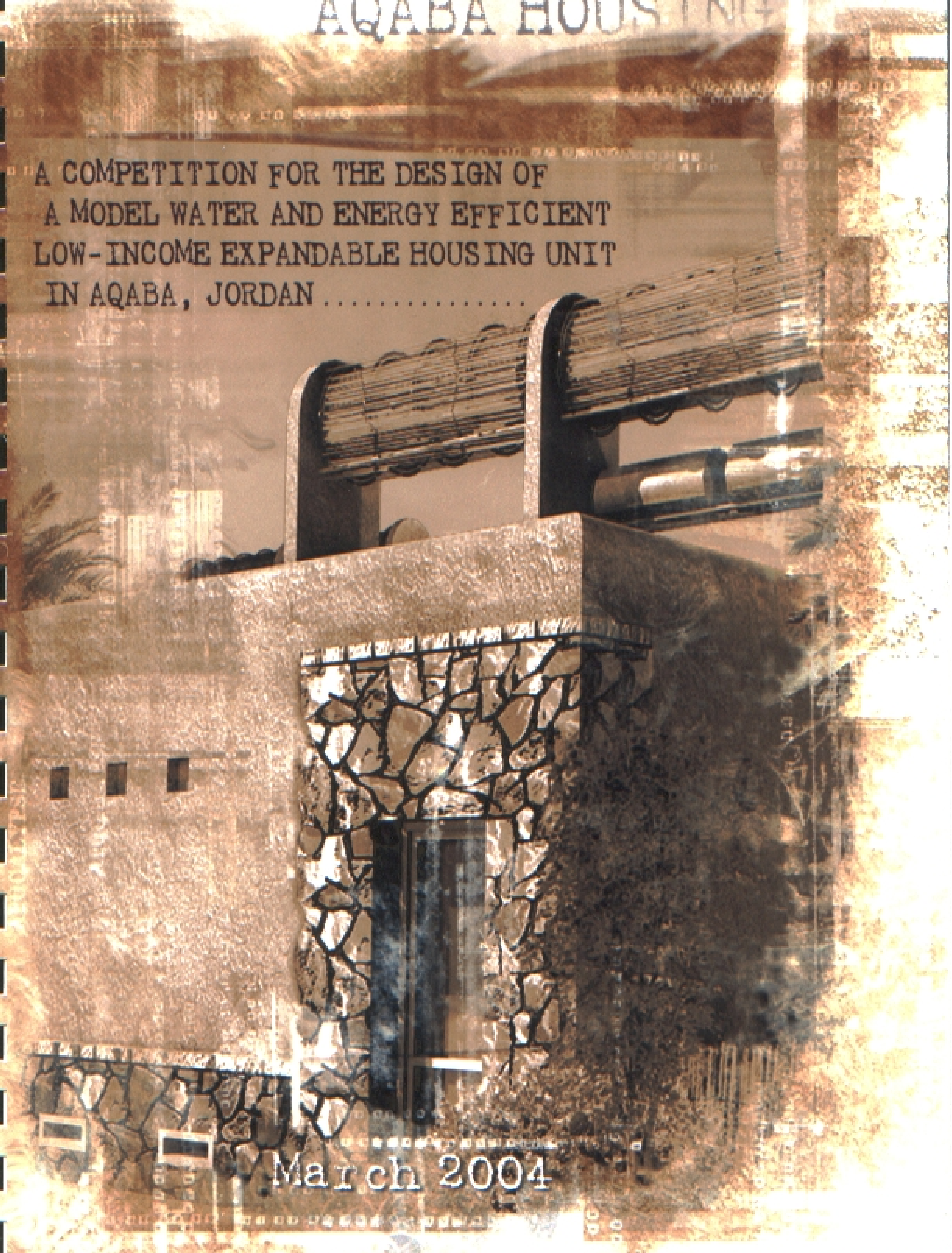
AQABA HOUSING COMPETITION

A COMPETITION FOR THE DESIGN OF
A MODEL WATER AND ENERGY EFFICIENT
LOW-INCOME EXPANDABLE HOUSING UNIT
IN AQABA, JORDAN...............



March 2004

INTRODUCTION

This report is a supplementary tool for explaining the conceptual and technical background of what may very well be a good design of passive house for hot and dry climates in general and for the shamiyya site in particular.

