# Utilization of Phosphogypsum and Surkhi as Clayey Soil Stabilizer - A Review

Mayur Sabhnani[1], Mahesh Ram Patel[2]

[1]M.Tech Scholar, Specialization in Transportation Engineering, Department of Civil Engineering, SSTC SSGI-Faculty of Engineering & Technology, Bhilai, Chhattisgarh, India

[2]Assistant Professor, Department of Civil Engineering, SSTC SSGI- Faculty of Engineering & Technology, Bhilai, Chhattisgarh, India.

***Abstract:*** **Clayey soil due to presences of clay minerals makes them inappropriate for construction purpose in its natural form. To make them more suitable for construction activities, several stabilizers are used to stabilize the clayey soil. This paper discusses the stabilization results of various studies conducted by different researchers, which is useful for determining the potential of industrial wastes for clayey soil stabilization. This review paper discusses the studies about the uses of phosphogypsum and surkhi generated as waste from the industries as a soil stabilizer. Phosphogypsum is generated as byproduct during the production of phosphoric fertilizer and surkhi or brick kiln dust is produced as waste during the manufacturing of fire clay bricks. The soil stabilized using these wastes which is generated from industries have significant effect on the clayey soil. Moreover, this soil stabilization method not only a very eco-friendly and cost-effective but also utilizes the wastes generated from industries in a more purposeful manner.**

**Keywords: Industrial waste, Phosphogypsum, Surkhi, Stabilization.**

## I. INTRODUCTION

During the construction of structures, various kinds of soils are used; however, some soils are used in their natural form because its suitability for construction purposes, whereas others soil deposits are unsuitable without treatment, such as the problematic soils.

Clayey soils are stiff during its dry state but give up their stiffness when it come contact with moisture [2]. Clays are usually low strength and high settlement. Reduction in strength occurs due to contact with water which leads to damages to structures and its foundations. This soil behavior can be a challenge to the engineers which is plans to build the structures on them. Due to this nature of clayey soils, geotechnical engineers are searching for various methods to improve its characteristics via ground improvement technologies.

These soils need to be modified by improving its properties, or excavated and then replaced with suitable soil before they can bear the loads by upper structures [1]. Due to high cost involved, for replacing the problematic soil with suitable soil many researchers often prefer improving the properties of clayey soil by stabilization [12, 13].

Stabilization of a soil can be defined as the modification of soil characteristics by mechanical, chemical or any other methods in order to improve the properties of the soil. In chemical stabilization the soil is modified by chemicals which improve the interfacial bond between soil particles and in mechanical stabilization, the soil properties is improved by soil grouting, sand mixing, compaction etc.

Such stabilization processes improve the various properties of the soil and generate an improved construction material. Improvements include increase in durability stiffness, dry density, soil strength and reduction in shrinkage/swelling potential and soil plasticity [2].

Stabilization concept is about 5000 years old. Researcher shows that stabilized earth roads were used in ancient Mesopotamia and Egypt and that the Romans and Greeks used lime as an additive for soil stabilization [3].

In today's scenario, infrastructural development are rapidly increased due to which there is an uncontrolled dumping and production of the industrial wastes occur, which poses major threat to the environment and must be prevented. For this, various

studies have suggested the uses of industrial wastes as soil stabilization. Many researchers shows that the industrial wastes have extensively potential to use as a stabilizer for soil in comparison to the other conventional materials like lime, cement etc.

The main objectives of this study are to review the stabilization of clayey soil using phosphogypsum and surkhi waste. Phosphogypsum is generated as by-product during the production of phosphoric acid from phosphate rock and in India, production of this waste is about 12 million tons per year [14]. About 50% of this waste is utilized for cement manufacturing as a replacement of natural gypsum, for nutrient restoring in agriculture field and for preparation of gypsum boards, etc. and the remaining waste is dumped in large stack [14].

Surkhi is a brick kiln dust which is generated as waste during the production of clay bricks in industries. In India it is estimated about 80 to 100 billion bricks were produced per year which generated surkhi as a waste material and this waste is mostly dumped on land which destroy the costly fertile land.

