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The Impact of Outdoor Thermal Environment on Iraqi Building Energy Performance

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Abstract

The performance of direct heat gain system is affective by the sever summer heat environment in the building design types in Iraq. Therefore, it is important to consider the outdoor environment while designing direct heat gain system. Base on analyzing the long term weather data over the past 10 years and examine the practical issues of building design, useful climatic information and patterns are identified. The provided information will enable people to better understand the trends of local buildings (modern and traditional intensive buildings type) climate and to build up the resources for assessing important issues of renewable energy and environmental design and to determine indoor environmental quality based on the outdoor microclimate.

The simulation result reveals how the relationship between the outdoor environment and indoor factors (indoor design building) the performance of direct heat gain system. The results indicated that the thermal storage mass of direct of direct heat gain system raises the room air temperature due to the large area of window. The climatic data currently being used for energy design calculations leads to inaccuracies in predictions of energy use.

Heating coefficients were consistently positive and their values varied between 0.1, to 0.46, while albedo values varied between 0.19 and 0.37. The results indicated that there is little monthly variation in the values of nocturnal net radiation. The energy cost of cooling fuel estimated for both building types.

Keywords: Albedo, Microclimatology, Modern, Outdoor environment, Traditional Building.

1. Introduction

Early the twentieth century, the traditional environment of Iraq is one of the sustainable urban environments schematic, design parameter and a construction. The traditional building marked by characteristics of intensive, planning work alleys narrow streets and is not allowed for vehicles to enter. The intensive design parameter was directing the building inward looking (to courtyard), which works efficiently to provide comfort heat and allow to carry out activities of the occupants, in addition to the mutual relationship between the inner courtyard and air shaft-guided north and the basement. The construction have been characterized in the thick walls for thermal insulation, narrow windows, small scales humanitarian and use of local materials in the construction**.**The traditional environment affected by changes and developments that have occurred in the world in the twenties of the last century in the planning , design, construction materials , and become perpendicular to the streets rather than organic , and directing the building outward rather than inward , and manufactured materials rather than local. The modern building became more exposure to the sky view and high heat mass storage. Sustainable buildings and urban development have become increasingly important, and passive design has attracted much attention. Direct heat gain system are an example of passive system that effective use solar heat by large windows and storage mass on the floor due to the large exposure to solar irradiation.

The Traditional intensive building in Iraq urban district, the solar heat gain is affected by shading and intensive building types and trees. Thus the heat gain is at the minimum especially in the summer time. The last couple of decades, the modern design buildings are established then they affected by the outdoor thermal radiant environment, the performance of direct heat gain system with thermal storage mass in the summer can be abundant and heat at the maximum. Therefore while designing direct heat gain systems, the design considering the outdoor environment (generous of sky view factor effect the surrounding building making the use of incoming solar radiant) is necessary.

In addition, in the case that a building is affected by outdoor environment, indoors factors such as position of thermal storage mass and windows can be condensed in design of direct heat gain system. This relationship between the outdoor environment and the design of thermal storage mass affects the total solar radiation on the storage mass on the floor, which is influential factor for room air temperature fluctuations.

Sustainable practices in building design and operation are becoming more and more important in the world (Hasson and Alaskary, 2013).

In arid fringe climate areas the design of buildings for comfort must address resisting summer heat inflow from outside - ejecting the heat buildup emanating from occupants and appliances inside the building. This approach is appropriate for comfort design for the majority of Iraq.

As a result of solar inflow variation with latitude, the summer winds flow over the substantial land area is warm. The western infiltrates cool air changes across Iraq in the general west to east flow of weather pattern.

Recent studies show that best results in energy saving can be achieved through passive design and recycling strategies.

It has been estimated that warm southern slopes will reduce annual heat consumption about 1.6-3.2 kWh/m2 According Yang (2004) to A the new green skyscrapers and intensive building types should seek to achieve energy use of about 100 kWh/m² / year or less, compared with 230 kWh/m² / year for fully air-conditioned – and in temperate zone heated – buildings and about 150-250 kWh/m² for un-air-conditioned offices. A number of papers investigate sourcing strategies when supplies have varying reliability Oak (3003). Padmanabhamurty, (1990 & 1991) Sani, S. (1990), while some work investigated disruption empirically by Eliasson, (1996). There are none of these cases are connection made between timing changes and severe weather. Asawa, (2008) proposed a coupled simulation of outdoor thermal balance and building heat load. This method can calculate heat load by considering the outdoor thermal radiation environment. Building material characteristics of internal surfaces and solar radiation direction is considered to calculate abuilding heat Ozaki, (2004).
This study objective is show the effect on the performance of direct heat gain systems during summer by using the building thermal simulation and established appropriate empirical local relationship for Baghdad region taking consideration of the microclimatological parameters of the outdoor and indoor thermal radiant environment. The solar irradiant contribution to heating the building was also determined.

