CHAPTER 1

SUITABLE SITE SELECTION FOR INSTALLATION OF A CEMENT PLANT

1.1 Introduction

Techno-economic feasibility study of a Project helps in arriving at investment decision. Setting up of a cement plant is very high capital intensive. Suitable plant site is essential for installation of an economically viable manufacturing unit. Minimum initial capital investment cost in setting up of a new cement plant and its low operating cost are very much required for its profitability.

Cement manufacturing is a continuous process. Except in case of machinery break downs and during the annual maintenance period, the plant is not stopped.

While selecting an appropriate site, various influencing factors are to be considered from the available alternative choices. Sometimes these may be of contradicting nature. Their pros and cons are to be thoroughly studied from overall cost considerations. Based on this comparative study, plant site which enables minimum capital expenditure and also results in minimum production cost is to be decided. This chapter highlights and discusses several related factors in this regard.

Figure 1.1 Cement Plant – A typical view.

1.2 Two Distinct Production Units

Cement plant has two distinct processes / product related installations; (i) Clinkerization unit manufacturing semi-finished product, viz: cement clinker and (ii) Clinker grinding unit producing the final finished product, viz: cement.

The first one is preferable to be located nearer to the Raw materials'source and the second one, proximity to the cement consumption market. As per the advantages of the Plant sites, an integrated plant or a plant with split location may be selected. In split location the Clinkerization unit and Cement grinding unit are located at separate appropriate places.

1.3 Clinkerization Unit

For manufacturing of cement clinker, several raw materials are needed. These are:

- Calcareous materials like Limestone, marl, sea shells etc. These are the main raw material forming about 75-80% of the total raw material required. For every one Ton of cement manufactured,about 1.5-1.6 Tons of the raw material is required. These are naturally occurring geological formations. In few cases, by-product chemical lime is used as calcareous material.
- Depending on the chemical composition of the raw material, following additive materials are needed. Requirement of these may be around 20-25% of the total raw material.
  (i) Argillaceous materials like clay etc.
  (ii) Ferruginous materials like Iron ore, laterite etc.
  (iii) Aluminous material like Bauxite, clay etc.

Coal or furnace oil is necessary as fuel for clinkerizing the raw meal to produce cement clinker.

For producing cement from clinker, following are needed.

(i) Gypsum 3-5% of the clinker.
(ii) Granulated Slag or any other puzzolonic material. This is ground with Clinker to produce varieties of blended cements. These may be to an extent of 30-60% of the clinker and sometimes even more..

As the final product is only 60-65% of the raw materials, the Clinkerization plant should be located nearer to the Lime Stone deposit. This deposit is normally in the form of hills or underground formation or sea bed which needs to be quarried. To operate one million Tons per year capacity plant for 50 years, about 80-100 million Tons of lime stone reserves are essential. From consideration of economy of scales, presently the plant capacities are more than 2.0 million Tons per year. Accordingly the deposit should not be less than 200 million Tons.

Currently, the largest Cement Kiln in the world is Xuan Thanh plant in Vietnam having production capacity of 4.13 million Tons per year (12,500 Tons per day).

Quarried Lime stone may be transported to the Plant site by road through heavy dumper- trucks or aerial ropeway. Aerial rope ways are not preferred at present because of their higher maintenance costs.

Lime stone Crusher may be located at the quarry, if the hauling distance is more than 5-10 km. Crushed material may be transported through a set of belt conveyors to the Lime stone storage located in the Plant.

In few cases, as the Lime Stone deposit occurs on a hill, primary crusher is located on the hill. Crushed lime stone is transported to the hill slope through a belt conveyor. The side of the hill was formed like a trough chute. Through this rock chute, the stone slides down and forms a stock pile. At the bottom, a secondary crusher is installed. It crushes the material to smaller stones and the output is transported to the Raw material storage by means of a belt conveyor.

Required additive materials may be available nearby or may be transported from distant sources to the plant through suitable means.

