



by Yüldürüm Yavuz

Settlement Programme for Semi-Nomads

Makkah and Jeddah Regions, Saudi Arabia



Architect

Zaki Mandoura

Fayez Mandoura

Client

HRH Prince Majid bin Abdul Aziz

Design

1992 - ongoing

Completed

2000 - ongoing

Settlement Programme for Semi-Nomads

Makkah and Jeddah Regions, Saudi Arabia

I. Introduction

The Settlement Programme for Semi-Nomads was created for a population of 8,078 poverty-stricken nomads, dispersed over an area of thirty-two loosely knit desert regions, south of Makkah and north of Jeddah in Saudi Arabia. The project provides a total of 1,154 houses, eleven schools, twenty-five mosques, four health-care units, three market halls and two wells. The ongoing programme is a pious attempt to house approximately fifty thousand semi-nomads, who struggle to survive the harsh climatic and economic conditions of the area. It aims to provide decent shelters that fulfil basic standards of comfort, and to create simple, unpretentious public centres to meet their primary social needs, such as health and education.

The implementation of the programme began in 1993 with the building of the first experimental houses to ascertain the most appropriate design for an efficient and economic shelter. The houses were built with local volcanic boulders, which scatter the surrounding countryside. The construction process, which has no precedent in Saudi Arabia, was carried out by masons and unqualified workers from nearby cities under the guidance of two engineers and one architect. To date, the programme has effectively resolved the basic shelter problems of about 10 per cent of the semi-nomad population in the Hijaz area. The chosen structural typology has become popular among local administrators, who have started to use similar forms, materials and techniques for the new public and administrative buildings in the vicinity.

II. Contextual Information

a. Historical background

The programme was started in 1992, when Prince Majid bin Abdul Aziz al-Saud, the governor of Makkah al-Mukarramah, was informed about a large group of impoverished local people living in the desert around the Holy City in miserable and unhealthy conditions. As technical advisors to the governor, architect Zaki Mandoura and his engineer partner Fayez Mandoura were given the job of investigating this astonishing situation and reporting their findings.

During their investigations, Zaki and Fayez Mandoura discovered that these local people from the Hijaz area were the remnants of ancient tribes of nomads who roamed the western deserts of the Arabian Peninsula. For centuries these nomads had supported themselves by transporting and guiding the pilgrims who came to Jeddah by boat and wished to go to Makkah and Medina through the desert trails for *Hajj*. Known as camel drivers (*jammel*), they provided pilgrims with camels, supplied charcoal for their cooking, carried their luggage, brought them water, milk, butter and honey, pitched their tents in holy places, and supplied and slaughtered sheep for sacrifice.

With the building of large airports and superhighways in Hijaz, these people completely lost their meagre incomes and tried to survive the hardships of their ancestral desert territories by selling charcoal and asking for alms and donations in urban centres nearby. A large majority did not have houses but lived under projecting rocks or in temporary makeshift sheds, built with branches covered by cardboard or cloth. Some built small huts with recycled tin containers to keep away the rain and provide privacy, but these would become unbearably hot on summer days, rendering them useless. Having no furniture at all, they usually sat and slept on bare ground. The few goats, sheep and chickens they kept for their own consumption were encircled with rough, simple fences made of branches, to keep out wolves, hyenas and foxes. These pens were usually built around a tree to shelter the animals from the scorching effects of the sun.

The decision was taken to settle these people on their own ancestral territories and supply them with minimal but decent shelters, health and educational services, and mosques.

b. *Local architectural character*

The large cities of the Hijaz region – Jeddah, Makkah and Taif – are among the most important urban centres of Saudi Arabia. Above all, the Holy City of Makkah is one of the oldest and most prominent settlements in the country as the home of the Holy *Qa'ba*, the focus of annual pilgrimage for all the Muslims of the world. Jeddah and Taif too, are important historical centres. These sprawling cities feature both traditional buildings, with typological and architectural features developed over centuries, and more recent structures of a contemporary international character.

In all three towns the historical centres are characterized by two-to-five-storey single residential buildings. Traditional houses, many still standing today, have masonry walls constructed with courses of coral stone (about one metre high) from the Red Sea, and a single layer of mangrove branches from the East African coastal towns, used as tie-beams. Openings to the exterior take the form either of flat windows veiled by timber lattices (*mashrabiyya*), or of projecting bay windows with internal seating (*roshan*), also protected by intricate timber lattice work. The timber used for the windows, doors and floors comes from Central Africa, India or Indonesia. All traditional houses have rainwater cisterns (*sahrij*) and septic tanks for waste-water discharge (*budul*). At present, all areas of these cities, both old and new, are serviced by vast networks of piped fresh water as well as by modern sanitary sewage systems.

