



SITE CHARACTERIZATION THROUGH SOIL SAMPLE OF DIFFERENT GHATS OF ALLAHABAD FOR FORENSIC CONSIDERATION

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ABSTRACT

Now days it is significant to utilize amalgamation of independent analytical techniques. In order, to truly portray or characterize between different samples of geological micro evidence in culprit examination. Ganga and Yamuna are the two major rivers of India which after flowing through different regions meets at a common region called Sangam of Uttar Pradesh. Aarael, Saraswati, Kali mandir and Gau are the Ghats of Yamuna River while Ram, Sangam, Kali and Dashashvamedh are the Ghats of Ganga River at Allahabad. The geology of the region is intricate and numerous substances are carried by the Ganga and Yamuna River and leave behind in the region. To characterize these Ghats for forensic consideration (including criminal and environmental), soil samples were accumulated from various Ghats of Yamuna River such as Aarael Ghat, Saraswati Ghat, Kali Mandir Ghat, Gau Ghat and Ghats of Ganga Ram Ghat, Sangam Ghat, Kali Ghat and Dashashvamedh Ghat, examined using a combination of forensic geological techniques principally colour, odor, particle size distribution, pH, microscopical observation, sedimentation duration, density determination and chemical examination. In the study, the result established give out homogenous data throughout the profile in all the characteristics analyzed. The research indicate that the amalgamation of different, autonomous techniques used to characterize sediments from the both river banks can accord significantly to future forensic investigation.

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INTRODUCTION

Soil is the medium present on surface of earth which supports plant growth. Soil is mainly made up of weather-beaten rock, but it also possesses air, bacteria, water and humus. It is the soil formation process which makes all soils unique. Soil is class evidence; it cannot be individualized to an appropriate region. Every soil type has unique characteristics, which acts as identification marker. Soils differ within a few meters horizontally or vertically differ and can be easily transferred from one location to another. Forensic scientists are using unique characteristics of soil to solve crimes. General make up sand, silt, or clay of soil are analyzed and then its mineral and chemical composition are also analyzed.

METHODOLOGY

Collection of samples

Samples of soil from different four Ghats of Yamuna and four Ghats of Ganga River at Allahabad were collected. From each Ghats of Yamuna and Ganga river four soil samples were collected i.e., Aarael Ghat (SY₁, SY₂, SY₃ and SY₄), Saraswati Ghat (SY₁, SY₂, SY₃ and SY₄), Kali mandir Ghat (SY₁, SY₂, SY₃ and SY₄) and Gau Ghat (SY₁, SY₂, SY₃ and SY₄) of Yamuna river and from Ram Ghat (SG₁, SG₂, SG₃ and SG₄), Dashashvamedh Ghat (SG₁, SG₂, SG₃ and SG₄), Kali Ghat (SG₁, SG₂, SG₃ and SG₄) and Sangam Ghat (SG₁, SG₂, SG₃ and SG₄) of Ganga river. After collection of soil samples from different Ghat of Yamuna and Ganga River, it was analyzed for colour, odour, texture, specific gravity, pH, sedimentation

and examined for animal, plant debris and chemical test performed for detecting insoluble carbonates.

Colour determination by matching each soil samples with Munsell soil colour chart

Soil color is registered by comparison of a standard color chart known as Munsell book of colors. Munsell notation distinguishes three characteristics of the color the hue, value and chroma. Each soil samples were compared with the standard color chart of 10 YR and the color of soil with its chroma and value were noted.

Odour determination

Soil smells due to the production of two small molecules by small organism geosmin and 2-methylisoborneol (MIB), Vass (2002). These compounds are mostly produced by bacteria belonging to the genus *Streptomyces*. Presence of which was detected in some soil samples

Texture examination by performing particle size distribution analysis

For determining the particle size of the soil samples five sieves of mesh size- 90micron, 125micron, 180micron, 355micron, 710micron were used, 40gm of each soil sample from all the Ghats was taken and sieved for a fixed duration of 3min., after that the amount of soil retained on each sieve was weighed one by one. The sieve retaining maximum amount of soil upon it denotes the particle size of that soil.

