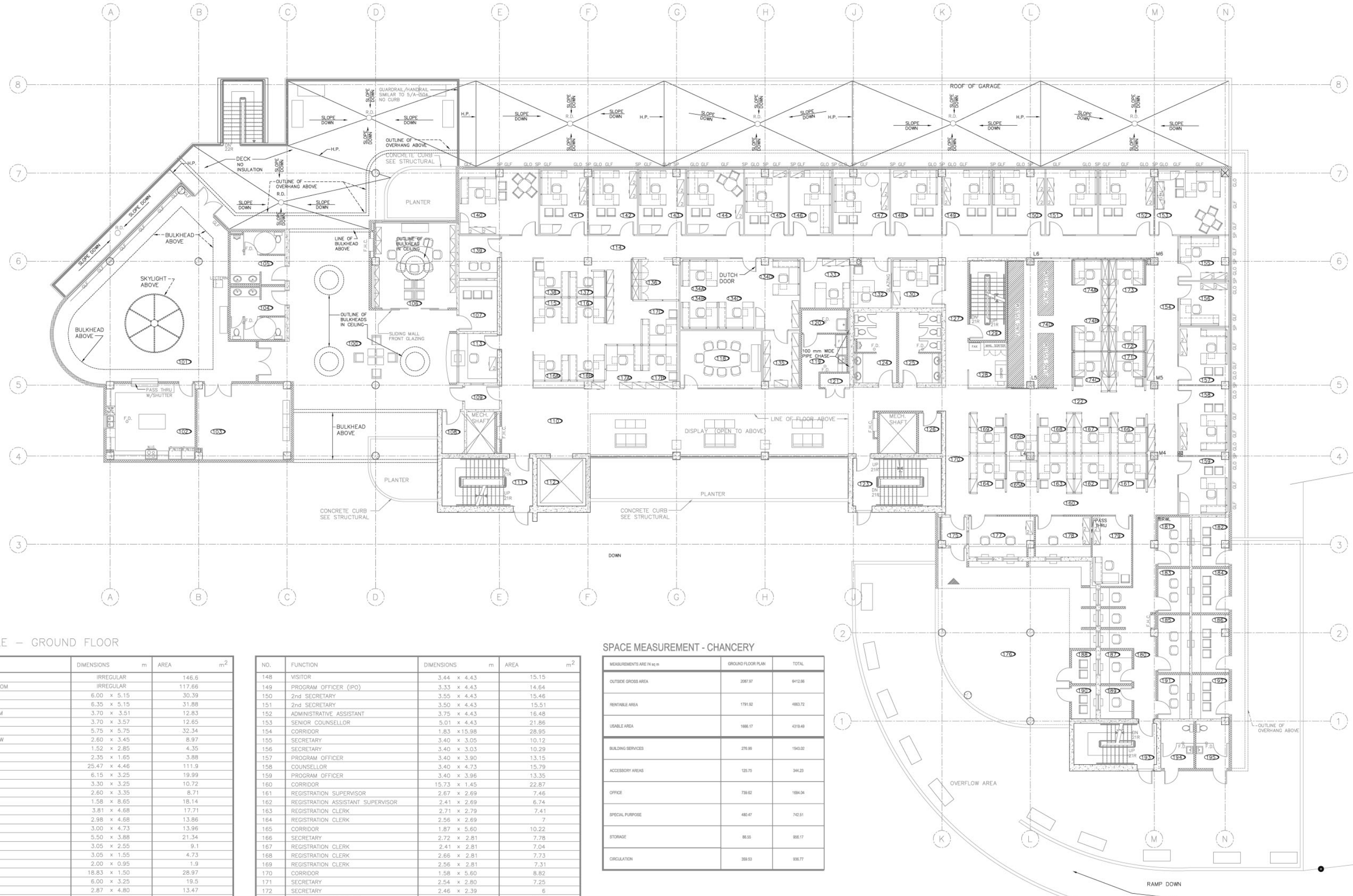
Existing - Ground Floor Layout



SPACE SCHEDULE – GROUND FLOOR

NO.	FUNCTION	DIMENSIONS m	AREA m²
100	LOBBY	IRREGULAR	146.6
101	MULTI PURPOSE ROOM	IRREGULAR	117.66
102	KITCHEN	6.00 x 5.15	30.39
103	CHAIR STORAGE	6.35 x 5.15	31.88
104	WOMEN'S WASHROOM	3.70 x 3.51	12.83
105	MEN'S WASHROOM	3.70 x 3.57	12.65
106	LIBRARY	5.75 x 5.75	32.34
107	CONSULAR INTERVIEW	2.60 x 3.45	8.97
108	ELECTRICAL	1.52 x 2.85	4.35
109	AIR LOCK	2.35 x 1.65	3.88
110	CORRIDOR	25.47 x 4.46	111.9
111	STAIRWELL #1	6.15 x 3.25	19.99
112	ELEVATOR	3.30 x 3.25	10.72
113	RECEPTION	2.60 x 3.35	8.71
114	CORRIDOR	1.58 x 8.65	18.14
115	LOG / PROT	3.81 x 4.68	17.71
116	SPARE	2.98 x 4.68	13.86
117	SPARE	3.00 x 4.73	13.96
118	MEETING ROOM	5.50 x 3.88	21.34
119	KITCHEN	3.05 x 2.55	9.1
120	JANITOR	3.05 x 1.55	4.73
121	T.C.	2.00 x 0.95	1.9
122	CORRIDOR	18.83 x 1.50	28.97
123	STAIRWELL #2	6.00 x 3.25	19.5
124	MEN'S WASHROOM	2.87 x 4.80	13.47
125	WOMEN'S WASHROOM	2.83 x 4.80	13.65
126	ELECTRICAL ROOM	1.52 x 2.75	4.19
127	CORRIDOR	1.50 x 8.88	13.35
128	FAX / PHOTOCOPIER	2.56 x 3.08	7.88
129	STAIRWELL #3	2.38 x 5.39	12.96
130	DRIVERS	3.56 x 3.33	11.67
131	--- NOT IN USE ---	---	---
132	MAIL DISPATCH	2.73 x 3.33	8.78
133	MAIL/ SHREDDING	3.33 x 3.33	11.09
134	3 ACCT.	8.10 x 4.74	38.75
135	FILE ROOM	2.53 x 3.88	9.63
136	PHOTOCOPIER	3.12 x 4.11	12.63
137	SUPPLY CLERK	2.95 x 4.22	12.4
138	ADMIN. / PER. ASSISTANT	3.81 x 4.20	15.97
139	INTERVIEW	2.60 x 2.90	7.88
140	1st SECT. ADMIN. / CONSUL (MAO)	5.40 x 4.43	23.67
141	2nd SEC. MCE CDN.	3.24 x 4.34	14.27
142	CONSULAR ASSISTANT	3.32 x 4.34	14.58
143	CONSULAR ADMINISTRATIVE ASSISTANT	3.19 x 4.34	13.88
144	SENIOR MCC	3.80 x 4.43	17.14
145	PROPERTY CLERK / SECRETARY	2.96 x 4.35	12.85
146	PROPERTY ASSISTANT	2.82 x 4.45	12.86
147	PROPERTY MANAGER	3.83 x 4.43	16.72

NO.	FUNCTION	DIMENSIONS m	AREA m²
148	VISITOR	3.44 x 4.43	15.15
149	PROGRAM OFFICER (IPO)	3.33 x 4.43	14.64
150	2nd SECRETARY	3.55 x 4.43	15.46
151	2nd SECRETARY	3.50 x 4.43	15.51
152	ADMINISTRATIVE ASSISTANT	3.75 x 4.43	16.48
153	SENIOR COUNSELLOR	5.01 x 4.43	21.86
154	CORRIDOR	1.83 x 15.98	28.95
155	SECRETARY	3.40 x 3.05	10.12
156	SECRETARY	3.40 x 3.03	10.29
157	PROGRAM OFFICER	3.40 x 3.90	13.15
158	COUNSELLOR	3.40 x 4.73	15.79
159	PROGRAM OFFICER	3.40 x 3.96	13.35
160	CORRIDOR	15.73 x 1.45	22.87
161	REGISTRATION SUPERVISOR	2.67 x 2.69	7.46
162	REGISTRATION ASSISTANT SUPERVISOR	2.41 x 2.69	6.74
163	REGISTRATION CLERK	2.71 x 2.79	7.41
164	REGISTRATION CLERK	2.56 x 2.69	7
165	CORRIDOR	1.87 x 5.60	10.22
166	SECRETARY	2.72 x 2.81	7.78
167	REGISTRATION CLERK	2.41 x 2.81	7.04
168	REGISTRATION CLERK	2.66 x 2.81	7.73
169	REGISTRATION CLERK	2.56 x 2.81	7.31
170	CORRIDOR	1.58 x 5.60	8.82
171	SECRETARY	2.54 x 2.80	7.25
172	SECRETARY	2.46 x 2.39	6
173	SECRETARY / INTERVIEW	2.36 x 3.38	8.16
174	REGISTRY FILES	7.02 x 8.81	61.33
175	AIR LOCK	1.73 x 1.95	3.27
176	LOBBY	IRREGULAR	100.75
177	RECEPTIONIST	4.42 x 2.75	11.62
178	CASHIER	3.75 x 2.75	10.31
179	V.V. ASSISTANT	2.65 x 4.75	12.54
180	CORRIDOR	IRREGULAR	28.9
181	INTERVIEW BOOTH	2.15 x 3.35	7.14
182	INTERVIEW BOOTH	2.50 x 3.35	8.13
183	INTERVIEW BOOTH	2.15 x 3.00	6.45
184	INTERVIEW BOOTH	2.50 x 3.00	7.5
185	INTERVIEW BOOTH	2.15 x 3.90	8.38
186	INTERVIEW BOOTH	2.50 x 3.90	9.5
187	INTERVIEW BOOTH	2.13 x 2.24	4.77
188	INTERVIEW BOOTH	1.65 x 2.25	3.7
189	INTERVIEW BOOTH	2.13 x 2.24	4.76
190	INTERVIEW BOOTH	1.65 x 2.25	3.7
191	INTERVIEW BOOTH	2.15 x 3.00	6.45
192	INTERVIEW BOOTH	2.50 x 3.00	7.45
193	STAIRWELL #4	5.60 x 2.80	15.68
194	WOMEN'S BARRIER-FREE WASHROOM	2.23 x 3.19	7.1
195	MEN'S BARRIER-FREE WASHROOM	2.23 x 3.19	6.97

02 | GROUND FLOOR PLAN

SPACE MEASUREMENT - CHANCERY

MEASUREMENTS ARE IN sq m	GROUND FLOOR PLAN	TOTAL
OUTSIDE GROSS AREA	2087.97	6412.66
RENTABLE AREA	1791.92	4663.72
USABLE AREA	1666.17	4319.49
BUILDING SERVICES	276.99	1543.02
ACCESSORY AREAS	125.75	344.23
OFFICE	739.62	1684.04
SPECIAL PURPOSE	480.47	742.51
STORAGE	86.55	956.17
CIRCULATION	359.53	936.77

NOTE 2012-10-03:
This drawing was developed from NRB-C-019-02F rev.B and files sent by the mission.

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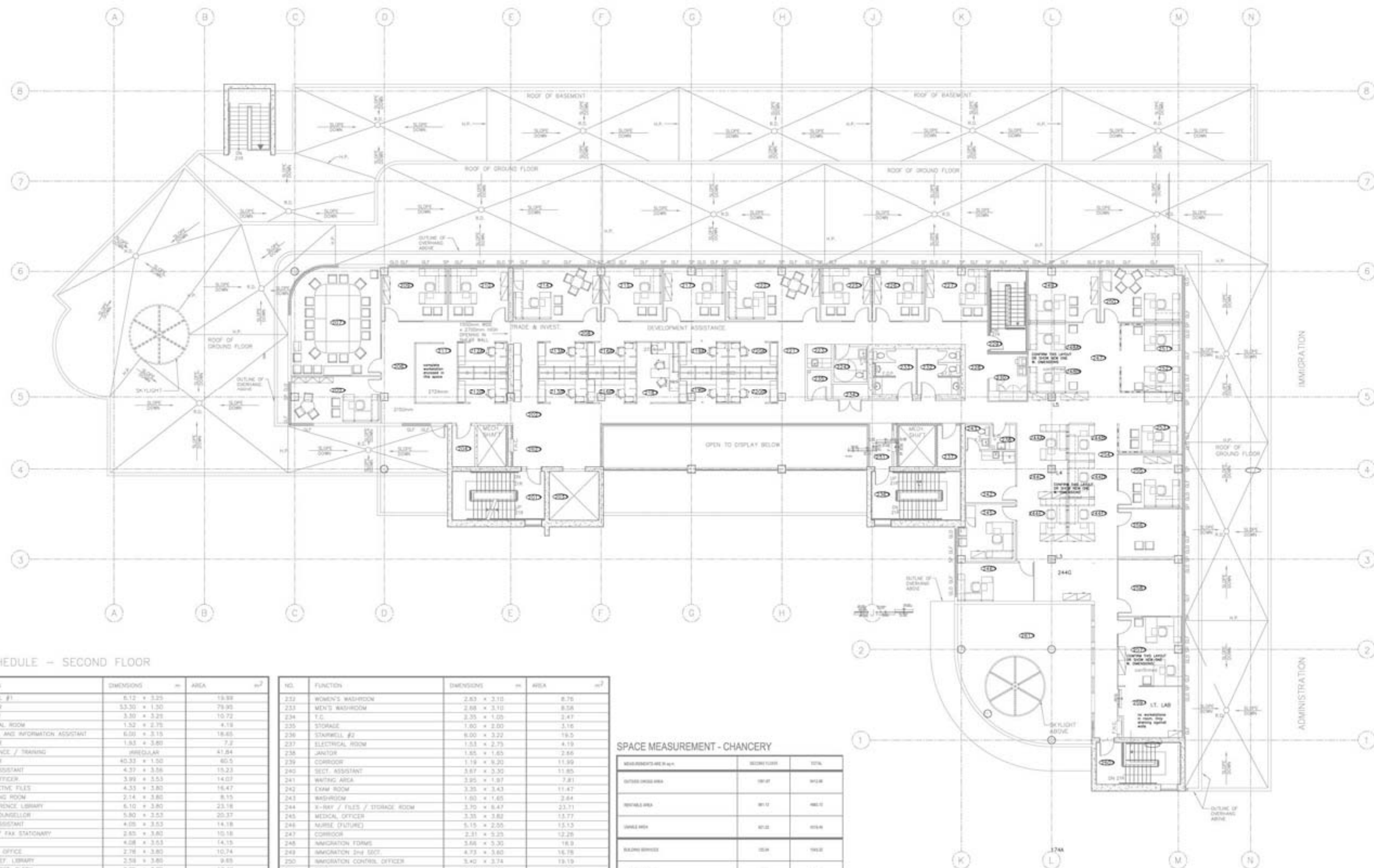
CHANCERY
NAIROBI
KENYA

GROUND FLOOR PLAN
ARCHITECTURE &
INTERIOR DESIGN

NRB-C-019-02 C

Proposed - Ground Floor Layout

Existing - Second Floor Layout



SPACE SCHEDULE – SECOND FLOOR

NO.	FUNCTION	DIMENSIONS m	AREA m²
201	STAIRWELL #1	6.12 × 3.25	19.89
202	CORRIDOR	53.30 × 1.50	79.95
203	ELEVATOR	3.30 × 3.25	10.72
204	ELECTRICAL ROOM	1.52 × 2.75	4.18
205	P.E. REF. AND INFORMATION ASSISTANT	6.00 × 3.15	18.65
206	CORRIDOR	1.93 × 3.80	7.2
207	CONFERENCE / TRAINING	IRREGULAR	41.84
208	CORRIDOR	40.33 × 1.50	60.5
209	COMM. ASSISTANT	4.37 × 3.56	15.23
210	COMM. OFFICER	3.99 × 3.53	14.07
211	TRADE ACTIVE FILES	4.33 × 3.80	16.47
212	T.I. WAITING ROOM	2.14 × 3.80	8.15
213	T.I. REFERENCE LIBRARY	6.10 × 3.80	23.18
214	TRADE COUNSELLOR	5.80 × 3.53	20.37
215	COMM. ASSISTANT	4.05 × 3.53	14.18
216	COPIER / FAX STATIONARY	2.65 × 3.80	10.18
217	SPARE	4.08 × 3.53	14.15
218	VISITOR'S OFFICE	2.78 × 3.80	10.74
219	DEVEL. REF. LIBRARY	2.59 × 3.80	9.85
220	DEVEL. SECT. CLERK	3.25 × 3.79	12.48
221	DEVEL. WAITING DISPLAY	1.80 × 3.79	6.57
222	DEVELOPMENT COUNSELLOR	6.23 × 3.53	21.73
223	COFFEE COUNTER	1.60 × 1.55	2.48
224	UNISEX WASHROOM	2.30 × 2.35	5.41
225	DEVELOPMENT SECT.	3.38 × 3.55	11.82
226	DEVELOPMENT VISITOR	3.43 × 3.55	12.31
227	DEVELOPMENT PROGRAM OFFICER	4.13 × 3.53	14.32
228	CORRIDOR	1.57 × 3.80	5.7
229	STAIRWELL #3	2.37 × 5.39	12.96
230	FAX / PHOTOCOPIER / STATIONARY	2.56 × 3.15	7.88
231	CORRIDOR	1.48 × 2.90	4.28

NO.	FUNCTION	DIMENSIONS m	AREA m²
232	WOMEN'S WASHROOM	2.83 × 3.10	8.76
233	MEN'S WASHROOM	2.88 × 3.10	8.58
234	T.C.	2.35 × 1.05	2.47
235	STORAGE	1.60 × 2.00	3.16
236	STAIRWELL #2	6.00 × 3.22	19.5
237	ELECTRICAL ROOM	1.53 × 2.75	4.19
238	JANITOR	1.65 × 1.65	2.66
239	CORRIDOR	1.19 × 9.30	11.99
240	SECT. ASSISTANT	3.67 × 3.30	11.85
241	WAITING AREA	3.95 × 1.97	7.81
242	EXAM ROOM	3.35 × 3.43	11.47
243	WASHROOM	1.60 × 1.65	2.64
244	X-RAY / FILES / STORAGE ROOM	3.70 × 6.47	23.71
245	MEDICAL OFFICER	3.35 × 3.82	13.77
246	NURSE (FUTURE)	5.15 × 2.55	13.13
247	CORRIDOR	2.31 × 5.25	12.26
248	IMMIGRATION FORMS	3.66 × 5.30	18.9
249	IMMIGRATION 2nd SECT.	4.73 × 3.60	16.78
250	IMMIGRATION CONTROL OFFICER	5.40 × 3.74	19.19
251	SECT.	4.19 × 2.33	9.77
252	SECT.	4.19 × 2.82	11.82
253	VISITOR	3.79 × 2.03	7.7
254	CORRIDOR	1.50 × 20.90	32.32
255	SPARE	4.23 × 3.54	14.71
256	IMMIGRATION CAIPS	4.23 × 3.22	13.55
257	S.A. OFFICE (2)	4.23 × 4.53	18.63
258	D.C.C.	4.23 × 3.75	15.76
259	SIGNET SUP. & STORAGE	4.23 × 3.40	13.9
260	STAIRWELL #4	5.59 × 2.77	15.88
261	UPPER LOBBY	IRREGULAR	73.14
262	LOBBY	5.80 × 2.90	16.82

SPACE MEASUREMENT - CHANCERY

MEASUREMENTS ARE IN sq.m.	SECOND FLOOR	TOTAL
OUTSIDE GROSS AREA	[illegible]	[illegible]
RENTABLE AREA	[illegible]	[illegible]
USABLE AREA	[illegible]	[illegible]
BUILDING SERVICES	[illegible]	[illegible]
ACCESSORY AREAS	[illegible]	[illegible]
OFFICE	[illegible]	[illegible]
SPECIAL PURPOSE	[illegible]	[illegible]
STORAGE	[illegible]	[illegible]
CIRCULATION	[illegible]	[illegible]

NOTE:
This drawing was developed from SK-02-380-3_revC.

03 | SECOND FLOOR

NOTE 2012-07-31:
This drawing was developed from NRB-C-019-03F rev.C and files sent by the mission.

NOTE 2012-08-10:
This drawing will be finalized pending information requested to be sent by the mission.

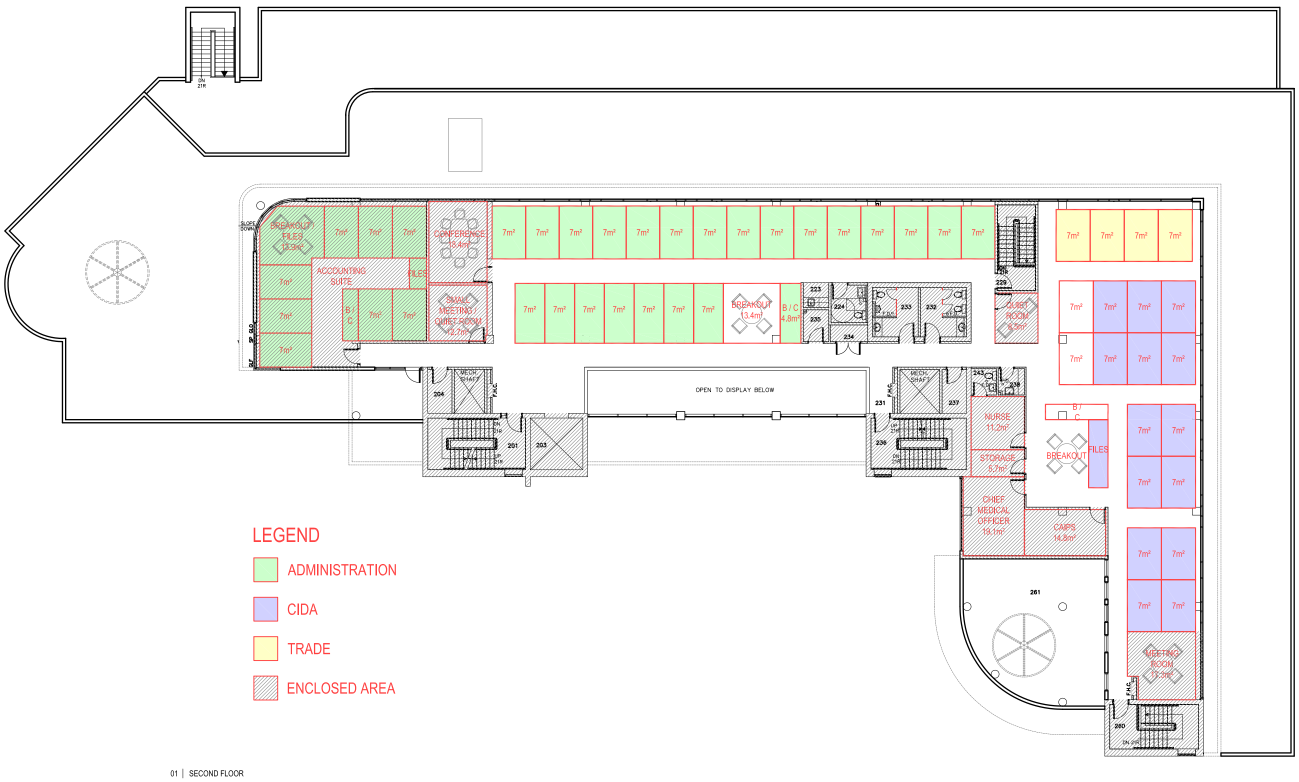
DIN A0 1189×841

CHANCERY
NAIROBI
KENYA

SECOND FLOOR PLAN
ARCHITECTURE & INTERIOR DESIGN

NRB-C-019-03 D

Proposed - Second Floor Layout



CHANCERY
NAIROBI
KENYA

PRELIMINARY CONCEPT
BLOCKING EXERCISE
SECOND FLOOR

SK-2012-0320-4 B

THIRD FLOOR PLAN

0 1 2 5 10m

SPACE SCHEDULE – THIRD FLOOR

NO.	FUNCTION	DIMENSIONS m	AREA m²
301	STAIRWELL #1	6.14 × 3.25	19.99
302	LOBBY	5.60 × 2.75	15.4
303	ELEVATOR	3.30 × 3.25	10.72
304	ELECTRICAL ROOM	2.23 × 1.50	3.34
305	CORRIDOR	IRREGULAR	20.53
306	MEETING ROOM	4.45 × 5.02	22.08
307	LIBRARY	4.52 × 2.79	12.41
308	WAITING AREA	2.04 × 3.49	7.13
309	SECRETARY / FILES	4.45 × 3.23	14.4
310	H.O.M.	6.80 × 5.10	34.4
311	CLOSET	1.60 × 2.05	3.22
312	WASHROOM	1.60 × 2.92	4.58
313	CORRIDOR	1.60 × 3.55	5.68
314	PHOTOCOPIER / STATIONARY	4.00 × 2.48	9.92
315	FAX / PRINTER	4.00 × 2.82	11.28
316	COUNSELLOR (POLITICAL)	5.82 × 3.53	20.42
317	CORRIDOR	31.60 × 1.50	49.57
318	KITCHEN	1.90 × 3.20	5.96
319	JANITOR	1.90 × 1.65	5.96
320	C.C.C.	2.72 × 4.58	13.26
321	2nd SECT.	4.52 × 3.53	15.83
322	3rd SECT.	4.56 × 3.53	15.83
323	MSR	3.61 × 4.58	17.07
324	VISITOR	3.78 × 3.58	13.38
325	SECTY.	4.13 × 3.53	14.35
326	CORRIDOR	1.20 × 3.80	4.56

NO.	FUNCTION	DIMENSIONS m	AREA m²
327	TECH.	2.43 × 3.53	8.88
328	IDACS	1.78 × 3.66	6.51
329	UNISEX WASHROOM	2.30 × 2.35	5.41
330	SECURITY OFFICER	2.93 × 3.56	10.09
330A	---	4.93 × 3.53	17.3
331	LIAISON OFFICER	6.21 × 3.53	21.58
332	SLO SECT.	4.43 × 3.38	15
333	CORRIDOR	1.50 × 3.80	5.7
334	ATTACHÉ ASSISTANT	3.04 × 4.19	15.28
335	STORE ROOM	2.83 × 2.75	7.77
336	MILITARY ATTACHÉ	4.43 × 5.03	22.06
337	MAP ROOM	2.89 × 4.19	11.86
338	CORRIDOR	13.85 × 1.50	22.23
339	WOMEN'S WASHROOM	2.87 × 3.10	8.76
340	MEN'S WASHROOM	2.87 × 3.10	8.58
341	ELECTRICAL ROOM	1.20 × 0.72	0.86
342	CORRIDOR	1.53 × 2.90	4.42
343	STAIRWELL #2	5.99 × 3.24	19.5
344	T.C.	2.35 × 1.05	2.47
345	MAILROOM / WORK-AREA	4.35 × 4.65	20.22
346	VAULT	4.15 × 5.80	24.07
347	SHREDDER	3.35 × 1.60	5.36
348	CORRIDOR	7.05 × 1.20	8.46
349	TECH. WORK	4.20 × 4.57	18.96
350	C.C.R.	4.40 × 5.85	26.44

NOTE:
This drawing was developed from SK-02-380-4_revC.

EXTERNAL AFFAIRS AND INTERNATIONAL TRADE CANADA — AFFAIRES EXTERIEURES ET COMMERCE EXTERIEUR CANADA

REVISIONS NO. REVISION		REVISIONS DATE/BY/PAR
L		
K		
J		
I		
H		
G		
F		
E		
D		
C	AREA CALCULATIONS	07.03.27 P.L.MCAKALE
B	PARTITION REVISIONS AS PER J. TÉTRAULT	06.01.24 M. GANNON
A	FURNITURE REVISIONS AS PER K.LARGE/ SRPD	05.11.22 P.L.MCKALE

A detail no. / no. du detail
B where detail required / ou detail exige
C where detail located / ou detail se trouve

CONSULTANT/SEAL — EXPERT-CONSEIL/SCEAU

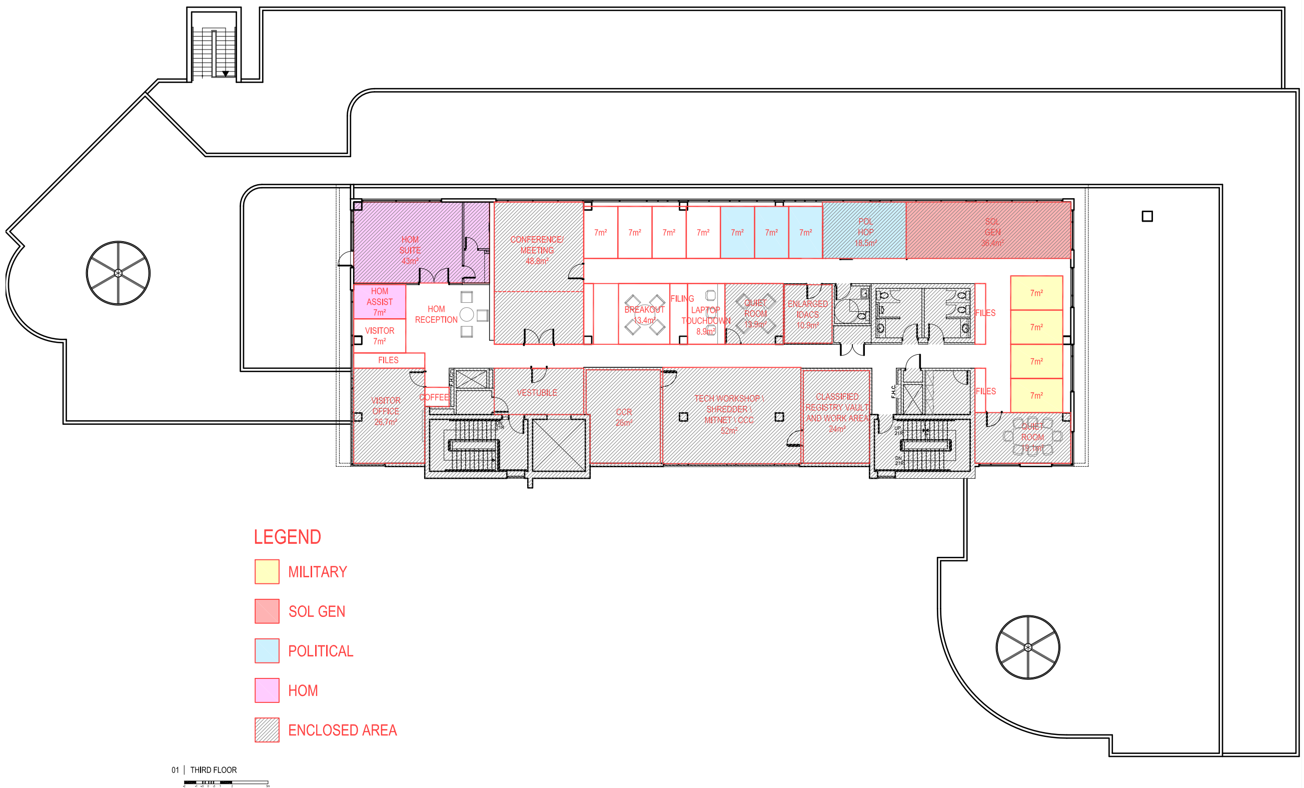
DESIGNED BY/DATE — CONCU PAR/DATE: W. GILLIS 02.12.10
DRAWN BY/DATE — DESSINE PAR/DATE: A. WHITE 04.08.13
REVIEWED BY/DATE — EXAMINE PAR/DATE
APPROVED BY/DATE — APPROUVE PAR/DATE
PROJECT MANAGER — ADMINISTRATEUR DE PROJET
PROJECT TITLE — TITRE DU PROJET: CANADIAN HIGH COMMISSION

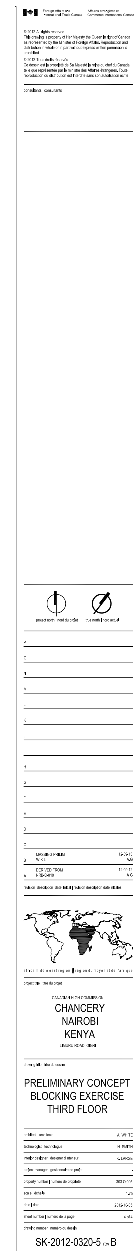
CHANCERY
NAIROBI
KENYA

LIMURU ROAD, GIGIRI

DRAWING TITLE — TITRE DU DESSIN:
THIRD
FLOOR PLAN

SCALE — ECHELLE: 1 : 100
CAD SYSTEM/VERSION — SYSTEME CAO/VERSION: AutoCAD Release 2002
PROPERTY NO. — NO. DE LA PROPRIETE: 3030095
PROJECT NO. — NO. DU PROJET
SHEET NO. — NO. DE LA FEUILLE: 4 of 4
DRAWING NO./REVISION — NO. DU DESSIN/REVISION: NRB-C-019-04F /C


HOM SUITE 43m²
CONFERENCE/ MEETING 48.8m²
7m²
7m²
7m²
7m²
7m²
7m²
7m²
POL HOP 18.5m²
SOL GEN 36.4m²
HOM ASSIST 7m²
HOM RECEPTION
VISITOR 7m²
FILES
BREAKOUT 13.4m²
FILING
LAPTOP TOUCHDOWN 8.9m²
QUIET ROOM 13.9m²
ENLARGED IDACS 10.9m²
FILES
7m²
7m²
7m²
7m²
VISITOR OFFICE 26.7m²
COFFEE
VESTUBILE
CCR 26m²
TECH WORKSHOP \ SHREDDER \ MITNET \ CCC 52m²
CLASSIFIED REGISTRY VAULT AND WORK AREA 24m²
FILES
QUIET ROOM 19.1m²
LEGEND
MILITARY
SOL GEN
POLITICAL
HOM
ENCLOSED AREA
01 | THIRD FLOOR


africa middle east region | région du moyen et de l'afrique
project title | titre du projet
CANADIAN HIGH COMMISSION
CHANCERY
NAIROBI
KENYA
LIMURU ROAD, GIGRI
drawing title | titre du dessin
PRELIMINARY CONCEPT
BLOCKING EXERCISE
THIRD FLOOR
architect | architecte A. WHITE
technologist | technologue H. SMITH
interior designer | designer d'intérieur K. LARGE
project manager | gestionnaire de projet -
property number | numéro de propriété 303 O 095
scale | échelle 1:75
date | date 2012-10-05
sheet number | numéro de la page 4 of 4
drawing number | numéro du dessin
SK-2012-0320-5_rev B

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Part 4
Building Envelope Upgrade Requirements

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Part 4. Building Envelope Upgrade Requirements

4.1 Architectural Upgrade Requirements

4.1.1 Exterior Walls

As referenced in Section 1.4 existing exterior walls are uninsulated and are comprised of cast-in-place reinforced concrete with a cementitious coating. They are marred by the presence of hundreds of cracks and significant areas of a black stain.

The following recommendations are made with the objective of improving exterior aesthetics, improving energy performance, offset of the increased cooling load imposed by the additional occupant and equipment loads, and to guard against and correct problems of rainwater infiltration. These recommendations are illustrated on the following five architectural drawings.

Exterior walls are proposed, in general, to receive 100 mm of rigid insulation, a waterproof membrane which also serves as a vapour retarder, a ventilated air space, and a lightweight rainscreen cladding. The cladding may be a metal panel system or it may be a fibre cement panel as illustrated.

Wall overhangs which are outboard of the true exterior walls are proposed to receive waterproof membrane and the panel cladding, without insulation.

Wall areas and soffits which are concealed by the overhang wall are proposed to receive insulation and waterproof membrane, without panel cladding.

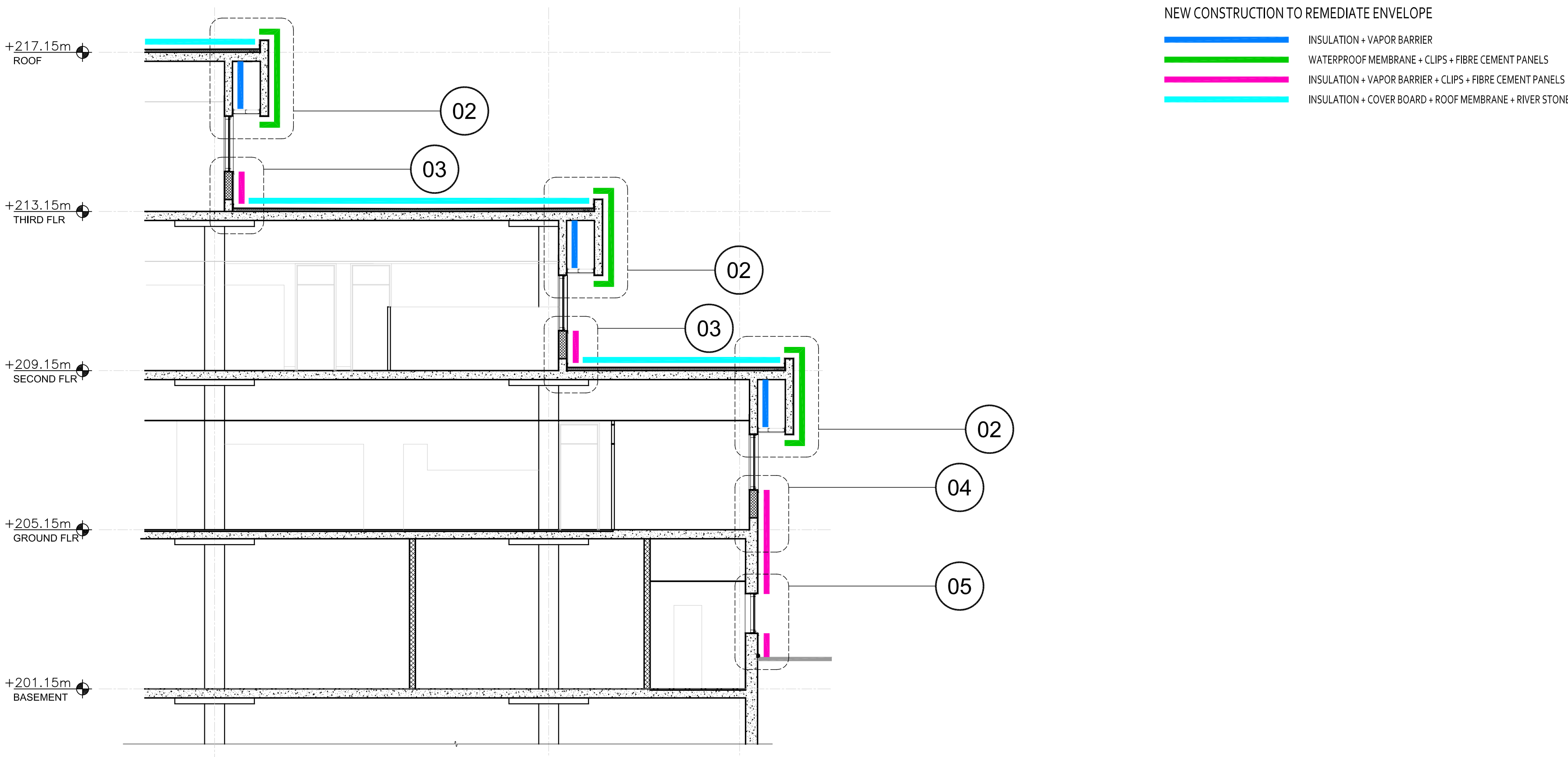
Soffits of the overhang are currently composed of cementitious plaster on metal lath and are not ventilated. It is proposed that these will be replaced with a metal grillage.

4.1.2 Exterior Windows and Curtainwall

As referenced in Section 1.4, existing exterior windows and curtainwall are comprised of tinted single-glazing in commercial curtainwall frames. We recommend that all glazing will be replaced with tinted double glazed units. Glass types will be in accordance with Section 4.2 for Physical Security Upgrades. Frame replacement and reinforcement will also be in accordance with Section 4.2.

4.1.3 Roof Assembly and Skylights

As referenced in Section 1.4 there are numerous deficiencies in the existing roofing assembly. The proposed recommended roofing replacement is described in Section 1.4. Existing skylights are leaking and are only single-glazed. The proposed skylight work is also described in Section 1.4.



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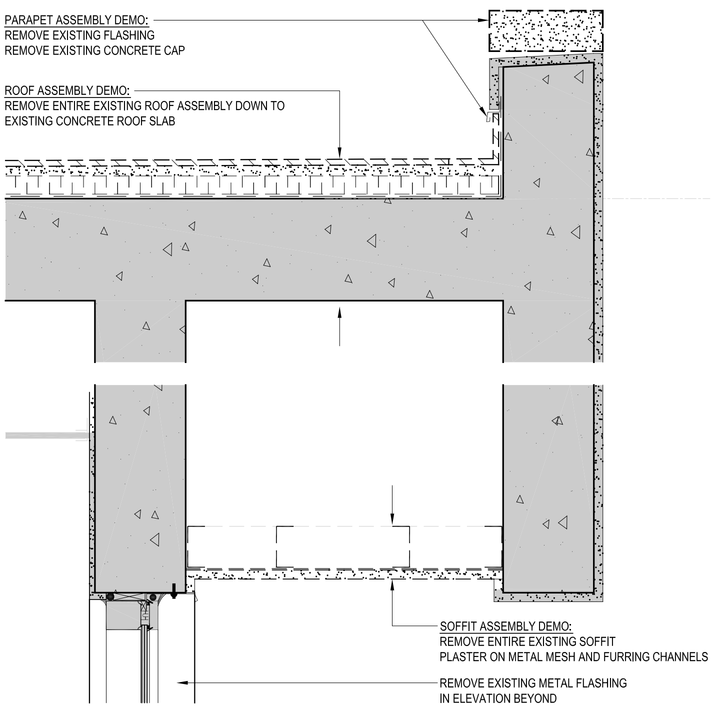
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

BUILDING SECTION - PROPOSED REMEDIATIONS

01

DATE: MAY 30, 2012
SCALE:
0 1.0 2.5 5.0 7.5 10.0

EXISTING CONSTRUCTION TO BE REMOVED



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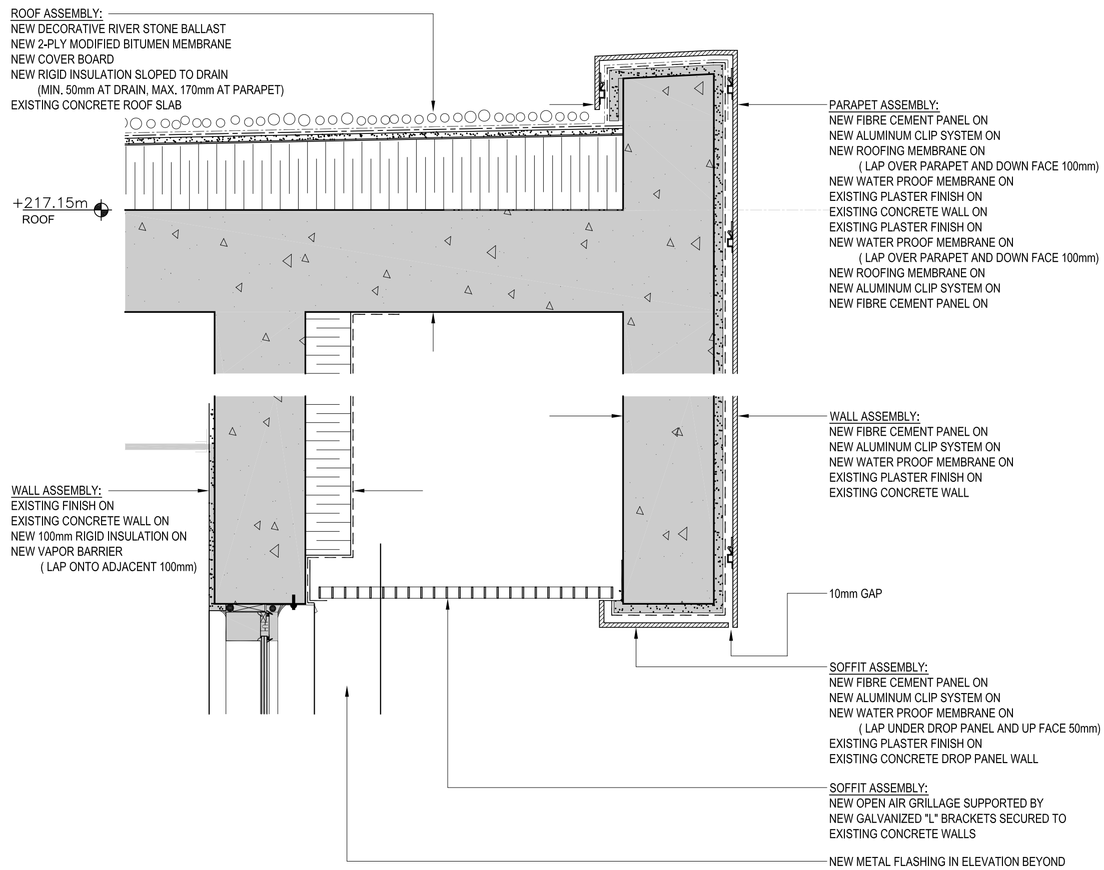

EXISTING CONSTRUCTION TO REMAIN
NEW VAPOR BARRIER
NEW ROOFING MEMBRANE

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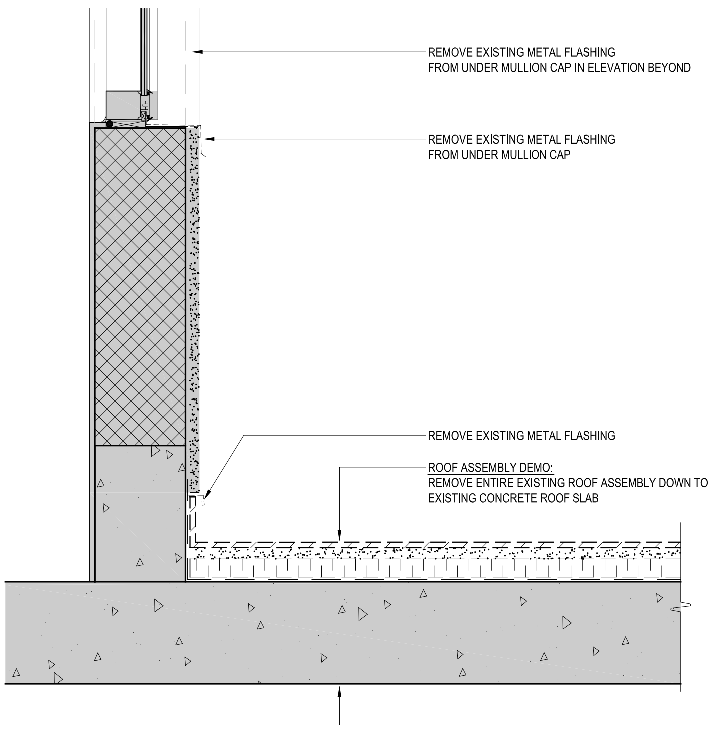
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS - ROOF AT PARAPET

DATE: MAY 30, 2012
SCALE:
0 100 250 500 750 1000

02

EXISTING CONSTRUCTION TO BE REMOVED



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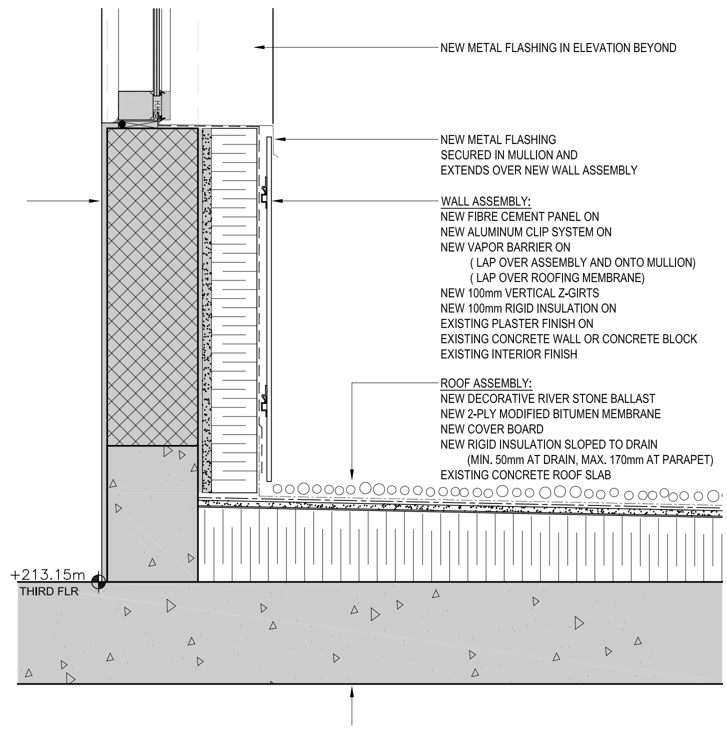

EXISTING CONSTRUCTION TO REMAIN
VAPOR BARRIER
ROOFING MEMBRANE

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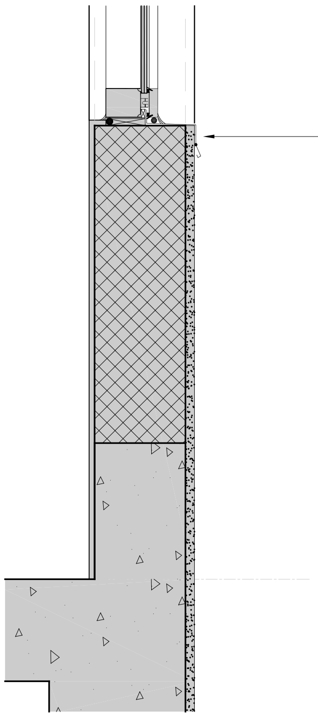
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS - ROOF AT WALL BASE

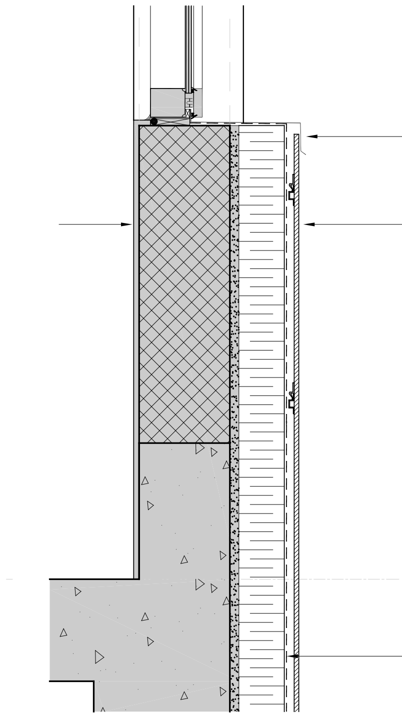
DATE: MAY 30, 2012
SCALE:
0 100 250 500 750 1000

03

EXISTING CONSTRUCTION TO BE REMOVED



NEW CONSTRUCTION TO REMEDIATE ENVELOPE



EXISTING CONSTRUCTION TO REMAIN
VAPOR BARRIER
ROOFING MEMBRANE

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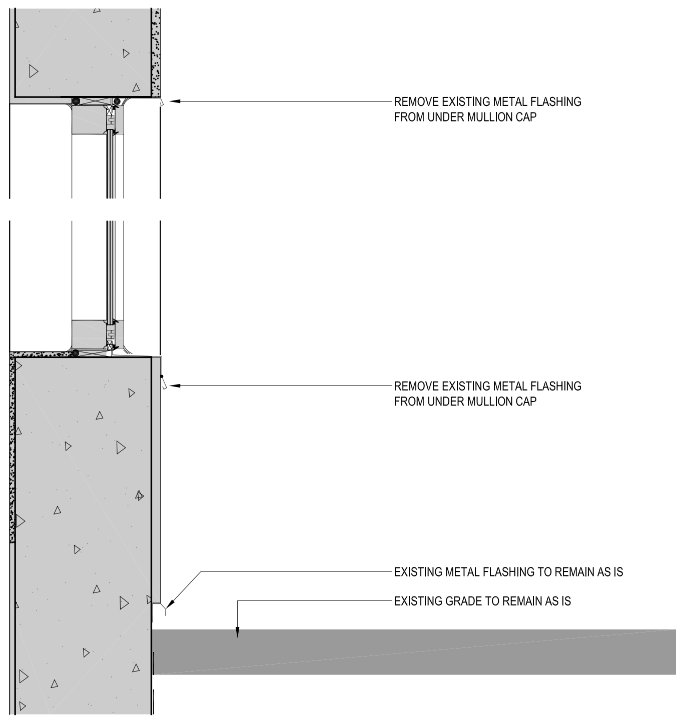
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS - WALL AT FLOOR SLAB

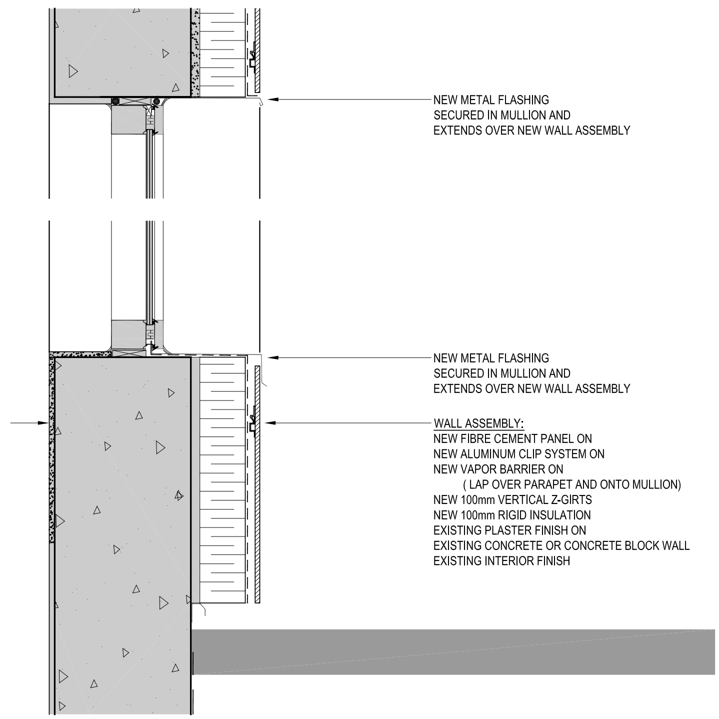
04

DATE: MAY 30, 2012
SCALE:
0 100 250 500 750 1000

EXISTING CONSTRUCTION TO BE REMOVED



NEW CONSTRUCTION TO REMEDIATE ENVELOPE



EXISTING CONSTRUCTION TO REMAIN
VAPOR BARRIER
ROOFING MEMBRANE

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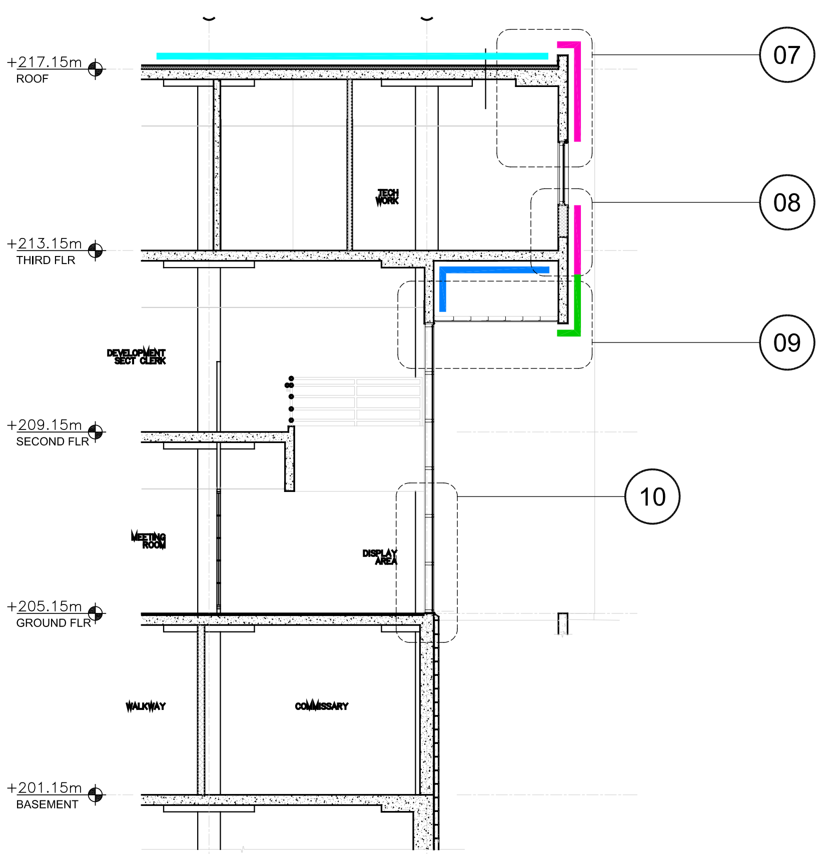
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS -WALL AT GRADE

DATE: MAY 30, 2012
SCALE:
0 100 250 500 750 1000

05



NEW CONSTRUCTION TO REMEDIATE ENVELOPE

- INSULATION + VAPOR BARRIER
- WATERPROOF MEMBRANE + CLIPS + FIBRE CEMENT PANELS
- INSULATION + VAPOR BARRIER + CLIPS + FIBRE CEMENT PANELS
- INSULATION + COVER BOARD + ROOF MEMBRANE + RIVER STONE

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ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

BUILDING SECTION - PROPOSED REMEDIATIONS 06

DATE: SEPTEMBER 05, 2012
SCALE:
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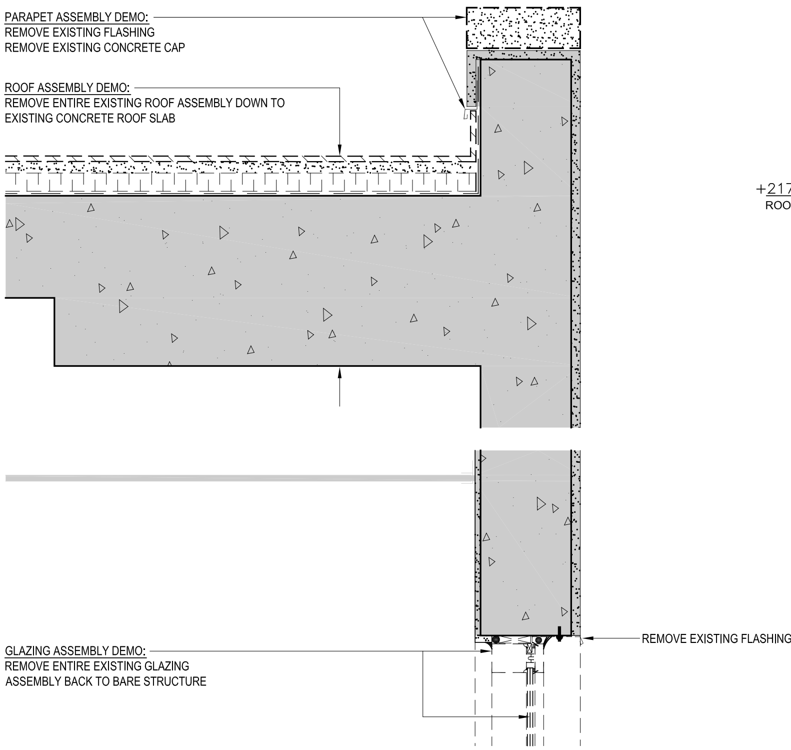

