Re-Assessment of National Energy Codes in Jordan in terms of Energy Consumption and solar right in Residential Buildings.

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ABSTRACT

The need for energy efficiency codes is increasing worldwide due to the continual decrease in the non- renewable energy resources such as fossil fuels. The time has come to improve the utilization of sustainable energy resources such as solar energy, wind, and water.

In Jordan, the need for developing energy codes manifests because of the great dependency on non-renewable resources which is considered a great obstacle against the national economy strategy.

This paper tests the Jordanian Energy Efficiency Codes, whether they are effective in finding solutions to provide comfortable indoor environment with the least dependency on technical and mechanical solutions.

The paper selected ten items in the Jordanian energy efficiency code , that deal with solar energy, in terms of heating and cooling loads, to find better solutions for better building performance.

It studies the set back regulations in the Greater Amman Municipality in Jordan to show how these regulations affect households in obtaining their solar rights.

Computer simulation conducted by DEROB-LTH (Building Energy Software Tools Directory) was utilized to test the existing regulations to explore their effectiveness and efficiencies in obtaining the solar right in residential buildings.

The results show that the existing regulations are not successful in providing the apartment blocks in Amman with their solar energy right.

1. INRODUCTION

Energy Efficiency Building codes in Jordan were put as an attempt to decrease the dependency on non-renewable energy recourses, oil and electricity, and increase dependency on renewable energy recourses such as sunlight, wind and geothermalHeat, codes mainly deal with finding the most suitable solutions to achieve these goals, either by using design with passive techniques, which mainly depends on climatic design such as building orientation, materials, opening percentage, in addition to using suitable insulation techniques and suitable surrounding plant coverage.

Different attempts in many developed countries were introduced as an effort to define codes for energy efficiency in residential, commercial, and office buildings in trying to solve the issue of the increasing dependency on non-renewable energy recourses and to propose effective means to lessen greenhouse gas emissions, which is a worldwide problem.

Many studies were conducted in different parts of the world in different climates to try to reach the most optimal solution for these challenging problems.

The Inter-governmental Panel on Climate Change (IPCC) submitted many reports in attempt to raise public awareness in the matter of energy use and environmental implications, which generated interest in having a better understanding of energy use in buildings, especially in the relation between energy and prevailing weather conditions [1, 2].

One of the main concerns in energy efficiency codes is thermal comfort, (heating in winter, and cooling in summer)

A great proportion of this energy consumption was due to the growing demand for better thermal comfort in terms of space heating in winter and space cooling during the hot/humid summer months [4, 5].

This increase in demand for better thermal comfort is due to the increasing temperature trend over the past few decades, resulting in less discomfort in winter and more discomfort during summer [6e8].

Another important issue that faces Jordan is the dependency on fossil fuel to produce energy, at the time when this country suffers from lack in this kind of energy recourse.

Most of the energy needs in Jordan is imported, it is an issue that poses a difficult challenge for Jordan. The Jordanian national economy is under a lot of pressure and burden due to the lack of conventional commercial energy recourses. This small country imports 96% of its fuel needs. In 2007, it reached 2.76 billion JD, accounting for 19.5% of GDP. [9]

From here the need for these kinds of codes emerges.

Energy efficiency building codes deals with a lot of aspects that concern ways to improve thermal comfort in residential buildings, these aspects include the building itself and in addition to its surrounding environment for the influence it has on the building in terms of the solar right that building attains, and which in turn affects thermal comfort of that building.

2. SURROUNDING ENVIRONMENT

2.1. Adjacent Buildings and Setbacks

Surrounding environment includes everything that is adjacent to the building being built or natural, in this paper, adjacent buildings will be chosen as a type of surrounding environment, they will be studied in terms of regulated setbacks, because of the influence these setbacks have in affecting the solar right and thermal energy of the building, tests will be conducted on heating loads needed in winter. Setback regulated by Greater Amman Municipality are shown in Table 1

TABLE 1

2.2. Testing Existing Regulated Setbacks

In winter solar altitude angle in Jordan is 34.5° to the south. If a 200m² building (A) was oriented at the east-west axis, with the southern façade being the back side of the building, the required heating load consumption for that building if not surrounded by any other buildings will be 6463.255 KWh.

If a 1-story building (B) with the height of 3m is placed to the south of the original Building (A) which is at the same time the back side of the building as shown on Fig 1, at a distance of 7m, as regulated from Amman Greater Municipality, then required heating load for building (A) in winter will rise to become: 6626.358 KWh

FIG. 1

If a 2-storey building (B) with the height of 8m is placed on southern side of building (A) and at the same distance (7m) as regulated from Amman Greater Municipality as shown in Fig 2, heating load required in winter for building (A) will rise to become 7587.175 KWh

FIG. 2

The third case to be studied is placing a 3-storey building (B) with the height of 11m at 7m southern side of building (A) as shown in Fig 3.

FIG 3

At this case heating load required for building (A) in winter will become 7966.338 KWh

2.3. Finding Alternatives

In the previous section, setbacks regulated by Amman Greater Municipality for buildings located in areas of type A regarding the back setback which is 7m was tested in four cases: if building the simulated building (A) is not surrounded by any buildings, if a 1-story building was placed on the southern side of the original building (A) at the distance of 7m, if a 2-storey building was placed, and if a 3-storey building was placed on the southern side of building (A) at distance of 7m

Results for the four cases are shown in Table 2:

TABLE 2

It can be seen that heating load increases noticeably with the increase of the height of the adjacent building (B), this is due to the blocking of the sun the new building (B) causes from reaching simulated building (A), which is the reason this building will require more heating load in winter to reach thermal comfort.

