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NATIONAL HOME BUILDERS
NHBRC
REGISTRATION COUNCIL

Professional Engineering Services

Forensic Investigation and Structural Engineering
Remedial Concepts to Erf 23375, George,
House Botha

Forensic Report – Rev 0

16 November 2023

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- A - Forensic Investigation (November 2023): Drawings and Bending Schedules
- Drawing No. HB – 01: Forensic Investigation and Structural remedial concepts
 - Bending schedule No. HB-01
- B - Architect drawings
- C - Structural engineering drawings

EXECUTIVE SUMMARY

This **Forensic Investigation and Structural Engineering Remedial Concept Report** is presented by **TechQ Development Pty (Ltd)** based on the *Request for Proposals (RFP)* called by the **National Home Builders Registration Council (NHBRC)** in terms of the *Housing Consumer Protection Measures Act (Act 95 of 1998) and Regulations (HCPMA)*, and the *NHBRC Technical Requirements at Erf 23375, George (House Botha)*, Western Cape Province. This property forms part of the “**Blue Mountain Village Estate**” development. A design review discussion session was held with the NHBRC on 16 November 2023, with relevant comments incorporated in this report.

The objective of the structural remedial concepts proposed within this report is towards a safe building in accordance with the **SANS 10160-1, Table 1**. Details on the Forensic investigation and structural engineering remedial concepts are provided on the drawings in **Annexure A**.

Documentation made available to **TechQ** included the municipal approved Architect’s drawing and Structural Engineering reinforced concrete foundation strip footings, all noted in **Section 1.3**.

No geotechnical investigation was conducted as the degree structural cracks and settlement of the soils in the immediate areas of the damaged structure can be classified as “low-risk” cracks.

Section 2.2 of this report provides detail on the condition assessment of the structure and overall site properties, which portrays a sound building.

The concepts outlined in **Section 3** of this report are based on site inspections and the assessment done towards the structural elements of the building.

In summary, the following options are presented.

Section	Concept Remedial Actions
<ul style="list-style-type: none"> Brick Walls 	<p><u>REMEDIAL A: Reconstruct brick wall sections</u></p> <ul style="list-style-type: none"> Site preparation in erecting scaffolding inside the garage footprint to support the roof structure before any remedial works commence. Demolish wall sections as indicated on drawing No. HB-01, from surface bed level, Detail 1 to 4. Reconstruct walls and lintel to detail on drawing No. HB-01 – Detail 5 & 6.
<ul style="list-style-type: none"> Concrete Works 	<p><u>REMEDIAL B: Concrete lintel and Underpinning</u></p> <ul style="list-style-type: none"> Reinstall 280mm wide concrete lintel with proper reinforcing in brickwork above lintel Reinforced concrete underpinning of strip foundations for garage opening <p>Full details and Bending schedules as per drawing No. HB – 01</p>
<ul style="list-style-type: none"> Stormwater 	<p><u>REMEDIAL C: Stormwater and Paving</u></p> <p>Replace gravel pebbles with concrete aprons and open channels as detailed on drawing No. HB – 01 : Detail 7</p>

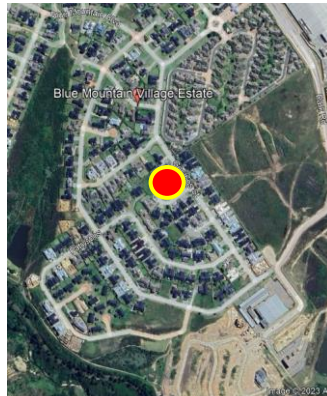
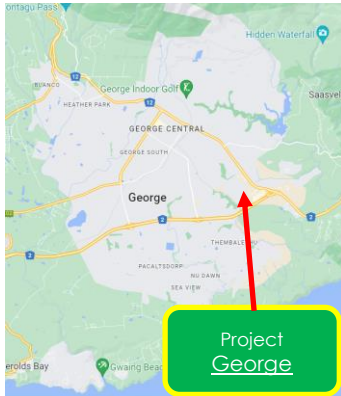
---- End of Executive Summary ---

1 PROJECT LOCALITY, SCOPE AND INFORMATION

1.1 Project Locality

Erf 23375, George (House Botha), is located at No.10 Kougaberg Street, Blue Mountain Village Estate, George within the boundaries of the **Mossel Bay Local Municipality** as show on the Figures below.