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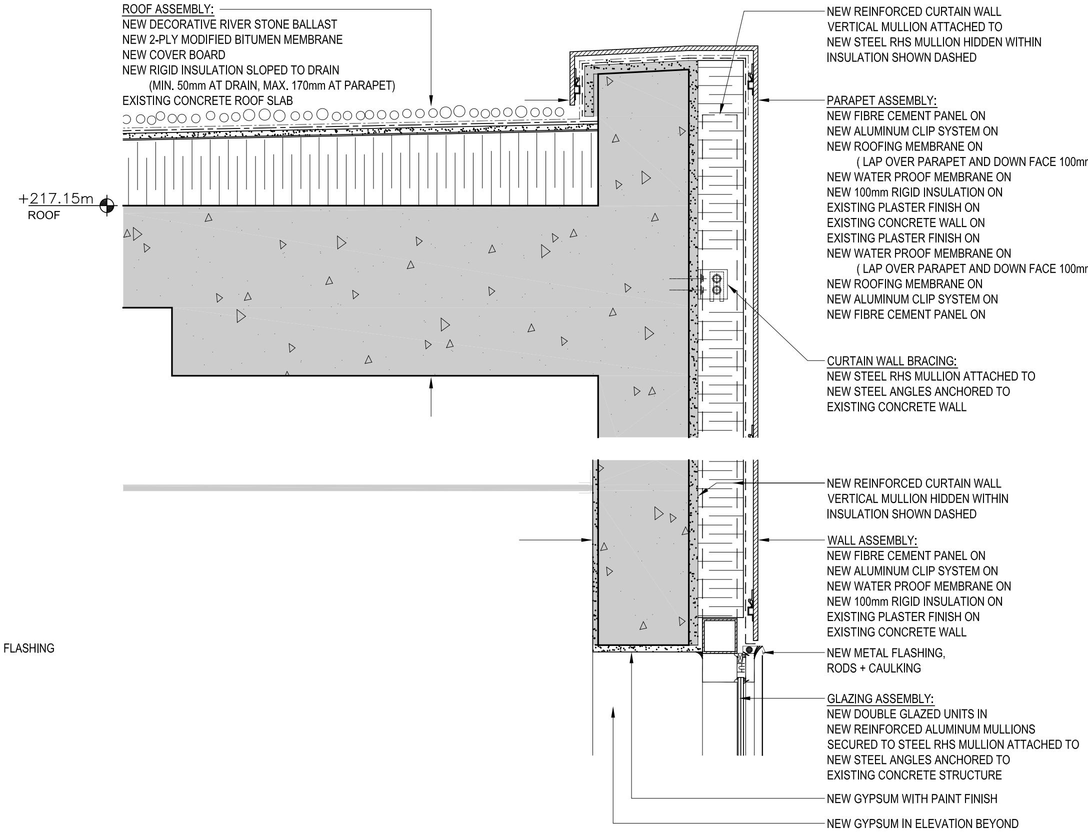

EXISTING CONSTRUCTION TO REMAIN
NEW VAPOR BARRIER
NEW ROOFING MEMBRANE

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ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS - ROOF AT PARAPET & GLAZING 07

DATE: SEPTEMBER 05, 2012
SCALE:
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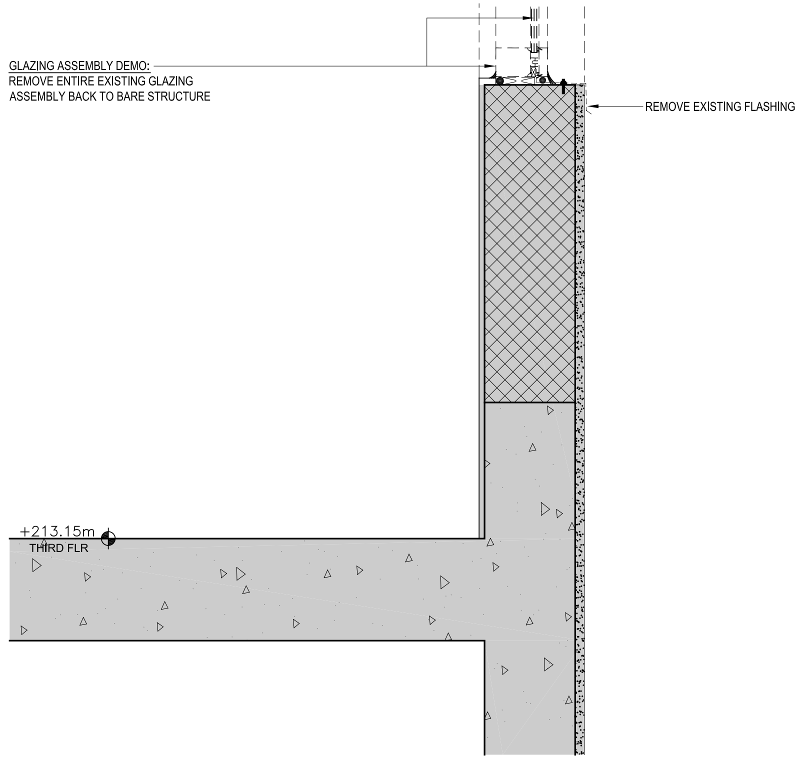
EXISTING CONSTRUCTION TO BE REMOVED



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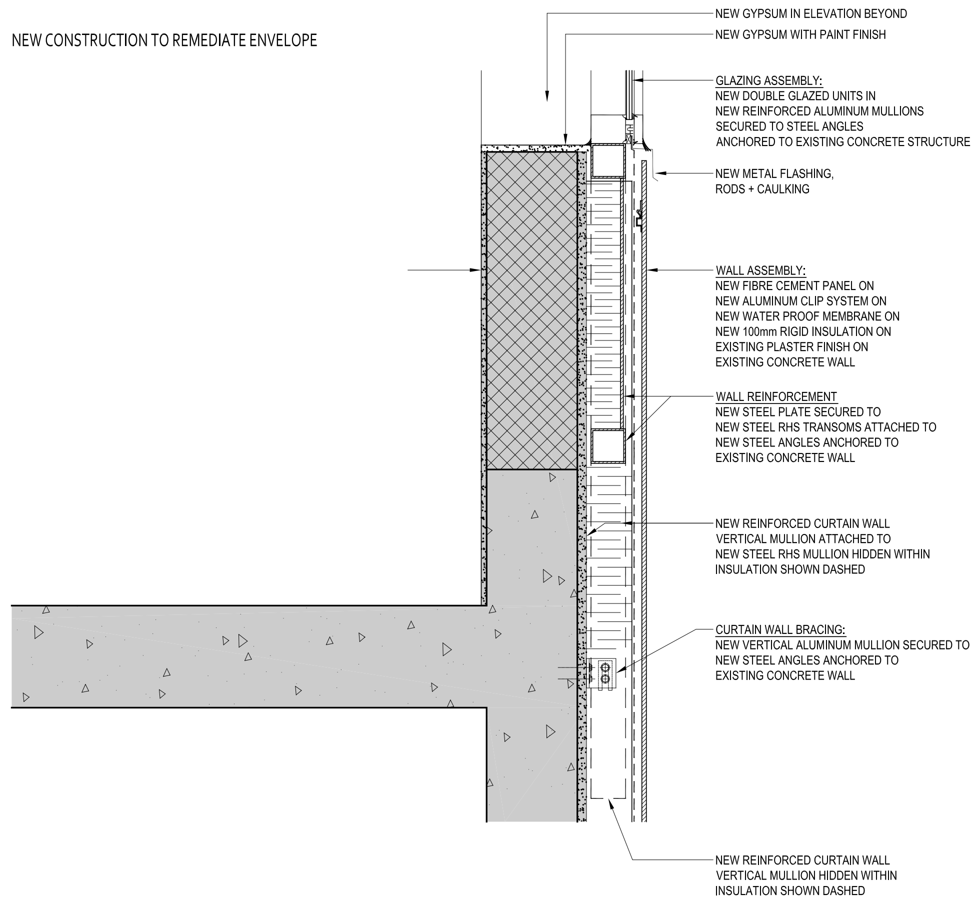

EXISTING CONSTRUCTION TO REMAIN
NEW VAPOR BARRIER
NEW ROOFING MEMBRANE

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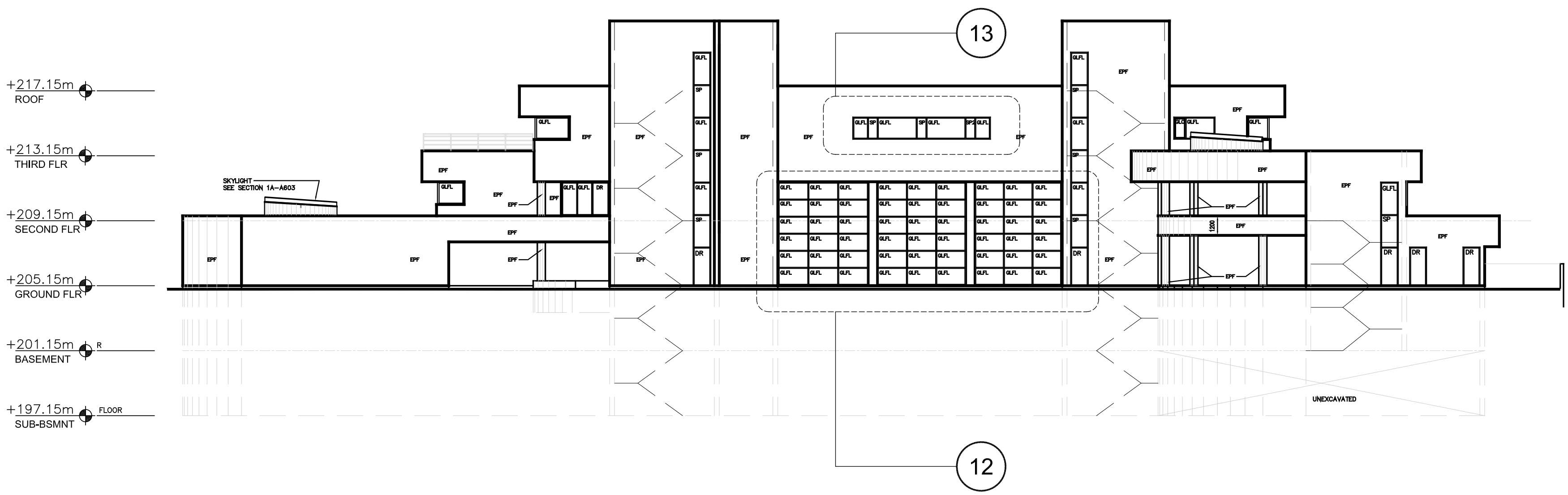
ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

SECTION DETAILS - GLAZING AT FLOOR SLAB

08

DATE: SEPTEMBER 05, 2012
SCALE:
0 100 250 500 750 1000



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ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

BUILDING NORTH-EAST ELEVATION - PROPOSED

11

DATE: SEPTEMBER 5, 2012
SCALE:
0 1.0 2.5 5.0 7.5 10.0

EXISTING CONSTRUCTION TO BE REMOVED

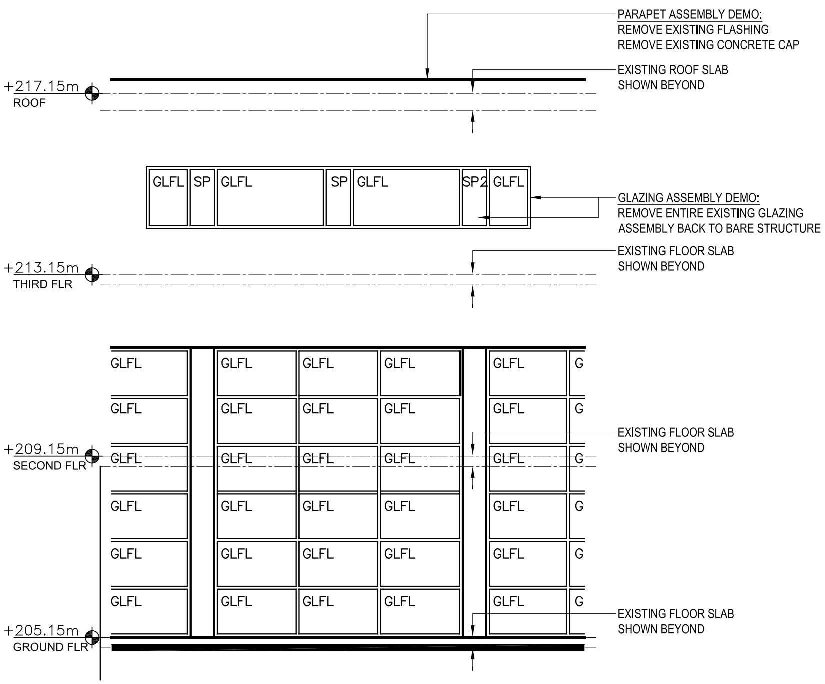
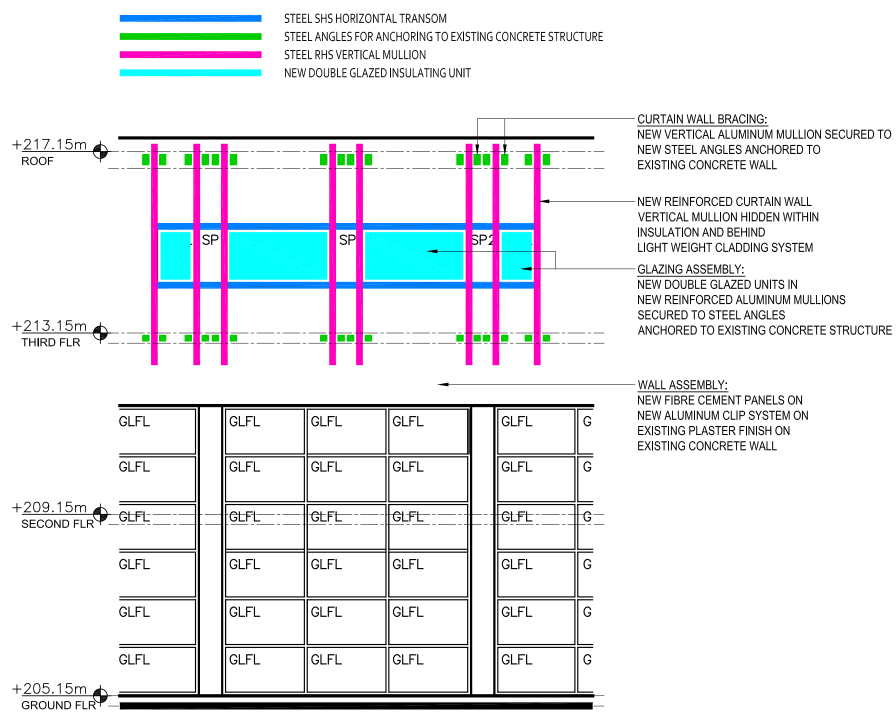


DIAGRAM OF GLAZING REINFORCING



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ENVELOPE MODIFICATIONS TO EXISTING CANADIAN CHANCERY
LIMURU ROAD, GIGIRI, NAIROBI, KENYA

ENLARGED NORTH-EAST ELEVATION - PROPOSED

13

DATE: SEPTEMBER 5, 2012
SCALE: 0 1.0 2.5 5.0 7.5 10.0

4.2 Security Upgrade Requirements

4.2.1 Introduction

As part of a number of building envelope enhancements proposed for the Canadian Chancery in Nairobi measures are included to address deficiencies in the building with regards to blast resilience and security.

These proposed security upgrades relate to the glazed areas of the building and would take advantage of the proposed replacement to improve thermal performance of all glazing in the building, including the two story lobby curtain wall on the north-eastern elevation.

The majority of the enhancements described in this report address the building envelope's resilience against bomb blast threats, although forced entry resistance is also considered.

The design basis bomb blast threats are defined in accordance with ISO 16933:2007 - Explosion resistant security glazing. The defined threat for the north-eastern elevation is DFAIT Level 1. The defined threat for all other elevations is DFAIT Level 2.

The following areas are covered in this report:

- Lobby curtain wall on the north-eastern elevation.
- High level glazing on north eastern elevation.
- General glazing on all other elevations.
- Forced entry requirements within 3metres of ground level.

4.2.2 North Eastern Lobby Curtain Wall

Replacement of the existing single glazing with double glazed insulating glass units (IGU) to improve thermal efficiency is proposed as part of the overall building enhancements. The existing aluminum framing is not sufficiently robust to support the IGUs under the defined blast loading. The proposed glass replacement provides an opportunity to also upgrade the framing to meet the blast protection requirements. Three enhanced framing concept options have been considered as described in this report.

4.2.2.1 Option 1 - Aluminum framed curtain wall with mid height support

Due to the required height of the mullions a single span arrangement using readily available standard aluminum extrusions is not feasible façade, even when reinforced with steel inserts.

Therefore it is necessary to introduce an additional support beam at Level 2 (+4m above ground level) which would span between existing structural columns. To avoid imposing lateral blast loads onto these columns, struts are required to transfer bomb blast reaction forces from the facade into the plane of the level 2 slab where they would be dissipated into the overall mass of the building.

In order to align the support beam and column struts with the level 2 slab a mod-

est rearrangement of the sizes of the glazing units may be necessary. At this stage glazing modules of 1.8m wide by 1.0m high are proposed which will leave a 300mm gap at the top of the curtain wall that would require a spandrel panel or some other closing component.
The proposed curtain wall make up for Option 1 is as follows:

- 1.8m x 1.0m IGUs (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- Inner face of IGUs to be bonded to mullions and transoms using suitable structural silicone sealant such as Dow Corning 993 or 995.
- 120mm x 60mm x 3mm aluminum profile transom*.
- 225mm x 80mm x 3mm aluminum profile mullion* with internal steel reinforcement.
- 150mm x 150mm x 12.5mm steel SHS (grade355) support beam.
- 120mm x 120mm x 5mm steel SHS (grade 355) strut (or equivalent CHS if visually preferable).

* note that aluminum section details are based on Schüco profiles and must be confirmed, along with the steel member sizes, at detailed design stage if this option is adopted. Other suppliers' sections may also be suitable.

The indicative details shown require site application of structural silicone sealant at the inner face of the IGUs. Alternative methods using pre-fixed carrier frames bonded offsite to the IGUs could be developed at detailed design stage if preferred.

The suitability of the glass make up and framing sizes noted above under non-blast design criteria must also be considered and confirmed as part of the overall design coordination.

Horizontal blast reactions at the tops of the enhanced mullions may exceed the lateral capacity of the existing reinforced concrete downstand panel to which mullions are currently attached. A bracing detail, as illustrated later in this report under Option 3, may also be required for Option 1.

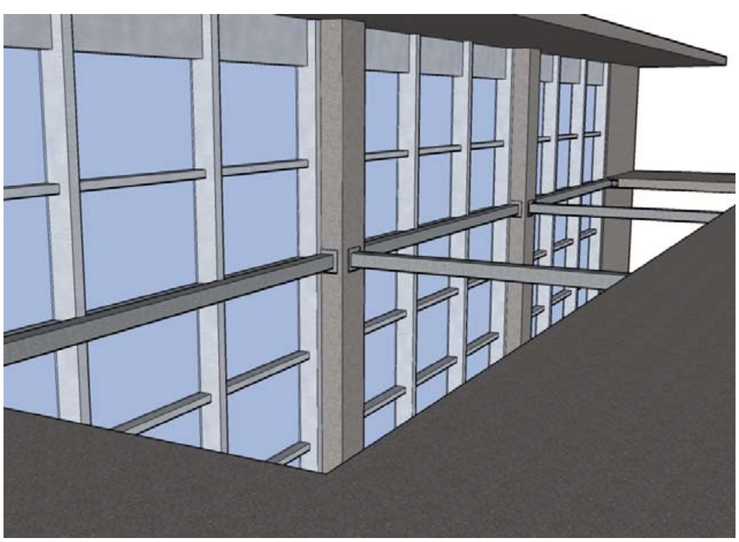


Figure 4.2.1: Option 1 internal view from Level 2

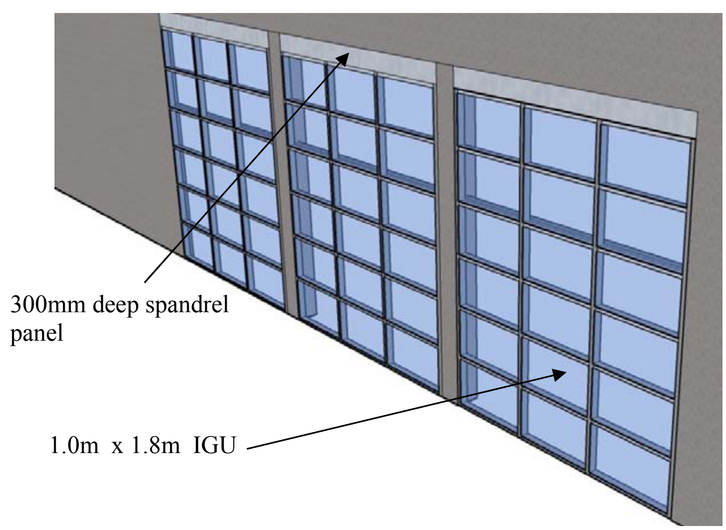


Figure 4.2.2: Option 1 exterior sketch showing spandrel panel requirement

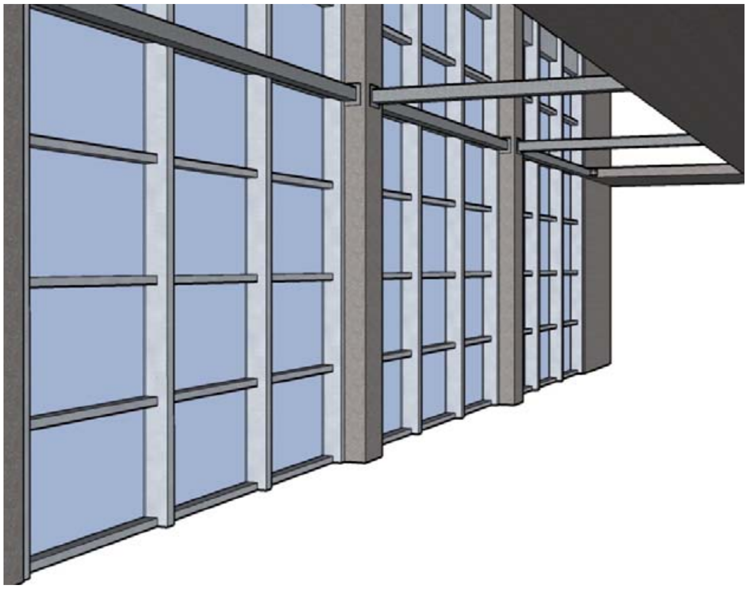


Figure 4.2.3: Facade interior showing transoms and mullions.

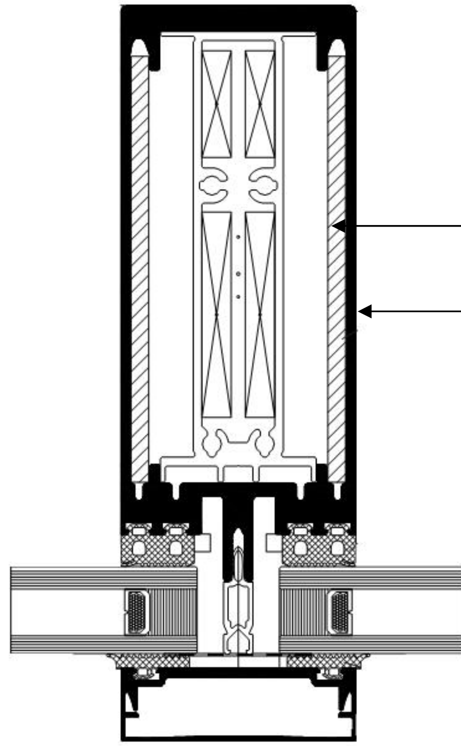


Figure 4.2.4: Reinforced aluminium section For blast enhanced condition inner face gaskets to be replaced (partially or fully as required by detailed design) with structural silicone sealant.

4.2.2.2 Option 2 - Steel framed curtain wall with mid height support

This option follows the same principles as Option 1 but replaces the aluminum extruded sections with steel box sections. By using an all steel facade the depth of the mullions and transoms can be reduced. The mid-height support and struts at column locations are still required.

The steel box sections can be clad in aluminum (or another material at the architect's discretion) for a more aesthetically pleasing solution.

Extruded aluminum carrier frames can be fixed to the front faces of the steel box sections in order to accept the IGUs and to achieve a satisfactory bond between the glass and the frames using structural silicone sealant.

The proposed curtain wall make up for Option 2 is as follows:

- 1.8m x 1.0m DGU's (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- Inner face of IGUs to be bonded to mullions and transoms using suitable structural silicone sealant such as Dow Corning 993 or 995.
- 100mm x 60mm x 5mm steel RHS transom.
- 120mm x 80mm x 10mm steel RHS mullion.
- 150mm x 150mm x 12.5mm steel SHS (grade355) support beam.
- 120mm x 120mm x 5mm steel SHS (grade 355) strut (or equivalent CHS if visually preferable).

The indicative details shown require site application of structural silicone sealant at the inner face of the IGUs. Alternative methods using pre-fixed carrier frames bonded offsite to the IGUs could be developed at detailed design stage if preferred.

The suitability of the glass make up and framing sizes noted above under non-blast design criteria must also be considered and confirmed as part of the overall design coordination.

Horizontal blast reactions at the tops of the enhanced mullions may exceed the lateral capacity of the existing reinforced concrete downstand panel to which mullions are currently attached. A bracing detail, as illustrated later in this report under Option 3, may also be required for Option 1.

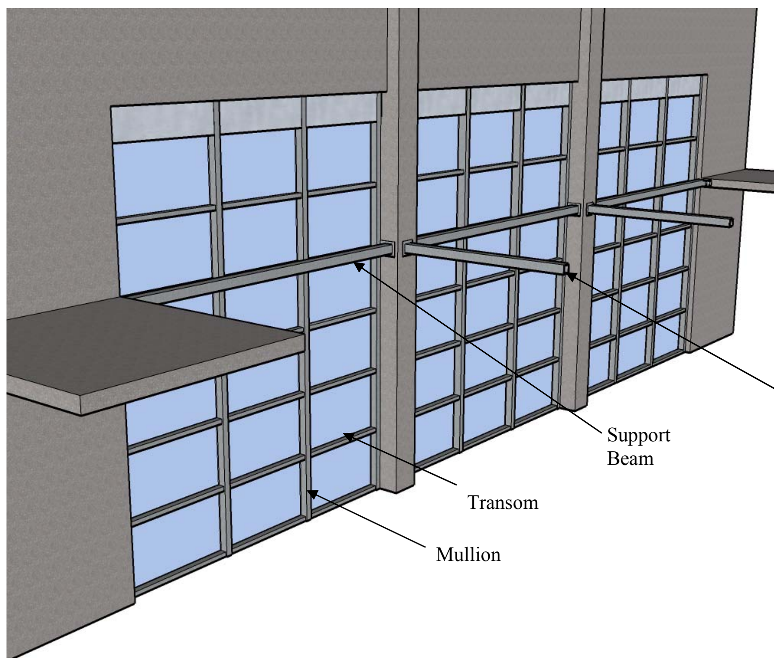


Figure 4.2.5 - Option 2 transom and mullions

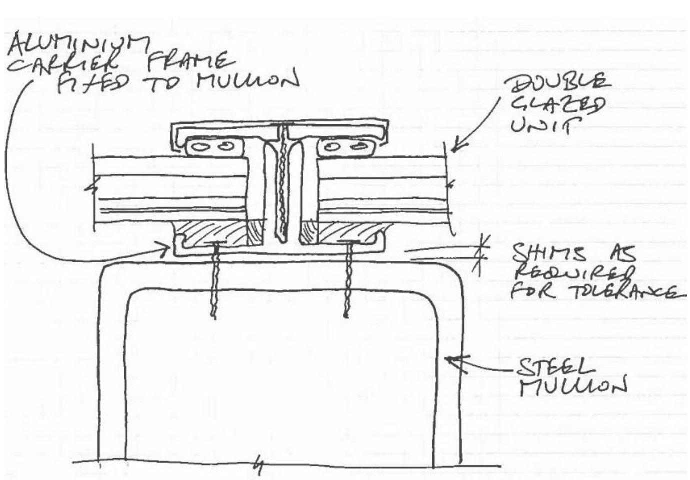


Figure 4.2.6 - Indicative sketch of carrier frames to fitted to the front of steel box sections

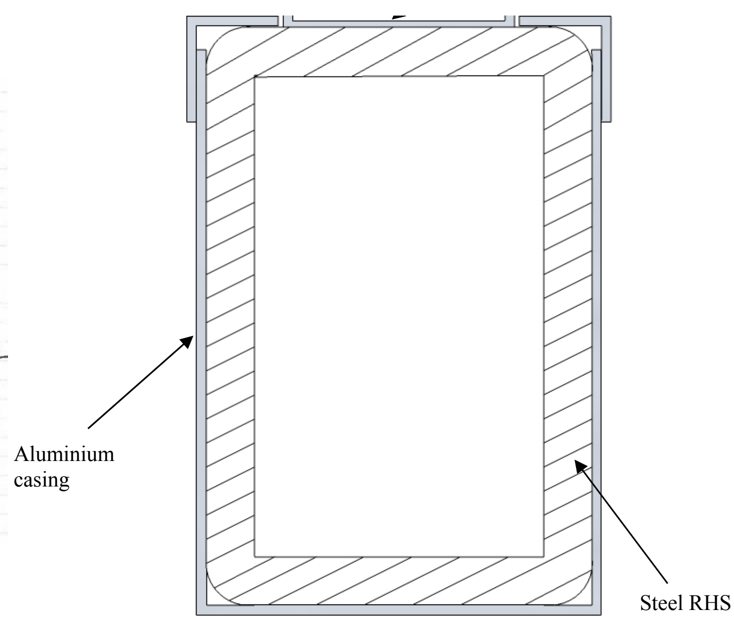


Figure 4.2.7 - indicative sketch of aluminium casing on steel box section.

4.2.2.3 Option 3 – Full height steel framed curtain wall

Option 3 removes the requirement for additional supporting structure behind the curtain wall by adopting full height steel mullions. Due to the height of the facade this requires a deeper steel section than shown in Option 2; however the total depth is still expected to be less than that of Option 1.

One challenge with opting for full height mullions is the head restraint. It is clear by inspection that the reinforced concrete down stand at the head of the facade will not have sufficient capacity to resist the horizontal reaction forces from the facade under blast. Therefore it will be necessary to provide a restraint mechanism through the use of either a tie or a strut element. As the site inspection indicated that an internal strut may cause coordination issues with existing building services a possible arrangement for an external inclined tie member is illustrated here. Note that although the primary function of this tie is to resist the initial inward blast reaction due to an external explosion, the member should be designed with sufficient compression capacity to resist a subsequent outward reaction as the curtain wall systems rebounds after its initial inward response.

Steel sections can be clad in aluminum if required visually with extruded carrier sections to ensure satisfactory structural bonding of the IGUs as described in Option 2.

Extruded aluminum carrier frames can be fixed to the front faces of the steel box sections in order to accept the IGUs and to achieve a satisfactory bond between the glass and the frames using structural silicone sealant as described in Option 2.

Without the need to align internal support beams and struts with the Level 2 slab the IGUs for Option 3 can be of the same dimensions as the existing single glazed units.

The proposed curtain wall make up for Option 3 is as follows:

- 1.8m x 1.05m DGU's (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- 100mm x 60mm x 5mm steel RHS transom.
- 200mm x 100mm x 16mm steel RHS mullion.

As for Options 1 & 2 the indicative details shown require site application of structural silicone sealant at the inner face of the IGUs. Alternative methods using pre-fixed carrier frames bonded offsite to the IGUs could be developed at detailed design stage if preferred.

The suitability of the glass make up and framing sizes noted above under non-blast design criteria must also be considered and confirmed as part of the overall design coordination.

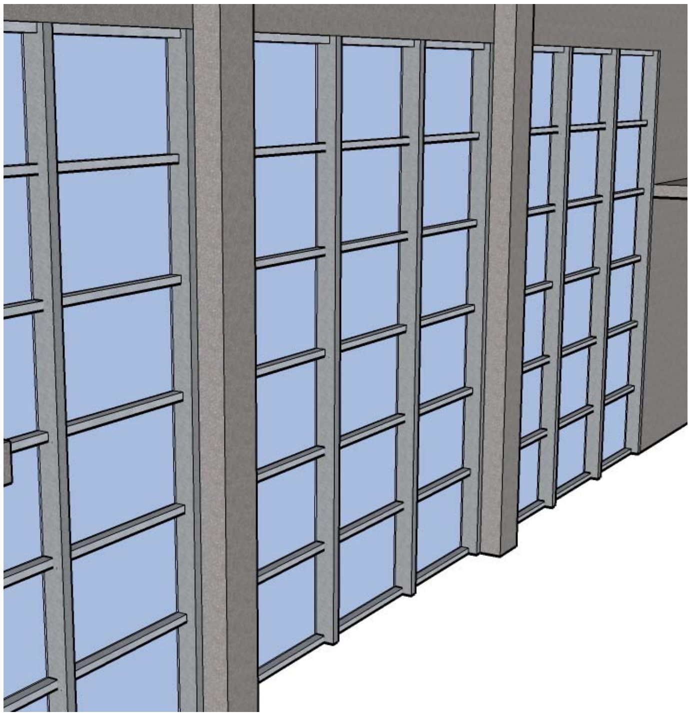


Figure 4.2.8 - Option 3 transom and mullions.

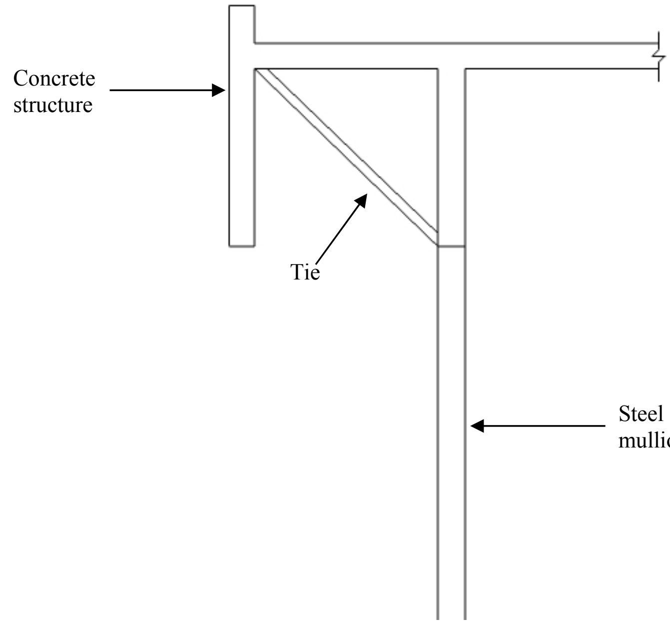


Figure 4.2.9 - schematic diagram showing tie requirement.

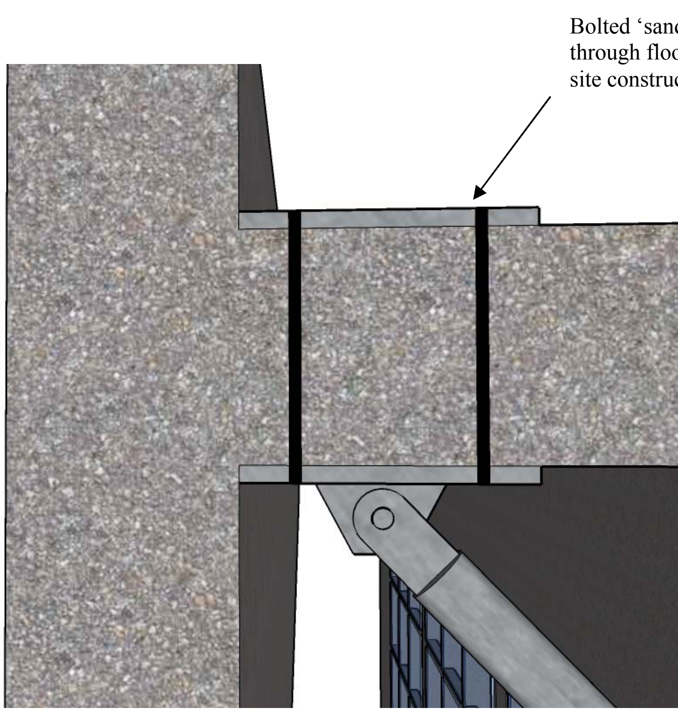


Figure 4.2.10 - Potential slab to tie connection (indicative only)

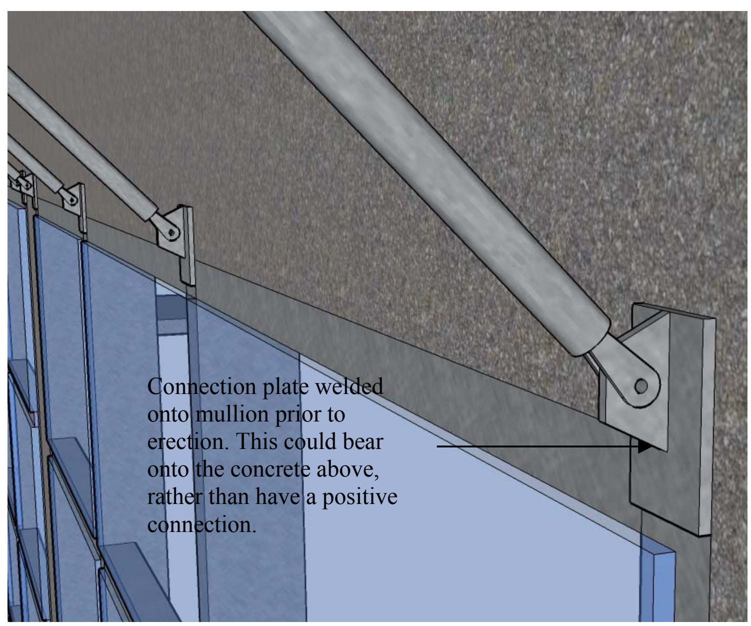


Figure 4.2.11 - Potential mullion to tie connection (indicative only)

4.2.3 North Eastern Elevation

This report section considers the windows at level 3 on the North East elevation of the Chancery. Replacement of the existing single glazing with double glazed insulating glass units (IGU) to improve thermal efficiency is proposed as part of the overall building enhancements. Neither the existing frames nor their fixings to the structure are considered sufficiently robust to support the IGUs under the defined blast loading. The proposed glass replacement provides an opportunity to upgrade the framing to meet the blast protection requirements.

Both the concrete masonry below the window cills and the narrow concrete downstands above the windows are potential weaknesses in the load path under blast loading from enhanced window frames back to the primary building structure. One option would be to install new slab to slab mullions inside the current exterior wall line to provide support for new blast enhanced windows that would take the place of the existing units. However as this would impinge significantly on the internal floor space and possibly with services above the ceiling it is proposed that a new framing system should be fitted to the outside face of the concrete wall with mullions spanning from slab to slab. Blast resistant window units could then be fixed to the new mullions and transoms. This approach is made feasible by the proposal to improve the existing exterior assembly by applying external insulation and a new cladding system to the outside of the concrete structure. The insulation layer provides a zone in which to accommodate the framing for the blast resistant windows. The transom and mullion framing will be hidden with architectural cladding so that the only visible elements of this system are the windows themselves.

To minimize the required mullion depth in order to avoid an excessive depth of new external insulation/cladding it is proposed to vertically split the largest of the existing window modules by providing central mullions.

Note the new blast resistant windows would sit outboard of the position of the existing window units, which would be removed. This would leave deeper window internal reveals than at present to which architectural finishes may need to be applied.

The 700mm high masonry wall below the windows also requires blast protection. This can be done using steel plate spanning between the transoms and mullions. The steel plate and the framing system will need to be offset from the wall sufficiently such that they can deflect inwards under blast load without impacting on the masonry which could cause fragmentation hazard to occupants. This offset should be in the region of 50 to 100mm.

The proposed blast resistant window system includes the following elements:

- 1.4m high x 1.0m wide DGUs [CHECK DIMENSIONS] (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- 1.4m high x 1.2m wide DGUs [CHECK DIMENSIONS] (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- 6mm thick steel plate spandrel panels in front of masonry walls.
- 100mm x 100mm x 4mm RHS transom.

- 200mm x 100mm x 16mm steel RHS (acting in its minor axis).

The suitability of the glass make up and framing sizes noted above under non-blast design criteria must also be considered and confirmed as part of the overall design coordination.

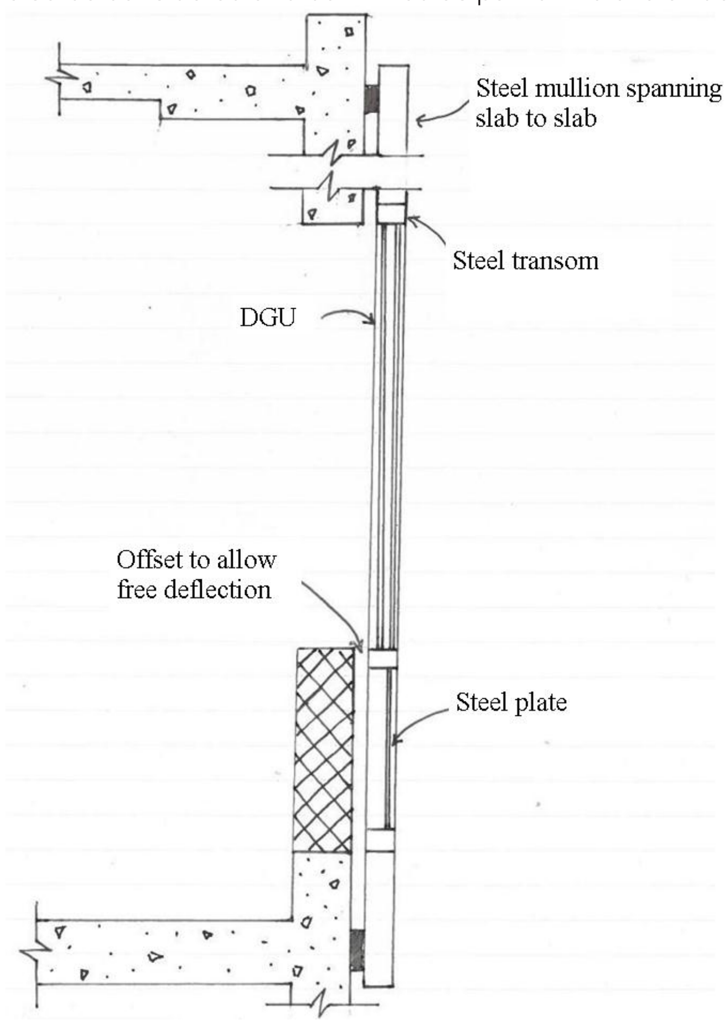


Figure 4.2.12 - Section through scheme for window replacement at high level. (Cladding and finishes omitted for clarity)

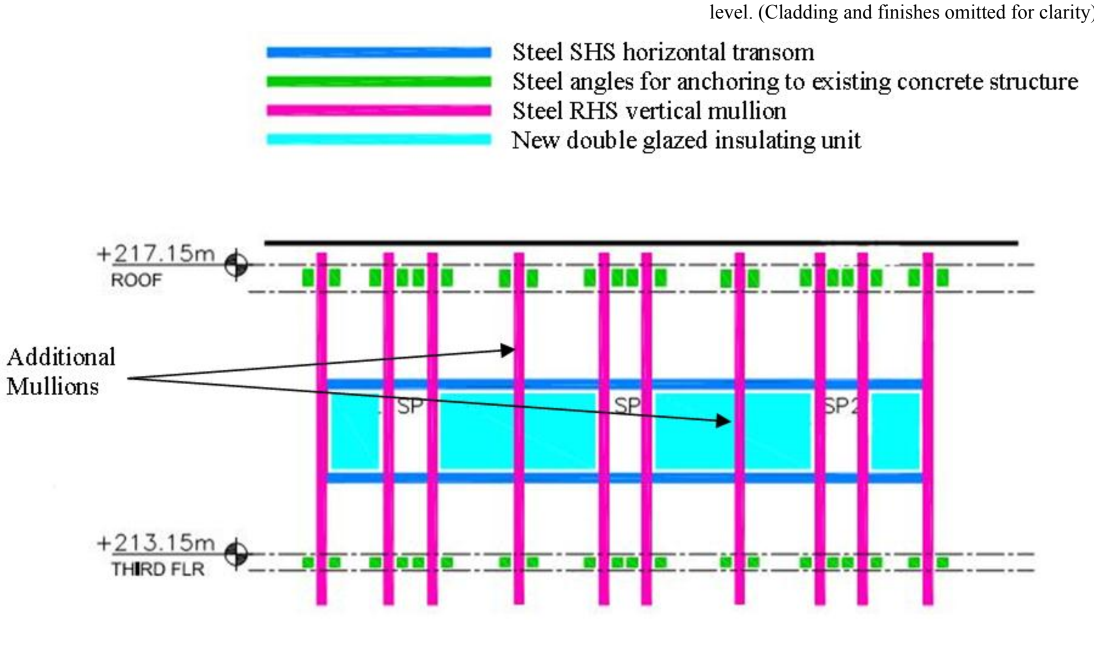


Figure 4.2.13 - Schematic drawing of the window coverings to be applied.

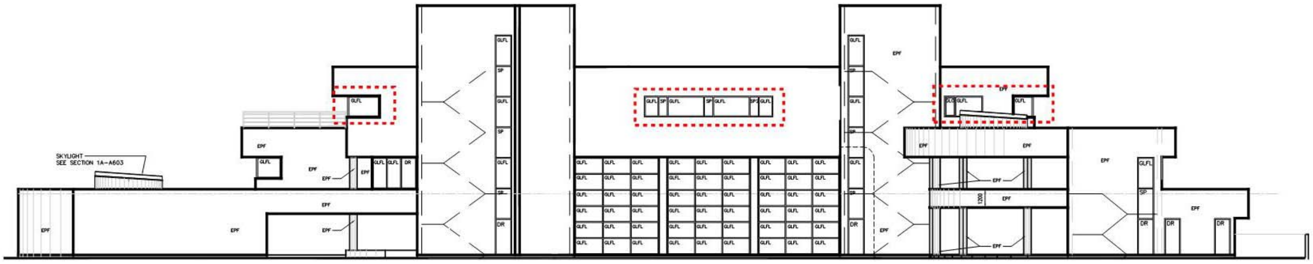


Figure 4.2.14 - High level windows being considered shown in dotted line.

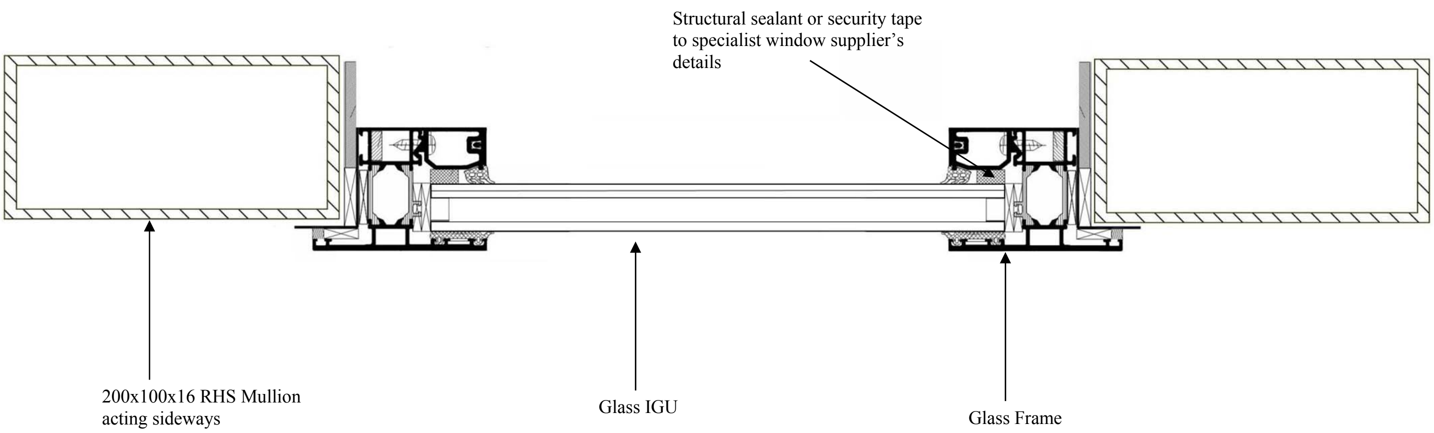


Figure 4.2.15 - proprietary window frames fixed into opening formed by steel RHS mullions. Vertical section would look similar, only with 100x100x4mm RHS's

4.2.4 Stairwell Glazing

There are two stairwells on the North east elevation, each with a strip of windows which will also be required to resist the defined bomb blast threat. In order to achieve this, it is proposed that a proprietary blast enhanced glazing system be installed.

Such a system would comprise transoms spanning the width of the opening with suitable vertical sections fixed regularly to the edges up the height of the opening in the concrete wall.

The proposed blast resistant window system includes the following elements:

- 1.0m wide x 2.0m high IGU's (8mm heat strengthened outer lite - air gap as required for thermal performance - 12.76 heat strengthened laminated inner lite).
- 100mm x 60mm x 2mm aluminum profile transom.
- Vertical edge profile aluminum frame compatible with transom depth and width regularly fixed to the concrete structure.

Note that aluminum section details are based on Schüco profiles and must be confirmed at detailed design stage. Other suppliers' sections may also be suitable.

The suitability of the glass make up and framing sizes noted above under non-blast design criteria must also be considered and confirmed as part of the overall design coordination.

No further physical enhancement against forced enrty of the lowest unit of the glazing to each stairwell is proposed.

The fire escape at the bottom of the stairwell will also need to meet the same blast and forced entry protection as well as relevant fire protection. It is suggested that a proprietary door system form a specialist manufacturer be used.

* Please note that aluminium profile sections are approximate based information provided by Shuco. These will need to be analysed further at detailed design stage.

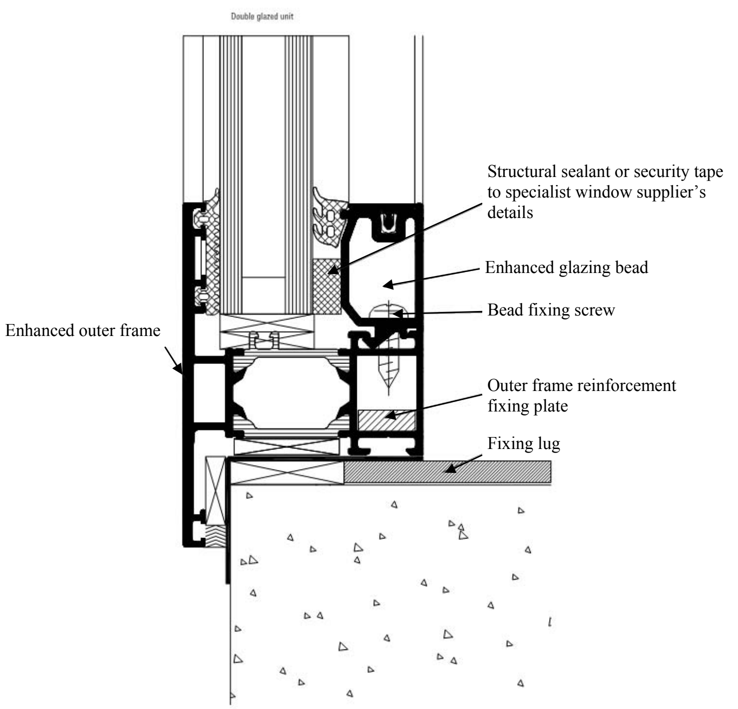


Figure 4.2.16: Example of aluminium profile section for outside edges of opening (Taken from Schuco AWS 66E specifiers guide)

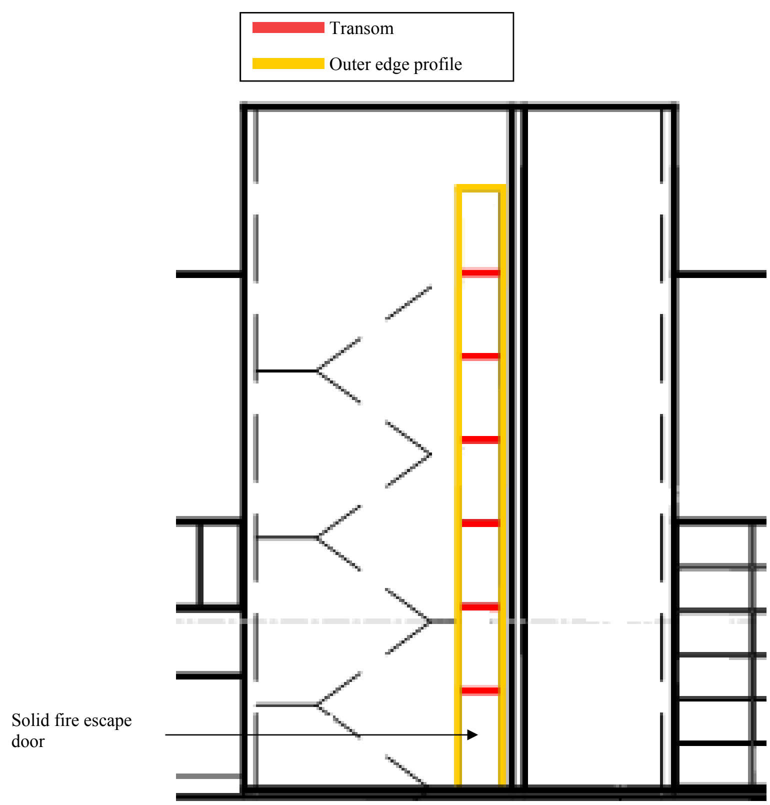


Figure 4.2.17: Sketch showing location of stairwell glazing.

4.2.5 General Glazing

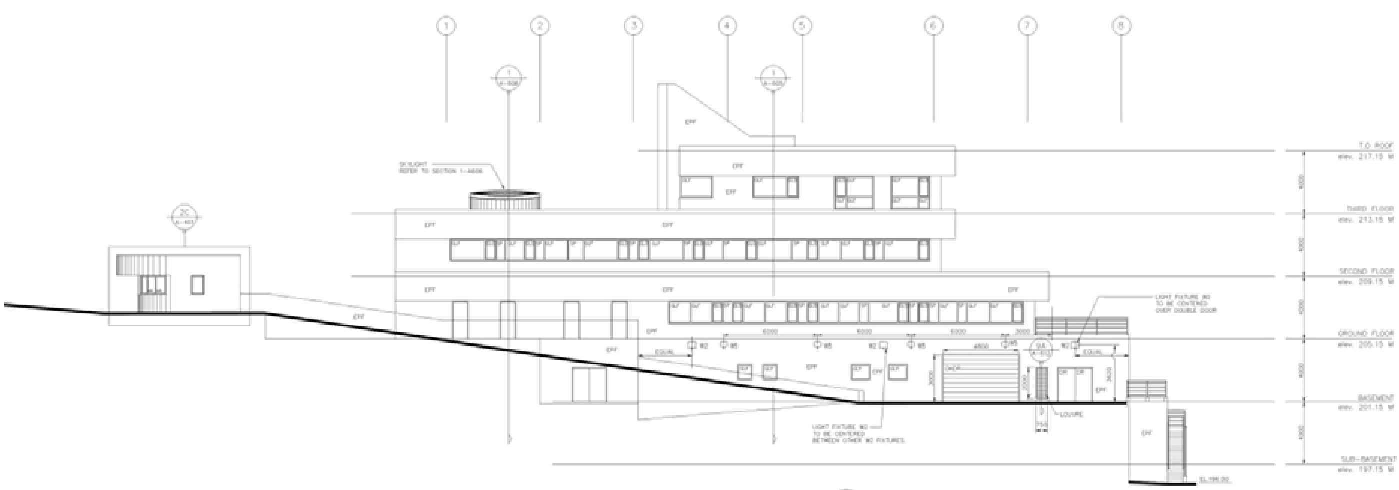
For the north-west, south-west and south east elevations the intention is to replace the current glazing with new double glazed IGUs to improve the thermal performance of these areas of the building envelope. This glazing replacement provides an opportunity to enhance the blast resilience of these windows, which currently have single panes of monolithic heat strengthened glass. As confirmed by DFAIT (conference call DFAIT - Arup February 9, 2012) the blast performance target for these windows is ISO 16933:2007 Hazard Rating C under the defined blast loading for these elevations as far as is practicable without installation of blast enhanced glazing frames.

The architect has established that the existing frames can be modified to accept thicker IGUs in place of the existing single glazing. Although sufficient information for detailed blast analysis of the existing frames is not currently available, analysis of the proposed IGUs indicates that under the reduced blast loading in these locations it is reasonable to conclude that the existing conventional frames are unlikely to suffer widespread failure and that the hazard to occupants from glass or frame debris would be low. This conclusion should be reviewed again during the detailed design stage but is considered an appropriate basis for the concept stage blast enhancement measures proposed below.

It is currently assumed that the connections of existing frames to the head and sill assemblies will require reinforcement. This should be analyzed in the next stage of design development by removal of an existing window and investigation of the connection method used.

The proposed blast enhanced window system includes the following elements:

- New IGUs comprising an 8mm heat strengthened outer lite, an air gap as required for thermal performance and a 12.76 heat strengthened laminated inner lite.
- Consider the use of security tape to bond the new IGUs to the existing frames as an alternative to conventional gaskets



NORTH-WEST ELEVATION 1 A-402

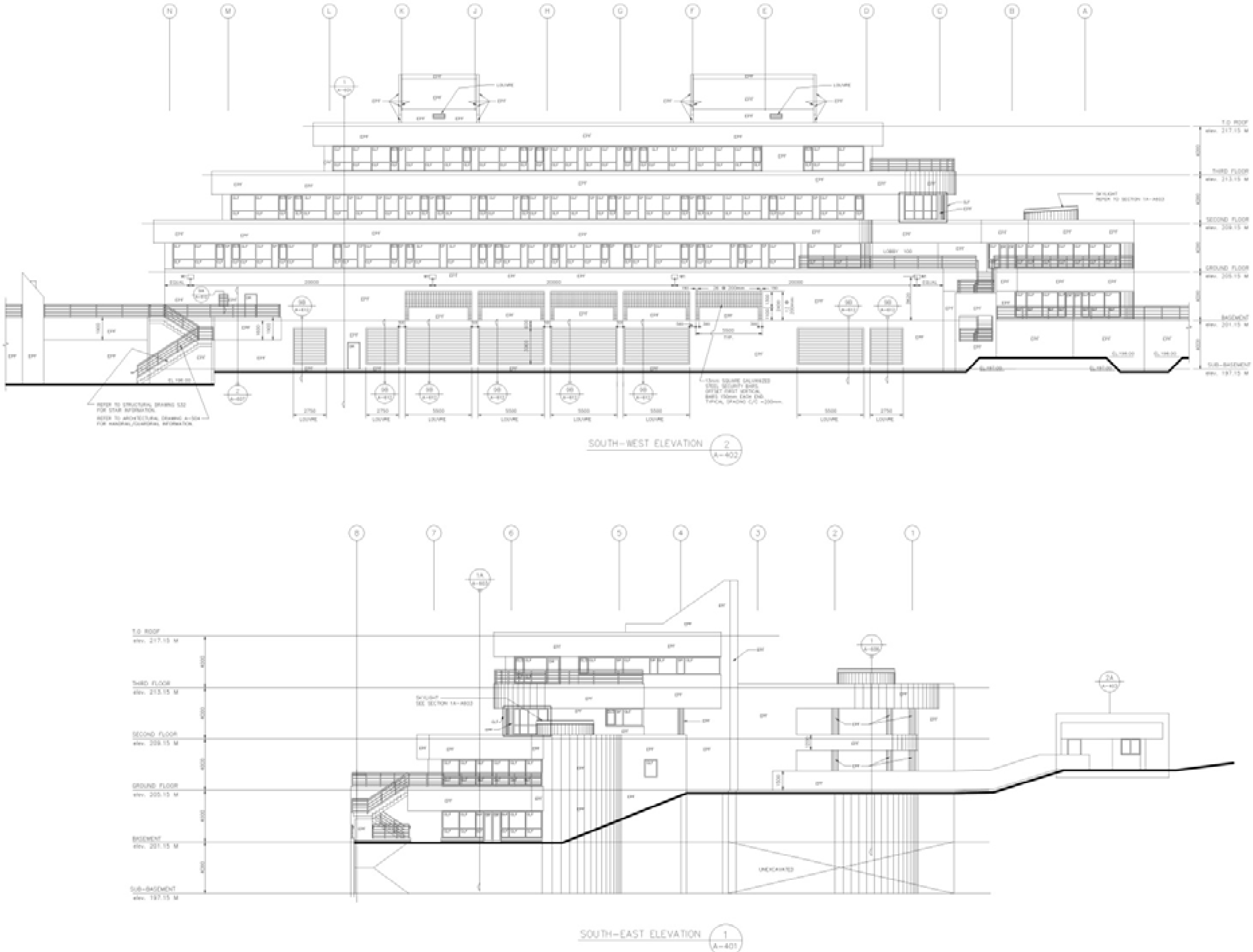


Figure 4.2.18: The elevations to which 'general glazing' requirements apply

4.2.6 Physical Security

In order to meet the forced entry requirements for this project the base of the glazed curtain wall on the north eastern elevation will need additional measures to resist a physical attack. By itself the glass for the IGUs proposed on previous pages to provide blast resilience will not meet the project forced entry (FE) requirements. The disadvantage of providing thicker, stiffer glass that would meet the required FE rating is that it would increase the reactions imposed on the curtain wall frames under blast loading and likely require the use of deeper sections.

Two approaches to resolving this issue have been considered.

The first is to install a security fence, possibly in conjunction with 'hostile' planting along the outermost edge of the planted zone immediately outside the curtain wall. Indicative details are shown opposite.

