

ABSTRACT

Sustainable Architecture aims to minimize or nullify the negative impact on the environment, which happens mainly due to the use of inappropriate building systems. Building system is an umbrella term that constitutes building construction methodology, Choice of building materials, building maintenance and servicing and disposal of a part or whole building at the end of its service life. Building system especially after the advent of ordinary portland cement, was found to have a very high negative impact on the environment due to the emission of green houses and dioxins during the manufacture of building materials during its service life or after disposal. This paper brings into light the sustainable quotient of an Agraharam (a series of houses built near or around a Hindu temple that serves as residential Quarters to the Brahmins who serve in the temple) that was built before 211 years at Ayanavaram, Chennai. The Agraharam has 13 identical houses in structurally sound condition, very little modification has been carried out in all the houses and these modifications are mostly limited to services such as incorporation of power supply, plumbing and drainage. Hardly any modification has been done on the superstructure that is built with burnt clay bricks, lime and sand. The Agraharam in reference can be analysed thoroughly for its characteristics that make it a good example for sustainable architecture.

Keywords: Sustainable quotient, agraharams, flexible housing, spatial planning, mass-void relationship.

I. INTRODUCTION

This paper aims to highlight the sustainable quotient of an Agraharam and also to bring light the two hundred year old construction practices that were used to build the row of houses around the temple, and also to ascertain the link, if any, between the erstwhile construction practices and sustainability. The term 'building practices' refers to building materials, skill and resources that was built before 211 years at Ayanavaram, Chennai. This paper's scope shall be confined to:

- Identification of construction materials used in the agraharam.
- Contribution of site planning to manage the comfort of the occupants.
- Construction details that have vanished, yet offer scope for revival.
- Establish relationship between the built form and inhabitants.
- Impact of buildings built around the houses at the same time and their relevance.

What is agraharam architecture

Some residential areas like Tiruvallikeni (Triplicane) and Mylapore in Chennai have several houses dating from the early 20th century, especially those far removed from arterial roads. Known as the Agraharam, this style consists of traditional row houses usually surrounding a temple. Many of them were built in the traditional Tamil style, with four wings surrounding a square courtyard, and tiled sloping roofs. Typically, agraharams can be seen where an entire street is occupied by Brahmins, particularly surrounding a temple. The architecture is distinctive with Madras terraces, country tile roofing, Burma teak rafters and lime plastering. The longish homes consisted of the mudhal kattu (receiving quarters), irandaam kattu (living quarters), moon dram kattu (kitchen and backyard) and so on. Most houses had an open to sky space in the centre called the mitham, large platforms lining the outside of the house called the thinnai and a private well in the backyard. The floors were often coated

with red oxide and sometimes the roofs had glass tiles to let in light. The agraharam quadrangle seen in Triplicane is around the Parthasarathy Temple and its tank.

II. AYANAVARAM - ITS LOCATION AND FABRIC

The need to document traditional setting

In traditional houses like agraharams, an individual is always a part of the community forming an interaction with different user groups. There are lot of opportunities for an individual to have community interaction in such systems. Traditional built environment plays a major role in bringing the individual an interactive, a sense of community and a healthy society.

Also the traditional housing systems provides a sustainable environment which shows that a community knit is achieved not only in one generation, but also for future generations. There is a need for understanding the dynamism and adaptability of the traditional built environment so that it can be self adaptive for successive generations. There is a gap in research of traditional built environment that adapts to the changing needs of the society. Traditional built environment has much to do with nature and type of the space, habitation, living pattern and concern for climate change has been ignored. It should be the architects who should understand the relation between traditional built environment and the end users, infer the valuable traditional knowledge and should avoid damage to the environment and to the traditional patterns of the society.

Why kasi viswanathar agraharam?

Ayanavaram or Ayanapuram is one of the many localities of Chennai located in West Chennai, 8 kilometers from the city centre. The Konnur high road, one of the important connecting roads in Chennai runs through Ayanavaram. Ayanavaram is one of the peripheral commercial areas of Chennai. 100 years old railway Quarters for the railway staff is located in Ayanavaram. The selected sample is 211 years old and still getting stronger though the quality maintenance offered by the trustees are good. However, this small housing colony does not have a single drawing to explain its architecture. With conservation losing sheen rapidly in the backdrop of urbanization, the heritage value of this agraharam will go for a toss if the project is neglected.

