

Analysis of a structural masonry building system in low-income housing

Caio Barroso Costa¹, Walzenira Parente Miranda², Erika Cristina Nogueira Marques Pinheiro³

¹Graduating, Estácio de Sá University, Brazil

²Civil Engineer, Work Safety Engineer, Didactics Specialist in Higher Education, Graduated in Law, University Professor (Estácio de Sá College and Nilton Lins University, Brazil

³Civil Engineer, Work Safety Engineer and Degree in Mathematics (Specialist in Didactics in Higher Education and Tutoring and Teaching in EAD -University Professor (Estácio Do Amazonas College, Nilton Lins University and Unip), Brazil

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Abstract— Engineering, as well as society, has evolved side by side over the years, but the economy in our country has not entered the same axis, leaving millions of unemployed people, and with low income. Soon with high rent values, many of these people end up being evicted, or just surviving, and not living. It was there that Engineering, together with the State, aligned ideas that would bring housing accessibility to low-income people, on the one hand, Engineering creating a constructive system with very low operating costs, bringing convenience and security to future residents, and the other the State financing part of this operation. In this present work, we will analyze how this structural masonry construction system works in a popular housing in My House My Life, in our city, Manaus, showing how it positively impacted society to have a place that it can call home.

I. INTRODUCTION

Evolution, whatever the area, depends on motivations, or needs needs. In the case of Civil Engineering, it advances as society gives indications that it needs improvement.

Analyzing the problem of the housing deficit in the country, which is 7.757 million homes, according to a study released by the Getúlio Vargas Foundation

(FGV) in 2018[1], the evolution would have to come in some way, and based on this study and so many others.

As the last few years, we have read news and managed information that the state of our economy is worrying, and there has been a huge unemployment rate in our society at large. This has directly affected the way everyone lives because people work for a

living, but nowadays, this concept is another, one works to survive.

Having this thought, engineering together with the State,

organized an action plan to help such low-income people to have a decent housing, with security that is crucial in the situation that we all live today, and accessibility in obtaining it. With this was created by the Federal Government in 2009 the Program My House My Life (MCMV), where popular housing is built that allow people with low income, to have their home, to call home.



Fig. 1: Typology of a popular housing Smart Tree - Manaus.



Fig. 2: Popular housing Smart View of the Sun - Manaus.

To reach this accessibility to all, had to be planned a whole project behind, from the purchase of land by the developer, to the marketing that would be made of the enterprise, but where I want to get, is that one of the main factors of all this, comes from a base for every engineer who aims for success: a work with low production cost and a shorter execution time. And this low cost aligned with a reduction in time, vieram of minute calculations, from the concreting of the radier to the size of the concrete block that will be used. However, it is worth noting, that always considering, in this case, the NBR 15.575/2013[2] of ABNT, in relation to items such as structural safety, thermal and acoustic performance, fire resistance, watertightness, durability and maintainability and have less environmental impact, with their minimum values required.

This work will analyze the line of reasoning for the execution of a qualified and efficient project, going back a little and discovering how this whole concept of structural masonry began, which is so implemented nowadays, and which has become a formula of success and guarantee of life for many families who previously did not have adequate housing conditions. We also contemplate the particularities of this construction system, in which we will present it, pointing out the advantages and disadvantages of structural masonry, also addressing the positive and negative impacts, socioeconomically, caused by the construction of such popular dwellings.

II. METHODOLOGY

Brazil today and in the past has always had as a great psychosocial villain the discrepancy that are the socioeconomic classes, and as most consumers, are those of the lower classes, there is more demand for housing to this population group. The choice of the construction system to be evaluated had as its basic premise the great need that is the construction of these houses in our national territory, so that in addition to a better housing condition having low cost of acquisition, by this vast group of consumers, being able in itself to solve this saturation relative to population density

to which we are currently, with a large number of people without minimum housing conditions, and with estimates that over time, population growth will be even higher.

Thus, we will use the parameters created by SINAT (National Technical Evaluation System) of PBQP-H (Brazilian Habitat Quality and Productivity Program) to determine the technologies that will be analyzed.

SINAT [3] is also responsible for validating the DATec (Technical Evaluation Document) of construction systems, but for this research they will not be evaluated. For the analysis of the construction system, we will use as a basis a type of plan for a multifamily residence.

For this project, as I had direct experience in the subject that incorporates the theme of this article, working at Morar Mais Empreendimentos Imobiliários Ltda, where I had extreme participation, from the process of creating enterprises, through studies of feasibility of land, analysis of preliminary projects and executive projects of it, and in the monitoring of the works of the program Minha Casa Minha Vida (MCMV) for which this company I worked.

