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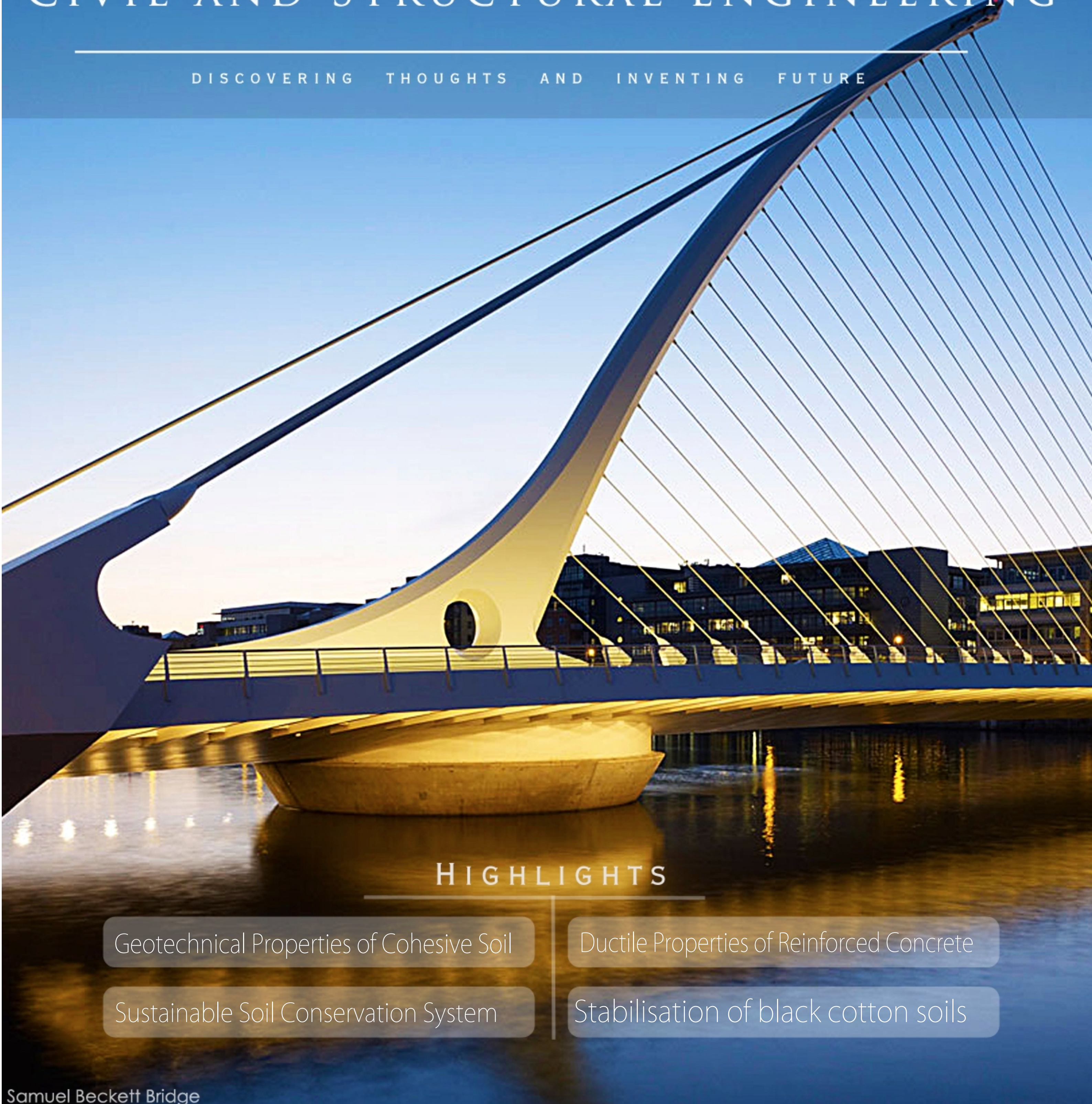

HIGHLIGHTS

- Geotechnical Properties of Cohesive Soil
- Ductile Properties of Reinforced Concrete
- Sustainable Soil Conservation System
- Stabilisation of black cotton soils

Samuel Beckett Bridge

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Interpretation of Rice Husk Ash on Geotechnical Properties of Cohesive Soil

By Grytan Sarkar, Md. Rafiqul Islam, Dr. Muhammed Alamgir, Dr. Md. Rokonuzzaman

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Abstract - This paper demonstrates the effects of rice husk ash (RHA) on the geotechnical properties of soil in stabilized forms specifically strength, workability, compaction and compressibility characteristics. Therefore, laboratory tests such as compaction, Atterberg limits, free swell index, unconfined compressive strength, direct shear and consolidation tests for different percentages of RHA content and original soil samples were performed. These test results show that the soil can be made lighter which leads to decrease in dry density and increase in moisture content and reduced free swelling and compressibility due to the addition of RHA with the soil. Besides that the unconfined compressive strength and shear strength of soil can be optimized with the addition of 10% RHA content.

Keywords : RHA, Index Properties, strength properties, swelling and consolidations.

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INTERPRETATION OF RICE HUSK ASH ON GEOTECHNICAL PROPERTIES OF COHESIVE SOIL

Strictly as per the compliance and regulations of:

Interpretation of Rice Husk Ash on Geotechnical Properties of Cohesive Soil

Grytan Sarkar [α], Md. Rafiqul Islam [σ], Dr. Muhammed Alamgir[ρ], Dr. Md. Rokonuzzaman [Ѡ]

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I. Introduction

Generally, partially saturated clayey soils having high plasticity are very sensitive to variations in water content and show excessive volume changes. Such soils, when they increase in volume because of an increase in their water contents, are classified as expansive soils. This highly plastic soil may create cracks and damage on the pavements, railways, highway embankments, roadways, building foundations, channel and reservoir linings, irrigation systems, water lines, sewer lines etc (Gromko, 1974, Mowafy, 1985 and Kehew, 1995). Thereafter, highly plastic soil exhibits undesirable engineering properties under load. They have low shear strengths and tendency to lose shear strength further upon wetting or other physical disturbances (Mitchell, 1986). Therefore, this plastic soil are very prone to shear failure due to the constant load over time and considered poor material for foundations(Liu, et. al., 2008).

Khulna is the southwest part of Bangladesh having high clayey and silt content of very soft to soft consistency up to 20 ft. from the ground surface level on the basis of several soil report collected from CRTS of Khulna University of Engineering & Technology.

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High water content, high compressibility and low workability of these soils often caused difficulties in the civil engineering construction projects. The soil which is used for the construction pavement or sub-base should have some specification of geotechnical properties for obtaining required strength against tensile stresses and strains variety. In this study, RHA was used for the improvement of workability, compressibility and compaction characteristics as well as the physical properties of highly plastic clayey soil. In the earlier, cement and lime are the two main materials used for stabilizing soils which is now costly in price due to the sharp increase in the cost of energy since 1970s (Neville, 2000). RHA is the most cost-effective locally available materials act as a binding agent like cement which increases some geotechnical properties as well as stabilization of soil as an alternative option of cement and lime.

Rice husk is an agricultural waste obtained from rice milling. About 108 tons of rice husks are generated annually in the world (Alhassan, 2008). In Bangladesh, about 39.3 million ton of rice is produced annually (Mustafi, 2005) which generate about 9.83 million ton of RH after milling of the paddy is used as animal food as well as fuel in rural area. RHA which is generated from the burning of Rice husk is considered as waste material and usually dumped backside of the kitchen of the village people in Bangladesh. Rice husk ash has high quantity of silica with small quantities of oxide (Agarwal, 1989, Kumar, 1993) having high specific surface that is very suitable for activating the reaction of soil and act as a binding material like cement. Thus RHA can be used as a cost-effective additive particularly in regions having high production capacity like Bangladesh. The silica content in RHA depends on the burning temperature. The technique which is used for burning RH to produce amorphous silica is suitable for pozzolana cement production, have been developed (Kumar, 1993, Ahmed, et al.1993). A mini incinerator has been designed by Ahmed, et al.(1993) in BCSIR laboratory, Dhaka to produce RHA and a comparative study has been carried out in relation to compressive strength and setting time of the pozzolana cement prepared by using this ash and boiler ash.

II. Materials and Methods

a) Specification of Soil

Nearly greyish silty clayey soil was used in this study, collected from Khanjahan Ali Hall at Khulna University of Engineering & Technology(KUET) in Khulna, Bangladesh. The collected soils was hard and it was pulverized manually by hammer. Then the soils were screened through the sieve of 4.75 mm apearture before preparing the specimensfor testing. According to the AASHTO classifiation systems, the soil is classified as A-7-6 and acoording to the Unified soil classification sytems, soil is CL(Clay with low plasticity). The particle size distribution of the original soil is shown in the Figure 1.

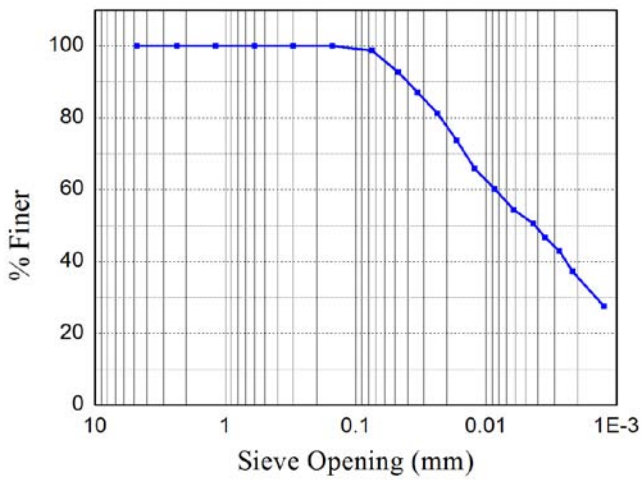

Fig 1 : Particle size distribution of original soil

b) Specification of RHA

RHA was prepared by simply burning rice husk, collected from the locally available mill. In this arrangement, rice husk were kept into a Steel box of 1.5m x 1.5m in dimensions. Five thermocouples with a connecting data logger were used for measuring the burning temperature. Briquettes were used as fuel to start and maintain fire. The produced RHA contains about 93% silica which is a key factor for improving the properties of soil.

c) Preparation of testing samples

The collected soils and ash contents were oven-dried at 105^{0}C overnight to remove moisture and repress microbial activity.Then the oven dried samples were mixed throughly by hand in a large tray in a dry state as per shown in Table 1.

Table 1 : Combination scheme of soil samples

Samples ID	Samples Description		
	Soil (gm)	RHA (gm)	% Ash content
Original soil	4000	--	0
R1	4000	200	5
R2	4000	300	7.5
R3	4000	400	10
R4	4000	500	12.5

d) Testing procedure

To determine the workability, compressibility, strength and compaction characteristics of treated and original soil samples several tests were performed in the laboratory.

Before conducting the compaction test, the non-treated and RHA treated soils (5, 7.5, 10% and 12.5% RHA content) were mixed with water for about ten minutes by hand. After that, the mixtures were put into polyethylene bags and mixing was continued by shaking, overturning and pressing the bag to squeeze out the air from the soil voids. In the similar way, different amount of water contents were added to the different soil samples and mixing were done as described before to obtain the optimum moisture content and maximum dry density. A series of standard proctor tests on non-treated and RHA treated soils were conducted according to ASTM D 698.

Specific gravity of original and ash treated soil samples were determined according to ASTM D854. Consistency of the original and treated soil samples were determined by Atterberg limit test (ASTM D-4318).The effect of shrinkage of fine grained soils are of considerable significance to cause serious damage to small building and highway pavements. Free swell index of soil samples were determined as per as IS: 2720(Part-40). Ten grams of soil samples were put into two 100ml glass cylinders and the remaining volumes of the cylinders were filled with distilled water and kerosene respectively. After keeping it overnight the volume of soil in each cylinder was measured and from this volume free swell index of soil was determined from the equation shown in below.

Free swell index (%) =

$$\frac{Volume\,of\;in\,distilled\;water - Volume\,of\;in\,distilled\;kerosene}{Volume\,of\;in\,distilled\;kerosene} x100$$

All the test specimens for strength and consolidation tests were prepared by compacting the soils mixed with RHA (0, 5, 7.5, 10% and 12.5%) in the standard compaction molds at the corresponding optimum moisture content which has been determined already. The specimens were demolded after completion of compaction and samples of different size were prepared as per requirement for performing the selected test in uncured condition.

The uncured unconfined compressive strength of the cylindrical specimens (36 mm diameter and 71 mm length) was determined according to ASTM D-2166. Drained shear strength parameters(c & φ) were determined by direct shear test (ASTM D 3080) of the compacted uncured soil specimens (60mm diameter and 25 mm height). Settlement characteristics of soils were determined by performing consolidation test (ASTM D-2435) on the samples of 63.5 mm diameter and 25 mm height.

III. Results and Discussions

a) Compaction characteristics

The variation of optimum moisture content and maximum dry density of RHA treated and untreated soil is shown in figure 2. This figure represents the maximum dry density of soil decreases gradually with an increase of RHA content. This is due to comparatively low specific gravity value (2.25) of RHA than that of replaced soil (2.65) and the initial simultaneous flocculation and agglomeration of clay particles caused by cation exchange may be the another cause. On the other hand, the optimum moisture content of soil increases with an increase RHA, because RHA are finer than the soil. The more fines the more surface area, so more water is required to provide well lubrication. The RHA content also decrease the quantity of free silt and clay fraction, forming coarser materials, which occupy larger spaces for retaining water. The increse of water content was also attributed by the pozzalanic reaction of RHA with the soil.

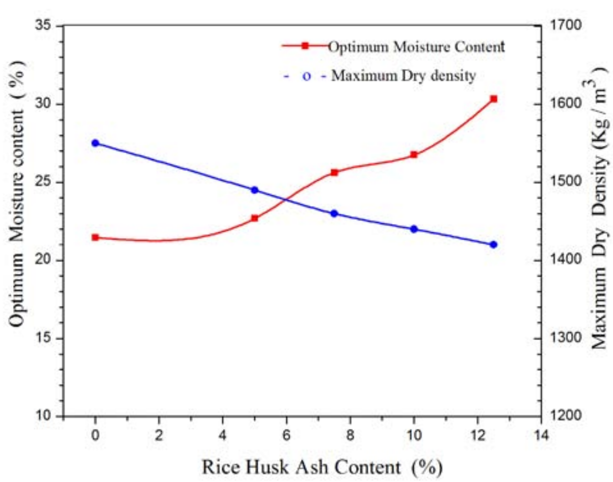

Fig 2 : Variation of maximum dry density and optimum moisture content with rice husk ash content.

