ELSEVIER

Energy and Buildings 35 (2003) 161–174

ENERGY and BUILDINGS

www.elsevier.com/locate/enbuild

A comparision of new Turkish thermal insulation standard (TS 825), ISO 9164, EN 832 and German regulation

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Received 28 July 2001; accepted 4 February 2002

Abstract

Nowadays, the most common characteristic of all regulations and buildings is that heat energy requirement of a building is calculated and evaluated for the whole building, not as a sum of those for individual building components. In this paper, first, the recently revised Turkish standard is described in general, and then compared with the ISO 9164, EN 832 and the German regulation. The calculation procedures presented in the standards are evaluated, based on the results of three different types of buildings. The new TS 825 is an application of ISO 9164 in every respect. It uses the same equation, same restriction and same flexibility. EN 832 is basically similar to the ISO 9164 and so is the new TS 825. The most important difference in EN 832 is that solar energy gain is calculated in quite detail including passive solar gains, as well as direct solar gains. This approach gives more accurate results but need huge and detailed database. German regulation is harmonious with ISO 9164, EN 832 and TS 825 only from the point of view of principles and concepts. However, it is a very simplified one, the calculation method defined in the German regulation gave Q_{year} far from the actual heating energy requirement of buildings for the countries with moderate climate. The main differences between the calculation methods presented in the standards are "the acceptance of climatic data," "the calculation method of internal heat gains," "the calculation method of solar heat gains" and "the acceptance of the air change rate values."

The effects of parameters and the building types on the energy demands are discussed in order to determine which parameter should be constant but which ones should be variable, to obtain more simple but accurate results, and to show to designers the parameters to be effectively controlled to decrease the energy requirements of the buildings. Independently of building type, the higher the area of component, the more influential is its U-value on the Q_{year} except ground. Ground has always the least effect on the Q_{year}. The effect of air change rate is high being almost similar for all types of buildings, however air change rate affects Q_{year} slightly less at the terraced office building than the others. With lower U-values of wall and window, the effects of window area and window directions on the Q_{year} of detached buildings are minimized. Terraced buildings are more sensitive to window area than the window directions. It is clear that the increase in south window area, for all types of buildings, has slightly more effect on Q_{year} than the increase in north, east and west window areas. The effects of r and g on the Q_{year} increase, when the heat loss decreases but solar gain increases. Therefore, for modern buildings, to accept these parameters as a constant is not fairly significant.

Keywords: Thermal insulation standards; Energy efficient buildings; Solar architecture

1. Introduction

Energy consumption for heating is too high in Turkey because buildings have almost no insulation. Average consumption for heating in dwellings is above 200 kWh/m^2 per year [1]. In addition, almost no building has passive solar techniques and solar energy can not meet a significant part of their heat energy requirements despite the fact that Turkey has plenty of solar energy. For example, daily total global solar energy is about 30 000 kJ/m^2 and sunshine duration is around 10 h in summer and about 9000 kJ/m^2 and 3 h in Winter, in Trakya (north-west of Turkey) [2].

Until recent years, efforts have been made to reduce the energy consumption by imposing restrictions on the U-value of building components (such as wall, window, roof, etc.) in both the Turkish and the International standards and regulations [3–8]. This approach has the following shortcomings:

1. With the restriction on only U-value of the building components, thermal bridges particularly at joints of building components are virtually ignored. Therefore, actual heat loss of a building is most probably greater

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0378-7788/02/$ – see front matter
PII: S0378-7788(02)00020-8

Nomenclature

A	area of exposed building component (m^2)
A_{sn}	solar effective collecting area of the surface n (m^2)
A_{snj}	solar effective collecting area of the surface n having orientation j (m^2)
A_n	net heating floor area (m^2)
b	width of thermal bridge (m)
F_{Cn}	reduction factor taking into account permanent curtains
F_{Fn}	reduction factor taking into account frames of transparent surfaces
g	solar transmission factor of glazing
$g_{\perp}$	solar transmission factor of glazing for the normal incidence
GLR	gain/loss ratio
H	specific heat loss (W/K)
H_T	specific heat loss by transmission (W/K)
H_V	specific heat loss by ventilation (W/K)
I	solar radiation on vertical surfaces (W/m^2)
k_f	thermal transmittance of transparent surfaces (W/m^2K)
k_{ef}	equivalence thermal transmittance of transparent surfaces (W/m^2K)
l	length of thermal bridge (m)
n_h	air change rate (h^{-1})
q_{sj}	total energy of the global solar radiation on a surface unity having orientation j during the calculation period (J/m^2)
Q_{year}	net space-heating requirement for year (J)
$Q_{h,m}$	net space-heating requirement for month (J)
Q_H	net space-heating requirement for year (kWh per year)
Q_T	heat loss per year by means of transmission (kWh per year)
Q_L	heat loss per year by means of ventilation (kWh per year)
Q_I	internal gains per year (kWh per year)
Q_s	solar gains per year (kWh per year)
r	shading factor for transparent surfaces
s_n	shaded fraction for a surface exposed to the sun
S_F	coefficient for useful solar gains of transparent surfaces (W/m^2K)
t	number of seconds in a month ($60*60*24*30 = 2\,592\,000$; s)
T_i	inside (internal) temperature (K or °C)
$T_{o,m}$	monthly average outside (external) temperature (K or °C)
U	thermal transmittance of exposed building component (W/m^2K)
U_{TB}	thermal transmittance of thermal bridge (W/m^2K)
U_l	linear thermal transmittance of thermal bridge (W/mK)
V_V	ventilated volume (m^3)
V_{gross}	volume of the building calculated by using the external width, length and height (m^3)

Greek letters

η_m	monthly average utilization factor for gains
ϕ_i	internal gains (W)
$\phi_{s,m}$	Monthly average solar gains (W)
ξ	Factor characteristic of thermal bridge expressing lateral heat loss

Indices

i	surface number, direction
j	direction
m	monthly average, value for month
s	solar

than the calculated value based on this approach. In a research on Turkish buildings, there is about 95% increase in U-value of walls due to thermal bridges [9].
2. Heat loss by air infiltration and ventilation are not taken into consideration. This also results in actual heat loss being higher than the expected value.
3. Climatic data (outdoor air temperature, etc.) in the equation are given as average value, minimum value, maximum value or the value expected with 90–95% probability. Particularly in a country with a moderate climate such as Turkey, heat loss calculated by using constant value for the whole heating period incurs considerable deviations from the actual heat loss.

Influenced by the above objections, especially during the last decade, international standards and regulations have been improved. The innovations included in these new international standards are as follows:

1. Restriction about the heat loss of buildings is on the scale of whole building, instead of only on building component. An upper limit is imposed on the Q value, which is the net total heat energy requirement of the whole building, and thermal bridges are included in the calculations procedure for the Q value.
2. Heat losses due to air infiltration and ventilation are taken into account. Air change rate (n_h) is a simple parameter in the equation taking into consideration the quality of framework on the heat loss of buildings.
3. Although calculation based on the unsteady-state regime is the most accurate, equations are very complicated. There have been numerous attempts to implement a computer programme for calculation according to the unsteady-state regime [10], but no international agreement has been yet reached. Therefore, international standards and regulations still accept the use of steady-state regime calculation procedure. But they recommend using climatic data as daily or monthly average values instead of one value for the whole heating period.