CHAPTER I
INTRODUCTION AND DESCRIPTION OF STUDY SITE
CHAPTER -1

INTRODUCTION AND DESCRIPTION OF STUDY SITE

1. Introduction - The standard of living style of human community has been improving significantly through the development of a wide range of industries along with the invention and production of many useful products. The modernization and industrialization of developing countries has led to the increased use of fossil fuels and their derivatives. As such, developing countries are confronted with the great challenge of controlling the atmospheric pollution, especially in the rapidly growing urban centers. This vigorous industrial development has led to many undesirable outcomes too. Particularly, some industrial sectors have started to impose serious burdens on the natural environment (Araujo, 2011\(^1\) and Ilia et al., 2007\(^2\)).

In India the increasing economic development and a rapidly growing population that has taken the country from 300 million people in 1947 to more than one billion people today, is putting a strain on the environment, infrastructure and the country's natural resources. Soil erosion, deforestation, rapid industrialization, urbanization and land degradation are all worsening problems. Over exploitation of the country's resources its land or water and the industrialization process has resulted environmental degradation of resources and generation of pollution. The word pollution has been taken from the Latin word Pollutionem (meaning to defile or make dirty).

Pollution means the presence of undesirable substance in any segment of environment, primarily due to human activity discharging by-products, waste products or harmful secondary products, which are harmful to man and other organisms (Santra, 2001\(^3\)). The environmental pollution affects the health of more than 120 million people worldwide. Improper environmental protection planning
plays an important role in polluting the environment and causes severe degradation in ecosphere, hydrosphere and atmosphere (Tiwari et al., 2008). Distress about air pollution in urban regions is getting additional importance worldwide, especially pollution by gaseous and particulate trace metals (Azad and Kitada, 1998; Cachier et al., 2005). A great deal of consideration has focused on particulate matter (PM) pollution, due to their severe health effects, especially fine particles. Several epidemiological studies have indicated a strong connection between elevated concentrations of inhalable particles (Particles between 2.5 and 10 micrometers in diameter and Particles less than 2.5 micrometers in diameter) and increased mortality and morbidity (Lee, 2006 and Amodio et al., 2012). Particulate matter pollution in the atmosphere primarily consists of micron and sub-micron particles from anthropogenic and natural sources.

Numerous studies and the lack of effective policies reveal that air pollution continues to threaten public health (Medina et al., 2009). Studies of long-term exposure to air pollution (especially particulates and dust) suggest an increased risk of chronic respiratory illness (Schwartz, 1994) and of developing various types of cancers (Knox and Gilman, 1997 and Nyberg et al. 2000). Motor vehicle traffic and energy generation processes in manufacturing industries are the main contributors of deterioration of air quality in the urban centers. The high average of fleet, poor fuel quality, insufficient car maintenance and high concentration of vehicles in the areas with inadequate infrastructure all contribute to the high pollutant load.

India is one of the foremost developing countries that have undergone rapid industrialization in the few decades of near past. India today is among first ten industrialized countries of the world (Sharma, 2004). Besides steel and power
industries the cement production of India is recognized as one of the most important
industry. The expenditure pattern of cement often denotes economic development of
any nation. The rapid and unsafe growth of various industries during the last 50 years
has, however, resulted in striking deterioration of the environment.

