"TECHNO ECONOMIC FEASIBILITY REPORT ON MOSAIC TILES USING WASTES"

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India
New Delhi

TO THE USERS

This Techno-Economic Feasibility Report has been prepared on the basis of information available. The intention here is to provide preliminary information to the prospective entrepreneur. Prior to making a firm decision for investment in the project the entrepreneur must verify the various feasibility aspects together along with the addresses for the procurement of plant and machinery and raw materials independently. The information supplied in this report is obtained from the reliable sources.

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1. INTRODUCTION

Over the last two decades, provision of tiles on the walls and floors of buildings has seen a tremendous upswing. Bathrooms, kitchens, shelves, facades, garden fountains and home accessories find a greater use of tiles these days. However, the only factor that is examined while selecting tiles is their physical appearance. No attention is paid to the technical aspects of the tiles selected which if considered may lead to a better service by them and their negligible maintenance in future. Surface flatness, edge curvature, war page, surface quality, water absorption, scratch hardness, abrasion resistance, thermal shock resistance, crazing resistance and resistance to action of chemicals are a few such properties which should be examined before selecting for use in residential, public or industrial buildings.

There were times when only 4 inch size white glazed tiles were used to clad the walls of bathrooms up to 7 feet level. Now the tiles have entered even the drawing rooms. Not only glazed but hand made tiles, hand painted tiles, border tiles and even glass embossed tiles in which the pattern that is embossed in tiles is of multi-coloured glass are being manufactured these days. The designs printed over the tiles are computerized and screen-printed. Not only this, one manufacturer has tried to vivify the grandeur of Indus Valley civilisation by producing tiles called Mohanjodaro collection, carrying various symbols discovered during archaeological excavations. Many manufacturers have collaborated with foreign countries to produce quality-tiles. Such a scenario having tough competition and high creativity demands a thorough study of these products before making the final selection.

Size and finish: Now there is a large variation in the size of tiles. Many sizes, varying from 4”x4” to 16”x16” are available. Though the most preferred shapes are rectangular and square, ‘hexagonal and octagonal shapes are also being produced. The finish may be glossy, semi-glossy, matt, luster and of many other types. Table 1 and Table 2 show various sizes and finishes of floor tiles and wall tiles being produced these days.

Colour: There is a revolution on the colour-front. Such a stunning variety of colours is available that it is difficult to count their number. For instance, one manufacturer is producing floor tiles having 99 colours and wall tiles in 282 colours. Not only this, the manufacturers are ready to produce tiles of the colour and shade as per individual’s choice. Even computerised designing as per individual choice is adopted.

Floor tile groups: Tiles used in floors are now categorised into four groups with respect to the service to be rendered and the intensity of traffic on them. These groups are Group-II, III IV and V. While Group-II tiles are for low and light traffic, Group-V tiles are for very heavy traffic. It is better to specify the group with respect to the intensity of the traffic while placing a demand for floor tiles as this will bring durability and economy. There is no fun in using Group-V tiles in an area where traffic is light. It will cause extra expenditure only. Similarly, use of Group-II tiles in areas of dense traffic such as cinema halls, commercial centres, railway stations etc will result in their wearing out soon.

Various groups of floor tiles, their suitability and their areas of application. Group-V tiles combine high hardness with complete acid and alkali resistance together with high abrasion resistance. Under the abrasion resistance test, a set load of Corborandum, water and steel balls is applied on the tile surface using a standard abrasion meter. No abrasion has to be visible after 12000 revolutions. Thereafter, the tile is subjected to Mark resistance test. If no mark is noted, Group-V standards are met with. Such tiles are highly suitable for industrial floorings also.

Tile properties: Different properties have been specified for tiles to be used in walls and floors. Bureau of Indian Standards has evolved IS codes — IS 13753 and IS 13755 for wall and floor tiles respectively. European Standard EN-87 enlists the technical features of wall and floor tiles under the Groups EN159Blll and EN159Blla, respectively. Table 4 shows some important properties of these tiles that should be checked before their purchase. While an organization can get the tiles tested for these properties, an individual can ask the manufacturer or the supplier to show the test certificate for the batch to which the tiles under purchase belong.

Tiles being ceramic products, a variation in their length and shade is likely to occur during the firing process. A buyer should therefore be careful towards these properties. Reputed manufacturers should themselves discard tiles having variation in length and shade beyond permissible limits as otherwise their reputation may be at stake. Presence of just a few such tiles may ruin the aesthetic effect of the tiled wall or floor.

In addition to the properties given in Table 4, the resistance of the tile surface to staining by household chemicals and swimming pool salts should be checked as per procedure laid in European Standard EN122. The manufacturer is bound to mention the abrasion resistance class of the tiles on the box containing them. If in doubt, this test can be got carried as per method of testing in EN154.

Thickness, weight and lot: The thickness of floor tiles varies from 7 to 10 mm. Floor tiles are contained in boxes and number 10 to 50 depending upon the size of the tiles. A box having 25 tiles of size 200x200 mm will weigh around 16 kg while another having only 10 tiles of size 400x400 mm will weight 32 kg. Wall tiles have a thickness of 6 to 8 mm. A box containing 25 tiles of size 200x300 mm will weigh 19 kg and one having 40 tiles of size 200x150 mm will weigh 14.5 kg only. The weight of ceramic tiles for a thickness of 6 mm may be taken as 16 kg/m2. Tiles, these days, are pre-polished, repair free and ready to use. This aspect should also be examined while selecting the tiles.

Manufacturing process: The process of manufacturing of tiles has undergone a significant change during the last few years. Earlier, the tiles used to be subjected to multi-firings. First, these were baked at very high temperatures. Thereafter, glazing which consisted of a mixture of Glass and Zirconium or such elements used to be applied on the tiles. Then the tiles were rebaked. The tiles produced these days are single fired i.e. the manufacturing designing and glazing are done in one process thereby producing more durable and maintenance-free tiles. These single-firing manufacturing processes have been brought by the manufacturers to India from the pioneer countries in tiles such as

Spain and Italy. Italy still reigns as the king of tiles. In fact the word “tile” itself has been derived from Italian word “Teluga” which means a covering.

Today, as many as 21 reputed companies are producing tiles in India. The competition is fierce. The result is that some of the manufacturers are declaring their product as “exclusive” and not decreasing the costs while other are fighting for survival by keeping very little margins. During the last few years, the prices have come down well. Though hand made and hand painted tiles have uneven edges, odd sizes and very bright colours yet are very costly because these involve carving, are not produced on mass scale and considered to be an exclusive and class item.

Terrazzo tiles: Till early nineties, terrazzo tiles remained under most use Composed of marble chips mixed with coloured or white cement, mechanically ground, hydraulically pressed and then finished, cured and polished, these tiles act as somewhat structurally strong members of the building. Terrazzo tiles, however, need to be polished at regular intervals, the weight is heavy and there is always a tendency of their becoming slippery. These days terrazzo tiles have given way to ceramic tiles. A 6 mm thick ceramic tile serves the purpose at a place where a 25 mm thick terrazzo tile has to be used. There is no comparison of the finish as the ceramic tiles provide a highly attractive surface while the terrazzo tiles begin to look ugly after a year or so. There may be a lot of breakage during the transportation and handling of terrazzo tiles. This factor is also taken care of by ceramic tiles.

Mosaic floor tiles are also known as terrazzo tiles. The main raw materials used for the manufacture are cement concrete and coloured stone chips. These tiles are made generally in the sizes of 200 x 200 x 20mm and 300 x 300 x 25 mm. these tiles can also be made in various other sizes, shapes according to market demand. The tiles are used for flooring of both residential and commercial buildings. The top surface of the tiles is decorated with marble stone chips of various colours with suitable addition of cement colour. These tiles are impermeable, easy to replace and long lasting.

Construction of floor by laying these tiles is time saving. It is also economical to repair the floor or do patch work by replacing the damaged tiles in course of use. Since the tiles are available in various decorative colours and sizes, the item is gaining popularity and the demand is increasing day-by-day. There is a great upsurge in the building construction activity due to increase in population. The requirement of residential houses hospitals and commercial buildings is increasing day by day. Government of India in its 10^{th} five Year Plan has given greater emphasis on housing activity. Socio-economic changes in society, improved standards of living, renovation of old buildings and all-round development in the country, have increased building construction activity and the demand of Mosaic flooring tiles.

Ceramic vitreous floor tiles, granite and marble stone tiles, red clay flooring tiles are some of the substitute material used in place of mosaic tiles. The demand for Mosaic tiles is estimated to be around 25% of the total requirement of flooring tiles. Taking the above factors into consideration the demand is expected to

increase at the rate of 10% every year during the current plan period. Hence there is a good scope for setting up of new units for the manufacture of mosaic tiles.

The basic raw materials used in the manufacture of mosaic floor tiles are cement (grey and white) stone/marble chips. Fine aggregates like sand, dolomite powder and colouring oxide ordinary Portland cement can be used for mosaic tiles of dull colours. For such applications where distinct designs and deep colour shades and marble boundaries are desired white cement may be employed. Hard limestone, dolomite chips, crushed cuddeppha stone of suitable sizes are to be used as course aggregate. Colours should not be added in quantities exceeding 10% of the cement used in tile mix, otherwise strength of tiles will be adversely affected.

The process for the manufacture of Mosaic tiles consists of three layers, the facing, the intermediate and backing layers. The raw materials (cement, marble chips, marble powder, colouring oxides, sand stone chips) are mixed according to the pre-determined proportions thoroughly and mixture is kept separately on the platform of hydraulic/mechanical press for ready use. The mixture for three layers is prepared in the following proportions.

1.	Facing mixture	Proportion
	Grey cement	1.5
	Marble chips	4
	White cement	1
	Marble powder	1
	Colouring oxide	0.1 to 0.5%

2.	Intermediate Mixture	
	Grey cement	1
	Sand	1
3.	Backing Mixture	
	Grey cement	1
	Sand	3
	Stone chips	1

Suitable iron moulds are fitted with the bottom plate of the press. The facing mixture is first fed into the mould to a thickness of about 6.5 mm and then intermediate and backing mixture is spread over to the thickness of about 9 mm each. The mixture is pressed under the pressure of around 150 kg/sq.cm. which varies according to the size of the tile. The tiles are taken out from the moulds and kept for 24 hours for air setting and then immersed in water for curing for a period of about 15 days. The cured tiles, are then taken from the curing tank and kept in shed for a period of about 4-5 days for drying. The tiles are then polished and ground on super (leveling machine.) After polishing, the tiles are given final touch of finish by hand and then sent to store for dispatch.

Manually operated presses are also used for making the tiles for small batches of production. But the tiles made by this press do not have uniformity due to difference of pressure in each cycles with variation in pressure of the manually operated presses.

For maintaining uniformity in quality the following Indian standards specifications may be considered:

IS 1237:1980 Cement concrete flooring tiles.

As per IS 1237:1980 the use of raw materials is divided into three forms viz. topping mixture, intermediate mixture and backing mixture.

Production Capacity (per annum)

It is envisaged that unit will produce about 8 lakhs pieces of assorted sizes valued at Rs.65,00,000.

Motive Power 20 HP.

There is no water pollution in manufacture of mosaic tiles, however, there would be some air pollution while handling dry raw materials like cement and marble powders. Simple methods to cover the discharging bins for mixing or connecting it with cyclonic dust collector would be sufficient to control the pollution. Alternatively, the operator should use dust mask.

It is not applicable as far as fuel energy is concerned. Simple precautions and knowledge of effective utilization of electrical power is necessary.

Laying of tiles: The walls and floors will come alive only if laying of tiles has been done in a proper manner. How-so-ever beautiful or costly the tiles may be, they will lose all the elegance and aesthetic effects if the tile-joints are thick and uneven; cut-pieces are not used at right places and symmetry is not maintained. Cut-tile-pieces should be used only at the ends (never in the middle) of the walls, on window sills and door jambs. Grouting of joints should be done with a water-proof epoxy grout. No excess grout should be left over the tile surface and

should be wiped off at the earliest. The base should be checked to be rough before fixing tiles on it. A guide-rod should always be prepared by the mason before start of work. This guide-rod should carry the markings of tile-size and gaps for grouting among them.

Whenever a laid tile gets broken, it should be removed in a very patient manner by using a chisel and hammer and without affecting the adjacent tiles. Breaking should always be started at the centre of the tile and not from edges. After the removal of tile, the base mortar should also be chipped off. Grouting of the joints should be done when the fixed tile has sufficiently dried up.

The future belongs to tiles. Less involvement of labour, easy maintenance, abrasion resistance, a short time required for laying, wide variety and colours, cost competitiveness, pre-polishing and readiness for use are a few such factors which make tiles a highly attractive item for use. While the present cost of about Rs 20 per sq. ft. for plain tiles and Rs 30 per sq. ft. for special coloured or printed tiles is lesser than what it was years earlier, the prevailing competition among tile-manufacturers promises still lower rates in future.

The most important factor to consider when choosing a type of tile, is where it will be installed. Not all tiles are suitable for all applications. However, whatever type of tile you choose, if it is installed properly, it will bring a lifetime of function and beauty to any installation.

Glazed products perform according to the hardness of their glaze. This hardness is determined by the manufacturer and rated using a proper scale.

Various Types of Tiles

Ceramic tile is a mixture of clays and other natural materials that are mined from the earth, shaped and fired at high temperatures. Traditional ceramic tile can be naturally-colored and left unglazed, like terra cotta, or they can feature colored or highly designed surfaces which can be glazed (finished with a glass surface) from matte to high gloss. Tile terminology can be confusing. Most types of tiles that are made from clay or a mixture of clay and other materials, then kiln-fired, are considered to be a part of the larger classification called “Ceramic Tiles”. These tiles can be split into two groups, porcelain tiles and non-porcelain tiles. These non-porcelain tiles are frequently referred to as ceramic tiles by themselves, separate from porcelain tiles.

“Ceramic” or non-porcelain tiles are generally made from red or white clay and fired in a kiln. They are almost always finished with a durable glaze. This glaze carries the color and pattern. These tiles are used in both wall tile and floor tile applications, are softer and easier to cut than porcelain, and usually carry a 0 to 3 PEI rating. Non-porcelain ceramic tiles are usually suitable for very light to moderate traffic and generally have a relatively high water absorption rating making them less frost resistant. They are more prone to wear and chipping than porcelain tiles. To be used outdoors, we recommend the tile must be frost-proof and unglazed. A tile is considered frost-proof if its absorption rate is 0.5% or less.

Porcelain tiles are also ceramic tiles, but are composed of finer clays and fired at much higher temperatures. That process makes porcelain tile more homogenous (can have a through-body coloration, so scratches or dings are

less obvious), much stronger and less prone to moisture and stain absorption. For those reasons, porcelain can be suitable for both indoor and outdoor installations.

Porcelain tile is a tile that is generally made by the dust pressed method from porcelain clays which results in a tile that is dense, impervious, fine grained and smooth, with a sharply formed face. Porcelain tiles usually have a much lower water absorption rate (less than 0.5%), than non-porcelain tiles, making them frost resistant or frost-proof. Glazed porcelain tiles are much harder and more wear and damage-resistant than non-porcelain ceramic tiles, making them suitable for any application from light traffic to the heaviest residential and light commercial traffic. Through body porcelain tiles carry the color and pattern through the entire thickness of the tile, making them virtually impervious to wear. They are suitable for any application from residential to the highest traffic commercial or industrial applications. Porcelain tiles are available in matte, unglazed or a high polished finish.

Wall and floor tile used for interior and exterior decoration belongs to a class of ceramics known as whitewares. The production of tile dates back to ancient times and peoples, including the Egyptians, the Babylonians, and the Assyrians. For instance, the Step Pyramid for the Pharoah Djoser, built in ancient Egypt around 2600 B.C., contained colorful glazed tile. Later, ceramic tile was manufactured in virtually every major European country and in the United States. By the beginning of the twentieth century, tile was manufactured on an industrial

scale. The invention of the tunnel kiln around 1910 increased the automation of tile manufacture. Today, tile manufacture is highly automated.

The American National Standards Institute separates tiles into several classifications. Ceramic mosaic tile may be either **porcelain** or of natural clay composition of size less than 39 cm2 (6 in.2). Decorative wall tile is glazed tile with a thin body used for interior decoration of residential walls. Paver tile is glazed or unglazed porcelain or natural clay tile of size 39 cm2 (6 in.2) or more. Porcelain tile is ceramic mosaic tile or paver tile that is made by a certain method called dry pressing. Quarry tile is glazed or unglazed tile of the same size as paver tile, but made by a different forming method.

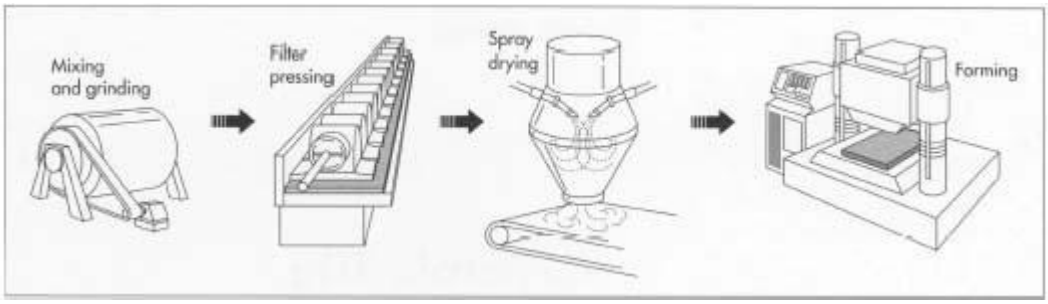
Europe, Latin America, and the Far East are the largest producers of tile, with Italy the leader at 16.6 million ft.2/day as of 1989. Following Italy (at 24.6 percent of the world market) are Spain (12.6 percent), Brazil and Germany (both at 11.2 percent), and the United States (4.5 percent). The total market for floor and wall tile in 1990 according to one estimate was $2.4 billion.

The United States has approximately 100 plants that manufacture ceramic tile, which shipped about 507 million ft^2 in 1990 according to the U.S. Department of Commerce. U.S. imports, by volume, accounted for approximately 60 percent of consumption in 1990, valued at around $500 million. Italy accounts for almost half of all imports, with Mexico and Spain following. U.S. exports have seen some growth, from $12 million in 1988 to about $20 million in 1990.

Because the tile industry is a relatively mature market and dependent on the building industry, growth will be slow. The United States Department of Commerce estimates a three to four percent increase in tile consumption over the next five years. Another economic analysis predicts that 494 million ft.2 will be shipped in 1992, a growth of about 4 percent from the previous year. Some tile manufacturers are a bit more optimistic; an American Ceramic Society survey showed an average growth of around 36 percent per manufacturer over the next five years.

The raw materials used to form tile consist of clay minerals mined from the earth's crust, natural minerals such as feldspar that are used to lower the firing temperature, and chemical additives required for the shaping process. The minerals are often refined or beneficiated near the mine before shipment to the ceramic plant.

The raw materials must be pulverized and classified according to particle size. Primary crushers are used to reduce large lumps of material. Either a jaw crusher or gyratory crusher is used, which operate using a horizontal



The **initial** step in ceramic tile manufacture involves mixing the ingredients. Sometimes, water is then added and the ingredients are wet milled or ground in

a ball mill. If wet milling is used, the excess water is removed using filter pressing followed by spray drying. The resulting powder is then pressed into the desired tile body shape. squeezing motion between steel plates or rotating motion between steel cones, respectively.

Secondary crushing reduces smaller lumps to particles. Hammer or muller mills are often used. A muller mill uses steel wheels in a shallow rotating pan, while a hammer mill uses rapidly moving steel hammers to crush the material. Roller or cone type crushers can also be used.

A third particle size reduction step may be necessary. Tumbling types of mills are used in combination with grinding media. One of the most common types of such mills is the ball mill, which consists of large rotating cylinders partially filled with spherical grinding media.

Screens are used to separate out particles in a specific size range. They operate in a sloped position and are vibrated mechanically or electromechanically to improve material flow. Screens are classified according to mesh number, which is the number of openings per lineal inch of screen surface. The higher the mesh number, the smaller the opening size.

A glaze is a glass material designed to melt onto the surface of the tile during firing, and which then adheres to the tile surface during cooling. Glazes are used to provide moisture resistance and decoration, as they can be colored or can produce special textures.

Once the raw materials are processed, a number of steps take place to obtain the finished product. These steps include batching, mixing and grinding, spray-drying, forming, drying, glazing, and firing. Many of these steps are now accomplished using automated equipment.

Batching

- For many ceramic products, including tile, the body composition is determined by the amount and type of raw materials. The raw materials also determine the color of the tile body, which can be red or white in color, depending on the amount of iron-containing raw materials used. Therefore, it is important to mix the right amounts together to achieve the desired properties. Batch calculations are thus required, which must take into consideration both physical properties and chemical compositions of the raw materials. Once the appropriate weight of each raw material is determined, the raw materials must be mixed together.

Mixing and grinding

- Once the ingredients are weighed, they are added together into a shell mixer, ribbon mixer, or intensive mixer. A shell mixer consists of two cylinders joined into a V, which rotates to tumble and mix the material. A ribbon mixer uses helical vanes, and an intensive mixer uses rapidly revolving plows. This step further grinds the ingredients, resulting in a finer particle size that improves the subsequent forming process (see below).

