



Energy and Environmentally Efficient Architectural Model Using Native and Adopted Strategies for Lyari Hospital

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Abstract: The healthcare industry is becoming a model for the larger world in developing an ecological environment; medicine approach is: “first do no harm”. Developing new hospital campus in urban site; ideas of therapeutic architecture based on ASHRAE recommendations of sustainable site planning principles. For the energy and environmentally efficient architectural model for the design of Lyari hospital, we developed a series of models using native and adopted architectural strategies. The environmentally efficient master plan will form design decisions so that the foot print of the proposed development does not overwhelm the capacity of the site. The climate of Karachi has additional challenge of humidity control, compared to rest of the cities in Pakistan due to the proximity of sea. For all code and standards defined in climate consultant, the comfort zone of winter and summer temperature range lies between 20°C and 31°C respectively. The traditional passive architectural strategies are still most popular in designing the climatic responsive buildings for Karachi. The Double skin façade building presented a model of the envelop for Karachi which was simulated to be 87% more efficient from energy conservation perspective then vice versa

Keywords: Healthcare care energy efficiency and climate consultant

1. INTRODUCTION

Establishing sustainable goals: early in the process, evaluate site under consideration for environmental opportunities and constrains. Development of an environmental masters plan during the first phase of site development to ensure the preservation of the site's ecologically significant areas. The above shown environmentally master plan will inform design decisions so that the foot print of the proposed development does not over whelm the capacity of the site. The project is at Lyari, at the same time, led by nonprofit organization, Lyari, SPO (strengthening Participatory Organization, more focus has been given to ‘patient-centered care’ to foster the healing environment. This is truly one of the most important paradigm shifts in the culture of hospital design, and provides architects an opportunity to explore their creativeness to achieve this challenge. Tools and techniques were also explored in this regard to evaluate the hospitals and case studies were conducted in Pakistan to see the achievement of Healing Environment within Hospitals from early stages of design to final product. The healthcare in Pakistan is administered mainly in the private sector which accounts for approximately 80% of all outpatient visits.

The other issue is to document the specific conditions of hospital buildings in terms of its design determinants, spatial organization and areal distribution

as there is very little unpublished information available in Pakistan concerning energy aspects of hospital buildings e.g. Lyari.

2. BACKGROUND

The objectives of the Project are to improve the quality of life and the accessibility to health services of the regional people in Sindh by establishing a specialized children's hospital in Lyari.

- a) To function as a tertiary hospital to cure the diseases of children including infants in Karachi
- b) To increase the health care coverage of children patients in Northern Sindh.
- c) To perform an education function for paediatrics interns and a re-education function for paediatricians
- d) To conduct research and prevention activities for young children's diseases in the region

The site is located at cheel hawk, it is designed for an NGO, above photo, in developing new hospital campuses on urban sites., ideas of therapeutic landscape merge with sustainable site-planning principles in developing healing gardens, green roofs, and native plantings.

The climate consultant software 2) defines the criteria for each comfort model, using its specific details for 14 design strategies. This selection further figures out the percentage of comfort range in psychometrics chart.