The specific gravity of composite soil is decreasing due to the addition of RHA as shown in Figure 3 because of the low specific gravity of participating RHA as compared with soil.

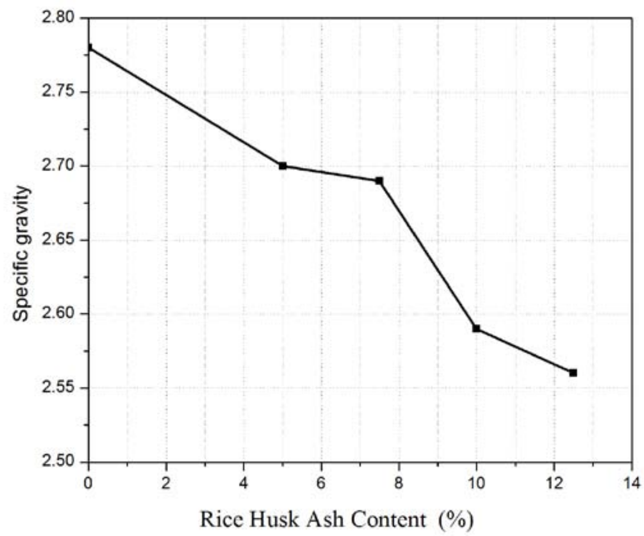

Fig 3 : Variation of specific gravityof soil with rice husk ash content.

b) Index Properties

Soil index properties are used extensively by engineers to discriminate between the different kinds of soil within a broad category.The index properties of soil is obtained from Atterberg limit test results and free sweel index test. The Atterberg limits are a basic measure of the nature of a fine-grained soil. The test result of atterberg limt is shown in Table 2.

Table 2 : Atterberg limit test result

RHA(%)	LL(%)	PL(%)	PI(%)	SL(%)	SR
0	46	22	24	22	1.62
5	50	27	23	27	1.55
7.5	52	31	21	28	1.49
10	55	34	21	31	1.51
12.5	56	36	20	34	1.37

Figure 4 shows that liquid limit of soil increses graduallywith the increses of RHA content. This improvement attributed that more water is required for the RHA treated soil to make it fluid because of the pozalonic characteristics of RHA. Similar trend was obtained for plastic limit that the value of plastic limit increases with the increases of RHA due to the pozalonic charactericts of RHA as shown in Figure 5. This increase of plastic limit implies that RHA treated soil required more water to change it plastic state to semisolid state. This may also improve the shear strength characteristics of soil.

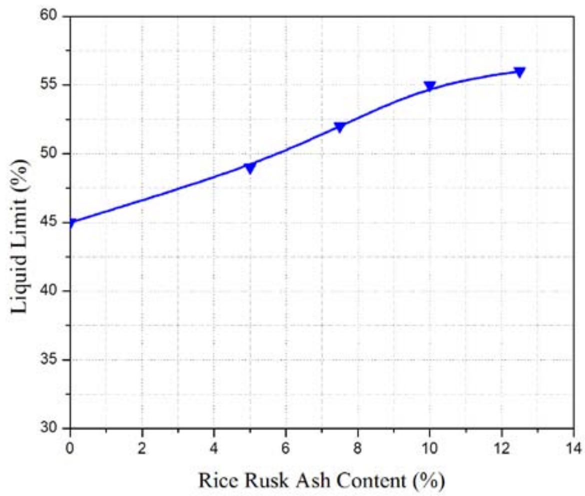

Fig 4 : Variation of LL with RHA

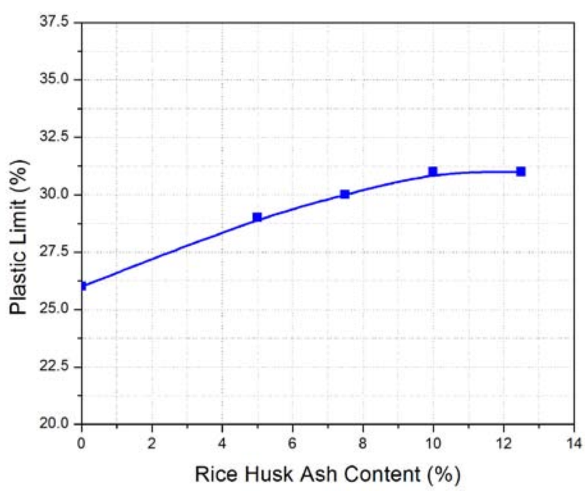

Fig 5 : Variation of PL with RHA

The shrinkage limit (SL) is the water content where further loss of moisture will not result in any more volume reduction. The variation of shrinkage limit and shrinkage ration is shown in Figure 6. Figure 6 illustrate that as the addition of RHA the value of shrinkage limit increases. It is clear from that result that the RHA treated soil absorb more water to change it semisolid state to solid state. This figure also illustrate the variation of shrinkage ratio with the RHA content. The value of shrinkage ratio decreases with the increases of RHA .

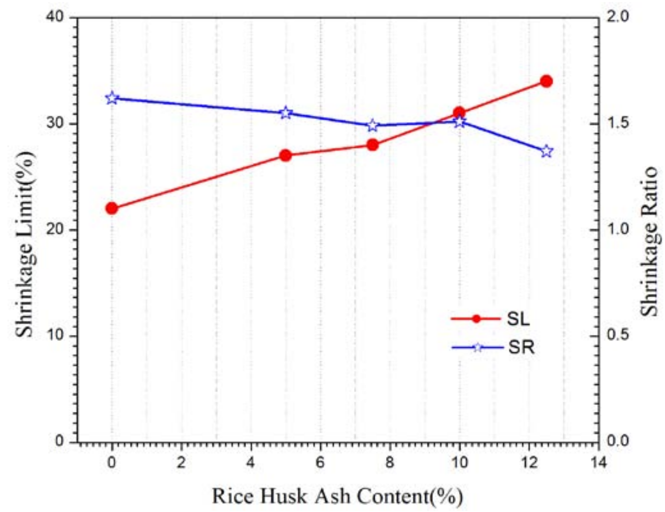

Fig 6 : Variation of Shrinkage Limit(SL) and Shrinkage Ratio(SR) with RHA

From the test result of Atterberg limit, changing of soil grain size due to the addition of RHA can be illustrated by plasticity chart. The effect of RHA on the particle size of soil is shown in Figure 7. This figure illustrate that initially the soil was clay with medium plasticity. Due to the addition of RHA, the soil class shifts to silt (due to the increase in particle sizes for the aaglomeration of caly particles with RHA) and high plasticity zone. For 12.5% of RHA, it changes to silt with high plasticity.

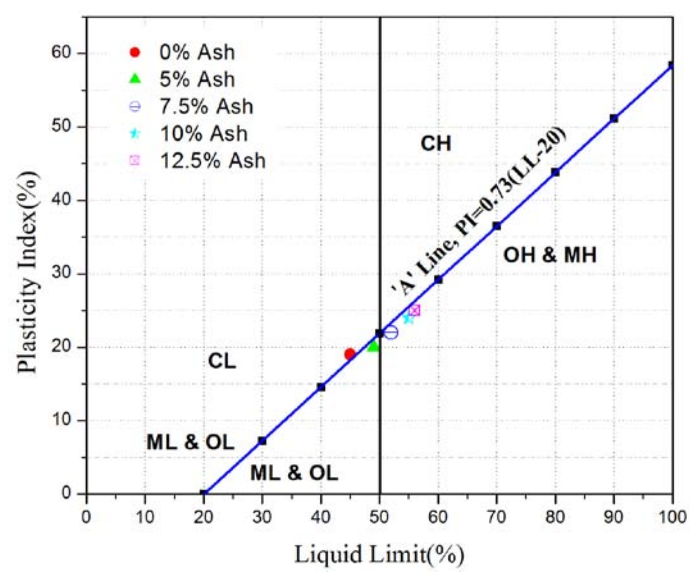

Fig 7 : Plasticity chart showing the original and RHA treated soil

The variation of free swell index with increasing RHA content is shown in Figure 8. The free swell index gradually decreased from 20% to 17.5% for up to 10% RHA content. After the addition of 2.5% more RHA content with the soil, it felt down pointedly from 17.5% to

10%. So it is clear from the above discussion that swelling of soil as well as the possibility of crack formation on foundation can be minimized with the addition of RHA.

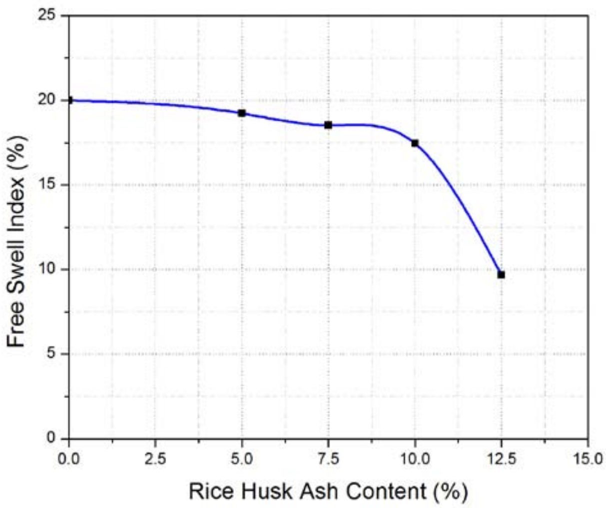

Fig 8 : Variation of Free swell index with RHA

c) Strength Characteristics

Unconfined compressive strength

The test result of unconfined compressive strength is shown in Figure 9. This figure illustrates the stress-strain behavior of original and RHA treated soil under vertical load. Initially the stress is gradually increases with the increase of strain. After attaining the peak stress, it decreases with the increase of strain for all the combination of RHA and soil. Approximately all the specimen shows shear failure after observing the failure plane of specimens. The variation of unconfined compressive strength for soil at different percentages of RHA is shown in Figure 10. There is a rapid increase of unconfined compressive strength from 0.06 MPa to 0.172 MPa with the addition of only 5% RHA. The optimum value of unconfined compressive strength 0.255 MPa were obtained for 10% of RHA content. After that, the value of unconfined compressive strength decreased from 0.255 MPa to 0.211 MPa for 12.5% of RHA content. So it can be accomplished that the maximum unconfined compressive strength were obtained at 10% of RHA and after that the value of unconfined compressive strength decreased with the addition of RHA. The following mechanism also explains that there is an positive impact of RHA on uncofined confined compressive strength.The reason for this improvement is due to the pozzolanic reactions of RHA with soil. This results in agglomeration in large size particles and causes the increase in compressive strength

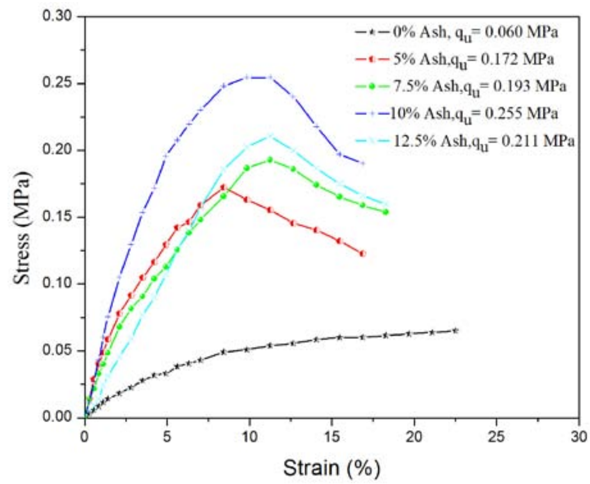

Fig 9 : UCS of original and RHA treated soil

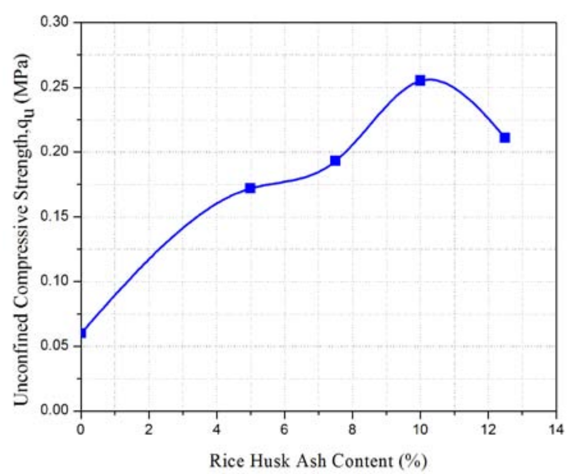

Fig 10 : Variation of UCS with RHA

Mohr-Coulomb's shear strength parameters

The Mohr-Coulomb shear strength envelops of the RHA based composite soils are shown in the Fig. 11. Fig. 12 shows the variation of the intercept or cohesion (c) and angle or frictional angle (φ) corresponding lines. This Figure illustrates that the slope of the of curve increases with the increases of RHA and there is a rapid increase in cohesionupto 5 % of RHA content ant it decreases for the further amount of RHA content. The improvement of angle of internal friction(φ) implies that the silica content in RHA act as a binder which agglomerate the particles into a larger one and the soil changes from clay to silt. However, the 10% RHA addition gives the outermost shear strength envelope.

