ECONOMY AND COMMON SENSE
SIMPLE SOLUTIONS FROM PAST FOR TODAY AND BEYOND

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Abstract: The builder used constructing material due to rational reasons: source at hand with short delivery pathways; nature of material is verified from forefathers; handling with material is imparted through childhood. The last one has the most significant role in vernacular architecture. Why? In childhood way of thinking and solving problems are raised. Sincere constructional solutions in architecture are result of logic and local knowledge. Local knowledge may be concerned as variable resulting variances of solutions of the same problem - clay ceiling in Egypt and Yemen.

The following paper shows how solutions from nowadays have origin in "past" architecture. Smart materials using low tech, with no artificial energy have much in common with smart materials "invented" in modern age. Clay and pine tree branch has much in common with reinforced concrete; soft soil and straw has much in common with fibreglass flooring; thin gypsum layers covering rammed earth may extent life span of construction as thin façade coating protect insulation from decay.

1. INTRODUCTION

Human Being is meant to survive as best as possible within the given conditions as are environment, climate, culture, social class and nevertheless the time of life span. Using local materials and "home - made" logic may follow towards efficiency and making life as comfortable as possible. The vernacular architecture has proven the simple solutions with as less energy and material consumed as possible are the best solutions.

What we may learn from organising survival in past: work near at home – known landscape, climate and in case of any emergency - home at hand; using natural materials – commonly with reuse of built materials, also; nearby resources of mate-

rial and labour force - rational using of resources. Much the same is in modern economics: local schools – knowledge of local environment, recycling cycles, human resource management and implementing new short transportation lines and standards. Introducing building habits from vernacular architecture to modern architectural design has many obstacles and there is plenty to do especially from architectural, legislative and economical aspect. Time consuming production should be optimised with collaboration of new approaches as prefabricated building parts – modular panels, new standards and improved communication between different professions. The lack of researches combining architecture and health – for example, how natural materials as rammed earth or thick stone walls may affect on illness of tenants.

The field of vernacular architecture know-how of is wide, commonly researched at level of visual presence in environment, exploring proportions (openings, construction positioning) and revealing habits of inhabitants. As an architect I am very interested in tacit knowledge used in this architecture, how the optimisation of construction was introduced and why, where and how. In the following paper the system of ceiling and wall of clay will be presented and interpolated with nowadays solutions. As it is expected the solutions haw much more in common as it may be thought.

2. SIMPLICITY OF SHELTER CONSTRUCTIONS

Travelling across fertile fields of the delta of the Nile in Egypt we may found some very modest shelters made of the cut corn tied in sheaves. The distinction from other shelters is that there is no roof. The reason of specific shelter design lies in usage, availability of materials and time needed for construction and never the less climate conditions. The shelter lies at the field nearby the road or path. Rectangular plan approx. 180 by 260 cm, the height is given by the height of corn sheaves approx. 220 cm. Sheaves are tied up with roughly tilled crossbars at one half of height. The entrance is hardly to be found, there is only narrow gap to enter inside. The gap is turned away from the path or out of sight of passing traveller. The shelter is not designed for human however is shaped for harvesting and field tools (pickaxe, spade, rake, etc); very seldom is used as peasant resting place. The rectangular form is driven by pure logic however less material may be needed to erect a shape from triangle plan having a pyramid roof shape. The reasons of rectangular plan (there are rounded corners) are in size of tools to be kept in and there is easier to erect corner building with wooden frame than symmetrical pyramid shape. I needed much time to solve the riddle of a shelter in the field without the roof at the field. Climate in Egypt is dry and hot it is expected the shelters for humans are designed with roofs, the second hypothesis was the shelter is used for peasant resting place late in the

