The various technologies of mini cement plants known differ mainly in pyroprocessing system through the use of

A) The Fuller Pyzel fluidised bed process,
B) Reba flame firing sintering grate,
C) Travelling grate (Dwight-Lloyd sintering machines),
D) Rotary kiln and
E) Vertical shaft kiln.

A Fluidised Bed Process:

Of these fluidised bed or Pyzel process is least popular because the number of plants working on this process is less on global basis and not much is known about this process except some broad principles of working. This process invented by Robert Pyzel has been developed by Fuller in the United States of America. A 100 tonnes per day pilot plant based on this technology undertaken by M/s. Scientific Design Company, Newyork, U.S.A for the last three and half years on an experimental basis, is reported to be in operation.

Details of the process :

The plant consists of a fluidised bed-reactor raw meal comprising timely ground feed mixture pneumatically conveyed to the fluidised bed along with fuel and preheated air. The temperature of the fluidised bed is maintained at approximately 1315°C by infusing fuel directly into the fluidised bed.

Cement-clinker being almost refractory, coarse clinker particles of 0.8 to 8mm can be maintained in granular form in suspension, when finely ground raw mix is pneumatically blown in and raw cement-phases are formed on the hot surface of characteristically round clinker-particles, so that they grow in size continuously.

The burnt clinker leaves the fluidised bed through an overflow and is cooled to 95°C in a grate or shaft cooler. All the particles below 2.5mm are separated from the main clinker-system by means of a sieve and fed back into the reactor as 'seed-clinker'. The size of the clinker-particle varies within a very narrow range. Since the amount that overflows from the kiln-discharge and irregular clinker size are avoided, they help in consuming less power in clinker-grinding.
The specific heat-consumption without any heat recovery systems is 2,600 Kcal/Kg of clinker. By adopting the heat recovery systems for heating the fluidised bed air (combustion air) and raw mix, the value has been reported to be as low as 1046 Kcal/Kg. of clinker.

The requirement of energy for the production of clinker alone by the fluidised bed reactor is 55 kWh/t as against 20-25 kWh/t of clinker in the case of Rotary or Shaft kilns.

This process stands a good chance for a promising market in U.S.A. as there are very strict specifications of environmental protection regarding oxide of sulphur and nitrogen. At the same time special low alkali cement specifications necessitate the rejection of large quantity of dust in rotary kiln burning operation. This dust with high alkali-content can be used as a cement raw mix in the Pyzel reactor.

By the calculations of economy and comparison of cost, it was found that notwithstanding the consumption of high heat and the requirement of high energy, the costs of production for Pyzel clinker produced from kiln dust containing high alkali are lower than the cost of production of clinker from
rotary kiln. This is low due to the fact that in this case, the cost of crushing and grinding will be considerably less.

The specific advantages of the Pyzel process have been claimed where there is:

a) high alkali problem,
b) strict environmental protection regulations regarding oxides, sulphur and nitrogen from exit gases,
c) the problem of disposal of kiln dust with high alkali content, and
d) the using of different fuels like gas, oil, coal, anthracite and coke.

The excessive requirement of energy in this process can be offset by the captive power-generation from the heat recovery system.

The loss of high investment for the heat recovery systems, stringent controls through an elaborate instrumentation, automation and non-availability of highly skilled personnel for the operation of the reactor, go against the very need for a mini cement plant in the Indian context of having to reduce the investment and to provide local rural
employment potential. Nevertheless, the systems of heat-recovery are also understood to be not so efficient and if the temperature of the exit-gasses being high, they go against the concept of fuel-economy.

B Reba Process:

In this process, the feed operation requires crushing of limestone to 15mm size, storage in bays/bins, proportioning of raw materials and final grinding in a roller/ball mill, homogenisation of raw meal and storage.

The fuel used in this process is oil or gas. The homogenised raw meal is fed to noduliser where nodules are formed with addition of water and are then fed to combustion-chamber. The nodules are dried in the preheating zone and heated in the calcining zone to about 1100°C. The upper fresh core transports the material from calcining zone to sintering zone. The granulated material is then sintered at about 1450°C. The lower fresh core transports this clinker directly into shaft cooler. The flow of gases is in opposite direction to the flow of material and thus air used to cool the clinker heats up and is used as secondary air together with primary air while burning the fuel.
The cooled clinker is transported to the storage yard and then glazed with gypsum to get Portland cement.

