

Full Length Research Paper

Historicity of the material concrete in the city of Tlemcen

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The relative question to the first uses of the concrete as a material of construction in the domain of building in Algeria, and especially in the city of Tlemcen, is the heart of the work that we intend to publish. The objective of this research is to illustrate the history of the evolution of the use of material concrete in the domain of construction in the city of Tlemcen. The applied methodology is to collect all information relative to the projects of construction made on concrete in the period spanning from 1892 to 2005 from the archives of the township of Tlemcen, and therefore, reach a bank of data that gathers all information referring to every project of construction in concrete, whose exploitation drove us to distinguish five periods where the processes of construction knew a certain number of evolutions, notably in relation to the historicity of the use of the material concrete. Moreover, inserting this bank of data in a card which situates the city of Tlemcen and while appropriating an adequate software to it, we were able to reach all information concerning the date of the project, society of realization, the materials of construction and processes, graphic documentation, etc.

Key words: Archives, concrete, card, history, Tlemcen.

INTRODUCTION

Humanity, through its evolution, used materials of construction, susceptible to offer comfort, aesthetics, suppleness, stability, resistance and durability to the achieved works, progressively (Torrenti et al., 1999; Dubois, 2005). The concrete, on the basis of cement (Brahma, 1992; Vicat, 2000), answered the set of these requirements. Since the end of the 19th century, while some properties worthy of use thereafter were offered in an extraordinary manner, all materials used ancestrally and extensively were eliminated in the domain of construction (Marcel, 1995).

Therefore, how did humans live with this change? Was this material ever adopted quickly or did it give its proofs a long time ago? What is the process in the history of this material that drove to the fantastic development for it to be used more in the world of construction? What were the conditions for its development? Numerous questions on the history of the use of this enigmatic material are observed and they deserve to be clarified. For the case of

the survey that we chose to treat, the context is the city of Tlemcen.

To bring some answers to the calm questions, we collected some information available to the service of the archives of the town hall of Tlemcen in order to identify the process of construction that was adopted, as well as the different used materials, with the goal of characterizing chronologically, the evolution of the use of the material concrete in construction in Tlemcen.

STUDY LITERATURE

With regards to the study literature, we led a meticulous research where we could collect the data concerning more than fifty projects on one period spanning from the end of the 19th century to the beginning of the 21st century. It is necessary to underline the fact that it is during this period that the concrete marked its evolution as a material of construction in the world (Nachtergal, 1994). Also, during a good part of this period, Algeria was occupied by France, who had put legislative texts in place, permitting a better organization and arrangement

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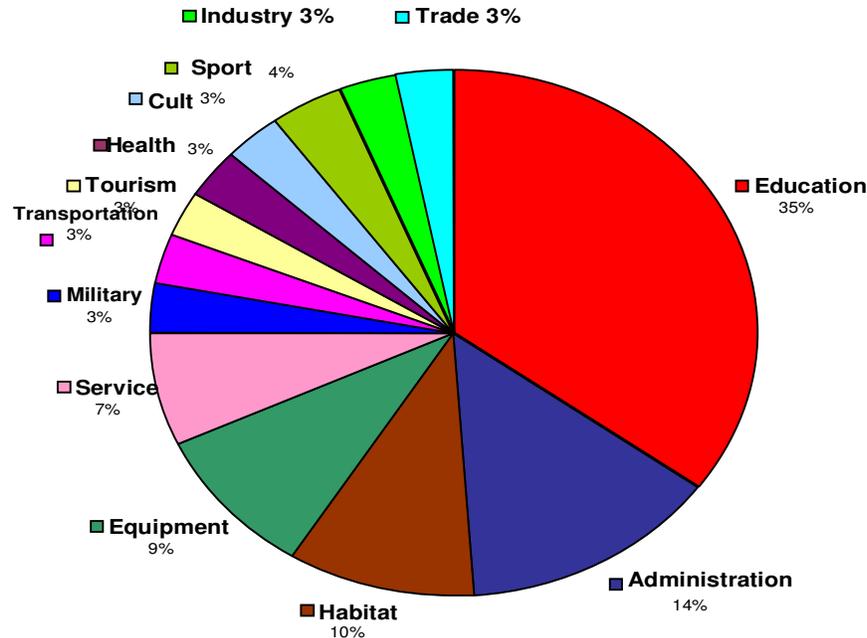


Figure 1. Distribution of the projects by sectors.

of the urban territories, thereby obeying strict procedures that thus concern production of urbanism documents (card, plan, report, decree, etc.) and storage (Olivier, 1980; Poussin, 2005).

