Energy Efficient Building Code for Jordan

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This scientific paper describes the criteria of developing the new Energy Efficient Building Code for Jordan. In addition, some of the architectural aspects for design of energy efficient buildings is discussed in this paper within the context of the building codes of Jordan. International building codes and 16 professional technical committee from the Jordanian market helped in the conveyance and development of this code.

1. ABSTRACT

The Energy Efficient Building Code was developed to face energy challenges Jordan has recently concurred. The code was prepared utilizing many local, regional and international related resources. In addition, 16 expert engineers from the Jordan construction market helped in developing the code and translate Jordan's market needs into its content. A combination between architectural aspects, mechanical considerations and electrical principles were added up into the energy efficient building code for Jordan, producing the most recent sustainable building related code in the region.

2. INTRODUCTION

2.1. Background

Jordan is privileged with an exceptional geographic location and incomparable environmental circumstances, nevertheless, the use of clean energy sources in Jordan is very low.

Moreover, energy use by the residential sector in Jordan is 24% of the total expenditure, which is equal to that of the industrial sector.

As the living standard increases, people tend to install heating and/or cooling equipment in order to overcome the problem of poor thermal comfort. For buildings not adapted to the climate, energy use will excessively get high and the impact on the environment will be negative.

In a world where 'sustainability' is debated and becoming more recognized, protecting the environment becomes a necessity rather than a luxury.

This calls for architects, urban planners and engineers to develop and apply concepts in building design and choice of materials, in order to reach sustainability in the building sector and to provide a comfortable internal environment, with minimum energy use.

Therefore, the Jordan National Building Council contracted the Building Research Center at The Royal Scientific Society to develop a new Code of Practice, titled "Energy Efficiency in Buildings Code", for improving thermal performance and minimizing energy consumption in buildings.

2.2. Related Codes

The Building Research Center (BRC) has started preparing the Energy Efficiency Building Code since the beginning of 2008 amongst a package of 5 building codes relating to the subject and mandated by the Jordanian National Building Council. The New Energy Related codes are:

- Mechanical services specifications
- Electrical services specifications
- Gas Piping Code
- Thermal Insulation Code (Updated)
- Energy Efficient Building Code

In 1998 RSS prepared the Insulation Code which specifies the design requirements concerning the U value. Due to Recent increase in energy consumption and prices, the following minimum requirements had to be updated to match such changes:

- Design requirements concerning the U value for windows, roofs and floors.
- Insulation materials types properties and standards.
- Principles of thermal design and dampness in buildings.
- Periodic Heat Flow and Time-Lag and Decrement Factor.

2.3. International Codes and other resources

International references and resources were used such as:

- ASHRAE, USA
- CIBSE, UK
- Energy conservation in buildings code, India

Feedback from 16 qualified local specialists in energy saving in buildings was also used in developing the code.

3. METHOD

3.1. Objectives

Applying the findings of this project and the code will ensure:

- Better practice in the building sector in terms of environmental needs.
- Lowering heating and cooling bills.
- Improving the thermal conditions inside buildings
  Minimizing the negative effect of energy consumed in heating and cooling.

3.2. Presentation

A Technical committee consisting of 2 civil engineers, 4 mechanical engineers, 7 architects and 3 electrical engineers helped in revising and development of the first draft of the Code, presenting a very successful outcome in only 8 months of work.

4. THE CODE

4.1. Contents

The Energy Efficient Building Code contains the following chapters:

[1] Chapter One: Generalities
- Objectives of the code: providing the architect and designer with the minimum requirements for designing an energy efficient building
- Domain of Practice: all new construction, and any new extensions that consume energy, mandatory for:
  - building envelop
  - mechanical systems
  - electrical lighting
  - electrical power equipments
  - water heating system.
- Application method
- Technical requirements for design
- Inspection
- Architectural definitions
- Mechanical Definitions
  Electrical definitions

[2] Chapter Two: Architectural design principles and requirements:
- General: thermal design and passive design, climate design importance on the architectural elements of a building.
- Objectives of Architectural design:
  - thermal comfort
  - minimizing energy consumption
  - lowering energy bills.
- Architectural design considerations:
  - climatic data of site
  - internal circumstances
  - building and space function
  - building material properties
  - tools and methods for application.

[3] Chapter 3: Mechanical ventilation
- Field of application
- Types
- mandatory requirements

[4] Chapter 4: Heating and air conditioning
- Design considerations
- general requirements:
  - device accreditation
  - duct system
  - electrical wiring
- mandatory requirements for non residential buildings
  - Energy Efficiency Labeling
  - control devices
  - piping and ducting systems
  - system balance
  - thermal condensers
  - economizers
  - air conditioning systems

[5] Chapter 5: Hot water supply
- Device placing
- hot water demand calculation
- piping insulation
- equipment efficiency
- control system
- swimming pools

[6] Chapter 6: Lighting system
- General
- Lighting controls
- power consumption in lighting
- power consumption in outdoor lighting
- recommendations.

[7] Chapter 7: Electrical power
- Requirements:
  - Transformers
  - motor efficiency
  - inspection and monitoring
  - distributor efficiency
- recommendations.

[8] Appendices:

4.2. Architectural Aspects

Climate zone and region. Tables for temperatures, humidity, wind speed, radiation and any other climate data important for the design was included in this part.

Site and orientation. Utilization of the site advantages and finding ways to minimize effect of disadvantages concerning wind direction and speed, desired solar radiation and temperature was shown. Recommendations only were given, with no obligatory terms such as:
- preferred building to the south
- long axis directed east west
- in hot areas using arcades and shading in the south façade
- balconies and terraces to the south and east.

