C O N T E N T S

EXECUTIVE SUMMARY

FINDINGS & RECOMMENDATIONS

I. MACRO OVERVIEW OF CEMENT INDUSTRY

Capacity and Production

1. India is the second largest cement producer in the world with cement production capacity of 175 mn.t. (June 2006) and production of 148 mn.t. (2005-06). In 2006-07, cement production has been estimated at 162 mn.t. as against the target of 165.5 mn.t. India is far behind China which produced 1060 mn.t. cement in 2005.

2. The average annual growth of cement production during the first four years of the X Plan has been 8.67 per cent. Cement demand has increased in line with the production. With the increasing GDP growth and per capita income and rising levels of living standards, demand for cement is expected to go up substantially during the XI Plan period.

3. The annual per capita cement consumption in India is 130 Kg. which is much lower than the world average of 355 kg. It is lower even compared to other developing countries like Brazil (191kg.) and Thailand (366kg.).

4. Corresponding to the targeted annual growth of 9% in GDP, the demand of cement is expected to increase 11.5% annually. Accordingly, the targeted cement production and capacity by the end of the XI Plan are 269 mn.t. and 298 mn.t. respectively, with capacity utilisation of 90%.

Infrastructure

5. The industry depends on infrastructure facilities in the field of coal & power supply and rail transportation for its sustainable development. To meet the demands of the cement industry, enhanced efforts would be required to provide for the requisite infrastructure facilities, which are already overstretched.

Fuel Supply

6. In 2005-06, the cement industry got 58% of its fuel requirements from coal linkages. The rest has been sourced from import (19%) and open market (6%); and use of lignite (3%) and pet coke (14%).

7. With the expected increase in cement production by 66%, it is expected that the fuel requirement would go up by 102% since the new capacities, both addition to existing capacities and new plants, are coming up with captive power generation facilities in view of problems in the grid power supply.

8. The fuel demand is likely to go up from 28.68 mn.t. coal equivalent in 2006-07 to 57.97 mn.t. in 2011-12. This includes 18.25 mn.t. coal requirement for captive power plants.

9. The following measures need to be taken to ensure adequate supply of fuel for cement industry to meet the target of the XI Plan:

   (a) Ensuring 80% of the fuel requirement of cement industry by coal companies through linkages/ Fuel Supply Agreements (FSAs).

   (b) Timely sanction of long-term coal linkages for capacity additions.

   (c) Allotment of more coal blocks to cement plants on priority basis.

   (d) Promoting setting up of coal washeries for cement companies.

   (e) Encouraging coal mining for captive use by cement companies.

   (f) Abolition of import duty on coal and pet coke.

   (g) Permitting duty free import of tyre chips (shredded tyres) by end users for use as alternative fuel.

   (h) Promoting lignite based cement plants.

   (i) Encouraging setting up of captive power plants for cement industry by ensuring appropriate coal linkages and abolition of all types of duties on generation of power for captive use.

Power

10. Since availability and quality of power supply from power utilities continue to be problems, the use of captive power is continuously increasing. In 2004-05, 48% of the total cement produced was by using captive power as against only 17% in 1985-86. It is expected that 2000 MW captive power would be required by the cement industry by the end of the XI Plan.

Investment

11. To attain the targeted capacity addition, an investment of Rs. 52,400 crores would be required during the XI Plan. This includes Rs. 34,400 for green field plants, Rs. 6,400 crores for expansions and upgradation, Rs. 10,000 crores for captive power generation, Rs. 1,100 crores for conversion from wet process plants to dry process plants and Rs. 500 crores for setting up of coal washeries.

Taxes and Tariffs

12. The taxes and duties on cement are very high (30% of sale price) as compared to taxes prevailing in competing countries such as China (19%) and Malaysia (0%). The duties need to be aligned to the ASEAN levels which are also likely to give fillip to the demand for cement.

Environmental Clearances

13. In view of dwindling availability of limestone and coal reserves in the main land and for better access to international markets, clearances under the Coastal Regulation Zones guidelines on proposals for setting up of new cement plants in coastal regions need to be given in a time bound manner.

14. Environmental clearances by Central and State agencies needs to be granted in a time bound and expeditious manner so as to considerably reduce the aggregate processing time varying between 1.5 to 3 years being taken presently.

Demand of cement

15. Construction of cement concrete roads needs be encouraged for National Highways, State Highways, District, Metro and City roads and under centrally funded projects such as PMGSY, Jawaharlal Nehru Urban Renewal Mission and Bharat Nirman Yojana.

16. Urban land ceiling Act needs to be repealed in the remaining States also so as to boost construction activities.

17. Presently, OPC is used in the Government/ Public Sector for most construction activities. The performance requirements of most constructions could be met by using PPC/ Slag cement. With a view to promote use of PPC and Slag cement in order to conserve non-renewable resources and efficient resource utilization, the following needs to be done:

    a) Construction codes of Central/ State Governments and their entities should be appropriately modified to allow use of PPC and slag cement.

    b) Excise duty should be lowered by 25% for PPC manufactured with 25% or more fly ash.

    c) Incentives should be given for manufacturing composite cement using both fly ash and slag.

Mini Cement Plants

18. There are 206 mini cement plants in operation, which produced about 6 mn.t. cement in 2005-06.

19. The technology used by mini cement plants is obsolete and non-competitive. The mini cement plants are availing the benefit of a concessional excise duty of 250/- per tonne as against Rs. 400 per tonne applicable for large plants.

20. The mini cement plants would be able to survive only in isolated and difficult terrain such as the North East, J&K and hilly areas where they are likely to remain insulated from competition from large plants.

21. Installation of green-field mini cement plants should be encouraged only in cement deficit far-flung States viz., the North Eastern States and Jammu & Kashmir.

22. The present limit on production capacity to be qualified as mini cement plant should be enhanced from 900 to 1200 tpd for rotary kiln plants and from 300 to 400 tpd for VSK based plants.

Limestone Inventory

23. The gross reserves of cement grade limestone are estimated at 97,430 mn.t. as on 31st March 2006. Out of these 22,476 mn.t (23%) are of proven category, 19,031 mn.t (20%) of probable category and 55,923 mn.t (57%) of possible category.

24. Since sizeable quantities of proven limestone reserves are located in inaccessible areas viz., difficult terrains, reserved forests, bio-zones, coastal regulatory zones, etc., the reserves available for cement industry are estimated to be less than 50%. These reserves would suffice only for the life cycle of cement plants that would be existing at the end of the XI Plan period.

25. Concerted efforts would be required to identify new commercially exploitable limestone deposits. Joint exploration should be intensified by various State Departments of Mines & Geology (DMG) in association with NCCBM, IBM, MECL etc. for exploring/ identification of new limestone deposits.

26. A lower rate of royalty may be fixed for utilizing low grade (high silica/ high magnesia) limestone and calcareous shale.

27. Eco-friendly mining activity should be permitted to exploit limestone deposits located in eco-sensitive regions.

Miscellaneous

28. The cement industry should be consulted while negotiating/signing bilateral and multilateral trade agreements. Cement industry has potential for manufacture of cement and management of cement plants in Asian countries, which should be exploited to India's advantage.

29. The supply of fly ash free of cost to cement industry should be ensured on a long term basis. In this regard, cement manufacturers could meet the expenditure required for providing necessary infrastructure facilities for receiving ash, as mutually agreed between the industry and the power utilities.

II. PRODUCTIVITY, TECHNOLOGY AND ENVIRONMENTAL ISSUES IN CEMENT INDUSTRY

Technology

30. Presently, there are 130 large cement plants of varying capacities, of which 73 plants accounting for 84% of the total manufacturing capacity are of 1 mn.t. per annum and above.

31. The modern Indian cement plants are comparable with state of the art plants elsewhere in the World. However, there is scope for further improvement in the areas of in-pit crushing and conveying, pipe conveyors, co-processing of waste derived/ hazardous combustibles as fuel, neurofuzzy expert system, cogeneration of power, multi chamber/dome silos, bulk transport of cement, palletizing and shrink wrapping for packing & despatch.

32. The status of key performance parameters of the Indian cement industry vis-à-vis their counterparts in other countries is as below:

a) Energy

i) The average thermal energy consumption during 2005-06 was 725 kcal/kg for producing clinker. The average electrical energy consumption was 82 kWh/t for producing cement. 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, which are comparable with 650 kcal/kg of clinker and 65 kWh/t of cement achieved in Japan. Therefore, there is a huge scope for improvement.

ii) Energy conservation in modern cement plants in India is better than all other countries, except Japan and Korea.

b) Environmental Compliance

i) All large plants have provided necessary air pollution control equipments to control dust emission and are compliant with emission standards of the Central Pollution Control Board (CPCB).

ii) Japan and Korea have stringent particulate emission limits followed by Canada, European Union and India.

c) Use of Industrial Wastes

i) Cement plants in India utilized about 20% of fly ash generated by thermal power plants and almost all the granulated slag generated by steel plants in 2005-06, as compared to almost 100% fly ash and 84% of granulated slag utilised by the Japanese cement industry.

ii) Japan, US, Canada and EU use more than one industrial waste to manufacture composite cement. However, In India the extant quality standards allow manufacturing of cement by blending with either fly ash or slag only. Manufacturing of cement using more than one waste is not allowed in India in view of absence of quality standards permitting the same.

d) Use of Alternate Fuels

i) Use of hazardous and refuse derived combustibles and municipal solid waste as fuel is common in countries like Canada, EU, Japan and Korea, but regulations do not yet permit such use in India.

ii) CPCB is actively engaged in plant level trials in respect of wastes such as shredded tyres, refinery sludge, paint sludge, Effluent Treatment Plant sludge and Toluene Di-Isocyanite tar waste, and in formulation of guidelines for use of these wastes as fuel by cement industry. A notification allowing the use of these wastes is expected shortly.

33. Industry should bring down average thermal energy consumption by the end of the XI Plan period to 700 K.Cal/kg. clinker from 725 K.Cal/kg. clinker in 2005-06. The average electrical energy consumption should also be brought down to 75 kWh/t cement from 82 kWh/t presently.

34. Ministry of Environment & Forests (MoEF) should formulate guidelines for:

a) Implementing the principle of 'Polluter to Pay' for disposal of wastes.

b) Treatment, storage & disposal facilities for cost effective co-processing of combustible industrial wastes in cement kilns as an alternative to incineration.

c) Restricting land filling of hazardous and toxic combustible wastes having potential for co-processing in cement kilns.

35. Duty free import of pollution control and energy efficiency improving equipments should be allowed.

36. Excise duty should be lowered by 25% on clinker produced through co-processing of hazardous wastes and bio-fuels, subject to a minimum of 20% replacement of conventional fuel.

37. With a view to commercially harness new resources and waste heat generated in the production process, the following initiatives should be taken:

a) Setting up a pilot project under public private partnership for use of algae growth as fuel through carbon dioxide fertilization. Ministry of Non Conventional Energy could be requested to coordinate and assist.

b) Incentivising setting up of plants for cogeneration of power using waste heat recovery in production process. The incentive could include capital subsidy and tax exemption.

38. The BIS should develop quality standards so as to allow manufacture of composite cement using various sorts of waste products, in line with the international practices.

ISO Accreditation

39. Presently 76 cement plants have ISO-9000 (Quality Management System) certification, 38 plants ISO-14000 (Environmental Management System) certification and 15 plants ISO-18000 (Occupational health and Safety Management System) certification. More and more cement plants are seeking these quality certifications.

40. All large plants should have ISO 9000 (Quality Management System) and ISO 14000 (Environmental Management System) Certification by the end of the XI Plan.

Research & Development (R&D)

41. Following thrust areas have been identified for taking up specific projects:

- Co-processing of hazardous wastes in cement manufacture.
- Processing of fly ash for enhanced use in cement/concrete.
- Development of cements and binders based on nano-technology.
- Improving the performance of size reduction operations.
- Evaluation of technologies for co-generation of power from waste heat.
- Adaptation of low NO_x & low SO_2 technologies
- CO_2 absorption through Algal Farms.
- Standardization of composite cement.

42. There is a need to evolve appropriate mechanisms for transfer of technologies to the industry whether developed indigenously or imported. Possibility of securing financial support under various schemes, existing or initiated in the XI Plan needs to be explored.

43. There is a need for assessment of technologies proposed to be imported by the cement plants with a view to assimilate and adapt these. NCCBM is ideally placed to act as a nodal agency for this purpose.

44. In 2005-06, the R&D expenditure was only 0.08% of sales turnover of the cement industry. This was substantially lower compared to about 0.23% in Japan in 2001. Though the Government collects Cement Cess for R&D purposes from cement manufacturers, only a partial amount from the collections is allocated for R&D activities.

45. The NCCBM would need additional infrastructure viz., buildings, equipments and manpower to meet the vastly increased technical and technological needs of the industry. This would require allocation of additional funds to the tune of Rs. 25 crores to the NCCBM for meeting its capital investment needs. Since the NCCBM is primarily an R&D organisation, it should be supported by annual grants of about Rs 15 crores lest it loses its R&D focus and the objectives for which it was established gets defeated.

46. Total Cement Cess collected should be kept in a separate account and fully used for:

a) R&D covering productivity, energy, environment, wastes utilization, alternate fuels, quality, application of nano-technology etc.

b) Capability building for testing and utilization of hazardous wastes and adoption of state-of-the-art technologies.

c) Skill upgradation and institutional capability building for HRD to meet the changing scenario, including setting up of a national level training institute & upgradation of RTCs.

Manpower

47. To attain the targeted capacity addition, the industry would require 43,000 additional technical personnel, including 12,000 engineers & supervisors by the end of the XI Plan period. In addition, the industry would require about 40,000 unskilled workers. This would be over and above the replacement demand of personnel that would arise in the existing plants.

III. LOGISTICS RELATED ISSUES

Rail Transport

48. Cement is a low value and high volume commodity, which requires long distance movements both for inputs and outputs. Railways is, therefore, the most economical and energy efficient mode of transport.

49. Transportation of cement, fly ash and other inputs over long distances by road is not only costly but also inefficient in terms of energy consumption, cost and transit loss.

50. As against the target of transporting 60% of cement and clinker by the railways, as recommended by the Task Force on Cement Industry for the IXth Plan, presently only 45% is being transported by railways.

51. The railways need to provide for transporting of at least 50% of cement and clinker both for the existing production and the targeted additional production. The requirement of rail facilities for movement of other inputs like coal, gypsum, granulated slag and fly ash would also increase substantially.

52. With cement industry adding over 118 mn.t. capacity during the XI Plan period, timely availability of adequate number of wagons needs to be ensured–

- through a long term transport agreement; and
- cement industry specific long-term policy.

53. To encourage transportation of bulk cement by railways, appropriate incentive schemes should be worked out on long-term basis, besides making the existing schemes effective and user friendly.

54. The present rate of concession of 15% for loading cement in open wagons should be suitably increased and extended to clinker also.

55. Railways should initiate the process of supervising weighment of wagons at loading point and avoid re-weighment enroute or at destination. This will not only ease the additional financial burden on the cement industry but will also help increase the rail co-efficient for cement.

56. Railways need to improve the handling and storage facilities at major terminals by providing proper platform, sheds and facilities for loading and unloading. Railways should also set up new terminals in a time bound manner so as to be operational by the middle of the XI Plan.

57. The classifications of fly ash for freight charges prevailing earlier should be restored with a view to encourage more use of fly ash.

58. A freight rebate, as is given for bulk movement of cement, should be given for movement of fly ash in special purpose wagons. The Railway Board has been providing such rebates for bulk movement of cement on the Malkhed-Bangalore and the Wadi-Kalamboli routes. The rebate needs to be extended till the life of the wagon, i.e. 35 years, so as to make investments in special purpose wagons a viable proposition.

Inland Water Transport

59. Presently there are 3 waterways - the Ganga-Bhagirathi-Hooghly River System from Allahabad to Haldia, (ii) the Brahmaputra from Sadiya to Dhubri and (iii) the West Coast Canal from Kollam to Kottapuram (Kerala).

60. Inland Waterways has several advantages such as energy efficiency, environment friendliness and low maintenance cost over other modes of transportation and these do not require high skilled personnel.

61. Cement Industry has not been able to take advantage of the inland waterways systems for transportation of cement/clinker since the cement plants are located in remote areas involving long distance road/ railway movements up to the nearest waterways systems.

62. Required infrastructure should be developed by providing suitable connections from landlocked cement plants to the river systems. Dedicated terminals with proper loading/unloading system should be established to facilitate multi-modal transportation and facilities for night navigation.

63. The incentive of 20 paise per tonne per km. available for moving cargo through national waterways is subject to the following conditions:

- The scheme is applicable for movement of cargo for at least 100 km. in NW-1 and NW-2 in one trip one way by mechanized vessel registered under the Inland Vessels Act, 1971.
- In NW-3, the scheme is applicable for movement of more than 50 km. one way by any mechanized vessel registered under the Inland Vessel Act.
- The Scheme is not applicable for exclusive movement between the route of Haldia and Kolkata where infrastructure facilities are fully developed.

Government should consider relaxation/withdrawal of the above conditions.

64. Dedicated terminals need to be developed on the three national waterways for loading and unloading of Cement.

Bulk Transportation

65. While the World over 70% of cement is transported in bulk, it accounts for only 5% in India. Modernization of construction industry is heavily dependent on easy availability of cement in bulk and Ready Mix Concrete (RMC) plants near the consumption centres.

66. Transportation of cement in bulk is devoid of seepage and pilferage. It is environment friendly, and ensures easy availability of cement in large volumes and consistency in quality. It needs lesser storage space and enhances the shelf-life of cement.

67. With the advent of mega infrastructure projects, large housing complexes, shopping malls and other large construction activities, transport of cement in bulk provides huge advantages to construction industry.

68. Bulk cement transportation in specialized tankers viz., railway wagons, trucks or ships provide business opportunity to railways, truck and cargo operators. Public/Private partnership would help in attracting huge investments. Railways could be the major beneficiary due to fast turn around time. The potential of coastal transportation of cement in bulk is under exploited.

69. There are only two rail bulk cement terminals (Kalamboli & Bangalore) and three port based bulk cement terminals (Mumbai, Surat and New Mangalore). Non-availability of land near railway goods sheds on long-term lease is a major limitation in setting up bulk cement terminals.

70. Railways should provide land near railway goods sheds on long-term lease to cement companies for setting up cement bulk terminals.

71. Govt. should permit setting up of port based bulk terminals for bulk transportation of cement.

72. Cost of setting up of a bulk cement terminal of 1 mn.t. capacity is around Rs. 80 crores. Since the payback period is long, a rebate in excise duty for a specified period should be given for cement despatched from cement plants to the bulk terminals.

73. The State Governments are authorized to grant environmental clearances to the stand alone grinding units. For the purposes of environmental clearances, port based/inland bulk handling terminals should be treated at par with the stand alone grinding units and State Governments should be authorised in this regard.

Ready Mixed Concrete (RMC)

74. While the World over the construction activity uses RMC almost exclusively, the use of RMC in construction activity is only 10% in India.

75. RMC is a corollary to bulk handling and transportation of cement. Since it is produced under controlled conditions, it provides consistency in quality.

76. RMC can be directly poured in the required form, which saves considerable time and improves the quality of construction. As against this, site-mixed concrete not only pollutes environment but also occupies public space and hinders traffic around construction sites.

77. The RMC is subject to VAT whereas the same ingredients (sand, cement and aggregates) when used for site mix are not subject to VAT. To promote RMC and provide for a level playing field, the State Governments should be persuaded to withdraw VAT/Sales Tax on RMC.

Cement Export/Import

78. India exported 9.19 mn.t. cement and clinker in 2005-06. With appropriate interventions, the annual exports could be doubled during the XI Plan.

79. Lack of infrastructure facilities, both for movement of cement from land-locked units and at Ports, is a deterrent to exports. There is no dedicated berth for handling cement at any of the Indian Ports. The best loading rate of cement at Indian Port is 2,500 tonnes/day, which is far below the international levels of 12,000 – 15,000 tonnes/day.

80. Government needs to facilitate setting up of at least a terminal each on the east and west coast for exports.

81. Cement manufacturers should be encouraged to explore the possibilities of markets and consultancy business in Asia, Europe, Africa, etc.

82. Though export of cement is limited, concerted efforts are required to protect the existing export markets in view of increasing competition from China. In this regard following steps are required:

- Reduction of taxes and levies.
- Making available power and other inputs at international prices.
- Reducing port and bunker charges.
- Including cement and clinker in the focused products for the purposes of exports.

83. Cement and clinker should be included for preferential treatment in FTA with Bangladesh.

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SUB-GROUP –I

MACRO OVERVIEW OF CEMENT INDUSTRY

I. CAPACITY, DEMAND, PRODUCTION AND INFRASTRUCTURE

1.0 Introduction

1.1 Cement plays a very important role in the development of infrastructure and per capita consumption of cement is accepted as an important index of the country's economic growth.

1.2 Over the years since its inception in India in 1914, technology has developed and the country today has most of its capacity with the state of art technology. Skilled manpower development has also been rapid and the industry offers turnkey cement projects for cement production to countries abroad.

1.3 Indian cement industry provides direct employment for around 70,000 people while creating 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.

1.4 The cement industry is one of the important contributors to Government exchequer. Excise duty collected by cement industry alone accounts for 5% of the total excise collection.

1.5 Though the cement industry has been in existence for over 9 decades, any appreciable growth could be witnessed only after the introduction of partial decontrol in 1982 culminating in total decontrol in 1989. The industry sustained a CAGR of 8% during the last decade. This would not have been possible, if the Government did not implement their liberalization policies. The industry also responded positively by adding capacities and increasing production continuously to meet the growing demand.

1.6 On the global scene, Indian cement industry ranks second only next to China in the cement producing countries of the World.

World Cement Production (2005)

Country	Cement Production (Mn.t.)	% to Total
China	1060	47
India	143	6
USA	106	5
Japan	74	3
Russia	65	3
Korea	62	3
Thailand	50	2
ROW	699	31
Total	**2259**	

1.7 The quality of Indian cement matches with the World's best. The current capacity of the cement industry is 174.99 mn.t. (large plants: 163.89 mn.t. and Mini Cement Plants 11.10 mn.t.). The total cement production for the year 2005-06 was around 148 mn.t.

1.8 Indian cement and clinker are being exported to various countries across the globe. With a beginning of mere 1.6 lakh tonnes in 1989-90, exports reached 10 mn.t. in 2004-05. Export of cement/clinker in 2005-06 was over 9 mn.t. and the current year could witness an export of 10-11 mn.t. The industry has capacity and capability to export to the extent of 15-20 mn.t. annually.

1.9 Globalization leading to innovative methods of improving productivity and efficiencies through continued research is a compelling necessity and Indian cement industry has not fallen short. Some of the achievements are –

- Upgrading by converting wet process plants to semi-dry and full dry process resulting in economies in fuel and power consumption. Wet process capacity, which accounted for 97% in 1950, has been brought down to 3% in 2005. Dry process accounts for 96% and semi-dry process 1% in 2005.

- Establishing captive power facilities to overcome erratic and low quality power supply by various State Electricity Boards while economizing in costs.

- Gainful utilization of hazardous wastes like fly ash from thermal power plants and slag from steel plants for producing blended cements having better properties.

- Adopting split-location grinding operations close to far away markets and source of hazardous industrial wastes like fly ash and slag.

- Countering the myth that cement industry is a polluting industry to almost pollution free situation by employing ESPs, Bag filters etc. Today the industry's emissions are less than the prescribed standards.

- Using coastal shipping facilities for economizing on transportation where feasible to transport cement/clinker to the markets/grinding units.

- Popularizing ready mix concrete, which was not in practice in India a decade back, thus improving the quality and speed of construction while avoiding environmental pollution due to site mixing.

- Introducing benchmarking facilities to continuously improve on various performance parameters.

- Setting up cement plants/grinding facilities abroad and providing consultancy including management of cement factories in other countries.

2.0 Review of the Status of Cement Industry during X Five Year Plan

2.1. The Working Group on Cement Industry for X Five Year Plan - 2002-07 set a production target of 150.47 mn.t. for the year 2005-06. This has however been revised to 142 mn.t. by the Deptt. of IPP, Ministry of Commerce and Industry, on the basis of the economic situation of the country.

2.2 The industry has shown much improved performance and not only crossed the production target set by the Deptt. of IPP but also almost reached the target set by the Working Group for X Five Year Plan, falling short of only around 2 mn.t. Export performance has, however, been better as over 6 mn.t. of cement

was exported during the year 2005-06 as against the target of 4.5 mn.t. set by the Working Group for X Five Year Plan.

2.3 The following table provides a quick comparison of the performance of the cement industry with the X Plan projected figures.

Performance of Cement Industry during X Plan

(Mn.t.)

Year	Capacity		Production			Demand		Cement Exports			
	As per the Working Group	Actual	As per the Working Group	Revised by IPP	Actual	As per the Working Group	Actual Consum-ption	As per the Working Group	Actual		
									Cement	Clinker	Total
End of IX Plan											
2001-02	135.00	145.99	113.00	111.00	106.90	109.00	103.51		3.38	1.76	5.14
X Plan											
2002-03	139.53	151.17	113.17	115.45	116.35	109.67	112.59	3.50	3.47	3.45	6.92
2003-04	152.72	157.74	124.38	126.00	123.50	120.63	119.86	3.75	3.36	5.64	9.00
2004-05	168.86	165.39	136.70	133.00	133.57	132.70	129.08	4.00	4.07	5.99	10.06
2005-06	185.06	171.34	150.47	142.00	147.81	145.97	141.56	4.50	6.01	3.18	9.19
2006-07	202.64	174.99*	165.56		162.00**	160.56	152.00**	5.00	7.00**	3.00	10.00
CAGR %		**3.69**			**8.67**		**8.00**				**14.24**

** Capacity : As in June 2006 ** Estimated*

2.4 Capacity

2.4.1 During the X Plan years, the installed capacity of cement grew at a CAGR of 3.69%. At the end of June 2006, the installed capacity of the cement industry stood at 174.99 mn.t. A capacity of 29 mn.t.[1] was added during the X Plan upto June 2006. The capacity added during the 1st and 2nd years of the X Plan surpassed the target of the Working Group by around 12 mn.t. and 5 mn.t. respectively. However, for the next 2 years the actual capacity added was less than targets. In the year 2005-06 of the X Plan, the capacity added fell short by around 14 mn.t. If the low demand scenario of the Working Group is considered, then the capacity additions during 1st four years of the plan have been higher and could be so even in the last year of the X Plan, as around 9 mn.t. capacity is likely to be added during the remaining part of the year 2006-07.

2.4.2 The difference in the capacity mentioned in the Working Group Report and the actual achievement during 2005-06 should not be considered as a gap in

[1] *Though the capacity added was 30.44 mn.t. comprising of 21.08 mn.t due to expansion/modernization and 9.36 mn.t. due to greenfield plants, a capacity of 1.44 mn.t. has been derated. Thus in effect the addition of capacity during the 4 ½ years of the X Plan was 29.00 mn.t..*

capacity additions. Around 30 mn.t. capacity (modernization/greenfield) is in the pipeline and is likely to mature partly in 2006-07 and during the next year. Techno-economic problems for setting up capacities are time consuming, causing much delay. Had such problems been minimal, production would have been at the same level of set target.

2.4.3 Normally, capacities are added well in advance to meet the growing demand. However as the demand pattern for varieties of cement showed a shift towards PPC and slag, the shortfall in capacity creation against the target is not a matter of concern. Even at this stage, the existing capacity is in excess of demand. In fact, consequent to better realization by the cement companies during the last quarter of 2005-06 and the 1st quarter of the current year, most of the cement plants have concrete plans to increase capacities both through expansions and Greenfield installations to the extent of 35 – 40 mn.t. during the next five years i.e. by the end of XI Plan.

2.4.4 However, addition of such capacities would depend upon assured availability of the main fuel coal. Towards this, the Government should take a policy decision that the core sector cement industry, which needs only 5% of the total coal production, should be assured of the coal supply. As cement forms main ingredient in the growth of infrastructure industry, most needed for the economic growth of country, it should be allowed to sustain a healthy growth if the targetted economic growth in the XI Plan is to be achieved.

2.5 Cement Production

2.5.1 Cement production during the X Plan has recorded a growth of 8.67% (CAGR). While the target has been crossed by around 3 mn.t. in year 2002-03 and fell short of the target marginally for the 2nd year, there was a shortfall of around 3 mn.t. in the remaining years of the Plan. However, when compared with the low demand scenario, the actual production crossed the targets by 5 - 12 mn.t.

2.5.2 With the average capacity utilization increasing from 82% in 2001-02 to 90% in 2005-06 and around 95% in April-June 2006, the industry has been producing to meet the growing demand and will continue to do so with addition of capacities each year.

2.6 Capacity Utilization

2.6.1 Capacity utilization for large plants during the 1st two years was 81% but subsequently increased to 90% in the 4th year. In the first quarter of 2006-07, it averaged at 95% and this is inclusive of public sector plants. In fact, average capacity utilization of private sector plants in 1st quarter of 2006-07 was around 97% while that of the public sector was 46%.

2.7 Cement Consumption

2.7.1 Consumption of cement during the X Plan years has recorded a CAGR of 8%. While the consumption for the 1st year of the X Plan was higher than the projected figure by Working Group and for the 2nd year almost at the same as projected, it is noticed that the actual demand was less than the projected demand for the next 2 years. While the projected demand for 2006-07 is 160.56 mn.t., the actual consumption is likely to be less by around 8 mn.t. However, consumption during the X Plan years was higher than the projected demand by the Working Group for the X Plan in the lower growth scenario. Consumption has been generally 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. Had such construction activity picked up the expected growth, cement consumption would have also gone up as projected in the high growth scenario. With higher emphasis being laid towards road construction, increased mass housing and other projects of Bharat Nirman etc. the demand is expected to grow by 9 –11% during the XI Plan, the industry is confident to meet such demand.

2.7.2 ***Cement Consumption – Regionwise – Statewise:*** Cement consumption during the year 2005-06 increased over the previous year in all the regions, though the growth in the central region was less than 1%.

(Mn.t)

Region	2004-05	2005-06	% Change
North	24.26	27.06	11.5
East	20.40	22.66	11.1
South	33.43	39.37	17.8
West	24.58	25.90	5.4
Central	20.41	20.57	0.8
All India	123.08	135.56	10.1

2.7.3 A statewise comparison of growth in consumption during the year 2005-06 compared to 2004-05 is given in ***Annexure-I.***

2.7.4 A positive growth has been noticed in most of the states except Delhi which recorded a negative growth of 6.6%, Assam 2.9%, N.E. States 19.1% and the Union Territory of Goa, Daman,Diu 37.6%. The highest growth of 51% has been recorded by Union Territory of Andaman & Nicobar, followed by Chhattisgarh 47.3%, Chandigarh 40.2% and Andhra Pradesh 34.1%. Uttar Pradesh is the only state, which witnessed a growth of less than 1%.

2.7.5 The low growth during the year 2005-06 is mainly due to road and other infrastructure not picking up as expected as also the low performance of the housing sector.

2.8 Exports

2.8.1 Indian cement industry has been exporting cement, the final product and also clinker, which is an intermediate product, to countries across the globe for the last one-and-a-half decades.

(Mn.t.)

