Establishing, Adoption, and Implementation of
Energy Codes for Buildings

Construction Materials & Local Market Survey In Palestinian Territories

August 2002

Contents

List of Tables

Figures

1. INTRODUCTION

1.1 General Scope

Construction and design of buildings in Palestinian Areas have changed considerably over the last century. Flat roofed and thin walled buildings of relatively low thermal insulation have replaced the old dome-roofed thick high walled houses, which were characterized by good thermal insulation and ventilation. New buildings are, however, characterized by more efficient use of construction material. The need for heating, cooling and ventilation systems increased sharply and energy consumption in the new buildings increased ever since.

After signing of the Palestinian-Israeli Agreement (OSLO II) in September 1995, the PA areas witnesses a construction boom of buildings and housing units. This wave of construction followed years of strict limitations by Israel on Palestinian construction in the PT. The number of new building licenses granted in West Bank and Gaza Strip from 1996 to 1997 reached 19,786...

The present project is concerned with energy efficiency in buildings. Introducing Energy Codes for buildings that include adoption of high insulation materials, new techniques and building methods for minimizing heat loss in winter and heat gain in summer, better ventilation and solar lighting will yield to more efficient utilization of energy. The project will have an impact on lowering energy consumption in buildings and minimize greenhouse gas emissions. Energy efficient buildings will also create better comfort and a healthier environment for residents.

It well known that most of the Palestinian modern buildings consist of walls constructed from stones, concrete ,bricks and plaster with a total thickness exceeding 25 cm. Flat roofs are constructed of concrete , hollow bricks and plaster. Technical papers by Palestinian researchers have shown that the typical values of thermal transmittance of walls range between 1.5 and 1.8 Kcal/hr.m^2.$C^{0.}$Compared to values range between 0.1and 0.35 Kcal/hr.m^2.C^0.Accordingly, energy loss in winter in local homes exceeds 6 times energy loss in buildings in the USA similar weather conditions.

Selection of suitable energy efficient materials in buildings is sufficient to improve thermal resistance dramatically, hence minimizing energy losses. Modern and adopted techniques must be adopted for this purpose .Improving energy efficiency in buildings by development of energy codes must be accompanied by proper passive solar design. If it is succeeded to do so, then there will be an opportunity to design houses that work with climate not against. To make best use of this opportunity, it must be understood the wide variety of energy conservation and thermal behaviors, so as to appropriately

select a suitable combination for a particular climate and proper materials. In doing so, we will obtain the highest possible comfort at lowest possible expenditure for materials and energy.

1.2 The Purposes of the study

This study aims to review the tradition used and available construction materials in PA and to introduce thermal specifications and energy efficient materials. In addition, this study aims to indicate and explore the economics issues and marketing matters. Therefore, this study is structured as the following

- The major types of building construction materials have been presented, Identifying building materials and building components
- The cost items of various types of construction materials have been analyzed

1.3 Methodology

The methodology of this study is based on:

1. Review of available literature.
2. Field visits to the concerned parties to conduct interviews with officials to get the data concerning Construction materials. In this regard, officials from PECDAR, Palestine Standards Institution (PSI),Ministry of Public Works, Ministry of Industry, Palestinian energy Authority (PEA), Palestinian Central Bureau of Statistics, An-Najah University were interviewed.
3. Contact the local companies working in the field .About 20 each of the suppliers of construction materials (manufacturers, trading companies, wholesalers, retailers, and agents) and consumers (construction companies) are selected.(Jordan Cement Company ,Nassar Stone company , Bethlehem Plastic Company, Al-Omari Company , NAPCO – National Aluminum Profile Company, AMIN Aluminum Company

1.4 Buildings Material in Palestinian Areas

In this report, the term "contemporary building" implies the following types of construction:

- Reinforced concrete structure, hollow block masonry walls and partitions, plaster and paint finish.
- Stone masonry bearing walls, reinforced concrete slabs hollow block partitions, plaster.
- Solid concrete block masonry bearing walls, reinforced concrete slabs and hollow block partitions. The mechanization of the construction of these traditional building types is already well advanced in Palestinian Areas for high rise multi-storey buildings.

- Modern building in Palestine consists of walls constructed " Stone, Concrete , Bricks, plaster with total thickness exceeding 25 cm. Typical value of the thermal transmittance of walls range 1.5 and 1.8 Kcal/hr.m^2.C^0

Table 1 Thermal Properties of construction materials used in tradition walls

The Material	*Thermal Conductivity (W/m.C^0)*	*Density kg/m^3*
Stone	2.0	2400
Concrete	1.6	2350
Plaster	1.25	1950

Source : Adham al_ayash ,Thermal Insulations Materials,1990

- Stone is commonly used in the construction of residential houses and public buildings it is used for cladding the external fascias of the building. This type of construction usually consists of 8X25 cm stone plate, a 22 cm layer of concrete backing behind the stone layers.

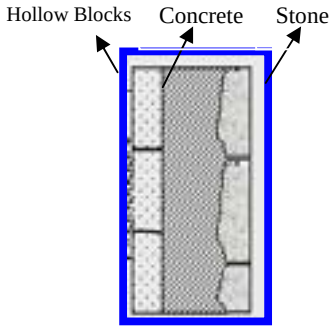


Figure 1: The Traditional Construction Materials used for the walls

- Light weight concrete blocks are used in construction of the outer walls and ceiling slabs of the buildings.

- In rural areas, in low-cost construction 20 cm hollow concrete blocks are commonly used and rendering the inner and outer wall by cement plaster. The inner walls are usually constructed with 10 cm hollow concrete blocks... The walls are of hollow concrete blocks rendered with cement plaster for both wall faces. The roof is a concrete slab with a layer of sloping cement sand screed of an average thickness 7 cm.

Table 2 Thermal Properties of Tradition Walls

Total Thickness of the Wall (cm)	***Thickness of Concrete layer (cm)***	***Thermal Transmittance ($W/m^2.C^0$))***	***Thermal resistance R-value ($m^2.C^0/W$)***
24	17	3.18	0.148
28	21	2.95	0.173
32	25	2.75	0.198

Source : Adham al_ayash ,Thermal Insualtion Materials,1990

- Reinforced concrete usually structurally as high stability and solidity. The need for comfortable indoor climate has lead to development of new construction techniques to over come the drawback of using concrete on

the indoor climate, by introducing thermal insulation materials and by using hollow concrete blocks or foamed blocks for the exposed exterior walls and the roof of the buildings. For instance, Polystyrene boards 2cm thick are sometimes used placed behind the concrete layer, followed by another layer of 7cm hollow concrete blocks to serve as insulation.

2. STONES

2.1 Types of building stone

Building stone is obtained by taking rock from the earth and reducing it to the required shapes and sizes for construction. Building Stone can be divided into three groups on the basis of geologic origin:

1. Igneous,

   - Igneous stone is the result of solidification from molten state

2. Sedimentary,

- Sedimentary stone is composed of sand, clay, and other substances derived from the breaking down of existent stone into small particles which are taken up and carried by water and then settled from the water into beds. These particles, together with the remains of plants, are formed into stone by mechanical pressure or are cemented together by chemical or organic action

3. Metamorphic.

- Metamorphic stone is the ultimate product from both igneous and sedimentary stone formed either by pressure , heat, or moisture, or various combustion of these forces (Reyad ,2000)

2.2 Textures & Colors of stone

Palestine boasts a wide variety of colors and types of stone. The colors of stone range from those with golden tones to those with beige and pink and beige and gray or darker beige, varying according to geographical area. Most types of stone product meet international standards and specifications.

Different types of stone and marble are distributed across the West Bank. Stones are usually described in terms of their location - for example, 'Jemmaeen stone', 'Yata stone', 'Bani Naim stone' and so on. A narrower categorization of stone is based not only on location, but also on stone type, shape and color. For example, the main types of stone are: Injasah, Jarra'ah, al-Shyoukh, Tafouh, Sanout, Qabatya and Yatta (based on location). Each one of these has different categories - according to the layer of earth from which it is extracted - and hence, different uses.

A wide variety of colors and types of stone: golden tones to those with beige and pink and beige and gray or darker beige

Table 4 Absorption and Emittance of various types of Stone

Type of Stone	*Absorption*	*Emittance*
sandstone	50-70	85-95
Limestone	60	85-95
Granite	65-80	85-95
Marble	50	85-95

Source: DR. REYAD ABDEL –KARIM (Construction Stone In Palestine), 2000

2.3 Classification of Stones

A broader classification of stones describes different types as *polished stone, rough stone, bush light chiseled stone* and others. All types of finished stone are marketed in the West Bank, particularly rough stone. The stone is primarily used in construction and it is required by municipality law to use it in most areas of the West Bank. The white stone of *Injasa*, *Aseerah*, *Sannout*, and *Shyoukh* is the most popular type of stone in the West Bank, and thus is the most expensive local stone.

Table 5 Thermal Properties of Various types of Stone

Type of Stone	*Density Kg/m^3*	*Specific Thermal Conductivity (W/m.K)*	*Specific Heat Capacity (KJ/KgK)*	*Specific Vapor Penetration* (**MN.s/g.m**)
sandstone	2600	2.30	0.83	80-135
Limestone	2600	2.9	0.86	
Granite	2800	3.5	0.9	
Marble	2500	2.2	.80	

Source: Palestine Standards Institution (PSI)

Stone type preferences differ according to geographical area. Traditionally, demand for Palestinian finished stone has been concentrated in the southern, central urban and semi urban areas, while construction in the north (for example, Jenin and Tulkarem) has depended to a greater extent on cement blocks for construction. However, more and more limestone buildings have been constructed in these areas in recent years, being seen as an indicator of wealth. Meanwhile, different localities exhibit their own preferences concerning type of stone. For example, *Asseerah* and *Jarra'ah* stones are the most popular stones in Ramallah, Nablus, and Tulkarem, while other types such as *Sour Maeen, Abu Alkhabaz, Injasa* and *Shyoukh* are preferred in Hebron.

2.4 Specifications and Uses Major Stone Types in Palestinian Lands

Table 6 A : Classifications of Major types of Stones Used in West Bank and Gaza

Stone Type	*Source*	*Classifications*	*Specifications*	*Uses*
Injasah	Hebron-Bini Na'em	It is classified into five major categories: Asfar, Sid, Ardi, Sous.	The "Ardi" type is the best one. White color, veined, different colors, hard, minimal absorption water	"Chiseled" for building,polished stone, paving sidewalks, Garden walls, decorating public places
Jarra'ah	Nablus	Band 60, and Band 40	Usually gray, minimal absorption water, veined, hard, uniform color	Building, paving, decorating public places
Aseerah	Nablus-Aseerah	Band 60, and Band 40	White, minimal absorption of water, hard, uniform color	Building (all sides), paving, decoration
Al Shyoukh	Hebron-Al Shyoukh	Asfar, Sid, Ardi	White color, absorbs water, not uniform color	Building, paving, decorating public places,renovating ancient places
Tafouh	Hebron - Tafouh	Bind Asfar, Ardi	Beige color, soft stone, absorbs water, not uniform color	Paving, polished stone, decoration
Samouh	Hebron-Samouh	Asfar, Ardi	Different colors, hard stone, minimal absorption of water	Building, paving, decoration
Qabatya	Jenin-Qabatya	Bind Awal (cover), Bind Ardi	Different colors (almost beige), absorbs water, color is changeable with time, hard stone	Building, paving
Yatta	Hebron – Yatta	Bind Asfar, Ardai	White color, hard, almost uniform color, absorbs water	Building,polished, paving,decoration

Source: The Union of Stone and Marble in Palestine

Table 6 B: *Thermal Properties of Major types of Stones Used in West Bank and Gaza*

Stone Type	Density Kg/m^3	Thermal Conductivity (W/m.c^0)
Injasah	2200	1.53
Qabatya	2580	2.23
Aseerah & Jameen	2650	2.6
Samouh	2500	2.20
Tafouh	2000	1.40

2.5 The Markets for Palestinian stone

There are currently two major geographical markets for Palestinian stone: the West Bank and Israel. Secondary markets, and ones with great potential for expansion, are other markets in the region as well as internationally. The most significant market for Palestinian stone is neighboring Israel, consuming around 71% of sales. The West Bank is the second largest consumer, accounting for around one quarter of total sales.The Gaza Strip market, in contrast, consumes only 2% of total production, as construction is heavily dependent upon cement blocks. On the other hand, Gaza produces terrazzo tile, which is often made into beautiful patterned tiles. Meanwhile, export markets currently account for only 4% of sales. Palestinian stone and marble production comprises around 4% of world production and less than 2% of world production value. It represents one third of Turkey's output and half that of Germany**.** the total value of annual sales of Palestinian stone is estimated to be around $425 million. Of this, 71% goes to Israel, 4% to export markets, 2% to Gaza and just under one quarter to the West Bank market. (PECDAR, 1998)

Table 7 Annual Sales by Market Destination

Market	% of Total Production	Sales in US$
West Bank	23%	95,869,943
Israel	71%	295,946,345
Export Market	4%	16,673,034
Gaza Strip	2%	8,336,517
Total	**100%**	**416,825,838**

- *Sales figures include Value Added Tax (VAT@17%)*
- Source: PECDAR

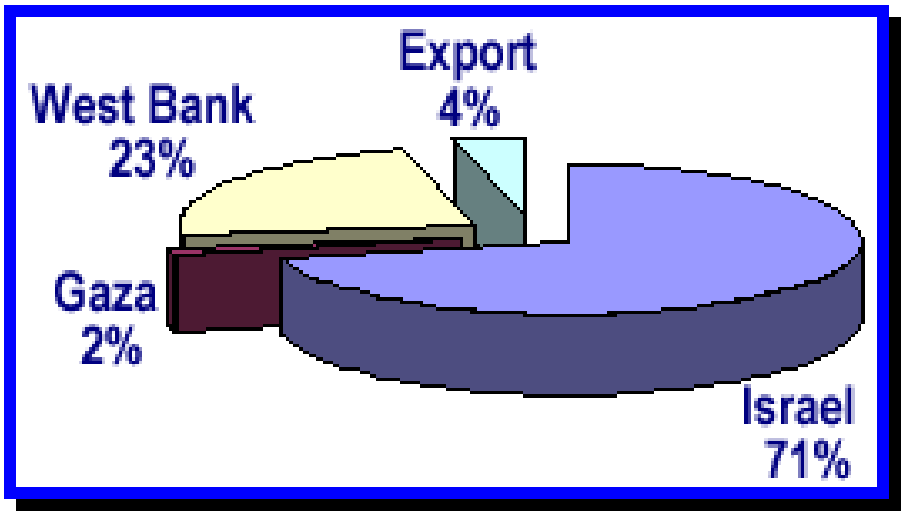


Figure 2: Percentages of Sales by Market

2.6 Export Market Destinations of Stone

Palestinian stones have a good potential for export, as they are similar to several marbles currently in demand in world markets. This is particularly true for those with golden color tones and those with beige and pink and beige and gray or darker gray.

Rough blocks, polished slabs and tiles have also been found to be feasible products for the export market**.** Rough blocks are currently exported to Italy and Israel. Their sale is relatively profitable as they allow a high profit margin with low investment and production costs.

- **Israel**

  The Israeli market is the most important market for Palestinian stone. Stone-cutting establishments sell their product to Israeli companies and contractors, who use them in settlement construction in the West Bank and Israel. Before the Intifida, the Israelis used to buy directly from stone-cutting establishments in the West Bank. Now, however, they buy their products through distributors. Another method of marketing in Israel is through Arab-Israeli contractors.

- **The Middle East**

The Middle East region as a whole is also a strong and growing market. This market is close to Palestine and is supported by business and personal relationships, as distribution systems are already developed through Middle-Eastern countries. Until recently, Jordan and the Arab countries' markets were major importers of the West Bank limestone. However, this share has declined due to the restrictions on export imposed by the Israeli authorities and the high cost of transportation across the bridge, which is conducted via old and limited

number of trucks. Exports have also been affected as a result of the competition of Jordanian products and the closure of Gulf countries' markets after the Gulf War. Total limestone exported to Jordan and the Arab countries is estimated at around 4%.

- **International**

The United States is a large, highly competitive market, with marble produced domestically as well as being imported from the entire world, including nearby Mexico. Europe is another good market. However, Palestinian marble exported to this market competes with similar materials from Italy, Portugal, France and Spain. Nevertheless there is still potential for the export of rough blocks such as golden and gold-beige marbles, which are not otherwise available in Europe. Other areas are Asia and the Pacific Rim.

2.7 Stone Cutting Facilities in West Bank &Gaza

The sources of stone are the some 222-255 stone quarries situated across the West Bank. The vast majority of these are concentrated in the Hebron area, which is also known for using the most modern and sophisticated machinery for extracting stone and for producing stone that has minimal defects, a good color and uniform texture.

The work performed by quarries is the production of stones of different sizes and textures for use in construction, in addition to the production of cement and tar for use in construction.

