International Journal of Architectural, Civil and Construction Sciences
ISSN: 2415-1734
Vol:5, No:4, 2011

Analysis of Climatic Strategies in Designing the Residential Buildings in Cold Dry Climate of Tabriz Metropolis to Reduce Air Pollution in Urban Environment

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***Abstract*—**Nowadays, the earth is countered with serious problem of air pollution. This problem has been started from the industrial revolution and has been faster in recent years, so that leads the earth to ecological and environmental disaster. One of its results is the global warming problem and its related increase in global temperature. The most important factors in air pollution especially in urban environments are Automobiles and residential buildings that are the biggest consumers of the fossil energies, so that if the residential buildings as a big part of the consumers of such energies reduce their consumption rate, the air pollution will be decreased. Since Metropolises are the main centers of air pollution in the world, assessment and analysis of efficient strategies in decreasing air pollution in such cities, can lead to the desirable and suitable results and can solve the problem at least in critical level. Tabriz city is one of the most important metropolises in North west of Iran that about two million people are living there. for its situation in cold dry climate, has a high rate of fossil energies consumption that make air pollution in its urban environment. These two factors, being both metropolis and in cold dry climate, make this article try to analyze the strategies of climatic design in old districts of the city and use them in new districts of the future. These strategies can be used in this city and other similar cities and pave the way to reduce energy consumption and related air pollution to save whole world.

***Keywords*—**Air pollution, Urban Environment, Metropolis, Residential building, Fossil energies.

I. Introduction

AIR pollution of cities especially metropolises is one of the most important problems of the world. This pollution is the result of the lavished consumption of the fossil energies by the buildings and automobiles that are the major consumers of such energies. In cold region cities, that have long winters, consumption of the fossil energies is higher than the other regions, especially by the buildings and so, proper designing of the context of the cities and their buildings can reduce the energy consumption.Paying attention to the old districts of such cities, can lead us to this reality that they have built based on correct and proper strategies that have relationship directly to the cold climate and can help us design the new parts of the cities. It is tried in this article to analyze these strategies used in the old districts of Tabriz city and offer them as the correct items to design new districts and buildings of the city and similar cities that can reduce the consumption of energy especially the fossil energies in the world.

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II. Climatic Specifications of Tabriz City

Tabriz city has about two million people and is the largest city in the North west of Iran and the largest in the cold-dry climate of the country. Sunny days are almost in low level and snowing is major. Freezing days are as follow: (see Table I) [1]

TABLE I
FREEZING DAYS OF TABRIZ CITY SINCE 1957 TO 85

Month	Max (day)	Min (day)	Average
Jan.	30	19	28
Feb.	29	17	24
Mar.	25	3	14
Nov.	25	Zero	8
Dec.	30	19	25

Also, the conditions of sunny days in this city are as follow: (see Table II) [1]

TABLE II
SUNNY DAYS OF TABRIZ CITY SINCE 1957 TO 85

	Real time		
Month	Maximum	Minimum	Average
Jan.	177	46	111
Feb.	185	95	145
Mar.	242	87	183
Apr.	256	172	201
May	249	215	279
June	380	324	351
July	376	329	354
Aug.	417	85	322
Sep.	325	267	292
Oct.	273	153	244
Nov.	247	65	180
Dec.	183	71	134
Annual	3005	2698	2802

Average monthly temperature and snowing and raining rates also are as follow: (see Table III) [1]

TABLE III
THE AVERAGE MONTHLY TEMPERATURE AND SNOWING AND RAINING RATES

Parameter / Month	Average Temp.(˚c)	Average Raining & snowing (mm)
Jan.	-2.3	29
Feb.	zero	25.5
Mar.	5.3	47
Apr.	11.2	53.2
May	16.4	44.7
June	21.7	17.5
July	26	4.4
Aug.	25.6	3.3
Sep.	21.4	8.8
Oct.	13.8	26.9
Nov.	6.9	29.3
Dec.	1.2	18.7

These tables simply show us the cold dry climate of the city. In addition, the directions of the prevailing winds are Eastern and north Eastern that are cold winds and so the building must be protected against these winds. [2]

III. THE FABRIC SPECIFICATIONS OF THE OLD DISTRICTS OF TABRIZ CITY

If the fabric specifications of the old districts as well as the Maghsoudieh district are studied, the following results will be obtained:

A. The Angle of Position

In study of the old districts of Tabriz, it can be obtained that the Southern side of major numbers of buildings are positioned with the angle of 12.5 degrees towards South east. This is for better absorption of sun light in winter day by this side. (see Fig. 1) [3]

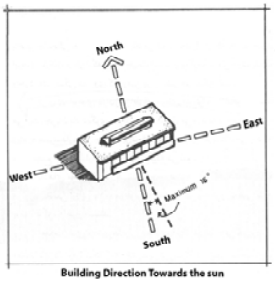

Fig. 1 Building Direction Towards the sun

B. Fabric of the City

The fabric in such cities as well as Tabriz, is compact and dense, because buildings must have low area in front of the air to reduce energy waste and heat loss. (see Fig. 2) This compact position can be seen in floors so that many buildings are built by more than one floor to reduce the ratio of roof area to total built area and about four floors (four families) have just a single roof. It should be noticed that the roof area is very important in a building and is the most critical point of a building for heat loss. (see Fig. 3) [4]

