9. The Use of Prefabrication in the Reconstruction of Ech-Cheliff (Al Asnam), Algeria

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The city of Ech-Cheliff lies in a long east-west valley in the middle of a mountainous area halfway between Algiers and Oran and along a secondary communication line between the city of Ténès to the north and Tiaret to the south. Its climate is mild in winter and hot in summer, when temperatures can rise to 50°C. The town was founded by the French in 1843 on the site of a Roman city. Because of this colonial past, it lacks the urban and architectural characteristics of the traditional Arab city. It regained its Arabic name, El-Asnam, after independence. To mark a new beginning it was renamed Ech-Cheliff after the 1980 earthquake.

Thanks to the Ech-Cheliff River, the city is situated in one of the best irrigated areas in the country and consequently one of great agricultural wealth. The wilaya (administrative district) comprises about one million inhabitants, with a density of 116 persons per square kilometer. Only in the Ech-Cheliff valley is the population increasing. Between 1970 and 1980, priority was given to developing large industrial complexes in the valley. Population in the rest of the wilaya is migrating to other parts of the country.

On September 9, 1954, the city was hit by an earthquake that measured 6.7 on the Richter scale, and 1,250 of its 40,000 inhabitants were killed. Several prominent French architects were called in to assist in its reconstruction. One of them, Jean Bossu, was put in charge of the design of the Reparatous Center, which included a mixture of commercial and housing activities in a low-rise architectural solution that tried to fit in with the local way of life. Two commercial levels were protected by a lateral portico; an elevated street above connected courtyard houses. Ventilation was provided through narrow openings. Together with Jean Bossu, the structural engineer, René Sargen, designed a heavy slab rigidified by a waffle structure and supported by posts. His calculations were based on the latest French seismic building codes.

By the time an earthquake again struck at 1:26 p.m. on October 10, 1980, the city population had risen to over 100,000 inhabitants. The first tremor reached a magnitude of 7.2 on the Richter scale and was followed by a second, less violent one a few hours later. The region affected by the earthquake covered an area of 30 by 90 kilometers and extended over four wilayas. In the city 1,600 persons were killed and 4,600 injured; in all the wilaya of Ech-Cheliff 2,600 were killed and 8,300 injured; about 30,000 houses were totally destroyed and 25,000 partially damaged leaving over 400,000 people homeless. The destruction rate was as high as 71 percent in the city itself, and the overall cost of damages was estimated at 20 billion Algerian dinars (US$4 billion at present rate).

The president declared a seven-day period of national mourning, and the rescue and rebuilding of El-Asnam began almost immediately. The first measures undertaken were to organize rescue operations for persons under collapsed buildings; to treat and evacuate the wounded; bury the dead; take the necessary measures to prevent epidemics; set up tent villages for survivors; supply food, water, medicine, clothes, etc.; safeguard the security of persons and property; and provide medical care. Although the work of international relief organizations was appreciated and acknowledged, the official newspaper of Algeria wrote two years later: “The gigantic work of reconstruction undertaken at Ech-Cheliff has demonstrated that Algerians are today able to face any challenge when the political will is there and where mobilization works. . . . In 1980, Algeria showed that it was a great nation, [able] to look after itself, to tend to its wounds and to heal them without outside help.”

Twelve billion Algerian dinars (US$2.4 billion) were earmarked for the rebuilding of the city. Immediate action had been taken by the National Popular Army after the earthquake, and on October 15 the disaster area had temporarily been placed under military command. Also on October 15, five new sites for settlements were chosen on sound foothills away from alluvial areas. On October 20, the infrastructure studies for the new sites began, and ten days later the first of them were finished. By the beginning of November, work on the infrastructure had been started. By December, all the disaster victims had been organized according to their original neighborhood and sheltered in 30 tent villages, and 450 elementary schools with 1,300 tent classrooms were teaching over 80,000 pupils in the wilaya (secondary students were dispatched to neighboring wilayas). The schools and hospitals were Algerian-made light prefab structures originally designed for the southern regions of the country. By the beginning of February 1981, the first serviced sites were complete, and by May the first thousand prefab dwellings were ready for occupancy. The following August, 11,000 dwellings were completed; by January 1982, 18,000; and by May 1982, 20,000, and not a single disaster victim was still living under a tent. Very few industrialized countries could have accomplished so much within less than two years of a major disaster. More than 80,000 persons were rehoused in more than 12,000 prefabricated dwellings in the city; the total was

Pl. 1  Collapsed building in the old city center
20,000 new dwellings in the wilaya; and the old neighborhood structures had been respected in the new population distribution.