Determination of presence of plant or animal debris and structure of soil particles under microscope

Analysis of organic components of soil can provide complementary and independent types of information about its geological origin, dominant vegetation, management and environment, Dawson and Stephen (2010) same was observed under the compound microscope by placing small amount of soil sample on microscopic slides.

pH measurement by digital pH meter

For measuring the pH value of each soil sample a buffer solution was prepared by dissolving a buffer capsule of range 1-7 in 100ml distilled water and shaken vigorously till it completely dissolves into it. Labeled soil samples were weighed on weighing machine 1.8 gm and were mixed in 50ml distilled water. Filtered and tested for its pH value by pH meter.

Sedimentation rate analysis

Complete settlement time of soil samples was noted by placing 2 gm of measured soil sample in 10ml graduated cylinder filled with 10ml acetic acid.

Specific gravity test for fine aggregate of soil through density bottle method

This test is performed to determine the specific gravity of fine-grained soil by density bottle method as per IS: 2720 (part 3/sec 1) - 1980. Density bottle of 25ml and prepared soil sample (5gm) was kept inside hot air oven separately to completely dry, then density bottle was weighed. Soil samples

were put inside the density bottle with the help of funnel and filled with distilled water about half of the density bottle and closed with stopper and kept as such for about 2 to 8 hour depending upon the soil. After that samples were kept upon water bath for about 1 hour to maintain the temperature of density bottle and soil to 27 C and then samples were weighed and readings were noted. After that density bottle was filled with distilled water value was noted, then various values were put in the following formula to calculate the specific density of each soil sample.

$$\text{Specific gravity} = \frac{W_a}{(\text{weight of density bottle filled with distilled water} - \text{weight of density bottle}) + (\text{weight of density bottle} + \text{soil after water bath} - (\text{weight of density bottle} + \text{soil}))}$$

with distilled water – weight of density bottle)- (weight of density bottle+ soil after water bath – (weight of density bottle + soil)

Microscopical observation of soil with chemical reagents

A small portion of soil sample was moistened with water and a small amount of Conc. HCl was added to it and nature of reaction as- bubbles and colour was absorbed.

RESULTS

Odour

Odour detected in all the soil samples of Kali Mandir and Gau Ghat including a sample of Saraswati Ghat while odour was not detected in any soil samples of Ghat of Ganga River.

Specific gravity determination

Specific gravity of Aarael Ghat at 27 C - SY₁ is 1.47, SY₂ is 1.13, SY₃ is 1.31 and SY₄ is 1.28 g/cm³.

Specific gravity of Saraswati Ghat at 27 C - SY₁ is 1.25, SY₂ is 2.94, SY₃ is 2.08 and SY₄ is 1.92 g/cm³.

Specific gravity of Kali Mandir Ghat at 27 C of SY₁ is 2.77, SY₂ is 2.63, SY₃ is 1.13 and SY₄ is 2.27 g/cm³.

Specific gravity of Gau Ghat at 27 C - SY₁ is 1.92, SY₂ is 2.63, SY₃ 2.17 is and SY₄ is 2 g/cm³.

Specific gravity of Ram Ghat at 27 C - SG₁ is 1.78, SG₂ is 2.77, SG₃ is 2.63 and SG₄ is 2.63 g/cm³.

Specific gravity of Sangam Ghat at 27 C of SG₁ is 2.27, SG₂ is 2.17, SG₃ is 2.63 and SG₄ is 2 g/cm³.

Specific gravity of Kali Ghat at 27 C - SG₁ is 1.78, SG₂ is 2.77, SG₃ is 2.63 and SG₄ is 2.63 g/cm³.