The design process went through three different stages: first, technical analysis of the given requirements, regulations and climatic data from which recommendations were drawn in setting out the preliminary sketches of the housing unit(s). Secondly, with the particularity of the severe hot climate in Aqaba, we introduced a double-use low-cost passive solar system for both passive cooling and water heating. In stage three, certain design elements were developed and studied more closely for practicality, availability and for aesthetic add-ons. Eventually, alternative site or urban structure has been studied for best outcomes of usable external space and for avoiding any obstructions against the reach of wind or sun.

A brief breakdown of the cost was included in the report highlighting the cost of special design elements used for achieving a sustainable water and energy efficient housing development.

Conclusions and recommendations were drawn on the need for similar initiatives which will enhance future applications of reasonably affordable energy-saving design approaches and systems to protect energy resources from depletion and prevent further environmental pollution.

RESEARCH AND CLIMATIC DATA ANALYSIS

Design requirements, building regulations, socio-economic and climatic conditions are all determinant factors that influenced the design of this project. However, the criticality of the hot-dry climate for most of the year made it a more dominant one.

Analysing the climatic data of the Aqaba area[1], using personal and other research work on similar climatic cases[2] and supported by general knowledge and practical experience, the following recommended design criteria were considered:

1- North-South orientation with respect of the sun is best where the sun penetrates facades only marginal. In winter[3] lower sun paths allows solar access and need horizontal shading.

2- Increased night ventilation in combination with internal thermal storage capacity is recommended in the summer where internal heavy structures absorb day's heat after being cooled at night. Conversely, low continuous ventilation rates in the winter decreases temperature variations.

3- Roof insulation is highly recommended to protect against sun's radiation as the roof is the largest exposed surface area to the sun.

4- Vegetation in hot climates helps in maintaining cooler surroundings as it provides shade and with the use of proper filtering[4] maintains a damp cool atmosphere.

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[1] In Aqaba, the weather is hot and dry with highest monthly mean maximum temperatures of 39.40 degrees centigrade in July and lowest of 8.98 degrees centigrade in January. Prevailing winds are northern and annual precipitation 30mm. Latitude is 29.50 N, Longitude 35 degrees E, and altitude is 218.3M above sea level.

[2] A computer simulation study was conducted by al-Ajam on a lower desert valley in North Shouneh in Waqqas which has a hot and arid climate. Also, see references for more advanced research work on similar climates.

[3] Winter is less critical in the case of Aqaba, as temperatures are tolerable.

5- Medium sized south windows

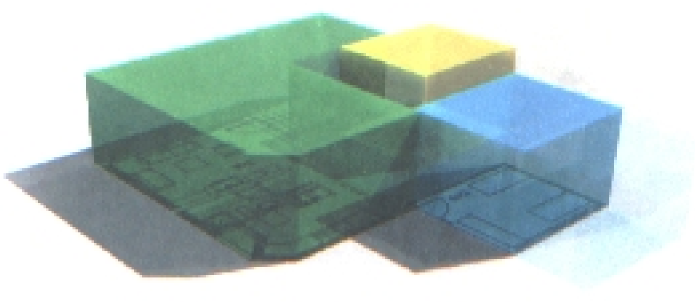
6- Compact forms or layouts minimize solar exposure in the summer and heat losses in the winter.

7- Compact urban design is recommended for obtaining acceptable micro-climate in hot season. Walls and masses can be used to direct or block winds, create shade.

Design Strategy

Combining both technical and climatic aspects, the preliminary sketches were materialized into its final shape which is better absorbed virtually rather than orally. Nevertheless, we shall try to convey the picture in words.

The house unit, the houses and the buildings were designed to provide a pleasant comfortable atmosphere with minimum energy use. The three-room starter unit is to be expanded incrementally by extended family members or relatives to a maximum of three similar independent houses yet, sharing a common shaded courtyard.

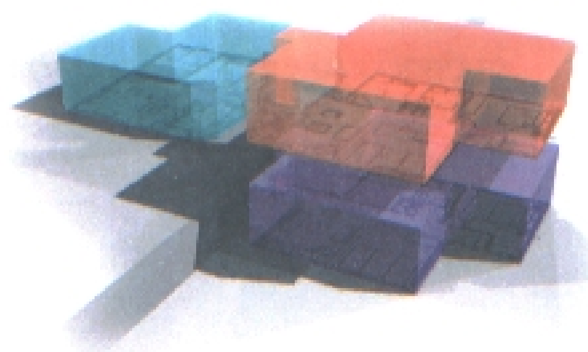


STARTER UNIT BUILDING STAGES

STAGE 1: ROOM NO. 1 , KITCHEN AND BATHROOM

STAGE 2 : ROOM NO. 2

STAGE 3 : ROOM NO. 3



STARTER UNIT EXPANSION STAGES

STAGE 1: GROUND FLOOR PLAN TO BE BUILD ALL AT ONCE

STAGE 2 : FIRST FLOOR CAN BE BUILD ON STAGES

STAGE 3 : SECOND UNIT CAN ALSO BE BUILD ON STAGES

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[4] Palm trees are a good example on low water-consuming plants and with the use of gravel layer on top, can maintain dampness for longer periods.

