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Extent of risk management implementation in some of rock laboratory tests for tunnel projects by means of AHP method

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ABSTRACT

In any project, especially infrastructure ones such as tunnels, tests play a major role in predicting and showing the properties of the ground built on. For such construction through a rock mountain terrain, it is quite not easy to predict the engineering property of such materials. Since working with rock is a quite challenge because of the nature of rock materials, it needs a lot of care and persuasion when dealing with such. For such rock materials, it needs both of field and laboratory tests to ensure the process of obtaining the final engineering property of the materials. This paper concentrate on some of the laboratory tests required for tunnel project held in rock profile sites. Emphasizing on safety, accuracy that enquired during such tests and try to run those under risk management process by means of AHP to get the responded weights for those factors such as test procedure with average of weight (49.43%) indicates the caution to be taken during test beside major parameters such as sample size and mass in accurate manner to avoid risk in test and results obtained.

Keywords: Tunnel, Risk, Risk management, Rock laboratory tests, AHP

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1. Introduction

Tunnel projects, regardless the reason of construction; road tunnel, drainage corridor or utility tunnel. Such a project with great concern should handle in such way that a dependable systematic way of management to applied in which it includes the principal way of managing the phases of the tunnel project. Geotechnical, rocks, concrete, cement and also aggregate tests are necessary in order to prevent geotechnical failures and ensure that materials acquiesce within standards[1-3]. Such projects always face risks and uncertainties during different phases of the project. Most of the tunnel projects executed in north of Iraq are with in rock ground profiles; Knowledge about the mechanical properties of rocks is crucial for all construction work in rock mass. The design and analyses of any rock-engineering project for civil or mining applications require careful mechanical characterization of the host rock. For this purpose, rock cores drilled on-site and rock samples are prepared for laboratory testing. These samples then go through various standard rock tests procedures to determine several physical and mechanical properties. The rock mass profile should undergo a processed number of laboratory-standardized tests. Test such as Uniaxial compressive strength, Point load test, Tensile strength test Indirect (Brazilian test), ultra-sonic, Schmidt hammer, Slake durability testing, and Moisture content measurement[4, 5]. Managing risk system during testing, and managing to apply the process to achieve it using techniques including planning, identifying, and assessment of risks that properly could occur. Risk-based testing is described as a risk management process that complies with to test process; figure (1) shows the Risk management process[6, 7].
The Analytical Hierarchy Process (AHP) is widely recognized as a multi-criteria decision support system that was implemented to inspect the weight of each factor been considered during the test.

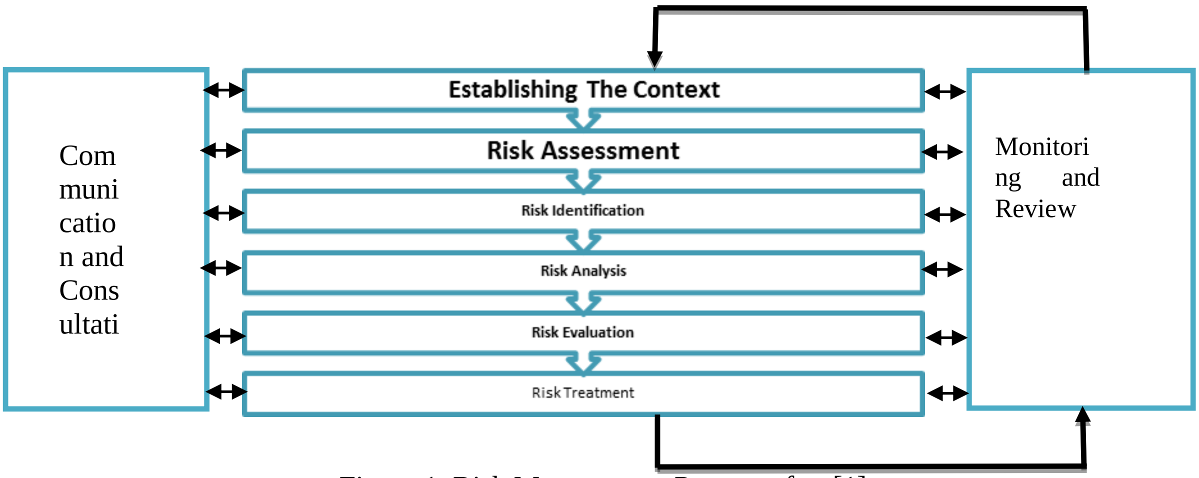

Figure 1. Risk Management Process after [1]