Sometimes it is necessary to add water to improve the mixing of a multiple-ingredient batch as well as to achieve fine grinding. This process is called wet milling and is often performed using a ball mill. The resulting water-filled mixture is called a slurry or slip. The water is then removed from the slurry by filter pressing (which removes 40-50 percent of the moisture), followed by dry milling.

Spray drying

- If wet milling is first used, the excess water is usually removed via spray drying. This involves pumping the slurry to an atomizer consisting of a rapidly rotating disk or nozzle. Droplets of the slip are dried as they are heated by a rising hot air column, forming small, free flowing granules that result in a powder suitable for forming.

  Tile bodies can also be prepared by dry grinding followed by granulation. Granulation uses a machine in which the mixture of previously dry-ground material is mixed with water in order to form the particles into granules, which again form a powder ready for forming.

Forming

- Most tile is formed by dry pressing. In this method, the free flowing powder—containing organic binder or a low percentage of moisture—flows from a hopper into the forming die. The material is compressed in a steel cavity by steel plungers and is then ejected by the bottom plunger. Automated presses are used with operating pressures as high as 2,500 tons.

Several other methods are also used where the tile body is in a wetter, more moldable form. Extrusion plus punching is used to produce irregularly shaped tile and thinner tile faster and more economically. This involves compacting a plastic mass in a high-pressure cylinder and forcing the material to flow out of the cylinder into short slugs. These slugs are then punched into one or more tiles using hydraulic or pneumatic punching presses.

Ram pressing is often used for heavily profiled tiles. With this method, extruded slugs of the tile body are pressed between two halves of a hard or porous mold mounted in a hydraulic press. The formed part is removed by first applying vacuum to the top half of the mold to free the part from the bottom half, followed by forcing air through the top half to free the top part. Excess material must be removed from the part and additional finishing may be needed.

Another process, called pressure glazing, has recently been developed. This process combines glazing and shaping simultaneously by pressing the glaze (in spray-dried powder form) directly in the die filled with the tile body powder. Advantages include the elimination of glazing lines, as well as the glazing waste material (called sludge) that is produced with the conventional method.

Drying

- Ceramic tile usually must be dried (at high relative humidity) after forming, especially if a wet method is used. Drying, which can take several days, removes the water at a slow enough rate to prevent shrinkage cracks. Continuous or tunnel driers are used that are heated using gas or oil, infrared lamps, or microwave energy. Infrared drying is better suited for thin tile, whereas microwave drying works better for thicker tile. Another method, impulse drying, uses pulses of hot air flowing in the transverse direction instead of continuously in the material flow direction.

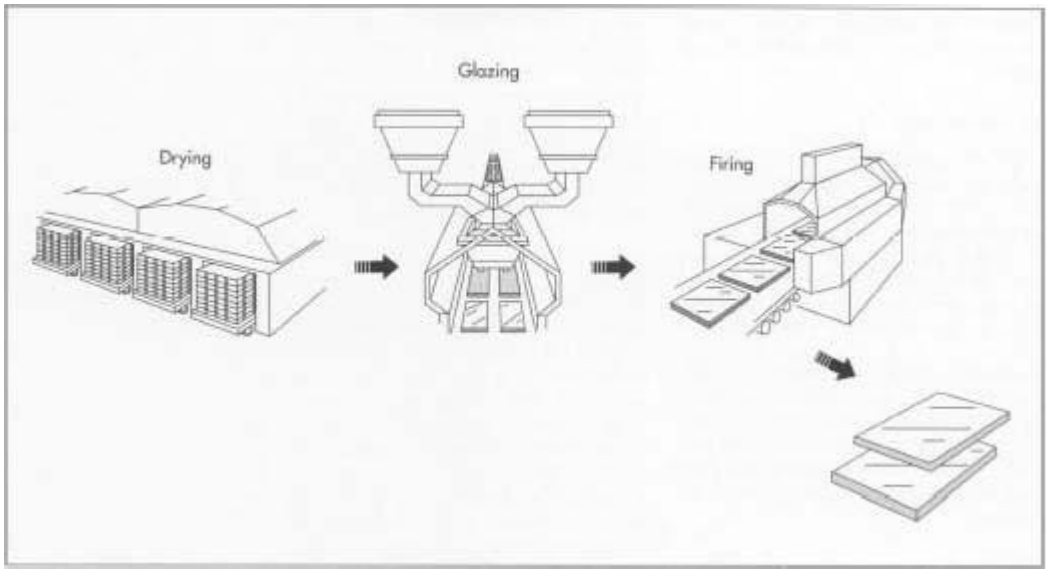
Glazing

- To prepare the glaze, similar methods are used as for the tile body. After a batch formulation is calculated, the raw materials are weighed, mixed and dry or wet milled. The milled glazes are then applied using one of the many methods available. In centrifugal glazing, the glaze is fed through a rotating disc that flings or throws the glaze onto the tile. In the bell/waterfall method, a stream of glaze falls onto the tile as it passes on a conveyor underneath. Sometimes, the glaze is simply sprayed on. For multiple glaze applications, screen printing on, under, or between tile that have been wet glazed is used. In this process, glaze is forced through a screen by a rubber squeegee or other device.

  Dry glazing is also being used. This involves the application of powders, crushed *frits*(glass materials), and granulated glazes onto a wet-glazed tile surface. After firing, the glaze particles melt into each other to produce a surface like granite.

Firing

- After glazing, the tile must be heated intensely to strengthen it and give it the desired porosity. Two types of ovens, or



After forming, the file is dried slowly (for several days) and at high humidity, to prevent cracking and shrinkage. Next, the glaze is applied, and then the tile is fired in a furnace or kiln. Although some types of tile require a two-step firing process, wet-milled tile is fired only once, at temperatures of 2,000 degrees Fahrenheit or more. After firing, the tile is packaged and shipped.

Kilns, are used for firing tile. Wall tile, or tile that is prepared by dry grinding instead of wet milling (see #2 and #3 above), usually requires a two-step process. In this process, the tile goes through a low-temperature firing called bisque firing before glazing. This step removes the volatiles from the material and most or all of the shrinkage. The body and glaze are then fired together in a process called glost firing. Both firing processes take place in a tunnel or continuous kiln, which consists of a chamber

through which the ware is slowly moved on a conveyor on refractory batts—shelves built of materials that are resistant to high temperatures—or in containers called saggers. Firing in a tunnel kiln can take two to three days, with firing temperatures around 2,372 degrees Fahrenheit (1,300 degrees Celsius).

For tile that only requires a single firing—usually tile that is prepared by wet milling—roller kilns are generally used. These kilns move the wares on a roller conveyor and do not require kiln furniture such as batts or saggers. Firing times in roller kilns can be as low as 60 minutes, with firing temperatures around 2,102 degrees Fahrenheit (1,150 degrees Celsius) or more.

- After firing and testing, the tile is ready to be packaged and shipped.

Byproducts

A variety of pollutants are generated during the various manufacturing steps; these emissions must be controlled to meet air control standards. Among the pollutants produced in tile manufacture are fluorine and lead compounds, which are produced during firing and glazing. Lead compounds have been significantly reduced with the recent development of no-lead or low-lead glazes. Fluorine emissions can be controlled with scrubbers, devices that basically spray the gases with water to remove harmful pollutants. They can also be controlled with dry processes, such as fabric filters coated with lime. This lime can then be recycled as a raw material for future tile.

The tile industry is also developing processes to recycle wastewater and sludge produced during milling, glazing, and spray-drying. Already some plants recycle the excess powder generated during dry-pressing as well as the overspray produced during glazing. Waste glaze and rejected tile are also returned to the body preparation process for reuse.

Quality Control

Most tile manufacturers now use statistical process control (SPC) for each step of the manufacturing process. Many also work closely with their raw material suppliers to ensure that specifications are met before the material is used. Statistical process control consists of charts that are used to monitor various processing parameters, such as particle size, milling time, drying temperature and time, compaction pressure, dimensions after pressing, density, firing temperature and time, and the like. These charts identify problems with equipment, out of spec conditions, and help to improve yields before the final product is finished.

The final product must meet certain specifications regarding physical and chemical properties. These properties are determined by standard tests established by the American Society of Testing and Materials (ASTM). Properties measured include mechanical strength, abrasion resistance, chemical resistance, water absorption, dimensional stability, frost resistance, and linear coefficient of thermal expansion. More recently, the slip resistance, which can be determined by measuring the coefficient of friction, has become a concern.

However, no standard has yet been established because other factors (such as proper floor design and care) can make results meaningless.

Natural Stone tiles consist of any product quarried from the earth and can be categorized into Marbles, Granites, Limestones, Travertines, Slates, Quartzites and various other products. Each type of Natural Stone will vary from piece to piece in regards to color, surface texture, edge treatments, durability and maintenance.

- **Marble:** Metamorphic stone formed millions of years ago due to the action of extreme heat and pressure. Marble is simply "changed" limestone that, due to the heat and pressure, has crystallized, melted and re-cooled. Coloring is extremely varied and often accompanied with lots of veining and other mineral deposits.
- **Granite:** Igneous stones formed millions of years ago under conditions of extreme heat. Hard and crystalline in nature, granite is most often seen polished.
- **Limestones:** Sedimentary stone formed millions of years ago due to the action of water and extreme pressure. Fossilized seashells and other sea life and treasures are often found in limestone. Primarily light beige and tan in coloring.
- **Travertines:** Sedimentary stone formed millions of years ago due to the action of water and heat. Water and gases percolating through the stone give travertine its characteristic holes.
- **Slates:** A metamorphic stone formed millions of years ago and derived from sedimentary rock. Slate is normally split (cleft) rather than cut with a

saw as other stones are. Coloring can vary widely and wildly. Typically, slate is not "finished", as the natural cleft surface is its focal point and source of interest and beauty.

- **Quartzites:** A rock formed from the metamorphism of quartz sandstone consisting essentially of quartz in interlocking grains.
- **Tumbled:** Stone finish achieved by putting the stones in a machine that “tumbles” the stones around together causing an uneven rough surface and edges. This finish has a rustic appeal.

Glass tiles can be either cast glass, layered or laminated glass, fused glass or cut glass- each with its own unique appearance and translucency.

- **Cast glass:** A solid product that consists of a hot liquid that is poured and then cooled. The color is either applied to the back of the tile, or within the glass itself.
- **Layered or Laminated glass:** A layered product that literally "sandwiches" different pieces of glass together. It is then heated, or fused together to create one unit.
- **Cut glass:** A large piece of glass cut into smaller pieces, similar to mosaics.
- **Fused glass:** Similar to layered glass, whereas different pieces are fused together to create one piece, however fused glass is more artistic and can utilize different shapes of glass to create one piece (for example a triangular piece fused to a square piece).

Metal tiles are referred to as anything that is solid metal, a metal laminate, a metallic glaze, a metal and resin composite or simply a tile that gives an illusion of metal with a lustrous finish.

Resin tiles consist of either stone or cement particles mixed with an epoxy or other chemical to increase durability and allow for limitless options in shape and texture.

Glazed tiles are coated with a liquid glass, which is then baked into the surface of the clay. The glaze provides an unlimited array of colors and designs as well as protects the tile from staining. The unglazed tiles are pretty much the same as the glazed tile, except that their surface is not coated. Full-body porcelain tiles do not show wear because their color extends throughout the tile, making them ideal for commercial applications.

A glazed tile is already stain proof, so there is no purpose to putting on a sealer. You may put a penetrating sealer on your unglazed tile or your grout joints. The penetrating sealer is an invisible, stain resistant shield that is absorbed into the surface. Some sealers enhance the appearance of unglazed tiles. A glazed tile is already stain proof, so there is no purpose to putting on a sealer. You may put a penetrating sealer on your unglazed tile or your grout joints. The penetrating sealer is an invisible, stain resistant shield that is absorbed into the surface. Some sealers enhance the appearance of unglazed tiles.

Many tiles have a glazed surface. **Glaze** is liquid glass that is sprayed or poured onto the surface of the tile. It is then fused to the body of the tile using tremendous heat during the firing process. Strength and wear resistance are determined by its hardness. The following factors will have an effect on the glaze hardness:

- **Temperature** – Higher temperatures result in harder glaze.
- **Color** – Dark glaze colors such as blacks and blues are usually softer than the lighter color glazes.
- **Gloss Level** – Shiny glazes are usually softer than matte or satin finished glazes.

What if your tile is not glazed? Since unglazed products do not have a glaze, they do not have a PEI rating, but can be installed anywhere - interior or exterior. However, unglazed tiles are more susceptible to staining and mold. It is not advised to install these products in wet areas, unless the tile will be maintained with a penetrating sealer on a regular basis.

The **shading** and **texture** of the product are other factors to consider. Do you want tiles with a smooth surface or a rough, textured surface? Do you want the tiles to all look the same, or have some or a lot of variation for a unique installation? Whatever the look you decide, keep in mind that **shade variation is inherent in all fired products.** Many tiles are deliberately produced with a wide shade variation in order to capture the natural beauty of the product.

Eco-Friendly tiles are generally man-made tiles that recycle or reuse materials from other tiles or industrial products with a nod to an environmentally-conscience manufacturing process.

Special features For Mosaic Tiles

1. Mosaic resists abrasion & will not dust up.

2. Highly decorative quality of mosaic flooring combined with a high resistance to wear and case of cleaning makes it specially suitable for use in entrance halls corridors and clock rooms and pillars of residential buildings and in the main rooms of offices, hospitals and schools if and when finds permit. Its use can be recommended wherever the noise of foot steps is not an objection.

3. It can be laid in a wide variety of colours. The cement being tinted with pigments to harmonize consist with the colour of the marble chips. To ensure these qualities the aggregate should be hard and the surface of the flooring close to required textured.

As regards sloppiness the mosaic tiles surface can be classified as only fire, slipperiness can be reduced to great extent by avoiding the use of any kind of wax polish. Special non slip surface may be obtained by adding into the mosaic tiles material such as silica which however reduces the shine or carborundum grit which may increase the cost considerable dust tends to accumulate in the joints unless they are nicely filled and polished. Usually dust is much less conspicuous on a jointed on a patterned surface than on plain one.

Marble slurry waste has been characterized in terms of physical, chemical, mineralogical and morphological properties. The bulk densities of marble slurry waste are in the range of 0.9 – 1.4 g/cc and the particle densities are in the range of 2.7 to 3.0. The particle size ranges from few microns to about 300 microns. Marble slurry waste is mainly dolomitic lime as seen from the

mineralogical phase analysis. However, it also contains silica as the major impurity with other elements in traces.

Based on the characteristics of marble slurry waste, it has been used as a raw material in the development of value added products such as bricks, decorative bricks, mosaic tiles, and polymer composite products.

Marble slurry waste has also been effectively used in the manufacture of mosaic tiles. The mosaic tile consists of two layers, wear layer and base layer. The wearing layer consists of marble slurry waste; mosaic chips and cement (white or gray). The base layer consists of marble slurry waste, sand or stone dust and grey cement. The tiles with various compositions were cast, cured and tested as per standard.

Characteristics of Mosaic Tiles

Sl.No.	Composition	Marble Waste content (%)	Transverse strength, kg/cm^2	Water Absorption (%)
1.	Top layer WC -1 MW-2 MC-1.75 Base layer OPC-1 MW-3.9	63	42	10.7
2.	Top layer WC -1 MW-1 MC-1.6 Base layer OPC-1 MW-3	56	36	12
3.	Top layer WC -1 MW-0.53 MC-2.12 Base layer OPC-1 MW-1.5 SD-1.5	34	68	5

4.	WC-1 MW-4 RO-0.1	74	41	12.5

Based on the characteristics of marble slurry waste, certain additional developments were also undertaken. Polymer composite products such as bath tub, kitchen sink, shower tray, wash basin and soap dish have also been developed, wherein upto 50% marble slurry powder has been used. These products are better in their performance characteristics as compared to the conventional ones, along with a cost saving of upto 30%.

Uses Application and Scope

Mosaic tiles are used for finishing of floor. These are generally used in entrance halls corridors and clock rooms of public and pillars of residential buildings and in the main rooms of offices, hospitals and schools. Due to the higher cost these are used at there places. Due to large numbers of special features described under the leading features. Its demand is quite high. Though the cost of these tiles course higher but this cost is compensated due to its long life. Tiles are very hard. So required no frequent replacement. Once they are laid down they do not need any maintenance for a long period. Demand of there tiles are large in the cities where the standard of living is high. These tiles serve good purpose that they give a far better finish and strength too to the floor.

Plant and Machinery cost in such an industry is not much. Return is about 35% Minimum optimum capacity is 5,000 tiles per day. For this capacity unit the plant and machinery cost is estimated to be Rs.1,60,000 Return is 40% . But this

return may vary according to market position and price fluctuation. The process and economics are based at this minimum optimum capacity.

2. BIS SPECIFICATION

IS: 9472 - 1980 Code of practice for laying of Mosaic parquet flooring.

Cement Mosaic Flooring Tiles

Quality and Standards: IS 1237- 1980

Classification

Cement concrete flooring tiles shall be of two classes as given below depending on the duty they perform:

(a) General Purpose tiles – Used for flooring in such places where normally light loads are taken up by the floors such as office buildings, schools, colleges, hospitals and residential buildings.

(b) Heavy duty floor tiles – Used for heavy traffic conditions; such as foot paths, entrances and staircases of public buildings, passages of auditoriums and storage godowns.

Materials

1. Cement – Cement used in the manufacture of tiles shall be ordinary Portland cement conforming to IS:269-1976+ or rapid hardening Portland cement conforming to IS 8041-1978* or white Portland cement conforming to IS:8042-1978 or Portland pozzolana cement conforming to IS:1489-1976.
2. Aggregates – Aggregates used in the backing layer of tiles shall conform to the requirements of IS:383-1970. for the wearing layer, unless

otherwise specified aggregates shall consist of marble chips or any other natural stone chips of similar characteristics and hardness, marble powder or dolomite powder, or a mixture of the two.

3. Pigments – Pigments, synthetic or otherwise, used for colouring tiles shall have durable colour. It shall not contain matters detrimental to concrete and shall according to the colour required to be onf the following or their combinations:

Pigments		Relevant Indian Standard
a) Black or red or brown pigments		IS : 44-1969
b) Green pigments		IS : 54-1975
c) Blue pigments		IS : 55-1970**
	or	IS : 56-1975
	or	IS : 3574 (Part II) – 1966
d) white pigments		I S : 411-1968
e) Yellow pigments		IS : 50-1979
	or	IS : 3574 (Part I) – 1965.

i. Colours other than mentioned above may also be used.

ii. The pigments shall not contain zinc compounds or organic dyes.

iii. Lead pigments shall not be used unless otherwise specified by the purchaser.

Manufacture

1 Cement concrete flooring tiles shall be manufactured form a mixture or cement, natural aggregates, and colouring material where required, by

pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 14 N/mm^2 (140 kg/mm^2)

2 The proportion of cement to aggregate in the backing of the tiles shall be not leaner than 1:3 by mass.

3 Where colouring material is used in the wearing layer, it shall not exceed 10 percent by mass of cement used in the mix.

4 On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that wou7ld ensure their conformity to the requirements of this standard. Tiles shall be stored under cover.

Dimensions

1 The size of cement concrete flooring shall be as follows:

Length	Breadth	Thickness
Mm	mm	mm
200	200	20
250	250	22
300	300	25

Note – the thickness shall be measured at two points situated approximately 50 mm from the ends on the fracture line of the tile that was tested for wet transverse strength according to 11.5. the total thickness is the arithmetic mean of these two measurements.

Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles in the floor shall have dimensions which shall be such as to make two half tiles when joined together, match with the dimensions of the one full tile.

General Quality

Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included)m, holes cavities and other blemishes. The edges of the wearing layer may be rounded.

Finish

The colour and texture of the wearing layer shall be uniform throughout its thickness. No appreciable difference in the appearance of the tiles, from the point of view of colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

Note 1 - When indenting for plain cement and plain coloured tiles, the purchaser should specify the colour by the code number of the appropriate or nearest matching colour given in IS:1650-1973*. It should be noted that due to the nature of the product, the range of colours for flooring tiles is limited and the tiles may not be produced to match all the colours specified in IS:1650-1973*. Purchases are recommended to consult the manufacturers while selecting the colours of tiles which they wish to procure.

Note 2 – Exact matching of the shade of the colour may not be always possible in actual manufacture. There may be some variations in colour in different batches due to variations in the basic colour of raw materials.

When indenting for terrazzo tile, the purchaser shall state the size of chips to be used in the wearing layer.

Note - It is recommended that the purchase should consult the design cards of the manufacturers while specifying the size of chips. It is hardly possible to cover the colour for terrazzo tiles in a comprehensive chart since numerous colour compositions are possible. The colour patterns will not only vary with the colour used but also with the sizes of chips and their distribution, and its choice is left to the mutual agreement between the purchaser and the supplier.

Physical Requirements

The tests on tile shall not be carried out earlier than 28 days from the date of manufacture.

1. **Flatness of the tile surface** – The tiles when tested according to the procedure laid down in Appendix A of the code IS 1237: 1980, the amount of concavity and convexity shall not exceed 1 mm.
2. **Perpendicularity** – When tested in accordance with the procedure laid down in Appendix B of the code IS 1237: 1980, the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.