Specific gravity of Dashashvamedh Ghat at 27 C - SG₁ is 1.92, SG₂ is 2.63, SG₃ 1.66 is and SG₄ is 3.12 g/cm³.

Microchemical test

Presence of insoluble carbonates such as chalk, dolomite or limestone was observed in all the soil samples of Aarael, Saraswati, Kali Mandir, Gau Ghat of Yamuna River. Presence of insoluble carbonates such as chalk, dolomite or limestone was observed in all soil samples of Sangam Ghat while same was absent in all soil samples of Ram, Kali, Dashashvamedh Ghat of Ganga River.

DISCUSSION

The characterization of Ghats was performed by colour observation by referring to revised standard soil color chart.

Table 3.1 Observed color of soil samples of Ghats of Yamuna based on Munsell soil color chart-

Collection site of soil samples	Munsell soil colour chart used to compare soil colours	Result obtained through standard Munsell soil colour chart of various samples in the form of ratio of their value and chroma			
		SY ₁	SY ₂	SY ₃	SY ₄
Aarael Ghat	10YR	Value-7	Value-7	Value-7	Value-6
		Chroma-1	Chroma-1	Chroma-1	Chroma-1
		Ratio-7/1	Ratio-7/1	Ratio-7/1	Ratio-6/1
Saraswati Ghat	10YR	Value-6	Value-6	Value-6	Value-6
		Chroma-4	Chroma-4	Chroma-4	Chroma-4
		Ratio-6/4	Ratio-6/4	Ratio-6/4	Ratio-6/4
Kali Mandir Ghat	10YR	Value-3	Value-3	Value-3	Value-3
		Chroma-2	Chroma-3	Chroma-3	Chroma-3
		Ratio-3/2	Ratio-3/3	Ratio-3/3	Ratio-3/3
Gau Ghat	10YR	Value-3	Value-3	Value-3	Value-3
		Chroma-4	Chroma-4	Chroma-4	Chroma-4
		Ratio-3/4	Ratio-3/4	Ratio-3/4	Ratio-3/4

Table 3.2 Observed color of soil samples of Ghats of Ganga based on Munsell soil color chart

Collection site of soil samples	Standard Munsell soil colour chart used to compare soil colours	Result obtained through standard Munsell soil colour chart of various samples in the form of ratio of their value and chroma			
		SG ₁	SG ₂	SG ₃	SG ₄
Ram Ghat	10YR	Value-5	Value-5	Value-5	Value-5
		Chroma-2	Chroma-2	Chroma-2	Chroma-2
		Ratio-5/2	Ratio-5/2	Ratio-5/2	Ratio-5/2
Sangam Ghat	10YR	Value-5	Value-4	Value-5	Value-5
		Chroma-1	Chroma-1	Chroma-1	Chroma-1
		Ratio-5/1	Ratio-5/1	Ratio-5/1	Ratio-5/1
Kali Ghat	10YR	Value-7	Value-7	Value-7	Value-7
		Chroma-1	Chroma-1	Chroma-1	Chroma-2
		Ratio-7/1	Ratio-7/1	Ratio-7/1	Ratio-7/2
Dashashvamedh Ghat	10YR	Value-6	Value-6	Value-6	Value-6
		Chroma-1	Chroma-1	Chroma-2	Chroma-1
		Ratio-6/1	Ratio-6/1	Ratio-6/1	Ratio-6/1

Table 3.4- Calculated values of particle size of soil samples of Aarael Ghat (Yamuna River)

I.S sieve size(in mm)	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SY ₁	SY ₂	SY ₃	SY ₄	Average			
0.180	4	3.7	2.7	2.8	3.3	8.25	8.25	91.75
0.125	18.5	17.1	12.6	5	13.3	33.25	41.5	21.57
0.090	14	15.1	21.9	27.5	19.62	49.05	90.55	9.45
Pan	3.5	4.1	2.8	4.7	3.77	9.42	99.97	0.03

