STRUCTURAL ASSESSMENT AT HOUSE VAN DYK, 58 PRIDE OF INDIA CRESENT IN WAVECREST OF JEFFREYS BAY

DETAILED FORENSIC REPORT: STRUCTURAL ENGINEERING REV 2

MAY 2024

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Abbreviations / Acronyms / Definitions

NHBRC	National Home Builders Registration Council
DPC	Damp Proof Course
SES	Shumba Engineering Services
RC	Reinforced Concrete
SANS	South African National Standards

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Document Information and Approvals

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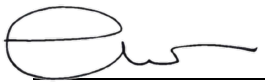
C W Molokomme		21 May 2024
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Executive Summary

In order to restore house Van Dyk to be a functional facility that meets acceptable norms and standards, the National Home Builders Registration Council (NHBRC) appointed Shumba Engineering Services (SES) as professional Structural Engineers to conduct a condition assessment of the building amongst other services. The scope of the condition assessment included identifying defective structural elements, performing structural infrastructure capacity checks, proposing repair methods and recommendations proposals.

As part of their assessment, Shumba Engineering Services performed a visual assessment of various elements of the building facility, took photographs, performed structural infrastructure design capacity checks and drew conclusions and recommendations from the information obtained. Remedial proposals and upgrading solutions were tabled for structural engineering defects that were observed. A photographic record of the condition of the various elements of the building was compiled and presented as part of the findings in the report. Finally a general and summarised proposed structural engineering scope of work was tabled.

The site appears to have averagely poor founding material. There is a gentle slope towards the northern side of the site. The general structural integrity condition of the existing external walls appears to be fairly good. However, there are cracks on the external wall which range from about 0.5mm wide (minor) to about 4mm wide (major). There is a major diagonal crack on the main bedroom external brick wall showing signs of significant foundation settlement. The homeowner, Mr Van Dyk, confirmed that there were severe municipal water pipe leakages within the premises before. Additionally, it appears the water leakages might have contributed to this major foundation settlement as this is the lowest point in the direction of water flow.

There are no aprons or stormwater channels around the building. There is a major diagonal to vertical crack on the main bedroom internal wall (about 4mm wide) showing signs of major foundation settlement. There is dampness on the main bedroom internal brick wall. It appears the dampness on these walls are due to the bathroom showers. The structural condition of all surface beds floor appears good with very minor hair line cracks on the floor tiles. The structural condition of the roof trusses appears very good showing no signs of structural defects. There are no roof gutters and there are no rainwater downpipes on the entire building. The external foundation wall of the main bedroom shows lateral movement below the DPC level.

It is recommended that new aprons or stormwater channels are constructed. The horizontal crack around the entire external wall at floor level must be repaired by removing the mortar bed within the crack, cut to trim back the DPC and apply a new mortar bed or SANS approved polyurethane sealants. All vertical and diagonal cracks on internal brick walls less than 2.5mm cracks are to be repaired by removing plaster for a width of 300mm on either side of the crack, clean with compressed air to remove dust and loose material, nail fixing a 600mm wide galvanised wire mesh spanning over the crack and replaster over. All major cracks, however, must be repaired as per typical detail in figure 3. Roof gutters and rainwater downpipes should be installed to divert storm water away from the building's foundations. Additionally, new concrete aprons and or stormwater channels must be installed. The isolation joint sealant between surface bed and brick wall must be carefully removed and reinstalled using Sikaflex PRO-3 i-cure polyurethane sealants or similar SANS approved products.

1 Introduction

Shumba Engineering Services was appointed by the National Home Builders Registration Council (NHBRC) as their preferred Structural Consulting Engineering service provider for the House Van Dyk in Jeffreys Bay (Kouga Municipality) in the Sarah Baartman District Municipality of Eastern Cape Province of South Africa. The scope of services expected from Shumba Engineering Services primarily includes the following:

- Structural Condition Assessment and;
- Reporting.

The project scope is expected to include the following summarised activities:-

1. Renovations/remedials to existing building which includes;
    - Remedial works to external brick walls, internal brick walls and surface beds;
    - Foundation underpinning;
    - New roof gutters and rainwater downpipes;
    - New aprons and stormwater channels around existing building.

In order to restore the existing building and upgrade the house structural infrastructure, a structural engineering condition assessment was conducted to determine the condition of the house. Various defects were observed and recorded. Remedial proposals to correct the defects were tabled.

2 Purpose of the Report

The purpose of this document is to report on the following:

- The condition of the existing building and structural engineering elements.
- The defective building's structural engineering elements and the scope of work and remedial procedure to follow.

3 Project Location

House Van Dyk is in Jeffreys Bay (Kouga Municipality) in the Sarah Baartman District Municipality of Eastern Cape Province of South Africa. The reference coordinates of the site are 34^{0}00'50.55"S and 24^{0}54'50.71"E. A map of the general location within the Sarah Baartman District Municipality as well as a locality map of House Van Dyk is shown in Figures 1 and 2 respectively.

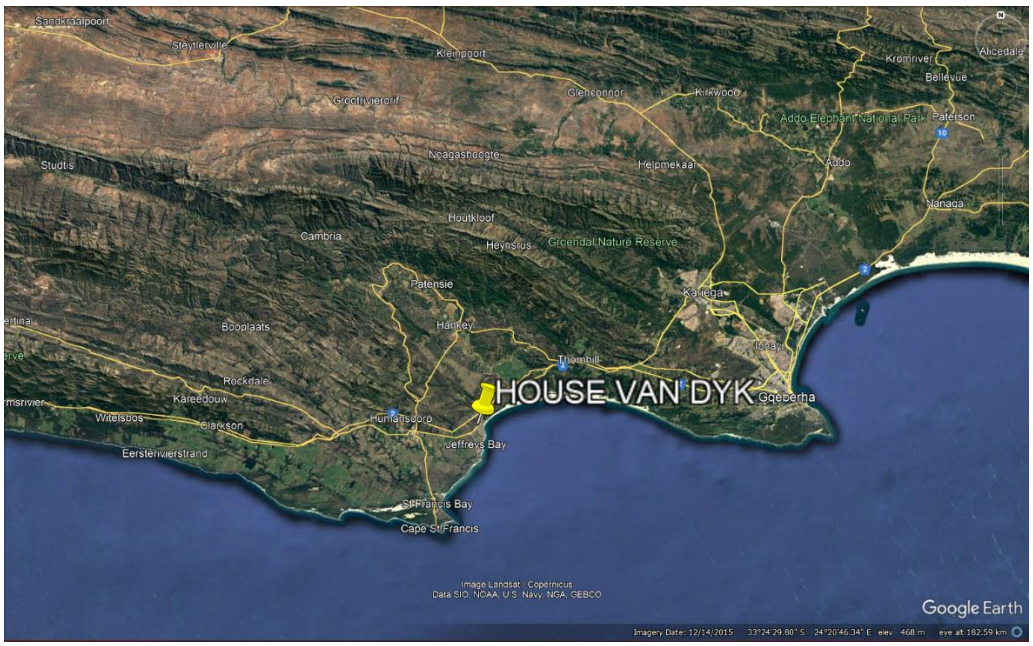

Figure 1 : House Van Dyk District Locality Plan adopted from Google Earth on 15 March 2023

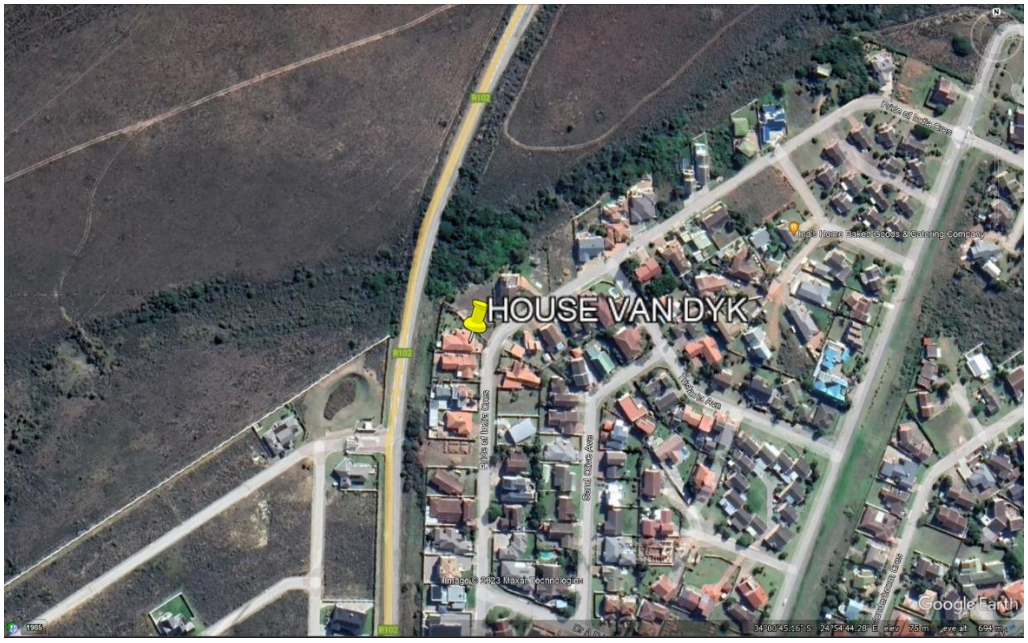

Figure 2 : House Van Dyk Locality Plan adopted from Google Earth on 15 March 2023

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4 Assessment Methodology and Approach

4.1 Structural Engineering Assessment Methodology

Structural engineering assessment was conducted on the 28th February 2023 in accordance with the following methodology:

An initial visual **site inspection and assessment** was conducted to identify of all defective elements. All the information was compiled into this condition assessment report. During the assessment, **consultation** with the current house owner was performed to understand any further structural related problems that they face.

A **desk top study** of the project location, available project information and documentation of photographs taken during the site inspection was undertaken and conclusions drawn from this information. There were no structural drawings, topographical survey and architectural drawings provided at the time of structural assessment. However, a geotechnical field investigation report undertaken by Dwala group was provided to SES by the NHBRC to further understand the foundation conditions.

Documentation of the photographic report and main report framework was performed. Specific remedial measures, specifications and proposed scope of work were drawn and passed onto the project consulting team members. All the above were compiled into this condition assessment report. The report should be used as a basis for making decisions regarding the remedial works of various defected structural elements of the building.

5 Structural Engineering Assessment Findings

5.1 Geotechnical and Topographical Condition

The following observations were made regarding the geotechnical conditions across the site:

- The entire site appears to have poor founding material;
- There is a gentle slope towards the north direction across the entire site. However, no topographical survey was available at the time of the site assessment.

A copy of the Geotechnical field investigation report is shown in Appendix D of this report.

5.2 External Brick Walls Condition

The following observations were made regarding the existing external wall of the building:

- The existing structure was constructed out of brick walls;
- All existing external walls are brick cavity wall consisting of face-brick on the outside face and plastered brick on the inside face of the building;
- The general structural integrity condition of the existing external walls appears to be fairly good. However, there are several cracks on the external wall which ranges from about 0.5mm wide (minor) to about 4mm wide (major) showing signs of foundation settlement;
- There is a horizontal crack around the entire external wall at floor level (DPC level). It appears the horizontal crack is due to a bond mortar separation in-between the DPC and mortar bed course;
- There are diagonal cracks on the external brick wall above windows showing signs of foundation settlement. The crack width range from about 0.1mm to about 2mm;
- There is a major horizontal crack on the external brick wall above the back entrance door. The crack is about 4mm wide. It appears the crack is due to insufficient supporting capacity for the timber roof trusses;
- There is a major diagonal crack on the main bedroom external brick wall showing signs of foundation settlement;
- There are no aprons or stormwater channels around the building;
- The homeowner, Mr Van Dyk, confirmed verbally that there were severe municipal water pipe leakage within the premises which totalled to about 180kl in one month. Additionally, it appears the water leakage might have contributed to this foundation settlement. All municipal water pipes runs above ground and all underground pipes have now been disconnected ;

A photographic record of the building's external wall is shown in Appendix C of this report.

5.3 Internal Brick Walls Condition

The following observations were made regarding the internal brick walls:

- There are several diagonal cracks (about 0.5mm wide to 3mm wide) above the windows showing signs of settlement;
- There is a horizontal crack (about 2mm to 4mm wide) on the internal wall above lintel level of the sitting room window and above back entrance door;
- There is a diagonal-vertical crack on the internal brick wall next to the lounge/garage entrance;
- There is a major diagonal to vertical crack on the main bedroom internal wall (about 4mm wide) showing signs of foundation settlement;
- There is dampness on the main bedroom internal brick wall. It appears the dampness on these internal bedroom walls are due to the bathroom showers;

A photographic record of the building's internal wall is shown in Appendix C of this report.

5.4 Roof and Roof Trusses Condition

The following observations were made regarding the roof trusses:

- The structural condition of the roof trusses appears very good showing no signs of structural defects;
- There are no roof gutters and there are no rainwater downpipes on the entire building.

A photographic record of the building's roof trusses is shown in Appendix C of this report.

5.5 Surface Bed Floor Condition

The following observations were made regarding the surface bed floors:

- All surface bed floors are tiled with ceramic floor tiles;
- The structural integrity condition of all surface beds floor appears good with very minor hair line cracks on the floor tiles;
- The veranda's isolation joint sealant between surface beds and brick walls is delaminating. It appears there is a slight settlement of either the surface bed or brick wall;
- The edge floor tiles on the veranda have been replaced. It appears floor tiles were installed with half the portion over brick and half portion on surface bed. Due to the building settlement this has caused the floor tiles to crack and delaminate in certain places.

A photographic record of the building's surface bed floor is shown in Appendix C of this report.

5.6 Foundation Condition

The following observations were made regarding the foundation:

- The building appears to be supported on strip footings;
- No structural drawings are available at this stage and it is unclear whether the foundations are reinforced or not.
- There is lateral movement of the foundation wall of the main bedroom below the DPC level which could be due to the reaction of the weaker underlying soil conditions.

A copy of the Geotechnical field report is shown in Appendix D of this report.

6 Remedial Scope

6.1 External Brick Walls

All existing external walls are brick cavity wall consisting of face-brick on the outside face and plastered brick on the inside face of the building. There is a horizontal crack around the entire external wall at floor level (DPC level). It appears the horizontal crack is due to a bond mortar separation in-between the DPC and mortar course bed. There are diagonal cracks on the external brick wall above windows showing signs of foundation settlement. The crack's width ranges from about 0.1mm to about 2mm. There is a major horizontal crack on the external brick wall above the back entrance door. The crack is about 4mm wide. It appears the crack is due to insufficient supporting capacity for the timber roof trusses. There is a major diagonal crack on the main bedroom external brick wall showing signs of a significant foundation settlement. There are no aprons or stormwater channels around the building.
It is recommended that:

- The horizontal crack around the entire external wall at floor level must be repaired by removing the mortar bed within the crack, cut to trim back the DPC and apply a new mortar bed or SANS approved polyurethane sealants;
- Minor vertical and diagonal cracks (less than 2mm wide) on external brick walls must be repaired by removing mortar bed within the cracks and applying new mortar bed. However, for major vertical and diagonal cracks (about +3mm wide), it is recommended that these cracks are repaired as per detail in figure 3 below;
- A major horizontal crack on the external brick wall above the back entrance door must be repaired by carefully removing the lintel above the door/window, replace the lintel with a new RC beam and grout in between the lintel and existing brick above. Alternatively, demolish the lintel and brick wall above lintel and reconstruct with new RC beam and new brick wall. The construction sequence of this repair must be closely coordinated by the engineer as it will involve high risk occupational health and safety during propping of the roof trusses and demolish;
- The major diagonal cracks on the brick wall above the main bedroom window must be repaired by carefully removing the existing brickwork above the window and replace with the new RC lintels;
- New aprons or v-channels must be constructed all the entire building to divert storm water way from the building.

