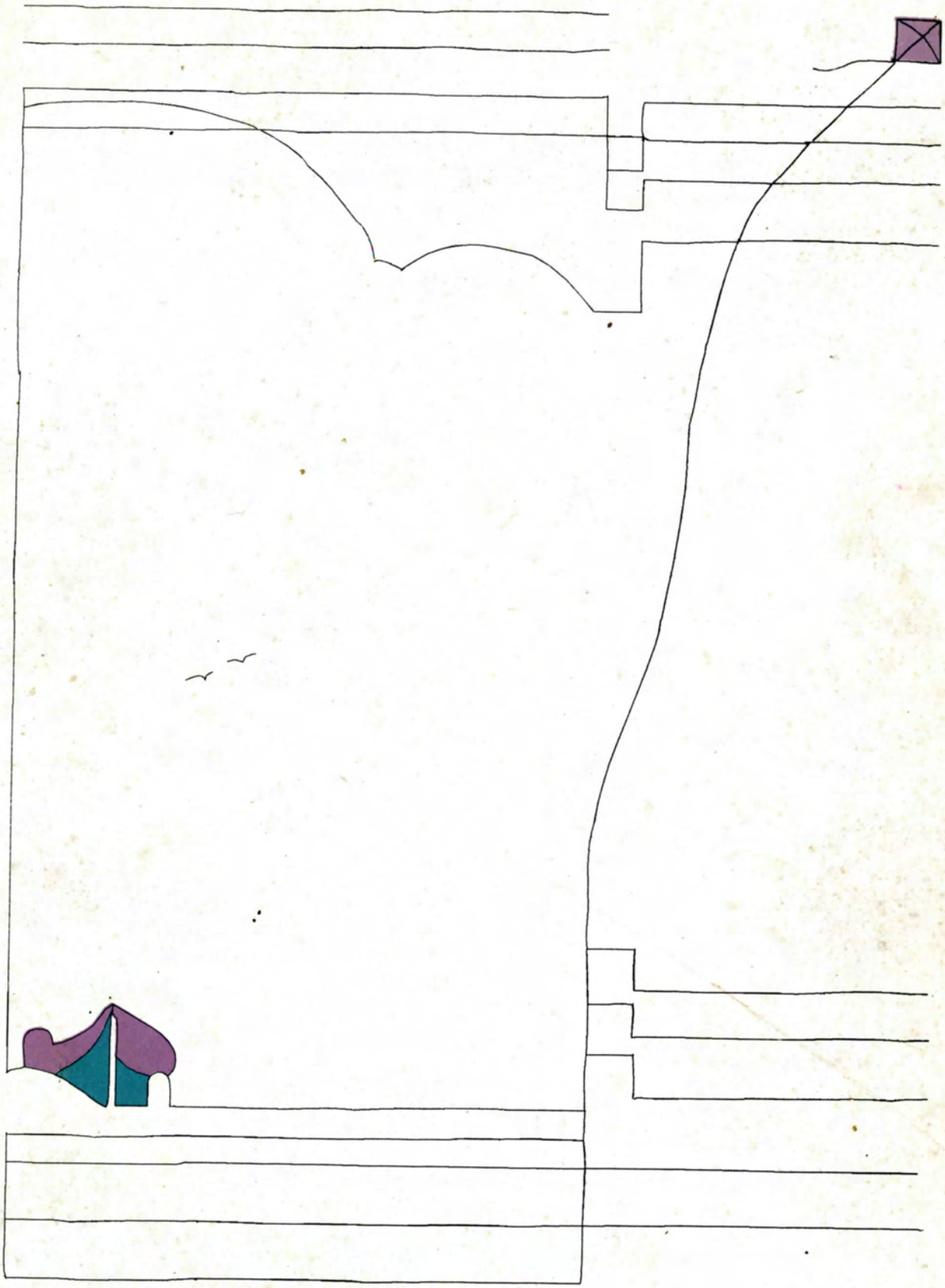

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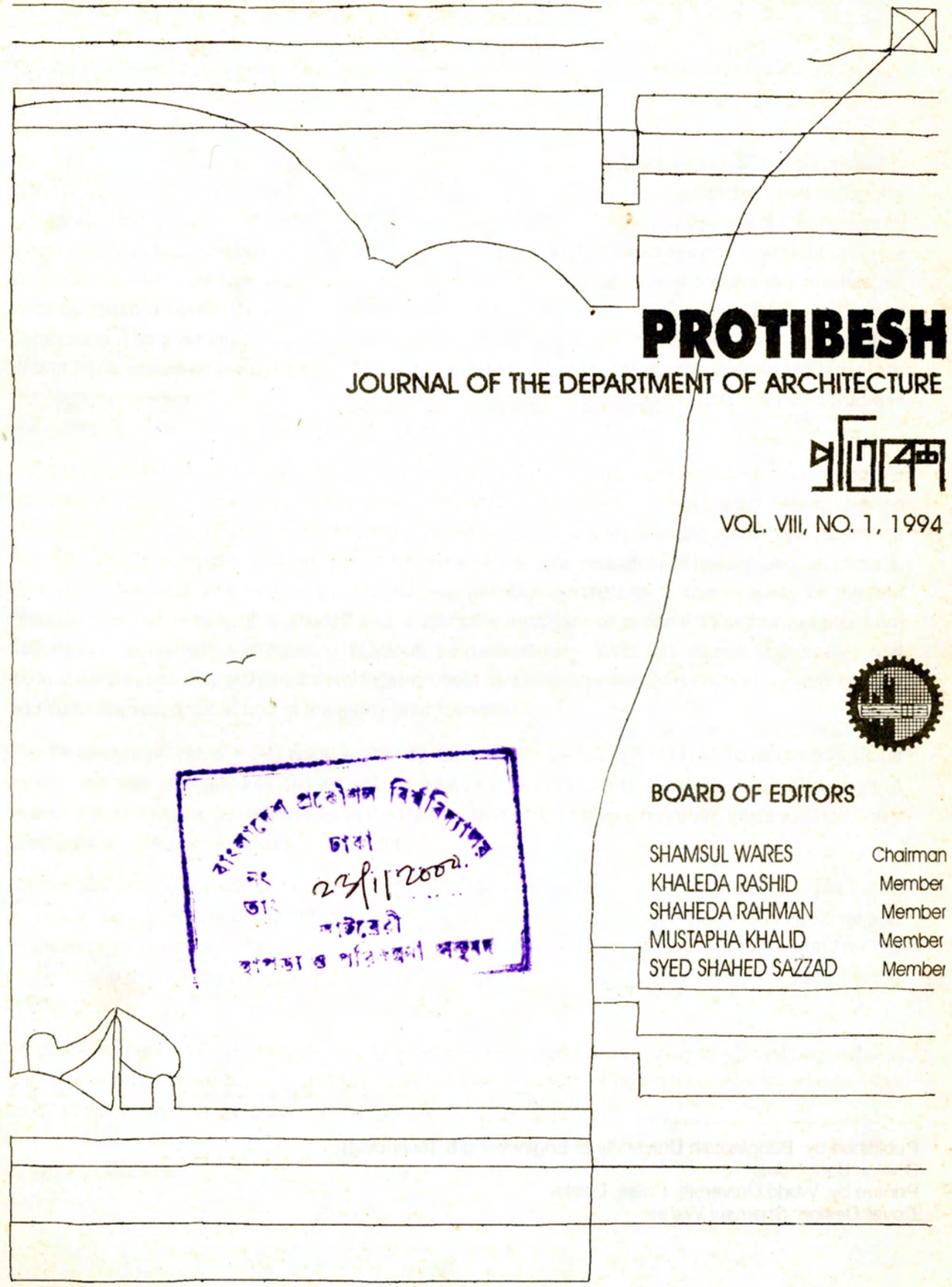
VOL. VIII, NO. 1, 1994

A JOURNAL OF THE DEPARTMENT OF ARCHITECTURE, BUET



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JOURNAL OF THE DEPARTMENT OF ARCHITECTURE

প্রতিবেশ

VOL. VIII, NO. 1, 1994

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Editor's Notes

It was not until the 1970's that architects as well as clients by begining to sense a loss of cultural identity in the post war built-environment, began to search for a new expression to reflect their own nationality and local culture. The search for a new expression was primarily motivated by a sense of reconstructing a community architecture based on lessons from the past, although the society continued to disintegrate into individualism. This new search did not mean to bringing the past into the present day realities but to bring about a continuity with the past and took various forms of Historicism, Regionalism and Symbolism. The graduates of our department who began to practice architecture after the Liberation War of 1971, absorbed various influences of this new global concern along with abstract Modernism of the west. By the end of 1980's it became gradually apparent that most of these global attempts to adress the issues of culture lacked intensity and clarity and became superfluous.

The idea that cultural development is a key feature of the all encompassing development of communities has recently been increasingly recognised. Cultural identity now appears as a major historical driving force pointing to future directions for meaningful development. The undustanding of culture is a complex process and therefore demands serious attentions with scientific objectivity to history, people, climate, ecology, economics and technology. Our society although consists of a vast majority of illiterate population is not simple. It is divided into a complex amalgam of political thoughts ranging from nationalism, socialism, liberalism to religious fundamentalism. With this complex character and motivation of our society architects need to bring about an architecture which is environmentally socially and culturally responsible and at the same time humanistic.

The 12 articles provided in this issue written by authors with particular expertise have raised various issues and also attempted to answer many questions. Materials in these writings are the result of intensive studies and research as well as the free expression of intution. Togather, these writings, have attempted to form the very basis of architecture.

The articles printed here were submitted on time and this issue of the journal was due to be published much earlier. I apologise on behalf of the Editorial Board for failing to publish the journal on time and for causing inconvenience to many. I also apologise for the printing mistakes and particularly for not being able to provide the necessary references to all images and pictorial documents provided in the articles.

I express my regards to all the technical member who reviewed the articles and advised suggestions to each author. I also express my gratitude to all the members of the Editorial Board for their labour and services without whom the issue would not have seen the light.

Shamsul Wares

PROTIBESH

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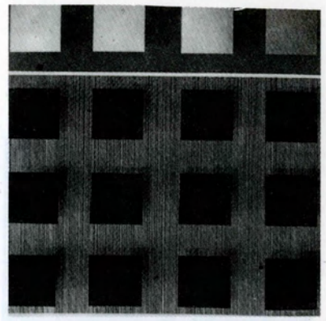
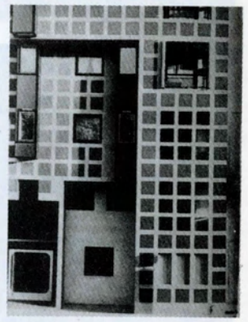
ART AND ARCHITECTURE

On Painting and Architecture

Zainab Faruqui Ali





Abstract

Architects have always turned to paintings for inspiration. They have compared architecture with paintings, and also have used paintings for their presentation.

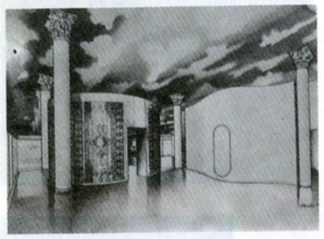
The bold 'Carceri' etchings of G. B. Piranesi have influenced the French visionary architects Boullee and Ledoux, English neoclassicist John Soane, modern master L. I. Kahn, and many more. The interplay of planes of the pictures of Japanese paintings have appeared in the asymmetrical spatial arrangement of Wright's prairie houses. Again, Mies' works after 1923 display influences of paintings of that time. Corbusier painted vigorously from 1917 to 1925; and all the pushed and pulls, the tensions of the plans, the free space, the mobility, the weightlessness of his purist villas echo his purist paintings.

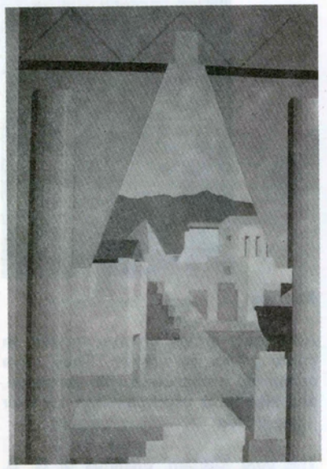
Hence, at no time paintings failed to produce spirits to those who were occupied with architectural conceptions.

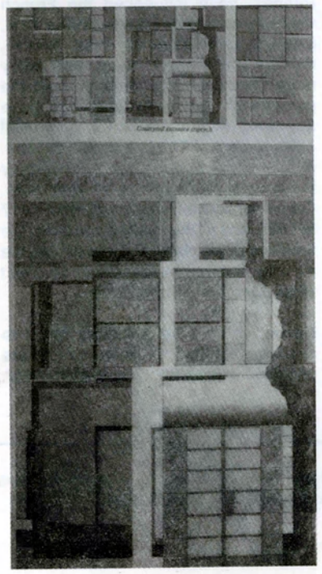
Paintings-hung from the living room walls or displayed in the superbly-lit modern art museums, give us joy, take us to far away places, stir our memories. Their colours create mood, compositions evoke thoughts. From the very beginning of the history, paintings have provided stimulus to many great architecture. Architects have always turned to paintings and architecture of the masters for inspiration. Paintings have dictated architecture, we have compared architecture with painting, and also architects have used paintings for their presentation. Many a times paintings have led the way of architecture, and those bold brush stokes, pale water colours or majestics ketches have guided architects in developing their ideas. Many times architects have adopted the style of painting as their presentation technique. Michael Graves' superb drawings exemplify this . Otto Wagner, Stanley Tigerman or Aldo Rossi very often treat their architectural presentation as a painter would paint on his canvas. (fig.1)

The great Italian maestro Michelangelo introduced a dynamic space, instead of static emptiness, shown in perspective in his painting 'The Last Judgment'. This spatial conception was achieved by the same master some years later in architecture in the Capitol, Rome. And throughout the artistic period of Renaissance, paintings were in advance to architecture in expressing the Renaissance feeling.

Zainab Faruqui Ali, B. Arch., Assistant Professor: Several years experience as designer in architectural firms in USA. Areas of interest are architectural design, history, theory conservation of architecture and Energy conscious design.