After the compilation of the data, we proceeded to their treatment while achieving for every project, a card containing all useful information, such as: situation of the work, date of realization, the undertaken construction, function, used materials, graphic documentation, particularities, etc. The analysis of this information permitted us to find the answers previously to several calm questions.

METHODOLOGICAL APPROACH

Research within the archives, especially proves to be nit and thus demands a big thoroughness when it is about carrying projects of two or several appellations. It was especially the case in the sector of education. Besides, the studied project's majority includes coins projects annexed to planning and repairing, of which the processes of construction varied. The total number between projects and under projects treaties rises to a hundred and eight. These projects are classified by the chronological order in Appendix 1.

Figure 1 illustrates the different project distributions studied by the sector, of which the most important (35%) is the one of education.

The exploitation of the set of these data succeeded in the production of a card that situates the different projects studied according to the ordering recommended by the sector on the one hand, while using their appellation of origin, and presented on the other hand, all relative information to every project that are inserted with the help of hyperlinks on the so-called card. This card has been elaborated with the Autocad software where each sector has been identified in a specific manner by a colour in a plan (Figure 2). The whole graphic documentation has been digitalized with the help of the A0 scanner that is built inside the card with hyperlinks.

In the first time, the projects were implanted in the intramurals. Once this urban space has in itself densities, the projects spread outside the battlements of the city, especially in the southern part, thus preserving the Fertile Crescent situated at the north.

While referring to Figure 3, if one takes the example of the realization of one primary school (Henri Adès), by a simple click right - Button - on the project illustrated on the card, a window presents itself under the shape of a picture, so the wanted information will be selected automatically from this window.

Use of the concrete in Tlemcen

The mass of data that have been collected was the object of numerous verifications, due to the worrisomeness of eliminating the potential mistakes of transcription or seizure. It is through the analysis of these data that we intend to answer the objective that we assigned ourselves, which is to know the evolution of the use of the concrete as a material and as a process in time and in space for the studied projects of construction. The relative card analysis for the studied projects permitted us to divide the historicity of the evolution of the use of concrete and its constituent in Tlemcen in five periods.

1st period (1900 to 1930)

During this period, the cement was used like an addition to the hydraulic lime and its use was limited. The distinction of the different types of cement was made by numbering (cement marks N°1, cement marks N°2, etc.). As for the aggregations, the preference went to the use of the thin sand and granulates calibrated: thick gravel or ballast curdled and broken to the ring (0.06) and very solid gravels to the ring (0.03) (Nachtergal, 1994).

The identification of the granular classes of granulates was taken by their maximal diameter (D) (Domede, 2006). Also, the mixture of the components was achieved there "without addition of water", after verification by the agent of the company. The stones had to be

