

Sustainable City Strategies for Developing Countries

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“Our societies will never be great until our cities are great. There is the decay of the centre and despoiling of the suburbs. There is not enough housing for our people, nor enough transportation for our traffic. Open lands are vanishing and landmarks are being violated... A few years ago we were concerned about the ugly country.... Today we must act to prevent an ugly city.”
Lyndon B. Johnson
President, USA, 1964.

Summary

That an urban crisis engulfing most parts of the “civilized” world exists is very obvious to everybody who lives and works in the urban areas. The feeling of frustration is so strong that there are some who would like to abandon the city altogether. The common bond of having to eke out a living plus the desire to interact socially makes them perforce stay together, but a relentless quest for greener pastures causes them to sever their roots and leave their homes.

The basic perception of **“progress being synonymous with the city”** causes people to migrate to the metropolis, much as moths towards a candle flame. To pursue the analogy, hopeful emigrants might often find their wings clipped, if not singed, by being caught in the vicious trap of inadequate shelter, encroachments, prohibitive land prices and inflation.

To curb man's innate desire for self-improvement in economic terms or otherwise, is to stifle the human spirit which is constantly searching for fulfillment. There is therefore a need to revamp, to change the basic fabric of day-to-day living to suit the needs and conditions of the people and the times. It is time that all antiquated and inapplicable planning strategies (one of the largest contributors to the ascending inflation scale) be re-evaluated. With the population increasing drastically, we tend more and more to concentrate on the already heavily populated areas. But unless we learn the true meaning of planning, which is the injection of diversity and variety into a meaningful pattern, we will succeed in making our cities unlivable, unworkable places of infernal sameness, plagued by the discomforts arising from the shocking lack of the basic necessities of life - a fate which in fantasy is better known as hell!

The major protagonists of this unlivable hell are the shelterless - their needs, their future and their financing often becoming mere items at board room discussions or seminars. In urban India, as also in most developing nations, this problem of the shelterless is most acutely felt in Metropolitan areas.

Planners, administrators, sociologists and architects have attempted to grapple with the situation intermittently, but like the Loch Ness monster, the problem has eluded them not only because of its gargantuan size, but because of the consequential complications. That the problem is man-made is apparent. The only way to tackle it is to understand it completely and above all, to have a holistic approach, together with the backing of a team of people who know something about everything and everything about something. Most of all one has much to learn from the past and the rationale of “living with nature” as propagated in our ancient text, known as the “Vastu Vidya”. This text needs to be demystified and the reasoning of linking Human Settlements to religion needs to be understood. These forms of guidelines for Sustainable Development, though mystified, exist in most developing countries.

1. Overview

An inadequate comprehension of the housing problem in its totality has resulted in a large proliferation of slums and unauthorized colonies on prime lands in the city. In addition to this are the unemployed educated, the destitute, senior citizens and working women, which when combined, comprise almost 1/3 of Delhi's urban population (taken as a case in point). The same may be true in metros of other developing nations, the extent of which may vary, although the problem areas remain similar. Though the government is spending a vast sum on various programmes for the benefit of these groups, the demands are growing at a faster rate than the delivery system. Limited by their own resources, this vital segment of the population encroaches upon public land or resides in low rental areas which, for the most part, are devoid of all facilities and amenities. Such disorientation puts severe environmental constraints upon both the city and city dwellers, and the basic constitutional right of "living with dignity", is fast becoming a distant dream.

The government's efforts to solve this problem, however, have further been aggravated by increasing investments made in urban areas, leading to inadvertent migration resulting in these high density, unlivable pockets – "a forced living option". In Delhi around 600,000 such households with a population of around 3 million (and ever on the increase), inhabit such shanties on prime public land, amounting to about 4,000 hectares. To use an analogy, this problem, with no apparent feasible solution in sight, seems to roll along like the veritable snowball, ever increasing in size. The failure of municipal bodies and government housing agencies with respect to the needs of this strata of society is leading to public resentment and consequently to the breaking down of law and order.

There is little evidence of success in the popular slogan of "one household - one house". Although there is no dearth of various planning strategies, technological efforts, slum clearance and rehabilitation schemes in subsidized, standardized, unlivable, unaffordable housing units, and the Government is constantly ready with new solutions, the problems keep outpacing any solutions. Although the government has repeatedly emphasized its role as the Great Provider at policy level (for political gains or otherwise), it has been frequently found wanting in this aspect, with neither the resources nor the ability to carry out its plans. Surely it is time for the government to admit its limitations and face up to the reality of the situation?

Populist schemes such as the *Panchayati Raj*, professing 'power to the people', are formulated but they either stagnate at the discussion table or die a natural death at the execution stage since they clash with other policies and schemes which are formulated on the principles of centralized decision-making processes. By the time some semblance of a solution is achieved, the problem is already out of hand and requires a different solution. It is therefore time that limitations in this role are accepted by the government. The *Panchayati Raj* typically depended on the wisdom of the five headman of the village to look after the day-to-day problems of the village, thereby dealing with problems in their initial stages. It was only the residual problems that were taken to the next level of decision-making where the individual representatives went to the decision-making body of the group of villages, following the principle that "Every action is best performed at the lowest level that it can be best performed"

The city is what it is today principally due to external factors (bureaucratic and political) influencing its planning strategies. One glaring misfortune is that the common man seems to have almost no influence whatsoever on his life-style in terms of planning or decision-making. He is dependent, almost body and soul as it were, on the civil servant who is the major planner and decision-maker. This natural obeisance is a spillover from the British Raj days when the government servant was kingpin and service centres, administration offices, etc., revolved around him like satellites. Business centres had to move to the periphery, while at the hub of the city was the civil servant and his entourage of domestic help. When the British civil servant completed his term in office it was expected that he would return to his homeland. Today upon retirement, however, the bureaucrat instead provides sustenance for his entire entourage of domestic and office staff, who after retirement are willing to stay on permanently in the metro that they ruled. Where the bureaucrat takes up residence, initially determines the pace and nature of development and eventually the fate of the metro hinges on this.