Cement industry is one of the most important industries involved in air
pollution. The aerial discharge of cement factories consist of Particulate matter,
Sulphur dioxide and Nitrogen oxides producing continuous visible clouds which
ultimately settle on the vegetation, soil and effects whole biotic life around, as a result
the whole ecosystem around the cement factory is subjected to extraordinary stress
and abuse. The cement industry is involved in the development of structures in this
advanced and modern world because it is the basic ingredient of concrete used in
constructing modern edifices and structures. In fact, life without cement in this 21st
century is inconceivable. Cement, however, generates dust during its production.
Cement dust contains heavy metals like nickel, chromium, cobalt, mercury and lead
pollutants (Baby et al., 2008). Heavy metals (HMs) and organic compounds, such as
polycyclic aromatic hydrocarbons (PAHs), as well as dust and other pollutants, have
been identified in the emissions from cement plants (Koren and Bisesi, 2003). The
use of solid wastes, as supplementary fuel or as raw material substitute, and several
processes associated with cement manufacturing result in high emissions of heavy
metals. In spite of the fact that metals are frequently blocked within the clinker, some
of them are volatilized and condense on the dust particles (Schuhmacher et al.,
2002; Isikli et al., 2003; Isikli et al., 2006). Estimated atmospheric emissions of
As, Cd, Cr, Ni and Pb from cement production were of 124, 116, 692, 769 and 892
tons, respectively in Europe for the year 2000 (Pacyna et al., 2007). Al, Be and Zn
have also been distinguished in the emissions from cement plants; In addition,
combustion processes and in particular cement manufacturing have been pointed out as one of the most important sources of polycyclic aromatic hydrocarbons (PAHs) released into the atmosphere (Kaantee et al., 2004). However, the emissions of PAHs (quantity and type) linked to cement production depend on the fuel, the manufacturing process and the pollution control devices.

A heavy metal, as defined by the Van Nostrand's chemist dictionary is a "metal of high specific gravity" characterized by strong attraction to natal tissues with slow eliminations. Metals like Hg, Ni, Sb, Pb, Cd, As, TI, Cr, V etc. are acutely toxic to human beings when adsorbed in quite small amounts. There are three main kinds of sources of metals in the environment. The most obvious is the process of extraction and purification, mining, smelting and refining. The second is the release of metals from fossil fuels such as coal or oil when they are burned. Cd, V, Hg, Cr, Cu, Pb, etc. all are present in these fuels and considerable amounts enter into the atmosphere. The third and the most diverse source are production and use of industrial products containing metals or metal compounds.

Cement is a fine, gray or white powder which is largely made up of Cement Kiln Dust (CKD), a by-product of the final cement product, usually stored as wastes in open-pits and landfills. Exposure to cement dust for a short period may not cause serious problem, however prolonged disclosure can cause serious permanent damage to plants and animals (Hemminki, 1999). Cement dust of sufficient quantities have been reported to dissolve leaf tissues (TRF, 2008). Other reported effects of cement dust on plants include condensed growth, reduced chlorophyll, blocked stomata in leaves, cell metabolism disruption, interrupt absorption of light and diffusion of gases, lowering starch formation, reducing fruit setting, inducing premature leaf fall and leading to stunted growth thus causing suppression in plants and in animals, it leads to
various respiratory and hematological disease, cancers, eye defects and genetic problems (Iqbal and Shafug, 2001; Mohammed and Sambo, 2008; Ogunbileje and Akinosun, 2011).

Air pollution in developing countries is derived not only from stack emission of pollutants from relatively large industries, like iron and steel, metals and petroleum products industries, but also from fugitive emission of pollutants from small-scale factories, such as cement mills, lead refineries, chemical fertilizer and pesticide factories and so on, where inadequate pollution control measures exist and pollutants are allowed to escape to the atmosphere. Since industrial activities always involve energy generation, the combustion of fossil fuels is a main source of air pollution in the developing countries, where coal is widely used not only for industrial, but also for domestic consumption.

Studies have shown adverse respiratory health effects in the people exposed to cement dust, exemplified in augmented frequency of respiratory troubles (Al-Neaimi et al., 2001). It has also been revealed that people of cement dust zone are badly affected by gastro intestinal diseases and respiratory problems, etc. (Adak et al., 2007; Zeleke et al., 2010 and Kakooei, 2012).

Moreover gaseous and particulate pollutants there are also enhanced levels of toxic heavy metals in the environment of cement factory like nickel, mercury, lead, chromium posing very potential hazard for all living organisms. Increased concentrations of the above pollutants cause progressive reduction in the photosynthetic ability of leaves, mainly a reduction in growth and productivity of plants. Heavy metal pollutants are stable in the environment but highly toxic for biological organisms (Zou et al., 2006 and Levent et al., 2009). Among the heavy metals lead, nickel, chromium, Mercury are most dangerous heavy metals released by
cement factories (Kumar et al., 2008) and is responsible for causing various biochemical changes which also includes cytotoxic and mutagenic effects (Yahaya et al., 2012) such as cell-mitosis, chromosomal bridge, chromosome fragmentation, vagrant chromosomes, chromosomal aberrations, stickiness, DNA fragmentation etc in various plants as well as in humans.