The contemporary architecture in these cities reflects a very international approach. Reinforced concrete, steel, glass and other manufactured building materials are abundantly used by local and foreign architects who work in Saudi Arabia. Jeddah, sprawling over an area of more than 1,500 square kilometres, is a showcase for modern international architecture. With its protected, finely restored historical centre – al-Balad – and its predominantly white buildings, it is like a rapidly developing Mediterranean town. Makkah, on the other hand, is very quickly losing its traditional architectural character, particularly with the medium-sized skyscrapers recently built to house pilgrims around the Holy *Qa'ba*.

The architectural character in smaller settlements of the desert regions is typified by Rabig, one of the eleven sub-centres (*muhafaza*) of Makkah al-Mukarramah district (*wilayat*), and Nwaiba'a, a secondary sub-centre (*markaz*) of Rabig. Here, the traditional architecture is totally lost, if such a thing ever existed. Almost all the buildings are constructed in reinforced concrete in a nondescript architectural style. They are usually clad in lavish materials with careless workmanship, creating an eyesore for the observer.

c. *Climatic conditions*

The western coast of Saudi Arabia, facing the Red Sea, has a subtropical climate. In its central area, around Jeddah and Makkah, summers are very warm, with a high percentage of moisture, while winters are moderate with relatively low humidity. The region receives light but sudden rains, sometimes accompanied by thunderstorms, from November through to February. In spring and autumn rain is rare in the region. Occasional southerly winds, particularly during the winter months, give rise to sandstorms and heavy rainstorms. These usually flood the valleys where the semi-nomads live, causing damage to their scant belongings, shabby shelters and few animals.

In the summer, the maximum temperature averages 45°C, while in the winter the mean temperature is approximately 10°C. A maximum of 49.6°C was measured in Makkah on 1 August 1996, and a minimum of -1.5°C was measured in Taif on 26 January 1997.

d. *Site and topography*

The site of the Settlement Programme for Semi-Nomads covers a large portion of the long coastal plain of western Saudi Arabia, extending north-south along the Red Sea coast, locally known as the Tihamah. The project area extends from Bethna, approximately 250 kilometres north of Makkah, to as far as Megat, lying approximately 150 kilometres to the south. The coastal plain of Tihamah, almost 65 kilometres wide near the Yemeni border, narrows to 12–20 kilometres within the borders of the site. To the east of the Tihamah plain run the high volcanic mountain ranges of Hijaz and Asir, which slope sharply towards the sea. The ranges are broken by several valleys, which carry rich, fertile silt to the coastal plain via flash floods from the winter rains.

The Tihamah plain is extremely variable along the extent of its length. Wide, salty flatlands alternate with relatively fertile stretches of valley bed. Hot and humid marshlands are seen side by side with arid lava fields. Within the boundaries of the site these lava fields are frequently observed. A basic characteristic of the site is the abundance of basalt boulders showered over the area by ancient volcanic eruptions. The plain is covered by coarse and fine sand with small hills, usually formed by lava crops. Those responsible for implementation of the programme have been careful to site the permanent shelters on high ground or on the side of slopes, to avoid the flash winter floods that affect the valley beds.

In general the site is sparsely dotted with a type of acacia tree (*salam*), which grows to a height of 6–7 metres. This fan-shaped tree – which has long, succulent thistles adored by goats and camels – has small, green leaves, which provide the sole, rather meagre, source of

shade in the desert. Its dry branches are also processed by the nomads to produce charcoal. Another plant that is frequently found in the region is *Calotropis Procer* (*ausher*), a durable, light-green bush with wide leaves and grey-purple flowers, which grows to a height of 2 metres. Because of its poisonous sap, the plant is of no use to people or animals. *Karad* and *sameer* are variations of the *salam* trees and grow at higher elevations nearby; their branches are also used to produce charcoal. After the rains, for a short while, the whole desert is covered by short, wild shrubs and grasses, which serve as vital food for the goats, sheep and camels. However, these shrubs very quickly dry up under the sun. Within the site area there are also occasional oases, with lush, green shrubs, date palms and freshwater springs, such as the one between Mghaynia and Shegga, north of Jeddah.

The site is also rich in terms of fauna. Wolves (*daeb*), foxes (*thaleb*), hyenas (*dabae*) and wildcats (*vashak*) are frequently hunted because they feed on domestic animals. There are also dreaded species such as snakes (*thabem*), scorpions (*agrab*) and poisonous spiders (*shabet*). Deer (*vael*), rabbits (*arnab*) and hedgehogs (*gunfuz*) are seen occasionally.

III. Programme

The programme was formulated upon the discovery in 1992 of the impoverished nomads living in the desert, who faced severe hunger and health problems. Prince Majid and his advisors, Zaki and Fayez Mandoura, sought to create a programme that would allow these people to settle in simple permanent shelters around small centres that would serve their basic social needs.