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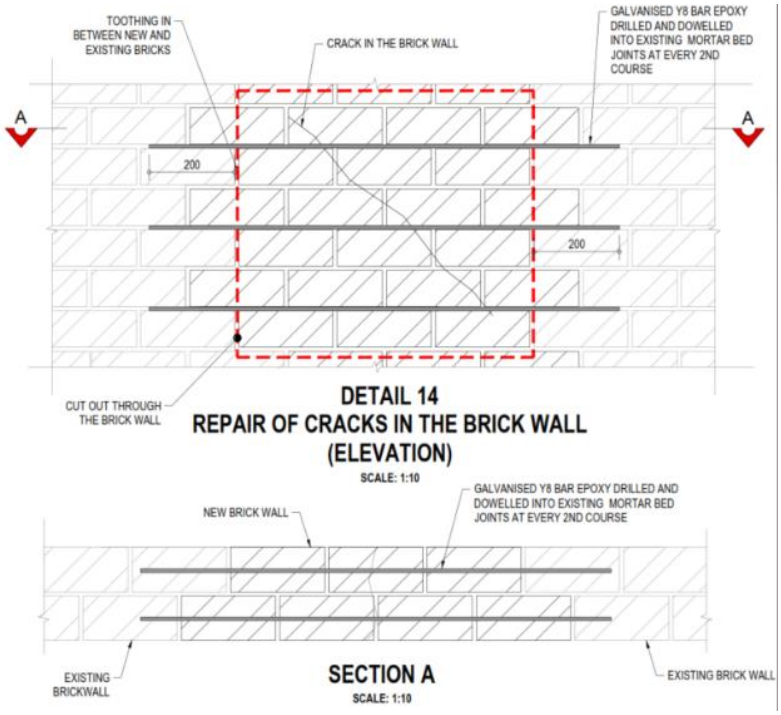

Figure 3: Typical crack repair

6.2 Internal Brick Walls

There are several diagonal cracks (about 0.5mm wide to 3mm wide) above the windows showing signs settlements. There is a horizontal crack (about 2mm to 4mm wide) on the internal wall above lintel level of the sitting room window and above back entrance door. There is a diagonal-vertical crack on the internal brick wall next to lounge/garage entrance. There is a major diagonal to vertical crack on the main bedroom internal wall (about 4mm wide) showing signs of major foundation settlement. There is dampness on the main bedroom internal brick wall. It appears the dampness on these internal bedroom walls are due to the bathroom showers.
It is recommended that:

- All vertical and diagonal cracks on brick walls less than 2.5mm cracks are to be repaired by removing plaster for a width of 300mm on either side of the crack, clean with compressed air to remove dust and loose material, nail fixing a 600mm wide galvanised wire mesh spanning over the crack and replaster over. All major cracks however, must be repaired as per typical detail in figure 3 above;
- The horizontal crack (about 2mm to 4mm wide) on the internal wall above lintel level of the sitting room window and above back entrance door must be repaired by carefully removing the lintel above the door/window, replace the lintel with a new RC beam and grout in between the lintel and existing brick above. Alternatively, demolish the lintel and brick wall above lintel and reconstruct with new RC beam and new brick wall. The construction sequence of this repair must be closely coordinated by the engineer as it will involve high risk occupational health and safety during propping of the roof trusses and demolish;
- The dampness on the wall must be repaired by removing the plaster and applying SANS approved waterproofing products.

6.3 Roof and Roof Trusses

The structural condition of the roof trusses appears very good showing no signs of structural defects. There are no roof gutters and there are no rainwater downpipes on the entire building.
It is recommended that:

- Roof gutters and rainwater downpipes must be installed to divert stormwater away from the building's foundations. Additionally, new concrete aprons and or stormwater channels must be installed.

6.4 Surface Beds and Floor Condition

All surface bed floors are tiled with ceramic floor tiles. The structural integrity condition of all surface bed floor appears good with very minor hairline cracks on the floor tiles. The isolation joint sealant between the surface bed and the brick wall is delaminating showing signs of slight movement of the surface bed and or brick wall. The edge floor tiles on the two outside verandas have been replaced. It appears floor tiles were installed with half the portion over brick and half portion on the surface bed. Due to the building settlement this has caused the floor tiles to crack and delaminate.
It is recommended that:

- The isolation joint sealant between the surface bed and brick wall must be carefully removed and reinstalled using Sikaflex PRO-3 i-cure polyurethane sealants or similar SANS-approved products;
- All veranda edge floor tiles installed with half the portion over brick and half the portion on the surface bed must be removed and reinstalled with an isolation joint between the surface bed and brick wall. This will prevent the tiles from further cracking.

6.5 Foundations

The building appears to be supported on strip footings. However, no structural drawings are available at this stage and it is unclear whether the foundations are reinforced or not. The north side of the building appears to have severe cracks showing signs of settlement.
It is recommended that:

- All external brick wall foundation on the north side of the building be underpinned with RC concrete. The underpinning must be designed and supervised by a competent Structural Engineer. All cracks on the north side of the building should be repaired after underpinning construction is done;

<u>Specification for Underpinning Works</u>

- Foundation underpinning shall be done on the entire external wall of the northern and western sides of the building.
- The Contractor shall submit a proposed sequence of underpinning blocks for approval by the Engineer before excavations. For example, the sequence shall be such that all sections marked 1 will be excavated, cast and dry-packed before starting excavation of sections marked 2; and all sections marked 2 will be excavated, cast and dry-packed before starting excavation of sections marked 3, etc.
- The contractor is to keep a record of the sequence and dimensions of the underpinning actually carried out, including details of excavation, casting concrete and pinning up for each section.
- Before starting the work the Contractor is to check for any services that could be damaged by the underpinning work.
- The Contractor shall be responsible for ensuring that his operations do not in any way impair the safety or condition of the building both before and during the execution of the work and should immediately inform the Engineer if he considers that more stringent procedures than those specified are necessary.
- Excavation and concreting of any section of underpinning shall be carried out on the same day.

- The underside of the existing footings is to be cleaned of all loose materials or soil before underpinning.
- Excavation to any section of underpinning shall not be started until at least 48 hours after completion of any section/s of the work.
- The disturbed soil beneath existing footings shall be well compacted before constructing any concrete works related to underpinning.

Projecting portions of existing footings are to be carefully cut off where directed.
Place a 50mm concrete blinding layer (10MPa) on the compacted soil layer before underpinning.
The bottom of the underpinning to be reinforced with Ref. 617 mesh placed 50mm above the blinding layer.
Underpinning is to be carried out in small sections of 1.5m length x 0.8m width x 0.8m depth. The new underpinning foundation blocks shall be spaced 1.0m apart.
The body of the underpinning is to be constructed in 25MPa/19mm reinforced concrete and in to be cast to the widths shown unless otherwise directed by the Engineer.

- The mass concrete is to be stopped off 50mm below the underside of the existing footing.
- The final pinning up over the whole width of the footing is to be carried out with 1:3 mix cement to sharp sand (wholly free from foreign particles) dry pack mortar 24 hours after the concrete has been poured.
- Excavated material intended for backfilling is to be kept protected from drying out or wetting and is to be placed in a maximum of 150mm layers, carefully compacted with a compacting plate.
- And unless a proper dewatering method is used, the works should not be attempted on wet ground.

7. Summary of Findings and Remedial Action

Item no.	Area Description	Findings	Remedial Measure
1	Roof	No roof gutters and rainwater downpipes	Installation of roof gutters and rainwater downpipes. Additionally, aprons and stormwater channels to divert stormwater.
2	Main bedroom	Minor diagonal and vertical cracks	Nail-fixing galvanized wire mesh and plastering over
		Major diagonal cracks on the internal and external brick walls	Wall stitching, as per typical detail in Figure 3 Install a new concrete lintel above the window level.
		Dampness on the internal brick wall	Removing the plaster and applying SANS approved waterproofing product
3	Sitting room	Horizontal crack (on the internal wall above lintel level	Replace the existing wall with a new 25MPa/19 reinforced concrete beam above the window level
4	Lounge/garage	Minor diagonal to vertical	Nail-fixing galvanized wire mesh and

	entrance	crack on the internal brick wall	plastering over minor cracks (refer to a method in paragraph 6.2)
		Major diagonal to vertical crack on the interior wall	To be repaired through wall stitching, as per typical detail in Figure 3
5	Outside Verandas x 2	Floor tiles installed with half the portion over brick and half portion on surface bed causing them to crack	Removed and reinstall tiles with an isolation joint between the surface bed and brick wall
6	Back Entrance	Diagonal cracks on the external brick wall above the door/window	Replace the existing lintel with a new 25MPa/19 reinforced concrete beam above the door/window level
7	Surface Beds	Very minor hairline cracks on the floor tiles	Replace damaged tiles with similar or equivalent type
		Isolation joint sealant between the surface bed and the brick wall is delaminated	Reinstate seal using Sikaflex PRO-3 i-cure polyurethane sealants or similar SANS-approved products
		Horizontal crack around the entire external wall at the DPC level	Apply a new mortar bed or SANS-approved polyurethane sealants (see paragraph 6.4)
8	Foundations	Differential settlement	Concrete underpinning as per specifications in paragraph 6.5 and drawing in Appendix A
		Lateral movement of foundation wall near the main bedroom	Concrete Underpinning as per specifications in paragraph 6.5 and drawing in Appendix A
9	Stormwater Drainage	No gutters and drain pipes around the entire house	New 25MPa concrete aprons and stormwater channels around the existing building

8 Recommendations

The following structural engineering scope of work is therefore proposed:

- Remedial works to external brick walls, internal brick walls and surface beds;
- Foundation underpinning;
- The homeowner should consider installing new roof gutters and rainwater downpipes;
- New aprons and stormwater channels around the existing building;

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PROJECT NAME	:	STRUCTURAL ASSESSMENT AT HOUSE VAN DYK, 58 PRIDE OF INDIA CRESENT IN WAVECREST OF JEFFREYS BAY.
PROJECT No.	:	
TITLE OF DOCUMENT	:	Structural Engineering Assessment Report Rev 2– May 2024

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DATE **May 2024**	SIGNATURE 	SIGNATURE	SIGNATURE

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9 Appendices

Appendix A: Drawing for Foundation Underpinning

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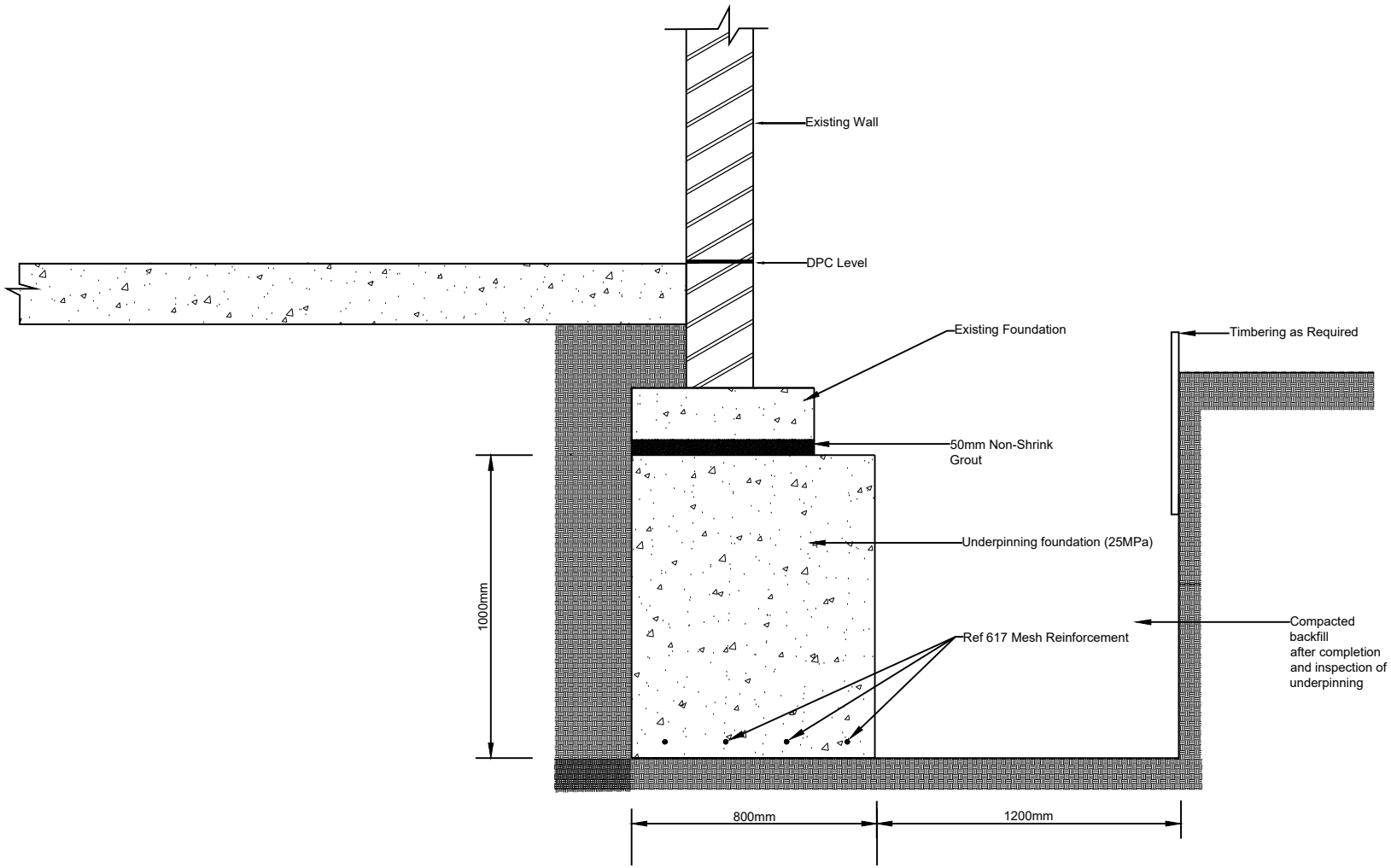

SECTION FOUNDATION UNDERPINNING (1.5m x 0.8m x 0.8m)

SCALE: N . T .S

Appendix B: Typical Drawing: Beam at Window/Door Level, Apron and V-Drain Details

