ISSN (ONLINE) 2583-2506
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RBIJMR-Rayat Bahra International Journal of Multidisciplinary Research, Vol. 04, Issue 01, June, 2024

# Stabilization of Expansive Soil using Fly Ash, Marble Powder and Rice husk ash

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***Abstract:*** *In the era of industrialization and infrastructure development there is need of infrastructure with proper soil condition consisting desired consideration of safety following all the design criteria. Increasing industrialization and construction need increase in the rate of waste production which lead direct impact on the land and all environments. The waste produced from industry is used for improving engineering properties of soil which is indicated by various literature references. Expansive soil is type of soil which is accompanied by the change in volume with water content change. So, it is need to improve the behavior of soil before construction. Fly ash and marble powder are the by product from construction industries which is produced in large quantity and is leading hazards on human health after dumping whereas rice husk ash is a agricultural waste. As the simultaneous need of soil stabilization and management of waste material lead use of industrial waste for stabilization purpose. Using these waste leads efficient economic stabilization and sustainable way of controlling harmful impact to the whole environment. This review study shows the various literature reviews showing that use of fly ash, rice husk ash and marble powder for the stabilization of expansive soil. It is concluded from that all the engineering properties of expansive soil is stabilized using these additives resulting detrimental effect leading feasible and economical solution.*

***Keywords:*** Expansive soil, Stabilization, fly ash, Marble powder, Rice husk ash

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ISSN (ONLINE) 2583-2506
http://publications.rayatbahrauniversity.edu.in
RBIJMR-Rayat Bahra International Journal of Multidisciplinary Research, Vol. 04, Issue 01, June, 2024

## 1. Introduction

Increase in urbanization, population growth rate and industrialization demand great construction of infrastructure in the field of civil engineering. Due to demands of all these leads the uses of land upon which there is to do construction. Construction of structures lead uses of (covers) whole land which is covered with different types of soil. Out of different types of soil expansive soil leads many types of problems after the construction of field. The reason of which civil engineers are looking for a tremendous solution for providing safe zone to the structures for making structure safe from different type of failure it is mandatory to stabilize the soil which is expansive in nature.

This review paper really researched for different types of stabilization method and the materials used by different researcher from past decades for stabilizing the soil expansive in nature which really enhance the structure to not fail upon different type of loadings and conditions. Researcher uses different types of materials and different types of stabilization techniques for stabilization of soil expansive in nature.

Different methods for stabilization for soil which is expansive in nature involves mechanical, chemical, thermal, electrical, bituminous, cement etc. types of stabilization. Out of which this paper represents stabilization of soil by chemical stabilization. Chemical stabilization involves uses of different chemicals for modifying the all engineering properties of soil expansive in nature. The chemicals generally many researches use like fly ash, ash from rice husk, powder of marble, lime, fine sand, ash of bagasse, slag from blast furnace, etc.

Research of different reviews indicates use of marble powder, ash of fly and ash from rice husk for stabilization of expansive soil. Different literature reviewer from different researcher's study includes following studied including with various conclusions.

## 2. Materials

### 2.1 Expansive soil

The soil which changes its volume during (due to) the contact of moisture content is known as expansive soil. Expansive soil is rich in montmorillonite mineral for clay. Worldwide distribution of this type of soil in different places leads damage and failure of the structure. Commonly this type of soil found in Maharashtra, Tamil Nadu, Utter Pradesh, Andhra Pradesh, Madhya Pradesh etc. Which is covered around $1/5^{th}$ of area of land in India(Thakur et al., 2023). Around 3% of land area is occupied by soil expansive in nature in worldwide manner. Expansive soil is characterized by the nature having low in

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strength, low in consistency limit, swelling in nature high shrinkage value less CBR value as well as have a low compaction value. Stabilization enhance increase in value of resistance lowering the value of plasticity for decreasing permeability, lowering shrinkage value as well as improve in free swell index and values for compaction parameter (Gyanen. Takhelmayum, 2013). Fig. following shows the soil expansive in nature (Thakur et al., 2023).

Fig.1.: Expansive Soil.

**Fly Ash**

Fly ash is defined as by-product (waste product) produced from industries during combustion of coal which is known for cause of pollutants in term of environmental condition (Ahmaruzzaman, 2010). Fly ash generated different types of degradation causing harmful contamination which directly harm the land from the total ash production only utilization of ash constitutes about three percentage to seventy-five percentage of utilization(Pan et al., 2003). Add of ash of fly improves different engineering properties of soil(*NII-Electronic Library Service*, n.d.). Fly ash shown in figure below is by-product which have no plasticity nature which improves ability to work of soil by the help in changing different size of grains. Fly ash is helpful for decreasing limit of plastic as well as liquid with decreasing in index of plasticity(Rashid & Majeed, n.d.).

