

# The Soil-Cement Brick on Construction with Structural Masonry – An Alternative in the Fight Against Housing Deficit and Environmental Pollution in the State of Rondônia\*

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**Abstract**— *The Housing Deficit in the State of Rondônia is increasing, not only due to the absence of effective public policies dedicated to the treatment of housing, but also due to the lack of study and application of new technologies in the area of civil construction, which can generate great savings and remarkable rapidity in the construction of housing units. This deficit is characterized by the lack of housing and the existence of those considered inadequate to human occupation with quality and safety, due to its operability, physical characteristics and location. However, there is a need for greater economy and productivity in the construction of housing, in order to be able to supply part of this demand, without letting the quality levels drop. In the light of Sustainable Development, it will be proposed and directed the correction of this paradigm that tends to hold more weight in the "social" dimension. The application of the Structural Masonry System with the use of the Cement Brick, popularly known as "ecological brick", is the main basis of this study, where it is intended to demonstrate that its option for housing construction can be an excellent response to the housing deficit and environmental pollution, generated by the rubbish of Civil Construction in the State of Rondônia.*

**Keywords**— *housing deficit, masonry structures, soil-cement, brick ecological.*

## I. INTRODUCTION

Issues related to environmental preservation and sustainable development have been discussed since the last century<sup>1</sup>.

The Amazon region, of which the State of Rondônia is a part, is one of the main poles of attention to the object of these discussions Mendes (2001).

Development, which has undergone profound transformations in the last decades, is also based on the notions of territoriality and sustainability, requiring not only the creation and reproduction of economic capital, but also human capital (knowledge, skills and competences) and social capital (trust, cooperation, organization and social participation).

This development needs to be human, social and sustainable, that is, it must be focused on promoting the quality of life for people. The Regional Development, according to Medeiros (2001), refers to the improvement of the standard of living of the population. It also points out that this factor is observed with the increase in the level of income, which must be higher or, at least, equal to the demographic growth.

We can not talk about Regional Development without considering the beacon linked directly to the Sustainability factor, which it must contain, in order to meet the criteria agreed in political development and economic growth movements that contemplate the preservation and the

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Nations Conference on Environment and Development Rio (92); complemented in 2001 in Germany) and COP7 (Marrakesh / 2002).

\* This article was derived from the studies and preparation of the master's thesis entitled: "STRUCTURAL ALVENARIA WITH BRICK OF CEMENT: A Technological Alternative in the Fight Against Housing Deficit and the Generation of Rubbish in Civil Construction in Rondônia", under the aegis of the author

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<sup>1</sup> The consolidation of the discussions began with the United

environmental balance of the planet .

The housing issue is one of the constituent elements of the social dimension that forms the basis of sustainable development, as advocated by Bossel (1999), and this factor encapsulates the housing deficit, one of the recursive aspects of increasing poverty and violence in society .

This deficit has been evolving for decades, is increasing and accentuated, as evidenced in the reports of the National Household Sample Survey (PNAD) and the IBGE census, based on the results of the surveys to indicate the housing deficit, and the development of methodologies for its definition and classification, carried out by the João Pinheiro Foundation (FJP), Federal University of Minas Gerais. They point to the existence of this deficit in all the territorial units of the country, such as the State of Rondônia, where in the past and present development projects have caused intense migratory flows to this region. The main vectors for the maintenance of this deficit throughout the State are related to: constant and high population growth, either by birth rate or migration; the fall in the income level of the citizen; the absence of consistent public policies dedicated directly to the treatment of housing issues; to the current constructive methods that do not support the demand for the housing volume and, finally, the lack of research for the development and application of new technologies to combat the obsolescence of the current construction methods.

Another important factor in this scenario is the question of the environmental degradation that the construction industry has generated, according to the results of the Civil Engineering Research Foundation (CERF) 1, according to Sjöström (1966), namely:

- Civil Construction consumes 15 to 50% of the natural resources extracted and 2/3 of all wood consumed on the planet;
- The raw materials used, such as copper and zinc, have scarce mapped reserves, their current balance on the planet is critical, will sustain only another 60 years;

- This activity generates high levels of dust, CO2 and debris (its daily volume is twice that of urban solid waste) and are highly polluting elements;
- The cement produced, to meet the demand of this area, is thousands of tons / day and each ton of clinker to process it generates 600Kg of CO2 / day.

