International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 11 | Nov 2018 www.irjet.net p-ISSN: 2395-0072

# A Literature Survey on Addition of Silica Fume on Clayey soil

**Bincy K Varghese[1], Tellma John[2]**

[1]*M.Tech Student, Dept. of Civil Engineering, Toc H Institute of Science & Technology, Arakkunnam, Kerala, India*
[2]*Asst. Professor, Dept. of Civil Engineering, Toc H Institute of Science & Technology, Arakkunnam, Kerala, India*

---

**Abstract -** *Clayey soils or expansive soils seems to be problematic for civil engineering constructions from earlier days. Due to the poor engineering properties of these types of soils, the studies to modify its properties are continuing. The usage of waste materials such as slag, rice husk ash etc are found to be economic. Silica fume is a mineral admixture cheaper than Portland cement which can be used as an effective material to stabilize clayey soil. This review paper is concentrated on studies done in the field of stabilizing expansive soil or weak soil with silica fume (SF).*

***Key Words*: Stabilising clay, Waste management, Consistency limit, Optimum moisture content, maximum dry density, Expansive soil**

## 1. INTRODUCTION

In India expansive soils cover about $0.8X10^6$ $km^2$ area which is approximately 20% of surface area. Additives are used in order to improve the soil properties when the structures are founded in weak or expansive soil. Soil improvement is used to address soil problems as an alternative to implementing structural solutions, such as building retaining walls or buttresses, thickening road pavements or increasing the extent of foundations. Chemical improvement is usually most effective in the case of clay soils because it can be used to change the nature of the material. Chemical means can be used to strengthen the soil and to eliminate its sensitivity to water and the resulting stress history. Methods involving chemical stabilisation are performed to improve soil strength, mitigate total and differential settlement and reduce construction time and costs and to improve other issues that may influence certain projects on soft ground.

### 1.1 Silica Fume

Silica Fume is an ultrafine powder collected as a by-product of silicon metal and ferrosilicon alloy production. It is spherical in shape and the average particle size of silica fume is found to be 0.1-0.15µm. It is available in grey to off-white colours and in several product forms. Condensed silica fume is essentially silicon-dioxide (more than 90%) in non crystalline form. Specific surface area is about $20,000m^2/kg$. Silica fume is used as an artificial pozzolanic admixture in concrete. As far as the production of silica fume is concerned nearly 100,000 tons of micro silica is produced each year world wide. Iron also has a large amount of micro silica production.

**Fig -1**: Silica Fume

## 2. LITERATURE REVIEW

Serhat Baspinar M et al. (2013) studied the effect of different quantities of silica fume addition on the properties of fired clay brick. Uniaxial pressing was carried out to prepare the samples and firing temperatures was 800°c, 900°c, 1000°c and 1100°c. Microstructures of the samples were investigated by Scanning Electron Microscopy (SEM). Effect of silica fume addition on the bulk density, water absorption and pore structure of the brick was analysed. Strength and efflorescence behaviour was also assessed. The strength of the fired samples at 1000 and 1100°c were significantly improved with Silica fume addition. It was concluded that the reactive amorphous nature of SF particles enhances the sintering action locally and this gives better strength behaviour. SF addition also improved the efflorescence behaviour of the bricks. It was concluded that the effect of silica fume addition on the fired clay brick mainly depends on the firing temperature. At low firing temperatures, silica fume addition has a tendency to decrease the bulk density and at higher firing temperatures, SF addition allows better sintering action with a drastic increase in bulk density.

Chhaya Negi et al. (2013) investigated the effect of Silica fume on engineering characteristics of expansive clay like Black csotton Soil. A series of laboratory experiment has been conducted on black cotton soil blended with Silica fume content varying from 5% to 20% by weight of dry soil. The experimental results showed a significant increase in California bearing ratio and unconfined compressive strength. The Differential free swell of the clay is reduced from 50% to 7% with increase in Silica fume content from 0% to 20% respectively. The Proctor compaction results showed a small decrease in Maximum dry density and increase in Optimum moisture content. It was concluded that the Silica fume can be used to improve the characteristics of black cotton soil.

Ishraq Khudhair Abass et al. (2013) studied some of the Geotechnical Properties of Stabilized Iraqi Clayey Soils. To study the effect of engineering properties of kaolin clayey soils an experimental program was conducted. They were consistency limits test, specific gravity test, compaction test, unconfined compression test and California bearing ratio test. Lime and silica fume was used for stabilisation and also its blend. The varying percentages were 2.5%, 5.0%, 7.5% and 10.0% for (Lime) and 2.0%, 4.0% and 6.0% for (Silica Fume). The optimal percentage of Lime-Silica Fume combination was found to be (2.5%L+6.0%SF). Results indicated that the engineering properties of clayey soils can be enhanced, by blending Lime and Silica Fume together.