Year	Cement Export	Clinker Export	Total Exports
2001-02	3.38	1.76	5.14
2002-03	3.47	3.45	6.92
2003-04	3.36	5.64	9.00
2004-05	4.07	5.99	10.06
2005-06	6.01	3.18	9.19

2.8.2 Exports of Cement/Clinker during the X Plan recorded a growth of 14.24% (CAGR). For the 1st two years of the X Plan, the actual exports of cement almost touched the target set of the Working Group, while the target has been surpassed in the next two years with a similar trend in the final year of the Plan.

2.8.3 The Working Group X Plan considered mainly cement exports. However, since cement industry exports clinker also, the total exports would include cement and clinker. Even considering cement alone, the industry has performed well.

2.8.4 The industry has capacity and capability to export cement/clinker to the tune of 15 – 20 mn.t. during the next 5 years and could increase its spread to more countries including farther destinations like USA. However, industry has been facing problems in export activity due to lack of modern ports with modern bulk handling facilities, proper approach road facility to reach ports and high cost of inputs and high transportation costs all making Indian cement less competitive in the international market.

2.8.5 With the Government giving due thrust to development of infrastructure including roads, ports etc., it is assumed that there would be appreciable demand of cement in the domestic markets during the XI Plan and hence the export activity may be sustained at the 10 mn.t. level with a slight growth in the last year of the XI Plan.

2.9 Imports

2.9.1 Imports of cement/clinker are very minimal and only negligible quantities are imported as special purpose cements.

2.9.2 Impending threat to Domestic Industry due to Imports

2.9.2.1 The cement industry has been facing a major problem of capacity-demand mismatch, as capacities are being added every year and demand does not grow at projected pace. Thus, there is always a surplus situation, which has also affected the bottom lines of the cement industry since several years. The present duty on import of cement/clinker is as under:

- Cement – Basic duty 12.5%, CVD Rs.400/- per tonne, SAD 4% and Education Cess 2%.

- Clinker – Basic duty 12.5%, CVD Rs.350/- per tonne, SAD 4% and Education Cess 2%.

2.9.2.2 Encouraging import of cement/clinker by reducing or nullifying the duties would affect the domestic industry severely which is already suffering.

2.9.2.3 The cement industry had made due representations to the Commerce Ministry that cement/clinker should be kept under the negative list while signing FTAs with BIMSTEC countries as also the ASEAN countries, as it would result in increased imports leading to (i) output contraction (ii) employment loss and (iii) decline in investment and capacity utilization. In fact, detailed reports prepared by an expert with in-depth knowledge of the implications of such agreements have also been submitted to the Commerce Ministry to support the cause of the cement industry (Please see ***Annexure-II***).

3.0 Demand Forecast for the XI Plan

3.1 The approach paper for XI Five Year Plan suggests that the economy could grow between 8 and 9% per year. The paper has also considered three scenarios of GDP growth at 7%, 8% and 9%. The expected growths of the Manufacturing sector to achieve such a growth for the three scenarios have been mentioned as 9%, 10% and 11%.

3.2 Further, it has been found by examining growths of GDP and cement consumption over the last 10 years that the cement consumption is always higher with rare exceptions. The ratio as noticed happens to be 1 : 1.2/1.3. This also supports the assumption of the approach paper that cement growth should be 2% over the GDP growth.

3.3 The Committee on Infrastructure under the chairmanship of the Prime Minister has however identified an ambitious programme for infrastructure development which will cover the entire XI Plan period.

3.4 Preliminary exercise considered by the Planning Commission suggests that investment in infrastructure defined as roads, rail, air and water transport, power generation, transmission and distribution telecommunication, water supply, irrigation and storage will need to increase from 4.6% of GDP to between 7 and 8% in the XI Plan period. In other words, of the increase of 6 percentage points in total investment needed to accelerate from 7% growth to 9%, about half should be in infrastructure.

3.5 In view of accelerated growth of infrastructure, it is assumed that the cement demand also would experience a further increase and hence for 8.5% GDP, the cement industry would need to grow at least at 11%. Further, if the infrastructure sector performs better than expected, then the GDP is likely to grow at 9%, in which case the cement industry will have to grow at 11.5%.

3.4 On the above assumptions three scenarios of cement demand estimates for the XI Plan years are being put forward:

1) The low growth scenario assuming that the factors responsible to achieve the required performance be conducive to 8% GDP growth for which cement industry's growth should be 10%.

2) The average growth scenario under the assumption that the thrust given to infrastructure improves it's performance, leading to a GDP growth of 8.5%, needing cement industry's growth of 11%.

3) The high growth scenario under the assumption that the infrastructure sector performs even better than expected leading to a GDP growth at 9%, implying a growth of 11.5% for cement.

Low Growth Demand Scenario

(GDP 8%, Cement 10%)

(Mn.t.)

Year	Domestic Demand	Cement and Clinker Exports	Production Required	Capacity* Needed
End of X Plan				
2006-07	*152.00*	*10.00*	*162.00*	*180.00*
XI Plan				
2007-08	166.60	10.00	176.60	196.22
2008-09	182.66	10.00	192.66	214.07
2009-10	200.33	10.00	210.33	233.70
2010-11	219.76	10.50	230.26	255.84
2011-12	241.13	11.00	252.13	280.15

**90% capacity utilization*

Average Growth Demand Scenario

(GDP 8.5%, Cement 11%)

(Mn.t.)

Year	Domestic Demand	Cement and Clinker Exports	Production Required	Capacity* Needed
End of X Plan				
2006-07	*152.00*	*10.00*	*162.00*	*180.00*
XI Plan				
2007-08	168.06	10.00	178.06	197.84
2008-09	185.89	10.00	195.89	217.65
2009-10	205.67	10.00	215.67	239.64
2010-11	227.64	10.50	238.14	264.60
2011-12	252.02	11.00	263.02	292.24

**90% capacity utilization*

High Growth Demand Scenario

(GDP 9%, Cement 11.5%)

(Mn.t.)

Year	Domestic Demand	Cement and Clinker Exports	Production Required	Capacity* Needed
End of X Plan				
2006-07	*152.00*	*10.00*	*162.00*	*180.00*
XI Plan				
2007-08	168.79	10.00	178.79	198.66
2008-09	187.51	10.00	197.51	219.46
2009-10	208.38	10.00	218.38	242.65
2010-11	231.66	10.50	242.16	269.07
2011-12	257.61	11.00	268.61	298.46

**90% capacity utilization*

However, in view of the Government's latest reviewed pragmatic approach giving thrust and focus in sustaining a 9% GDP growth during the XI Plan, the high growth scenario may be adopted for the XI Plan where the growth of cement sector would be 11.5%.

Regionwise/Statewise projections are given in ***Annexure-III***

4.0 Infrastructure

4.1 The cement industry needs adequate infrastructure viz. coal, power and also transport facilities for both inward movement of raw materials from supply sources to plants and outward movement of cement/clinker from plants to grinding units, markets and ports for exports.

4.2 All the three infrastructures are in the public sector and the industry has been facing constraints due to low-level performance of these sectors. The details are discussed in the following paragraphs.

4.3 Coal

4.3.1 Coal continues to be the main fuel for the Indian cement industry and will remain so in the near future as well. The industry is mainly using coal from various coalfields in the country. It is also procuring coal through open market and direct imports. Lignite from deposits in Gujarat and Rajasthan are also being used by cement plants. Pet coke has also been successfully utilized by some cement plants, mainly in Gujarat, Rajasthan and MP, thereby substituting main fossil and conventional fuel coal upto 100% in some plants.

4.3.2 In the recent past, waste derived fuels including hazardous combustible wastes have also been tried due to economic pressures in cement manufacturing process owing to tough competition in domestic and global markets as well as ecological reasons on account of waste disposal and co-processing in cement rotary kilns being most effective mode of waste treatment.

4.3.3 Presently coal is supplied to the cement industry through linkages and FSAs. Cement industry is getting only 60% of coal requirement through linkage/FSA. The industry is trying to meet the shortage through imports, use of pet coke and open market purchases. Still, substantial demand remains unsatisfied. Besides new capacity, expanded capacities are awaiting sanction of long-term linkages for supply to such new units. All this could result in loss of cement production to the extent of 10 –20%.

4.3.4 The recent decision of the Coal Ministry has been that the cement industry should obtain rest of the coal requirement through e-auction in the open market by electronic bidding. The process is cumbersome and time taking. The quality of coal is also not assured. Further, the distances may also vary substantially depending on source of e-auction. There is also no certainty that the cement companies' bid will succeed in getting the coal. As the cement kilns consume coal round the clock, the arrangements have to be firm and continuous

and full coal supplies to cement industry should therefore be through the regime of linkage/FSA so that the performance/growth of the industry is not affected.

4.3.5 The procurement of fuel by cement industry during X Plan (large plants) is given in table below:

Procurement of Fuel by Cement Sector during X Plan

(Mn.t.)

Year	Receipt Against Linkage From CIL	Receipt Against Linkage From SCCL	Total Receipts	Coal Import equivalent to Domestic Coal	Open Market	Lignite	Pet Coke equivalent to Domestic Coal	Total Fuel	%age Receipt against Total Fuel
2002-03	8.01	4.34	12.35	5.12	0.77	0.05	1.66	19.95	62
2003-04	8.67	4.68	13.35	4.45	1.03	0.11	2.26	21.20	63
2004-05	9.90	4.94	14.84	5.08	1.27	0.76	2.99	24.94	60
2005-06	9.53	5.28	14.81	4.76	1.55	0.82	3.46	25.40	58
2006-07 (Est.)	11.00	5.78	16.78	4.90	2.00	1.00	4.00	28.68	58

Notes: One tonne of imported coal = 1.4 tonnes of domestic coal
One tonne of pet coke = 1.6 tonnes of domestic coal

4.3.6 The table below gives the position of cement production, clinker production and fuel consumed during the 5 years 2002-03 to 2006-07.

Fuel Consumption Trends in X Plan (For Large Plants)

(Mn.t.)

Year	Cement Prodn.	Clinker Prodn.	Cement/ Clinker Ratio (2/3)	Coal Consumption in Kiln	Coal for Captive Power Plant	Total Fuel Consp.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2002-03	111.35	97.29	1.14	17.35	2.57	19.92
2003-04	117.50	102.68	1.14	17.75	3.22	20.97
2004-05	127.57	109.42	1.17	20.15	3.63	23.78
2005-06	141.81	116.34	1.22	20.74	4.31	25.05
2006-07 (Est.)	156.00	131.00	1.19	23.58	5.10	28.68

NOTE: During the X Five Year Plan period the average cement/clinker ratio has been 1.17. However looking into trend, the ratio for 2006-07 and the XI Five Year Plan period the has been taken as 1.19.

4.3.7 Taking 156.00 mn.t. as the estimated production for 2006-07, the projected cement production and requirement of coal/fuel during XI Plan (for large plants) is given below:

Projected Coal Requirement during XI Plan

(Mn.t.)

Year	Domestic Consumption (Growth 11.5%)	Cement/ Clinker Exports	Total Cement Production Requirement	Cement/ Clinker ratio (1.19)	Coal/Fuel Requirement for kilns (@ 18% of clinker)	Fuel/Coal Requirement for CPP	Total Requirement (Indgn. Coal) (6+7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
End of X Plan							
2006-07	*146.00*	*10.00*	*156.00*	*131.00*	*23.58*	*5.10*	*28.68*
XI Plan							
2007-08	162.79	10.00	172.79	145.20	26.14	8.65	34.79
2008-09	181.51	10.00	191.51	160.93	28.97	11.05	40.02
2009-10	202.38	10.00	212.38	178.47	32.13	13.45	45.58
2010-11	225.66	10.50	236.16	198.45	35.72	15.85	51.57
2011-12	251.61	11.00	262.61	220.68	39.72	18.25	57.97

Notes:

i) The estimates are only for large plants. A coal/clinker ratio of 18% has been adopted corresponding to 180 kg. of coal for each tonne of clinker produced

ii) For 2000 MW likely capacity addition – coal requirement assessed at 6,000 t/annum/MW (f grade coal).

iii) The consumption will be lower if imported coal and pet coke are used.

4.3.8 The breakup of expected fuel consumption for the terminal year X Plan (2006-07) & requirement of indigenous coal for XI Plan (2011-12) is given in table below:

(Mn.t.)

Type of Fuel	Terminal Year of X Plan (2006-07)		Terminal year of XI Plan (2011-12) *Indigenous coal required
	Estimated Consumption	Indigenous Coal Equivalent	
Indigenous coal	13.68	13.68	
Imported coal	3.50	4.90	
Pet coke	2.50	4.00	39.72
Lignite	1.00	1.00	
Sub Total	**20.68**	**23.58**	**39.72**
CPP	5.10	5.10	18.25
Total	**26.68**	**28.68**	**57.97**

***** *The demand of indigenous coal will reduce corresponding to imports and usage of pet coke. This is exclusive of loss in transit, loss of moisture and loss as washery rejects.*

4.3.9 Quality of Coal/Need for Beneficiation

4.3.9.1 With depletion of higher coal quality reserves and increased production from open cast mines, the overall quality of indigenous coal has been deteriorating. This will call for beneficiation of coal in regional washeries before it is supplied to cement plants. Presently about 1.50 mn.t. of coal is being washed for use by the cement plants. It is likely to go up in the future.

4.3.9.2 Capacity additions have to be done on a continuous basis to meet the growing demand, which would depend on the availability of the main fuel coal both for cement production and also captive power generation. If capacity is not built up as required, there will be shortages of cement, which can have an adverse affect on cement production and prices. Creation of additional capacity will stabilize the prices.

4.4 Power

4.4.1 Production of cement is a continuous process and therefore needs uninterrupted power supply. Majority of cement production operations depend exclusively on power. The requirement of power is 20 MW for a million tonne plant. Generally, 120 units of power were consumed for production of one tonne of cement, which has been brought down to 82 units by the industry's continuous efforts towards energy conservation.

4.4.2 Most of the cement units have installed captive power generation capacities to the extent of 60% of their requirement, and in some cases 100% of the requirement. However, some of the states (such as Andhra Pradesh, Chhattisgarh, Madhya Pradesh and Rajasthan) have imposed use of minimum quantity of grid power, ranging between 50–80% of the contract demand. Some states impose electricity duty/electricity tax/electricity development cess/consumption tax/wheeling charges if state grid is used for transport on captive power generation. Because of these restrictions, the cement industry is not able to take full advantage of installed low-cost captive power generation capacity.

4.4.3 The captive power generation capacity installed by cement industry as on 31.12.2005 is 1824.90 MW. Of this, 61% is based on diesel and the rest 39% is thermal. In addition, some plants have installed wind power generation facilities.

4.4.4 The details of cement produced by use of captive power from the years 1985-86 to 2005-06 are given in the table below:

Year	Million Units Produced by Captive Sets	Cement Production from Captive Power	
		(Mn.t.)	(Percentage)
1985-86	634.92	5.29	16.50
1986-87	646.20	5.39	15.48
1987-88	795.65	6.63	17.72
1988-89	756.08	6.30	15.09
1989-90	854.10	7.12	16.59
1990-91	930.14	7.75	16.94
1991-92	1166.30	9.72	19.21
1992-93	1100.00	9.17	18.07
1993-94	1248.65	10.41	19.24
1994-95	1481.18	12.34	21.15
1995-96	2109.06	17.58	27.24
1996-97	2346.49	19.55	27.94
1997-98	2575.87	21.47	27.97
1998-99	3192.91	26.61	32.58
1999-00	4298.71	37.38	39.68
2000-01	4880.98	42.44	45.34
2001-02	4866.46	42.32	41.33
2002-03	5363.92	46.64	41.89
2003-04	5298.10	46.07	39.21
2004-05	6396.66	60.92	47.75
2005-06 (P)	6371.93	60.69	42.79

4.4.5 It is observed that cement production by use of captive power has been increasing year after year. In fact, it has more than doubled in the last 10 years from 21.15 % in 1994-95 to 47.75 % in 2004-05.

4.4.6 ***Future Scenario:*** By the end of XI Plan, cement production is expected to reach 269 mn.t. requiring an additional power of around 2000 MW.

4.5 Transportation

4.5.1 Due to location specific nature of the cement industry, cement plants are concentrated at limestone deposits which are available in few states. The main raw material coal is available only in 4/5 states, mostly in the eastern region. Further, cement is a high volume, low priced commodity. In view of this, long leads of movements are necessary both for inward movement of raw materials coal, gypsum etc and outward movement of cement/clinker to grinding units/markets and railways is the only economic mode of such transportation for the cement industry.

4.5.2 The Task Force on Cement Industry, in its IX Plan Report, inter alia, recommended 60% movement of cement production by rail on macro level. However, the railways could not reach this percentage level, rather kept on declining every year mainly due to high logistics cost as compared to road transport.

4.5.3 Presently the railway's share as percentage of total diespatches has dropped to 39% as against 57% a decade ago.

4.5.4 Details of railways' performance for coal and cement movement, problems faced by the cement industry in transportation of raw materials inputs and cement and clinker along with suggestions/ recommendations are included in the report of Sub-Group III.

5.0 Investment Trends

5.1 The capacity existing as on 30.6.2006 is around 175 mn.t. By end of the X Plan, the capacity is expected to reach 180 mn.t. The capacity has to reach 298 mn.t. by the end of XI Plan. In other words, a capacity of 118 mn.t. has to be installed during the years of the XI Plan.

5.2 The capital investment needed for installing Greenfield cement plants with a capacity of 86 mn.t. works out to Rs.34,400 crores @ Rs.4000 per annual tonne. Investment needed for 32 mn.t. through brownfield expansions and technology upgradation would be of the order of Rs.6,400 crores @ Rs.2000 per annual tonne. Further, an investment of Rs.10,000 would be needed for installing captive power capacity of about 2000 MW. A further investment of Rs.1,100 crores would be required for conversion of existing wet process plants of 3.5 MTPA to dry process. An additional investment of Rs.500 Crores would be required for setting up coal washeries with a total capacity of 5 mn.t. Thus, the total investments to be made by the cement industry during the XI Plan period is likely to be Rs.52,400/- Crores.

5.3 For adding capacity of 118 mn.t. as projected (assuming 90% capacity utilization), following inputs will be required by the end of XI Plan.

a) Limestone reserves of 22127 mn.t.

b) Coal – around 29 mn.t.

- Captive power generation using diesel as fuel is turning out costly with increasing diesel prices year after year. Hence there could be a shift in the existing captive power capacity from diesel to thermal, which would call for additional coal requirement, while the new Greenfield units may like to install thermal power generation facility that depends on coal.

c) Power – 2000 MW

d) Manpower - About 43,000 (12,000 engineers/scientists and 31,000 skilled workers). In addition there would be requirement of 40,000 semi-skilled/unskilled workers.

In early 90's to train employees of cement industry, RTC's were set up one each in four regions – North, East, South and West with help from Holder Bank and programmes offered. Several technical and unskilled persons from various cement companies received benefits from these training centers.

5.4 To meet the requirements of the focussed development of infrastructure during the XI Plan years, capacities will have to be added, which can be done only if due support of the inputs comes forth. Any lag in addition of capacity would lead to production shortages, which could affect cement prices. Addition of capacity would stabilize the prices.

6.0 Concerns of the Cement Industry

6.1 Cement demand during the years of the X Plan grew at a CAGR of 8%.

6.2 Though the growth has met the targets fixed for the X Plan in the low growth scenario, which assumed a growth of 8% in the last 3 years of the Plan, it has fallen short of the targets set in the high growth scenario during the years 2004-05 and 2005-06 by around 3 mn.t. and 4 mn.t. respectively. In the final year of the X Plan the actual demand is likely to fall short of the target by around 8 mn.t.

- Growth of cement demand year-over-year was 9% or more in the last 2 years of Plan.

- Most of the large plants have been operating at capacity utilistiaon of 97% and more to meet the demand.

- Realizations have been reasonable during the last quarter of 2005-06 and 1st quarter of 2006-07 which has encouraged cement manufacturers to announce capacity additions.

7.0 Factors affecting Cement Industry' Competitiveness

- Cement is one of the highly taxed commodities in our country. Taxes and levies account for around 30% of sale price (and over 70% of ex-factory costs).

Taxes and Levies as %age of sale price	
Malaysia	0%
China	19%
India	Around 30%

- High rail/road transportation costs add up to selling price.

- In view of the uncertainty of Grid Power, being erratic and poor quality, most of the cement units installed captive power to the extent of 60% and in some cases 100%. The new greenfiled units install 100% captive power facility as part of the machinery and equipment.

  Some States impose levies on captive power generation as also some minimum demand charges adding to cost of cement.

- Procedural delays in obtaining clearances for limestone mining land acquisition, environment etc. which takes more than 2 years causing time and cost over runs.

- Laws are rigid towards exit of an industry.

8.0 Enhancing Cement Consumption

Per capita consumption of cement in India in 2005 was 130 kg as against 355 kg of world average and several developing countries have higher per capita consumption than India – Brazil (191), Argentina (131), Indonesia (129), Thailand (366) and Philippines (147). Therefore, there exists enormous scope for enhancing the consumption of cement in India.

8.1. Concrete Highways/Roads

8.1.1 India has around 33 lakh km. of road network, less than half of which is paved. Out of this, about 68,000 km. are designated as National Highways which, though, just about 2 per cent of the total length, carry almost 40 per cent of the traffic. Even the National Highway system is in urgent need of attention, since about one-third need major repairs and another one-third have inadequate width. These deficiencies affect the speed and life of vehicles, causing loss of thousands of crores of rupees to the economy every year.

8.1.2 Concrete roads, in addition to providing an excellent surface (virtually maintenance-free) enjoy lower life cycle cost and entail considerable saving in fuel for load carriers running upon them as compared to bituminous roads. It has been estimated that fuel savings can amount up to Rs 10,000 crores with corresponding reduction in import of fossil fuel if around 12,000 km of National Highways (double lane) are made of concrete. A point not sufficiently appreciated is the environment friendliness of concrete roads vis-à-vis bituminous roads.

8.1.3 The World Bank has recommended for its road projects in India, the construction of concrete roads instead of bituminous roads.

A note on the subject "A case for Concrete Roads" is at ***Annexure IV***.

8.2 Concrete pavements for rural roads

8.2.1 It is a known fact that while about 65% of the country's population lives in villages, most of the villages do not have proper all-weather connectivity roads to the nearest highways. Bituminous roads become unserviceable after 1-2 years due to lack of maintenance.

8.2.2 Further, rural areas have wet soils due to agricultural activities. A concrete surface would help overcome the water logging due to wet soil and is not damaged due to movement of iron-tyred vehicles. Concrete roads have a long life and need no maintenance for long years as much as 35 years, and this conforms to the guidelines set for PMGSY – a minimum maintenance free service life for five years.

8.2.3 States of Tamil Nadu, Andhra Pradesh and Gujarat have laid 6000 km of concrete roads in rural areas.

8.2.4 Cost-wise, though the initial cost of concrete pavement is 10% higher than bituminous ones, it turns out to be cheaper by 21% on life-cycle basis. In fact, concrete pavements could be comparable with bituminous ones even at the initial laying, if use of fly ash is permitted.

8.2.5 In view of the advantages, Rural Development Ministry has approved construction of 200 km. of concrete roads in rural areas as a pilot project in 12 States. In spite such a decision, no progress has been made till date.

8.3 Check-dams and Canal Lining:

8.3.1 India faces scarcity of water both in cities and in rural areas every year. A large percentage of water is lost due to seepage from irrigation canals, which can be avoided with proper lining of the canals with concrete. Today, more than 30% of water is estimated to be lost through seepage which loss can be reduced to one-third or less, by lining canals with concrete. Concrete check-dams and canal lining have proved to be economically viable.

8.4 Use of fly ash for production of PPC

8.4.1 Fly ash, generated by the thermal power plants, is hazardous to the environment and has to be disposed off to consumers who could put it to gainful use. Cement is one of the industries that can consume large quantities of fly ash to manufacture PPC having better properties than OPC and hence suitable for a variety of applications.

8.4.2 To use fly ash in manufacture of PPC, the cement industry has invested large amounts of money, including collection of fly ash. To meet the production targets during the XI Plan period, the cement industry would need fly ash as it would not only help in saving the environment but also in saving the non-renewable precious source of limestone. Therefore, the supply of fly ash free of

cost to cement industry should be ensured on a long term basis. The industry would incur the cost of necessary infrastructure facilities for receiving ash and other incidental costs as mutually agreed between the industry and the power utilities**.**

8.4.3 Currently production of PPC forms 60% of the total cement production. By end of XI Plan, it would account for 65 – 70%. BIS has permitted use of fly ash to the extent of 35%. However, actual use by the cement plants ranges from 20 – 30% on quality consideration of clinker and limestone. The requirement of fly ash by the end of XI Plan would work out to over 45 mn.t. (assuming on an average PPC would contain 25% fly ash).

8.5 Use of Blast Furnace Slag for production of Slag Cement

8.5.1 Another hazardous material, a reject from Iron & Steel manufacturing units – Blast Furnace Slag, which is an environmental pollutant, is being put to gainful use in the cement manufacture. Slag cement has special uses particularly in construction of bridges and constructions at locations where soil is alkaline.

8.5.2 Currently, slag cement accounts for around 10% of the total production. Depending upon the granulated slag availability, it would increase to 12% by the end of XI Plan.

8.6 Use of Pet coke as alternative fuel

8.6.1 Pet coke from petroleum refineries is an alternative fuel for the cement industry. Currently, the availability of pet coke is only 4 mn.t. from the refineries in Gujarat and Panipat. Additional requirement of pet coke has to be imported from middle-east countries.

8.7 Use of Tyre Chips (Shredded Tyre)

8.7.1 Central Pollution Control Board has approved use of tyre chips. This is not an environmental issue, as evinced by its wide use across Western Europe.

8.8 Use of waste derived fuels in the manufacture of cement

8.8.1 Waste derived fuels like municipal wastes etc. could be gainfully put to use by the cement industry as alternative fuel in kilns. Though tests have been made and found suitable, permission for use of such waste derived fuels has not yet been granted by the Government.

8.9 Reduction of Taxes and Levies on Cement

8.9.1 Cement is one of the highest taxed commodities in India. It is subject to Government levies both by Centre and States. Taxes and levies on cement comprise duties on power tariff, sales tax, etc. and royalty / cess on limestone/coal/ gypsum as well as excise duty.

8.9.2 The average tax on cement is as high as Rs.931 per tonne. This constitutes around 30% of the selling price of cement.

Break-up of Govt. Levies on Cement

	Rs/Tonne (Avg.)
Average Sales Tax/VAT @ 12.7%	362.00
Service tax	1.00
Excise duty on cement (400+2% Education cess)	408.00
Royalty and cess on limestone	69.00
Royalty on coal	22.00
Duties on power tariff	27.00
Sales tax on stores/spares/raw material/packing	15.00
Octroi	23.00
Excise duty on stores/spares	4.00
Total Government levies on cement	**931.00**

Such a high incidence of taxes/levies on cement makes cement costly to the consumer.

9.0 Recommendations

Growth of cement industry, having a multiplier effect on growth of other sectors, is of prime importance to national economic growth. A healthy growth of cement industry to meet the target in the XI Plan would depend largely upon following measures:

- ***Adequate supply of fuel/coal for cement industry -***
  - ***(a) Ensuring 80% of the fuel requirement of cement industry by coal companies through linkages/Fuel Supply Agreements (FSAs).***
  - ***(b) Timely sanction of long-term coal linkages for capacity additions.***
  - ***(c) Allotment of more coal blocks to cement plants on priority basis.***
  - ***(d) Promoting setting up of coal washeries by cement companies.***
  - ***(e) Encouraging coal mining for captive use by cement companies.***
  - ***(f) Abolition of import duty on coal and pet coke.***
  - ***(g) Permitting duty free import of tyre chips (shredded tyres) by end users for use as alternative fuel.***
  - ***(h) Promoting lignite based cement plants.***
  - ***(i) Encouraging setting up of captive power plants for cement industry by ensuring appropriate coal linkages and abolition of all types of duties on generation of power for captive use.***
- ***The cement industry should be consulted while negotiating/signing bilateral and multilateral trade agreements. Cement industry has potential for manufacture of cement and management of cement plants in Asian countries, which should be exploited to India's advantage.***
- *In view of dwindling availability of limestone and coal reserves in the main land and for better access to international markets, clearances under the Coastal Regulation Zones guidelines on proposals for setting up of new cement plants in coastal regions need to be given in a time bound manner.*

- *Environmental clearances by Central and State agencies should be granted in a time bound and expeditious manner so as to considerably reduce the aggregate processing time varying between 1.5 to 3 years being taken presently.*

- ***Construction of cement concrete roads needs be encouraged for National Highways, State Highways, District, Metro and City roads and under centrally funded projects such as PMGSY, Jawaharlal Nehru UrbanRrenewal Mission and Bharat Nirman Yojana.***

- ***Urban land ceiling Act needs to be repealed in the remaining States also so as to boost construction activities.***

- ***Presently, OPC is used in the Government/Public Sector for most construction activities. The performance requirements of most constructions could be met by using PPC/Slag cement. With a view to promote use of PPC and Slag cement in order to conserve non-renewable resources and efficient resource utilization, the following needs to be done:***
  - ***Construction codes of Central/State Governments and their entities should be appropriately modified to allow use of PPC and slag cement.***
  - ***Excise duty should be lowered by 25% for PPC manufactured with 25% or more fly ash.***
  - ***Incentive should be given for manufacturing composite cement using both fly ash and slag.***

- The supply of fly ash free of cost to cement industry should be ensured on a long term basis. In this regard, cement manufacturers could meet the expenditure required for providing necessary infrastructure facilities for receiving ash, as mutually agreed between the industry and the power utilities.

II. Performance of Mini Cement Plants and Measures for their Growth

1.0 Introduction

The prevailing scenario of acute cement scarcity in mid seventies with inadequate investment in this core sector, led to the Government policy for promotion of mini cement plants which could fulfill many objectives in addition to producing cement to meet the local needs. Taking into account various factors which were prevailing at that time the Government of India came out with the policy for promotion / establishment of mini cement plants in early 1979. In addition to the several incentives and concessions offered by the Government for establishing mini cement plants, the policy also entailed fulfillment of certain socio-economic objectives by setting up the mini cement plants.

1.1 Government Policies

The policy of the Govt. of India to encourage the establishment of mini cement plants first announced vide Notification No.9-28/78-Cem dated 04 January 1979, through a press note, had the following incentives for establishment of mini cement plants :

- The capacity for a mini cement plant will be limited to 200 tonnes per day (tpd) or 66000 tonnes per annum (TPA)

- Mini cement plant will be allowed a rebate in the payment of excise duty upto 50% for a period of five years

The Govt. of India, vide Notification No.2/18/85-Cem dated 01 August 1986, enhanced the capacity of mini cement plants based on rotary kiln technology to 300 tpd or 99000 TPA.

The Govt. of India, vide Notification No.2/18/85-Cem dated 30 June 1987, permitted the existing mini cement plants to expand their capacity upto 600 tpd or 1,98,000 TPA by installation of pre-calcinator / balancing equipment or by way of modernization but in no case by addition of another kiln or by substitution of the existing kiln by a kiln of a larger size.