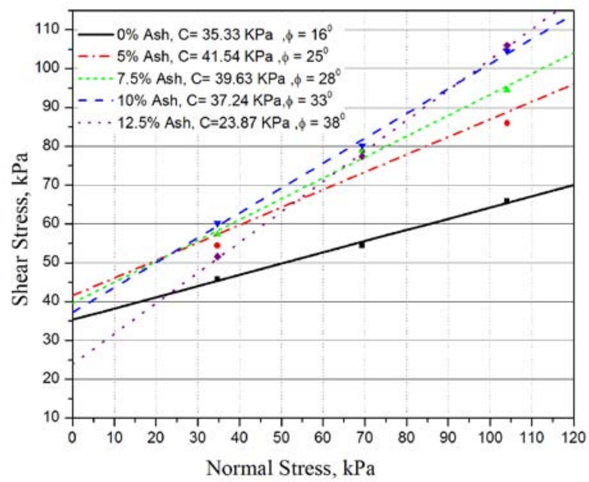

Fig 11 : Shear strength parameters(c &φ) of original and RHA treated soil

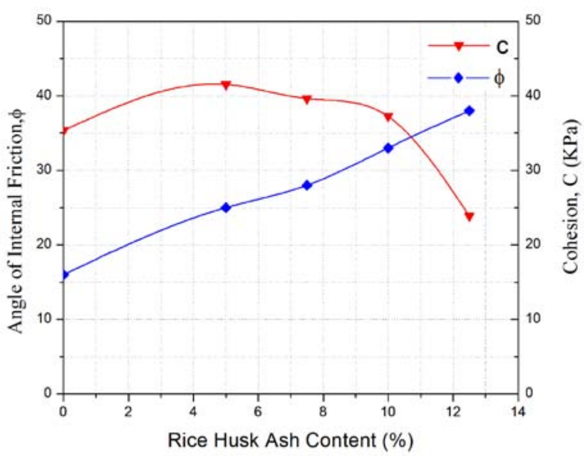

Fig 12 : Variation of shear strength parameters(c&φ) with RHA

d) Consolidation characteristics

In this study one dimensional consolidation test were performed to determine the consolidation characteristics of original and RHA treated soil and the corresponding consolidation curves are shown in Figure 13. The variation of compression index and initial void ratio with RHA content are shown in Figure 14. Firstly, this plot shows that the compression index (Cc) is decreasing gradually from 0.368 to 0.328 with increasing RHA for up to 7.5%. The value of Cc decreased well under from 0.328 to 0.248 for the addition of 10% RHA with the soil and after that it is slightly increased from 0.248 to 0.258 for 12.5% RHA content. This decrease in compression index implies that there could be a result of increased formation of pozzolanic products within the pore spaces of soil from physicochemical changes (Osinubi et al. 2006) which leads to a reduction in compression index. When the rice husk ash content exceeds the quantity required for the soil-ash reaction, they will be filled between the voids of the soil. A more compact state of the soil is probably attained. On the other hand the value of initial void ratio (e_o) increased gradually from 1.305 to 1.378 with increasing RHA for up to 7.5%. Then the value of e_o decreased well under from 1.378 to 1.315 for the addition of 10% RHA and after that, it decreased slightly from 1.315 to 1.314 for 12.5% RHA content.

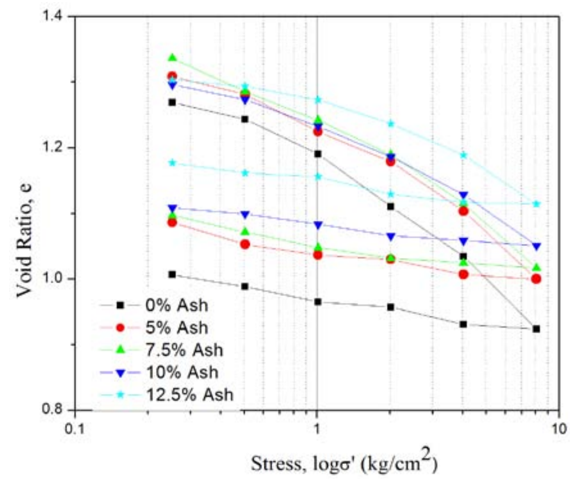

Fig 13 : Plot of void ratio,e versus effective stress, σ

The variation of compression index and initial void ratio with RHA content are shown in Figure 14.

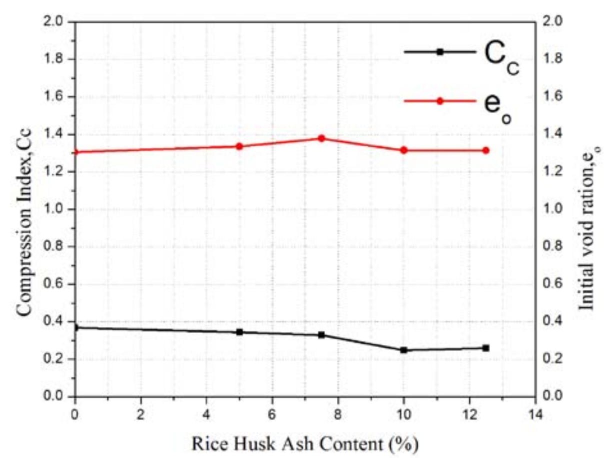

Figure 14 : Variation of Initial void ratio(e_o) and Compression index(c_c) with RHA

IV. Conclusions

In this study the effect of RHA on the geotechnical properties of cohesive soil are investigated and it can be concluded that there is an improvement of all the geotechnical properties of RHA treated soil. It was observed that the maximum dry density of soil decreased with the addition of RHA because of the lower specific gravity of RHA. The value of optimum moisture content of RHA treated soil increased because of the pozzalonic action of RHA and soil, which needs more water. Moreover, the value of liquid limit and plastic limit also increased with the increasing percentage of RHA whereas the value of plasticity index shows different characteristics. Increasing the amount of RHA cause a decrease in shrinkage limit as well increase in shrinkage ratio which improves the shear strength characteristics of soil. The pozzalonic behavior of RHA makes the RHA treated soil coarser than original soil samples due to the agglomerations of RHA and soil particles. This improvement changes the naming of soil from clay to silt. The free swell index test result shows a negative relationship with RHA as it decreased with the increase of RHA content which reduced the possibility of crack formation on the surface of foundation. The optimum unconfined compressive strength was obtained for 10% of RHA content. The best shear strength envelope of soil was obtained for 10% of RHA. The cohesion of soil shows an increasing order for first 5 % of RHA and after that this value decreases with the addition of RHA whereas the angle of internal friction shows a positive relationship with RHA content. From the consolidation test result, it can be concluded that the values of compression index decreased with the increases of RHA and the initial void ration shows positive relation with RHA.

References Références Referencias

1. Ahmed, S., Hossain, M. I. and Farooque, K. N. (1993). "Studies on rice husk ash cement." Bang. J. Sci. Ind. Res., 28(2):71
2. Agrawal, B. M. (1989). "Utilization of rice husk ash." Glass Ceram. Bull., **36:** 1-2.
3. Alhassan, M. (2008). "Permeability of lateritic soil treated with lime and rice husk ash." Assumption University Journal of Thailand, 12(2): 115–120
4. Gromko, J.G. (1974). "Expansive Soils", Journal of the Geotechnical Engineering Division. Vol.100, pp. 666-687.
5. Kumar, A. (1993). "Rice husk ash based cements, mineral admixture in cement and concrete, progress in cement and concrete." Ed. Ghosh, S. N. Sarker S. L. and Harsh, S. ABI Books Pvt. Ltd. CGCRI, Kolkata, India, 4:342- 367.
6. Kehew, E.A., (1995). "Geology for Engineers and Environmental Scientists." 2nd ed. Prentice Hall Englewood Cliffs, New Jersey, pp. 295-302.
7. Liu, C. and Evett, J. (2008). "Soils and Foundations." Pearson-Prentice Hall, Seventh Edition, Upper Saddle River, New Jersey
8. Mitchell, J.K. (1986). "Practical Problems from surprising soil Behavior." J. Geotech. Eng., , Vol. 112, No. 3, 255-289.
9. Mowafy, Y.M. (1985). "Treatment of Expansive Soils: A laboratory Study." Transportation Research Record 1032, pp. 34-39.
10. Mustafi, B. A. A. (2005). "Statistical Yearbook of Bangladesh Bureau of Statistics." (BBS).
11. Neville, A M (2000). "Properties of Concrete." 4th ed. Pearson Education Asia Ltd., Kuala Lumpur, Malaysia
12. Osinubi , K. J. and Eberemu, A. O. (2006) "Effect of Bagasse Ash on the Strength of Stabilized Lateritic Soil," Proceedings of 5th Nigerian Material Congress, Abuja, 15-18, pp. 214-220.

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Mitigation of Soil Erosion with Jute Geotextile Aided by Vegetation Cover: Optimization of an Integrated Tactic for Sustainable Soil Conservation System (SSCS)

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I. Introduction

Soil, one of the most fundamental and essential resources of our earth, providing the medium for plant growth and water retention; hence make certain conservation of life in the earth. Prime soil resources of the worlds are finite over the human time frame, and prone to degradation. Natural balances amid pivotal natural resources like soil, water, and plant deteriorated due to disproportionate and Unplanned use of these resources for centuries in Bangladesh. Consequently, a substantial amount of soil loss becomes a very common phenomena and one of the most vital tribulations as it has enormous effects on the soil feature, aquatic being, soil productivity in natural and managed ecosystems, and on the entire environment of the country.(Chowdhury. E. H et. al., 1988)

Scientists and professionals are sentient about apposite utilization of soil, and considered soil erosion as one of the most severe environmental problems in the earth and ecosystem (Govers, G. et. al 1990). Around one-third of the world's coastal regions are at soaring jeopardy of soil erosion (Caffyn et al., 2002) for the most part, from land-based sources of contamination and infrastructure development. Erosion is one of the most significant forms of land degradation (soil truncation, loss of fertility, slope instability), greatly influenced by land use and management (Rey, 2003; Bini et al., 2006). Soil erosion would remain an imperative global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life (Esrawan et al., 2001).

Detrimental impact of accelerated soil erosion on entire surrounding had been recognized since agricultural societies of ancient date back to Plato and Aristotle (Marsh, 1864; Lowdermilk, 1953; Dale, 1955). Formerly, a handful investigation of the changes and comprehensive inventories of components of natural resources took place to illustrate the cause, effect, and remedy; which leads to modern research. At present, the focal causes of land use alteration around the world is pervasive use of land for agricultural purposes plus substantial expansion of urban areas and changes in the land cover. This directly affects ecological landscape functions and processes with all-embracing consequences for biodiversity as well as natural resources (Hansen et al., 2004; State et al., 2001). The potential for surface runoff and soil erosion has consistently affected by land use, crop growing and vegetation cover reduction in an enormous quantity (Van Ropey et al., 2001).

Evaluation of soil loss along with runoff associated sediment yield is obligatory for the resolution of several applied environmental troubles. For instance,

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this is important to assess contaminant mobility (Johansen et al., 2003), efficacy of land management treatments (Hastings et al., 2003), post-fire hydrology (Johansen et al., 2003) indices of ecosystem health (Davenport et al., 1998) and archeological site stability (Sydoriak et al., 2000). In favor of the rationale that soil quality has influence over to whole ecosystem, this is essential to take urgent actions for appropriate conservation of this pivotal resource. Although extensive attempt has gone into studying and controlling soil erosion (Pimentel et al., 1987; Renard et al., 1997; Fullen and Booth, 2006) optimization of integrated strategy for sustainable system for watershed management is yet to commence.

Sustainable Soil Conservation System (SSCS) implies the prudent use land, water and vegetation to obtain optimum production along with enhancing the productivity of resources in ways that are ecologically protective, socially acceptable, efficiently productive, economically viable and institutionally sustainable with least disturbance to the environment (Hurni, 1997).To achieve sustainable development, sustainable technologies needed to be developed, transferred and adopted (Guerin, 2001).

The intention of the study was to amplify our understanding of the effect of different initial soil surface roughness and rainfall intensity on runoff and sediment yield in a variety of stages of runoff generation for the period of comparing the data found from field experiment and from the analysis, and optimize JGT as stabilizer for land as well technical feasibility study of JGT designed for soil erosion reduction, slope stabilization and bio-mass augment; hence providing a sustainable conservation method for land and watershed management in Bangladesh. Moreover, in this study, we investigated the rainfall intensity, runoff, soil moisture contents and rate of erosion on several model beds with the variation of slope.

The use of JGT for soil surface management has not received significant consideration despite their potential (Ogbobe et al., 1998). Jute produced in Bangladesh was once known as the 'Golden fiber' accounting for 80% of total world export. In course of time with the advent of synthetic material jute lost that primary position and had to go for diversification (such as JGT) ; nonetheless, strength properties of JGT are often superior to synthetic fibers (Mandal, 1987). Initially it gets the high strength and non-hazardous properties; likewise it is a renewable source of energy as natural bio-mass and it protects soil and can endow with instant rain splash and runoff control, creating a stable non-eroding environment (Mitchell et al., 2003). It also protects seeds in the preliminary stages of vegetative growth and helps vegetation establishment (Langford and Coleman, 1996).

Influence of vegetation cover on water infiltration, runoff and erosion has been reported by numerous investigators including Rauzi (1963), Orr (1970), Busby and Gifford (1981).Vegetation cover provides incredibly imperative function in reduction of erosion rate in quite a lot of mode such as interception, restraint, retardation, infiltration, transpiration etc (Gray and Leiser, 1982). Greenway (1987) notes that roots reinforce the soil, increase soil shear strength, reduce susceptibility to erosion and extract moisture from soil.

II. Study Area

The study area was Beel Dakatia, situated at the district of Khulna, southwestern part in Bangladesh and falls within the Ganges tidal deltaic plain. Lies between administrative boundaries of Dumuria and Phultala Upazilas of Khulna district (longitudes 89°20'E and 89°35'E and latitudes 22°45'N and 23°00'N). The climate of the area is characterized by sultry summers, moderate winters, tropical cyclones, tidal inundation, heavy rainfall and salinity. The average annual rainfall during is about 1,750 mm. (Rahman 1995; Chowdhury 2006)

III. Treatment of JGT

Generally jute fiber is swelled and degraded within six months in water and less durable in acidic, alkaline and other solutions. Therefore some chemical treatment is necessary to convert jute into design biodegradable (5-20 years) and hydrophobic in nature without changing its environmental friendly properties. Designed for the treatment purpose firstly, we collected JGT from local jute mill, after that we prepared a mixer of Copper Sulphate (0.01 kg/m^2), Sodium Carbonate (0.1 kg/m^2) and sprayed manually over JGT mat and then dried in sun light. As soon as treated JGT were fully dried, we laminated the JGT mat by an emulsion made from Bitumen (0.5 kg/m^2) and Kerosine (0.4 L/m^2). Finally, we added Sodium Silicate (0.005 kg/m^2) solution on the bitumen treated surface and a layer of Rice mill by product (0.075 kg/m^2) and kept it under sun light until fully dried. Treated JGT shows following properties:

Table 1 : Properties of Treated JGT

Weight (g/m^2)	800
Thickness (mm)	5
Spiral angle (degree)	9
Water holding capacity %	275
Tensile strength (kN/m) (MDXCD)	18 X 18
Porometry (micron)	200
Elongation on break %	6

IV. Research Methodology

We established study plots within the Beel Dakatia in such a way that reflects a variety in the slope and vegetation cover. The studies were conducted during the year of 2009 on eight 5.0 X 8.0 m runoff plots. Runoff plots numbered (P1-P8) consisted of a set of eight sheet metal sediment traps with aperture parallel to the slope contour.

