Journal of Mineral Resources Engineering, 10(1): 61-75, (2025)

Imam Khomeini International University
Vol. 10, No. 1, Spring 2025

نشریه مهندسی منابع معدنی
Journal of Mineral Resources Engineering
(JMRE)

Research Paper

Production of Building Bricks from Lorestan Shale and Investigation of Effective Parameters

Bayranvand F.[1], Barani K.[2*], Ghaedrahmati R.[2]

1- M.Sc Student, Dept. of Mining, Faculty of Engineering, Lorestan Unniversity, Khorramabad, Iran
2- Associate Professor, Dept. of Mining, Faculty of Engineering, Lorestan Unniversity, Khorramabad, Iran

Received: 27 Feb. 2024 **Accepted: 28 Apr. 2024**

Abstract: In this research, the possibility of producing building bricks from the shale reserves of Lorestan province has been investigated. Sampling was done in six different areas, and after conducting XRF tests, one sample was selected for brick production. 10 different combinations of bricks with different percentages of shale were made from the selected sample. Compressive and bending strength and water absorption tests were performed on the manufactured samples. The results of the tests showed that with the increase in the percentage of shale, the amount of water absorption increased, so that the samples consisting of 90 to 100% shale had 14.8% water absorption. The sample containing 10% shale has a water absorption rate of 11.1%. Also, the results showed that increasing the percentage of shale decreased the compressive and bending strengths of bricks. The sample with the highest compressive strength, with a value of 27.2 MPa, corresponds to the sample containing 10% shale, while the compressive strength of the sample containing 100% shale is only 11.2 MPa. Based on the INSO-7 (Iranian national standard), the manufactured bricks are of good quality and can be used as building bricks and facing bricks in buildings.

Keywords: Building brick, shale, Amiran formation, Lorestan province.

How to cite this article
Bayranvand, F., Barani, K., and Ghaedrahmati, R. (2025). *"Production of building bricks from Lorestan shale and investigation of effective parameters"*. Journal of Mineral Resources Engineering, 10(1): 61-75.
DOI: 10.30479/jmre.2024.20019.1683

*Corresponding Author Email: *barani.k@lu.ac.ir*

IINRODUCTION

Shale is a soft, brittle, fine-grained, and easily eroded sedimentary rock formed from mineral-rich silt or mud that was deposited in an aquatic environment, buried by other sediment, and compacted and cemented into hard rock [1,2]. One of the most important and effective parameters for determining the quality of building bricks is the selection of high-quality raw materials [3,4]. There have been many studies on the use of shale for brick production [5-17]. The possible utilization of different waste materials, such as oil shale ash mixed with marble and granite sludge, to produce low-cost, compressed, strong, lightweight masonry bricks was investigated. The results showed oil shale ash acted as a self-cementitious material and a good binding material if added to pozzolanic waste materials such as granite and marble sludge [18]. The effect of different contents of sewage sludge on the properties of green or fired shale bricks was examined experimentally. It was found that the physical, mechanical, and thermal performances, as well as the microstructure of the bricks, were apparently affected by the addition of sewage sludge [19]. Applications of oil shale in building materials were evaluated in Estonia. The results showed that shale ash has few cementing properties, which is due to its fine grain and mineralogical composition. By adding clay materials, brick porosity and insulation properties are improved. Also, manufactured bricks have an acceptable compressive strength [20]. In this research, the use of shale from the Amiran formation located in Lorestan province for the production of building bricks was investigated.

MATERIALS AND METHODS

The sample used in this research was obtained from six different points of the Amiran Formation. Table 1 shows the chemical compositions of the samples, determined by the XRF analysis. Sample number 2, which has the highest amount of SiO_2 and the lowest amount of CaO and LOI, was chosen as the sample used for brick manufacturing.

Bricks were manufactured in the Alla factory located in Isfahan. In order to find the best combination, the shale sample was gradually replaced by a part of the factory soil. 11 different combinations of bricks were made. The composition and mixing percentage of the bricks are shown in Table 2.

To manufacture bricks, 1 kg of soil along with 100 cc of water is poured into a mold and put under pressure in a molding machine. The raw bricks were placed in the furnace at a temperature of 800 for 24 hours. The water absorption, compressive strength, and bending strength of the manufactured brick samples were determined according to the Iranian national standard (INSO-7).