Spatial layout of agraharam

Kasi Viswanatha Swamy temple agraharam is a south facing development consisting of 13 nos. identical house with an effective plot area of 35'0" x 101'0". The agraharam was originally flanked by Kasi Viswanatha Temple on the East side and Tawker's choultry on the West side. The North side had nothing but agricultural lands and palm groves. Agraharam abuts the road on South which is now called as Konnur High Road. The backyard is very spacious and has a stable for rearing cattles. There is a door leading to a passage that is meant for conservancy staff and also for the tenant's ablutions. Bathing facility is available within the premise, as there is a well inside. The courtyard is the critical design element that brings in light and fresh air throughout the day and also helps in maintaining the comfort level of the occupants. The roof is mostly sloped with a few areas being exception.

The site made available for the construction of this agraharam is linear. Hence 13 nos. Typical houses were constructed one next to another in the area available between the temple and the choultry. The dwelling units are south facing with a front setback of 27'0". But recently shops were built on the front of the agraharam, leaving 9'0" front setback. When the agraharam was built in 1806, there were hardly any developments around it except the temple and the choultry. Palm groove at the rear and paddy fields on other sides enveloped the agraharam, temple and choultry. Typical houses ensures speedy construction, easy maintenance and gets rid of socioeconomic differences.

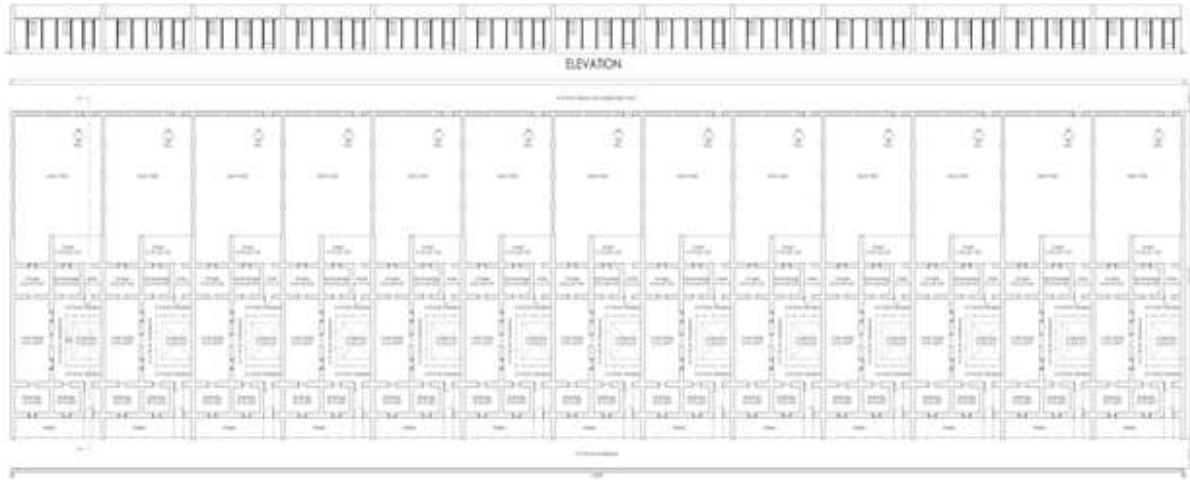


Fig.1 Site Planning of Kasi Viswanathar Koil Agraharam

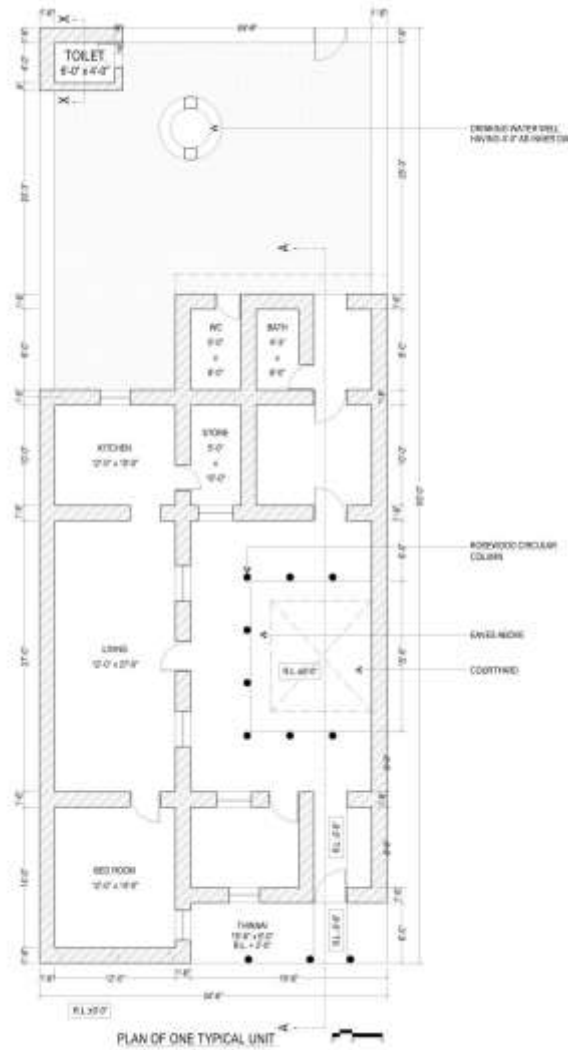
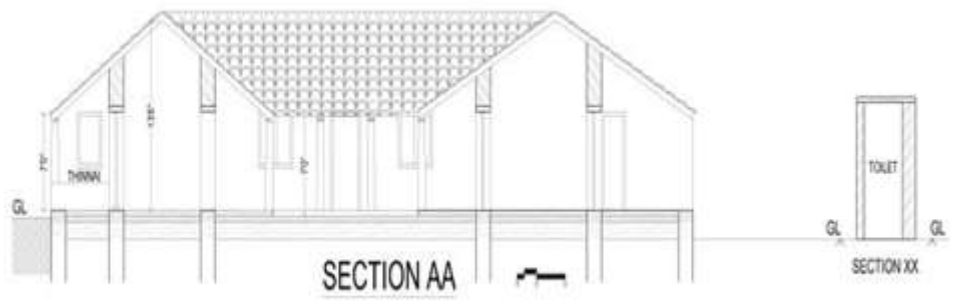
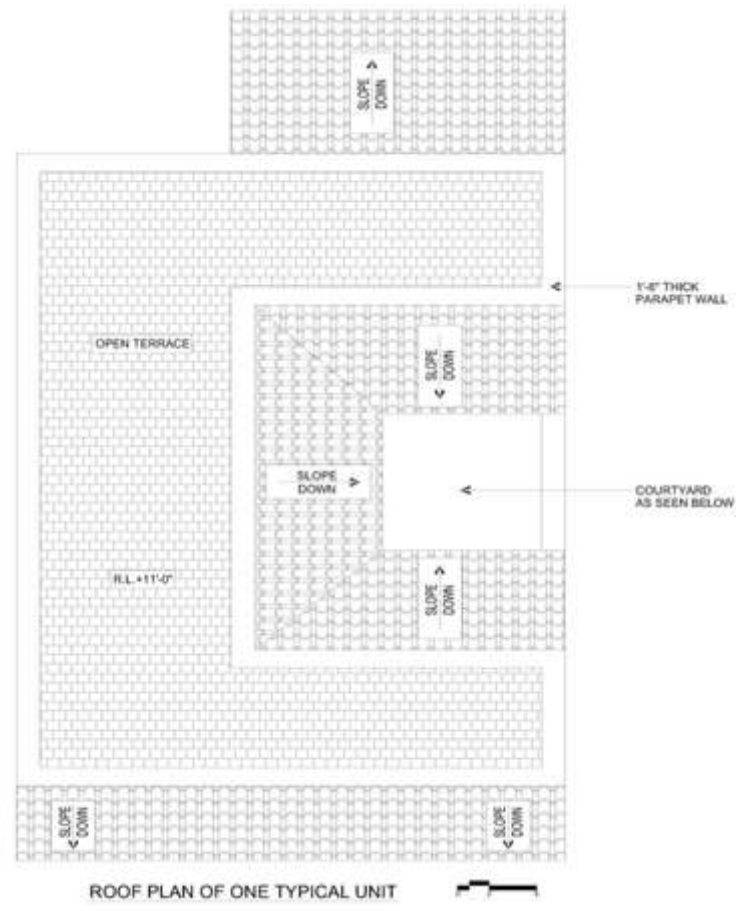


