International Conference on Case Histories in Geotechnical Engineering

(1998) - Fourth International Conference on Case Histories in Geotechnical Engineering

Mar 8th - Mar 15th

Effects of Effluents of Industrial Waste on Soil Properties (A Case Study of Nandesari Area, Vadodara)

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Proceedings: Fourth International Conference on Case Histories in Geotechnical Engineering, St. Louis, Missouri, March 9–12, 1998.

EFFECT OF EFFLUENTS OF INDUSTRIAL WASTE ON SOIL PROPERTIES
(A case study of Nandesari Area, Vadodara)

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Paper No. 10.08

ABSTRACT

Around Vadodara City (Gujarat) number of chemical industries dispose of water, air and oil based pollutant everyday. The pollution process in soil due to the industrial effluent discharge on to the land and its effect on the geotechnical properties of soil are discussed in the present case study, Uncontrolled exploitation of the natural resources have resulted in an unanticipated soil behaviour due to environmental degradation. This resulted in an increased interest in the study of environmental geotechnics which is a means of forecasting soil behaviour to the changing environment.

KEY WORDS

Environmental Geotechnics, Industrial Waste, Geotechnical Properties, X-Ray Diffraction, Chemical Analysis.

INTRODUCTION

The need to set up more industries led to the disposal of industrial wastes on to the land thus polluting the soil and the ground water equally. Due to rapid urbanisation, these waste disposed lands are reclaimed to construct multistoreyed and other kinds of structures in developed as well as in developing countries for want of space. Engineering works in the environment involve the effects and cost of loading the land surface with artificial structures. Thus soil strength under building, roads, bridges, embankments, and dams is widely studied, both before and after loading, with the aid of concepts and techniques developed by the specialised technology of soil mechanics. The highly compressible materials beneath Mexico city provide one of the most striking examples of the problems which arise in cities with inadequate foundation in their subsoil.

EXPERIMENTAL INVESTIGATION

The experimental investigation are planned to examine the effect of dye stuff industry waste collected from effluent near Nandesari on various geotechnical properties of clayey soil. The physical and engineering properties of clayey soil are determined by performing various experiments as per respective Indian standard. The chemical analysis of soil and industrial waste as well as Base-exchange capacity and X-ray diffraction are also carried out.

Liquid limit and plastic limits increases with the increase in percentage of the conformination. While shrinkage limit decrease as shown in Fig. 1, 2 & 3.

Free swell index and swelling pressure also increases with increase of percentage contamination. Soil without any contamination shows 50% free swell values which increases to 100% for contaminated soil (Fig. 4). Swell pressure also increases from 0.35 Kg/sq.cm. to 0.667 Kg/sq.cm. when the soil is fully contaminated (Fig. 5). The swell pressure test carried out on fully dry sample compacted with its maximum dry density and tested at no volume change condition.