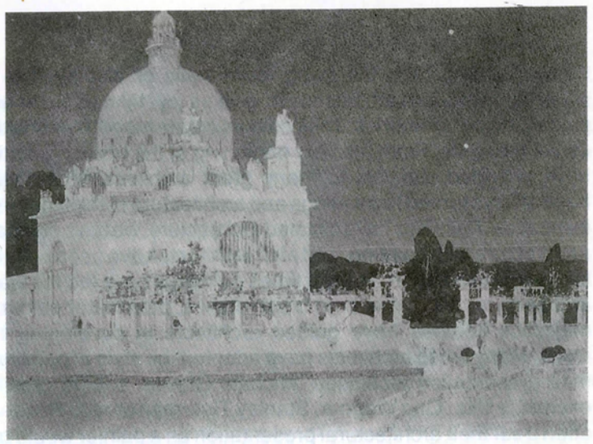
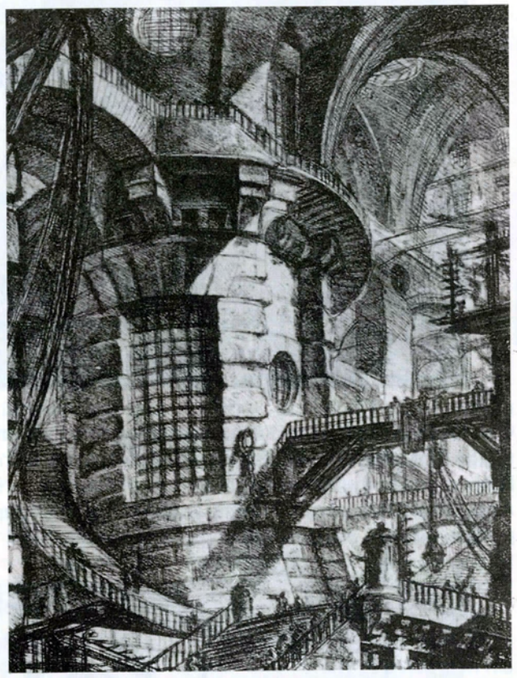


FIGURE 1

Piranesi

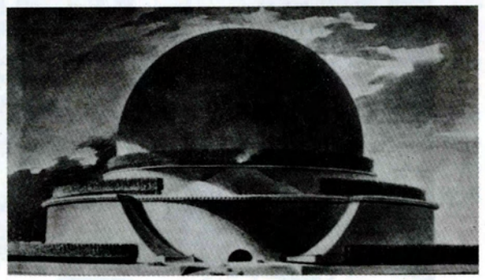
In the mid 18th century, the introduction of Romantic Classicism in Europe was geared by a Scottish painter, a Venetian painter-etcher and a German Archaeologist. Certain aspects of Romantic Classicism were boldly presented by the 'Carceri' or prison series etchings of G. B. Piranesi. In 'Carceri' drawings, architectural fantasy strains and tries to break the boundaries of human perception. With his multiple perspectives and superb management of light, Piranesi was working towards mastery of spatial ambiguities in art. Lines in his pictures move and soar, stirring our imagination, making us wonder and filling us with sadness ad a sense of mystery (fig.2).

figure 2

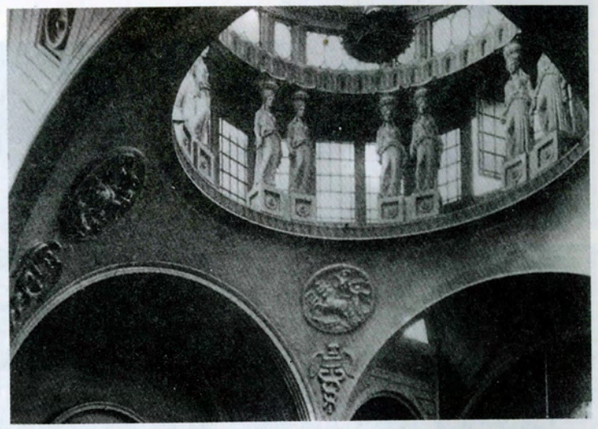


French visionary architects like Boullee and Ledoux constantly derived influences from Piranesi. Ledoux's work shows presence

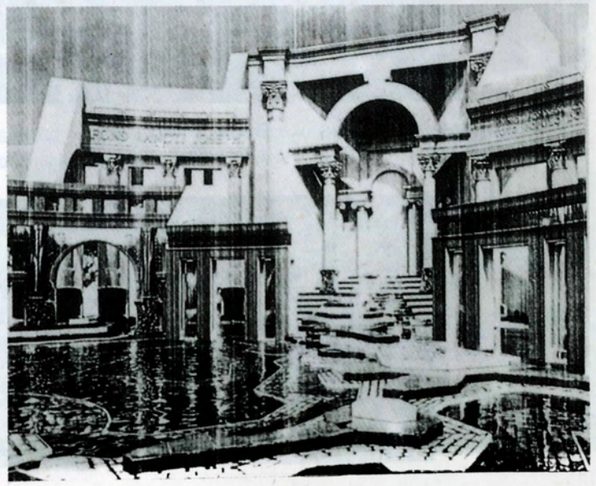
figure 3



of Piranesian touches of visual drama (fig 3). In England, romantic classicist John Soane's Bank of England buildings ad his own museum carried the spatial and decorative innovations of interiors of this period. In the Colonial Office of the Bank of England building in London the lighting of the dome-topped arched interior echoes similar effect of the Piranesian interior sketches (fig 4). Spanish art nouveau master Gaudi's Sagrada Familia in Barcelona point to the dream like forms of Piranesi. Coming to modern times, such influence can be observed in

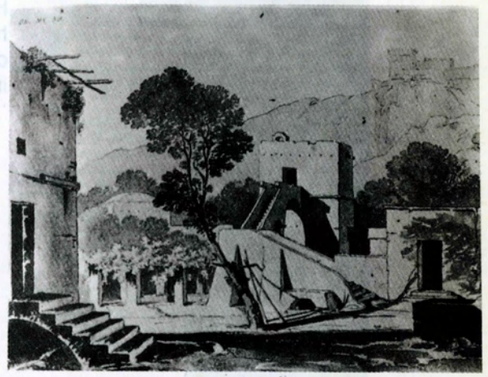


Charles Moore's Piazza D'Italia's complex arrangement of arcades (fig.5). The carefully calculated spatial complexity with its dramatic lighting inside the Assembly building in Dhaka by L. I. Kahn may also recall the same effects created by the superimposed perspectives of Piranesi etchings



Schinkel

Karl Friedrich Schinkel is ranked among the best-known romantic classical architects of 19th century. He is notable for his concern for the necessity of relating his buildings to their surrounding environment . His early 19th century proposals include harmonious and organised

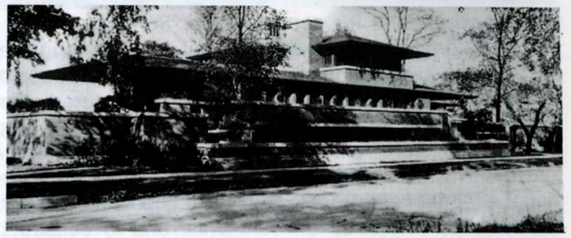


urban environment for central Berlin. Schinkel himself was a painter before he became a theatre set decorator and eventually an architect. It is through his paintings that he developed a sense of proportion and total composition whose matured expression was delivered in his architecture (fig.6). A competent landscape painter, Schinkel spent many years painting for patrons and for himself. This occupation taught him to extract the essence of visual experience, to record in his sketchbook conformations of natural and man-made environments, and to construct in his paintings evocative scenes of a romantic world. Schinkel's unfailing skill in fusing logic and charm, order and variety is evident in his buildings of Potsdam which was based on fusing lightness and strength, clarity and elaboration into sublime and perfect colour schemes of his earlier age. T. Fontane once remarked that he painted like an architect and built like a painter.[1] The "malerische" character of his architecture would come not from decorative surfaces or other colouristic effects, but from an approach to the total environment of a building, the essential features of which he was assimilating and developing during his years as a painter. His interest in the relationship between nature and architecture was stimulated and sustained by exercises in fantasy landscapes which found its ultimate success in the Court Gardeners House at Potsdam (fig.7).

1. Pundt, H. G., *Schinkel's Berlin*, Harvard University Press, Cambridge, Mass. 1972; p 99

Wright

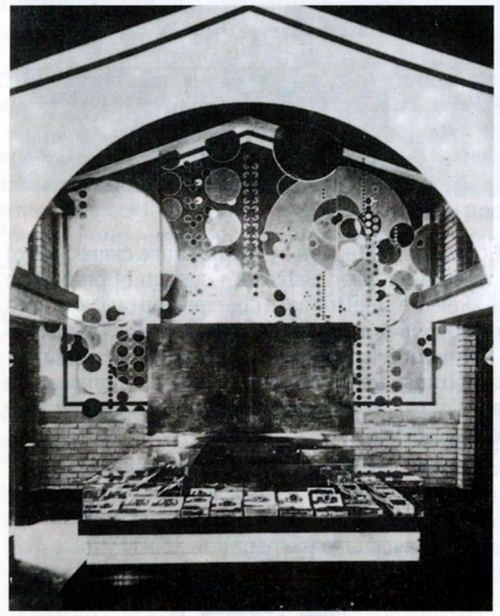
Modern master Frank Lloyd Wright was influenced by Japanese paintings. The interplay of planes in he pictures of Japanese prints have appeared in the asymmetrical spatial arrangement of his prairie houses (fig.8). These houses also contain the same type of Japanese lightness and natural settings. The delicate proportions of the Hardy House, with its three levels poised in the side of a hill above lake Mendota, the elaborate but serene interweaving of lower and higher spaces and masses in the Coonley House; the clean progression and regression of light coloured planes in the Gale House are all examples of this subtle but definite influence. He believed that Japanese paintings contained the interior space harmony which penetrates the outward form and " is its determining character, that quality in the thing . . . . .that is its significance and its life for us"[2] (fig.9).



V. Scully compared Wright's work with paintings by saying, 'Robie House combines Cezanne's reverence for the majesty of solid things and his recongnition of the forces that pull at them with Picasso's fragmentation of solids into planes which move continuously through space' (fig .10). His murals in the Midway Gardens in Chicago, called 'City by the sea' displays a complex non perspective composition of overlapping coloured circles. This design extended beyond the painted frame and even the architectural moulding, and in the process blends the pictorial with the structural (fig. 11). These techniques incorporate the advanced theoretical ideas at that time since Wassily Kandinsky overlapped circles in paintings in similar manner in about the same time.[3] By studying the prairie houses, we see that Wright varied the stained

2. Hanks, D. A., *The Decorative Designs of Frank Lloyd Wright*, E. P. Dutton, NY. 1979; p7
3. Hanks; p 121

glass windows from room to room and by changing the windows, he changed the colour, the quality and the play of light. Wright's most important single window designs were for the Avery Coonley Playhouse of 1912. The clerestory windows, contemporary with some of first European abstract paintings, have affinities with the later paintings of Piet Mondrian (fig. 12).



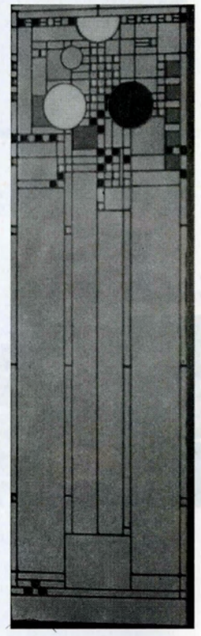
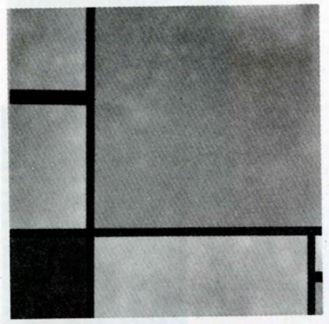


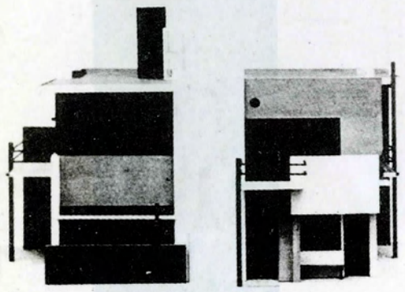
FIGURE 11 AND 12

De Stijl

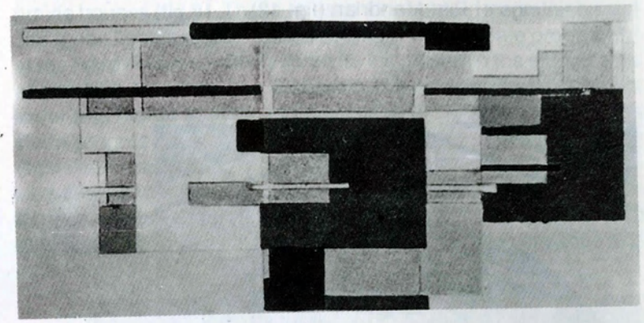
The rhythmic patterns of sliding lines and planes which van Doesburg developed and Mondrian culminated around 1920, are visible in many of the later architects such as Rietveld's or Mies's interwoven arrangement of plastic masses. Mondrian claimed that he was seeking an abstract formulation which could merge both the continuity and the stability of modern times. The order created by his long, crossing lines,his tensely balanced proportions, and his rectangles of primary colours were the inspiration for planning, massing and elevation treatment of the "International style" architecture of the 20s and 30s. Theo van Doesburg and G. Rietveld grasped clearly the three dimensional aspect of such geometrical abstraction. Rietveld's Schroeder House was named

FIGURE 13





a cardboard Mondrian. The small rectangular house is composed of planes, horizontal and vertical, sometimes intersecting each other. The smooth surfaces are directly influenced by Mondrian paintings in both colour and composition like a visual music in touch with emotions[4] (fig.13).



Mies

Mise van der Rohe was influenced by the romantic classicism of Schinkel, and when he applied Schinkel's system of proportion and order to the skeleton steel frame, it changed the built form into shifting planes suspended in space which is the image of suprematism. Farnsworth is also purely suprematism display or the architecture of transparency pointing to the dematerialisation of architecture[5] (fig 14). Mies's works after 1923 display to a varying degree three major

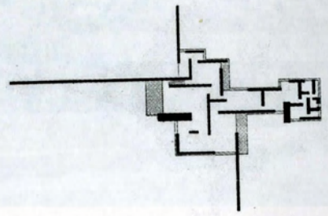


FIGURE 14

influences, the two of which were paintings of that time.-De Stijl and Kasimir Malevich's suprematism. It was suprematism that encouraged Mies to ultimately develop the free plan. Mies's project for a brick country house of 1923 shows influence of the De Stijl movement in the simplicity and clarity of plan. The pin-wheel plan allows the lines continuously outward and interrupts them rhythmically with other lines in a way expressed by van Doesburg in 'Rhythms of a Russian Dance of 1917[6] (fig 15). Mies's European Master work, the German State pavilion or the Barcelona Pavilion at the Barcelona World Exhibition of 1929 displays

4. Curtis, W. J., *Modern Architecture since 1900*, Oxford Phaidon Press Ltd., 1987; p 93

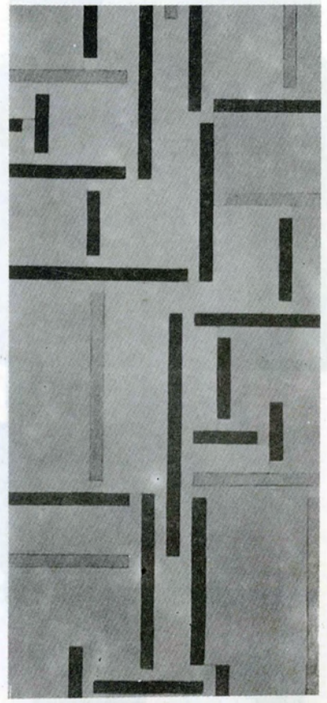
5. Frampton, K., *Modern Architecture*, Thames and Hudson Ltd., London, 1985; p 232

6. Drexler, A., *Mies van der Rohe*, George braziller, Inc., 1960.

horizontal centrifugal spatial arrangement that was subdivided and articulated by free-standing planes and columns. Contemporary photographs after restoration in 1986 reveal the inexpressible quality of its spatial and material forms. Certain displacements in its volume were brought about by creating images of the main bounding planes made of marble. Also the Tinian marble wall in its turn reflected the chromium plated steel mullions, and thus forming a suprematist composition[7] (fig 16). Again, Malevich's 'White on White' expressing the non objectivity of universal space is very close to the 'almost nothing' concept of Mies van der Rohe's architecture.

