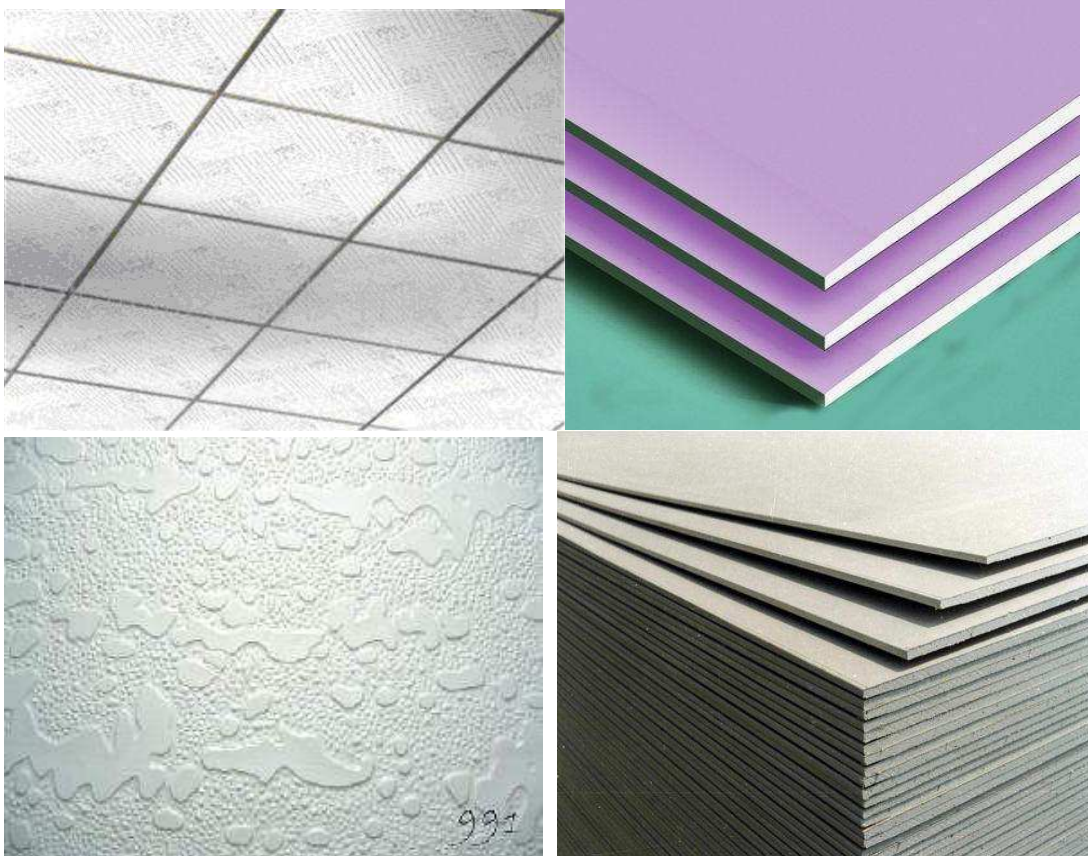


PROJECT ON GREEN INDUSTRIES

PART III

DETAILED FEASIBILITY ANALYSIS OF GYPSUM BOARDS & PANELS – CEILING & INSULATION



For
**DEPARTMENT OF INDUSTRY
MINISTRY OF ECONOMIC AFFAIRS
ROYAL GOVERNMENT OF BHUTAN**

By
IDRG CONSULTANCY SERVICES
In Association with Druk Associates
November 2011

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CHAPTER 1 - PROJECT AT A GLANCE

1. Project concept – Detailed feasibility analysis on **gypsum board & panels**. The project envisages the manufacture of various types of gypsum boards and panels based on gypsum mineral available in Bhutan. The cost presentation and financial analysis for the project are based on production of gypsum panels by semi-automatic process.
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 viz gypsum mineral. 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. The units for the manufacture of main raw materials viz gypsum mineral and hemi-hydrate gypsum are located at Pema Gatshel, Samdrup Jongkhar. The proposed project shall help in value addition to the indigenously available gypsum mineral, initiate economic activity and create employment opportunities. As gypsum board and gypsum panels are relatively new product to Bhutan construction industry, the project need to explore the possibilities of export of gypsum panels in adjoining Indian markets. Accordingly, main factors for deciding the location of the project would be vicinity to raw materials source, vicinity to markets and vicinity to Indian markets. Keeping in view, the various parameters, these sites have been short listed in the order of preference.

<u>Location</u>	<u>Overall rating</u>
Phuentsholing	46
Gelephu	44
Thimphu	41
Paro	40
Punakha	39
Wangdue	38
Samdrup	37

It is recommended that to begin with a project be setup at Phuentsholing / Pasakha. Similar projects could be setup near to other major cities which would constitute the major construction sites.

3. Markets -

Gypsum board / gypsum panel are relatively new products to construction industry in Bhutan. These are used for a variety of applications viz ceiling, wall paneling, partitions, ducting, insulation & acoustic purposes. Due to obvious reasons, wood has been extensively used in the building construction in Bhutan including for wall paneling, insulation & ceiling applications. Now a days, the wood has become both scarce and costly and some of the applications of wood need to be replaced by alternative materials. Gypsum boards having characteristics of thermal insulation and sound barrier could replace wood in many applications. Similarly, the cost of bricks especially red bricks is very high in Bhutan and gypsum board could be economically used for inner partitions. Gypsum board / gypsum panels are recyclable and these are termed as green materials of construction. Promoting use of gypsum board / gypsum panel in construction shall be inconsonance with the environmental policy of Royal Government of Bhutan which lays huge emphasis on protection on environment and sustainable development. Further, the cost of major raw materials viz gypsum mineral being relatively lower in Bhutan, the project would be able to compete in the Indian market and export their produce to Indian markets.

4. Annual production	Items	Capacity (in numbers)
Capacity	Gypsum panels, reinforced with glass fiber	- 4, 80,000
Recommended		

5. Land and Building Requirement	Plot area	2000 sq. meters
	Built up area	100 sq meters
	Industrial shed	500 sq. meters

6. Power Requirement	165 KWH
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7. Main machinery	Working stations with fixtures	Nu. 2, 50,000/-
	Mould for gypsum panels	Nu. 25, 00,000/-
	Panel hanger strands	Nu. 7, 00,000/-
	Hot air oven drier	Nu. 75, 00,000/-
	Drums & buckets	Nu. 15,000/-
	Miscellaneous equipment & tools	Nu. 35,000/-

8. Man power Requirement	Manager	- 1
	Production supervisor	-2
	Marketing / sales / office staff	-2
	Skilled workers	-10
	Unskilled workers	-4
9. Total project Cost	Nu. 216.41 lacs	
10. Project Implementation Period	10-11 months	
11. Means of Finance	Debt -	Nu. 151.49 lacs (70%)
	Equity -	Nu. 64.92 lacs (30%)
12. Break up of Cost of project	Machinery	- Nu. 144.10 lacs
	Construction cost	- Nu. 28 lacs
	Misc. fixed assets	- Nu. 3 lacs
	Pre-operative exp.	- Nu. 5 lacs
	Training expenses	- Nu. 1.44 lacs
	Interest	- Nu. 21.78 lacs
	Working capital	- Nu. 13.08 lacs
	Total	- Nu. 216.41 lacs
13. Annual sales Turnover	Nu. 228 lacs	
14. Financial Analysis	IRR – 31% on equity	
	IRR – 19% on investment	
	NPV – Nu. 70.56 (12% discount rate)	
	Pay back period – 3 years 6 months	
	Project break-even – 48%	

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 the production of gypsum board / gypsum panel which are extensively used in the construction industry.

2.2 Project Justification

2.2.1 High growth in construction sector

Government of Bhutan has an ambitious program of infrastructure development for which reasonable budget provisions have been made in 10th & 11th five years 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 programs.

During last few years, there has been spurt in construction activities in Bhutan especially in major cities. With the economic growth, there has been a tremendous increase in migration of rural population to urban areas. This has resulted in increased demand of residential accommodation leading to increase in construction activities. Besides residential houses, the construction activities are being carried out for building of new schools, institutions, hotels, hospitals as well as commercial establishments. These construction activities have created a huge demand for construction materials.

2.2.2 Gypsum board – a part replacement to wood

Due to obvious reasons, wood has been extensively used in the construction of buildings in Bhutan for flooring, paneling, insulation and various other purposes. In the today's context, wood is increasingly becoming scarce and costly. Some of the applications of wood viz for insulation, ceiling, partition, paneling, etc need to be replaced by alternative materials. Gypsum board offers an alternative to wood for applications like ceiling, insulation and partition. Besides, gypsum board is a modern material of construction used extensively in the construction and finishing of the buildings.

2.2.3 Construction material – based on indigenous raw materials

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. Gypsum mineral is indigenously available in Bhutan. Some of the gypsum is also being converted to Plaster of Paris (POP). The project envisages the production of gypsum board from indigenously produced gypsum / hemi-hydrate gypsum. The production of gypsum board shall add value to the indigenously produced gypsum, help in economic development, provide employment opportunities and also make available the construction material for the construction industry.

2.2.4 Gypsum board – environment friendly material of construction

Gypsum boards are preferred world over in view of their characteristics for being recyclable material. These are known as green material of construction. In the context of Bhutan, gypsum being indigenously available such projects could cater to the demand of gypsum board both in Bhutan as well as in adjoining foreign markets. Besides, the production of gypsum board shall help in part replacement of wood and thus, the project would have positive impact on environment.

Gypsum board is relatively a new product for use in the construction industry in Bhutan. However, in view of the following considerations, there is enough justification for setting up such a project in Bhutan.

- The project is based on indigenously available raw materials
- The use of gypsum board shall help in part replacement of wood & bricks and thus create positive impact on environment
- The use of gypsum board facilitate faster installation and reduces the cost of construction
- Gypsum board is a recyclable material and hence environment friendly
- Being green material of construction helps in sustainable development
- Use of gypsum board helps in construction of green buildings
- In the production of gypsum board, there is no pollution angle

CHAPTER 3 – PRODUCT DESCRIPTION AND PRODUCT MIX

3.1 Historical perspective

Gypsum has been known for centuries and is one of the oldest building materials in the world. The earliest use of gypsum discovered was in Anatolia around 6000 B.C. Later, in about 3700 B.C., gypsum was used on the interiors of the great pyramids in Egypt. One of the early uses of gypsum in building construction appears to have occurred in 3700 B.C. when the Egyptians used gypsum blocks and plaster applied over woven straw lath in the building of the pyramid of Cheops. As a testimony to the strength and durability of gypsum, some of this construction is still intact and viewable, including walls decorated with murals composed of tinted plaster. For centuries now, gypsum has played a crucial role in construction. American settlers recognized gypsum's potential use as plaster and as a soil amendment. Modern gypsum board has as its predecessor a product called "Sackett Board," a composite material that was made of layers of thin plaster placed between four plies of wool felt paper. Sackett Board was patented in 1894 by Augustine Sackett, the man generally considered to be the grandfather of the gypsum board manufacturing industry.

Today, the United States' principal interior wall material is gypsum wallboard. Often also referred to as drywall, rock, plasterboard, gyp-board, or by the trade names Sheetrock or Gyp-roc, gypsum drywall is a sheet of gypsum with a paper facing and backing. The wallboard is approximately 92% gypsum (calcium sulfate dihydrate $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), 7% paper, and 1% impurities and additives. Gypsum is found in every continent of the world and is one of the most widely used minerals.

3.2 The chemistry of Gypsum board

Pure gypsum is a white to transparent mineral, but sometimes impurities color it grey, brown, or pink. Its chemical name is calcium sulphate dihydrate, and its chemical formula is $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. When gypsum is heated, it loses about three quarters of its water and becomes hemihydrate gypsum ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$), which is soft and can be easily ground to a powder called hemihydrate gypsum plaster or Plaster of Paris. If this powder is then mixed with water to form a paste or slurry, then it will dry and set rock hard. The chemically combined water, previously driven off by heating, will recombine, and the material will revert to the original chemical composition of gypsum. While the hemihydrate gypsum plaster is in slurry form, it can be poured between two paper layers to make wallboard, used to fill cracks and crevices, or poured into a mold.



Plaster of Paris is a building material. Plaster of Paris is raw gypsum that is chemically altered by heat to remove much of the water contained in the gypsum molecule and then hydrated to make it useable as a plastering material. It remains a viable product to this day.

3.3 Definition and categories of gypsum board

Gypsum board is the technical product name used by manufacturers to define a specific gypsum-core board material that is typically installed on the walls and ceilings of the interior or exterior of a residential or non-residential structure. The product is defined by the **ASTM C11** standard as **“the generic name for a family of sheet products consisting of a noncombustible core primarily of gypsum with paper surfacing.”** Drywall and plasterboard are non-technical synonyms for gypsum board.

Gypsum board manufacturing companies also manufacture gypsum sheets products that do not have a paper facing. These products are called gypsum panel products and are defined by the **ASTM C11** standard as **“a family of sheet products consisting essentially of gypsum.”** Glass mat-faced panels and panels manufactured without a facing that have a gypsum core are examples of gypsum panel products. The commonality between the board and the panel definitions is the gypsum core. The core often contains additives, but to be considered a gypsum board or panel, and be regarded as drywall, the core must be predominantly gypsum.

