STRAW BALE ECOLOGICAL HOUSING PROGRAM

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MAINSTREAM-CURRENTLY NOT WORKING

China is making remarkable economic growth. However, current data confirms that this rapid growth has come at the expense of the environment. The degradation of the environment is threatening the sustainability and viability of the communities where the 1.3 billion people of China live.

There are three main problems concerning current construction materials in rural China.

1. The Current Construction Materials Are Not Environmentally Friendly

China's large population has created severe housing needs. The type of new houses that rural people are building is creating significant environmental problems. The new houses in rural areas are almost always constructed of brick. Brick is made by firing clay-rich topsoil at very high temperatures. The production process consumes a great amount of coal and destroys arable land, at the same time causing air pollution. The use of brick has increased tremendously since 1990. The following statistics illustrate the problems that brick making causes:

- At present brick factories in China occupy 400,000 hectares land[1]
- Brick making destroys 63,333 hectares of arable land every year[2]
- Brick firing consumes 100 million metric tons of coal per year

The government has realized the damage that brick making is causing and is beginning to limit the number of the brick-making factories. At the same time the government is seeking viable substitutes for bricks. Due to the current lack of viable substitutes for brick, brick construction is still widely used in many rural areas of China. Since 2001, the use of brick was banned in 170 large and medium cities in China. The same restriction was applied to other cities at the end of 2004.[1]

2. The Current Housing Stock in Rural Areas Is Not Energy Efficient

In northern China, a significant portion of people live in substandard and dangerous housing. The houses are often built of mud and rocks and such houses offer little protection from severe cold (as low as -40 Celsius), requiring residents to burn very large amounts of coal. This is a drain on household resources and a source of significant local and global pollution. The heating expenses for residents of poorly-constructed houses are a significant annually recurring cost that keeps the rural poor (mostly farmers) from improving their lives and rising above poverty. An 80 square meter house needs to burn about five tons of coal per winter in order to keep all the rooms livable. However, poor farmers cannot afford to buy five tons of coal so they buy only one ton of coal to keep the sleeping area warm at night and leave other rooms unheated. The uneven indoor temperature often causes of colds and upper-

respiratory disease in winter. The children and the elderly are especially susceptible to sickness under these cold conditions. Typically, residents heat their homes with a "Kang" – a raised bed platform constructed with bricks and concrete tiles and heated by hot flue gases on their way from the kitchen to the chimney. The price of coal has doubled over the past five years from 200 yuan ($24 USD) to 400 yuan ($49 USD) per ton. The typical farming household annual income is 2000-3000 yuan ($244 - $366 USD) and fuel expenses are a sizable drain on their financial resources. The burning of coal in winter causes considerable local air pollution. Some parts of the province in northern China have 17 tons of coal ash per square kilometer drifting to the ground each month.

3. The Current Housing in Rural China is Unsafe During Earthquakes

Brick houses are very unsafe during earthquakes because the walls are very heavy and not tied together well. Bricks have little ability to absorb seismic energy through deformation and brick walls collapse easily. Several brick schools were destroyed in Chifeng, Inner Mongolia, after a relatively small 5.9 Richter scale earthquake that struck the region in August 16, 2003.

AN ALTERNATE VISION

What is the solution to these problems that China confronts? In 1998, the Adventist Development and Relief Agency (ADRA) China Office introduced straw bale construction technology to China to provide a significant answer to these problems. Straw bale construction technology utilizes compressed straw as primary wall material to replace brick. The straw bale wall has much higher insulation value than brick. On average, a straw bale house is 68% more energy efficient than a brick house of the same size under the same winter conditions. The Straw Bale Ecological Building Program was designed to build local people's capacity to build structures utilizing straw bales. Straw bale construction is:

- Resource efficient
- Energy efficient
- Cost efficient
- Healthy and comfortable
- Earthquake resistant
- Durable
- Culturally sensitive

Working with One World Design Architecture in the USA and with technical expertise from Kelly Lerner, over 400 local building professionals were trained by this program. The project built over 600 energy efficient houses and three schools in 59 communities from 1998 to 2004. A local straw bale construction approach was developed based on locally available building materials, local construction skills and techniques, and local housing styles.

