CHAPTER II
STRUCTURE OF INDIAN CEMENT INDUSTRY

2.1 Introduction

Cement is one of the key infrastructure industries that play a crucial role in India’s economic and social development. Cement is an essential ingredient in the construction industry, especially in the government infrastructure (roads, railways, dams, bridges, factories etc.) and private housing sector. Therefore, the demand for cement, being a derived one, depends primarily on industrial activity, real estate business and infrastructure sectors of the economy and it varies seasonally as well as regionally. India, in spite of being the second largest producer of cement in the world after China, is one among the global best in terms of technology, quality, efficiency and productivity parameters. The growth of cement industry can be considered as an indicator of economic activity as it accounts for 1.3 percent of Gross Domestic Product (GDP) and employs around 70,000 people (Cement Manufacturers’ Association [CMA], 2009) directly and huge indirect employment through process machinery manufacture, raw materials and other sources. It is estimated that one million tonne of cement production provides employment to around 50,000 persons downstream (Planning Commission, 2008). The extent of utilization of cement is an important indicator of a country's social and economic growth.

The chapter initially presents the origin of cement along with cement production and consumption, trade, prices and cost, in the global perspective. The characteristics of the Indian cement industry are provided in a concise and succinct way and also explains its history before and after Independence and through the Five Year Plans, policies etc. The chapter
discusses in detail about the cement manufacture and its varieties, export, import, consumption, raw materials, energy, and transport. Lastly, it deals with the Research and Development activities as well as mergers and acquisitions in the Indian cement industry.

2.2 Origin of Cement and the Cement Industry in the Global Perspective

The beginning of construction activities can be traced back to the early stages of civilization. The word ‘Cement’ came from the Roman word ‘Opus Caementicium’ - a powder that when mixed with water creates a heavy paste that when allowed to dry forms a very sturdy, rocklike surface that will hold together structural elements such as bricks and stone. It was known in one form or other, since time immemorial. Initially clay was used as a binding agent till the Egyptians discovered lime and gypsum mortar for constructing Pyramids. The Greeks used some form of mortar and finally the Romans developed cement by mixing slaked lime with pozzolana, a volcanic ash from Mount Vesuvius, being capable of hardening under water and that produced structures of remarkable durability. John Smeaton is credited with a primitive form of Portland Cement that he used in the construction of a lighthouse in England in 1756. The present form of cement evolved from the invention of Joseph Aspdin, a British stonemason in 1824. Thus, the cheap and reliable Portland cement facilitated a revolution in construction technology as cement, in the form of concrete, became, quite literally, the foundation of cities, transportation systems, and factories (Mabry, 1998).

The structure of the cement industry in global perspectives can be understood from the analysis of Porter’s five “competitive forces”. It proves that the rivalry within the cement industry is moderate because of the oligopolistic nature of the industry around the world and the threat of
substitutes is very low due to lack of substitutes. The next force of competition is buyer bargaining power which is very low and firms have an easier time setting price while buyers act generally as price takers whereas the supplier bargaining power is high due to their regional concentration and high cost in switching between suppliers. The cement industry has high barriers to entry given its capital intensive nature and long gestation period and high barriers to exit.

**Global Production and Consumption of Cement**

Cement is produced in 156 countries across the world. The global cement production stood at 2.87 billion tonnes and the production capacity was around 2,872 mn.t., during 2008 (International Cement Review [ICR], 2009). China is the largest producer and consumer (approximately produced 1,400 mn.t. and consumed 1390 mn.t. in 2008) of cement in the world due to the recent massive developmental and infrastructure projects undertaken by the Chinese Government. India stands second in cement production with 187.61 mn.t. followed by U.S.A, Japan and Russia with 84, 68 and 53 million tonnes respectively in 2008-09. Initial fact finding suggests that cement production has recently been concentrating in the developing world (Miller, 2009). It can be attributed to tighter environmental regulations in the Europe, cheaper labor and less stringent environmental regulations or subsidies (Mishkin, 2007; Miller, 2009) in developing countries.

India consumed 180 mn.t. in 2008 becoming the second largest consumer in the world followed by U.S.A, Russia and Brazil with 94, 62, and 51 mn.t. respectively (ICR, 2009). Quite interestingly, the top five producers reflect more or less the top five consumers, of cement in the world. China increased its consumption from 34 percent in 1998 to 49 percent in 2008 with a compound average growth rate (CAGR) of 10.5 percent whereas the CAGR of rest of the world was four percent over the
same period. The figure below shows the recent trends in world cement consumption.

**Figure: 2.1**  
**World Cement Production by Region and Main Countries in 2009**

Cement consumption is highly correlated to the GDP per capita of a nation. The intensity of cement use, after initially rising, declines with increasing GDP per capita, although this is not the case for all materials (Chateau et al., 2005). This can be understood from the bell-shaped curve of cement consumption per capita in Figure 2.2 (The inverted U-shape of the curve explains the time evolution of cement intensity per unit of GDP). It is clear that the countries with highest GDP per capita, the cement consumption is less whereas developing and emerging economies consume large quantities of cement during their initial stages of development. However, as their economies mature, the demand for cement per unit of GDP is likely to decline in a similar manner to that experienced by developed countries (Taylor, Tam, and Gielen, 2006).
Figure: 2.2
Cement Consumption Per Capita and GDP Per Capita in 2008

Source: Adapted from Indian cement industry: Trade Perspectives, (n.d.).
Notes: Consumption, Exports and GDP data from USGS, ITC and IMF respectively. The size of the bubble represents the country’s total consumption.

Global Cement Trade

The volume of cement trade was around 6 percent of total cement production in 2008 (International Cement Review, 2009) and the rest, utilized for domestic consumption. The world cement trade grew at a CAGR of 13 percent during 2001 to 2008 and U.S.A turned out to be the largest cement trader with total trade of $US 1,396 million during 2008, followed by Germany, Belgium and Netherlands. Being the largest importer of cement, U.S.A accounts for 11.4 percent of total imports. Russia ranks second in world cement imports with 8.5 mn.t., followed by Nigeria (8.2 mn.t.), UAE (8 mn.t.) and Spain (7.7 mn.t.) in 2008. China tops in cement export with 26 percent of total export and Japan holds the second position in world cement exports with 11.6 mn.t., followed by Thailand (11.3 mn.t.), Turkey (10.6 mn.t.) and Germany (8.3 mn.t.) in 2008. The major five players in the global cement industry are Lafarge (France), Holcim (Switzerland), Heidelberg Cement (Germany), Cemex (Mexico) and Italcementi (Italy).
Prices and Cost of Cement

The actual price of cement in the international market varies between Asian and European countries and is determined by several factors like investment costs, production cost, taxes, shipping costs, and institutional costs. These cost differentiation, amongst these countries, can be attributed to differences in labour cost, price of machinery and availability of subsidies. The demand for cement is price inelastic due to lack of substitutes and therefore, it resulted in persistent increase in cement prices in real terms, in spite of recession in various countries. The cement industry is a highly capital intensive industry, as capital costs equal three years turnover of cement companies (Cembureau, n.d.) and employment of labour is relatively smaller as modern cement plants are highly automated. The lifetime of a cement plant is up to 50 years. Regardless of all these variations between countries, the main cost of cement production lies with energy consumption.

2.3 Indian Cement Industry Characteristics

The government-owned Cement Corporation of India has ten units across the country with a total capacity of 3.84 million tonnes per year (CMA, 2009). However, only three are operational (producing 1.4 million tonnes per annum). As of March 2009, the Indian cement industry comprises of 148 large plants and 365 mini and white cement plants where 94 percent of the cement production in the country is from large plants (CMA, 2009). The installed capacity of large plants is 219.17 mn.t. while that of mini and white cement plants is 11.10 mn.t. The total cement production during 2008-09 stood at 187.61 mn.t. There are 95 cement plants operating with million tonnes and above capacity. The total turnover of the industry is about 18,500 mn.US$ (CMA, 2009). The per capita cement consumption in India is very low compared to other economies and is
around 156 kg in 2008 against the world average of 396 kg. in 2006 (CMA, 2009). Even amongst the BRIC economies India has the lowest level of per capita cement consumption. The cement consumption during the year 2008-'09 grew at 8.5 percent, lower than the previous year’s 9.8 percent by 1.3 percent. During the period from 2001 to 2008, India’s cement trade increased from US$ 4.1 million to US$ 44.2 million, a CAGR of 40.3 percent. The increase in trade was led by rise in imports, which increased, from US$ 0.3 million in 2001 to US$ 37.1 million in 2008, at a CAGR of 91.3 percent (Indian cement industry: Trade perspectives, n.d.). The industry also has a high rate of excise duty and accounts for 5 percent of total excise collection (Planning Commission, 2008). Despite the fact that the cement industry is totally decontrolled and delicensed, government controls the prices of coal, power, railway, freight, royalty and cess on limestone which are the inevitable factors required for the manufacture of cement.

The non-uniform distribution with concentration of potential deposits of limestone only in a few geological horizons has resulted in formation of, so called, cement producing clusters. The seven clusters namely Satna, Chandrapur, Gulbarga, Yerraguntla, Nalgonda, Bilaspur and Chanderia contribute to 48 percent of total annual cement production in 2008-09 (CMA, 2009). This has also been the primary reason for regional imbalances in cement production in the country, entailing large distance of movement of cement from the plants.

**Trends in Cement Prices in India**

Cement prices, being market determined, varies with respect to different zones and is consistently high all times. The increase in cement prices can be largely attributed to the rise in input prices of energy, raw materials and of transport. Average cement prices increased from `145 per bag in
financial year 2003 to `241 per bag in financial year 2008 and is currently hovering at `245-250 per bag.

The industry witnessed the largest decline in annual Wholesale Price Index of cement during 1997-98 by four percent and in the distant past by three percent in 2002-03. Historically, the southern region has reported the highest decline in cement prices (due to its larger size and presence of a number of players) while the western region has shown least price declines. The table below shows the Wholesale Price Index of cement in India from 1994-95 through 2008-09 and the same is plotted in the following figure.

<table>
<thead>
<tr>
<th>Year</th>
<th>WPI for Cement</th>
<th>Change in Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-95</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>1995-96</td>
<td>130</td>
<td>16</td>
</tr>
<tr>
<td>1996-97</td>
<td>134</td>
<td>3</td>
</tr>
<tr>
<td>1997-98</td>
<td>129</td>
<td>-4</td>
</tr>
<tr>
<td>1998-99</td>
<td>131</td>
<td>2</td>
</tr>
<tr>
<td>1999-00</td>
<td>128</td>
<td>-2</td>
</tr>
<tr>
<td>2000-01</td>
<td>137</td>
<td>7</td>
</tr>
<tr>
<td>2001-02</td>
<td>149</td>
<td>9</td>
</tr>
<tr>
<td>2002-03</td>
<td>145</td>
<td>-3</td>
</tr>
<tr>
<td>2003-04</td>
<td>147</td>
<td>1</td>
</tr>
<tr>
<td>2004-05</td>
<td>153</td>
<td>4</td>
</tr>
<tr>
<td>2005-06</td>
<td>167</td>
<td>9</td>
</tr>
<tr>
<td>2006-07</td>
<td>197</td>
<td>18</td>
</tr>
<tr>
<td>2007-08</td>
<td>218</td>
<td>11</td>
</tr>
<tr>
<td>2008-09</td>
<td>223</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Economic Survey 2009-10, Government of India; Researcher’s calculation.
Figure: 2.3
Wholesale Cement Price Movement in India
(1994-95 to 2008-09)

Price of cement alters greatly in spite of the identical supply position in northern, southern and western zone. According to the press release made by the Builders Association of India (2009), the cement prices per bag in January 2009 in some of the major cities such as Delhi, Mumbai, Hyderabad, Chennai and Bhopal are `210, `240, `190, `245, and `206 respectively. Almost 66 percent of cement is supplied by the biggest two producers in the Mumbai market, which is the main west zone. The cement prices have risen sharply since March 2006 largely due to an improvement in the demand-supply dynamics (Industry Research Service, 2008). The figure followed shows the cement price changes of the major cities in India from 1998 to 2009.

Source: Table 2.1
The scenario for the Indian cement industry gets more challenging as cement manufacturers will find it difficult to hike prices because of the close watch of the government; the worsening demand-supply equation would inevitably exert pressure on cement prices in the country. The government has been consistently intervening to check cement prices in its attempt to aid its efforts at curbing inflation. However, with inflation coming down, government might moderate its stance towards cement prices, which might encourage players to raise prices (Burde, 2008).