The first experimental house was built in the desert district of al-Melha, 74 kilometres south of Makkah in 1993. In these initial years, nomad families were encouraged to settle around ancient desert wells to benefit from the water and the small centres that were being created around the wells. These centres consisted of a *masjid* (large mosques), or *musalla* (small mosques), a primary school, a market hall and, occasionally, a health centre. At first, the families were reluctant to leave their traditional territories to come and settle in a community. Hence, the shelters around the new centres were very loosely arranged, with great distances between housing groups. Only small housing groups could be created, the number of houses being dictated by the number of related family members in each case. Other families completely refused to leave their ancestral territories. Many of the houses were therefore built singly or as tiny groups, in the middle of the desert, miles away from the newly established centres. In spite of many complicated problems, during this first phase of the programme, 560 houses were built, together with four *masjids* four smaller *musallas*, four boys' schools, three girls' schools and one well with a water tower, within a period of three years.

The second phase of the project started in 1996 when preparations were made for the organization of a social programme for the welfare of these people, aimed at educating family members to be productive and self-sufficient in matters such as poultry production, basket weaving, handicrafts, sewing, health care and child care. The programme's objective was to develop human resources and establish productive families amongst these very poor nomads. This was thoroughly discussed in several meetings with the professors of King Abdulaziz University in Jeddah and Umm al-Kurra University in Makkah. The discussions centred

mainly on the subject of organizing a non-profit-making charitable society to upgrade the living conditions of the nomads. While work on the construction of new houses continued, the first application for such a society was officially made in 1998. During this phase of the programme, within a period of four years from 1996 to 2000, 594 extra houses were completed, together with four schools, seventeen *masjids*, four health centres, three market halls and two wells.

Right from the start of the programme, the buildings were carefully designed and tested on site to achieve the most economic shelters that could fulfil basic standards of comfort, so as to use the financial means in the most efficient manner and house as many families as possible. For this, the project architect decided to use locally available building materials and developed his construction techniques accordingly.

During the implementation of the programme, various donors and government agents wanted to supply electricity generators for the settled communities. This was rejected by the architect, who felt that electricity would turn the settled nomads into consumerists, demanding air-conditioning, refrigerators and television sets, which would ruin the untouched simplicity of their lives. Air-conditioning and television sets would confine them into their houses, and refrigerators would change their eating habits so that, instead of consuming freshly cooked food everyday, they would eat unhealthy, refrigerated junk.

IV. Description

a. *Building data*

At present, the Settlement Programme for Semi-Nomads comprises a total of 1,154 single-storey housing units, eleven schools, twenty-five mosques, four health-care units, three market halls and two wells. These are distributed unevenly around thirty-two different centres, with a distance of 400 kilometres between the two most distant points at the extremes of the site. Except for the health centres, all the buildings have been designed with courtyards. Most of the houses occupy a built area of 60 square metres, which, together with a 90-square-metre courtyard, form a total area of 150 square metres each. The total built-up area of all the housing is 69,240 square metres. Together with the courtyards, the total area occupied by the 1,154 units is 173,100 square metres.

Of the twenty-five mosques, eleven are of the medium-sized *masjid* type, with a rectangular, double-bayed prayer hall that opens onto a rectangular *sahn* (courtyard) at the front of the building. Each *masjid* occupies a total area of 290 square metres, of which 130 square metres are reserved for the prayer hall. The total area occupied by the smaller *musallas* is 130 square metres, with a 72-square-metre single-bay prayer hall and a 58-square-metre *sahn* in front of the entrance. The eleven *masjids* occupy a total area of 3,190 square metres, of which 1,430 square metres is the total built area for the prayer halls. The equivalent figures for the fourteen *musallas* are 1,820 square metres and 1,008 square metres respectively.

The eleven school buildings are built according to three different floor plans. The small, six-classroom primary schools comprise two types, differing slightly for boys and girls because

of the addition of a toilet and a guard's room next to the entrance in the case of the girls' schools. The third type is a larger school with nine classrooms. All are single-storey, U-shaped buildings, with large courtyards at their centres. In general, the schools are built near the mosques, so as to share the mosques' free-standing toilets. However, in some cases, a smaller room designed for administrative purposes has been converted into a washroom with toilets.

Of the eleven schools, only two are of the larger type. These cover an area of 860 square metres each, including their respective courts. The other nine are of the six-classroom type. These are built over an area of approximately 500 square metres each, including their courtyards. The two girls' schools each occupy an additional 50 square metres, due to the extra spaces for the guard's room and toilet. Their respective built-up areas are 407 square metres each for the larger schools, 346 square metres for each of the girls' school, and 296 square metres for each boys' school. The total built-up area of classrooms and other spaces for all the schools is 3,578 square metres and the total area occupied by all eleven schools adds up to 6,320 square metres.

Unlike the other buildings, the health-care centres do not have forecourts. They are built over an area of 160 square metres each. These buildings have a central waiting hall with doctors' and nurses' offices and check-up rooms on each side. The total built-up area for the four health centres already constructed is 640 square metres.

The market halls, which have been built in only three of the largest settlements, are in the form of rectangular concrete platforms, shaded by three bays of stone vaulting, carried by eight stone piers. Each hall occupies an area of about 60 square metres, totalling 180 square metres for all the halls.

