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High-Rise Housing: In Search for a Solution to the Urban Housing Crisis in the Developing Countries

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Abstract: This paper argues that high-rise housing cannot solve the urban housing crisis in the developing countries if their economy, technological state, afford ability and life-style of majority of the urban population are considered; instead the low-rise high density housing would meet the demand of the masses. It will discuss the suitability of such buildings considering the aspects of density, cost, technique and services. The paper is based on the findings of a study titled 'Feasibility of High-Rise Housing as a Solution to the Present Urban Housing Crisis in Bangladesh' undertaken in 1993-98 at the Bangladesh University of Engineering & Technology. Therefore, it will often draw examples from Bangladesh among other developing countries.

Keywords: High-Rise, Cost, Affordability, Density, Developing Country, Services, Techniques

Introduction

Large-scale migration resulting from the new status and widespread social and economic disparities between many large urban centers in the developing countries and their rural hinterland caused severe housing shortages in last several decades. These cities have to provide the mostly unskilled and destitute recent migrants with proper housing at a fast rate. Many developed countries embarked upon building high-rise housing to meet similar needs, followed by the newly independent countries in the 1960s. However, futility of such action was evident immediately, as the Low-Rise High-Density (LRHD) housing was found suitable from both economic and social points of view, by demolishing the tower blocks.

The paper looks into the suitability of high-rise housing objectively and examines saving in land and cost, and the density that can be achieved by building high. It recognizes that land and finance are important housing resources, which are scarce in the countries under consideration. Therefore, housing solutions should be able to increase their supply and provide access to these by the target groups. It also considers that the widening gap between the housing resources and the affordability is causing problem in the developing countries urban areas.

Density: The total amount of built-up area and the amount of built-up space determine afford-able housing. Equally important are the community service index and number of floors. Floor Area Ratio (FAR) does not rise in direct proportion to an increasing number of floors. It is on a gradually flattening curve as taller the structures, further apart they should be placed to provide the required light and ventilation. The recommended building to building distance for adequate natural light and comfort ventilation may vary from 2 to 6 times of the height of the building depending on the climate, wind direction, layout pattern, obstacles etc. (Muktadir, 1975). Densities also vary with the amount of space per household, and hence with income and can affordability. The gain in net density reduces if the shared neighborhood areas are taken into consideration. For housing units of 25m^2 area, as the FAR increases from 1 to 4, the net site density increases by 50%. Higher FAR is marginally relevant to the majority of population, and is largely counter-productive when the cost involvement is considered (Correa, 1988), as higher the building goes, costlier it becomes. The effects of increasing building height on density vary considerably. For a given floor space rate, density can be increased by reducing the total living space rate, space provided for community services, and by increasing the number of floors.

Little is gained by increasing the number of floors when the total living space rates are high. But the effect of an increase in building height becomes prominent as total living space rates and floor space rates decrease (Stone, 1970). At 2 m^2/person rate, the effect of building height on density is negligible compared to the relative effect of decrease in the total living space rate until the latter falls below 9 m^2/person. A density of 500 persons/acre can be achieved by keeping less than a third plot coverage with one-story buildings, if the communal service index is 10%. Functional requirements for light, ventilation, sun, privacy, sanitation etc. will make it necessary to adopt tall buildings for higher density. Even with two-storied development, densities of 1000 persons/acre may be achieved provided the total living space standard is 5 m^2/person.

The effects of building height become visible at 8 m^2/person space rate. But it is still insignificant until the total living space rate falls below 35 m^2/person. A density of 130 persons/acre may be achieved with 1-story buildings without exceeding one-third plot coverage and 10% general ser-vice index; doubling the height will give a 250 persons/acre density. At 20 m^2/person, the effect of building height on density becomes prominent if the living space falls below 75 m^2/person. A maximum of 50 persons/acre density can thus be achieved with one third plot coverage.