According to **Bureau of Indian Standards**, gypsum board has been defined as under:

“Gypsum plaster boards consist of a gypsum plaster core with or without fibre encased in and firmly bonded to strong durable paper liners to form rectangular boards. Core shall be dried across full width. The face and back papers shall be securely bonded to the core. The paper surfaces may vary according to the use of the particular type of board, and the core may contain additive to impart additional properties. The longitudinal edges are paper covered and profiled to suit the application.”

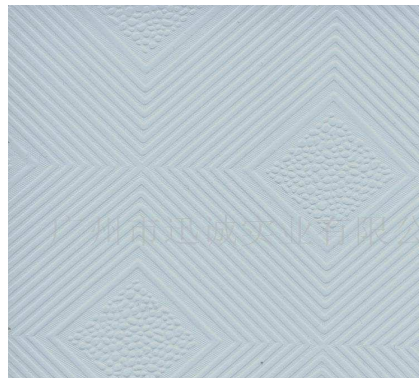
3.4 Product range

Today, gypsum board is everywhere. It covers the interior of more than 97% of the new homes constructed in the U.S. and Canada, and is used to finish the interior and sheath the exterior of non-residential structures throughout the world. From a humble beginning as a plaster lath, gypsum board has evolved to include products that provide increased sound attenuation, superior impact and weather resistance, and improved mold and mildew resistance, while continuing to display the natural fire-resistive quality inherent in gypsum. Gypsum board can be manufactured as plain, laminated and reinforced boards. Reinforcing materials generally used are glass, paper, natural fibers, etc. As mentioned earlier, there are two distinct categories of gypsum board:

- Gypsum panel products – cast sheets without paper backing
- Gypsum board with paper backing

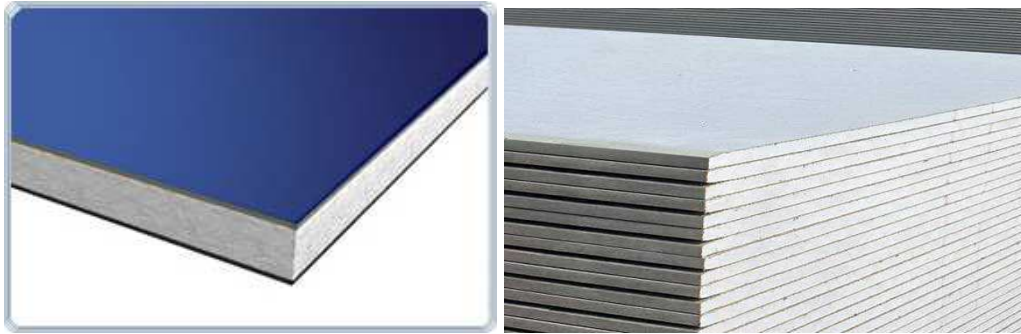
3.4.1 Gypsum Panel products

Gypsum sheets are invariably manufactured from Plaster of Paris reinforced with glass or other reinforcing fiber. Usually, the size is 610 X 610 mm with 12.5 mm thickness. The weight of the sheet is around 3.5 kg to 3.75 kg. These are produced in various designs and textures. The production machines are semi-automatic.



Plaster of Paris (POP) sheets have been most widely used in the construction of false ceilings in India. It offers a smooth and uniform finish. These are easy to construct and maintain. The light weight also does not add any significant weight to the support structure of any construction. However, mechanical strength and moisture resistance have been the areas of concern in use of POP boards.

3.4.2 Gypsum board - Gypsum board laminated with paper is a modern product and is produced with the help of automatic machines for a wide range of applications.



Gypsum plaster boards are the ultimate ceiling solution for today's buildings. Along with aesthetic appeal, they are lightweight and also offer high levels of performance in terms of fire rating, acoustic insulation and thermal insulation as compared to POP sheets.

3.5 Advantages of Gypsum board

Gypsum is a perfect substitute to traditional materials like bricks, wood and plywood. It offers the following advantages when used in building construction.

- Reduces construction cost
- Facilitates faster installation
- Offers greater ease of construction
- Improves site cleanliness and safety
- Provides high quality wall finish
- Gypsum board is 100% green product and its manufacturing process is environment friendly
- Gypsum board is recyclable, conserve resources and helps in sustainable development
- Installation of gypsum board systems can effectively contribute to the construction of high performance green buildings

3.6 Areas of applications

Gypsum board is the premier building material for wall, ceiling, and partition systems in residential, institutional, and commercial structures. Gypsum products provide fire resistance, sound control, economy, versatility, quality, and convenience. Gypsum boards and panels are manufactured for use in a variety of applications and performance situations: ceramic tile and marble backing materials, exterior building sheathings, plaster bases, elevator and pipe shaft enclosure systems, and ceiling and soffit enclosures. Modern manufacturing permits specialized additives and sheet materials to be placed in boards to provide increased impact resistance and sound attenuation qualities.



Gypsum board finds extensive application in the construction of buildings. The main application areas include ceiling, wall paneling for thermal insulation and acoustic properties, for partitions and various other applications. Gypsum board is ideal for partitions between office cabins, conference and meeting rooms, multiplexes, classrooms, banquet rooms etc. where sound level not exceeding 20 dB is appreciated. Two major applications of gypsum board viz for ceiling purposes and for sound absorption are as given below:

3.6.1 Gypsum board for acoustic applications

Use of gypsum board in buildings imparts excellent acoustic properties. Increasing land costs have resulted in larger amounts of high density multi-family housing in world over housing markets. The result of high density housing is individual living units positioned closer together than traditional single-family housing. Further, in developed countries, home theatre systems are becoming more prevalent in use and sophistication, resulting in the potential for more noise being transmitted between wall partitions. Commercial buildings such as schools, hospitals and hotels also have an increasing need to control sound between areas of a building. All of these changing market dynamics have resulted in an increased need for higher rated Sound Transmission Class (STC) wall partitions, which reduce the transmission of airborne sound between living spaces within buildings.



With the ongoing development process, the situation would be similar in Bhutan also specially in major cities and the requirement for roof and wall paneling to reduce the transmission of air borne sound is likely to increase at a very fast pace.

3.6.2 Gypsum board for ceiling application

False ceilings are amongst the most common choice recommended as a part of ceiling design. Typically, false ceilings are suspended a few inches below the structural ceiling on a metal framework. Though having a false ceiling may appear as a slightly expensive proposition at first, it has distinct functional as well as aesthetic advantages which make them well worth the money. False Ceilings serve a dual purpose within an indoor space:

- **Aesthetics:** the design, patterns and concealing of electrical wiring
- **Functional:** light reflectance, sound absorption, thermal insulation and support to fixtures



On the aesthetics front, all services like wiring, ducting and insulation can be concealed within the false ceilings. Lights can be inset into a false ceiling, which prevents having to dust them while providing with a clean, level surface below.

3.7 Gypsum board – Standards and quality control

3.7.1 ASTM Standards

Gypsum board and gypsum panels are specifically manufactured to ASTM standards as shown in the chart below.

All of the standards list specific criteria for product evaluation. ASTM C1396, for example, lists specific criteria for evaluating gypsum board products. These include general physical characteristics applicable to all gypsum boards, such as flexural strength, humidified deflection, and nail-pull resistance; and characteristics such as water resistance and water absorption for specific board products.

GYPSUM BOARD AND PANEL STANDARDS		
STANDARD	TITLE	BOARD OR PANEL PRODUCT
C 1396	Gypsum Board	Paper-faced gypsum boards including: <ul style="list-style-type: none"> • Gypsum wallboard • Gypsum shaftliner • Water-resistant gypsum board • Gypsum sheathing board • Veneer plastic base • Gypsum lath • Gypsum ceiling board and exterior soffit board
C 1177	Glass Mat Gypsum Substrate for Use as Sheathing	Glass-mat faced panels used as exterior substrates
C 1178	Coated Glass Mat Water-Resistant Gypsum Backing Board	Coated glass-mat faced water-resistant panels used as a base for tile
C 1278	Fiber-Reinforced Gypsum Panel	Interior and exterior cellulose fiber-reinforced gypsum panels
C 1658	Glass Mat Gypsum Panel	Glass-mat faced: <ul style="list-style-type: none"> • Interior gypsum panels • Shaftliner panels • Water-resistant panels used as a base for tile (other than C 1178 material)

3.7.2 BIS Standards

Bureau of Indian Standards (BIS) have laid down the following standards for gypsum and gypsum boards:

IS 2469: 1976 – Glossary of terms relating to Gypsum

IS 2547 (Part II): 1976 – Specification for gypsum building plaster

IS 12679: 1989 – By-product gypsum for use in plaster, blocks and boards – specification

IS 2542 (Part I/Sec 1 to 12): 1978 – Methods of test for gypsum plaster, concrete and products

IS 2095 (Part I): 1996 – Gypsum plaster boards – Specification

CHAPTER 4 – MARKET ANALYSIS

4.1 World market scenario

Although use of gypsum wallboard increased worldwide, only industrialized nations, such as the United States, used gypsum primarily for wallboard products. In developing countries especially in the Middle East and Asia, most gypsum was used in the production of cement or as a plaster product. **Estimated world production capacity for gypsum wallboard in 2001 exceeded 60 billion square feet or about 5.6 billion square meters at more than 250 plants worldwide.** Almost one-half of this capacity was in the United States. Asia mainly China and Western Europe each accounted for about one-fifth. Construction or expansion of dozens of wallboard plants is underway in many countries throughout the world. The use of synthetic gypsum by United States and other industrialized nations has increased.

4.2 Market Scenario in United States

Gypsum is omnipresent in modern construction in United States. Nearly every house constructed or renovated in the past 40 years has incorporated gypsum board on most of its walls and ceilings.



Hotels, office buildings, schools, and even detention facilities are full of gypsum board, gypsum panels, and gypsum plaster. In the United States, most gypsum is used to manufacture wallboard and plaster for homes, offices, and commercial buildings. According to a study carried out by Mineral Information Institute (MII) in 2001, an average new American home contains more than 7.31 metric tons of gypsum or, in other terms, more than 6,144 square feet or 571 square meters of gypsum wallboard.

4.3 Market scenario in China

China's gypsum board industry has made great strides over the last 30 years. Records show that the sales of gypsum board averaged around 100Mm²/y in the 1990s. However, at the end of 2003, total domestic sales increased to 300Mm²/y. In 2004, it exceeded over 450Mm²/y and is still growing at a rapid rate.



With the rapid development of China's economy, and the resulting requirements placed on gypsum products, more and more foreign companies such as Knauf, BPB now owned by Saint-Gobain, and Lafarge have established their own factories in China.

4.4 Indian market scenario

The world market for gypsum boards is estimated to be around six billion sq meters. As compared to this, the Indian market is very small at present and is estimated to be around 25 million sq meters of gypsum board. Market trends have however revealed that the Indian market for gypsum board is registering a growth of around 15 percent per annum and as such, India is one of the fastest growing markets in the world. The growth in gypsum board market is much faster than the growth rate of cement, which is growing at only about 10 per cent per annum. An important reason for the fast growth of gypsum board market in India is the boom in the construction sector. Besides, gypsum board is substituting traditional solutions such as brick and mortar, and plywood. Gypsum board is a mix of gypsum and paperboard. These boards come in the form of 4 ft x 6 ft sheets. One can use them to create internal walls. These boards offer the advantages of very good sound, water, thermal and fire insulation. Plywood, the other product that is commonly used in interiors, does not offer very good protection against fire.

Traditionally, the gypsum panels have been used in Indian buildings for false ceiling. Since, many years, these panels are POP caste sheets and these are manufactured by manual or semi-automatic process. A number of small and medium units have been manufacturing gypsum panels with different designs and textures. As regards, the gypsum board, Gypsum India happens to be the market leader controlling major share of the gypsum board market in India. Recently, in 2007-08, M/s Lafarge, France in collaboration with Boral of Australia have setup gypsum board manufacturing unit **Lafarge Boral Gypsum India Pvt. Ltd.** in India at Alwar, Rajasthan. The investment in the plant is around Rs. 100 crores



Lafarge Boral plant is claimed to be a Greenfield plant for manufacturing plasterboards. The plant will have a capacity of 10 million sq meter of different type of gypsum boards. This plant will be located in Alwar district of Rajasthan. So it will be ideally situated to cater to the north Indian and the NCR market, which are among the fastest growing markets in this country. Rajasthan has also been chosen because large gypsum deposits are available in that state.

Gypsum boards are hundred per-cent **green products** and the entire manufacturing process itself is environmental friendly. Lafarge Boral Gypsum India (LBGI) is an accredited member of the Indian Green Building Council (IGBC). The Leadership in Energy and Environmental Design (LEED-INDIA) Green Building Rating System is a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings and gypsum board systems can contribute upto 14 points to green buildings under the LEED rating system. The rank of 'Green Credits' is given to the buildings, based on its environmental footprint during construction and normal occupation.



A view of Indira Gandhi International Airport (IGI)

With a large number of real estate development projects coming up in India, boom in the construction of multiplexes, shopping complexes, hotels, airports, educational institutions, hospitals and other construction projects, the demand for gypsum board is likely to grow at a very fast pace in Indian market. Further, with the growing emphasis on environmental protection, sustainable development emphasis on construction of green buildings of international standards, gypsum board and gypsum panel would find more and more application in the construction industry in India. The extensive use of gypsum board in the construction of new terminal at India Gandhi International (IGI) Airport is an indicator about the future trend in the application of gypsum board in India.

