The effect of zeolite and cement on Babolsar sandy soil compression

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1- Introduction:

The major features of loose sandy soil are the weak resistance and volume instability. Using the technique of adding cement is one of the most frequently used options for engineers to stabilize the soil type. Cement has attracted special attention since on the one hand, it requires a high amount of energy to produce and on the other hand it produces about 8% of carbon dioxide of the world. Therefore, optimization of its composition is considered to be the main objective such that the least amount of energy is used to produce it and the least harm is done to natural resources and finally, it yields the best possible performance.

Hence, finding a suitable replacement for cement in construction projects can be viewed as one of the best ways to protect the environment. Pozzolan which has long been used as a substitute for cement in construction can reduce the problems related to cement production and its environmental impact. Zeolite is one form of pozzolan.

Extensive use of zeolite in the world, especially in the industrial and developed countries has started many years ago. Moreover, in terms of cost and access, preparation of these minerals in Iran is very cheap and easily available. For this reason, their use is very effective in economic terms in addition to reducing environmental problems. Accordingly, the effects of zeolite as a cement replacement on sandy soil compression are discussed in this study.

Materials used

Materials used in this study consist of sandy soil of Babolsar, Portland cement type II of Neka and zeolite of Semnan. In choosing materials to be tested, we tried to prepare suitable materials for stabilizing soils of the coastal strip of north of the country.

2-The compression testing

Sample preparation was done as soon as possible after the completion of mixing and testing was performed according to standard D 698 -07E1. Standard compression tests on mixing designs of 24 cement and zeolite states including different percentages of 2, 4, 6 and 8 percent of dry weight of the sample and the replacement percentage of 0, 10, 30, 50, 70 and 90 zeolite was done with cement. In each design, a total of five samples were used to obtain the optimum moisture for compression. Different amounts of sand, cement and zeolite dried in the oven were isolated based on percentages stated for each sample (a total of 3 kg) and they were mixed with a relatively low moisture and the mixture was compressed in a standard proctor cast using a hammer with free fall. This method was repeated until the weight of the soil in the cast passes the maximum value and it starts to decline.

Results:

The results showed that, with increasing replacement of zeolite instead of cement, maximum dry density of the samples compared to samples with only cement is reduced. The amount of this reduction in the design of 2% cement is, 1.2% and in the cement 8% is 2 percent. However, the optimum moisture content in all mixtures has been approximately 14%.

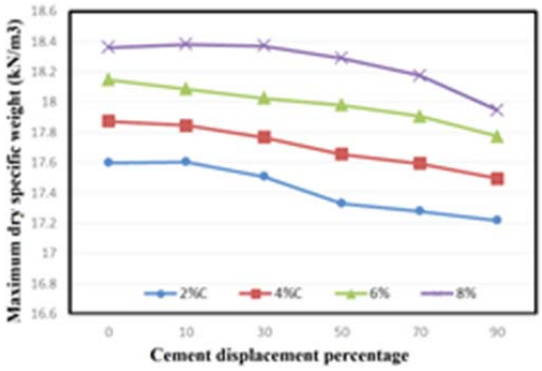

Fig. 1: Overall results of compression using different percentages of zeolite replacement for cement

According to density test results on samples in which cement is used it can be observed that with the increased percentage of cement, with almost constant optimal moisture at 14%, the maximum dry density of the samples increases. The reason for this issue is the finer cement compared to sand and filling the empty space between the sand particles. On the other hand, the higher weight of cement (GS) solid grains compared to sand also contributes. However, the density of the samples decreases with increasing zeolite replacement percent, because of the low density of zeolite grains compared to the cement and sand. Because according to the test results to (GS) density test performed in this study, the parameter (GS) was 2.22 in zeolite, 2.71 in sand and 3.11 in cement. However, the optimum moisture content in all mixing designs is almost constant and equal to 14%.

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3- Conclusion

In this study, zeolite has been introduced as a pozzolanic mineral to reduce environmental problems of cement in cement sand. According to standard density test results on samples of cement zeolite it was observed that:

1. The maximum dry density increases with increasing the amount of cement.
2. The maximum dry density decreases with increasing cement replacement percent of zeolite.
3. The optimal moisture content for all scenarios is approximately 14%.
4. The maximum reduction of dry density resulting from the use of zeolite instead of cement is between 2 and 2.5 percent.