Blooming of cement factories has resulted in the environmental deterioration and in turn degrades the human health status in whole world. Studies have shown adverse respiratory health effects in the people exposed to cement dust, exemplified in augmented frequency of respiratory troubles. Different greenhouse gases and solid particles derived from cement industries threaten air. As the time passes, these gases and solid particles gradually condense the environment and can be potential risk for world’s atmosphere, inhabitants and animals. Dust is released in to the atmosphere, with both visible and latent consequences on human health, soil and vegetation. Heavy metal accumulations in plant and soil from natural and artificial sources and subsequent consequences represent important environmental pollution problems. Food safety issues and potential adverse health risks make this one of the most serious environmental concerns (Cui et al., 2004).

The past decade has witnessed industries the world over redefine their goals and perspectives to make their operations socially more acceptable and resource-wise sustainable, even while retaining and reinforcing their identity as vehicles of economic growth and national development. This is the latest paradigm shift in the continuing polemics of developmental priorities versus environmental imperatives. The material balance of cement mill is negative with 1.45 tonne of raw materials for 1 tonne of cement production. Suspended Particulate Matter (SPM) in emission and extensive use of water are historically known as major environmental concerns of
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cement industry. Recently, SPM is rechristened for Repairable particulates as PM 2.5 and PM10. The SO₂, NOₓ, CO₂ and CO is the other major concerns in the ambient air quality around the cement plants. The use of coal or pet coke do make SO₂ (0.50Kg tonne⁻¹ in the dry process and up to 5.9 in the wet process) in objectionable concentrations in the emission. Cement manufacturing is energy intensive. Around 400 kcal kg⁻¹ is required for clinker production and the power requirement is an average of 82 kHz tonne⁻¹. The fugitive dust is the major concern for the ambient air quality with respect to Particulate Matters (PM 2.5 and PM 10). Apart from the primary air pollutants from the stack, volatile organic compound (VOC), polychlorinates biphenyls (PCB), polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) HF, HCl and few metal oxides could be the concerns in the air quality which warrants occupation health of the workers (Lee, 1998)³⁵.

Kim and Kang (1997)³⁶ found lungs deposition of inhaled fine particulates. Cement dust particles varies in size from 0.1-100 µm, this particulate matter surface has a greater tendency of binding up soil derived elements and had a larger surface area of small sized particles which has affinity of accumulation of elemental concentration. Quraishi (1997)³⁷ reported concentrations of highly toxic metal, Hg in the particulate fallout from the cement plant in the range of 0.045-0.070 mg kg⁻¹. Although, the basic constituents of cement dust are calcium (CaCO₃), silicon (SiO₂), aluminium (Al₂O₃), ferric and manganese oxides. Its production produces known toxic, carcinogenic and mutagenic substances, such as particulate matters, SO₂, NO₂, volatile compounds, long lived dioxins and heavy metals. Exposure to cement dust for a short period may not cause serious problem, however prolonged exposure can cause serious irreversible damage to plants and animals (Akpan et al., 2011)³⁸. Decrease in
the chlorophyll content ('a' and 'b') ultimately decreased the photosynthesis rate was observed by George and Alias (2003)\textsuperscript{39}.

Dust consists of tiny solid particles carried by air currents. These particles are formed by disintegration or fracture process (Zerrouqi, 2008)\textsuperscript{40}. Particles that are too large to remain airborne settle, while others remain in the air indefinitely. The cement industry also plays a vital role in the imbalances of the environment and produces air pollution hazards (Ade-Ademilua, 2008)\textsuperscript{41}. The atmospheric emissions of cement plants include a wide range of pollutants, major air pollutants due to cement manufacturing are CO\textsubscript{2}, NO\textsubscript{x}, SO\textsubscript{2}, particulate matter (PM) (Canpolat et al., 2002\textsuperscript{42} and Yatkin, 2010\textsuperscript{43}). The damaging effect of these pollutants on both fauna and flora can be very considerable (Rovera et al., 2011)\textsuperscript{44}.