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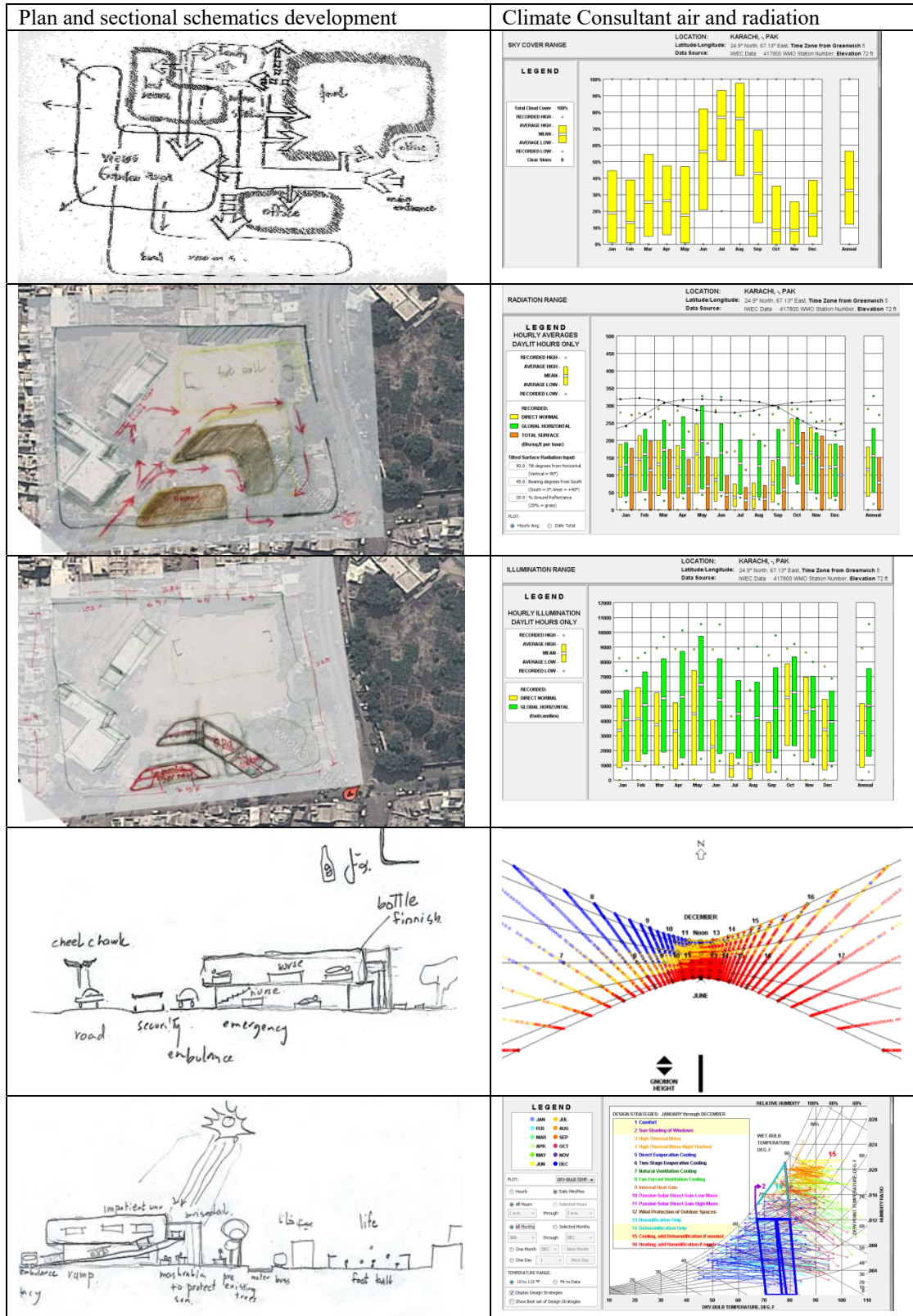


Fig.1 Analysis of the design

The sun shading, thermal mass and ventilation requirements are important passive cooling strategies for the hot humid climate of Karachi. These variables affect the summer cooling needs in particular.

The variety of analysing climatic parameters for a particular location is facilitated with the help of available human thermal comfort models (HTCMs). Each model set particular criteria based on the descriptive study of a specific code and standard. The simplified explanation of each HTCM¹ is prescribed before the selection. This paper gives a comparative analysis for the application of various HTCMs using a weather file of Karachi city in Pakistan². The access to data maps and drawings concerning hospital buildings is a major constraint in Pakistan. The overall structure and nature of maintenance system of hospital buildings is still at its infancy level. Therefore it is a rational need to understand the types, nature and characteristics of hospital buildings in Pakistan.

At present there is no such standard method of hospital building design in Pakistan which promotes the healing environment. Neither there are any healing environment laws nor legislation at professional level statuary that may provide guidelines to create healing environments in hospital buildings.

