The Future of Buildings Energy Usage in Bolivia

By Christian Stalberg - July 10, 2013

Through the Partners of the Americas* program, I had the pleasure of spending almost three weeks traveling in Bolivia for purposes of sharing information about green building and energy efficiency. I taught seminars in Santa Cruz, Cochabamba and La Paz about the value of using whole building energy performance simulation software tools when designing energy efficient buildings. I observed that these cities each have different climates when considering building design. Santa Cruz being relatively hot and humid has different requirements for human comfort in buildings than does say La Paz. For example, Santa Cruz, while it does not require heating, can benefit from cooling and humidity control. By contrast, providing human comfort in buildings in La Paz will require heating. Cochabamba, on the other hand, has a most moderate climate rarely requiring either heating or cooling. All three climates have the benefit of an abundance of solar energy which can be used for daylighting as well as solar thermal and electric generation purposes.

Space Conditioning

During my travels throughout Bolivia I noticed that providing mechanically conditioned air inside homes and smaller commercial buildings for most people is a relatively new concept. For example, in some of the lecture halls where I taught, they would bring in a portable propane powered radiating heater for heating. The idea of central air conditioning, heating and ventilation – which is so common in the United States for example – appears to be a relatively new concept in Bolivia. This is an opportunity that I would suggest could and should be missed however, certainly in some parts of Bolivia. Central air, heating and ventilation requires mechanical systems which require energy, i.e. electricity to drive fans. Then there is the energy consumed to generate either the heat or cooling itself to then be circulated by the fans. An alternative to these mechanical systems are passive design techniques. I will talk about that in a moment.

Windows

I also observed that newer buildings in Bolivia make extensive use of windows. While this provides aesthetically pleasing views and vistas for the building inhabitants, it can present many problems in terms of human comfort. In spaces that make extensive use of windows conditions of overheating is quite common, even to the point of having to introduce window air conditioning units. Conversely, temperatures at night and in the early morning for these same spaces can be quite cold, again requiring the introduction of mechanical heating.

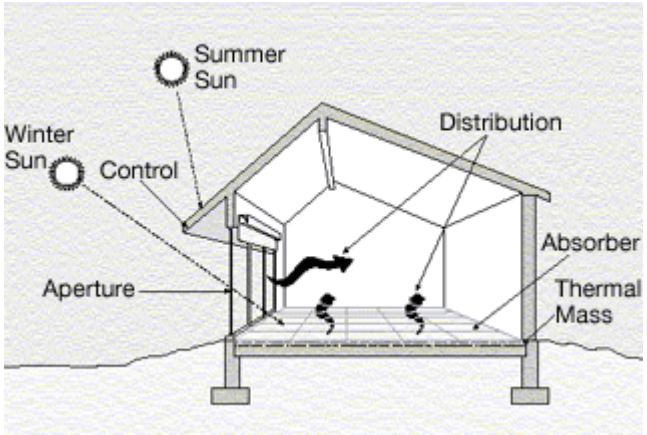
Most windows in use in Bolivia are single pane and many of these are tinted, especially among houses. Apparently double pane thermal windows are relatively new to Bolivia. Window science has advanced greatly in the last decade such that now you can now select windows to perform more specifically for the conditions of your building. Double and even triple pane glass windows are now available with a variety of gasses between the panes. You can now specify windows according to the amount of energy you wish to block outside or retain inside, control glare, and other characteristics. Window films are also available for existing windows to introduce some of these properties.

Lighting

I was surprised at how many buildings did not make use of natural lighting in Bolivia, designers preferring instead to use electric lighting. Lighting in commercial buildings constitutes approximately one-third of the total electric load on average. In climates like Santa Cruz, the heat from these lights contribute to human discomfort and increase the cooling load on the building. Given the abundance of direct sunlight and diffuse skylight available in Bolivia, this is largely unnecessary. Using daylighting strategies, much of the lighting levels necessary for many everyday tasks can be provided freely.