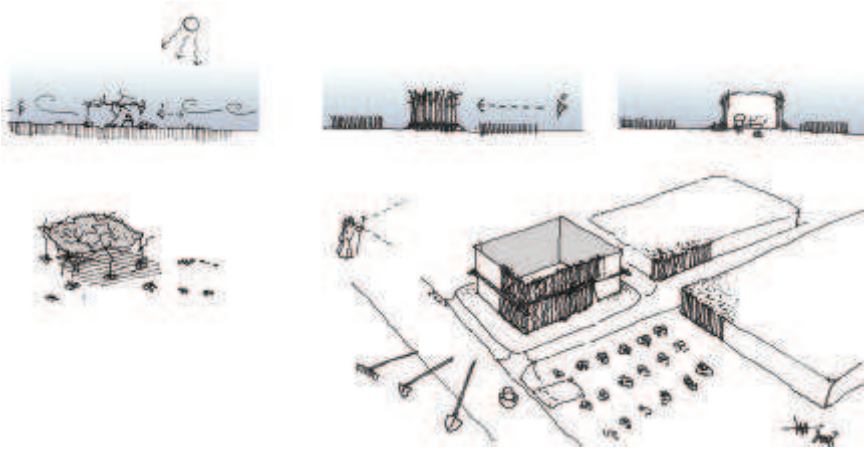

Figure 1. Shelter found in the delta of the Nile in Egypt (2004) and shade structure at the outskirts of old city Mareb in Yemen (2005). Both structures are examples of very modest construction using locally available materials with no or as little as possible forming of elements. Estimated life span of structures is about one year (drawing by author).

afternoon when the sun inclination is low – resulted in long shadows. Last hypothesis was eliminated due to there is no windows or even doors to observe the harvest field. Field workers usually take the mid-day rest in the shadow of palm trees at the irrigation ditch. At the end prevailed the common sense: shelter's very modest design, details and used material are good indicator the structure is meant to serve one whole fertile period. After one year the structure become unstable and is rotten at the ground due to the periodical watering the field.

The second structure which implied this article was found at the outskirts of old ruined town Mareb in Yemen. There was very plain shelter made of bush branches, roofing or better to say shade was made from densely woven branches. Few posts support the shade and some cornerstones are set to support post at the position. Rectangular shape of plan has 180 by 180 cm or less, the height is defined by the length of available sticks (posts) and is pragmatically taken, also. The reason is the security of person taking a rest. The structure is quite the opposite form Egyptian tool shelter; here are few posts and shade, the vertical barrier is limited to the essence of supporting construction. There is no doubt the structure serves as tanshumans shelter – when travelling across desert. The secure (visual and snake free) shade has great value. Origin of design is very primal – stick and branch – as may follow towards the first architecture. Resting traveller may observe the whole horizon and not to be seen or exposed. Militant groups are still a real threat for travellers in Yemen, not to be seen is reasonable reason.

Figure 2. This is a sketch of two simple walls using the same technology – hand moulded walling with mud. The wall as enclosure of property has shards of glass to prevent people climbing over (drawing by author).

3. DWELLINGS AND LAYERD CONSTRUCTIONS

The concept of simplicity of construction joints and details has the role when combining different building materials. Layered constructions begin with structures (wood, sheaves) as were described in previous chapter. Life span of structure may be extended by smart combining of building material in the order to resists the of weather conditions. To postpone the decay of used building materials the development of new building techniques was invented. Summarising some of one level detail (one material – one function) with others the new multi-layered constructions were developed. Those multi-layered constructions enable to build more than one cell structures in planar and storeys in vertical plane. The smart combination of wooden sticks and clay may be useful to build multi-storey houses (Shibam in Yemen) however there are not just clay and wood. Presented roofing and wall constructions are good examples how the tacit knowledge of builder and experiences from forefathers was used to optimise the structure concerning stability, resistance and ambient conditions. Hereby tacit knowledge is a combination of knowledge of life experiences, logic as reasonable thinking and concerning for the resources (building materials, working force and working animals).