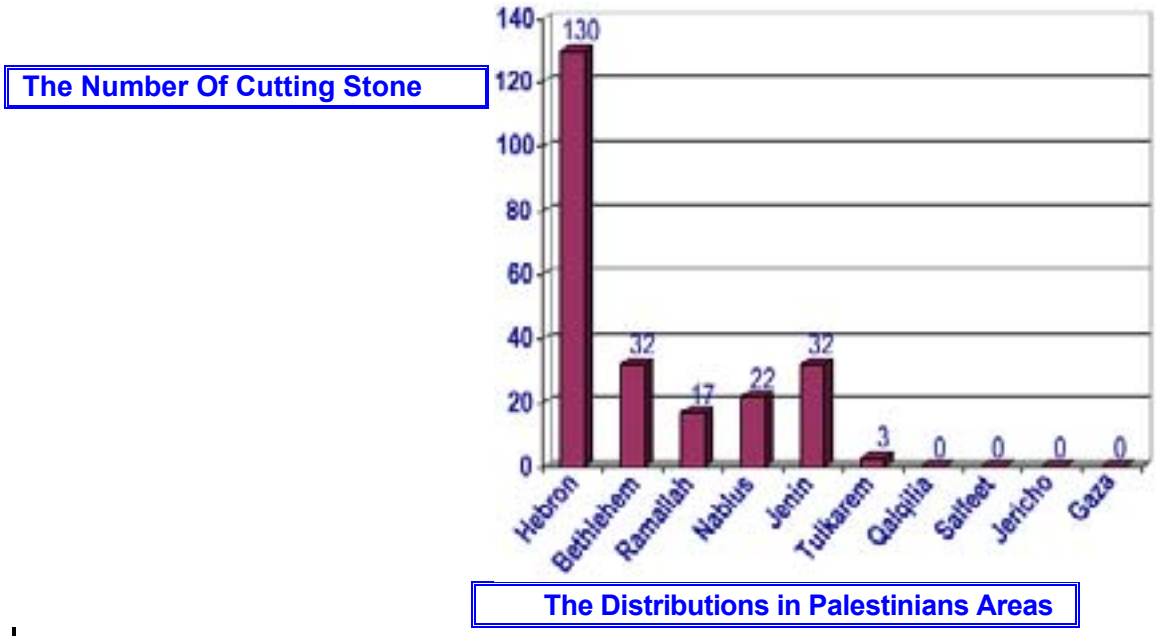


Figure 3 Stone Cutting Facilities

Altogether there are approximately 600 stone cutting facilities in the West Bank and Gaza. During the 1990s, there has been a significant increase in the number of new stone-cutting establishments. For example, in the two decades prior to 1990, a total of 46 new establishments were started. The years 1991 - 1995 then saw a further 28 new establishments open. Stone cutting establishments are spread across several areas of the West Bank. Major suppliers of stone are Bethlehem and Hebron, with other concentrations found in the northern districts of Jenin, Tulkarem, and Nablus Most stone cutting establishments are private companies. More than half of these are owned by companies, while the rest are owned by individuals. The type of machinery and equipment used in stone cutting establishments tends to vary by geographical area. In general, the trend towards investment in modern working tools is increasing, with more technological advances being found in Bethlehem and Hebron areas where in some cases, large investments have been made on fully-automatic machines such as gang saws, mono-blade machines, cutting saws, and polimachines for slabs and tiles.

There are approximately 245 stone cutting workshops in the West Bank and Gaza. These are establishments that either import or buy finished material from local stone cutting facilities. They then custom design or decorate finished products for end users. Workshops are found primarily in Hebron and Ramallah areas, with a significant secondary concentration in Gaza.*(The Palestinian Ministry of Industry)*

Table 8 Distributions of Stone Cutting Facilities & Quarries in West Bank and Gaza

Location	*No. of Cutting & Shaping facilities*	*No. of Quarries*
Hebron	175-180	125-135
Bethlehem	205-215	30-35
Ramallah	55	15-20
Nablus	55-65	20-25
Jenin	75-80	30-35
Tulkarem	10	2-5
Qalqilia	7-10	0
Salfeet	5-10	0
Jericho	2	0
Gaza	10	0
Total	**599-637**	**222-255**

Source: The Palestinian Ministry of Industry 2000.

2.8 The growth of the stone cutting industry

The ensuing construction boom has fueled the growth of the stone cutting industry. As an example of the magnitude of the boom, in 1989 the new constructed area was estimated to be 268.9 thousand square meters while in 1996, the area of new construction was 2132.2 thousand square meters (PECDAR, 1996).

The construction materials sector now faces the challenge of supplying construction materials - whether locally produced or imported - at a rate and cost compatible with the pace of construction. This demand reveals the urgency of the need for developing the stone sector in order to ensure the timely and efficient delivery of the required products.

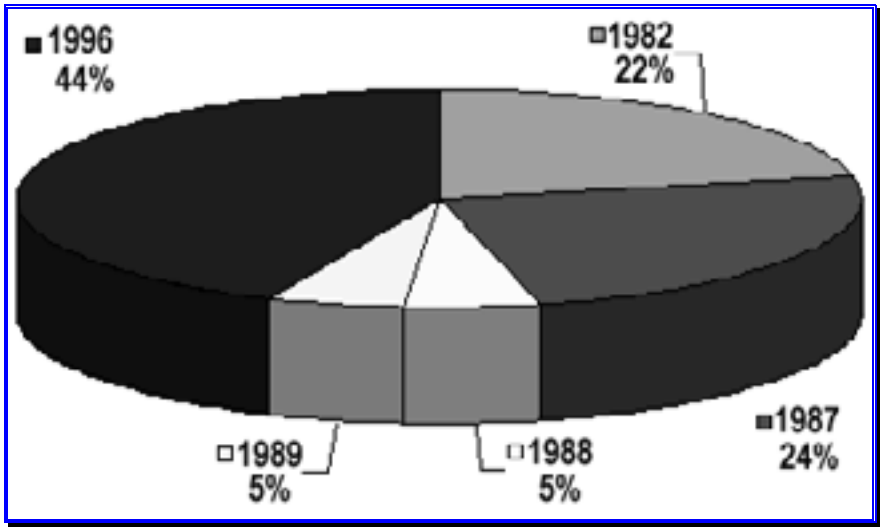


Figure 4 The Construction Boom in Palestinian Areas.

3. CEMENT

3.1 Portland Cement

The fundamental ingredient in concrete is calcium silicate cement made with a combination of calcium, silicon, aluminum, and iron. Producing a cement that meets specific chemical and physical specifications requires careful control of the manufacturing process. The first step in the Portland cement manufacturing process is obtaining raw materials. Generally, raw materials consisting of combinations of limestone, shells or chalk, and shale, clay, sand, or iron ore are mined from a quarry near the plant. At the quarry, the raw materials are reduced by primary and secondary crushers. Stone is first reduced to 5-inch size (125-mm), then to 3/4-inch(19 mm). Once the raw materials arrive at the cement plant, the materials are proportioned to create cement with a specific chemical composition. Two different methods dry and wet, are used to manufacture Portland cement. In the dry process, dry raw materials are proportioned, ground to a powder, blended together and fed to the kiln in a dry state. In the wet process, slurry is formed by adding water to the properly proportioned raw materials. The grinding and blending operations are then completed with the materials in slurry form. After blending, the mixture of raw materials is fed into the upper end of a tilted rotating, cylindrical kiln. The mixture passes through the kiln at a rate controlled by the slope and rotational speed of the kiln. Burning fuel consisting of powdered coal or natural gas is forced into the lower end of the kiln. Inside the kiln, raw materials reach temperatures of 2600F to 3000F (1430C to 1650C). At 2700F (1480C), a series of chemical reactions cause the materials to fuse and create cement clinker-grayish-black pellets, often the size of marbles. Clinker is discharged red-hot from the lower end of the kiln and transferred to various types of coolers to lower the clinker to handling temperatures. Cooled clinker is combined with gypsum and ground into a fine gray powder. The clinker is ground so fine that nearly all of it passes through a No. 200 mesh (75 micron) sieve. This fine gray powder is Portland cement.

3.1.1 Types of Portland Cement

Different types of Portland cement are manufactured to meet various physical and chemical requirements. The list below provides eight types of Portland cement.

Type I Portland cement is a normal, general-purpose cement suitable for all uses. It is used in general construction projects such as buildings, bridges, floors, pavements, and other pre-cast concrete products.

Type IA Portland cement is similar to Type I with the addition of air-entraining properties.

Type II Portland cement generates less heat at a slower rate and has a moderate resistance to sulfate attack.

Type IIA Portland cement is identical to Type II and produces air-entrained concrete.

Type III Portland cement is high-early-strength cement and causes concrete to set and gain strength rapidly. Type III is chemically and physically similar to Type I, except that its particles have been ground finer.

Type IIIA is air-entraining, high-early-strength cement.

Type IV Portland cement has a low heat of hydration and develops strength at a slower rate than other cement types, making it ideal for use in dams and other massive concrete structures where there is little chance for heat to escape.

Type V Portland cement is used only in concrete structures that will be exposed to severe sulfate action, principally where concrete is exposed to soil and groundwater with a high sulfate content.

White Portland cement
In addition to the eight types of Portland cement, a number of special purpose hydraulic cements are manufactured. Among these is white Portland cement. White Portland cement is identical to gray Portland cement except in color. During the manufacturing process, manufacturers select raw materials that contain only negligible amounts of iron and magnesium oxides, the substances that give gray cement its color. White cement is used whenever architectural considerations specify white or colored concrete or mortar. It is used mainly for architectural purposes such as pre-cast wall and facing panels ,terrazzo, stucco, cement paint

3.1.2 Blended Hydraulic Cements

Blended hydraulic cements are produced by intimately blending two or more types of cementations material. Primary blending materials are Portland cement, ground granulated blast-furnace slag, fly ash, natural pozzolans, and silica fume. These cements are commonly used in the same manner as Portland cements.

Blended hydraulic cements are classified as follows:

1. Portland Blast-furnace slag cement
2. Air entrained Portland blast-furance slag cement
3. Sulphate resistant Portland blast furnace cement
4. Portland-pozzolan cement

5. Air Entrained Portland –pozzolan cement

3.2 Cement Industry

The cement industry considers in all universe countries as one of the strategic industries , the cement represents a great importance in the projects of the construction , reconstruction and development ,on both levels as the specific levels and the general ones, the international production magnitude from the cement reaches nearly1300 million ton annual , this industry in Palestine has a specific importance , in this time in particular where the Palestinian society passes in construction stage and a populating of what increases the demand size on the cement , and this is what gives an extreme importance to establish local factory on the market compliance from the cement material by the specifications the competition prices ،and to putting limit in front of the subjection of the Palestinian market to the Israeli economy in this side .The size of demand on cement estimated in Palestine areas between 1.7- 1.6 million ton of year 1997.About 3 million ton is expected in the year 2003.
The Palestinian market gets all his needs from the cement by means of the import where the imported quantity spreads according to the source as follows :(*Source:* ***Palestinian National Information Center*** *)*

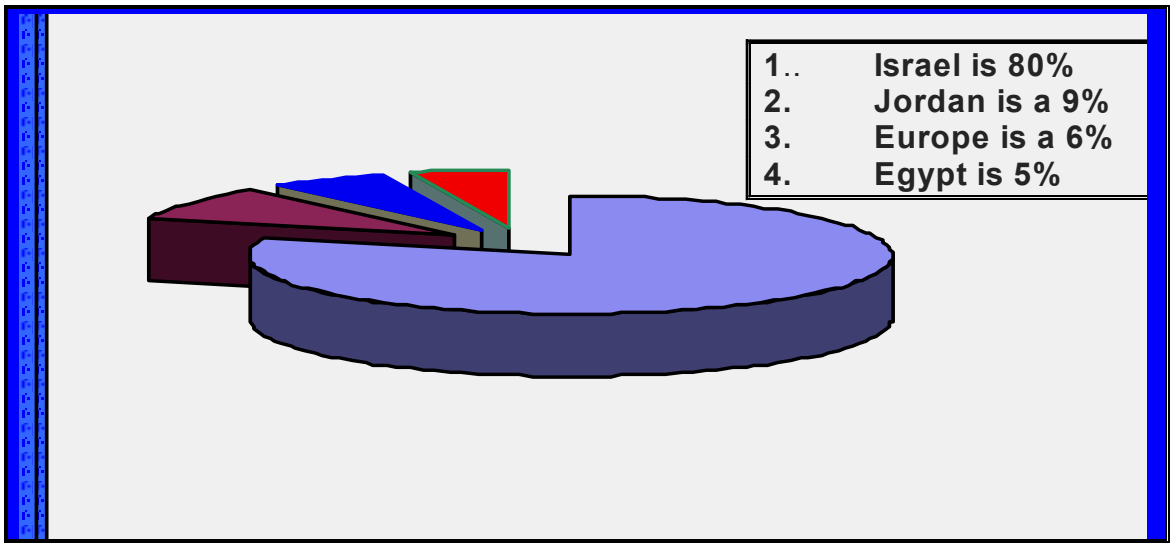
Israel is 80% ، Jordan is a 9% ، Europe is a 6% ، Egypt is 5%

3.2.1 The Sources of the Consumed Cement in the Palestinian lands

The needs of the Palestinian market from the cement during the Israeli occupation to the West Bank and the Gaza Strip have been obtained from two main sources:
1. The first - the company of the Jordanian cements plant.
2. The second from the import from Egypt to the market needs satisfaction and a specially are in Gaza Strip.

After the Israeli occupation to west Bank and Gaza strip in year 1967 ، and as a result to the military policy of Israel, a wide monopolization operation on the cement trade and that advantage the company practiced a Nishar Israeli
But after the Palestinian authority arrival and the signing of the economic agreements with Israel ,many changes on the cement import operation and the distribution happened ،where allowed to the Palestinian to import the cement from definite new sources , in addition to the foundation of the Palestinian company to the cement marketing in a year 1994 , where this company succeeded in the acquisition on some financial renunciations

from the Nishr company , the company was offering an opponent by a value 5 dollar to each ton and the tax restoration added on this opponent and the execution of this agreement has continued in a beginning a year 1995
The foundation of the Palestinian company to the commercial services completed , and undertook the cement import operation from Israel and Jordan and Egypt , according to signed trade agreements with the productive companies . As for the European cement have kept by means of the company a Nashar is imported. And the cement distribution operation by the Palestinian company to the cement marketing and that replaces the connecting between the distributors and the Palestinian company completes to the commercial services. And estimates that the marketing company share by a 87% from the market of the bagged cement in west Bank and the remaining one a 13% do by his marketing the company is an Algabria company in Hebron.



3.2.2 The Sources of Export Cement In Palestinian Areas

The trade agreements have defined all the sides that the cement material can import from Jordan, Egypt, Turkey, Greece, in addition to Israel
The Palestinian company has estimated the cement marketing and the size of the Palestinian market to a year is 1996 ، by 1.3 to 1.5 million ton ،from 600 thousand ton to west Bank , and the previous table have clarified the consumed quantities in the Palestinian lands from each country , and we notice that the Israeli cement he represents what his rate is a 58% from the consumed quantities ،the European cement controls on a 25% ، as for the sources from the Nishar company have informed that the companies sales is to west Bank and Gaza strip to a year 1996 1.1 million ton grew up . Added what imports from the other countries and that he is estimated at 150 thousand ton, the consumption size arrives at 1.25 million ton

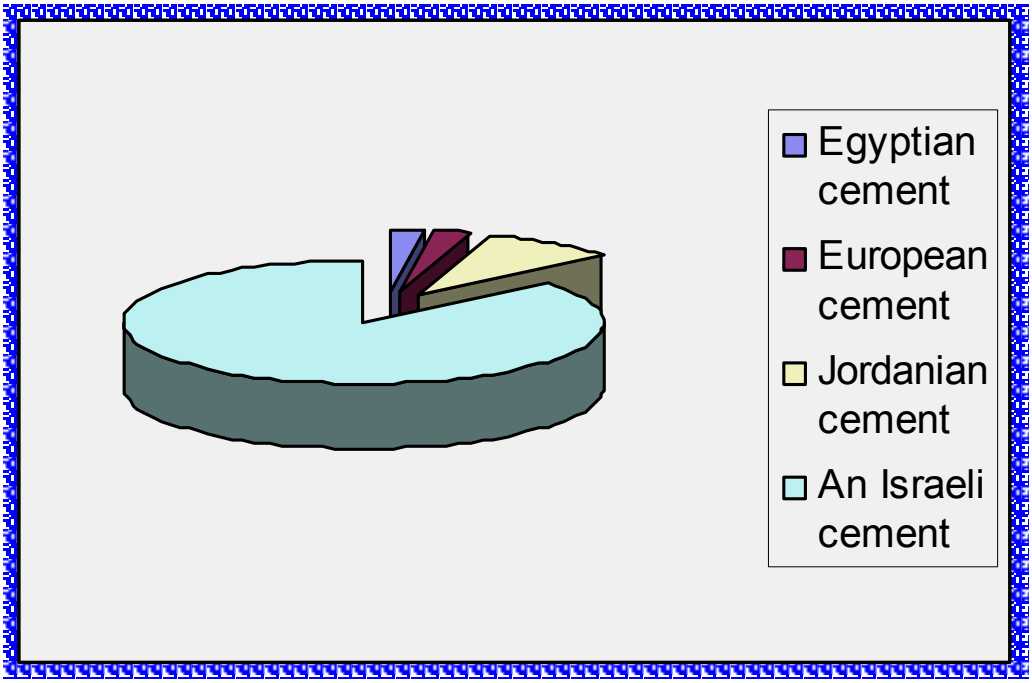
Table 9: The distributed cement sources in the West bank and the Gaza strip to the year 1996, 1999. (Thousand ton)

Source	Quantity		Quantity	
	1996	%	1999	%
Israel	350	58%	1.280	80%
Jordan	100	17%	144	9%
Europe	150	25%	96	6%
Egypt	-	-	80	5%
Total	600	100%	1600	100%

Source: *Palestinian National Information Center*

The commercial profit to the importer cement in the Palestinian lands is estimated by about 38 million dollar of year 1997 ، and this profit spreads between all sides:

1. The services company
2. The marketing companies
3. The cement merchants



The table below represents the value of the achieved profits from the cement according to total production to the year of 1997*(Palestinian National Information Center)*

Table10: The Value of the Achieved Profits from the Cement

The exporter	***Egyptian cement***	***European cement***	***Jordanian cement***	***Israeli cement***
The profits value	0.8	0.96	3.528	32.52
The Ratio	2.1%	2.6%	9.3%	86%

4. CONCRETE

4.1 Basic Raw materials of concrete & Processes of Manufactures

4.1.1 Ingredients

In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. Within this process lies the key to a remarkable trait of concrete: it's plastic and malleable when newly mixed, strong and durable when hardened. These qualities explain why one material, concrete, can build skyscrapers, bridges, sidewalks and superhighways, houses and dams. The key to achieving a strong, durable concrete rests in the careful proportioning and mixing of the ingredients. A concrete mixture that does not have enough paste to fill all the voids between the aggregates will be difficult to place and will produce rough, honeycombed surfaces and porous concrete. A mixture with an excess of cement paste will be easy to place and will produce a smooth surface; however, the resulting concrete is likely to shrink more and be uneconomical. A properly designed concrete mixture will possess the desired workability for the fresh concrete and the required durability and strength for the hardened concrete. Typically, a mix is about 10 to 15 percent cement, 60 to 75 percent aggregate and 15 to 20 percent water. Entrained air in many concrete mixes may also take up another 5 to 8 percent. Portland cement's chemistry comes to life in the presence of water. Cement and water form a paste that coats each particle of stone and sand. Through a chemical reaction called hydration, the cement paste hardens and gains strength. The character of the concrete is determined by quality of the paste. The strength of the paste, in turn, depends on the ratio of water to cement. The water-cement ratio is the weight of the mixing water divided by the weight of the cement. High-quality concrete is produced by lowering the water-cement ratio as much as possible without sacrificing the workability of fresh concrete. Generally, using less water produces a higher quality concrete provided the concrete is properly placed, consolidated, and cured.

