

A land subdivision proposal for resettlement (of tsunami victims in Sri Lanka)

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The tsunami 12/26 left a multitude of challenges to us, and one is the resettlement of the homeless.

For obvious reasons, the homeless fear to resettle in their previous houses and expect from the authorities land further inland. Moreover, the proposed 100m no construction coastal zone itself will push the resettlements towards inland. Therefore, post-tsunami resettlement, unless addressed carefully, is likely to contribute towards deforestation, paving the way for further environmental crises. Haphazard resettlement should therefore be avoided.

For optimized land use, housing schemes with apartments is the obvious choice. However, almost all the houses affected are detached ones (i.e., separate houses) and the people long used to such living are likely to find apartment-housing disturbing. Therefore, a compromise should be reached: provide detached houses for victims while optimizing land use as much as possible. This problem cannot be addressed at individual house level. The more desirable broader approach should begin from the land-subdivision stage itself.

This article, firstly, introduces briefly what an environment-friendly house (i.e., passive house) is. Then it presents a land subdivision proposal for an environment-friendly residential settlement catering to the needs of the residents while optimizing land use.

The article is based on the book "Energy Efficient Houses for Tropical Climates" authored by Prof Thishan Jayasinghe, Department of Civil Engineering, University of Moratuwa, Sri Lanka (www.mrt.ac.lk). First published in 2003, the book contains mainly the findings of research he had carried out with Prof Rahula Attalage from the Department of Mechanical Engineering of the same university.

This article covers in detail only the land subdivision aspect. Subsequent articles will cover in detail the concept behind the passive approach to housing and the development of passive housing plans.

Active house and passive house

An active house provides its occupants with indoor thermal and visual comfort through active means. For example, fans or air-conditioners provide thermal comfort and artificial lighting provides visual comfort even during the daytime.

A passive house, on the other hand, relies heavily on the environment in providing its occupants with indoor thermal and visual comfort. It achieves thermal comfort by controlling heat gains and facilitating natural ventilation. For visual comfort during the daytime, it uses daylight.

Active houses heavily depend on electricity while indirectly contributing to environmental degradation. Passive houses, on the other hand, work with the environment in ensuring thermal and visual comfort for their occupants. Therefore, besides being environment-friendly, passive houses are energy-efficient – a consolation for our country groping in the darkness of a worsening energy crisis.

Concepts and elements of a passive house

A summary of passive concepts and elements applicable to houses are:

- Thermally comfortable microclimate around the house, achieved through vegetation
- Compact building form with minimized thermally undesirable elements (e.g. roof)
- Openings with appropriate orientation (i.e., facing shadable orientation) and shading of openings
- Thermally appropriate wall and roofing materials
- Courtyard (if possible)
- Proper external surface (e.g., light colour)

Thermally comfortable microclimate achieved through vegetation: This is essential because it is this outdoor environment that the passive house will interact with in order to create thermally comfortable conditions indoors.

Compact building form with minimized thermally undesirable elements: Compact form reduces exposure of the house to direct solar radiation. The roof, looking up into the sky, is exposed to sun throughout the daytime round the year. It is therefore thermally undesirable and hence its area should be minimized by, say, resorting to multi-storey housing.

Openings with appropriate orientation (i.e., facing shadable orientation) and shading of openings: Openings are required for ventilation of the indoors and for daylighting. However, to control direct solar gains into the house, the openings should be of the appropriate orientation. Openings facing north or south experience direct solar radiation at high solar altitude angles. Overhangs (i.e., horizontal projections) can effectively shade such openings (Figure 1). However, openings facing east or west are vulnerable because they receive direct solar radiation at low solar altitude angles. Overhangs are not effective on them. Consequently, in passive houses, north or south facing openings are preferred and they should be protected by overhangs. If openings facing east or west are unavoidable, they should be short in height and should be provided with overhangs projecting to a considerable length.

Thermally appropriate wall and roofing materials: As wall material, either clay bricks or hollow cement-sand blocks or solid cement-sand blocks are preferred instead of light walling materials such as GI sheets, asbestos sheets, etc. Cement stabilized soil also can perform very well. Clay tiles are preferred for the roof. However, cement fibre sheeting is desirable provided their external surface is maintained in light colour by painting periodically. Provision of a ceiling can improve the thermal performance of the roof. Another improvement is reflective thermal insulation.

Courtyard: The courtyard can be used for promoting ventilation and daylighting.

Proper external surface: The outer surface of the external walls and the roof should be of light colour to reduce direct solar gains into the passive house. The other wall surfaces should be of light colour to enhance visual comfort utilizing daylight.

It is important to note that adoption of passive concepts and incorporation of passive techniques is much easier if the house is a multi-storey one.

Important aspects in development of environment-friendly residential settlements

Two most important requirements for the successful incorporation of passive concepts and elements are the thermally comfortable microclimate and the appropriately oriented openings.