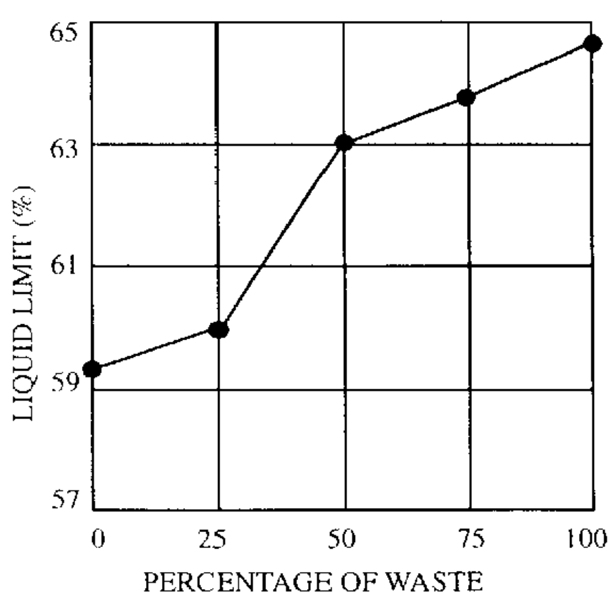

Fig. 1 Liquid limit v/s percentage of waster ch-soil

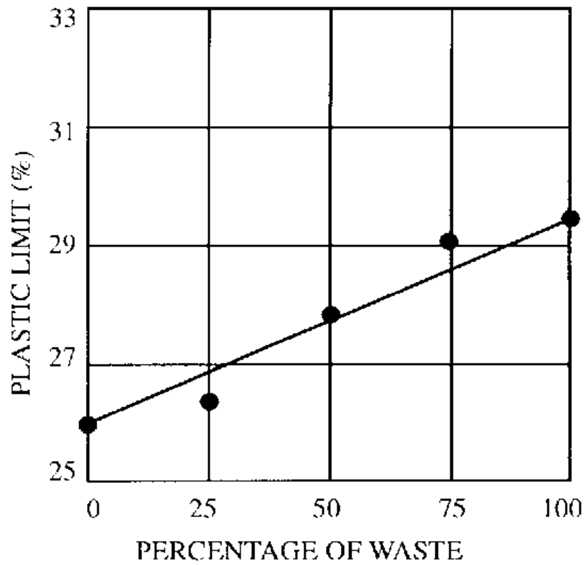

Fig. 2 Plastic limit v/s percentage of waste ch-soil

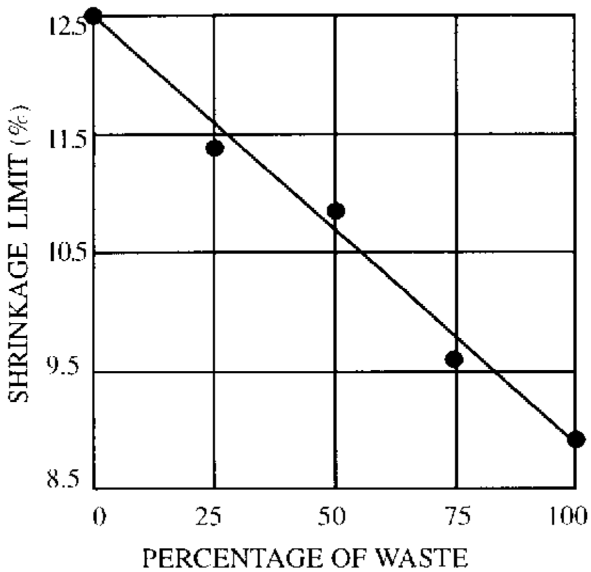

Fig. 3 Shrinkage limit v/s percentage of waste ch-soil

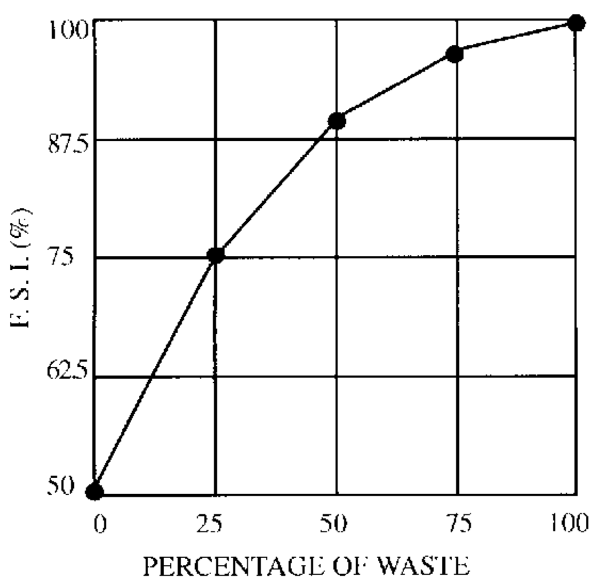

Fig. 4 Free swell index v/s percentage of waste ch-soil

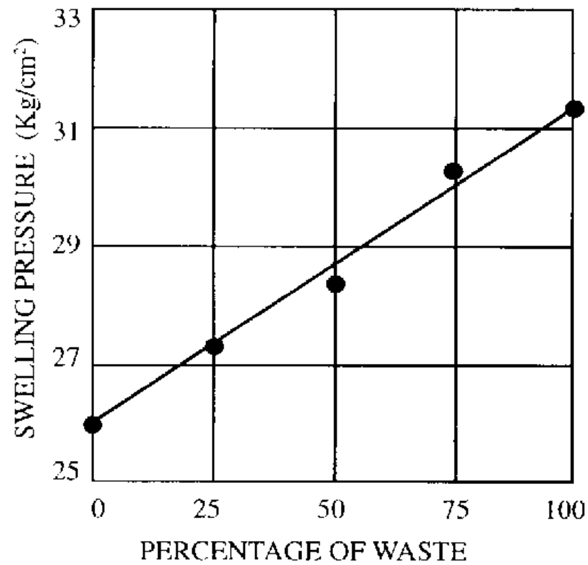

Fig. 5 Swelling pressure v/s percentage of waste ch-soil

Comparision of physical properties, engineering properties and chemical analysis of CH-soil before and after contaminated with industrial waste are shown in Table 1 and Table 2.

TABLE-1 : PHYSICAL AND ENGINEERING PROPERTIES OF SOIL SAMPLE

Parameter	Original soil	Contaminated soil
Specific Gravity	2.68	2.78
Liquid Limit	59.4%	64.6%
Plastic Limit	25.9%	29.2%
Shrinkage Limit	12.5%	8.9%
Free Swell Index	50.0%	100.0%
Swelling Pressure (Kg/Sq.cm.)	0.35	0.667
Maximum dry density (gm/cc)	1.52	1.60
Optimum moisture content	21.5%	23.3%
Compression Index	0.487	0.59
Pre-consolidation Pressure	0.475	0.415
Cohesion (Kg/Sq.cm.)	0.80	0.70
Angle of shearing resistance	11.00°	13.00°
Base exchange capacity (meq/100 gm)	86.00	180.00

From Table 1 it infers that the liquid limit, plasticity index, swelling characteristics of soil increases after contamination with industrial waste. It is also found that the value of sodium ion, potassium ion, calcium ion, magnesium ion, copper ion and ferrous ion all are increased by several times.