2. Materials and methodology

The rock mass is a widely known material combined of intact and discontinuities it is naturally with variance properties. Rock discontinuity, hydraulic, strength, and other properties of rock masses have different from a type to another, or to be more precise from a specified location to another. Most of the methods used in this paper are experimental work. To be more specific laboratory tests were held, on rock types gathered from three different locations of tunnel projects under construction in the north of the Kurdistan region of Iraq. Those are from projects (Massif (Permam), Bani harrier, and Haybat Sultan tunnel projects) (figure 2); Each with different properties. Tests used such as Point load test, Uniaxial compressive strength, Tensile strength test Indirect (Brazilian test), ultra-sonic, Schmidt hammer, Slake durability testing, and Moisture content measurement. This paper checks the risk management process application and focuses on the errors and misleading judgment that eventually describe weather the experiment is within the safe side. Factors as sampling, dimensions, calibration, equipment, safety tools, test procedure, and calculations. All those steps can include defects or errors eventually misleading to final results and as a result risk to the whole process that affects time, cost, quality, and safety. AHP method is a management tool, it is often used to solve the problems of unclear definition and unreasonable structure in decision-making and risk assessment. A typical hierarchical structure in AHP analyses is composed of three main components, such as alternatives, criteria, and a goal. In this study, the AHP analyses were performed specifically for to give the weight of risk factors regarding the study of interest.

Figure 2. Haybat Sultan, Bani harrier and Salahuddin (Permam) Tunnels /located area of study

2.1. Tests description for rock

The main difference in soils and rocks is in the hardness or more precisely, in the degree of compaction, in other words, the bonding between grains and the mode of formation. By testing rock materials for describing the index and strength properties, which will be furthermore effective as it influences the design of the tunnel (rock nature grounds). Such include water content, durability; strength will describe the condition of the rock and classify it accordingly to give a preliminary support design for rock and method of construction. The laboratory test is combined with the in-situ tests to reduce the uncertainty and risk because the rock is a nonhomogenous material. Sample collected as mentioned earlier from three tunnel project sites and cores collected from those (figure 3).

Figure 3. Sample collection and core collecting from Three tunnels locations area of study

2.1.1 Moisture content of rock

According to[8], any material, water content is considered as one of the great importance index properties used in establishing a correlation between soil or rock behavior and its index properties. Water content for any material is applied in order to express the different phase relationships of such components such as air, water, and solids for a given volume of material. The quality of results obtained by this standard depending mainly on the personals that performing it, and the adequate of the equipment and facilities been used in Figure (4).

Figure 4. Samples for water content test

2.1.2 Uniaxial compressive strength of rocks UCS

According to [9], The method allocates the equipment, instrumentation, and specified procedures to find the unconfined compressive strength for intact rock core samples. Peroration and sample collecting include extracting cores from the rock block to be trimmed into suitable dimensions. A cylindrical core of at least 54 mm in diameter and length/ diameter ratio of 2.0–3.0 (ISRM suggests 2.5–3.0 and [10] suggests 2.0–2.5). Here, a cylindrical rock specimen is subjected to an axial load, without any lateral confinement. The axial load is increased gradually until the specimen fails. The normal stress applied vertically on the sample, at the failure point, recorded as uniaxial compressive strength, fondly known as UCS. (Figure 5)

Figure 5. Samples for uniaxial compression test

2.1.3 Brazilian (Indirect Tensile Strength) test

Brazilian Test is one of the geotechnical laboratory tests used for indirect measurement of the tensile strength of rocks. It is widely used as laboratory testing methods in a geotechnical investigation in rocks for simplicity and efficiency in tests. According to [11], the sample diameter shall preferably be not less than NX core size (54 mm), or at least 10 times the average grain size and (0.2-0.75) thickness-to-diameter ratio. Figure (6)

Figure 6. Samples for Brazilian (Indirect Tensile Strength) test

2.1.4 Point load test

Point load test or (PLT) (figure 7) is considered as rock testing procedure applied for the aim of calculating rock strength. The obtained value is accordingly would help in finding some other related strength parameters of rock [12]. In (PLT), a sample of rock is mounted in between two pointed platens, and pressure applied to the sample is failed eventually.