A second approach is to incorporate a layer of internal secondary glazing into the lower levels of the blast enhanced curtain wall (up to three meters above ground level). This can be attached to the rear face of the mullions so as to avoid a second-

ary framing system.
Products/materials tested to EN 357, achieving the required rating, would be expected to meet the defined forced entry requirements.

There are options in terms of glass thickness and this will depend on whether a conventional (glass/pvb) make up is required or a polycarbonate/glass make up is preferred. Two options are likely to be:

- 28mm thick conventional pvb laminated glass; or
- 16mm thick glass/polycarbonate build up.

The sketch provided gives an indication of the fixing of the glass which would need to be developed further at the detailed design stage to ensure that the system meets the physical security requirements in its entirety.

The secondary screen should only extend to a height 3m. The gap between the inner and outer screens should be closed off to ensure that no dirt or debris can fall between the two screens and get trapped. The most appropriate location for this

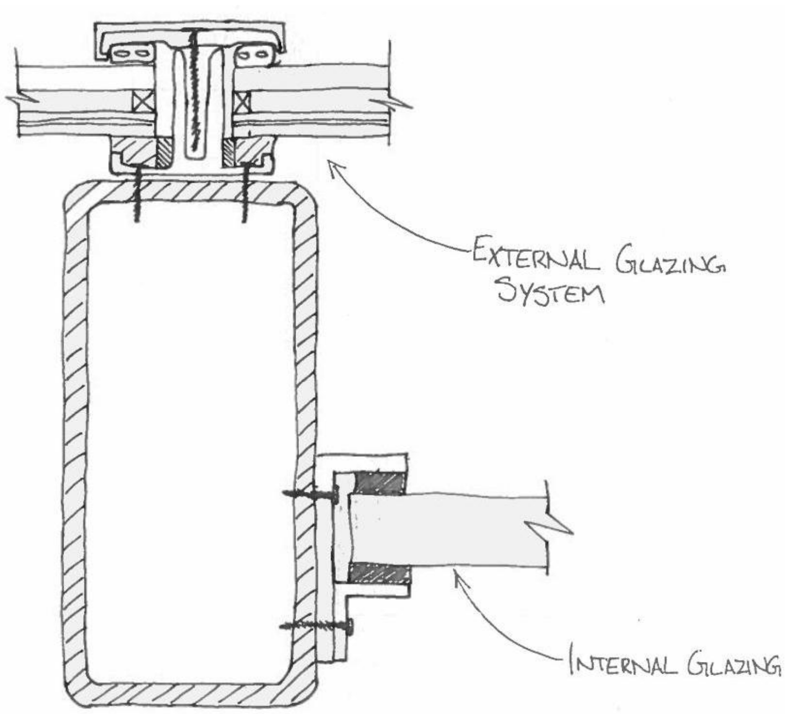


Figure 4.2.19: Indicative sketch showing secondary glazing system to provide resilience against physical attack. The framing will need to be developed further at detailed design stage.

Figure 4.2.20: Weld mesh fence

closer is at transom locations to restrict visual impact.

Adopting a secondary screen for forced entry resistance poses problems with regard to ventilation, cleaning and maintenance. As the gap between the two screens is likely to be limited to 150mm – 200mm and depth of the proposed mullion sections is greater still, safe cleaning of the glass will not be achievable without removal of either the inner or outer screen. A cleaning and maintenance regime should be developed that involves temporary removal of glazing.

Additionally, ventilation of the space between the two screens will also be desirable in order to prevent condensation within the cavity. It should be determined in the next stage of design whether a mechanical ventilation system is required or whether the provision of convective airflow, through ventilation slots in the mullions, will be sufficient.

Further consideration should be given during detailed design to maintenance, cleaning and the avoidance of condensation between the inner and outer glazing.

The use of a proprietary secondary glazing system such as those supplied by Selectaglaze http://www.selectaglaze.co.uk may provide a further option for an internal FE resistant screen, particularly if an accredited system is preferred.

4.2.7 Internal Partitions

Anti-shatter film (ASF) is to be applied to the face further from the external windows of all internal glazed partitions that are not of laminated or fully tempered glass.

The ASF, which may be applied by “daylight” fixing without anchoring to its frames or extending into the glazing rebates, should be certified to BS EN 12600 Class 2B2 and not less than 100 microns thick.

4.2.8 Skylights

An assessment of the skylights under blast loading has not been conducted at this point. However, as noted in section 1.4.4, it is proposed that all of the glazing that comprises the skylights be replaced for water penetration issues. This stance is supported by the requirement to improve blast resilience. The glass should be replaced with an equivalent build up to that described in section 8.5. The existing framing will need to be assessed at scheme design stage to determine whether replacement is required. Replacement of the framing has already been accounted for in the cost estimations. .

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Appendix A

Sample Calculations Package

Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Introduction

The following calculations provide a summary of the calculations carried out through the development of concept designs for the curtain wall to be installed at the North Eastern elevation. The intention is to assess proposed designs against blast loads and to determine their performance in relation to DFAIT's performance requirements.

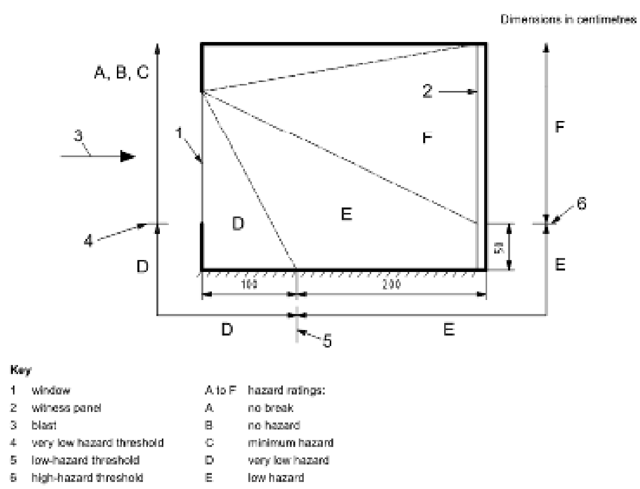
All blast calculations are carried using Ergo. Ergo is a software package, developed by Arup, for the simple analysis of structures and façade elements under blast loads. It is based on classical single degree of freedom (SDOF) theory for the dynamic, nonlinear analysis of the effects of highly transient loads on structural elements and frames, and on glazed & non-glazed façade elements. The glazing module of is validated against hundreds of live blast tests carried out by the UK government over a period of approximately 20 years.

Blast Loads and Performance Criteria

For security reasons, the blast explicit blast loads will not be documented here. Different parts of the building are to be subjected to different blast loads which will be referred to DFAIT Level 1 and DFAIT Level 2. DFAIT Level 1 is the most onerous of the two blast threats.

The North Eastern curtain wall described here will be subject to DFAIT Level 1 blast loading.

DFAIT's performance criterion is Level C – Minimum hazard (see below) in accordance with ISO16933:2007. It should be noted that, in terms of design by calculation, Level C is assumed when the pvb interlayer of laminated glass is not expected to tear.



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Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Glazing Calculations

Pane 1

Pane width: 1.8m
Pane Height: 1.05m
Outer lite: 8mm heat strengthened
Inner lite: 12.76mm heat strengthened laminate (0.76mm pvb interlayer)

Results:

Max Displacement = 165mm
Short Edge Reaction = 12.6 kN/m
Long Edge Reaction = 17.7 kN/m

Pane 2

Pane width: 1.8m
Pane Height: 1.0m
Outer lite: 8mm heat strengthened
Inner lite: 12.76mm heat strengthened laminate (0.76mm pvb interlayer)

Results:

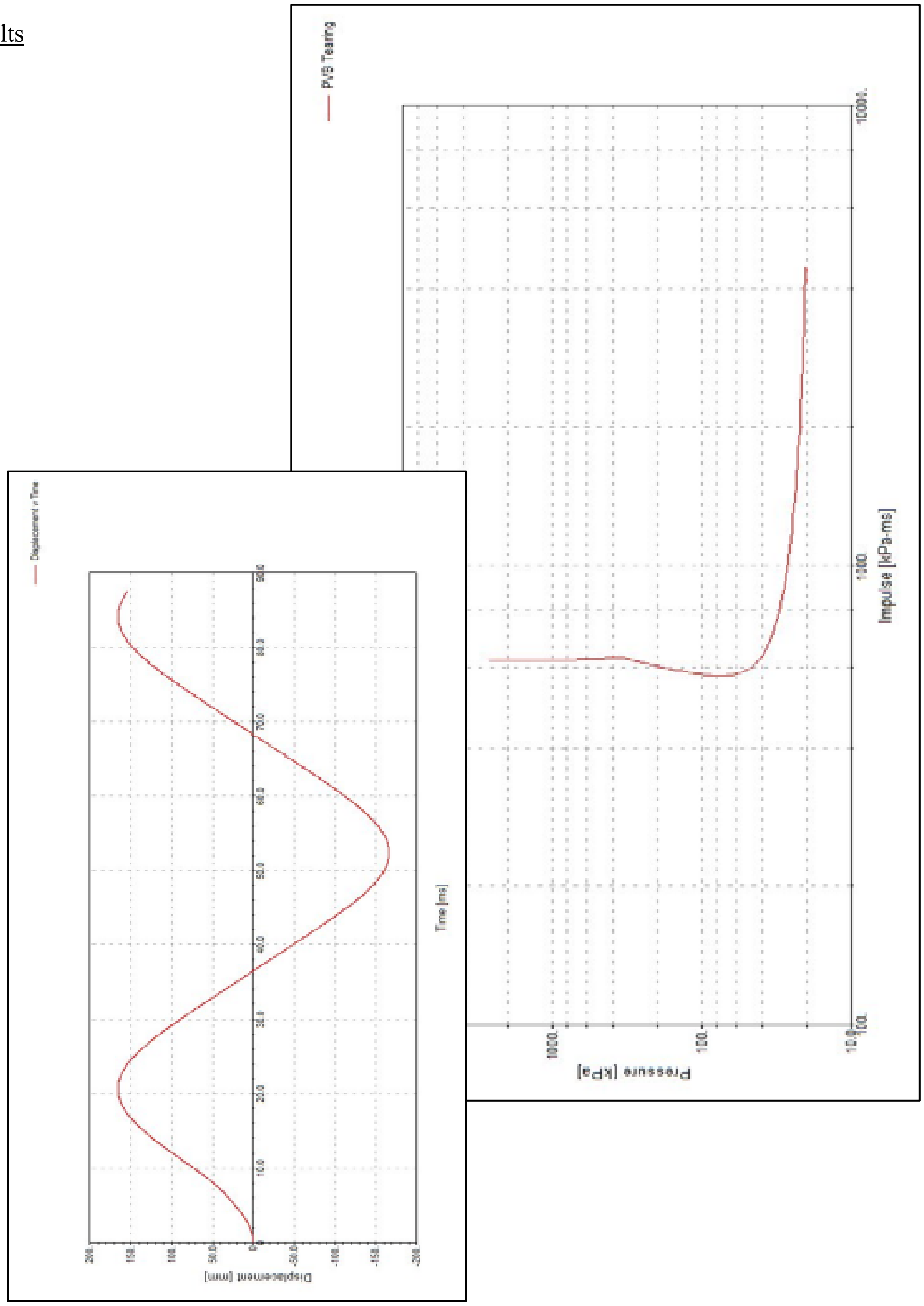
Max Displacement = 160mm
Short Edge Reaction = 12.2 kN/m
Long Edge Reaction = 17.1 kN/m

Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Pane 1 - Results



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Calculation Sheet

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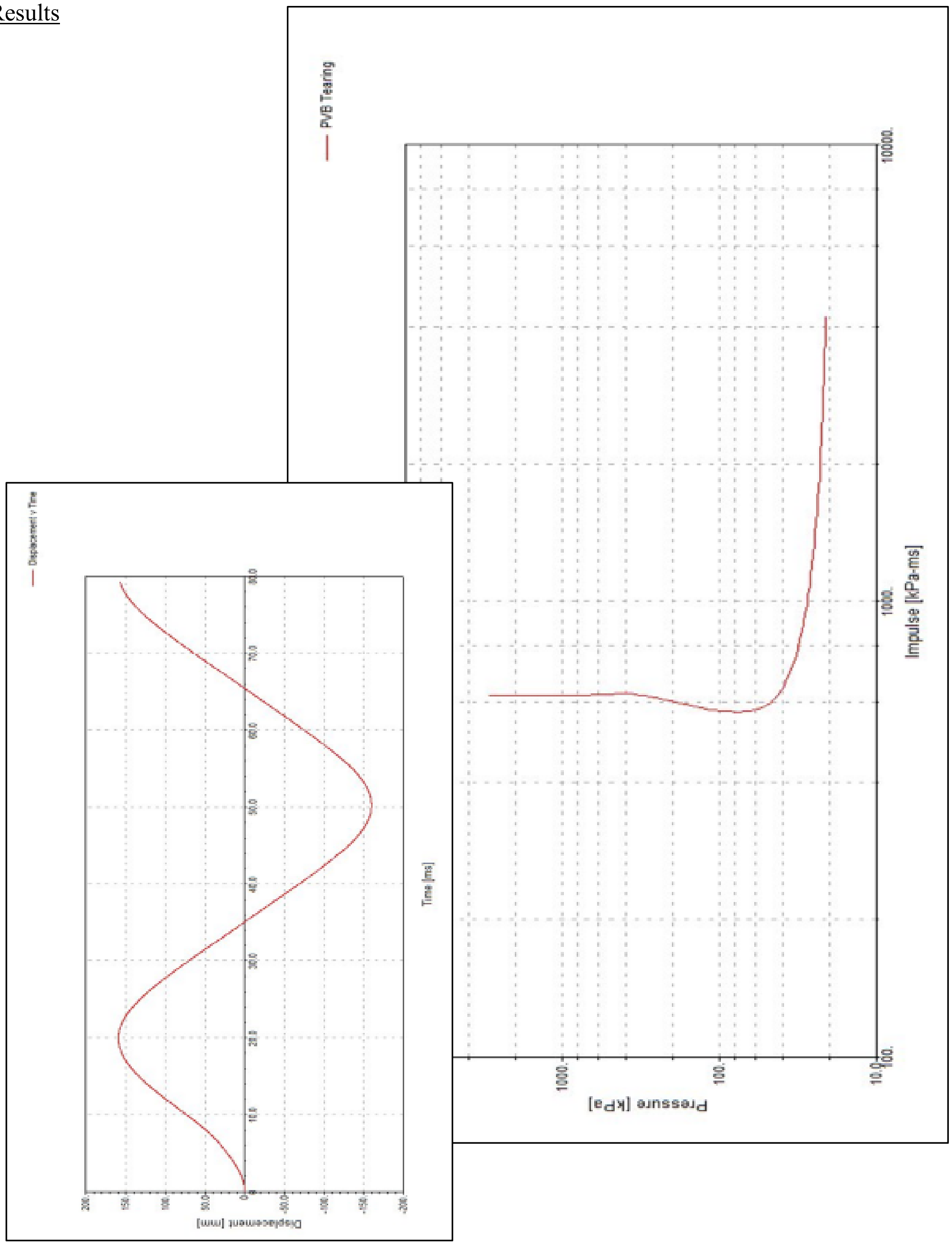
Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Pane 2 Results

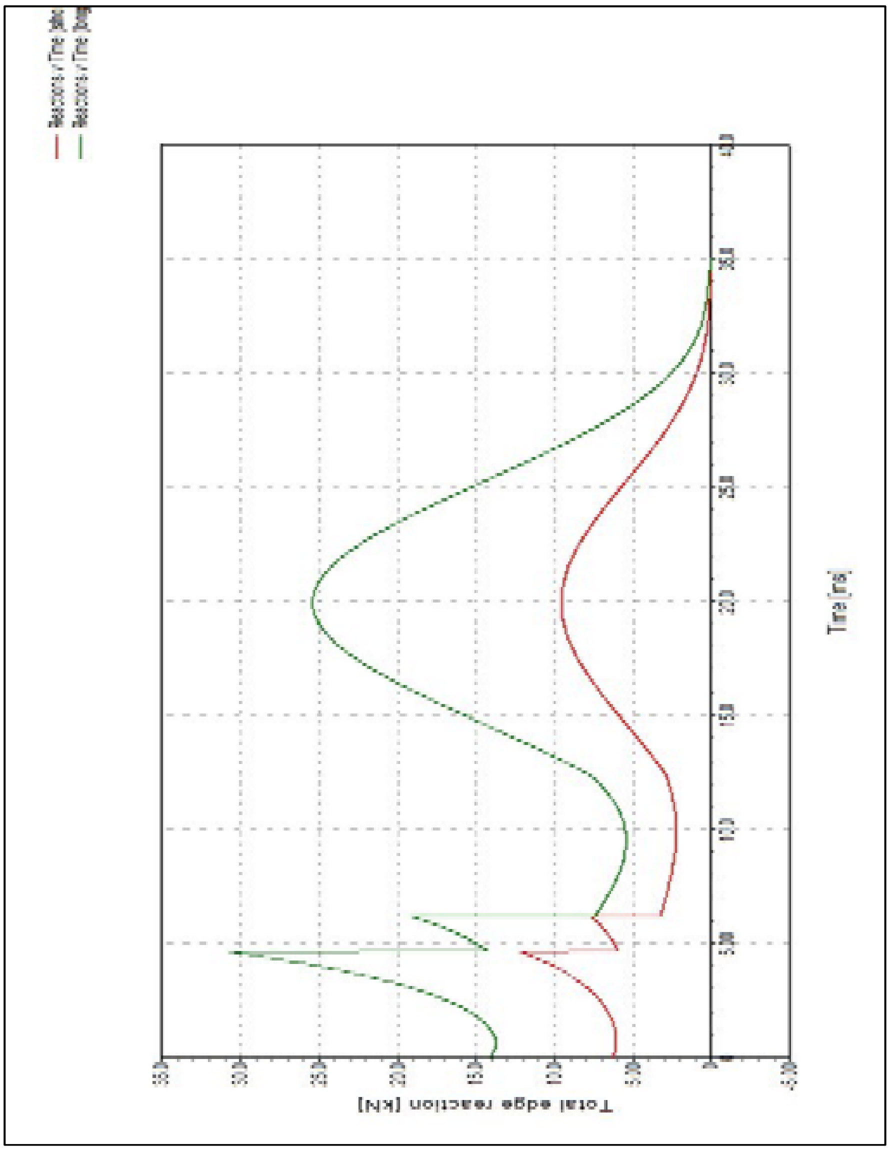


Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Glass Edge Reactions



Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
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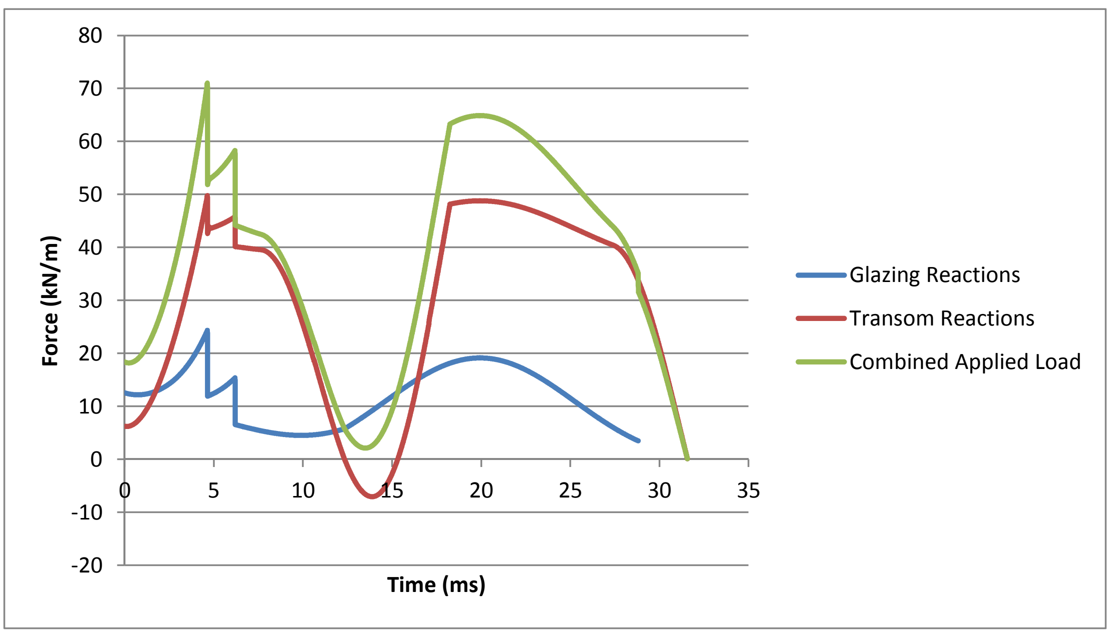
Transom and Mullion Analysis

A number of transom and mullions were assessed and an example is provided here. The input load for the assessment of the mullions was the reaction-time history extracted from the glazing assessment and illustrated on the previous page.

In addition, the mullions will need to resist the reaction forces from the transom sections framing into them. This was done by converting the point loads from the transoms to equivalent uniformly distributed loads. These were then combine with the reaction time histories from the glass to provide an input load for the mullion as shown below.

Acceptable performance criteria for non-structural steel elements such as façade transoms and mullions are given below:

Ductility ratio < 20
Support rotation < 6°



Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	1 of 3	-
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
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Example Mullion

Section: 200 x 100 x 16mm rectangular hollow section (RHS)
Grade of Steel: 355N/mm^2
Static increase factor: 1.1
Dynamic increase factor: 1.2
Span: 6.4m

Results:

Max displacement = 230mm
Ductility Ratio = 2.5
Support rotation = 4.2°
Peak end reaction = 130 kN

Mullion performs within acceptable limits.

Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
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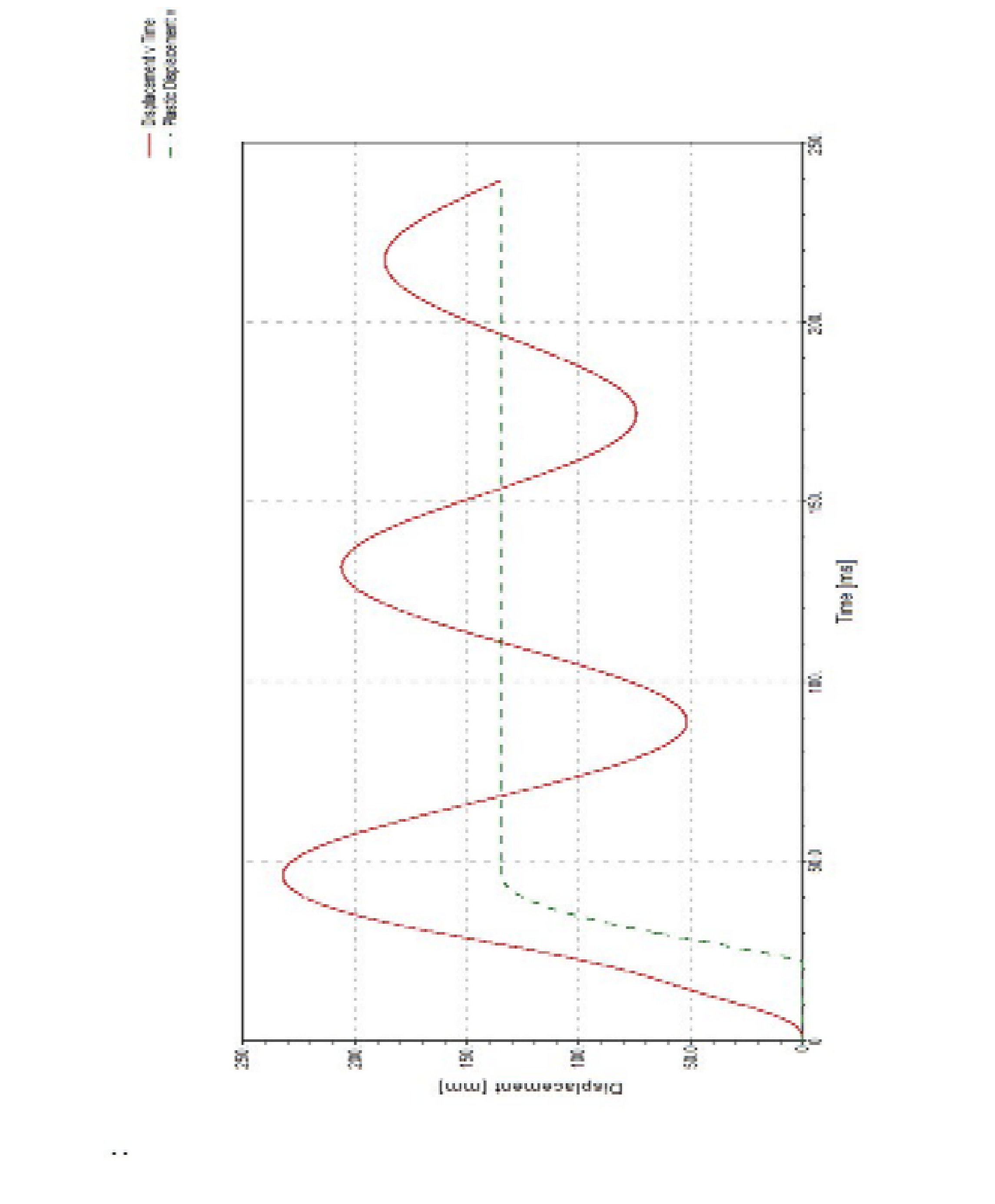
Calc title	North-Eastern Elevation Curtain Wall – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	



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Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number 219716-00	Package number 2 of 3	Revision -
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Introduction

The following calculations provide a summary of the calculations carried out through the development of concept designs for the high level glazing to be installed at the North Eastern elevation. The intention is to assess proposed designs against blast loads and to determine their performance in relation to DFAIT’s performance requirements.

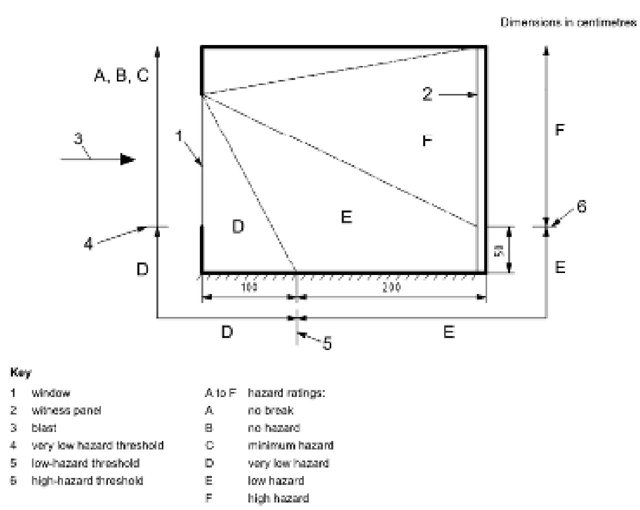
All blast calculations are carried using Ergo. Ergo is a software package, developed by Arup, for the simple analysis of structures and façade elements under blast loads. It is based on classical single degree of freedom (SDOF) theory for the dynamic, nonlinear analysis of the effects of highly transient loads on structural elements and frames, and on glazed & non-glazed façade elements. The glazing module of is validated against hundreds of live blast tests carried out by the UK government over a period of approximately 20 years.

Blast Loads and Performance Criteria

For security reasons, the blast explicit blast loads will not be documented here. Different parts of the building are to be subjected to different blast loads which will be referred to DFAIT Level 1 and DFAIT Level 2. DFAIT Level 1 is the most onerous of the two blast threats.

The North Eastern glazing described here will be subject to DFAIT Level 1 blast loading.

DFAIT’s performance criterion is Level C – Minimum hazard (see below) in accordance with ISO16933:2007. It should be noted that, in terms of design by calculation, Level C is assumed when the pvb interlayer of laminated glass is not expected to tear.



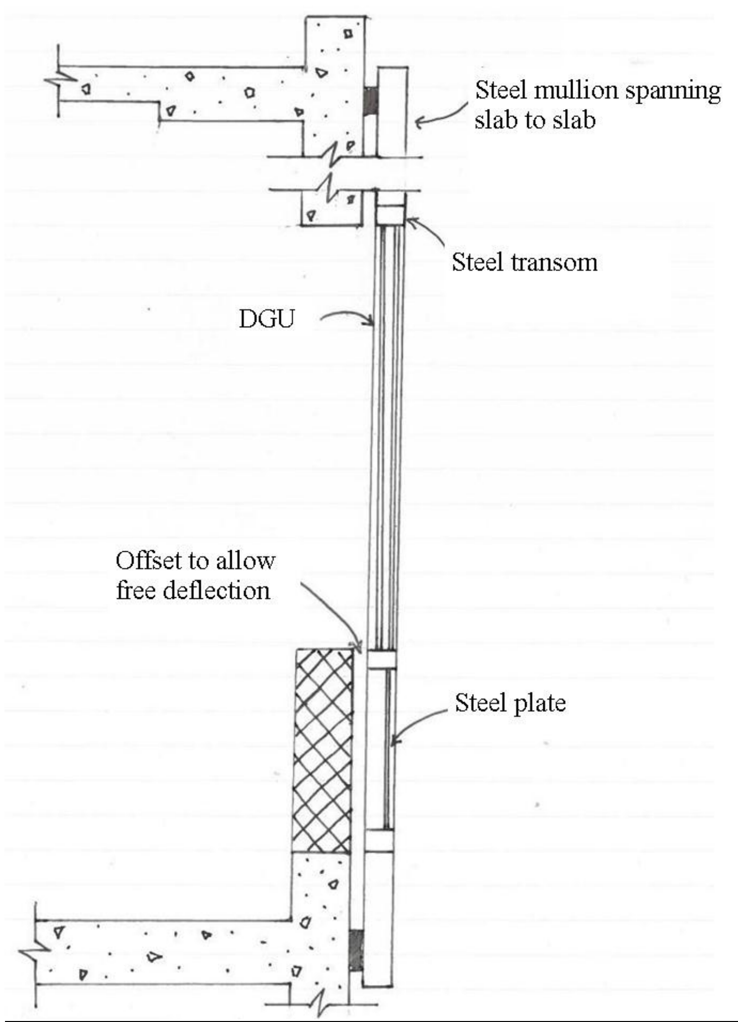
Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	2 of 3	-
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Glazing Concept

The concept design for this area of the structure is to provide window coverings to the existing window openings. The window coverings will comprise of steel transoms and mullions, fixed to the outside of the concrete structure at floor level. Within these transoms and mullions, windows will be fixed. IN addition, a steel plate will be provided at low level to provide protection to the existing up-stand masonry wall. The coverings, with the exception of the windows will be hidden my architectural cladding that will be fixed to the exterior of the building.



Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	2 of 3	-
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Glazing Calculations

Pane 1

Pane width: 2.5m
Pane Height: 1.4m
Outer lite: 8mm heat strengthened
Inner lite: 12.76mm heat strengthened laminate (0.76mm pvb interlayer)

Results:

Max Displacement = 220mm
Short Edge Reaction = 14.3 kN/m
Long Edge Reaction = 20 kN/m

Transom and Mullion calculations

A number of transom and mullions were assessed and an example is provided here. The input load for the assessment of the mullions was the worst case reaction-time history extracted from the glazing and steel plate assessments.

Acceptable performance criteria for non-structural steel elements such as façade transoms and mullions are given below:

Ductility ratio < 20
Support rotation < 6°

Mullion

Section: 200 x 100 x 16mm rectangular hollow section (RHS) – acting in its minor axis.
Grade of Steel: 355N/mm^2
Static increase factor: 1.1
Dynamic increase factor: 1.2
Span: 4.0m

Results:

Max displacement = 130mm
Ductility Ratio = 2
Support rotation = 4°
Peak end reaction = 100 kN

Mullion performs within acceptable limits.

Calculation Sheet

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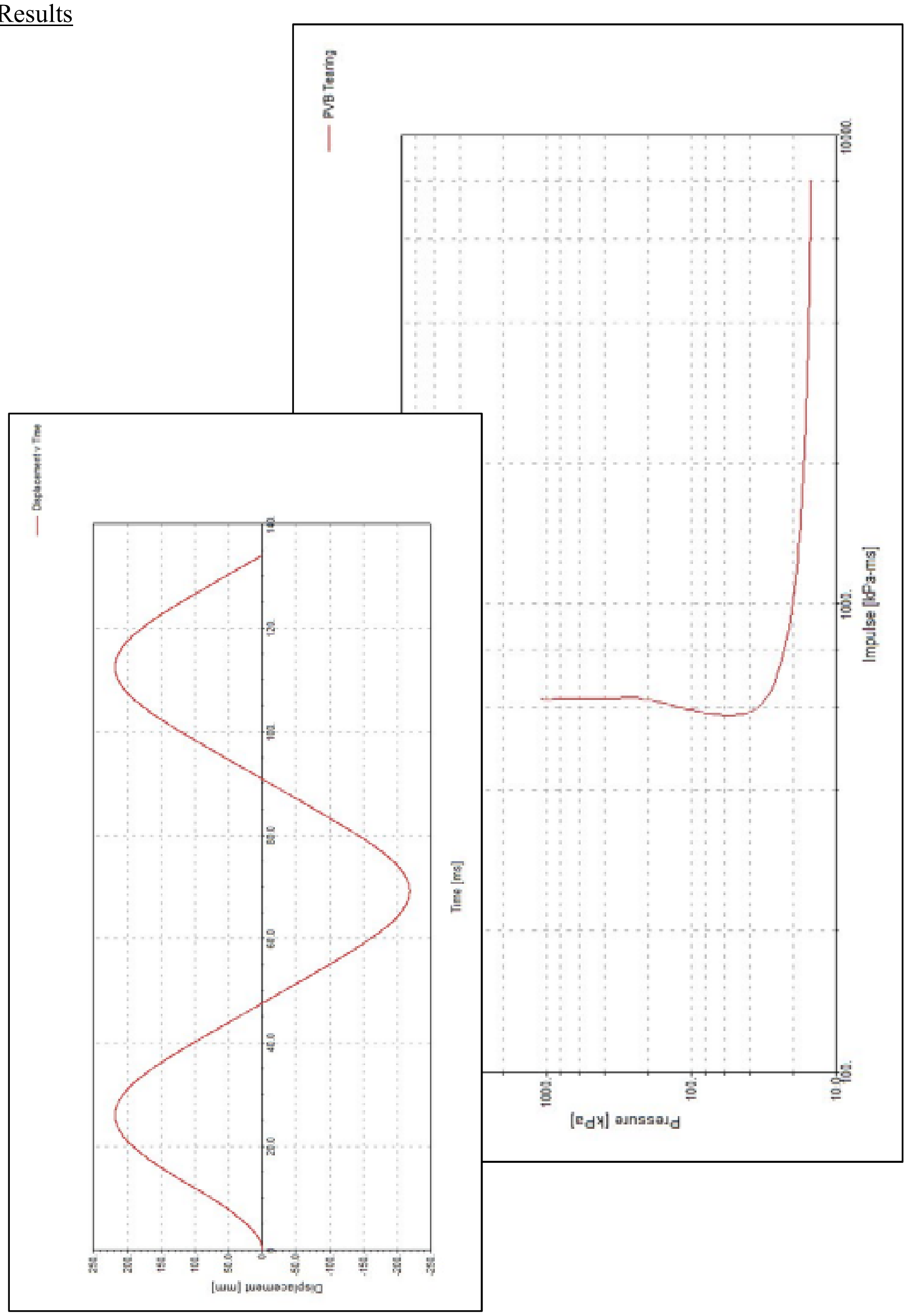
Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	2 of 3	-
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Pane 1 - Results

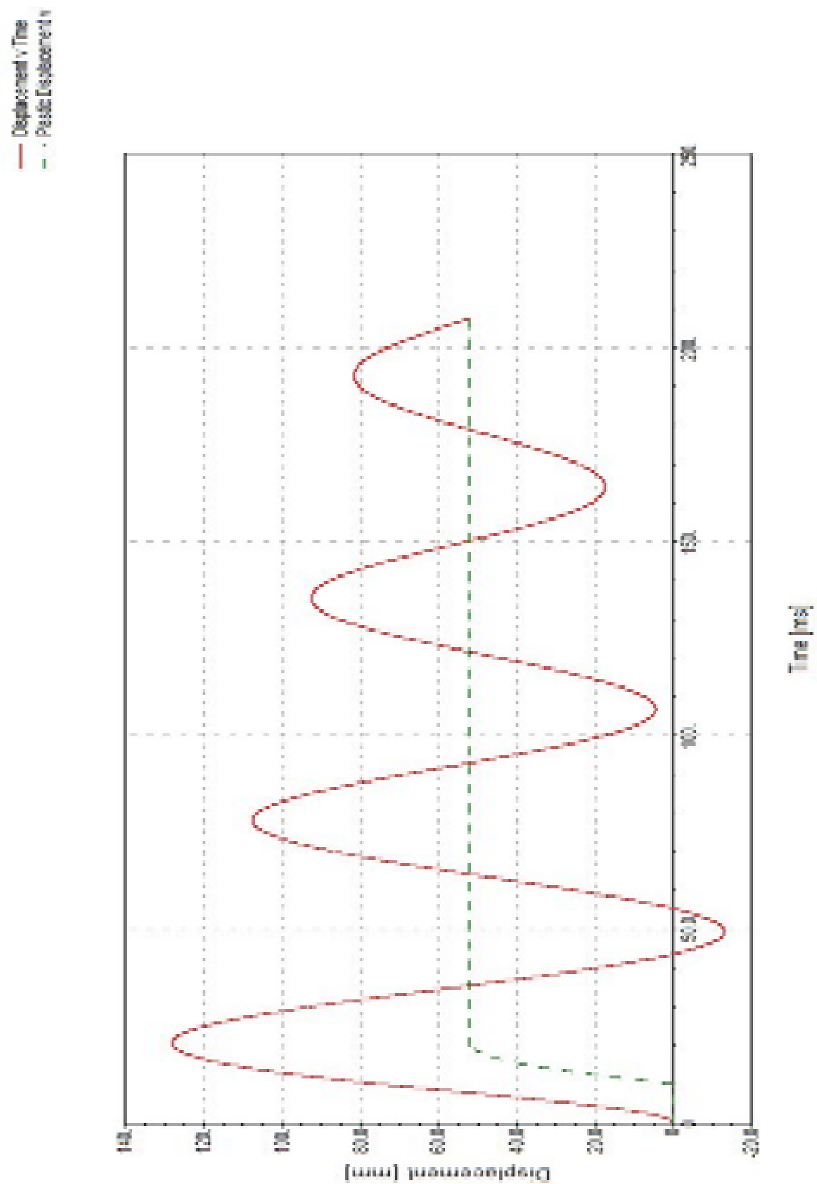


Calculation Sheet

ARUP

Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	2 of 3	-
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Mullion – Results



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Calculation Sheet

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Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	2 of 3	-
Calc title	North-Eastern Elevation High Level Glazing – Blast Design	Member/Location	London	
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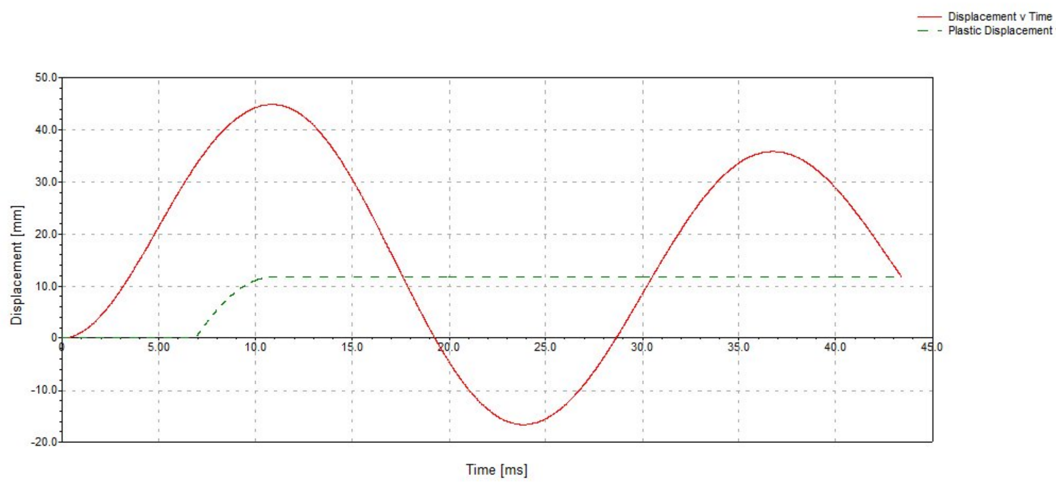
There was a requirement to ensure that the combined deflection of the steel plate and the mullion would not allow contact with the internal masonry wall which would lead to an increase in hazard. The deflection time histories of each element were combined and an offset at the connections was provided to ensure that this does not occur.

Because the steel plate only deflects by approximately 45mm (see below) it deflected within the structural depth of the mullion, in this case 100mm and so the deflection of the mullion governs. Assuming a sinusoidal mullion deflection, and a wall height of 700mm, the offset required is 50 to 100mm.

Steel plate deflection:
:



Calculation Sheet

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Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	3 of 3	-
Calc title	General Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Introduction

The following calculations provide a summary of the calculations carried out through the development of concept designs for the building on all except the north eastern elevation. The intention is to replace the glazing but to retain the existing frames.

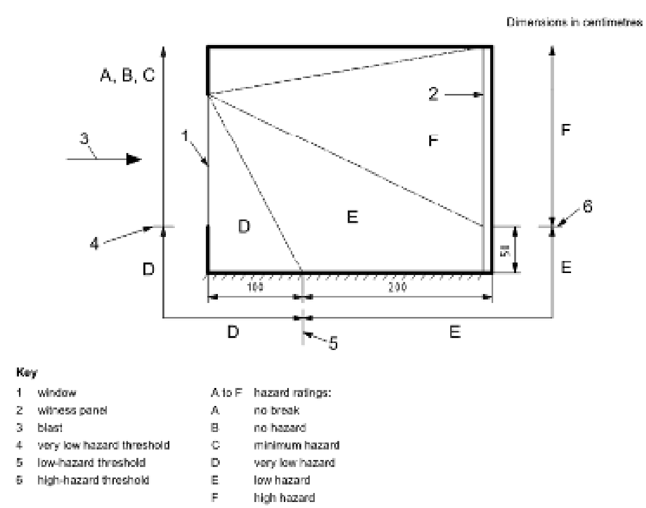
All blast calculations are carried using Ergo. Ergo is a software package, developed by Arup, for the simple analysis of structures and façade elements under blast loads. It is based on classical single degree of freedom (SDOF) theory for the dynamic, nonlinear analysis of the effects of highly transient loads on structural elements and frames, and on glazed & non-glazed façade elements. The glazing module of is validated against hundreds of live blast tests carried out by the UK government over a period of approximately 20 years.

Blast Loads and Performance Criteria

For security reasons, the blast explicit blast loads will not be documented here. Different parts of the building are to be subjected to different blast loads which will be referred to DFAIT Level 1 and DFAIT Level 2. DFAIT Level 1 is the most onerous of the two blast threats.

The glazing described here will be subject to DFAIT Level 2 blast loading.

DFAIT's performance criterion is Level C – Minimum hazard (see below) in accordance with ISO16933:2007. It should be noted that, in terms of design by calculation, Level C is assumed when the pvb interlayer of laminated glass is not expected to tear.



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Calculation Sheet

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Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	3 of 3	-
Calc title	General Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date 14/09/12		

Glazing Concept

The intention is to replace the glazing around the chancery, but retain the existing framing elements.

Glazing Calculations

Pane 1

Pane width: 2.25m
Pane Height: 1.2m
Outer lite: 8mm heat strengthened
Inner lite: 8.76mm heat strengthened laminate (0.76mm pvb interlayer)

Results:

Max Displacement = 120mm
Short Edge Reaction = 13.8 kN/m
Long Edge Reaction = 1.2 kN/m

Transom and Mullion calculations

A number of transom and mullions were assessed and an example is provided here. The input load for the assessment of the mullions was the worst case reaction-time history extracted from the glazing. The cross sectional properties were scaled from drawings but the wall thickness of the extrusions was not known and so a 3mm wall thickness has been assumed.

Acceptable performance criteria for non-structural aluminium elements such as façade transoms and mullions are given below:

Ductility ratio < 5
Support rotation < 12°

Mullion

Section: 75 x 60 x 3mm box extrusion.
Grade of Steel: 170N/mm^2
Static increase factor: 1.1
Dynamic increase factor: 1.1
Span: 2.0m

Calculation Sheet

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Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number	Package number	Revision
		219716-00	3 of 3	-
Calc title	General Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Results:

Max displacement = 155mm
Ductility Ratio = 4
Support rotation = 9°
Peak end reaction = 100 kN

Mullion performs within acceptable limits.

Calculation Sheet

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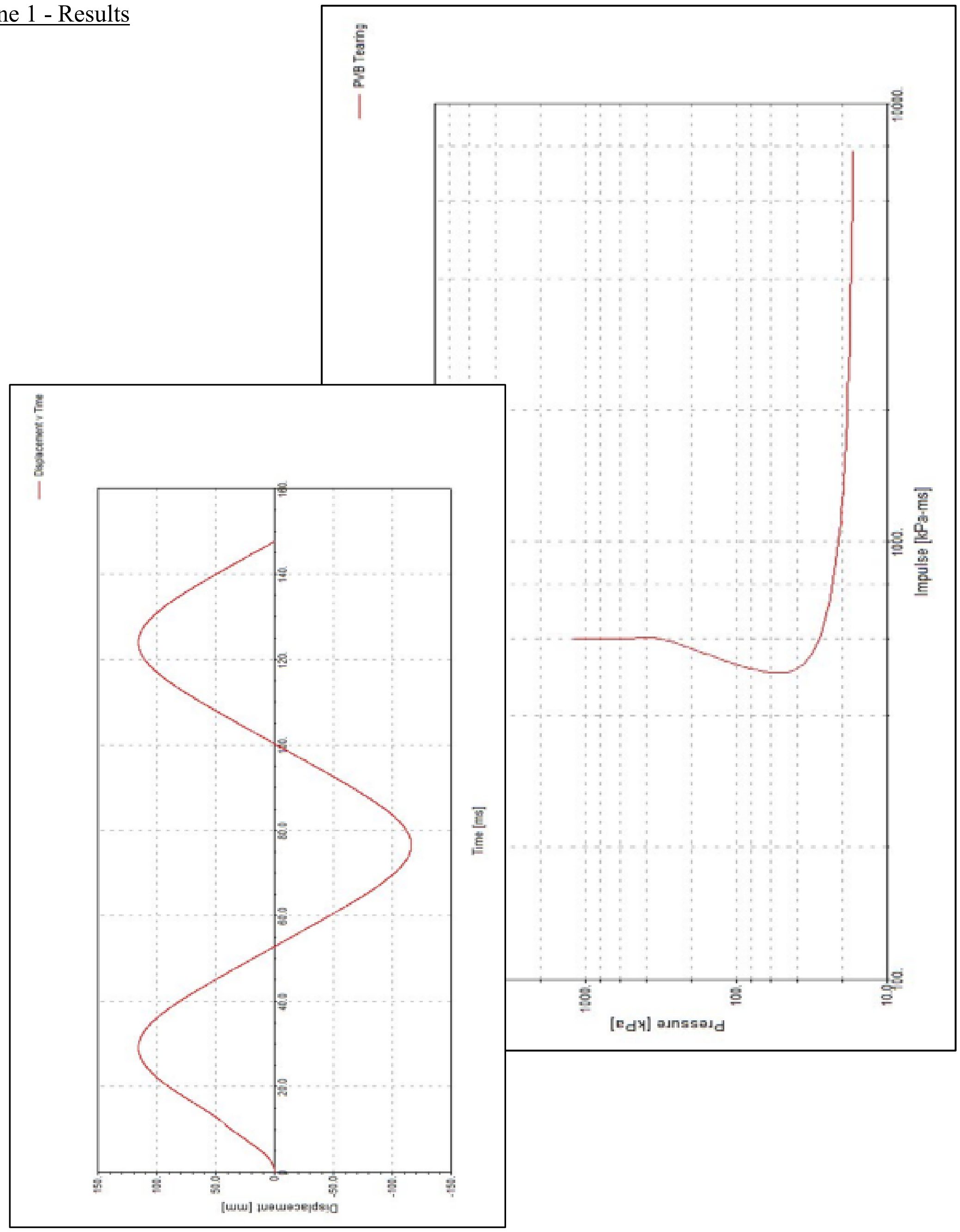
Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number 219716-00	Package number 3 of 3	Revision -
Calc title	General Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

Pane 1 - Results



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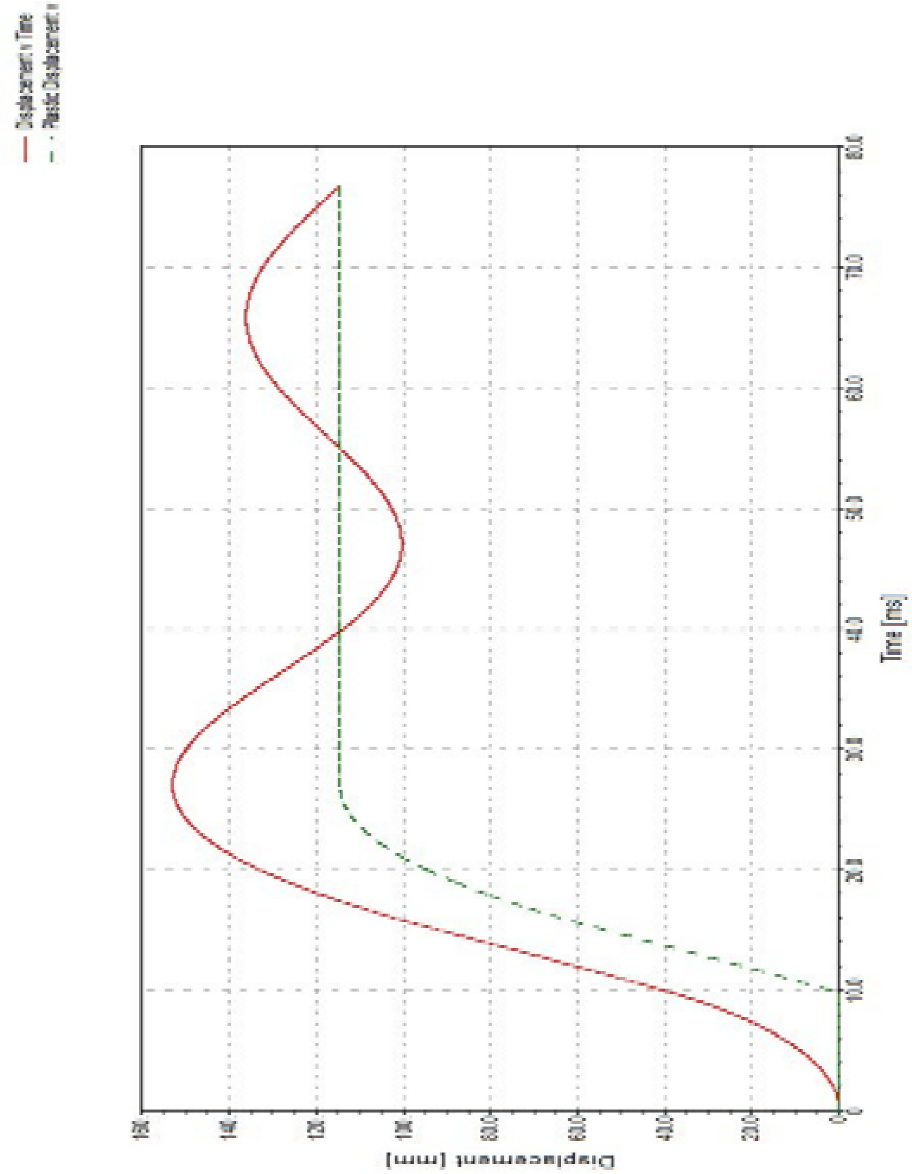
Job title	Canadian Chancery Nairobi - Building Envelope Upgrades	Job number 219716-00	Package number 3 of 3	Revision -
Calc title	General Glazing – Blast Design	Member/Location	London	
		Drg. Ref.		
		Date	14/09/12	

<u>Mullion – Results</u>



Part 5
Structural Assessment

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Rounthwaite Dick and Hadley Architects Inc.

Canadian High Commission Nairobi

Interim Draft Structural Assessment

REP/219713/S01

Final | December 13, 2012

Job number 219713

Arup Canada Incorporated
2 Bloor Street East
Suite 2400
Toronto ON M4W 1A8
Canada
www.arup.com

ARUP

Contents

Executive Summary

Arup Canada Inc. was commissioned to conduct a structural evaluation of the existing Canadian High Commission building in Nairobi, Kenya. The existing building is a three story reinforced concrete structure with two basement levels founded on spread footings. Our deliverable for the scope of work, as outlined in DFAIT's Statement of Work for Structural Evaluation and in our proposal dated January 26, 2012, is a final report that assesses the structural performance of the building against the requirements of the National Building Code of Canada 2010.

The purpose of this evaluation is to determine the overall structural safety of the Chancery which includes assessing the building for gravity and lateral loads. The input to our assessment of the existing building includes drawings of the existing building, geotechnical reports, structural observations and material tests. A full list of consulted materials is given in Section 5.2, an overview of the building is given Section 5.3, and a summary of our site observations is given in Section 5.4.

The Statement of Work defines the building performance to be evaluated against the requirements of NBCC (National Building Code of Canada 2010. DFAIT missions are post-disaster facilities, capable of continuing operations immediately following an earthquake. Section 5.5 performance objectives and loads that were considered.

We have evaluated the site class/seismic hazard information provided by DFAIT's Technical Advisor by performing a desktop seismic hazard study. This study was informed by a comprehensive literature review and a site specific seismic hazard assessment previously completed by Arup in 1991 for a nearby site. Our preliminary estimate of the site specific hazard based on data from our 1991 report suggests that High Commission site may experience seismic shaking two times higher than that given by DFAIT. Details are given in Section 5.5.3.

We have analyzed the High Commission structure under gravity and lateral loads. Based on our analysis, the building has the capacity to resist the gravity loads as identified in the existing building's structural drawings, with the exception of several areas that require either strengthening or limitation of imposed loads. The results of this analysis, and the areas where the load should be limited are given in Section 7.1.

The lateral analysis considers the effects of an earthquake on the building. We have considered a site class of C, an importance factor of 1.5 (Category 1, Immediate Occupancy) and minimal ductility (R_DR_O = 1.95, see Section 5.6). We have considered both the DFAIT seismic hazard and the Arup estimate of the seismic hazard. In addition, the National Research Council (NRC) Guidelines for Seismic Evaluation of Existing Buildings recommend that the earthquake loads be reduced by a factor of 0.6 for evaluations. We present the seismic demand both with and without this factor, giving a total of four cases altogether. In all these cases, the foundations were taken to be fixed to the ground, that is, no rocking of the foundations was allowed.

We have also conducted a preliminary assessment of foundation rocking which indicates that while the total base shear is only slightly reduced when the foundations are allowed to rock, rocking under the most highly loaded walls allows them to share their load with the more lightly –loaded perimeter walls. A more detailed analysis of the rocking behaviour may reduce the retrofit required below the Ground level.

Based on our assessment, the existing building will require structural strengthening and retrofit work to meet the Immediate Occupancy requirements of the NBCC 2010. The extent of retrofit varies, depending on what seismic hazard is expected. A retrofit based on the DFAIT level of shaking may not be sufficient to deliver the desired service level. On the other hand, a retrofit based on the current Arup estimated hazard may be more expensive and disruptive than necessary. The extent of retrofit work is laid out in Section 8, and consists of the following types of work:

- Shear Walls and Cores: strengthening by way of thickening the concrete walls and addition of concrete boundary elements to provide flexural strength and concrete confinement.
- Diaphragms: strengthening by way of steel drag plates between lateral elements.
- Foundations: enlarging the foundations and installation of micropiles.

In the next steps, we will carry out the following analysis as the next step towards detailed assessment and design of the required retrofit:

- Probabilistic Seismic Hazard Assessment (PSHA): A detailed PSHA will give a reliable hazard curve on which to base the subsequent analysis.
- Site Geotechnical Investigation: Further detail of the soil parameters is needed. This will confirm the site class, determine the foundation rocking behaviour and the effects of the unbalanced load on the site.
- Non-Linear Time History Analysis: a time history analysis that takes into account the rocking of the foundations, the ductility of each element and the soil-structure interaction will give a much clearer picture of how the force is distributed throughout the building and what retrofit is required for each element.
- Based on the above, we would produce a series of structural drawings that identify the retrofit work required and work with DFAIT to develop a phased construction scheme that affords minimum disruption to the High Commission's operations.

Further to the original brief, DFAIT has asked us to comment on the performance of the building relative to life safety (i.e. $I_e = 1.0$), the NRC factor of 0.6 for evaluations, and both the Arup and DFAIT seismic loads. We have carried out a quick review and have the following assessment.

We recommend the building be retrofitted for life safety, for the following reasons:

1. We do not have a reliable estimate of the seismic hazard. We have reason to believe that the DFAIT-provided response spectrum is an

underestimate of the seismic hazard. Considering the Arup upper bound hazard, the walls and cores do not have the capacity to reach the 0.6 capacity threshold, even given the I_e of 1.0.

2. There are discontinuities in the lateral load path between the horizontal and vertical lateral load resisting system. For example, the diaphragm to shear core W2 connection at the basement level does not have the capacity to reach the 0.6 threshold under DFAIT loads.

For these reasons, we recommend that the building be retrofitted.

5.1 Scope of Evaluation

We have carried out the following work to date:

1. Review of existing building drawings.
2. Measurement of building to confirm that it was built as set-out in the structural drawings.
3. Extraction and compressive testing of concrete cores.
4. Extraction and tensile testing of steel samples.
5. Seismic desktop study to assess site class & Regional Seismic hazard.
6. Evaluation of existing conditions, deficiencies and details.
7. Structural Analysis:
    - Gravity demand and capacity of floor & roof slabs, column & walls.
    - Lateral demand and capacity shear walls, cores and retaining walls.

5.2 Referenced Documents

Adams, J., Halchuk, S., & Awatta A. "Estimated Seismic design values for Canadian missions abroad." Geological Survey of Canada, 2008. Open File 5814.

American Society of Civil Engineers. ASCE/SEI 31-03 Seismic Evaluation of Existing Buildings. Reston: American Society of Civil Engineers, 2003.

Britech Consulting Engineers Ltd. Preliminary Report on the Structural Stability Investigations at the Canadian High Commission Chancery Building at Gigiri, Nairobi, Kenya. Nairobi, 2009.

—. Report on the Quality of Structural Concrete Incorporated into the Canadian High Commission Chancery Building at Gigiri, Nairobi, Kenya. Nairobi, 2009.

Department of Foreign Affairs and International Trade. "New Chancery, Nairobi, Kenya." n.d.

Golders Associates. "Evaluation of Surface Fault Displacement and Earthquake Ground Shaking Hazards, Canadian Chancery, Nairobi, Kenya." 2001.

Institute for Tesearch in Construction. Guidelines For Seismic Evaluation of Existing buildings. Ottawa: National Research Council of Canada, 1993.

"Notes from site visit April 31 - May 2, 2012." n.d.

Pinnacle Projects Limited. Canadian High Commission Building Proposal for Investigation of the Causes of Cracks on the External Wall Decorative Plaster. Proposal. Nairobi, 2009.

Structural Audit Systems Ltd. Canadian High Commission - Chancery Building basement slab capacity. Nairobi, 2009.

"Structural Investigation of Floor Slab at Canadian High Commission." Nairobi, 9 February 2009. Memo.

Existing building survey and material test results completed to date by Howard Humphreys.

Nairobi Chancery Concept Planning for Consultant Visit by DFAIT, dated February 2012

5.3 Building Description

The Canadian High Commission in Nairobi, Kenya is a reinforced concrete building, built in 2003. It has two basements levels and three levels above ground. All storeys have a floor-to-floor height of 4m. The building sits on a slope: at the front face, the ground floor is at grade, and at the rear, both basement levels are above ground. The footprint of the building is approximately 80 m by 45 m.

The structure was designed to meet the requirements of the 1995 National Building Code of Canada and the Republic of Kenya Building Code, 1968.

The floors and roofs of the High Commission are two-way reinforced-concrete slabs with drop panels at the columns. The floors are supported by columns, walls and cores. The walls and cores provide lateral stability to the building.

The existing drawings indicate that the walls, columns and cores are founded on spread footings. It was beyond the scope of this investigation to confirm the footing construction.