Fig 2. Plan of one typical unit and its section





Form:

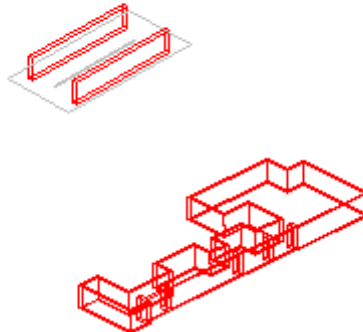


Fig 3. Form and Open spaces in the house

Linear form with a proportion of almost 1:3 and parallel walls giving a strong sense of direction. Variation in distribution of spaces from one end to the other.

Open space within the house and eccentric courtyard plays a major role in the circulation of the house. Vast utilization of the courtyard is achieved by creating varying levels in the courtyard and acts as an interactive space for the people. These spaces are also flexible wherein a variety of activities takes place. Some activities include resting, interaction, movement inside, sleeping, conducting ceremonies, etc.,

Analysis of the agrapharam

The three urban design theories as given by Roger, the figure ground theory, linkage theory and the place theory is taken into consideration for spatial analysis of the built environment, though it is quite serious when dealing with the traditional houses, the following are the indicators taken into account in bringing the outcome of the study.

1. Identity
2. Form
3. Spatial Planning
4. Mass-void relationship
5. Circulation
6. Sense of place
7. Multi-functionality/ Flexibility
8. Spatial Planning
9. Responsiveness to the human needs

Spatial Planning:

The house has a linear form. A simple plan starting from a semi-open space called the 'Thinnai'. Rooms are arranged in a linear fashion and towards an eccentric linear courtyard. All the private spaces are aligned in a linear form on one side. One can see that the services are segregated to the rear end of the house. The entrance on both the side of the house keeps one intact with the immediate surrounding.

Two major elements: corridors and courtyard forms the major circulation zone within the entire house.

Mass Void Relationship:



Fig 4. Mass void Relationship

Sense of Place

As already seen the total number of hours spent by the users in each of the space show their creation of opportunities for interaction which brings a strong sense of community among the users. Also the plan shows the linear distribution of spaces at intervals providing different level of activities and varied experience of space throughout the house. The house is distributed from the front to the back creating immediate level of interaction with the street. The hierarchy and size of the spaces are evident in the entire agrapharam being the replication. The major feature of these houses is its flexibility of various spaces not only in creating interest and variety of the space but also overcomes the constraint of size of the house when it can be adapted for any number of people being added over generations. The corridors and courtyard not only appears to be an element but also serves as a circulation space and interactive space with various type like open, semi-open and closed spaces. The quality of light and shade shows the quality and variety achieved in those days.

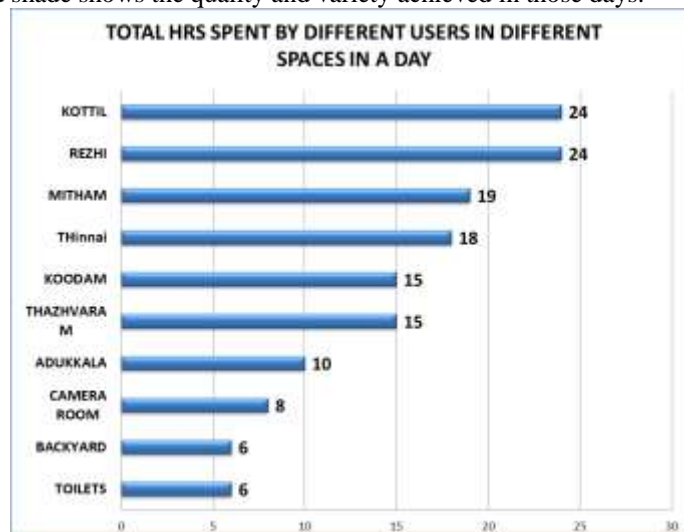


Fig 5. User activity analysis

Flexibility/Multifunctional Space

The major feature of these houses is its flexibility of various spaces not only in creating interest and variety of the space but also overcomes the constraint of size of the house when it can be adapted for any number of people being added over generations.

