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Sustainable Design in South Korea and Vietnam: Referencing Culture Through Modern Architecture

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Abstract

In an age when high-rise design is driven by grandeur aspirations of tallest and biggest, two high-rise towers in South Korea and Vietnam provide examples of innovative sustainable design that address each country's respective unique cultural vernacular through the lens of modern architecture.

The strategies addressed here examine how cultural context can become the basis for sustainable design, providing synergies and authenticity to contemporary architecture in emerging economies. Each design embraces concepts for natural and cross ventilation, high-performance building envelopes as well as geothermal technology, water conservation and waste water management.

The tower designs combine art, sculpture and architecture into one form balancing ecological, economic and cultural motivators that advance sustainable design, specific to the markets of emerging countries. The architectural heritage of a culture in concert with modern design can bring new meaning to the term of sustainability.

Keywords: Sustainable Design, Cultural Context, South Korea, Vietnam, Mixed-Use Towers

Cultural Context and Challenges: Vietnam and South Korea

As of this writing, South Korea is eleven times and Vietnam is more than five times the global average in population density. According to the United Nations Population Fund, by 2008, half of the world population will live in cities and by 2030, the developing world will be home to 80 percent of the world's urban population.

Figure 1: The Landmark – Hanoi, Vietnam
Concept design. Tower view looking northwest.

Figure 2: GS Square at Anyang – Anyang, South Korea.
Concept Design. Tower view looking west.

This reality makes it imperative to identify local, culture-specific solutions that minimize dependency on natural resources and respond to the pressures of population growth, mass migration to cities, increased wealth and income disparities and the associated increased energy demand.

Traditional Korean and Vietnamese lifestyles and dwellings have evolved over many centuries, allowing societies to adapt to seasonal and climatic changes within each country. For example, vernacular Korean interiors are characterized by naturally heated or ventilated interior and semi-exterior spaces. And in a similar strategy to the temperature controlled and ventilated spaces of Korean architecture, traditional Vietnamese architecture is defined by the layering of spatial boundaries to achieve maximum comfort during most parts of the day and the year.

However, these traditional methods, which stem from a reaction to the constraints of the natural environment, have been all but abandoned due to the proliferation of technical developments, made possible and accelerated by the availability of cheap fossil fuels as a universal source of energy supply. Architecture and urban design can offer solutions to mitigate this dependency, as communities in culturally and climatically diverse regions seek to realize design strategies that respond to the environment.

Motivators in Industrialized Nations and Developing Countries: Status vs. Survival

The energy consumption of a nation is correlated with per-capita income and buying power. However, with Europe and Japan leading the way, changes in legislation and incentive programs have been established to reduce energy consumption. In addition to legislation, the symbolism, social status and the personal convenience and health benefits that come with environmentally-friendly design are driving this change in the developed world.

However, in developing countries, the human motivation, market characteristics and societal behavior toward sustainable design are different. The compound impact of third party endorsements, legislative mandates and incentives common in developed countries are virtually nonexistent. The motivations for individual investors and developers to pursue sustainable design objectives are more directly linked to immediate performance benefits such as the elimination of brownouts through an independent energy supply. Going forward, incentive programs with increased emphasis on renewable energies, water supply and clean air are needed to raise the demand for modern sustainable design technologies that relate to the cultural and geographic origin of a place.

Consequently, design strategies that address energy reduction, water conservation and pollution control at corporate, private and public levels are paramount in developing countries. Solutions are needed that respond to the local climate, cultural traditions, and social, environmental and economic relevance and viability.

A Tale of Two Towers – High Rise Sustainable Design in South Korea and Vietnam

GS SQUARE AT ANYANG – Anyang, South Korea

At 79 stories and 294 meters high, GS Square at Anyang will be South Korea's first sustainable mixed-use high-rise development. The project is comprised of 230 residential units and 66,000 square meters of retail amenities.

Located 30 minutes just south of Seoul, the tower features a unique natural ventilation concept of internal stack systems, multiple sky gardens, rainwater harvesting and ground-source heat pump technology, in addition to a naturally ventilated retail atrium with full access to daylight and views of a pedestrian plaza.

Consistent with the traditional Korean vernacular, the design responds to the local cultural values that form the basis for a modern transformation through a sustainable design solution.