Figure 1: Picture of the Canadian High Commission in Nairobi

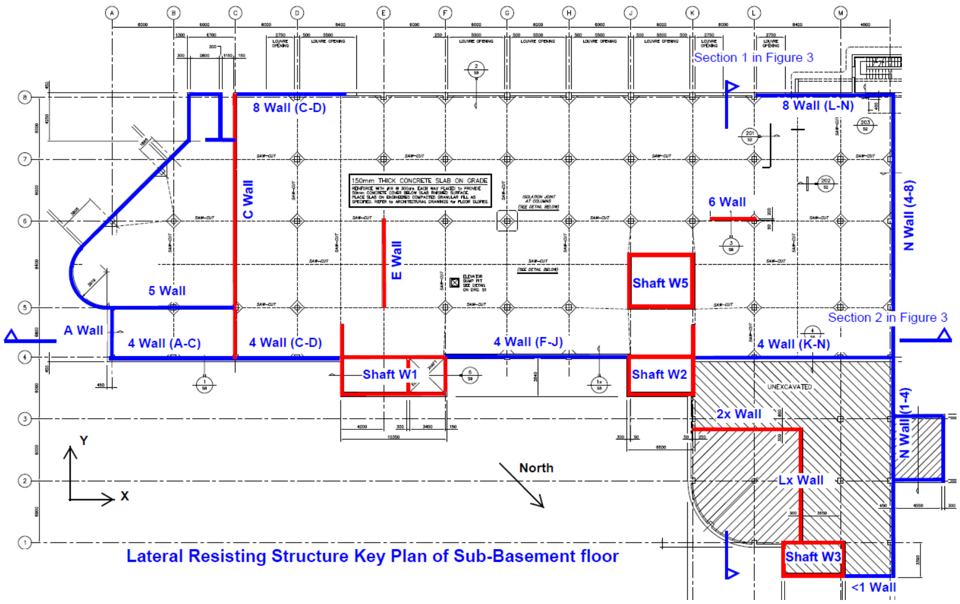
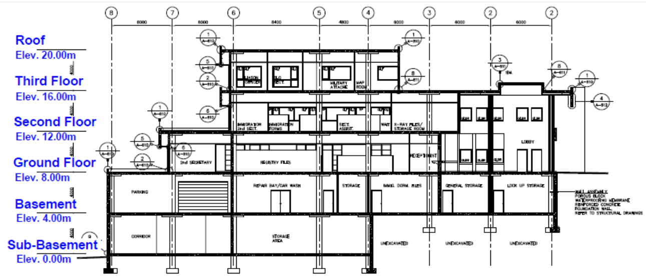
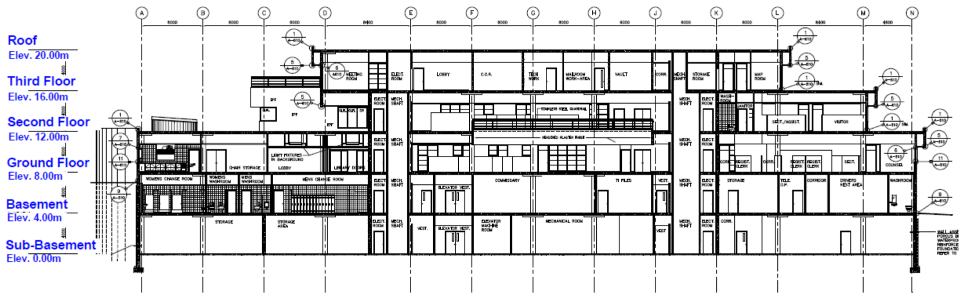


Figure 2: Key Plan of Lateral Resisting Structures at Sub-Basement Level
(See Appendix D for Other Levels)



Building Cross Section 1
(Refer to figure 2 for section position)



Building Cross Section 2
(Refer to figure 2 for section position)

Figure 3: Key Elevations of Building

5.4 Site Observations, Inspections and Testing

Arup conducted a site visit to the high commission on April 30th and May 1st, 2012. Based on our walk-through of the building, and the survey undertaken by Howard Humphreys, the building structure seems to have been generally well constructed.

Numerous cracks were observed in the façade and nonstructural partitions, but they appear to be a result of poor detailing, and are not of concern from the perspective of structural integrity. Where exposed or extracted the concrete showed good placement & consolidation.

The cracks observed included:

- Cracking of the applied plaster finish on the down-turn edge beam. This appears to result from inadequate detailing and absence of expansion joints.
- Large horizontal crack at the underside of the second floor at the north-west corner. This is a crack through a non-structural wall caused by a flexible ground floor and a stiff second story.
- Cracks in masonry partitions at the basement level: this is due to the settlement of slab on grade adjacent to suspended slab.
- Large cracks in the third floor edge beam on the front façade: It appears that the edge beam is attracting more load than it was designed for. Even though the slab has enough capacity with the beam, it is stiffer & attracts the load. These cracks should be cleaned and grouted to prevent further ingress of water.

5.5 Evaluation Criteria

5.5.1 Performance Objectives

DFAIT has specified that the High Commission is a high importance building. This means that the building should be occupiable immediately following a rare earthquake, defined as the earthquake that has a 2% probability of exceedance in 50 years. For the evaluation of existing buildings, "NRC Guidelines for Seismic Evaluation of Existing Buildings" recommends that a load factor of 0.6 be applied to the seismic loads. If a building does not have the capacity to resists these reduced seismic effects, it should be retrofitted to resist 100% of the design load.

However, DFAIT has requested that we perform our evaluation without this reduction factor. We have presented the results for both the reduced (60%) and full (100%) loadings.

5.5.2 Gravity Loads

The floors slabs were checked according to the loads shown on the structural drawings, except in areas where we observed higher imposed loads.

5.5.3 Seismic Hazard

As per our proposal, we have carried out a desktop seismic hazard study to confirm the seismic response curve specified by DFAIT. The NBCC 2010's design basis is the median expected ground motion with a 2% probability of exceedance in 50 years.

The seismic hazard estimate given by DFAIT is likely unconservative because it is an extrapolation from a 475 year period (10% in 50 year exceedance) to a 2475 year return period (2% in 50 year exceedance). The 475 year return period study is based on a smaller catalogue of earthquakes and does not include events that contribute significantly to the 2475 year seismic hazard.

We carried out a seismic hazard study on a nearby site in 1991. Based on the seismic source model from this study, we have estimated the seismic hazard for the High Commission site. Our results show a level of shaking approximately two times larger than DFAIT's values.

As noted in our technical note (see Appendix A), the 1991 study was a simplified model and we would expect a more detailed model to provide a smaller hazard as we would better define the extent of the East African Rift System (EARS) in the model and possibly use some more appropriate ground motion attenuation models. It is difficult to say how conservative the simplified model is without doing the more detailed study, but we are confident that the value we have recommended is a sensible robust number. This view was confirmed by John Adams in his note dated 2nd July 2012. Please remember that though the region around Nairobi has not experienced many earthquakes in the recent past, we know that there is a major active plate boundary (the EARS) within some 25km of the city (see Figure 4b of our Technical Note) and that the EARS is capable of generating earthquakes of magnitude 7Mw and greater. Therefore, we believe the seismic risk in Nairobi is underestimated by the local codes.

As such, the DFAIT and Arup values should be considered as lower and upper bounds on the seismic hazard. As such, we recommend a site-specific probabilistic seismic hazard assessment for the High Commission site.

Our structural analysis evaluates the demand based on both DFAIT's and Arup's hazard curves.

5.6 Detailing Requirements

Ductility is the structure's ability to sustain damage without losing its load carrying capacity. Provisions of the NBCC 2010and CSA A23.3 give requirements intended to give the structure enough ductility to sustain the damage expected during an earthquake.

According to clause 4.1.8.10 (2) in the NBCC 2010, a post-disaster building shall

- not have any irregularities conforming to Types 1, 3, 4, 5, and 7 as described in Table 4.1.8.6., in cases where IEFaSa(0.2) is equal to or greater than 0.35 (for the Canadian Chancery IEFaSa(0.2) is 0.4065),
- not have a Type 6 irregularity as described in Table 4.1.8.6.,
- have an SFRS with an Rd of 2.0 or greater, and
- have no storey with a lateral stiffness that is less than that of the storey above it.

Table 1 itemizes the irregularity types that cannot exist for a building to be labeled a post-disaster building as well as comments that identify whether or not the Canadian Chancery building complies with the requirement.

Table 1 - NBCC 2010 Irregularity Types

Irregularity Type	Comments	Compliant	Potential Retrofit
Vertical Stiffness Irregularity Exists if any storey is less than 70% of the stiffness of any adjacent storey, or less than 80% of the average stiffness of the three storeys above or below.	The lateral stiffness of the SFRS of the roof storey is less than 70% of the stiffness of the storey below it.	No	Lengthen existing shear walls between second floor and roof.
Vertical Geometric Irregularity Exists when the horizontal dimensions of the SFRS in any storey is more than 130% of that in an adjacent storey.	The third floor has a horizontal dimension that is 130% more than the horizontal dimension of the roof.	No	Lengthen existing shear walls between second floor and roof.
In-Plane Discontinuity in Vertical Lateral-Force-Resisting Element Exists where there is an offset of a lateral-force-	Neither of these cases exist for this structure	Yes	

resisting element of the SFRS of a reduction in lateral stiffness of the resisting element in the storey below.			
Out-of-Plane Offsets Discontinuities in a lateral force path, such as out-of-plane offsets of the vertical elements of the SFRS.	There are no out-of-plane offsets in the structure.	Yes	
Discontinuity in Capacity – Weak Storey A weak storey is one in which the storey shear strength is less than that in the storey above.	There are no weak storeys in the structure.	Yes	
Torsional Sensitivity Exists when the ratio B calculated according to Sentence 4.1.8.11.(9) exceeds 1.7.	The maximum ratio B is 1.3.	Yes	

For the SFRS to achieve an R_d of 2.0 the shear walls must be classified as moderately ductile as defined in CAN/CSA A23.3-04. The concrete reinforcing details do not meet the requirements, see Table 2.

Table 2: CAN/CSA A23.3-04 Prescriptive Requirements for Moderately Ductile Walls

Clause	Comments	Compliant	Potential Retrofit
21.7.2.2.4 - crossties or legs of overlapping hoops shall have centre-to-centre spacings not exceeding 350 mm.	Drawing S30 shows ties at 300 mm centre-to-centre.	Yes	
21.7.3.3.1 - rebar ratio shall not be less than 0.0025 in each direction	For the 300mm thick walls have 15M bars, 500 mm centre-to-centre, giving a reinforcing ratio of 0.0027.	Yes	
21.7.3.3.1 - rebar ratio shall not be less than 0.0025 in each direction	For the 400mm thick walls have 15M bars, 500 mm centre-to-centre, giving a	No	Thicken wall to provide additional reinforcing.

	reinforcing ratio of 0.002.		
21.7.3.3.2 - ref. 21.6.6.9. - buckling prevention ties shall… be detailed as hoops.	Drawing S21 shows typical wall corner and intersection details that do not have hoop ties.	No	Provide thickening around ends and corners of shear walls with tied reinforcing.
21.7.3.3.3 - Corners and junctions of intersecting walls must have horizontal bars extend to the far face of the joining wall and be bent around a vertical bar with a standard 90 degree hook.	Drawing S21 shows typical wall corner and intersection details that show compliance to this clause.	Yes	

5.7 Demand/Capacity Ratios for Key Elements

5.7.1 Slabs

Our analysis indicates that the slab capacities are generally sufficient for the imposed loads. The capacity checking results include the slab bending capacity, the slab shear capacity and the punching shear capacity. The software used for this analysis is "spSlab v3.50" with an equivalent frame method. Details are described in the following paragraphs.

5.7.1.1 Slab bending capacity

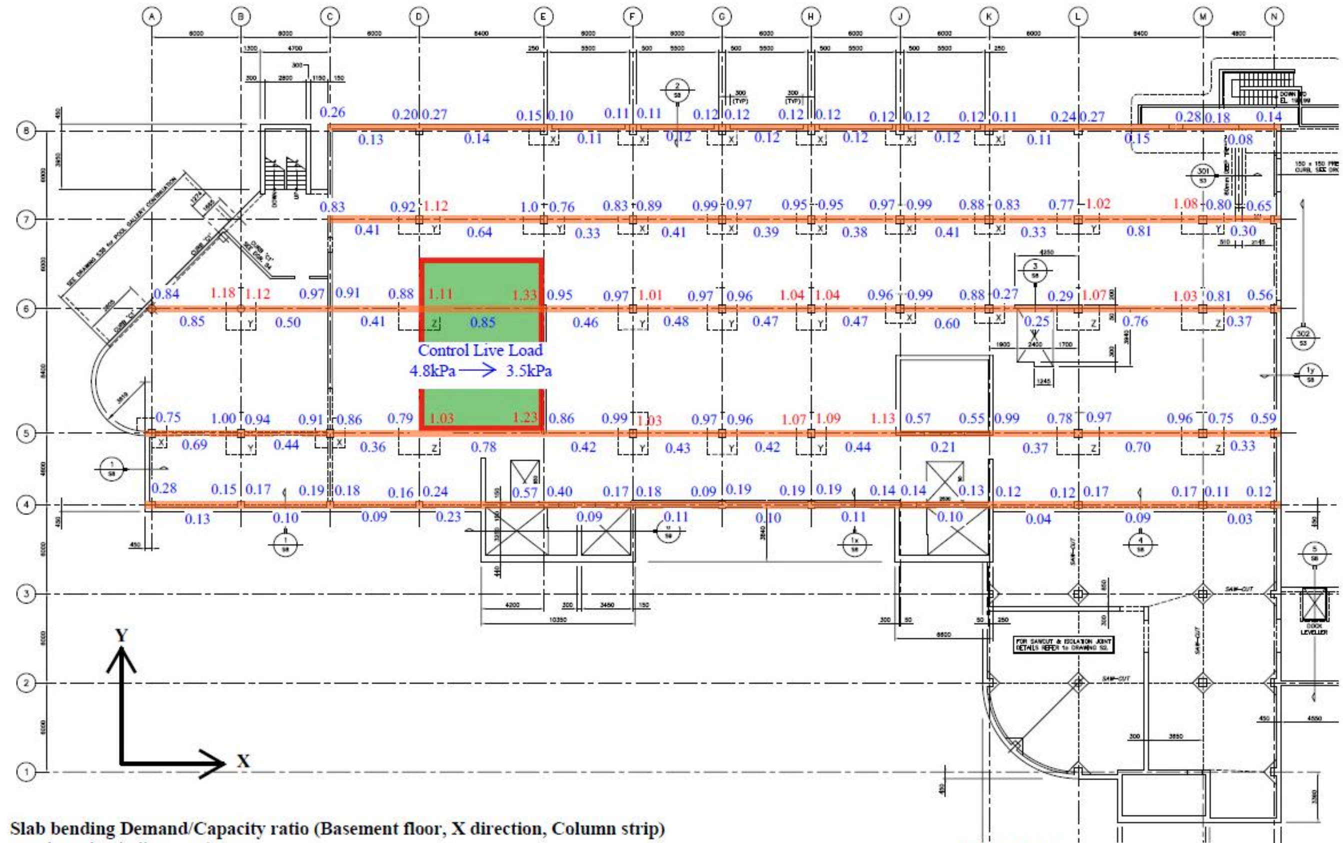
The bending capacities of the slabs are generally sufficient for the imposed loads, but some design moments in column strips exceed the limit around supports. The maximum D/C ratio is around 1.5 which is located in the 8.4m long span supported by wall (with no drop panel) on grid E. For these areas we suggest the imposed live load to be limited to reduce the demand. In other areas, the D/C ratios in the columns strips are less than 1.2 and the slab capacities are sufficient when considering moment redistribution. The details of floor loading assumptions, and slab bending D/C ratios are marked up in Figure 4 to Figure 9. The areas where we suggest controlling the imposed live load are also marked up in these figures. As the slab performance is similar in different floors, for clarity we only show the complete information in basement floor slab (Figure 4 to Figure 5). In other floors we only show areas where the demand exceeds the capacity in Figure 6 to Figure 9.

5.7.1.2 Slab shear capacity

The shear capacities of the slabs are sufficient to take the imposed loads. The shear D/C ratios of basement floor are shown in Figure 10. There are similar results in other floors and no D/C ratio exceeds 1.0.

5.7.1.3 Punching shear capacity

The punching shear capacities around columns and around drops are sufficient to take the imposed loads. The punching shear D/C ratios around columns are the critical cases as they are larger than the values around drops. The punching shear D/C ratios of basement floor are shown in Figure 11. There are similar results in other floors and no D/C ratio exceeds 1.0.



Slab bending Demand/Capacity ratio (Basement floor, X direction, Column strip)
- Red number indicates D/C>1.0
- When the support is a wall, the bending moment is considered to be shared by the column strip and middle strip with the same D/C ratio as the wall can help distribute the load.
- Bending moment exceeds the capacity at some supports slightly, but when considering moment redistribution between supports and mid-span they are safe except at the 8.4m long span.
- All D/C ratios are less than 1.0 in middle strips so they are not shown in this drawing.

Design Loads

Dead -	Structure	6.0kPa
	- Mech. & Elect.	0.2kPa
	- Architectural	1.0kPa
		7.2kPa
Live -		4.8kPa

Figure 4: Slab bending D/C ratios (Basement floor, X direction, Column strip)

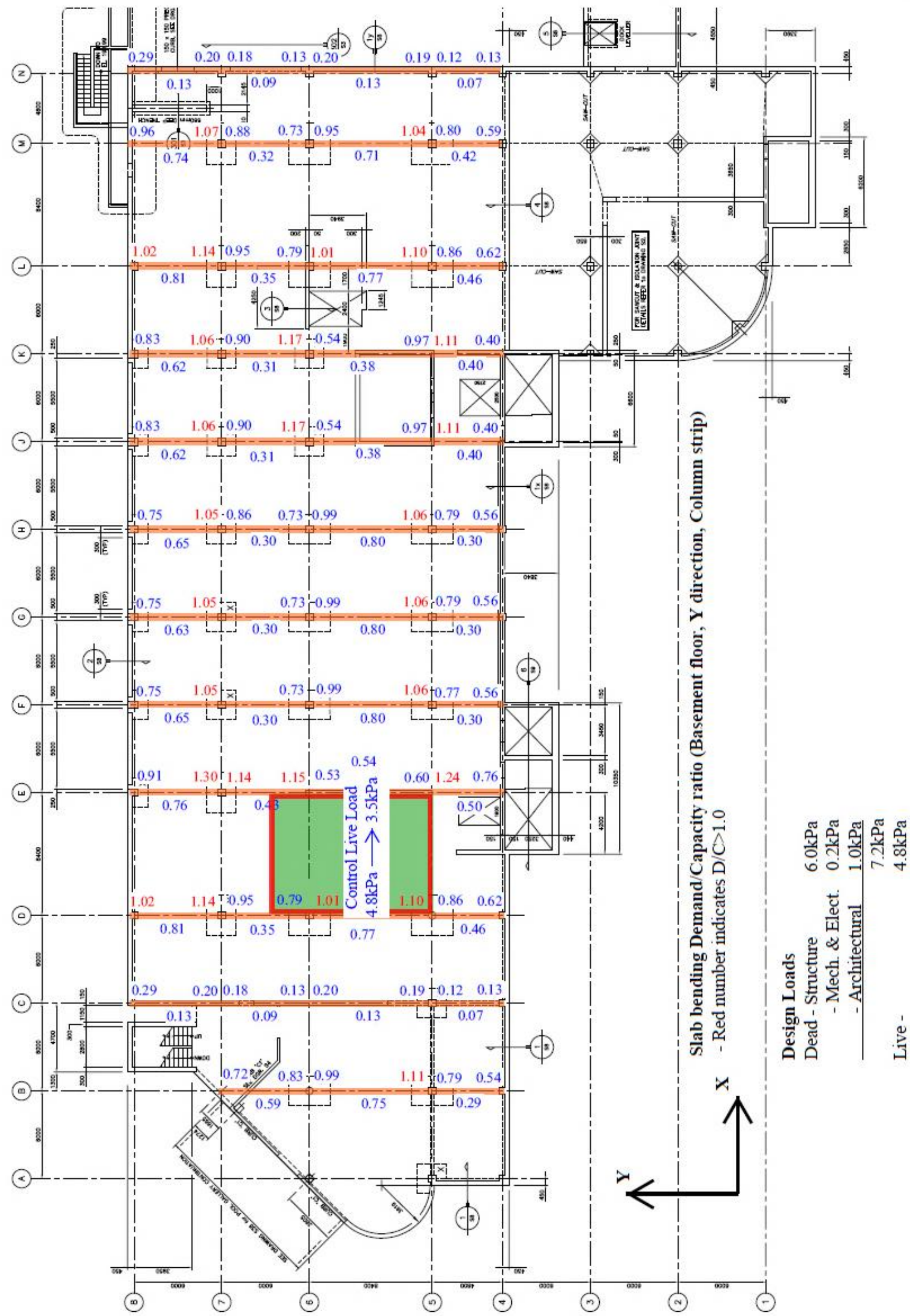


Figure 5: Slab bending D/C ratios (Basement floor, Y direction, Column strip)

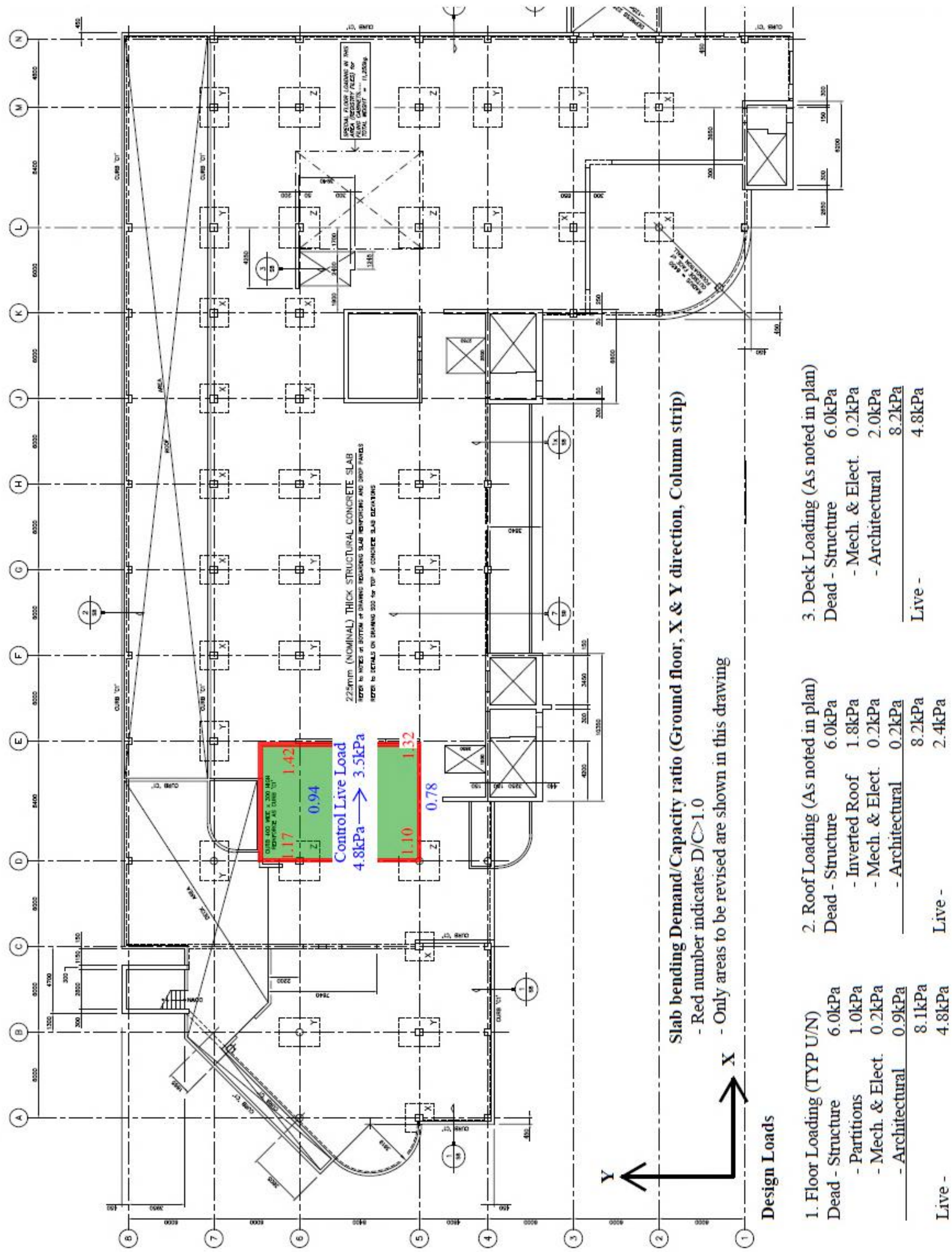


Figure 6: Slab bending D/C ratios (Ground floor, X and Y directions, Column strip)

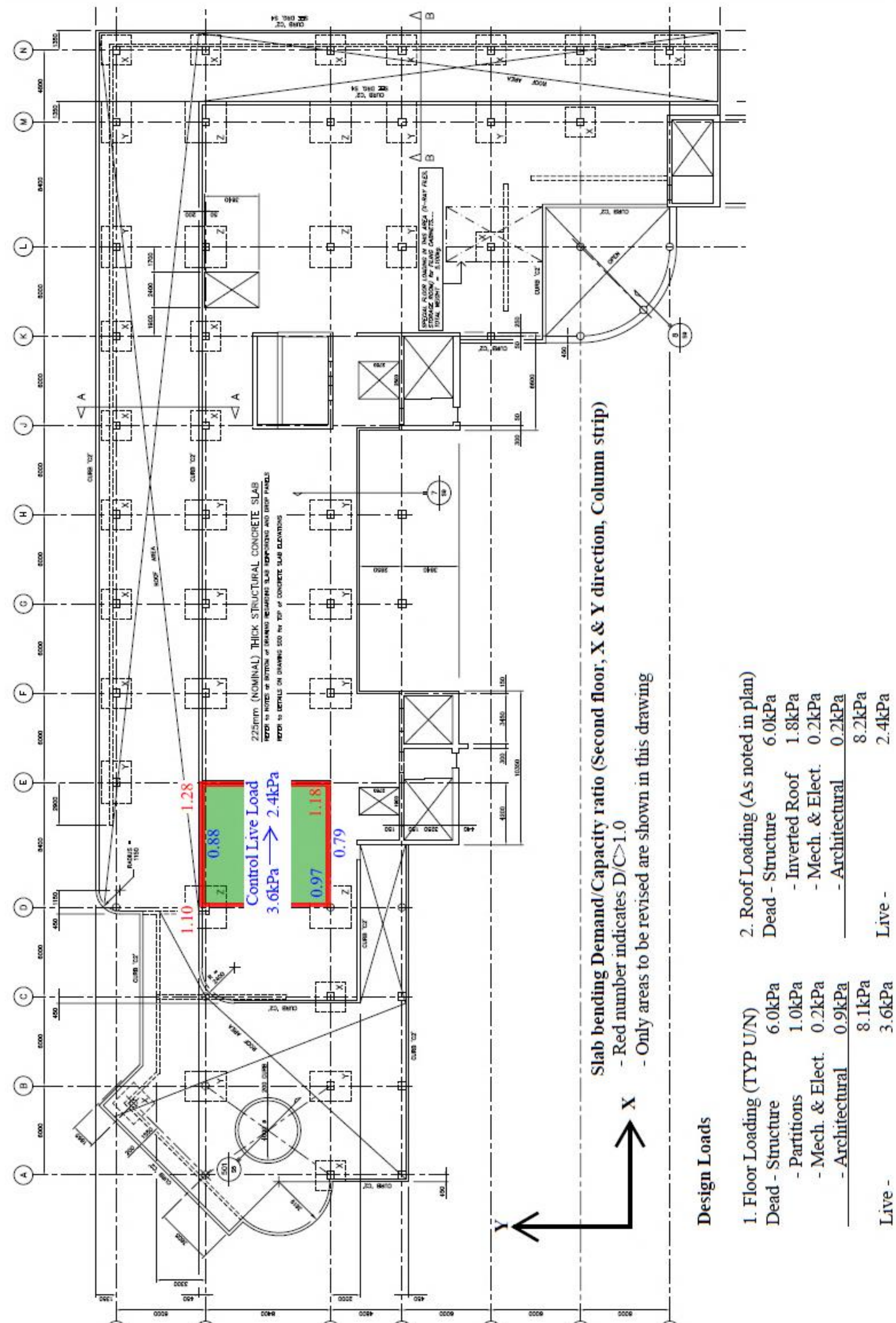


Figure 7: Slab bending D/C ratios (Second floor, X and Y directions, Column strip)

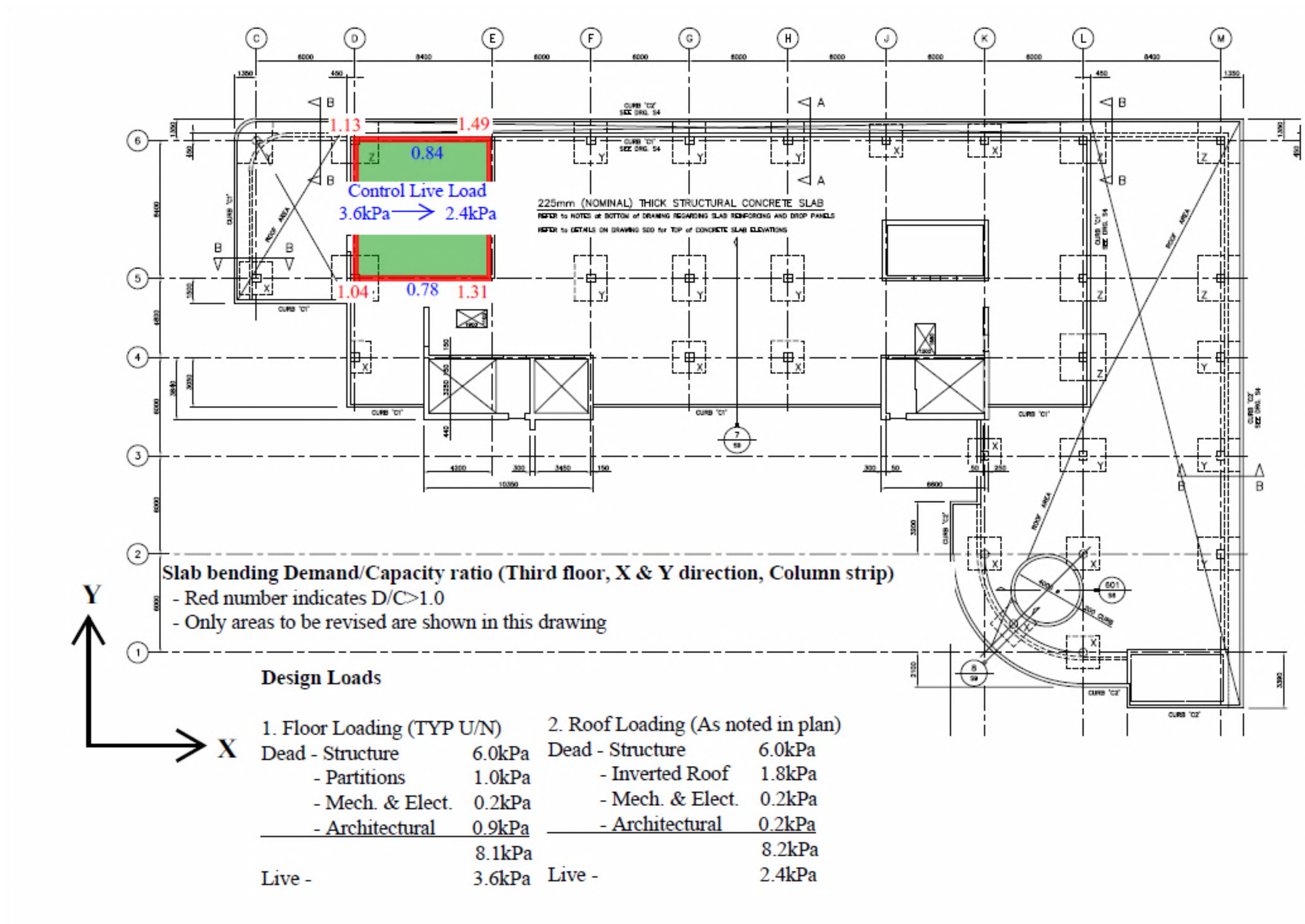
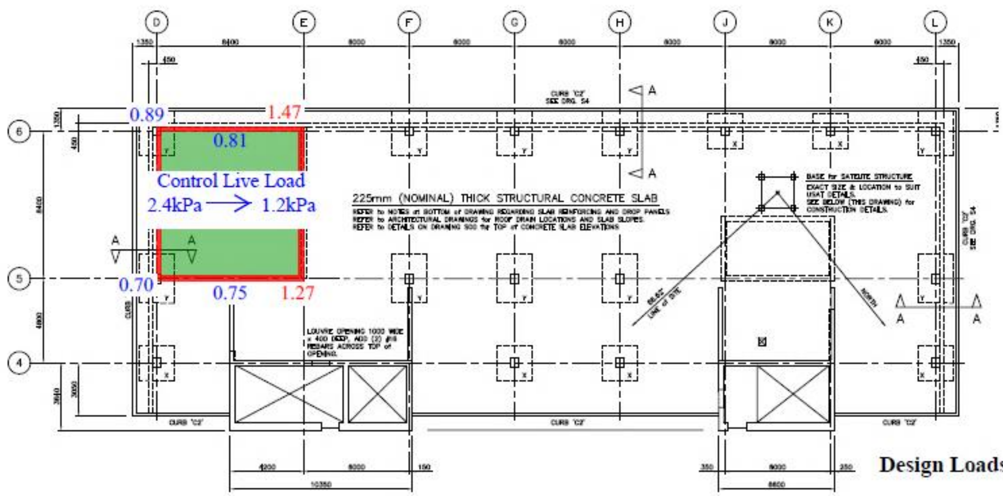
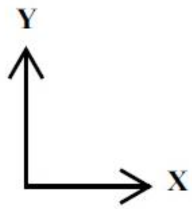


Figure 8: Slab bending D/C ratios (Third floor, X and Y directions, Column strip)





Slab bending Demand/Capacity ratio (Roof, X & Y direction, Column strip)
- Red number indicates D/C>1.0
- Only areas to be revised are shown in this drawing

Design Loads

Dead	- Structure	6.0kPa
	- Inverted Roof	1.8kPa
	- Mech. & Elect.	0.2kPa
	- Architectural	0.2kPa
		8.2kPa
Live -		2.4kPa

Figure 9: Slab bending D/C ratios (Roof, X and Y directions, Column strip)

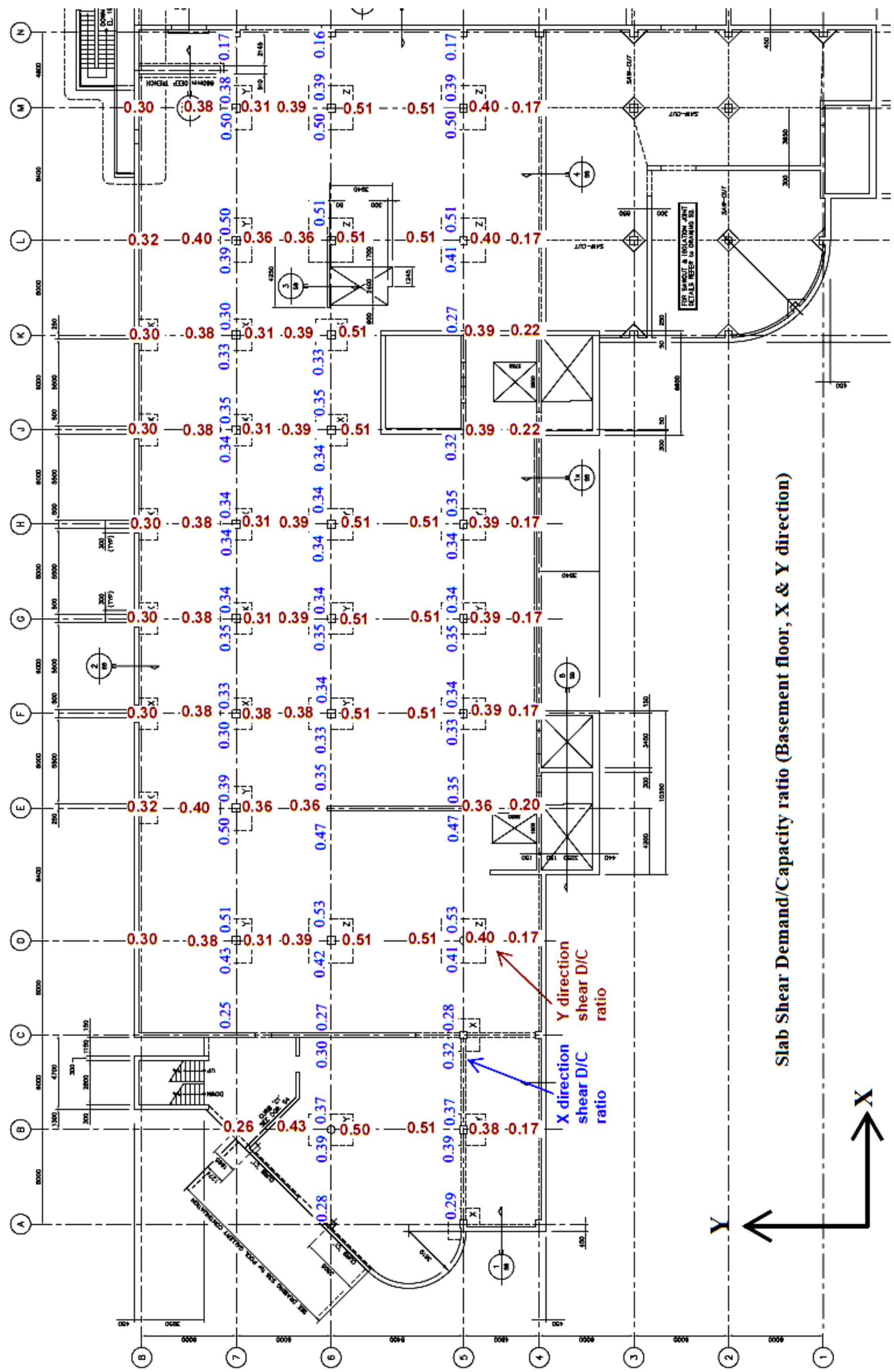


Figure 10: Slab shear D/C ratios (Basement floor, X and Y directions)

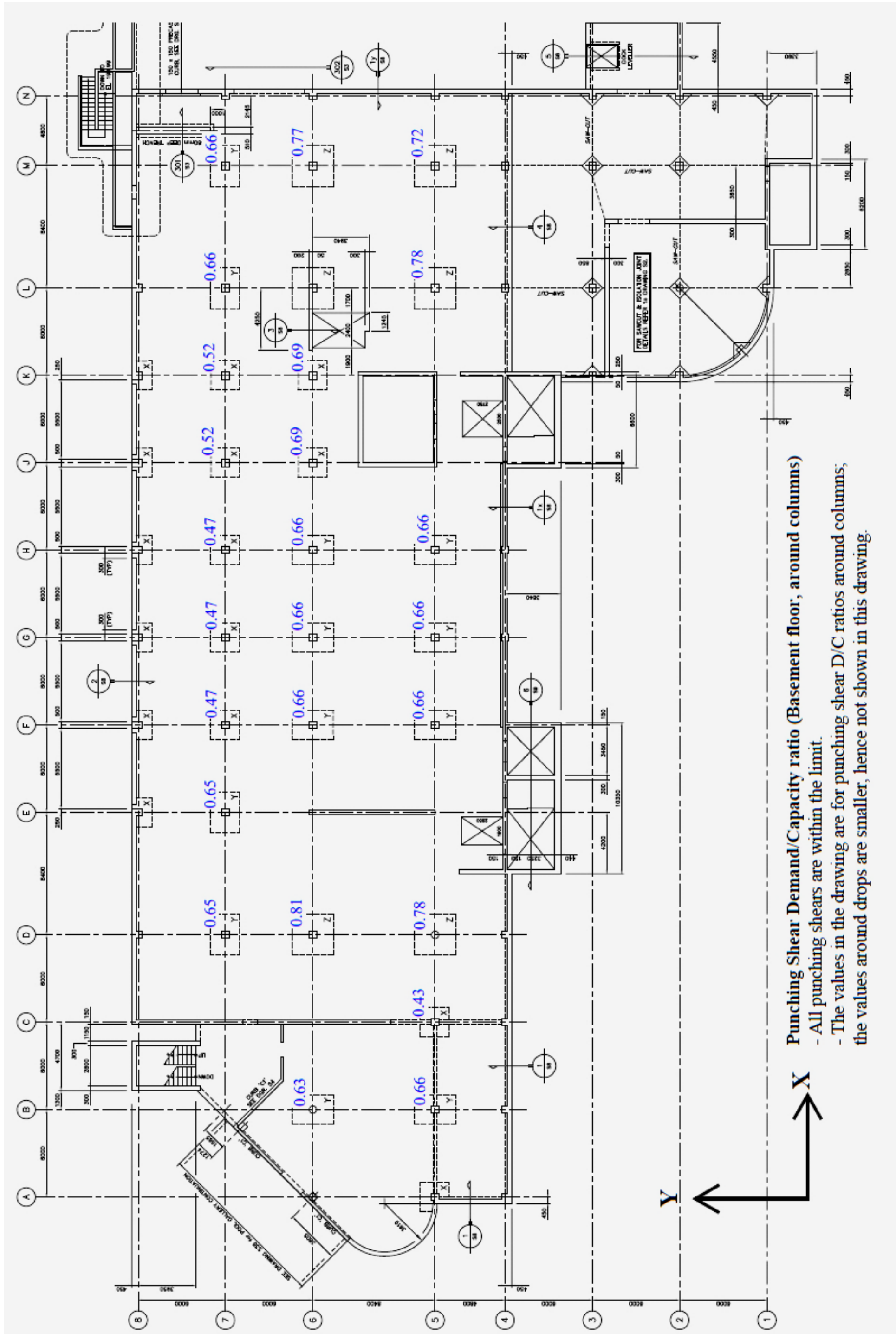


Figure 11: Punching shear D/C ratios (Basement floor, around columns)

5.7.2 Columns

The columns were designed to carry gravity load only, so the capacities of columns were reviewed comparing to demand under gravity load in this report. The column forces considered in the analysis include one axial force and two direction bending moments, and the results show that the columns are sufficient to take gravity load. Figure 12 shows the column schedule in which total 7 column sections are considered for different sizes or reinforcement. Figure 13 shows the detailed comparison results of column forces and capacities.

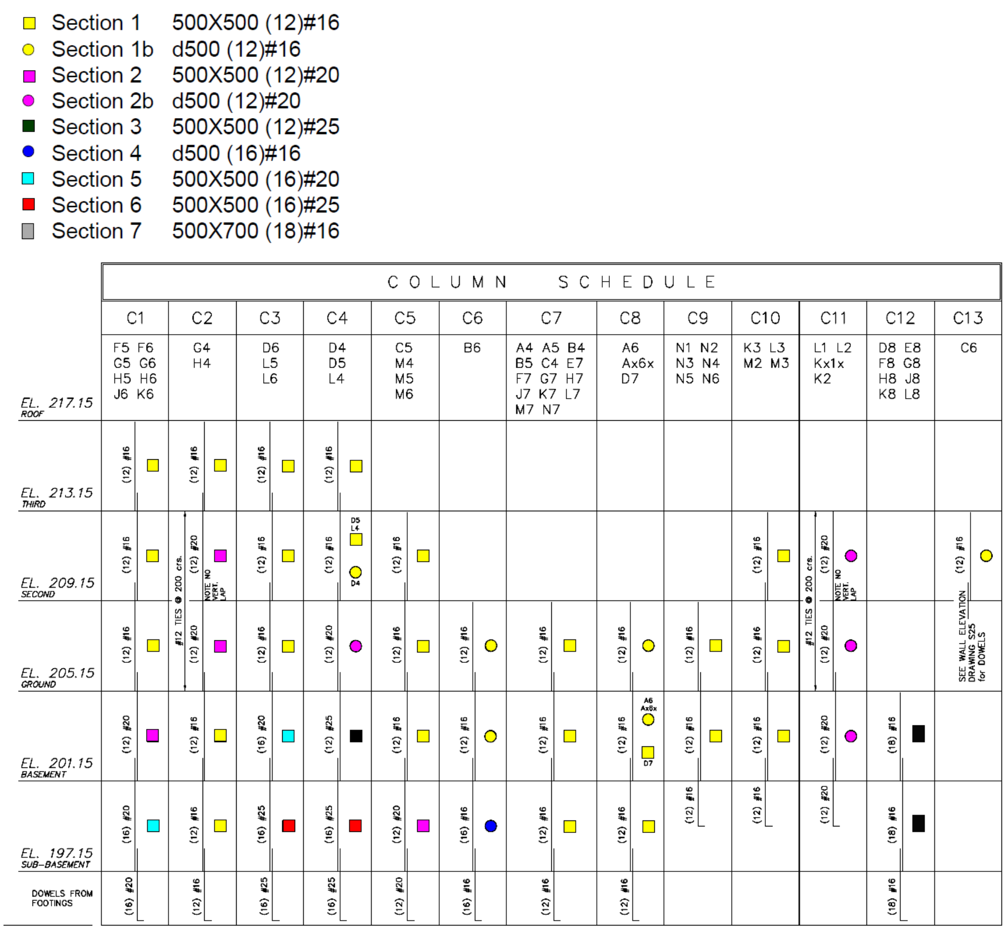


Figure 12: Column Schedule

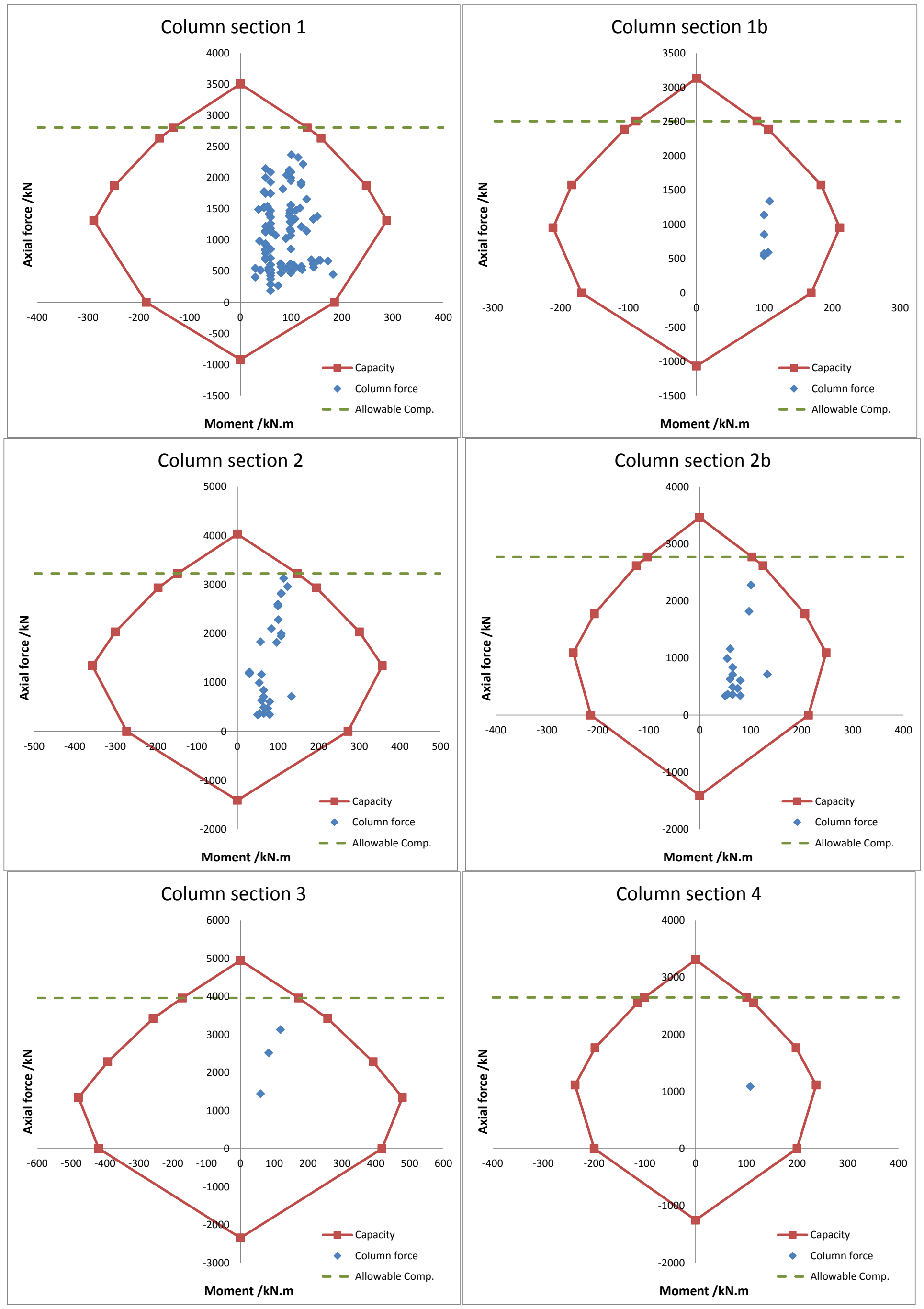


Figure 13: Column capacity checking under axial force and bending moment

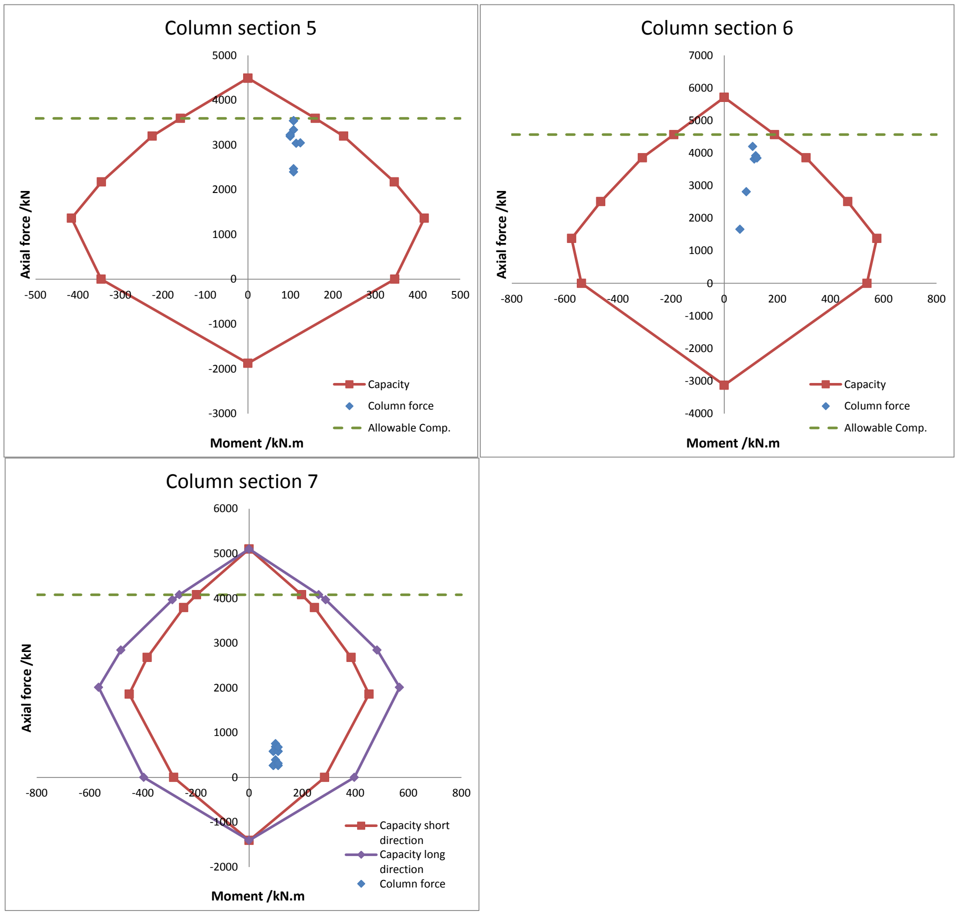


Figure 13: Column capacity checking under axial force and bending moment (Continued)

The columns were not considered to be part of the SFRS, but they should have sufficient capacity to support their gravity loads while undergoing earthquake-induced deformations according to NBCC 2010. The maximum inter-storey deflection at any level shall be limited to 0.01 h_s for post-disaster buildings. The deformations of all columns under seismic considering torsion are evaluated in this chapter. The Maximum inter-storey deflection is 12mm which is within the limit.

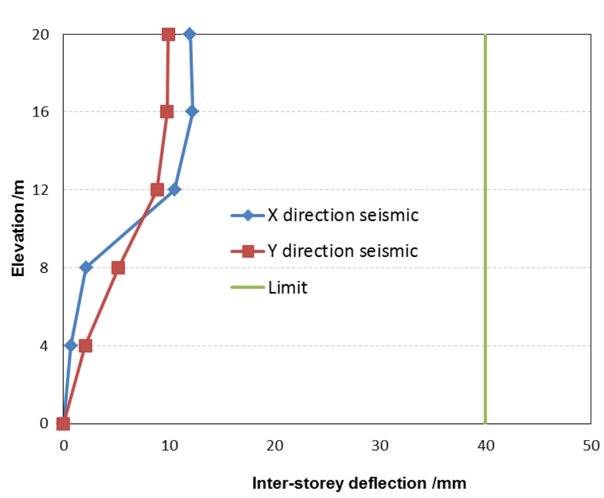


Figure 14: Maximum Inter-Storey Drift under Seismic (Arup 100% loading)

The capacities of columns were checked under the seismic deflection. The worst case appears in the column around corner such as column M/7, ground floor. This column is subject to large axial force and moment under gravity load because of 8.4m span, and has the largest curvature under seismic deformation because the deep beam adjacent to this column reduces the free length of the column. The load combination of dead load, live load and earthquake load are considered and combination (1.0D+0.5L+1.0E) is adopted in the capacity checking in accordance with NBCC 2010. Our evaluation procedure is:

1. Find the curvature-moment curve (Figure 15) of this column under defined axial force under gravity load.
2. Apply the bending moment to this column from gravity load (Point A in Figure 15).
3. When the column is subject to an earthquake, there will be a lateral deformation in this column and lead to additional bending curvature. Find the moment capacity with this additional bending deformation (Point B in Figure 15). If the capacity of column at this point is larger than gravity load, it means this column has sufficient capacity to take gravity load while undergoing earthquake-induced deformations.

The analysis result shows the columns in this building have sufficient capacities to support the gravity load under a severe earthquake. The moment-curvature response has been evaluated.

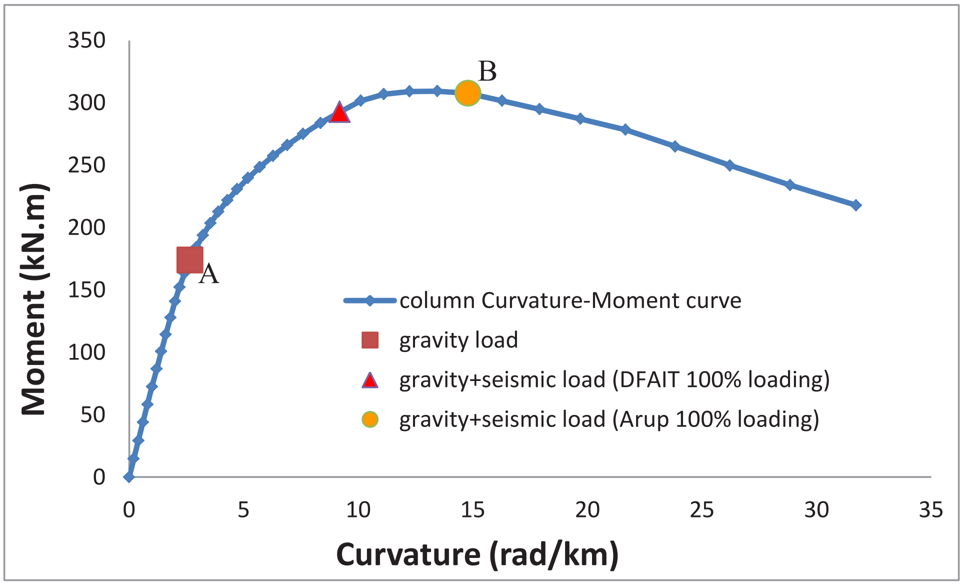


Figure 15: Column capacity evaluation under seismic

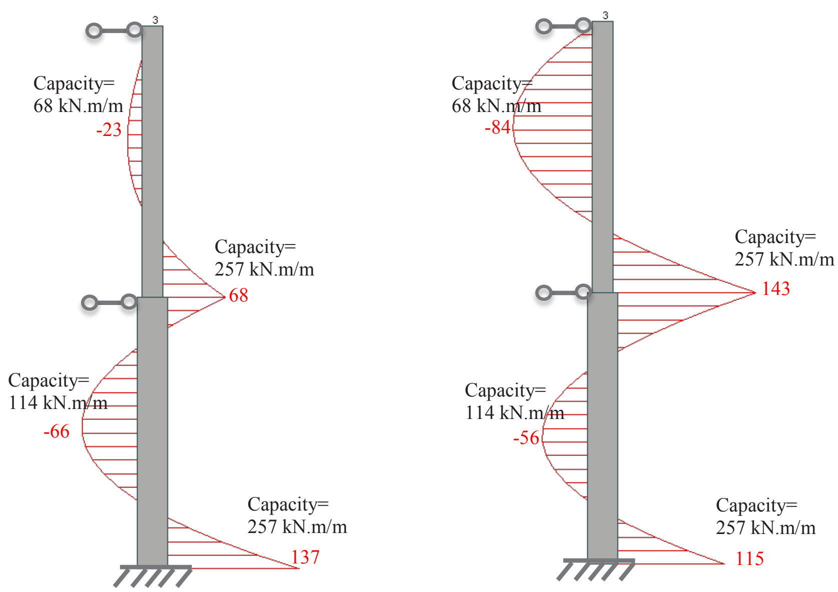
5.7.3 Retaining Walls

During earthquakes, the lateral earth pressure on basement walls is significantly increased. We have evaluated the loads on the retaining walls on grid 4, following the method recommended by Structural Commentary J of the NBCC 2010. This is a conservative design method, which means that the true demand may be lower than we find here.

The Ground and Basement level supports are considered as pins, since the walls are propped by the floor slabs. The base is considered fixed because the wall continues below the sub-basement floor and is fully restrained by the surrounding earth.

The analysis result shows the retaining walls have sufficient capacity to resist static earth pressure. The bending moment in retaining walls is significantly increased under seismic loads, especially in basement storey walls. The bending moment in the middle span of the walls in basement storey exceeds their capacity which will cause visible crack on the inside surface of these walls. However since these walls have more capacity around support area, they still can resist seismic earth pressure when consider bending moment redistribution.

Given the sloping site, the determination of the lateral soil load during an earthquake is a complex problem, and is best addressed with complete soil-structure interaction analysis.



Static earth pressure (1.4DL) Static + dynamic earth pressure (DL+EQ) (Arup 100% loading)

Figure 16: Retaining Wall bending capacity checking

5.7.4 Shear Walls and Cores

We carried out a 3D finite element analysis according to the provisions of the NBCC 2010. The analysis considered the following:

- The seismic response spectrum provided by DFAIT and Arup desktop analysis.
- R_d = 1.5, since the building does not meet the detailing requirements for R_d = 2.0. R_o=1.3 as SFRS are conventional construction shear walls.
- I_E = 1.5 for Post-Disaster structure.
- An earthquake load factor of 0.6, as per "NRC Guidelines for Seismic Evaluation of Existing Buildings" is considered. Also 100% full loading results are listed in the report for comparison.
- The building seismic mass is 96,600 kN.
- Unbalance soil load on the structure due to the varying grade.

The primary period of building was determined to be 0.32s from a dynamic analysis in ETABS 9.7.4. This compares to 0.47s by the NBCC simplified method. The distribution of forces in the building was assessed using the equivalent static force procedure in ETABS 9.7.4.

There is a significant difference in seismic load between the DFAIT and the Arup desktop analysis response spectra.

From the DFAIT response spectrum, the total seismic load F_x = 18,200kN, F_y = 17,400kN (100% loading, X and Y direction are defined in Figure 17). This base shear is approximately 20% of the building's seismic weight.

The Arup response spectrum gave a load approximately double the DFAIT value, 40% of the building's seismic weight.

The unbalanced soil pressure at north-east side was combined with seismic forces as part of lateral load in the analysis.

The outline of finite element analysis model is shown in Figure 17.

