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Influencia del acristalamiento sobre los parámetros y la calificación energética de acuerdo con la orientación del edificio y los porcentajes de aberturas de fachada

The influence of glazing over the parameters and energy rating according to the building orientation and the façade openings percentages

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***Resumen*— Es bien conocida la importancia de los cristales en la demanda de energía del edificio, ya que la envolvente térmica es lo más importante. En este trabajo se ha realizado un estudio de la influencia de la transmitancia térmica (factor U) y el factor solar (valor g) de tres tipos diferentes de acristalamiento en la calificación energética. Se ha realizado el análisis en una vivienda unifamiliar situada en la ciudad de Sevilla, España, con diferentes hipótesis, en concreto seis porcentajes de apertura que van desde 10 a 60% considerado por el Código Técnico de la Edificación español, y cuatro orientaciones según las direcciones cardinales. Para los tipos de zona climático y acristalamiento considerados, el valor del parámetro g tiene mayor incidencia en el rendimiento energético que la transmitancia térmica. Se ha establecido qué orientación proporciona mayor ahorro de energía, independientemente de la demanda de calefacción y enfriamiento y de la calificación energética. Además, hay que considerar los valores ideales de ambos parámetros para cada orientación con el fin de mejorar la calificación energética. Por lo tanto, al seleccionar un tipo de acristalamiento, sería importante tener en cuenta los mejores valores de los parámetros "T" y "g" para cada orientación con el fin de obtener menor gasto de energía.**

Palabras clave— Valor G; factor U; porcentaje de apertura; orientación de la fachada; clasificación energética; porcentajes de ahorro.

***Abstract*— It is well known the significant impact of glazing over the building energy demand making it the thermal envelope's most important part. A study of the influence of thermal transmittance (U-factor) and solar factor (g-value) of three different glazing types over the parameters and energy rating are shown in this paper. A single-family dwelling located in Seville city, Spain, has been analyzed to which a set of hypotheses, six opening percentages ranging from 10 to 60% considered by the Spanish Building Code on its simplified option, and different combinations, four orientations matching the cardinal directions, has been applied. For the climate zone and glazing types considered, the g-value parameter has a higher incidence on the global demand and energy rating than thermal transmittance. It is established which orientation greater energy savings can be achieved independently for heating, cooling demand and energy rating. Also the ideal values for both parameters that should be considered in each orientation in order to improve the energy rating. Therefore, when selecting a type of glazing it would be important to consider the best "U" and "g" parameter values together for each orientation in order to get the lowest energy demand possible.**

Index Terms— G-value; U-factor; opening percentage; façade orientation; energy rating; saving percentages.

I. Introduction

In general, glazing is the building's thermal envelope element which has the most impact on energy performance. One of the reasons is, its inherent characteristics allow the solar radiation to enter inside as well as the higher thermal transmittance compare to the opaque area, another would be the higher percentage that is represented on a façade's opening. In addition, this element becomes even more important as opening percentages increase, which has resulted in many studies that have been performed considering different conditions, buildings, climate zones, etc.

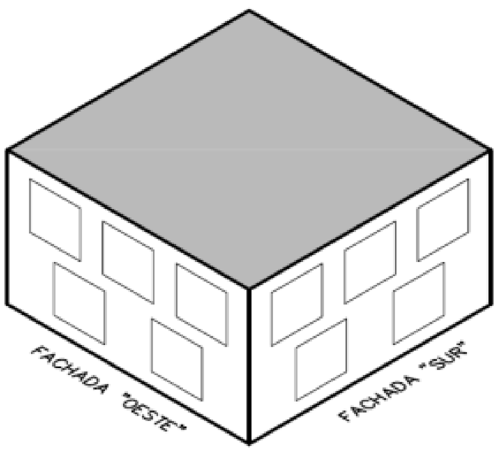

Fig. 1. Hypothetical dwelling.

