HYPOTHESIS OF DECODIFICATION AND UPDATING OF CLAY FINISHING SOLUTION IN THE EXPERIMENTAL ARCHITECTURE

Alessandra Focà
Dipartimento DASTEC - Università Mediterranea di Reggio Calabria
alessandra.foca@unirc.it

B.- TRADITIONAL TECHNIQUES AND DISTRICT REHABILITATION

Abstract

The research here presented, in progress into Architectural Technology Ph.D., aims to develop, by the study of vernacular raw earth know-how, a finishing solution that meets the performance requirements expressed by today's market.

The goal is to develop, through the study of the traditional constructive experiences in clay, a finishing solution that answers to the performance requirements expressed from today's market. It finalized to investigate such system of protection of the surfaces, to analyze its technical performances and to verify its applicability in the contemporary supply chain. The results would be able, besides, to satisfy the increasing demands of the market between the innovative building materials to natural base, into a sustainable development.

Case-study will be the village of Tiébélé in Burkina Faso where the study of the technical system of the compound district allows to deepen the relationship between housing organization and building technology. In tribes of western Africa, in fact, the typology of residences symbolize the relationships between the family nucleus and social organization.

The Kassena compound, with plant in strengthened cell, it is a flexible system, that allows frequent amplification and transformation works following the family increase in population and baiting a continuous process of adaptation to the needs of the family. The building weaving, in clay, it is realized in bench, on which is set a finishing layer to set up an external earth plaster, dawadowa, that gives waterproofing to the structure and that is base layer for the paintings.

Introduction

The reasons for development and behavioral change of local users involved new dwelling forms and started a process of constructive emulation that reflects on the traditional technique of compromising existing buildings. Such condition can be recovered through a rediscovery and valorization process of rural building updating in terms of physiognomic as functionally. Each architectural reality move in a specific encoding of internal relations, from birth or by conditions induced by the context, due to the typological features that depict the peculiarities of local ownership. This induces to highlight the conservation guideline, not only purely safeguard attitudes, but started by implementation and updating processes of the traditional technique while enhancing the intrinsic features, it will achieve new performance standards.

The hypothesis of de-codification of traditional architecture will be founded by an investigation of the morpho-typological and functional-technology aspects of the traditional setting, that attention on the possibility to decline it according to the typical elements of the art of the building in West Africa. The goal of this way of study is the update and reinterpretation of vernacular language, earned by path of knowledge of transformation governance, of a relationship analysis between architecture and climate,
Papers

of technological and typological invariants control. Case-study will be the village of Tiébélé in Burkina Faso.

In particular, through laboratory test and experimentations in prototype-building, the research aims to investigate a sustainable and reversible revetment skin system, to analyze technical performance and to test their applicability in contemporary production chain. The results could also meet new production needs into of innovative building materials with natural base, in of sustainable development field.

This research is carried out with prof. Corrado Trombetta inside the TEMENOS Unit Research, coordinated by prof. Rosario Giuffrè, Department DASTEC University Mediterranea of Reggio Calabria (Italy).

Materials in type behavior of bioclimatic architecture

The well-established paradigm of sustainable development bring together all useful topics to understand how the environmental system react when exposed to unbalancing pressure such as consuming non-renewable resources, invasiveness of transport, production, human interventions, and sense how to cope and to find the best thing to recover the dangerous drift by now taken. Today the issue of sustainability is ahead of all development policy statements issued by international organization and governments of many countries of the world. From a recruitment principle this concept begins to go in hand with strategies, objectives, funding, international agreements.

Sustainable development poses to close-up the environmental consequences associated with different phases of the construction process; thinking of sustainable buildings means thinking of a greater durability, less wastage of resources in all phases of the construction process, life and management of building to get to the choice of materials based on environmental quality, comfort requirements, health and the energy level. Therefore it’s important to approach the building engineering in its life cycle, from choosing the location of buildings management of demolition, materials and components disposal, as life cycle phase is substantial for the environment preservation. Among the various indications is fundamental the relationship CIB TG16, Sustainable Construction (1994) to relate the phases of construction process with environmental resources.

The need to find natural solutions with high performance and low cost, you can refer to vernacular architecture?

The British architect Laurie Baker noted that “vernacular architecture almost always has solutions for all our problems of construction. All that is required is adding to our experience of the twentieth century to improve what has already been completed”. In fact, the current opposition between tradition and modernity often seems to arise from a misunderstanding of both. Modernism was rooted deeply in tradition as demonstrated by important figures of modern architecture such as Luis Kahn and Hassan Fathy, regionalism can be at its best when meant among a process of interpretation of cultural contents and constructive development.