Buildings are replicated in successive attached blocks creating a network of courtyards and wind tunnels in such a way that allows continuous airflow. This is specifically intended to cool both courtyards and indoors.

SITE LAYOUT

Ventilation

In order to further activate ventilation through the housing unit, a passive solar system constructed on the roof was created to enhance and accelerate stack effect[5] creating airflow through shafts positioned in the heart of each house. As the cool air enters from the lower openings in the walls, it warms up as it rises[6] and is sucked up through the shafts due to extensive difference in pressure between lower cool points and the heated air under the corrugated panels which are subjected to sun's heat.

Further cooling is achieved as airflow is created between the external double hollow block walls. They breathe and exhale through small lower and upper openings thus cooling the walls and minimizing heat transfer indoors.

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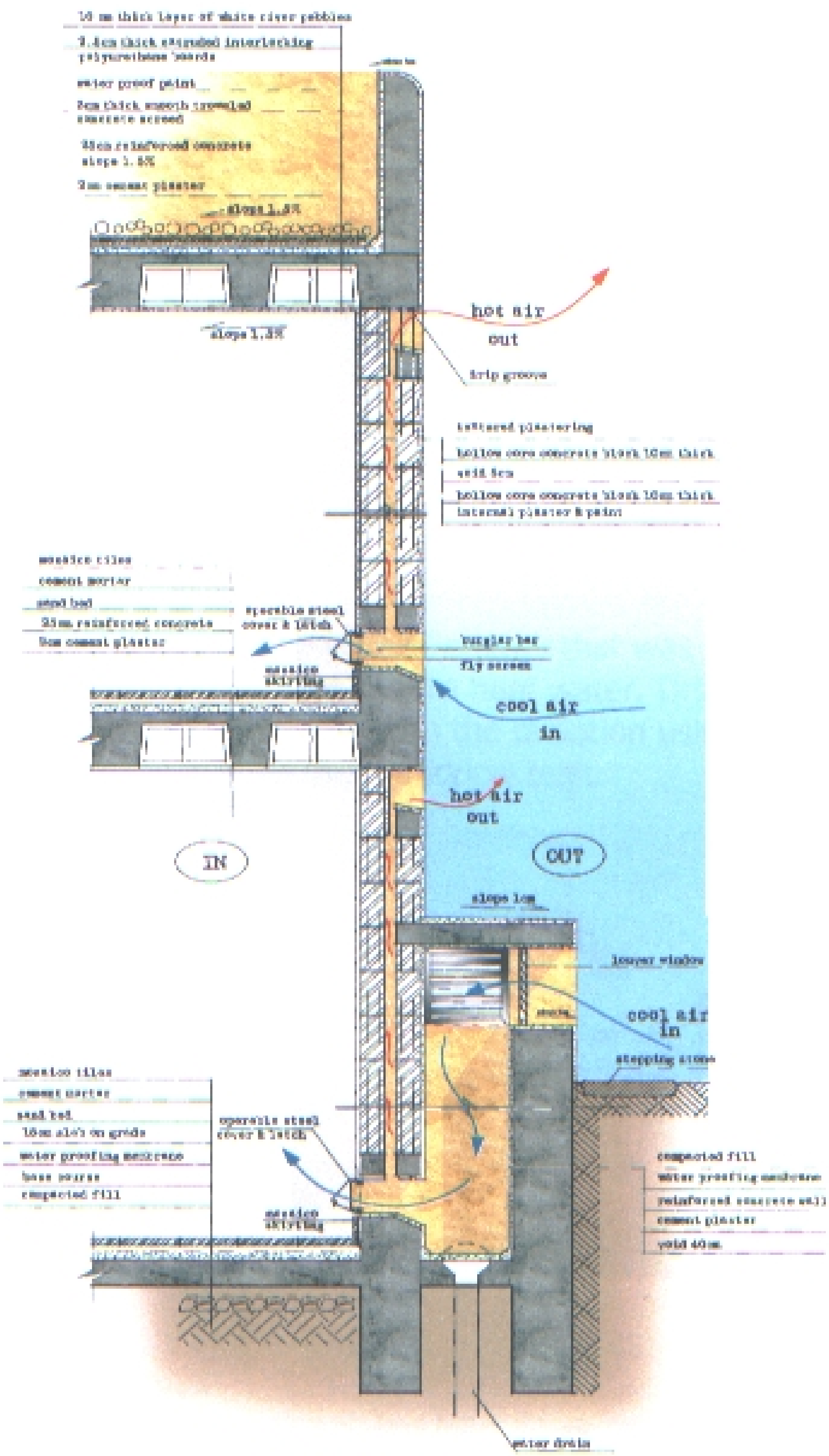
[5] Similar to traditional "malqaf"

