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**EXTENDED ABSTRACT**

# Investigation of the Effect of Different Factors on The Dissolution Rate and Single-Site Compressive Strength of Gypsum- Containing Materials (Case study: Marash Zanjan Dam)

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## 1. Introduction

Soluble rocks such as gypsum and anhydrite are problematic rocks in geological engineering and geotechnics. The presence of these rocks in the construction of water structures such as bridge piers, coastal walls, diversion dams and dams, etc. due to their solubility and behavioral mechanism and deformability of gypsum-containing materials poses serious challenges in terms of stability The construction of Marash Dam, which is located about 98 km from Zanjan city, has special complications due to the presence of gypsum and anhydrite materials along with marl materials. Due to the fact that the materials of the dam bed, which contain gypsum and anhydrite materials, are exposed to loading and moisture, as well as solubility at the same time, so it is very important to study the mechanism of solubility and final strength of these rocks at different humidity. The effect of moisture on the deformation of gypsum materials is quite obvious and can sometimes lead to a decrease or increase in the strength of gypsum materials in certain conditions, Hooka et. al. (2006). At high pressures and in the presence of moisture, the dissolution rate as well as the compressive strength of gypsum and anhydrite samples have complex behaviors and depending on the contact area of the materials relative to each other and the moisture content, the dissolution rate can decrease and increase resistance over time, Hasan F, Ibrahim A, (2021). Based on the explanations provided and others' research, in the present study, according to the site conditions, rock samples from different depths (10 samples) to perform uniaxial tests and determine the Young's modulus and other parameters including natural density, moisture content and Poisson's ratio. And the porosity was transferred to the laboratory. In addition to resistance tests, solubility tests were performed to determine the maximum solubility of materials containing gypsum and anhydrite under different conditions (Marash dam water and distilled water and water containing 1% sodium chloride). By performing statistical and graphical analyzes, the behavioral status of gypsum rock samples in relation to various parameters has been investigated and its results have been presented.

## 2. Methodology

In this study, samples containing gypsum were first prepared from the Marash Dam site and transferred to the laboratory for testing. Considering that the purpose of this research is to determine the solubility of gypsum materials in different conditions and solutions and also to determine the uniaxial compressive strength of the modulus of elasticity of these materials, then using a conductor and electrical conductivity test, the solubility of these materials in different environments was examined. Finally, after determining the engineering

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parameters of the tested samples, the necessary analysis was performed on the uniaxial compressive strength and Young's modulus relative to the other parameters.

## 3. Results and discussion

### *3.1. In the following, the analyzes related to uniaxial tests of gypsum specimens with respect to different parameters are presented.*

According to Fig. 1, the changes in porosity percentage are between 17 and 27%, which shows that the samples have significant empty cavities relative to each other, which indicates the non-uniformity of porosity and fracture of site rocks, and also with increasing porosity., The values of modulus of elasticity and maximum uniaxial compressive strength are reduced, the slope of reduction of compressive strength is greater than the percentage of porosity compared to the modulus of elasticity. The correlation of the two graphs to the porosity percentage is relatively the same.

According to Fig. 2, the relative density changes are between 1.96 to 2.17g/cm3. As the relative density increases, the modulus of elasticity values increase relatively and the maximum uniaxial compressive strength decreases. Also, the correlation of maximum compressive strength to relative density is higher than Young's modulus and the general trend of both parameters to relative density is almost incremental.

According to Fig. 3, the variation in moisture content is between 5 and 12%. As the moisture content increases, the maximum compressive stress decreases and the Young's modulus increases. In other words, the trend of the diagram is the maximum compressive stress and Young's modulus with respect to the percentage of moisture decreasing and increasing. The low correlation coefficient of both parameters to the percentage of moisture indicates that there is no significant relationship between the percentage of moisture and these two parameters and changes in Young's modulus and maximum compressive strength to the percentage of moisture are not significant.

According to Fig. 4, the Poisson's ratio changes between 0.18 and 0.29. The slope of changes in Young's modulus and uniaxial compressive strength is decreasing compared to Poisson's coefficient and the correlation coefficient of both graphs is very low, which shows that with changes in Poisson's coefficient, the parameters of uniaxial compressive strength and Young's modulus do not change much.

