iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5129

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Effect of Zeolite and Cement Addition on Properties of Granular Soil

Umashankar kushwaha[1], Prof. R.K. Yadav[2]
[1]ME scholar, Dept. of Civil Engineering Jabalpur Engineering College, Jabalpur
[2]Associate Professor, Dept. of Civil Engineering, Jabalpur Engineering College, Jabalpur

Abstract: It is well known that the cement stabilized sand is one of economic and environmental topics in soil stabilization. In this instance, sand, cement and other materials such as fiber, glass, nanoparticle and zeolite can be commercially available and effectively used in soil stabilization in road construction. The influence and effectiveness of zeolite on the properties of cemented sand systems have not been completely explored. In this study, based on an experimental program, the effects of zeolite on the characteristics of cemented sands are investigated. Stabilizing agent includes Portland cement and zeolite. Results show the improvement of unconfined compressive strength (UCS) and failure properties of cemented sand when the cement is replaced by zeolite at an optimum proportion of 30% by the weight of cement. The present study aims to quantify the influence of the amount of cement, zeolite in the evaluation of unconfined compressive strength (UCS) of zeolite–cement–sand mixture. A series of unconfined compression tests, four cement contents (varying from 4 to 10%) and six zeolite contents (varying from 0 to 70%) were performed in this study. Adding zeolite to cemented sand increases unconfined compressive strength of the mixtures (for all ranges of cement studied in this experimental work). The optimum value of zeolite for all cement contents is 30% (by the weight of cement) increasing UCS value from 16 to 33% for cement content 4 to 10% respectively.

Keywords: Geotechnical properties of sand, cemented sand, zeolite, strength, UCS stress-strain graph.

I. INTRODUCTION:

A. General

Soil stabilization with cement has been a ground improvement method in geotechnical engineering for many years. Using cemented soil is a versatile and reliable technique among others to increase shear strength parameters. By avoiding borrowing materials from elsewhere, the cemented soils have advantages of economy, simple and rapid performance. The cemente stabilization technique is particularly suited for soils such as loose sand deposit. cementation of sand can result in increasing brittle behavior of the material. The unconfined compression test is one of the major and rapid laboratory tests to evaluate the effectiveness of the stabilization with cement or other additives. The compressive strength of artificially cemented soils has been studied in the past by several investigators. A number of studies have been done to assess the mechanical behavior and compressive strength increase of cemented sands using added fiber, glass, fly ash, silica fume and nanoparticle in the same manner. However, there has been a little effort to the use of pozzolans such as natural zeolite. The natural zeolite, an extender, has been investigated for use as cement and concrete improver. The natural zeolite contains large quantities of reactive SiO2 and Al2O3. Similar to other pozzolanic materials, zeolite substitution can improve the strength of cement by pozzolanic reaction with Ca(OH)2, prevent undesirable expansion due to alkaliaggregate reaction, reduce the porosity of the blended cement paste, and improve the interfacial microstructure properties between the blended cement paste observed that the pozzolanic activity of natural zeolite is higher than that of fly ash but lower than that of silica fume. Yılmaz et al. (2007) concluded that the clinoptilolite blend decreases the specific weight of cements.

B. Objectives of Present Study

1) Determine the basic properties of locally available sand.
2) The stress-strain curves of specimens stabilized with different % cement contents with respect to different zeolite substitution.
3) UCS values of different % of cement stabilized sand with different zeolite substitution and their comparison.

II. MATERIALS USED AND METHODOLOGY

A. Sand
B. the present study the sand sample were obtained from bank of Narmada river Jabalpur district of Madhya Pradesh state of India with latitude 23.1815°N and longitude79.9864°E. The sand of this region is SP as per IS classification. The various properties of sand are tested in the laboratory and results are as given in table2.1.

