

GREEN HOME WITH ENERGY SAVING DESIGN - ECO HOMES IN JORDAN

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Abstract

Aside from harnessing the earth's richest energy source — sunlight — green builders and designers examine a number of issues to make a building eco-friendly. Building materials are a huge concern. Even today, the building industry in the United States uses up forty percent of all raw materials. Any reduction through the use of sustainable, recycled materials will have a huge impact on resource preservation. Durability is another issue; if environmentally-friendly materials need to be replaced frequently, then they become less and less efficient. Good location is a central component of eco construction. Homes should be close to the community or public transportation to reduce the need for driving and they should be in a place that will not harm the environment around them. Green homes should also be designed to encourage recycling, manage water use, and minimize energy use, in this paper we will present a new design for Eco Homes in Jordan

Keywords: Eco Homes, Rockwool, Green building

I. INTRODUCTION

Sustainability represents a balance that accommodates human needs without diminishing the health and productivity of natural systems. The American Institute of Architects defines sustainability as “the ability of society to continue functioning into the future without being forced into decline through exhaustion or overloading of the key resources on which that system depends.”

The typical design process is a “stovepipe” process with each discipline working independently and sequentially. “Green building experts encourage project teamwork to promote an open exchange of ideas and generate integrated, whole-systems solutions. In the conventional, linear development process, key people are often left out of decision-making or brought in too late to make a full contribution. Collaboration, on the other hand, can reduce and sometimes eliminate both capital and operating costs while at the same time meeting environmental and social goals.” Sustainable development provides a framework for crossing between disciplines and integrating the process.

In the beginning, many early green designs focused on one issue at a time, mainly energy efficiency or use of recycled materials. But during the 1980s and 1990s, green designers began to realize the integration of all these factors would produce the best green results. Now, most green buildings have combined these factors into the following core topic areas: site selection, energy efficiency, water conservation, resource efficient materials and indoor environmental quality.

Our demand on natural and finite resources such as energy, water, and building materials can be reduced and our contribution to environmental quality enhanced by incorporating green building principals into the design, construction, and renovation of buildings. Green buildings are designed and constructed to maximize whole life-cycle performance, conserve resources, and enhance the comfort of their occupants. This is achieved by the smart use of technology such as fuel cells and solar heated water tanks, and by attention to natural design elements such as maximizing natural light and building orientation. The result is a highly efficient building that saves money, is aesthetically pleasing, and contributes to the comfort and productivity of its occupants. Buildings are responsible for approximately 55% of the energy consumed in Jordan as shown in Figure 1. It's estimated that a significant portion of this energy use would be unnecessary if all buildings were probably insulated.

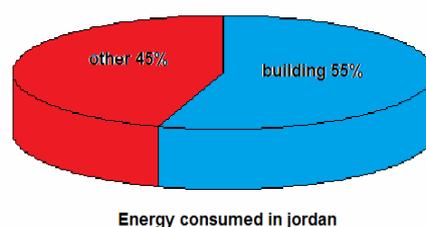


Fig.1 Energy Consumed in Jordan

II. ROCK WOOL FOR ECO HOME

Rock wool insulation provides excellent thermal resistance and can play a significant role in reducing the energy used in heating and cooling residential and commercial buildings by reducing the transfer of heat (and cold) through a buildings envelope and can helps to minimize the amount of energy needed to heat and coal a buildings but also reduces the greenhouse gas such as CO₂, commonly produced by cool fired power plants.

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from sitting to design, construction, operation, maintenance renovation and deconstruction. This practice expands and complements the durability, and comfort. Green building is also known as a sustainable or high performance building.

Green buildings are designed to reduce the overall impact of the built environment as shown in Table 1 on human health and the natural environment by:

- Protecting occupant health and improving employee productivity.
- Efficiently using energy, water and other resource.
- Reducing waste, pollution and environmental degradation.

Table 1 : Impacts of the built environment

Ultimate effects:	Environment effects:	Consumption:	Aspects of Environment:
Sitting	Energy	Waste	-Harm to
Design	Water	Air pollution	human health
Construction	Materials	Water	-Environment
Operation	Natural	pollution	degradation
Maintenance	Resources	Indoor	-Loss of
Renovation		pollution	resources
Deconstruction		Heat islands	
		Storm water	
		runoff Noise	

For that we suggest using Rockwool which is available in Jordan for isolation because the thermal characteristics of the building envelope are among of the main criteria, which

determine the overall thermal performance. For this reason, a code for thermal insulation is introduced. The code deals with thermal characteristics of roofs, external walls, and glazed surface with the objective of reducing the heat flow through the building envelope. This is done through the limiting of the U-value for the roof and external walls together with defining the type of glass for windows and openings. The use of insulation materials is regarded as the most effective means of reducing the rate of heat transfer from outside to inside during the hot summer, and from the inside to outside during the cold winter.