Fig. 2 Compact fabric of the city

Fig. 3 Multi storey buildings

C. Use of Central Yard

In many buildings of the old districts of the city, central yards are used, so that, the yards have surrounded by the buildings. This model, creates two main parts for the building that called winter and summer residences. In cold dry climate, the central yards are inclined to the Southern part of the buildings so that, the big part is the winter residence and the small part is the summer residence. This is for winters long term period in such climate.Sometimes this model changes to a “U” shaped model, so that, the summer residence completely omitted. This model can be seen in the “Ghadaki House” in the “Maghsoudieh” district. (see Fig. 4 & Fig. 5) [5]

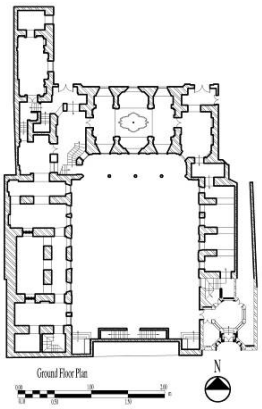

Fig. 4 U shaped form of the building

Fig. 5 North Elevaion of Ghadaki House

D. Use of Underground Floor

The earth is a good thermal mass that hasn't any thermal convection and heat loss. Therefore, in this climate, many of buildings are tucked to the earth at least in one floor and made the underground floors. This can help to the less heat loss by decreasing the thermal surfaces of the buildings. (see Fig. 6)

Fig. 6 The Underground Floor

E. Use of Southern Windows Having Sun Shelters

In winter residences and spaces that are in front of the winter sun light, large windows are used that have full height and Maximum width (or several numbers of windows in the side).these kind of windows have sun shelters ,so that, the summer light cannot pass through the shelter and enter the inner space, but the winter light can do this. (see Fig. 7)

Fig. 7 South Elevaion of Ghadaki House

F. Use of Materials That Are Thermal Mass

These kind of materials can absorb the sun light heat in day and give it back through the night, so that, the heat passes through the Southern windows and is absorbed by these materials as well as stone or brick and is given back to the air of the rooms through the night and makes them warmer.

G. Use of Thick Walls as Thermal Insulations

In the sides of buildings that face the winter cold weather and cold winds, as well as Eastern and Northern sides, the stone or brick walls are built in thickness of about 60 to 100 cm that perform as a thermal insulation and reduce heat loss and thermal convection. [6]

H. Color of Materials

In this city, there is a large Use of dark materials that have no gloss and mainly have grained texture as well as stone or brick or adobe that have maximum light absorption and minimum light reflection.

I. Use of Southern Slopes for Building Positions

In old districts of the city, in all Sloppy grounds, the buildings are positioned in the southern slopes of the ground to absorb maximum light in winter. [7]

J. Use of Slopes Back to Cold Wind

Counter to the past item, the buildings are sited in the slopes back to the prevailing winds that are mostly cold winds. The major cold winds are North eastern and Eastern. This can reduce the impact of the winds to the building sides and so, reduce the cooling of the buildings especially through the winter nights. [8]

K. Volume of Buildings

It is tried to choose the cube form and volume for the buildings of the city, because, cube is a special volume that has maximum interior volume against minimum exterior surface. that this ratio is 1/8 . Furthermore, the ratio between Southern to eastern and Western sides is about 1.3/1. This is for the need of being large surface in southern side to absorb more sun light in winter. [9]

L. Construction of Urban Routes and Circulations

It is tried to build streets and alleys with average width to avoid creating wind tunnels and on the other hand, these are sited vertical to the direction of the prevailing cold winds. Many alleys are created nonlinear and have curve or non geometric folded forms to prevent creating and boosting wind tunnels. From the coating of the streets and alleys point of view, many of them have been coated by pavement and in reality, this is the best way for coating because it can resist against cold weather better than asphalt and doesn't create heat islands over the city during summer. (see Fig. 8 & Fig. 9) [10]

Fig.8 Non linear routes

Fig.9 Non linear routes

M. Types of Plants

In designing streets and yards(or central yards), it is tried to use forever green types of plants as well as pine in compact and periodic position because these types of plants never lose their leaves during winter and can protect these building sides are against the prevailing cold winds. [11]

N. Form of Plants Position

As it mentioned, it is tried to use plants (trees) as pine that never lose their leaves in winter. The form of their position in site is not linear, because this form, intensifies the cold wind's speed and so, if the linear form is destined it must be vertical to the direction of the cold wind, so, in many houses and alleys, tried to form the plants in compact and periodic position to reduce the speed of the wind and make a bar against the wind. [12]

O. Use of Low Height and Flat Roves

Many buildings in old districts have low height and flat roves. Because low roof lets inner space getting warmer and flat roof makes snow remain on the roof and so, it performs as insulation and doesn't let thermal waste from the roof. [13]

IV. Conclusion

There are many strategies used in old districts and buildings of Tabriz city that can protect them against the terrible cold weather in winter and reduce the need for artificial heating and cooling, because there was no technology in the past or at least it was very limited. These strategies were reduce consumption of the fossil energies on the other hand and indirectly have influence on reducing the air pollution in the past ages. Therefore, using these strategies can help design new part of the city and similar cities and can help reduce air pollution in those cities. These strategies can be summed in the following phrases:

1) 12.5 degrees rotation of buildings to the south east.
2) Compact urban fabric.
3) Use of central yard.
4) Creation underground floor.
5) Use of solar window (southern window) having sun shelter.
6) Use of materials are thermal mass.
7) Use of materials and thick walls that create thermal insulation.
8) Use of dark color materials and resistant against freezing.
9) Use of Southern ground slopes for buildings.
10) Use of ground slopes back to prevailing cold winds.
11) Usage of cubic forms for buildings.
12) Creating average width streets that are located vertical to direction of cold winds that have non linear and curving forms.
13) Usage of plants or trees like pine in compact and periodic position against cold winds.
14) Usage of low height and flat roofs.

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