Table-2.1: Basic properties of Narmada sand

Properties of Sand	Values
Soil type as per IS: 1498-1970	SP
Specific Gravity	2.64
Fine Content (<75µ),%	4.00
Coefficient of uniformity, Cu	2.91
Coefficient of curvature, Cc	1.14
Maximum Dry Density (g/cc)	2.13
Optimum Moisture Content	6.08

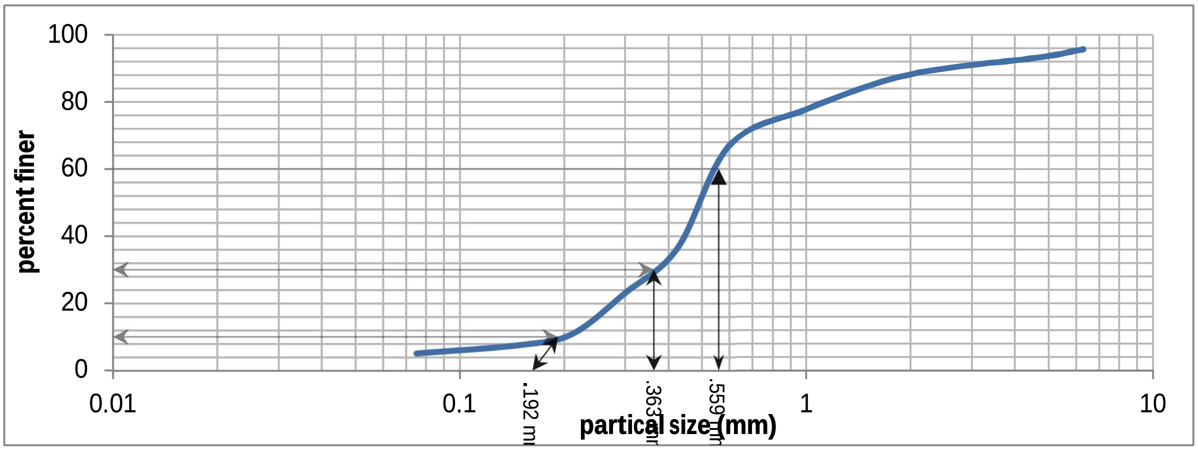

Figure1: particle size distribution curve

C. Zeolite

The zeolite is of natural clinoptilolite kind and particles smaller than 75µm are referred to as fine aggregates. zeolite is non-plastic and classified as silt according to the unified soil classification system with specific gravity 2.2. Zeolite have unique characteristics such as high specific surface area and cation exchange capacity as well as ability to store heat between hydration and dehydration cycles (Colella et al., 2001). Moreover, zeolite, which is a softer material than the Portland cemen , increases the fineness of the ground material and reduces the grinding time (Canpolat et al., 2004). The replacement of Portland clinker by zeolitic tuff reduces workability (Sersale, 1995) and increases water demand As a cement–water mixture contacts with zeolite minerals, the alumino-silicate framework of the zeolite starts decomposing, under the attack of OH^- in a high-pH solution. Depolymerised species, such as $[SiO(OH)_3]^-$ and $[Al(OH)_4]^-$, enter the solution and react with Ca^{2+}, forming hydrated calcium silicate and calcium aluminate compounds, very similar to those formed during the hydration of cement**.** These are the chemical composition of zeolite.

Table2.2: chemical composition of zeolite (AKSHAR EXIM CO.PVT.LTD)

SiO_2	67.44%
Al_2O_3	10.8%
Fe_2O_3	0.84%
CaO	1.24%
pH	7.1

III. EXPERIMENTAL WORK

Tests on the cemented sand and zeolite samples with different proportion of zeolite were performed in three stages.

In the first stage, Geotechnical characteristics of the sand samples were determined by conducting grain size analysis, specific gravity test, as per Indian Standard codes of practice.

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In the second stage, Take sand sample and add different % of cement by weight of sand (4%, 6%, 8%, 10%) and determine ucs value of prepared specimens.

In the third stage, Now all the different cement contents (4%, 6%, 8%, 10%) is replaced by different zeolite contents (10%, 20%, 30%, 50%, 70%) by weight of cement and determine UCS value of specimens.