3.1. Wall

Constructional system depends on function of a wall. Primal function of a wall is to divide or to enclose given area. One of reasons of enclosure is to built a physical line of border where public ends and private starts. Enclosure is made from mud shaped

or moulded with bare hands without panelling or even any particular tool. The wall is high enough to prevent peeking of passing person. Shards of glass have been put into the top of the wall to prevent uninvited people climbing over. The wall serves its prime function – dividing of property.
The wall may enclosure backyard for daily pasture of hen flock. Backyard serves as working place of a farmer so the wall needs no glass into the top. Farmer is the safeguard. Observing and analysing the wall of enclosure reveals the base has not been specially developed or it has no meaning. The load of wall is not critical in relation to its stability; usually enclosure walls use principle of curved lines. This principle could be presented with sheet of paper when curved may stay still at place – it cannot fall down.

The second phase of walling is to bear the loads of roofing. At this phase better basis is introduced – the stones put at the bottom of the wall – like a foot heel. In the plain explanation – the wall needs something tough and resistant beneath to be stable. At dwellings the innovation with the stones (Yemen) or with bricks (Slovenia) is well observed. The base is made from different, roughly shaped stone blocks up to 30 – 50 cm above ground level. The belt of wall from ground 0 cm level to the height of 50 cm is most commonly gradually damaged and consecutively is affected the stability of wall. Rain drops rebounding from the ground, animal digging and other physical damages are the most common reasons to built better and resistna base. Setting the stones is to prevent decay and to improve resistance at the most sensitive point. The next detail of wall is where the roof meets the wall. Theoretically is the cross – section of two planes vertical and horizontal (angled in Slovenia). Practically there are few problems, how to carry the load of roof and bridge the same load from roof over the wall towards the ground. Detail is solved by different ways using vault (clay lump bricks) or using wooden beams integrated in clay earth wall. When using vault the clay lump bricks are built in as common brick using clay mortar. The second solution – with wooden beams – gives a variety of solutions. The principle resists, only the variations of realization are very interesting and the improvements of building processes may be researched. The principle is clear, wooden beams are bearing the load, clay or earth covering is above those beams it serves as flooring in the next storey. Wood has the function of material bearing the stretches and the clay bears no stretch. Conjunction of wood and clay summarises in better construction to bear loads of the building. Another important quality may be ascertain -wood in clay clothing or embedded wooden branches are preserved from decay. Wall humidity varies between 0,4 to 6%, the % of humidity is normal for wood elasticity attributes, also (Zbašnik, 2006). The humidity in the wall construction is too low to allow of growth of mould (needs > 20%). The loam "envelope" physically serves as a hull from insects. The tacit knowledge of the builder combined with taught knowledge of forefathers through the childhood are the essence of understanding the material

Figure 3. Sketches of elements to reinforce the wall capacity to bear the load and to achieve higher resistance. Enveloped wood in the wall construction is well preserved from insects and mould (drawing by author).

habits and needs. The appropriate mixture of earth, clay and water is not an experiment it is the life guidance however not written down, yet! The clay and its chemical composition of loam interacted with water cause adhesiveness. Dried mixture causes some cracks on the surfaces however they are not deep and the wood remains intact.

3.2. Roofing and ceiling

Ceiling uses rather similar principle however here clay with loam is used as cladding material. The upper surface of wood cross beams roughly unified in thickness - approx. 8 cm in diameter. The thickness of clay load varies from 20 to 30 cm. The thickness of construction takes from 33 to 43 cm! The specific weight of clay is estimated from 1700-2200 kg/m^3 (Zbašnik, 2006). Estimated weight of construction per sq meter is more than 340 kg! Observing several different building principles of solving the problem of horizontal construction reveals some smart optimisation of bearing construction. The optimisation is seen from the bottom where crossbeams are set in spatial construction – branches are set in triangle sitting on some heavy branches in the opposite direction. The reason for such invention lies in that there wood and especially construction wood is scarce. Using thinner branches, setting them in spatial skeleton construction may lead towards better bearing conditions. Given solution have many advantages:

with smart repositioning of beams and crossbeams the weight of construction is lowered approx. 15%;

crossbeams are shorten – easier to find in nature;

from aesthetical aspect of view such construction offers more pleasant ambient;

from functional aspect the higher ceiling offers more pleasant air temperature – an

