DETAILED FEASIBILITY ANALYSIS OF CEMENT BASED PRODUCTS

Part II

For

DEPARTMENT OF INDUSTRIES
MINISTRY OF ECONOMIC AFFAIRS
ROYAL GOVERNMENT OF BHUTAN

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CHAPTER 1 - PROJECT AT A GLANCE

1. Project concept – Detailed feasibility analysis on **cement based products.** The project envisages the manufacture of various types of cement based products viz cement concrete bricks, solid blocks, hollow blocks, paver blocks, cement concrete tiles and mosaic flooring tiles.

2. Location - Location of the proposed unit should preferably in the vicinity of the major sites of construction as well as sources of raw materials. Punakha, Wangdue, Thimphu, Phuentsholing, Gelephu, Paro and Samdrup happen to be the main towns and would constitute the major sites of construction. Besides, Wangdue being the site of biggest ongoing power projects has also tremendous potential for construction activities. In past also, a cement brick unit was setup near to the site of Taala Power Project. The units for the manufacture of main raw materials viz stone aggregates and sand also need to be promoted near the proposed project. Cement, in any case, has to be transported from the cement factories. Keeping in view, the various parameters, these sites have been short listed in the order of preference.

Location	Overall rating
Punakha	45
Wangdue	42
Thimphu	42
Phuentsholing	41
Gelephu	41
Paro	41
Samdrup	41

It is recommended that to begin with a project be setup at Punakha. Similar, projects need to be setup near to major cities, which would constitute the major construction sites.

3. Markets - Cement based products proposed to be manufactured by the unit are the basic building blocks of any construction project and on an average, they account for nearly 10% of the estimated cost of the building. The cost of transport of raw materials and finished goods has to be kept at minimum level so as to make the products competitive. Normally, the construction projects whether big or small, prefer to buy these products from nearest sources and therefore, vicinity to major sites of construction would be an important parameter for healthy functioning of the unit. As the cost of red bricks is very high in Bhutan due to heavy transport

cost, there exists a good market for cement bricks. There is already one unit manufacturing such products in Thimphu and the proposed unit in Punakha has bright prospects of success owing to future growth in the construction activities in an around Punakha.

4. Annual production capacity recommended -	Items		Capacity (in numbers)
	Solid blocks	-	2,00,000
	Hollow blocks	-	2,00,000
	Paver blocks	-	6,00,000
	Grey mosaic tiles	-	6,00,000
	Colored tiles	-	2,00,000

5. Land and building requirement

Plot area 6000 sq. mts
Built up area 208 sq mts
Industrial shed 900 sq. mts

6. Power requirement: 45 KWH

7. Main machinery

Hydraulic system
Mould vibrator
Ram vibrator
Pallet feeder
Mix feeder
Mix feeder bin
Cavity block ram & mould
Pallet stacker
Pan mixer
Water dosing pump
Wheel barrows
Skip loader
Color mixer

8. Man power requirement

Manager	– 1
Plant supervisor	– 2
Office staff	– 2
Laboratory technician and assistant	– 2
Machine operators	– 4
Unskilled workers	– 15

9. Total project cost: Rs. 127.46 lacs

10. Project implementation period	11-12 months		
11. Means of finance	Debt -	Rs. 89.22 lacs (70%)	
	Equity -	Rs. 38.24 lacs (30%)	
12. Break up of cost of project	Machinery	-	Rs. 44.68 lacs
	Construction cost	-	Rs. 45.13 lacs
	Misc. fixed assets	-	Rs. 3.00 lacs
	Pre-operative exp.	-	Rs. 5.00 lacs
	Training expenses	-	Rs. 0.45 lacs
	Interest	-	Rs. 11.79 lacs
	Working capital	-	Rs. 17.41 lacs
	Total	**-**	**Rs. 127.46 lacs**
13. Annual sales turnover	Rs. 250 lacs		
14. Financial analysis	IRR – 27% on equity IRR – 18% on investment NPV – Rs. 42.28 lacs (12% discount rate) Pay back period – 4 Years 6 months Project break-even – 66%		

CHAPTER 2 – JUSTIFICATION OF THE PROJECT

2.1 Project Concept

The project is for carrying out detailed feasibility analysis for setting up a manufacturing unit in Bhutan for cement based products viz cement concrete solid blocks, hollow blocks, paver tiles, grey mosaic tiles and color tiles mainly to cater the domestic demand in construction material sector.

2.2 Project Justification

Infrastructure is the building block of economic growth. It forms the foundation of an economy, reinforces its structures and integrates it into productive system. It is economy's spinal cord that builds, shapes, nourishes, energizes & synergizes its existence, growth and continued incremental progress. Government of Bhutan has an ambitious program of infrastructure development for which reasonable budget provisions has been made in 10th five year plan.

Bhutan is passing through fast growing phase of development. Starting in early 1960, Bhutan embarked on planned economic development through successive five year plans. Over the years, ever increasing generation of electricity by installation of new hydro power projects has facilitated the establishment of new industries within the broad framework of sustainable and environmental friendly development. As power, transport and other infrastructure are the basic requirements for economic growth, the development of infrastructure has also been in the focus of developmental programmes. Over the years a number of power projects, roads, bridges, hospitals, schools and commercial and residential buildings have been built. This has resulted in a rapidly growing construction industry.

A society becomes functional and productive only when it is empowered by social infrastructure development such as housing, schools, hospitals, roads, bridges etc. Cement concrete based products are essential for such development and hence products like cement concrete blocks, hollow blocks, pavers and tiles etc. has been identified. The manufactures of these products are environment friendly and could be commercially exploited profitably with low investment. These items are extensively used in various activities of infrastructure development like hydro electric power generation, roads, bridges, housing and commercial building which is part of urban development.

With a view to cut down the cost of raw materials in construction industries and also to accelerate the pace of industrialization in Bhutan, the government is keen to promote industrial units for manufacture of construction materials. Setting up of such industries would help in easy availability of construction materials at economic prices, generation of employment opportunities, optimum use of natural and human resources and above all accelerating the pace of industrialization in the country.

The construction sector as such contributes to 25% of Bhutan GDP which is further likely to grow. The establishment of industrial unit for the manufacture of cement based products is most suited for development in private and public sector. The following factors contribute to its growth:-

- Requires local resources such as natural & rivers sand, crushed stone aggregate & cement etc. These raw materials are abundantly available across the country near to the development activities.
- The industries could be set up near the source of raw materials and market minimizing the transportation cost which is otherwise too heavy.
- A unit with selected machinery and equipment can produce various types of cement based products required in the construction & infrastructure development activities and thereby facilitating the industrial unit to market their production throughout the year and attain regular margins and economics of production.

In view of the above, a project has been designed for the manufacture of various cement based products viz cement concrete solid blocks and hollow blocks including bricks, concrete paving blocks, cement concrete tiles and mosaic flooring tiles, primarily to meet the domestic demands in Bhutan. It is important to note that cement concrete bricks are usually more costly than red clay bricks, however, in case of Bhutan, red clay bricks are quite expensive in view of the heavy transport costs involved and therefore, production of cement concrete bricks becomes a viable proposition. The details of the products proposed to be manufactured, raw materials required, manufacturing technologies and machines have been given in forth coming discussions.

CHAPTER 3 – MARKET ANALYSIS

3.1 Demand and supply scenario

The cement based products envisaged to be manufacture in the unit are the basic building blocks of any construction viz housing and commercial buildings, industrial estates, road and bridges, hydro electric power projects and any other type of construction. As discussed earlier in the part I of the report in a developing economy like Bhutan, the construction becomes the major activity in various spheres of development, be it power, road, urban infrastructure and housing, education, health, communication. Evidently, the strengthening of infrastructure has become a focused sector for development in Bhutan. It could be observed that a lot of construction activities are either in the process of implementation or planned to be taken up in near future both in public and private sector. With the growing pace of development in infrastructure sector mainly power & roads and increasing trend of urbanization, the construction activities are likely to gain further momentum.

As per the estimate of structural experts, the demand of building construction unit for load bearing & partition wall is around 5% of the cost of construction, flooring tiles – 5% and paving blocks is 2-3% of the construction & development cost of buildings. Thus the cement based products shall account for a total of 10% of the estimated cost of building construction envisaged for urban & rural development. This estimate shall further include a part of budget earmarked for the development of footpaths, pavements, bridges & roads etc.

Further, an ambitious power project Punatshangchhu- Hydroelectric Power Project is being setup at Wangdue. The project has a provision of construction of a township, hospitals, including also roads infrastructure. A number of other power projects have also been planned for adding around 340 MW capacity per annum. The implementation of the project will lead to a lot of construction activities in and around the project location. Further, the programme for construction of roads and bridges in Bhutan is being taken up on an extensive scale. The 10th five year plan document emphasizes on construction of road network including national highways, rural roads along with a number of bridges and also on broadening and up-gradation of existing roads and highways. Similarly, it is estimated that the urban population is likely to grow much higher than the present level resulting in the additional requirement of housing facilities and commercial constructions.

As mentioned in the part I of the report, hydro-electric power projects, road constructions and urban development constitute the main sectors requiring these construction materials. Taking into consideration, the financial allocation to these sectors in 10th five year plan of Bhutan and considering the requirement of cement based products at around 1.5%of the total cost in power projects, around 0.5% in road and bridge construction projects and around 10% in urban development projects, the total projected requirement of cement based products for 10th five year plan works out to be approximately Rs. 68 crores. Besides, there would be additional demand of Rs. 7 crores (10% of the government sector demand) from private sector construction projects

and thus the total demand would be around Rs. 75 crores. This would lead to a demand level of around Rs. 15 crores of cement based products per annum and therefore 4-5 units for the production of cement based products are considered viable, taking into consideration, the available demand level at around 80% of the projected requirement.

The activities in all these sectors of construction shall generate a huge and long term demand for various construction materials. As the items proposed to be manufactured in the project are the basic units for construction for any type construction, prima-facie, there would be no problems in marketing the products of the unit. There is already one unit near Thimphu having facilities for the production of cement concrete bricks and blocks and they have been able to successfully market their products. In the construction of housing colonies of Tala Power Project, cement concrete bricks have been used. Keeping in view, the boom in construction industry in Bhutan, there is ample scope for setting up few more units for the production of cement products.

3.2 Competitive Advantages

The cement products proposed to be manufacture by the unit constituent the basic building blocks for any construction activity. The main competition would be from the red clay bricks or the cement products produced at far of locations. The unit in Punakha is being recommended mainly for catering to the local demand of hydro-electric power related construction activities in the area and the competitive advantages would be as under: -

- Production of tailor made goods in terms of design and quality as per requirement of the concerned authorities in hydro-electric power project and other private customers.
- Lower transport cost of finished goods from factory to construction site, the unit being in Punakha which is around 15-18 kms from the project site in Wangdue.
- Value addition on local raw materials.
- Better inventory control management as the production can be planned as per demand of the customers.
- The unit being in vicinity to power project, the products could be supplied at short notice to customers including hydro-electric power project.

There is already one unit at Thimphu for the manufacture of cement based products. The proposed project is being recommended to be setup near Punakha in view of the upcoming hydro electric power project in Wangdue. It is envisaged that the proposed project shall be able to supply the hollow blocks and tiles for the construction activities related to power project and other construction projects at economical prices due to lower cost of transport of finished goods from the manufacturing unit to the construction sites.

3.3 Target market and Marketing Strategy

The industrial units for the production of cement based products could be developed as a cluster of a number of units manufacturing different products. In this cluster, a number of units could be setup for manufacturing different products. This would enable the individual units to achieve better economics of production since it would be possible to transport the raw materials in bulk at an economical price and also to market wide range of product from one center of production. The cluster approach would also help in developing and refining the skills of manpower to be employed in these units through joint programmes of training and demonstration. The following strategy could be adopted by the unit for better market access.

- Long term contract with hydro-electric power project authorities for supplying the cement based products on mutually agreed terms and conditions as the project would be the main buyer.
- Ensuring the quality and design of the products as per requirement of the project authorities.
- Direct sales to construction projects in private sector.
- Sales of floor tiles through hardware stores.

All construction projects viz building construction in both in public and private sector, road construction, bridges could be the target market for the project. In most of the private housing construction, normally the red bricks have been used in the past, however, their cost is quite prohibitive on account of heavy transport cost. The unit has to strive for a placement of red bricks by cement concrete bricks both on cost considerations as well as on advantages associated with the use of cement bricks viz less consumption of cement in the construction for wall construction and plastering. The marketing team of the unit has to create awareness among the prospective buyers about the advantages associated with the use of cement bricks. The unit also needs to market the cement blocks and paver blocks to road construction agencies and contractors by offering quality products at a competitive rate as compared to the blocks usually cast near the site of construction. This should be possible as the unit can avail the benefits of bulk purchase of raw materials and supply the quality goods at competitive prices to the market. The unit also needs to have some skilled peoples on contract basis who could educate and guide the supervisors, masons and workers at construction sites in correctly laying the bricks with optimum use of cement mortar and also in plastering of the constructed walls and surfaces, so as to achieve the best results.

3.4 Product range and product description

As mentioned above, the project has been designed for the production of a variety of cement based products. The unit shall have two manufacturing sections, the first for the production of cement concrete blocks, hollow blocks and paving blocks and the second for the production of cement concrete tiles and mosaic flooring tiles.

3.5 Cement Concrete blocks and hollow blocks

All these years the smallest unit of construction has been red clay bricks. However due to use of fertile top and bio-fuel the use of red clay bricks is being discouraged world over. Inconsistent quality, size & shape and low crushing strength are some of the factors declining the use of bricks. The most successfully used alternative material is cement concrete bricks and blocks. The mechanical strength of these blocks is consistent and much better than the clay bricks. This ensures structural stability. The two plane surface of the blocks obviates necessity of plaster and if required the quantity of mortar used is very low.

These masonry units viz cement concrete blocks are used for both load bearing and non-load bearing walls, partitions and panels, retaining walls. The hollow (open & closed cavity) blocks are made with normal weight aggregate and are known as normal weight units. The hollow load bearing concrete blocks are made of standard sizes viz.

Bricks	-	230 x 115 x 75 (mm)
	-	190 x 90 x 90 (mm)
Solid Blocks	-	400 x 200 x 200 (mm)
	-	300 x 200 x 150 (mm)
	-	290 x 200 x 140 (mm)
Hollow Blocks	-	400 x 200 x 200 (mm)
	-	400 x 200 x 150 (mm)

The weight varies from 17-31 kg. The hollow blocks have one or more large holes or cavities. The cavities which pass through the blocks are called open cavities hollow blocks and those which do not effectively pass through the block are closed cavity block. A hollow block should have 50 to 75% material of total volume. The solid block has solid material not less than 75% of the total volume.