Reba process has not been operated so far on solid fuel, i.e. coal and as such, no operational data of such applications are available and considerable engineering adoption of technology will have to be taken for the utilisation of coal as fuel specifically under Indian conditions for utilising coal with high ash-content and low calorific value.

It was claimed by the firm M/s. Ready Mix Cement, Engineering of the Federal Republic Germany that the Reba kiln installations for the production of cement in the range of 50-200 TPD would have low cost of investment and less consumption of energy. The consumption of heat is estimated to be approximately 730 Kcal/Kg. of clinker. Furthermore, the consumption of electrical energy should correspond to that of rotary kilns. The consumption of energy for burning materials alone is claimed to be 14 kWh/t.

It is understood that the Reba process has been tried successfully only for burning lime and the firm is yet to establish the technology for the burning of cement clinker.
The quality of limestone and fuel tried is very rich i.e. very high percentage of lime in limestone of the order above 52% and coal with very low ash-content (10%) and high calorific value.

M/s Ready Mix Cement Engineering Co., West Germany claims that this process has many advantages like:

i) less wear and tear problems on the refractory lining,
ii) no environmental problems,
iii) exceptional flexibility of the system, and
iv) no lagging, coking and ring formations etc. Still the technology has not been proved using cement grade limestone and Indian coals with high ash-contents. No commercial plants on this technology are in operation in the world.

C **Travelling Grate Sintered Process**: 

In the process, the feed operation requires crushing of limestone to -15 mm size in a crusher/mill, storing the materials of -15 mm size in gantry/storage bins, proportioning of raw materials and final grinding in closed circuit ball mill/roller mill, homogenisation of raw meal and storage,
crushing and screening of coal to \(-15\) mm size in closed circuit operation and storing of crushed coal in bin.

The raw meal and crushed coal are then extracted from respective bins according to the requirement and then conveyed to a drum-type noduliser. In addition, the nodulizer is also fed with 15\% of \(-5\) mm size burnt clinker to form core of nodules and 15\% water spray. The nodules are conveyed by a belt-conveyor to moving sinter bed made of cast iron grate base. A \(75\) mm thick layor of \(+5\) mm and \(-10\) mm burnt clinker is first spread over this bed and then the fresh nodules fall over this. The sinter-bed passes through various zones over some distance where suction is maintained through ID fan. Light diesel oil is fixed over the bed in load erected about \(200\) mm above the height of the bed. The nodules undergo various reactions as they pass through various zones and the resulting clinker is discharged through a rotating arm type breaker in red-hot condition over an open pan type horizontal conveyor where it undergoes cooling also. This clinker is carried to the storage yard and finally ground with gypsum in a grinding mill to get portland cement.
This process already practised in the Wuyan Cement Factory, in Jammu & Kashmir state, India, for the last two decades with an installed capacity of 60 tonnes per day requires a continuous use of light diesel oil as fuel in addition to the low volatile coal already contained in the nodules. The cement production of the plant has never exceeded 55% of installed capacity. The cost of fuel is as high as Rs. 166 per tonne of clinker. Apart from the high cost of production, the plant also finds it difficult to cope up with frequent breakdowns and quite involved maintenance is required due to complicated machinery. Then the consumption of electrical energy per tonne of cement produced is as high as 208 kWh. The consumption of heat per kg. of clinker production is also as high as 2404 kcals.

Although the quality of the cement produced by this process is reported to be meeting all the specifications squarely, the working of the plant and its profitability are a problem for the plant management and as such an alternative, CRI-VSK, is being finalised with the help of CRI.
D Small Rotary Kiln:

The proven technology considered for mini cement plants is essentially a dry process with suspension preheater.

Here, the kiln feed and fuel-preparation require operations of crushing and grinding like:

1) crushing of limestone and additives in a hammer mill or 2-stage, viz. Jaw crusher and hammer mill to 15 mm size,
2) storing the crushed raw materials in storage yard/bins,
3) proportioning and grinding the raw meal in a roller/ball mill,
4) homogenising and storage of raw meal in blending and storage section, and
5) fuelling viz. coal (VM 25-30%) is pulverised in a separate section combined with coal drying cum grinding section.

