DOWNLOAD PDF CLIMATE RESPONSIVE BUILDING

Chapter 1 : Climate Responsive Design | Architectus

However, with climate responsive design, reducing the amount of energy used to cool and heat the building can result in using natural systems, meaning the sun and the wind. With these, if building occupants are open to adding or removing layers during the seasons, it's amazing how much energy can be saved.

A modern regional architecture has evolved since the s where the building form and fabric embrace a climate responsive approach to design. This is becoming an increasingly important part of a creating ecologically sustainable buildings and development. A core philosophy is to harmonise the building form and fabric with the site and climate thereby reducing ecological impacts and achieving energy efficiency whilst providing human health and comfort and creating opportunities for social interaction and a productive learning environment. The University of the Sunshine Coast in Queensland, Australia, has embraced an ecological vision from its inception. From the first steps of its master planning through to its newest building, the Chancellery, the University demonstrates an evolution of innovation that embodies the principles of climate responsive ecological design. Second, it presents the climatic data that forms the basis of the passive design strategies. The third section discusses the innovative design strategies and attributes of the Chancellery followed by outcomes from initial research on how these strategies have enabled it to meets its environmental objectives. The paper is intended to provide building design professionals and contractors with a new model for university buildings and campuses and to provide a case study for climate responsive design in warm temperate climates. Chancellery, Student Services, academic offices, classrooms, lecture theatre, cafe Climate type: Warm temperate Climate control: Mixed mode, displacement, air-conditioned and natural ventilation Floor space: Fully enclosed area -3, m2, roofed semi-enclosed floor area - m2, total area - 4, m2 Number of floors: University of the Sunshine Coast Building population: Lincolne Scott Structural Engineers: A variety of guidelines for sensitive climatic building design were developed including the use of shaded space and sun control, passive cooling through cross ventilation and the use of lightweight exterior construction of low thermal capacity to avoid the accumulation and re-radiation of heat. An ability to create a sense of place and an identity for the new campus within the early phases of development, A capacity to order long-term growth and change within a comprehensive but flexible plan, The use of land in a conservative manner, and The support of passive environmental design principles for all campus buildings Initial buildings such as the Administration Building were constructed of double skin masonry and naturally ventilated whilst minimising active systems of climate control. In some case buildings such as the University Library were air conditioned in response to the functional requirements for full climate control. It is important to recognise that this approach to the building designs was supported by the conceptual point of departure for the campus, namely the Jeffersonian planning concept. Colonnades form the perimeter of the green space providing sheltered circulation MGT Architects University of Virginia, creating an "academical village" comprising visual, social, environmental qualities Collins The Jeffersonian concept is based upon the following principles: Social issues are demonstrated in the creating of a sense of place. The concept is particularly grounded in the climatic context of the location, which support and facilitate many of its principles. Winters feature warm sunny days with night temperatures below the comfort zone, whilst summer conditions are more subtropical with humid conditions, overcast skies and some monsoon rains. Rainfall events occur mainly in the summer period with a dryer winter. A key factor of the Queensland climate is high level of irradiation particularly in November and December when clear sky conditions can prevail. This combination of high temperatures and humidity highlight the importance of air movement in achieving levels of comfort. The coastal location and topography around the University create a mesoclimate of sea breezes from the north east and south east, providing airflow through the site as shown in Figure 4. The sea breezes assist in moderating the high summer temperatures. In winter the southeast trade winds can create exposed conditions to the southeast quadrant of the site. Airflow across the site Hyde Climate Responsive Strategies The principle climate responsive strategies found in Queensland to extend comfort zones using passive building features are: These strategies are often combined to create passive building systems, such as linking high thermal capacity materials thermal mass for heat sink effects, with passive solar for winter heating and with cross ventilation at night for summer cooling. The site planning principles that form the basis of the Master Plan and Chancellery designs are to orientate the buildings to minimise solar gain, reduce density and modify the building massing to increase airflow though the site. Relatively high wind speeds are needed to achieve cross ventilation with rates of 1 m per second to achieve indoor comfort conditions. High humidity is a key climatic constraint of this site due to its coastal location and topography. The master planning principles for the University have set up what appears to be a standardised visual and organisational hierarchy. However the climate determinants across the site present very different conditions creating unusual opportunities for environmental design. Site micro-climate can be modified through site planning leading to improved thermal comfort of outdoor spaces, increased capacity for ventilation and sun control in buildings and reduced cooling loads Brooks Therefore site planning and the organisation of interior spaces can directly impact indoor environment quality and resulting occupant health, comfort and productivity. The siting and thermal comfort of outdoor spaces will also contribute to levels of social interaction and opportunities for outdoor teaching and informal learning. Hyde provides climate matching strategies for buildings such as plan orientation, permeable wall and roof designs, thermal mass to floors and the use of shade verandahs and courtyards Hyde Research shows that plan dimensions beyond 15m reduce the effectiveness of natural ventilation strategies and lead to greater use of mechanical ventilation and cooling. The Chancellery is planned as a series of climate responsive zones Hyde from the external spaces to the buffer zone formed by the sunshading, louvres and shade verandah, to the passive zones able to be modified by light and ventilation without the use of air conditioning, to the active zones less influenced by the environmental affects of the external wall and windows and typically requiring air conditoning. Ground Floor Plan Figure 6: Level 1 Floor Plan The Chancellery consists of four buildings as identified in Figure 5, separated by external breezeways beneath a mono-pitch roof. The overall external plan dimensions are 75m east to west and 34m north to south. Buildings 1 and 2 are between 7m and 8m deep and consist of staff offices and tutorial room areas organised as cellular perimeter spaces. Windows are oriented towards the north east providing optimum daylighting, solar access and summer solar control due to the high altitude of the sun in summer. The cellular organisation of space provides small populations and therefore a high degree of occupant control well suited to manually controlled mixed mode ventilation AE e. The long and thin plan shape encourages cross ventilation through rooms which can be enhanced by opening doors to the external breezeways whilst also contributing to a more sociable learning environment. Building 3 is 18m deep north to south and is occupied by Student Services at ground level and the Chancellery at level 1. Ceilings heights vary between mm and mm in height throughout, extending