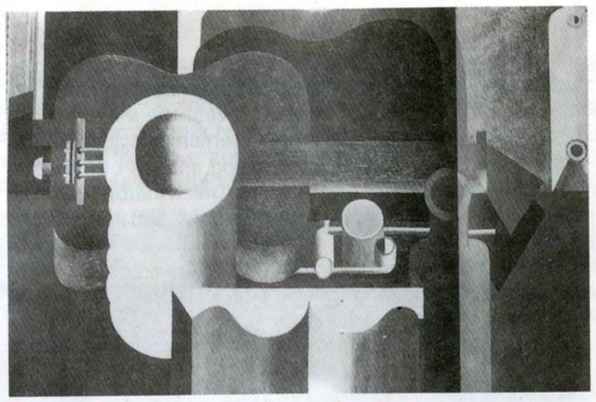
Cubism

Architects who considered themselves modernists around the beginning of 20th century were generally associated with the influence of abstract art on architecture. This modern movement, descended from both Cubism and Futurism, filled a desperate gap in the architectural thought immediately after the first world war in Europe. Form-hungry architects banked on the work of Malevich, Lissitsky, Mondrian and van Doesburg, and extracted from it a reservoir of rectangular forms and rules for introducing them to one another. Picasso and Braque produced a visual language mixing abstract elements and parts of realistic elements, thus developing three-dimensional sense of forms within the two dimensional universe of the canvas. By representing the object from many angles gives movement to the viewer, who can move freely, may be only in thought, around the object (fig. 17). Before Cubism, the viewer was used to watching an object from single viewpoint. This idea of space when transformed to architecture gave spaces a new mobility. Instead of the traditional system fof static, purely visual, arrangement of spaces composed in term of axes and symmetries, the architecture now became the sum total of complex experience of movement. An important transition of cubism into purism happened in France in the hands of Le Corbusier and Ozenfant. While Le Corbusier was working in 1908 in Paris with Perret, he would spend his lonely hours wandering around the museums watching the paintings of Cezanne and others. Corbusier and Ozenfant started using the combination of abstract forms with representational fragments and with spaces in tight layers in their paintings. The subject matter was everyday objects of the cafe table, the studio and the machine shop: guitars, bottles , and pipes were presented in their typical forms in a plastic composition. In his 'Still life' of 1920, outlines of bottle and guitar are reduced to simple geometric shapes and visual tension is achieved by overlapping of object (fig. 18). Same as Schinkel, painting improved Corbusier's sense of scale, proportion and composition. Corbusier painted throughout the time of 'L'Esprit Nouveau', from



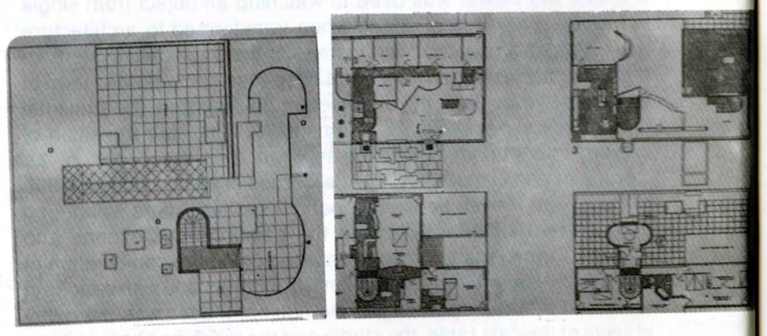
7. Frampton, K.; p 165

FIGURE 18



1917 to 1925, his Purist period. But in the process he was formulating his new concept of architectural form accentuated by love of pure shapes. The merging of contours, between the different objects and outlines points to the interpenetration of inner and outer space achieved later in his buildings. His carrier as a painter became important to him when he became Le Corbusier the architect, because it helped him with a laboratory of forms. All the pushes and pulls, the tensions of the plans, the free space, the mobility, the weightlessness of his purist villas echo his purist paintings (fig 19).

figure 19



Without this "plastique" experimentation in painting which he dealt with his feeling and passion, Corbu probably would never have created the forms that appeared in his architectural work. In architecture, whether Corbu asserted the order-giving power of the right angleor developed a free system of organising spaces, he incorporated all of the contemporary theories on the composition of plastic space. From the geometric simultaneity of Cubism, the grid-space theory and to the dynamism of Kandinsky, Corbu assimilated them all in his work[8] (fig. 20).

8. Besset, M, *Le Corbusier*, Rizzoli Int. Publications, Inc.,NY. 1976; p144

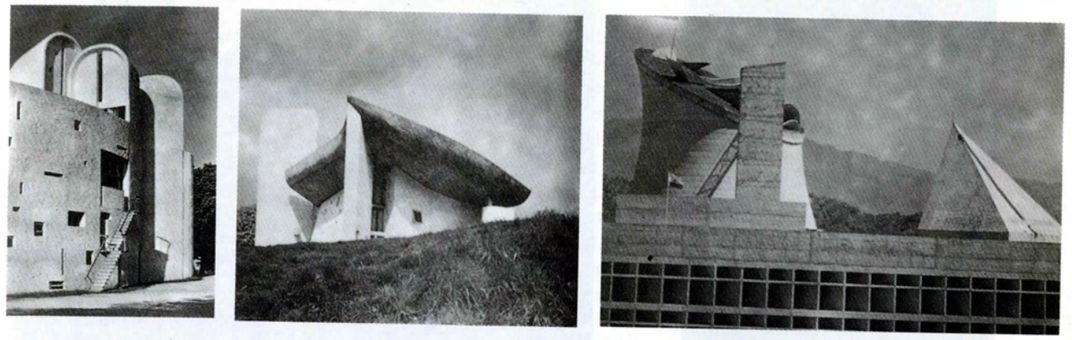
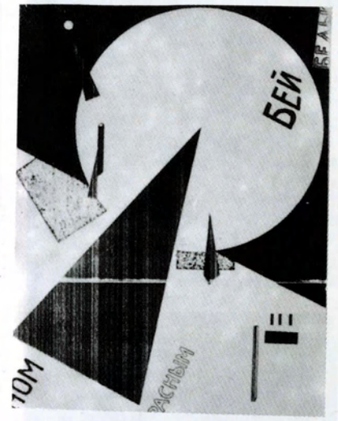


FIGURE 20

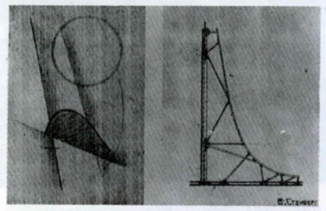
Russian Constructivism

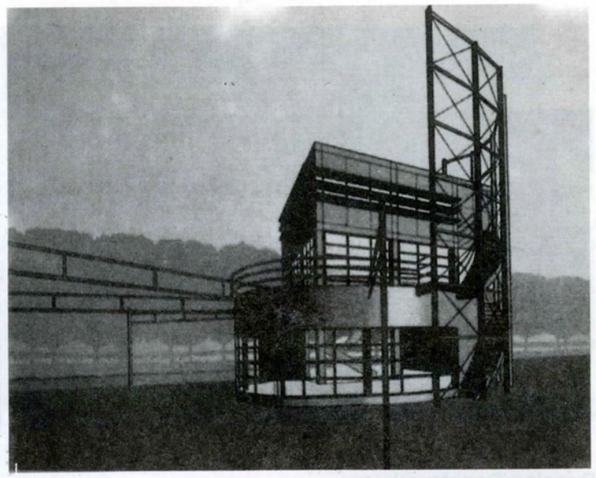
Development of the Russian avant-garde architecture or the constructivist architecture was tremendously influenced by the movement in painting called Suprematism. Beginning with the Revolution of 1917, Russian Constructivism tried to symbolise the very idea of a revolutionary society. They used light, plane, space, colour, volume along with materials, constructed in a composition. Their preference for inclined planes, dynamic stairs and contrasting geometry, wheels, windmills, unfinished material texture, of black an red components came from the paintings of Kandinsky (fig 20). Constructivist architecture tried to fuse the abstract art with the articulation of functional and mechanically moving parts. Sant Elia worked with images of a new architecture made of light materials, with elevators snaking up and down, or ramps and stairs crisscrossing the interior space (fig 21a). Lissitsky's paintings 'Beat the whites with the Red Wedge' is simplified suprematist forms and spatial concept. Lissitsky's 'Lenin Tribune' design of 1920, a collage painting of engineered structure and floating form, was becoming models for a new kind of weightless architecture. Constructivism was an anti traditional art, anti traditional construction movement. Tatlin regarded himself as an artist-engineer. Melnikov's designs were combining in a fresh structuralist manner elements like exposed frame constructing angular roof, spiral stair, grid-fenestration, with horizontal, vertical and diagonal lines juxtaposed together. Architecture was now similar to new and dynamic forms of paintings, and the constructivist architects energies were exclusively devoted to the invention of never-seen-before forms. (fig 21b).Ivan Leonidov's competition entry 'Palace of Culture' most effectively suggest that he was drawing upon the suprematist resource of Malevich as in 'Red Square or Peasant Woman in two dimensions'.[9] These machine-romantic constructivists wanted to provide 'artistic objects for everyone'. The idea of production of art in favour of production of useful objects' exemplified by the two paintings 'Composition' and 'Construction' shows vividly how painting had inspired architecture in this period[10] (fig. 22).

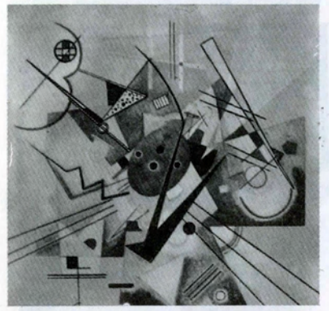


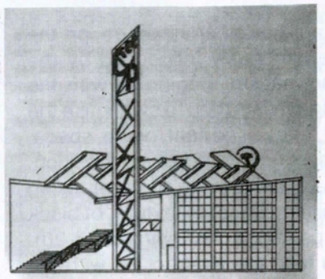
9. Guggenheim Magazine, Guggenheim Museum, NY. Fall 1992; p 24

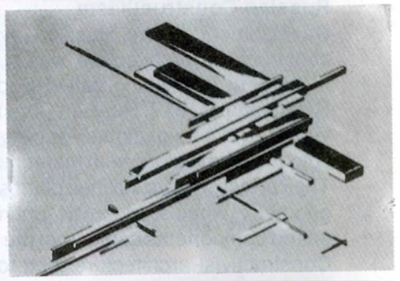
10. Guggenheim Magazine; p 19

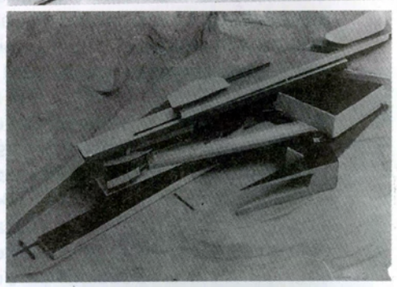


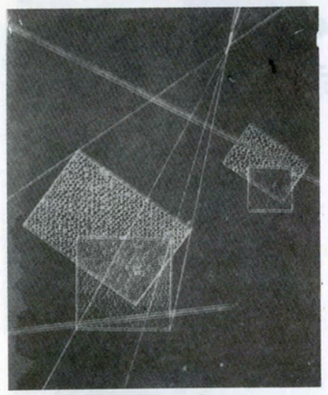


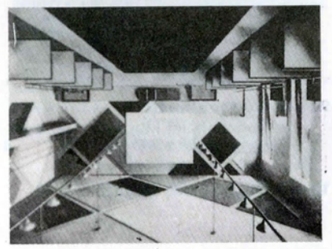


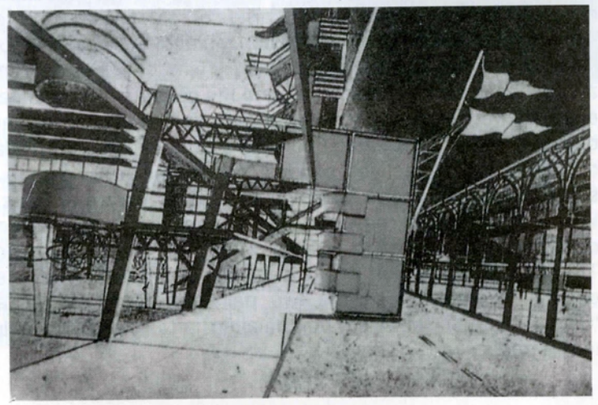








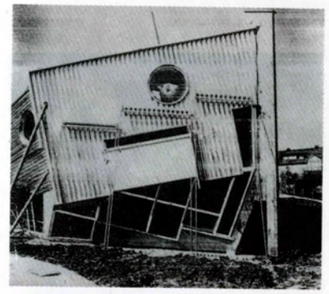


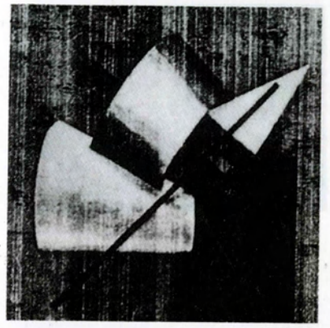


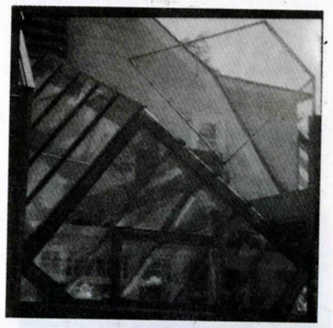
Deconstructivism

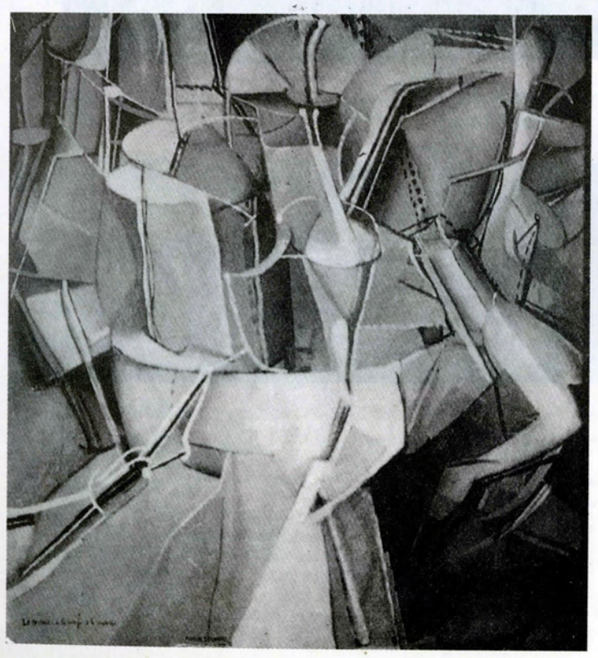
The deconstructivist architects of today are pursuing the unfinished architectural revolution begun by the Russian Constructivists. One such architect is Zaha Hadid whose design process begins with visionary paintings of suprematist-constructivist nature, in which she explores buildings and cities. Her work shows a direct debt to paintings, and sculptures of Malevich and Tatlin.[11] (fig.23). Today's deconstructivists have used work of Russian avant-garde as the starting point of their compositions which can be supported with the examples of works of Chernikov and Hadid. (fig. 24,25). Suprematist scaleless, measureless appearance is being applied by deconstructivists such as Peter Eisenmann or Rem Koolhaus. Bernard Tschumi's Parc de la Villete of 1986 explodes and deconstructs the idea of mechanical construction explored by Chernikov (Fig. 25,26,27).

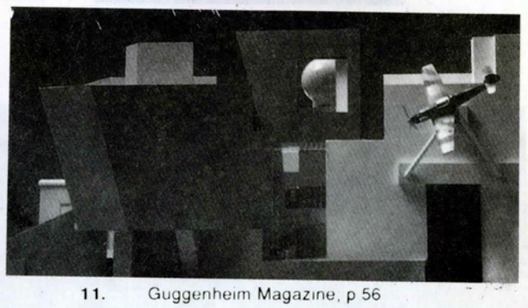
Similar to the cubist and constructivist paintings, in Frank Gehry's deconstructive building the eye wishes to carry out an acrobatic tour around its walls, roof, and foundations. Here the role of viewer and the viewed are taken as basic criteria. His work give an unexpected visual orchestration by creating unusual effects with variety of material . 'Buildings under construction looks nicer and poetic that buildings finsihed'- is the underlying idea of his deconstructive architecture[12] On looking at painting Gehry appreciates the immediacy in paintings, as if the brush strokes were just made. Because of his involvement with paintings, he wanted to bring out these qualities to buildings, such as how a building could be made to look like it is in process, and how can the expressive and compositional attitudes of painting be explored in a building. Gehry' keen interest lies in the unfinished quality that is found in paintings by Jackson Pollock, de Kooning, or Cezanne, which give the impression that the paint was just applied[13] (fig.28).