4.5 Marketing network in India

There exists a strong and well established network for marketing of Gypsum board and panels in India. Normally the dealers/traders engaged in the business of constructions materials mainly for interiors of the building also deal in the gypsum board and gypsum panels. These dealers/traders primarily supply Gypsum board/panels for false ceiling and partitions, aluminum sections, plywood, vinyl flooring, flush doors, laminates etc. **An illustrative list of dealers in the field of gypsum board and panels is given in Annexure- I**

4.6 Market scenario in Bhutan

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 gypsum board is most suited for development in private and public sector. Natural fiber reinforced POP blocks and tiles could be used for insulation in buildings in Bhutan and these could be exported also. The starting material for POP blocks and tiles is Plaster of Paris which is being produced in Bhutan. Production of POP has some environmental impact but in production of POP blocks and tiles, there are no environmental concerns. The process is based on making slurry of POP and fibers followed by casting and it would be a green technology. Short fibers from paper recycling and other natural fibers could be used for reinforcement. Presently, substantial quantity of wood is being used in buildings in Bhutan including for insulation. POP tiles and blocks would be a part replacement to wood which is going to become scarce and costly in future. Accordingly, production of POP blocks & tiles would help in resource (wood) conservation and shall have no adverse impact on environment. As the starting material for the product is POP, the production process and the product could be totally environment friendly and shall help in resource conservation.



Building under construction in Bhutan

The product is relatively quiet new to the construction industry in Bhutan, however, keeping in view, the modern trends in construction industry, there appears to be good scope for gypsum board in Bhutan market. The following factors are likely to contribute to the growth of gypsum board market in Bhutan.

- The main raw material required for the production of gypsum board / gypsum panel is gypsum mineral which is indigenously available in Bhutan.
- Setting up of facilities for production of gypsum board shall help in adding value to the natural resources available in Bhutan add value to gypsum mineral and produce green material for construction.
- The production process of gypsum board / gypsum panel is environment friendly and the proposed industry could be classified as a Greenfield project.
- Traditionally, wood has been extensively used in building construction in Bhutan for ceiling wall paneling, insulation and various other purposes. Slowly the wood is getting scarce as well as costly and gypsum panel / gypsum board shall enable a part replacement of wood mainly for insulation and ceiling purposes.
- Bricks especially red bricks in Bhutan are quiet costly. Gypsum board could replace the brick construction mainly for inner partitions.
- Gypsum board is a recyclable and therefore, termed as green material of construction. A large part of used gypsum board is recycled for production of fresh gypsum boards.
- The use of gypsum board in Bhutan shall be in consonance with the principles of environmental policy strongly advocating for sustainable development.

- The industries could be set up near the source of raw materials and market minimizing the transportation cost which is otherwise too heavy.

4.7 Competitive strength of gypsum board produced in Bhutan

Gypsum panel / gypsum board would be a relatively new product for construction industry in Bhutan. As mentioned earlier, it could be used in buildings in Bhutan as a part replacement to wood viz for ceiling and wall paneling and in place of bricks for interior partitions. Now a day, the cost of wood becomes quite prohibitive for extensive use in buildings; there are ample opportunities for use of gypsum boards. The cost of gypsum board is relatively much lower as compared to wood and their installation is also quite easy. Keeping in view, the cost of bricks in Bhutan, the use of gypsum board for interior partition could also be quite economic. The project envisages the production of gypsum board based on indigenously available gypsum mineral and the cost of production is likely to be quite competitive viz a viz imported boards or other materials viz wood, plywood, etc.

4.8 Demand for gypsum boards in Bhutan & Demand supply gap

Gypsum boards are not much used in the construction industry in Bhutan. However, use of POP is quite relevant in the construction of dwelling units. There are no authentic estimates about the demand of gypsum board in Bhutan. However, keeping in view, the extensive use of wood in buildings in Bhutan, it can be safely presumed that there would be a substantial market for gypsum board in Bhutan as they would offer an option to replace wood in many applications mainly ceiling and wall paneling.

4.9 Exports prospects

A large amount of gypsum mineral is being exported from Bhutan mainly to India. The quality and prices of Bhutan gypsum mineral are quite competitive in Indian markets. Evidently, the value added products based on Bhutan gypsum are likely to be quite competitive in Indian and other adjoining markets provided the quality standards are adhered to in the production of gypsum boards. The demand for gypsum board in Indian market is growing at a very fast pace and there exists substantial scope for the export of Bhutanese product in India.

4.10 Future market projections

As mentioned earlier, gypsum board is a relatively new product for construction industry in Bhutan. However, keeping in view, the international trend for promotion of green materials of construction and the strong emphasis of Bhutan government on protection of environment and sustainable development, there exists a huge opportunity for large scale production of gypsum board in Bhutan, both for domestic as well as export markets. India is going to be big market for gypsum board in future and if a modern unit is setup for production of gypsum board, it could cater to a large part of Indian market also.

4.11 Target market and marketing strategy

Real estate developers, government organizations and institutions, educational trusts and private house builders would be the main customers for gypsum board. As gypsum board is the new product to Bhutan construction industry, the architects and building contractors need to be approached and convinced about the performance and price advantages in the use of gypsum board. The aspect relating to gypsum board being recyclable and green material construction need to be emphasized upon mainly with the government agencies engaged in the building construction activities to convince them about the advantages associated with the use of gypsum board. Construction of schools & colleges, hotels, hospitals, government offices, multiplexes, shopping complexes could be the target markets for promoting the use of gypsum boards. Main users and buyers of Gypsum boards would include Building construction companies, building contractors, private house owners, state housing development corporations, state industrial development corporations, various other infrastructure development corporations architects and interior contractors.

CHAPTER 5 – RESOURCES

5.1 Main resources

The main resources for the production of gypsum panel / gypsum board include the following:

- Land and building
- Plant and machinery
- Raw material viz gypsum
- Power
- Water
- Skilled and non-skilled workers

5.2 Land and building

It has been envisaged in the project that the land for setting up manufacturing unit would be available from Government of Bhutan on lease basis. The building and the shed for housing the machinery and equipment and the offices has to be constructed as per requirement. The manufacturing section shall be shed construction. The godowns, offices shall be accommodated in constructed building. The total land requirement for setting up of the project would be 2000 sq. meters. The requirement of total built up area and other constructions would be as under:

- | | | |
|---|---|----------------|
| • Total land requirement | - | 2000 sq. meter |
| • Constructed area for godowns, offices and Testing lab | - | 100 sq. meter |
| • Industrial sheds for installations of machines | - | 500 sq. meter |

5.3 Plant & Machinery requirements

The details of plant and machinery have been given in subsequent chapters.

5.4 Raw materials and consumables

Gypsum is the main raw material required for the production of gypsum panel / gypsum board. The list of raw materials for gypsum panel and gypsum board would include the following:

A). Gypsum panel

- Plaster of Paris – Hemi-hydrate gypsum
- Reinforcing material viz glass fiber, chopped glass strands
- Mould release agent
- Packaging material

B). Gypsum board

- Gypsum mineral
- Gypsum board paper
- Additives, chemicals and reinforcing materials
- Packaging materials

5.4.1 Availability of Gypsum in Bhutan

Natural gypsum mines constitute the only source of gypsum in Bhutan as there is no production of synthetic gypsum or reprocessed gypsum. Gypsum mines in Bhutan are located in north in Pemagatshel area. Most of gypsum mined in this area is transported to Penden Cement Plant in Bhutan and other adjacent Indian States viz West Bengal, Assam and Arunachal Pradesh, etc.



Gypsum mine in Khothakpa, Eastern Bhutan is a part of the Himalayan ranges. This mine is hilly terrain and therefore proposed to be worked out by opencast system of mining. In view of non-availability of manpower required for manual operation and restricted area available for the required level of production the method of operation is proposed to be worked by semi-mechanized method. The mine benches are developed at 10 meter interval. The mining is done from the top bench-downwards. With of the benches is maintained not less than the height of the benches.

Mining activity consists of cyclical activity. It consists of removal of overburden with the help of dozers, loaders and tippers. The exposed gypsum is blasted after drilling. The blasted material is sorted by laborers and stacked as boulders or dust. The material is loaded into trucks either by front-end wheel loaders or manually from the site depending on whether it is dust or boulder. The loaded truck is then covered with tarpaulin to avoid loss of material and to control of dust during transport. Each truck carries about 9 MT of gypsum from Pemagatshel to Samdrup Jongkhar. The dust is loaded by wheel loaders and the boulders manually into trucks and transported to Samdrup Jongkhar dump-yard for selling to the end users.

Gypsum finds extensive use in cement, textile, paint, pottery and building industry. The mineral calcined at around 200oC loses 75 % of its water and the product known by its trade name as 'Plaster of Paris' is being widely used in building industry as good finishing material. In recent time craftsman are using calcined gypsum for making various decorative items owing to use easy molding properties to any shape. It is also used in hospitals for orthopedic treatment. High quality gypsum is used for producing medical quality calcined gypsum. Gypsum is also used in fertilizer industry.

The Company produces two grades of products viz. Mixed and Boulder gypsum. Boulder being of premium quality it is in great demand for POP and Cement industries at home and in India. M/s Druk Satair Corporation Ltd, Samdrup Jongkhar, Bhutan produces Plaster of Paris in the Gypsum plant located at Khothakpa, Pemagatchal.



In general, the Indian market consumes about 81% of our produce, Bhutan 13% and the balance is dispatched to Nepal & Bangladesh. The estimated production of gypsum mineral in Bhutan is around 330,000 MT of gypsum per annum. Gypsum happens to be one of the ten major commodities which are exported from Bhutan. During 2009, the total export of gypsum from Bhutan in terms of value was around Nu 430 million. Accordingly, there would be no problem in procurement of gypsum or Plaster of Paris viz hemi-hydrate gypsum to the project as this is abundantly available in Bhutan.

5.4.2 – Quality of gypsum mineral produced in Bhutan

Gypsum mineral found in Bhutan is of high purity. The following table depicts the chemical composition of Gypsum mineral found in Bhutan.

Chemical composition of Bhutan gypsum

S.No.	Constituents	percentage(%)
1.	SiO ₂	8.0-9.62
2.	Al ₂ O ₃	0.51-1.0
3.	Fe ₂ O ₃	0.03-0.5
4.	CaO	28.0-30.0
5.	MgO	0.16-0.20
6.	K ₂ O	0.04-0.6
7.	Na ₂ O	0.16-0.18
8.	SO ₃	41.15-43.90
9.	CaSO ₄ .2H ₂ O	88.0-92.0
10.	Moisture	6.0-8.0
11.	Loss on ignition	12.7-14.

Source: publication on Bhutan Gypsum by CBRI India

It would be seen from the above that gypsum mineral found in Bhutan is ideally suited for a variety of applications viz. Potteries, fertilizers, soil reclamation and construction materials viz. cement, gypsum board and panels.

5.4.3 Paper and other raw materials

Another main raw material happens to be the paper known as gypsum board paper manufactured from recycling of paper waste. Besides starch, reinforcing fiber material and miscellaneous chemicals would also be needed for the production of gypsum board. Gypsum board paper and chemicals need to be imported as per requirement. The list of manufacturers of gypsum board paper and other chemicals and additives is given in the annexure II to this report.

5.4.4 Annual requirement of raw materials

The financial projections & analysis of the project is based on the production of gypsum panels. For production of gypsum panels, only hemi-hydrate gypsum (POP) and reinforced material would be required. The annual requirement of raw material would be as under:

Hemi hydrate gypsum	1440 MT
Reinforcing fiber / glass fiber	12 MT
Mould release agent, and other chemicals	LS

5.4.5 Recommended sources of raw materials

Gypsum mineral would be the main raw material required for the production of gypsum board. As gypsum is available in abundant quantity in Bhutan, this could be procured from indigenous sources viz M/s Druk Satair Corporation Ltd. For production of gypsum panels, hemi-hydrate gypsum or Plaster of Paris is also locally available. Reinforcing glass fiber has to be imported. In case, the production of gypsum board is envisaged, the gypsum board paper and other chemicals need to be imported.

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

Being an indigenously produced mineral, gypsum is relatively quite economical in Bhutan as compared to other sources viz India and other markets. Moreover, only a part of gypsum is consumed in Bhutan and the major quantity is exported. It would, therefore, be quite viable to procure the main raw material viz gypsum from Bhutan only. Hemi-hydrate gypsum / POP would also be quite economical in Bhutan as compared to imports. Reinforcing material viz glass fiber, gypsum board paper and other chemicals, however, need to be necessarily imported.