Regionalism as well as modernism has the primary aim to minimize the environmental impact through the use of suitable materials in every place, and both revise morphological and constructive solutions of the past, adapting to the today living local styles. (1)

Beyond, the rediscovery of pre-modern building techniques can allow recovery, in the contemporary technology, of building materials with durability attest by the use and compatibility with heritage existing building.

Vernacular architecture
Knowledge of environmental system which reference about the, implementing these techniques through the climatic bias on human activity and transmitted through generations. The analysis of the relationship between development and natural factors given off simple and compact forms. These types enhancing the use of natural local materials with technologies proved to relate with surroundings, assuring the effectiveness of constructions processes in its environments. The buildings, arranged according to orientation, exposure, ventilation and soil evolution, become part of the environment. This concept has an empirical relationship with the context, daily-verified in activities, without the need for theoretical structure. (2)

Today’s cultural engineering, influenced by the sustainability, upgrade coexistence of variability and permanence, where permanence is the lesson of the tradition and variability is the adaptability to changing needs of contemporary society and the integration with innovation technology. The delicate coexistence of these two identity matrices, however, lead to cultural synthesis between old and new only in cases of slow and gradual becoming.

The use of raw earth construction, economic building material and immediate availability, shows a strong roots over the territory: houses made of clay are environmentally friendly and deeply tied to the context and the cycle of use of the material.

**Case-study of the cob residences of kassena compound in Burkina Faso.**

At the heart of West Africa, just south of the Sahel belt, there is, little known, “the land of upright people”, Burkina Faso. French ex-colony, with 274,000 km² size and an estimated population of more than 15,000,000, is one of the most smaller but more densely populated country of continent, who, surrounded by Mali, Benin, Togo, Ghana and Côte d'Ivoire and closet to margins of the major trade, it hasn’t any natural resources but has a rich cultural heritage.

The climate has two distinct seasons: the dry season lasts from November to May and the wet season from June to October instead; the hottest period goes from March to June, while from December to February blow incessantly Harmattan winds. The population is unevenly distributed, in the north expanses of desert lands, while the central and southern regions has overflow population.

Kassena ethnic group is present in the district of Nahouri, in the south of the country. This department, with Po, the capital city, and four rural sites, Guiaro, Zecco, Ziou e Tiébélé, has about 120,000 inhabitants Kassena, one of gourounsi ethnic groups, constituting 5.3% of the total population in Burkina Faso. Their allocation area does not respect today’s political borders but at the Bukina area adds a site on the north of Ghana, kassena inhabited by about 130,000 other Kassena men. Today the kassena towns are sixty-seven on average large (villes or villages) located between the south-west of Burkina Faso and northern Ghana.

Kassena village differ from the usual concept of village as a cluster of residential buildings which we are accustomed. It is a vast area that joins more fortress-house, compound, each inhabited by one family, usually far out of sight apart. Whole built has reddish-brown painting walls which, without interruption, protects the family from evil spirits.

**Fig. 1 Burkina Faso and kassena place**
The tribes of West Africa can still be described as a "home society", a particular form of social organization. Therefore it becomes necessary to explore the connection between houses and social groups and to consider these little buildings like culturally living form, who have birth, evolve, move and die. Place of living and lodge of cosmic symbolism, shells and personifications of man-woman relations.

The house shape is the first element to identify the magical and religious background of the community to which it belongs to. From plant, techniques used and the orientation it’s possible to know what prominence was given to sacred value of foundation. The quadratic plant indicates a willingness to follow a favorite direction, to identify preferred disastrous and directions. In Egypt and Mesopotamia the houses had all quadratic plant to relate with the sun worship was crucial because it originated the natural phenomena that governed the life of the country. Same plant were also Greek, Etruscan and Roman houses. On the contrary examples of round-shaped buildings denoting affiliation with a totemic religion wedded to the earth worship: Everyone is the center of the world, along with his round house. The round-shaped construction is called into question by the quadratic form only after the Christian colonization. Examples of totemic house are still in the traditional celtic house; the trulli of Puglia or nuraghi of Sardinia may be considered types born with the influence of totemic religion. (3)

Kassena village is a compound, sonro, occupied by members of the same family under the guidance of the elderly. The concession has fortify courtyard houses which are accessed from one entrance at the west, wa-zuuri; it maintained that character of strength needed for a single-family village miles away from the others and thus being exposed to frequent attacks of men like invaders or wild animals. The typology has always developed according to the primary goal of defending themselves from the assault of the invaders. Still the eight-shaped house hold down this peculiarity: the entry is very low, semicircular, about 50 cm and to enter in the main chamber you must also overcome a wall of 50 cm located immediately behind the entrance. The enemy was so compelled to put his head before the rest of the body and the warrior in defense of the home could easily cut off the head of the invader.