the effect of natural light and ventilation deep into the room. Building 4 contains a lecture theatre to the ground level and an outoor terrace to level 1 available to all students and staff across the campus. Breezeways and stairs are treated as external naturally ventilated spaces. This provides comfortable thermal conditions deep inside the plan and reduces the effective depth of each of the four buildings to achieve more effective cross ventilation and daylighting. Cross section looking east The section of the building is open to promote ventilation cooling and the shedding of heat by stack effect. Connected vertical and horizontal voids and high ceilings and soffits minimise the effects of temperature gradients in the same way employed by Clare Design in the Buderim House Hyde Cross section of breezeway A central outdoor space serves as a shaded meeting place and also acts as a semi-enclosed courtyard that introduces light and ventilation into the building. The space is oriented towards the south west avoiding direct sunlight penetration for most of the year and is cooled by breezeway openings that channel air through the space. A concrete floor is shaded and provides thermal cooling to the space during the day, whilst the double height volume separates warmed air from the occupants. Responding to this goal, a variety of natural ventilation strategies have been implemented in early buildings including the Faculty of Arts that experimented with natural ventilation techniques such as landscaped courtyards, wind scoops and breezeway openings that together with varied air pressures and the stack effect achieve an air funnel effect to the courtyard. Other buildings such as the University Library utilise air conditioning to ensure a stable environment for the book collection and constant thermal comfort in a deep plan building. Natural ventilation can significantly reduce energy usage and green house gas emissions whilst reducing maintenance and operation costs. In the context of educational buildings higher levels of fresh air and air change effectiveness can improve indoor air quality and lead to improved learning outcomes CHPS Fisher points to overwhelming evidence of the relationship between thermal comfort and academic achievement Department of Education, Training and Youth Affairs and Coward demonstrates the benefits of indoor air quality to environmental, social and economic outcomes in adult education buildings, in his review of the literature Coward. The Chancellery is provided with a zoned system where each building incorporates a different conditioning strategy that responds to how each space is used and provides energy efficiency and indoor environmental quality benefits. These strategies provide varying levels of natural ventilation whilst promoting a high indoor air quality for the whole faculty with fresh air quantities exceeding the Australian Standard Mixed mode systems Mixed-mode ventilation systems provide a hybrid approach to ventilation and cooling that provides outside air into a building by both passive and mechanical means to achieve cooling and heating. Natural ventilation is provided from operable windows, louvres or dampers either automatically or manually operated and mechanical ventilation and cooling is provided from systems that include an air distribution system and refrigeration equipment. Typically natural ventilation is used when the weather conditons are suitable and air conditioning is used when the weather conditions are too hot or too cold to rely on natural ventilation. A manually operated system allows occupants to decide when they prefer to use natural ventilation by simply opening the window. Simple controls such as reed switches can ensure that air conditioning systems are deactivated when windows are open. An automatically controlled system is more sophisticated with communication between a weather station, the natural ventilation openings and the air conditioning system. Such a system will be pre-programmed to automatically close windows and switch to air conditioning mode when temperatures are too hot or too cold for natural ventilation. They will also automatically switch to air conditioning mode at the onset of rain or excessive wind AE d. Design investigations of thermal comfort were completed during the design development phase of the Chancellery to determine which passive design and natural ventilation strategies achieved the least number of hours of discomfort each year and thus reduced annual hours where air conditioning would be needed. It was determined that the use of 24 hour ventilation through night purging, combined with the use of exposed thermal mass, cross ventilation for teaching rooms and ventilating skylights and clerestories in public areas, would achieve the best thermal comfort conditions AE e. A combination of simple horizontal and vertical solar shading, internal blinds, thermal mass and night time purging maximise the period of the year during which natural ventilation can provide adequate cooling and thereby minimise the use of air conditioning. A site wide building management system BMS links to a local BMS panel within the building to control local air conditioning and ventilation plant such as the displacement system, toilet exhaust and fan coil units to achieve energy and operational efficiency. Offices and tutorial rooms are designed to operate with a mixed-mode changeover capability. Each room is provided with natural cross ventilation by means of operable sliding windows to the outer wall and an exhaust damper located at high level to the wall adjacent to the breezeway. Sun hoods are designed to provide weather protection so that windows can remain open during summer rain. If desired by the occupants doors can be left open when rooms are in natural ventilation mode. Individual fan coil units provide heating and cooling from locations above doorways. Fresh air intake is provided from the naturally ventilated breezeways immediately adjacent to the fan coil units by means of high-level anodised aluminium grilles. A reed switch disables the air conditioning, and opens the high level damper. The air conditioning cannot be switched back on whilst the window remains open. If the occupant wishes to change to air-conditioned mode they must close the window and switch the system on by means of controls provided to each room. The reed switch will then close the damper above the door to improve efficiency of cooling in the room Figure Building management personnel are responsible for leaving windows open to allow night time purging during warmer months to remove heat which is built up during the day. The air conditioning system is controlled by the site wide BMS operating during standard business hours and fan coil units can also be shut down via occupant timer controls when rooms are unoccupied. The displacement system used in the lecture theatre space has an economy cycle for energy saving. Air conditioned systems with mixed mode option The deeper plan spaces of the Chancellery and Student Services support higher levels of privacy and separation and are provided with air conditioning to provide maximum thermal comfort and control of indoor conditions, while maintaining a reduced level of mixed mode changeover capability. Fan coil units provide the flexibility for units to be switched off when certain offices are not in use or when weather conditions permit, providing significant energy conservation benefits. Units are located above offices and service areas and screened by Hi-Light proprietary horizontal anodised aluminium louvers. Offices are provided with individual thermostats and controls. Ventilating skylights above the chancellery central function space exhaust relief air from the air conditioning system and provide night purge ventilation. Offices are provided with natural cross ventilation and a level of individual control and flexibility by means of openable windows. Reed switches disable the air conditioning when a window is opened. Displacement Supply Air Systems Displacement systems introduce cooled and fresh air at floor level, allowing the air to remove heat and pollutants from the space as it warms and rises by convection before being expelled at high level AE d.

