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EFFECT OF INDUSTRIAL WASTE AND RBI GRADE 81 ON SWELLING CHARACTERISTICS OF CLAYEY SOIL

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Abstract. *This paper deals with improvement of swelling characteristics of clayey soil by adding industrial waste and RBI Grade 81. The construction of road in clayey soil is challenging due to its more swelling and more shrinkage characteristics. To overcome this problem there are two solutions one is replace the clayey soil by good quality granular material. The second is stabilizing the subgrade clayey soil by using various industrial wastes. Generally pond ash, fly ash and stone dust are use for soil stabilization. The swelling and shrinkage characteristics of clayey soil are considerably improved if it treated with industrial wastes and RBI Grade 81. The RBI Grade 81 is chemical soil stabilizer. The differential free swell index (DFS) test was carried out on different mix of soil, industrial waste and RBI Grade 81. The result shows that the DFS index of untreated soil obtained is 65% reduces to 35% by addition of 20% fly ash and 4% RBI Grade 81. This reduction in DFS index helps to reduce the effect of moisture variation in clayey soil.*

Key words: *Swelling; DFS index; fly ash; pond ash; stone dust; RBI Grade 81™.*

1. INTRODUCTION

The growth of Indian economy depends on agricultural development. The agricultural development depends on good road network in villages. The soil in villages is mostly clayey soil and it is very difficult to construct roads in this soil. The general solution for this soil is replacing it by good quality materials. The cost of construction of road depends on crust thickness and materials available near the site. If the good quality material is transported from longer distances, the cost construction of road increases. To reduce the cost of construction it is possible to stabilize the locally available soil by using industrial waste and RBI Grade 81. The thermal power plant waste like fly ash and pond ash is used for soil stabilization. Theses waste pollutes the soil, air and water. The stone dust is by-product obtained from stone crushers. These industrial wastes help to improve the swell-

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ing and shrinkage characteristics of clayey soil. The RBI Grade 81 having binding property which helps to improve the permeability of clayey soil.

Sureka Naagesh et al. [1] carried out the studies on effect of bio-enzyme on swelling properties of expansive soil. The expansive soil was treated with different dosage of bio-enzyme. The experimental result shows that the swelling of an expansive soil reduces considerably. Ravi Shankar et al. [2] studied the effect of bio-enzyme on lateritic soil for highways. Terrazme is the stabilizing agent in bio-enzyme helping to improve the unconfined compressive strength (UCS), CBR value and permeability of soil. The lateritic soil properties improved considerably for 200 ml/ 2 m^3 dose of bio-enzyme. Prasad et al. [3] used various industrial wastes for construction of flexible pavement. The various reinforced materials used like waste plastic and waste rubber in moorum/ fly ash subbase course laid on sand subgrade. The test result shows that maximum load carrying capacity of the model flexible pavement system has significantly increased for both moorum and fly ash subbase reinforced with waste plastics as well as waste tyre rubber. The CBR test results for different materials reinforced with waste plastic and waste tyre improved significantly. Sridharan et al. [4] worked on shear strength studies on soil-quarry dust mixtures. The quarry dust was mixed with soil to improve the strength characteristics for different applications like embankment, back-fill material, subbase material. The quarry dust added in different percentage in different soil shows the improvement in shear strength of these soils. Guney et al. [5] studied geoenvironmental behavior of foundry sand amended mixtures for highway subbases. A laboratory testing program was conducted on soil-foundry sand mixtures amended with cement and lime to assess their applicability as highway subbase materials. The increase in strength can be obtained in the field by compacting the foundry sand-based mixtures. For all mixtures, the q_u (unconfined compressive strength) decreased and the k_r (hydraulic conductivity ration) increased with an increasing number of freeze – thaw cycles. Rafat [6] carried out the work on use of several waste materials and by-product such as fly ash, bottom ash, foundry sand, cement kiln dust, wood ash and scrap tire rubber. The fly ash used in making controlled low-strength material. These controlled low-strength materials can be used for various applications such as back fills, structural fills, conduit bedding, erosion control, void filling.

2. MATERIALS

2.1 Soil sample

The soil sample collected from road near by Aurangabad (M.S.) India. The soil is mostly clayey soil. The basic properties of soil sample are tested in the laboratory and results are as given in table 1.

2.2 Fly ash

The fly ash sample is collected from Parli Thermal Power Plant, District Beed, in Maharashtra State of India. The typical values for different geotechnical properties of fly ash acceptable for embankment are as given in table 2. The properties of fly ash depend upon type of coal, pulverization and combustion technique, collection and disposal systems.