3. **Straightnes**s – When tested according to the procedure given in Appendix C of the code IS 1237: 1980, the gap between the thread and the plane of the tile shall not exceed 1 percent of the length of the edge.

4. **Water absosrption** – when tested according to the procedure laid down in Appendix D of the code IS 1237: 1980, the average percentage of water absorption shall not exceed 10.

5. **Water transverse Strength** – When tested according to the procedure laid down in Appendix E of the code IS 1237: 1980, the average wet transfers strength shall not be less than 3 N/mm^2 (30 kg/cm^2).

6. **Resistance to Wear** – When tested in the manner specified in Appendix E of the code IS 1237: 1980, the wear shall not exceed the following value

a) For general purpose tiles

1) Average wear	3.5 mm
2) Wear on individual specimen	4 mm

b) For heavy duty floor tiles

1) Average wear	2 mm
2) Wear on individual specimen	2.5 mm

3. RAW MATERIAL

The Mosaic mix consists of graded marble chips and marble powder of various colours in required proportions and water. Marble powder whenever used should not be more in volume than the quantity of cement used. The marble

aggregated should be of crushed variety franular, free from fine dust and other impurities. The grading of marble chips used. Varies from 1"to 1/2". Pigment used should not exceed in quantity by 10% of the weight of cement. The formulation used in their discussion as under.

The simplest one -

Marble chips six 1/2" white - single part

Portland cement - Three parts.

Along with the above constituent some other additives are also mixed with the mixture in order to reduce the cost of production. The above aggregate are only for 1/2" size chips.

1. Marble chips size 1/6" (0.0625")

   Marble chips - Single part

   Portland cement - Two parts.

2. For marble chips size

   1/6" to 3/16" (0.0625 to 0.1875")

   Marble chips - Single part

   Portland cement - 25 part.

Pigments are used to provide the required colour to the cement. The quantitative requirement of the raw material is as follows on the basis of 5,000 tiles per day per shift.

Marble chips - 500 Kg

Portland Cement - 1,500 Kg

Other ingredients - According to requirements.

a. The composition described above are on volume basis.

b. For various colour of tiles different coloured pigments can be used according to requirements.

c. Coloured marble chips can also be used. All depends upon the design & market demand.

4. KEY FACTS OF PROJECT ANALYSIS

The Important facets of project analysis are :

- Market analysis
- Technical analysis
- Financial analysis
- Economic Analysis
- Ecological analysis

Market Analysis

Market analysis is concerned primarily with two questions:

- What would be the aggregate demand of the proposed product/service in the future?
- What would the market share of the project under appraisal?

To answer the above questions, the market analyst requires a wide variety of information and appropriate forecasting methods. The kinds of information required are :

- Consumption trends in the past and the present consumption level
- Past and present supply position
- Production possibilities and constraints
- Imports and exports
- Structure of competition
- Cost structure
- Elasticity of demand
- Consumer behaviour, intentions, motivations, attitudes, preferences, and requirements.
- Distribution channels and marketing policies in use
- Administrative, technical, and legal constraints.

Technical Analysis

Analysis of the technical and engineering aspects of a project needs to be done continually when a project is formulated. Technical analysis seeks to determine whether the pre-requisites for the successful commissioning of the project have been considered and reasonably good choices have been made with respect to location, size, process, etc. The important questions raised in technical analysis are:

- Whether the preliminary tests and studies have been done or provided for?
- Whether the availability of raw materials, power, and other inputs has been established?
- Whether the selected scale of operation is optimal?

- Whether the production process chosen is suitable?
- Whether the equipment and machines chosen are appropriate?
- Whether the auxiliary equipments and supplementary engineering works have been provided for?
- Whether provision has been made for the treatment of effluents?
- Whether the proposed layout of the site, buildings, and plant is sound?
- Whether work schedules have been realistically drawn up?
- Whether the technology proposed to be employed is appropriate from the social point of view?

Financial Analysis

Financial analysis seeks to ascertain whether the proposed project will be viable in the sense of being able to meet the burden of servicing debt and whether the proposed project will satisfy the return expectations of those who provide the capital. The aspects which have to be looked into while conducting financial analysis are :

- Investment outlay and cost of project
- Means of financing
- Cost of capital
- Projected profitability
- Break-even point
- Cash flows of the project
- Investment worthwhileness judged in terms of various criteria of merit
- Projected financial position
- Level of risk

Economic Analysis

Economic analysis, also referred to as social cost benefit analysis, is concerned with judging a project from the larger social point of view. In such an evaluation the focus is on the social costs and benefits of a project which may often be different from its monetary costs and benefits. The questions sought to be answered in social cost benefit analysis are:

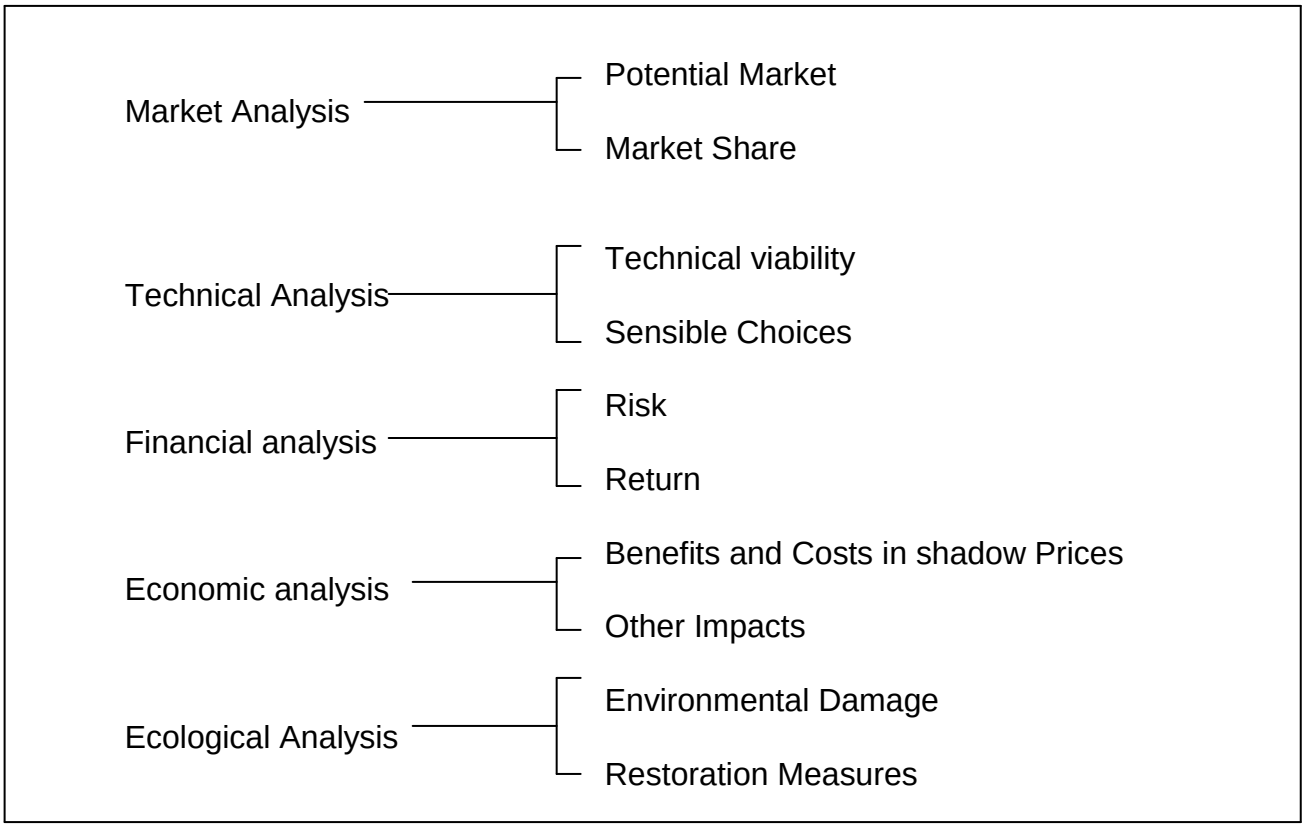
- What are the direct economic benefits and costs of the project measured in terms of shadow (efficiency) prices and not in terms of market prices?
- What would be the impact of the project on the distribution of income in the society?
- What would be the impact of the project on the level of savings and investment in the society?
- What would be the contribution of the project towards the fulfillment of certain merit wants like self-sufficiency, employment, and social order?

Ecological Analysis

In recent years, environmental concerns have assumed a great deal of significance – and rightly so. Ecological analysis should be done particularly for major projects which have significant ecological implications (like power plants and irrigation schemes) and environment-polluting industries (like bulk drugs, chemicals, and leather processing). The key questions raised in ecological analysis are :

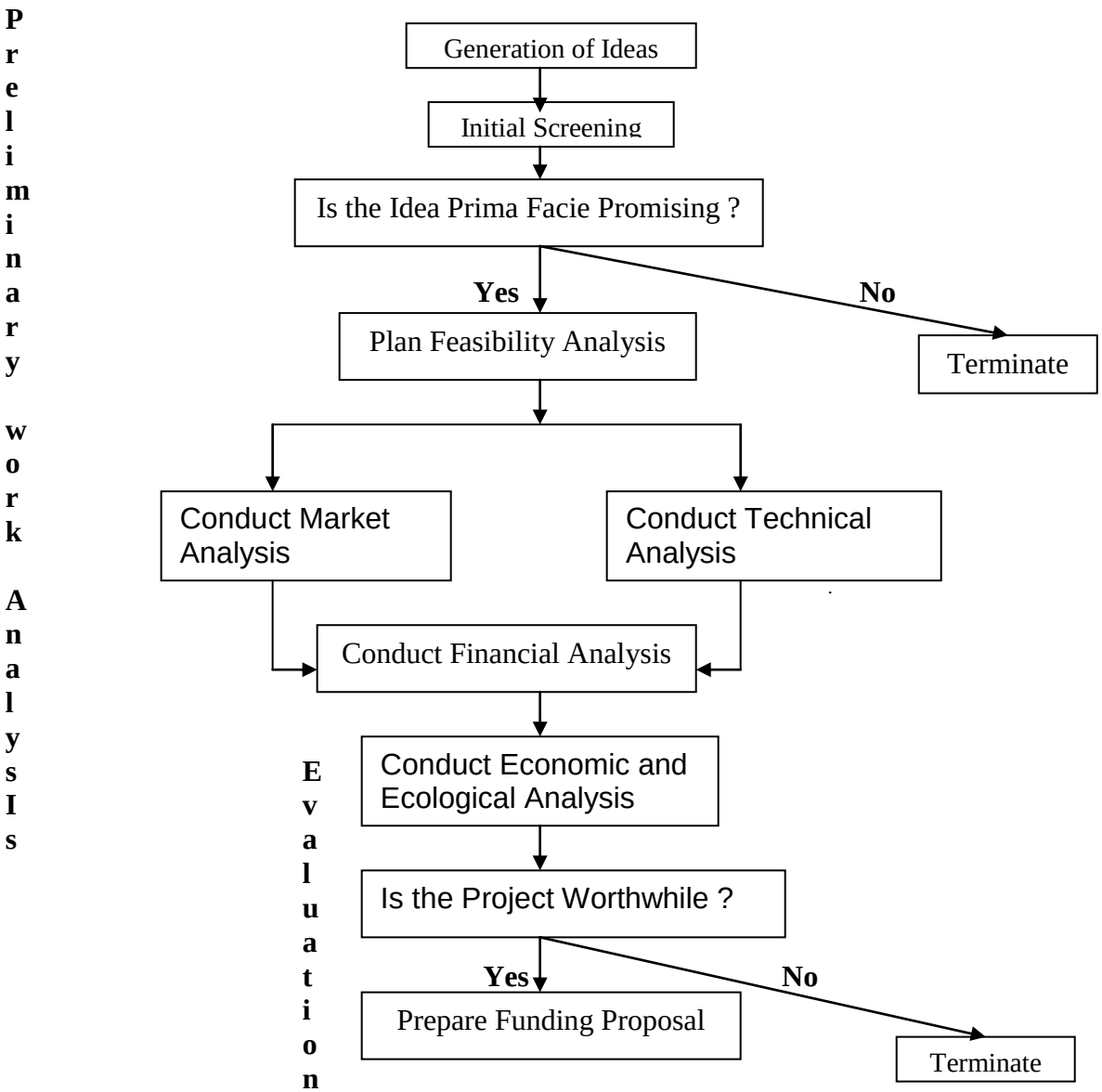
- What is the likely damage caused by the project to the environment?
- What is the cost of restoration measures required to ensure that the damage to the environment is contained within acceptable limits?

Key Issues in Project Analysis



FEASIBILITY STUDY: A SCHEMATIC DIAGRAM

We have looked at the six broad phases of capital budgeting and examined the key facets of project analysis. The feasibility study is concerned with the first four phases of capital budgeting, viz, planning, analysis, selection (evaluation), and financing, and involves market, technical, financial, economic, and ecological analysis. The schematic diagram of the feasibility study is shown in Exhibit.



Feasibility Study : A Schematic Diagram

5. OBJECTIVE OF CAPITAL BUDGETING

Finance theory rests on the premise that managers should manage their firm's resources with the objective of enhancing the firm's market value. This goal has been eloquently defended by distinguished finance scholars, economists, and practitioners. Here is a sampling of their views:

"In a market-based economy which recognizes the rights of private property, the only social responsibility of business is to create value and do so legally and with integrity. It is a profounder error to view increases in a company's value as a concern just for its shareholders. Enlightened managers and public officials recognize that increases in stock prices reflect improvement in competitiveness – an issue which affects everyone who has a stake in the company or economy"

"Should a firm maximize the welfare of employees, or customers, or creditors? These are bogus questions. The real question is: What should a firm do to maximize its contribution to the society? The contribution to the society is maximized by maximizing the value of the firm".

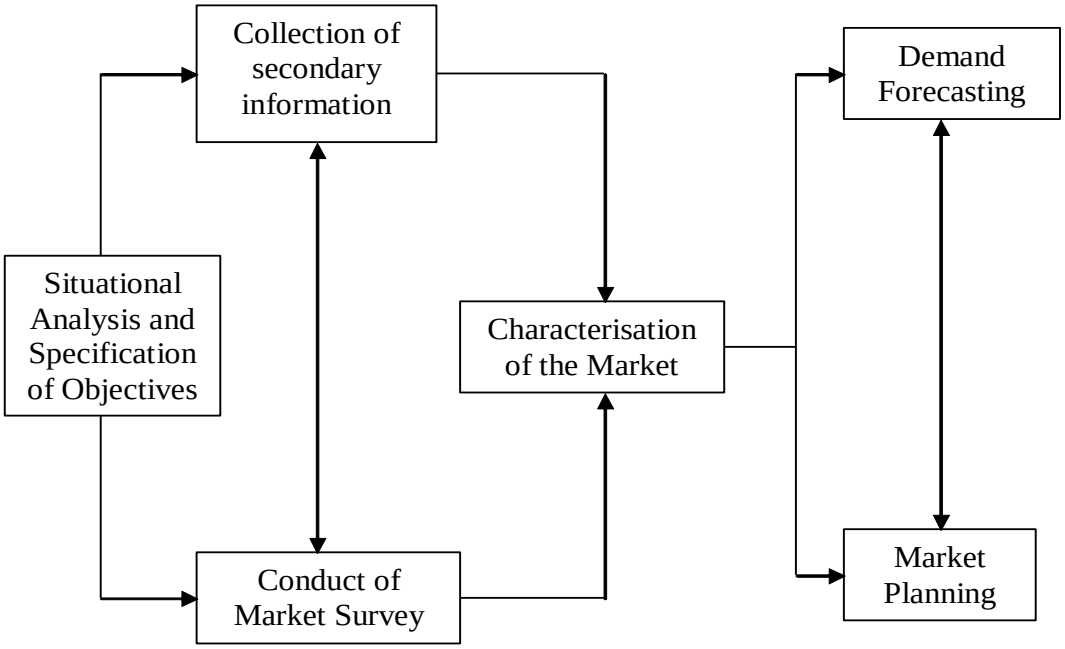
6. MARKET AND DEMAND ANALYSIS – AN IMPORTANT TOOL

In most cases, the first step in project analysis is to estimate the potential size of the market for the product proposed to be manufactured (or service planned to be offered) and get an idea about the market share that is likely to be captured. Put differently, market and demand analysis is concerned with two broad issues: What is the likely aggregate demand for the product/service? What share of the market will the proposed project enjoy?

These are very important, yet difficult, questions in project analysis. Intelligent and meaningful answers to them call for an in-depth study and assessment of various factors like patterns of consumption growth, income and price elasticity of demand, composition of market, nature of competition, availability of substitutes, reach of distribution channels, so on and so forth. Yet, sometimes project feasibility studies seem to make a short shrift of market and demand analysis. One finds cursory statements like “the market is attractive” or “the demand ids expected to exceed supply” as substitutes for a thorough market and demand analysis in project evaluation exercises.

Given the importance of market and demand analysis, it should be carried out in an orderly and systematic manner. The key steps involved in market and demand analysis are depicted in Exhibit & discusses these steps. It is organized into seven sections as follows:

Key steps in Market and Demand Analysis and their Inter-relationships



- Situational analysis and specification of objectives
- Collection of secondary information
- Conduct of market survey
- Characterisation of the market
- Demand forecasting
- Uncertainties in demand forecasting
- Market planning

7. SITUATIONAL ANALYSIS AND SPECIFICATION OF OBJECTIVES

In order to get a “feel” of the relationship between the product and its market, the project analyst may informally talk to customers, competitors, middlemen, and others in the industry. Wherever possible, he may look at the experience of the

company to learn about the preferences and purchasing power of customers, actions and strategies of competitors, and practices of the middlemen.

If such a situational analysis generates enough date to measure the market and get a reliable handle over projected demand and revenues, a formal study need not be carried out, particularly when cost and time considerations so suggest. In most cases, of course, a formal study of the market and demand is warranted. To carry out such a study, it is necessary to spell out its objectives clearly and comprehensively. Often this means that the intuitive and informal goals that guide situational analysis need to be expanded and articulated with greater clarity. A helpful approach to spell out objectives is to structure them in the form of questions. Of course, in doing so, always bear in mind how the information generated will be relevant in forecasting the overall market demand and in assessing the share of the market that the project will capture. This will ensure that questions not relevant to the market and demand analysis will not be asked unnecessarily.

To illustrate, suppose that a small but technologically competent firm has developed an improved tiles based on a new principle that appears to offer several advantages over the conventional tiles. The chief executive of the firm needs information about where and how to market the new tiles. The objectives of the market and demand analysis in this case may be to answer the following questions:

- Who are the buyers of tiles?
- What is the total current demand for tiles?

- How is the demand distributed temporally (pattern of sales over the year) and geographically?
- What is the break-up of demand for tiles of different sizes?
- What price will the customers be willing to pay for the improved tiles?
- How can potential customers be convinced about the superiority of the new tile?
- What price and warranty will ensure its acceptance?
- What channels of distribution are most suited for the tiles? What trade margins will induce distributors to carry it?
- What are the prospects of immediate sales?

8. COLLECTION OF SECONDARY INFORMATION

In order to answer the questions listed while delineating the objectives of the market study, information may be obtained from secondary and/or primary sources. Secondary information is information that has been gathered in some other context and is already available. Primary information, on the other hand, represents information that is collected for the first time to meet the specific purpose on hand. Secondary information provides the base and the starting point for the market and demand analysis. It indicates what is known and often provides leads and cues for gathering primary information 5equired for further analysis. This section looks at secondary information and the following at primary information.

General Sources of Secondary Information

The important sources of secondary information useful for market and demand analysis in India are mentioned below:

Census of India : A decennial publication of the government of India, it provides, inter alia information on population, demographic characteristics, household size and composition and maps.

National Sample Survey Reports : Issued from time to time by the Cabinet Secretariat,, government of India, these reports present information on various economic and social aspects like patterns of consumption, distribution of households by the size of consumer expenditure, distribution of industries, and characteristics of the economically active population. The information presented in these reports is obtained from a nationally representative sample by the Interview method.

Plan Reports: Issued by the Planning Commission usually at the beginning, middle and end of the five-year plans, these reports and documents provide a wealth of information on plan proposals, physical and financial targets, actual outlays, accomplishments, etc.

Statistical abstract of the Indian Union : An annual publication of the Central Statistical Organisation, it provides, interalia, demographic information, estimates of national income and agricultural and industrial statistics.

India Year Book: An annual publication of the Ministry of Information and Broadcasting,. It provides a wide range of information on economic and other aspects.

Statistical Year Book: An annual publication of the United Nations, it provides world statistics relating to various aspects like population, demography, gross domestic publication, industrial production, international trade, etc.

Economic survey : An annual publication of the Ministry of finance, it provides the latest data on industrial production, wholesale prices, consumer prices, exports, agricultural production, national income, etc.

Guidelines to industries: this is an annual publication of the Ministry of Industrial Development.

Annual Survey of Industries: An annual publication of the Central Statistical Organisation, it contains information on various aspects of industry: number of units and state-wise distribution, average number of working days, employment, materials consumption, quantity of products, etc.

