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# Development of a Concept Sustainable Village- A Case Study at Calicut

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## ABSTRACT
It was found out from the census 2011 that the rural population in Kerala has considerably decreased whereas the urban population doubled. So it is evident that the rural mass are migrating to the cities deliberately resulting in a lot of problems like decreased open spaces in cities, traffic congestion, high rise buildings, environmental pollution, health problems, etc. The construction industry is one of the major sources of environmental pollution as it accounts for quite a large portion of $CO_2$ emissions. After the safe life period of buildings, Civil Engineers are facing problems of demolishing these concrete building jungles, disposing the debris, etc. Hence the habitat should be sustainable and the concentration of people in the urban areas should be curtailed. Buildings shall use the products that are non-toxic, reusable, renewable, and recyclable wherever possible. In this project we have developed a new concept of the self-sustained village, where sustainable construction materials are used and where there are lots of job opportunities, agriculture, etc. In this village, houses are made of Compressed Stabilized Earthen Blocks (CSEB) and employed vernacular architectural styles. Electricity is generated from natural resources like solar power plants. Biogas is used for cooking gas and manure. Implementation of these concepts will make the village purely sustainable. As a case study of this concept a land in Quilandy, Calicut was planned experimentally. Implementing this concept in the rural and suburb areas will result better living standards, pure environment and facilitate a decrease of migration to urban areas and thereby contribute to sustainable development.

## Keywords
Biogas, Cost effective construction, Solar panel, Sustainable, Organic farming.

## 1. INTRODUCTION
Being engineering disciples, the latest phrase "Think globally and act locally" is to echo constantly in our ears. The sustainable village has the vision to design comfortable construction that gives back to nature and in turn benefitted with the boon of both modern & antique worlds. Nature is blessed with so many gifts; we have abundant renewable energy sources such as sun, wind and biogas, also skill and manpower to tap them. Through this project, our attempt was to integrate natural materials and ensure almost all the basic needs of the inhabitants were fulfilled there itself. In this village, all the food grains needed should be produced indigenously, renewable source of energy should be used to run appliances, locally available materials should be used for building construction, waste management should be done in an environmental friendly way, the atmosphere should be pollution free-all together natural resources should be used in such a way as to meet not only the needs of the present, but also for the future generations.

The concept of sustainable village is closely interconnected with environment and economy and safeguard the protection of natural resources, which in turn leads to a minimum acceptable quality of life. A sustainable village has efficient basic amenities for a reasonably comfortable existence of the occupants, planned housing colonies with adequate infrastructure like schools, parks, drainage system and local Medicare establishments, an appropriate transport system without affecting the environment, effective environmental infrastructure to address the issues of untreated sewage and waste threatening water ecosystems, A mechanism for industrial dispersal to satellite villages where better employment opportunities.

## 2. IMPORTANT COMPONENTS OF SUSTAINABLE VILLAGE

### 2.1 Agriculture
Agriculture pivots our life and sustainable village meet all the needs of its occupants, including edible, non-edible crops and medicinal plants. A part of the village shall be reserved for fruits, vegetables, cash crops, grains, pulses etc. cultivated by organic farming techniques which preserves and respects the environment's balance, enhances natural resources and guarantees healthier products. Organic farming is the form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control to maintain soil productivity and control pests on a farm. It excludes or strictly limits the use of manufactured fertilizers, pesticides, plant growth regulators and genetically modified organisms.

### 2.2 Energy Resources
T In sustained village renewable natural resources such as wind and solar energy is made use in the production of electricity. A solar panel or photovoltaic panel is a packaged interconnected assembly of solar cells. The solar panel is used as a component in a larger photovoltaic system to offer electricity for commercial and residential applications.

The forbidden energy in bags allows it to be used as a fuel and can be compressed, like natural gas to power motor vehicles. Biogas is produced by the anaerobic digestion of biodegradable materials

such as biomass, manure, sewage, green waste; plant material, etc. from biogas plant which can fade with biodegradable wastes including sewage, sludge and food waste. During the process, an airtight tank transforms biomass waste into methane producing renewable energy that can be used for heating, electricity, and many other operations..[1]

## 2.3 Cost-Effective Construction

The construction industry is one of the major sources of environmental pollution as it account for quite a large portion of $CO_2$ emissions whereas cost-effective construction technology reduces its emission and helps the protection of the environment.

### *2.3.1 Brick Arches*

The new RCC lintels which are costly can be replaced by brick arches for small spans and save construction cost up to 30–40% of RCC construction.

### *2.3.2 Mud House*

Mud is environmentally the most sustainable material. Besides its obvious Eco friendly nature, it's easy availability makes it almost a no cost material. The moist plastic mixture of Mud with water can be used with or without stabilizing additives for the production of mud bricks or mud walls. Normally, a 25 sq.m house on a 250 sq.m plot would require about 60 cubic meters of mud for its walls.

