

# Application of Sustainable Design Principles in Sector 53 Housing, Chandigarh

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**Abstract**—The sustainability is very wide area and all kind of sectors are trying to integrate sustainability in their respective field as per definition given in various forums. The architects or building designer have also tried to define sustainable for their field but architecture itself is not very well defined subject so it is really difficult to workout the design process or design principles in achieving sustainability. Recently attempt to quantify or measurement of sustainability through rating system has given a hope to architects or designers but these are also misleading because these rating system only define the evaluation criteria not the design criteria's. The design process or design principles are known to architects or designers but achieving sustainability in these design principle is new area and still to be explored.

This paper will discuss briefly about important design process or principles such site planning, block design or unit design in housing by defining first sustainable principles of design with the help of rating system and will also showcase in achieving the design objective in proposed housing project of sector 53 housing.

**Keywords:** Housing, Orientation, Unit design, Sector-53

## 1. INTRODUCTION

The definition of sustainable development is “Development that meets the needs of the present without compromising the ability of future generations to meet their own need”

- from the World Commission on Environment and Development's (the Brundtland Commission) report Our Common Future (Oxford: Oxford University Press, 1987).

This definition is very general and it does not give any clue for the sustainable design principles or design process for architects or designers.

The rating criteria's like Green Rating for Integrated Habitat Assessment (GRIHA) and Leadership in Energy & Environmental Design (LEED) again gives the evaluation of process or product but not able to define the sustainable principles of design or design process at all.

Design process or design principles are known to architects but how to achieve sustainability is not easy task. Author has tried to define the design objective from combining the design process or design principles in general and the objectives of rating system. These design principles are given below:

1. Using natural resources unlimited in nature like sun and wind : Through design techniques
2. Conservation of natural resources which are limited in nature : use of alternate building material
3. Environmental impact: Using material and technology which gives less pollution to environment.
4. Using non polluting renewable energy system such as solar panels, solar water heater.
5. Recycling the waste (waste water, solid waste etc) and re using these waste to have less impact on environment.
6. Using rain water harvesting techniques to
7. Conserve water for present as well future generation.

The scope of this paper is limited to only dealing with point 1 as stated above. In the paper under various heading such as site planning , block and unit design, first paragraph consist of general understanding of sustainable principles, in the next one or two paragraph GRIHA rating have been quoted and finally application of the design process or design principles in the proposed project are given.

## 2. DESCRIPTION OF PROJECT

The proposed site is situated in sector 53 and allocated to Chandigarh housing board by Chandigarh Administration for General housing for people of Chandigarh. The Chandigarh housing board is the nodal agency of Chandigarh administration to provide good housing solution to people in non profitable basis. The site area of the proposed housing is 12 Acres (Approx) and developments norms are given below:

1. F.A.R =1.5
2. Ground Coverage-30 %
3. Max permissible height -21m
4. Set back-6m Min



Author is his M.Arch thesis has altered the height restriction from 21m to 45 m for academic purposes so that ground coverage could be minimized and utilized for green.

### 3. SITE PLANNING PRINCIPLES

### 3.1 BLOCKS ORIENTATION

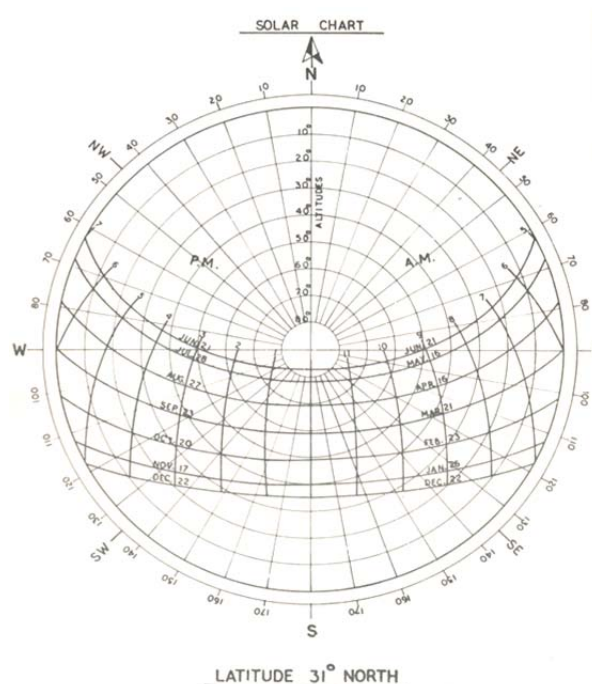
Practically it is not possible to have all blocks of housing in best or optimized orientation but adopting right design process may lead to achieve to maximum block in best or optimize orientation. Most of architects have misconception about the orientation, most of architectural schools are teaching wrong concept about orientation, they never analyze in depth about the orientation and for them orienting longer sides of building in N-S is best orientation for housing in composite climate but this is completely false notion which can be proved later in this paper.

