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REVIEW OF THE IMPLEMENTATION OF THE GUIDELINES FOR CALCULATING THE VOLUME OF SOFT ROCK EXCAVATION AND ROCK EXCAVATION (CASE STUDY: ALIGNMENT IMPROVEMENT PROJECT ON THE ACCESS ROAD TO THE MULTIPURPOSE CONTAINER PORT (WAE KELAMBU))

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ABSTRACT

Soft rock excavation and rock excavation in road construction projects are critical factors influencing cost, time, and quality. In practice, however, discrepancies often occur between the initial calculations (MC-0) and actual field conditions due to limited geotechnical data and inaccurate calculation methods. This study aims to evaluate the application of Circular Letter Number: 01/SE/Db/2025 regarding Guidelines for Calculating the Volume of Soft Rock and Rock Excavation in the Multipurpose Container Port Access Road Alignment Improvement Project (Wae Kelambu). The research employed a quantitative descriptive method with a case study approach. Primary data included topographic surveys, boring tests, Standard Penetration Tests (SPT), geoelectric tests, and uniaxial compressive strength laboratory tests, while secondary data consisted of contract documents, technical specifications, and design drawings. The findings reveal significant differences between MC-0 volume calculations and actual field volumes, influenced by sample point density and accuracy, local geological conditions, and analytical methods. Implementing the latest guidelines enhances calculation accuracy, minimizes the likelihood of claims and contract addenda, and supports cost and time efficiency. This study is expected to contribute to the practical application of technical guidelines in similar infrastructure projects, thereby reducing the risk of error in estimating excavation volumes

Keywords: *Soft rock excavation, Rock excavation, Volume calculation, Geotechnical data, Infrastructure Projects*.

ABSTRAK

Galian batuan lunak dan galian batu dalam proyek konstruksi jalan merupakan faktor krusial yang memengaruhi biaya, waktu, dan kualitas. Namun dalam praktiknya, seringkali terjadi ketidaksesuaian antara perhitungan awal (MC-0) dengan kondisi aktual di lapangan yang disebabkan oleh keterbatasan data geoteknik serta metode perhitungan yang kurang akurat. Penelitian ini bertujuan untuk mengevaluasi penerapan Surat Edaran Nomor: 01/SE/Db/2025 tentang Pedoman Perhitungan Volume Galian Batuan Lunak dan Galian Batu pada Proyek Perbaikan Alinyemen Jalan Akses Pelabuhan Peti Kemas Multiguna (Wae Kelambu). Penelitian ini menggunakan metode deskriptif kuantitatif dengan pendekatan studi kasus. Data primer yang digunakan meliputi survei topografi, uji bor (boring test), Standard Penetration Test (SPT), uji geolistrik, dan uji laboratorium uniaxial compressive strength (UCS), sedangkan data sekunder terdiri dari dokumen kontrak, spesifikasi teknis, dan gambar desain. Temuan penelitian menunjukkan adanya perbedaan signifikan antara perhitungan volume MC-0 dengan volume aktual di lapangan, yang dipengaruhi oleh kerapatan dan akurasi titik sampel, kondisi geologi lokal, serta metode analisis. Penerapan pedoman terbaru

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terbukti meningkatkan akurasi perhitungan, meminimalkan potensi klaim dan adendum kontrak, serta mendukung efisiensi biaya dan waktu. Studi ini diharapkan dapat berkontribusi pada penerapan praktis pedoman teknis dalam proyek infrastruktur serupa, sehingga mengurangi risiko kesalahan dalam estimasi volume galian.

Kata kunci: *Galian batuan lunak, Galian batu, Perhitungan volume, Data geoteknik, Proyek infrastruktur.*

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INTRODUCTION

Based on Law of the Republic of Indonesia Number 2 of 2022 concerning Roads, road infrastructure plays a central role in the national logistics system by connecting production, industrial, and consumption areas, while reducing interregional distribution costs[1]. Land routes to ports are particularly critical nodes because that is where the flow of export-import goods transfers modes from trucks to ships or vice versa. Without reliable road access, modern loading and unloading facilities at ports cannot be utilized optimally, so that obstacles on land will "clog" the sea logistics chain and reduce national competitiveness[2].

The Wae Kelambu Multipurpose Port in Labuan Bajo was inaugurated in 2021 to separate cargo traffic from the old city's tourist area and is now the main logistics gateway for West Manggarai Regency and the eastern part of Flores Island.

