Mini Review
Volume 12:11, 2022

Journal of Civil & Environmental Engineering

ISSN: 2165-784X
Open Access

A Constitutive Model of Sandstone

Sitesh Singh*

Department of Engineering & Technology, Wollega University, Nekemte, Ethiopia

Abstract

It is extremely challenging to describe the time dependent behaviour of sandstone under stress due to its homogeneity at the macro scale and heterogeneity at the macro scale. Crack initiation and progression may be affected by macro scale heterogeneity. The development of macro scale fractures is strongly influenced by crack clusters. A time-dependent damage model is presented in this paper to investigate the effect of crack evolution on the occurrence of fractures during creep deformation. Based on the elastoplastic theory of rock and the micro-heterogeneous characteristics of sandstone, the instantaneous elastoplastic damage model of sandstone was initially developed. The Nishihara model and the elastoplastic damage constitutive model were combined to create a viscoelastic plastic creep damage model. The outcomes of the corresponding analytical solutions have confirmed the proposed models. The time-dependent behaviour of sandstone was examined using conventional constant strain rate tests and multi-step creep tests to support the model. Both the time-dependent viscoelastic deformation characteristics of sandstone and the creep behaviour's viscoelastic plastic deformation characteristics are well-represented by the proposed damage model, as demonstrated by the findings.

Keywords: Elastoplastic • Viscoelastic plastic • Micro-heterogeneous

Introduction

On the failure and damage of micro-units, the damage model can also replicate the propagation process of microscopic cracks in sandstone. The study of the propagation of microscopic cracks in sandstone may yield an efficient instrument from this investigation. Many examinations have shown the way that quartz-rich stone can disfigure and at last bomb under a consistent differential worry about broadened timeframes, a peculiarity known as weak jerk (or time-subordinate twisting, curtailed to TDD in the accompanying), particularly for sandstone (a stone frequently found in the rooftops and floors of coal creases). In creep experiments, deformed sandstone taken from deep coal mines typically exhibits three strain-versus-time regimes: primary creep, or the stage with a decreasing strain rate; secondary creep, or the stage with a constant strain rate; tertiary creep, or the stage with the failure due to an increasing strain rate. However, the creep behaviour of rock has been broken down into three categories by some researchers: viscoelastic TDD, viscoelastic TDD, and elastic instantaneous deformation A constitutive model that can be utilized to replicate the creep deformation of rock and gain a deeper comprehension of the failure evolution of rock can be constructed using this categorization, which identifies three types of deformation.

Description

In order to describe the elastic plastic short-term behaviour and the elastoplastic time-dependent behaviour, extensive research has been conducted on the viscoelastic plastic deformation of a damage model. Irreversible thermodynamics is used to describe their damage law. With the help of non-associated plastic flow, the total creep strain has been divided into instantaneous elastic strain, instantaneous plastic strain, time-dependent viscoelastic strain, and time-dependent visco-plastic strain based on experimental data, suggesting that the proposed constitutive relationship would be ideal for semi-brittle rock material. The results show that the creep model's strain curves accurately describe the three stages of creep and agree well with the experimental findings. In addition, a lot of papers have been written about how to describe all stages of rock creep behaviour. However, the majority of published papers either attempt to replicate all stages of creep behaviour or primarily focus on strain-time curve fitting. We still do not know how crack evolution influences the formation of rock fractures, despite the fact that all of them have achieved good agreement with experimental results. As a result, in addition to matching the numerical and laboratory strain curves, some researchers have investigated crack evolution prior to rock failure. The creep constitutive model, which was able to accurately characterize the time-dependent creep deformation, was constructed using the Norton–Bailey equation. Using the Norton bailey creep equation as well as the time-independent damage evolution law, the creep model could also be used to demonstrate the failure of rock mass slope. In addition, a discrete element grain-based model in three dimensions has been developed to simulate the fracture evolution of rock around underground excavations. The results of the simulation and the laboratory are in good agreement. These papers discuss the crack propagation and damage evolution induced by stress concentration prior to the creep failure. Other researchers have also investigated the creep behaviour of engineering structures like roads and tunnels [1-3].