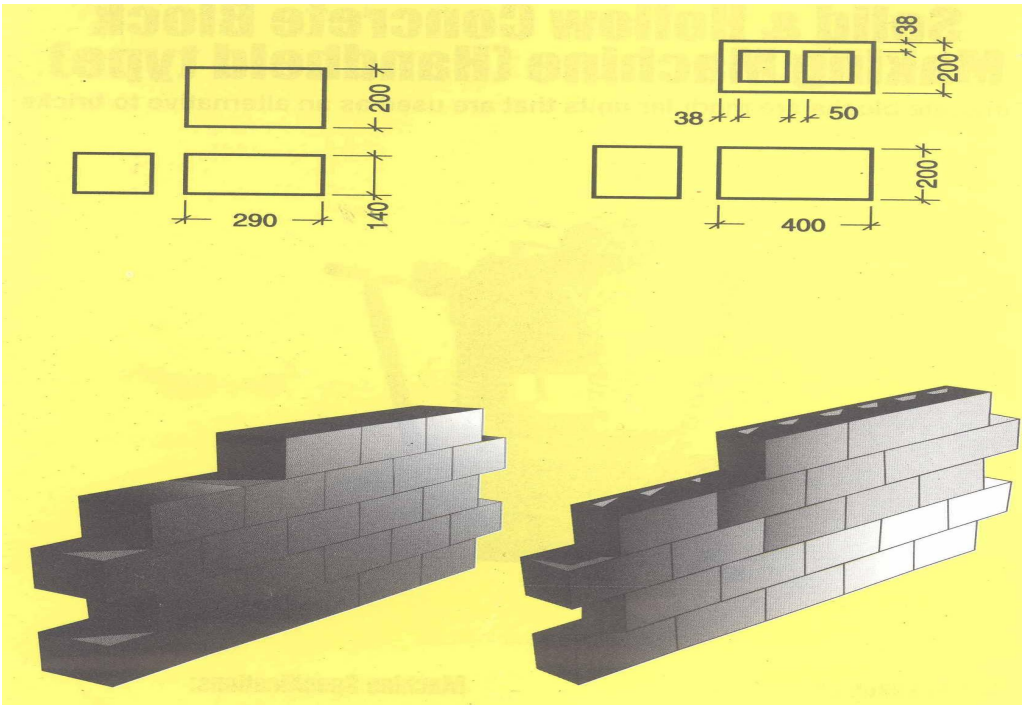
The masonry building units are made in sizes & shapes to fulfill different construction needs these includes stretchers, corners, double corners, pier, jamb, header, bull nose. Half lengths are made to fulfill masonry needs. Blocks of sizes other than mentioned above can also be manufactured as per the mutual agreement between the buyer & manufacturer. However care has to be taken that the vibro presses are capable of generating the desires pressure to solidify the block and impart sufficient green strength.

The hollow concrete blocks are required to conform to be following requirement:

- Load bearing units should have minimum bulk density of 1100 kg / m^3 and 1500 kg/m^3
- Average minimum compressive strength specified varies from 3.5 – 15 N/mm^2

- Solid concrete blocks used as load bearing unit shall have a bulk density of not less than 1800 kg/m^3
- The minimum average compressive strength should be 4.0 – 5.0 N/mm^2

The standard dimensions viz length, breadth and thickness and the weight per unit for solid cement concrete blocks and hollow cement concrete blocks are as given below:

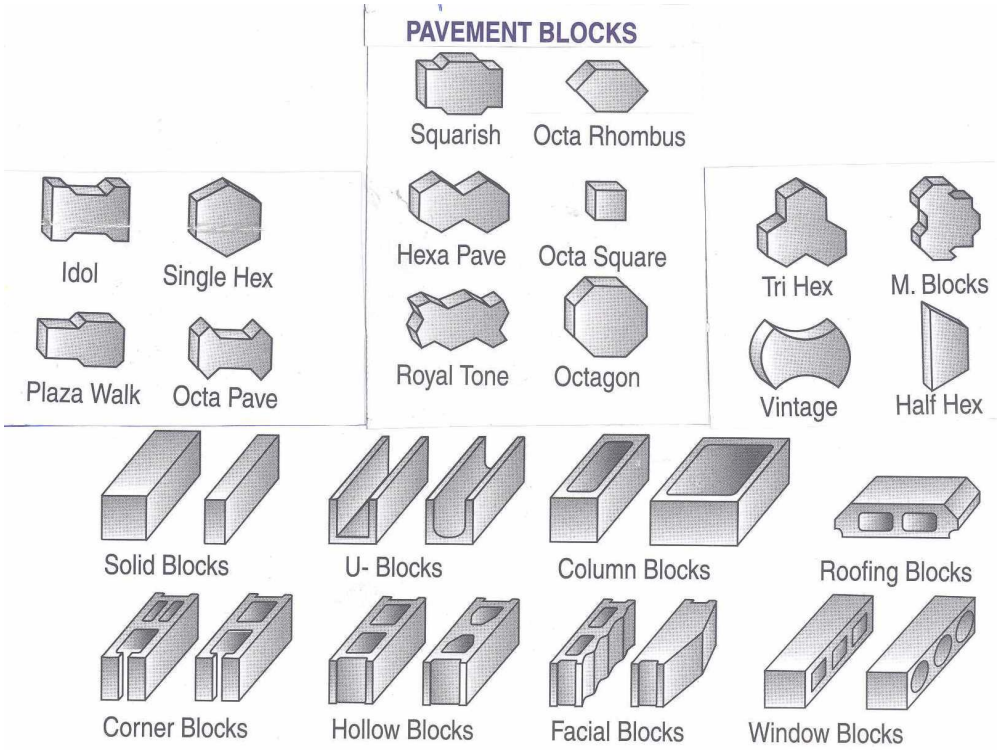


Solid Concrete Block Specifications:		Hollow Concrete Block Specifications:	
Length	290 mm	Length	400 mm
Width	200 mm	Width	200 mm
Height	140 mm	Height	200 mm
Weight: 16 kg		**Weight: 16 kg**	

3.5.1 Paver Blocks

The paving blocks of different sizes and shape find application in pavements, footpaths, gardens, passengers waiting halls, bus stops, industry and other public places. The product is commonly used in urban areas for the above applications. Concrete paving blocks is an ideal material for easy laying of footpath. It gives aesthetic look and fine finish. This also finds extensive use outside the large public buildings and houses.

The Paver blocks are made both in natural cement color and different bright colors. As per the application they are made both in plain geometrical designs & interlocking. Paver blocks are used for light, medium & heavy duty applications and these are designed and manufactured accordingly.



Light Usage: Side walks, walk ways, garden path, verandahs, swimming pool decks, Terries, pavements, footpaths, bicycle path, jogging track etc.

Medium Usage: Hotel-driveways, restaurant, shopping mall/plazas, amusement parks, holidays parking lots embankment, canal lining.

Heavy Usage: Inland container depots, industrial floor, ramps, petrol pumps, service stations, factory compound, bus terminals & road sides etc.

Paver blocks are classified in different grades as per Indian Standards keeping in view the quantum of the load of traffic at their intended sites of use. The details are as under:

Grade	Specific compressive strength of paver block at 28 days N/ mm^2	Traffic category	Recommended minimum paver block thickness	Application
M -30	30	Non traffic	50 mm	Building premises monument, landscape, public garden and park drives.
M-35	35	Light traffic	60 mm	Pedestrians shopping complexes, car parks, office complexes, driveways, farm site, local & residential footways.
M-40	40	Medium traffic	80 mm	City streets, small & medium roads, paths.
M-50	50	Heavy traffic	100 mm	Bus terminals, industrial complexes houses, service stations.
M-55	55	Very heavy traffic	120 mm	Container terminals, bulk cargo areas, airport pavements.

The use of concrete paver has many advantages over the conventional.

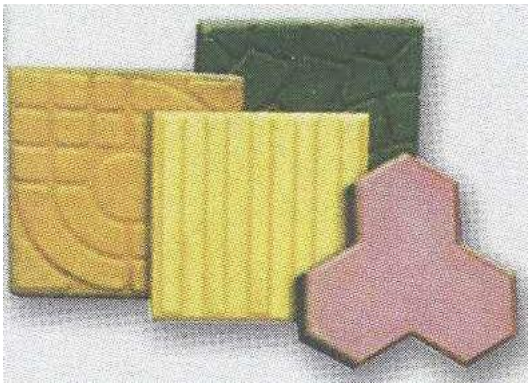
- Quality control possible with in house concrete testing laboratories.
- Easy installation without specialized equipment.
- Can be unlocked, removed & re-fixed to facilitate repairs.
- Sophisticated & attractive appearance.
- Maintenance free & economical.
- High compressive strength.
- Low water absorption.
- High abrasion resistance.

Comparison of Pavers to IPS

Sl. No.	Pavers	IPS
1.	Cracks are not found	Cracks appear after sometime
2.	No skilled labour required	Skilled labour required
3.	Can be removed anytime without brakeage	Cannot be removed without brakeage
4.	No accumulation of water	Accumulation of water
5.	Can be use for roads, pavements, gardens etc.	Not used generally require alternate material
6.	Good & bright appearance	Dull appearance

3.6 Cement Concrete tiles and Mosaic flooring tiles

The cement concrete tiles are used both for laying floors inside & outside the buildings. The mosaic flooring tiles are also known as terrazzo tiles. The natural occurring raw materials like marble chips, stone chips, stone dust, sand, stone aggregate and cement is used in the production of tiles. The construction of floor by laying these tiles is time saving. The repair of damaged floor can easily be carried out by replacing the tiles. The colorful stone chips tile is a good decorative flooring material. The promotion of these items will help in promoting the use of natural resources.



Cement concrete tiles proposed to be manufactured can broadly be classified in the following categories:

- **Plain Cement Tiles:** In the manufacture of plan cement tiles no pigment or stone chips viz marble chips & others are used.
- **Plain Colored Tiles:** The tiles have a plain colored wearing surface.
- **Terrazzo Tiles (Chequered Tiles):** Are also known as Mosaic Flooring Tiles. The wearing surface is composed of stone chips in a matrix of ordinary or colored Portland cement mixed with or without pigments and the surface is mechanically ground to achieve the smoothness.

The cement concrete flooring tiles are classified as below depending upon their intended applications:

- **General Purpose Tile:** These are used for flooring in such places wherein normally uses conditions are not quite heavy resulting in light load applications usage such as office buildings, schools, colleges, hospitals & residential building.
- **Heavy Duty Floor Tile:** These are used for heavy traffic conditions such as footpath, entrances & stair cases of public buildings.

The tiles are made in various sizes depending upon their use and usage conditions. The details of the recommended sizes are as under:

Cement Concrete Flooring Tiles	Cement Concrete Terrazzo Tiles
200 x 200 x 20 (mm)	200 x 200 x 22 (mm)
250 x 250 x 22 (mm)	250 x 250 x 22 (mm)
300 x 300 x 25 (mm)	300 x 300 x 25 (mm)

3.7 Standards and quality specifications

Bureau of Indian Standards (BIS) have prescribed a number of standard specifications for hollow and solid cement concrete blocks, Paver blocks, cement concrete flooring tiles and Chequered cement concrete tiles. The details of the standard specifications are as follows:

IS 2185 (Part 1): 2005	Concrete Masonry Units - Specification Part 1 Hollow & Solid Concrete Blocks
IS 2185 (Part 2): 1983	Specification for Concrete Masonry Units Part 2 Hollow & Solid Lightweight Concrete Blocks
IS 15658: 2006	Pre-cast Concrete Blocks For Paving - Specification
IS: 1237 – 1980	Specification For Cement Concrete Flooring Tiles
IS 13801: 1993	Chequered Cement Concrete Tiles Specification

In addition to the above standards, Indian Standards specification relating to cement viz IS-269, IS-8112, IS-455, IS-1484, part 1 & 2, IS-8041, IS-8042, for stone aggregates IS-383 for water IS-456, for additive and pigments IS 44, IS-54 & 56, IS 3574, IS 411, IS 50 & IS 3574 also need to be referred to.

CHAPTER 4 – RESOURCES

4.1 Main Resources

The main resources for the production of cement-based products include the following:

- Land and building
- Plant and machinery
- Raw materials viz Portland cement, stone aggregates, natural sand, stone crush, synthetic and natural pigments
- Power
- Water
- Skilled and non-skilled workers

It has been envisaged in the project the land for the project would be available on lease basis from Government of Bhutan. The building and the shed as per requirements has to be constructed for the unit. There would be two production sections of the unit viz cement concrete block manufacturing section and cement concrete tiles & mosaic flooring tiles section. Persons having sufficient experience in the production of these products have to be employed as production supervisor so as to ensure the manufacturing of quality goods. Experienced machine operators would also be needed for main machine for hydraulic presses. The operators can also be trained by the machine manufacturers at the site of the factory during installation and commission of the machine.

4.2 Raw materials and consumables

4.2.1 Raw materials for cement concrete blocks

The main raw materials required include cement, stone aggregates, fine and coarse sand, chemical additives and water. The details are as under:

- Portland cement complying to Indian Standard grade 33, 43 & 53 is widely used in the manufacture of blocks.
- The stone aggregate should be hard preferably more than 5 on morsh's scale. It should be free from deleterious matters. Grit size of 8 mm & less is mostly used.
- However in case of large size blocks the mesh size could be up to 12 mm.
- The natural sand & stone crush of size 2 mm & below is used. It should be free from clay dust & deleterious matters.
- The water should be free from the matters harmful to concrete and reinforcement or matters likely to cost efflorescence in the product.
- Additives and admixtures are used to accelerating the process of setting, water reduction, minimizing of air en-trapping & as super plasticizers. Chemical

additives are also used for imparting water proofing characteristics. Colors and pigments are also used for imparting color to the products.

4.2.2 Raw materials for cement concrete tiles and mosaic flooring tiles

The details of raw materials used for plain cement tiles, plain colored tiles and terrazzo tiles are as under:

- White or Grey colored Portland Cement of various grades confirming to Indian Standard such as IS 269, IS 8041, 8042, IS 1489, grade 43, 53 etc. are used.
- Stone crush of 6 mm & below is normally used for backing layer. It should be free from soft, honey combed particles & deleterious matters. For the wearing layer the aggregate consists of marble or stone chips of similar character & hardness, Marble powder & Dolomite powder is also used.
- Synthetic or natural pigments are used in the concrete mix to obtain colorful tiles of desired shades. It should provide durable colors and should be free from matters deleterious to concrete pigments either singly or in combination. It is recommended to use pigment to a maximum of 9% by weight of cement used in the top layer concrete. The pigment should be finer than cement (fineness between 2-15 m^2/kg). It should be free from zinc compound and organic dyes.

4.3 Comparative analysis of sources and prices of critical inputs & consumables

As mentioned earlier, the raw materials required for manufacture of cement products include the following: -

- Portland Cement grey
- White cement
- Stone aggregates
- Marble stone chips / powder
- Natural river sand
- Stone dust
- Natural / Synthetic pigments
- Additives

The major raw materials for the project include cement, stone aggregates and sand / stone dust. All these raw materials are available in Bhutan and the cement could be directly procured from the cement companies. The stone aggregates, stone dust and river sand is also available in Punakha and Wangdue area where the project is to be located. Marble stone, chips and powder is also available in Bhutan. The pigments and additives need to be imported as per requirement depending on the production programme.

4.4 Recommended sources

A list of raw material supplier has been given in the Annexure II. As mentioned above, it would be more economical to purchase the cement directly from cement companies.

4.5 Annual requirement of raw materials

The annual requirement of various raw materials along with their prices have been given in the chapter 9 relating to cost presentation.

