Passive Design Strategy on Residential Buildings for Sustainable Development of Lhasa

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Summary

Environmental issue is one of the biggest problems in the world. According to the experiences of developed countries, the environmental load growth is always the result of developing. With the increasing of the environmental problems, it is easy to assume that if the developing countries follow the track of developed ones, the global environment faces more serious damage. This research aims to find one of the solutions for developing cities to control the environmental load by passive design strategy.

This research takes Lhasa as the example city to study the passive design strategy. The reason is that Lhasa's climate has abundant solar radiation in winter, so there is a possibility to reduce the considerable heating energy consumption by only passive design and the current energy balance shows Lhasa faces serious power shortage due to the developing. With the building information from the field survey, the passive design characteristics in Lhasa are studied by simulation and the effects of passive design methods are clarified. By the combinations of the passive design methods and the corresponding additional costs, the passive design strategies are proposed and each of the effectiveness is verified in the future scenario study by simulation. The result shows that Lhasa city can get a sustainable development with few heating energy increasing by the proper passive design strategy.

This dissertation consists of six chapters. The chapter outlines for this dissertation are described as follows;

Chapter 1 shows the research background and purpose of the whole research.

Chapter 2 shows the necessary information of Lhasa for this research. In this chapter, the climate, energy condition, economic situation and development of the residential buildings are grasped by the documents investigation. The climate condition shows that it is a good choice to use abundant solar energy to save heating energy. The power supply condition shows that Lhasa already faces seriously electricity shortage. The development of the residential buildings and the economic growth show that the fossil fuel consumption growth in the future cannot be avoided. All these information indicate the necessity and the priority of passive design.

Chapter 3 shows the field survey which has been implemented in Lhasa. The purpose of the field survey is to grasp the building information such as the plan, material, structure and envelope thermal performance for the simulation setting in Chapter 4, and to grasp the living style information such as the people number of a household, daily schedule and home appliances for the simulation setting in Chapter 5. The field survey shows the possibility of energy saving by applying passive design strategy because the existing buildings originally have the conception of passive design.

Chapter 4 shows the passive design characteristics study. The effects of passive design factors are classified for making the passive design strategy in Chapter 5. By the comparison of heating energy consumption between three types of residential building, it is clear that more than 27% energy consumption can be reduced by add sunroom, and 56% energy can be reduced by the combination of sunroom and north balcony. Among all envelope thermal performance design factors, the windows type has the strongest influence to energy, especially the low-e windows. Adding insulation also has good energy saving effect (17% reduction for direct solar gain type), however, its thickness does not have large influence.

Chapter 5 proposes the passive design strategy for Lhasa city by the combined consideration of both passive design effect and the corresponding extra cost. Through the scenario study, effectiveness of the strategy is verified by simulation. At the same time, the whole process of making the strategy is shown. Following methods are recommended as passive design strategy according to the cost-effectiveness analysis: 2cm insulation layer, double glass, north balcony, low-e windows. By applying the strategy proposed in the thesis, 64% heating energy can be reduced in 2030. This result also shows that the way of making passive design strategy can be applied to other developing cities and useful for the local government to plan policies to control the environmental load of residential buildings by the proper passive design.

Chapter 6 summarizes conclusions of proceeding four chapters as the general conclusion and proposes some recommendations for future work.