**Mini Cement Plants**

Experimentations in small scale cement plants in India can be traced back to the Indo-Chinese War in 1962 when people within the Indian Defense establishment took a number of initiatives designed to provide localities in outlying areas with cement plants (Sigurdson, 1977). Since the first mini-cement plant was commissioned in 1976, their number rose to 25 in 1985, 118 in 1987, 180 in 1992, and about 300 in 1999 and 365 in 2009 (Nath and Bose, 2002; CMA, 2009). Mini cement plants produce from 100 tonnes...
per day (tpd) (33,000 tonnes/annum) to 600 tpd (1, 98,000 tonnes/annum); In India these are of 100, 200 and 300 tpd capacity only. Plants above 600 tpd production capacity are classified as large cement plants. Cement manufactured by large plants using Rotary Kiln requires high capacity, huge deposits of lime stone in its vicinity, high capital investment and long gestation period whereas mini cement plants are based on vertical Shaft Kiln technology used for producing limited quantities of cement, needs small deposits of limestone and coal and that transport costs need not be a constraint. Against the requirement of `3500 per tonne of capacity of large plants, capital costs for mini-cement plants come to about `1,400 to `1,600 per tonne (The Investment Information and Credit Rating Agency [ICRA], 2006). The advantages of mini cement plants includes the possibilities of exploitation of smaller limestone deposits, meeting the smaller local market demands at little transportation costs using much less power, water and other inputs and reduction of strains on transportation facilities. Furthermore, there is a possibility of cement manufacture being opened to smaller entrepreneurs whose access to financial and technical resources are very limited (Goel and Nair, 1978).

2.4 Growth and Development of the Indian Cement Industry

2.4.1 Prior to Independence

Manufacture of cement in India dates back to 1889 when a Calcutta based company endeavored to manufacture cement from Argillaceous (Kankar). But the first organized manufacture of Portland cement in India was initiated by the South India Industries Ltd. in Madras in 1904, with a potential capacity of 10,000 metric tonnes per year (Podder, 1962). In spite of the sufficient demand for the product their attempt was a failure because of technological defects and inadequate supply of raw materials. The real
commencement of cement manufacture began in the year 1914, at Porbander in Gujarat state by India Cement Co. Ltd. with 100 metric tonnes per day (Das, 1987). Two more plants, one at Katni (Madhya Pradesh) in the year 1915 and the other at Lakheri (Rajasthan) in 1916 came up with cement production. The First World War gave further impetus to this infant industry and the output of these factories was taken under Government control. The total production of these three plants was 85,694 metric tonnes in 1918 (Podder, 1962). Between 1919 and 1924, six new plants were set up with cement production and the capacities of the existing plants were increased. The total manufacturing capacity in 1924 was 559,800 metric tons whereas the actual production stood at 267,965 metric tons which is less than 50 percent of the rated capacity (Podder, 1962).

During the period of 10 years (1914-1924) the total cement consumption was around two million tonnes, of which nearly 50 percent consisted of imports (Nath and Bose, 2002). Thus, with production outstripping demand and the prevailing prejudice (preference for imported cement, despite the quality of imported and indigenous cement were the same) about the Indian cement among the consumers intensified the problem of disposal of produced cement. This led to a price war among the companies which resulted in cutting down of prices to an extent where it fell below the actual cost of production and resulted in the closure of three factories. Hence, in 1924, Government of India intervened and referred the working of the cement industry to the Tariff Board. Apart from recommending protection for the industry, the Tariff Board also stressed upon the urgency for cooperation amongst the existing units which led to the formation of Indian Manufacturer’s Association in 1925 primarily to regulate cement prices.
Cement being a relatively new building material, required popularisation among its customers. Thus, Concrete Association of India was formed in 1927 to educate the public in the uses of cement and to promote free technical aid and service. In order to promote and control the sales and distribution of cement, Cement Marketing Company of India Ltd. was formed in 1930. With all these efforts, there has been a noticeable increase in the production capacities of existing plants and a new plant was also set up, raising the installed capacity to 1,089,00 metric tonnes by 1934 (Goel and Nair, 1978). Due to the increase in production from 2.7 lakh tonnes in 1924 to 8.6 lakh tonnes in 1935, the imports declined to 32,000 tonnes in 1937-38 from 145,000 tonnes in 1915 (Podder, 1962).

In 1936, ten existing companies merged to form Associated Cement Companies Ltd. This merger resulted in better efficiency and self-reliance with the pooling of resources and technology. Great industrialist Sir F.E Dinshaw writes that, “the merger will not be to attain a monopolistic position; its primary object will be to make and deliver cement as cheaply as possible so that it may be able to hold its own stand against any possible internal as well as foreign competition” (Information Bulletin published by ACC). After a year, Dalmia-Jain group established five new cement plants with a total installed capacity of about 575,000 tonnes per year (Goel and Nair, 1978). Once again the price war started in 1938 where cement was sold even less than a rupee per bag (Podder, 1962). Later, the ACC and Dalmia-Jain group entered into an agreement on prices and distribution of cement which continued till the end of Second World War. During the period of Second World War, the demand for cement increased and Government was consuming about 90 percent of total production and the rest was left for private consumption. In order to satisfy the rise in the civilian demand for cement after war, the Government, in 1945, prepared a cement expansion scheme, the objective of which was to expand capacity in
a planned manner. Before independence the country was endowed with 24 factories with an annual capacity of nearly 2.7 mn.t. (Das, 1987).

2.4.2 Post Independence

The cement industry obtained its first Indian Standard Specification for Portland cement from the Indian Standards Institution soon after independence. On partition, India remained with 19 factories with annual productive capacity of 2.1 mn.t. (Das, 1987). India suffered severe shortage of cement as five plants went to Pakistan and was unable to meet half of the country’s requirements. With this decline in the cement productive capacities of the different groups and excess cement demand over supply, Govt. revised the cement expansion scheme in 1948 which resulted in a speedy increase in the cement output. Under this scheme two new factories were established and three were expanded. Between 1947 and 1951 six more factories were established in different parts of the country. Hence, in 1950-'51 there were 22 operating units with 3.2 million metric tonnes of output (Podder, 1962).

2.4.3 Growth through the Five Year Plans

In 1951, cement production was planned as a part of the First Five Year Plan (1951-1956). In spite of the various hindrances faced by the industry, actual production reached 5.02 mn.t. at the end of the first plan against an envisaged capacity of 5.4 mn.t. During this period, among other factories, a factory was established in the Public Sector in U.P in 1954 (Podder, 1962). As the first five year plan mainly addressed the agrarian sector including investments in dams, roads, irrigation etc., it led to an increase in the productive capacities of cement industry. Thus, being encouraged by the success of the first five year plan, the Govt. increased the capacity almost exponentially at 15 mn.t. for the Second Five Year Plan (1956-1961). Licenses were freely issued and cement production rose to 7.8 mn.t. in 1960.
from 5.02 mn.t in 1956 (Podder, 1962). During this period, White cement and Portland Blast Furnace Slag cement were also manufactured, for the first time. ACC plant at Porbander completely started producing White cement. In 1958, demand slowed down due to scarcity of foreign exchange and hence establishment of new plants as well as expansionary activities were set back and the target of 15 mn.t. capacity was brought down to 10 mn.t. Imports were stopped to encourage exports. The total number of plants increased from 27 in 1956 to 34 in 1961 and hence the installed capacity increased to 9.4 mn.t. (Das, 1987). The first group of cement machinery manufacturers was established by the end of this plan under foreign technical collaboration.

In order to meet the increasing demand, the Third Five Year Plan (1961-1966) focussed on massive construction programmes in different sectors, many new cement plants were also set up and the targets of annual capacity and production were subsequently stepped up to 15 and 13 mn.t. respectively (Goel and Nair, 1978). During the Fourth Five Year Plan (1969-1974), the Govt. referred the recurring complaints to Tariff Commission. The Govt. allowed an interim price increase of `10.00 p.t based on Tariff Commission recommendation. The actual production reached 14.6 mn.t. during 1973-74 against the target of 18 mn.t. The capacity utilization level reached a high level of 94 percent in 1969 (National Council for Applied Economic Research [NCAER], 1979). The number of units increased to 52 (including two grinding plants) and the number of states having cement plants came up to 14 by 1973. The public sector established nine factories. ACC continued to be the largest group in the industry with 17 units as against 14 in 1961. South zone accounted for 20 units followed by West, East and North with 13, 10 and 9 units respectively (Das, 1987). Industry then faced an accentuated problem of regional imbalance in location (or production). Based on several
representations by the manufacturers, the Govt. felt the need of a detailed enquiry into the various problems of the industry. The Govt. requested the Tariff Commission to take into account the considerations such as cost, price, location, and capacity utilization and freight pooling and distribution etc. On the basis of the report submitted by Tariff Commission in 1974, Govt. accepted most of the recommendations and rejected the rest, which improved the situation. In 1976, 54 units were operating with total capacity of 21.32 mn.t. against which the actual production was about 18.61 mn.t. (Das, 1987). In 1977, the capacity utilization in the cement industry was 89 percent, with 20 units working above their full capacity (due to regular and adequate supplies of power and coal) (NCAER, 1979). The investor’s interest in the country was revived following the Govt.’s announcement of a new policy assuming a post tax return of 12 percent on net worth and a considerable new capacity was by then under various stages of implementation (Das, 1987). At the end of the Fifth Five Year Plan, in 1978-79, the industry recorded 19.42 mn.t. of production and achieved a growth rate of 7.2 percent per annum. The cement industry developed largely in the private sector and accounted for 88 percent and 90 percent of the total installed capacity as well as production respectively by 1979 (Rao and Chander, 1980) and the Govt. had set up mini-cements plants in 1979, to exploit smaller deposits of limestone in remote areas. At the beginning of the Sixth Five Year Plan (1980-1985) three new factories (2 in public sectors and 1 in private sector) started cement manufacturing. With these new units and expansion of the existing ones, the licensed capacity increased to 255.16 whereas actual production decreased to 177.90 lakh tonnes (Das, 1987). However the price control did not have the desired effect. Because of the rise in input cost and reduced profit margins, the manufacturers could not allocate funds for increase in capacity. As a result the capacity utilization declined to a deplorable low level of 67 percent in
cement production increased from 21.06 mn.t. in 1982-83 to 30.13 mn.t. 1984-85 (Bajaj, 1986). The partial decontrol introduced in 1982, made significant changes in the industry particularly in the Seventh Five Year Plan (1985-1989). Production increased from 32.1 mn.t. in the beginning of the seventh five year plan to 45.41 mn.t. at the end 1989-90. The capacity utilization during 1988-89 was 76 percent. The total decontrol on prices and distribution of cement in 1989 resulted in significant progress in terms of capacity and production. The price per bag of cement went up to `135-153 in 1997-98 from `80-85 in 1990-91 (Dutt and Sundaram, 1993). The targeted capacity and production for the Eighth Five Year Plan (1992-1997) was 90 mn.t. and 76 mn.t. respectively. This includes an export target of 5 mn.t. placing the domestic demand at 71 mn.t. (Kothari’s Industrial Directory of India, 1996-97). During this plan period, cement industry has recorded an average growth rate of 7.4 percent. At the end of this plan actual production was 76.22 mn.t. against a target of 76 mn.t. (CMA, 1998). The growth rate achieved was 9.46 percent. For the Ninth Five Year Plan (1997-2002) in 1997-98, the target set was 81 mn.t. The industry has been able to meet its target with a production of 83.16 mn.t. with a growth rate of 9.11 percent. In 1998-99 the industry has achieved production of 87.91 mn.t. with a growth rate of 5.7 percent, in spite of a sluggish market throughout the year. In 1999-2000, actual production was 100.45 mn.t. against a target of 94 mn.t. The growth rate achieved was 15 percent. During the Tenth Five Year Plan (2002-2007), cement production grew at a healthy CAGR of 8.67 percent while the installed capacity showed modest CAGR of 3.69 percent. The average annual growth rate was 10.24 percent and exports too showed an upward trend during this plan period. The industry is subject to quality control order issued on 17.2.2003 to ensure quality standards. The targeted cement production and capacity by the end of the Eleventh Five Year Plan
(2007-2012) are 269 mn.t. and 298 mn.t. respectively, with a capacity utilisation of 90 percent. Corresponding to the targeted annual growth of 9 percent in GDP, the cement demand is expected to increase 11.5 percent annually (Planning Commission, 2008).

Table: 2.2
**Growth of Indian Cement Industry through the Five Year Plans**

<table>
<thead>
<tr>
<th>Five Year Plans (Year)</th>
<th>Capacity (mn.t.)</th>
<th>Production (mn.t.)</th>
<th>Capacity Utilization (in percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Plan Period (1950-51)</td>
<td>3.28</td>
<td>2.20</td>
<td>67</td>
</tr>
<tr>
<td>I (1955-56)</td>
<td>5.02</td>
<td>4.60</td>
<td>92</td>
</tr>
<tr>
<td>II (1960-61)</td>
<td>9.30</td>
<td>7.97</td>
<td>86</td>
</tr>
<tr>
<td>III (1965-66)</td>
<td>12.00</td>
<td>10.97</td>
<td>91</td>
</tr>
<tr>
<td>IV (1973-74)</td>
<td>19.76</td>
<td>14.66</td>
<td>74</td>
</tr>
<tr>
<td>V (1978-79)</td>
<td>22.58</td>
<td>19.42</td>
<td>86</td>
</tr>
<tr>
<td>VI (1984-85)</td>
<td>42.00</td>
<td>30.13</td>
<td>72</td>
</tr>
<tr>
<td>VII (1989-90)</td>
<td>61.37</td>
<td>45.42</td>
<td>74</td>
</tr>
<tr>
<td>VIII (1996-97)</td>
<td>105.26</td>
<td>76.22</td>
<td>72</td>
</tr>
<tr>
<td>IX (2001-02)</td>
<td>145.99</td>
<td>106.90</td>
<td>73</td>
</tr>
<tr>
<td>X (2006-07)</td>
<td>177.83</td>
<td>161.66</td>
<td>91</td>
</tr>
<tr>
<td>XI (2007-12)</td>
<td>298*</td>
<td>269*</td>
<td>90*</td>
</tr>
</tbody>
</table>

Source: RBI Report on Currency and Finance (various issues), Government of India; Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi.

