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Assessment of Physico-Chemical Properties of Contaminated Soil Samples From Yamuna Riverbed

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ABSTRACT

With the increase of urbanization and industrializations the metro cities are going to be worst affected. The load of sewage and industrial pollutants not only pollute the riverbeds and landfills sites but also contaminate the large area surrounding them causing health as well as construction hazards. Effluents from most of the major industries and domestic sewage directly enters in to Yamuna river, constantly altering the physical and chemical nature of surrounding water and soil. The entire stretch of river Yamuna in Delhi segment is highly polluted due to heavy sewage load .The polluted run off which contain acidic and basic contaminants along with complex organic constitutes and heavy metals certainly alter the geotechnical properties of soil. The soil pollutant interactions results in to change in physico-chemical and engineering properties of the surrounding soil environment. The contaminated soil samples were collected from different locations along the Yamuna riverbed and analyzed for chemical and physical parameters. Results shown so far reflects the effect of pollutants on the chemical properties of the soil with particular reference to change in soil pH , total soluble salt contents (TSS), salinity, cation exchange capacity (CEC), water soluble chloride and water soluble sulphate and organic matter contents. The physical and chemical properties of soils are also reported to be deviate compare to blank soil samples.

This study was the part of Innovation project conducted by research team from University of Delhi under guidance of scientists of Central soil and materials research station, New Delhi

Keywords: Soil contamination, Yamuna riverbed, Physico-chemical properties, Geotechnical property.

INTRODUCTION

Pollution is one of the most challenging problems of today's era. It draws major public attention and is the result of industrialization, modernization and technological advancement in all fields of life in the global world. Air, Water, Soil, all have been adversely affected due to pollution. Unorganized, indiscriminate and unscientific dumping of wastes is very common disposal method in the Indian cities which cause adverse impacts to the environment. Sewage and domestic waste materials from different sources end up at dumpsites and due to the heterogeneity and complexity of wastes, these dumpsites contain a variety of contaminants which pollute the soil of the area.

The increasing pollution level of river Yamuna in Delhi pose a serious threat to health as well as durability of various infrastructure projects along the river bed. Forecasting, analyzing and solving the geotechnical problems involving the influence of different types of contamination is emerging as a mandatory approach for accurate investigations. The release of pollutants from various industries influence the physical, chemical and engineering properties of soil .

The effect on chemical properties of soil after interaction with pollutants results into change in acidic and alkaline behavior, leaching of toxic cations, flocculation and deflocculation, salinity, ,salt contents, organic matter and mineralogy. The index properties of soils related to its strength characteristics are to be correlated with chemical changes.

The River Yamuna

The river Yamuna flows through National capital region covers 22 km of rout with 18 drains directly open in to the river stream converting Yamuna in to world most polluted river.

Usually no water or extremely little water is allowed to flow downstream of Wazirabad barrage during lean seasons. From Wazirabad to Okhla barrage the 22 km stretch is known as Delhi segment. (Table-I and Figure.I). The Najafgarh drain which open in to river just after the Wazirabad barrage is considered as the most polluted segment of the Yamuna River. Beyond the Okhla barrage whatever water flow in Yamuna River is the domestic and industrial waste water generated from east Delhi, Noida and Sahibabad and joins the river through Shahdara drain.

Table-I Different Segments of River Yamuna

River Segment	Segment Area	Segment Length
Himalayan Segment	From Origin to Tajewala Barrage	172 Km
Upper Segment	From Tajewala Barrage to Wazirabad Barrage	224 Km
Delhi Segment	From Wazirabad to Okhla Barrage	22 Km
Eutrophicated Segment	From Okhla Barrgage to Chambal Confluence	490 Km

Diluted Segment	Chambal Confluence to Ganga Confluence	468 Km

The pollution menace

Delhi has been identified with 26 industrial areas contributing their load to the river Yamuna. The river has been getting a large amount of partially treated and untreated wastewater during its course through National Capital Territory (NCT) of Delhi,(Figure II and III).
The biological system of the river is completely destroyed and mixing of different inorganic and organic chemicals makes Yamuna water a complex chemical matrix which ultimately leads to changes in the compositions of the surrounding soil and ground water. The toxic effect of chemicals not only disturb the biotic components but also effect various structures developed along the Yamuna river bed.

The effect on chemical properties of soil after interaction with pollutants results in change in acidic and alkaline behavior, leaching of toxic cations, flocculation and deflocculation, salinity, ,salt contents, organic matter and mineralogy.