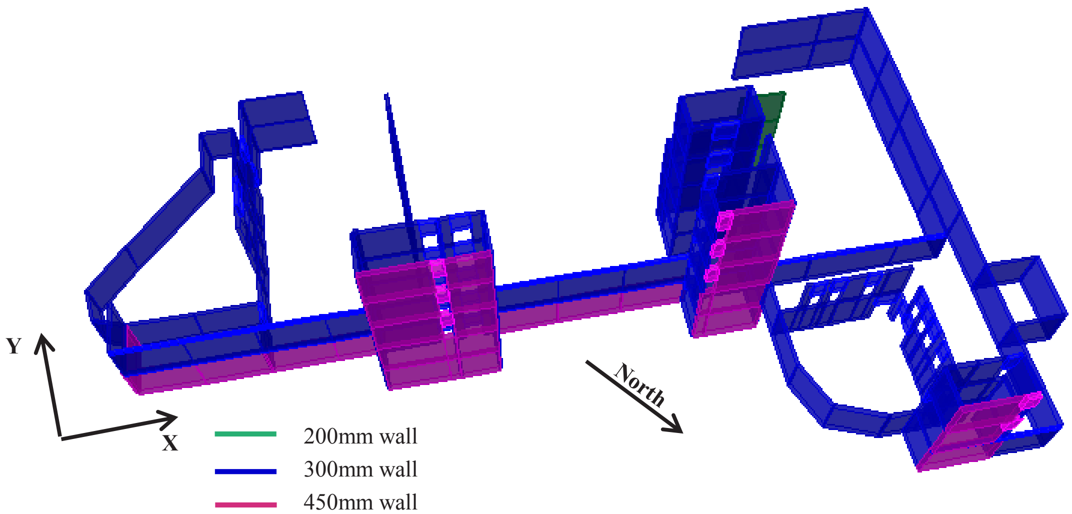


Figure 17: Outline of Finite Element Model of Lateral Force Resisting System (ETABS)

The D/C ratios of walls and shafts are listed in Table 1. This table should be read together with Figure 2 and Figure 3 for wall layout definition. The walls are categorized as slender walls and perimeter walls. The slender walls are the cores and interior walls that extend from the foundation to the roof level. These walls have an aspect ratio greater than two and will exhibit both bending and shear deformation. The perimeter walls are squat walls extending from the foundation to ground level. Their behaviour is dominated by shear deformation. For those walls and shafts that do not have sufficient capacity, the recommended retrofit method will be introduced in Chapter 8.

Walls and Shafts capacity checking under seismic (Slender Walls)

		Capacity				Demand (ARUP 100%Loading)				D/C (DFAIT 60% Loading)				D/C (DFAIT 100% Loading)				D/C (ARUP 60% Loading)				D/C (ARUP 100% Loading)			
		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)	
wall name	Storey no.	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X
6 WALL	Ground floor	3515			1634	4220			1055	0.37			0.20	0.61			0.33	0.72			0.39	1.20			0.65
	Basement	3515			1634	4220			660	0.37			0.12	0.61			0.21	0.72			0.24	1.20			0.40
	Sub-Basement	3515			1634	1579			161	0.14			0.03	0.23			0.05	0.27			0.06	0.45			0.10
C WALL	Ground floor	9884			1863	5909			1477	0.18			0.24	0.30			0.40	0.36			0.48	0.60			0.79
	Basement	50778			7087	30423			10836	0.18			0.47	0.31			0.78	0.36			0.92	0.60			1.53
	Sub-Basement	106136			10266	32383			10630	0.09			0.32	0.16			0.53	0.18			0.62	0.31			1.04
E WALL	Third floor	12589			3503	7674			1919	0.19			0.17	0.31			0.28	0.37			0.33	0.61			0.55
	Second floor	12589			2907	14597			1731	0.35			0.18	0.59			0.30	0.70			0.36	1.16			0.60
	Ground floor	12589			3083	24803			2552	0.60			0.25	1.00			0.42	1.18			0.50	1.97			0.83
	Basement	12589			3503	24803			570	0.60			0.05	1.00			0.08	1.18			0.10	1.97			0.16
	Sub-Basement	12589			3503	27953			1370	0.68			0.12	1.13			0.20	1.33			0.23	2.22			0.39
2X WALL	Ground floor	11722			1961	5344			1336	0.14			0.21	0.23			0.35	0.27			0.41	0.46			0.68
	Basement	17954			3100	8330			4143	0.14			0.41	0.24			0.68	0.28			0.80	0.46			1.34
LX WALL	Ground floor	14712			1345	2893			1051	0.06			0.24	0.10			0.40	0.12			0.47	0.20			0.78
	Basement	21210			3235	7913			4535	0.11			0.43	0.19			0.72	0.22			0.84	0.37			1.40
SHAFT W1	Third floor	53557	22410	5127	6478	17490	10489	2622	4373	0.10	0.14	0.16	0.21	0.17	0.24	0.26	0.34	0.20	0.28	0.31	0.41	0.33	0.47	0.51	0.68
	Second floor	53557	22410	5127	6478	49441	37055	6646	8148	0.28	0.51	0.40	0.38	0.47	0.84	0.66	0.64	0.55	0.99	0.78	0.75	0.92	1.65	1.30	1.26
	Ground floor	53557	22410	5127	6478	87198	66755	7431	9439	0.50	0.91	0.44	0.45	0.83	1.52	0.74	0.74	0.98	1.79	0.87	0.87	1.63	2.98	1.45	1.46
	Basement	53557	22410	5127	6478	77024	63754	1212	883	0.44	0.87	0.07	0.04	0.73	1.45	0.12	0.07	0.86	1.71	0.14	0.08	1.44	2.84	0.24	0.14
	Sub-Basement	53557	22410	5127	6478	55204	65330	2847	638	0.32	0.89	0.17	0.03	0.53	1.49	0.28	0.05	0.62	1.75	0.33	0.06	1.03	2.92	0.56	0.10
SHAFT W2	Third floor	20164	17375	4102	4166	5222	13049	3262	1305	0.08	0.23	0.24	0.10	0.13	0.38	0.41	0.16	0.16	0.45	0.48	0.19	0.26	0.75	0.80	0.31
	Second floor	20164	17375	4102	4166	19599	30401	4338	3722	0.30	0.54	0.32	0.27	0.50	0.89	0.54	0.46	0.58	1.05	0.63	0.54	0.97	1.75	1.06	0.89
	Ground floor	20164	17375	4102	4166	39889	51502	5275	5072	0.61	0.91	0.39	0.37	1.01	1.51	0.66	0.62	1.19	1.78	0.77	0.73	1.98	2.96	1.29	1.22
	Basement	20164	17375	4102	4166	32439	44928	2108	1003	0.49	0.79	0.16	0.07	0.82	1.32	0.26	0.12	0.97	1.55	0.31	0.14	1.61	2.59	0.51	0.24
	Sub-Basement	20164	17375	4102	4166	20922	34777	2272	285	0.32	0.61	0.17	0.02	0.53	1.02	0.28	0.03	0.62	1.20	0.33	0.04	1.04	2.00	0.55	0.07
SHAFT W3	Second floor	17302	9823	2556	3927	7523	13356	3339	1881	0.13	0.42	0.40	0.15	0.22	0.69	0.67	0.24	0.26	0.82	0.78	0.29	0.43	1.36	1.31	0.48
	Ground floor	17302	9823	2556	3927	28113	27004	4273	5193	0.50	0.84	0.51	0.40	0.83	1.40	0.85	0.67	0.97	1.65	1.00	0.79	1.62	2.75	1.67	1.32
	Basement	17302	9823	2556	3927	26625	23838	2799	4097	0.47	0.74	0.34	0.32	0.78	1.24	0.56	0.53	0.92	1.46	0.66	0.63	1.54	2.43	1.10	1.04
SHAFT W5	Third floor	19280	10896	2790	4117	10172	4319	1080	2543	0.16	0.12	0.12	0.19	0.27	0.20	0.20	0.32	0.32	0.24	0.23	0.37	0.53	0.40	0.39	0.62
	Second floor	19280	10896	2790	4117	26123	12108	1947	3988	0.41	0.34	0.21	0.30	0.69	0.57	0.36	0.49	0.81	0.67	0.42	0.58	1.35	1.11	0.70	0.97
	Ground floor	22791	18766	2790	4117	45649	38935	6715	4882	0.61	0.63	0.74	0.36	1.02	1.06	1.23	0.60	1.20	1.24	1.44	0.71	2.00	2.07	2.41	1.19
	Basement	22791	18766	2790	4117	45649	38935	2541	1106	0.61	0.63	0.28	0.08	1.02	1.06	0.46	0.14	1.20	1.24	0.55	0.16	2.00	2.07	0.91	0.27
	Sub-Basement	22791	18766	2790	4117	41666	34563	1775	412	0.56	0.56	0.19	0.03	0.93	0.94	0.32	0.05	1.10	1.11	0.38	0.06	1.83	1.84	0.64	0.10

Walls and Shafts capacity checking under seismic (Walls below Ground floor around perimeter)

		Capacity				Demand (ARUP 100%Loading)				D/C (DFAIT 60% Loading)				D/C (DFAIT 100% Loading)				D/C (ARUP 60% Loading)				D/C (ARUP 100% Loading)			
		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)	
wall name	Storey no.	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X
<1 WALL	Basement	5488			1822	1849			2036	0.10			0.34	0.17			0.57	0.20			0.67	0.34			1.12
4 WALL (A-C)	Basement	32070			5613	8233			3146	0.08			0.17	0.13			0.29	0.15			0.34	0.26			0.56
	Sub-Basement	32070			5613	11570			2791	0.11			0.15	0.18			0.25	0.22			0.30	0.36			0.50
4 WALL (C-D)	Basement	29188			4771	5276			3986	0.06			0.26	0.09			0.43	0.11			0.50	0.18			0.84
	Sub-Basement	29188			4771	9159			3325	0.10			0.21	0.16			0.36	0.19			0.42	0.31			0.70
4 WALL (F-J)	Basement	81092			8186	19111			7688	0.07			0.29	0.12			0.48	0.14			0.56	0.24			0.94
	Sub-Basement	81092			8186	26521			6226	0.10			0.23	0.17			0.39	0.20			0.46	0.33			0.76
4 WALL (K-N)	Sub-Basement	92696			7694	14446			2462	0.05			0.10	0.08			0.16	0.09			0.19	0.16			0.32
5 WALL	Sub-Basement	25517			5543	11008			1557	0.13			0.09	0.22			0.14	0.26			0.17	0.43			0.28
8 WALL (C-D)	Basement	7587			2430	2045			2097	0.08			0.26	0.14			0.44	0.16			0.52	0.27			0.86
	Sub-Basement	7587			2430	2974			1145	0.12			0.14	0.20			0.24	0.24			0.28	0.39			0.47
8 WALL (L-N)	Basement	13394			3402	8452			4016	0.19			0.36	0.32			0.60	0.38			0.71	0.63			1.18
	Sub-Basement	13394			3402	15544			2973	0.36			0.27	0.59			0.45	0.70			0.52	1.16			0.87
A WALL	Basement	7323			2386	6715			2767	0.28			0.35	0.47			0.59	0.55			0.70	0.92			1.16
	Sub-Basement	7323			2386	6482			3054	0.27			0.39	0.45			0.65	0.53			0.77	0.89			1.28
N WALL (1-4)	Basement	117375			8662	15024			8582	0.04			0.30	0.07			0.51	0.08			0.59	0.13			0.99
N WALL (4-8)	Basement	169261			10448	9444			4883	0.02			0.14	0.03			0.24	0.03			0.28	0.06			0.47
	Sub-Basement	169261			10448	29572			9453	0.05			0.28	0.09			0.46	0.10			0.54	0.17			0.90

* Local axis X-X of shaft is along global X direction. Local axis X-X of wall is along wall plane. Global axes are difined in Figure 2.

* Highlighted D/C values are walls or shafts where demands exceed capacities. (D/C = Demand/Capacity)

Table 1: Walls and shafts capacity checking under seismic (highlighted cells indicate D/C ratio >1.0)

5.7.5 Stability of Walls and Cores

5.7.5.1 Fixed Foundations

The overturning moment on the foundations of the shear walls exceeds the foundation capacity in many instances

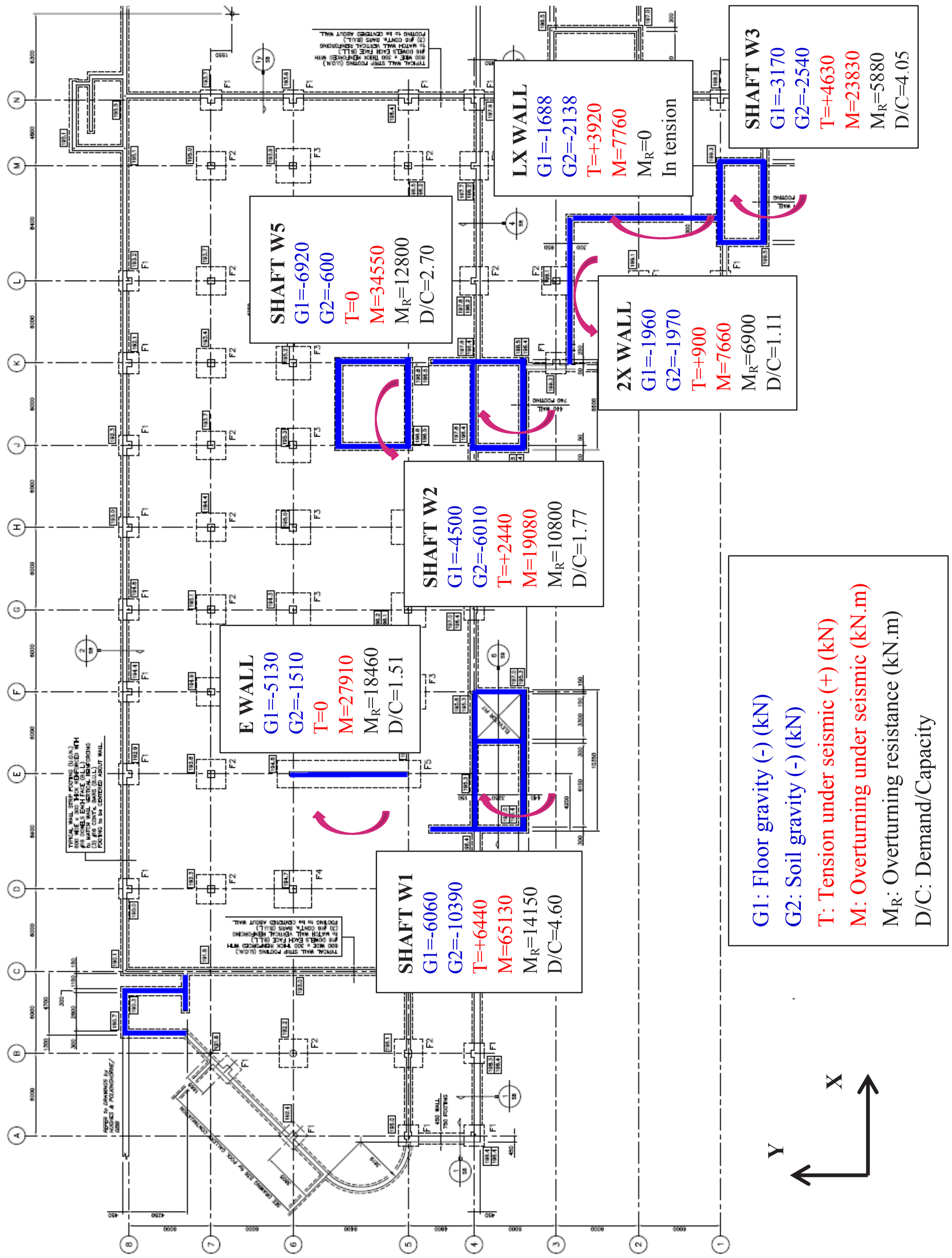


Figure 18: Walls and shafts overturning checking (Arup 100% loading)

Figure 18 shows the walls and cores whose fixed-end moments exceed the capacity of the foundation to resist overturning. The recommended retrofit method will be introduced in Chapter 8.

5.7.5.2 Rocking of Foundations

Since the applied moments exceed the foundation resistance, and since the foundations are not positively connected to the ground, we expect that the foundations will rock.

There are two categories of shear walls and cores: the slender walls that extend above the ground floor (the shafts and the walls on lines E & 6), and the squat walls that only extend from the foundation to the ground level (the perimeter walls).

The squat perimeter walls are very long and will not rock. Since the slender walls are tied to the perimeter walls at the Ground, Basement and Sub-Basement levels, they will not undergo rigid-body rocking. However, since the resistance is less than the impose loads, it is unreasonable to expect them to stay rigidly connected to the ground.

We have modeled the foundation flexibility by allowing the bases of the foundation walls to rotate freely. This gives an upper bound on the flexibly of the walls. The stability of the walls is entirely due to the restraint of the diaphragms tying the slender walls to the perimeter walls.

In the pinned model, we found that the fundamental period of the building in the front-to-back direction changed from 0.32 s to 0.36 s, resulting in a 5% decrease in seismic base shear. If we consider the true response to be about halfway between the full fixed and fully pinned cases, the base shear will drop 3%. This is much smaller than the variability of the seismic load and the material properties, therefore rocking of the foundations will not significantly reduce the overall seismic load on the structure.

Despite not reducing the overall base shear, the lateral loads are distributed differently in the two models, as shown in Figure 19.

In the fixed base model, the bending moment in the slender walls increased from the top of the walls down to the ground level, and then remained roughly constant from there down to the foundations. This suggests that the slender walls carry the loads from above the ground level down to the foundations, but are partially propped by the ground, basement and sub-basement slabs.

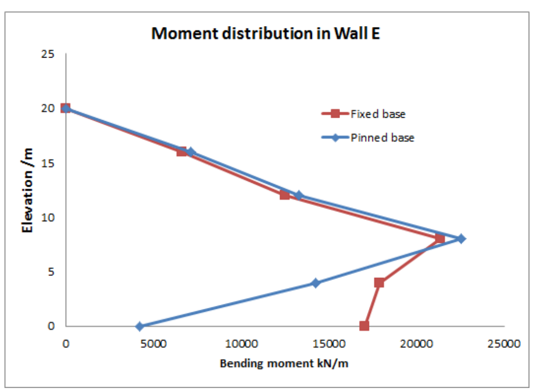


Figure 19 - Moment Distribution in Wall E

In the pinned base model, the bending moment in the slender walls above the ground level is identical to the bending moment in the fixed base walls. However, below the ground level, it reduces to almost nothing at the foundation level. This indicates that if the slender walls undergo significant rocking, they will shed all the load from above the ground level to the perimeter walls and will not help to carry the loads imposed below the ground level. Tables 2 shows the demand and capacity under the fully pinned condition.

Since the perimeter walls have significantly more capacity than the slender walls, this redistribution of load away from the slender walls may be very beneficial. Detailed soil-structure interaction may result in significantly reduced loads on the slender shear walls, reducing the need for retrofit.

Walls and Shafts capacity checking under seismic (Slender Walls, pinned base model)

		Capacity				Demand (ARUP 100%Loading)				D/C (DFAIT 60% Loading)				D/C (DFAIT 100% Loading)				D/C (ARUP 60% Loading)				D/C (ARUP 100% Loading)			
		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)	
wall name	Storey no.	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X
6 WALL	Ground floor	3515			1634	4722			1180	0.41			0.22	0.69			0.37	0.81			0.43	1.34			0.72
	Basement	3515			1634	4722			775	0.41			0.15	0.69			0.24	0.81			0.28	1.34			0.47
	Sub-Basement	3515			1634	1621			405	0.14			0.08	0.24			0.13	0.28			0.15	0.46			0.25
C WALL	Ground floor	9884			1863	7497			1874	0.23			0.31	0.39			0.51	0.46			0.60	0.76			1.01
	Basement	50778			7087	44085			15805	0.27			0.68	0.44			1.14	0.52			1.34	0.87			2.23
	Sub-Basement	106136			10266	49023			16391	0.14			0.49	0.24			0.81	0.28			0.96	0.46			1.60
E WALL	Third floor	12589			3503	8274			2069	0.20			0.18	0.34			0.30	0.39			0.35	0.66			0.59
	Second floor	12589			2907	15539			1816	0.38			0.19	0.63			0.32	0.74			0.37	1.23			0.62
	Ground floor	12589			3083	26534			2749	0.64			0.27	1.07			0.45	1.26			0.54	2.11			0.89
	Basement	12589			3503	26534			2564	0.64			0.22	1.07			0.37	1.26			0.44	2.11			0.73
	Sub-Basement	12589			3503	16985			4246	0.41			0.37	0.69			0.62	0.81			0.73	1.35			1.21
2X WALL	Ground floor	11722			1961	5770			1443	0.15			0.23	0.25			0.38	0.30			0.44	0.49			0.74
	Basement	17954			3100	2731			488	0.05			0.05	0.08			0.08	0.09			0.09	0.15			0.16
LX WALL	Ground floor	14712			1345	1700			1245	0.04			0.28	0.06			0.47	0.07			0.56	0.12			0.93
	Basement	21210			3235	8883			6308	0.13			0.60	0.21			0.99	0.25			1.17	0.42			1.95
SHAFT W1	Third floor	53557	22410	5127	6478	19041	10028	2507	4760	0.11	0.14	0.15	0.22	0.18	0.23	0.25	0.37	0.21	0.27	0.29	0.44	0.36	0.45	0.49	0.73
	Second floor	53557	22410	5127	6478	53398	35567	6385	8740	0.31	0.49	0.38	0.41	0.51	0.81	0.64	0.69	0.60	0.95	0.75	0.81	1.00	1.59	1.25	1.35
	Ground floor	53557	22410	5127	6478	92975	62841	6819	9918	0.53	0.86	0.41	0.47	0.89	1.43	0.68	0.78	1.04	1.68	0.80	0.92	1.74	2.80	1.33	1.53
	Basement	53557	22410	5127	6478	80659	60844	5541	1223	0.46	0.83	0.33	0.06	0.77	1.38	0.55	0.10	0.90	1.63	0.65	0.11	1.51	2.72	1.08	0.19
	Sub-Basement	53557	22410	5127	6478	45809	39196	8608	2988	0.26	0.54	0.51	0.14	0.44	0.89	0.86	0.24	0.51	1.05	1.01	0.28	0.86	1.75	1.68	0.46
SHAFT W2	Third floor	20164	17375	4102	4166	6010	13200	3300	1503	0.09	0.23	0.25	0.11	0.15	0.39	0.41	0.18	0.18	0.46	0.48	0.22	0.30	0.76	0.80	0.36
	Second floor	20164	17375	4102	4166	22068	33985	5196	4112	0.33	0.60	0.39	0.30	0.56	1.00	0.65	0.50	0.66	1.17	0.76	0.59	1.09	1.96	1.27	0.99
	Ground floor	20164	17375	4102	4166	44320	60409	6606	5563	0.67	1.06	0.49	0.41	1.12	1.77	0.82	0.68	1.32	2.09	0.97	0.80	2.20	3.48	1.61	1.34
	Basement	20164	17375	4102	4166	36380	51937	4939	1710	0.55	0.91	0.37	0.13	0.92	1.52	0.61	0.21	1.08	1.79	0.72	0.25	1.80	2.99	1.20	0.41
	Sub-Basement	20164	17375	4102	4166	25597	26320	2847	848	0.39	0.46	0.21	0.06	0.65	0.77	0.35	0.10	0.76	0.91	0.42	0.12	1.27	1.51	0.69	0.20
SHAFT W3	Second floor	17302	9823	2556	3927	6829	9809	2452	1707	0.12	0.31	0.29	0.13	0.20	0.51	0.49	0.22	0.24	0.60	0.58	0.26	0.39	1.00	0.96	0.43
	Ground floor	17302	9823	2556	3927	27326	19184	3385	5177	0.48	0.60	0.41	0.40	0.81	1.00	0.68	0.67	0.95	1.17	0.79	0.79	1.58	1.95	1.32	1.32
	Basement	17302	9823	2556	3927	21968	16080	4364	4294	0.39	0.50	0.52	0.33	0.65	0.83	0.87	0.56	0.76	0.98	1.02	0.66	1.27	1.64	1.71	1.09
SHAFT W5	Third floor	19280	10896	2790	4117	7513	4002	1001	1878	0.12	0.11	0.11	0.14	0.20	0.19	0.18	0.23	0.23	0.22	0.22	0.27	0.39	0.37	0.36	0.46
	Second floor	19280	10896	2790	4117	19956	13239	2320	3111	0.32	0.37	0.25	0.23	0.53	0.62	0.42	0.39	0.62	0.73	0.50	0.45	1.04	1.22	0.83	0.76
	Ground floor	22791	18766	2790	4117	34241	43701	7616	3571	0.46	0.71	0.84	0.27	0.77	1.19	1.39	0.44	0.90	1.40	1.64	0.52	1.50	2.33	2.73	0.87
	Basement	22791	18766	2790	4117	34241	43701	6591	4526	0.46	0.71	0.72	0.34	0.77	1.19	1.20	0.56	0.90	1.40	1.42	0.66	1.50	2.33	2.36	1.10
	Sub-Basement	22791	18766	2790	4117	16137	20747	5187	4034	0.22	0.34	0.57	0.30	0.36	0.56	0.95	0.50	0.42	0.66	1.12	0.59	0.71	1.11	1.86	0.98

Walls and Shafts capacity checking under seismic (Walls below Ground floor around perimeter, Pinned base model)

		Capacity				Demand (ARUP 100%Loading)				D/C (DFAIT 60% Loading)				D/C (DFAIT 100% Loading)				D/C (ARUP 60% Loading)				D/C (ARUP 100% Loading)			
		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)		Moment (kN-m)		Shear (kN)	
wall name	Storey no.	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X	Y-Y	X-X	Y	X
1 WALL	Basement	5488			1822	2219			2645	0.12			0.44	0.21			0.74	0.24			0.87	0.40			1.45
4 WALL (A-C)	Basement	32070			5613	11317			4138	0.11			0.23	0.18			0.38	0.21			0.44	0.35			0.74
	Sub-Basement	32070			5613	16192			3835	0.15			0.21	0.26			0.35	0.30			0.41	0.50			0.68
4 WALL (C-D)	Basement	29188			4771	7082			5855	0.07			0.38	0.12			0.63	0.15			0.74	0.24			1.23
	Sub-Basement	29188			4771	8330			5088	0.09			0.33	0.15			0.54	0.17			0.64	0.29			1.07
4 WALL (F-J)	Basement	81092			8186	21608			9531	0.08			0.36	0.14			0.59	0.16			0.70	0.27			1.16
	Sub-Basement	81092			8186	26966			7997	0.10			0.30	0.17			0.50	0.20			0.59	0.33			0.98
4 WALL (K-N)	Sub-Basement	92696			7694	13027			3399	0.04			0.14	0.07			0.23	0.08			0.27	0.14			0.44
5 WALL	Sub-Basement	25517			5543	16840			2134	0.20			0.12	0.34			0.20	0.40			0.23	0.66			0.39
8 WALL (C-D)	Basement	7587			2430	2867			2925	0.12			0.37	0.19			0.61	0.23			0.72	0.38			1.20
	Sub-Basement	7587			2430	3877			1598	0.16			0.20	0.26			0.34	0.31			0.39	0.51			0.66
8 WALL (L-N)	Basement	13394			3402	11495			5232	0.26			0.47	0.44			0.78	0.51			0.92	0.86			1.54
	Sub-Basement	13394			3402	21805			3903	0.50			0.35	0.83			0.59	0.98			0.69	1.63			1.15
A WALL	Basement	7323			2386	9657			4015	0.40			0.51	0.67			0.86	0.79			1.01	1.32			1.68
	Sub-Basement	7323			2386	9671			4743	0.40			0.61	0.67			1.01	0.79			1.19	1.32			1.99
N WALL (1-4)	Basement	117375			8662	20018			10757	0.05			0.38	0.09			0.63	0.10			0.75	0.17			1.24
N WALL (4-8)	Basement	169261			10448	12679			7127	0.02			0.21	0.04			0.35	0.04			0.41	0.07			0.68
	Sub-Basement	169261			10448	45191			15180	0.08			0.44	0.14			0.74	0.16			0.87	0.27			1.45

*** Local axis X-X of shaft is along global X direction. Local axis X-X of wall is along wall plane. Global axes are difined in Figure 2.**

*** Highlighted D/C values are walls or shafts where demands exceed capacities. (D/C = Demand/Capacity)**

Table 2: Walls and shafts D/C ratio with estimate of rocking effects (highlighted cells indicate D/C ratio >1.0)

5.7.6 Diaphragms to Transfer Lateral Load

The capacity of diaphragms to transfer shear force under seismic loads are evaluated in this chapter. The demands of shear force in diaphragms are extracted from ETABS model with R_dR_o taken as 1.0 for diaphragm design in accordance with NBCC 2010.

There are stiff perimeter walls below ground level, and this change may cause shear distribution in the walls and shafts. Strong diaphragm slab on ground level is required to ensure the shear redistribution.

Other insufficient diaphragms are around the shafts located in the edge of building which take most of lateral loads form upper floors but have limited contact areas to the main slab.

Figure 20 shows the diaphragm capacity checking results, and insufficient diaphragms are highlighted by red color. The recommended retrofit method will be introduced in Chapter 8.

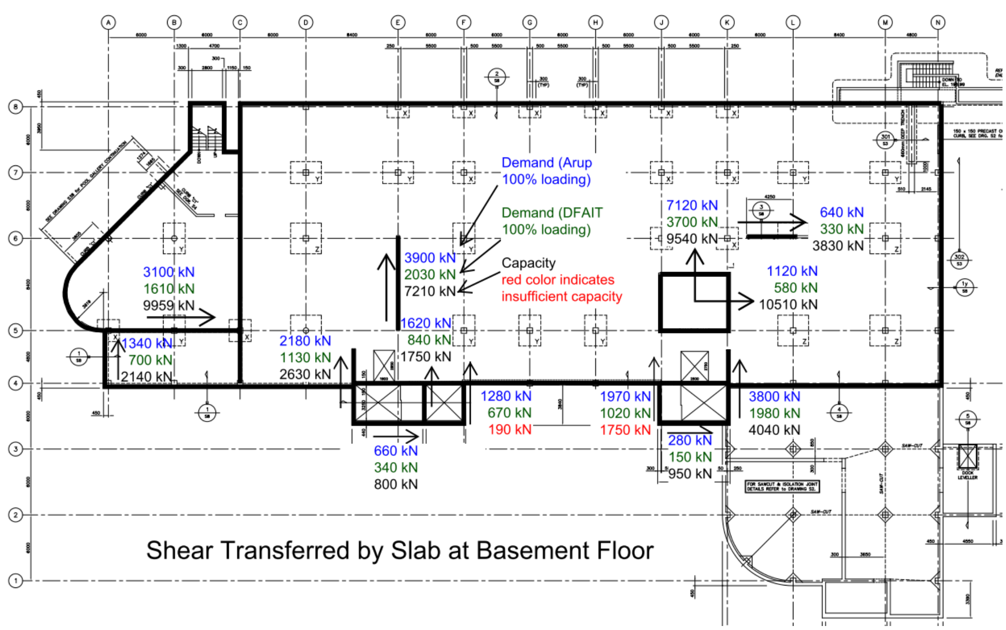


Figure 20: Diaphragm capacity evaluation to ensure the shear transfer

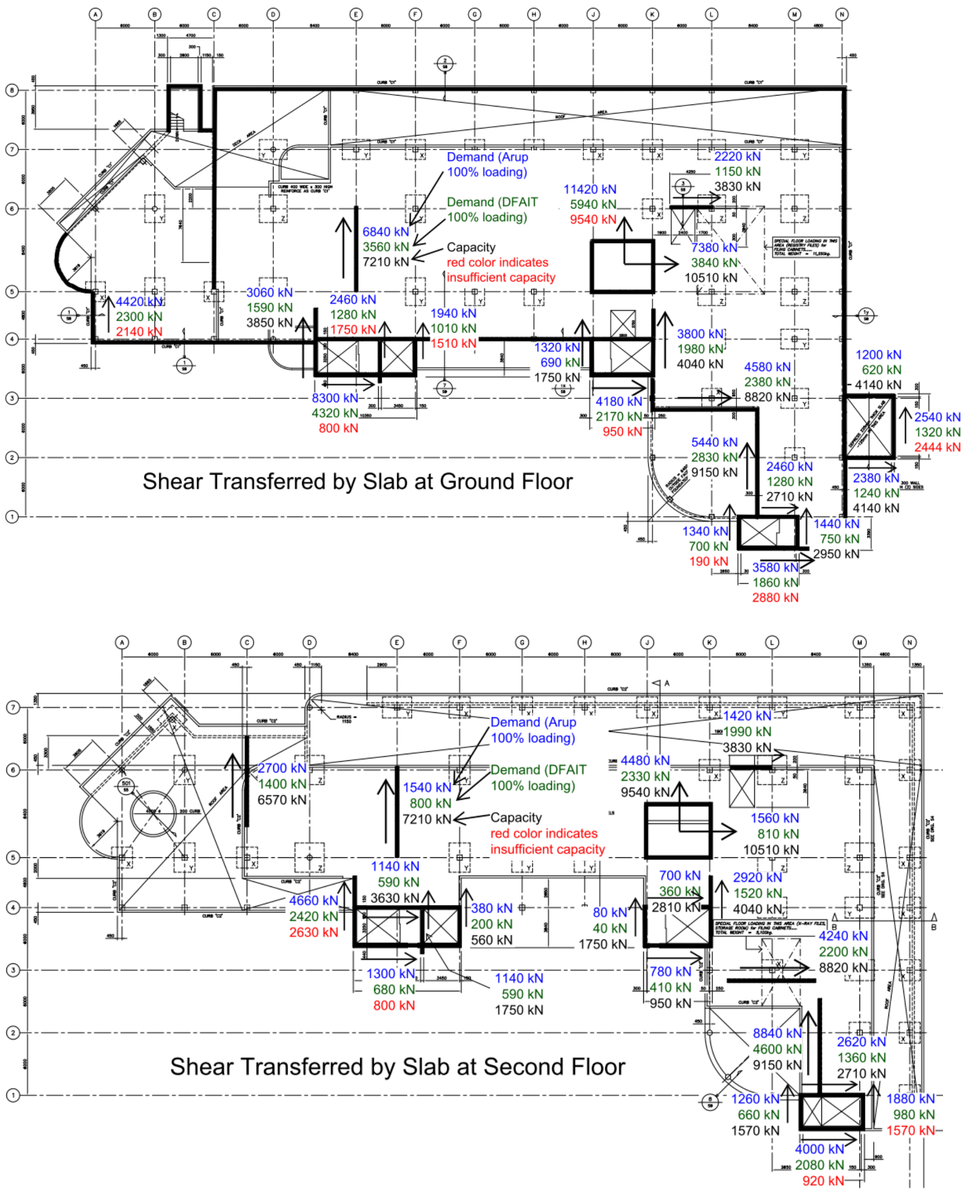
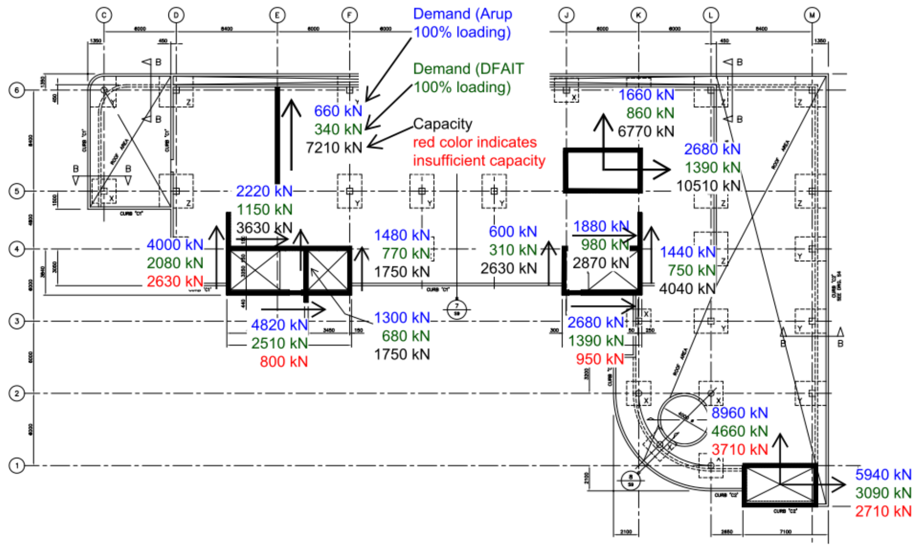
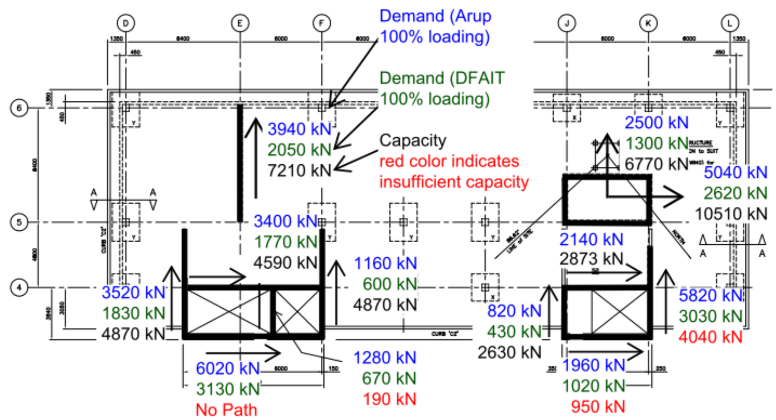


Figure 20: Diaphragm capacity evaluation to ensure the shear transfer (Continued)



Shear Transferred by Slab at Third Floor



Shear Transferred by Slab at Roof

Figure 20: Diaphragm capacity evaluation to ensure the shear transfer (Continued)

5.8 Areas requiring retrofit

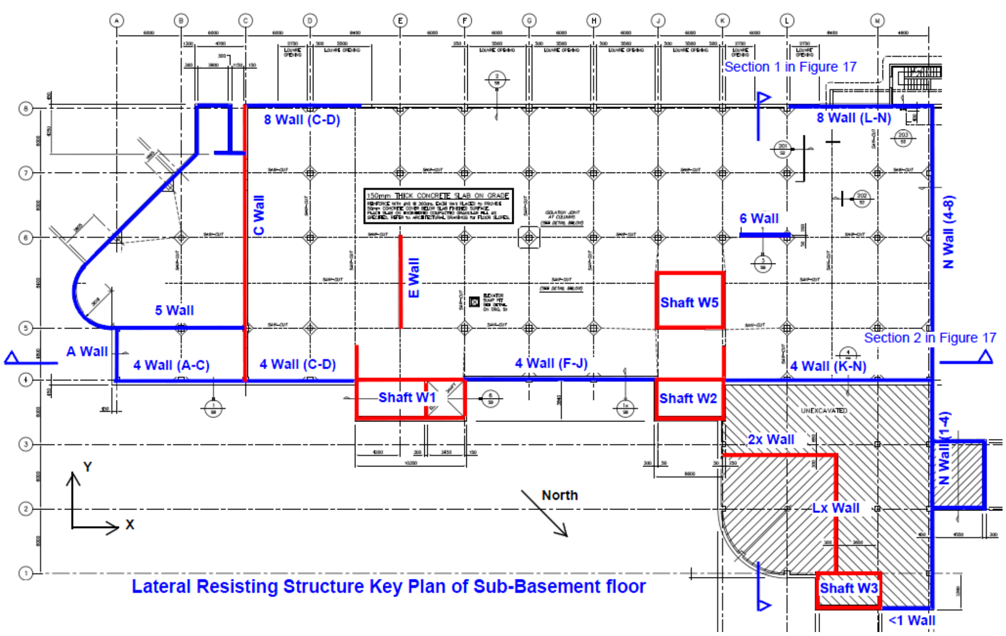
5.8.1 Walls and shafts

The following plans and wall elevations summarize the broad areas of the High Commission that will require retrofit under both the DFAIT and the Arup seismic hazard scenarios. There are a variety of drivers for retrofit:

- Insufficient moment capacity,
- Insufficient shear capacity, and
- Inadequate detailing.

Only the retrofit required under full seismic loading is shown, since the 60% load can only be applied for evaluation, not for retrofit.

For those walls requiring retrofit we recommend to strengthen them by conventional thickening method. The typical details of shear wall thickening and end zone enlarging are shown in Figure 21 and Figure 22. The areas requiring retrofit and the additional sizes under DFAIT and Arup seismic force are shown in Figure 23 and Figure 24 (see figure below for layout of walls, red color shows the walls requiring retrofit). The recommended new thicknesses of the walls are based on our seismic analysis results, and at the same time we have also considered to keep the continuity of walls after the retrofit.



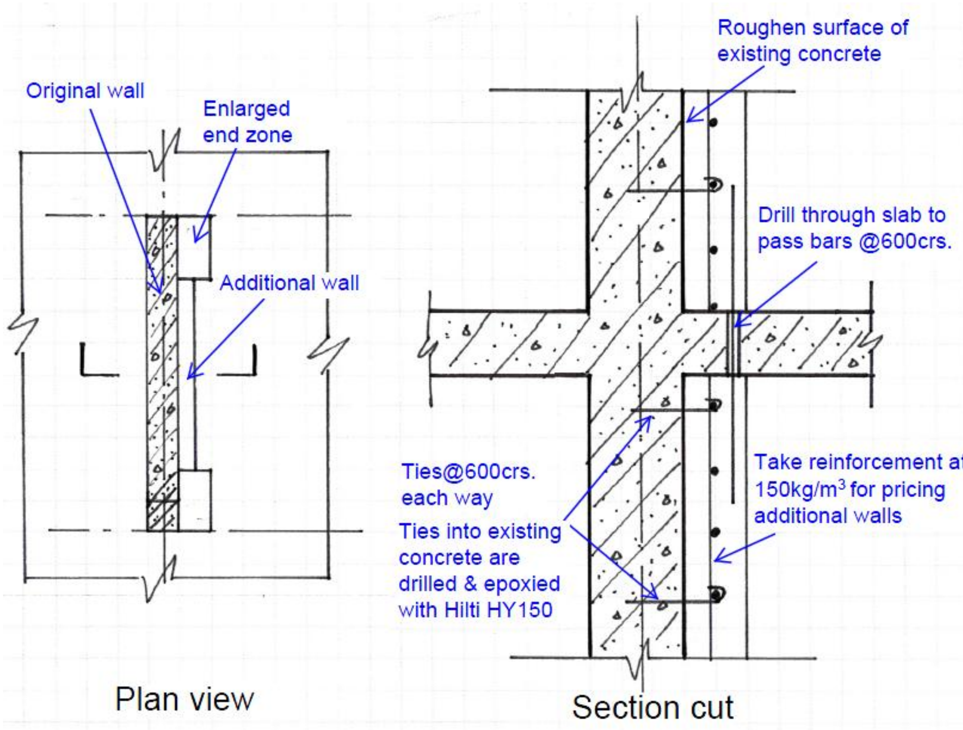


Figure 21: Typical details of shear wall thickening

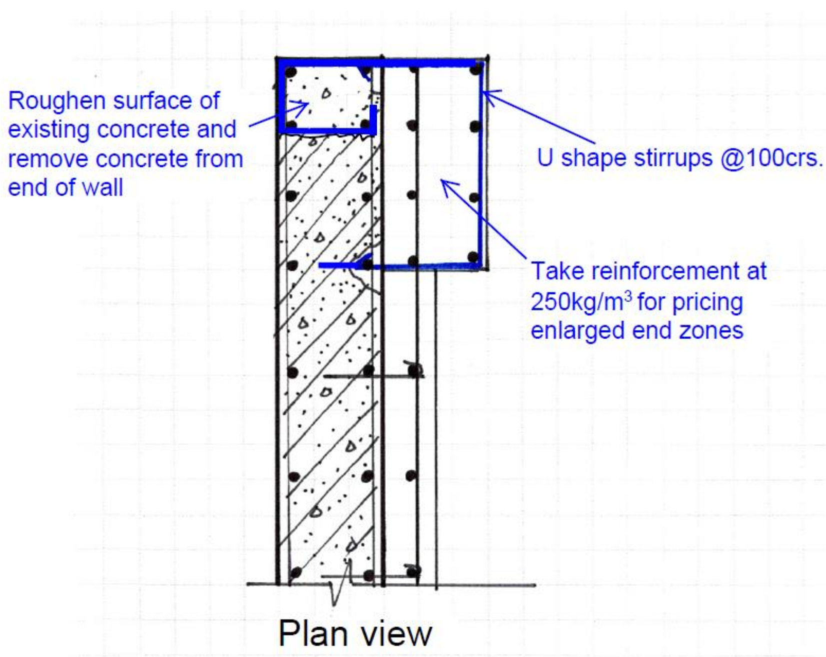


Figure 22: Typical details of compression zone enlarging

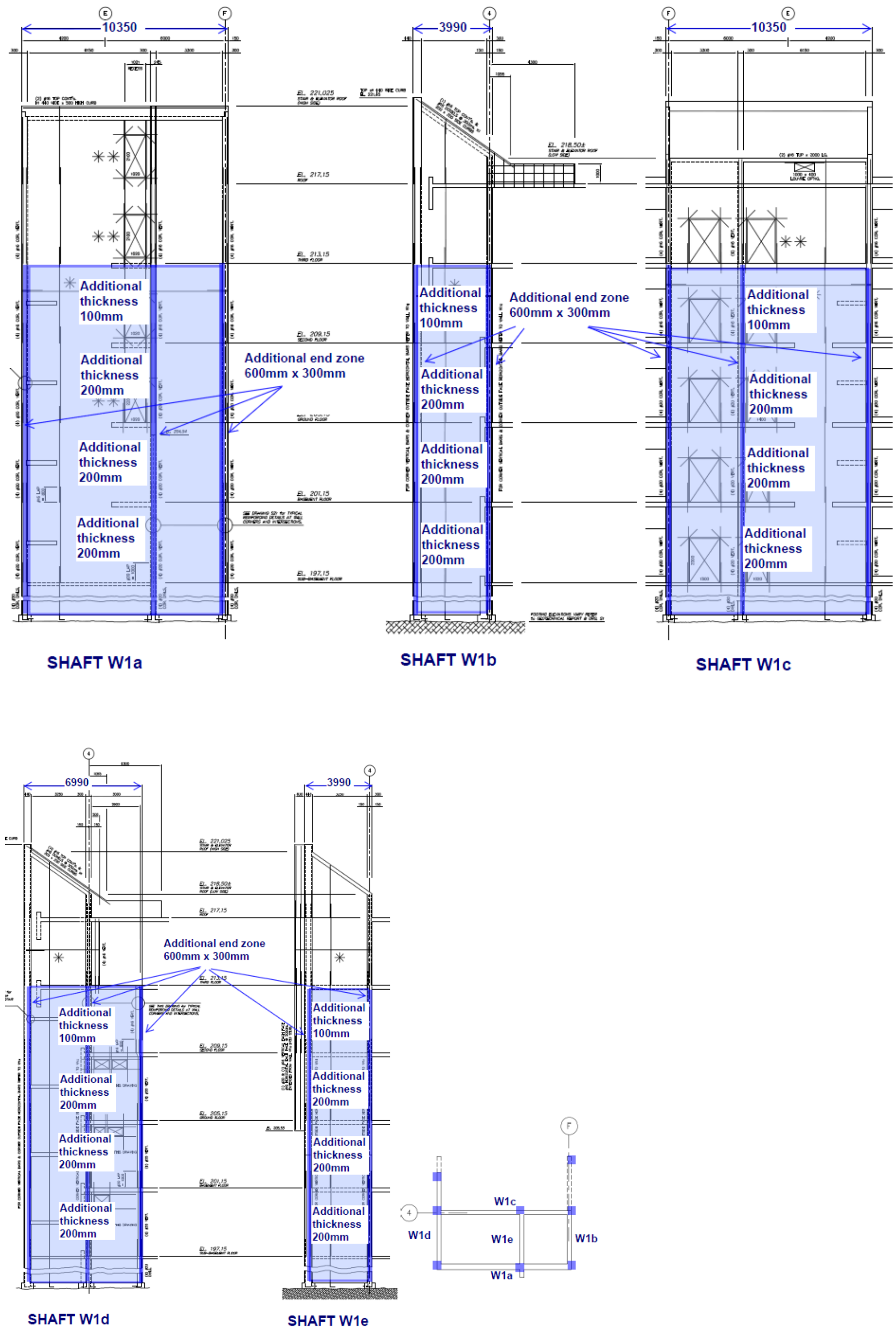


Figure 23: Retrofit areas in walls and shafts under DFAIT 100% loading

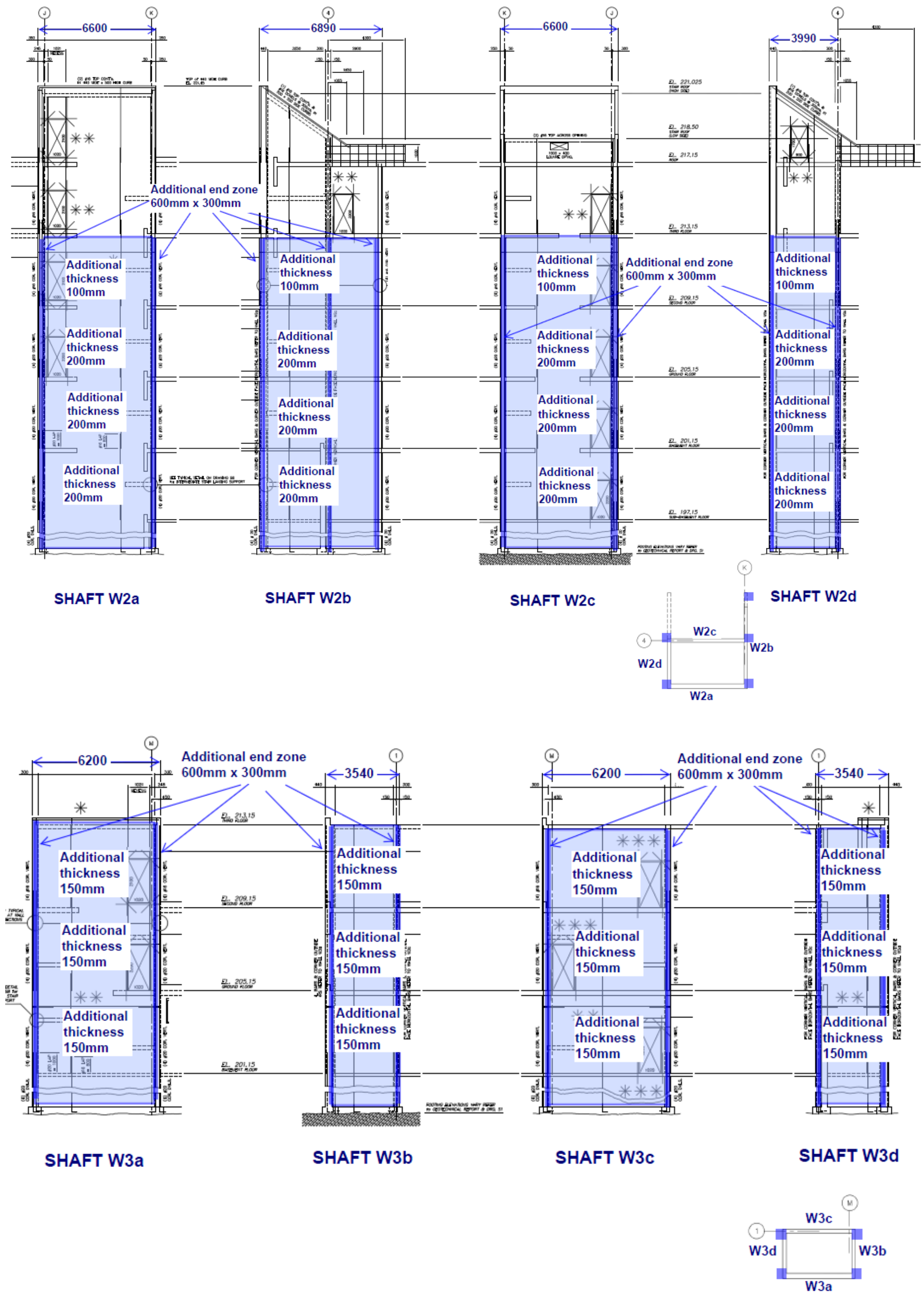


Figure 23: Retrofit areas in walls and shafts under DFAIT 100% loading (Continued)

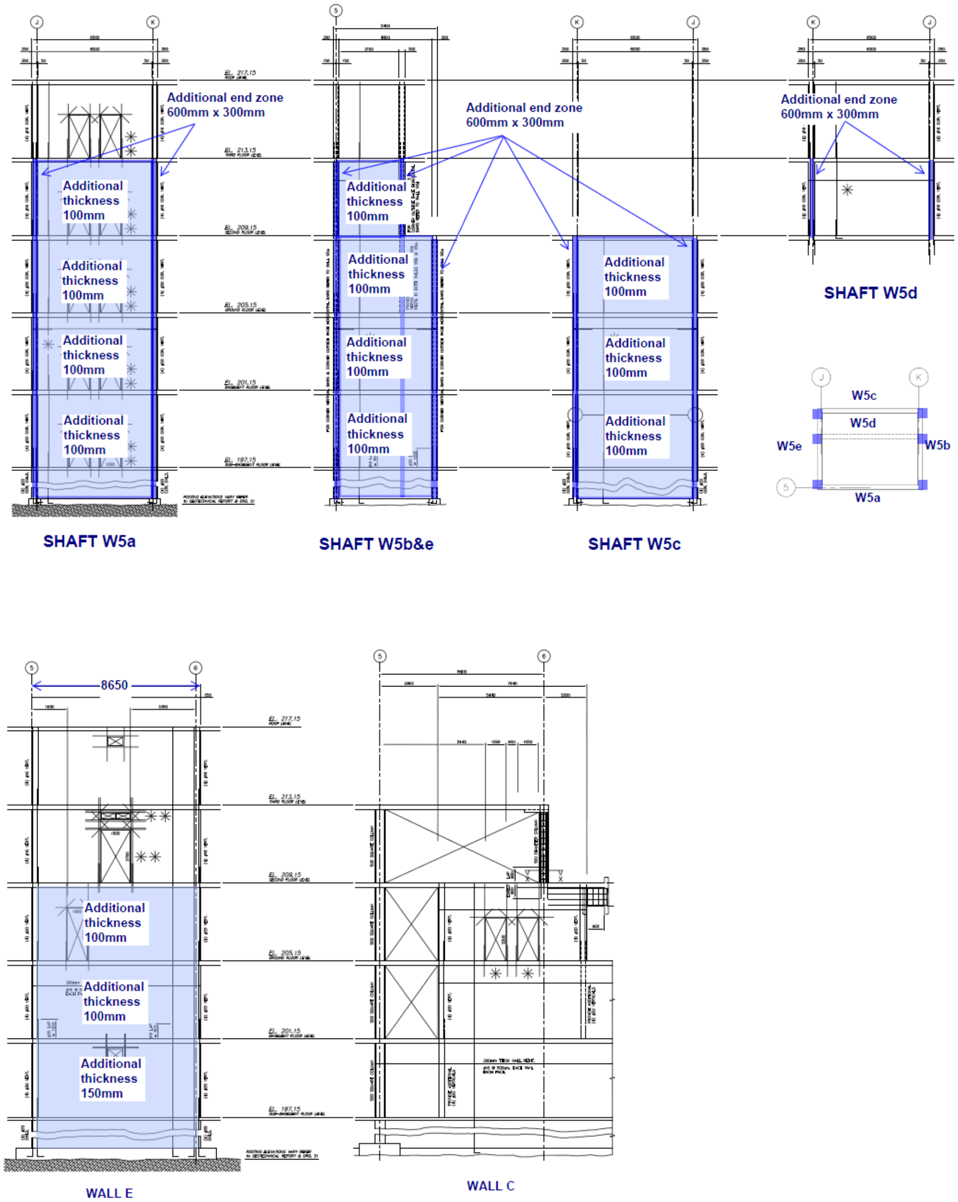


Figure 23: Retrofit areas in walls and shafts under DFAIT 100% loading (Continued)

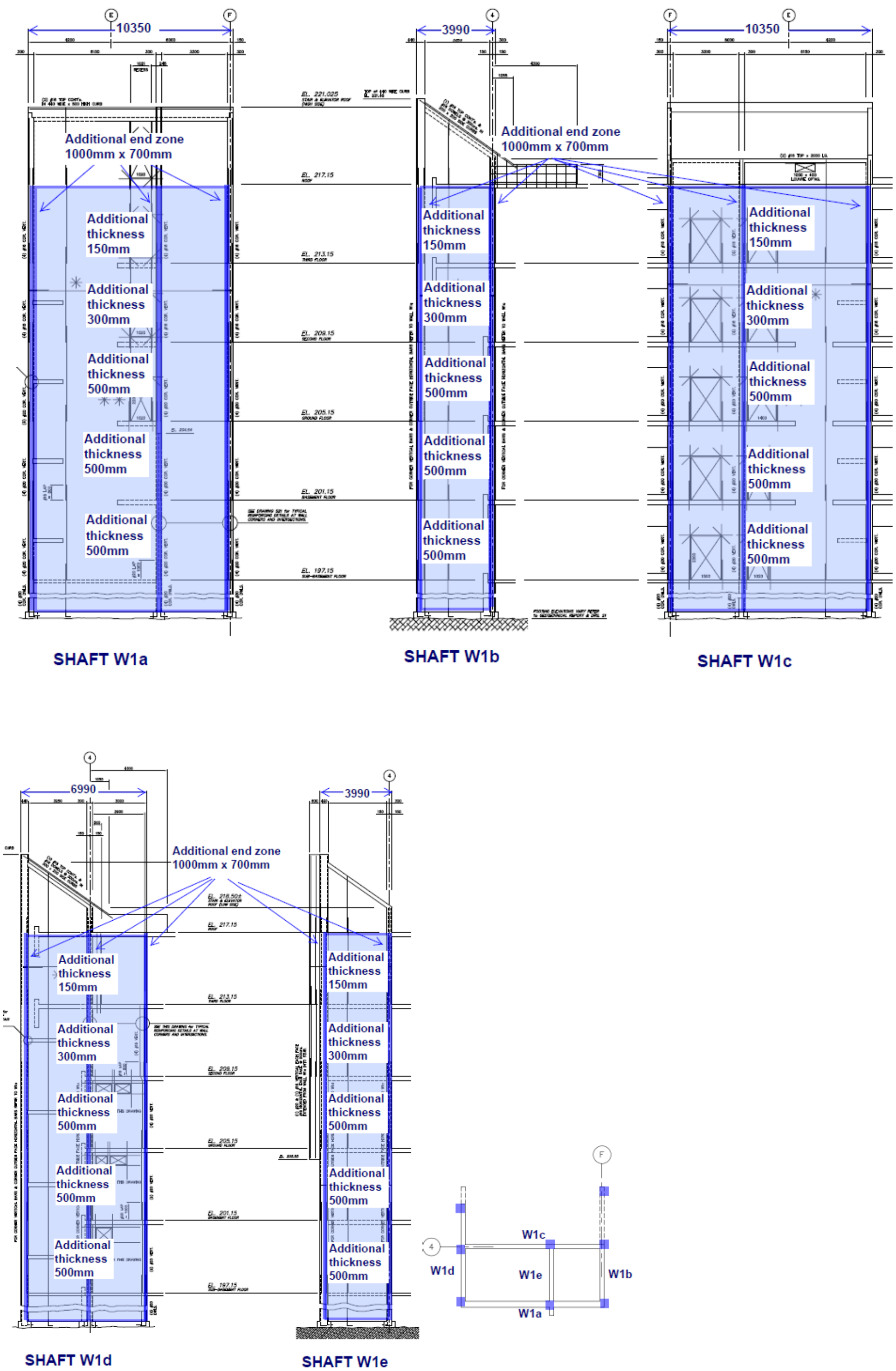


Figure 24: Retrofit areas in walls and shafts under Arup 100% loading

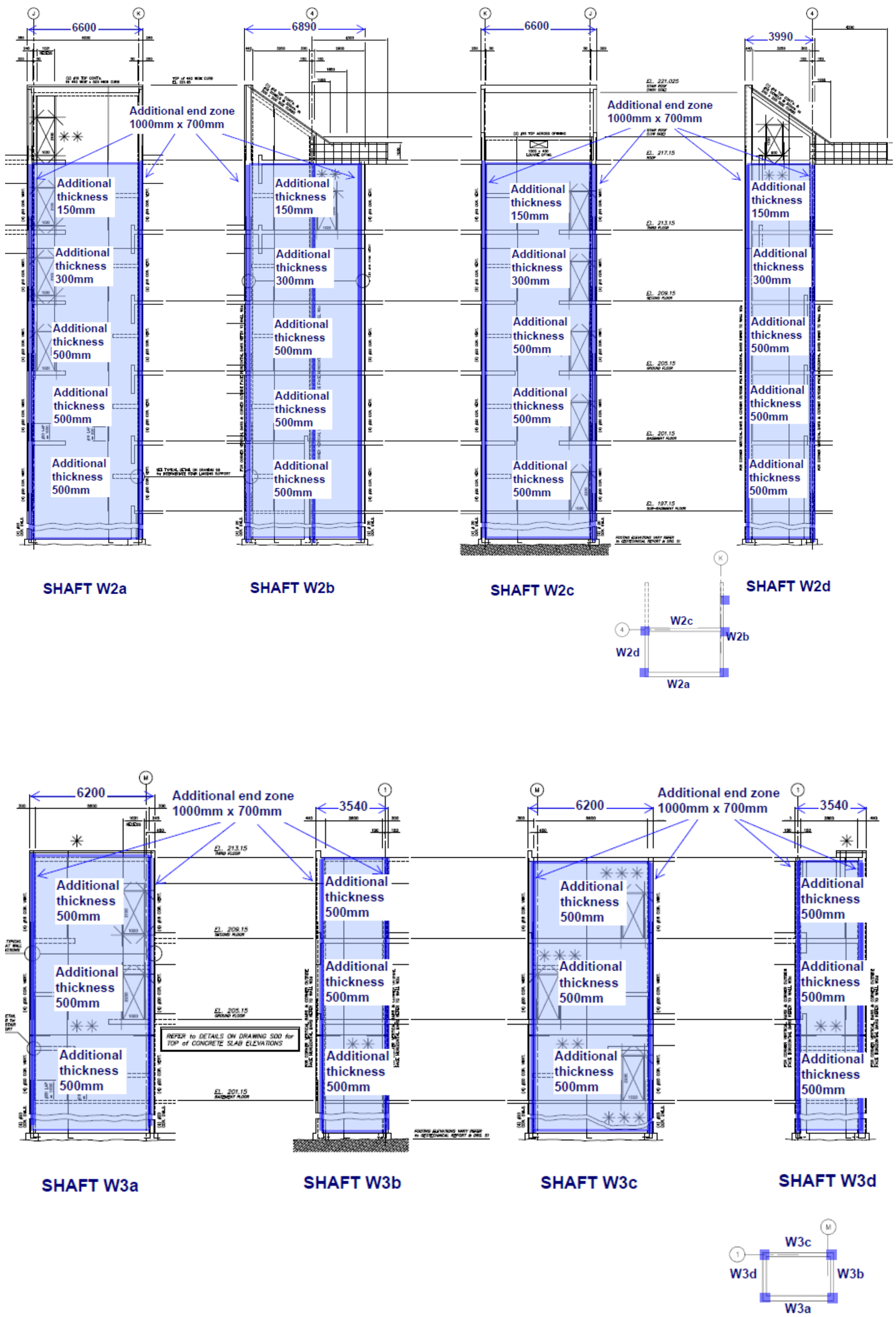


Figure 24: Retrofit areas in walls and shafts under Arup 100% loading (Continued)

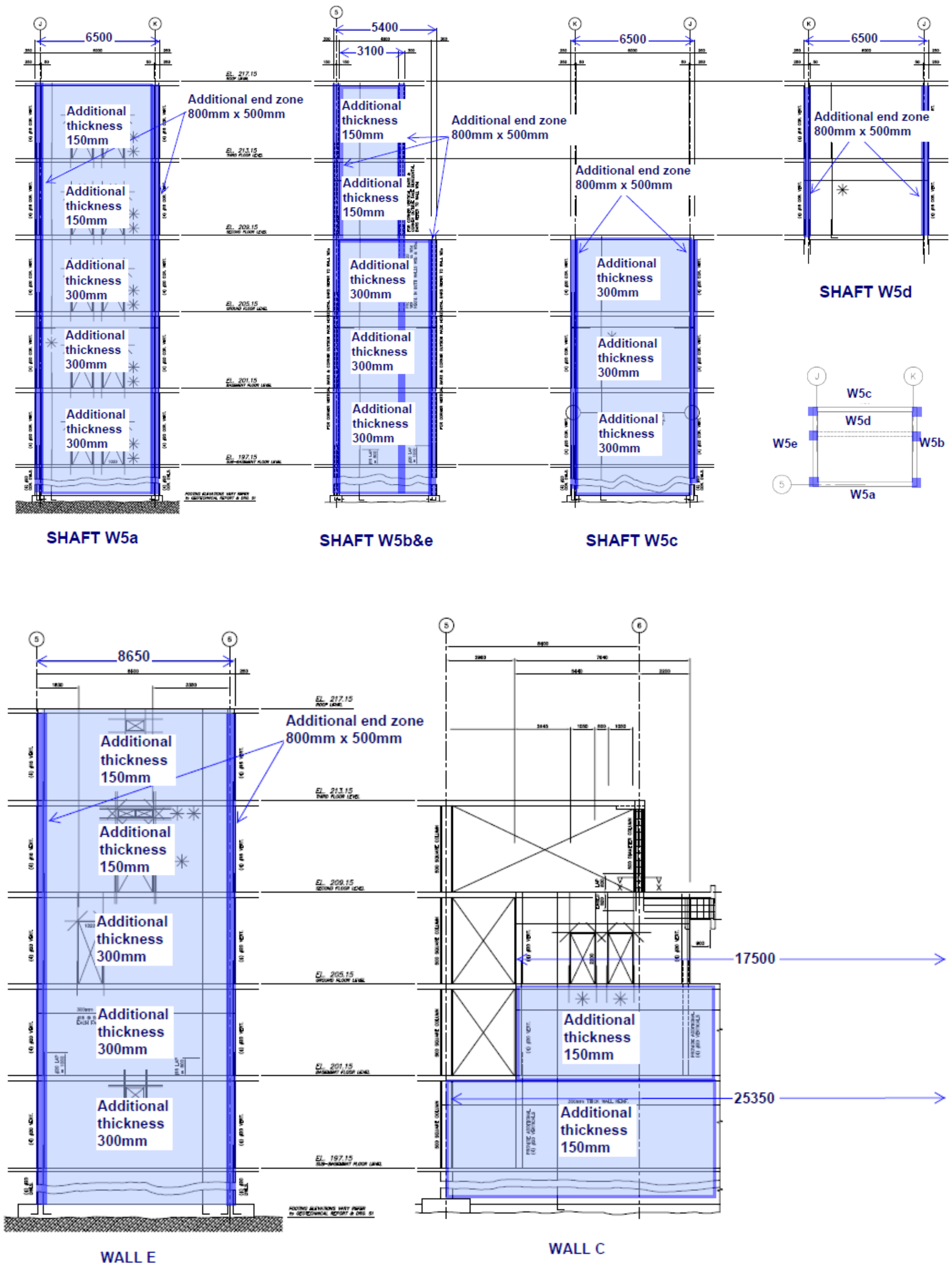


Figure 24: Retrofit areas in walls and shafts under Arup 100% loading (Continued)

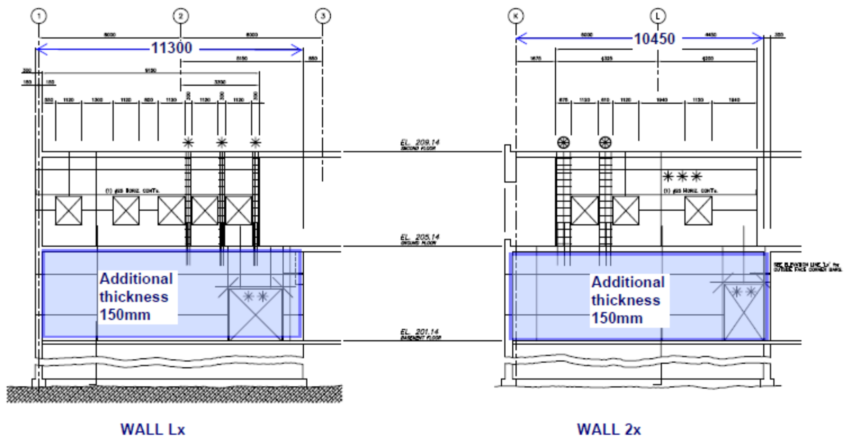


Figure 24: Retrofit areas in walls and shafts under Arup 100% loading (Continued)

5.8.2 Diaphragms

We recommend use steel plate floor trusses for the diaphragms reinforcing to ensure the lateral load transfer. The typical details of steel plate floor trusses and their connection with walls and slabs are shown in Figure 25. The layouts of steel plate floor trusses are shown in Figure 26.

