CHAPTER - 3

A FOCUS ON SOIL AND ITS POLLUTION BY CEMENT DUST
3.1 Soil and its properties
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Nature mainly consists of three substances air, water and soil. An imbalancing of any of three causes major problems in natural processes. Soil is the medium of many substances but for agriculturists, it is most important medium for growing plants.

3.1 SOIL AND ITS PROPERTIES:

The word soil is derived from a Latin word solum, which means earthy material in which plants grow. Soil is one of the most significant ecological factor, which is derived from the transformation of surface rocks. It is nothing but soil on which plants depends for thier nutrients, water and mineral supply and anchorage. It constitutes an important medium wherein numerous animals live. In fact, soil of a nation is its most valuable material heritage.¹

Soil system is indeed very complex and dynamic. Soil is actually formed as a result of ion term process of complex interactions, disintegration and decomposition of rocks due to weathering leading to the production of mineral matrix in close association with interstitial organic matter.

Soil profile:

Soil profile is the term used for the vertical section of mature soil upto the parental material to show different depths, different compositions and natures. Normally three main horizon or groups of horizons can be recognised. These are the upper horizon or ‘A’ horizon, middle horizon or ‘B’ horizon and ‘C’ horizon. Some workers recognized an additional horizon called organic or ‘O’ horizon, above the ‘A’ horizon. These horizon are often divided by the use of appropriate subscripts such as O₁, A₁, O₂, A₂, A₃ and so on.²
A horizon designates the top stratum which is subjected to marked leaching. It is a layer of greatest biological concern as the plant. Roots, small animals and microflora and fauna are found here most densely. In this zone the concentration of the organic matter is highest, and hence it is the dominant reservoir for the plant nutrients.

The 'B' horizon or the sub soil lying under 'A' horizon has little organic matter, very few plants, roots and a sparse microflora and fauna. In it iron and alluminium compounds are often accumulated 'A' and 'B' horizons collectively represent the true soil. In this layer the organic matters are present in small amounts and little or no life is noted.

**Soil formation:**

The soil profile is formed by interaction of various pedogenic factors under special set of conditions. The following fundamental processes namely humification and eluviation and illuviation develop a soil profile.³

Humification : Top layer of the soil called 'A' horizon contains abundant dead remains of plants, animal and products of microbial metabolism, these products undergo decomposition which may produce some soluble organic compound and some amorphous incompletely decomposed black colored organic residue, the humus. The process of humus formation is called humification. The humus of organic compounds becomes mixed with the fine particles of weathered rock. Some soluble organic compound are removed from the top soil by water which percolates through humus mixed soil.

Eluviation and illuviation : Water is an important agent which percolates downwardly through mineral and organic substances of 'A' horizon or top soil, It removes a number of soluble chemicals from the soil constituents and is termed as eluviation and the surface layer from which components are lost is called eluvial layer of 'A'horizon. The eluviated substances go more
downwardly and are deposited in the lower zone or 'B' horizon which is called illuvial layer. The process of accumulation of eluviated soil is called illuviation.

The fundamental soil forming processes involved in the development of soil profile are described as below:

Gleyzation: This process takes place in wet and cold. Tundra regions where saline conditions do not exist, in this process there develops a compact structureless and sticky surface layer. This layer is blue green in color, poorly aerated and has reduced content or iron compounds. It favours surface accumulation of peat material and undergoes a series of chemical, physical and biological chancers which produce a characteristic soil.

Podzolisation: In temperate zones where climate is cold and moist, the rate of decomposition is slow, and in the decomposition process, acids are produced which make the soil acidic. The acidic unproductive soil is called podzo and the process is called podzolisation. In the process of podzolisation humus and some minerals including dissolved Si, Fe and Al salts from ‘A’ horizon move downwardly with percolating water and accumulate in the lower horizons. This process is more effective in sandy base poor parent materials under intense and thick vegetational cover.

Laterisation: In tropical and subtropical regions, when rainfall occurs the organic matter and minerals are leached away and hydroxide of alluminium and iron precipitated in the form of residue which is called 'Laterite' and the process is termed as 'laterisation'. In this process silica is completely removed.

Soil Texture:

Mineral fraction of soil consists of particles of various sizes. According to their size, soil particles are grouped into several types. The particle sizes of group are suggested by International Society of Soil
Sciences. The particle types are generally called soil separates or soil fractions. Important characteristics of different soil separates are as follows:

Sand: The fractions of soil consists of loose and friable particles of 2.203 to 0.2 mm. diameter. Sand particles can be seen with unaided eyes. They play less important role in physico chemical activities. When coated with clay, these sand particles take very active part in chemical reactions. Sand increases the size of pore spaces between soil particles and thus, facilitate movement of air and water in the soil.

Silt: It consists of soil particles of intermediate sizes between sand and clay (Diameter range .02 mm. to .002 mm.). Silt, when wet feels plastic, but in dry state feels like flour or talcum. Silty soil has got large exposed surface area than the sandy soil. Silty soil contains significant quantities of nutrients, both organic and inorganic. That is why they are very fertile. Soil, rich in silt process having great water holding capacity, are good for agriculture.

Clay: This soil fraction contains smallest particles (below .002 mm. diameter) which exhibit plasticity and smoothness when wet and hardness when dry. They take very active part in physiochemical reactions of the soil. They have highest water holding capacity. The clay acts as store house for water and nutrients.

**Inorganic and Organic components in Soil:**

The soil is essential silicate mineral, 74.3% of which consists of silicon and oxygen. The common elements in soil are oxygen 46.6%, silicon 7.9%, alluminium 8.1%, iron 5.0%, calcium 3.6%, sodium 2.8%, potassium 2.6% and magnesium 2.1%. Finely divided quartz, SiO₂, commonly occurs in soil.

Among the silicates, orthoclase: KAlSi₃O₈, albite: NaAlSi₃O₈ and epidote: 4 CaO 3 (AlFe)₂O₃ 6SiO₂·H₂O are common components of soil minerals. Iron oxides, FeO(OH), and magnetite, Fe₃O₄, constitute a major
mineral fraction of many soil. In some soils maganese oxide and titanium oxides are relatively abundant, calcium carbonate is also a common soil component.

The clay mineral in soil are secondary minerals, essentially hydrated alluminium and iron silicates, which serve to bind cations such as $\text{Ca}^{2+}$, $\text{Mg}^{2+}$, $\text{Na}^+$, $\text{K}^+$ and $\text{NH}_4^+$, these cations are not leached by water and are available as plant nutrients.