Table 3.5- Calculated values of particle size of soil samples of Saraswati Ghat (Yamuna River)

I.S sieve size(in mm)	Weight of fine aggregate of soil retained(in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SY ₁	SY ₂	SY ₃	SY ₄	Average			
0.180	2	12.1	17	31.8	15.72	39.3	39.3	60.7
0.125	2.9	9.1	1.6	0.6	3.55	8.87	48.17	51.83
0.090	12.5	11.8	4.6	0.6	7.37	18.42	66.59	33.41
Pan	22.6	7	16.8	7	13.35	33.37	99.96	0.04

Table 3.6- Calculated values of particle size of soil samples of Gau Ghat (Yamuna River)

I.S sieve size	Weight of fine aggregate of soil retained(in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SY ₁	SY ₂	SY ₃	SY ₄	average			
0.180mm	28.8	27.8	29.3	13.9	24.95	62.37	62.37	37.63
0.125mm	4.9	3.7	4.6	8.8	5.5	13.75	76.12	23.88
0.090mm	4	6	2.9	11.6	6.125	15.31	91.43	8.57
Pan	2.3	2.5	3.2	5.5	3.375	8.43	99.86	0.14

Table 3.7- Calculated values of particle size of soil samples of Kali mandir Ghat (Yamuna River)

I.S sieve size	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing (%)
	SY ₁	SY ₂	SY ₃	SY ₄	Average			
0.180mm	5.0	6.5	5.1	1.8	4.6	11.5	11.5	88.5
0.125mm	8.0	4.1	7.4	5.8	6.325	15.81	27.31	72.69
0.090mm	18.9	22.4	16.2	19.9	19.35	48.37	75.68	24.32
Pan	8.1	7.0	11.3	12.5	9.725	24.31	99.99	0.1

Table 3.8- Calculated values of particle size of soil samples of Ram Ghat (Ganga River)

I.S sieve size	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SG ₁	SG ₂	SG ₃	SG ₄	Average			
0.180mm	16.6	20.2	16.5	21	18.53	46.32	46.32	53.68
0.125mm	10.8	6.7	6	5.2	7.175	17.92	64.24	35.76
0.090mm	10.0	10.1	10.6	8.6	9.825	24.56	88.80	11.2
Pan	2.6	3.0	6.9	5.2	4.425	11.06	99.86	0.14

Table 3.9- Calculated values of particle size of soil samples of Sangam Ghat (combination of Yamuna and Ganga River)

I.S sieve size	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SG ₁	SG ₂	SG ₃	SG ₄	Average			
0.180mm	16.6	20.2	16.6	22	18.85	47.1	47.1	52.9
0.125mm	10.4	6.7	6	5.2	7.07	17.6	64.7	35.3
0.090mm	10.2	10.1	10.6	7.5	9.6	24	88.7	11.3
Pan	2.8	3	6.8	5.3	4.47	11.17	99.87	0.13

Table 3.10- Calculated values of particle size of soil samples of Kali Ghat (Ganga River)

I.S sieve size	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SG ₁	SG ₂	SG ₃	SG ₄	Average			
0.180mm	1.8	9.9	0.8	14	6.62	16.5	16.5	83.5
0.125mm	11.1	14.4	7.1	10.3	10.8	27	43.5	56.5
0.090mm	19.2	14.7	12.1	13	14.67	36.5	80	20
Pan	7.9	1.0	20	2.7	7.9	19.75	99.75	0.25

Table 3.11- Calculated values of particle size of soil samples of Dashashvamedh Ghat (Ganga River)

I.S sieve size	Weight of fine aggregate of soil retained (in gm)					Percentage retained	Cumulative percentage retained	Percent passing
	SG ₁	SG ₂	SG ₃	SG ₄	Average			
0.180mm	17.2	2.8	2	0.3	5.57	13.92	13.92	86.08
0.125mm	7.9	13.1	4.4	1.7	6.77	16.67	30.59	69.41
0.090mm	10.4	17.9	29.3	18.2	18.95	47.37	77.96	22.04
Pan	2.5	6.8	6.6	18.4	8.57	21.42	99.38	0.62