Figure 7. Samples for point load test

2.1.5 Slake durability test

The slake durability test is considerably an easy-going test to find the effect of weathering up on Rock and its disintegration [13]. The slake durability test is a simulated weathering test to determine the abrasion resistance and durability of rocks. The slake durability test procedure is a method for obtaining the effect of weathering and the probable amount of deterioration of such weak rocks over a specified time. The test sample consists of a minimum of (10 rock lumps), each with a mass of 40-60 g, to give a total sample mass of range between 450-550 g (Figure 8).

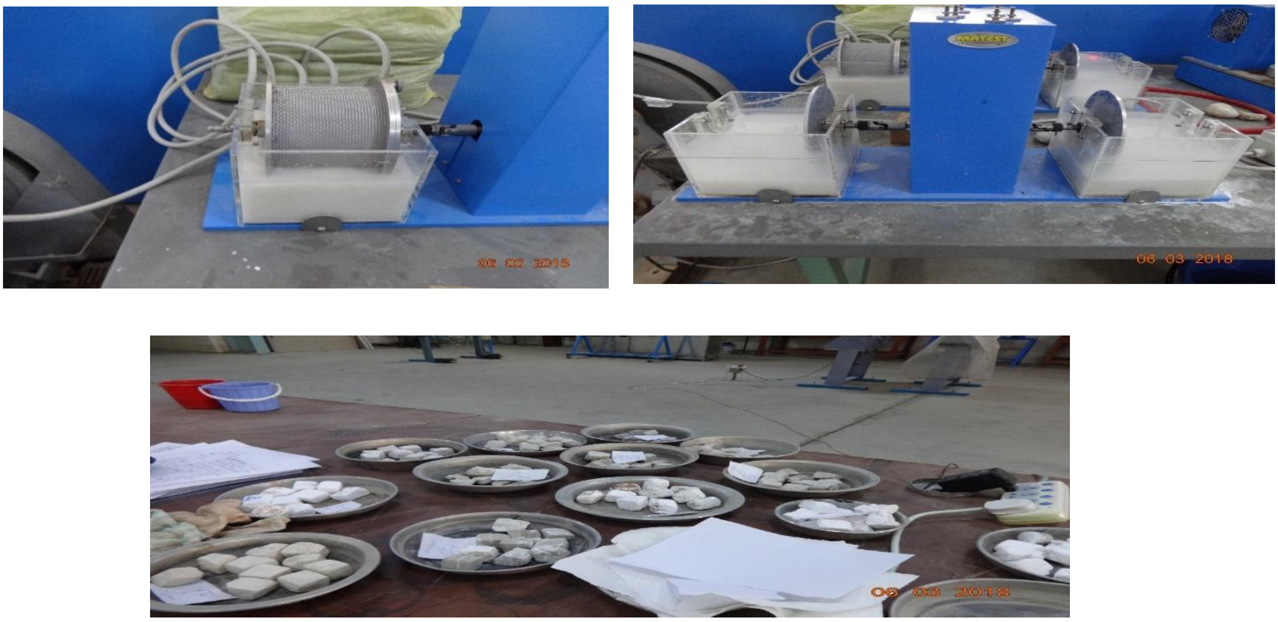

Figure 8. Samples for slake durability test

2.2. AHP the analytical hierarchy process

The Analytical Hierarchy Process (AHP) is a decision-assistant technique developed by Saaty [14, 15]. Its main objective is quantifying relative priorities for a given set of options over a ratio scale, primarily based upon the judgment of the decision-maker, and emphasize on the importance of the intuitive judgments of such decision-maker, as well as the consistency of the comparison of options in the decision-making event [16]. Since a decision-maker bases judgment on knowledge and experience, then makes decisions accordingly, the AHP approach agrees well with the behavior of a decision-maker. AHP is now widely accepted as a systematic method for comparing a list of objectives or alternatives [17]. When used in the systems engineering process, AHP can be a powerful tool for comparing alternatives. In this paper, an AHP method was established in order to get into the risk factors, and accordingly to assist the management process. Saaty [14, 15] conducted steps for applying the AHP:

1. give a clear definition of the problem and outcome aim of the project overall.
2. build up the Structure of hierarchy starting from up by including the main objective of the project and down to the list of factors and alternatives.
3. Conduct a set of pair-wise comparison matrices (size m*m) Table 1. Shows The pair-wise comparisons.
4. The method tends to give the eigenvectors by the weights of each criterion and eventually the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the process.
5. Establishing the pair-wise comparison matrices, the consistency is determined by using the eigenvalue, $\lambda\, max$, to calculate the consistency index, CI as follows: $CI = (\lambda\, max - m)/(m - 1)$., where m is the matrix size. consistency ratio (CR) is another check for the consistency index and is shown in table2. (the number should be (< 0.1) to achieve the consistency).
6. Steps from 3 to 5 are applied for all stages in the process.

Table 1. AHP Scale and Pairwise Comparisons[16]

Numerical rating	Verbal judgment	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The importance of one over another affirmed on the highest possible order
(2,4,6,8)	Intermediate values	Used to represent a compromise between the priorities listed above
Reciprocal of above non-zero numbers.	if the activity *(x)* has one of the above non-zero numbers assigned to it when compared with activity *(y)* then *(y)* has the reciprocal value when compared with *(x)*	

Table 2. Random Consistency [10]

Size of Matrix (m*m)	1	2	3	4	5	6	7	8	9	10
Random Consistency (RI)	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Reasons for the usage of the AHP method in this study were as follows:

- Flexible in the approach of what is well known as decision-making.
- The process reflects interactively what people think
- Reduce the complexity of decisions to a series of one-on-one
- comparisons, then synthesizing the results
- Benefits over decision matrices
- Results presented as a percentage out of all options evaluated

3. Results and discussion

As was mentioned earlier the study area took place for three different locations of tunnel projects under construction in Kurdistan region of Iraq. Those are from projects (Massif (Permam), Bani harrier, and Haybat Sultan tunnel projects). Sample collecting and test application were conducted between 2017 and 2018. As a denotation, not all sample test results were included in the study as it takes massive space to be discussed and conclude.

3.1. The water content of rocks (ω_c)

To calculate the water content of rock results of samples prepared for 3 test types were used and an average was taken as follows:

$$\omega_c = (water\ mass, Mw/Grain\ \ solid\ mass, Ms) * 100 \quad (1)$$

The results of one of the locations are illustrated in Table 3.

Table 3. sample of results obtained from massif location

S.N.	Sample Description	Can No.	Weight of can(g)	Weight of can +wet rock sample (g)	Weight of can +dry rock sample (g)	Water content %
1	9A	3M	94.83	911.94	909.67	0.28
2	9B	32	9.66	140.59	140.32	0.21

As table 4. Shows the average amount of water content regarding the three-test type applied.

Table 4. Average water content value obtained for massif tunnel regarding three test types

S.N.	Tunnel Name	Average Water content % from uniaxial compression test samples	Average Water content % from Point Load test samples	Average Water content % from Brazilian test samples	Average of water content regarding 3 test results
1	Massif (Permam)	0.32	0.37	0.18	0.29

For all three locations table 5. Demonstrate the total results for the water content test.

Table 5. Average water content value obtained for three locations regarding three tests applied

S.N.	Tunnel Name	Average of water content regarding 3 test results%
1	Massif (Permam)	0.29
2	Bany Hareer	0.15
3	Haybat Sultan	2.58

As it can be noticed from Table5. The average water content for Haybt Sultan tunnel location was somehow greater than the other locations due to the difference in rock types and the most likely fresher geological content. Water content can be considered as s one of the most important factors affecting rock strength. In [18], mentioned that any increase in water content in some cases would lead to a decrease in strength after 1% of water saturation. This indicates that the Haybat sultan strength parameter is weaker than other locations as to be noted accordingly.