Natural Ventilation

A key component of the project's sustainable design strategy is its approach toward natural ventilation and energy conservation. The tower's natural ventilation strategy is based upon a system of internal thermal stacks that are negatively pressurized with strategic placement of inlets and outlets and coordinated site wind patterns. (See figure 4)

Figure 3: Tower view looking northeast

Skygardens at every seventh floor clearly distinguish this tower as a breathing element, communicating environmental connection, performance and health. The tower sets a new benchmark for green development in the rapidly expanding area of greater Seoul.

Figure 4: Site plan diagram with prevailing wind directions

The residential tower is naturally ventilated. Its site orientation and the location of air terminals respond to the prevailing wind directions during hot summer months. Southern and southwestern winds are captured at the southwest elevation from June through August; northern and eastern winds are captured at the northeast elevation in August and September.

Thermodynamic principles allow for cross ventilation in all residential units, drawing air from inlets at the exterior wall at natural positive pressurization points. Air, together with heat, moisture and odors from kitchens and bathrooms is drawn to internal stacks, by virtue of pressure differentials.

This system is a low-cost, high-performing component that directly references the "ondol", a traditional Korean natural forced air and heating system.

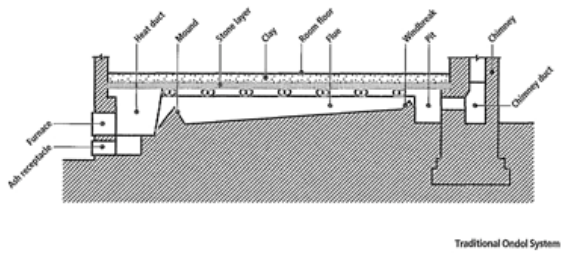

Figure 5 : Cross-section of the traditional Korean ondol system

Airflow guided heating and cooling systems are an integral part of Korean culture and architecture. The ondol is a traditional Korean under floor heating system for indoor climate control similar in principle to a Roman hypocaust. Air is drawn from the outside, heated by a stove and ducted through horizontal passage ways below the floor to a negative pressurized stack.

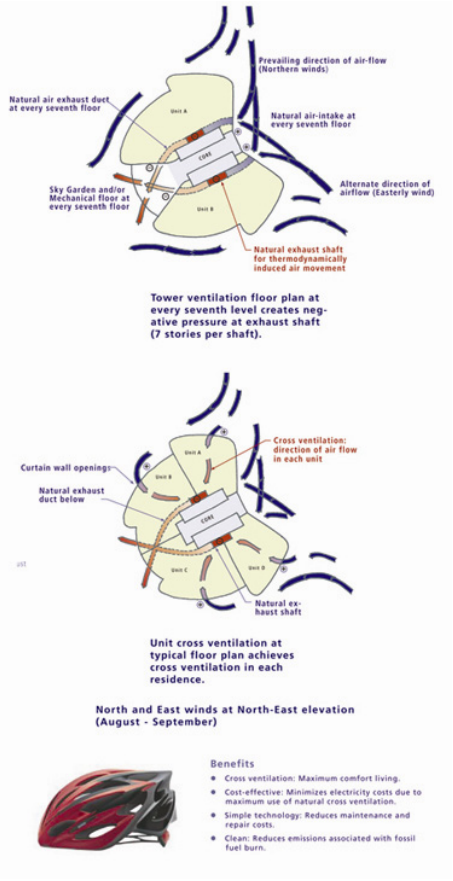

Figure 6: Airflow plan diagrams

Upper plan diagram, Step 1: Internal shafts (colored in red) are located between residential units and core walls where wind pressure differentials (see Figure 7), cause negative pressurization, pulling air from the positively pressurized units.

Lower plan diagram, Step 2: Air enters the exterior enclosure of each residential unit and is drawn to negative pressurized internal shafts, providing for cross ventilation in each unit.