Annual Reports of the development Wing, Ministry of commerce and Industry: An annual publication, it gives a detailed review of industries under the purview of the wing. It also provides information about new items manufactured for the first time in India and the list of protected industries.

Annual Bulletin of statistics of Exports and Imports: An annual publication of the Ministry of commerce, it provides data on imports and exports for a very large number of items and as per international classification.

Technico-Economic surveys : The National council of Applied Economic Research has conducted and published techno-economic surveys for various states.

Industry Potential surveys: The Industrial Development Bank of India in consortium with other financial institutions has conducted and published industrial potential surveys for several backward areas.

The Stock Exchange Directory: This directory, published by the Bombay Stock Exchange, provides a ten-year picture of performance and financial statements for all listed companies and other important companies. It contains very valuable information for comparative analysis. It is periodically updated.

Monthly Studies of Production of Selected Industries : A monthly publication of the Central Statistical Organisation, it provides all-India data on production, number of units installed, capacity, state-wise break-up, stock level, etc., for several selected industries.

Monthly Bulletin of reserve Bank of India : this provides information on production indices, prices, balance of payment position, exchange rates, etc.

Publications of Advertising Agencies: the leading advertising agencies like Clarion Mcann and Thompson have published test markets, marketing rating indices of towns of India, consumer index of markets, and other studies which throw valuable light on Indian markets.

Other publications: Among other publications, a mention may be made of the following: (i) Weekly bulletin on Industrial Licences, Import Licences and Export licences (published by the government of India; (ii) Studies of the State Trading Corporation; (iii) Commodity reports and other studies of the Indian Institute of Foreign Trade; (iv) Studies and reports of export promotion councils and commodity boards; and (v) Annual report on Currency and finance (issued by the Reserve Bank of India).

Industry specific sources of Secondary Information

The important industry-specific sources of secondary information are given in Exhibit

Evaluation of secondary Information

While secondary information is available economically and readily (provided the market analyst is able to locate it), its reliability, accuracy, and relevance for the purpose under consideration must be carefully examined. The market analyst should seek to now:

- Who gathered the information? What was the objective?
- When was the information gathered? When was it published?
- How representative was the period for which information was gathered?

- Have the terms in the study been carefully and unambiguously defined?
- What was the target population?
- How was the sample chosen?
- How representative was the sample?
- How satisfactory was the process of information gathering?
- What was the degree of sampling bias and non-response bias in the information gathered?
- What was the degree of misrepresentation by respondents?

9. CONDUCT OF MARKET SURVEY

Secondary information, though useful, often does not provide a comprehensive basis for market and demand analysis. It needs to be supplemented with primary information gathered through a market survey, specific to the project being appraised.

The market survey may be a census survey or a sample survey. In a census survey, the entire population is covered. (The word 'population' is used here in a particular sense. It refers to the totality of all units under consideration in a specific study. Examples: All industries using milling machines, all readers of the Economic times). Census surveys are employed principally for intermediate goods and investment goods when such goods are used by a small number of firms. In other cases a census survey is prohibitively costly and may also be infeasible.

Due to the above mentioned limitations of the census survey, the market survey, in practice, is typically a sample survey. In such a survey a sample of population

is contacted or observed and relevant information is gathered. On the basis of such information, inferences about the population may be drawn.

The information sought in a market survey may relate to one or more of the following

- Total demand and rate of growth of demand
- Demand in different segments of the market
- Income and price elasticities of demand
- Motives for buying
- Purchasing plans and intentions
- Satisfaction with existing products
- Unsatisfied needs
- Attitudes toward various products
- Distributive trade practices and preferences
- Socio-economic characteristics of buyers.

10. MARKET SURVEY FOR MOSAIC TILES

The ceramic industries of India play a vital role in the industrial growth which in turn contributes to the economy of the country. It can be considered a core industry as the progress of many industries is linked to the growth and development of this industry such as power generation transmission, production of glass, crockery, insulators, electronics, castings, white wares, refractories, abrasives, cement, sanitary wares and mosaic tiles etc. The main objective of this article is to analyze the present status of mosaic tiles industry in

terms of its capacity, production, foreign trade and to examine the scope for investment in this industry.

At present there are six units manufacturing mosaic tiles with a total installed capacity of 64,900 tons/P.A. Mosaic tiles from the essential part of the modern housing programme. Thus the ideal assessment demand of these tiles should be based on the building construction activity in the country. However in the absence of sufficient and relevant information on building construction activities in the country the indigenous demand for glazed tiles has to be assessed . On the basis of the past consumption pattern.

Company	Cap. Installed (Tons)	Profit/ Return	Current Sales	Ratio of Investment
Purshotam Pottery Works	8,000	10.76	10.92	0.91
Somany Pick-linton,Ltd.	21,600	15.91	20.16	1.42
Mumbai Potteries Ltd.,	10,911	Loss	14.42	0.98

SOURCE : Mumbai Stock Exchange directory.

11. PROCESS OF MANUFACTURE

Basic steps are as follows.

i. Mixing of aggregate

ii. Wetting

iii. Dressing

iv. Setting.

Assure mixing of all the ingredients properly completely dry & free from any dust & other foreign materials, sometimes marble clips are washed with water and dried. Mixed can be perfumed.

1. Manual process

2. Mechanical process.

Mechanical mixing is preferred . Due to the advantage of a proper and through mixing. Proportion for the mosaic mixture and thickness adopted for the finish vary with the grading of marble clips proposed to be used. The time consumed in this mixing is from 2 to 3 hours. After proper mixing the mix is made into a paste with water. The wet paste of mixture is then filled in the die according to the pre-estimated quantity. These dies are made of wild steel or cast iron. After filling the paste of the mixture into the die, it is pressed with the male die with help of hydraulic press.

Hydraulic press will avoid the fist stage finishing of tiles. Also it helps to keep the dimensions of the tiles exactly similar. After pressing in the dies these tiles are removed from the dies and left for one day for setting and hardening. After

setting and hardening the tiles are kept for about 7 days in water. This time is required to impart sufficient hardness to the tiles. Process of keeping the tiles in water is wholly manual and an important factor. After setting, the tiles are subjected to polishing step. In this step the set tiles are cured ground and polished. Surface of the tiles are cured ground and polished . Surface of the tiles is ground evenly with machine fitted with coarse grade first blocks (No. 24 to 60). water is used during grinding. After first grinding the surface is washed and cleaned with water.

Second grinding is then carried out with machine fitted with fine grade grit blocks (No.120 to 150) . Sometime curing also becomes necessary. It is due to pin holes remaining during pressing. In curing a thin layer of cement is applied on the surface and left for a complete full day for setting . After grinding, polishing is carried out.

Method of manufacture of coloured tiles is almost same. In the above aggregate the appearance is white spots on gray background. For other colours various pigments are used along with the other ingredients for various backgrounds. Pigment should be of good quality so that only the colour should be seen and tiles must smooth, shining and charming.

Important Features

Selection of materials and construction of walls and roofs is generally recognised the same but it can't be said for the floors. The director general of the cement and concrete association in annual report complaints about poor

performance of floor and floor topping (usually stemming from poor specification poor workmanship or both) continue the age of structural material which can be used successfully for floors is fairly limited and we believe that production will continue. However it doesn't mean that their will be no progress or improvements in the construction and finishing of floors as consideration efforts are being made to change and improve portland cement concrete, which is the main material used for structural floor slabs. This development is mainly towards the use of fiber evenly disposed throughout the concrete mix. In recent years because of the great increase in prices when used as reinforcement, unless it is continuous protected by impermeable highly alkali concrete. Considerable efforts have been made to find a satisfactory substitute to lack the tensile stress so far this has not met with any significant success. Many of the materials used for floor tiles are well known and are in common use.

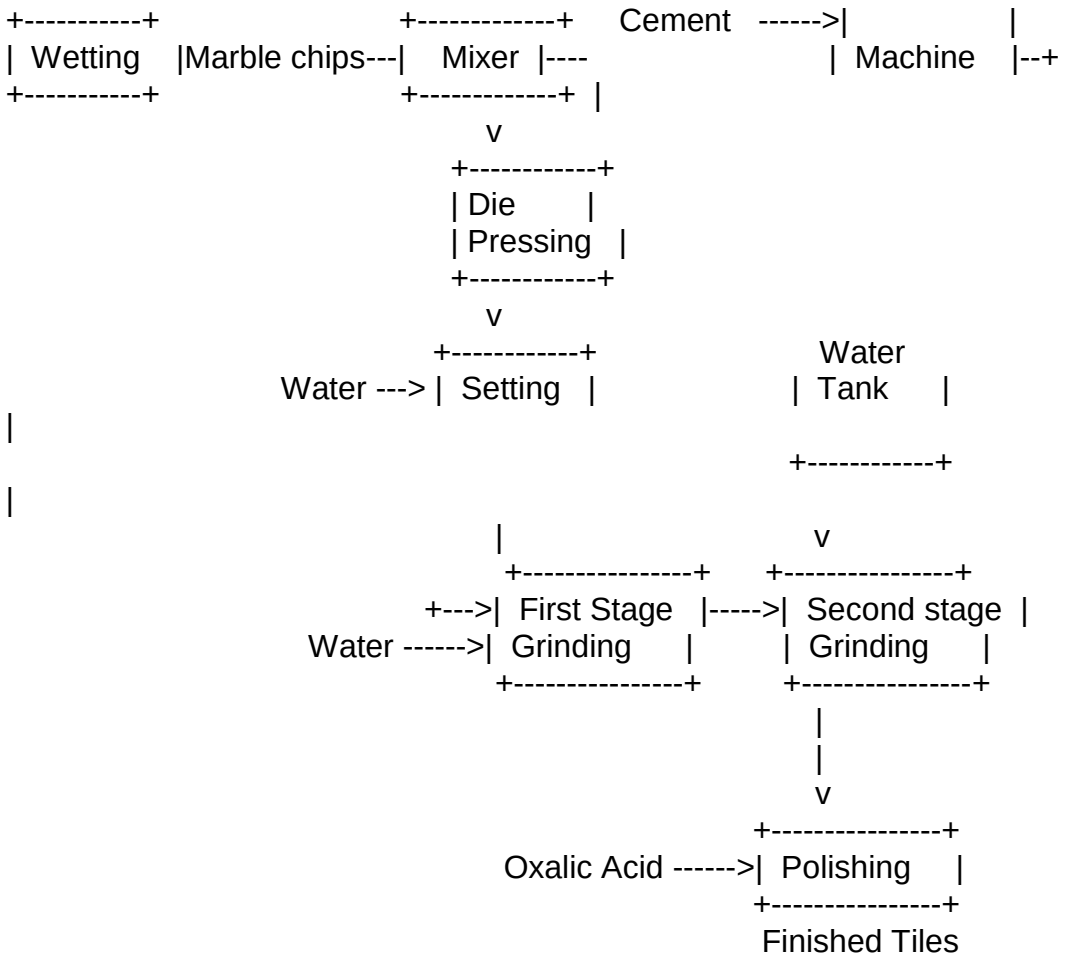
The more important clauses includes the following

1. The tiles must be made by a combinations of vibrations and hydraulic pressure.
2. After Pressing, the tiles have to be ground and grouted various degree of Polishing can be requested by the Purchaser.
3. After grinding the minimum thickness of the facing layer shall not be less than 1/4 in (6 mm) .The face layer to consist of good quality marble and Portland cement.
4. Any slight surface imperfection cases be made good by grouting with cement coloured to match the tiles.

5. On completion of face should be free from projections, depressions and crazing.
6. The base concrete should consists of Portland cement and aggregates which comply with B.S.882 aggregates from virtually sources for concrete.

The tiles vary in size from 150 mm x 150 mm (6" x 6") to 500 mm x 500 mm (20"x20") and in thickness from 16 mm (5/8 in) to 35 mm (13/8 in) the thickness of the actual terrazzo is about 10 mm (3/8 in) the remainder being a fine concrete.

FLOW DIAGRAM FOR MANUFACTURING OF MOSAIC TILES



12. PRECAST MOSAIC TILES FLOORING

The Tiles :

The pre-cast tiles usually contain a mosaic surface 1/2" to 3/16" thick with backing of cement concrete or mortar. They are available in sizes 8" to 12" square and in thickness varying from 3/8" to 1". The tiles are manufactured in factories by using the wet process described here and are always pressed with a hydraulic device. A tiled floor adopts itself easily to slight settlement of the foundation and back fill and any crack that develops imperceptibly localized at the points. Tiles can also be easily replaced for repairs. Three tiles may be delivered either surface finished or ready for in situ surface grinding

Lying :

The base is cleaned with water and mopped. The tiles are usually set on a mortar beiling of thickness varying from 1/4" to 3/4" for tiles of thickness 1"/1/2", yhr mortar bed may be up to 1" thickness. The bedding for the tiles shall be with the lime mortar in 1:1 proportion (1,lime putty : 2 course sand) mix. Cement mortar 1:6 may be used if lime mortar is not available. How ever, if cement mortar is used the tiles will have to be laid immediately after the bedding is spread and not postponed to the next day is done in the case of lime mortar.

When lime mortar is used for the bedding it is spread tapped and corrected to proper levels and allowed to harden till the mortar has become sufficiently hard to enable them to place wooden plank across and square on it. Before the tiles are set over this bedding near grey cement allure of heavy lime consistency is spread the rate of it. Cost of cement per 100 square feet over such a area would accommodate about twenty tiles. Lime is stretched to

guide the tiles layers. Tiles are washed clean and filled in this grout one after another each tile being gently tapped with wooden mallet till it is properly bedded and is in level with the adjoining tiles. The joints are kept as thin as possible (1/16") and in straight lines or to suit the required pattern. Where a full size tile can not be fixed these are cut (sawn) to the required size and their edges rubbed smooth to ensure a straight and turn joints. After tiles are laid, surplus cement grout that may have come up is cleaned off.

Curing, Grinding and Polishing

The day after tiles are laid all joints are cleaned of the grey cement grout with a wire brush or towel to a depth of 1/16 inches and all dust and loose morter removed and salaried - joints are then grouted with grey or white cement mixed with or without pigment to match to the shade of the matrix of the layer of the tiles. The same cement is applied to the entire surface of the tiles in a thin cost in order to protect the surface form abrasive damage and fill the pin holes that may exist on the surface.

The floor is then kept wet for at least 7 days after which the surface is ground evenly with machine fitted with course grade grid blocks. Water is used profusely during grinding. This grinding is done to match the level of the laid tiles. Generally this grinding is done to match the level of the laid tiles as grid blocks (No. 24 to 60). When all the surface known as coarse ground grinding is them carried out with machine fitted with the fine grade glide blocks (No. 120 to 150) again after complete grinding the surface is cleaned with water.

Final grinding is performed with the grinding machine fitted with finest grade grit block (NO. 220 to 350) . This grinding is carried out the day after the second grinding.

Normally the first and second grinding are done in the factory by the manufacturer, so only find grinding is required for polishing the tiles at site. After the final polish, oxalic acid is dusted over the surface at the rate of 2/3 1bs. per 100 square feet sprinkled with water and rubbed hard with a pad of woolen rag. The rubbing is done by hands. After this final rubbing the entire floor is washed with water and cleaned. Oxalic acid treatment gives a shine to the tiles. It can be because after a certain period of use they get automatically natural shining. To ensure the perfect laying of tiles. Inspection is done at various stages. These are listed below ;

1. Suitable of aggregated.
2. Correct proportioning of materials.
3. Mixing.

4 Suitable size of bat.

5 Correct level of dividing strips.

6 Correct consolidation.

7 Proper curing.

Location Conditions

There is no major factor which effects very much in selecting the site. But some minor factors are always there wish govern the cost of production to the lower side.

Raw Material Supply

The raw materials for the mosaic tiles are cement and marble chips. Both are abundantly available in all portion of India. Quote can also be arranged from the Government for regular supply of cement. Since cement some times is in short supply.

Transportation Facilities

There is not difficulty in getting the raw material at site. But the transportation of the finished tiles is very considerable. If the market of the tiles is at a distance then the cost of transportation will be on higher side and then the cost of transportation will be on higher side and thus the cost of product shall increase. In order to overcome this, the site selected should be at nearest distance from the market. This transportation is usually done by roads.

Labour :

This is the factor which should be considered carefully. The whole mosaic tiles plant depends upon the availability of labour in the plant in order to avoid any labour shortage.

Water Supply :

The industrial water required for the industry is substantial. So it should be ensured that the water supply is continuous. Some reservoir can also be made. By considering all these factors the site selected should be near to big cities. Since most at the consumers of these mosaic tiles are in the cities . The recommended places are undeveloped areas, Kanpur, Chandigarh, Lucknow

etc. More places can also be selected according to the manufactures circumstances and the limitations.

13. PLANT ECONOMICS

Rated Plant capacity = 5000.00 NOS/day
= 1500000.00 NOS/annum

MOSAIC TILES

Basis

No. of working days = 25 days/month
= 300 days/annum

No. of shifts = 1 per day

One shift = 8 hours

.

LAND & BUILDING

1. Land Required 2000 sq.mt
   @ Rs. 2200/-per sq.mt Rs. 44,00,000.00

2. Covered Area 800 sq.mt.
   @ Rs. 4500/-per sq.mt Rs. 36,00,000.00

TOTAL Rs. 80,00,000.00

PLANT & MACHINERY

1. Dry Mixture heavy duty complete with all equipments	Rs.	50,000.00
2. Wetting M/c. complete with all accessories & equipments	Rs.	40,000.00
3. Hydraulic press 10 ton complete with all accessories & equipments	Rs.	60,000.00
4. Male and female Dyes & Maids	Rs.	30,000.00
5. Grinding M/c. complete with all accessories & Equipments	Rs.	80,000.00
6. Misc. Tools & Equipments	Rs.	60,000.00
TOTAL	**Rs.**	**3,20,000.00**

OTHER FIXED ASSETS

1. Office equipment, furniture plus other equipment & accessories	Rs.	40,000.00
2. Installation and Electrification	Rs.	32,000.00
3. Preliminary & Preoperative Expenses	Rs.	10,000.00
TOTAL	**Rs.**	**82,000.00**

FIXED CAPITAL

1. LAND & BUILDING	Rs.	80,00,000.00
2. PLANT & MACHINERY	Rs.	3,20,000.00
3. OTHER FIXED ASSETS	Rs.	82,000.00

	TOTAL	**Rs.**	**84,02,000.00**

WORKING CAPITAL REQUIREMENT/MONTH

RAW MATERIALS

1. Cement 37.5 ton @ Rs. 5000/-per ton		Rs.	1,87,500.00
2. Marbles chips 12.5 ton @ Rs. 2500/-per ton		Rs.	31,250.00
3. Ingredients - different types of aggregates		Rs.	15,000.00
4. Miscellaneous colours & pigments		Rs.	12,000.00
	TOTAL	**Rs.**	**2,45,750.00**

SALARY & WAGES / MONTH

1. Production Manager/Tile Tec	1 No.	Rs.	15,000.00
2. Civil Engineer	1 No.	Rs.	10,000.00
3. Supervisor	2 No.	Rs.	17,000.00
4. Foreman	1 No.	Rs.	7,500.00
5. Skilled workers	10 No.	Rs.	60,000.00
6. Unskilled workers	20 No.	Rs.	1,00,000.00
7. Typist/Clerk	1 No.	Rs.	5,500.00
8. Peon/Watchman	2 No.	Rs.	8,000.00
	TOTAL	**Rs.**	**2,23,000.00**
Plus perks @ 33% p.a.		Rs.	73,590.00
	TOTAL	**Rs.**	**2,96,590.00**

UTILITIES AND OVERHEADS

1. Power Consumption of 5000 Kwatt hrs @ Rs. 4.75 per Kwatt hr.	Rs.	23,750.00
2. Water Consumption of 500 KLs @ Rs. 3.00 per KL	Rs.	1,500.00
TOTAL	**Rs.**	**25,250.00**

Total load is 28 Kwatts

TOTAL WORKING CAPITAL/MONTH

1. RAW MATERIAL	Rs.	2,45,750.00
2. SALARY & WAGES	Rs.	2,96,590.00
3. UTILITIES & OVERHEADS	Rs.	25,250.00
TOTAL	**Rs.**	**5,67,590.00**

1. WORKING CAPITAL FOR 1 MONTHS	Rs.	5,67,590.00
2. MARGIN MONEY FOR W/C LOAN	Rs.	1,41,897.50

COST OF PROJECT

TOTAL FIXED CAPITAL	Rs.	84,02,000.00
MARGIN MONEY	Rs.	1,41,897.50
TOTAL	**Rs.**	**85,43,897.50**

TOTAL CAPITAL INVESTMENT

TOTAL FIXED CAPITAL	Rs. 84,02,000.00
TOTAL WORKING CAPITAL FOR 1 MONTHS	Rs. 5,67,590.00
TOTAL	**Rs. 89,69,590.00**

COST OF PRODUCTION/ANNUM

1. Working Capital for 1 year	Rs. 68,11,080.00
2. Interest @ 13.50% on T.C.I	Rs. 12,10,894.65
3. Depreciation @ 10.00% on buildings	Rs. 3,60,000.00
4. Depreciation @ 20.00% on Plant and Machinery	Rs. 64,000.00
5. Depreciation @ 20.00% on office equipment & furniture	Rs. 8,000.00
TOTAL	**Rs. 84,53,974.65**

TURN OVER/ANNUM

1. By sale of 15,00,000 tiles p.a. @ Rs. 7/-per tiles	Rs. 1,05,00,000.00
TOTAL	**Rs. 1,05,00,000.00**

PROFIT = RECEIPTS - COST OF PRODUCTION

= 1,05,00,000.00 - 84,53,974.65

= 20,46,025.35

PROFIT SALES RATIO = Profit / Sales x 100

$$= \frac{20,46,025.35}{1,05,00,000.00} \times 100$$

= 19.49 %

RATE OF RETURN = Operating profit / T.C.I x 100

$$= \frac{20,46,025.35}{89,69,590.00} \times 100$$

= 22.81 %

BREAK EVEN POINT (B.E.P)

Fixed Costs of the plant are as under -

1. Interests		Rs. 12,10,894.65
2. Depreciation		Rs. 4,32,000.00
3. 40.00% of salaries		Rs. 14,23,632.00
4. 40.00% of overheads		Rs. 1,21,200.00
	TOTAL	**Rs. 31,87,726.65**

$$B.E.P. = \frac{\text{FIXED COSTS}}{\text{FIXED COSTS + PROFIT}} \times 100$$

$$= \frac{31,87,726.65}{31,87,726.65 + 20,46,025.35} \times 100$$

= 60.91 %

LAND MAN RATIO = Total land / Manpower

2000 : 38 :: 53 : 1

RESOURCES FOR FINANCE

1. Term loans from Financial institutions (80.00 % of fixed capital) at @13.50% p.a rate of interest	Rs.	67,21,600.00
2. Bank loans for 3 months (75.00 % of working capital) at @ 13.50% p.a rate of interest	Rs.	4,25,692.50
3. Self raised capital from even funds & loans from close ones to meet the margin money needs at a @ 13.50% p.a rate of interest	Rs.	18,22,297.50
TOTAL	**Rs.**	**89,69,590.00**

1. 14. MOSAIC TILE CALCULATOR

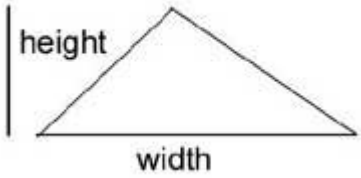
1.1.1 How much tile do you need? You'll know in just 4 quick steps . . .