A database would be developed concerning energy efficiency of hospital buildings in Pakistan, for future researches. A documented record would be available with state institutions about nature of hospital buildings in Pakistan. Here we present two key observations in response to our set thesis, first the clinical teams which are facing increased demand to perform more efficiently, consistently and safely in delivering improved outcomes. Second, they need to be able to stay up-to-date with clinical advances, and communicate effectively with patients as well as an ever more networked Asian peer group (the table shows the classification for 2013 till 2015 health affairs).

Table. 1 Health Services and Affairs

Classification	2016-2017	2017-2018
Medical appliances equipments and product	260	100
Hospital services	8180	8306
Public service: health	1029	356
Administration of Health	394	1255
Total	9863	10017

¹ Energy Design Tool: (<http://www.energy-design-tools.aud.ucla.edu/>)

² Climate Consultant Graphic Based Computer Program: Climate Consultant 6.0 BETA (built 3) November 11, 2014 (<http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php>)

Hospital team faces impossible choices to balance cost and quality of care.

Medicine and public health institution will explicitly commit to promoting the health restoration of the natural, and built environments. These commitments will extend to the determinants of health and disease. The project defined a series of goals to create a building and landscape that will integrate building purpose, program and academics. Thus the project focused on energy performance and indoor environment quality (through abundant day lighting and the use of nontoxic material). Given the orientation of the restricted site, optimizing energy performance required the careful integration of exterior shading device.

Table. 2. Per bed population in Pakistan

year	per bed population
2010	1508
2011	1515
2012	1525
2013	1532
2014	1541
2015	1550
2016	1557
2017	1565
2018	1575

Human health cannot be treated separately from the natural environment. Thus this is important to consider these factors

3. LITERATURE REVIEW

A setting designed to use natural capital- sun, wind and water to reduce operating costs and maintenance; uses renewable resources Malkin,. (1992). The general Hospital site in Lyari, SPO (strengthening Participatory Organization): In developing new hospital campus in urban site ideas of therapeutic landscape merge with sustainable site planning principles in developing healing gardens, green roofs, and native planting Stichler, (2008). For the landscape design of Lyari hospital, we developed a series of gardens using native and adopted planting strategies, permeable paving, water features in the campus forecourt, and an intimate healing garden on a rooftop nestled between inpatient wings Hannen, Scott. (2009).

Currently there is a collective understanding that a healing environment is beneficial for patients and for healthcare staff. Healing principles (Morris, 2003).

Organization of spaces, regular maintenance and comprehensive environmental design are three significant principle components (Frumkin, 2003) that are essential to create effective healing environment. The Lyari hospital of project's central organizing principles evolved from four primary tenets, with associated benefits

In the recent project of Lyari design we applied EBD theory as far as we could. However it was difficult to implement into real project because it is rather a new concept in Karachi while it is prevalent in the practice of North American healthcare design.

(Schettler, 2001) represented the architectural explanation of healthcare organization as environmentally functionality which determines healthcare facility design in terms of acute care. (Hampton, 2007) explains about performance indicators for environmentally healing organization that, access and climatically appropriateness differs from country to country with varied temporal realities. (Kellert, 2005) developed the standards for site allocation plan and circulation in hospital design. He stressed on using appropriate tools i.e. Achieving Excellence Design Evaluation Tool (AEDET) (Wickersheimer, 2013) which consist different models for site allocation plan and circulation in hospitals.

The typology of circulation in hospital buildings is an especial focus in the study of circulation patterns in hospitals by Rossi, and Lent, (2006) and its impact on the design determinants as displayed in form of research by Sadek and Shepley (2016). They used a matrix of cause and effect (fishbone diagram) to evaluate the typology of circulation. (Mazlum 2015) discussed in his work on the lean design that typology of circulation add efficiency to hospital buildings.