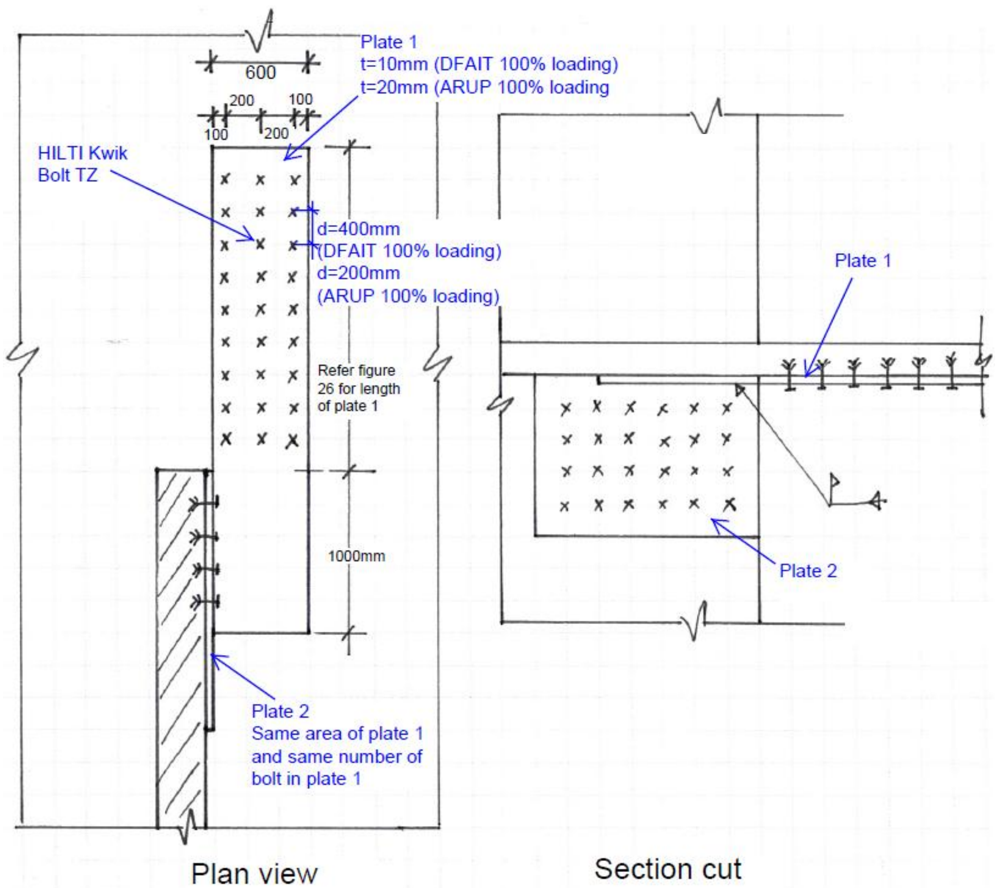


Figure 25: Typical details of diaphragms reinforcing

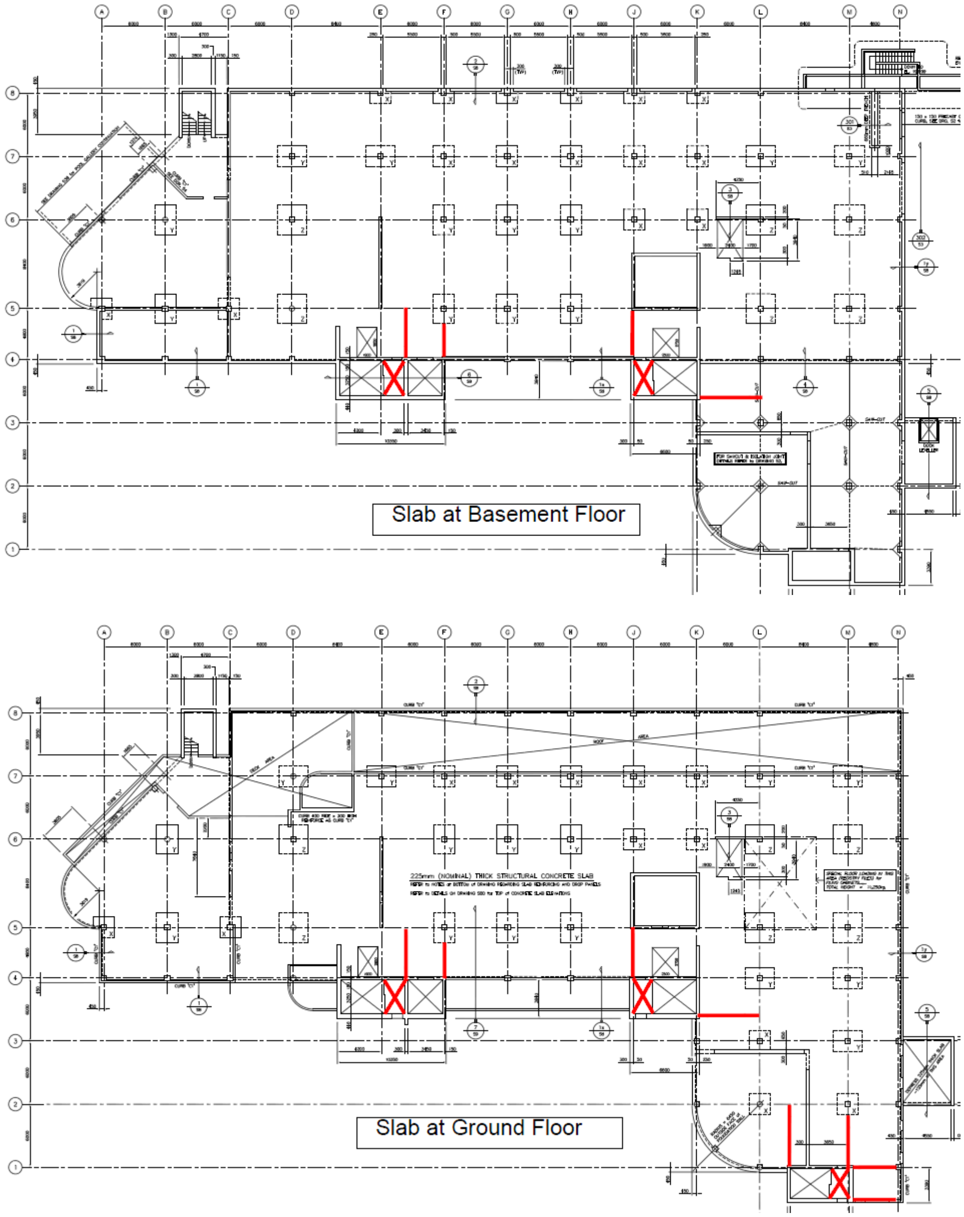


Figure 26: The layouts of recommended steel plate floor trusses

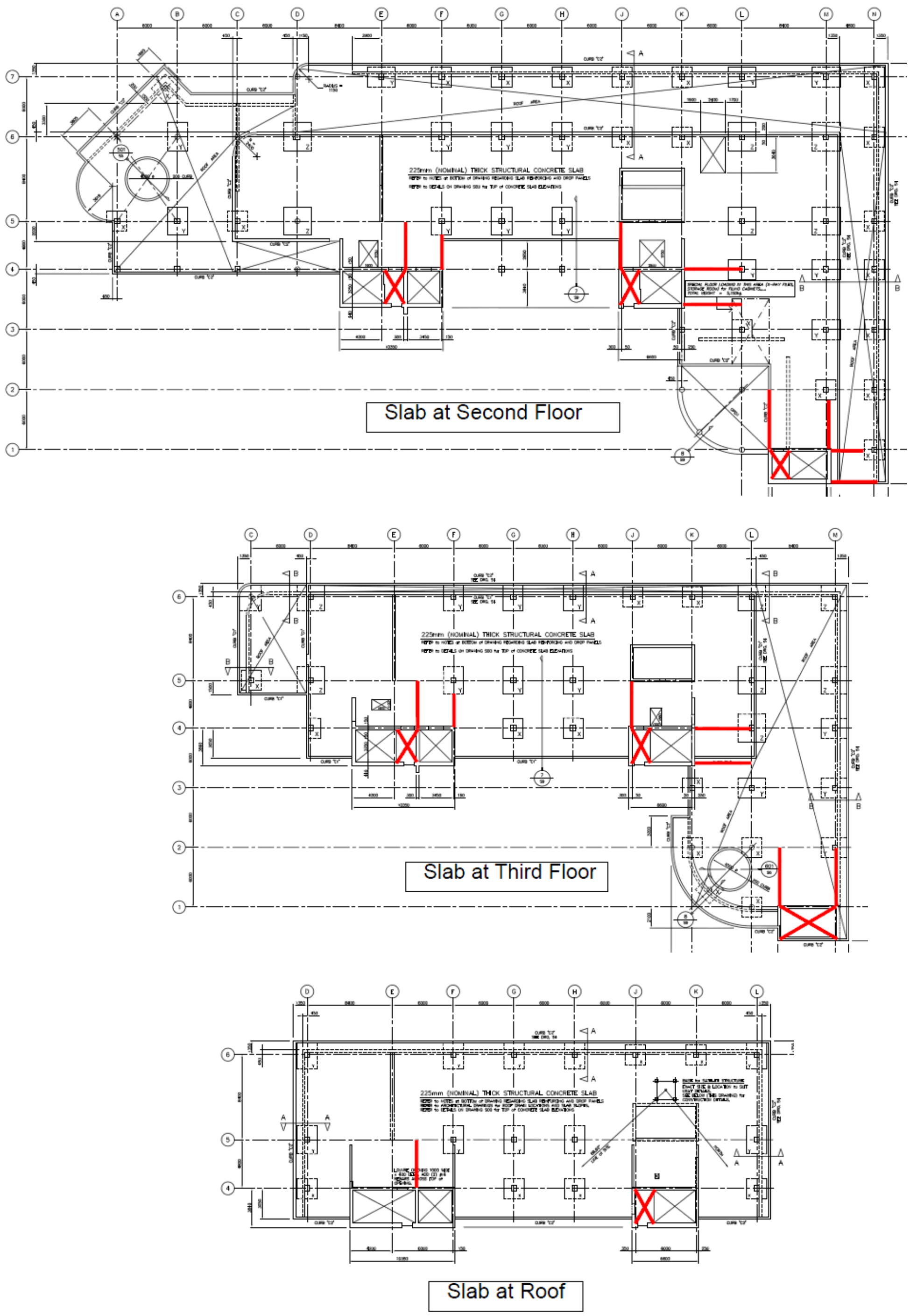


Figure26: The layouts of recommended steel plate floor trusses (Continued)

5.8.3 Foundation

Based on the DFAIT and Arup seismic hazard levels and the analysis done to date, we expect that the foundations will need to be retrofitted.

We recommend that future design work include detailed evaluation of foundation retrofit options including rock anchors, micropiles, helical screw anchors, footing enlargement as well as dynamic analysis with allowance for rocking behavior.

For costing purposes, however, we have provided sketches of one retrofit option. The typical details of the given retrofit are shown in Figure 27. The layout of retrofit range and estimated pile number and sizes are shown in Figure 28. These quantities are given for the purpose of determining a high-level cost estimate. Detailed site information and design will be required to finalize the foundation retrofit design.

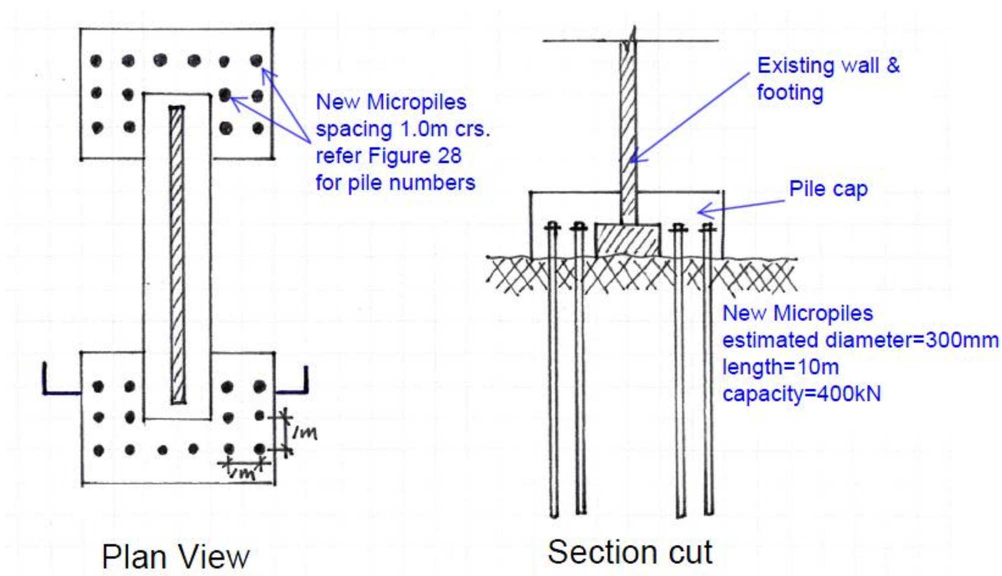


Figure 27: Typical details of foundation retrofit by microplies

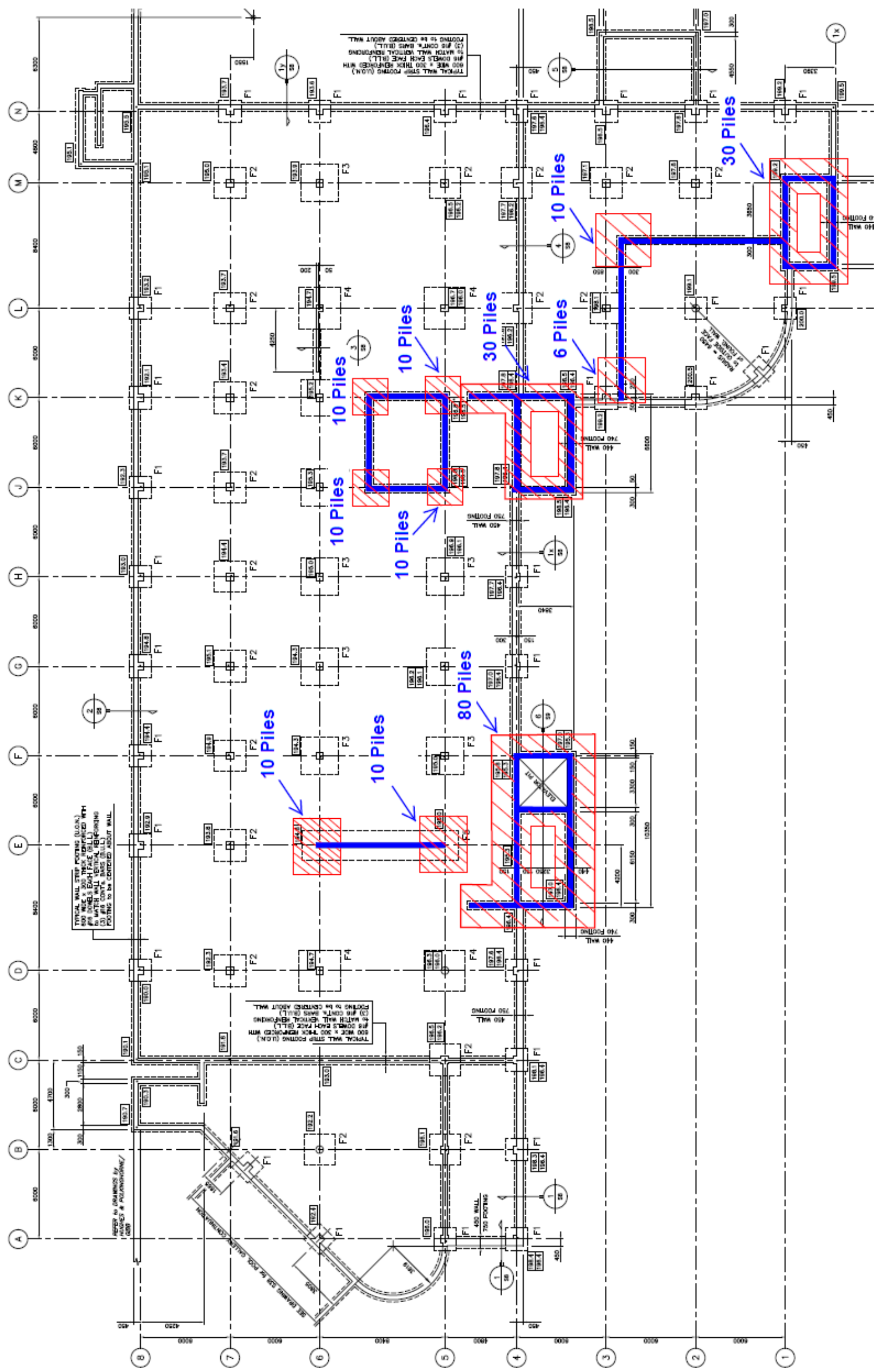


Figure 28: Layout of recommend retrofit area of foundation

Number of piles shown is for Arup 100% loading. For DFAIT 100% loading, number of piles will be half of what is shown.

5.9 Conclusions

Our evaluation indicates that Canadian High Commission in Nairobi does not currently have the structural capacity to resist the actions of the anticipated level of earthquake. Retrofit work will be required to improve the building's seismic performance to the immediate occupancy level. The extent of retrofit work will included

- Shear Walls and Cores: shear strengthening by way of additional concrete or fibre wrap and possible additional of boundary elements to provide flexural strength and concrete confinement.
- Diaphragms: shear strengthening by way of composite fibre slab reinforcement or new concrete collector beams.

In the next steps, we will carry out the following analysis as the next step towards detailed assessment and design of the required retrofit:

- Probabilistic Seismic Hazard Assessment (PSHA): A detailed PSHA will give a reliable hazard curve on which to base the subsequent analysis.
- Site Geotechnical Investigation: Further detail of the soil parameters is needed. This influences both the foundation rocking and the effects of the unbalanced load on the site.
- Non-Linear Time History Analysis: a time history analysis that takes into account the rocking of the foundations, the ductility of each element and the soil-structure interaction will give a much clearer picture of how the force is distributed throughout the building and what retrofit is required for each element.
- Based on the above, we would produce a series of structural drawings that identify the retrofit work required and work with DFAIT to help develop a phased construction scheme that affords minimum disruption to the High Commission's operations.

Appendix A – Seismic Hazard Desktop Study

Technical Note

ARUP

13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

t +44 20 7636 1531
d +44 20 7755 4473

Project title	Nairobi Canadian Chancery	Job number	219716
cc	Ziggy Lubkowski	File reference	60
Prepared by	Nina Jirouskova	Date	2 May 2012
Subject	Seismic Hazard Desk Study		

1 Introduction

Arup has been appointed to carry out the assessment of the Canadian Chancery in Nairobi, Kenya. Nairobi is localised in a seismically active region of Africa and the risk of earthquakes damaging the site should be considered for the assessment.

This technical note presents a seismic hazard desk study carried out for the site. It presents the regional and local geology, tectonics, and seismicity, reviews the available seismic hazard studies and gives recommendations for the site soil classification and the seismic design according to the National Building Code of Canada (NBCC, 2010).

2 Geology & Tectonics

2.1 Regional Geology & Tectonics

The site is mainly influenced by the geodynamics associated with the East African Rift System (EARS). As shown in Figure 1, it controls the major tectonic features of eastern Africa over almost 3,500 km from the Red Sea down the eastern side of the African Continent to central Mozambique. The EARS crosses the central region of Kenya where the African plate is in the process of dividing itself into the Nubian and the Somalian Plates. The rift walls are predominantly shaped by normal faults with many offsets. The faults that form the borders of the EARS often extend as much as two kilometres above the valley floor, and continue downward for as much as 40 km.

The EARS breaks into two branches, the western branch which contains the East African Great Lakes, and the Eastern Branch that roughly bisects Kenya north-to-south on a line slightly west of Nairobi.

The geology of Kenya is presented in Figure 2. It is predominantly dominated along the EARS Eastern Branch fault system in western Kenya and by Tertiary and Quaternary volcanic deposits, and by Quaternary sediments in eastern Kenya. The formations were deposited on a Precambrian

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basement. According to this geological map of Kenya dated 1962, Nairobi area is underlain mainly by tertiary sediments and volcanic deposits.

2.2 Local Geology & Tectonics

As mentioned, the tectonics of Nairobi are mainly controlled by the eastern branch of the EARS. Figure 3 shows the fault pattern in the region, as interpreted by Baker et al. (1972). The Kenya rift is divided into northern, central, and southern segments, based on general structural orientation. The Kenya rift is bounded by major normal faults forming the Nguruman, Mau, and Elgeyo escarpment on the western side and the Aberdare escarpment on the eastern side. There is also a smaller Laikipia escarpment northwest of the Aberdare. Simplified fault structure map of the EARS and Kenya rift is shown in Figure 4. Extensive faulting is associated with the regional tectonic system, and Golders Associates identified the presence of a fault running through the site which might need further study for accurate assessment of its influence on the seismic risk of the site.

Geologically, the Canadian Chancery site is mostly underlain by tuff deposits, as reported in Golders Associates (2001).

3 Seismicity

Apart from showing the EARS, Figure 1 shows the distribution of past earthquakes in East Africa. As expected, the two EARS branches are the most seismically and volcanically active areas in the region.

The Main Shock in the whole region is attributed to an event dated 1910 that occurred near present day Burundi, with a magnitude 7.5, localised on the western Branch of the EARS. The largest earthquake ever recorded in Kenya occurred near Subukia in 1928 (Ambraseys, 1991) with a magnitude of 6.9Ms. It is shown as a black star on Figure 4.

The seismicity of the EARS within 500km radius of the site was analyzed using data from various catalogues including the USGS-NEIC catalogue for the period 1973 to 2012. Figure 5 shows the distribution of earthquakes in the region over a very short time-span. The figure clearly shows that the seismic activity of the Eastern Branch is currently localised in the southern part of the branch (Northern Tanzania) about 100miles from Nairobi. The most recent earthquake occurred on the 17 April 2012, a magnitude 4.6Mw event, which was located near Limuru about 30km north of Nairobi (see Figure 7).

Seismicity of the Kenya Rift Valley itself has been dominated by earthquakes of low to intermediate magnitudes concentrated in the regions highlighted in gray (Nyanza rift, southern Kenya rift, and northern central Kenya rift) in Figure 4.

Even though no significant earthquakes are known to have significantly affected Nairobi to date, the city is located very close to the Eastern branch of the EARS. There is therefore a significant risk of future possible events occurring closer to the site and damaging it.

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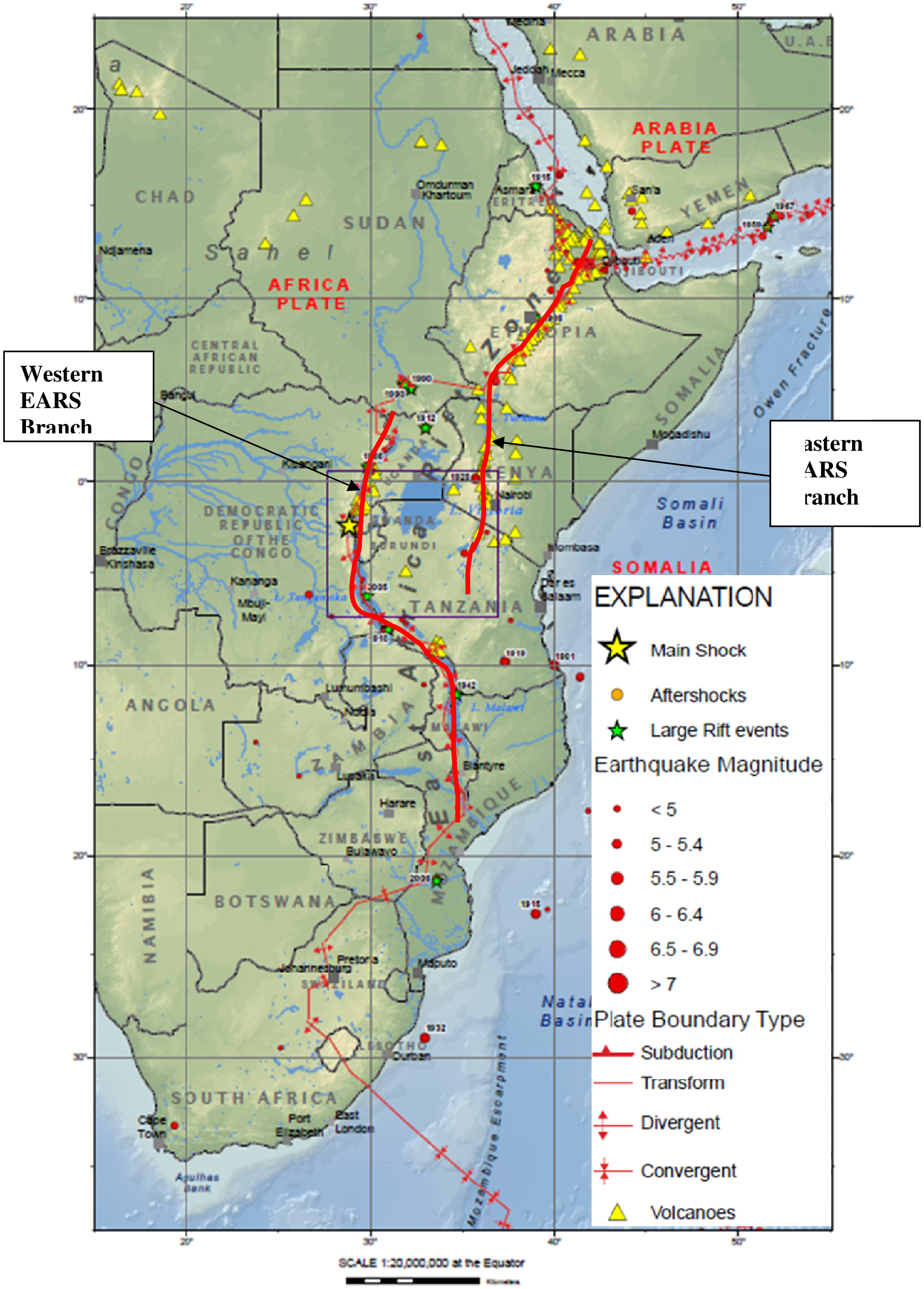

Figure 1- Tectonic Setting and past earthquakes of east Africa (USGS)

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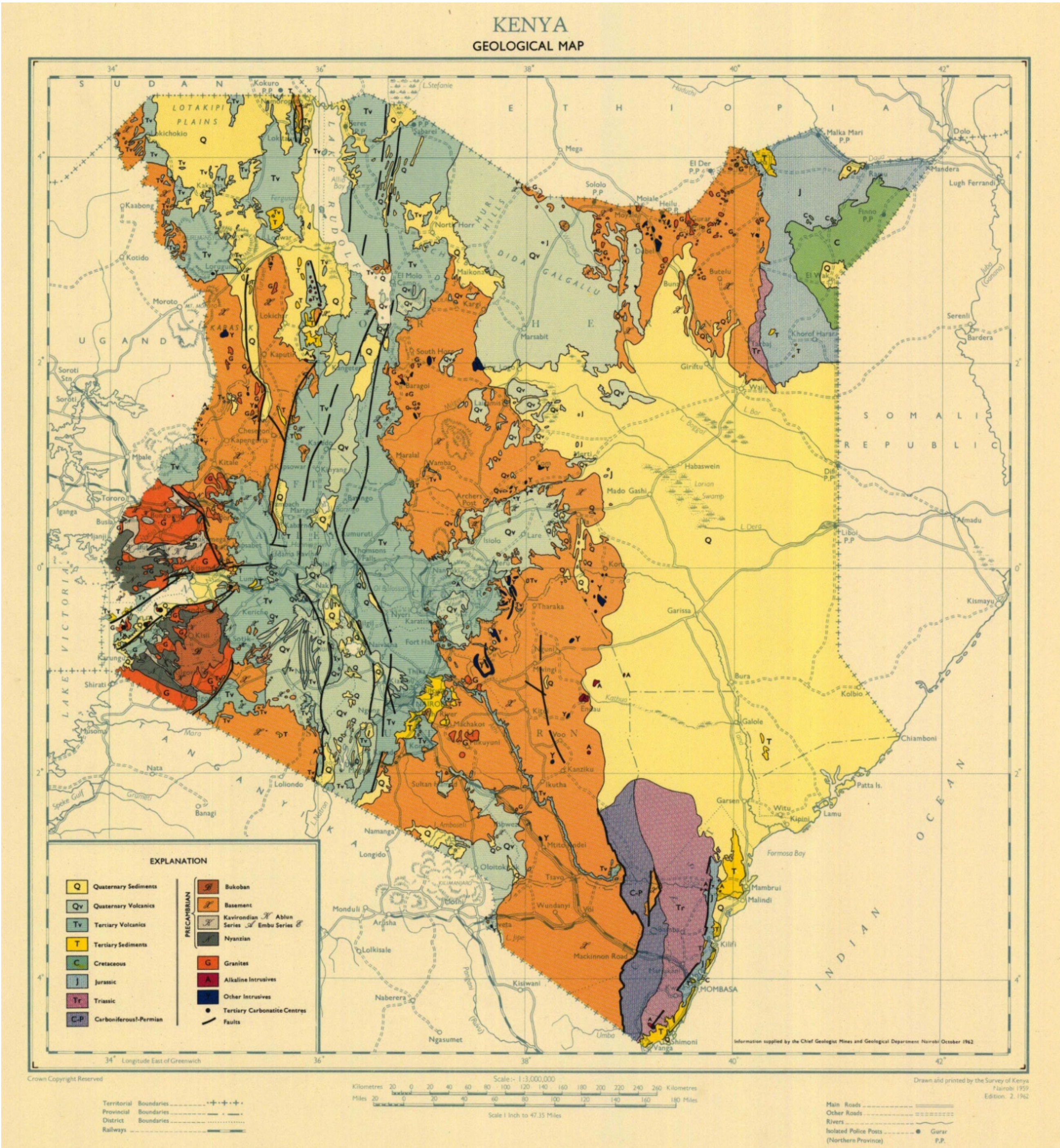

Figure 2- Geological Map of Kenya (1962)

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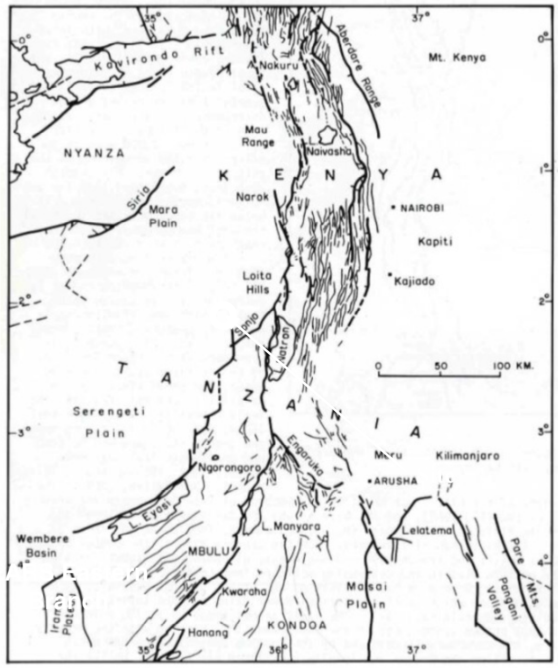

Figure 3- Fault map in southern Kenya and northern Tanzania (Baker et al., 1972)

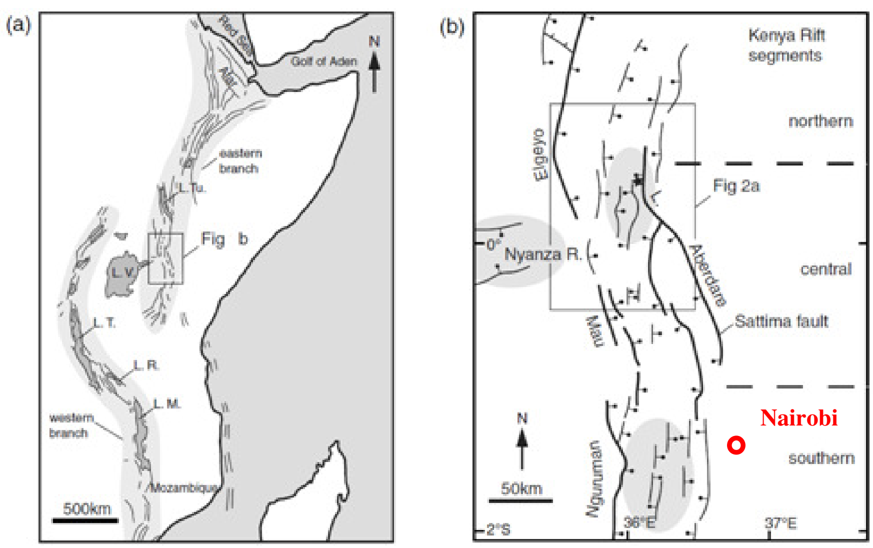

Figure 4- Simplified fault structure map of EARS and Kenya Rift (Zielke & Strecker, 2009).

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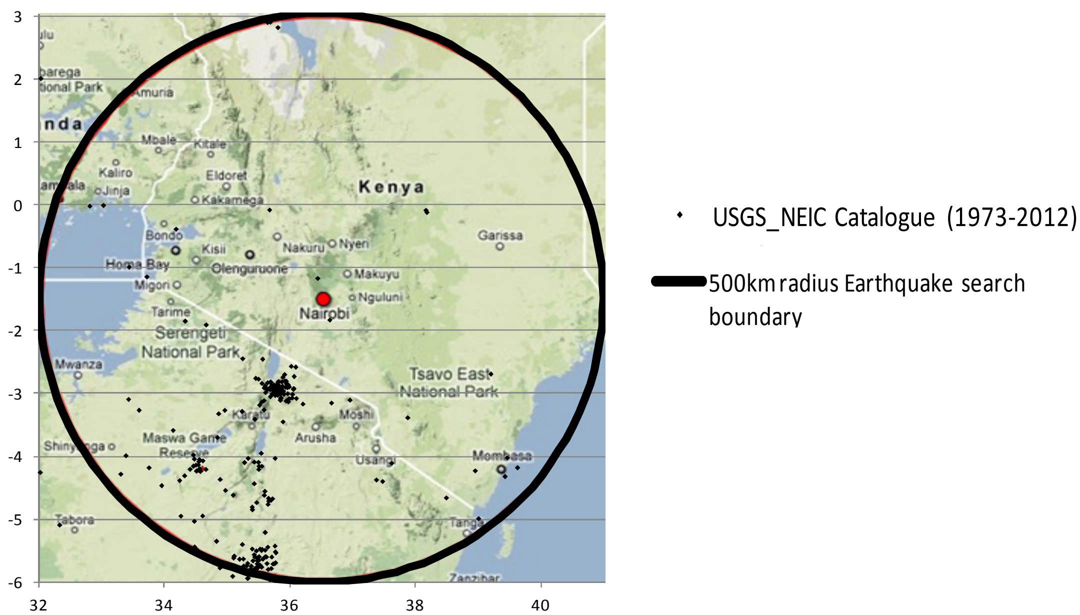

Figure 5- Regional seismicity 1973-2012 within 500km radius from the site

4 Review of Seismic Hazard Studies

This section summarizes the findings from existing seismic hazard assessment studies for Nairobi region, which include international journals and conference papers or past project studies. Those studies and documents are reviewed herein, in order to derive an estimate of the appropriate seismic hazard level in terms of the peak ground acceleration (PGA) for the site.

4.1 Regional Seismic Hazard Maps

4.1.1 Kenyan Guidance on Seismic Design (1973)

The Kenya Code of Practice for the design and construction of buildings and other structures in relation to earthquakes provides seismic zone map for Kenya in terms of earthquake intensity[1], as shown in Figure 6**Error! Reference source not found.**. It indicates that Nairobi is located in Zone VII (very strong - slight to moderate damage in well-built ordinary structures, considerable damage in poorly built or badly designed structures). Wald et al. (1999) derived a relationship between the intensity in Modified Mercalli scale and the Peak Ground Acceleration as

$$\log PGA = 0.273\ (I + 1.66)$$

with the PGA in cm/s^2

Intensity VII corresponds to a PGA of about 0.2g according to this relationship, while the USGS scale of equivalence between Modified Mercalli Intensities and PGA give a range of PGA values of about 0.18g to 0.34g for I=VII. Due to the high uncertainty associated with the use of intensity

[1] Intensity is a measure of the observed damage resulting from an earthquake.

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information, and since the return period for this zone map is unknown, the use of this hazard map as a basis for seismic design is not recommended.

4.1.2 UBC (1997)

Appendix of the Chapter 16 in the Uniform Building Code (1997) gives recommended seismic design values for a number of cities outside the United States of America. It should be noted that the technical basis of this data is unknown and therefore should be used with caution.

Nairobi is classified as UBC Zone 2A, which corresponds to an effective peak ground acceleration (EPA) of 0.15g on bedrock for a 475 year return period ground motion.

4.1.3 GSHAP (1999)

As part of the decade for natural disaster reduction, the United Nations carried out the Global Seismic Hazard Assessment program (GSHAP) in order to produce a seismic hazard map of the world. The project consisted of local studies that were integrated into regional and global maps.

Figure 7 shows the seismic hazard map that was derived by GSHAP for East Africa and Kenya, based on the findings of Midzi et al. (1999). This shows the PGA at bedrock with a 10% probability of exceedance in 50 years (i.e. a 475 year return period). It can be seen that the higher hazard areas clearly follow the rift valley. On the map, Nairobi sits in the zone with a bedrock PGA of about 0.04 to 0.08g.

The USGS webtool using the GSHAP findings gives for Nairobi a bedrock PGA value of 0.12g for a 2475 year return period ground motion. This corresponds to a PGA of 0.06g for a 475 year return period.

However, attention should be paid to the fact that GSHAP map was computed based on the earthquake data from a rather short time period of occurrence, and may therefore not be fully representative of the longer term seismicity in the region.

4.1.4 Adams et al. (2008)

Adams et al. (2008) presents the estimated seismic design values for Canadian Missions abroad in accordance with the National Building Code of Canada (NBBC, 2010). The values are for Class B rock for a 2475 year return period event. The method used is based on applying spectral shape and magnification factors to the PGA values given by the GSHAP seismic hazard project, in order to generate values for the spectral design parameters used in the National Building Code of Canada. The values given for Nairobi are listed in Table 1.

Table 1 – NBBC 2010 Recommended Design 5% damped Spectral Accelerations at Bedrock

Spectral Acceleration (g)				
PGA	0.2s	0.5s	1.0s	2.0s
0.13	0.217	0.105	0.05	0.015

Since these values are based on the GSHAP results, they may therefore not be fully representative of the longer term seismicity in the region.

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Figure 6- Seismic Hazard Zone Map of Kenya (Kenyan Guidance on Seismic Design, 1973).

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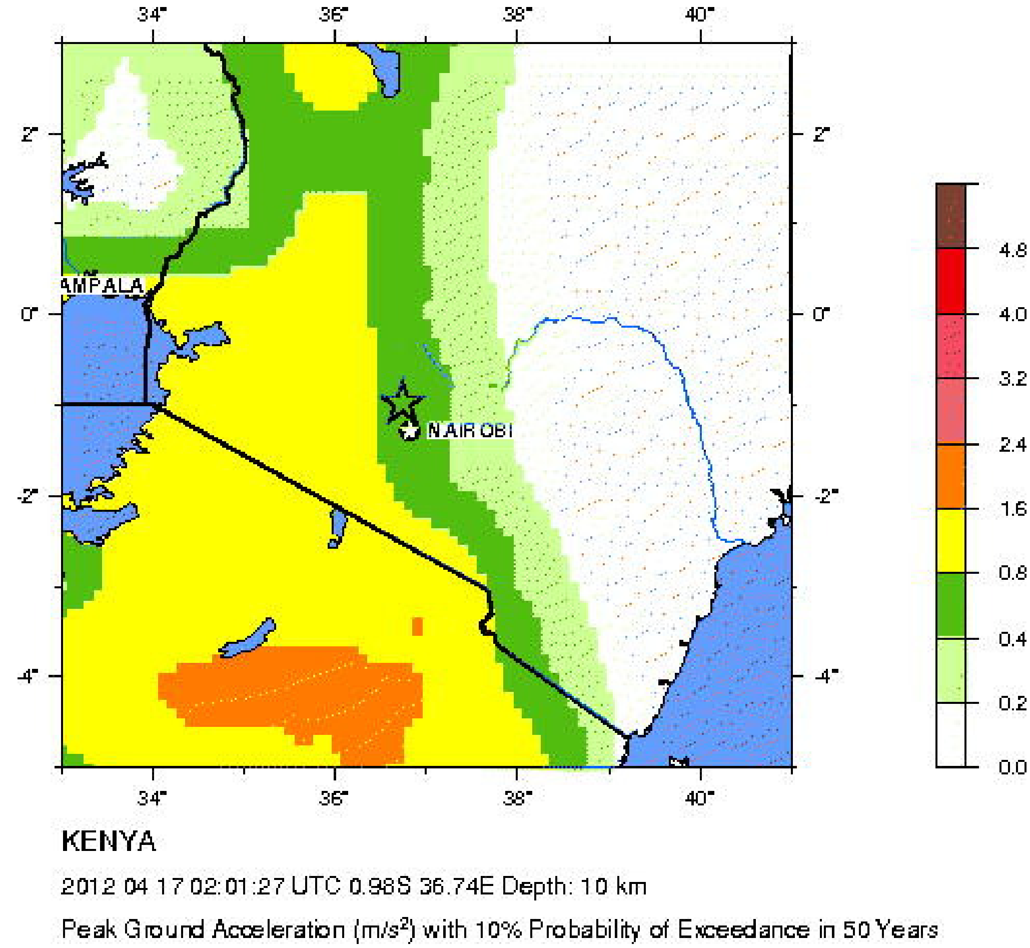

Figure 7- Peak Ground Acceleration (m/s^2) with 475 years return period for Southern Kenya (GSHAP; Midzi et al., 1999)

4.2 Previous Regional Seismic Hazard Studies

4.2.1 Arup (1991)

Arup carried out a simplified seismic hazard study for the Moi Library project in Nairobi. The results of the seismic hazard assessment were given in terms of Effective Peak Acceleration (EPA) for a 500 year return period scenario. The EPA is defined as the spectral acceleration over the range 1-10Hz, divided by 2.5, and is broadly equivalent to the PGA. For the worst case scenario (an earthquake originating at 10km below ground), an EPA of 0.16g was derived.

Using the source model for this study, and the latest attenuation relationships by Atkinson & Boore (2007, 2011) and Akkar & Bommer (2010), the probabilistic seismic hazard analysis was rerun using the in-house Oasys SISMIC software in order to obtain the seismic hazard values in terms of PGA for 475 and 2475 year return periods, both for Bedrock (Site Class B - Vs=760m/s) and Stiff Soil (Site Class C - Vs=540 m/s). The results of the analysis can be seen in Table 2. The corresponding response spectra are shown in Figure 8.

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Table 2 – Peak Ground Accelerations derived based on Arup (1991)

Year Return Period	Peak Ground Acceleration (g)	
	Bedrock (Vs=760m/s)	Stiff Soil (Vs=540m/s)
475	0.11	0.12
2475	0.25	0.27

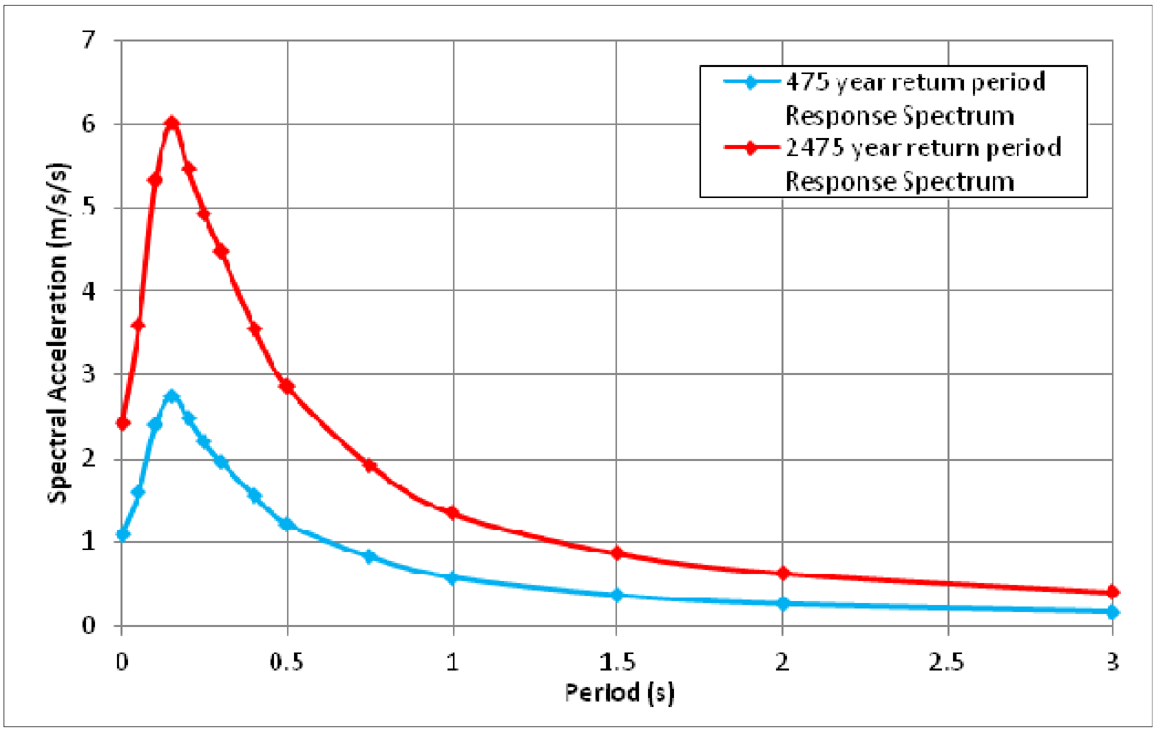

Figure 8- Response Spectra for 475 and 2475 year return periods after Arup (1991).

4.3 Recommended PGA

Very few seismic hazard studies have been carried out in the region. The GSHAP study is the basis for the NBBC (2010) and might be considered as one of the most detailed regional study to date. However, as mentioned, the GSHAP study has some limitations.

The simplified seismic hazard study for a site in Nairobi by Arup (1991) shows rather higher seismic design acceleration values than GSHAP. Those results are consistent with the UBC (1997) recommendation for seismic design in Nairobi.

Basing the seismic design of the site on Adams et al. (2008) following the NBBC (2010) recommendations for Canadian missions abroad might therefore be unconservative. The Arup (1991) study may, on the other hand, be too conservative. A detailed site specific probabilistic seismic hazard assessment study is therefore recommended.

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5 Recommended Design Parameters

5.1 Site Classification

Golder's Associate (2001) site investigation report showed that competent rock is expected to be encountered at shallow depth. Slightly decomposed tuff was revealed at 5m depth maximum.

According to the USGS web tool, which generates $V_{s,30}$ Maps for any location in the world, Nairobi sites range from Site Class C to D (ASCE 7), with shear wave velocities ranging from 300 to 490 m/s (see Figure 9). Golder's Associate (2001) findings suggest that a classification as Site Class C (ASCE 7-05) corresponding to very dense soil and soft rock is more suitable for the site.

However, this should stand as a preliminary site classification that may need to be confirmed by appropriate site investigation. It should also be noted that the 2010 National Building Code of Canada follows the same site classification system as the ASCE 7.

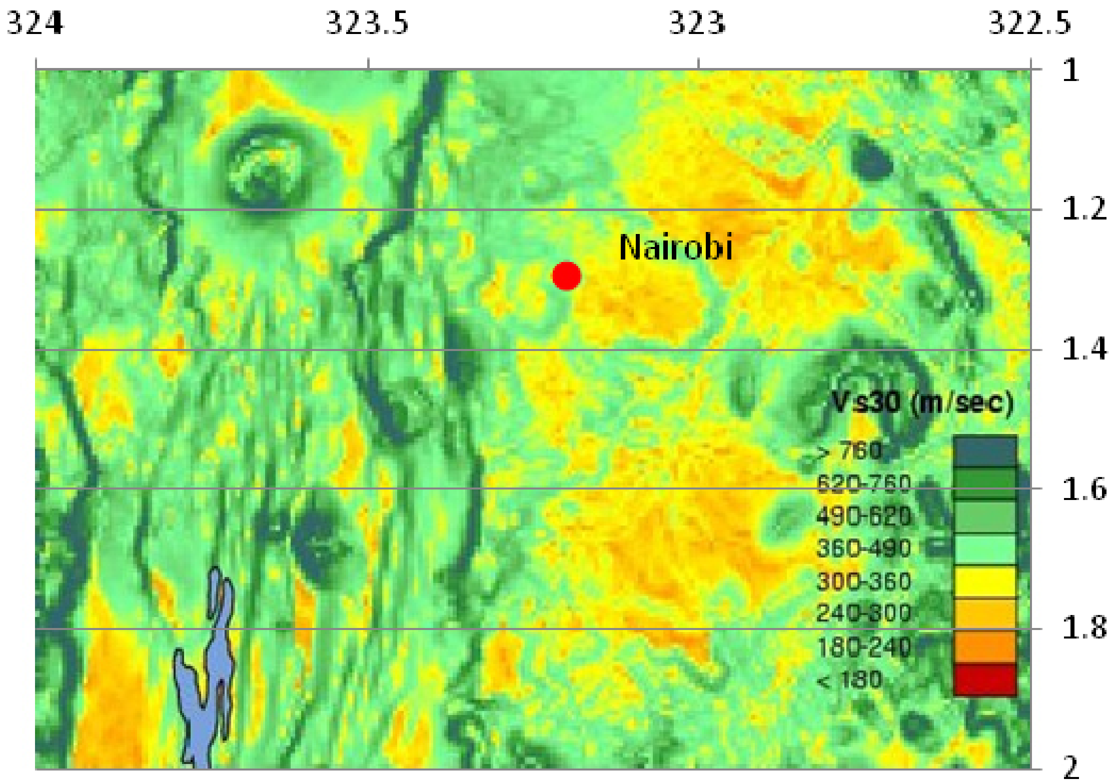

Figure 9- Vs,30 Map of Nairobi Region (USGS)

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5.2 Seismic Design Guidelines - National Building Code of Canada (2010)

The Nairobi Canadian Chancery shall conform to NBBC (2010). In absence of a site specific probabilistic seismic hazard assessment study, lower bound and upper bound spectra have been derived based on the Estimated Seismic Design Values for Canadian Missions abroad derived as reported in Adams et al. (2008) (see Section 4.1.4), and the results from Arup (1991) respectively.

5.3 Recommended Design Spectrum

Figure 10 shows the response spectra derived according to the NBBC (2010) for Site Class C based on the seismic design values from Adams et al. (2008), and Arup (1991) for an estimation of the lower bound and upper bound spectra. In absence of a site specific study, it is recommended to use the most conservative design spectrum, based on Arup (1991) findings.