The soil productivity is determined primarily by organic matter, which constitutes less than 5% of the soil. The organic matter provides pool for microorganism, takes part in chemical reactions such as ion exchange, governs the physical properties of the soil, and some times contributes to the weathering of mineral matters.

The biologically active components of organic matter consists of polysaccherides, amino sugars, nucleotides, organic sulphur and phosphorus compounds. The humic material constitute the most important class of complexing agents. They show higher uptake of heavy polyvalent cations.

Both mineral and organic fractions of soil exchange cations. Humus shows very high cation exchange capacity (300-400 mg/100 gm.). The cations in soil are leached by carbonic acid in soil and exchanged for

$$\text{H}^+(\text{Soil}) + \text{Ca}^{2+} + 2\text{CO}_2 + 2\text{H}_2 \rightarrow (\text{Soil}) \text{H}^+ + \text{Ca}^{2+} + (\text{root}) 2\text{HCO}_3^- \quad (1)$$

Thus essential trace level metals are made available to plants as nutrients.

In the cation mineral portion of soil, the metal-oxide surface develops negative charge at high pH and exchanges for anions:

$$\text{O|}[\text{M-OH}^+ + \text{HPO}_4^{2-}] \leftrightarrow \text{M-OPO}_3\text{H}^2+ + \text{OH}^-$$
Macro and micro nutrients

For plants, the essential micronutrients are Boron, Chlorine, Sodium, Copper, Iron, Magenese, Zinc, Vanadium and Molybdenum. These elements are required at trace levels and if present at higher levels, have a toxic effect. Most of these serve as components of essential enzymes some of them such as Chlorine, Magnese, Iron, Zinc and Vanadium are likely to take part in photosynthesis.

The essential macronutrients are Carbon, Oxygen, Nitrogen, Phosphorus, Sulphur, Potassium, Calcium and Magnesium. The atmosphere and water are the sources of Carbon, Hydrogen and Oxygen. Nitrogen may be obtained by some plants, directly from the atmosphere through nitrogen fixing bacteria. The other essential macronutrients are obtained from the soil, N,P,K are commonly added to soil as fertilizer.

Calcium deficiency in soil is due to calcium uptake by plants, leaching by carbonic acid in acid soil, and competition with high level of Sodium, Potassium and Magnesium in alkline soils. Calcium deficient soils are generally treated with lime to provide the required calcium supply for plants.

Magnesium is made available to plants through ion exchanging organic matter or clays which hold magnesium rather strongly, Magnesium deficiency in soil is caused by high levels of calcium, sodium or potassium.

Nitrogen is absorbed by higher plants in form of nitrate ions and is used in protein synthesis including all enzymes, Nitrogen deficiency thus reduces growth and metabolic processes, resulting into yellowing and sometimes reddening of leaves.

Phosphorus is absorbed in form of phosphates and its supply in soil is both through organic compounds and inorganic sources. It is an essential constituents of DNA and is involved in all energy currency ATP contains
phosphates. Its deficiency causes reduced growth, delayed flowering and darkening of leaves.  

Sulphur is similarly supplied through organic and inorganic sources, absorbed as sulphate and its deficiency caused chlorosis of leaves.  

Potassium is an form of minerals and is absorbed directly as K⁺ ion and its deficiency causes root rotting and water balance of plant is disturbed. Magnesium present as Mg salt is absorbed in ionic form and its deficiency causes chlorosis and reduced growth. This element is the essential constituent of chlorophyll.  

3.2 SOIL OF STUDY AREA:  

The soils of the Damoh district classified as medium black soils under the broad classification of Indian soils. The soil formation is related to the interaction effect of cement, vegetation, soil forming material relief and drainage over a length of time. The climate of Damoh district is dry and sub humid. It has relatively medium soil development, as deeper soils modified by leading effect of relief runoff and vegetation. The soil has formed in material from sedimentaries of Vindhyan system consisting of sandstones. Mostly in predominant areas the soils have been derived from the weathered basalt as it is subjected for a long time to the process of weathering. In valley and alluvial plain, soils are formed from the deposited material. Topography effects soil formation through its influence of drainage runoff and erosion.  

The soils of Damoh district area range from recent to relatively old and matured. The recent or young soils have very little or no profile development while matured soils have well distinct horizons. With a view to summarise available information on various relevant aspects considered during the present investigation, a brief review of work carried out so for on
morphological physical and chemical properties of black soil has presented in this chapter:

**General characteristics of Black soils:**

In many parts of the world, apparently similar black soils have been known to occur generally under similar climate where a variety of geological formation exist. Black clay soil of warm regions which are known as Rendzina, Black cotton soils, regur or tirs are having the following features like:

1. Clay texture
2. No alluvial and illuvial horizons
3. Moderated to strong granular structure in upper 15 to 50 cm. becoming blocky or massive below
4. High coefficient of expansion and contraction on wetting and drying respectively
5. Gilgai micro relief
6. Extremely plastic consistancy
7. Exchange complex nearly saturated with calcium or calcium and magnesium
8. Clay minerals predominantly montmorillonite group (2:1 expanding type)
9. Solum more than 25 cm. deep ideally more than 75 cm.
10. Dark colour with low chroma
11. Lot of medium content of organic matter gradually decreasing with depth.
12. Stage of weathering relatively unadvanced or minimum.
Morphological characteristics of Black soil:

For proper understanding of genesis, development, characteristics of soil properties, and influence of environmental factors on soil properties, it is essential to undertake the investigation on the morphological characteristics of soil profile. A brief review is as below:

Soil colour: Colour is one of the most useful and important characteristics for soil identification especially when combined with soil structure. The black colour of the soils was described to iron content, organic or little extent to titanium iron compounds. Black cotton soils are formed under periodic anaerobic conditions. Sorption of organic matter and formation of dark colour was always associated with sorption of cations like Ca$$^{++}$$ and Mg$$^{++}$$ which might contribute to dark colour of clay organic matter complex. The nature of clay mineral is an important factor in formation of dark colour. High exchange capacity of clay is also important factor in the formation of dark clay organic matter complex.

Thickness of horizon: Thickness of a horizon too vary from 110 cm. to 130 cm. and A c horizon from 25 cm. to 40 cm. in case of vertisol and AB horizon 10 to 16 cm. while B horizon at 40 to 60 cm. for inceptisol.