However, the winding section of the Labuan Bajo Wae Kelambu Port Road, which follows the contours of volcanic hills, often causes queues of heavy transport vehicles, leading to delivery delays and increased operational costs. Work package for Alignment Improvements on Roads Access to the Multipurpose Container Port (Wae Kelambu) worth IDR 107,975,619,000.00 from the 2024-2025 State Budget is a continuation of the previous package with alignment repairs that were originally at a grade of 18% to 10% in accordance with the road terrain classification in Letter Circular Letter No. 20.SE/Db/2021 Regarding Guidelines for Road Geometric Design[3].

The hilly topography of the Labuan Bajo area consists of volcanic breccia, lava alteration, and layers of recrystallized limestone material which, according to SNI 2825:2008 classification, can be categorized as soft rock (uniaxial compressive strength of 0.6 - 12.5 MPa) to hard rock (> 12.5 MPa)[4]. Vertical alignment improvements in such terrain require fairly deep excavation, including limited blasting. This is where the risk of volume misestimation becomes very high. Insufficient excavation will halt work, while excessive excavation increases disposal costs, triggers claims, and can shift the project schedule in a domino effect.

To reduce the risk of misestimating the above volume, Circular Letter Number: 01/SE/Db/2025 was issued regarding the Guidelines for for Calculating the Volume of Soft Rock Excavation and Rock Excavation, issued by the Director General of Highways on January 17, 2025, states that soft rock excavation and rock excavation work requires accurate sampling locations for rock samples. Accurate location determination affects the collection of excavation type data, excavation boundaries, and excavation boundary drawings. With these guidelines, it is hoped that in practice they will result in cost and time efficiency while maintaining construction quality.

METHODS

This research uses a quantitative descriptive research design with a case study approach. A case study was chosen because the research focused on one specific object, namely the Alignment Improvement Project on the Access Road to the Multipurpose Container Port (Wae Kelambu). The quantitative descriptive approach enabled researchers to measure and compare the volume of excavation numerically and describe the implementation of existing guidelines.

This research was conducted over a period of four months, starting from March to July 2025. The research was conducted at PT. Brantas Abipraya (Persero) on the Alignment Improvement Project on the Multipurpose Container Port Access Road (Wae Kelambu). Specifically, it was conducted in Wae Kelambu Village, Labuan Bajo City, East Nusa Tenggara Province.

This research is a case study of a portion of the soft rock and rock excavation work carried out in the Alignment Improvement Project on the Multipurpose Container Port Access Road (Wae Kelambu). The research sample will include a portion of the relevant soft rock excavation and rock excavation work segments at the project site, selected based on the availability of field measurement data and complete project documents. In this study, the samples examined are the process of how the guidelines for calculating the volume of soft rock excavation and rock excavation are implemented in a construction project on the alignment improvement project on the access road to the Multipurpose Container Port (Wae Kelambu). The data used in this study consists of primary and secondary data. Primary data was obtained directly from the field through topographic measurements before and after excavation using a total station, in order to calculate the actual volume of soft rock and hard rock excavation, as well as field documentation to support observations. Meanwhile, secondary data was collected from various project documents, including the Bill of Quantity (BOQ) containing unit prices and work volumes, shop drawings, and project technical specifications referring to

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the Director General of Highways Circular Letter No. 16.1/SE/Db/2020 concerning General Specifications for Highways 2018 (Revision 2). Secondary data also included work progress reports (daily, weekly, monthly) and guidelines for calculating excavation volumes as stipulated in Circular Letter No. 01/SE/Db/2025.

Furthermore, the data obtained will be processed systematically to analyze the implementation of guidelines for calculating the volume of soft rock and rock excavation. The analysis process is carried out through several main stages, beginning with problem identification, namely examining the differences between the volume calculation results based on MC-0 and actual data in the field, as well as the factors that influence them.

Next, a literature study was conducted to obtain the theoretical basis, concepts, and technical standards relevant to the excavation volume calculation method. The next stage included field observations, data collection, and verification to ensure the accuracy and completeness of the information used in the analysis. After that, a review and comparison between the MC-0 data and the actual results were carried out to assess the suitability of the calculation method with the conditions in the field. The data processing was carried out using AutoCAD and Civil 3D software to process existing topography and elevation data.