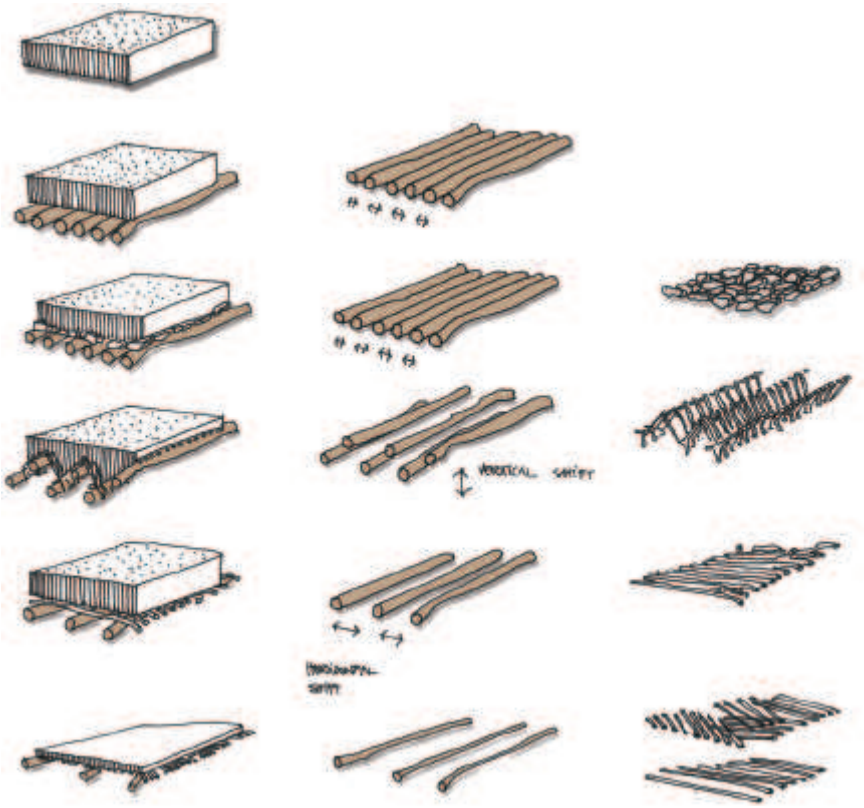

Figure 4. Comparison of different ceiling constructions where the path of optimising may led towards inventive and better solutions, depending on knowledge, availability of resources and needs of inhabitants (drawing by author).

area of hot air is higher than before.

Despite of implementing new cross – section of construction the weight is still a problem, the next step was lowering the weight of clay. At this point straw "fibers" of length up to 15 cm are used. Mixture of clay and straw in given equilibrium (approx. 70% of clay, 10% of water and 20% of straw) has better attributes than pure clay. The specific weight is lowered for 15-20%. In the combination of zigzag beams and crossbeams the ceiling weight made of cob is lowered from 340 kg/sqm to approx. 280 kg/sqm. Integrated straw has another function – it takes local stretches and makes the mass more firm. Due to the last attribute the thickness of cladding may be lowered. In the ruined and abandoned city Mareb in Yemen some constructions of flooring (ceiling) are just few cm thick (from 5 to 8 cm). The constructions of same thickness are seen in Egypt (Sinai Peninsula), also. However the zigzag ceiling

proves as blind deviation in the process of optimisation better solution may be seen in Egypt (Sinai), in Mareb (Yemen) and in Prekmurje (Slovenia). The ceiling is made from wood and cob where wooden elements are thin sticks of reed stem put in different directions laid on few bearing crossbeams. Layers of stems improve stability of construction and the cob layer could be just few cm thick – it has function of covering and protecting the wooden – reed structure. The ceiling gets new aesthetical value – pattern of reed stems and heavy crossbeams elaborates the new understanding of an ambient for living and enjoying. The most advanced solutions I have found are using woven coconut palm thatch mat above the crossbeams, upper cladding with cob (beaten with the feet). Those were the most elegant solutions of ceiling I have seen.