Table 1 Basic Properties of Soil Sample

Properties of Clayey soil	Value
Specific gravity	2.39
Liquid limit (%)	60
Plastic limit (%)	25.50
Plasticity index (%)	34.50
Maximum dry density (g/cm^3)	1.44
Optimum moisture content (%)	28.65
Differential free swell index (%)	60
Silt and clay content % (below 0.075)	76.15
Sand content % (0.075 to 4.75 mm)	14.75
Gravel content % (4.75 to 80.0 mm)	9.10

2.3 Pond ash

The pond ash sample is collected from the Thermal Power Plant located at Parli, in Beed district of Maharashtra state of India. After burning of coal in thermal power plant, about 20% to 30% of ash is collected at bottom in the form of slurry. This slurry is deposited in the pond. After evaporation of water from slurry, remaining ash in dry form is called as pond ash. The basic properties of pond ash are as given in table 2.

Table 2 Typical Geotechnical Properties of Fly Ash and Pond ash

Parameter	Normal Range	Normal Range
Specific Gravity	1.90 – 2.55	2.37
Plasticity	Non - plastic	Non - plastic
Maximum Dry Density (g/cc)	0.9 – 1.60	0.9 – 1.60
Optimum Moisture Content (%)	38.0 – 18.0	38.0 – 18.0
Permeability (cm/s)	Negligible	Negligible
Particle Size Distribution (% of material)		
Clay size (less than 0.002mm) %	1 – 10	0
Silt size (0.075 to 0.002 mm) %	8 - 85	21
Sand size (4.75 to 0.075 mm) %	7 - 90	79
Gravel size (80 to 4.75 mm) %	0 - 10	0

2.4 Stone Dust

For the construction industry huge amount of crushed aggregates are required. The different types of rocks are crushed in the stone crusher to get required size of aggregates. During crushing of rocks huge amount of stone dust is formed which is deposited at the crusher site. Earlier stone dust was considered to be waste product. Nowadays it is considered as a by-product of stone crusher plant. The various properties of stone dust are depending on the type of rock used for crushing. The various properties of stone dust are as given in table 3.

Table 3 Properties of Stone Dust

Properties of stone dust	Value
Specific Gravity	2.76
Plasticity index (%)	Non- plastic
DFS (%)	00
MDD g/cm^3	1.95
OMC (%)	8.14
Soaked CBR value (%)	11.12
Silt and Clay (below 0.075mm) (%)	13.81
Sand (0.075 to 4.75 mm) (%)	--
Gravel fine (0.075 – 0.475 mm) (%)	26.18
Medium (0.475 - 2.0 mm) (%)	48.71
Gravel coarse (2 – 4.75 mm) (%)	11.15

3. Experimentation

The DFS test was performed as per Bureau of Indian Standard (IS: 2911, Part-3) [7]. The mixes of soil, fly ash, pond ash, stone dust and RBI Grade 81 in various proportions were tested to find values of DFS.

4. Result and Discussion

4.1 Effect of RBI Grade 81 and Fly ash on DFS index of soil

The Fig. 1 shows that the DFS for different proportions of soil, fly ash and RBI Grade 81 reduces as compared to untreated soil. The decrease in DFS index indicates that the swelling and shrinkage of clayey soil is reduced due to addition of fly ash and RBI Grade 81.

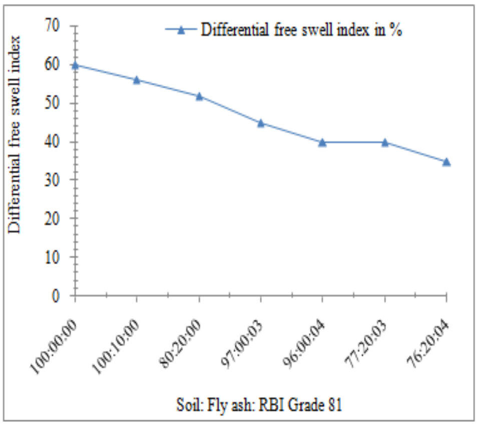

Fig. 1 Effect of RBI Grade 81 and fly ash on DFS of soil

4.2 Effect of RBI Grade 81 and Pond ash on DFS index of soil

The clayey soil was tested for DFS for different proportions of soil, pond ash and RBI Grade 81. The clayey soil had the maximum differential free swell index due to its mineral constitutes. The Fig.2 shows that DFS of treated soil with pond ash only decreases as compared to untreated soil. The DFS value reduces considerably due to addition of RBI Grade 81 as compared to untreated soil and soil treated with pond ash. When the RBI Grade 81 and pond ash are added in different proportions to the clayey soil, the DFS index decreases considerably. The decrease in DFS indicates the reduction in swelling of clayey soil due to chemical reaction between pond ash and RBI Grade 81 with the clayey soil.