The above shows that density cannot be increased significantly by increasing the building height, until the ratio of the total living space rate to the floor space rate is 3.75:1 and the units are smaller. The significance of this in terms of living conditions is important. At low floor space rates (2-3 m^2/person), the achievement of high densities by increase in building height to two floors and above is justified if total living space rates fall as low as 75-100 m^2/person. Very high densities like 2000 persons/acre can only be achieved by adopting as low as 2.5-5 m^2/person.

Not much land can be saved by increasing the density with higher buildings (Fig. 2). Small savings achieved by

Not much land can be saved by increasing the density with higher buildings (Fig. 2). Small savings achieved by high density are offset by an increase in unit area cost. Say 300 families live in 2-storied row houses taking up half of a one-acre land. Going to double that height releases 25% of the land. But going from 4 to 10 floors releases only an additional 15% per floor. Another 10-story building can be put in the same site, which will release no additional land per floor. Meanwhile, the net density will have doubled. Gross density will have changed only if some of the released land is used for houses, instead of extra community facilities.

Cost: Most of the costs of constructing a building are affected by density, though not uniformly. Costs of service, infrastructure and transport vary inversely with densities moving along a curve of diminishing returns. The relationship of the costs to densities relates to a trade-off between land and building cost. With increasing FAR, the built area goes up requiring taller construction at higher cost, and the land component cost per unit decreases along a curve. Hence, the most economical built form for a fixed land price lies at the trade-off point at the intersection of the two cost curves (Correa, 1988).

Except variation in the foundation cost, the unit construction cost of buildings super-structure up to a height of 4 floors varies only 3-7%. Buildings above that height require different technology and construction method instead of block masonry work. Materials, workers and expertise requirements in high-rise building also change, needing additional equipment and special fixtures. High-rise buildings in the developing countries use excruciatingly scarce commodities. Labor cost in a floor in a High-rise building is 5% higher than that at the immediate bottom floor; accruing mainly from carrying charges and special workers.

Design fees and management expenses are also high for high-rise buildings, often for items not present in lower structure. For charges on a percentage basis of the cost, the fees become more for same items. Moreover, it is usually difficult in these countries to find a building professional with experience and confidence in designing high-rise buildings. When found, they charge exorbitantly to the full advantage of the situation. These contribute in a sharp increase in the construction cost of higher than walk-up buildings.

Rise in the construction cost with the increase in the building height is prominent in many developing countries, like in Bangladesh where this sector is mainly labor-depended despite many high-rise buildings being built. Unit construction cost of a 7-storied building in Bangladesh is 56% higher than that of a 4-storied building. Unit cost of a 4-storied building is doubled in a 10-storied building and is multiplied about 250% in a 15-storied building. However, unit construction cost is about the same for buildings similar in construction method within a range of one or two floors. For example, there is little difference in construction costs of identical dwelling units in 2-4 storied buildings (8%) or in 6-8 storied buildings (10.4%) (Table 1 & Fig. 6).

The planning authorities in Bangladesh require a building higher than 4-floors to be built with car space on the ground. This made the adoption of beam-column method inevitable, and increased the overall building cost by about 40%. It is also necessary to install and maintain lift, fire protection arrangement and fire escape in high-rise buildings, which further raise the area and cost considerably. Area and cost of the vertical circulation space is an addition to the habitable space's area and cost in a High-rise dwelling. For example, in a flat with 75 m^2 net area, about 15% space would be occupied by a staircase. Moreover, the expensive materials like steel and concrete for a staircase and labor cost for steelwork take nearly a quarter of the building cost.

Rising density often reduces dwelling costs to some extent by reducing the amount of apportion-ed land. As density rises only at a diminishing rate with increasing building height, the corres-ponding reductions in cost too will take place at a diminishing, and then negligible rate beyond 4 or 5 floors (Turkey, 1957). Dwelling costs are minimized at a height where the rate of decreases in land costs exceeds the rate of increases in construction costs (Gokhale, 1973; Figs. 3, 4, 5). This allows some penetration by the lower- and middle-income groups in the city's intermediate zone without a reduction in the standard or the size of the dwelling they can afford.