3.2. Uniaxial compressive strength of rocks UCS

The uniaxial compressive strength (σ_u) ,and axial strain(ε_a) for the taken sample calculated as follows:

$$\sigma_u = \frac{P}{A} \quad (2)$$

$$\varepsilon_a = \frac{\Delta L}{L} \quad (3)$$

Where:

σ_u= Uniaxial Compressive strength,
P=Load at Failure,
A=Cross Sectional Area of the cylinder,
ε_a=Axial Strain,
L=Original Undeformed Length, and
ΔL=changed in the measured Length, Sample of Results Demonstrated through table 6. For Massif Tunnel.

Table 6. Part of the uniaxial compression test regarding massif tunnel location

S.N	Tunnel Name	Sample code	Average diameter (Davg.) from (3) readings(mm)	Average Length (Lavg.) from (3) readings(mm)	Area (A) (m^2)	P fail(N)kN	**ΔL** (mm)	$\boldsymbol{\varepsilon_a}$	$\boldsymbol{\sigma_u}$ (Mpa)
1	Massif	masif 1	54.46	115.26	0.0023	156.72	0.9	0.0078	67.277
2		masif 2	54.40	111.53	0.0023	111.87	1.5	0.0134	48.123
3		masif 3	54.54	136.07	0.0023	121.4	1.3	0.0096	51.966

And accordingly, the results of the three locations study area demonstrated through table 7.

Table 7. Results of average uniaxial compression test for the three locations

S.N.	Tunnel Name	Average Uniaxial Compressive Strength ($\boldsymbol{\sigma_u}$)Mpa	Average Axial Strain($\boldsymbol{\varepsilon_a}$)
1	Massif (Permam)	68.538	0.011
2	Bany Hareer	52.40	0.011
3	Haybat Sultan	20.40	0.035

Regarding the average uniaxial compression test results higher scores were Massif Tunnel then Bany Hareer Tunnel and at the least Haybat sultan Location, according to [19]as shown in (Table8) give a clear indication about classifying the rock regarding compressive strength classifications for the three types. Both Massif and Bani Hareer Location rocks can be considered as moderately hard rock while for Haybat Sultan Location it is considered as a very weak rock.

Table 8. Classification of rock regarding compressive strength values

Rock classification	UCS(MPa)
Very Weak Rock	1-25
Weak Rock	25-50
Moderately Hard Rock	50-100
Hard Rock	100-200
Very Hard Rock	>200

As for classification regarding axial strain results, after [20](Table 9.) classification illustrate that all three locations rock sample collected were in the brittle and moderately brittle zone which is an indication to how the rock should be treated regarding excavation and construction.

Table 9. Classification of rock regarding axial strength values

Rock classification	Axial Strain (%)
Very Brittle	<1
Brittle	1-5
Moderately Brittle	2-8
Moderately Ductile	5-10
Ductile	>10

3.3. Brazilian (Indirect Tensile Strength) Test

The splitting tensile strength (Figure 9) of the specimen shall be calculated as follows:

$$\sigma_t = \frac{2P}{\pi DL} = \frac{P}{\pi RL} \quad (4)$$

Where:
σ_t= Splitting Tensile Strength, (MPa),
P=Maximum applied Load at Failure(kN),
A=Cross Sectional Area of the cylinder,
L=Thickness of Specimen, (mm), and,
D=Diameter of the specimen, (mm).

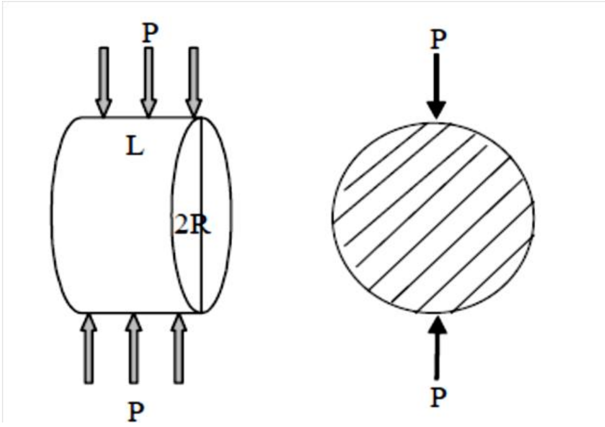

Figure 9. Specimen parameters for Brazilin Test

Sample of Results Demonstrated through table 10. For Massif Tunnel location regarding Brazilin Test