Concrete can be separated into the following general categories based on density :

- Insulating Light weight concrete ,Using pumice ,scona, perlite,vermiculite .
- Normal weight concrete using sand ,gravel ,,crushed stone .

Concrete cab be used in a wide variety of wall, floor, and roof/ceiling.

4.1.2 Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories-fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch (9.5-mm) sieve. Coarse aggregates are any particles greater than 0.19 inch (4.75 mm), but generally range between 3/8 and 1.5 inches (9.5 mm to 37.5 mm) in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Recycled concrete is a viable source of aggregate and has been satisfactorily used in granular sub bases, soil-cement, and in new concrete. Aggregate processing consists of crushing, screening, and washing the aggregate to obtain proper cleanliness and gradation. If necessary, a benefaction process such as jigging or heavy media separation can be used to upgrade the quality. Once processed, the aggregates are handled and stored in a way that minimizes segregation and degradation and prevents contamination. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Consequently, selection of aggregates is an important process. Although some variation in aggregate properties is expected, characteristics that are considered when selecting aggregate include:

- grading
- Durability
- Particle shape and surface texture
- Abrasion and skid resistance
- Unit weights and voids
- Absorption and surface moisture

Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability, pump ability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate are specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate are used to obtain uniform textures in exposed aggregate concrete. Close control of mix proportions is necessary to avoid segregation.

Particle shape and surface texture influence the properties of freshly mixed concrete more than the properties of hardened concrete. Rough-textured, angular, and elongated particles require more water to produce workable concrete than smooth, rounded

compact aggregate. Consequently, the cement content must also be increased to maintain the water-cement ratio. Generally, flat and elongated particles are avoided or are limited to about 15 percent by weight of the total aggregate. Unit-weight measures the volume that graded aggregate and the voids between them will occupy in concrete. The void content between particles affects the amount of cement paste required for the mix. Angular aggregate increase the void content. Larger sizes of well-graded aggregate and improved grading decrease the void content. Absorption and surface moisture of aggregate are measured when selecting aggregate because the internal structure of aggregate is made up of solid material and voids that may or may not contain water. The amount of water in the concrete mixture must be adjusted to include the moisture conditions of the aggregate. Abrasion and skid resistance of an aggregate are essential when the aggregate is to be used in concrete constantly subject to abrasion as in heavy-duty floors or pavements. Different minerals in the aggregate wear and polish at different rates. Harder aggregate can be selected in highly abrasive conditions to minimize wear.

Table 11 Types of Various Aggregate Used in Concrete

Aggregate Used in concrete	
Normal weight concrete	Sand and gravel concrete Crushed stone and sand concrete Air-cooled slag concrete
Light weight concrete	Coal cinder concrete Scoria concrete Pumice concrete Cellular concrete

Although most drinking water is suitable for use in concrete, aggregates are chosen carefully. Aggregates comprise 60 to 75 percent of the total volume of concrete. The type and size of the aggregate mixture depends on the thickness and purpose of the final concrete product. Almost any natural water that is drinkable and has no pronounced taste or odor may be used as mixing water for concrete. However, some waters that are not fit for drinking may be suitable for concrete. Excessive impurities in mixing water not only may affect setting time and concrete strength, but also may cause efflorescence, staining, corrosion of reinforcement, volume instability, and reduced durability. Specifications usually set limits on chlorides, sulfates, alkalis, and solids in mixing water unless tests can be performed to determine the effect the impurity has on various properties. Relatively thin building sections call for small coarse aggregate, though aggregates up to six inches (150 mm) in diameter have been used in large dams. A continuous gradation of particle sizes is desirable for efficient use of the paste. In addition, aggregates should be clean and free from any matter that might affect the quality of the concrete. Soon after the aggregates, water, and the cement are combined, the mixture starts to

harden. All Portland cements are hydraulic cements that set and harden through a chemical reaction with water. During this reaction, called hydration, a node forms on the surface of each cement particle. The node grows and expands until it links up with nodes from other cement particles or adheres to adjacent aggregates. The building up process results in progressive stiffening, hardening, and strength development. Once the concrete is thoroughly mixed and workable it should be placed in forms before the mixture becomes too stiff. During placement, the concrete is consolidated to compact it within the forms and to eliminate potential flaws, such as honeycombs and air pockets. For slabs, concrete is left to stand until the surface moisture film disappears. After the film disappears from the surface, a wood or metal hand float is used to smooth off the concrete. Floating produces a relatively even, but slightly rough, texture that has good slip resistance and is frequently used as a final finish for exterior slabs. If a smooth, hard, dense surface is required, floating is followed by steel toweling. Curing begins after the exposed surfaces of the concrete have hardened sufficiently to resist marring. Curing ensures the continued hydration of the cement and the strength gain of the concrete. Concrete surfaces are cured by sprinkling with water fog, or by using moisture-retaining fabrics such as burlap or cotton mats. Other curing methods prevent evaporation of the water by sealing the surface with plastic or special sprays (curing compounds). Special techniques are used for curing concrete during extremely cold or hot weather to protect the concrete. The longer the concrete is kept moist, the stronger and more durable it will become. The rate of hardening depends upon the composition and fineness of the cement, the mix proportions, and the moisture and temperature conditions. Most of the hydration and strength gain take place within the first month of concrete's life cycle, but hydration continues at a slower rate for many years. Concrete continues to get stronger as it gets older.

4.1.3 The Forms of Concrete

Concrete is produced in four basic forms, each with unique applications and properties.

1. Ready mixed concrete, by far the most common form, accounts for nearly three-fourths of all concrete. It's batched at local plants for delivery in the familiar trucks with revolving drums.
2. Precast concrete products are cast in a factory setting. These products benefit from tight quality control achievable at a production plant. Pre-cast products range from concrete bricks and paving stones to bridge girders, structural components, and panels for cladding.
3. Concrete masonry, another type of manufactured concrete, may be best known for its conventional 8 x 8 x 16-inch block. Today's masonry units can be molded into a wealth of shapes, configurations, colors, and textures to serve an infinite spectrum of building applications and architectural needs.
4. Cement-based materials represent products that defy the label of "concrete," yet share many of its qualities. Conventional materials in this category include mortar, grout, and terrazzo. Soil-cement and roller-compacted concrete-"cousins" of concrete-are used

for pavements and dams. Other products in this category include flow able fill and cement-treated bases. A new generation of advanced products incorporates fibers and special aggregate to create roofing tiles, shake shingles, lap siding, and countertops. And an emerging market is the use of cement to treat and stabilize waste.

4.1.4 Mixing and Pouring of Concrete

Depending on the size of construction, concrete is mixed either by small stationary mixers using volume batching, a stationary batching plant and transit mixers , or by central batching plants operated by a supplier of ready mixed concrete. Large –scale projects place concrete by pump or by crane and bucket. A pump is not economical for small quantities which are poured using wheel barrows and hoist .On very small sites, manual labor is used.
Except on small sites (one-storey buildings), concrete is placed by using high frequency poker vibrator. On small sites, the concrete is placed by tamping .
As seen from the above, mechanization of concrete mixing and pouring is well advanced for contracts of certain size. On the other hand, small –sized buildings built by owner builders or small contractors are still using manual methods of construction .The reasons for this are:

- The quantities involved are small : the use of more sophisticated mixing and transporting equipment is not cost-effective

- Ready –mixed concrete is not used because the cost is relatively high and the suppliers of ready –mixed concrete will not supply less than a minimum quantity of 6 to 10 cu.m per batch .These per batch quantities cannot be used on small building sites.

i. Placing and Finishing Concrete

Mixing, transporting, and handling of concrete should be carefully coordinated with placing and finishing operations. Concrete should not be deposited more rapidly than it can be spread, struck off, consolidated, and bull floated. Concrete should be deposited continuously as near as possible to its final position. In slab construction, placing should be started along the perimeter at one end of the work with each batch placed against previously dispatched concrete. Concrete should not be dumped in separate piles and then leveled and worked together; nor should the concrete be deposited in large piles and moved horizontally into final position.
In some types of construction, the concrete is placed in forms, then consolidated. Consolidation compacts fresh concrete to mold it within the forms and around embedded items and reinforcement and to eliminate stone pockets, honeycomb, and entrapped air. It should not remove significant amounts of intentionally entrained air. Vibration, either internal or external, is the most widely used method for consolidating concrete. When

concrete is vibrated, the internal friction between the aggregate particles is temporarily destroyed and the concrete behaves like a liquid; it settles in the forms under the action of gravity and the large entrapped air voids rise more easily to the surface. Internal friction is reestablished as soon as vibration stops.

Concrete that will be visible, concrete slabs can be finished in many ways, depending on the intended service use. Options include various colors and textures, such as exposed aggregate or a patterned-stamped surface. Some surfaces may require only strike off and screeding to proper contour and elevation, while for other surfaces a broomed, floated, or toweled finish may be specified. In slab construction, screeding or strike off is the process of cutting off excess concrete to bring the top surface of the slab to proper grade. A straight edge is moved across the concrete with a sawing motion and advanced forward a short distance with each movement.

Bull floating eliminates high and low spots and embeds large aggregate particles immediately after strike off. This looks like a long-handled straight edge pulled across the concrete. Jointing is required to eliminate unsightly random cracks. Contraction joints are made with a hand groover or by inserting strips of plastic, wood, metal, or preformed joint material into the unhardened concrete. Saw cut joints can be made after the concrete is sufficiently hard or strong enough to prevent raveling. After the concrete has been jointed, it should be floated with a wood or metal hand float or with a finishing machine using float blades. This embeds aggregate particles just beneath the surface; removes slight imperfections, humps, and voids; and compacts the mortar at the surface in preparation for additional finishing operations. Where a smooth, hard, dense surface is desired, floating should be followed by steel toweling. Toweling should not be done on a surface that has not been floated; toweling after only bull floating is not an adequate finish procedure. A slip-resistant surface can be produced by brooming before the concrete has thoroughly hardened, but it should be sufficiently hard to retain the scoring impression.

ii. Chemical Admixtures

Chemical admixtures are the ingredients in concrete other than Portland cement, water, and aggregate that are added to the mix immediately before or during mixing. Producers use admixtures primarily to reduce the cost of concrete construction; to modify the properties of hardened concrete; to ensure the quality of concrete during mixing, transporting, placing, and curing; and to overcome certain emergencies during concrete

operations. Successful use of admixtures depends on the use of appropriate methods of batching and concreting. Most admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or at the jobsite. Certain admixtures, such as pigments, expansive agents, and pumping aids are used only in extremely small amounts and are usually batched by hand from pre-measured containers. The effectiveness of an admixture depends on several factors including: type and amount of cement, water content, mixing time, slump, and temperatures of the concrete and air. Sometimes, effects similar to those achieved through the addition of admixtures can be achieved by altering the concrete mixture-reducing the water-cement ratio, adding additional cement, using a different type of cement, or changing the aggregate and aggregate gradation.

iii. Classes of Chemical Admixtures

Admixtures are classed according to function. There are five distinct classes of chemical admixtures: air-entraining, water-reducing, retarding, accelerating, and plasticizers (superplasticizers). All other varieties of admixtures fall into the specialty category whose functions include corrosion inhibition, shrinkage reduction, alkali-silica reactivity reduction, workability enhancement, bonding, damp proofing, and coloring. Air-entraining admixtures, which are used to purposely place microscopic air bubbles into the concrete, are discussed more fully in "Air-Entrained Concrete." Water-reducing admixtures usually reduce the required water content for a concrete mixture by about 5 to 10 percent. Consequently, concrete containing a water-reducing admixture needs less water to reach a required slump than untreated concrete. The treated concrete can have a lower water-cement ratio. This usually indicates that a higher strength concrete can be produced without increasing the amount of cement. Recent advancements in admixture technology have led to the development of mid-range water reducers. These admixtures reduce water content by at least 8 percent and tend to be more stable over a wider range of temperatures. Mid-range water reducers provide more consistent setting times than standard water reducers.

Retarding admixtures, which slow the setting rate of concrete, are used to counteract the accelerating effect of hot weather on concrete setting. High temperatures often cause an increased rate of hardening which makes placing and finishing difficult. Retarders keep concrete workable during placement and delay the initial set of concrete. Most retarders also function as water reducers and may entrain some air in concrete. Accelerating admixtures increase the rate of early strength development, reduce the time required for proper curing and protection, and speed up the start of finishing operations. Accelerating admixtures are especially useful for modifying the properties of concrete in cold weather. Super plasticizers, also known as plasticizers or high-range water reducers (HRWR), reduce water content by 12 to 30 percent and can be added to concrete with a low-to-normal slump and water-cement ratio to make high-slump flowing concrete. Flowing concrete is a highly fluid but workable concrete that can be placed with little or no vibration or compaction. The effect of super plasticizers lasts only 30 to 60 minutes, depending on the brand and dosage rate, and is followed by a rapid loss in workability.

As a result of the slump loss, super plasticizers are usually added to concrete at the jobsite. Corrosion-inhibiting admixtures fall into the specialty admixture category and are used to slow corrosion of reinforcing steel in concrete. Corrosion inhibitors can be used as a defensive strategy for concrete structures, such as marine facilities, highway bridges, and parking garages, that will be exposed to high concentrations of chloride. Other specialty admixtures include shrinkage-reducing admixtures and alkali-silica reactivity inhibitors. The shrinkage reducers are used to control drying shrinkage and minimize cracking, while ASR inhibitors control durability problems associated with alkali-silica reactivity.

iv. Concrete Workability

An on site simple test for determining workability is the SLUMP TEST.
This consists of a conical mould 300mm. high, with an opening at the top of 100mm. diam., and at the bottom of 200mm. diam..
The mould is filled with concrete in 4 layers and rodded to remove air voids, with the smaller orifice uppermost.
The "slump" is the difference in height between the height of the mould and the height of the concrete column with the mould removed.
The workability of the concrete will depend upon the situation into which the concrete is being placed.
Low workability, i.e. stiff concrete, is needed for carriageway concrete which is laid by a "paving train".
High workability concrete is needed in situations of high density of reinforcing steel to enable the concrete to flow around all the reinforcing without leaving any voids

Specifying &Measuring Concrete Strength

The strength/grade of concrete is specified and measured in newtons/sq. mm., meganewtons/sq. meter or even megapascals, in fact the numerical figure will be the same in each case.
E.g. strength of 20 newtons/sq.mm. is the same as 20 meganewtons/sq.metre.

The strength/grade of concrete is normally specified by stating the strength you wish the concrete to achieve after a period of 28 days. The strength is measured by crushing concrete cubes to failure and recording this strength.
Concrete cubes are made from fresh concrete sampled at the time of pouring by placing correctly sampled concrete into a steel mould and compacting to remove air voids.
The concrete is allowed an initial "set" period of 24 hours, the mould is then stripped and the cube is cured in water at a temperature of 20 deg.c for 28 days prior to crushing.

