

TECHNOLOGICAL EVOLUTION OF SOCIAL HOUSING 1940-2005. THE BUILDINGS OF PATRONAT MUNICIPAL DE L'HABITATGE DE BARCELONA

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Keywords: Social Housing; Building Technology; Construction History; Barcelona; Patronat Municipal De l'Habitatge De Barcelona.

Abstract

The aim of this study is to show how building technologies for social housing in Barcelona changed. The social housing in the conventional thinking about the history and evolution of building technology is one of the least innovative sectors from the point of view of the construction technique.

To achieve that objective the author had searched original information about real constructed buildings in the project files of the Patronat Municipal de l'Habitatge de Barcelona (<<http://www.pmhb.org>>) from the 40ies to nowadays. Afterward he had compared this case study information with a parallel study about the evolution of price of housing materials came out in economical journals of construction.

The conclusions are for the period between 1940 and today the technology of construction applied to social housing has completely changed more than one time. The buildings of 1940s have no similarities with buildings of 1980s and these are absolutely different of the buildings of today. Two cycles of change have been completely done.

All technical systems of building (structure, façade, building services, etc.) have not changed at the same time. Between the 1940s and the present there have been two main periods: Until 1980s the most of changes are placed in the structure of buildings and after the 1980s the most important changes are placed in the building services; many of them forced by the emergence of the new regulations. Pavements and coatings have evolved and changed by the market laws and fashion trends during all time.

From the point of view of construction technology someone can distinguish three phases:

- A neo-traditional stage.
- A failed attempt of mass industrialization with the idea of earn money and time.
- An attempt of intelligent industrialization of building parts with the main idea of assure the quality.

1. Introduction

The main aim of this study is to show how the technology of social housing in Barcelona changed from the 1940s to nowadays, identified the main changes and put them into a context. The social housing in the conventional thinking about the history and evolution of building technology is one of the least innovative sectors from the point of view of the construction technique but, in reality, all technical systems of building (structure, façade, building services, etc.) have changed and they have not changed at the same time. Since 1940 the technology of construction applied to social housing has completely changed: new kind of techniques, new materials, new regulations, new social demands and a new conception of social housing too. In effect two cycles of changes are completely done. The buildings of

1940s have no similarities with buildings of 1980s and these are absolutely different of the buildings of today.

After Spanish civil War people had a social emergency because, between others, they needed a lot of new houses. In Barcelona social housing have been constructed by Instituto Municipal de la Vivienda till today under the name of Patronat Municipal de l'Habitatge (<<http://www.pmhb.org>>). The same public enterprise has constructed social housing in Barcelona since 1927.

In the early 1940s, after the Civil War, Spanish government passed the Social Emergency Plan who gave the main indications to build new social housing [1]:

- Minimum composition of 6 rooms for the new houses (hall-dining room-living room, 3 bedrooms, kitchen and bathroom).
- All rooms have to be independent except the living room.
- All bedrooms have to ventilate directly on the façade. One of them has to have enough area for one double bed. The apartment has to have minimum two more bedrooms to separate children by sex.
- No circulation space in the apartment, only one corridor to gain access at bedrooms.
- No more communal closed courtyards. The new buildings were narrow bay with two main façades.
- Coherent spatial distribution with the new kind of buildings. All liveable rooms have to ventilated directly on façade.
- One or two balcony, one of them dedicated to washing.

In the beginning of the study period these indications, and other circumstances like restrictions of steel, made significant and considerable changes on construction technology. Afterward the reasons of main changes were the increase of energy demand, new housing materials and especially new regulations.

During the studied period one of the most spectacular and interesting change is the evolution of the building services. The building services are a hide part of building but it makes possible the comfort inside. Even so, in the early 1940s the building services in social housing almost existed. In the years that followed the building services have gained importance and complexity in parallel a the emergence of new regulations. That changes increased the price of the building services too. But only in few buildings the building services have been an important part of building project. The most of times the building services doesn't incorporate to architecture project from the beginning. Usually they incorporate to architecture project from advanced stage of design. One of the most important problems to achieve the main objective is the little information in the projects about building services. Before years 1970s the information about building services in the projects was the minimum. The schemes of building services was generalized since years 1970s, most of times, forced by a new regulation.