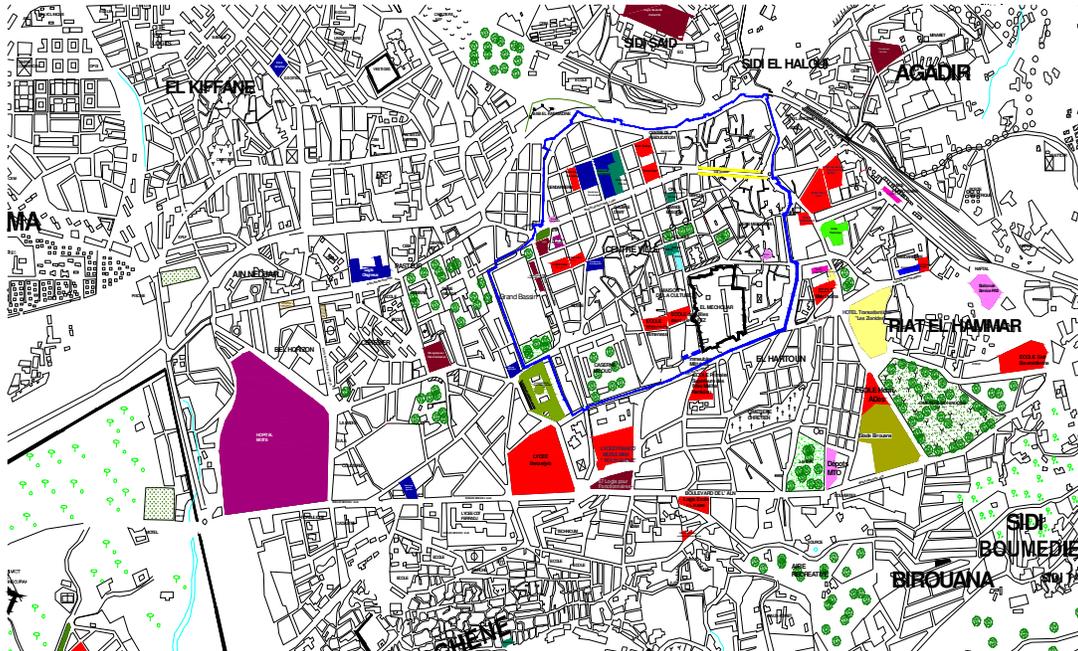


Figure 2. Card presenting the projects studied intra and extramurally.

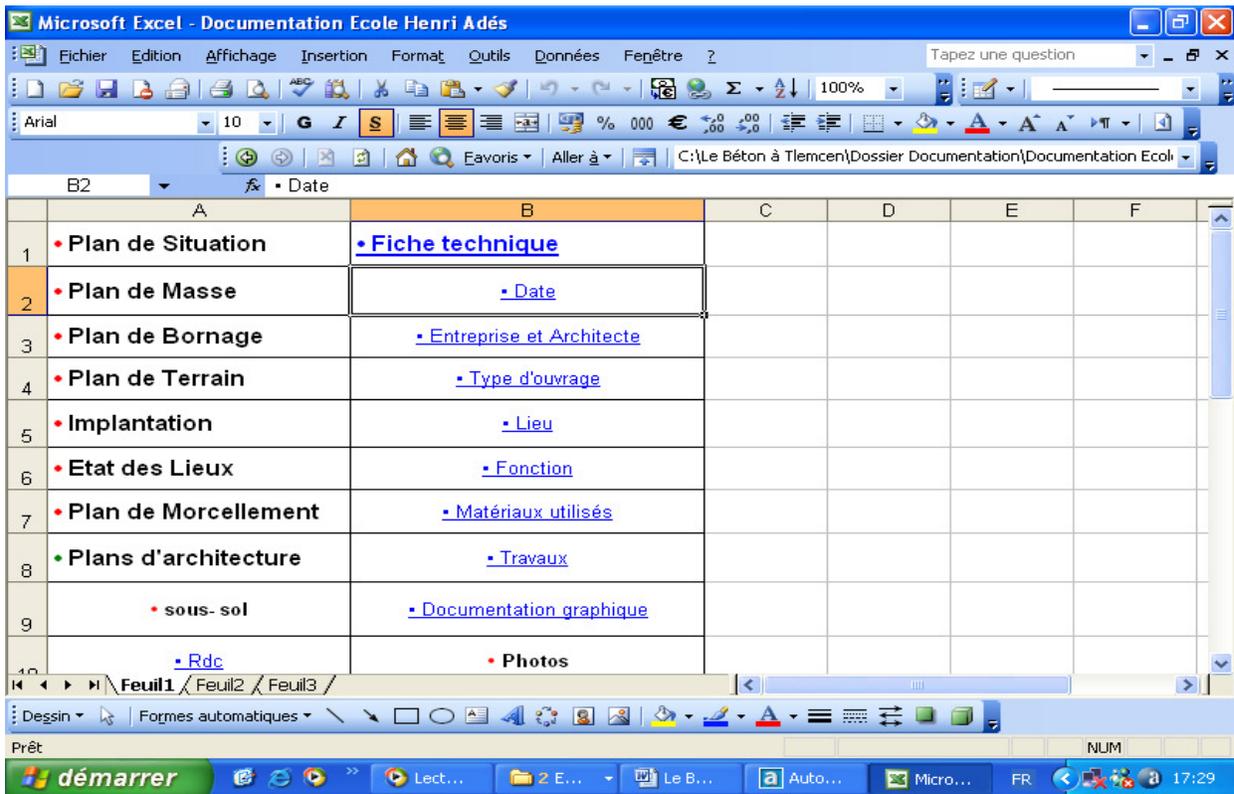


Figure 3. Access to the documentation of the project targeted.

watered before wastage, and then the concrete was used immediately. To the exception of some works of planning made of

concrete, we attended to the first use of the skinny concrete in Tlemcen, which is for the confection of tiling in tiles of cement

Table 1. Source and use of the materials (Period 1900 to 1930).