Further, a notification No. 20/99-Central Excise dated 7th May 1999 was issued by the Govt. of India notifying the enhancement of the installed capacity of Mini Cement Plants to 900 tpd or 2,97,000 TPA.

The Govt. of India, vide Notification No.12/95-C.E dated 16.3.1995, the installed capacity of the plant based on VSK technology was enhanced from 200 tpd to 300 tpd or 99000 TPA.

The Govt. of India, vide notification No. 5/94 – Central Excise dated 1 March 1994, clarified that "The concession for central excise is not available to cement manufactured in a factory from the clinker not manufactured from the same factory"

The Govt. of India, vide their Notification No. 12/95-CE dated 16 March 1995, further clarified that the concession for central excise was not available to cement bearing a brand name or trade name of another person.

The excise duty structure for mini cement plants vis-à-vis large plants from 1979 till date is shown below :

Date	**Excise Duty (Rs. Per Tonne of Cement)**	
	Mini Cement Plants	**Large Plants**
4.1.1979	32.50	68.25
	Partial Decontrol Introduced	
28.2.1982	100.00	135.00
1.3.1983	170.00	205.00
28.2.1984	205.00	205.00
28.2.1985	225.00	225.00
28.2.1988	215.00	215.25
6.10.1988	115.00	215.25
28.2.1989	Full Decontrol Introduced	
28.2.1990	90.00	225.75
28.2.1992	165.00	333.50
28.2.1994	185.00	330.00
14.3.1995	200.00	350.00
28.2.2003 Onwards	250.00	400.00

As a result of the Government's encouragement and technological support extended by the National R&D laboratories in the country, a number of mini cement plants came up in different parts of the country, mostly on Rotary Kiln and Vertical Shaft Kiln technologies.

The first VSK based (30 tpd CRI-MVSK) mini cement plant became operational in early 1981; whereas the first (200 tpd) mini cement plant based on rotary kiln technology went on stream in 1982. In addition, some VSK plants mostly in small-scale sector came up, whose plant and machinery were supplied by M/s Shree Engineers, Jodhpur.

1.2 Fulfillment of Objectives by Mini Cement Plants

The Government, while enunciating the policy for promotion of mini cement plants, had identified the following objectives to be fulfilled by these cement manufacturing units :

- Cement industry is brought within the financial access of smaller entrepreneurs.
- A sense of ownership is cultivated in entrepreneurs with relatively smaller means.
- Creation of increased employment opportunities in rural areas on a well-dispersed basis.
- Contribution to uplifting the local economy and development.
- Realisation of quicker returns on capital invested because of low gestation period.
- Exploitation of smaller deposits of limestone scattered all over the country.
- Economic utilization of industrial wastes and byproducts in certain cases.
- Development of cement industry in terrains where movement of machinery and cement are difficult.
- Reduction of strain on country's transportation infrastructure.
- Lower capital investment per unit capacity.

So far as the fulfillment of the objectives set by the Government for promotion of mini cement plants is concerned, it is generally felt that objectives like development of new generation of entrepreneurs, socio-economic upliftment of the local areas, making cement available locally without long distance of transportation etc., have been fulfilled by mini cement plants to a significant

extent. However the locational objectives of setting up these plants in remote areas, where large cement plants cannot be set up due to the lack of infrastructure, has not been fulfilled to the required extent. It is important to note that despite the guidelines provided by the Government, many mini cement plants have been setup/operating in close vicinity of the large cement plants, resulting in marketing problems and transportation of cement over longer distances for mini cement plants.

1.3 Status of Mini Cement Plants - A Review

As on 31st March 1996, 267 mini cement plants (out of 311 mini cement plants set up) having an installed capacity of 7.73 mn.t, were in operation, contributing a production of about 5.50 mn.t, as in the table below:

Status as on 31st March 1996

Sl No.	Technology	Set Up		In Operation		Under Implementation	
		Nos.	Installed Capacity (LTPA)	Nos.	Installed Capacity (LTPA)	Nos.	Installed Capacity (LTPA)
1	RK	31	34.85	22	28.25	5	8.94
2	CRI-MVSK	97	27.47	71	22.35	26	12.59
3	RRL-VSK	17	1.75	13	1.42	17	1.40
4	Saboo-VSK	166	26.12	161	25.32	26	7.62
	Total	311	90.19	267	77.34	74	30.55

Production : 5.50 mn.t.

Note : *In addition there are some VSK plants, whose technologies are not based on any of the above three sources. The Working Group could not collect any reliable information pertaining to these plants.*

As on 31st March 2001, out of a total of 365 units set up, with a capacity of about 11 mn.t, only about 132 mini cement plants with a capacity of 6 mn.t,

producing about 4 mn.t of cement per annum, were reported to be in operation as indicated in table below :

Status as on 31st March 2001

Sl No	Technology	Cement Plants				
		Set Up		In Operation		
		Nos.	Installed Capacity (LTPA)	Nos.	Installed Capacity (LTPA)	Production (LTPA)
1	Rotary Kiln	31	40.03	24	34.11	23.88
2	NCB-MVSK	101	33.54	30	11.79	8.25
3	RRL-VSK	31	2.86	-	-	-
4	Saboo-VSK	202	34.49	78	13.78	6.89
	Total	365	110.92	132	59.68	39.02

VSK – Vertical Shaft Kiln; RRL– Regional Research Laboratory (Jorhat)

Note : *In addition there are some VSK plants, whose technologies are not based on any of the above three sources. The Working Group could not collect any reliable information pertaining to these plants.*

The Working Group on Mini Cement Plants for the X Five Year Plan (2002-2007) had made an optimistic estimate of 18.60 mn.t of installed capacity per annum and a corresponding production estimate of 13 mn.t, by the terminal year of X Five Year Plan (2006-07). Further, the Working Group also assessed that on a more conservative estimate, the operating capacity may be over 16.10 mn.t per annum with a production of about 9 mn.t by the end of the X Five Year Plan (2006-07).

The present status of mini cement plants as provided by All India Mini Cement Manufacturers' Association, is summarized below :

Status as on 31st March 2006

Originally set up	Cement Plants (Nos)		Operating capacity (Mn.t)
	Closed	In Operation	
RK 39	26	13	2.93
VSK 333	140	193	3.47
Total 372	166	206	6.40

Source : AIMCMA – Hyderabad

Thus, it could be seen that during the X Five Year Plan, there has been an addition of 8 plants, based on Rotary Kiln technology, increasing the operating capacity from 5.96 mn.t to 6.40 mn.t.

As only, 13 rotary kiln plants and about 193 VSK plants with an installed capacity of 2.93 mn.t and 3.47 mn.t respectively, are at present contributing to cement production, a detailed study should be conducted to assess their modernization/capacity enhancement needs vis-à-vis their financial requirements.

The Government of India and many State Governments are focusing on infrastructural projects, rural development and housing, which could result in increased demand for cement. Towards meeting this demand, the cement industry is poised for an annual growth rate of 11.5% during the XI Five Year Plan period. Mini Cement Plants can play their complimentary role in supplying cement to meet the local requirements.

1.4 Recommendations

- ***Installation of green-field mini cement plants should be encouraged only in cement deficit far-flung States viz., the North Eastern States and Jammu & Kashmir.***

- ***The present limit on production capacity to be qualified as mini cement plant should be enhanced from 900 to 1200 tpd for rotary kiln plants and from 300 to 400 tpd for VSK based plants.***

III. National Inventory of Limestone

1.0 Introduction

1.1 National Inventory of Cement Grade Limestone is the basic pre-requisite for planning the strategy for the growth of the Cement Industry. The twin objectives of inventory is to update the availability of the limestone and to bring into focus the limiting factors affecting the availability of limestone.

1.2 The gross reserves of Cement grade limestone stood at 97430 mn.t. as on 31st March 2006 but only 44632 mn.t. of proved equivalent reserves are available for present and future use due to various environmental and technological constraints.

1.3 To mitigate this adverse effect of reduced availability, focused efforts are required for proper utilization of 32632mn.t (33.50%) of marginal grade limestone. There is also need to review the provisions of the Coastal Regulation Zone and Forest Conservation Act to enable eco-friendly use of enormous reserves of cement grade limestone.

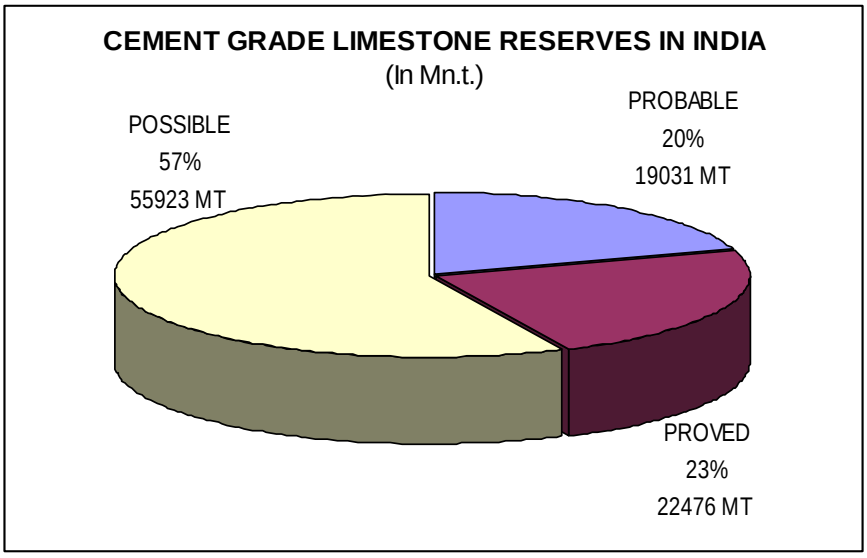
1.4 About 76% of the gross reserves are concentrated in just six states and there is a possibility of further growth of Cement Industry in these areas. Such a growth within the existing clusters may have adverse impact on environment. Studies on carrying capacity have to be conducted within the clusters to assess the environmental load vis a vis the additional cement capacity, based on the available limestone reserves and infrastructure.

2.0 Status of Limestone Availability

2.1 Limestone is perhaps the most extensively exploited mineral gift of nature and the cement industry is the largest beneficiary of this mineral. Hence, the information on the latest status of availability of cement grade limestone is essential not only for entrepreneurs in making technological and financial decisions intending to set up green field cement plants but also helps planners in formulating the strategy for the growth of the cement industry. Although, many national and state level geological agencies have been exploring such deposits for different limestone based industries, it was only in the late sixties that serious attention was paid towards the assessment and exploration of cement grade limestone reserves in a more comprehensive manner keeping in view the potential for the growth and development of Indian cement industry. National Council for

Cement and Building Materials (NCB), the then Cement Research Institute of India, had taken up updation of the national inventory of cement grade limestone as a continued programmed project since 1974.

2.2 In the year 1974, the total limestone reserves as estimated were of the order of 44,000 mn.t, with only 3020 mn.t (6.8 %) of proved category. As on 31 March 2006, the country's estimated gross reserves of cement grade limestone stand at 97430 mn.t. Out of this, 22476 mn.t (23%) of **proved** category, 19031 mn.t (20%) of **probable** category and 55923 mn.t (57%) of **possible** category reserves. The status of cement grade limestone reserves zone-wise is shown in the table below. The **proved equivalent** reserves of all the categories have been estimated as 63760 mn.t. The substantial increase in reserves have been possible due to the continuous proving of limestone deposits by various national and state level geological agencies.



2.3 Based on the prima-facie availability of freehold cement grade limestone reserves, there is very limited scope for further addition of cement manufacturing capacity in the states of Kerala, Tamil Nadu, Bihar, Uttar Pradesh, Manipur, Orissa and West Bengal. However, states of Andhra Pradesh, Assam, Gujarat, Himachal Pradesh, Karnataka, Chhattisgarh, Meghalaya, Jammu & Kashmir and Rajasthan have potential for further creation/expansion of cement manufacturing capacity.

State-Wise Status of Cement Grade Limestone Reserves(*)in India

(As on March 2006)

Zone	State	Reserves in million tonnes				
		Proved	**Probable**	**Possible**	**Total**	**Proved equivalent**
North	Haryana	31.22	1.93	2.42	35.57	33.78
	H P	1809.60	000	4269.70	6079.30	3945
	J & K	123.22	524.37	5009.53	5657.12	2995.04
	Rajasthan	563.80	3321.29	3748.97	7634.06	4763.19
	Uttaranchal	188.20	1227.19	453.43	1868.82	1273.95
	Uttar Pradesh	327.90	412.02	225.25	965.17	728.94
Total of North Zone		**3043.94**	**5486.80**	**13709.30**	**22240.04**	**13739.90**
East	Assam	338.83	244.00	906.20	1489.03	962.73
	Manipur	11.02	2.68	7.86	21.56	16.83
	Meghalaya	547.42	980.41	4779.90	6307.73	3623.66
	Arunachal	0.00	108.00	275.50	383.50	213.35
	Orissa	87.36	95.83	410.55	593.74	359.72
	Bihar	120.22	67.14	658.74	846.10	496.59
	West Bengal	6.40	3.20	0.00	9.60	8.64
	Jharkhand	54.58	55.65	114.16	224.39	150.62
	Nagaland	10.48	113.57	896.63	1020.68	538.30
Total of East Zone		**1176.31**	**1670.48**	**8049.54**	**10896.33**	**6370.44**
West	Chhatthisgarh	2540.49	797.72	1177.86	4516.07	3687.82
	Gujarat	3709.96	6707.99	0.00	10417.95	8405.55
	M P	1592.49	251.68	736.80	2580.97	2137.07
	Maharashtra	890.78	111.02	812.33	1814.13	1374.66
	Diu	48.84	0.00	0.00	48.84	48.84
Total of West Zone		**8782.56**	**7868.41**	**2726.99**	**19377.96**	**15653.94**
South	A P	959.41	1442.38	28032.60	30434.39	15985.38
	Karnataka	7718.37	2270.53	2820.12	12809.02	10717.80
	Kerala	44.58	9.35	40.37	94.30	71.31
	Tamil Nadu	750.46	282.75	454.27	1487.48	1175.52
	Andaman	0.00	0.32	0.51	0.83	0.48
	Lakshdweep	0.00	0.00	90.00	90.00	45.00
Total of South Zone		**9472.82**	**4005.33**	**31437.87**	**44916.02**	**27995.49**
Grand Total (Gross)		**22475.63**	**19031.02**	**55923.70**	**97430.35**	**63760.00**

(*) The above reserves are gross reserves inclusive of lease hold / free hold under forest, CRZ, and blocked due to other constraints.

3.0 Locational Constraints of Limestone Availability

3.1 Regional Imbalance

3.1.1. A closer look at the national inventory of cement grade limestone reveals that about 76 percent of the total reserves are concentrated in just six states of Andhra Pradesh, Karnataka, Gujarat, Rajasthan, Madhya Pradesh and Chhattisgarh. Andhra Pradesh alone has the privilege of having about 31% of the country's total reserves. However, the maximum cement consumption and demand during the last few years have been 15.88 mn.t in Maharashtra (12.50% of all India consumption), followed by Uttar Pradesh 14.12 mn.t. (11.10%), Tamilnadu 9.554mn.t (7.50%) Andhra Pradesh 8.55 mn.t (6.72%), Gujarat 8.71 mn.t (6.85%), Karnataka 8.11mn.t (6.38%), Rajasthan 6.97mn.t (5.48%), West Bengal 6.23mn.t (4.90%) and Madhya Pradesh 6.29 mn.t (5.28%). Juxtaposition of States with maximum limestone reserves and states with maximum cement consumption reveals a major inbuilt anomaly between consumption and scope for growth in cement capacity. This is due to the regional imbalance in the availability of limestone; with about 46.1% of the total reserves in South zone, 22.8% in Northern zone, 19.8% in Western zone, and a meagre 11.2% in Eastern zone. The non-uniform distribution with concentration of potential deposits only in a few geological horizons has resulted in formation of, so called, cement producting clusters. The seven clusters namely Satna, Chandrapur, Gulbarga, Yerraguntla, Nalgonda, Bilaspur and Chanderia contribute to 51% of total installed capacity and 52% of total annual cement production (2005-2006). 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.

3.2 Environmental Considerations

3.2.1 The availability of potential limestone deposits has also been restricted due to environmental constraints, as many of these deposits are located in reserve forests, bio-zones and environmentally sensitive areas of near tourist centers / hill-stations or under thickly populated or cultivated fields. Population growth, rapid urbanization and developmental projects have also led to encroachment of some of the potential limestone deposits. About 28% of the reserves have been restricted due to forest and other constraints.

3.3 Other Factors

3.3.1 The limestone reserves available at deeper levels and the deposits located in inaccessible / remote areas, without adequate basic infrastructural facilities makes it impossible to utilize such deposits. Inhomogeneous deposits with frequent intercalations/ inter-beddings and small-scattered deposits not suitable for large scale mechanized mining etc. further restricts the availability of cement grade limestone for large cement plants.

4.0 Utilisation of Marginal Grade Limestone

4.1 As per the estimates, about 32632 mn.t (33.5%) of the total 97430 mn.t of limestone reserves are of marginal grade. In addition, due to the poor and variable coal quality with high ash content, even a part of the cement grade limestone is turning to be marginal grade for cement manufacture. Since the available cement grade limestone reserves are not going to last forever, utilization of marginal grade limestone must be given immediate attention and priority through development of suitable techniques. Marginal grade limestone can be utilized for cement manufacture through any of the following techniques:

- **Computer aided deposit evaluation and mine planning for rational/optimal utilization of different grades of limestone through selective mining and blending.**
- **Use of sweetener which could be high grade limestone or industrial wastes like lime sludge etc.**
- **Modifications in raw mix design and process parameters and use of mineralisers.**
    - **Use of low ash fuels, such as Petcoke etc.**
    - **Use of natural gas as fuel.**
    - **Manufacture of low CaO reactive belite and other special cements.**
    - **Upgradation of limestone quality through dry beneficiation techniques.**

4.2 The excessive use of sweetener is already affecting the economic viability of a number of cement plants. NCB has been carrying out detailed studies to determine the suitability of Indian limestones to different techniques of beneficiation including the relatively conventional Differential Grinding and Sieving Techniques (DGS) as well as non-conventional techniques like Electrostatic Separation (ESS), Optical Sorting and Bacterial Leaching.

5.0 Potential Limestone Deposits in and around Cement Cluster Zones

5.1 Andhra Pradesh: Andhra Pradesh with total reserves of 30434 mn.t (proved equivalent 15986 mn.t) of cement grade limestone ranks first in the country with about 33.5 percent of total reserves of the country (*Annexure-V*). As per the national inventory of cement grade limestone, the potential limestone deposits are available in the following districts.

5.1.1 ***Adilabad District*:** Extensive limestone reserves of 4182 mn.t are available to cater to the requirement of large cement plants. These reserves are falling under reserve forest, and need to be de-reserved for exploitation.

5.1.2 ***Cuddapah District:*** The Cuddapah district is endowed with 5050 mn.t of cement and high-grade limestone reserves under thick soil over burden. The land is very fertile in this region hence the cost of land is very high.

5.1.3 ***Guntur District:*** The Guntur district has 6210 mn.t of cement grade limestone reserves with a number of potential deposits. The deposits are covered under soil over burden of 3 to 4 meters.

5.1.4 In addition to the above, few more potential limestone deposits are occurring in Khammam, Krishna, Kurnool and Nalgonda districts. But all these deposits are either falling under cultivated land or under reserve forest. No limestone deposit is available in the government land. District-wise Status of cement grade limestone availability in the State is given in ***Annexure-V***.

5.2 **Karnataka:** Karnataka is the second largest state, with total reserves of 12809 mn.t of Cement grade limestone (proved equivalent 10718 mn.t). The cement grade limestone deposits are available in ten districts, of which Gulbarga, Bijapur, Chitradurga, have potential for greenfield cement projects. District-wise availability of cement grade limestone is as given in *Annexure-V*. The potential limestone deposits for greenfield cement projects are located in the following districts :

5.2.1 ***Gulbarga District :*** The Gulbarga district alone possesses more than 87 percent of the total limestone reserves of the State. The deposits are horizontally bedded, massive with consistent quality and categorized as simple deposits as per NCB norms for proving limestone deposits. These limestone deposits are ideally suited for setting up large/mega cement projects.

5.2.2 ***Bagalkot (Bijapur) District:*** The limestone deposits of Gulbarga district are extended in adjoining Bijapur district. The limestone deposits of Kaladgi groups are also reported in the district. These deposits are variable in quality in respect of silica and magnesia and categorized as simple to complex deposits as per NCB norms.

5.3 **Gujarat:** Gujarat ranks as the third largest state with total reserves of all categories of 10418 mn.t (proved equivalent 8406 mn.t) of Cement grade limestone deposits reported in eight districts, of which seven districts possess proved category of reserves. The potential limestone deposits for green field cement projects are in Kutchh, Junagarh, Bhavnagar, Banaskantha districts of the state. District-wise status of cement grade limestone deposits is as given in *Annexure-V*.

5.3.1 ***Kutchch District:*** Kutchch district possesses more than 75 percent of the total limestone reserves available in the state. Extensive milliolitic limestone with little or no overburden is reported in the district, which could not be developed due to poor infrastructural facilities. The carrying capacity studies of the region carried out by NCB have established that despite extensive limestone deposits (7765 mn.t) suitable for cement manufacture, they are not available for mining. The reasons being the limestone deposits are lying below the Narayan Sarovar Sanctuary, having endangered floral and faunal species. The policy framework for utilizing these limestone deposits vis-à-vis Sanctuary limits needs to be looked into with a holistic view so as to develop the region industrially by protecting vital components of the environment for harmonious development.

5.3.2 ***Junagarh District:*** Junagarh is the second largest district in respect of cement grade limestone reserves with 1554 mn.t. Most of the deposits are smaller in size to sustain large capacity cement plant.

5.3.3 ***Bhavnagar District:*** Bhavnagar district is the third richest district of Gujarat State in respect of Cement grade limestone. The milliolitic limestone of coastal region is slightly crystalline, shallow in depth, with very erratic thickness. The brown to buff colored limestone is very high grade with impurities of Marl

(siliceous carbonaceous material). The area is well connected with roads/rail and located along the seacoast, and is ideally located for major cement projects along south coast of Gujarat. The availability of these potential deposits has been restricted due to CRZ (Coastal Regulation Zone) implementation.

5.4 **Rajasthan :** Rajasthan ranks fourth largest state in respect of cement grade limestone availability with total reserves of 7634 mn.t (proved equivalent 4763 mn.t). The cement grade limestone is reported to occur in 21 districts, however substantial limestone reserves are reported in 18 districts only. Potential limestone deposits for green field projects have been identified in Jaisalmer, Nagaur, Pali, Sikar and Jhunjhunu districts. The Rajasthan state has potential consumer market of Northern States and has very high potentiality for further cement capacity enhancement and for green field projects. Out of the total reserves of 7634 mn.t of all categories, only 564 mn.t (7%) are of **Proved** Category and remaining 93% are yet to be explored and proved. State Department of Mines and Geology and other agencies should take appropriate measures to prove and evaluate these limestone deposits. District-wise status of cement grade limestone deposits is given in *Annexure-V*.

5.4.1 ***Chittorgarh District:*** The largest cement grade reserves of 1479 mn.t are located in Chittorgarh area. Extensive limestone deposits have been reported all along the district between Chittorgarh to Nimbahera. The region is infrastructurally well developed for setting up greenfield mega cement plants.

5.4.2 ***Jaisalmer district :*** Jaisalmer district contains very high grade limestone deposits CaO : 44 to 55%, SiO2 : 0.5 to 6% and FeO : < 0.5% in and around Khinya, Abur, Sanu, Sam and Ramgarh Villages. Extensive mining activities are being carried out by Rajasthan State Mineral Development Corporation (RSMDC) for Chemical and SMS grade limestone, which have only 8 meter thickness and lying below 16 to 18m thickness of cement grade limestone bed. Therefore, huge quantities of limestone dumps are already available all along the quarry site. These limestone dumps can cater to the requirement of mega cement projects. The State - DGM has established 890 mn.t probable reserves in this area and notified a few mining blocks as suitable, for cement manufacture.

5.4.3 In addition to above, a few more suitable limestone deposits have been identified in Jaipur, Sikar, Nagaur, Pali and Jhunjhunu districts of the State.

5.5 **Chhattisgarh:** The state of Chhattisgarh jointly with neighbouring state of MP has been the largest cement producing state till recent years. The total cement grade limestone reserves available in Chhattisgarh are 4516 mn.t (Proved equivalent 3688 mn.t). The potential cement grade limestone deposits have been reported from seven district of the state. Details of district wise availability of cement grade limestone are as given in *Annexure-V*. The district wise potential limestone deposits are briefly described as below:

5.5.1 ***Raipur District:*** The Raipur district possesses nearly 50% of the total state's limestone reserves and also has well-developed infrastructure. The limestone deposits are horizontal and thickly bedded with consistent quality and described as simple deposits as per the NCB norms for proving limestone deposits. Though there is clustering of major cement plants in Raipur - Bilaspur sector, there is scope for additional cement projects, provided a thorough study is conducted for market viability and proper assessment of environmental load etc before setting any additional green field cement projects in this district.

5.5.2 ***Bilaspur District:*** The Bilaspur district is the second largest cement grade limestone bearing district of Chhattisgarh state with total reserves of 939 mn.t. This district has already four major cement projects and has further potential to add cement capacity.

5.5.3 In addition to above, a few more suitable cement grade limestone deposits are available in Bastar, Durg and Raigarh districts.

6.0 Potential Limestone Deposits away from Cement Cluster Zones

6.1 **Himachal Pradesh:** Himachal Pradesh is very rich in limestone availability ranking first in North Zone and sixth in the Country with total reserves of 6080 mn.t (proved equivalent 3945 mn.t). The geographical condition and general topography has restricted the growth of cement industry in the state. However, due to continued scarcity of cement in the northern states and rapid growth of construction activities in neighbouring states, there is enough potential for the growth of cement industry in the state for utilising the available limestone reserves. District-wise availability of cement grade limestone is also given in *Annexure-V*. District wise details of potential limestone deposits is as given below:

6.1.1 ***Shimla District:*** Shimla is having the largest cement grade limestone reserves of 2000 mn.t, sharing more than 32 percent of total reserves in the state. Though the limestone deposits are lying in hilly region, Shimla is relatively better placed in terms of infrastructural facilities.

6.1.2 ***Mandi District:*** Similar to Shimla, Mandi district is also well connected through network of roads and highways and therefore it will be easy to explore the possibility of setting up of major cement units around Alsindi and Sundernagar areas.

6.1.3 ***Solon Distric :*** Solon district has next highest reserves of cement grade limestone reserves in the state with nearly 480 mn.t. of proved category. This district has already one proposed two million tonne plant at Bagga limestone deposit proposed by Jai Prakash Industries.

6.1.4 ***Chamba District:*** Chamba district have huge limestone deposits of cement and high grade in Broh-Shind area, where a large capacity plant can sustain. However infrastructure and approach road to the limestone deposit has to be develop by state government or potential entrepreneur.

6.1.5 A few more potential limestone deposits have also been reported in Bilaspur and Sirmour districts of Himachal Pradesh.

6.2 **Jammu & Kashmir (J&K):** The prominent limestone horizons well developed in the J & K state are upper Triassic limestone of Ladakh with fragmentary remains of fossil Megalondon, the Acchabal-Bawan, Doru and Sop-Kokarnag areas of Anantnag district, Ajas, Gundi-Sunderkot and Sonarwani-Nandihal areas in Baramula district and Khrew, Wuyan areas in Srinagar district. The carboniferous limestone occurs along Murree thrust in Thanamandi Bafliaz-Mandi sector of Poonch and Rajouri district. A fairly thick band of marginal grade limestone of cretaceous age are reported around Khalsi in Ladakh region, the earliest known limestone deposits of Eocene age belonging to Hazara facies occur between Ramarachan and Siara areas of Kathua district. Though J&K state is endowed with good quality of limestone located in almost all the districts, with total reserves of 5657 mn.t, (proved equivalent 2995 mn.t), all other deposits except the deposits in Anantnag district, are inadequate to cater to the requirement of large capacity cement plants. District wise availability of cement grade limestone deposits have been given in *Annexure-V* and described as below:

6.2.1 ***Anantnag District:*** Sandran river valley in Varinag areas of Anantnag district is located between longitudes 75^{o} 10' - 75^{o} 20' and latitude 33^{o} 20' - 33^{o} 35'. An area of about 100Sq km was prospected by state Directorate of Geology and Mining (DGM) and about 16 blocks of limestone deposits have been identified around Sandran Valley with total reserves of 5450 mn.t. The prominent cement grade limestone deposits investigated by state DGM in Punjoo block. Punjoo block is located at a distance of 1 km east of Punjoo village, about 2 KM from Varinag. It consists of scarpment of limestone with moderate to steep slopes. There are two high grades limestone bands in this block, separated by a band of inconsistent quartzite and siliceous limestone. The overall thickness of limestone band in this area is 16 meter. The total reserves estimated in this block are of the order of 62.6 mn.t, which includes 46.97 mn.t without overburden. The average grade estimated in the area is very high (53.4% CaO, 0.75% MgO and 2.32% SiO2 content).

6.3 **Meghalaya:** Meghalaya is endowed with very good quality limestone and it has high potential for additional cement manufacturing capacity. The limestone deposits of East Khasi Hills and Jaintia Hills can be considered suitable for setting up major cement plants keeping in view the quality, reserves and broad infrastructural parameters. These cement grade limestone deposits are highly potential to cater to cement demand of North Eastern States as well as for export to adjacent countries of Bangladesh, Myanmar, and Bhutan etc. District-wise reserves of Meghalaya are given in *Annexure-V*. District wise details of Potential Limestone deposits is as given below :

6.3.1 ***East Khasi Hills District:*** The prominent limestone deposits of East Khasi Hills district are located in Mawlong-Ishamati, Shella, Komorrah and lower Cherra areas. Isolated small outcrops of limestone are also found near Umstew and Mawkma areas of Laitryngew and below the coal bearing sandstone of Langkerdem and Thangjinath coalfields of Pynursla areas at a distance of 53 Km from Shillong along Shillong Dawki road. Mawmluh-Cherra Cement Company Ltd is mining the limestone deposit of Cherrapunji and Komorrah limestone is being supplied to Chhatak Cement Co. Ltd., Bangladesh. In addition to this, Shella limestone deposit is identified for a proposed major cement plant to be set up in Bangladesh.

6.3.2 ***Jaintia Hills District:*** Jaintia Hills district is very rich in limestone having more than 70 percent of total reserves of the state. The deposits have been explored in details by Directorate of Mineral Resources (DMR) Meghalaya and

Geological Survey of India, Northeastern Region. Extensive deposits are reported around Litang River Valley over an area of 100 Sq. km. Other notable deposits include Lumshunong, Mynkre and Lakadong located along Shillong-Badarpur Road (NH-44).