The data collected went through exploratory research, where information had been collected due to my time inserted in the company, in which I could also due to the constant field visits to analyze descriptively and qualitatively about the construction process of these popular dwellings.

The various field visits to which he had made, helped much in the database and in the questions, I had at the time, thus being able to ask countless questions to my technical superiors. Also participating in many technical meetings, regarding the quality system, which in this case, the Performance Standard NBR 15.575, which deals with the performance of housing buildings and indispensable characteristics of a work for the consumer, with the objective of pusing comfort, accessibility, hygiene, stability, construction life, structural and fire safety. All this was the basis for the results and discussions to which I will later portray.

III. RESULTS AND DISCUSSIONS

3.1. INTRODUCTION OF RESULTS AND DISCUSSIONS The Construction System is based on how the project, whether residential, commercial, mixed, housing, or any other sector, will be carried out. There are several forms and methods of constructive models, but depending on the type of finish that will be used, for which socioeconomic sector will be destined, for what purpose it will be carried out, such types of systems are organized for a better cost-benefit, presenting their advantages and disadvantages.

As learned through the Engineering course, we had several subjects related to the construction system, and all almost always direct to a common denominator, which is cost-benefit. We know that engineering, the main focus is, to have a fast productivity, in a short interval of time, all this to generate less expense, to obtain higher revenue, but always respecting the determinations and standards that pbqp-h (Brazilian Program of Quality and Productivity of Habitat) assures the consumer who will reside such housing.

Through several studies of structural calculations, they concluded that the most well-known system today by developers throughout the country, is structural masonry, because, in addition to being more economical due to the low cost of material in function of the time that the manpower will take to lift it, it still brings security to those who reside.

In order to understand a little better how this system so old and so current at the same time, has become so popular in the midst of construction, not only for the popular housing segment, we will go back a little bit and talk about how it all began.

3.2. UNDERSTANDING ITS HISTORY Structural masonry, although the name may seem so modern and current, it is much older than we imagined, coming from and at the time of our friends men of Neanderthals, Prehistory.

The first masonry to which it was known, due to the lack of rationalization in the calculations, and the knowledge of the resistance of the materials that were used, stone or ceramic brick dry in the sun, presented great thicknesses in their works with greater magnitude, and so it was carried for many, many years.

Over time, several other types of materials were being inserted, progressing along with the evolutionary process to which it had passed, and until the beginning of our century, the constructions in stone masonry, or burnt ceramic brick, settled with clay, bitumen and later with lime mortars, pozzolan, until finally reaching portland cement.

In colonial Brazil, the use of these structural masonry was made through stones, raw clay bricks and pestle mud, a technique called ground mud was used. With the advances in the Empire, instead of raw clay bricks, the clay brick cooked from 1850 was implemented, and seeing that these materials and the new technique that was being used were being very favorable against some problems they faced, such as the lack of resistance to the action of the waters, and the spans that could not have greater lengths, eventually buried the technique of the dirt mud.

At the end of the 19th century, structural masonry saw powerful construction systems inserted in our environment, the so modern structures of iron and reinforced concrete,

which were quite modern and used in Europe, were gaining their spaces in Brazilian soils.

With the arrival of new methods, the construction system in structural masonry was forced to evolve together, as early as the 1960s, the structural masonry of hollow blocks of concrete is introduced in Brazil, for buildings on up to four floors, with technologies and procedures based on American techniques. From then on, in the State of São Paulo, where reinforced concrete structures and iron structures were commonly used, again the masonry structuring was insating, and resuming its prominent place.

The evolution was in constancy, so performance standards were created for calculation, execution and control of work, for the entire Brazilian territory, where the dissemination of this construction system was wanted to the Federation Units.

In the passing of the centuries, various forms, means of construction, which were implemented, used in civil construction. In order to reduce the great problem that had occurred in the country, which was the housing deficit, it was seen that the most practical way, which fit with the Brazilian method of building, taking into account both the labor force and the possibilities of rationing costs. The union of several factors such as speed, safety, cost savings and especially the safety to which it presented, caused structural masonry to be introduced once and for all in popular works as high standards.

Nowadays, this construction system remains efficient, but in need of technological advances, although we have groups of researchers in constant study for this, so much so that it is present in the bars of our universities today, so that someone can come and arrive with another innovative idea, to put an end, help society to have a decent housing, with accessibility and security.

3.3. BASIC CONCEPTIONS

3.3.1 - MASONRY

It is a structural system composed of rigid and congruent bricks or blocks. Possessing several constructive methods, but that is carried out from the union of blocks and mortar.