Chapter 2 : BOOK: Climate Responsive Architecture â€“ Chinese language translation | arvind krishan

The integration of climate data is a driving factor in the design of new buildings, as well as in the renovation of existing buildings. SERA is on the leading edge of architecture firms practicing climate responsive design, resulting in an integrated and efficient approach to designing resilient structures.

History[edit] The common definition of responsive architecture, as described by many authors, is a class of architecture or building that demonstrates an ability to alter its form, to continually reflect the environmental conditions that surround it. The term "responsive architecture" was introduced by Nicholas Negroponte , who first conceived of it during the late s when spatial design problems were being explored by applying cybernetics to architecture. Negroponte proposes that responsive architecture is the natural product of the integration of computing power into built spaces and structures, and that better performing, more rational buildings are the result. Negroponte also extends this mixture to include the concepts of recognition, intention, contextual variation, and meaning into computing and its successful ubiquitous integration into architecture. This cross-fertilization of ideas lasted for about eight years. His work moved the field of architecture in a technical, functional, and actuated direction. Each of these works monitors fluctuations in the environment and alters its form in response to these changes. All of these works depend upon the abilities of computers to continuously calculate and join digital models that are programmable, to the real world and the events that shape it. While a considerable amount of time and effort has been spent on intelligent homes in recent years, the emphasis here has been mainly on developing computerized systems and electronics to adapt the interior of the building or its rooms to the needs of residents. Research in the area of responsive architecture has had far more to do with the building structure [4] itself, its ability to adapt to changing weather conditions and to take account of light, heat and cold. This could theoretically be achieved by designing structures consisting of rods and strings which would bend in response to wind, distributing the load in much the same way as a tree. Similarly, windows would respond to light, opening and closing to provide the best lighting and heating conditions inside the building. This line of research, known as actuated tensegrity, relies on changes in structures controlled by actuators which in turn are driven by computerized interpreters of the real world conditions. Their goal is to limit and reduce the impact of buildings on natural environments. The objective is to demonstrate that energy use and the environmental quality of buildings could be rendered more efficient and affordable by making use of a combination of these technologies. These types of structural systems use variable and controllable rigidity to provide architects and engineers with systems that have a controllable shape. As a form of ultra-lightweight structure these systems offer a primary method for reducing the embodied energy used in construction processes. Bibliography[edit] Sterk, T.: Subtle Technologies, Riverside Architectural Press, , p. Victoria and Albert Museum. A detailed analysis of the emergence of responsive environments as a multidisciplinary phenomenon, nurtured by museums, arts agencies and resulting from self-initiated activities by practitioners working in different cultural contexts. It accents the creative role of museums in incubating new practices, terminology in this field, and the impact of interactive media installations in public spaces with a social message.