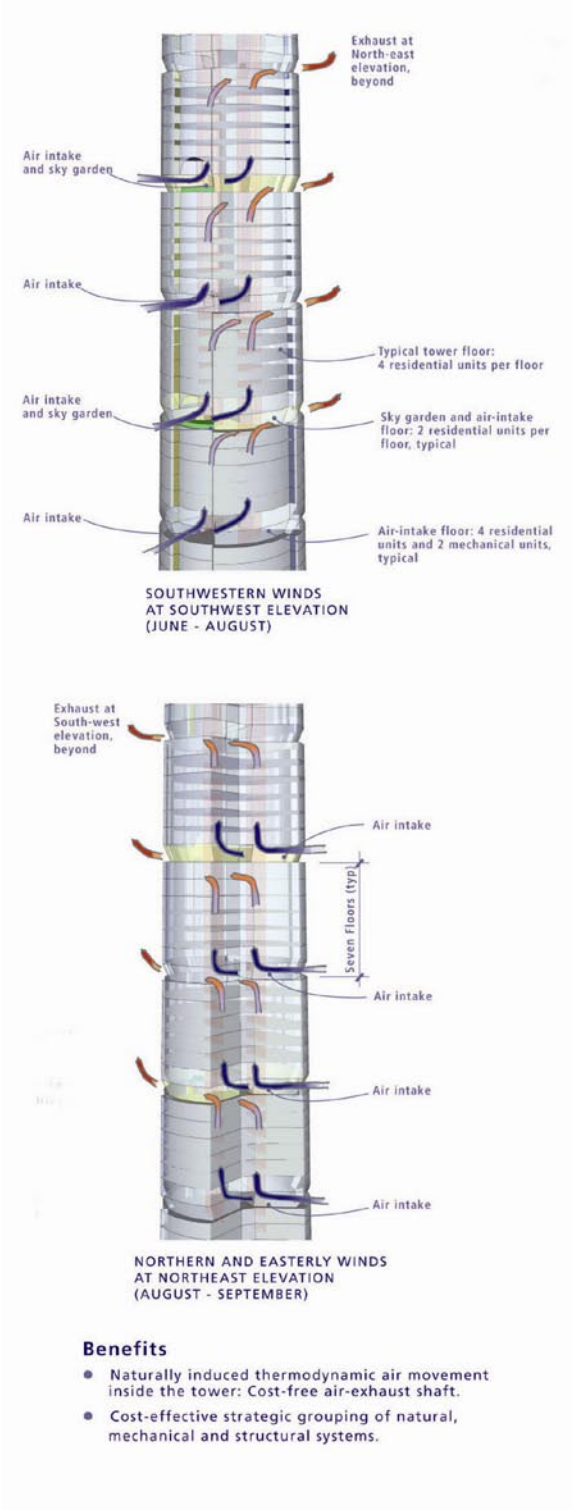

Figure 7: Air movement induced by internal thermodynamics and wind pressure differentials

Air is drawn from strategically-placed intake terminals and flows

through an internal stack shaft system of seven stories, creating negative pressure before being released at the respective opposite side of the building. Airspeeds within the shafts are further facilitated by outside wind pressure differentials.

Skygardens

The significance of the Korean garden space as a delineated, transitional and semi-private space is reinterpreted as vertical skygardens for all residential units. The contemporary skygardens in the tower are a key component of the natural cross ventilation concept derived from traditional Korean maru floor areas.

To address humidity and heat during the summer, the maru floor served as a veranda that separated the floor from the ground and provided ventilation to internal spaces. Maru floors also served as a place to hold big family events, and consistent with this function, skygardens serve as an extended living room and socializing area.

Figure 8: Mandaeru Pavilion – Gyeongsang-do Province, S. Korea

Maru floors are similar to a veranda and originated in the warm and humid regions of South Korea. Integral to a building's natural cooling system, air enters under the floor and is ducted to the interior, where it supplies the spaces with cool air. The Maru's above-ground elevation provides comfortable sun-protected exterior spaces through ventilation and humidity control.

Figure 9: Skygarden close-up view

Skygardens are combined with outside air intakes and are a key component of the natural cross ventilation concept for all residential units (see Figure 7). The gardens can be reserved by tower tenants for private use and represent an iconic marketing opportunity as a symbol of health and well being.

Building Envelope

Korean wall openings traditionally have two layers of sliding or pivoted elements, and occasionally a third set of framed mosquito nets. The ventilated wall cavity is often used as a utilitarian space for food storage or clothes drying.

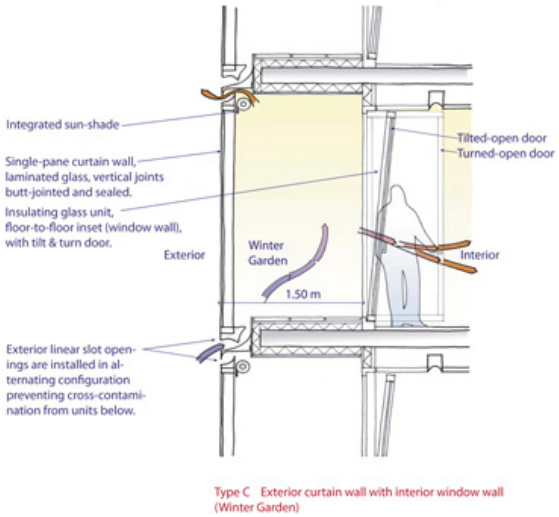

Figure 10: Winter garden, section diagram

Winter gardens in kitchens and dining rooms are unheated climate buffers and provide temperature and ventilation control for internal spaces. These spaces are cross-ventilated, creating comfortable ambient temperatures in mild seasons. During the hot summer months winter gardens perform as a heat shield.