Site coordinates are **South: 33° 59' 10,78"** **East: 22° 29' 41,25"**



Project Location: House Botha

1.2 Scope of Work

TechQ Development (Pty) Ltd was appointed by the **NHBRC** to conduct a **Forensic Investigation** on the single-storey building with the following specific deliverables.

- Investigate defects that have manifested at the above-mentioned home and classify them in terms of the Housing Consumer Protection Measures Act (Act 95 of 1998) and Regulations (HCPMA) and the NHBRC Technical Requirements.
- Determine the root causes of defects, report on the deformation of the existing structure and provide remedial solutions and specifications including drawings where necessary, towards the following areas as per previous reports filed by the **NHBRC**:
 - Cracks on the Garage opening.

Throughout the investigation and considerations of remedial works, special attention is drawn to **Chapter III** of the Act, clause 13(1)(b) – (i) “rectify major structural defects” and (ii) “deviation from plans or any deficiency related to design, workmanship or materials”.

1.3 Information Provided (Summary)

Information provided by the NHBRC, the Home Owner and Architect provided background to the site development and an understanding to analyse the structural system and present concept structural proposals.

1.3.1 Architectural drawings – Annexure B

Municipal approved architect drawings dated April 2017 (**JDS Studio Design**) outlined the layout of the structure with proposed water supply and sewer drainage.

The above and other items are further elaboration in **Section 2** and detailed on the drawings in **Annexure A**.

1.3.2 Structural Engineering specifications and drawings – Annexure C

Structural Engineer (**DMS Consulting Structural Engineers**) provided the flowing documentation.

- Strip foundation and surface bed detail
- Typical foundation details

No engineering notes are provided towards foundation earthworks, compaction of under-surface soils and construction/movement joints. Stiffening of brickworks (cavity walls) and detail towards reinforcement above large openings are missing from the structural drawings.

Refer to **Section 2** below for further comment on engineering scope of works.

2 FORENSIC INVESTIGATION

2.1 Site Topographical Survey and Site Slope

No site survey information was made available during the forensic investigation, however, indicative contour levels were detected from the Architect's layout indicating a 200mm slope over the entire site in a north-south direction. This slope indicates that stormwater drainage will accumulate at the back of the property, which is not desirable.

2.2 Condition Assessment

Construction of the building started late 2017 and occupation was taken in December 2018. The current condition of the structure is good, except for the large cracks on the north-western corner of the garage walls with anticipated settlement in the strip foundation at this point, which is probably the root cause of the defects.

The pictures below show the north elevation of the building with the area of investigation, being a large crack above the lintel over the garage opening. Elaborative comments are given in **Section 2.3.1** below.



Pic 01: North Elevation of building



Pic 02: Cracks above lintel



Pic 03: Cracks at corner brick wall

2.3 Areas of Investigation

2.3.1 Garage opening and brick walls

No structural engineering drawings "For Construction" were issued specifying details towards the earthworks or precautionary measures to prevent settlement of soils under the foundations and surface beds.

The wide garage opening of 4,865m is normal standard for a double garage, however, proper structural stiffening in the brickworks above the opening, either it be a lintel or brick on edge, needs to be in accordance with **SANS 10400 – K (Walls)** with special reference to [Table 28](#) and [Figure 32](#).

The photos below give evidence of possible settlement in the foundations which leads to horizontal and diagonal cracks in the garage walls, evidently resulted in the crack above the lintel.