By 1982, more than 10 billion Algerian dinars had already been invested in housing, and about 10 billion more were yet to be spent on social and economic problems. More than half of these projects were undertaken by the Algerians themselves because they involved earthworks, roads, water, sewerage systems, electric lines, and so forth. The Wall played a major role in the coordination. The oversight of the central government was represented by the weekly visit of the Minister of Housing and Planning. A local branch of the National Agency for Urban Studies and Implementation (CNURU) was first put in charge of land servicing, but it has since extended its responsibilities to include the completion of the Provisional Urban Plan (PUP) and the Urban Master Plan (PUD), which determine the new housing areas (ZHUN).

Within a day of the earthquake's occurrence the decision had been taken to use fast-track solutions based on industrialized systems and turnkey projects to solve the huge housing problem. Contracts with foreign companies were drawn up in Algiers by the Ministries of Housing and Planning, of Finance, of Commerce, and of the Interior. Layout and architecture were discussed with locally elected representatives. A local coordinating committee, La Coordination de l'Habitat, which included the local directorate of housing (DUCH) and other local public services, discussed implementation problems. Bylaws passed in 1981 and 1982 relieved the emergency program from time consuming formalities such as visas, customs, and taxes, in order to speed up reconstruction. The nearby ports of Ténès and Mostaganem were used to avoid the congested port of Algiers.

Eighteen national contracting companies and 24 foreign firms from 9 countries were selected to provide prefabricated dwellings. France supplied about 5,000 dwellings, Italy 4,600, Denmark 3,100, and Belgium 2,000; Canada, Great Britain, Portugal, Spain, and Switzerland sent smaller numbers. According to an agreement between the Algerian government and the foreign firms, local manpower was to be trained and Algerian materials and products were to be substituted for the original ones wherever possible. Algerian contractors worked night and day at an unprecedented pace to put in the infrastructure. Foreign contractors used their own personnel to set up their prefabricated buildings. In order to obtain a combination and variety of housing models, they were allocated small scattered sites.

In spite of the enormous number of houses set up and the diversity of the manufacturing countries who contributed to the project, the houses still offered a rather limited array of typologies. Most were detached one-story houses; a very few semi-detached two-story houses. They were often built with a metal frame and sandwich panels and usually included two or three bedrooms plus a living room, and measured from 65 to 78 square meters built on 200-square-meter urban plots. One of the recommendations made was that the original European model be modified whenever necessary so that the house could be entered into a hall and not directly into the living room. Another was to place the bedroom in the back; yet another to separate the WC from the bathroom.

The prefabricated dwellings cost only about 20 percent less than a normal dwelling, not including infrastructure costs. Their lifespan with normal wear and maintenance should be from 20 to 25 years, but given the profile of the inhabitants it will be less here.

Although problems could hardly have been avoided given
Fig 2  Proposed sizes for the new settlements

Fig 3  Typical layout for one of the new sites

Fig 4  Plan for two-bedroom prefabricated house

Fig 5  Plan for three-bedroom prefabricated house
the short time allowed, the adaptation of these dwellings to the
local way of life and to climatic conditions and the mono-
tonous, homogenous townscape they created have nonetheless
been criticized. Their design and layout certainly contribute
nothing to the definition of a strong urban character. Enclosure
walls of cement blocks are slowly being provided by the
authorities to ensure privacy around each house, but many
families have already built and decorated their own, and have
even built on extra rooms. Other solutions are also possible.
A landscaping policy may become necessary later on, and
some of the infrastructure is already in need of repair.

For a time, many residents seemed to be in doubt whether
they should consider themselves owners or tenants. The
owners of houses that were repairable and inhabitable in the
old city did not know if they should stay and invest in their
house. The poor were frightened by the rent and maintenance
expenses. No rents were asked in the beginning but now they
are being collected, and rehoused families have been offered
the option of buying their home.