Blended and homogenised raw meal is then fed to the suspension preheater of counter current type, where it is preheated and partially calcined by the kiln hot gases passing in counter current. Raw meal enters the kiln at a temperature of 450°-500°C. The exit gases from the preheater are then passed through the dust collection system and discharged to atmosphere. The dust collected is recycled.
Pulverised coal mixed with primary air is fired from the lower end of the rotary kiln through coal-burners. Secondary air is supplied through clinker cooler to make up for the combustion air. A flame at 1660°C is maintained. This heats the material as the kiln rotates 1 to 2 rpm. Various chemical reactions like calcination, sintering, cooling etc. take place as the material temperature goes up to 1440°C. Hot gases transfer the heat to material escape in counter-flow i.e., from the lower end to the upper end through suspension preheater and dust-collectors to atmosphere. Clinker is discharged into the clinker cooler which may be rotary, planetary or moving grate type. Clinker is then transported to storage yard and finally crushed with gypsum. Control is maintained through various controlling instruments and under the inspection of burning conditions.

**Vertical Shaft Kiln:**

This process falls under the broad category of semi-dry process. In this process, the preheating, decarbonising and sintering process should invariably proceed at a uniform rate. Therefore, a uniform chemical composition and fineness should be maintained. The distinctive feature of this process is that
fuel low volatile coal or coke breeze is interground with the raw mix for efficient burning called Black Meal process.

Vertical shaft kilns are fed with the raw-mix of appropriate composition in the form of nodules. The feed-operation requires crushing of limestone to -15 mm size in storage bins, proportioning of raw materials along with grinding in roller or ball mill, homogenising and nodulising in pantype noduliser. The successful operation of the shaft kiln to a great extent depends upon the size of nodules, their uniformity, porosity and thermal stability. The noduliser consists of an inclined disc or pan rotating about its axis. Raw meal is charged into noduliser by means of screw-conveyor and water is sprayed, while all the parameters are maintained at optimum conditions. Specially designed rotating scraper continuously cleanse the bottom and the collar of the drum of the raw meal is deposited. The nodules slide down the chute and are charged in the vertical shaft kiln evenly all around the periphery continuously with the help of a rotary feeder situated on the top of the kiln. The vertical shaft kiln in which the nodules are converted into clinker consists of a cylindrical shell with conical portion at the top and lined with refractory bricks. The sintering is normally complete
within the conical portion which is specially designed to accommodate the shrinkage of nodules. The various zones of reaction starting from the top of the kiln are: the drying zone, the calcinising zone, the sintering zone and the cooling zone. The combustion air supplied by roots blower ascending from below in the cooling zone absorbs heat from the descending clinker. The whole kiln-charge composed of unburnt nodules land clinker rests on a flat grate rotating slowly at the bottom of the kiln and mounted over the king shaft. The grate is driven with the help of variable speed motor in order to control the discharge rate of clinker. The clinker is finally taken out of the kiln bottom with the help of a triple air lock mechanically or hydraulically operated discharge gates.

A variation of the black meal process as proposed by Dr. Steven Gottlieb is 'Coal Slurry Process' the main difference being in the method of feed-preparation. The method requires the raw meal to be ground 'white' i.e., without fuel. The fuel (coal with volatile matter up to 16-18%) is ground separately in a wet ball mill to make slurry with about 50% moisture. The white meal and the 'coal slurry' are separately stored in hoppers over the nodulizer platform and are pumped.
at controlled rates (through flow meters) into a double paddle mixer to mix the feed continuously and discharge into the standard noduliser where practically no or very little water is added to give final shape to the nodules. These nodules are charged and burnt in the vertical shaft kiln in the same manner as in the case of 'Black Meal' process.

The main advantage claimed by this process is that by wetting the coal particles before nodulising, the retention time for the volatile component of the fuel is increased, thereby allowing this to travel to a zone where adequate oxygen is available to complete the combustion of the volatile matter within the bed thereby permitting a higher volatile content in the coal when compared to that used in the 'Black Meal' process.