Soil structure: It is concluded that mostly angular blocky structure at all depth was found in black soils. Generally upper part of horizon was sub angular blocky and lower part being more often angular blocky structure. It is also observe that moderate medium sub angular blocky angular to angular blocky structure for A1 & AB horizon, strong medium angular blocky for AC and weak to moderate coarse sub angular blocky for C horizon in case of chrmusterts.

Soil consistance: Consistency of black soil of A1 horizon under dry conditions varied from hard to extremely hard, under moist condition were firm and under wet condition and sticky or very plastic and very sticky. The consistence of AC hrrizon is usually similar to that of A1 horizon.
Soil cracks: The effect of temperature on swelling of clays found that swelling was considerably more in case of montmorillonitic clay of repulsive forces between the particles with increases in temperature.

It is also observed that there was a distinct pattern of drying near the soil surface and cracks walls with water content increasing with depth down and wide distance away from the cracks wall.

Physical properties of black soil:

Physical properties do not change their pattern easily in comparison to chemical properties of soil and hence impart the stable and most useful contribution in soil classification purpose and in the diagnosis management and improvement of cultivated soil.\textsuperscript{12}

Mechanical composition: Black soils are fine textured soils which contain high percentage of clay. Many workers reported that black soils of M.P. from district Jabalpur, Sagar and Damoh has textural variation from clay to silty clay loam. M.P. Soil survey scheme Sagar (1993) studied during soil survey work of Khajari Nala National water block and District Damoh and found clay content 47.75 percent in upper layer and varies 34.75 percent to 54.50 percent in upper layer and varies 34.75 percent to 54.50 percent in lower layers.\textsuperscript{13}

Water holding capacity: Water is a most important factors limiting or influencing the plant growth. Soil moisture also control two other important components which is essential to normal plant growth i.e. soil, air and soil temperature. Crop production is limited more often by an inadequate moisture supply than by any other factor. The capacity to retain moisture is a soil characteristics given much consideration in evaluating land for agriculture use.

The determination of water holding capacity of soil is very essential to have adequate idea of retention of soil moisture.
**Chemical properties of Black soil:**

Chemical properties deal with the chemical composition of soil and indicate about the nature and extent of weathering and stage of development of soils. These properties have a direct bearing on nutrient supply power of soils.

**pH of soil:** Soil reaction is the most important characteristics which influences many physical and chemical properties of soil. Suitabilities of soil a medium for the growth of plant and desirable microorganisms depends upon whether the soil is acidic, neutral or alkaline and therefore this property received special emphasis in soil classification purposes.

The soil reaction plays quite significant role in crop production. Each degree of soil reaction or set of chemical condition in soil, effects plant growth. Soil reaction then may be considered a symptom of the particular chemical condition which caused it and hence it may be used to indicate the possible effect of these conditions on plant growth.

Soil reaction is also useful in diagnosing the soil acidity and the fertilizers to use.

**Electrical conductivity:** Plant growth is deeply related to the total soluble salts of the soil. Plant growth is very sensitive of the soil. It effect the crops by way of nutrition uptake.

The salt content is determined in term of conductivity, electrical conductivity is a direct measure of water soluble salts present in the soil. It is related to total soluble salts depending upon the texture.

**Calcium carbonate:** The presence of CaCO₃ accumulation provides an insite of the vast climate. Movement of soil water in profile is slowed down in presence of Calcium carbonate.

**Organic carbon:** Many important soil properties including absorption and retention of water reserves of exchangeable bases, capacity to supply N,P
and other nutrient element to growing crop, stability of soil structure and reaction that go on during pedogenesis, are dependent to some degree on quantity of organic matter present in soil.

Plant residues are very important part of productive soil. They serve as the sources of food for energy and growth of soil microorganisms. The carbon nitrogen sulphur and phosphorus that are released in acid form during decay, have a solvent action on soil minerals. Thus liberating new supplies of nutrient elements from the soil.

The microorganisms effecting decay and the intermediate organic substances formed during the process, have very marked effects on soil aggregation.

The nature and quantity of vegetation that can be grown on a given piece of land. Strongly on the characteristic of the soil. Soil study for the properties and distribution of soil types is therefore essential both for an understanding of vegetation and for determining strategies and prospects for success in increasing the yield of plant materials used by human society. 14

3.3 EFFECT OF CEMENT DUST ON SOIL PROPERTIES:

Soil is the weathered top surface of earth's crust constituted by mineral matter, sand slit, clay and organic matter in different stages of decomposition microorganisms mixed together in such a way as to have capillary and non capillary pore spaces filed with moisture and air. This is the medium of anchorage and supply of nutrients and water for the plants and in turn the plants are the ultimate sources of food for all animals and man. Thus soil is the basic and most important life support component of biosphere. The effect of pollutants on soil are difficult to evaluate. 14,16

According to Black (1965) and Fitzpaulck (1971) industrial effluents give typical interpretation of soil, because effluent replenish important nutrient of soil and result low yield of crop. 16,17
In cement factories Air born pollutants emitted by factory stacks travel long distances and slowly deposit on soil, SO₂ present in the fume are responsible for acid rains and consequent lowering of soil pH. Chlorine and nitrogen oxides are other common gaseous pollutants which combine with water and pollute the soil. Air pollution by small particulate matter particularly near cement factories coal transhipments, mining belts etc. reach soil surface of neighbouring regions.¹⁸

Dust deposited on the ground may produce changes in soil chemistry, which may in the long term result in changes in plant chemistry.¹⁹,²⁰

The cement dust is reported to be harmful to vegetation, causing considerable reduction in agricultural production, the particulate material (dust) falling on the leaves may cause foliar injuries, reduction in yield, changes in photosynthesis transpiration and uptake as well as accumulation of minera; elements from soil.

Extensive field survey and laboratory investigations have been done to study the change and physical and chemical parameters of soil caused by cement dust.

Fajtondzhiev and Kolchakov (1988) worked on changes occur in soil in the vicinity of Valdimir Zamimor cement plant and found decrease in the water holding capacity, pore spaces and increase the thermal conductivity and specific heat of the soil.²¹ Same results were obtained by Shankaran, (1977)²². Saravananan and Appavu (1974) studied the changes in physical properties polluted with cement dust and found the reduction in the density, total pore space, hydraulic conductivity and infiltration rate, especially in the area closer to the cement plant and towards the direction having higher wind velocity.²³ Pandey et al. (1992) found that bulk density, water holding capacity, organic carbon, total nitrogen, CN ratio and pH were higher of higher values in control than polluted agroecosystem soil, except for organic
carbon and nitrogen. According to Sahu et al. (2001) cement dust works as soil binding agent, which increases soil bulk density significantly and reduces infiltration rate.