FINDINGS AND ARGUMENT

Figure 1 demonstrates the water adsorption of the bricks made from shale. It can be seen that by increasing the amount of shale from 10% to 20%, water absorption increases from 11.1 to 13.6%. With a

Table 1. Chemical composition of the samples

Sample No.	1	2	3	4	5	6
SiO_2	53.23	55.18	55.88	53.46	46.78	54.44
Al_2O_3	7.78	9.74	8.36	7.46	7.22	8.40
Fe_2O_3	7.13	9.33	8.33	7.10	7.45	9.33
CaO	12.23	5.11	9.27	11.73	15.07	8.25
Na_2O	0.45	0.42	0.38	0.36	0.44	0.48
K_2O	1.39	1.47	1.12	1.32	1.10	1.24
MgO	3.67	3.78	3.87	3.52	3.77	4.62
TiO_2	1.13	1.67	1.47	1.27	1.29	1.44
MnO	0.12	0.07	0.01	0.10	0.13	0.11
P_2O_5	0.16	0.17	0.017	0.15	0.17	0.19
LOI	12.37	9.89	10.83	13.14	16.23	11.24
S	0.22	0.06	0.02	0.21	0.21	0.10

Table 2. Compostions of the manufactured bricks

Sampel No.	Factory soil (mass%)	Shale (mass%)
1	90	10
2	80	20
3	70	30
4	60	40
5	50	50
6	40	60
7	30	70
8	20	80
9	10	90
10	0	100
11	100	10

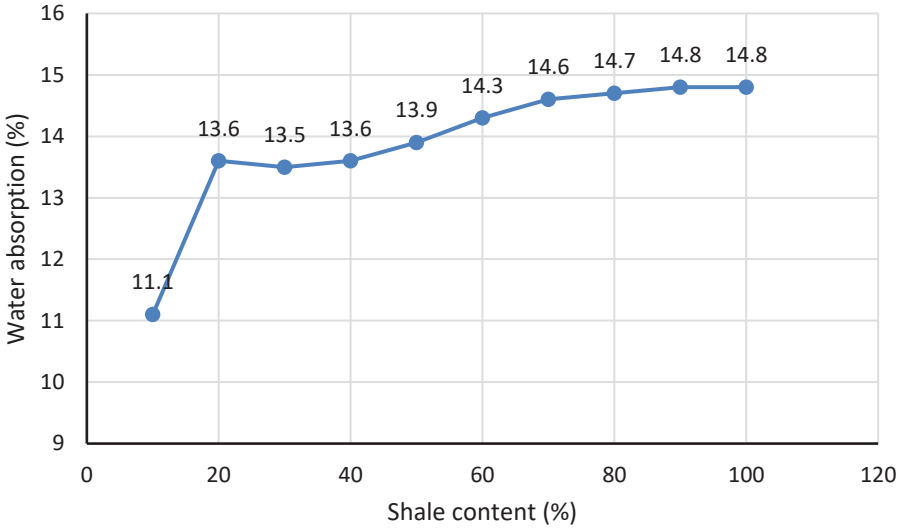

Figure 1. Effect of shale content on water absorption

further increase in the amount of shale, the water absorption increases with a slight slope. The maximum water absorption (14.8%) is related to samples containing 90-100% shale. In general, it can be concluded that increasing the amount of shale has a negative effect on the amount of water absorption.

Figure 2 shows the compressive strength of the bricks made from shale. It can be seen that by increasing the amount of shale from 10% to 100%, the compressive strength decreases from 272 kg/cm^2 (approximately 27.2 MPa) to 112 kg/cm^2 (approximately 11.2 MPa). 11.1 to 13.6%.

Figure 3 shows the results of the bending strength. It can be seen that the bending strength decreases from 70 kg/cm^2 (approximately 7 MPa) to 48 kg/cm^2 (approximately 4.8 MPa) by increasing the amount of shale from 10 to 100%.

CONCLUSIONS

The results of this research show that increasing the amount of shale in bricks increases water absorption and decreases the compressive and bending strengths. However, even when the weight composition of the brick is 100% shale, according to the INSO-7 national standard, the manufactured bricks have good quality and can be used in buildings. There are very few brick factories in Lorestan province, and most of the consumption needs of Lorestan province are met by Isfahan province. The results of this research show that the shale reserves of the province are of suitable quality for the development and operation of many brick factories.