The total built-up area for all the 1,197 various completed buildings is 75,896 square metres, and the total area occupied by them, including the courtyards, is 180,070 square metres.

b. Design concepts

It was decided from the very beginning that all the buildings in the programme should be built of the local volcanic stone so abundant in the area. This was not only to minimize construction costs but also to achieve a very simple, local shelter design that would adapt itself aesthetically to the desert landscape, while supplying proper protection from the harsh climate and the wild environment. Several different shelters were tested on site, until the most efficient form for the housing units was found.

The initial design of a simple rectangular block with a flat earth roof was later replaced with a design that was covered by a barrel vault along the longitudinal axis. Finally, the single, longitudinal roof vault was replaced by a triple, transversal vaulting system, each vault defining a separate room below. This final solution was intended to provide a more pleasant and attractive outlook to the otherwise simple and unpretentious design.

During the search for the most appropriate and economic shelter, an attempt was also made to use a wider variety of locally available building materials. Adobe therefore replaced stone as the major building material in a few of the experimental houses, but was soon discarded due to its water-absorbency and structural weakness.

In general, the houses are designed as simple, rectangular blocks, divided into three adjoining rooms with no passage in between. For communication, all rooms open onto a rectangular courtyard, surrounded by high walls. The main entrance leads into the courtyard from the shorter end of the courtyard, to avoid any direct view into the rooms. At one end is a reception room (*majlis*), with an extra door opening directly to the exterior to receive male guests. The room at the other end is reserved for the kitchen and daily living. In the early phase of design, a small bathroom–toilet was placed inside this room, with a separate entrance from the court. Upon public demand, however, these facilities were later built at one corner of the courtyard, as local tradition does not allow them to be placed within the living premises.

The shelters have minimal openings in order to keep out the extreme heat of the desert. Each room has a small, metal-shuttered window at the rear and a metal door that opens onto the courtyard at the front. These two openings allow light and ventilation into the rooms. Further natural ventilation is supplied via groups of three holes at the apex of the vaults to the front and rear. Most of the buildings are devoid of any kind of decoration. In some cases, however, the façades of the houses have been decorated by their owners, with simple motifs brushed on with white limewash.

In spite of the scarcity of water in the desert, the house owners have successfully attempted to grow a few trees and shrubs in their courtyards. There have also been some communal attempts to create small green playgrounds for children at some of the community centres. The trees and shrubs planted in these are closely tended by the community, and protected from grazing animals by barbed-wire fences.

Due to tribal conflicts caused by ancestral territorial rights in the desert, it was impossible to achieve a close-knit urban order in the settlement areas. The nearest thing to an urban grouping of buildings was the random clustering of a few shelters for close relatives from the same clan. Hence, the houses are very loosely scattered within the settlement areas, often with sufficient distance between them to avoid even visual contact. One main consideration was to protect the shelters from the devastating effects of occasional floods. Therefore the building sites were invariably located on the slopes of the valleys, away from the wide flood beds.

c. Structure, materials and technology

The first units were covered with flat earth roofs supported by timber or steel beams, spaced at 50-centimetre intervals. This method was found to be too expensive because both the timber and the steel had to be imported into Saudi Arabia and both required careful maintenance. Furthermore, during the winter rains, the flat roofs were leaking, creating a mess inside the shelters. A new vaulted roof was tested – approximately 30–35 centimetres thick and constructed of rubble stone – designed to drain rainwater as quickly as possible. This too was abandoned due to the formation of cracks in the cement mortar joints, caused by

climatic extremities and insufficient curing because of water shortage. Finally a new barrel vault, about 10–15 centimetres thick, was tested. It was made with smaller stones, laid over a mesh of steel bars measuring 8–12 millimetres, and covered with a thick mixture of concrete. The formwork for the vaults was made with 6-millimetre plywood, supported by timber beams resting on stone vaults, which were removed after the concrete was cured. This proved to be the best solution for a safe and reasonably economic roofing system. The curing of the concrete was achieved by watering it for a whole week, twice a day for the first four days and once a day afterwards.

In all the buildings 60-centimetre-deep continuous stone foundations were laid below the ground to bear the weight of the 50-centimetre-wide stone walls. In the case of the few adobe houses, these foundations were raised 40 centimetres above ground level, to break the contact of the mudbricks with groundwater.

The floors were made by pouring concrete 8–10 centimetres thick over a mat of crushed stone, finished with approximately 2.5 centimetres of levelling concrete. The walls were built with local volcanic stone and a cement and lime mortar, and the joints were seamed with plain cement mortar. The walls were left unplastered inside and out. Metal windows and doors were made to order in either Jeddah or Makkah.

As for the services and utilities, every house was allocated a small water tank to serve the bathroom. Water is either piped directly to the tank from the central well, or brought in by tank trailers. A septic well was also dug near every house for waste water from the bathroom. The houses do not have electricity or other services.

Origins of technology, materials, labour and professionals

The initial aim of developing a simple, unpretentious, low-cost house with basic services that would integrate closely with the environment, prompted the designer to use local materials and indigenous construction methods and technologies. Because implementation of the programme depended exclusively on charity funds, the chosen technology and materials, as well as the design concept, had to withstand criticism from the donors and administrators, who yearned for an extravagant modernity appropriate to opulent Saudi society.

