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FOUNDATION

Geotechnical Site Investigations

The first step in the home building process is the assessment of the physical properties of soil earth works and foundations of where the house is going to be built.

This process is referred to as the geotechnical investigation and it is carried out by a Geotechnical engineer.

Geotechnical investigations are performed by geotechnical engineers or engineering geologists to obtain information on the physical properties of soil earthworks and foundations for proposed structures and for repair of distress to earthworks and structures caused by subsurface conditions.

This type of investigation is called a site investigation. Additionally, geotechnical investigations are also used to measure the thermal resistivity of soils or backfill materials required for underground transmission lines, oil and gas pipelines, radioactive waste disposal, and solar thermal storage facilities.

A geotechnical investigation will include surface exploration and subsurface exploration of a site. Sometimes, geophysical methods are used to obtain data about sites. Subsurface exploration usually involves soil sampling and laboratory tests of the soil samples retrieved.

Surface exploration can include geologic mapping, geophysical methods, and photogrammetry, or it can be as simple as a geotechnical professional walking around on the site to observe the physical conditions at the site.

To obtain information about the soil conditions below the surface, some form of subsurface exploration is required.

Methods of observing the soils below the surface, obtaining samples, and determining physical properties of the soils and rocks include test pits, trenching (particularly for locating faults and slide planes), boring, and in situ tests. These can also be used to identify contamination in soils prior to development in order to avoid negative environmental impacts.

Once the Geotechnical investigation is done, it is necessary to determine if the type of soil chosen will be suitable for building. Loam & rock soil is the ideal soil type for laying a foundation even for a double storey home foundation: typically, it's a combination of sand, silt and clay. It is dark in colour and soft, dry and crumbly to the touch. Loam is great for supporting foundations because of its evenly balanced properties, especially how it maintains water at a balanced rate.

The dolomite soil condition is the biggest problem for site foundations in South Africa. It is responsible for what is referred to as sinkholes. Certain parts of the ground surface of South Africa are prone to sudden, catastrophic collapse, which may lead to death, injury or structural damage. Such features known as sinkholes occur in areas underlain by dolomite rock.

In terms of the NHBRC regulations, a geotechnical engineer needs to survey the surface to determine if the foundation is not underlain by dolomite conditions which during the rain water season, will not carbonate thus creating a sinkhole in which the home may collapse. In areas, where there is an abundance of dolomite soil conditions, a Raft foundation has to be created as a safe bet for creating a foundation for building on a house.

A raft foundation, also known as a mat foundation is essentially a continuous slab resting on the soil that extends over the entire footprint of the building, thereby supporting the building and transferring its weight to the ground in Dolomitic areas.

In addition to the Dolomite condition, there are other soil classifications by the NHBRC. It is important that a builder knows about the different classes of these soil classifications. Below is a table of the NHBRC's soil classifications, as well as their symbols and characteristics.

Classification of problematic soils according to the NHBRC's soil classification.

TYPICAL FOUNDING SOILCLASSIFICATION	CHARACTERISTIC OF PROBLEMATIC SOIL CLASSIFICATION	NHBRC SOIL SITE CLASSIFICATION
Rock	Stable	"R"
Clays (Fire grained soils with moderate to high plasticity)	Expansive	"H"
Sand (Including Silt & Gravel)	Comprehensible & Potentially Collapsible	"C"
Fine Grained Clay Silt, Sand and Gravel with Low Plasticity)	Comprehensible	"S"
Contaminated soils, Fills, Dolomitic variable areas, Marshes, Reclaimed areas and very soft areas	Variable	"P"