Schweitzer, (Gilpin, Frampton, 2004). explains that in addition to earlier techniques of analyzing design determinants the latest application to explore design determinants are space syntax analysis for enhancing accuracy of hospital design. (Kohn, *et al.* 2000), (Fottler

et al. 2000). also support this notion. It was also proved from (Giofrè, and Zoran, 2016) research case that lean principles to efficient environmentally design determinants for healthcare facilities is also a valid application. According to World Health Organization the design determinants for a standard hospital includes an approach to enable the user to improve control of architectural determinants (WHO, 2005) as initiated by International Network of Health Promoting Hospitals (HPH). The implementation of architectural design determinants involves 'connectivity' as studied by McIntyre, (2006), 'visibility' as analyzed by Verderber, (2010) and 'accessibility' as findings in his research related to context of innovation in hospital design. Similarly 'way-finding' and its relation with 'walkability, egress and entry' i.e. relationship between vehicular and pedestrian circulation as discussed in ADA (American Disability Act) are other design determinants .

3. MATERIALS AND METHODS

The main reason it that, in Karachi, there is little existing research on EBD, or even POE (post occupancy evaluation) of existing hospitals which is the most basic material for EBD research. Though we as researcher planned to design based on resources and available research. Moreover evaluating the research based on the adoptability into Karachi's unique culture and medical environment.

We designed the healthcare environment with natural day-lighting, meditative space for workers and staff, healthy materials and visual inspiration. Therefore the prospect of establishing green building protocols for the healthcare sector is daunting, given the technical sophistication of its building. The motto of quantifying performance benefits, however, makes such tool essential.

The data-driven approach Ulrich (1999) also facilitates correlation of the factors involved in the hospital's healing process and helps isolate specific inputs to expand the potential for increasing healing in hospitals.