Table 10. Part of Brazilin test regarding massif tunnel location

S.N	Tunnel Name	Sample code	Average diameter (Davg.) from (3) readings(mm)	Average Thickness (Lavg.) from (3) readings(mm)	(P) failure (kN)	(σ_t) Mpa
1	Massif	Masif 1	54.68	34.41	9.9	3.35
2		Masif 2A	54.41	17.13	9.2	6.29
3		Masif 2B	54.37	10.42	15.8	17.75

And accordingly, the results of the three locations study area demonstrated through table 11.

Table 11. Results of average Brazilian (indirect tensile) test for the three locations

S.N.	Tunnel Name	Average of Splitting Tensile Strength, (MPa)
1	Massif (Permam)	7.60
2	Bany Hareer	8.75
3	Haybat Sultan	4.98

As for the results of the Brazilin test tensile strength for rock is resistance to failure under tensile, the higher the number the higher in tensile resistance, according to the results both Massif and Bany hareer Tunnels carry a higher tensile strength number compared with that of Haybat Sultan Tunnel.

3.4. Point load test

To calculate the point load for the samples preliminary the Uncorrected Point load strength index is calculated via the point load test.

$$(I_1) = (P * 1000)/{D_e}^2 \ (Mpa) \qquad 5$$

Where:
De= Equivalent core diameter
${D_e}^2$ = (4A)/π
And (A) is calculated using the following (A=W*D)
Where:
W is the specimen width in (mm)
D is the distance between platens in (mm)
P is the breaking load in kN

The corrected point load strength index for the standard core size of 50 mm (I_{s50}) diameter is given by the following equation

$$I_{50} = (P * 1000)/[(D * W)0.75\sqrt{50})]\ Mpa \qquad (6)$$

Uniaxial compressive strength of rock may be predicted from the following equation

$$\boldsymbol{q_c} = \mathbf{22} * I_{s50}\ (\boldsymbol{Mpa}) \qquad (\mathbf{7})$$

Sample of Results Demonstrated through table 11. For Massif Tunnel location regarding Point Load Test

Table 11 Part of point load test regarding massif tunnel location

S.N	Tunnel Name	Sample code	(D) readings (mm)	Average Width (Wavg.) from (3) readings(mm)	L (mm)	(P) failure (kN)	$\boldsymbol{I_{50}}$ (MPa)	qc(Mpa)
1	Massif	masif 1+2A	34	50.097	30	10	5.33	117.35
2		masif 1+2B	51	54.88	26	10.5	3.86	84.9
3		masif 1+2C	47	51.61	27	12.5	5.11	112.51

and accordingly, through table 12. It can be demonstrated the results for the three locations of area of study

Table 12. Results of point load test regarding three locations

S.N.	Tunnel Name	$\boldsymbol{I_{50}}$ (MPa)	qc(Mpa)
1	Massif (Permam)	4.68	103.61
2	Bany Hareer	5.19	115.93
3	Haybat Sultan	2.59	51.02

Comparing the results [15] with table 13. It was found that both Massif and Bani Hareer were in the high strength range whiles Haybat Sultan rock samples were in the medium strength rock zone

Table 13. Classification of rock regarding point load results [15]

Rock classification	Point Load Strength Index (MPa)
Very High Strength	>8
High Strength	4-8
Medium Strength	2-4
Low Strength	1-2
Very Low Strength	<1

3.5. Slake durability test

The slake durability index via second cycle is calculated as the percentage ratio of final initial dry sample mass as follows:

$$Slake - Durability\ index, I_{d2}(\%) = \left[\frac{C - D}{A - D}\right] * 100\% \qquad (8)$$

Samples with second cycles indexes from 0-10% should be further characterized by their first cycle slake-durability indexes as follows:

$$Slake - Durability\ index, I_{d1}(\%) = \left[\frac{B - D}{A - D}\right] * 100\% \qquad (9)$$

Where:

(A) is weight of the sample and drum,
(B) weight of drum plus retained portion of the sample first cycle,
(C) weight of drum plus retained portion of sample second cycle, and
(D) drum weight (constant) to be weight at laboratory.