Compositional analysis of CH-soil has been carried out by X-ray diffractometer with and without contamination of dye-stuff industry waste. Fig.6 and 7shows the X-ray diffraction curves as obtained from the X-ray diffractometer. Referring to Fig.6 and 7, minerological composition of CH-soil has changed with contamination of waste. X-ray diffraction diagram of original sample soil has shown fourteen peaks, while contaminated soil has shown forty two peaks.

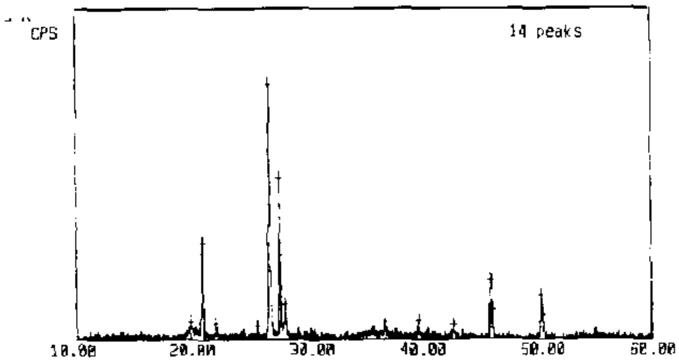

Fig.6 X-Ray diffraction peaks - original soil

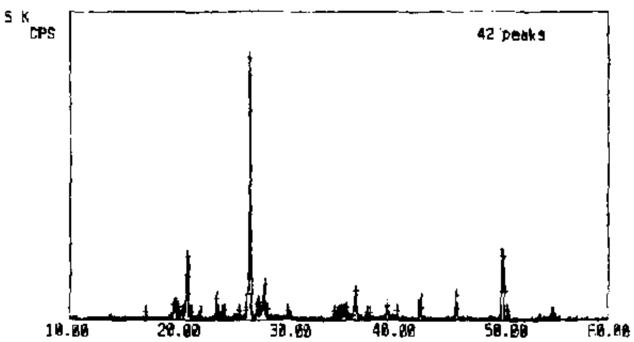

Fig. 7 X-Ray diffraction peaks - contaminated soil

TABLE-2 : CHEMICAL ANALYSIS OF SOIL SAMPLE

Parameter	Original soil	Contaminated soil
pH value	7.35	7.60
Na^+		
Total	12.00 mg/L	390.4 mg/L
Exchangeable	All	All
K^+		
Total	5.00 mg/L	5.263 mg/L
Exchangeable	All	All
Ca^{++}		
Total	28.10 mg/L	320.64 mg/L
Exchangeable	All	All
Mg^{++}		
Total	4.86 mg/L	48.6 mg/L
Exchangeable	All	All
Fe^{++}		
Total	0.17 mg/L	0.79 mg/L
Exchangeable	All	All
Cu^{++}		
Total	0.09 mg/L	0.31 mg/L
Exchangeable	All	All

DISCUSSION

Soil properties are modified when they are mixed with pollutants. The extent of modification of properties depends upon the type of clay itself and the nature of pollutant. The pollutant may be other clay minerals, organic solvents, inorganic salts or organic matters. If the pollutant contains other minerals, then physico-chemical interactions are possible between original clay and the pollutant and the properties are not as predicted by their theoretical properties. Pollutant, when come in contact with the clay-water systemm, alter the behaviour of clay by affecting the dielectric constant. Change in electrolyte concentration affects the behaviour of clay because of the change in electrical double layer. Both cation and anion exchange can take place for clay in the presence of pollutant, modifying the clay properties drastically.

Cause of change in properties of clay contaminated with pollutant may be due to effect of base exchange capacity, change in the thickness of diffuse double layer, dielectric constant and nature of pollutant. An increase in dielectric constant decreases interparticle shearing resistance and increases double layer thickness and with the increase in double layer thickness shows increase in liquid limit. Swelling properties of clayey soil is depend upon the kind and amount of clay mineral, their exchangeable ions, electrolyte content of the aqueous phase, etc. The contaminated soil shows increase in Na^+ content may lead to higher swelling potential. The permeability has a decisive influence on many engineering properties of sediments present in pollutant, for e.g. on the rate at which the void ratio decreases with an increase in load of sediments. The pollutant contaminated sand shows much more reduction in permeability than the original. An increase in the valency of cation and/or electrolyte concentration an increase of shear strength takes place. However, on the other hand, an increase in the ionic size and/or dielectric constant of pore fluid brings down the shear strength. However, no significant change in shear strength is observed in the study.

Both positive and negative effects of organic pollutants on the engineering properties of clays are possible. The problem of clay organic molecules interaction needs further concentrated research to improve understanding of the mechanism involved.

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