The housing deficit must first be qualified and classified by types of housing, occupation and social class occupant and / or without housing, in a second moment be quantified to formulate the demands that the Civil Construction and the Public Administrators must coexist in order to attenuate it.

New constructive techniques, to meet the demand for housing, with socially acceptable running costs and reduced construction time, with the lowest consumption of natural resources possible, must be identified to allow changes in the current social scenario, promoting **urbanism and the environment in harmony**.

## II. HOUSING DEFICIT

The identification of the importance of the construction of adequate housing to the human needs of occupation with quality and still to promote the sustainable development in this process, comes with the understanding that the housing deficit is the most immediate and intuitive notion of the necessity of construction of new housing for the solution of social and specific housing problems detected at a certain time (FJP, 2012,2015) and stands out because it is related to the deficiency of the housing stock (which requires replacement), to which it is also added to those without conditions to be inhabited , due to the precariousness of their constructions or due to the wear and tear on their physical structure (they must be increased to the spare stock). Therefore, the housing deficit is composed of the stock replacement deficit and the inventory increase deficit. The table below presents the components that should be considered for the calculation of the housing deficit.

Frame.2.1 - Components of Housing Deficit

<b>HOUSING DEFICIT</b>	
<b>Components:</b>	<b>Detailing:</b>
<p><b>Stock Replacement Deficit</b></p> <ul style="list-style-type: none"> <li>- Rustic households</li> </ul> <p><b>Déficit by Inventory Increase</b></p> <ul style="list-style-type: none"> <li>- Improvised households</li> </ul>	<ul style="list-style-type: none"> <li>- Cálculatión for áreas:</li> <li>- Urban                             <ul style="list-style-type: none"> <li>• Total</li> <li>• Rural agglomeration of urban extension</li> </ul> </li> <li>- Rural</li> </ul>

<ul style="list-style-type: none"> <li>- Family Cohabitation</li> <li>- Leased and Rented Rooms</li> <li>- Secondary cohabitatives families intending to establish exclusive domicile</li> <li>- Excessive rent burden</li> <li>- Household with overweigh of residentes per dormitory</li> </ul>	<ul style="list-style-type: none"> <li>- Subnormal clusters</li> <li>- Cálculacion by family income brackets in minimum wages</li> </ul>
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**Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center**

There are old buildings that, due to renovations and maintenance, only require physical repairs in their structure to remain habitable, are known as "inadequate households" and are not considered in the calculation of the deficit.

### 2.1 The Numbers Deficit in the State of Rondônia

The latest reports on the housing deficit (FJP, 2012 and IBGE, 2015), in addition to reviewing their theoretical conceptualization, presented statistical tables that illustrate the current scenario and the evolution of the housing issue, by type of deficit and housing, the values that comprise the North / Rondônia Region are considered.

#### 2.1.1 Housing and Percentage Deficit of Permanent Private Households in the North Region / Rondônia - 2012/2015

HOUSING DEFICIT					PERCENTAGE OF PERMANENT PARTICULAR HOMES			
YEAR IN ANALISIS	TOTAL	URBAN	RURAL		TOTAL	URBAN	RURAL	
			TOTAL	URBAN EXTENSION			TOTAL	URBAN EXTENSION
2012	38.898	36.881	2.017	2.522	6,90	8,50	1,50	10,30
2015	48.906	44.312	4.594	3.030	6,90	8,50	1,50	10,30

**Note:** in the calculation of the housing deficit, the family cohabitation includes only the coexisting families who want to constitute a new domicile. **Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center**

#### 2.1.2 Distribution of Percentage of Urban Housing Deficit (1), by Monthly Family Income Ranges, in the North Region/Rondônia – 2012/2015

MONTHLY FAMILY AVERAGE INCOME IN MINIMUM WAGES					
YEAR	Up to 3	More than 3 to 5	More than 5 to 10	Up to 10	Total (2)
2012	87,30	8,50	4,20	0,00	100
2015	81,50	10,50	6,00	2,00	100

(1) Including rural urban extension. (2) Exclusive without declaration of income.

**Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center**

#### 2.1.3 Households Vague in Conditions to be Occupied and in Construction (1), by Residence Status, in the North Region/Rondônia – 2012/2015

HOUSEHOLDS VAGUES				PERCENTAGE OF TOTAL HOUSEHOLD		
YEAR	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL
2012	87.241	59.455	27.786	15,50	13,80	21,30
2015	65.021	44.312	20.709	12,50	11,80	19,30

(1) Does not include ruined households.

**Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center**

2.1.4 Precarious Housing and Family Cohabitation, by Residence Status in the North Region /Rondônia – 2012/2015

HOUSING PRECÁRIOS				FAMILY COHABITATION		
YEAR	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL
2012	11.103	4.252	671	10.583	9.969	614
2015	15.402	5.899	930	7.297	6.873	424

Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center

2.1.5 Excessive Expenses with Rent and Excessive Density in Leased Households, in the North Region /Rondônia – 2012/2015

YEAR	EXCESSIVE OVERLOOK WITH RENAL	EXCESSIVE ADHESION		
		TOTAL	URBAN	RURAL
2012	21.176	2.216	2.216	0
2015	22.966	3.241	3.241	0

Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center

2.1.6 Participation of Components in the Housing Deficit , by Household Situation, in the North Region/Rondônia – 2012/2015

YEAR	URBAN					RURAL			
	PRECARIUS HOUSING	FAMILY COHABITATION	ONUS EXCESSIVE RENTAL	ADDITIONAL EXCESSIVE	TOTAL	PRECARIUS HOUSING	FAMILY COHABITATION	ADDITIONAL EXCESSIVE	TOTAL
2012	26,00	22,30	40,80	10,90	100,00	69,56	30,44	0,00	100,00
2015	29,53	18,35	45,51	6,61	100,00	56,89	43,11	0,00	100,00

Nota: In the calculation of housing deficit, the family cohabitation component includes only the coexisting families that declared intention of constitute a new home.

Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center

2.1.7 Total Cohabitation Families and Percentage of the Considered Housing Deficit by Household Situation, in the North Region/Rondônia – 2012/2015

CONVIVING FAMILIES					PERCENTAGE OF THE CONVIVING FAMILIES CONSIDERED			
YEAR	TOTAL	URBAN	RURAL		TOTAL	URBAN	RURAL	
			TOTAL	URBAN EXT			TOTAL	URBAN EXT
2012	10.583	9.695	1.730	888	63,10	64,40	100,00	48,80
2015	13.306	12.189	2.175	1.116	63,10	64,40	100,00	48,80

Source: Housing Deficit 2012/2015. João Pinheiro Foundation/ Statistics and Information Center

Currently, the number of construction companies with works in progress and in the completion phase is significant, but most programs do not include the most

deprived classes, especially those with low family income (my home, my life - 0 to 3 SM1) . With the end of the construction of the hydroelectric plant in Santo Antonio,

there was an evasion of the migrant population, which worked there, and in this case, a balance of housing available for sale and mainly rent was obtained, which generated a certain stagnation in the growth of construction industry.

Still, low-income families, lacking housing, were not able to take advantage of this balance of available properties, depending on their financial situation. The problem of the deficit continues, despite the positive demand, meaning the existence of an absurd paradox in this factor.

O programa Minha Casa, Minha Vida vem acontecendo e até a presente data já foram entregues mais de 4.000(quatro mil moradias) apesar do esforço e políticas empregadas, este resultado ainda é muito insuficiente para atender uma demanda declarada e crescente, segundo os valores dos quadros acima, de 2012 a 2015 o déficit habitacional cresceu 32,605%. Há que se considerar que os últimos dados disponibilizados ao público pelo IBGE/FJP são de 2015, o que significa uma provável mudança neste saldo para mais, se considerarmos a demora dos atuais programas habitacionais.

### III. THE IDEAL CONSTRUCTIVE TECHNIQUE

The problem is to identify constructive techniques based on the following assumptions:

- to develop affordable housing, using new materials of great quality, great durability and that do not degrade the environment;
- develop technologies that rationalize the execution time, using simple construction components with an industrial character, easy to assemble and with possibility of expansion of its original plant;
- to provide a high reduction of construction debris, lowering the levels of environmental pollution generated by this activity;
- to produce a safe and pleasant housing to the user in the aspects of appearance, conservation and cleaning, thermal and acoustic comfort and sealing, besides being ecologically correct.

According to Souza(1984), *housing is characterized as a defined product whose function is to satisfy user requirements that are understood, in the case of housing, as the level of conditions necessary to the safety and health of man, to his comfort and satisfaction of their economic concerns.*

The Project from Norma 02.136.01.001 (ABNT, 2004) - Performance of housing buildings up to 5 floors - Part 1: General Requirements establishes that under the various actions in housing, the building and its parts must meet the applicable requirements that are listed in table 1.