Chayan Gupta and Ravi K S (2014) studied Influence of Micro Silica Fume on Sub Grade Characteristics of Expansive Soil. Number of laboratory tests were conducted and it was proven that the material is good agent of stabilization of expansive soils for sub-grade modification. Tests like Standard compaction test, Maximum dry density, Optimum moisture content were carried out. Micro silica fume was increased at 5% each. The test was thus done in proportion of 5%, 10%, 15%, 20% and 25% respectively. It was noticed that 10% was optimum percent for soaked CBR which was same with unsoaked CBR as they both witnessed an increased.

Kalkan E and Akbulut S (2004) examined the effects of silica fume on permeability, swelling pressure and compressive strength of the compacted clay liners as a hydraulic barrier. . Thus, silica fume appears to be promising for construction material of liners subjected to leachate in solid waste containment systems. It was observed that silica fume addition leads to the reduction in Ps and permeability of soil while an increment was noticed in unconfined compression test values of the soil sample. It was thus recommended as modification agent of expansive soil.

Hasnnen et al. (2013) studied stabilization of soft soil subgrade layers by using lime-micro silica fume mixture (L-MSF) tests were conducted with addition of Silica fume in 3% proportions from 0% -12%. There was a considerable improvement in engineering characteristics of the soil. Liquid limit decreased by 20% from 53% - 33% with L-MSF 12-0%, PL values increased14% with LMSF by9%while PI values decreased by 24.79% with L-MSF 3%. The max dry density values decrease from 1.62gm/cm3 to 1.32 gm/cm3 with L-MSF 9-18%, OMC increased by 6.66% from 22% to 28.66% with L-MSF 12-0%. The CBR values was observed to have increased by 10.5% from 3% to 13.5 % with L-MSF 6-18%. They recommended that both lime and micro silica fume could be used in modification of black cotton soil for engineering use.

Mohhamed Khachi Al-Zairjawi et al. (2009) studied the effect of adding cement and silica fume with cement on compaction properties and shear strength of clayey soil. Inorganic clay with low plasticity was used for the study. A series of laboratory experiments have done and varieties of samples were made by mixing both cement and silica fume with cement. Four different percentages of cement (2%, 4%, 6% and 8%) and three different percentages of silica fumes (2%, 4% and 6%) were used. The results showed that adding cement and silica fume with cement decreases the maximum dry density and increases the optimum moisture content. The unconfined compressive strength of the soil was found to increase significantly with increase in the cement and silica fume with cement content especially after a long curing period.

Shivangi and Trivedi (2016) studied Impact of Micro Silica Fume on Engineering Properties of Expansive Soil. Laboratory tests were conducted on soil samples with increment in 5% proportion from 0%, to 15% of Silica Fume by weight of dry soil. Liquid Limit increased by 17% from 50% to 67% and Plasticity Index increased by 7% from 24% to 31%. There was an increase in Shrinkage limit, decrease specific gravity and differential free swell from 10.44% to 13.01%, 2.69% to 2.59%and 48.46% to 9% respectively indicating a fall in swelling characteristics of soil. It was thus recommended for use in stabilization of soils.

Thakare S W and Priti Chauhan (2016) carried out studies for stabilizing of local black cotton soil with lime, fly ash and micro silica. Series of laboratory tests have been conducted with varying percentage of these stabilizers, added individually and in combinations, to determine their optimum percentages. From the results, it is observed that CBR value, for both soaked and unsoaked conditions, increases substantially by addition of 5% micro silica along with 3% fly ash and 3% lime. The pavement designed with these improved values of CBR indicated a marked reduction in its thickness leading to economy in the construction of road pavements on or using soft clayey soils.

Uma G. Hullur (2018) conducted a study in which different admixtures were used with black cotton soil with varying percentages. Proctor test was done in order to assess the compaction behaviour. Black cotton soil was mixed with 10%, 20% and 30% of admixtures such as cement, Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin and Rice Husk Ash (RHA). The results showed, 10% FA gave maximum Max Dry Density(MDD) ,10% SF gave maximum MDD,20% RHA gave maximum MDD,30% GGBFS gave maximum MDD,30%Metakolin gave maximum MDD and similarly 30% cement gave maximum MDD. Hence for stabilization the above percentages can be considered as the optimum values of admixtures with black cotton soil.