Note: *Estimates

**2.5 Policy Phases**

Indian cement industry has thus been one of the pioneering industries in introducing policy reforms. After the delicensing, the cement industry has been growing rapidly at an average rate of 8 percent except for a short period in 1991-92 when the industry faced demand recession.


Cement was brought under the purview of Cement Control Order of 1956, both for price and distribution, to ensure fair price model for consumers as
well as manufacturers. The State Trading Corporation (STC) became the sole agent for distribution from 01.07.1956 and a notification was issued to all producers to sell their entire output to the corporation. During 1964-66, based on the number of representations by cement producers about the existing strict system of distribution and price control the Govt. decided to decontrol the industry, with effect from 01.01.1966, for enabling the industry to undertake expansion schemes. The Govt. decided to keep this system in force for two years. The industry accepted Govt.’s decision for a self regulating control through ‘The Cement Allocation and Co-ordinating Organization’ (CACO), which had control over all factories in the private and public sector (with a central office at Bombay and regional offices at Delhi, Calcutta and Madras). CACO was neither powerful to exercise efficient control over the various units nor could ensure equitable product distribution and hence could not succeed. During this period (1966-1967), the rise in capacity and production were less than two percent and five percent respectively (Das, 1987). The Govt., therefore, reintroduced the price and distribution control of cement with effect from 01.01.1968 and a ‘cement controller’ was appointed to look after the distributional system. Later on there were demands from the industry for an upward revision in the ex-works price of cement as a result of the rise in costs.

The Lav Raj Kumar Committee appointed in 1978, recommended a three-tier system of retention prices, to provide some kind of incentives to the working of the industry. Accordingly, in May 1979, Govt. accepted three prices for low, medium and high cost plants respectively. These prices were fixed so as to ensure a post-tax return of 12 percent on net worth (Das, 1987) at 85 percent capacity utilization (Dutt and Sundaram, 1993). The three-tier price system recommended by the Lav Raj Kumar Committee was in practice from May 1979 to March 1982.
2.5.2 Partial Decontrol (1982-1988)
In April 1981, the Govt. appointed Cement Development and Price Review Committee under the Chairmanship of Dr. A.K. Ghosh. In January 1982, Ghosh committee recommended for the “partial decontrol” which would enable a reasonable return on capital employed and will provide price incentive for generation of internal resources. Thus, Govt. allowed a dual pricing policy in March 1982 under which the cement industry had to give 66.6 percent of the installed capacity (Dewett, Varma, and Sharma, 1991) to the Govt. as levy cement and the remaining to be sold in the open market as non-levy cement. The sick units and the units starting production after January 1982 were to give a 50 percent of the installed capacity as levy cement. Later, it was reduced to 37.5 percent in the first year of their operation, 47.5 percent in the second year and 50 percent in subsequent years (Gokarn and Vaidya, 1993). All mini cement units except those established by MRTP houses became free from price and distribution control.

The impact of partial decontrol in cement in 1982 was the creation of new capacities and a subsequent increase in production. The installed capacity was doubled from 29 mn.t. in 1981 to 58 mn.t. by 1990 whereas production was more than doubled from 21 mn.t. to 45 mn.t. during the same period (Nath and Bose, 2002).

2.5.3 Total Decontrol from 1989
Encouraged by the positive response of the industry to the policy of liberalisation in the cement industry, Government decontrolled the industry fully on 1st March 1989. The prices and distribution of cement have been fully decontrolled with effect from 1st April 1989. All units were free to sell all their output at whatever price the market would bear.
2.5.4 Delicensing of Cement Industry (1991 onwards)

The cement industry has also been listed as a priority industry in Schedule III of the Industry Policy Statement making it eligible for automatic approval for foreign investment up to 51 percent and also for technical collaboration on normal terms of payment of royalty and lump sum know-how fee. With the free sale and distribution of cement, its production and prices are largely governed by economic factors, like, demand and supply, cost of raw materials and other inputs, production as well as distribution costs. The cement producers now experience a different market situation and the industry is now subjected to increased competitions with respect to availability of high quality cement. This implies lower cost of production, increased production efficiency, use of most modern technology for energy efficiency and quality cement production.

2.6 Cement Manufacture and Varieties of Cement

In the manufacture of Portland cement, two minerals are ground and blended together; one (a mineral such as chalk or limestone), containing calcium chloride and the other, (a mineral such as clay or shale), containing silica. Relatively small quantities of other materials are also added at this stage (Bianchi, 1982). This mixture after pre-heating is then heated in a kiln at a temperature of 1450°C (World Business Council for Sustainable Development [WBCSD], 2002a), causing chemical reaction inside. This leads to the fusion of raw materials to produce clinker. Clinker is cooled and is combined with gypsum and ground to a fine powder which forms the basic cement. Indian cement industry uses three processes in the manufacture of cement: dry process, semi-dry process and the wet process. There was a continuous transfer of technology from the old wet process to the modern dry process over the years. In general, the technological characteristics of local raw materials, particularly their water content,
determine the choice between the wet and dry processes. In the wet process, water is added to the raw materials to produce the slurry which usually contains 34-36 percent water by weight (Das and Kandpal, 1997), before being introduced to the kiln whereas the dry process involves mixing the raw materials together in their dry stage. A semi-dry process involves the addition to water only after the raw materials have been blended. The resulting nodules can then be pre-heated by using exhaust gases from the kiln (Bianchi, 1982). Semi-dry process uses more energy than the dry process but less energy than the wet process. The main advantage of a modern dry process over the wet process is the far lower energy consumption, and consequently lower fuel costs (WBCSD, 2002a) and lower requirements of water. Even though the incidence of power consumption is higher in the dry process, the total saving in fuel consumption would still be larger (Goel and Nair, 1978). Dry process kilns are typically larger, with capacities in India ranging from 300-8,000 tonnes per day (average of 2,880 tpd). While capacities in semi-dry kilns range from 600-1,200 tpd (average 521 tpd), capacities in wet process kilns range from 200-750 tpd (average 425 tpd) (Kumar, 2003).

Cement is moreover a relatively homogeneous product. India produces different varieties and grades of cement based on different compositions according to specific end uses namely, Ordinary Portland Cement (OPC) (33, 43, 53 grades), Portland Pozzolana Cement (PPC), Portland Blast Furnace Slag Cement (PBFSC) and many other varieties. All these varieties of cement have been covered by Indian Standard Specifications. The basic difference between these cement varieties lies in the percentage of clinker used. Some of these varieties are used for special applications, e.g. blended cement helps in resisting certain chemical agents, sulphate resisting cement can be used in places where concentration of sulphate is more, a low heat cement is used for mass concreting work like
dams, barrages and deep foundations. Blended cement is the cement with a fixed percentage of pozzolanes (for example, supplements such as slag and fly ash produced by the steel and electric power industries, respectively) replacing the Portland cement clinker portion of the cement mix. Blended cement is usually understood as cement that is blended by a cement manufacturer rather than a ready-mix supplier (also referred to as composite cement) (Callister, 1994). The use of blended cement, in which clinker is replaced by alternative cementitious materials, for example blast furnace slag, fly ash from coal-fired power stations, and natural pozzolanes, that results in lower CO₂ emissions (Josa, Aguado, Heino, Byars, and Cardim, 2004) and allows for a reduction in the energy used in clinker production (Worrell, Martin, and Price, 2000). The share of blended cement in total cement production has increased from 29 percent in 1997-98 to 54.5 percent in 2003-04 (India Brand Equity Foundation [IBEF], 2005), to 67 percent in 2007 (Government of India [GOI], 2009) and further to 74 percent in 2008 (National Council for Cement and Building Materials [NCB], 2009). The peculiarities of various types of cement are explained below.

- **Ordinary Portland Cement (OPC):** Also referred to as grey cement or OPC, it is the most common type of cement used in ordinary concrete construction. It has 95 percent clinker and 5 percent of gypsum and other materials. In the production of this type of cement in India, Iron (Fe₂O₃), Magnesium (MgO), Silica (SiO₂), Alumina (Al₂O₃), and Sulphur trioxide (SO₃) components are used.

- **Portland Pozzolona Cement (PPC):** It has a lower heat of hydration, which helps in preventing cracks and hence useful in the casting work of huge volumes of concrete. It has 80 percent clinker, 15 percent pozzolona and 5 percent gypsum. It can be availed at low cost in comparison to OPC as it uses fly ash, coal waste or burnt clay as the main ingredients in its manufacture.
- **Portland Blast Furnace Slag Cement (PBFSC):** The rate of hydration heat is even lower than PPC and is mostly used in construction of dams and similar massive projects. It consists of 45 percent clinker, 50 percent blast furnace slag and 5 percent gypsum.

- **Sulphate Resisting Portland Cement (SRC):** This cement is beneficial in the areas where concrete has an exposure to seacoast or sea water or soil or ground water. Under any such instances, the concrete is vulnerable to sulphates attack in large amounts and can cause damage to the structure. Hence, by using this cement one can reduce the impact of damage to the structure. This cement has high demand in India.

- **Rapid Hardening Portland Cement:** The texture of this cement type is quite similar to that of OPC, except that it is ground much finer and possesses immense compressible strength, which makes casting work easy.

- **Oil Well Cement:** Made of iron, coke, limestone and iron scrap, and is used in extraction of oil, constructing or fixing oil wells and withstands high pressure areas (Cemex, 2010). This is applied on both the off-shore and on-shore of the wells.

- **White Cement:** It is a kind of Ordinary Portland Cement. The ingredients of this cement are inclusive of clinker, fuel oil and iron oxide. The content of iron oxide is maintained below 0.4 percent to secure whiteness. White cement is largely used to increase the aesthetic value of a construction. It is preferred for tiles and flooring works. This cement costs more than grey cement.

- **Clinker Cement:** Produced at the temperature of about 1400 to 1450 degree Celsius, clinker cement is needed in the construction work of complexes, houses and bridges. The ingredients for this cement comprise iron, quartz, clay, limestone and bauxite.
### Table: 2.3
Variety-wise Cement Production in India  
(1992-93 to 2008-09) (in mn. t.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Ordinary Portland Cement</th>
<th>Portland Pozzolana Cement</th>
<th>Portland Blast Furnace Slag Cement</th>
<th>Sulphate Resistant</th>
<th>Indian Railway Standard Tariff 40</th>
<th>Others (#)</th>
<th>Total Cement Production</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VIII Plan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992-1993</td>
<td>36.47</td>
<td>8.33</td>
<td>5.37</td>
<td>-</td>
<td>-</td>
<td>0.55</td>
<td>50.72</td>
</tr>
<tr>
<td>1993-1994</td>
<td>38.69</td>
<td>9.24</td>
<td>5.30</td>
<td>0.03</td>
<td>0.01</td>
<td>0.82</td>
<td>54.09</td>
</tr>
<tr>
<td>1994-1995</td>
<td>41.18</td>
<td>10.69</td>
<td>5.83</td>
<td>0.22</td>
<td>0.05</td>
<td>0.38</td>
<td>58.35</td>
</tr>
<tr>
<td>1995-1996</td>
<td>45.04</td>
<td>11.77</td>
<td>7.10</td>
<td>0.25</td>
<td>0.05</td>
<td>0.32</td>
<td>64.53</td>
</tr>
<tr>
<td>1996-1997</td>
<td>48.46</td>
<td>13.6</td>
<td>7.33</td>
<td>0.20</td>
<td>0.08</td>
<td>0.31</td>
<td>69.98</td>
</tr>
<tr>
<td><strong>IX Plan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997-1998</td>
<td>54.30</td>
<td>14.48</td>
<td>7.45</td>
<td>0.19</td>
<td>0.06</td>
<td>0.26</td>
<td>76.74</td>
</tr>
<tr>
<td>1998-1999</td>
<td>57.40</td>
<td>15.57</td>
<td>8.21</td>
<td>0.21</td>
<td>0.06</td>
<td>0.22</td>
<td>81.67</td>
</tr>
<tr>
<td>1999-2000</td>
<td>62.76</td>
<td>21.30</td>
<td>9.39</td>
<td>0.15</td>
<td>0.17</td>
<td>0.44</td>
<td>94.21</td>
</tr>
<tr>
<td>2000-2001</td>
<td>58.06</td>
<td>24.50</td>
<td>10.34</td>
<td>0.13</td>
<td>0.30</td>
<td>0.28</td>
<td>93.61</td>
</tr>
<tr>
<td>2001-2002</td>
<td>57.68</td>
<td>32.29</td>
<td>11.89</td>
<td>0.12</td>
<td>0.25</td>
<td>0.17</td>
<td>102.40</td>
</tr>
<tr>
<td><strong>X Plan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002-2003</td>
<td>56.05</td>
<td>43.10</td>
<td>11.60</td>
<td>0.11</td>
<td>0.33</td>
<td>0.15</td>
<td>111.35</td>
</tr>
<tr>
<td>2003-2004</td>
<td>53.51</td>
<td>52.12</td>
<td>11.26</td>
<td>0.12</td>
<td>0.40</td>
<td>0.09</td>
<td>117.50</td>
</tr>
<tr>
<td>2004-2005</td>
<td>55.97</td>
<td>60.23</td>
<td>10.73</td>
<td>0.13</td>
<td>0.44</td>
<td>0.06</td>
<td>127.57</td>
</tr>
<tr>
<td>2005-2006</td>
<td>55.84</td>
<td>74.01</td>
<td>11.37</td>
<td>0.09</td>
<td>0.43</td>
<td>0.07</td>
<td>141.81</td>
</tr>
<tr>
<td>2006-2007</td>
<td>48.58</td>
<td>93.57</td>
<td>12.85</td>
<td>0.07</td>
<td>0.52</td>
<td>0.07</td>
<td>155.66</td>
</tr>
<tr>
<td><strong>XI Plan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007-2008</td>
<td>42.84</td>
<td>111.21</td>
<td>13.57</td>
<td>0.04</td>
<td>0.58</td>
<td>0.08</td>
<td>168.32</td>
</tr>
<tr>
<td>2008-2009</td>
<td>45.05</td>
<td>120.79</td>
<td>15.18</td>
<td>0.08</td>
<td>0.44</td>
<td>0.07</td>
<td>181.61</td>
</tr>
</tbody>
</table>

