Analysis Rock Mass Rating (RMR) Elevation Inlet Diversion Tunel Luewikeris

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Abstract. Leuwikeris Dam Project located in Handapherang Village, Cijeungjing District, Ciamis Regency, West Java Province is one of the dam projects built on volcanic sediment rocks including in the Old Volcanoes Formation. Limit Equilibrium Method (LEM), is a method used to find the Rock Mass Rating (RMR) value in each elevation on the slope of the Dodge Tunnel Inlet. Based on the analysis, the result of its RMR value at the elevation of 130 meters has rock mass class is II (Good), elevation of 140 meters has rock mass class is II (Good), elevation of 145 meters has rock mass class is III (Medium rock), and elevation 157 meters have a class of rock mass is III (Medium rocks).

1. Introduction

The state of the rock mass structure in nature that tends to be different is controlled by the appearance of geological structure, the field of discontinuity, the plane of the layer or the stocky. The apparition of rock mass that is filled by several layers of coating and stack shows the existence of a discontinuity plane. A more systematic approach to slope stability analysis by classification of slopes by using the Rock Mass Rating (RMR) approach. RMR can provide preliminary guidance in evaluating the slope stability in which the RMR is controlled by the geological structure, rock type and morphological state of a region provides useful information about the type of collapse as well as the things required for slope improvement. Problems often encountered by soil or open rock are deformation behavior, soft rock behavior and bad condition of rock mass structure.

On the other hand besides the Rock Mass Rating (RMR) approach, Limit Equilibrium Method (LEM) or Boundary Equilibrium Method can also be used in evaluating slope stability. LEM is widely used in analyzing slope stability because this method is considered a relatively simple method. One of the methods to be used is the Janbu Method [1] [2].

Knowledge of slope stability or so-called slope stability should be recognized by field workers in open cut activities. Knowledge of the stability of this slope is necessary to keep the excavation activity as expected. This is very important because of the slope stability will affect the excavation activities, either in whole or in some excavation activities, for example: The occurrence of landslides partially or all of the slopes will result in direct losses in the form of accumulated workers or equipment.

Indirect losses include delays in excavation and the cost of cleaning piles of rocks By conducting technical geological research in open dug areas, i.e. measuring discontinuity, surface data retrieval represented by surface geology data and subsurface data represented by coring data, the value of safety.
factor can be determined by using Limit Equilibrium Method (LEM), and determining Rock Mass Rating (RMR) can be an evaluation material and is also useful in planning open construction excavations.

Therefore, the evaluation of slope stability is an important part to prevent disturbance to the smoothness of production and the occurrence of a fatal disaster. Stability of the slopes in the excavation activities caused by the mass of rocks formed in nature, especially in the area of excavation is not ideal, one of which experienced discontinuity and physical properties of rocks or soil.

By evaluating the stability of the slope, it can then provide suggestions for following up on the research results. Objectives to be achieved from this research are: Knowing Rock Mass Rating (RMR) from the results of open field investigation of excavation on the slopes.

2. Research Method
Research methods used in this study are:

2.1. Stages of Library Studies
This stage is done before taking data to complete the initial knowledge about the condition of the study based on literature from previous researchers.

2.2. Observation and data retrieval
Rock observation and rock sampling is a special data retrieval stage directly in the field. Examples of rocks taken are on the surface (surface) and below the surface (subsurface). The sampling of rocks on the surface is ideal and representative distribution of rocks in the research area, while the sampling of rocks beneath the surface is obtained from the core drilling data of the Citanduy River Basin [3].

2.3. Rock Mass Analysis
In rock mass analysis was done by using the classification CRIEPI, 2004 and Rock Mass Rating (RMR). Rock mass analysis was conducted to determine the physical properties of the rocks in the field and as additional analysis to determine the stability of the slopes. Distribution of rocks in the study area, while sampling of rocks beneath the surface is obtained from the data.

3. Data & Analysis

3.1. Classification CRIEPI & RMR
Classification of soil and rocky periods is used based on the weathering rate of these rocks. To determine the degree of weathering of rocks on open excavations in the Duck Tunnel Inlet area should be identified between the BOR sample data with the CRIEPI classification 2004 and RMR.

Based on the classification, the data of rock classification in the Leuwikeris Dam area was found, namely on open cut in the following Inlet Diversion Tunnel area:

In the BH-1A drill well there is a classification of rock mass with a liquid limit of 20.13 - 21.83% and soil unit weathering rate is (D), andesite breccia and breccia tuffaan are in rough and moderate conditions with rock weathering (CL-CM) or a uniaxial compressive strength value ranging from 20-120 kg / cm2 at a depth of 69.40 - 76.53 meters.