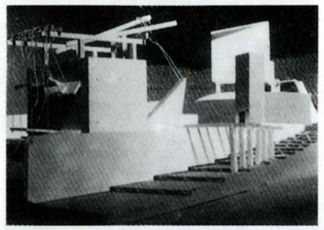


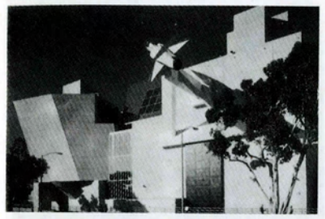


11. Guggenheim Magazine, p 56

12. Arnell, P. and Bickford, T., *Frank Gehry*, Rizzoli Int. Publications, Inc., NY. 1985; p XIII

13. Arnell, P. and Bickford; p 7

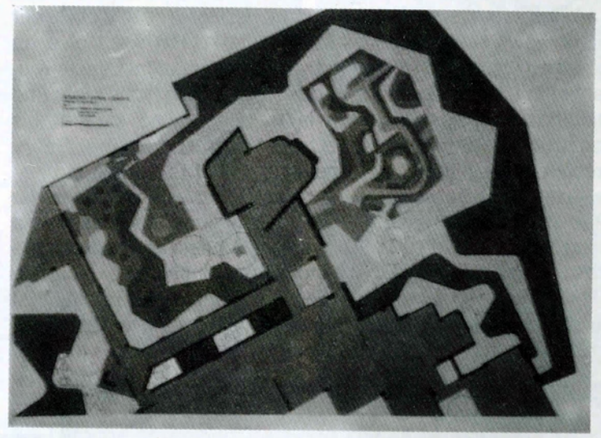


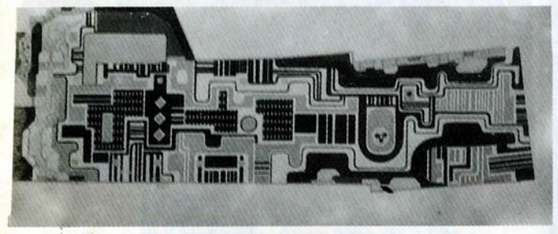


Landscape architecture

Brazilian painter - landscape designer Roberto Burle Marx has taken landscape design as a serious artistic endeavour. He approaches garden design as an artist, as a painter. His vast knowledge of plants and their life cycles allows him to design mature, organic, three-dimensional composition from the abstract painting.[14] (fig. 29a,b). Burle Marx has been painting with plants some of the most beautiful and meaningful landscape designs of the century. We can find the lyrical qualities of Matisse present in his colourful garden designs. At other times, the sensual painterly line Marx developed in his landscape designs with interlocking forms of planting beds, walks, pools, screen walls reveals his liking for abstract art of Arp, Calder, Miro & Picasso.

So we can say that one painting may tell us stories, another may make us think, but at no time has painting failed to produce spirits to those who were occupied with architectural conceptions. Painting thus will always keep on playing its role as a lyrical element as well





14. Adams, W.H., *Roberto Burle Marx*, New York Museum of Modern Art, 1991; p 21

as a source of inspiration for architects to come.

Fig Number Fig-Title Picture	Name Painting	Architecture
(1)	Stanley Tigerman,	(1) Otto Wagner
(1)	Aldo Rossi,	(1) Aldo Rossi
(1)	Micheal Graves,	(1)Micheal Garves
(2)	G. B. Piranesi	
(3)	Etienne Boullee	
(4)	Sir John Soane	
(5)	Charles Moore	
(6)	Karl F. Schinkel	
(7)	Karl F. Schinkel	
(8)	Frank Lloyd Wright	
(9)	Frank Lloyd Wright	
(10)	Frank Lloyd Wrgtht	
(11)	Frank Lloyd wright	
(12)	Frank Lloyd Wright	
(13)	Piet Mondrian	
(13)	Gerrit Rietveld	
(13)	Theo Van Doesberg	
(14)	(Unknown)	
(15)	Mies Vander Rohe	
(16)	Theo Van Doesberg	
(17)	Pablo Picasso	
(18)	Le Corbusier	
(19)	Le Corbusier	
(19)	Le Corbusier	
(20)	Le Corbusier	
(21a)	EL Lizzitsky	
(21b)	EL Lizzitsky	
(21b)	VladimirTatlin	
(22)	Laszlo Moholy -Nagy	
(22)	Teo Van Doesberg	
(22)	Stenberg	
(22)	Wassily Kandinsky	
(23a)	Bernard Tschumi	
(23a)	Melnikov	
(23b)	Zaha Hadid	
(23b)	Malerich	
(24)	Chernikov	
(24)	Zaha Hadid	
(25)	Zaha Hadid	
(26)	Bernard Tschumi	
(27)		
(27)	Frank Gehry	
(28)	Ivan Puni	
(28)	Fank Gehry	
(28)	Frank Gehry	
(28)	Frank Gehry	

(28)	Rrank Gehry
(28)	Frank Gehry
29a.	Roberto B. Marx
29b	Roberto B. Marx
29b	Roberto B. Marx
29c	Roberto B. Marx

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Humanism and Culture: A Discourse of Architectural Continuity in Bangladesh

Saif-ul-Haq

Abstract

Culture can be thought of as a 'thread' that continues through generations and to which events and developments are tied to. This 'thread' can take many forms and can be, among others, religion, science, cosmology, myths, folk-lore, etc.

This paper seeks to examine the form which the Bangladeshi 'thread' of culture takes. In this regard it argues that **Humanism** is the main theme along which it propagates. Therefore, to understand and participate effectively in this culture, the creative person needs to consider human experience as his base of studies.

Introduction

The concept of culture, cultural continuity and humanism deals, at an abstract level, with the values, traditions and ways of living. The beginning of discussion on such matters should therefore be focussed on the definition and meaning of these concepts.

Humanism is a doctrine which is centered upon human interest and values. It is the philosophy which regards man as the central object. It takes human experience as the starting point for man's knowledge. This concept asserts the essential dignity and worth of man and his capacity to achieve self-realization through the use of human and scientific method. Characterised by a shift of emphasis from the religious to the secular concerns, this idea of devotion to human welfare developed primarily from the European Renaissance movement.

Cultrue is the result of the development of intellect through learning, education and training. It is the arts, beliefs, customs, institutions

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and all other products of human work and thought created by people or a group, at a particualr time. Culture is both an intellectual activity as well as a folk attitude. It is the complete way of life, of a person or of a society. Some of its more visual indices could be the arts, articfacts and architecture. It rises from the wisdom of the people and can have many things as its central focus. At one period European culture was centered around religion and all its activities were focused on that . Buildings, paintings, literature and all other efforts of human endeavour were straining to attain the highest religious passion. At some other time and place someting different might have been the central theme. Nature, environment, superstition, honour are some such themes of culture.

In this discourse, the evolution of Bangladeshi[1] culture and its continuous propagation through generations is investigated. This is done with the implicit idea of discovering the process by which the concept of Humanism attaches itself, breaks away from or even dictates cultural continuance. Since continuity is the thems, cross cultural analysis shall not be a major portion. Instead, the pressures upon subsequent generations shall be looked into togather the inherent forces of the wider Bengali culture in order to determine what makes it a continuous chain. From this , it is hoped, a direction form the architectural continuity of Bangladesh will emerge:

The European pre-industrial society had three concurrent culture types. They were:

a. Aristocratic culture . This was maintained , propagated and sustained by the feudal system.

b. Religious culture. Determined by the religious community, this was also supported by the rulijg class.

c. Popular urban and rural cultures. This was essentially folk and was crafts based.

The imposition of a mercantile economy and industrialization gradually gnawed at and replaced these. In this manner, a new culture of dominance developed where the traditional craft based culture became obsolete. Theoritician Leon krier maintains that quick consumption possibilities became the criteria for accepted values.[2] From this developed the concept of style. This replaced imagery in the old system. The hands were divorced from the spirit. "Traditional (artisan) cultures were concerned with the production of objects of long-term use. Modernist (industrial) cultures were consumption.[3] Krier suggests that at this point, obligatory education even wiped away the popular knowledge which was in the collective memory. In this process culture lost its meaning, its historical context, its social function and ethical significance. There had been an obsession with commerce instead of culture and with money instead of beauty. Therefore, Humanism as an essence of culture was obliterated.

Reference :

1. The term 'Bangladeshi' is a term associated with the present day political boundary of Bangladesh
2. Krier, "Somal dictator ship policy statement" in Archtectural Design, Vol57 No. 1/2, 198/ Post Modernism and Discontunity
3. ibid,pc 39

Theme; Bangladeshi Culture, A Dis-course of Its Continuity

With this introduction to culture and an exposure to at least one of the external disparaging forces, the focus turns toward the theme of this paper-the Bangladeshi culture. In the effort to map its development and changes, the idea of Humanism shall be resorted to as the 'sounding board' to test the reasons of reactions to the extremely bewildering forces that were exerted on it. Hopefully it shall make an interesting contrast to Leon krier's and also Prince Charles's tragic view of European culture.[4]

a. Language as a Vehicle of Continuity

Although Bangladesh is relatively young among the world's emerging nations, the history of its society and of the larger political and cultural systems on the Indian subcontinent of which the *Bangalee*[5] people have been a part, is long and complex. However, in spite of repeated ravages of political, social, cultural and other forces, a remarkable resilience has been shown by the language. It is the force that not only represents the essence of the Bangalee, but is also the pivotal factor on which events in history turned course. The fact that the language is the living representation of the *Bangalee* people and that it is the basis of folk culture, adequately signifies that countinuity of culture has as its common denominator, the language and it, in turn, is a metaphor of the common man.

Bangla[6] is a derivative of the Eastern *Prakrit* language. This language and its script is identified at about 1000 AD and then by the Hindu rulers for the next century.[7] From about 1200 A.D the Muslim conquests began. At this time one peculiarity is observed. It remains unclear as to how the transfer took place between the pre-Islamic and the Islamic; and how the desert-born religion took roots in the alluvial soil of Bengal. Compared to about ten years in North India, this process took nearly a century here. This was a time of turmoil. The evolution of literature in this period is not very clear and there is also a discontinuity in archaeological information.[8] Strangetly enough, when literature emerges at about 1350., it displayed a remarkable degree of maturity. It would therefore be reasonable to assume that it had existed and had developed verbally among the people, but in these troubled times, no attempts were made for documentation.

The period between 1350 to 1800 AD is known as the Medieval period *of Bangla* literature. It should be noted here that in this period all literary activities were in poetry. Alaol, Krittibas, Chandidas, are some well known poets of this period.[9] The medieval writings were mostly eulogistic extended poems. The Hindus depicted the tale of Radha-Krishna and the Muslims narrated the tales of Muharram and Lady Julekha. Sufiism was very strong at this time and since this was not essentially different from Tantric Buddhism and Sakthi Brahmanism, there were numerous exchanges between the Hindu

4. "Prince Charles and the Architectural Debate" in Architectural Design, Vol 59,No. 5/6, 1989.
5. Bangalee is the collective name of the people living in the geographical area known as Bengal. At present, Bengal is divided into West Bengal in India, and Bangladesh.
6. Bangla is the language of the Bangalee.
7. Nyrop, .R.F.Benderly, B.L, Conn, C.C Cover, W.W,Eglin,D.R.Area Handbook for Bangladesh.
8. Haque, E.I.Islamic Art., Heritage of Bangladesh, Dhaka 1983 P. 37
9. Department of Films and Publication *This is Bangladesh*

and the Muslim poets.[10] This reflects the religious harmony which exist between Hindus and Muslims based on cultural similarities.

Prose in *Bangla* literature only started when English style education and the English language were introduced. Bengali writers, being influenced by these, started writing in the prose form in novels, short stories and journalism.[11] At this time a remarkable phenomenon took place. Before the advent of the prose form in the written language, the two religions co-existed peacefully. With the introductin of prose, scholars from both the religions took it to extremes. Rejecting *Bangla* as too barbaric for literature, the indus proposed a Sangskritised pendantic version while the Muslims came up with a Perso-Arabic one.

Meanwhile., the common people were speaking in the well known vernacular Bangla. They rejected both the proposals and opted for the writen form of the verbal language. At this period,.British missionary William Carey and the Bengali scholar Raja Ram Mohan Roy developed a written form of the verbal Bangla with a detailed grammatical base. This proved to be the middle ground between the pedantry and the vernacular and was quicklyaccepted by the people. Another good reason was that it was the most effective way of expressinig the folklore and folk traditions which was previously carried verbally. Also, it was the most direct way of intellectural activity, expression of free thinking and cultural consciousness. Gradually, this flourished into a cultural revival which happened due to the powerful appeal to the senses of the common man by literary stalwarts like Rabindranath Thakur, Bankim Chandra, Sarat Chandra, Kazi Nazrul Islam. Michael Madhusudhan Datta, Meer Mosharraaf Hossain etc. Rabindranath Thakur deserves special mention here because of his excellence in novels, short stories, poetry, plays, songs, dances, art and nearly in all other conceivable forms of cultural expressions ad is evern today, an almost 'one-man' symbol of the *Bangla* culture.

This remarkable revival merged with incipient nationalism which ultimatedly lead to a cultureal renaissance. It happened not because of the influences of the elite and the so-called intellectuals, but because of the strength ofthe common person. It was a clear victory of Humanism in the cultural continuity of Bengal.

The formation of modern *Bangla* is not the only instance of the triumph of humanism. Just after independence from the British in 1947, the present Bangladesh became the eastern section of a two-part country called Pakistan. here again a cultural crisis began. The West Pakistan-based authorities declared Urdu to be the state language. As before, the common people did not accept the imposition of trestrictions of their language and started political movement. This was led by the intellectuals and the students. During a particularly severe upsurge on the 21st of Feburary 1952, some students were shot dead near the Dhaka Medical College. To

10. Dimock, E. C. "Muslim Vaishnava Poets in Bengal" in David Kopfed *Bengal Regional Identity*, Asian Studies Center, East Lansing, Michigan, 1969
11. Nyrop et al ibid.

commemorate this incidence, a *Shaheed Minar* or a monument to the martyrs was built on the site of the killings. Since language is the thing most dear to the *Bangalees* the symbolism associated to this structure was so intense and its appeal so herculean, that it became the symbol of Bangladeshi nationalism. The very fact that it was the structure which, despite its abvious lack of high architectural or sculptural characteristics[12] has become the most replicated structure in Bangladesh, indicates the overwhelming scope of the force it represents— the language. The contention between East and West Pakistan encompassed many more factors: social, economic, political and everything else except religion. But when the issue came to, language, the people were quick to mobilize and make a statement. In fact, it was the language movement which led the then East Pakistanis to the greater movement of independence which resulted in the free and sovereign country in 1971.

Once again it was Humanism, manitested in the language of the people which played the nost important role in the sequence of events and led to the continuity of cluture. It must be remembered that it is the force of the common man, and its strength had been tested. Its unique accent started because it could best depict the tolklore and folk traditions— and the essence of Bangladshi culture is folk.

b. Architecture as a Vehicle of Continuity

Bangladesh is a agriculture based riverine country set in rich alluvial soil. The structure built by the people are flimsy huts of mud or bamboo and covered by thatch. This gossamer like structure has however, a remarkable persistency and has remained unchanged in shape and structure for thousands of years. It has a curvilinear roof shape which is generated by the bent form of bamboo and is also a response to the torrential rains of the area.

When the Muslims came to Bengal they already had a highly developed architecture of their own. Their conquest of Bengal was not one of violence and destruction but of gradual influence and submission. This was something which had a two-way process attached to it. While the *Bangalees* gradually adapted Islam as a religion, Islam as a culture was also adopting the *Bangalee* traditions.

The mosques of Bengal soon took the shape of the curvilinear roof as an echo of the common man's hut. Their roofs changed to *do-chala* and *chau-chala* shapes and curved cornices appeared in the scene. Admittedly, it was a response to the intense rains of the region, but the form so painstakingly copied in brick was also a salute to the common person. So profound was its assertion, that it acted even on people outside the region and so the shape was imported to distant places of North India and beyond where there is no apparent climatic reason for it.[13]

12. Ali, M. M. "Sthapatyar Proyojo o Bibortan" (in Bengali), in Shamsur Rahman ed. *Muldhara* Year 1 No. 5, 28 Jan. 1990.
13. Brown. I. Indian Architecture (Vol.), Bombay, 1956

Later on, these huts were also found to be instrumental in forging a new house type for the colonialising British. The 'Bungalow' is a derivation from the same origin and it is a type which has spread not only all over the Indian subcontinent, but to most other countries of the world as well.[14]

In this manner, the image of the simple rural hut— a testament to humanism, has remained over the centuries as the symbol of the strength and continuity of *Bangla* culture.