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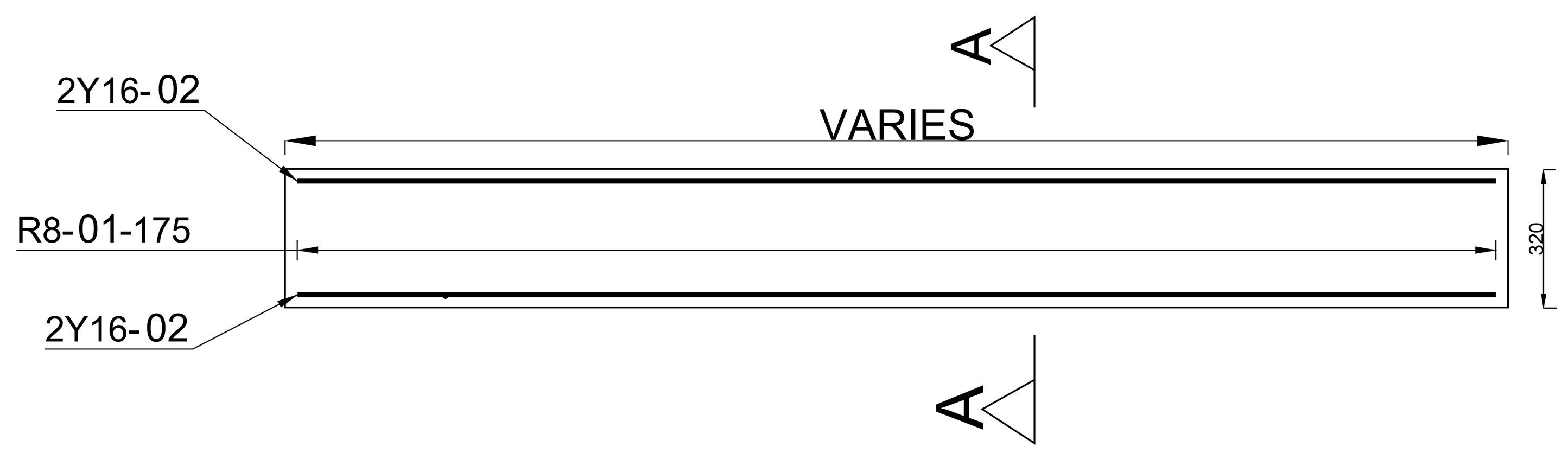
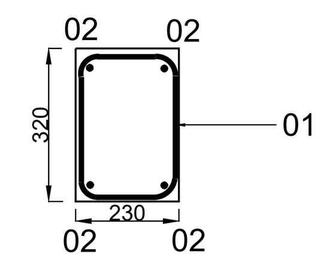
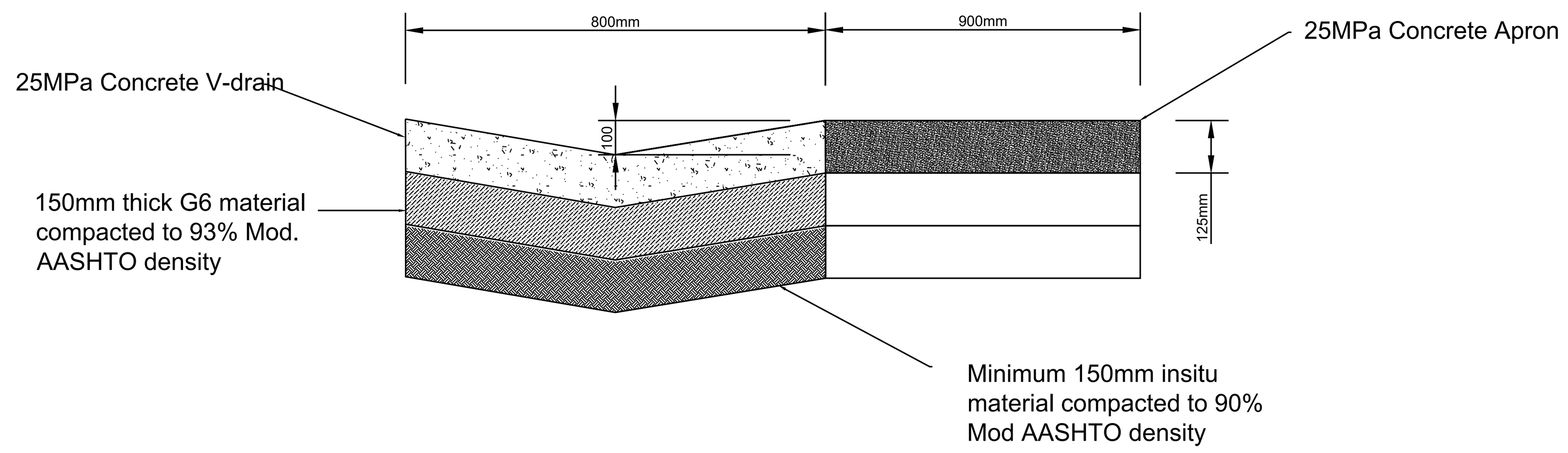


TYPICAL DRAWING: BEAM ELEVATION
320mm x 230mm BEAM (25MPa/19mm)



SECTION A-A: RC BEAM



TYPICAL SECTION OF V-DRAIN AND APRON
25MPa/19mm)

MEMBER	NO OF	DIA	CUT LENGTH	BAR MARK	SC	A	B	C	D	E/R	kg
1	1	R8	1050	01	60	280	180				
	1	Y16	VARIES	02	35	VARIES					

NB: LENGTH OF BARS "VARIES" DEPENDING ON THE WIDTH OF THE DOOR/WINDOW OPENING

THESE NOTES SERVE AS PART OF THE SPECIFICATION. IN THOSE CASES WHERE THESE NOTES DIFFER FROM SPECIFICATIONS, THE DISCREPANCY SHALL BE REFEREED TO THE STRUCTURAL ENGINEER, WHO SHALL TAKE THE FINAL DECISION.

CONCRETE NOTES:

1.0 SETTING OUT AND GENERAL:
1. 1 THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ARCHITECTS' DRAWINGS.
1.2 ALL DIMENSIONS AND HEIGHTS ARE TO BE CHECKED ON SITE BEFORE WORK IS PUT IN HAND.
1.3 REPORT DISCREPANCIES TO ARCHITECT OR ENGINEER.
1.4 THIS DRAWING MUST NOT BE USED TO SCALE OFF. USE ONLY WRITTEN DIMENSIONS. CONTACT THE ENGINEER OR ARCHITECT WHERE CLARITY IS SOUGHT.
1.5 FOR SETTING OUT DATA, SETTING OUT POINTS AND DATUM LEVELS REFER TO ARCHITECTURAL AND CIVIL ENGINEERING DRAWINGS.WHERE THERE IS DISCREPANCY OF LEVELS BETWEEN THE ARCHITECTURAL AND STRUCTURAL DRAWINGS, THE ARCHITECTURAL DRAWINGS WILL TAKE PRECEDENCE.
1.6 STRUCTURAL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE PROJECT SPECIFICATION AND THE RELEVANT S.A.N.S SPECIFICATIONS. ALL CONCRETE WORK IS TO BE DONE IN ACCORDANCE WITH S.A.N.S 1200G AND EARTHWORKS IN ACCORDANCE WITH S.A.N.S 1200D.
1.8 CONSULT RELEVANT ARCHITECT'S, MECHANICAL, ELECTRICAL & PLUMBING DRAWINGS AND DETAILS AS RELEVANT FOR DRAINAGE, STORMWATER OUTLETS, RWDPS AND HOLES AND SLEEVES FOR THESE SERVICES. NO HOLES ARE TO BE CORED WITHOUT ENGINEERS WRITTEN APPROVAL.
2.0 FOUNDATIONS
2.1 ALL FOUNDATION EXCAVATIONS TO BE INSPECTED AND APPROVED IN WRITING BY THE ENGINEER BEFORE CONCRETE IS CAST.
2.2 NO FOUNDATIONS ARE TO BE CAST IN FILL MATERIAL.. A 50mm THICK LAYER OF 10MPa / 19mm BLINDING CONCRETE IS TO BE CAST UNDER ALL REINFORCED BASES, REINFORCED STRIP FOOTINGS AND GROUND BEAMS.
2.3 ANY OVER EXCAVATIONS ARE TO BE MADE GOOD WITH 10MPa / 19mm CONCRETE AT THE CONTRACTOR'S EXPENSE.
2.4 BACKFILLING OVER COLUMN BASES SHALL BE DONE WITH AN APPROVED MATERIAL COMPACTED IN LAYERS IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
2.5 ALLOWABLE BEARING PRESSURE UNDER:
CONCRETE BASES = 500kPa.
STRIP FOOTINGS= 500kPa
RETAINING WALL STRIP FOOTING= 500kPa
3.0 CONCRETE
3.1 CONCRETE CHARACTERISTIC 28 DAY STRENGTH:
SUSPENDED SLABS & BEAMS: 30MPa / 19mm
3.2 CONCRETE TEST CUBE TEST RESULT TO BE SUBMITTED TIMEOUSLY TO ENGINEER FOR PERUSAL ,RECORDS, COMMENT AND APPROVAL.
3.3 ALL CONCRETE TO BE ADEQUATELY CURED BY KEEPING SURFACES CONTINUOUSLY DAMP FOR AT LEAST 5 DAYS AFTER CASTING.
3.4 ALL CONCRETE TO BE CONSTRUCTED TO THE S.A.N.S 1200G PERMISSIBLE DEVIATION DEGREE OF ACCURACY CLASS II UNLESS SPECIFIED OTHERWISE.
3.5 CONCRETE CUBE TEST RESULTS TO BE SUBMITTED TIMEOUSLY TO ENGINEER FOR PERUSAL, RECORDS, COMMENT AND APPROVAL.
4.0 REINFORCEMENT
4.1 CHARACTERISTIC STRENGTH:
MILD STEEL: 250N/mm2
HIGH YIELD STEEL: 450N/mm2
4.2 ALL REINFORCEMENT TO BE CHECKED AND APPROVED BY ENGINEER BEFORE ANY CONCRETE IS CAST. 48 HOURS WRITTEN NOTICE TO BE GIVEN TO ENGINEER BEFORE TIME OF INSPECTION.
4.3 LAP LENGTH TO REINFORCING TO BE MINIMUM 50 x SMALLER BAR DIAMETER, UNLESS OTHERWISE NOTED.
4.4 MESH REINFORCEMENT REFERENCE 617 TO BE PLACED IN SLAB (TOP) MINIMUM LAPS = 300mm UNLESS OTHERWISE NOTED.
4.5 THE CONTRACTOR MUST TAKE PARTICULAR CARE TO ENSURE THAT THE SPECIFIED COVER TO ALL REINFORCEMENT HAS BEEN ATTAINED THROUGHOUT BEFORE THE ENGINEER IS CALLED TO SITE FOR INSPECTION OF THE REINFORCEMENT.
4.6 COVER TO REINFORCEMENT:
SUSPENDED BEAMS: 30mm
4.7 CONTRACTOR IS TO CONDUCT HIS OWN INSPECTION OF REINFORCEMENT BEFORE CALLING THE ENGINEER FOR INSPECTION.
5.0 FORMWORK AND PROPPING
5.1 STRIPPING TIMES FOR:
COLUMN AND WALL SHUTTERING: 2 DAYS.
BEAM SHUTTERING: 7 DAYS IN HOT WEATHER, 12 DAYS IN COLD WEATHER.
FLAT SLABS: 4 DAYS IN HOT WEATHER, 7 DAYS IN COLD WEATHER.
5.2 PROPPING TIMES FOR:
SLABS AND BEAMS: 14 DAYS IN HOT WEATHER 21 DAYS IN COLD WEATHER
CANTILEVER SLABS AND BEAMS: 21 DAYS
(*SUBJECT TO CUBE TEST RESULTS BEING SUBMITTED TIMEOUSLY TO ENGINEER FOR APPROVAL).*
NO DE-PROPPING OF SUSPENDED ELEMENTS UNTIL INSTRUCTED BY ENGINEER.
5.3 CONCRETE FINISHES: UNLESS NOTED OTHERWISE
COLUMNS AND WALLS: OFF SHUTTER
BEAMS AND SLAB SOFFIT: OFF SHUTTER
TOP OF SUSPENDED SLABS: STEEL FLOAT
SURFACE BEDS: POWER FLOAT
5.4 SIDES OF GROUND BEAMS TO BE SHUTTERED.

REINFORCEMENT NOTES:

1. REFER TO DRAWING CONCRETE LAYOUT.
2. REINFORCEMENT YIELD STRENGTH :
   HIGH TENSILE 'Y' 450MPa
   MILD STEEL 'R' 250MPa
   WELDED STEEL WIRE MESH 485MPa
3. ALL REINFORCEMENT TO CONFORM TO THE REQUIREMENT OF SANS 920 AND SANS 1024.
4. ALL REINFORCEMENT CUTTING AND BENDING TO BE DONE IN ACCORDANCE WITH SANS 282.
5. ABBREVIATIONS :
   B.................BOTTOM
   B1 .... LOWEST OF THE BOTTOM LAYERS
   B2 ....SECOND LOWEST OF THE BOTTOM LAYERS
   T................TOP
   T1 ....HIGHEST OF THE TOP LAYERS
   T2 ....SECOND HIGHEST OF TOP LAYERS
   NF .... NEAR FACE
   FF .... FAR FACE
   EF .... EACH FACE
   EW .... EACH WAY
   AS .... ALTERNATELY STAGGERED
   AP ....ALTERNATELY PLACED
   ABR .... ALTERNATE BAR REVERSED
   UB .... U-BAR
   VER............ VERTICAL
   HOR............HORIZONTAL

No	Date	Details	Chd	Appd
A	18-01-2024	ISSUED FOR INFORMATION	AM	

Revisions

Client:

User Client:

Consultant:
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Discipline: STRUCTURAL

Service: REMEDIAL WORKS FOR HOUSE VAN DYK

Drawing title: TYPICAL DRAWING: BEAM, APRON AND V-DRAIN DETAILS

Engineers:

Drawn By:	Designed By:	Checked By:
T. Sekhukhune	T. Sekhukhune	WC. Molokomme

Size:	Scale:	Original Date:
A1	AS SHOWN	FEB 2024

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SES/066/00/S/01	Rev 0

CONSTRUCTION

Appendix C: Structural Engineering Photographic Report

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Project:
ETS-CM-010836-WN: Professional Consultancy Services for House Van Dyk in Jeffreys Bay in the Sarah Baartman District
– STRUCTURAL ENGINEERING DISCIPLINE

Report Title:
Structural Engineering condition Assessment Report

Report Sub-Title:

HOUSE VAN DYK
PHOTOGRAPHIC REPORT

Revision:	**02**
Date:	**21.05.2024**

NATIONAL HOME BUILDERS NHBRC REGISTRATION COUNCIL

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Photo 1: Horizontal crack at surface bed level

Photo 2: Bond mortar separation in-between the DPC and mortar course bed .

Photo 3: Horizontal crack at surface bed level

Photo 4: Horizontal crack at surface bed level .

Photo 5: Horizontal crack above back entrance door.

Photo 6: Crack on window seal

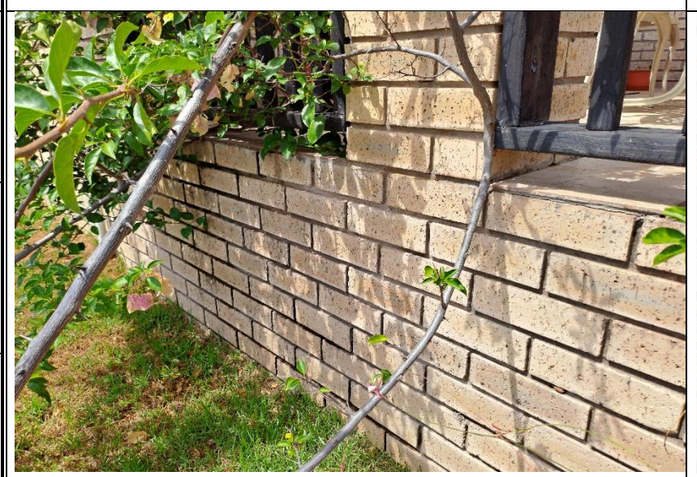

Photo 7: No aprons or stormwater around the building.

Photo 8: No aprons or stormwater around the building.

Photo 9: No roof gutters or rainwater downpipe.