Alternatives suggested to overcome this problem, and assist simulated building (A) to acquire its solar rights are divided into two options: increase the distance between building (A) and adjacent building (B), and change the location of building (B)

2.3.1 Increasing Setback Distance

At the sun altitude in winter being 34.5˚ in Jordan, and in order for simulated building (A) to acquire its solar right, and for 2-storey building (B) with the height of 8m not to block the sun, the distance between the two buildings should be at least 13m, as shown in Fig 4

FIG 4

At this case heating load will be 6523.222 KWh

For the case of placing a 3-storey building, the minimum distance will increase, and so on, where the distance between the two buildings is in direct proportion with the height of the building

2.3.2 Changing the Location of Building (B)

The second solution suggested was to change the location of building (B), and place it on the northern or western side of building (A)

In the case of building (B) being a 2-storey building, and placing it on the western side of building (A) at distance of 5m as shown in Fig 5, heating load consumption for building (A) in winter will become: 6805.228 KWh

FIG 5

And when placing the 2-storey building (B) on the northern side of simulated building (A) at distance of 5m as shown in Fig 6, heating load consumption for building (A) will be 6594.422 KWh

FIG 6

Tests regarding 3-storey building with the height of 11m were done in the same manner. When building (B) was placed on the west side of building (A) at distance of 5m, heating load consumption for building (A) becomes: 6836.468 KWh

And when placing building (B) on the northern side of building (A) at 5m distance, heating load consumption for building (A) in winter will be: 6594.27 KWh

2.4 Results and Discussion

The previous tests and results showed that adjacent objects to a building play a significant role in the consumption of energy for that building especially in winter, where these adjacent objects; in our case adjacent buildings, may prevent the sun from entering the building in winter because of the relatively low angle of the sun altitude during that season.

The main aim of the study is to reduce energy consumption as much as possible, that’s why different aspects such as the setbacks regulations that have been set by the Greater Amman Municipality were studied.

Type A buildings of these regulations were studied, and even those, who have the largest setbacks of all of the 4 types did not pass the test.

When comparing building consumption of energy during winter without any adjacent buildings with the buildings consumption with adjacent objects at distances regulated by the Municipality, results showed a significant increase in heating loads, especially when the adjacent buildings were 2 stories or higher, because it is when building (B) gets higher than 1-storey, it blocks the sun from reaching building (A).

FIG 7

Some solutions were recommended to solve this problem but the most successful ones in terms of convenience was to change the position of building(B) to the eastern, eastern or northern side of building (A)

In case of building (B) being 2-storey building, results when changing its location and its influence on the energy consumption of building (A) during winter were as follows:

FIG 8

In case of building (B) being 3-storey building, results when changing its location and its influence on the energy consumption of building (A) during winter were as follows:

FIG 9

2.5 Conclusions

In order for the building to obtain its complete solar right during winter, no obstacles should block the way of the sunlight that enters it. Unfortunately, there are no regulations to protect solar right of buildings regarding adjacent building and setbacks.

The existing setbacks regulations are vague and when put to test, do not serve energy efficiency of buildings and especially in winter, when sun altitude during that season is relatively low, and easily blocked.

Setbacks regulations set standards for front, side and back setbacks in relation to the building's entrance, regardless of the buildings orientation. It is known that in Jordan sun travels in the sky from east to west passing through the south, that is why this particular side of the building should be protected during winter, and forbid any obstacles in that side from preventing the sun to enter the building.

Tests were done on setbacks to find the best solutions for adjacent buildings; results showed that the southern side cannot handle to have more than 1-storey buildings adjacent to the original one. Higher buildings should be regulated to occupy the east, west, or northern side of the building, and preferably the northern. It is recommended that setbacks regulations should be clearer in deciding the direction of adjacent buildings, being north, south, east, or west and not just be satisfied by determining on which façade in relation to the entrance of the building.

References

[1] Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (2007), IPPCC, Climate Change, Cambridge University Press

[2] Levine M, Urge-Vorsatz D, Blok K, Geng L, Harvey D, Lang S, et al, (2007). Residential and commercial buildings. In: Metz B, Davidson OR, Bosch PR, Dave R,Meyer LA, editors. Climate change: mitigation. Contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change. Cambridge: Cambridge University Press; p. 387e446.

[3] Levermore GJ, (2008). A review of the IPCC assessment report four, part 1: the IPCC process and greenhouse gas emission trends from buildings worldwide. Building Services Engineering Research and Technology 2008;29(4):349e61.)

[4] Lam JC, Tsang CL, Yang L, Li DHW, (2005). Weather data analysis and design implications for different climatic zones in China. Building and Environment ;40(2):277e96.

[5] Lam JC, Wan KKW, Tsang CL, Yang L, (2008). Building energy efficiency in different climates. Energy Conversion and Management ;49(8):2354e66.),

[6] Lam JC, Tsang CL, Li DHW, (2004). Long-term ambient temperature analysis and energy use implications in Hong Kong. Energy Conversion and Management ;45(3):315e27.

[7] Lam JC, Wan KKW, Wong SL, Lam TNT, (2010). Long-term trends of heat stress and energy use implications in subtropical climates. Applied Energy;87 (2):608e12.

[8] Wan KKW, Wong SL, Yang L, Lam JC (2010). An analysis of the bioclimates in different climates and implications for the built environment in China. Building and Environment ;45(5):1312e8.)

[9] Akash BA, Mohsen MS, (1999). Energy analysis of Jordan’s urban residential sector. Energy; 24(9):823–31.