CHAPTER 5 – THE PLANT

5.1 Selection of technology

The basic process involved in the manufacture of cement concrete blocks includes mixing of cement, stone aggregate and sand in appropriate proportion and casting of blocks. The manufacturing process for paver blocks and cement concrete tiles and mosaic flooring tiles also involves similar operations. For the manufacturing of cement concrete blocks, manual, semi-automatic and automatic processes of operation are used. The major item of machines for automatic, semi automatic & manual process are similar except that in case of automatic machines, the transportation of raw material, mixture, charging of press & shifting of green product from one machine to the other is carried out with the help of material handling equipments such as shovel loader, conveyer belt, screw conveyer & fork lifter etc. Keeping in view, the size of demand for these products in Bhutan, a semi automatic process has been taken into consideration in the proposed project. The plant would have following two manufacturing sections.

- Hollow blocks and Paver blocks section
- Mosaic tiles and Colored tiles section

5.1.1 Process Technologies used

As mentioned above, for the production of cement products normally following type of process technology are used

- Manual process wherein the mixing of various ingredients and casting of blocks and bricks is carried out manually.
- Semi-automatic process using semi-automatic machines for mixing and casting operations.
- Fully automatic process.

5.1.2 Factors influencing the choice of technology

A number of factors need to be taken into considerations while deciding the choice in favour of a process technology. These factors mainly include

- Factor inputs
- Market findings viz size of market and recurrence of repeat demand
- Purchasing power of consumers and prevailing price spectrum
- Future projections of market demand
- Availability of skilled manpower and support facilities
- Availability of infrastructure and transport facilities
- Environmental considerations

5.1.3 Technology recommended

As stated earlier, the project is based on semi-automatic process technology wherein for mixing and casting semi-automatic machines are proposed to be used. Keeping in view, the relatively small size of demand in Bhutan, the semi-automatic operations are most suited and this would offer the following main advantages.

- Low capital cost
- Common mixing plant for all the products
- Facility for easy change of modes
- Feasibility for production of low volumes of a specific size and design of the product.

5.2 Production Capacity

In both the manufacturing sections, an appropriate product mix of most commonly used items has been taken into considerations while calculating the production capacity of the unit. The annual production capacity of both the sections has been taken for the manufacture of blocks & tiles. For the purpose of financial analysis product mix has been taken into consideration on the basis of single shift working for 300 days in a year. 100 days of production has been taken for the manufacture of each item mentioned below. 90% of installed machine capacity has been taken as the production capacity of the plant at optimum. The product mix along with quantity of each item of production per annum is as given under.

Cement concrete blocks and paver blocks:

Solid blocks	390 x 190 x 140	2,00,000 nos
Hollow blocks	390 x 190x 190	2,00,000 nos
Paver blocks	225 x 112 x 80	6,00,000 nos

Cement Concrete tiles and Mosaic Flooring tiles:

Grey mosaic tiles	300 x 300 x 22	3,00,000 nos
Grey mosaic tiles	250 x 250 x 22	3,00,000 nos
Colored tiles	250 x 250 x 22	2,50,000 nos

5.3 Details and specification of machinery and equipments:

A). For cement concrete block manufacturing section:

	Particulars of Machine
1	**Hydraulically operated stationary block making machine with:-**
	Hydraulic system - 5 HP
	Mould vibrator – 2 HP x 2
	Ram vibrator – 1.5 HP x 1
	Moulding area – 860 x 600 (mm)
	Pallet feeder – hydraulic x 1
	Mix feeder – hydraulic x 1
	Mix feeder bin - hydraulic x 1
	Moulds:-
2	200 x 200 x 400 (mm) cavity block ram & mould
3	150 x 200 x 400 (mm) cavity block ram & mould
4	100 x 200 x 400 (mm) cavity block ram & mould
5	200 x 200 x 400 (mm) solid block ram & mould
6	150 x 200 x 400 (mm) solid block ram & mould
7	100 x 200 x 400 (mm) solid block ram & mould
8	Paver block mould (or mould of any size as per market demand)
9	Pallet stacker
10	Pan mixer of 500 kg. capacity with 15 HP motor
11	Mix conveyor with 2 HP motor
12	Platform electronic weighing scale 500 kg. capacity
13	Water dosing pump with 2 HP motor
14	Wheel barrows with pneumatic wheels
15	Pallet truck 1500 kg. capacity
16	Pallet truck capacity 500 kg. with pneumatic wheels
17	Pallets size 900 x 650 x 250 (mm)
18	Skip loader
19	Color mixer 100 kg. capacity 7 HP

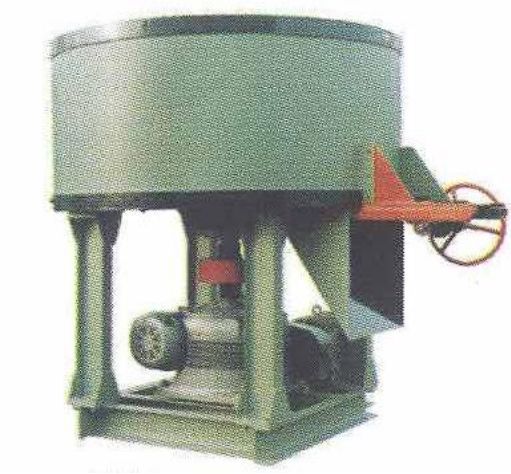
B). Cement concrete tiles and mosaic flooring tiles section:

	Particular of Machine
20	Hydraulic press (Cap. 150 kg/ sq. cm) with pressure gauge
21	Hydraulic double piston pump with 5 HP motor combined with safety valve, capable of feeding 4 to 5 presses, ram vibrator 1.5 HP, mould vibrator 2 HP
22	Leveling (grinding) machine complete with all attachments grinding capacity 4 tiles at a time (5 HP)
23	Semi polishing machine with 2 HP motor for sample polishing for testing
24	Mould with 1 set of extra mould
25	Pallets
26	Tipping borrows

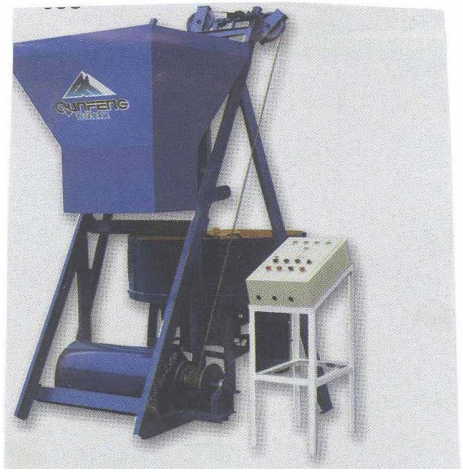
5.4 Process of manufacture

5.4.1 Cement concrete blocks

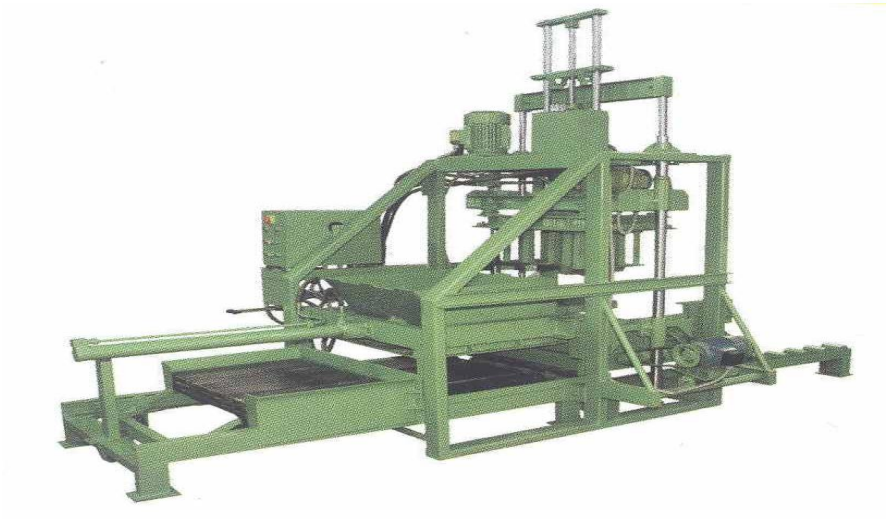
The manufacturing process of cement concrete blocks mainly involves mixing and casting of blocks. The concrete mix in respect of cement aggregate and sand should be suitably proportioned to gain required strength of block conforming to the standards. The factors like quality of raw materials, grading, homogenous mixing, vibro pressing and curing plays a vital role in producing quality blocks. The coarse, fine & medium grade materials should preferably be mixed in the ratio of 40:20:40 for obtaining better interlocking of grains. Vibration & pressing action together helps in better dispersion of mixture and compaction. The amount of water required for the mixture varies depending upon the grading of aggregated & capacity of press machine.



PAN MIXER

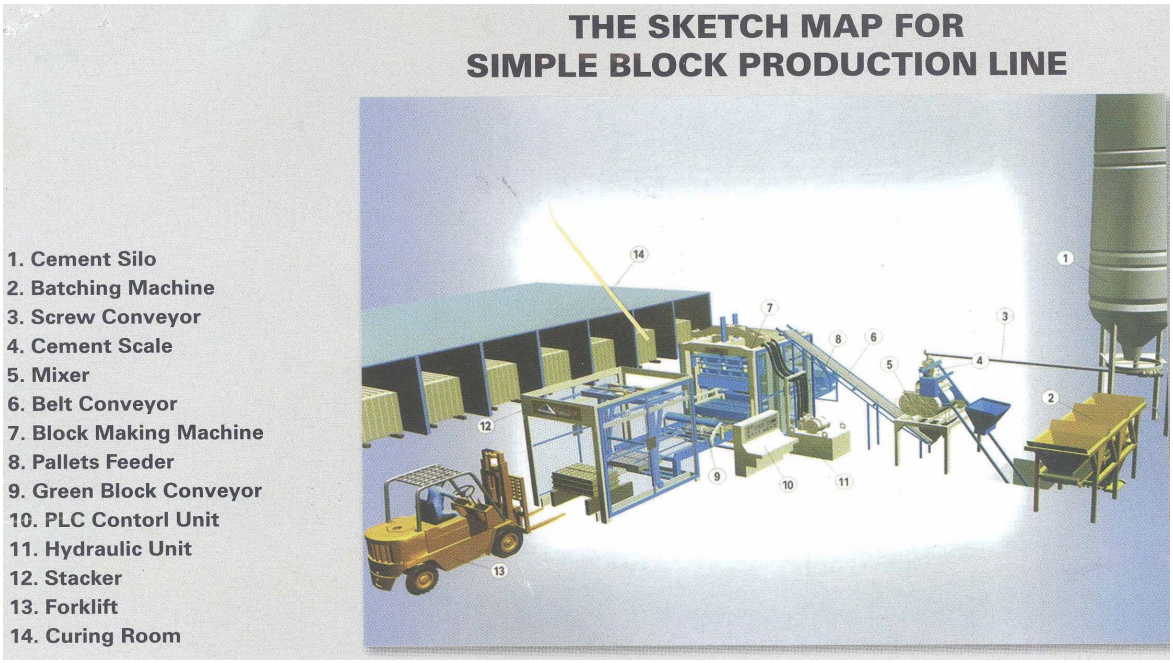


SKIP LOADER



VIBRO-HYDRAULIC PRESS

Batching equipment is used for proportioning the ingredient accurately. Concrete mixer is used for homogenous mixing and blocks are shaped in a vibro compactor. Material handling is carried out with the help of shovel loader, screw & belt conveyer and forklift etc. The blocks after formation are stacked on pallets and carefully shifted to shed in a humid atmosphere to develop initial strength in 24-36 hours. The blocks are stacked & sprayed with the water. The spraying of water must be continued intermittently for a period of three weeks for complete curing. The blocks are then allowed to dry for four week before dispatch.



As stated above, keeping in view the size of the demand for these products in Bhutan, a semi-automatic process has been recommended in the project.

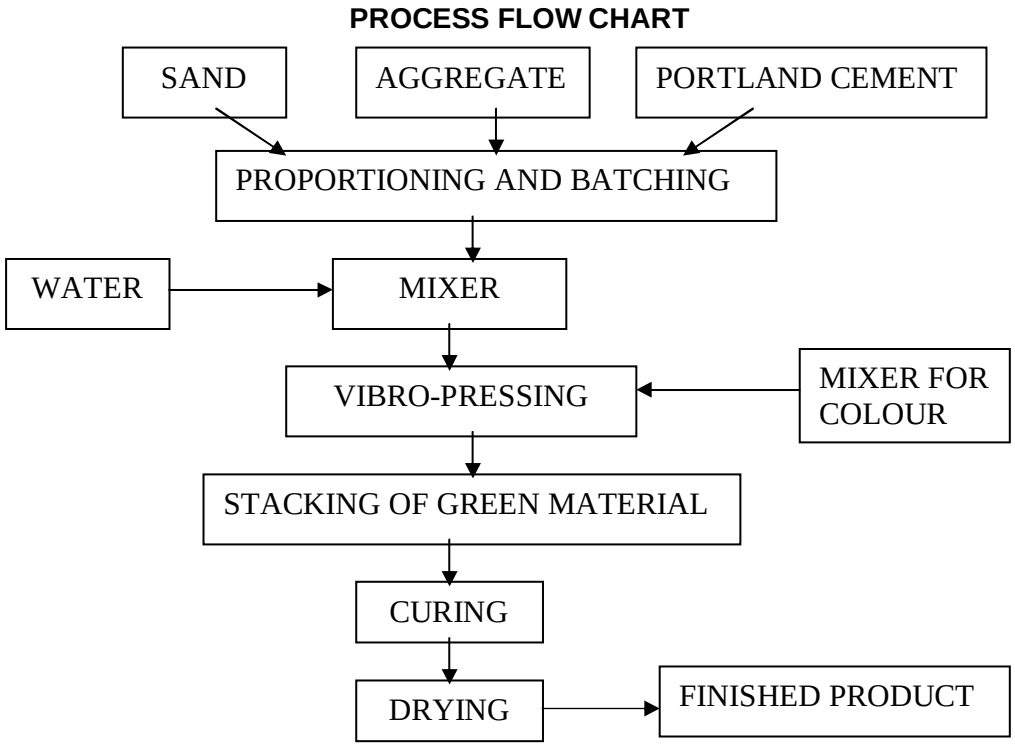
5.4.2 Paver Blocks

The manufacturing process for Paver blocks is similar to the process employed for block making and the raw material used are also same. However, for various raw materials and their quality the corresponding Indian Standard may be referred to. The pavers are made both in the natural color and in a range of other shades. The top layer of the Paver is laid with the coloring material.

Synthetic or natural pigments are used in the concrete mix to obtain coloured Paver blocks of desired shades. It should provide durable colors and should be free from matters deleterious to concrete pigments either singly or in combination. It is recommended to use pigment to a maximum of 9 percent by weight of cement used in the top layer concrete. The pigment should be finer then cement (fineness between 2-15 m^2/kg). It should be free from zinc compound and organic dyes.

In the production process of Paver blocks, the raw materials are mixed in suitable grade & ratio. After homogenous mixing, it is compacted with the help of suitable die in a Vibro-pressing machine. For colored layer of blocks, the pigment is separately mixed in a counter current mixer with fine grade aggregate. The mixture of desired colour is uniformly spread over the top layer of the block with the help of a front feed drawer. In case of non automatic process, the mixture is spread manually before compaction. The paver blocks are sifted in a shade with the help of pellet stacker/forklift. After initial development of strength in a period of 24-36 hrs, the blocks are stacked & subjected to water spraying and misting for curing. After three weeks of curing, the block are allowed to dry before dispatch.