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Project:
ETS-CM-010836-WN: Professional Consultancy Services for House Van Dyk in Jeffreys Bay in the Sarah Baartman District
– STRUCTURAL ENGINEERING DISCIPLINE

Report Title:
Structural Engineering condition Assessment Report Rev 2

Report Sub-Title:

HOUSE VAN DYK
PHOTOGRAPHIC REPORT

Revision:	**02**
Date:	**21.05.2024**

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Photo 10: Major vertical-diagonal crack on the internal bedroom wall.


Photo 11: Vertical crack on internal wall.


Photo 12: Vertical crack on internal wall.


Photo 13: Horizontal crack above window.


Photo 14: Vertical crack on internal wall.

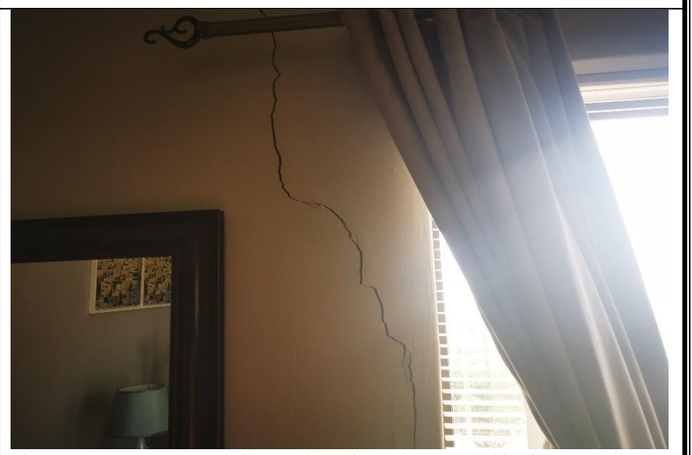
Photo 15: Major vertical-diagonal crack on the internal bedroom wall.


Photo 16: Horizontal crack above window.


Photo 17: Dampness on internal brick wall.


Photo 18: Diagonal crack on the internal bedroom wall above window.

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Project:
ETS-CM-010836-WN: Professional Consultancy Services for House Van Dyk in Jeffreys Bay in the Sarah Baartman District
– STRUCTURAL ENGINEERING DISCIPLINE

Report Title:
Structural Engineering condition Assessment Report

Report Sub-Title:

HOUSE VAN DYK
PHOTOGRAPHIC REPORT

Revision:	**02**
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Photo 1: Vertical crack on internal wall.

Photo 2: Dampness on internal brick wall.

Photo 3: Dampness on internal brick wall.

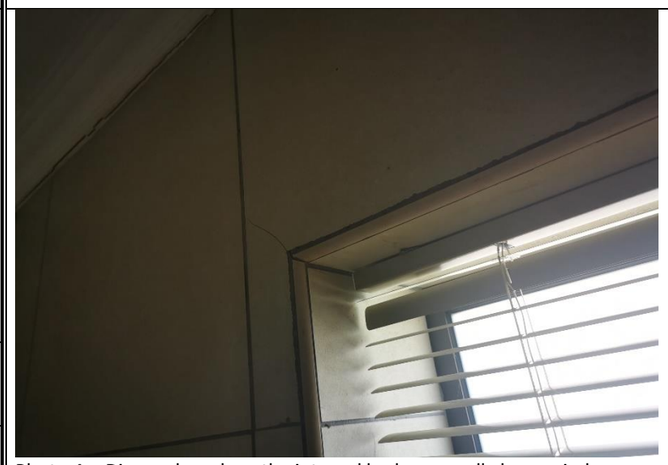

Photo 4: Diagonal crack on the internal bedroom wall above window.

Photo 5: Timber roof trusses

Photo 6: Timber roof trusses

Photo 7: Cracks on external brick wall above window.

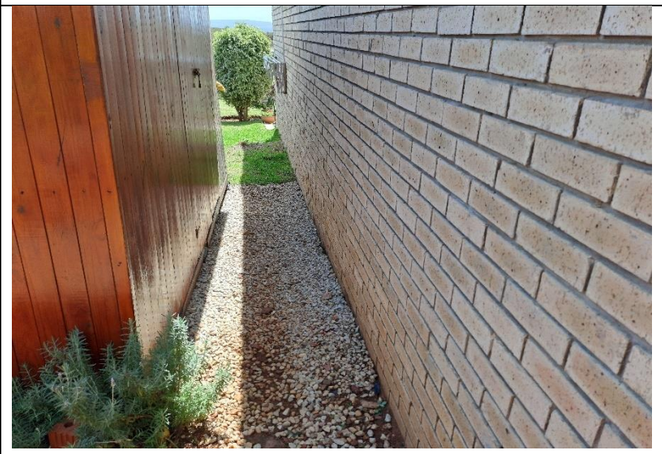

Photo 8: No aprons or stormwater around the building.

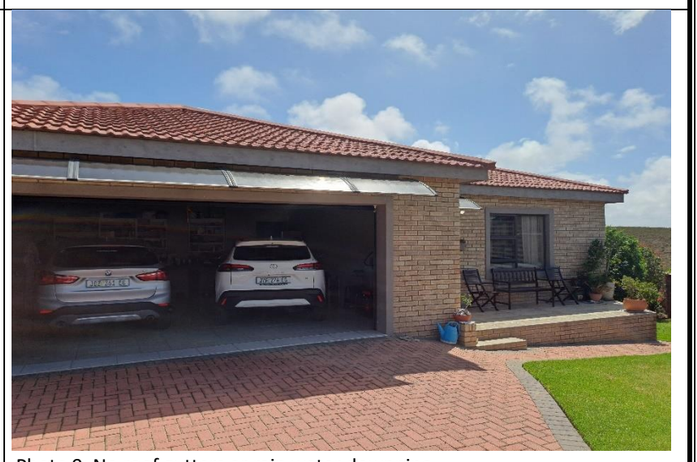

Photo 9: No roof gutters or rain water downpipe.

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Project:
ETS-CM-010836-WN: Professional Consultancy Services for House Van Dyk in Jeffreys Bay in the Sarah Baartman District
– STRUCTURAL ENGINEERING DISCIPLINE

Report Title:
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PHOTOGRAPHIC REPORT

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Photo 1: Cracks on floor tiles.

Photo 2: Cracks on floor tiles.

Photo 3: Algae and moulds has developed on the surface of the brick walls.

Photo 4: Delamination of floor tiles.

Photo 5: Delamination of joint sealant.

Photo 6: Algae and moulds has developed on the surface of the brick walls.

Photo 7: Delamination of joint sealant.

Photo 8: Delamination of joint sealant.

Photo 9: Garage floor tiles

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Project:
ETS-CM-010836-WN: Professional Consultancy Services for House Van Dyk in Jeffreys Bay in the Sarah Baartman District
– STRUCTURAL ENGINEERING DISCIPLINE

Report Title:
Structural Engineering condition Assessment Report

Report Sub-Title:

HOUSE VAN DYK
PHOTOGRAPHIC REPORT

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Photo 1: General site view.


Photo 2: General site view.


Photo 3: Boundary wall.


Photo 4: No aprons around the building .


Photo 5: Boundary wall.


Photo 6: Boundary wall.


Photo 7: Typical site soil material. It appears the founding material has clay content.


Photo 8: Typical site soil material. It appears the founding material has clay content.

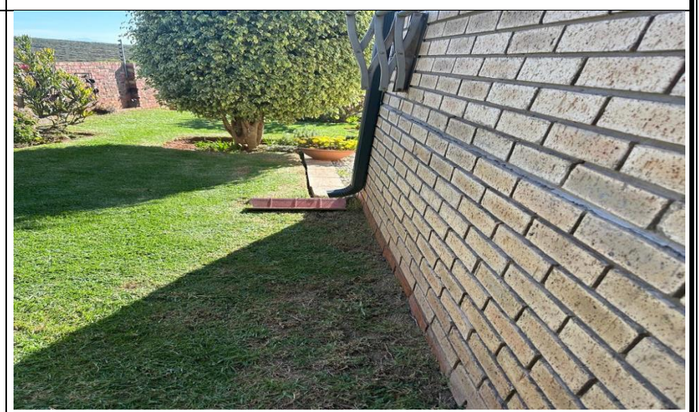
Photo 9: Lateral Movement. External wall of the main bedroom

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Appendix D: Geotechnical Field Report

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GEOTECHNICAL INVESTIGATION FOR 58 PRIDE OF INDIA CRESCENT, WAVECREST, JEFFREYS BAY

HOUSE VAN DYK

Prepared By:

DWALA GROUP
GEOTECHNICAL ENGINEERING

Prepared For:

NATIONAL HOME BUILDERS
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Document control			
Report title	Geotechnical report for the proposed remedial works for a deforming house (House van Dyk)		
Client	National Home Builders Registration Council (NHBRC)		
Date	**15 February 2023**	**Keywords**	
Compiled by	Lethabo Moatshe	Fill	Collapsible
Approved by:	Nhlanhla Magigaba	Concrete apron	Water Leakage
Rev	00		

Contents

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EXECUTIVE SUMMARY

NHBRC appointed Dwala Group to carry out a geotechnical investigation for a deforming structure (House van Dyk). The study area is situated at 58 Pride of India Cresent, Wavecrest in Jeffreys Bay, Eastern Cape Province. The geotechnical investigation comprised of desktop study, fieldwork (test pit excavation, soil profiling, and sampling of selected horizon for laboratory testing), laboratory testing and reporting.

The main objective of the investigation was to investigate the cause of the deformation in the existing structure, evaluate the founding conditions, and give recommendations for remedial actions.

The geological profile revealed that the site is underlain by fill and mudrock bedrock.

Zone C2: This zone covered the entire site and is characterized by potentially collapsible and compressible fill and completely weathered mudrock (silty sands, sandy material). The expected total settlement for this zone is greater than 10 mm and a differential movement that is 75% (**C2**).

The strip footings are placed directly on a thin layer of sandy fill material which is potentially collapsible and compressible and as such, no measures were put in place to prevent collapse settlement on the site.

Based on the soil profile characteristics and the condition of the structure, it is evident that the structure should have been founded either on a foundation of substantial stiffness if it had to perform satisfactorily. This would have required a soil raft of non-active material placed on a concrete raft foundation with high stiffness. This solution would typically be combined with limited articulation and a substantial brick force specification.

Due to the fact that the foundation material below the foundation is collapsible and compressible, the underpinning of the foundation is considered suitable for strengthening the foundation.

Measures to attempt to stabilise future soil moisture change and hence curb further movement as effectively as possible must be implemented.

1. Introduction

NHBRC appointed Dwala Group to carry out a geotechnical investigation for a deforming structure (House van Dyk). The study area is situated at 58 Pride of India Cresent, Wavecrest in Jeffreys Bay, Eastern Cape Province. Fieldwork, carried out on the 27th of January 2023, included excavation of test pits, soil profiling, soil sampling, and exposing existing foundations of the structure to assess the possible factors that might be causing the house to deform (crack).

The objectives of the geotechnical investigation were to:

- Present a discussion on the prevailing condition of the structure.
- Determine the stratigraphy of the site and its geotechnical properties.
- To determine whether any problem soils are present at the site that could have had an effect on either founding or construction methods for the structure to deform (crack).
- To delineate the site into appropriate geotechnical zones according to any essential differences in founding conditions encountered.
- To evaluate the founding conditions at the site and to recommend building precautions necessary for different geotechnical zones.
- To obtain basic data concerning the use of the in-situ materials for guideline purposes.
- To present findings and recommend measures to restrict or reduce further structural distress in the structure.

The approach to the investigation was to assess the status quo in terms of the characteristics of the soil profile and the measures implemented (if any) to protect the structure against potential differential movements. This is followed by recommendations on appropriate rectification measures.

2. Available information

At the time of the investigation, the following information was available:

- The 1:50 000 scale geological map of Humansdorp sheet 3424BB (Council for Geosciences, 2019).
- Aerial photographs, sourced from Google Earth®.

3. Site locality and description

The proposed site is situated at 58 Pride of India Cresent in Wavecrest, Jeffreys Bay located in the Eastern Cape Province. It can be accessed via main road R102, onto St Francis Street, Seetuin Road, Dr A D Keet Road onto Pride of India Cres which forms the eastern boundaries of the site. The house is approximately 6 km north of Jeffreys Bay Main Beach. The area consists of residential developments. Figure 1 below shows the site locality of the investigated house.

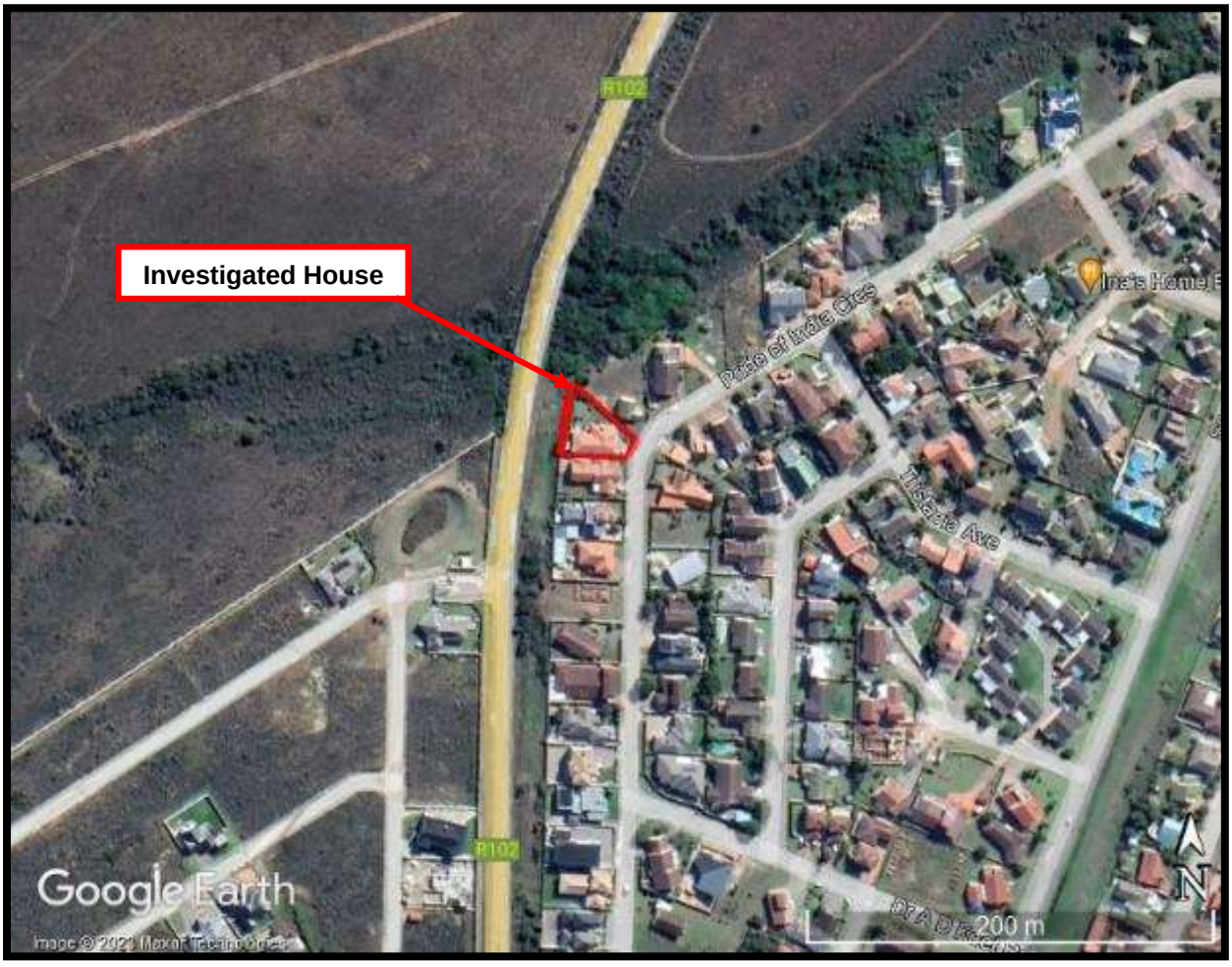

Figure 1: Showing the investigated house in Wavecrest, Jeffreys Bay (red outline).

