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A STUDY ON DESIGNING RELATIONSHIP BETWEEN TOPOGRAPHIC STRATEGY AND SPACE OF CONGREGATE HOUSING IN SLOPING FIELDS

Abstract: *The article studies the relationship between a topographic strategy and space design of congregate housing in sloping fields based on the analysis of original site and the residential space. Through a diachronic study, the topographic strategy of congregate housing in sloping fields can be classified as several types, and this classification can be proved by a plenty of cases, while the author's aim is to explore the relationship between the tactic of site and the organization of space which reveal the topographic and social forces behind it, rather than study one-way object. After a digital analysis of a plenty of typical cases around the world, the author has revealed three key factors of a sloping site which have great influence on congregate housing organization and how it can be utilized in urban planning. The objectivity factors are a slope, section form and orientation, which have decisive impact on space organization and the structure of congregate housing in the city. This paper reveals the typological relationship of one of those element 'slope' in details. It intends to inspire future architectural practice in sloping fields, and also to make a supplement to the current study of urban residential area planning.*
Keywords: *topography strategy, congregated housing, sloping fields, space organization, residential area planning.*

Introduction

Sloping fields are gradually being explored with the trend of urban expansion; topography is one of the most decisive factors in many excellent cases. After exploring a plenty of projects in sloping fields, it was found that the major type of those buildings are residential ones. Due to the special scale and functional attribute of residential units, they have great advantages to fit the complexity of topography, while independent houses are not included in cases. It is because the volume and form of them are more flexible, and the relationship between that space and topography are hard to define. This thesis intends to reveal the relationship between a topographic strategy and space organization; therefore the residential buildings consisting of units, like congregated housing and villa group, etc. are selected as the main objects.

From the thesis of morphology, the construction surface between the ground and a building is 'form', and the complicated organization between them is the 'structure'. In regard to practical construction, the definition of 'Topographic strategy' is how to create flat land on slope for construction, since the daily life usually happens on the flat ground. Some fundamental information on construction in sloping field has been extracted by diachronic studying of the former research; the topographic strategy of congregate housing in sloping fields can be classified as three types: Underground, On the surface, Overhead. These methods are respectively subdivided into ten categories (Fig.1).

Space organization in sloping field housing is different from those on flat land; most of them are greatly influenced by the terrain. However, from the perspective of typology, the book <Mountain Dwelling> concludes three basic prototypes: a Point, a Line, a Surface, and it subdivides them into more specific ones by experience in mountain building construction. The Point layouts contains 'Centric', 'Directional', 'Non-Directional', 'Enclosing' and 'Row', the Line layouts contain 'Curved' and 'Straight', which have been changed into 'Opening' and

'Enclosing'. It is because the organization is utilized to describe the relationship of the space rather than the shape. Finally, the Surface layouts are composed by a line, a block, a surface and Z shape roads. The diagrams of them are drawn and complemented by the author. (Fig.2).

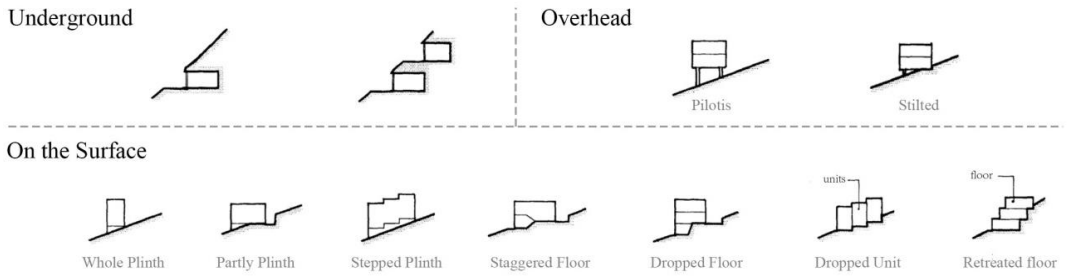


Figure 1. Types of the topographic strategy.
Source: LU Jiwei, WANG Haisong. (2005), Mountain building design, 83