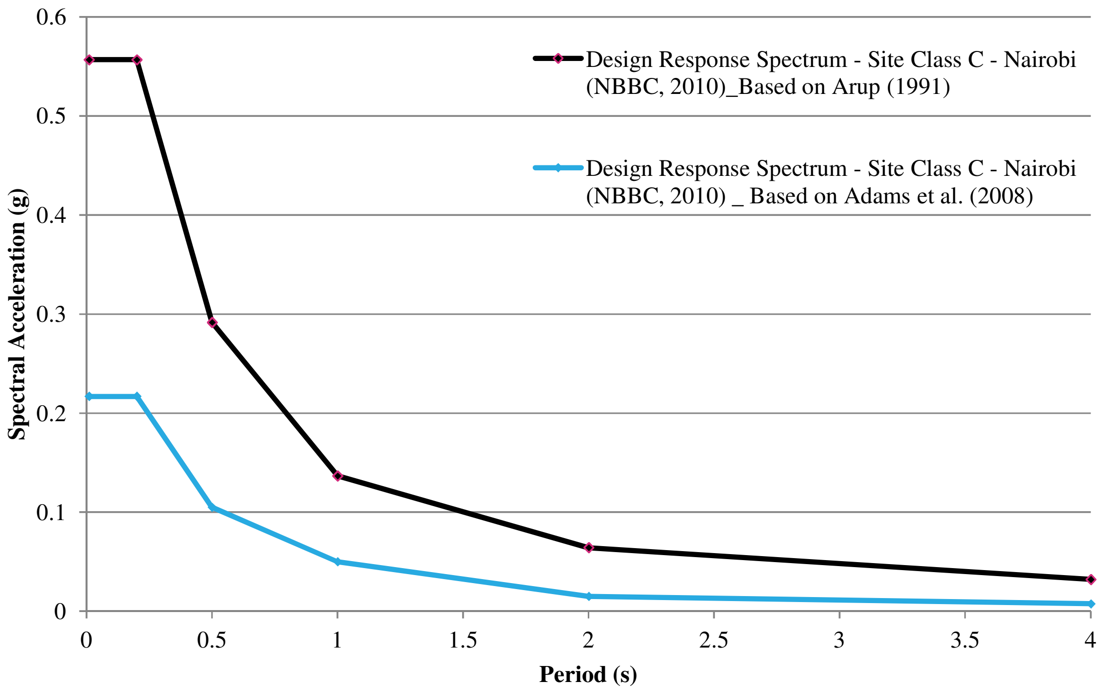

Figure 10- Design response spectrum for the site (NBBC, 2010)

6 Other Earthquake Induced Hazards

6.1 Liquefaction

According to Golder & Associates (2001), the site investigations identified the deposits to be mostly volcanic and tuff deposits, with the upper 2.5 to 5m being clayey. Based on Youd & Perkins (1978), the liquefaction potential for such deposit is very low.

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However, this observation is made based on very general data. Further investigation may be needed to assess the liquefaction risk with better accuracy.

6.2 Fault Rupture

Previous site investigations by Golder Associates (2001) revealed a fault running through the site. They indicated a displacement of 1m across the fault zone since the deposition of the tuff 1.8 million years ago. Golders therefore conclude the fault rate movement as negligible and it shouldn't be necessary to design the Chancery Building to accommodate the effects of surface fault rupture.

Though we agree the risk of future movements on this fault are probably very low, the argument presented by Golders is flawed, as they haven't shown that the fault has not moved within the last 10,000years. Ideally the undisturbed material overlying the fault should be dated, which would give a minimum date for last movement.

6.3 Shakedown Settlement

Large settlements and differential settlements caused by compaction of the loose soil, settlement and tilting of structures due to liquefaction of saturated granular soil, lateral movements of natural slopes have been observed in the earthquakes in the EARS.

Due to the site category, it is unlikely this would be an issue. However, further site investigation would help confirm this conclusion.

6.4 Volcanoes

The stretching process associated with the East Africa Rift is often preceded by huge volcanic eruptions which flow over large areas and are usually preserved/exposed on the flanks of the rift. These eruptions are considered by some geologists to be "flood basalts", where the lava is erupted along fractures (rather than at individual volcanoes) and runs over the land in sheets like water during a flood. Such eruptions can cover massive areas of land and develop enormous thicknesses (the Deccan Traps of India and the Siberian Traps are examples). Many active volcanoes are in the vicinity of Nairobi, as shown in Figure 1.

Therefore the design may need to account for additional roof loading due to ash fall. Further work would be required to give an estimation of this additional load.

7 Conclusions and Recommendations

The present seismic desk hazard study shows that the seismic risk needs to be carefully considered for design of the Canadian Embassy site in Nairobi, especially since a fault was indentified running through it, Nairobi being located in a potentially highly seismic zone. It is understood that the design shall comply with the 2010 National Building Code of Canada. The recommended seismic design values by Adams et al. (2008) for Nairobi seem to be at the lower bound of the literature review findings, and due to the limitations of the GSHAP study on which they are based, an upper bound design spectrum for the site based on the results derived after Arup (1991) is recommended to be rather used at that stage. Further site specific seismic hazard assessment study is therefore highly recommended in order to accurately consider the seismic risk in design.

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Technical Note

219716 2 May 2012

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DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Nina Jirouskova	Ziggy Lubkowski	Ziggy Lubkowski
Signature		Z. Lubkowski	Z. Lubkowski

Appendix B – Nairobi Chancery Concept Planning for Consultant Visit

This section was intentionally deleted

Appendix C – Material Test Results

Your ref
Our ref SH/1239/PFS/MIA/mnk
Contact

Britech Ltd.
Consulting Engineers,
P.O. Box, 15130, 00509,
Langata, Nairobi, Kenya.
Office Phone: + 254 20 2325683
Scott's Mobile: +254 733 618641
Wambua's Mobile: + 254 723 714781
Office Mobile: + 254 773 210558
E-mail: mdsurtech@swiftkenya.com
Website: www.surtech-aces.com

28th May, 2012

Howard Humphreys (East Africa) Ltd.
Consulting Engineers,
Muthangari Drive, off Waiyaki Way, Westlands,
P.O. Box 30156, 00100, GPO,
Nairobi.

E-mail: info@howardhumpreys.co.ke
Tel No.: + 254 20 4445254/6
For the attention of Mr. Richard Kaburu

Dear Mr. Kaburu,

Re:- Report on the Structural Quality of Reinforcement Steel and Concrete in the Canadian High Commission Chancery Building at Gigiri in Nairobi

We refer to your email dated Tuesday, 10th January, 2012 in which you requested for a quotation for conducting structural integrity tests on the Canadian High Commission Chancery Building at Gigiri in Nairobi. Our Principal Engineer, Peter Scott, prepared and sent a quotation which was accepted by you and Britech Ltd. were commissioned on Tuesday, 7th February, 2012 to conduct the works.

Under close supervision by Ms Caroline Ray, Ms Joanne Gakungu and Mr. Joseph Gathii, Britech Project Engineer, Mr. Malick Isiaho, Senior Technicians, Mr. Peter Kaguru and Mr. Davies Githehu led a ten man team who extracted seven concrete cores and two reinforcement bars from predetermined locations in the Canadian High Commission Chancery Building on Friday, 11th and Saturday, 12th May, 2012. The concrete and steel samples were delivered to the Britech Materials Testing Laboratory for concrete compressive strength and reinforcement bar mechanical testing.

The quality of the concrete sampled from the building was found to be just satisfactory if the specified strength was no more than 20N/mm^2 except for the staircase landing walls between the 2nd and 3rd floors.

We trust that the attached report is fully in accordance with your requirements but if you have any queries please do not hesitate to contact the undersigned.

Yours sincerely,
Peter Scott

Eng. P.F. Scott
Registered Consulting Engineer (E071)

encl. Report on the Structural Quality of Reinforcement Steel and Concrete in the Canadian High Commission Chancery Building at Gigiri in Nairobi.

c.c. Ms. Caroline Ray

HOWARD HUMPREYS (EAST AFRICA) LTD
CANADIAN HIGH COMMISSION CHANCERY NAIROBI

REPORT ON THE STRUCTURAL QUALITY OF REINFORCEMENT STEEL AND CONCRETE IN THE CANADIAN HIGH COMMISSION CHANCERY BUILDING AT GIGIRI, NAIROBI, KENYA

PROJECT No. SH/1239

MAY, 2012

Britech Consulting Engineers Ltd.,
Quarry Lane off Bogani Road, Karen,
P.O. Box 15130, 00509, Langata,
Nairobi, Kenya.
Office Phone:- + 254 20 2325683
Office Mobile: + 254 773 210558
Scott's Mobile: - + 254 723 382082
E-mail:- mdsurtech@swiftkenya
Website:- www.surtech-aces.com

BRITECH LTD. CONSULTING ENGINEERS

REPORT ON THE STRUCTURAL QUALITY OF REINFORCEMENT STEEL AND CONCRETE IN THE CANADIAN HIGH COMMISSION CHANCERY BUILDING AT GIGIRI, NAIROBI, KENYA

PROJECT No. SH/1239

CONTENTS

1.0 INTRODUCTION

We refer to the structural report of November 2009 on the quality of structural concrete incorporated into the Canadian High Commission Chancery Building at Gigiri, Nairobi Kenya. In section five of this structural report, further investigation into the structural design of the Chancery Building was recommended by us.

The Canadian High Commission Chancery Building is located along Limuru Road in the Gigiri area of Nairobi.

The main objective for the Structural Forensic Investigations of the building is to ascertain the quality of reinforcement steel and concrete used in this project. Determination of these parameters provides a significant step in evaluating the overall structural design of the building and on the quality of the works conducted during construction.

Further to consultation between Mr. Richard Kaburu and our Engineer Peter Scott, a nine man team consisting of our senior technicians Peter Kaguru and Davies Githehu visited the Canadian High Commission Chancery Building on Friday 27th April 2012 to prepare and remove wall and ceiling finishes in readiness for a subsequent inspection by a team of Engineers from Canada. On Friday 11th and Saturday, 12th May, 2012 another team lead by our Project Engineer Mr. Malick Isiaho conducted concrete core drilling and reinforcement rebar extraction under strict supervision from Ms Caroline Ray the Resident Regional Director of Consulting Engineers Arup, Ms Joanne Gakungu of Howard Humpreys (East Africa) Ltd. and Mr. Joseph Gathii the Property Manager at the Canadian High Commission.

With the use of a cover meter to detect the location of reinforcement bars seven concrete cores and two reinforcement bars were carefully extracted from predetermined locations in the Canadian High Commission Chancery Building. The voids resulting from the extraction of the cores were immediately filled with high strength non-expanding mortar.

Due to the expansive area exposed during the extraction of the reinforcement bars at the parapet wall in the basement, further arrangements were made and the void covered with high strength concrete on Thursday 24th May 2012.

Below are some photographs showing the exposed areas.

Photograph 1:- Exposed area after reinforcement bar extraction at basement level.

Photograph 2:- Exposed area after concrete core cutting at the staircase landing on the 2nd Floor.

2.0 METHODOLOGY FOR SAMPLING

On Friday 11th and Saturday 12th May, 2012 respectively, Britech Project Engineer, Mr. Malick Isiaho accompanied by Senior Technicians Peter Kaguru, Davies Githehu and seven others visited the Canadian High Commission Chancery Building armed with a concrete coring machine, grinder, chisels, hammers, electric drill and a cover meter for sample extraction. Seven concrete cores and two reinforcement bars were sampled from locations predetermined by Ms. Ray as follows:-

- Sub-basement level wall along grid J.
- Sub-basement level wall along grid E.
- Basement level wall along grid C.
- Staircase landing wall at 1st floor.
- Staircase landing wall at 2nd floor.
- Staircase landing wall between 1st and 2nd floor.
- Staircase landing wall between 2nd and 3rd floor.
- Basement level on a parapet wall between grids H and J. Both reinforcement bars were extracted from the same position.

The seven concrete cores and two reinforcement bars were carefully labelled, packed and delivered to the Britech Materials Testing Laboratory in Nairobi on Saturday 12th May 2012.

Below are photographs showing the samples after extraction.

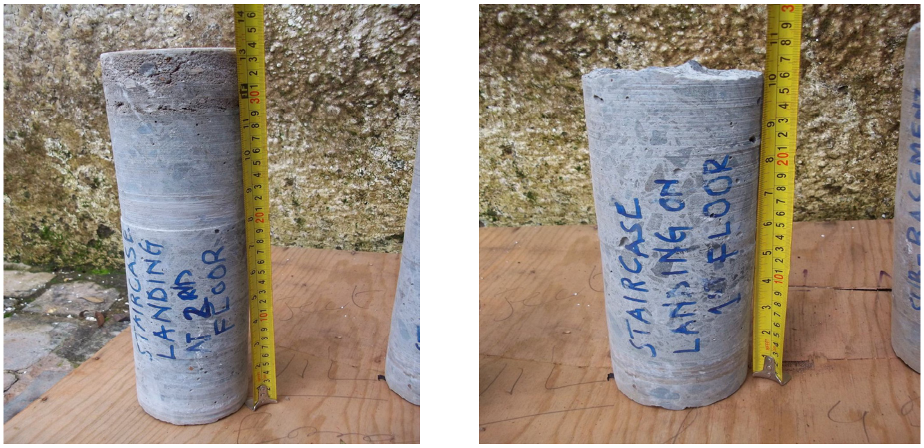
Photographs 3:- Samples just after extraction on site.

2.1 Sample Preparation

In accordance with CAN/CSA A23.2-14C "Obtaining and Testing Drilled Cores for Compressive Strength Testing" all the concrete cores met all the requirements for compressive strength crushing. The concrete cores were measured and photographed before and after trimming at the Ministry of Geology and Mines on Thursday 17th May 2012.

Further to instructions from the Client to proceed with testing, the concrete cores were soaked in water at room temperature for 24 hours, labelled, measured and photographed again before and after crushing on Wednesday 23rd May 2012. The reinforcement bars were delivered at the Kenya Bureau of Standards for mechanical testing.

Below are photographs of the prepared samples.

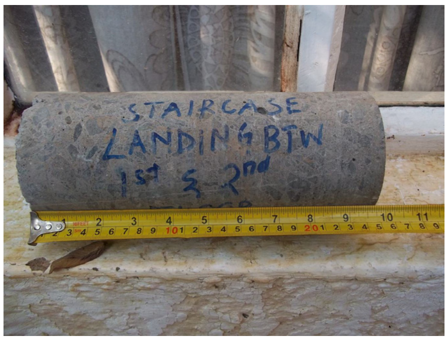


Photographs 4:- Staircase landing at 1st and 2nd floor cores before trimming.

Photographs 5:- Staircase landing between 1st, 2nd and 3rd floor cores before trimming.

Photographs 6:- Sub-basement and basement cores before trimming.

Photographs 7:- Sub-basement cores along grids E and J respectively after trimming.



Photographs 8:- Staircase landing cores between 1st, 2nd and 3rd floors after trimming.

Photographs 9:- Staircase landing cores at 1st and 2nd floors after trimming.

Photograph 10:- Basement wall core along grid C after trimming.

3.0 LABORATORY TESTING

In accordance with CAN/CSA A23.2-14C "Obtaining and Testing Drilled Cores for Compressive Strength Testing" all the seven concrete cores were carefully trimmed and the following details for each of the samples recorded:-

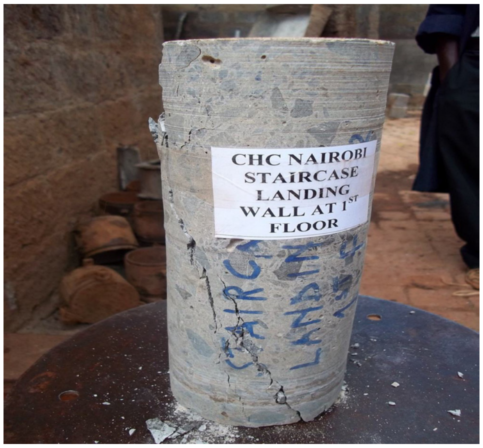
- Identification of the sample (location in the structure, date and time sample was taken).
- Core diametre and length in millimetres.
- Core length after trimming.
- Mass of concrete at the time of testing.
- Moisture condition of sample prior to testing.
- Age of concrete.
- Any abnormalities in the core sample.

In addition to the Canadian Standards mentioned above, the sub-basement wall concrete core along grid J was tested in accordance with British Standards BS 1881 part 120 " Method of Determination of Compressive Strength of Concrete Cores". This was due to the presence of reinforcement bars in the concrete core.

The concrete core compressive strength test results were recorded and tabulated on the concrete cores compressive test results sheet No. 96141 presented overleaf.

The two reinforcement bars were prepared in accordance with BS 4449: 2005 + A2: 2009 "Steel for Reinforcement of Concrete". The bars were tested at the Kenya Bureau of Standards and a certificate issued which is appended overleaf.

Below are photographs of the crushed concrete cores:-



Photographs 11:- Staircase landing cores at 1st and 2nd floor respectively after crushing.

Photographs 12:- Staircase landing cores between 1st, 2nd and 3rd floors after crushing.

Photographs 13:- Sub-basement wall cores along grids E and J respectively after crushing.

Photograph 14:- Basement wall core along grid C after crushing.

4.0 ANALYSIS OF LABORATORY TEST RESULTS

Though information regarding the class of concrete specified for use in the construction of the Chancery Building was not given to the consultants, laboratory test results indicate the properties of the concrete.

All the concrete cores satisfied the requirement with regard to density of normal weight dry concrete. BS 5328: 1997-Part 1 proposes a concrete dry density ranging between 2000kg/m^3 and 2600kg/m^3 for normal weight concrete. Visual inspection of the core surfaces and manual extraction of the reinforcement bars using chisels revealed a well bonded and compact concrete mix.

Five of the seven concrete cores crushed had a compressive strength ranging between 20N/mm^2 and 26N/mm^2. The concrete core from the sub-basement wall along grid J had the least compressive strength of 19.2N/mm^2 but this could be contributed to by the presence of reinforcement bars in the core. This is echoed in the Canadian Standards CAN/CSA A23.2-14C "Obtaining and Testing Drilling Cores for Compressive Strength Testing" clause 4.1.1 foot note (1) which states "Cores that contain embedded reinforcement can yield lower values than cores without embedded steel". The highest compressive strength of 26.9N/mm^2 was registered from the basement concrete core. The concrete core results are detailed overleaf in the results sheet No. 96141 dated Wednesday 23rd May 2012.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The purpose of the testing reported above was to determine the quality of concrete and reinforcement steel incorporated in the Canadian High Commission Chancery Building, specifically the compressive strength and mechanical properties of the steel. After visual, physical sampling and analysis of the laboratory results for the tested cores we can conclude that the quality of concrete is just acceptable if the specified strength was no more than $20N/mm^2$.

APPENDICES

APPENDIX I

6.1 STEEL REINFORCEMENT AND CONCRETE CORE SAMPLE LOCATIONS

APPENDIX II

6.2 REINFORCEMENT STEEL BARS CERTIFICATE

**Kenya Bureau of Standards Certificate
to be submitted Separately**

Kenya Bureau of Standards
Quality products for quality life

Fax: +254 (0) 20 604031 /609660
E-Mail:info@kebs.org
Website: www.kebs.org

KEBS Centre, Popo Road
P.O. Box 54974, 00200 Nairobi
Tel: (+254 ...

Laboratory Test Report

Page 1 of 1

Report Ref: KEBS/TES/ME/0983/2012

PRIVATE SAMPLE

Date: 05 June 2012

1. Description of Sample: REINFORCED STEEL BARS - 16mm
2. Sample Submitted by: SURTECH LIMITED
3. Customer Contact: PETER NJOROGE
4. Customer's Ref. No:
5. Customer's Address: P.O. BOX 15130-00509
6. KEBS Sample Ref.No: BS/12244/12
7. Date of Receipt : 25 May 2012
8. Date Analysis Started: 29 May 2012
9. Sample Submission Form No: 71252
10. Additional information provided by the customer:
11. Acceptance criteria-title and number of specification against which it is tested:
    BS 4449:2005 British Standard Specification for Steel for the reinforcement of concrete.
12. Parameters tested and Method(s) of test: as listed in the report below

LABORATORY TEST REPORT

No.	Parameters		Results	Requirements	Test Method No
1.	Re-bend		No signs of fracture or cracks	Shall show neither rupture nor cracks visible to a person of normal or corrected vision.	BS 4449
2.	Tensile				
I	0.2% proof stress	N/mm²	577	485-650	BS 4449
II	Elongation	%	20	14Min	BS 4449
III	Mass/metre run	kg/m	1.515	1.508-1.651	BS 4449
IV	Stress ratio	Rm/Reh	1.23	1.06Min	BS 4449
V	Tensile Strength	N/mm²		-	BS 4449
VI	X-sectional area	mm²	192.95	185-217.2	BS 4449

COMMENTS/REMARKS:
The sample performed as shown

Henry Were - Assistant Manager, Mechanical & Civil Lab
FOR: MANAGING DIRECTOR

05 June 2012
Date of Issue

Kenya Bureau of Standards
Quality products for ...

Fax: +254 (0) 20 604031/609660
E-Mail info@kebs.org
Website: www.kebs.org

Laboratory Test Report

Report Ref: KEBS/TES/ **ME/0984/2012**

Date: **05 June 2012**

1. Description of Sample: **Reinforcement Steel Bars - 25mm**
2. Sample Submitted by: **SURTECH LIMITED**
3. Customer Contact: **PETER NJOROGE**
4. Customer's Ref. No:
5. Customer's Address: **P.O. BOX 15130-00509**

6. KEBS Sample Ref.No: **BS/12245/12**
7. Date of Receipt : **25 May 2012**
8. Date Analysis Started: **29 May 2012**
9. Sample Submission Form No: **71252**

10. Additional information provided by the customer:

11. Acceptance criteria-title and number of specification against which it is tested:
BS 4449:2005 British Standard Specification for Steel for the reinforcement of concrete.

12. Parameters tested and Method(s) of test: as listed in the report below

LABORATORY TEST REPORT

No.	Parameters		Results	Requirements	Test Method No
1.	**Re-bend**		No signs of fracture or cracks	Shall show neither rupture nor cracks visible to a person of normal or corrected vision.	BS 4449
2.	**Tensile**				
I	Elongation	%	15	14Min	BS 4449
II	Mass/metre run	kg/m	3.666	3.677-4.023	BS 4449
III	Stress ratio		1.49	1.06Min	BS 4449
IV	X-sectional area	mm²	466.95	451.7-530.3	BS 4449
V	yield stress	N/mm²	431	485Min	BS 4449

COMMENTS/REMARKS:
The sample performed as shown

Henry Were - Assistant Manager, Mechanical & Civil Lab
FOR: MANAGING DIRECTOR

05 June 2012
Date of Issue

APPENDIX III

6.3 CONCRETE CORE COMPRESSIVE STRENGTH TEST RESULTS

CONCRETE CORES COMPRESSIVE STRENGTH TEST RESULTS

PROJECT : FORENSIC STRUCTURAL INVESTIGATION OF THE CANADIAN HIGH COMMISSION NAIROBI — **JOB NO. :** SH/1239

CLIENT : CANADIAN HIGH COMMISSION NAIROBI — **CHECKED BY :** M.I.A

DATE : 23/05/12

CORE MARK NO.	HEIGHT OF CORE (mm)	DATE OF CRUSHING	DIAMETER OF CORE (mm)	MOISTURE CONDITION	WEIGHT OF CORE (gm)	CORE DENSITY $(Kg/m)^3$	CROSS SECTIONAL AREA "A" (mm^2)	UNCAPPED HEIGHT OF CORE (mm)	MODE OF FAILURE	CLASS OF MIX	MAXIMUM LOAD KN	MEASURED COMPRESSIVE STRENGTH N/mm^2	ESTIMATED COMPRESSIVE STRENGTH N/mm^2	FINAL ESTIMATED CORE STRENGTH AFTER ADJUSTING FOR BARS N/mm^2	REMARKS
Staircase landing btw 2nd & 3rd Floor	205	23/05/12	95	Moist	2987	2056	7088.2	205	Vertical Rupture	-	135	19.0	19.0	19.0	Absence of reinforcement bars
Staircase landing btw 1st & 2nd Floor	250	23/05/12	95	Moist	3665	2068	7088.2	250	Vertical Rupture	-	145	20.5	20.5	20.5	Absence of reinforcement bars
Staircase landing at 1st Floor	252	23/05/12	95	Moist	3746	2097	7088.2	252	Vertical Rupture	-	155	21.9	21.9	21.9	Absence of reinforcement bars
Staircase landing at 2nd Floor	245	23/05/12	95	Moist	3627	2089	7088.2	245	Vertical Rupture	-	150	21.2	21.2	21.2	Absence of reinforcement bars
Sub basement wall along grid E	242	23/05/12	95	Moist	3626	2114	7088.2	242	Vertical Rupture	-	145	20.5	20.5	20.5	Absence of reinforcement bars
Sub basement wall along grid J	250	23/05/12	95	Moist	4015	2266	7088.2	250	Vertical Rupture	-	132	18.6	18.6	19.2	2R16 bars @ 30mm & 50mm from both ends
Basement wall along grid C	248	23/05/12	95	Moist	3753	2135	7088.2	248	Vertical Rupture	-	191	26.9	26.9	26.9	Absence of reinforcement bars

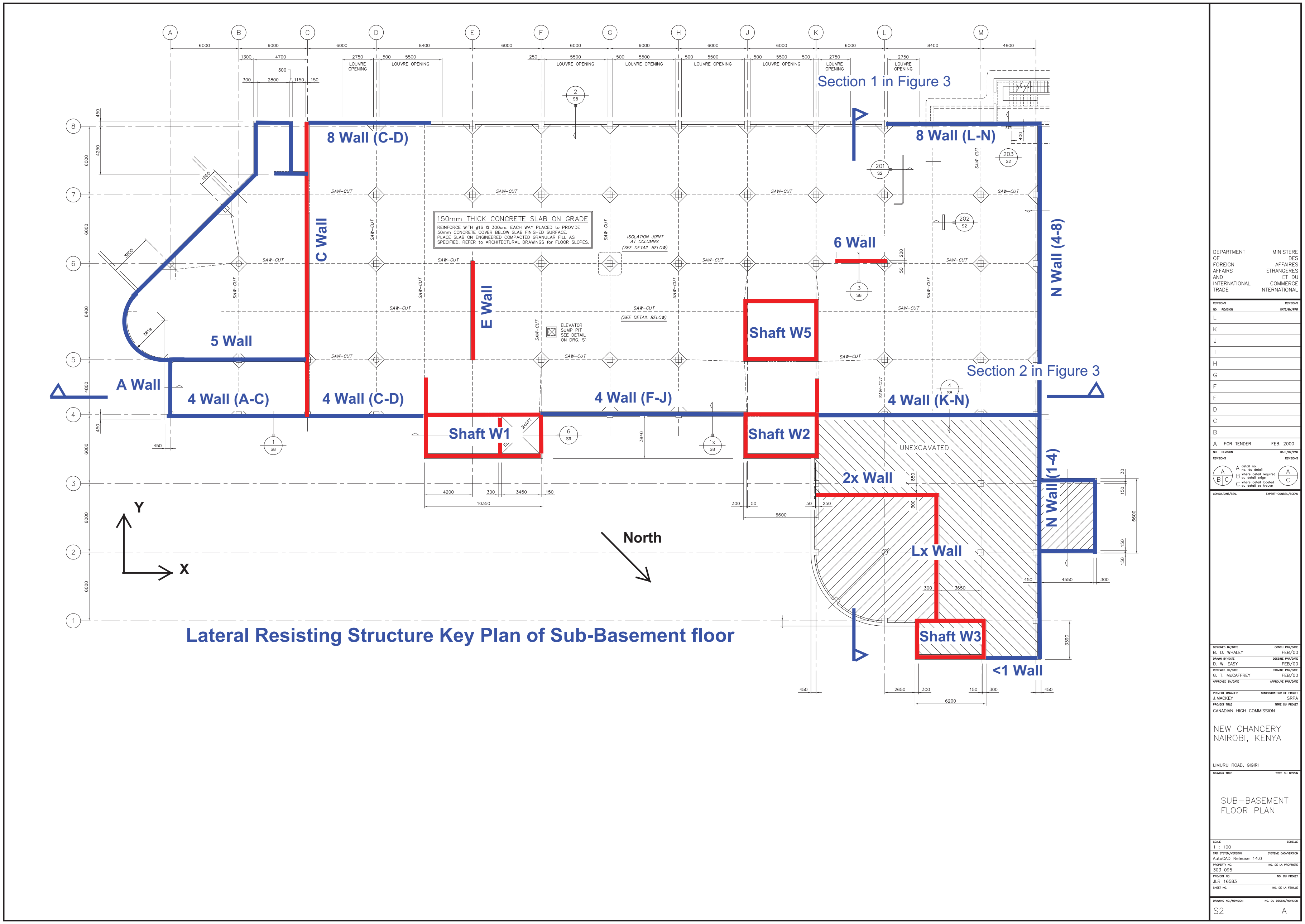
Britech

Britech Ltd.
P.O. Box 15130, 00509,
Langata, **Nairobi, Kenya**.
Office Phone: +254 20 2325683
Office Mobile: +254 773 210558
E-mail: mdsurtech@swiftkenya.com

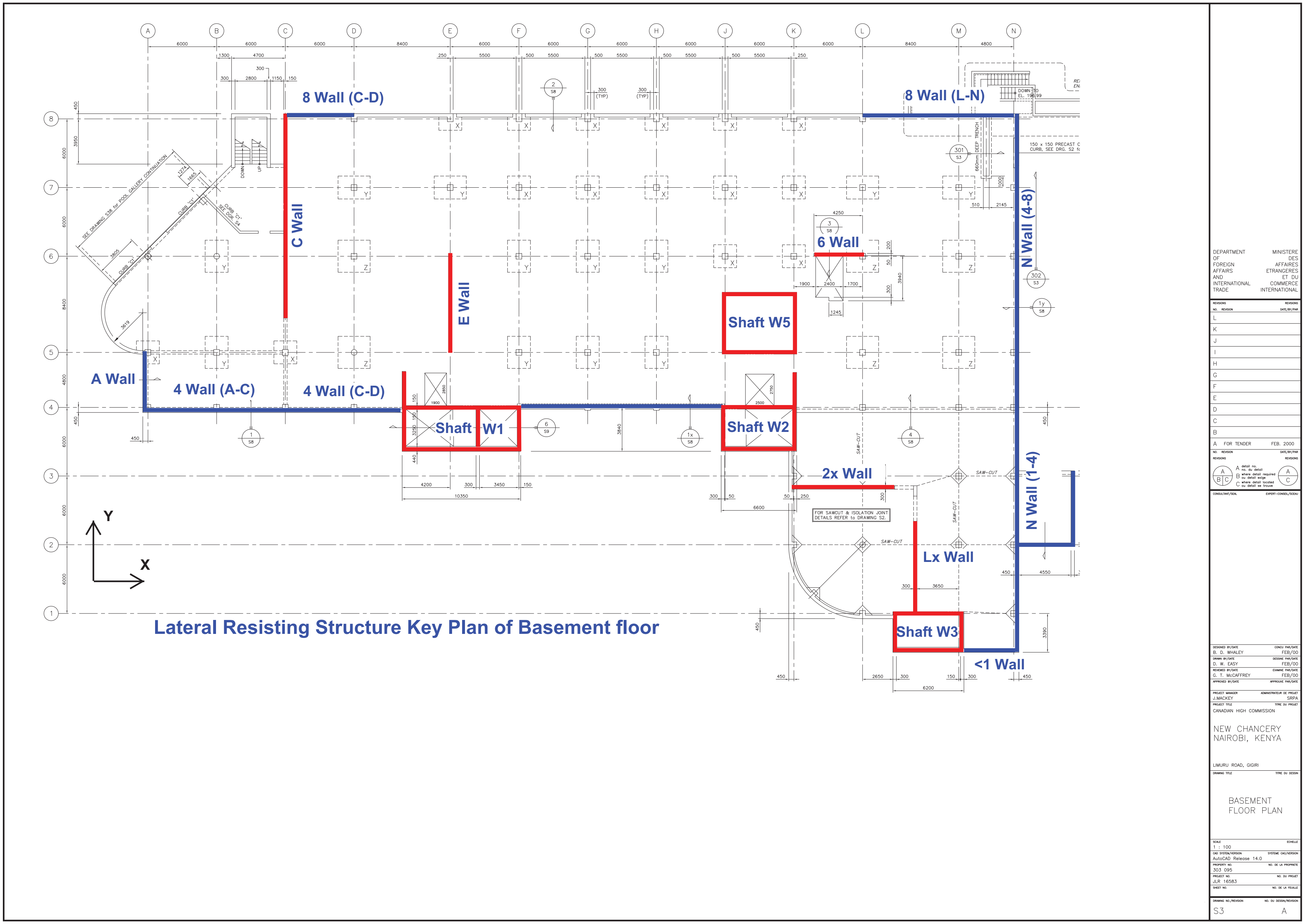
SHEET No.

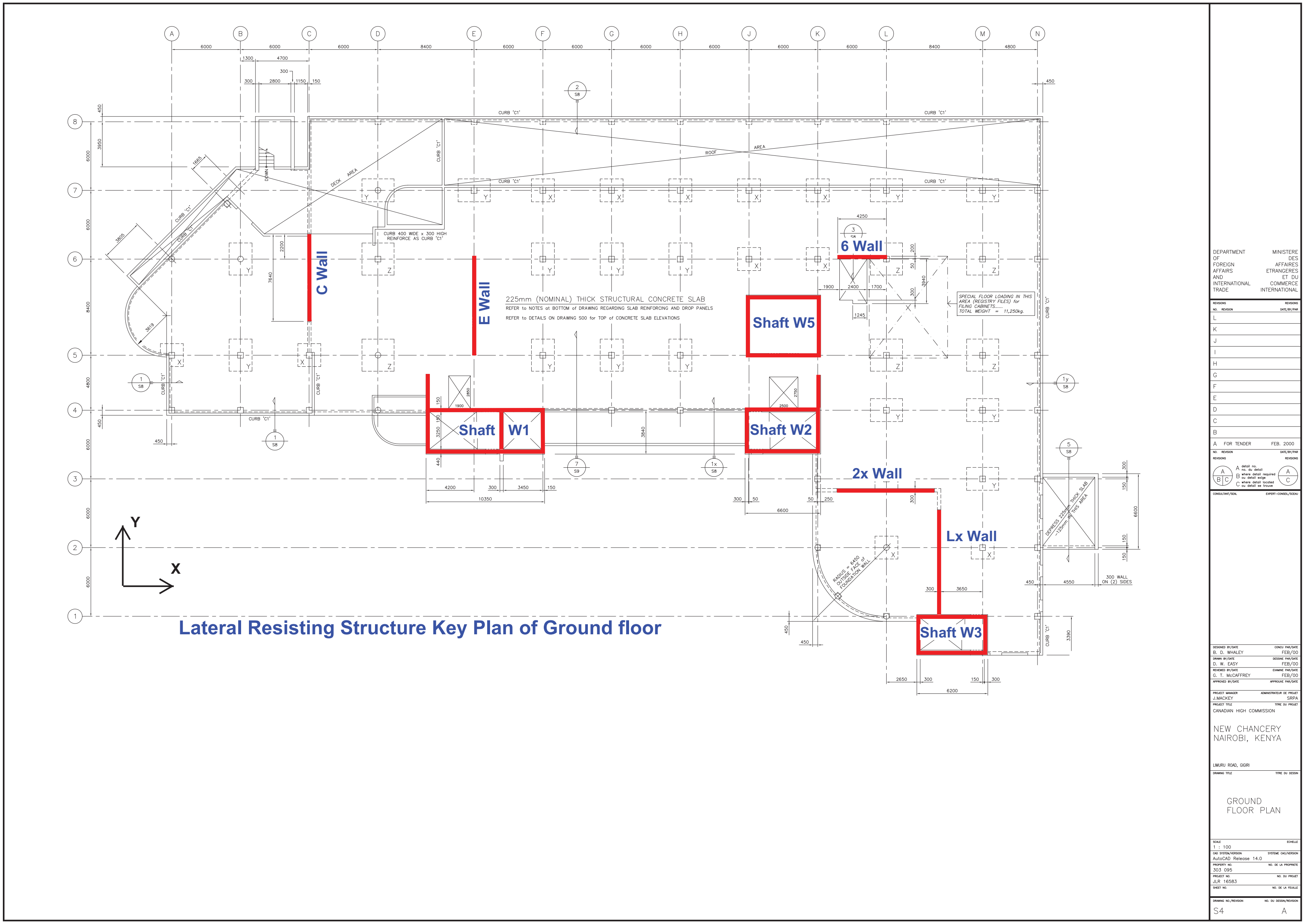
96141

Appendix D – key plans of lateral resisting structures

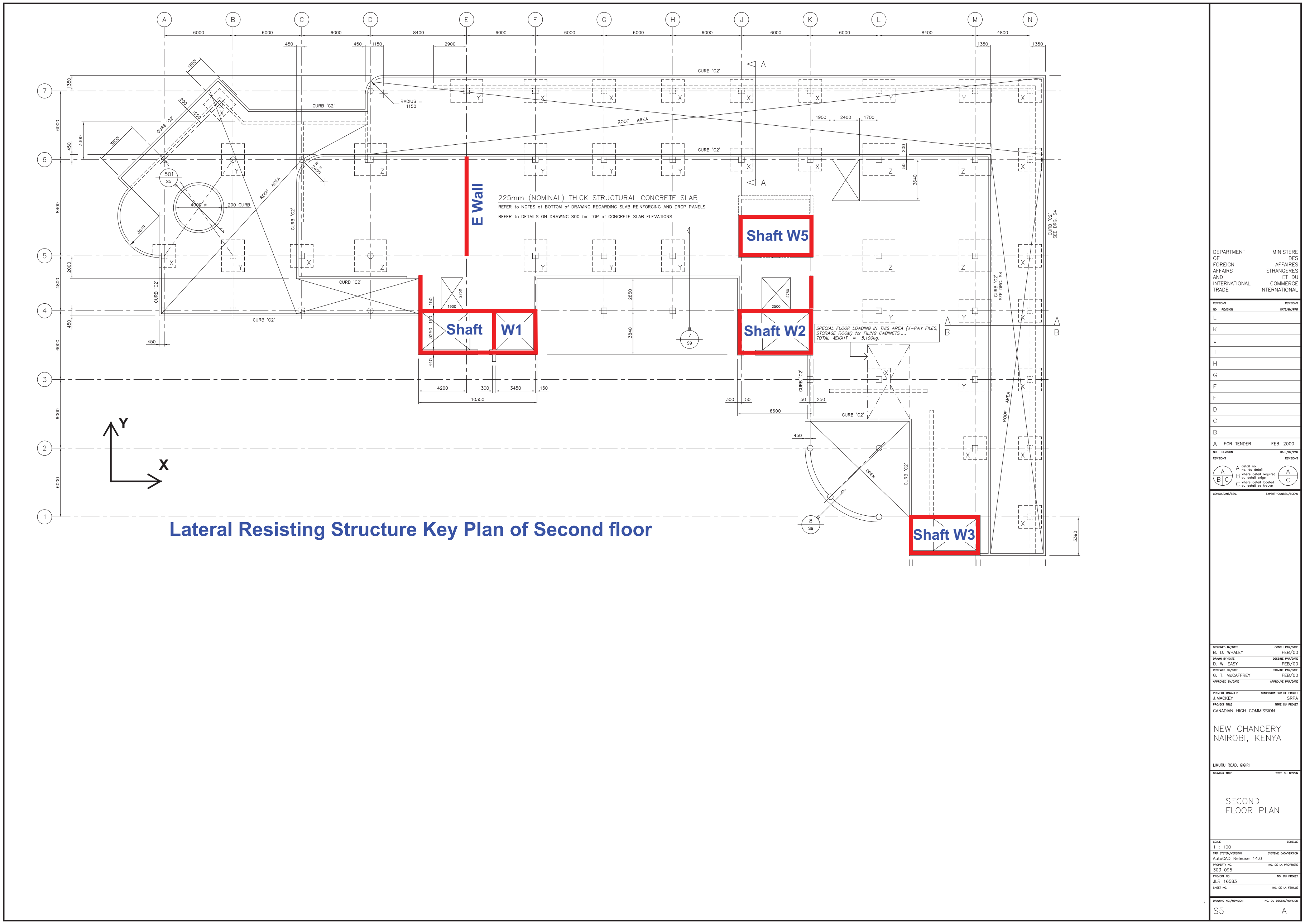


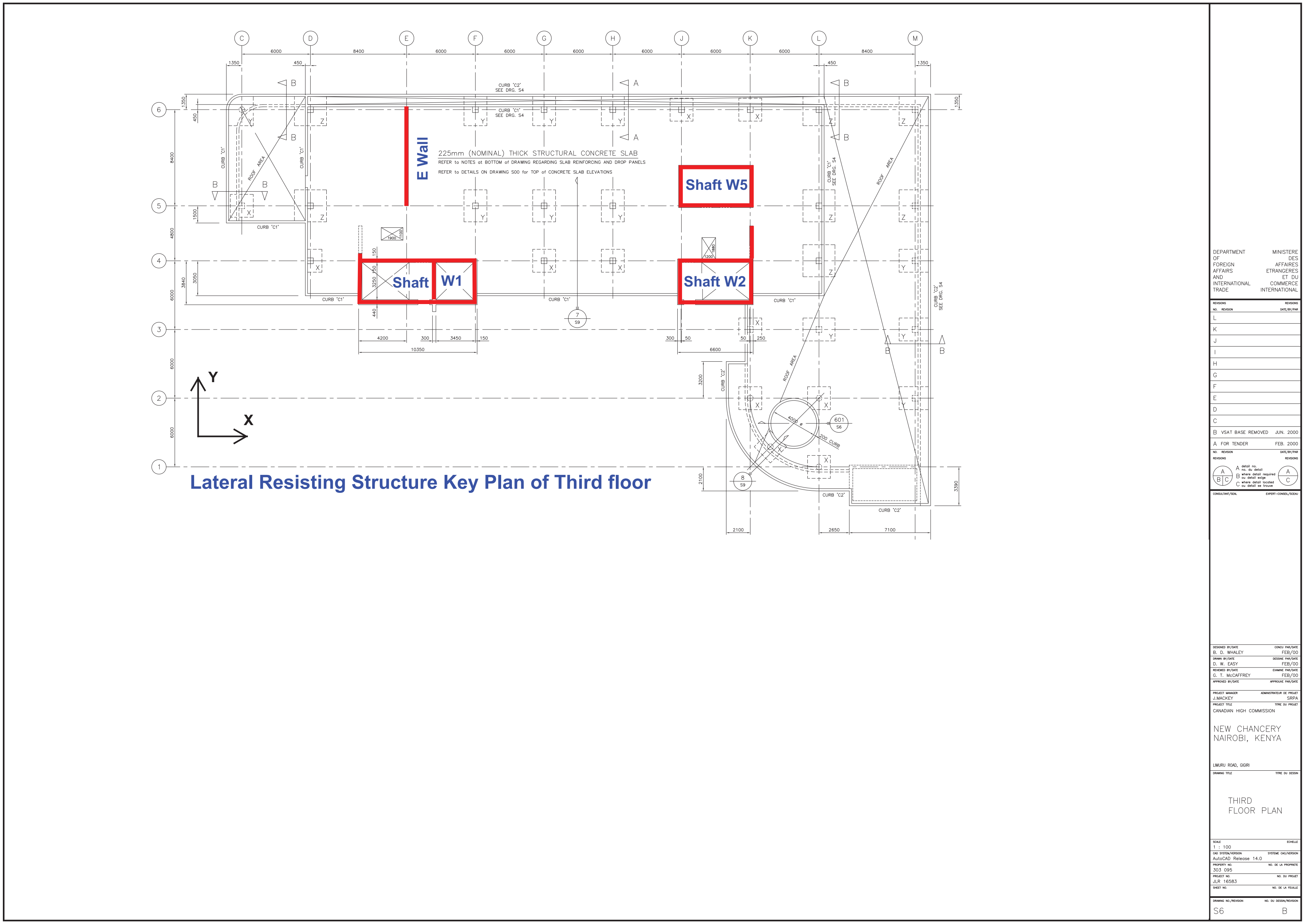
Lateral Resisting Structure Key Plan of Sub-Basement floor


8 Wall (C-D)
8 Wall (L-N)
C Wall
E Wall
6 Wall
N Wall (4-8)
Shaft W5
A Wall
4 Wall (A-C)
4 Wall (C-D)
Shaft W1
Shaft W2
2x Wall
N Wall (1-4)
Lx Wall
Shaft W3
<1 Wall
Y
X
Lateral Resisting Structure Key Plan of Basement floor
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
A FOR TENDER FEB. 2000
B. D. WHALEY FEB/00
D. W. EASY FEB/00
G. T. McCAFFREY FEB/00
J.MACKEY SRPA
CANADIAN HIGH COMMISSION
NEW CHANCERY
NAIROBI, KENYA
LIMURU ROAD, GIGIRI
BASEMENT FLOOR PLAN
1 : 100
AutoCAD Release 14.0
303 095
JLR 16583
S3
A

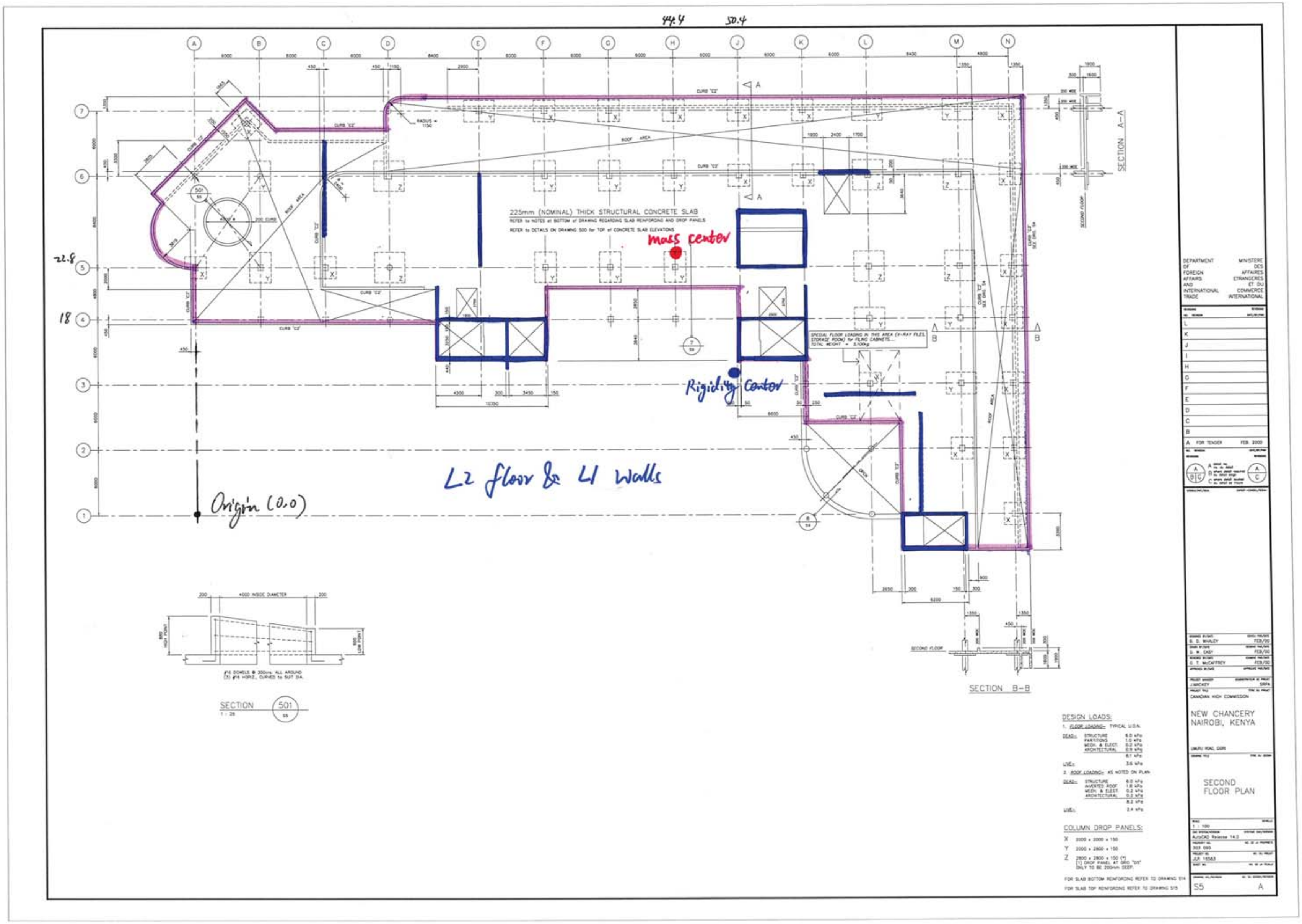


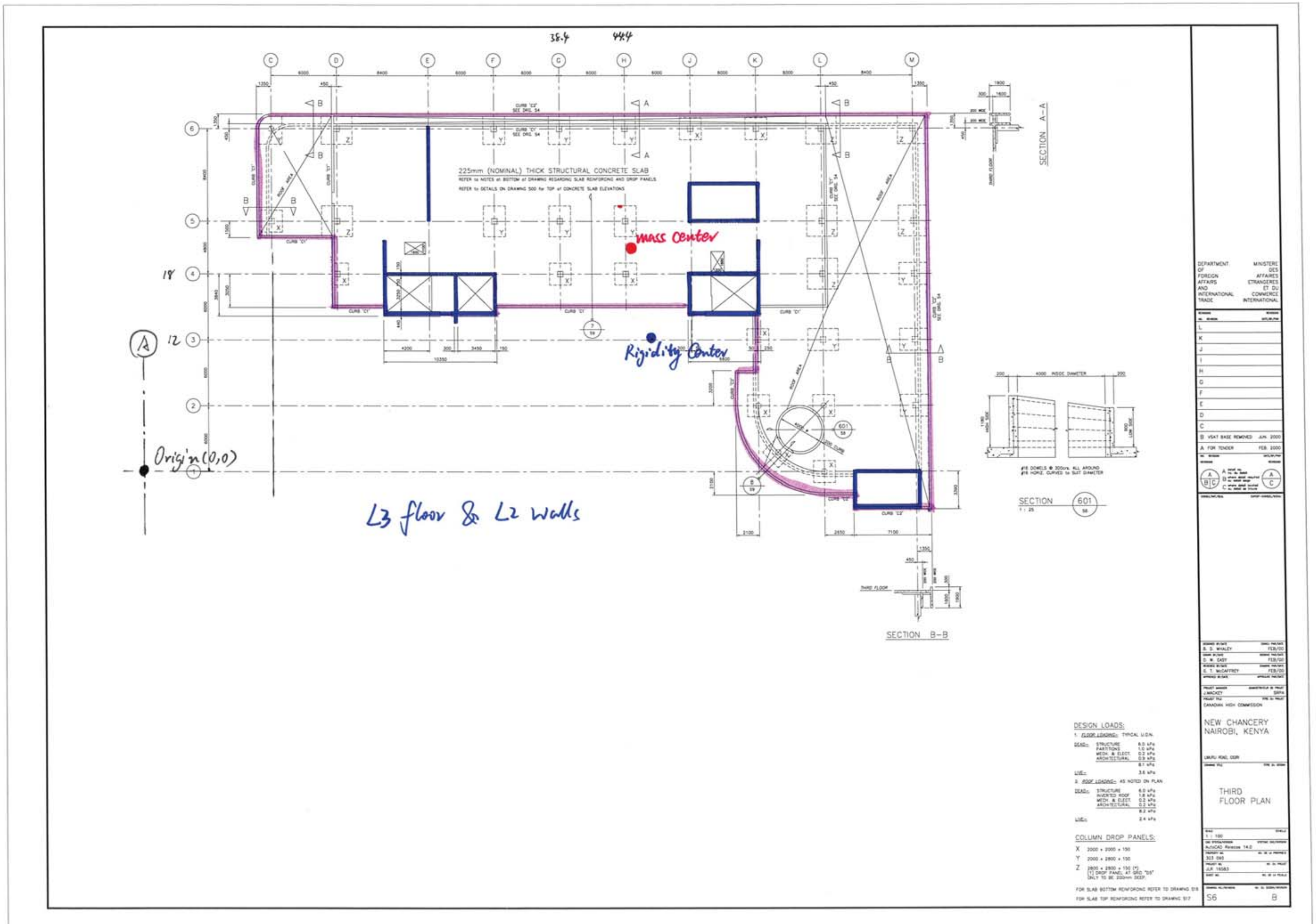
Lateral Resisting Structure Key Plan of Ground floor


Lateral Resisting Structure Key Plan of Second floor
E Wall
Shaft W5
Shaft
W1
Shaft W2
Shaft W3
Y
X
225mm (NOMINAL) THICK STRUCTURAL CONCRETE SLAB
REFER to NOTES at BOTTOM of DRAWING REGARDING SLAB REINFORCING AND DROP PANELS
REFER to DETAILS ON DRAWING 500 for TOP of CONCRETE SLAB ELEVATIONS
SPECIAL FLOOR LOADING IN THIS AREA (X-RAY FILES, STORAGE ROOM) for FILING CABINETS..... TOTAL WEIGHT = 5,100kg.
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
A FOR TENDER FEB. 2000
B. D. WHALEY FEB/00
D. W. EASY FEB/00
G. T. McCAFFREY FEB/00
J.MACKEY SRPA
CANADIAN HIGH COMMISSION
NEW CHANCERY
NAIROBI, KENYA
LIMURU ROAD, GIGIRI
SECOND
FLOOR PLAN
1 : 100
AutoCAD Release 14.0
303 095
JLR 16583
S5 A

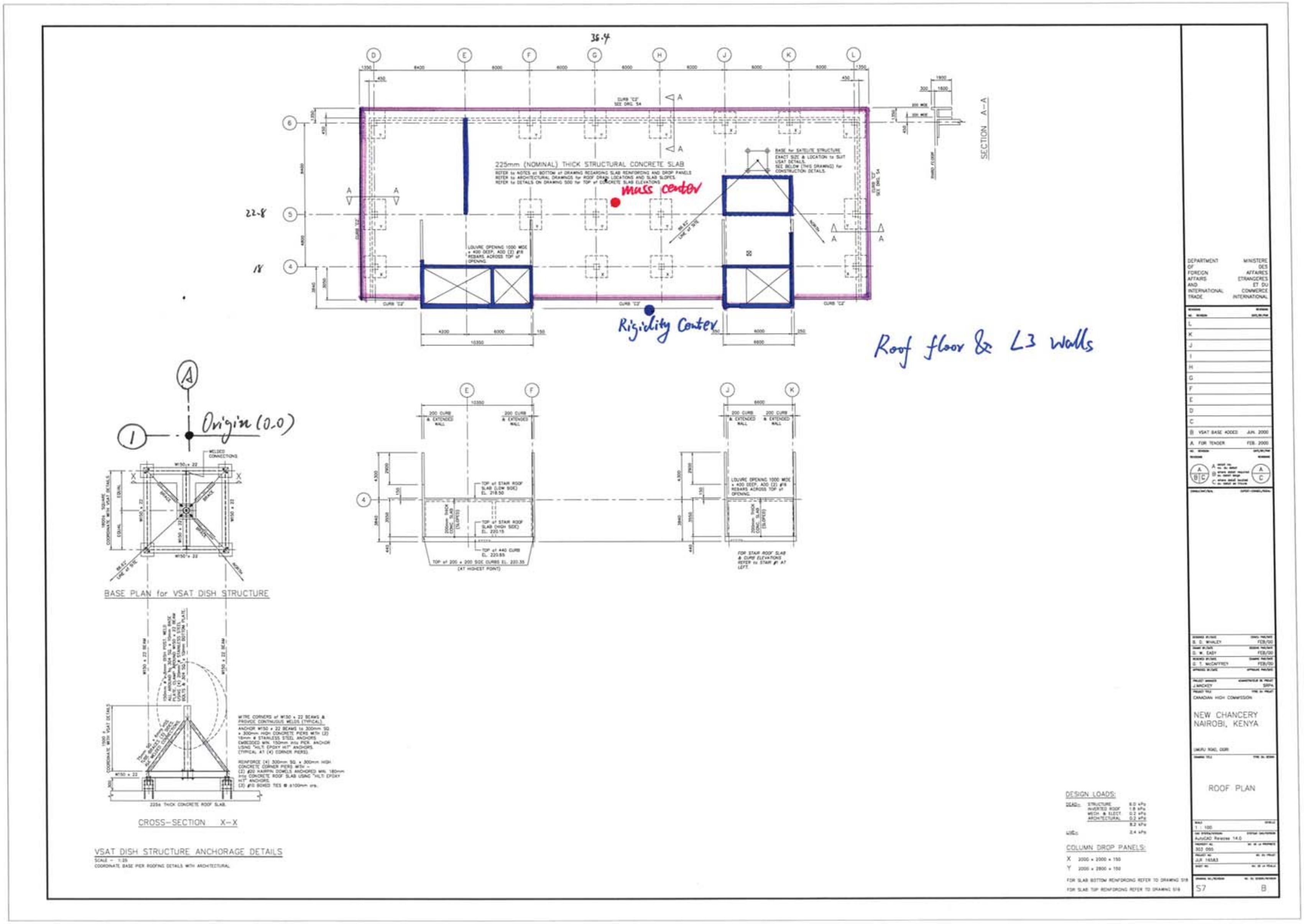

Lateral Resisting Structure Key Plan of Third floor
E Wall
Shaft W5
Shaft W1
Shaft W2
Y
X
225mm (NOMINAL) THICK STRUCTURAL CONCRETE SLAB
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
B VSAT BASE REMOVED JUN. 2000
A FOR TENDER FEB. 2000
B. D. WHALEY FEB/00
D. W. EASY FEB/00
G. T. McCAFFREY FEB/00
J.MACKEY SRPA
CANADIAN HIGH COMMISSION
NEW CHANCERY
NAIROBI, KENYA
LIMURU ROAD, GIGIRI
THIRD
FLOOR PLAN
1 : 100
AutoCAD Release 14.0
303 095
JLR 16583
S6
B

Appendix E – Floor mass and rigidity center


44.4
50.4
22.8
18
225mm (NOMINAL) THICK STRUCTURAL CONCRETE SLAB
mass center
Rigidity Center
L2 floor & L1 walls
Origin (0.0)
SECTION A–A
SECTION B–B
SECTION 501
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
NEW CHANCERY NAIROBI, KENYA
SECOND FLOOR PLAN
DESIGN LOADS:
COLUMN DROP PANELS:
S5
A



225mm (NOMINAL) THICK STRUCTURAL CONCRETE SLAB
mass center
Rigidity Center
Origin (0,0)
L3 floor & L2 walls
SECTION A-A
SECTION B-B
SECTION 601
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
NEW CHANCERY NAIROBI, KENYA
THIRD FLOOR PLAN
DESIGN LOADS:
COLUMN DROP PANELS:
S6


Roof floor & L3 walls
mass center
Rigidity Center
Origin (0,0)
225mm (NOMINAL) THICK STRUCTURAL CONCRETE SLAB
SECTION A-A
BASE PLAN for VSAT DISH STRUCTURE
CROSS-SECTION X-X
VSAT DISH STRUCTURE ANCHORAGE DETAILS
DESIGN LOADS:
COLUMN DROP PANELS:
DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE
MINISTERE DES AFFAIRES ETRANGERES ET DU COMMERCE INTERNATIONAL
NEW CHANCERY
NAIROBI, KENYA
ROOF PLAN
S7
B

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Part 6
Project Phasing Plan

Part 6. Project Phasing Plan

6.1 Phasing Objectives and Assumptions

It is intended that the phasing of the work will incorporate rectification of deficient existing building conditions, exterior envelope improvements, physical security improvements, structural retrofit, and the space optimization fit-up. All project components need to be integrated into a rational stage-by-stage work program.

We have assumed that Chancery operations will be ongoing throughout the construction stages and that no functions will be relocated offsite.

Safe ongoing occupancy will require that temporary security measures will be provided and that life safety work including dustproof protective hoardings and exit pathways will be provided.

A tolerance for noise intrusion will be required. The most disruptive activities can be scheduled for nights and weekends but it is assumed that general construction activities will be performed within normal work-day hours.

A construction program with a 24-month duration is outlined. Significant abbreviation of this timeframe will only be feasible if a significant proportion of Chancery functions are temporarily located offsite. This is not currently envisioned.

6.2 Proposed Phasing Sequence and Timeframes

The following sequence and timeframes include an idea that envelope work for re-roofing and for insulation and cladding of exterior walls can proceed contemporaneously with the interior works and be virtually independent of the interior works. Re-glazing for thermal and physical security upgrades however, should be timed to coincide with each sequential phase on an area-by-area basis.

Phase One: Structural retrofit at the sub-basement level including new elevator pit. Structural retrofit at the basement level including new elevator hoistway. New enclosures at the ground floor for Chancery Reception and Immigration Waiting.
Estimated duration: 13 weeks.

Phase Two: Set up swingspace at existing Multipurpose Area, Chair Storage, and Library. Provide approximately 15 workstations.
Estimated duration: 3 weeks.

Phase Three: Provide new curtainwall and framing for physical security at the northeast elevation of the Ground Floor. Perform structural retrofit and fit-up work to the area north of gridline 6 and east of gridline K at the ground floor.
Estimated duration: 12 weeks.

Phase Four: Perform fit-up to area south of gridline 6 at ground floor.
Estimated duration: 4 weeks.

Phase Five: Structural retrofit and fit-up to Immigration Interview Area at ground floor north of gridline 4.
Estimated duration: 12 weeks.