Topographically the site is moderately sloping at an angle of approximately 7° towards the northeast.

The investigated house is covered by pavement on the driveway (southeast), south side and southwest corner of the house. The garden area on the north side of the house is covered by grass, some trees and flowers with a portion on the northeast corner of the house covered by decorative stones as shown in Figure 2 below.

Figure 2: Showing the topography, vegetation and decorative stone cover on the site.

4. Climate

The climate in Jeffreys Bay is warm and temperate. The climate of the area is classified as Cfb by the Köppen-Geiger system. The temperature here averages 17.7°C. Rain falls in Jeffrey's Bay throughout the year with the lowest precipitation in May, averaging 39 mm. In November, the precipitation reaches its peak, with an average of 60 mm. The rainfall is approximately 565 mm annually (Climate-data.org: 2012).

The Weinert Climatic N-number for the area (Weinert, 1980) is <5, which indicates that the climate is semi-humid to humid and chemical weathering processes are dominant.

5. Investigation Methodology

The geotechnical investigation comprised desktop study, fieldwork, laboratory testing and analysis and reporting.

5.1 Test pitting

To meet the requirements for a stand to be registered with NHBRC the investigation was carried out in accordance with the specification for geotechnical site investigations for housing developments (National Department of Housing specification GFSH- 2).

Fieldwork included excavation and profiling of two (2 No.) test pits. A two-person team carried out the test pitting in order to comply with accepted safety requirements as reflected in the Site Investigation Code of Practice (SAICE, 2010). The test pits were set out and profiled by a team of engineering geologists/ geotechnical engineers in accordance with South African standards (Standards South Africa. South African. National Standard. Profiling, Percussion Borehole and Core Logging in Southern Africa SANS 633:2012). Test pit details are summarised in Table 1 below.

Table 1: Test pit summary

Test Pit No	Coordinates (WGS84)		Depth (m)	Remarks
	Latitude	Longitude		
HD1	34° 0'50.61"S	24°54'49.96"E	1.10	Refusal on soft mudrock bedrock
HD2	34° 0'50.39"S	24°54'50.55"E	0.80	Refusal on soft mudrock bedrock

5.2 Laboratory testing

Representative samples were recovered and submitted to the SANAS-accredited Engineering Laboratory in Gqeberha for testing. Soil testing included the determination of the Foundation Indicators (comprising sieve and hydrometer grading analyses and Atterberg Limits) as well as the determination of in-situ moisture content.

6. Geology

According to a 1:50 000 scale geological map of the Humansdorp sheet 3424BB (Council for Geoscience, 2019), the investigated site is underlain by mudrock and sandstone of the Ceres Subrgroup of the Bokkeveld Group of the Cape Supergroup as shown in Figure 3 below.

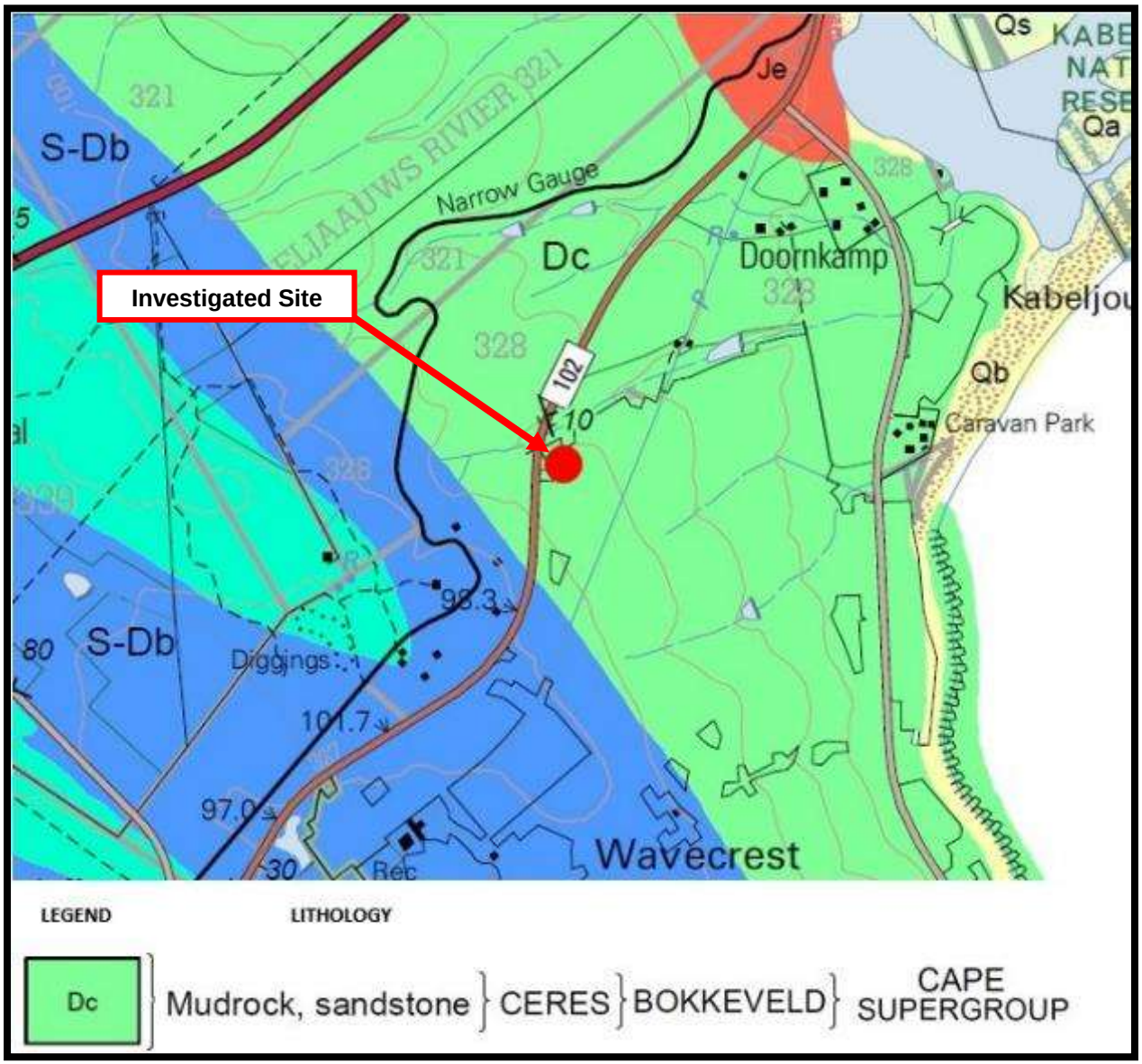

Figure 3: Showing the general geology map of the site; (Geological Survey, printed by the Government Printer, Pretoria, 2019).

7. Results of Investigation

The detailed descriptions of the soil profiles encountered in the test pits are presented in Appendix B; while the soil profiles for the whole site are summarised below in Table 2.

Table 2: Test pit profile summary

Test Pit No:	Brick Wall	Concrete Foundation	Fill horizon	Mudrock bedrock
HD1	0 – 0.10	0.10 – 0.35	0.35 – 0.60	0.60 – 1.10
HD2	0 – 0.10	0.10 – 0.30	0.30 – 0.40	0.40 – 0.80

Figure 4 below shows the test pits excavated on-site. The profile on-site comprises the following:

- Fill horizon; and
- Mudrock bedrock

Figure 4: Showing the test pit profiles on site.

7.1 Fill horizon

A fill horizon was encountered in the two (2 No.) test pits excavated on site. The layer comprises slightly moist, greyish brown patched olive green, red and black, clayey sand with sub-angular gravel, pebbles, and sparse rubble and waste. The horizon has a consistency that is medium-dense. The thickness of the horizon varies from 0.25 m in test pit HD1 to 0.10 m in test pit HD2.

7.2 Mudrock bedrock

The mudrock bedrock was encountered in the two (2 No.) test pits excavated on site. It occurs as completely to highly weathered, orangey-brown mottled black and red, very closely jointed, laminated, very fine-grained, very soft rock. Refusal was encountered in all the test pits on soft mudrock.

8. Groundwater conditions

Groundwater seepage was not encountered in the test pits excavated on site.

9. Plumbing Services

The plumbing services of the house are located above ground on the south side of the house. Initially, the pipes were located underground until a water leakage occurred allowing water to flow underground into the foundations. An excess amount of water leaked underground into the foundations in a short space of time which was seen from the water bill.

10. Laboratory tests

Representative samples of the materials encountered on site were taken and submitted to a soils laboratory where they were subjected to the following tests:

- Grading and Atterberg Limits including moisture content.

The laboratory results are attached as Appendix C to this report.

10.1 Foundation Indicators

Representative samples were collected for laboratory testing and submitted for foundation indicator tests. The test results are attached in Appendix C and summarised in Table 3 below.

Table 3: Summary of Foundation Indicator test results

Hole no.	Depth (m)	Soil composition				GM	Atterberg limits			Activity	Moisture Content	Unified soil classification
		Clay (%)	Silt (%)	Sand (%)	Gravel (%)		LL (%)	PI (%)	LS (%)			
Fill horizon												
HD1	0.35 – 1.10	4.0	26.0	38.0	32.0	1.37	20.0	8.0	4.0	Low	18.2	SC
Completely weathered mudrock bedrock												
HD2	0.40 – .50	10.0	23.0	44.0	23.0	1.16	26.0	10.0	5.0	Low	17.5	SC

Where:
GM = Grading modulus
LL = Liquid Limit
PI = Plasticity Index
WPI = Weighted Plasticity Index (PI x % passing the 0.425 mm sieve)
LS = Linear Shrinkage
Activity = Expansiveness of the soil according to Van der Merwe's method
SC = Clayey sand

Table 3 above indicates that:

The **fill material** underlying the site consists of clayey sand (**SC**) with a moisture content of 18.2%. The horizon has a very high grading modulus of 1.37. The fine fractions of this material also exhibit a low (20.0%) liquid limit as well as low (4.0%) linear shrinkage. The plasticity index (PI) of the soil is low (12.0%). The material has a low potential expansiveness, according to the method proposed by Van der Merwe (1973).

The **completely weathered mudrock** underlying the site consists of clayey sand (**SC**) with a moisture content of 17.5%. The horizon has a high grading modulus of 1.16. The fine fractions of this material also exhibit a moderate (26.0%) liquid limit as well as a low (5.0%) linear shrinkage. The plasticity index (PI) of the soil is low (10.0%). The material has a low potential expansiveness, according to the method proposed by Van der Merwe (1973).

11. Geotechnical Considerations

The following constraints, as proposed by Partridge, Wood, and Brink (1993), have to be considered for the classification of this site.

11.1 Shallow seepage/groundwater level

Groundwater seepage was not encountered in the test pits excavated on site.

11.2 Collapsible soil profile

The foundation indicator test results (see Section 10) indicate that the fill horizon material and the completely weathered mudrock bedrock on-site comprise coarse-grained soils of 70% in the fill material and 67% in the completely weathered mudrock material. Coarse-grained soils are prone to collapse upon wetting and additional loading.

The coarse materials of the fill and completely weathered mudrock bedrock where the foundations of the investigated house are placed underwent collapse settlement when water was introduced into the foundations from the water leakage that occurred and the additional load of the house.

11.3 Compressible Soil Profile

The foundation indicator test results (see Section 10) indicate that the fill horizon material and the completely weathered mudrock bedrock on-site comprise fine-grained soils of 30% in the fill material and 33% in the completely weathered mudrock.

The fine materials of the fill and completely weathered mudrock bedrock where the foundations of the investigated house are placed underwent settlement when the moisture conditions under the foundations' changed due to the water leakage that occurred.

12. Current Site Conditions

12.1 Foundation conditions

Inspection of the foundations of the investigated house showed that the house is founded on “strip footings” of a limited thickness (averages at 0.23 m), width and depth, probably representing a low-stiffness ground beam or a low-stiffness raft if cast integrally with the floor slab. The strip footings are placed directly on potentially collapsible and compressible fill that is medium-dense and very soft mudrock bedrock material. The soil profile at the excavated test pit indicates that no proper measures (e.g. densification of fill and completely weathered mudrock materials/ improvement of the collapsible soil profile and/or replacement with an engineered fill) were put in place to prevent settlement**. The stiffness of the foundations is inadequate to withstand the differential settlement that inevitably occurred due to the collapsible settlement of the materials.**

The strip footing foundation is thin with a varying thickness between 200 mm in test pit HD2 to 250 mm in test pit HD1. This foundation is considered to be inadequate to withstand collapse settlement, however, the structural engineer will confirm the suitability of the footing.

Furthermore, the sandy fill material where the foundations are placed is very thin ranging from 0.25 m in test pit HD1 to 0.10 m in test pit HD2. These materials collapsed when the moisture conditions changed from dry to moist due to the water infiltration from seasonal rainfall and water leakage from plumbing services. This horizon was found to be wet (moisture content of 18.2%), and the infiltration of water into this medium-dense horizon resulted in the collapse of the horizon.

12.2 Concrete Apron

The function of a concrete apron around a building is to protect the foundations and the soil under and around it from water and prevent it from directly infiltrating into the foundations by draining them away to prevent foundation movement and structural damage.

The southeast portion of the house which is the driveway is covered with intact brick pavement which protects the foundations from water infiltration.

The northwest, southwest corner and south sides of the house are covered by decorative stones which are loosely placed and do not drain water away or prevent water from directly infiltrating into the foundations. These decorative stones prove not to be effective in preventing ingress of water.

Figure 5: Showing the absence of a concrete apron on the north and the portion on the west side of the investigated house.

The north, south and west sides of the house do not have a concrete apron around them to prevent the water from directly infiltrating into the foundations and draining them away from the foundations as shown in Figure 5 above which is detrimental to the foundations as they are not protected from water ingress.

The absence of an effective concrete apron around the investigated house allowed water to permeate the soil directly and infiltrate through to the foundations saturating the soil around and underneath the foundations. This triggered the movement of foundations which resulted in the collapse settlement of the foundations and structural damage to the house.

12.3 Leaking plumbing services

In reference to the discussions with the homeowners, it was indicated that the plumbing on the south side of the house (along the side of the main bathroom) was initially underground until a water leakage occurred allowing water to flow underground into the foundations. An excess amount of water leaked underground in a short space of time which was seen from the water bill. This excess water infiltrated the soil underlying the house, putting pressure on the foundation and exacerbating the failure of the house resulting in cracks and structural damage.

During the site inspection, it was found that the house foundation was built on collapsible soil material, this assessment was based on the nature of structural damages observed on the brick wall around the structure and the soil profile underlying the site. This is problematic since inter alia seasonal moisture changes in the foundation and sub-foundation horizons of especially lightly loaded fixed structures give rise to volumetric changes. Volumetric change in the soil skeleton in turn induces stresses in the footings and super-structure, leading to super-structure strain and cracking. Due to the repetitive nature of the stress variation, conventional crack repair measures generally are unsuccessful.

12.4 Water damping conditions

The walls and wardrobe of the main bedroom and the grouting of the tiles in the main bathroom are visibly damp due to water damage as can be seen in Figure 6 below which the homeowners have tried to curb using moisture absorbers placed in the wardrobes.