Public facilities had been provided by the beginning of 1984.
Between October 1980 and January 1984, 1,700 primary class-
rooms, 37 middle schools, and 8 high schools, 6 hospitals, 17
health centers, and 15 polyclinics had been constructed in the
wilaya. Sports, leisure, and cultural facilities are the next pri-

ority. There are a few state-owned prefabricated retail shops
in the neighborhood, but many families go shopping at the
gates of the old city where provisional barracks made out of
planks and sheet iron shelter privately owned shops and a few
artisanal activities. The prefabricated housing camps for the
staffs of foreign contracting companies are now being reused
for offices and even for a motel.

The debris was completely removed from the old urban cen-
ter, and unoccupied buildings and open plots now await tech-
nical structural expertise, strengthening, and zoning recom-

mendations. The old outskirts are still inhabited. Prefabricated
buildings housing a mosque, a hospital, and the wilaya's offices
are located in the old center. A new city square has been laid
out where Jean Bossu's Reparatus Center used to stand.

The government charged the National Agency for Technical
Controls (CTC) to undertake a systematic survey of the
structures in the disaster area. Buildings were classified ac-

cording to three categories. undamaged structures or struc-
tures with minor damage that could be immediately reused;
structures to be assessed for extent of damage and the cost of
recovery; and structures beyond repair. The main reasons why
so many structures had not held up to the quake were also de-
termined: they were insufficient building codes, poor architect-
ural or structural design, and poor implementation and
insufficient supervision of the construction.

After the first surveys undertaken by the CTC, an architec-
ture, engineering, and planning agency, the ETAU, whose lo-
cal branch later became an independent agency under the name
of Bureau d'Etudes d'Architecture (BEA), took charge of the
study to determine the feasibility of rehabilitating structures
found to be worth saving. It was also responsible for techni-
cal assistance during the work. A total floor space of about
330,000 square meters was involved in these studies. They in-
cluded several hundred dwellings and many public facilities,
all of which were surveyed to determine the extent of the damage and the technical and economic aspects of repairing it: the feasibility of techniques for adding jackets around posts or trusses, bracing shells, underpinning masonry walls, and so forth. The cost of reinforcement varied with each building, of course, but it was usually less than 50 percent of the cost of a new building, even before adding the expense of demolition, and the time involved was usually around 25 to 30 percent less than for a new building of the same type, not including the time needed for demolition.

A team consisting of civil engineers, specialists in plumbing, electricity, and heating, architects, and surveyors has been organized by the BEA of Ech-Cheliff to provide assistance to contracting companies. The BEA has also prepared two pamphlets—one for specialized contracting agencies and one for ordinary people to use, but reliable advice cannot really be provided until the results of the microzoning survey are known. The BEA also presents reports to the Commission du Contentieux, a litigation commission under the authority of the wall, which settles financial claims involving work under construction at the time of the earthquake.

All private building-permit authorizations have been suspended in the disaster area. If someone wants to build a private house, he either has to ask for a special authorization from the CTC (the price for which sometimes amounts to a tenth of the construction costs), or to buy a plan from the catalogue that the BEA has compiled of earthquake-proof villas. The set of plans costs about US$120, and a building permit is then granted.

The authorities have asked for a geological microzoning study that will identify precisely which places are dangerous and should not be built on, which can be built on, and which have particular requirements—a study that requires quite sophisticated technology. The American firm of Woodland Clyde Consultants has undertaken it, under the administration of the CTC and DUCH. It will not be completed until fall, but it already appears that the geological properties of the city center's subsoil were not changed by the quake.