Source: Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi.
Notes: (#): Includes-Oil well, Low heat, Special Cement, Silicate, Silver and GPC

Apart from these, some of the other types of cement that are available in India can be classified as: low heat cement, high early strength cement, hydrophobic cement, high aluminium cement, masonry cement. Portland cement dominated the production scene among all the varieties until 2002-03. Since then there has been a quantum jump in the production of Portland Pozzolona Cement which is mainly due to its flyash based production. In 2008-09, PPC accounted for 67 percent of the total production while that of...
OPC is only 25 percent. Table 2.3 shows the quantities of varieties of cement produced in India.

2.7 Export

India started its cement exports during the Pre-Plan period (1950-51) with 5,107 metric tons (Podder, 1962). Initially the country’s main exports consisted of Portland cement and were limited to Pakistan and Nepal. Since then, export continued to increase up to 1953-54 (9,387 metric tons). But by the end of first five year plan it came to 5,685 metric tons (Podder, 1962). In 1958, due to the decline in domestic demand/consumption, and to intensify cement exports it became essential to subsidise exports as the cost of production in India was slightly greater than that of foreign countries due to heavy freight charges. Later on, in 1960-61, white and coloured cement were also added to the export list and the destinations were extended to countries like Kuwait, Bahrain, Singapore, Vietnam, Hongkong, Ceylon, Malaya, Burma, and Kenya etc. Thus, in 1961, exports reached 91,457 metric tons earning a foreign exchange of `8,461,405 (Podder, 1962). The total decontrol in 1989 followed by the delicensing in 1991 led to an increase in cement (2.54 lakh tonnes) and clinker exports. The industry achieved a substantial growth in exports from 1.18 mn.t. in 1992-93 to 2.85 mn.t. in 1993-94 (Kothari’s Industrial Directory of India, 1996-97). Cement and clinker exports have grown at a CAGR of 18.1 percent since 1995-96 with total exports of 9 mn.t. in 2003-04 (CMA, 2005). This accounts for 7.7 percent of the total production. Exports of cement/clinker during the Tenth Plan recorded a growth of 14.24 percent (CAGR). The western region, due to its proximity to the coasts, accounts for 92.4 percent of total exports, of which Gujarat holds a share of 76 percent (Planning Commission, 2008). In 2006-07, the majority of exports were from Gujarat mainly to West Asian countries. At present, the Indian export of cement and clinker are mainly to
Iraq, Nepal, Qatar, Kuwait, other Middle East countries, Bangladesh, Sri Lanka etc. Cement exports grew at a CAGR of 13.1 percent between 1997-98 and 2006-07, with export prices reaching a high of $60 to $70 a tonne in 2006-07 (Sundaram, 2008). Cement and clinker exports from India declined in financial year 2009, as companies diverted exports to the domestic market to capitalize on the higher domestic cement prices (Industry Research Service, 2008). During the period from 2001 to 2008, India’s cement exports increased at a CAGR of 9.9 percent, from US$ 3.7 million to US$ 7.2 million (Indian cement industry: Trade Perspectives, n.d.).

To ensure improved domestic availability of cement, Government banned exports of cement and clinker from India in April 2008 which was later partially lifted in May 2008 by allowing export to Nepal and exports from Gujarat (the state which makes up 90 percent of the overall Indian cement exports) and then was fully lifted in December 2008. This lead to a sharp 33 percent drop in cement and clinker exports in 2007-08 from 9.00 mn.t. in 2006-07 to 6.10 mn.t. in 2008-09 (CMA Annual Report, 2010). Government had also abolished basic customs duty (12.5 percent), Counter Veiling Duty (CVD) (\408/tonne) and Special Additional Duty (SAD) (4 percent) before the ban on exports, permitting duty-free imports (Care Research, 2007). On various representations, Government re-imposed CVD and SAD in January 2009 but Custom Duty continues to be zero. Hence, there was a marginal increase of 1.3 percent in overall exports during 2008-09 over the year 2007-08 from 6.02 mn.t. to 6.10 mn.t. During 2008-09, cement exports dropped by 12 percent whereas clinker exports increased by 22 percent (CMA Annual Report, 2009).

Table 2.4 shows the Indian cement export performance from 1970-71 to 2008-09. Cement industry has the capacity to export cement/clinker for about 15-20 mn.t. during the XI Plan period (Planning Commission,
2008). The deceleration on cement plant capacity expansion in European countries due to strict EU Norms on pollution is a good opportunity to export bulk cement to countries like Spain and Greece.

Table 2.4
Export of Cement from India (1970-71 to 2008-09)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cement (in Lakh Tonne)</th>
<th>Year</th>
<th>Cement (in Million Tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-76</td>
<td>3.36</td>
<td>1994-95</td>
<td>1.70</td>
</tr>
<tr>
<td>1979-80</td>
<td>0.50</td>
<td>1995-96</td>
<td>1.57</td>
</tr>
<tr>
<td>1980-81</td>
<td>0.74</td>
<td>1996-97</td>
<td>1.97</td>
</tr>
<tr>
<td>1981-82</td>
<td>0.26</td>
<td>1997-98</td>
<td>2.68</td>
</tr>
<tr>
<td>1982-83</td>
<td>0.05</td>
<td>1998-99</td>
<td>2.06</td>
</tr>
<tr>
<td>1983-84</td>
<td>0.06</td>
<td>1999-00</td>
<td>1.95</td>
</tr>
<tr>
<td>1984-85</td>
<td>0.29</td>
<td>2000-01</td>
<td>3.15</td>
</tr>
<tr>
<td>1985-86</td>
<td>0.47</td>
<td>2001-02</td>
<td>3.38</td>
</tr>
<tr>
<td>1986-87</td>
<td>0.48</td>
<td>2002-03</td>
<td>3.47</td>
</tr>
<tr>
<td>1987-88</td>
<td>0.00</td>
<td>2003-04</td>
<td>3.36</td>
</tr>
<tr>
<td>1988-89</td>
<td>0.31</td>
<td>2004-05</td>
<td>4.07</td>
</tr>
<tr>
<td>1989-90</td>
<td>1.43</td>
<td>2005-06</td>
<td>6.01</td>
</tr>
<tr>
<td>1990-91</td>
<td>2.54</td>
<td>2006-07</td>
<td>5.87</td>
</tr>
<tr>
<td>1991-92</td>
<td>2.88</td>
<td>2007-08</td>
<td>3.65</td>
</tr>
<tr>
<td>1992-93</td>
<td>6.65</td>
<td>2008-09</td>
<td>3.20</td>
</tr>
</tbody>
</table>

Source: Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi.

Thus, India can increase exports up to 15 mn.t. by the end of XI Plan period. Due to large scale capacity expansion in the cement industries in UAE, Saudi Arabia, Iran, Pakistan and Egypt the Indian cement industry has to find newer markets for its cement exports in Africa and Europe in addition to the major exports of cement and clinker to Sri Lanka and clinker to Bangladesh. India can increase its cement exports to a greater extent and also diversify its export market by improvising its port facilities, transport infrastructure and bulk transportation etc. The strengths and weaknesses for cement exports listed in the task force report for the 11th Five Year Plan set up by the Planning Commission, 2008 are as follows:
Strengths

- Indian cement exporting companies have established strong presence in SAARC countries, West Asia and some countries in Africa.
- In Indian cement industry, energy consumption both thermal and electrical is as low as compared to best elsewhere in the world.
- The industry is supported by availability in abundant quantity of cement grade limestone. Cement production is not only sufficient to meet the domestic demand in full but also export in large quantities.

Weaknesses

- Lack of infrastructure facilities both for movement of cement from land locked cement units and also at ports add to cost for cement exports.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item</th>
<th>/tonne of Cement (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Royalty and Cess on Limestone</td>
<td>69</td>
</tr>
<tr>
<td>2</td>
<td>Royalty on Coal</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>Royalty on Gypsum</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Duties on Power Tariff</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>Sales Tax on Stores &amp; Spares for Cement Production</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Indian Costs Compared to Competing Countries</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Interest on Export Credit</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>Power Tariff</td>
<td>180</td>
</tr>
<tr>
<td>3</td>
<td>Port Charges</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>383</td>
</tr>
<tr>
<td></td>
<td>Overall Impact</td>
<td>517</td>
</tr>
</tbody>
</table>


- Loading facilities at ports are very poor. Best loading rate of 2,500 tpd, is far low compared to international levels of 12,000-15,000 tpd.
High costs due to heavy taxation, the table given above show the state levies and taxes on the cement exports. The cement industry, therefore, has a disadvantage of about US $11.5 per tonne of cement exported as compared to its competitor.

2.8 Import

During 1912 and 1913, imported cement was selling in Bombay at `45 to `50 per ton. Before the First World War, in 1914, India imported 152,946 metric tons of cement with the largest amount of Portland cement from Great Britain (Podder, 1962). From 1919 to 1924 four fifth of the imported cement was from Britain. Post war period faced a direct competition between Indian cement and British cement due to greater preference for the latter in spite of the good quality of former over the latter. During the Second World War (1943-44 to 1945-46) cement imports were very low. Barring few exceptions during 1948 to 1950 the cement imports were kept at a low level till 1956 wherein imports shot up to 116,500 metric tons because of heavy shortage of cement in the country (Podder, 1962). The sharp decline in consumption coupled with increase in production and shortage of foreign exchange, cement imports were reduced to 4,310 metric tons in 1959 and further to 1,775 metric tons in 1960 (Podder, 1962). Imports were then allowed only for varieties of cement not manufactured in India. Apart from a five tonne import of cement in 1971-72 there were no imports till 1977. Imports restarted in 1977-78 with 312 tonnes and increased to 1655 tonnes in 1978-79. No particular trend was observed till 1983-84 where it reached a high of 2385 tonnes. After that it started to decline drastically and touched 176 tonnes in 1986-87 (Indiastat.com) Imports were almost non-existent from 1987-88 onwards. The abolition of basic customs duty on cement of 12.5 percent in 2007 led to a quantum jump in imports from 211771 tonnes in 2006-07 to 621469 tonnes in 2007-
08 and further to 873565 tonnes in 2008-09 (Indiastat.com). China was India’s main source of cement imports during 2008, with imports worth US$ 13.9 million followed by Italy and Taiwan with imports worth US$ 13.5 million and US$ 2.5 million, respectively (Indian cement industry: Trade Perspectives, n.d.). During 2008, India’s top five import sources led by China together accounted for close to 92 percent of India’s total cement imports.