4.2 Types of Concrete

Table 12 Composition and Properties of Different Types Concrete

Type of Concrete	*Materials and parts by volume in mix*	*Properties*	*Area of Use*	*Density Kg/m^3*	*Thermal Conductivity (W/m.c^0)*
Lime sandstone	Lime :1 Quartz sand :9	Durable ,senstive to moisture	Internal and external structures, cladding	2100	1.207
Lime concrete	Lime :1/1 Sand:2/4 Aggregate :4/6	Elastic, not very resistant to water and frost	Internal light structures, regulating of moisture	2150	1.265
Lime pozzolana concrete	Lime/Pozzolana:3 Sand :1 Aggregate :2	Medium strength, elastic, frost and moisture resistant	Internal and external structures	2260	1.45
Portland concrete	Cement :2/1 Sand :6/3 Aggregate :5/3	Strong,durable ,not particularly elastic, frost and moisture resistant	Internal and external structures, foundations	2160	1.255
Portland – pozzolana concrete	Cement/pozzolana: 1 Sand:3 Aggregate:5/3	Strong,durable ,little to moderate elasticity, frost and moisture resistant	Internal and external structures, foundations	2300	1.75
Gypsum concrete	Gypsum :1 Sand :1 Aggregate :2	Not very resistant to water and frost	Internal light structures	1860	0.87

Source: Jordan Cement Company

4.2.1 Ready-Mixed Concrete

Ready mixed concrete, by far the most common form of concrete, accounts for nearly three-fourths of all concrete. Ready mixed refers to concrete that is batched for delivery

from a central plant instead of being mixed on the job site. Each batch of ready mixed concrete is tailor-made according to the specifics of the contractor and is delivered to the contractor in a plastic condition, usually in the cylindrical trucks often known as "cement mixers."

Table 13 Distribution of Ready Mix Concrete Companies in Palestinian Areas

Location	***No. of Ready mix concrete***
Hebron	8
Bethlehem	6
Ramallah	7
Nablus	6
Jenin	3
Tulkarem	2
Qalqilia	2
Jericho	2
Total	***36***

Source: The Palestinian Ministry of Industry 2000.

Ready mixed concrete is particularly advantageous when small quantities of concrete or intermittent placing of concrete are required. Ready mixed concrete is also ideal for large jobs where space is limited and there is little room for a mixing plant and aggregate stockpiles. There are three principal categories of ready mixed concrete:

- Central-mixed concrete is completely mixed at the plant then transported in a truck-mixer or agitator truck. Freshly mixed concrete may be transported in a open dump truck if the jobsite is near the plant. Slight agitation of the concrete during transit prevents segregation of the materials and reduces the amount of slump loss.
- Transit-mixed (also known as truck-mixed) concrete, materials are batched at a central plant and are completely mixed in the truck in transit. Frequently, the concrete is partially mixed in transit and mixing is completed at the jobsite. Transit-mixing keeps the water separate from the cement and aggregates and allows the concrete to be mixed immediately before placement at the construction site. This method avoids the problems of premature hardening and slump loss that result from potential delays in transportation or placement of central-mixed concrete. Additionally, transit-mixing allows concrete to be hauled to construction sites further away from the plant. A disadvantage to transit-mixed concrete, however, is that the truck capacity is smaller than that of the same truck containing central-mixed concrete.

- Shrink-mixed concrete is used to increase the truck's load capacity and retain the advantages of transit-mixed concrete. In shrink-mixed concrete, concrete is partially mixed at the plant to reduce or shrink the volume of the mixture and mixing is completed in transit or at the jobsite.

4.2.2 Light Weight Aggregate concrete

This usually produced as blocks, slabs or floor beam units. Mineral insulating aggregate in concrete can be light expanded pumice, vermiculite aggregate that has excellent insulating properties due to the lowest moisture absorption coefficient.

Table 14 Thermal Properties of Light Weight Aggregate Concrete

Bulk Density (Kg/m^3)	*Thermal Conductivity ($W/m.C^o$)*	*Specific Heat Capacity (KJ/Kg/C)*
800	.39	.97
900	.44	.97
1000	.49	.97
1100	.55	.97
1200	.62	.97
1300	.70	.97
1400	.79	.97
1500	.89	.97
1600	1.00	.97
1800	1.30	.97
2000	1.60	.97

Source: *Palestine Standards Institution (PSI)*

4.2.3 Pre-cast Concrete (Artificial Stone)

Pre-cast Concrete or sometimes called cast stone or artificial stone, is a masonry material made of reinforced concrete whose facing surface has a decorative .It may be either smooth, polished, or textured, and colored

Pre-cast concrete products may be divided into two general categories

1. Facing for exterior or interior walls of buildings

The pre-cast concrete used for facing buildings usually has a textured or polished surface with granite, quartz, and vitreous ceramics materials of specific color selected for the job.

2. Miscellaneous items for masonry work such as stair treads and coping

Pre-cast concrete is widely used in hotels. The concrete provides superior fire resistance and sound control for the individual units .

There are two types of pre-cast products. Standard products such as beams, decks, are shaped in one way and used over and over again. The other type of product is a specialty product, designed especially for the building, bridge, or

structure where it will be used. Most pre-cast companies have their own carpentry shops where skilled workers create forms for the many specialty pre-cast products available. Architectural concrete is often cast specially for each new project.

The forms, whether standard or specialty, are well oiled. Concrete is placed in the forms and allowed to cure. After curing, the product is carefully lifted from the form and taken to a yard for further curing before it is shipped to the project site. The form is then carefully cleaned and prepared for the next batch of concrete. Many pre-casters can turn over their forms every one or two days

4.2.4 Autoclaved Cellular Concrete

Autoclaved cellular concrete (ACC) is a lightweight pre-cast concrete building material that is cured under elevated pressure inside special kilns called autoclaves. Though ACC has been used successfully throughout most of the world .

ACC, sometimes known as autoclaved aerated concrete, is made with all fine materials-nothing coarser than finely ground sand. What makes ACC different from lightweight aggregate concrete is that ACC contains millions of microscopic cells that are generated during the manufacturing process. In addition, ACC is unlike many other concrete products because it may be drilled, sawed, chiseled, nailed, or screwed using conventional carpentry tools.

The basic raw materials are Portland cement, limestone, aluminum powder, water, and a large proportion of a silica-rich material-usually sand or fly ash. Once raw materials are mixed into slurry and poured into greased molds, the aluminum powder reacts chemically to create millions of tiny hydrogen gas bubbles. These microscopic, unconnected cells cause the material to expand to nearly twice its original volume-similar to the rising of bread dough-imparting the lightweight cellular quality to ACC. After a setting time ranging from 30 minutes to 4 hours, the foam-like material is hard enough to be wire cut into the desired shapes and moved into an autoclave for curing.

The autoclave uses high-pressure steam at temperatures of about 356° F (180°C) to accelerate the hydration of the concrete and spur a second chemical reaction that gives ACC its strength, rigidity, and dimensional stability. Autoclaving can produce in 8 to 14 hours concrete strengths equal to strengths obtained in a concrete moist-cured for 28 days at 70° F (21°C). The final products are usually shrink wrapped in plastic and transported directly to the construction site.

ACC, which is about one-fourth of the weight of conventional concrete, is available in blocks, wall and roof panels, lintels, and floor slabs. Each of these products can be

manufactured in a range of sizes depending on specific applications, allowing for maximum efficiency and flexibility in construction. ACC can be used for all types of structures ranging from single-family housing to large industrial complexes.

ACC is an inert, nontoxic substance that has an energy-efficient and pollution-free manufacturing process. Perhaps the most significant environmental benefit of using ACC is that fly ash can be used as the silica-rich component. The electric utility industry generates more than 50 million tons of fly ash each year-only a fraction of which can be recycled.

ACC is reasonably frost and sulfate resistant, allowing it to be used around the world in all climatic zones and for a wide range of applications. When it is used on the exterior, ACC is normally protected by stucco or other protective coatings. ACC also is an inorganic material, making it 100 percent termite and vermin proof and resistant to rotting and mold

4.2.5 Concrete Blocks

Concrete masonry has become a standard building material. Concrete blocks create structures that are economical, energy efficient, fire-resistant, and involve minimal maintenance. In addition, concrete masonry allows architectural freedom and versatility. Concrete masonry homes, traditionally popular in Gaza strip

The standard concrete block is a rectangular 8X8X16-inch unit (20X20X40 cm) made mainly of Portland cement, gravel, sand, and water. The concrete mixture may also contain ingredients such as air-entraining agents, coloring pigment, and water repellent. During the manufacturing process, a machine molds moist, low-slump concrete into the desired shapes. These blocks then undergo an accelerated curing process at elevated temperatures inside a special chamber

Concrete block is a masonry unit, usually with single or multiple hollows available solid, made of following ingredient: water, Portland cement, blended cements and various types of aggregate such as sand, gravel, crushed stone. Aggregates are generally designated as fine or coarse.

There are three types of concrete blocks

1. Hollow load bearing
2. Hollow non-load –bearing

3. Solid load bearing

The term "concrete block" was formerly limited to hollow masonry units made with aggregates such as sand, gravel, crushed stone, but the term today covers all types of concrete block, including solid units, made with any of the various kinds of aggregate.

The weight and texture of concrete block depend largely on the type of aggregate used in its manufacture. Block. made with sand and gravel and crushed stone weighs from 18-22 kg .These blocks are strong and durable, with a low absorption rate, blocks made with light weight aggregate weigh 11-16 kg .light weight blocks are produced as non-bearing units, for use as backup walls or load-bearing units, for use as the finished surface of both interior and exterior walls.

Table 15 Distribution of Manufacturing Block Concrete in Palestinian Areas

Location	***No. of concrete Block***
Hebron	12
Bethlehem	18
Ramallah	27
Nablus	16
Jenin	9
Tulkarem	5
Qalqilia	8
Jericho	2
Total	***97***

Source: The Palestinian Ministry of Industry

Table 16 Thermal Resistances Values of Various Dimensions of Concrete Blocks with Different Densities

Unit Dimensions of the Block (cm) (Width X Length X Thickness)	Weight Kg	Density Kg/m^3	Thermal Conductivity $(W/m.c^0)$	Thermal Resistance $(m^2. c^0)/W$
H.C.B 40X20 X 20	18	1125	0.52	0.38
H.C.B 40 X 20 X20	21	1350	0.62	0.32
H.C.B 40 X 20X20	14	875	0.46	0.43
H.C.B 40X20 X 15	16	667	0.45	0.33
H.C.B 40 X 20X10	11	1375	0.63	0.15
H.C.B 40 X 20 X 7	8	1428	0.70	0.10
H.C.B 40 X 20X7	9	1607	0.74	0.09

Source: Palestine Standards Institution (PSI)

The percentage of the cavities in H.C.B:

H.C.B 40 X 20 X 7 = 40.1 %

H.C.B 40 X 20X10 = 40.2 %

H.C.B 40X20 X 15 = 46.9 %

H.C.B 40 X 20 X20 = 47.8 %

4.2.6 Calcium Silicate Bricks - YTONG

Bricks are cast in different sizes and textures which makes their use beneficial for architectural features, besides their uses as partitions .Plastering to lime and silicate bricks may be deleted and instead mere pointing of joints applied .Lime and silicate bricks are less expensive and have better thermal insulations than the traditional concrete blocks.

The advantage of these kinds of bricks that used for building walls are :

- White in color with a smooth surface that reflects the sun and diffuses light inside rooms
- Dimensions and shapes are exact uniform
- Reasonable resistance to climatic conditions
- Insulates against summer heat and keeps the indoor warm in winter
- Does not need plastering or painting

- Strong and can be used as a bearing wall

The disadvantages are:

- The bricks absorb water which makes the wall damp. Sometimes discoloring is observed, for best use it is advisable to build cavity walls , this making kind of wall more expensive .

Table 17 Comparisons of Thermal Properties for Ytung & Expanded Polystyrene

	Density Kg/m^3	***Specific Thermal Conductivity (W/mK)***	***Specific Heat Capacity (Wh/Kg.C^0)***
Ytung	650	0.22	0.27
Expanded Polystyrene	40	0.04	0.40

Table 18 The Dimensions of Calcium Silicate Bricks

Solid	***Hollow***
90X190X290 mm	90X190X290 mm
140X190X290 mm	140X190X290 mm
190X190X290 mm	190X190X290 mm

5. INSULATION MATERIALS

5.1 The Importance of Thermal Insulation In Building

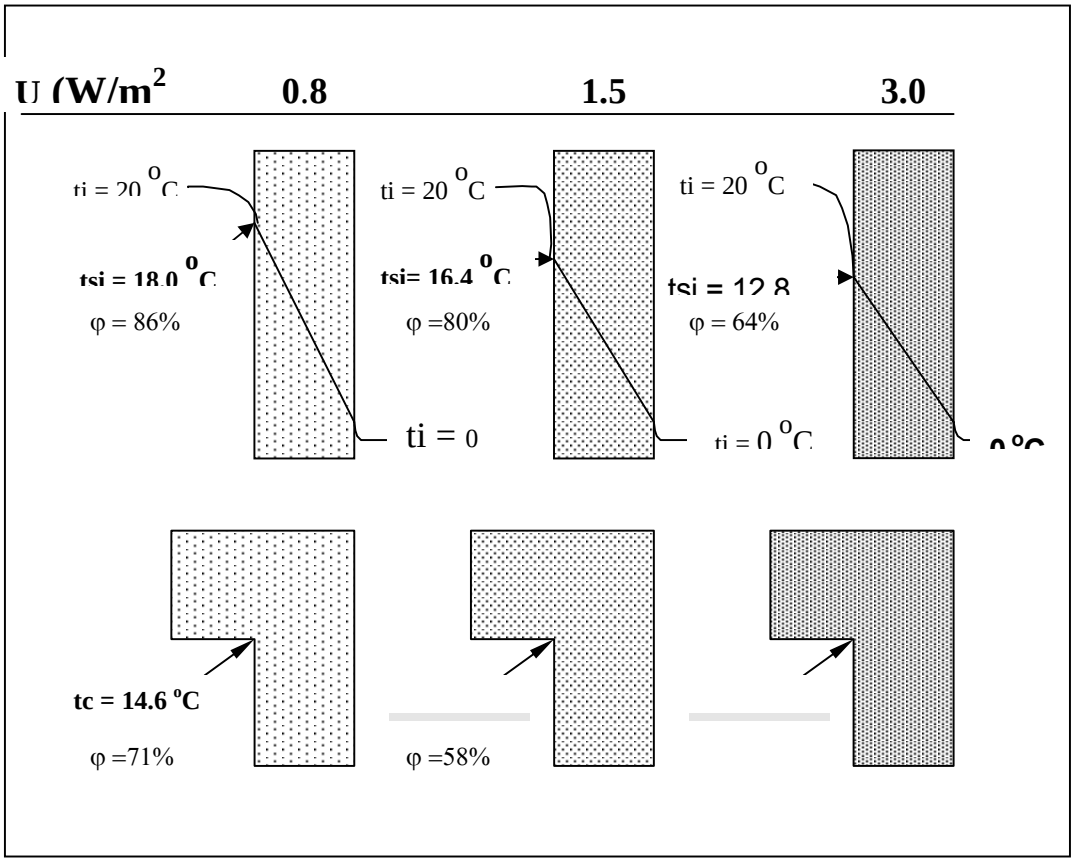


Figure 5 Temperature drop between ambient air temperature and surface temperature on inside of the buildings (Tsi = Surface inside temperature)

Why should apply the thermal insulation in buildings? The answers are as follows:

- To save energy, not only in winter but also in summer when we are dealing with buildings that are air conditioned.
- To protect the supporting structure of our buildings against temperature variations that occurs on the outside, from day to night and summer to winter.
- To increase our comfort by :

1. Creating a pleasant ambient air temperature (18 to 21 C ^{0})
2. Controlling relative humidity of air 40 to 60 %for temperatures of 21 to 21 C ^{0})
3. Limiting temperature drop between ambient air temperature and surface temperature on inside of our buildings Providing for good ventilation

- To control condensation in constructions. Less condensation should get into the construction during the winter and the intermediate seasons than the quantity that leaves the construction during summer and intermediate periods (Spring and Autumn

5.2 Types of Insulation Materials

Saving in recurrent costs over the life of a dwelling unit due to energy and thermal efficient building components far outweigh the additional , up- front capital investments.
Historically, thermal insulation was achieved naturally by the sheer thickness of adobe walls which were up to 100 cm thick. These structures provided natural insulating cooling and ventilation by properly orienting the dwelling to catch the predominant summer breezes .Smaller size windows also protected the interior from the direct sunlight.
In Palestinian Areas, winters, unlike those in most Middle Eastern countries, are severe.
Energy efficient buildings are required .The principle of thermal insulation in buildings must therefore be stressed. The initial extra cost of insulation will be offset by savings in running costs.

- Polyurethane and polystyrene foams are used in construction generally as thermal insulation for roofs, exterior walls.

Polyurethane, made either by reacting isocyanates with carboxylic compounds and adding a compound that produces carbon dioxide to make urethane foam, or by reacting adiisocyanate with a compound containing an active hydrogen
Polyurethane foam is available as rigid board 0.914 and 1.219 m, widths1.219 to 3.658 m length according to Bethlehem Plastic Company that is manufacturing these materials.

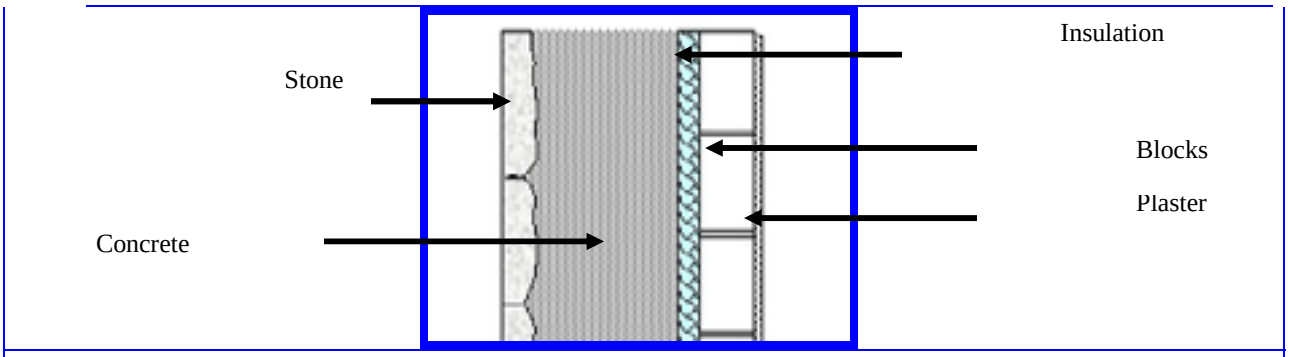


Figure 6: Construction Wall Insulated with Polystyrene

- Polystyrene, a polymerized styrene with compounds added to produce carbon dioxide to make polystyrene foam.