In the meanwhile, a Habitat team has undertaken the preliminary studies for a new master plan for the Algerian National Agency for Regional Planning (ANAT). This team included T. Akgur, a planner; A. Guloglu, an architect; R. Bademli, an economist; F. Mokrane, a sociologist; G. Lengyel, an engineer; and a legal adviser. The sites for the new settlements were chosen without much regard for the long term, and a coherent development pattern had to be established. Because agricultural land lay to the north of the old urban center, expansion in that direction was not advisable. In addition, Chettia, a large settlement 10 kilometers to the north, had already been established as an independent municipality. It was recommended that it not be integrated into the new master plan because it was too far away. Outside of Chettia, most of the population, over 60,000 people, live south of the railway line; 15,000 to 20,000 of them are inside the old urban perimeter. Since the subsoil is stable and the soil less fertile to the south, development in this direction was recommended. The team also recommended, however, that a new connecting road to Chettia be built.
For several reasons, the Habitat team proposed that a new urban center be built that would be distinct from the old one. Density is presently 50 to 60 persons per hectare everywhere—even within the old urban perimeter, which had a density of 400 to 500 before the quake; none of the subcenters that developed after the earthquake had taken precedence over the others, and the city therefore lacked a main city center. If priority were given to the rehabilitation of the old city, however, the new settlements might be deprived of new investment; social distinctions may develop between a modern wealthy central area and the poorer peripheral settlements, adding as well to the difficulties of the public transportation system. Reoccupation of the old center would also make unavoidable a northward development along the Ech-Cheliff River onto alluvial lands needed for agriculture and where seismic risks are higher.

For the construction of the new center, an orthogonal road pattern was recommended with three-way roads to ease traffic congestion and act as potential major crossroads for the city. In the proposal the main streets are laid out to take advantage of the prevailing north-south winds. The central area would consist of an administrative center housing both the wilaya and the municipal government and the law courts, offices and commercial activities, a mosque, bus terminal, stadium, cultural center, youth center, post office, library, hammam, restaurants, hotels, and so forth. The authorities still have to prepare a precise brief for the center, which will in any case be a flexible, open-ended solution with several implementation phases. The main avenues are broad—which also has advantages in the event of earthquakes—with two-way traffic, a median divider, and parking along the curbs. Public parks and urban gardens are planned for the main spine. Highrise blocks are designed
Damage and loss of human life had been blamed not only on structural flaws but also on a development pattern that encouraged concentrated development in high-risk seismic areas. The aims of the new master plan were therefore to reduce density in those areas and to avoid establishing large-scale industries which would concentrate jobs in the cities, to limit the expansion of existing cities, and instead develop a network of smaller towns and settlements. These aims would require a reorientation of economic development and of the distribution of any population increase, and this in turn required studies to determine how socioeconomic activities previously concentrated in Ech-Chelif could be redistributed in new piedmont settlements and rural areas. Boundaries would have to be established for built-up areas to safeguard agricultural land and hydraulic works, particularly in mountainous regions. The importance and quality of services in rural areas would have to be improved as well, in order to discourage migration into the cities, and a communications infrastructure developed.

To understand the extent of construction investments made by Algerian authorities in Ech-Chelif, one has to bear in mind that in the year 1981, 28,000 publicly built urban dwellings, 22,000 publicly built rural dwellings, and 15,000 private dwellings were built in all of Algeria; in the same year 20,000 publicly built dwellings were constructed in Ech-Chelif wilaya alone. The Ech-Chelif project acted as a catalyst in generating a reassessment in the national policy of construction technology, as it focused attention on the light prefabricated systems so successfully used to rebuild the city in such a short time.
However, the long-term implications of lower densities, high infrastructure costs, limited economic life of structures, and high maintenance expenses have yet to be resolved. The nation’s effort to aid Ech-Cheliff will not end with the provision of 20,000 dwellings. The new housing settlements need landscaping and the infrastructure needs improvement. Social facilities are lacking. When the seismic-microzoning study is over, buildings will have to be brought up to conform to a new Algerian building code. A new master plan should be drawn up in coordination with local and national authorities and final decisions made regarding the city center. A reconstruction agency is needed to deal with legal problems, financial compensation, reconstruction, and, more generally, the development of the city.

Discussion

QUESTION: You mentioned that standards were being imposed that would make the buildings earthquake resistant, but those standards are not apparent in the buildings themselves. Judging by the slides you showed, most of them look like ordinary buildings; some even had temporary corrugated roofs. What are the restrictions that earthquake resistance imposes? Does it only affect the detailing of the building, or can it be seen in some way in its architecture?