4.3 Effect of RBI Grade 81 and stone dust on DFS index of soil

The clayey soil had maximum DFS index due to its mineral constitutes. The results obtained for DFS for different proportions of RBI Grade 81 and stone dust are shown in Fig. 3. The DFS of modified soil with stone dust only decreases as compared to untreated soil. The decrease in DFS indicates the reduction in swelling of clayey soil due to particles of stone dust and chemical reaction of RBI Grade 81 with the clayey soil and also the permeability of soil mass decreases.

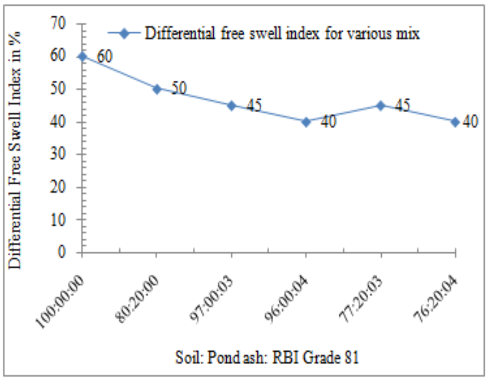

Fig. 2 Effect of RBI Grade 81 and pond ash on DFS of soil

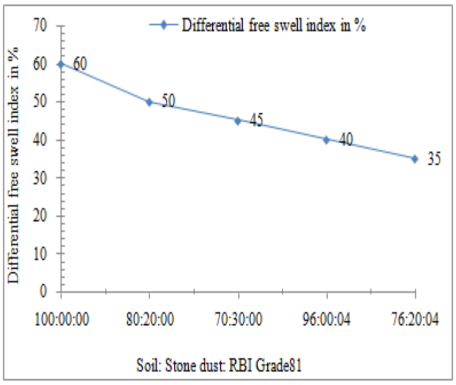

Fig. 3 Effect of RBI Grade 81 and stone dust on DFS of soil

5. Conclusion

The following conclusions are drawn from the experimental work.

1. The DFS index of clayey soil is reduced due to addition of various industrial wastes up to certain extent.
2. When the soil treated with RBI Grade 81 and various industrial wastes the DFS index reduces considerably.
3. The failure of roads constructed in clayey soil is generally due to swelling and shrinkage characteristics. The mix of various industrial wastes and RBI Grade 81 in the soil helps to reduce these characteristics.

The important advantage of use of these industrial wastes in construction of roads reduces pollution of environment and solves the problem of disposal of these wastes up to a certain extent.

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UTICAJ INDUSTRIJSKOG OTPADA I RBI GRADE 81 ADITIVA NA KARAKTERIRISTIKE BUBRENJA GLINOVITOG TLA

Ovaj rad se bavi poboljšanjem karakteristika bubrenja industrijskog otpada dodavanjem nusprodukata industrijske proizvodnje i RBI Grade 81 aditiva. Izgradnja puteva u glinovitom zemljištu je izazov zbog toga što ta vrsta zemljišta ima izražene karakteristike bubrenja i skupljanja. Da bi se ovaj problem revazišao, postoje dva rešenja. Jedno je da se glinovito tle zameni korišćenjem kvalitetnog zrnastog materijala. Drugo je da se glinovita podloga stabilitzuje korišćenjem različitog materijala od industrijskog otpada. Uopšteno govreći, koriste se šljaka, elektrofilterski pepeo i kamena prašina za stabilizaciju tla. Karakteristike bubrenja i skupljanja glinovitog zemljišta se mogu popraviti ako se ono tretira nusproduktima industrijske proizvodnje i aditivom RBI Grade 81. RBI Grade 81 je hemijski stabilizator tla. Sprovedeno je ispitivanje difrencijalnog indeksa bubrenja na različitim mešavinma zemljišta, industrijskog otpada i RBI Grade 81. Rezultati pokazuju da je DFS indeks netretiranog zemljišta od 65% smanjen na 35% dodavanjem 20% elektrofilterskog pepela i 4% RBI Grade 81. Ovo smanjenje DFS indeksa pomaže da se efekat varijacije vlage u glinovitom zemljištu umanji.

Ključne reči: *bubrenje; DFS indeks; elektrofilterski pepeo; zgura; kamena prašina; RBI Grade 81™*