The analysis continues with an evaluation of volume differences and identification of the main contributing factors, such as variations in geological conditions, work implementation methods, number of test samples, and environmental influences. The results of this analysis form the basis for concluding the level of accuracy, effectiveness, and relevance of the application of the excavation volume calculation guidelines to actual field conditions.

RESULTS AND DISCUSSION

MC-0 is the process of verifying and adjusting the details of the work contained in the contract documents (plan drawings, quantity lists, and prices) with the actual conditions in the field when the project is about to begin. The goal is to ensure that all parties have the same understanding and agreement regarding the scope of work, volume, and actual field conditions[5].

Initial Mutual Check Calculation Method (MC-0) for Soft Rock Quarrying and Rock Quarrying

SPT Boring Test Results

Based on the tests that have been conducted, in test B-1, rock was found at a depth of 10-24.5 meters with an SPT value >50 at a depth of 8-30 meters. In test B-2, rock was found at a depth of 0-30 meters with an SPT value >50 at a depth of 3-30 meters, B-3 found rock at a depth of 0-30 meters with an SPT value >50 at a depth of 2-30 meters, and B-4 found rock at a depth of 5 meters with an SPT value >50 at a depth of 5-30 meters[6]. Details of the boring & SPT test results can be seen in **Table 1.**

Table 1 Summary of Boring & SPT Test Results

No	Soil Depth Rock Type (m)	Soil Depth With SPT Value>50 (m)
B-1	10 – 24,5	8 – 30
B-2	0 – 30	3 – 30
B-3	0 – 30	0 – 30
B-4	5 - 30	5 -30

(Source: PT. Brantas Abipraya, 2025)

Geophysical Testing Results

The test results for line 3 are as follows:

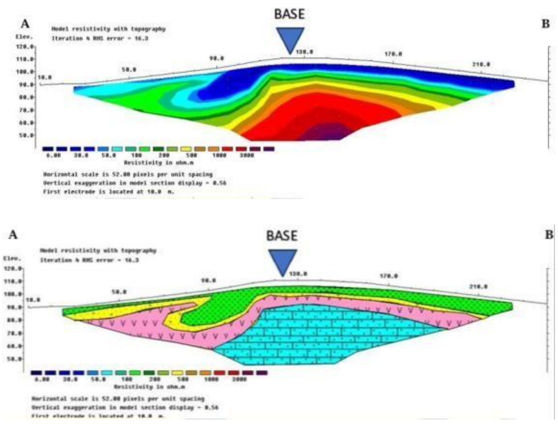

Figure 1 Resistivity Cross Section of Track 3 Extending 230 m

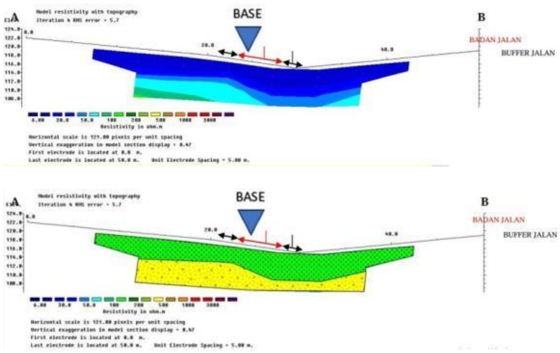

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Figure 2 Cross-section of Resistivity of Track 3 Crossing 50m
(Source: PT. Brantas Abipraya, 2025)

The results of the geophysical testing of line 3 with a line length of 230 m and a cross line of 50 m with a spacing between electrodes of 10 m, using a Wenner Schlumberger 2D configuration, with a maximum datum depth measurement of 46.8 m on the longitudinal line and 10 m on the cross line. The resistivity profile of line 3 has a resistivity scale ranging from 6 to 3000 ohms (Ω) and an RMS error of 16.3% on the longitudinal line and an RMS error of 5.7% on the transverse line. On line 3, the resistivity colors range from dark blue for the lowest values to purple for the highest values. For line 3, there are several color distributions indicating the presence of different types of soil or subsurface rock layers[7].