In understanding the rationale as contained in the Vastu Vidya (India specific), one would have understood the manner of exercising controls in Human Settlement patterns for a system that is sustainable, whilst at the same time respecting the social fabric of the citizens that the settlement was designed for (see box 1). The other aspect of the forms of governance as being subservient to the Vastu Vidya and co-related and contained in the Artha Shastra (the text for the rules and forms of Good Governance – see Box 2) must also be de-mystified and dovetailed into the understanding of providing sustainable human settlements. Careful examination shows that it is the tropical regions, the areas with the most fauna and flora, which are today considered as the developing nations. It is these regions that have the largest amount of disease as well as the antidotes for the disease. These regions are the most densely populated areas of the world, have the largest amount of produce from the land and are interdependent according to social and community values. These regions also abound in myths and religious beliefs which have been their mainstay in the past

Box 1 – Vastu Vidaya

The Vastu Vidya—the traditional Indian texts containing the fundamental principles of planning and building for Human Settlements, is the parallel of the Feng Shui in the Far East. Though propagated through myths and religion, if analyzed logically is a complete builders manual of do and don'ts. These texts have a strong understanding of climatology, behaviour of building materials and their appropriate application, respect for the natural elements and most importantly, the control of human aspirations. The texts are zone specific and several versions exist, but the fundamental logic of living with nature is the common thread that holds all the versions together. These texts were revered by King and citizen alike, and propagated by the religious heads through the planners.

Similarly the traditional architecture in the Asian region, as also in most parts of the tropical regions of the earth, was more than just the built-up form and its symbolism. The town planning methodologies, the mysticism linking it to religion, the symbolism and the architecture all provided for a total form of sustainable human settlements. Over years of rationalization, the past generations realized that most of the problems relating to sustainable human settlements were related to the immense human desire to leave an imprint in the sands of time. This aspiration to make an individual statement could be best met by the buildings man built. This would also be the single largest contributor to environmental degradation. The control of this aspiration was best exercised through formulation of mystic codification propagated around religion. A sensible form of controls,

Box 2 - Artha Shastra

Artha Shastra is a Hindu text written for good governance and the rules that the king, the religious leaders and people must live by. Though mystified around religion the fundamentals are true and co-relate with the democracies that we are trying to develop today.

There are various versions of this text written by several authors and translated in English. The document goes into various details such as the basis for town planning for good governance, strategies for defense, basis of tax and revenue generation, etc.

considering the fact that man has never had to deal with the phenomenal level of land and building-related issues as he is confronted with today. The very existence of mankind seems to be at stake but in spite of this, individualistic issue based approaches are being explored, with each issue seeming larger than the previous one. A point of view that requires consideration is that maybe earlier generations realized that the single largest factor that could affect sustainable development was the built form and the city plan. What we today call Behavioral Sciences was encompassed in the traditional building and planning strategies. Today what is known as architecture was in fact the most powerful tool that was devised through which the behavioral pattern of the entire society was controlled. Today it is being intensely debated whether or not architecture is a science or an art, with no conclusions emerging. Architects and planners are today considered as a supportive profession to the Engineers, but continue to feel that it is the architectural profession that should be the lead profession. Architects themselves do not realize that it is not the engineers that pose a threat to them, but they are a threat to their own profession. If Architects and Planners are to command the respect they did in the past, then their endeavours should be the integration of the architect, the engineer, the artist and the artisan. Though designated the leader of the team, the architect in the past worked in close co-operation with the religious head, who was responsible for overseeing that the social aspects were well-integrated in the planning and implementation stages to provide for Sustainable Development issues.

The endeavour to provide for sustainable human settlements led man to mystify¹ the guidelines for social and value-based controls. This mystification ensured that the entire interdependent system of sustenance was respected. The forms of mystification gave rise to various religious beliefs of the regions and the forms of governance are a derivative of both these aspects. A simple analogy of sustainable development is clear if religion is examined from a very interesting point of view. All religions are the same and only the manner of explanation differs. All religions propagate sustenance through interdependence and most religions are based on the Fatherhood of God and the Brotherhood of Man, (e.g. the commandments say so or the Holy Book says so), but religions or the manner of living in the tropical regions suggest the Brotherhood of Man and thereby the Fatherhood of God, i.e. in coexistence one can achieve salvation. Two different ways to look at religion, one with a top down approach and the other with a bottom up approach, but both clearly propagating sustainability through interdependence. That is why, it is often said that Hinduism is not a religion, but a way of living. It is also within the Tropical Regions that humankind worshipped or propagated myths around the elements or plants and even animals that helped sustenance. The Hindus in the Indian Subcontinent, the First Nations in the Americas, the Africans, the Greeks, the Chinese and the entire so-called Orient, offer examples of this belief and form of worship.

Strangely, most of this system of planning with religion seems to be true within the Tropical Belt, and as one moves away from the tropics towards the poles, the interdependency seems to reduce considerably, until it is almost absent in those regions close to the poles. It is within the tropics that society is interdependent and it also within this region that most of the values for survival are propagated around religion. Mysticism is a way of life and is the chord that holds society together. It was therefore the responsibility of architect or the planner of the human settlements to ensure that the principles of interdependency were respected as propagated by the religious doctrines and their propagators. The built-up form, being the most powerful manner of influencing the human mind, was thus utilized to full advantage. It was also within the tropical regions that most diseases were prevalent but the largest variety of plants and herbs also existed within this region. It was almost as if nature had provided the largest laboratory for man within this region, to explore, to appreciate and evolve the principles of co-existence. Today, the aspect of disease is being highlighted and is used as a tool for labeling this region as a developing region. The aspect of co-existence with nature and its other offshoots such as the forms of human settlements, the regional-specific customs, the resultant forms of governance, traditional values, customs and cultures are being limited to Romanticism only. So intense is this belief that the civilizations in the tropical regions are themselves convinced about their own shortcomings and aspire to mimic the so called advanced nations without attempting to delve into their own past and the understand their own values. It is not that the development of the so-called advanced nations must be ignored and wished away, this would be a grave error, but the rationale of the past must be dove tailed into present day developments without losing sight of coexistence. This is best understood by examining the rationale that governed the nature and patterns of human settlements and their inter-relationships.