The process flowchart for the manufacture of cement concrete blocks and paver blocks is as given below:



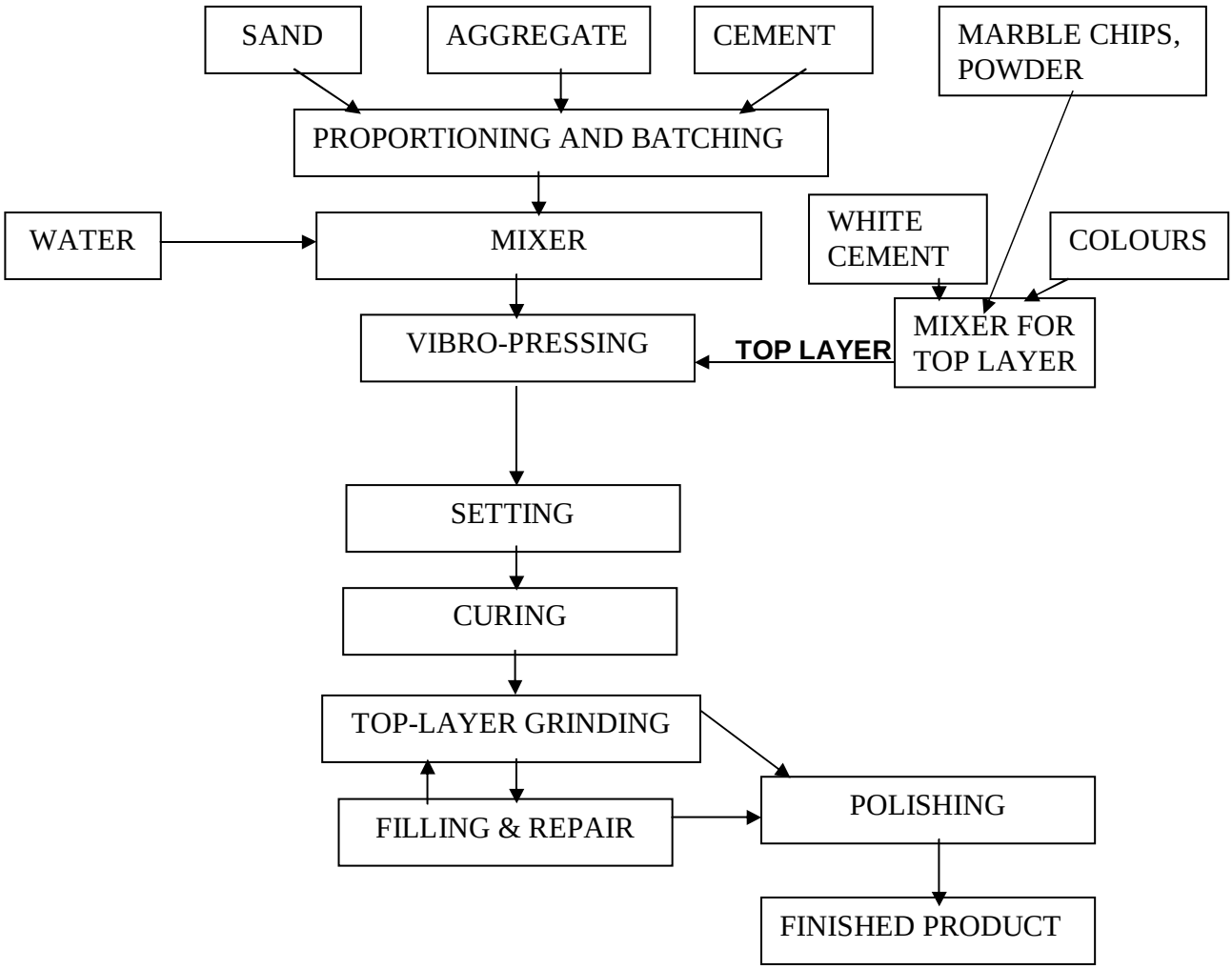
5.5 Cement concrete tiles and mosaic flooring tiles

Basically, the manufacturing process of tiles is also similar to production of blocks. Cement, coarse & fine aggregate are mixed in a ratio of 1:4 for the backing layer. A homogenous mass is obtained with the help of a suitable mixes by adding required quantity of water. The mixture for wearing layer is separately prepared using marble chips, colored stone chips, marble dolomite powder with grey or white cement. The selection of pigment, marble or colored chips etc. is made to produce distinctive designs & deep color shades. The pressing of the tiles in done in a Vibro-press in two successions for molding the backing & facing layers.

Suitable iron moulds are fitted with the bottom plate of the press. The facing mixture is first spread into the mould to a thickness of about 6.5 mm & then backing mixture is filled to form a thickness of 15.5 mm. It is pressed to form the shape at a pressure of around 150 kg/sq. cm. The tiles are ejected from the moulds and stacked in shade for 24 hours to develop initial strength. It is then sprayed with water alternatively immersed in water for curing. After two weeks, the cured tiles are stacked in shade for drying and then ground & polished to make the top surface smooth. The tiles are finally finished manually for any minor visual defect and packed for dispatch.

The process flowchart for the manufacturing of plain and coloured mosaic tiles is given below: -

PROCESS FLOW CHART



5.6 Process and quality control

The products proposed to be manufactured by the unit are the basic construction materials and it is desirable that they are manufactured as per quality standards. Accordingly, a common testing laboratory for both the sections is purposed for the testing of raw materials and finished products and also to ensure in process quality control. The laboratory will be equipped with the following equipments to carry out the various tests as per standard procedure. The details of the tests which need to be carried out and the list of equipment is as given below:

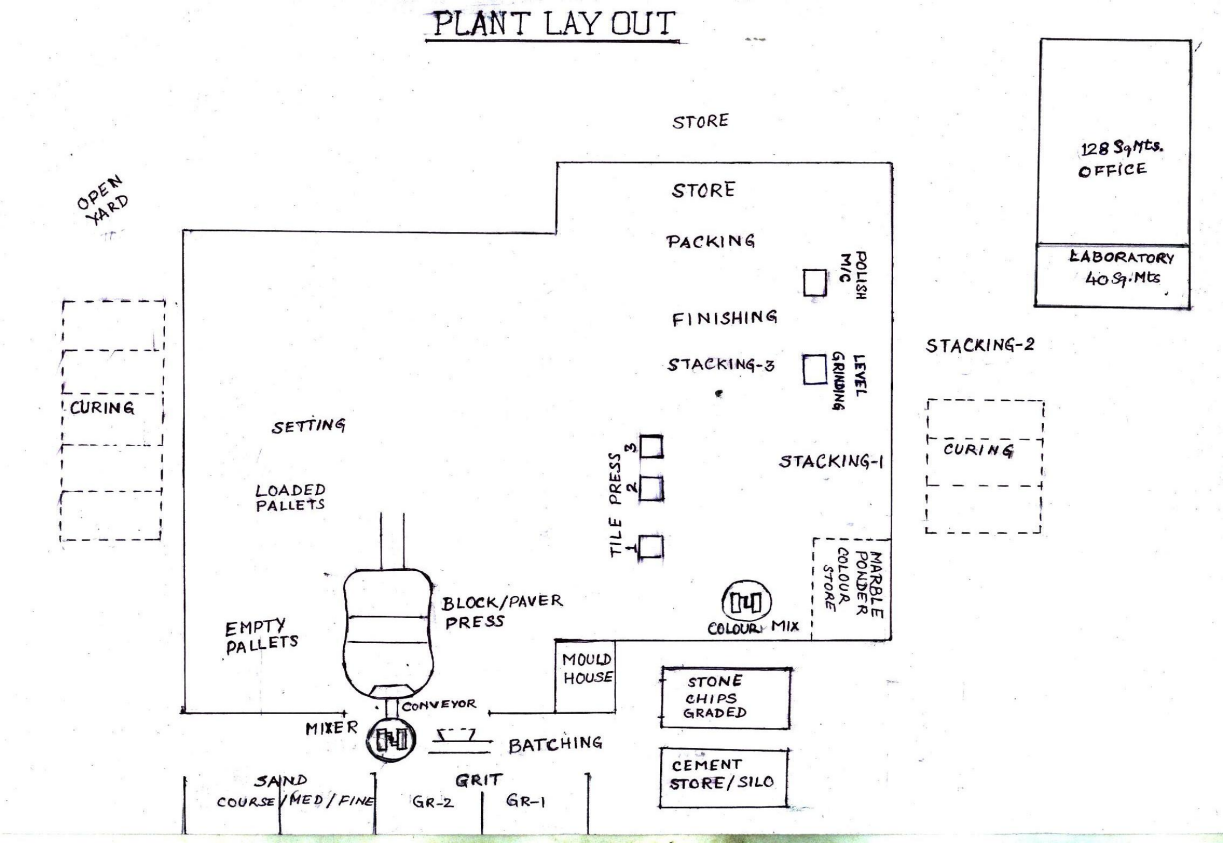
5.6.1 Physical Tests:

- Visual inspection for defect like crack, chipping, open course, sponginess
- Dimensions, flatness of tiles surface, perpendicularity, straightness
- Density
- Moisture absorption
- Drying shrinkage
- Water absorption
- Compressive strength
- Modulus of rupture
- Abrasion resistance

5.6.2 Testing Equipments:

- Steel scale, calipers, rectangle, vernier scale, magnifying glass etc
- Balance with accuracy up to 2nd place of decimal
- Electronic platform type weighing machine
- Vibrating screen set (for grading of raw material)
- Equipment for determination of porosity and water absorption
- Glass apparatus like beaker flask, test tube, etc
- Universal testing machine
- Micro meter gauge, dial gauge
- Abrasion testing machine
- Drying oven
- Rapid moisture testing equipment

5.6.3 Plant Layout



5.7 Technical know-how

The manufacturing process for the production of cement based products is relatively simple and involves two major operations viz mixing of cement, stone aggregates and sand in suitable proportion and casting of the mix in the form of blocks of requisite size. The ratio of the ingredients in the mix has to be suitably adjusted to impart the required strength to the block depending on its sues. These ratios are well-known for various standard products. Proper mixing, Vibro pressing and proper curing also play major role in the quality of the products. Besides, design of the product is another aspect which needs to be looked into. With a view to produce quality goods at economical cost, experienced people in the production of similar products need to be employed. The basic details of the technology and machine operations are also provided by the machine manufacturers. The machine suppliers also train the operators and skilled workers at their own factory or at the site of installation of their machines. This aspect has been discussed by IDRG team with some of the machine suppliers also. A provision has been made in the project for process and quality control laboratory and the finer technological details viz ratio proportion of ingredients and curing time could be adjusted keeping in view the local conditions and the test results of the products.

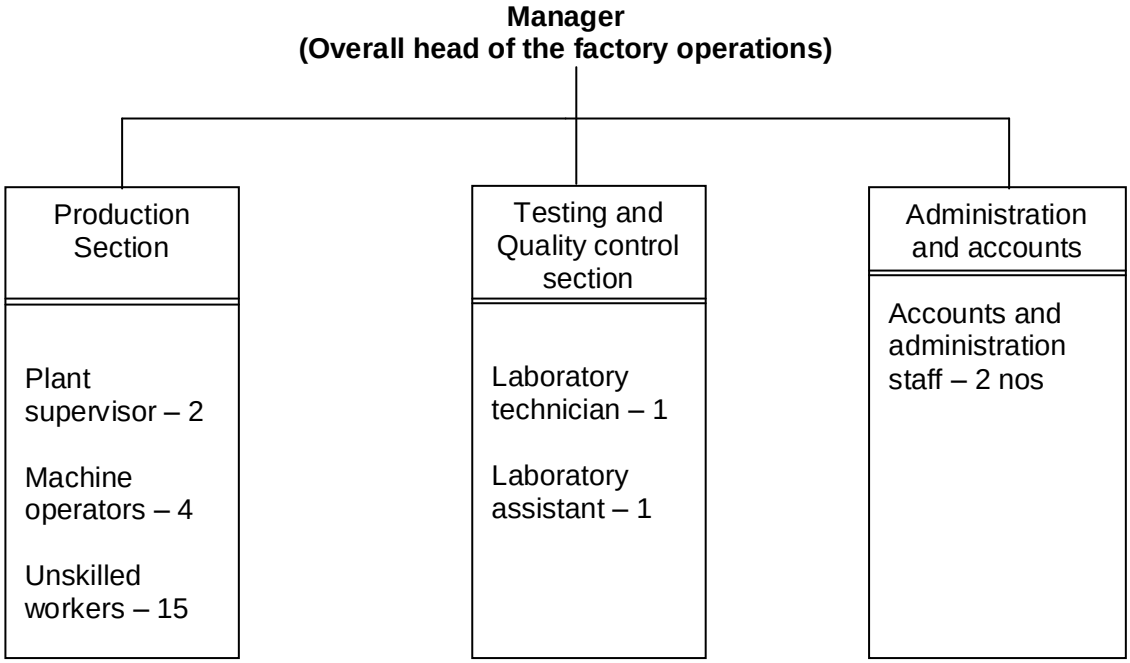
5.8 Requirement of power and fuel

It is estimated that 45 KWH power connection would be required for the production unit including the power requirement for production machines and general purpose lighting. The cost of the power has been calculated on the basis of Re. 1.45 per unit.

5.9 Requirement of manpower

The annual production turnover and the financial projections are based on single shift operation of machines. For operation of the unit, 3 managerial and office staff, 3 marketing executives, 1 laboratory technician, 1 laboratory assistant, 2 plant supervisors, 4 skilled workers and 15 unskilled workers would be required. In case the unit is required to be operated in more than one shift, additional staff would be required. In addition to this, there would be a requirement of contract workers during the construction phase of the factory and installation of machinery and equipment. The organization chart for single shift operation would be as under:

5.10 Organization Chart



The project has a good employment potential for skilled and unskilled workers, which would be employed in the production unit. Beside the project would generate employment potential in marketing & sales of its produce, transport of raw materials and finished products. The project would thus create opportunity both for direct & indirect employment.