Cement dust and dust pollution were found to elevate the levels of soil pH, it causes the alkalization of soil, ground water and precipitation and alteration in metabolism. It has also been reported that in alcalized environment, the parameters of trees were in negative co-relation with the increase in pH, K and Ca increase in the soil. (Adamson et al., 1994, Mandre et al., 1994, Mandre, 1997 Luoy, 1997 and Mandre et al. 1998)26,27,28,29,30

Liu et al. (1997) also recorded the flying cement dust decrease the yield of crop due to increase in calcium content in polluted soil.31

Giri and Sakthidevi (1981) and Rao et al. (1985) found that cement dust cause alkalinity in the soil and make it unfavourable to plant growth, and, under condition of cement dust pollution the plants get encrushed with cement and result decrease in chlorophyll content and disturbance in reproductive processes especially fertilization and pollination.32,33

Khopkar et al. (1988) studied on trace metal present in soil polluted with cement dust suffer from Fe, Pb, Cd and manganese toxicity.34 Lukaszewski et al. (1988) also recorded the same results.35 Ambasht (1978) studied on soil properties and observed that plant grows in calcium rich soil with alkaline pH are called as calcicoles. These plant can not tolerate low pH or high concentration of alluminium.36

In a soil study performed surrounding two cement factory properties, Asubiojo et al. (1991) found elevated levels of chromium, silica, iron and calcium, with contamination levels of chromium decreasing dramatically with distance from the facilities. These soil changes in turn effect vegetation growth.37 Iqbal and Shafiq (1998) suggested that specifically mineral content of the cement dust slowed growth rate.38
Khosla and Parmar (1988), while working on the effect of cement dust sal trees, found that deposited particulates alter soil pH, and rendered the soil conditions. They also noted erratic behaviour of phosphorus and sulphur. Calcium and potassium were higher in the top soil layer while magnasium and sodium were found to higher in deeper soil layers.39

Singh and Rao (1981) studied that cement dust generate undesirable changes in physicochemical changes in soil.40 Hemida et al. (1993) collected nearly 40 soil samples and recorded the same results.41

3.3 ANALYSIS OF VARIOUS SOIL SAMPLES POLLUTED WITH CEMENT DUST:

3.3.1 The collection and preparation of soil samples:

One of the most important aspects of soil testing is to obtain a soil sample which is representative of the area. The importance of soil analysis is to know the nature of soil, because the production of crop in any region depends on the properties of soil as well on the crop variety and the agricultural practices. For testing purpose only a small quantity of soil is required. Therefore, is it important that the sample must be representative of the area from which it is collected.

Cement dust causes pollution in soil, so to study the effect cement dust on soil of the study area of Narsingarh and Imlai and nearby villages situated around 5 kms. area has been selected. Soil samples collected as per procedure given below and all necessary precautions as outlined in the literature were followed furing sampling and subsequent analysis.

(i) clean polythene bags used for collecting and mixing soil samples.
(ii) With an angle a boring about plough deep (6 inches) maked and pulled it up with the soil each soil sample marked with the help of paper tages indicating full particulars.
(iii) Collected samples from the area spread n a polythene sheet for drying when it is sufficiently dry to pass through between the fingers, removed matter like loose roots, small stones etc. The dried soil samples after grinding in wooden pastle and mortar mixed thoroughly and passed through 2 mm. diameter sized sieve and then are ready to use for the analysis.

3.3.2 Methodology:

The following physico-chemical parameters were analysed to evaluate the quality of soil samples of the study area:

**Soil texture**: The texture is determined by feel or rubbing the soil between the thumb and the fingers. Proficiency is gained through experience, trial and error and comparison with known samples.

**Sand silt and clay**: The international method called pipette is employed. This method is based on the stocks law. Stocks suggested a relationship between the radius of a spherical particle and the rate of its sedimentation in a liquid. He stated that resistance offered by the liquid to the fall of the particle varied with the radius of the sphere and not with the surface. The formula is given below:

\[ V = 2gr^2 \frac{(D-d)}{ln} \]

Where,

- \( V \) = Velocity of the fall of particles in cm/second
- \( r \) = acceleration due to gravity
- \( D \) = density of the particle
- \( d \) = density of the liquid
- \( n \) = absolute viscosity of the liquid (Coefficient of viscosity of the liquid through which the particle is falling)

**Procedure**: 20 gms. (2 mm.) of dry earth transferred to a tall 800 ml. beaker. Added 50-60 ml. of 6% (20 volumes) \( \text{H}_2\text{O}_2 \). Mixed well and allow the
reaction to proceed for 5 minutes, and then place it on a hot water bath for about 15 minutes. Keep the cover glass on. After 15 minutes immersed the beaker into the water bath for another 15 minutes. Continue stirring to avoid frothing. Remove to add a further 25-40 ml. of H₂O₂ and after a minute replace the beaker on top of the bath and keep it there for 10 minutes and then immersed again for 5 minutes. Dilute the soil suspension to about 50 ml. bring it to boil on a burner, and keep repeating treatment with H₂O₂ till most of the organic matter is oxidised.

Acid treatment: At the cold condition of the beaker contents, cleaned the sides of the beaker with rubber policeman and add 25 ml. of acid for each percent of CaCO₃. Dilute to approximately 250 ml. and thoroughly rub the soil with a rubber pestle. Allowed the reaction to proceed for an hour, rubbing at intervals.

Tested after one hour, to make sure that an excess of acid is present and then filter through a Buchner funnel using hardened filter paper.

Washed the soil with three separate portions of each of 100 ml. of distilled water. Attempt not made to wash the soil to the bottom of the filter as this decrease the rate of filtration and may cause some of the fine particles to pass through the filter. After the washing process is complete, spread out the filter paper on a large clock glass and washed the soil with a jet of hot water on to a wire mesh (1mm.) No. 709 with squatte apparatus 0.2 mm. wide. The sieve is held over the mouth of a funnel which is placed over a bottle of one litre capacity. When no more soil can be removed, rolled the filter paper into a loose ball, wet is and thoroughly squeeze like a sponge. Repeated this process until no more turbid liquid can be obtained, gently rubbed the material on the sieve with a rubber pestle under a jet of water until no more material will pass through. Transferred the course material thus left on the sieve to a weighted dish. Dried it at 100° in an air oven and fined it out is its weight:
Calculation:

Percentage of coarse sand = \( \frac{W2-W1}{20} \times 100 \)

Where,

\( w1 \) = Weight of dish
\( w2 \) = weight of dish + dry coarse sand,
\( w2-w1 \) = weight of coarse sand - weight of air dry soil taken for the determination is 20 gms.