Table: 2.6

Import of Cement by India (1914 to 2008-09)

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity Imported (In Tonne)</th>
<th>Year</th>
<th>Quantity Imported (In Tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1914</td>
<td>152946</td>
<td>1960</td>
<td>1775</td>
</tr>
<tr>
<td>1920</td>
<td>120409</td>
<td>1971-72*</td>
<td>5</td>
</tr>
<tr>
<td>1925</td>
<td>69295</td>
<td>1975-76*</td>
<td>-</td>
</tr>
<tr>
<td>1930</td>
<td>69091</td>
<td>1980-81*</td>
<td>1970</td>
</tr>
<tr>
<td>1935-36</td>
<td>59739</td>
<td>1985-86*</td>
<td>331</td>
</tr>
<tr>
<td>1940-41</td>
<td>4618</td>
<td>1990-91*</td>
<td></td>
</tr>
<tr>
<td>1945-46</td>
<td>751</td>
<td>2006-07</td>
<td>211771</td>
</tr>
<tr>
<td>1949-50</td>
<td>309316</td>
<td>2007-08</td>
<td>621469</td>
</tr>
<tr>
<td>1950-51</td>
<td>18364</td>
<td>2008-09</td>
<td>873565</td>
</tr>
<tr>
<td>1955-56</td>
<td>17004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Indiastat.com; Divatia (1996).
Note: *In '000 Tonne
#Reliability of the data is doubtful and hence not furnished.

2.9 Consumption

In sharp contrast to production, the per capita consumption of cement in the country is one of the lowest. With just a meager per capita consumption of nine kg per annum in 1951-52 (Podder, 1962), now it has risen to 156 kg in 2008 (CMA, 2008). The cement consumption projections by National Council of Applied Economic Research (NCAER), on a conservative basis, have placed the cement demand of 225 mn.t. by the year 2010-11. The per capita consumption was 0.48 kg in 1914 which then increased to 1.12 kg in 1924. There was an increasing trend observed in the
per capita cement consumption apart from few years (1942-46) where it showed a declining trend. The rate of growth of per capita cement consumption in the country increased to 9.6 percent in 1955-59 from 7.4 percent in 1951-55. The per capita cement consumption increased to 17.53 kg in 1960 (Podder, 1962) and to 26 kg in 1970 and went on to 30 kg in 1980. Table 2.7 shows the per capita cement consumption in India from 1989 to 2008.

Table 2.7
Per Capita Consumption of Cement in India (1989 to 2008)
(In Kgs/Annum)

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Capita Cement Consumption</th>
<th>Year</th>
<th>Per Capita Cement Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>59</td>
<td>1999</td>
<td>97</td>
</tr>
<tr>
<td>1990</td>
<td>57</td>
<td>2000</td>
<td>99</td>
</tr>
<tr>
<td>1991</td>
<td>63</td>
<td>2001</td>
<td>97</td>
</tr>
<tr>
<td>1992</td>
<td>61</td>
<td>2002</td>
<td>106</td>
</tr>
<tr>
<td>1993</td>
<td>62</td>
<td>2003</td>
<td>110</td>
</tr>
<tr>
<td>1994</td>
<td>65</td>
<td>2004</td>
<td>118</td>
</tr>
<tr>
<td>1995</td>
<td>72</td>
<td>2005</td>
<td>125</td>
</tr>
<tr>
<td>1996</td>
<td>78</td>
<td>2006</td>
<td>136</td>
</tr>
<tr>
<td>1997</td>
<td>82</td>
<td>2008</td>
<td>156</td>
</tr>
<tr>
<td>1998</td>
<td>85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi.

Till the beginning of 1980’s Government continued to be the major consumer of cement. The reasons for low consumption can be ascribed to slow development in the areas of housing, roads, and the highly income elastic nature of cement demand. During the year 1982, the Govt.’s consumption of cement (central and state) was 9.67 mn.t. against the production of 22.54 mn.t. (42.9 percent of production). The partial decontrol in 1982 led to an increase in private consumption and the Govt.’s consumption declined to 22.5 percent of production in 1987 (as cited in Singh, 1992). The cement consumption in India is given in Table 2.8. The cement industry after recording a negative growth in consumption during...
2000-01 by 1.9 percent, regained its growth in 2001-02 by 9.7 percent. Consumption of cement during the Tenth Five Year Plan has recorded a CAGR of eight percent which was lower than the estimates for the high growth scenario. This is mainly due to the low growth in infrastructure development and other projects where cement is used.

### Table: 2.8
Cement Consumption in India (1994-95 to 2008-09)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cement Consumption (in mn.t.)</th>
<th>Cement Consumption Growth (in percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-95</td>
<td>56.67</td>
<td></td>
</tr>
<tr>
<td>1995-96</td>
<td>62.97</td>
<td>11.12</td>
</tr>
<tr>
<td>1996-97</td>
<td>68.16</td>
<td>8.24</td>
</tr>
<tr>
<td>1997-98</td>
<td>73.89</td>
<td>8.41</td>
</tr>
<tr>
<td>1998-99</td>
<td>79.77</td>
<td>8.0</td>
</tr>
<tr>
<td>1999-00</td>
<td>92.05</td>
<td>15.40</td>
</tr>
<tr>
<td>2000-01</td>
<td>90.28</td>
<td>-1.92</td>
</tr>
<tr>
<td>2001-02</td>
<td>99.01</td>
<td>9.67</td>
</tr>
<tr>
<td>2002-03</td>
<td>107.59</td>
<td>8.67</td>
</tr>
<tr>
<td>2003-04</td>
<td>113.86</td>
<td>5.83</td>
</tr>
<tr>
<td>2004-05</td>
<td>123.08</td>
<td>8.10</td>
</tr>
<tr>
<td>2005-06</td>
<td>135.56</td>
<td>10.14</td>
</tr>
<tr>
<td>2006-07</td>
<td>149.36</td>
<td>10.18</td>
</tr>
<tr>
<td>2007-08</td>
<td>164.03</td>
<td>9.82</td>
</tr>
<tr>
<td>2008-09</td>
<td>177.98</td>
<td>8.50</td>
</tr>
</tbody>
</table>

Source: Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi; Researcher’s calculation.

Cement consumption reached its peak level during 2008-09 registering 8.5 percent growth. Northern region accounted for highest growth contributed by additional demand from major projects, namely, Commonwealth Games, sewerage line project in Punjab, National Irrigation Project in Haryana, Delhi Metro, flyover and Delhi airport and the re-imposition of Counter Veiling Duty (CVD) and special CVD on imported cement. The maximum cement consumption and demand goes to Maharashtra with 12.50 percent of total consumption followed by Uttar Pradesh (11.10 percent) and Tamilnadu (7.50 percent) (Planning Commission, 2008).
2.10 Demand

In 1924, 397,000 metric tonnes of cement was demanded; out of which 268,000 metric tonnes was produced in the country and the rest was imported (Podder, 1962). The domestic productive capacity and demand of cement increased substantially except in 1948 and 1949 when the demand sharply outstripped production in the wake of independence. The slowdown in cement demand in 1958 was mainly due to the shortage of internal finance, foreign exchange and shortage of steel which reduced the tempo of new construction in the private sector (Podder, 1962).

Table: 2.9
Projects under the National Highways Development Programme

<table>
<thead>
<tr>
<th>Project Phases</th>
<th>Details</th>
<th>Date of completion</th>
<th>Cement Requirement (mn.t.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDP Phase II</td>
<td>NSEW corridor and port connectivity</td>
<td>Dec 2010</td>
<td>7.61</td>
</tr>
<tr>
<td>NHDP Phase III</td>
<td>Connecting state capital &amp; places of economic and tourist importance to phases I &amp; II</td>
<td>Dec 2013</td>
<td>14.98</td>
</tr>
<tr>
<td>NHDP Phase IV</td>
<td>Upgradation of existing highways to two lane</td>
<td>Dec 2015 (as per financing plan)</td>
<td>12.75</td>
</tr>
<tr>
<td>NHDP Phase V</td>
<td>Six laning of GQ and other high density corridor</td>
<td>Dec 2012</td>
<td>4.14</td>
</tr>
<tr>
<td>NHDP Phase VI</td>
<td>Express ways</td>
<td>Dec 2015</td>
<td>3.00</td>
</tr>
<tr>
<td>NHDP Phase VII</td>
<td>Ring roads, bypasses and flyovers and selected stretches</td>
<td>Dec 2014</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>42.48</strong></td>
</tr>
</tbody>
</table>

Sources: NHAI, committee on infrastructure, I-Sec Research, April 2008; NHDP, Opportunities in infrastructure (Roads) by Ministry of Road Transport and Highways, Government of India. www.infrastructure.gov.in

Note: Cement demand assuming 25 percent of roads made of concrete.
Cement consumption varies across regions due to the differences in the demand-supply balance, per capita income and the level of industrial development in each state (IBEF, 2005). The private sectors percentage in the total cement consumption is increasing. Housing accounts for the largest share (over 55 percent) of the total cement consumption in India. The housing sector is followed by infrastructure sector (25 percent) and commercial projects (20 percent) (ICRA, 2006). Cement concrete roads costs more but they have longer life. This is because of the fact that about 35 percent of the cost of a concrete road is spent on cement, whereas the percentage spent on cement for other types of construction is around half as much (Planning Commission, 2008). Table 2.9 presents cement requirement for various projects under the National Highways Development Programme (NHDP). As per NCAER study, under high growth scenario, the demand for cement (including exports) is expected to increase to 244.82 mn.t. by 2010-11. The demand for cement in India is given in Table 2.10.

### Table 2.10
**Demand for Cement in India* (1980-81 to 2008-09) (in Million Metric Tonne)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand</th>
<th>Year</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>28</td>
<td>1995-96</td>
<td>69.6</td>
</tr>
<tr>
<td>1981-82</td>
<td>30.2</td>
<td>1996-97</td>
<td>76.2</td>
</tr>
<tr>
<td>1982-83</td>
<td>32.6</td>
<td>1997-98</td>
<td>83.2</td>
</tr>
<tr>
<td>1983-84</td>
<td>35.3</td>
<td>1998-99</td>
<td>90.5</td>
</tr>
<tr>
<td>1984-85</td>
<td>37</td>
<td>1999-00</td>
<td>96.6</td>
</tr>
<tr>
<td>1985-86</td>
<td>38.5</td>
<td>2000-01</td>
<td>99.3</td>
</tr>
<tr>
<td>1986-87</td>
<td>38</td>
<td>2001-02</td>
<td>106.9</td>
</tr>
<tr>
<td>1987-88</td>
<td>39</td>
<td>2002-03</td>
<td>111.1</td>
</tr>
<tr>
<td>1988-89</td>
<td>42</td>
<td>2003-04</td>
<td>117.1</td>
</tr>
<tr>
<td>1989-90</td>
<td>43</td>
<td>2004-05</td>
<td>126.7</td>
</tr>
<tr>
<td>1990-91</td>
<td>45.8</td>
<td>2005-06</td>
<td>147.8</td>
</tr>
<tr>
<td>1991-92</td>
<td>53.6</td>
<td>2006-07</td>
<td>161.5</td>
</tr>
<tr>
<td>1992-93</td>
<td>54.1</td>
<td>2007-08</td>
<td>180</td>
</tr>
<tr>
<td>1993-94</td>
<td>57.9</td>
<td>2008-09**</td>
<td>185</td>
</tr>
<tr>
<td>1994-95</td>
<td>58.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Centre for Industrial and Economic Research, 2008.
Notes:*Including imports, ** Estimates.
2.11 Raw Materials

2.11.1 Limestone
The primary raw materials used in cement manufacture are limestone or chalk, clay or shales and marl. In India, there are no chalk deposits; hence the cement industry is primarily based on limestone. These feedstock materials provide calcium carbonate, silica, alumina and ferric oxide which, when burned in kilns, produce cement clinker. Limestone is the most ample source of Calcium Oxide (CaO). The clinker is then ground or milled with additives such as gypsum (a setting retardant) to form cement. This is stored on-site and transported either in bulk or packed in paper or plastic-lined paper bags before shipment. Typically, 1.4-1.5 tonnes of limestone are required per tonne of clinker (Podder, 1962). Consequently, cement plants are located close to the quarries of limestone deposits. Limestone deposits are abundant and unevenly distributed in the country. Limestone deposits are mainly found in the Southern region followed by the Western region. In 1975, both South (36.34 percent) and West (28.6 percent) regions of India produced 64.94 percent of the total production of limestone. Adoption of modern techniques like photogrammetry and remote sensing has enabled the industry to discover virgin limestone. Cement industry is the biggest limestone user in the country accounting for over 75-80 percent of limestone produced in India. For cement, the Calcium Oxide content of limestone should be a minimum of 44 percent. Thus, for a one million tonne cement plant, assured availability of cement grade limestone reserves of the order of 50-60 mn.t. in the close vicinity is important. Table 2.11 shows the region-wise status of cement grade limestone reserves in India.

However, 23 percent of proved equivalent reserves fall under forest areas and 7.5 percent are restricted under Coastal Regulation Zone and other regulated areas. Out of total limestone reserves, over 45 percent of the
inventory of cement grade limestone is in the Southern region, followed by
the Northern region with 21.84 percent, the Western region with 12.34
percent and the Eastern region with 15.82 percent and rest 3.64 percent with
Central region.