Around the courtyard, naboo, there are different types of units: round-shaped construction, draa, with hut shingle for young men, rectangular house for couples, pseudo-round, with particular eight-shaped plant for the elderly and small children, all covered flat roofs and small conical barns, tule, for stores. Mangolo, the rectangular house, made up of a room and a large hall to receive guests. In rounded house, dinian, also with a double room, a secondary one is used as kitchen site. In some cases of eight-shaped houses is found the presence of third room, an hall of access. All the houses are about 10 m² for 2-3 m high. The flat roof, supported by wooden floors, is used to dry the crop out of the reach of animals. It is also used to sleep during the hot season. Those are accessed by external stairs of tree trunk with Y-shaped and steps to carving.

It is not a hard-shell distribution system, but the frequent renewal works following the family increase give way to a continuous construction-destruction process: the destroyed houses after the damage of the rains fall aren’t repaired, but leave way for new constructions, since, according to anthropological “logic of the clan”, a boy who grows up build a new rectangular house, while a girl once marriage, moved in the her husband’s concession.

Every year, at the end of the dry season (March to May) the inhabitants of the concession undertake repair works of the spoiled buildings, of damp-proof layer damaged and of decoration faded by thunderstorm of the rainy season. Maintenance is a rite like a principle such as the expulsion of the hate spirits and the availability those favorable reception. In this important activities each family member have a duty: the men are involved in construction, the women in painting.
The structure of this small house is mainly composed of raw earth. Walls are build up through the cob technique (bauge in french), by placing the clay directly, without formwork but continuing for overlapping planes. Several variants be founded in the south-Sahelien, despite the continuous heavy rainfall put to the test the buildings. The only other material used to build these small buildings is the wood, needed to set up the floor of flat roofs. During the hottest months the crop is put to dry on the rooftop, creating a temporary ventilated cover.

Clay, after riddled by hand to remove of impurities, is kneaded by feet with plenty of water (15-20%) until it becomes elastic, homogeneous and tensile. The plastic quality of this material is the building key factor, so to find the suitable clay was ruled the land surface, too dry and impossible to work. A considerable strength improvement of those structures can be achieved with the addition of straw fiber to the dough.

Walls, usually with a section of 10-30 cm at the base 5-15 cm at the top, are set to a wider foundation, about 30 cm high and 20-60 cm wide. When foundation dried, starting to work up the wall with a rich ritual. Workers mould clay spheres with 15-20 cm diameter and 3 kg weight about, then the owner set up and press forming a row like a cord along the sign of the wall. Continue arranging staggered rows. Achieved 50-70 cm height, the wall share is settled and spread out 2 - 3 days before to proceed arranging next rows. The earth setting for compression, removing the voids of dough reduces its water permeability, to obtain a one monolithic structure. This action is favored by drafting a coarse daub composed of white clay, cow dung and ash.

After the construction, the building envelope is completed by two successive layers of dough 0.3-0.4 cm thick, wet applied. A bottom layer with white clay and the finish layer, with red clay, are both very fine grading, so as to give the surface a ceramic appearance. Finishing, which is also ground for the mural decoration, is wet constantly kept for the work span.

Plastering is not homogenous for all parts of the building; the foundation, the top and the roof floors are carefully polished with a smooth stone in order to seal up any gaps and annually repaint with a plant brew. In fact the organic component of the finishing plaster is composed of a decoction of black beans and a chemical reaction which make the surface waterproofer is heat activating.

Indeed to define this plaster “water-tight” is partially incorrect, since the property blocking the moisture condensation leak, it would even be detrimental to the building structure, instead it give a more compact, a feature that severely limits the absorption of water than a traditional clay plaster.
Wall painting is an art with embellishment function, apotropaic, but also has surfaces cover function. The drawing is made dipping chicken or guinea-fowl feathers in a black colour act as water and thin coal dust natural, continuing from top to bottom. The signs so facts are filled with the same black o with white colour, sign of purity and beauty, rubbing a kaolin stone. Complete the decoration clay trimming which next to the practical function to interrupt the percolation of rainwater and cover the drawings below, have an important iconic meaning, contextually incisions are made to channel the runoff of rainwater.