2. Methodology

1.1 Climatic Data Analysis

The general weather patterns in Iraq are typified by cool winters with southwest winds and moisture, and hot summers with northerly winds, either dry or dusty with sever heat up to more than 50C.

The collection of the data for this study was governed by the availability for research of free data from the Central Iraqi Weather Bureau, Baghdad Station. Due to the nature and scope of the study, it was realized that the analysis could only be carried out for a single geographical region in Iraq. This region is loosely referred to Baghdad although the sources of data are from different locations within this region.

The study identified basic calculations, which rely on climatic data for their calculation includes total energy, heating coefficient, net solar radiation, and albedo .

Table 1 shows the collected mean monthly temperature data together with similar moving average and linear trend lines. The results of the analysis show that annual average of mean temperatures measured at Baghdad over the last 50 years have increased of 7%. During the last 50 years, monthly degree-day value has decreased by some 9%.

The field measurements data for the models development were between January 2001 and March 2012.

Meanwhile, field measurements data between November and May, 2012 was used for the model validation. The quantities were monitored: daily minimum, maximum, average air temperature was monitored by means of shielded copper-constantan thermocouples. Total solar radiation. Incident and reflected solar hemispherical radiation (0.3 -3 micros) for the reference point. The instrument was used with Eppley pyrometer model 4-48, mounted horizontally with its sensing surface 1.5 m above the ground surface. The ratio of daily total reflected and incoming shortwave radiation were calculated for surface albedo. Percentage of green cover area ratio, actual sunshine hour's ratio n/N, wind speed WS, relative humidity, and rainfall. Hourly first- differences terms for current and prior weather variable were also included. Note that the information contained in the first differences variables is implicit in the current and prior data, but providing this information explicitly was found to improve model performance.

3. Results and Discussion

This study reveals to show the effect of the thermal radiant environment of the performance of direct heat gain system based on following considerations, the effect of the intensive building type suburbs make the room air temperature increase, direct heat gain system with thermal storage mass beneficial with modern and traditional intensive building types and how position and area of thermal storage mass designed when the building is affect by the outdoor thermal radiant environment. Table 1 lists the diurnal change in the total solar radiation on the experiment side, while Table 2 shows the solar energy and total energy (fuel consumed for indoor air conditioning) absorbed in the thermal storage mass and the distribution of the daily direct solar radiation incident on the floor of both types of buildings.

3.1. Estimation of Albedo

It is a well-known fact that part of the short-wave radiation reaching the building surface is reflected. The fraction of radiation reflected by the building surfaces depends on the nature of the building structure materials as well as on the density and quantity of building materials. Mean hourly values of albedo outdoor the building were calculated for each month of the recording period and are listed in Table 4. This table shows that there is a very noticeable diurnal variation in each month, whereby for low solar elevations (solar altitude < 30º) albedo rises quite significantly. Part of this rise has been explained by Fritschen (1967) as being due to reflection within the upper half of the glass dome enclosing the Pyranometer sensor. However, a large portion of the rise in albedo value at low solar altitude is undoubtedly a real effect of the building materials themselves.

Three methods are currently in use to estimate the average albedo of the entire day. The first of these is the arithmetic average of point values taken over daytime hours. The second is the method pioneered by Stanhill et. Al. (1966) which uses the slope of the regression line relating reflected short-wave radiation to global incident radiation. A third method was uses by Montheith and Szeicz (1961) and Fritschen (1967), who calculated the average albedo of the whole day as the ratio of daily total reflected short-wave radiation to incident global solar radiation.

The average albedo values for each month using the three methods are given in Table 5. The Stanhill method gives lower values in each month than the other two methods. However, it is found little acceptance, because the regression slope value is lower than almost all point measurements in the course of the day (Idso et. Al. 1969; Nkemdirim, 1972a).

A test of the average albedo values of modern and traditional designs buildings listed in Table 5 reveals that is a considerable variation in the monthly average value. Most of the monthly change could be due to the change of solar altitude angle from month to month . Some of these changes may be due to the building structure materials, condensed building and the surface area exposed to the sky vies. It is likely that the modern and traditional design building surface layer has a higher brightness when it is observed at very oblique angles. Observed naturally, many gaps od darker appearance and some traditional building materials will be seen, so that the brightness will be less. The great differences in albedo between the modern and traditional design buildings at albedo.

The monthly total of solar energy and fuel for cooling energy inputs to both building types were plotted against outdoor air temperature and average total solar radiation .

The data demonstrated a linear and exponential variation, as indicated in table 6, and regression coefficient, a1 using Y = a1 + a2 X, and correlation coefficient, R are shown in Table7.