We used a profile probe to measure moisture contents of soil and implemented a self reading rain gauge to measure the rainfall intensity; in addition at each site, we also evaluated bulk density and surface shear strength. Every plot was different from each other in such a manner that at least one of the three parameters (Geotextile, vegetation cover, and slope) is dissimilar as follows:

Study plot	Geotextiles	Vegetation Cover	Slope
P1	No	Bare	20%
P2	No	Bare	Flat
P3	No	Vegetated	20%
P4	No	Vegetated	Flat
P5	Yes	Bare	20%
P6	Yes	Bare	Flat
P7	Yes	Vegetated	20%
P8	Yes	Vegetated	Flat

Table 2 : Variation among Plots

We prepared bare plots by removing the grass turfs and rotavating the surface and did maintain in a bare condition by regular herbicide treatments. To maintain perfect slope we used level. After implementing JGT mat on four plots, a layer of soil of average thickness 100mm was laid over the mat, later the surface was finished uniformly.

We planted native grass in four plots and nourished them. We used traps and water stage recorder for measurement of soil sediment yield, soil splash height, and runoff volume. Total runoff during a rain was channeled through traps fabricated from a 2000 L reservoir and 3 mm mesh hardware cloth in each plot. Each trap consisted of a 30 cm diameter circular tube inserted into the soil, containing a similar-sized funnel on top of the reservoir; however, analogous splash traps have been used by Poesen and Torri (1988). After collecting the jar we dried the sedimentation by oven and weighted them.

Our study was distinctive in several respects, as we physically captured soil and sediment in collector traps, more to the point we were able to measure slope erosion directly, rather than relying on ocular estimates or indirect techniques such as erosion pins (Haigh 1977) or erosion bridges (Ranger and Frank 1978). Four technicians were employed during the study to monitor and evaluate overall criteria.

V. Results and Discussion

Variation in erosion rate, runoff and moisture content illustrate the competence of each plot to sustain against the susceptibility of soil degradation. Results showed that during the experimental period total runoff from plots aided with both JGT and vegetation cover was ~70% and ~35% less than those of bare plots and plots with either JGT or vegetation cover respectively (Table-3). Sediment yield from the plots with both JGT and vegetation cover were about 95% and 65% less than those of bare plots and singly treated plots respectively. Although, mere implementation of JGT or vegetation cover can shrink considerable amount of erosion, consequence of combined outcome was tremendous. Mean total soil loss equates to 18, 7.5, 5.5 and 1 t/ha from the bare plots, vegetated plots, JGT plots and combined JGT and Vegetated plots respectively (Table-3). However, amount of slope is a crucial factor for soil degradation, its affect can be alleviated by JGT and vegetation cover.

A broad observation confirms that the JGT plays the essential role of catalyst to burgeon native grasses. Whereas in the plots with JGT and grasses contain at least 40% more grasses than those of the plots without JGT implemented. JGT slows down and catches runoff so that sediment settles and moisture retains in the root zone and encourages vegetation growth by creating a congenial climate conductive to augmentation on the soil surface. Moreover, the density of the grass roots within the soil mass and the root tensile strength contribute to the ability of the soils to resist shear stress; hence increase the shear strength of soil.

When JGT turn out to be drenched they swell to the soil surface, enhancing the tendency to support surface micro-topography and hence runoff and erosion control. Results put forward JGT aided by vegetation cover are very functional in dipping soil erosion and runoff. This is for the reason that JGT serve as a defensive barrier that dissipates raindrop kinetic energy impact. Following severe rainfall (Graph-1), fine sediment was visible, trapped by the JGT resulting in decreased surface erosion. Besides offering defense, JGT might have improved soil organic matter that bind soil particles and aid the retention of topsoil structure and aggregate stability, thereby reducing surface erosion by encouraging infiltration. Both of the remedial processes increase the quantity of moisture content (Graph-2). This is due to the intermingle opening of JGT, which provides a porous soil condition and water passes into the underlying soil, in contrast grasses absorb moisture in the root zone. Outcome of the treatment in the plots corroborate the significance of

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retaining protective vegetative covers on sloping land. In view of the fact that vegetation cover serve as a shielding hurdle that squanders the impact of raindrop kinetic energy. Every part of these aspects may perhaps have contributed to the increased effectiveness of JGT in attenuation of soil erosion and total runoff.

VI. Conclusion

The results subsequent to one year of research signify the combined implementation of JGT aided by native vegetation cover drastically trimmed down soil erosion rate and runoff. Intended for sustainable soil conservation by means of eco friendly, low cost technology combined application of JGT and vegetation cover can be the factual competent as JGT has distinct advantages in respect of each variable determinant. JGT is excellent design biodegradable, anionic, price-competitive and environment friendly material; besides its flexibility and distinctive physical characteristics coupled with its high spin ability make it an ideal material for new technical applications. Even though we have been able to formulate several preliminary comparisons and note general trends, further adaptive relentless research with technology development and participatory dissemination addressed along with existing functioning relations between the government, multilateral development partners and the local people will be necessary prior to obtain optimum outcome.

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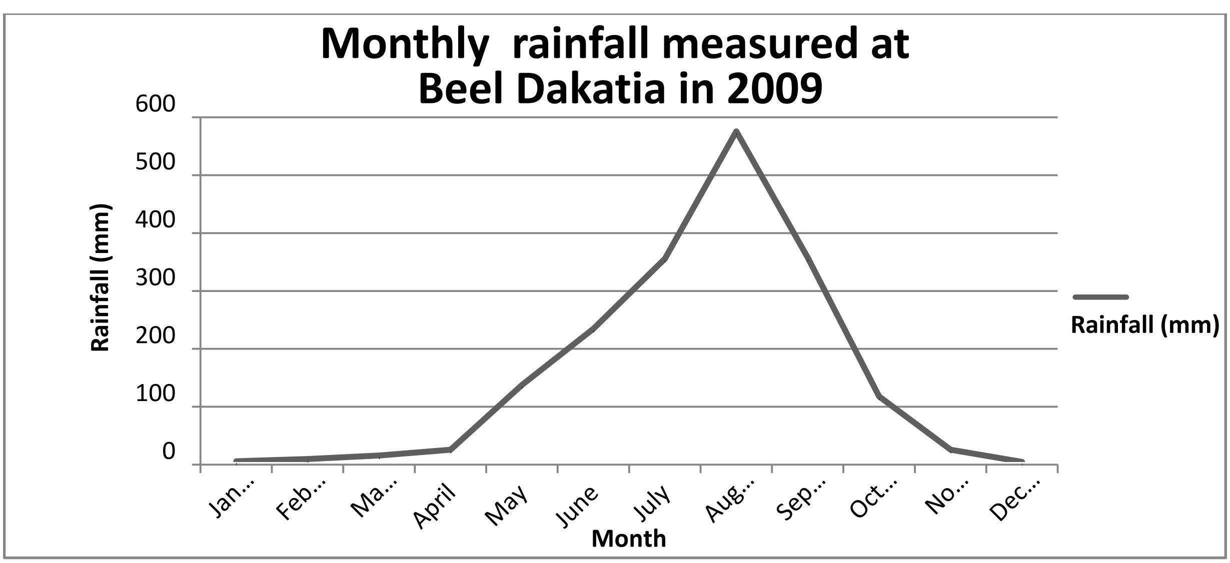
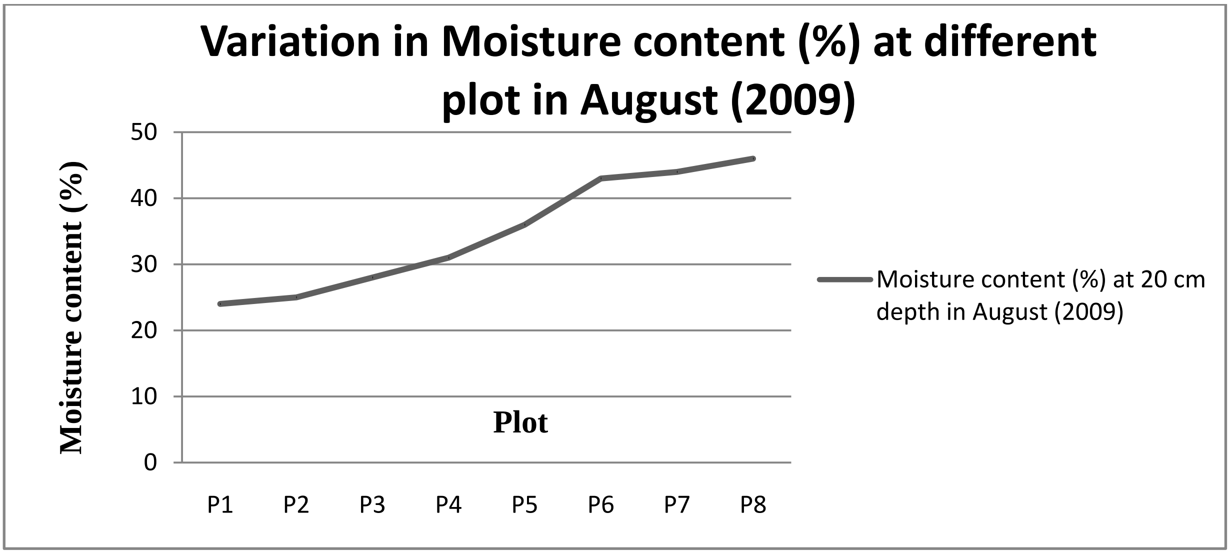
References Références Referencias

1. Bini, C., S. Gemignani and L. Zilocchi, 2006. Effect of different land use on soil erosion in the pre-alpine fringe (North-East Italy): *Ion budget and sediment yield. Sci. Total Environ.*, 369: 433-446. DOI: 10.1016/j.scitotenv.2006.06.001
2. Busby, R.E., and G.E. Gifford. 1981. Effects of livestock grazing on infiltration and erosion rates measured on chained and unchained Pinyon-Juniper sites in southern Utah. J. *Range Manage*. 34:400-405
3. Caffyn, A., B. Prosser, et al. (2002). "Socio-economic framework: A framework for analysis of socio-economic impacts on beach environments" *Istituto Agronomico per Oltremare*, 37(50), pp. 167 - 184.
4. Chowdhury E. Haque and MD Ziarat Hossain (1988) *Riverbank Erosion in Bangladesh. Geographical Review*
5. Chowdhury, S. Q. (2006) *Banglapedia*: National Encyclopedia of Banldesh
6. Dale T, Carter VG (1955) *Topsoil and Civilization* (Univ of Oklahoma Press,Norman, OK).
7. Davenport, D.W., D.D. Breshears, B.P.Wilcox, and C.D. Allen. 1998.Viewpoint: Sustainability of pin on juniper ecosystems—Aunifying perspective of soil erosion thresholds. J. *Range Manage*. 51:231–240.
8. Eswaran, H., R. Lal and P.F. Reich. 2001. Land degradation: an overview. In: Bridges, E.M., I.D. Hannam, L.R. Oldeman, F.W.T. Pening de Vries, S.J. Scherr, and S. Sompatpanit (eds.). Responses to Land Degradation. Proc. 2nd. *International Conference on Land Degradation and Desertification*, Khon Kaen, Thailand. Oxford Press, New Delhi, India.
9. Fullen, M.A., Booth, C.A., 2006. Long-term grass lay set aside on sandy soils: A case study. J. *Soil and Water Cons*., 61: 236-241.
10. Govers, G. 1990. Empirical relationships on the transporting capacity of overland flow, *International Association of Hydrological Sciences*, Publication 189, 45–63
11. Gray,D. H., and A. T. Leiser. 1982. *Biotechnical Slope Protection and Erosion Control*. Van Nostrand Reinhold Company. New York.
12. Greenway, D. R. 1987. *Vegetation and Slope Stability*. In Slope Stability, Eedited by M. F. Anderson and K. S. Rechareds. Willy and Sons New York
13. Guerin, T. F. (2001). Why sustainable innovations are not always adopted, *Resources, Conservation and Recycling*, Vol.34, 1-18.
14. Haigh, M.J. 1977. The use of erosion pins in the study of slope evolution. British Geomorphological Research Group, Technical Bulletin 18:.31-49.
15. Hansen, A.J., R. De Fries and W. Turner, 2004. *Land use Change and Biodiversity*: A Synthesis of Rates and Consequences during the Period of Satellite Imagery. In: Land Change Science: Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface, Guttmann, G. and C. Justice (Eds.). Springer-Vela, New York, ISBN: 10: 1402025610, pp: 277-299.
16. Hastings, B.K., F.M. Smith, and B.F. Jacobs. 2003. Slash treatment greatly reduces sediment yield froma rapidly eroding pin on-juniper woodland. J. *Environ. Qual*. 32:1290–1298.
17. Hurni, H. (1997). Concept of sustainable land management, *ITC Journal* 3/4, Enchede, The Netherlands, 210-215.
18. Johansen, M.P., T.E. Hakonson, F.W. Whicker, and D.D. Breshears.2003. Pulsed redistribution of a

contaminant following forest fire:Cesium-137 in runoff. J. *Environ. Qual*. 32:2150–2157
19. Langford, R.L., Coleman, M.J., 1996. Biodegradable erosion control blankets prove effective on Iowa wildlife refuge. In: *XXVII th Int. Erosion Control Assoc. Proceedings of Conf.*, Seattle, USA, pp. 13-20.
20. Lowdermilk WC (1953) *Conquest of the Land* Through 7,000 Years (US Department of Agriculture, Washington, DC).
21. Mandal, J. N. (1987). Geotextiles in India, *Geotextiles and Geomembranes*, Vol.6, 253-274.
22. Marsh GP (1864) *Man and Nature*; or, Physical Geography as Modified by Human Action (Scribner, New York).
23. Mitchell, D.J., Barton, A.P., Fullen, M.A., Hocking, T.J., Zhi, Wu Bo, Zheng, Yi, 2003. Field studies of the effects of jute geotextiles on runoff and erosion in Shropshire, UK. *Soil Use Manage*., 19: 182-184.
24. Ogbobe, O., Essien, K. S., Adebayo, A. (1998). A study of biodegradable geotextiles used for erosion control, technical note, *Geosynthetics International*, Vol.5, No.5, 545-553.
25. Orr, H.K. 1970. Runoff and erosion control by seeded and native vegetation on a forest burn: Black Hills, South Dakota. *USDA Forest Service Research Paper* RM-60. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
26. Pimentel, D., Allen, J., Beers, A., Guinaud, L., Linder, R., McLaughlin, P., 1987. World agriculture and soil erosion: Erosion threatens world food production. *Bio-Sci*., 37: 277-283.
27. Poesen, J. & D. Torri 1988. The effect of cup size on splash detachment and transport measurements Part 1: Field measurements. In Geographic process in Environments with Strong Seasonal Contrasts Volume-1 Hillslope Process, Imeson A, Sala M (eds) *Catena Supplements 12*: 113-126
28. Rahman, A. (1995) Beel Dakatia: *The Environmental Consequences of A Development Disaster*. (Michigan University Press)
29. Ranger, G.E.; Frank, F.F. 1978. The 3-F erosion bridge--a new tool for measuring soil erosion. *Dept. of Forestry Pub.*
30. Rauzi, F. 1963. Water intake and plant composition as affected by differential grazing on rangeland. J. *Soil Water Conserv. 18*:114-116.
31. Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C., 1997. *Predicting Soil Erosion by Water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE)*, Agriculture Handbook 703, USDA-ARS, South West Watershed Research Center, Tucson, AZ.
32. Rey, F., 2003. Influence of vegetation distribution on sediment yield in forested gullies. *Catena, 50*: 549-562. DOI: 10.1016/S0341-8162(02)00121-2
33. State, C., N.D. Boatman, R.J. Borolo, C.R. Carvel, G.R. De Snoop and P. Eden, 2001. Ecological impacts of arable intensification in Europe. J. *Environ. Manage*., 63: 337-365. DOI: 10.1006/jema.2001.0473
34. Sydoriak, C.A., C.D. Allen, and B.F. Jacobs. 2000. Would ecological landscape restoration make the Bandelier Wilderness more or less of a wilderness? In Proceedings: Wilderness Science in a Time of Change Conference: *Wilderness Ecosystems, Threats, and Man-agement, Missoula, MT. RMRS-P-15-VOL-5*. 23–27 May 1999.USDA Forest Service, Rocky Mountain Research Station, Og-den, UT
35. Van Ropey, A.J.J., G. Givers, E. Van Heckle and K. Jacobs, 2001. The impacts of land use policy on the soil erosion risk: A case study in central Belgium. *Agric. Ecosyst. Environ., 83*: 83-94. DOI: 10.1016/S0167-8809(00)00173-0