7.0 Action Plan

7.1 The total Proved Equivalent Reserves in the gross limestone reserves of 97430 mn.t. is estimated to be 63,760 mn.t. However, 22.5% of this proved equivalent reserves i.e., 14346 mn.t. falls under forest areas and other 7.5% i.e., 4782 mn.t. is under CRZ & other regulated areas. The net Proved Equivalent Reserves available is, therefore, 44632 mn.t. The amount of reserves needed for operating existing large capacity cement plants with total installed capacity of 180 mn.t. (at the end of X plan, year 2006) is estimated to be about 13365 mn.t. To cater to additional capacity of 118 mn.t., during the XI plan, 8316 mn.t. of additional reserves will be required for a plant life of 45 years. Therefore, the net proved equivalent reserves available at the end of the XI plan after meeting the estimated annual installed capacity of 298 mn.t. is estimated to be only 22505 mn.t. which are inadequate for future requirement of any additional capacity beyond XI plan period**.**

Availability of Limestone Reserves for Future Requirements

(Mn.t.)

Gross Reserves	97430
Proved Equivalent Reserves	63760
P.E. Reserves Restricted:	
Under Forest (22.5%)	14346
CRZ & Other Regulated Areas (7.5%)	4782
Sub-Total	19128
Net Proved Equivalent Reserves Available	44632
P.E. reserves required for operating existing large capacity cement plants (installed capacity 180.0 mn.t)	13365
Additional reserves required during XI plan (to cater additional capacity of 118 mn.t)	8762
Sub-Total	22127 +
Net P.E. reserves available at the end of XI plan after meeting annual installed capacity of 298 mn.t	22505

** PE : Proved Equivalent*

7.2 In order to ensure the availability of cement grade limestone to meet the requirement of projected cement capacity beyond XI plan period, appropriate measures have to be taken up on a war footing. Accordingly, following thrust areas have been identified:

7.2.1 ***Intensified Exploration Activity:*** The availability of **Proved** category cement grade limestone reserves is inadequate to sustain the projected growth trend of cement industry and there are still 77 percent reserves in probable and possible categories which are to be converted into proved category by intensifying the exploration activities by state DMG's and other exploration agencies. Joint exploration has to be taken up by various State Department of Mines & Geology (DMG) in association with NCB, IBM etc. for exploring / identification of the limestone deposits. The state DMG's may be advised to incorporate the activity of proving of cement grade limestone deposits in their annual field program. The deposits falling under reserve forest can only be explored by the State/Central exploration agencies by taking a formal permission from the concerned department. Such an action has already been initiated by the DMG, Karnataka and exploration has been taken up in association with NCB. Similar arrangements have to be worked out with other state DMG's.

7.2.2 ***Potential deposits away from clusters:*** Presently 52 percent of total production of cement is from seven cement clusters. The studies have indicated that there is enough potential for setting up additional cement capacity in and around existing clusters. Such a growth within the cluster will have adverse impact on existing infrastructure and environment. There is, therefore, urgent need to identify potential limestone deposits away from existing clusters. The exploration activity has to be intensified to explore the deposits in northeastern states, HP and Jammu and Kashmir. Also, there is a need to adopt an eco-friendly mining technology to exploit the limestone deposits located in eco-sensitive hilly regions.

7.2.3 ***Use of marginal grade limestone:*** Efforts have to be intensified to utilize 33.5 percent i.e. 32632 mn.t of marginal and sub-marginal grade limestone associated with cement grade limestone. This will improve the life of mine and mine environment by drastically reducing the waste dumps presently lying in the existing quarries and occupying precious land.

7.2.4 ***Dereservation of limestone deposits falling under Eco-sensitive zones and other states:*** About 14346 mn.t (22.5%) of cement grade limestone are restricted due to implementation of forest conservation act. Most of the potential deposits of hill states and northeastern and other states and coastal zones have been covered under forest and are not available for cement manufacture in these

cement deficit areas. Efforts have to be made to release the deposits for exploitation on a selective basis. A beginning has already made in this direction in Himachal Pradesh and Karnataka. Present practice of afforestation of equivalent coverage of land in place of mining lease land, and its substitution by alternative land reclamation, landscaping etc., has to be encouraged in other regions.

7.2.5 ***Relaxation of Coastal Regulation Zone:*** The exploitation of off shore/ onshore deposits has been restricted by declaring coastal stretches as coastal regulation zone (CRZ). The coastal stretches upto 500m from high tide line and the land between the low tide line and high tide line is covered under CRZ. Review of the provisions of the Coastal Regulation Zone is essential to enable eco-friendly use of enormous reserves of cement grade limestone blocked in Gujarat Coast and to save operating plants from gradual demise.

7.2.6 ***Incentive for Using Low Grade Limestone, Industrial and Mining Wastes:*** Technologies for use of marginal grade limestone, including limestone with high silica, magnesia or alkalis need perfection on a mission mode, their promotion on large scale need suitable incentives to the cement plants. A lower rate of royalty may be fixed for utilizing low grade (high silica / high magnesia) limestone and calcareous shale.

7.2.7 ***Periodic Re-assessment of Limestone Reserves:*** In order to ensure the availability of various grades of residual limestone reserves for rational utilisation, periodic re-assessment of captive limestone mines of all cement plants should be carried out by an independent agency such as NCB or IBM.

8.0 Recommendations

- *Concerted efforts would be required to identify new commercially exploitable limestone deposits. Joint exploration should be intensified by various State Departments of Mines & Geology (DMG) in association with NCCBM, IBM, MECL etc. for exploring/ identification of new limestone deposits.*
- ***A lower rate of royalty may be fixed for utilizing low-grade (high silica/ high magnesia) limestone and calcareous shale.***
- ***Eco-friendly mining activity should be permitted to exploit limestone deposits located in eco-sensitive regions.***

***

Annexure-I

Regionwise/Statewise Cement Consumption

(Large Plants)

(Mn.t.)

Region/State	2004-2005	2005-2006	% growth over pre. year
Northern Region			
Uttranchal	1.47	1.83	**24.2**
Haryana	4.25	4.93	**16.1**
Punjab	5.24	5.66	**8.0**
Rajasthan	6.97	8.27	**18.7**
Himachal Pradesh	1.45	1.59	**9.8**
Chandigarh	0.19	0.27	**40.2**
Delhi	3.75	3.50	**-6.6**
Jammu & Kashmir	0.95	1.01	**7.0**
Total: Northern Region	**24.26**	**27.06**	**11.5**
Eastern Region			
Assam	1.12	1.09	**-2.9**
Bihar	3.80	4.36	**14.7**
Jharkhand	2.31	2.63	**13.7**
Orissa	3.90	4.15	**6.3**
West Bengal	6.22	6.59	**5.9**
Chhattisgarh	2.09	3.08	**47.3**
Other N.E.States	0.95	0.77	**-19.1**
Total : Eastern Region	**20.40**	**22.66**	**11.1**
Southern Region			
Andhra Pradesh	8.55	11.46	**34.1**
Tamil Nadu	9.55	11.13	**16.5**
Karnataka	8.11	9.38	**15.8**
Kerala	6.13	6.50	**6.1**
Pondicherry	0.26	0.33	**24.6**
Andaman & Nicobar	0.05	0.08	**51.0**
Goa,Daman,Diu etc.	0.78	0.49	**-37.6**
Total : Southern Region	**33.43**	**39.37**	**17.8**
Western Region			
Gujarat	8.71	9.12	**4.7**
Maharashtra	15.88	16.78	**5.7**
Total : Western Region	**24.59**	**25.91**	**5.4**
Central Region			
Uttar Pradesh	14.12	14.20	**0.6**
Madhya Pradesh	6.29	6.37	**1.3**
Total : Central Region	**20.41**	**20.57**	**0.8**
Grand Total	**123.08**	**135.56**	**10.1**

Annexure-II

IMPLICATIONS OF FREE TRADE AGREEMENTS (FTAs)

FTA with ASEAN Countries

In case of India-ASEAN FTA, the report has suggested that the elimination of tariffs for cement and clinker would result in increased imports leading to –

- Output contraction estimated at around Rs.3968 Crores
- Employment loss of 12%
- Decline in investment of Rs.3133 Crores and capacity utilization

thus, having an adverse effect on Indian economy. The adverse impact of Indian-ASEAN FTA is noticed for select varieties of cement and put in negative list and some items are also put in 1 - 5% duty. The above is based on data obtained from 3 of the ASEAN countries. In fact, the total ASEAN would result in far higher figures.

FTA with BIMSTEC Countries

The report on BIMSTEC countries, states that elimination of tariffs will result in –

- Output contraction estimated at around 4.9%
- Employment loss of 6.2%
- Decline in investment and capacity utilization (excess capacity of Rs.1600 Crores).

all having an adverse impact on Indian economy. Adverse impact of BIMSTEC FTA is noticed for most of the varieties of cement. Hence put in negative list.

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Annexure-III

Regionwise/Statewise Cement Demand Estimates
High Growth Demand Scenario (11.5%)

(Mn.t.)

Region/State	2007-08	2008-09	2009-10	2010-11	2011-12
Northern Region					
Uttranchal	2.27	2.52	2.81	3.12	3.47
Haryana	6.14	6.82	7.58	8.42	9.36
Punjab	7.04	7.82	8.69	9.66	10.75
Rajasthan	10.30	11.44	12.72	14.14	15.72
Himachal Pradesh	1.98	2.20	2.45	2.72	3.03
Chandigarh	0.33	0.37	0.41	0.45	0.50
Delhi	4.36	4.85	5.39	5.99	6.66
Jammu & Kashmir	1.26	1.40	1.56	1.73	1.93
Total	**33.69**	**37.43**	**41.59**	**46.24**	**51.42**
Eastern Region					
Assam	1.35	1.50	1.67	1.86	2.06
Bihar	5.43	6.03	6.70	7.45	8.29
Jharkhand	3.28	3.64	4.04	4.50	5.00
Orissa	5.16	5.73	6.37	7.08	7.88
West Bengal	8.20	9.11	10.13	11.26	12.52
Chhattisgarh	3.84	4.26	4.74	5.27	5.85
Other N.E.States	0.96	1.06	1.18	1.31	1.46
Total	**28.22**	**31.34**	**34.83**	**38.72**	**43.06**
Southern Region					
Andhra Pradesh	14.27	15.86	17.62	19.59	21.79
Tamil Nadu	13.86	15.39	17.11	19.02	21.15
Karnataka	11.68	12.98	14.42	16.03	17.83
Kerala	8.09	8.99	9.99	11.11	12.35
Pondicherry	0.41	0.46	0.51	0.56	0.63
Andaman & Nicobar	0.10	0.11	0.12	0.13	0.15
Goa,Daman,Diu etc.	0.61	0.67	0.75	0.83	0.93
Total	**49.02**	**54.45**	**60.51**	**67.27**	**74.81**
Western Region					
Gujarat	11.36	12.62	14.02	15.59	17.33
Maharashtra	20.90	23.22	25.80	28.68	31.89
Total	**32.26**	**35.83**	**39.82**	**44.27**	**49.23**
Central Region					
Uttar Pradesh	17.68	19.65	21.83	24.27	26.99
Madhya Pradesh	7.93	8.81	9.79	10.88	12.10
Total	**25.61**	**28.45**	**31.62**	**35.15**	**39.09**
Grand Total	**168.79**	**187.51**	**208.38**	**231.66**	**257.61**

Annexure –IV

A CASE FOR CONCRETE ROADS

1. Concrete Roads – a need

Roads are accelerators of economic growth and a world class road network can provide boost to our economy, industry and tourism.

India has around 33 lakh kms. of road network, less than half of which is paved. Out of this, about 68,000 kms. are designated as National Highways which, though just about 2 per cent of the total length, carry almost 40 per cent of the traffic. The National Highway system is in urgent need of attention, since about one-third need major repairs and another one-third have inadequate width. These deficiencies affect the speed and life of vehicles causing loss of thousands of crores of rupees to the economy every year.

The Prime Minister's 1999 policy statement on National Highway Development Project is the right answer to our National need. It envisaged expansion of 4 lane Golden Quadrilateral of 6000 km. and construction of 4-lane North-South & East-West corridor of 7000 km.

This policy statement contemplated extensive use of concrete in road construction because, concrete roads offer various fallout advantages:

- **Cheaper in the long run (lower life cycle cost)**
- **Environment friendly, as bitumen causes pollution**
- **It provides an annual savings in fuel, estimated at Rs.200 crores per 1000 km.**

There are many reasons for opting concrete roads for sustainable development as illustrated below:

Characteristics	**Concrete Road**	**Bitumen Road**
Initial Cost	More or less same	
	Some times 10% higher or lower	
Service Life	40 years	10-15 years
Annual Maintenance per km	5,000/- to 10,000/- per year	Very high –Rs. 1 lakh per year

Characteristics	Concrete Road	Bitumen Road
Vehicle Optg. Cost	LOWER due to long lasting smoothness	HIGHER since road needs frequent resurfacing
Life cycle cost	Lower	Higher
Raw Material	Local	Obtained from Imported crude
Requirement of Bitumen will skyrocket with rapid growth of road network. Scarcity of bitumen may increase in future		
Environmental Friendliness	High	Low
• Fossil fuel	Saved	
• GHG gas emissions	Reduced	No effect
• Fly Ash Disposal	Can be used	No
These aspects also dictate a careful combination of choices with preference for Concrete Road		

Major economic advantages of concrete road generally not factored lie in fuel saving. Study conducted by Portland Cement Association (PCA), USA and Central Road Research Institute (CRRI), India indicated that savings in fuel for 15 tonne trucks (India) will be around 14% (study by CRRI) whereas for 20 tonne trucks (USA), it is 19% (Federal Highway Administration).

For 10,000 km. of concrete roads (10,000 trucks per day), the annual savings in fuel will be about Rs. 2,000 crore. This will undoubtedly reduce fuel consumption and would thereby save precious Foreign Exchange outgo.

Concrete roads also ensure lower GHG emissions and are therefore more environmental friendly.

2. Relative Economics of Concrete Roads

Although generally initial capital cost is slightly higher for concrete roads than bitumen ones, following advantages offset the initial cost on life cycle basis.

- Savings in annual maintenance cost, which is almost nil in case of concrete roads
- Savings in periodic laying cost – not applicable for concrete roads.
- Saving in fuel consumption and vehicle operating costs including vehicle maintenance costs.
- Total cost of concrete roads cheaper by 10-20% on life cycle basis.

- Concrete roads conserve road construction materials in the sense that concrete pavements require less thickness than flexible pavements designs for the similar load and soil conditions.
- Under deteriorating soil conditions, the required thickness of the flexible pavement increases considerably. For a very poor soil, the thickness may even touch 1000 mm. The thickness of the concrete pavement, on the other hand, is only marginally affected by soil conditions.
- Marginal cost differences observed between concrete and bitumen pavements will become negligible if bitumen road requires soil stabilisation or polymer modified bitumen is required to be used or asphalt treated drainage layer is required.
- On the contrary, with advancement of technology and construction practices for concrete roads, the initial cost of concrete roads will keep coming down in future

The Projected Bitumen Demand Supply position in forthcoming years gives a grim picture as indicated in the table.

('000 tonnes)

Fiscal	Demand	Domestic Supply	Surplus/ (Deficit)
2001	2675	2773	98
2003	3005	2840	(165)
2005	3375	3109	(266)
2007	3795	3109	(686)
Source : J.S. Oberoi (Ex-Member of the OCC) Report of the Bitumen Supply & Demand Balance.			

Construction cost of bitumen roads is highly sensitive to Bitumen Price & Quality.

- Bitumen prices have risen 300% in the last decade whereas cement prices increased by 90% only
- A further increase in current bitumen price will make cost of concrete and bitumen roads nearly the same
- No commitment from refineries for quality of bitumen; no test certificates available; quality of bitumen alleged to be the cause of poor road sometimes

What we lose by continuing Bitumen roads can be summarized as:

For 13,000 km of Expressways

- Higher maintenance cost (Avg per year) — Rs. 6,500 per km.
- Fuel saving per year — Rs. 5,200 per km.
- Higher vehicle maintenance

Cost of Concrete Roads can be reduced substantially if fly ash is used

- Use of fly ash upto 30% can further reduce cost of concrete road by 4 - 6%
- Use of fly ash in concrete roads increases durability and performance and thereby decrease its life cycle cost.

3. Technological Advantages of concrete roads

Choice of Concrete Pavement for NHDP:

- Concrete pavement has been chosen for World Bank funded segments of Golden Quadrilateral on life cycle cost basis
- Present hesitation for our own funded segments due to higher initial cost - self defeating because in the long run, more length of concrete roads can be built with the same amount of money
- Roads are invariably not maintained properly due to paucity of funds
- Overloading of single-axle trucks and high ambient temperatures prevailing in most parts of the country make bitumen roads unsuitable.
- Project completion time can be significantly reduced by use of RMC leading to lower capital cost

Concrete Road : The only Choice for NHDP

Even on initial cost basis, concrete pavement should be the preferred choice for NHDP where:

- Sub-grade is poor
- Heavy rainfall is received
- Traffic density is high
- Cost of aggregates is very high
- Cement available in close proximity
- Easy availability of fly ash and slag

World Bank has chosen Concrete for NH-2; the details are as follows:

Total length involved	477.35 km
Concreting of new 2 lanes	398.60 km
White topping existing 2 lanes	100.85 km
Under consideration additional white-topping	145.00 km
Recent experience of NHAI indicates that through international competitive bidding, concrete pavements cost worked out comparable to bitumen roads	

USA's Experience in Concrete Roads

- First Federal - Aid Highway Act passed in 1916 directing the federal governments to cooperate 50:50 with the states in road building
- During 1920's and 1930's $ 2 billion for federal - aid road construction was authorised
- "Federal - Aid Highway Act of 1956" called for 41,000 miles of Interstate roadways at an estimated cost $ 41 billion
- When the 41,000 mile roadways system was complete about 60% of it was in concrete

To sum up, concrete roads will provide the following advantages:

- Long service life - maintenance-free
- Pollution-free construction - Eco-friendly
- Economical in the long run
- Superior performance - good riding quality
- Fuel Savings
- Easy to Maintain
- Ability to take heavy loads
- Water resistance
- Better reflectivity in night
- Resistant to effect of oil spillage
- No need to import bitumen
- Reduction in maintenance cost of commercial vehicles
- Reduction in vehicular maintenance combined with fuel saving has multiplier effect on economy as a whole.

The following conclusions emerge from the aforestated :

- Assessment of the viability of concrete roads vis-à-vis bituminous roads to be done on life cycle cost basis as is the practice abroad.
- Indian economy is now going through second-generation reforms wherein cost effectiveness is the key parameter. A beginning is therefore required to be made for laying concrete roads even for non-World Bank aided projects.
- Concrete roads to be encouraged for more than two lanes both at National and State Highway levels.
- The matter should be taken up with concerned departments to opt for concrete roads if found favourable on life cycle cost basis.
- Progress in building concrete pavements has slowed down due to higher initial costs. Concrete construction can get a boost if the excise duty burden on cement used in these roads is reduced.
- More funds to be allocated for concrete roads both at Centre and States.

4. Case Studies

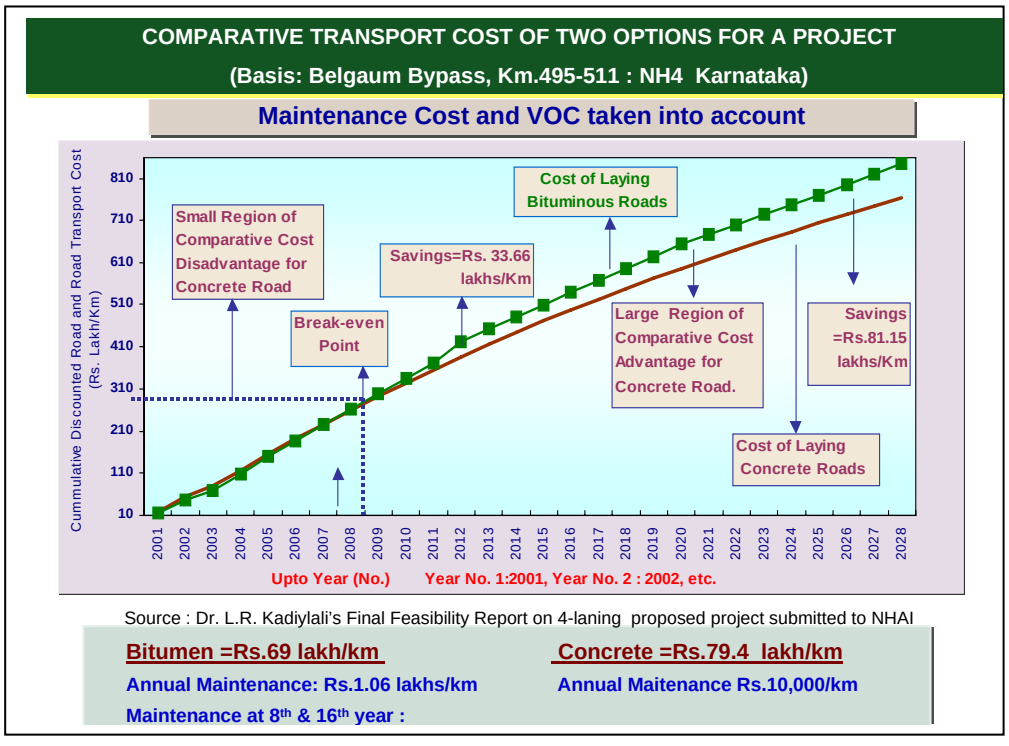
A few case studies of cost-benefit analysis between bitumen and concrete roads are given below :

4.1. Belgaum By-Pass case study

Characteristics	Concrete Roads	Bitumen Road
Initial Cost@	Rs. 79.4 lakh/km Higher by 15%	Rs. 69 lakh/km
Service Life	40 years	10 – 15 years
Annual Maintenance*	Low – Rs. 10,000/year	Very High Rs. 1 lakh/year #
Vehicle Optg. Cost	LOWER due to Long Lasting smoothness	HIGHER since road needs frequent resurfacing
Life cycle cost**	Lower – by 14 %	Higher

@ Source : Belgaum by-pass report submitted to NHAI
* Figures for 2-lane National Highway pavement **Discount rate 12%
# Including routine repairs and resurfacing which needs to be done once in 6 to 8 years

i)



ii) Inferences on Economics Of Concrete Pavement For Belgaum By-Pass

- Higher initial capital cost of concrete pavement is offset by saving in maintenance and Vehicle Operating Cost (VOC)
- With both – Break Even in 7 years
- With maintenance saving only – Break Even 11 years

4.2 Golden Quadrilateral – relative economics

Concrete Pavement				
	Length (Km.)	**Value (Rs. Cr.)**	**Value/Km. (Rs. Cr.)**	**Difference in average cost of concrete segments over bitumen segments 10.6%**
Contracts awarded	710.01	2848.97	4.01	
Contracts to be awarded	535.33	2089.20	3.90	
Total	**1245.34**	**4938.17**	**3.97**	
			Bitumen Pavement	
	Length (Km.)	Value (Rs. Cr.)	Value/Km. (Rs. Cr.)	
Contracts awarded	2161.83	7289.68	3.37	
Contracts to be awarded	819.84	3419.50	4.17	
Total	**2981.67**	**10709.18**	**3.59**	

4.3 NH2: Delhi-Kolkata - relative economics

Concrete Pavement				
	Length (Km.)	**Value (Rs. Cr.)**	**Value/Km. (Rs. Cr.)**	**No Difference in cost of concrete and bitumen pavement**
Contracts awarded	417.75	1816.30	4.35	
Contracts to be awarded	131.33	498.20	3.79	
Total	**549.08**	**2314.51**	**4.21**	
			Bitumen Pavement	
	Length (Km.)	Value (Rs. Cr.)	Value/Km. (Rs. Cr.)	
Contracts awarded	74.00	315.98	4.27	
Contracts to be awarded	350.74	1518.00	4.33	
Total	**424.74**	**1833.98**	**4.32**	

Relative Economics show :

- Marginal cost differences observed between concrete and bitumen pavement will become negligible if bitumen road requires soil stabilization or polymer modified bitumen is required to be used or asphalt treated drainage layer is required.

5. Construction of Concrete Roads in Rural Area

The maintenance of bituminous roads in the rural area will be difficult because of non-availability of adequate funds from the State Govt. budgets and low priority for maintenance of rural roads as compared to State Highways by the State Govts. Moreover the steep rise in the price of crude oil in the international market and non-availability of bitumen as per demand for construction and maintenance of all road infrastructure will make it almost impossible to maintain these rural roads in proper condition. In view of above, the best alternative will be to construct cement concrete roads in the rural areas to avoid the maintenance problem and being much more economical on life cycle cost basis.

In view of above, MORD & MOC&I, Government of India decided to implement a pilot project for concrete roads under PMGSY in 12 States. DPR's were got prepared through reputed consultants and cost estimates were prepared in 2003-04 and got approved from Empowered Committee of MORD in April 2004. The average cost difference for all the States was found 25% between concrete and bituminous pavement roads.

The initial cost and life cycle cost comparison for both type of roads has been made as given below, which was submitted to MORD by CMA in 2005 after updating the cost estimates for year 2005. Based upon this analysis, MORD had decided to implement a Technology Demonstration Project in all the States on 10% balance roads to be constructed.

LIFE CYCLE COST ANALYSIS
(PROPOSAL FOR CONSTRUCTION OF CONCRETEROADS IN RURAL AREAS UNDER PMGSY)

DATA ASSUMPTION

(Ref. CMA's Letter No. 405(R)/630/2005 dated 13th July 2005.)

- Analysis Period = 20 Years
- Discount Rate = 10%
- Inflation Rate = 5% Per Year

Cost (Rs. Lakh) Per Km.

	Flexible (BT)	**Rigid (Concrete)**
• Construction Cost	27.86	32.76
• Routine Maintenance/Year	00.14 (average)	00.10 (average)
• Renewal (5 Years)	3.50	
• Strengthening (10 Years)	6.50	-

(Rs. Lakh per km)

S. No.	**Item**	**Initial Cost**	**Maintenance Cost 20 Years**	**Total LCC**
1.	Cement Concrete Road with 30% roads using fly ash Mixed concrete	2.76	1.28	34.04
2.	Bitumen Road	27.86	12.62	40.48

A case study for construction of concrete road under PMGSY in Uttar Pradesh:

Following cost comparison was prepared based upon the design as per IRC Codes and cost Estimates analysis for UP – Lucknow area:

LIFE CYCLE COST ANALYSIS FOR PMGSY ROAD IN UP FOR 3.75 m WIDE ROAD

(Rs. Lakh per km)

S. No.	Item	Initial Cost	Maintenance Cost 20 years	Total LCC
1.	Cement Concrete Road with 50% roads using	4.88	3.00	47.88
2.	Bitumen Road	35.24	22.10	57.34

Note : CC road is cheaper by Rs. 9.55 lakh/km on LCC basis compared to BT roads

From both the above case studies, it is clear that concrete roads are economical on life cycle cost basis as compared to bitumen roads. Maintenance of bitumen roads will be expansive and on account of budget constraints with State Governments and administrative problems, it will be difficult to maintain these bitumen roads and therefore concrete roads should be constructed to make national assets.

6. Use of Blended Cement

In 1970, due to strict price and distribution controls, cement production became uneconomic and output stagnated. As a result there was a grave shortage of cement. To satisfy the demand, several producers started manufacturing PPC, blending in different pozzolanas, some suitable and some not so suitable.

As a result several cases of unsatisfactory performance by PPC were reported. Consequently, the CPWD imposed a ban on use of blended cement for bridges that continues to be in force even today. Therefore, all the Government tenders specify use of only OPC. This obliges the cement industry in India to produce OPC, which increases green house emissions and reduces the potential available to the cement industry to utilize available fly ash and slag.

There are several developments over the past few years in development and manufactured of blended cements in the country. Now a days, blended cements are manufactured under strict quality control and meet international standards and the same compare favourably with OPC and in most cases offer far superior properties in different applications. As a result of this, BIS has approved blended cements and have incorporated them in the standards and they are widely used in all types of construction activities in the country by several construction industries.

By using blended cements, cement industry supports the cause of Sustainable Development by way of reducing the green house gases into the atmosphere and also reduces the menace of the huge quantity of fly ash and slag generated by other industries.

Therefore it is desirable that Government takes a concerted view and lifts and the ban on the use of PPC and other blended cements in the public tenders and incorporates necessary amendments in the cement specification provided in the tenders.