5.6 Energy and Fuel Requirement

The financial projections in the project have been made based on the production of gypsum panels by manual process. Power would be required only for drying of the sheets and general lighting purpose. The details of power requirement viz connected load are as under:

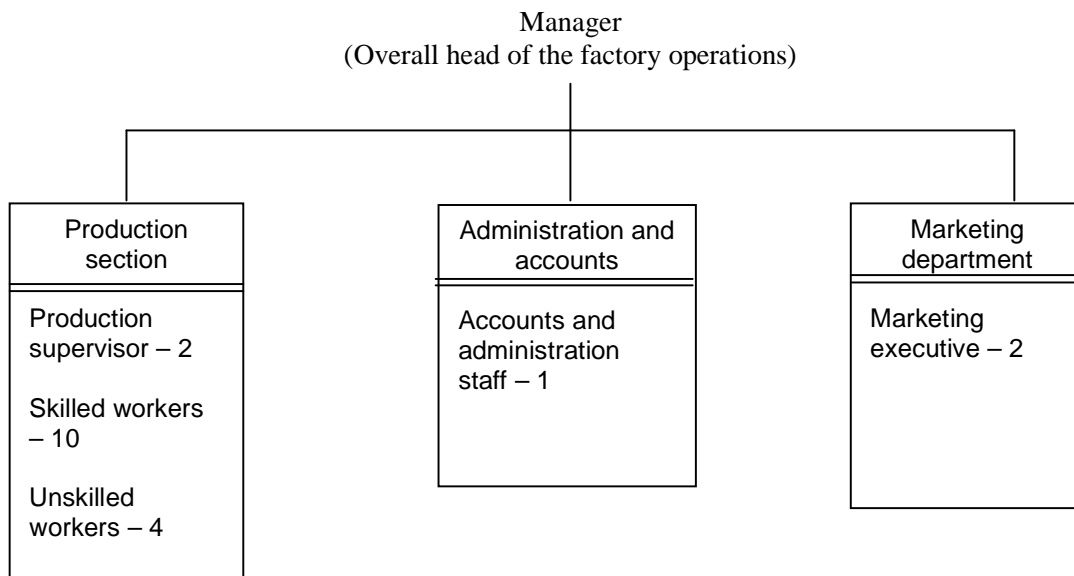
Power requirement for production machines / dryer	-	150 KWH
Power requirement for general purpose with lighting Of stores, offices and production unit	-	15 KWH
Total	-	165 KWH

5.7 Manpower requirement

The details of manpower requirement would be as under:

- Manager - 1
- Plant supervisor - 2
- Marketing / sales / office staff - 3
- Skilled workers - 10
- Unskilled workers - 4

5.7.1 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 opportunities both for direct & indirect employment.

CHAPTER 6 – THE PLANT AND SELECTION OF TECHNOLOGY

6.1 Technologies employed for production of gypsum board

One hundred kilograms of gypsum contains approximately 21 kilograms of chemically combined water. To initiate the manufacturing process, natural gypsum rock or synthetic gypsum is crushed to a powder. The powder is heated to about 350 degrees F, driving off three fourths of the chemically combined water in a process called “Calcining”. The calcined gypsum or hemihydrate gypsum is then used as the base for gypsum plaster, gypsum board, and other gypsum products. Commercially, hemi-hydrate gypsum is known by its trade name viz Plaster of Paris (POP).

There are two distinct type of gypsum board as mentioned in details in chapter 3. These are **gypsum panel** products and **gypsum board**. Gypsum panel is a traditional product made by casting of hemi hydrate gypsum without any covering on sides. This is invariably manufactured by semi-automatic or manual process and has application mainly for ceiling purposes in the buildings. Gypsum board is a modern product with core of gypsum covered in two layers of special gypsum board paper. The gypsum boards are produced by modern automatic machines with huge turnover in terms of production and requiring large investments for installation of the plant. The gypsum board is being produced for a variety of applications and is categorized as green materials of construction.

6.2 Manufacturing technology for gypsum panels

6.2.1 Machines and equipments

In a typical gypsum panel manufacturing unit, comprises of around 50 working stations. There are 5 working stations in each row and total 10 rows of working stations. The working tables are specially designed with arrangement for lowering and lifting of the upper part of the mould for casting POP tiles. The lower part of the mould is made up of metal in the form of rectangular tray with a depth of around 30 to 40 mm. The inner side of the bottom has a special design which is imparted to the lower portion of the gypsum cast sheet. The edges of the tray mould are specially designed which will enable the formation of shape with outer extending edges in the gypsum cast sheet. These outer edges / grooves shall help to hang the sheet / tile on the aluminum frame while using the tiles for ceiling applications.

The upper part of the mould is mounted on the table with a handle which is used for lowering and lifting the upper part of the mould. The outer edges of the upper part of the mould / area are slightly smaller than the bottom portion of the mould. The top portion of the mould has built in square design and the walls of square extruding outside for creating a honeycomb square structure on the upper part of the cast sheet. The depth of the extruded honeycomb structure in the upper mould is so adjusted that around 9 mm sheet with four side edges of around 25-30 mm and inside square structure of around 20-22 mm depth is created in the sheet. The other machines required include hangers for drying the gypsum cast sheets and hot air tunnel drier. The sheets can be either sun dried or these can be dried in a tunnel drier.

6.2.2 Process of manufacture:

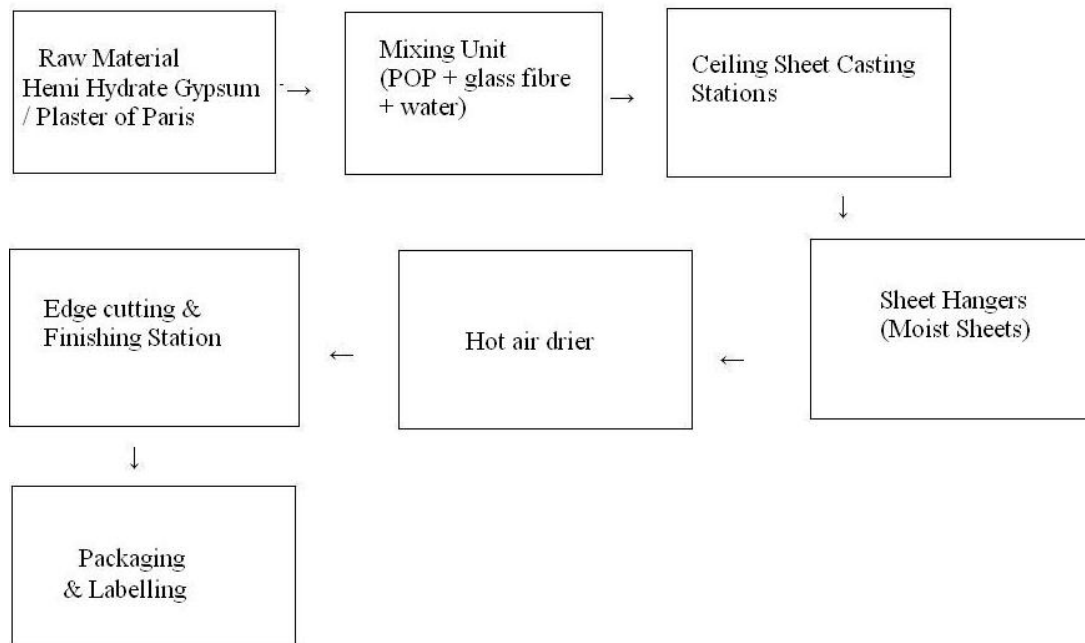
The mould is opened and both the sides of moulds are clean with a piece of cloth. A mixture of water and caster oil is sprayed on both the parts of the mould i.e. the tray and the upper closer. A weighed quantity of Plaster of Paris is taken in a bucket. Water is added to POP to make the thick paste of POP. The paste is stirred with a wire brush so that no solid specs are left in the paste. A small quantity of glass fiber chopped strands is added to this paste. The paste is then immediately transferred to the lower portion of the mould.

Size of sheet: 610mm X 610mm

Thickness of sheet: 9mm

Weight of sheet: 3.75 Kg

6.2.3 Process flowchart for gypsum panel:



6.3 Manufacturing technology for gypsum board

6.3.1 Machines and equipment

Nowadays, the paper faced gypsum board production line is the professional equipment for producing the new decorated material. The principal working process are as follows: first, we take certain amount of hemihydrate gypsum powder, water and other additives, through the automatic measurement device and automatic conveying system, they will be conveyed into the mixer and changed into the gypsum slurry which will be scattered on continuous moving faced paper evenly. Second, at the same time, with the continuous moving and vibrating, the slurry will gradually diffuse and even scattered. Then the slurry will go into the forming machine and compound with the top and bottom faced paper. By the process of extruding and forming, the slurry will be encased by the faced paper and the continuous pulpous gypsum boards are formed. In the forming line, the wet solid paper faced gypsum board will be gradually formed after the process of recondition, natural coagulating, automatic cutting, etc. The wet board will be arranged according to the programmed control system. With the help of rollers, belt conveyer and overturner, they will quickly enter into the dryer. Fourth, the board will be strictly controlled in the separate temperature zone of the dryer. After blowing into different thermal hot air, the moisture of the wet board will be evaporated. Because of the reaction of the starch, the board will be attached to the faced paper, and then the dry gypsum board will form and exit from the dryer.

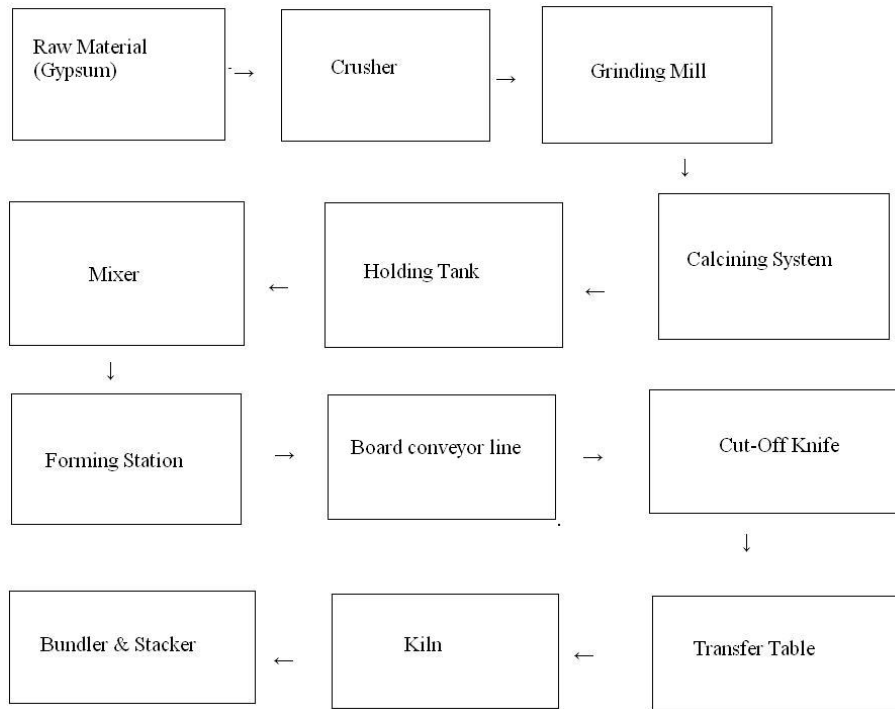


The automatic plants for the production of gypsum board are usually of high capacity viz. two million square meters of paper faced Gypsum board and above. The cost of two million square capacity plants is around US\$ 875,000 OR Rs. 39.37 million FOB Chennai, India.

6.3.2 Manufacturing process

To produce gypsum board, the calcined gypsum is mixed with water and additives to form slurry that is fed between continuous layers of paper on a board machine. The paper edges of the board are machine wrapped as the face and back paper become chemically and mechanically bonded to the gypsum core. As the board moves down a conveyer line, the calcium sulfate re-crystallizes or rehydrates, reverting to its original rock state. The board is then cut to length and conveyed through dryers to remove any free moisture. After being cut, the wallboard members are moved away from the cutting station to a loading area where they are loaded into a drying system to dry the cut wallboard members.

6.3.3 Process Flowchart for gypsum board



6.4 Selection of technology

6.4.1 Factors influencing the choice of technology

There are two distinct products viz gypsum panel products and gypsum board requiring different technological inputs investment pattern and different marketing strategies. A number of factors need to be taken into considerations while deciding the choice of favour of a process technology. These factors mainly include

- Factors inputs
- Adaptability of technology
- Market findings viz. size of market, estimates about acceptability of the product and recurrence of repeat demand
- Purchasing power of consumers and prevailing price spectrum
- Future projections of market demand
- Projections about the potential for exports
- Availability of skilled manpower and support facilities
- Availability of infrastructure and transport facilities
- Environmental considerations

6.4.2 Comparison of products / manufacturing technologies

The following table depicts the comparison of various factors concerning the selection of technology in the context of Bhutan for production of gypsum based panels products and gypsum board.

S. No	Factors for selection of technology	Gypsum Board	Gypsum Panel
1	Raw materials	Gypsum, the main raw material indigenously available, paper to be imported	Gypsum, the main raw material, indigenously available
2	Investment	Modern plant require around Rs 200 million and above. The smallest unit costs around Rs. 5 crores.	Moderate investment required. Medium size unit requires plant and machinery for Rs. 10 millions.
3	Production Output	The average production output is over 10 million square meters. The smallest plant for 2 million square meter	The output is moderate, 1 lac square meter and above.
4	Level of technology	Completely automatic hi-tech process	Semi automatic / manual process of manufacturing
5	Size of domestic market	Relatively new product limited market	Relatively new product limited market
6	Prospects for exports	Good	Good

6.4.3 Technology recommended

Gypsum board with paper backing happens to be modern material of construction widely used in the modern building construction. Gypsum panel are mainly used for ceiling applications, insulation and decoration / designs. Keeping in view, the comparison of various factors for selection of technology as given above, it is recommended that the Bhutan project be setup for production of gypsum panels based on semi automatic / manual process of manufacture. Apparently, the required level of investment, the production turnover and adaptability of the product and technology does not support the viability of the hi-tech project for the production of gypsum board, at present. However, once the use of gypsum panels becomes popular in the building construction in Bhutan, the bigger project for gypsum board be considered at a later stage.