One authoratative index of a culture's valuation of nature is its attitude and means of transforming the natural into the cultural.[15] Bangladeshi culture has displayed an association with the environment in not only its architecture, but in its folk traditions, its philosophy and in its everyday attitudes.[16] Contemporary architects operating in this scenario should be sympathetic to this fact of culture. This means essentially rethinking their position and establishing a new base of studies which is based on the common man. The success of the language and the form of the common man's hut remains exemplary in this regard. Only by starting a new from a folk base can the *Bangalee* assert themselves as a dynamic, and appropriately creative society.

c. Building Material as a Vehicle of Countinuity

Brick as a building material never had any difficulty in asserting itself. Made from the soil of the land, it was a representation of the land itself. The earliest remains of Buddhist architecture which goes back to the third century B.C. show remarkable techniques in the use of good quality bricks. The production methodology and the techniques have developed during the centuries and the material has almost become a representation of the culture itself. Therefore, there is a continuity of culture in the use of this material and in the resultant morphology of the structures.

Unfortunately, with the advent of modern materials and the acceretion of foreign values, acceptance of brick as an aesthetically pleasing material has deteriorated Therefore, whatever details that were developed from the Buddihist times are slowly being forgotten by the people.The splendid brickwork in the Buddhist monasteries, the Sultanate mosques and inthe everyday buildigs of the past are ignored, little studied and about to be forgotten.

This is a very serious issue for the contemporary architects who should concentrate on design and detaling with bricks. Manufactures too should research on quality, size, shape and color of this material, while the social reformers and scholars should focus on turning the direction of our acquired western aesthetic values into the traditional track.

14. King A. D. *The Bungalow: The production of a global culture,* London, 1984
15. Glassie Honry. "Vernaoilar Archyitecture and Society" in material culture, Spring, Vol. 16, No. 1,1984
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d. Outdoor Spaces as a Vehicle of Continuity

Buildings hardly ever played an important role in the everday life of the *Bangalee.* He built his thatched structure in the most simple way and was content with it. If it was blown away or was washed out, he simply built another. This attitude, when taken in a collective manner resulted in non-structures as tehidentifying spaces. The *vitti* of land for the home became the courtyards and open spaces became significant[17]. Trees became the places for outdoor gatherings and the symbol of collective activity.

Architects and planners must realise that both forms and spaces acquire meaning in very special ways.anthropological and psycho-analytical studies relating to the building profession should be sponsored so that more elaborate results could be applied during design.

FINAL NOTES

There are many more factors that could be studied to understand the thread of culture as it propagates through the generations. Painting. sculpture, dance, music, behaviour are some examples of these .Due to the limited scope of this paper, only those aspects that were of pafrticular interest to the architecture community were discussed.It should be noted that this paper is not an end but essentially a beginning of the investigation into the idea of **Humanism** and cultural continuity in Bangladesh

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Rekha Temples of Bengal : Re-confirming the Harmony between Man and Cosmos

Kabita Chakma

Abstract

Using an examination of the Rekha temples of Bengal as a vehicle, this paper attempts to demonstrate a symbolic correspondence between the universe, a human being and architecture. In establishing this symbolic correspondence the paper reveals one of many ways of interpreting meaning in architecture and discloses the surprisingly complex symbolism of the architecture of the Rekha temple. In Indian tradition the structure of the cosmos as a whole becomes the paradigmatic model of each and every entity within the cosmos. This view posits that a human being, a microcosm, is an integral part of the entire universe, the macrocosm, and that a microcosm is a reflection of the macrocosm. This microcosmic and macrocosmic correspondence is projected in the architecture. There thus exists a homologous relationship between the macrocosm, the microcosm and architecture. Through this homologous relationship, architecture *re-confirms* a bond between the cosmos and a human being.

The Rekha Temples of Bengal

The Rekha temple type is one of the most common early Hindu temple style found in Bengal.[1] It reached its zenith in Medieval Bengal. Examples of this temple type which survive in Bengal cover a period from the seventh century to the late eighteenth century.[2] Rekha temples are generally referred to as *rekha deul*. The Bengali term *"deul"* means "temple", and is a derivative of the Sanskrit term *devakula*[3], meaning " belonging to the divinities or celestials". The rekha deul of Bengal are described in the ancient architectural manuals, the Silpasastra[4] as "*nagara*" (North-Indian) temples.[5] These temples, however, are not unique to Bengal, they are found in Orissa and are common in many other parts of India.

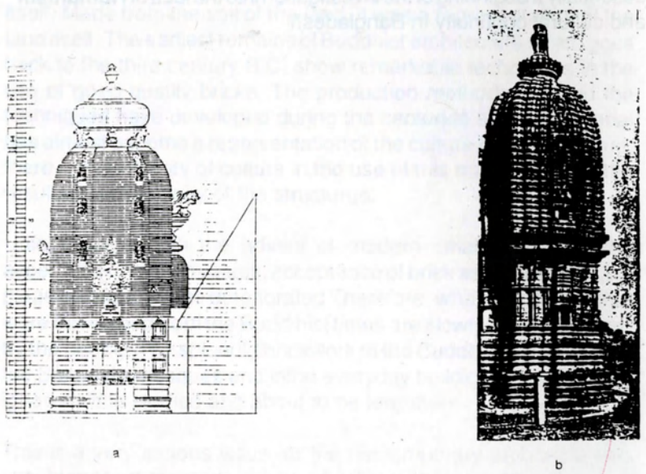

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Fig. 1a. Rekha temple from the Silpasarini Silpasastra (Boner, 1975, pl. f. p. 75); b. Rekha temple from Bengal (Michell, 1983)

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A Rekha temple has a pillar-like structure, with a square sanctum and vertical projections from the base to the tower. The lofty curvilinear tower *sukanasa sikhara* gradually diminishes at the apex and is crowned with a large *amalaka sila* (ribbed copping-stone) which carries a *kalasa* (pitcher shaped) finial. The temple's richly ornamented, hollow, pillar-like superstructure conspicuously celebrates the vertical. The slender and elegant Rekha temples may have square, cruciform or polygonal (octagonal, dodecagonal etc.) plan forms.

The main body of the temple is an elaborate structure usually referred to as the *prasada*. While the classical Indian Rekha temple has a porch or "front hall", *mukhasala* attached to the prasada, in Bengal the prasada usually stands alone.

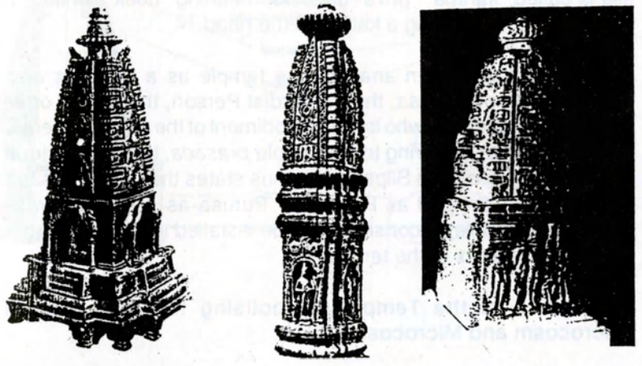

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Fig. 2. Model of votiave Rekha temples: a. Dinajpur, Bangladesh (Saraswati, 1976, pl. VII. 14); b. Jhewari, Chittagong, Bangladesh (ibi., pl. VII. 15); c. India (Michell, 1977, p.87).

Macrocosmic and Microcosmic Correspondence

In the traditional Indian view the macrocosm is the entire universe, while a microcosm is a human being who is an integral part of the entire universe. There exists a direct correspondence between the macrocosm and a microcosm. One of the symbols used in Indian Hindu and Buddhist literature to establish an analogical relationship between the macrocosm and microcosm is that of *meru*. The macrocosm, the universe, is said to be centered around the cosmic column, Mount Meru, and the microcosm, a human body, is said to be centered around the spinal column, *merudanda* (meaning meru column).[6]

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10. Bhuvanapradipa, XV. 13 Bose, N. K. ibid.
11. Bhuvanapradipa, XV. 10 Bose, N. K. ibid.
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Rekha Temples as a Representation of the Macrocosm

Temples in the Indian tradition are perceived as cosmic mountains. There are therefore many temples called Meru, Mandara or Kailasa,[7] the names of the cosmic mountains. Rekha temples specifically are referred to by one of the ancient architectural manuals, the Bhuvanapradipa Silpasastra, as Meru,[8] Maha-Meru[9] Mandara,[10] and Kailasa.[11]

Rekha Temples as a Representation of a Microcosm

The Rekha temple is analogically viewed as a practitioner of yoga, yogapurusa, who is seated cross-legged in yogic contemplation. The elements of the temple are referred to with the same terms as those used for the body of the practitioner of yoga: the base of the temple is called *"jangha"* the "legs" or "shins", the vertical body rising towards the *amlalaka-sila* is called the *"skandha"*, and the *amalaka-sila* is called *"kantha" "griva"* or *"beki"* meaning "neck"; while the *amalaka-sila* supporting a kalasa is the head.[12]

Reinforcing this human analogy, the temple as a whole is also considered to be Purusa, the Primordial Person, the Father of all beings, the archetype, who is the embodiment of the entire universe, the macrocosm. Referring to the temple *prasada*, the architectural manual, the Silparatna Silpasastra, thus states that "The Prasada should be worshipped as Purusa"[13] Purusa as *prasada-purusa* (Lord of the temple) is considered to be installed in the *kalasa* (the pitcher at the apex of the temple.[14]

The Crown of the Temple symbolising the Sun in both Macrocosm and Microcosm

The crown of the temple consists of the *amalaka-sila* (clogged ring-stone) and the *kalasa* (pitcher). The shape of the *amalaka-sila* is like the fruit of the Amalaka tree, the celestial tree, which is the embodiment of the Hindu trinity: the Amalaka tree embodies Visnu at its base, Siva at a higher level, and Brahma at its summit. The leaves, flowers and fruits of the tree represent the celestial beings *(deva)*, and on its branches rests the Sun.[15]

The attainment of awakening by a yogic practitioner is symbolically represented by the crowning of his/her body by the Sun. The crowning of the Rekha temple by the Sun is thus analogous to both the crowning of Mount Meru, the macrocosmic axis, by the Sun and the crowning of the *merudanda* the microcosmic axis of spinal column of an awakened human being, by the Sun.

The Lotus Symbolishing the Sun in the Macrocosm and a Microcosm

The *amalaka-sila* is carved like a lotus and radiates from the centre like the rays of the sun, so that "The disc of the sun looks like the pericarp of the sky-lotus of which the petals are the directions of the compass and the filaments the solar ray;"[17]

In Indian tradition the Sun and the lotus are analogous symbols.[18] The interpretation of the *amalaka-sila* as a lotus suggests that the temple, the meru pillar, is also a lotus pillar. The Brhadaranyaka Upanishad refers to the *amalaka-sila* as the lotus at the summit of heaven, the cosmic region: "The *Amalaka* ring-stone on the shaft of

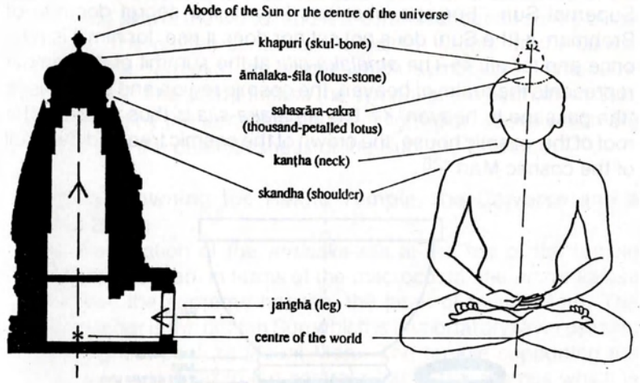

Fig. 3 An analogy between a Rekha temple (after Michell, 1977, p.70) and a yogapurusa (author).

the Pillar of the Sikhara symbolises the celestial region where the rays of the sun spread like the filaments of the lotus of the Zenith.[19] The lotus depicted in the *amalaka-sila* at the zenith of the temple is the *"sahasrara-kamala"* the "thousand-petalled lotus."

In the practice of yoga, the human subtle body is assumed to consist of a number of energy centres called *cakra* placed one above another along the spinal column, the *merudanda*. The *sahasrara-cakra* is the top most cakra of the human subtle body located at the peak of *merudanda* the location which coincides with the human skull. The *sahasrara-cakra* is referred to as a *sahasrara-kamala* a thousand-petalled lotus. The awakening of a yogic practitioner is depicted as the blooming of the thousand-petalled lotus at the crown of the head of human body. The *amalaka-sila* in the form of the lotus at the summit of the Rekha temple is thus analogous to the thousand-petalled lotus at the crown of an awakened human being.

18. For more details see Zimmer, Heinrich, Myths and Symbols in Indian Art and Civilization, Spiritual Disciplines, ed. by Joseph Campbell, Bollinge Series VI, New York: Pantheon Books, 1953, p 90; 1968, The Art of Indian Asiz, Its Mythology and Transformations, vol. 1 & 2, completed and ed. by Joseph Campbell, Bollinge Series XXXIX, New Jersy: Princeton University Press, pp 158-213; Snodgrass, op, cit. 1985, p 97; also see Chakma, Kabita, The Cosmic Symbolism of the Traditional Architecture of Bengal, M. Thesis, University of Sydney, 1993, p 175.
19. Brhadaranyaka Upanisad, VI. 3,6, cited in Kramrisch, Stella, op. cif. 1976, p. 351
20. The Silpasarini Silpasastra States that the stone should be carved as lotus petals. See Boner, op. cit. Silpasarini, Studies in Temple Architecture, ed. by Chandra Pramod, New Delhi: American Institute of Indian Studiesl 1975, p.79
21. Boner, Alice, Sarma, Sadasiva Rath & Das, Rejendra Prasad, New Lights on the Sun Temple of Konaraka, Varanasi : Chowkhambha Publications, 1972, p. 220. For details see the extracts from the Baya Cakada, Leaf L, 13.; Boner 1966, p, xl.
22. Aitareya Brahmana, XIV. 6.44, Commentary, cited in Kramrisch, op. cit. 1976, p. 355.
23. Chandogya Upanisad, III. 113 cited in Kramrisch, op. cit. 1976, p.355
24. Kramrisch, Stella, Ibid 1976, p. 35.
25. Coomaraswamy, Ananda K., Selected Papers, vol 1 & 2, ed. by Roger Lipsey, Bollingen series: LXXXIX, New Jersey: Princeton University Press, 1977, 1.p. 469
26. The Silpasarinj refers to the Kalasa as having six parts: garbha, dori, saraba, bala and dhvaja-danda, Boner, op. cit. 1975, p.77..

27. Commaraswamy, A. K. Symbolism of India Architecture, Jaipur: The Historical Research Documentation Programme, 1983, n. 11, p. 45.

28. Munduka Upanisad, II. 2. 10-11. Upanisad, The Principal Upanisads, ed. with introduction, text, translation and notes by S. Radhakrishnan, Delhi, Bombay, calcutta, Madras: Oxford University Press, 1990.

29. Chandogya Upanisad, III, 19.4; Taittiriya Aranyaka, II, 2.2 cited in Krimrisch, p 357

30. Aitareya Brahmana, V. 28.1, cited in Kramrisch, 1976, p. 351.

The correspondence between the summit of the temple and the top of a microcosm, the *sahasrara cakra* of the human body, is also revealed in the architectural term itself. The vaulted circular stone, often carved in the form of lotus petal,[20] sited between the *amalaka-sila* and the *kalasa* is, called *"khapuri"* in Orissan, and "*kharpara*" in Sanskrit, both meaning "skull."[21] The *sahasrara cakra* is stationed at the summit of the human skull, where lies the Vortex of Brahman (*brhmarandhra)* the door to cosmic consciousness, and to the Sun. The *kharpara* has a hole for the insertion of the foot of the *kalasa*, which corresponds exactly to the opening in the skull, the b*rhmarandhra*..[22] Just as the peak of the golden mountain, Meru, is the abode of the Supernal Sun, "the one Sun that never leaves the Meru"[23] so an awakened person is ever illuminated by the Supernal Sun, "For one who thus knows the secret doctrine of Brahman, it (the Sun) does not set nor does it rise; for him it is day, once and for all."[24] The *amalaka-sila* at the summit of the temple represents the realm of heaven, the cosmic region and symbolises "the passage to heaven".[25] The *amalaka-sila* is thus "at once the roof of the cosmic house, the crown of the cosmic tree and the skull of the cosmic Man."[26]

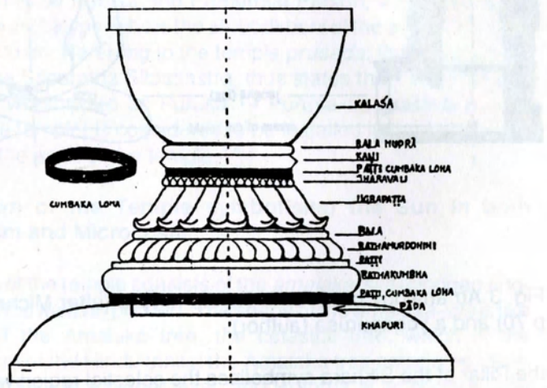

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Fig. 4. The khapuri or kharpara supporting the eleven ornamental bands (egarupattka, egarumundi or ugrapatta) and surmounted by the kalasa (Boner, Sarma, and Das, 1972, p. 223, fig. 11).