So rapid was the transformation during the Industrial Revolution that all the wisdom and the rationale of the past was buried. The process of rationalization of the past took a back seat and even reference to traditional values of coexistence was considered archaic.

"... we have the paradox of a world in which growing investment in education goes with the growing numbers of illiterates; growing investment in industry actually decreases jobs, and where fabulous unprecedented wealth co-exists with the highest of poverty and environmental destruction in recorded history."

Ashok Khosla, Development Alternatives, India

2. Land and Appropriate Planning

Evolving appropriate sustainable city strategies for developing, as well as developed countries, requires a re-examination of modern day frameworks of 'the city' as well as its components. The modern-day framework has, for over a century, ensured that cities have developed in tandem with political and economic resources. In other words, that as long as there is ample money that is expendable as well as access to other resources, most

¹ Mystify, or mystification is used in its sense of inducing a sense of the sacred. Thus mystifying planning controls would be to declare them as sacred and part of the spiritual and/or religious doctrine.

modern cities have rapidly developed with little consideration given to their natural environment and long term sustainability.

Sustainability can be achieved as long as some very basic issues are examined, developed, and implemented. Prior to the Modernist movement the majority of town planners, architects, engineers, artisans etc. had a natural understanding of the relationship between the built form and the natural environment. One characteristic of the Modernists was the imposition of their rational concepts to make the earth conform to their vision of man.

In order to achieve sustainability, smooth amalgamations of traditional (read context specific) building practices and modern technologies can be developed and implemented. Of course this is an arduous task, but at the same time there are some very basic guidelines and issues that, when viewed in the correct perspective, could form the foundations of sustainable development. Amongst other things, we could do well to deal with the issues of Land, Roads, Water Supply, Water Disposal and Appropriate Building Materials.

Technologies that are appropriate at a national level must be segregated from those that are appropriate for local consumption. This would distinguish technologies that need to go into macro-industrial production from the micro-enterprise. Appropriate technologies are those that respond to the local environment, resources and economic needs.

Raising public awareness on environmental and equity issues is indispensable for sustainable development. For the successful implementation of comprehensive and appropriate development issues, it is essential to educate the public, government, social and technical institutions and business groups about comprehensive sustainable development issues.

It is essential to ensure that future generations are constantly made aware of sustainable development issues in their decision-making process. The subject must be introduced into the basic educational curriculum. Just as an individual understands the implications of his daily financial decisions, similarly he should be cognizant of the social and environmental implications of his actions.

3. Land Value and Credit Reforms

"We have not inherited the Earth from our forefathers, but borrowed it from our children." Chief Seattle, 1854.

Land is the basic matrix of life and all development activities generate on or from it. The other essential input for generating development activities is capital. In most developing countries absolute value is based on land holdings. The fact that you can trade in land is in itself the core of the problem. Logically, it is the asset on the land that can be bought and sold, and not the land itself. Most developing countries are suffering from the ill effects of unsustainable land and credit-related financial policies. The three areas that need critical examination are: -

- The commodification of land, which is the largest contributor to inflation
- Credit against land as a mortgageable asset, which in turn leads to inequity
- Lack of access to credit due to land as the basis for credit and inequitable access to land

The values attributed to a product are frequently unrepresentative of its real value, as a result of various market and credit systems. The manner in which land is valued is a typical example that has far-reaching effects. In most Asian countries land has become a tradable commodity. Land values are often far greater than the produce of the land or the value of the asset on it. For instance, if the cost of a building is X, then typically in an Asian metropolis, the value of the land may be as high as 20X, or even up to 200X i.e., it gets magnified to a disproportionate extent.

This is mainly due to the banking system which lends against the value of land, in addition to the value of the existing or potential asset. The outcome is inflationary effects on all products (since real estate value constitutes a major component of a product's value) and it leads to speculation that also fuels inflation, without any real value / product / asset, being created.

A possible remedy may lie in changing the financing system, so that lending agencies such as banks remove the land value from the project cost. Instead, a project should be financed against the produce or value of the asset created on it. If land is valued, then it would be safe to assume that the entire earth stands sold today. Is this an acceptable hypothesis?

A safe barometer for sustainable development would be land values not exceeding the cost of construction by more than four times, even in the most expensive metropolitan real estate. In other words, if the construction cost is X, then the land cost should not be more than 4X. Any increase in land cost beyond four times would result in the commodification of land that consequently leads to the quality of construction being adversely effected. For example, since the owner/builder has spent a high price just for the land, he will compromise on the building itself. This is most often done by constructing thinner walls with more plinth area to save on construction, material and labour costs. This then leads to the use of inappropriate building materials and a complex process of problems is set in motion.

If we were to hypothetically take away the value of land from the cost of an immovable asset, the entire economic face of financial as well as legal transactions would change. Approximately seventy percent of litigations in our courts are land-related. Land values and land ownership are considered synonymous with progress but this perspective needs to be re-examined. Traditional building practices, as well as the Artha Shastra, propagated a system that was very different from present day practices. Over the years, we linked value to the land and made this a transactable commodity with astronomical value.

While it may not be feasible to adopt the above strategy with immediate effect, one could work towards achieving this objective in an incremental manner by reducing the limits of the drawing capacity against land on a yearly basis until the objective of de-linking land from drawing power is achieved.

