

The Use of Natural Resources for Housing in Rural Areas of Morocco

Stone as an alternative building material

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Introduction

The shortage of houses has been assessed after the independence of the country in 1956. The State undertook programs without real result in the field because of economic constraint. In order to alleviate this constraint, research for availability of cheap, adequate and available materials has been launched by the state.

In order to promote the use of local building materials aiming to reduce the building cost and to provide means for housing construction for the large parts of the population staggered all over the country, the State decided to stress on the use of the stone and the earth as local building materials.

The Ministry of Housing has taken in charge the task of studying and investigating the real possibilities existing in the country as far as the stone is concerned.

In this respect, particularly in the rural areas, the investigation had to locate the different deposits in the Kingdom and to undertake the realisation of prototype houses and piloted villages in order to involve and make aware all the concerned actors and the users for the different advantages in the use of the stone.

Study dealing with construction with stones has been launched in south central of Morocco by Ministry of Housing (5).

The goal of this study was to investigate stone deposits existing in the region and to gather maximum information about the construction made with stone. And by phase, generalize the study to the other regions. Some of the main results of the study will be presented in this paper.

The extraction and the distribution at wide scale of the stone have been studied in order to define the most economical way to make this material available.

The use of other building materials such as cement, steel and wood cannot give solutions to the huge housing shortage expressed through the increasing housing and the exiting precarious building areas.

The results of the study have shown that a rational use of the stone has to be prepared in order to support the building of more social houses both in urban and rural areas.

Some proposals will be made in this paper to improve the results of the studies mentioned.

Objectives

The aim of the paper is to discuss the possibilities of the use of the stone as a building material for housing in rural areas of the country. Some criteria of the economic advantages of using stone for housing could be considered through the substitution of the stone to the cement blocks. The evaluation of the cost of the stone blocs is obviously a determinant element in the process of the stone exploitation.

Other factors could be taken into account in the global evaluation like energy saving, draw material and the effect on jobs, and the contribution of new technical solutions bringing innovations in housing through the improvement of structural elements like roofing for example.

The objectives can be related to three essential orientations, which are:

- To promote the improvement of the cost in the construction of economical housing by the introduction of stone blocs shaped in the quarries
- To search a stimulating effect by the choice of a material largely available
- To equip progressively the artisan quarries with simple tools to increase the output.

General Context

Morocco has an important deficit in the housing field resulting from high rate of population growth (more than 3% a year) and high cost of building material (increase of 7% a year). Building materials like cement, steel and wood are made available or bought at a very high price. Other local materials like sand and gravel for example are produced also at high cost. Recent evaluation has shown that the needs are of more than one million dwellings. Those needs are more important in rural areas where live about 60% of the total population.

In this respect the State should develop a strategy in order to increase drastically the building material supply all over the different regions of the Kingdom. The use of conventional building materials would be a heavy burden for the national budget. Therefore the mobilisation of suitable quantities of locally available materials appears to be the unavoidable solution. Also the need to reach the population staggered through out the rural areas, requires the use of materials taken directly from the soil

Rural areas are mainly concerned with the conditions above cited. Housing need in rural areas is the urgent priority for the acute shortage of about 60% of the global demand. Here, local building materials are more affordable than the conventional ones, out of reach of the rural people.

An action of construction in this field should be taken within orientations of the Social and Economic Development Plan of the Kingdom, which promote “**strategy allowing optimal use of human resources and materials and the appeal to local resources and traditional ways of construction in the order to improve the existing stock and to favor new housing programs**”.(1)

The Country

Morocco is a Monarchy, Alaouit dynasty, branch of the prophet Mohammed’s family. It is a State where rights and democracy are being strengthened. Its population of about 27 millions, is composed with berbers and arabs. Islam is state religion and the arab is the official language.

Located in the north ouest of Africa, Marocco by its position could be considered as a gate to Europe with 15 kms of seawater from Gibraltar. Its boundaries are Algeria to the east, Mauritania to the south, Atlantic Ocean to the ouest and Mediterranean Sea to the north.

It is mainly an agriculture country. Its natural resources are phosphate and mines of iron, coal and lead. Fishing and tourism are also important resources of external income. Its climate is mild in the centre and the north and dry in the south. It has many mountains like Rif in the north and the Atlas in the centre and the south. The highest summit is Toubkal with 4160m high.

The Housing Situation after 1956

Morocco undergoes a high demographic growth as other developing countries. Many people left the rural areas in the hope of a better life. As consequence of the exodus, slums proliferated in the large cities of the Kingdom such Casablanca, Rabat, Fes, Tanger, Marrakech, affecting their spatial organisation.

Despite the ambitious housing programs undertook within the urban areas, the situation is getting worse. Housing shortages are estimated at **one million units** today. All efforts to solve shortages were undertaken within the urban areas mainly

along the Atlantic coast. Rural areas were abandoned generating massive population migration in search of better living conditions.