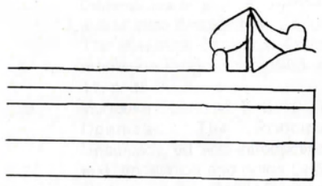
The kalasa (pitcher) as the Womb of the Sun

The *amalaka-sila* holds at its centre the pitcher (*kalasa*), painted in a golden coloured material, which is also called *amrta-kalasa*, the pitcher of ambrosia, the life bestowing nectar. The dark interior of the golden pitcher *kalasa*, the top-most element of the temple, is referred to as "*garbha*", "womb",[27] and represents the "cosmic

womb", the *hiranyagarbha, Brahma-sthana.* The *garbha* is the dark chamber within the super luminious golden pitcher, the Sun. The *garbaha* of the golden pitcher, the Sun, is like the solar orb, the solar plate itself, through which one can not gaze, or pass either physically or psychically. The garbha contains the quality of the "ineffable", which is the "Way beyond the Sun", referred to as the *brahma-patha*, the path of the Highest Brahman.[28] The embryo is concealed with in the womb of the golden pitcher, as "In the highest golden sheath is *Brahman* without stain, without part; pure it is, the light of lights..... The sun shines not there, nor the moon and stars, these lightenings shine not, where then could this fire be? Every thing shines only after that shining light. His shining illumines all this world."[29] The kalasa is thus the solar orb that is stationed at the apex of the axis of the world, and is the transcendental centre of the universe. The golden container the golden womb, amrta-kalasa, contains the "embryo" as *amrta* which symbolises immorality, permanency. The *amrta-kalasa* the symbol of the permanent Sun, is supported by the *amalaka-sila* the "High Altar, above which are the rays and the deathlessness of the Sun, the Brahman."[30]

The Sun Crowning the Rekha Temple, the Universe and a Human Being

While the location of the *amalaka-sila* at the top of the temple symbolises heaven, in terms of the macrocosm, the *amrta-kalasa* symbolises the supreme heaven, the peak of Mount Meru. The golden pitcher is the golden Sun which is immortal and ever present on the highest peak of Mount Meru. The temple supporting the golden sun is likened to the central pillar of the cosmos which is described as "the pillar of light, extending downwards from the sun in the zenith and rests on the earth."[31] The *amalaka-sila*, the sky-lotus of the Rekha temple, is thus illuminated by the Sun, the *kalasa*. In this way, the Sun is the crown of the Rekha temple, the crown of the universe (the macrocosm) and the crown of a human being (the microcosm).



ENVIRONMENT AND ARCHITECTURE

Ventilation and Comfort in Interior Spaces

Meer Mobashsher Ali

Bangladesh is a country in the tropics having a hot-humid climate and it is difficult to obtain reasonable thermal comfort level in interior spaces in buildings. Comfort level depends on various objective factors like air temperature and radiant temperature, relative humidity, vapour pressure in ambient air and precipitation, air velocity and air pollution, solar radiation and glare, metabolic heat production and activity level, clothing, etc. From the study of these factors it can be easily established that due to harsh climatic conditions comfort level cannot be achieved by micro-climatic and structural control only. Besides, only a few of these factors can be controlled by architectural elements. Hence considerable importance is given on air movement. Air movement depends primarily on factors like location of buildings, placement of buildings in relation to one another, orientation of buildings, cross ventilation through interior spaces, orientation of openings both inlet and outlet, size and control of openings.

In hot-humid climate as in Bangladesh evaporative cooling of sweat is the most suitable means to approach attainment of comfort level in absence of outright lowering of temperature.

For evaporative cooling massive air change and considerable indoor air velocity is required about 10,000 cft. per hr. of air volume per person is necessary. If we consider three persons per room a volume of 30,000 cft. per hr. is necessary. This for a room of volume $10' \times 15' \times 8'$ means about 25 air changes per hour. Furthermore, a velocity as high as 300 ft. per min is required to keep continuous process of evaporation without the discomfort of wet skin. 100 ft. per min is slightly over one mile per hour (one mile per hour is 88 ft. per min). This according to Beaufort Scale would slightly exceed the

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speed under classification of "calm". A speed of 300 ft. per min. (approx. 35 miles per hr.) would be under the classification of "slight breeze" This speed will rustle leaves and can be felt on the face. Any speed higher than this might hinder the normal function of the room by blowing paper or light objects.

In Bangladesh outdoor air movement is not much. Specially it is not so during all parts of the day. Sometimes the outdoor is very calm and air is still. Even with proper size and location of windows it will be a mistake to assume air velocities indoors to be more than 40 percent of the outside velocity. To maintain a velocity gradient buildings are to be placed 2H distances apart. Due to various factors like security, dust, noise and privacy windows are mostly grilled and curtained which seriously disturb the badly needed airflow required for comfort.

In view of the prevailing conditions it may be safely assumed that some kind of mechanical means of ventilation is necessary to achieve tolerable comfort level in the indoor environment. As a matter of fact most of the living quarters do have ceiling fans. Those who can afford are keen to make use of ceiling fans, size of the fans being between 36″ and 56″. An increase of 30 ft. p.m. in the rate of air movement appears to correspond in its effect to a reduction of 1°F in dry bulb temperature. The air velocities and circulation pattern of a particular size of ceiling fan and axial fan are shown in fig. I and fig. II.

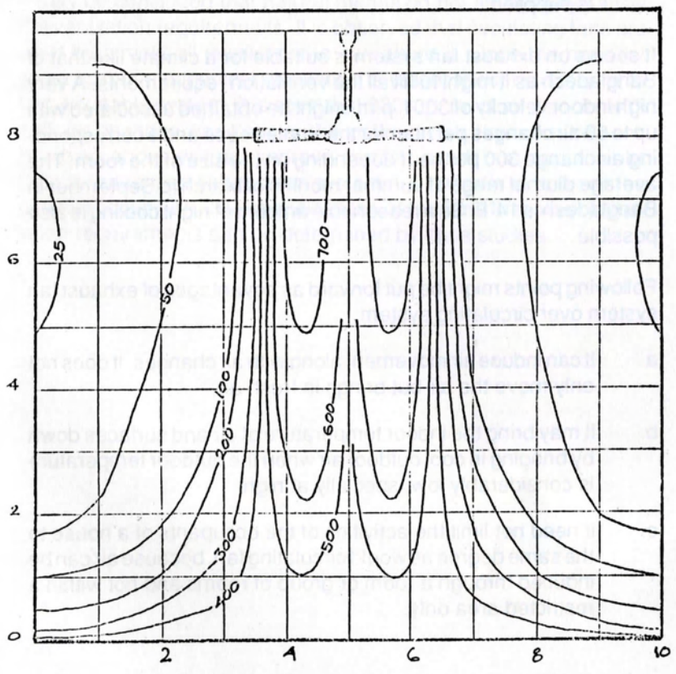
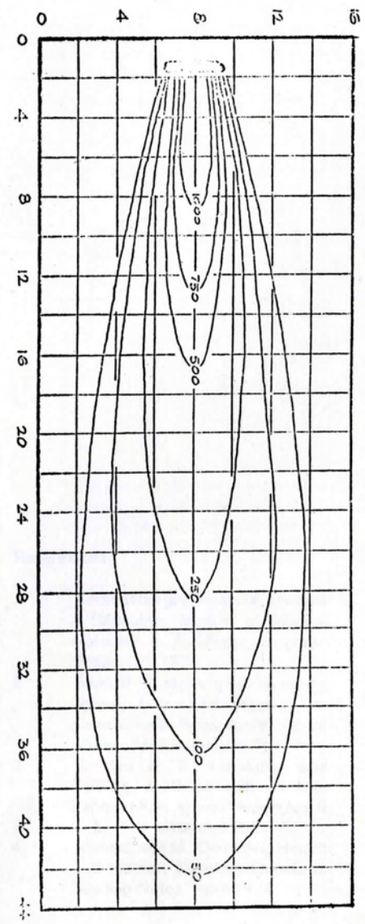


Fig. 1 Air velocity distribution for 36 inches ceiling fan.



The circulating fans have some inherent disadvantages. Main disadvantages are :

a. It doesn't induce air change. It churns the air in the surrounding air. Sensation of coolness is mainly achieved by enhanced evaporation from the skin.

b. At least one fan is necessary in every room.

c. Air velocity directly below the fan may be annoying.

d. Fans might be noisy at high speed.

e. Since it is suspended from the ceiling, height of the ceiling has to be increased by 2 feet or more.

Mechanical ventilation system are usually installed in one of the following forms:

a. Exhaust system : where indoor air is forced out and fresh air finds its way through grills or openings. Indoors are under slightly reduced pressure.

b. Plenum system : where air is forced in from outside through grills. Indoors are under slightly increased pressure.

c. Balanced system : where air is both supplied and removed by mechanical means. Mostly used when heated or cooled air is supplied.

It seems an exhaust fan system is suitable for a climate like that of Bangladesh as it might fulfill all the ventilation requirements. A very high indoor velocity of 300 f. p.m. might be obtained associated with up to 80 air changes per hour for the whole house and a corresponding air change 300 per hour depending on the size of the room. The average diurnal range of summer months of March to September in Bangladesh is 14°F. So a reasonable amount of night cooling is also possible.

Following points might be put forward as advantages of exhaust fan system over circulating system.

a. It can induce air movement along with air changes. It does not only move the air but brings in fresh air.

b. It may bring the indoor temperature of air and surfaces down by bringing in cool outdoor air when the outdoor temperature is considerably low, specially at night.

c. It need not limit the activities of the occupants of a house to the same degree as would circulating fan, because air can be induced through a room or group of rooms and not within a restricted area only.

d. With a centralized system less noise will be perceptible; the source (fan) being away from rooms.

e. It is possible to lay out the buildings more close to one another to achieve a greater density level specially with low rise buildings. The rules of open type layout to ensure a suitable outside air velocity need not be adhered to.

f. It gives more freedom to the arrangement of rooms. Only single bay arrangement of rooms are suitable to ensure reasonable ventilation by natural means. In exhaust fan system double banked arrangement of rooms may be used efficiently :

g. A little deviation from the optimum orientation from ventilation point of view will not be critical under exhaust fan system. Orientation can give maximum consideration to solar radiation.

h. Room height need not be excessive. A height of eight feet is satisfactory because no extra height for fixtures like circulating fan would be necessary.

i. For further improvement of the system blow fans might be installed to induce air inside.

It may be concluded that natural means do not adequately satisfy the ventilation requirements. It is observed that circulating fans are used by almost all dwellers who can afford it. Once the need for some sort of mechanical ventilation is established, next step is to find a suitable system. It is seen that 300 f. p. m. of air velocity with 100 air changes per hour is the optimum air flow requirement. Anything above will not improve comfort conditions appreciably. With a centralized exhaust fan system it is possible to achieve the optimum condition. The specifications of the fans and other installation requirements can be determined by case studies.

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Application of Passive Cooling Methods

Khairul Enam

Abstract

The paper discusses the various possibilities of passive cooling methods and their application potentials in the warm-humid region of Bangladesh. The paper attempts to recognise the natural balance of global system as a generating force, opens a new dimension in Architecture and landscape design, the dimension that has been long ignored. The concept of passive system is a new beginning of an old forgotten idea. The study attempts to compile some of the results of works on passive cooling and outlines an approach towards site planning and design.

The study is concerned with the following passive cooling systems:

a. Radiative cooling
b. Convective cooling
c. Evaporative cooling

The study also attempts to suggest some outline on the application of passive systems in the context of Bangladesh.

INTRODUCTION

The overall impact and heat exchange of urban sink with built forms are being evaluated by modelling approaches. There are basically two categories of urban climate modelling. The first one deals with microclimate variations occurring below roof level or street level, known as urban canopy-layer (UCL). The second one is the urban boundary-layer (UBL) models that simulate the climatic variations occurring above roof level of the heat sink. UBL models are extensively used (Taesler, 1986) and are divided into classes, i.e. convective, radiative and dynamic models, depending on their purposes. The UBL models express the urban boundary conditions in simulating average values of urban roughness and surface temperature.

A more detailed study of an area could be accessed by Urban 3 models which fall into the first category of modelling. The Urban 3 interprets a city by a series of rectangular blocks intermixed with streets, parking lots and parks. The specific sizes of the built volumes and built areas along with its material characteristics, distribution and climatic data are the basic input of the model.

The model gives an idealistic overview of the urban situation and the results are considered to depict the general conditions. The model operates well in a street canyon arrangement, but in a complex where canyon type building arrangements are not followed, the results of the model may deviate from the reality.

The thermal comfort criteria out-doors is quite different to that of indoors. There has been substantial work done on the comfort issues in out-door spaces at EXPO'92, Seville. The studiess how that thermal balance out-door results in :

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ESW=M(I-U) + (R+C) + H - Cres - Eres - Edif
Where M(I-U) is the net metabolic heat production
H= Direct, diffuse and reflected solar radiation absorbed by the subject.
R=Represents the long wave radiation exchange with the surrounding surface.
C=Air convection
Cres - the sensible heat
Eres - the latent heat due to the respiration
Edif - the skin diffusion heat

ESW- The regulation sweating term, the only means of attaining thermal balance and giving a measure of the adaptive effect of the body, and consequently the level of comfort.

Where
HD = direct solar gain
Hd = diffuse solar gain from sky
Hr = reflected solar gain from vertical and horizontal surfaces
ARC = long wave radiation exchange to sky
ARS = long wave radiation exchange to surfaces
Cv = convection with the air
E = evaporation or sweating[1]

It is observed that the body can balance the heat only by sweating and to some extent reradiating to sky, with much discomfort. The study further indicated that radiative heat gain (direct + diffuse + reflected), can be controlled to some extent, and long-wave heat exchange and air convection can be attempted to achieve a cooling effect.

The techniques applied for the control of out-door spaces at the EXPO'92 followed the main conditioning actions, i.e. blocking solar radiation by a large tent and patio, reduction of surface temperature by employing water ponds (15 hectares) and cascades running over 400m at a height of 6 inches.

Air temperature is reduced by installing 12 cool towers equipped with wind catchers and micronizers.

The micronizers (water sprays) are used extensively in the foliage of trees and pergolas which produced cool air flow in the pedestrian areas of the EXPO'92 complex. There are about 12 different systems with 7000 micronizers installed in the complex to attain the air cooling conditions.

Early examples of passive cooling systems can be observed in Moghul gardens (1526-1757).[2] The gardens were cooled by intelligent use of thermal resistant materials, plants and water.

References

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2. Bowen, A. B. Cooling Achievements in the Gardens of Moghul India. Paper Published in the proceedings of the International Passive and Hybrid Cooling Conference, 1981.

Three types of gardens were built by the Moghuls, the palace gardens, tomb gardens and pleasure gardens. Gardens were conceived as the extension of indoor living spaces. Plants were used both for decorative and shading purposes. The extensive use of water for evaporative cooling was the most striking feature of the garden. The cooling qualities of water had been exploited by a large water body, fountain surface flowing, and spray. The layout of gardens was planned to allow breezes to flow over the water bodies and fountains to cool the garden pavilions. The combined effect of all the elements provided cool relief from the arid heat of the Indian climate.

Other examples of deriving passive cooling from the landscape are briefly discussed in the following passage.