Chapter 3 : Climate Responsive Design -SERA Architects

The U.S.-India Joint Center for Building Energy Research and Development (CBERD) conducts energy efficiency research and development (R&D) with a focus on better understanding the performance of climate responsive buildings.

Surinder Bahga, Founder of the Architectural Organisation, Saakaar Foundation, in Chandigarh, shares real experiences in design of sustainable buildings in different climatic zones, especially with reference to energy-efficient buildings in the Indian subcontinent. The world is facing a real energy crisis. Buildings consume 52 per cent of total energy in terms of their construction, use and maintenance. With the world witnessing a major environmental crisis, the concept of Sustainable Building Design has come to the forefront, particularly in the last two decades. The concept of climate-responsive design is related to green buildings and involves the use of principles that are in conformity with nature, rather than against it. It involves a dynamic change in the way we design our modern structures. Well-designed buildings go a long way in reducing operational costs by avoiding resource wastage. Environment-friendly buildings are increasingly becoming popular and may grow over three times in the next five years, thereby offering new opportunities to the beleaguered construction industry. The buildings should be designed in such a way that they conform to the particular climatic type. However, comfort can also be achieved with less consumption of energy. The consumption of resources, such as fossil-based energy, is continuously rising, just like the demand for energy-based comfort. Energy conservation requires serious consideration. Construction industry being one of the mammoth consumers of energy, it is time that we give a serious thought to the way we erect our buildings. India is on the threshold of stepping into a new era of development. So, energy- efficient architecture is the path to be adopted. For designing any energy-efficient building, climate of a place plays a very important role. Hence, the climatic parameters of India should be considered for designing energy-efficient buildings in other parts of the world having similar climatic conditions. Each region has been given guidelines to design buildings to suit climate of that particular zone. Each zone is discussed below: Composite region Characteristics of the composite region are very hot and dry summer, followed by a humid season with monsoon rains. There are certain design considerations for composite region buildings which should resist heat gain in summer and resist heat loss in winter. Orient the buildings with longer axes in the east-west direction. Ensure adequate shading on the south side to cut off direct solar radiation during summers and permit winter sun. Avoid externally reflected light from ground and other surfaces. Prefer internally reflected light using light shelves or windows at a high level. Roof insulation, wall insulation and cavity walls must be opted for. Promote heat loss in summer monsoon: Courtyards, wind towers and arrangement of openings; trees and water ponds for evaporative cooling; light outer colour and glazed china mosaic tiles on rooftop are the best approaches. Design considerations for day-lighting in composite region: Area of the openings should be determined by the duration of the predominant season in this climate. Compact internal planning in the form of courtyard type with large projecting eaves and wide verandahs is preferable for this climate type. High-level windows with the sill above eye level or light shelves that would admit reflected light towards the ceiling are preferable. Low level window openings towards the verandahs or courtyard are acceptable. Light-coloured reflective ceiling either spectral or mirrored for well diffused interior lighting is preferred. Fenestrations are planned to ensure good cross-ventilation which helps in reducing the load on the cooling devices in summer. The cool air that enters from the lower windows becomes warm and exits from top, maintaining airflow. Windows are deeply recessed in the walls to provide adequate shading from direct sunlight. Natural light is provided to all spaces as far as possible. Interiors are plastered and painted white to get better reflectivity. Energy-efficient lighting equipment is provided to minimise energy consumption. Hot and dry region Very high daytime temperatures, with very little precipitation and a short and mild winter are the characteristics of this region. Design considerations for hot and dry region: The main aim is to resist heat gain â€” proper orientation decreases exposed surface area. Increase shading by overhangs, projections and surface reflectivity by providing light-coloured finish. Increase thermal capacity time lag by cavity walls and thermal resistance by insulating the building envelope. Decrease air exchange rate ventilation during day-time by scheduling air changes. Provide ventilation by windows and exhausts. Increase air exchange rate ventilation during night-time by courtyards, wind towers and arrangement of windows. Increase humidity levels by trees, water bodies and evaporative cooling. Design considerations for day-lighting in hot and dry region: Smaller openings that are efficiently shaded. Building with compact internal planning having courtyard, with dense grouping so that the east and west walls are mutually shaded. High-level windows with a sill above the eye level or light shelves, which would admit reflected light to the interior. Low-level windows are acceptable if they open towards a shaded and planted courtyard. Warm and humid region High humidity, strong sun, and glare from the sky and horizon characterise this climate. Design considerations for warm and humid region: Decrease exposed surface area by proper orientation and shape of the building; increase thermal resistance by roof and wall insulation; increase buffer spaces by providing balconies and verandahs; increase shading of walls and glazing by overhangs, fins etc. Increase surface reflectivity by light coloured surfaces and broken china mosaic tiles on rooftop. Proper ventilation through windows and exhausts is essential. Increase air exchange rate during the day by ventilated roof construction, courtyards, wind towers and arrangement of openings. Design considerations for day-lighting for warm and humid region: Larger openings facilitate ventilation with large overhangs, wide overhanging eaves, or other shading devices by cutting off solar radiation. Specially-designed louver systems permit view of the sky and ground near the horizon only. Elongated plan with windows opening towards verandahs or galleries. High-level windows with sill above eye level light shelves that would admit reflected light to the interior. Low-level windows are acceptable, as shading of all vertical surfaces is beneficial provided they are well shaded with broad overhanging eaves or open towards verandahs. Window sill should be reflective. Moderate region The characteristic weather of this region is generally comfortable, neither too hot nor too cold. Design considerations for moderate region: To resist heat gain, decrease exposed surface area by orientation and shape of the building. Increase thermal resistance by providing roof insulation and east and west wall insulation. Increase shading on east and west walls by overhangs, fins and trees. Increase surface reflectivity by using light-coloured textures. Encourage ventilation by locating windows properly. Increase air exchange rate with the help of courtyards and arrangement of openings. Cold and cloudy region The characteristics of this region are low precipitation and variation in temperatures between day and night and also from summer to winter. Design considerations for cold and cloudy region: In order to resist heat loss, exposed surface areas are reduced by careful orientation and shape of building. Increase thermal resistance by wall and roof insulation and double glazing and thermal capacity time lag by providing thicker walls. Increase buffer spaces by providing air locks and lobbies. Decrease air exchange rate. Increase surface heat absorption by providing darker colours inside as well as outside. Reduce shading on walls and glazed portions. Utilise heat from appliances and provide thermal storage mass like trombe wall, mass wall etc. Design considerations for day-lighting in cold and cloudy region: Ensure openings to admit solar light and retain it. Integrate active and passive solar strategies such as sunspace and solarium with day-lighting strategies. Top lighting strategies such as skylightsâ€"domed or pyramid shapedâ€"with baffles to control glare are more efficient. Glazing area should be 3 to 9 per cent of the floor area to provide adequate lighting levels. Light wells or atria with light-coloured walls and other specifications as discussed in the respective sections on them. Conclusion Climatically, India is devided into five different types of zones. Each zone has its own guidelines for designing buildings in that particular region. Practical approach to design has been discussed in this article. Since buildings consume a major share of energy in their construction, use and maintenance, it is the foremost duty of all architects to design their projects to save energy. It will help us in saving our environment and thereby mother earth for future generations.