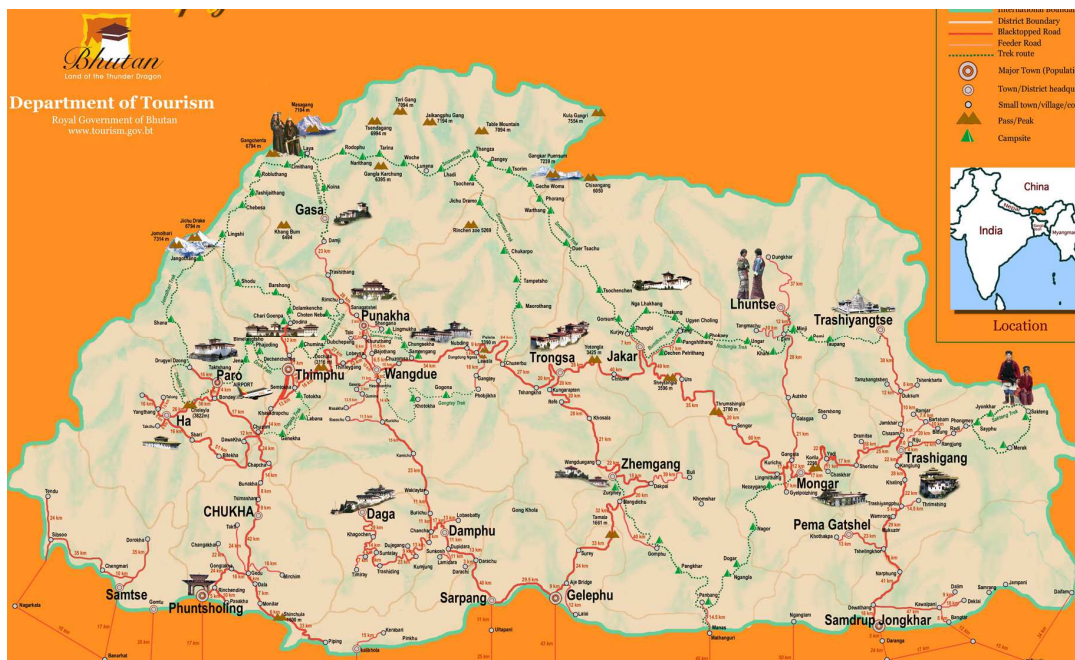
6.4.4 Availability of technical know how

The process or the production of gypsum panels is relatively simple. In the initial phase, persons having experience in the production of gypsum panel need to be employed for standardizing the production conditions. Over a period of time, these people can train the local workers in the casting of gypsum panel.

CHAPTER 7 – PLANT LOCATION AND INFRASTRUCTURE

7.1 Potential Locations

Location of the proposed unit should preferably in the vicinity of the major sites of construction as well as sources of raw material. Thimphu, Phuentsholing, Punakha, Wangdue, Gelephu, Samdrup and Paro happen to be the main towns and would constitute the major site of construction. M/s Druk Satair Corporation Ltd, the company manufacturing gypsum and hemi-hydrate gypsum is located at Pema Gatshel, the main area where gypsum is available. The unit for gypsum panel could either be setup in the vicinity of major sites of construction or at the site of availability of raw material. Keeping in view, the present size of Bhutanese market for panel products and the need for export of the finished product to adjoining Indian markets, it would be better if the project is setup near to the Indian border viz at Phuentsholing or Gelephu. The setting up of the project at these locations would help in keeping the transport cost of raw materials and finished products at a minimum level.



7.2 Selection of suitable locations

In order to select the suitable location for the manufacturing plant, various parameters viz availability of land, vicinity to raw material sources, vicinity to markets, 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

S. No	Locations	Land access conditions	Vicinity to raw material sources	Vicinity to markets	Investment considerations	Operational logistics	Future development possibilities	Overall Rating
1	Phuentsholing	7	7	8	8	8	8	46
2	Gelephu	7	7	8	7	8	7	44
3	Thimphu	7	6	7	7	7	7	41
4	Paro	7	6	7	6	7	7	40
5	Punakha	7	6	7	7	7	7	39
6	Wangdue	7	5	7	6	7	7	38
7	Samdrup	6	7	6	6	7	6	37

It is therefore proposed that the unit be located near Phuentsholing or Gelephu, preferably at Phuentsholing. The requisite infrastructure viz land, power, road transport and communication facilities required for the proposed unit are available in and around Phuentsholing. 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 electrical repairs which could be taken care of by the skilled workers of the unit. Alternatively, the assistance could be taken of from the existing mechanical and electrical repair workshops.

It is therefore proposed that the unit be established in Phuentsholing or Pasakha Industrial Estate near Phuentsholing. Location of the plant in Phuentsholing would involve the additional cost of transportation of Gypsum mineral/plaster of Paris from Eastern Bhutan to the project site. However this cost is likely to be offset by the savings in the transport of Gypsum board/panels to the target markets in India mainly Calcutta and other cities in Bengal and Bihar and North Eastern Region. Further the cost of transport of panels to Thimpu, Paro and punakha in Bhutan would be considerably reduced. Accordingly the proposed project at Phuentsholing could successfully cater to the local market of gypsum panel in Bhutan as well as supply the same in adjoining Indian markets at competitive prices.

CHAPTER 8 – ENVIRONMENTAL IMPACT

8.1 Environmental aspect of manufacturing process

Manufacture of gypsum panels and gypsum board basically involves three stage production process, the first being calcination of gypsum, the second being casting of panel / board and the last stage being drying of gypsum board or gypsum panels. In all the three stages of the production process, there is no environmental pollution. During calcination stage, the calciner is heated by burning the fuel oil and there may be little pollution angle. However, the recommended project is based on calcined gypsum / hemi-hydrate gypsum normally known by the trade name of POP and the process of manufacturing gypsum panel would be totally environment friendly. The drier unit for drying of gypsum panels is based on hot air drying and there would be no pollution. The waste during the production of gypsum panels would be very small in quantity however, this could be recycled.

8.2 Waste generated and mitigation measures

In the manufacturing process of gypsum panels, no solid, liquid or gaseous wastes are generated. However, during casting of gypsum panels, there may be some waste in the form of broken or defective panels. The material being gypsum, it could be easily recycled and as such the project would be totally environment friendly.

8.2.1 Waste generated during construction phase

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.

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 the topography of the	Used for earth filling.	No adverse impact.

		construction site.		
4.	Brick stone cement aggregate	5% of the quantity used	Used for flooring and earth filling.	No adverse impact

8.2.2 Waste generated during project operation phase

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 * Some solid waste would be generated in the form of defective / broken gypsum panels as also edge trimmings of gypsum panels.	Small quantity	Can be disposed off for earth filling. Gypsum being recyclable, large quantities can be used for making gypsum panels	No adverse impact

CHAPTER 9 – IMPLEMENTATION SCHEDULE

9.1 Implementation schedule for manufacture of gypsum board / gypsum panel

The project implementation schedule has been prepared keeping in mind.

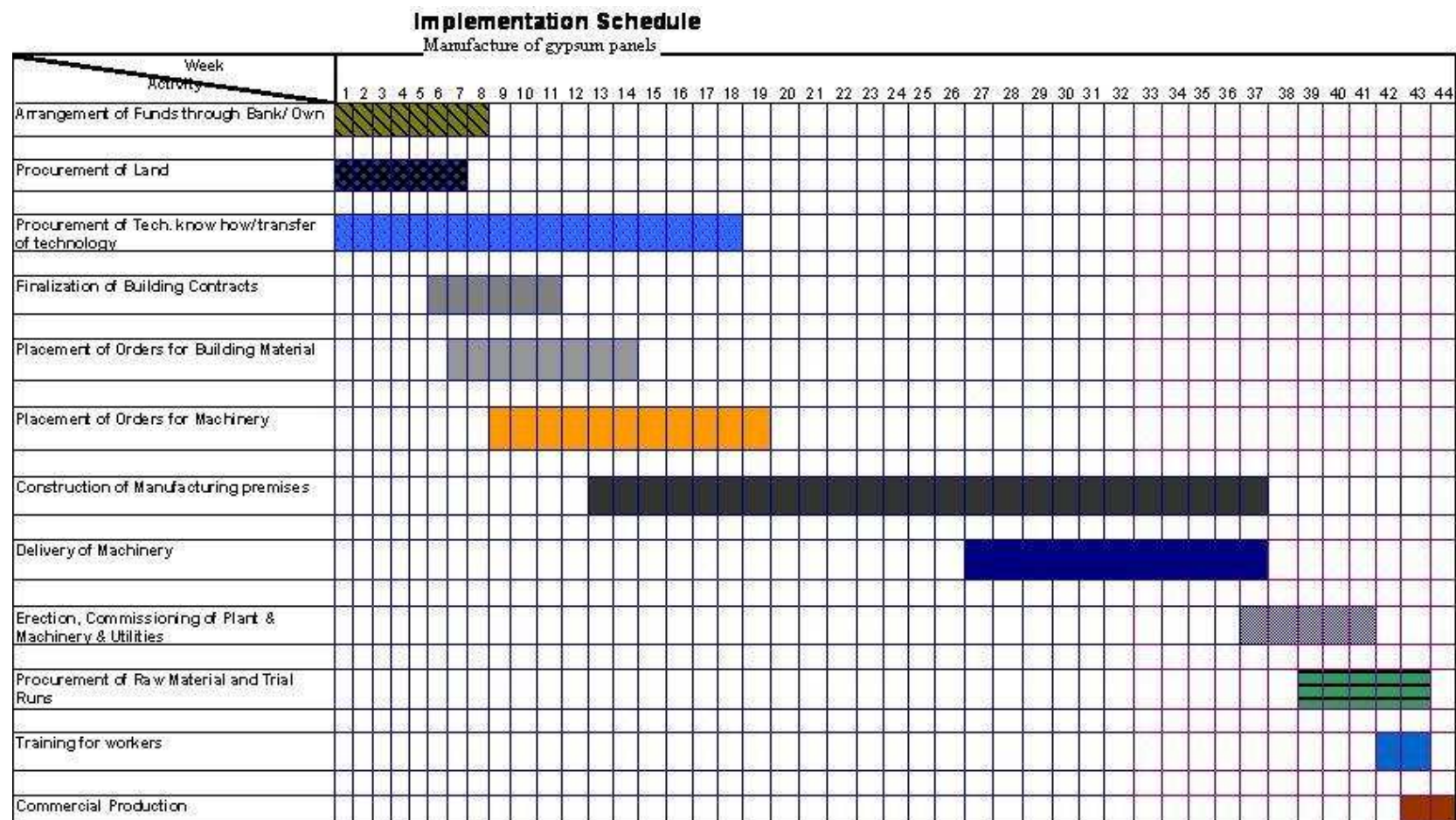
- a) Optimal utilization of time and resources
- b) Scheduling of activities in parallel to reduce the time required from inception to production
- c) Skill transfer for staff involved in production and maintenance

The implementation schedule has been divided into weeks. The following would be the sequence and duration of different activities at the initialization of the project.

1. **Arrangements of funds** for the project. A time period of 8 weeks has been earmarked for the same.
2. Along with arrangement of funds, **procurement of land** needs to be initiated for the project. A period of 7 weeks has been allocated for this activity.
3. Discussions for **procurement of technology and know how / transfer of technology** have to be started along with the initiation of the project. A total of 18 weeks have been earmarked for this.
4. After arrangements of funds and procurement of land and **contracts for building construction** need to be placed. Depending on the arrangement of funds this activity can commence as soon as arrangement of funds is completed and a period of 5 weeks has been earmarked for the same.
5. After finalization of contract for building construction the **order for building material** have to be placed. A total of 7 weeks has been allocated to the same.
6. It is planned that by this time the discussions with the technology vendor would be complete and the **orders for placement of machinery** would commence by the 9th week and be completed by the 19th week depending on the progress of construction.
7. It is expected that the **construction of manufacturing premises** will take approximately 30 weeks.
8. Regular review of the construction premises will help plan **delivery of machines** which can start by the 27th week and end by the time the construction is completed.
9. The **erection, commissioning of plant maintenance and utilities** can commence by the 41st week keeping in mind the progress of construction and finishing of the premises. Some of the erection work may need to be initiated as they may require bolting, grouting to the shop-floor.
10. The **procurement of raw material** should be initiated while the commissioning is about to be completed and **trial runs** started. For this project this is expected to be in the 46th week from the commencement of project.

11. The **staff training** will commence with the trial runs.
12. It is envisaged that the **commercial production** should start in the 51st week after initiation of the project.