Fig. 2.: Fly Ash

**Marble powder**

Marble powder is a by-product producing during the cutting and finishing of marble. Marble powder after by production leads serious environmental problem when it thrown directly to the open land. Marble is used in the field of construction from many decades ago. Finning of marble processing leads large production of waste of marble(Demirel, 2010). Single weight of marble is deceased up to 25% reduced weight. Marble is rich is component like calcite as well as dolomite. Dust of marble also good in content like calcium of carbonate and silica marble powder is significantly play enhancing role for stabilizing and improving engineering properties of soil expansive in nature (P Kearey, 2009).

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Fig. 3.: Marble Powder.

**Rice Husk Ash**

High protective type of covering that covered grain of rice separated during process of milling are known as rice husk. These are most common in country producing rice. Around seven hundred tones of millions rice husk produced world widely(Yousuf Sheikh et al., 2008). Rice husk constitutes 50 percentage of cellulose, 25 to 30 percentage of lignin, 15 to 20 percentage of silica as well as 10 to 15 percentage of moisture. 90 to 150 kg/m3 of bulk density contains rice husk (Yousuf Sheikh et al., 2008).

Fig. 4.: Rice Husk Ash.

Ash from rice husk is greatly used is stabilizing materials by enhancing index of plasticity, strength of shear parameter, California Bearing ratio etc. The husk of rice burning generates around twenty percentage of weight of ash.

## 3. Literature Review

'Magdi M.E. Zumrawi and Omer S.M Hamza' in 2012 investigated for soil of expansive subgrade by Ash of fly and lime to make improvement in characteristic of soil. They took varying percentage of additives for performing different test in laboratory for finding the nature of swell and characteristic of strength. Zero to 15 percent and Zero to 40 percent of additives (lime as well as fly ash) were added. They conduct test for untreated and within combined state. The test performed were property of index, test for compaction, CBR test, UCS test, test for free swell and test for swelling pressure. They added fly-lime in percentage 5 and eight for lime and percentage 0,5and to for ash of fly. They found increase in value for UCS and CBR for fly lime additive reduced in swell with varying additive content. They concluded use of these additives were economically as were successful for soil with expansive in nature(Zumrawi & Hamza, 2014).

Ramdas, T.L. et.al. in 2010 investigated properties index, test for compaction, UCS and swelling which were done by mixing different percentage of ash of fly as well as dust of stone.

They found from observation percentage as 30 and 25 for dust of stone and ash of fly were marked of expansive soil was more controlled by combined state of additive than dust of stone alone. OMC of soil found to be suitable for 20 and 25 percent of dust of stone and ash of fly as well as reduction in swell to increment in strength for the soil which is undertaken for treated condition(Kumar & Darga, n.d.).

Gyanen. Takhelmagum et. al. in 2013 investigated properties of index test for compaction, UCS which were done by mixing fly ash of fine and coarse mixtures. They took the percentage of additives from five to thirty. Additives of admixture improves properties of soil expansive in nature. Ash of fine fly mixture with 25 percent gives more strength as compared to ash of coarse fly (Gyanen. Takhelmayum, 2013).

P. Indiramma and CH. Sudharani in 2014 investigated for soil properties which maintained for sustainable environment by using waste produced from industry. They use dust of quarry and ash of fly for improving expansive soil properties. They discussed about consistency limit, Compaction test and characteristics for strength(Www et al., 2008).

Prof. J.M Raut, et.al.in 2014 they studied and researched about the by-product produced from industry which quite expansive as well as difficult to easily found. They uses ncessum as well ash of fly with varying percentage for improving soil which is expansive in nature. They carried different test for observation which they presented in their papers(Raut & Professor, 2007).

Magdi M.E. Zumrawi in 2015 they study and researched about effect of additives in combined state for stabilization of soil in subgrade condition. They took fly ash as 0%, 5%, 10%, 15% and 20% with cement content as five percent. They conduct test like limit of consistency, test for compaction, CBR test, Potential of swell as well pressure of soil for both natural and soil with admixture. They found fifteen percentage of cement of ash of fly with five percent of cement for improving strength to durability which help to reduce swell and plasticity. They conclude cement-fly mixture of ash for good and economical material for good expansive subgrade(Zumrawi, 2015).