The lowering of this exodus could be obtained through the improvement of rural living conditions through better education, good job opportunities, decent houses and good communication with the external world.

After independence, the State was confronted by too big obstacles:

- A multitude of precarious houses
- A considerable number of shantytowns
- A housing deficits
- A national park in decay

Important efforts have been made in order to tackle this situation, and to satisfy people needs and to offer an adequate building context for the housing sector. In fact, all solutions to improve housing context and to reduce houses shortages, are not neglected in particular through the local materials network.

Local Building Materials

The local buildings materials could be defined through the following criteria:

- Geographic availability: the extraction site should be near the project construction.
- Technical availability: the know-how should be put together with appropriate technology (photos 1 and 2).
- Economical availability: the means used for the extraction, the implementation and the transport will not increase heavily the construction cost.

The **rural world** is getting ready to the criteria mentioned above. In this fact, policies about local building materials recommended by the government are:

- To allow an optimal use of human hands and materials
- To give advantage for the use of local natural resources and traditional mode of construction
- To improve the existing building stock



Photo 2



Photo 1

The Case of Calcarenite Stone

General Considerations

The stone is available all over the country and can be exploited under different forms according to the importance of the project. It could be exploited and shaped mechanically or gathered from the soil like in the east region. Its use as local building materials is aimed mainly for self help vernacular housing. It is always a

good quality. The stone is one of the local resources, which have an interest to its availability, and different functions it creates. The stone could be satisfactory to the construction in general and to housing in particular through a rational understanding. The stone is considered as the most abundant local building resources for different functions it provides.



Photo 3

If we refer to a study about Regional Architecture, it results that the stone is dominant element in different systems of construction. It is present in the different economic regions of the country. It continues to be utilized according to the tradition of its locality.

One of the most used stone is called “calcarenite” (Ref.3), a kind of a limestone. It is a tender stone obtained through natural sediments of sand and shells. It is also porous and easy to shape and resisted to compression of 50 to 100 bars. Its availability gives a good investigation field. In the region of Casablanca for example, the deposit as estimated for one million m³ within areas of 32 km². Many other deposits are available all over the national territory and particularly on the Atlantic coast. It’s also the case in the east region, which could be investigated for its deposits and traditional construction methods risk being lost.

The stone is the local building material, which is widely available all over the country and mostly along the Atlantic coast. It is a noble material, which very well adapted to drastic climatic conditions. Traditionally the extraction and the shaping of the stone (photo 4) are made through simple and cheap tools (photo 5).



Photo 4



Photo 5

The stone can be used directly as taken from the soil or could be transformed in more regular form suitable for the construction of high quality and for the public buildings.

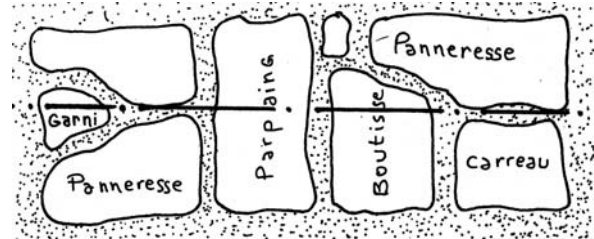
Technical Aspects

The use of the stone under blocs as building technique is presented in the following scheme Ref.(7).

Its use changes from one place to another, sometimes as basement, and sometimes as bearing walls, and sometimes used with other material like the earth.

Stone blocs are laid down on layer of earth mortar.

The wall is about 30 cm wide. Sand and lime could be added in the mortar.



Cultural Aspects

For the architecture, the stone was and stays a noble material. It perpetuates through the times reminding its prestige through the old constructions which became today historical monuments like the Ksours, the Kasbahs, the walls, the Towers, and the moque. It is also a material adapted to various climatic environments. The stone has many uses according to the local tradition. Through time, many of the users became real artisan masons. The skill evolved as an heritage.

Economic Aspects

The following table compares between cement block and shaped stone block for one square meter:

Wall with cement bloc of 20 cms		Wall with stone bloc of 30 cms
10 units x 3.5 dh	Blocks	21 Units x 5.22 dh
10 litres x 0,36 dh	Mortar layer	22 Litres x 0.36 dh
1,4 hours x 7 dh	Man power	2.5 hours x 7 dh
x 25 dh	Interior coating	x 25dh
x 23 dh	External coating	–
x 20 dh	Linkage	1hour x 7 dh
167.04 dh/ m ²		116 dh / m ²

1\$ = 9 dh (dirham)

Proposed Strategies

The success in the use of the stone depends on a good promotion. In this context, the actions, which should be taken, are:

- Identification and selection of quarries
- Feasibility studies of the substance
- Technical studies from specialised laboratory
- Definition of norms related to the quality of the substances
- Elaboration of technical specifications
- Organisation of workshop like seminars with all concerned users like investors, contractors, traders, professional and users.