Also the heat transfer from the building takes place through the following elements:

- 1-Walls
- 2-Roofs
- 3-Ground
- 4-Infieation
- 5-Windows and glazing surfaces

During the summer, the amount of heat transfer through roofs and walls ranges between 60-70%. For solar heating we are going to use the one which is made in Jordan Thermosyphon solar water heater relies on the natural circulation of water between collector and the tank or heat exchanger. As water in the vacuum tube is heated it rises naturally into the tank, while cooler water in the tank flows down to the bottom of the vacuum tubes, causing circulation throughout the system.

III. MATERIALS AND DESIGN METHOD

Selection: Green building material selection is based on the product that best meets the established environmental criteria and the most appropriate application for the project. When comparing similar types of products a rating system can be established by giving higher points to products that meet the environmental criteria and lower point to materials that don't meet the criteria. By totalling the points an "environmental" score or rating can be ascertained. Sometimes a product may have strength in some areas but may have a characteristic causing enough concern to not be selected if it does not meet the projects environment goals. Selected green building material is then incorporated into the project specifications.

As the earth's population continues to explode and developing nations begin to use their share of the worlds resources, it is necessary to ascertain how we, as a planet, use our earths precious resources.

The United States consumes nearly 25 percent of the world’s energy, yet has only 5 percent of earth’s population. Over one-third of this energy is consumed by buildings. This doesn’t consider the amount of embodied energy used in the manufacture of building materials or the finite resources used in product composition.

During construction or at the end of useful building life, construction materials and components are often discarded with construction debris accounting for nearly 28 percent of land fill waste in this country. Inappropriate use of building materials that emit chemicals can pollute the indoor environment contributing to poor Indoor Air Quality (IAQ) with some new building chemical concentrations up to 100 times greater than outside levels. With Americans spending nearly 90 percent of their time indoors, it is not surprising that the World Health Organization estimates approximately 30 percent of all buildings will have IAQ concerns during the facility's occupancy. Green or environmentally friendly materials can help create more sustainable, healthful, and ecologically sensitive buildings. This is achieved through environmental material assessment and green building specification. It is crucial for the specifications to be enforced during construction to ensure an environmentally friendly application of materials. When the building is complete sustainable facility maintenance practices help ensure the improved performance of green building materials and ultimately the environmental green building.

For our project of 230 square meter house we use the prices of the materials and energy as in October 2010 as shown in Fig. 2

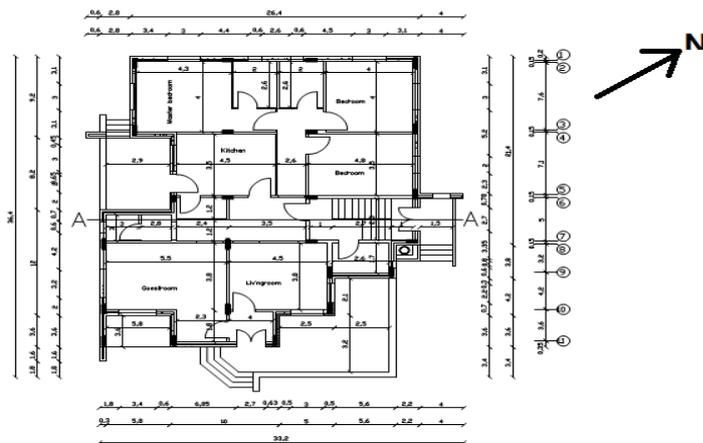


Fig. 2: 230 square meter house

In accordance with ASTM C 665-84 and ASTM C 547-77 we suggest using the following types of Jordanian Rockwool as shown in Table 2 and Table 3.