Some of these studies are based on establishing a window rating system that allows the solution of the one which offers better performance in energy saving to be obtained. In Denmark, Nielsen et al., (Nielsen, 2000) focus on a simple calculation method for glazing and windows' energy performance based on a net energy gain indicator, which is the solar gain minus the heat loss. In a similar way, Urbikain and Sala, (Urbikain, 2009) propose a window energy rating system, WERS, for residential buildings for two climate zones, C1 (Bilbao) and D1 (Vitoria), as defined in the Spanish Building Code.

Other studies consider different technical aspects of openings. Persson et al., (Persson, 2006) focus on how the window size influences over the energy balance, considering a semi-detached terraced houses that are highly airtight and insulated in Gothenburg, Sweden, reducing the windows size in the south façade and increasing them at the same time on the north one. Gasparella et al., (Gasparella, 2011) state that even with triple glazing being used on the most efficient unit, in terms of insulation level, it is also characterized by its low g-value which is an asset in summer due to lower solar radiation input, but a liability in winter since the heat gain is reduced inside the building. Seunghwan Yoo et al., (Yoo, 2013) analyze the thermal behavior of different window systems over the heating energy consumption considering a common apartment unit in South Korea, in order to assess their effect on the energy rating.

II. Objective

It is intended in this present research to determine the influence of two of the characteristic parameters which define the window's glazing: U-factor and g-value, over the heating and cooling demand, and energy rating for existing buildings considering different façade's opening percentages, orientations and glazing types.

In addition, it is also intended which façade has more impact on the energy saving and most importantly, the best value for both parameters together in every orientation considered.

III. Method

This study focuses on a hypothetical 200 m^2, two storey-

TABLE I
SET OF COMBINATIONS

HIPÓTESIS / COMBINACIOES / VIDRIOS				MONOLITICO S	DOBLE NORMAL															DOBLE BAJO EMISIVO
CONSIDERACIONES DE PARTIDA	HIPÓTESIS (Huecos)			REFERENC IA	COMBINACIONES (Orientaciones)															
					Una				Dos						Tres				Cuatro	
TODOS LOS CASOS	%	MEDIDAS	SUPERFICIE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
5 huecos por Fachada de iguales dimensiones.	A_10%	1,10 X 1,00	5,50 m2	N S E O	N	S	E	O	N E	N O	N S	S E	S O	E O	N S E	N S O	N O E	S E O	N S E O	IDEM Combinaciones vidrio DOBLE NORMAL
Misma geometria (Rectangular).	B_20%	1,55 X 1,41	11,00 m2																	
Misma posición (Horizontal).	C_30%	1,90 X 1,73	16,50 m2																	
Porcentaje marco: 25%. Porcentaje vidrio: 75% Retranqueo: 25 cms.	D_40%	2,20 X 2,00	22,00 m2																	
Orientación: N S E O.	E_50%	2,45 X 2,23	27,50 m2																	
	F_60%	2,69 X 2,44	33,00 m2																	
					S E O	N E 0	N S O	N S E	S O	S E	E O	N O	N E	N S	O	E	S	N	---	IDEM Combinaciones MONOLITICO

detached dwelling with a square geometry located in the city of Seville (Fig. 1), to which some technical considerations have been established with regards to its thermal envelope and installations.

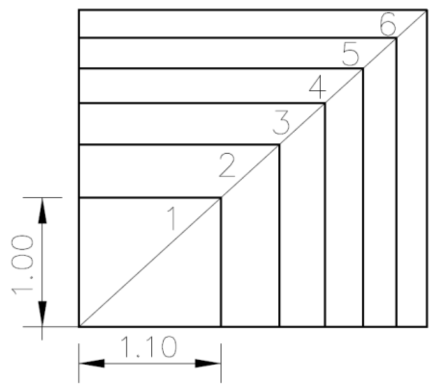

Fig. 2. Opening increasing.