Comparison of technologies most appropriate to Indian conditions for the manufacture of cement on small scale:

A comparative position of the use of different technologies is given in the Table 7.1. The processes involving Rotary and Vertical Shaft Kilns are discussed below elaborating with special reference to experience in India.
Table 7.1: Comparison of different technologies for mini cement plants

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Description</th>
<th>VSK</th>
<th>Rotary Kiln</th>
<th>Lurgi Sinter Bed</th>
<th>Reba Process</th>
<th>Fluidized Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Limitation of size</td>
<td>Upto 200 tpd 20-30 tpd</td>
<td>Generally above 150 tpd 200-300 tpd unit under running in India. 50 tpd CRI/VSK under installation</td>
<td>30 to 1200 tpd (experimental unit in USA)</td>
<td>100 to 400 tpd</td>
<td>100 to 500 tpd (experimental unit in Germany)</td>
</tr>
<tr>
<td>2</td>
<td>Number of plants</td>
<td>2393 (China) 260 (World) including India</td>
<td>19 (India) (less than 200 tpd)</td>
<td>60 tpd (India)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td>Raw materials</td>
<td>The raw materials should have good nodulizability apart from satisfying other characteristics required for cement grade</td>
<td>The raw materials should have good nodulizability apart from satisfying other chemical characteristics</td>
<td>The raw materials should have good nodulizability apart from satisfying other characteristics required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fuel</td>
<td>Low volatile fuel such as coke breeze or Jhama coal or char/finens etc. Fuel has to be inter-ground with raw mix limiting VM 12%</td>
<td>Medium to high volatile coal with preferably not more than 25% ash</td>
<td>Low volatile fuel Oil or gas like coke breeze or low volatile coal plus diesel oil</td>
<td>Low grade solid fuels such as high ash coals</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Heat Input Kcal/kg Clinker</td>
<td>900 to 1100</td>
<td>900-1100</td>
<td>Claimed 1200 but actual consumption</td>
<td>Claimed 730</td>
<td>1050 to 1400 with heat recovery</td>
</tr>
<tr>
<td>6</td>
<td>Instrumentation</td>
<td>Very simple</td>
<td>Simple</td>
<td>Simple</td>
<td>Complex</td>
<td>Complex</td>
</tr>
</tbody>
</table>
alkali are found in the cement raw material due to internal circulation. Therefore exhaust gas is to be let out periodically so as to remove alkalies from the system.
b) Choice of raw materials for good modulizability

c) No control of fuel at the burning stage

d) Delivery time is more

e) Experience with suspension pre-heater in such small capacity is rather limited

f) Requirement of costly infrastructural facilities

g) Requirement of relatively skilled manpower

b) High maintenance and investment cost Red spot & fire brick spalling are usual

b) Very high fuel consumption

b) Experience with Indian coals not available

b) Experience with Indian coals not available

b) Commercial plants not available

b) Commercial plants not available

- Source: National Seminar on MCPs 1982, New Delhi, CRI, p.43.
The production of cement using a small rotary kiln is well-known in India, although it has receded to the background over the past 2 to 3 decades, making room for bigger kilns for the obvious advantage of scaling up factor. However, the small rotary kilns of the past were mainly working on wet process only and did not deserve any comparison in the present context owing to their high fuel-consumption. The present trend, however, is to obtain the technology to the dry process and to add a suspension preheater system in the small rotary kiln also. This, however, does not solve all the problems experienced earlier such as inadequate instrumentation, lack of control, ring-formation owing to small diameters, spalling of refractories and red spots. The use of dry process has its own limitations in the context of the alkali content of raw meal unless the fuel-economy is sacrificed to some extent by providing bye-pass. The loss of material and heat through dust-emission is indispensable at least to a certain extent.

The specific output of wet process rotary kiln is 0.5 tonnes per day, per cubic meter and that of dry process rotary kiln is 1.3 T/m$^3$/day as against 2.4 T/m$^3$/day in the case of shaft kiln.
The average refractory consumption by cement industry in India using rotary kiln process is 1.2 Kg/tonnes of clinker and annual average expenditure is about 2% of the cost of production of cement as against a refractory consumption of 0.4 Kg/tonnes of clinker produced in VSK process with negligible amount of expenditure on the cost of installation of these refractories.

The amount of water required is $2.5 \text{m}^3$ per tonne of cement produced in wet process rotary kiln installations and $1.8 \text{m}^3$ per tonne of cement production in dry process rotary kiln installations against $0.8 \text{m}^3$ per tonne of cement production in vertical shaft kiln process installations.

These small rotary kiln plants require highly skilled personnel to operate the kiln and demand larger ground-space and heavier steel-structures for installation which result in the increased cost of foundation and housings. A small rotary kiln installation designed for a daily output of 200 tonnes occupies as much as 7 times the floor-space required for a vertical kiln installation of the same capacity. The amount of steel needed in the construction of vertical shaft kiln installations is only one fifth of that necessary for rotary kiln installations of similar output.
The consumption of grinding media in the case of dry process rotary kiln plants is around 859 gms. per tonne of clinker produced as against 400 to 600 gms per tonne of clinker produced in vertical shaft kiln plants.