Despite the fact that there are a few published articles on the macroscopic failure behaviour or viscoelastic plastic properties of rock induced by microscopic damage evolution during time-independent deformation, only a small number of studies closely combined rock's microscopic damage evolution with macroscopic TDD and creep behaviour's viscoelastic plastic mechanical properties. The greater part of the distributed models is isotropic, and the homogeneity model can't actually portray the heterogeneous qualities of sandstone in the musicale. Based on laboratory test results, this work develops a viscoelastic plastic time-dependent damage constitutive model and an instantaneous elastic-plastic damage constitutive model of sandstone. The Nishihara model and an analytical solution to an elastic-plastic model serve as validations for these models, respectively. On sandstone, which is frequently used in coal mine roofs, a series of conventional constant-strain-rate tests and multi-step creep tests

***Address for Correspondence:** Sitesh Singh, Department of Engineering & Technology, Wollega University, Nekemte, Ethiopia E-mail: sitesh32@gmail.com*

Received: 02 November 2022, Manuscript No. jcde-23-86772; **Editor assigned:** 04 November 2022, PreQC No. P-86772; **Reviewed:** 16 November 2022, QC No. Q-86772; **Revised:** 21 November 2022, Manuscript No. R-86772; **Published:** 28 November 2022, **DOI:** 10.37421/2165-784X.2022.12.479

were carried out as an addition to this work. After that, the results of the simulation and those of the laboratory are thoroughly examined together. For sandstone, this study develops a damage constitutive model that ought to be capable of describing all stages of creep behaviour. Crack propagation or damage evolution prior to creep failure can be modelled using the damage model as well. A viscoelastic plastic damage model was developed in this study to investigate the TDD characteristics of sandstone, particularly the progression of cracks prior to rock failure. Analytical solutions were used to verify the damage model's elastoplastic and viscoelastic plastic behaviours. Uniaxial compressive strength tests and multi-step creep tests were carried out on the sandstone following the validation of the damage model to evaluate its strengths and weaknesses [4,5].

Conclusion

The study's findings demonstrate that the instantaneous elastic-plastic damage model is capable of illustrating the sandstone volumetric strain progression from compression to dilation. Before the primary fracture appears, the specimen experiences a rapid succession of numerous small fractures. The phenomenon that small specimen damage can result in the formation of micro cracks, which accumulate to cause the specimen to fracture, is captured by the damage model. The last disappointment mode given by the mathematical reproduction is predictable with that separated from research facility test results. The behaviour of viscoelastic plastic deformation can be replicated by the viscoelastic plastic damage model. However, in contrast to the conclusion of the conventional constant-strain-rate test, the multi-step creep tests reveal rock cracks at each stress loading stage. Similar to the findings of the UCS tests, the final macroscopic fracture can be attributed to the gradual accumulation of cracks.

Acknowledgement

None.

Conflict of interest

No potential conflict of interest was reported by the authors.

References

1. Agirbas, Asli. "Teaching construction sciences with the integration of BIM to undergraduate architecture students." Front Archit Res 9 (2020): 940-950.

2. Bosché, Frédéric, Adrien Guillemet, Yelda Turkan and Carl T. Haas, et al. "Tracking the built status of MEP works: Assessing the value of a Scan-vs-BIM system." J Comput Civ Eng 28 (2014): 05014004.

3. Brilakis, Ioannis, Manolis Lourakis, Rafael Sacks and Silvio Savarese, et al. "Toward automated generation of parametric BIMs based on hybrid video and laser scanning data." Adv Eng Inform 24 (2010): 456-465.

4. Chacón, Rolando. "Designing construction 4.0 activities for AEC classrooms." Buildings 11 (2021): 511.

5. Chacón, Rolando, David Codony, and Álvaro Toledo. "From physical to digital in structural engineering classrooms using digital fabrication." Comput Appl Eng Educ 25 (2017): 927-937.

6. How to cite this article: Singh, Sitesh. "A Constitutive Model of Sandstone." J Civil Environ Eng 12 (2022): 479.

How to cite this article: Singh, Sitesh. "A Constitutive Model of Sandstone." J Civil Environ Eng 12 (2022): 479.