Soil has been recognized as the major sink for anthropogenic heavy metal deposition through various pathways (Harrison et al., 1981\textsuperscript{45}; Li et al., 2001\textsuperscript{46}; Rashed, 2010\textsuperscript{47}; Guo et al., 2012\textsuperscript{48}). The contamination of soil by heavy metals can be problematic on several levels because they do not degrade biologically (Emmanuel et al., 2009)\textsuperscript{49} and this always result in several soil dysfunctions leading to concerns about the environmental quality. Metal contaminated soil poses risks to humans and animals through ingestion of plants that have bio-accumulated toxic metals from contaminated soil (Turner, 2009)\textsuperscript{50}. Due to the hazards posed by heavy metals in soil, determination of their levels in the soil is a necessary indicator showing anthropogenic input in the environment (Manta et al., 2002\textsuperscript{51}; Addo et al., 2012\textsuperscript{52}). It also assists in the development of remediation activities and policies. This is due to the fact that contribution of heavy metals to environmental problems from industries, mining and allied routes were investigated in many studies recently (Addo et al., 2012)\textsuperscript{53}.
Cement production is an important emission source of heavy metals such as Cd, Cr, Pb and Zn. These heavy metals are deposited into soil at various distances depending on wind velocity and particle size (CPCB, 2007) through cement dusts and stack fumes (Govil and Krishna, 2005). Heavy metal contaminated soil affects the ecosystem, when heavy metals migrate into groundwater or are taken up by flora and fauna, this results in great risk to ecosystems due to bioaccumulation (Bolt, 2008 and Bhagure and Mirgane, 2010).

A number of characteristics of dust are important in considering its impacts. Dust can have both a physical and a chemical impact. Dusts are particles or aggregates of particles 1 to 150 microns in diameter, fumes 0.2 to 1 and smokes are less than 0.2 microns. Dust is usually formed as a result of mechanical attrition and chemical reaction. Excessive inhalation of mineral dusts causes lung problems. For example, silica causes silicosis, fluorides causes’ fluorosis and others. Dust falling onto plants may physically smother the leaves.

The cement kiln dust, containing oxides of calcium, potassium and sodium is a common air pollutant affecting plants in various ways that is cement dust and cement crust on leaves plug stomata and interrupt absorption of light and diffusion of gases, lowering starch formation, reducing fruit setting (Peters, 2009) inducing premature leaf fall and leading to stunted growth. Cement-Kiln dust affects plant growth mostly by the formation of crusts on leaves, twigs and flowers. The crust is formed because some portion of the settling dust consists of the calcium silicates, which are typical of the clinker (burned limestone) from which cement is made, when this dust is hydrated on the leaf surfaces, a gelatinous calcium silicate hydrate is formed, which later crystallizes and solidifies to a hard crust (Joshi, 2009).
Physiological disorders such as reduced growth are ultimately due to the cumulative effects of the causal factors on the physiological processes necessary for plant growth and its development. Air pollution has become a major threat to the survival of plants in the industrial areas. Injury to the plants ranges from visible markings on the foliage, reduced growth and yield to premature death of the plant. The pollutants can cause a serious threat to the overall physiology of plants. Leaf is the most sensitive part to the air pollutants. Plants demonstrate a wide array of responses when exposed to pollutants in the form photosynthesis, respiration, enzymatic reactions, stomatal function, membrane disruption, senescence and ultimately death (Karthiyayini, et al., 2005).

Particle size is important if dust is to act in this way on stomata functions. Dusts of diverse origin have very different chemistries. The chemical effect of dust, either on soil or directly on the plant surface, may be more important than any physical effects. Dusts are of a wide variety of sizes. Cement kiln dust was almost 1-100μm in diameter.