Polystyrene foam is available as rigid boards in width of (0 .406, 0.610, 1.219 m) and in thickness (12.7, 19.05, 25.4, 38.1, 50.8, 76.2, 101.6 mm)
There are three types of Polystyrene Boards

One: Extruded Polystyrene
Two: Low and Medium Density Expanded Polystyrene
Three: High Density Expanded Polystyrene

Table 19 Chemical and Physical Characteristics of Polystyrene Boards

The Property		The Type of Polystyrene		
		ONE	TWO	THREE
Density (Kg/m^3)	MIN	15	20	25
	MAX	20	30	35
Compressive Strength (N/m^2)		0.215	0.215	0.188
Water Uptake %		5	3	2
Thermal Conductivity (W/m.C)		0.040	0.039	0.037
Maximum Service Temperature for Continuous operation(C^0)		70	70	70
vapor permeability μ Newton.s/g.m		100-270	160-380	215-540

Table 20 Chemical and Physical Characteristics of Polyurethane

The Property	The Type of Polyurethane		
	ONE	TWO	THREE
Density (Kg/m^3)	27	27-40	40-64
Compressive Strength (MN/m^2)	55	105	205
Water Uptake %	3	3	3
Thermal Conductivity (W/m.C)	0.025	0.022	0.020
Maximum Service Temperature for Continuous operation(C^0)	100	100	100
vapor permeability μ Newton.s/g.m	160-540	160-540	160-540

Source: Bethlehem Plastic Company

Rock Wool Panels (RWP)

It used and produced mostly in Jordan by JORDAN ROCK WOOL INDUSTRIES CO. LTD; **R.W** Panels (slabs) are formed from bonded fibers with thermosetting binder.
Panels are produced as rigid and semi rigid with various thickness and densities.
Rigid panels with high density are designed to be used under normal compression load, therefore they are recommended for roof & floor insulation. Panels can be provided with different facing materials in standard dimensions, other dimensions can be produced upon request.

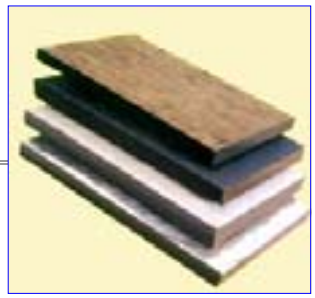


Table 21 Thermal Properties of Rock Wool Panels

Type	*Dimension/M*		*Thick MM*	*Density Kg/M^3*	*K. Value w/m °C*	*Facing Materials*
	Width	*Length*				
Semi Rigid Panels	0.6	1.0 & 1.2	30-100	40-80	0.032	* Polyethylene sacks * La Foil
Rigid Panels	0.6	1.0 & 1.2	30-100	90-140	0.035	* Bituminous Paper * F.G .Veil

Source: JORDAN ROCK WOOL INDUSTRIES CO. LTD

• Semi Rigid Panels are used to insulate:

* Building “Walls”.
* Prefabricated Buildings.
* Solar heating system.

• Rigid Panels are used to insulate:

* Building (Roofs, Floors & Partitions).
* Duct internal lining.

Table 22 Chemical and Physical Characteristics of others Major Insulation Materials

Major Insulation Material Type	*Density Kg/m^3*	*Thermal Conductivity (W/mK)*	*Specific Thermal Capacity (KJ/KgK)*
1. Expanded perlite, untreated, 17cm	100>	0.045-0.055	3-4
2. Expanded perlite with bitumen 19 cm	100>	0.055	3-4
3. light weight aggregate concrete 4. block work (structure) 7.5 cm	200-1600	0.210	1
5. Foam glass boards 17 cm		0.045	1.1
6. foam glass granules 35 cm		0.035	1
7. Mineral wool 15 cm	20-300	0.04	0.8
8. Expanded Polyurethane 13,5 cm	27<	0.035	1.5

Source: Palestine Standards Institution (PSI)

5.3 Some Suggestions for Appropriate insulating materials in Palestinian Areas

The following paragraphs discuss appropriate insulating materials for Palestinian Areas

In the past the stationary dry air was considered as a very good insulator. This is the reason why concrete blocks have voids, the same reason why light weight concrete for roof screeds have air alveols.
Also, cavity walls were originally introduced to increase the insulation properties of exterior walls. Trapped air is one of the most important components which enter into the manufacture of most insulating materials.
The major manufactured insulation materials fall into two major groups:

- Organic (manly plastics)
- Mineral.

They are produced in various shapes and types with different physical properties .Each is intended for a specific insulating purpose in the building industry
Among the more commonly available insulation materials on the local market the following should be mentioned:

- Organic insulating materials such as :
  1. Polystyrene in its two forms (expandable and extruded)
  2. Polyurethane produced in sheets of different densities and sizes or as a liquid foam which can be poured in place or injected

- Mineral insulation materials (non-organic) :
  1. Light weight concrete
  2. Foam concrete
  3. Rock wool which is manufactured in Jordan in different shapes and densities
  4. Glass wool and fiberglass manufactured as blankets or rigid sheets sometimes with an aluminum vapors barrier fastened to one side.
  5. Perlite produced as tiny particles which can either fill cavity walls, voids or be mixed into the composition of weal concrete and concrete blocks.

To be complete on the subject of insulation, we cannot conclude without mention the adverse effect of infiltration through cracks of doors and windows due to bad workmanship and design and the lack of proper weather stripping. Double glazing is an improvement over single sash thin glass. Apart from necessary fresh air for health purposes; losses due to infiltration are variable and are conditional on many factors:

- Wind velocity
- Length and size of cracks and openings
- Orientation of windows and doors.

5.4 Improving Insulating Qualities of Concrete

Concrete, in its natural, normal dense state, has poor insulating properties and unless treated with additives and /or combined with specific thermal insulating materials, allows heavy energy losses to a structure.
The losses are of different types:

1. Thermal conductivity due to difference in temperature (gradient)between internal and external temperatures
2. Direct solar heat which has to do with texture and reflective properties of the exposed surface
3. Several other factors among which is wind velocity , and the number of times heat traverses the surface of different materials (concrete-air-concrete plaster)

I will devote our discussion to improving the insulating qualities of concrete in order to enhance its insulating qualities at the optimum initial cost

A.Cavity Construction in Walls

The cheapest and most cost effective insulating material is air. A double concrete wall separated by a cavity of air is an effective insulator and doesn't involve the introduction of any additional material. Other means of reducing heat losses are by applying an external skin of stone wall and internal skin of either concrete or block wall. The comparative value of the transmittance factor is shown in the following table.(Table 24)
A further improvement to the above is the introduction in the cavity of infill insulating material. A few such materials include: Polystyrene, Polyurethane, Perlite, Fiberglass, Rock wool.

Table 23 Comparative "U" values for Insulated Wall Sections

Type of Wall Section	***Transmittance "U" ($W/m^2.C$)***	***Density (Kg/m^3)***	***Thermal Conductivity (W/m. C)***
Block wall 7 cm + 5 cm Cavity and Block wall 7 cm	1.61	--------	Concrete block = 0.90 Cavity = 0.29
Block wall with 5 cm Polystyrene	0.54	20	0.32 W/m.C
Block wall with 2 cm Polyurethane	0.82	30	0.25 W/m.C
Block wall with 5 cm Rock wool	0.66	80	0.35
Block wall with 5 cm Perlite grains	0.84	45	0.045

It is conclusive that polystyrene is the most cost effective infill material based on initial installation cost and local availability.
Light weight concrete with reduced conductivity can be produced by two methods:|
By adding air entraining agents
By using light weight aggregates.

B- Additives and Air Entraining Agents

If concrete is mixed with special chemicals which entrain air (by creating small cells) , we get is commonly called foam concrete . The concrete thus treated is ideal for application on roofs as screeds.

C. Perlite Concrete

Vermiculate or perlite can be used in concrete to produce light weight screeds laid over structural roof slabs. They also provide good thermal insulation and decrease dead loads on buildings. Proposed admixtures to produce perlite concrete in two densities, 305 kg/m^3 and 365 kg/m^3, are shown below

Table 24 Thermal Properties for Perlite Concrete

Perlite (m^3)	*Cement (Kgs)*	*Compressive Strength (Kg/cm^2)*	*Thermal Conductivity (W/m^2. C)*	*Dry density (Kg/m^3)*
1.0	150	4.0-6.0	0.064-0.074	305
1.0	200	8.0-10.0	0.072-0.082	365

D. Ribbed Slabs vs. Solid Slabs

Ribbed slabs have a slight advantage over solid slabs in so far as insulating considerations are concerned. However, they are not cost effective as the following table shows (with respect to initial cost)

Table 25 Thermal Transmittance of Ribbed vs. solid Slabs

Type of Slab	*Thermal Transmittance (W/m^2. C)*
Ribbed 25 cm	1.78
Solid 15 cm	1.83

Table 26 : Thermal Conductivity Values of Different Types of Construction Materials

Type of the Construction Materials	*Density (Kg/m^3)*	*Thermal Conductivity ($W/m.C^0$)*
Cement Plaster	1850	0.72
	1570	0.53
Gypsum Plaster	1280	0.46
	1120	0.38
Perlite Plaster	610	0.19
	400	0.08
Cellular Plaster	880	0.25
Autoclaved Cellular Concrete	320	0.08
Moist Cured Cellular Concrete	350	0.09
	835	0.19
Light Weight Concrete with Expand Perlite	400	0.16
	1120	0.39
Light Weight Concrete with Expanded Vermiculite	400	0.16
	0.16	0.26
Normal Concrete	2240	1.40
	2480	1.80
Solid concrete Blocks	1900	1.20
Hollow Concrete Blocks	1600	1.00
	1400	0.90

	1200	0.77
	1000	0.65
Hollow Blocks for Slabs	1400	0.95
Expanded Polystyrene	30	0.030
	25	0.034
	15	0.037
Extruded Polystyrene	25	0.030
Polyurethane	30	0.027
Rock Wool (Rigid Board)	140	0.040
Glass Wool (Rigid Wool)	150-100	0.060-0.045
Perlite	100	0.060
Vermiculate	100	0.070
Polystyrene (Particles)	15	0.045

Type of the Construction Materials	***Density (Kg/m^3)***	***Thermal Conductivity ($W/m.C^0$)***
Lime stone	2200	1.53
	2180	1.50
Sandstone	2300	1.50
	2000	1.30
Marble	2500	2.20
Granite	2600	2.30
Basalt	2600	2.30
Normal Glass for Windows	2500	1.05
Heat Resistant Glass	2250	1.10
Flint Glass	3500	0.70
Aluminum	2800	200
Steel	7800	60
Concrete with Normal Aggregate	1600	0.81
	1800	1.10
	200	1.40
Concrete With Light Aggregate	600	0.22
	700	0.26
	800	0.28
	1000	0.36
	1200	0.46
	1400	0.57
	1600	0.75
	1800	0.92

	2000	1.20
Concrete with gravel or crushed –stone aggregate and closed texture	2000	2.03
Concrete with broken –brick aggregate and closed texture	1600	0.76
	1800	0.93
	2000	1.05
Gas (aerated) concrete , light weight lime concrete	500	0.19
	600	0.23
	800	0.29
	1000	0.35
Type of the Construction Materials	***Density (Kg/m^3)***	***Thermal Conductivity (W/m.C^0)***
Porous concrete containing non-porous aggregate (gravel, etc)	1500	0.64
	1700	0.81
	1900	1.11
Porous broken –brick or slag concrete	1200	0.47
	1400	0.58
	1600	0.76
Pumice-stone concrete ,expanded clay concrete	800	0.29
	1000	0.35
	1200	0.47
Concrete with wood product aggregate	800	0.41
	1000	0.52
Asphalt	2000	0.70
Bitumen	1400	0.14
PVA * filler – 2 mm & 5 mm	1200	0.23
Glass Fiber mats - quilted - loose - loose - roll - 2 layer - glass fiber for slabs	75 75 90 100 100 75	0.041 0.041 0.041 0.041 0.041 0.041
Mineral –fiber slabs	80	0.041
	110	0.041
	140	0.041
Slag-wool mats	130	0.070
Slag- wool slabs	180	0.070
	180	0.070
Rock wool	58	0.041

	65	0.041
Acetone – formaldehyde resin foam	30	0.041
Urea-formaldehyde resin foam	11	0.041
	46	0.041
Polystyrene bead board	15	0.041
	20	0.041
	30	0.041
	40	0.041
Dense polystyrene foam with skin	40	0.041
Type of the Construction Materials	***Density (Kg/m^3)***	***Thermal Conductivity (W/m.C^0)***
Dense polystyrene foam with skin	50	0.041
	60	0.041
Dense polystyrene foam ,rolled	30	0.041
Polyurethane foam	30	0.041
Phenolic resin foam	20	0.041
	100	0.041
Polyvinyl chloride foam * PVA = Polyvinyl alcohol	40	0.041
	70	0.41
Foam glass	150	0.047
	300	0.116
Asphalt screed	2000	0.70
Gypsum mortar,gauged with sand	800	0.41
	1000	0.52
	1200	0.70
Aerated Gypsum	600	0.23
Lime Gypsum		0.70
Lime Plastering	1600	0.87
Portland cement and Lime mortar	1800	0.87
Cement mortar	1800	1.39
Terrazzo	2000	1.16
Blast –furnace slag Foamed Granulated Granulated Granulated	350 700 900 1300	0.14 0.19 0.26 0.40
Gravel	1850	0.81
Pumice gravel	600	0.19
Perlite	100 700 900	0.06 0.12 0.15
Coal slag	800	0.19

Sand	2000	0.58
Broken brick	1200	0.41
Natural Pumice, foamed –iron slag	800 1000 1200 1400	0.29 0.35 0.47 0.58
Type of the Construction Materials	***Density (Kg/m^3)***	***Thermal Conductivity (W/m.C^0)***
Gypsum Plasterboard slabs up to heavy slabs with d= 18 mm	 1150	0.21 0.47
Glass- fibre resinfaced gypsum board	1200	0.49
Gypsum wallboard without finish	600 750 900 1000 1200	0.29 0.35 0.41 0.46 0.58
Tiles	1700	1.04
	2300	1.04
Cement –bonded blocks including mortar joints • Sand lime units 1.Hollow units 2.Solid units	 1000 1200 1600 1800 2000	 0.50 0.56 0.79 0.99 1.11
Granulated slag blocks Porous units Porous units Solid units Solid units Solid units	 1400 1600 1800 2000 2200	 0.58 0.64 0.76 0.84 1.05
Lightweight Concrete blocks Solid units Two –cavity units Three-cavity units	 800 1000 1200 1400 1600 1000 1200 1400 1400 1600	 0.41 0.47 0.52 0.58 0.79 0.44 0.49 0.56 0.49 0.56

Lightweight lime –concrete blocks Steam cured Air cured	 800 1000 800 1000 1200	 0.41 0.47 0.44 0.56 0.70
Natural Stones Granite , Marble, Basalt Sandstone, Shell Lime stone Limestone , amorphous	 2700 2300 2600	 3.48 2.32 1.22
Window glass An area of glazing	2500	0.81
Metals Aluminum Lead Cast Iron Copper Steel	 2700 11300 7200 8900 7800	 203 50 383 58

6. WINDOWS & DOORS

6.1 Windows

Openings in walls to provide natural light, ventilation, or views are classed as windows. The first glass windows were fixed in crude wood frames. Progressive builders combined more and more small pieces of glass to fill larger openings. The most common metals used in the construction of windows and frames are aluminum, steel, and stainless steel. Metal windows are made in a wide variety of types. Wood Windows provide good insulation and are inexpensive, but they tend to swell and shrink with changes in moisture. .Metal windows have more strength and rigidity, but they offer poor insulation and are subject to the condensation of moisture on their inner surfaces. Although steel windows are stronger than aluminum, they must be painted and maintained.

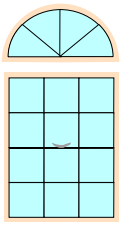
Supplies of doors and windows in steel, wood, aluminum or hardened PVC are readily available in Palestinian Areas. Initial pricing suggests that wood is cheaper than steel, and steel cheaper than aluminum, although prices are closer to each other and aluminum is becoming a popular material for windows.
From experience, steel doors are preferred for front doors for security reasons .Inner doors are usually wooden.
Lintels are often cast insitu and project pricing implies that this is the cheapest approach.

Table 27 Thermal Resistance of Different Types of Windows

The Type Of Window	***The Average total thermal resistance (R_{mw}) (m^2.C/W)***
Wood Window with (2mm) Thick Ordinary Glass	0.19
Wood Window with Double Glass	0.30
Aluminum Window with (2mm) Thick Ordinary Glass	0.17
Aluminum Window with Double Glass	0.20

Source: Palestine Standards Institution (PSI)

6.2 Glass



The basic raw materials used in manufacture of glass for construction purposes are sand (Silica), soda (sodium oxide), and lime (calcium oxide), with the addition or substitution of various other chemicals to modify the characteristics of the resultant glass products.