1. Measure Your Surface

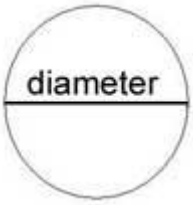
Measure the dimensions of the surface you would like to mosaic and calculate the area using the formulas from elementary school:

RECTANGLE AREA = length x width

TRIANGLE AREA = 1/2 x width x height



CIRCLE AREA = 0.785 x diameter x diameter



Keep in mind that 1 ft^2 is 144 in^2. If you get your answer in square inches, just divide by 144 to get the answer in square feet. We have help with the formulas at the bottom of the page if you need it.

2. Look Up An Estimate

Now look up an estimate of the number of mosaic tiles you need based on square footage. These estimates assume a grout spacing of 1/16" between the tiles. Remember that 1 ft^2 is 144 in^2. The first three columns refer to mosaic marble stone of different types. The forth column refers to 3/4" glass mosaic tile.

	number 3/8" stones	number 9/16" stones	number 3/8" tiles	number 3/4" tile	sheets iridescent tile
1 ft^2	752	369	752	218	10
2 ft^2	1505	737	1505	436	20
3 ft^2	2257	1106	2257	654	31
4 ft^2	3009	1475	3009	873	41
5 ft^2	3762	1843	3762	1091	51
6 ft^2	4514	2212	4514	1309	61

7 ft^2	5266	2580	5266	1527	72
8 ft^2	6019	2949	6019	1745	82
9 ft^2	6771	3318	6771	1963	92
10 ft^2	7523	3686	7523	2181	102

3. Are You Cutting the Tiles?

Cutting a mosaic tile in pieces theoretically decreases the amount of tile you need. How is this so? You will have more pieces, so there will be more grout lines in the mosaic. More grout lines means more grout and less mosaic tile. The effect can be significant. For example, it requires 218 of the 3/4" glass mosaic tiles to cover 1 square foot with a grout spacing of about 1/16 inch, but if you cut the tiles into pieces, you might only need 200 tiles. *On the other hand, people who cut tile probably should budget a little extra as waste.* That's why we use 218 per square foot as a rule of thumb for 3/4" mosaic tile.

4. Consider the Spacing Between Tiles

Tile coverage is determined as much by the grout spacing between the tiles as it is by the area you are covering. All of the calculations in our tables assume a grout spacing of 1/16" between the mosaic tiles. This spacing is common with stone, ceramic and glass mosaic tile because it ensures enough grout will penetrate between the tiles and seal over the adhesive underneath. It also provides enough gap between the tiles to ensure that the tiles are visually distinct at a distance so that the mosaic does not look like one big piece. For advice about choosing a grout color, see our page of Mosaic Instructions.

Note that 3/4" glass mosaic tile sometimes comes face-mounted on paper so that the installer can glue the whole sheet to a wall and then peel the paper off

the face of the tile and then grout. These sheets are made according to metric standards, so that the grout spacing is slightly larger than 1/16". Typically there are 225 tiles mounted on a sheet that is 1.15 square feet. Our metallic glass mosaic tiles and swirled glass mosaic tiles are cut from such sheets. Most artists remove the tiles from the sheets before using, so this doesn't matter.

Help With The Formulas

RECTANGLE AREA = length x width

length inch	**width inch**	**area ft^2**
12	12	**1**
12	24	**2**
24	24	**4**
24	48	**8**
48	48	**16**

TRIANGLE AREA = 1/2 x width x height

length inch	**width inch**	**area ft^2**
12	12	**0.5**
12	24	**1**
24	24	**2**
24	48	**4**
48	48	**8**

CIRCLE AREA = 0.785 x diameter x diameter

diameter inch	**area ft^2**

12	**0.8**
18	**1.8**
24	**3.1**
30	**4.9**
36	**7.1**
48	**12.6**

15. UTILIZATION OF MARBLE WASTE IN TILES

Rajasthan alone produces 95% of the total marble produce of the country. Marble reserves in India are estimated at twelve hundred million tones with Rajasthan accounting for ninety one percent of the reserves i.e. eleven hundred million tones. Nearly seventy percent of this precious mineral resource gets wasted due to non-upgradation of technology in mining, processing and polishing. The processing waste being dumped on the riverbeds is threatening the porosity of aquifer zones. According to estimation there are 1100 gangsaws operating in Rajasthan. In gangsaws about 30% weight of marble blocks are converted into powder and it is about 1.5 million tones per annum. Requirement of water in the processing plants is about 2,75,0000 liters per hour. Thus a "FILTER PRESS" is a key component in the Eco-Friendly technology for marble processing. The amount of water saved can be reused in further processing leading to arresting environmental degradation around the processing plant.

Table: Marble Waste in Rajasthan ('000 tones)

Year	*Marble Production*	*Mine Waste*	*Processing Waste*	*Polishing Waste*	*Total Waste*	*Mined out Reserves*
1988-89	***1093.60***	***1822.67***	***546.80***	***182.27***	***2551.73***	***3645.33***
1989-90	***1140.59***	***1900.98***	***570.30***	***190.10***	***2661.38***	***3801.97***
1990-91	***1442.72***	***2404.53***	***721.36***	***240.45***	***3366.35***	***4809.07***
1991-92	***1739.65***	***2899.42***	***869.83***	***289.94***	***4059.18***	***5898.83***
1992-93	***2050.26***	***3417.10***	***1025.13***	***341.71***	***4783.94***	***6834.20***
1993-94	***1875.40***	***3125.67***	***937.70***	***312.57***	***4375.93***	***6251.33***
1994-95	***2324.24***	***3873.73***	***1162.12***	***387.37***	***7423.23***	***7747.47***
1995-96	***3034.76***	***5041.27***	***1512.38***	***504.13***	***7057.77***	***10082.53***
1996-97	***3326.41***	***5544.02***	***1663.21***	***554.40***	***7761.62***	***11088.03***
1997-98	***3441.00***	***5735.00***	***1720.50***	***573.50***	***8029.00***	***11470.00***
1998-99	***3850.09***	***5900.00***	***1923.50***	***613.13***	***8334.00***	***11780.00***
1999-2000	***3650.00***	***5795.00***	***1805.40***	***595.00***	***8125.00***	***11590.00***
Quantity %	*30%*	*50%*	*15%*	*05%*	*70%*	*100%*

QUARRYING OF MARBLE:

Table: Marble Production in Rajasthan ('000 tones)

Year	*Marble*	*Serpentine (Green Marble)*	*Total*
1992-93	***2056.26***	***82.20***	***2138.46***
1993-94	***1875.40***	***106.70***	***1982.17***
1994-95	***2324.24***	***171.91***	***2482.17***
1995-96	***2840.00***	***183.96***	***2496.15***
1996-97	***2912.58***	***201.16***	***3023.96***
1997-98	***3239.86***	***201.40***	***3113.26***
1998-99	***3284.19***	***289.456***	***3573.652***
1999-2000	***3185.10***	***275.345***	***3460.445***

It has been observed from the waste production scenario that mechanization lead to reduction in the waste as such following measures may substantially reduce the waste generation.

- Increase mechanization of the quarries.
- Systematic and scientific investigation of the quarry lease through core drilling, ultrasound scanning before quarrying the face of mine.
- Training of staff in waste reduction measures.
- Production of block at quarry site, suitable to gangsaw plant.

Quarrying Waste disposal Practices:

- The waste generated during the quarrying operations is mainly in form of rock fragments.

- The khandas generated by the quarries are usually dump in empty pits in the near by area thereby creating huge mounts of waste.
- The waste and overburden is dumped on roads, riverbeds, pasturelands and agriculture fields leading to wide spread environmental degradation.
- The quarry operators express their inability in proper segregated and disposal of waste due to the small sizes of the quarry. Most of the quarries in the Rajsamand are of one hectare size or less.

Processing of Marble:

Marble blocks are brought from mines to processing units. The blocks are dressed if required and fixed on equipment called gangsaw. This equipment has gang of many saws numbering from 62 to 72 and hence it is called a gangsaw. Each saw is brazed with number of segments called diamonds segments. These segments act as teeth and cut block into required thickness. The normal thickness is 18mm. This thickness of segment is approx. 5mm while saw thickness is 3 mm. The saw when moves, it cuts stone. In this process heat is also generated alongwith generation of dust. The water required per plate is 10 to 12 liters per minute and therefore, a gangsaw requires about 43000 liters water per hour.

Damage due to Unscientific Disposal of Slurry Waste:

The marble slurry generated during the processing of marble causes the following environmental damage:

- The porosity and permeability for the topsoil is reduced tremendously and in due course of time it results in water logging problems at the surface and thereby are not allowing the water to percolate down. When and where it has happened the ground water level has adversely been affected and it has gone down to deeper levels.
- The fine marble dust reduces the fertility of the soil by increasing its alkalinity.
- The waste thus dumped dries out and the fine marble dust suspends in the air and is slowly sprayed out through wind to the nearby area. It settles down on crops and vegetation, thus severely threatening the ecology of the marble clusters.

When dumped along the catchment area of natural rainwater, it results in contamination of overgrown water reservoirs and also causes drainage problem.

The Main Problems Identified In Respect of Marble Industry Are:

- *Addressing major environmental hazards as the waste generated at marble quarries, marble processing plants create adverse impact on environment.*

- *There is low value addition in marble block/ marble waste generated during mining and cutting.*

- *There are number of players who are not totally organised and look for quick above average profits rather than becoming proactive to environmental issue.*

- In spite of high potential, persons involved in trade of Marble artifacts are not getting benefits in commensurate with the efforts put-in by them. They have common grievances, yet they have not, come together and address their problems in a unified manner. It may be noted here that due to already trimmer market and limited buyers, who come to these places, all of them are witnessing stiff competition with each other.

- *Further a new set of entrepreneurs / artisans for converting waste to value added products need to be developed by extensive research for utilizing the benefits and skills involved in manufacturing value - added products.*

A) **Waste Management**:

The filter press is a major step in conserving not only the ecology and environment but more significantly conserving the most precious natural resource “WATER”. The use of filter press has decreased the water content in the marble slurry from alarming 80% to a reasonable 20%. This has also resulted in simplifying the task of managing marble slurry due to the solid content in the slurry being raised to 80% from the previous 20%. This resulted in substantial conservation of water and also reduced the disposable

quantity of marble slurry in the form of cake thereby avoiding spillage on the road. Installation of first fully commercial indigenous Filter Press in the works of Arihant Tiles & Marbles Pvt. Ltd., Amberi, Udaipur. In addition, four more Filter Press have been placed and installed at the works of: -

- M/s Shubh Sangemaramar Pvt. Ltd.
- M/s Amarjothi Granites Pvt. Ltd.

And the remaining two are at Rajsamand;

- M/s Shyam Marbles Pvt. Ltd.
- M/s Thakur Marbles Pvt. Ltd.

As in case of Mining waste, several training programs has been organised for the development of Artisans manufacturing marble artifacts. The stone-carving tradition in India is one of the richest in the world. Guilds of masons and stone carvers have existed here since the seventh century BC. The skills were handed down as family lore from father to son, a practice prevalent in some parts of the country even today.

Building micro enterprises amongst existing artisans by way of persuading them to avail benefits under the schemes of NABARD/TIFAC and also by persuading them to adopt cluster approach for production/marketing of artifacts. Approach is that there is no elimination of human input/ amalgamation of human / machinery input/ preserve and develop traditional art. This will help in achieving batch production of high quality artifacts that will lead to improved realization of the value of the products made.

1. As per the report of the CRRI marble slurry can be successfully used in: -

- Construction of road pavement layers upto 25 - 35%
- Construction of embankments
- Back fill material for retaining walls
- In mass concrete work as a replacement of fine aggregate i.e. sand upto 40%

2. As per the report of CBRI on the use of marble dust in brick making asserts that: -

- Strength of bricks made of marble slurry is more than clay bricks
- Marble bricks are more durable in natural environment conditions.

3. Research work has been carried out by HASETRI, (J. K. Industries, Kankroli) and as per their report, marble slurry powder can be partially used as inert filler in rubber and plastic industry.

Pilot Scale Operations:-

Encouraged by the research findings, UCCI under took pilot scale manufacturing operations for reduction of various building / construction material using marble slurry powder like:-

- Brick / block making
- Tree Guards
- Arch Foundations
- Twin Pit Pour Flush Latrines
- Pavement Blocks
- Compressed Blocks
- Roofing tiles

- Roofing Channels
- Wall Panels
- Road Pavement Tiles
- Floor Tiles

These Pilot Scale operations were conducted at the facilities of Development Alternatives New Delhi and Susanji Udyog Pvt. LTD, Hyderabad. The articles so produced were properly tested and the results are very promising and conforming to relevant Indian Standards specifications.

Collector Rajsamand & Director, DPIP - District Poverty Initiative Project has principally agreed for installing three marble slurry based building material production units in the Rajsamand district and a project proposal for making a 750 Mt. Demonstration test stretch of road using marble slurry was also got sanctioned.

Since With reference to the above facts and figures, now the endeavor should be to promote interested entrepreneurs in setting up units of marble slurry based building and construction material.

16. TILES FROM MARBLE SLURRY WASTE

The Rajsamand district of Rajasthan is renowned for marble deposits. There are about 1800 marble mines, about 200 gang saws cutting units and about 2000 small cutting units. Marble slurry waste is generated as a byproduct to the tune of nearly 2.0 lakh tonnes per year. These marble processing units are dumping marble slurry in nearby pits or vacant areas, leading to serious

environmental concern. The utilization rate of marble slurry powder in this region is very dismal. For gainful utilization of marble slurry waste, the studies on the characterization and development of value added products was undertaken sponsored by the Department of Scientific & Industrial Research, New Delhi.

Marble Slurry Waste Characteristics

Marble slurry waste has been characterized in terms of physical, chemical, mineralogical and morphological properties. The bulk densities of marble slurry waste are in the range of 0.9 – 1.4 g/cc and the particle densities are in the range of 2.7 to 3.0. The particle size ranges from few microns to about 300 microns. Marble slurry waste is mainly dolomitic lime as seen from the mineralogical phase analysis. However, it also contains silica as the major impurity with other elements in traces.

Based on the characteristics of marble slurry waste, it has been used as a raw material in the development of value added products such as bricks, decorative bricks, mosaic tiles, and polymer composite products.

Properties of Marble Slurry Powder

1.1.1.1 Characteristic Property		Characteristic	% Weight
Form	Fine powder	SiO_2	15-30
Colour	Off white	Al_2O_3	1-2
Shape	Angular	Fe_2O_3	2-5
Particle Size (μm)	<45 -300	CaO	20-40

Particle Density (g/cc)	2.70 – 3.00	Na_2O	0.2-0.5
Bulk Density (g/cc)	0.9 – 1.4	K_2O	0.1-0.3
Loss on Ignition	23-35%	MgO	20-30
		TiO_2	0.05-0.2
		SO_3	0.3-1.4
Moisture (%)	<5	P_2O_5	0.1-0.3
Mineralogy	Dolomitic lime, Silica		

Value added products from Marble Slurry Powder

The clays used for the manufacture of bricks are a blend of different minerals of various sizes. They are finely divided, platy, crystalline hydrated alumino-silicates. These clays become cohesive and plastic with the addition of water and can be moulded into bricks, which when dried retain definite shape with sufficient strength.

Marble slurry waste has been effectively used for the manufacture of a variety of bricks with cement, hydrated lime and gypsum as binder with the inclusion of sand or stone dust. The bricks were either water or steam cured to achieve the desired strength and water absorption properties. Marble chips have also been used in the mix composition to produce decorative bricks.

Characteristics of Marble Slurry Waste based Bricks, Decorative Bricks.

Sl.No.	Composition (%)	Compressive Strength kg/cm^2			
		7 days WC	14 days WC	21 days WC	12 hrs SC
1.	**Bricks** Marble waste – 40 Sand – 40				

	Hydrated Lime – 15 Gypsum - 05	55	61	71	59
2.	Marble waste – 50 Sand – 30 Hydrated Lime – 15 Gypsum - 05	70	72	80	85
3.	**Decorative Bricks** Marble Waste – 40 Stone dust – 20 Mosaic Chips 30 White Cement-10	Compressive Strength kg/cm^2, 21 days 58			
4.	Marble Waste – 30 Mosaic Chips 60 White Cement-10	87			
5.	Marble Waste – 30 Mosaic Chips 60 OPC-10	46			

Marble slurry waste has also been effectively used in the manufacture of mosaic tiles. The mosaic tile consists of two layers, wear layer and base layer. The wearing layer consists of marble slurry waste; mosaic chips and cement (white or gray). The base layer consists of marble slurry waste, sand or stone dust and grey cement. The tiles with various compositions were cast, cured and tested as per standard.

CHARACTERISTICS OF MOSAIC TILES

Sl.No.	Composition	Marble Waste content (%)	Transverse strength, kg/cm^2	Water Absorption (%)
1.	Top layer WC -1 MW-2 MC-1.75 Base layer OPC-1	63	42	10.7

	MW-3.9			
2.	Top layer WC -1 MW-1 MC-1.6 Base layer OPC-1 MW-3	56	36	12
3.	Top layer WC -1 MW-0.53 MC-2.12 Base layer OPC-1 MW-1.5 SD-1.5	34	68	5
4.	WC-1 MW-4 RO-0.1	74	41	12.5

Based on the characteristics of marble slurry waste, certain additional developments were also undertaken. Polymer composite products such as bath tub, kitchen sink, shower tray, wash basin and soap dish have also been developed, wherein upto 50% marble slurry powder has been used. These products are better in their performance characteristics as compared to the conventional ones, along with a cost saving of upto 30%.

The techno-economic analysis indicates that marble slurry waste can be effectively utilized in the manufacture of various value added building products.

Recycled Glass – From Waste Material to Valuable Resource

Terrazzo Tiles. Some precast concrete manufacturers and architectural concrete producers are offering terrazzo tiles that utilize rather expensive specialty aggregates such as marble chips. Crushed glass constitutes a relatively low-cost alternative to such materials, even if the glass needs to be

sorted by color. Efforts are now under way to mass-manufacture Glass Concrete. terrazzo tiles. Because of the relatively high cost of the specialty aggregates and the premium prices fetched by terrazzo tiles, this application qualifies as a value-added product. Although it does not utilize as large quantities as the commodity products, it has the potential of impacting the local glass recycling economy.

Concrete is a marvelous construction material. It can be very durable, is wonderfully moldable and adaptable to myriad applications, its ingredients are readily available and inexpensive. We have the technical know how to engineer its mechanical and other properties to fulfill almost any set of reasonable specifications. Concrete is also an excellent medium to recycle solid waste, which is welcome news to municipalities that are hard-pressed by the scarcity of suitable landfills.