Table 5.2: NHBRC site classification designations linked to construction types

Site class designations	Typical founding material	Character of founding material	Single storey masonry house construction type
R	Rocks	Stable	Normal
H	Clays, silty clays, clayey silts and sandy clays.	Expansive soils	Normal
H1			Modified normal / soil raft
H2			Stiffened or cellular raft / piled or split construction / soil raft
H3			Stiffened or cellular raft / piled construction / soil raft.
C	Silty sands, sands, sandy and gravely soils	Compressible and potentially collapsible soils	Normal
C1			Modified normal / compaction of in-situ soils below individual footings / deep strip foundations / soil raft.
C2			Stiffened strip footings, stiffened or cellular raft / deep strip foundations / compaction of in-situ soils below individual footings / piled or pier foundations / soil raft.
P	Contaminated soils, controlled fill, dolomitic areas, landslip, landfill, marshy areas, mine waste fill, mining subsidence, reclaimed areas, uncontrolled fill, very soft silts / silty clays.	Variable	Variable
S	Clayey silts, clayey sands of low plasticity, sands, sandy and gravely soils	Compressible soils	Normal
S1			Modified normal / compaction of in-situ soil below individual footings / deep strip foundations / soil raft.
S2			Stiffened strip footings, stiffenend or cellular raft / deep strip foundations / compaction of in-situ soils below individual footings / piled or pier foundations / soil raft.

EXCAVATIONS FOR FOUNDATIONS

Any excavation more than 3 m deep shall be designed by a professional engineer or other approved competent person. Any excavation for any foundation shall be taken down to firm natural ground: Provided that it shall be permissible to cast any foundation in filled ground if approved measures are taken to ensure the stability and the serviceability of the building. The bottom of any excavation in ground other than rock shall be horizontal: Provided that where such a bottom is in the form of steps, such steps shall have horizontal and vertical surfaces. Where any foundation is placed on solid rock, the bearing area shall be cleaned and, where necessary, so stepped or dowelled as to prevent lateral movement of such foundation. Except where the foundation for any external masonry wall is placed on solid rock, the bottom of the excavation for such a foundation shall not be less than 300 mm below the level of the adjoining finished ground.

Engineered Fill' is the material that is going to be used to fill in a depression or hole in the ground, or create mounds or otherwise artificially change the elevation of the ground. These may include earthworks such as infill, raising or levelling ground, embankments, foundation pads, road bases and landscaping. Fill may be engineered or non-engineered. Engineered fill is selected, placed and compacted to an appropriate specification in order to that it will exhibit the required engineering behaviour.

Non-engineered fill usually involves the disposal of waste materials. Normally such fill would occur on sites where uncontrolled filling has taken place and therefore no reliance can be placed on the type of fill material and method of placement.

Once the surface ground has been levelled, the next step is to dig up the foundation Trenches. Before concrete can be poured into the trenches, the trenches must thoroughly be compacted and a level surface obtained before concrete is poured in.

The following tables shows the various concrete mix guidelines as per the NHBRC recommendations for the different applications of concrete.

Table 4.2: Mix designs for different grades of concrete (see SANS 2001-CC2)

Grade of concrete	Cement kg	Sand		stone		Water[b] L
		L	Wheelbarrows[a]	L	Wheelbarrows[a]	
Class 42,5 N or R cement with 19 mm stone						
10	100 (2 bags)	290	4,5	290	4,5	72
25	100 (2 bags)	200	3,0	200	3,0	55
Class 32,5 N or R cement with 19 mm stone						
10	100 (2 bags)	260	4,0	260	4,0	67
25	100 (2 bags)	160	2,5	160	2,5	50
Class 42,5 N or R cement with 13 mm stone						
10	100 (2 bags)	330	5,0	230	3,5	71
25	100 (2 bags)	200	3,0	160	2,5	56
Class 32,5 N or R cement with 13 mm stone						
10	100 (2 bags)	290	4,5	200	3,0	66
25	100 (2 bags)	160	2,5	130	2,0	51

[a] A standard wheelbarrow for concrete (SANS 795 type 5 wheelbarrow) has a capacity of between 60 L and 70 L with no projection of material above the rim of the wheelbarrow.

[b] Only sufficient water should be added to produce a workable mix. The quantities of water are for guidance only as the actual quantity required will depend on a number of factors, including the moisture content and quality of the sand and the type of cement used.

Notes on mixes in Tables 1a – 1d:

1. Low-strength (15 MPa) concrete is suitable for unreinforced foundations (single storey only); mass fill, infill concrete in masonry (only with 13,2-mm stone).
2. Medium-