USE OF CLAY STABILIZED FLY ASH FOR RAISING ASH POND

Desai N.H.
Director, Unique Engineering Testing & Advisory Services, Udhna, Surat. uniquet@wilnetonline.net

Desai M.D. (Ph D)
Rtd. Prof. SVNIT, Surat, Consulting Engineer, earthmdd@yahoo.co.in

ABSTRACT: The use of Fly ash for raising of ash pond is used in practice. To improve technological inputs the paper presents studies on fly ashes collected from ESP Hopper, Bottom and Ash pond. The engineering characteristics of ash from Naroli Power Palnt are described. The project requirements of raising pond and construction of new pond in expansive soil area have been examined. Design mix of 10 % pulverized soil (CH type) with fly ash of Naroli showed good compactability, high shear resistance & CBR value. Using clay stabilized Fly ash typical design of dyke to raise / construct new one was evolved for consideration as alternative.

1. INTRODUCTION

The commonly available fly ash is from Ukai Power project, which uses Bituminous coal. The only project based on locally mined lignite coal is at Nani Naroli, South Gujarat. The plant, for environmental aspects, uses dose of lime with coal. Thus the ash produced is dissimilar to normal ash available. The ash is collected by precipitators in a hopper, bottom ash is collected separately and surplus Fly ash with bottom ash is transported by water to a ash pond nearby. Thus three types of ashes – Fly ash, Bottom Ash and Pond ash are available.

Project planners have surveyed borrow areas in lagoon 2 to make use of excavated earth for dyke construction. Due to seepage from lagoon 1, the area is water logged and shows high alkalinity. The soil is CH Expansive Group with depth of 3 to 4 m below G.L. Top crust of clay has fissured dessicated lumpy structure. Table 1 is summary of data available for soils in borrow pits. They also represent foundation soil for proposed dyke. Physical properties of 3 fly ashes are shown in Table 2. The variation of grain size is shown in Figure 1. Table 3 shows heavy compaction characteristics and UCC of specimens casted at OMC MDD for 3 to 56 days. The light compaction indicated low density of 1.1 to 1.145 -g/ cc and hence heavy compaction was adopted for test & field construction. Figure 2 shows trends of compaction curves.

The chemical analysis of 3 samples are compared with typical other fly ashes. There is high loss of ignition, high CaO, SO_3, and low SiO_2, Fe_2O_3 and Al_2O_3. The self-binding of Fly Ash and pond ash do not show all CaO as free lime.

Table 1 Properties Of Available Soil In Lagoon 2.

Passing 75 μ (%)	75 %
G, Sp. Gravity	2.5
Liquid Limit	70
Plasticity Index	46
DFI (%)	50 TO 70
OMC (%)	22
MDD (g / cc)	1.48
Cu	3 t/m^2 @ MDD
ϕ (Degree)	10 ° @ OMC
k (cm / sec)	1.5 x 10^{-6}

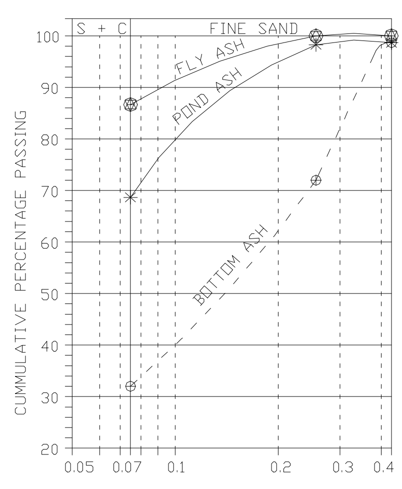

Fig. 1: Comparision of Available Ashes at Naroli.