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Spatial elements in the agrapharam

The thinnai

Thinnai is a very important element in our traditional architecture. It acts as a transitional space for the house. It is very much a casual seating space which is utilised by even strangers, travellers for sleeping/ dining. In this agrapharam, the original thinnai stretches between the East and west boundary walls, except at the entrance,

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where there is a relief for 3'9". The height of the thinnai is 2'0". It is frequently used by the occupants of the house as well as by outsiders. Dressed granite slab of size 1'0" x 6'3" x 0'3" is used on the edge of the thinnai to ensure that the floor finish doesn't get damaged due to the frequent usage. The stone slab is also seen on the areas where the wooden columns are resting on the floor. This is done to ensure that base for the wooden column is stabilised.



Fig 6. View of the agrapharam and Thinnai as a transitional space

PIRAI

In the gable walls of agrapharams, a prismatic recess is seen called as 'pirai' in tamil. It is used for keeping oil lamps through the night. This prismatic recess is an extruded equilateral triangle whose sides and depth are 6". Apart from this there are also cuboidal recesses in the wall that runs normal to the gable walls. The cuboidal recess measures 1'0" x 1'0" x 0'6".



Fig 7. Pirai as a traditional design feature in traditional houses - cuboidal and prismatic recess

Wooden columns

Each house has atleast 6 nos. Rose wood columns in the fore court, courtyard and backyard. The shaft of the column is turned to get a tapering cylindrical profile. The column has 5" diameter at the base and 3.5" diameter at the top. The shaft is 6'5" high which is capped by an intricately done capital. The head of the capital is a square plate of dimensions 8" x 8" x 1". The head holds the wooden roof beams.



Fig 8. Wooden columns(Rosewood) as seen in courtyard. The latch which is still intact from the day of construction

Doors and windows

All the doors and windows are made of Rosewood. Excellent seasoning, good quality timber, good workmanship and adequate maintenance has proved fruitful for the builders as no window or door has replaced due to damage/ deterioration. However in many areas, windows and doors have been moved / replaced due to the additions and alterations. Main door measures 3'9" x 6'6", made from 4" x 6" rose wood section for frame

and 1.5" x 5" planks for shutter. The shutter is a braced door with the planks held together by 3 nos. 2.5" x 4" sections which act as top rail, lock rail and bottom rail. All the doors have bottom rail.

The two other doors that are fixed in the passage leads from the front to the rear measure 3'3" X 6'6". They share the same specifications of main door. Main door and the other two doors in passage have single leaf. All other doors are 3'0" x 6'6" in size. They have two leaves. These doors are fixed in the bedroom wall or kitchen wall. The shutters are panelled. Frame for all windows are made of 3" x 4" rose wood sections and shutters are panelled made from 1.5" x 4" sections. The accessories used in the windows and doors are unclear, but the hardware is still functioning. Occasionally, occupants change the hardware / accessories. The window frame is fixed with 0.5" dia MS rods for protection. The rods have still not corroded, may be due to maintenance.



Fig 9. Doors and windows with a yellow paint where turmeric is used for hygiene. Staircase with lime concrete and Thulasi madam with a courtyard can be seen

Staircase

Not all the dwellings has a flat roof. The dwellings that have a flat roof have a staircase leading to the roof from the courtyard. However, it is believed that the original staircase must have been built with rosewood, resembling a ladder. It is not clear whether the staircase that remains today was built 206 years ago. The staircase seen today is made of lime concrete.

Well

All the houses had a well. The families had no other source of water at the time of construction 206 years ago except Otteri Nullah that flowed 1 kilometer away from this site. Though Otteri nullah was almost perennial, the distance of 1 kilometre to fetch water must have forced the builder/owner to take the decision to dig well for every house.



Fig 10. Courtyard view into the living room and Well-The only source of water when the agraharm was originally constructed.

Courtyard

A court or courtyard is an enclosed transitional space by a building that is open to the sky. These areas in public buildings were often the primary meeting places for some purpose, leading to the other meanings of court. Both the words 'court' and 'yard' derive from the same root, meaning an enclosed space. Each dwelling in this agraharam boasts of a courtyard measuring 11'6" x 11'6". The courtyard is placed East in which 'Thulasi

maadam' is placed. Every morning, while watering the 'thulasi' plant, water spills on the floor also thereby reducing the heat on the floor and balancing the micro climate. The courtyard in addition to providing lighting and ventilation to the living room, helps in maintaining the thermal comfort of the occupants. During the day, the walls of the building get heated, resulting in rise of temperature of the courtyard. The heat in the courtyard creates negative atmospheric pressure in the area, thereby drawing air from the surroundings. The air that gushes to the courtyard is drawn from front / rear of the building through the windows of all rooms. This results in fresh air being drawn continuously from all sides, keeping the rooms airy and cool. The hot air that reaches the courtyard goes up by virtue of its temperature, loses heat and dissipates.