Table.1: User Requirements

<b>Security</b>	- Structural safety - Fire safety - Safety in use and operation	
<b>Habitability</b>	- Sealing - Hygrothermal comfort - Acoustic comfort - Light comfort - Health, hygiene and air quality - Functionality and accessibility - Tactile and anthropodynamic comfort	NBR 9050
<b>Sustainability</b>	- Durability - Maintainability - Environmental Impact	

Source: Project from Norma 02.136.01.001 (ABNT, 2004)

There are two types of construction / masonry currently used:

Conventional / common masonry, whose basic function is sealing or closing, where high volume of construction waste (debris) is generated, has a very high cost and time of execution and requires a lot of labor. In this constructive process the materials used come from the high extraction of nonrenewable resources of nature, generating much CO2 in

their manufacture, such as cement, for example.

The structural masonry, where the walls of the building are the structure of the dwelling, assimilating the two main systems of a conventional construction: the reinforced concrete structure and the masonry closures (CAMPOS, 2009).

It is a constructive process in which the walls of the house are used to resist the loads, replacing the pillars and beams

used in the systems in reinforced concrete, steel or wood (ROMAN et al., 1999). This modality results in a substantial reduction in the use of iron and wood in the

construction of a dwelling, basically it does not generate rubble, it requires very little labor and the costs and time of execution are much smaller.



Fig.1 – Conventional Construction

Source: [spolx.com.br/imóveis/vendo-casa--em-construção-405639726](http://spolx.com.br/imóveis/vendo-casa--em-construção-405639726)



Fig. 2 – Construction with Structural Masonry

Fonte: [www.tilego.com.br/site/?p=27](http://www.tilego.com.br/site/?p=27)

In the comparative process and considering the assumptions already presented, Structural Masonry is the most ideal to meet the economic, technical, social and ecological requirements that are encapsulated in the housing and environmental issue of the State of Rondônia.

#### IV. THE RAW MATERIALS EMPLOYED IN THE STRUCTURAL MASONRY

The raw material to be used in this constructive modality should consume low levels of natural resources (renewable and certified and / or recyclable), with materials without toxic components; minimize the use of industrially

produced materials and generate low costs and execution time in the construction of housing, without promoting aggression to the environment that conventional / common masonry does.

The issues to be factored are: reducing the cost of building a housing; reduction of its execution time and obtaining the least possible environmental impact, with the reuse or elimination of construction waste. In the case of Rondônia, located in the Amazon region where the tropical climate prevails, the high temperature and humidity are important issues to be observed as basic attributes of a quality construction dwelling.

The most used materials in Structural Masonry are the pre-cast blocks of structural ceramics, concrete (figures 3 and 4) and brick/block of soil-cement (figures 5).



Fig.3– Structural Ceramic Block  
Source: [www.blococeramico.com.br/blocos](http://www.blococeramico.com.br/blocos)



Fig. 4-Concrete Block  
Source: [tuboscopel.com.br](http://tuboscopel.com.br)

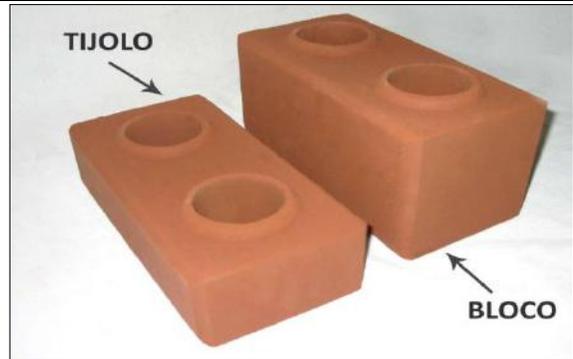


Fig. 5 – Brick and Block of Soil-Cement  
Source: [www.ecomaquinas.com.br](http://www.ecomaquinas.com.br)

#### 4.1 Pre-Molded Ceramic or Concrete Blocks

Structural or Concrete Ceramic Blocks use the same constructive techniques, but due to the difference of the basic materials that constitute them, do not have the same benefits.