IV. RESULTS AND DISCUSSION

A. Compressive Strength

This test was performed in accordance with IS 2720: Part10.The results by using varied cement content (4%, 6%, 8% and 10%) of cemented sand with different % of zeolite (10%, 20%, 30%, 50%, 70%) replacement by weight of cement. Unconfined Compressive strength for curing period of 7 days are summarized and presented in the following Table. It was found that the changes in UCS were significant up to 30% zeolite replacement by the weight of cement content after 7 days of curing. Further increase in zeolite percentage UCS values get decreases.

eolite% replacement	Cement 4%	Cement 6%	Cement 8%	Cement 10%
0	0.44	1.09	1.83	2.27
10	0.446	1.14	1.87	2.38
20	0.452	1.23	2.01	2.5
30	0.51	1.36	2.34	3.01
50	0.432	0.98	1.72	2.21
70	0.4	0.75	1.4	1.82

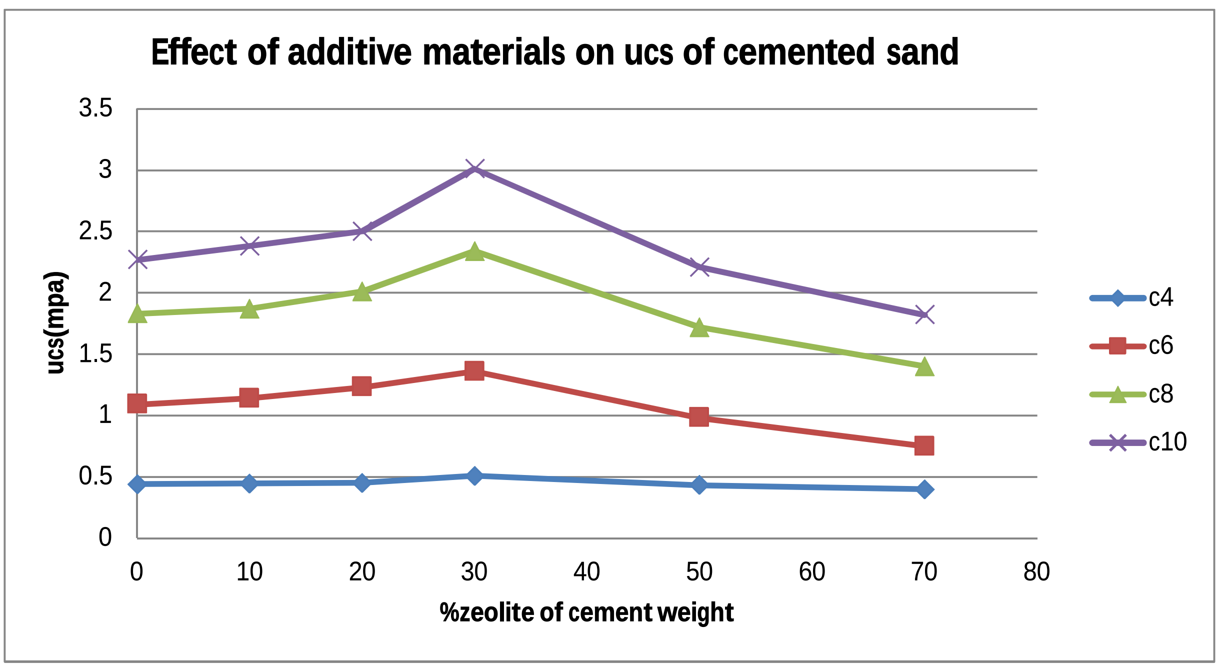


Figure2: Effect of zeolite on cemented sand on UCS value

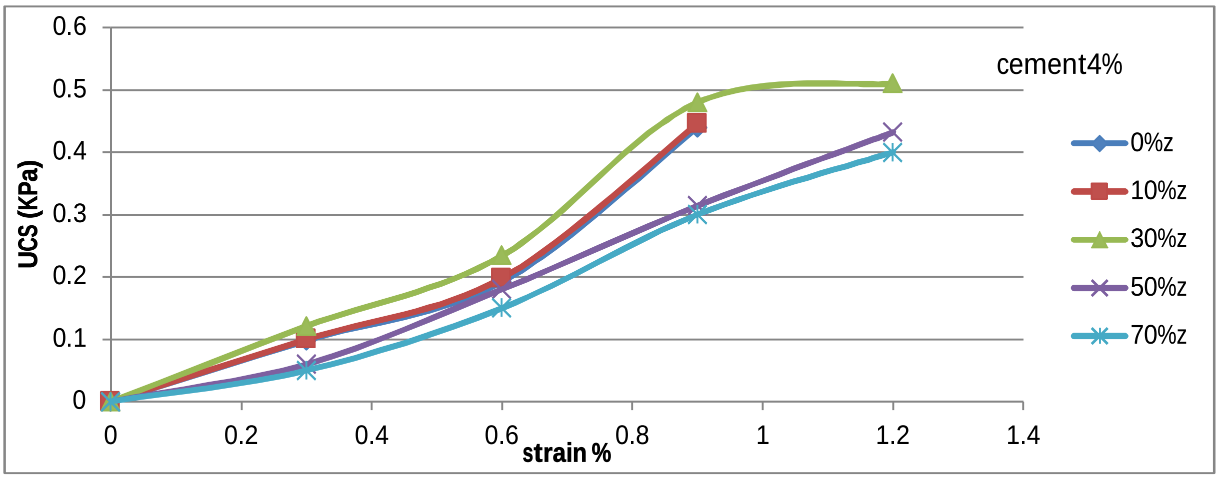
Results of unconfined compression tests for different cement contents (4%, 6%, 8% and 10%) and replacements of cement by zeolite by weight (0%, 10%, 20%, 30%, 50% and 70%) are presented in Fig.2