Fig 11. View of Thulasi madam in the courtyard and view of courtyard form the kitchen

Construction practices adopted

1. Brick work using lime mortar

This is one of the oldest known type of mortar, dating back to 4th century B.C. and widely used in Ancient Rome and Greece, when it largely replaced the clay and gypsum mortars common to Ancient Egyptian construction. Despite its enduring utility over many centuries, lime mortar's effectiveness as a building material has not been well understood; time honored practices were based on tradition, folklore and trade knowledge, indicated by the vast number of old buildings that remain standing. Only during the last few decades has empirical testing provided a scientific understanding of its remarkable durability. Traditional buildings built using lime mortar move and absorb moisture, which prevents the masonry from cracking. Also by using lime mortar expansion joints can be avoided. Clay bricks of size 6 3/4" x 4 1/4" x 2" are used for the construction of foundation and superstructure.

2. Foundation and superstructure

Though a very little information could be obtained in this front, there is no doubt that the foundation is a stepped footing under all load bearing walls. However doubt persists over the depth and width of the footing. No steel is used in the foundation of super structure. All peripheral walls and most inner walls are built with clay bricks and lime mortar for a thickness of about 1'6". Few walls are 1'1.5" thick but made of same materials. Both brick and lime are permeable materials that allow air to pass through them. This helps in maintaining the thermal comfort of the buildings' occupants.

3. Roofing

Rosewood beams are first placed upon opposite walls across the width of the room, 450mm to 600mm apart. High density and high strength clay bricks, made to special thin size measuring 25mm x 75mm x 150mm, are used. Properly mixed and matured lime mortar is used for bonding the flat tiles that are placed at an angle of 45 degrees to the wall, or diagonally across the room width. These terrace tiles, placed on the edge, ensured tensile strength. The roof is cured for a minimum of one week to achieve early setting. Thereafter, a 75mm thick layer of broken bricks or brick bats would be laid where nearly half the volume would be made up of lime mortar, three parts brick, one part gravel and one part sand. This layer provided the compressive strength and load bearing capacity to the roof. This layer needs to be well compacted, cured and levelled. The final layer would depend upon the slab being an intermediate one or the final roof. If intermediate, a floor finish like red oxide or lime mortar would be applied and if final, there would be courses of 50mm thick flat weather-proof tiles topped by thick mortar to slope of 1 in 30. The soffit of the sloping roof has rose wood purlins, rafters and 8" x 8" pressed clay tiles. The rafters are seated on the top of a rose wood beam which in turn rests on rose wood circular

columns. The tiles are held firmly in place by the self-weight of a tile and the downward pressure exerted by the tile at the top. The bottom most pan tile is fixed to the pressed clay tile using lime mortar.



Fig 12. a. Street House Relationship b. Entry into the individual unit c. Backyard of the house d. Roof soffit Detail e. Unorganised Garden in Backyard. f. Inspection Chamber lid as seen in Courtyard.





4. Drainage





All the occupants, men and women alike had to use the open yards for defecating and urinating. There were no sanitary facilities during the time the agraharam was built. However, septic tank and soak pit were built decades later by the trust. With the advent of underground sewer lines laid by the corporation, the septic tanks were abandoned and the sewage and sullage lines were connected to the sewer mains. All the sewage that gets collected in the septic tank are channelized through inspection chambers that are built in the courtyard and reach the main sewer.