Material	Source	Nature of the employment
Cement	Of the Mediterranean;	Sealers
Cement marks N°2	Of Grenoble;	Works of foundations
Cement marks N°3	Analogous to the cement of Rivet and Nice; Analogous to the cements half slow Vicat	Current works in elevation
Hydraulic lime	-	Works of foundations
Fat lime	-	
Plaster	Warehouses of Tlemcen	Sealers
Hard stone	Of the career of Boumediene	Masonry works
Ashlars half hard	Of the Ravine of Ras el Ain of Oran	Masonry works
Sand	Of the career of El Kalaa or Boumediene	Realization of mortars
Curb-stones	Career of Boumediene	Curb-stones
Stones of tuff or materials	Works of demolition	Blockage and replenishment of the excavations

tablet. The realization of structures made of reinforced concrete was rare, besides it was called armed cement concrete, and we often met the appellation concrete that was curdled to the hydraulic mortar.

Results of the first period

Most projects, concerning the sector of education, where we note that the process of construction was used more until 1930, remained the masonry of:

1. Quarry stones, hordes mortar of hydraulic lime and cement.
2. Stones of different sizes or hard stones of Boumediene to the mortar of cement.
3. Bricks hordes to the mortar of cement.

While doing this research, we recovered a certain number of notebooks of the loads revealing the materials used for the composition of the concrete during this period, as well as the new techniques used in construction (Table 1).

2nd period (1931 to 1949)

During these two decades, the studied projects target the sectors of education and facilities.

Standardization on the quality of the constituent was got in place (apparition of new "NPS norms"). Indeed, the cements are classified in relation to the mechanical resistances: cement 20/25 (resistance to traction on 7 and on 28 days) (Nachtergal, 1994), cement 160/250 and 250/315 (resistance to the compression on 7 and on 28 days) (Nachtergal, 1994). Lime 3/5 and the aggregations opposite the thickest diameter (gravel of 20 and 30 mm granulates) descended from the crushing careers of the region. Also, the mixture concrete was designated according to the type of granulates that it was composed of: curdled concrete or concrete gravels.

Results of the second period

Concerning the level of construction techniques, the reinforced

concrete began to acquire a step on the masonry bearer and used it in the realization of the frame bearer (soles, tie beams, etc.).

The brick made of terracotta is now used for separation with the agglomerate of cement that appears.

The materials used to this time and their source are illustrated on Table 2.

3rd period (1950 to 1969)

During this period, we attended to the effort of construction in the sector of continuous education and also attended to works of planning, extension, confrontment and thick repairs since this park begins to grow old and require maintenance and interview.

For recall, this period knew the war of Algeria and its independence (the 05/07/1962). The efforts agreed by France in the sector of building are a means of strategic affirmation of its supremacy during the seven long years of war (1954 to 1962). Then, the first years of independence reveal the will of the country to develop itself and to assure the Algerian citizens of their needs concerning education, health, leisure, etc.

We observe that during this period, new binders are used as the HTS cement, for lime 30/60 and XEH lime.

Also, the used granulates are normalized and identified by granular classes: sand of chalky stone crushing, gravel 8/16, gravel 15/25, gravel of sea 5/15, gravels 6.3/25 and stones 25/63.

The mortars and the concretes diversify to answer new jobs on concrete cast, benched concrete, gigantic concrete, cellular concrete, concrete of cleanliness, etc. Some additions are incorporated there as the pouzzolane, granulated cork and the grain of rice.

Results of the third period

In process construction, the reinforced concrete became the material that is used more for the works of frame. The evolution of the means of setting and tightening these works facilitated its expansion a lot and contributed to the increase of its mechanical qualities. Besides, a certain interest is dedicated to tightness in order to increase the life span of the structures, while using the bituminous products. Also, we must note that the agglomerate of

Table 2. Source and use of the materials (Period 1931 to 1949).

Material	Type	Source	Nature of the employment
Lime	According to the NP15301S and NP15310S norms	Of the warehouses in the region	Sealers and concretes
Cement artificial Portland CPA marks POLIET and CHAUSSON	160/250 and 250/315	Of the Mediterranean factory of Gargenville	Mortars and concretes
Gravels	Sand and gravel	Crushing of the careers' hard stones in the region	Concrete under foundations and in elevations

Table 3. Source and use of the materials (Period 1950 to 1969).