How to reach the strategies above expressed????

Some essential stages has been proposed as following:

Research and Studies

An experimental research about the stone “calcarenite” has been established by Ministry of Housing in cooperation with French Centre for Studies in Construction (C.S.T.B.) in other to study feasibility of this stone on physical, technical and economic aspects.

The system as indicated in the attached paper was entirely mechanised and consists to cutting large bloc of **1 m³ into smaller blocs of 40×20×30** as shown in annex.

Because of economical constraint defined by the study in the use of the stone in mechanical ways, compared to other cement brick less expensive, the project has been carried out as expected. Thus an option has been taken for the second solution below



Photo 6

Handy Preparation of The Stone

Shaped by hand, the stone could be used through various forms:

- Blocks of 15 to 20 cm wide associated with gypsum boards from inside of the wall (in the regions rich in gypsum).
- Sawn blocks on one side and used with other matter
- Blocks used in the natural shape for structural walls

The craft quarries must be equipped progressively with simple tools in order to improve the output. This last solution has given some encouragements by public bodies.

However, the following weaknesses should be taken to test the technical defects caused through:

- Bad setting of the stones.
- Miss use of different layers.
- Irregular jointing.

A **second study** has been launched in the central south region to gather maximum information and to class all graphical and written data in order to provide a guide and manual for the users of the stone (REF.5). The objective of the study is to establish a **geophysical map** all over the country.

Strategies Requirements

The implementation of this strategy requires a commitment from public authorities in order to inform about and to sustain the material in the initial phase mainly at the economic side (subsidy and reduction of taxes).

They should be applied in the global process of the exploitation and the use of the stone.

The State should encourage the use of this material in the construction of the public buildings

For example: administration buildings (photo 7), schools (photo 8), hospitals, and other social cultural buildings.



Photo 7



Photo 8

Pilot villages: all agencies under ministry administration have taken in charge the realisation of pilot villages and housing prototypes in areas where the stone is largely available. Pilot villages have about 20 to 100 houses realised entirely with stone by mason and artisan living in the areas. Each house has about 60m² with a living room, bedroom, kitchen, toilet and courtyard.

Dissemination to the public: in order to obtain a large use of the stone, it is important to disseminate the information and result of the study all over the country.

National agencies will charge to undertake organisational action in order to give information through workshops, seminars, and the mass media.

Training and Education: training and education through existing centres will be encouraged and implemented in order to give sufficient knowledge about the use of the stone. People working on building site will be concerned in the workshop and more data will be given for the advantage of the stone as building materials in the rural areas with hot and cold climate.

Motivation of Private Sector: incentives will be provided to the private sectors in order to use the stone on a large scale. These incentives will be given a taxes reduction and loans with low interest.

Finance: as exploitation, the quarries need investment. The state will help the developer to get loans and subsidised rate. Also the stone in the market and its use in the construction will have reduced taxes.

The availability of land and finance resources: developer weanling to use the stone in their projects will be helped to mobilise land and finance resources. An agreement will be concluded between local authorities and the developers to manage this requirement.

The Actors and Roles

In order to implement the strategy, the concerned actors, which could assume the different roles, are as follow:

The State and the Ministry of Housing

The role of the State in particular should be dominant for the success of any research related to the stone in short and medium terms. However, the State has to encourage all organisms under its control to participate actively in the process of sensitisation and vulgarisation through:

- Leaflets, mass media, seminars, workshop, and fairs.
- Reduction of tax rates
- Launching of prospective studies all over Economic Regions defined in the process of national development
- Realisation of pilot villages (photo 9) and prototypes of houses (photo 10) with materials locally available.
- Establishment of experimental study about the extraction of the stone in a shape ready for use.



Photo 9



Photo 10

Local Authorities

The capacity of understanding of the public authorities, and their availability to be a real partner will give success to the strategy. Their role should be presumed in the:

- Identification of deposits
- Help for making road to the deposits and making necessary infrastructure.
- Facilitate the access to the information.
- Leasing the site, for the investors.

The Users and the Banks

- Provide finance for the investment.
- Installation of the equipments.
- Exploitation of the deposits.

Quality Control Offices

Professional bodies in the control field should provide technical expertise and experimental analyses.

The Professional

The role of structures and professional organizations is capital in the sensitisation of the different partners. The architects and engineers will help in the design of the houses and public buildings for the use of the stone through its different forms.

The Dealers.

They have to promote the distribution of the product through conventional commercial circuit, to assure a wide availability of the stone like the other building materials.

The Enterprises of Constructors

The enterprises should improve the ways they build. In this case, the use of the stone by skilled workers will help in developing this material.