Graph-1 : Monthly Rainfall Measured at Site



Graph-2 : Moisture Content at Different Plots in 20 cm Depth

Plot	Erosion Value Measured in the site (g/m^2)	Erosion Rate Equivalent t/ha/yr	Runoff (L/m^2)
P_1	21050	21	79.5
P_2	17308	17.3	71.9
P_3	8255	8.2	49.5
P_4	7005	7.1	43.3
P_5	6140	6.1	43.6
P_6	4920	4.9	35.5
P_7	1150	1.1	20.8
P_8	809	0.8	17

Table-3 : Measured Variation in Erosion And Runoff

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Moment Capacity, Cracking Behaviour And Ductile Properties Of Reinforced Concrete Beams Using Steel Slag As A Coarse Aggregate

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Abstract - This research paper outlines the method of preparation, testing procedure and salient results on the eco-friendly concrete that is manufactured using the waste products of steel industries. Results of eight flexural behaviour of Steel slag concrete beams and thier comparison with normal weight concrete (NWC) with reinforcement and without reinforcements are presented and discussed .The concrete is of grade 20 and the reinforced concrete beams of size 150 mm x 150 mm x 900 mm were prepared to study the structural behaviour. Similar grade concrete using NWC were also prepared and reinforced. It has been observed from the experimental investigation of the beams, that the moment capacity of SSRC beams was higher than NWC beams . In addition, the mode of failure observed in SSRC was ductile compared to the brittle failure of NWC beams. Thus, the SSRC beams showed a ductile failure, giving amble warning before failure happened. SSRC beams also exhibited a lot of cracking thus the crack width and crack spacing was small. The other advantage for SSRC beams was deflection. The SSRC beams exhibited higher deflection under constant load until failure, compared to NWC beams that failed in brittle manner without warning.

Keywords : Steel slag reinforced concrete (SSRC), Structural Behaviour, Failure Mode,Ductile Behaviour, crack study.

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Strictly as per the compliance and regulations of:

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I. Introduction

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization. In the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. Use of more and more environment-friendly materials and industrial wastes in any industry in general and construction industry in particular, is of paramount importance. A number of studies have been conducted concerning the protection of natural resources, prevention of environmental pollution and contribution to the economy by using the waste material like fly ash and steel slag. This would pose problem for their safe disposal and Sometimes degrades the environment. The structural grade Steel slag concrete produced using Slag is a byproduct of metal smelting in the process of refining metals and making alloys referred to hereafter as SSRC. Slag appears in concrete, aggregate road materials, as ballast, and is sometimes used as a component of phosphate fertilizer. Like other industrial by products, slag actually has many uses, and rarely goes as waste. Ashour (2000) concluded from his investigation the members with a displacement ductility in the range of 3 to 5 has adequate ductility and can be considered for structural member subjected large displacements, such as sudden force caused by earth quake. Delsye et al.(2006) conducted an experiment on light weight concrete beams made with oil palm shell. From their research it was concluded that all the LSC beams are satisfied all the serviceability requirements as per ACI 318 and BIS 8110 codes. Ganesan et al(2007) conducted an experimental programme has been carried out to compare the behaviour of high performance concrete (HPC) and steel fibre reinforced high performance concrete (SFRHPC) flexural members under two point loading. Results indicate that introduction of steel fibres significantly improves the cracking behaviour in terms of significant increase in first crack load and the formation of large number of finer cracks. However, only marginal improvement was observed in the case of ultimate load. Addition of steel fibres to HPC imparted high ductility to structural members which is essential for seismic force resisting structures. Hisham Qasraui et al. (2009) studied the effect of waste material of steel plant in concrete. In their investigation local unprocessed steel slag was used in concrete as fine aggregate replacing the sand partly or totally. The compressive strength of concrete was reported to be improved when steel slag is used for low sand replacement ratio (up to 30%). Johnson Alengaram et al, (2008) conducted experiments on palm kernel shell concrete and its comparison with normal weight concrete (NWC). From their work they conclude that the PKSC beams showed a ductile failure, giving ample warning before failure. PKSC beams also exhibited a lot of cracking thus the crack width and crack spacing were small. The other advantage for PKSC beams was deflection. The PKSC beams exhibited higher deflection under constant load until failure, compared to NWC beams that failed in brittle manner without warning. Khidhair et al. (2009) has used

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the steel slag as replacement of aggregate in the concrete. The results showed that the density of concrete, compressive strength, flexural strength after 7 days and 28 days were increased by increasing slag content while water absorption was decreased by increasing slag content. Matsunaga et al. (2003) have prepared SSC with small amount of an alkali activator (calcium hydroxide or lime dust). The compressive strength of these SSC products was reported to exceed 18 N/mm^2, which is the general design strength of breakwater blocks. It was also reported that the 91 days compressive strength is approximately 1.3 times greater than 28 days strength. Ramakrishnan et al. (1987) studied the flexural fatigue performance of concrete reinforced with collated hooked-end steel fibres of size 50 mm× 0.50 mm and 60 mm×0.80 mm. Two different fibre volume fractions of 0.50% and 0.75% were tested. After addition of these fibres to the concrete, the ductility and post-crack energy absorption capacity were greatly increased.

II. Research Significance

The present investigation was planned to study the performance of SSRC beams containing slags as a coarse aggregate subjected to flexural bending loading. Concrete containing five volume fractions of steel slags of 10%, 20%, 30%, 40% and 50% with steel slag is tested. The flexural bending tests of SSRC were determined for different volume fractions of steel slags and compared with that of plain and reinforced concrete beams.

III. Material Properties

a) Steel Slag-Physical and Chemical Properties

Steel slag aggregates are highly angular in shape and have rough surface texture. They have high bulk specific gravity and moderate water absorption (less than 3 percent) The physical properties of steel slag are shown in Table 1.

Figure 1 : Steel slag used for concrete mix

Property	Value
Specific Gravity	3.2 - 3.6
Unit Weight, kg/m^3	1600-1820
Absorption	up to 3%
Maximum size of aggregate, mm	16.00
Aggregate impact value (%)	8.00
Aggregate crushing value (%)	9.00

Table 1 : Typical physical properties of steel slag

Constituent	Composition (%)
CaO	40 - 52
SiO_2	10 - 19
FeO	10 - 40 (70 - 80% FeO, 20 - 30% Fe_2O_3)
MnO	5 - 8
MgO	5 - 10
Al_2O_3	1 - 3
P_2O_5	0.5 - 1
S	< 0.1
Metallic Fe	0.5 - 10

Table 2 : Typical steel slag chemical composition

The chemical composition of slag is usually expressed in terms of simple oxides calculated from elemental analysis determined by X-ray fluorescence. Table 2 lists the range of compounds present in steel slag from a typical base oxygen furnace. Virtually all steel slags fall within these chemical ranges but not all steel slags are suitable as aggregates of more importance is the mineralogical form of the slag, which is highly dependent on the rate of slag cooling in the steel-making process. The cooling rate of steel slag is sufficiently low so that crystalline compounds are generally formed. Free calcium and magnesium oxides are not completely consumed in the steel slag, and there is general agreement that the hydration of unslaked lime and magnesia in contact with moisture is largely responsible for the expansive nature of most steel slags. Steel slag is mildly alkaline, with a solution pH generally in the range of 8 to 10. However, the pH of leachate from steel slag can exceed 11, a level that can be corrosive to aluminum or galvanized steel pipes placed in direct contact with the slag.

b) Concrete Properties

The concrete mix was made with ordinary Portland cement, river sand and coarse aggregate of maximum size 20mm. Cement, sand and coarse aggregates was 1:1.5:3 in proportion by weight. Steel slag of 0.5 mm diameter and 30 mm length was used for the entire concrete mix. Steel slags are obtained from north Chennai steel plant. First dry mix was prepared from ordinary Portland cement, river sand and coarse aggregates maximum 20mm, and steel fibers were added to the dry mix of the materials. Water was then added to the mix to prepare the concrete. The W/C ratio for the mix was 0.50. After through mixing, beam specimens were cast along with companion cube moulds to measure the compressive strength of concrete. All the beams and companion cubes were compacted properly. The beam specimens were stripped from their moulds after 24 hours and submerged in water tank for 28 days for curing after casting. Before testing, the beams were coated with whitewash to facilitate the observation of cracking pattern.

IV. Experimental Program

In the present investigation, tests (Figure:2) were conducted on ten beam specimens of 150 mmX150 mm X 900 mm cast in moulds. Specimens labels are shown min Table 3 according to the volume of steel slag added in to the concrete. The steel slags are added in to 10%-50%. The beams referred as 10% of steel slag as SSRC1 respectively. The reinforcement used are 2 Nos. of 12mm diameter bar for all the beams. All the nine beams were tested in a Universal Testing Machine (U.T.M) of capacity 40 tonnes available in the structural Engineering Laboratory of Dr.M.G.R University. During testing, the beams were preloaded with a minimal force of 0.5 kN to allow initiation of the diagauges. The developments of cracks were observed and crack width was measured at the level of tensile reinforcement using a hand-held microscope with sensitivity of 0.02 mm. All strain, crack width and deflection measurements were measured at every load increment. The first crack load was noted immediately after its formation and all the cracks were marked as and when they propagated in the beam.

Figure 2 : Experimental set up

V. Test Result and Discussion

a) Ultimate moments and Cracking Behaviour

A comparison between the experimental ultimate moments (M_{ult}) and the theoretical design moments are shown in Table 3. The theoretical design moments (M_{des}) of the beams was predicted using the parabolic rectangular stress block analysis are recommended by IS 456-2000. For slag beams, the ultimate moment obtained from the experiments was approximately 2% to 32% higher compared to predicted values. From the performed tests, it was observed that for steel slag concrete beams, IS 456 can be used to obtain a conservative estimate of the ultimate moment capacity and also adequate load factor against failure.

Table 3 : Comparison between experimental and theoretical ultimate moments

Beam No.	Experimental Ultimate moment(kN m)	Theoretical design moment (kN m)	Capacity ratio of Steel slag concrete beams
NWC	6.94	5.24	1.32
SSRC1	6.81	5.24	1.30
SSRC2	6.68	5.24	1.27
SSRC3	6.41	5.24	1.22
SSRC4	5.87	5.24	1.12
SSRC5	5.61	5.24	1.07
PSCB1	5.34	5.24	1.02
PSCB2	4.67	5.24	0.90
PSCB3	2.54	5.24	0.50
PCCB	5.34	5.24	1.02

Crack widths were measured at every load interval at the tension steel level and the crack formations were marked on the beam. The initial cracks were occurred at about 15% to 30% of the ultimate load. It was noticed that first crack always appeared close to the midspan of the beam. The cracks formed on the surface of the beams were mostly vertical, suggesting failure in flexure.

Flexure failure pattern of S.S.R.C beam

Shear failure of Plain S.S.C beam

Figure 5 : Failure pattern of concrete beams

b) Deflection behaviour

Figures 4 show the typical experimental load-deflection curves for steel slag concrete beams. In all beams, before cracking occurred, the slope of the load-deflection curved was steep and closely linear. Once flexural cracks formed, a change of slope of the load-deflection curve was observed and this slope remained fairly linear until yielding of the steel reinforcement took place.

Table 4 compares the predicted midspan deflection under service moments with the experimental values. The predicted deflection is calculated from load values according to the strength of materials equation, using the formula

$$\Delta = \frac{5Wl^3}{163EI} \qquad (1)$$

Where,
Δ = Midspan deflection in mm,
W = Load acting on the beam in kN,
l = Effective span of the beam in mm and
EI = Flexural rigidity in N/mm^2.

It was observed that the deflection obtained from the experiment at the service moments compares reasonably well to the predicted deflection. The modulus of elasticity of concrete very much governed by the stiffness of the coarse aggregate. From the properties in Table 1, it can be seen that steel slag is porous in nature also equal density compacted to granite, which directly influence the stiffness of the aggregate. Due to the equal modulus of elasticity of the steel slag beam when compared to R.C.C beam, the deflection under the service loads is acceptable as the span–deflection ratios ranged between 167 to 291 and are within the allowable limit provided by IS 456. IS 456 recommends an upper limit of span/250 for the deflection in order to satisfy the appearance and safety criteria of a structure.

From the load deflection graph it is observed that the beams beam behave similar to conventional R.C.C beams and 10% to 50% steel slag to concrete shows behaviour at the yield point and have further yielded with loads. Particularly the beam specimens with normal concrete have no ductile failure the failing in compression remaining all specimens are failure in shear failure. Hence it is also observed that the grade of concrete and reinforcement ratio and spacing of stirrups have certain effects on the flexural behaviour of reinforced concrete beam.