Dispersion: The volume of suspension makeup in the cylinder upto 1000 ml. after rendering it alkaline to phenolphthalein with 1 NaOH solution. Usually 10 ml. of 1N NaOH is required. The suspension thus prepared vigorously by shaking preferably over night.

Separation of silt and clay: The suspension shaked by repeated inversion of the cylinder for about 1 minute and allow to stand for the requisite time taken from the silt column against the observed temperature. Then withdraw 25 ml. of the suspension in a pipette fixed in a corck so that when the corck rests on the top of the bottle, the point of the pipette is at required distance below the surface of suspension. Care being taken to avoid too rapid ingress of the liquid with consequent eddying in the bulk of suspension. Begin this operation about 20 seconds before the time is up. This sample sample taken into a weighed dish, dried it at 100° then ignited and weighed as silt plus clay. The weight of silt and clay calculated by

\[ \text{Percent of silt + clay in the soil} = \frac{W2-W1}{25} \times 20 \times 1000 \]

Where,

\( W1 \) = Weight of dust,
\( W2 \) = Weight of dish + clay (in 25 ml. suspension)
\( W1-W2 \) = Weight of silt + clay.
Clay: The contents of the cylinder again shaked for one minute and sample in the same at a depth of 10 cm. after the settling time taken for the clay. It is also dried, ignited and weighed and results calculated:

Percent of clay = \(\frac{W2-W1 \times 20 \times 1000}{25}\)

Where,

- \(W1\) = Weight of dust,
- \(W2\) = Weight of dish + clay (in 25 ml. suspension)
- \(W1-W2\) = Weight of clay.

Fine Sand: Poured away the bulk of the supernatant liquid and transferred the sediment to a 400 ml. beaker, making up with water to a height of 10 cm. above the base marked with a pencil using foot rod, stir well and allowed to stand for the requisite period taken from the silt column against the observed temperature. Then pour away the turbid suspension, filled the beaker again to the mark with water and repeated this process till the liquid is no longer turbid at the end of the period. The residue is the fine sand which is collected, dried at 100°C and weight. Calculation:

Percent of fine sand = \((W2-W1)100/20\)

Where,

- \(W1\) = Weight of dish,
- \(W2\) = Weight of dish + fine sand
- \(W2-W1\) = Weight of fine sand.

(iii) Water holding capacity: Apparatus procedure and calculation are as under:

Apparatus: Circular brass prepared from a thick metal sheet, boxes of 5.6 cm. internal diameter and 1.6 cm. depth. The bottom is perforated with holes of 0.75 mm. dia. spaced 4 mm. apart. Each box is sitted with a brass ring made from spring which serves to hold the filter paper in position.
Procedure: The air dry soil crushed in a porcelain mortar sieved it through a small sieve of 1.5 mm. holes, when crushing is as complete as possible, returned the coarser particles remaining on the sieve to the finer particles and mixed them thoroughly. Place a filter paper at the bottom of a circular brass box with a perforated bottom and weighed it. Soil in a small quantities at a time added and go on tapping and filling until the box is nearly full. Tap the box and level it off. The box placed in a Petri dish containing water. The box sub merged in water upto 1/4" depth, leave in the air oven at 105°c and dried to a constant weight. The moisture taken up corrected for by the filter paper by weighing six dry filter paper and then weighed again and after saturation with water. Subtract the average amount of moisture taken up by the filter paper and represent the rest as a percentage of the oven dry soil.

Calculation: Water holding capacity %age = \( \frac{W3-W2-W4}{W2} \times 100 \)

Where, \( W1 \) = Weight of the box + filter paper,
\( W2 \) = Weight of the box + dry soil,
\( W3 \) = Weight of the box + soil after moist it
\( W2-W1 \) = Weight of dry soil,
\( W3-W2 \) = Weight of moisture absorbed,
\( W4 \) = Moisture absorbed by the filter paper
(Average amount absorbed by 1 filter paper)
\( W3-W2-W4 \) = Moisture held by the soil alone

(iv) Soil pH: It is negative log of the hydrogen ion concentration.

Procedure: Soil to water ratio is 1:2 and 20 gm. of soil is taken in a 100 ml. beaker into which 40 ml. of distilled water is added, the suspension is stirred at regular intervals for 30 minutes and the pH is recorded. The suspension stirred well just before the electrodes are immersed.
(v) Electrical conductivity: Electrical ions are the carrier of electricity the electrical conductivity of the soil water system rises according to the content or soluble salts in the soil giving rise to more of ion pairs on dissection as in case of a dilute solution thus the measurement of EC can be directly related to the soluble salt concentrations of the soil. Instrument and procedure are as under:

Instrument: The apparatus for measuring electrical conductivity consists of an Alternate current salt bridge or electrical resistance bridge and conductivity having electrode coated with platinum black. The instrument is also available as an already calibrated assembly for giving directly the conductivity of solution in milli ohms at 25°C.

Procedure: 20 gms. of soil is shaken with 40 ml. of distilled water in a 150 ml. Erlenmeyer (conical) flask for one hour and allowed to stand alternatively the clear extract after pH determination is used for conductivity measurement. The conductivity of the supernatant liquid determined with the help of the salt (conductivity) bridge the measurement of EC (expressed as m. mhos/cm. or m.s./cm.) is to be adjusted for a known temperature usually 25°C.

(vi) Calcium Carbonate: When a soil containing calcium carbonate is treated with a solution of a strong acid, the carbonate is decomposed by the acid and carbon dioxide is evolved:

\[ \text{CaCO}_3 + \text{HCl} = \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2 \]

The amount of acid consumed is therefore is a measure the quantity of Calcium carbonate present.

Procedure: The calcium carbonate percentage determined by rapid titration method. Weight out 5 gm. of soil and transferred to a tall 15 ml. beaker by means of a pipette with an enlarged jet added 100 ml. of N hydrochloric acid, cover with a clock glass and stir vigorously several times, for a period
of one hour. Then allow to settle and pipette off 20 ml. of the supernatant liquid, transferred to a small conical flask, add 6-8 drops of bromthymol blue indicator solution and titrate with N Sodium hydroxide. Titration completed at the end point is approached, then carried out a blank determination to obtain the titre of the hydrochloric acid.