The Mason and Self help Builders

They should be trained and formed about the quality and advantages in the user of the stone.

The Building Cooperatives

Building cooperatives should play a great role in the use of the locally available material. They can provide assistance to the contractors and to the local authorities in the access to land for the building of the project using mainly this kind of material in order to encourage the extension of the local economy and give work for people in rural areas.

The Users

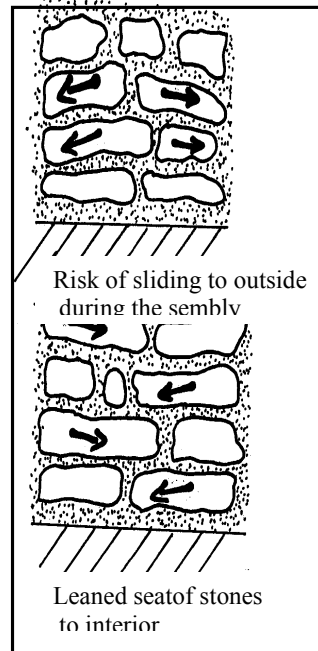
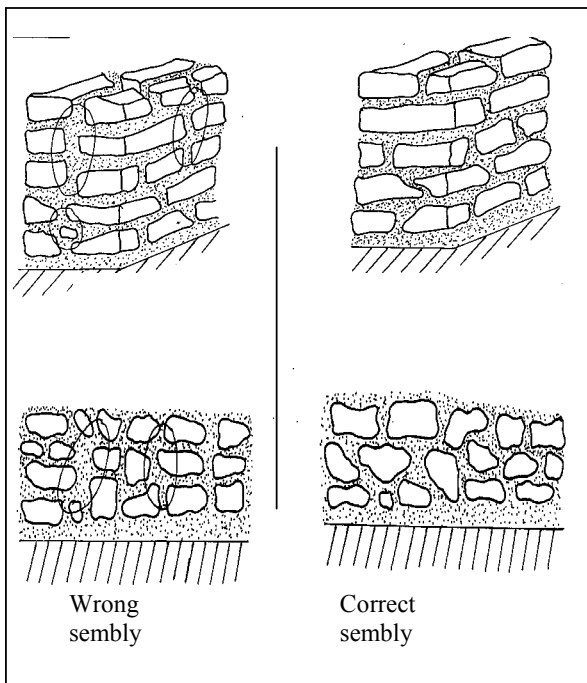
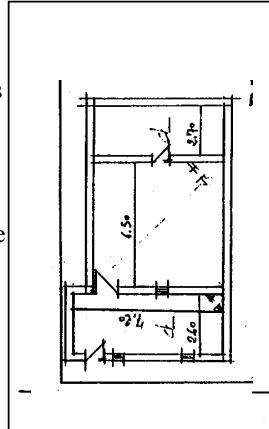
The users should be assisted and trained in order to know more about using the stone. A technical guide should be available to help the users to build their own house in correct way.

Design Aspects

The design of the house is organized around courtier with doors and windows. Small outside opening can found used for ventilation mainly (see cross-section and facade).

The stone is bearing wall with flat roof constituted by wood beams and a layer of mortar in the new houses. The flat roof is made with reinforced cement concrete because of the cost of the wood. Bricks and cement blocs stated to be used.

Some technical advices for using stone blocks are presented as following, in order to avoid defects and collapse risks:Ref.(7)



Conclusion and Recommendations

Finally, the stone has many qualities. However its use needs appropriate ways of production, distribution and implementation. Efforts will be made to help various contractors and professionals to promote its use through appropriate design and building systems. Local people in the rural areas will be encouraged to use largely this material, which is economical and climatically suitable.

In order to make available the stone as local building materials in big quantities to put on the market, some proposals should be recommended as below:

- Establish legal standards for rational use.
- Assure technical feasibility with regard the resistance to external efforts.
- Develop competitive implementation techniques with regard to other building materials.
- Assure direct economical gain and indirect advantages with regard to the energy consumption for heating and cooling especially in arid and semi arid regions.
- Confirm the durable and the traditional use of the material in comparison to the new building materials.

- Assure a permanent training and recycling in different disciplines, which should be given more attentions in the process of improvement and the safeguard of the local know-how in the rural areas.
- Encourage innovation and research to:
 - Promote the research, the innovation and the experiment process
 - Initiate pilot programs by specialized offices, architects and engineers.
 - Associate students at the end of their studies in the research and innovation.
- The stone should be used in the right place and in the rational manner.
- The assistance and expertise are necessary to give guides and recommendations on technical aspects.
- Provide feasibility studies, of the construction of prototypes and evaluation of the results.

References

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- (6) Photos taken by myself.
- (7) Revetement de Sols Scelles, D.T.U-52.1 C.S.T.B (France) 1985.