Material	Type	Source	Nature of the employment
Lime	30/60; XEHS 30/60	Of the warehouses in the region	Sealers and concretes
Cement	White terrific cement 259/315; HTS cement	Of the Mediterranean	Mortars and concretes
Cement artificial Portland	160/250 250/315	Of the Mediterranean	Mortars and concretes
Aggregations	Gravel of the sea 5/15; Chalky gravel; Gravel 8/16 and 15/25; Gravel 6.3/25; Stones 25/63	Crushing the careers' hard stones in the region	Concrete in foundations and in elevation

concrete substitutes itself more and more for the quarry stones of stone and the full brick and hollow firing in the works of masonry. The materials used for the composition of the concretes during this period are less admired by the new French norms (Table 3).

4th period (1970 to 1990)

It is about the period where the independent Algeria put the quinquennial programs opening up on modernity and the economic development in place. The studied projects belong to various sectors (education, habitat, sport and leisures, etc.) where the structures (foundation and thick curve) are achieved exclusively in the concrete of cement. Indeed, the industrialization of the building requires the speed and the resistance raised from the concrete.

Results of the fourth period

From this period, the lime is reserved to the sealers and the prefabrication became one of the very common construction processes that correspond to the requirements of the moment. Besides, the normalization knew a certain evolution and notably the technical regimentation specifying thus, and in the detail, the act to build. Consequently, this answers the new recommendations.

We note that career granulates could not constantly be sufficient due to increasing demand, and therefore the use of the sea sand at

this time was allowed. Also, the set of the used materials were locally available (Table 4).

5th period (1991 to 2005)

During this period, the hydraulic lime disappeared completely, leaving the place exclusively to the cement Portland, whose normalization knew since the beginning of the 21st century a new flight.

Results of the fifth period

The classes of resistances have been reviewed in order for the suppliers of the construction materials to be held responsible for the same reason as the masters of the work or the enterprises in the act to construct, while offering a guarantee on the resistance of the cements' compression in 28 days (CPJ 32.5, CPA 42.5 and 52.5).

Also, the lasting development notion requires the preservation of the natural resource and landscape heritage, what contributed to reduce the wild exploitation of the sandpits appreciably in the region and promoting the opening of numerous private and state-controlled careers.

The consigns of Table 5 used lately some materials that appeared in the files of the works treated.

Table 4. Source and use of the materials (Period 1970 to 1990).

Material	Type	Source	Nature of the employment
Hydraulic lime	30/60	Of the factories of the region	Sealers
Cement CPA	160/250 250/315	Of the factories of the region	Thick works in foundations
Plaster	-	Of the factories of the region	Distempers
Sea sand	-	Beaches of the region	Mortars and concretes
Grinding sand	-	Grinding of hard limestone of the region	Mortars and concretes
Crushing sand	-	Crushing of the careers' hard stones of the region	Mortars and concretes

Table 5. Source and use of the materials (Period 1991 to 2005).

Material	Type	Source	Nature of the employment
Cement CPA	32.5	Of the factories of the region	Thick works
Cement CPA	42.5	Of the factories of the region	Thick works and sealers
Plaster	-	Of the factories of the region	Distempers
Sand	-	Beaches of the region	Mortars and concretes
Gravels	-	Grinding of hard limestone of the region	Mortars and concretes

RESULTS OF THE RESEARCH

We note therefore that the concrete as a material and process of construction, known in Tlemcen, as everywhere in the world, is a certain evolution in the domain of the building. We were able to thank the relative archives to the projects achieved within the city of Tlemcen during one century of age, to show the place taken in a progressive manner by this material in the different yards.

Face 4 regroups the results of this striking progression presented during five distinct periods in which the materials and process of construction elders by the products were substituted on the basis of concrete.

During these five distinct periods, we note the evolution of the use of concretes in construction, as well as the receding remark of the use of lime in foundations and elevations.

While analyzing the results illustrated by Figure 4, we distinguish that the use of the lime in construction during the first period was frequent. The first constructions made of concrete started at this time; however the reinforced concrete in the construction was rare.

During the second period, the use of lime moves back little by little, while on the other hand, the constructions made of concrete and reinforced concrete evolved progressively.

For the other periods that follow, the growth of the works achieved in concrete and in reinforced concrete stays hitting, however the structures achieved on the basis of lime are rare.