Savings attained by going high cannot be sustained as the medium- and high-rise apartments are generally built in high standards (Rahman, 1994c). High-rise apartments are usually related to the upper income groups, and are used as a showpiece by the governments who value the image these provide in overcoming the stigmas attached with poor housing (Grimes, 1976; Peattie, 1987). However, many low to moderate standard economy apartments have been built in the countries South East Asian countries. When the much-acclaimed public housing started in Honk Kong and Singapore in the 1950s, substandard and shared flats were strategic norms.

Hence, a comparable density, construction and finishing cost of an individual flat in a high-rise building would be about 3-5 times higher than that in a low-rise (1-2 floors) building. This will achieve a substantial saving in land price only through accommodating a higher number of families on it. A comparative study in Bangladesh showed that a standard low-cost house will cost US$ 2700, whereas units of same size and similar standard in a 4-storied building on .02 acre of land will cost more than four times at US$ 11,000 each (Rahman, 1991,1994a).

Developed land ripe for high-rise building well-placed in the city would cost 7-15 times more than the type of land on which lower-middle- and middle-income housing is developed. These are the low undeveloped lands in the peripheral locations about to be taken up by various types of uses of the sprawling metropolises. For example, Residential land price in Dhaka ranges between US$ 50/m^2-850/m^2 (Rahman, 1994d). Dhaka is the most unjustly structured city in the world where the rich enjoys greater benefits than the poor, atypical of many such developing world cities (Wilcox, 1983). Here, the upper 20% of the people own 80% of land (Islam, 1978).

A 4-storied building built on a peripheral land after earth filling (in fringe areas) will require piling and a beam-column construction method instead of a cost-saving masonry method. It is often a wrong practice that concrete beam-column method is used even when neither the soil condition nor structural requirements necessitate that. This is done with a pre-conceived notion that it will permit vertical extension if and when need and afford ability allows that, desired changes and internal readjustments. The cost is further increased by

Table 1: Cost of Dwelling Unit at Different Heights in Bangladesh

Type	Number of Floor	Cost US$/ sq.m	Rise in Unit Cost	Dwelling Cost US$(1)	Land Cost US$/(2) Dwelling	Savings in Land Cost (3)	(4)	Total Cost US$	Change in unit Cost (5)
Low-	1	100	--	7,200	9,500	–	--	16,700	--
Rise	2	114	14.0%	9,576	5,544	41.6	41.6	15,120	- 9.5%
Walkup	4-5	125	7.9%	10,500	2,770	70.8	50.0	13,270	- 12.2%
Medium	6-7	192	56.1%	17,280	1,980	79.2	28.5	19,260	+45.1%
-Rise	8-9	212	10.4%	19,080	1,485	84.4	25.0	20,565	+ 6.8%
High-	10-12	240	13.2%	22,800	1,140	88.0	23.2	23,940	+16.4%
Rise	15-24	291	21.3%	27,645	790	91.7	30.7	28,435	+18.8%
	20-24	355	22.0%	33,725	570	94.0	27.8	38,295	+20.6%

Notes: 1) Staircase added for 2-6 stories, lift added for 7-24 stories (price excluded), habitable space-72 m^2;
2) Developed land at Intermediate location costing US$88/$m^2$. 2/3rds of built-up coverage assumed;
3) Percentage savings on the price of single-unit land (US$ 9500);
4) Percentage savings on immediate lower building's land price;
5) Cost of a single dwelling unit+ cost of the apportioned land;
6) Percentage change in total price on immediate lower type.
Source: Rahman (1998).