Table 3.12 Measured pH data of soil sample of Yamuna Ghats

Collection site of sample	Range of buffer solution	Room temperature	SY ₁	SY ₂	SY ₃	SY ₄
Aarael Ghat	1-7	15°C	7.18	7.27	7.24	7.02
Saraswati Ghat	1-7	15°C	8.59	8.01	8.61	8.64
Kali mandir Ghat	1-7	15°C	7.23	7.85	7.92	7.81
Gau Ghat	1-7	15°C	7.67	8.08	7.38	7.58

Table 3.13 pH data of soil samples of Ganga Ghats

Collection site of sample	Range of buffer solution	Room temperature	SG ₁	SG ₂	SG ₃	SG ₄
Ram Ghat	1-7	20°C	6.94	7.59	8.02	8.44
Sangam Ghat	1-7	20°C	6.84	7.59	8.02	8.44
Kali Ghat	1-7	20°C	6.90	6.95	6.77	6.87
Dashashvamedh Ghat	1-7	20°C	6.94	6.92	6.90	6.96

Table 3.14 Observed sedimentation time of soil samples of Yamuna Ghats

Sample's origin	Volume of graduated cylinder	Volume of acetic acid taken	Time taken for complete sedimentation SY ₁	Time taken for complete sedimentation SY ₂	Time taken for complete sedimentation SY ₃	Time taken for complete sedimentation SY ₄
Aarael Ghat	10ml	10ml	2min. 00sec	2min03sec	2min.00sec	3min.01sec
Saraswati Ghat	10ml	10ml	8min. 06sec	4min.56sec	6min.08sec	5min.49sec
Kali mandir Ghat	10ml	10ml	5min. 25sec	8min.08sec	6min. 57sec	2min.48sec
Gau Ghat	10ml	10ml	5min.08sec	5min.11sec	8min.09sec	7min.45sec

Table 4.16 Observed sedimentation time of soil samples of Ganga Ghats

Sample's origin	Volume of graduated cylinder	Volume of acetic acid	Time taken for complete sedimentation SG ₁	Time taken for complete sedimentation SG ₂	Time taken for complete sedimentation SG ₃	Time taken for complete sedimentation SG ₄
Ram Ghat	10ml	10ml	2min.29sec.	2min.11sec.	6min.1sec.	5min. 52sec.
Sangam Ghat	10ml	10ml	4min.1sec.	6min.1sec.	2min.1sec.	1min.11sec.
Kali Ghat	10ml	10ml	29sec.	38sec.	6min.41sec.	1min.6sec.
Dashashvamedh Ghat	10ml	10ml	59sec.	2min.6sec.	1min40sec	1min.20sec.

Table 3.15 Comparative table for all the parameters used to characterize all the Ghats of Ganga River.

