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Affordable Housing for the Future Competition

Design of a Model Water- and Energy-Efficient Low-Income Apartment Building in Abu Alanda, Jordan

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Research and Design Methodology

Prototype

In the search for a suitable prototype that fulfils the cultural, social and area requirements for Jordan, the basic apartment unit was designed containing the main spaces present in an average Jordanian family home.

From the very beginning sustainability was taken into consideration in the design of the housing unit itself by applying techniques of wall and roof insulation with affordable materials.

But the real challenge was in assembling the housing units in groups that fit in such a steep sloping site (slope 18% to 29%) while maintaining easy vehicular and pedestrian access, maintaining required density and relative privacy for each unit as well as achieving best orientation for optimum solar energy utilization and proper natural ventilation.

Therefore strategic decisions were made from the outset:

1. The building block should always have a main South – North orientation without jeopardizing its ability to adapt to the topography as the location of each block changes and the orientation of each plot changes with respect to the total project site.

2. Despite of the apparent extra cost of indoor parking, it was decided to preserve the site by minimizing the asphalted outdoor car parks; parking garages were created under the buildings for residents while limited outdoor parking lots were provided for visitors and for public areas. To avoid creating steep ramps leading to parking garages all covered parking garages were located on the lowest side of each block thus maintaining ramp-free easy access. The covered parking garages occupy only one half of each building to save on excavation and allow for natural ventilation and easy access. The paved areas on top of covered parking between adjacent buildings will be used as local children's playgrounds for each building.

3. The above decisions resulted in creating a gallery type open corridor allowing access from parking garages to apartments at the far end of each block; the corridor has one staircase at each end and an elevator shaft was provided for future installation by building occupants. When compared to typical apartment blocks in Jordan where one staircase serves two apartments on each floor, this "Gallery" connection is an added feature as it provides an alternative fire escape route to apartments on opposite ends; in addition to giving each apartment an independent private entrance while maintaining social interaction between occupants of each floor.

Design Concept

Objective

To create a versatile, **atypical prototype** of buildings that is orientation guided, site & topography sensitive, energy efficient, water efficient and cost saving. A prototype that is aesthetically pleasing without pretentiousness and without incurring unjustified costs resulting from unnecessary cosmetic architectural elements.

Energy Efficiency

A South – North oriented design was achieved with a combination of four adjacent apartments and two sets of stairs and cores for future elevators. The apartments' construction was made energy efficient by insulating walls and roofs with locally available materials and by avoiding thermal bridges in almost all the external building skin. The apartment was oriented in a way were most of the rooms were facing South and to make it respond to this kind of orientation a "Duplicate Skin" was made of the South façade and part of the roof to achieve the following:

1. The Duplicate Skin or Detached Façade became the main feature of the building that is always facing south. Made of RC structure & hollow block construction with colored plaster, the Duplicate Skin became the skin that is environment friendly, playful and yet serene through its carefully proportioned openings.

2. The Duplicate Skin became the Environmental Regulator for each building through the following:

   - It provides shade to the southern façade, windows and openings.

   - The space between the Skin and the south wall of each apartment is a green space with planters. The vegetation growing on the Duplicate Skin will make it a green wall juxtaposed in front of the southern façade.

   - Its L-shaped section also provides shading to most of the apartment roof area during the summer and still maintains a free air circulation between the two layers (Roof & Duplicate Skin).

   - The roof part of the Duplicate Skin acts as a structural frame that carries the solar panels. The solar panels are connected to the frame by means of a pivoted joint that contains the in & out water pipes but allows proper orientation of solar collectors towards the sun. The pivoted feature also allows easy access for cleaning and periodical maintenance.

- The roof part of the Duplicate Skin also creates a shelter covering the roof mounted water tanks that are a cause of visual pollution in most of Jordanian cities and villages.

3. The Duplicate Skin is a living membrane that provides character, color, shading, collection of solar radiation and an orientation conscious element.

Water Efficiency

Water harvesting was made possible by creating underground collection reservoirs in the site and under the buildings:

1. Each building contains an underground water reservoir located under the parking garages (or they could be located at the higher basement level where no garages exist). Rain water collected from roofs of buildings in these reservoirs is used for cleaning shared facilities and for watering plants within the premises of each building.

2. Surface water from the site is collected into underground water reservoirs that exist under paved playgrounds; it will be used to irrigate the plants in various open areas in the site, particularly in the park. It can also be used for cleaning public pathways and site facilities.

Cost Estimate

Option 1: Apartment Building with Indoor Parking Garages

Area of each apartment: 113.9 to 115 m^2

Total floor area including staircases and open corridors: 581.6 m^2

Total area of one apartment block including parking garages: 3469.6 m^2

Basement 3 parking garages were considered as part of the total cost while roof mounted solar panels were not included in the cost estimate as they can be installed at a later date.

Description	Percentage	Cost (JD)
Substructure	4%	31,426.40
Superstructure	34%	267,124.40
Finishing Materials	58.5%	459,611.10
Insulation Materials	2%	15,713.20
Landscaping	1.5%	11,784.90
Total Cost	100.00%	785,660.00

Table: Breakdown of Estimated Cost for Option 1

Option 2: Apartment Building with Outdoor Parking

Area of each apartment: 113.9 to 115 m^2

Total floor area including staircases and open corridors: 581.6 m^2

Total area of one apartment block: 3188.8 m^2

In this option, it was assumed that outdoor parking will be allocated for each apartment building with access from the higher and lower streets. Roof mounted solar panels were not included in the cost estimate as they can be installed at a later date.

Description	Percentage	Cost (JD)
Substructure	4%	29,974.72
Superstructure	34%	254,785.12
Finishing Materials	58.5%	438,380.28
Insulation Materials	2%	14,987.36
Landscaping	1.5%	11,240.52
Total Cost	100.00%	749,368.00

Table: Breakdown of Estimated Cost for Option 2

Total Cost Estimate per Square Meter

Total Cost estimate per square meter for Option 1:

785,660.00 ÷ 3469.6 m^2 = 226.441 JD

Total Cost estimate per square meter for Option 2:

749,368.00 ÷ 3188.8 m^2 = 235.00 JD

Life Cycle Cost Analysis

Twenty-Year Life Cycle Cost Analysis for Option 1:

Description	Yearly Expenditure	Number of Years	Cost
Capital Investment			785,660.00
Maintenance	800	20	16,000.00
Electricity	5280	20	105,600.00
Water	1320	20	26,400.00
Total Life Cycle Cost			933,660.00

Table: Life Cycle Cost Analysis for 20 Years for Option 1

Twenty-Year Life Cycle Cost Analysis for Option 2:

Description	Yearly Expenditure	Number of Years	Cost
Capital Investment			749,368.00
Maintenance	800	20	16,000.00
Electricity	5280	20	105,600.00
Water	1320	20	26,400.00
Total Life Cycle Cost			897,368.00

Table: Life Cycle Cost Analysis for 20 Years for Option 2