Table 4 : Deflection of concrete beams at service load moments

Beam No.	Deflection form experiment Δexp (mm)	Theoretical deflection Δthe (mm)	Δexp / Δthe	Span/Δexp	Displacement Ductility ratio μ = Δu/Δy	Mode of failure
NWC	4.50	1.51	2.98	174	3.46	Flexure
SSRC1	5.50	1.63	3.37	167	3.67	Flexure
SSRC2	4.53	1.41	3.21	173	3.11	Flexure
SSRC3	5.72	1.76	3.23	151	3.00	Flexure
SSRC4	4.00	1.35	2.96	291	3.00	Flexure
SSRC5	4.20	1.30	3.23	229	2.80	Flexure
PSCB1	5.50	1.50	3.67	276	2.11	Shear
PSCB2	5.30	1.40	3.78	320	2.00	Shear
PSCB3	4.95	1.25	3.96	267	1.76	Shear
PCCB	4.50	1.20	3.75	162	1.88	Shear

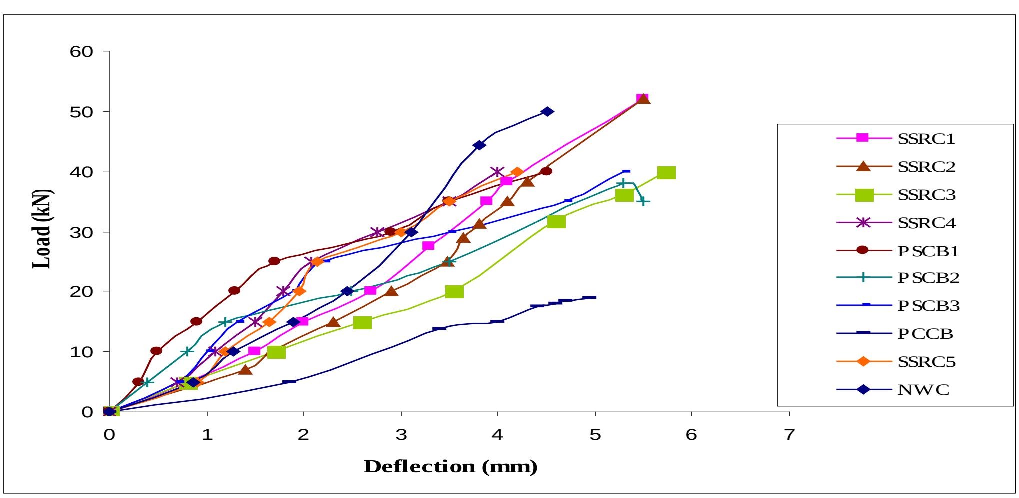

Figure 4 : Load Vs Deflection of tested beams

c) *Ductility Behaviour*

The ductility of reinforced concrete structures is also of paramount importance because any member should be capable of undergoing large deflection at near maximum load carrying capacity, providing ample warning to the imminence of failure. In this study, the displacement ductility was investigated. Table 4 shows the ductility of the tested steel slag concrete beams. The displacement ductility ratio is taken in terms of $\mu = \Delta u/\Delta y$, which is the ratio of ultimate to firest yield deflection, where Δu is the deflection at ultimate moment and Δy is the deflection when steel yields. In general, a high ductility ratio indicates that a structural member is capable of undergoing large deflections prior to failure. In this investigation it was observed that the steel slag beams have ductility ratio of more than 3 which means relatively good ductility. One of the important factors contributing to the good ductility behaviour of the steel slag beam was toughness and good shock absorbance nature of steel slag aggregate as indicated by the aggregate crushing value and aggregate impact value from Table 1. Ashour (2000) mentioned that the members with a displacement ductility in the range of 3 to 5 has adequate ductility and can be considered for structural member subjected to large displacements, due to sudden force caused by earthquake.

VI. Conclusion

From the experiments conducted, it was generally observed that the investigation of flexural behaviour of steel slag concrete beam gives encouraging results in favor steel slag to be used as coarse aggregate.

1. All steel slag concrete beams showed typical structural behaviour in flexure. The overall flexural behavior of SSRC beams used in this study closely resembles that of equivalent beam made with NWC.
2. The experimental ultimate moment gives a conservative estimate for steel slag concrete beams for 7% to 32% of a theoretical ultimate moment.
3. Deflection of steel slag concrete beams calculated using Equation (1) under service loads can be used to give reasonable predictions. The deflection under the service loads for beams were within the allowable limit provided by IS 456(2000).
4. Steel slag beams showed good ductility behaivour. All the beams exhibited considerable amount of deflection, which gives enough warning before failure.
5. The crack widths at service loads varies from 0.20 mm to 0.45 mm and this was within the maximum allowable limits.

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Abbreviations

NWC : Normal weight cement concrete beam
SSRC : Steel slag Reinforced cement concrete beam
PCCB : Plain cement concrete beam
PSCB : Plain steel slag concrete beam

References Références Referencias

1. Ashoor S.A (2000), "Effect of compressive strength and tensile reinforcement of flexural behviour of high-strength concrete beams", Engineering Structures, 22(5),pp.413-423.
2. Delsye C L , Md.Abdul Mannan and Kurian V.John, 2006, "Flexural Behaviour of Reinforecd Lightweight Concrete Beams Made with Oil Palm Shell(OPS), Vol.4,No.3,pp.459-468.
3. Ganesan N, Indira P V, Abraham R, 2007,"Behaviour of Steel Fibre ReinforcedHigh Performance Concrete Members under Flexure", IE(I) Journal, Vol 88, pp-20-23.
4. Hisham .Q, Faissal .S and Ibrahim .A, 2009, Use of low CaO unprocessed steel slag in concrete as fine aggregate, Construction and Building Materials., 23,1118-1125.
5. Johnson Alengaram U, Mohd Zamin Jumaat, Hilmi Mahmud, 2008, "Ductility Behaviour of Reinforced Palm Kernel Shell Concrete Beams", European Journal of Scientific Research, Vol.23, No.3,pp.406-420.
6. Khidhair .J, Falak .O and Mohammed .O, 2009,Using of Steel Slag in Modification of Concrete properties, Engineering & Technology Journal., 27(9), 1711-1721.
7. Matsunga ,2003, Development environmental friendly block made from steel slag, Concrete Journal., 41(4), pp.47-54
8. Ramakrishnan, V., Oberling, G., Tatnall, P., 1987, " Flexural Fatigue Strength of Steel Fiber Reinforced Concrete.Fibre Reinforced Concrete—Properties and Applications",SP-105-13, ACI Special Publication, American Concrete Institute, Detroit, p.225-245.

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Stabilisation of Black Cotton Soils Using Fly Ash, Hubballi-Dharwad Municipal Corporation Area, Karnataka, India

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Abstract - Urbanisation and growth in the economy of tier-2 cities of India have led to the steep increase in the building construction activities and has necessitated the implementation of infrastructure projects such as highways, railways, air strips, water tanks, reclamation etc. These projects invariably require quality earth in massive quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. The twin city of Hubballi-Dharwad is a fastest growing tier-2 city of Karnataka state and is the second largest city of the state just next to Bangalore. The wide spread of the black cotton soil in the twin city of Hubballi-Dharwad has posed challenges and problems to the construction activities. A task was therefore undertaken to investigate and improve the engineering properties of the black cotton soils of Hubballi-Dharwad Municipal Corporation area so that, a better understanding is facilitated for the civil engineering practitioners, while dealing with these soils.

Keywords : Stabilisation of black cotton soils, Fly ash, Hubballi-Dharwad Municipal Corporation, Karnataka, India.

GJRE-E Classification : FOR Code: 090501

STABILISATION OF BLACK COTTON SOILS USING FLY ASH,HUBBALLI-DHARWAD MUNICIPAL CORPORATION AREA, KARNATAKA, INDIA

Strictly as per the compliance and regulations of:

Stabilisation of Black Cotton Soils Using Fly Ash, Hubballi-Dharwad Municipal Corporation Area, Karnataka, India

Udayashankar D.Hakari [α] , S.C.Puranik [σ]

Abstract - Urbanisation and growth in the economy of tier-2 cities of India have led to the steep increase in the building construction activities and has necessitated the implementation of infrastructure projects such as highways, railways, air strips, water tanks, reclamation etc. These projects invariably require quality earth in massive quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. The twin city of Hubballi-Dharwad is a fastest growing tier-2 city of Karnataka state and is the second largest city of the state just next to Bangalore. The wide spread of the black cotton soil in the twin city of Hubballi-Dharwad has posed challenges and problems to the construction activities. A task was therefore undertaken to investigate and improve the engineering properties of the black cotton soils of Hubballi-Dharwad Municipal Corporation area so that, a better understanding is facilitated for the civil engineering practitioners, while dealing with these soils. The West Coast Paper Mills, Dandeli (Karwar Dist, Karnataka), located at about 60 km. from Hubballi-Dharwad generates huge quantity of fly ash and the fly ash management is posing serious problem. Considering the proximity and availability aspects, the Dandeli fly ash was chosen to be used for the task, as a stabilizer of black cotton soil. The paper investigates the effect of Dandeli fly ash treatment to the black cotton soils of Hubballi-Dharwad on their index, compaction and strength properties in an effort to improve their geotechnical characteristics. It is observed that the geotechnical properties of the Hubballi-Dharwad black cotton soils improve considerably by using Dandeli fly ash as stabilizer. The plasticity parameters such as liquid limit, plastic limit and shrinkage limit exhibit favorable changes in their values i.e. the liquid and plastic limits decrease while the shrinkage limit increases with the addition of fly ash. The compaction characteristics viz. the maximum dry density increases with the corresponding decrease in the optimum moisture content. The California bearing ratio as well as the unconfined compressive strength of these soils show an increase in their values upon the addition of fly ash. The study reveals that the most favourable results can be obtained by using the fly ash at 20% to 40% which may be termed as optimum percentage of fly ash that can be mixed with the soils under study.

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Keywords : Stabilisation of black cotton soils, Fly ash, Hubballi-Dharwad Municipal Corporation, Karnataka, India.

I. Introduction

The black cotton soils possess low strength and undergo excessive volume changes, making their use in the constructions very difficult. The properties of the black cotton soils may be altered in many ways viz. mechanical, thermal, chemical and other means. Modification of black cotton soils by chemical admixtures is a common stabilisation method for such soils (Bell, 1993). Among various admixtures available lime, fly ash and cement are most widely and commonly used for the stabilisation of the black cotton soils. Fly ash contains siliceous and aluminous materials (pozzolans) and also certain amount of lime. When mixed with black cotton soils, it reacts chemically and forms cementitious compounds. The presence of free lime and inert particles in fly ash suggests that it can be used for stabilisation of expansive soils (Indraratna et.al., 1991).

The Hubballi-Dharwad Municipal Corporation (HDMC) area lies between 15 ° 18' 25" - 15° 30' 47" North latitudes and 74° 57' 37" - 75° 11' 0" East longitudes. Hubballi-Dharwad is a twin city in the state of Karnataka and is considered as second biggest city in the state and is the largest city corporation in the state next only to Bangalore. It is recognized as the commercial hub of the North Karnataka region with tremendous increase in the commercial and industrial activities taking place in the twin city at present. In order to provide a matching infrastructure for sustaining the growing economy, there has been a rapid change in the land use in the twin city. Most of these areas comprise of agricultural fields with the black cotton soil coverage. As a matter of fact, the construction of the buildings, roads and other structures on these expansive soils has become inevitable. The wide spread of the black cotton soil in the twin city of Hubballi-Dharwad has posed challenges and problems to the construction activities. However no work has so far been carried out with regards to the stabilisation of Hubballi-Dharwad black cotton soils and to study the effect of fly ash on these soils in improving their geotechnical properties. The possible use of fly ash for stabilizing these soils has been explored in this study.

The West Coast Paper Mills, Dandeli (Karwar dist, Karnataka), located at about 60 km. from Hubballi-Dharwad, generates huge quantity of fly ash and its disposal and management is posing serious problem. Considering the proximity of the source and availability aspects as well, the Dandeli fly ash (DFA) has been preferred and used for the stabilisation of the black cotton soils under study. Fig. 1 shows the location details of Dandeli and Hubballi-Dharwad.

Fig. 1 : Karnataka state map showing the location of Hubballi-Dharwad and Dandeli

II. Review of Earlier Work

A number of researchers have worked in developing different methods of soil stabilization, which are practical and economical. Amarjit Singh (1967) reported the use of fly ash and lime for stabilizing soils in road construction. Amos and Wright (1972) have studied the effect of mixing fly ash with black cotton soils. In the recent past, many researchers have carried out experimental and field studies for the stabilization of expansive soils using fly ash. Yudhbir and Honjo (1991) stated that the pozzolanic fly ashes can be advantageously made use of to improve the geotechnical properties of black cotton soils. Modification of black cotton soils by chemical admixtures is commonly adopted method for stabilizing the swell-shrink tendency of expansive soils (Bell, 1993). Sivapullaiah et.al.(1996) reported that the addition of fly ash decreased the liquid limit of black cotton soils and studied the effect of fly ash on the index properties of these soils from Karnataka, India. Bhoominadhan and Hari (1999) proposed the use of fly ash in construction works like brick making and soil stabilization. Cokca (2001) studied the effect of fly ash on expansive soils and he concluded that fly ash can be recommended as an effective stabilizing agent for the improvement of expansive soils. Pandian et.al.(2002) studied the effect of Raichur fly ash and Neyveli fly ash on the CBR characteristics of black cotton soils from Karnataka, India and reported the beneficial aspects of the fly ash-soil mixes in road construction. Phanikumar and Sharma (2004) presented the effect of fly ash on free swell index, swell potential, plasticity, compaction, strength characteristics of expansive soils and concluded that the fly ash improves the plasticity, compaction and strength characteristics of black cotton soils obtained from Andhra Pradesh, India.

The stabilization of black cotton soils with fly ash is thus well recorded and recognized in the literature; particularly in the past two decades.