1.4 Cement Grinding and Packing Unit

For manufacturing the final product viz: cement, the following materials are needed.

- Cement clinker produced in the Clinkerization unit
- Gypsum to grind with clinker to adjust cement setting properties. Its requirement is only 3-5% of the cement. It is available as a natural deposit or as a by-product of chemical industry.
- The other additional materials as above (i) and (ii) to produce blended cements.

1.5 Site Selection - Influencing Factors

Factors that influence proper site selection.

They are:

(i) Proximity to the main raw material source
(ii) Availability of adequate land for the expected maximum capacity of the plant and its future expansions as well as for residential colony.
(iii) Availability of adequate electric power and water source
(iv) Sufficient fuel source: coal, oil and gas
(v) Location which will have least environmental impact
(vi) Approach to the plant site: road, rail and air connections, water canals, river, sea route etc.
(vii) Proximity to the market
(viii) Availability of skilled and experienced man power
(ix) Local community / municipal regulations and government requirements
(x) Community and labour attitudes
(xi) Proximity to an already developed area
(xii) Climatic conditions; maximum and minimum temperatures, humidity and its range, rain fall: average, maximum and maximum hourly intensity and snow fall
(xiii) Geological and Foundation conditions
(xiv) Consideration for political and strategic issues

These factors are discussed in the following section.

1.5.1 Proximity to the Main raw Material Source

As mentioned earlier (Section 1.3), for every one ton of cement produced,1.5-1.6 tons of Lime stone is needed. Accordingly, the Plant should be located nearer to this main Raw material source as otherwise it would be more expensive to transport Lime stone instead of the final product i.e., cement.

As earlier expressed (Section 1.5), if the market is quite far away, it would be economical to split the plant into two parts, sited at different places. The Clinkerization unit may be located closer to the Raw material source and the semi-finished product clinker may be transported through rail or road or by sea to the Clinker grinding plant positioned nearer to the market. This way, the transportation of Clinker is easier and less costly instead of the Raw Material and, Clinker would not get affected or damaged by the weather conditions during transport unlike cement and the likely losses will be substantially less.

1.5.2 Availability of Land

Requirement of land depends on the capacity of the Plant along with its potential for expansion and the sizes of the planned intermediate storages of the materials at different stages of plant operation. Location of the Lime stone deposit and adequate area for plant siting may be at different locations as per the local situations. Accordingly, lime stone crushing plant may be located nearer to the stone quarry while the rest of the plant can be at a convenient location nearby.

For an integrated plant with provision of future expansion, about 150-200 Hectares of land is needed. Pant structures may be located to suit the process and the ground contour levels of the site. Ground floor levels of process structures may be accordingly decided such that grading and leveling cost would be less.

Location of the residential colony may be little away from the plant site to minimize pollution due to possible gases let out, dust and noise generated during the Plant operation. It is preferable to have good greenery between the plant and colony areas.This also reduces the noise from the plant. A good residential colony with modern facilities attracts and retains right operating personnel.

A million Tons per year plant may need about 250-300 persons. About 30-35 Hectares of land may be needed for the Residential colony. However, it all depends on the types of residential quarters and other amenities proposed to be provided. Possible future expansion of the colony is to be kept in view while acquiring the land.

Thus, adequate land is to be procured with proper notification and compensation to the land owners. Land prices are to be duly taken into account.

1.5.3 Availability of Adequate Electric Power and Water Source

These are required to be available nearby. Otherwise, it will be costlier to bring them over a long distance.

Water requirement of a one million Tons per year plant may be around 2000-3000 cu.m per day including about 200 cu.m for the colony. Suitable all seasons dependable water source is to be located. If needed, a water purification plant is to be considered for drinking water.

Power requirement may be around 20-25 MVA for a million tons per year plant. Proximity to an Electric Sub-Station and supply line is to be investigated and finalized with the Electricity authorities. Otherwise a Power Generation plant may have to be installed. This is to be weighed against drawing the Power supply line from a far off Grid.