Weighing the rock mass for each slope, calculation and analysis of Rock Mass Rating using five parameters developed by [4] [5] as follows: The Power of the Whole Rock, Rock Quality Designation (RQD), Distance Between Discontinuities, Conditions of Discontinuity, Water Condition.
### Table 1. Classification CRIEPI, *(Central Research Institute of Electric Power Industry)*, 2004

| KLASIFIKASI BATUAN | PEMERIAN (DESKRIPSI) | KUAT TEKAN UNIAXIAL (kg/cm²) | KARAKTERISTIK | KENAMPANAN | REKAHAN | SUARA PUKULAN |
|-------------------|----------------------|-----------------------------|---------------|------------|---------|---------------|
|                   |                      | 1500–2000                   |               |            |         |               |
| A                 | Kimia batuan sangat keras, titik lapuk (toksik), rehakan tertutup tanpa pelapukan. |               | Sangat kekuatan | Tidak ada pelapukan/alteration | Sangat kekuatan | -             | Nyaring     |
| B                 | Mineral pembentuk batuan sedikit lapuk, kondisi batuan keras, rehakan tertutup tanpa pelapukan. | 800–1100       | Sedikit kekuatan &实质性 | Kuart | Tidak ada | -             | Nyaring     |
| C                 | Mineral pembentuk batuan lapuk, kondisi batuan keras, ilatan antar blok batuan agak kurang dan setiap blok cenderung mengalas pada sepanjang bidang rehakan bila dipukul keras dp palu geologi, rehakan kadang terlihat mineral lempung/mineral lain. | 400 – 900      | Sedikit kekuatan &实质性 | Lapisan lapisan keras & agak lunak | Mineral lempung | Mutul disfusikan dp palu geologi | Agak lebar  |
| D                 | Mineral pembentuk batuan lapuk, kondisi batuan masih sedikit keras, pengelupusan terjadi sepanjang bidang rehakan bila dipukul sedang dp palu geologi, rehakan kadang terlihat mineral lempung/mineral lain. | 200 – 400      | Lunak &实质性 | Lapuk kedalaman & agak lunak | Mineral lempung | Mutul disfusikan dp palu geologi | Labar       |
| E                 | Mineral pembentuk batuan lapuk, kondisi batuan masih sedikit keras, pengelupusan terjadi sepanjang bidang rehakan bila dipukul mudah dp palu geologi, rehakan terlihat mineral lempung / mineral lain. | 50 – 200       | Sangat lunak &实质性 | Lapuk kekuatan & ada perubahan (tak impo) | Mineral lempung | Sangat mulai disfusikan dp palu geologi | Sangat lebar |

#### 3.2. Elevation of 130 Meters

The Power of the Whole Rock. The strength of intact rocks is known by using direct test in the field of Compressive Strength (UCS) testing by looking at the condition of rock mass in the field using Field Estimates of Uniaxial Compressive strength of intact rock based on Hoek-Bray (1981), ie using geological hammer and then weighting with using table Classification of rock mass based on [5]. Table weighting Rock Mass Power. Based on the table below (see table 4.4) then the rock mass strength value for the elevation of 130 meters is > 250 Mpa. (weight = 15). 2. Rock Quality Designation (RQD) RQD observation is very important because it involves Fracture in close proximity, RQD calculation is done directly in the field and based on the length of the slope (horizontally) by looking at the square of the slope of the field about 100 meters and the height of the slope 15 meters as follows: RQD = 100e -0.1. (0.1 + 1) = 100e (-0.1 × 1.906) × (0.1 × 1.906) + 1 = 50% From the above calculation, then RQD weighting in search using the rock mass classification table according to Bieniawski (1989). Based on the weighted table below (See table 4.4), the RQD value at the 157 meter elevation is 50–75%. (Weight = 13).

#### 3.3. Distance Between Discontinuities

The solid distance is the distance between two discontinuity fields adjacent to the normal direction or perpendicular to the discontinuity field [5]. So Measurement distance between discontinuities is done on the same set. [5] does not explain how to calculate discontinuity spaces if there is more than one set of discontinuities in a rock mass. However, if there is more than one set of discontinuities in rock
mass, the discontinuity spacing used is the distance of discontinuities having the smallest average value.

In the data retrieval the field distance Inter Distance discontinuity varies so that the smallest average indigo is 200 - 600 mm. Based on the table below (see table 4.4), it is known that the weight of the distance between the discontinuities at the 150 meter elevation is 10.

3.4. Conditions of Discontinuity
The discontinuity field state is obtained from the direct description of the field in the form of the level of continuity of the discontinuity field, the width of the opening, the roughness of the discontinuity field, the discontinuity filler material, and the degree of weathering. Based on observations in the field the discontinuity conditions are length of discontinuity, width of openings, fine - coarse, filler material, and discontinuity weathering rates at discontinuity conditions for each slope. Based on the above table in knowing the weight of discontinuity condition at 130-meter elevation is 13.

3.5. Ground Water
Ground water conditions at elevation of 157 meters, from direct observation in the field that at this level has been found soil conditions on the slopes that are moist - wet. From the observation at the location then the weighting of groundwater conditions on the slopes can be found in the rock mass classification table according to [5] and based on the table in know the weight of the discontinuity condition at 130 meters elevation is 10. Each weighting and analysis of these five parameters, as follows Rock Mass Power > 250 Mpa, Weight : 15, Rock Quality Designation: 50% (Weight: 13), Distance Between Discontinuities: 200 - 600 mm (Weight: 10), Circumstances Discontinuity: 13 (Weight: 13), Ground Water Condition: Moisture (Weight: 10), Total Weight: 61. Rock Mass Class: II (Good)

From this result then each weight is added to get the total weight value that will be used to classify the mass of the rock, so the total weight of the rock is 61. Based on the next result the total value of Rock Mass Rating of RMR in the input on the rock mass classification table based on [5].