3.3.2 - STRUCTURAL MASONRY

It is the entire structure in masonry, having been previously sized with rational calculation procedures for load support in addition to

its own weight. It is confused with the construction process itself, when we verify its two functions that its basic elements perform in the buildings, that is, sealing and resistance to masonry can be dismembered in two segments, depending on the reinforcements.

3.3.2.1 – STRUCTURAL MASONRY NOT ARMED

when it does not have armor or having them for construction or mooring purposes, not taking into account the efforts and loads that will fall on it. However, this type of structure is very important, due to the fact of avoiding cracks, resulting from efforts in masonry, since they do not absorb impact, leaves the masonry in more dubious comes out, besides participating positively in the safety of loads not previously predicted.

3.2.2.2 – ARMED STRUCTURAL MASONRY that has, in this case, the intention of absorbing the previously calculated efforts, its insertion is by the leaks of the blocks or between bricks, involved by graute.

3.3 – MATERIALS are the raw material used for the manufacture of the main component to assist in the services of civil constructions, in the case of structural masonry, will be made by cement, lime, sand, clay, gravel, and compounds in the freshstate: mortar and graute. Besides steel that helps in what is important material in composition.

4 – ADVANTAGES OF STRUCTURAL MASONRY we know that time in engineering is crucial, especially in the economic part, so when building with ceramic blocks or concrete blocks, making the structural function of the building, we have a large reduction in the consumption of wood, steel and concrete shapes. Thus, a faster and cheaper work, which provides the consumer who will acquire, more accessibility as to values, because one is in function of the other.[4]



Fig. 3: Infrastructure Phase, presenting the typology of the plant, Popular Housing Smart View of the Sun - Manaus.



Fig. 4: Suprastructure Phase, Popular Housing Smart View of the Sun - Manaus.

5 – DISADVANTAGES OF STRUCTURAL MASONRY what we can analyze from cause a certain limitation in constructions that use structural masonry, is the restriction regarding changing the typology of the place, and its architecture, because, as blocks were used, whether ceramic or concrete, they do not actually function as sealing blocks, but rather as the structure itself, serving exclusively for the structural function, therefore, by NBR 15.575 and the Customer Manual that is required by PBQP-H[5], in which it presents certain orientations that future residents should be careful, such as: do not drill through the walls that have a structural function, for insertion of network points, or allocation of equipment that exerts burden on it, due to all these walls have already been previously calculated to perform exclusively structural function.

6 – SOCIOECONOMIC IMPACTS Safter reading an interview by Inês da Silva Magalhães, Former Minister of Government Cities (2016) [6], which addresses us on the socioeconomic theme of the My House My Life program, which makes us think that not only the physical intervention itself, is synonymous with that the whole problem of the housing deficit will be solved, with the experiences told by it, we can observe some important points. How could a family, who for a lifetime reside in a precarious place that has never had basic sanitation, or access to leisure and or some social activity, could simply change locations and already change their lives with it? Thus it makesus think that, not only do we need to have aphysical project, one needs to work together with these families, policies of insertion in their new life, let's say, because it will have to bear new economic aspects, such as the rates that every residence must bear, such as: electricity bills, water bills and the portions of their new residence.

Another important point regarding these impacts is that, as much as this housing policy is, sometimes some regions do not behave as expected, because the entire economy of the locality tends to change, and moreover, since more people will move to these areas, the greater the supply, thus

often increasing materials and services from such regions.

7 – The CONSTRUCTION SYSTEM AND ITS RESULTS Structural masonry, within the masonry, is an important system, which is in the technical environment, and is increasingly being inserted, still lacks much insertion of this knowledge within universities, as we have with reinforced concrete, steel, wood, insert disciplines related to structural masonry for both design and sizing. Within the scenario of Housing of Social Interest, that there was this outbreak of housing in Brazil, which was accompanied by a growth, a need for expansion of Civil Construction, so masonry became one of the most used techniques, because it manages to marry technical, technological aspects, performance issues as a whole, since designed, a project thought, elaborated, from the design of the architectural project to the roofing system, we have a constructive system, idealized, according to the premises and technical idealizations.

According to Architect Siegbert Zanettini [7] who addressed construction, who said that it is a delayed industry, which has missed many opportunities and continues to lose them. From this sentence we can imagine, that we often wonder what is the best constructive system for such building, what is there of know-how within a company that will provide, establish and meet all performance criteria, which are the broadest possible, within the conception, of durability, of safety, so there are several elements that are to be thought of within the composition of the project, and civil construction, often works on a level of empiricism, that is, it is often worked with lack of design, with lack of detail, without thinking about the compatibilizations, which today, it is not feasible to elaborate a structure, or think of a structure, and then make several tears in structures and structural elements where one should not.