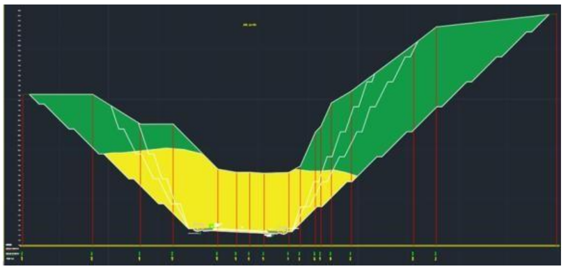

Figure 3 Cross-section of Geophysical Survey with Road Design
(Source: PT. Brantas Abipraya, 2025)

At the patch cross section at STA 2+150, lithology in the form of claystone and sandstone, which are classified as soft rocks, was found. In stratigraphy, claystone is characterized by its green color, while sandstone is indicated by its yellow color. The composition of the cross section consists of 60% claystone and 40% sandstone.

Calculation Results for Soft Rock Excavation Volume and MC-0 Rock Excavation

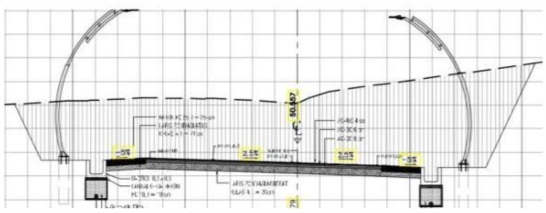

Figure 4 Calculation Results for Soft Rock Excavation and Rock Excavation Volumes
(Source: PT. Brantas Abipraya, 2025)

Based on Figure 4, the total volume of soft rock excavation is 21,534.75 m3 and the volume of rock excavation is 88,671.30 m3. The volume of excavation is obtained using the following formula:

$$V = \frac{STA_1}{STA_2} \times P$$

V = Volume

STA_1 = Area Width at the first STA

STA_2 = Area Width at the second STA

P = STA length

The calculation results for the excavation volume for MC-0 are based on the results of Boring SPT and Geophysical testing, where to determine the area of each cross section at a specific STA, it is necessary to perform interpolation between test data to produce an approximate value to determine the volume.

Review of Guidelines for Calculating the Volume of Soft Rock Excavation and Rock Excavation

Test Sample Collection

In the Alignment Improvement project on the Multipurpose Container Port Access Road (Wae Kelambu), sampling for testing was carried out using the core drilling method from block samples or rock fragments.The rock block or boulder samples taken must be larger than the dimension requirements for uniaxial compressive strength testing of rock specified in SNI 2825:2008 on the method for testing the uniaxial compressive strength of rock or ASTM D71012-23[8],[9].

UCS Laboratory Testing

The uniaxial compressive strength of intact rock (σc) is required to determine the maximum strength of the rock to withstand pressure or load until it collapses and is expressed in MPa units. The uniaxial compressive strength test of intact rock (σc) must follow the procedures specified in SNI 2825:2008 or ASTM D7012-23.

Determination of Excavation Boundaries

The identification of layers must be based on geotechnical issues and the complexity of local geological conditions. In the Alignment Improvement Project on the Multipurpose Container Port Access Road (Wae Kelambu), the determination of stratigraphic boundaries or stratigraphy is based on the results of uniaxial compressive strength tests on cross-sections at

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each STA, as shown in Figure 5. Excavation volume calculations must be detailed whenever there is a change in excavation type and must be conducted in three dimensions, accompanied by sketches, photos, descriptions, longitudinal sections, cross-sections, location index maps, and the results of uniaxial compressive strength tests at each test point[10].

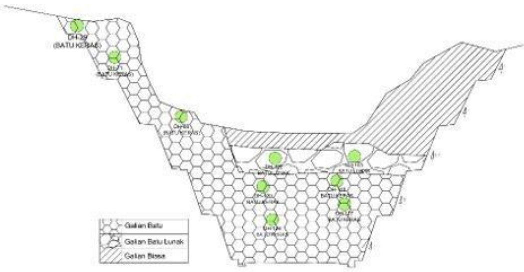

Figure 5 Excavation Stratigraphy Based on Uniaxial Test Results

Calculation Results for Soft Rock Excavation and Rock Excavation Based on the Guidelines for Calculating the Volume of Soft Rock Excavation and Rock Excavation

Figure 6 shows the calculation results for soft rock excavation and rock excavation work following the guidelines for calculating the volume of soft rock excavation and rock excavation.