Hassan A.M. Abdelkader et.al. in 2021 investigated waste material use as in low-cost that also causes less impact to environment. They did marble for study from east Cairo lies in Egypt. They took varying percentage of dust of marble as 5,10,15,20 and 25 by weight of dry soil. They performed laboratory test as limits of Atterberg's compaction from standard proctors, UCS test, test for CBR percentage of swelling, shrinkage of linear test, XRD as well as XRF observation for both untreated and additive stabilization soil. They cured sample for days

seven for UCS, swell test, CBR test, OMC and MDD. They found marble dust useful for increasing index of plasticity, potential of swell (decreasing).Whereas OMC decreases and MDD increases. And there is increment in UCS, CBR with content of calcite combined to dust of marble content(Abdelkader et al., 2021).

Ankush Kumar jain, et.al. in 2020 clarify dust of marble influence for behaviour of geotechnical improvement with understanding interactive mechanism different test for geotechnical compressive examination of physic-chemical (like conductivity of electrical and value of PH) also analysis in micro (includes mineralogical to micro structural there elemental, spectroscopy of infrared Fourier transforms) had performed by adding content of marble powder upto 80%. They observed improvement in plasticity also in behaviour of swell. Marble content upto 20% accelerate strength. They conclude percentage of marble dust best for improvement is 20 percent. The examination of physic-chemical with analysis of micro improves gradation alteration interlocking, composition of mineralogical, micro structural, elemental and also chemical factor were controlled by dust of marble presence of mineral, curing method, longevity temperature, OMC effect were investigated thoroughly(Jain et al., 2020).

Onur Baser in 2009 investigated limestone waste and dolomite marble waste dust for stabilizing expansive soil. They prepared expansive soil by mixing bentonite with kaolinte. They determine distribution of grain size limit of consistency composition for chemical and mineral percentage of soiling and also soil rate. Increasing stabilizer increase soil rate and decrease soil percentage. They cured sample for seven and twenty eight days which effect soil rate with satisfied way(Başer, n.d.).

F. Yilmaz and M.Yuradakul in 2017 studied about waste material utilization. They determined different values for compaction limits of Atterbeg's, UCS with ratio change of dust of marble. Dust of marble increase properties of soil in mechanical condition and searched about stabilization of soil that help for management waste(Yilmaz & Yurdakul, 2017).

Ram Ditta and Varinder Singh investigated dust of marble effect for index properties of soil. They study about different limit of plastic, shrinkage, liquid pressure of swell and also index of free swell that were decreases with increment in dust of marble. Whereas there was CBR ratio increased. They obtained 30% dust of marble was economical for providing good strength to flexible pavement(Ditta & Singh, 2019).

J Naji et.al. in 2020 researched about experimental work for studying effectiveness of dust of limestone and Ash of fly for enhancing soil expansive in nature which was taken from Haspolat Nicosia. They took limestone as 5%

fine Ash as 10% and both at combined state as 5% to 10% of dry soil weight cured for one fourteen and twenty eight days. They additives as (5% and) gives 220% CBR values 82% shrinkage as volumetric with potential of swell as 100%. They concluded additives enhanced expansive soil property in efficient manner with soil in untreated condition. They finalize dust of limestone and ash of fly for effective stabilizer providing good disposal solution for stabilization(Naji et al., 2020).

Muhammad Rehan Hakro, et.al. in 2021 study about dust of marble for expansive state for purpose of stabilization. They added dust of marble from zero to twelve percent reports there was two percent increment of soil. They conducted test as limits of Atterberg's test for proctors and CBR test. They found there is decrement in value of plastic plasticity index and swell where as density and value of CBR were increased which are economical and also amicable for disposal on land(Rehan Hakro et al., 2021).

Chen, James A and Uloko, Josiah O studied laboratory results discussed and compared dust of waste ceramic (WCD) and also waste marble (WMD) for expansive soil. They studies about different test carried for stabilizing soil as limits of Atterberg's, Compaction CBR test and also pressure of swell. They add additives in different percentage from zero to thirty percent with five percent weight soil increment. They conduct test according to ASTM. They found decrement in limit of liquid from seventy one to thirty five percent with WCD addition from zero to thirty percent and on WMD increased it reaches seventy one percent top thirty eight percent. They was decrement in swell from 110 to 36% and also 111 to 39% on adding WCD and simultaneously WMD. The increase in CBR value at soaked reached to 4.1 from 1.6% with WCD percentage and reached 3.9% from 1.6% with WMD addition. They finalize WCD was more conventional than WMD for stabilizing expansive soil(Chen et al., n.d.).