4. Land Use, its Distribution and Management on a Sustainable Basis

National and state planning commissions deal largely with financial planning and resource management, which are divorced from land use planning. Land use planners are not involved in the process of formulating development strategies and plans of a region at a macro-level for sustainable human settlement design. Development strategies that are based on natural resource planning are often relegated to the background, and instead allow political considerations to dictate the regional plans. This results in the misuse of land, inequitable growth and extensive degradation.

Presently, there is widespread inequity with regard to access to land in most Asian countries. Equitable distribution of land should be an integral part of the devolution of power. Access to land by itself is not adequate unless micro-credit and other support services to generate produce from the land are provided.

5. Land - Flat Versus Gradient

Besides the financial and legal aspects of land issues that need to be re-formulated, the physical characteristics of land need to be re-defined. There is a general misconception that it is more economical to build on flat land rather than on undulating terrain. Historically, urban centres that were built on higher ground were situated thus not only for militarily strategic reasons. Higher land lends itself to better drainage and more economical disposal systems owing to natural slopes. There are some pertinent lessons that we can learn from the past in order to have sustainable development in the present. Provided one respects the lay of the land and determines a city master plan on the basis of water supply systems and the disposal of waste etc. there are greater chances of developing a sustainable city environment. The micro plan can then be envisaged leading to comprehensive development plans.

6. Roads

The largest single contradiction in our present day planning methodologies is the relationship between roads and drainage systems. Roads require minimal slope while drainage requires steep slopes and yet we choose to

combine the two by placing our drainage systems alongside roads. If the performance criterion of roads and drainage is taken separately then possible solutions emerge that are very different from present day planning practices. If one were to de-link drainage from road networks on undulating land, then the obvious first step would be to first establish drainage routes. These routes should logically follow the shortest path to ensure maximum slopes and therefore emerge as straight lines placed within the lowest formation of the land to be developed. Roads should then wind across this path thus ensuring minimal road slopes, meandering across from one side to the other. Areas between the road and the drainage paths should be used as neighborhood green areas or public recreational areas and development zones should therefore be located on the outer areas of the meanders created by the roads.

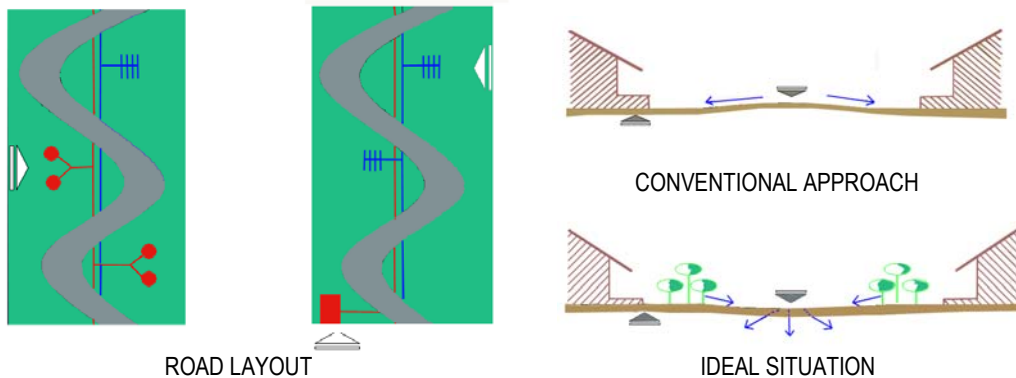


Fig 1: Road Layout

In flat land areas, inappropriate and unsustainable road designs have become increasingly prevalent. The problems that arise, stem from the fact that most roads, without proper drainage culverts, are built higher than adjacent lands. These roads act as mini-check dams, causing water logging and flooding. This problem is further compounded when houses are consequently built higher than the roads. Since developments on flat lands have inadequate slopes for natural drainage, deep waste and storm water drains have to be built, once again generating a complex series of problems.

7. Water Supply

Sustainable and appropriate water supply systems are vital for any urban centre. At present, most water supply lines are placed underground. This is a primary cause of water-related disease problems, in more ways than one. Since the water supply in a centralized system, as we have today, cannot be guaranteed around the clock, municipal authorities find it necessary to supply water only during specific times, forcing households to store water in often unhygienic receptacles. Shutting down water supply at intervals causes vacuums in the pipes resulting in their deterioration, thus contaminating the water with pollutants that are sucked in. One solution to this dilemma would be to, wherever possible, place water supply lines above ground level. This would reduce the amount of road digging undertaken by the municipal authorities whenever pipe repairs have to be done. The above ground pipes could then be incorporated into decorative fencing along road boundaries. Where lines cross the road they may be taken underground by sloping the pipe at an inclination of not more than 45 degrees. Any leakage can be swiftly attended to and the pipes can also be used as low-level advertising spaces. With this type of water supply system, unauthorized connections can be stopped by residents' associations and by empowering neighborhood associations.

8. Water Drainage

Traditionally sewage and kitchen and bath waste- were never intermingled. Both these were separated right at the source itself. The night soil as well as the water that was used was disposed of by allowing it to percolate into the soil. Whether this was done through localized pits or by physically lifting and disposing it in pits at distant locations, the night soil was never disposed of in combination with the kitchen and bath waste. It is not that our earlier generations were incapable of designing good enough drains to transport the combined effluent. Logical analysis shows that they chose not to adopt this system owing to their complete understanding of sustainable

development. As stated earlier, human settlements of the past almost always existed on high land, therefore disposal through drains was even easier, thus negating the argument of non-availability of technology, which is often used as the main reasoning. We acknowledge the advanced systems of planning adopted in the town planning strategies as adopted in Mohenjadaro and Harrappa and yet we fail to take cognizance of one of the strongest features of these developments. It is now acknowledged that the planning of the past provided for separate drainage systems for the kitchen and bath wastes. They did recognize the fact that wastewater does not necessarily mean contaminated water, as in the water used in disposal of night soil, and very simple methods were adopted to clean kitchen and bath waste. This was done at the first point, i.e. the house itself and the methods applied were extremely elementary by disposal in the kitchen garden. The plants used here were papaya or banana, which are good digesters of grease, which in turn is also a nutrient for these plants.