Table: 2.11
Region-Wise Status of Cement Grade Limestone Reserves in India
(As on 31 March 2006)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Reserves in Million Tonnes</th>
<th>Total</th>
<th>Proved Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proved</td>
<td>Probable</td>
<td>Possible</td>
</tr>
<tr>
<td>North</td>
<td>2716.04</td>
<td>5074.88</td>
<td>13484.05</td>
</tr>
<tr>
<td>Central</td>
<td>1920.39</td>
<td>663.70</td>
<td>962.05</td>
</tr>
<tr>
<td>East</td>
<td>3716.80</td>
<td>2468.20</td>
<td>9227.40</td>
</tr>
<tr>
<td>West</td>
<td>4600.74</td>
<td>6819.01</td>
<td>812.33</td>
</tr>
<tr>
<td>South</td>
<td>9521.66</td>
<td>4005.33</td>
<td>31437.87</td>
</tr>
<tr>
<td>Total</td>
<td>22475.63</td>
<td>19031.12</td>
<td>55923.70</td>
</tr>
</tbody>
</table>

Source: Task Force Report on Cement Industry for the 11th Five Year
Plan set up by the Planning Commission, Government of India, 2008.

Andhra Pradesh ranks first in the country with total reserves of 30434 mn.t.
(33.5 percent) and proved equivalent 15986 mn.t. (31 percent) of cement
grade limestone. Second largest state is Karnataka, with total reserves of
12809 mn.t. of cement grade limestone (proved equivalent 10718 mn.t.)
followed by Gujarat with 10418 mn.t. (proved equivalent 8406 mn.t.) and
Rajasthan with 7634 mn.t. (proved equivalent 4763 mn.t.). About 28
percent of the limestone reserves have been restricted due to environmental
constraints, such as reserve forests, bio-zones etc.

2.11.2 Gypsum

Gypsum is another raw material, used as a retarding agent and is added to
the extent of five percent (Podder, 1962) ground along with clinker during
the manufacture of cement. India has good reserves of natural gypsum,
mainly in the states of Rajasthan, Gujarat and Tamil Nadu. About 50 kgs. of
gypsum is needed per tonne of cement (Planning Commission, 2008).
Consumption of gypsum varies from two to six percent in different plants depending upon the quality of clinker. At the present level of production, the annual requirement of gypsum is estimated at about five mn.t. Certain chemical industries generate chemical gypsum as by-product in the form of phosphogypsum. Some cement plants located near to these industries are using chemical gypsum as a substitute product for natural gypsum.

2.11.3 Coal
Coal is the basic and indispensible fuel as well as raw material for cement manufacture. Firstly, the heat value in coal provides the thermal energy required for the operation of the kiln. Secondly, the mineral content in coal (basically, silica content) acts as a constituent in clinker. Since the nationalization of coal mines, the investment in coal mining for commercial sale has been determined by the availability of financial resources with Coal India Ltd. The coal linkage committee classified coal consumers as core and non-core. Cement is included in the core sector.

Cement industry needs about 200 kgs. of coal to produce one tonne of clinker (Planning Commission, 2008). Coal constitutes around 35-40 percent of the production cost of cement. The industry uses about five percent of coal produced in the country. Cement industry consumes about 10 mn.t. of coal annually. Coal is abundantly available primarily in Orissa, Jharkhand, Chhattisgarh, West Bengal, eastern Madhya Pradesh and, north Andhra Pradesh. As per the data published by Geological Survey of India as on 01.04.2009, the estimated coal resources in the country stand at 267.21 billion tonnes. Table 2.12 gives the State-wise coal resources in the country. Coal consumption for burning varies from 23 to 33 percent in wet process plants and from 14 to 18 percent in dry process plants (Podder, 1962). Currently, 60 percent of coal requirement for the industry is met through
linkages and Fuel Supply Agreements and the rest through imports, open
market purchases, use of alternate fuels such as lignite and pet coke.

Table: 2.12
State-Wise Status of Coal Reserves in India in mn.t.
(As on 1st April 2009)

<table>
<thead>
<tr>
<th>State</th>
<th>Proved</th>
<th>Indicated</th>
<th>Inferred (Total)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Bengal</td>
<td>11652.84</td>
<td>11603.25</td>
<td>5070.70</td>
<td>28326.79</td>
</tr>
<tr>
<td>Bihar</td>
<td>0.00</td>
<td>0.00</td>
<td>160.00</td>
<td>160.00</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>39479.33</td>
<td>30894.31</td>
<td>6338.32</td>
<td>76711.96</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>8041.18</td>
<td>10294.58</td>
<td>2645.25</td>
<td>20981.01</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>10910.64</td>
<td>29191.79</td>
<td>4380.67</td>
<td>44483.10</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>866.05</td>
<td>195.75</td>
<td>0.00</td>
<td>1061.80</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>5255.36</td>
<td>2907.21</td>
<td>1992.17</td>
<td>10154.74</td>
</tr>
<tr>
<td>Orissa</td>
<td>19943.63</td>
<td>31484.05</td>
<td>13799.18</td>
<td>65226.86</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>9193.61</td>
<td>6748.04</td>
<td>2985.27</td>
<td>18926.92</td>
</tr>
<tr>
<td>Assam</td>
<td>348.65</td>
<td>35.85</td>
<td>3.02</td>
<td>387.52</td>
</tr>
<tr>
<td>Sikkim</td>
<td>0.00</td>
<td>58.25</td>
<td>42.98</td>
<td>101.23</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>31.23</td>
<td>40.11</td>
<td>18.89</td>
<td>90.23</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>89.04</td>
<td>16.51</td>
<td>470.93</td>
<td>576.48</td>
</tr>
<tr>
<td>Nagaland</td>
<td>8.76</td>
<td>0.00</td>
<td>13.18</td>
<td>21.94</td>
</tr>
<tr>
<td>Total</td>
<td>105820.32</td>
<td>123469.7</td>
<td>37920.56</td>
<td>267210.58</td>
</tr>
</tbody>
</table>


Yet, there has been deterioration in the quality of coal over the years with
the increase in the ash content (25-30 per cent) entailing lower calorific
values for coal (3500-4000 kcal/kg) and improper and inefficient burning,
etc. This has led to increase in coal consumption which resulted in higher
fuel and transportation costs. As a solution to these problems cement
industry implemented coal washeries, this reduces the ash content of the
coal at the mine itself. Lignite from deposits in Gujarat and Rajasthan, and
Pet coke which is a residual product from oil refinery with high calorific
value and insignificant ash content, are also used as a substitute for coal in
some plants. Still, there is inadequacy of coal in the country. According to
the working group report for the cement industry for the current Five Year
Plan (2007-12), the coal requirement will increase by 70 percent to 57.97
mn.t. in 2011-12 from 35 mn.t. in 2007-08. The rate of import duty continues at five percent w.e.f. 2006-07. During 2008-09, cement industry consumed 2.41 mn.t. of pet coke. Some of the cement plants have been using pet coke as fuel in the Kilns and also in Captive Power Plants (CPPs) to some extent. Table 2.13 shows the requirement of indigenous coal for the Eleventh Five Year Plan (2011-12). The demand of indigenous coal will reduce corresponding to imports and usage of pet coke.

**Table: 2.13**

<table>
<thead>
<tr>
<th>Requirement of Indigenous Coal for 2011-12 (in mn.t.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Kilns:</td>
</tr>
<tr>
<td>39.72</td>
</tr>
<tr>
<td>For Captive Power Plants:</td>
</tr>
<tr>
<td>18.25</td>
</tr>
<tr>
<td>Total:</td>
</tr>
<tr>
<td>57.97</td>
</tr>
</tbody>
</table>


Notes: *The estimates are only for large plants.

During 2008-09, industry received 14.29 mn.t. of coal which is two percent less than 14.56 mn.t. received during 2007-08. The other minerals used by the cement industry are Quartz, Bauxite, Iron Ore, Kaolin, and Fireclay.

**Table: 2.14**

<p>| Consumption of Minerals in Cement Industry in India (1993-94 to 2004-05) (in '000 Tonne) |
|---------------------------------------------|---------------------------------------------|</p>
<table>
<thead>
<tr>
<th>Year</th>
<th>Limestone</th>
<th>Coal</th>
<th>Gypsum</th>
<th>Quartz</th>
<th>Bauxite</th>
<th>Iron Ore</th>
<th>Kaolin</th>
<th>Fireclay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993-94</td>
<td>805</td>
<td>115</td>
<td>25</td>
<td>66</td>
<td>344</td>
<td>652</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1994-95</td>
<td>764</td>
<td>122</td>
<td>26</td>
<td>137</td>
<td>382</td>
<td>736</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1995-96</td>
<td>813</td>
<td>131</td>
<td>33</td>
<td>113</td>
<td>417</td>
<td>616</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1996-97</td>
<td>846</td>
<td>137</td>
<td>34</td>
<td>132</td>
<td>428</td>
<td>761</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1997-98</td>
<td>898</td>
<td>136</td>
<td>34</td>
<td>134</td>
<td>424</td>
<td>705</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1998-99</td>
<td>933</td>
<td>113</td>
<td>33</td>
<td>221</td>
<td>426</td>
<td>746</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1999-00</td>
<td>1018</td>
<td>126</td>
<td>39</td>
<td>186</td>
<td>442</td>
<td>750</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2000-01</td>
<td>985</td>
<td>110</td>
<td>36</td>
<td>180</td>
<td>336</td>
<td>726</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2001-02</td>
<td>1073</td>
<td>131</td>
<td>37</td>
<td>274</td>
<td>339</td>
<td>701</td>
<td>163</td>
<td>178</td>
</tr>
<tr>
<td>2002-03</td>
<td>1137</td>
<td>144</td>
<td>38</td>
<td>271</td>
<td>345</td>
<td>828</td>
<td>177</td>
<td>207</td>
</tr>
<tr>
<td>2003-04</td>
<td>1185</td>
<td>146</td>
<td>42</td>
<td>304</td>
<td>423</td>
<td>837</td>
<td>190</td>
<td>270</td>
</tr>
<tr>
<td>2004-05</td>
<td>1201</td>
<td>162</td>
<td>49</td>
<td>290</td>
<td>487</td>
<td>916</td>
<td>193</td>
<td>273</td>
</tr>
</tbody>
</table>

Source: Indiastat.com

Note: NA-Not Available.
2.12 Energy

Cement production is highly energy intensive (accounts for 30-40 percent of cement production costs) (Szabó, Hidalgo, Císcar, Soria, and Russ, 2003) and globally, the cement industry accounts for about two percent of the world’s primary energy consumption (International Energy Agency [IEA], 1999). Most of the energy (over 85 percent) is consumed in the clinkerization process, in the kiln, or in the attached preheaters and cyclones, while the remaining part is mainly electricity used to grind the raw material and the cement clinker (Szabó et al., 2003).

In 2006, India ranked fifth in the world in terms of primary commercial energy consumption, accounting for about 3.9 percent of the world’s commercial energy demand (British Petroleum Statistical Review of World Energy, 2007). Industry sector continues to be the highest energy consumer in the country, consuming 44 percent of total commercial energy during 2005-06, with coal and lignite meeting nearly 60 percent of total commercial energy consumption followed by the transport and residential sectors (The Energy Resources Institute [TERI], 2008).

The cement industry uses both fuel (mainly coal) and power as energy inputs. On an average, energy costs in the form of fuel and electricity represent about 40-45 percent of the total production cost in producing a tonne of cement. Both thermal and electrical energy comprise about half each of this overall energy cost (Government of India, 2009). Specific thermal energy consumption in India’s cement industry is 3.3–4.0 gigajoules (GJ) per ton of clinker (Bhushan, 2009). During 2006-07, the average thermal energy consumption was 723 kcal/kg for producing clinker and the average electrical energy consumption was 82 kwh/t for producing cement (CMA, 2010). The best energy consumption achieved by an Indian cement plant was 667 kcal/kg of clinker in thermal energy and 68 kwh/t.
cement in electrical energy (NCB, 2006). Therefore, there is huge scope for improvement in energy efficiency. Clinker production is the most energy-intensive stage in cement production, accounting for nearly 75 percent of total industry energy use.

Production of cement is a continuous process and hence power should be too. Cement manufacturing consumes power mainly for raw meal grinding, kiln rotation and clinker grinding. Specific power consumption in the Indian cement industry is about 100 kwh/ton of cement (Bhushan et al., 2005). Cement industry consumes about 5.5 bn units of electricity annually; one ton of cement approximately requires 120-130 units of electricity (Chandak, 2009). Power tariffs vary according to the location of the plant and the production process. The power tariffs also vary according to different states as power is supplied by the respective State Electricity Boards. It is estimated that, in a one million tonne per annum capacity cement plant, one-hour power cut (equivalent to 4 percent downtime) will result in a loss of production of about seven percent (200 tonnes) (Raina, 2002). Apart from the production loss, the additional coal requirement would be about four tonnes for a one-hour power cut, amounting to the mere wastage of coal (Raina, 2002). To obtain uninterrupted and quality power supply almost all the cement units have installed captive power plants.