Examined Parameters	Ram Ghat				Sangam Ghat				Kali Ghat				Dashashvamedh Ghat			
	SG ₁	SG ₂	SG ₃	SG ₄	SG ₁	SG ₂	SG ₃	SG ₄	SG ₁	SG ₂	SG ₃	SG ₄	SG ₁	SG ₂	SG ₃	SG ₄
Colour	greyish yellow brown	greyish yellow brown	greyish yellow brown	greyish yellow brown	brownish grey	brownish grey	brownish grey	brownish gray	light grey	light grey	light grey	light grey	brownish h gray	brownish h gray	brownish gray	brownish gray
Odour	absent	absent	absent	absent	Absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
pH values	6.94	7.59	8.02	8.44	7.59	8.02	8.44	8.64	6.90	6.95	6.77	6.87	6.94	6.92	6.90	6.96
Specific gravity	1.78 g/cm ³	2.77 g/cm ³	2.63 g/cm ³	2.63 g/cm ³	2.27 g/cm ³	2.17 g/cm ³	2.63 g/cm ³	2 g/cm ³	1.78 g/cm ³	2.77 g/cm ³	2.63 g/cm ³	2.63 g/cm ³	1.92 g/cm ³	2.63 g/cm ³	1.66 g/cm ³	3.12 g/cm ³
Chemical test for Presence of insoluble carbonates	Negative	negative	Negative	negative	negative	negative	Negative	negative	negative	Negative	negative	negative	Negative	negative	negative	Negative
Sedimentation rate	2min. 29sec.	2min. 1sec.	6min. 29sec.	5min. 52sec.	4min. 1sec.	6min. 1sec.	2min. 1sec.	1min. 11sec.	29sec.	38sec.	6min. 41sec.	1min. 6sec.	59sec.	2min. 6sec.	1min. 40sec.	1min. 20sec.

Table 3.16 Comparative table for all the parameters used to characterize all the Ghats of Yamuna River.

Examined Parameters	Aarael Ghat				Saraswati Ghat				Kali Mandir Ghat				Gau Ghat			
	SY ₁	SY ₂	SY ₃	SY ₄	SY ₁	SY ₂	SY ₃	SY ₄	SY ₁	SY ₂	SY ₃	SY ₄	SY ₁	SY ₂	SY ₃	SY ₄
Colour	light gray	light gray	light gray	Brownish gray	Dull yellowish orange	Dull yellowish orange	Dull yellowish orange	Dull yellowish orange	Dark brown	Brownish black	Brownish black	Brownish black	Dark brown	Dark brown	Dark brown	Dark brown
Odour	absent	absent	absent	absent	absent	present	absent	absent	present	present	present	present	present	present	present	present
pH value	7.18	7.27	7.24	7.02	8.59	8.01	8.61	8.64	7.23	7.85	7.92	7.81	7.67	8.08	7.38	7.58
Specific gravity	1.47g/cm ³	1.13g/cm ³	1.31 g/cm ³	1.28g/cm ³	1.25 g/cm ³	2.94 g/cm ³	2.08 g/cm ³	1.92g/cm ³	2.63g/cm ³	1.13 g/cm ³	2.27 g/cm ³	2.63 g/cm ³	1.92 g/cm ³	2.63 g/cm ³	2.17 g/cm ³	2 g/cm ³
Chemical test for Presence of insoluble carbonates	Positive	Positive	Positive	Positive	positive	positive	Positive	Positive	Positive	Positive	positive	Positive	positive	positive	positive	Positive
Sedimentation rate	2min. 00sec	2min. 3sec.	2min. 00sec	3min. 01sec	8min. 06sec	4min. 56sec	6min. 08sec	5min. 49sec	5min. 25sec	8min. 08sec	6min. 57sec	2min. 57sec	5min. 08. sec	5min. 11sec	8min. 09sec	7min. 45sec