In the cost factor, they present the highest market price and in the construction process they require a lot of cement with the application of mortar, plaster or plaster, increasing even more the execution time (waiting for the cure of the concrete / plaster) and, consequently, the final cost of housing / housing.

The thermal insulation property of these blocks is insufficient to generate the ideal occupational comfort of quality, in the region under study. To present the desired thermal property, the treatment required will further increase the cost per meter built. The Concrete Block requires a high amount of cement (80% of this material in its formulation and is a highly polluting material), as well as gravel and sand.

The Ceramic Structural Block has the same process of manufacturing the common ceramic bricks, used in the conventional construction. They are cooked in high temperature furnaces, using wood as the main fuel, causing tree extraction, which means the degradation of forests.

#### 4.2 Soil-Cement Brick

Soil-cement is a material obtained by homogeneous mixing of soil, cement and water in suitable proportions, being compacted in hydraulic press and matured by wet curing, not needing to be cooked in high-temperature furnaces. This process, collaborates with the environment because it does not emit toxic gases (CO<sub>2</sub>) into the atmosphere.

The soil to be used has to be sandy with a percentage of clay that should be within the range of 20% to 35%, the ideal (economical and safe) ratio of cement applied in the soil-cement formulation should be within the range of 5% to 10% of the total formula, and the percentage of water should not exceed 5%, Giuseppeponi et al (2004).

Consideration should also be given to the possibility of using construction waste, according to Souza et al (2008) and Casanova (1988), further reducing the cost and extraction of soil (soil) in its manufacture.

The ABNT Standard - NBR 10836 establishes an average value greater than or equal to 2.0 MPa at the seven days of maturation and in the calculation of the average, only one of

the individual values may have a resistance less than 2.0 MPa, provided that it is equal to or higher than 1.7 MPa and for water absorption, the mean value must be less than or equal to 20%.

In Souza et all (2006), the following values were extracted from the Soil-Brick Compression Compression Table, according to its formulation:

Table.2 – Resistance to Soil-Cement Brick Compression

FORMULATION	RESISTANCE AVERAGE(Mpa)			
	28 days	56 days	120 days	
Soil + 6% cement	1,60	<b>3,40</b>	4,1	4,70
Soil + 8% cement	2,31	<b>4,20</b>	5,03	6,63
Soil + 10% cement	2,69	<b>5,57</b>	7,30	7,71

Source: Study of the Use of Concrete Residues in the Manufacture of Pressed Soil-Cement Bricks (Souza et all, 2006)

In the tests of compression and water absorption, performed in Porto Velho (RO), in the Laboratory of Technological Control of Dynamics Engineering, under the responsibility of Engineer Nélio Alencar, the following results were obtained:

Table.3 – Results of Resistance and Absorption of Soil-Cement Bricks

		<b>DINÂMICA ENGENHARIA</b> LABORATÓRIO DE CONTROLE TECNOLÓGICO ENGº NÉLIO ALENCAR CNPJ: 34.738.559/0001-35				
<b>ROMPIMENTO DE BLOCOS DE CONCRETO</b>						
Empresa:	ECOTIJOLOS RONDONIA IND E COM LTDA	Tipo:	Vibrado			
Endereço:	Rua: General Osorio nº 222 - Sala 26 - Centro PVH-RO					
Local:		Coleta				
Amostra:	Tijolos solo cimento					
Série:	001/02	Absorção:	8%			
Equipamento:	Prensa Hidráulica					
	Zeloso					
Referência:	Mod. PC 100 n: 424 Série 0580	Capacidade:	100.000Kg			
<b>Dados Informados:</b>						
Dosagem Projeto:	12 Mpa	Material:				
		Cimento:	12,5 Kg			
Tipo de Cimento:	CP II F 32	Areia:	84 Kg			
		Argila:	36 Kg			
		Água:	4 Lts			
<b>Dados dos Blocos:</b>						
Forma:	Retângular	Dimensões:	12,5X25X7 cm			
		Superfície:	312,50 cm <sup>2</sup>			
<b>Resultados Obtidos:</b>						
Corpo de Prova	Data de Moldagem	Data de Ruptura	Idade em Dias	Carga de Ruptura (kgf)	Resistência à Compressão (Mpa)	
					Unitario	MEDIA
1	23.04.09	29.05.09	37	29.000	9,28	
2	23.04.09	29.05.09	37	28.000	8,96	<b>8,96</b>
3	23.04.09	29.05.09	37	27.000	8,64	
4	19.05.09	29.05.09	10	11.000	3,52	<b>3,52</b>

Source: Dinâmica Engenharia(2009)

Observing the table above, it is verified that the test piece 4 was not computed in the average as a function of the date of maturity of the brick and comparing this result with that of table 2, it is possible to observe the excellent degree of resistance presented, well above the parameter established by NBR 10836, characterizing the good quality of the soil of the region.