2. Method

To achieve the main objective the author searched original plans, technical reports and budgets of constructed buildings in the archive of PMHB from the 1940s to nowadays and ordered the buildings by age and technical characteristics to make a try. The try was: Torre Llobeta (1946); Can Peguera(1949); Bonsuccés (1958); Building J of housing park Montbau (1959); El Polvorí (1961); Wellington (1964); Building N of housing park Montbau (1966); Paral·lel (1966); Almirall Cervera (1968); Building B of housing park La Mina (1971); Building B of housing park Canyelles (1972); Building A of housing park Canyelles (1974); Can Ferrero

2 (1985); Passeig de l'Exposició (1996); Mecànica Foneria (1996); Segre 123 (1998); Torre Baró-Martorelles (2001); Riera Alta (2004); Concili de Trento (2005). Afterwards he compared this case study information with a parallel study about the change of price of housing materials came out in economical journals of construction along the length of the studied period.

3. Plumbing

The most important changes on the drain-waste-vent systems are the housing material changes and the design of the system. Until years 1970s the most utilized material was fibre cement. On account of him toxicity the laws of 1984, 1993 and 2001 forbade the use of Fibre cement in all uses in housing. PVC replaced fibre cement as most used material. The drain-waste-vent system of Building B of housing park of Canyelles (1972) is completely in PVC. Afterward other kinds of plastic were used like High Density Reticulated Polyethylene (building at Torre Baró, 2001) or Polypropylene (building in street Riera Alta, 2004). Concrete have been the most used material for the sewer collection system when they are buried but when the building have basement plant and the sewers hang under the ceiling, the sewers are in plastic. The change of fibre cement to PVC is obligated on account of the toxicity of the material. The other changes of material obey to economic reasons or functional reasons in the case of sewers. The most important change in design of the drain-waste-vent system has been first the inclusion of separated networks for rainwater and wastewater in years 2000s and afterward rainwater, wastewater and greywater. The building in Torre Baró (2001) have a separated drain-waste-vent system. This change was obligated by regulation. Separate the networks of rainwater and wastewater made several changes in drain-waste-vent system. It occupies more space and wastewater network needs ventilation because the pressure of WC discharges sucks the water in the siphons of the rest of the network. These two facts have been several impacts in the ground plans of housing buildings.

The water supply system has changed the housing material and the design. Along the length of the studied period the height of the buildings increased a lot (building in the street Wellington, 1964, have 15 plants). On account of that the pressure of water supply was not enough for raise the water until the high floors. That obligated to install pressure raiser equipment and water supply networks that could stand surcharges. The water supply system has had several changes of material too (Table 1). In the early projects it was in lead but on account of economic reasons the lead change into galvanized steel in years 1960s (for health reason the lead finally disappear of the water supply systems). The galvanized steel is more resistant to impact than lead but lead can be welded. Usually in years 1960s was do the interior of apartments in lead and the rest of water supply system in galvanized steel. In years 1980s the copper is still more expensive than galvanized steel but it has an advantage over galvanized steel. The copper can be welded and it's easier to work than galvanized steel. In the recent buildings, like building Can Ferrero 2 (1985), usually only the water supply connection with the urban net is in galvanized steel. Copper have replaced recently by plastic materials (polyethylene and polypropylene) in specific situations like the water supply systems of the interior of the bathrooms. Copper is more resistant to impact and heat but plastic materials are easier to work and cheaper. The main change in the design of water supply systems has been the partitioning the network with a shut-off valve before going into a new room forced by new regulations.

Table 1. Price evolution €/ml without taxes of pipe of 20mmØ [2].

Year	Lead	Stainless Steel	PVC	Copper	Polyethylene
1950	0.75	0.45	-	-	-
1964	0.40	0.15	0.09	-	-
1985	1.57	1.26	0.40	2.07	-
2001	2.44	4.28	0.41	3.01	2.07
2010	7.70	8.50	0.70	2.94	2.37

4. Gas Supply

The gas supply system was developing in parallel of water supply system until year 2000 when gas service almost disappeared of social housing. In year 2000 Government of Barcelona passed Solar Thermal Order of Barcelona. That order forced, the most of times, to install solar collectors systems in buildings. The collateral effect of that was the increase of the price construction of building and the most of the property developers eliminated the gas supply system of them buildings with the intention of don't raise the price construction. Until years 1970s the gas supply systems was completely in lead. Afterward (Building B of housing park of Canyelles, 1972) the gas supply system put together lead and galvanized steel. Lead in the interior of the apartment and galvanized steel in the rest of the network because it is more resistant to impact. In years 1980s the lead was substituted by copper and only rests in galvanized steel the gas supply connection with urban net.