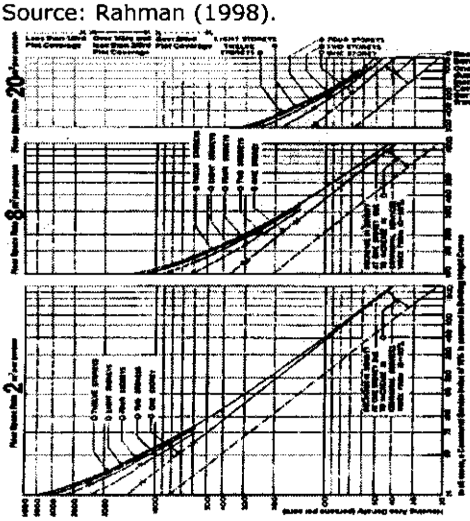

Fig. 1: Density Achieved by Various Building Heights, Floor Space Rates and Plot Coverage

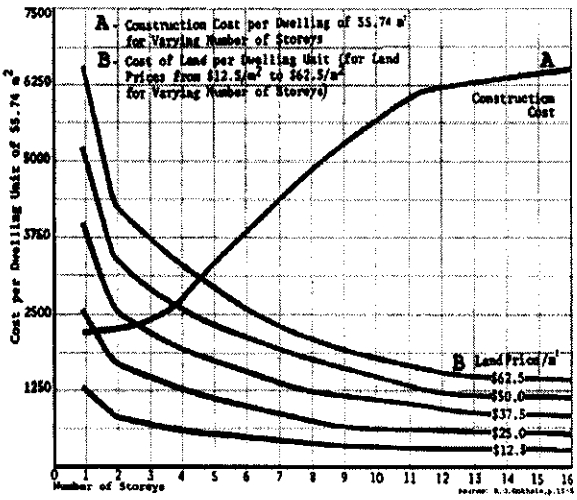

Fig. 3: Construction Cost Versus Apportioned Land Cost in High Rise Building

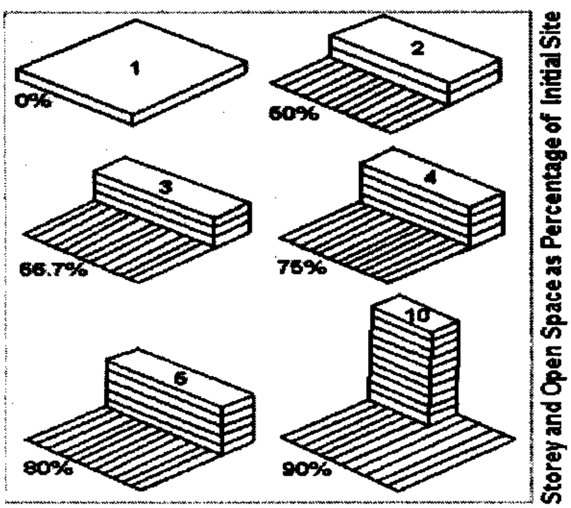

Fig. 2: Storey and Open Space as Percentage of Initial Site

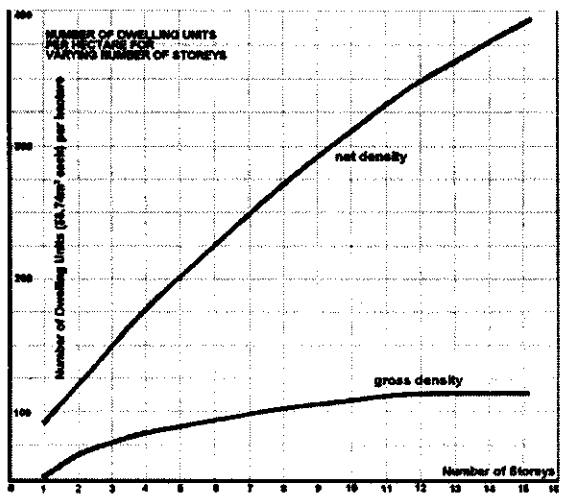