The larger amount of cement causes the greater UCS for a given void ratio and zeolite content. Cement replacement by zeolite (by weight) for the whole range of cement studied causes UCS to increase first and then decrease, and polynomial relationships can be observed for all

the soil-cement-zeolite mixtures. Fig.2 shows that, at 30% replacement of cement (by weight) by zeolite, the maximum UCS is obtained The 30% replacement of cement by zeolite is enough to generate a significant increase in strength.

B. Strain Graph

The stress-strain curves of specimens stabilized with 4%, 6%, 8% and 10% cement contents with respect to different zeolite substitutions, under the condition of constant void ratio, are illustrated in Fig.3. It is shown that the maximum axial stress significantly increases due to cement stabilization, and the strain corresponding to the peak axial stress decreases. By increasing zeolite replacement of cement by weight, the peak strain increases in comparison with cemented samples. In other words, utilizing zeolite in cemented sand increases the displacement at failure, and reduces the brittle behavior. Since the main objective of this paper is to estimate UCS, less attention is paid to the strain and failure types.



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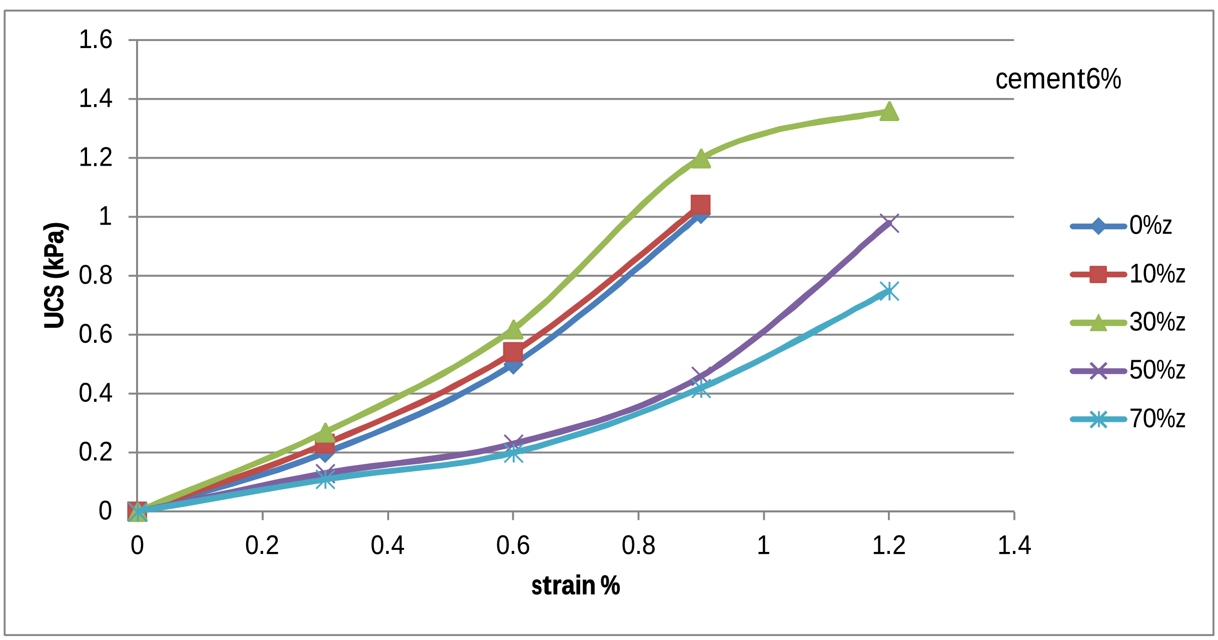