## ORIENTATION FOR SUN

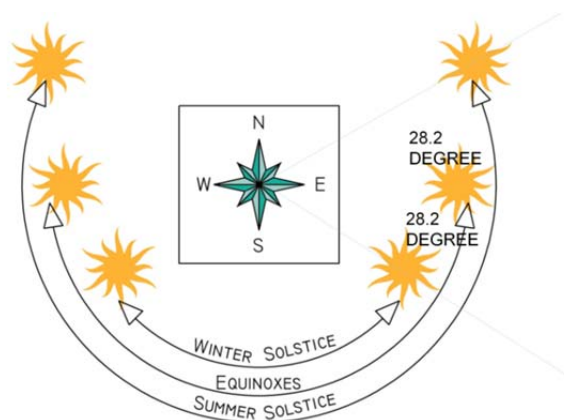
The orientation of building blocks is being worked out on the basis of sun's movement around building in different time of day as well different periods of seasons. Normally it can be

The proposed housing is located in Chandigarh and the exact cartographic co-ordinates of Chandigarh are  $30^{\circ} 44' 14\text{N}$ ,  $76^{\circ} 47' 14\text{E}$  but solar charts are available in the difference of  $1^{\circ}$ , so solar chart of  $31^{\circ}\text{N}$  can be used for practical purposes.

The climatic of Chandigarh falls under composite climatic zone. In Summers temperature ranges from 27<sup>0</sup> C to 40<sup>0</sup> C which is above human comfort zone, and in winters temperature falls between 1<sup>0</sup> C to 16<sup>0</sup> C which falls below human comfort zone but through Bio climatic charts we can analyze that summers are more critical then winters. The design should be made in such a way to address both issues i.e. to allow heat gain in winters and avoid heat gain in summers .



**Fig. 2: Solar chart of Latitude  $31^{\circ}$**



**Fig. 3: Solar azimuth range throughout year in Chandigarh.**

Winter solar solstice (Fig. -3) is very less wide so the N-S is best orientation for winters because it allows max heat gain on longer side of building. In summers the mornings are not having so much temperature but evenings are critical because the heat gained by building in the whole day makes it more critical. The objective of summers is to avoid the evening sun, it simply means to avoid W and SW sun directly. Through solar chart it can be establish by placing the longer side SSE-NNW direction, max of W and SW sun could be avoided. SSE-NNW is not best direction for winters but it can be considered second best orientation after N-S direction because it allows morning to afternoon sun.

Already established fact that summers are more critical then winters, SSE-NNW can be best or optimum direction for summers as well winters both.

The another aspect is that project like housing are having two or three layers on longer side, so N-S direction will only allow sun to southern facing rooms not northern side facing room at all. SSE-NNW on the other side will allow the sun to NNW direction rooms except winter. So SSE-NNW can be good direction from this aspect also.

In the end it can be concluded that for considering summer as well winter the optimum orientation for sun is SSE-NNW.

#### ORIENTATION FOR WIND:

The wind direction in Chandigarh for summers as well monsoon is SE-NW and the wind direction in winter is NW to SE. The winter and summer wind is not desirable but monsoon wind is very much desirable due to humidity in this period. The blocks may be designed in such as fashion to allow SE-NW wind direction.



Fig. 4: Orientation SE-NW for all housing blocks

#### ORIENTATION FOR SUN & WIND:

Site shape and size also determine the orientation of blocks so by considering the all factor is mind, for this particular site SE-NW is optimum orientation

The effort is made to provide all blocks to be placed in SE-NW direction and all blocks in this project are facing SE-NW direction.

#### 3.2 DISTANCE BETWEEN BLOCKS:

The orientations of blocks are not sufficient but the placement of blocks with respect to each other plays another crucial role to allow desirable light and ventilation in the blocks.

As per National building code 2005 the minimum distance between the blocks should not be less than the  $\frac{2}{3} \times \text{max height of building block}$  and on boundary not less than  $\frac{1}{3}$  of max height of block. The basis of these norms is to allow appropriate sun light and ventilation in buildings.