Calculation : \[ \% \text{CaCO}_3 = (\text{Blank titration} - \text{actual titration}) \]

(vii) Organic Carbon : The organic matter (humus) in the soil is oxidized by chromic acid (potassium dichromate + conc. sulphuric acid) utilizing the heat of dilution of sulphuric acid. The unreached dichromate is determined by back titration with ferrous ammonium sulphate (redox titration)

\[ 2K_2Cr_2O_7 + 8H_2SO_4 = 2K_2SO_4 + 2Cr_2(SO_4)_3 + 8H_2O + 6O \]

\[ 3C + 6O = 3CO_2 \]

Procedure : The soil is ground and passed through 2 mm. sieve and 100 gm. is placed, at the bottom of a dry 500 ml. corning conical flask, 10 ml. of 1N \( K_2Cr_2O_7 \) (49.049 of AR chemical per litre) is pipetted in and swirled a little. The flask is kept on asbestos sheet than 20 ml. of \( H_2SO_4 \) (S.p.g. 1.84 containing 1.25% litre silver sulphate) is run in and swirled again two or three times. The flask is allowed to stand for 30 minutes and thereafter 200 ml. of distilled water is added, after incorporation of 10 ml. of phosphoric acid (Ortho phosphoric acid) and 1 ml. diphenylamine indicator (0.5 gm. dissolved in a mixture of 20 ml. of water and 100 ml. of conc. \( H_2SO_4 \)) contents are titrated with ferroud ammonium sulphate (0.5 N FA 196 gm. of the hydrated crystalline salt per litre containing 20 ml. \( H_2SO_4 \)) till the colour of flask changed from deep violet to green. Simultaneously, a blank is run without soil.

Calculation :

\[ \text{Organic Carbon (\%)} = (B-T) \times 0.003 \times 100 \]

\[ \text{Soil Weight} \]
Where, \( B \) = volume (in ml.) of N/2 ferrous ammonium sulphate required for blank titration (blank reading) and
\[ T = \text{Volume of N/2 ferrous ammonium sulphate needed for soil sample (experimental reading)} \]

(viii) Nitrogen: Mineralizeable nitrogen is determined by alkaline permanganate method. The method involves distilling the soil with alkaline potassium permegnate solution and determination of the ammonia liberated, which serves as an index of the available/mineralizable nitrogen status.

\[ 2\text{KMNO}_4 = \text{K}_2\text{O} + 2\text{MnO}_2 + 3\text{O} \]

Organic matter + O = Release of R-NH\(_2\)

\[ \text{R-NH}_2 + \text{H}_2\text{O} = \text{R-OH} + \text{NH}_3 \]

\[ 2\text{NH}_3 + \text{H}_2\text{SO}_4 = (\text{NH}_4)\text{2SO}_4 \]

\[ \text{H}_2\text{SO}_4 + 2\text{NaOH} = \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

Procedure: In a 500 ml. dry Kjeldahl flask, 20 gram of soil is taken, to this 20 ml. of water is added followed by 100 ml. each of 0.32% KMNO\(_4\) and 2.5% NaOH solutions. The frothing during boiling is prevented by liquid paraffin (1 ml.) & bumping by adding a few glass blades. The contents distilled in a kjeldahl assembly at a steady rate & the liberated ammonia collected in a conical flask (250 ml.) containing 20 ml. of boric acid solution with mixed indicator with the absorption if ammonia, the pinkish colour turns to green. Nearly 100 ml. of distillete is to be collected in abot 30 minutes which is titrated with 0.02 N H\(_2\)SO\(_4\) to the original shade (pinkish). Blank correction (without soil) is to be made for the final calculation.

Calculation:

\[
\text{Nitrogen (Kg/ha)} = \text{Rx}0.02\times\frac{1}{20}\times0.014\times10^6
\]

\[
= \text{Rx}31.26
\]

Where, \( R = \text{Volume of 0.02 N H}_2\text{SO}_4 \text{ required for titration.} \)
ix) Phosphorus: In soil testing the available phosphorus content is readily determined by extraction with suitable reagents according to specified soil-solution ratio and time of shaking. In the filtered extract, phosphorus is estimated colorimetrically by adding ammonium molybdate and there after reducing the molybdanum phosphate complex in acidic medium, the intensity of blue colour on reduction provides a measure for the concentration of 'P' in the test solution. Available phosphorus in soil is determined by the Olson's method.

Olson’s method: This method is based on the extraction of available phosphorus from soil shaking with N/2 sodium bicarbonate solution adjusted to pH = 8.5.

Reagents:

(i) Sodium bicarbonate N/2 solution adjusted to pH = 8.5 (42.0 gm. NaHCO₃ dissolved in 1 ltr.)

(ii) Darco-G.60 charcoal treated with N/2 NaHCO₃ to remove any adhering phosphate.

(iii) Ammonium molybdate solution: dissolved 1.50 gm. of ammonium molybdate in 100 ml. of 3.2 N hydrochloric acid. Add 5 ml. conc. HCl to neutralize NaHCO₃ in the aliquot.

(iv) Stannous chloride: Dissolved 10 gm. of SnCl₂.2H₂O in 25 ml. conc. HCl. Dilute this solution to 1320 ml. for use in this estimation.

Procedure: 2.5 gms. of the soil sample taken and then add 50 ml. of N/2 NaHCO₃ and a pinch of Darco-G.60, shake the mixture for 10 minutes and filter and wash with water. Add about 10 ml. ammonium molybdate solution and 5 ml. SnCl₂ solution. Shake well and make volume to 50 ml. Then compared the blue colour colorimetrically and calculated phosphorus in the soil.
Calculation: Available 'P' (kg./ha)

\[ \text{ug } P \text{ in the aliquot(R)} \times \text{Total extraction vol.} \times 2.24 \times 10^6 \]

vol. of aliquot \times 1/\text{wt. of soil taken} \quad 10^6

\[ \text{ug of P} \times 8.96 \]

(x) Potassium: The terms available potassium in a corporated both exchangeable and non-exchangeable forms of the nutrient present in soil. The reding exchangeable and water soluble 'K' is determined in the neutral normal ammonium acetate extract of soil. The ammonium ion provides a sharp and rapid separate ion from exchange complex while other cations bring about a gradual replacement of either lesser or greater amount of 'K' which generally increase with period of contact. The estimation of 'K' in extract is carried out with the help of flame photometer.

Reagents:

(i) Neutral normal ammonium acetate solution of 2 N ammonium hydroxide are prepared and equal volumes of the two are mixed in a large beaker and the pH adjusted to 7.0 with acid or ammonia.

