INFLUENTIAL THE OPTIMUM ORIENTATION FOR RESIDENTIAL UNITS IN HOUSING-BLOCKS

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Abstract - Orientation is the main aspect in climatic design. The architect faces the problem of choosing a residential unit type to reach the optimum orientation in housing-blocks. The problem of orientation in residential unites was discussed and the aspects affecting it were defined. Two scales were developed to evaluate orientation efficiency of unite types in housing-blocks. A chart was presented demonstrating the sequence of information flow and the evaluation mechanism to reach the optimum orientation for all units.

Keywords - Orientation – Design tool – Residential buildings – Climatic design

I. INTRODUCTION

The Mediterranean area is characteristic with its moderate climate. To obtain thermal comfort in buildings and to reduce energy consumption in sort of operating time of mechanical means such as electric fans and air-conditions, a climatic design approach should be used.

Climatic design approach and the use of architectural measures depends in the first place on orientation. Obtaining good orientation in residential buildings is an important aspect in the first design phases.

II. PROBLEMATIC AND AIM

The architect faces the problem of choosing the right residential unit type in housing-blocks, which presents the optimum orientation for all units. There are always alternatives for the choice and arrangement of the units in the block, which are effected by different design aspects. The evaluation of these alternatives from the orientation point of view leads to the optimum possible orientation for all unites.

Aim of this paper is to present a design tool determining the optimum orientation for residential units in housing-blocks.

1. Orientation:

According to building regulations every room or space in a residential unit with a living function must be naturally lighted and ventilated. The size of an opening to achieve those demands is related to floor area and function of the room [2]. So every room in a residential building must have minimum an external wall.

The orientation of the whole building should as far as possible be in accordance with the different requirements for these rooms. The choice of orientation is subject of many considerations, including the view in different directions, the position of the building in relation to roads nearby, the topography of the site, the location of sources of noise, and the nature of the climate. The orientation of a room is defined as the direction faced by its external elevation [3]. Theoretically there are recommendations describing the best orientation for every room in a residential unit, with respect to its surrounding environment. Practically and because of the complexity of the design process and the number of other aspects affecting it, the demand of room orientation can be redefined and put in the following order:

- Achieving -as a minimum- an external wall for every room for the reasons of natural ventilation and lighting.
- Sharing the view between rooms in accordance to their functions
- Arranging rooms and spaces with their external walls facing as possible the main directions (North – South - East and West).

2. Factors Affecting Orientation:

From the previous definition of orientation and the priorities set for this aspect, there are factors in the planning and design process affecting it. Those are going to be discussed here.

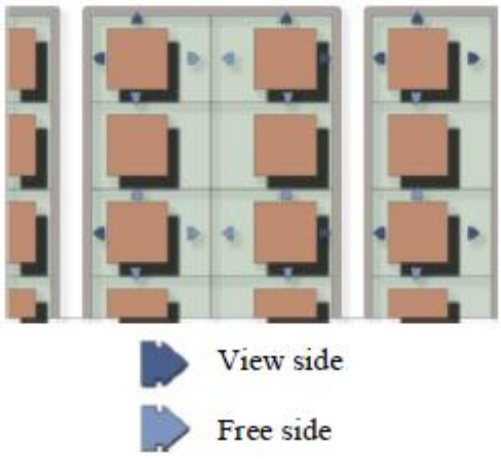


Fig. 1: Arrangement of pots and its effect on orientation

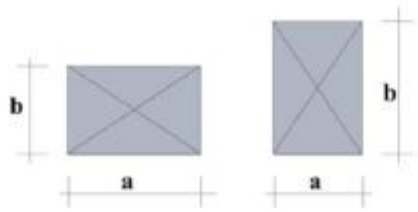


Fig.2: the possibility of arranging the units to view side is better when the front length of the plot bigger than its depth

2-1. Shape of Plots:

There are three factors affecting orientation

- **Arrangement of plots:** Plots are always arranged in single or back-to-back rows. Any of these arrangements results a middle plot and a side one. A middle plot has one or two view sides and a side plot has two or three view sides by back-to-back and single rows respectively.
- **Geometrical proprieties:** The length of fronts affects the number of units, which can be placed to the view side.
- **Area:** Plot area or the built up area plays an important roll of determining the number of residential units per floor in other words the building typology.

2-2. Building Density:

It means the setbacks and distance between buildings, which can be classified into[1]:

- Attached buildings: Attachment side is a lost free side for the house.
- Semi attached buildings: Distance between buildings has to be carefully determined to assure relatively good ventilation and lighting conditions.
- Detached buildings: Distance between buildings provides excellent ventilation and lighting conditions.