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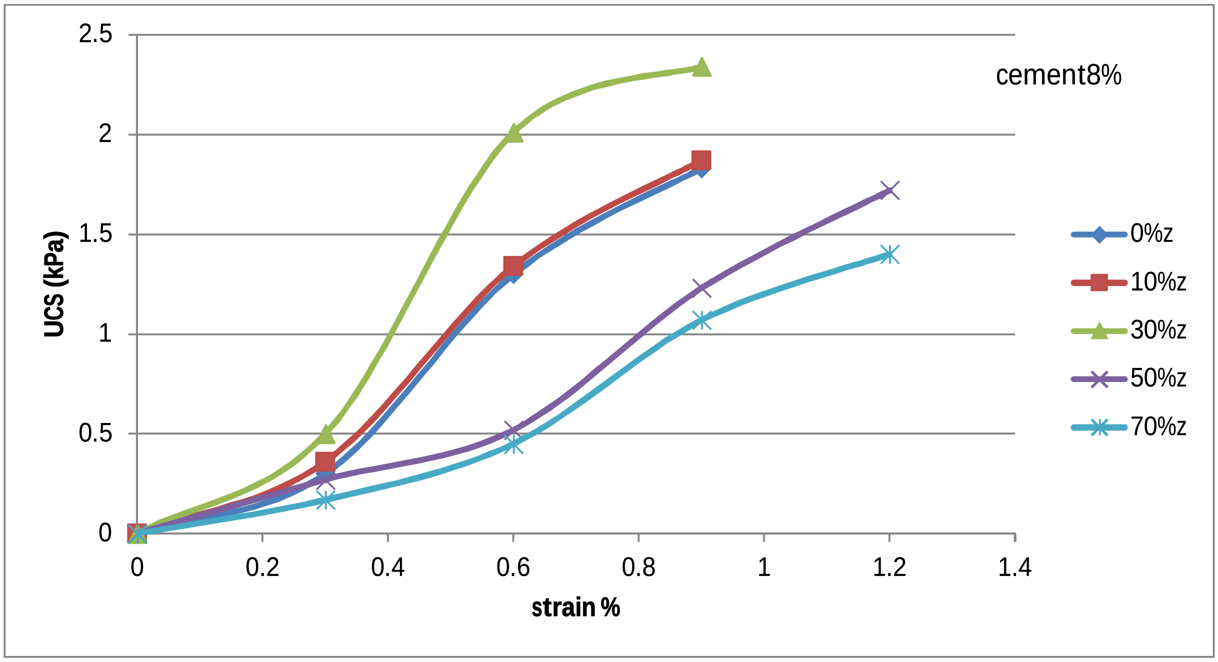