The major building material, volcanic stone, is found abundantly in the coastal Tihamah plain. Mainly black in colour, the stone has streaks of red and yellow, which create a multicoloured surface texture when it is roughly cut for wall construction. Imported cement was used for making the mortar, the floor slabs and the vaults. The sheet iron used for the manufacture of metal doors and windows; the steel and timber used for beams to support flat roofs; and the plywood used in making formwork for the vaulting, were all imported, since they are not produced in the Kingdom.

Due to the scarcity of local skill in traditional construction, the labour force had to be recruited from foreign workers who had arrived in the Kingdom to look for jobs. These people mostly came from Yemen, Bangladesh, India, Pakistan and Egypt. There were also local volunteers who enthusiastically helped the foreign workers to speed up the building

process. Since the simple construction work did not require any particular qualifications, the unskilled foreign workers easily adapted to digging foundations, building stone walls, pouring concrete and executing vaulted roof structures. They were guided by a single site engineer, who was instrumental in the execution of the programme.

Zaki and Fayez Mandoura, the architect and engineer who conceived the whole Settlement Programme, are partners and relatives as well. Coming from Indonesia originally, they settled in the Kingdom and accepted Saudi nationality. They carried out the design and organization of the project, while another local engineer of Palestinian origin was recruited as a site engineer to supervise and control the construction. These three people have been responsible for the whole process, from 1992 until 2000.

During the earlier phase of the programme, when the team was experimenting with using adobe to build the shelters, expert knowledge was required for possible mass production in this very basic traditional material. A French construction firm, 'Espace Mondial 2001' from Paris, was consulted for this purpose. Their proposal was found to be too elaborate and expensive. Furthermore, their design, with all the conveniences of a contemporary urban settlement, was far from the reality of life in the desert (see appendix 1). Hence the proposal was rejected and the programme was conducted according to a simpler and more realistic design, using traditional methods and very humble means.

V. Construction Schedule and Costs

a. Project History

The programme was set up in 1992, as soon as the situation of the impoverished nomads became apparent. At the instigation of HRH Prince Majid bin Abdulaziz, the governor of Makkah, his technical consultants, Zaki and Fayez Mandoura, prepared a report about the situation. This formed the basis for a programme for the proper settlement of the nomads. A social donation programme was set up in 1993 by Prince Majid, who asked the King and other local notables to direct their annual *zakat* (Muslim tax for the poor) towards the realization of this project. With the Prince's personal support, implementation of the project began – although it did so illegally because many government ministries (Construction, Planning and Education) opposed the programme, arguing that it lacked a proper urban and architectural concept as well as modern amenities such as electricity, sewage networks and piped water. In fact, since the beginning of the programme, many government administrators have been reluctant to accept the reality of a group of impoverished nomads living in the desert, miserable and neglected, so close to rich Saudi cities.

The implementation of the programme began with the building of the first experimental buildings to determine the most appropriate design for a simple, durable and economic shelter. By 1996, 560 nomad families had been settled in their new houses.

The second phase of the project began in 1996 when preparations were made to organize a social welfare programme. To raise funds more easily and to arouse more interest in the Settlement Programme, a non-profit-making charitable society was established in 1998, with

three founding members: Prince Majid's deputy director, Dr Rabia Dahlan, and Zaki and Fayeze Mandoura. Later, this number was increased to twenty, with prominent Saudi citizens joining the society. The nine-member executive committee of the new Society of Makkah al-Mukarramah for Development and Social Services was chaired by HRH Prince Majid bin Abdul Aziz. Henceforth the society took over responsibility for making decisions and raising funds for the programme. During the same year, implementation of the second social aid programme began within the nomad community. It aimed to teach the nomads simple, productive skills like handicrafts, sewing, health and child care and chicken farming. By the end of the year 2000, housing and community services such as schools, small health-care units and mosques, had been completed for a total of 1,154 nomad families.

In the year 2000, Prince Majid was replaced as governor of Makkah by his younger brother, Prince Abdul Majeed bin Abdul Aziz, who seemed to be less interested in the programme. At the same time, certain changes took place in the administrative structure of the charitable society, which continued to conduct the settlement programme. The executive board is still directed by HRH Prince Majid bin Abdul Aziz but Dr Rabia Dahlan, one of the three initial founders of the society, has been replaced by Sheikh Abd al-Rahman al-Fakih, a well-known and generous citizen of Makkah. He apparently has a different approach to the solution of housing for the poor. Like most of the administrators in Saudi Arabia, he believes that stone construction is old-fashioned while concrete structures are modern and befitting of a progressive community. At present, therefore, with the support of the society, a different approach to the programme is being tested. This aims to create an urban environment for the rural nomads of the region through the construction of 140 concrete buildings and all the other amenities of a contemporary human settlement, 400 kilometres south of Makkah, where a devastating flood recently destroyed a group of makeshift nomad shelters. Even though they are still founders and members of the society, Zaki and Fayeze Mandoura have resigned from their executive positions within the organization to avoid unnecessary conflict. As a result, construction of new stone houses in the desert regions around Makkah has halted for the time being.

b. *Costs and financing*

The Settlement Programme for Semi-Nomads was completely financed by private donations from prominent Saudi citizens. Among these, the yearly *zakat* of HM King Fahd was of particular importance.

