

Environmental Control in Korean Traditional Houses

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ABSTRACT: The importance of relation between architecture and climate is growing rapidly as the importance of sustainable building is increasing. Korean traditional house has been developed for thousand years and build to be most adequate house for Korean climatic condition. Namely, Korean traditional houses applied environmental strategy in most of the design such as building location, space composition, heating and cooling and also in materials. This paper discusses some of the passive environmental techniques to improve microclimate, solar control, thermal comfort and ventilation techniques.

Keywords: traditional house, sustainable design, day lighting

1. INTRODUCTION

Environmental architecture is the concept of accepting climate or nature into architecture, and traditional architecture has been developed by the experience of climate and living style for thousands years.

Korean traditional houses preferred south orientation to receive maximum solar radiation in winter and used higher heat capacity wall material for insulation. In summer, openings of wooden floor living room which is the centre of the house, was designed for natural cross ventilation.

In this paper, passive environmental control in Korean traditional houses according to climate condition was analyzed. To analyze the environmental strategy in Korean traditional houses following research methods are used. Firstly, climate type was analyzed. Korea showed both continental and oceanic climate characteristics and this two climate types are influencing differently according to the location. Secondly, architectural responses due to the climate condition were researched. Floor type was divided into four types according to the areas and each

environmental strategy were classified and analyzed. Cooling and shading in summer, heating and absorbing solar radiation in winter was mainly researched.

2. CLIMATE ANALYSIS

The Republic of Korea is located in the middle latitudes of the Northern Hemisphere, with latitude range of 33°N-38°N and longitude range of 125°W-131°W. Climate in Korea is regarded as a continental climate from a temperate zone and a monsoonal climate from a precipitation zone due to the Eurasian Continent on the east coast and also adjacent to the Western Pacific. Therefore it shows complex climate characteristics which both continental and oceanic features. Table I summarized the climate characteristics of Korea.

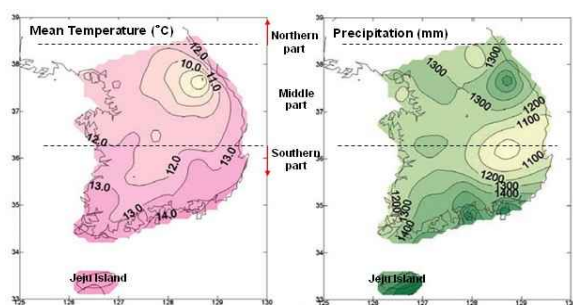
The annual mean temperature ranges from 10 to 16°C. The warmest month is August, whereas January is the coldest one. The monthly mean temperature ranges from 23 to 27°C in August and from -6 to 7°C in January. The days under the 0°C is almost 100days in middle part, 50 days in southern part and 17days in Jeju Island.

Table I. Climate characteristic of South Korea

	Spring	Summer
Month	Mar, Jun, Jul	Aug, Apr, May
Type	Warm, Dry	Hot, Humid
	Autumn	Winter
Month	Sep, Oct, Nov	Dec, Jan, Feb
Type	Mild, Dry	Cold

The annual precipitation ranges from 1,000 mm to 1,800 mm but more than half of the annual precipitation falls during the rainy season in summer. The winter precipitation is less than 10% of the total annual precipitation. The prevailing winds are south-westerly in summer and north-westerly in winter. Humidity is highest in July, reaching 80~90% nationwide. On the contrary, the lowest means of monthly humidity are 30~50% in January and April. The relatively low humidity shows from September to October.

Figure1 shows the Average annual temperature and precipitation in South Korea.

**Figure1.** Annual Mean temperature and Precipitation

3. ARCHITECTURAL RESPONSES

3.1 Building location

In Korean traditional architecture, Feng-shui theory was the main factor when positioning the building. The ideal location according to Feng-shui was that building should be facing the south with the water (river, lake) in the front and the mountain in

the back of the building. Therefore most of traditional house orientation was south.

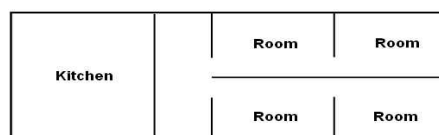
Southern facing house can receive significant solar radiation in winter and least solar radiation in summer.

