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Experimental Investigation on Dynamic Characterization of Equi-Proportionate Silt-Sand Range Pond Ash at High Strain

Introduction

- Utilization of coal ash in place of soil demands a detailed study on its dynamic characterization and liquefaction potential evaluation in seismic prone regions, as it may cause instability of fill material under dynamic loading conditions.
- In this study, the liquefaction potential of coal ash was evaluated by performing extensive laboratory cyclic triaxial tests by determining the dynamic characteristic and cyclic resistance of equi-proportionate silt–sand range pond ash.

Material and its collection

The pond ash tested for this study was collected from an intermediate point between disposal point and outflow point of Talcher thermal power station (TTPS) ash pond, Odisha, India that lies in the seismic zone–III (moderate seismic intensity). The ash samples have been collected at a depth of 0.5 m below the ground surface.

Methodology

Multiple sets of consolidated undrained cyclic triaxial tests (strain-controlled) were performed on the collected pond ash samples (Fig. 1). Specimen of size 50 mm (diameter) × 100 mm (height) was prepared using a conventional moist tamping method.

The dynamic shear modulus (G_{dyn}) and damping ratio (D) of pond ash samples were calculated using the following Eqs. (1–3).

$E = \sigma_d/\epsilon$ - (1), $\gamma = (1+\nu)\,\epsilon$, $G_{dyn} = E/2(1+\nu)$ - (2)

$D = A_L/4\pi A_T$ - (3), E: Young's modulus, σ_d: deviator stress, ε: axial strain, γ: shear strain, υ: Poisson's ratio, A_L: area enclosed by the hysteresis loop and A_T: area of the shaded triangle

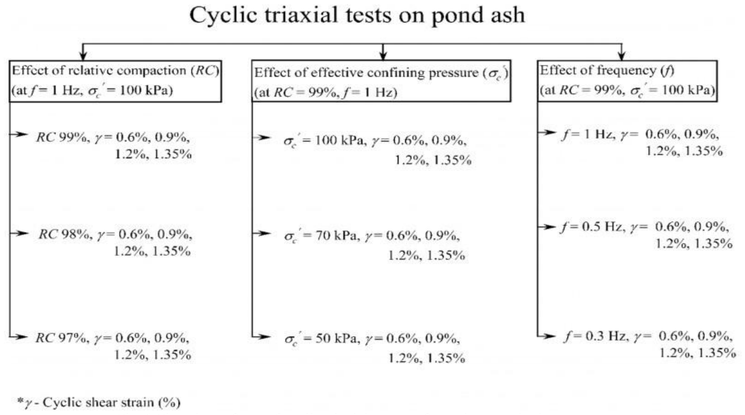

Fig. 1 Flowchart of sets of cyclic triaxial tests performed on pond ash

Results and Discussion

The progress of cyclic loading on pond ash specimen leads to lower its stiffness, which in turn causes a decrease in the area of hysteresis loop as shown in Fig. 2. the occurrence of complete loss of effective stress can be noticed when the pore pressure approaches its initial confining pressure as represented in Fig. 3. At this stage, the initiation of liquefaction of pond ash specimen was noticed. number of cycles for liquefaction with shear strain is presented in Table 1.

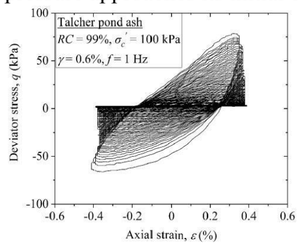

Fig. 2 Variation of deviator stress with axial strain of pond ash specimen prepared with RC = 99% tested at $\sigma c'$ = 100 kPa, f = 1 Hz and γ = 0.6%

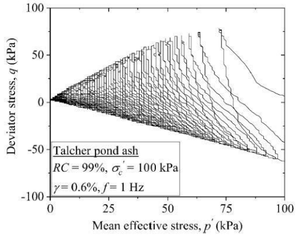

Fig. 3 Variation of deviator stress with mean effective stress of pond ash specimen prepared with RC = 99% tested at $\sigma c'$ = 100 kPa, f = 1 Hz and γ = 0.6%

Table 1. Number of cycles (NL) required for liquefaction

Relative compaction, RC (%)	Effective confining pressure, σ_c' (kPa)	Frequency, f (Hz)	Number of cycles for liquefaction (N_L)			
			Cyclic shear strain, γ (%)			
			0.60%	0.90%	1.20%	1.35%
99% (e – 0.737)	100	1	67	51	40	22
98% (e – 0.754)	100	1	57	42	30	19
97% (e – 0.772)	100	1	56	33	26	16
99% (e – 0.737)	100	1	67	51	40	22
99% (e – 0.737)	70	1	61	45	30	20
99% (e – 0.737)	50	1	58	40	21	19
99% (e – 0.737)	100	1	67	51	40	22
99% (e – 0.737)	100	0.5	74	70	52	41
99% (e – 0.737)	100	0.3	87	86	70	66

Conclusion

- Reduction in the value of the dynamic shear modulus of pond ash was noticed with the increment of cyclic shear strain amplitude (0.6– 1.35%) for all the varying parameters considered (relative compaction: 97–99%, confining pressure: 50–100 kPa and loading frequency: 0.3–1 Hz). The damping ratio of pond ash was observed to be decreased with varying high shear strains.
- Pond ash of this study contains an equal proportion of silt and sand range particles (50% fine particles), which results in less strength and tends to degrade at an early stage of loading cycles. 50% decay of dynamic shear modulus occurs within 5–28 cycles of loading. In addition, the presence of non-plastic fines readily causes liquefaction.
- The present study is confined to a range of relative compaction, effective confining pressure, loading frequency and amplitudes of cyclic shear strain. Hence, it has much scope to investigate further for better inferences on the cyclic strength of pond ash.

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