Fig. 4: Change in Housing Area Density With Change in Building Height

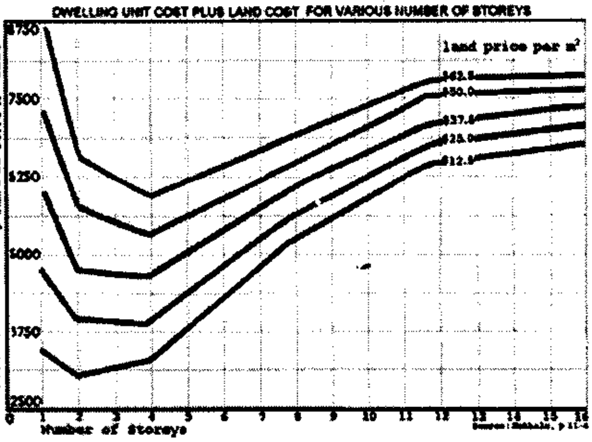

Fig. 5: Cost of Dwelling Unit in Different Heights Including Land Cost

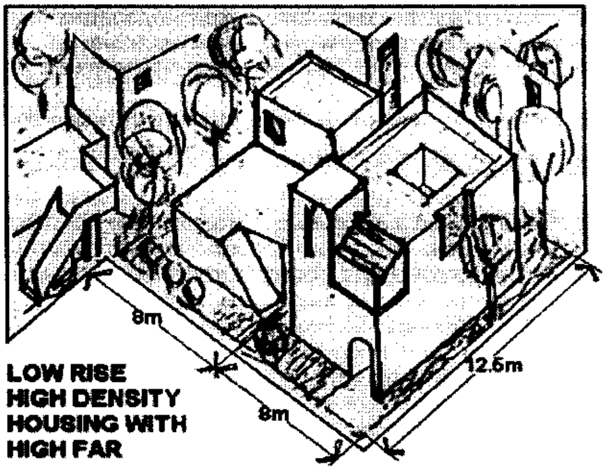

Fig. 7: Low Rise High Density (LRHD) Type Housing Development

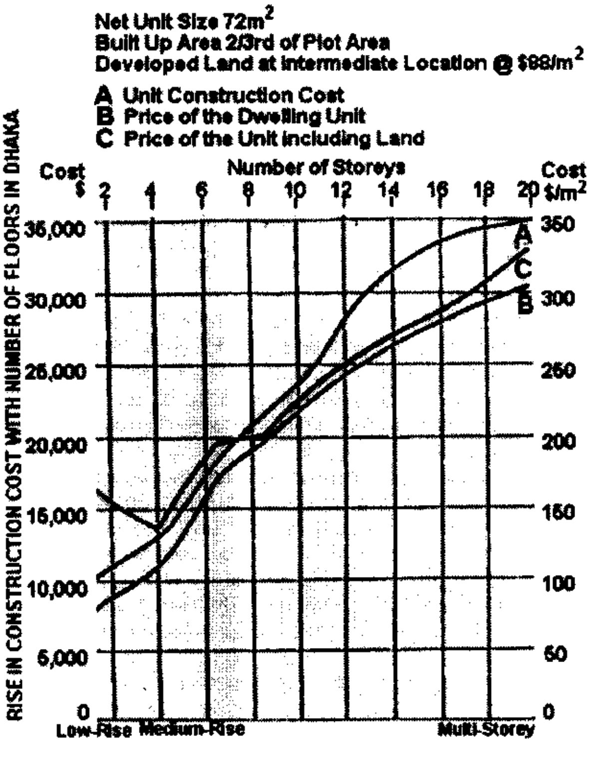

Fig. 6: Increase in Building Construction Cost With Number of Storeys in Dhaka

40-50% in such cases.