THERE ARE SEVERAL CHALLENGES FACED

1. Lack of Rural Acceptance of Straw-bale Housing Construction

Though straw bale house construction has over 100 years of history in North America, it is still a new technology to the Chinese people. China has a long history of using straw in construction, but building with straw has been considered a sign of poverty and backwardness in modern times. As the Chinese economy develops, it is every rural farmer's life long dream to live in a brick house. At first, there were strong objections to and many doubts about the idea of using straw in construction. After repeated education on the history of this technology and showing the photos of completed house, rural farmers remained skeptical. Their first doubt was the feasibility of using straw bale in construction and their second doubt was the durability of straw bale houses.

2. Cultural Preference of Brick Houses

China has a long history of using bricks in construction. Traditionally, the rich have always lived in brick houses. A brick house is a symbol of wealth and success. It is very difficult to change rural people's traditional preferences.

3. Low Level of Environmental Awareness Among the General Public

In China, the environmental awareness among the general public was and continues to be very low. It is even more so among the rural farmers. For rural people, "environmental protection" is just government propaganda that they hear from the media, but it does not have much to do with their lives. In this context, it was challenging to explain the positive environmental impact that this technology brings.

WE HAD THREE APPROACHES TO MEET THESE CHALLENGES

1. Financial Incentive to Meet the First Challenge – Acceptance

The first straw bale structure, a school, was built in Zhangbei, Hebei province as earthquake reconstruction in fall 1998. ADRA provided the technical and financial support for the construction. This was the first demonstration of this strawbale technology in all of China. In summer 1999, three residential houses were built with foreign financial and technical resources. The first two projects did not require a financial match from the local government or the beneficiaries. Since 1999, all subsequent structures required match funds from local government and from the new residents. In the beginning, as an incentive to take a risk, a large financial subsidy was given to the individual users so that their contribution to the houses was as low as 20% or less. This provided incentive for the new residents to "risk" living in a straw-bale house and thus provide an example. The project also targeted mainly poor farmers who had not saved enough money to build a new brick house. With the high financial subsidy and the tangible straw bale houses had been built in China, the first challenge was met, but not without difficulty. The subsidy was reduced dramatically in the following years as people realized the benefits of the houses and gained faith in this straw bale building technology.

2. Repeated Education to Meet the Second Challenge—Environmental Awareness

The environmentally friendly aspects of the straw bale structures were repeatedly

emphasized during technical trainings, users' education meetings, on-site informal conversation, and house-to-house visitation. Such education always emphasized the direct financial, health and community benefits that users can realize through the project, such as using a waste product to build with, lower heating expenses, the comfort that living in a warm house, the safety of the house during earthquake, and cleaner air for everyone. After continued education, some users were able to mention those environmental benefits. The level of environmental awareness has been increased, but remains low. Lower cost of construction and lower cost of annual heating for straw-bale houses remain incentives to construct, while health and community benefits are not a perceived incentive.

3. Adapt the Technology into the Existing Construction System -- Cultural Preference for Bricks

Though straw bale construction has three main structural types: loadbearing, non-loadbearing, and hybrid, after experimentation, the project chose a non-loadbearing structural system for demonstration in China. A system of brick columns and concrete beams support the room and straw bales are in-filled between the posts. Since the straw bales do not bear any loads and brick columns are well embraced by the rural people, users have confidence in the safety of their houses. At this time, bricks are the most cost-effective construction material that can be used as supporting posts and construction workers are very familiar with them. Wood, steel, and concrete would be much more expensive for a structural system and are not commonly used in constructing residential houses in rural areas.

