UGC MINOR RESEARCH PROJECT

EXECUTIVE SUMMARY

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

Title of the Project:

Wealth from Waste - Fly ash Characterization for its bulk utilization in Geotechnical Engineering Applications

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1.1 Six most potential industries

Six most potential industries have been identified and the details are given below

1. **Simhadri Thermal Power plant (NTPC), Visakhapatnam**

   Simhadri Super Thermal Power Station, is a unit of NTPC and is about 30 km from Visakhapatnam, India. NTPC is a coal-based Power plant consisting of 4 units of total installed capacity of 2000 MW. The coal for the power plant is sourced from Kalinga Block of Talcher Coal fields in Odisha. The fly ash from the plant, hereafter referred as NPFA, is collected by using electrostatic precipitators. The production of NPFA in the year 2017 is 5100 metric tonnes.

2. **Dr. Narla Tata Rao Thermal Power plant (NTPC), Vijayawada**

   Dr. Narla Tata Rao Thermal power station is located at Vijayawada in Andhra Pradesh. This power plant is a unit of NTPC. It is located in between Ibrahimpatnam and Kondapalli villages. At present the total installed capacity is 1760MW. The fly ash from Narla Tata Rao power plant, hereafter referred as NTFA, is collected by using electrostatic precipitators.

3. **Damodaram Sanjeevaiah Thermal Power plant (NTPC), Nellore**

   Sri Damodaram Sanjeevaiah Thermal Power Station is a unit of NTPC, located in Nelatur Village, near Krishnapatnam and at a distance of 23 km from Nellore city of Andhra Pradesh. The proposed capacity of plant is 1600 MW. The Power station is designed for blended coal in the ratio of 70% washed domestic coal from Talcher Coalfield to 30% imported coal. The fly ash from Damodaram Sanjeevaih power plant, hereafter referred as NDFA is collected by using electrostatic precipitators.

4. **Hinduja National Power Corporation (HNPC) Limited, Visakhapatnam**

   Hinduja National Power Plant Corporation Limited is located in Pedagantyada mandal, about 20 km from Visakhapatnam. The plant was established in 2008 with total power generation capacity of 1040MW with two units producing 520MW each. The fly ash from Hinduja power plant, hereafter referred as HNFA is collected by using Electrostatic Precipitators. The utilisation of HNFA is around 40%.

5. Thermal Powertech Corporation Limited (TPCL), Nellore

Thermal Powertech Corporation Limited is located about 24 km from Nellore in Andhra Pradesh adjacent to SGPL plant. The plant is now known as Sembcorp Energy India Limited, Phase-I. The plant was established in 2015 with total power generation capacity of 1320MW with two units producing 660MW each. The fly ash from Thermal Powertech Limited, hereafter referred as TPFA, is collected by using Electrostatic Precipitators. The utilisation of TPFA is around 50%.

6. Sembcorp Gayathri Power Limited (SGPL), Nellore

Sembcorp Gayathri Power Limited, is located about 24 km from Nellore in Andhra Pradesh, adjacent to TPCL plant. The plant is now known as Sembcorp Energy India Limited, Phase-II. The plant was established in 2016 with total power generation capacity of 1320MW with two units producing 660MW each. The fly ash from Sembcorp Gayatri Power limited, hereafter referred as SGFA, is collected by using Electrostatic Precipitators. The utilisation of fly ash is around 50%.

1.2 Physical and Engineering characteristics of the fly ash samples

The physical and engineering characteristics of the fly ash samples in the study are given in Table-1

Table-1 Physical and Engineering properties of the fly ash samples

Fly ash	G	% Sand	% Silt	% Clay	OMC (%)	MDD (kN/m^3)	CBR (%)	K (cm/s)
NPFA	2.07	25.0	72.4	2.6	15.5	14.6	15.1	2.1×10^{-5}
NTFA	1.97	17.8	80.7	1.5	17.2	14.3	42.4	0.8×10^{-5}
NDFA	1.93	42.3	57.7	0	17.9	13.9	43.2	7.7×10^{-5}
HNFA	1.99	53.5	44.5	2	15.7	13.9	10.5	7.9×10^{-5}
TPFA	1.96	42.9	53.3	3.8	8.8	13.5	11.4	6.2×10^{-5}
SGFA	2.18	32.0	62.4	5.6	9.6	15.0	10.4	0.8×10^{-5}

The compaction characteristics of fly ash samples are shown in Fig.1.