III. Materials and Methods

The properties of the materials used and the details of the methods of testing are as follows.

a) Materials used

i *Black cotton soil*

Twenty natural black cotton soil samples were collected from different locations of Hubballi-Dharwad Municipal Corporation (HDMC) area were studied for their expansive characters. These samples have been identified for their swell potential and have been broadly grouped into three categories based on their degree of expansiveness and problematic nature as (i) Highly expansive and problematic group, (ii) Moderately expansive and problematic group and (iii) Least expansive and problematic group (Hakari and Puranik, 2010). In the present work, one sample from each of the above category has been considered for the stabilisation study. The location and the category of these samples are indicated below:

Sl.no.	Soil sample no.	Location	Category of soil
1	BC 8	Charanthimath Gardens, Dharwad.	Highly expansive and problematic soil
2	BC 10	Shalini Lay out, Gadag Road, Hubballi.	Moderately expansive and problematic soil
3	BC 11	Adjacent High Court, Dharwad.	Least expansive and problematic soil

About 200 kg. of the above black cotton soil samples were collected by open excavation from a depth of 1 meter from the natural ground level. The soil samples were air dried and pulverized to pass through IS 425 micron sieve before testing. The geotechnical properties of the above soils are given below at Table-1.

ii. *Fly ash*

The fly ash used in this work is procured from "The West Coast Paper Mills, Dandeli, Karwar District, Karnataka. It is located reasonably near at about 60 kms. from Hubballi-Dharwad twin city. The fly ash sample is designated as DFA (Dandeli Fly Ash). The DFA belongs to class-F category and its chemical composition and physical properties are given below in the Table-2 (a) and (b) respectively.

iii. *Black cotton soil and DFA mixes*

The black cotton soil samples were mixed with DFA on dry weight basis in varying percentages of 10%, 20%, 30%, 40%, 50% and 60%. The corresponding mixes have been designated as M-10, M-20, M-30, M-40, M-50 and M-60 respectively. M-0 indicates virgin soil sample. The finely blended mixes were then kept for oven drying for 24 hours and tests were conducted immediately after wet mixing with water in required quantity depending on the test. For the strength test, curing periods of 7, 14 and 28 days were considered.

Constituents	Percentage (%)
Silica (Si O_2)	57.00
Alumina ($Al_2 O_3$)	23.00
Ferric oxide ($Fe_2 O_3$)	8.32
Calcium oxide (CaO)	2.70
Magnesium oxide(MgO)	0.83
Titanium Oxide (Ti O_2)	0.23
Loss on ignition	7.92

Table 2 (a): Chemical composition of Dandeli Fly ash (DFA)

Sl.no.	Property	Value
1.	Specific gravity	2.07
2.	Grain size distribution:	
	Clay size	4.0 %
	Silt size	85.0 %
	Fine sand size	11.0 %
3.	Atterberg limits:	
	Liquid limit	59.0 %
	Plastic limit	Non-plastic
	Plasticity index	--
	Shrinkage limit	Varies with initial water content

Table 2 (b): Physical properties of Dandeli Fly ash (DFA)

b) *Tests conducted*

The tests for the determination of specific gravity, Atterberg limits, compaction parameters, unconfined compressive strength and California bearing ratio were conducted as per relevant I.S. codes.

IV. Materials and Methods

a) *Liquid limit*

The results indicating the effect of varying percentages of DFA on the liquid limits of selected black cotton soil samples are presented in Fig.2.

The liquid limit decreases with the addition of fly ash. The results show a considerable decrease in the liquid limit upto 30% increase in the fly ash percentage (i.e. M 30 mixes) and then after the decrease is observed to be marginal for further increase of fly ash percentage. The liquid limit of the black cotton soils is essentially controlled by the thickness of the diffused double layer and the shearing resistance at particle level. The addition of fly ash results in the decrease of liquid limit due to the effect of reduction in the diffused double layer thickness as well as due to the effect of dilution of clay content of the mix. The decrease of liquid limit becomes very marginal or nil beyond 50 – 60 % of fly ash. This is due to the increased dilution effect i.e. due to the increased percentage of coarser size particles in the mix because of the increased percentage of fly ash.

Category under which the soil is identified	Least expansive and problematic soils	Moderately expansive and problematic soils	Highly expansive and problematic soils
Soil sample no. →	BC 8	BC 10	BC 11
Properties ↓			
Plasticity characteristics :			
Liquid limit (%)	54.6	50.7	68.4
Plastic limit (%)	13.6	18.5	23.2
Plasticity index (%)	41.0	32.2	45.2
Shrinkage limit (%)	9.5	12.2	10.62
Compaction characteristics :			
Optimum moisture content (OMC) (%)	23.5	32.0	31.0
Maximum Dry Density (MDD) (gm/cm^3)	1.86	1.60	1.65
California Bearing Ratio (CBR) (%)	4.05	2.50	0.96
Strength characteristics :			
Unconfined compressive strength(UCS)(kN/m^2)	116.3	72.5	74.5

Table 1 : Geotechnical properties of the selected black cotton soil samples

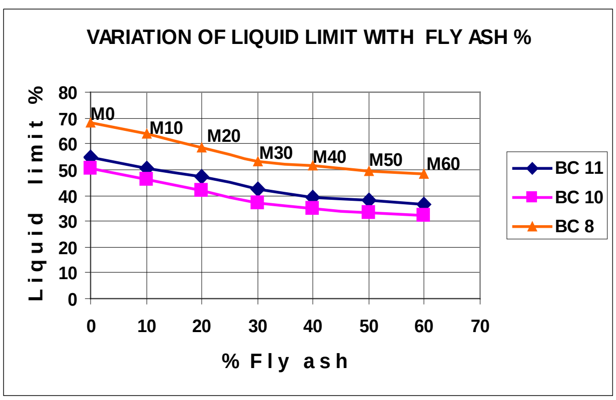

Fig. 2 : Variation of liquid limit with DFA percentages

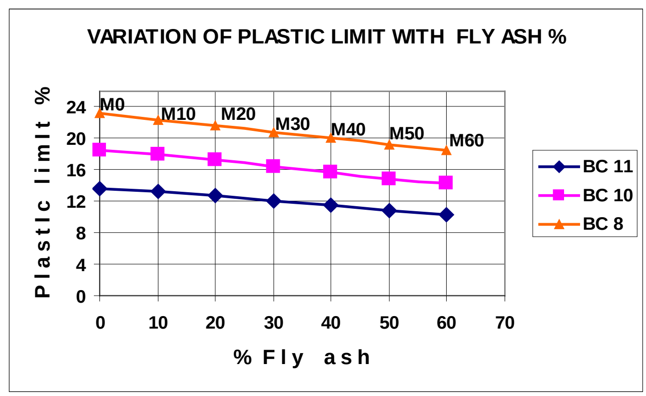

Fig. 3 : Variation of plastic limit with DFA percentages

b) Plastic limit

Fig.3 shows the variation of the plastic limit of the samples with DFA percentages. As can be seen from the graph, the addition of fly ash results in a steady decline in the plastic limit of the soils. The decrease of the plastic limit is observed to be more significant for the sample BC 8 as compared to the samples BC 10 and BC 11.

On addition of fly ash, the plastic limit of the soil may increase due to flocculation owing to the presence of free lime in the fly ash. But in the case of DFA, the free lime content is not sufficient enough as to increase the plastic limit and hence no such change is observed. Further increase in the addition of fly ash results in the decrease of plastic limit. This is because of the fact that as the quantity of fly ash in the mix increases, the amount of soil to be flocculated decreases and also the finer particles of fly ash may be incorporated in the voids of flocculated soil. This leads to the decrease in the water held in the pores leading to the decrease of the plastic limit.

c) Plasticity Index

The variation of plasticity index of the samples with the addition of different percentages of DFA is shown in the Fig.4. As seen from the graph, the addition of DFA decreases the plasticity index of the soil samples. The decrease is observed to be more with the increase in the quantities of fly ash up to 30% and then the trend of decrease is nominal with further increase in the percentages of fly ash.The effect on the liquid limit and plastic limit by the addition of fly ash is observed to reflect the trend of variation of plasticity index upon the addition of fly ash in increasing percentages.

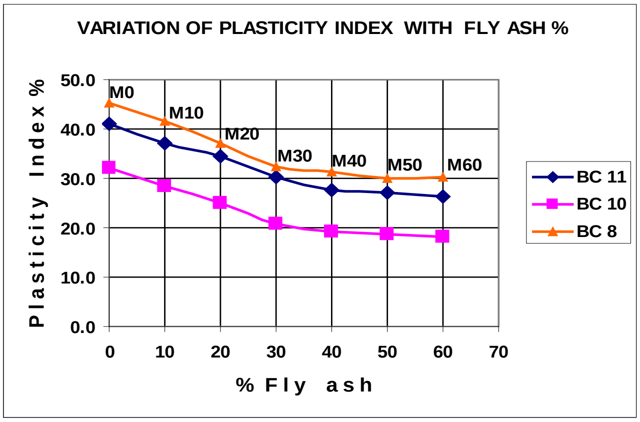

Fig.4 : Variation of plasticity index with DFA Percentages

d) Shrinkage limit

Fig.5 shows the variation of shrinkage limit in respect of the study samples BC 11, BC 10 and BC 8 upon the addition of DFA in increasing percentages It is seen that the shrinkage limits of the samples follow a steady increase with the addition of DFA in increasing percentages. The increase in the shrinkage limit with the addition of DFA is mainly due to the flocculation of clay particles caused by the free lime present in the DFA resulting in the reduction of friction between the particles; and also due to the substitution of finer particles of black cotton soil by relatively coarser fly ash particles.

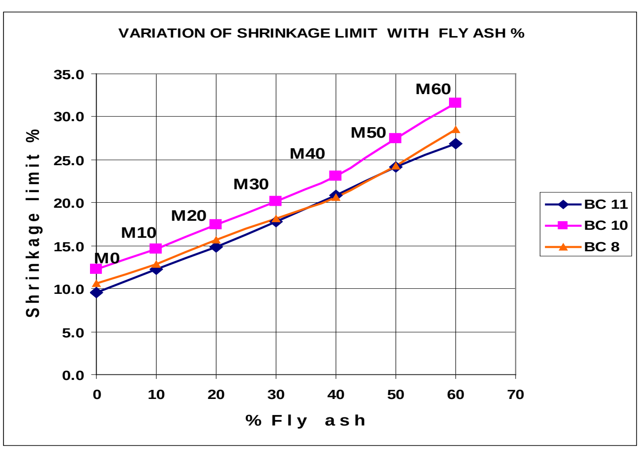

Fig.5 : Variation of shrinkage limit with DFA percentages

e) Compaction parameters – Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)

Fig.s 6(a), (b) and (c) below show the variation of dry density-moisture content relationship for the varying percentages of DFA for the study samples BC 11, BC 10 and BC 8 respectively.

It is seen that density-moisture content relation is affected and varies upon the addition of DFA in increasing percentages; for all the three black cotton soil samples considered for the stabilisation study. It is observed from the Fig.6 that, the trend of increase in MDD and decrease in OMC with increasing percentages of DFA is observed up to 30 - 40% and the MDD is observed to decrease with further increase in the DFA percentages.

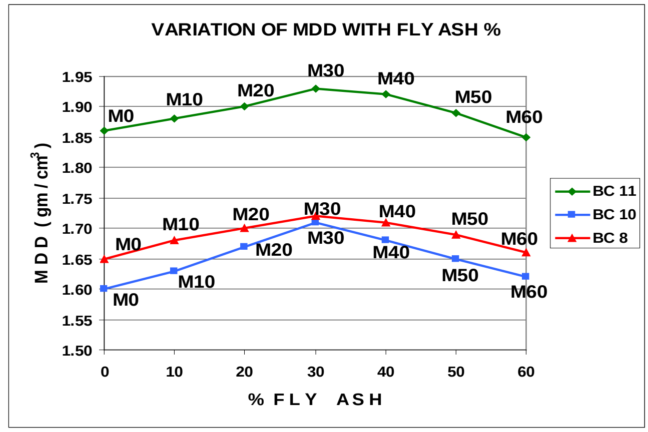

Fig.7(a): Variation of MDD with varying DFA Percentages

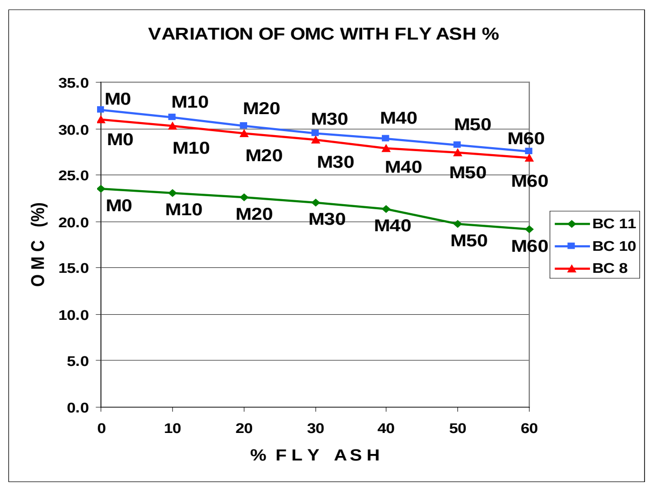

Fig.7(b): Variation of OMC with varying DFA Percentages

Fig.s 7(a) and (b) present the variation of MDD and corresponding OMC respectively for the soil samples BC 11, BC 10 and BC 8 with the varying percentage of DFA from 10% to 60%. Fig.s 7(a) and (b) indicate that, on addition of fly ash to the black cotton

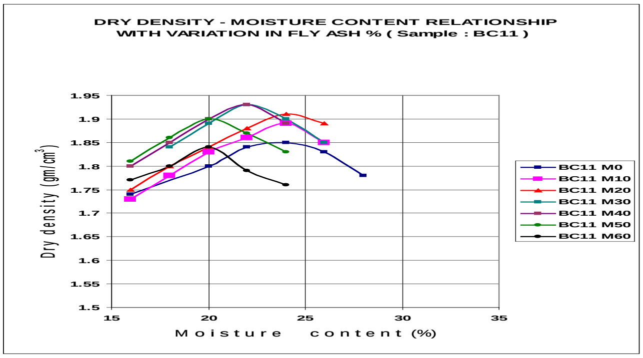

Fig.6(a): Variation of Moisture content – Dry density relationship of soil sample BC 11 with DFA percentages

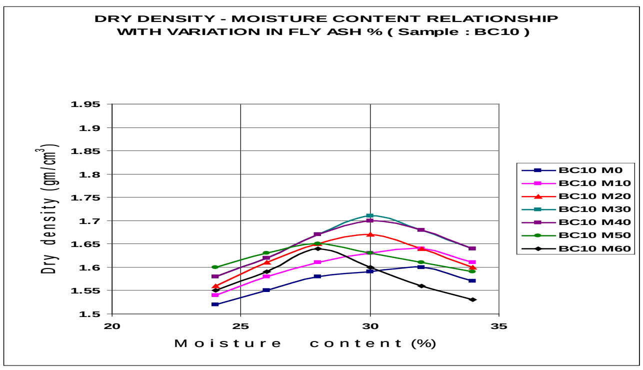

Fig.6(b): Variation of Moisture content – Dry density relationship of soil sample BC 10 with DFA percentages

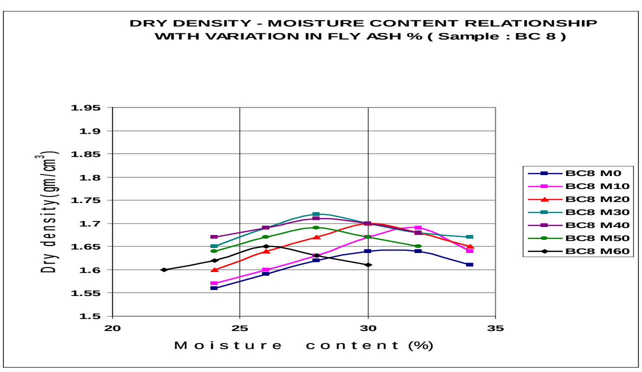

Fig.6(c): Variation of Moisture content – Dry density relationship of soil sample BC 8 with DFA percentages

Soil, the MDD increases and the OMC decreases. The MDD shows a gradual increase with the increase in the fly ash percentages up to 30-40% of fly ash. There after it exhibits a decreasing trend with further increase in the fly ash percentages. The OMC values corresponding to their respective MDD values show a steady decrease with the increasing fly ash percentages. The decreasing trend of OMC continues up to a certain fly ash percentage; here in the present study it is between 40 – 50%, and then after it appears to be stable with very marginal variation in its value.