III. INFERENCES

The following are the inferences drawn from the selected Agraharam sample:

- Relationship between the house and the immediate surrounding (Street)
- Hierarchy of interaction spaces
- Sense of Place
- Defensible space
- Community Interaction spaces
- Provision of Spaces for all types of users
- Flexibility in spaces in the entire house

S.NO	TYPE OF SPACE	ORIGINAL VERSION OF THE AGRAHARAM	RECENT TRANSFORMATION OBSERVED	EVIDENCE SEEN IN THE AGRAHARAM
1.	Semi-Private and private spaces	Flooring was initially clay and finished with cow dung and turmeric.	Intially with grano flooring and recently most of the spaces are finished with ceramic tile flooring.	
2	Gable walls of agraharams	An elemental recess was constructed to light the houses using oil lamps.	Electrical lighting had taken over	
3	Toilets	No drainage facilities in the initial days and open yards were used for defecating and urinating	Sewage collected in the Septic tanks are channelized to the main sewer	
4	Open Backyard	Landscaping was given more importance by the occupants and plants and trees were grown.	Space is shrinking due to the increase in the size of the family.	

5	All spaces	The entire walls were originally painted with lime for its antiseptic properties	Pigments may have been added to give them different colour walls.	
6	Roof tiles	All houses were built with clay barrel roof tiles.	Due to non availability of original material, clay barrel roof tiles have been replaced with mangalore tiles. In some cases, bitumen sheet was used to cover the tiles to prevent water seepage. Bitumen sheet are not heat proof whereas the clay tiles are heat proof even during peak summer. This flat roof is called as 'Madra Terrace Roof, which is very effective in heat insulation and water proofing.	
7	Pirai	There is a small prismatic recess in the gable walls for keeping oil lamps through the night. Each recess measures 1'0"x1'0"x0'6"	Pirai which is a standard traditional design feature is fast disappearing due to the advent of electricity and limited use of oil lamps.	
8	Doors and Windows	Excellent seasoning, good quality timber, good workmanship and adequate maintenance has proved fruitful for the builders as no window or door has been replaced due to damage / deterioration.	in many areas, windows and doors have been moved / replaced due to additions and alterations. All the doors have bottom rail. The accessories used in the windows and doors are unclear, but the hardware is still functioning. Occasionally, occupants change the hardware / accessories. The practice of applying turmeric on the door frame for hygienic reasons has eroded but the	

		There is a practice of applying turmeric on the door frame for hygienic reasons	faith still remains and as a result, yellow paint to resemble turmeric is done.	
9	Well	All the houses had a well. The families had no other source of water at the time of construction 206 years ago except Otteri Nullah that flowed 1 kilometre away from this site.	Wells have proven benefits over other domestically controllable water sources. While deep bore-wells exploit sub-soil water table, wells don't. The water is often coming from an aquifer or groundwater, and can be easily deepened, which may be necessary if the ground water level drops, by telescoping the lining further down into the aquifer.	
10	Drainage	All the occupants, men and women alike had to use the open yards for defecating and urinating. There were no sanitary facilities during the time the agraharam was built.	Septic tank and soak pit were built decades later by the trust. With the advent of underground sewer lines laid by the corporation, the septic tanks were abandoned and the sewage and sullage lines were connected to the sewer mains. Originally this door was a double door made of wood. After the passage was put to disuse, the door was not properly maintained.	

Problems in agraharams

Today, the restoration works in the agraharams have to be carried on once in few months which is not only getting expensive but, it is also difficult to find skilled labour. Many of the surviving examples of agraharam architecture today are kovil (temple) houses occupied by the descendants of those who worked in the temple in one capacity or the other. Owned by the trusts administering the various temples, they are in disrepair because the tenants are not authorized to carry out restoration. The temple trusts are often not very keen on restoring these ancient buildings. They say they have other plans for the property like expanding the temple premises or housing the temple car. No wonder, many of these houses are being replaced with modern multi-storied apartments, resulting in a reduction in their numbers.

IV. CONCLUSION - A WAY TO STOP THE DECLINE

A vast variety of people are unaware of the heritage of our city and culture. Very little maintenance is good enough to protect these structures. Many structures world over have survived the test of time if only a little care is taken. It should be the firm decision of the owners of heritage properties, Architects and Government to decide



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that a functional building shall not be demolished or altered for monetary benefits. Education is also one important factor to stop damaging heritage structures. For example in one of the houses damage to lime plastering and repairing it has been done. To reaffirm that a well maintained building / housing can last for centuries and don't necessarily have to be demolished just because it is old. A structure built with sound technical know-how and workmanship and quality building materials can withstand most natural disasters while protecting its occupants.

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