Therefore in winter, traditional houses could receive most of sunlight and blocked north-west wind due to the mountain located in the north direction of the house but in contrast, least direct sunlight with south-east wind in summer.

3.2 Floor Plan

Various types of floor plan were developed and classified into single line, double line, and ‘ㄱ’ shape plan according to the climate condition.

Double-line floor plan was developed in mountain area and in northern part of Korea. In this area, winter is extremely cold but summer is not too hot so key issue in building design was to keep the heat inside and minimize the heat loss. Double line floor plan is a very compact shape. Rooms are sharing walls in each side and minimize the envelope area. Minimizing building envelope can reduce heat loss of the building. Figure2 shows the double line floor type.

**Figure2.** Double line floor type

In the middle part of South Korea, ‘ㄱ’ shaped floor plan was developed. Exterior areas were increased compare to the double line floor plan and Daecheng was created in the centre of the house. This floor plan is primarily considering summer time in hence sunlight and wind direction in summer is the major consideration. For example if the building orientation is south, major rooms and Daecheng create south-north axis to be efficient in solar radiation and in natural ventilation. Figure 3 shows the ‘ㄱ’ shape floor type.

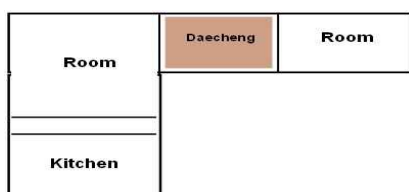


Figure3. ‘ㄱ’ shape floor type

In southern part, open floor plan was developed due to the relatively high temperature compare to the other areas. It's called single-line floor type. All the rooms are arranged in a single line with Daecheng in the centre. It shows the similar concept with ‘ㄱ’ floor plan on receiving solar radiation and in natural ventilation method but simpler floor plan to be more efficient for prevailing wind in summer. Daecheng is larger than the ‘ㄱ’ floor plan.

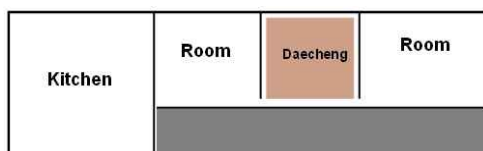


Figure4. Single line floor type

The last type only shows in Jeju Island so it's called Jeju single-line floor plan. Jeju is the warmest area but also shows heavy wind due to the oceanic climate. The main building is designed with single-line floor plan and other spaces are located separately and fences are built higher than the other area to reduce the damage of wind power. Heating wasn't essential in Jeju climate so only small part was heated. Storehouse is located in the back of the house (usually north) to have natural cooling in the space.

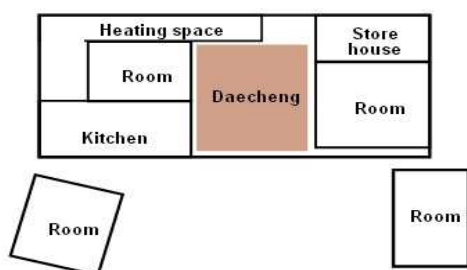


Figure5. Jeju single line floor type

3.3 Day lighting strategy

In Korean traditional house, Roof eaves and opening are the main topic for daylighting strategy. Roof makes important role in buildings. It prevent falling rain inside the building, avoid direct sunlight and control the inside temperature. In Korean traditional house they used roof with long eaves. This Korean style eave prevent direct sunlight and create convection below the eave so it reduces the heat and coldness. Furthermore, it reduces the sunlight in summer where the height of the sun is high and leads the light into deeper space in winter where the height of the sun is low.

The length of the eaves is designed according to the sun altitude. When the sun altitude is above the 63.5° (summer) sunlight to Daecheng should be avoided and when the sun altitude is below the 40° (winter) sunlight should be inside the space. But if the length of the eave is too long then it decrease the sunlight coming into the room and makes shadow. To prevent this situation sand which has higher reflection rate are covered in front of the rooms. It makes uniform illuminance inside the house. Figure6 shows the effect of eaves in different sun position.