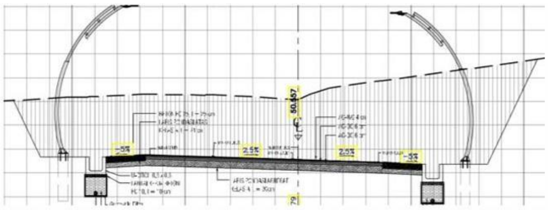

Figure 6 Calculation Results Based on the Guidelines for Calculating the Volume of Soft Rock Excavation and Rock Excavation

Based on Figure 6, the total volume of soft rock excavation is 15,393.954 m3 and the volume of rock excavation is 92,485.705 m3.

Comparative Analysis of MC-0 with Actual Field Conditions

Based on a review of MC-0 soft rock excavation and rock excavation and a review of the actual field using guidelines for calculating the volume of soft rock excavation and rock excavation, the following differences were found :

1. Method for Determining the Type of Excavation

Based on a review of MC-0 and actual field conditions, it can be seen that there are differences in the methods used to determine the type of excavation. In MC-0, the calculation of the volume of soft rock excavation and rock excavation is determined based on the results of SPT boring tests and geoelectric tests, while in the actual field, the calculation of the volume of soft rock excavation and rock excavation is determined based on the results of uniaxial tests[11].

2. Calculated Volume of MC-0 and Actual Field Volume

Differences in the methods used to determine the type of soft rock and rock excavation can affect the accuracy of determining the type of soft rock and rock excavation. Based on the discussion of the review of MC-0 and actual field conditions, it shows that there are differences that are not too significant in terms of volume and rupiah value in soft rock and rock excavation. The difference in the volume of soft rock quarry is 6,140.79 m^3 or, in rupiah terms, Rp.745,415,359.27, and the volume of hard rock quarry is 3,814.41 m^3 or, in rupiah terms, Rp.787,002,735.89.

This comparison certainly has an effect on the construction process for the first party, namely the owner, and the second party, namely the service provider. These differences certainly have an impact on project implementation, including the following:

1. Financial and Contractual Impact

Due to the difference in the volume of soft rock excavation and rock excavation between MC-0 and the actual field, where soft rock excavation decreased by IDR 745,415,359.27 from the original amount in MC-0 of Rp.2,614,049,074.03 to Rp.1,868,633,714.77, and in hard rock excavation, an increase of Rp.787,002,735.89, which was originally Rp.18,294,986,524.15 to Rp.19,081,989,260.04. The total deviation from the project's financial plan when comparing MC0 with the actual field costs for soft rock excavation and rock excavation is +Rp.41,587,376.62. From the total price change, there is an increase in the total price, therefore it is necessary to make an addendum to the contract.

2. Project Schedule Impact

Changes in the volume of MC-0 with actual field conditions also result in schedule changes to a project. The time required to complete soft rock excavation work using four excavator buckets was reduced by 10 days, from 33 days to 23 days, while rock excavation work using three excavator breakers took 14 days longer than the original 333 days, to a total of 347 days. The changes in the time required for soft rock excavation and rock excavation will impact other

DOI : 10.56911/jdk.v2i2.207

work because soft rock excavation and rock excavation are major work items due to their interdependence and simultaneous execution. One example is slope reinforcement work such as soil nailing and rockbolt.

CONCLUSIONS

Based on the results of the discussion, it can be concluded that the review of the implementation of the guidelines for calculating the volume of soft rock and rock excavation based on the Circular Letter of the Director General of Highways No. 01/SE/Db/2025 plays an important role in improving the accuracy of volume calculations for the Multipurpose Container Port Access Road Alignment Improvement Project (Wae Kelambu). These guidelines not only affect the accuracy of volume measurements, but also budget planning, implementation schedules, and the contractual compliance of the project.

The analysis results show a volume difference between the MC-0 data and the actual conditions, namely a decrease in soft rock excavation volume of 6,140.79 m^3 and an increase in rock excavation volume of 3,814.41 m^3. This difference is due to the different methods used to determine the type of excavation, where the MC-0 data is based only on limited tests, while the actual data uses 73 more representative UCS test samples. This difference has an impact on project costs and implementation time, with changes in the value of work and shifts in the duration of soft rock and rock excavation. Therefore, consistent application of guidelines and adequate field testing are essential to ensure volume accuracy, cost efficiency, and the effectiveness of road construction project schedules.

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