Ranjneesh Sharma et.al. studied about dust of kota stone for improving subgrade characteristics having soil black cotton in nature. They conduct compaction test like MDD and OMC varying stone kota slurry from three to twenty four percent after each variation of three percent. They conduct CBR test also that verified soaked value of CBR with 15% dust of stone kota blended give value reached 8.37 from 2.12 i.e 295%(R. Sharma et al., n.d.)

Yatesh Thakur et.al. in 2020 investigate marble dust effect for determining index properties varying percentage from 0 to 10% with dry weight soil. They found 67.49 to 52.01% index of plasticity from 37.16 to 10.43% swell of free from 60 to 14. They said marble dust switch potential characteristics of soil expansive in nature. They concluded marble dust helpful for

significant improvement which reduced excellent extent (Yatesh Thakur, 2020).

Chen James A, et-al. in 2017 researched about comparing effect of dust of waste ceramic (WCD) dust of waste marble (WMD) and also dust of quarry (WQD) for enhancing properties of soil. They carried test like limits of Atterberg, Compaction, CBR test and pressure of swell. They took activities from zero to thirty percent increment by five percent increase in dry weight of soil. They conduct test according to ASTM. They noticed decrement in limit of plastic to 35 from 67% with WCD, WMD and also with WQD. They observed decrease free swell to 45% from 111%, 53% from 111% and 40% from 111%, for WCD, WMD and WQD. CBR soaked value increased to 4.1 to 1.6, 4.1 from 1.6% and 4.5 to 1.6% with WCD, WMD and also WQD. They finalize WQD was more potential as compared to WCD and also WMD for improving the properties of expansive soil(Joseph & Josiah, 2017).

Chrakhan Amjed Hwayyiz, et-al. in 2023 investigate for determining the powder of marble effect for features of geotechnical. Which includes the limits of consistency, density and strength of shear parameters and characterstics of swell in clayey soil which was taken from exbil city. They took powder of marble as percentage varying from 6, 12, 18, 24, 30, 36% for treating soil expansive in nature. They finalize the powder of marble for enhancing properties in geotechnical manner. They adviced 18% of powder of marble in prove significant change which was economical and environmentally beneficial (Chakran Amjed Hwayyiz, 2023)

Manmay Kumar Mohanty in 2015 researched expansive soil stabilization by fly ash. They attempted stabilization of soil black in nature from Nagpur and ash of fly from Sterlite Jharsuguda Odisha. They took additives as varying percent from 10, 20, 30, 40 and 50%. They found decrease in Index of plasticity with increment in content of fly ash, where as increment workability by grain size changing and reaction of colloidal, soaked and un-soaked value of CBR were noticed and they finalize ash of fly improve properties of soil expansive in nature(Mohanty, 2015).

Umar Zada, et-al. in 2023 researched about different recent trends, different opportunities, challenges with different admixture for improving properties of soil so that, that had no any effect on environmental aspects including economic aspects. They studied about material that stabilize soil are like powder of waste marble, ash of fly, powder of egg shell, waste of stone and powder of lime. They furthermore said different types of critical review made from analyzing stabilizer for improving property of soil in geotechnical content which leads sustainability for application in field(Zada et al., 2023).

A. Seco et-al. in 2010 researched about expansive soil stabilization by use of industrial waste and by product for improving mechanical properties and capacities for also reducing swelling nature researcher represent using waste reduces economic as well as environmental benefits for proper management of them. Researcher did different type of treatments and test to the in treated soil helps for improving strength parameter. They took most too important waste material as fly ash of rice husk which they considered in their experiments(Seco et al., 2011).

Fusheng zha et-al. in 2008 researched about potential as well as effectiveness of soil expansive in nature by use of ash of fly and ash-lime of fly as a admixture increasing percentage of admixture decrease index of plasticity and swell (free, pressure and potential) axial shrinkage. Increasing curing time for soil which is treated decrease potential of swell and pressure for swelling. Increasing the curing time indicates good strength increment. Researcher also discussed relationship between different properties for index of plasticity as well as swell. Shrinkage for soil which is free and post treated(Zha et al., 2008).

Akshay Kumar Sabat and Subasis Pati in 2014 researched about different effects of solid waste which are prominent and obtained for laboratory studies. They researched and finalized solid waste treatment for improving engineering properties of soil is appropriate for construction by using stabilization method(Sabat & Pati, n.d.).