At present, kitchen and bath waste are taken separately to the point of the first manhole and are then combined and discharged into a combined manhole. At this point, corrective action can be taken and both the effluents disposed of separately. Kitchen and bath waste can be safely discharged into the open storm water drains that are presently provided outside every developed plot of land. This water must be allowed to absorb into these drains that often lie unutilized for most parts of the year and are often blocked due to non-utilization. Lately, there has been a practice of plastering the inner surfaces of these drains thus preventing line percolation and ground water recharge. Some may argue that this is unhygienic, but any unmaintained service is unhygienic. The answer therefore lies in regular maintenance and not in its avoidance. The centralized system of city management is ill equipped to perform this function effectively. This is where the issue of a decentralized system of city management down to the neighborhood level would become important.

An area so far unexplored for waste percolation is the soling layer of the road. It seems that large parts of our roads lie underutilized. Natural slopes to enable wastewater flow are available because buildings are built with plinths higher than the road. Waste-water can therefore be allowed to flow under the roads into the soling layer, through leaking pipes, thus providing for wastewater disposal that is not exposed.

Some argue that the separation of kitchen and bath waste from the main sewage line leads to sewage disposal line obstructions owing to inadequate water. Here again it seems that the root of the problem is not being examined and a solution that leads to further complications is being relied upon. The first discrepancy in this argument is that it presupposes handling of the effluent through a centralized system. If the soil water were disposed of at the localized level, then the excess water required to carry it over large distances would be unnecessary. It may be seen that the civilizations of the past dealt with high densities within their fort precincts in this manner. Densities within the urbanized areas or within the confines of the forts were often far higher than the ones that we are unable to deal with today and yet we quote high densities as the main reason for our centralized municipal malfunctioning. However, localized disposal of soil water is only possible where the soil is absorptive and this is largely possible on the higher lands. The alluvial basin or flat land that we build on today is not as absorptive and is ideal for agriculture owing to its ability to retain water and this is where the proper identification of land for human settlements assumes tremendous significance.

Today, as things stand, Delhi is on the brink of a major disaster. The water shortage has reached alarming proportions and the next elections may well be contested on the assurances that the political parties can give with regard to water. Our text, the Vastu Vidya stated that if a planner should design his human settlement around water, then he will live for 6000 years. Today this seems truer than ever. This statement did not however mean that the Sthapati would never die, but implied that the settlement would be sustainable and would be so for thousands of years, thus the Sthapati would be remembered. The question upper most in everyone's mind is "Has Delhi run dry" or "Where has all the water of Delhi disappeared"? In a couple of years the essential appendage to a Delhite may well be a mobile phone in one hand and a bottle of suspect mineral water in the other. The cell phone and the computer may well be considered a mark of mobility and the rapid progress of information technology, but a bottle of mineral water can hardly be considered a sign of progress.

An area that requires critical examination is the flushing cistern that we use today. The earlier flushing cistern of the British Raj was 5 gallons. This has now been scaled down to 12 litres, based on the quantum of water required to take down toilet paper. The traditional cistern was based on the water required to flush newspaper, which was used as toilet paper when the typical bottom on the throne was a British one. Most Indians wash and

with the availability of the super satin variety etc. even 6 litres is adequate. While it may not be possible to replace almost 4 million cisterns that are of the 12-litre variety, a simple solution may suffice. Encourage people through the media to use approximately 6 litres of stones on the opposite side of the ball valve in the typical cistern. Even bottles filled with water and then sealed would reduce the capacity of the cistern to 6 litres. Considering an average of 4 flushings per person of the 4 million people owning these, one would conserve approximately 96 million litres of water per day in Delhi alone.

In Delhi there are over 2 million vehicles, which requires nearly 6000 hectares of paved parking. The water falling on these vast paved areas also find its way into the famous storm water drains. If one were to use the ferrocement jaalis (the typical perforated concrete panels that one uses in toilets for ventilation) for the parking areas, and grow grass within the perforations, the result would be soft paved parking areas. The vehicles would not pressurize the roots of the grass and one could safely mow the lawn. A fringe benefit is the reduction of heat build up within the urbanized areas.



Fig.2-3: Grass grown in perforations of ferrocement jaalis (see ferrocement concrete panel in inset)

Emphasizing the first point, never has land been traded upon more than in this century. Consequently, there has never been more discontent amongst people than in this century. Environmental degradation has reached new heights. Roads are designed on a 'universally standard' basis, without considering their multifarious functions and the natural lay of the land. Cities spring up on seemingly empty canvases, barely surviving their unnatural locations and consuming massive resources. Water is one of the earth's greatest resources, and yet we have forgotten the numerous ways to replenish the earth. Building materials are standardized to theoretically ensure consistency and uniformity, without considering the long term and humane effects of the manufacturing process and material usages.

The reason that developing countries seem to suffer from seemingly malfunctioning cities, more so than so-called 'developed' countries, has more to do with the efficiency of the respective political and economic structures than anything else. High population densities, availability of resources, archaic dogmas, and modernization need not be the stumbling blocks of sustainable development. We can learn from our historical past, immediate past and present to ensure sustainability through appropriate technologies, planning and thinking.

9. Sustainable Building Technologies and Appropriate Materials

Building activity and related industrial production in developing nations accounts for a large proportion of their Gross National Product (GNP). Within these societies, use of inappropriate building technologies and designs is the largest single contributor to environmental degradation, depletion of natural resources and inequitable distribution of wealth and opportunity. Developing nations must therefore focus on the use of appropriate technology in their building industry. At least 50 percent of developing nations' GNP goes into building and construction. Of this 50 percent, 60 percent is for material consumption and 40 percent is for labour. Therefore, in order to have sustainable development it is imperative to identify the areas where macro industry and micro enterprise are required. If, as in the case of most macro industries, the add-on is more than 40 percent then there is unsustainable and inappropriate development.