During the first phase of the programme, from 1993 to 1996, SAR 15 million was collected, a large portion of which came from the *zakat* of the King. The amount and type of donations changed from year to year. Some families even donated food to the nomads. During the second phase of the programme, from 1996 to 2000, a total of SAR 20 million was collected in two instalments, and again a large part of this came from the King's yearly *zakat*. A portion of this sum was donated to the society to be spent on social upgrading and adult education. The whole programme, therefore, was implemented over eight years with SAR 35 million (USD 9.3 million), donated by well-to-do Saudi citizens and the royal family.

Because the programme was implemented in rural areas under difficult conditions, the majority of the funds were spent on labour and the manufactured building elements and materials that were transported from nearby cities. Stone, the major building material, was collected for free from the area surrounding the site. Every building required the varied services of between fifteen and twenty labourers. Their distribution and costs was as follows:

For the execution of stone walls:

three masons at SAR 80–100 (USD 27) per day

four regular labourers at SAR 50 (USD 14) per day.

For mixing concrete and mortar:

five regular labourers at SAR 50 (USD 14) per day.

For digging the foundations:

two labourers at SAR 50 (USD 14) per day.

For collecting and breaking stones:

three labourers at SAR 50 (USD 14) per day

one driver with a truck to carry the stones at SAR 100 (USD 27) per day.

For carrying water to the site:

one driver with a tanker at SAR 100 (USD 27) per day.

For plumbing:

one plumber at SAR 100 (USD 27) per day.

The cost of manufactured building elements and industrial materials was as follows:

Imported 8–12-millimetre steel bars: SAR 1,350 (USD 360) per tonne;

400 kilograms per house = SAR 540 (USD 144) per house.

Metal doors: SAR 200–250 (USD 53–67) per unit;

six units per house = SAR 1,200–1,500 (USD 320–400) per house.

Metal windows: SAR 80–100 (USD 21–27) per unit;

three units per house = SAR 240–300 (USD 63–80) per house.

Imported cement: SAR 300 (USD 80) per tonne;

8 tonnes per house = SAR 2,400 (USD 640) per house.

Besides these, for each house, the following natural building materials were collected from the surrounding countryside, free of charge:

Natural volcanic stone: 82 cubic metres.

Sand from valley beds: 80 cubic metres.

Gravel from valley beds: 10 cubic metres.

Water from nearby wells: 12 cubic metres.

The total cost of construction for the 1,197 buildings built over an area of 75,896 square metres was: SAR 30 million (USD 8 million)

c. *Comparative costs*

During the implementation of the programme, approximately SAR 400 (USD 107) per square metre was spent on the construction of each house. Thus, each 60-square-metre house was to cost a total of SAR 24,000 (USD 6,400). A very standard type of construction in urban areas on the other hand, costs SAR 1,000 (USD 267) per square metre. Accordingly, 75,896 square metres of construction for the 1,197 completed buildings, which has cost approximately SAR 30 million (USD 8 million), would have cost SAR 75 million (USD 20 million) if they had been built in the cities, with modern technology and municipal services.

d. *Qualitative analysis of costs*

It would be incorrect to make a qualitative comparison between the urban examples of housing and the rural Settlement Programme for Semi-Nomads. The main concern of the programme was to give the homeless nomad a basic shelter to provide protection from the devastating effects of the desert. Hence, the houses lack many of the vital but expensive urban services such as gas, electricity, telecommunications, paved traffic roads, etc. Their needy users are totally dependent on natural ventilation to withstand the heat of the desert, self-produced charcoal for their cooking, and miles of dirt tracks for walking or driving to the nearest highway, which leads them to the centres of urban life in the vicinity. Nevertheless, considering the small amount of money that has been spent on these simple shelters, it is obvious that the decision to build them out of local stone was an appropriate one, not only because of limited funds, but also because of the negligible maintenance they require, the very basic human need for shelter they fulfil, and the simple architectural quality they display, which conveniently merges into the natural environment.

e. *Maintenance costs*

Within the past eight years since 1993, the maintenance costs of the houses and the public buildings have been negligible due to the extensive use of durable, volcanic stone in their construction. A few early examples of adobe houses have been abandoned due to their failure against rain and their constant need of maintenance. There have also been difficulties with the early flat-roofed shelter types, which have not sustained their impermeability against flash rains. There have been no problems of constructional maintenance with the vaulted shelters, on the other hand, except for occasional repainting of metal doors and windows, which show signs of corrosion over time due to high humidity.