According to which the colour of all the samples of Aarael Ghat and Kali Ghat are of similar colour light gray. All the samples of Saraswati Ghat are dull yellowish orange in colour. All the 3 samples (SY₂, SY₃ and SY₄) of Kali Mandir Ghat are brownish black, while SY₁ of Kali Mandir Ghat and all the four samples of Gau Ghat are dark brown. All samples of Ram Ghat (SG₁, SG₂, SG₃, and SG₄) and SG₄ of Sangam Ghat are greyish yellow brown. SG₁, SG₂, SG₃ of Sangam and all the four samples of Dashashvamedh Ghat are brownish grey in colour. The samples detected for characteristic odour in a study of Vass (2002) soil smells due to the production of two small molecules by small organism geosmin and 2-methylisoborneol (MIB). Presence of which was detected in SY₂ soil sample of Saraswati Ghat and all the four samples of Gau Ghat, Kali Mandir Ghat. The soil samples were also subjected to texture examination by performing particle size distribution analysis as described in Forensic physics manual (2005) by Directorate of Forensic Science, Ministry of Home affairs. Which suggested that the I.S sieve size retaining the maximum amount of soil on it denotes the particle size of that particular soil as it was observed that SY₃, SY₄ of Aarael Ghat, SY₁ of Saraswati Ghat, SY₁, SY₂, SY₃, SY₄ of Kali Mandir Ghat and SG₁, SG₂, SG₃, SG₄ of Kali Ghat and SG₂, SG₃, SG₄ of Dashashvamedh Ghat, all comes out to be of 0.090mm. SY₂, SY₃, SY₄ of Saraswati Ghat, all the samples of Gau Ghat, Ram Ghat and Sangam Ghat comes out to be of 0.080mm. I.S sieve size or it can be said that it is made up of fine sand.

Two samples of Aarael Ghat SY₁ and SY₂ differ from all the samples as its examined sieve size was 0.125mm or made up of very fine sand, as compared to the WRB Soil Particle Size Classification System. All samples were examined for presence of plant and animal debris under microscope and also observed for their crystal structure. SY₄ of Gau Ghat is marked with presence of animal debris shell silica and hairs. Plant debris was found in SG₃ of Kali Ghat, and also in all the samples of Dashashvamedh Ghat. All soil samples were subjected to pH determination by digital ph meter and pH values were compared to the soil pH ranges given by United States Department of Agriculture Natural Resources Conservation Service. Soil sample of Aarael Ghat SY₁ to SY₄ and SY₂ of Ram Ghat are neutral to slightly alkaline in nature. All the soil sample of Kali Mandir Ghat and Gau Ghat are neutral, slightly, moderate to strong alkaline. pH values of all the samples of Saraswati Ghat was strongly alkaline in nature, SG₁ of ram Ghat, Sangam Ghat and all the four samples of Kali Ghat and Dashashvamedh Ghat were neutral, SG₃ of Ram Ghat, SG₂ of Sangam Ghat is moderate alkaline, SG₃ and SG₄ of Sangam Ghat and SG₄ of Ram Ghat are strong alkaline in nature. As per IS: 2720 (part 3/sec 1) - 1980 density bottle method is the accurate method for determination of specific gravity of soil, test was performed on all the collected soil samples and it was observed that specific gravity of soil samples of Ghats of Yamuna River as Aarael Ghat ranges between 1.28-1.47g/cm³, Saraswati Ghat 1.25-1.92g/cm³, Kali Mandir Ghat 1.13-

2.77g/cm³, Gau Ghat 1.92-2.63g/cm³ and Ghats of Ganga River as Ram Ghat lies between 1.78-2.77g/cm³, Kali Ghat 1.78-2.77g/cm³, Dashashvamedh Ghat 1.92-3.12g/cm³, Sangam Ghat 2-2.63g/cm³. Microchemical observation with chemical reagents was also performed for characterization of Ghats. As suggested in the practical manual of forensic physics (2005) by Directorate of Forensic Science, Ministry of Home affairs, formation of bubbles on addition of Conc. HCl on moistened soil sample is indication of presence of insoluble carbonates in soil, as same is observed in all the soil samples of Ghats of Yamuna River.

Conclusion

Study concluded that colour, odour, pH values and microchemical test for presence of insoluble carbonates of soil samples of Yamuna river Ghats shows variation from soil samples of Ghats of Ganga river when Ghats of both river were compared across the entire sample profiling. The data described here presents a complete characterization of rivers banks of Ganga and Yamuna in terms of their colour, specific gravity and sedimentation duration.

These data could be used to compare soil or sand of Ghats of Yamuna and Ganga River with sand or soil from other locations. The data from this study could be used as an investigative benefit in forensic interrogations including sand and soil.

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