Bidula Basa researched about stabilizing commercial clay which has high plasticity by treating fly ash. Researcher evaluated different engineering properties by treating fly ash and without treating of fly ash. Researcher took proportion for fly ash as zero percent, 20 percent, 40 percent, 60 percent, 80 percent and 90 percent. Researcher found decrease in plasticity index free soil and pressure of swelling on increasing fly ash content. Reduction in OMC whereas increase in dry density upto 20 percent fly ash. After that decrease with further increment in content of fly ash and same for strength of unconfined compression, CBR test was done for soaked and un-soaked condition. Which result peak of ash content with value at 20 and 80 percent. Researcher concluded fly ash with good potential for improving different properties of soil expansive in nature(Bose, 2012).

Zalih e Nalbantoglu in 2004 researched self cementing property of fly ash for stabilization of application in world-wide form. Different foundation pressure as well as swell potential can be reduced by proper and effective implementation of ash of fly. There is wide distribution of soil which is expansive in nature which is produced in Cyprus with condition for geology as well as climate. The soil which are

expansive in nature possess different types of problems like high in plasticity, potential of swell as well as low in strength. When researcher added fly ash to the soil they noticed fly ash is helpful for improving all these different types of parameters. Researcher (CEC) for indicating the mineralogy of ash of fly as well as absorption of potential for water plasticity(Nalbantoğlu, 2004).

Anil kumar Sharma and P.V Sivapullaiah in 2015 researched about use of mixture of both ash of fly and slag which is obtained from blast granulated ground for stabilization process of soil in expansive nature. Researcher uses these two material for the cementing process for different limits of Atterberg, Which also help to enhance UCS values and different swell potential. Adding binder reduces limit of liquid and index of plasticity which increment in the strength. Increasing content of binder enhance pozzolanic reactivity. Researcher found 20% is the optimum value for improving all properties of soil. Researcher also did various study for the mineralogical as well as morphological study for optimum value that result formation with particles which are in hydrated condition and compound in cementious condition resulting from the reaction held with binder clay. They concluded using ground granulated blast furnace Slage with ash of fly stabilize the soil expansive in nature resulting economic benefits(A. K. Sharma & Sivapullaiah, 2016).

Shi He et. al. in 2018 researched for treating soil with nature of expansive by using the stabilizer on ionic soil for improving the properties of different swelling and behavior of shrinkage. Different test were performed like strength test for UCS test for swell for one dimensional for which they took soil from Dallas for using soil before treatment as well as after treatment. They used stabilizer for different three dosages and four periods of curing. They found after investigation, Stabilizer reduces swelling characteristics and plasticity of soil as well they noticed increment in strength for soil. They also treat same stabilizer for different injection in deep by pump of hydraulic(He et al., 2018).

Rahmat Ali in 2014 researched about stabilization of problematic soil (expansive soil) by the use of ash from bagasse and dust from marble. The select different five sites by visually in specting with area having crack in wide dry soil condition from selected district Bannel districts soil have limit of plasticity and liquidity as 30 and 50 percent. They used ash of bagasse and dust of marble and performed different test for lab with adding and without adding stabilizer used for different properties of soil. They concluded these stabilizer used for stabilization purpose are suitable solution for environmental to economical and help to reduce different problem of disposal(Ali et al., 2014).

Anand Puppola et. al. investigated for treatment of soil in expansive nature by different stabilizer like fiber as well as ash of fly. Researcher uses ash of fly and fibers of polypropylene were used. They uses two same nature of soil for control soil. These two different used for increasing strain shrinkage. Ash of fly reduce plasticity as well characteristics of swell of free which helps in reducing cost of land filling as well enhancing efforts for recycling(Puppala et al., n.d.).

Adarsh Minhas and Veena Uma Devi in 2016 studied dust of marble used for stabilizing soil having alluvial in nature. Alluvial soil is termed for variation on volume with change in water content. Researcher used dust of marble for improving different engineering properties of alluvial soil and giving best alternative for reducing the environmental hazards. Researcher concluded dust of marble used for settling different problems with different types for settling different problems with different types of disposal process and give best approach for economical as well as environmental solution(Minhas & Student, n.d.).

Parte Shyam Singh and Yadav R.K in 2014 studied for identifying dust of marble effect for different index properties of soil in expansive with nature. They took 0 to 40% of dust of marble by soil dry weight for laboratory experiments. They found reduction in plasticity index from 28.35-16.67 percentage increment in limit of shrinkage from 8.06-18.39 percentage with adding 10 to 40 percentage of soil in expansive nature also decrement in swell of free from 66.6 to 20.0 percentage. Researcher concluded improvement in different index properties with sufficient addition of dust of marble and sufficient addition of dust of marble and sufficient reduction in the properties of expansive nature of soil(Shyam Singh et al., 2014).