Chapter 4 : Building climate responsive homes in Lesotho, Africa - Climate CoLab

Climate responsive or solar passive building design can play a significant role in reducing the energy demand of buildings without compromising modern living standards. The most important function of buildings is to provide shelter with appropriate thermal and visual indoor comfort for its occupants.

This proposal was moved here from Adaptation Workspace Pitch A Building Technology that is less fossil fuel dependent, affordable, encourages capacity building, and is more climate responsive. Description Summary Summary People living in poorer and colder regions of the world have homes that have little or no heating during winter months, unless they are wealthy. Living in unheated homes, besides being uncomfortable, during winter is a health risk for children and the elderly. The home is warm in winter naturally heated and cool in summer. It has seen two winters with almost no fossil fuel or electric heating. The key characteristics of our home, built for four elderly ladies, are: Is this proposal for a practice or a project? Practice What actions do you propose? Local contractors, architects, engineers, and the Government in Lesotho are very interested in learning how to build our structures - as cost of heating buildings, or cooling in summer, is a heavy drain on the economy. We are trying to resolve the housing problem of this group of people as well as the more privileged. Architects and engineers work mostly for paying clients and are able to solve the housing needs of mostly the rich, the upper and middle class folks. If we provide an affordable solution that provides high performance buildings with everyday materials - the impact will be dramatic. There is an urgent need for such intervention. The section below shows how the heating and cooling system works. The need for a technology like ours is very broad. Our strategy would be to work as a non-profit, providing pro-bono service, to charities and teaching and training to the poor and service providers. We need act as a catalyst to stimulate the middle and upper income housing market, in order to find employment for our workers - so they can go back and build their homes with the help of the money earned and with sweat equity. The commercial market place as well as the upper income housing could easily absorb our trained workers. One needs to develop an effective marketing and business plan. Broadly speaking we need to do the following: The building process needs to be taught. We need to train local architects, engineers and contractors. Workers need to learn how to fabricate our proposed inexpensive modular reusable forms for wall construction. They need to know how to erect the walls so they are well insulated and structurally sound. They need to understand how to run the copper pipes, the design of mixing valves, the use of hot water for shower as well as for heating, the use of underground water tanks as thermal storage and heat exchanger. They need to understand how to build affordable perimeter baseboard heating system to maximize storage of heat within walls. The design of under-slab heating system, can be challenging, in order to prevent heat loss from the ground. They slab needs to be insulated at the same time detailed carefully to prevent slab settlement possibilities. The correct placement of pipe in the slab is important to avoid puncturing the pipe and at the same time to allow adequate heat transfer. The correct construction of insulated heat exchangers - so water remains hot for a longer period. The hot water once it has transferred the heat to the heat exchanger has to be brought back to the solar water heater on the roof to be re-heated. With the help of simple low wattage sump pump this can be achieved easily provided the pipe size and length are optimized. One needs to leverage the design to use the same copper pipes and circulation system to cool the homes, using cold tap water, in summer. Given the high unemployment in poorer countries, our technology which can employ unskilled and semi-skilled labor, will provide people with jobs, gainful employment with both economic, social, and mental health benefits. Unemployment is very high in most poor countries and especially in Lesotho. The sisters have the land and are trying to raise funds to build four more similar elderly home. They also would like to build teachers homes, clinics, schools and hospitals using the building technology. They are also interested in teaching local villagers the technique so the villagers can build their one or two room homes. The homes have been very cost competitive. We think our numbers are very conservative. As ours is a non-wood, non-combustible technology, and by avoiding wood construction we will further reduce global warming GW and GHGe. The group cannot afford high tech solutions, large and expensive clusters of solar PV, etc. The life cycle cost Grand Total: For our prototype we have made an allowance for supplementary heating for about 30 days in a year for cloudy days. We have assumed a 30 year life cycle for our calculations. The numbers are very compelling. Please see chart above. In future we expect industrialized countries to pay for these CC, and it may result in a monthly paycheck