[0, 1]: Weak use (10 to 20%)

[0, 2]: Moderate use (20 to 40%)

[0, 3]: Middle use (40 to 60%)

[0, 4]: Big use (60 to 80%)

[0, 5]: Very big use (more than 80%)

Conclusion

The apparition of concrete in the world of construction in different domains of building and in public works revolutionized the process and uses of construction practiced a long time ago. As such, new needs appeared with the advent of this material.

Besides, the qualities of this material did not stop improving continuations to the different researches done in this domain. This is due to its composite "property" that gives it, on our days, the merit to be classified among the materials that is used more in the world

Indeed, age was necessary in about one century between the time of deposit of the binder's patent invention designated under the name of "cement artificial Portland" and its use in the confection of the composite mixture (that is, the concrete of cement). The two world wars that humanity knew during the first half of the XXème century were the precursors of a very big consumption in concrete and other materials for the entire city's reconstruction.

In this same context, we tried to draw the historicity of the use of this material in the city of Tlemcen, and also by a research of all construction projects made of concrete

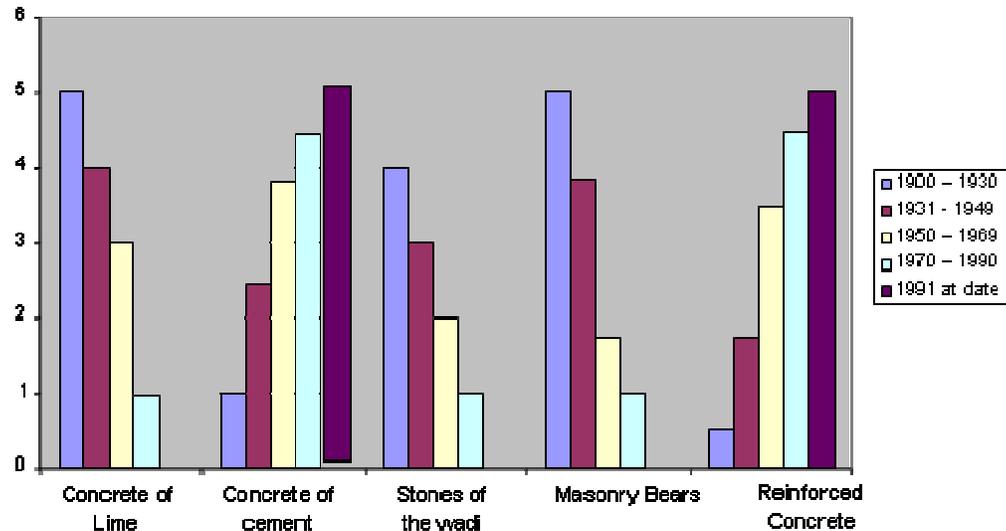


Figure 4. Evolution of the materials and processes of construction.

in this city through the consultation of the township's archived files, while sweeping through this research about one century ago. In this manner, we could gather all relative information to the projects studied by the chronological order in a bank of data that contains technical cards for every treated project as well as the whole available graphic documentation. Accessibility to these data proves to be methodical because all the files are digitalized and a cascade is bound between them. Thus, once the situation card is opened, one is permitted to have access to all information concerning these data while clicking merely on one of the fifty seven studied projects.

With the aid of these information, we could show the place that was taken in a progressive manner by this material in the different yards. We noted that the use of the concrete since the beginning of the XX^{ème} century was nearly diffident; however, the use of the hydraulic lime always remained frequent in these features of hardening and resistances declared by the patents established at that time by Louis Vicat (Vicat, 2000).

We distinguished, through this research work, the striking progression of the cement concrete according to five distinct periods generating the substitution of the materials and process of construction elders (the lime, plaster, etc.) in foundations and in elevations.

Besides, we identified the source of the constituent on the basis of the concretes prepared. The dosages of the mortars and concretes varied according to the source of the materials and their availability. The sand of the sea was used at that time, as well as some classes of gravels and stones modified today.

Also, the introverted information revealed that several structures in masonry have been demolished, thereby leaving the place to the new work reconstruction made of concrete and reinforced concrete. This material's innovation imposed itself progressively on all yards and found its application in foundations, as well as in individual house tiles and public buildings that are in the veils of art works or buildings.

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Appendix 1. Presentation of the studied project.