## 3. CONCLUSION

Expansive soils are characterized by their considerable volumetric deformations representing a serious challenge for the stability of the engineering structures such as

foundations. Serious researches attempts have been tried to remedy such soils by means of additives such as cement, lime, steel fibres, stone dust, fly ash and silica fume. Soil improvement using the waste material like Slag, Rice husk ash, Silica fume etc., in geotechnical engineering has been recommended from environmental point of view. Silica fume is widely used for applications in concrete, but its applications in stabilising clayey soils is not so popular and the studies in this field are to be done. The studies showed that the silica fume is a valuable material to modify the properties of soil subgrade to make them suitable for construction. Silica fume stabilization may be used as a successful way for the treatment of expansive clay. Silica fume is a valuable material to modify the properties of soil subgrade to make them suitable for construction.

## REFERENCES

[1] Dr. Adel A. Al-Azzawi, Khalida A. Daud, Muhammed A. Abdul Sattar (2012) , "Effect of Silica Fume Addition on the Behavior of Silty-Clayey Soils", Journal of Engineering and Development, Vol. 16, No.1, ISSN 1813- 7822,p-92-105

[2] Chen, F.H. (1988), "Foundation on Expansive Soil", Development in Geotechnical Engineering, p. 463, (Elsevier)

[3] Abd El-Aziz M , Abo-Hashema M and El-Shourbagy M. (2004), "The effect of Lime-Silica Fume Stabilizer on Engineering Properties of Clayey Subgrade", Fourth Mansoura International Engineering Conference *(4th IEC)*

[4] Kalkan, E. and Akbulut, S. (2004), "The Positive Effects of Silica Fume on the Permeability, Swelling Pressure and Compressive Strength of Natural Clay Liners", Journal of Engineering Geology, Vol. 73, pp. 145-156.

[5] Luther, M. D (1990), "High-Performance Silica Fume (Microsilica)-Modified Cementitious Repair Materials", 69th Annual Meeting of the Transportation Research Board, paper no. 890448 (January), pp. 88-94.

[6] Kalkan E (2009) "Influence of Silica Fume on the Desiccation Cracks of Compacted Clayey Soils", Journal of Applied Clay Science, Vol. 43, pp. 296-302.

[7] Sivapullaiah, P.V., Sridharan, AS, Bhaskar, R.K.V, "Role of Amount and Type of Clay in the Lime Stabilization of Soils", Ground Improvement, Vol. 4, pp. 37– 45.

[8] Chayan Gupta and Ravi K. S. (2014) "Influence of Micro Silica Fume on Sub Grade Characteristics of Expansive Soil" International Journal of Civil Engineering Research, 5(1), 77-80.

[9] Chhaya N, R.K.Yadav and A.K. Singhai. (2013). "Effect of Silica Fume on Engineering Properties of Black Cotton Soil". International Journal of Scientific and Engineering Research, 4 (8), 828-832

[10] Ishraq Khudhair Abass (2013) "Studying some of the Geotechnical Properties of Stabilized Iraqi Clayey Soils", Eng. & Tech. Journal, 31(6).

[11] Mohammed Khachi Al-Zairjawi (2009). "Effect Of Adding Cement And Silica Fume With Cement On Compaction Properties And Shear Strength Of Clayey Soil" Al-Qadisiya Journal For Engineering Sciences, 2.

[12] Shivangi. B and Trivedi. M.K. (2016) ," Impact of Micro Silica Fume on Engineering Properties of Expansive Soil. - *International Journal of Science Technology*

[13] S.W.Thakare, Priti Chauhan (2016) "Stabilization of Expansive Soil with Micro Silica, Lime and Fly Ash for Pavement", International Journal of Engineering Research Volume No.5, Issue Special 1 pp : 09-13.

[14] Uma G. Hullur (2016) A Review On Soil Stabilization Using Different Industrial Wastes And Admixtures In Recent Years", International Journal of Informative & Futuristic Research (ISSN: 2347-1697), Vol. 4 No. (4), pp 6022-6025,

[15] Hassnen M, Jafer Hayder Abbas Obaid Ahmed Hassan Hadi. (2013). "Stabilization of soft soil subgrade layers by using lime-micro silica fume mixture", Euphrates Journal of Agriculture Science-, *5*(1), 44-51.

[16] M. Serhat Baspinar, Ismail Demir, Mehmet Orhan (2013) "Utilization potential of silica fume in fired clay bricks", Waste Management & Research, 28: 149–157