for the residents, or the CC can be a co-lateral for a construction loan. The chart below shows a comparison of temperature inside the home of a un-insulated masonry structure versus our prototype in Lesotho. The readings below are actual on site reading at our Lesotho home during winter and partly extrapolated for summer - based on our experience with masonry structures in other similar countries climate, elevation, latitude. In summer our structure remains cool. In summer the temp ranges between 68 F to 74 F. These readings may vary slightly from building to building and region to region but the bottom line is a lot less heating and cooling is required with our building types. Masonry structures perform poorly and mimic outside air temperatures. In summary, we will need: Grants and Governmental support to demonstrate the technology, as these homes can benefit people in many countries. We are developing solutions for a non-paying client who is having a huge negative effect on the environment with the GHG emissions. Hence it is in the interest of international organizations, donors, working on GHG issues to support us in reducing these emissions. Unless we can build more prototypes, and demonstrate successful models, it will be difficult to advance and promote the technology. Larger facilities can be built by similar process - which will introduce a "green" culture in building construction in Lesotho and many other developing and developed countries. Future homes will need to target better sewage management. Separation of black water from grey water. Utilization of grey water for farming. We hope to direct the black-water to bio-digesters in order to generate bio-gas which can subsequently be used for heating, and the remaining waste to be used as fertilizer. Lesotho also has a water problem. It hardly rains in Lesotho and Lesotho has a dire need for potable water. Our prototype structure collects rain water and the harvested grey water is used for farming. The rain water is not potable. However improved techniques for rain water harvesting may result in recycling that water as potable water. That will be a huge benefit to Lesotho. The technology we are trying to introduce will drive people to share resources. The reusable lightweight form-work, helps speed up construction and reduces the cement utilized in the walls. It avoids mortar joints - which are the weak link in masonry wall construction and where usually cracks and failures start. Team work will be key among the workers. A small group of villagers could form a group, a cooperative or a collective, and help each other in using these forms to build their homes. Who will take these actions? They also need to house their teaching staff. SOC also has clinics, schools, student dormitories, and hospitals. They all need to be heated during winter. The money saved can be invested in their various charitable programs. We have also spoken to local Architects, Engineers and building officials and they all agree that the need for such buildings are widespread. However they need someone to train and teach them in the building method. Local contractors, engineers, developers are keen on learning the technology. In the long term such a technology needs an infrastructure of trained professionals, workshops, training centers, engineers and architects who can supervise the construction of structurally sound buildings. SOC is willing to provide the infrastructure support if funding is obtained for a viable program. If one is able to initially demonstrate successful prototype structures, the Government may be emboldened to build schools, dormitories, orphanages,clinics and hospitals with this type of structure. We need money to demonstrate several small building types - and then we think the technology will take off on its own. It will help in capacity building. We are also in discussions with the banking sector and they have shown an interest in micro-finance loans - if the loans are given to a viable group as opposed to individuals. They need loan guarantees, and other mechanisms to insure loan payoffs. In the past we were able to see promise with what we are proposing. In and we were asked by a major South Asian NGO, The Aga Khan Foundation, to demonstrate our ability to build earthquake resistant structures in a earthquake devastated region of Pakistan. We built several lean concrete, with conventional reinforcement and membrane reinforced elastic skin structures. Our design were vetted and approved by international as well as local structural engineers. Our technology in Lesotho is a continuation of the same technology and we believe we can easily replicate that earlier experience. See slide below for examples of our work. Where will these actions be taken? Buildings in Haiti and Pakistan have added features that make them seismic resistant. The structures were designed in collaboration with structural engineers.

Chapter 5 : Climate-responsive Building Design in North-East India | Sadhan Mahapatra - calendrierdelasc

chancellery climate responsive design strategies Building planning The site planning of outdoor spaces, streets and landscaping and organisation of interior spaces to respond to specific climate and physical environments are key strategies of climate responsive design.