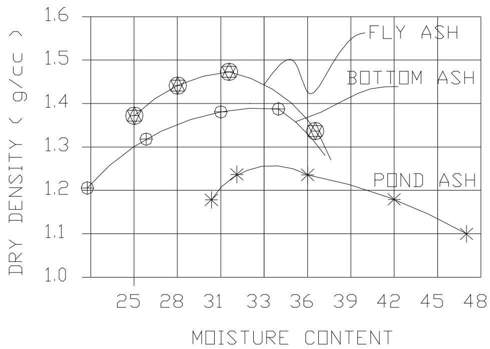

Fig. 2: Compaction Charecteristics of Fly, Bottom and Pond Ashes.

For use as soil for dyke construction, characteristics of Fly ash and pond ash are compared to specified values by IRC: SP 20- 2002 in Table 5.

The Problem was to evolve construction material and design for raising dykes of lagoon 1 immediately, and extension of dykes for making lagoon 2 in future.

2. FIELD RECONAISSANCE

The data available was compiled, the seepage at toe of lagoon 1 was observed. Prima faci, the foundation, borrow pit soil, state of water logging and time ruled out earlier option of using CH Soil for dyke construction economically. As a last resort stabilization of alkaline clay would be considered as alternative.

The representative samples of available 3 types of ashes were collected from hopper, ash pond, and bottom ash.

Table 2 Engineering Characteristics Of Lignite Fly Ashes Of Naroli.

Sample Type	Grain Size Analysis			Atterburg's limit		Specific Gravity	DFS Index
	Med Sand	Fine Sand	Silt & Clay	LL	PL		
Pond Ash after cycles of drying wetting in field	01	30	69	a. 75	NP	2.65	7
				b. 77	NP		
Bottom Ash	01	67	32	a. 51	NP	2.63	5
				b. 56	NP		
Fly Ash Collected From Hooper	00	14	86	a. 52	NP	2.5	4
				b. 66	NP		

a. Test immediate on mixing water, b. Test after 24 hrs. of mixing water.

Table 3 Compaction And Shear Resistance Of Compacted Specimens Using Heavy Compaction Test.

Sample	MDD	OMC	Unconfined compressive strength kg/cm^2				Soaked CBR	K
	g/cc	%	3 days	7 days	28 days	56days	Curing 3 days	in cm/sec
Pond Ash	1.25	33	-	1.0	10.1	-	20	-
Bottom Ash	1.38	30$\pm$2	-	-	-	-	-	-
Fly Ash	1.41	27	-	0.5	9.2	-	25-30	-
FA + 10 % Pulverized local CH soil	1.36	26.3	8.9	8.9	20.4	32.2	52	55.6 x 10^{-6}
FA + 20 % Pulverized local CH soil	-	-	9.3	12.0	22.2	20.6	51	26.6 x 10^{-6}

Table 4 Chemical Analysis of FA , Pond Ash (Tested At CGCRI Ahmedabad)

	Pond Ash	Bottom Ash	FA
% Moisture	4.9	-	0.27
% Loss on ignition	5.23	1.7	4.78
% Calcium as CaO	18.78	17.94	28.87
% Mg as MgO	0.16		
% Silica as SiO_2	44.32	55	32.75
% Sulfates as SO_3	5.45	7.04	16.35
% Alumina as Al_2O_3	19.16	12.8	11.6
% Iron as Fe_2O_3	2.92	3.02	3.02

The soluble sulfate (as SO_3) not greater than 1.9 g/ liter when tested as per BS 1377 – 1975 (test 10) but using a 2:1 water soil ratio. (IRC: SP 20 – 2002). Pond Ash - CLASS C. Fly Ash – Class C, Fineness 6400 m^2/g.

Table 5 Geotech properties of fly ash (a) acceptable for embankment construction and (b) Nani Naroli.