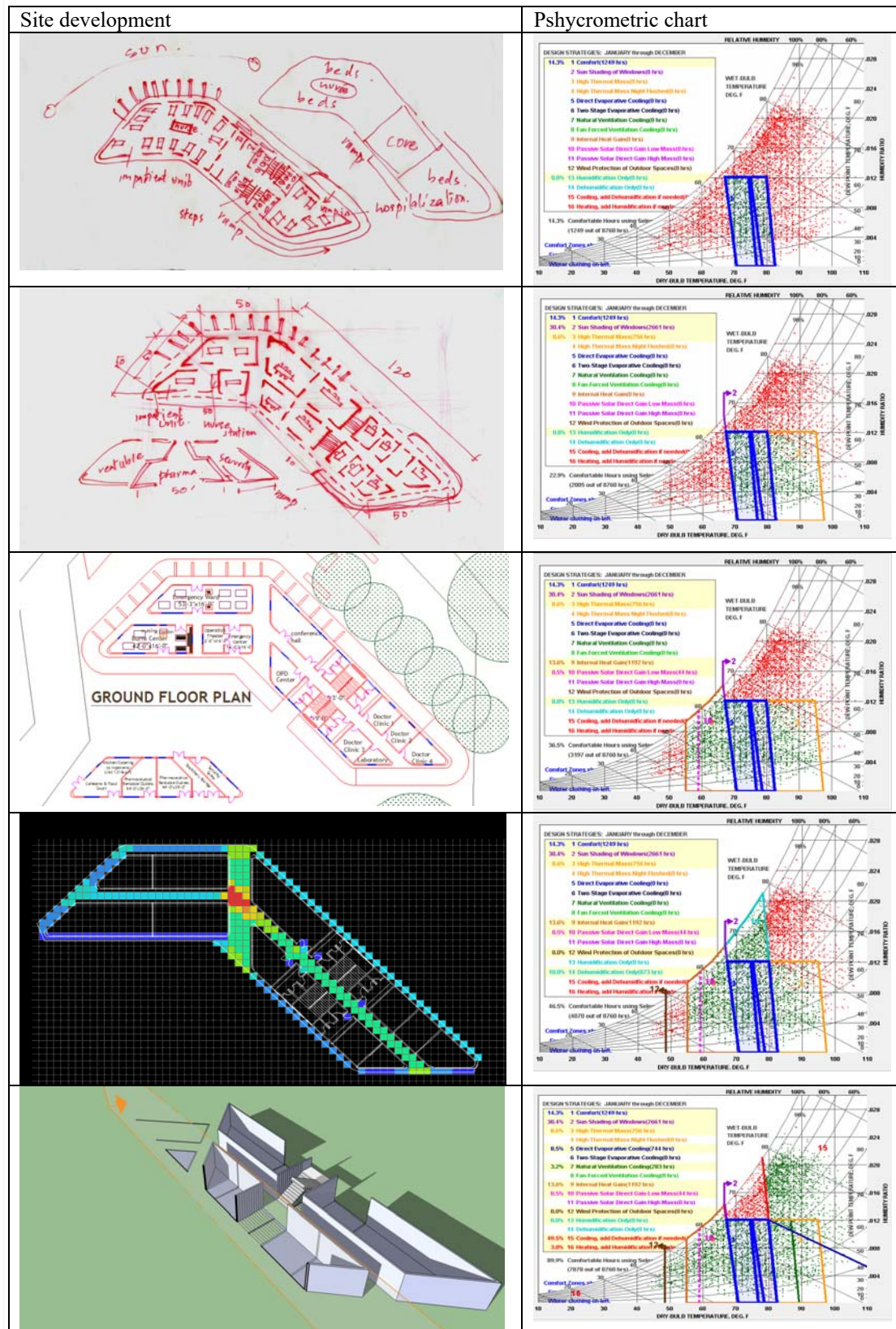


Fig.2 The development of the model

Lyari Hospital is a 300 bed hospital designed in 2013, this project is a new expansion of 300 bed hospital next to the existing hospital making it is total of 600 bed general hospital and the biggest acute bed hospital in the region.

The total floor area of the new building is 300x 400 feet with 3 floors above and one below ground. The design will be finishing in September 2014 and its construction will be completed by the year 2018 through fast tract construction.

This was considered as a case study on the climate consultant software as shown in (Fig.1).

The program consists of the following main components

- ☐ 100 acute bed PCUs (Patient Care Unites) and ICUs
- ☐ Neuro Center: outpatient clinics
- ☐ Emergency
- ☐ Surgery extension of 25 new operating rooms
- ☐ Health Screening Center

2.1. Site Planning and Massing

One of the client's goals for the new hospital is that it should function together with the existing context, as a operational facility³. It was essential to connect lower podiums as close as possible so that, the service zone of the two buildings can operate as a single department. It became crucial to secure a wide space which is uninterrupted by "cores" such as elevators, stairways, and mechanical shafts, and large enough to accommodate the size of surgery or ICUs on the same floor. Among many massing options, the "Central Spine Linear Street Core" (Corvalan, *et al.* 2010).

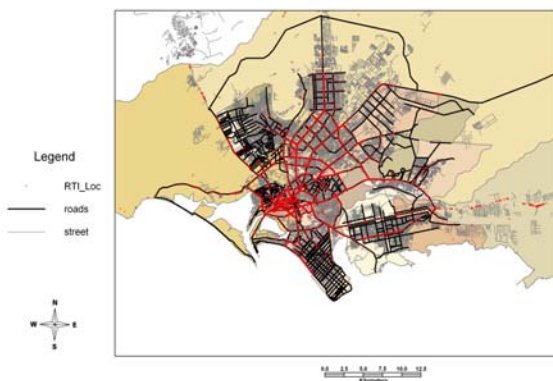


Fig. 3 Red concentration shows Lyari area in Karachi

4. DISCUSSION

³ California energy code comfort model (option 1)

The living building site is based on responsible site selection, limits to growth, habitat exchange, here following the green guide. Healthcare has deep roots and successes in both the policy and implementation arenas associated with toxic and waste reduction, ecological footprint responding to the layered ecological urges of our time.

In healthcare, sustainable building represents a bold move towards precaution and prevention. The building stands for health. In creating it, the organization is essentially investing in keeping people healthier. It is merely not a sickness treatment place any more but a representation of mindset and culture from the traditional idea. In discussion session we measured and tested it and convinced that it has tremendous impact on a person's ability to attain health.