Implementation Schedule – Graphic view



CHAPTER 10 – COST PRESENTATION

10.1 Capital costs

10.1.1 Cost of Land and building

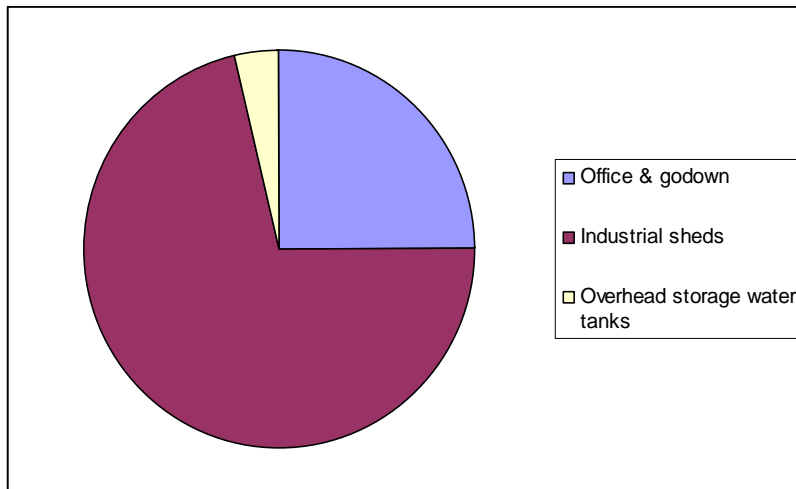
A). Plot and built up area

- Total land requirement	-	2000 sq. meters
- Constructed area for godowns & offices	-	100 sq. meters
- Industrial sheds for installations of machines	-	500 sq. meters

B). Cost of construction

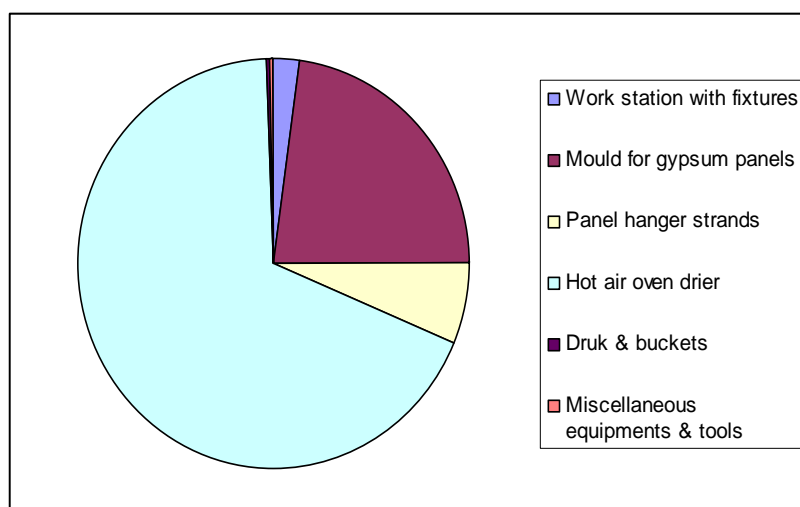
- Office and godown (100 X 7000)	-	Nu. 7, 00,000/-
- Industrial sheds (500 X 4000)	-	Nu. 20, 00,000/-
- Overhead storage water tanks	-	Nu. 1, 00,000/-
Sub-total	-	Nu. 28, 00,000/-

C). Land on lease @ Nu. 40/- per sq. mt / annum



10.1.2 Cost of Machines and Equipments

S. No	Item of machinery	Nos	Value
1.	Working stations with fixtures	50	Nu. 2, 50,000/-
2.	Mould for gypsum panels	100	Nu. 25, 00,000/-
3.	Panel hanger strands	50	Nu. 6, 00,000/-
4.	Hot air oven drier	1	Nu. 75, 00,000/-
5.	Drums, buckets & stirrer motor	5	Nu. 1, 15,000/-
6.	Miscellaneous equipment & tools	LS	Nu. 35,000/-
Total			Nu. 1, 10, 00,000/-



10.1.3 Miscellaneous Fixed Assets - Nu. 3 lacs

10.1.4 Pre-operative expenses - Nu. 5 lacs

10.2 OPERATING COSTS:

10.2.1 Cost of Raw Materials (per month)

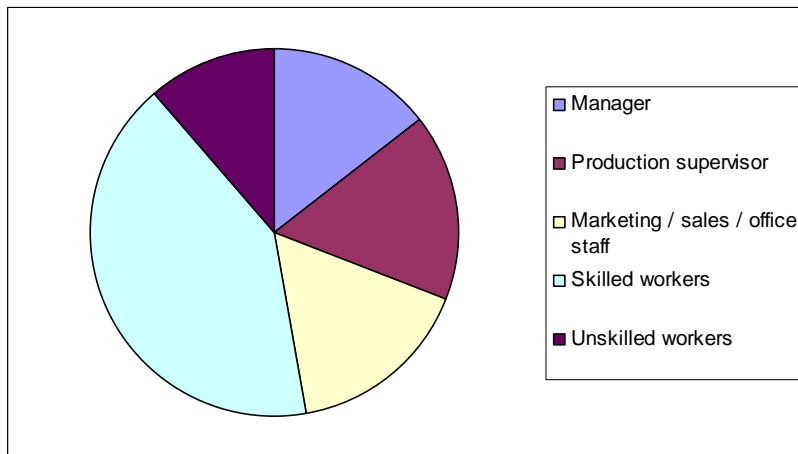
Raw material (PM)	Quantity	Price per unit or tonne	Total amount (Nu.)
Hemi hydrate gypsum	120 MT	Nu. 4000/-	4,80,000/-
Reinforcing fiber / glass fiber	1 MT	Nu. 1,00,000/-	1,00,000/-
Mould release agent, and other chemicals		LS	20,000/-
Packing cartons & labels		LS	1,00,000/-
	Sub-total		7,00,000/-
	Wastage allowance 10%		70,000/-
	Total		7,70,000/-

Total annual cost of raw material per annum - **Nu. 92, 40,000/-**

10.2.2 Salary and wages

Manager	1	35,000	35,000/-
Production supervisor	2	20,000	40,000/-
Marketing / sales / office staff	2	20,000	40,000/-
Skilled workers	10	10,000	1,00,000/-
Unskilled workers	4	7,000	28,000/-
	Total		2,43,000/-

Salary and wages per annum = Nu. 29, 16,000/-



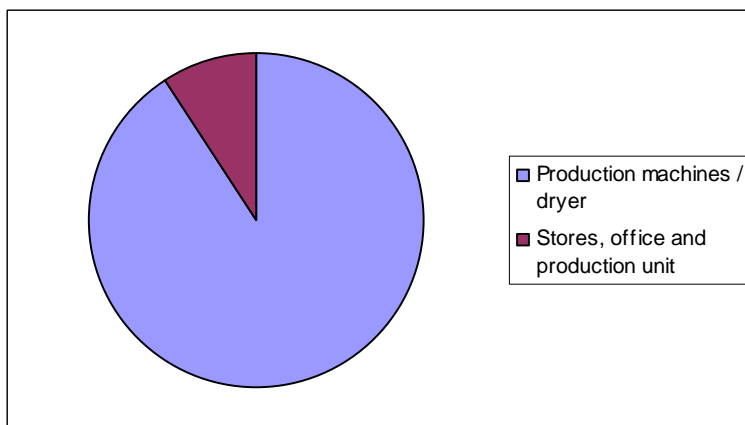
10.2.3 Cost of Power and Fuel

Power requirement for production machines / dryer - 150 KWH

Power requirement for general purpose with lighting
Of stores, offices and production unit - 15 KWH

Total - 165 KWH

Annual cost of power - Nu. 12, 67,200/-



CHAPTER 11 – FINAL ANALYSIS

11.1 Project Assumptions

Assumptions at a Glance		
S. No.	Particulars	Rate/Amount
1	Total Project Cost	216.41
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) per sq.m.	7000
9	Construction Cost (Shed) per sq.m.	4000
10	Repayment period of Debt	8 yrs
11	Moratorium period	1 yr.
12	Installed Capacity (no. in lacs)	6
13	Capacity Utilization	80%
14	Working Capital Cycle	1 month

11.2 Total Project Cost

Total Project cost		
1	Machinery	144.10
2	Construction Cost	28.00
3	Miscellaneous Fixed Assets	3.00
4	Pre operating Expenses	5.00
5	Training Expense	1.44
6	Interest	21.78
7	Working Capital	13.08
	TPC	216.41

* A provision has been made for Rs. 3.00 lacs in the project cost on account of miscellaneous fixed assets, which include office furniture, computers and communication equipments. The lump sum figure of Rs. 3.00 lac is considered reasonable for this project.

11.3 Means of Finance

Means of Finance		
Debt	151.49	70%
Equity	64.92	30%
Total	216.41	100%

The total investment of Rs. 216.41 lacs is proposed to be financed partly through debt (Bank Overdraft / Cash credit limits / Term loan / Loan from financial institutions etc.) and partly through Equity i.e. Shareholder's funds (Share Capital and profits generated from operations). Debt: Equity ratio of 2.3:1 is in line with industry norm.

11.4 Investment on Machinery and Equipments

MACHINERY

	Name of Machinaries	Quantity	Cost
	Working stations with fixtures	50	250000
	Mould for gypsum panels	100	2500000
	Panel hanger strands	50	700000
	Hot air oven drier	1	7500000
	Drums & buckets	LS	15000
	Miscellaneous equipment & tools	LS	35000
	Total		11,000,000
Add	Packaging, Forwarding, Transport and Insurance @ 11%		1210000
Add	Installation, Erection and Commissioning @ 5%		550000
Add	Duty and Taxes @ 10%		1100000
Add	Spare Parts @ 5%		550000
	TOTAL		14410000

11.5 Cost of Construction

Construction Cost

Office and Godown (100 Sq. mtr. @ 7000per Sq. mtr.)	700000
Industrial Shed (500 Sq. mtr. @ 4000 per Sq mtr.)	2000000
Overhead storage water tanks	100000
Total	2800000

Cost of construction @ Rs 7000/sq meter and cost of shed @ 4000/sq meter has been taken based on prevailing market costs.

11.6 Cost Break up

Particulars	Amount (Nu. In lacs)
Raw materials & consumables	92.40
Utilities & fuel	13.87
Wages & salaries	33.53
Indirect expenses	51.19

The details of the cost of raw materials are as given in table no. 10.8. The requirement of various raw materials per unit of product is as given in chapter 4. The Indirect expenses include factory / general overhead, lease rent, selling expenses, interest and depreciation as given in table 10.10.

11.7 Expenses Incurred

Expenses (in Rs.)

1	Salary and Wages				
	Type of Employees	No. of Employees	Per month	Per Annum	Total
	Manager	1	35000	420000	420000
	Production supervisor	2	20000	240000	480000
	Marketing / sales / office staff	2	20000	240000	480000
	Skilled workers	10	10000	120000	1200000
	Unskilled workers	4	7000	84000	336000
	Sub Total				2916000
	Other Benefits @ 15%				437400
	Total				3353400
2	Training and Development Cost (1% of Machinery)				144100
3	Power (165@80%,2*8hrs/day,25days/month)	Rate=2/unit			1267200
4	Water and Diesel	RS. 10000 pm			120000
5	Selling Expenses (Publicity and Marketing Expense)	5% of Sales			1140000
	Total				6024700

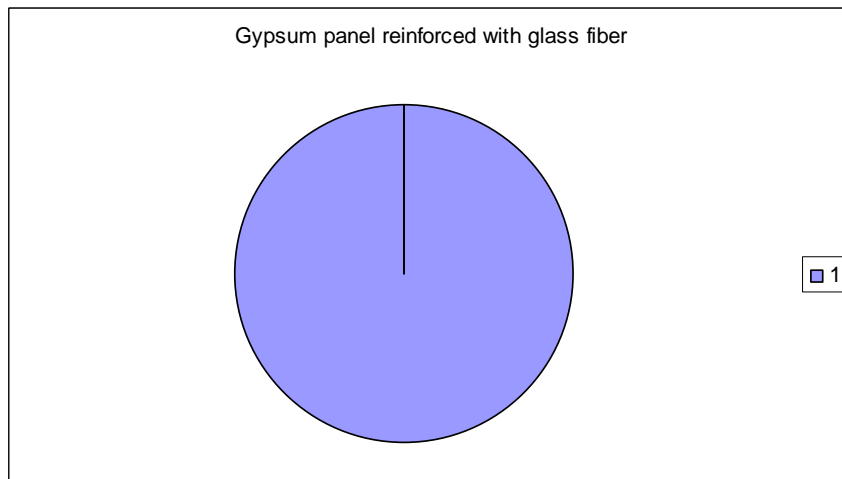
11.8 Cost of Raw Materials

Raw Material Cost (Per Unit)

Raw material (PM)	Quantity (MT)	Price per unit (Rs.)	Total amount (Rs.)
Hemi hydrate gypsum	120	4000	480000
Reinforcing fiber / glass fiber	1	100000	100000
Mould release agent, and other chemicals		LS	20000
Packing cartons & labels		LS	100000
	Sub-total		700000
	Wastage allowance 10%		70000
Total Cost (Monthly)			770000
Total Cost (Annual)			9240000.00

11.9 Annual Turnover

Total turnover (per annum)		Units	Per unit	Total amount
Gypsum panels, reinforced with glass fiber	Size: 610mm X 610mm Thickness: 9mm	4,80,000	Nu. 50/-	2,40,00,000/-
Total				2,40,00,000/-
Wastage @ 5%				12,00,000/-
Total				2,28,00,000/-



11.10 Income statement

(All figures in Nu. Lacs)

Income Statement											
Operating years		1	2	3	4	5	6	7	8	9	10
Capacity											
Installed Capacity (no. in lacs)		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Capacity Utilisation		80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
PRODUCTION		4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Sales Revenue		228.00	228.00	228.00	228.00	228.00	228.00	228.00	228.00	228.00	228.00
Raw Material & Consumables		92.40	92.40	92.40	92.40	92.40	92.40	92.40	92.40	92.40	92.40
Utilities & Fueles											
Power		12.67	12.67	12.67	12.67	12.67	12.67	12.67	12.67	12.67	12.67
Water, Diesel, etc		1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Sub Total		13.87	13.87	13.87	13.87	13.87	13.87	13.87	13.87	13.87	13.87
Wages & Salaries		33.53	33.53	33.53	33.53	33.53	33.53	33.53	33.53	33.53	33.53
Factory Overheads		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
General Overheads		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Lease											
Land		0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Estimated Cost of Production		145.61	145.61	145.61	145.61	145.61	145.61	145.61	145.61	145.61	145.61
Selling Expenses		11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40
Cost of Sales		157.01	157.01	157.01	157.01	157.01	157.01	157.01	157.01	157.01	157.01
EBITDA		70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99
Interest		18.18	15.91	13.63	11.36	9.09	6.82	4.54	2.27	0.00	0.00
Depreciation		15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81
PBT		37.01	39.28	41.55	43.82	46.09	48.37	50.64	52.91	55.18	55.18
Taxation		11.10	11.78	12.47	13.15	13.83	14.51	15.19	15.87	16.56	16.56
PAT		25.90	27.49	29.09	30.68	32.27	33.86	35.45	37.04	38.63	38.63

It would be seen from table above that the PBT in the 1st year of operation is 37.01 lacs which works out to be 16.22%. In the tenth year, the percent of PBT would be 24.20%. Similarly, PAT in the first year Rs. 25.90 lacs accounting for 11.35% of the total turnover. PAT in the tenth year would rise to 17%. These figures could vary depending upon change in tax structure.