ABDULAC: Are you referring to the prefabricated buildings or to the concrete buildings? The latter were not really rebuilt; some were merely strengthened. On the other hand, new prefabricated constructions can withstand earthquakes better than concrete structures.

LIES HAMIDI: The building of permanent structures awaits the completion of the microzone study being done by an American firm in association with Stanford University. Nothing has yet been constructed either in the city or in the wilaya of El-Asnam, aside from the 20,000 dwellings that are either wood- or steel-frame structures. No new reinforced concrete structures have been built.

QUESTION: Has the new center taken earthquake-resistance standards into account, and if so have they affected the architecture of the buildings?

HAMIDI: The earthquake standards will be taken into account. But building a new center is only a proposal; the architecture and construction are still to be determined.

ABDULAC: It is a scheme at a very early planning stage, and it may not be implemented at all. The site proposed for it will, however, be more stable in earthquakes; its proposed design calls for broad avenues so that rescue operations will have the benefit of unblocked streets; and the general shape of the buildings will be regular, with axes of symmetry. All this, of course, would increase resistance to earthquakes. But other details will be designed only after the project has been accepted.

NADER ARDALAN: The image the new prefabricated houses produce is obviously quite different from the traditional or indigenous housing of that area of Algeria. What do you think the impact of this new image will be on Algeria as a whole? Do you think it will cause other people to adopt this style, or not?

HAMIDI: Probably not. Following the October 1980 disaster, we chose this housing in response to a particular situation, and only for urban areas, of course. The 20,000 houses in rural areas have all used local materials, not imported prefab dwellings.

FRANÇOIS VIGIER: I gather that the choice was dictated by the realities of the situation—cost and the need to supply new housing very rapidly. Had the decision been made to build housing with a greater life expectancy, do you have any idea how much more it might have cost and the extent to which the reconstruction effort would have been slowed down?

HAMIDI: About 90 percent of the prefabs were steel-frame structures; probably only 1,000 out of the 20,000 units were wood. The cost varied from 100,000 dinars to 120,000 dinars, that is, from $15,000 to $20,000, per dwelling. It was an emergency situation, and the decision was made on the grounds of speed, not cost.

ABDULAC: The urban program built 20,000 dwellings in twelve months; the rural program implemented with traditional techniques built 6,000 dwellings in 24 months. That is quite an important difference for people living in tents.

SUHA OZKAN: I come from Turkey which regularly has earthquakes, and as a result it has developed a lot of expertise in disaster housing. I myself have some fifteen years of experience with it, and one thing I have learned from that experience is that the emergency funds injected into these disaster areas bring prosperity to them. In places like Gediz in western Turkey and the Van and Erzurum areas in eastern Turkey the survivors thank God when their houses collapse, because it means prosperity is on the way. The government, for political reasons clearly, injects much more money than is necessary, and generates so much building and economic activity that it transforms the whole social, cultural, architectural, and planning structure of the society. The disaster efforts spoil the places they are trying to recover. Significantly as well, disaster housing provided by the government—at very low rates, of course, almost life-long mortgages—is then either totally transformed or totally rejected. These boxes you have shown are the same sort of standard Third World disaster houses—a corrugated-iron roof over a box in which is a living room and sleeping rooms. These houses are alien to the local way of living; if people have no choice but to move into them, the alterations and additions they make are enormous and provide a lesson in cultural history and architectural forms. All the houses you showed looked as if they had just come from the factory. Does that mean they were accepted as they were? Or that no one has moved in?

HAMIDI: I don’t think there was a choice in October 1981; 400,000 people were homeless. The problem could not be put in terms of cultural considerations, but rather of survival. People had to go somewhere. It is very cold in El-Asnam in winter and very hot in summer. They couldn’t go on living in tents.

LARI: What are the criteria you applied to arrive at the selection of this particular system?

HAMIDI: Speed was the overriding concern.

LARI: But were there not other systems available which could also have met the criterion of speed, but would have been culturally more acceptable?

HAMIDI: I don’t think so. The whole 20,000 were built in eight months—between November 1981 and July 1982.