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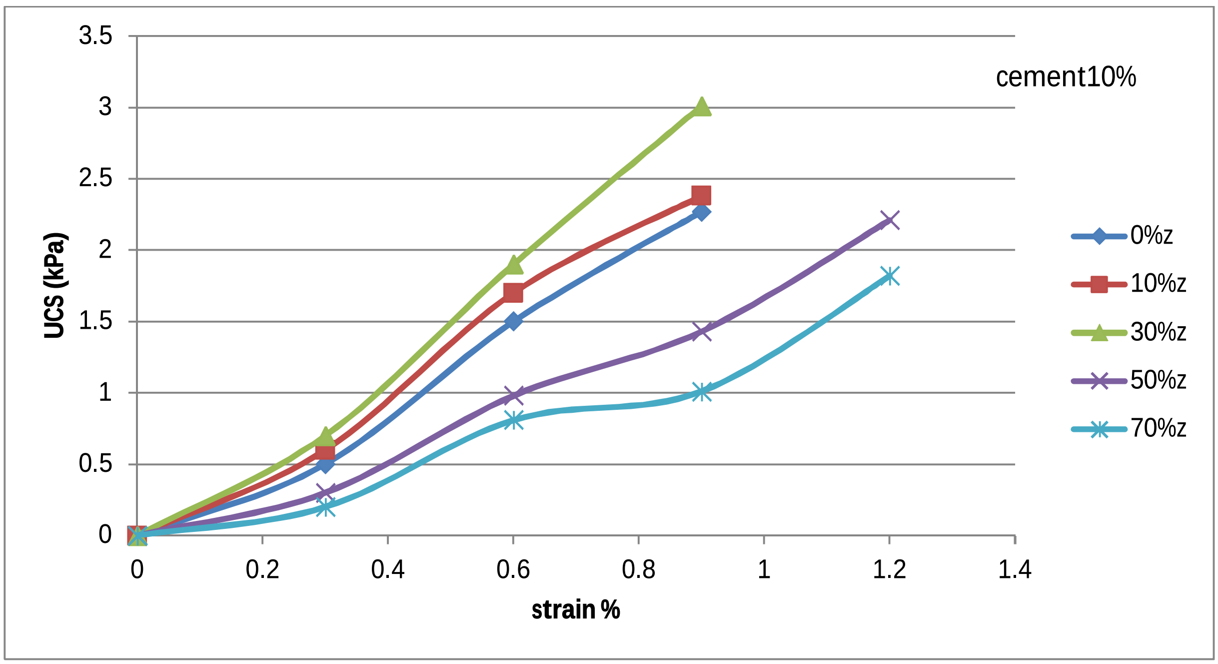


(d)

Figure3: Stress-strain curves of zeolite-cemented sand

V. CONCLUSION

Based on the findings of the present investigations, the following conclusion can be drawn.

A. Using zeolite with replacement of cement upto some proportion causes an increase in UCS of cement stabilized sand.

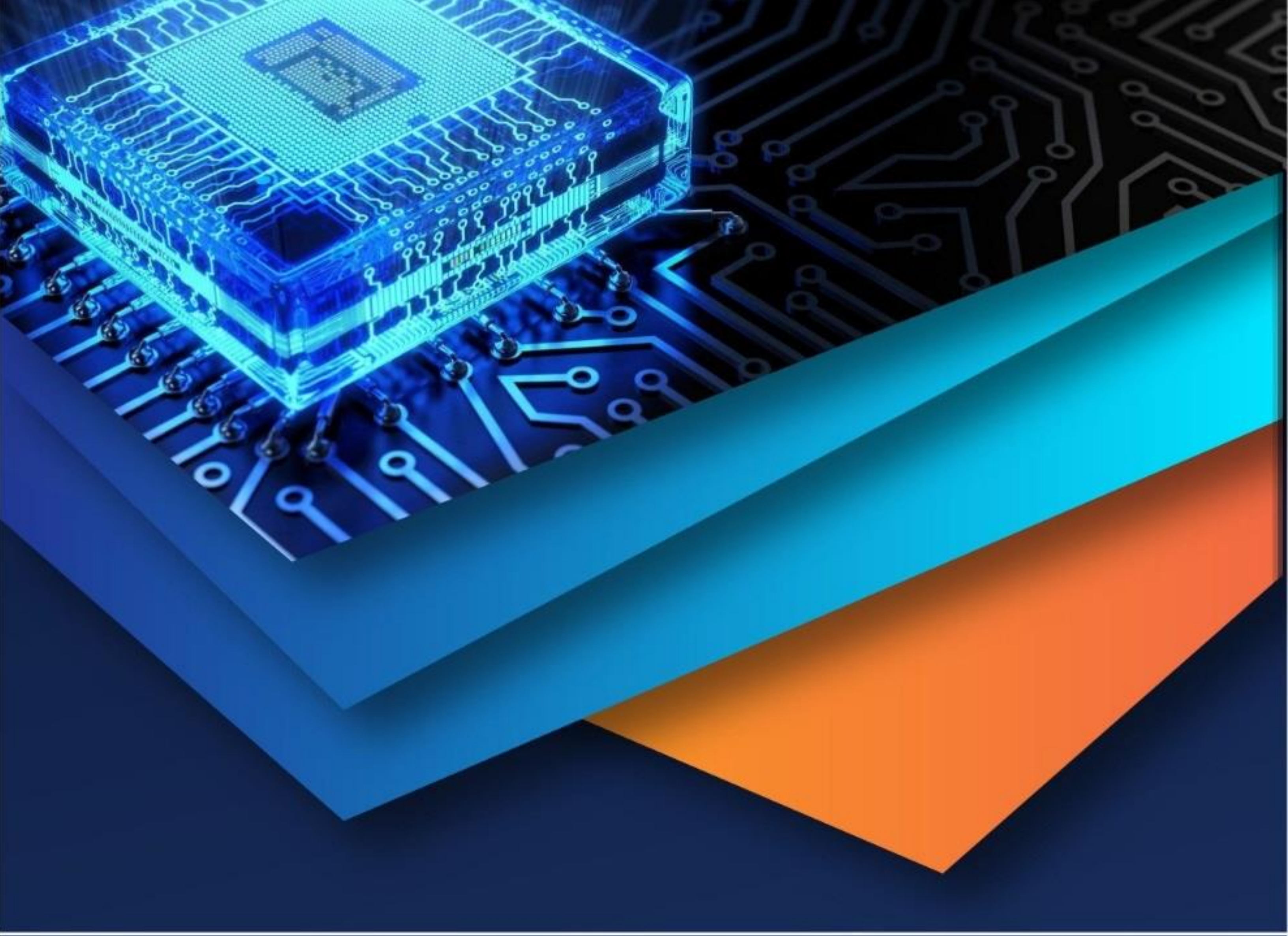
B. With the increase in the zeolite up to 30% by weight of cement, the unconfined compressive strength (UCS) of the mixture is increased, further addition in zeolite replacement UCS values get decreased.