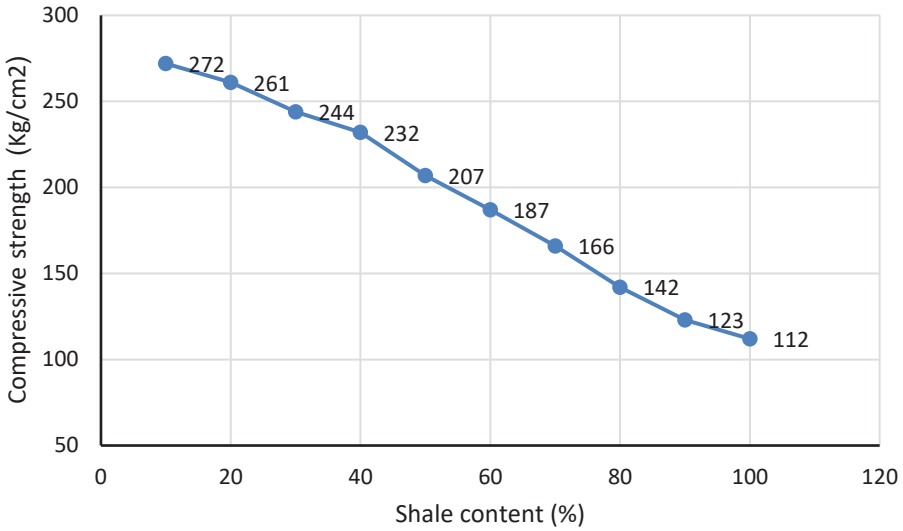

Figure 2. Effect of shale content on compressive strength

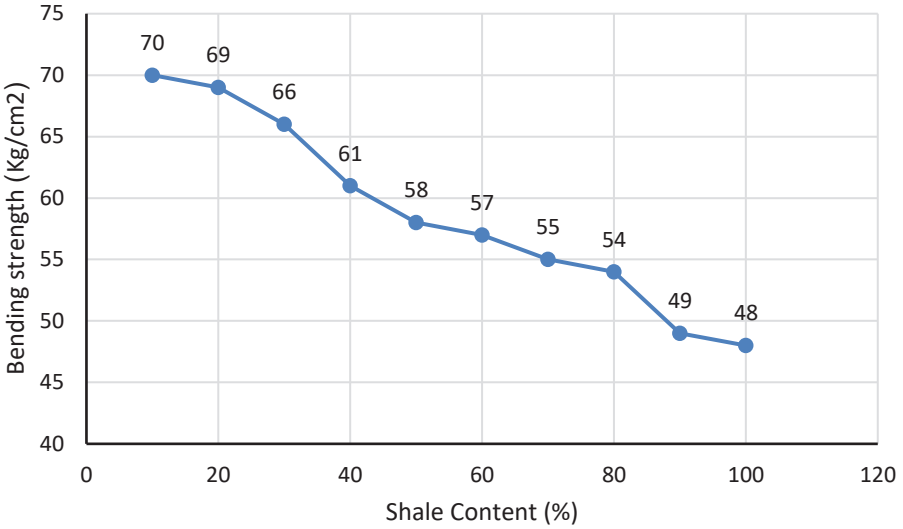

Figure 3. Effect of shale content on bending strength

REFERENCES

[1] Karimpour, M. H. (2010). *"Industrial minerals and rocks"*. The Fifth Ed., Ferdosi University, pp. 398. (In Persian)

[2] Nasiri, Y., Mosaviharami, R., Mahbobi, A., and Yeganeh, B. (2011). *"Facies and sedimentary environment of Amiran formation in Lorestan region"*. In: The 15th conference of the Geological Society of Iran. (In Persian)

[3] Mahdavinejad, M. J. (2005). *"Creativity and the process of creative education in architectural design"*. Beautiful Arts, 21: 66-57. (In Persian)

[4] Zomorshidi, H., and Habibabad, A. S. (2018). *"Bricks and the art of brickwork from ancient times to today"*. Iranian-Islamic City, 9(33): 5-17. (In Persian)

[5] Mor, F., and Moradi, S. (2005). *"Investigating the geochemistry and mineralogy of brick-making and production brick soils, Kovar and Marvdasht, Fars province"*. In: The 9th conference of the Geological Society of Iran. (In Persian)

[6] Khan, M. H., Yousaf, W., Sadaqat, B., Javed, N., and Olukade, A. (2022). *"A Workflow for Shale Play Exploration and Exploitation"*. In: Offshore Technology Conference Asia, Virtual and Kuala Lumpur, Malaysia, March 2022. DOI: https://doi.org/10.4043/31504-MS.

