Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 55(7) (2023) 283-286
DOI: 10.22060/ceej.2023.21428.7719

Investigation of the effect of particle size and coal waste solution on sand stabilization with cement

M. Amiri[1], M. Jiryaei Sharahi[2]*

Department of Civil Engineering, Qom University of Technology, Qom, Iran.

ABSTRACT: The accumulation of coal waste from industry has made these materials available and economical to use in ground improvement, thereby reducing environmental pollution. Research has shown that adding cement to coal reduces coal pollution. Therefore, coal wastes of different sizes can be mixed with cement, and the resulting mixture can be used to stabilize and improve sandy soil in road construction or the construction of stone columns. The main objective of this study is to investigate the effect of particle size of coal wastes and coal leachate on the stabilization of fine sand with cement. To achieve this goal, different weight percentages of cement and coal wastes of various sizes were mixed, and the physical and strength characteristics of the resulting mixtures were investigated using several tests such as standard Proctor compaction and unconfined compression tests. To determine the optimal mixing ratio, the study examined the effect of the weight ratio of cement to coal wastes (0/100, 10/90, 20/80, 30/70, 40/60, 50/50) and the particle size of coal wastes passing Sieve No. 40, Sieve No. 200, as well as coal waste solution. The results show that the addition of finer particles of coal waste improves the strength of soils. The unconfined compression test results indicate that increasing the ratio of additives from 2.5% to 7.5% increases the compressive strength, and the optimal mixing ratio of additives is 90% cement and 10% fine coal waste particles.

Review History:

Received: May, 28, 2022
Revised: Apr. 29, 2023
Accepted: May, 18, 2023
Available Online: May, 3, 2023

Keywords:

Soil stabilization
sand
coal waste
standard compaction
compressive strength

1- Introduction

The accumulation of coal waste from industry has made these materials available and economical to use in ground improvement, reducing environmental pollution. Research has shown that adding cement to coal reduces coal pollution. Therefore, coal wastes of different sizes can be mixed with cement, and the resulting mixture can be used to stabilize and improve sandy soil in road construction or the construction of stone columns. Research has also shown that coal waste can react pozzolanically with cement or lime, hindering and stabilizing acid pollutants and heavy metals of coal. [1-10].

Despite the existing research on the use of coal wastes in concrete and soil stabilization with cement, there are still questions that need to be addressed. Coal wastes are available in both fine and coarse forms, as well as leachate and the effect of coal particle size or its leachate on mixing has not been thoroughly investigated in previous research. Furthermore, there has been very little research done on the amount of each coal and cement needed for stabilizing fine and loose sands. Therefore, it is necessary to conduct further research to gain a better understanding and insight into appropriate mixing ratios. The main objective of this study is to investigate the effect of coal wastes particle size and leachate on fine sand stabilization with cement..

2- Methodology

To conduct the experiments in this research, soil from the beaches of Babolsar city in Mazandaran province was used. According to the ASTM D2487 standard, the soil used was classified as poorly graded sand (SP). The soil had a friction angle of 27 degrees and cohesion of 0.11 kg/cm^2. Additionally, the maximum void ratio, minimum void ratio, and specific gravity of soil solids were e_{max}=0.81, e_{min}=0.56, and G_s=2.78, respectively. Coal wastes from the Alborz Central Coal Washing Plant, located in Zirab City, were used as a stabilizer in the present study.

In this study to achieve the optimum ratio of additives to the soil, the studied soil was mixed with 5% and 7.5% of additives, including cement and coal powder. Cement with weight ratios of 100 to 0, 90 to 10, 80 to 20, 70 to 30, 60 to 40, and 50 to 50 were mixed with coal wastes and then the samples were subjected to standard compaction tests according to ASTM D1557. After determining the optimum moisture percentage and dry unit weight of each mixing ratio, the samples for unconfined compressive strength testing were made and tested after curing duration. Unconfined compressive strength tests were conducted according to ASTM D2166 To investigate the effect of coal wastes particle size on stabilized samples, Different sizes, including coal

*Corresponding author's email: jiryaei@qut.ac.ir

Table 1. Uniaxial compressive strength (qu) for samples with different ratios of coal waste .

C*	CW**	Coal passing Sieve No.		
		40	200	Caol Solution
5	0	257	257	257
	10	214	278	315
	20	180	215	248
	30	173	168	205
	40	111	117	158
	50	76	84	131
7.5	0	386	386	386
	10	362	431	468
	20	308	335	348
	30	275	271	303
	40	199	198	230
	50	117	147	212

* Cement content (%).

** Percentage of cement replaced by coal waste (%).

wastes passing through a 40 sieve, coal wastes passing through a 200 sieve, and coal wastes in solution were considered.