1.5.4 Availability of Adequate Fuel Source - Coal, Oil or Gas

Coal is normally used for making cement clinker. With a calorific value of 4000 Kcal /kg of coal, it is needed to the extent of about 25% of the cement weight. For one million Tons per year plant, 250,000 Tons of coal is required. Depending on its source, mode of transportation to the site, frequency of getting it, possible bottle necks in transport, coal storage capacity is to be decided. It is preferable to have covered storage to avoid wetting during rainy season. Suitable measures like installation of water sprinklers have to be done against self-burning of coal in Storage yard.

Oil requirement would be around 1%. That is, for one million Tons per year plant around 10,000 Tons of oil is required. Fuel oil storage is to be properly planned according to its source of supply, distance, mode of transport etc. To ensure continuous operation of the plant, oil transportation to the site and its sufficient storage along with all the safety measures are to be effectively implemented.

Gas storage is to be planned similar to oil as per its calorific value etc. Safety measures have to be strictly adhered to as per the Authorities, while creating the oil and gas storages.

1.5.5 Location which will have Least Environmental Impact

Conversion of any agricultural land into industrial area and removal of trees in the area during construction of the plant should be strictly as per the government norms.

The norms of the Pollution Control Board have to be duly satisfied in regard to the particulate matter in the atmosphere, harmful chemicals in the gases let out from the Chimney and pollutants from the effluent treatment plant.

Cement plants generate objectionable gases, dust and noise at different stages of the production process. Gases like SO_2, Chlorine, NOx and CO_2 are generated. The sulphurous fumes, nitrous oxides and carbon dioxide may be released into the atmosphere through chimney. The height of the chimney should be adjusted so that these gases disperse into the atmosphere within the permissible limits under normal wind conditions. However, the particulate matter in the released gases should be within the prescribed limits.

Otherwise, the surrounding habitation and the agricultural land may get affected leading to possible litigation. Clean environment should be maintained at a possible minimum cost

Dust pollution may be controlled through proper dust collection equipment, like Dust Collectors and Electro Static Precipitators installed at different stages of the plant operation.The scatter of dust on the surrounding agriculture land should be within the limits.

Noise control may be possible by growing adequate greenery and tall trees inside and around the plant area. Some Cement plants leave a green corridor with tall leafy trees around the plant to achieve this. Side cladding of the main process structures help to an extent in reducing the noise effects. If required, air-tight measures for the plant structures (crushers, screen houses and mill houses) need to be implemented to minimize the noise pollution. These can be in the form of hollow brick cladding, insulation and double entry doors and fully closed windows and sky lights. If properly done, the side cladding also enhances the aesthetics of the structures and buildings.

Quarrying of the limestone, should not leave ugly spots particularly when highways run nearby. Such ugly spots should be covered with artificial creepers etc. as being adopted in developed countries (USA, European countries etc.).

It is preferable to treat the plant area with proper landscaping design such that a pleasing environment prevails inside the area. This will enhance the general ambience and also contribute to the productivity of the people.

Table 1.1 gives pollution standards as per the Government.

1.5.6 Approach to the Plant Site; road, rail and air connections, water canals, river, sea route etc.

Easy access to the Plant site is preferable. Proximity to the main highways and railways is a big advantage to the plant site. Raw materials can reach the plant and finished product can be sent to the market at minimum cost. Otherwise additional expenditure is to be incurred

Table 1.1 Revised National Ambient Air Quality Standard (MoEF Notification G.S.R 826(E), Date 16.11.2009).