5. Heating

Until years 1990s the buildings of PMHB didn't have a heating system but since housing park of Montbau (1966) high electrification was contracted because of the projects considered electric heating appliances (between other electric appliances, in that years the number of electric appliances in the houses increased a lot). From years 1990s to 2000s the most used heating was heat water system with steel casting radiators. After year 2000, without gas installations, the heat water systems of heating disappeared too of the buildings.

6. Sanitary Hot Water (SHW)

The evolution of SHW production has depended on the energy source. Until the housing park of Montbau (ending years 1950s) the apartments had individual water storage for a hot water production with gas supply. Afterward the water storage were substituted for instant water-heater supplied with gas too. Since year 2000 (passed of the Solar Thermal Order of Barcelona) the gas supply have almost disappeared and the most of the home production of hot water comes to electric energy. In the other hand after thanks to Thermal Order of Barcelona the most of buildings have had a solar collectors system for hot water production before the emerge of Eco-efficiency Decree (2006) and Technical Building Code (2006).

7. Electricity Supply

The most important changes in the electric supply system have been the increase of the electrical consumption due to the appearance and generalization of the new appliances and the changes of design of the electricity supply system due to new regulations. In the 1973 the Regulations for Low Voltage electrical Installations (in Spanish Reglamento Electrotécnico de Baja Tensión, REBT) were passed. The application of the new regulation forced several changes in the electrical installations. The most important are the obligations of to have earthing

lug, forced to put the conductors in a protection tube, forced to have a minimum number of electric circuits in houses and their function, specified the characteristics of installation and users protections and specified the documentation in the project. That regulation doubled the price of the electricity supply installation (Table 2). In 2002 new REBT was passed. The most important changes of new regulation were: explain the role of enterprises and installers in the project and during the construction of the building; increase the minimum number of circuits of houses and forced to edit an electric project with architectural plans and an electric report of the project. The new regulation increases the electric installations too but less than the first REBT (Table 2).

Table 2. Price evolution of electric installations in social housing [3]. Where: 1. Building estimate €/m² without taxes; 2. Electric installation estimate €/m² without taxes; 3. % of electric installation estimate into a global estimate.

year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
1	7,54	12,54	18,74	46,83	93,85	116,01	225,09	318,31	379,20	471,80	851,01
				1973-REBT		2002-REBT					
2	0,21	0,33	0,44	0,94	4,08	9,20	11,98	15,79	19,26	25,45	45,00
3	2,79	2,63	2,34	2,01	4,35	7,93	5,32	4,96	5,08	5,39	5,29

8. Kitchens

The most important changes in kitchens were the design of them (identification and separate the different works inside, worktop in the same level with the kitchen fittings, measuring and modulation the space), housing material changes, energy sources changes and new appliances. Modern kitchen was defined in 2nd CIAM (1926) [4] but at the beginning of this study (years 1940s) the most of the characteristics of it didn't arrive at social housing kitchens. Maybe the reason was in one hand the kitchen in bourgeoisie homes only the service used the kitchens and was not applicable on social housing and in the other hand it didn't have an own kitchen model for a social housing. At the beginning of the period studied the kitchen was almost a residual space: little rooms with peculiar geometry due to the kitchens (and bathrooms) were the last in order of importance. Most of the apartments had worktop at the same level with the kitchen fittings but it was too little and it seems there's no point in function rounds and not a trace of size coordination between kitchen fittings and furnishings. Until the years 1990s the changes were been punctual arrivals without consolidation. In the middle of years 1990s the modulation precast and size coordination finally arrived at the kitchen furniture (kitchens of building Mecànica Foneria, 1996 are modulated). In years 1990s the modern kitchen was finally consolidated in social housing of PMHB. The most important housing material changes have been in worktop and fittings materials. The worktop in the beginning years '40 was it formed by 'azulejo' tin-glazed ceramic tile (building Torre Llobeta, 1946). Quickly the worktop was made of