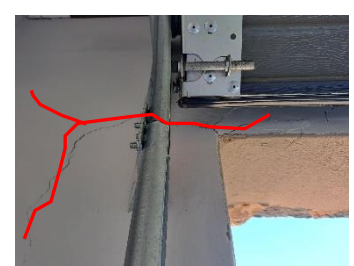
Pic 04: Diagonal cracks in walls above surface bed



Pic 05: Horizontal crack on exterior and internal walls



Pic 06: Crack above lintel result in plaster band coming loose



Pic 07: Diagonal crack on inside wall

2.3.2 Cracks on inside walls of the Garage

Settlement of the foundations of the garage section of the building is the possible route cause of structural cracks in the brick walls of the garage. The photos below show horizontal and diagonal cracks above openings and at the corners of the garage brick walls.



Pic 08: Crack in foundation continuing into exterior wall



Pic 09: Diagonal crack on both walls joining at the corner



Pic 10: Crack above door leading into the kitchen



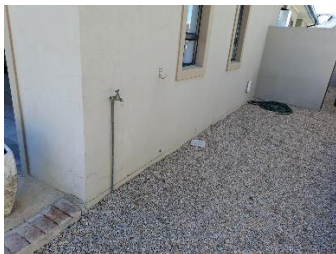
Pic 11: Vertical crack above DB board in the garage

The diagonal cracks above the door leading to the kitchen as well as the vertical crack above the DB board is not part of the current scope, however, further settlement in the foundation footings will worsen this situation over time. Crack repair to these areas is proposed **using expanded metal lath application repairs** to low- and high-level cracks.

2.3.3 Paving and Stormwater drainage

The Architect drawings clearly indicates block paving all around the building for proper stormwater drainage. Paving on the northern, eastern and southern boundaries consists of concrete aprons divided by single brick borders. Gravel pebbles on a waterproofing membrane covers the western boundary of the building, in different levels, which was seen to already create problems with stormwater drainage and will impact negatively on the structure if not corrected.

The pictures below show the status of the stormwater drainage in close proximity of the investigated area – garage opening.



Pic 12: Gravel pebbles on waterproof membrane



Pic 13: Combination of concrete and brick paving in front of garage and the driveway

Rainwater downpipes are positioned on different positions compared to the Architect's layout. A downpipe is detailed on the north-west corner of the building next to the site water tap, which is missing as shown in **Pic 12** above.

3 ENGINEERING REMEDIAL SOLUTIONS AND RECOMMENDATIONS

The single storey structure is constructed on strip foundations (850 x 250 – engineering drawings) with external cavity walls (280mm with 50mm void) and internal masonry walls (100mm). The walls of the investigating area – garage - are plastered and painted as artistic finishing. **Contributing factors** towards the **possible route causes** resulting in the cracks and settlement of the areas of concern are elaborated on in **Section 2.3** above.

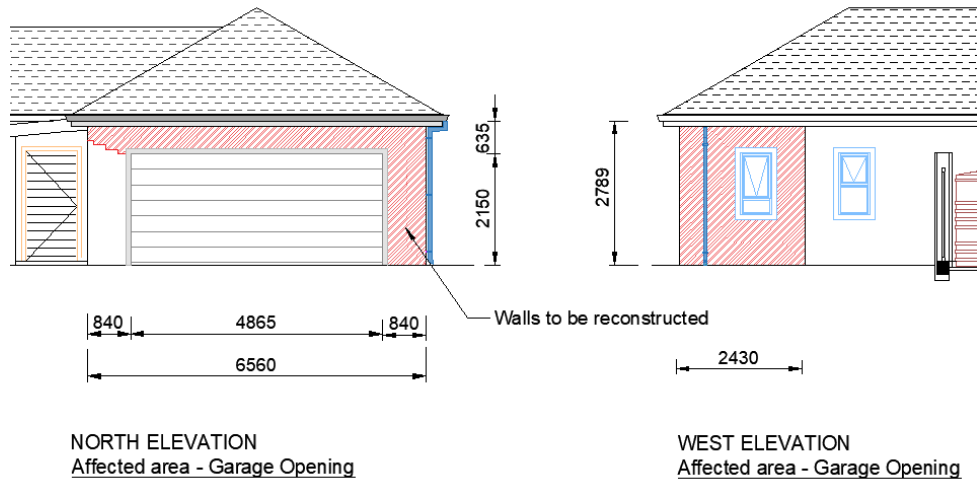
Engineering remedial concepts are categorised and described below with full details on the drawings attached as **Annexure A**.