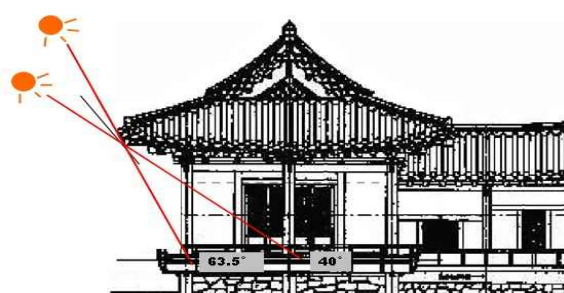


Figure6. Effect of eaves in summer and winter sun altitude

3.4 Heating System

Korean traditional houses used floor heating system called ‘Ondol’ for more than 2000 years. The floor of Ondol is made of flat stones and mud. It's heated by burning the wood or straw. Then the heat and smoke passes through the pathways of beneath the flat stones. Room floor is heated due to the

convection and radiation in heat exchange cycle. A stove and chimney are outside the Ondol room at the entrance, and the exit of smoke is through a pathway beneath the floor. Figure 7 shows the principle of Ondol.

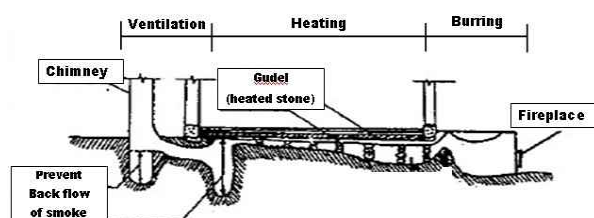


Figure7. Configuration of the Ondol

Ondol keeps the room warm during the winter when the outside stove is lit. During the summer, the under-floor stones keep the room cool. Ondol also controls the humidity of the room. Mud in the Ondol emit humidity in winter and reduce in summer. Especially in rainy season humidity can be removed by heating the floor slightly.

3.5 Natural ventilation

Korean traditional houses are well equipped for cross ventilation due to the openings and location of the building. For middle and southern part houses, Daecheng makes cross ventilation with two side open structure. The ground temperature rises due to the radiation of the sun in southern facing court of the house. But trees or hills in back side of the building create cool air and temperature goes down. In this context temperature difference make air circulation which means that it create natural convection of the air. Therefore cool air is created due to the air movement in Daecheng even without the wind. Figure 8 shows the air current in traditional houses.

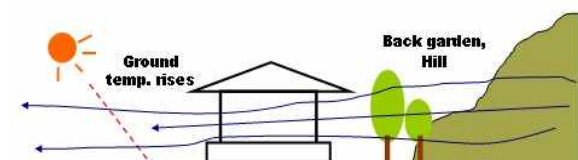


Figure8. Air movement principle in Korean traditional house

This ‘southern facing building with trees or hills in the back’ location principle also prevents cold Northwest wind in winter. Hills and trees block the wind firstly then fence blocked the wind secondly finally the reduced wind comes in to the houses.

4. CONCLUSION

This paper analyzed the environmental control in Korean traditional houses.

Environmental strategy in Korean traditional houses were solar radiation absorption by south orientation, daylight control by roof eaves and openings, cross ventilation due to the open space, floor radiation heating system and soil wall for insulation.

Traditional strategy cannot be fully adapted in to modern architecture. There are limit and weakness in traditional strategy. But the basic concept of traditional houses which is creating comfort by nature should be always remembered when designing the buildings.

REFERENCES

- [1]Byeong K. 2006. *Feng-Shui and ecological interpretation of traditional Korean settlement*. Journal of the architectural institute of Korea. Vol.22 No.6, pp.19-30
- [2]Gun K, Jae G. 2004. *Daylighting control of Korean traditional houses built in Chosun dynasty especially on examples located on Gyungbuk province*. Journal of the Korea institute of ecological architecture and environment. Vol.4 No.3. pp. 79-85
- [3] Jerhard H. et al. 2005. *Climate Design: Solutions for Buildings that Can Do More with Less Technology*. Birkhäuser Basel, 1 edition.
- [4]Seung L. 2002. *Environmental control in Korean traditional architecture*. Korea association of air conditioning refrigerating and sanitary engineers Journal. Vol 19. No.2. pp. 126-135