Hence energy conservation becomes a necessity rather than an option in both commercial and residential buildings and hence it becomes desirable to design climate responsive buildings by incorporating appropriate solar passive features. Climate responsive building design is a concept that integrates the micro-climate and architecture with human thermal comfort conditions. This concept takes into account the solar passive techniques, micro-climatic conditions and thermal comfort conditions that improve the building artificial energy efficiency. This fact is well supported by various studies on vernacular architecture as well as on modern architecture throughout the world. Thermal comfort not only makes the occupants comfortable but also decides the energy consumption in the building and thus its sustainability. Throughout the world, from ancient times people have used solar passive techniques that have evolved through generations. These structures got attention for detailed study among the researchers at present times. Different researchers had done extensive study on thermal performance of vernacular buildings in the different parts of the world. However, vernacular architecture of North-Eastern India which perfectly represents the principle of climate-oriented architecture still lacks experimental validation and quantitative analysis. A field study has been carried out to evaluate the thermal comfort perception of the occupants in naturally ventilated buildings at different bioclimatic zones of North-East India. The survey was performed in naturally ventilated buildings during the winter, pre-summer season in There were occupants from 75 vernacular buildings who participated in this study and questionnaire responses were collected. We came across some interesting findings related to bioclimatism, socio-economic status, cultural setup and sustainability in this vernacular architecture. We also found different solar passive features available in most of these houses related to temperature control and promotion of natural ventilation. These houses are constructed using locally available building materials. Since these materials have low embodied energy and are from the same climatic zone. Henceforth, they fit into the local environment perfectly and represent a unique example towards achieving sustainability. Introduction Energy and architecture form a natural marriage if indoor comfort and respect for environment are secured. Although energy conservation is an important issue in present days but human thermal comfort is the primary concern in case of buildings. Henceforth, it becomes necessity rather than an option for energy conservation and carbon emission reduction to design built environment considering the local environment and socio-cultural setup and to make the system more sustainable. It is commonly agreed within the thermal comfort research community that combination of built environment and individual thermal comfort expectation creates acceptable thermal environmental conditions for the occupants within the space [2]. Built environment and comforts standards are increasing with the economic development and consequently increasing the energy demands. It is evident from different study that the local climate influences 1 Corresponding author: In building design the weather condition or the climatic parameters i. This fact is well supported by various studies on vernacular architecture as well as modern architecture throughout the world. Out of the various factors that affect architectural design, climate control is of prime importance as it involves maintaining comfortable conditions inside the building. If this objective is disregarded discomfort will prevail, resulting in lower productivity and increase the psychological stress. Simultaneously, the energy cost of maintaining comfort conditions will rise. Hence it is desirable to design climate responsive buildings by incorporating appropriate solar passive features. Buildings based on local climate provide uniqueness, sense of belonging, social and cultural identity [5, 6]. We carried out thermal comfort field survey at representative location across the three different bioclimatic zones in naturally ventilated buildings during the winter and pre-summer season in During our field survey it is found that comfort is a combination of number of various factors and thermal environment is one of them. There were occupants from 75 vernacular buildings who participated in the study and questionnaire responses were collected. We have also collected temperature, relative humidity and day lighting level data, both inside and outside of the houses. We tried to generate qualitative and quantitative information about the comfort status of the residents of vernacular buildings of North-East India based on our study. Bioclimatism and Vernacular Architecture Climate, socio-cultural setup, economy, building materials and technology availabilities are the main factors that greatly influence the building architecture and its sustainability. Since climate varies from place to place thus the favorable architectural solutions for built environment are also region specific. Vernacular architecture constructed by the people reflects their need and socio-cultural values [6]. These buildings are constructed using locally available materials and shows a greater respect to the existing environment and also takes into account the constraints imposed by the climate. Vernacular architecture is often forgotten in modern times could be the best example of harmony among the human behavior, building and the physical environment. However, it may not be appropriate to adopt these models as readymade solutions for modern architecture. Our advanced technical capability and cultural context prevent us from returning to these old-fashioned architectural forms. But we can learn a lesson from the approach of the builders who acknowledged the interdependence of human beings, buildings and physical environment [7]. Bioclimatism is a concept that integrates the micro-climate and architecture to human thermal comfort conditions [6]. It is revealed from different studies on vernacular architecture that bioclimatism is a critical parameter for achieving sustainability of modern architecture [8, 9]. This concept takes into account the solar passive techniques and micro-climatic conditions in building design; which improves the building artificial energy efficiency and thermal comfort conditions in the built environment. Vernacular architecture is a term used to categorize methods of construction which uses locally available resources to address the local needs [10]. These kinds of structure evolve over time to reflect the environmental, cultural and historical context in which they exists. The building knowledge in these kinds of architecture