2-3. Building Typologies:

Residential buildings can be classified as shown in figure 3 in single-family houses and blockhouses. Blockhouses are divided into low-rise buildings and height rise buildings [5]. The only difference between them is their height or number of floors but both are built using the same typologies. This work is concerned with blockhouses.

Building typologies affect the orientation efficiency of single residential units. By increasing the number of units per floor the possibility for each unit of sharing the external sides decreases.

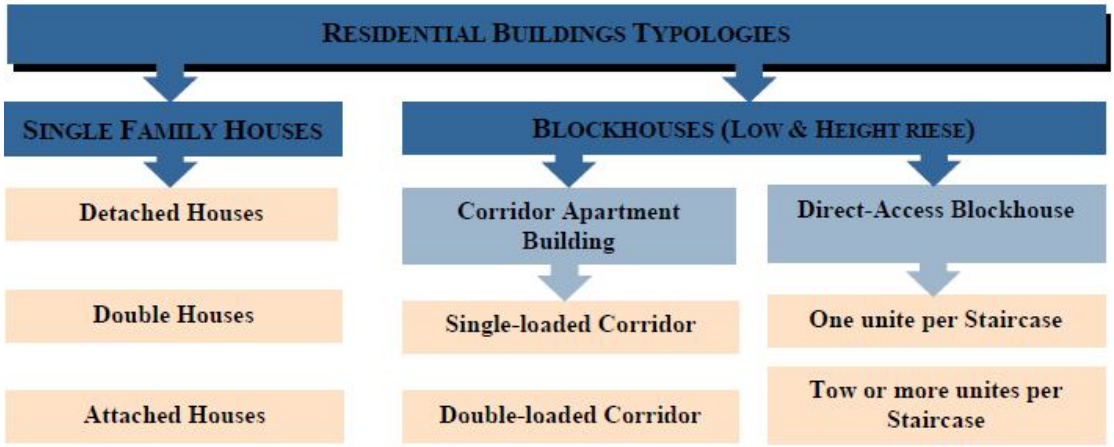


Fig. 3: Residential buildings typologies

2-4. Unit Typologies:

Residential units can be divided into single story type, two or more story type, and split-level type [4]. Those types have different possibilities of orientation when used with different building typologies. They can be used to obtain better orientation conditions.

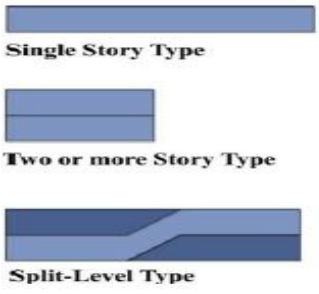


Fig. 4: Residential unit types

3. The Evaluation Tool

To handle the problem of orientation in blockhouses there are four factors affecting this aspect. Two of them are variables and considered as tools in the hands of the architect to work with. Those are the building typology and unit typology. The other two factors are not directly constants but their values are given in every situation and their for considered constants. Those are shape of plot and density.

3-1. The Evaluation Scale:

As a result of the previous discussion two scales are developed to evaluate the orientation efficiency of residential units in blockhouses. With the two scales different alternatives can be evaluated. Comparing the evaluation results gives the optimum orientation.

$$\text{Orientation efficiency} = \frac{\text{Length of free sides}}{\text{Circumference of the unite}} \times 100\ \%$$

Orientation efficiency of a residential unit is measured by the proportion of the length of its free sides to its circumference. It shows the possibility of orienting rooms to free sides or external walls. It measures the efficiency of different unite types in a blockhouse.

$$\text{View efficiency} = \frac{\text{Length of free sides to view}}{\text{Length of free sides}} \times 100\ \%$$

View efficiency of a residential unit is measured by the proportion of the length of its free sides to the length of its side or sides to view. It shows the possibility of situating rooms with living functions such as living, dinning, study rooms to view side or sides.

3-2. The Evaluation Chart

The evaluation process is presented in this chart to demonstrate the sequence of information flow and the evaluation mechanism.

The process can be divided to three phases. The first one is the data input phase, were the information of the plot are defined. The second phase is the calculation phase, were the given information from first phase are calculated to determine the values of different variables. The third phase is the evaluation phase. It is the data processing phase for different alternatives in the evaluation loop. Comparing the results shows the optimum orientation alternative.