Sl. No.	Pollutant	Time Weighted Average	New Standards (Schedule VII, Rule 3 (3B) 16th Nov 2009		Methods of Measurement
			Concentration in ambient air		
			Industrial Area Residential, Rural and Other Areas	Ecologically Sensitive Area (Notified by Central Govt.)	
1	Sulphur Dioxide (SO2)	Annual Avg*	50.0 μg/m^3	20.0 μg/m^3	- Improved West and Gacke method - Ultraviolet fluorescence
		24 hours**	80.0 μg/m^3	80.0 μg/m^3	
2	Oxides of Nitrogen as NO2	Annual Avg*	40.0 μg/m^3	20.0 μg/m^3	- Modified Jocob and Hochheise (Sodium Arsenite) - Chemiluminescence
		24 hours**	80.0 μg/m^3	80.0 μg/m^3	
3	Particulate matter (size less than 10μm)	Annual Avg*	60.0 μg/m^3	60.0 μg/m^3	- Gravimetric - TOEM - Beta attenuation
		24 hours**	100.0 μg/m^3	100.0 μg/m^3	
4	Particulate matter (size less than 2.5μm)	Annual Avg*	40.0 μg/m^3	40.0 μg/m^3	- Gravimetric - TOEM - Beta attenuation
		24 hours**	60.0 μg/m^3	60.0 μg/m^3	
5	Lead (pb)	Annual Avg*	0.50 μg/m^3	0.50 μg/m^3	- AAS/ICP method for sampling on EPM2000 or Equivalent filter paper - ED-XRF using Teflon filter paper
		24 hours**	1.0 μg/m^3	1.0 μg/m^3	
6	Carbon Monoxide (CO)	8 hours**	2.0 mg/m^3	2.0 mg/m^3	-Non Dispersive Infra Red (NDIR) -Spectroscopy
		1 hour	4.0 mg/m^3	4.0 mg/m^3	
7	Ozone	8 hours**	100.0 μg/m^3	100.0 μg/m^3	-Photometric -Chemiluminescence -Chemical method
		1 hour	180.0 μg/m^3	180.0 μg/m^3	
8	Ammonia (NH3)	Annual Avg*	100.0 μg/m^3	100.0 μg/m^3	- Chemiluminescence - Indo-Phenol Blue method
		24 hours**	400.0 μg/m^3	400.0 μg/m^3	
9	Benzene	Annual Avg*	5.0 μg/m^3	5.0 μg/m^3	- GC based continuous analyzer - Adsorption/desorption followed by GC analysis
10	Benzo(a) pyrene	Annual Avg*	1.0 ng/m^3	1.0 ng/m^3	- Solvent extraction followed by GC/HPLC extraction
11	Arsenic	Annual Avg*	6.0 ng/m^3	6.0 ng/m^3	-AAS/ICP method for sampling on EPM2000 OR Equivalent filter paper
12	Nickel		20.0 ng/m^3	20.0 ng/m^3	-AAS/ICP method for sampling on EPM2000 OR Equivalent filter paper

Table 1.2 Ambient Air Quality Standards in Respect of Noise.

Area Code	Category of Area/Zone	Limit in dB (a) LeQ	
		Day	Night
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

in making an approach road and also a railway siding. Maintenance cost of these is added to the annual expenditure of the Plant.

If a flowing water body exists nearer to the plant site, it would be advantageous to consider transport of the goods through boats/vessels or small ships. This is common in Plants located nearer to sea coast/river. This mode is the cheapest way of transport. However, re-handling needed to change the transport mode to reach the market has to be studied properly as every re-handling leads to some material losses and extra expenditure.

Proximity to an operating airport helps in reaching the plant conveniently by the Senior Personnel and also to receive any spare parts urgently needed etc.

1.5.7 Proximity to the Market

Cement is a high volume and low cost product. It is to be sold at a price to get reasonable profit. Cement produced is to be transported to the market by means of railways or road trucks or water ways which leads to additional cost. Obviously, closer to the market results in less transportation cost and wastage. It is not always possible to have cement consumption market nearer to the Plant location since the plant is located nearer to the natural Raw material deposit. This is a very important issue to be carefully weighed against the available alternative sites.