Annexure-V

District- Wise Inventory of Cement Grade Limestone Deposits

Sl. No	District	Reserves in mn.t			Total	Proved Equivalent
		Proved	Probable	Possible		
Andhra Pradesh						
1	Adilabad	81.18	0.00	4100.90	4182.08	2131.63
2	Anantpur	0.00	27.00	4.40	31.40	21.10
3	Cuddapah	376.00	99.00	4574.93	5049.93	2732.77
4	Guntur	122.21	758.80	5329.02	6210.03	3317.88
5	Karimnagar	31.00	0.00	206.50	237.50	134.25
6	Krishna	70.56	180.74	721.64	972.94	557.90
7	Kurnool	39.00	94.74	9189.55	9323.29	4700.09
8	Mahaboobnagar	46.00	0.00	24.77	70.77	58.39
9	Nalgonda	25.00	282.10	3843.02	4150.12	2143.98
10	Rangareddy	168.46	0.00	0.00	168.46	168.46
11	East Godavari	0.00	0.00	0.76	0.76	0.38
12	Khammam	0.00	0.00	0.56	0.56	0.28
13	Nellore	0.00	0.00	24.85	24.85	12.425
14	Visakhapatnam	0.00	0.00	10.00	10.00	5.00
15	Weast Godavari	0.00	0.00	1.70	1.70	0.85
Total		**959.41**	**1442.38**	**28032.60**	**30434.96**	**15985.385**
Assam						
1	N. Cachar Hills	286.80	244.00	855.30	1386.10	885.25
2	Karbi Anglong	52.03	0.00	50.90	102.93	77.48
Total		**338.83**	**244.00**	**906.20**	**1489.03**	**962.73**
Arunachal Pradesh						
1	Lohit	0.00	91.00	49.00	140.00	88.20
2	Siang	0.00	0.00	226.50	226.50	113.25
3	Dibang Valley	0.00	13.50	0.00	13.50	9.45
4	Upper Subansiri	0.00	3.50	0.00	3.50	2.15
Total		**0.00**	**108.00**	**275.50**	**383.50**	**213.35**
Jharkhand						
1	Hazaribagh	3.41	14.13	50.86	68.40	38.73
2	Ranchi	5.06	0.00	38.68	43.74	24.40
3	Singhbhum	46.11	41.52	24.62	112.25	87.48
Total		**54.58**	**55.65**	**114.16**	**224.39**	**150.61**
Bihar						
1	Palamau	50.25	25.00	118.81	194.06	127.16
2	Rohtas	69.97	42.14	539.93	652.04	369.43
Total		**120.22**	**67.14**	**658.74**	**846.10**	**496.59**

Sl. No	District	Reserves in mn.t			Total	Proved Equivalent
		Proved	Probable	Possible		
Diu						
1	Diu	48.84	0.00	0.00	48.84	48.84
Total		**48.84**	**0.00**	**0.00**	**48.84**	**48.84**
Gujarat						
1	Amreli	233.31	0.00	0.00	233.31	233.31
2	Banaskantha	270.96	4.50	0.00	275.46	274.11
3	Bhavnagar	540.85	0.00	0.00	540.85	540.85
4	Junagarh	1553.98	0.00	0.00	1553.98	1553.98
5	Kutchch	1061.68	6703.49	0.00	7765.17	5754.12
6	Sabarkantha	32.60	0.00	0.00	32.60	32.60
7	Surendra Nagar	8.70	0.00	0.00	8.70	8.70
8	Rajakot	7.88	0.00	0.00	7.88	7.88
Total		**3709.96**	**6707.99**	**0.00**	**10417.95**	**8405.55**
Haryana						
1	Ambala	13.91	1.93	2.42	18.26	16.47
2	Mahendragarh	17.31	0.00	0.00	17.31	17.31
Total		**31.22**	**1.93**	**2.42**	**35.57**	**33.78**
Himachal Pradesh						
1	Bilaspur	370.00	0.00	500.00	870.00	620.00
2	Chamba	400.00	0.00	0.00	400.00	400.00
3	Kullu	0.00	0.00	19.70	19.70	9.85
4	Mandi	500.00	0.00	550.00	1050.00	775.00
5	Sirmur	50.00	0.00	0.00	50.00	50.00
6	Shimla	0.00	0.00	2000.00	2000.00	1000.00
7	Solan	480.00	0.00	1200.00	1680.00	1080.00
8	Kangra	9.60	0.00	0.00	9.60	9.60
Total		**1809.60**	**0.00**	**4269.70**	**6079.30**	**3944.45**
Jammu & Kashmir						
1	Anantnag	109.88	497.46	4843.00	5450.34	2879.60
2	Baramulla	0.00	1.20	23.40	24.60	12.54
3	Kathua	0.00	0.00	45.45	45.45	22.72
4	Rajauri	0.00	18.21	4.00	22.21	14.75
5	Srinagar	13.34	7.50	75.30	96.14	56.24
6	Ladakah	0.00	0.00	0.52	0.52	0.26
7	Poonch	0.00	0.00	11.80	11.80	5.90
8	Udhampur	0.00	0.00	6.06	6.06	3.03
Total		**123.22**	**524.37**	**5009.53**	**5657.12**	**2995.04**

Sl. No	District	Reserves in mn.t			Total	Proved Equivalent
		Proved	Probable	Possible		
Karnataka						
1	Belgaum	169.00	80.00	65.22	314.22	257.61
2	Bagalkot – Bijapur	427.14	340.63	325.45	1093.22	828.31
3	Chitradurga	26.24	77.05	276.12	379.41	218.235
4	Gulbarga	7095.89	1687.55	2086.93	10870.37	9320.64
5	North Kanara	0.10	68.80	37.00	105.90	66.76
6	Tumkur	0.00	16.50	29.40	45.90	26.25
Total		**7718.37**	**2270.53**	**2820.12**	**12809.02**	**10717.80**
Madhya Pradesh						
1	Bhind	0.00	24.00	0.00	24.00	16.80
2	Damoh	259.90	0.00	280.21	540.11	400.01
3	Dhar	9.84	17.02	0.00	26.86	21.75
4	Hoshangabad	0.00	0.00	39.45	39.45	19.73
5	Jabalpur	141.80	6.78	112.85	261.43	202.97
6	Mandsaur	461.23	0.00	7.12	468.35	464.79
7	Morena	8.82	17.01	221.51	247.34	131.48
8	Panna	30.27	3.15	1.88	35.30	33.41
9	Rewa	197.21	118.58	0.00	315.79	280.22
10	Satna	334.42	65.14	73.56	473.12	416.80
11	Sidhi	149.00	0.00	0.22	149.22	149.11
Total		**1592.49**	**251.68**	**736.80**	**2580.97**	**2137.07**
Chhattisgarh						
1	Bastar	142.85	408.68	209.35	760.88	533.60
2	Balaghat	11.80	2.02	3.40	17.22	14.91
3	Bilaspur	530.36	26.50	382.08	938.94	739.95
4	Durg	254.42	60.25	0.00	314.67	296.60
5	Raigarh	67.93	48.06	6.03	122.02	104.59
6	Raipur	1511.13	246.46	577.00	2334.59	1972.15
7	Rajnandgaon	22.00	5.75	0.00	27.75	26.03
Total		**2540.49**	**797.72**	**1177.86**	**4516.07**	**3687.83**
Maharashtra						
1	Chandrapur	636.93	33.96	754.82	1425.71	1038.11
2	Yeotmal	171.85	77.06	26.51	275.42	239.05
3	Gadchiroli	82.00	0.00	0.00	82.00	82.00
4	Nagpur	0.00	0.00	31.00	31.00	15.50
Total		**890.78**	**111.02**	**812.33**	**1814.13**	**1374.66**
Manipur						
1	Ukhrul	11.02	2.68	7.86	21.56	16.83
Total		**11.02**	**2.68**	**7.86**	**21.56**	**16.83**

Sl. No	District	Reserves in mn.t			Total	Proved Equivalent
		Proved	Probable	Possible		
Meghalaya						
1	West Garo Hills	29.77	281.95	0.00	311.72	227.14
2	West Khasi Hills	0.00	37.00	0.00	37.00	25.90
3	East Khasi Hills	433.65	374.25	3779.85	4587.75	2585.55
4	Jaintia Hills	84.00	287.21	1000.05	1371.26	785.07
Total		**547.42**	**980.41**	**4779.90**	**6307.73**	**3623.66**
Nagaland						
1	Tuensang	0.00	111.07	2.50	113.57	79.00
2	Phek	10.48	2.50	894.13	907.11	459.30
Total		**10.48**	**113.57**	**896.63**	**1020.68**	**538.30**
Orissa						
1	Koraput	23.48	78.50	231.80	333.78	194.33
2	Sambalpur	1.57	7.15	153.84	162.56	83.50
3	Sudargarh	62.31	10.18	24.91	97.40	81.89
Total		**87.36**	**95.83**	**410.55**	**593.74**	**359.72**
Rajasthan						
1	Ajmer	0.00	99.14	268.87	368.01	203.83
2	Alwar	0.00	0.00	27.00	27.00	13.50
3	Banswara	0.00	395.00	125.00	520.00	339.00
4	Bhilwara	30.78	22.00	78.00	130.78	85.18
5	Bundi	92.40	116.83	1200.86	1410.09	774.61
6	Chittorgarh	249.52	583.87	645.35	1478.74	980.90
7	Jaipur	26.54	390.00	0.00	416.54	299.54
8	Jhunjhunu	0.00	122.79	125.52	248.31	148.71
9	Jhalawar	0.00	0.00	32.50	32.50	16.25
10	Jodhpur	0.00	8.23	51.78	60.01	31.65
11	Jaisalmer	0.00	1120.00	50.00	1170.00	809.00
12	Kota	75.00	114.70	29.00	218.70	169.79
13	Nagaur	10.27	0.00	124.26	134.53	72.40
14	Pali	0.00	47.37	296.70	344.07	181.51
15	Sirohi	60.00	0.00	427.80	487.80	273.90
16	Sawai Madhopur	9.00	63.94	0.00	72.94	53.76
17	Sikar	0.00	29.98	0.00	29.98	20.99
18	Udaipur	10.29	207.44	266.33	484.06	288.66
Total		**563.80**	**3321.29**	**3748.97**	**7634.06**	**4763.19**
Tamil Nadu						
1	Anna	63.32	24.23	144.27	231.82	152.42
2	Coimbatore	36.58	29.11	29.92	95.61	71.92
3	Kamarajar	83.42	5.33	17.89	106.64	96.10
4	Madurai	3.15	2.24	11.54	16.93	10.48

Sl. No	District	Reserves in mn.t			Total	Proved Equivalent
		Proved	Probable	Possible		
5	Ramanathapuram	0.00	41.10	0.00	41.10	28.77
6	Salem	62.72	43.10	25.24	131.06	105.51
7	South Arcot & Pondicherry	0.00	6.04	13.59	19.63	11.02
8	Tirunelveli	32.55	52.97	85.49	171.01	112.37
9	Tiruchirapalli	468.72	78.63	126.33	673.68	586.93
Total		**750.46**	**282.75**	**454.27**	**1487.48**	**1175.52**
Uttaranchal						
1	Almora	9.00	34.77	0.00	43.77	33.34
2	Dehradun	76.60	546.42	360.43	983.45	639.31
3	Tehri-Garhwal	79.6	573.00	0.00	652.60	480.70
4	Pithoragarh	23.00	73.00	93.00	189.00	120.60
Total		**188.20**	**1227.19**	**453.43**	**1868.92**	**1273.95**
Uttar Pradesh						
1	Sonbhadra	327.90	412.02	225.13	965.05	728.88
	Total	**327.90**	**412.02**	**225.13**	**965.05**	**728.88**
	Grand Total	**22475.63**	**19031.02**	**55923.70**	**97430.35**	**63759.94**

Grand Total of Gross Reserves (in Mn.t) = 97430

Gross of Proved Equivalent (in Mn.t) = 63760

SUB GROUP-II

PRODUCTIVITY, TECHNOLOGY AND ENVIRONMENTAL ISSUES IN CEMENT INDUSTRY

1.0 Introduction

1.1 The Indian cement industry is the second largest producer in the world comprising of 130 large cement plants and 206 operating mini cement plants consisting 13 rotary kiln plants and 193 VSK plants. The installed capacity and production during the year 2006-07 are expected to be 180 mn.t and 162 mn.t respectively. 76 large cement plants have ISO-9000 (Quality Management System) certification, 38 plants ISO-14000 (Environmental Management System) certification and 15 plants OHSAS-18000 (Occupational Health and Safety Management System) certification. Large number of cement plants are taking action for getting these certifications.

1.2 Modernization and technology up-gradation is a continuous process for any growing industry and is equally true for the cement industry. The Indian cement industry today is by and large comparable to the best in the world in respect of quality standards, fuel & power consumption, environmental norms, use of latest technology and capacity. The productivity parameters are now nearing the theoretical bests and alternate means, like alternate fuels and raw materials have to be found to ensure further improvement in productivity and reduction in production costs.

1.3 Cement industry being energy intensive, the energy conservation and alternate cheaper, renewable and environmentally friendly sources of energy have assumed greater importance for improving productivity. The major challenges confronting the industry today are raging insecurity in indigenous fuel availability, perennial constraints like higher ash content, erratic variations in quality of indigenous coal and inconsistent power supply with unpredicted power cuts. Keeping these challenges in view, the efforts by the industry towards energy conservation and finding alternate cheaper, renewable and environmentally friendly sources of energy must continue.

1.4 The role of R&D in the growth of cement industry cannot be overlooked. However, data reveal that the expenditure on R&D activities related to cement in India is much below compared to some of the developed countries and is

progressively dwindling. One major paradox in the contemporary R&D canvas for the Indian cement industry is virtual absence of any R&D infrastructure for plant and machinery design. This deficiency is galling, considering that India is the second largest cement producer in the world, next to China. China has three flourishing Research and Design Institutes for cement plant and machinery catering, besides China, to a host of developing countries in meeting their needs of lower-cost cement capacity enhancement. This wide gap needs to be bridged by strengthening R&D base particularly on identifying and dovetailing the alternate cheaper, renewable and environmentally friendly sources of energy and design of state-of-art energy efficient and environment friendly process upgradation & plant machinery and equipment.

1.5 Human resources base and skill development of employees to cope up with the quantitative and qualitative demands of a fast expanding industry and changing technologies need continuous upgradation at all levels. The projected fast-track cement capacity growth to reach 298 mn.t by 2011-12 faces a threat of acute shortage of skilled and technical manpower, if one goes by the present disposition of their availability and slow incremental growth in India. To fulfill this objective, organizations like NCB at national level and RTCs at regional levels have to augment and diversify their HRD capability manifold through investments in infrastructure, HRD development packages and services. With the influx of new technologies and initiatives to provide alternate sources of energy and raw materials, the rules of the game shall be dynamic, and both management and engineering skills shall need up-gradation at the engineering and management levels.

2.0 Review of Technological Status

2.1 Process Profile

2.1.1 The Cement Industry today comprises mostly of Dry Suspension Preheater and Dry-Precalciner plants and a few old wet process and semi-dry process plants. Till late 70’s the Cement Industry had a major share of production through the inefficient wet process technology. The scenario changed to more efficient large size dry process technology since early eighties. In the year 1950, there were, only 33 kilns out of which 32 were based on wet process and only one based on semi-dry process. Today, there are 162 kilns in operation out of which 128 are based on dry process, 26 on wet process and 8 on semi-dry process.

Changing Process Profile of Indian Cement Industry

Item	1950	1960	1970	1983	1995	2001	2006
Wet Process							
Number of Kilns	32	70	93	95	61	32	26
Capacity (TPD)	9151	25011	38441	39641	25746	13910	11420
% of Total	97.3	94.4	69.5	41.1	12	5	3
Dry Process							
Number of Kilns		1	18	50	97	117	128
Capacity (TPD)		300	11865	51265	188435	282486	375968
% of Total		1.1	21.5	53.2	86	93	96
Semi-Dry Process							
Number of Kilns	1	3	8	9	8	8	8
Capacity (TPD)	250	1200	5000	5500	5244	5260	4195
% of Total	2.7	4.5	9	5.7	2	2	1
Total Kilns	**33**	**74**	**119**	**154**	**166**	**157**	**162**
Capacity (TPD)	**9401**	**26511**	**55306**	**96406**	**219425**	**310706**	**391583**
Average Kiln Capacity (TPD)	285	358	465	626	1322	1921	2417

2.2 Kiln Capacity and Size

2.2.1 The economic unit capacity for cement plants in India till early sixties was about 300 TPD. In mid sixties this was standardized at around 600 TPD for both wet and dry process plants. About a decade later, i.e. from mid seventies, the new plants installed were of 1200 TPD capacity. The advent of precalciner technology in mid eighties provided an opportunity to the industry to modernize and increase the capacity of existing dry process plants, to convert plants from wet to dry process as well as to set up large capacity plants incorporating the latest technological advancements. This led to installation of single line kilns of 3000 TPD (1 MTPA) capacity and more. The present trend indicates the preference of still larger kilns of about 6000 TPD capacity and above. Already there are nine kilns of 8000 tpd capacity in operation and three kilns of capacity 10000 – 12000 TPD are under installation. The liberalization of imports and lowering of customs tariffs in recent years have opened up further avenues of inducting state-of-the-art-technology and equipment in cement plants. The green-field plants being installed now are based on most advanced and the best available technology.

2.2.2 Plants with a total capacity of two million tonne and above at a single location, numbering 25, are having a total capacity of 65.6 MTPA accounting for 41% of installed capacity of large plants, whereas plants with a capacity between 1 to 2 million tonnes, numbering 48 are having a total capacity of 68.4 MTPA, accounting for 43% of installed capacity. Balance 57 plants are of capacity less

than 1 MTPA, having a total capacity of 25.8 MTPA, accounting for 16% of total installed capacity of large cement plants.

2.2.3 Average annual installed capacity per plant in India is about 1.2 MTPA as against more than 2.1 MTPA in Japan. This is due to blend of small and large plants coming up at various stages and still operating in India as against smaller plants having been decommissioned in Japan.

3.0 Present Status of Technology

A comparison of the status of the modernization in equipment and also the technologies absorbed or implemented by the Indian cement industry alongwith status of Global Technology is as under :

Present Status of Technology

	Low Technology Plants	**Modern Plants**	**Global Technology**
Mining & Material Handling	Conventional	Computer aided	Computer aided
Crushing	Two stage	Single stage	In-pit crushing & conveying
Conveying of Limestone	Dumpers/Ropeway/ Tippers	Belt conveyors	Pipe conveyors, Belt conveyors
Grinding	Ball Mills with / without conventional classifier	VRM's Roll Presses with dynamic classifier	VRM's, Roll Presses, Horo Mills with dynamic classifier
Pyro Processing	Wet Semi Dry Dry - 4 stage preheater - Conventional cooler - Single channel burner	Dry - 5/6 stage preheater - Hig Efficiency Cooler - Multi Channel Burner	Dry - 6 stage preheater - High Efficiency Cooler - Multi Channel Burner - Co-processing of WDF - Co-generation of power - Low NO_x/SO_2 emission technologies
Blending & Storage	Batch-Blending Silos	Continuous Blending silos	- Continuous Blending - Multi-Chamber Silos - Dome silos
Packing & Despatch	Bag	- Bag - Bulk	- Bulk - Palletizing & Shrink Wrapping
Process Control	Relay Logic / Hard Wired / PLC	- DDC - Fuzzy Logic expert system	- DDC - Neurofuzzy expert system
Plant Size, TPD	300-1800	3000-6000	6000-12000

The directions in which the modernization activities are proceeding are as illustrated below :

3.1 Mining

3.1.1 For rational exploitation of the raw material source, a systematic mine plan is developed by cement plants. Computer-aided techniques for raw material deposit assessment to arrive at proper extraction sequence of mining blocks, keeping in view the blending operational requirements, are envisaged and put to use in number of units.

3.2 Crushing

3.2.1 Mobile crushers have come in use in some of the newer plants, keeping in view the split location of limestone deposits and long conveying distances. The mobile crushing plant is stationed at the mine itself and raw material is crushed at the recovery site.

3.3 Grinding

3.3.1 Vertical Roller Mills (VRM) have given the real breakthrough in the area of grinding. The VRM draws 20-30 % less electrical energy as compared to the corresponding ball mill system, apart from its ability to give much higher drying capacity. These mills can accept larger feed size and hence mostly be used with single stage crushing. VRMs are now being used in clinker and slag grinding and also as pre-grinder to existing grinding installations.

3.3.2 Another breakthrough that has come with the application of high pressure grinding rolls (HPGR) has been widely adopted in Indian cement industry. The HPGR is being used as pre-grinder for upgrading the existing ball mill systems. Different modes of operating HPGR in open circuit, pretreatment with circulation, pretreatment with de-agglomeration and recirculation and closed circuit are in operation. Such installations could achieve an increase in capacity upto 200% and savings in power consumption to the extent of 30 to 40% as compared to ball mills.

3.3.3 High efficiency separators are now widely used for better classification of product and help in increasing the mill capacity besides reducing the specific power consumption. The new classifier designs include two-stage separation integrating primary and secondary separation. High efficiency separators are also used now with VRM’s for further improvement in their performance.

3.3.4 A new mill system called Horizontal roller mill has been developed which is capable of producing uniform raw meal and have advantages in processing raw materials containing higher percentage of quartz.

3.4 Pyro-processing

3.4.1 The introduction of precalciner technology has increased the production from the kiln by 2.0 to 2.5 times and enabled utilization of high ash coals with lower calorific value, as well as various agricultural and industrial combustible wastes. Systems have been developed to use fuels like lignite and petcoke and various alternate fuels.

3.4.2 The advantages of economy of scale are fully exploited by the cement industry through the precalciner technology. Many single kilns capable of producing more than 6000 tpd capacity have already been installed and are operating with state-of-the-art technology and kiln capacities in the range of 10000-12000 tpd are under installation.

3.4.3 Many cement plants have some excess capacity at both upstream and downstream, which could be utilized economically if the kiln output can be increased at modest costs. Traditionally, the kilns have been designed with specific volumetric loading of 1.5 to 2.2 tpd/m^3 for SP kilns and 3.0 to 4.0 tpd/m^3 for precalciner kilns. The corresponding thermal loads in burning zone for such kilns have remained between 3.5 to 4.5 x 10^6 Kcal/m^2/hr. Many cement plants have gradually increased the specific volumetric loading upto 7-7.5 tpd/m^3, ensuring much higher than originally designed output.

3.4.4 The introduction of high efficiency and low pressure-drop-cyclones have led to conversion of conventional 4-stage cyclone preheaters to 5-stage and even 6-stage cyclone preheaters with improved thermal efficiency.

3.4.5 The latest development like controlled flow grate clinker cooler system and cross bar cooler ensure better clinker distribution, increase in cooler heat recuperation efficiency, decrease in clinker exit temperature and reduced maintenance costs.

3.4.6 The limitations of the conventional straight pipe burner have been overcome by use of highly flexible multi-channel burner. The multi-channel burner enables easy and sensitive flame shape adjustment as well as gives rise to better entrainment of secondary air.

3.4.7 High Alumina refractory bricks which were mostly used in pre-heating / pre-calcining zone in the past, are now replaced by light weight high strength insulating bricks. The Aluminum-Zirconium-Silicate bricks with coating repellent properties are also in use now in transition zones. With the new improved refractory bricks it is possible to increase the refractory lining life and reduce the radiation losses in the kiln. Greater use of monolithic refractories in pre-heater, pre-calcinator, cooler, kiln outlet zone etc. is in practice now.

3.4.8 Conventional analog instrumentation is gradually being replaced with digital instrumentation. The large mimic diagrams used of late are being replaced by cathode ray tube (CRT) display. Motor controls by relay sequence are being changed to programmable logic controllers. Analog PID controllers are being replaced with multi-loop digital controllers. Due to the advent of microprocessors, a variety of advanced control concepts like adaptive control, self-tuning control, feed forward control, etc. have been introduced in the Indian cement industry.

3.4.9 As a corollary to automation, quality is also maintained by continuous monitoring of the raw mix composition with the help of X-ray analyzer and automatic proportioning of raw mix components. New type of on-line bulk material analyzers have also been developed based on Prompt-Gamma-ray Neutron Activation Analysis (PGNAA) for giving maximum control over raw mix. The analyzer quickly and reliably analyses the entire flow-on-line providing real time results. The latest trends in on-line quality control include computers and industrial robots for complete elemental analysis by X-ray fluorescence, on-line free lime detection and particle size analysis by latest instrumental methods and x-ray diffraction techniques respectively.

3.4.10 It is also important to phase out the manual sampling systems especially so when the super high capacity plants are being installed, and the stakes are high. Auto sampler technology should be dovetailed into the plants for ensuring disciplined sampling and control.

4.0 Upgradation of Technology of Low Technology Cement Plants

4.1 The technological spectrum in the industry is very wide. At one end of the spectrum are the old wet process plants, while at the other end, are the new state-of-the-art technology plants presently being built by the Industry. In between these two extremes, are the large number of dry process plants built during the period 1965-90. These plants could not fully modernise or upgrade side by side with advent of newer technologies and had thus remained at intermediate technology

level. Also, the level of technology is not same at all the plants built during the same period.

Majority of the cement plants in the country in the capacity range of 0.4 to 1.0 MTPA were set up more than 15-20 years ago i.e. before 1990's. They were based on state-of-art technology at that time. Since then, numerous developments have taken place in the cement manufacturing technology.

Though some of the old plants have been modernized to a limited extent by retrofitting the new technologies, substantial scope still exists for adopting the state-of-art technologies and bringing the old plants at par with world-class plants in terms of productivity, energy efficiency and environment friendliness, leading to cost competitiveness.

Moreover, the emission norms are likely to become more stringent in future and at the same time, the cement plants will be required to utilize waste derived raw materials and fuels to a large extent. The modifications of old plants to comply with these future requirements will also become inevitable. Therefore, there is a need to carry out a comprehensive assessment of all the earlier generation plants in the country to identify the extent of modernization required to improve their all round efficiency and enable them to meet the future criteria of viability, competitiveness and compliance with regard to energy consumption enabling them to comply with the provision of the Energy Conservation Act 2001.

4.2 Perceived Benefits of Technology Upgradation

It is envisaged that the technology upgradation measures for the Pre-1990 era cement plants would result in :

- Increase in capacity : 25-30 MTPA
- Reduction in thermal energy consumption : 15-20 kcal/kg clinker
- Reduction in electrical energy consumption : 5-10 units/t
- Reduction in cost of production of cement : 5-10% because of above initiatives
- Reduction in energy costs through co-processing : 10–15%
- Reduction in the CO_2 emissions (through blended cements & energy conservation) : 20%

5.0 Future Modernization Needs of the Indian Cement Industry

5.1 Although the industry has largely set up plants with energy efficient equipment, there are still some areas for further improvements like :

- Appropriate pre-blending facilities for raw materials
- Fully automatic process control and monitoring facilities including auto samplers and controls.
- Appropriate co-processing technologies for use of hazardous and non hazardous wastes
- Interactive standard software expert packages for process and operation control with technical consultancy back-up
- Energy efficient equipment for auxiliary/minor operations
- Mechanized cement loading operations, palletization/shrink wrapping
- Bulk loading and transportation, pneumatic cement transport
- Low NO_x/SO_2 combustion systems and precalciners
- Standards for making composite cement so that all the fly ash and other industrial wastes viz. slag are fully used.
- Co-generation of power through cost-effective waste heat recovery system (only one demonstration unit in operation)
- Horizontal roller mills (Horo Mills) for raw material and cement grinding
- Advanced computerized kiln control system based on artificial intelligence

5.2 To motivate the industry to adopt state-of-the-art equipment and technologies for further improving the environmental performance and energy efficiency, duty free import should be allowed.

6.0 Fuel Requirements and Alternate Sources of Energy

6.1 Fuel

Coal continues to be the main fuel for the Indian cement industry and will remain so in the near future as well. The industry is mainly using coal from

various coalfields in the country. It is also procuring coal through open market and direct imports. Lignite from deposits in Gujarat and Rajasthan is also being used by cement plants. Pet coke has also been successfully utilized by some cement plants, mainly in Gujarat, Rajasthan and MP, thereby substituting main fossil and conventional fuel coal upto 100% in some plants. In the recent past, waste derived fuels including hazardous combustible wastes have also been tried due to economic pressures in cement manufacturing process owing to tough competition in domestic and global markets as well as ecological reasons on account of waste disposal and co-processing in cement rotary kilns being most effective mode of waste treatment.

6.2 Alternate Sources of Energy

Cement manufacture is a highly energy intensive process. Thermal Energy itself account for 20-25% of the cost of cement production. The increasing costs of conventional fuels besides environmental considerations for conservation of non-renewable fossil fuels have drawn major attention of Indian manufacturers to substitute them with alternate/waste derived fuels (WDF) including hazardous combustible wastes (HCW) and cut down the energy costs. Further, for minimizing dependence on coal, it is necessary to use alternate fuels of sufficient combustible value to the extent possible. Use of alternate/high grade fuel depending upon their availability, costs, logistics etc., therefore becomes imperative.

While the use of alternate fuels/WDF by cement industry primarily began for economic reasons, it eventually proved to be more beneficial in relation to ecological objectives. The utilization of alternate fuels/WDF by the cement industry is expected to reduce green house emissions. The practice of using WDF/HCW has been evolving and growing over the past two decades in the cement industry in several countries abroad. 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) upto 30% 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.

Co-processing in cement kilns is considered as a technically feasible and economically viable option not only for treatment of wastes having combustible value, but also a better and a cost effective option for co-processing other hazardous wastes too, owing to the wide range of temperature levels from 800^0C to 1600-1700^0C with a wide spectrum of residence times upto 3 minutes, and the biggest advantage of the complete absorption of the ash in the cement complex compounds. With this wide range of temperature and residence times almost all types of hazardous, non hazardous, combustible and non combustible wastes can be co-processed in the cement kilns. Alkaline combustion environment and oxidizing atmosphere in the kiln help in complete destruction of toxic/hazardous organic components of HCW. Thus, co-processing of wastes in cement kilns is the most effective way for disposal of wastes compared to methods of their disposal through landfills or incineration in dedicated waste incinerators. In latter methods of treatment for wastes, energy is not recovered. The use of combustible wastes in cement kilns is regarded as "energy recovery" unlike "disposal" if land-filled or incinerated.

6.2.1 Advantages of Co-processing in Cement Rotary Kiln

The direct and indirect benefits accrued through co-processing of combustible wastes and secondary fuels in cement kilns are :

- Conservation of fossil (non-renewable) fuels.
- Reduction in energy costs
- Effective method of waste disposal resulting in elimination of incineration and land filled residues due to their absorption in clinker
- Prevention of environmental degradation
- Reduction in green house gas emissions and global warming alleviation
- Minimising environmental impact due to reduced load on coal mining

6.2.2 Experiences of Using WDF in Overseas Cement Plants

A host of hazardous combustible wastes derived from a variety of industries are regularly recycled by cement plants in EU Countries. The consumption of cut or shredded tyres alone is on the verge of reaching one million tonne. Over the past 20 years, the European Cement Industry has reduced its energy consumption by 30%, equivalent to saving of approximately 11 million tonnes of coal per year. In 2004-05 alone, EU countries substituted around 3.5 million tonnes of conventional fossil fuel. Cut tyres are already being burnt as a partial replacement of main fuel in four UK cement works. Once authorized for the trials, cement plants are subjected to a rigorous programme of monitoring of emission levels and testing of samples. One of the most comprehensive trials with tyres as secondary fuel at BCC's Westbury plant demonstrated a 27 percent reduction in the works overall impact on the local environment. Emission results showed an increase of sulphur dioxide (SO_2), whilst still remaining 30 per cent below permissible limits, 43 percent reduction in emissions of dioxins and furans without significant change in the emissions of heavy metals.

At Lafarge's Cauldon site, the stack emission results during the period of trials with tyres substituting 15% coal and coke, are summarized below :

Impact of Tyre Derived Fuel (TDF) on Stack Emissions

Pollutant	**Stack Emissions (mg/m^3)**		**Percentage Change**
	With Main Fuels (Coal & Coke)	**With Main Fuels Plus TDF (15% Substitution)**	
Particulates	60	60	No change
NO_x	1180	800	- 32
SO_2	500	500	No change
VOC's	129	68	- 47
Dioxins	0.12 ng/m^3	0.03 ng/m^3	- 75

Based on above results, the above plant has been granted permission by the Environmental agency to use tyres substituting conventional fuels upto 25%.

6.2.3 Emission Limits by European Commission

The emissions limits for cement kilns utilizing WDF prescribed by European Commission (Directive 2000/76/EC) are shown below :

Emission Limits for using WDF in Cement Kilns

Component	Limit value (mg/m^3)
Dust	30
NO_x	800 (existing plants); 500 (new plants)
SO_2	50
Total organic compounds	10
HCl	10
HF	1
Dioxins and furans	0.1
Cadmium + Thallium	0.05
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	0.5
Mercury	0.05

However, in India, there are emission limits only for particulate matter (dust).

6.2.4 Initiatives on Co-processing of WDF in India

Use of hazardous and refuse derived combustible and Municipal Solid Waste (MSW) as fuel is common in countries like Canada, EU, Japan and Korea. Encouraged by the successful implementation and benefits achieved from waste utilisation using best available techniques in other countries, a few cement plants in India have also attempted to co-process the WDF. CPCB is actively engaged in plant level trails in respect of wastes viz. used tyres, refinery sludge, paint sludge, effluent treatment plant (ETP) sludge and toluene Di-Isocyanite (TDI) tar waste from petroleum industries and in formulation of guidelines for use of these wastes as fuel by cement industry.

6.2.5 Potential Alternate Fuels in India

A few cement plants have already started using pet coke in substantial quantities, lignite and several combustible wastes like rice husk, bamboo dust etc. Presently a number of cement plants are utilizing pet coke to the extent of 60-80% and agricultural wastes such as rice husk and bamboo dust to the extent of 10-15%. Natural gas is considered as a promising fuel in the near future for cement industry particularly for those plants located in the vicinity of natural gas sources, or far off from the coal deposits or using low/marginal grade limestone, which otherwise can not be utilized rationally. However, availability of gas for cement industry is still a remote possibility because of its high costs, limited availability

due to large dependency on OPEC countries and high cost of laying pipelines for the transportation of gas.

The following fuels are considered to have good potential in the present context of Indian economics to either partially or fully substitute coal in cement manufacture in the coming years.