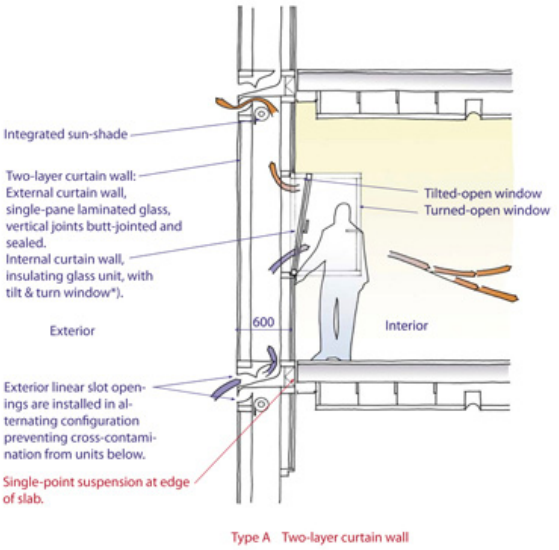

Figure 11: Two-layer wall, section diagram

East and west facing bedrooms and living rooms feature floor-to-floor, two-layer curtain walls. Two-layer walls provide comfortable air supply without wind gusts, prevention of wind-driven rain, and noise insulation, in addition to solar, temperature, and condensation control.

Responding to contemporary needs, the exterior walls of bedrooms and living rooms subject to direct sun light exposure act as climate buffer zones to control temperature and ventilation in the form of two-layer walls.

Similarly, the utilitarian interstitial space between the kitchen or dining room and the exterior wall is reinterpreted through the form of modern winter gardens and two-layer facades used as climate buffer zones to control temperature and ventilation.

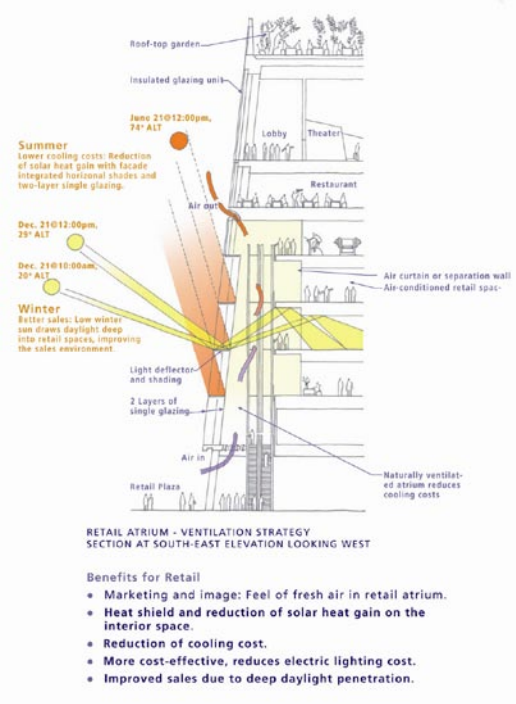

Figure 12: Anyang retail atrium, diagrammatic section at south-east elevation

In the retail atrium, natural ventilation is induced by thermal stack effect, providing a feel of fresh air. A multi-story, two-layer façade with integrated shading shelves serves as heat shield and light deflector, reducing solar heat gain in the atrium. Reduced cooling and electrical lighting needs and deep daylight infiltration contribute toward high energy savings and sales performance.

Additional sustainable design elements include:

- The use of geothermal heat pumps to eliminate the need for cooling towers and to supply electricity free of carbon impact at a reduced cost.
- Rainwater harvesting for site landscape irrigation and as onsite greywater use.
- Reduced steel use due to built-up steel milling processes.
- Convenient public transportation service via integrated metro-station, located in the basement of the retail podium.
- Strong correlation of environmental design aspects of the development with the city-owned eco-park, adjacent to the site.
- Retail atrium with access to natural ventilation, daylight and views.