WE ALSO OVERCOME PARTICULAR OBSTACLES

1. Size of the Window and Color-Tinted Glass

One of the obstacles encountered in the early stage of the program was the conflict between energy efficient (passive solar) design and cultural preference, such as the preference for large north-facing windows which allow more light to come in but result in heat loss, and also the popularity of using blue-tinted glass in south-faced windows which was considered to be fashionable but blocks solar gain. These issues were pointed out during the technical training sessions. Local designers were encouraged to design smaller north-facing windows and avoid blue glass. They were also asked to convince users to build smaller windows. These obstacles were overcome in the late stages of the project.

2. Inclusion of the Middle Class

The program was designed to benefit the poor, but if only houses for the poor were built, this might have labeled the houses "for the poor only" and stigmatized both the construction system itself and also the poor families living in them. By including the middle class, who have the discretionary income needed to furnish the houses, the project avoided stigmatization and the houses have become desirable.

THERE ARE A FEW CHALLENGES REMAIN

1. Lack of Rural Acceptance of the Straw Bale Housing Construction

Though demonstration has been made for a few years, given the sheer size of both the populace and country, for most of rural residents there is a lack of information about and personal experience with straw bale buildings.

2. Lack of an Established Chain of Manufacture and Supply for Straw Bales in Local Areas

There is no "industrialized" system for supplying straw bales in most areas. The market demand for SB housing has not grown big enough to stimulate a supply market.

3. Limited Availability of Cost Effective and Efficient Baling Machinery

The current local balers are not cost effective and are inefficient in operation.

4. Lack of Building Code for Public Facilities

At present there are no official standards and codes for building with straw bales in China.

5. Availability and Low Cost of Bricks in Rural Area

The government brick ban has not been implemented in rural areas. Bricks are still widely available and inexpensive.

6. Often the Funding Cycle Does Not Match the Building Construction Season

Many deadlines for funding are in May or June. Usually funds are available in July. The preparation for the construction needs to start in March so that construction can begin in May. Delays in funding often cause delays in completion of buildings and push construction into the winter season.

IT TAKES TIME FOR CHANGE

A technology transfer project like this one requires a long-term commitment that goes beyond two or three years. The project estimates that it will take at least ten years to fully transfer straw bale construction technologies to China.

1998-2000: Introduction of the new technology
Build local technical capacity
Develop culturally appropriate designs
Adapt the new technology into existing building systems

2001-2003: Large scale demonstration and dissemination of residential housing using straw bale building techniques
Improve the building technique (insulation, plaster formula, etc.)
Build a variety of residential housing prototypes

2004: Demonstration of public buildings such as schools
Provide advanced technical training for architects, engineers, academics, and government officials
Dissemination among the private building sector

2005-2006: Continued demonstration of public building
Local replication of residential house in a bi-lateral demonstration ecological project
Feasibility study and local demonstration initiated by the local academics
Formation of a local Chinese Straw Bale Building Association
Facilitation of SB Building Code development and implementation

2007 onward: Establishment of SB Building Code
Local replication of SB with local financial and technical resources
Local building professional's further study of SB technology in China's context.

FROM FRINGE TO MAINSTREAM

Sustainable Development - Energy Efficient Buildings at Every Level [4]

Current day China is much more sustainable than most of the world with an ecological footprint of only 1.5 ha/capita compared to 6.4 ha/capita in Canada and 9.5 ha/capita in the US[3], but China is also less developed industrially and economically. With over 1.3 billion people, the direction of China's development will have tremendous impacts for the global community. There is both great opportunity and great danger.

China's development will require tremendous amounts of energy. Currently, China's buildings are built with little thought toward their energy use, short term or long term, and the general public doesn't have much awareness about how their choices effect the greater environment, nor do they have an appreciation for the long-term importance of their choices given a context of rising energy prices.

China will have a great opportunity to focus its development efforts on strategies and technologies with long-term sustainability—taking a much less energy intensive development path than taken by Western Europe or the Americans.

The construction of energy efficient buildings and environmental awareness education, as demonstrated by the straw bale ecological housing program, can be two critical aspects of China's economic, social, and environmental development. Only choosing a sustainable development path, will next generation in China have a bright and sustainable future.

Reference:

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3. Living Planet Report, 2004, WWF International.
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