In developing concrete products with crushed waste glass aggregate, the economics is controlled by the price the product can fetch on the open market. Commodity products, by definition, are characterized by low values, which exert strong pressures on the production and manufacturing technology. The value added by the glass is marginal to nonexistent in those cases. But by utilizing the special properties of glass, chemical, physical, or esthetic, novel products can be developed, for which the prices fetched in the open market are much less exposed to competitive pressures. A beautiful tabletop counter made of polished glass aggregate concrete has the potential to stand on its own and does not need to compete with other materials, many

of which are likely to be much more expensive to produce. After all, this is an engineered material. Prudent application of technical know-how all but guarantees a cost-effective satisfaction of all reasonable material specifications. In conventional concrete, we are more likely to be concerned with strength, durability, and workability. Crushed glass aggregate adds a new dimension to the possibilities for architectural concrete applications.

This is truly a case where a waste material is turned into a valuable commodity. This is independent of any bonus the consumer may be willing to pay for products made with recycled materials. We do not have to limit ourselves to waste glass. The recycling and reuse of glass cullet, there are other solid waste components that are good candidates for being turned into valuable commodities. The various ashes and microsilica that are byproducts of industrial processes or combustion and are already widely utilized in the concrete industry. Other possibilities are offered by the reprocessing of carpets. The nylon fibers have interesting effects on the strength, workability and thermal properties of concrete.

Ceramic Tiles from High-Carbon Flyash

Only about 20% of Illinois fly ash is utilized, mostly by the concrete industry. Use of fly ash as a major ingredient in manufacturing ceramic tiles can increase the ash utilization, as well as reduce the cost of raw materials in the tile industry and provide a competitive edge to U.S. tile manufacturers against foreign competition.

The project included laboratory characterization of the materials, scale-up

investigation in a custom tile manufacturing facility, and trials with large-scale industrial equipment.

A process was developed that allows utilization of fly ash with moderately high carbon content in manufacturing ceramic tiles. The method leads to oxidizing the residual carbon, thus removing a potential source of tile warping, surface defects, and loss of strength. The approach was based on holding the tiles at the temperature sufficient for carbon oxidation, before the liquid phase formation seals the system of pores supplying oxygen to the tile's interior. Subsequently, tiles were heated to the firing temperature when sintering and fusion combined to form a tile body with low porosity and adequate strength.

The pilot-scale experiments and successful runs on the actual mass-production, industrial type equipment indicated that characteristics of fly ash-based tile bodies are superior to those required for wall tile applications, and comparable to those required for floor and outdoor applications. The developed processing method has general applicability to other Class F fly ashes as well. It has also been confirmed that fly ash tiles with low water absorption can be made at temperatures significantly lower than those required for conventional ceramic tiles.

Annually, the state of Illinois produces over 5% of the 60 million tons of fly ash generated in the U.S. Only about 20% of this fly ash is utilized by the cement and concrete industry, and the majority of the rest is landfilled. Any non-concrete

utilization of the fly ash currently being disposed will not only be environmentally sound and cost effective, but also will create a stable year-round demand.

The overall objective of this project was to utilize fly ash generated by burning of Illinois coal as the major raw ingredient for manufacturing ceramic tiles for wall, floor, and outdoor applications. Considering the size of the tile industry, a considerable fraction of the fly ash produced in Illinois can be utilized to prepare ceramic tiles. As raw materials contribute to the major cost in running a tile plant, replacement of costly raw materials by fly ash is attractive to tile manufacturers. Such utilization is environmentally attractive, and the state economy will benefit from such an undertaking.

Tile manufacturing process. The predominant raw material for ceramic tiles is clay. Various processed clays are available for the industry and offer a range of thermal characteristics, plasticity, color, and fineness. Actual mixes for tile manufacturing contain one or several types of clay and additions, such as fluxes (talc, nepheline syenite, wollastonite.)

Preparing mixes of clays and other ingredients at the production facility can be done by different ways, which in turn determines the subsequent processing methods [Jones and Berard, 1972]. Three methods are presently used: dry pressing, wet pressing, and slip casting.

- In dry pressing, the raw mix contains about 5% of water (based upon the weight of solid). The floor, wall, and outdoor tiles produced by this method mostly have a flat surface, and the production rate for this method

may be very high.

- In wet pressing, the amount of water used is higher (approximately 25%), and the resulting material has the consistency of putty. This process has the advantage of reasonably high production rates, and fairly complicated designs are adequately reproduced.
- In the slip casting method, a self-supporting shape, called a cast, is produced in a water-absorbent mold from a specially formulated slip, i.e. semi-liquid mixture of clay and water. Any intricate designs can be adequately reproduced in this processing method. However, a number of parameters play an important role in successful slip casting, which is even more complex in the presence of the multimineralic material, such as fly ash.

All these processes produce so-called green tile body, which is then fired at approximately 1,100°C to produce sintered tiles. In most cases, the fired tile bodies are glazed in a secondary firing at a relatively lower temperature. Glazing improves the surface durability and adds different aesthetic values to tiles. A glaze is a glassy material designed to melt on the surface of a ceramic body, and to stay adhered upon cooling.

Properties of tiles. Acceptance criteria for commercially produced tiles may be subdivided into three categories: facial and structural soundness, dimensional characteristics, and physical properties. Of these categories, the latter is directly related to the properties of tile materials. Therefore, the tile bodies, regardless of their application, need to satisfy the two most important requirements, water

absorption and breaking strength (reflecting tensile strength). The tile bodies are customarily classified by their water absorption as shown in Table 1.

Table 1. Classification of tile bodies

	Water absorption, %
Non-vitreous	>7.0
Semi-vitreous	3.0-7.0
Vitreous	0.5-3.0
Impervious	<0.5

Table 2 summarizes the physical characteristics of various types of tiles as specified by the existing standards.

Table 2. Standard physical characteristics of ceramic tiles

		Water absorption,% (max.)	Breaking strength, lbs (min.)
Unglazed	Mosaic tile	3.0	250
	Quarry tile	5.0	250
	Paver tile	5.0	250
Glazed	Wall tile	20.0	90
	Mosaic tile	3.0	250
	Quarry tile	5.0	250
	Paver tile	7.0	250

Fly ash as raw material. In 2001, about 100 ceramic tile-manufacturing plants in the United States produced 620 million square feet of tiles, and the quantity is expected to rise in the near future. This number, however, covered only 26% of the total U.S. demand, the balance being supplied by imports. Because of the high cost of raw materials, U.S. manufacturers are less competitive than their foreign counterparts. Owing to its chemical composition and physical characteristics, fly ash can be used as partial replacement for clay in

the ceramic tile industry. The composition of fly ash is such that it can be used as a major raw ingredient for making wall and floor tiles. The ash chemical composition is shown in Table 3 in comparison with a typical clay used in tile manufacture and a prospective clay/fly ash blend as an alternative raw material.

Therefore, utilization of fly ash for making ceramic tiles is very attractive. Such utilization is environmentally sound, preserves our resources, creates a year-round demand for fly ash, and benefits the economy of the state.

Experimental. High carbon content is potentially the most important characteristic of flyash that may have an adverse effect on the process implementation. Whereas carbon is easily burned out on the tile surface, its particles can be entrapped inside the tile body and cause a wide range of defects during sintering. In extreme cases it results in swelling and delamination. Blistering, or formation of swollen patches on the tile surface, or bloating of the entire tile body was an issue for the first firing tests conducted with ash-containing mixes. Thereafter the major part of this project focused at the development of practically feasible measures to remove the carbon particles from fly ash or to alleviate its effects. First, the attempt was made to preheat fly ash in order to remove carbon and volatiles before blending with other mix ingredients. Fly ash was heated at 20°C per minute to 800, 900, 1000, 1100, and 1200°C. It was observed that above 800°C, fly ash started to sinter, and at 1000°C it formed a fairly hard mass. It was apparent that in a large-scale commercial production this approach was impractical. More realistic would be the one-step thermal

treatment combining carbon removal by oxidation with sintering. The development of the temperature profiles of such process was the principal objective of trial tests in laboratory electric furnaces and in commercial-size batch furnaces at M.E. Tile Co.

To minimize or eliminate effects of carbon on the tile appearance, two approaches were conceived. The first was fast firing. It was based on severely limiting oxygen access to the carbon in the tile body interior. During firing, oxidation of the present carbon begins at a temperature below 700ºC. A few different untreated fly ashes with carbon content ranging from 3 to 20% were mixed with other ingredients and fired at a rate of as high as 40°C/minute to 1,200°C. When tiles were fired at this high speed of the temperature rise, the tile surface sintered and became virtually impervious to air. As a result, carbon particles encapsulated inside the specimen were not oxidized and did not generate any internal pressure to cause bloating. In this fast firing, most of the tile bodies showed no surface deformation. At the same time, the residual carbon did not seem to have any effect on the strength.

However, these results were not consistently positive. Evidently, variations of porosity and compactness of formed tile body could be a contributing factor to this phenomenon. Besides, the black core of carbon-rich material may be undesirable from the standpoint of the tile appearance.

A more satisfactory solution to this carbon problem was slow firing. At slow firing rate, carbon burns out while the piece being fired remains porous. First,

several tile bodies were fired in a laboratory furnace using different firing schedules. Air has been passed through the furnace to intensify the oxidation and shorten the time needed to decrease the carbon content to an acceptable level. It was observed that holding the tile in the furnace at 750°C for 12 minutes is adequate for an approximately 10 mm thick tiles to burn the interior carbon particles (see Table).

Table Tile Characteristics

Sample No.	Firing time, min.	Breaking load, lbs	Visible carbon
1	12	341	Abundant
2	15	346	Minimal
3	15	225	Minimal
4	18	295	None
5	18	318	None

After the key process parameters were studied at the laboratory scale, the experiments were transferred to the small commercial scale production facility at M.E. Tile Co. Green tiles were produced by wet ram pressing, roller pressing, and slip casting. The tiles were fired in electric kilns with programmable controllers.

A number of test firings under varied temperature profiles were conducted in order to minimize or eliminate dark core near the center of the fired tile bodies. Under the optimal conditions that have been established, tile bodies could have been prepared with virtually no dark core.

A number of process parameters were varied in order to develop the optimized mix composition and firing conditions. To determine the effect of moisture on the pore structure, the tiles were pressed and fired from the mixes with the different water content. Experimental firings were also conducted with mixes containing fluxes (nepheline-syenite, talc) to optimize the firing temperature and reduce water absorption. The results helped to finalize the mix composition intended for

the pilot tests at the TCA facility.

When tiles were produced without disqualifying surface and dimensional defects, they were subjected to physical testing. The tile bodies were tested for breaking strength by the test method ASTM C 648 based on a three-point support and a single point loading.

Water absorption is a reliable indicator of the degree of the tile body sintering. The following Table gives an example of the results of water absorption tests for one of the mix compositions (average for batches of 8) as a function of the firing temperature.

Table. Water absorption of tiles

Sample No.	Firing temperature, ºC	Water absorption, %
1	1086	11.3
2	1117	11.1
3	1152	10.6
4	1175	7.7
5	1184	6.6

.

While slight reduction in water absorption with progressive firing temperatures is obvious, a substantial decrease in water absorption occurred between 1152 and 1175°C, and continued to the final firing temperature of 1184°C. In further tests, improvements of the firing conditions led to producing tiles with water absorption as low as 0.3 to 0.5%.

Statistical analysis of the physical test results produced by testing several batches of tiles demonstrated very close correlation between firing shrinkage and porosity of the fired tiles (correlation coefficient r = - 0.92). Correlation between shrinkage and breaking strength was statistically significant at the 99%

level.

Pilot tile production. The project was brought to conclusion by the pilot production of tiles at the TCA research center in Anderson, SC. The facility has two pieces of the core tile-making equipment, namely a hydraulic press and a roller kiln. The press by WELKO (Italy) is a commercial model with maximum load of 650 ton. The kiln by Studio Uno (Italy) is a shortened version of a commercial kiln.

Because of the experimental nature of the test run, the press and the kiln were operated in a batch mode. The press was loaded manually. The green tiles were oven dried and loaded into the kiln. Individual tiles were pressed and fired under varying conditions in order to define the optimum conditions. Efficient carbon removal was the main criterion of the process optimization.

Process parameters were set in the course of testing as follows:

Tile size: 300x300 mm (12”x12”)
Thickness: 7.1 mm to 8.7 mm ($^{9}/_{32}$” to $^{11}/_{32}$”) Moisture: 7 to 7.7%
Pressure: 190 to 220 kg/cm^{2h}
Firing time: 60 to 100 minutes
Pre-heating temperature: 660 to 740ºC Firing temperature: 1143ºC
Pre-heating time: 24 to 50 min.

After the tiles were manufactured standard tests were performed to verify their compliance with the standard specifications. Average water absorption was 14.5%, and average breaking strength, 255 lbs.

The processing method was developed that allows utilization of Illinois coal fly ash with moderately high carbon content in manufacturing ceramic tiles. The results demonstrate that high dosages of fly ash can be used in successful commercial manufacturing of ceramic tiles using wet pressing, slip casting, and dry pressing methods. The cause of the problems relevant to processing and aesthetics have been identified, and remedial measures developed. The temperature profile of firing was developed that leads to oxidizing residual carbon from the ash and removal of a potential source of the tile warping, surface defects, and loss of strength. The characteristics of fly ash-based tiles are superior to those required for wall tile applications, and comparable to those required for floor and outdoor applications. Also, the processing method developed has general applicability to other Class F fly ashes, although some specific processing steps may need adjustments due to significant shifts in the fly ash characteristics.

The marketing and economic feasibility study based upon this concept confirmed that considering the size of the tile industry, a reasonable fraction of the fly ash produced in Illinois can be utilized to prepare ceramic tiles. Pursuing this technology is also important from the tile manufacturer's viewpoint, as raw materials contribute to a major cost of running a tile plant. Replacement of costly raw materials by less expensive fly ash would not only be attractive to tile manufacturers, but also it would make the U.S. tile industry more competitive against the foreign imports. It makes perfect sense to build a tile plant close to or at the property of a utility company. The latter can also add value to its waste material (fly ash) if its characteristics are stabilized at the specified level by homogenization.

The next step in the development of the proposed technology would be producing a batch of tiles in the continuous mode on the prototype equipment suggested for the prospective commercial plant. Such test would provide all information necessary for the actual plant design and engineering

17. TECHNO ECONOMIC PRODUCTION CAPACITY OF 8 LAKHS MOSAIC TILES WITH CAPITAL INVESTMENT RS. 65,00,000 AS PER QUALITY STANDARD IS: 1237-1980

Mosaic floor tiles are also known as terrazzo tiles. The main raw materials used for the manufacture are cement concrete and coloured stone chips. These tiles are made generally in the sizes of 200 x 200 x 20mm, and 300 x 300 x 25mm. These tiles can also be made in various other sizes, shapes according to market demand. The tiles are used for flooring of both residential and commercial buildings. The top surface of the tiles is decorated with marble stone chips of various colours with suitable addition of cement colour. These tiles are impermeable, easy to replace and long lasting.

Construction of floor by laying these tiles is time saving. It is also economical to repair the floor or do patch work by replacing the damaged tiles in course of use. Since the tiles are available in various decorative colours and sizes, the item is gaining popularity and the demand is increasing day-by-day. There is a great upsurge in the building construction activity due to increase in population. The requirement of residential houses hospitals and commercial buildings is increasing day by day. Government of India in its

10th Five Year Plan has given greater emphasis on housing activity. Socioeconomic changes in society, improved standards of living, renovation of old buildings and all-round development in the country, have increased building construction activity and the demand of Mosaic Flooring tiles.

Ceramic vitreous floor tiles, granite and marble stone tiles, red clay flooring tiles are some of the substitute material used in place of mosaic tiles. The demand for Mosaic tiles is estimated to be around 25% of the total requirement of flooring tiles. Taking the above factors into consideration the demand is expected to increase at the rate of 10% every year during the current plan period. Hence there is a good scope for setting up of new units for the manufacture of mosaic tiles.

Basis and Presumptions

i. It has been taken into consideration that the unit will work on two shifts basis per day for 300 days in a year.
ii. To achieve full plant capacity 1 to 2 months trial production is required.
iii. Labour and wages mentioned as per the prescribed minimum wages.
iv. Interest rate at 12% considered in the project profile both for recurring and non-recurring investment.
v. Margin money will vary from 10- 25% depending upon the location and scheme adopted by the entrepreneurs.
vi. Operative period of the project is around 10 years considering technology obsolescence rate and period of repayment of loan.

vii. The costs of land, construction charges, machinery and equipment, raw materials and consumables, other Contingent expenses etc. indicated in the scheme are based on the prices prevailing at the time of project preparation. Therefore, these are subject to necessary changes from time to time based on the local conditions.

Implementation Schedule

Sl. No.	Activity	Period (in months)
1.	Project report preparation, selection of site, selection of machinery and registration as SSI etc.	6
2.	Processing for financial assistance, procurement of machinery and civil construction etc.	6
3.	Trial run and marketing set up etc.	2
Total Time		14

Technical Aspects

Process of Manufacture

The basic raw materials used in the manufacture of mosaic floor tiles are cement (grey and white) stone/marble chips. Fine aggregates like sand, dolomite powder and colouring oxide ordinary portland cement can be used for mosaic tiles of dull colours. For such applications where distinct designs and deep colour shades and marble boundries are desired white cement may be employed. Hard limestone, dolomite chips, crushed cuddappha stone of suitable sizes are to be used as course aggregate. Colours should not be

added in quantities exceeding 10% of the cement used in tile mix, otherwise strength of tiles will be adversely affected.

The process for the manufacture of Mosaic tiles consists of three layers, the facing, the intermediate and backing layers. The raw materials (cement, marble chips, marble powder, colouring oxides, sand stone chips) are mixed according to the pre-determined proportions thoroughly and mixture is kept separately on the platform of hydraulic/mechanical press for ready use. The mixture for three layers is prepared in the following proportions.

1. Facing mixture	1.1.2 Proportion
Grey cement	1.5
Marble chips	4
White cement	1
Marble powder	1
Colouring oxide	0.1 to 0.5%
2. Intermediate Mixture	
Grey cement	1
Sand	1
3. Backing Mixture	
Grey cement	1
Sand	3
Stone chips	1

Suitable iron moulds are fitted with the bottom plate of the press. The facing mixture is first fed into the mould to a thickness of about 6.5mm and then

intermediate and backing mixture is spread over to the thickness of about 9mm each. The mixture is pressed under the pressure of around 150kg/ sq. cm. which varies according to the size of the tile. The tiles are taken out from the moulds and kept for 24 hours for air setting and then immersed in water for curing for a period of about 15days. The cured tiles, are then taken from the curing tank and kept in shed for a period of about 4-5 days for drying. The tiles are then polished and ground on super (leveling machine. After polishing, the tiles are given final touch of finish by hand and then sent to store for dispatch.

Manually operated presses are also used for making the tiles for small batches of production. But the tiles made by this press do not have uniformity due to difference of pressure in each cycle with variation in pressure of the manually operated presses.

Quality Control and Standards

For maintaining uniformity in quality the following Indian standards specification may be considered:

IS 1237:1980 Cement concrete flooring tiles. As per IS 1237:1980 the use of raw materials is divided into three forms viz. topping mixture, intermediate mixture and backing mixture.

Production Capacity (per annum)

It is envisaged that unit will produce about 8 lac pieces of assorted sizes valued at Rs. 65,00,000

Motive Power 40 HP.

Pollution Control

There is no water pollution in manufacture of mosaic tiles, however, there would be some air pollution while handling dry raw materials like cement and marble powders. Simple methods to cover the discharging bins for mixing or connecting it with cyclonic dust collector would be sufficient to control the pollution. Alternatively, the operator should use dust mask.

Energy Conservation

It is not applicable as far as fuel energy is concerned. Simple precautions and knowledge of effective utilization of electrical power is necessary.