Described types of ceilings and walls are just few examples where vernacular cultural aspects are clearly expressed. The wooden structures are not complete constructional skeletons with infill of clay. The examples show the combination of clay and wood bearings as additional constructional elements. Origins as simplicity and logic are two cornerstones of vernacular knowledge and may be seen through the sections of structures.

Given weights of constructions are calculated from given theoretical specific weights of materials. An important relation is not in the specific numbers of weights but the estimated level of optimizing the structure in relation to material usage. The shares of the mixture elements in cob and other constructions are gathered with observing and discussing with workers in manufactures in Yemen.

4. OPTIMISED LAYERED CONSTRUCTIONS

In architecture any structure has its own lifecycle and life span. Lifecycle is understand as sum of all cycles (producing the material from ore, moulding and shaping elements, transportation of finished building elements, working – erecting the structure, finishing, management of built material, demolishing, reuse) on the other hand the life span is described as span of the structure to serve the needs of inhabitants. Part of life span is management of built materials as preserving surfaces and bearing construction.

The surface of earth, mud structures have great disadvantage due to low resistance to the influence of water (rain). Earth walls are traditionally finished externally with lime or earth renders and internally with similar but finer earth or lime plasters. Solving the problem of watering the construction is quite easy using gypsum render as covering surface.

In Yemen the technique of protecting such structures against the rain is named qudad. Rather the technique could be said the process which takes one whole year

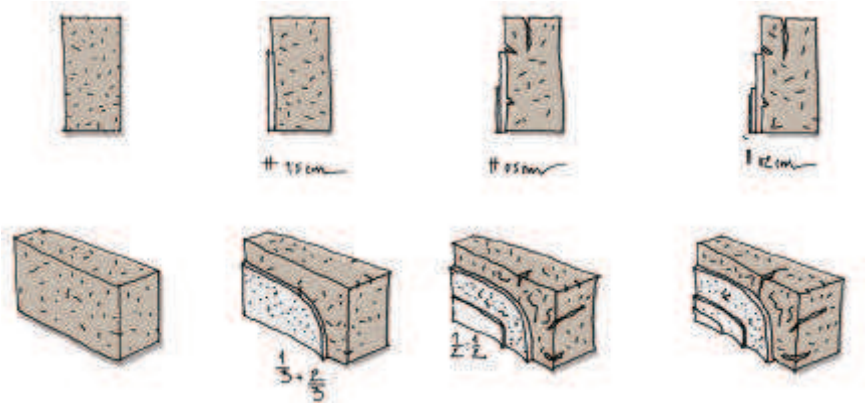

Figure 5. Clay, cob and earth structures rendered using qudad technique (drawing by author).

to be finished. The period of one year is wisely taken using common sense and logic – during the period of one year all weather conditions are taken and all the building mistakes are revealed (high temperatures, rainy period, sand storms, over-drying the construction). Technically qudad relies on process of putting very thin protecting layers. First layer uses one third of lime and two thirds of clay, second uses one half of a lime and one half of sand and the last layer is made of mixture of gypsum and volcanic ash. Each layer is thinner and has less hard grains.

Process gradually leads to the perfection of exposed surface. The correlation between qudad and moisturising beauty cream could be made. Covering cracks with thin layers postpone life span of structure for many decades. There are health benefits, also – less possibility to intrude dust and insects (wasp, ants, spiders, scorpions) in the construction. Aesthetically buildings become more attractive and all architectural elements become part of the one whole building and they are not just windows and doors. One of the most interesting places to observe white qudad in sharp contrast to blue sky and brown hills is city of mud "skyscrapers in the desert". Shibam is the city in Yemen, multi – storey buildings (up to 7 floors) are placed on a rectangular grid. Upper parts of the buildings are covered by whitewashed qudad – like snow caps in the mountains.