VI. Technical Assessment

a. *Functional assessment*

The vaulted structural system was flexible enough to be used effectively, not only for the houses but also for all other public and private functions as well. The simple house plans, designed according to local social and religious traditions, function very efficiently in terms of family privacy. The exterior courtyards, surrounded by walls high enough to protect their inhabitants from the unwelcome glances of strangers, are well-defined transition areas

between the interior and the desert environment outside. The placing of the *majlis* on one corner of the house, with an extra door opening directly to the exterior to admit male visitors, is convenient. The removal of the toilet and the bathroom to one corner of the courtyard might be considered to be problematic, particularly while returning to the house after taking a shower. Nevertheless, this was a common wish of the users, who preferred the bathroom to be outside to avoid undesirable odours within the living premises.

b. Climatic performance

The old town houses of Jeddah, Makkah and Taif are equipped with high ceilings and projecting windows with seating (*roshan*), covered by wooden lattice work (*mashrabiyya*), which protects the interior from public view, while allowing air into the house. These are traditional building elements to fight the extreme heat of the desert climate. The houses built for the nomads in the desert do not have such sophisticated solutions against the heat. But they are efficient in terms of comfort because of their thick stone walls and their simple door and window openings on the front and rear walls, which supply sufficient light and cross-ventilation within the rooms. The additional height added by the vaults is another asset in fighting the heat, trapping hot air and discarding it by cross-ventilation through the holes in the walls at this level.

With their simple forms, and rough, unplastered walls built with local stone, the housing units, loosely distributed over large stretches of desert land adapt extremely well to the environment. So much so that, from a distance, it is often rather difficult to distinguish a single standing house from its natural surroundings. The vaulted stone buildings are also well built to withstand heavy rains, harsh winds and possible fires. Their structural resistance to earthquake forces has not been tested and therefore cannot be verified.

c. Choice of materials and technology

The choice of a sturdy building material and a proper technology for the execution of a low-cost, maintenance-free and long-lasting shelter was a fundamental issue for the success of the programme. Following the process of experimentation with various building designs, the final choice of a unit constructed entirely out of local stone has resulted in shelters that are strong, sturdy, and almost entirely maintenance-free. Even though the metal doors and shuttered windows seem to be a sensible choice against strong winds and sandstorms, within the past eight years, these have been the only elements that have required occasional repainting due to corrosion.

The use of traditional technologies, where all execution is carried out by hand with simple tools and cheap labour, was a positive decision for the revival of the traditional art of building. This is particularly important in a rich and rapidly changing country like Saudi Arabia, where most new construction is realized with highly sophisticated machinery and technological means

d. *Design features*

The initial decision to create an unpretentious, simple form for the shelters and other public buildings was an appropriate one for a programme of charity and social upgrading. When the early experimental units with flat roofs failed to be waterproof, they were roofed over, first with a single vault in the longitudinal direction, and then with triple vaults transversely. This final structural solution has added visual interest to the otherwise plain and humble forms of the earlier examples. Further variations of the final prototype were tested on an L-shaped plan, with the bathroom and kitchen placed in the short leg of the L, drastically reducing the size of the courtyard. Furthermore, for ease of construction, the L-plan's two perpendicular vaults were left abutting instead of crossing each other at the junction. The same awkward solution is observed at the corners of the U-shaped school buildings.

Due to the very loose dispersal of the shelters, with great distances in between, no serious disturbance to the surrounding environment was observed. Also, the increase in vehicular traffic on the desert tracks was negligible because of the low-density population and the rural character of the settlement districts.

The interiors of both the houses and the public buildings are sparsely furnished with whatever could be found by their impoverished users. The schools are furnished with donated desks and blackboards, either donated or supplied by the Ministry of Education. Sometimes the same thin mattress is used to sit on in the *majlis* during the day, and to sleep on in the bedroom during the night. The few pots and pans used as kitchen utensils are usually kept on the floor, unless a cardboard box is utilized as a kitchen table. In the future, some simple, built-in furniture could be incorporated into the shelters, to overcome such difficulties.

VII. Users

As explained above, the shelters were built for the homeless, impoverished nomads roaming the desert in the Tihamah coastal plain, to the north and south of Makkah and Jeddah. These people are struggling to survive on alms, and the few Riyals they receive from the sale of the charcoal they produce. Their cultural level is very low, and in the new schools, operated by the Saudi Ministry of Education, their children are being educated for the first time.

Even though some of the users were initially hesitant to live in such unusual houses, with curved stone-and-concrete roofs that seemed to defy the forces of gravity, the demand for stone shelters is very high today among those who have not yet been allocated one. The owners of the houses talk approvingly about the cooling effects of the thick stone walls and the cross-ventilation within the rooms. They do complain, however, about insufficient daylight in the interiors. They also long for other modern amenities like air-conditioning, television, refrigerators and gas ranges, even though they would hardly be able to pay for the electricity required to operate such gadgets.