NBC 2005 norms are minimum standard not the best solution for distance between blocks. The appropriate and specific distance between blocks will depend on the orientation of blocks.

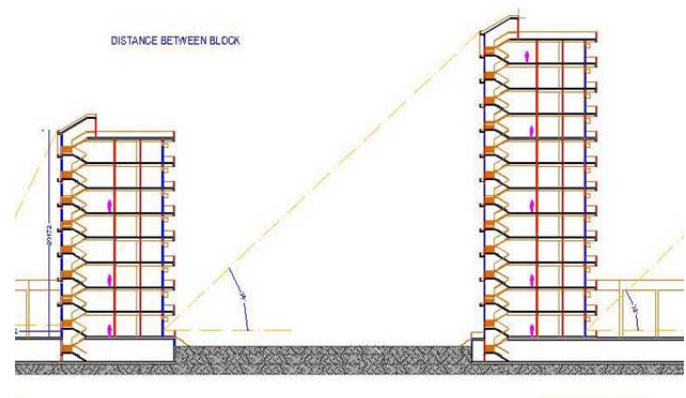


Fig. 5: Distance between blocks

For South facing blocks, the lowest floor windows should subtend a maximum angle of  $22.5^\circ$  with the top of the adjacent building / object for allowing winter sun directly entering to the lowest floor.

For this proposed project the orientation is already decided as SE-NW. For SE-NW direction around  $38^\circ$  to  $39^\circ$  angle is appropriate to allow winter sun on the lower floors of the another block and as per NBC norms it worked out to be  $56.3^\circ$  (As per  $\frac{2}{3}$  height norms of NBC 2005), so this solution is very appropriate within limits.

In this project sciography has been worked out the help of software sketchup and real time location of the project is entered in this sketchup model. The shadow of building blocks is worked out in different period and different time as shown in Fig. -4. it can be concluded the  $39^\circ$  angle is appropriate which is used in this solution.



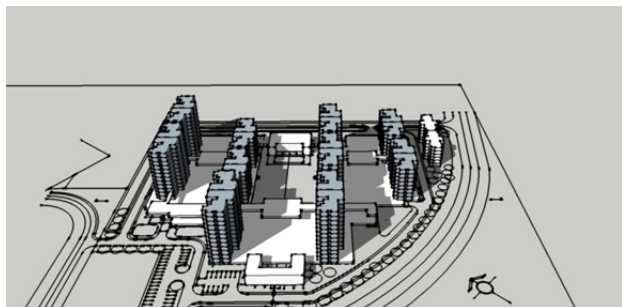


Fig. 6 : Shadow of blocks on June 21 ,5 p.m

### 3.3 LANDSCAPING

Landscaping does not mean just planting some trees and having green areas, it has significance role in saving energy demand of buildings, it has role in reducing the environment pollution. Landscaping can play major role in human health (physical as well psychology level).

As per Green Rating for Integrated Habitat Assessment (GRIHA) rating evaluation criteria no5 “Reduce hard paving on-site and /or provide shaded hard- paved surfaces” and criteria no 10 “Reduce landscape water requirement. These criteria’s are not sufficient to address the importance of landscaping.

The advantage of landscape elements such as trees are enormous , trees are able to provide sufficient oxygen levels , provide shade for earth surface and for buildings , create wind flow , through evaporation create microclimate in summers , provide fruits , herbs and so many other things. All these advantages in evaluation criteria’s can not be incorporated so shading is the major factor considered in GRIHA criteria’s. Trees can save energy demand of building if appropriately selected and placed. Trees are able to reduce mitigating heat island effect through shading only. The few criteria of selection of trees are as follows:

- Tall and less wide trees for buildings to shadow on south side and also deciduous trees
- Less height and more wide trees on south for ground shadow.
- Vegetation on eastern side to allow SE Low winter sun and to stop NE low morning sun.
- Plants hierarchy on north as well north west side to stop cold winds.
- Evergreen low height trees on western side.

In the proposed project all trees are native plants so these trees have less demand of water to fulfill the criteria no 10 of GRIHA. Trees are placed as per criteria discussed above, on the north east side ever green Bottle brush trees to avoid the morning summer direct sunlight, on southern side the deciduous trees Amaltas and Kachnar to allow the winter sun and to avoid the summer sun, on southwest side the evergreen

Ashoka to avoid low sun in summers and on north west side the evergreen silver oak to avoid the low summer sun.