The rotary kiln plants require a large inventory of spares both indigenous and imported. The vertical shaft kiln technology is wholly indigenous with no dependence whatsoever on import either by way of knowhow or machinery and equipment.

Rotary kiln installations require drying and crushing of coal and transport of the same to the kiln from the yard. As such, they require additional equipment for the same which means high equipment-costs and electricity bills. In the case of shaft kilns the fuel can be used in the very condition of delivery i.e., without drying or crushing.

The rotary kilns require separate cooler for cooling hot clinker whereas shaft kilns have their own cooler; thus no separate cooler is required.

The stoppages of rotary kiln due to power-failures or break-downs result in heavy losses of production as it takes considerable time to restart and stabilise the kiln after
repairing etc. The operation of the shaft kiln can be interrupted easily at any time. These kilns could be stopped and restarted after a stoppage of 48 hours without losing the heat of the kiln. There have been instances in which shaft kilns were still perfectly under fire even after two week's shut down, with the result that production could be resumed without trouble and without the necessity of rekindling the controls of the kiln.

The vertical kiln could be installed in a battery of row. More kiln units in a row would not necessarily increase operating personnel because of the absence of visible flame. The operation of the kilns can be automated to a far reaching extent. For instance, five or more kilns in a row would provide the great advantage of flexibility in production to follow seasonable market-demand as well as to accommodate and operate kiln during the periods of power-cuts.

In vertical shaft kiln, the alkalies escape with free gases and as such the quality of cement could be better due to the possibility of eliminating alkalis from the cement.
Development of vertical shaft kiln process by Cement Research Institute of India appropriate to Indian conditions: (Vide Annexure VII-1).

In the past, the relative lack of experience with the vertical shaft kiln technology vis-a-vis the regular rotary kiln has given room for certain reservations for the acceptance of the VSK process. Now, CRI has not only gained a vast experience of this technology but also developed, improved and designed vertical shaft kilns.

The Cement Research Institute has perfected the vertical shaft kiln technology under Indian conditions by remodelling and modifying the 20 tonnes per day plant at Muduvathur in Tamil Nadu gifted to the Cement Research Institute in the year 1974. The plant as received in 1974 was redesigned and restructured. The following salient modifications were incorporated to achieve the clinker production of Indian standard quality on a sustained basis.

i) The noduliser was modified to give uniform nodules of envisaged size. To achieve this, the collar height and the drum diameter were to be adjusted along with the speed of noduliser and the angle variation of the drum-inclination.
ii) The rotary feeder was so designed that it was possible to feed the green nodules at any desired point on the nodule bed surface in kiln while in operation. This has facilitated the operation of the kiln to a great extent.

iii) The L/D ratio of vertical shaft kiln and the cone angle of the vertical shaft kiln were so chosen as to care for the shrinkage of nodules and the required retention time.

iv) The chimney was modified and provided with damper control to give better regulation of chimney draft.

v) The most important achievement was the design, fabrication and installation of a new flat rotary grate with variable speed drive which not only ensured the proper distribution of combustion air in the kiln but also helped uniform discharge of clinker and good burning at the sintering zone.

vi) The discharge gates were modified to ensure no air leakage through them.

vii) Simple control instrumentations were adopted.
All controls have been installed in the business platform to enable the burner to control the quality of the clinker.

Another important aspect of the Cement Research Institute's vertical shaft kiln technology is that the plants based on this technology can be completely fabricated or manufactured in India without any need for the import of machinery. Moreover, unskilled or semi-skilled personnel can operate this plant after due training.

**Fuel for CRI-VSK Mini Cement Plants:**

**Suitability:**

Suitable fuels for vertical shaft kiln mini cement plants are those that have a volatile matter content limited to 10%. Such fuel can be classified as:

1) Fuel available in natural form-Jhama cola or low volatile coal.
2) Fuels obtained as bye-product. Eg: coke breeze or low temperature carbonization (LTC) char.