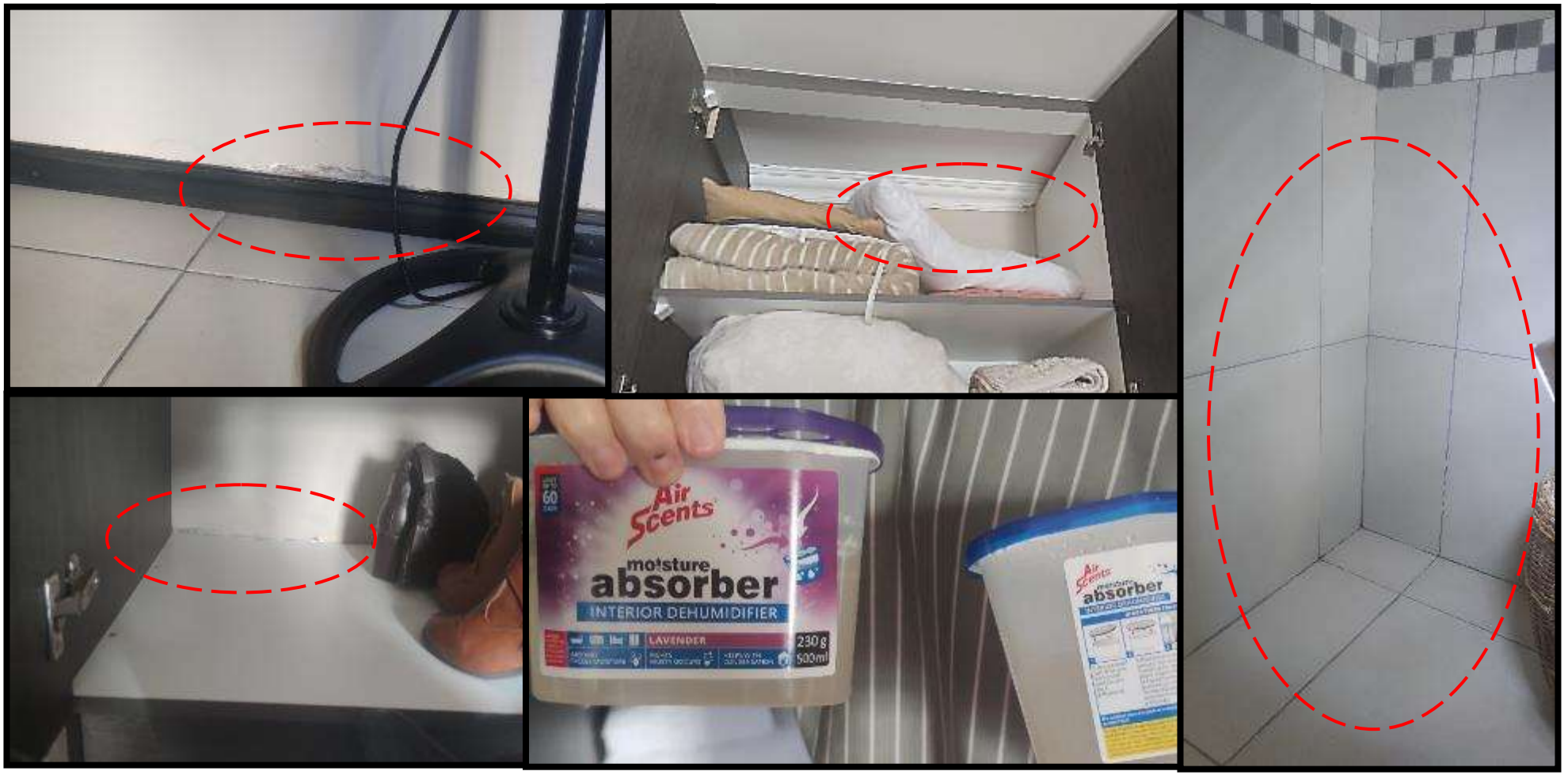

Figure 6: Showing the water damage on the bedroom walls, wardrobe and damp bathroom walls.

12.4.1 Walls and grouting of tiles affected by water damping

As the property was been exposed to a leaking pipe, damping occurred resulting in water damage to the bedroom walls, and bathroom tiles (on the walls and floors). Water damping does damage to interior walls, and the grout between the tiles weakens the tile adhesive and saturates the subfloor, as was seen in this property. After penetrating dampness, grout can crack or deteriorate even in well-designed tile flooring, leading the tiles to come loose. It is likely that the grouting was weakened by the standing water, thus leading to damp walls and flooring. It is essential that the house be cleaned up because if the walls and floors remain damp over some time, mould growth can develop, and tiles may weaken and become loose.

12.4.2 Cupboards affected by water damping

Water damping has resulted in damage to the wardrobes in the main bedroom. The interior of the wardrobe is damaged and may require replacement. The direct contact with moisture has caused a slight change in the appearance of the wardrobe. Joints have also loosened and the wood itself is warped with some minor cracks. The damage to wood can progress from slight to severe in only a few days. If left unattended these cabinets can develop mould because of long exposure to water and especially if they remain damp for a long period.

12.5 Structural conditions

The house under assessment displayed structural distress (lateral and vertical movement) because of heave and ultimately differential settlement. Cracks were observed on the interior walls, the floor, the ceiling and the ceiling skirt, above the sliding door and bedroom doors and extending from the corners of the windows and doors as shown in Figure 7 below.

Figure 7: Showing the horizontal, vertical and diagonal cracks on the interior walls, floor and ceiling skirt around the investigated house.

Horizontal cracks were also observed on the exterior walls of the house and some extending from the windows as shown in Figure 8 below.

Figure 8: Showing the cracks on the exterior walls around the investigated house.

The homeowners indicated that one of the bedroom doors which has a visible crack above the door frame was stuck and could not open. The jammed doors and the observed cracks around the investigated house are an indication of foundation movement and settlement. It is worth noting that this site has most likely experienced collapse settlement.

Based on the soil profile characteristics on the site and the condition of the structures, it is evident that the structures should have been founded either on a foundation of substantial stiffness if it had to perform satisfactorily. This would have required a soil raft of non-active material of about 1.50 m in thickness, or a concrete raft foundation with high stiffness. These solutions would typically be combined with limited articulation and a substantial brick force specification.

13. Engineering Geological Zoning

For urban planning purposes, the site is zoned according to the NHBRC classification systems. Due to the presence of potentially expansive and compressive soil horizons under the entire site, the site has been delineated into one geotechnical zone. The descriptions of this zone are as follows:

Zone C2: This zone covered the entire site and is characterized by potentially collapsible and compressible thin fill horizon and completely weathered mudrock (silty sands, sandy material). The expected total settlement for this zone is greater than 10 mm and a differential movement that is 75% (**C2**).

Table 4: Geotechnical Characteristics

Geotechnical Characteristics				
Typical Founding Material	**Character of Founding Material**	**Expected Range of Total Soil Movements (Mm)**	**Assumed Differential Movement (% of Total)**	**Site Class**
Silty sands, sands, sandy and gravelly soils	Compressible And Potentially Collapsible Soils	<5,0 5,0-10,0 **>10,0**	75% 75% **75%**	C C1 **C2**

The expected immediate total settlement of the foundations in test pit HD1 (west side of the house) is 12.00 mm on the thin fill material based on a founding depth of 0.35 m, a strip footing width of 1.01 mm and an in-situ stiffness of 7 MPa (using the method proposed by Janbu et.al, 1956).

The expected immediate total settlement of the foundations in test pit HD2 (north side of the house) is 10.00 mm on the thin fill material based on a founding depth of 0.30 m, a strip footing width of 0.85 mm and an in-situ stiffness of 7 MPa (using the method proposed by Janbu et.al, 1956).

A settlement that is 10 mm or larger is likely to be a differential settlement and may compromise the structure of the development.

The allowable bearing capacity (FoS=3) of this material is approximately 73 kPa.

14. Conclusions

The conclusion of the investigation can be summarised as follows:

- The horizontal and diagonal cracks indicate movement of the foundations and water ingress.
- The fill and completely weathered mudrock material comprise predominantly clayey sand material.
- The laboratory tests indicate that the soil profile has low potential expansiveness, however, it **is potentially collapsible and compressible due to the sandy nature of the materials.**
- Settlement calculations show that upon loading and change in moisture content of the soils (from partially saturated to a fully saturated state) on site, the settlement for the site is approximately **11.0 mm**.
- Current foundations are placed directly on medium-dense, thin clayey sand fill that is not well densified and as such, no measures were put in place to prevent settlement of the collapsible soils underlying the site. The strip footings were not adequate to handle the large settlement that was experienced on the site due to the collapsible and compressible soils.
- **The structural distress which is observed on this site can mainly be ascribed to the differential settlement, which is a result of collapsible and compressible material below the founding level.**
- **The north, south and west sides of the house have no effective moisture barrier/apron. Concentration and discharging of rainwater, via downpipes, against to structure has increased the risk of differential settlement.**
- **The leakage of the plumbing services that occurred on the site exacerbated the structural failure of the house.** It caused the damping of the bedroom walls and tile joints in the main bathroom.
- Cracks smaller than 0.5 mm could have been caused by a combination of settlement and temperature differences. Other factors may have contributed, but it is difficult to determine (e.g. moisture content in masonry bricks).

15. Recommendations

Plans for the buildings have not been obtained to study the footing details. However, for purposes of prescribing rectification measures and based on what we have seen first-hand of the actual footings, this information is not critical:

The approach followed in the rectification process represents a dichotomy, viz:

- Underpinning;
- Incorporating measures to attempt stabilising future soil moisture change and hence curb heave/shrinkage movement as effectively as possible; and
- Protecting the structure against additional potential movement by strengthening the superstructure where necessary, but at the same time providing flexibility to it by way of movement joints (these recommendations will be done by a structural engineer).

15.1 Foundations

Due to the fact that the foundation material below the foundation is potentially collapsible and compressible, the **underpinning of the foundation should be considered and investigated**. There is a risk of cracking during the process and the shrinkage of the fresh concrete, but this will stabilize with time. It is also difficult to underpin the internal walls. Should the client select this option, the structural engineer can prepare a detailed procedure for the process.

15.2 Soil Moisture Stabilisation

Water must be kept away from the foundations. To stabilise the soil moisture around the foundations of the house an adequate apron of approximately 1.50 m width must be constructed around the house in such a way that water does not pond anywhere directly next to the structure of the house. This will require draping of the soil before placing the apron. **When carrying out the above it must be confirmed that no services are leaking.**

In addition, while a garden may be established near the buildings, no large trees should be planted near the buildings. Watering plants close to the house may have a negative effect on the moisture stabilisation below the foundation.

15.3 Professional Indemnity

Dwala Group has not carried out detailed construction supervision or design and therefore accepts no responsibility for the design and/or failures and consequences, therefore, that may occur in the future. We would, however, like to assist with recommendations for the repair of the structure.

The recommendations and methods of construction must be finalised with a contractor. It must be emphasised that all measures to render an existing structure crack free, is certainly more difficult to incorporate than in the case of a new structure still to be built. Although there is no guarantee against minor and isolated cracks developing subsequent to the implementation of these measures, a high success rate is possible, particularly to the extent of maintaining a high degree of aesthetical appeal.

16. References

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Appendix A

Summary of Standard Soil and Rock Profile Description Terminology

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

Term	Description
Dry	
Slightly moist	Requires addition of water to reach optimum moisture content for compaction
Moist	Near optimum content
Very Moist	Requires drying to attain optimum content
Wet	Fully saturated and generally below water table

2. COLOUR

The Predominant colours or colour combinations are described including secondary coloration described as banded, streaked, blotched, mottled, speckled or stained.

3. CONSISTENCY

3.1 Non-Cohesive Soils

Term	Description
Very Loose	Crumbles very easily when scraped with geological pick
Loose	Small resistance to penetration by sharp end of geological pick
Medium Dense	Considerable resistance to penetration by sharp end of geological pick
Dense	Very high resistance to penetration to sharp end of geological pick. Requires many blows of hand pick for excavation.
Very Dense	High resistance to repeated blows of geological pick. Requires power tools for excavation

3.2 Cohesive Soils

Term	Description
Very soft	Easily penetrated by thumb. Sharp end of pick can be pushed in 30 - 40mm. Easily moulded by fingers.
Soft	Pick head can easily be pushed into the shaft of handle. Moulded by fingers with some pressure.
Firm	Indented by thumb with effort. Sharp end of pick can be pushed in up to 10mm. Can just be penetrated with an ordinary spade.
Stiff	Penetrated by thumbnail. Slight indentation produced by pushing pick point into soil. Cannot be moulded by fingers. Requires hand pick for excavation.
Very Stiff	Indented by thumbnail. Slight indentation produced by blow of pick point. Requires power tools for excavation.

4. STRUCTURE

Term	Description
Intact	Absence of fissures or joints
Fissured	Presence of closed joints
Shattered	Presence of closely spaced air filled joints giving cubical fragments
Micro-shattered	Small scale shattering with shattered fragments the size of sand grains
Slickensided	Polished planar surfaces representing shear movement in soil
Bedded Foliated	Many residual soils show structures of parent rock.

5. SOIL TYPE

5.1 Particle Size

Term	Size (mm)
Boulder	>200
Pebbles	60 – 200
Gravel	60 – 2
Sand	2 – 0,06
Silt	0,06 – 0,002
Clay	<0,002

6. ORIGIN

6.1 Transported Soils

Term	Agency of Transportation
Colluvium	Gravity deposits
Talus	Scree or coarse colluvium
Hillwash	Fine colluvium
Alluvial	River deposits
Aeolian	Wind deposits
Littoral	Beach deposits
Estuarine	Tidal – river deposits
Lacustrine	Lake deposits

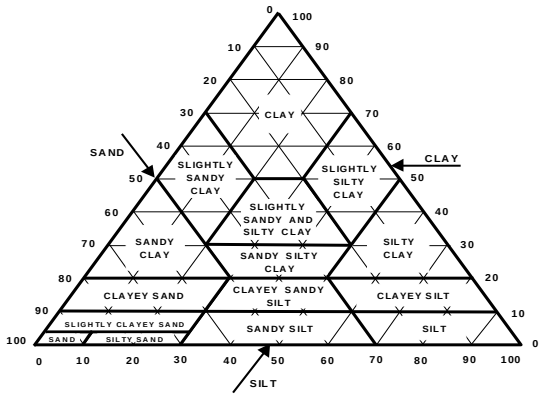
6.2 Residual soils

These are products of in situ weathering of rocks and are described as e.g. Residual Shale

6.3 Pedocretes

Formed in transported and residual soils etc. calcrete, silcrete, manganocrete and ferricrete.

5.2 Soil Classification



SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

Term	Symbol	Diagnostic Features
Residual Soil	W5	Rock is discoloured and completely changed to a soil in which original rock fabric is completely destroyed. There is a large change in volume.
Completely Weathered	W5	Rock is discoloured and changed to a soil but original fabric is mainly preserved. There may be occasional small corestones.
Highly Weathered	W4	Rock is discoloured, discontinuities may be open and have discoloured surfaces, and the original fabric of the rock near the discontinuities may be altered; alternation penetrates deeply inwards, but corestones are still present.
Moderately Weathered	W3	Rock is discoloured, discontinuities may be open and will have discoloured surfaces with alteration starting to penetrate inwards, intact rock is noticeably weaker than the fresh rock.
Slightly Weathered	W2	Rock may be slightly discoloured, particularly adjacent to discontinuities, which may be open and will have slightly discoloured surfaces, the intact rock is not noticeably weaker than the fresh rock.
Unweathered	W1	Parent rock showing no discolouration, loss of strength or any other weathering effects.