A set of hypotheses and combinations have been considered (Table I). Six opening percentages, ranging from 10 to 60%, which contemplates the current Spanish Building Code on its simplified option (CTE, 2006), four orientations matching the cardinal directions, north, south, east and west (Table II), and the two characteristic parameters from three different glazing types (Table III), a single pane, considered as baseline, and two others with better performance such as double clear and low-e windows, both commercially available.

A total of 186 results were obtained, 31 for each opening percentage. From them it has been determined the orientation and glazing type which has the most effect on the parameters and energy rating.

The glazing characteristic parameter values were changed during the study, while the rest of the building construction's elements remained the same.

IV. Preliminary Considerations

Prior to entering the different data into the simplified energy rating tool for existing buildings, a study of the number and the size openings were considered to establish a common baseline for comparison as opening percentage increases. To that end five façade opening are established increasing their size proportionally (Fig. 2).

The U-factor and g-value considered for the single monolithic glass has been established from the energy rating software tool used, being 5.7 W/m^{2}K and 0.82 respectively. For the two others better performance glazing, they have been taken from commercial brand´s technical data sheets, being 2.8 W/m^{2}K and 0.72 for the double clear glass and 1.6 W/m^{2}K and 0.41 for low emissivity.

In order to allow as much solar radiation as possible over the glazing surface, no shading from neighboring buildings is considered nor shading devices, except for the one produced by the window setback itself. A simplified energy rating tool for existing buildings is used (CE3x, 2013).

V. Results and Discussion

From the results obtained, the best value combination is established considering the solar and thermal transmittance for each four orientations in order to increase the building's energy efficiency.

A noteworthy result is that for the heating demand, glazing which obtains the best result is the double clear pane, despite having a higher thermal transmittance than the double low-e window. On the cooling demand the opposite occurs.

Depending on the glazing type, the change from heating to cooling demand happens at different opening percentage.

TABLE II
PARAMETERS AND ENERGY RATING, ORIENTATIONS AND TYPE OF GLAZING

Number of orientations			One	Two	Three	Four
DEMAND	HEATING	Orientation	N	N - W	N - W - E	N - W - E - S
EMISSIONS		Glazing	Double C	Double C	Double C	Double C
DEMAND	COOLING	Orientation	E	E - W	E - W - S	E - W - S- N
EMISSIONS		Glazing	Double LE	Double LE	Double LE	Double LE
ENERGY RATING		Orientation	E	E - W	E - W - N	E - W - N- S
		Glazing	Double LE	Double LE	Double LE	Double LE

TABLE III
HEATING AND COOLING DEMAND ACCORDING TO OPENING PERCENTAGES AND TYPE OF GLAZING

	Predomina Calefacción.			A_10%		B_20%		C_30%		D_40%		E_50%		F_60%	
	Predomina Refrigeración.			22,00 m2		44,00 m2		66,00 m2		88,00 m2		110,00 m2		132,00 m2	
				Parámetros Demanda		Parámetros Demanda		Parámetros Demanda		Parámetros Demanda		Parámetros Demanda		Parámetros Demanda	
Combinación	Tipo vidrio	Transmit/FS	Orientación	Calef.	Refrig.	Calef.	Refrig.	Calef.	Refrig.	Calef.	Refrig.	Calef.	Refrig.	Calef.	Refrig.
15	U doble N g doble N	2,80 0,72	Norte Sur	36,5	21,0	28,4	30,4	23,8	36,6	22,7	42,6	21,1	48,2	18,5	50,5
	U doble BE g doble BE	1,60 0,41	Este Oeste	38,3	18,4	34,2	24,5	31,7	29,0	29,1	33,0	27,0	36,6	25,6	41,1