The main source of naturally occurring low volatile fuel has been confined to Jharia coal field, Bihar, while small deposits also have been noticed in Jammu and Kashmir.
The broad specifications of Jhama coal are as follows:

- **Ash**: 18 to 23%
- **Moisture**: 1.5 to 3.5%
- **Volatile matter**: 5 to 8%
- **Fixed carbon**: 65 to 75%
- **Calorific value**: about 6000 Kcal/Kg.

Jhama coal has already been tried successfully in CRI's vertical shaft kiln plant at the Tamil Nadu centre, thereby establishing its suitability for vertical shaft kiln technology. Similarly, low volatile coal from Jammu and Kashmir state has also been tried at CRI's VSK plant and found to be successful. The estimated reserves of Jhama coal are 450 million tonnes in B.C.C.L. lease-hold area alone while those of low volatile coal in Jammu and Kashmir is three million tonnes. Thus, the availability of these fuels is assured on a long-term basis for vertical shaft kiln plants.

The other suitable fuel viz. coke breeze and low temperature carbonisation char are usually obtained as bye-products of high temperature carbonisation and low temperature carbonisation of coal respectively.
The coke breeze can be successfully used in the vertical shaft kiln plant, while low temperature carbonisation char can be used partially as an admixture with coke breeze/Jhama coal in VSK Plants. The broad specifications of coke breeze are as follows:

- **Calorific value**: 5000 to 6000 Kcal/Kg.
- **Ash**: 22 to 32% on dry basis
- **Volatile matter**: 0.3 to 12% on dry basis
- **Fixed carbon**: 50 to 65 on dry basis

**Availability**:

The availability of coke breeze in India from various sources is given in Table 7.2. The LTC char contains high volatile content (710%) and this has to be mixed with coke breeze/Jhama for use in VSK plants. At present, the LTC char in India is available from Neyveli (Tamil Nadu) and Coal Carbonisation Complex, Singareni in Andhra Pradesh. Nearly 1.3 lakh tonnes of coke breeze are available from different sources.
Table 7.2: Availability of coke breeze in India from various sources

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sources</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beehive coke ovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Owned by M/s B.C.C.I.</td>
<td>37,200 t/annum</td>
</tr>
<tr>
<td></td>
<td>b) Owned by Private Parties</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>Merchant coke ovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Barares coking unit</td>
<td>9,000 t/annum</td>
</tr>
<tr>
<td></td>
<td>b) Lodha coking unit</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>c) Loyabad coking unit</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>d) Bhowarh coking unit</td>
<td>750 t/annum</td>
</tr>
<tr>
<td></td>
<td>e) Giridh coking unit</td>
<td>Exact quantity not known</td>
</tr>
<tr>
<td></td>
<td>f) Durgapur Project Ltd.</td>
<td>700 t/annum</td>
</tr>
<tr>
<td></td>
<td>g) F.C.I. Sindri</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>Steel Plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Bokaro Steel Plant</td>
<td>Exact quantity not known</td>
</tr>
<tr>
<td></td>
<td>b) TISCO, Jamshedpur</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>c) Bhilai Steel Plant</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>d) Durgapur Steel Plant</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>e) Rourkela Steel Plant</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>f) TISCO, Burnpur</td>
<td>36,000/48,000 t/annum</td>
</tr>
<tr>
<td></td>
<td>g) Kalinga Iron Works, PO Matkambeda 758036 Dist. Koorijhar (Orissa)</td>
<td>24,000 t/annum</td>
</tr>
</tbody>
</table>

Source: National Seminar on MCPs, 1982, New Delhi, CRI, p.51.
Report of the special group constituted to study the working of Mini cement plants employing the Vertical Shaft Kiln at Lokapur and Hosdurga in Karnataka:

The Planning Commission, while considering the proposal for setting up of mini cement plants in the north-eastern region devised amongst other things, that the North-Eastern Council (N.E.C.) should make a detailed study of the performance of two mini cement plants working in Karnataka which have recently gone in to operation. Accordingly, a team comprising of representatives from under mentioned governmental and institutional agencies was constituted to visit the mini cement plants in Lokapur and Hosdurga in Karnataka.

The group consisted of the following members:

1) Sri.S.R.Khanna, Industrial Advisor, Directorate General of Technical Department

2) Dr.D.K.Ray, Advisor (minerals), North-Eastern Council

3) Sri.C.S.Pani, General Manager (Technical), Industrial Development Bank of India.