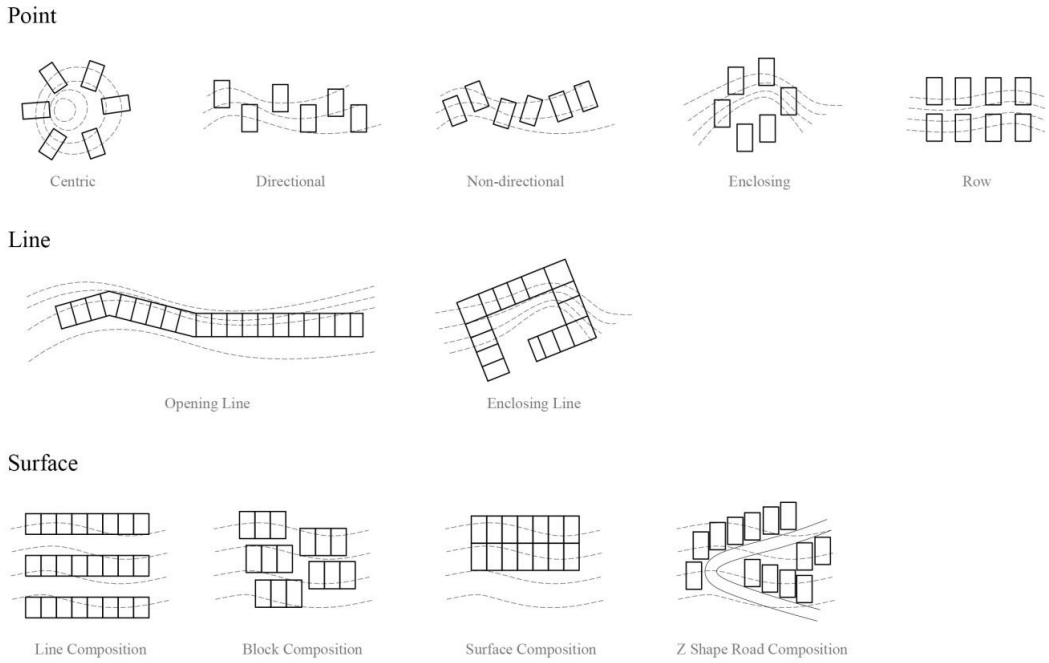


Figure 2. Layouts of residential buildings in the mountain.
Source: Drawn by the author

Strategy

This study is aimed at finding the relationship between a topographic strategy and space organization in congregated housing design. A slope is one of the most significant elements of a mountain. Therefore, the built-up projects have been classified by their original slope of sites. Analyzing and comparing the data by a topographic strategy and space organization, the relationship between them in different ranges of slopes would be found.

The study is based on the following strategies:

1. Founding the data on their original topography, such as a contour line and section drawings, it would help to reveal the rebuilt raw form of the sloping land. Then we compare them to the built-up situation, so the topographic strategies could be found. It turns out that some of the projects have not used a single topographic method. In those cases, the author needs to calculate the rate of different methods in the construction land and reveal the reasons behind.

2. Calculating the volume of the earth in the construction process of one project to explore the economic reason or comprehensive consideration of using this or that method. It could be helpful in studying the design and construction regularity in sloping field.

3. Classifying the slope of a mountain into five ranges by geographic guidance: Gentle slope land (3%~10%), Medium slope land (11%~25%), Steep slope land (26%~50%) , Sharp steep land (51%~100%) and a Cliff (>100%). Then, cases in belonging to same sloping ranges would be analyzed together, exploring how a slope influences selecting topographic methods and organization of residential space.

Conclusion

Thus, based on our analysis of the congregated housing in different slope ranges, as well as the analysis of the relationship between topographic strategy and space organization the conclusion includes two parts below:

The influence of a topographic strategy by a slope: First, the strategy of 'Overhead' is the most flexible one fitting to almost every range of slopes, because it has fewer contact area with the ground. However, the number of built-up cases with the use of the overhead method is far fewer than the other; the reason may be technical and economic considerations. Since the concrete structures are widely used in modern buildings, the embedded depth of a foundation would naturally being taken into consideration in design. The height of pilotis will not be calculated in the embedded depth, in this cases, the foundation column will be much stronger and bigger than the others.