Table 28: Thermal conductivity of the glass

Glass Type	***Density Kg/m^3***	***Thermal Conductivity Kw/m***
The ordinary transparent	2500	1.05
The heat Resistant	2250	1.10

In the construction field ,the glass is available for use in flat form as window , heavy sheet , float plate , tempered , heat strengthened , heat-absorbing, insulating- double glass ,and other applications covered by the term glazing .
It is also used as surfacing materials, alone or as part of a system of construction (curtain walls).

In construction specifications, "glazing "is the term used for the installation of glass. The materials used to make a weather tight joint between the glass and the frame into which the glass and the frame into which the glass sets are called the glazing materials.
Sheet glass is produced in a number of thickness .These thickness are designated , respectively , as single strength (SS), and double strength (DS) .Thick sheet glass , manufactured by the same method as window glass, is used in openings which exceed window glass size recommendations

Window and heavy sheet glass is a soda-lime (silicon, calcium, and sodium) type of glass. Its composition and characteristics are fully covered under the main heading, Glass, because of the manufacturing process, a wave or draw distortion runs in one direction through the sheet, and the degree of distortion controls the grading and usefulness of this category of glass. The surface has a brilliant fire polished finish (the natural as – manufactured finish, also called fire finish)
Window and heavy sheet glass are available in various types, strength, and qualities, in thickness ranging (1.58-12.7 mm) and sizes up to maximum of (3.048 x 2.134 m)

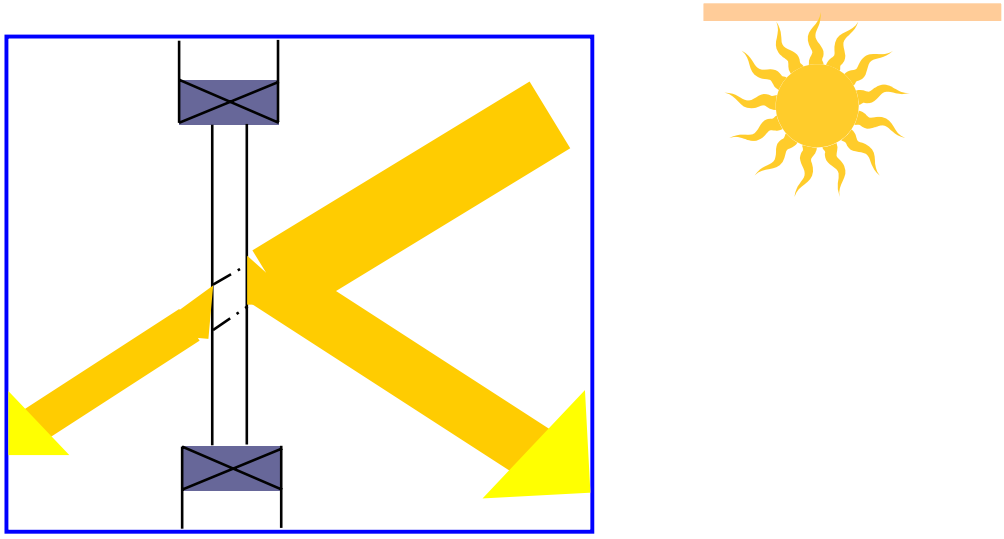
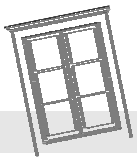


Figure 7: Illustration of The glazing's effectiveness in rejecting solar heat gain

Table 29 Properties of Different Types of Glass

Type of the glass	***Strength or Classification (mm)***	***Quality*** *	***Thickness (mm)***	***Weight Kg/m²***
Window	2.381 (single Strength)	AA ,A, B	2.16-2.54	5.96
	3.175 (Double Strength)	AA,A,B	2.92-3.40	8.06
	3.175 (Double Strength)	green house	2.92-3.40	8.06
Heavy Sheet	4.763	AA,A, B	4.62-5.21	11.96
	6.35		6.10-6.60	15.82
	9.525		10.16-10.92	23.73
Tinted	3.175	AA,A ,B	2.92-3.40	8.06

- Quality AA is generally selected for higher grade work
- Quality A is select glass for superior glazing
- Quality B is suitable for general glazing; green house grade is for general glazing but in limited sizes.



6.3 Aluminum

The basic raw material from which aluminum is produced is bauxite, an ore containing a high percentage of aluminum oxide.
Aluminum windows and doors are made from aluminum –alloy sections that have been formed by extrusion. This process consists of forcing a bar of the desired shape and size. Aluminum windows are usually given an etched and lacquer finish. The joints in aluminum windows and frames are either welded or fastened mechanically. Aluminum windows are produced in three basic grades: Residential, commercial, and monumental. National Aluminum &
Profile Co. Ltd. NAPCO has established standard size and construction requirements for each of these grades. Windows confirming to each of these grades are tested for water leakage, wind load, structural strength, and air infiltration. Manufactures' catalogs give details of actual dimensions, and rough –opening sizes.

1. The Effects of Current Political Situation On Construction Materials Industry in Palestinian Lands

Since September 29th, 2000 as the result of the closure policy on the Palestinian territories where over three million Palestinian are being cut off from the rest of the world , and are forced to be confirmed to their cities ,villages, and refugee camps. In addition to the siege, there is also a deliberate and systematic destruction for some of the basic physical, social and productive infrastructure by the Israeli military forces and the Israeli settlers**.** The closures and the economic blockade of the Palestinian territories had a direct negative affect on all sectors of economy and caused damages and losses in all forms of social life for the residents On the other hand the continuation and escalation of these practices creates state of instability and put difficulties in front of achieving the various development programs and plans. The construction and building sector in the PNA areas, which plays an important role in the national economy has been practically suspended due to the dependence of this sector on the import of basic and various construction materials like cement, steel and timber, which the Israeli forces do not allow their entry to the Palestinian area through their control of the borders checkpoints. The direct and indirect losses and damages in this sector can be explained in the following points.

First: Preventing the supply of basic construction materials such as cement, steel, gravel, timber and other material has stopped the factories and plants depending on these materials in their production activities . Even though the blockade on the cement material has eased up recently, other major materials which constitute the concrete mix such as aggregates have not. This caused the stoppage of executing hundreds of private and public construction.

Second: stoppage of a major part of Palestinian traditional industries , which is the stones and marble industry, whereas more than 220 factory and plants have been closed in the northern governorates and around 5,800 workers have been dismissed, this caused a daily lose of 1,400,000 US$ as result the suspension of exporting and local use of stone and marble due to suspension of projects.

Table 30: Losses of stones and Marble Factories in the Northern Governorates

Governorates	No. of closed factories	alue of Daily Losse US$

Bethlehem	150	600,000
Hebron	70	450,000
Ramallah and Beirah	30	100,000
orth Governnorates in West ban	112	250,000
Total	462	1,400,000

Source: Palestinian National Information Center, 2001

Third: The bombardment by Israeli military forces of some building in investment projects caused the transfer of investment from abroad in the field of housing and building which has negatively affected for construction projects has caused the suspension of these projects. (Table no.40).

Table 31: Approved investment projects qualified for exemptions as per investment encouragement law according to the residence of the investor. First quarter - second 1999

Residence of invest	West Bank	Gaza Strip	Total
Local	40,223,542	52,259,640	92,483,182
Foreign	10,198,265	4,961,000	15,159,265
Total	50,421,807	75,220,640	107,642,447

Source: Report on Palestinian Economy UN Special Representative Office autumn 1999

Summary : This situation , which the Palestinian National Authority Territories and the Palestinian people are living under , imposed by the Israeli leaders and its military forces has caused the Palestinian economy a huge losses which shall have sever future reflect directly on the standard of living for the Palestinians . The financial losses has been estimated at US $227 million as a result of the Israeli demolishing and destruction of homes , social and services facilities and are as follow.

- Direct financial losses as result of destruction and damaging of houses 14 million US$
- Direct financial losses resulting from destruction and damaging of public and social services buildings and infrastructure 20 million US$
- Construction of new housing units to home the displaced families and to replenish the housing stock 63 million Us$
- Losses resulting from destruction and disassblemement of building , construction and quarries sector 130 million US$

Total 227 million US$

This in addition to another losses resulting from the deterioration of other productive activities related to the building and construction sector is difficult to measure on the short term.(Palestinian National Information Center Report, 2001)

Stone Type	Source	The Price (Dollors/m^2)

2. The Average Cost Items of Different Types of Construction Materials Used Locally

		Plain *(Maseh)*	Finished *(Madkook)*
Bini -Na'em	Hebron-Bini Na'em	14	17
Al Shyoukh	Hebron-Al Shyoukh	14	17
Tafouh	Hebron -Tafouh	14	17
Samou'	Hebron-Samou'	14	17
Injasah	Hebron-Bini Na'em	19	22
Yatta	Hebron – Yatta	19	22

Type of Cement	The Units	The Average Cost ($)	The Source
Portland 250	Ton	77	Israel
White Cement	Ton	73	Jordan
Sulphate Resistant Portland	Ton	107	Turkey
		150	Denmark
		90	Israel

Table 32: The Average Cost of Different Types of Stones

Note: The Prices included only the pieces of normal Saraheeh, special pieces will include different

Table 33: The Average Cost of Cements

Table 34: The Average Cost of Different Types of Gypsum Boards Work for Walls

Stone Type	Source	The Price (Dollors/m^2)			
		Plain *(Maseh)*		Finished *(Madkook)*	
		A	***B***	***A***	***B***
Jarra'ah	Nablus	21	18	24	21
Aseerah	Nablus- Aseerah	25	18	28	21
Aro-eef	Nablus	25	21	28	24
Jameen	Nablus	21	18	24	21
Alem-alhda	Hebron	21	18	24	21
Deir Jereer	Ramallah ,Deir- Jeree	14		17	
Beir-Zeit	Ramallah,Beir-Zeit	13		16	

Type of Gypsum	The Units Of measures	The Average Cost ($)	The Average Cost ($) of Finish work Per (m^2)
Normal Gypsum Boards (1.2m X 3.0 m X 14 mm	m^2	6.5-7.5	12 – 16
Water Proof Gypsum	m^2	9.00- 10.5	
Fire Proof Gypsum	m^2	9.00- 10.5	

Table 35: The Average Cost of Plaster Work

Plaster Type	The Units	The Average Cost ($)	
		Material	Workmanship
Internal Plaster	m^2	1.5	2.5
External Plaster	m^2	1.8	4.5
Plaster with (sheberz Spray)	m^2	2.5	6.5

Table 36: The Average Cost of Different Types of Marbles &Granite

Type & Dimensions	*The Units*	*The Average Cost ($)*	*Uses*	*The Source*
Marbles (2cm Thick)	m^2	26-50	Floors –terrazzo Tiles, Stairs	Imported-*Italy,Spain, India,Turkey*
Marbles (3cm Thick)	m^2	50-60		Imported-*Italy,Spain, India,Turkey*
Marbles (2cm Thick)	m^2	16-19		Local
Marbles (3cm Thick)	m^2	22-25		Local
Granite	m^2	60-150	Kitchens	Imported-*Italy,Spain, India,Turkey*

Ceramics 2 X 40 X40	m^2	6-12	Floors Walls	Imported-*Italy,Spain, India,Turkey*
Porcelian	m^2	25-50	Walls	Imported-*Italy,Spain, India,Turkey*

Table 37:The Average Cost of Ready -Mix Concrete

The Type	***Unit Of Measure***	***The Average Cost ($ /m^2)***
Ready -Mix Concrete 150 Kg/cm^2 Strength	m^3	45
Ready -Mix Concrete 175 Kg/cm^2 Strength	m^3	49
Ready -Mix Concrete 200 Kg/cm^2 Strength	m^3	53
Ready -Mix Concrete 250 Kg/cm^2 Strength	m^3	60
Ready -Mix Concrete 300-350 Kg/cm^2 Strength (Plus the cost of pumping)	m^3	67
Concrete Admixture (Flocet)	20 Liter	25
Plaster Admixture (Plaz)	20 Liter	17

Table 38: The Average Cost of Hollow Concrete Blocks for Walls

The Type	***UNITS***	***The Cost Of Material & Work***	***The Source***
Hollow Concrete Block (7*40*20) cm	m^2	5.5	Local
Hollow Concrete Block (10*40*20) cm	m^2	6.5	
Hollow Concrete Block - (15*40*20) cm	m^2	8.00	
Hollow Concrete Block (20*40*20) cm	m^2	9.00	

Table 38: The Average Cost of Etong Blocks for Walls

The Type	***UNITS***	***The Cost Of Material & Work***	***The Cost Of workmanship***	***The Source***
Etong Blocks (Thickness=7) cm	m^2	6.5	2.1	

Etong Blocks (Thickness=10) cm	m^2	9.00	2.1	Israel
Etong Blocks (Thickness=15) cm	m^2	13.2	2.2	
Etong Blocks (Thickness=20) cm	m^2	17.5	2.3	

NOTE : The average weight of Etong = 0.45-0.50 Ton/ m^3 and the weight of Hollow concrete blocks = 1.5 Ton/ m^3

Table 39: The Average Cost of Different Types of Blocks for Slabs

The Type	The Cost workmanship	The Cost ($) Material	The Units	The Source
Hollow Concrete Block (14*40*20) cm	2.1	0.45	No.	Local
Hollow Concrete Block (17*40*20) cm	2.1	0.50	No.	
Hollow Concrete Block (20*40*20) cm	2.2	0.8	No.	
Hollow Concrete Block (24*40*20) cm	2.3	0.9	No.	

Table 38: The Average Cost of Etong Blocks for Slabs

The Type	The Cost ($) Material	The Units	The Source
Etong Concrete Block (14*40*20) cm	0.785	m^2	Israel
Etong Concrete Block (17*40*20) cm	0.952	m^2	
Etong Concrete Block (20*40*20) cm	1.12	m^2	
Etong Concrete Block (24*40*20) cm	1.35	m^2	

Table 40:The Average Cost of Insulation Material

The Type	*Unit Of Measure*	*The Average Cost ($)*
Vermiculite (8 cm thickness)	m^2	10

Perlite (8 cm thickness)	m^2	10
Polystyrene (Expanded)	m^3	64
Polystyrene(for walls)	m^3	67
Polystyrene(for roofs)	m^3	98
Rigid Boards of Rock Wool (for walls) 50 mm thickness	m^2	6.5
Rigid Boards of Rock Wool (for walls) 40 mm thickness	m^2	8
Fiber Glass	m^2	0.5
Aluminum Foil -wide 10 cm	Roll=50m	11.5
Aluminum Shutters (insulated Polyethane)	m^2	50
(Kalkal) Polystyrene (2&3&5*50*100)	m^3	50
(Randoban) Polystyrene (2,3,5 *50*100)	m3	Type A=120 Type B= 90
Etong for Slabs (15,18,20,22,25,28,30*30*60)	m3	70
Etong for Walls (7,10*30,50,60*60)	m3	85

Table 41: The Average Cost of Different Types of Profiles of Aluminum

The Type	The Average Cost ($ / m^2)		The Source
	Single Glaze	Double Glaze	
A) PROFILE 7000 - Sash			
Kaleel (Maformal)	80	95	Israel
Jordan	70	85	Jordan
Turkey	70	85	Turkey
NABCO	70	85	Local(Nablus)
B) PROFILE 4000-Casement	80	95	

Table 42: The Average Cost of Different Types of Paints

The Type	*UNITS*	*The Average Cost by US ($)*			*USES*
		Israeli Products	*Local Products*	*Dulux Products*	
Polycide	18 Liter	15-22	12.5-15	15-22	Ceilings.
Emulsion	18 Liter	23.5-30	22	23.5-30	interior walls -Sides
Super Grill	18 Liter	43-60	30-38	43-60	Internal-External
Bendroll	18 Liter	41-45	36	41-45	Internal-External
Super look Normal	5 Liter	20-23	16	20-23	
Undercoat	5 Liter	18- 20	16	18- 20	

3. The Investment during the Last Three Years

in Building Construction Materials in Palestinian Lands.

(1) General speaking , the average cost of construction new building in the present time can be shown as followings:

Table 43 : The Average cost of construction new building in US $ per m^2

Building Type	***The Cost in Us ($) per m^2***
Residential building	200-250
(Villa Style)	280-300
Super deluxe	350-450

(2) In order to meet one of the important stated purposes of the study , there is a need to point out the investment in building construction materials related to the below industries during the past three years.