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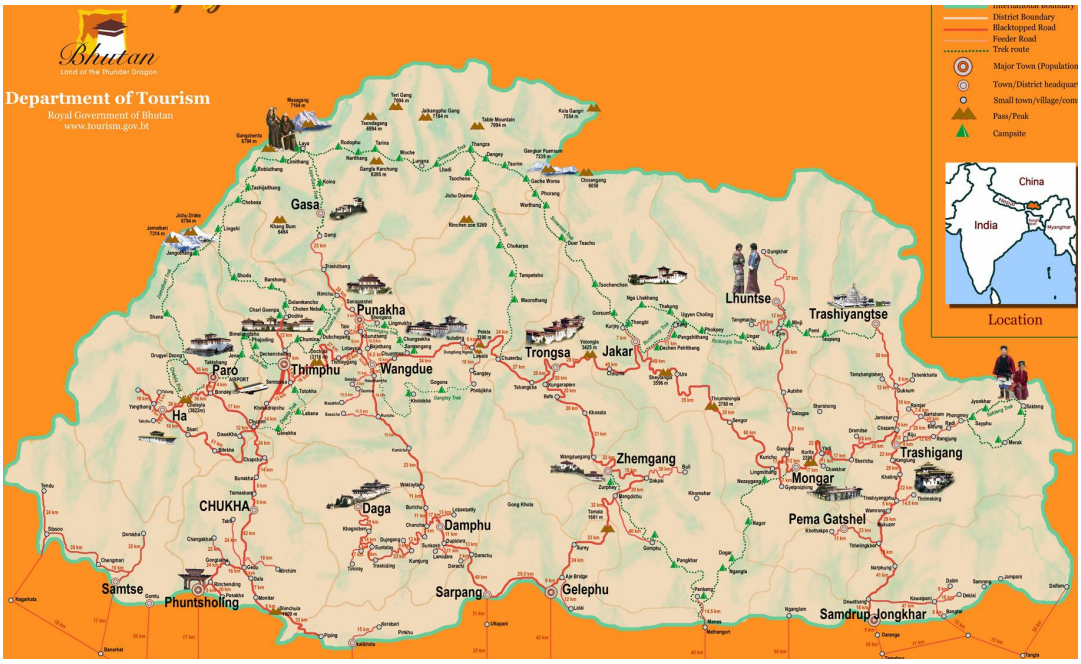
CHAPTER 6 – PLANT LOCATION AND INFRASTRUCTURE

6.1 Potential Locations

Location of the proposed unit should preferably in the vicinity of the major sites of construction as well as sources of raw materials. Thimphu, Phuentsholing, Punakha, Wangdue, Gelephu, Samdrup and Paro happen to be the main towns and would constitute the major sites of construction. Besides, Wangdue being the site of biggest ongoing power projects has also tremendous potential for construction activities. In past also, a cement brick unit was setup near to the site of Taala power project. The units for the manufacture of main raw materials viz stone aggregates and sand also need to be promoted near the proposed project. Cement, in any case, has to be transported from the cement factories.



6.2 Selection of suitable locations

In order to select the suitable location for the manufacturing plant, various parameters viz availability of land, environmental conditions, investments considerations, operational logistics, future development possibility, socio-economic factors including availability of services like transport and communication facilities etc. have been taken into consideration for ranking the locations. The table below shows the ranking of locations:

Ranking of possible locations based on various parameters

		Weightage of location related parameters						
S. No.	Locations	Land Access conditions	Environmental Conditions	Socio economic factors	Investment Consideration	Operational Logistics	Future development possibilities	Overall Rating
1	Punakha	7	7	7	9	8	7	**45**
2	Wangdue	7	7	6	7	8	7	**42**
3	Thimphu	7	7	6	8	7	7	**42**
4	Phuentsholing	7	7	6	7	7	7	41
5	Gelephu	7	7	6	7	7	7	41
6	Samdrup	7	7	6	7	7	7	41
7	Paro	7	7	6	7	7	7	41

It is therefore proposed that the unit be located near Punakha. It may be mentioned that the project site is almost in between Wangdue and Punakha. The requisite infrastructure viz land, power, road transport and communication facilities required for the proposed unit are available in and around Punakha and the infrastructure facilities are likely to be further developed due to setting up of hydro electric power project. The project has been conceptualized in totality and all the manufacturing operations are proposed to be carried out in the unit itself. The project has an inbuilt provision for spare parts, components & tools and the cost for the same has been incorporated. There may be some requirement of minor mechanical or electric repairs which could be taken care of by the skilled workers of the unit. Alternatively, the assistance could be taken off from the existing mechanical and electrical repair workshops.

Further keeping in view the fact that on the considerations of market demand, all major towns and sites of big projects constitute the potential market for the cement based products since these products happen to be the basic building blocks of any construction activity. Accordingly, it is recommended that a number of such units need to be promoted at different locations to meet the local demand. Punakha has been recommended as the selected location for the project since there would be lot of construction activities in near future both for the hydro electric power project and also creation of support facilities for the project as well as there would be lot of construction activities in the private sector to meet the growing demand of housing and commercial establishments.

CHAPTER 7 – ENVIRONMENTAL IMPACT

7.1 Environmental aspect of manufacturing process

The manufacturing process involved in the production of cement based products are basically mixing of various ingredients viz cement, stone aggregate and sand, the conversion of raw material mix into the form of paste followed by casting of the mix in requisite shape and sizes. There are no solid, liquid or gaseous effluents generated during the manufacturing process. However, while preparing the mix of cement, stone aggregates and sand, some dust particles get floated in the air causing higher level of suspended particulate matter (SPM) in the air. This could be checked and controlled by providing appropriate coverings to the mixing bins, use of exhaust fans and sprinkling of water on sand and stone aggregates as also during mixing operations. A provision of dust collector would further minimize the SPM in the air and improve the working conditions in and around the manufacturing unit. The wearing of mask by workers to protect them from inhaling of dust particles is also recommended.

7.2 Waste generated and mitigation measures

In the manufacturing process of cement based products, no solid, liquid or gaseous wastes are generated. However, as mentioned above, during handling of cement, stone aggregates and sand, dust particles flow in the air resulting in higher level of suspended particulates matter (SPM). In order to reduce the SPM, various methods could be used viz covering of mixing bins, used of exhaust fan, sprinkling of water and use of dust collectors. Besides, there would be some waste of metal scrap, wooden scrap, broken bricks, stone aggregates, etc during construction phase of the project. The waste generated during construction phase is mainly used for earth filling & flooring. The details of the waste generated during construction phase and project operation phase along with mitigation measures are given below in subsequent paras.

7.2.1 Waste generated during construction phase and mitigation modes

The details of the waste generated during construction phase and the mitigation measures are as under: -

S. No.	Type of waste/scrap	Quantity	Mitigation measures	Impact on Environment
1.	Metal scrap	Around 2-3 % of the steel used in construction	Sold to trade channels for reprocessing.	No adverse impact
2.	Wooden scrap	Around 5-7% of the wood used in construction.	Used as fuel.	No adverse impact

3.	Clay stones, mounds	Depending upon on the topography of the construction site.	Used for earth filling.	No adverse impact.
4.	Brick stone cement aggregate	5% of the quantity used	Used for flooring and earth filling.	No adverse impact

7.2.2 Waste generated during project operation phase and mitigation modes

The details of the waste generated and the mitigation measures are as under:

S. No.	Type of waste	Quantity	Mitigation measures	Impact on environment
1.	Liquid effluents	Nil	Not applicable	No adverse impact
2.	Gaseous effluents	Nil	Not applicable	No adverse impact
3.	Solid effluents or waste * During handling of raw materials, there is likely to be higher level of SPM in the air in the production shed.	Small quantity	SPM can be checked by sprinkling of water, covering of mixing bins and use of dust collectors.	No adverse impact

CHAPTER 8 – IMPLEMENTATION SCHEDULE

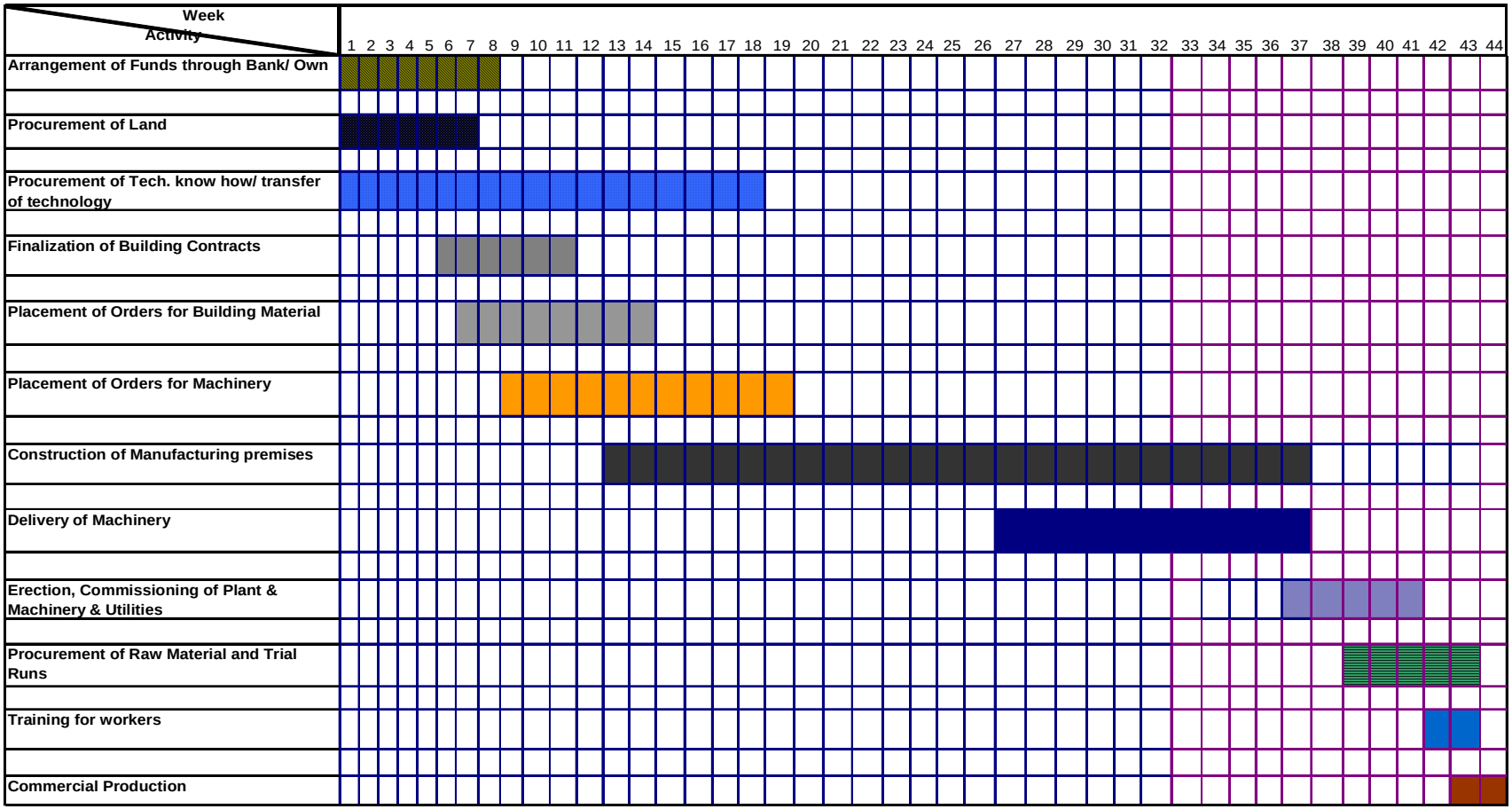
8.1 Implementation Schedule – Table

Particular	From	To	Total Weeks
Arrangement of Funds through Bank/ Own	1	8	8
Procurement of Land	1	7	7
Procurement of Tech. know how/ transfer of technology	1	18	18
Finalization of Building Contracts	6	11	5
Placement of Orders for Building Material	7	14	7
Placement of Orders for Machinery	9	19	10
Construction of Manufacturing premises	13	43	30
Delivery of Machinery	27	43	16
Erection, Commissioning of Plant & Machinery & Utilities	41	46	5
Procurement of Raw Material and Trial Runs	46	48	2
Training for workers	48	49	1
Commercial Production	49	50	1

8.2 Implementation schedule – Graphic view

Implementation Schedule

Manufacture of Exercise Books



CHAPTER 9 – COST PRESENTATION

9.1 Capital costs

9.1.1 Cost of Land and building

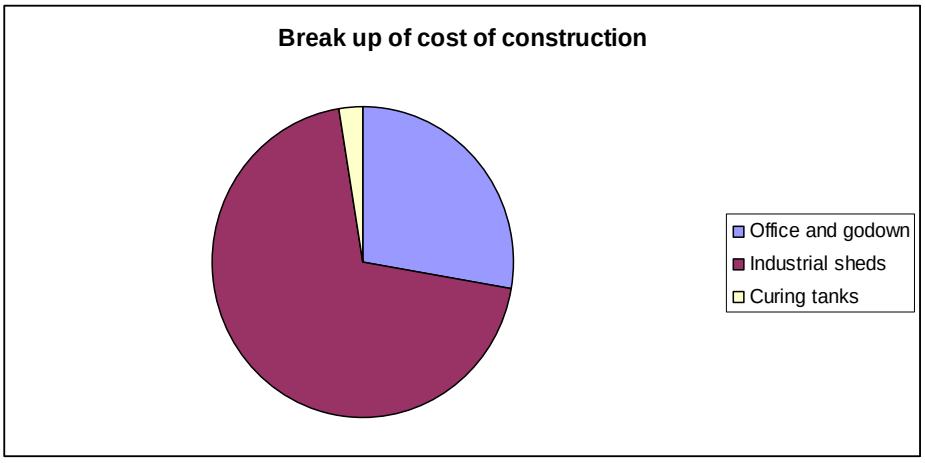
A). **Plot and built up area**

- Total land requirement	-	6000 sq. mt.
- Constructed area for godowns, offices and Testing laboratory	-	208 sq. mt.
- Two Industrial sheds of 450 sq. mt each for installations of machines	-	900 sq. mt.
- Curing tanks for blocks and tiles	-	2 nos

B). **Cost of construction**

- Office and godown (208 X 6000)	-	Rs. 12,48,000/-
- Industrial sheds (900 X 3500)	-	Rs. 31,50,000/-
- Curing tanks	-	Rs. 1,15,000/-
Sub-total	**-**	**Rs. 45,13,000/-**

C). **Land on lease @ Rs. 10/- per sq. mt / annum**



9.1.2 Cost of Machines and Equipments

S. No.	Particulars of Machine	Nos	Amount
1	**Hydraulically operated stationary block making machine (M1) with:-** Hydraulic system - 5 HP Mould vibrator – 2 HP x 2 Ram vibrator – 1.5 HP x 1 Moulding area – 860 x 600 (mm) Pallet feeder – hydraulic x 1 Mix feeder – hydraulic x 1 Mix feeder bin - hydraulic x 1	1	5,92,000
	Moulds (M2):-		
2	200 x 200 x 400 (mm) cavity block ram & mould (M3)	1 set	18,500
3	150 x 200 x 400 (mm) cavity block ram & mould (M4)	-do-	18,500
4	100 x 200 x 400 (mm) cavity block ram & mould (M5)	-do-	17,000
5	200 x 200 x 400 (mm) solid block ram & mould (M6)	-do-	16,000
6	150 x 200 x 400 (mm) solid block ram & mould (M7)	-do-	16,000
7	100 x 200 x 400 (mm) solid block ram & mould (M8)	-do-	16,000
8	Paver block mould (M9) (or mould of any size as per market demand)	-do-	86,000
9	Pallet stacker (M10)	1	3,60,000
10	Pan mixer of 500 kg. capacity with 15 HP motor (M11)	1	2,50,000
11	Mix conveyor with 2 HP motor (M12)	1	1,86,000
12	Platform electronic weighing scale 500 kg. capacity (M13)	1	62,000
13	Water dosing pump with 2 HP motor (M14)	1	24,000
14	Wheel barrows with pneumatic wheels (M15)	4	28,000
15	Pallet truck 1500 kg. capacity (M16)	2	40,000
16	Pallet truck capacity 500 kg. with pneumatic wheels (M16)	2	68,000
17	Pallets size 900 x 650 x 250 (mm) (M17)	500	4,90,000
18	Skip loader (M18)	1	30,000
19	Color mixer 100 kg. capacity 7 HP (M19)	1	62,000
	Sub-Total		**23,80,000**