Parameter	Normal Range	Lignite FA of S.Gujart	
	(IRC SP: 20 / 2002)	FA	POND ASH
Specific Gravity	1.9-2.55	2.5	2.18/2.65
Plasticity	Non Plastic	NP	NP
Max. Dry Density (g/cc) (Heavy compaction)	0.9 to 1.6	1.47	1.25
OMC (%) (Heavy compaction)	38 to 18	27-33	36
Cohesion (kn/m2)	Negligible	20	25
Angle of friction (ϕ)	30° - 40°	* 28	30
Compression index (Cc)	0.05-0.4	-	-
Permeability (cm/sec)	8×10^{-6} to 7×10^{-4}	1.2×10^{-7}	2.2×10^{-6}
Particle size distribution			
Clay fraction (< 0.002)	1 to 10	-	-
Silt fraction (0.002-0.015)	8 to 85	86	69
Sand fraction (0.075-4.75)	7 to 90	14	30
Co efficient of uniformity	3 -11	2.2	6.4

*** Immediate on remoulding**

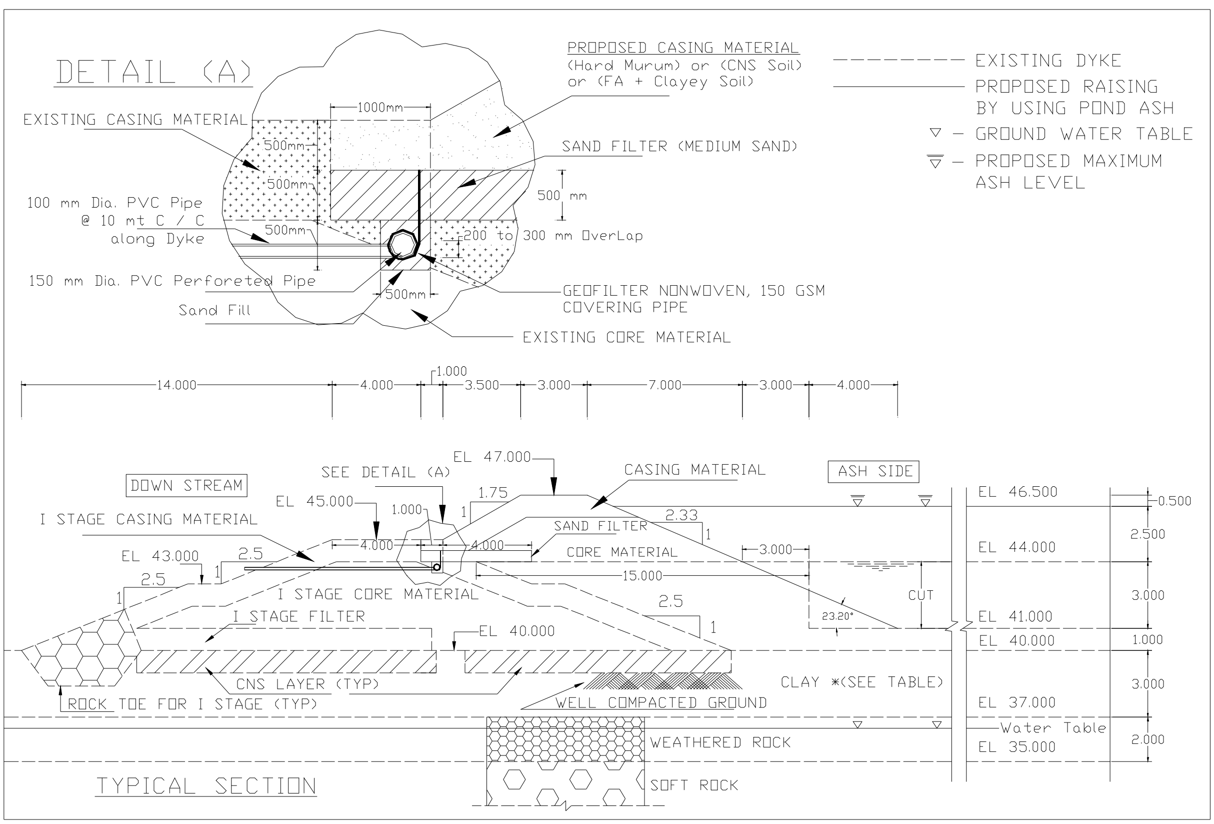

Fig. 3 : Typical Design for Raising of Pond using Pond Ash at Naroli.