10. Micro-Enterprise and Sustainable Consumption Patterns

The developing nations are today following the advanced nations' policy of achieving economic growth through macro-industrial production, which revolves around the concept of large-scale production and high-consumption patterns. The consequent environmental impact is often overlooked. Large-scale production and consumption necessitates large distances for transportation of raw material and end product, high marketing costs and other add-ons. Advanced nations today have 30% actual production costs and 70% add-on value to a product. Developing nations still have 70% production costs and 30% add-on value, but are rapidly following the unsustainable patterns of the developed nations.

Macro-production essentially leads to a centralized economy and imbalanced growth, while micro-production facilitates distribution of wealth and power. There is a need to differentiate between products that need to go into the macro-enterprise and those that are appropriate for micro-enterprise. A safe barometer to evaluate products that should be in the micro-industry should be established. Broadly, if add-on costs exceed 40%, then the product or the means of production must be re-examined for possible manufacture at the micro-industry level.

11. Building Materials

Misuse of building materials is probably the largest single factor that contributes to environmental degradation. In the last century the largest amount of development in the construction industry has been that of surfacing materials. RCC (reinforced cement concrete) was clearly not the answer and it is to protect RCC that several surfacing materials have been developed, which also provide colour and texture.

A common misconception is that the life of a building depends on the strength of the building material. This is incorrect. If the soil bearing capacity of earth is 2-3 kg/sq cm then it would seem irrational to use building materials of 300-400 kg/sq cm. The strength of the material required is the direct consequence of its surface requirements. Surface engineered building materials require serious consideration.

Uniformly distributed load on wall is less than 0.5 kg / sq. cm.

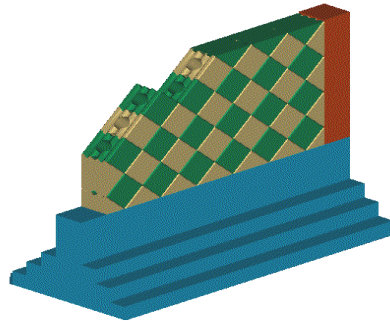


Fig.4

Soil bearing capacity is less than 3 kg / sq. cm.

Traditionally, a considerable amount of importance was given to the choice of materials to ensure conservation of natural resources. It is the incorrect choice of materials that has resulted in the environmental degradation that we have today.

A closer look at brick and reinforced cement concrete, two of the most widely used materials of the industrial age, establishes the incorrect evaluation of the materials we choose to build with, reinforcing the efficacy of the mystical forms of establishing ecological balances.

To begin with, let us look at the most ubiquitous actor in the building drama- THE BURNT CLAY BRICK. This tiny element of the building industry has for centuries been most misunderstood. Today, the brick is considered a building material with universal application and standards. The sole determining factor is the crushing strength of the brick. However, the performance criterion around which the crushing strength has been formulated is often relegated to the background or has been long forgotten. Analyzing the established rule of thumb for crushing strength throws up a contradiction. Since the soil bearing capacity of most soils is a mere 2 Kg. / sq.cm., then the reason for using bricks of crushing strengths of 150 to 200 Kg./ sq.cm. is open to question. It seems highly

illogical to use material of such high strength when the soil that the building is to rest on is of a lower crushing strength.

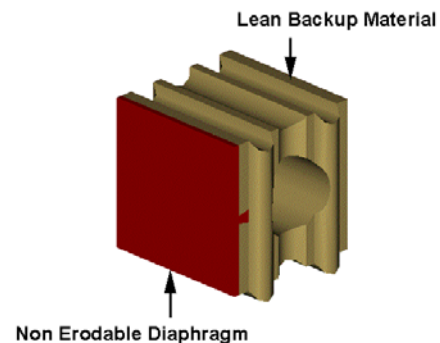
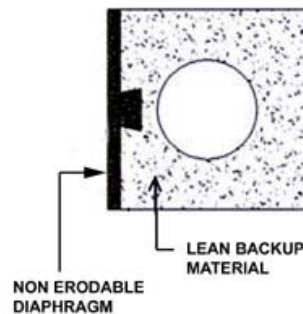
Yet the practice of achieving high crushing strengths for bricks is correct for an entirely different reason. The rationale is very simple: the strength determining factor for the brick is a direct consequence of its surface requirements. To ensure non-erodability, clay must be burnt adequately. Suitable non-erodability is achieved when there is a crushing strength of above 150 Kg./sq. cm. If the strength achieved is lower, then the brick wall would require additional surface treatment such as cement plaster. In blocking off the natural porosity of the brick, one is confronted with the additional problem of having created a heat trap, apart from having used an unnecessary expensive material.

Another aspect of the brick that requires rationalizing is the size itself. There is a basic error in standardizing the size of a brick at 3"X 4.5"X 9" for the entire country. The physical aspect of clay and its content varies from region to region. In attempting to standardize this building element we are actually trying to standardize the quality of clay that the earth yields. This is clearly not possible and in order to obtain a standard product, set technological solutions such as High Draft Kilns are invented. This further leads to consumption of coke that aggravates the fragile ecological balance. However, the bricks of yesteryear were of excellent quality in terms of strength and surface requirements. This was because the clay of the region determined the thickness of the brick and the final decision was that of the potter working in that area.

The brick seems to be the most widely used walling component and the most misunderstood. The fundamental error in crushing strengths of bricks was discussed with a view to rationalize material use. Before going back to the brick and any possible alternatives, let us establish the criterion for good walling elements. It is a misnomer that walling elements require great strength. This first assumption is where the basic approach to materials really goes wrong. Walling elements must essentially be non-erodable and this must be the main criterion. Low thermal conductivity is the next priority as well as the least amount of consumption of "processed material". Economy, colour and texture as intrinsic elements are other criteria that must be met.