Above mentioned decoction is also sprinkled to complete wall decoration with a small broom, waterproofing the envelope and giving it the characteristic reddish color.

The position of designs subjects on the wall surface is relevant like the symbol itself. The drawings associated with the male prestige (sticks, drums, strips of cloth) are realized outside the compound, around the door. The reason black and white striped reminiscent of the fabric of men's shirts, a pattern of triangles draws amulets that, in non-Islamic environment, has powerful remedies. A large number of drawings are then linked to the role of women and within the home and community. These are placed to decorate the interior walls. Pieces of calebasse, fruits like pumpkins, are the most usual since calebass is the symbol of the home; calebasse is the kassena woman's dowry so that a woman without calebasse not be taken as wives. Others, displayed with abstract expression are the network rush to keep up the calebasse, pestles and bowls. There are many usual subject dating back to the economic life of the family also: fishing nets, to remember at young the importance of this activity to salvation of the people from famine, chicken fingerprints or the ears of a mile the most important livelihood.

Discoloration of the painting has always been a good indicator of performance fall of natural falshing compound for these people and to start the rebuilding process of the plaster in question.

Today's the traditional technique above-mentioned was unfortunately "put aside" by a damaging modernization: the natural compound with clay and decoction of black beans is added to hot tar. This black dough is so manually affixed, smooth and when dry covered with a layer of white paint talc based. Tow-three days after, that surface is homogeneous and highly absorbent, features that facilitate the painting adhesion. In this case the drawing was made with a stick and a rag dipped in tar. Even the refills are tar. This technique is not only bad historically for the abandonment of traditional technique with loss of red-brown colors, but mainly because the strong water-resistant properties of tar does not allow for breathing of earth structure, necessary for healthy internal environment.

The implementation of the technique

All external sensible heat factors must pass through the envelope before affecting the room temperature. The daily fluctuation of the temperature, roughly sinusoidal, filtering through the structural elements is changed as amplitude and radiated over time. Both these functions of materials can be exploited to move closer to aims of interior comfort.

In order to balance the external thermal forces is necessary to define the physical requirements of opaque envelope. These qualities can be determined by analyzing the processes and properties that
allow a control surface like touching issues such as heat transmission characteristics, humidity and performance fall. This is possible through the control of two main factors. The first is identifiable in the insulating properties of the material, characterized by k thermal, lower this value, better the effect of insulation (thermal transmittance expressed as kg/m²). The second is the heat storage of material, characterized the specific heat capacity: higher is capacity, lower the temperature excursion propagated through the material. This delay, known thermal inertia, it offers the possibility to accumulate heat at times when the temperature is higher and dissipate when the temperature is lower.

Earth walls are characterized by good heat capacity, moisture permeability, the predisposition to regulate thermal-hygrometric microclimate; the thermal inertia and the phenomena of evaporation of the moisture absorbed during the night from the surface of the wall promotes the comfort indoor.

The best indoor climate also stems from a clay property called potential absorption, that is the ability to absorb excess moisture in air (without losing consistency) and transfer it when the environment is drier. Studies of prof. Gernot Minke, University of Kassel, has shown that the function of relative humidity control is carried out in the first 2 cm thick of raw earth structure, leaving the role of regulator of the microclimate indoor at the layer plaster. (4)

potential absorption of clay plaster is 1.5-3 times as high as traditional plaster.

Substances that are added to the slipping of binder and aggregates to improve certain qualities are called additives. These are organic in nature when used in the same state, synthetic, if they have been treated before the use changed their characteristics. The organic substances were used in the past when the availability of materials and their costs were determined. In this direction attempts have been made more desperate by adding substances to improve the characteristics of mortars. (5)

Studies made by Ferruccio Micocci on mortar additives with organic substances had highlighted issues of great vulnerability to biological attack, and solubility. The mortars with the addition of synthetic additives, the first problem is instead the formation of soluble salts, with consequent risk of efflorescence, cracking, etc..

Laboratory tests will be done on the subject to different mortars compositions: the structural clay, rough coat and finishing solution; the aim is to quantify the value the density, compressive strength, thermal conductivity and vapor permeability.

References

(5) P. Gasparoli. Le superfici esterne degli edifici Degradi Criteri di Progetto Tecniche di manutenzione, Alinea Firenze, 2002