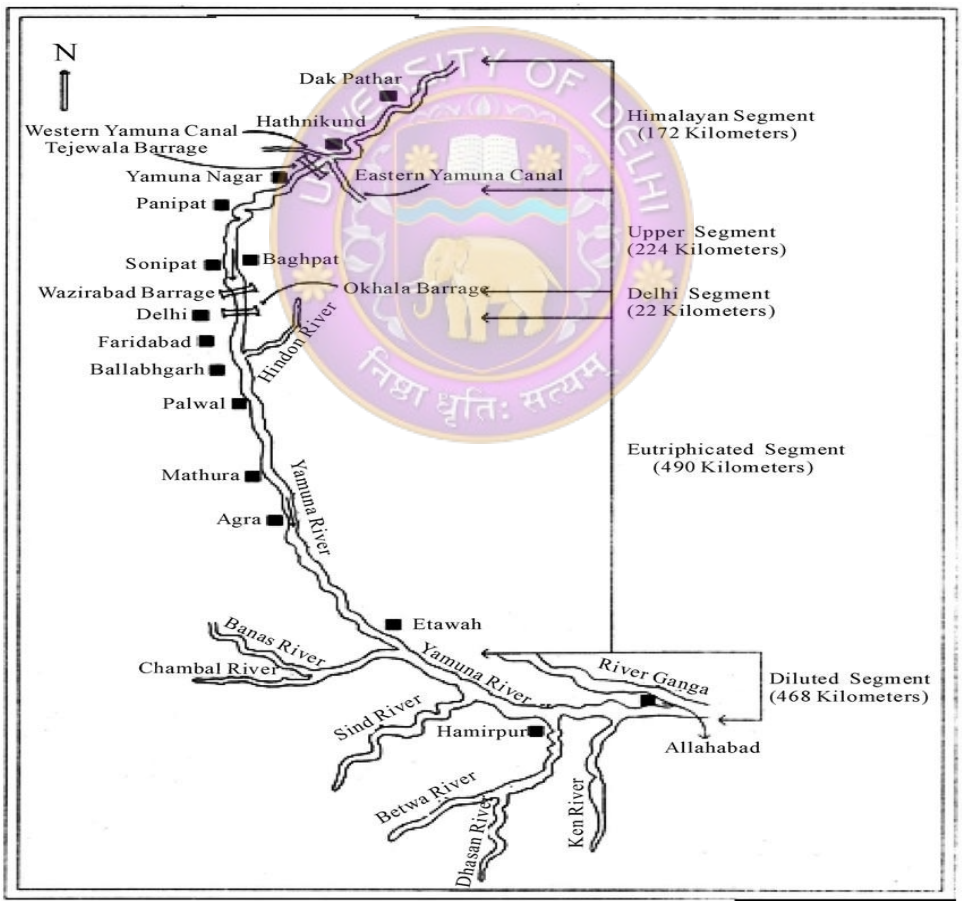


Figure.1 Route map of river Yamuna

According to the Central Pollution Control Board (CPCB) the water quality of Yamuna River falls under the category “E” which makes it fit only for recreation and industrial cooling, completely ruling out the possibility for under-water life . The pollution of the Yamuna River from domestic discharges from Delhi, Ghaziabad,

Noida, Faridabad, Mathura and Agra has rendered the river unfit for any use. Yamuna's water quality in the Himalayan segment and in the segment after confluence with the Chambal river is relatively better. In Delhi around 3296 MLD (million litres per day) of sewage by virtue of drains out falling in Yamuna and approximately 3.5 lakh people live in the 62000 'Jhuggis' that have come up on the Yamuna river bed and its embankment.

Figure-II and III Showing Pollution of Yamuna River

METHODOLOGY

Based on comprehensive field survey various locations have been selected in NCT region of Delhi and collected contaminated and blank soil samples. In the first phase of study, area along Yamuna river bank. stretched up to 20 km in NCR was chosen.

Table-II Location of the Sampling Points

Sample. No.	Sampling Location
S-1	Up Stream of Wazirabad Barrage , Jagatpur Village (R/B)
S-2.	Down Stream Wazirabad Barrage, Left Bank (L/B)
S-3	Blank soil sample from 300 meter away from down stream Wazirabad Barrage
S-4	ITO barrage, Down Stream , (R/B)
S-5	Blank soil sample from 300 meter away from down stream ITO Barrage
S-6	Blank soil sample from 300 meter away from down streamNizamuddin Barrage
S-7	OkhlaBarrge, Down Stream, (R/B), KalindiKunj

VISUAL OBSERVATION

Fig.IV-XIII Showing sampling and in situ testing

The work has been performed in the laboratories of Chemistry department of Dyal Singh College, University of Delhi as well as in the laboratories of Central soil and materials research station (CSMRS), Ministry of water resources, New Delhi .The sample collected were analyzed for their physico-chemical properties using different volumetric, gravimetric and instrumental analytical procedures as per BIS, ASTM standards. (Table III and IV)

