Energy and Resource Positive Building Design in Urban Resilience Context

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ABSTRACT

This paper presents state of art urban resilience building technologies for improving energy efficiency and saving resources, making particular reference to case studies that include a cultural building, a commercial complex, community regeneration for low income groups and system housing. Some current measures to promote green remodeling of buildings as well as developing sustainable community in Korea will be introduced with a holistic view. Through the case studies, the need for passive and low energy design in urban community resilience buildings has been identified.

INTRODUCTION

Background and Purpose of Study

Environmental problems that are mainly due to the excessive use of energy and natural resources have brought about the need for a new paradigm shift. Eventually, the climate change underway today will be more than unpredictable. It has been forecast in the Stern report that GHG emissions will reduce the world’s GDP by 5-20% each year. For this reason, it is urgent to realize global sustainability by improving energy efficiency and saving resources through national action plans and international collaboration. Currently, Energy Technology Perspectives 2014: 2 degree scenario predicts that the world population and economic growth with energy policy and technology adoption will reduce oil demand by 30% in 40 years. It also said that improving energy efficiency would diminish carbon emissions significantly by 50%, or more.

In Korea, the building sector currently is responsible for more than 24% of total domestic energy use, and has seen an annual increase rate of 20%. An IPCC Report estimates that in 2030, the building sector will have the highest potential for reducing CO2 emissions. The Korean government has launched its “Low Carbon Green Growth” policy as the new growth engine for national economic development. To this end, various action plans have been made by supplying 2 million green homes with a view to developing global change mitigation as well as promoting the green economy and quality of life. A new trend of sustainable urban community regeneration has recently been promoted.

Method of Study

This is a kind of descriptive study that was conducted with a view to disseminating information and experiences on urban regeneration with particular reference to energy and resources positive building design. Representative urban regeneration projects ranging from commercial complexes to community housing have been examined in rather qualitative terms.

PROBLEM PERCEPTION

High Urbanization Rate

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In Korea, urbanization proceeded rapidly during the modernization and industrialization period in the 1960s. The urban population, just 2.8% in 1915, increased to 27.7% by 1960 and to 81.9% by 2010, and a level of urbanization that took Europe centuries to achieve occurred in just 40 years. The urban population increased from 20.49 million in 1975 to 38.33 million in 2005, an increase of 17.84 million, which means an 87% increase in only 3 decades.¹

Urban Decline Symptoms

To counteract this drastic urbanization and industrialization the government constructed extensive new cities and industrial complexes. But beginning in 2000, the growth in the urban population became stagnant due to the low birth rate and high aging, and the economic activities of many cities were down and symptoms of a partial or total decline in social economic activities could be seen.

Figure 1 shows the declining cities in Korea. Of 144 cities and districts in the country, 55 are declining and 41 show signs of decline, which means that 67% of the cities are declining or have started declining. Of the assessment methods, the social and economic indexes presents the average population growth and reduction of change in number of enterprises in the last 5 years, and the environmental index selects the regions in which more than 50% of buildings are older than 20 years. When these 2 or more of 3 indicators are applicable, the region was evaluated as ‘declined.’²

The declined regions during the past high growth period are the mixed-use complex and multi-story high-rise housing areas where the regeneration projects were positively implemented. However, the original residents of the regional community were not able to afford the high housing price and increased rental. In the end, they were driven out of the community. Thus, a new paradigm shift of urban redevelopment is needed in an urban resilience context, which can be defined as ‘a system to cope with physical/environmental, economic and socio-political strategies to enhance sustainable development for the human ecosystem’. The existing buildings should be refurbished to increase the region’s values through facility improvement, introduce cultural spaces and procure a social safety network. Thus, it is necessary to realize sustainability by remodeling buildings and regenerating community in an urban resilience context.

BUILDING ENERGY/RESOURCES AND URBAN REMODELING POLICIES IN KOREA

Two Million Green Home Project

According to this policy, the Two Million Green Homes Project has been launched with the vision, goals and strategy as summarized in Figure 2. One aspect of the plan is to supply two million green homes, with the vision of promoting climate change mitigation, green growth and quality of life. Three major strategies are 1) Green home technologies development 2) setting up award policy 3) publicity and supply schemes.