7.1 – STRUCTURAL MASONRY PROJECT CHARACTERISTICS In the architectural design one should consider the positioning of the gateways and the sealing walls, in the typology of the slab, in the necessary technical spaces, in the prediction of the expansion joints. In the case of popular housing, in its draft approval with the agency, we must always respect all the basic rules, there are several, I can mention some: such as the removal of 30 meters for the Permanent Protection Areas (APP), have sewage treatment station project, but as we are talking about the construction system itself of the building itself, all material, all uneven that is allocated in determining environment, is previously calculated, because everything generates loads, and we know that what holds the building, are the walls themselves that make the structural function of the whole, so the ceramic or concrete blocks, should not be less than 9cm, this being the limit, because the

recommended is 10cm, among many others that ABNT NBR 15.575:2013 - Performance of housing buildings requests.

7.2 – FUNCTIONS AND PROPERTIES OF COMPONENTS (BLOCKS, MORTARS AND GRAUTES) have aspects that should be thought of, such as the choices of materials, such as a laying block, in which they are leaked with a double central septum, which is twice the thickness of the ceramic block plus the thickness of the joint, precisely for the second squeezing, onwards, to have where to lean, not staying in the void and not causing problems of acoustic and thermal performance. If the wall has openings the flow of forces passes through the stretches between these openings. If the wall has no openings, the flow of forces takes place along the wall.

If I have a concrete block instead of a ceramic block, I have a much smaller area of contact, that is, different from the solid brick, where there is a contact area, that is, being able to work with a slightly smaller mortar resistance range, it is not usually measured area content incorporated in the mortars, but this is fundamental because it is often replaced by lime, if using air-incorporator additive, and with it, we have bubbles, facilitating the deformation of the joint and the crushing of the joint.

A badly dosed graute, loosens from the wall, so the consistency of the mixture must have cohesion and fluidity, sufficient to fill all the holes of the blocks, its retraction should also not lead to the separation between the graute and the internal walls of the blocks and its compressive strength of the graute, the mechanical properties of the blocks and mortar, will define the characteristics to the compression of the masonry.



Fig. 5: Single-country houses My House My Life, Popular housing Vila Smart Campo Belo - Iranduba, Amazonas.



Fig. 6: Houses in structural masonry, Vila Smart Campo Belo, Iranduba, Amazonas.



Fig. 6: Details of the construction system in structural masonry, Vila Smart Campo Belo, Iranduba, Amazonas.

8 - NBR 15.575 The NBR 15575 Performance Standard has arrived to modify our concepts of design and construction of our buildings. The main point of this standard is that it is not a prescriptive standard, which fixes type and quality of materials, minimum thicknesses, among other things.

The NBR 15,575 sets the minimum parameters for the overall performance of the building, without saying how to achieve it. In general, it divides the needs to be achieved, such as: safety, habituality and sustainability. Compliance with all items of NBR 15,961 and 15,812 already guarantee structural requirements, stresses and deformations, and the minimum service life of 50 years.

Fire safety will also depend on wall coverings to meet the requirements of stability, watertightness (fireproof) and thermal insulation (fire extinguisher).

Acoustic performance must be achieved in different

classes of external noise. The noisier the outside, the higher the requirement for the walls. This value also varies depending on the type of environment, being more rigorous for dormitories than for the rooms.

IV. CONCLUSION

The popular housing stems from society, and construction has shown that it is a very important presence in people's lives, because from it, we can draw up plans that are beneficial for everyone, both in the economic part for construction companies, and for the accessibility of the construction company to deliver to people who have a precarious housing condition, a comfortable home, safely, with more than minimal conditions for habituality and sustainability. We can know through analyses and experiences of our own, how the My House My Life Program works, created together with the Government to try in a certain way, to alleviate the problem of the housing deficit, which reaches to this day a large population of Brazilian soil. However, with this measure, it was noted that there was rather a considerable advance in our country.

We also saw how is the process of this construction system called structural masonry, where we can know the necessary materials that compose it, its advantages and disadvantages when deciding whether or not to really make necessary the construction in structural masonry or reinforced concrete, but as we have seen, for this type of housing of social interest, certainly the structural masonry is outperformed due to the great rationalization of activities, the less costly labor, the non-use of forms, in short, is much more economically viable, also having its execution time and smaller delivery.

I believe that if we invest more in our universities in studies, adding to the researchers we already have in our country, in the future civil construction can add much more with its technological advances, and discovering new ways to build with safety, habituality and sustainability even greater than the conditions we have today.

Science allows us to dream, it is a straight path, where the end, we can not see.

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