(ii) Potassium chloride solution, a stock solution of 1000 ug k/ml is made by dissolving 1.908 gm. of AR potassium chloride (dried at 60°C for one hour) in distilled water and making upto 1 litre.

Procedure: 5 gms. of soil is shaken with 25 ml. of neutral normal ammonium acetate (pH 7) for 5 minutes and filtered immediately through a dry filter (Whatman No. 1), first few ml. of the filtrate rejected. Potassium concentration in the extract is determined in the flame photometer after necessary calibration of the instrument.

Std. curve for K: From the stockck requird aliquots are diluted (in 50 or 100 ml. col. flask) with the ammonium acetate solution to give 10 to 40 ppm of
'K'. After attaching the appropriate filter & adjusting the gas and air pressure, the flame photometer reading is set up zero for blank (ammonium acetate) and at 100 for 40 ppm K. The curve is obtained by plotting the reading against the different conc. (10, 15, 20, 25, 30, 35 ppm) of 'K'.

Calculation:

\[
\text{available 'K' (Kg/ha)} = R \times \frac{\text{vol. of extract}}{\text{Wt. of soil taken}} \times 2.24 \times 10^6
\]

Where, \[ R = \text{ppm of K in the extract (obtained from std. curve)} \]
\[ = \text{ppm of K} \times 11.2 \]

To study the effect of cement dust on physico-chemical as well as mechanical chemical properties in study area of Narsingarh and Imlai and nearby villages situated around 5 kms. radius has been selected. Soil samples were collected and experiments were carried out to analyse various parameters.

3.5 RESULTS AND DISCUSSION:

(a) Sand silt and clay: The analytical data in presented in Table 2.1 as per the analysed average result. Sand percent varied from 10.80 to 16.80 in Narsingarh and it is varied from 12.80 to 16.80 in Imlai area Diamond II and clay percent 41.62 to 43.92 in Narsingarh and in Imlai 43.92 to 27.92. Where as silt percent varies from 47.28 to 39.29 in Narsingarh and 43.28 and 55.28 at Imlai unit.

Results have been shown that soil near Narsingarh cement factory cement plant having high clay percent followed by silt and sand percent, only one sample was found to be silty clay at 1 km. On the other hand soil near the Imlai plant was found to have silty clay loam texture and having high silt percent followed by clay and sand percent. (Fig. 3.1 and 3.2).
(b) Water holding capacity: Collected soil samples have analysed for water holding capacity, and results showed that water holding capacity varied from 38.77 to 69.92 and 46.29 to 55.69 in Narsingarh and Imlai respectively. At the distance of 1 km. area from Narsingarh it was 38.77 and from Imlai 46.29%, while at 5km. from Narsingarh it was 69.92 and from Imlai it was 55.69%. Data showed that WHC percentage is increasing with the increase of distance from cement factory. (Fig. 3.1 and 3.2) Decline in the percentage of water holding capacity means decrease in content of moisture and organic matter. These results are in agreement with Tripathi (1996), who found that the water holding capacity of soil increases with the increase in distance from the source site of cement dust.42

According to Ambasht (1988), the dust decomposition affects porosity of the soil, thus decreases water holding capacity, because WHC is relatively proportional to porosity of the soil. Although near Narsingarh cement plant almost all the soil sample were found of clay texture, but the WHC decreases near the factory, same was repeated in the case near Imlai plant, where soils are silty clay or silty clay loam. It clearly indicate that the cement dust badly affect the WHC of the soil, by decreasing the porosity in large amount.43

(c) Soil pH: Data of the pH analysis of different soil samples are given in Table 2.2 and 2.3 Soil pH found to be varied from 8.0 to 8.3 at Narsingarh and 7.8 to 8.3 at Imlai factory area. pH of the soil at 1 km. from Narsingarh was 8.3 and from Imlai 8.3 and at 5 km. from Narsingarh it was 8.0 and from Imlai it was 7.8. Hence the soil were found to be alkaline type and having decreasing pH with the increase of distance. (Fig. 3.3) These results are in agreement with Singh (1979), Haynes and Kramer (1982) and Dzombak (1986).44,45,46

According to Richards (1954) black alkali soil which they term sodic or solonetz formed by the accumulation of alkalies such as Na and K etc. in
excess, such soils have low salt content but high exchangeable sodium. High salinity decreases adsorption of nutrients by plants and caused plasmolysis of cell cytoplasm. In the plants presence of excess salts retard the germination of seeds and growth of seedlings.\textsuperscript{47}

\(\text{Ca}^{++}\) also will \underline{makes the soil alkaline}, thus raising the \underline{pH and osmotic pressure of soil to undesirable levels}.

(d) \textbf{Calcium Carbonate} : The analytical data of calcium is presented in Table 2.2 and 2.3. The average calcium carbonate varied from 8.0 to 4.0 in Narsingarh area in order to increase the distance from 1 km. to 5 km. Similar results have been obtained for Imlai, the percentage of calcium carbonate content was 3.0 at 1km. decreased to 0.5 percent at 5 km. The result reveals that the calcium carbonate content decreases with increasing distance.\textsuperscript{(Fig. 3.4)} The reason is the content of calcium carbonate near the cement factory is due to higher dust fall which contains calcium carbonite and basic in nature. These results are in agreement with Tripathi (1996).\textsuperscript{48} According to Czaja (1962) the increase in concentration of \text{Ca}^{++} makes the soil alkaline or saline.\textsuperscript{49}

(e) \textbf{Organic Carbon} : The analytical results of organic carbon is presented in Table 2.2 and 2.3. The average value of organic carbon content from Narsingarh 0.66% at 1 km. and at 5 km. distance 0.35%. At 1 km. From Imlai it was 0.93% and at 5 km. 0.54%. Data clearly showed gradual decrease in the organic carbon content in the soil in accordance to the distance from the cement plant. \textsuperscript{(Fig. 3.4)} The results are in good agreement with Tripathi (1996).\textsuperscript{42} According Bauder (1999) the amount of organic carbon depends on the rate of accumulation or decomposition of organic matter in soil, which is result of the balance of organic matter product, climate and environment. Organic carbon content is proportional to organic matter, thus it shows that accumulation is faster than the decomposition, which makes soil unfertile. \textsuperscript{49}
(f) **Electrical conductivity**: The analytical results of electrical conductivity in represented in Table 2.2 and 2.3. The average value of EC from upto 2 km. from Narsingarh was varied from .2613 to .2639 and at 5 km. it was found .1193.1 km. from Imlai it was found .3069 and upto 3 km. varied from .2525 to .2569, and at 5 km. .1195. Thus it is vary obvious from the data that the electrical conductivity decreases as the distance from the plant increases. (Fig. 3.3) These results are in good agreement with Parthasarthy et.al. (1975). Electrical conductivity is relatively proportional to ionic concentration and ionic concentration is directly dependant upon the total salt content and its dissociability and due to high percentage of soluble salt near the factory area, the electrical conductivity is found to be high.50