3- Discussion and Results

Table. 1 displays the uniaxial compressive strength (q_u) of 28-day samples containing 5% and 7.5% cement, as well as different ratios of coal waste passing through sieve No. 40 and 200, along with coal waste solutions. The replacement of a portion of cement with coal wastes that passed through sieve No. 40 resulted in a reduction of the maximum unconfined compressive strength. This can be attributed to the relatively large size of the coal wastes particles, which did not participate in the chemical reactions with cement and thus caused a decrease in the uniaxial compressive strength when compared to using only cement..

Using 10% of coal waste causes a 20% reduction in uniaxial compressive strength. In this case, it is not unreasonable to use coal waste because, firstly, the pollution from coal is controlled, and secondly, the consumption of cement is reduced without significantly decreasing its strength. By replacing 10% of cement with coal wastes passing through a 200 sieve or solution, the maximum uniaxial strength increases due to chemical and pozzolanic reactions between cement particles and coal wastes. Mixing cement with coal wastes solution has resulted in a higher maximum uniaxial strength than using coal passed through a 200 sieve. When using coal wastes solution, the saturation of the coal wastes and the best possible cement hydration process yield the highest strength possible.

4- Conclusions

In this study, fine sandy soil was mixed with 5% and 7.5% additives, including cement and coal waste powder, to investigate the effect of coal wastes on stabilization behavior. Cement was mixed with wastes in weight ratios of 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50. Standard-Proctor compaction tests were carried out separately to determine the optimum moisture content and maximum dry unit weight of each mixing ratio. Unconfined compressive strength tests were conducted to investigate the effect of coal wastes particle size on stabilized samples, with different sizes considered such as coal wastes passing through a 40 sieve, coal wastes passing through a 200 sieve, and coal wastes in solution. Results show that replacing a part of cement with coal wastes passing through sieve No. 40 reduces the maximum uniaxial compressive strength compared to using only cement due to it not participating in chemical reactions with cement. However, replacing 10% of cement with coal wastes passed through a 200 sieve or solution increases the maximum uniaxial strength due to the chemical and pozzolanic reactions between cement particles and coal wastes. The optimal percentage of mixing coal wastes with cement was found to be 10%. Using smaller particles of coal wastes leads to greater maximum resistance than without using coal wastes. In the case where the coal wastes solution is used, the maximum strength is obtained due to the saturation of the coal wastes and the best possible cement hydration process..

References

[1] M. Frías, M.S. De Rojas, R. García, A.J. Valdés, C. Medina, Effect of activated coal mining wastes on the properties of blended cement, Cement and concrete composites, 34(5) (2012) 678-683.

[2] C.R. dos Santos, J.R. do Amaral Filho, R.M.C. Tubino, I.A.H. Schneider, Use of coal waste as fine aggregates in concrete paving blocks, (2013).

[3] M. Naghipour, M. Tazikeh, B. Hoseinian, The Use of Coal Waste in Concrete Construction & Survey of Compressive Strength, Concrete Research, 9(2) (2017) 43-53.

[4] H. Amiri, S. Azadi, M. Karimaei, H. Sadeghi, D. Farshad, Multi-objective optimization of coal waste recycling in concrete using response surface methodology, Journal of Building Engineering, 45 (2022) 103472.

[5] M. Taslimi Paein Afrakoti, A. Janalizadeh Choobbasti, M. Ghadakpour, S. Soleimani Kutanaei, Investigation of the effect of the coal wastes on the mechanical properties of the cement-treated sandy soil, Construction and Building Materials, 239 (2020) 117848.

[6] A. Modarres, Y.M. Nosoudy, Clay stabilization using coal waste and lime—Technical and environmental impacts, Applied clay science, 116 (2015) 281-288.

[7] O.P. Navagire, S.K. Sharma, D. Rambabu, Stabilization

of black cotton soil with coal bottom ash, Materials Today: Proceedings, 52 (2022) 979-985.

[8] A. Modarres, S. Hesami, M. Soltaninejad, H. Madani, Application of coal waste in sustainable roller compacted concrete pavement-environmental and technical assessment, International Journal of Pavement Engineering, 19(8) (2018) 748-761.

[9] S. Mansouri, M. Nasiri, A. Modarres, Technical and environmental impacts of coal waste used as a soil stabilizer in construction projects of forest roads, Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, 42(3) (2021) 491-500.

[10] M.S. Shirin, M.M. Islam, M. Kumruzzaman, Stabilization of coal mine waste and its practical application as a road subgrade, American Journal of Traffic and Transportation Engineering, 5(5) (2020) 51-56.

HOW TO CITE THIS ARTICLE
M. Amiri, M. Jiryaei Sharahi, Investigation of the effect of particle size and coal waste solution on sand stabilization with cement , Amirkabir J. Civil Eng., 55(7) (2023) 283-286.

DOI: 10.22060/ceej.2023.21428.7719