By way of evapotranspiration, vegetation uses up incident solar radiation and reduces outdoor air temperature. Vegetation can therefore be considered as nature's air-conditioner. Such a cool neighborhood is the desirable microclimate for passive houses. For cooling outdoor air, researchers have found out that a network of vegetated areas distributed in the neighbourhood is more desirable than one big equivalent vegetated area. Therefore, the green areas should be properly planned and distributed. Equally as important is that most, if not all, houses in the neighbourhood adopt a passive approach, interacting with and nurturing this microclimate. It is this microclimate that passive houses depend on for provision of indoor thermal comfort.

Vegetation offers benefits in addition to natural air-conditioning. Trees can shade houses from direct solar radiation. Moreover, trees by the road can shade non-vegetative surfaces such as road surface and cement tiles of sidewalks, reducing the radiation of heat to pedestrians and houses.

Due to provision of large windows due to aesthetic reasons, the front façade of a house is likely to contain a large area of glass. Therefore, houses should face a shadable orientation such as north or south. For this, access roads should be planned along east-west direction.

Therefore, both with respect to the creation of the microclimate and orientation, land subdivision should be right in the first place.

A land subdivision proposal for an environment-friendly residential settlement

A land subdivision proposal for an environment-friendly housing scheme is presented in Figure 2. The proposed plot extent per house is 7 perches, measuring 11 by 16 metres. It clears the minimum required (i.e., 6 perches) by the Building Regulations in Sri Lanka for areas where pipe-borne water is

available. This plot is adequate for a typical multi-storey passive house.

Although the main access roads are planned along north-south, the secondary access roads have been planned east-west. This arrangement ensures that the front facades of the houses face north or south, which are shadable directions. Using overhangs, large glazed openings can be protected from solar radiation.

In this proposal, ten houses form a row. Each plot can facilitate a back garden of at least 4.5 by 11 metres, i.e. about 50 square metres. The back gardens of two adjacent rows of houses form a “back garden park” of 0.1 hectares. Moreover, a strip of 1.5m is reserved for planting a line of trees for shading the front of houses and non-vegetative surfaces (e.g, cement tiles of the sidewalks). These tree-lines can be considered as “linear parks”. The network of “back garden parks” and “linear parks” is desirable for the creation and sustenance of a thermally desirable microclimate for the neighbourhood.

The road surface, unlike the vegetative surface, is thermally undesirable as it heats up and radiates heat to people and houses. Moreover, precious land area should not be wasted for roads. Therefore, the road area per plot is minimized by arranging the smaller dimension of the plot along the road.

Access roads are arranged in staggered manner due to two reasons. Firstly, to disturb the wind flow, enhancing cross ventilation across the houses. Secondly, to discourage speeding of vehicles on the access roads for enhanced traffic safety in the residential neighbourhood.

Moreover, the problem of excessive surface run off causing flashfloods following heavy rains can also be addressed through proper land subdivision. To control excessive surface runoff following heavy rains, covered underground water detention and infiltration pits with unlined base are provided at suitable intervals on the 1.5m strip along the side walks. Besides discouraging flashfloods, this measure will discourage soil erosion and siltation of the drainage network.

Summary

The basis of the approach is the passive house, which relies on the environment for providing indoor thermal and visual comfort for

its occupants. Its little dependence on electricity is a significant benefit that is welcome for our country facing a worsening energy crisis.

Passive concepts and elements applicable to houses are thermally comfortable microclimate achieved through vegetation, compact building form with minimized thermally undesirable elements (e.g., roof), openings with appropriate orientation (i.e., facing shadable orientation) and shading of openings, thermally appropriate wall and roofing materials, courtyard (if possible), and proper external surface (e.g., light colour).

Two most important aspects of the passive approach, namely the microclimate and orientation, can be effectively facilitated only if land is subdivided with a passive approach in mind.

The key features of this land subdivision proposal for accommodating an environment-friendly residential settlement are:

- A seven perch plot (11 by 16 metres).
- Secondary access roads along east-west so that the front facades can be effectively shaded with overhangs.
- Two adjacent rows of back gardens form a “back garden park” of extent 0.1 hectares.
- Strip of 1.5m width by the roads for planting trees forming “linear parks”.
- Staggered access road arrangement for enhanced cross ventilation of houses and traffic safety.
- Covered rain water detention and infiltration pits to control excessive surface runoff, discouraging soil erosion, drainage siltation and flashfloods.

This land subdivision proposal can accommodate about 3600 houses (even with an allowance of 10% for common facilities) in an area of one square kilometer. At four personnel per household, it can ensure environment-friendly living for 14,000 people only utilizing 1 square kilometer of land, while providing thermal and visual comfort through passive means.

This proposal should receive attention of the authorities because it provides a land-optimized solution to the resettlement of tsunami victims ensuring them energy-efficient detached houses with thermal and visual comfort through environment-friendly means.

NOTE:

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