- Pet coke
- Lignite
- Natural gas
- Waste derived fuels (including used rubber tyres)
- Refuse derived fuels
- Bio-mass wastes including fruit of Jatropha Carcus, Pongamia & Algae.

Pet coke **:** A residual product from oil refinery with relatively low volatile matter, insignificant ash content and high calorific value, but often with high sulphur content as compared to Indian coal. Petcoke production in India is presently around 2 MTPA, out of which about 1.50 MTPA is used by major Indian cement plants. Petcoke has been successfully used in kiln firing upto 100%; however, a few cement plants are using petcoke also in the precalciner alongwith coal to a large extent.

Lignite **:** A natural fuel with low ash content and high calorific value compared to coal is considered a promising alternate source of fuel for cement plants particularly located in the vicinity of lignite deposits. The important known deposits of lignite in India are in Tamilnadu, Rajasthan, Gujarat, J&K and Kerala. The total geological reserves of lignite have been assessed at over 24000 million tonnes. About 90 % of these occur in Tamilnadu alone.

Natural Gas **:** An excellent fuel for effective utilization of marginal grade limestone and conserve higher grade limestone for future needs. Natural gas reserves in the country are estimated at 718 billion cubic meters (BCM). Out of these, 253 BCM are on the on-shore and remaining 465 BCM on the off-shore. Assam (on-shore) has the maximum reserves of 156 BCM followed by Gujarat (on-shore) with 93 BCM. The major gas fields in India are western (off-shore), Krishna-Godavari (off & on-shore), Cauvery (on-shore) Assam (on-shore) and Jaisalmer (on-shore).

***Wastes Derived Fuels* :** The use of industrial wastes can provide twin benefits - energy conservation and environmental protection. However, various factors such as availability, characteristics, economics and effects on kiln operation, refractory lining and product quality etc. need to be assessed, prior to its use in cement manufacture. From legislative point of view, while there are no restrictions on recycling biomass or agricultural wastes, use of combustible and hazardous wastes, including toxic wastes from chemical, pesticides, pharmaceutical, petroleum refining and other industries are awaiting clearance from the CPCB and State Central Pollution Control Boards.

Shredded Tyres typically have a sulphur content of 1-2 %. They contain chlorine, metals such as cadmium, chromium, zinc and benzene compounds. In modern kiln system with calciner and high precalcination rate the use of complete tyres through kiln inlet is restricted to a relatively small amount of 5 % of fuel requirement. To use higher proportion in calciner, size reduction to pieces of maximum 50x50 mm in size is necessary.

Share of Hazardous Combustible Waste utilization in EU countries

Country	Year	Percent	Year	Percent
Belgium	1999	30	2005	45
Denmark	1999	4	2005	30
Germany	2001	30	2005	45
Finland	2000	3	2005	30
France	1999	27	2005	40
Great Britain	1998	6	2005	25
Neither lands	1999	72	2005	75
Austria	1999	29	2005	40
Poland	1999	1	2005	15
Portugal	1999	1	2005	20
INDIA	1999	0	2005	0

Quantities of waste Fuels in Cement Industry of EU

Waste Type	Quantity in 1997 ($x10^3$ tonnes)	Estimated (2003) ($x10^3$ tonnes)
Waste Tyres/rubber	413	469
Household RDF	115	132
Sewage Sludge	81	99
Used Oil, Spent solvent and Hazardous waste	1038	1140
Plastics	71	85
Waste Paper	27	31
Waste Wood	9	12
Others	44	53
Total	**1800**	**2050**

***Refuse Derived Fuel (RDF) from Municipal Solid Wastes* :** The generation of municipal solid wastes (MSW) in the country is estimated around 45 MTPA during 2005-06, which is expected to go upto about 55 MTPA by 2010. Presently, more than 10 MTPA of MSW are generated per year in 23 large cities/metros. New Delhi and Mumbai generate about 4500 tpd (1.5 MTPA) and around 6000 tpd (2.0 MTPA) of MSW respectively. The safe disposal of municipal solid wastes has become an environmental problem and a health hazard because of pollution in the surrounding environment of the garbage dumping yards. These dumps constantly produce and release methane gas, which contributes to global warming. The new technologies developed elsewhere in the world can be adopted for converting MSW to RDF, which is a rational approach of solving the disposal of MSW.

***Bio-mass Wastes* :** The following Biomass is widely used in Indian cement plants depending upon the location and availability of the same.

- Ground nut shell
- Coconut shell
- Mustard stem
- Coir waste
- Wood waste
- Rice Husk
- Cashew Shell
- Bagasse
- Parthenium Grass
- Saw Dust

The availability of agricultural wastes is seasonal and, therefore, cement plants cannot be assured of continuous supply round the year.

Currently there is a National Drive towards generation of Bio-Diesel. It is widely discussed that Bio-Diesel can reduce India's dependence on fossil fuel for its energy needs and simultaneously it would reduce global warming & greenhouse gases. Bio-diesel is an eco-friendly, alternative diesel fuel prepared from domestic renewable resources i.e. vegetable oils. It is a mono-alkyl ester of long chain of fatty acids derived from vegetable oil and is produced by trans-esterification of vegetable oil with methanol or ethanol. Trans-esterification is a reaction of oil (Triglycerides) with alcohol to form ester and glycerol.

Another very important biomass plant which can be grown in the water bodies is Algae. Algae have calorific value as good as coal. The Algae (Genera Amphora, Cymbella, Nitzschia, etc.) and green Algae (Chlorophyceae & genera Chlorella in particular) have an oil density of about 50% by weight. It is recorded that Algae can under controlled conditions produce 15,000 gallons of oil per acre per annum. The Algae is harvested daily, and a combustible vegetable oil is squeezed out, which can be used as bio-diesel for automobiles. The dried green flakes that remain can be further reprocessed to create ethanol. The calorific value of Algae oil is 9572 kcal/kg approx. and that of the Algae bio mass (50% oil content) is 4786 kcal/kg approx.

Algae is a carbon dioxide gobbling plant, and thrives on it, in the presence of water and sunlight. Algae farms would be based on the use of open, shallow ponds in which some source of waste CO_2 could be efficiently bubbled into the ponds and captured by the Algae. It is understood that CO_2-gobbling Algae technology has been developed that uses a screen-like algal filter, capable of handling 140 cubic meters of flue gas per minute - equal to exhaust from 50 cars or a 3 MW power plant. The same technology can be used in the stacks of Power plant and cement kiln to reduce our CO_2 emission and produce bio mass for replacing coal. This would be a fine example of using the natural growing Algae, as a CO_2 recycling agent to produce coal equivalent fuel. Algae is like a breath mint for smokestacks and will reduce CO_2 emissions too.

7.0 Energy Management

7.1 Energy Performance Scenario

The industry's average consumption in 2005-06 was 725 kcal/kg clinker thermal energy and 82 kWh/t cement electrical energy. It is expected that the industry's average thermal energy consumption by the end of XI Plan (Year 2011-12) will come down to about 710 kcal/kg clinker and the average electrical energy consumption will come down to 78 kWh/t cement.

The best thermal and electrical energy consumption presently achieved in India is 667 kcal/kg clinker and 68 kWh/t cement which are comparable to the best figures of 650 kcal/kg clinker and 65 kWh/t cement in a developed country like Japan.

7.1.1 The improvements in energy performance of cement plants in the recent past have 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.

7.2 Cogeneration of Power utilizing Waste heat in Cement Plants

In case of dry process cement plants, nearly 40 percent of the total heat input is rejected as waste heat from exit gases of preheater and cooler. The quantity of heat lost from preheater exit gases ranges from 180 to 250 kcal/kg clinker at a temperature range of 300 to 400^{o}C. In addition, 80 to 130 kcal/kg clinker heat is lost at a temperature range of 200 to 300^{o}C from grate cooler exhaust. The waste heat have various applications such as drying of raw materials and coal, but even after covering the need for drying energy in most cases, there is still waste heat available which can be utilized for electrical power generation thereby making additional power available and reducing CO_2 emission.

The cement industry is yet to adopt the cogeneration technology due to various technical, financial and institutional barriers. Recently, a model demonstration project has been jointly implemented by New Energy and Industrial Technology Development Organisation of Japan (NEDO), and Govt. of India under Green Aid Plan (GAP). The system has been installed on a kiln of 4550 tpd clinker capacity with 4 stage suspension preheater and precalciner. The exhaust gas flow through preheater (PH) boiler is of the order of 3,60,750 Nm^3/hr at 340^oC whereas through air quench cooler (AQC) boiler, it is 1,96,000 Nm^3/hr at 360^oC. The power generated is of the order of 7700 kW at 6.6 KV. The installation cost of the system is around Rs 840 million. The economic efficiency analysis indicates reduction of :

- $56.07x10^6$ kWh of power purchased - Rs 232.70 million/year
- Fossil fuel consumption of 14517 tonnes/year
- CO_2 emission of about 45098 tonnes/year

Presently, there are 60 dry process cement plants having a capacity of 1 mtpa and above which need to be studied for assessing suitability for cogeneration of power which will largely depend upon quantity and quality of waste heat available, quality of grid power and its cost etc. Further, there is a need to identify the technical and institutional interventions that would enable the technology adoption on a large scale.

Moreover, since the cost of installation of such cogeneration power plants which work on bottoming cycles due to low/medium temperatures of exhaust gases, is very high, the govt. should consider incentivising setting up plants for cogeneration of power through waste heat recovery in production process. The incentives could include capital subsidy and tax exemption.

8.0 Benchmarking Process, Operation and Management Control Practice by Indian Cement Industry

8.1 The objectives of benchmarking exercise carried out jointly by CMA & NCB are :

- Best practice identification in technology, management or control – monitoring
- Assessment of gaps in technology/management
- Investment sensitivity assessment
- Selection of optimum technology/management at minimum cost and maximum benefit
- Least cost strategies for CO_2 emission reduction

8.2 A review of the progress indicates encouraging trend and achievement of the objectives with participation of 75 operating plants in the benchmarking exercise comprising around 70% of the total number of plants. Capacity wise, the participating plants cover 67% of the total installed capacity. The remaining cement plants are expected to participate in the benchmarking exercise by the middle of XI Plan.

8.3 The success achieved and its usefulness has instilled confidence for its further expansion during the XI Plan, on the following lines :

- To implement the on-line system for data entry at plant level, their analysis at CMA and on-line despatch of results to the participating plants.
- To enlarge the participation to cover 100 plants, or 85% of the total capacity.
- To involve plants from other countries in the benchmarking exercise by approaching individually or through their association.

8.4 A general review of performance of cement plants in the stated countries reveal the following :

- Energy conservation in modern plants in India is better than all other countries except Japan & Korea.
- The energy consumption of vintage plants in India compares fairly better than similar plants in Arab Union, Turkey and Iran but are behind similar plants in Canada and Switzerland.
- Japan & Korea have stringent particulate emission limits followed by Canada, European Union (EU) and then India.
- Recycling of industrial wastes in manufacture of cement is highest in Japan followed by India.
- Japan, US, Canada and EU use more than one industrial waste to manufacture composite cement. However, composite cement is not allowed to be manufactured in India due to absence of BIS standards.
- Use of hazardous and refuse derived combustible and Municipal Solid Waste (MSW) as fuel is common in countries like Canada, EU, Japan and Korea, but regulations do not yet permit in India.
- Comparison of fuel consumption between Indian cement plants and plants in Japan, Canada and EU shows wide margin in favour of the latter on account of proportionate credits derived in substituting fossil fuel consumption.

Regular exchange of data on respective plants will be taken up, once the on-line version takes off. This would help in graduating from National level benchmarking to International level and the focus would shift to achievement of international best practices.

9.0 Recycling Technologies

9.1 Generation rate of hazardous wastes at about 4 MTPA and Municipal Solid Waste (MSW) at about 45 MTPA is posing a very serious threat to the society from the safety, health and environment considerations. Moreover, there are several non-hazardous wastes from agricultural activities and industries amounting to about 400 MTPA that need proper measures and guidelines for their gainful utilization.

9.2 Some initiatives being planned and implemented by various agencies at centre and state level are not entirely adequate at present. Hence, there is an urgent need to address the issue of gainful utilization and safe disposal of hazardous and non-hazardous wastes including MSW. Cement industry and power plants can provide a very safe, controlled and ecologically sustainable solution for this problem.

9.3 Cement industry, in the past, has successfully utilized the wastes such as fly ash from thermal power plants, slag from steel plants and phospho-gypsum from the fertilizer industry. Now it is ready to offer solution for the management of all kinds of wastes by co-processing them in the kiln and captive power plant (CPP) as alternate fuels and raw materials (AFR's) depending upon their physico-chemical properties.

9.4 Proposed Initiatives

The various initiatives to be taken up in the XI plan towards the above objectives are :

9.4.1 Manufacture of Composite Cement

Composite cement is generally manufactured as an admixture of clinker, gypsum and more than one industrial waste in varying proportion depending upon the cement produced.

The European Standard EN-197 allows combination of various industrial waste such as granulated blast furnace slag (GBFS), fly ash, silica fume, natural and calcined pozzolana, burnt shale etc. in cement. This provides avenue for better utilization of the various kinds of wastes to a large extent than at present.

Non availability of the standards for composite cement in India, prevent manufacturers from utilizing both fly ash and slag when they are available in the same place. They have to perforce choose one of them, for logistic reasons. For example, we take the cement plants located in the Eastern part of India. Most of them have captive power plants, and there are other power plants too in the vicinity, generating fly ash. But because the plants are making slag cement, they are unable to use not only the fly ash of the near by power plants, but also of their own captive power plants.

Indian cement industry has represented to BIS to formulate suitable standards for the composite cements in line with the European Standards. If these standards are implemented, the usage levels of fly ash and GBFS in cement will stand greatly enhanced reducing their impacts on the environment.

9.4.2 Formulation of Guidelines

Ministry of Environment & Forests (MoEF) should formulate guidelines for :

- Implementing the principle – "Polluter to pay" for disposal of wastes
- Treatment, Storage & Disposal Facilities (TSDF) for cost effective co-processing of waste in cement kilns as an alternate to incineration, and
- Restricting land filling of hazardous and toxic combustible wastes having potential for co-processing in cement kilns should be formulated.

9.4.3 Upgradation of Central Laboratories to Analyse Hazardous Wastes

The laboratory facilities available at national and states level are not adequate to cater to the Hazardous wastes characterization. There is a need to augment these facilities to meet the Hazardous Waste characterization demand. Some efforts are already in progress with the help of GTZ. However, other national laboratories need to be equipped with these facilities.

9.4.4 Conversion of MSW into Coal Equivalent Fuel

Measures are required for its proper management and co processing in cement kiln as the best option. The unsorted MSW has very low calorific value (1000 – 1600 Kcal/kg), and has contamination possibility from unknown sources. For co-processing MSW in cement kilns, quality control on the MSW is very important and it should have higher calorific value in the range of at least 3000 Kcal/kg.

9.4.5 Use of Algae Growth as Fuel through Carbon Dioxide Fertilization

Algae farming offer one of the best opportunities to recycle and reduce CO_2 emissions in cement manufacture. Algae harvested from these farms can provide sufficient biomass which can be used as fuel back in the kiln thereby recycling CO_2. This approach will reduce the fossil fuel consumption in the kiln and reduce CO_2 generation.

Several efforts towards this objective are in progress worldwide. It is proposed that initiative should be taken to set-up a pilot project under public-private partnership for use of Algae growth as fuel through carbon di-oxide fertilization.

9.4.6 Incentives to Use Biomass in Coal Based Power Plants

Use of biomass for power generation in the captive power generation units is one of the major avenues for cement industry to reduce the use of fossil fuels. There are two considerations that limit the use of biomass by them.

- Cost of biomass based fuels and
- AFBC boiler technology used in these power plants.

To increase the use of biomass in the CPPs of cement plants, it is desired that incentives be provided on tonnage basis and capital incentive be given for modification of Fluidized bed Combustion boilers (FBC) to Circulating Fluidized Bed Combustion Boilers (CFBC).

9.4.7 Incentives to Cement Plants for Plantation of Jatropha and Castor Oil Plants

The fruit complete with the shell and the seed with oil has a calorific value equivalent to coal, and can be easily fed to the cement kiln, through an additional feeding and transport arrangement. For every million trees, from the fourth year onwards the plantation can supply bio mass fuel equivalent to 5000 tonnes of coal. If we plant castor oil plants in between the Jatropha trees, then another 5000 tonnes of bio fuel can be generated per million trees. Thus from a million tree plantation 10000 tonnes of fuel can be replaced every year. The castor oil can be harvested every year and the total bio mass can be used in the kiln. Incentives should be provided to the cement industry to grow bio mass generating trees like Jatropha and Castor oil, and use the fruit as fuel replacing the fossil fuel (coal).

It is proposed that excise duty should be lowered by 25% on clinker produced through co-processing of hazardous wastes and bio-fuels, subject to minimum of 20% replacement of conventional fuel. This would go a long way in providing the solution to the energy crisis.

10.0 Pollution Control and Use of Waste Materials

Cement being one of the six core sector industries, plays a vital role in infrastructure development especially in a developing country like India. Sustainable growth of the industry for enabling sustainable growth of infrastructure calls for leveraging pollution control measures with rapid growth of the industry.

Notably, unlike in most chemical, agro-industrial and metallurgical industries, cement manufacture does not significantly generate any toxic, hazardous or obnoxious pollutants. It contributes to atmospheric pollution in the form of suspended particulate matter (SPM) and emission of a major green-house gas like CO_2, generated from decomposition of the carbonate raw material (mostly limestone) and burning of fossil or alternate fuel (coal, lignite, petcoke etc). Ecological concern arising from the degradation of mined out area is also one factor in the pollution control initiative of the industry. Fugitive (particulate) emission is also a potential pollutant during in-process material handling in several stages of cement manufacture; ranging from limestone excavation to final packing of cement. The contemporarily adopted state-of-the-art-technology in cement manufacture has also incorporated advanced air pollution control devices (APCD), equipment and systems like bag filters and ESPs, and the contribution to the

atmospheric pollution has been drastically reduced. This is endorsed by the fact that leading cement plants have become traditional winners of trophies for regional best practice and performance in environmental protection, corporate social responsibility, and in upliftment of the quality of life for the neighbourhood population.

10.1 Emission Levels- Standards and Practices

The Central Pollution Control Board (CPCB), has brought out the standards for emission levels for particulate matter from stacks in cement plants in the year 1987.

Particulate Emission Norms in India

Capacity	Emission Limit (mg/Nm^3)	
	Protected Area	Other Area
<200 TPD	250	400
>200 TPD	150	250

In continuation Ministry of Environment and Forests has notified standards on 03 February 2006 under Environment (Protection) Rules 1986 which is as under :

Sl. No.	Cement Plant	Emission Limit (mg/Nm^3)
1	New Cement Plants	50
2	Cement plants located in critically polluted area and urban area having population of 1 lakh & above	100
3	Existing cement plants	150

The general level of permissible dust emission in India for existing operating plants is 150 mg/Nm^3. However, the limit for new plants in our country is 50 mg/Nm^3 which is at par with various countries.

The norms of particulate emission in other countries are as shown below :

Country	Emission Limit (mg/Nm^3)
Australia	50
Germany	50
South Africa	120
Switzerland	50
Japan	100
U.S.A.	100/50
Portugal	100 (Existing Kilns) 50 (New Kilns)

Apart from the Regulatory measures, the Central Pollution Control Board, following the provisions in the Charter of Corporate Responsibility for Environmental Protection (CREP) – A joint Government-Industry initiative inked in 2003, is in the process of development of :

- Load Based Emission Standards
- Norms for SO_2 and NO_x emission levels
- Guidelines for reduction of fugitive emission in cement plants.

These are pursued in association with expert agencies, knowledge bodies and the cement manufacturers. These measures will further help to reduce the overall emission loads. The present status of the above initiatives is as under :

Load based emission standards: CPCB has proposed the load-based standards for particulate emission from cement plants. The views on the proposed emissions are being collected from stakeholders.

SO_2 and NO_x emission standards: CPCB and NCB have compiled the emission levels/ data of SO_2 and NO_x from various cement plants in the country. Soon the emission standards are to be developed keeping in view the technology available to reduce emissions of these gases.

Fugitive emissions: CPCB has proposed guidelines for prevention and control of fugitive dust emissions in cement plants. The views of the stakeholders are being incorporated.

10.2 Pollution Control Compliance

The CPCB conducts regular survey of pollution control compliance of individual cement plants and compiles the data for the entire industry at regular intervals for initiating measures for further improvement. As per the latest joint survey in 2005 by the National Task Force, it was observed that all large plants have provided necessary air pollution control equipments to control dust emission and are 100% compliant with emission standards of Central Pollution Control Board (CPCB).

10.3 Constraints faced by the industry

10.3.1 There are several constraints faced by the cement industry with regard to emission control, many being beyond its control. These may be classified as external ones like poor quality of coal and power etc., which need to be tackled at the national level; and internal ones, such as constraints of layout to accommodate dust collection equipment within the existing space, non-availability of water in arid regions for proper functioning of APCD etc.

10.3.2 There are frequent and wide variations in the quality of coal received by Indian cement plants, which lead to improper and ever-changing combustion conditions, difficulty in proper control of air flow rate. These deficiencies have snowballing effect in high concentration of CO in the exit gases with potential threats of explosion in the ESP. Quite often the CO concentration even exceeds the limit beyond the designed functioning parameters of the ESP, mainly due to the poor and variable quality of coal. As a safety precaution, the ESP trips, thereby temporarily causing high dust emission through the stack.

10.3.3 To overcome such and other adverse situations arising out of using low calorific value and high ash coal, many cement plants have switched over to imported coal/pet coke and are going for Captive Thermal Power Plant to fulfill its power requirement. These actions have contributed to stable process and in turn have helped to reduce emissions significantly. However, plants located deep inland or at uneconomic distance from coal source can not afford such measures.

The various options available to overcome this problem are :

- Allocation of coal of better quality and consistency to cement plants and also speeding up privatization of collieries for captive consumption of cement plants should be considered.
- Import duty on coal to be brought down along with freight subsidy for land locked plants.

Further, to ensure compliance of emission norms, the following measures need to be put into practice :

- Most of the cement plants have installed the opacity meters. However, installation of Continuous Measurement Systems (CMS) for continuous measurement of particulate emissions is desirable.
- Cement plants should take various steps to reduce fugitive emissions comparable to the “best practice” elsewhere in the world.
- The plants should ensure that the transfer points are covered, roads are paved, water sprinkling arrangement are made and vacuum cleaning are done on regular basis & the facility is also developed for covered storage.
- The Fly ash should be transported in the closed containers.

For proper operation of ESP, continuous and good quality power is a pre-requisite. Long durations of low voltage, fluctuation in voltage and frequency, unscheduled power cuts, etc. have an adverse effect on the efficiency of the ESP, resulting in higher emission. In order to overcome these constraints, plants need be equipped with captive power units, of sufficient capacity for clinkerisation and provide power for smooth and continuous functioning of pollution control equipments. State Governments be directed to relax restrictions imposed for installation of captive power generation, provided these units meet the environmental standards.

10.4 Utilization of Industrial Wastes in India

10.4.1 Cement plants in India utilized about 19% of fly ash generated by power plants & 100% of granulated slag generated by steel plants during the year 2005-06, as compared to almost 100% fly ash and 84% of granulated slag in the Japanese cement industry.

10.5 Green House Gas Emission and Role of Cement Industry

Cement industry is an obvious candidate for GHG emission reduction. 1 tonne of cement produced generates almost equal quantity (0.85 to 1.15 tonnes) of CO_2 in the manufacturing process through (i) dissociation of carbonate, (ii) burning of fossil fuel or alternative combustibles, and (iii) use of grid or captive power. The approximate contributions of each of the 3 main sources of CO_2 emissions are:

Calcination - 50 to 55%

Fuel combustion - 40 to 50%

Electricity - upto 10%.

CO_2 emission from cement production in some major cement producing countries in 2003 is as under :

Country	**Cement Production (Mn.t.)**	**CO_2 Emission (Mn.t.)**	**Emission Factor (tonne of CO_2 /tonne of cement)**
China	862.0	429.578	0.498
India	121.4	61.291	0.505
United States	92.8	46.265	0.499
Japan	73.8	34.266	0.464

The cement industry could significantly reduce the CO_2 emission during last 8 years. The reduction due to increased substitution of clinker by fly ash for larger quantity of blended production could reduce the emission from 1.12 tonnes CO2 in 1996 to 0.84 tonnes in 2004.

10.6 Clean Development Mechanism (CDM) and Carbon Trading

Over the last few years, CDM linked carbon trading has drawn Indian cement industry into hectic activity for carbon trading through reduction of GHG emission and trading the emission reduction (termed as Certified Emission Reduction – CER) in the International Market.

10.6.1 Types of Projects and Benefit from CDM Finance

All CDM projects must result in a net GHG reduction, as in the case of energy efficiency improvement, renewable energy generation, or carbon sequestration through afforestation and reforestation. Typical CDM projects fall into the following categories :

- Renewable energy
- Fuel switching (in industry, transport, residential sector, etc.)
- Solid waste management
- Advanced coal-based power generation technologies
- Renovation and modernization
- Demand-side management
- Industrial energy efficiency improvement

10.6.2 Indian Scenario

Keeping in view the confusion and arbitrariness in the CDM trading activities and complaints received from different quarters, the Government of India decided to set up an agency to help Indian applicants including industries for CDM project.

CDM-India was established in August 2003, through an agreement between GTZ (German Technical Cooperation) and the Bureau of Energy Efficiency (Ministry of Power), Government of India, under the Indo-German Energy Programme (IGEN) – (Component 3) as the capacity building facility that can help reduce transaction costs in the early market development process. Its objective is to foster high quality CDM projects that will successfully complete the project cycle and provide experience through “learning by doing”. These projects should serve as models for adoption by others. Capacity building and support to public and private sector institutions for preparation and implementation of internationally acceptable projects under the Clean Development Mechanism is its primary aim. It actively cooperates with the Designated National Authority (DNA). The DNA in India is the Secretary, Ministry of Environment and Forests (MOEF) for institutionalizing CDM projects from India.

Certain projects in Indian Cement Industry which now seem to have high potential for CDM-related Carbon Credits are: fuel Switching (including Use of Waste Fuel provided it reduces GHG), Use of alternative and renewable energy, use of wastes in place of clinker etc.

Status of CDM Projects : Indian Cement Industry Sector
(as on July 30, 2006)

Company [Validator]	Unit	Project/Annual Average Carbon Credit (tCO_2e)
Registered by CDM Executive Board (pending issuance of CERs)		
Gujarat [**RWTUV**] Ambuja (**17.12.2005)**	Ropar (Punjab)	Biomass for Power (24 MW)/ **25937**
Shree Cements [**SGS**] Ltd.**(20.02.2006)**	Beawar (Rajasthan)	Blended Cement/ **68014**
JK Cement Ltd. [**TUV-SUD**] **(15.05.2006)**	Nimbahera (Rajasthan)	Waste Heat Recovery for Power Gen.(13.2 MW)/ **70796**
Shree Cements Ltd. **(18.05.2006)** [**SGS**]	Beawar(Rajasthan)	Alternative Fuels/ **107074**
ACC Ltd. [**SGS**] **(21.05.2006)**	New Wadi, Tikaria, Chanda, Kymore, Lakheri, Chaibasa	Blended Cement/ **405314**
Birla Corporation Ltd. **(26.05.2006)** [**DNV**]	Raebareli	Blended Cement/ **26415**
Grasim Inds.Ltd.[**DNV**] (GIL-CDS) **(29.05.2006)**	Reddipalayam (Tamil Nadu)	Alternative Fuels/ **51932**
Binani Cement Ltd. **(18.06.2006)** [**SGS**]	Binanigram (Rajasthan)	Blended Cement/ **21961**
Ultra Tech Cement Ltd. [**DNV**] **(28.07.2006)**	Tadipatri(Andhra Pradesh), Arakkonam(Tamil Nadu)	Blended Cement/ **41838**
Jaiprakash Associates [**DNV**]	Rewa, Bela (MP), Sadva Khurd (UP)	Blended Cement/ **22902.3**
OCL India Ltd. [**DNV**]	Rajgangpur (Orissa)	Blended Cement (Slag), Blended Cement(Fly Ash)/ **123926**
Under request for Registration after Validation		
Gujarat Ambuja [**DNV**]	Maratha, Gujarat, Himachal, Bhatinda, Ropar, Rabriyawas	Blended Cement/ **551829**
Orient Cement [**DNV**]	Jalgaon(Mah.), Devapur (AP)	Blended Cement/ **99453.04**
Projects closed for comments at the validation stage and pending request for registration		
Ambuja Cement [**SGS**] Eastern Ltd.	Sankrail(WB)	Blended Cement/ **27308**
Birla Corpn. Ltd. [**DNV**] [**SGS**]	Chittorgarh Durgapur (WB), Satna (MP)	Blended Cement/ **43604** Energy Efficiency/ **14109.1**
Century Textiles & Industries Ltd. [**TÜV SÜD**]	Century Cement, Manikgarh, Maihar	Blended Cement/ **19587.1** **39256** **163938.6**

Company [Validator]	Unit	Project/Annual Average Carbon Credit (tCO_2e)
Dalmia [**SGS**] Cement(Bharat) Ltd.	Dalmiapuram(TN)	Blended Cement/ **59988.2**
Grasim Inds. Ltd. [**TUEV-RHEIN**]	Vikram Cement (Neemuch)	Alternative Fuels/ **30072**
*Indorama Cement [**SGS**]*	Raigad (Maharashtra)	Blended Cement(Slag)/ **42881.4**
Lafarge India [**DNV**]	Arasmeta, Jojobera, Sonadih	Blended Cement/ **40835.32**
Mysore Cements Ltd. [**DNV**]	Ammasandra (Karnataka)	Blended Cement(Slag)/**66095.3**
Vasavadatta Cement [**DNV**]	Sedam (Karnataka)	Blended Cement/ **22681**
Projects open for comments at the validation stage:		
Indorama Cement [**SGS**]	Raigad (Maharashtra)	Alternative Fuels(Waste Flue Gases)/ **10600**
Madras Cements Ltd [**Bureauveritas**]	*Tamil Nadu*	41.6 MW Grid connected electricity generation(Bundl-ed Wind Farm)/ **73318.8**
		Total CERs: **2460133, or about 2.50 mns.**

Source : CDM Database compiled by Cement Manufacturers' Association

*Total CERs for the entire crediting period of 10 years = (10** 2460133*), or 24601330(i.e. about 25 millions).*

Notes :

1. *There are so far 26 CDM projects from 19 Indian cement companies under different stages of registration with the UNFCCC EB.*
2. *Of the above, types of projects are as under:*

   Blended Cement: 17 nos.(15 with fly ash, 3 with slag),

   Alternative Fuels: 5 nos.,

   Energy Efficiency: 2 nos.,

   WHR: 1 no.(power generation),

   Wind Farm: 1 no.
3. *VALIDATORS: DNV- 11 projects(BC 10, AF 1):* 1 of BC from Birla Corp Ltd & 1 of AF from Grasim South got registered.
4. *SGS- 10 projects(BC 6, AF 2, EE 2):* 3 of BC, one each from Shree Cements, ACC, and Binani, & 1 of AF from Shree Cements got registered.
5. *TUV- SUD-2 projects(BC 1, WHR/power 1):* WHR/power from J K Cement registered.
6. *RWTUV- 1 project(AF biomass /power):* Registered- from GACL.
7. *TUEV- RHEIN- 1 project (AF)*
8. *Bureauveritas- 1 project (Wind Farm)*

11.0 Human Resource Development

11.1 During the XI Five Year Plan period, the production capacity of the cement industry is expected to increase by about 118 million tonnes. This capacity increase will be achieved through green-field plants as well as brown-field expansions, based on modern manufacturing technologies.