Contextual Implications

The project is ideally located on an urban high density site that shares access to an eco-park, public transportation, entertainment, hotel, commercial offices and retail, while providing an environment that pursues the highest aspirations of sustainable design and living.

Respecting the shared historical and cultural continuum of ancient Korean values and principles, while at the same time striving toward a modern high-tech civilization, the tower's modern and sustainable design serves as a vitally important symbol in a country fractured by political conflict and socio-economic disparity.

Figure 13: Retail podium with hotel and Eco-park at southwest corner

The integration of the residential tower with an Eco-Park partially owned by the city, public underground transportation, hotel, entertainment, offices and retail amenities all contribute to the contextual richness of this project.

THE LANDMARK – Hanoi, Vietnam

Centrally located in the capital's Ba Dinh district, the 65-story, 257-meter high Landmark is west of the main train station and one city block away from a future elevated light rail station. In an effort to attract international business to the country's growing economy, this high-rise emphasizes progressive sustainable design solutions and the modern conveniences of a mixed-use building consisting of residential units, offices and commercial retail. The tower's design maximizes energy efficiency principles in response to the city's intense year-round climate. Six-story tall stacked skygardens offer an urban respite with expansive views of the capital and the river Hong Ha. The project is currently under construction and is expected to be complete in 2010.

Figure 14: Schematic Design: Evening view looking west

A central spine of multiple-story, full-depth sky gardens is illuminated over the entire height of the tower, creating a strong sculptural presence. Residential units occupy the upper part and commercial offices the lower part of the tower. A retail podium engages the tower at the base.

A Sculpture of Intrinsic Vietnamese Culture

The Landmark's sleek and tapered design is a reference to a traditional garment, the Ao Dai, a design unique to Vietnam. Its form is defined by bold vertical lines fl owing upwards, reaching out toward the sky as a representation of Vietnam's growing influence in Asia. The tower is a reminder that indigenous design, cultural achievements and intellectual heritage can evolve and emerge as a new form. The threads binding a civilized society can be sustained through reinterpretation into urban, modern attire.

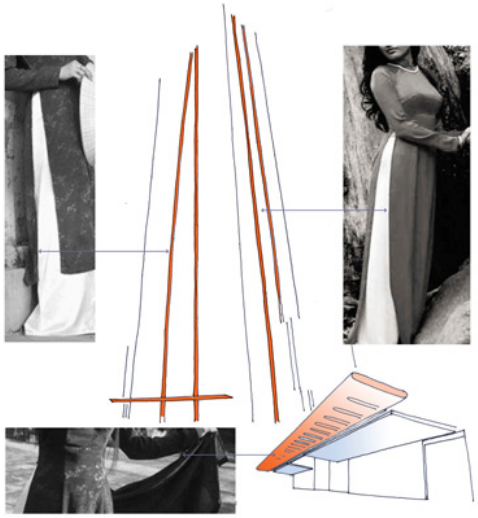

Figure 15: Form and enclosure, borrowed from a traditional Vietnamese dress

A strong reference for the building's design comes from an apparel design and symbol unique to Vietnam, the Ao Dai dress. The tower's sculptural form is defined by bold vertical lines fl owing upwards, narrowing and reaching out towards the sky.

Skygardens

The garden is an integral Vietnamese design element as a reference to nature and has a profound place in the experience of architecture. Internal spaces, gardens, scenery and plants, clouds and water co-exist in a harmonious way.

Emphasizing this cultural motif, the Landmark's key design element is a central, transparent stack of sky gardens, free of columns or service cores, symbolizing civic openness and transparency. In the context of Vietnam's war torn history, this central stack of skygardens symbolizes the healing and unification of modern day Vietnam.

Serving as an iconic focal point of the building, the tower's green spine acts as a link between the past, present and future; connecting ideals and aspirations and mending disparities of thought and interest. Skygardens are open to the outside at low and high points of the atria on either side of the tower, allowing for cross ventilation.

The transparent skygarden atria serve to symbolize the importance of supporting the sustainability of both people and place and creating an integral community and modern day expression of strategic optimism.

Figure 16: Interior windows at the Dien Tho residence

Hue, Vietnam

Referencing nature with framed views and intentional visual connections to elements of the natural environment are intrinsic Vietnamese values and part of the architectural vernacular.