The second inventive optimisation of moulded clay and rammed earth could be found in Pannonian region in Slovenia. The owner of vineyard cottage explained how the walling of rammed earth was made using fresh juniper or other available coniferous tree branches. Smart usage of local natural material has many surpluses. Fresh juniper branches or any other coniferous tree leak resin (yellow sticky substance). Resin mineralizes after drying and helps to stick together branch and clay grains. Needles of branches extend the connection surfaces between clay grains and wood-

en branch – reinforcement of the wall. Mineralized resin with clay grains change physical attributes of construction – it prevents water penetrating and the whole part becomes hard as a stone. I am quite convinced the consequences of resin and clay mineralization were merely pure luck as so many other discoveries in human history! Those kinds of discoveries could not be found if there was no wisdom of forefathers.

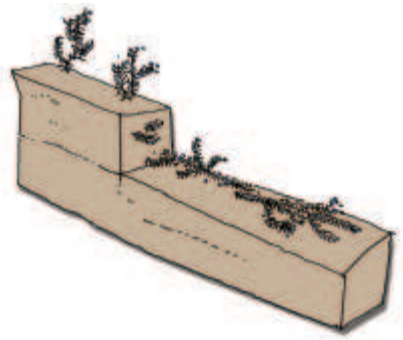

Figure 6. Rammed earth and the juniper branches (drawing by author).

In the parts of very hot climate and short but heavy rain period some piles of branches could be found at the top of the building. Flat roof made of cob and plastered with gypsum could be damaged by overheating the surface and by heavy rain. Putting branches freely across the roof plane may prevent or at least reduce the influence of climate conditions. On the sunny day branches serve as shade tool – preventing overheating. When it rains the branches stop fast falling rain drops and disperse them – prevent direct watering the roof.
Using branches on roof has much in common with juniper branches in the wall – the same principle is used – to extend the surface to achieve stability of material and postpone the life span of the building.

5. NEW OLD CONSTRUCTIONS

Many of new inventions in structural engineering have origins in vernacular architecture. Nothing is completely new it is just reshaped, redesigned and reused! Reinforced concrete is very familiar with constructions mentioned in the previous chapters. Concrete combined with steel rods (fine and corded) is one of the most popular materials used in multi-storey buildings.
The cob was reinvented when fibreglass concrete was developed – the thin fibreglass have the function of receiving and bearing local stretches within the thin thickness of concrete. Equally dispersed fibres of straw have the role of bearing stretches and to lower the specific weight of covering (cladding) mass.
Wall plaster and the qudad from Yemen are most direct reinvention in modern architecture. The difference remains – today the investor has no time of one whole year to wait and to examine whole surface of building – therefore the standards were implemented and the tacit knowledge was put aside. The development without tacit knowledge could not be realized!

7. CONCLUSIONS

The human resides between heaven and earth, life happens in the space between (Norberg-Schulz, C., 1971). All spaces don't possess quality, all quality spaces are not intended for living and not all spaces are quality spaces.
Exploring vernacular architecture in Africa (Egypt), Near East (Yemen) and in Europe (Slovenia, Croatia) has proven the baseline of economy has never been changed; there is always the quest of using optimal solution. Peeling particular contextual segments and merging them into sensible entities proved useful. We must never forget that vernacular architecture needed plenty of time to achieve economic solutions.
Changed relation money – time has boosted global economy and not only the nature but also the vernacular architecture may also be at risk due to mixing apples and pears. The examples from past may not be directly copy pasted for a better life standard and making living / working space. Outcome of expected climate changes should be in common pathway of vernacular and modern architecture, respecting each other origins and goals – to survive and to please other subjective reasons why we live.

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Curriculum

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