Fig. 7 : Landscaping in proposed project .

The proposed project have 20 % built up and 80 % open spaces , out of these open spaces mostly it is green surfaces in the form of lawns , for pathways grass pavers and small height shrubs in planting bed etc.

The green roof terrace has been provided in all blocks of the project and basement roof is provided with green vegetation and lawns to act as piazza for the users of this housing .The SW side of all blocks has no opening and made as green walls to reduce the mitigating heat island effect as well create the microclimatic condition . The planting bed has been provided on windows and continuous pergolas are provided at the lintel level with green vegetation.

### 3.4 PARKING AND CIRCULATION

Parking and vehicular circulation is most crucial aspect in sustainable housing project. Parking normally given 2 ECS per flat and in some project it might go higher. Surface parking is not good solution because it consume landscape areas, attempt should be made either multistoried parking block or basement parking.

As per GRIHA rating criteria no 7 “Plan utilities efficiently and optimize on-site circulation efficiency.” The commitment for this criterion is “minimize road and pedestrian walkway length by appropriate planning and provide aggregate corridors for utility lines.” GRIHA rating does not address the issue of parking solution directly.

In the proposed project one periphery road is given for one way circulation and this road can act as fire tender road also. The effort has been made to give one exit from back and combining the all service corridor on the back road. In this process only 10.7 % road of site area is used which can be

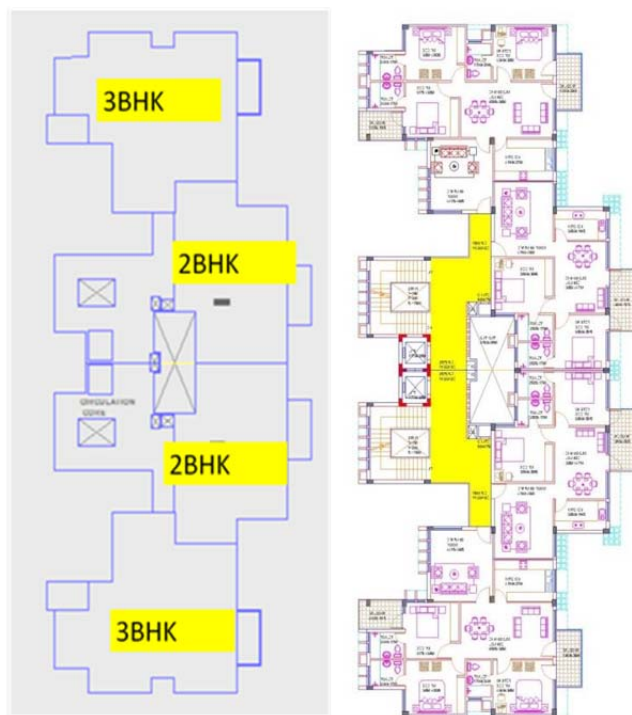
considered as good solution as compared to convention approach of giving 15-20 % road .

Surface parking has been completely avoided for occupant of housing except visitor parking , parking for club and school .All parking has been given in two basements , so occupant are forced to park their vehicle in basement parking . The all piazza are linked by pedestrian walkways and all facilities like club, swimming pool, market, school are within 5 min walking considered good for walking.

#### 4. BLOCK AND UNIT DESIGN

Block design and unit design are supposed to design in such a fashion to allow light and ventilation in each room and buffer spaces such as staircases, lifts, toilets etc should be placed on non desirable orientation like NW, W. Activities like kitchen, dining area etc should be placed in desirable direction like South /Southeast.

As per GRIHA rating criteria no 13“Optimize building design to reduce the conventional energy demand.” The commitment for this criteria’s is “Plan appropriately to reflect climate responsiveness, adopt an adequate comfort range, less air-conditioned areas, day lighting integration, avoid over-design of the lighting and air-conditioning systems .”