2. HARDNESS

Classification	Field Test	Compressive Strength Range MPa
Extremely Soft Rock	Easily peeled with a knife	<1
Very Soft Rock	Can be peeled with a knife. Material crumbles under firm blows with the sharp end of a geological pick.	1 to 3
Soft Rock	Can be scraped with a knife, indentation of 2 to 4 mm with firm blows of the pick point.	3 to 10
Medium Hard Rock	Cannot be scraped or peeled with a knife. Hand held specimen breaks with firm blows of the pick.	10 to 25
Hard Rock	Point load tests must be carried out in order to distinguish between these classifications	25 - 70
Very Hard Rock	These results may be verified by uniaxial compressive strength tests on selected samples.	70 - 200
Extremely Hard Rock		>200

3. COLOUR

The predominant colours or colour combination are described including secondary colouration described as banded, streaked, blotched, mottled, speckled or stained.

4. FABRIC

4.1 Grain Size

Term	Size (mm)
Very Coarse	>2,0
Coarse	0,6 – 2,0
Medium	0,2 – 0,6
Fine	0,06 – 0,2
Very Fine	< 0,06

4.2 Discontinuity Spacing

Description for: Bedding, foliation, laminations	Spacing (mm)	Descriptions for joints, faults, etc.
Very Thickly Bedded	> 2000	Very Widely
Thickly Bedded	600 – 2000	Widely
Medium Bedded	200 – 600	Medium
Thinly Bedded	60 – 200	Closely
Laminated	3 – 60	Very closely
Thinly Laminated	<3	

5. ROCK NAME

Classified in terms of origin:

IGNEOUS	Granite, Diorite, Gabbro, Syenite, , Dolerite, Trachyte, Andesite, Basalt.
METAMORPHIC	Slate, Felsite, Gneiss, Schist, Quartzite
SEDIMENTARY	Shale, Mudstone, Siltstone, Sandstone, Dolomite, Conglomerate, Tillite, Limestone.

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B

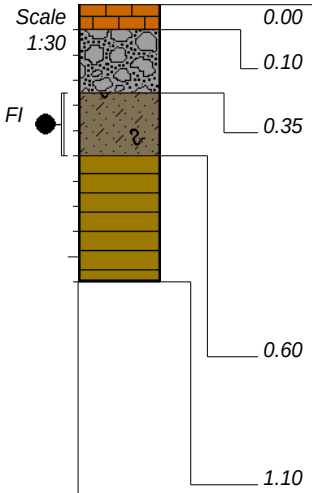
Soil Profile Descriptions

DWALA GROUP
No Limitations

National Home Builders Registration Council (NHBRC)
House van Dyk

HOLE No: HD1
Sheet 1 of 1

JOB NUMBER: 100150



Brickwall.

Concrete Foundation.

Slightly moist, brown, grey patched olive green, red and black, MEDIUM DENSE, clayey sand with subangular gravel, pebbles, and sparse rubble and waste.
Fill.

Note: Presence of roots.

Completely to highly weathered, yellowish-brown mottled black and red, very closely jointed, laminated, very fine-grained, VERY SOFT ROCK. Mudrock.

END OF HOLE.

NOTES

1) Sidewalls are stable.
2) Refusal on soft mudrock.
3) No groundwater seepage was intercepted.
4) FI and MC sample taken at 0.35--0.60 m depth.
5) The footing is placed at a depth of 0.35 m and has a thickness of 0.25 m and a width of 1.01 m.

CONTRACTOR :
MACHINE : Pick and shovel
DRILLED BY :
PROFILED BY : LM

INCLINATION :
DIAM :
DATE :
DATE : 27/01/2023

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : LM
SETUP FILE : STANDARD.SET

DATE : 08/02/2023 10:26
TEXT : ..s\HouseVanDykLogs1.0.txt

HOLE No: HD1
Jeffreys Bay

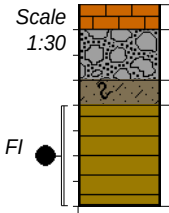
DWALA GROUP
No Limitations

National Home Builders Registration Council (NHBRC)
House van Dyk

HOLE No: HD2
Sheet 1 of 1

JOB NUMBER: 100150

Scale 1:30



0.00	Brickwall.
0.10	Concrete Foundation.
0.30	Slightly moist, brown, grey patched olive green, red and black, MEDIUM DENSE, clayey sand with subangular gravel, pebbles and sparse rubble. Fill. Note: Presence of roots.
0.40	Completely to highly weathered, grey, yellowish-brown mottled black and red, very closely jointed, laminated, very fine-grained, VERY SOFT ROCK. Mudrock.
0.80	END OF HOLE.

NOTES

1) Sidewalls are stable.
2) Refusal on soft mudrock.
3) No groundwater seepage intercepted.
4) FI and MC sample taken at 0.40--0.80 m depth.
5) The footing is placed at a depth of 0.30 m and has a thickness of 0.20 m and a width of 0.85 m.

CONTRACTOR :
MACHINE : Pick and shovel
DRILLED BY :
PROFILED BY : LM

INCLINATION :
DIAM :
DATE :
DATE : 27/01/2023

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : LM
SETUP FILE : STANDARD.SET

DATE : 08/02/2023 10:26
TEXT : ..s\HouseVanDykLogs1.0.txt

HOLE No: HD2
Jeffreys Bay

DWALA GROUP
No Limitations

National Home Builders Registration Council (NHBRC)
House van Dyk

LEGEND
Sheet 1 of 1

JOB NUMBER: 100150

	SAND	{SA04}
	CLAYEY	{SA09}
	MUDROCK	{SA12}
	BRICKWALL	{SA14}
	CONCRETE	{SA34}
Name ●	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : LM
SETUP FILE : STANDARD.SET

DATE : 08/02/2023 10:26
TEXT : ..s\HouseVanDykLogs1.0.txt

LEGEND
SUMMARY OF SYMBOLS

Appendix C

Laboratory Test Results

Outeniqua Lab EC cc.

Materials Testing Laboratory

Registration No. 2009/230653/23

170 Sidwell Avenue, Sidwell, Port Elizabeth : PO Box 3186, George Industria, 6536

Tel: 041 4512464 : Fax: 041 4534959 : e-mail: luwayne@outeniqualab.co.za / agovender@outeniqualab.co.za

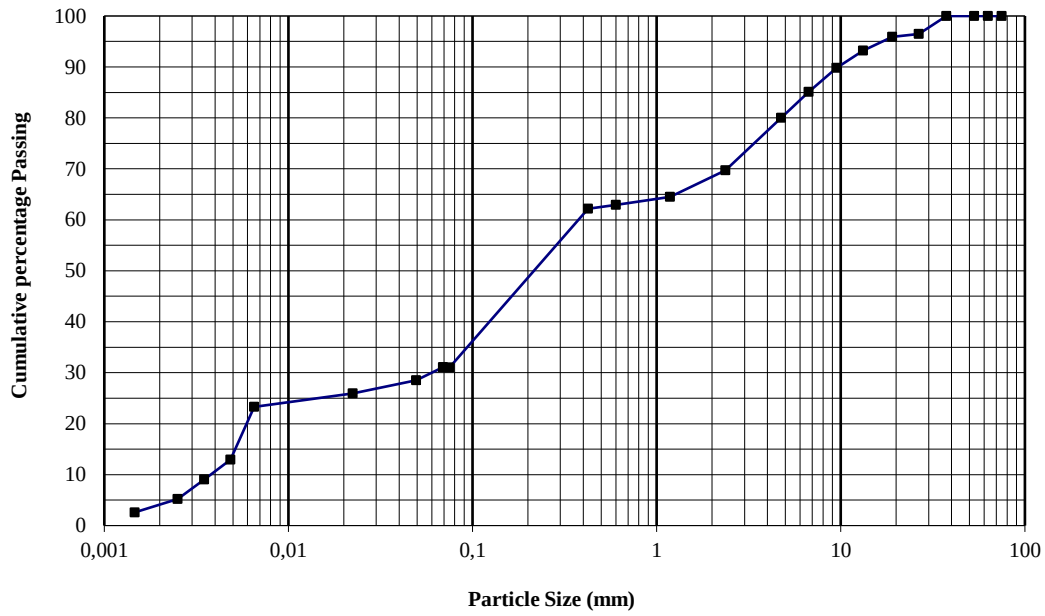
Customer :	Dwala Group (Pty) Ltd	Project :	House Van Dyk
	66 Ingersol Road	Date Received :	27/01/23
	Lynnwood Glen - Pretoria	Date Reported :	06/02/23
	0081, South Africa	Req. Number :	47/23
Attention :	Lethabo Moatshe - 0813487547	No. of Pages :	1/2

TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

Material Description:	Dark Brown - Clayey Silty Gravelly Sand	Sample Number:	16581		
Position:	HD1	Liquid Limit	20	Linear Shrinkage	4
Depth (m):	0,35-1,1	Plasticity Index	8	Insitu M/C%	18,2

Sieve Size(mm)	% Passing
75,0	100
63,0	100
53,0	100
37,5	100
26,5	97
19,0	96
13,2	93
9,5	90
6,7	85
4,75	80
2,36	70
1,18	65
0,600	63
0,425	62
0,075	31
0,0690	31
0,0494	28
0,0223	26
0,0065	23
0,0049	13
0,0035	9
0,0025	5
0,0015	3

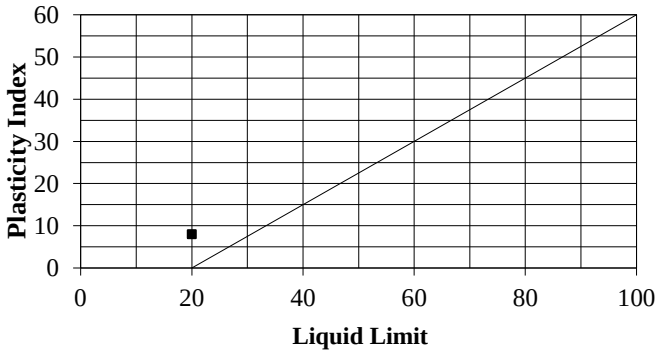
Particle Size Distribution



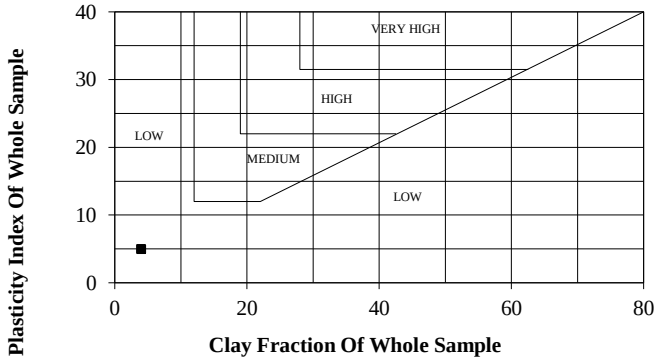
% Clay	4	% Silt	26	% Sand	38	% Gravel	32
Unified Soil Classification		SC		PRA Soil Classification		A-2-4	

Plasticity Chart

A Line



Potential Expansiveness



Notes:

- **Specimens delivered to Outeniqua Lab in good order.**

L Malgraff (Member)
For Outeniqua Lab EC cc.

1. The test results are reported with an approximate 95% level of confidence.
2. This report (with attachments) is the correct record of all measurements made, and may not be reproduced other than with full written approval from the Technical Director of Outeniqua Lab.
3. Results reported in this Test Report relate only to the items tested and are an indication only of the sample provided and/or taken.
4. Measuring Equipment, traceable to National Standards is used where applicable.
5. While every care is taken to ensure the correctness of all tests and reports, neither Outeniqua Lab nor its employees shall be liable in any way whatever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequence thereof.

Outeniqua Lab EC cc.

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Registration No. 2009/230653/23

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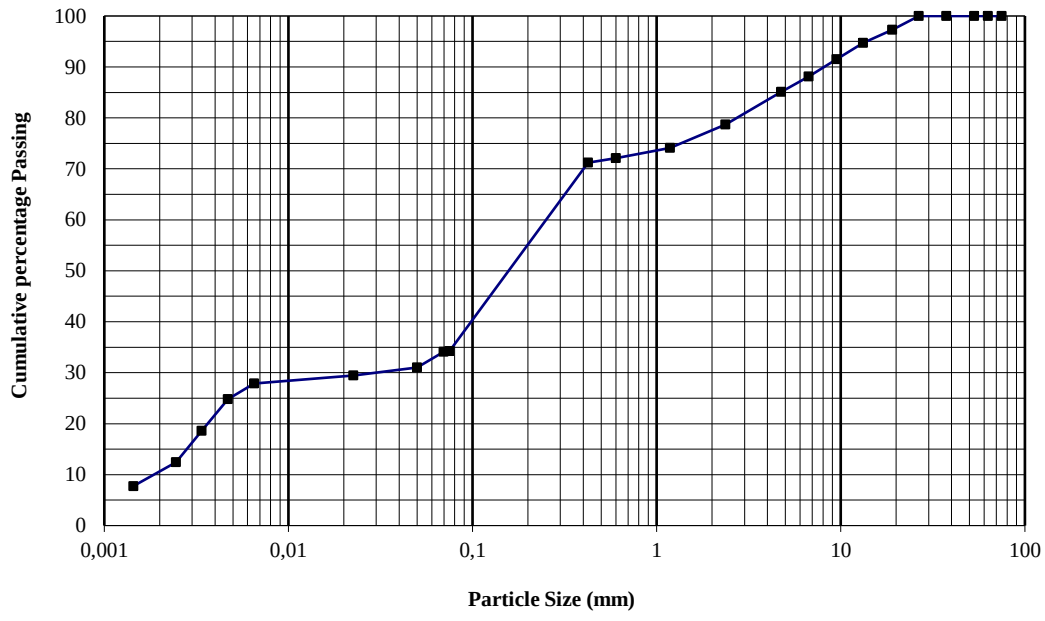
	0081,South Africa	Req. Number :	47/23
Attention :	Lethabo Moatshe - 0813487547	No. of Pages :	2/2

TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

Material Description:	Dark Brown - Clayey Silty Sand	Sample Number:	16582		
Position:	HD2	Liquid Limit	26	Linear Shrinkage	5
Depth (m):	0,4-0,8	Plasticity Index	10	Insitu M/C%	17,5

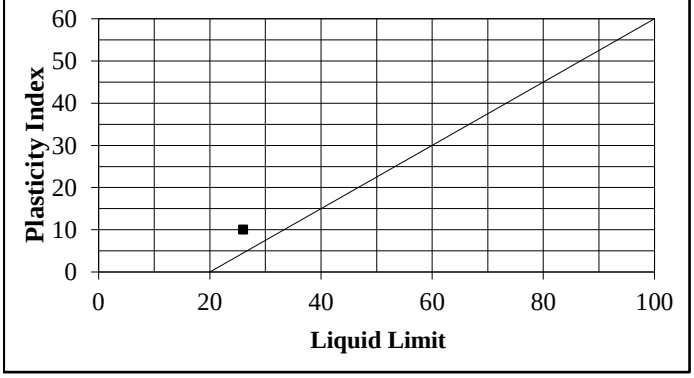
Sieve Size(mm)	% Passing
75,0	100
63,0	100
53,0	100
37,5	100
26,5	100
19,0	97
13,2	95
9,5	92
6,7	88
4,75	85
2,36	79
1,18	74
0,600	72
0,425	71
0,075	34
0,0699	34
0,0500	31
0,0225	29
0,0065	28
0,0047	25
0,0034	19
0,0025	12
0,0014	8

Particle Size Distribution

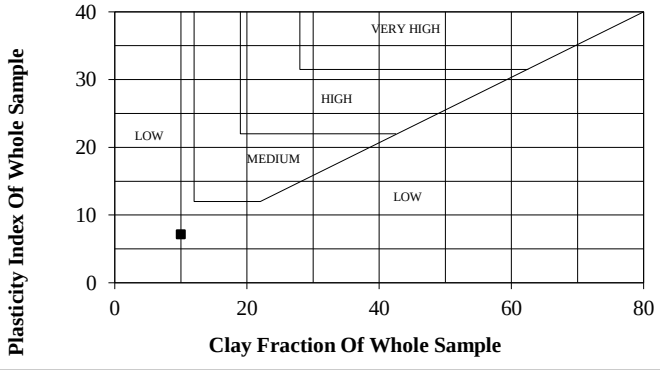


% Clay	10	% Silt	23	% Sand	44	% Gravel	23
Unified Soil Classification		SC		PRA Soil Classification		A-2-4	

Plasticity Chart



Potential Expansiveness



Notes:

- **Specimens delivered to Outeniqua Lab in good order.**

L Malgraff (Member)
For Outeniqua Lab EC cc.