3. INVESTIGATION

Representative samples were analyzed for chemical analysis, physical properties as well as engineering properties for adoption as construction material. The parameters for preliminary design of cuts in pond and slopes of dykes to be raised are compiled in Table 6.

4. ANALYSIS

Pond and fly ash can be considered, as core materials for constructing dykes. Though fly ash and bottom ash has lower percentage of SiO_2 + Al_2O_3 & Fe_2O_3 than usually specified (70 %), the pond & fly ash exhibit self-cementing pozolonic activity with high CaO content. The CaO content is higher in fly ash than pond ash. Thus part of lime is leached by water. The pond and fly ash falls in " c " type. The structure of lime its mineralogical exploration may be academically interesting. pH was more than 11.

High calcium fly ashes are reported in many countries. It is characterized by Higher CaO, MgO, SO_3 and lower SiO_2, Al_2O_3 in chemical analysis. Fly ash with CaO > 15% as in Naroli, generally consists of Calcium Alumino silicate (CAS) type. It generally contains substantial amount of crystalline compounds of C_3A, C_4A_3S, CS and CAO.They also exhibit high alkali content which is responsible for Soda lime, Alumino silicate glass (NCAS), crystalline alkali sulfates such as Thenardite (NS) and APhlhilite [N (K) S]. (Mehta,P.K., 1986). Though such ashes are quite suitable for making Portland cement, the sulfate environment for RCC is still questioned by the many users.

From the considerations of excavation in lagoon 1 as increasing storage capacity, short distance for transport and suitable engineering properties, pond ash was preferred for use as embankment material for core of dykes.

5. DESIGN MIX

The various trials of mixing local soil (CH) pulverized to fine sand size indicated very high potential of providing earthwork material having no limitations of clay & fly ash. Table 3 shows results.

6. DESIGN OF DYKES

The designed cut in lagoon 1 ash pond with dyke constructed using same is shown in Figure 3.

The field check shows vertical cuts up to 4 m in Ash pond were feasible. The insitu structure of ash in pond was stratified mudstone, which crumbles on cycle of drying \ wetting and compacting by heavy roller. The filter, toe drain and drainpipes at regular interval along the dyke are provided to drain off seepage. . A typical design with core of pond ash Geofilter and murrum or stones collected from mines for dyke over the insitu pond ash stabilized subsoil was economically possible. (Tailor, 2002) To avoid handling dust probems, 10 % Pulverized CH Soil mixing was tried, the results of compaction strength and social CBR are shown in Table 3.

Tests of soil montinonillomite with FA lignite containing free lime have shown suitability as CNS or fill material for construction. The lime reactivity with soil attributes to gain strength with time.

Table 6 Design parameters for pond ash for use in raising / constructing dyke.

Property		Property	
Cu by UCC	6.45 kg / cm^2	Cu (kpa)	20
MDD (g / cc)	1.2 to 1.3	ϕ (Degree)	28°
OMC (%)	36	CBR (%)	26

7. CONCLUSION

Uses of local high Calcium Pond Ash for construction of extension or new dyke provided a economical solution. It was time saving as well as safe in region of water logged CH type subsoil region.

CNS soil for fill material is not available in South Gujarat region. This combination provides excellent replacement of CNS soil.

REFERENCE

IRC Special Publication No 20 – 2002, pp 222

Joshi, R.C. (2000). Soil Improvement using Fly ash, *Proc. IGC 2000 millennium conference, Bombay*.

Mehta, P.K. (1988). Effect of Fly ash composition on sulfate resistance of cement, *ACI Journal,* Nov.

Unique Eng. Testing & Adv. Services (2000) Test report on Fly, Bottom & Pond Ashes of Naroli - Technical report.

ACKNOWLEDGEMENT

The authors are grateful to Hitesh Desai (Unique Engg. Testing & Advisory Services) for association.