C. The optimum zeolite content was found as 30% by the weight of cement for the all proportions of cement used (4%, 6%, 8% and 10%), which can improve UCS from 16 to 33%. For cement content 4% and 10% respectively.

D. By increasing zeolite replacement by the weight of cement the peak strain increases in comparison with cemented sample. It reduces the brittle behavior of cemented sand. Based on the above test results it can be recommended that OPC replaced with 30% zeolite by the weight of cement is an optimum proportion of mix that can be used as a stabilized agent for sand. The sand stabilized with 7% cement and 30% zeolite by weight of cement can be used as sub-base of roads and similarly sand stabilized with 10% cement and 30% zeolite can be used as base course of roads.

REFERENCES

[1] Ameta N.K. and Wayal AbhayShivaji(2008), Ahmadi, B. and Shekarchi, M. 2010. Use of natural zeolite as a supplementary cementitious material, Cement and Concrete Composites, 32, (2), 134–141.
[2] Astm D 2166. 2000. Standard test method for unconfined compressive strength of cohesive soil, Philadelphia, American Society for Testing and Materials.
[3] ASTM D 422. 2003. Standard test method for particle-size analysis of soils, Philadelphia, American Society for Testing and Materials.
[4] ASTM D 2487. 2006. Standard classification of soils for engineering purposes, Philadelphia, American Society for Testing and Materials.
[5] ASTM C 150. 2007. Standard specification for Portland cement, Philadelphia,
[6] ASTM D 854. 2000. Standard test methods for specific gravity of soil solids by water pycnometer, D 854, Philadelphia, American Society for Testing and Materials.
[7] Bilim, C. 2011. Properties of cement mortars containing clinoptilolite as a supplementary cementitious material. Construct. Build. Mater., 25, (8),3175–3180.
[8] Canpolat, F., Yılmaz, K., Kose, M. M., Sumer, M. and Yurdusev, M. A. 2004.Use of zeolite, coal bottom ash and fly ash as replacement materials in cement production. Cem. Concr. Res., 34, (5), 731–5.
[9] Clough, G. W., Sitar, N., Bachus, R. C. and Rad, N. S. 1981. Cemented sands under static loading. J. Geotech. Eng. Div., 107, (6), 799–817.
[10] Colella, C., Gennaro, M. and Aiello, R. 2001. Use of zeolitic tuffs in the building industry. Rev. Mineral Geochem., 45, (1), 551–87.
[11] Consoli, N. C., Cruz, R. C., da Fonseca, A. V. and Coop, M. R. 2011. Influence of cement-voids ratio on stress-dilatancy behavior of artificially cemented sand. J. Geotech. Geoenviron., 138, (1), 100–109.



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