1. The test results are reported with an approximate 95% level of confidence.
2. This report (with attachments) is the correct record of all measurements made, and may not be reproduced other than with full written approval from the Technical Director of Outeniqua Lab.
3. Results reported in this Test Report relate only to the items tested and are an indication only of the sample provided and/or taken.
4. Measuring Equipment, traceable to National Standards is used where applicable.
5. While every care is taken to ensure the correctness of all tests and reports, neither Outeniqua Lab nor its employees shall be liable in any way whatever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequence thereof.

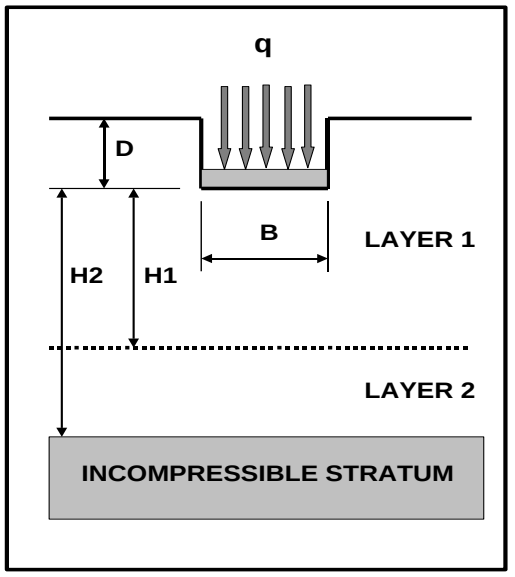
Appendix D

Settlement Calculations

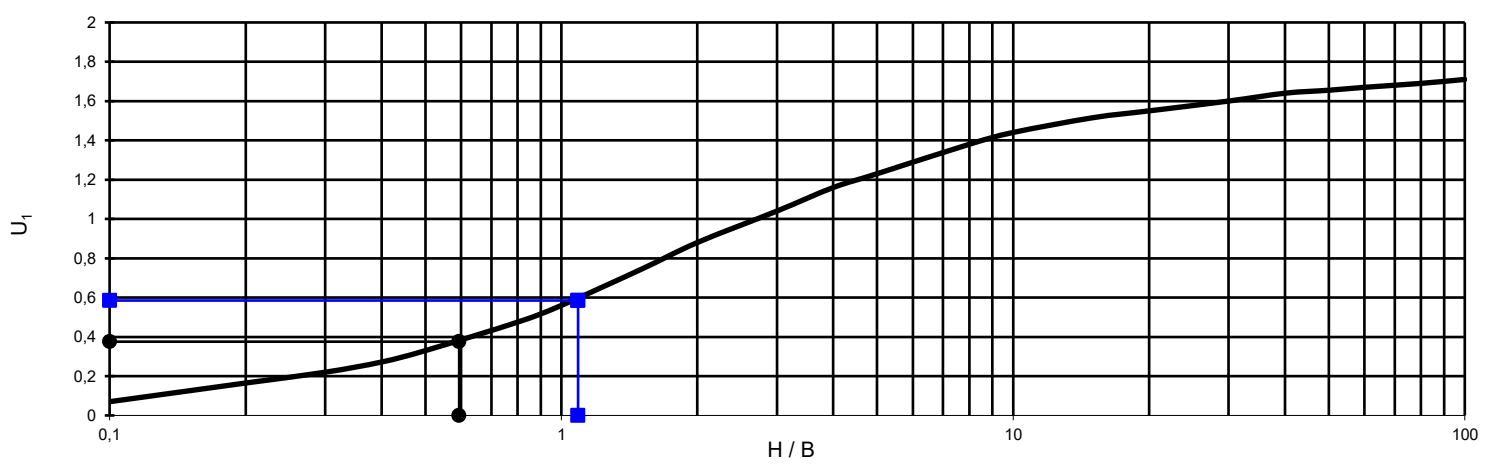
PREDICTION OF THE AVERAGE ELASTIC SETTLEMENT OF A STRIP FOOTING

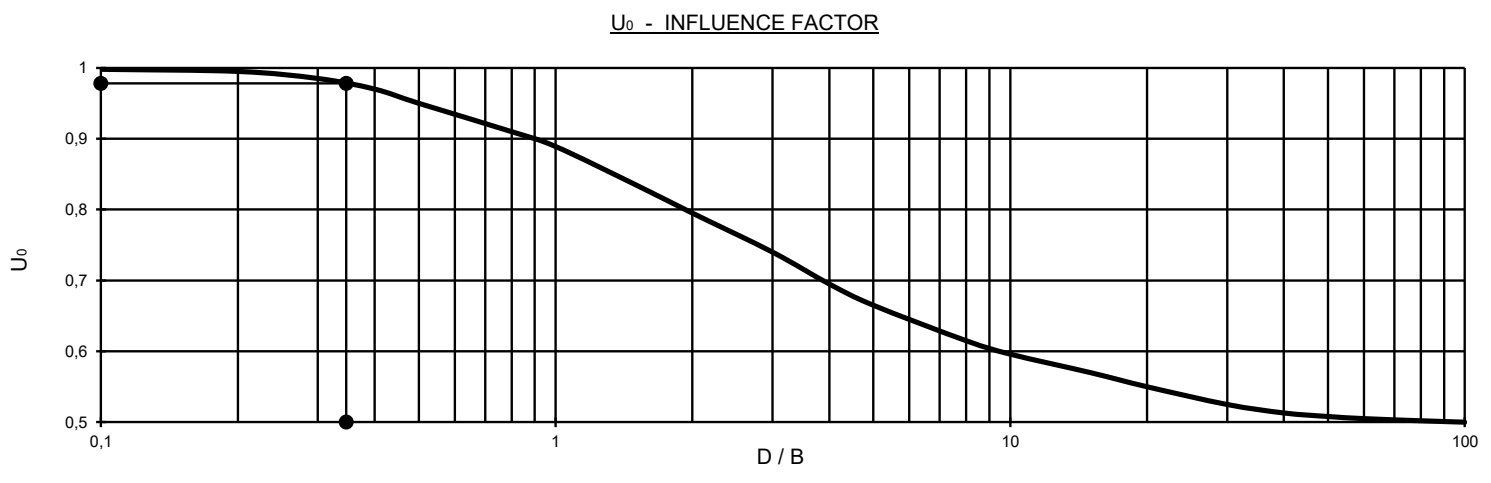
PROJECT NAME	House van Dyk
PROJECT NUMBER	100150
PROBLEM DESCRIPTION	HD1-Settlement on In-Situ Materials
LOCATION	Jeffreys Bay

INPUT PARAMETER	LAYER 1	LAYER 2	UNIT
FOUNDING DEPTH (D)	0,35	0,35	m
WIDTH OF THE FOOTING (B)	1,01	1,01	m
DEPTH OF LAYER (H1, H2)	0,6	1,1	m
STIFFNESS OF COMPRESSIBLE STRATUM	7	7	MPa
FOUNDATION PRESSURE (q)	150	150	kPa
H / B	0,59	1,09	
D / B	0,35	0,35	
U_1 - INFLUENCE FACTOR	0,38	0,58	
U_0 - INFLUENCE FACTOR	0,98	0,98	
AVERAGE IMMEDIATE SETTLEMENT ***	8	4	mm
TOTAL IMMEDIATE SETTLEMENT PREDICTED		12	mm



*** - After Janbu, Bjerrum and Kjaernsli

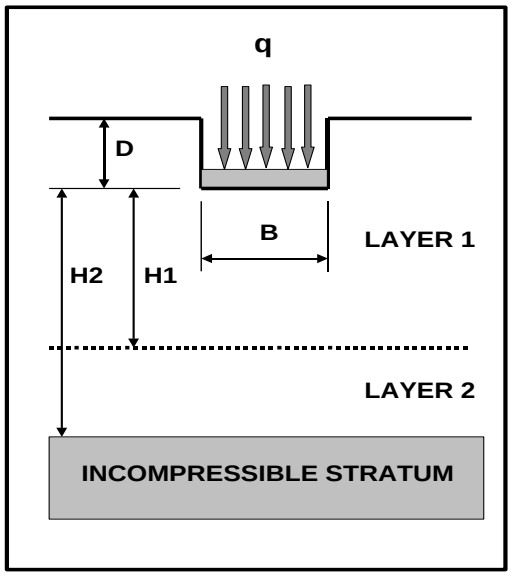




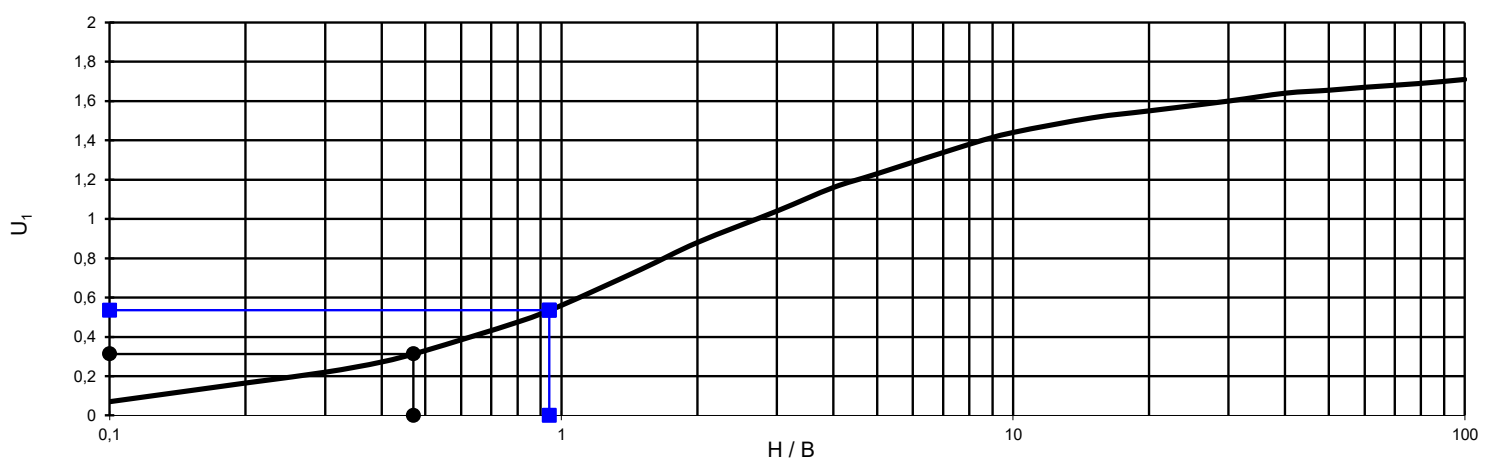
PREDICTION OF THE AVERAGE ELASTIC SETTLEMENT OF A STRIP FOOTING

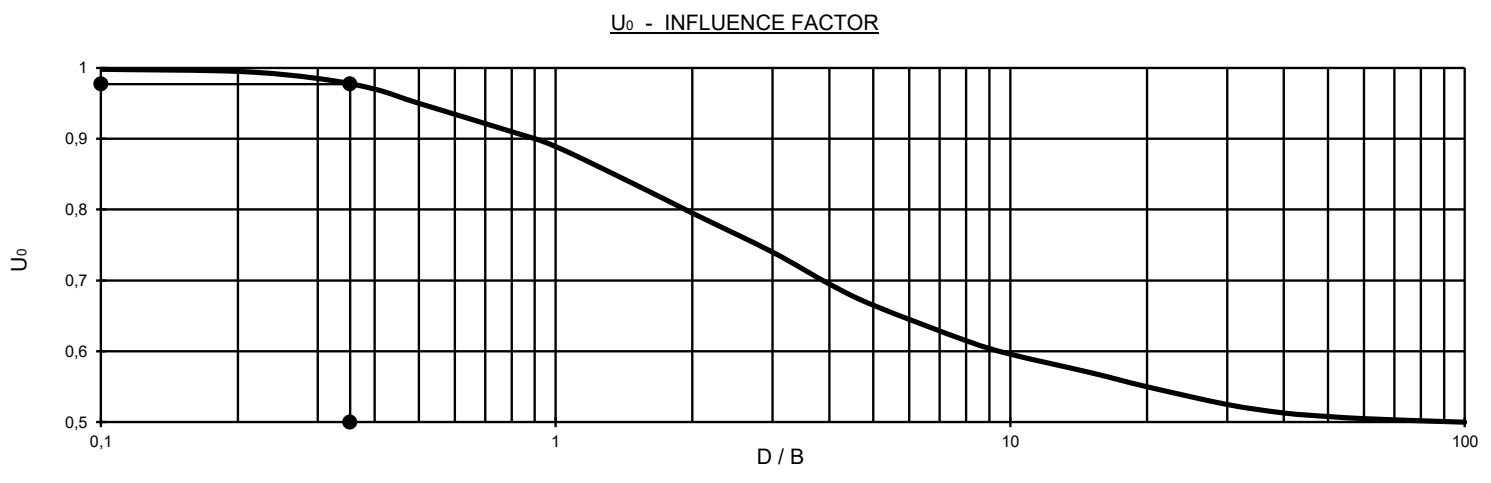
PROJECT NAME	House van Dyk
PROJECT NUMBER	100150
PROBLEM DESCRIPTION	HD2-Settlement on In-Situ Materials
LOCATION	Jeffreys Bay

INPUT PARAMETER	LAYER 1	LAYER 2	UNIT
FOUNDING DEPTH (D)	0,3	0,3	m
WIDTH OF THE FOOTING (B)	0,85	0,85	m
DEPTH OF LAYER (H1, H2)	0,4	0,8	m
STIFFNESS OF COMPRESSIBLE STRATUM	7	7	MPa
FOUNDATION PRESSURE (q)	150	150	kPa
H / B	0,47	0,94	
D / B	0,35	0,35	
U_1 - INFLUENCE FACTOR	0,31	0,54	
U_0 - INFLUENCE FACTOR	0,98	0,98	
AVERAGE IMMEDIATE SETTLEMENT ***	6	4	mm
TOTAL IMMEDIATE SETTLEMENT PREDICTED		10	mm



*** - After Janbu, Bjerrum and Kjaernsli





Appendix E

Site plan


House van Dyk
Test pit positions
Legend
House van Dyk Outline
Test pit
HD2
HD1
R102
Google Earth
60 m
N