Fly ash dust from power stations ranges from 1-2000 μm diameter, but is mostly evenly distributed in the 1-400 μm diameter range (Semhi, 2010). Coal dust itself, however, varies from 3-100 μm diameters. (Milford & Davidson, 1985) noted that many metals occur as small particulates and may form an important part of the smaller fractions of dust particles. Levels of deposition vary greatly. For limestone quarries and cement factories, field rates that cause harmful effect. Some dusts are relatively inert in their chemical effects, however, limestone quarry dust, cement dust and that from many roads is highly alkaline. Wang, (2013) described solutions of cement kiln dust; analysis showed that it contained a number of metals and bisulphate, all of which could have a direct toxic effect. A number of mineral elements can be supplied in lime and cement dust (Mutlu et al., 2013), for example, found that
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Rainfall around a cement plant in South Wales was high in phosphorus and vanadium and had a high pH, pH of only 6.5-8.6 range this may have been due to partial neutralization by high SO₂ emissions also produced at the plant.

Variation in elemental concentration due to cement dust pollution in the adjoining areas of a cement plant and the effects on the soil, plant, animal and human health has been a major concern and no work on effect of dust on crop plants and extent of toxicity on crops has been done, therefore very meager information is available about the pollution caused by the cement dust in the state of Chhattisgarh. Variation in mass and elemental condition of particulate matter with local climatic conditions, process mechanism in factories has showed the need of environmental quality assessment of surrounding environment of single point source. In light of above knowledge present research work was planned to investigate the influence of cement industry particulates and sediments on soil, air and vegetation quality around selected cement plants.

1.1 Objectives of the present work:-

1. To study ambient air quality and chemical composition of dust around the cement plant.

2. To study the effect of cement dust on physico-chemical properties viz pH, Electrical conductivity, CaCO₃ and organic carbon content of soil.

3. To study the effect of cement dust on changes in nutrient content and accumulation of heavy metals in soil.

4. To study the effect of cement dust on chlorophyll contents of the leaves of crop plants grown in the vicinity of cement industry.

5. To study the effect of cement dust on yield and uptake of nutrients and heavy metals by crops grown in the vicinity of cement industry.
1.2 Description of study site - The state is situated at the highest summer temperature profiles, probably due to emission of huge amount of green house gases by many sources such as; forest vegetation, rice field, combustion of fossil fuels, biomass burning, etc. Most of the heavy metal industries, cement plants, thermal power plants of the country are operation in this part of the country. The state is very sensitive to the environmental threat due to geographical, geological and metrological reasons. Cement plant selected for the study is located in district Baloda Bazar (plate-2). District lies in 21°32'48" north and 81°56'40" east. It has an average elevation of 254 m (833 ft) in Chhattisgarh state is inhabited by a total of 150,109 people (2008 census) and the city of Baloda Bazar possesses 30,912 numbers of households. It is 84 km from Raipur & 60 km from Bilaspur. Total area is about sq. 16 km. The main occupation of the people is agriculture and service in cement factories.

A. Climate:- The climate of the area is humid and tropical; it is characterized by hot and humid summer and well distributed rainfall during the south west monsoon season. The cold season commences from December and continues till the end of February. The summer season is from March to middle of June. The rainy season is in between June to end of September and the remaining two months October and November may be categorized as post monsoon season. Therefore, climatologically, four season viz. summer (pre monsoon, monsoon, post monsoon and winter are distinctly identified. The annual rainfall is 1290 mm; about 86% rainfall is received during June to September.

B. Soils of Chhattisgarh - Across Chhattisgarh, soil types are diverse because of the topographical variations. Soils are classified as Entisols are extremely shallow, very well drained, and sandy-loam in texture. They are mostly developed on steep, sloping hills and ridges, very stony, strongly eroded, and acidic. They are further
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classified as loamy-skeletal, kaolinitic, hyperthermic, Lithic. Locally, they are called Bhata and are characterized by their red color and lateritic features; Inceptisols are shallow, well-drained, loamy soils on the gentle sloping and undulating plateau (slightly dissected) with moderate erosion and occurrence of stones. They are immature soils with weakly developed profile features. They are classified as clay loamy, kaolinitic, isohyperthermic, Inceptisols are locally called matasi soils. They have a light texture and a shallow to moderate depth. These soils are widely used for growing short-duration rice after bunding and leveling. After rice, they are left fallow under rain fed conditions. Other crops grown on these soils include groundnut, soybean, maize, wheat, vegetable, and fruit crops. Alfisols are medium deep, well drained, clay-loam soils on gently sloping undulating to rolling plateau with moderate erosion hazards, usually occurring on the mid-slopes. They are classified as fine-loamy, kaolinitic, isohyperthermic the local name is dorsa soil. Most soil is red to red-yellow in colour with low silica and high iron contents in study area.