Phase Six: Structural retrofit and fit-up to remainder of Immigration Area at ground floor.
Estimated duration: 12 weeks

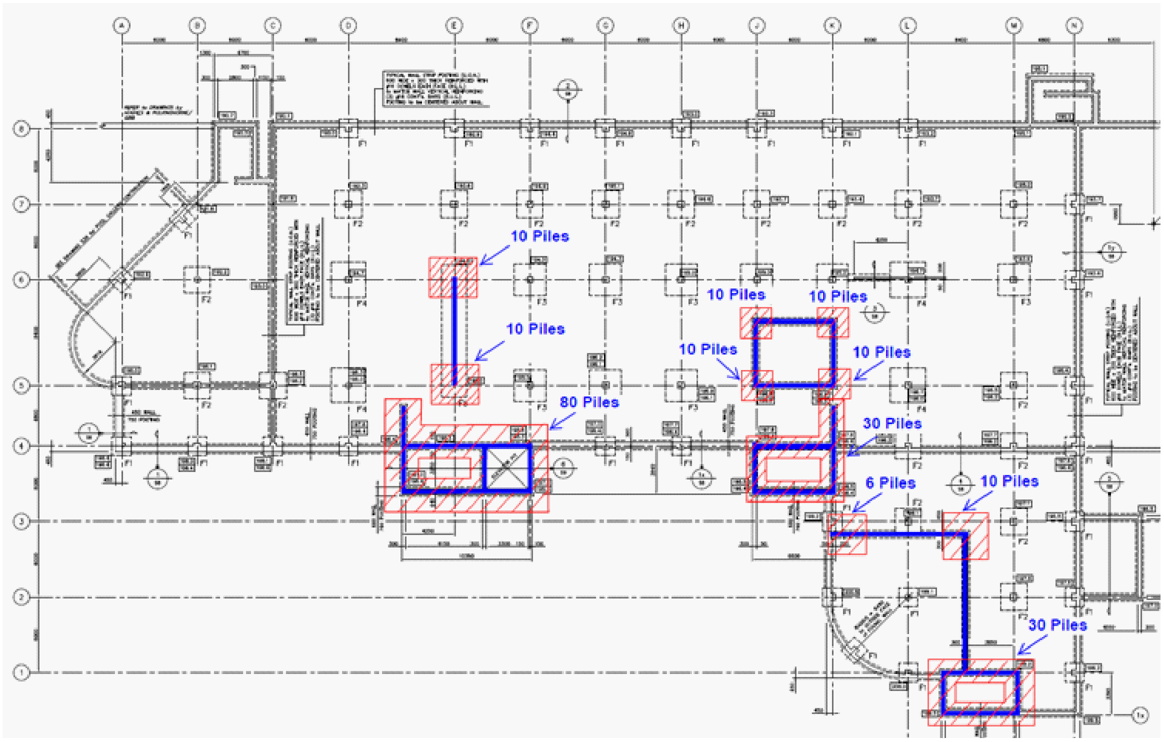
Phase Seven: Structural retrofit and fit-up to second floor east.
Estimated duration 12 weeks.

Phase Eight: Structural retrofit and fit-up to second floor west.
Estimated duration: 12 weeks.

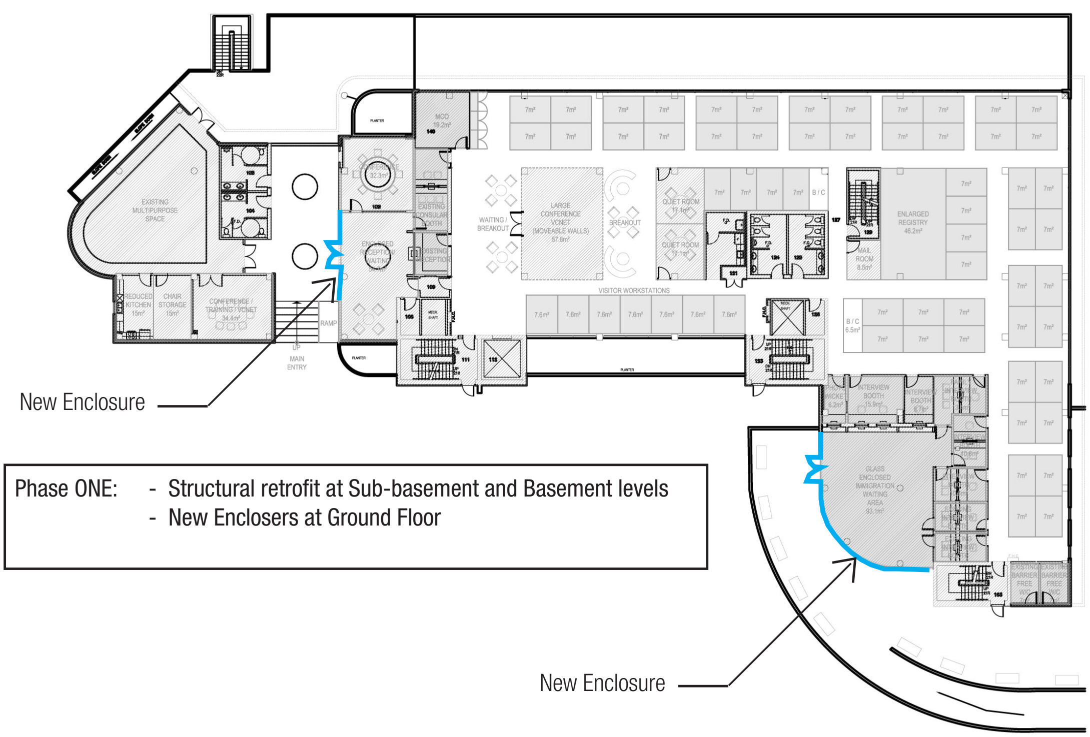
Phase Nine: Structural retrofit and fit-up to third floor east.
Estimated duration: 12 weeks.

Phase Ten: Structural retrofit to third floor west. Final balancing of air and water systems.
Estimated duration: 12 weeks.

The total duration of the above is 104 weeks (24 months).

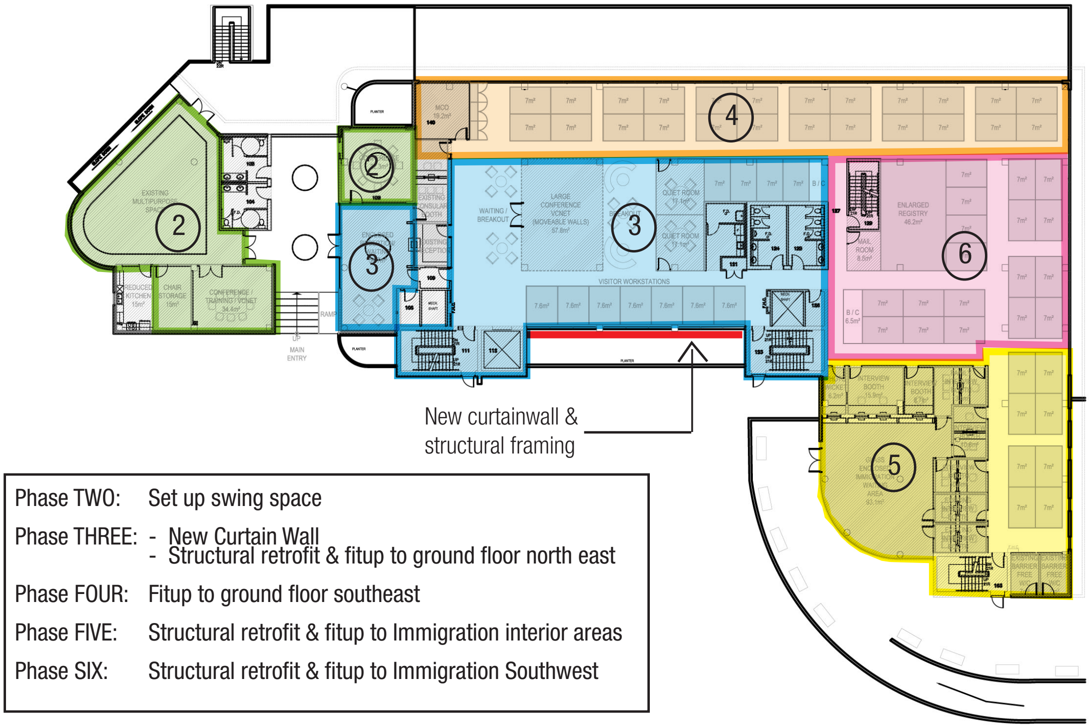


Sub-Basement Plan - Phasing Diagram

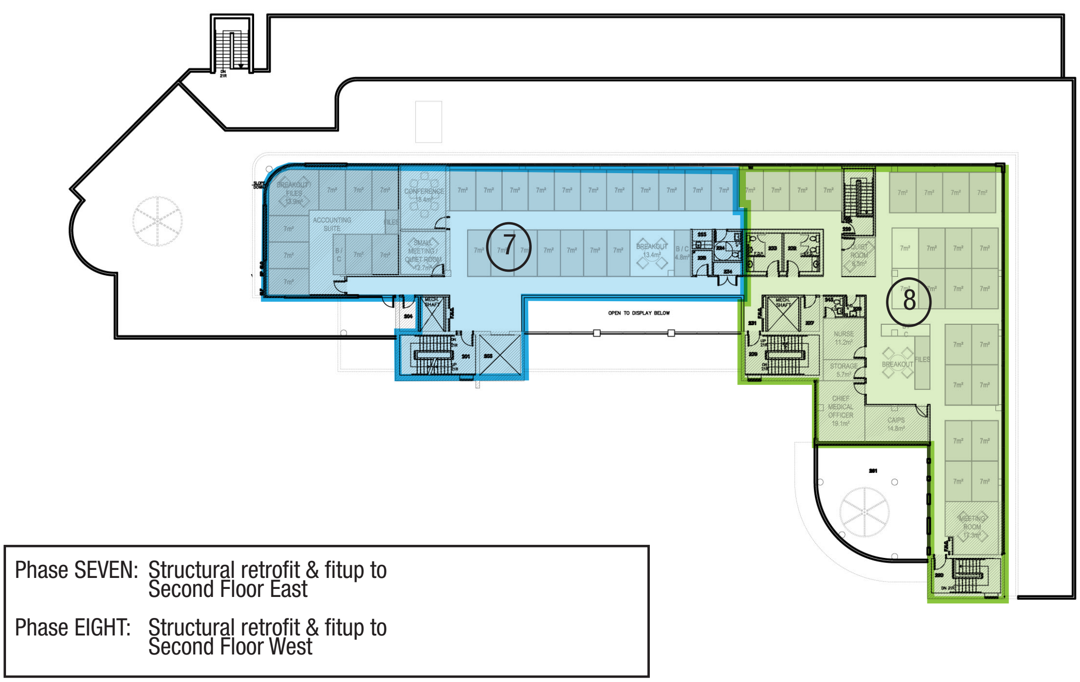


Phase ONE:
- Structural retrofit at Sub-basement and Basement levels
- New Enclosers at Ground Floor

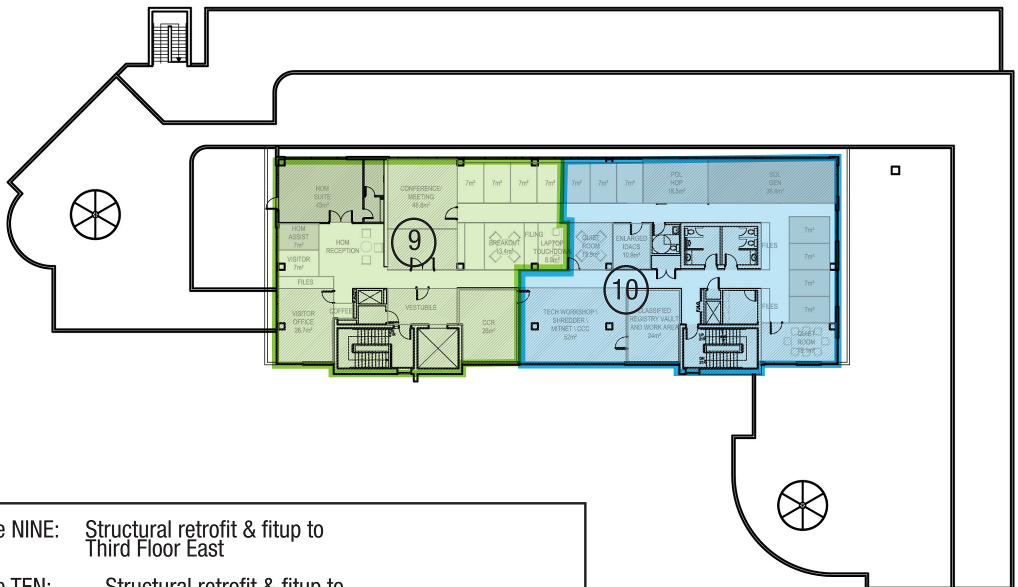
Ground Floor Plan - Phasing Diagram



Ground Floor Plan - Phasing Diagram



Second Floor Plan - Phasing Diagram



Phase NINE:	Structural retrofit & fitup to Third Floor East
Phase TEN:	- Structural retrofit & fitup to Third Floor West - Final balancing of air and water systems

Third Floor Plan - Phasing Diagram

Part 7
Conceptual (Indicative) Construction Cost Estimate

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CANADIAN HIGH COMMISSION, NAIROBI, KENYA
PROPOSED BUILDING CONDITION MITIGATION WORKS
PRELIMINARY COST ESTIMATE
DATE: 18TH APRIL 2013

	COST ESTIMATE MAIN SUMMARY	TOTAL KSHS	TOTAL CANADIAN $	TOTAL CANADIAN $
			C $1=KSHS 80	
7.1	**RECTIFICATION OF DEFICIENCIES**			**1,431,192.38**
7.1.1	Building Structure	5,285,100	66,064	
7.1.2	Building Envelope	39,327,600	491,595	
7.1.3	Building Interior	8,042,650	100,533	
7.1.4	Mechanical Systems	17,339,000.00	216,737.50	
7.1.5	Electrical Systems	20,509,000.00	256,362.50	
7.1.6	Life Safety, Fire Detection and Fire Suppression Systems	432,000.00	5,400.00	
7.1.7	Vertical Transportation Systems	270,000.00	3,375.00	
7.1.8	Building Grounds	23,290,040	291,126	
7.2	**MOULD ABATEMENT**	**600,000**	**7,500.00**	**7,500.00**
7.3	**SPACE OPTIMIZATION REQUIREMENTS**			**1,448,992.50**
7.3.1	Architectural Elements	65,897,400	823,718	
7.3.2	Structural Elements	Not required	-	
7.3.3	Mechanical Elements	31,050,000	388,125	
7.3.4	Electrical Elements	14,472,000	180,900	
7.3.5	Site Elements	Not required	-	
7.3.6	Temporary Requirements	4,500,000	56,250	
7.3.7	Infill of Atrium	(Separate Estimate)		
7.4	**BUILDING ENVELOPE UPGRADE REQUIREMENTS**			**2,731,796.63**
7.4.1	Architectural Upgrade Requirements	128,081,920	1,601,024	
7.4.2	Architectural and Security Upgrade Requirements for Windows and Curtain Wall	90,461,810	1,130,773	
7.5	**SEISMIC UPGRADE REQUIREMENTS**			**963,405.00**
7.5.1	Walls and Shafts	62,172,400	777,155	
7.5.2	Diaphragms	1,700,000	21,250	
7.5.3	Foundations	13,200,000	165,000	
7.6	**PROGRAM TOTAL**			
7.61	**Program Estimated Cost**	**526,630,920**	**6,582,887**	**6,582,887**
	Preliminaries (10%)	52,663,092		658,289
		579,294,012		**7,241,176**
	Contingency Sum (10%)	57,929,401		724,118
		637,223,500		**7,965,300**
	Allowance for Price Change (10%)	63,722,350		796,530
		700,945,850		**8,761,830**
	VAT (16%) (Canadian Chancery to Apply for Exemption from Government of Kenya)	112,151,336		1,401,893
	GRAND TOTAL	**813,097,186**	**CANADIAN $**	**10,163,723**

7.6.2	**Separate Cost Estimate**	
	Infill of Atrium	56,250.00
		56,250
	Preliminaries (10%)	5,625
		61,875
	Contingency Sum (10%)	6,188
		68,100
	Allowance for Price Change (10%)	6,810
		74,910
	VAT (16%) (Canadian Chancery to Apply for Exemption from Government of Kenya)	11,986
	TOTAL	**86,896**

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013/MAIN SUMMARY/1

CANADIAN HIGH COMMISSION, NAIROBI, KENYA
PROPOSED BUILDING CONDITION MITIGATION WORKS
PRELIMINARY COST ESTIMATE
DATE: 18TH APRIL 2013

ITEM	COST ESTIMATE COLLECTION PAGE	TOTAL KSHS	TOTAL CANADIAN $	TOTAL CANADIAN $ C $1=KSHS 80
7.1	RECTIFICATION OF DEFICIENCIES			
7.1.1	BUILDING STRUCTURE	5,285,100		66,064
7.1.1.1	Repair of Cracks on Basement Floor Slab : Parking Level	518,200	6,478	
7.1.1.2	Repair of Cracks on Building Facade and Parapets	-	(See section 7.4)	
7.1.1.3	Repair of Cracks on Basement Foundation/Retaining Walls	4,116,900	51,461	
7.1.1.4	Repair of Cracks at underside of the second floor slab at gridline 7 between D and E	30,000	375	
7.1.1.5	Repair of Cracks at corners of third floor window at North East Façade between gridlines F and J	80,000	1,000	
7.1.1.6	Repair of Cracks in shear walls	150,000	1,875	
7.1.1.7	Repair of Cracks in concrete block walls	390,000	4,875	
7.1.2	BUILDING ENVELOPE	39,327,600		491,595
7.1.2.1	Replacement of Roof Assemblies	37,457,600	468,220	
7.1.2.2	Repair of Exterior walls	-	(See section 7.4)	
7.1.2.3	Repair of Exterior Windows and Curtain wall	-	(See section 7.4)	
7.1.2.4	Repair of Sky lights	1,870,000	23,375	
7.1.3	BUILDING INTERIOR	8,042,650		100,533
7.1.3.1	Flooring	4,116,500	51,456	
7.1.3.2	Wall Finishes	1,806,150	22,577	
7.1.3.3	Partitions, Doors & Frames, and Ceiling Finishes	-	(See section 7.3)	
7.1.3.4	Rectification of Water Damage at corridor 110	220,000	2,750	
7.1.3.5	Repair of Dock Leveller	1,600,000	20,000	
7.1.3.6	Grab bars	300,000	3,750	
7.1.4	MECHANICAL SYSTEMS	17,339,000		216,737.50
7.1.5	ELECTRICAL SYSTEMS	20,509,000		256,362.50
7.1.6	LIFE SAFETY, FIRE DETECTION AND FIRE SUPPRESSION SYSTEMS	432,000.00		5,400.00
7.1.7	VERTICAL TRANSPORTATION SYSTEMS	270,000.00		3,375.00
7.1.8	BUILDING GROUNDS	23,290,040		291,126
7.1.8.1	Reconstruct Ramp to Immigration Entry	17,984,540	224,806.75	
7.1.8.2	Reconstruct Ramp to Canadian Club/Pool Deck	5,305,500	66,318.75	
7.2	MOULD ABATEMENT	600,000		7,500.00
7.3	SPACE OPTIMIZATION REQUIREMENTS	-		
7.3.1	ARCHITECTURAL ELEMENTS	65,897,400		823,718
7.3.1.1	Demolitions	3,089,500	38,618.75	
7.3.1.2	New exterior walls	8,500,000	106,250.00	
7.3.1.3	New partitions	15,468,000	193,350.00	
7.3.1.4	New interior doors and frames	471,000	5,887.50	
7.3.1.5	Ceilings	3,502,500	43,781.25	
7.3.1.6	Furrings	2,223,450	27,793.13	
7.3.1.7	Floor Finishes	23,730,000	296,625.00	
7.3.1.8	Wall Finishes	7,112,950	88,911.88	
7.3.1.9	Millwork and Fitments	1,800,000	22,500.00	
7.3.2	STRUCTURAL ELEMENTS	-	Not required	-
7.3.3	MECHANICAL ELEMENTS	31,050,000.00		388,125
7.3.4	ELECTRICAL ELEMENTS	14,472,000.00		180,900
7.3.5	SITE ELEMENTS	500,000	Not required	-
7.3.6	TEMPORARY REQUIREMENTS	4,500,000		56,250
7.3.6.1	Phasing of Works	500,000	6,250	
7.3.6.2	Swing space Creation	4,000,000	50,000	
7.3.7	INFILL OF ATRIUM	4,500,000		56,250.00
7.4	BUILDING ENVELOPE UPGRADE REQUIREMENTS	-		

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013/COLLECTION PAGE/1

ITEM	COST ESTIMATE COLLECTION PAGE	TOTAL KSHS	TOTAL CANADIAN $	TOTAL CANADIAN $
				C $1=KSHS 80
7.4.1	ARCHITECTURAL UPGRADE REQUIREMENTS	128,081,920		1,601,024
7.4.1.1	Exterior Walls	128,081,920	1,601,024	
7.4.2	ARCHITECTURAL AND SECURITY UPGRADE REQUIREMENTS FOR WINDOWS AND CURTAIN WALL	90,461,810		1,130,773
7.4.2.1	North-eastern Lobby Curtain Wall	23,440,000	293,000	
7.4.2.2	North-eastern Elevation Windows	3,020,850	37,761	
7.4.2.3	Stairwell Glazing	4,543,800	56,798	
7.4.2.4	General Glazing	56,307,160	703,840	
7.4.2.5	Interior glazed partitions	3,150,000	39,375	
7.5	SEISMIC UPGRADE REQUIREMENTS	-		
7.5.1	WALLS AND SHAFTS	62,172,400		777,155
7.5.1.1	Shear walls and shaft walls thickening	62,172,400	777,155	
7.5.2	DIAPHRAGMS	1,700,000		21,250
7.5.2.1	Steel Plate Floor trusses	1,700,000	21,250	
7.5.3	FOUNDATIONS	13,200,000		165,000
7.5.3.1-4	Micropile retrofit design to reinforce foundations	13,200,000	165,000	
	Sub-Total			**6,639,137**

CANADIAN HIGH COMMISSION, NAIROBI, KENYA
PROPOSED BUILDING CONDITION MITIGATION WORKS
PRELIMINARY COST ESTIMATE
DATE: 18TH APRIL 2013

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
7.1	**RECTIFICATION OF DEFICIENCIES**						
7.1.1	**BUILDING STRUCTURE**						
7.1.1.1	**Repair of Cracks on Basement Floor Slab : Parking Level**						**6,477.50**
.1	**Cracks Extending through topping, waterproof membrane, and structural slab**						
A	Carefully hack and remove 500mm wide x 50mm (approx) thick concrete topping to expose waterproof membrane: prepare surfaces for repairs: dispose arisings	m	40	1,000	40,000.00	500.00	
B	200mm wide butyl membrane waterproofing treatment to cracks in floor	m	40	3,000	120,000.00	1,500.00	
D	200mm wide hot applied reinforced asphalt waterproofing membrane to in floor	m	40	800	32,000.00	400.00	
E	50 mm Cement and sand screed or machine power float finish to concrete topping with hardener	m2	20	2,500	50,000.00	625.00	
F	Make good all disturbed surfaces and remove all stains	Item			24,200.00	302.50	
.2	**Cracks Extending through topping thickness only**						
A	Carefully chase and rout-out cracks in floor approximate 20mm deep: prepare surfaces for repairs: dispose arisings	m	60	500	30,000.00	375.00	
B	Prepare and apply rubberised caulking to in floor: to manufacturers specifications	m	60	3,000	180,000.00	2,250.00	
C	Make good all disturbed surfaces and remove all stains	Item			42,000.00	525.00	
					518,200.00	**6,477.50**	
7.1.1.2	**Repair of Cracks on Building Facade and Parapets**						
	(Refer to cost estimate in section 7.4 Building envelope Upgrade requirements)				-	-	
7.1.1.3	**Repair of Cracks on Basement Foundation/Retaining Walls**						**51,461.25**
A	Excavate to expose existing waterproof membrane: part keep in designated area on site for re-use as backfill and part remove from site and dispose: in 3 locations	m3	386	3,000	1,158,000.00	14,475.00	
B	Carefully remove stone paving: keep for re-use: dispose debris	m2	133	1,200	159,600.00	1,995.00	
C	200mm wide butyl membrane waterproofing treatment to cracks in floor	m	241	3,000	723,000.00	9,037.50	
D	200mm wide hot applied reinforced asphalt waterproofing membrane to cracks in floor	m	241	800	192,800.00	2,410.00	

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013 / DETAILS / 1

ITEM		DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
								C $1=KSHS 80
	E	Graded aggregate gravel filling: watered and compacted to approval	m3	386	3,500	1,351,000.00	16,887.50	
	F	Take from stockpile on site for re-use: re-fix interlocking stone paving: jointed in cement and mortar to match existing	m2	133	2,500	332,500.00	4,156.25	
	G	Make good all disturbed surfaces and remove all stains	item			200,000.00	2,500.00	
						4,116,900.00	**51,461.25**	
7.1.1.4		**Repair of Cracks at underside of the second floor slab at gridline 7 between D and E**						**375.00**
	A	Carefully chase and chip out unstable edges of 70mm deep crack: prepare surface for repairs: dispose arisings	m	1	2,000	2,000.00	25.00	
	B	Apply bonding agent to 70mm deep crack as specified	m	1	4,000	4,000.00	50.00	
	C	Seal crack with approved cementitious grouting material: to 70mm deep crack	m	1	4,000	4,000.00	50.00	
	D	Make good all disturbed surfaces and remove all stains	Item			20,000.00	250.00	
						30,000.00	**375.00**	
7.1.1.5		**Repair of Cracks at corners of third floor window at North East Façade between gridlines F and J**						**1,000.00**
	A	Carefully chase and chip out unstable edges of 20mm deep crack: prepare surface for repairs: dispose arisings	m	4	2,000	8,000.00	100.00	
	B	Apply bonding agent to 20mm deep crack as specified	m	4	4,000	16,000.00	200.00	
	C	Install cementitious grout: approx 20mm deep crack	m	4	4,000	16,000.00	200.00	
	D	Make good all disturbed surfaces and remove all stains	Item			40,000.00	500.00	
						80,000.00	**1,000.00**	
7.1.1.6		**Repair of Cracks in shear walls**						**1,875.00**
	A	Carefully chase and chip out unstable edges of 20mm deep crack: prepare surface for repairs: dispose arisings	m	10	2,000	20,000.00	250.00	
	B	Apply bonding agent to 20mm deep crack as specified	m	10	4,000	40,000.00	500.00	
	C	Install cementitious grout: approx 20mm deep crack	m	10	4,000	40,000.00	500.00	
	D	Make good all disturbed surfaces and remove all stains	Item			50,000.00	625.00	
						150,000.00	**1,875.00**	
7.1.1.7		**Repair of Cracks in concrete block walls**						**4,875.00**
	A	Carefully chase and chip out unstable edges of 20mm deep crack: prepare surface for repairs:	m	30	2,000	60,000.00	750.00	
	B	Apply approved concrete bonding agent to 20mm deep crack as specified	m	30	4,000	120,000.00	1,500.00	
	C	Prepare and install approved cementitious grout to crack in wall (approx 20mm deep)	m	30	4,000	120,000.00	1,500.00	
	D	Make good all disturbed surfaces and remove all stains	Item			90,000.00	1,125.00	
						390,000.00	**4,875.00**	

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013 / DETAILS / 2

ITEM		DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
								C $1=KSHS 80
7.1.2		**BUILDING ENVELOPE**						
7.1.2.1		**Replacement of Roof Assemblies**						**468,220.00**
	A	Remove existing flat roof covering assembly comprising waterproofing membrane, thermal insulation material and fabric, stone paving on roof, ceramic tile finish, loose stone gravel and roof screed: remove all debris and arisings from site and dispose	m2	2,568	1,500	3,852,000.00	48,150.00	
	B	Supply and fix new 4mm x 2-ply modified bituminous roofing felt membrane to manufacturer's instructions	m2	2,568	2,600	6,676,800.00	83,460.00	
	C	supply and fix new approved water resistant cover board	m2	2,568	3,000	7,704,000.00	96,300.00	
	D	Supply and fix new 110mm (Average) Thermal insulation laid to slope to existing drains on roof	m2	2,568	3,000	7,704,000.00	96,300.00	
	F	50mm (Average) light weight cement and sand screed: laid to falls and cross falls on roof	m2	2,568	850	2,182,800.00	27,285.00	
	G	10mm Non-slip granito tiles or stone finish to match existing: pointed in matching proprietary grout	m2	2,568	3,500	8,988,000.00	112,350.00	
	H	Allow for adjustments, repair works and dressing of new roof covering to existing stainless steel roof drain fulbora outlets	Item			150,000.00	1,875.00	
	I	Make good all disturbed surfaces and remove all stains	Item			200,000.00	2,500.00	
						37,457,600.00	**468,220.00**	
7.1.2.2		**Repair of Exterior walls**						
		(Refer to cost estimate in section 7.4 Building envelope Upgrade requirements)				-	-	
7.1.2.3		**Repair of Exterior Windows and Curtain wall**						
		(Refer to cost estimate in section 7.4 Building envelope Upgrade requirements)				-	-	
7.1.2.4		**Repair of Sky lights**						**23,375.00**
	A	Carefully remove existing skylights approximately 4-metre diameter skylights: complete with all accessories: hand over to client or dispose as directed.	No	2	25,000	50,000.00	625.00	
		New skylights						
	B	Supply and fix new 4-metre diameter skylights: comprising sealed double glazed units in approved framework	No	2	800,000	1,600,000.00	20,000.00	
	C	Approved powedercoated aluminium flashing around skylights	m	30	4,000	120,000.00	1,500.00	
	D	Make good all disturbed surfaces and remove all stains	Item			100,000.00	1,250.00	
						1,870,000.00	**23,375.00**	

ITEM		DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
								C $1=KSHS 80
7.1.3		**BUILDING INTERIOR**						
7.1.3.1		**Flooring**						**51,456.25**
	A	Remove all broadloom carpet tiles in all areas of the building: clean all surfaces to remove adhesives and carpet remnants: prepare surfaces to receive new floor finish: dispose arisings	m2	2,869	1,000	2,869,000.00	35,862.50	
	B	Remove existing polished blue pearl granite tile from all areas of Ground Floor except washrooms and stairs: clean all surfaces to remove adhesives and grout: prepare surfaces to receive new floor finish: dispose arisings	m2	459	2,500	1,147,500.00	14,343.75	
	C	Make good all disturbed surfaces and remove all stains	Item			100,000.00	1,250.00	
	D	New Floor Finishes: *(Refer to Section 7.3 Space Optimization Requirements)*				-	-	
						4,116,500.00	**51,456.25**	
7.1.3.2		**Wall Finishes**						**22,576.88**
	A	Remove all existing vinyl wall covering from all perimeter walls in all building: dispose arisings: prepare surfaces to receive new finishes	m2	4,589	350	1,606,150.00	20,076.88	
	B	Make good all disturbed surfaces and remove all stains	Item			200,000.00	2,500.00	
						1,806,150.00	**22,576.88**	
7.1.3.3		**Partitions, Doors & Frames, and Ceiling Finishes** *(Refer to Section 7.3 Space Optimization Requirements)*						
7.1.3.4		**Rectification of Water Damage at corridor 110**						**2,750.00**
	A	Remove existing dry wall partitions: dispose arisings	m2	20	1,000	20,000.00	250.00	
		Partitioning						
	B	"Dry Wall" gypsum plasterboard partitions complete with steel stud framework anchored on block walls or concrete: cladded with 12.5mm plasterboard on both sides: skim, prepare and paint as specified: to Interior Designers approval : at wall of mechanical shaft	m2	20	8,500	170,000.00	2,125.00	
	C	Make good all disturbed surfaces and remove all stains	Item			30,000.00	375.00	
						220,000.00	**2,750.00**	
7.1.3.5		**Repair of Dock Leveller**						**20,000.00**
	A	Allow sum for repair of Dock Leveller by an expatriate specialist: including airfare, hotel accommodation, materials spares and labour charge	Item			1,600,000.00	20,000.00	
						1,600,000.00	**20,000.00**	
7.1.3.6		**Grab bars**						**3,750.00**
	A	Remove existing grab bars: supply and fix new grab bars in barrier-free washrooms: to meet Canadian Barrier-Free design standards	No	5	50,000	250,000.00	3,125.00	
	B	Make good all disturbed surfaces and remove all stains	Item			50,000.00	625.00	
						300,000.00	**3,750.00**	

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013 / DETAILS / 4

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
7.1.4	**MECHANICAL SYSTEMS**						**216,737.50**
7.1.4.1	Toilet Exhaust Fans: Check cause of excessive rattling noise at ceiling grilles; measure air flow; undercut doors for air transfer. (16 locations).	Item			300,000.00	3,750.00	
7.1.4.2	Repair defective UPS Extract Fan.	Item			100,000.00	1,250.00	
7.1.4.3	Return Air Ductwork: Provide new galvanized steel ductwork from the ceiling plenums of the Ground, Second, and Third Floors to air handling units Nos. 2, 3, & 4 in the Sub-Basement Mechanical Room.	Item			2,500,000.00	31,250.00	
A	Currently, the Mechanical Room is under negative pressure; return air is drawn from the ceiling plenums across a fire damper into the two duct shafts, down the shafts, across fire dampers, into the open space of the Mechanical Room.				Included above		
B	The new work will involve the construction of 3 bellmouths (at Ground Floor, Second Floor, and Third Floor), a new return air duct in each of the 2 shafts, and ductwork across the Mechanical Room to connect to AHU's Nos. 2, 3, and 4.				Included above		
7.1.4.4	Dryer Exhaust: Provide a new flexible exhaust duct from the new location of the clothes washer/ dryer through the exterior wall.	Item			50,000.00	625.00	
7.1.4.5	New Potable Water Treatment System: Provide a new chemical treatment system for potable water	Item			3,000,000.00	37,500.00	
7.1.4.6	New Sewage Treatment System: Provide a new sewage treatment system.	Item			10,000,000.00	125,000.00	
7.1.4.7	Swimming Pool Heater Coupling: Replace the rusted union coupling between the booster heater and the pipe work.	Item			5,000.00	62.50	
7.1.4.8	Recommission Domestic Solar Water Heater System: Inspect, service, and recommission the system by a Solarhart approved Contractor.	Item			50,000.00	625.00	
7.1.4.9	Replacement of Galvanized Steel Cold Water Distribution Pipework: Replace existing galvanized cold water piping with copper pipe wherever accessible. Existing pipes are a mix of copper and galvanized steel.	Item			50,000.00	625.00	
7.1.4.10	Recommissioning: For cost estimates related to rebalancing of air distribution system, rebalancing of hydronic system, recalibration of equipment sensors, rebalancing of terminal units, adjustment of VAV dampers and controls, and adjustment of control sequences, refer to Section 7.3.3.	Item			refer to Section 7.3.3.1		
7.1.4.11	Allow for Main Contractor's attendance on pecialists Mechanical Works s and associated builders work	Item			1,284,000.00	16,050.00	
					17,339,000.00	**216,737.50**	

CANADIAN CHANCERY, NAIROBI COST ESTIMATE 17.06.2013 / DETAILS / 5

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
7.1.5	**ELECTRICAL SYSTEMS**						**256,362.50**
7.1.5.1	Switchgear Drip Guards: Provide custom-fabricated drip guards to switchgear as required to prevent water damage in the event of sprinkler discharge.	Item			150,000.00	1,875.00	
7.1.5.2	Replace Receptacles in Proximity to Washbasins: In Washrooms, replace power receptacles which are adjacent to washbasins with GFI (RCD) protected type.	Item			120,000.00	1,500.00	
7.1.5.3	Replace Lighting Fixtures in Transformer Room: Replace the four explosion-proof “wellglass” lighting fixtures with fluorescent fixtures.	Item			40,000.00	500.00	
7.1.5.4	Replace Transformer Alarm: Extend transformer alarm system to Guard House and incorporate buzzer or other signal, distinct from fire alarm. (CDN value).	Item			200,000.00	2,500.00	
7.1.5.5	Repair Fuel Piping in Generator Room: Repair leaking overhead piping within the room.	Item			50,000.00	625.00	
7.1.5.6	Replace Generator Exhaust Piping: Remove existing “inverted” generator exhaust stack piping and replace with new stack, remote from air intakes and operable windows.	Item			800,000.00	10,000.00	
7.1.5.7	Switchgear:						
	• Update and replace existing wall-mounted single line diagram to incorporate previously replaced changeover section.	Item			50,000.00	625.00	
	• Remove breakers for defunct changeover section and blank- off.	Item			100,000.00	1,250.00	
	• Rewire emergency lighting in Switchgear Room with an un-switched feed so that lights will only illuminate in the event of main power supply failure	Item			30,000.00	375.00	
7.1.5.8	Replace Central Lighting Control System with Room-Based Control System: For cost estimate refer to Section 7.3.4.	Item			750,000.00	9,375.00	
7.1.5.9	Separate Price - Replace existing generator with two synchronized 150kw generators: indoor type configured to allow servicing of each separately with suitable load shedding measures: one generator to run at night time and on weekends and both generators to run in peak demand	Item			9,000,000.00	112,500.00	
7.1.5.10	Power Quality Check: Perform a power quality check with a recording power analyzer. Check for items such as short interruptions, sags, swells, transients, noise, flicker, harmonic distortion, and frequency variation.	Item			350,000.00	4,375.00	
7.1.5.11	Separate Price - Provide Central UPS System: Remove the harmonic mitigating transformer in the clean power room and substitute a central UPS. Change the feeder from the Electrical Room. Provide a split A/C unit for cooling.	Item			6,500,000.00	81,250.00	
7.1.5.12	Exit Lights: Replace the lens and/or stickers to incorporate the green running man pictogram in accordance with NBCC.	Item			150,000.00	1,875.00	

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
7.1.5.13	Lightning Protection: Remove and replace existing lightning protection on parapets of terraces and roofs in conjunction with the roof replacement and cladding work.	Item			700,000.00	8,750.00	
7.1.5.14	Allow for Main Contractor's attendance on Electrical Works specialists and associated builders work	Item			1,519,000.00	18,987.50	
					20,509,000.00	**256,362.50**	
7.1.6	**LIFE SAFETY, FIRE DETECTION AND FIRE SUPPRESSION SYSTEMS**						**5,400.00**
7.1.6.1	Recommission Fire Alarm System: For cost estimate refer to Section 7.1.3.4. (The system should be recommissioned by Edwards technicians located in Dubai; devices which were previously replaced should be replaced with devices that are compatible with the Edwards system; the system should be recommissioned in conjunction with the new Space Optimization fit-up work).	Item			400,000.00	5,000.00	
7.1.5.14	Allow for Main Contractor's attendance on Life Safety, Fire Detection and Suppression specialist works and associated builders work				32,000.00	400.00	
					432,000.00	**5,400.00**	
7.1.7	**VERTICAL TRANSPORTATION SYSTEMS**						**3,375.00**
7.1.7.1	Elevator Power Transfer: Check and rectify the elevator power transfer system and UPS system as required to ensure that elevator power will reset automatically following a power failure	Item			250,000.00	3,125.00	
7.1.5.14	Allow for Main Contractor's attendance on Vertical Transportation System specialist works and associated builders work				20,000.00	250.00	
					270,000.00	**3,375.00**	
7.1.8	**BUILDING GROUNDS**						
7.1.8.1	**Reconstruct Ramp to Immigration Entry**						**224,806.75**
A	Hack or demolish existing walls or ramp concrete slabs: prepare surfaces to receive new construction: dispose arisings	Item			150,000.00	1,875.00	
B	Remove existing paving blocks: excavate to reduce levels: part back fill and compact to approval; remove surplus from site and dispose	m3	95	1,500	141,750.00	1,771.88	
C	Graded aggregate gravel fill: compacted to approval; to receive new ramp slab	m3	31	3,000	92,250.00	1,153.13	
D	75mm Mass concrete class 15 blinding	m2	126	750	94,500.00	1,181.25	
E	Vibrated reinforced concrete class 25/20mm wall foundation	m3	7	15,000	100,800.00	1,260.00	
F	200mm Reinforced concrete class 25/20mm ramp slabs	m2	115	3,000	344,400.00	4,305.00	
G	200mm Reinforced concrete class 25/20mm retaining walls	m2	37	3,000	110,400.00	1,380.00	
H	High yield steel reinforcement to approved Canadian or BS standard	kgs	4,815	150	722,280.00	9,028.50	
I	Formwork to sides of wall foundation	m2	10	800	7,680.00	96.00	

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
J	Formwork to sides of retaining walls	m2	74	800	58,880.00	736.00	
K	Formwork to edges of ramp slab, 150-225mm wide	m	56	100	5,600.00	70.00	
L	New terrazo or non-slip granito tile finish on ramp slab	m2	98	3,500	343,000.00	4,287.50	
M	New painted mild hand rail to detail	m	56	8,000	448,000.00	5,600.00	
N	Supply and fix new fibre cement cladding to side walls; with Aluminium clip system; allow for scafolding as necessary	m2	337	45,000	15,165,000.00	189,562.50	
O	Allow for repairs to floor finish at existing ramp landings as directed	item			200,000.00	2,500.00	
					17,984,540.00	**224,806.75**	
7.1.8.2	**Reconstruct Ramp to Canadian Club/Pool Deck**						**66,318.75**
A	Hack or demolish existing walls or ramp concrete slabs: prepare surfaces to receive new construction: dispose arisings	Item			75,000.00	937.50	
B	Remove existing paving blocks: excavate to reduce levels: part back fill and compact to approval; remove surplus from site and dispose	m3	85	1,500	127,500.00	1,593.75	
C	Graded aggregate gravel fill: compacted approval; to receive new ramp slab	m3	25	3,000	75,000.00	937.50	
D	75mm Mass concrete class 15 blinding	m2	100	600	60,000.00	750.00	
E	Vibrated reinforced concrete class 25/20mm wall foundation	m2	100	3,000	300,000.00	3,750.00	
F	200mm Reinforced concrete class 25/20mm ramp slabs	m2	250	3,000	750,000.00	9,375.00	
						0.00	
G	200mm Reinforced concrete class 25/20mm retaining walls	kgs	9,100	150	1,365,000.00	17,062.50	
H	High yield steel reinforcement to approved Canadian or BS standard	m2	60	800	48,000.00	600.00	
I	Formwork to sides of retaining walls	m2	500	800	400,000.00	5,000.00	
J	Formwork to edges of ramp slab, 150-225mm wide	m	100	100	10,000.00	125.00	
K	New terrazo or non-slip granito tile finish on ramp slab	m2	70	3,500	245,000.00	3,062.50	
L	Supply and fix mild steel pipe guard rails with pickets to detail: with paint finish	m	100	8,000	800,000.00	10,000.00	
M	New continuous kick plate	m	100	2,500	250,000.00	3,125.00	
N	Supply and fix mild steel hand rail to detail: with paint finish	m	100	8,000	800,000.00	10,000.00	
					5,305,500.00	**66,318.75**	
7.2	**MOULD ABATEMENT**						
7.2.1	**Remove mould in accordance with CSA 82 Mould Guidelines for the Canadian Construction Industry.**						**7,500.00**

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
A	Carefully remove mould where directed in areas exposed on removal of the vinyl wall covering on exterior walls listed in Section 7.1.3.2.	Item			600,000.00	7,500.00	
					600,000.00	**7,500.00**	
7.3	**SPACE OPTIMIZATION REQUIREMENTS**						
7.3.1	**ARCHITECTURAL ELEMENTS**						
7.3.1.1	**Demolitions**						**38,618.75**
A	Carefully dismantle and remove all internal demountable partitions to enclosed offices and meeting rooms: allow client to keep selected items and remove debris from site	m2	1,815	1,000	1,815,000.00	22,687.50	
B	Demolish existing concrete block walling internal walling to enclosed offices and meeting rooms: remove debris from site	m2	284	1,000	284,000.00	3,550.00	
C	Carefully remove floor carpet to broadloom and remove granite floor tiles (Refer to 7.1.3.1.1 and 7.1.3.1.2)						
D	Remove existing acoustic ceiling tiles complete with support grid work including suspension system: in Immigration area on ground floor rooms 207, 242, 244, 245, and 246, at 2nd floor and all ceilings in 3rd floor	m2	1,281	500	640,500.00	8,006.25	
E	Remove existing rendered plaster ceiling for area to receive new curtain wall at enclosed reception waiting	m2	150	1,000	150,000.00	1,875.00	
F	Allow for removal of existing millwork at redundant interview booths, coffee stations, kitchens and miscellaneous locations	Item			200,000.00	2,500.00	
					3,089,500.00	**38,618.75**	
7.3.1.2	**New exterior walls**						**106,250.00**
A	Provide new reinforced aluminium curtain wall, including glazed aluminium doors, to enclose Reception Waiting and Immigration Waiting: assembly extend to underside of 3rd Floor structure (refer to Figure 4.2.19 in Section 4.2.6 of the Report for anticipated steel vertical mullions and aluminium framing).	m2	160	15,000	2,400,000.00	30,000.00	
B	External glazing: Sealed units comprised of 8mm grey tinted heat strengthened outer lite, air space, 12.76mm heat strengthened laminate inner lite.	m2	160	25,000	4,000,000.00	50,000.00	
C	Internal glazing: 28mm thick laminated glass, to a height of 3m: to Reception Waiting. Not required for Immigration Waiting.	m2	60	35,000	2,100,000.00	26,250.00	
					8,500,000.00	**106,250.00**	
7.3.1.3	**New partitions**						**193,350.00**
.1	New partitions will primarily consist of reused SMED demountable partitions. These will include opaque wall panels, glazed wall panels, doors, door frames, and hardware. Vinyl wall coverings on opaque partitions are required to be replaced. New components as required are available from Haworth Canada.	m2	1,089	12,000	13,068,000.00	163,350.00	

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
.2	Secure partitions in 150mm reinforced concrete block with plaster finish to two new interview booths and the photo wicket at Ground Floor: and for revisions to the Elevator Vestibule at the 3rd Floor. Bullet resistant windows and pass-throughs in the demising walls of the interview booths will be supplied by DFAIT: bullet resistant door in the elevator vestibule wall will be supplied by DFAIT. Allow for fixing bullet proof doors and windows	m2	120	20,000	2,400,000.00	30,000.00	
					15,468,000.00	**193,350.00**	
7.3.1.4	**New interior doors and frames**						**5,887.50**
A	900 x 2400 mm solid hardwood door with: varnished or painted finish	No	6	32,000	192,000.00	2,400.00	
B	200 x 50 mm hollow profiled metal frames and architraves	m	34	5,000	171,000.00	2,137.50	
C	Supply and Fix approved Ironmongery to new doors	Item			108,000.00	1,350.00	
					471,000.00	**5,887.50**	
7.3.1.5	**Ceilings**						**43,781.25**
A	New acoustic tile ceilings : complete	m2	1,281	2,500	3,202,500.00	40,031.25	
B	Allow for removal and re-installation of ceiling suspension as directed	Item			300,000.00	3,750.00	
					3,502,500.00	**43,781.25**	
7.3.1.6	**Furrings**						**27,793.13**
.1	New furrings comprising gypsum drywall on furring channels or gypsum plaster on strapping to accommodate power and communications	m2	494	4,500	2,223,450.00	27,793.13	
					2,223,450.00	**27,793.13**	
7.3.1.7	**Floor Finishes**						**296,625.00**
.1	Provide flame finished granite tile at exterior (covered) Lobby, Multipurpose Room, and Enclosed Reception Waiting.	m2	459	14,000	6,426,000.00	80,325.00	
.2	Provide recessed floor grilles at entrances to Enclosed Reception Waiting and Immigration Waiting.	No	6	15,000	90,000.00	1,125.00	
.3	Provide new carpet tile to all other occupancies and circulation areas for the Ground, Second, and Third Floor. Allow for new screeds or repairs as directed	m2	2,869	6,000	17,214,000.00	215,175.00	
					23,730,000.00	**296,625.00**	
7.3.1.8	**Wall Finishes**						**88,911.88**
A	Provide new vinyl wall covering to shear walls, masonry walls, existing partitions, exterior perimeter walls at all occupancies and circulation areas including Janitor Rooms, Kitchen/Coffee Rooms, Stairs, Equipment Rooms, and Utility Rooms. (wall finish in washrooms to be retained)	m2	3,212	2,000	6,424,600.00	80,307.50	

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
B	Provide new paint finish to shear walls, masonry walls, existing partition walls, and exterior perimeter walls at all occupancies and circulation areas	m2	1,377	500	688,350.00	8,604.38	
					7,112,950.00	**88,911.88**	
7.3.1.9	**Millwork and Fitments**						**22,500.00**
.1	Provide new counters as required for 2 new interview booths, 2 reconfigured interview booths, and photo wicket.	No	5	200,000	1,000,000.00	12,500.00	
.2	Provide new counters and cabinets for Kitchen/Coffee Rooms to incorporate barrier-free requirements (three locations).	Item			600,000.00	7,500.00	
.3	Allow for extra millwork and fitment replacement.	Item			200,000.00	2,500.00	
					1,800,000.00	**22,500.00**	
7.3.2	**STRUCTURAL ELEMENTS** *(No structural revisions required)*						**0.00**
7.3.3	**MECHANICAL ELEMENTS**						**388,125.00**
7.3.3.1	The mechanical Space Optimization (fit-up) work is anticipated to require a significant degree of HVAC work including removal and replacement of duct runs, removal and relocation of VAV boxes, supplemental VAV boxes, new flex duct and diffusers, relocated and new return air grilles, removal and replacement of thermostats, recalibration of equipment sensors, and rebalancing of air and hydronic systems. This is throughout the Ground Floor, Second Floor, and Third Floor, and is required due to the space revisions and increase in the number of occupants and heat generating equipment (i.e., personal computers).	Item			24,000,000.00	300,000.00	
7.3.3.2	The new enclosure of the Reception Area will involve provision of a 20kW capacity dedicated split DX unti with mixing boxes to provide out door air and cool the space, together with new duct work, diffusers, return air grilles and thermostatic control.	Item			1,300,000.00	16,250.00	
7.3.3.3	The new enclosure of the Immigration Waiting Area will involve provision of 2No split AC units of 20kW to cool the space, together with new ductwork, diffusers, return air grilles, and thermostatic control.	Item			2,450,000.00	30,625.00	
7.3.3.4	Revisions to the automatic sprinkler system will be required throughout the three floors to reposition a relatively small number of heads. The sprinkler system will be required to extend to serve the new enclosures of the Reception Waiting and Immigration Waiting Areas.	Item			500,000.00	6,250.00	
7.3.3.5	Allow for minor revisions to the plumbing and drainage system.	Item			500,000.00	6,250.00	
	Allow for Main Contractor's attendance on pecialists Mechanical Works s and associated builders work	Item			2,300,000.00	28,750.00	
					31,050,000.00	**388,125.00**	

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ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
7.3.4	**ELECTRICAL ELEMENTS**						**180,900.00**
7.3.4.1	The electrical Space Optimization (fit-up) work is anticipated to require a very significant amount of relocation and addition of power receptacles, data ports, communications ports, and associated conduit and wiring from the existing distribution panels. Open office areas are expected to be served from new outlets in new perimeter wall furrings, column furrings, furrings on shear walls, and new poke-through monuments in the floor slabs. (Utility poles are to be avoided).	Item			6,000,000.00	75,000.00	
7.3.4.2	Lighting fixtures will be repositioned to suit the new l	Item			4,800,000.00	60,000.00	
7.3.4.3	A minor extent of work will be required for repositioning of fire alarm call points, smoke detectors, heat detectors, etc.	Item			1,800,000.00	22,500.00	
7.3.4.4	The enclosure of the Reception Waiting and Immigration Waiting Areas will involve the addition of power, data, and communications receptacles, new lighting fixtures, and extension of the fire alarm system.	Item			800,000.00	10,000.00	
7.3.4.4	Allow for Main Contractor's attendance on Life Safety, Fire Detection and Suppression specialist works and associated builders work				1,072,000.00	13,400.00	
					14,472,000.00	**180,900.00**	
7.3.5	**SITE ELEMENTS**						**0.00**
7.3.5.1	*(No site work is required for site optimization)*						
					0.00	**0.00**	
7.3.6	**TEMPORARY REQUIREMENTS**						
7.3.6.1	Phasing of Works						**6,250.00**
A	Allow programming of renovation and fit-out works and phased accordingly. Ten phases and an overall construction timeframe of 24months is anticipated	Item			500,000.00	6,250.00	
					500,000.00	**6,250.00**	
7.3.6.2	Swing space Creation						**50,000.00**
A	Allow for creation of a swing space (for purposes of temporary office working space during renovations) comprising of a temporary set-up of 15 work stations complete with mechanical, electrical and telecommunication services provision	Item			4,000,000.00	50,000.00	
					4,000,000.00	**50,000.00**	
7.3.7	**INFILL OF ATRIUM**						**56,250.00**
7.3.7.1	Allow for the extension of the Second floor into the existing atrium consisting new steel floor framing, new floor assembly of metal deck, concrete topping, carpet flooring ; new ceiling; extension of the air distribution system; extension of the sprinkler system; extension of electrical systems (Approx 60m2)	Item			4,500,000.00	56,250.00	
					4,500,000.00	**56,250.00**	

ITEM		DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
								C $1=KSHS 80
7.4		**BUILDING ENVELOPE UPGRADE REQUIREMENTS**						
7.4.1		**ARCHITECTURAL UPGRADE REQUIREMENTS**						
7.4.1.1		**Exterior Walls**						**1,601,024.00**
	A	Remove existing metal flashing (approx 1400 mm girth)	m	537	600	322,200.00	4,027.50	
	B	Remove existing metal flashing (approx 1000 mm girth)	m	241	600	144,600.00	1,807.50	
	C	Remove existing concrete capping on walls and parapet walling	m	537	1,200	644,400.00	8,055.00	
	D	Remove existing eaves soffit boards complete with support system	m^2	376	800	300,720.00	3,759.00	
		New Construction to remedy envelope						
	E	Fibre cement cladding to side walls to match new building cladding complete with Aluminium clip system	m2	2,288	45,000	102,960,000.00	1,287,000.00	
	F	New roof membrane to parapet top and side drop	m2	280	3,000	840,000.00	10,500.00	
	G	New water proof membrane to plastered wall surfaces	m2	1,719	3,000	5,157,000.00	64,462.50	
	H	New metal flashing with rods and caulking	m2	1,042	3,000	3,126,000.00	39,075.00	
	I	New 100mm rigid insulation	m2	806	7,500	6,045,000.00	75,562.50	
	J	New 100 mm vertical z-girts	m2	806	5,000	4,030,000.00	50,375.00	
	K	New soffit assembly comprising open air grillage supported by new galvanised "L" brackets secured to walls	m2	376	12,000	4,512,000.00	56,400.00	
						128,081,920.00	**1,601,024.00**	
7.4.2		**ARCHITECTURAL AND SECURITY UPGRADE REQUIREMENTS FOR WINDOWS AND CURTAIN WALL**						
7.4.2.1		**North-eastern Lobby Curtain Wall**						**293,000.00**
	A	Remove existing curtain wall framing and glazing	m2	120	2,000	240,000.00	3,000.00	
	B	New curtain wall framing including 100mm x 60mm x 5mm RHS transoms at 1050mm c/c, 120mm x 80mm x 10mm RHS mullions at 1800mm c/c, 120mm x 120mm x 5mm RHS diagonal struts at 1800mm c/c and 150mm x 150mm x 12.5mm central RHS support	m2	120	15,000	1,800,000.00	22,500.00	
	C	New external double glazed curtain wall units in aluminium framing comprising grey tinted 8mm heat strengthened outer lite, air space, and 12.76mm heat strengthened laminate inner lite	m2	120	120,000	14,400,000.00	180,000.00	
	D	New internal glazing comprising 28mm laminated glass in aluminium frames, 3m high	m2	50	140,000	7,000,000.00	87,500.00	
						23,440,000.00	**293,000.00**	
7.4.2.2		**North-eastern Elevation Windows**						**37,760.63**

ITEM	DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
							C $1=KSHS 80
A	Remove existing windows	m2	22	2,000	44,100.00	551.25	
B	New steel plate and steel framing consisting steel RHS 100 x 200 x 16mm verticals and 100 x 100 x 4mm horizontals	m2	22	15,000	330,750.00	4,134.38	
C	New ribbon windows in aluminium frames fastened to steel framing and sealed double glazed units comprising grey tinted 8mm heat strengthened outer lite, air space, and 12.76mm heat strengthened laminate inner lite	m2	22	120,000	2,646,000.00	33,075.00	
					3,020,850.00	**37,760.63**	
7.4.2.3	**Stairwell Glazing**						**56,797.50**
A	Remove existing stairwell strip windows	m2	17	2,000	34,800.00	435.00	
B	New steel plate and steel framing consisting aluminium RHS 100 x 60 x 2mm horizontal and vertical profiles	m2	17	15,000	261,000.00	3,262.50	
C	New glazing comprising grey tinted 8mm heat strengthened outer lite, air space, and 12.76mm heat strengthened laminate inner lite	m2	17	120,000	2,088,000.00	26,100.00	
D	Remove existing doors and frames: provide force-protection rated doors and frames	No	3	720,000	2,160,000.00	27,000.00	
					4,543,800.00	**56,797.50**	
7.4.2.4	**General Glazing**						**703,839.50**
A	Remove all existing glazing	m2	559	750	419,160.00	5,239.50	
B	Retrofit the existing mullion nose with new aluminium extrusions to increase glazing pocket depth: reinforce frame connections	m2	559	22,500	12,574,800.00	157,185.00	
C	New glazing comprising grey tinted 8mm heat strengthened outer lite, air space, and 12.76mm heat strengthened laminate inner lite	m2	559	73,000	40,798,240.00	509,978.00	
D	Reinstall existing pressure plates and snap-on caps	m2	559	4,500	2,514,960.00	31,437.00	
					56,307,160.00	**703,839.50**	
7.4.2.5	**Interior glazed partitions**						**39,375.00**
A	Apply approved anti-shatter film to all interior glazed partitions	m2	450	7,000	3,150,000.00	39,375.00	
					3,150,000.00	**39,375.00**	
7.5	**SEISMIC UPGRADE REQUIREMENTS**						
7.5.1	**WALLS AND SHAFTS**						
7.5.1.1	**Shear walls and shaft walls thickening**						**777,155.00**
A	Allow for all necessary excavations and drilling	m3	365	3,000	1,094,400.00	13,680.00	
B	Remove all excavated materials from site	m3	365	1,500	547,200.00	6,840.00	
C	Graded aggregate gravel as filling to excavations: compacted to approval	m3	3,500	3,500	12,250,000.00	153,125.00	
D	Concrete class25/20mm graded aggregate gravel as thickening to walls	m3	821	15,000	12,312,000.00	153,900.00	

ITEM		DETAILED ESTIMATE DESCRIPTION	UNIT	QUANTITY	RATE KSHS	AMOUNT KSHS	AMOUNT C $	AMOUNT C $
								C $1=KSHS 80
	E	High yield Ssteel reinforcement to approved Canandian or BS standard	kgs	205,200	150	30,780,000.00	384,750.00	
	F	Formwork to sides of wall thickenings	m2	2,736	800	2,188,800.00	27,360.00	
	G	Allow for additional thickness of base at columns	Item			1,000,000.00	12,500.00	
	H	Make good all disturbed surfaces and remove all stains	Item			2,000,000.00	25,000.00	
						62,172,400.00	**777,155.00**	
7.5.2		**DIAPHRAGMS**						
7.5.2.1		**Steel Plate Floor trusses**						**21,250.00**
	A	Steel Plate Floor trusses - Type 1	No	20	30,000	600,000.00	7,500.00	
	B	Steel Plate Floor trusses - Type 2	No	20	30,000	600,000.00	7,500.00	
		Sundry						
	C	Make good all disturbed surfaces and remove all stains	Item			500,000.00	6,250.00	
						1,700,000.00	**21,250.00**	
7.5.3		**FOUNDATIONS**						
7.5.3.1-4		**Micropile retrofit design to reinforce foundations**						**165,000.00**
	A	Micropile set with 80No x 300mm diameter x 10metre deep micropiles with and including steel plate and bolt assembly	No	1	4,000,000	4,000,000.00	50,000.00	
	B	Micropile set with 30No x 300mm diameter x 10metre deep micropiles with and including steel plate and bolt assembly	No	2	1,500,000	3,000,000.00	37,500.00	
	C	Micropile set with 10No x 300mm diameter x 10metre deep micropiles with and including steel plate and bolt assembly	No	7	600,000	4,200,000.00	52,500.00	
	D	Micropile set with 6No x 300mm diameter x 10metre deep micropiles with and including steel plate and bolt assembly	No	1	1,500,000	1,500,000.00	18,750.00	
	F	Make good all disturbed surfaces and remove all stains	Item			500,000.00	6,250.00	
						13,200,000.00	**165,000.00**	