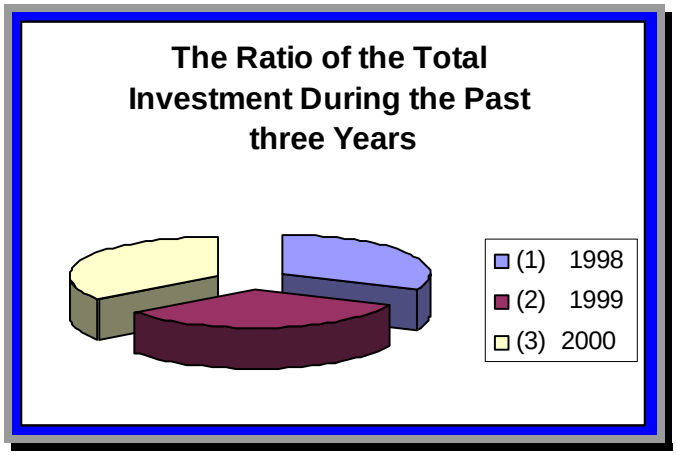
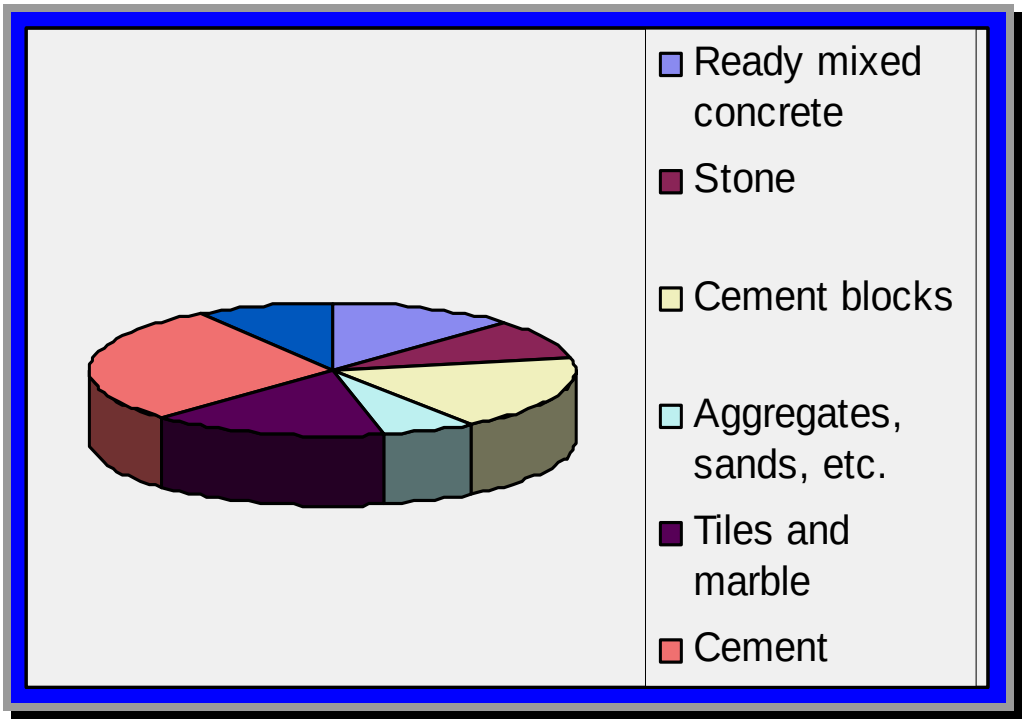


Table 43: The Total Investment in Building Materials during the Past Three Years

Present industries	*Ratio*	*(1) 1998*	*(2) 1999*	*(3) 2000*
Total investments	%	1,010,954,000	1,061,502,000	1,114,577,000
Ready. mixed concrete	4.00	40,438,160	42,460,080	44,583,080
Stone	3.04	30,733,002	32,269,661	33,883,141
Cement blocks	5.93	59,949,572	62,947,069	66,094,416
Aggregates, sands, etc	2.04	20,623,462	21,654,641	22,737,371
Tiles and marble	4.99	50,446,605	52,968,950	5,617,392
Painting materials	0.5	5,054,770	5,307,510	5,572,885
Reinforced steel	1.79	18,096,077	19,000,886	19,950,928
Electrical materials	0.16	1,617,526	1,698,403	1,783,323
Cement	9.28	93,816,531	98,507,386	103,432,746

Aluminum materials	2.93	29,620,952	31,102,009	32,657,106
Total	***36.82***	***248,795,779***	***261,235,642***	***274,297,400***

Source: DR. NIDAL RASHID SABRI ((International Lab our Organization, PEP, Ramallah, Palestine) 2000



The Ratio of the Total Investment of Present industries for 2000 year

SUMMERY

- Building materials industry in Palestinian Areas still doesn't cover all the requirements of local Market and imports make up the balance

- There is a limited types of building materials produced in West Bank and Gaza for example there is a lack in cement industry which forms a major part in building construction

- The stone cutting industry in the West bank is the largest construction industry and has a great influence in gross domestic product.

- Variety of cement blocks (solid ,hollow concrete) used for walls and slabs are locally produced from local materials.

- All material used in construction industries are purchased from Israel or other countries except aggregate and stone which are used in ready mix concrete industry and as a result of the present difficult situation Israel Preventing the supply of basic construction materials such as cement, steel, gravel, timber and other material and do not allow their entry to the Palestinian area through their control of the borders checkpoints

- Aluminum sections are imported for local fabrication in many relatively small workshops of doors , windows .

- Using Insulation Materials in construction or improving the energy saving in construction materials in Palestinian Areas still in the first stages due to :

1. Economical situation in the present time as most of the materials used in construction industries including the insulation ones are purchased from other countries which explains the high cost of the construction materials used locally

2. Design, supervision, overheads and management in Palestinian Lands shares low percentage of the total cost, which means this affects the quality of construction and paying less attention to insulation materials.

3. Many Construction factories have no control on the dimension standards that are followed in their factories and no defined of energy saving or thermal properties of their products. Besides

there is a lack of qualified managers who can manage and control the factory in specific and experienced methods and lack of actual production data.

- There is a need to put or adopt specific standard manuals to guide and control the construction works in all sites and areas.

Suggestions & Recommendations

Contingent upon a strict and widespread use, insulation and solar energy are cost effective elements in housing and should be encouraged.
With respect to initial cost constructions alone, it is imperative that improving the insulating qualities of concrete should be encouraged using the most cost effective methods and materials.

Polystyrene Blocks and ribs are recommended to use in building construction as being a rigid, light and at the same time insulating material .In block form Polystyrene can be used as an external or internal wall partition, the cavities in the polystyrene blocks forming the wall .Further more, polystyrene blocks can be used in roofs slabs instead of the traditional concrete blocks. In my opinion this method of construction minimizes costs due to the light weight polystyrene .Polystyrene sheets can be used as heat insulators when used in cavities formed by two concrete block walls .The use of polystyrene as a light weight and insulating material will ultimately result in overall savings.

I can conduct that concrete can be used as energy saving materials in many forms Light weight concrete is of utmost importance to the construction industry . Most of research should focuses on high –performance concrete, by which is meant cost-effective material that satisfies demanding performance requirements, including durability. The advantages of light weight concrete are its reduced mass and improved thermal insulation properties, while maintaining adequate strength. The reduced weight has numerous advantages, not the least of them being a reduced demand on energy during construction .Light weight concrete produced as blocks for walls or roofs or light plaster for walls or roofs (ribs for screeds) cellular or perlite or foam concrete.

More research and studies on various types of concrete (cellular or perlite or foam concrete.) Can be carry out in order improve the energy efficiency. For example:

1. light weight insulating hollow blocks can be produce using light weight aggregate combined of pumice in addition to Portland cement and. Particles of perlite and polystyrene can be use as additional aggregates in different composition in order to determine new K values and water absorption, compressive strength, oven – dry bulk density for different composition of concrete .On the other hand, the main test can be carry out by means of the (Guarded Hot Box Apparatus)

2. Study the possibility of developing new kind of Light weight concrete , which combines the advantages of normal-weight aggregate with cellular concrete to achieve good thermal properties

Many options should take into consideration in order to develop or introduce such materials as acceptable thermal insulating materials or local energy efficient material either for walls or roofs.

For instance, it is necessary to study the wastes of wood or papers or plastic, aluminum foils and use it in cavity walls as boards or fibers.

List of References

1. Center for National Information (Palestine databank) Reports 1999, 2000, 2001
2. Palestinian Central Bureau of Statistics, The average prices of different building materials ,2000
3. The Union of Stone and Marble in Palestine Studies, 2000.
4. Palestine Standards Institution (PSI)
   - Thermal Insulation for Building , 1999
   - Rigid Cellular Plastics for thermal Insulation, 1999
5. PECDAR Reports on local Construction Materials 1996, 1998
6. DR. NIDAL RASHID SABRI (Housing As An Internal Leading Sector in the Palestinian Economy) (International Labour Organization, PEP, Ramallah, Palestine) 1999
7. DR. REYAD ABDEL –KARIM (Construction Stone In Palestine) ,An-Najah National University ,Nublus,2000
8. Adham al_ayash ,Thermal Insualtion Materials ,Building research cnter ,RSS, Jordan 1990
9. Jordonian Thermal Insulation Code , Ministry of public work ,Jordan , 1990
10. Ministry of public work Report , 2001

APPENDICES

Appendix A: *Important Factors in the Physics of building Materials*

In every building project it is very important to have clear picture of a material's physical properties. There are different demands on the different groups of materials

- Weight indicates what structural loading can be anticipated in the building, which building techniques can be used
- Compressive strength is an expression of how much pressure the material tolerates, and is of particular importance in design of columns and other vertical structural elements.
- Tensile strength expresses how much a material can be stretched; this is important for calculation of horizontal structural elements and suspended structures.
- Thermal Conductivity describes a material's ability to conduct heat. It describes the insulation properties that can be expected of this material as a layer with an external wall, for example. The conductivity of a material is dependent upon the weight of the material, the temperature, its moisture content and structure.
- Heat capacity of a material is its ability to store warmth, which tends to even out the temperature in a building and also in many cases reduces energy consumption .heat capacity, is strongly related to material's weight.
- Air permeability indicates how much air allowed through a material under different pressures. It depends upon a material's porosity, the size and structure of its pores. The moisture content of the material also plays an important role, as water in pores will prevent air passing through. The right specification of material is particularly important when making a building airtight.
- Vapour Permeability gives the equivalent picture of water vapour penetration under different pressures. This can vary according to the material's moisture content and temperature.

Appendix B : ESTIMATE COST OF DIFFERENT TYPES OF CONSTRUCTION MATERIALS

PRICES IN US $

SECTION NO. 1

ITEM	DESCRIPTION	UNIT	ESTIMATE COST IN US $
No.			
1.01	M.C. SITE LEVELING (EXCAVATION)	M.C.	5
1.02	M.C. FOUNDATIONS EXCAVATION	M.C.	10
1.03	M.S. BASE COURSE	M.S.	3.5
1.04	M.C. IMPORTED FILL	M.C.	3
	SECTION NO. 2		
2.01	M.S. a) BLINDING UNDER FOUNDATION	M.S.	6
2.02	M.C. a) REINF.CONCRETE FOR FOUNDATUINS & FOOTING	M.C.	135
	b) FOR GROUND BEAMS	M.C.	140
	c) FOR REINF. WALLS (AT BASEMENTFLOOR)	M.C.	140
	d) FOR COLUMNS PORTIONS (NECKS)	M.C.	170
2.03	M.S. REINF. CONCRETE FOR SLAB ON HARD CORE 10 cm	M.S.	12
2.04	M.C. a) REINF.CONCRETE FOR STAIRS	M.C.	150
	b) FOR REINF. WALLS	M.C.	145
2.05	M.C. a) REINF.CONCRETE FOR COLUMNS	M.C.	165
	M.C. a) REINF.CONCRETE FOR COLUMNS BETWEEN WINDOWS -DOORS	M.C.	160
2.06	M.S. REINF. CONCRETE FOR SLABS 20 cm	M.S.	35
2.07	M.S. REINF. CONCRETE FOR STAIRS SLABS 20cm	M.S.	36
2.08	M.S. REINF. CONCRETE FOR SUNBREAKERS	M.S.	36
2.09	M.S. REINF. CONCRETE ABOVE ENTRANCE 12cm	M.S.	32
3.01	M.S. a) STONE WALLS 30 cm	M.S.	60
	b) STONE WALLS 25 cm	M.S.	57
	c) STONE CLADDING OVER R.C. ELEMENTS	M.S.	50
4.01	M.S. a) HOLLOW BLOCK 10 cm	M.S.	10
	M.S. b) HOLLOW BLOCK 20 cm	M.S.	12
	M.S. c) HOLLOW BLOCK 30 cm (15+5+10cm)	M.S.	24.25
	SECTION NO. 3		
5.01	M.S. a) THREE COATS INTERNAL PLASTER	M.S.	7
	b) THREE COATS EXTERNAL PLASTER	M.S.	8
	c) FOUR COATS EXTERNAL PLASTER FOR EXT. COLUMNS..	M.S.	11
6.01	M.S. TERRAZZO TILES 30 X 30 X 2.8 cm + SKIRTING SIZE 30 X 7.0 X 1.5 cm	M.S.	16
6.02	M.S. WHITE PORCELAIN GLAZED WAL TILES 20 X 20 X .6 cm	M.S.	22

6.03	M.S. NON SLIP CERAMIC FLOOR TILES 20 X 20 X .6 cm	M.S.	22
6.04	M.S. LOCAL MARBLE SILLS 3 cm THICK FOR WINDOWS & DOORS	M.S.	36
6.05	M.S. LOCAL MARBLE SILLS 3 cm THICK FOR PARAPETS	M.S.	42
6.06	M.S. LOCAL MARBLE TILES 30 mm THICK FOR STAIR LANDINGS	M.S.	38
6.07	M.R. LOCAL MARBLE TILES 30 mm THICK -STAIR LANDINGS SKIRTING	M.R.	11
6.08	M.R. LOCAL MARBLE TILES 30 mm THICK FOR STEPS & TREADS STAIRS	M.R.	27
6.09	M.R. LOCAL MARBLE FOR STAIR FLIGHT SKIRTING	M.R.	11
6.10	M.S. LOCAL MARBLE FOR URINALS..	M.S.	11
7.01	NO. a) WOODEN DOORS TYPE D 3	NO.	140
	b) WOODEN DOORS TYPE D 6	NO.	170
	c) WOODEN DOORS TYPE D 7	NO.	170
	d) WOODEN DOORS TYPE D 8	NO.	220
7.02	NO. CHALK BOARDS	NO.	180
7.03	M.R WOODEN BELTS 200 X 20 mm	M.R.	6
7.04	M.R WOODEN BELTS 120 X20 mm	M.R.	7
7.05	NO. WOOD & STEEL CABINET a) TYPE B1	NO.	300
	b) TYPE B2	NO.	450
	c) TYPE B4	NO.	180
	d) TYPE B5	NO.	365
7.06	NO. WOOD GAS COLLECTOR CABINET....	NO.	60
8.01	M.S. ALUMINUM WINDOWS OF TYPE W1,W2,W3,W4	M.S.	115
8.02	M.S. ALUMINUM WINDOWS OF TYPE W5	M.S.	100
8.03	M.S. WINDOWS PROTECTION STEEL	M.S.	32
8.04	M.R. BALUSTRADES STEEL PIPES FOR a) BALCONY B.S. -SOLID BAR	M.R.	42
	b) STAIRS HAND RAIL OF 2" Dia	M.R.	23
	c) HANDICAPPED RAMP	M.R.	23
8.05	L.S. GRABS BARS FOR HANDICAPPED TOILETS OF 1.5" Dia	L.S.	100
8.06	NO. FASON STEEL DOORS FOR a) D1 120 X 250 cm	NO.	320
	b) D2 100 X 250 cm	NO.	310
	c) D4 150 X 250 cm	NO.	390
	d) D5 90 X 205 cm	NO.	285
8.07	NO. EXTERNAL GAS CABINET	NO.	300
8.08	NO. COLLECTOR GAS CABINET	NO.	75

9.01	M.S. EMULSION PVA-BASED PAINT FOR INTERIOR	M.S.	3
9.02	M.S. POLY-CIDE FOR INTERIOR- CEILINGS	M.S.	2
9.03	M.S. PAINT MATT OIL FOR WALLS (1.5 m)	M.S.	4
9.04	M.S. SUPER - CRYLE FOR EXTERIOR & CORRIDORS	M.S.	4
	SECTION NO. 4		
10.01	M.S. SPECIAL PLAIN CONCRETE (PITCAL)FOR SCREED TO ROOF	M.S.	8
10.02	M.S. WATERPROOFING MEMBRANCE OF BETUMIN ROLLS	M.S.	7
10.03	M.R. METAL COVER TO EXPANSION JOINT a) 1mm THICK STEEL SHEET 70mm WIDE	M.R.	20
	b) FIX ALUMINUM (T) SECTION COVER	M.R.	23
10.04	M.R. GALVANIZED METAL SHEET EXPANSION JOINT COVER FOR ROOF	M.R.	28
10.05	M.R. POLYSTYRENE FILLER BOARD	M.S.	2
10.06	M.S. HOLOW BLOCK (7 cm)	M.S.	0
10.07	S. LEAN MIX CONCRETE TO ENCASE PROJECTED COLUMNS ROOF	L.S.	500
	SECTION NO. 5		
11.01	L.S. MAIN DISTRIBUTION BOARD (MDB)	L.S.	1250
11.02	NO. DISTRIBUTION BOARD (MDB) a) DB - G	NO.	500
	b) DB - F	NO.	450
	c) DB - S	NO.	450
	d) DB - C	NO.	450
11.03	M.R. PVC CONDUIT a) 4" PVC CONDUIT MAIN ELECTRIC CABLE INTAKE	M.R.	6
	b) 2" PVC CONDUIT MAIN ELECTRIC CABLE INTAKE	M.R.	4
	c) 1" PVC CONDUIT FOR CANTEEN INTAKE	M.R.	3
11.04	NO. BUILD MANHOLES a) 50 X 50 X 80 cm ELECTRICAL MANHOLE	NO.	110
	b) 50 X 50 X 80 cm TELEPHONE MANHOLE	NO.	110
11.05	M.R. NYY CABLES FROM MDB a) 5*10mm2 NYY CABLE IN 36 mm PVC	M.R.	13
	b) 3*6mm2 NYY CABLE IN 29 mm PVC	M.R.	8
	c) 3*4mm2 NYY CABLE IN 29 mm PVC	M.R.	4.3
11.06	NO. CONNECT AND TESTING LIGHTING POINTS INCLUDING (3*1.5 mm2)	NO.	10
11.07	NO. CONNECT AND TESTING LIGHTINGFIXTURE a) 2*36 W FLUORESCENT	NO.	50
	b) 2*8 W 3H D EMER.	NO.	70

	c) 2*18 W FLUORESCENT	NO.	40
11.08	NO. CONNECT AND TESTING SOCKET OUTLET a) 16 Amp FLUORESCENT	NO.	15
	b) DITTO - WATERPROOF	NO.	17
	c) 16 A. 3PIN WITH AUTO…	NO.	17
11.09	NO. CONNECT & TESTING OUTLET POINTS a) TELEPHONE OUTLETS	NO	20
	b) COMPUTER OUTLETS	NO	25
	c) TV SOCKET OUTLETS	NO	25
11.10	NO. FLUSH MOUNTED METAL GALV,JUNCTION BOX a) 50*50*15 cm	NO.	80
	b) 30*30*15 cm	NO.	40
	c) 30*30*15 cm FOR COMPUTER	NO.	80
11.11	L.S. INSTALL 2" # 1" PVC CONDUIT FROM TV JUNCTION BOX TO ROOF	L.S	60
11.12	L.S. EARTH SYSTEM FOR a) FOUNDATION EARTHING - WELDING 30/30mm	L.S	550
	b)# 19mm, 1.5m LONG COPPER COATED STEEL	L.S	120
	c) EARTHING CONNECTION	L.S	40
11.13	NO. CONNECT & TEST FIRE ALARMS a) 4 ZONES PANEL	NO.	0
	b) BREAK GLASS	NO.	0
	c) ENUNCIATOR WITH FLASHER	NO.	0
	d) DITTO BUT FOR W.P	NO.	0
	e) HEAT DETECTOR UNIT	NO.	0
	f) SMOKE DETECTOR UNIT	NO.	0
11.14	NO. CONNECT & TESTING 250 (W) HPS WALL	NO.	200
11.15	NO. CONNECT GONG BELL FOR a) OUTDOORS ELECTRICAL BELL	NO.	120
	a) INDOORS ELECTRICAL BELL	NO.	0
11.16	NO. CONNEC BELL PUSH BUTTON FOR GONG BELL SYSTEM	NO.	25
11.17	NO. SOUND SYSTEM a) PORTABLE MICROPHONE WITH STAND	NO.	30
	b) FM RADIO COMPATIBLE WITH WIRELESS MICRO.	NO.	60
	c) WIRELESS MICROPHONE.	NO.	40
	d) AMPLIFIER 200 WATT WITH CHARGER	NO.	220
	e) F. CABINET FOR HOUSING SYSTEM	NO.	45
11.18	NO. CONNECT AND COMMISSION WALL MOUNTED LOUD SPEAKERS	NO.	60