S.R. Hosamani and A.M. Hulagabali studied of comparative of soil with expansive in nature by using dust from marble ash from bagase ash of husk of rise and ash of fly. Researcher studied about MDD, OMC strength for shear and different index of free swelling which were taken in different percentage and periods of curing. The initial or untreated properties of soil were found as 24 KPa, 52%, 46% 1.22g/cc and 34% for UCS index of free swell index of plasticity MDD, OMC. When husk of rise ash added UCS increase to 179KPa which ash of bagasse enhance 141 KPa at 15 percentage of fourteen curing days. At 20% UCS and MDD value with ash of fly found as 91 KPa with 92 KPa and OMC to MDD value obtained were 25.5% and 1.44g/cc with same ratio of ash of fly. Again they 15% of rise husk ash and ash of bagasse take with ash of fly and dust of marble at from 5 to 15 percentage. After 14 curing day soil with black cotton in nature improved by ash from rise husk and dust of marble having strength 193 KPa. Researcher concluded best

ratio for good resulting in stabilization was black cotton soil (70%) of ash of rise (15%) and dust of marble (15%)(Hosamani & Hulagabali, 2016).

Dhrav Saxena in 2018 researched effect of power from marble as well as sand which is fine in nature for properties of soil with expansive in nature. Researcher presented different characteristics for compaction limit for Atterberg's ratio of California bearing permeability as well as parameter for strength of soil clay in nature. Researchers take 30-50 percent of power of marble and sand also from 20-40 percent from analysis of results they found limit of liquid index of plasticity OMC permeability MDD and shrinkage limit CBR and angle of friction in internally increase with increasing content of marble power is optimum for clayey soil for the flexible pavement cost of construction(Saxena, 2017).

Syed Aaqib Javed and Sudipta Chakraborty in 2019 researcher for stabilizing soil by using stabilizer as ash from rise husk (RHA) and dust from marble which is both economically and environmentally friendly. They performed experiment in series as 0, 5, 10, 15 and 20 percent for soil in dry weight condition liquid limit from 38.8% reached to 32.86% in RHA as 32.86% and MD as 49.52% MDD was in decrease condition and OMC was on increment condition. CBR value found as increase with MD. They finalize RHA is for small improvement and MD was for greater improvements(Aaqib Javed & Chakraborty, 2019).

## 3.1 Methodology and Tests

### 3.1.1 Expansive Soil

Table below describes the characteristics of expansive soil (Sefene, 2020):

Table 1: General properties of expansive soil

| Properties | Quantity |
|---|---|
| Liqiud Limit% | 81.84 |
| Plastic Limit% | 47.01 |
| Plastic Index% | 34.84 |
| OMC% | 35.74 |
| MDD% | 1.33 |
| CBR Swell% | 1.77 |
| Free Swell% | 170 |
| UCS (KN/m2) | 217.75 |
| AASTHO classification of soil | A-7-5 |
| Clay and silt, gravel, content of organic% | 97,26 and 0.4 respectively |
| Colour | Brownish black |

### 3.1.2 Fly Ash

Table included below describes the component, figure below is brief view and graph describes improvement in engineering properties of expansive soil by using fly ash (Bose, 2012).

ISSN (ONLINE) 2583-2506
http://publications.rayatbahrauniversity.edu.in
RBIJMR-Rayat Bahra International Journal of Multidisciplinary Research, Vol. 04, Issue 01, June, 2024

Table 2: Fly Ash Composition

| Components | percentage | Constituents | percentage |
|---|---|---|---|
| MgO | 0.57 | Fe2O3 | - |
| Al2O3 | 24.12 | Na2O3 | - |
| SiO2 | 52.55 | MnO | - |
| K2O | 0.965 | TiO2 | - |
| P2O5 | 0.72 | SO3 | - |
| CaO | 2.65 | Loss of Ignition | 18.18 |

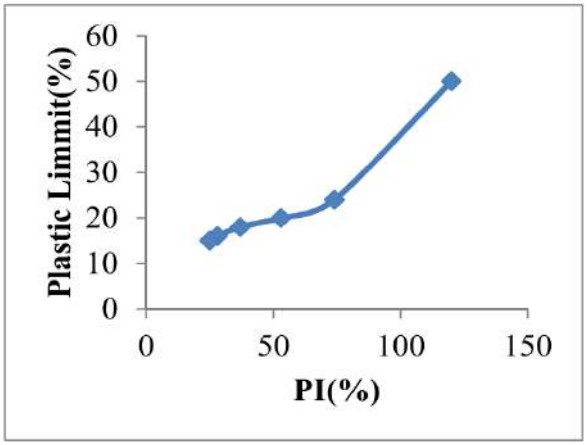


Fig.7: Variation of limit of liquid with PI%.