There is an acute need for additional technical manpower at all levels , suitably trained in the operation and management of the modern greenfield and brownfield cement plants which will be set up to realize the projected enhancement of the cement production capacity. In addition, the skills of manpower already employed in existing cement plants has to be upgraded in areas such as the operation of state-of-the-art manufacturing technologies, utilization of alternate and unconventional raw materials and fuels, energy conservation, pollution control and sustainable development.

Indian cement industry provides direct employment for around 70,000 people while creating 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.

Generally, in a one million tonne per annum (1 MTPA) modern cement plant, around 400 skilled technical manpower is required, out of which around 150 will be at managerial and supervisory levels. The cement industry will require a total of 34400 skilled technical manpower for 86 mn.t Greenfield expansion, 4800 skilled technical manpower for 32 mn.t brownfield expansion and 4000 skilled technical manpower for 2000 MW captive power plant operation. Accordingly, a total of about 43000 additional technical manpower, including 12000 engineers & supervisors, will be required to attain the targeted capacity additions. In addition, the industry would require about 40000 unskilled workers. This does not include the replacement demand of personnel that would arise in the plants already in existence.

The basic qualifications for the different categories of manpower required by cement plant is as under :

Engineering Graduates	Graduate in Chemical / Mechanical / Electrical / Civil / Electronics & Instrumentation / Geology / Mining
Engineering Diploma Holders	Diploma in Chemical / Mechanical / Electrical / Civil Engg.
Science Graduates	Chemistry / Physics / Mathematics
Skilled Workers	ITI trade passed in the disciplines of Fitter / Welder / Auto Mechanic / Draftsman / Electrician

The training needs for various categories of manpower for cement plants are elaborated as under :

11.2 Worker Level Staff (Computer based Training)

For the worker level staff, onsite practical training programmes will have to be organized at cement plants. These programmes can be best handled by the RTCs of the cement industry located in different regions of the country. However, the training activities of the RTCs will have to be expanded in terms of Computer Based Training (CBT) programmes, with the technical support of research and consultancy organizations such as NCB. Computer based training packages need to be developed for specific subjects for training the workers on regular basis. ITI trade passed skilled workers shall be trained for 3 months in various disciplines at RTCs before they join the cement plants.

11.3 Managerial & Supervisory Level Staff

In this category fresh engineering graduates & diploma holders and science graduates numbering about 12000 will enter the industry. As such, they will need detailed orientation courses in cement technology before they actually start working.

The new green-field projects coming up will be based on high capacity kilns (5000–10000 tonnes per day), state-or-art technology including computerized operating & control systems. To operate such plants efficiently, the operators need simulator based training. Presently, only NCB–Hyderabad is having the simulator facility. It is proposed to have simulator facility at NCB–Ballabgarh also to meet the requirement of cement plants in Northern / Western regions.

11.4 The above stated requirements call for the setting up of a national level training institute under the aegis of NCB for providing the entry level training as well as the continuing education on a sustained basis to the manpower working in the Indian Cement Industry. NCB, in fact, has been handling the above training tasks successfully, though to a limited extent, for nearly three and a half decades now. The Council is in an ideal position to fully assume the role of "trainers to the cement industry in India", with appropriate expansion of its activities. This would require strengthening of its infrastructure and manpower, specifically in terms of the following :

- Modern lecture hall complex with training aids, laboratories, workshop, library and hostel facilities at its Hyderabad Unit and strengthening of these facilities at its Ballabgarh Unit.
- Computer based training facilities at its Hyderabad and Ballabgarh Units including a Cement Process Simulator at its Ballabgarh Unit.
- Additional teaching manpower of 25 in total, covering all major areas of cement manufacture along with supporting staff of 10 for its Ballabgarh and Hyderabad Units.

The round-the-year training activities of the proposed training institute of NCB will include the following programmes :

- Post Graduate Degree in Cement Technology (2 years)
- Distance Learning Programme – PG Diploma in Cement Technology (1 year)
- Certificate courses in individual areas of cement technology (3 months)
- Short term intensive training courses (5-10 days duration)
- Computer based training for operators & technicians (2-4 weeks duration)

12.0 Research and Development

12.1 In today's fast progressing world, no industrial system can grow without R&D support. The role of R&D in the growth of cement industry in India is well known and documented. In order that the desired results are produced, research

has to be properly focused and mission-oriented, taking into account what that industry aspires. The research efforts could be directed towards :

- Technological developments in the process of cement manufacture and the related plant and machinery and systems design
- Operational improvements to ensure cost reduction, productivity enhancement, environmental protection and quality improvement
- R&D to ensure proper utilization of cement in constructions and propagate its use for newer applications
- R&D work to identify new pozzolonic materials for use as additives in cement.
- Finalization of the standards of composite cements as is done abroad so that all types of pozzolonic materials can be added to clinker for making cement.
- Research for newer methods of manufacturing such as nano-technology

12.2 Any attempt to reduce the expenditure on R&D for considerations of economy can be counter-productive in the long run. Therefore, adequate funds have to be made available for a meaningful R&D.

12.3 During the last decade a number of cement manufacturing organizations have developed their in-house R&D units and today there are 7 units dedicated to R&D on cement in India.

12.4 Two major organizations namely National Council for Cement and Building Materials and Research & Consultancy Directorate of The ACC Ltd. are fully devoted to research and development activities. The results of the R&D work carried out by them are regularly transferred to the cement industry for commercial application. Besides, a number of cement plants in the country are carrying out in-house R&D to upgrade the existing technology, modernization for improving productivity and energy efficiency of their plants. 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.
- Gujarat Ambuja Cement Ltd.

12.5 The R&D expenditure in India as a percentage of the gross domestic product (GDP) has been around 0.7% during the last two decades. For a comparison, most of the developed countries spend between 2 to 3% of their GDP on research & development. A comparison of gross expenditure on R&D (GERD) with China & USA is given below :

Gross Expenditure on R&D

	GERD (in $bn)	**% World GERD**	**% GERD/GDP**	**GERD per Inhabitant**
China	72	8.7	1.2	56.2
USA	290.1	35.0	2.8	10059
India	20.8	2.5	0.7	19.8

GERD : Gross Expenditure on R&D

Spending on R&D is seen as a sign of potential healthy growth for firms and progress in technology that helps boost economies and create jobs. But previous surveys have shown the gap between the EU and Japan and the United States was widening. Heads of European Union states want R&D spending, comprising public funding and private investment, to reach 3 percent of gross domestic product (GDP) by 2010. At the moment, that figure is closer to 1.9 percent, short of the US rate of 2.6 percent and 3.2 percent in Japan.

Data compiled from various R&D organizations show that total expenditure on R&D activities related to cement is only 0.08% of sales turnover of the industry during the year 2005-06. Correspondingly, the expenditure on R&D units on cement in a developed country viz. Japan is about 0.23% of the annual turnover.

	Amount	**% of Total Turnover**	**No. of R&D Units**	**Cement Production (MTPA)**
Japan (2001)	1.4b Yen (Rs 52.5 crores)	0.23	14	83
India (2005)	Rs 40 crores	0.08	7	150

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 a sustainable development.

12.6 A broad listing of specific areas of research undertaken by various R&D units and suggested areas of research and development is given in the following Table :

Review of Research & Development – X Plan

Sl. No.	Areas	X Plan Achievements	XI Plan Priority	Benefits
1	Upgradation of low grade limestone & mines rejects	Moderate	Very High	Utilization of marginal / low grade limestone which is abundant & closer to consumption centers; conservation of limestone reserves
2	Maximising the use of fly ash in cement, concrete and other building materials	High	Very High	Increased utilization of fly ash having disposal problem, energy conservation & reduction in GHG emission
3	Adaptation of technologies to reduce NO_x & SO_2 emissions in cement plants	Moderate	High	Reduction in environmental emissions
4	Adaptation of technologies for utilization of combustible wastes as alternate fuel	Moderate	Very High	Conservation of natural resources; integrated solutions to wastes management
5	Energy conservation through comprehensive energy audit & operational diagnostics	Moderate	High	Energy conservation; reduction of GHG emissions
6	Optimization of precalciner operation	High	Moderate	Heat economy; enhanced output; stable operation
7	Design & development of mobile quality control for roads, bridges & dams	High	High	Improvement in quality of concrete construction
8	Development of technology for cost effective concrete rural roads & highways etc.	Moderate	High	Cost effective, durable and maintenance free concrete roads

Thrust Areas of Research & Development – XI Plan

Sl. No.	Areas of Research & Development	Expected Benefits
1	Co-processing of hazardous wastes (HW) in cement manufacture	Resource conservation & integrated solution to wastes management
2	Development of high performance cement based composites	Improved properties to meet the growing need of durable construction
3	Multi-model transportation of cement including bulk transportation	Reduction in seepage losses and improvement in environment at construction sites
4	Enhancing the use of fly ash in cement & concrete through processing of fly ash	Increased fly ash utilization, cost reduction & reduction in GHG emission
5	Development of cements & binders based on nano-technology	Improved properties & resource conservation
6	Utilization of PPC for pre-stressed concrete	Increased waste utilization & cost reduction
7	Development of cost effective model housing or urban & rural areas	Cost effective construction technologies
8	Improving the performance of size reduction operations	Reduction in cost of production
9	Studies on evaluation of technologies for co-generation of power from waste heat	Reduction in GHG emission & energy conservation
10	Recycling of aggregate from demolished construction	Improved wastes management
11	Benchmarking of environmental parameters of Indian cement industry	Improved environmental conditions
12	Utilization of non-conventional granulated slags in cement manufacture	Resource conservation & improved waste management
13	Adaptation of low NO_x & low SO_2 technologies	Improved environmental conditions
14	Upgradation of low grade limestone	Resource conservation
15	Studies on critical environment parameters for sustainable development of major limestone bearing regions for creating additional cement capacity	Environmental improvement
16	Initiatives to reduce CO_2 emissions (such as CO_2 absorption by Algal Farms, CO_2 absorbing cement formulations etc.)	Environmental improvement
17	Standardisation of composite cements	Improved wastes management

12.7 Technology Transfer Mechanism

As per the details enumerated in the previous chapters, the following technologies need to be developed or adopted either through indigenous efforts or adaptation of imported technology for wider application during XI Plan :

- Appropriate co-processing technologies for use of hazardous and non-hazardous wastes
- Cogeneration of power utilizing waste heat
- Low SO_2/NO_x emission technologies
- Technologies for processing of fly ash for enhanced use in cement / concrete
- Development of cements & binder based on nano-technology
- Use of Algae growth as fuel through carbon dioxide fertilization
- Conversion of municipal solid wastes to fuel (coal)

It is proposed to explore the possibilities of securing financial support under various schemes in vogue or complemplated during the XI Plan period. Details of some of the schemes being operated by the Govt. Deptt. Viz. Deptt. Of Science and Technology (DST) and Deptt. Of Scientific and Industrial Research (DSIR) are as under :

Technology Development Board (DST)

Deptt. Of Science and Technology, Govt. of India through Technology Development Board (TDB) has instituted a framework with the sole objective of translating the fruits of indigenous research as well as adaptation of imported technology into commercial products and services. The board provides financial assistance in the form of equity, soft loans or grants. The type of projects eligible for funding include :

- Development & commercialization of a new product/process/ application through indigenous technology.
- Significant improvements in the existing product/ process/application.
- Substantial quality upgradation, reduced material consumption, reduced energy consumption, cost reduction, improved competitiveness, improved ergonomics.

- Development and deployment of technology or design to satisfy existing occupational health and/or safety standards, or improve upon them.
- Development and deployment of technology or design necessary to satisfy domestic or foreign environmental requirements or standards current or anticipated.
- Development and deployment of technology or design necessary to satisfy the requirements of domestic legislation, and/or decisions of the judiciary or product liability legislation in export markets.
- Adaptation/modification to product/process which has been imported so as to make it suitable for wider domestic application.
- Replacement of imported raw materials/components with indigenous substitutes.
- Proving the socio-commercial viability of new and/or renewable sources of energy commercially delivered to consumers.
- Hazardous waste recycling management.

Technology Development and Demonstration Programme (DSIR)

Similarly, the Department of Scientific & Industrial Research (DSIR) under its Plan Scheme Technology Promotion, Development & Utilisation Programme (TPDU) is promoting industry's drive to take up development of New Products/Processes, Capital Goods/Process Equipment & Technology Absorption Projects through Technology Development and Demonstration Programme (TDDP). The TDDP has the following objectives :

- To promote innovation by sharing risk with innovators.
- To forge industry – institute cooperation.
- To strengthen the National Innovation capability.

Towards achieving the above objectives, the Department provides, partial financial support to New Product/Process Equipment/Capital Goods Development projects & Technology Absorption projects taken up by Indian industry, in all sectors.

These projects should aim at development of a new product or a process (including development of process equipment) or capital goods with attractive market potential or aim at absorption of imported technology with know-why investigations to come with an improved, innovative product/process. The projects should result in significant benefits in terms of raising the technological level of the industry concerned, high turnover, energy and material savings/recovery and export sales etc.

Proposals for these R&D projects such as the following are considered for partial financial support :

- Development of a new/improved product resulting in prototype development and ending with demonstration in commercial environment.
- Development of a new/improved process resulting in establishment of process know-how, development of process equipment and demonstration of yield, efficacy etc. in a pilot plant.
- Development of capital goods for Indian/export market resulting in prototype development and ending with performance evaluation by one user from the targeted market.
- Absorption of imported technology with know-why studies resulting in development of improved, innovative product/process.

12.8 Technology Imports

As per the present arrangement/practice, the technologies, imported by cement plants directly, remain captive of one entity only. With a view to saving on additional expenditure and time in case of repetitive imports, NCB may be involved as an intermediary for assessing the technology in Indian context, assimilating it and also for adapting it suitably for every subsequent use.

12.9 NCB's Growth Needs during XI Plan

As an R&D and industrial services organization set-up for the Indian cement industry, NCB's mandate is to serve the cement industry in all areas covering utilization of raw materials and energy, plant operation and maintenance, quality control, environmental improvement and continuing education, for enabling the industry to enhance its all round productivity and sustain the same on continuous basis. Having fulfilled this objective for over 3½ decades, NCB on its part will have to gear up in a big way to meet the vastly increased technical needs of the industry, which will have a capacity of 298 mn.t. by the end of XI Plan.

The above scenario specifically requires major addition of infrastructure like building, equipment facilities in laboratories as well as for in-plant studies and manpower of about 100 scientists, engineers and supporting staff in NCB over the next 5 years. For this purpose, a capital investment of about Rs 25 crores has to be made during the XI Plan. Being a non-profit service provider, NCB will also require an enhanced annual grant to the extent of Rs 15 crores by the end of XI Plan for meeting part of its revenue expenditure. This enhancement of the grant from present level to about Rs. 4 crores needs to be effected in stages over the next 5 years starting from 2007-08.

12.10 Application of Nanotechnology to Cement and Concrete

Investigation and modification of nanostructure of cement/concrete, with a view to improve the performance and durability characteristics of cementitious systems and achieve sustainable development, constitute one of the most active research fields today. Nanotechnology has the potential to improve construction materials, including concrete. Application of nanotechnology in construction sector is presently being investigated in many countries including USA, Canada and European Union.

Nanotechnology can be defined as (1) the research and development that uses matter existing at the **"**nanoscale**"**; (2) the engineering of materials in nanoscale (1-100 nanometers in length); (3) the fabrication of devices with atomic or molecular scale precision. A nanometer is equal to 10^{-9} or one billionth of a meter. Nanotechnology has made rapid advances since the early 1990s and has been hailed as nothing short of a revolution. Nanotechnology has the potential to affect and improve almost all walks of life. Some of the important areas, which stand to benefit from developments in nanotechnology, include :

- Energy storage, production and conversion
- Agricultural productivity enhancement
- Water treatment
- Disease diagnosis and screening
- Drug delivery systems
- Food processing and storage
- Air pollution and remediation
- Construction
- Health monitoring
- Vector and pest detection and control

12.10.1 Nanostructure of Cement/Concrete

Concrete has a nanoscale structure comprising of hydrates of cement, additives and aggregates, its properties can be controlled by manipulating its nanostructure. The main "glue" that holds concrete together is calcium-silicate-hydrate, the hydration product of Portland cement. Calcium-silicate-hydrate consists of a gel composed of colloidal particles in 1 to 100 nm range and the pores present in calcium-silicate-hydrate are also of nanometer-scale. These nanoscale pores together with the "type / morphology of gel" control the properties of C-S-H.

The nanostrcuture of C-S-H is still not understood completely. A better understanding of nanostructure of cementitious systems would provide us a greater capability of control and manipulate the properties and behaviour of cements and concrete. Nanotechnology has provided us the ability to observe the structure at its atomic level and measure the strength and hardness of micro- and nanoscopic phases of cementitious materials. The "amorphous" C-S-H gel has been found to have a highly ordered crystal nanostrcuture. Nanotechnology is providing a close-up look at the hydration of cement grains and the nanostrcuture of cement reactivity. Nano-engineered polymers have been found to act as highly efficient superplasticizers for concrete. Nanoparticles, such as silicon dioxide, have been found to be a very effective additive for achieving high-performance and self-compacting concrete with improved workability and strength. Reinforcement of cementitious binders with nanodiameter fibres and rods can result in higher performance of cementitious materials in general, by impeding crack formation and growth. It is expected that the addition of nanoparticles to concrete will improve the control of concrete microstrcuture beyond what is possible today with existing technologies. Therefore the product should be more durable in terms of its resistance and lifespan.

12.10.2 Expected Developments in Cement and Concrete through Application of Nanotechnology

The application of nanotechnology to cement and concrete is expected to result in development of eco-friendly, high performance cement / binders and concrete with improved durability characteristics. It would also help in achieving

the goal of sustainable development. The major developments are expected along following lines.

- Cement/binders modified by nanoparticles and produced with substantially reduced volume of Portland cement component (down to 10-15%)
- Cements/binders reinforced with nano-particles, nano-rods, nano-tube, nano-nets, or nano-springs
- Cements/binders based on the alternative systems (MgO, phosphate, geopolymers, gypsum)
- Cements/binders modified by nano-sized polymer particles, their emulsions or polymeric nano-films
- Catalysis for the low-temperature synthesis of clinker and accelerated hydration of conventional cements
- Grinding aids for superfine grinding and mechano-chemical activation of cements
- Cement based composites reinforced with new fibers containing nanotubes as well as with fibers covered by nano-layers (to enhance the bond, corrosion resistance, or introducing the new properties, like electrical conductivity etc.)
- Next generation of superplasticizers for “total workability control” and supreme water reduction
- Cement based materials with supreme tensile and flexural strength, ductility and toughness
- Cement based materials with engineered nano- and micro- structure exhibiting supreme durability
- Self-healing materials and repair technologies utilizing nano-tubes and chemical admixture
- Materials with self-cleaning/air-purifying features based on photocatalyst technology

12.10.3 Beneficial Action of Nano-particles on the Microstrcuture and Performance of Cement-Based Materials

For the decades, major developments in concrete performance were achieved with application of super-fine particles: fly ash, silica fume, and now, nanosilica.

Beneficial action of nano-particles on the microstrcuture and performance of cement-based materials arises from the following factors :

- Well dispersed nano-particles improve the segregation resistance and workability of the system
- Nano-particles fill the voids between the cement grains, resulting in the immobilization of "free water" (filler effect)
- Well dispersed nano-particles act as centers of crystallization of cement hydrates, therefore accelerating the hydration
- Nano-particles favour the formation of small sized crystals such as $Ca(OH)_2$ and Afm) and small sized uniform clusters of C-S-H
- Nano-SiO_2 participates in the pozzolanic reactions, resulting in the consumption of $Ca(OH)_2$ and formation of extra C-S-H
- Nano-particles improve the structure of the "aggregates" contact zone, resulting in a better bond between aggregates and cement paste
- Nanoparticles improve the toughness, shear, tensile and flexural strength of cement based materials

A superplasticizer (Gala) containing nano-SiO_2 particles at a dosage of 1.3% provided nearly two fold increase in concrete compressive strength at the age of 7 and 28 days. The early strength of 68.2 Mpa was three times higher than that of reference concrete.

12.10.4 Expected Benefits of Nano Technology

The benefits expected from application of nanotechnology to cement and concrete include :

- Improvement in performance characteristics through development of newer binders and cementitious composites.
- Saving in energy through development of low energy cements
- Enhanced utilization of wastes
- Saving in raw materials
- Reduced environmental emissions
- Longer service life of structures

Development of efficient nucleating agents and low energy cements will contribute to increased use of supplementary cementing materials, such as fly ash and slag while making concrete production more environmentally sustainable.

12.10.5 Nanocem Consortium and other International Organizations

Applications of nanotechnology to cement and concrete are being investigated by a number of organizations world over. Some of these organizations and the work being carried out by these are given below :

Nanocem Consortium

Nanocem is a European body comprising of 32 academic and industrial partners with an interest in cementitious materials. The members of Nanocem collectively have access to a large range of state of the art equipment for the study of cementitious materials. Some of the industrial and academic partners of Nanocem are : Lafarge Centre de Recherche, France; Holcim Group Support Ltd, Switzerland; Heidelberg Cement AG, Germany; Aalborg Portland, Denmark; University Court of the University of Aberdeen, UK; Leeds University, UK; University de Bourgogne, France; U-Surrey, University of Surrey, UK; Technical University of Denmark, Denmark; University of Kassel, Germany, Ecole Polytechnique Federate de Lausanne, Switzerland and University of Florence, Italy. Nanocem has identified its research objectives as below.

- Identify, study and elucidate the fundamental mechanisms underlying specific cementitious materials related problems.
- Link features and processes occurring at the nano-scale with engineering performance at the macro-scale.
- Develop the basic knowledge required to develop new cementitious materials, fundamentally improve existing materials and solve problems related to the present materials.
- Improve the image of cement and concrete as sustainable, high-technology materials.
- Enable technological breakthroughs in the field of cement and its applications.

The consortium has taken up projects to investigate hydrate assemblage containing C-S-H, pore structure of cementitious materials by NMR, organo-aluminate interactions and hydration of blended cement.

National Research Council, Canada

National Research Council, Canada has identified the construction industry as a large potential market for nanotechnology and has initiated projects to develop new technologies and products for the construction industry. The National Research Council Institute for Research in Construction (NRC-IRC) has taken up investigations on the nanoscale properties of concrete with a view to create stronger more durable concrete in a more sustainable manner. The institute is presently working on developing new cements, concretes and admixtures (concrete performance-enhancing additives). Initial research has concentrated on such areas as low energy cements, nanocomposites, improved particle packing, and novel approaches for the controlled release of chemical admixtures.

Federal Highway Administration, USA

Under FHWA's Advanced Infrastrcuture Research program, a variety of nanotechnology applications are being investigated. These include :

- Investigations on alkali-silica reactivity (ASR) and delayed ettringite formation, at the molecular level, using neutron-scattering technology and other processes.
- Fundamental research into the interactions between fly ash and the nanostrcuture of Portland cement gel, using neutron scattering technology.
- Investigations on hydration of cement and the nanostrcture of cement reactivity.
- The feasibility of Cyberliths, or Smart Aggregates, as wireless sensors embedded in concrete or soil.

12.10.6 Research Objectives Identified by NCB

The research objectives for application of nanotechnology in cement science have been formulated so as to take the lead in this field to provide cutting-edge nanotechnology-based materials for the construction industry. The identified research objectives are listed below :

- To develop new technologies and products based on nanotechnology, with an emphasis on cements, cement-based products, admixtures and concretes.
- Synthesis and use of reactive/non-reactive nanoparticulates
- Investigations on role of nanoparticles in cement binders
- Investigating new approaches to reinforcement of cement based materials using nano-rods, nano-tubes, nano-nets etc.

The achievement of above research objectives would require a collaborative approach and pooling of resources. Efforts will be required to identify the institutions at national and international level having similar interest and capability for taking up projects to meet the above objectives, collaborations and research would follow.

13.0 Schemes for improvement of Productivity, Technology and Environment

In order to achieve the various objectives/targets in the XI plan, the following schemes are proposed to be taken up :

i) ***Upgradation of technology of low technology cement plants :*** Comprehensive assessment of all the pre-1990 cement plants and operating mini cement plants to identify the technological gaps and the extent of modernization as well as funds required including chalking out appropriate action plans.

ii) ***Cogeneration of power utilizing waste heat in cement plants :*** Studies for assessing the suitability for cogeneration of power in 60 dry process cement plants having a capacity of 1 mtpa and above capacity including identification of technical and institutional interventions required as well as extent of financial incentives viz. capital subsidy etc. required to make it viable for large scale adoption.

iii) ***Benchmarking Process, Operation and Management control practice by Indian cement industry :*** Studies for Improvement of the benchmarking model to make it on-line system for data entry at plant level, their analysis and on-line despatch of results etc. Benchmarking of Indian industry with International industry for achievement of international best practices in terms of technology, productivity, energy, use of alternate fuels, types of cements etc.

iv) ***Recycling Technologies :*** The following studies are proposed :

(a) Manufacture of composite cement: Studies for development of suitable standards for manufacture of composite cement in line with international standards.

(b) Conversion of MSW into coal equivalent fuel : Setting up a demonstration project for converting MSW into coal equivalent fuel for its proper management & co-processing in the cement kiln.

(c) Use of Algae growth as fuel through carbon dioxide fertilization studies for developing Algae farming technology and its use as fuel in cement kiln.

v) ***Human Resource Development :*** Setting up a national level training institute, under the aegis of NCB, through appropriate expansion of its existing activities for providing the entry level training as well as the continuing education on a sustained basis to the manpower needs of cement industry.

14.0 Recommendations

The recommendations highlighting the action plans and support required are as under:

- *Industry should bring down average thermal energy consumption by the end of the XI Plan period to 700 K.Cal/kg. clinker from 725 K.Cal/kg. clinker in 2005-06. The average electrical energy consumption should also be brought down to 75 kWh/t cement from 82 kWh/t presently.*
- ***All large plants should have ISO 9000 (Quality Management System) and ISO 14000 (Environmental Management System) Certification by the end of XI Plan.***
- ***Ministry of Environment & Forests (MoEF) should formulate guidelines for:***
  - ***Implementing the principle of 'Polluter to Pay' for disposal of wastes.***
  - ***Treatment, Storage & Disposal Facilities (TSDF) for cost effective co-processing of combustible industrial wastes in cement kilns as an alternative to incineration.***
  - ***Restricting land filling of hazardous and toxic combustible wastes having potential for co-processing in cement kilns.***
- *Duty free import of pollution control and energy efficiency improving equipments should be allowed.*

- *Excise duty should be lowered by 25% on clinker produced through co-processing of hazardous wastes and bio-fuels, subject to a minimum of 20% replacement of conventional fuel.*
- ***With a view to commercially harness new resources and waste heat generated in the production process, the following initiatives should be taken:***
  - ***Setting up a pilot project under public private partnership for use of algae growth as fuel through carbon dioxide fertilization. Ministry of Non-Conventional Energy could be requested to coordinate and assist.***
  - ***Incentivising setting up plants for cogeneration of power using waste heat recovery in production process. The incentive could include capital subsidy and tax exemption.***
- *The BIS should develop quality standards so as to allow manufacture of composite cement using various sorts of waste products, in line with the international practices.*
- ***Total Cement Cess collected should be kept in a separate account and fully used for:***
  - ***R&D covering productivity, energy, environment, wastes utilization, alternate fuels, quality, application of nano-technology etc.***
  - ***Capability building for testing and utilization of hazardous wastes and adoption of state-of-the-art technologies.***
  - ***Skill upgradation and institutional capability building for HRD to meet the changing scenario, including setting up of a national level training institute & upgradation of RTCs***

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SUB-GROUP – III

LOGISTICS RELATED ISSUES – RAIL TRANSPORT, BULK TRANSPORT, CEMENT EXPORT, CEMENT IMPORT AND WTO

1.0 Introduction

1.1 The industry needs to prepare itself to face the challenges thrown by globalisation. The Sub-Group III has hence focussed its stress on three main issues, which are of urgent concern to the industry, viz., Bulk Cement Transportation, RMC, Exports and the problem likely to be faced due to the implications of WTO, particularly FTAs with Sri Lanka, Thailand and other counties under SAARC, BIMSTEC, and ASEAN.

1.2 Competitiveness of the industry is a key issue, and the impact of costs such as, royalty on limestone, grid power, railway freight and taxes & duties come into sharp focus. The industry is saddled with heavy taxes and duties and such duties accounting for over 70% of the production cost. These costs restrict industry's performance and growth also have a direct bearing on exports.

2.0 Rail Transport

2.1 Cement, being a low value and high volume commodity, its dependence on railways for movement of finished product need not be emphasized. Dependence on railways also increases because it is mineral based industry and around 1.5 tonnes of limestone is required to produce one tonne of cement. Accordingly, most of the cement plants are located at or near the limestone deposits, which are mostly away from the main cement consumption centres. The industry, therefore, has to depend mainly on railways to despatch cement particularly for distance beyond 30 to 40 kms.

2.2 Besides limestone, other major raw materials required by the industry are coal & gypsum. Both are location specific. Industry needs about 200 kgs. of coal to produce one tonne of clinker. Similarly, about 50 kgs. of gypsum is needed per tonne of cement.

2.3 With the recent trend of setting up of grinding units near the consumption centres, industry depends heavily on railways for movement of clinker. Similarly fly ash from thermal power plants and granulated slag, which is

a bi-product of steel plants, need to be moved from the power plants/steel plants to consuming cement factories.

2.4 The Task Force on cement industry for the IX Plan period recommended a target of 60% of cement product to be moved by rail. This includes movement of clinker also. However, due to various constraints, target could not be achieved and railways at present are moving only about 39% of cement by rail. The trend of modewise cement despatches during last 10 years is given in the table below:

Cement Despatches by Rail, Road and Sea

Year	Despatches (Mn.t.)				%age Despatches by Rail to Total
	Rai.l	Road	Sea	Total	
1997-98	32.58	43.99	-	76.57	43
1998-99	32.72	49.11	-	81.83	40
1999-00	38.71	55.29	-	94.00	41
2000-01	36.8	56.64	-	93.44	39
2001-02	36.2	64.06	2.11	102.37	35
2002-03	37.12	72.25	1.70	111.07	33
2003-04	39.28	76.45	1.50	117.23	34
2004-05	41.45	83.55	2.14	127.14	33
2005-06	48.11	85.61	7.87	141.59	34
2006-07 (Upto Sep.06)	28.39	39.90	3.65	73.65	39

2.5 In addition to the above, the railways have been moving about 15 mn.t. of clinker to grinding units.

2.6 It would be seen from the above table that there has been continuous fall of rail share of cement despatches till 2004-05. However, since then with the improvement in railway's performance, share of cement traffic again has started increasing. Cement production during XI plan period is likely to increase to about 269 mn.t. With the recent improvement in railway's performance, it would be realistic to fix a target of 50% of cement production to be moved by rail. In addition to this, the movement of clinker by rail also would increase from 15 mn.t. at present to 30 mn.t. The requirement of rail facilities for movement of other inputs like coal, gypsum, granulated slag & fly ash will also increase. Following table will give the expected targets for movement of all inputs finished product to be moved by railways in the terminal year of XI Plan i.e. 2011-12.