Table 2. Weighting of Rock Mass Classification

| Kekuatan Massa Batuan | Unitasting Compressive Strength | > 250 Mpa | 100-250 Mpa | 50 - 100 Mpa | 25 - 50 Mpa | 15 - 25 Mpa | < 1 Mpa |
|-----------------------|-------------------------------|----------|-------------|-------------|-------------|-------------|--------|
| Botot                | 15                             | 12       | 7           | 4           | 2           | 1           | 0      |
| RQD                  | 90 - 100 %                     | 75 - 90 % | 50 - 75 %   | 25 - 50 %   | < 25 %      |             |        |
| Botot                | 29                             | 17       | 13          | 4           | 3           |             |        |
| Jarak Discontinuitas | 0.6 - 2 m                      | 200 - 600 mm | 60 - 200 mm | < 60 mm     |             |             |        |
| Botot                | 15                             | 10       | 8           | 5           |             |             |        |

| Kondisi Discontinuitas | Ciri-ciri tanah kandur | < 1 m | 1 - 3 m | 3 - 10 m | 10 - 20 m | > 20 m |
|------------------------|-------------------------|-------|---------|----------|----------|--------|
| Botot                  | 6                       | 4     | 2       | 1        | 0        |        |

| Kekerasan Kekeran | Ciri-ciri tanah kandur | < 0.1 mm | 0.1 - 1.0 mm | 1 - 5 mm | > 2mm |
|-------------------|-------------------------|-----------|--------------|----------|-------|
| Botot             | 6                       | 1         | 0            |          |       |

| Kelerasan Kekeran | Ciri-ciri tanah kandur | < 5 mm | 5 mm - 10 mm | 10 mm - 20 mm | > 20 mm |
|-------------------|-------------------------|--------|--------------|---------------|---------|
| Botot             | 6                       | 4      | 2            | 0             |        |

| Material Pengerintah | Ciri-ciri tanah kandur | < 5 mm | > 5 mm |
|----------------------|-------------------------|--------|--------|
| Botot                | 6                       | 4      | 2      |

| Peralatan | Ciri-ciri tanah kandur | < 5 mm | > 5 mm |
|-----------|-------------------------|--------|--------|
| Botot     | 6                       | 4      | 2      |

| Kondisi Air Tanah | Ciri-ciri tanah kandur | Kering | Lembah | Basah | Menetes | Mengair |
|-------------------|-------------------------|--------|--------|-------|---------|---------|
| Botot             | 15                      | 10     | 7      | 4     | 0       |
After viewing the table and weighing the calculation of rock mass classification it can be concluded that the measurement area at elevation of 130 meters has rock mass class is II (Good). Then the same calculation and weighting are done at the other level.

3.6. Elevation of 140 Meters
Rock Mass Power: 100 - 250 Mpa (Weight: 12), Rock Quality Designation: 70% (Weight: 13), Distance Between Discontinuities: 0.6 - 2 m (Weight: 10), Circumstances Discontinuity: Smoothness, opening, roughness, materail filler, and weathering sturdy (Weight: 11), Ground Water Condition: Moisture (Weight: 10), Total Weight: 61. Rock Mass Class: II, Description: Good.

3.7. Elevation of 145 Meters
Rock Mass Power: 100 - 250 Mpa (Weight: 12), Rock Quality Designation: 54% (Weight: 13), Distance between Diskontinuita: 200 - 600 mm (Weight: 10), Circumstances Discontinuity: Severity, openings, strengths, materail fillers, and weathering sturdy (Weight: 12), Ground Water Condition: Moisture (Weight: 10), Total weight: 57, Classification of rocks: III, Description: Rocks are.

3.8. Elevation of 157 Meters
Rock Mass Power: 100 - 250 Mpa (Weight: 12), Rock Quality Designation: 52% (Weight: 13), Distance Between Discontinuities: 60 - 200 mm (Weight: 8), Circumstances Discontinuity: Severity, openings, strengths, materail fillers, and weathering sturdy (Weight: 10), Ground Water Condition: Moisture (Weight: 10). Total Weight: 53. Classification of rocks: III. Description: medium rock.

4. Conclusion
Based on the weighting of the calculation of rock mass classification it can be concluded that the measurement area at elevation of 130 meters has rock mass class is II (Good). Based on the weighting of the calculation of rock mass classification it can be concluded that the measurement area at elevation of 140 meters has rock mass class is II (Good). Based on the weighting of the calculation of rock mass classification it can be concluded that the measurement area at elevation of 145 meters has a rock mass class is III (Medium rocks). Based on the weighting of the calculation of rock mass classification it can be concluded that the measurement area at the elevation of 157 meters has a rock mass class is III (Medium rocks).

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