ENGINEERING GEOLOGY AND ROCK MECHANICS

Discontinuities
SKAA 2712

Prof. Madya Dr. Edy Tonnizam bin Mohamad

Faculty of Civil Engineering,

Universiti Teknologi Malaysia, Johor, Malaysia

Segamat Quarry

- In terms of geological properties, studies have to be made into rock mass properties, which include study of the weathering profile and discontinuity characteristics.
- Weathering effect is crucial especially in tropical climate where it can change the various properties of the original material into different materials. Therefore, an understanding of the weathering effect on those materials is very important.
- On the other hand, **discontinuities** can reduce or enhance the rock mass strength (Edy Tonnizam et al., 2005).
- Joints will normally reduce the rock mass strength by providing weakness planes in the rock mass whereas, accumulations of stronger material at joints surfaces such as iron pan and quartz will increase the rock material strength (Edy Tonnizam et al., 2005).

A Malaysian Example

Mersing

Photo by Edy Tonnizam, 2010

Photo by Edy Tonnizam, 2010

What need to do?

- During field studies
- geological data collection
- mapping of discontinuities
- and assessment of rock mass conditions from scan line surveys

Hard rock?

- Hard rocks are depending greatly on the discontinuities to determine their mechanical behaviour.
- It is therefore essential that both the structure of rock mass and the nature of its discontinuities to be assessed.

Definitions

- **Joint** – A break of geological origin in the continuity of a body of rock and no visible displacement
- **Fault**- A fracture/ fracture zone with displacement
- **Discontinuity**- General term for any mechanical discontinuity in a rock mass. Discontinuities include all types of mechanical break or plane of weakness in rock mass such as joints, bedding plane, fractures and shear zones that weakened the strength of rock masses.

Discontinuity

- Discontinuity measurements are made to assess weakness planes that in some cases will enhance the strength of rock mass.
- Discontinuities with the influence of frequency and orientation, within rock mass may assist and ease the excavation process in much stronger material.

How to describe discontinuity?

i) Orientation – described in dip direction/dip
ii) Number of sets
iii) Spacing
iv) Persistence
v) Roughness
vi) Wall Strength
vii) Aperture
viii) Filling
ix) Seepage
x) Block size

Segamat Quarry

How to measure orientation?

- Described by the dip of the steepest declination, and by the dip direction measured from true north
- By geological/Brunton compass

Measuring Equipment

Measuring Equipment

How to measure orientation and spacing?

- Scan line techniques are well known for measuring joint spacing.
- With this technique, a measuring tape was set up on the exposed faces of the rock mass normal to strike of the discontinuity sets.

Why orientation is so important?

- The orientation relative to an engineering structure largely controls the possibility of unstable conditions
- Risk of instability increases when sufficient no. of discontinuities and joint sets for slip present
- The mutual orientation of discontinuities will determine the shape of blocks

What is a scan line survey?

- Data such as
- distance between discontinuities
- orientation
- infilling
- and aperture are recorded

The structural data can be analysed by using stereographic projections to determine the number of joint sets and the discontinuity orientations.

Measuring discontinuities on sandstone by scan line method

Scanline

- The spacing between adjacent joints is established by counting the number of joints intersecting a line of known length and expressed as mean spacing in metres.
- According to Priest and Hudson (1976) and ISRM (1981), the recommended length of a scan line has to be between 10 to 50 times the estimate mean value of discontinuity spacing.

Spherical projection

- A discontinuity plane can be presented as a great circle or as a pole on a reference hemisphere
- The dip is plotted at right angles to the strike, measured from periphery towards the centre
- Important to differemtiate pole and great circle

Spherical projection

- The idea is to obtain orientation data for different discontinuity sets
- So that clusters can be recognised
- Then, contours are drawn
- From the contour, great circle will be drawn to present the orientation of weakness plane.

- Normally, there are three types of failures that occurs on rock with weathering grade I to III; plane failure, wedge failure and toppling failure.
- Plane failure occurs when geological discontinuity, such as a bedding plane, strikes parallel to the slope face and dips into the excavation at an angle greater than the angle of friction.

- Wedge failure occurs when two discontinuities strike obliquely across the slope face and their line of intersection daylights in the slope face, the wedge of rock resting on these discontinuities will slide down the line of intersection, provided that the inclination of this line is significantly greater than the angle of friction.
- Toppling failure when form of columnar separated by steeply dipping discontinuities.

- Fully weathered or moderate weathered rock, which the weathering grade are grade IV to VI behaves differently (Edy Tonnizam et al., 2011).
- Therefore, modes of this failure like to be soils slope like circular failure. Circular failure occurs when the material is very weak, as in a soil slope or when the rock mass is very heavily jointed or broken, as in a waste rock dump, the failure will be defined by a single discontinuity surface but will tend to follow a circular failure path.

References

- Edy Tonnizam Mohamad, Khairul Anuar Kassim and Ibrahim Komoo (2005). To Rip or To Blast : An Overview of Existing Excavation Assessment. *Brunei International Conference on Engineering and Technology* (BICET 2005) : 27-36.
- Edy Tonnizam Mohamad, Seyed Vahid Alavi Nezhad Khaili Abad & Rosli Saad (2011), Challenges of Excavation by Ripping Works in Weathered Sedimentary Zone, Electronic Journal of Geotechnical Engineering, Bund 16 O, pp 1337-1350, ISSN 1089-3032
- International Society of Rock Mechanics, (1981), *Rock Characterization Suggested Method. Testing and Monitoring*.: London., Pergamon Press.
- Priest, S.D., and Hudson, J.A., (1976). Discontinuity spacings in rock*.: International Journal of Rock Mechanics, Mineral Science & Geomechanics Abstract*, v. 13 : 135-148.