The above observations in the variation of MDD and OMC values with the varying percentages of DFA suggest an optimum percentage of fly ash between 30 – 40% as suitable for addition to the study black cotton soil samples so as to obtain the best possible favourable changes in the compaction parameters for these soils i.e. to obtain a higher value of MDD and a lower value of OMC for any particular soil sample.

The behaviour of black cotton soil is controlled by diffused double layer. The addition of fly ash in small percentage results in the decrease of repulsive pressure of soil particles. This in turn reduces the resistance to compactive effort and the mix gets compacted to relatively higher densities. Though there will be flocculation due to free lime in the fly ash, this effect is dominated when the fly ash percentage is low. Hence a marginal increase in dry density is observed. Further addition of fly ash beyond 30-40% results in increased flocculation due to increased availability of free lime content of fly ash. This would increase the repulsive forces of soil particles, thereby increasing the resistance to compactive effort and hence the density of mix starts decreasing.

f) Strength characteristics – Unconfined Compressive Strength (U C S)

The effect of addition of fly ash to the black cotton soil samples BC 11, BC 10 and BC 8 on their UCS values along with the variation of UCS with increase in the curing period is presented respectively at Fig.8(a), (b) and (c) below.

The Fig.8(a), 8(b) and 8(c) exhibit that the UCS of the black cotton soil samples increases with the addition of DFA; suggesting an improvement taken in the strength characteristics of the black cotton soil + fly ash mixes. It is observed that, an increase in the values of UCS is gradual and relatively small for smaller curing periods of 7 days and 14 days. The improvement in the UCS is comparatively better for a longer curing period of 28 days; as can be seen from the graph pertaining to 28 days curing. For the same mix of any of the sample, at the relative increase in the UCS is thus observed maximum when a curing of 28 days is allowed.

It is seen that the strength increases on addition of small percentage of 10% or 20% of fly ash. Further increase in fly ash percentage shows no considerable increase in the strength. This is due to the probable disturbance of soil skeleton and consequent reduction in cohesion. The strength of soil is observed to improve considerably with curing time which is due to the pozzolanic reactivity of the free lime content of the fly ash.

g) California Bearing Ratio (C B R)

The variation of CBR (soaked condition) of the three black cotton soil samples with the addition of DFA in increasing percentages is shown in Fig.9. The CBR value of the soil increases with the addition of DFA up to a certain percentage of fly ash (30-40% here) and there after it starts decreasing for further addition of DFA.

The low CBR of the black cotton soil (as compared to the black cotton soil-fly ash mixes) is attributed to its inherent low strength which is due to the dominance of the clay fraction. Addition of fly ash to the black cotton soil increases gradually the CBR of the mix up to a peak value of addition of 30-40% of fly ash. This is due to the frictional resistance contributed from the DFA in addition to the cohesion from the black cotton soil. Further increase in the fly ash percentage causes a reduction in the CBR due to the reduction in the cohesion because of the decreasing b lack cotton soil content in spite of increase in strength due to increase in fly ash content. It is hence observed that, a suitable mix proportion (M30 for BC 11 and BC 8, M40 for BC 10 in the present study) optimizes the frictional contribution of fly ash and the cohesive contribution from black cotton soils; leading to the maximization (peak value) of the CBR.

V. Conclusions

Based on the results of the investigation, following conclusions are drawn.

i) Dandeli fly ash is used as a stabiliser for improving the geotechnical characteristics of Hubballi-Dharwad black cotton soils. Addition of Dandeli fly ash significantly improves the index properties, compaction and strength characteristics of black cotton soils understudy and the effects of fly ash treatment vary depending upon the quantity of fly ash , that is mixed with the study black cotton soil samples.

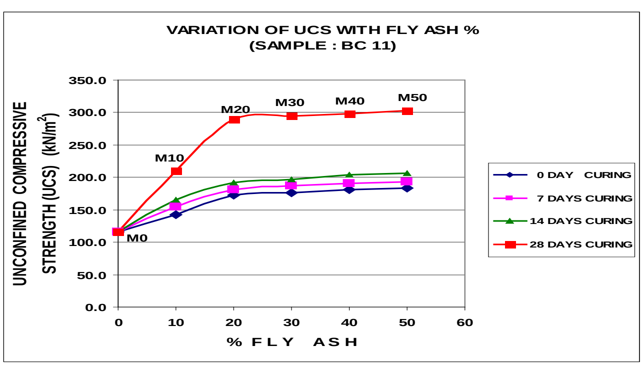

Fig.8(a): Variation of UCS with DFA percentages for different curing periods in respect of sample BC 11

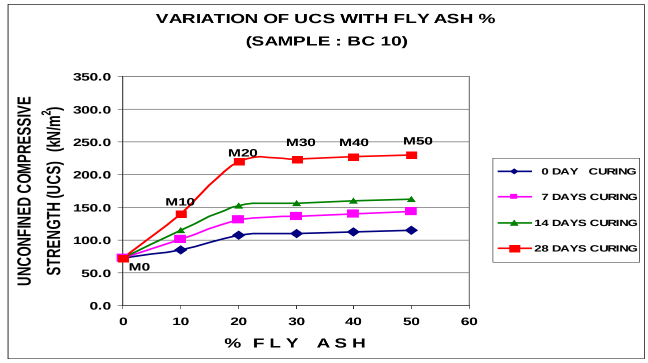

Fig.8(b): Variation of UCS with DFA percentages for different curing periods in respect of sample BC 10

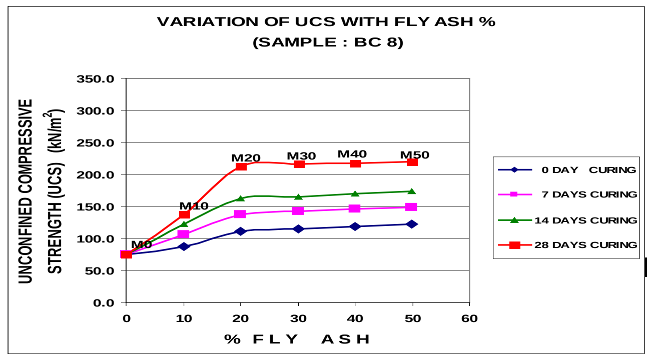

Fig. 8(c): Variation of UCS with DFA percentages for different curing periods in respect of sample BC 8

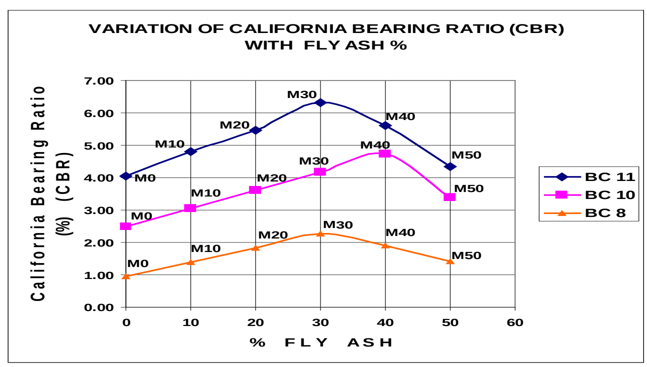

Fig.9: Variation of CBR with DFA percentage

ii) The liquid limit and plastic limit of the soils decrease with the addition of Dandeli fly ash which indicates a desirable change as the soil + fly ash mix can gain shear strength at an early stage than the virgin soil with the change in the water content. The relative decrease in the plasticity index of the soils is another favourable change since it increases the workability of these soils. The shrinkage limit of the soils increases with the addition of Dandeli fly ash, which facilitates in checking the volume change behaviour of the soils over a large variation in the moisture content as the season changes.

iii) Addition of Dandeli fly ash brings in an improvement in the compaction parameters of the study soils, by increasing the maximum dry density of soils with decrease in the corresponding values of optimum moisture content.

iv) The unconfined compressive strength of these soils increases upon the addition of Dandeli fly ash. The trend of improvement in the unconfined compressive strength is observed to be more pronounced with the curing of the soil + fly ash mix. A curing period of 28 days is observed to yield the maximum enhancement in the unconfined compressive strength.

v) The California bearing ratio of the study soils increase gradually with the addition of Dandeli fly ash up to a certain percentage of Dandeli fly ash, beyond which, further increase in Dandeli fly ash percentage is observed to cause a decreasing trend in the California bearing ratio values. The improvement in the California bearing ratio value of the black cotton soil upon the addition of Dandeli fly ash suggests that, it can be effectively used in bulk as sub-base material in combination with the study soils, for the road construction works.

vi) The study of variations of different parameters viz. liquid limit, plastic limit, plasticity index, shrinkage limit, maximum dry density, optimum moisture content, unconfined compressive strength and California bearing ratio with the addition of Dandeli fly ash suggest that, for each parameter of the study soil samples, there exists an optimum Dandeli fly ash percentage for mixing with the soil under consideration; at which the respective parameter attains its most desirable value from geotechnical point of view.

Table-3 lists such optimum Dandeli fly ash percentage recommended for different parameters of the study soils. Remarks made thereon in the table indicate the effect of addition of Dandeli fly ash beyond the optimum percentage on these parameters. The geotechnical properties of Hubballi-Dharwad black cotton soils can be favourably changed using the Dandeli fly ash and an optimum quantity between 30-40% can yield the best possible results.

Table 3 : Recommended DFA percentage for the stabilisation of the study soils

Soil parameters considered for assessment of stabilisation results	Optimum DFA %	Value of the parameter at optimum DFA %			Remarks
		BC 11	BC 10	BC 8	
Liquid limit (%)	30	42.3	37.3	53.1	The decrease in liquid limit is marginal with further increase of DFA beyond 30%.
Plastic limit (%)	20 – 30	12.7	17.2	21.6	Beyond 30% DFA the rate of decrease of plastic limit is relatively less as compared to the rate of decrease up to 30% DFA.
Plasticity index (%)	30	30.2	20.9	32.0	No considerable reduction in plasticity index value beyond 30% DFA.
Shrinkage limit (%)	30 – 40	17.8	20.2	18.1	Increase in shrinkage limit, though continuous with increase in DFA%; further increase in the shrinkage limit is not as effective and considerable beyond 40% DFA.
Maximum dry density (gm/cm^3) and Optimum moisture content (%)	30	1.93 and 22.0	1.71 and 29.5	1.72 and 28.8	The soil samples yield peak values of maximum dry density and corresponding values of optimum moisture content for addition of DFA at 30%.
Unconfined compressive strength (kN/m^3)	20 – 30	176.2 (0 day curing)	110.5 (0 day curing)	115.1 (0 day curing)	Unconfined compressive strength attains peak value at DFA % between 20 and 30, beyond which the increase in the strength is marginal. The trend is same for increased curing periods.
California bearing ratio (%)	30 – 40	6.32	4.17	2.28	California bearing ratio reaches peak value when the DFA% is between 30 and 40, beyond which it starts decreasing with further addition of DFA.

References Références Referencias

1. Amarjit Singh (1967). Use of lime-fly ash in soil stabilisation for roads, Jl. Of Indian Roads Congress, vol-XXX-1,143.
2. Amos,D.F. and Wright,J.D.,1972, The effect of soil fly Ash on soil physical characteristics, Proc. of Third Mineral Waste Utilisation Symposium, Chicago, pp. 95-104.
3. Bell, F.G., 1993, Engineering treatment of soils, E & FN Spon Publishers, London.
4. Bhoominathan,A. and Hari,S.,1999, Behaviour of fly ash under static and cyclic loading, Proc.of Indian Geotechnical Conference, Calcutta,pp.324-326.
5. Cokca,E.,2001, Use of class-C fly ashes for the stabilisation of expansive soil, Jl.of Geotechnical and Geoenvironmental engg.,vol.127,pp.568-573.
6. Hakari,U.D.and Puranik,S.C.,2010,Evaluation of swell potential and identification of expansive and problematic soils in civil engineering works by newly developed matrices
7. based on index and grain size properties, Electronic Journal of Geotechnical Engineering (EJGE),vol.15, pp.1712-1726.
8. Indraratna,B.,Nutalaya, P. and Kuganenthria, N.,1991, Stabilisation of a dispersive soil by blending with fly ash, Qtrly Jl. of Engineering Geology, vol.24,pp.275-290.
9. Pandian, N.S., Krishna, K.C.and Leelavathamma, B., 2002, Effect of fly ash on the CBR behaviour of soils, Proceedings of Indian Geotechnical Conference, Allahabad, vol.1,pp.183-186.
10. Phanikumar, B.R. and Sharma,R.S.,2004, Effect of fly ash on engineering properties of expansive soils, Jl.of Geotechnical and Geoenvironmental engg., vol.130(7),pp.764-767.
11. Shivapullaiah, P.V., Prashanth,J.P., Sridharan, A., 1996, Effect of fly ash on the index properties of black cotton soil, Soils and Foundations, vol.36, pp.97-104.
12. Yudhbir and Honjo,Y.,1991,Applications of Geotechnical engineering to environmental control, Theme lecture 5, 9 ARC, vol 2,pp.431-469, Bangkok,Thailand.

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Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

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- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
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Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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Approach

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- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
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Topics	Grades		
	A-B	**C-D**	**E-F**
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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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