Figure 1 Present condition of declining cities in Korea

Figure 2 Concept of Two Million Green Homes
Enactment of Urban Regeneration Act

The Korean Government established the Urban Regeneration and Assistance Act in June of 2013 to effectively implement urban regeneration with the institutional and financial support of the Government. The goal of urban regeneration is to resolve the problems of the regional community by discovering regional assets such as the natural environment, culture, history and traditional heritage, on the premise that the local government and the residents comprise the main manipulator, so that the Central Government consolidates diverse assistance programs into one for effective support.

This act is composed of 3 main sectors. The first defines the organization and management for urban regeneration implemented by the central and local government and the regional community. The second defines the establishment of the urban regeneration plan. The central government proposes the basic direction for urban regeneration of the country every decade, and the local government sets up the strategic action plans for urban regeneration. The third involves the preparation of economic resources and administrative support for the regeneration.

CASE STUDIES

Cultural Building Regeneration: Rebirth of Old Government Building as a Cultural Space

The twin buildings built in the early 1960s were regenerated as a History Museum, as shown in Figure 3(left). Remodeling focuses on preserving the existing historical building by utilizing passive and low energy building design elements such as natural light, roof garden, PV etc. Eventually it has been certified to be the very best grade in terms of energy efficiency and green building performance by G-SEED(Green Standard for Energy and Environmental Design), Korean green building certification system. It is meaningful to regenerate the urban cultural space in its resilience context as a role model for urban sustainability.

Art and Culture Regeneration: ‘Gamcheon Village’, Busan City

Since Bukchon's landscape was changing due to the rapid development of Hanoks and the construction of multi-story buildings, The Seoul Institute(SI) came up with a new policy to beautify Bukchon in response to the requirements of a residents group promoting a project for the beautification of Bukchon. In the policy-making process, the SI worked with residents, experts and governmental officials. Unlike previous unplanned projects, the new policy made Hanok Registration voluntary and encouraged people to mend their houses with local government support. Since 2001, the policy has been a great success, not only in forming an attractive residential folk village but also a revitalized business area, where the residents are proud to live in Bukchon.

From an architectural point of view, it is notable that the courtyard idea of Hanok is a climate responsive low energy design in terms of inducing upward cool air movement through the inner courtyard by protecting direct solar radiation, building materials of thermal mass such as mud walls, roof tiles, and under floor heating systems, Ondol as well as the openable hanging windows for maximum ventilation during summer.(Figure 3 -right)

Figure 3       Urban Resilience of Tradition

Preservation of Traditional Village: ‘Bukchon’

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Mixed-Use Urban Complex Regeneration: ‘Time Square’

Established in 1919 in Seoul, KyungBang is one of the oldest Korean textile companies. On this site, Kyungbang Phil department building was built in 2005. They have developed a new multiple complex by remodeling the Department building with extended complex. The complex itself aimed at: 1) providing a regeneration program for a changing society, 2) enabling a regeneration of the commercial sub-center, 3) fulfilling green building guidelines, 4) revitalizing the industrial area as an urban entertainment lifestyle center(UELC) as summarized in Figure 4.

Benefits provided by the mixed-use urban resilience complex include an increase in the floating population by 30%, revitalization of the surrounding commercial area and activation of local economic activities by upgrading regional community life for the public.

COMMUNITY REGENERATION FOR LOW INCOME GROUPS

Art and Culture Regeneration: ‘Gamcheon Village’, Busan City

Gamcheon Village in Busan, the second-largest city in Korea, is an exemplary case of urban regeneration, in which a village formed with old houses on a mountain slope was transformed into a large culture-art gallery. Gamcheon Village was formed in 1950 during the Korean War by refugees, who temporarily built their own houses on a mountain slope. The narrow and complicated alleys extend like a spiderweb through the entire village. The rebirth of this deteriorated village as a current cultural village began with the redecoration of Gamcheon village by young artists in 2009-2010. They installed 22 art works in the village and repaired broken doors, peeling walls and the general landscape of the village.