Project no.	Title	Date of realization	Sector	References limp of archive
1	Construction of a primary school (School Slane - " Ibn Khaldoun ")	1892	Education	2431 2539
2	Enlarging the shops of the school (Arabe -Française Décieux)	1907	Education	2569
3	Construction of a primary school (School Sidi Boumédiène).	13/03/1912	Education	2548 2549
4	Construction of a building on the floor in border of the appendix of the MTO nursery	1927	Service	10112
5	Construction of 11 lodgings	1927	Habitat	10113
6	Construction of a thermal factory	1927	Industry	10113
7	Construction of an indigenous school of boys "Ibn Badiss"	1930	Education	2452
8	Construction of an indigenous girls school "Metchkana"	1930	Education	2457
9	Construction of a class in the nursery school "Ximenss"	1933	Education	2547
10	Amenities and interview in the school (Duffau "Ibn Marzouk")	1933	Education	2447
11	Construction of stores	1933	Trade	10129
12	Construction of a bank "immeuble du crédit foncier"	1933	Equipment	10129
13	Construction of a primary school superior to that of the girls of Tlemcen " Maliha Hamidou"	1935	Education	2438 2439
14	Construction of a nursery school in the suburb of the station	1936	Education	2452
15	Construction of a bank: BNA 527	1937	Equipment	10145
16	Construction of a municipal stage and a swimming pool	1937	Sport	2824
17	Thick repairs on the girls school 'Rue de Fez'	1939	Education	2547
18	Construction of the Transatlantic hotel "Zianideses "	1942	Tourism	10635
19	Construction of a primary school "Henri Adès" -"Ibn Mssaib"	1950	Education	2465 2466
20	Construction of three lodgings for the account of the OLAGINEUX society	1950	Administration	10168
21	Construction of a primary school 'Riat El Hammar' "Tchiali Mostapha"	1951	Education	2569
22	Construction of a primary school "Demoiselles"	1951	Education	2611
23	Construction of twelve lodgings in the school 'EL Kalaa'	1951	Education	2611
24	Construction of a mixed hospital in Tlemcen	27/04/1952	Health	10717
25	Construction of a high school for boys -"Ibn Zerdjeb"	06/1953	Education	2436 2437
26	Construction of a building "Hôtel EL Mansour"	1954	Tourism	10228
27	Construction of a Centre of professional education	1954	Education	10228
28	Construction of a European girls school	1955	Education	2438 2439
29	Construction of two collective buildings for lodgings of study (Français – Moslem)	1955	Habitat	10228

Appendix 1. Contnd.

30	Construction of an high school "polyvalent"	1956	Education	2441
31	Construction of a Hotel in the Stations "la grande poste"	1956	Equipment	10115
32	Construction of a Health center	1956	Health	10715
33	Construction of a service station in the RN2	1956	Service	10235
34	Heightening of two floors of a building administrative EGA.	1956	Administration	10234
35	Construction of a building for the agricultural service installation	1957	Administration	10242
36	Construction of temporary offices of the prefecture	1957	Administration	10242
37	Construction of two buildings	1957	Military	10238
38	Construction of 91 lodgings for civil servants	1958	Habitat	10246
39	Construction of a service station in the RN22	1958	Service	10246
40	Construction of 67 lodgings for civil servants	1958	Habitat	10248
41	Construction of a lodging to the station of Tlemcen	1958	Transportation	10251
42	Construction of collective evolutionary lodgings	1958	Habitat	10251
43	Temporary building construction for the subdivision "commissariat"	1958	Administration	10243
44	Construction of a bank B N C I A "national Bank for trade and industry"	1958	Equipment	10244
45	Construction of 60 lodgings in Bel air	1960	Habitat	10328
46	Construction of a barrack that keeps mobility	1960	Military	21061
47	Construction of a mosque in Feddan Sbaa	1961	Cult	10331
48	Construction of a reservoir of 500 m3 in Boudghène	-10-1961	Equipment	10331
49	Construction of a laundry and a drier to the Moorish bath	1961	Service	10328
50	Amenities of a building in offices of the INTERCRO	1961	Administration	10328
51	Construction of a primary school (Jules Ferry "El Makarri")	15/10/1964	Education	2536
52	Construction of a primary school (Pierre Curie "Dar El Hadith")	1965	Education	2539
53	Amenities of the stage of Birouana	1966	Sport	2838
54	Construction of a station road SNTV	1969	Transportation	10638
55	Construction of a direction of unit and lodgings of function for SAA	21/12/1980	Administration	10633
56	Construction of a direction for DUCH	1993	Administration	1946
57	Construction of a Mosque in Oudjlida	2005	Cult	/