

# A Review-Improvement of Bearing Capacity of Soft Clay by Stone Column Technique

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**Abstract**— Bearing capacity is the important factor in the construction of buildings. There are many trending methods which are used to improve the bearing capacity of soft clay. One such method is stone column technique. Now a day's most of industries and buildings are being constructed away from city limits i.e. in the agricultural lands, ponds etc. This technique is very helpful in construction of buildings in soft clay and agricultural lands. Industrial wastes such as quarry waste, bagasse ash, silica fume are widely used. In this paper, a review of researchers about the industrial waste is being presented.

**Index Terms**— Bearing capacity, stone column, quarry waste, bagasse ash, silica fume.

## I. INTRODUCTION

Soil is important factor in the construction field. The soil forms the platform for buildings and foundations. In the coastal areas, the bearing capacity of the soil is low. The bearing capacity is improved by stone column technique. The materials used in the stone column technique are quarry waste, bagasse ash and silica fumes. Stone column is the ground improvement technique used to improve the load bearing capacity and reduce the settlement of the soil. It is also called as granular columns or granular piles. This technique is also known as vibrio replacement.

In this technique dense aggregate column is constructed by means of a crane – suspended down hole vibrator. Quarry wastes are the materials discarded after crushing. Silica fume is a by-product of producing silicon metal or Ferro silicon alloys. One of the most beneficial uses for silica fumes is concrete. It is used as soil stabilizer. Bagasse ash is obtained from sugarcane industry. Agro waste is used in the construction field. Bagasse is fibrous waste after the extraction of juice. It exhibits pozzolanic property. Geo synthetics such as geo grids and geo textiles can be used as encasement for the mixture used in the stone column technique. Geo synthetics are used for balancing the load and settlement properties.

## II. MATERIALS

### A. Quarry Waste

Quarry waste or quarry dust is a byproduct of the crushing process which is used in the stone column technique. It is the crushed form of rock particles. When huge rocks are breaks into small pieces in construction fields. It is like sand but mostly grey in color. In addition, it is mineral particles. The

studied quarry waste materials can be used as construction material in road construction etc. It is partially or fully places the quantity of cement used in construction. It is easily produced and transport to the construction sites [1].



Figure 1 Quarry Dust

### B. Silica Fume

Silica fume also known as micro silica. It is an amorphous (non- crystalline) polymorph of silicon dioxide, silica. It is an ultra-fine powder collected as a byproduct of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolonic materials for high performance concrete.

Silica fume is added to the Portland cement concrete to improve his properties such as compressive strength, bond strength and abrasion resistance. The specific gravity of silica fume varies from 2.2 to 2.3[3].



Figure 2 Silica Fume

### C. Bagasse Ash

Bagasse ash is a residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry [8]. It is the pulpy residue left after the extraction of juice from sugarcane. Due to its less cost of production it can be used extensively as cement replacement material. It increases the bearing capacity of the soil. It forms a good binding material. It is also used in the production of steam in large turbine to produce power.



Figure 3 Bagasse Ash

D. Geo Synthetics

Geo synthetics are generally polymeric products such as geo- textiles, geo -grids, geonets, geo-membranes, geo-foam, geo-cells and geo- composites. It is used as reinforcement in stone column technique. It carries the load uniformly to the soil. It can be effectively used in construction of buildings in soft clay.



Figure 4 Geo-Synthetics

III. REVIEW OF RESULT

The industrial wastes such as quarry waste; silica fume are extensively used as reinforcing materials in stone columns technique. They are implied in the stone column technique such as to improve the bearing capacity of the soil. The quarry waste, silica fume and bagasse ash are mixed in equal proportions and implied with the geo synthetics in this technique. They carry the load applied by the building and thus increasing the bearing capacity of soil.

Chemical Composition	Percentage[%]
SiO <sub>2</sub>	94.3
Al <sub>2</sub> O <sub>3</sub>	0.09
Fe <sub>2</sub> O <sub>3</sub>	0.1
CaO	0.3
MgO	0.43
So <sub>3</sub>	Nil
K <sub>2</sub> O	0.83
Na <sub>2</sub> O	0.27

Table 1 Composition of Silica Fumes

The mixture of silica fume and concrete is tested. It reveals at the stage of 90 days; the mixture is 17% higher than the control paste. The compressive strength test is conducted. It

exhibits excellent pozzolanic reactivity with the cement particles [3]. It exhibits lesser slump value which is 15mm less than original concrete slump value [3]. The composition is listed in the table 1.

Quarry dust or quarry waste is crusher product obtained during quarrying. It is comparatively used to increase the bearing capacity. Test were conducted on the mixture. It has a better load settlement values. Quarry dust is the waste material and easily available [2]. The load settlement curve shows the better load bearing capacity for quarry based soil than ordinary soil bed. The properties of quarry are listed below in the table 2.

Chemical Composition	Percentage[%]
SiO <sub>2</sub>	60.13
Al <sub>2</sub> O <sub>3</sub>	16.07
Fe <sub>2</sub> O <sub>3</sub>	8.28
CaO	9.89
MgO	5.42
So <sub>3</sub>	0.11
K <sub>2</sub> O	0.02
Na <sub>2</sub> O	0.08

Table 2 Composition of Quarry dust

In a typical sample the proportion of pith about 5% fibres73% and rind22% by weight was found by mechanical separation. Hence void age in porous bagasse particles was found to be about 66%. Due to its light weight it can be used in the reinforcing purposes. Srinivasan et al studied the nature of bagasse ash and concluded that it can be used as cement replacement to improve the quality and reduce the cost of construction as concrete [8]. The properties of bagasse ash are listed as follows in table 3.

Components	Bagasse %
Cellulose[%]	52.3±0.7
Polyoses[%]	17.2±0.3
Insoluble Lignin[%]	21.4±1.1
soluble Lignin[%]	1.5±0.1
Total Lignin[%]	22.9±1.2
Ash[%]	2.5±0.1
Extractives[%]	Non-determined
Total	94.9±2.3

Table 3 Composition of Bagasse Ashe

The Geo synthetics are used as reinforcing material in the construction filed. The load settlement tests were conducted using the geo synthetic materials along with the industrial waste. It shows the better results than ordinary soft clay stone

technique test. The settlement obtained is 75mm and load applied is equal [7]. The composition of geo synthetic is as follows,

Properties	Geo synthetic
Weight	45 G/M <sup>2</sup>
Mesh size	2.5×2.5 mm
Coating cement	18%
Tensile strength	400 MP

Table 4 Composition of Geo-Synthetics

#### IV. CONCLUSIONS

1. The stone column technique helps in increasing the bearing capacity of the soft clay.
2. Quarry waste, bagasse ash, silica fume provides better aggregate in the stone column technique.
3. Quarry dust is cheap and effectively available and used to improve load deformation characteristics of the soil.
4. The load carrying capacity of the soft clay can be increased by geo textiles.
5. Silica fume forms strong bond with the waste materials and acts as a good binding material.
6. By using bagasse ash, disposal of chemicals and gases in the soil can be reduced.

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