The following summer cost of cooling the both building types were based on the represented figure of US$ 7.38 / gal oil and 2.46/gal oil which was found US $ 10.25/ m2 and US $ 3.75/m2 of the modern and intensive building types floors respectively.

3.2 Heating coefficient

The heating coefficient is defined as the rate of change in long wave radiation loss for a unit change in net radiation. The heating coefficient (β) was calculated from the slope of the regression line of Qn plotted against Qin.

A good linear regression equation is deducted for each annually average monthly good correlation confidents (R2 = 0.55 – 0.97).

The values of (β) [β = (1-slope) / slope] obtained for each month summarized in Table (5). There is some indication from the data in this table that there are considerable differences in the values of the heating coefficient for each month. Whatever the explanation, it seems that the heating coefficient should not be considerable a characteristic exclusively of the surface, but rather as representing between properties of the building surface and the atmosphere Idso 1967...

4. Conclusions

A series of proper combinations concerning radiation fluxes inside the Iraqi buildings design types based on the outdoor microenvironment were performed.

This study shows the beneficial effects of outdoor and indoor environments data is significantly needed for sustainable building design assessing energy input. It has been shown that information will determine the effectiveness of building design strategies.

The use of historical climatic data significantly overestimates building energy requirements:

Climatic data used for building design calculations should be regularly reviewed and updated, otherwise its use may result in buildings not suitable for this region environment.

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Table 1. Monthly variation of Q $_{out}$ and $_{in}$

Time	Q MJ/m2	Modern	Traditional
Month	Outdoor	Indoor	Indoor
April	9.1	5.0	3.5
May	8.3	2.0	0.83
June	9.6	2.5	1
July	11.4	4.7	3.3
August	13.0	5.0	3.7
September	13.1	5.1	3.9
October	14.2	5.3	4.1

Table 2 Monthly average of mean daily values of albedo were calculated for each month of the recorded period.

Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
0.37	0.33	0.30	0.28	0.25	0.20	0.19	0.18	0.16	0.19	0.27	0.32

Table 3. Diurnal variation of albedo for the new and old buildings.

Modern					Traditional			
Hours	April	May	June	July	April	May	June	July
7			0.4	0.3			0.35	0.25
8			0.28	0.2			0.23	0.15
9	0.4	0.3	0.19	0.16	0.35	0.25	0.14	0.11
10	0.3	0.22	0.18	0.15	0.25	0.17	0.13	0.1
11	0.24	0.18	0.17	0.14	0.19	0.13	0.12	0.09
12	0.21	0.21	0.16	0.15	0.16	0.16	0.11	0.1
13	0.24	0.2	0.16	0.15	0.19	0.15	0.11	0.1
14	0.23	0.2	0.17	0.15	0.18	0.15	0.12	0.1
15	0.22	0.24	0.18	0.17	0.17	0.19	0.13	0.12
16	0.28	0.24	0.2	0.18	0.23	0.19	0.15	0.13
17		0.25	0.2	0.19		0.2	0.15	0.14

Table 4. Average albedo values using (a) arithmetic average of point measurements, (b) regression slope and c average daily.

	Modern			Traditional		
Months	a	b	c	a	b	c
May	0.27	0.2	0.24	0.22	0.15	0.19
June	0.25	0.16	0.24	0.2	0.11	0.19
July	0.2	0.14	0.18	0.15	0.09	0.13
August	0.18	0.13	0.18	0.13	0.08	0.13

Table 5 Monthly average of mean daily values of heating coefficients each month of the recorded period.

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
0.1	0.22	0.28	0.39	0.41	0.45	0.46	0.43	0.38	0.33	0.25	0.12

Table 6. Monthly ration of the solar energy to total energy

Months	Modern	Traditional
April	0.49	0.44
May	0.40	0.36
June	0.38	0.35
July	0.38	0.33
August	0.41	0.37
September	0.45	039
October	0.51	0.44

Table 7. The expansion coefficient a_1 for $Y = a_1 + a_2X$ and the correlation coefficient.

Energy	**Modern**			**Traditional**		
Outdoor Air temperature	$\mathbf{a_1}$	$\mathbf{a_2}$	$\mathbf{R^2}$	$\mathbf{a_1}$	$\mathbf{a_2}$	$\mathbf{R^2}$
Solar Energy	6.474	0.770	0.55	6.029	0.0606	0.85
Fuel Energy	16.336	0.359	0.72	16.156	-0.294	0.60
Solar Radiation						
Solar Energy	12.420	-0.023	0.53	10.236	-0.171	0.48
Fuel Energy	38.610	-3.661	0.74	6.555	0.299	0.51

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