big size marble pieces (building at Bonsuccés Square, 1958). For economic reasons marble slab turn into granite in years '90 (building Mecànica Foneria, 1996) and granite turn into mineral agglomerate slab in years 2000 (building in street Riera Alta, 2004). The sink turns the ceramic material into stainless steel in years 1990s (building Mecànica Foneria, 1996). The evolution of stove concerned the changes of energy sources into home. The kitchen range substituted by gas stove in ending years 1950s (building at Bonsuccés Square, 1958). Until years 1990 the stove was mobile in the same appliance with the oven (both with gas supply). In years 1990s the mobile gas stove with oven were substituted by built-in gas stove and independent oven (building in street of Exposició, 1996). The independent oven can had a different energy source than stove (usually electricity) and it didn't have to be under stove and turns easier to work with it. In years 2000 the gas supply has almost disappeared from social housing and stoves and ovens usually have used electricity. One important change too has been the role of kitchen into the house. During the period studied the kitchen earned importance like a social space in the house and that has resulted in a more important place into house and accurate design.

In the housing park of Canyelles PMHB essayed with mass industrialized techniques. The structure of these buildings was built with industrialized formworks (tunnel formwork) and PMHB essayed to extend the industrialized techniques to rest of the building (precast façades, etc.). In the building B (1972) the architects essayed with economical criterion of joined the most of installations in a one technical wall (shared with bathroom) but with one problem. These kitchens had important functional problems. The most important they didn't almost have work space. In the other hand the building A (1974) had a conventional kitchen with the most of the modern kitchen parameters. The kitchens of building A didn't have the advantages of industrialized technologies but it was more comfortable. In that case was a design fail not a technique fail. After Canyelles that criterion was left during long time. Today intelligent industrialized like one industrialized wall with the most of installations incorporates is usually.

9. Bathrooms

The main changes in the bathrooms have been the generalization of bathtubs and bidets, changes of housing materials and the position of the bathroom into the house (plus all the changes in plumbing explained). In the years 1940s the bathrooms was next to the façade. With new structural dispositions (in the early 1960s, the structural walls was turned 90° until they rest in perpendicular with the façade and beginning the reinforced concrete structures in social housing) and new ventilation system (Venturi Effect in building in street Wellington, 1964) the bathroom could be in the interior of the building. Always it was a service room and it had no importance for the designer, only technique questions about the building services. In the years 1940s usually the bathroom was composed of WC, washbasin and shower (bathtub and bidet didn't be usual). In the ending of years 1960s the porcelain sanitary fittings were generalized (building in Parallel street, 1966). Beforehand the 'bañoaso' (little bathtub with shower) was so habitual. In the years 1980s the porcelain bathtub was substituted by enameled steel bathtub (building Can Ferrero 2, 1985). At the same time the bidet was generalized. After years 1980s have not important changes. Only the acrylic sanitary fittings have appeared and improvements in the fittings like water economize systems. In effect the bathrooms have not changed a lot. Maybe the reason is the use of that room that concerns human behaviour and is not easy to change [5]. Almost all essays of radical changes in bathrooms have failed.

10. Conclusions

- Throughout the study period the construction technology applied to social housing have changed a lot but not constant in time. Particularly the building services. Before the years 1970s the most of changes concerned the structure and façades and afterwards the most of changes have been in the building services (the most of them forced by new regulations).
- During the studied period the construction technology of social housing have completed two cycles of change. From years 1940 to 1980 and from years 1980 to nowadays. The length of time of each cycle is reduced. That may indicates the functional life of buildings is shorter than before.
- Force the changes without the conditions are almost impossible. The use of mass industrialization in housing parks is an example of failed attempt to introduce new technological systems.
- The most of the housing material changes have been by: changes of the relative price between them (plastic materials for copper); better properties (copper for stainless steel); new regulations restricted them utilisation (fibre cement, lead).
- The regulations have a great power over the construction technologies and the constructed buildings. Especially over the building services.
- Energy sources that supply the building can force the choose of the technology, especially in building services.
- The technological transferences and the productive changes of the industries (inclusive industries take up in other fields) have influence in the technology of construction and in the price of construction materials.
- The rise of purchasing power have influenced in the construction of social housing. More appliances and more demands over the building between others.

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