**Fig. 8: Block and Unit design**

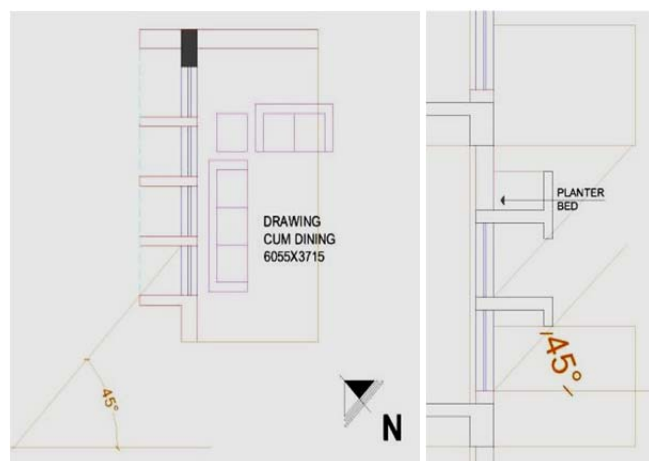
The blocks have been deign in such a way that all units are scattered and least overlap in desirable direction i.e. SE to allow light and ventilation in all units equally.

The blocks have been deign in such a way that all units are scattered and least overlap in desirable direction i.e. SE to allow light and ventilation in all units equally. The kitchen and dining area of all units are facing South East to allow winter sun to enter directly in these areas to avoid germs.

The circulation core consist of staircases, lifts etc have been placed on North west to avoid afternoon sun of summers. The toilets of units are also placed facing North West direction to act as buffer for heat gain in other parts of flat.

The opening sizes of windows have been worked out to achieve the desired level of lux in bed room and kitchen i.e. 50 lux and 200 lux respectively. Lux level has been calculated by assuming sky luminous 8000 lux in Chandigarh and 1 day light factor is considered as 1% of sky luminous i.e. 80 lux. The multiplication factor for bed room and kitchen are 2.5, .625 respectively. Multiplication factors are already given in GRIHA rating volumes. The opening size of bed room has been worked out 1900x1950x2100.

The glass for window facing SE has been selected as double low E-glass of visible transmission .63 and Solar heat gain coefficient .23. This will allow to considerable heat gain and allow enough light in the rooms.



**Fig. 9: Louvers in North West and South east direction**

The horizontal louvers have been provided on South east side and the combination vertical and horizontal louvers in room facing North West side.

Pergola has been provided continuous on walls at lintel level to reduce the heat gain and allow the wind to flow thorough opening of pergola.

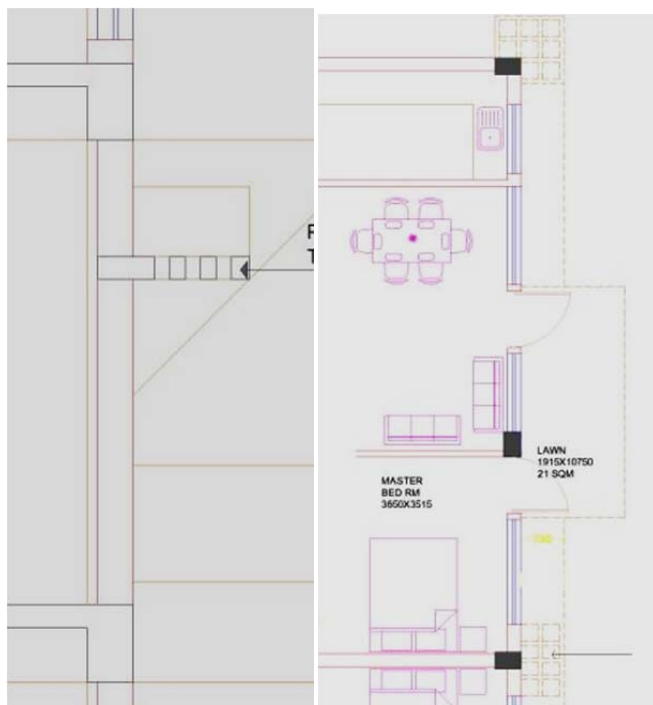


Fig. 10: Plan and Section of Pergola for shading of wall.

## 5. CONCLUSION

The rating criteria's does not provide the design process or design principles for housing project and even these criteria's have limitation in evaluation process also for design process or application of sustainable design principles. It is up to architects or designers to implement creative solution to achieve sustainability. Principles of design are not complicated but implementation of these principles for unique site or project makes it not even complicated but challenging proposal too.

The proposed project has been designed on the sustainable design principles and only few design principles has been discussed in this paper. The design process or design

principles such as site planning, block and unit design are the foundation of sustainability. If the foundation is not strong then you cannot erect a building, in similar way if these basic principles are not done creatively, the meeting of other criteria's will be only eye wash in the name of sustainability.

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