is often transported by traditions and is thus more based on the knowledge achieved by trial and error and often handed down through the generations [11]. This kind of architecture is greatly influenced by culture and geographical location but the most fascinating aspect is that these architectures show identical architectural solutions in similar climates across totally different and very distant geographical locations. This architecture is of great wealth for the modern architecture as it represents solutions which show maximum adaptability and flexibility and thus sets an example towards sustainability. In modern times, building materials like cement, steel and bricks are highly energy intensive. Different study reported that the embodied energy cost as well as running cost can be significantly reduced in climate-responsive building design [12]. So climate responsive building design has become a necessity rather than an option for energy conservation and carbon emission reduction [13]. So we must not underestimate the solutions of vernacular architecture. Rather it demands for a systematic and detailed scientific understanding. Bioclimatic classification of North-East India The weather of any place represents an integrated effect of all atmospheric variables over a brief period of time. Climate is the average weather over a period of many years. Both weather and climate are described by the climatic factors like solar radiation, ambient temperature, air humidity, precipitation, wind speed and sky condition [14]. The characteristics and consequently the requirements of comfort for each climatic zone differ from other zone. The entire northeast region has very uneven topography and the climate of any place is affected by the topography of the particular place. The major landforms affecting the climate of the site are mountains, valleys, water bodies and plains. Above all the whole of northeast is heavily vegetated. All these have varying effects on the micro-climate of a place and hence the climate has to vary from place to place. Therefore entire northeast region is reclassified freshly at micro-climatic level [14]. This work has done with the help of the temperature data both maximum and minimum of monthly averages for thirty-year normal data , humidity thirty years normal of monthly average data at 8. Entire northeast India is classified into three major bioclimatic zones namely; warm-humid, cool-humid and cold-cloudy [Table 1 and Figure 1] [14]. The bioclimatic charts are constructed for three different bioclimatic zones of the region namely; warm and humid, cool and humid and cold and cloudy climate based on the works 15 of Milne and Givoni [15]. The climate of a given location is analyzed in its own terms and the analysis leads to certain passive solar design strategies. The monthly climatic lines are drawn on the psychometric chart. The two end points of the climatic lines are given by the mean minimum temperature and mean minimum relative humidity and mean maximum temperature and mean maximum relative humidity. The proportion of the monthly lines falling within a particular passive design strategy indicates in terms of percentage the potential use of that passive design [Figure 2 and Table 2] [14]. Bioclimatic zones specification of warm and humid climatic zone shows that high humidity and excessive rainfall are the prime factors that influence the comfort condition inside the built space [6]. Solar radiation and wind speed and direction have also an impact in the building structures. Due to heavy rainfall in the region, the entrances of the houses are pulled inside and half of the wall is made up of backed brick masonry and above that the wall is made of by wood. In case of mud architecture; the houses are made on the raised platform so that the drained water from the roof cannot crumble to the side walls. Because of excessive rainfall it is observed that the roofs of the traditional houses are slanting and facing two or four directions. Roofs are extended to act as overhang to protect the wall from rainfall. We also found that the wind direction is intelligently used for natural ventilation. Figure 3 represents the features that enhances air circulation and hence promotes natural ventilation. In case of pukka building surkhi is used in fixing the bricks and for plastering. Study shows that 0. Use of surki is quite common in the buildings of this climatic zone. An advanced passive feature like an air gap is maintained in the lower side of ceiling Figure 4. This air gap is created by using two layers, one of bamboo and the other of wood to construct the ceiling. Figure 5 shows veranda is in the east and in the west side running along north to south of a school building constructed in the year Vertical wooden structure is present to block the afternoon sun rays entering into the classrooms. Overhang on windows is also used to block the sun rays. Almost all the houses in this zone have rooms with ceiling height ranging from 4. This height helps in the formation of natural draft to enhance ventilation [6]. A typical rural house of cool and humid climatic zone is low energy dwelling. These houses are constructed only by using locally available materials. Orientation of the house in rural area plays a major role. Most of the houses are east-west oriented and south facing to receive maximum solar radiation. Figure 6 represents the bamboo, bamboo leaves and cane arrangement used to make false ceiling and roofing. The walls of the houses are made by sandwiching a particular species of bamboo between two layers of processed mud. Processing enhances binding property and adds porosity to mud. Increase in porosity actually increases the water retention property of mud which intern provides resistance to temperature change and thus helps in retaining comfort conditions [6]. In urban houses the 16 outer walls are 0.

Chapter 6 : Climate-Responsive Design Conforming with nature - India's first NewsPortal on Projects

Climate responsive design in buildings takes into account the following climatic parameters which have direct influence on indoor thermal comfort and energy consumption in buildings: â€¢ The air temperature, â€¢ The humidity, â€¢ The prevailing wind direction and speed, â€¢ The amount of solar radiation and the solar path.

Chapter 7 : Responsive architecture - Wikipedia

Alp Ahmet, "Vernacular Climate Control in Desert Architecture", in: Washburn Brooks, ed., "Contemporary and Traditional Arabian Design, Review ", College of Environmental Design, King Fahd University of Petroleum and Minerals, Dhahran,

Chapter 8 : Responsive architecture - six amazing projects - DesignCurial

CLIMATE RESPONSIVE ARCHITECTURE. THE ELEMENTS OF CLIMATE aspects of climate which affectaspects of climate which affect human comfort and the use of buildings.