The lower land price relates to undeveloped tracts of flood-prone low or agriculture land at the peripheral areas of the city. It is also close to the price at which the Housing and Settlement Department's can supply developed land from its Land Bank in Dhaka. In those cities of the developing world where the market is controlled by the land speculators in the absence of effective land management and legislation, its cost constitutes a large part of the housing cost, particularly that of the low-income groups (IFHP, 1979).

Mass Production Technique: Sometimes mass housing is taken synonymous to Industrialized System Building (ISB) producing and using prefabricated components. This is often claimed as the rationalization of economy in design, site-work, and materials. However, in many countries, ISB has become a sometimes appealing, sometimes appalling reality. It is only a partial answer to housing production, even in the advanced countries (Strassmann, 1975). Repeated failures and waste mark ISB in most of the developing countries. Performance of the high quality components is often offset by patchwork or poor fits and by early cracks. Moreover, the system itself involving mechanized system and skilled worker introduces demand of precision that could be avoided in other methods. It compels high-rise living of an inferior quality as a result of unplanned and uncoordinated actions aimed at reducing cost.

In the developing countries, traditional craftsmen and conventional building material factories may take time to develop, but so does a smooth ISB (Payne, 1977). A country cannot afford to build a large volume of dwellings or close the housing deficit fast regardless of time saving if moulds and cranes have to be imported. It is surprising that monetary savings from speedy construction in ISB is very small. If there is any rationality in using the system, then that is on cost-reduction, subject to many factors e.g. design, volume, standard, consistency, proper joints etc.

Carrying of panels and modules is more difficult than carrying the sum of their parts. Damage during carrying and storing is also less likely and less costly in the later case; a 20% damage rate is not unusual during the first couple of years in an ISB project (Stone, 1970). More serious is the problem of making joints-locking, gluing, welding, hammering, or snapping components together, which need time and experience for perfection. Transport and joining skill cannot yet overcome the inadequacies in volume. Fixed costs of machinery and structure can push unit costs up if demand is insufficient, which often is the case if no public sector support is provided.

ISB can reduce the cost, which rises asymmetrically without limit, only marginally (Strassmann, 1975). It applies mainly to the erection of the walls, floors and the roofs, which take 30-40% of the total construction cost

(Stone, 1970). If taxes, insurance, management and sales costs are added, savings by ISB would be less than 10%, even with optimistic assumptions if the installation cost of windows, plumbing and fixtures is not added. Installation of heavier and more complex components would further raise capital costs, volume requirements and uncertainty.

ISB cannot save on overall labor cost as it spends more to make lighter-weight precision components, which warrants expert labor. Any reported larger saving had been due to reductions in quality or to use of less land which are not assured advantages of ISB, not due to efficiency increases. Economizing through quality reduction or land saving is independent of the construction method, and can often be unnecessary for lack of demand. The only case in favor of ISB is to add management costs and to attribute any savings due to higher density. Only a minimum of 160 dwellings/acre density makes ISB feasible by reducing equipment installation and panel transportation cost per dwelling unit (Gokhale, 1973).

No developing country had enough technological means, light-weight materials or expertise to support an ISB in the early-1970s (UN, 1972a, 1972b). There is no indication that the lack has been overcome thereafter. Several South-East Asian, Middle-East and Latin American countries adopted prefabricated building technology to little advantage. For example, in the Saudi Arabia, prefabrication is widely used only to avoid on site casting and delays. These are neither standardized except seldom on project-basis only, nor produced in a mass scale. Use of non-standard elements in fact increases the building cost.

The building technique in most of the developing countries is so backward that the normal amount of factor price distortion is not enough to justify the use of ISB. Special guarantees and subsidies for projects and the entrepreneurs are needed in the initial years to promote the product to win over the conventional construction method (Rahman, 1995a). Building techniques in any country need to adapt to local climatic or social requirements, resource availability, society's economy, people's taste or prevailing stage of technology. The low labor cost of the clay-brick industries using rudimentary techniques and unskilled labor in many of the developing countries has enabled labor-intensive methods to compete successfully with a production process that has been mechanized in the developed countries.

