SANS 1936 and related standards

Development on dolomite land

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Overview

• Dolomite related standards
• Perspective on risks involved
• Assessment of hazard
• Performance based standard
• Overview of requirements
• Some problem areas
• Where to from here?
• Conclusions
## Dolomite related standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SANS 1936</td>
<td>Development of dolomitic land</td>
</tr>
<tr>
<td></td>
<td>Part 1  General principles and requirements</td>
</tr>
<tr>
<td></td>
<td>Part 2  Geotechnical investigations and requirements</td>
</tr>
<tr>
<td></td>
<td>Part 3  Design and construction, buildings and infrastructure</td>
</tr>
<tr>
<td></td>
<td>Part 4  Risk management</td>
</tr>
<tr>
<td>SANS 633</td>
<td>Soil profiling and borehole logging on dolomite land</td>
</tr>
<tr>
<td></td>
<td>Changed from general to dolomite-specific guidelines</td>
</tr>
<tr>
<td>SANS 634</td>
<td>Geotechnical investigations for township development</td>
</tr>
<tr>
<td></td>
<td>Minor amendments only – largely unchanged</td>
</tr>
<tr>
<td>SANS 2001-BE3</td>
<td>Repair of sinkholes and dolines</td>
</tr>
<tr>
<td></td>
<td>Corrected, simplified and harmonized with other standards</td>
</tr>
</tbody>
</table>
Perspective on risks involved
Gauteng Province

• 1.4% of area of RSA
• 22% of population
• 33% of GDP
• 25% on dolomite

Prohibiting development is not an option!
West Driefontein, 1962

17 people killed
1 person killed

Venterspost, 1971
No deaths

Bank Compartment, 1975
No deaths

Orkney, 1986
No deaths
Total recorded fatalities to date = 38

No deaths

N14: Centurion 2012
13 967 road deaths in South Africa in 2010 alone!
Problems with pre-2009 drafts
.... or why all the delays?

- Not written by geotechnical fraternity
- No consensus (i.e. sustained opposition)
- Requirements out of proportion to risk
- Prohibited development on high risk land
- Failed to recognise engineers’ ability to find solutions.
Hazard Assessment
Transported sand and gravels

Residuum

Typical soil profile - before development
Typical soil profile - before development
Cavities (receptacles)

Typical soil profile - before development
Subsidence caused WT drawdown or water ingress
96% of sinkholes caused by water ingress
Buttrick’s “Scenario Supposition” method

• Looks at various scenarios:
  – Static water table
  – Uncontrolled drawdown of WT.

• Factors considered:
  – Receptacle development
  – Mobilising agency
  – Mobilization potential
  – Potential development space

  - Likelihood of sinkhole development
  - Potential size of sinkholes
1. Receptacle development

Cavities assumed to be present even if not encountered during drilling
2. Mobilising agency

- Typically water ingress or water table lowering
- Generally assumed water ingress will occur
3. Mobilisation potential

Function of:
- grading
- permeability
- erodibility
- consistency
- cohesion
- cementing, etc
4. Potential development space

- Based on assumed angles of draw in various horizons
- Determines maximum potential sinkhole size
Performance based standard
Performance based regulatory system:

<table>
<thead>
<tr>
<th>Level</th>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Goal / objective</td>
<td>Broad statement of intent that reflects societal expectations</td>
</tr>
<tr>
<td>Level 2</td>
<td>Functional Requirement</td>
<td>Functional or qualitative requirements to be met without specifying procedures, etc</td>
</tr>
<tr>
<td>Level 3</td>
<td>Performance Requirements</td>
<td>Quantitative requirements that will ensure functional requirements are satisfied</td>
</tr>
<tr>
<td>Level 4</td>
<td>Evaluation</td>
<td>Confirmation that the nominated performance is achieved</td>
</tr>
</tbody>
</table>
Scope of Standard:
l
development of dolomite land to ensure:
• people live and work in a safe environment
• damage to property is within acceptable limits
• cost effective and sustainable land use.
Land that is underlain by dolomite shall present an acceptable risk of sinkhole and subsidence formation over time.
Level 3 Performance Requirements

Quantitative requirements that will ensure functional requirements are satisfied

Performance requirement:
Less than 1 event per hectare in a 200 year period

achieved by:
• Establish inherent hazard class
• Determine precautions required for various categories of development
• Ongoing risk management procedures
<table>
<thead>
<tr>
<th>Level 4</th>
<th>Evaluation</th>
<th>Confirmation that the nominated performance is achieved</th>
</tr>
</thead>
</table>

- Development to be undertaken under supervision of a competent person
- Overview by state authorities
- Compulsory reporting to central database
Overview of requirements

1. Investigate Site
   SANS 1936-2
2. Classify Site
   SANS 1936-2
3. Permissible Land Use
   SANS 1936-1
4. Dolomite Area Designation
   SANS 1936-1
5. Design and other requirements
   SANS 1936-3
6. Risk management
   SANS 1936-4
Overview of requirements

- Investigate Site (SANS 1936-2)
- Classify Site (SANS 1936-2)
- Permissible Land Use (SANS 1936-1)
- Dolomite Area Designation (SANS 1936-1)
- Design and other requirements (SANS 1936-3)
- Risk management (SANS 1936-4)
Investigation requirements

