FEASIBILITY OF USING GREEN ROOF AND SHADING DEVICE BY ADOPTING THE TOTAL ENERGY CONSUMPTION APPROACH: A CASE STUDY IN TEHRAN

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ABSTRACT

Greenhouse gases are responsible for climate change, and the building sector is one of the main areas to reduce carbon dioxide emissions. In terms of air pollution, Tehran is one of the top cities in the ranking (Heger and Sarraf 2018). Therefore, paying more attention to this issue is absolutely essential. GB (green building) is one of the parameters to achieve a sustainable city. This paper analyses GR (green roof) and SD (shading device), which are two crucial parts of a GB from the EC (energy consumption) approach in a residential building in Tehran city.

The heating and cooling system in the building is based on natural gas and electricity. This paper compares energy consumption, including ELC (electricity consumption) and GC (gas consumption) before and after GR and SD to find out whether or not they are suitable for this building and the current case study.

Keywords: Green building, Green roof, Shading devices, Electricity consumption, Gas consumption.

INTRODUCTION

With the remarkable rise in EC and greenhouse gases due to increasing population and improvement of living standards, energy conservation has become a crucial subject in sustainable development (Li *et al*. 2021). The building sector consumes 40% of global energy and produces 30% of carbon dioxide emissions (Wu *et al*. 2019). Greenhouse gases are responsible for climate change (Mustaffa, Mat Isa, and Che Ibrahim 2021).

According to predictions carbon emissions of buildings will go up to 42.4 billion tons in 2035, 43% increase compared to 2007 (Kearney 2010). saving energy and following carbon emission reduction is a significant issue now and in the future. The concept of green building has been known as an innovative approach to carrying out and reaching sustainability (Abdelaal and Guo 2021). A GB is usually introduced as an environmentally friendly building with efficient energy, low environmental impact and high-recycled materials compared to a non-green building (Ali and Al Nsairat 2009). GB does not only reduce the negative impact on the environment but also decreases operating energy costs. Using fossil fuels for generating electricity indicates an unsustainable urban area (Martinopoulos 2020). Roofs generally cover 20-25% of the total urban area (Izquierdo, Rodrigues, and Fueyo 2008). A GR is a good step to reach a green building and following it, sustainability. In recent years GR approach has illustrated sustainability and has been spreading fast in many countries (Shafique, Kim, and Rafiq 2018). GR prevents short wave radiation absorption and works like thermal insulation in the roof, which means it prevents heat entering in summer and heat escaping in the winter (Gunawardena, Wells, and Kershaw 2017).

Furthermore, it can mitigate the urban heat island effect(Takebayashi and Moriyama 2007)(Ouldboukhitine, Belarbi, and Sailor 2014), Reduce water runoff(Speak *et al*. 2013). Only 13% of the solar radiation can pass through the GR while 27% is reflected and 60% is absorbed by soil and plants (Ekaterini and Dimitris 1998). Another part of GB is the green façade and window shading is a segment of the green façade(Zheng, Dai, and Tang 2020). Shading devices(SD) are widely used in building to improve energy performance by controlling solar radiation and sunlight(Yao 2020). For instance, if the window is completely shaded by the shading device, it can block solar heat gain by approximately 80% (Chi *et al*. 2020). Using SD for the windows in the height of summer reduces the temperature by 4-6 degrees. (Ip *et al*., 2004).

CONCLUSION

The result of the analysis shows that in terms of both GR and SD, inference about the efficiency of any of them depends on many parameters, like HVAC system, type of climate zone, etc. For instance, in this building, if the heating system was based on electricity, the EC could be different. According to the result, there was not a remarkable difference in EC in the building with and without GR due to increasing in GC. The creation of a GR is more effective and affordable if we use it in a climate zone with prolonged sunshine duration per day and moderate winters.

As seen in the results, GR has well performance in the summertime and reduces ELC for cooling, but in the winter it will increase GC for heating. In addition, the function of GR in reducing cooling load is proportional to substrate's insulation performance and reflection and absorption of solar radiation by vegetation layer (Feyisa, Dons, and Meilby 2014) (Abuseif, Dupre, and Michael 2021).

In the case of SD, there was a considerable decrement in ELC in the winter due to sunlight blockage and a twofold increase in GC for the same reason. The main reason for this problem is using fixed SD in the building, utilization of a moveable SD on daily, monthly or seasonal terms allows it to be more efficient compared to a fixed one (Akbari Paydar 2020).

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