Table 2: Jordanian Rockwool Properties

Dimension / M		Thick MM	Density KG / M3	K. value W / M ° C	Facing material
Width	length				
1.2	6.0 As req.	30 - 100	30 - 60	0.032	Alu foil Bituminous paper

Table 3: Jordanian Rockwool Properties

Dimension / M		Thick MM	Densi ty KG / M3	K. value W / M ° C	Facing material
width h	length h				
1 - 1.2	6 As req	30 - 100	40 - 140	0.03 - 0.035	-Kraft paper* Alu foil -Galvanized wire mesh

You'll find that you have several options to consider when selecting what type of windows you should use in your home. When selecting windows for energy efficiency, it's important to first consider their energy performance ratings in relation to our climate and our homes design. Although very strong, light and almost maintenance free, metal or aluminum window frames conduct heat very rapidly. Because of this, metal makes a very poor insulating material. To reduce heat flow and the U-factor, metal frames should have a thermal break—an insulating plastic strip placed between the inside and outside of the frame and sash. Thermosyphon solar water heater relies on the natural circulation of water between collector and the tank or heat exchanger. As water in the vacuum tube is heated it rises naturally into the tank, while cooler water in the tank flows down to the bottom of the vacuum tubes, causing circulation throughout the system.

IV. RESULTS

Construction cost constitutes only a fraction, though a substantial fraction, of the total project cost. However, it is the part of the cost under the control of the construction project manager. The required levels of accuracy of construction cost estimates vary at different stages of project development, ranging from ball park figures in the early stage to fairly reliable figures for budget control prior to construction. Since design decisions made at the beginning stage of a project life cycle are more tentative than those made at a later stage, the cost estimates made at the earlier stage are expected to be less accurate. Generally, the accuracy of a cost estimate will reflect the information available at the time of estimation.

Construction cost estimates may be viewed from different perspectives because of different institutional requirements. In spite of the many types of cost estimates used at different stages of a project, cost estimates can best be classified into three major categories according to their functions. A construction cost estimate serves one of the three basic functions: design, bid and control. For establishing the financing of a project, either a design estimate or a bid estimate is used. As prices of October 2010 the cost of our project without an added materials to convert the normal building to green building is 59000 Jordanian dinars as shown in Table 4

Table 4: Bid Estimate Based on Engineers List of Quantities

Item		Unit	Quantity	Unit price (JD)	Total price (JD)
Excavation works (cut+fill)		m ³	610	6	3650
Concrete works		m ³	173	55	9500
Steel		Ton	21	600	12600
Blocks (10cm)		Unit	2100	0.32	650
Blocks (15cm)		Unit	2400	0.38	900
Slab blocks		m ²	1500	0.40	600
Formworks		m ²	230	14	3200
Masonry works		m ²	311	30	9300
Paint works		m ²	712	4	2850
Plastering works		m ²	712	4.5	3200
Windows		m ²	20	40	800
Tile works	Mosaic	m ²	257	8	2000
	Ceramic	m ²	144	10	1400
	Panel	m ²	230	1.5	250
	Marble	m ²	5	21	100
Doors	Wooden doors (2*1)	Unit	12	80	950
	Steel doors (2*1.3)	Unit	3	150	450
Electrical works					1900
Mechanical works					3900
Sanitary works					1100
Overall total price					59000

The prices of the added materials to convert the normal building to green building are 6650 JD as shown in Table 5

Table 5: Added Materials to Convert the Normal Building to Green Building

Item	Unit	Quantity	Unit Price (JD)	Total Price (JD)
Roof	m ²	230	3	2990
Walls	m ²	311	5	1555
Floor	m ²	230	5	1150
Pipe	m	15	4	60
Solar Heater	Unit	1	500	500
Double glass windows	m ²	20	70	1400
Total				6650

The operation energy cost for the two kinds of buildings calculations were 2330.92 JD yearly for the normal building and 721.6 JD for the same building with added materials as shown in Table 6

CONCLUSION

In this paper we introduce to use Jordanian Rockwool in Green Home design as Eco-Home, the cost of additional materials constitute only a small percentage of construction prices, and the construction operational cost much lower than the savings that can be achieved in case do not use additives, the use of environmental friendly materials, can insurance better environmental life, and clean more, reduce the energy uses, reduce air pollution and imported energy in Jordan to a minimum. In this work we can minimize the depletion of resources and nature to a minimum and reduce pollution indoors, and therefore emissions of toxic gases, as a result of reducing energy use. Encourage use of Jordanian industries that depend on natural resources in Jordan, especially in the manufacture of solar water heaters and rock wool.

Table 6: Yearly operation cost

Season	Item	Cost (JD)	
		Normal building	Green building
Summer For 4 month	Conditioning	621.4	165.76
	Hot Water		
	Fixed costs (lighting,refrigerator,TV,and ... etc.)		
Winter For 4 month	Heating (warm)	1430.12	480.92
	Diesel		
	Electricity		
Spring and autumn For 4 month	Hot water	279.4	74.92
	Fixed costs (lighting,refrigerator,TV,and ... etc.)		
	Fixed costs (lighting,refrigerator,TV,and ... etc.)		
Total		2330.92	721.6

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