Financial Aspects

A. Fixed Capital

(i) Land and Building	**(Rs.)**
i) Land 30,000 sq. m. @ Rs. 3334 / sq. m	1,00,00,000
ii) Building	
Office, Stores etc. 1000 sq. m @ Rs. 10000/m2	1,00,00,000
Workshed 1600 sq. m @ 5000/m2	80,00,000
Curing Tanks	8,00,000
Compound wall, sanitation civil work, Gate and	12,00,000

roads etc.	
Total	**3,00,00,000**

(ii) Machinery and Equipments	**Nos.**	**(Rs.)**
Hydraulic press (Cap. 150kg/sq. cm) with pressure gauge	3	10,00,000
Hydraulic double piston pump with 5HP motor combined with safety valve, capable of feeding 4 to 5 presses	1	3,00,000
Leveling (grinding) machine complete with all attachments grinding capacity 4 tiles at a time (5HP)		5,00,000
Colour mixing muller for mixing colour with cement (3HP), D.G. Set, Bore well with water storage tank, water distribution system, pollution control systems electrical lighting etc.	Lot	20,00,000
Semi polishing machine with 2HP motor for sample polishing for testing	1	1,00,000
Total		**39,00,000**
Erection and installation charges for the above machines @10% of the cost		3,90,000
Tipping borrows 4 cft/7 cft cap		1,00,000
Plain and checkered tile moulds complete with frame, plate and plug 3 sizes, 10 sets		8,00,000
Weighing machine, working tables racks etc.		6,00,000
Testing equipments and material handling equipments		8,00,000

Office equipments and furniture	5,00,000
Total cost of m/c and equipment is	70,90,000
(iii) Pre-Operative Expenses	5,00,000

Total Fixed Capital	**(Rs.)**
Land and building	3,00,00,000
Plant and machinery	70,90,000
Pre-operative expenses	5,00,000
Total	**3,75,90,000**

B. Working Capital (Per Month)

(i) Staff and Labour (per month)	**No.**	**Salary**	**(Rs.)**
General Manager	1	25,000	25,000
Supervisors	4	5,000	20,000
Accountant/Clerk	4	5,000	20,000
Skilled Workers	12	5,000	60,000
Un-skilled Workers	20	3,500	70,000
Watchman/Peons	6	3,500	21,000
		Total	2,16,000
Perquisites @ 15%			48,000
		Total	**2,64,000**

(ii) Raw Material (per month)

Particulars	Quantity	Rate	Amount (Rs.)
Portland (Grey) cement	60 MT	4,000	2,40,000
White cement	58 MT	8,000	4,64,000
Sand	160 MT	200	32,000
Stone/Marble chips	48 MT	3,000	1,44,000
Mineral colours	2 MT	10,000	20,000
		Total	**900,000**

(iii) Utilities (per month)		(Rs.)
Power 30x16x4x25	LS	48,000
Water Charges	LS	5,000
	Total	53,000

(iv) Other Contingent Expenses	(Rs.)
Postage and Stationery	5,000
Telephone	10,000
Consumable Stores	10,000
Repair and Maintenance	18,000
Transport Charges	10,000
Insurance	23,000
Sales Expenses, advertisement and publicity	25,000
Total	**1,01000**

Total Recurring Cost (per month)

Staff and Labour	2,64,000
Raw materials	9,00,000
Utilities	53,000
Other Contingent expenses	1,01,000
Total	**13,18,000**
Total working Capital (on 3 months basis)	39,54,000

C. Total Capital Investment

Fixed capital	Rs. 3,75,90,000
Working capital	Rs. 39,54,000
Total	**Rs. 4,15,44,000**

Machinery Utilization

Efficiency and working hrs. considered for full capacity	Efficiency 80% of the installed capacity of 16 hrs. and 300 days in a year.
Time/period of achieving capacity utilization	6 months from the date of commencement of commercial production.

Financial Analysis

(1) Cost of Production (per year)	**(Rs.)**
Total recurring cost (per year)	1,58,16,000
Depreciation on building @5%	10,00,000
Depreciation on machinery and equipment	3,90,000

@10%	
Interest on Capital Investment @12%	49,85,000
Depreciation on mould, racks, tools, testing equipments @25%	5,75,000
Depreciation on office equipment and furniture @, 20%	1,00,000
Total	**2,28,66,000**

(2) Total Turnover (per annum)

Particulars	**Quantity**	**Rate (Rs.)**	**Amount (Rs.)**
Grey mosaic tiles 10" × 10"	6,00,000	18.33/ tiles	1,10,00,000
Grey mosaic tiles 8" × 8"	6,00,000	16.67 /tiles	1,00,00,000
Coloured tiles	4,00,000	22.50/ tile	90,00,000
		Total	**3,00,00,000**

(3) Net Profit (per year)

$$= \begin{matrix} 3,00,00,000 \\ 2,28,66,000 \end{matrix} \quad - \quad = 71,34,000$$

(4) Net Profit Ratio

$$= \frac{\text{Net profit per year} \times 100}{\text{Turnover per year}}$$

$$= \frac{71,34,000 \times 100}{\quad\quad\quad\quad\quad\quad}$$

3,00,00,000

= 23.78%

(5) Rate of Return

$$= \frac{\text{Net Profit per year} \times 100}{\text{Total Investment}}$$

$$= \frac{71,34,000 \times 100}{4,15,44,000}$$

= 17.17%

(6) Break-even Point

Fixed Cost	**(Rs.)**
Total Depreciation	19,65,000
Total Interest	49,85,000
40% of Salary and wages	12,67,000
40% of other contingent expenses	4,85,000
Insurance	2,76,000
Total	**89,78,000**

$$\text{B.E.P.} = \frac{\text{Fixed cost} \times 100}{\text{Fixed cost + Profit}}$$

$$= \frac{89,78,000 \times 100}{89,78,000 + 71,34,000}$$

= 55.7%

18. INSTITUTIONS PROVIDING TERM LOANS

Institutions that provide term loans in India may be divided into three broad categories as follows:

All India Financial institutions These include IFCIP ICICI, and IDBI, the three oldest general term-lending institutions (ICICI and IDBI have been transformed into banks in recent years)1 specialised institutions like Exim Bank, IL&FS, Power Finance Corporation, IDFC, and SIDBI, and insurance companies (TIC and GIC) with marginal exposure to term-lending.

State Level Financial Institutions Most of the states have a State Industrial Development Corporation(SIDC) and a State Financial Corporation (SFC) which are refinanced by IDBI.

Commercial Banks Historically1 commercial banks were marginal players in the term- lending arena, as their main thrust was on providing working capital finance. In recent years, commercial banks have stepped up their term-lending activities.

19. MOSAIC TILE MACHINE AND EQUIPMENT

Addresses of Machinery and Equipment Suppliers

1. M/s. Bhagvati Engg. Works
Nazarbag,
Morvi - 363 691
(Gujarat)

2. M/s. Bhavani Engg. Works
37, Sunshine Industrial Estate,
Behind Maniar Traders,
Near Ajit Mill Rakhial,
Ahmedabad - 380 023

3 M/s. Hydro Engg. Works
K1/116, G.I.D.C., Morvi,
(Gujarat)

4. M/s. Ashok Engg. Works
8/1, Ajit Industrial Estate,
Rakhial, Ahmedabad - 380 023

5. M/s. Jay Khodiyar Engg. Works
6, Pruthvi Plot,
Morvi - 363 691, (Gujarat)

6. M/s. Naveen Engg. Works
K1/102, G.I.D.C.,
Morbi - 363 641, (Gujarat)

7. M/s. Vishwakarma Engg. Works
Behind Sukhram Nagar,
Navneet Prakashan,
Rajpur - Gomtipur, Ahmedabad - 380 021

Detailed Product Description

CE/standard

Our current projects tile machinery.

Full or Semi automatic.

EU/300-PL (Current)

EU/450-PLC

EU/450-PLC-V (Current)

Capacity 8/h

120 or 260 m2 daily

Tile in size 200x200 to 400x600mm

Also; Used for auto. Presses.

Attention!! To floor tile manufactures; we can turn to your automatic system floor tiles production press to new vacuum system. This project will be prepared in 45-50 days and sent to xx country and city by de-monte in its package in one day. We will assemble it in 1,2 days and the know-how will be given free. If it is wanted, the system can be turned auto the period and old working mode easily. It has no working risk. It is guaranteed for 3 years.

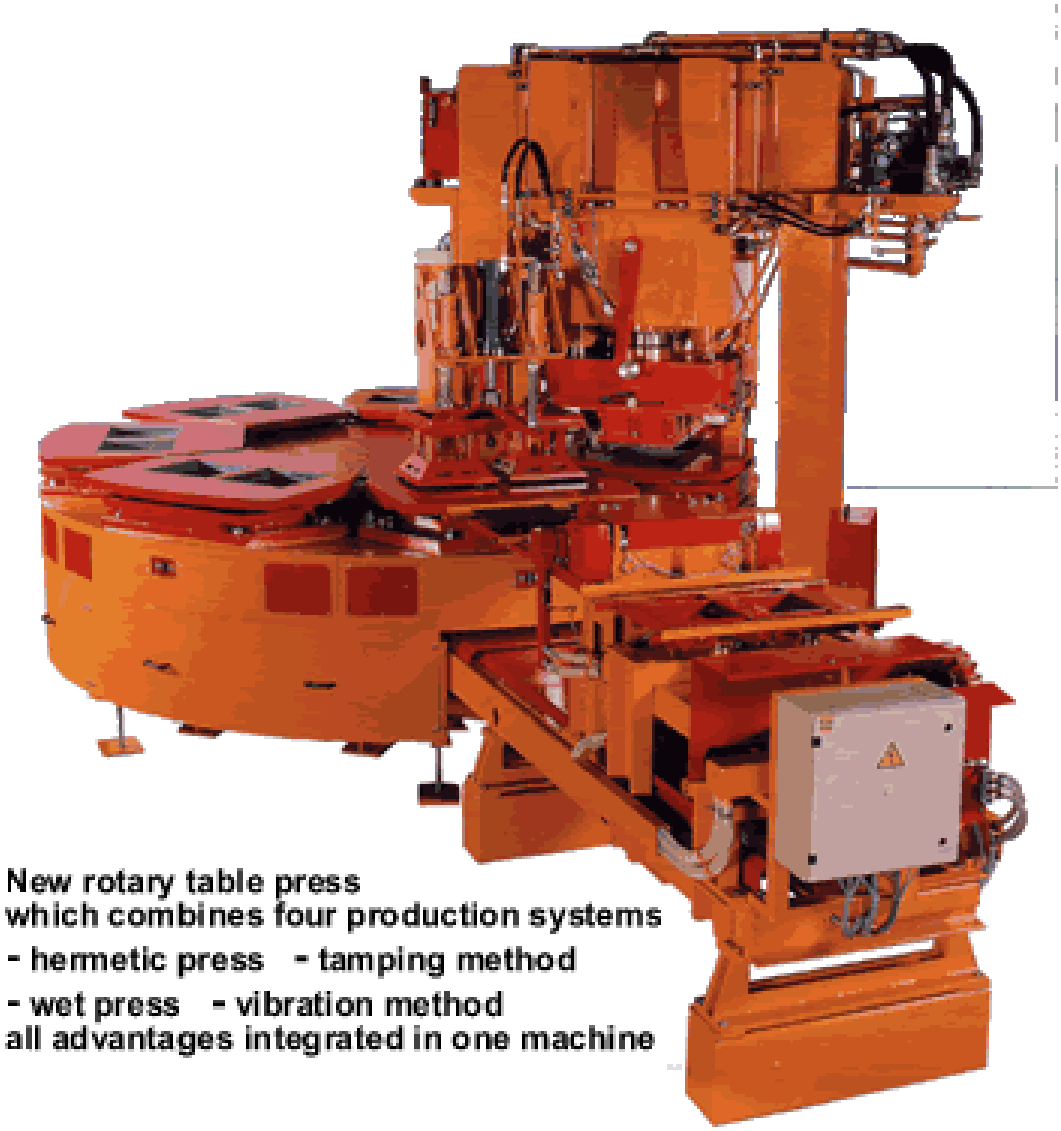
Brand Name:TSE/CE

Place of Origin: Mede In Turkey

Model No: Type:EU/300-PL

Innovated technology to make slabs with the Multi-System-Press 970

Optimally compacted tiles and slabs with the highest quality



Multi-System-Press 970 - SATURN

First layer dosing

A new dosing system gives exact dosing with both liquid and compact facemix. Marbeling also possible.

Second layer dosing

improved filling system without disturbing the face mix. Exact dosing also to give variable product thickness.

Precompression

new tamping method with adjustable tamping power for optimal grain placing and water exchange had better compaction.

Vibration

new vibration system with uni-directional vibrations, of which the power of the unbalanced mass and intensity can be adjusted. This improves the evenness of the grain distribution and gives better compaction.

Ejection hydraulically

Various take-off methods as i.e. direct product placing onto pallets or via vacuum supported ejector for thin tiles, as well as suitable for all products.

Mainpressing

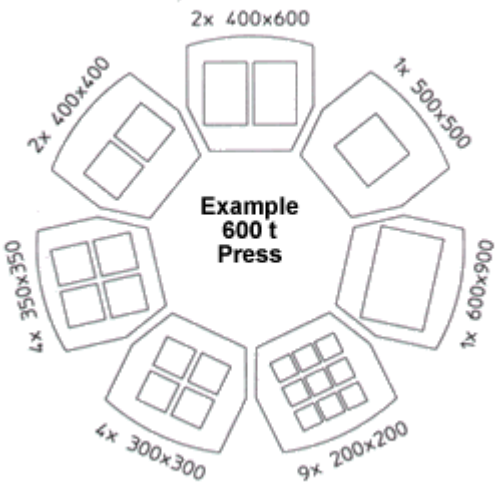
Optimal compaction of tiles and slabs via individual press rams and spherically mounted pressing tools Pressing power: adjustable up to 400 tons per slab dimension 400x400.

Multi-System-Press 970 Saturn

Reliability of operation: _____

secured by high quality components and a well conceived desing such as a closed press body and servo technique. High reliability due to easy and quick mould exchange.

Great attention was put to utmost economy, quality and reliability during the development of this new range of presses. This Multi-System-Press combines hermetic-, tamping-. Wet- and vibrations systems. Newly developed dosing equipments allow variable but precise filling.



The Multi-System-Press 970 can be combined with all the well proved horizontal and vertical stacking devices made by Schauer & Haeberle Gmbh.

Multi-System-Press 970	**Saturn/600**	**Saturn/800**	**Saturn/1.000**	**Saturn/1.200**
Number of stations	7	7	7	7
Pressing power pre-pressing	38t.	38t.	76t.	76t.
Pressing power main-pressing	600t.	800t.	1.000t.	1.200t.
Cycle time approx.	9-10sec	9-10sec	9-10sec	9-10sec
Capacity in 8h with 300x300 mm	1.000m	1.000m	1.550m	1.550m
Dimension max.	600 x 600 mm	600 x 900 mm	500 x 750 mm	500 x 750 mm
No. Per mould	1	1	2	2
1st layer doser content approx.	220l.	220l.	400l.	400l.
2nd layer doser content approx.	280/550l.	280/550l.	420/500l.	420/500l.
Electrical power approx.	73kW	93kW	120kW	120kW
Compressed air demand approx.	900l.	1.200l.	1.700l.	1.700l.
Weight approx.	45t.	60t.	80t.	85t.

A machine designed for highest tile, slab and paver quality all at lowest manufacturing cost

- in one unit design
- prepressing station on request with tamping equipment
- supervision of slab ejection
- supervision of slab thickness
- dip vibrator on request
- automatic doser for 1st and 2nd layer
- signal transfer via field BUS system on request with screen control
- 3 independent working hydraulic systems with manual emergency operation
- rotary table drive via servo motor with regenerative braking
- rotary table bearing with big rolling bearing free from play highest precision of mould positioning
- special vibrators, frequency controlled
- stepless filling system for variable, product thickness on request
- hydraulic pressing tool fastening device for quick changing on request
- mould equipment of high performance steel
- all functions with supervised final switch
- easy to maintain and clean
- central lubrication on request

Example: Saturn 970-800 tons pressing power mainpressing

Use:

Special new design without columns to manufacture concrete tiles and slabs up to size 300 x 300 mms 4-fold, 400 x 600 mms 2-fold and 600 x 900 mms 1-fold ea. up to 100 mms thickness final measurement.

Technical design:

Complete hermetic turntable press with internal ring gear drive.

Control of lowering vibrating table

Connecting possibilities for accessories as:dip vibrator, colouring injector, mixture distributor, second layer elevator

Prepressing station with stripping device for the mould and, if desired, with tamping equipment

Special vibrators below the moulds with frequency regulation

Hydraulically operated ejector for safety product sliding out of the mould

Tile or slab ejecting control

Independent complete hydraulic power packs and controls for mainpressing and prepressing station. If desired, each usable for all two functions in cases of emergency or service works. Total pressing power up to 800 tons with adjustable high efficiency hydraulic system. Hydraulically operated return stroke for press-cylinder.

Technical data:

pressing power main pressing station: 800 tons pressing power prepressing station:38 tons weight of the machine incl. 1 set of moulds: 60.000 kgsel. power: 93 kW supply voltage:3 x 400 V/ 50 cps air demand:1.200 l/min. cycle time according to product thickness: 9 -10 seconds

stroke of mould lifting cylinder:180 mm

2. Terrazzo pressing machine

2.1 Terrazzo Pressing Machine/Kebo-125E

2.1.1 Our tile machines will be based on your to kind of shows you need Die Model

3.

Terrazzo machine
Characteristics：

terrazzo Machine: It's with the merits of fas molding speed, large output, reliable performance, PLC automatic control and convenient operation. It's hydipneumatic, with the speed as high as 7-8 pieces/min. In addition, the rate of finished products is high,and the quality-price-relative is better.

terrazzo Machine:The tiles made of the mortar concrete with press-filtering molding are high density,strong intensity,and nice dimensions, which are the excellent

Terrazzo machine
Technical Characteristics：

Molding Presssure	125T
Molding Speed	7∽8 Pieces/min
Mainframe Power	5.5KW
Mainframe Weight	5T

on the concrete products, meeting the different construction requirements.
terrazzo Machine:The machine is with multiple functions. By changing molds,it could be used to produce master tile ridge tile,edge tile,drain-tile,etc .In addition,it could also be used to product various top-grade colorful ground tile,including terrazzo tile,bathing tile,etc.

4. Tile Machine

4.1 Tile Machine/Kebo-125C

4.1.1 Our tile machines will be based on your to kind of shows you need Die Model

5.

***Tile Machine* Characteristics：**

***Tile Machine*:** It's with the merits of fas molding speed,large output,reliable perfomance,PLC automatic control and convenient operaion.It's hydipneumatic,with the speed as high as 7-8 pieces/min.In addition,the rate of finished products is high,and the quality-price-relative is better.

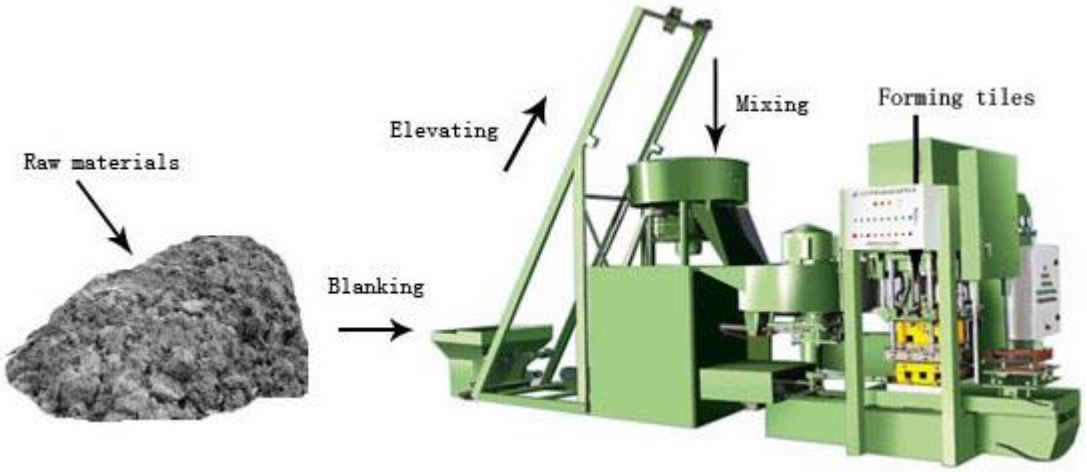
***Tile Machine*:**The cement-tiles made of the mortar concrete with press-filtering molding are high density,strong intensity,and nice dimensions,whih are the cxcellent on theconcrete products, meeting the different construction requirements.

***Tile Machine*:**The machine is with multiple functions. By changing molds,it could be used to produce master tile ridge tile, edge tile, drain-tile,etc .In addition, it could also be used to product various top-grade colorful ground tile, including terrazzo tile,bathing tile,etc.

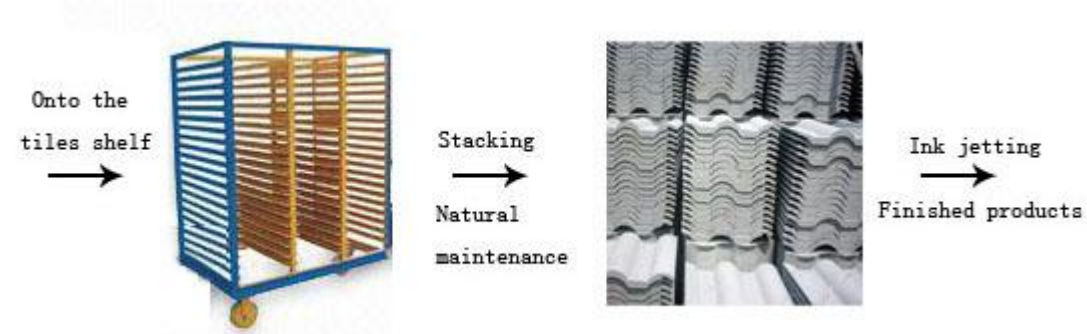
***Tile Machine* Technical Characteristics：**

Molding Presssure	125T
Molding Speed	7∽8 Pieces/min
Mainframe Power	5.5KW
Mainframe Weight	5T
Overall Dimensions	2700×1600×2480mm

Tile Machine Production process



Tile Machine



6. Tile Making Machine

7.

7.1 Tile mahcine/Kebo125D

7.1.1 Our Tile Making Machines will be based on your to kind of shows you need Die Model

Characteristics of KB -125D Full-Automatic Tile making Machine:

Tile making Machine: KB-125D High-Speed Press-Filering Cement-Tile Molding Machine is the products with high advanced technologies developed by the Company itself. It combines the advanced international technologies and he actual status in China perfectly, with the excel-lent mechanical and economic performer. In addition to the merits of Type C, it also has the human-machine interface, with simple operation and the functiln of automatic supervision.