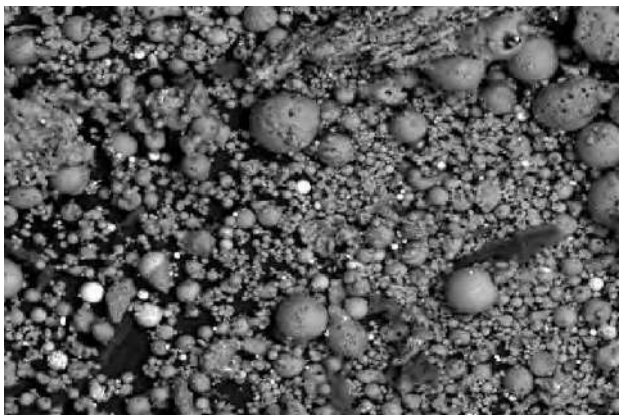

Fig. 5.: Arrangement of Fly Ash particle by SEM

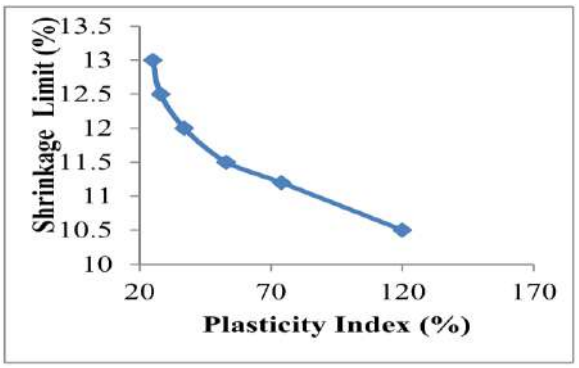


Fig. 8.: Variation of shrinkage limit with PI%.

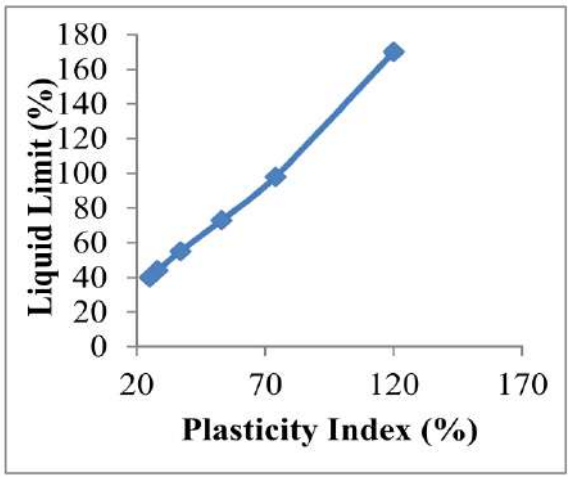


Fig. 6.: Variation of limit of liquid with PI%.

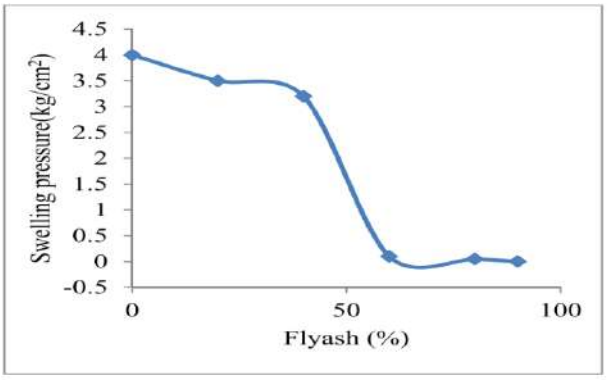


Fig. 9.: Change of Swell Pressure with fly ash%.