9.1.3 Cement concrete tiles and mosaic flooring tiles section

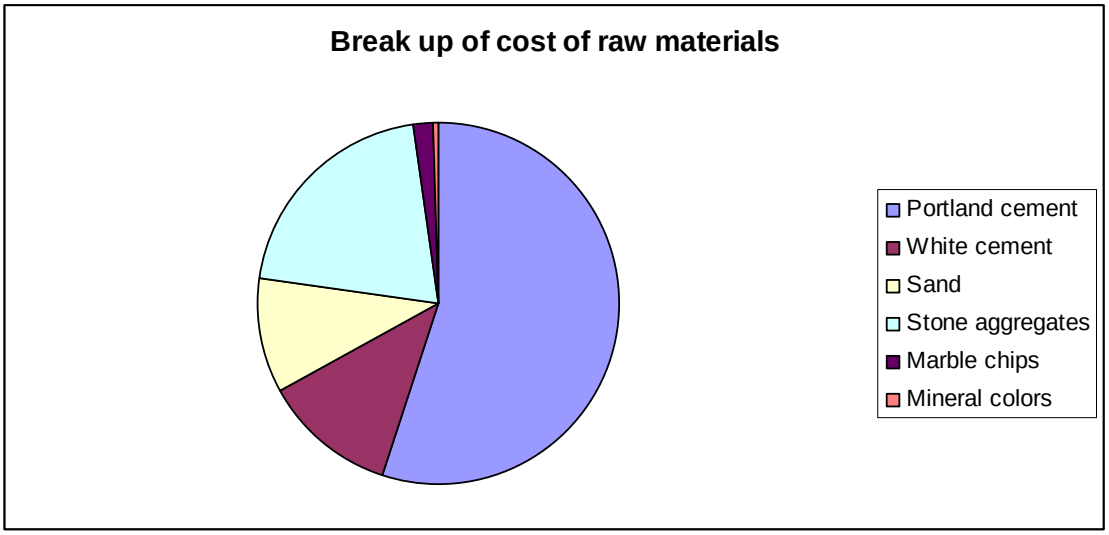
S. No	Particular of Machine	Nos	Amount
20	Hydraulic press (Cap 150 kg/sq cm) with pressure gauge (M20)	3	3,00,000/-
21	Hydraulic double piston pump with 5 HP motor combined with safety valve, capable of feeding 4 to 5 presses, ram vibrator 1.5 HP, mould vibrator 2 HP (M21)	1	1,00,000/-
22	Leveling (grinding) machine complete with all attachments grinding capacity 4 tiles at a time (5 HP) (M22)	1	1,50,000/-
23	Semi polishing machine with 2 HP motor for sample polishing for testing (M23)	1	25,000/-
24	Mould with 1 set of extra mould (M24)	1set	70,000/-
25	Pallets (M25)	250	1,50,000/-
26	Tipping borrows (M26)	LS	10,000/-
	Sub-Total		**8,05,000/-**

9.2 OPERATING COSTS:

9.2.1 Cost of Raw Materials

(ii) Raw material (PM)			
Portland cement	133 MT tonnes	@ Rs. 5000/-	6,65,000/-
White cement	16 MT tonnes	@ Rs. 9000/-	1,44,000/-
Sand	500 MT tonnes	@ Rs. 250/-	1,25,000/-
Stone aggregate	452 MT tonnes	@ Rs. 550/-	2,48,600/-
Marble chips	21 MT tonnes	@ Rs. 900/-	18,900/-
Mineral colors	Lump-Sum		7,500/-
	Sub-total		**12,09,000/-**
	Wastage allowance 5%		60,450/-
	Total		**12,69,450/-**

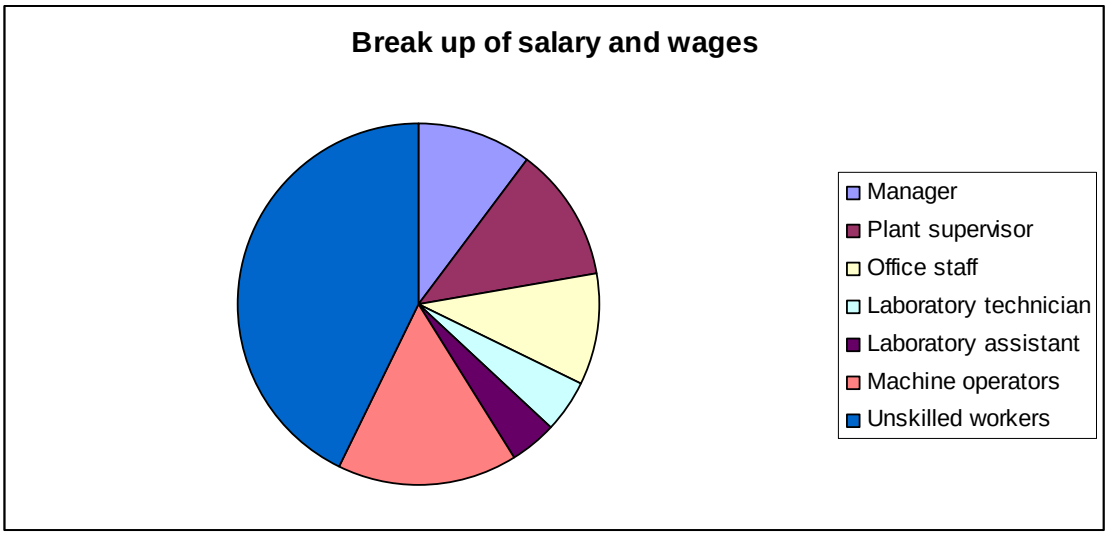
Total annual cost of raw material - Rs. 1,52,33,400/-



9.2.2 Salary and wages

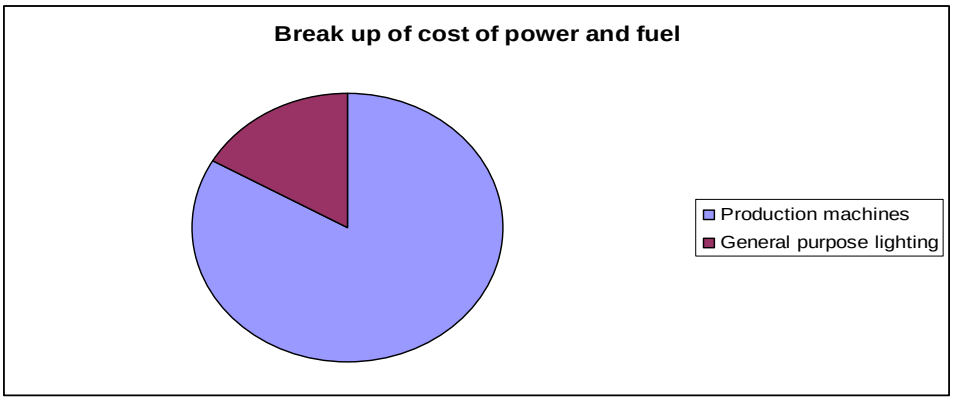
Manager	1	25,000	25,000/-
Plant supervisor	2	15,000	30,000/-
Office staff	2	12,000	24,000/-
Laboratory technician	1	12,000	12,000/-
Lab assistant	1	10,000	10,000/-
Machine operators	4	10,000	40,000/-
Unskilled workers	15	7,000	1,05,000/-
	Total		**2,46,000/-**

Salary and wages per annum = Rs. 29,52,000/-



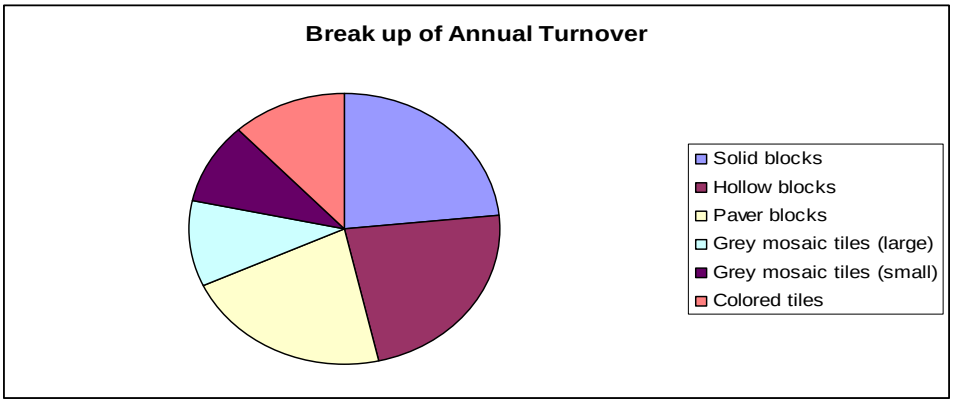
9.2.3 Cost of Power and Fuel

Power requirement for production machines	-	37.5 KWH
Power requirement for general purpose with lighting Of stores, offices and production unit	-	7.5 KWH
Total	**-**	**45 KWH**
Annual cost of power	**-**	**Rs. 1,25,280/-**



9.2.4 Annual Turnover

Total turnover (per annum)				
Solid blocks	390 x 190 x 140	2,00,000 nos	@ Rs. 29/-	58,00,000/-
Hollow blocks	390 x 190x 190	2,00,000 nos	@ Rs. 29/-	58,00,000/-
Paver blocks	225 x 112 x 80	6,00,000 nos	@ Rs. 9/-	54,00,000/-
Grey mosaic tiles	300 x 300 x 22	3,00,000 nos	@ Rs. 8.50/-	25,50,000/-
Grey mosaic tiles	250 x 250 x 22	3,00,000 nos	@ Rs. 8/-	24,00,000/-
Colored tiles	250 x 250 x 22	2,50,000 nos	@ Rs. 12/-	30,00,000/-
Total				**2,49,50,000/-**
Wastage @ 5%				**4,99,000/-**
Net Turnover				**2,44,51,000/-**



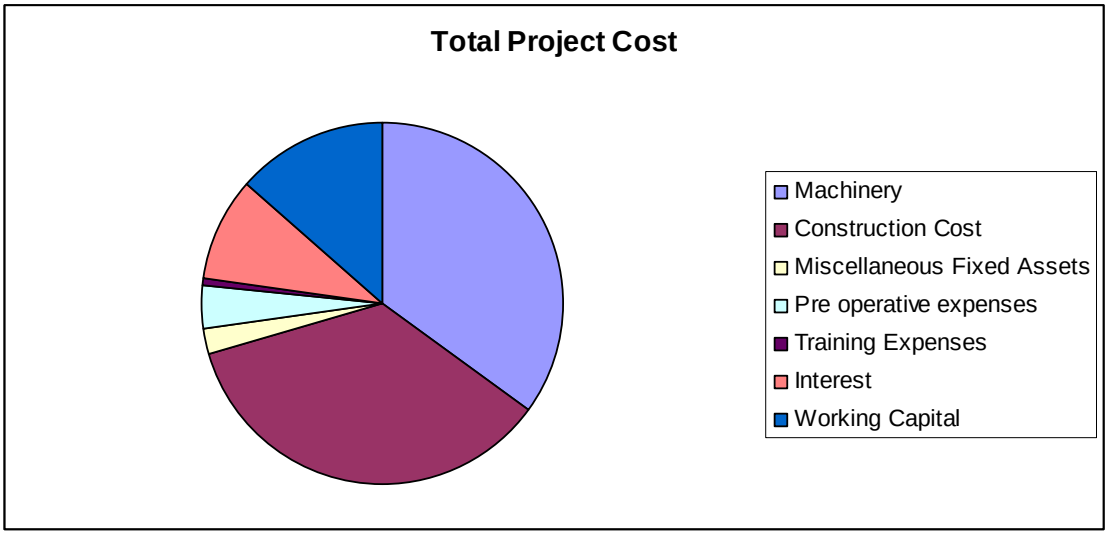
CHAPTER 10 – FINANCIAL ANALYSIS

10.1 Project Assumptions

Assumptions at a Glance		
S. No	**Particulars**	
1	Total Project Cost (in Rs. Lacs)	127.46
2	Debt	70%
3	Equity	30%
4	Rate of Interest	12%
5	Depreciation (Building)	SLM 10 yrs
6	Depreciation (Machinery)	SLM 20 yrs
7	Tax	30%
8	Construction Cost (Building) Rs. per sq/mt	6000
9	Construction Cost (Shed) Rs. per sq/mt	3500
10	Repayment period of Debt	8 yrs
11	Moratorium period	1 yr.
12	Installed Capacity (in lac units)	20.5
13	Capacity Utilization	90%
14	Working Capital Cycle	1 month

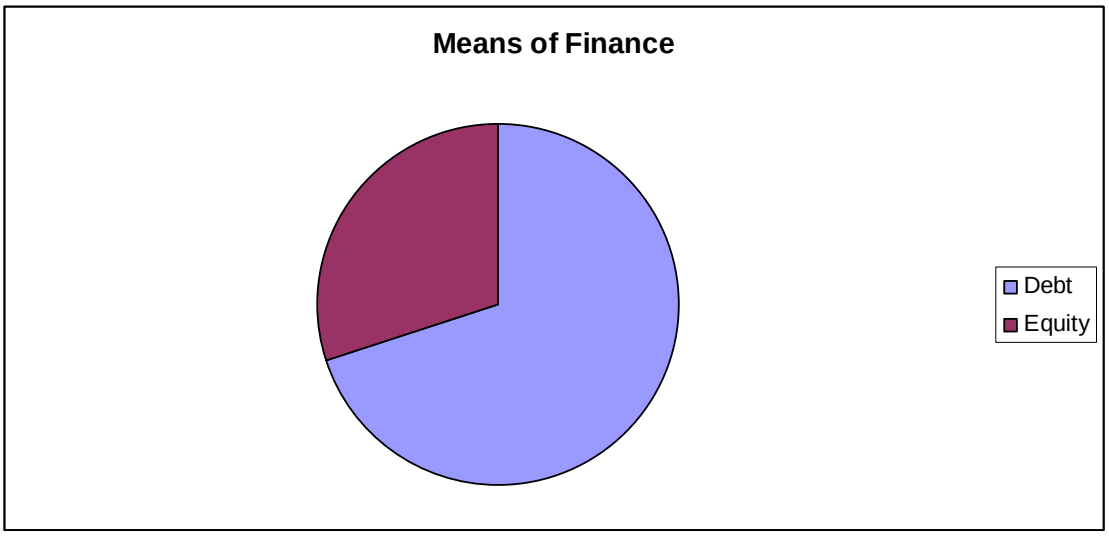
10.2 Total Project cost

Total Project cost (in Rs. Lacs)		
1	Machinery	44.68
2	Construction Cost	45.13
3	Miscellaneous Fixed Assets	3.00
4	Pre operating Expenses	5.00
5	Training Expense	0.45
6	Interest	11.79
7	Working Capital	17.41
	Total	**127.46**