To many housing critics, spontaneous and incremental building is the proof of the low- and lower-middle-income households' capability to build for themselves (Payne, 1977; Khan, 1991). To others it is a myth that the migrants can be engaged in building for themselves at an acceptable level since most of them come from the rural areas where they possess rudimentary building skills (Varkey, 1994). There are other sides of the arguments that utilizing 'sweat equity' of the destitute in self-help scheme is a double exploitation (Payne, 1984). Sites-and-services schemes and other low-income housing projects in the developing countries often substitute self-help by contracted labor in housing production, which can mobilize the underused labor efficiently in many situations (Payne, 1984). It is but one means of mobilizing the underused labor close to its shadow wage. Projects show that the participants mostly lack the skills required for sound and acceptable con-struction. Families could benefit through mutual-aid and self-help in the low-income housing where makeshift materials were used. However, the homeowners' amateur efforts were no longer sufficient in high-standard projects (Laquian, 1983). Also in a large scale, it needs to be organized. Self-help schemes in the Public sector have been successfully carried out for 1-floor dwellings in many countries (Laquian, 1983; Payne, 1984), and a few with 2-storey blocks.

Therefore, it appears that combination of pre-fabrication and traditional methods may be the most effective means of realizing the comparative advantages of the both (Grimes, 1976). To optimize the benefits from various approaches, housing managers have combined comparative advantages of each approach in their programs. The family taking on the tasks of designing and actually building the house can reduce the cost dramatically, though it will take longer to complete. The use of often-scavenged materials is a feature of the method reducing cost and optimizing resources (Benjamin and others, 1985). The pace of construction might also better suit the needs and resources of the family.

Advocates of self-help construction have been critical of project interventions that accelerate the pace of consolidation and thereby limit the scope for self-help. Among such interventions are design, predisposition of project participation towards faster completion of units, imposition of time limits, prescription of a limited list of building materials, or the setting of unrealistic standards with respect to quality or materials which are very common in high-rise construction.

Incremental building is one way of mobilizing individual's resources according to the availability and afford ability and at owns pace, and providing affordable shelter. This is not possible to apply in high-rise apartments. The self-help process using the participants' initiative, skills and resources cannot be adopted in high-rise construction, as it requires more know-how and exper-tise. It restricts activity to a handful of developers who can amass huge funds needed for such projects and lure clientele to consume that, to the very few professionals who can design the structures, and to fewer construction companies that build them. This decreases the scope of employment for the migrants in the informal construction sector, who lack skill and sees toward the capacity of the sector to absorb them. On the other hand, same amount of investment can create more jobs if LRHD housing is built, especially for the unskilled recent migrants.

Few countries have explored the possibility of reducing the cost of construction at different heights and various levels of density. India has succeeded in lowering the construction cost through technological adaptation and rediscovery of the uses of traditional materials. In the present economical condition of Bangladesh, which has large unemployment and unabated migration to fuel that in the urban areas, adoption of labor-intensive vernacular methods should be a rational choice, which can provide to the newly arrived rural destitute (Rahman, 1995a).

Utility Services: Cheap provision of potable water or sewerage disposal would warrant low-rise development, as known technologies of multi-story blocks are unable to cope with such methods. Collection from public hydrants, use of vault-storage and pit latrines can be efficiently utilized in a low-rise house; living close to the ground satisfies both a technical and social requirement. A multi-story flat would require more space and technical know-how and entail more cost to accommodate vertical service ducts. This will generate extra pressure on the main and will increase the capital cost.