The utilization of phosphogypsum and surkhi as stabilizer for soil has been investigated by a number of researchers for improvement in the various properties like strength, California bearing ratio value etc.

## II. LITERATURE REVIEW

### *a. Stabilization using Phosphogypsum*

**P.T.Ravichandran et al (2015)** studied about the changes in geotechnical properties of clayey soils by treating them with industrial waste like fly ash along with phosphogypsum. The various test conducted on soil samples which is prepared by adding phosphogypsum varied from 2 to 6 percent with 5 percent fly ash by dry weight of soil. After performing various tests on the stabilized soil mixture concludes by saying that the addition of phosphogypsum and flyash, significant improve the properties of soil.

**Jijo James et al (2014)** analyzed about the strength behavior of lime stabilized expansive soil on addition with phosphogypsum. The use of phosphogypsum as an additive to lime stabilized soil enhances the performance is studied by the authors. The authors concluded that addition of phosphogypsum in lime stabilized expansive soil improve both the early and late strength of soil.

**Sleiman M. Al-Zaidyeen et al (2015)** studied the effect of phosphogypsum in soil stabilization. The main aim is to use phosphogypsum (PG) waste as a stabilization material to improve the properties of soil. Depending on the test result which was conducted on soil sample treated with 0%, 5%, 10%, 20% and 25% of phosphogypsum. The authors concluded that the use of phosphogypsum as a soil stabilizer could decrease the thickness of the pavement layer and solve the negative environmental impact which was caused due to the dumping of phosphogypsum.

**Shantanu Mehta et al (2017)** studied about the effect of phosphogypsum in expansive soil which is highly plastic in nature due to which it has high swelling and shrinkage properties on addition and removal of water. The authors shows that phosphogypsum can be effectively used as a stabilizer in expansive soil and the use of this waste as a soil stabilizer could also solve the negative impact on environment.

**S Chandrakar et al (2017)** studied the effect of phosphogypsum as a stabilizer for clayey soil. The authors of this study shows that the phosphogypsum can be used as a suitable stabilizer in clay soil, can be more environmental friendly and economical solution than cement and lime. The main objective is to study the properties of clayey soil with addition of phosphogypsum varying from 2 to 8%, which concluded that the phosphogysum can be used to improve the performance of swelling clay soil.

### *b. Stabilization using Surkhi*

**Kanav Mehta et al (2019)** analyzed about the performance evaluation of fiber reinforced brick kiln dust/surkhi and cement stabilized-clay mixes as a sub-grade material. The authors concluded that addition of cement with brick kiln dust can be used effectively as a stabilizer for clayey soil. The study shows that replacement of clay with surkhi and cement increases the soaked and unsoaked California Bearing ratio (CBR) value of mix in comparison to the individual stabilizers.

**E.Balasubramanian et al (2020)** studied about the stabilization of compressible soil using surkhi and granite dust. After conducting the various tests on the stabilized soil which was prepared by addition of surkhi at range of 30%, 35%, 40%, 45% and granite dust is added at range of 5%, 10%, 15%, and 20%. The authors found that the stabilizer which is used increase the density, unconfined compressive strength (UCS) and CBR value of soil and corresponding reduction in plasticity index of the soil was also observed.

**Rachit Mishra et al (2019)** studied the effect of polypropylene fibers and surkhi on geotechnical properties of soil which is expansive in nature. The poor shear strength and high swelling/ shrinkage problems are resolved by replacing the soil with surkhi and polypropylene fiber in different combination. The tests were conducted on stabilized soil such as Atterberg's limit, water content, UCS test and standard proctor test and authors found that the stabilizer which is used, increase the CBR value and proctor density.

## III. CONCLUSIONS

The following main inference can be drawn from the review of the literature on the utilization of phosphogypsum and surkhi for the stabilization of the soil.