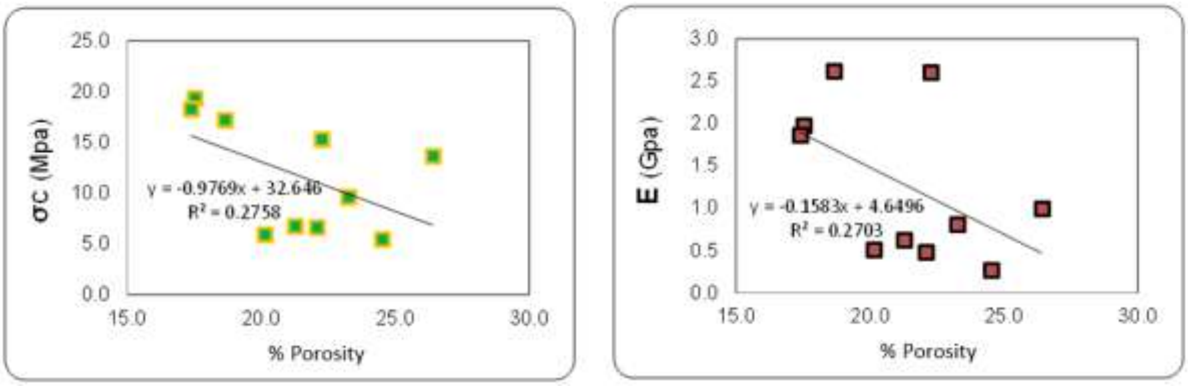


**Fig. 1.** Diagram of changes in maximum uniaxial compressive stress and modulus of elasticity relative to porosity percentage

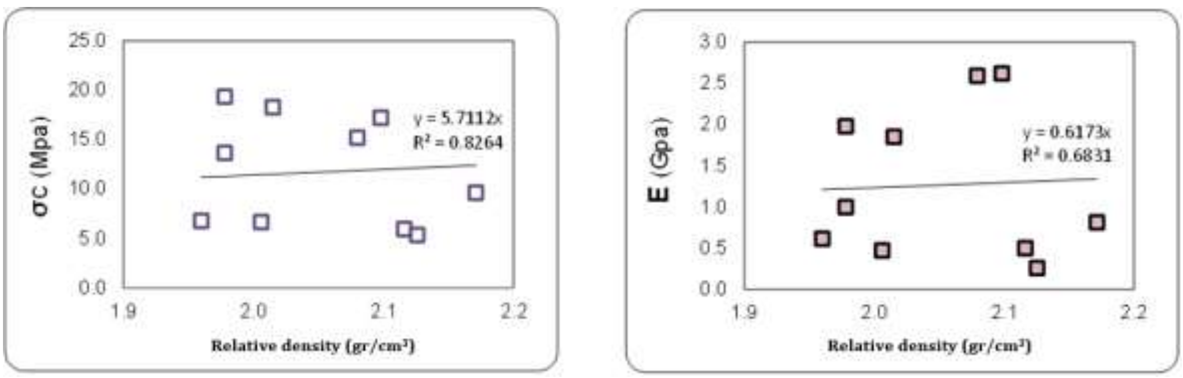


**Fig. 2.** Graph of more changes in uniaxial compressive stress and modulus of elasticity than relative density

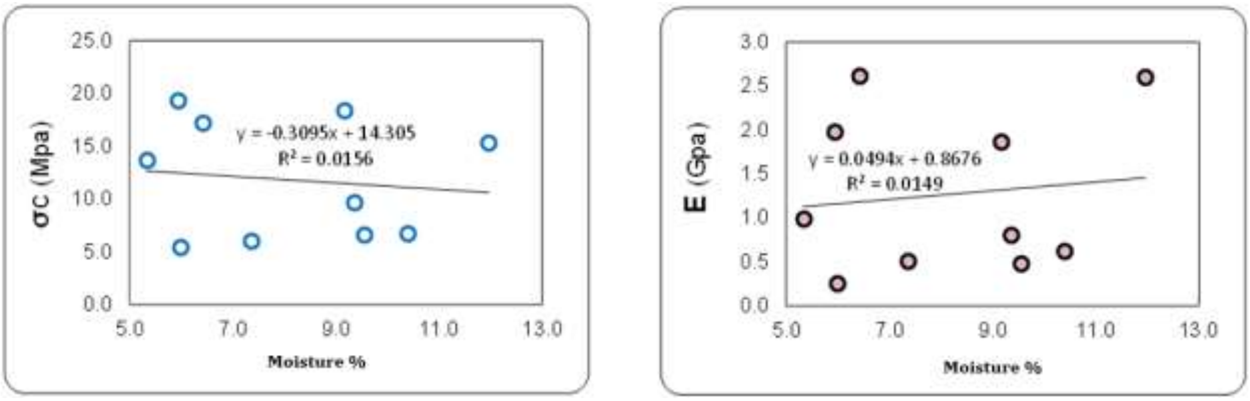


**Fig. 3.** Diagram of changes in maximum uniaxial compressive stress and modulus of elasticity with respect to moisture content

