Computer-aided processing of discontinuity data: A case study from km 26.5, Kuala Lumpur-Karak Highway, Malaysia

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"Discontinuity" is a term used in geology and engineering geology to describe any break within a rock mass characterised by very low or zero strength (ISRM, 1978). It includes joints fractures cracks, fissures, bedding planes, faults and other similar planes which divide the rock mass into rock blocks. The influence of discontinuities and their characteristics on stability and engineering behaviour of a rock mass has been recognised for some time, e.g. Mueller (1963) stressed on the importance of the degree of fracturing and the use of a fracture index in sub-dividing a rock mass into homogeneous zones.

The processing of discontinuity data is one of the tasks faced by geologists, whether in classical or

applied geological work, before such data can be used for further interpretation. For a long time, this data processing has been carried out manually, based on procedures developed e.g. by Schmidt (1925) and others. In recent years a number of computer programs for such data processing have become available. This paper discusses the use of one such program, WINGESAP, whose initial development started at the Chair of Geotechnics (Prof. Dr. Ing. K.W. John), Institute of Geology, Ruhr University, Bochum and was subsequently refined by N. Graf, Geo-System, Bochum. Data collected from km 26.5, Kuala Lumpur-Karak Highway, (Abdul Ghani Rafek, 1994) was processed at Geoplan, Witten, using different plotting procedures. The results are presented in Table 1 the density isoline plots. The orientation of major discontinuity planes is in the form of dip direction and amount of dip (α/β).

The results of the density isoline plots shown in Table 1 were determined as follows:

(a)   Manual processing using the counting nets of Braun (1969);

(b)   1% fixed area cone using the program WINGESAP;

(c)   Variable area cone using the program WINGESAP whereby
       $F = 100/n \%$
       F = counting cone area in %
       n = number of readings

(d)   Mixed evaluation method, with WINGESAP. In this case the following formula is used:
       $\eta = \eta_1 XF_1/(F_1 + F_2) + \eta_2 XF_2/(F_1 + F_2)$
       F_1 = percentage area of first counting cone
       η_1 = number of readings within first counting cone
       η_2 = number of readings within second counting cone
       η = the results, i.e. the number for that counting area

(e)   Determination using the cosine method. This method was developed by Adam (1989) and uses the direction cosines between the centre of the counting point and the discontinuity reading.

Comparison of the different plots and the results in Table 1 leads to a number of conclusions. Amongst them are:

• all the different plotting techniques show that there are four major discontinuity sets.

• with computer-aided processing, the different techniques yield the same results for the orientation (within a range of five degrees). By comparison, differences of the greater than 10 degrees are obtained by manual plotting.

• the values of the percentage density maximums are determined to a greater accuracy using the program WINGESAP.

• using the manual method, eight different discontinuity sets were determined. However some of them have low density and may not be of significance.

• using the different computer-aided processing techniques, it was found that five discontinuity sets were determined by two techniques and four by the remaining two techniques This is being investigated further.

Table 1. Results of processing of discontinuity data using different plotting techniques: Kuala Lumpur-Karak Highway, km 26.

TECHNIQUE	Orientation of major discontinuity planes (α/β) and stereographic density (%)
Manual	055/85; > 6.0; 096/85; 6.0; 110/50; > 6.0 345/86; > 6.0; 000/82; 5.0–6.0; 130/78; 5.0–6.0; 030/55 & 030/55; 3.7–5.0
1% area	0070/85; 19.0; 348/86; 15.0; 093/88; 13.0; 027/49; 11.0; 116/58; 10.0
F = 100/η	076/87; 18.0; 346/87; 15.0; 115/58; 12.0; 027/49; 7.0
Mixed evaluation	348/86; 18.0; 065/85; 17.0; 093/88; 13.0; 116/57; 10.0; 027/49; 7.0
Cosine method	065/85; 17.0; 353/84; 17.0; 114/62; 13.0; 033/47;110