In 2004-05, 48 percent of the total cement produced was by using captive power as against only 17 percent in 1985-’86. In 2008-09, 102.59 mn.t. (56.5 percent of total production) of cement was manufactured using captive power as against 81.84 mn.t. (48.6 percent of the total production) in 2007-08 (CMA Annual Report, 2009). Table 2.15 shows the Indian cement production using captive power.
Table: 2.15
Cement Production by Use of Captive Power (1992-93 to 2008-09)

<table>
<thead>
<tr>
<th>Year</th>
<th>Units Produced by Captive Set (Mn. Units)</th>
<th>Cement Production by use of Captive Power (in mn.t.)</th>
<th>Percentage of Cement Production by Use of Captive Power to Total Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-93</td>
<td>1100.00</td>
<td>9.17</td>
<td>18.07</td>
</tr>
<tr>
<td>1993-94</td>
<td>1248.65</td>
<td>10.41</td>
<td>19.24</td>
</tr>
<tr>
<td>1994-95</td>
<td>1481.18</td>
<td>12.34</td>
<td>21.15</td>
</tr>
<tr>
<td>1995-96</td>
<td>2109.06</td>
<td>17.58</td>
<td>27.24</td>
</tr>
<tr>
<td>1996-97</td>
<td>2346.49</td>
<td>19.55</td>
<td>27.94</td>
</tr>
<tr>
<td>1997-98</td>
<td>2575.87</td>
<td>21.47</td>
<td>27.97</td>
</tr>
<tr>
<td>1998-99</td>
<td>3192.91</td>
<td>26.61</td>
<td>32.58</td>
</tr>
<tr>
<td>1999-00</td>
<td>4298.71</td>
<td>37.38</td>
<td>39.68</td>
</tr>
<tr>
<td>2000-01</td>
<td>4880.98</td>
<td>42.44</td>
<td>45.34</td>
</tr>
<tr>
<td>2001-02</td>
<td>4866.46</td>
<td>42.32</td>
<td>41.33</td>
</tr>
<tr>
<td>2002-03</td>
<td>5098.03</td>
<td>44.33</td>
<td>39.81</td>
</tr>
<tr>
<td>2003-04</td>
<td>5298.10</td>
<td>46.07</td>
<td>39.21</td>
</tr>
<tr>
<td>2004-05</td>
<td>6396.66</td>
<td>60.92</td>
<td>47.75</td>
</tr>
<tr>
<td>2005-06</td>
<td>7359.63</td>
<td>70.09</td>
<td>49.43</td>
</tr>
<tr>
<td>2006-07</td>
<td>7874.75</td>
<td>75.00</td>
<td>48.18</td>
</tr>
<tr>
<td>2007-08</td>
<td>8592.98</td>
<td>81.84</td>
<td>48.62</td>
</tr>
<tr>
<td>2008-09 *</td>
<td>9233.47</td>
<td>102.59</td>
<td>56.49</td>
</tr>
</tbody>
</table>

Notes: * Provisional.

It is obvious from Table 2.15 that there has been a gradual increase in cement production by using captive power keeping aside the slight decreases occurred in the few years. Thus, the percentage of cement production using captive power has only increased over the years and more than 50 percent of the cement production is through captive power by 2008-09. It is expected that 2000 MW captive power would be required by the cement industry by the end of the XI Plan (Planning Commission, 2008).

As on 31st March 2009, the total captive power generating capacity installed in cement industry was around 2728 MW (CMA Annual Report, 2009). Of this, 42 percent is based on diesel and 58 percent on thermal. In addition, wind farms of around 85 MW capacities have been installed.
Coal is the major fuel used in cement production. In India, about 94 percent of the thermal energy requirement in cement manufacturing is met by coal. The remaining is met by fuel oil and high-speed diesel oil (Schumacher and Sathaye, 1999). The coal supply through Fuel Supply Agreements (FSA)/Linkage was only 14.29 mn.t. and the total fuel consumption of the cement industry was 29.57 mn.t., leaving a gap of about 15.28 mn.t. between the actual requirement and supply. The linked coal supply was only 48 percent of the total fuel consumption during the year 2008-’09 (CMA Annual Report, 2009). Besides coal, a number of cement plants are also using alternate fuels like pet coke to the extent of 60-80 percent, lignite and several combustible wastes such as rice husk and bamboo dust to the extent of 10-15 percent (Planning Commission, 2008). The alternative fuels such as Pet coke, Lignite, Natural gas, Waste derived fuels (including used rubber tyres), Refuse derived fuels, Bio-mass wastes including fruit of Jatropha Carcus, Pongamia and Algae are considered to have good potential in the present context of Indian economy to either partially or fully substitute coal in cement manufacture in the coming years.

In 1992, the Indian cement industry consumed approximately 195 PJ of final energy and 261 PJ of primary energy whereas in 2002, annual final energy consumption only increased to approximately 352 PJ of final energy and 466 PJ of primary energy even though production almost doubled over the same time period (Sathaye, Price, Can, and Fridley, 2005). In general, the improvement in energy efficiency is the outcome of transfer of technology from the inefficient wet process to the more efficient dry process and adoption of less energy-intensive equipment and practices. Besides, the improvements in energy performance of cement plants in the recent past have also been possible largely due to:

- Retrofitting and adoption of energy efficient equipment
- Better operational control and optimization
- Upgradation of process control and instrumentation facilities
- Better monitoring and Management Information System
- Active participation of employees and their continued exposure in energy conservation efforts etc.

Implementation of advanced technology has reduced both energy and materials consumption in Indian cement plants (Ministry of Commerce & Industry, 2004). Assuming average energy intensity values reach today’s best practice levels, this leads to energy consumption for production of cement in India of between 1,100 and 1,700 PJ of final energy and 1,500 to 2,100 PJ of primary energy in 2020 (Sathaye et al., 2005).

**Alternate Fuels used in the Cement Industry**

The use of alternative fuels reduces the usage of non-renewable fossil fuels such as coal as well as the environmental impacts associated with coal mining; contributes towards a lowering of emissions such as greenhouse gases by replacing the use of fossil fuels with materials that would otherwise have to be incinerated with corresponding emissions and final residues; maximizes the recovery of energy from the alternative fuel material (Environment Protection Agency [EPA], 2008). Thus it helps in reducing cement manufacturing cost because of reduction in energy costs.

Scrapped tyres, ETP Sludge, MSW fluff, refinery tank bottom sludge, oil contaminated soil, drill cuttings waste of oil exploration are the most commonly used combustible wastes in the cement industry throughout the world, substituting fossil fuels (coal/fuel oil/natural gas) up to 30 percent and higher in some cases. The second largest used alternate fuel in cement manufacture is waste oil. Waste plastics, refinery sludge, sewage sludge, animal bone meal, wood waste, saw dust, coconut shells, rice husk, paper etc have also been widely used. Figure 2.5 shows the possible sources
of alternative fuels from other sectors of the economy that can be used in cement industry.

Figure: 2.5
Possible Alternative Fuels that can be used in the Cement Industry


2.13 Environmental Impacts of Cement Production

Cement factories play an important role in overall emission of greenhouse gases. Cement is one of the most polluting industries contributing five percent, (IEA, 1999; Worrell, Martin and Hendriks, 2001; Adam, 2007; Loreti Group, 2008) of the world’s total emission of greenhouse gases. The average world carbon intensity of carbon emissions in cement production is 0.81 kg CO$_2$/kg cement. While China is the largest emitter, the most carbon intensive cement region in terms of carbon emissions per kilogram of cement produced is India (0.93 kg CO$_2$/kg), followed by North America (0.89 kg CO$_2$/kg), and China (0.88 kg CO$_2$/kg) (Hendriks, Worrell, Jager, Blok, and Reimer, 2004). Among the Green House Gases, CO$_2$—the main contributor to global warming is emitted
largely during fossil fuel incineration and partly during the chemical processes involved in cement manufacturing (Das and Kandpal, 1997). The cement industry is one of the most energy-intensive sectors in India that results in the emission of carbon dioxide. And CO$_2$ emissions from Indian cement industry are 750 kg per ton (Bhushan and Monali, 2005). The utilization of alternate fuels/waste derived fuels by the cement industry is expected to reduce green house emissions to some extent (Hendriks et al., 2004). One of the few ways of reducing CO$_2$ from cement production is CO$_2$ capture and storage (Barker, Turner, Napier-Moore, Clark, and Davison, 2009). Over the years with the progress in technology Indian cement industry saw a declining trend in Green House Gases emissions and is shown in Table 2.16.

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission (tonne) per tonne of Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1.20</td>
</tr>
<tr>
<td>1996</td>
<td>1.12</td>
</tr>
<tr>
<td>2000</td>
<td>0.96</td>
</tr>
<tr>
<td>2003</td>
<td>0.88</td>
</tr>
<tr>
<td>2004</td>
<td>0.94</td>
</tr>
<tr>
<td>2005</td>
<td>0.88</td>
</tr>
<tr>
<td>2006</td>
<td>0.86</td>
</tr>
<tr>
<td>2007</td>
<td>0.85</td>
</tr>
<tr>
<td>2008</td>
<td>0.84</td>
</tr>
</tbody>
</table>


Carbon dioxide emissions can be reduced by improving the energy efficiency of the process, shifting to a more energy efficient process, replacing high carbon fuels by low carbon fuels, applying lower clinker/cement ratio (increasing the ratio additives/cement): blended
cements, application of alternative cements (mineral polymers) and CO₂ capture and storage (Barker et al., 2009). On average blended cements may reduce carbon emissions from 0.81 kg to 0.64 kg per kg cement (20 percent) (Hendriks et al., 2004). As most of cement production is carried out in the developing countries, the environmental burden borne by them is also high.

### 2.14 Transport

Cement is a high volume commodity and therefore highly freight intensive in nature, which requires long distance movements both for outward movement of cement and clinker and inward movement of inputs namely coal, gypsum, limestone, fly ash, slag, etc. Freight accounts for about 18 per cent of the total cost. Most of the cement plants are located at or near the limestone deposits, which are aloof from the collieries and cement consumption centers. Hence, railways is the most economical and energy efficient mode of transport. Cement companies have started preferring road transportation even for longer distances because of insufficient wagon supply to the cement industry. Table 2.17 shows the trend of cement despatches by various modes of transport.

The industry has witnessed a rise in movement of cement through the sea route apart from the existing road and rail despatches. Split-location units are another move adopted by companies to cut down on distribution costs. Under this concept, the clinkerisation unit is located close to the limestone reserves, while the grinding units are located at 2–3 different locations; generally closer to the markets (Industry Research Service, 2008).
Table 2.17
Mode-Wise Cement Despatches in India (1992-93 to 2008-2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cement Despatches (in mn.t.)</th>
<th>Percentage of Despatches by Rail to Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rail</td>
<td>Road</td>
</tr>
<tr>
<td>1993-94</td>
<td>28.45</td>
<td>25.77</td>
</tr>
<tr>
<td>1994-95</td>
<td>29.29</td>
<td>29.02</td>
</tr>
<tr>
<td>1995-96</td>
<td>29.12</td>
<td>35.37</td>
</tr>
<tr>
<td>1996-97</td>
<td>31.08</td>
<td>38.81</td>
</tr>
<tr>
<td>1997-98</td>
<td>32.58</td>
<td>43.99</td>
</tr>
<tr>
<td>1998-99</td>
<td>32.72</td>
<td>49.11</td>
</tr>
<tr>
<td>1999-00</td>
<td>38.71</td>
<td>55.29</td>
</tr>
<tr>
<td>2000-01</td>
<td>36.80</td>
<td>56.64</td>
</tr>
<tr>
<td>2001-02</td>
<td>36.20</td>
<td>64.10</td>
</tr>
<tr>
<td>2002-03</td>
<td>37.12</td>
<td>72.30</td>
</tr>
<tr>
<td>2003-04</td>
<td>39.28</td>
<td>76.58</td>
</tr>
<tr>
<td>2004-05</td>
<td>41.45</td>
<td>83.55</td>
</tr>
<tr>
<td>2005-06</td>
<td>48.11</td>
<td>85.61</td>
</tr>
<tr>
<td>2006-07</td>
<td>59.37</td>
<td>88.25</td>
</tr>
<tr>
<td>2007-08</td>
<td>63.86</td>
<td>98.01</td>
</tr>
<tr>
<td>2008-09</td>
<td>68.33</td>
<td>107.36</td>
</tr>
</tbody>
</table>

Source: Cement Statistics (various issues) Published by Cement Manufacturers’ Association, New Delhi.