11.11 Repayment of Interest Schedule on Loans

(All figures in Nu. lacs)

Repayment and Interest Schedule for Loans											
									216.41	151.49	18.93585
Operating Years	1	2	3	4	5	6	7	8	9	10	
Rate of Interest	12%										
Loan (Outstanding)	151.49	132.55	113.62	94.68	75.74	56.81	37.87	18.94	0.00	0.00	
Interest	18.17842	15.90612	13.63381	11.36151	9.08921	6.816907	4.544605	2.272302	0	0	
Moratorium											
Repayment	18.93585	18.93585	18.93585	18.93585	18.93585	18.93585	18.93585	18.93585	0	0	
Closing Balance	132.55	113.62	94.68	75.74	56.81	37.87	18.94	0.00	0.00	0.00	

11.12 Depreciation

(All figures in Nu. Lacs)

Depreciation

Operating Years		1	2	3	4	5	6	7	8	9	10
Machinery @ 10%		14.41	14.41	14.41	14.41	14.41	14.41	14.41	14.41	14.41	14.41
Construction Cost @ 5%		1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Total		15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81	15.81

11.13 Projected Fund Flow Statement

(All figures in Nu. Lacs)

Projected Funds Flow Statement

Years	Construction Period	Operation period									
	1	1	2	3	4	5	6	7	8	9	10
SOURCES OF FUNDS											
Equity	64.92										
Debt	151.49										
PBDIT		70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99
Total Sources A	216.41	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99	70.99
APPLICATION OF FUNDS											
Fixed Assets Purchase	200.33										
Miscellaneous Fixed Assets	3.00										
Increase in Current Assets	13.08										
Repayment of Loan Payment		18.94	18.94	18.94	18.94	18.94	18.94	18.94	18.94	0.00	0.00
Payment of Interest on Term Loan		18.18	15.91	13.63	11.36	9.09	6.82	4.54	2.27	0.00	0.00
Taxation		11.10	11.78	12.47	13.15	13.83	14.51	15.19	15.87	16.56	16.56
Total Application B	216.41	48.22	46.63	45.03	43.44	41.85	40.26	38.67	37.08	16.56	16.56
SURPLUS/(DEFICIT) A-B	0.00	22.78	24.37	25.96	27.55	29.14	30.73	32.32	33.91	54.44	54.44
OPENING CASH & BANK BALANCES		0.00	22.78	47.15	73.11	100.66	129.80	160.53	192.85	226.76	281.20
CLOSING CASH & BANK BALANCES	0.00	22.78	47.15	73.11	100.66	129.80	160.53	192.85	226.76	281.20	335.64

11.14 Discounted Cash Flow

Discounted cash flow techniques: The DCF techniques of capital budgeting – especially the internal of return method, and the net present value method – are rapidly gaining acceptance and are eventually replacing the less accurate methods (such as the payback and average rate of return) of evaluating the investment proposals of a firm.

The net Present Value method (NPV): Belonging to the category of time adjusted (Discounted cash flow) techniques; NPV represents a sophisticated method of evaluating the profitable investment opportunities of a firm. Here first of all the cash inflows and outflows are calculated. These cash flows are expressed in terms of the present values by discounting at a cut off rate (cost of capital). The important steps in the calculation of NVP are as follows:

1. Cash inflows after tax (but before depreciation) are to be calculated).
2. Cash inflow at the end of the year should include the salvage value of the project, if any.
3. Working capital, if any at the end of the project's life should be include in cash flow.
4. Calculate all cash outflows. If all cash outflows are made in the initial year, there present value will be equal to the amount of cash actually spent.
5. Select an appropriate (rate cut off rate / cost of capital) of interest to discount the cash flows.

NPV is calculated by using the following formula;

$$NPV = \frac{A}{(1+k)} + \frac{A}{(1+k)^2} + \frac{A}{(1+k)^3} + \dots + \frac{A}{(1+k)^n}$$

$$NPV = \sum_{t=1}^n \frac{A_t}{(1+K)^t} - C$$

Legends: A= Cash flow amount; k = Rate of Interest; n = Time period in Years;

NPV method is defined as 'the scientific process of calculating the present value of cash flows- both inflows and outflows –of an investment proposal using a discount rate (generally the overall cost of capital) and subtracting the present value of outflows to find the net present value.

Acceptance rule: If $NPV > 0$, a project may be accepted, and
If $NPV < 0$, a project may be rejected.

When the NPV is zero, the firm becomes indifferent between accepting or rejecting the project.

For Gypsum board Project:

Cash Outflow in Construction period (2 Yrs.)	= 216.41
Net Cash Inflow in Operation Period (10 yrs)	= 582.93
NPV of cumulative cash flows @ 12%	= 70.56

Conclusion: Since NPV > 0, the project is acceptable.

Internal Rate of Return: Another sophisticated discounted cash flow technique is the internal rate of return. Joel Dean is credited with introducing this concept. Also known by various names such as time-adjusted rate of return, marginal efficiency of capital and rate of return over cost the internal rate of return is defined as “the discount rate, which makes the net present value of a project ‘zero’”. In other words IRR is the rate, which equates the present value of cash inflows with the present value of outflows. Instead of discounting the cash flows at cost of capital (cut off rate) to determine the net present value of a project, we are answering the question “what rate of return does the project earn” this rate (IRR) can be calculated by the following formula:

$$C = \sum_{t=1}^n \frac{A_t}{(1+r)^t}$$

Legends: C = Discounted Cash flow amount; r = rate of interest; n= Time period in years; A = Cash flow amount.

For Gypsum Board Project:

Investment	= 216.41
Net Cash flow (Investment)	= 366.52
(Over construction period + 10 years)	
IRR on Investment	= 19%

Equity (During construction period)	= 64.92
(Share Capital + General Reserves)	
Net cash flow (Equity)	= 284.72
(Over construction period + 10 years)	
IRR on Equity	= 31%

Conclusion: Against Cost of Capital of 12%, the IRR on Investment is coming to 19% and IRR on Equity is coming to 31%, which is very healthy.

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			41.71	43.30	44.90	46.49	48.08	49.67	51.26	52.85	54.44	54.44
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Add back financial Expenses			18.18	15.91	13.63	11.36	9.09	6.82	4.54	2.27	0.00	0.00
Terminal value												14
Total inflow			59.89	59.21	58.53	57.85	57.17	56.48	55.80	55.12	54.44	68.44
Outflows												
Investment	203.33	13.08										
Bridge Loan	0	0										
Total outflow	203.33	13.08										
Net Cash flow	-203.33	-13.08	59.89	59.21	58.53	57.85	57.17	56.48	55.80	55.12	54.44	68.44
IRR on Investment (%)	19%											
NPV (12% Discount Rate)	Rs. 70.56											
Pay Back Period	3.5 Years											
Discounted Cash flow Statement (Equity)												
Years	t=0	t=1	1	2	3	4	5	6	7	8	9	10
Inflows												
Net Cash Accruals After Interest & Tax			41.71	43.30	44.90	46.49	48.08	49.67	51.26	52.85	54.44	54.44
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Less: Loan Repayment			18.94	18.94	18.94	18.94	18.94	18.94	18.94	18.94	0.00	0.00
Terminal Value												14.00
Total Inflow			22.78	24.37	25.96	27.55	29.14	30.73	32.32	33.91	54.44	68.44
Outflows												
Equity	61.00	3.9										

		3										
Total Outflow	61.00	3.9 3										
Net Cash Flow	-61.00	- 3.9 3	22. 78	24. 37	25.9 6	27. 55	29. 14	30. 73	32. 32	33. 91	54. 44	68. 44
IRR on Equity	31%											

(All figures in Nu . Lacs)

	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			41.71	43.30	44.90	46.49	48.08	49.67	51.26	52.85	54.44	54.44
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Add back financial Expenses			18.18	15.91	13.63	11.36	9.09	6.82	4.54	2.27	0.00	0.00
Terminal value												14
Total inflow			59.89	59.21	58.53	57.85	57.17	56.48	55.80	55.12	54.44	68.44
Outflows												
Investment	203.33	13.08										
Bridge Loan	0	0										
Total outflow	203.33	13.08										
Net Cashflow	-203.33	-13.08	59.89	59.21	58.53	57.85	57.17	56.48	55.80	55.12	54.44	68.44
IRR on Investment (%)	19%											
NPV (12% Discount Rate)	Rs. 70.56											
Pay Back Period	3.5 Years											
	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			41.71	43.30	44.90	46.49	48.08	49.67	51.26	52.85	54.44	54.44
Less: Change in Working Capital			0	0	0	0	0	0	0	0	0	0
Less: Loan Repayment			18.94	18.94	18.94	18.94	18.94	18.94	18.94	18.94	0.00	0.00
Terminal Value												14.00
Total Inflow			22.78	24.37	25.96	27.55	29.14	30.73	32.32	33.91	54.44	68.44
Outflows												
Equity	61.00	3.93										
Total Outflow	61.00	3.93										
Net Cash Flow	-61.00	-3.93	22.78	24.37	25.96	27.55	29.14	30.73	32.32	33.91	54.44	68.44
IRR on Equity	31%											

11.15 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	64.92	64.92	64.92	64.92	64.92	64.92	64.92	64.92	64.92	64.92	64.92
1.2	General Reserves		25.90	53.40	82.48	113.16	145.43	179.28	214.73	251.77	290.40	329.03
1.3	Debt	151.49	132.55	113.62	94.68	75.74	56.81	37.87	18.94	0.00	0.00	0.00
	Total Liabilities	216.41	223.38	231.94	242.09	253.83	267.16	282.08	298.59	316.69	355.32	393.95
2	Assets											
2.1	Gross Fixed Assets	203.33	203.33	203.33	203.33	203.33	203.33	203.33	203.33	203.33	203.33	203.33
2.2	Accumulated Depreciation		15.81	31.62	47.43	63.24	79.05	94.86	110.67	126.48	142.29	158.10
2.3	Net Fixed Assets	203.33	187.52	171.71	155.90	140.09	124.28	108.47	92.66	76.85	61.04	45.23
2.4	Working Capital Assets	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08
2.5	Cash & Bank Balances	0	22.78	47.15	73.11	100.66	129.80	160.53	192.85	226.76	281.20	335.64
	Total Assets	216.41	223.38	231.94	242.09	253.83	267.16	282.08	298.59	316.69	355.32	393.95

11.16 Break Even Point and Sensitivity Analysis

Break even point can be determined algebraically or graphically.

(i) Algebraic method: Break even point is calculated by dividing the fixed costs by the contribution per unit. Contribution per unit is the difference between the selling price and variable cost per unit. Break even level of sales is obtained by multiplying the break even point of output with the selling price. The various terms used are defined in the following fashion:

Contribution = Sale price – Variable cost per unit

Profit = Contribution – Fixed cost

$$\text{Break –even point of output (Unit)} = \frac{\text{Fixed cost}}{\text{Contribution per unit}}$$

$$\text{Break even point of sales (Rs.)} = \frac{\text{Fixed cost}}{\text{Contribution per unit}} \times \text{Selling price}$$

$$\text{or Break –even point} = \frac{\text{Total Fixed cost}}{\text{Total Contribution}} \times \text{Sales}$$

$$\text{or BEP} = \frac{\text{Fixed cost}}{\frac{1 - \text{Variable cost per unit}}{\text{Selling price per unit}}}$$

$$\text{or BEP} = \frac{\text{Fixed cost}}{\text{P /V ratio}}$$

	Break Even Point And Sensitivity Analysis				
	Normal	Case1	Case2	Case3	Case4
Variable Cost (Rs. Lacs)					
Raw material & Consumable Stores	92.40	101.64	92.40	92.40	101.64
Utilities	13.87	15.26	13.87	13.87	15.26
Total Variable Cost	106.27	116.90	106.27	106.27	116.90
Average Variable Cost (per piece)	22.14	24.35	22.14	22.14	24.35
Fixed Cost (Rs. Lacs)					
Wages & Salaries	33.53	33.53	36.89	33.53	35.21
Repairs & Maintenance	3.00	3.00	3.30	3.00	3.15
General Overheads	2.00	2.00	2.20	2.00	2.10
Lease charges	0.80	0.80	0.88	0.80	0.84
Financial Expenses	18.18	18.18	20.00	20.00	21.00
Depreciation	15.81	15.81	17.39	17.39	18.26
Total Fixed Cost (Rs. Lacs)	73.32	73.32	80.65	76.72	80.56
Average Fixed Cost (Rs. per piece)	15.28	15.28	16.80	15.98	16.78
Average Selling Price	47.50	47.50	47.50	47.50	45.13
Project Break Even Point (No. lac)	2.89	3.17	3.18	3.03	3.88
Project Break Even	48%	53%	53%	50%	65%
Cash Break Even Point	2.27	2.48	2.49	2.34	3.00
Cash Break Even	38%	41%	42%	39%	50%

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

Under Case-1: Assuming a 10% increase in variable costs (like raw materials, consumables & utilities) and keeping all other costs as constant, the Project BEP level increases from 48% in Normal to 53% and cash BEP level increases from 38% to 41%.