Table-III

CHEMICAL PARAMETERS	IS: CODE
pH	IS:2720-1987
Total soluble salts	IS:2720, part-27
Water soluble Sulphate	IS:2720-1977
Water soluble Chloride	BS codes
Organic Matter	IS:2720, part-22, -1972
Calcium Carbonate	IS:2720-1976
Cation Exchange capacity (CEC)	IS:2720-1976

Table-IV

ENGINEERING PARAMETERS	IS :CODE
Methods of test for soils Preparation of dry soil samples for various tests	IS 2720 : Part I : 1972
Soil Classification	IS:1498-1970
Mechanical Analysis (Particle size distribution)	IS:2720, part-4,1975
Atterbergs Limit	IS:2720, part-5-1979
Compaction test	IS: 2720 ,Part 8) – 1983
Relative density test	IS: 2720 ,Part 14) - 1983
Soil Permeability	IS:2720, part-17-1985
Shear Strength	IS: 2720,Part 11-1971
Specific Gravity	IS:2720

Sample No.	Sampling Location	pH	Conductivity µmhos/cm	Salinity %	Calcium Carbonate Content %	Organic Matter % by wt.	Water soluble Chloride % by wt.	Water soluble sulphate % by wt	Cation exchange capacity meq/100 gram
S-1	Up Stream of Wazirabad Barrage , Jagatpur Village (R/B)	7.35	105	0.1	1.5	0.15	0.02	0.015	7.0
S-2.	Down Stream Wazirabad Barrage, Left Bank (L/B)	7.38	185	0.1	2.5	0.39	0.038	0.030	6.0
S-3	Blank soil sample from 300 meter away from down stream Wazirabad Barrage	7.40	89	0.1	2.0	0.20	0.035	0.028	12.5
S-4	ITO barrage, Down Stream , (R/B)	7.82	402	0.4	5.0	4.06	0.099	0.110	9.8
S-5.	Blank soil sample from 300 meter away from down stream up stream ITO Barrage	7.50	135	0.1	4.0	0.48	0.042	0.057	10.6

S-6	Blank soil sample from 300 meter away from down stream Nizamuddin Barrage	7.61	150	0.2	3.5	0.73	0.003	0.047	16.4
S-7	Okhala Barrage, Down Stream, (R/B), Kalindi Kunj	8.69	555	0.6	7.2	6.0	0.152	0.162	8.9

Table-V Chemical analysis of soil samples from Yamuna river bed

The results of chemical analysis of contaminated soils are presented in Table V

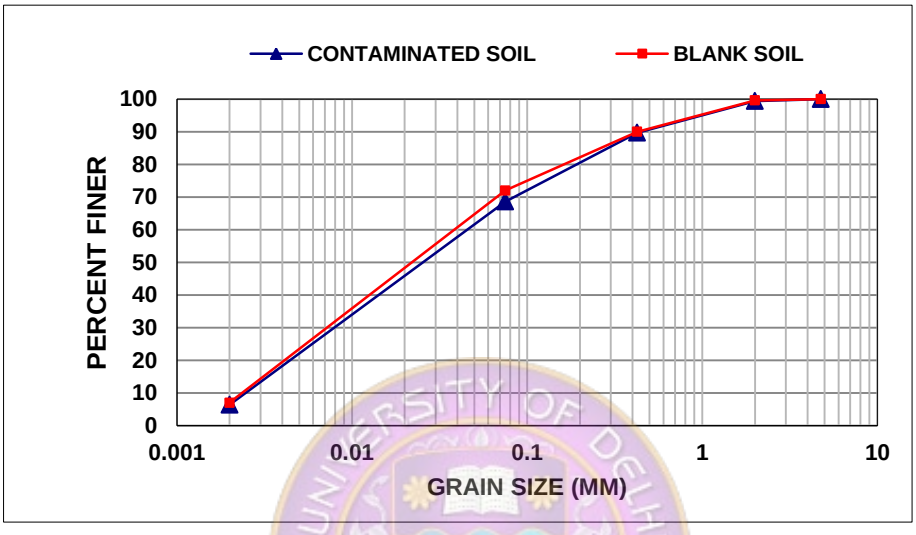
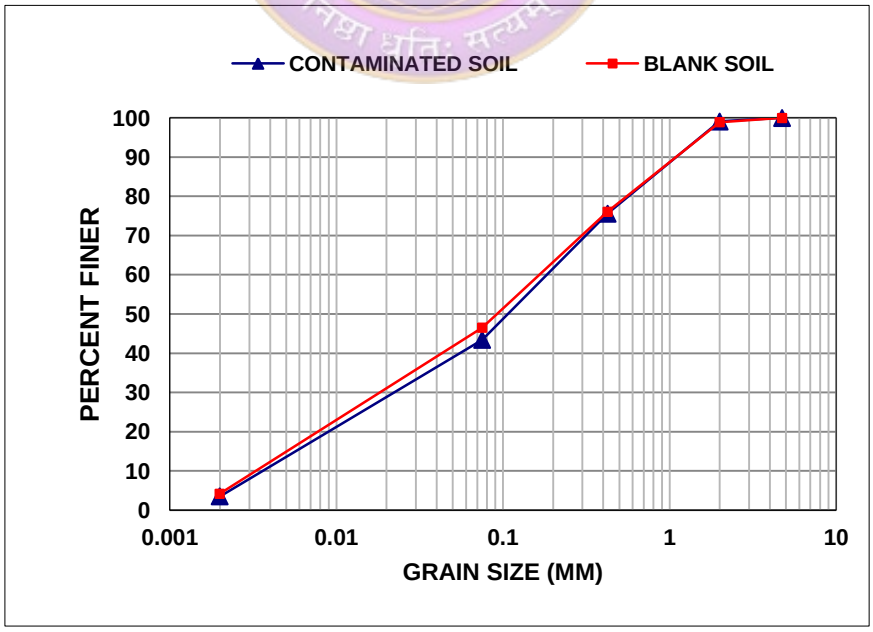