QUESTION: Since 1960 the UN has been developing an aid program for natural disasters as a part of the Center for Hous-
ing, Building, and Planning—now Habitat—in Nairobi. When disaster strikes, a team of experts on logistics, on materials, on site selection, and so on, can be on the scene within twenty-four hours. This is supposed to help avoid past errors. Were these United Nations experts called upon in the Algerian case? Dr. Abdulac mentioned that five sites were selected within a period of five or six days for the new units. Was that a political decision or a technical decision? From a planning point of view, if the intention was to protect the agricultural belt to the north, planning another anchor of activity in Chettia and expecting the two cities to stay separated for very long is folly. If the United Nations team had been called in, the selection of the five sites could have been made in the first five to seven days, and they would have been in the correct place.

HAMIDI: The sites that were chosen—Chettia and the four others—are not agricultural areas. They are on the hills of El-Asnam; the agricultural areas in the valley of the Cheliff have not been touched.

COMMENT: I understand that, but the minute a core of activity is sited beyond the agricultural area, eventually the two ends will come together. Putting all the urban development on the same side and eliminating Chettia would have been a better solution.

PERRY NEUBAUER: To follow up on Professor Vigier’s earlier question, what were your criteria in choosing the prefab system you did? Certainly speed was important, buildability was important, something that would fit on the site. What makes us a little restless is that the houses chosen do not seem to have any particular connection with what used to be there. The people who live there may want to change them over time, but for the moment that is all they have. Had you had more time, would you have selected a different kind of system, or would you have still stayed with the one you chose?

HAMIDI: I think we would do it the same way.

NEUBAUER: You are satisfied that the housing requirements for these people would be the same, had you been building a normal housing project and not meeting a housing emergency?

HAMIDI: The people have been asked if they want to buy their house. Eighty percent do; only 20 percent choose to continue renting. They are not, by the way, just boxes; their standards are quite high.

NEUBAUER: So you think that what you have built there would be valid, even if there had been no earthquake?

HAMIDI: No, I did not say that. After the microzoning study has been completed, we will of course return to traditional housing.

OZKAN: If a person can pay for a house, then there is no problem. The architect will provide whatever he likes. The problem with emergency housing is that suddenly 10,000 or 100,000 people are homeless. They don’t have time to adapt to a totally new kind of housing; if that is what you give them, then discontinuity will result. If the government and the architect can lengthen the period of time for adaptation by providing some provisional solution—of which there are now some very good examples available—for shelter, they can later decide in a more rational way what kind of permanent shelter should be made available. In my country, we have given them earthquake-proof houses right away. We should have given them temporary shelter instead and avoid injecting too much money into the area. Many people in Turkey say they don’t want prefab houses, they would rather build their own. What they want are materials, credit, and a site. With those they can do much better for less, and they will avoid having all those wheeler-dealer arrangements between contractors, governments, and officials, of which they are clearly aware, in their community.

CHARLES CORREA: If I were a peasant and my house had just fallen on my head, I think I would be ready to try anything. If the government came along with a box I would probably accept it. Don’t be sentimental about houses that can collapse and kill people. After a typhoon hit the east coast of India, we provided the homeless with one non-collapsible room. With time they could add onto it, and they in fact have done so. I imagine people found these boxes very acceptable, but it shouldn’t trap them for the next thirty years. If you had given them a minimal house—literally, one room—which is fireproof, earthquake-proof, people-proof, and let them add on to it in their own way, over the long haul that would make a much finer kind of environment, I agree, but I think, if I may say, Suha, that you cannot ignore the shock of an earthquake and how compelling the security of a brand-new solution might be. In the same circumstances I think any of us would be willing to try something new. You don’t agree?

OZKAN: After the 1970 earthquake, one village was given 400 foam domes. With those domes they could extend the period of adaptation and building. They didn’t need a new house in fifteen days. They had a secure shelter for a month or two, or even six months.

CORREA: Maybe this minimal accommodation should be incremental.

OZKAN: The foam domes were, actually. They were supposed to be temporary, but some lasted for ten years, and some are still there.

HAMIDI: The authorities in the rural areas did provide what Suha recommends. They supplied traditional materials to the people to construct their own houses.