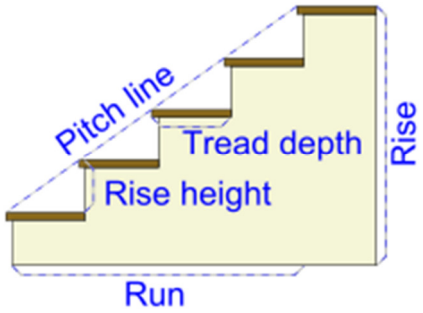
Passive Design

The idea behind passive design is to create an environment inside the building which takes advantage of microclimate conditions of the building site such that human comfort is provided while requiring few to no mechanical inputs, i.e. heating, cooling, lighting or ventilation. We know that temperature swings inside the building interior can be moderated through the use of thermal mass materials such as concretes, ceramics, adobe and water. Using passive solar design techniques we can shape and orient the building envelope to maximize its capture of solar radiation. The captured solar radiation can then be stored during the day and then released at night to maintain comfortable temperatures. Using building site microclimate data for wind direction and speed, we can place openings in the building to capture and circulate cooling breezes through the building interior to naturally ventilate the building. Using interior and exterior shading devices we can block solar gains in the summer cooling season while allowing full capture of this free source of heat in the winter.



Building Code

When teaching about energy efficient buildings I am always comparing buildings. More specifically, I am comparing buildings that perform above the minimum standards for energy efficiency prescribed by the building code. A building code is a set of standards established and enforced by local government that requires that new and renovated buildings meet minimum standards for health, safety and energy efficiency. The United States and many other countries have building codes. I learned that Bolivia does not have a building code. Given the absence of a building code, the energy efficiency of buildings in Bolivia cannot be compared with one another as there are too many variables to allow for a fair and equitable comparison. In the area of safety one experience I encountered frequently was the variability in stair design and construction, where the rise and run varied widely from building to building, sometimes even from floor to floor within the same building. Poorly designed stairs are a source of accidents. This problem could be addressed via the existence and enforcement of a building code.



There are other reasons why having a building code is important. Powering buildings in the USA account for 72% of electricity use and 36% of natural gas use. Without a building code providing an average energy usage profile it is impossible for the government and private sector to forecast and plan for energy supplies into the future.

Education

During my trip I gave seminars at three universities: Universidad de Aquino Bolivia in Santa Cruz; Universidad Mayor de San Simon in Cochabamba; and, Universidad Mayor de San Andrés in La Paz. My seminars were about energy modeling of buildings and touched on principles of passive design including solar design, natural ventilation, energy storage and daylighting. I learned that these principles are relatively new to architecture students in Bolivia. During my lectures I always point out how important energy efficient buildings are to mitigating climate change. In some parts of the world, 50% of electricity generation from coal fired power plants is used to power buildings. Coal fired power plants constitute the single largest contributor to climate change. Energy efficient buildings can save money for building owners and managers, provide greater comfort to the building occupants, and fight climate change. Strategies for designing and constructing energy efficient buildings – whether residential, commercial or industrial – should become a routine part of the curriculum for architecture and building mechanical engineering students.

Epilogue

I found the interest in energy efficient buildings to very high among the students in encountered in Bolivia. My observation is that they are eager to learn more about techniques and strategies for incorporating energy

efficiency into the design of buildings. My hope is that their desire will translate into changes in the curriculum of the schools they attend, as well as in the design studios of architects and building mechanical engineers in Bolivia where they will eventually work. Bolivia has a great opportunity to improve its building stock by considering the adoption and enforcement of a building code to include the element of energy efficiency. The result can be greater safety and comfort for building occupants, and reduced energy costs both in terms of dollars and cents as well as the mitigation of climate change. Viva Bolivia!

* Partners of the Americas is an international network that promotes social and economic development in the Americas through leadership, voluntary service, and development programs. Its mission is to connect individuals, volunteers, institutions, businesses, and communities to serve and to change lives through lasting partnerships. Partners envisions an interconnected hemisphere that maximizes the social and economic potential, and leverages the full diversity, of the Americas.