Graphical representation of the rehabilitation works is also given below for ease of reference.

3.1 Remedial work A: Reconstruct Brick Walls

The north-west corner of the garage has settled and the current stormwater application of gravel pebbles is the possible route cause of this defect. It is anticipated that the strip foundation has settled in this area, however, a detailed geotechnical investigation would have confirmed this assumption.

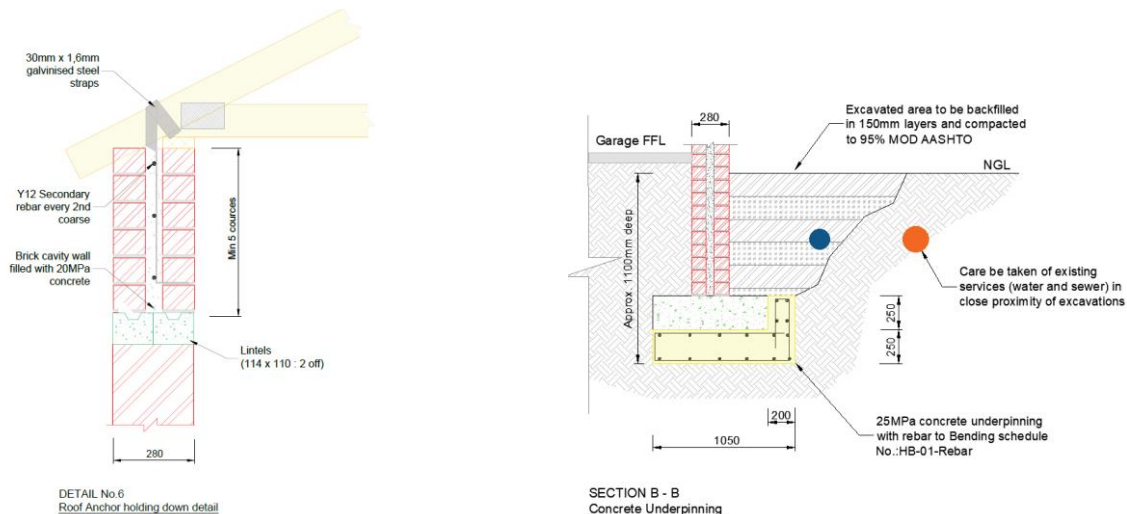
Irregular structural diagonal cracks occur on the northern and western façades of the garage – 1,5m both sides - and is recommended to be reconstructed from surface bed level up to wall-pate level as indicated on **drawing No. HB-01** attached as **Annexure A**. A graphical representation is given below.



3.2 Remedial works B: Concrete works – Lintel and underpinning

The focus area of the investigation is the large crack above the garage opening. Lintels were installed over the 4,865m opening, however, the differentiation between the concrete lintels and the brickwork above the lintels up to wall-plate level is most probably due to foundation settlement, cracks forming in the walls and no articulated reinforcement in the brickworks above the lintels.

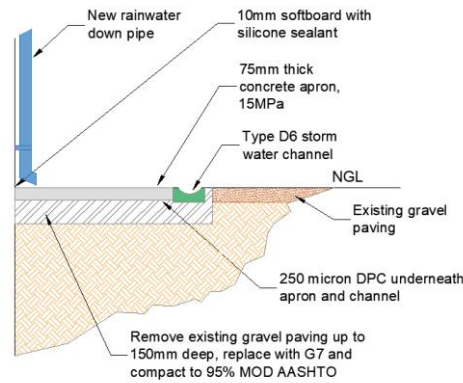
SANS 10400-K, with reference to Table 28 and Figure 32 is clear on the requirements for brickwork over openings less than 5m wide. Remedial detail is given on **drawing No. HB-01** and graphically indicated below.