Building form. This section shows the relationship between exposed surface and volume of the building with energy losses and gains, affect of height of building and shape of plan for high-rise buildings, shallow plans and deep plans, shape of building roofs and shape of building walls. Recommendations only were given, with no obligatory terms concerning this section.

Site landscaping. Recommendations only were given, with no obligatory terms such as:
- deciduous trees for south facades
- height of trees relationship with tree location
- shadow consideration in cold areas

- evergreen trees for hot climate
- green landscaping (solar reflection)
- wind breakers from trees.

Passive solar techniques for thermal efficiency. Definitions for direct solar gain and loss through windows, thermal storage wall and sunspaces were given in this part.

Building Envelope: Thermal insulation and obligatory requirements for U-values were taken from the new updated thermal insulation code as shown in tables 1, 2 and 3. Recommendations for this sections was as the following:

- solar reflectance higher than 0.7 for roof, e.g. light colors.
- smooth surfaces
- emissivity higher than 0.75 and absorption higher than 0.3 for roofs
- window areas concerning function, location and orientation
- minimum areas of windows in wind exposed facades.
- locations of functions on the plan related to orientation
- service areas locations

Sealing of openings (air leakage). Requirements for this part are:

- air leakage not more than 3 liters/second for doors and 2 l/s for other vertical openings
- windows and doors sealing
- insulation of materials connections to avoid thermal bridges, piping, service holes and shutter boxes.

Natural lighting. Importance of natural lighting in minimizing electrical energy consumption was described in this section, defining skylight and window lighting properties. Requirements for this part are:

- obstacle angle in front of window not more than 70 degrees
- 50% of opening should be on at least 2 different sides,
- ratio of window to wall area above10% for services,
- 15% for residential functions,
- visual lighting transmittance above 0.45,
- skylight maximum area 12% from roof,
- light colored internal surfaces.

Recommendations for this sections was as following:

- organized distribution of windows
- window height
  window location.

Shading devices. This section describes objectives, dimensions, types and uses of shading devices such as horizontal, vertical, crossed, movable, natural and internal. It also states requirements as the following:

- void between external shading device and window
- use of light weight materials

Recommendations for this sections was as the following:

- shading coefficient less than 0.2
- movable shading on east, south east, west, west south facades
- external shading is better than internal shading

Natural ventilation: This section describes ventilation advantages and minimum ventilation rates needed for a healthy comfortable living. It also states requirements as the following:

- first phases of design
- distance not more than 5 times the height between two walls or out side and inside
- humidity 40% to 70%
- shaded ventilation point
- avoid pollution points near ventilation points

Recommendations for this sections was as the following:

- architectural solutions for protection from dust
- maximizing benefit from natural ventilation
- small openings in big ones
- additional ventilation equipments for redirecting air
- uses of colestra brick and meshes in front of openings

There was also a section about means of natural ventilation such as one side and two side ventilation, cross ventilation, stack effect ventilation. Elements of ventilation were also described, the opening width, inlet and outlet dimensions.

Some means of improving natural ventilation were discussed such as:

- night ventilation
- shaft
- chimney
- wind catcher

Courtyard and Atrium. In this section the definition and usage of these element are defined. It also states requirements when using and designing a courtyard or an atrium such as the following:

- beginning of design
- openings on court
- ventilation points to get rid of hot air
  proper shading devices.

Table 1: U-values for Walls.

Walls	**U-value W/m^2.K**
Opaque walls or any part of it	0.57
Total Wall including percentage of openings	1.6
Divider walls between 2 different energy source provider for 2 building spaces.	2.0
Divider walls between 2 parts of the building one of them is heated/ air conditioned and the other not.	2.0

Table 2: U-values for Exposed Floors and Roofs.

Exposed Floors and roofs		**U-value W/m2.K**
Exposed for outdoor air	Heat transfer towards the top	(1.2) 0.55
	Heat transfer towards the bottom	0.8
Floors/ Roofs dividing to floors with different energy source provider		1.2
Floors located above un heated/ air conditioned basements or spaces		1.2

Table 3: U-values for Window Types

Window Type	**U-Value (window) W/m^2.K**	**Allowed ratio of window to wall**
Aluminum/ steel frame, single glazing	5.7	20.1%
Aluminum/ steel frame,double glazing	3.4	32.9 %
Wooden/ plastic frame, single glazing	4.8	24.3 %
Wooden/ plastic frame,double glazing	3.1	40.7 %

4.3. Appendices

Some helpful appendices has been added in the end of the code, including the following:

Jordan Climate Data. 14 climate stations data in Jordan has been selected to verify concerned weather data for passive architectural design and other climatic design purposes.

U-values for Openings. 3 tables describing u-values of opening including windows, skylights and windows with internal shading devices has been included into this appendix.

Physical Properties of Building Materials. This appendix incorporate 9 tables describing some of the building materials properties, such as emissivity, absorption, reflection and shading coefficient for glass, structural materials and window frames. Other building properties are referenced to the new updated Thermal Insulation Code of practice, Jordanian Building Codes.

Internal Shading Devices. Some practices of internal shading devices and techniques are shown as figures in this appendix.

External Shading Devices and Sun Charts. Calculations of external shading devices dimensions and the use of sun charts for that purpose is shown in this appendix in the form of formulas and charts.

Ventilation. Complimentary ventilation issues are added in this appendix in order to enrich some definitions and techniques for natural ventilation.

5. RESULTS

A 208 pages Code of Practice was issued by the Council on the end of August 2008, waiting for approvement from the Ministries Council in order to be published and become experimented and obligatory for all buildings in Jordan.

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