Second, in case of gentle slope land (3%~10%), most cases use the strategy of 'Stepped Plinth'. In medium slope land (11%~25%), the majority of cases use strategy of 'Staggered floor', 'Dropped Floor' or both of them. The reason can be seen from the formula 'Height/ length= slope'. As well as the slope rising, the height of plinth is rising. When it comes close to the height of half of a storey or even higher, the plinth volume could be used as interior space, so that the strategy of grounding changes to Staggered floor and Dropped Floor naturally. Moreover, cases in steep slope land (26%~50%) usually take the 'Dropped unit' method, residential units raise stepped. (Table 1, Table 2, Table 3.)

Finally, the strategy of 'retreated floor' is widely used in sharp steep land (51%~100%) and the cliff (>100%). When a slope rises beyond 50%, the residential units probably do not use other methods standing side by side. Because every household needs natural lights and winds, they must be tall, or they will be blocked by the building in front of them. (Table 4, Table 5.)

The influence of space organization by a slope

Generally, congregated houses in gentle slope land (3%~10%) show 3 types of space organization, while the topographic strategies have fewer choices. The first one is a 'line' layout, the terrace house stands side by side, being connected straightly by outdoor roads. They usually face to the light and have good physical condition. The second one is a 'directional point' layout, the residential units are built separately due to the light requirements. The roads are generated in the gap of houses. In most cases, the roads are relatively flexible in gentle slope land, which can reach almost every residential unit.

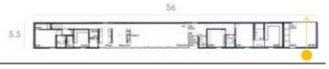
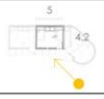
As soon as a slope rises, the cases show more utilization of 'Staggered floor' and 'Dropped Floor'. It creates a different level in a building, which brings more entrance and platform to connect it with the outdoor space. In some projects, the level is different inside in the circulation design, such as corridor or straight staircase. For the functional concerns, the units behind could use the former one's roof as their platform.

When a slope is beyond 50%, the congregate housing in sharp steep land always uses the method of 'a retreated floor'. In this case, the straight staircase will not be fitting the slope, as it will waste the interior space. Therefore, the vertical staircase and an elevator are necessary. They give more freedom in the height of a building and numbers of storeys. The upper floors set back to the mountain side and create a balcony. Some of cases even leave a gap between a mountain and a building for their physical condition.

Table 1

Analysis of the cases in gentle slope land. Source: Drawn by the author

Gentle Slope Land (3%~10%)

SLOPE	PHOTO	PROJECT NAME	PROJECT TYPE	YEAR	LOCATION	TOPOGRAPHIC STRATEGY		SPACE ORGANIZATION		HOUSEHOLDS RELATIONSHIP	RELATIONSHIP BETWEEN LIGHTS AND CONTOUR LINE	HOUSEHOLDS PROTOTYPE
5.2%		Viviendas de Autoconstrucción en Palencian a	Congregate Housing	2003	Spain/Palencia na	On the Surface	Stepped Plinth	Line	Opening Line	Terrace	Parallel	
5.2%		valadas houses	Villa Group	2011	Portuga/Montemor-O-Nove	On the Surface	Whole Plinth	Point	Centric	Interlock	Parallel	
5.2%		Jintai Village Reconstruction	Villa Group	2012	China/Sichuang	On the Surface	Stepped Plinth	Point	Row	Separated	Vertical	
7.0%		Frankfurt, Riedberg	Congregate Housing	2009	Germany/Frankfurt	On the Surface	Staggered floor+ Dropped Floor	Line	Enclosing Line	Interlock	Vertical	
8.8%		Catamountain Cluster Housing	Dormitory	2016	United States /Woodland Park	On the Surface	Stepped Plinth	Line	Enclosing Line	Terrace	Vertical	
8.8%		villas at bom sucesso resort	Villa Group	2003	Portuga/Obidos	Overhead	Stilted	Surface	Line Composition	Terrace	Parallel	
8.8%		Argentina Five house	Villa Group	2014	Argentina	Overhead	Stilted	Point	Row	Separated	Vertical	
10.0%		Common City Hoshida	Congregate Housing	1992	Japan/Osaka	On the Surface	Staggered floor	Surface	Block Composition	Separated	Vertical	