Regarding Thermal Insulation, the soil-cement brick, in relation to the other materials used in the civil construction industry, presented the following result (NETO, 2009):

Table.4: Thermal Conductivity Coefficient (K)

MATERIAL	THERMAL CONDUCT. COEFFICIENT(K)
Concrete	$2,50 \times 10^{-3}$
Bricks	$1,65 \times 10^{-3}$ a $2,40 \times 10^{-3}$
<b>Compacted Soil-Cement</b>	<b><math>1,83 \times 10^{-3}</math></b>
Adobe	$3,70 \times 10^{-3}$
Soil-Compressed	$2,89 \times 10^{-3}$
Bitudobe	$3,60 \times 10^{-3}$
Mortar 1:4	$1,80 \times 10^{-3}$

Source: ,Neto(2009)

The value of the conductivity coefficient is lower in compacted soil-cement, which means that thermal transmission is less efficient in this material, due to its high density physico-chemical composition, so the heat is not completely transmitted through it one environment to another.

Another factor that contributes to this low thermal conductivity are the existing holes in its structure, generating air pipes, formed by the rows that make up the wall of a building, from the base to the ceiling / ceiling. In them the convection process is formed with air that is heated and dissipated with the entrance of cold air, giving it a relative advantage over the other materials studied.

In the comparative process soil-cement brick was chosen mainly because its raw material (soil / soil) is abundant in Rondônia, and its extraction does not compromise environmental preservation.

## V. STRUCTURAL MASONRY WITH SOIL-CEMENT BRICKS

Structural Masonry added to the use of the Cement Brick (Figures 6 and 7) is currently the most appropriate response to assist in combating Housing Deficit and Environmental Pollution generated by the Construction Industry and the ease of extraction of raw material, to serve it, in the State of Rondônia.



Fig. 6 – Structural Masonry with Soil-Cement Brick in execution

Source: [turma1aintermachaddo.blogspot.com/2012/09/quais-os-materiais-que-precisamos-para.html](http://turma1aintermachaddo.blogspot.com/2012/09/quais-os-materiais-que-precisamos-para.html)



Fig. 7 – Soil Brick Housing Complete

Source: [sustentoevinda.blogspot.com](http://sustentoevinda.blogspot.com)

Designed primarily for the construction of low-cost housing, this constructive technique has been extended to larger buildings with high quality finishes such as large luxury homes, buildings with more than four floors and commercial and / or commercial facilities. Industries. The combined use of structural masonry and soil-cement brick catalyzes some benefits / advantages that other construction techniques do not currently offer, such as:

- the final cost of building a house is 30% to 40% cheaper than conventional buildings;
- also be cheaper than constructions with concrete blocks or structural ceramics, depending on their manufacturing costs;
- the construction time has lower parameters than the other techniques in up to 1/3 of the conventional time (will depend on the architectural lines and the finish to be applied);
- the soil-cement construction process is very simple and can be quickly assimilated by unskilled labor, provided it is trained.

However, some technical care must be observed in order for these benefits to be enjoyed, namely:

- preparation of adequate training for the workforce involved in the construction process;
- the assembly of the first row must be absolutely precise, strictly obeying the template

- of the floor plan of the housing that will be built;
- the alignment of the other rows and bricks within them must be absolutely accurate, respecting the plumb and dimensions specified in the design;
- the mooring between the walls and the formation of grates (internal concrete columns) must be faithful to the techniques of this constructive process and to the project itself;
- The specifications of the bricks must be strictly in accordance with the ABNT standards.

#### VI. TABLES OF COSTS PROJECTED FOR THE CONSTRUCTION OF A POPULAR HOUSE OF 43M<sup>2</sup> - PROJECT MY HOUSE MY LIFE

The tables below correspond, respectively, to the Conventional Constructive Method, with the use of the traditional Brick / Bahia block and the Structural Masonry, a with the Concrete Blocks and another, with the Building Blocks (ecological brick). These tables only contemplate the steps of structure, sealing, internal and external coating, hydraulic and electrical installations were not computed because in each constructive modality these procedures are specific, the same criterion applies to the processes of installation of doors and windows.