[7] Hossein Miremad, S., Mallayeri, S., and Shakeri, M. (2015). *"Investigating the effect of shale on the qualitative characteristics of clay bricks"*. In: The 7th Conference of the Economic Geology Society of Iran. (In Persian)

[8] Passey, Q. R., Bohacs, K. M., Esch, W. L., Klimentidis, R., and Sinha, S. (2012). *"My source rock is now my reservoir-Geologic and petrophysical characterization of shale-gas reservoirs"*. AAPG Search and Discovery Article, 80231: 1-47.

[9] Lotfiyar, A., Chehrazi, A., and Sabeti, N. (2016). *"Investigating shales as unconventional resources"*. Journal of Exploration & Production Oil & Gas, 135: 65-72. (In Persian)

[10] Kaykha, S., Mosavi, M., Rahanamrad, J., and Golkahzar, M. (2013). *"Introduction of shale mineral for making bricks in Saravan region"*. In: The second National Conference on New Materials and Structures in Civil Engineering. (In Persian)

[11] Tabatabaie, H., Haroni, H. A., and Ayati, F. (2012). *"Investigating areas with the potential of brick raw materials in order to solve environmental problems in Isfahan province"*. Advanced Applied Geology, 2(3): 41-58. (In Persian)

[12] Sobhani, E., and Zolfaghari, S. (2013). *"Using shale brick as a sustainable building material in urban buildings"*. In: The Third International Conference on Sustainable Development and Urban Development. (In Persian)

[13] Taleb Beydokhti, A., Mohamadi Ostadkalayeh, R., and Moomeni, A. (2024). *"Study of the engineering characteristics of slates for brick production in north Hamadan province"*. New Findings in Applied Geology, 18(35): 203-219. DOI: 10.22084/nfag.2023.27632.1549. (In Persian)

[14] Li, L., and He, Y. (2023). *"Exploration on the Utilization, Treatment, and Resource Utilization of Oil-Based Rock Cuttings in Shale Gas Extraction Process"*. Probe - Environmental Science and Technology, 5(3): 9-12.

[15] Hu, W., and Liu, Q. (2022). *"Research Progress on Thermal Properties of Aerated Concrete, Sintered Shale Brick and Composite Materials"*. Highlights in Science, Engineering and Technology, 28: 428-434.

[16] Zhao, H., Ding, J., Li, S., Wang, P., Chen, Y., Liu, Y., and Tian, Q. (2020). *"Effects of porous shale waste brick lightweight aggregate on mechanical properties and autogenous deformation of early-age concrete"*. Construction and Building Materials, 261: 120450.

[17] Nweke, O. M., and Omeokachie, A. I. (2023). *"Ceramics Properties of Indurated-Shale Quarry Wastes from Abakaliki, Southeastern Nigeria: Application as Raw Materials in Roofing-Tile Production"*. Clays and Clay Minerals, 71(2): 143-165.

[18] Hadi, N. A. R. A., and Abdelhadi, M. (2018). *"Characterization and utilization of oil shale ash mixed with granitic and marble wastes to produce lightweight bricks"*. Oil Shale, 35(1): 56-69.

[19] Wu, J., Yin, S., Zhang, L., and Song, X. (2021). *"Manufacture of sustainable fired shale bricks using sewage sludge as raw material"*. Materials Research Express, 8(9): 95510.

[20] Usta, M. C., Yörük, C. R., Hain, T., Paaver, P., Snellings, R., Rozov, E., Gregor, A., Kuusik, R., Trikkel, A., and Uibu, M. (2020). *"Evaluation of new applications of oil shale ashes in building materials"*. Minerals, 10(9): 765.