In spite of the frankly positive responses of the users, local architects have criticized the programme heavily because they find it unarchitectural. Criticism from government administrators was even greater because they believe in settlements that are more urban, with

all modern services. There has been little popular reaction from the urban centres, because the project was not well publicized in the cities.

VIII. Persons Involved

Throughout the programme, only a handful of people became involved. During the first phase, from 1993 to 1996, HRH Prince Majid bin Abdul Aziz al-Saud acted as the client, and raised the funds through pious donations. The Society of Makkah al-Mukarramah for Development and Social Services established during the second phase, took over the sponsorship, with Prince Majid still leading the nine-member executive committee. From the beginning, Zaki bin Ahmad Hatib Mandoura was the only architect involved and he was the mastermind behind the programme, together with his cousin and partner, the engineer Fayez bin Huseyn Mandoura. Site engineer Mohamed Mahmoud Megat was particularly instrumental in the implementation of the whole project. Sheikh Mansi al-Biladi al-Harbi, one of the notables of the small town of Rabig, also took part in the implementation of the programme, acting as an intermediary between the nomads of his tribe (*kabila*) and the engineers and the architect.

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Urban Criterion:

- Several communities are to be moved to proposed sites for urban development, based on tribal, territorial and environmental considerations.
- Creating small residential clusters, based on family structure considerations, nearest to their present locations to gain experience of building process for future expansion.
- Residential clusters at high fringes of valleys, accessible and visible from local routes to link them with neighbors.
- Grouping neighborhoods around an urban node to enable social and economical activities.
- Careful gradual introduction of public services, not to disturb their present life pattern.
- Nodes are comprised of the water source (water wells), where educational, health care and economical activities should be located.
- Urban nodes nearest to main road, to link clusters and communities to each others.

Architectural Criterion:

- Intensive use of local stone in walls and roofs to minimize transportation and manufacturing cost.
- Dedicating construction cost mainly for labor wages.
- Proper stone wall thickness for maximum insulation and structural stability.
- Improving comfort inside rooms by reducing windows openings, discharging hot air through overhead openings.
- Improving shading and increasing cross ventilation by proper orientation.
- Privacy in orientation and room setup.
- Durable materials and details, simple construction techniques to lower repair/maintenance cost and facilitate learning.

Feed-Back:

- 750 no. of houses completed.
- 17 no. of urban nodes completed.
- 700 no. of families now occupying their houses.
- Cost of dwelling unit is less than 6,667.00 US.\$
- Health level is very high, less diseases, less ills, hygiene is far more better and they look cleaner.
- Education level is improving rapidly in 11 no. of schools of 100 classrooms up to intermediate level for both sex.
- People perform prayers regularly in 17 mosques.
- Vaulted Stone buildings became preferred style in the area.
- Process continues until everyone in the area joins the program, as long as funds flow in.
- Finally, Plans for Economical Development are in progress and soon to implement.

Note:

- Slides form 1-4 shows the situation of villages before the construction begins.
- Slide from 5- 15 shows already constructed building types.

Basic Data:

- **Beneficiaries:-** Small scattered societies, economically, healthily and educationally poor, historically lived on serving old routes that became out of use by modern roads and highways.
- **Environment:-** Arid nature, rocky mountains, sandy valleys, hot dry climate, few rain falls, few leafless trees grow on valleys, few desert plants.
- **Geography:-** Several locations, 50-120 km from nearest city, 30-80 km off road, south east of Makkah and north of Jeddah.
- **Population:-** Approx. 20,000 capita, about 2500 families.
- **Social Characteristics:-** Semi Nomads, Muslims, Avg. family size 6-12 persons.
- **Area of Scope:-** Approx. 2000 km² in two sectors.
- **Natural Resources:-** Limited ground water, free stone on mountains usable for construction.
- **Economical Resources:-** Firewood collection/charcoal-making and animal-breeding.
- **Finance:-** Donation of Approx. 25,000,000 SR (6,666,000 US\$) by the Custodian of Two Holy Mosques.
- **Administrative Sponsor:-** HRH. Prince Majed Bin Abdul Aziz (Governor of Makkah al Mukarrama Region).

Existing Conditions:

- Primary surveys and reports indicated:- majority were living under tents in primitive sheltering conditions, in best cases few families were in tin cottages, whole family in one space, with no sanitary facility, food was low in quantity and quality, poor health condition, many lung and eye diseases were noted, economically poor, social welfare represents main income, very limited economical and natural resources, ignorance and lack of education, etc.

Available Resources:

- Funds were enough to serve 20% of the population, based on intensive economized program.
- Natural resources were only ground water that could be pumped out, in addition to loose stone on mountains that could be used for construction.
- Human resources were hopeless to participate in the development process, they were unskilled and physically weak.

Project Objectives:

- Improving living conditions
- Providing basic sheltering, health care and educational services.
- Developing socio-economical resources.

Project Policies:

- Optimal utilization of funds to achieve wider service.
- Careful social solutions to avoid the impact of sudden abrupt change in lifestyle.
- Establishing basic environmental economy.