A large tree could be used for cooling for both horizontal and vertical surfaces. The precise placement of a tree south and west of a residence can optimize the energy saving during the warmest afternoon periods of summer.[3]

Table 1 indicates the experimental results conducted by John H. Parker, 1981, on effects of shading by plants on vertical surfaces.

Table 1
Average reduction in surface temperature for east and west facing light-coloured walls with various types of landscape plants providing shade or cover. Data was recorded on warm summer days in Miami, Florida.

Landscape Elements	Average temp. reduction (ATR) during day with no direct sunlight °F	ATR during day with direct sunlight°F
Large tree		
Moderate-size	6.4	24.5
Shrub		
Tree/hedge	7.6	24.3
Combination	10	28
Moderately thin vine	8	13.8
Moderately thick vine	7.5	16

The temperature reduction capabilities of a tree by evapo-transpiration is recorded by Bowen, 1980. A single tree of medium size is found to reduce the shaded area temperature by 2 to 3°C

Duckworth and Sanbury 1954, found that the temperature of Golden Gate Park was 8°C cooler than the nearby areas.

3. Parker, J. 'A comparative analysis of the role of various landscape elements in passive cooling in warm humid environment'. The paper was published in the proceedings of the International Passive and Hybrid Cooling Conference, p. 368.

A full size tree as Moffat's experiment result evaporates 1460 kg of water per sunny day, which is equivalent to 870MJ cooling capacity.

According to Moffat's observations, the latent heat transfer from wet grass can result in 6 to 8°C cooler surface than an exposed soil surface. One acre of grass area can transfer more than 50 GJ/day.

All these studies indicate that plantation and grass areas can play a vital role in reducing the air temperature of an environment. The challenge is to show that these potentials for passive cooling could be employed rationally in the out-door environment.

Evaporative Cooling
Evaporative cooling has a significant contribution in the hot dry regions. In hot humid regions during hot summer days when RH values are comparatively low, evaporative cooling may be employed for passive cooling.

The mode of evaporative cooling :

A. Water spraying :

The results of different observations and experiments are summarized here.

The exposed exterior pavements and surfaces are heated by solar radiation and the hot ambient air can be cooled effectively and inexpensively by spraying them with water. As water evaporates it draws most of the required latent heat from the surface thus lowering its temperature. The surfaces can be sprayed intermittently, since it is only necessary to keep the surfaces moist. — Yellott. 1961

B. The skytherm system, proposed by Harold Hay, 1965

The system was thermopond on roof in thermal contact with structural roof and covering the ponds by movable insulation. Hay proved that, under suitable climatic conditions, comfortable conditions can be maintained indoors by covering the ponds with insulating panels during the day in the summer and during the night in the winter.

C. The energy roof :

The cooling capability of the 'Energy roof' invented by A. L. Pittinger and W.R. White was investigated during a four-year programme carried out in 1977 and 1978, at the College of Architecture, Arizona State University.

The system uses a roof pond supported like Harold Hay's Skytherm by a metal ceiling. The insulation floats on the water in the pond under a thin, transparent plastic film. For winter heating the water

from the pond is pumped up during daylight hours to a distributing tube, which allows it to flow in a thin layer above the insulation. In summer the same pump is operated at night for radiative cooling. In addition a water spray causes evaporative cooling to take place at the upper-surface of the plastic film, further removing heat from the water flowing under the film.

D. The cool pool :

The cool pool is proposed and tested by Karen Crowther at Davis, California (1979). The pool is supported by a concrete roof and is shaded by louvers from the direct rays of the sun, so that it "sees" only the northern sky. The pool water, in addition to radiative losses, cool water then circulates through the warm interior spaces and rises back to the pool again.

In out-door spaces water bodies with open systems, intermittent sprays and fountains can minimise the solar heat. The methods have already been in use for centuries in the Middle East, India and Bangladesh. However, integrating the method with trees, sheds and grass areas can further improve the thermal conditions of our environment.

Radiative Cooling

The main source of radiative cooling is the clear sky. All material objects emit heat in the form of infrared radiation. The intensity of this radiation is dependent on the temperature and emissivity of the object.

The Materials like concrete, glass, paints and water have high emissivities in the infrared part of the specturm. A highly reflective or transitive material has an emissivity near zero. The hemispherical emissivity of the radiator can have values between zero and one.

The exposed surfaces will lose heat when ambient air temperature is lower than the surface temperature. Similarly, they will gain heat when air temperature is higher than the surface. The rate of these convective exchange between radiating surface and air is also dependent on wind speed. The cloud cover condition of atmosphere and ambient humidity greatly reduces the gradient heat loss of a surface.

The infrared heat transfer to sky occurs both in day and night. The effect are noticeable during the night when it is not masked by the abundant inflow of energy form the sun.

The infrared radiation emitted from substances at the earth's surface can be absorbed and reemitted many times by water droplets and atmospheric gases like carbon dioxide, water vapour and ozone before escaping into space.

All the exterior materials both in horizontal and vertical surfaces have high emissivites. Many of the severe conditions could be avoided if the surfaces were shaded to cut out the direct sun. Plants, patio, screens and buildings can play a significant role in providing the desired shading when landscaping and architecture jointly work towards the goal.

Convective Cooling or Ventilative Cooling

Historically, man has relied upon natural ventilation for comfort in buildings as well as out-door spaces during warm seasons. In tropical humid climates, the poor rural people are very primarily dependent on natural ventilation.

The out-door air movement in urban areas is influenced by built form and landscape. The structure/open space relationship are the basic determinants of wind movement in out-door spaces.

"Siting and site layout as well as landscaping represent two important groups of strategies to improve the micro climate around buildings. Saving existing shade trees and taking benefits from any local breeze are the primary recommendations for site planning."[4]

The wind effects in out-door spaces have been summarised by A. Fernandes, S. de Schiller and J. M. Evans in the study of Wind in Urban Spaces (PLEA'91). There are 12 studies regarding the behaviour pattern of wind movement in out-door spaces (p. 37), the wind movement effects in high-rise buildings, wise effect, venturi effect, etc. can be noted for effective use.

There are elaborate studies by Baruch Givoni showing the distribution of wind speeds in different urban configurations with different height-spacing ratio (Urban Design in Different Climates, 1989. p. 3-41 to 3-43). From the studies of: Acuk, 1975, it is observed that scattered high rise building devolopments in a predominantly low rise environment gives better relative wind velocity than an all low rise environment, in a canyon type layout.

The dynamics of air flow have been referred to as turbulent, laminar and separated flow in the studies of Arthur Bowen, "classification of air motion systems and patterns". The wind movement in or around the building is created by positive and negative forces. The experiment results show that with inclined and staggered building layouts better air flow results may be achieved in the leeward side. Trees and shrubs combined can direct the wind in the intended direction.

All these studies indicate that wind movement or ventilative cooling is a controllable feature and needs the attention of the designers at the conceptual level. The direction of wind, wind speed, layout of building, open spaces and planting all interact together to achieve an effective ventilation condition for outdoor comfort.

4 Fleury B., Antinucci M., D. Asiain J.L., and Yannas S., Horizontal Study on Passive Cooling, 1990. p. 4.

Application of passive cooling systems in Bangladesh context.

In Bangladesh nearly 80% of the total population who live in rural areas depend on passive systems for both out-door and indoor living comfort conditions. In rural areas people spend most of the day time in out-door spaces. The comfort of gentle breeze under the shade of trees are much more preferred than the closed indoor spaces. Extensive vegetation, water streams and ponds and very limited use of brick and concrete in structures and pavements, ensure an out-door environment that seldom crosses the comfort range in hot summer days.

Bangladesh enjoys warm-humid-monsoon climate and in the rainy season RH value of air varies between 80 to 88% with the air temperature between 28°C to 33°C. There is very low possibility for evaporative cooling in this season. The summer and winter season are comparatively dryer and the RH value range remains between 55% to 70%. Air temperature in summer rises upto 41°C and winter temperature remains between 7.22°C to 31.11°C.

The preliminary observations indicate that there are ample possibilities for the application of passive cooling systems in our urban areas that can substantially reduce the out-door temperature.

The following measures may be taken into account in the attempt for reducing out-door temperature.

a) To provide shade in the exposed pavements and streets by planting appropriate trees and shrubs.
b) Selection of materials with low reflectivity for pavements, streets and exterior building surfaces.
c) To adapt the passive planning considerations for streets and building orientation and layout, encouraging wind movement and shading.
d) use of water for evaporative cooling in hot summer and winter days.
e) Roof shading by patios or gardening.

The above measures, at least in part, are usually included in most of the ongoing or existing developments in urban design but the decision making regarding the outdoor environment primarily lacks climate consciousness objectively and are predominantly piecemeal in nature. The main input is required in the awareness and conceptual decision making level rather than on the financial aspect of the development projects.

An effective utilization of out-door developments in the passive approach of design needs elaborate studies in landscaping, material characteristics, planning tools and techniques as well as climatic factors.

Hollow Roof Tiles : Passive Solar Heat Control in Tropical Climate

Professor Abu H. Imamuddin
Professor Azizul Haque
Bikash Saud Ansary

Abstract

The present research work was conducted with two isolated and identical rooms having South facing roofs specially constructed for the purpose. It was made possible for the roofs to be tilted at different angles. The roof of one room was finished with hollow brick tiles and the other with bare concrete. Thus the effect of hollow brick tiles as a means of passive solar heat control, could be compared with that of concrete roof under similar conditions. Experimental results show a substantial reduction of ceiling temperature for the room with hollow brick roof tiles and in some extreme conditions it was found to be around 12°C lower than that of the concrete roof ceiling.

Introduction

The primordial role of architecture was to act as an instrument for modifying extremities of nature even the most rudimentary shelters of the past and present were built to serve the very basic purpose of protection against the adversities of climatic environment. The physical environment, either man-made or natural, controls sun, wind, rain and light, acting as filter or amplifier. Environmental response of people in different cultures and climates thus found expression in their built-form producing a distinctive character in their architecture. Eskimos' Igloos, Bedouins' Black Tents and Arabs' Mashrabias are all indicative of the relative importance placed on the passive control of climate through the design of dwelling units.

As long as unselfconscious societies were preoccupied with their own cultural beliefs and attainments they maintained fairly consistent architectural development within a given geographic boundary. They shaped and organized their built-forms corresponding to prevailing climatic parameters in order to attain comfortable living conditions with the material, method and technology available.

Vernacular architecture therefore, developed with remarkable respect for solar geometry in its orientation and articulation. The traditional rural houses in Bangladesh centered around a courtyard can be explained as an oasis on an envelop of hot and humid climate. A house is never conceived in isolation from its trees and plants. This helped in exclusion of solar heat through shading and filtering hot summer wind and cold winter breeze. Walls could breathe through perforations and trapped hot air could escape through the slits between the roof and wall junction.

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In urban vernacular houses measures taken for passive climatic conditioning were also distinctly evident. The controlling elements were thick walls, high ceilings, clear story windows, double windows, a verandah running all around the outer periphery of the house in the form of canopy. The traditional building crafts developed by the Master masons were threatened by the new method, materials and means of construction developed during the industrial era.

The new technology was influenced by the spirit of building more with less time and material. The driving force was economy in all sectors of construction and management, leaving aside various important socio-cultural and human factors of habitation. Commercial success of rapid building technology was so overwhelming that it invaded entire formal construction sectors including dwelling house construction. The speed and economy of construction process gradually replaced all traditional elements of passive climatic control. Mechanical devices like ceiling fans, table fans, coolers, dehumidifiers, air conditioners, etc. were all introduced as an alternative means of environmental control.

This automatically placed high premium on energy consumption, not to speak about the associated installation and maintenance costs. Considering these factors, a long term return analysis may reveal that the traditional methods are still in many ways the more attractive alternatives. However, the purpose of the paper is in no way to advocate a return or revival to traditional practices, but to indentify alternative means and devices of passive control compatible with the contemporary building technology and discover new methods and systems to make the building itself an energy modifying instrument towards a conceptually coherent approach for a low energy, environment friendly and sustainable architecture for the developing world of the future.

Research Premise

Confronted with the energy crisis of the seventies, the developed countries turned to experiments in low energy architecture. Meanwhile, the developing countries were tempted to use the high energy models from the west. It is also evident that growing awareness about energy issues and the campaign for low energy consumption in the west, affected third world consciousness as a means for sustainable development.

The premise for research in climate responsive architecture is mutually opposing between developed and developing countries. The very global distribution have placed one in cold region and the other in hot region. One is trying to combat heat and the other is trying to combat cold.

Solar radiation is a major source of heat gain. The term 'Solar Passive' architecture is coined in cold countries and it applies to the use of solar radiation to the advantage of heating. On the contrary: the same terminology will apply in hot and humid countries to the exclusion of solar energies for comfortable living and working environments.

Thermal comfort is a product of diversified factors. The comfort response is also conditioned by cultural and psychological bias. Being confused by the complexity of the problem, architects are usually tempted to leave the matter to the mercy of mechanical devices. Contemporary studies on passive climatic control on the basis of different climatic regions are limited and not very well published. Designers therefore, are skeptical about their practical application and ultimate performance.

Hypothesis

In the contemporary world of information explosion we are flooded with climatic data, survey and analysis. However, they are yet to be processed in simplified forms for application by architects. Regualr practicing architects in the developing world seldom have time or resources or incentives to go through complex analysis or research to identify passive ways for climatic adaptation of buildings. Nevertheless, it is indeed possible to create an interest and incentive for applying climate adaptive architectural systems if a repertoire of passive control mechanisms, elements and materials are made available.

It is envisaged that techniques based on transformation of traditional methods, tested with the contemporary norms of architectural design and construction would definitely encourage their application. With this frame in mind an interdisciplinary research on passive climatic control has been undertaken at the Department of Architecture, BUET in collaboration with the Mechanical and Civil Engineering Departments. The very first endeavour of the research was to develop a mechanism of passive control of solar radiation through a device of thermal roof tiles. The research programme ventures into other areas of passive environmental control with a clear objective of developing easily applicable, economically viable and socially acceptable methods and devices, to augment natural incentive for popular architectural use. Application of double roof with a sandwich of air in between has been found in many examples of vernacular architecture, as well as in modern architecture, to offset heat gain by solar radiation. The system was considered more effective if air flow could be maintained in the space in between. The cost factor involved in making a double roof usually restrains such an undertaking of simple and straight forward solution. The hypothesis followed from this consideration was that if a cheaper means could be defaced that would perform the same insulating function with considerable efficiency, the acceptance of the system would grow automatically.

In vernacular architecture use of clay tile as a roofing material was all along very popular. Use of such tiles necessitated that the roofs be sloped. Popularity of tiled roofs subsided with the advent of R. C. C. flat roof construction system. The general practice is to apply a four inch or 100 mm thick lime terracing over the concrete roof that provides some degree of insulation. The flat roof remains exposed to solar radiation all day long and that becomes the major source of heat buildup inside the building. Moreover, the problem of rain water seepage is endemic in flat roof structures in the monsoon region.

Irrespective of the relative advantages and disadvantages between flat roofs and tiled sloped roofs, there is a market preference for tiled roof houses among the well-to-do class. This group is a trend-setter and stands as a reference group for the rest. So it is envisaged that the popularity of tiled roof may steadily grow if not for any technical reason but merely as a status symbol.

There is a distinct difference between the tile roof design of the past and present. The present one has a concrete roof underneath with tiles pasted over as facing material. The notion of passive solar control through the roof prompted the idea of developing thermal roof tiles that would perform with the same principle of double roofing. The central theme is that if the hollow tiles are designed and placed on a sloping roof in such a way that the hollows could form a continuous air tunnel through which the hot air may escape, then the solar heat transfer through the ceiling would be reduced substantially.

To simulate an average room size of a common dwelling house with the roof exposed to solar radiation, was considered most suitable for the proposed experiment. To obtain unobstructed solar radiation in Dhaka's setting, it was considered appropriate to conduct experimentation on the roof-level of a four-storey building, i.e. 40 ft. from ground level. An adjustable roof system designed to place the roof slope at varying angles, was deemed essential for evaluation of the impact of the slope and optimization of the effects. Orientation of the roof was in the north-south direction sloping down towards south, since north-south orientation of building is considered ideal in our climate. Effect of other orientations are to be studied at a later phase in the experiment.