Advanced and expensive methods like flush sewer and individual connections would prefer the service areas to be placed at the front to minimize the connection lengths and to allow the service mains to run along the road. Putting services along the back would reduce the cost incurred by individual users without disrupting a vernacular setting (Khan, 1982), where these considered dirty, wet and back (Imamuddin, 1983). During the first half of the last century, manually serviced privy and pit latrines had been operated through a back alley by grouping the areas such as kitchen, water points, toilets etc. towards the back of the house in the urban areas of the South and South-East Asia. Tower blocks disrupt the grouping of such areas towards the back secluded from the main living areas. Thus the lower- and middle-income people in these projects have a tendency to reject these (Imamuddin, 1983). Indigenous layouts can reduce the spending on street straightening except to the extent that is required to economize service layout. Sometimes services are shared among families as an option to reduce up to a third of the cost in the low-income housing projects (Grimes, 1976). Such arrangements, particularly with water points are found in many developing countries urban areas where services are expensive and coverage is not universal. Sharing cooking and sanitary facilities by time zoning is also found acceptable among the low-income households in many societies (Rahman, 1991, 1996), for example in informal tenement houses (Ullah & Chowdhury, 1994). However, such methods cannot be used extensively in the high-rise flats because of inhibitions put by both technology and culture.

Conclusion

High-rise housing blocks are less sensitive to the socio-cultural and religious determinants of life, factors that are now recognized. Indoor and outdoor spaces also need to be adjusted to people's preferred life-style. The leftover areas between the structures are not as usable as the small organic spaces generated by the LRHD form (Aicher, 1998); important as the occupants need to colonize and personalize the inhabited spaces. Studies e.g. by Newman (1972) showed that the anonymity of high-rise blocks facilitates crime.

Construction of LRHD housing is speedier as an individual building his own house decides himself basing on his objectives and available resources, and reduces the burden on the government. High-rise buildings have long construction periods tying up capital, which in many cases bears interests. This decreases the velocity of the fund's circulation to roll to produce more units.

4-5 story buildings can optimize the utilization of all resources considering aspects such as building cost, land cost, densities, building heights etc. (Gokhale, 1973; Figs. 3, 4, 5). Segal (1965) showed that a building reaches optimum height at around 8 floors, as all determinants e.g. building and site perimeter, spacing, ventilation and privacy requirements, site to building ratio, street frontage and street proportion, building height, site coverage, car parking areas etc. start to vary fast above this height.

Plot sizes ranging between 25-100 m^2 can satisfy the needs of 95% of the urban population in the developing countries given their income and afford ability. The LRHD housing is more economic than high-rise apartments, and provides better living environment. Moreover, it would reduce the disparities in urban scene where only the rich and powerful benefit. It would also free general public from the profit-motivated developers (Rahman, 1994a). A 50 m^2 plot for a 6-member family can generate a gross density of 240 persons/acre, considering space for circulation and communal facilities. FAR close to 4 can be achieved by terrace houses on $100m^2$ plots, which is about 10 times than the usual FAR found in the sites-and-services schemes developed by the public sector. Outputs of such schemes mostly end up at the hand of the elite and turn out being the most expensive areas of the cities. 120 m^2 flat can be designed by covering two thirds of plot area and about 50 m^2 on the upper level leaving the rest as open terrace. The pattern would permit a superior life-style with terrace, garden and direct access to ones own house (Fig. 7).

As long as a city's density remains within a limit of 120-400 persons/acre, efficient and cost-effective solutions with own resources can be derived. It has been observed that only the indigenous settlements in many newly developing countries composed of LRHD structures have properly utilized the scarce land to achieve an optimum density. It is evident that the low-rise structure is the optimal built form for the huge number of urban low- and middle-income people; only 1% of the urban population can afford apartments in taller structures in the developing countries (Rahman, 1994b).

Multipurpose courtyards are revered in many societies of the developing world for the socio-cultural and climatic reasons (Mallick & Huda, 1996). LRHD building is a cost-effective option considering the advantages of such spaces, generated primarily through a pattern of individual houses. Self-built informal housing should be perceived as part of such a form stretching all the way up the income profile to the elegant mansions making it one of crucial relevance to the entire cross-section of population instead of viewing these as ghettos (Correa, 1988).

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