- The review of literature shows that upon certain percentage addition of phosphogypsum the unconfined compressive strength (UCS), California bearing ratio value of clayey soil is increases, indicate that the strength gained by clayey soil depends upon percentage proportion of the phosphogypsum.
- The stabilization using phosphogypsum and surkhi also decreases the compressibility of clayey soil.
- Phosphogypsum and surkhi has a potential to be used as stabilizer for improving the clayey soil properties such as unconfined compressive strength, compressibility etc.
- The uses of industrial wastes for construction activities not only conserve the natural sources but it also solves the problem of unnecessary dumping over the fertile land.
- The soil stabilized using industrial waste has potential applications in the ground improvement. Moreover, this soil stabilization method not only a very eco-friendly and cost-effective but also utilizes the wastes generated from industries in a more purposeful manner.

## REFERENCES

[1] Chijioke Christopher Ikeagwuani, Donald Chimobi Nwonu (2019) "Emerging trends in expansive soil stabilisation: A review", Journal of Rock Mechanics and Geotechnical Engineering.

[2] Ali Akbar Firoozi, C. Guney Olgun, Ali Asghar Firoozi and Mojtaba Shojaei Baghini (2017) "Fundamentals of soil stabilization", International Journal of Geo-Engineering.

[3] McDowell Chester (1959) "Stabilization of soils with lime, lime-flyash, and other lime reactive materials", Highway Research Board Bulletin.

[4] P.T.Ravichandran, Divya Krishnan K, V.Janani, R.Annadurai, Manisha Gunturi (2015) "Soil stabilization with phosphogypsum and fly ash –A micro level study", International Journal of ChemTech Research, ISSN: 0974-4290.

[5] Jijo James, Prof. P. Kasinatha Pandian (2014) "Effect of phosphogypsum on strength of lime stabilized expansive soil", GRAĐEVINAR, 66 (12), 1109-1116.

[6] Sleiman M. Al-Zaidyeen , Arabi N. S. Al-Qadi (2015) "Effect of phosphogypsum as a waste material in soil stabilization of pavement layers", Jordan Journal of Civil Engineering, Volume 9, No. 1.

[7] Akshit Mahajan, Kanav Mehta, Arjun Kumar (2019) "Performance evaluation of fiber reinforced surkhi/brick kiln dust and cement stabilized-clay mixes as a highway subgrade material", International Journal of Modern Trends in Engineering and Reasearch, Volume 06, Issue 06, ISSN(online):2349-9745; ISSN(Print): 2393-8161.

[8] P.Ananda Krishnan, G.Pradeep Kumar, E.Balasubramanian, J.Ashiq Hussain (2020) "Stabilization of high compressible soil silt using surkhi and granite dust", International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 06, e-ISSN: 2395-0056, p-ISSN: 2395-0072.

[9] Mohit Verma, Rachit Mishra (2019) "Effect of polypropylene fibers and surkhi on geotechnical properties of expansive soil", International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 01, p-ISSN: 2395-0072, e-ISSN: 2395-0056.

[10] H. S. Goliya, Shantanu Mehta, Mohammed Islamuddin Faraz (2017) "Soil Stabilization by phosphogypsum, International Journal of Scientific & Engineering Research", Volume 8, Issue 7, ISSN 2229-5518.

[11] S Chandrakaran, Devipriya V P (2017) "Effect of phosphogypsum as stabilizing agent for swelling clays", National Conference on Recent Advancement in Geotechnical Engineering.

[12] Buhler R, Cerato A. (2007) "Stabilization of Oklahoma expansive soils using lime and class C fly ash", In: Geo-denver 2007: new peaks in geotechnics. ASCE.

[13] Hussey N, Cerato A, Grasmick J, Holderby E, Miller G, TabetW (2010) "An assessment of soil parameters governing soil strength increases". In: GeoFlorida 2010: advances in analysis, modeling & design. ASCE.

[14] Vasant G Havanagi, Anil Sinha, Parvathi G. S. (2018) "Characterization of phosphogypsum waste for Road construction", Indian Geotechnical Conference, Indian Institute of Science, Bengaluru.