To compare the effectiveness of thermal tiles it was decided to build two identical experimental structures adjacent to each other both roofs were constructed of commonly used roofing materials, the exposed surface of one was convered with hollow bricks, while the other was left bare. This enabled the simultaneous comparison of their thermal performances, which were related to their cost effectiveness as well. Since hollow roof tiles are not available in the market, their closest alternative, light weight hollow bricks made for

partition walls were used as tiles for the experimental purpose. It should be mentioned that prior to the experiment such hollow bricks have been used in sloping roofs of three residential houses as roof tiles with satisfactory technical and aesthetic results.

Experimental Set-up

The hollow brick is 230 mm in length, 170 mm in width and 115 mm in height, having two continuous holes along its length each measuring 75 mm in height and 55 mm in width.

In order to study the effect of hollow brick in real situations, two identical rooms were constructed on the roof of the old academic building, having a height of 30 ft. from ground, at the Bangladesh University of engineering and Technology premises, Dhaka (Latitude 23.7° N, Longitude 90.38° E).

The roof was so designed that it could be tilted about its central axis, and thus inclination of the roof could be changed form horizontal position (Zero degree inclination) to around 40 degree with the horizontal. In inclined position the roofs face south. The roof of one of the rooms had hollow brick cladding, the brick was so laid that the hollow section aligned with the inclination, thus making a hollow air duct along the length of the roof. The other roof was bare concrete slab. Two identical rooms with different roof systems were placed under similar conditions and their thermal behaviour pattern could be analyzed and compared for information.

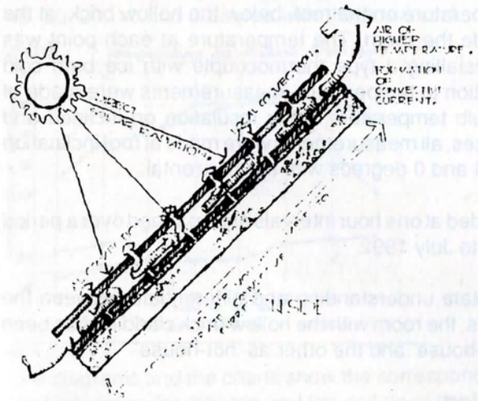


fig 1.

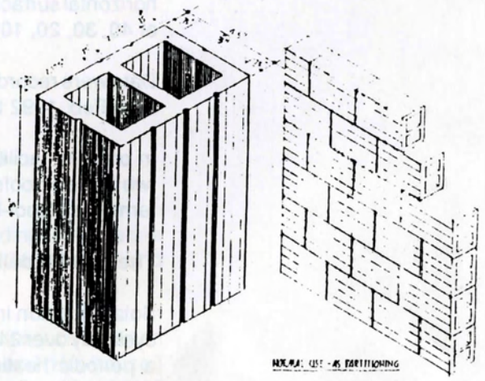


fig 2.

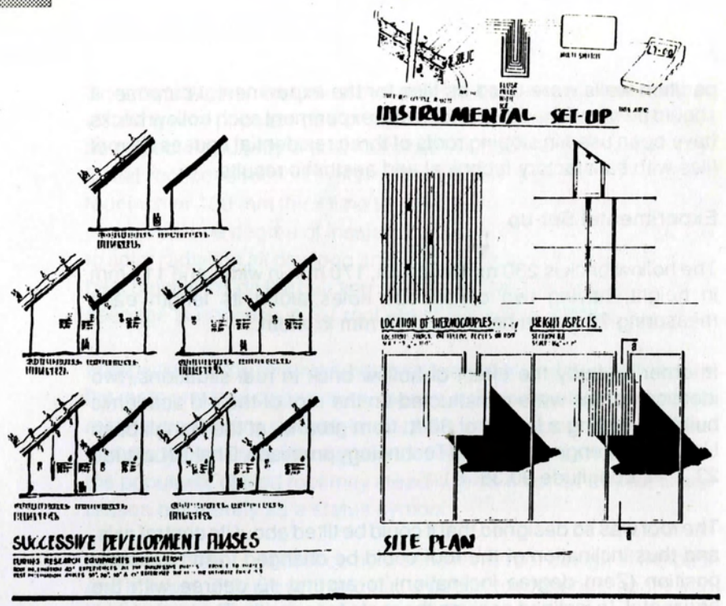


fig 3.

The schematic diagram of the set-up is shown in Figs. 1,2 and 3

Methodology and Instrumentation

The effect of hollow brick cladding was investigated by studying the variation of temperature on the roof, below the hollow brick, at the ceiling and inside the room. The temperature at each point was measured by installing J type thermocouple with ice bath cold junction. In addition to temperature, measurements were made of dry-bulb, wet-bulb temperature, solar insulation on inclined and horizontal surfaces, all measurements were made at roof inclination of 40, 30, 20, 10 and 0 degrees with the horizontal.

Data were recorded at one hour intervals and spanned over a period from Feb. 1992 to July 1992.

In order to facilitate understanding and differentiate between the two types of roofs, the room with the hollow brick cladding has been termed as 'cool-house' and the other as 'hot-house'.

Thermal Modeling

Solar radiation intensity and environmental temperature both vary cyclically over 24 hours, as a result the roof material is going through a periodic heating and cooling process. Thus the heat transfer problem is not a steady-state one. The heat balance for such situations may be written for the two situations as follows :

For hollow brick roof

Solar radiation incident on the roof-energy reflected back+Energy radiated out+Heat gain (loss) by the roof material+Heat taken away by the air in the duct+Heat conducted through the roof material+Heat convected inside the room.

For concrete roof

Solar radiation incident on the roof=Energy reflected back+Energy radiated out+Heat gain (loss) by the roof material+Heat conducted through the material+Heat convected inside the room.

Thermal analysis

It is important to note that the addition of brick cladding on the roof changes the thermal capacity of the roof and increases the resistance of heat transfer. In hollow brick since the top layer is being heated and the bottom remains cool, for negligible wind velocity either laminar or turbulent in the duct, hollow section the connective heat transfer from top to bottom layer will take place but this will be insignificant as it is a case of temperature-inversion.

Results and discussion

The temperature-time history (hourly temperature variation of the roof with time) for the varying roof treatments (i.e. roof with bellow-block cladding and roof with bare concrete) are shown in figs 4 to 9 both in line-diagram and bar- charts for different tilting positions of 40, 30, 20, 10 and 0 degree with the horizontal.

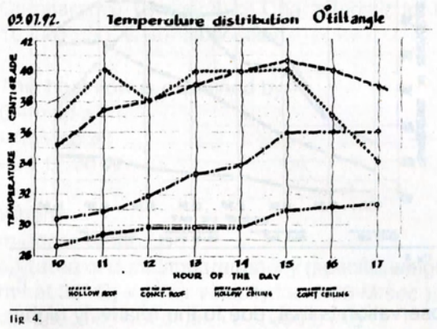


fig 4.

The diagrams and the charts show the corresponding temperature characteristics for roof top and the ceiling of the 'Cool-house' and the 'Hot-house'.

It was found that for 40 degree tilting position the difference between the two ceiling temperatures (i.e. of 'Cool-house' and 'Hot-house') was around 10 to 20 degree during the hottest part of the day (13:30 hr. to 16:30 hr).

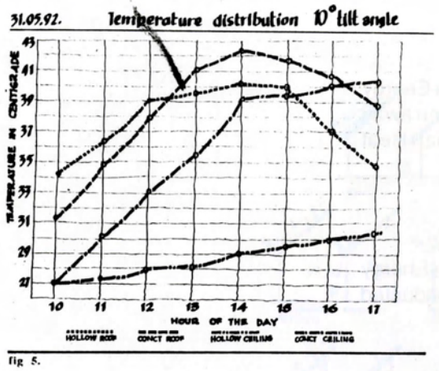


fig 5.

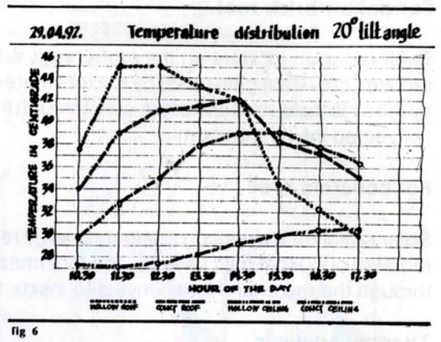


fig 6

This temperature difference remains fairly constant for different tilts between 10 to 40 degree with the horizontal and that indicates that the angle of roof tilts have little influence over the temperature change. However, a significantly lower temperature difference limited within 4-5 degrees was observed in horizontal position of roof. This result supports the hypothesis. In angular position (i. e. in 10, 20, 30, 40 degree) the air column within the ducts of hollow roof in cool house experience a temperature-gradient, which helps to generate a natural convective air current that takes away a considerable amount of heat.

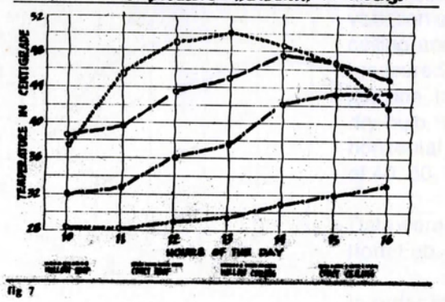


fig 7

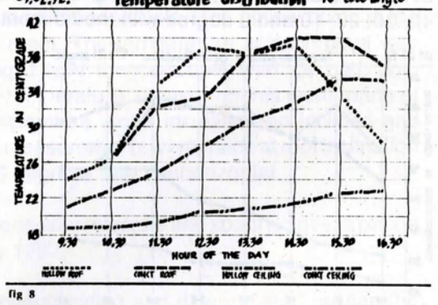


fig 8

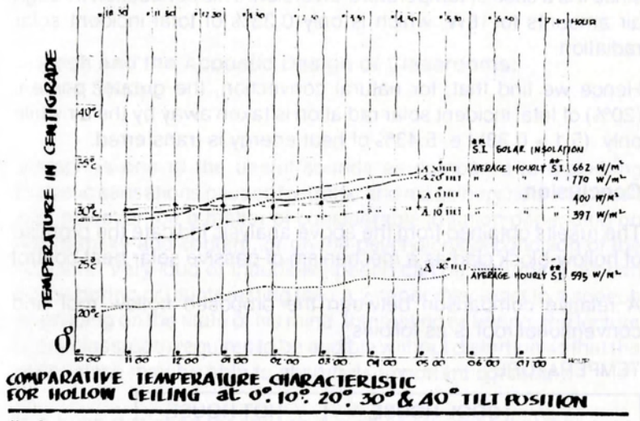
Another important observation is that, due to the relatively higher emissivity of concrete and absorptivity of brick, the roof temperature of hollow-brick i.e. 'Cool-house' shows faster rise and fall of temperature during the day compared to that of the 'Hot-house'.

Yet it is found that heat transfer by 'Cool-house' roof is significantly lower than that of 'Hot-house' through passive cooling by means of hollow-tiles (bricks). This keeps the ceiling temperature of 'Cool-house' constantly lower than that of 'Hot-house.'

The heat transfer of hollow roof can be explained by the following mechanism

- the heat taken away by the air (from the duct)
- heat transfer through the solid (brick fins)
- heat transfer by the air (within the duct)

Heat transfer analysis for heat taken away by the air through the duct is very much dependent on the prevailing wind velocity. The air velocity within the duct was considered equivalent to normal outside wind velocity i.e. 2.68 M/sec. or 6 miles/hr., measured at the site.



COMPARATIVE TEMPERATURE CHARACTERISTIC FOR HOLLOW CEILING at 0°, 10°, 20°, 30° & 40° TILT POSITION

fig 9

Comparative Temperature Characteristic for Hollow Ceiling at 0°, 10°, 20°, 30° & 40° tilt position.

This heat flow is explained by
$Q = m\ cp\ \Delta T$
$= A\ y v\ cp\ \Delta T$
$= 2.712.70$ W

Where
m=mass of air
=Δ (area of duct, apparatus) × y (specific weight of air, i.e. 1.17 kg/m^3 at 32° C) × v (air velocity i.e. 2.68 M/sec.)
cp=specific heat of air, i.e. 1006.6 j/kg C
ΔT=rise in air temperature within the duct i.e.
difference between inlet and outlet air temp i.e. 5C.
This calculation gives the amount of heat taken away by the air, which is 2,712.7j/sec. i.e. 2712.7 W

Since the incident solar radiation was 800 W/m for total roof area of 17 square meter the heat taken away amounts to 20% of this total incident radiation.

Again heat transferred from top of the hollow brick to the bottom of the brick is a case of parallel heat flow.
q= KAdt/dx
=715.176 W or 5.1% of total solar insulation.
Where:
K=conductivity of brick i.e. 1.32 W/m C
A=area of solid through which heat is transferred
dt=Temperature difference between upper layer and bottom layer of the brick i.e. 10° C.
dx= vertical height of brick or tile wall.

The heat transferred through the air layer is a very complicated one since it is a case of temperature-inversion. This conduction through air amounts to 16W, which is only 0.33% of total incident solar radiation.

Hence we find that, for natural convection, the greater percent (20%) of total incident solar radiation is taken away by the air while only (5.1 + 0.33) i.e. 5.43% of heat energy is transferred.

Conclusion

The ruselts obtained from the above analysis indicate the promise of hollow-block clad as a mechanism of passive solar heat control

A relative comparison between the proposed hollow roof and conventional roof is as follows:

TEMPERATURE :

	COOL HOUSE	HOT HOUSE
ROOF TOP :	39 C	33 C
CEILING:	19 C	27 C
ROOM :	22 C	24 C

For 40 degree tilt and hottest part of the day

The research work had to be done in non-ventilated situation because if ventilation is allowed the total impact of solar radiation within the room through the roof cover cannot be measured. This is the reason why the difference of room temperature between the two rooms is not very appreciable, as the cool house during the night period acts relatively more as a heat store than the hot house. Thus the heat stored contributes to the following day's starting room temperature, which remains higher in the 'Cool house.'

The comparison shows that when a conventional roof has lime-terracing the cost factor is very close to that of the proposed hollow brick cladded roof. For this research Mirpur Ceramic Partition Blocks were used, the ultimate shape of which has not yet been finalized for manufacturing purposes. When tiles will be designed and specifically manufactured for use, cost effectiveness will be made possible and it may prove to be more economically viable than the existing roof insulation facilities.

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Speech and the Acoustic Design of Classrooms: A Case Study

Dr. Nizamuddin Ahmed

Abstract

In a classrom it is most importance to provide conditions so that it may be possible for the teacher to verbally communicate with his students. Volume, shape, materials, etc can adversely affect speech clarity; the consequent annoyance is not uncommon. Reverberation Time being the single most important factor in room acoustics, designers tend to compromise volume, shape, materials, etc in order to achieve good hearing conditions. Acoustical design by its very nature cannot be generalized in view of the widely varying parameters involved. The paper takes a close look at a particular classroom to examine the methodology that may be carried out wherever corrective measures are entailed.

Speech and the Acoustic Design of Classrooms: A case Study

Speech is one of the useful sounds as compared to disturbing acoustic sensations caused by traffic and machinery noise. Speech can, however, be a matter of considerable irritation depending on the intensity and content, or on the psychological condition of the recipient. Very loud or inaudible speech can be disturbing, as can be the boring or uninteresting talk. A listener may react to a speech depending on the state of his mind. Interesting or boring, the lecture in any classroom requires to be audible without distortion so that the entire class may be able to absorb its important contents.

In a room designed for speech it is obviously essential that every person in the room should clearly hear and understand the utterances. Moreover, the natural qualities of the speaker's voice should be preserved, meaning that the listener should recognise the owner of the voice.

The above may be achieved by

(a) making optimum use of the limited amount of acoustic power i.e. the intensity of the speaker's voice.
(b) ensuring that the background noise (which may mask the desired sounds) is at a level below 30 dBA.
(c) limiting the size and manipulating the shape of the room
(d) appropriate positioning of absorbing and reflecting surfaces
(e) maintaining the reverberation time of the space within a specified range.

The paper is based on an investigation prompted by observations, often bordering on complaints, that the lecture rooms in the Civil Engineering Building (of the Bangladesh University of Engineering

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