Table 2.17 clearly shows that there has been a continuous fall of rail share of cement despatches over the time span. It remained constant during the period 2006-09. There has been always an increasing trend in cement despatches through road and it exceeded the rail transport in 1995-96 with 35.37 mn.t. Cement despatches through sea started in 2001-02 and showed an increasing trend till 2005-06 and then started to decline. Bulk transportation of cement in our country accounts for only five percent as against the global average of 70 percent in the developed countries and balance cement is distributed in outdated mode of 50 kg bags (CMA Annual Report, 2009). The First Rail Bulk Cement Terminal was commissioned in November 1997 with the active participation of Ministry of Industry, World Bank and Railways near Kalamboli, Mumbai. Since then, only one more
rail bulk terminal has been set up near Bangalore. In addition to this, three port-based bulk cement terminals using specialized bulk cement carriers for transporting cement through coastal shipping have been set up at New Mumbai, Mangalore and Surat (Planning Commission, 2008). Bulk cement transportation in specialized tankers, namely, railway wagons, trucks, or ships provide business opportunities to railways, truck, and cargo operators. Setting up bulk cement terminals would help in attracting huge investments.

2.15 Research and Development

In the 1990’s, a number of large cement manufacturers have developed their in-house Research and Development (R&D) units and have been recognized and registered with the Ministry of Science & Technology. There are seven units dedicated to R&D on cement in India. National Council for Cement and Building Materials and Research, an autonomous body under the administrative control of Ministry of Commerce & Industry & Consultancy and the Directorate of The ACC Ltd. are fully devoted to R&D activities. Besides these two, cement plants with R&D establishments at plant’s site are Dalmia Institute of Scientific & Industrial Research, India Cement Ltd., Grasim Industries Ltd., Madras Cement Ltd. and Gujarat Ambuja Cement Ltd. The activities of National Council for Cement and Building Materials and Research include cement and silicate research, standardization, calibration, testing and quality control, geological exploration, mine planning, system design and project engineering for mini and major plants, productivity enhancement, environment pollution control and management system, construction development and consumer protection, industrial information, marketing and publicity, and human resource and continuing education. This premier R&D institution in cement industry with its headquarters in Ballabgarh near Delhi and its regional unit at Hyderabad has creditable achievements in areas like energy and
environmental audit, process, diagnostic studies, computer aided mine planning, raw material investigations and raw mix design, assessment of quality and strength of concrete structures etc. Data compiled from various R&D organizations show that total expenditure on R&D activities related to cement is only 0.08 percent of sales turnover of the industry during the year 2005-'06 (Planning Commission, 2008). At present, the cement cess collected for R&D purposes from cement manufacturers’ is partially allocated by the government. The gap in the capital investment on R&D needs to be bridged because R&D can bring manifold returns to the industry and is important for sustainable development. Table 2.18 shows the thrust areas of R&D and expected benefits for the Eleventh Five Year Plan.
### Table: 2.18

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Areas of Research and Development</th>
<th>Expected Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co-processing of hazardous wastes in cement manufacture</td>
<td>Resource conservation and integrated solution to waste management</td>
</tr>
<tr>
<td>2</td>
<td>Development of high performance cement based composites</td>
<td>Improved properties to meet the growing need of durable construction</td>
</tr>
<tr>
<td>3</td>
<td>Multi-model transportation of cement including bulk transportation</td>
<td>Reduction in seepage losses and improvement in environment at construction sites</td>
</tr>
<tr>
<td>4</td>
<td>Enhancing the use of flyash in cement and concrete through processing of fly ash</td>
<td>Increased flyash utilisation, cost reduction and reduction in GHG emission</td>
</tr>
<tr>
<td>5</td>
<td>Development of cements and binders based on nano-technology</td>
<td>Improved properties and resource conservation</td>
</tr>
<tr>
<td>6</td>
<td>Utilisation of PPC for pre-stressed concrete</td>
<td>Increased waste utilisation and cost reduction</td>
</tr>
<tr>
<td>7</td>
<td>Development of cost effective model housing on urban and rural areas</td>
<td>Cost effective construction technologies</td>
</tr>
<tr>
<td>8</td>
<td>Studies on evaluation of technologies for co-generation of power from waste heat</td>
<td>Reduction in GHG emission and energy conservation</td>
</tr>
<tr>
<td>9</td>
<td>Recycling of aggregate from demolished construction</td>
<td>Improved wastes management</td>
</tr>
<tr>
<td>10</td>
<td>Benchmarking of environmental parameters of Indian cement industry</td>
<td>Improved environmental conditions</td>
</tr>
<tr>
<td>11</td>
<td>Utilisation of non-conventional granulated slags in cement manufacture</td>
<td>Resource conservation and improved waste management</td>
</tr>
<tr>
<td>12</td>
<td>Adaptation of low NOx and low SO2 technologies</td>
<td>Improved environmental conditions</td>
</tr>
<tr>
<td>13</td>
<td>Upgradation of low grade limestone</td>
<td>Resource conservation</td>
</tr>
<tr>
<td>14</td>
<td>Studies on critical environment parameters for sustainable development of major limestone bearing regions for creating additional cement capacity</td>
<td>Environmental improvement</td>
</tr>
<tr>
<td>15</td>
<td>Initiatives to reduce CO2 emissions (such as CO2 absorption by Algal Farms, CO2 absorbing cement formulations etc.)</td>
<td>Environmental improvement</td>
</tr>
<tr>
<td>16</td>
<td>Standardisation of composite cements</td>
<td>Improved wastes management</td>
</tr>
</tbody>
</table>

2.16 Mergers and Acquisitions

India's most remarkable and the first merger of the cement industry happened in the year 1936, when ten existing cement companies merged to form today’s ‘ACC Limited’. The Mergers and Acquisitions (M&As) activities in India gained momentum in almost all sectors after liberalization and globalization policies and the scenario of the Indian cement industry was not too different. Indian cement companies have been actively involved in mergers and acquisitions domestically as well as globally. Even though the Indian cement industry has experienced a secular growth in mergers and acquisitions after the liberalization policy in the 1990s, it witnessed a spurt in the number of M&As largely during the end of that decade. There are various reasons for M&As. M&As, according to the efficiency theory are planned and executed for reducing costs by achieving scale economies (Porter, 1985; Shelton, 1988) whereas the monopoly theory looks at it as the routes to raise market power (Steiner, 1975; Chatterjee, 1986). These motives are ultimately related to a common objective maximization of firms profit or to have better financial performance for the firms (Mishra and Chandra, 2010). A recent analysis of the cement firms on the pre and post M&A sales (turnover), value of assets and also the average costs, profitability, market share of the merged entity substantiates the above statements. The results indicated no increase in market shares after the mergers and the M&As are non-competitive and the merging firms have a very similar average cost structure so that they could not have been guided only by efficiency consideration. Hence, it is likely that market dominance seems to have been the objective (Pant and Ranjan, 2007). Other reasons for M&As includes acquisition of new technologies like usage of alternate fuels, benefits of tax shelter and savings in the time and cost required to set up a new unit.
This trend towards consolidation is often favourable for focusing on long term vision and their financial strength would help in rescuing assets that are on the verge of becoming, or have already become nonperforming assets of the firm and allows for improved operating conditions in the entire industry (Mehta and Nanda, 2006). On the other hand, consolidation leads to increase in the market share/concentration of few large companies which raises the chances of collusion and that ultimately leads to a decline in competition. Without change in costs, price increases indicate changes in market power and hence changes in profitability, which is the main reason for any collusive agreement (Friederiszick and Maier-Rigaud, 2008). Arora and Sarkar in their study detected the evidence of cartel formation in the Indian cement industry and this validates the above statement. Their analysis of structural factors could not explain the sudden jump in the price of cement in March 2006 across all zones. This led them to believe that the increase in price is the result of a tacit understanding among players of the cement industry to fix higher prices taking advantage of the boom in the cement sector (Arora and Sarkar, 2008). According to them, the very high demand fluctuations, consistent capacity utilization rates of 80 percent or more and no evidence of price wars, points that the players are not trying to restrict entry and are not stifling supply (as in the oil cartel) to get market power. Thus, cement industry facing the charges of cartelization, has borne a sharp rise of 42 percent in its raw material cost in the fourth quarter of fiscal 2008 even as the wholesale prices of cement surged by 8.5 percent during this period (The Associated Chambers of Commerce and Industry of India, 2008). In addition, the most recent study by Anand (2009), commissioned by the Competition Commission of India, to identify the presence of the alleged cartel in the Indian cement industry since 2000 using bottom-up industry methodology revealed that during the period 2000-2008, the prices for cement have risen more swiftly than prices for the
inputs (except for diesel prices) which was just opposite during 1994-1999. This change in the pricing patterns indicated the increase in the market power.

Some examples of internal consolidation in the Indian cement industry are: Gujarat Ambuja taking a stake of 14 per cent in ACC and taking over DLF Cements and Modi Cement in 2000 and 1998 respectively; ACC taking over IDCOL; India Cement taking over Raasi Cement and Sri Vishnu Cement in 1999 and Vishakai Cement and Yerraguntla Cement in 1998; Grasim’s acquisition of the cement business of L&T forming Ultra Tech and taking over Indian Rayon's cement division and Sri Digvijay Cements in 1999 and Dharni Cement in 1998; Ultra Tech taking over Narmada Cements in 1999. Merger and takeover of Damodhar Cement & Slag Ltd. [merged] and Shiva Cement Ltd. by ACC in 2005 and 2007 respectively; merger of Samruddhi Cement Ltd. [merged] and Ultra Tech Cement Ltd. in 2009. Some of the major M&A deals are shown in Table 2.19.

The M&As in the industry particularly during the last decade has led to the domination of cement production in India by top few cement companies like ACC, Gujarat Ambuja group, Grasim, Ultra Tech Cement Co. Ltd. etc. The basic trend of these activities is consolidation of production, market by larger players and gradual foothold of Multinational Corporations in India (Nath and Bose, 2002). Competition in the industry has intensified from past few years with the entry of these global majors. The domestic companies are adopting strategies like branding, huge spending on advertisements, strengthening distribution network etc. to survive in the market (Dhopatkar, 2010). However, despite this, the cement industry in India remains somewhat fragmented and M&A possibilities still exist.
Table: 2.19

<table>
<thead>
<tr>
<th>Year</th>
<th>Acquirer</th>
<th>Acquired Co.</th>
<th>Valuation (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>Lafarge</td>
<td>Tata Steel’s Cement Division.</td>
<td>75</td>
</tr>
<tr>
<td>2001</td>
<td>Italcementi group</td>
<td>Raymond’s Cement Division.</td>
<td>80</td>
</tr>
<tr>
<td>2001</td>
<td>Holcim &amp; GACL</td>
<td>Zuar i Cement (50:50 JV)</td>
<td>77</td>
</tr>
<tr>
<td>2005</td>
<td>Holcim</td>
<td>ACC (33.6 percent Stake)</td>
<td>107</td>
</tr>
<tr>
<td>2006</td>
<td>Heidelberg</td>
<td>50:50 JV with Indo Rama Cement</td>
<td>N.A</td>
</tr>
<tr>
<td>March 2006</td>
<td>Ciments Francais</td>
<td>Zuar i Cement Ltd.</td>
<td>N.A</td>
</tr>
<tr>
<td>May 2006</td>
<td>Foreign Funds</td>
<td>India Cements (7.5 percent)</td>
<td>‘592Cr / US$ 148.19 million</td>
</tr>
<tr>
<td>2007</td>
<td>Cimpor (Portugese)</td>
<td>Shree Digvijay Cement (53.63 percent)</td>
<td>‘322Cr</td>
</tr>
<tr>
<td>2008</td>
<td>CRH(Ireland)</td>
<td>MHIL (50 percent)</td>
<td>US$456mn</td>
</tr>
<tr>
<td>2008</td>
<td>Lafarge</td>
<td>L&amp;T Concrete’s RMC business</td>
<td>US$349 million</td>
</tr>
<tr>
<td>2008</td>
<td>Vicat SA</td>
<td>Sagar Cement (6.67 percent)</td>
<td>US$ 14.35 million</td>
</tr>
</tbody>
</table>

Source: Prowess; Jose, 2008; Wilson and Ding, 2007; Sivam, 2008; Care Research, 2007; Indian cement industry: Trade perspectives, n.d.; Indian construction industry.com.

Investment norms including guidelines for foreign direct investment are investor friendly. According to the Department of Industrial Policy and Promotion, cement and gypsum products have received cumulative foreign direct investment of US$ 1708.69 million between April 2000 and March
2010 (IBEF, 2010). These factors make Indian market a good platform for future investment.

2.17 Conclusion

This chapter provides a clear picture of the Indian cement industry from its various stages of development. It also helps to understand the importance of energy, transport, and raw materials used in the industry. Moreover, the chapter presents the recent trends in mergers and acquisitions in the industry. The detailed discussion about various characteristics of the industry such as production, consumption, export, Research and Development, etc. provides a background for the analysis of the objectives.
Endnotes

1 Section 2.2 is largely drawn from Wilson, J. W. & Ding, Y. C. (2007). *A comprehensive report on pozzolanic admixtures, the cement industry, market and economic trends and major companies operating in the far east, with reference to Pagan Island*. Prepared for the Secretary, Department of Public Lands, Commonwealth of Northern Mariana Islands.


3 Pre-investment data for the cement industry. (1963). In *Studies in Economics of Industry*, Prepared by The Research and Evaluation Division of the Centre for Industrial Development, Department of Economic and Social Affairs, United Nations.