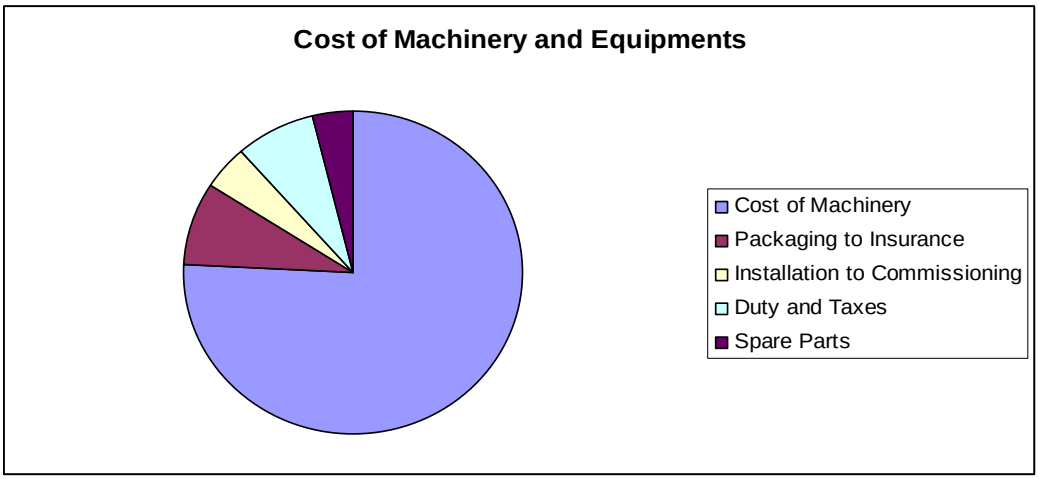
10.3 Means of Finance

Means of Finance		
	(In Rs. Lacs)	
Debt	89.22	70%
Equity	38.24	30%
Total	**127.46**	**100%**



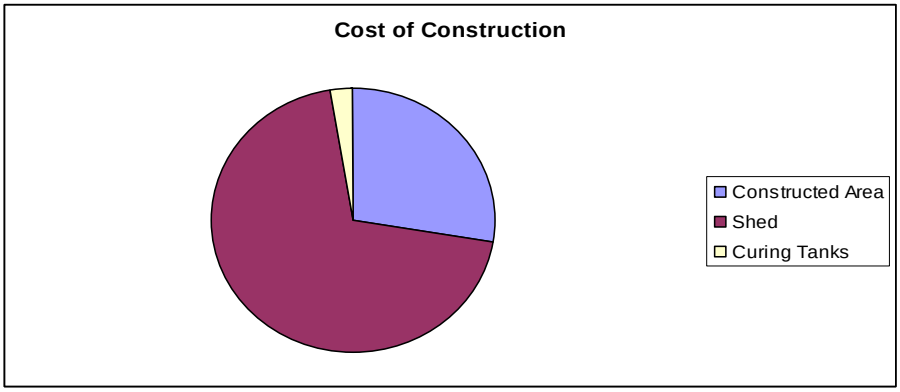
10.4 Cost of Machinery and Equipments

	MACHINERY	(In Rs.)
	M1	592,000
	M2	18,500
	M3	18,500
	M4	17,000
	M5	16,000
	M6	16,000
	M7	16,000
	M8	86,000
	M9	360,000
	M10	250,000
	M11	186,000
	M12	62,000
	M13	24,000
	M14	28,000
	M15	40,000
	M16	68,000
	M17	490,000
	M18	30,000
	M19	62,000
	Sub Total	**2,380,000**
	M20	300,000
	M21	100,000
	M22	150,000
	M23	25,000
	M24	70,000
	M25	150,000
	M26	10,000
	Sub Total	**805,000**
	Laboratory Equipments	**200,000**
	Total	**3,385,000**
Add	Packaging, Forwarding, Transport and Insurance @11%	372350
Add	Installation, Erection and Commissioning @ 6%	203100
Add	Duty and Taxes @ 10%	338500
Add	Spare Parts @ 5%	169250
	Total Cost	**4,468,200**



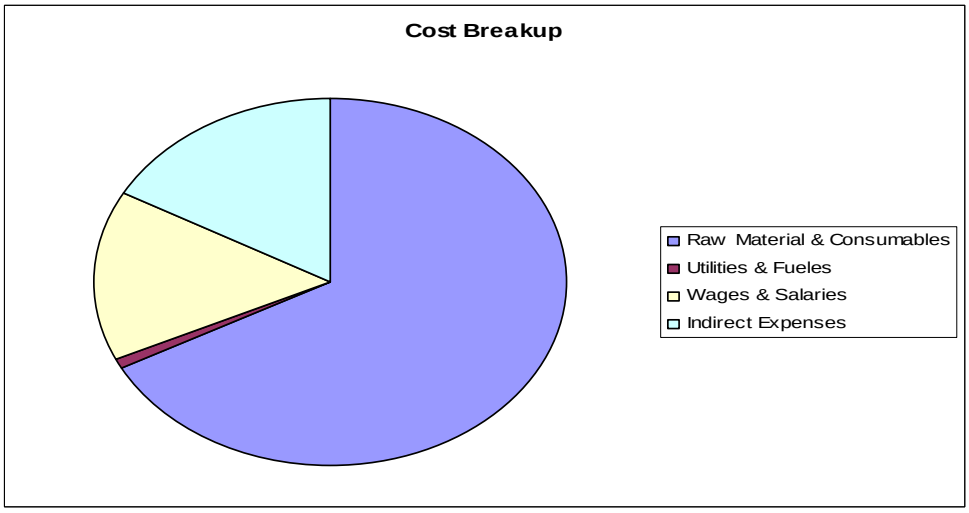
10.5 Construction Cost

Construction Cost	
	(In Rs.)
Constructed Area (208 Sq mtr @ 6000per Sq mtr) For offices, godown and laboratory	1248000
Shed (900 Sq mtr @ 3500 per Sq mtr)	3150000
Curing Tanks	115000
Total	**4513000**



10.6 Cost Break up

Particulars	Amount (in Rs. lacs)
Raw Material & Consumables	152.33
Utilities & Fuel	1.85
Wages & Salaries	33.95
Indirect Expenses	38.26



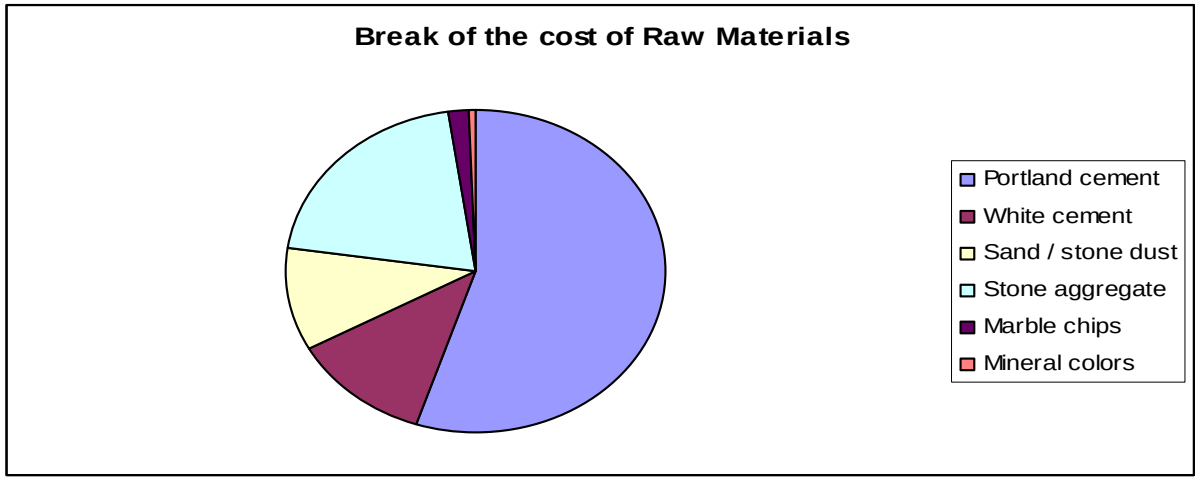
10.7 Expenses incurred

	Expenses (in Rs.)				
1	Salary and Wages				
	Type of Employees	No. of Employees	Per month	Per Annum	Total
	Manager	1	25000	300000	3
	Office's Staffs	2	12000	144000	2.88
	Plant Supervisor	2	15000	180000	3.6
	Laboratory Technician	1	12000	144000	1.44
	Lab Assistant	1	10000	120000	1.2
	Machine Operator	4	10000	120000	4.8
	Unskilled Workers	15	7000	84000	12.6
	Total				**29.52**
	Perks		at 15%		4.43
	Total				**33.95**
2	Training and Development Cost (1% of Machinery)				0.45
3	Power (60HP @ .75per hour,80% utilisation, 8hrs/day,25days/month)	Rate=1.45/unit	10440		1.25
4	Diesel, Water		5000		0.6
5	Selling Expenses (Publicity and Marketing Expense)	5% of Sales			12.23
	Total				**18.95**

10.8 Cost of raw materials

Raw Material Cost (Per Unit)

Particulars	Quantity (MT)	Rate / (MT)	Amount
Portland Cement	1596	5000	79.8
White Cement	192	9000	17.28
Sand / stone Dust	6000	250	15
Stone aggregate	5424	550	29.832
Marble Chips	252	900	2.268
Mineral Colors	18	5000	0.9
Sub Total			**145.08**
Handling Loses @ 5%			7.25
Total			**152.33**



10.9 Annual Turnover

Particulars	Units	Rate (in Rs.)	Total (in lacs)
Solid Blocks	200,000	29.0	58.0
Hollow blocks	200,000	29.0	58.0
Paver blocks	600,000	9.0	54.0
Grey mosaic tiles (Large)	300,000	8.50	25.5
Grey mosaic tiles (Small)	300,000	8.0	24.0
Color tiles	250,000	12.0	30.0
Less 2% wastage			4.99
	1,850,000		**245**

10.10 Income Statement

Income Statement											
Operating years		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capacity											
Installed Capacity (Litres)		2055556	2055556	2055556	2055556	2055556	2055556	2055556	2055556	2055556	2055556
Capacity Utilisation		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
PRODUCTION		1850000	1850000	1850000	1850000	1850000	1850000	1850000	1850000	1850000	1850000
Sales Revenue		244.51	244.51	244.51	244.51	244.51	244.51	244.51	244.51	244.51	244.51
Raw Material & Consumables		152.33	152.33	152.33	152.33	152.33	152.33	152.33	152.33	152.33	152.33
Utilities & Fueles											
Power		1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Water, Diesel, etc		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Sub Total		1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Wages & Salaries		33.95	33.95	33.95	33.95	33.95	33.95	33.95	33.95	33.95	33.95
Factory Overheads		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
General Overheads		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lease											
Land		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Estimated Cost of Production		196.73	196.73	196.73	196.73	196.73	196.73	196.73	196.73	196.73	196.73
Selling Expenses		12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23
Cost of Sales		208.96	208.96	208.96	208.96	208.96	208.96	208.96	208.96	208.96	208.96
EBITDA		35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55
Interest		10.71	9.37	8.03	6.69	5.35	4.02	2.68	1.34	0.00	0.00
Depreciation		6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72
PBT		18.12	19.46	20.79	22.13	23.47	24.81	26.15	27.49	28.83	28.83
Taxation		5.44	5.84	6.24	6.64	7.04	7.44	7.84	8.25	8.65	8.65
PAT		12.68	13.62	14.56	15.49	16.43	17.37	18.30	19.24	20.18	20.18

It would be seen from table above that the PBT in the 1st year of operation in Rs. 18.12 lacs which works out to be 7% of the total sales. In the 10th year, the %age of PBT would be 12%. Similarly PAT in the 1st year is Rs. 12.68 lacs accounting for 5% of total turnover. PAT in 10th would rise to 8%. These figures could vary depending upon change in tax structure.

10.11 Repayment of Interest Schedule on loans

	Repayment and Interest Schedule for Loans									
Operating Years	1	2	3	4	5	6	7	8	9	10
Rate of Interest	12%									
Loan (Outstanding)	89.22	78.07	66.92	55.77	44.61	33.46	22.31	11.15	0.00	0.00
Interest	10.71	9.37	8.03	6.69	5.35	4.02	2.68	1.34	0.00	0.00
Moratorium										
Repayment	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	0.00	0.00
Closing Balance	78.07	66.92	55.77	44.61	33.46	22.31	11.15	0.00	0.00	0.00

10.12 Depreciation

Depreciation

Operating Years		1	2	3	4	5	6	7	8	9	10
Machinery @ 10%		4.47	4.47	4.47	4.47	4.47	4.47	4.47	4.47	4.47	4.47
Construction Cost @ 5%		2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
Total		**6.72**	**6.72**	**6.72**	**6.72**	**6.72**	**6.72**	**6.72**	**6.72**	**6.72**	**6.72**

10.13 Projected fund flow

Projected Funds Flow Statement

Years		Construction Period	Operation period									
		1	1	2	3	4	5	6	7	8	9	10
SOURCES OF FUNDS												
Equity		38.24										
Debt		89.22										
PBDIT			35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55
Total Sources	A	127.46	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55
APPLICATION OF FUNDS												
Fixed Assets Purchase		107.05										
Miscellaneous Fixed Assets		3.00										
Increase in Current Assets		17.41										
Repayment of Loan Payment			11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	0.00	0.00
Payment of Interest on Term Loan			10.71	9.37	8.03	6.69	5.35	4.02	2.68	1.34	0.00	0.00
Taxation			5.44	5.84	6.24	6.64	7.04	7.44	7.84	8.25	8.65	8.65
Total Application	**B**	127.46	27.30	26.36	25.42	24.48	23.55	22.61	21.67	20.74	8.65	8.65
SURPLUS/(DEFICIT)	A-B	0.00	8.25	9.19	10.13	11.06	12.00	12.94	13.88	14.81	26.90	26.90
OPENING CASH & BANK BALANCES			0.00	8.25	17.45	27.57	38.64	50.64	63.58	77.45	92.27	119.17
CLOSING CASH & BANK BALANCES		0.00	8.25	17.45	27.57	38.64	50.64	63.58	77.45	92.27	119.17	146.07

10.14 Projected Balance Sheet

	Projected Balance Sheet											
Sn	**Description**	**Construction Period**	**Operati0on Period**									
		1	1	2	3	4	5	6	7	8	9	10
1.1	Equity	38.24	38.24	38.24	38.24	38.24	38.24	38.24	38.24	38.24	38.24	38.24
1.2	General Reserves		12.68	26.30	40.86	56.35	72.78	90.15	108.45	127.69	147.87	168.05
1.3	Debt	89.22	78.07	66.92	55.77	44.61	33.46	22.31	11.15	0.00	0.00	0.00
	Total Liabilities	**127.46**	**128.99**	**131.46**	**134.86**	**139.20**	**144.48**	**150.69**	**157.84**	**165.93**	**186.11**	**206.29**
2	**Assets**											
2.1	Gross Fixed Assets	110.05	110.05	110.05	110.05	110.05	110.05	110.05	110.05	110.05	110.05	110.05
2.2	Accumulated Depreciation		6.72	13.45	20.17	26.90	33.62	40.35	47.07	53.80	60.52	67.25
2.3	Net Fixed Assets	110.05	103.33	96.60	89.88	83.15	76.43	69.70	62.98	56.25	49.53	42.80
2.4	Working Capital Assets	17.41	17.41	17.41	17.41	17.41	17.41	17.41	17.41	17.41	17.41	17.41
2.5	Cash & Bank Balances	0	8.25	17.45	27.57	38.64	50.64	63.58	77.45	92.27	119.17	146.07
	Total Assets	**127.46**	**128.99**	**131.46**	**134.86**	**139.20**	**144.48**	**150.69**	**157.84**	**165.93**	**186.11**	**206.29**

10.15 Discounted Cash flow

	Discounted Cash flow statement (Total Investment)											
	Construction Period		Operation Period									
Years	t=0	t=1	1	2	3	4	5	6	7	8	9	10
Inflows												
Net Cash Accruals After Interest & Tax			19.41	20.34	21.28	22.22	23.15	24.09	25.03	25.97	26.90	26.90
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Add back financial Expenses			10.71	9.37	8.03	6.69	5.35	4.02	2.68	1.34	0.00	0.00
Terminal value												98
Total inflow			30.11	29.71	29.31	28.91	28.51	28.11	27.71	27.30	26.90	124.90
Outflows												
Investment	110.05	17.41										
Bridge Loan	0	0										
Total outflow	110.05	17.41										
Net Cashflow	-110.05	-17.41	30.11	29.71	29.31	28.91	28.51	28.11	27.71	27.30	26.90	124.90
IRR on Investment (%)	18%											
NPV (12% Discount Rate)	Rs. 42.28											
Pay Back Period	4 years 6 month											
	Discounted Cashflow Statement (Equity)											
Years	t=o	t=1	1	2	3	4	5	6	7	8	9	10
Inflows												
Net Cash Accruals After Interest & Tax			19.41	20.34	21.28	22.22	23.15	24.09	25.03	25.97	26.90	26.90
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Less: Loan Repayment			11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	0.00	0.00
Terminal Value												82
Total Inflow			8.25	9.19	10.13	11.06	12.00	12.94	13.88	14.81	26.90	108.90
Outflows												
Equity	33.01	5.22										
Total Outflow	33.01	5.22										
Net Cash Flow	-33.01	-5.22	8.25	9.19	10.13	11.06	12.00	12.94	13.88	14.81	26.90	108.90
IRR on Equity	27%											

The IRR on investment is 18% which is quite a positive indication about the financial health of the project because the cost of borrowing is 12%. Similarly IRR on Equity is 27% which again is a positive indicator. The NPV @ of 12% on investment is Rs. 42.28 lacs which is quite good for any investment.