1.2. Climate Consultant Methods and Scopes

Key building performance strategy

Site

- ☐ Mold free environment safeguard sensitive patients⁴

- ☐ Green roof

Energy

- ☐ Double skin façade⁵

☐ Metal elements avoided in room for electromagnetically sensitive patient: electronic equipment housed elsewhere, and metal-free furniture used where possible⁶

- ☐ Wood floors instead of carpet in all areas

☐ Hard materials preferred to soft ones to eliminate off gassing⁷

The aim is if the healthcare industry become a model for the larger world in developing an ecological approach to these environmental and health challenges?⁸Central to these approaches to medicine is the axiom: "first do no harm" (Ausubel, 2004).

Karachi is the largest and densely populated coastal city of Pakistan. Its geographical location is 24.9°N and 67.13°E with an elevation of 22MASL. The adverse impact of climate change is visible in Karachi due to the proximity of sea. The urban morphology of a typical house is based on private and semi-private zones A typical area for an urban hospital ranges

⁴ ASHRAE standard 55 and current handbook of comfort model (option 2)

⁵ ASHRAE handbook of fundamental comfort model up through 2005 (option 3)

⁶ Adaptive comfort model in ASHRAE standards 55-2010 (option 4)

⁷ For the purpose of sizing residential heating and cooling systems, the indoor dry bulb design conditions should be between 68°F (20°C) to 75°F (23.9°C)

⁸ 80% relative humidity and 66°F (18.9°C) wet bulb is used as the upper limit and 27°F (-2.8°C) dew point is used as the lower limit.

between 75-500 m², with significant number of middle income houses having approximate area of 200m² (Khalid and Raza 2013). The energy conservational techniques and passive design methods are not so common throughout the country. The life style of inhabitants and construction pattern in building sector of Karachi has led to inefficient energy consumption. In order to address the summer cooling demands, split air conditioners are widely used.

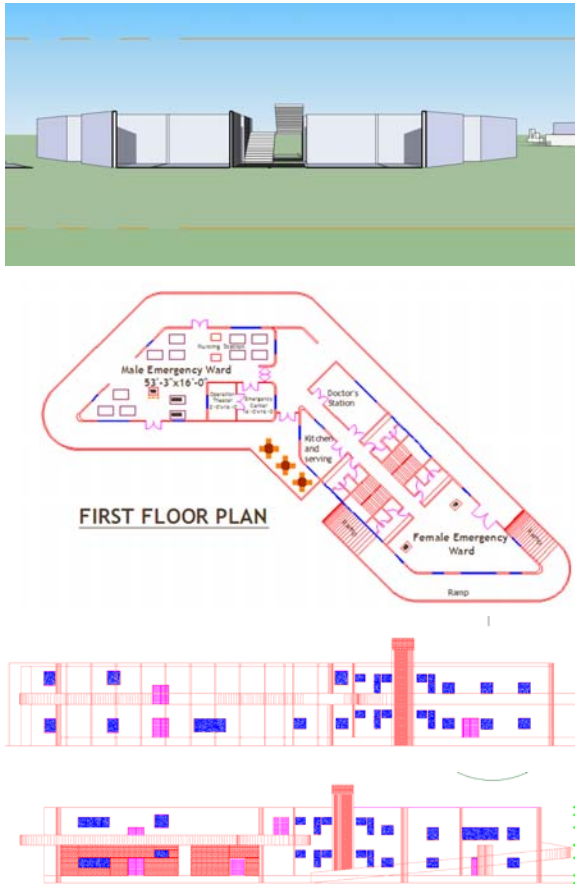


Fig. 4 . The plan and section of the hospital

The climate responsive building can be an effective cost efficient strategy for the residential building sector requiring an in depth analysis of Karachi's climate. The better understanding of temperature, Mutangadura, (2004). humidity conditions and various other climatic elements can help in designing energy efficient buildings. The performance, comfort and energy use in residential buildings is influenced by the climatic conditions and the way in which a particular residence responds and develops the local micro- climate⁹. The reduced need for the air conditioners in residential

sector can also effectively minimize the CO₂ emissions specifically.