[6] Heating stoves or cookers are placed under the shafts to further enhance airflow.



WALL SECTION

Internal mass

Increased night ventilation is exploited to the maximum by using internal heavy seismic reinforced concrete walls[7] that absorb the hot air during the day after being cooled at night.

Other protective measures against heat transfer through the walls are achieved using ivy-type vegetation on southern walls, mashrabiyas and pergolas[8].

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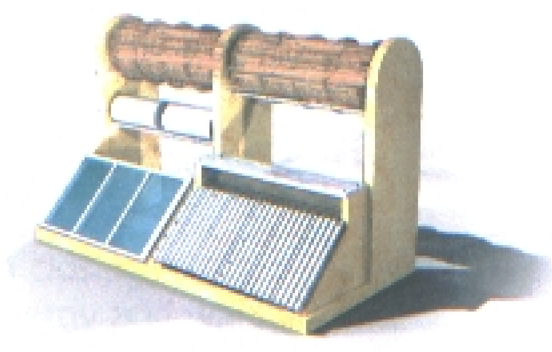
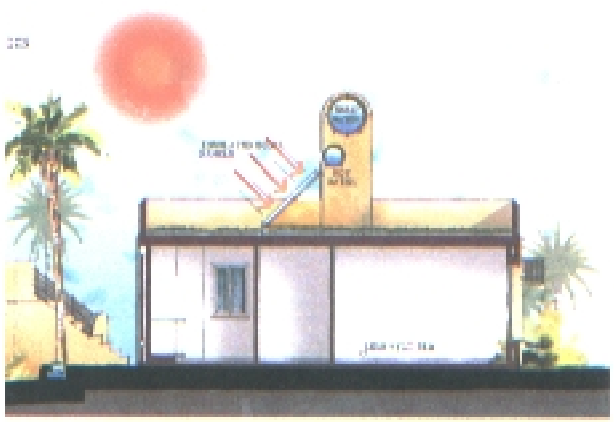
Heating Domestic Water

The sun is a free renewable source of energy that was used by the same solar system constructed up the roof to heat water. Drinking water tanks on the other hand, are protected from the radiation using a shell of cane sticks tied with ropes around the cylindrical tank.





[7] 25 cm thick reinforced concrete seismic walls have higher thermal capacity compared to hollow block work. Seismic walls are needed as "the Gulf of Aqaba is recognized as an active seismic zone where many destructive earthquakes have occurred."

[8] All made of sugar cane and wood.

Insulation

Although solar energy is a useful energy source yet, buildings have to be protected from its heat. The roof is the largest exposed surface in the building therefore, we have chosen to insulate it using a 2inch interlocking polyurethane boards topped with reflective white river pebbles.

Cost Calculations

Calculations have been estimated considering that the area of each housing unit is 80 m^2 and each plot contains three housing units (fully expanded building), i.e. a total of 240 m^2.

Item	Area (M^2)	Price in JD/M^2	JD*No.	Total cost in JD
Foundations and external works	160	20		3200
Superstructure	240	40		9600
Finishing and Landscape	240	50		12000
Insulation	160	2.5		400
Solar System	-		300*3	900
Total				26,100

A total cost of 26,100 JD per plot (3 housing units) can be translated into 8700 JD. The extra 8.75 JD/ M^2 is due to the use of solar system and the roof insulation[9] which is minimal considering that no fuel is needed for heating water. Also, cooling is providing a life-time comfort for no running cost.

Conclusion

In closing, we would like to thank all concerned bodies for promoting energy and water-saving climatic design and we hope that it will be incorporated in our building regulations. Energy conservation is translated into a healthy environment, an issue which is facing focused attention and concern globally and the challenge remains to be able to make it economically affordable.

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[9] One inch thick extruded polyurethane interlocking insulation boards.

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