ISSN (ONLINE) 2583-2506
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Table 4.: Ash of composition of Rice Husk

| S. No. | Components | Percentage% |
|---|---|---|
| 1. | SiO2 | 74.43 |
| 2. | Al2O3 | 4.77 |
| 3. | Fe2O3 | 0.87 |
| 4. | CaO | 2.76 |
| 5. | MgO | 1.59 |
| 6. | Loss of Ignition | 15.58 |

Table 5: Powder composition of marble

| S. No. | Components | Percentage% |
|---|---|---|
| 1. | CaO | 52.3 |
| 2. | MgO | 21.48 |
| 3. | SiO2 | 5.8 |
| 4. | Al2O3 | 4.63 |
| 5. | Fe2O3 | 0.7 |
| 6. | ZnO | 0.4 |
| 7. | TiO | 0.5 |
| 8. | Loss of Ignition | 14.19 |

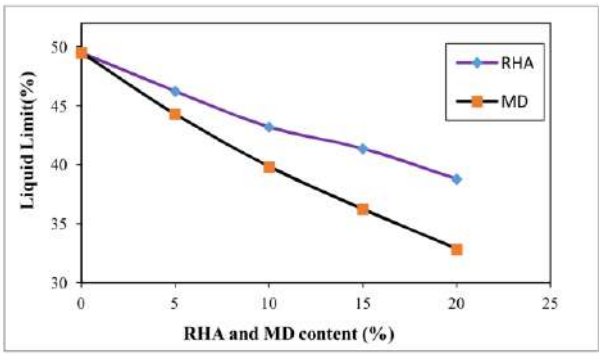


Fig. 10.: RHA as well as MD comparison for LL%.

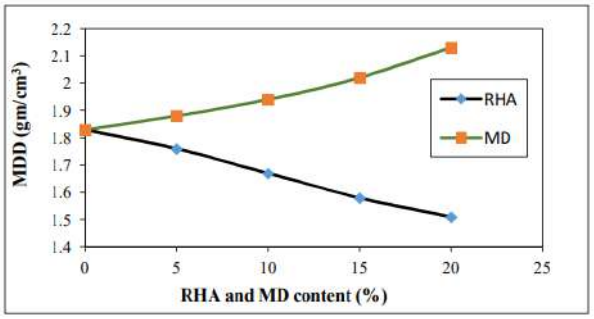


Fig. 11.: RHA as well as MD comparison for MDD (gm/cm3)

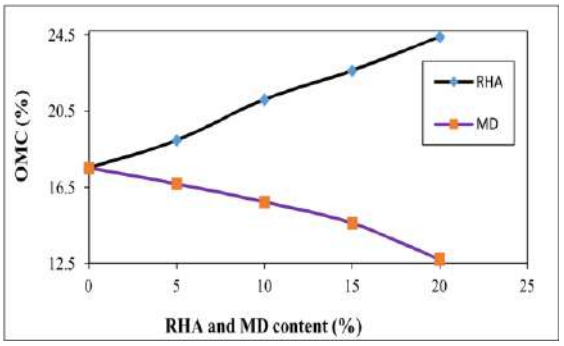


Fig. 12.: RHA as well as MD comparison for OMC (%).

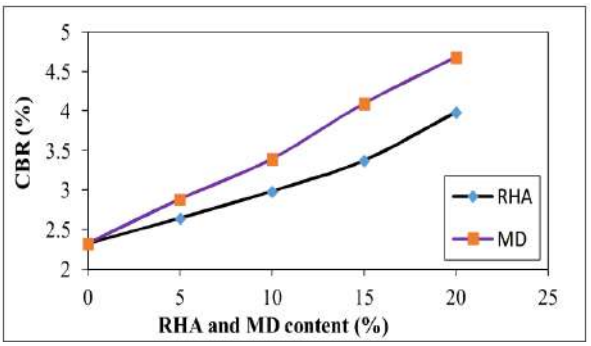


Fig. 13.: RHA as well as MD comparison for CBR (%).

Composition of ash of Rice Husk, marble powder and their reaction with expansive soil for improving the engineering properties are as shown in the figure below(Aaqib Javed & Chakraborty, 2019).

## 4. Conclusion

This research paper is concluded as the waste material produced from different production area are very important parameters for stabilizing the different engineering properties of the soil expansive in nature. The parameter like limits of Atterberg's, strength of unconfined compressive, California bearing ratio, Shrinkage value, swelling index, compaction parameter like MDD (maximum day density) and OMC (optimum moisture content) can be enhanced for suitable infrastructure construction on the soil expansive in nature. Ash from rice husk, Powder of marble as well as ash of fly are thus used as ecofriendly stabilizing stabilizer for expansive soil. Use of these different materials as stabilizer also protect the environment from different types of hazardous things and helpful for protecting the eco-system of whole earth.

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