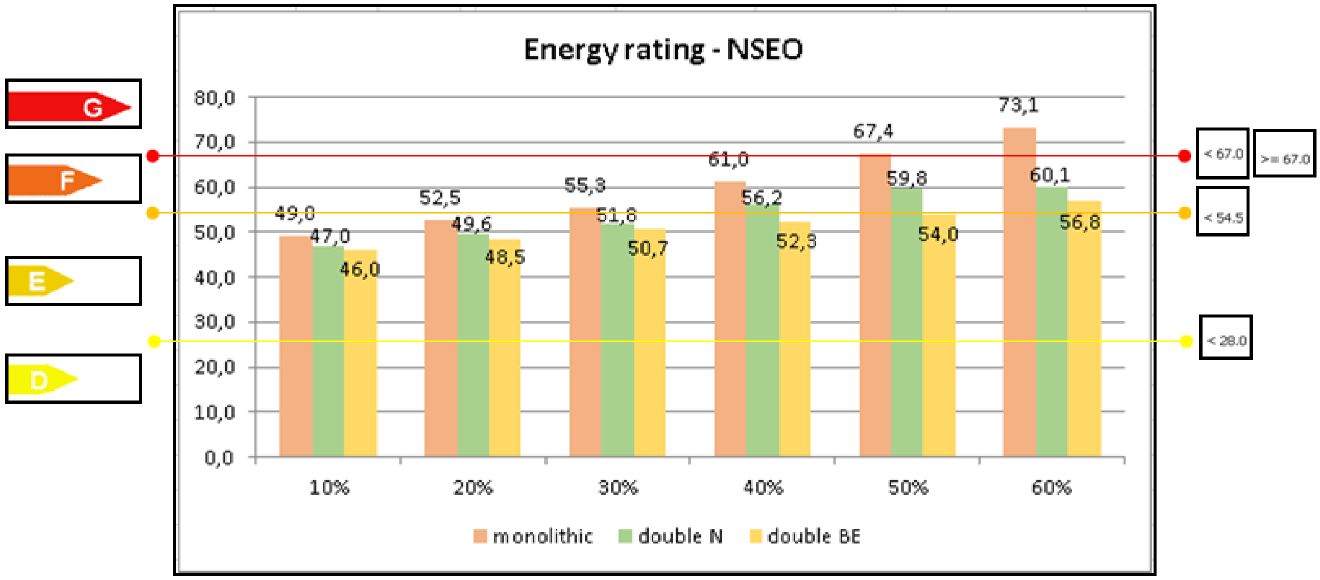

Fig. 3. Energy rating for different opening percentages and glazing types.

With double clear pane glazing, there is a change from heating to cooling demand at smaller opening percentage than with double low-e window which happens between 30 and 40%. This is due to the first glazing type has a higher g-value allowing more solar radiation to enter inside the building.

Another result would be how the building's energy rating gets worse as opening percentages change from 10% to 60% (Fig. 3). The difference is bigger with the single monolithic glazing and smaller with the double glazing low-e as expected. With high opening percentages a reduction in energy rating can be gotten depending on the better performance glazing's U-factor and g-value. Lastly, it is showed the ideal glazing's values for each orientation considered (Table IV). With regard to the U-factor, the lowest the better result it gets, but for the g-value, the highest the better only for the south orientation.

TABLE IV
BEST GLAZING VALUES FOR EACH ORIENTATION

Glazing's best parameters values			
north	south	east	west
lower U	lower U	lower U	lower U
lower g	highest g	lower g	lower g

VI. Conclusions

For the climate zone studied, Seville (Spain), catalogue as B4 according to the Spanish Building Code and glazing types, the first conclusion would be that g-value parameter has a higher incidence on the global demand and energy rating than thermal transmittance.

Secondly, it is established which orientation greater energy savings can be achieved separately for heating, cooling demand and energy rating. Thirdly, the ideal values for both parameters that should be considered in each orientation in order to improve the energy rating.

Therefore, when selecting a type of glazing to be placed in an energy retrofitting, it would be important to consider the best U and g parameter values together for each orientation in order to get the lowest energy demand possible.

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