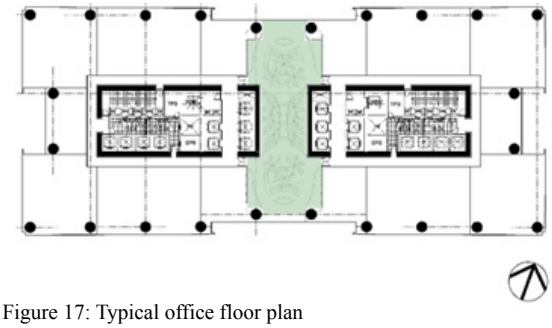

Figure 17: Typical office floor plan

The program requirement for large floor plates results in two tower components with independent service cores, separated by skygarden atria in the center of the tower.

Figure 18: Skygarden design at offices

Skygarden atria are four story (office floors) and six story (residential floors) unheated and cross ventilated spaces. They serve as shared communal living rooms for meetings or private functions. Spaces can be reserved electronically.

Natural Ventilation

Thirty-five floors of residential units occupy the upper part of the tower and share direct access to outside air via manually-controlled linear slots at the sill line of each curtain wall unit. Units adjacent to skygardens have access to cross ventilation from a positive pressure point at the unit's exterior to a negative pressure point created by the thermal uplift inside the skygardens at the unit's enclosure facing the atrium. Exterior corner units are cross ventilated via opposing pressure differentials at exterior walls.

Similarly, the ventilation strategy for the six-story retail atrium, topped by a large skylight, takes advantage of warm air buoyancy.

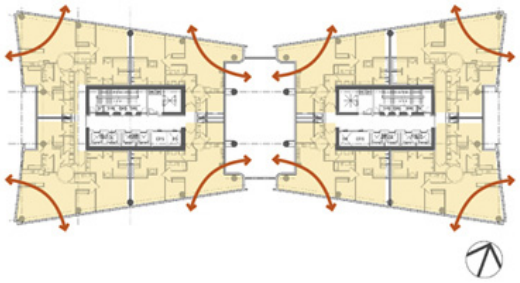

Figure 19: Typical residential floor plan

The tower's two core components provide two sets of four residential units, or eight units per floor. Each unit occupies a building corner, with internal units facing the sky garden atrium. All units have access to outside air via a ventilation device that is integral to the curtain-wall. Consequently, all units are cross-ventilated due to their corner unit configuration.

Retail Atrium and Main Entrance Lobby

The traditional Vietnamese market follows the archetype of south-east Asian markets with high roofs and cathedral ceilings to provide thermal stack and cross ventilation, and mitigate smells and minimize heat built-up. Hot air escapes by rising to the top of these atria and is vented to the exterior.

The design of the tower's six-story retail podium and main entrance lobby reflect these advantages. The atrium and lobby allow for deep daylight infiltration, thermodynamically directed air movement and exhaust at the top, creating pleasant, high-performing public interior spaces.

Figure 20: Retail atrium, view looking east

The six-story retail atrium consists of retail amenities in the lower portion and office spaces at the upper levels. The atrium is filled with natural light, providing for deep daylight infiltration, consistent with Vietnamese markets.

Figure 21: Ben Thanh Market in Ho Chi Minh City, Vietnam
Tall, vented ceilings of traditional southeast Asian markets provide for stack ventilation, releasing heat and odor at the top and drawing fresh air from lower levels.

Figure 22: Entrance lobby at corporate offices, west view
The tower's main office entrance is filled with daylight, facilitated by high ceilings. A hydronic floor reduces cooling loads by virtue of radiation and cools the occupied zone, allowing warm air to rise to the unoccupied upper portion of the space.

Rainwater Harvesting, Waste Water and Solid Waste Treatment

The current technical challenges and cost associated with water supply and sewage are critical and are projected to increase significantly in the future. Currently, there is no sewer connection for this project, and all sewage will be treated to the greatest extent onsite. Extensive rainwater harvesting for landscape irrigation and grey water use within the development together with water efficient appliances will significantly reduce potable water needs. Membrane bioreactors are being considered for onsite waste water treatment. Sludge will be periodically collected in the basement and shipped to off-site fertilizer processing.

Conclusion

As outlined in this paper, culture and architectural vernacular has much to offer the modern world. Sustainable design is not only a way of viewing and valuing good design, but a way to link the past with the present to protect our natural world and ecosystems. Architectural design has always served as both a structural space and as a witness to the culture and technology of its time. Lessons from our predecessors on how to keep warm and cool, maintain clean water and soil and negotiate space remain valuable resources. The practice of cross-cultural architecture offers great responsibilities and opportunities to promote public interest through sustainability by drawing from the past to build tomorrow's future.

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