• Appropriate investigation methods
• Minimum requirements
• Phased approach
  – Feasibility level investigations
  – Design level investigations
  – Investigation during construction
Overview of requirements .... (cont)

- Investigate Site
  SANS 1936-2

- Classify Site
  SANS 1936-2

- Permissible Land Use
  SANS 1936-1

- Dolomite Area Designation
  SANS 1936-1

- Design and other requirements
  SANS 1936-3

- Risk management
  SANS 1936-4
Classification criteria:

• **Sinkhole size:**

- Small <2m
- Medium 2m – 5m
- Large 5m – 15m
- Very large >15m

• **Likelihood of occurrence (per hectare):**

- Low >200y
- Med 20y – 200y
- High <2y
<table>
<thead>
<tr>
<th>Inherent Hazard Class</th>
<th>Size of sinkhole</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small &lt;2m</td>
</tr>
<tr>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Med</td>
</tr>
<tr>
<td>3</td>
<td>Med</td>
</tr>
<tr>
<td>4</td>
<td>Med</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>High</td>
</tr>
</tbody>
</table>
Overview of requirements .... (cont)

- Investigate Site SANS 1936-2
- Classify Site SANS 1936-2
- Permissible Land Use SANS 1936-1
- Dolomite Area Designation SANS 1936-1
- Design and other requirements SANS 1936-3
- Risk management SANS 1936-4
Permissible land use

• Type of development
  – Commercial
  – Residential
  – Agricultural, etc.

• Density of development
  – Size of stands
  – Height of residential structures

• Water ingress potential
  – Retaining structures (reservoirs, dams, etc.)
  – Irrigation (agriculture)
Overview of requirements .... (cont)

- Investigate Site SANS 1936-2
- Classify Site SANS 1936-2
- Permissible Land Use SANS 1936-1
- Dolomite Area Designation SANS 1936-1
- Design and other requirements SANS 1936-3
- Risk management SANS 1936-4
Dolomite area designation

- Determines precautionary measures required

<table>
<thead>
<tr>
<th>D1</th>
<th>No precautions required</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2</td>
<td>General measures, water ingress</td>
</tr>
<tr>
<td>D3</td>
<td>Additional measures</td>
</tr>
<tr>
<td>D4</td>
<td>Site specific – rational assessment</td>
</tr>
</tbody>
</table>
Overview of requirements .... (cont)

Investigate Site SANS 1936-2
Classify Site SANS 1936-2
Permissible Land Use SANS 1936-1
Dolomite Area Designation SANS 1936-1
Design and other requirements SANS 1936-3
Risk management SANS 1936-4

Dealt with in next presentation
Problem Areas

- Method of hazard classification
- Prohibition of development on D4 land
- Definition of a competent person
- Practicality of requirements
HAZARD CLASSIFICATION

• Problem:
  – Draft code specified Scenario Supposition method to exclusion of other approaches

• Solution:
  – Specified classification parameters – not method of classification
  – Opened the door for rational assessment
  – Made Scenario Supposition a “deemed-to-satisfy” method in an informative annex.
PROHIBITION OF DEVELOPMENT

• Problem:
  – Draft code prohibited development in high risk areas

• Solution:
  – Adopted same approach as Eurocodes, i.e.
    • provisions of code cover typical situations
    • high risk areas require additional measures
    • specified design by “expert” practitioner with full peer review procedures.
DEFINITION OF COMPETENT PERSON

• Problem:
  – No yardstick for judging competence

• Solution:
  – Adopted approach from ICE Site Investigation Steering Group
Competence levels:

- Required competence for high risk sites

- Competence levels:
  - Candidate
  - Registered professional
  - Experienced professional
  - Expert professional

- Recognition
- Experience
- Registration
- Education

- Required competence for high risk sites
- Minimum 5 years experience as an experienced geoprofessional. Refer Clauses 3.2.5 and 3.2.6
- Minimum 7 years experience in geotechnical engineering after registration. Refer Clauses 3.2.4 and 3.2.6

- Appropriate training and registration as P Tech Phn
- Undergraduate Student
- Learner

- National diploma in civil engineering
- Engineering technology
- Geology
- Geotechnical engineering
- Engineering

- School
- National diploma in civil engineering
- Learner
- Undergraduate Student
- Technician
- Registered professional
- Experienced professional
- Expert professional
- Candidate

- SABS
Precedent: Gautrain Project

- Rational assessment of risk
- Targeted precautionary measures
- Expert analysis and review

See Sartain et al.
Large diameter shafts to solid rock – up to 70m deep
PRACTICALITY OF REQUIREMENTS

• Problem:
  – Requirements not always achievable

• Solution:
  – Adopted “reasonably practicable” approach from OHS Act
  – Rational assessment alternative
Where to from here?

• Implement current requirements
• Continue to develop sinkhole database
• Rigorous analysis database
• Develop “geotechnical model” concept
• Revise code within 5 years

Standards are living documents!
Conclusion

Standards should **not stifle initiative** but:

- encourage further research / improvement
- provide a framework within which competent professionals can exercise their skills in a responsible manner.

Thank you