Sample of Results Demonstrated through table 14. For Massif Tunnel location regarding Slake Durability Test

Table 14 Part of slake durability test regarding massif tunnel location

S. N	Tunnel Name	Sample code	slake after second cycle	Description
1	Massif	Masif 1&2	99.62	Very High durability
2		Masif 3	99.72	Very High durability
3		Masif 4	99.89	Very High durability

Results Demonstrated through table 15. Illustrate the results for the three locations

Table 15 Slake durability test results regarding locations of study area

S. N	Tunnel Name	slake after second cycle (average)	Description
1	Massif	99.39	Very High durability
2	Bany Hareer	99.24	Very High durability
3	Haybat Sulatn	72.22	Medium durability

According to[21] (Table 16.), the results were indicated that a good weathering resistance for both massif and Bani hareer rock tunnel samples; very high whiles for Haybat sultan samples were in medium durability which gives a concerned to pay attention to the contact with weathering platforms available such as rain and any other source of water contact.

Table 15 Slake durability classification after [16]

Group Name	% Retained After Two (10-min) cycles
Very High Durability	>98
High Durability	95-98
Medium-High Durability	85-95
Medium Durability	60-85
Low Durability	30-60
Very Low Durability	<30

3.6. AHP Process

Analytical Hierarchy Process or as abbreviated (AHP) is such a technique that developed by Thomas L. Saaty in (1980) as a Multi-Criteria Decision Making method, where the input data can be obtained accordingly through some personal opinion such as satisfaction, or even through real measurements such as prices and weights [22, 23]. The AHP procedure involves four stages: first, build up the decision hierarchy, second determine the relative significance of related factors, third evaluate the suggested alternative, and finally calculate the overall weight regarding those attributes, and the crucial part is to check the consistency of the subjective evaluations [24]. In this study relative weights of factors were considered by mean of test importance and source of error that would cross the test during execution and implementation, simply by conducting pairwise comparing the factors concerning the goal of study; the AHP process was conducted using Microsoft Excel to simplify the process. The factors that used as a comparison factors were as follows:

As for practical tests, the five-test illustrated earlier would be compared as to establish a weight for the importance of the test priority and how that factor event lead to risk event if not considered (Table 16) regarding strength parameters of samples

Table 16. Pairwise matrix regarding the 5 tests

	water content	Slake Test	Brazilian Test	UCS test	Point Test	Load	sum	average
water content	1.000	0.500	0.250	0.143	0.125		2.018	0.404
Slake Test	2.000	1.000	0.333	0.143	0.333		3.810	0.762
Brazilian Test	4.000	3.000	1.000	0.250	2.000		10.250	2.050
UCS	7.000	7.000	4.000	1.000	4.000		23.000	4.600
Point Load	8.000	3.000	0.500	0.250	1.000		12.750	2.550
sum	22.000	14.500	6.083	1.786	7.458			

Accordingly, the weight of the factors is illustrated in Table 17.

Table 17 Normalized pairwise matrix regarding the 5 tests for the weight calculation

	water content	Slake Test	Brazilian Test	UCS	Point Load	sum	Average weight	consistency
water content	0.045	0.034	0.041	0.080	0.017	0.218	0.044	5.090
Slake Test	0.091	0.069	0.055	0.080	0.045	0.339	0.068	5.214
Brazilian Test	0.182	0.207	0.164	0.140	0.268	0.961	0.192	5.558
UCS	0.318	0.483	0.658	0.560	0.536	2.555	0.511	5.483
Point Load	0.364	0.207	0.082	0.140	0.134	0.927	0.185	5.186
sum	1.000	1.000	1.000	1.000	1.000		1.000	
							CI	0.0765
							RI	1.12
							CR	0.068 (accepted)

As it been noted from table 17. The rank of the most critical test to be put into priority risk concerns regarding strength parameters was as follows the uniaxial compression test (51.1%) represent the most critical test concerning the strength parameters of rock test and followed by the Brazilian Test (19.2%) in which it is reasonable since the test indicate tensile strength calculations.