Dealing with slope in multi-direction

In conclusion, the range of a slope is not absolute. It is an idealistic and one-way thing based on the formula 'Height / length = slope'. The built-up projects in most cases deal with the slope in the direction which is vertical to a contour line, resulting in the highest slope. On the other hand, a multi-direction solving of slope needs to be emphasized. The different levels could be treated in more direction, at the same time, the traffic may be generated (Fig.3).

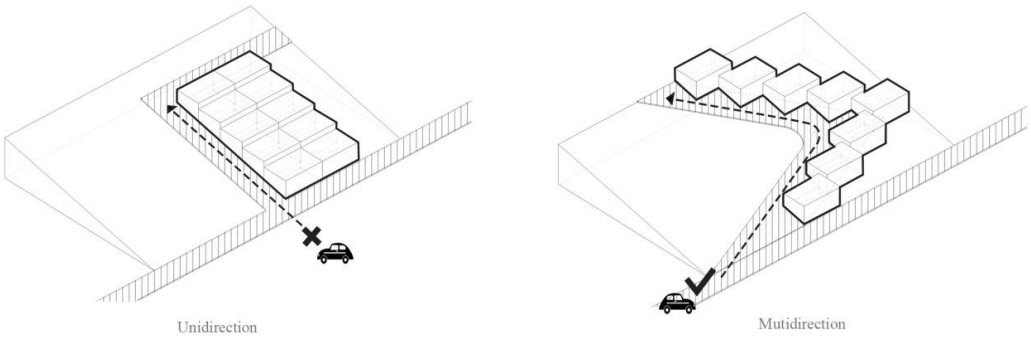


Figure 3. Diagram of solving slope in indirection or multidirectional. Source: Drawn by the author

Table 2

Analysis of the cases in medium slope land. Source: Drawn by the author

Medium Slope Land (11%~25%)

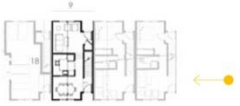
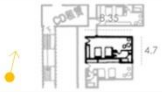
SLOPE	PHOTO	PROJECT NAME	PROJECT TYPE	YEAR	LOCATION	TOPOGRAPHIC STRATEGY		SPACE ORGANIZATION		HOUSEHOLDS RELATIONSHIP	RELATIONSHIP BETWEEN LIGHTS AND CONTOUR LINE	HOUSEHOLDS PROTOTYPE/ SUN DIRECITION
13.0%		SOCIAL HOUSING IN CABEZA DEL BUEY	Congregate Housing	2015	Spain - Cabeza del Buey, Badajoz	On the Surface	Stepped Plinth	Line	Enclosing Line	Terrace	Vertical	
13.0%		Hunter viewing housing	Congregate Housing	2015	United States/San Francisco, CA	On the Surface	Stepped Plinth+ Dropped Floor	Line	Enclosing Line	Interlock	Parallel	
19.0%		Courtdecor Oyamadai	Congregate Housing	2005	Japan	On the Surface	Dropped Unit	Surface	Block Composition	Interlock	Vertical	
21.0%		IAAP Exhibition Room Center.	Dormitory	2015	China/NanJing	On the Surface	Dropped Unit	Line	Opening Line	Terrace	Parallel	
21.0%		Siedlung Schlosspark	Congregate Housing	1963	Switzerland/Sinneringen	On the Surface	Dropped Floor	Surface	Line Composition	Terrace	Vertical	
25.0%		MOLVIZA-R Social Housing	Congregate Housing	2004	Spain	On the Surface	Stepped Plinth+ Dropped Unit	Surface	Z shape road Composition	Terrace	Vertical	
25.0%		18 FF Houses	Congregate Housing	2017	Cumbayá/Quito	On the Surface	Dropped Floor	Surface	Block Composition	Interlock	Vertical	
25.0%		Le Jardin du Côteau	Congregate Housing	2017	Seyssins, France	On the Surface	Dropped Floor	Surface	Surface Composition	Terrace	Parallel	