10.16 Break even point and sensitivity analysis

	Break Even Point And Senstivity Analysis				
	Normal	**Case1**	**Case2**	**Case3**	**Case4**
Variable Cost (Rs. Lacs)					
Raw material & Consumable Stores	152.33	167.57	152.33	152.33	167.57
Utilities	1.85	2.04	1.85	1.85	2.04
Total Variable Cost	154.19	169.61	154.19	154.19	169.61
Average Variable Cost (Rs. / Thousand Litres)	8.33	9.17	8.33	8.33	9.17
Fixed Cost (Rs. Lacs)					
Wages & Salaries	33.95	33.95	37.34	33.95	35.65
Repairs & Maintenance	5.00	5.00	5.50	5.00	5.25
General Overheads	3.00	3.00	3.30	3.00	3.15
Lease charges	0.60	0.60	0.66	0.60	0.63
Financial Expenses	10.71	10.71	11.78	11.78	12.37
Depreciation	6.72	6.72	7.40	7.40	7.77
Total Fixed Cost (Rs. Lacs)	59.98	59.98	65.98	61.72	64.81
Average Fixed Cost (Rs. per Thousands Litres)	3.24	3.24	3.57	3.34	3.50
Average Selling Price	13.22	13.22	13.22	13.22	12.56
Project Break Even Point (t)	1228503	1481383	1351353	1264206	1912865
Project Break Even	66%	80%	73%	68%	103%
Cash Break Even Point	1090767	1315296	1199844	1112697	1683617
Cash Break Even	59%	71%	65%	60%	91%

Case 1 - 10% Increase in Variable Cost
Case 2 - 10% Increase in fixed Cost
Case 3 - 10% Increase in Project Cost
Case 4 - 10% Increase in Variable Cost and Fixed Cost
5% Increase in Fixed Cost
5% Dcrease in Selling Price

The project break even in normal case is 66% i.e. after achieving 66% of the Projected Turn Over the unit would be in be in the profit zone.

10.17 Ratio Analysis

Ratio Analysis		
1	Return on Assets	10%
2	Return on Equity	33%
3	Debt-Equity Ratio	2.3%
4	Interest coverage Ratio	3

10.18 Foreign exchange implications

The foreign exchange requirement for the project would be only for the import of machines, equipments and accessories for a value of Rs. 45 lacs, during the setting up of the project. Approximately, Rs. 5 lacs worth of foreign exchange would be required for incidental expenses such as training, travel, etc. There would be no requirement of foreign exchange for raw materials as the project is based on indigenous raw materials.

CHAPTER 11 – ECONOMIC ANALYSIS

11.1 Economic Rate of Return (ERR)

Economic Rate of Return is the interest rate at which the cost and benefits of a project, discounted over its life, and equal. ERR differs from Financial Rate of Return in that it takes into account the effects of factors such as Price Controls, Subsidies and Tax breaks from local government, to compute the actual cost of the project to the economy.

The economic rate of return also includes indirect benefits to the economy that are likely to be ploughed back to the investors, people, government and other government or non-government agencies, over a longer period of time.

11.2 Relevance of ERR to the project

This concept of ERR is more relevant for big projects involving large capital deployment. For small projects, like the project under consideration, there may not be significant difference between Financial Rate of Return and Economic Rate of Return, as, while formulating the project, factors like Price Controls, Subsidies and Tax breaks from local government and also socio-economic benefits have not been taken into account.

11.3 Socio-economic impact of the project

As state above, the concept of ERR is not quite relevant for this project and the impact of the proposed unit would not be quite significant on the overall economic scenario of Bhutan. However, over a long time horizon and setting up of a number of similar units would result into following socio-economic benefits for the country.

- Indigenous production of cement based products would lead to self-reliance for these items in the field of construction materials sector and would provide a fillip to construction industry.
- Local production of cement based products would lead to **import substitution** which would result in saving in the cost of construction raw materials. Setting up of more units to meet the requirement of construction materials would have a multiplier effect on the growth of construction industry in Bhutan.
- There are possibilities of export of the value added cement based products to eastern and north-eastern parts of India and other neighboring markets. This would lead to earning to foreign exchange for the country.
- There are not many medium and small scale units manufacturing units in Bhutan. Setting up of this unit would have a catalytic effect on growth of entrepreneurship in medium and small scale sector.

- The setting up of the project would lead to generation of direct and indirect employment, both for skilled and unskilled workers which would result into economic upliftment of local population. This would also lead to upgradation of skills.
- There are employment opportunities in the project for persons with managerial, technical, financial and marketing capabilities. The employment of such people in the local industry would provide them an option to have an employment in private sector in Bhutan and also reduce the migration of qualified manpower.
- There would be revenue generation for the local government by way of excise, sales tax/VAT and income tax from the unit as well as from its promoters.
- Finally, the project would lead to enhancement of economic activities in the field of construction, transport of raw materials and finished goods, marketing and trade, repairs and maintenance, etc.

It is important here to mention that above benefits can only be listed but these cannot be quantified based on a single unit with small investment. However, as mentioned above, if a number of such units in construction material sector or any other sector of economy are setup, these would have a significant impact on overall economy of Bhutan.

Annexures

Annexure I

List of Machinery & Equipment Supplier

1. **M/s Engineers Enterprises,**
   189, Bharathiyar Road, Ganapathy
   Coimbatore – 641006, India
   Phone: 0422 – 2530639, 2530788, 2532260
   Fax: 0422 – 2531893, 2533716
   Web site: www.eng-ent.com
   E-mail: engineer@md3.vsnl.net.in

2. **M/s Victor Electrical & Machinery Manufacture,**
   2613 Netaji Subhash Marg, Darya Ganj
   New Delhi – 110002, India
   Phone: +91 (011) 23263118
   Fax: +91 (011) 23265823
   E-mail: victorelectrical@rediffmail.com

3. **M/s Columbia Machine, INC,**
   22 – D, Wadia Charites Bldg., S.A. Brelvi Road Fort
   Mumbai – 400023, India
   Phone: 2285 4138/2282 6751/2204 8660
   E-mail: columbiamachine@pokona.com

4. **M/s Buildtech Engineers Co.**
   Shree Ashadweep Complex
   16 – Civil Lines, Roorkee – 247667
   Phone: 01332 – 273443, (M) 09837045478, 09837137029

5. **M/s Karthik Industries**
   36, J.C. Road, Bangalore – 560002
   Phone: 91-80-2224825/2235218/2233739
   E-mail: karthikengineering@vsnl.com

6. **M/s Susanji Udyog Pvt. Ltd.**
   C-47, Industrial Estate, Sanathnagar
   Hyderabad – 500018
   Phone: 3704194, 3711464
   E-mail: susanji@satyam.net.in

7. **M/s Hydro Engineering Works,**
   K-1/116, CIDC, Morvi, Gujarat

8. **M/s Apco Concrete Blocks & Allied Products**
   7th Mile Kanakpura Road
   Doddasndra Post, Bangalore

9. **M/s Global Impex**
D-1 Madani complex, 2nd Floor, 100 Feet Road
Gandhipuram, Coimbatore – 641012
Phone: (0422) 4372010 / Fax: (0422) 4373340

10. **M/s S.P. Moress & Hydraulics**
52/3, Maruti Nagar, Old Mundhwa Bypass
Vadagaon, Sheri, Pune – 411014
Phone: (020) 32305157

11. **M/s Quangong Machinery Co. Ltd.**
Fengzhou Taoyuan Industrial Area
Quanzhou Fujjan – 326333, China
Phone: 86-0595-86799299

12. **M/s Hubei Export Corj**
365 Luoyu Road, Wohan Hubel – 430079
China
Phone: 86-27-62824939

13. **M/s Great Wall (Zhengzhou) Heavy Industries Co. Ltd.**
Room 080, 10/F, Onighua Business
No. 170, Nanjang Road, Zhengzhou
China Zhengzhou, Henen – 450012 China
Phone: 86-0371-63769782

14. **M/s Fujian Fufan Machinery Co. Ltd.**
A-1/7, Hutain, Bldg. No. 249
Jiahe Road, Quanzhua
Fujjan – 361000, China
Phone: 86-0592-5587850

15. **M/s Shandong Shengya Machinery Co. Ltd.**
Nanxinwang Shengli
Tacheng Linyi Shandong – 276131, China
Phone: 86-539-6732888

16. **M/s Shanghai Zenith Company**
No. 877, Dongfang Road
Pudong New Area Shanghai
Shanghai – 200122, China
Phone: 86-121-50583966

17. **M/s Build – Tech Engineers Co.**
Shree Ashadweep Complex
16 Civil Lines, Roorkee – 247667
Phone: +91-01332-273443 (M) 09837045478
Fax: +91 01223-274619

18. **M/s MASA Concrete Plants India Pvt. Ltd.**
HO 446, 2nd Cross 9th Main, HAL 3rd Stage
Indira Nagar, Bangalore – 560075, India
Phone: +91-080-41153708 / Fax: +91-080-41485888
(M) 09980944201
E-mail: info@masa-india.com / maniasaja@yahoo.com
Web site: www.masa-ag.com

19. **M/s Wirtgen India Pvt. Ltd.**
22-B, Kunbalgodu Industrial Area
Phase-I, Mysore Road, Bangalore – 560074
Fax: 080-2843-7579
E-mail: sales@wirtgenindia.com
Web site: www.wirtgenindia.com

20. **M/s Taurian Engineering Pvt. Ltd.**
302 A, Poonam Chambers
3rd Floor, Dr. Anni Besant Road
Wora, Mumbai – 400018, India
Fax: +91-022-66698010/20
E-mail: info@taurianengg.com
Web site: www.taurianengg.com

21. **M/s Shri Engineers Enterprises**
13, Sukhanivas Apts., S. No. 102/2/A/1
Senapati Bapat Road (Behind Shivaji Housing Society)
Near Asha Nagar, Shivaji Nagar
Pune – 411016, Maharashtra, India
Phone: 91-020-25631611, 32663054, Works: 020-32662980
Fax: 91-020-27271889 (M) 09822011041
E-mail: shrivg@vsnl.net / shrivg.nit@yahoo.com
Web site: www.shriengineering.com

Annexure II

List of raw material suppliers:

1. **M/s Penden Cement Authority Ltd.**
   Gomtu
   Pagli Gewog
   Samtse Dzongkhag
   Tel: 00975-5-371013/371014
   Fax 00975-5-371015/371070
   Email: pcaleps@druknet.bt

2. **M/s Druk Cement Co. Pvt Ltd.**
   Post Box No. 408
   Phuntsholing, Bhutan
   Tel: +975-5-252136/253581
   Fax: +975-5-254112
   Email: druk_cement@rediffmail.com

3. **M/s Lhaki Cement**
   Gomtu, Bhutan
   Tel: +975-5-371042
   Fax: +975-5- 371020
   Email: lhakicement@druknet.bt

4. **M/s Yangzom Cement Industry**
   Post Box No. 131
   Samtse, Bhutan
   Tel: +975-5-365341/365559
   Fax: +975-5-365383

5. **M/s Singye Stone and Sand Factory**
   Bjemina Industrial Estate
   Thimphu
   Bhutan

6. **M/s Colour Chem Ltd.**
   Fort House
   Dadabhai naroji Road
   Mumbai 400001

7. **M/s Travencore Titanium Products Ltd.**
   14, netaji subhash road
   Kolkata 700001

8. **M/s Sudarshan Chemicals**
   162, Wellsely Road
   Pune 311001

9. **M/s Associated Pigments Ltd.**
   14, Netaji Subhash Road
   Kolkata 700001

10. **M/s Amar Dye Chemicals Ltd.**
    Rangh Udyog, Shetala Devi Temple Road
    Mumbai 400 001

Annexure III

List of testing equipment suppliers

1. M/s ETS Intarlaken Technologies
   Contact Person: Mr. T. K. Basu
   Address : 5th Floor, 117 B T Road, Kolkata - 700 108
   West Bengal (India)
   Tel: +(91)-(033)-25770637 / 25772260
   Fax: +(91)-(033)-25772260 / 25770637
   E-mail : info@ets-test-equipments.com, etsin@satyam.net.in

2. M/s Prolific Engineers
   D-91, Sector 2, Noida - 201 301, India
   Tel: +(91)-(120)-4334481-82-83 / 4264881 / 3053325 / 2558838
   Fax: +(91)-(120)-2522648
   Email : info@prolific-test-equipment.com, prolific@eth.net

3. M/s Imperial Lab Equipment
   Address: 109, Vardhman Plaza Tower, H-3, Netaji Subhash Place
   District Center, PitamPura, New Delhi, Delhi
   Phone(s): 91-11-65154406 / 42470203
   Fax(s): 91-11-27352924

4. M/s Scientific Engineering Corp
   Address: 3280, Arya Pura Old Subzi Mandi, Delhi – 110007
   Phone(s): 91-011-23829918 / 23823794
   Mobile: 9811569035
   Fax(s): 91-011-23829918 / 23823794

5. M/s Toshniwal Brother Pvt. Ltd.
   388 Udyog Vihar Phase 3
   Gurgaon – 122006
   Haryana
   Ph +91-124-4003629 / 4003985
   Fax no +91-124-4003986

6. M/s Techno Testing Equipment Pvt Ltd.
   403, Marigold Building
   Neeo Garden, Viman Nagar
   Pune – 411014
   Ph: 020-40036219 / 419

7. M/s Blue Star Ltd.
   E/44/12, Okhla Industrial Area
   Phase II, New Delhi – 110020

8. M/s Associate Instrument Mfg India Ltd.
   Gillander House
   8 MS Road
   Kolkata – 700 001