4) Sri.S.Ganesh, Manager (Technical), Industrial Development Bank of India (was present during the visit to the Lokapur plant only).
5) Dr. J. C. Mishra, Larsen and Toubro Limited (co-opted at the instance of I.D.B.I.).

6) Sri. K. K. Shukla, Chief Manager, Cement Corporation of India.

7) Sri. P. C. Patnaik, Managing Director, North-Eastern Industrial and Technical Consultancy Organisation Limited (NEITCO).

The group visited the plants on 21st and 22nd December, 1991. The members deliberated on the various aspects of the operation of the two units and the unanimous findings of the group are as follows:

a) The plants are having trouble-free operation and giving desired quality and output of cement. This lays to rest all apprehensions about the provenness of technology in commercial scale applications. The operations of the two plants have stabilised at or near the rated capacities within a reasonable period (3-6 months) of time.

b) The plants are being operated by personnel without any high level of formal technical education. The educational background of the operators varied from under matriculation to graduates in non-technical disciplines. The operators are able to acquire the required skills with an 'on-the-job' training of 3 to 6 months. It is thus seen that the skill required to operate the vertical shaft cement kilns is not particularly difficult to import and
can be learnt with the normal training inputs and exposure to plant operations.

c) The group feels that adequate attention should be paid to raw material preparation and raw-mix design. Raw materials, investigations and mining should be carried out in sufficient detail. Since mini cement plants can be promoted by new and medium entrepreneurs with modest financial resources, it would be appropriate to provide a measure of relief to mitigate the burden of the additional costs involved in undertaking such investigations. The following recommendations are made in this behalf.

i) This component of capital cost may be separately financed on concessional soft terms by the financial institutions on the analogy of the schemes currently in operation by the financial institutions (Industrial Development Bank of India, Industrial Finance Corporation of India etc.) for encouraging industrial units to go in for I.S.I. markings for their products and commercial adoption of technologies developed by recognised research institutions like CSIR laboratories etc.

ii) State governments/State level institutions may introduce schemes of assistance by way of promotional measures similar to the background area subsidy schemes being operated by many state governments to supplement the central government scheme of subsidy to identify backward districts. The group is also of the view that percentage of CaO in limestone should
preferably be above 46% though the recommended range is 44-52%.

d) The group recommends that the mini cement plants should be planned for an optimum capacity of 100 tonnes per day consisting of multiple kilns. This capacity may, however, be attained in phases.

e) The fuel presently being used in the two vertical shaft kilns at Lokapur and Hosdurga is coke-breeze - the important consideration being the low volatile matter content. It has been reported that Cement Research Institute of India's experiments have demonstrated the suitability of Jhama coals. Currently, the sources of supply of coke breeze are limited to a particular (eastern) region of the country. This involves movement of the material over long distances and subject to the vagaries of transport bottlenecks for units sited in distant locations. Since mini cement plants are more relevant for location in remote areas to exploit small and scattered limestone deposits of appropriate grade, it is recommended that steps be initiated to develop alternative fuels and additional sources of supply. 'Semi-coke or devolatised coal' obtained from 'Bee hive' coke ovens and stack burning of coal could be potential alternative sources. The group has taken note of the fact that a significant beginning has been made in the country to produce solid fuels from urban wastes and agricultural soft coke as a domestic fuel and to that extent to release the pressure on supplies to the industrial sector.
f) The group held detailed discussions with the promoters of the two plants. The group is of the view that the following observations of the promoters merit attention at policy making levels in the government. Cement manufactured in the mini cement plants though free from distribution control are subject to price control. This leads to mal practices on the part of the buyers without any additional benefits accruing to the producers.

With a view to enlarging and consolidating the capital base for the company and raising financial resources for expanding their operations, the promoters of Veda Cement have introduced a novel incentive scheme of making preferential sale of cement to buyers who opt for subscribing to the preferential capital of the company.

g) The capital cost of a 100 tonnes per day Vertical Shaft Kiln mini cement plants derived from the capital cost of the two units visited is estimated around Rs.2 crores. It is thus seen that the capital cost per tonne of annual installed capacity in such units is significantly lower as compared to larger plants employing the conventional rotary kiln technology. The operational data of the two Karnataka units also indicate that the energy consumption per tonne of cement is significantly (10-15%) lower than the norms achieved in larger rotary kiln cement plants.

For these reasons, amongst others, a measure of continued support to encourage the establishment of vertical shaft kiln mini cement plants is recommended.