Under Case-2: Assuming a 10% increase in fixed cost (like wages & salaries, repairs & maintenance, general overheads, depreciation & lease charges) and keeping all other costs as constant, the project BEP level increases from 48% in normal to 53% and cash BEP level increases from 38% to 42%.

Under case-3: Assuming a 10% increase in Project cost (i.e. Financial Expenses), the project BEP level increases from 48% in normal to 50% and cash BEP level increases from 38% to 39%.

Under case-4: Assuming a 10% increase in Variable cost; 5% in fixed cost & 5% decrease in selling price, the project BEP level increases from 48% to 65% and cash BEP increase from 38% to 50%.

The project break even in normal case is 38% i.e. after achieving 38% of the projected turnover the unit would be in the profit zone.

11.17 Ratio Analysis

This is an important ratio for companies deciding whether or not to initiate a new project. The basis of this ratio is that if a company is going to start a project they expect to earn a return on it, ROA is the return they would receive. Simply put, if ROA is above the rate that the company borrows at then the project should be accepted, if not then it is rejected.

Return on Assets - ROA

Net Income + Interest Expense

Total Assets

For gypsum board / gypsum panel project

Ratio Analysis											
	Operation Period	Construction Period									
Year		1	2	3	4	5	6	7	8	9	10
Return On Assets - ROA		19.73%	18.71%	17.65%	16.56%	15.48%	14.42%	13.39%	12.41%	10.87%	9.81%
Return On Equity – ROE		28.52%	23.24%	19.73%	17.23%	15.34%	13.86%	12.68%	11.70%	10.87%	9.81%
Debt Equity Ratio	2.33	2.04	1.75	1.46	1.17	0.88	0.58	0.29	-	-	-

Conclusion: The ROA is varying from 28% in Yr-1 to 10% in Yr 10, which is quite healthy. There is steady decline from Yr 1 to Yr 10, in view of steady increase Total Assets from Yr-1 to Yr –10.

Return on Equity Analysis:

Sometimes ROE is referred to as Stockholder's return on investment, it tells the rate that shareholders are earning on their shares. But ROE is often misunderstood, for example if the return on equity is 10% then ten cents of assets are created for each dollar that was originally invested. Companies that generate high returns relative to their shareholder's equity are companies that pay their shareholders off handsomely, creating substantial assets for each dollar invested. These businesses are more than likely self-funding companies that require no additional debt or equity investments.

11.18 Foreign Exchange Implications

The foreign exchange requirement for the project would be mainly on two accounts viz.

- For the import of machines, equipments and accessories at a value of around Rs. 144 lacs during setting up of the project.
- Approximately, Rs. 10 lacs worth of foreign exchange would be required for incidental expenses such as training, travel, etc in the first year.

Thus, the total foreign exchange requirement for a period of 5 years would be around Rs.154 lacs. Against this, the foreign exchange earning from the export and foreign exchange saving due to import substitution is envisaged at Rs. 1140 lacs.

CHAPTER 12 – ECONOMIC ANALYSIS

12.1 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, are 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.

12.2 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.

12.3 Socio-Economic Impact of the Project

As stated 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.

- ❖ Value addition to indigenously available gypsum mineral, a major part of which is being presently exported at a lower price.
- ❖ Indigenous production of gypsum board / gypsum panels would lead to self-reliance for these items in the field of construction industry. This would also make available a modern material of construction to Bhutan construction industry.
- ❖ The production of gypsum board / gypsum panel shall enable the construction industry to use a green material construction for the green buildings.
- ❖ Gypsum board / gypsum panels can partly replace wood in the construction and their use would result in protection of environment and ecology.
- ❖ There exist possibilities of export of the gypsum board / gypsum panels to eastern and north-eastern parts of India and other neighboring markets. This would lead to earning of 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 up-liftment of local population. This would also lead to up gradation 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 school supplies 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 Gypsum Board Dealers

1. Ramsons Marketing

Address - 2, Jabakusum Hse, Nr Yoga Yog Bhawan, 34, Chittaranjan Ave,
Kolkata – 700012

Phone : +(91)-(33)-22121450, 32516055

Mobile/Cell Phone : +(91)-9831106810

2. Singh traders in Dhakuria

Address - 1/16, Sahid Nagar, Dhakuria, Kolkata – 700031

Phone Number - +(91)-9831310831

3. Ramria Assoc Pvt. Ltd

Address - A-53, 1ST FLR, Opp Lancer Public School, Prashant Vihar, Delhi – 110085

Phone - +(91)-11-66360636

Mobile/Cell Phone - +(91)-9811155386, 9312244145

Fax - +(91)-(11)-27553681

4. Unique Collections India Pvt Limited

Address - E-42/5, Okhla Indl Area, PH-II, Nr Nathu Sweets, Okhla, Delhi – 110020

Phone - +(91)-(11)-41709972

Mobile/Cell Phone - +(91)-9818311020, 9971099400

Fax - +(91)-(11)-41705095

Website - www.123ply.com

5. Shiv Shakti Traders

Address - S-52,, Main Gautam Puri Raod, brahmapuri, Delhi – 110053

Phone - +(91)-11-66227443

Mobile/cell Phone - +(91)-9811827826, 9811110231

6. P. R. Products

Address - 362, Industrial Area, Patparganj, Delhi - 110 092, India

Mobile / Cell Phone: +(91)-9311113481/9350852066

Website: <http://www.indiamart.com/p-r-products>

7. Ruby Interiors

Address: No. 111, Matheshwartala Road, Near China Town, Kali Temple,
Kolkata - 700 046, India
Mobile / Cell Phone: +(91)-9836684244/9830648551
Website: <http://www.indiamart.com/ruby-interiors/>

8. Navyug Traders

Address: No. B- 112, W H S, Timber Market, Kirti Nagar, New Delhi - 110 015, India
Phone: +(91)-(11)-24507349 Fax: +(91)-(11)-24507349
Mobile / Cell Phone: +(91)-9810083438/9871398112
Website: <http://www.indiamart.com/navyugtraders/>

9. Brillent Steel Screws

Address: No. 17, Channamal Park, East Punjabi Bagh, New Delhi - 110 026, India
Mobile / Cell Phone: +(91)-8882213311
Website: <http://www.indiamart.com/brillent-steel-screws/>

10. Ocean Boards Private Limited

Address: Opposite Garg & Company, Church Road, Siliguri - 734 001, India
Phone: +(91)-(353)-2777667 Fax: +(91)-(353)-2777667
Mobile / Cell Phone: +(91)-9434049644/9774006626
Website: <http://www.indiamart.com/oceanboard/>

11. Vinayak Anicillaries Tradex Pvt. Ltd.

Address : 51/A, Garcha Road,Kolkata-700019, West Bengal, INDIA
Phone : 91-33-64600823
Mobile : +919088242615
Fax : 91-712-2237864

12. Israil Plywood

Address : 157-C, Lenin Sarani,Kolkata-700013, West Bengal, INDIA
Phone : 91-33-22150585/22156244/30221585
Mobile : +919433004585
Fax : 91-33-22156244

13. S. A. R. International

Address: No. 802, Tower - 5, Uni Tech Heights, Greater Noida, Uttar Pradesh - 201 310,
India
Phone: +(91)-(120)-4292557 Fax: +(91)-(120)-4292557

Mobile / Cell Phone: +(91)-9910054102

Website: <http://www.indiamart.com/sarinternational/roofing-sheets.html>

14. Shri Balaji Trading Co.

Address: C-35, Sector-9, Noida, Uttar Pradesh - 201 301, India

Mobile / Cell Phone: +(91)-9810903895/9311814040

Website: <http://www.indiamart.com/shribalaji-trading/interior-designing-products.html>

15. S. G. T. C., India

Address: No. 17/1, Main Rohtak Road, Nangloi, New Delhi, Delhi - 110 041, India

Phone: +(91)-(11)-25949399 Fax: +(91)-(11)-25946915

Mobile / Cell Phone: +(91)-9811331020/9818210962

Website: <http://www.indiamart.com/sgtc-india/commercial-product.html>

16. Alex Interiors & Decorator

Address: 7051/4, Rameshwari Nehru Nagar, Opposite Sindhi Ghori Wale, Karol Bagh, Delhi, Delhi - 110 005, India

Phone: +(91)-(11)-25753259

Mobile / Cell Phone: +(91)-9310333260/9810493837

Website: <http://www.indiamart.com/alexinteriors/>

17. Essem Enterprise

Address: No. 7 Red Cross Place, 2nd Floor, Kolkata, West Bengal - 700 001, India

Phone: +(91)-(33)-22318914/22318876 Fax: +(91)-(33)-22318876

Mobile / Cell Phone: +(91)-9831002472/9433457815

Website: <http://www.indiamart.com/essementerprise/>

18. Mamodia Marketing

Address: No. 601, Netaji Subhash Complex, Wazirpur District Centre, New Delhi, Delhi - 110 033, India

Phone: +(91)-(11)-45052474/47580550/27352474 Fax: +(91)-(11)-45052474/47580550/27352474

Mobile / Cell Phone: +(91)-9810002064/9999350909

Website: <http://www.mamodiamarketing.com/>

19. Daksh Constructions & Interior

Address: Shop No. 3, 1st Floor, Gangania Complex, Sikandarpur, MG Road, Gurgaon, Haryana - 122 002, India

Phone: +(91)-(124)-4117356

Mobile / Cell Phone: +(91)-9650687711/9910235720

Website: <http://www.indiamart.com/daksh-constructions-interior/interior-works.html>

20. Shalimar Interiors

Address: A - 180, Sukhdev Market, Kortla Mubarakpur Timber Market, Bhisham Pitamah Road, Near Defence Colony, Red Light, New Delhi, Delhi - 110 003, India

Mobile / Cell Phone: +(91)-9810038131

Website: <http://www.indiamart.com/shalimarinteriors/>

Annexure II

List of raw material suppliers

1. Druk Satair Corporation Ltd.

Khothakapa
Pemagatchel
Samdrup Jongkhar
Bhutan

2. Shatrughan Industries

Address: Vill-parsa, P.O. Haripur - Gairwanna, GODDA, Bihar India
Website: <http://www.shatrughanindustries.com>

3. Mahashakti Mines and Minerals Co. Pvt. Ltd

Address: A-1/1 Patel Nagar, bikaner, Rajasthan India

4. Druk Plaster & Chemical ltd

Pemagatshel
Samdrup Jongkhar
Bhutan

5. Bhutan Gypsum Products

Pemagatshel
Samdrup Jongkhar
Bhutan

Annexure III

List of machine suppliers

1. Libran Engineering and Services

Address: C-33, First Floor, Malvia Nagar near HDFC Bank, New Delhi, Delhi - 110 017, India

Phone: +(91)-(11)-26681175

Mobile / Cell Phone: +(91)-9811055650

Website: <http://www.libranengineering.com/>

2. Vogue Marketing Technologies

Address: No. 3, 2nd Floor, 5th Cross, P & T Layout, Horamavu, Kalyan Nagar Post, Bengaluru, Karnataka - 560 043, India

Phone: +(91)-(80)-42126294

Mobile / Cell Phone: +(91)-9845380695/9845389695

Website: <http://www.indiamart.com/vogue-marketing/>

3. Shijiazhuang Zhongfeng Machinery Co. Ltd.

The western part of State Road 307, Jinzhou

Shijiazhuang, Hebei, China

Tel: +86-311-84328838

Fax: +86-311-84326836

E-mail: zfmachine@163.com

4. Essem Enterprise

Address: No. 7 Red Cross Place, 2nd Floor, Kolkata, West Bengal - 700 001, India

Phone: +(91)-(33)-22318914/22318876 Fax: +(91)-(33)-22318876

Mobile / Cell Phone: +(91)-9831002472/9433457815

Website: <http://www.indiamart.com/essementerprise/>

5. Varahi Exports

Address: Second Floor, Coins Corner, Dr. Yagnik Road, Rajkot, Gujarat - 360 001, India

Phone: +(91)-(281)-2371279

Mobile / Cell Phone: +(91)-9824332444

Website: <http://www.indiamart.com/varahiexports/>

Annexure IV

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5. The Gypsum Industry by Gypsum Association
6. Lafarge.com
7. Drywall systems by Saint Gobain
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Annexure V

ABBREVIATIONS

POP – Plaster of Paris
FGD – Flue-Gas Desulfurization
LBGI – Lafarge Boral Gypsum India
FG – Fluorogypsum
DB – Decibel
MII - Mineral Information Institute
ASTM – American Society for Testing and Materials
BIS – Bureau of Indian Standards
IS – Indian Standards
GA – Gypsum Association
IGI – Indira Gandhi International Airport