(g) **Nitrogen**: Total Nitrogen content of the soil has been analysed and the results tabulated in Table 2.2 and 2.3. 305 kg./haectare was found at 1 km. from Narsingarh and at 5 km. it was 231 kg./haectare. At 1 km. from Imlai it was 352 kg./haectare and at 5 km. 311 kg./haectare in soil. (Fig. 3.5)

Results obtained showed a clear trend of reduction in total nitrogen content in soil with the increasing distance. It confirms the trend of organic carbon content in polluted area, because total nitrogen content has direct relation to organic carbon percentage. The results are in good agreement with Pandey (1992).24

(h) **Phosphorus**: The analytical results for available phosphorus in polluted soil are given in Table 2.2 and 2.3. Phosphorus showed a positive trend towards the increment of distance from the dust source. It was 12.0 kg./haectare at 1 km. and 17.1 kg./hactare at 5 km. from Narsingarh and 10.4 kg. at 1 km. and 18.0 kg./hactare at 5 km. from Imlai. (Fig. 3.5) From the above result it can be revealed that the availability of phosphorus is heavily dependant upon the soil acidity (pH value) and form of phosphorus in the soil. In acid soils iron and acid phosphates dissolve less easily as the decline in the pH value increases. If the ground is basic (alkaline) as found in
CKD calcium phosphate are formed, solubility of which declines as the pH rises. These results are good agreements with the findings of Smith and Campbell (2000), who found a significant decrease in soluble reactive phosphorus concentration, and suggested that it might be through precipitation of calcium phosphate resulting in a mean loss of the quantity of phosphorus.51

(i) *Potassium*: Results obtained from the analysis of potassium in polluted soil are given in Table 2.2 and 2.3. Potassium was 776.25 and 427.50 kg./hactare in Narsingarh at 1 and 5 km. respectively. And at Imlai at 1Km. and at 5 km. it was 588.75 and 217.00 kg./hactare respectively. These data showed a decreasing pattern of potassium content in relation to distance. These data also clear that there is no relationship between the phosphorus and potassium content of the soil. (Fig. 3.5) These results are in agreement with Seeker and Ozaytekin (2002) and El-Monayeri et al. (1996), who suggested that cement dust cause increase in potassium content and it remains higher than Na, P and Mg in the affected soil.62,63

On the basis of results recorded it can be concluded that the contents of cement dust highly effected both of the mechanical and chemical properties of the soil. During the process of cement production, cement dust emitted into the atmosphere and spread around the area. As the dust contains heavy particulate matter, it slowly settle down to the ground, thus quantity of dust found to be higher in nearby area and decreases with the increases in distance. After settling down on the earth, it forms a crust on the soil, and produce cumulative effect on the properties and contents.

Cement dust mainly conatains CaCO₃ and raise the pH of soil and due to damaging of porosity it infulence water holding capacity and thus ion concentration, which tends to lead make soil saline. As the crust forms above the soil and higher pH organic matter decomposition also get effected, which increases organice carbon content of the soil. Nitrogen
effected, which increases organic carbon content of the soil. Nitrogen mineralisation process also decreases showed by the higher amount of available nitrogen. Calcium forms chelates with phosphorus, thus availability of phosphorus declined. On the other hand higher ion concentration was shown by higher potassium content.

These conditions are not favourable for the growth of plants and microbes, thus makes soil unfertile and tend towards the low crop yield.
Table (3.1): Mechanical properties of soil around Diamond Cement Factory.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Distance From the Factory (Kms.)</th>
<th>Diamond Cements, Diamond I, Narsingarh</th>
<th>Diamond Cements, Diamond II, Imlai</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>W.H.C.%</td>
<td>Sand%</td>
</tr>
<tr>
<td>1.</td>
<td>1.0</td>
<td>38.77</td>
<td>10.80</td>
</tr>
<tr>
<td>2.</td>
<td>2.0</td>
<td>47.77</td>
<td>12.80</td>
</tr>
<tr>
<td>3.</td>
<td>3.0</td>
<td>50.00</td>
<td>14.80</td>
</tr>
<tr>
<td>4.</td>
<td>4.0</td>
<td>54.81</td>
<td>14.80</td>
</tr>
<tr>
<td>5.</td>
<td>5.0</td>
<td>69.92</td>
<td>16.80</td>
</tr>
<tr>
<td>S.N</td>
<td>Distance From Factory (Kms.)</td>
<td>pH</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------</td>
<td>----</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
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<td>8.1</td>
<td>.1904</td>
</tr>
<tr>
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<td>5.0</td>
<td>8.0</td>
<td>.1195</td>
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</table>
Table (3.3) : Chemical analysis of soil around Diamond Cement Factory, Diamond I, Narsingarh

<table>
<thead>
<tr>
<th>S.N</th>
<th>Distance From Factory (Kms.)</th>
<th>pH</th>
<th>Electrical Conductivity</th>
<th>Value in percentage</th>
<th>Value in Kg./Hectare</th>
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<tr>
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<td></td>
<td></td>
<td>CaCO₃</td>
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<td>8.0</td>
<td>.1193</td>
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<td>0.35</td>
</tr>
</tbody>
</table>
Fig. 3.1: Mechanical properties of soil around Diamond Cement Factory (Narsingarh Plant)
Fig. 3.2: Mechanical properties of soil around Diamond Cement Factory (Imai Plant)
Fig. 3.3: pH and Electrical conductivity of soil around
Diamond Cement Factory.
Fig. 3.4: Calcium carbonate and organic carbon contents in soil around Diamond Cement Factory.
Fig. 3.5: Nitrogen, Phosphorus and Potassium contents of soil around Diamond Cement Factory.

Distance (km)

Kg/hectare

Nitrogen Narsingarh □ Nitrogen Imlai □ Phosphorus Narsingarh ■ Phosphorus Imlai □ Potassium Narsingarh ◯ Potassium Imlai
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