3.3 Remedial works C: Stormwater drainage and Paving repairs

A layout of proper stormwater drainage is elementary in support of safeguarding possible risks to foundation settlement. The following remedial works are proposed within the investigation area to improve the stormwater drainage, minimise future soil moisture change and repairs to the paved areas, graphically shown below and detailed on the drawing in **Annexure A – detail 7**.

- Conduct a proper site survey to determine adequate stormwater drainage with accurate levels.
- Remove existing gravel pebbles and membrane and replace with 150mm G7 material compacted to 95% MOD AASHTO.
- Cast concrete apron sections, 75mm thick, 1,0 meter wide in 15,m panels on suitable waterproofing.
- Install Type D6 open channel as stormwater drainage.
- Install rainwater down pipe at north-west corner of the garage.



DETAIL No.7
Storm water drainage

4 POSSIBLE ROUTE CAUSES OF DAMAGE AND CONCEPT PROPOSALS FOR REMEDIAL WORKS

Contributing factors towards the **possible route causes** resulting in the cracks can be some or a combination of the following.

- No engineering details towards proper measures in preventing settlement of underline soil materials or stabilisation of soils for foundations and paved areas.
- Ingress of stormwater into sub-soils on the western side of the building where gravel pebbles were imported.
- Possible poor masonry and concrete construction practice and workmanship.
- Limited to no engineering details towards brick wall stiffeners, thickening of wall planes or provision of flexible movement joints – **SANS 10400-K**.

The table below presents a summary to the forensic investigation and proposed concept options.

Section	Concept Remedial Actions
• Brick Walls	<p>REMEDIAL A: Reconstruct brick wall sections</p> <ul style="list-style-type: none"> • Site preparation in erecting scaffolding inside the garage footprint to support the roof structure before any remedial works commence. • Demolish wall sections as indicated on drawing No. HB-01, from surface bed level, Detail 1 to 4. • Reconstruct walls and lintel to detail on drawing No. HB-01 – Detail 5 & 6.
• Concrete Works	<p>REMEDIAL B: Concrete lintel and Underpinning</p> <ul style="list-style-type: none"> • Reinstall 280mm wide concrete lintel with proper reinforcing in brickwork above lintel • Reinforced concrete underpinning of strip foundations for garage opening <p>Full details and Bending schedules as per drawing No. HB – 01</p>
• Stormwater	<p>REMEDIAL C: Stormwater and Paving</p> <p>Replace gravel pebbles with concrete aprons and open channels as detailed on drawing No. HB – 01 : Detail 7</p>

5 RISKS & MITIGATION MEASURES

Qualifications, risks and possible sensitivity issues needs to be considered in performing the proposed remedial Works during the construction stage. The main objective of the Project is repair works to the structural deformation of the building, however, the following aspects with mitigation proposals, need to be taken into consideration in the Risk Register of the Project.

Risks and mitigation measures

Nature of Risk	Risk	Mitigation
Site and Construction Risks	Abnormal rainfall and restricted working space	Proper scheduling of Works, being aware of the "critical path" items and implementing effective construction methodologies, Quality Assurance and Controls.
Limiting Factors	Decanting plan	Phased implementation of Works in accordance with proper planned decanting program.
Health and Safety	Delays and Fatal	Detailed OH&S plan compiled.
Quality Assurance	Construction Management	QA and QC Inspection procedures in place and approved
	Sub-standard materials	Quality tests and Agreements in place
OH&S and Environmental	Disturbance to environment, community and workers	Focus on the environment, building rubble disposals, air and noise pollution and disruption of day-to-day operations

--- End of Report ---