### *2.3.3 Compressed Earth Block*

Compressed earth blocks (CEBs) are earthen bricks of cuboidal shape (may be solid or hollow or interlocking) added with stabilizers such as 5% cement, gypsum, and lime and compressed by hand-operated or motorized hydraulic machines under a pressure of 20-40 kg/cm$^2$. CSEBs rival the finest standard bricks available today in terms of strength and durability; is highly cost-effective and environmentally-friendly; can be safely used for construction of multi-storey buildings. Houses made from these earth blocks are strong and have a longer life and can be used for load bearing construction up to 3 storeys.

One of the factors that affect the use of CEBs is the mental barrier of using simple earth rather than burnt clay bricks. Non-availability of skilled manpower and technical guidance to produce large quantities of CEB with proper quality is also a determinant force.

### *2.3.4 Bambo*

In places where there is good strong mature bamboo available, the steel reinforcement rods in conventional reinforced cement concrete can be replaced by bamboo. This is possible because the tensile strength of some good types of bamboo is very similar to that of steel rods. One of the disadvantages of using bamboo is that as each bamboo varies in quality from other; it is not possible to calculate accurately the strength of structural elements. However, the bamboo system is perfectly adequate and safe for smaller roofs, sleeping lofts, shelves, benches, work tables, stair treads.

## 2.4 Green Buildings

The concept of Green Buildings envisions a new approach to save water, energy and material resources in the construction and maintenance of the buildings and can reduce or eliminate the adverse impact of buildings on the environment and occupants. By preferring Green Building over a conventional building we help this planet earth and the people to retain nature to a maximum extent possible.

## 2.5 Rainwater Harvesting

Water has been harvested in India since antiquity, with our ancestors perfecting the art of water management. Rain drop can be directly harvested in storage tanks, artificial wells, etc. or can be harvested the monsoon runoff by capturing water from swollen streams and store it in various forms of water bodies similar to harvesting water from flooded rivers.

### *2.5.1 Bamboo Drip Irrigation*

Tapping of stream and spring water by using bamboo pipes to irrigate plantations is known as bamboo drip irrigation. About 18-20 liters of water entering the bamboo pipe system per minute get transported over several hundred meters and finally gets reduced to 20 -80 drops per minute at the site of the plant.

### *2.5.2 Surangam (Tunnel method)*

When the terrain is such that there is high discharge in rivers in the monsoon and low discharge in the dry months its better to depend on groundwater than on surface water by a special water harvesting structure called *surangam* having about 0.45-0.70 meters (m) width and about 1.8-2.0 m high.

### *2.5.3 Beris*

These are 10-12 m deep pits dug near tanks to collect the seepage in areas with meager rainfall. The mouth of the pit is usually made very narrow to prevent the collected water from evaporating. The pit gets wider as it burrows under the ground, so that water can seep in into a large surface area. The openings of these entirely earthen structures are generally covered with planks of wood.

### *2.5.4 Tanks*

Underground tanks are built in the main house in the form of circular holes made in the ground in which rain water was collected.

### *2.5.5 Check-dam*

They are small barriers built across the direction of water flow on shallow rivers and streams for the purpose of water harvesting. Smaller dams retain excess water flow during monsoon rains in a small catchment area behind the structure. The major environmental benefit is the replenishment of nearby groundwater reserves and wells.

# 3. CASE STUDY

As a case study a site, located at Quilandy, Calicut has an area of 3.1 acres, mostly undulating was selected and conducted the total station survey. Above 200 data points were taken (such that very close intervals were taken in regions of greater undulations) and transferred to the computer to plot the contour map as given in figure 1, by using the software AutoCAD 2009.

## 3.1 Design of Road Pattern

Road pattern has carefully designed by analyzing the contour map and by considering the basic requirements as listed below: A straight alignment would be the shortest, though there may be several practical considerations which would cause a deviation from the shortest path., alignment should be safe and easy for construction, maintenance and for traffic operations also. The Initial cost, maintenance cost, vehicle operating cost should be lowest, minimize the cutting and filling. The alignment for secondary road was done by taking into account that maximum number of plots obtained. The traffic on this road will be

comparatively less since it is restricted to bicycle riders, pedestrians and other inmates and hence the width were provided as 4 meters. Very steep gradients were avoided as it is difficult to climb the grade and to reduce the vehicle operating cost. The road can be paved or earthen. Main road is meant only for outstation transportation and the internal road is sufficient for all the requirements of the occupants within the village. The detailing of road pattern is given in figure 2.

## 3.2 Divisions of Plot

*Residential plot (*P1 to p13 and p16 to p19)*:* It contains a low cost greenhouse, a biogas plant, a cattle shed, etc. The waste from the kitchen, other domestic wastes, cow dung, agro waste etc. was used as raw materials for the biogas plant and the biogas produced is used for cooking purposes. In addition to this, the residue from the biogas plant can be used as bio fertilizer for cultivation in the plot. The remaining area of land is reserved agriculture. Vegetables and fruits for the daily needs are produced there itself and also on the roof terrace which helps to reduce the temperature in the building as well.