Tile making Machine

Techincal Characteristics:

Molding Pressure	125T
Molding Speed	7~8 Pieces/min
Mainframe Power	5.5KW
Mainframe Weight	≈ 5T
Overall Dimensions	2700×1600×2480mm

SUPPLIER OF PLANT AND MACHINERIES

MIXER

M/s. A-One Packaging Machine
D-312, Sector-10
Noida
Ph:. 914443437
Fax:. 01180-4526188

M/s. Ambika Vijay Works
1H, Laxmi East Link Road
West, Mumbai - 53
Ph:. 6366894

M/s. Babbar Engineering
688/335, Munshi Ram Bagh
Near Ranjit Nagar
New Delhi - 110 008
Ph:. 5705367, 5705363
Also at: 8007/11, Multani Dhanda
Paharganj, New Delhi - 110 055
Ph:.3522232, 3677804
Fax: 3512178

PRESSES

M/s. Induyog (P) Ltd, Co.,
Okhla Industrial Estate,
New Delhi.

Presse Weld Engineers,
20 Likmanya Tilak Road,
Near Carnao Bridge,
Mumbai - 3.

RAW MATERIAL SUPPLIERS

CEMENTS

NECEM Cements Ltd.
Housing Cly. Rd.
Rukmini Ngr.
Dispur
Guwahati, Assam-781006 India
TEL : +91 (0) 361 261814
FAX : +91 (0) 361 260409
E-mail: navneet31@sancharnet.in

Kalyanpur Cements Ltd.
Maurya Centre, 1
P.O. Box 89
Fraser Rd.
Patna, Bihar-800001
India
TEL : +91 (0) 612 225639
FAX : +91 (0) 612 239884

Nirman Cements Ltd. A Khemka Group Company
501-B, Ashiana Chmbrs.
Exibition Rd.
Patna, Bihar-800001 India
TEL : +91 (0) 612 237832
FAX : +91 (0) 612 228793
E-mail: ncl@mail.girija.net.in

Grasim Cement
Grasim Vihar
V & P.O. Rawan
Teh. Simga
Raipur, Chhattisgarh-493332 India
TEL : +91 (0) 771 88218
FAX : +91 (0) 771 425721

Marble Chips :

M/s. Delhi Marble,
House , 38, Shardhanand Marg,
G.B. Road,
Delhi - 6

M/s. Delhi Builders Stores,
Sir Sohba Sing Building,
G.B. Road,
Delhi - 6.

PRESENT MANUFACTUERS OF MOSAIC TILES

M/s. Patel Tiles & Marble Ltd,
Atlas Mill Comp. Gosown 4/5,
B-Nath Pai Marg,
Mumbai.

M/s. Poonam Tiles & Marble Ltd,
382, GB. Gultekdi,
41/1, Shankashet Road,
Pune - 411 009.

M/s. Raju Tiles & Marble Inds.,
Shop No. 760.
Opp. Regent Cenema,
Ulhasnagar - 421 003.

M/s. Shreeram Tiles Works,
Kherdi Industrial Area of MIDC
Tal Chiplin,
Ratnagiri - 415 604.

Simplex Art Floorings Pvt. Ltd,
Dr. Rau Road , Yovji Castle,
Mumbai - 400 012.

M/s. S.K. Tiles Industries,
89/A, Mittal Chmb,
Nariman Point,
Mumbai- 21.

M/s. Standard Tiles Corpn,
12/14, Simpoli Road,
Mumbai - 66.

M/s. Super Tiles Works,
8, P.T.M. Nag Road,
Distt. - Nagpur.

M/s. Suresh Cement Tiles Works,
Kurkheda,
Tahsil gadas MIroli,
Chanda - 441 209.

M/s. TATA Tiles,
POB 201,
Kolhapur - 416 001.

M/s, Tolia Tiles Industries,
84, Mumbai Timber Market Road,
Mumbai - 10.

M/s. Vikram Tiles,
Nr. Tembalai Rly.Gate,
Pune - Bangalore Road.
Kolhapur - 416 004.

M/s. Adenwala Marbles Pvt. Ltd,
468/70, Duncan Road,
Opp. Round Temble,
Mumbai-4.

Antique International, Noida

Exporters of marble mosaic tiles, designer mosaic tiles, decorative mosaic tiles, hand cut mosaic tiles, slate stone, sandstone, pebble stone, silver grey quartzites and other natural stone.

Address: G-14, Site 5, UPSIDC, Greater Noida, Noida, Uttar Pradesh - 201 301, India

Phone: +(91)-9811170570

Website: http://www.naturalstonesexporter.com

Satish And Ish Private Ltd.

Suppliers of mosaic floor tiles, glazed mosaic tiles, designer mosaic tiles and handmade mosaic tiles. Also exports cement floor tiles, and storage tank.

Address: G.T. Road, Sarna, Post Office Malikpur, Pathankot, Punjab - 145 025, India

Phone: +(91)-(186)-2245096 Fax: +(91)-(186)-2245643

Website: http://www.indiamart.com/satishandish

RK International

Exporters of mosaic floor tiles used for bathroom, swimming pool, outdoor garden, habitat, hotel or table tops. Also supply multicolored tiles, sandstone tiles, red sandstone tiles, yellow sandstone tiles, green sandstone tiles, white sandstone tiles.

Address: Village Majra, P. O. Kund, Rewari, Haryana - 123 102, India

Phone: +(91)-(1281)-244937/244727 Fax: +(91)-(1281)-244938

Website: http://www.rkstones.com

Sagar Overseas, Rajasthan

Manufacturer and wholesale supplier of mosiac floor tiles, finished mosaic tiles, honed mosaic tiles, polished mosaic tiles and border mosaic tiles. Also deals in supplying of golden natural stone, golded polished stone and jackmulti stone.

Address: Mamta Circle, Sadar Bazar, Deoli, Tonk, Rajasthan - 304 804, India
Phone: +(91)-(1434)-232037 Fax: +(91)-(1434)-232037
Website: http://www.sagar-overseas.com

Rajasthan Stone Syndicate

Manufacturer and stokiest of mosaic floor tiles, attractive mosaic floor tiles, designer mosaic floor tiles. Also deals with various types of marble, limestone marble, dolomite marble, wall-cladding marble, roofing marble, flooring marble.

Address: 204, Rimson Industrial Estate, Dumping Road, Malad (West), Mumbai, Maharashtra - 400 064, India
Phone: +(91)-(22)-28765587/28765631/28896372 Fax: +(91)-(22)-28821055
Website: http://www.indiamart.com/rajasthanstones

Mineral Syndicate India

Supplier of mosaic stone floor tiles, mosaic flooring tiles, mosaic floor slabs, glass mosaic floor tiles etc. Also exporting gold green quartzite, red quartzite, himachal black quartzite, himachal green quartzite and shimla export quartzite.

Address: 7, Park Street, Sethi Sadan, M. I. Road, Jaipur, Rajasthan - 302 001, India
Phone: +(91)-(141)-3208133/4010590/5123149 Fax: +(91)-(141)-5108972
Website: http://www.mineral-syndicate.com

The Stone Studio

Deals in supplying of tiles, mosaic tiles, slate tiles, outdoor tiles, marble tiles, limestone tiles, natural stone tiles, granite tiles, kitchen tiles, bathroom tiles

and wall tiles. Also deals in natural stones, paving stones and natural stone slate.

Address: 36, Chandivli Village, Chandivli, Mumbai, Maharashtra - 400 072, India
Phone: +(91)-(22)-26175790 Fax: +(91)-(22)-26175792
Website: http://www.indiamart.com/thestonestudio

Axiom Trade Links Pvt. Ltd.

Engaged in supplying and exporting mosaic floor tiles, brick mosaic tiles, mosaic tilesmoasic stone, ledge stone, south granite, tan brown granite, kashmir white granite, kashmir gold granite, black granite, tropical green granite and madura gold granite.

Address: 45-46, Road No.4, 22 Godown Industrial Area Extension, Jaipur, Rajasthan - 302 006, India
Phone: +(91)-(141)-2210064 Fax: +(91)-(141)-2207687
Website: http://www.stoneall.com
Send Trade Enquiry Now

Opio Mosaica

Manufacturing and supplying mosaic tiles, flooring tiles, glass mosaic tiles bathroom glass mosaic tiles available in 20mm x 20 mm and 10 mm x 20 mm sizes finding applications in building elevations and exteriors.

Address: 282, Shivaji Market, 1st Floor, Pitampura Village, New Delhi, Delhi - 110 034, India
Phone: +(91)-(11)-39524618/27030786 Fax: +(91)-(11)-27030786
Website: http://www.indiamart.com/opiomosaica

Shon Ceramic Pvt. Ltd.

Supplying and manufacturing glass mosaic floor tiles, ceramic floor tiles, glazed mosaic floor tiles, unglazed mosaic floor tiles, crystal floor tiles available in different patterns and color combinations.

Address: 159, GIDC Estate, Makarpura, Baroda, Gujarat - 390 010, India
Phone: +(91)-(265)-2638406/2638306 Fax: +(91)-(265)-2638551
Website: http://www.indiamart.com/shonceramics

Aryan International, Andheri

Supplies and exports mosaic floor tiles, sandstone, granite tiles, marble tiles, limestone tiles, green marble tiles, black granite tiles, natural stone, marble inlay tiles, mosaic flooring tiles and other flooring tiles.

Address: 502/A, Padmarag C.H.S. Limited, 502/A, Padmarag C.H.S. Limit ed, Mumbai, Maharashtra - 400 059, India
Phone:+(91)-(22)-67021172/67021173/28255959
Fax:+(91)-(22)-67021174/28399990
Website: http://www.indiamart.com/company/701940/

Makwood Furniture

Manufacturer of all kinds of mosaic floor tiles.

Address: 21, 1st Cross Street, 1st Floor Trustpuram, Kodambakkam, Chennai, Tamil Nadu - 600 024, India
Phone: +(91)-(44)-52023729
Website: http://www.indiamart.com/company/1092572

BBM Impex Pvt. Ltd

Supplier and exporter of floor tiles, Indian stone floor tiles such as mosaic floor tiles, granite floor tiles, marble floor tiles, slate stone floor tiles. Also offers stone fireplace and stone fountains for garden and parks.

Address: 54, Regal Building, 2nd Floor, New Delhi, Delhi - 110 001, India
Phone: +(91)-(11)-23362513 Fax: +(91)-(11)-23367436

Veerabhadra International, Pune

Exporting and supplying mosaic floor tiles, brick tiles, mosaic tiles, sandstones tiles, granite tiles. Also exporting and supplying wash basins, hand wash basins, counter basins, bathroom commodes.

Address: Plot No. 10 V, Veerabhadra Nagar, Baner, Pune, Maharashtra - 411 001, India
Phone: +(91)-(20)-27290335 Fax: +(91)-(20)-27293482

Anant Ceramics

Wholesale dealer and supplier of mosaic floor tiles, water proof glass mosaics tiles, weather proof glass mosaics tiles, glass mosaics tiles, lightweight glass mosaic tiles, chemical proof glass mosaics tiles and fire proof glass mosaics tiles.

Address: 247 B, Shivaji Market, Pitam Pura, New Delhi, Delhi - 110 001, India
Phone: +(91)-(11)-45509052

Flemingo Natural Stones And Minerals

Engaged in supplying classical and modern type of mosaic floor tiles. which are used as floor tiles and as board in kitchen and bathroom. Also offer mosaic tiles in different colours, thickness and sizes as per the requirement of the buyer.

Address: Plot No. 114 H, RIICO Industrial Area, Deoli, Tonk, Rajasthan, India
Phone: +(91)-9314009700

Celestial India.

Engaged in manufacturing and supplying of floor tiles, wall tiles, stone slabs, slate floor tiles, roofing tiles, black sandstone, mosaic tile borders, copper natural slate, mosaic tile flooring, black glaxy granite slabs and tropical green vanity tops.

Address: C-77, Shyam Apartments Sarojini Marg, C - Scheme, Jaipur, Rajasthan - 302 001, India
Phone: +(91)-(141)-6456788/3219595 Fax: +(91)-(141)-2378921
Website: http://www.buybuildingstone.com/

Poddar Industrial Consultants

Exporters and suppliers of stone slabs, granite flooring tiles, sandstone slab, marble stones, granite slabs, granite tiles, marble slabs, marble floor tiles. Also supply slate stones, step stones, mosaic pavers, landscape pavers and marble tiles.

Address: D-14, Greater Kailash, Enclave-1, New Delhi, Delhi - 110 048, India
Phone: +(91)-(11)-26242840/26242844 Fax: +(91)-(11)-26242842/26242843
Website: http://www.indiamart.com/poddarindustrialconsultants

Addis Chemico Corporation

Manufacturer, supplier and distributor of bleaching powder. Also supplier of phenolic muratic acid, utensils cleaner, tiles cleaner, car cleaner, liquid cleaner, rust cleaner, marble cleaner, mosaic cleaner, herbal cleaner, neem cleaner and floor cleaner.

Address: 153 B. L. Saha Road, Kolkata, West Bengal - 700 041, India
Phone: +(91)-(33)-24038556/24649280 Fax: +(91)-(33)-24668491
Website: http://www.indiamart.com/addischemico

U. S. Tiles and Allied Products

Exporters and manufacturers of designer wall tiles, decorative tiles, mosaic floor tiles, checked tiles, mosaic kitchen tiles, cement tiles, glass mosaic tiles and concrete heavy duty tiles. Also supply of main hole covers, grass pavers and curve stones.

Address: Near Govt. Press, Opp. Govind Colony Mandir, Judges Road, Rampur, Uttar Pradesh - 244 901, India
Phone: +(91)-(0595)-2351393/2355923 Fax: +(91)-(0595)-2353275

Palazzo Marbles

Manufacturer, exporters and supplier of tiles like ceramic tiles, floor tiles, vitrified floor tiles, floor carpet tiles, bathroom tiles, garage floor tiles, kitchen floor tiles, kitchen tiles, mosaic floor tiles, roof tiles for embracing the beauty.

Address: D 504/1, Chetla Road, Alipore, Kolkata, West Bengal - 700 027, India
Phone: +(91)-(33)-32923227/32510908/24799630/247 Fax: +(91)-(33)-24794278
Website: http://www.indiamart.com/company/696273/

Ashish Impex

Specialized producer of wall and floor tiles like slate, limestone, sandstone,

marble, granite, quartzite, mosaic, cobbles and kerbs in different design.

Address: A-354, Meera Bagh, Outer Ring Road, New Delhi, Delhi - 110 087, India

Phone: +(91)-(11)-25251951/25251953 Fax: +(91)-(11)-25251954/25251955

Website: http://www.indiamart.com/company/16380/

Crystals India

Manufacturers of bathroom tiles, wall tiles, floor tiles, mosaic tiles, ceramic tiles and glazed wall tiles that are available in various colours and sizes. Also manufacture dolomite & magnesite powder which is used to manufacture terrazo mosaic tiles.

Address: C-32, Kalaimagal Street, Swarnapuri, Salem, Tamil Nadu - 636 004, India

Phone: +(91)-(427)-2447311/2448742

Website: http://www.indiamart.com/company/563591/

Nidhi Enterprises

Suppliers of ceramic wall tiles, floor tiles, italian wall tiles, spanish wall & floor tiles, exterior tiles, kitchen tiles, bathroom tiles, wooden flooring, glass mosaic, sanitary ware, shower enclosure, bathroom accessories, bathroom borders and pavers.

Address: C-1014, Sushant Lok, Phase -1, Gurgaon, Haryana - 122 002, India

Phone: +(91)-(124)-5107646 Fax: +(91)-(124)-5112646

Harrys International

Suppliers and exporters of bathroom tiles, floor tiles, multi colored tiles, ceramic floor tiles, vitrified tiles, ceramic wall tiles, ceramic mosaic tiles, ceramic bathroom tiles and designer ceramic tiles.

Address: 127/128, Harrys International, Opp. Vora Baugh Shoping, Morbi, Gujarat - 363 642, India

Phone: +(91)-(2822)-243024 Fax: +(91)-(2822)-243673

Website: http://www.indiamart.com/company/298202/

Associated Natural Stones India (P) Ltd.

Manufacturers and exporters of wall tiles, floor tiles, pavements, flags

available in slates, granite, marble, cobbles, pebbles, mosaics, limestone, sandstone, tumbled stones.

Address: 160 Aamrapali Apartments, 56 - I.P. Extension, New Delhi, Delhi - 110 092, India

Phone: +(91)-(11)-22247644/22247646/22247645 Fax: +(91)-(11)-22247643

Kavery Marbles

Manufacturers and exporter of mosaic flooring tiles, decorative wall tiles, ceramic wall and floor tiles.

Address: 318, Cauveri Road Karungalpalayam, Erode, Tamil Nadu - 638 003, India

Phone: +(91)-(424)-2212552/3100758 Fax: +(91)-(424)-2214801

Bisazza India Limited, Mumbai

Manufacturers and exporters of italian mosaic wall and floor tiles.

Address: 224/226/228, Solaris, C Wing, Saki-Vihar Road, Andheri (East), Mumbai, Maharashtra - 400 072, India

Phone: +(91)-(22)-28570190/28576947 Fax: +(91)-(22)-28570193

Safe-Maxx

Manufacturers of curved glasses, fire fusion glass, designer glass, bent toughened glass, security glass, curved glass, bent glass coffee tables, fusion glass, decorativeglass, glass mosaic, floor glass tiles, insulating glass etc.

Address: C. B-362, Ring Road, Naraina, New Delhi, New Delhi - 110 028, India

Phone: +(91)-(11)-25778055 Fax: +(91)-(11)-25778066

Website: http://www.indiamart.com/company/683690/

Spectrum Manufacturers

Manufacturers of all kinds of floor tiles, facing tiles, sidewalk tiles, concrete mosaic tiles, wild stone tiles, sand stone tiles, lime stone tiles etc.

Address: 14-A , Industrial Estate Chawni, Kota, Rajasthan - 324 007, India

Phone: +(91)-(94)-14184411

Website: http://www.indiamart.com/company/704540/

Akhand Exports, Inc.

Exporters and suppliers of flooring materials like mosaic tiles, acid proof lining, glazed tiles, marble, gramite and ceramic tiles and slabs.

Address: 3/A, Tushar Society, Opposite Ghelani Petrol Pump, Nizampura, Vadodara, Gujarat - 390 002, India
Phone: +(91)-(265)-2785424/3113067/2460335
Fax: +(91)-(265)-2795412/2460335

Italia Glass Private Limited

Manufacturer and exporter of all types of ceramic wall tiles, floor tiles and glass mosaic tiles.

Address: 4th Floor, Samaan 2nd, Opposite Reliance Petrol Pump, Anand Nagar, Ahmedabad, Gujarat - 380 051, India
Phone: +(91)-(79)-40006000 Fax: +(91)-(79)-40006150
Website: http://www.indiamart.com/company/1070592/

Nitco Tiles Limited, Pune

Manufacturers of various types of tiles such as ceramic floor tiles, cement mosaic tiles etc.

Address: E2/10, Salunke Vihar, Kondhwa, Pune, Maharashtra - 110 022, India
Phone: +(91)-(20)-26852549

G. T. Impex

Sellers of ceramic wall, floor tiles, glass mosaic tiles etc.

Address: 64, Mount Kailash, East of Kailash, New Delhi, Delhi - 110 065, India
Phone: +(91)-(11)-26442609/9313283325/9313771588 Fax: +(91)-(11)-26270421

City Ceramic

Supplying and exporting wall tiles, floor tiles, vitrified tiles and mosaic tiles.

Address: Shop No. 4, Heena Arcade, G. I. D. C. Chhar Rasta, Vapi, Gujarat - 396 195, India, Phone: +(91)-(260)-2990780

ANNEXURE

Recovery of the waste, on the basis of their mineralogical and chemical features, for different and compatible uses.

MUDS deriving from sawing of:

STONES, MARBLE, SLATES

Features of the waste: muds bearing at least 85% of calcium carbonate on dry matter.

Recovery activity: dehydration, drying, sieving, grinding, micronizing:

a) Paper industry;

b) Production of hydropaintings;

c) Neutralization of acid wastes;

d) Reagent for desulphuration of combustion smokes;

GRANITES

Features of the waste: filter pressed mud bearing more than 50 % of silicates

Recovery activity: dehydration, drying, sieving, grinding, micronizing, compacting and deironization:

a) Brick industry as material added to the mixture (not higher than 5% of dry matter);

b) ceramic industry;

Common to both:

a) Cement industry;

b) Road subfloor (recover subordinate to the fulfillment of leaching tests on the untreated waste according to a normalized method);

c) Environmental restorations (recover subordinate to the fulfillment of leaching tests on the untreated waste according to a normalized method);

d) As blanketing material for urban solid waste landfill disposal areas; (recovery subordinate to the fulfillment of leaching tests on the untreated waste according to a normalized method);

The Future

In order to maintain market growth, tile manufacturers will concentrate on developing and promoting new tile products, including modular or cladding tile, larger-sized tile, slip- and abrasion-resistant tile, and tile with a polished, granite or marble finish. This is being accomplished through the development of different body formulations, new glazes, and glaze applications, and by new and improved processing equipment and techniques. Automation will continue to play an important role in an effort to increase production, lower costs, and improve quality. In addition, changes in production technology due to environmental and energy resource issues will continue.