The professionals investigate and discover the assets of the village, and the artists create new art works to vitalize the village with creativity. The villagers participated actively in the villagers' conference and in the management of the village as volunteers, managers and reporters.(Figure 5) As a result of these efforts the village became known as a famous tourist attraction, and was visited by approximately 100,000 tourists in 2012.

Thus, it is significant that the example of Gamcheon village, a significantly deteriorated village that became a village of art and culture using the historical assets and the landscape of the region, is an exemplary and representative case of urban resilience.

House Repair Project with NGO: ‘Nosan-dong town’, Masan City

The House Repair Project in Nosan-dong is an example of household regeneration implemented as the Test-Bed of the Urban Renaissance Research Center, a Korean Urban Regeneration R&D consortium. Nosan-dong is a village/town in Masan, a southern port city in Korea, with poor residential environment and many illegal constructions, empty and deserted houses where security and crime are regional issues of concern.
There are three factors necessary to begin the house repair project: first, organization of professional workforce to perform the project; second, selection of houses as targets of the project; third, procurement of funds for the project. First, the ‘Marae Home Partner House Repair Team’ was organized, to establish the professional workforce for the project. The organization of the workforce requested the voluntary participation of the Habitat for Humanity Partners. The professional and engineering workforce was organized by local veterans with experience in construction projects. The personnel expenses of the professionals and the material costs were initially covered by the Test-Bed funds.

The city provided the material costs and the residents participated voluntarily in the project. The House Repair Team will establish the regional network and register ‘Marae Home Partner’ as a non-profit organization to establish it as a sustainable professionals and the material costs were initially covered by the Test-Bed funds.

A MODULAR SYSTEM HOUSING

With the changes in the construction environment, many problems are arising in the construction market. The first problem is the shortage of the skilled labours. According to the data of the Construction Workers Mutual Aid Association in 2009, Korea had a shortfall of 145,000 construction labours in 2013. The lack of skilled labours causes an increase in labour cost and total construction cost. Second, with climate change the number of construction work days has been reduced year after year. According to SI data in 2011, there were 70 rainy days in 1970 but as of 2000 this had increased to 90. This leads to extension of construction period, and increased financial costs. Third, with the strengthening of carbon emission regulation the production system of house reparation and maintenance led by the residents, and thereby develop and expand the entire project. To this end, the city government is making all the possible efforts to organize the necessary assistance funds. Eventually the voluntary house repair project became a project of enhancement through energy retrofit by remodeling deteriorated houses and improving residents’ quality of life by renovating the living environment. This is an exemplary urban resilience with the public participation.

A MODULAR SYSTEM HOUSING

The Modular System Housing is a resources positive construction method that uses ready-made modules manufactured in a factory, which are assembled on-site, allowing a short construction period, easy removal and a high reuse rate. This method facilitates on-site installation, including the foundation work of the site, within a few weeks. This system can offer great advantages, especially in urban built-up areas.

Application of System Housing in Urban Resilience

The characteristics and merits of System Housing can be applied for urban resilience building. The “Dreaming Attic of Cheoeyeon-dong, Seoul that was completed in March of 2014 is an exemplary case. This project was implemented through an agreement between the NGO "Habitat for Humanity, Seoul" and the district office. Four-story rental student housing on the public parking lot was built as a joint cooperation project, accommodating about 50 students from the countryside.

This system housing has been designed to improve energy efficiency and building performance compared with conventional houses. To identify the high-energy performance of the competed housing in use, the annual heating and cooling load has been simulated by using IES-VE(Apache, Suncast) Ver.2014 with the input data such as number of occupants, various heat emissions, infiltration rate and the local climate data. Figure 7 shows the monthly energy consumption patterns. It has been verified that the system house energy consumption rate for heating in kWh/m²yr is reduced to 21.2 from 77.0 for the conventional Korean houses, whereas the cooling in kWh/m²yr is comparatively reduced less from 55.1 to 40.3.

This project is a good example of an urban resilience building model that accomplishes two goals: enhancement of land usage rate and provision of housing for lower-income groups at the community level. If this project is applied in a region with deteriorated houses and community facilities for refurbishment, it may be an excellent measure to induce public participation in improving the urban residential environment, promoting quality of life and saving energy and resources.