	SECTION NO. 6		
12.01	NO. WHITE ORIENTAL TYPE TOILETS (44.5 X 58.5)cm HARSA OR EQUAL	NO.	200
12.02	NO. WHITE VITREOUS TOILETS SPECIALLY MADE- HARSA OR EQUAL	NO.	250
12.03	NO. WHITE VITREOUS CHINA EURP. TYPE TOILETS HARSA OR EQUAL	NO.	220
12.04	NO. WHITE VITREOUS CHINA WASH BASIN-HARSA OR EQUA -(40X24.5cm)	NO.	175
12.05	NO. WHITE VITREOUS CHINA SINGLE BOWL KITCHEN SINK-HARSA OR EQ	NO.	132.6
12.06	NO. WHITE VITREOUS CHINA EURP URINAL HARSA OR EQ. -39.5X33.5cm	NO.	150
12.07	NO. 4" PVC FLOOR TRAP-WITH BOX 10 X 10 cm	NO.	40
12.08	NO. DITTO BUT JUNCTION BOX WITHH 10 X 10 cm	NO.	30
12.09	NO. 4" CLEAN OUT OF DRAINAGE NETWORK	NO.	35
12.10	M.R. 4" VERTICAL DRAINAGE STACKS - UPVC	M.R.	7
12.11	NO. POLYETHYLENE BLACK WATER TANK	NO.	250
12.12	L.S. DOMISTIC WATER DISTRIBUTION NET WORK (DRINKING&SANITARTY)	NO.	2700
12.13	NO. PRECAST CONCRETE MANHOLES a) SIZE # 60cm & 100cm HEIGHT	NO.	300
	a) SIZE # 80cm & 150cm HEIGHT	NO.	350
12.14	M.R. 6" EXTERNAL SEWERS OF UPVC PIPES MARKED	M.R.	15
12.15	NO. SUPPLY & INSTALL (6 kg CO2)FIRE EXTINGUISHER	NO.	100
12.16	L.S. COMPLETE UNIT OF EXTERNAL DRINKING FOUNTAIN - WITH (10 no.)	L.S.	400
12.17	M.R.RAIN WATER a) 4" RAIN WATER PIPE	M.R.	20
	b) 3" RAIN WATER PIPE	M.R.	59.3
12.18	NO. 8"/4" PVC RAIN WATER ROOF DRAIN	NO.	55
12.19	NO. 4" UPVC FLOOR DRAIN	NO.	35
12.20	NO. STAINLESS STEEL (GRADE 316) LAB. SINK (60 X 40 X 25cm)	NO.	150
12.21	L.S. GAS DISTRIBUTION NETWORK FOR HOME ECONOMICS LAB…	L.S.	1500
12.22	NO. AXIAL WINDOW EXTRACTOR FAN. (VORTICE OR EQUAL)	NO.	0
12.23	M.R. RAIN WATER DRAIN TRENCH – (42 X 93 cm)	NO.	0
12.24	NO. RAIN WATER DRAIN MANHOLE - 61cm Dia-	NO.	0

12.25	L.S. SEPTIC TANK OF TWO COMPARTMENTS OF INT. DIM 740*440*400 cm	L.S.	5000
	SECTION NO. 7		
13.01	M.C. EXCAVATION FOR FOUNDATIONS OF RET. AND BOUNDARY WALLS	M.C.	8
13.02	M.S. COMPACT BASE COURSE - 15 cm	M.S.	4
13.03	M.C. CONCRETE B 150 a) BLINDING UNDER FOUNDATIONS 10cm	M.C.	6
13.04	M.C. CONCRETE B 200 FOR a) BOUNDARY WALLS AND FLOWER	M.C.	90
13.05	M.C. CONCRETE B 250 FOR a) FOUNDATIONS, FOOTING , TIE BEAM ..ETC	M.C.	125
	b) EXTERNAL STAIRS AND RAMPS	M.C.	120
	c) REINFORCED RETAINING WALL -R1, R2, R3..	M.C.	142.4
13.06	M.C. CONCRETE B 200 FOR EXTERNAL SEATING & PLAYGROUND STAIR	M.C.	60
13.07	M.S. 10 cm THICK REINF. - B 250 - FOR GROUND SLAB- SLAB ON GRADE-	M.S.	12
13.08	M.S. POLYSTYRENE FILLER BOARD	M.S.	2
13.09	M.R. PVC PIPES FOR WEEP HOLES IN RETAINING WALLS	M.R.	4
13.10	M.S. APLLY CEMENT AND SAND PLASTER- FOR WALL & WHERE REQI.	M.S.	6
13.11	M.S. WELL COMPCTED BASE COURSE 15 cm	M.S.	3.5
13.12	M.S. ASPHALT LAYER 5 cm	M.S.	5.5
13.13	NO. MAIN ENTRANCE STEEL GATES - a) DOOR TYPE 8 - 300 X 220 cm	NO.	0
	b) DOOR TYPE 8 - 420 X 220 cm	NO.	800
13.14	M.S. INSTALL CEMENT TILES a)400 X 400 X 40 SMOOTH FINIFH CEMENT	M.S.	15
13.15	M.R. PERFORATED PIPES UPVC 20 cm Dia A;ONG & BEHIND B.R.W.	M.R.	10
13.16	NO. BASKET BALL BOARD	NO.	300
	NO. BASKET BALL stand	NO.	350
13.17	L.S. MARKING PAINT FOR MARKING BASKET BALL & V. BALL	L.S.	200
13.18	NO. VOLLY BALL POSTS 4" Dia	NO.	100
13.19	NO. STEPPED FLAG POST	NO.	150
13.20	NO. ROOF FLAG POSTS	NO.	150
13.21	M.S. GALVANIZED STEEL MESH FENCE	M.S.	14

13.22	M.R. CURBSTONE FOR SIDEWALKS	M.R.	9
	SECTION NO. 8		
14.01	M.S. EMULSION PVA-BASED PAINT FOR INTERIOR	M.S.	3
14.02	M.S. POLY-CIDE FOR INTERIOR- CEILINGS	M.S.	2
14.03	M.S. PAINT MATT OIL FOR WALLS (1.5 m)	M.S.	4
14.04	M.S. SUPER - CRYLE FOR EXTERIOR & CORRIDORS	M.S.	4
14.05	SUPPLY & PAINT SUPER LUCK OIL PAINT FOR WINDOWS	M.S.	3
14.06	SUPPLY & INSTALLGOLVONIZED STEEL MESH FOR WINDOWS	M.S.	10
14.07	M.S. LOCAL MARBLE TILES 30 cm FOR STAIR a) SIZE 30 *30 * 3	M.S.	32
14.08	M.R. DITTO BUT FOR LANDINGS TILES a) 30 * 30 * 3 cm	M.R.	35
14.09	M.R. DITTO BUT FOR LANDINGS SKIRTING a) 30 * 12 * 1.5 cm	M.R.	10
14.10	M.R. DITTO BUT FOR STEPS AND TREADS OF STAIRS	M.R.	25
14.11	M.S. LOCAL MARBLE FOR SRAIR FLIGHT SKIRTING	M.R.	10
14.12	MR. SUPPLY &INSTALL CONECT &TESTING OF 1*16 CU CABLE	MR	150
14.13	NO. INSTALL CONNECT & TESTING EXT LIGHTING POINTS (3*1.5 mm2)	NO.	10
14.14	NO. CONNECT AND TESTING LIGHTINGFIXTURE a) 2*36 W FLUORESCENT	NO.	40
14.15	L.S SUPPLY INSTALL CONNECT & TESTING THE FOLOWING SURFACE	LS	350

BILL	DESCRIPTION OF WORK (Area = 1100 m^2)	AMOUNT
1.00	EXCAVATION , BACKFILLING AND SITE WORKS	8650
2.00	CONCRETE WORKS	88884
3.00	STONE WORKS	45810
4.00	CONCRETE BLOCKWORKS	5960
5.00	PLASTRING WORKS	27010
6.00	TILING , FLOORING AND MARBLE WORKS	31645
7.00	CARPENTARY AND JOINERY WORKS	8090
8.00	STEEL & ALUMINUM WORKS	35480
9.00	PAINTING WORKS	11010
10.00	INSULATION , ROOFING AND EXPANSION JOINTS	6692
11.00	ELECTRICAL WORKS	16568
12.00	PLUMBING , SANITARY AND MECHANICAL WORKS	22584
13.00	EXTERNAL WORKS	53934
14.00	MAINTINANCE WORKS FOR EXISTING BUILDING	9830
	GRAND TOTAL	372147

	NET GRAND TOTAL	372147

Appendix C *Terminology*

Absorption rate (initial rate of absorption

The weight of water absorbed by a brick or concrete masonry unit that is partially immersed in water for one minute, expressed in grams or ounces per minute.

Admixture

An ingredient other than cement, aggregate, or water that is added to a concrete or mortar mix to affect the physical or chemical characteristics of the concrete or mortar. The most common admixtures affect plasticity, air entrainment, and curing time.

Aggregate

Granular material such as sand, gravel, crushed gravel, crushed stone, slag, and cinders. Aggregate is used in construction for the manufacturing of concrete, mortar, grout, asphaltic concrete, and roofing shingles. It is also used in leaching fields, drainage systems.

"Aggregrate, concrete"

The fine and course aggregate used in manufacturing concrete. Both are usually washed and graded.

"Aggregate, lightweight"

One of several materials used to decrease the unit weight of concrete, thereby reducing the structural load and the cost of the building. The materials most commonly used are perlite and vermiculite. The use of lightweight aggregate is costly, but sometimes necessary in construction.

Aggregate panel

A precast concrete panel with exposed aggregate.

Air content

The volume of air present in a concrete or mortar mix, expressed as a percentage of the total volume. A controlled air content prevents concrete from cracking during the freeze/thaw cycle.

Air-entrained agent

An additive to hydraulic cement or an admixture for concrete or mortar that causes air to be incorporated in the form of minute bubbles on the concrete or mortar during mixing, usually to increase its workability and frost resistance.

Alkali

(1) A liquid that has a pH greater than 7.0. (2) Water soluable salts of alkali metals, such as sodium and potassium, whichoccur in concrete and mortar mixes. The presence of alkaline substances may cause expansion and subsequent cracking.

Amount of mixing

The mixing action employed to combine the ingredients of concrete or mortar, measured in time or number of revolutions.

Autoclave

A chamber in which steam at high pressure is used to cure precast concrete members.

Binder

(1) Almost any cementing material, either hydrated cement or a product of cement or lime and reactive siliceous materials. The kinds of cement and the curing conditions determine the general type of binder formed.(2) Any material, such as asphalt or resin, that forms the matrix of concretes, mortars, and sanded grouts. (3) That ingredient of an adhesive composition which is principally responsible for the adhesive properties that actually hold the two bodies together. (4) In paint, that nonvolatileingredient, such as oil, varnish, protein, or size, which serves to hold the pigment particles together in a coherent film.A stirrup or other similar contrivance, usually of small-diameter rod, which functions to hold together the main steel in a reinforced concrete beam or column.

Building Envelope

The elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior. Typically includes the roof, walls, windows and slab.

Block

A usually hollow concrete masonry unit or other building unit, such as glass block..

Blockwork

Masonry of concrete block and mortar

Cement mortar

A plastic building material made by mixing lime, cement, sand, and water. Cement mortar is used to bind masonry blocks together or to plaster over masonry.

Concrete

A composite material consisting of sand, coarse aggregate (gravel, stone, or slag), cement, and water. When mixed and allowed to harden, it forms a stone-like material

Concrete masonry

(1) Concrete blocks laid with mortar or grout in a manner similar to bricks. (2) Concrete that may be poured in place or as special tilt-up building walls.

Curing

The curing of concrete or mortar, particularly a test cylinder, in a controlled environment with no heat gain or heat loss.

Dimension stone

Stone that has been trimmed or cut to specifications for a particular use, such as for curbs, building stone, paving blocks.

Double glazing.

In general, two thickness of glass separated by an air space within an opening to improve insulation against heat transfer and/or sound transmission. In factory-made double glazing units, the air between the glass sheets is thoroughly dried and the space is sealed airtight, eliminating possible condensation and providing superior insulating properties.

Double-strength glass.

Sheet glass between 0.115" and 0.133" (33.38 mm) thick.

Expanded glass (foam glass)
A thermal insulation with a closed-cell structure, manufactured by foaming softened glass so as to produce a myriad of sealed bubbles, and then molding the glass into boards and blocks.

Emissivity

The rate at which absorbed energy is radiated away from an object. In roofing it describes the ability of the roof covering to quickly release absorbed heat energy. A desirable roofing membrane will easily release its absorbed heat energy, keeping the roof cooler than those that get hotter by slowly radiating their stored energy

Emittance.
The ratio of the radiant flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions

Factor (U-value).

A measure of the rate of non-solar heat loss or gain through a material or assembly. It is expressed in units of Btu/hr-sq ft-°F (W/sq m-°C). Values are normally given for NFRC/ASHRAE winter conditions of 0° F (18° C) outdoor temperature, 70° F (21° C) indoor temperature, 15 mph wind, and no solar load. The U-factor may be expressed for the glass alone or the entire window, which includes the effect of the frame and the spacer materials. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value

Glazing.

The glass or plastic panes in a window, door, or skylight

"Glass, structural"

Cast glass in squares or rectangles, 1""-2"" thick, sometimes laid up between concrete ribs, frequently as tile. Larger units are made in hollow or vacuum blocks. The wide use of the product is in colored and polished sheets for interior wall surfacing.

Stone

(1) Individual blocks of rock processed by shaping, cutting, or sizing. For use in masonry work. (2) Fragments of rock excavated, usually by blasting, from natural deposits and further processed by recrushing and sizing. For use as aggregate. (3) A carborundum or other natural or artificial hone used to sharpen cutting edges of tools

Thermal insulation (heat insulation)

A material that provides a high resistance to heat flow. Examples are foamed plastics, mineral or glass fibers, cork, and foamed glass. The material is used in the form of blankets, boards, blocks, and poured or granular fill

Thermal expansion.

Change in dimension of a material as a result of temperature change

Thermal mass.

Mass in a building (furnishings or structure) that is used to absorb solar gain during the day and release the heat as the space cools in the evening.

Insulation.

Construction materials used for protection from noise, heat, cold or fire

Insulation board, rigid.

A structural building board made of coarse wood or cane fiber in ½- and 25/32-inch thickness It can be obtained in various size sheets, in various densities, and with several treatments.

Masonry.

Stone, brick, concrete, hollow-tile, concrete block, gypsum block, or other similar building units or materials or a combination of the same, bonded together with mortar to form a wall, pier, buttress, or similar mass

R-value

The resistance to heat flow, this is the value most often used to indicate the insulating value of materials used to conserve energy. The higher the R-value the more resistance to heat-flow.

U-value :

The overall rate of heat flow; the coefficient of heat transfer from outside air to inside air. In roofing it is the time rate of heat flow per square foot from the warm side of the roof to the cooler side, per unit temperature difference between the two sides.
Btu / h · ft2 · F. The lower the U-value, the less heat flow occurs through a roof assembly.