Various elements of the house such as foundation, wall, side pillars, roof - pillars doors & windows can be of stone masonry built on well compacted ground improvement, compressed earth block, bricks, tiled roof with wooden rafters. Glass with wooden framework respectively.

Every home in Sustainable village will be supplied with solar a lantern which provides a minimum 10 hrs of 40W fluorescent light.

*Park* (P14): To ensure recreational space for the occupants

*Farm (*P15): A large area of land is reserved for agriculture. Variety of crops like coconut, plantain, vegetables, fruits etc were cultivated in this area. The lower portion of the plot was suitable for rainwater harvesting and stored water can be used for agricultural purpose.

*Shopping complex and water tank (*P20): Water for all the domestic purposes was stored in the water tank in this plot. The vegetables and fruits produced by Organic farming method in the agricultural area were sold in the shopping complex.

*Yoga and gymnasium (*P21): The plot can be used as yoga center and gymnasium. People can come here for mental relaxation and also to improve their health.
*Open air theatre* (P22): That means a theatre which is completely uncovered. Here the performance space is a simple semicircular space at the center, around which seating arrangement is done just like that of a stadium.

Thus we have planned the given plot as a piece of sustainable village concept.

# 4. CONCLUSION

Man, of course, has abused almost all the sources of nature. He may use and exploit all the sources of nature further both at the micro and macro level. "The development of the concept of the *Sustainable village* is a result of our quest for sustainable living with respect to culture, environment, social and spiritual need for mankind in harmony with the nature. .

A land area of 3.1 acres has been surveyed and plotted the contour map using the software Auto CADD. A suitable plot division has suggested with details of a typical residential building and its surroundings. *Sustainable village* will be a boon to all the habitat problems of the present day. With this vision and planning, we can change even the waste lands into ecofriendly sprawling villages throughout the country.

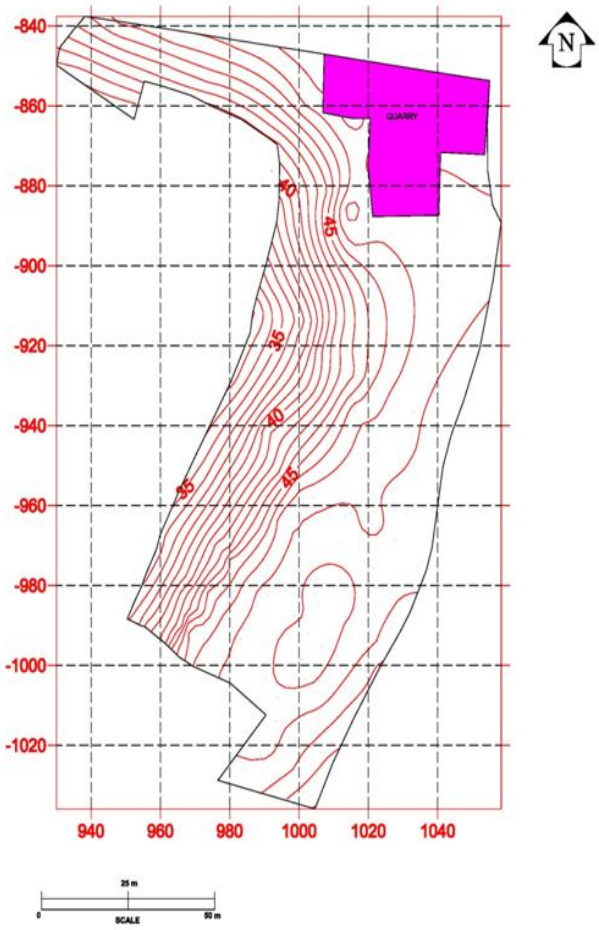


**Figure 1. Contour plot of the land surveyed.**

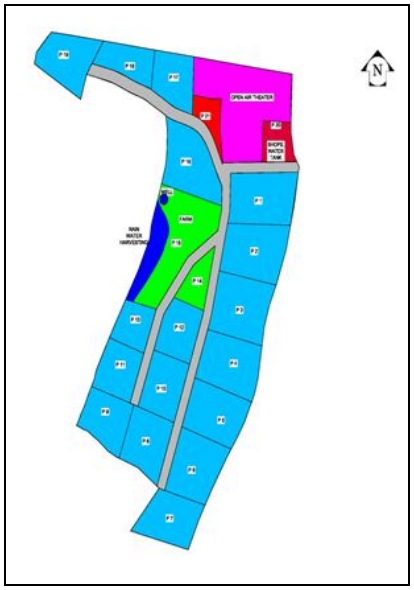

**Figure 2. C Design of Road pattern with division of plot**

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