C. Vegetation - Agriculture is the primary occupation of the people here. Nearly 80% of Chhattisgarh’s population is engaged in cultivation. The main crop grown is paddy especially in the central plains of the state and therefore, widely known as rice bowl of central India. Other crops grown here are oilseeds, coarse grains, wheat, groundnut, maize and pulses. The soil of the state is fit for the cultivation of horticultural plants like mango, guava and banana. The soil of Chhattisgarh is rich and is identified by its red color. The soil in the riverine plains is quite fertile. The two main rivers flowing through Chhattisgarh are Mahanadi and Indravati. There are several lakes in the state. Main cultivated crops are rice and wheat and maize crops in study area.

1.3 History and process detail of the cement industry - The industry was commissioned in 1983 and the present capacity is 3.5 metric tons per annum Cement
and 20 Megawatt Power. The plant has two kilns in which kiln I is running with semi dry process technology and kiln II is dry process. Both of the kilns are being used for making of Portland slag cement. The fly ash was being transferred pneumatically to two 180Tons capacity silos for captive use in cement plants. In addition to this, fly ash was also being brought from Korba for using in cement plant. Industry is proposing to use Spent Pot Lining (SPL) from BALCO, Korba in cement kiln using coal. Calorific value of this SPL is around 8000 kcal/J and main Hazardous substance in SPL is lead, Cadmium, Zinc Cyanide and Fluoride. SPL is waste material of Al-smelting industry and other fuels are Hard coal, brown coal and oil cock.

The industry has 420 hectare areas for mining of lime stone and 600TPD crusher at mines. The industry has 73MW (2x25 MW & 1x23MW) captive power plants with 3 field ESPs for controlling the air pollution. About 200 tons per day fly ash has been generating in thermal power plant 2x140 tones capacity. The industry is consuming 7 KLD (Kilo Litters Per Day) water from mines and 8 KLD from ground water source in the plant for cooling purpose and other uses. About 15 lacks KLD water has been stored in mine reservoir for using in the plant.

1.4 Over view of the cement industry in India - The Indian cement industry is the 2nd largest market after China accounting for about 7-8% of the total global production. The cement-manufacturing sector has about 134 cement plants with an installed capacity of about 330 million tonnes (MT) as of financial year ended 2011-12. Cement is a cyclical commodity with a high correlation with gross domestic product (GDP), growing at around 3x of GDP (Gross Domestic Product) growth rate. Amongst the private sector, the owner-ship of the cement plants is held by 54 companies, out of which only 5 companies own almost half the units (Table 1.1, 1.2). In terms of type of manufacturing process, majority share is by dry-process, and the contribution from the wet and semi-dry process is only marginal, US EPA, (2004)47.
The housing sector is the biggest demand driver of cement, accounting for about 64% of the total consumption. The other major consumers of cement include infrastructure (17%), commercial and institutional (13%) and industrial segment (6%).

1.5 Cement industries in Chhattisgarh - Chhattisgarh state is rich in mineral resources; therefore variety of industries established due to availability of raw material. Cement industry is one of the examples. Cement industry is significant sector of Chhattisgarh. The cement companies of the state are located about every part of the state (tab-1.3, plate-1). The cement industry is involved in the development of structures of this advanced and modern world because it is the basic ingredient of concrete use in constructing modern edifices and structures. In fact, life without cement in this 21st century is inconceivable.

The increasing number of cement factories in Chhattisgarh because of Government support and local demand, decreasing the health standard and thus poses threat to the flora and fauna (Tak and Bhat, 2009) of the region.