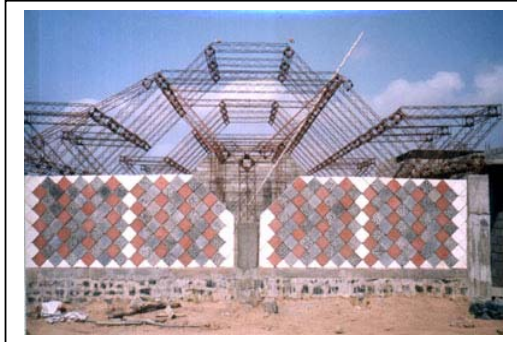


The high benchmark of load-bearing capacity for brick was established to ensure its non-erodability. It is also an established fact that the denser the burnt clay brick, the greater is the strength and non-erodability achieved. Conversely, greater density of bricks increases its thermal conductivity.

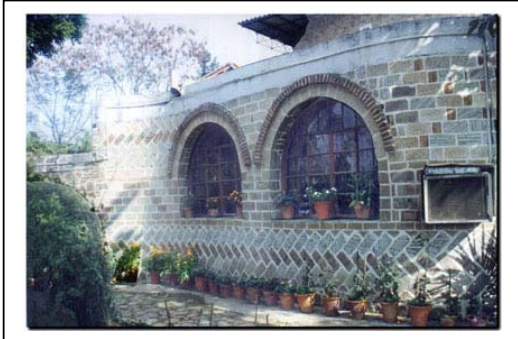


This results in higher internal temperatures resulting in the vicious cycle of expensive cooling systems. The essential criterion of a good walling material thus seems to be a non-erodable surface and a lean back up material.

This brings us to the concept of surface engineering. This refers to the creation of a permanent, non-erodable surface diaphragm composed of waste material. Integration of this diaphragm with a lean back-up material like mud or fly ash enables a walling block with a non-erodable surface and a body with low thermal conductivity. This surface diaphragm can also be made in the form of a tile with a wedge that can be integrated with the body material in the mould while casting the walling block. Tiles can be used on both sides of blocks for a permanent finish on the interior and exterior.



Surface En



12. Reinforced Cement Concrete

The second building material that dominates the building industry the world over is Reinforced Cement Concrete. RCC is considered as the epitome of human achievement in the realm of building materials. It is pertinent to question ones' blind and misplaced faith in it as a magic formula. In order to evaluate RCC, it is necessary to briefly go into what may have been the reason for its development. In the past, stone was the most resilient material known to man. However, transporting, handling and processing it, were cumbersome and required an immense amount of labour input. Besides, the available size of stone was a limitation in terms of design possibilities. With the rapid developments during the industrial revolution and the invention of cement as a quick setting adhesive, it became possible to crush stone and remould it, thus making it pliable in the creation of a variety of forms. Pliability was, therefore, the main criterion and to this extent the invention and usage of concrete is justified.

Reinforced Cement Concrete is an invention that forces natural materials to behave in a manner that we wish them to behave. Just as stone has the inherent quality of being able to take considerable crushing loads, the derivative of stone as used in concrete, has tremendous capabilities of resisting crushing loads. It is only when we try to use this material as flat slabs and push the material to respond against its natural properties, that we encounter a series of problems that constantly compound themselves. Instead of reflecting and examining where we may have gone wrong, we strive to find solutions without examining the base.

Typically, RCC consists of cement as an adhesive to bind sand and stone aggregate to create reconstituted stone. The coarse sand is the intermediate, used to fill voids, and the attempt is to once again achieve the strength of the stone that we crushed to begin with. The steel reinforcement is introduced in the lower regions of the RCC, to neutralize the tension generated when RCC is used in a flat form. In the upper regions, when seen in the cross section of the beam, concrete is behaving in compression and responding to its inherent qualities. The problem, thus, lies in the lower part of the RCC, which is being made to withstand tension - against its natural behavioral capabilities.

It is not as if stone is incapable of withstanding tension. Flat stone slabs have been used in Hindu temples to roof considerable spans and the form of construction adopted was on the basis of the inherent qualities of the material. For instance the flat stone slabs, in our traditional forms of construction, were used only where sedimentary stone existed. In areas where metamorphic or volcanic rock existed, compressive structures were built. Sedimentary rock is often capable of taking far more tensile stresses than RCC. Yet, the faith reposed in RCC is so great that it seems virtually impossible to convince the die-hards that there is a fundamental error in our perception of RCC.



Fig. 17: Stone Slabs used for roof in Hindu Temples

We have fallen into the trap of using standard details the world over for foundations, walls, roofs and other elements of a building. Each successive generation of architects and builders mindlessly adopts the existing norm without rationalizing their advantages or examining alternative solutions. It is an extremely small percentage that is involved in developing alternative technology and building materials.

13. Heritage-art-culture

These were not mere flights of fancy, as they seem to be today, but a way of living. To re-learn our heritage and history and imbibe what is relevant for us in today's world and make it a way of living - all this cannot be achieved at once. A harmonious blend of the past with the present, of tradition and the individual talent: that is what this paper seeks to illustrate and prove. The issues raised are not merely for the sake of making one aware of the problems. Most of us are aware of these, as we live with them. The intent here is to rationalize the problems with the single objective of arriving at workable solutions. In order to arrive at the solutions, one finds it necessary to link the solutions with the traditional wisdom of the past, with an open mind and some lateral thinking. One believes that the best solutions are often so simple that they get disregarded because of their simplicity.

14. Education, Training & Awareness for Sustainable Human Settlement Design

Although within the past few decades a number of institutions, research organizations and NGOs in India have worked in the field of sustainable development planning and appropriate building technologies and have made considerable headway, there has been no dynamic change in the mainstream planning and design of habitat. Two main problems exist in the current system.

