Department of Geology
University of Pretoria

ENGINEERING GEOLOGY GLY 363

MEMO SEMESTER SICK TEST

20 March 2009

TIME: 50 min
MARKS: 50
ANSWER ALL THE QUESTIONS IN THE ANSWER BOOK PROVIDED

Question 1 [15]

Climate and mineralogy play an important role in determining the engineering geological properties of residual and transported soils. Use andesite as an example to illustrate the above statement.

Andesite occurs in Ventersdorp Supergroup, Hekpoort Andesite Formation of Pretoria Group.
Both lithological units occur in climatic zones varying from dry (west, N > 5) to wet (east, N < 5).
Andesite mineralogy = intermediate rock; middle region of Bowen reaction series; amphibole (hornblende), plagioclase (Ca, Na), some pyroxene; fine-grained groundmass with phenocrysts.
Typical influence of climate:
N > 5 = physical weathering = small change to primary minerals; gravelly & sandy soils with mainly original mineralogical composition; shallow soils < 2.5 m + hard spheroids; good foundations; excavation difficulty.
N 2.5 – 5 = chemical weathering = change in primary mineralogy to clay minerals (plagioclase, pyroxene + amphibole to smectite clays), profile from red at surface to yellow transition zone to green highly weathered bedrock; expansive properties; soil thickness < 12 m; core stones.
N < 2.5 = graben structure in Witwatersrand Supergroup; chemical weathering; deep soils up to 50 m; highly compressible and non-expansive.

Question 2 [35]

Discuss and explain the following:

2.1 collapsible grain structure (10)

occurs where preferential weathering takes place in rocks with quartz and feldspar and chemical weathering.
Small clay particles removed through percolating groundwater above groundwater table (leached out)
Open structure remains with cavities where feldspar mineral grains were and quartz (resistant to chemical weathering) grains are bonded by clay bridges.
Soil strong when dry; when loaded and saturated sudden reduction in volume as clay bridges between quartz grains are lubricated and quartz grains go into dense packing.
Typical examples in SA: granite, arkose and feldspathic sandstone (quartz & feldspar).
Need long exposure to weathering and leaching without erosion removing the soil. Appears on certain historic erosion surfaces – above 1 500 m contour in Johannesburg Dome granite.
Foundation solutions: excavate and compacted backfill, dynamic compaction,

2.2 perched groundwater tables in Basement granite (5)

unweathered granite bedrock impervious, weathered granite profile abundance of Fe, Mn, Ca and Mg ions, N > 5 area rainwater accumulates on impervious bedrock or hardpan ferricrete (ferruginized residual soil), typical on lower slopes and flat lying areas.

2.3 main reasons for unstable slopes in clastic sedimentary rock sequences (5)

SA clastic sedimentary rocks deposited in horizontal beds, intercalated mudrock & sandstone.

Tectonic forces displaced and deformed beds – folding, jointing, tilting, etc.

Slope failures due to: sliding on bedding planes; pore water pressure build up on impervious mudrock; undercutting of sandstone by weathering and erosion of weaker mudrock layers

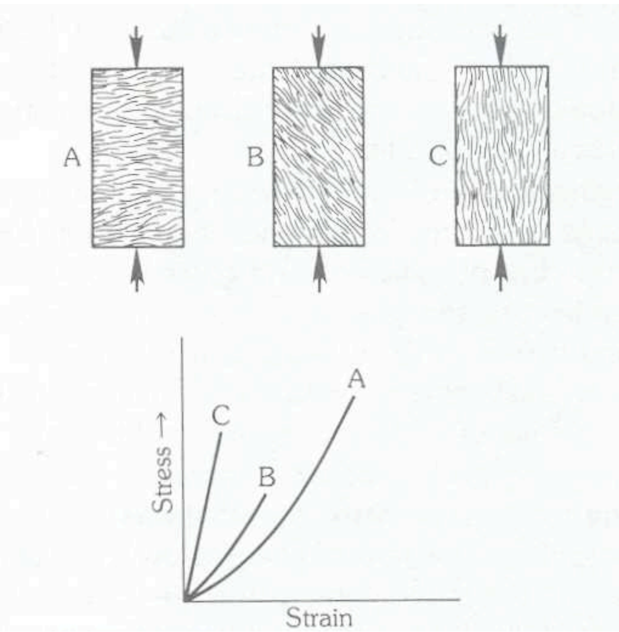
Block & wedge failures

2.4 anisotropic strength behaviour in metamorphic rocks (5)

some metamorphic rocks exhibit platy cleavage or foliation due to applied directional tectonic forces

foliation and banding cause alignment of platy minerals and separation of dark and light minerals.

Rock will behave differently depending on the orientation of applied stress.



2.5 surface effects of undermining (10)

depends on mining method:

coal mining: sinkholes over bord and pillar, regional subsidence over total extraction

deep coal mining: sinkholes, subsidence due to slope closure, tension cracks due to hanging wall settlement.

TOTAL **[50]**