Accordingly, a series of matrices were conducted to illustrate the importance of tests for durability and tensile strength parameters in table 18. Illustrate those outcomes and the priority of factors regarding compressive strength, durability, and tensile strength factors.

Table 18. weights regarding most critical and risky factors affecting the measurement of 3 different test outcomes

Rank due	Compressive strength	Durability Consideration	Tensile Strength Issues

to weight	issues		
1	UCS (51.1%)	Slake Test (51.6%)	Brazilian Test (52.9%)
2	Brazilian Test (19.2%)	Water Content Test (21.5%)	Point Load test (20%)
3	Point Load Test (18.5%)	Brazilian Test (11.6%)	UCS Test (18.5%)
4	Slake Test (6.8%)	Point load test (8.6%)	Slake Test (5.2%)
5	Water Content Test (4.4%)	UCS Test (6.7%)	Water Content Test (3.3%)

As the test advance through the procedure, it was a must to show the most risk factors parameters that take a place in the procedure of the test application and reading results. By taking the higher ranks for the three types of characterized stet outcomes those (compressive strength, durability, and tensile strength) an AHP analysis were conducted to demonstrate those factors. such factors were sample size (length, diameter, width), the mass of the sample, failure load readings, time measured, and procedure of the test. those were elected regarding judgment knowingly those would affect the final test results based on experience and judgments. As it can be noticed through table 19.

Table 19. weights regarding most critical and risky factors affecting the measurement of higher 3 ranked test parameters.

Rank due to weight	Compressive strength issues	Durability Consideration	Tensile Strength Issues
1	Test Procedure (49.3%)	Test Procedure (46.8%)	Test Procedure (52.2%)
2	Sample Size (27.2%)	Mass of Sample (26.8%)	Sample Size (23.1%)
3	Failure Load Readings (15.5%)	Sample Size (15.1%)	Failure Load Readings (16.8%)
4	Mass of Sample (4.7%)	Time Measured (7.3%)	Mass of Sample (4.5%)
5	Time Measured (3.3%)	Failure Load Readings (4%)	Time Measured (3.4%)

For all three tests with higher rank of risk, the most common risk was the risk regarding the test procedure in the average set as (49.43%) affecting the test results in which it is a high number after that sample size and mass obtained before the test application as a major risk factor which gives a spotlight on the caution in doing sample extracting and preparation.

4. Conclusions

For any project, if it is simple or massive starting from a simple house to furthermore infrastructure projects, tests, and sample collection are some of the main parts of the project process. tunnel projects specified were the area of study here due to the geological composition in which most of the rock regarding the three locations from which the samples were taken; for that reason, the test was mainly focused on rocks. Basically, five types of test were illustrated and thoroughly after test result demonstrations it was clear that rock samples from Massif (Pirmam) and Bani Hareer Tunnel location were more stable from strength and durability consideration whiles from Habyt Sultan tunnel location was so kind less in strength and some durability concerns required. as furthermore proceeded toward results regarding the manganite process by applying the AHP procedure method it was indicated that the most likely test with great concern to be a focus on was the uniaxial compression test, Brazilin test, and Slake durability test respectively. That would give a preliminary indication to focus on those tests based on expert judgment through weights. For the next step, the parameters that should be taken into consideration regarding those tests were test procedure, sample size, and mass obtained those must be taken into great caution to avoid any risk regarding the procedure and so on the final results because it will eventually affect the design process for the support system used for tunnel beside the results from geological explorations. Such concerns must be put into a priority in starting any project especially tunnel-like projects since geotechnical and geological reports are one of the most crucial parts for the success of a project too if not possible to avoid risk at least manage to treat it in a proper management process. Any managemental process that takes place during project implementation should regard risk factors starting from site survey and sample collecting heading to geological and geotechnical tests and that part if made with concern will affect the establishment of a good base for design and construction phases afterward.

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