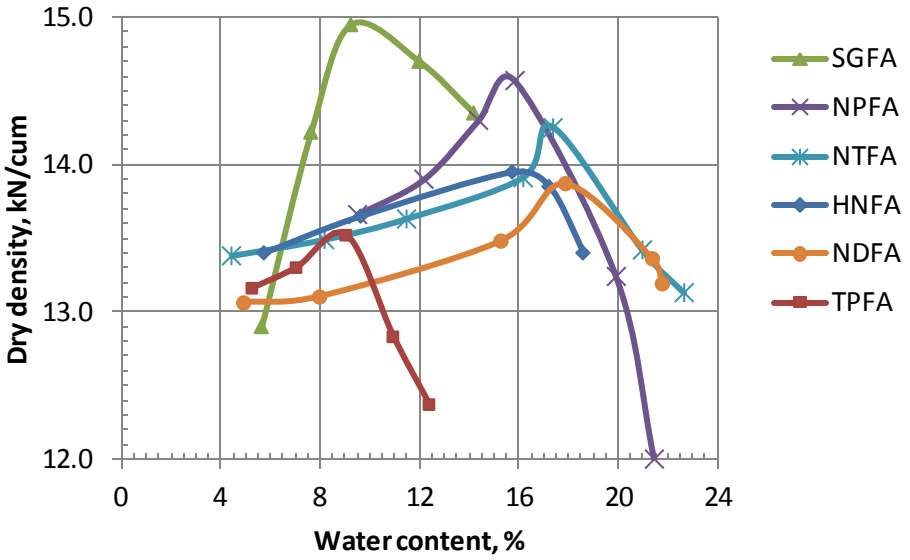

Fig.1 Compaction characteristics of Fly ashes in the study

1.3 Chemical composition of Fly ash

The results of chemical analysis are presented in Table-2

Table-2 Chemical Analysis of fly ash samples

S. No.	Chemical Compound	Result (%)					
		NPFA	NTFA	NDFA	HNFA	TPFA	SGFA
1	SiO_2	64.1	65.4	71.8	68.4	74.3	68.4
2	SiO_2+Al_2O_3+Fe2O_3	83.1	95.4	89.2	81.9	91.4	87.5
3	CaO	6.5	1.9	3.95	6.3	0.65	4.75
4	Loss on ignition	0.6	0.55	3.6	1.1	0.35	0

1.4 Suitability of fly ash and Stabilizers

The suitability of fly ash samples and the effect of stabilizers on the improvement of geotechnical characteristics of fly ash and the most effective stabilizers are given in Table-3

S. No.	Thermal plant	Fly ash	Stabilizer				Recommended Stabilizer
			Lime		Polypropylene		
			Optimum %	Curing	Optimum %	Curing	
1	NTPC, Visakhapanam	NPFA	5	No	2	No	
2	NTPC, Vijayawada	NTFA	0	NA	0	NA	
3	NTPC, Nellore	NDFA	8	No	2	No	
4	HNPC, Visakhapatnam	HNFA	5	2 days	2	No	
5	TPCL, Nellore	TPFA	5	No	2	No	
6	SGPL, Nellore	SGFA	5	No	2	No	

1.5 Summary of findings

1) The fly ash samples from all six thermal power plants were found to be silty sand with marginal clay content of 0-5%. It is non-plastic and non-swelling with a specific gravity of particles in the range of 1.93-2.18. The OMC was in the range of 8.8-17.9% and the MDD is in the range of 13.5-15.0 kN/m^3. The permeability is in the range of 0.8×10^{-5} - 7.9×10^{-5} cm/s
2) There is considerable variation in the grain size distribution, specific gravity, compaction and CBR characteristics from sample to sample of fly ash from the same thermal plant. There was difficulty in conducting a reliable strength test using direct shear as the samples were disturbed during the transfer from the compaction mould to the shear box of the direct shear apparatus. Soaking the compacted fly ash samples caused softening of the soil considerably and the soaked compacted fly ash sample could not support any load from the plunger in CBR test. unsoaked CBR tests were therefore conducted.
3) Treatment of NPFA fly ash with lime (0 to 10%) increased the OMC and there is no significant effect on MDD. The CBR of the NPFA improved significantly from 15.4% to 33.7% when the lime content is increased from 0 to 5%. Treatment of NPFA fly ash with polypropylene (0 to 6%) increased the OMC and decreased the MDD. Polypropylene of 2% improved CBR of NPFA fly ash from 10.4% to 26.1% with 0 days curing.
4) There is no significant improvement in the CBR of NTFA on addition of lime (0-10%) or polypropylene (0-6%). The CBR of NTFA fly ash is significantly high (42.4%) without any stabilizer.
5) Treatment of NDFA fly ash with lime (0 to 10%) and polypropylene (0-6%) decreased the OMC and increased the MDD, but with polypropylene increased the OMC and decreased the MDD. The CBR of the NDFA improved significantly from 43.2% to 53.7% when the lime content is increased from 0 to 8%. Polypropylene of 2% and 4% improved CBR of NDFA fly ash from 43.2% to 61.3% and 73.1% respectively with 0 days curing.
6) Treatment of HNFA fly ash with lime (0 to 10%) decreased the OMC and increased the MDD but with polypropylene increased the OMC and decreased the MDD. The CBR of the HNFA improved significantly from 10.5% to 83% when the lime content is increased from 0 to 5% with 2 days curing. Polypropylene of 2% improved CBR of HNFA fly ash from 10.5% to 96% with 0 days curing.
7) Treatment of TPFA fly ash with lime (0 to 10%) increased the OMC but there is no significant effect on MDD. The CBR of the TPFA improved significantly from 11.4% to 48.2% when the lime content is increased from 0 to 5%. Treatment of TPFA fly ash with polypropylene (0 to 6%) increased the OMC and decreased the MDD.
8) Treatment of SGFA fly ash with lime (0 to 10%) increased the OMC and there is no significant effect on MDD. The CBR of the SGFA improved significantly from 10.4% to 59.2% when the lime content is increased from 0 to 5%. Treatment of SGFA fly ash with polypropylene (0 to 6%) increased the OMC and decreased the MDD. Polypropylene of 2% improved CBR of SGFA fly ash from 10.4% to 58.2% with 0 days curing.
9) Curing period has no significant effect for improvement of CBR of any fly ash with lime or polypropylene as stabilizer, except in case of HNFA fly ash with lime as stabilizer.
10) The optimum % stabilizer (lime or polypropylene) for each fly ash is given in Sec. 1.5 of Appendix-1 above.