Commodity	Qty. in million tonnes	Wagon requirement per day in terms of rakes	Remarks
Cement	130	150	2500 tonnes per rake with 350 working days
Clinker	30	24	'N' rake to 3600 tonnes for 350 days
Coal	30	24	Out of total requirement of 46 MTs, balance quantity is expected to be moved by road from coalfield/ports
Slag	10	8	--
Fly ash	10	10	Subject to availability of suitable wagons and incentives

2.7 At present, entire fly ash is being moved by specially designed road tankers. However, recently railways have converted some old petroleum tank wagons with a remaining working life of about 5 to 7 years for this purpose. To attract fly ash traffic, railways may have to either purchase specially designed wagons for fly ash or allow an attractive freight rebate, to enable the cement industry to make investment in these specially designed wagons, in line with rebate currently allowed on movement of cement in bulk.

2.8 The targets indicated above will not only help the cement industry to achieve the ambitious target of cement production of 269 mn.t. for the terminal year of XI plan, but will also help the country economically as rail is the most fuel efficient mode of transport while reducing burden on road sector.

2.9 Reduced level of rail movement would result in additional transport cost to cement industry which may ultimately have its impact on the market price of cement as well as its availability, particularly in far off areas where movement by road would be difficult such as Assam & North Eastern States.

2.10 To achieve the target of rail movement for the XI Five Year Plan, railways have to gear up suitably to meet the growing requirement of cement industry. Major problems envisaged in this regard are as under:

a) Increase in freight rates

Movement by rail involves multiple handling and in shorter leads road transport is more cost effective. No doubt, during the past couple of years, railways did not increase rail freight for Cement, but recent increases are likely to shift the pressure in favour of road.

b) Long Term Incentive Scheme

This Incentive Scheme was a bold initiative meant to sustain and encourage growth in freight traffic and applicable to the entire traffic. It was also meant for long term at least up to three years. Incentive was to be given immediately by way of rebate on RRs. However, refund route has robbed the incentive value inherent in a rebate scheme and is fraught with uncertainty and delays in-built in any refund process.

The scheme is being implemented on incremental traffic that too for one year and on refund basis for rest of the period. Further, a clarification given by the Railway Board has restricted the incentive to the incremental traffic only, thus diluting the efforts to boost cement loading.

c) En-Route Re-Weighment of Cement and Levy of Penal Charges

Cement companies are experiencing hardships due to frequent en-route re-weighment of cement and also forced to pay heavy penal charges with no fault of theirs.

All major cement players located in SEC Railway have been subjected to re-weighment of cement/clinker rakes and heavy penalty levies.

Cement is a bagged commodity and as per Weights and Measures Act, the packers are calibrated to fill 50 kg. per bag. So long as there is no variation in the number of bags in a wagon. Moreover, there is no weighment of empty rakes as railways are going by the printed tare weight of wagons, ignoring increased weight on account of added material during maintenance and repairs.

d) Re-Weighment of Coal Rakes/Wagons En-route/Destinations

Railway Board's circular No. TC-I/2002/109/5 dated 15th November 2002 clearly states that once a wagon/rake is weighed at originating station/first available weighbridge station under the supervision of railway staff, no rake/wagon should be re-weighed at enroute/destination stations under normal circumstances. For a customer, it is not clear which weighment the railways are treating as final i.e. the first weighment of the originating point or the second point at enroute/destination stations.

It has been reported that on re-weighment, sometimes excess weight is found in few wagons and shortage in the remaining wagons of a rake, but in totality there is net shortage of coal in almost all the rakes to the originating weighment. However, Railways ask customers to pay the penalty for those wagons found with excess weight, whereas no credit is given for the shortage of weight detected in the remaining wagons of that particular rake. This does not stand to any logic.

e) Loading of Cement in Box 'N' Rakes

Railway Board has recently increased the concession to 15% from the earlier 10% for loading in open wagons to meet the cost of fixing tarpaulins, twines, wagons cleaning, insurance, etc. However, they have also levied a surcharge of 5%, which has nullified the increase in the concession.

Cement industry has been pleading from time to time, that this concession is inadequate even to meet the cost of tarpaulins, twines, etc.

f) Freight Rebate for Clinker when Moved to Open Wagons

Like cement, quality of clinker also deteriorates when it comes into contact with water/moisture. To protect the clinker from rains, industry has to meet the cost of fixing tarpaulins, twines, etc. Railway Board gives a 15% freight rebate when cement is moved in open wagons, but there is no such rebate for clinker.

g) Development of Terminals

Presently most of the major terminals lack facilities such as covered sheds, lighting for 24 hours working, proper raised platforms & other logistic requirements.

Moreover because of the various restrictions in truck movements in important cities, it is not always possible to lift the material lying on platform in time. On account of these constraints, cement plants are required to pay huge wharfage/demurrage charges at the terminal points.

Further, most of the cement terminals at or near metro cities have reached a saturation point, where additional unloading is not feasible.

h) Transportation of Fly Ash and Slag By Rail

At present, cement industry is consuming more than 18 mn.t. of fly ash, which is likely to increase 35-40 mn.t. by the end of XI Plan. Cement industry is presently moving almost entire quantity of fly ash by road, as movement by rail is uneconomical. However, there is a huge potential for railways to tap this market.

i) High freight rates

Recently a study made by one of the premier chambers shows that while passenger fare rates are lower by 55% in India as compared to China, freight rate for goods are higher by over 60% as compared to China.

j) Increase in Carrying Capacity of Covered Wagons:

Due to increased carrying capacity, the additional bags are now stacked near the doors of the wagon. Even after taking all necessary precautions, rain water penetrates from the door. As a result, almost all the bags, stacked near the door, get damaged.

k) Maintenance Charges for Railway Track

Normally, railway tracks in the private sidings are being maintained by private siding owners. However, certain small portion at the connecting point, where the track portion is very small is also being rounded off to higher side and maintenance for the same is levied. For instance, even in case where the length of such track which is being maintained is below 0.1 km, it is rounded to half KM and is being charged to cement companies.

3.0 Bulk Cement Transportation

3.1 Indian cement industry witnessed vibrant growth during the last two decades. The distribution and usage system of cement in the country, however, continues to remain primitive and as such needs upgradation. In the developed countries, over 70% of the cement is transported and distributed in the form of bulk, whereas in India, it accounts for around 5% only and balance cement is distributed in outdated mode of 50 kg bags. Availability of cement in bulk and its usage is critical for the modernization of the construction industry. The first step is to put up modern Bulk Cement Terminals at important distribution/consumption centers in the country. These terminals could either be based on movement by rail for land locked plants or from coast based cement plants to port based terminals through coastal shipping.

3.2 The First Rail Bulk Cement Terminal was set up with the active participation of Ministry of Industry, World Bank and Railways in 1995-96 near Kalamboli, Mumbai. Since then, only one more rail bulk terminal has been set up near Bangalore. In addition to this, 3 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.

3.3 So far no terminals have been set up to take advantage of viable river routes.

3.4 Advantages and Benefits of Bulk Transportation

3.4.1 Cement, in bulk, is transported in specialized bulk carriers (wagons, road tankers and ships) and then unloaded and stored in silos at bulk terminals and then further distributed in specially designed bulk road tankers to the construction sites where 15 – 30 tonnes mobile silos are installed. It is then pumped into these silos for storing and consumption. While the entire process is very efficient and environment-friendly, it has several other benefits:

- The loss on account of seepage, multiple handling and occasional bursting of bags is totally avoided. With the targetted cement production of 269 mn.t. by end of the XI Plan, there could be a loss of around 2.7 mn.t. if cement is transported in bags, taking into account a loss of 1% due to seepage and multiple handling. This national loss could be eliminated by transportation of cement in bulk.

- Pilferage during transit and at the site is avoided.

- Dust emissions at railway yards, cement handling godowns, transportation by trucks and construction sites is now a major concern in cities. The resultant Suspended Particulate Matter (SPM) levels lead to crores of rupees being spent by the government towards health related issues. Use of bulk cement through modern bulk terminals and related equipment would significantly contribute to reduction in pollution levels.

- Plastic bags, which are currently the preferred mode of packing used in India, are not environment friendly, since these bags are non bio-degradable. Bulk transportation avoids such pollution.

- A major advantage of transporting bulk cement is the easy availability in large volumes and consistent quality.

- The shelf life of cement is increased when transported in bulk and stored in silos.

- Need for storage space is considerably reduced resulting in savings in multiple handling and storage costs.

- Transportation of cement in bulk has been able to reduce the project implementation time and cost. In mega-cities such operations have been demonstrated successfully. Construction of Flyovers, Multistoried buildings, Housing complexes, Malls etc. have been possible only with the help of modern construction technology including usage of Ready Mix Concrete (RMC) and Bulk Cement. RMC is a corollary to Bulk Cement. RMC has advantage of consistency in quality and helps in speeding up construction activities.

- With the advent of mega Infrastructure Projects, face of construction industry is changing rapidly. The concept of Housing Complexes, Malls and Multiplexes is becoming popular in smaller towns also. Construction industry would immensely benefit from development of Transportation of Cement in Bulk and RMC.

- Bulk Cement can only be transported in specialized tankers - be it railway wagons, trucks and ships, resulting in captive business for railways, truck operators and cargo liners. This system would attract private investment in development of railway yards/sidings. These facilities would normally be away from the existing congested railway facilities. It would help railways to develop existing and new terminals economically for other industries too.

- Railways could be the major beneficiary of transportation of Cement in bulk as this efficient system would result in faster loading/unloading, higher turn-around time for the wagons and higher track availability. This becomes important because of the competitiveness of railways viz-a-vis road.

- Bulk Cement transported through coastal route would help in faster turn-around at ports. Most of the vessels reaching ports occupy berths for 3- 4 days only in a month thus permitting usage of such berths for handling other cargo. Such movement would lead to efficiency of Ports apart from higher revenue generation.

3.4.2 Advantages of transportation of cement in bulk have been recognized by various Government agencies but still not fully exploited. Such a vast potential, which remains untapped, needs immediate attention of concerned Government

agencies so that models like New Mangalore, Surat and Mumbai can be emulated at least at one Port each on East and West Coasts in the immediate future. Similarly rail terminals at new Mumbai and Bangalore need to be set-up near other major consumption centres.

3.5 Bulk Terminal and Its Limitations

3.5.1 Though, first Bulk Cement Terminal was set up more than 10 years ago, much progress has not been made for setting up of desired number of terminals at other important consumption centers. This has been mainly because of the following factors:

- Non-availability of land near railway line/goods shed around major consumption centers particularly metropolis at economical price.
- Based on current market prices of land near major consumption centers, the setting up of bulk terminals becomes unviable.
- For movement of bulk cement, specially designed rail wagons have to be owned by Terminal owner, as railways as a matter of policy are not making investment in any type of special purpose wagons. Railways are at present giving rebate of 22.5% for a limited period of 10 years. With this rebate restricted to 10 years period, the heavy investments to be made on procurement of specially designed wagons and plants and machinery, become unattractive and unviable.
- Promotion of usage of Bulk Cement is a time consuming process and needs heavy investment for educating consumers. The Government departments are particularly reluctant to use cement in bulk in spite of various benefits. This is mainly because of the century old construction practices being followed by these Departments.
- Despite vast coastal line of 7000 km. with 13 major ports and 187 minor ports, not much progress has been made in setting up of bulk terminals except the 3 terminals established in 90s. One of the impediments is the initial heavy investment, return on which is spread over 20 – 25 years. Concerned Government agencies are reluctant to allow setting up of storage silos, and handling facilities near the water front despite the fact that entire process of transportation, handling and bagging of cement is totally covered and devoid of even any fugitive emission. In fact, the entire system is eco-friendly.

- Government of India in 1999, authorized State Government to give Environment Clearance for setting up of stand-alone grinding units whereas in case of port based cement handling and storage terminals, Central Government is reluctant to give environmental clearances resulting in non-utilization of cost-effective and environmental friendly mode of transportation, which could ease pressure on over strained railways and road transport system.

- All laws and rules applicable to factories and industrial units are applicable to Bulk terminals. In the era of liberalisation there are some 30 odd inspectors and agencies that control the compliance of various rules for industrial and commercial establishments. These rules and regulations do not apply to packed cement conventionally transported through public railway yards or by road. These issues act as deterrents for cement companies to invest in Bulk Cement Terminals. As cement companies hesitate to put up infrastructure for bulk movement, the availability of cement in bulk remains limited, and so does the user base for bulk cement and RMC.

4.0 Ready Mix Concrete (RMC)

4.1 In India, growth of Ready Mix Concrete (RMC) industry is directly linked to growth of bulk cement especially in urban centers. RMC industry assures several benefits, not only to large consumers, but even to smaller consumers. The industry's growth has not kept pace with the growth in cement industry mainly because of RMC units not being able to compete with the age-old practice of site mixing. The industry being in organized sector is faced with inherent disadvantage of heavy investment on plant and machinery and very high prices of urban land, in addition to high taxes and levies.

4.2 With unprecedented boom in construction sector, big players in organized sectors have also started entry even into in small cities and towns. For meeting requirement of bulk cement in semi-urban areas, large projects in many cases are converting cement from bags into bulk before consumption in their batching plants due to non-availability of facility of Bulk Cement and RMC.

4.3 The need of the hour is to change the consumer perception i.e. from bags to bulk by creating an enabling situation that would promote setting up of RMC plants. With planned growth of GDP at 9%, the pressure on implementing agencies putting infrastructure projects would be enormous, both in terms of cost and scale. Only solution would be to provide transportation of cement in bulk and also use of RMC.

4.4 Most of the smaller scale construction activities even in mega cities are in the hands of unorganized contractors, who resort to old age practice of using site mixing. Public land is invariably used to dump all the construction materials causing adverse impact on environment. No taxes are involved in site mix concrete. Contractors for obvious reasons choose not to maintain desired level of concrete quality.

4.5 Considering the eventual cost of frequent repairs required for poor construction, the outflow of wasteful expenditure from nation's economy would reduce, as RMC would bring improvement in quality of construction and move the construction industry in line with international practices. There are significant long-term financial benefits in terms of quality and durability.

5.0 Export of Cement

5.1 Indian Cement Industry with state-of-the-art technology can boast of quality that matches with World's best. The industry is capable of producing cement to the specified standards of any importing country. Indian cement has made its strong presence in various countries across the globe and during the last two decades it has extended its availability to over 35 countries.

5.2 With a beginning of mere 1.5 lakh tonnes in 1989-90, Indian exports have grown to over 10 mn.t. in 2004-05. During the last few years Indian cement has established itself not only in the neighbouring SAARC countries but also in West Asia and African continent.

5.3 The details of cement & clinker exports during the last 5 years are given in the following table.

(Mn.t.)

Year	Cement Export	Clinker Export	Total Exports
2001-02	3.38	1.76	5.14
2002-03	3.47	3.45	6.92
2003-04	3.36	5.64	9.00
2004-05	4.07	5.99	10.06
2005-06	6.01	3.18	9.19

5.4 Cement Industry has the capacity to export cement / clinker to the tune of 15 – 20 mn.t. during the XI Plan period. However, the boom in cement demand in West Asia which has provided a good opportunity for cement exports is likely to

taper-off by mid 2008. Hence Indian exporters would have to penetrate in other markets, which are likely to be Africa, Europe and also United States of America. The industry has been facing problems in increasing exports due to lack of modern ports with mechanized bulk handling facilities, proper connectivity to ports, high cost of inputs and transportation making Indian cement less competitive in the International market.

5.5 World Scenario

5.5.1 The World Cement consumption has grown steadily at 4 – 5% to reach 2.3 Billion Tonnes in the year 2005. The world cement capacity was at 2.74 Billion Tonnes.

5.5.2 India produced 148 mn.t. (including mini cement plants) which accounts for 6.43% of world cement production. India is the second largest producer in the world after China which accounted for 1060 mn.t. having share of 46% of world production.

5.6 Per Capita Consumption

5.6.1 The per capita consumption of cement in the world is 355 Kgs, as against 130 Kgs in India. The growth possibility of Indian cement industry is hence enormous.

5.7 Cement & Clinker Trade

7.1.1 World Cement Exports during the year 2005 were 160 mn.t. accounting for 7% of the World Cement Production. The Major cement exporting countries are :

Country	**Million Tonnes**
China	20
Canada	8
Egypt	9
India	10
Indonesia	7
Japan	10
Thailand	9
Turkey	11

5.7.2 The above 8 countries accounted for over 50% of world exports. India's share of exports was 6.25% of world trade.

5.7.3 The major importing countries in 2005, were the United States of America – 30 mn.t. followed by UAE, Spain, Vietnam, Singapore, Iraq and most African countires. Our own neighbours import cement and clinker : Bangladesh - 6 mn.t. of clinker and Sri Lanka 2.4 mn.t. of cement and one mn.t. of clinker annually.

5.8 Export Scenario for Next 5 Years

5.8.1 Due to huge construction boom in the middle-east, supported by astronomical rise in oil prices and reconstruction activity in Iraq, the export of cement & clinker has largely been to these countries besides Africa and Srilanka in the last 2 years. The FOB prices have also been healthy.

5.8.2 Large scale capacity expansion in the cement industry is happening in UAE, Saudi Arabia, Iran, Pakistan and Egypt and the capacities are expected to be commissioned in 2007-08. These capacity expansions will facilitate their self sufficiency in cement requirement necessitating the Indian Cement producers to concentrate on newer markets of Africa and Europe besides stepping up despatches of cement and clinker to Srilanka and clinker to Bangladesh.

5.8.3 The details of consumption of cement in Middle East countries during the year 2005 including surplus/(deficit) :

Table 1: Cement statistics in the Middle East – 2005(E)

Country	Effective Capacity	Consumption	PCC (kg per person per year)	Last three-year average consumption growth (%)	Surplus/ (Deficit)
Saudi Arabia	26.8	26.7	1109	9.44	0.1
Iran	35.0	37.0	548	11.03	(2.0)
UAE	13.1	12.7	2920	25.66	0.4
Oman	2.4	2.8	866	18.10	(0.4)
Qatar	1.5	2.3	3541	14.78	(0.8)
Kuwait	3.0	4.9	1708	21.23	(1.9)
Bahrain	0.2	0.9	1287	7.23	(0.7)
Yemen	1.5	3.9	195	12.53	(2.4)
Syria	5.4	7.0	364	11.42	(1.6)
Jordan	4.0	3.8	655	13.48	0.2
Lebanon	4.8	2.6	587	1.32	2.2
Iraq	2.5	11.0	405	n/a	(8.5)
Total	**100.2**	**115.6**	**643**	**14.19**	**(15.4)**

Source: CMA

5.8.4 The changed scenario due to capacity additions in the above mentioned countries in respect of supply, demand and surplus/(deficit) is given in the following table.

Table 2: Middle East cement – 2010 (F)

Country	Effective Capacity	Consumption	PCC	Surplus/ (Deficit)
Saudi Arabia	53.0	38.0	1360	15.0
Iran	73.0	60.0	830	13.0
UAE	26.1	20.4	3505	5.7
Oman	5.4	4.3	1072	1.1
Qatar	3.7	3.5	4603	0.2
Kuwait	4.7	7.8	2220	(3.1)
Bahrain	0.4	1.3	1635	(0.9)
Yemen	6.0	5.4	228	0.6
Syria	11.0	10.5	462	0.5
Jordan	6.5	5.0	733	1.5
Lebanon	4.8	3.1	657	1.7
Iraq	7.5	18.0	572	(10.5)
Total	213.1	177.3	903	24.8

Source: CMA

5.8.5 Bangladesh imports 6 mn.t. of clinker and Srilanka imports 2.4 mn.t. of Bulk Cement and one mn.t. of clinker annually. These are SAARC nations and continued preference should be given by lower customs duty for Imports from India.

5.8.6 European countries have slowed down on cement plant capacity expansion especially due to strict EU Norms on pollution. This will give us a good opportunity to export bulk cement to countries like Spain & Greece.

5.8.7 Though large growth in exports in the near term is difficult, India, by exploring new markets and maintaining a large presence in Sri Lanka and Bangladesh, can maintain current level of growth and increase exports upto 15 mn.t. by end of XI Plan period.

5.9 Strengths and Weaknesses for Cement Exports

5.9.1 Strengths

⇒ Indian cement exporting companies have established strong presence in SAARC countries, West Asia and some countries in Africa.

⇒ Indian cement industry, 2nd largest in the world only after China has 90% of the plants producing well over 100% of the capacity. The cement industry can boast of having most modern state-of-the-art technology cement plants at par with the best in the World. Energy consumption both thermal and electrical is as low as compared to best elsewhere in the World.

⇒ The Indian cement industry comprising of 130 cement units mostly having capacity over million tonnes per annum spread across the country. These plants are manned by highly skilled team of personnel trained and experienced having stood test of the time. The industry is fully supported by availability in abundant quantity of its main raw material – cement grade limestone. Cement production is not only sufficient to meet the domestic demand in full but also export in large quantities. The industry is gearing itself to put in huge investments in next five years to meet the growing demand.

5.9.2 Weaknesses

Indian cement industry in the past and also at present is confronted with various problems in exploiting export potential in full. These are mainly-

⇒ High costs due to heavy taxation.

State Levies and Taxes on Cement Exports

Sl No.	Item	Rs/t. of Cement (Avg)
1	Royalty and Cess on Limestone	69
2	Royalty on Coal	22
3	Royalty on Gypsum	1
4	Duties on Power Tariff	27
5	Sales Tax on Stores & Spares for Cement Production	15
	Total	134
	Indian Costs Compared to competing Countries	
1	Interest on Export Credit	53
2	Power Tariff	180
3	Port Charges	150
	Total	383
	Overall Impact	517

Say USD 11.5

⇒ The major raw material required for clinker/cement production is limestone which is available in adequate quantity. Limestone along with other inputs such as silica sand, laterite, bauxite etc. are to be procured by paying considerable royalty to State/Central Government. Similarly, power tariff & duties on power tariff, VAT on stores &spares and heavy port charges make Indian exporters less competitive in export market. The Cement Industry, therefore, has a disadvantage of about USD 11.5 per tonne of cement exported as compared to its competitors.

⇒ Lack of infrastructure facilities both for movement of cement from land locked cement units and also at ports adds to cost for cement exports. There is not even a single dedicated berth for handling cement at any of the Indian ports. Exporters have to incur additional cost due to non-availability of berths at ports by way of heavy wharfage charges to Shipping companies. Another component that adds to the cost is heavy inland freight incurred by the land locked plants to move cement from the plants to the ports.

⇒ Loading facilities at ports are very poor. Best loading rate of 2,500 tonnes per day, which is far low compared to international levels of 12,000-15,000 tonnes per day.

⇒ Taxation in most of the countries is rationalized and a single point value added tax is charged. In China, it is 17% of the F.O.B. value.

⇒ DGFT, in May 2005, have restricted import of duty-free inputs to the levels of actual consumption. In other words, efficient cement exporting units are being penalized for their efficiency. Standard input/output norms once approved by Government should continue to be allowed.

⇒ China has enormously improved its export performance from 5 mn.t. in 2004 to over 21 mn.t. in 2005. This has been possible because of the low rate of taxation and high level of improved infrastructure facilities for handling & trasnportaion of cement. It has been reported by China Cement Association that 60% of total cement in manufacture and despatch chain is covered by low cost Inland waterways.

⇒ It is of paramount importance that the Government and industry look at the cement exports strategically. Government should create a level playing field for the industry to increase exports as envisaged in the XI Five Year Plan.

6.0 Imports and implications of WTO

6.1 The Indian Cement industry has achieved technological excellence at par with the World's best and also acceptability of Indian cement has extended as far as Europe. To sustain the level of competitiveness, Government needs to provide level playing field in terms of (i) lower taxes, (ii) quality inputs and (3) infrastructure & lower cost of transportation. Mature Indian cement industry fully supports Government's policy of globalisation. However, it is necessary for the Government to have a look at the support in terms of subsidies & non-tariff barriers being provided to the cement companies in other countries.

6.2 Indian Government should consider imposing such quality testing and registration barriers as are applicable to Indian cement manufacturing companies. Cement being a commodity of mass consumption needs to maintain the quality specified under BIS specifications. Production, distribution & sale of cement is subjected to testing by BIS authorities and unless imported cement is put under similar system of testing for achieving minimum norms of BIS, a potential threat of addressing quality complaints would be extremely difficult to contain.

6.3 The import duty on cement is already at a very low level of 12.5% resulting in eminent threat to the domestic industry. Indian cement industry has been impressing upon Government to keep cement/clinker in the negative list for FTAs as it would lead to (a) output contraction (b) employment loss (c) decline in investment and capacity utilisation.

7.0 Inland Waterways

7.1 Cement Industry, in India, has recognized importance of logistics cost to remain competitive both in domestic and international markets. At present, bagged and bulk cement is mainly transported either by rail or by road. Only around 2% of cement is transported in bulk through coastal route. One of the viable alternative measures for increasing bulk transportation is good connectivity of cement manufacturing units with ports through water ways. No doubt, transportation of cement through inland waterways is smooth but at present is not hassle free and does not compliment with the entire transportation system.

7.2 Presently, three national waterways (i) The Ganga-Bhagirathi-Hoogly River System from Allahabad to Haldia (1620 kms.) – NW-1; (ii) The Brahmaputra from Sadiya to Dhubri (891 kms) – NW-2 and (iii) The West Coast Canal from Kollam to Kottapuram along with Champakara and Udyogmandal canals (205 kms.) – NW-3 are operative. Its shares is just 0.24% of total transport volume of the country.

7.3 Inland waterways sector in India is still in its infancy as compared to countries like USA, Russia, China and European Region. In India total cargo transported through IWT mode is largely confined to Goa, West Bengal, Assam, Mumbai and Kerala. As a result, Cement Industry, which is located in land locked areas, is not in a position to take advantage of the system. Very negligible quantity of Cement is transported through Inland Waterways system.

7.4 IWT Infrastructure

7.4.1 The infrastructure and the facilities have not improved at the desired level even now. The growth in cargo movement depends on ensuring efficiency parameters of time taken in delivery of cargo and cost effectiveness of operations so as to have lower freight structure than rail / road. Various plan schemes are underway to improve efficiency to these parameters. These are proposed to be continued in XI Plan. They include putting in place :

- Adequate fairway (LAD and Width of Waterway), Night Navigation facilities and Channel Marking.
- Loading / unloading and storage facilities at the terminals.
- Availability of suitable barges for difference type of cargo (General, POL, Container etc.).
- Fuel efficient M.V. Vessels
- Arrangements for Multi Modal Transportation.

7.4.2 Due to the above mentioned infrastructural deficiencies, a vessel is not able to make as many trips as it should, to make the operations commercially viable. Also, 50% of the operating cost is the fuel component.

7.5 Advantages

- Low level of skills required for IWT movement.
- Low maintenance cost compared to other modes.
- Energy efficient and environment friendly mode.
- Can reduce burden on over-stretched rail and road transportation system, specially for the backward areas in North-Eastern Region.

8.0 Recommendations

- ***With cement industry adding over 118 mn.t. capacity during the XI Plan period, timely and adequate wagons availability needs to be ensured –***
  - ***Through a long- term transport agreement.***
  - ***Cement industry specific long-term policy.***
- ***To encourage transportation of cement by railways, appropriate incentive schemes should be worked out on long-term basis, besides making the existing schemes effective and user friendly.***
- ***The present rate of concession of 15% for loading cement in open wagons should be suitably increased and extended to clinker also.***
- ***Railways may initiate the process of supervising weighment of wagons at loading point and avoid re-weighment enroute or at destination. This will not only ease the additional financial burden on the industry but also help increasing the rail co-efficient for cement.***
- ***Railways need to improve the facilities at the major terminals by providing proper platform, sheds and facilities for loading and unloading. Railways should also set up new terminals in a time bound manner so as to be operational by the middle of XI Plan.***
- ***The classifications of fly ash for freight charges prevailing earlier should be restored with a view to encourage more use of fly ash.***

  A freight rebate, as is given for bulk movement of cement, should be given for movement of fly ash in special purpose wagons. The Railway Board has been providing such rebates for bulk movement of cement on the Malkhed-Bangalore and the Wadi-Kalamboli routes. The rebate needs to be extended till the life of the wagon, i.e. 35 years, so as to make investments in special purpose wagons a viable proposition.
- ***Railways should provide land near railway goods sheds on long-term lease to cement companies for setting up cement bulk terminals.***
- ***Govt. should permit setting up of port based bulk terminals for bulk transportation of cement.***

- ***Cost of setting up of a bulk cement terminal of 1 mn.t. capacity is around Rs. 80 crore. Since the payback period is long, a rebate in excise duty for a specified period should be given for cement despatched from cement plants to the bulk terminals.***

- *The State Governments are authorized to grant environmental clearances to the stand alone grinding units. For the purposes of environmental clearances, port based/inland bulk handling terminals should be treated at par with the stand alone grinding units and State Governments should be authorised in this regard.*

- *The RMC is subject to VAT whereas the same ingredients (sand, cement and aggregates) when used for site mix are not subject to VAT. To promote RMC and provide for a level playing field, the State Governments should be persuaded to withdraw VAT/Sales Tax on RMC.*

- ***Government needs to facilitate setting up of at least a terminal each on the east and west coasts for exports.***

- ***Cement manufacturers should be encouraged to explore the possibilities of markets and consultancy business in Asia, Europe, Africa etc.***

- *Though export of cement is limited, concerted efforts are required to protect the existing export markets in view of increasing competition from China. In this regard following steps are required:*

  - ***Reduction of taxes and levies.***

  - ***Making available power and other inputs at international prices.***

  - ***Reducing port and bunker charges.***

  - ***Including cement and clinker in the focused products for the purposes of exports.***

  Cement /Clinker should be included for preferential treatment in FTA with Bangladesh

- ***Required infrastructure should be developed by providing suitable connections from landlocked cement plants to the river systems. Dedicated terminals with proper loading/unloading system should be established to facilitate multi-modal transportation and facilities for night navigation.***

- ***At present, incentive of 20 paise per tonne per km. for moving cargo through national waterways is subject to the following conditions:***

  - ***The scheme is applicable for movement of cargo for at least 100 km. in NW-1 and NW-2 in one trip one way by mechanized vessel registered under the Inland Vessels Act, 1971.***

  - ***In NW-3, the scheme is applicable for movement of more than 50 km. one way by any mechanized vessel registered under the Inland Vessel Act.***

  - ***The scheme is not applicable for exclusive movement between the route of Haldia and Kolkata where infrastructural facilities are fully developed.***

  Government should consider for relaxation/withdrawal the above conditions.

- *Dedicated terminals need to be developed on the three national waterways for loading and unloading of Cement.*

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