**Table 1.1 over view of the cement industry in India**

<table>
<thead>
<tr>
<th>Cement Industries in India</th>
<th>No. of Kiln</th>
<th>Cement Capacity, MTA</th>
<th>Clinker Capacity, MTA</th>
<th>Energy Consumed, KWH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC Jamul</td>
<td>3</td>
<td>1.584</td>
<td>0.761</td>
<td>83</td>
</tr>
<tr>
<td>Ambuja Eastern</td>
<td>1</td>
<td>1.2</td>
<td>1.08</td>
<td>87</td>
</tr>
<tr>
<td>C.C.I.-Akaltar</td>
<td>1</td>
<td>0.4</td>
<td>0.38</td>
<td>Closed</td>
</tr>
<tr>
<td>C.C.I.-Mandhar</td>
<td>1</td>
<td>0.4</td>
<td>0.38</td>
<td>Closed</td>
</tr>
<tr>
<td>Century Cement</td>
<td>2</td>
<td>1.2</td>
<td>1.122</td>
<td>102</td>
</tr>
<tr>
<td>Grasim Cement</td>
<td>2</td>
<td>2.3</td>
<td>1.6</td>
<td>80</td>
</tr>
<tr>
<td>L &amp; T Cement</td>
<td>1</td>
<td>2.75</td>
<td>2.23</td>
<td>65</td>
</tr>
<tr>
<td>Lafarge – Arasmeta</td>
<td>1</td>
<td>2.24</td>
<td>1.2</td>
<td>63</td>
</tr>
<tr>
<td>Lafarge – Sonadigh</td>
<td>1</td>
<td>1.2</td>
<td>0.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Table 1.2: General Information about Cement Plants in India.

<table>
<thead>
<tr>
<th>Particulars (as of September, 2011)</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of cement plants</td>
<td>200</td>
</tr>
<tr>
<td><strong>Installed Capacity</strong></td>
<td>153.59 Mn.T</td>
</tr>
<tr>
<td>• Private Sector</td>
<td>155.23 Mn.T</td>
</tr>
<tr>
<td>• Public Sector</td>
<td>09.36 Mn.T</td>
</tr>
<tr>
<td>Cement Production</td>
<td>200.57 Mn.T</td>
</tr>
<tr>
<td><strong>Process wise capacity</strong></td>
<td></td>
</tr>
<tr>
<td>• Dry</td>
<td>125.83 Mn.T (96.3%)</td>
</tr>
<tr>
<td>• Wet</td>
<td>1.53 Mn.T  (1.2%)</td>
</tr>
<tr>
<td>• Semi-Dry</td>
<td>0.19 Mn.T  (0.1%)</td>
</tr>
</tbody>
</table>

Table 1.3: General Information about Cement Plants in Chhattisgarh.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Plant Name</th>
<th>S. No</th>
<th>Plant Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CCI Cement Plant (Akaltara)</td>
<td>8</td>
<td>Ultratech Cement Plant (Rawan)</td>
</tr>
<tr>
<td>2</td>
<td>Lafarge Plant (Arasmeta)</td>
<td>9</td>
<td>Rungta Mohra Cement Plant (Proposed)</td>
</tr>
<tr>
<td>3</td>
<td>Imami Cement Plant (Baloda Bazar)</td>
<td>10</td>
<td>Century Baikunth Cement Plant (Baikunth)</td>
</tr>
<tr>
<td>4</td>
<td>Lafarge Cement Plant (Sonadih)</td>
<td>11</td>
<td>CCI Cement Plant (Mandhar)</td>
</tr>
<tr>
<td>5</td>
<td>Ambuja Cement Plant (Rawan)</td>
<td>12</td>
<td>ACC Cement Plant (Jamul)</td>
</tr>
<tr>
<td>6</td>
<td>Shree Cement Plant (Semaradih &amp; Bharuwadih)</td>
<td>13</td>
<td>Jaypee Cement (Bhilai)</td>
</tr>
<tr>
<td>7</td>
<td>Grasim Cement Plant (Rawan)</td>
<td>14</td>
<td>J.K. Laxmi (Durg)</td>
</tr>
</tbody>
</table>
Plate: 1 Cement plant location in Chhattisgarh
1.6 References –