Table 3

Analysis of the cases in steep slope land. Source: Drawn by the author

Steep Slope Land (26%~50%)

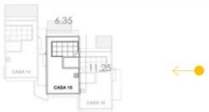
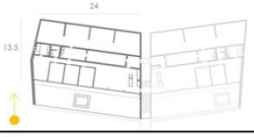
SLOPE	PHOTO	PROJECT NAME	PROJECT TYPE	YEAR	LOCATION	TOPOGRAPHIC STRATEGY		SPACE ORGANIZATION		HOUSEHOLDS RELATIONSHIP	RELATIONSHIP BETWEEN LIGHTS AND CONTOUR LINE	HOUSEHOLDS PROTOTYPE/ SUN DIRECITION
30.6%		Szuflandia Apartment	Apartment	2016	Poland	On the Surface	Retreat Floor	Point	Directional	Separated	Parallel	
36.4%		Vila Butantã	Villa Group	2004	Brazil/Sao Paulo - SP	On the Surface	Dropped Floor	Surface	Line Composition	Terrace	Parallel	
42.0%		Bruggerberg	Appartment	2013	Switzerland/Brugg,	On the Surface	Retreat Floor	Surface	Block Composition	Terrace	Vertical	

Table 4

Analysis of the cases in sharp slope land. Source: Drawn by the author

Sharp Steep Slope Land (51%~100%)

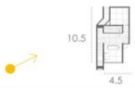
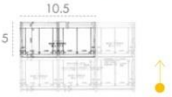
SLOPE	PHOTO	PROJECT NAME	PROJECT TYPE	YEAR	LOCATION	TOPOGRAPHIC STRATEGY		SPACE ORGANIZATION		HOUSEHOLDS RELATIONSHIP	RELATION-SHIP BETWEEN LIGHTS AND CONTOUR LINE	HOUSEHOLDS PROTOTYPE/ SUN DIRECITION
48.8%		Tolo Holiday Villa	Holiday Villa	2005	Ribeira de Pena, Portugal	On the Surface	Dropped Unit	Surface	Surface Compo-sition	Interlock	Parallel	
56.0%		Pedregulho, No Rio	Appartment	1946	Rio de Janeiro, Brasil	Overhead	Pilots	Line	Opening Line	Terrace	Vertical	
57.0%		MIYAWAKI Greendo	Congregate Housing	2014	Japan	Underground		Surface	Line Compo-sition	Interlock	Vertical	
67.5%		LA CITÉDES ÉTOILES	Congregate Housing	1981	France	On the Surface	Retreat Floor	Surface	Surface Compo-sition	Interlock	Vertical +Parallel	

Table 5

Analysis of the cases in the cliff. Source: Drawn by the author

The cliff (>100%)

SLOPE	PHOTO	PROJECT NAME	PROJECT TYPE	YEAR	LOCATION	TOPOGRAPHIC STRATEGY		SPACE ORGANIZATION		HOUSEHOLDS RELATIONSHIP	RELATIONSHIP BETWEEN LIGHTS AND CONTOUR LINE	HOUSEHOLDS PROTOTYPE/ SUN DIRECITION
148.0%		Kandalama hotel	Holiday Hotel	1991	Sri Lanka	Overhead	Pilots	Line	Opening Line	Terrace	Vertical	
173.0%		Rokko Housing I	Congregate Housing	1983	Japan	On the Surface	Retreat Floor	Surface	Block Composition	Terrace	Vertical	

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Endnotes

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