14.1 The challenge: to create a corps of sustainable design implementers

The first and most important problem is a lack of integration of these efforts within the education system, since development as well as research in the field of sustainable human settlements and building systems is not linked with the academic institutions. Consequently, future architects and planners, who continue to absorb outdated, conventional methods, cannot apply their skills in the everyday working system. At best any change and development work continues to remain one of many pilot projects, or 'alternative' options. Their propagation at a mass level is hindered by the lack of appropriately trained professionals within the profession, government agencies and amongst the educators themselves. This lack of awareness also exists amongst the general public, who are further with a woeful lack of information and expertise.

Currently there are over hundred accredited schools of architecture and planning in India, with many more soon to receive government recognition. A central approving authority grants recognition to these institutes. The curriculum and syllabus for these schools are defined within a common framework laid out by the recognizing authority. As a result, education provided within this formal system functions on the principle of the lowest common denominator – institutions are thus unable to strive for excellence and further, regional response is lacking. In such a system students are unable to develop skills to deal with sustainable design and technology issues. This is largely due to the following reasons:

- Lack of awareness and exposure to sustainability issues in a holistic manner.
- Lack of awareness and inability of the faculty to guide and support the students in these efforts.

Due to the requirements of working within the stipulated centralized syllabus, the educational institutes and faculty therein are required to function within the conventional framework. Frequently, despite attempts to look for options, the faculty does not respond to students even when they independently attempt to delve into such projects. In fact at times they are even discouraged to step outside the established norms and approach.

There is further no organized feedback of research and developments in sustainable design into the institutions. Few students and faculty members return to encourage work in this area, hence remain singular and isolated efforts. The system remains static in the absence of a discerning coterie to advocate the necessary change. Any significant change may be effected through a cyclic link between agencies dealing with sustainable development and educational institutions, so that appropriate development methods become a mainstream concern and expertise.

14.2 The need for more holistic planning and research

The other problem is that, much of the research done in building technologies and planning is not done in a holistic manner, to be truly sustainable. The research institutions, development agencies and other organisations address each issue individually and in a singular way. For instance, agencies involved with building technologies focus on specific technologies such as ferro-cement or soil blocks as isolated elements, while others deal with pollution, transport planning, environment or social issues. Co-ordination and cross-sectoral work between these agencies is lacking and thus development activities related to the design and management of human settlements does not take place in a holistic manner.

14.3 New models for educational institutions and curricula

The education, training and awareness for sustainable human settlement design should focus on training future professionals in the areas of appropriate building technologies and sustainable planning. Through such a programme, a discerning group of trained personnel would be created to become future practitioners and educators within the field as well as in government and other institutions. In India an example of such a new educational institution is the Academy for Sustainable Habitat Research and Action (ASHRA²) described in the text box below.

Box 3 - Academy for Sustainable Habitat Research and Action (ASHRA)

ASHRA is envisaged as a program to train future professionals in the areas of appropriate building technologies and sustainable planning strategies and develop a corps of sustainable habitat advocates, within the mainstream. The primary target group is architectural and engineering students who are the future decision makers.

The main focus will be to take sustainable practices from lab to land through a network of students with the Anangpur Building Centre as the catalyst. A website and over 11 films have been made and the site has been selected as the best educational site by Study Web. These resources will be used for lectures and online education. Students will be enrolled as members to the website, from this group of students the most motivated 30 students will be selected for hands on training on live pilot projects at the ASHRA's base at Anangpur Building Centre. After one year of training these students will go back to their colleges to complete their education and influence students and teachers.

The objective of ASHRA is to facilitate the absorption and diffusion of sustainable planning and design practices and technologies into the main stream and its propagation at a mass level. Through its partners in diverse countries having similar problems it will foster exchange of knowledge and experiences. It will specifically look at the relevance of traditional wisdom in several areas of the world and dovetail it into development practices of today. It will create links between agencies in sustainable development work and educational institutions in a cyclic self-sustaining manner. Typically it takes a few decades for a fresh approach and thinking to become part of the conventional education curriculum, but through the ASHRA process, hopefully the time taken for this is will be shortened.

Developing modules that become a part of the regular curriculum at school level should also be high on the educational agenda. Just as mathematics and other sciences are right from the primary level of the basic school curricula, the subject of sustainable development must be taught so as to become a part of the daily thought process.

14.4 Awareness Promotion and Diffusion of Technology

Apart from training, information dissemination is also a necessary objective. Awareness promotion, information and technical support will be provided to students of architecture and planning, to architecture and planning schools, as well as to architects, builders and developers, interested citizens, institutions, business and industry in a comprehensive manner. Developing countries can set up Academies similar to ASHRA, but which are suited

² The word 'Ashra' encompasses the concepts of home, security, support, refuge, and shelter

to their zones and the programmes can be location specific. The process of rationalization and adaptation is much the same but if these Academies interact on a continuing basis, the very fundamentals of sustainable development can be re examined and definitive corrective actions initiated.

15. Conclusion

Human settlements are the basis of all development activities and the interaction of man with his environment. The building industry and other activities related to human settlements account for nearly half of the GNP in most developing countries. It is also the single largest factor that contributes to environmental degradation and has a direct consequence on finance, productivity and social behaviour. The design of human settlements encompasses a plethora of issues including land use strategies, watersheds and drainage systems, water supply, economic activity and resource generation etc. Their sustainable approach in a holistic manner is a powerful mechanism for promoting appropriate development.

These are just some of the issues pertaining to sustainable building technologies and appropriate building materials, and yet they form the core of sustainable development. Once the question of macro industry versus micro enterprise is addressed it becomes obvious that there is more at stake than just simply building materials. To ensure consistent sustainable development at all levels, long term strategies must envision the processes of manufacturing, creating viable livelihoods, appropriate technologies and appropriate materials. Once these strategies are combined with the parameters set down, sustainable city strategies for developing countries can be implemented and a healthy future ensured.