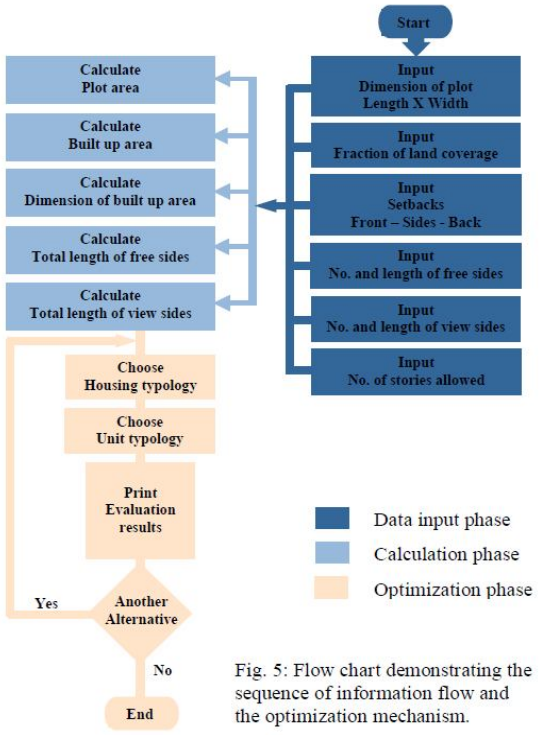


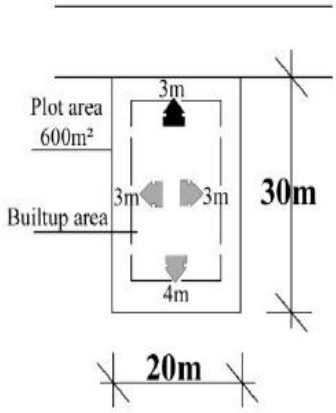
Fig. 5: Flow chart demonstrating the sequence of information flow and the optimization mechanism.

4. Worked Example

To show how this tool works consider a middle plot of 600 m². An investigation is made to evaluate weather its better to build a blockhouse with 2 single story unite type or 4 split-level unit type per floor.

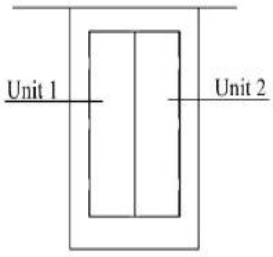
Data input phase:

Dimension of plot	20 X 30 m
Fraction of land coverage	55 % over ground floor
Setbacks:	
Front	3 m
Sides	3 m
Back	4 m
No. of free sides	4
Length of free sides	14 & 23 &23 &14 m
No. of view sides	1
Length of view side	14 m
No. of stories allowed	5



Calculation phase:

Plot area	600 m²
Built up area	330 m²
Dimension of built up area	14 X 23 m
Total length of free sides	74 m
Total length of view sides	14 m



Evaluation phase (Investigating alternatives)

Alternative one

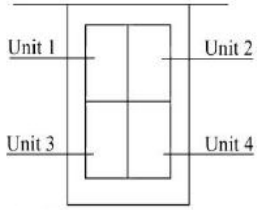
Housing typology	Two units per staircase
Unit typology	Single story type
Area of unit	150 m²
Orientation efficiency unit	$\frac{(7+7+23)X100}{(7+23)\ X\ 2} = 62\%$
View efficiency	$\frac{(7)\ X\ 100}{(7+7+23)} = 19\%$
Total No. of unites	10 units

Alternative two

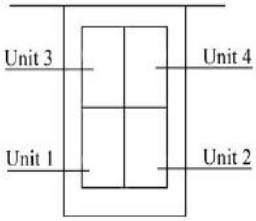
Housing typology	Four unites per staircase
Unit typology	Split-level type
Area of unit	150 m²
Orientation efficiency	$\frac{(7+11.5)2X100}{(7+11.5)\ X\ 4} = 50\%$
View efficiency	$\frac{(7x\ 2)\ X\ 100}{(7+11.5)\ X\ 2} = 19\%$
Total No. of unites	10 units

First to fourth floor

Alternative 1: Two unites per staircase



First & third floor



Second & fourth floor

Alternative 2: Four unites per staircase

Comparing the two alternatives:

- Alternative one has an orientation efficiency of 62% against 50 % of alternative two.
- Alternative one and two are having the same view efficiency of 19 %

So its obvious from the orientation point of view that alternative one is better than alternative two.

CONCLUSION

5-1. Results:

- This tool should be used in the planning phase (Land parceling) to evaluate the orientation efficiency of the plots in a certain area.
- This tool is valid to evaluate the orientation efficiency of residential units in house-blocks. Similar tools can be developed for other housing typologies.
- The importance of this tool appears by increasing the number of units per floor.
- It can be used to make a comparison study between different housing typologies and to classify them according to their orientation efficiency.
- This tool succeeded converting the evaluation of orientation from a qualitative to a quantitive form.

5-2. Recommendations:

- It's recommended to develop a scale considering the orientation of the units to the main directions.
- It can be simply formulated to a computer program, maybe also be imbedded in a CAD-program, which the data can be directly evaluated.
- There are many aspects in the design process, which can be formulated in a quantitive way. That makes its evaluation easier, and helps making climatic approach in design more understandable.

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