1.5.8 Availability of Skilled and Experienced Man Power

In a high intensive industrial environment, it may be difficult to get skilled labour and even if it is possible to get, they may be more expensive. Local labour laws, trade unions practices, restrictive approaches for recruitment and training also should be considered. Healthy practices towards the labour, pay in the long run of the Plant operation.

Skilled and experienced man power is usually brought from areas outside the Plant area. Unskilled labour may be recruited locally. The local pool of labour may be trained to semi-skilled level to operate minor equipment and to carry other works. However over a period of time, these semi-skilled persons may be absorbed as skilled operators.

1.5.9 Local Community / Municipal Considerations and Government Requirements

These requirements are very important concerns to be properly deliberated for each site and understood. Taxation laws need to be studied and followed.

Restrictions and local norms towards pollution are to be clearly understood and weighed in terms of cost. The new Plant should not impose any risk to the local habitants. Local community should have least restrictions to the new plant persons and should be amicable. To this extent, the public relations are very important and should be cordial. If any such restrictions exist, these are to be understood and should be tried to modify them with sincere empathy and in cooperation with the local authorities.

Impact of Property tax and water consumption practices are to be assessed.

For a new plant which is located away from the existing habitation, these may not be applicable.

One can explore the exemptions and incentives the Government gives to set up the industry in the area.

1.5.10 Community and Labour Attitudes

These are very important to facilitate smooth execution and running of the Plant. Healthy practices are to be inculcated and developed right from the beginning of the Site activities.

1.5.11 Proximity to an Already Developed Area

Proximity to developed infrastructure is a plus point to the site. This helps in reducing the cost towards creation of new infrastructure. But the other costs such as labour, materials etc. may be more expensive. However it is very rare for Cement Plant to be located in such areas as these are normally located in remote areas.

1.5.12 Climatic Conditions

Local climatic conditions influence the Architectural treatment of the Plant and Colony structures and their relative locations.

Roofing and side cladding are decided based on rain fall, pollution levels and the wind directions.

Plant drainage is decided considering the general gradient of the area, its outfall and the maximum hourly rain intensity.

Requirement of heating and insulation are planned based on the minimum and maximum atmospheric temperatures and the periods of their occurrences.

Seismically safe facilities are to be provided in Earthquake prone areas.

Climatic conditions need to be studied are:

(i) maximum and minimum temperatures
(ii) maximum wind speed, prevailing wind direction
(iii) average humidity and its range
(iv) rain fall: Yearly average and maximum, number of rainy days, maximum hourly intensity, occurrence of storms and, their severity and frequency
(v) snow fall intensity
(vi) Earthquake zone of the area
(vii) General atmospheric corrosion in the area

1.5.13 Geological and Foundations Conditions

Study of the geological maps, general stratigraphy of the area / zone and the un-lined sides of any ground water wells in the area help in assessing the possible type of sub-strata likely to be encountered at any particular site. If reasonably hard stratum is not available up to 5-6 m depth, the foundation costs will increase. Further, if the study indicates that only softer strata is available at deeper depths, costlier deep foundations like piles may have to be adopted.

These are only indicative. The type of foundation required is to be based on detailed foundation investigations of the finally selected site.

1.5.14 Consideration for Political and Strategic Issues

The laws of the country and the local state are to be properly studied and understood prior to selecting a Plant site as they are to be honoured and should be strictly followed.

Cement plants are normally located in under-developed areas due to availability of the Raw materials. Governments give some incentives and concessions to the industry if it is set up in certain notified areas as it helps in local employment and rapid development of the area.

Taxation and royalty concessions, creation of required infrastructure in the area and supply of power and water may be offered by the Government to help in setting up of the plant. Water and power tariffs also may be reduced for the new Industry if local employment grows. They may offer starting of a school in the residential colony also.

It is essential that a team of specialists of the concerned disciplines should visit the available alternate Project sites and evaluate them with due consideration for the above site specific issues and select a suitable site for a Plant.