Figure- XIV: Mechanical analysis results of Down Stream Wazirabad Barrage, Left Bank (L/B) S-4 and blank soil sample (S-5)



Figue-XV: Mechanical analysis results of ITO barrage down stream (R/B) S-13 and blank soil sample (S-14)

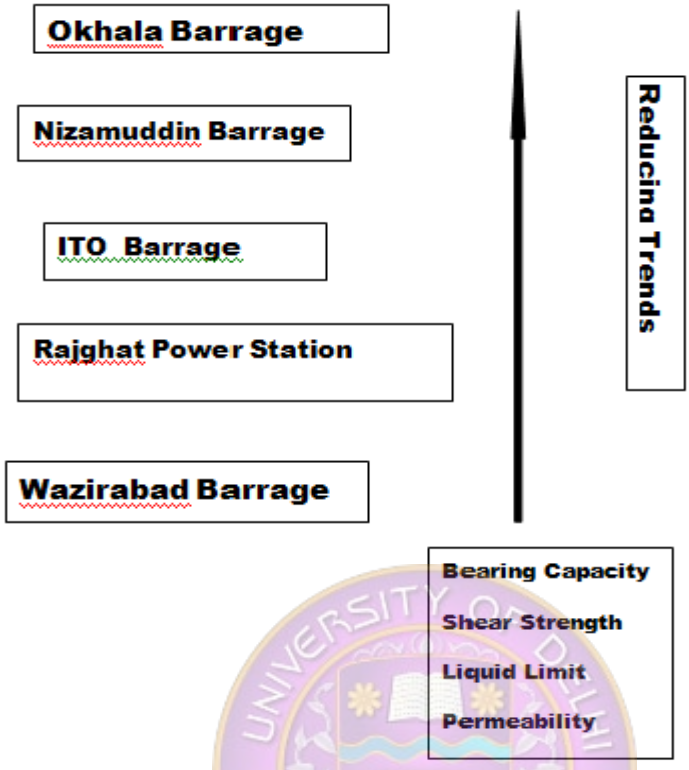


Figure-XVI Showing Decreasing Trends of Engineering Properties from Wazirabad to Okhla.

DISCUSSION

The results presented in Table-V shows that there an increasing pattern of concentration of various chemical parameters starting from Wazirabad to Okhla barrage. The value of pH is shows mostly alkaline nature. The increase in total soluble salts contents was also observed. The similar trends were also observed for other parameters. Which might be due to increasing pollutant concentration down stream of Wazirabad.

The results of Mechanical properties of contaminated soils are presented in figure. XIV and XV. It was observed that particle size of contaminated soils will shifts towards more finer fractions compare to blank soil samples. The soil pollutant interactions leads to weathering actions which finally changes the mineralogical compositions of contaminated soils.

The effect of change in chemical environment due to pollutants also results in to decreasing strength properties of soils. The reducing trend was observed for various engineering properties from Wazirabad to Okhla as presented in figure-XVI.

The strength characteristics of soil are affected extensively due to change in soil's internal structure and mineralogy.

CONCLUSION

The results shows that the effect of different contaminants are quite significant in form of change in pH, total soluble salt content, organic matter, water soluble sulphate and water soluble chloride contents. Due to the leaching of cations and deflocculation the consistency characteristics of the soil is also reduced.

The strength characteristics of soil are affected extensively due to change in soil's internal structure and mineralogy.

The data obtained during the experiments is an indication that alteration in soil properties due to pollutants must be assessed for drawing safe design criteria for upcoming civil engineering structures along Yamuna riverbed and also helps in assessing possible deterioration of existing structures.

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