2.2. Envelope design

The architectural elements like wall, roof and window must have a required minimum level of thermal resistance. It can be made possible with the use of locally available insulating materials, increased thickness, and double glazed pan windows. The right choice of material and their correct selection for each envelope component must be a high priority. Keeping the building size small with appropriate floor area, will have less cooling needs. This concept also supports the Karachi's structure of housing where apartment buildings are equally popular as compared to rest of the country.

The following conclusions have been drawn from above discussion:

The formulation of energy conservation code and standards can be one of the effective strategies for the residential sector extra energy consumption control.

The California code gives some similarity to ASHRAE standards when applying to Karachi contextual climatic conditions and vice versa. The climate of Karachi has additional challenge of humidity control, compared to rest of the cities in Pakistan due to the proximity of sea. For all code and standards defined in climate consultant, the comfort zone of winter and summer temperature range lies between 20oC and 31oC respectively. The traditional passive house strategies are still most popular in designing the climatic responsive buildings for Karachi.

2.3 Phase 1:

- Site survey for the target area for the medical treatment of the hospital including existing hospitals;
- Analysis of the requirement for the project including the function of the hospital, medical plan, layout plan, operating and maintenance plan, and so on;
- Finalizing the medical plan in accordance with the function of the hospital
- Preparation of the Project Implementation Plan including the Employer's scope of work to be done in advance of the commencement of the construction including site preparation, infrastructure necessary to construct and operate the hospital;
- Preparation of schematic, basic, and detail design for Hospital Building;
- Preparation of the specifications of the facilities such as, but not limited to, mechanical and electric machineries and facilities, to be installed in the hospital;
- Preparation of the list and specifications of the medical equipment and facilities;

⁹ The Enercon in 1994 worked with a team of Oxford Brooks University, UK for setting appropriate indoor temperature standards for Pakistan.

h) Analysis of the Operation Plan, if exists; and i) Assistance in the preparation of the bidding documents and issuing the bids.

Space syntax used to reduce while planning horizontal circulation for the nurse

Site 300x 400 feet

- 30 % circulation + 200'x200' diagnosis
- 10 % site for spine circulation
- 300 bed 200'x200' + 30% circulation
- Emergency 100'x100' + 50% circulation
- Outpatient unit 100'x200' + 50% circulation

Thus air quality up gradation, increased day lighting, high-performance ceiling, work path planning and support distribution, communication system, standardized, non handed rooms, single, acuity, adoptable rooms.

Perhaps the bottom line on the health and human performance benefits of green building comes to this

- a) If we know from personal and anecdotal experience that having a thermally comfortable, well lit, properly ventilated work space, preferably with daylight and a view of nature, is likely to have a positive effect on our well-being and morale, and therefore would inspire greater work performance; and
- b) If sustainable physical elements, such as adequate air exchange produce any positive in employee and health and well-being; and
- c) If we can built green hospital to a high standard at little or no extra cost

5. CONCLUSION

The design posed two fundamental questions

1. What specific innovations could be made to improve care delivery- and at what cost
2. Translated into currency how much more productive, and how much less dangerous to patients, would healthcare delivery be?

The design innovations and their costs were organized into four categories

1. Energy and Environment
2. Indoor environmental quality (IEQ)
3. Operational efficiency
4. Infection Control

● Building operation for reduced energy consumption: includes in terms of energy and environment primarily sustainable systems- energy, water, secondly, sustainable system management, and tertiary automatic controlled operable window.

● Indoor Environmental quality includes following variables: air quality upgrade, increased parameter wall and day lighting, under slab ducting for perimeter displacement system diffusers, ceiling system for

movable walls, high performing ceilings, interior landscaping atria, Diurnal (daily activity) rhythm interior lighting.

The study found out that after entrance the major activity zone is the information desk and it must be located at a central place from where all the connecting roots sprung up and from that point people dispersed in every direction therefore information desk shall be centralized along with a direct access.

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