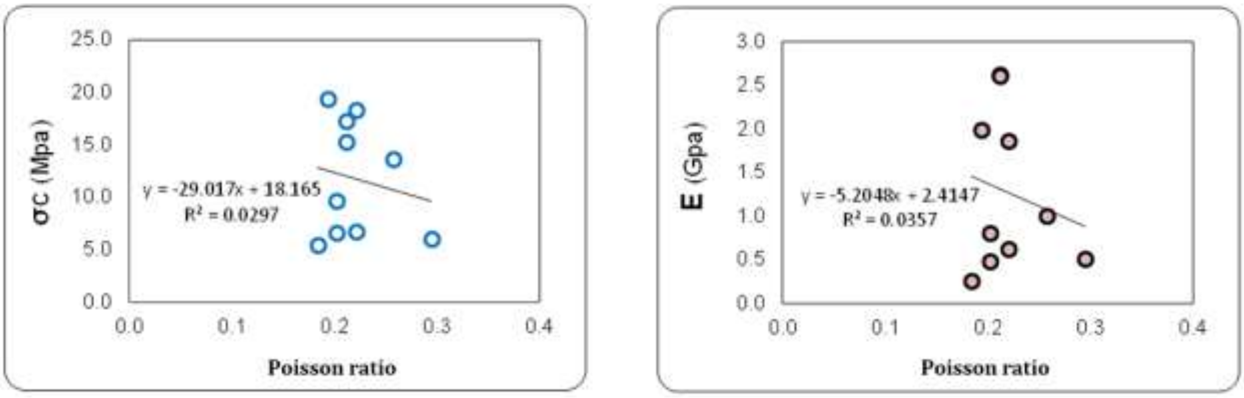


**Fig. 4.** Graph of changes in maximum uniaxial compressive stress and modulus of elasticity versus Poisson ratio

## 4. Conclusions

1) The solubility of gypsum in solutions containing 1% sodium chloride is higher than the water samples of Marash dam and this shows that the presence of salt increases the solubility of gypsum.

2) Based on the changes in electrical conductivity relative to the weight percentage of gypsum, in the water sample of Marash dam compared to the other two solutions at a lower weight percentage has reached saturation, which indicates the dissolution of gypsum-containing materials in the water solution of Marash dam lower than the sample Distilled water and water solution contain one percent of sodium chloride, which can be due to the presence of impurities in the water of Marash Dam.

3) Changes in porosity percentage between 17 to 27% show that the samples have significant empty cavities relative to each other, which indicates non-uniformity of porosity and fracture of the site rocks and also confirms the presence of marl layers between gypsum rocks. he does.

4) With increasing porosity, the values of modulus of elasticity and maximum uniaxial compressive strength decrease, the slope of decreasing compressive strength is greater than the percentage of porosity compared to the modulus of elasticity. Due to the filling of gypsum-containing rocks with marl materials, the increase in porosity can be due to leaching of marl materials and increasing the volume of cavities, which in turn reduces the bearing capacity of gypsum-bearing materials.

5) Changes in the relative density of gypsum rocks in the area of the dam site are not noticeable (1.96 to 2.17 g / cubic centimeter) and with increasing the relative density, the values of modulus of elasticity increase relatively and the maximum uniaxial compressive strength decreases. Find. Also, the correlation of maximum compressive strength to relative density is higher than Young's modulus.

6) Humidity percentage changes are between 5 to 12%. As the moisture content increases, the maximum compressive stress decreases and the Young's modulus increases. In other words, the trend of the diagram is the maximum compressive stress and Young's modulus with respect to the percentage of moisture decreasing and increasing.

7) Poisson's coefficient changes are between 0.18 to 0.29, the changes between the minimum and maximum Poisson's coefficient is about 50% and is a considerable number. The slope of changes in Young's modulus and uniaxial compressive strength is lower than the Poisson's ratio, and due to the fact that at high values of Poisson's ratio, Young's modulus values and uniaxial compressive strength are reduced by more than three

times can be high ductility The rock samples are due to the presence of marl materials, which based on the Yang modulus change diagrams and uniaxial compressive stress relative to the moisture content, it can be seen that the moisture content is higher in these areas that marl materials both absorb more moisture and increase coefficient. Poisson ultimately reduces the modulus of elasticity and ultimate uniaxial compressive strength.

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