Table.5 – Costs Construction – conventional masonry.

ELEMENTS	UNITY	AMOUNT	COST(R\$)	
			UNITY	TOTAL
Ceramic blocks / Bahian brick (14x19x29cm), 12mm joints with mixed cement mortar, hydrated lime and sand without sieving 1: 2: 8 trace. Wall thickness 14cm.	m <sup>2</sup>	80,78	35,52	2.869,
Steel reinforcement for pillars or beam 8mm diameter. Cut and fold even.	kg	49,85	10,79	537,8
Solid wood formwork for pillars and similar structures, including assembly and dismantling.	m <sup>2</sup>	21,60	24,26	524,02
Concrete pillar, fck = 25 mpa, with crane. Launching, densification and finishing	m <sup>3</sup>	0,81	370,77	300,32
Masonry feature for conduits with diameters less than or equal to 40 mm	m	27,5	3,68	101,20
Linear tapping in masonry for extensions / distribution with diameters less than or equal to 40 mm.	m	33,8	7,61	257,22
Plaster applied to both pillars and concrete beams and masonry of internal walls, with trowel.	m <sup>2</sup>	106,9	2,61	279,01
Plaster applied to both pillars and concrete beams and masonry with external walls, with trowel.	m <sup>2</sup>	55,19	5,61	309,62
Mortar with 1: 2: 8 mortar, mechanical preparation with concrete mixer 400l, manually applied on interior walls of areas with an area less than 10m <sup>2</sup> and spans, thickness of 20mm, with execution of slabs.	m <sup>2</sup>	162,09	23,43	3.797,77
Plaster 1: 2 mortar (lime and sand sifted fine), thickness 0.5cm, manual preparation of mortar.	m <sup>2</sup>	162,09	13,76	2.230,36
Manual application of acrylic sealer bottom on inner and outer walls of homes.	m <sup>2</sup>	162,09	2,26	366,32
Manual application of paint with acrylic textured paint on exterior walls of houses, two colors.	m <sup>2</sup>	55,19	15,48	854,34
Application and sanding of latex mass in inner walls of house, two coats.	m <sup>2</sup>	106,9	8,66	925,75
<b>TOTAL COST</b>				<b>14.390,91</b>

Source: Author(2016)

Table.5 – Costs Construction – concrete masonry.

ELEMENTS	UNITY	AMOUNT	COST(R\$)	
			UNITY	TOTAL
Structural masonry of concrete blocks 14x19x39, (thickness 14cm), fbk = 4,5mpa, with spans, using pallet.	m <sup>2</sup>	86,18	50,75	4.373,64
Graute for structural masonry of concrete blocks, trace 1: 2: 2,4: 1 (cement / coarse sand / gravel 0 / additive).	m <sup>3</sup>	1,008	367,07	370,01
Vertical frame of structural masonry, diameter 10.00mm.	kg	22,4	6,16	137,98
Manual application of cast gypsum (without taliscas) in walls of environment	m <sup>2</sup>	106,9	11,9	1.272,11

ELEMENTS	UNITY	AMOUNT	COST(R\$)	
			UNITY	TOTAL
areas between 5sqm and 10sqm, thickness of 0.5cm.				
Manual application of acrylic sealer bottom on inner and outer walls of homes.	m <sup>2</sup>	162,09	2,26	366,32
Manual application of paint with acrylic textured paint on exterior walls of houses, two colors.	m <sup>2</sup>	55,19	15,48	854,34
Manual application of paint with acrylic latex paint on walls, two coats.	m <sup>2</sup>	162,09	6,12	991,99
<b>TOTAL COST</b>			<b>8.366,39</b>	

Source: Author(2016)

Table.7 – Costs Construction – soil-cement masonry.

ELEMENTS	UNITY	AMOUNT	CUST(R\$)	
			UNITY	TOTAL
Mortar 1: 1: 10 trace (cement, glue pva and medium sand), manual preparation.	m <sup>3</sup>	0,68944	421,88	290,86
Structural masonry of soil-cement 14x15x30, (thickness 15cm), fbk = 4,5mpa, with spans.	m <sup>2</sup>	86,18	34,89	3.006,82
Graute for structural masonry of soil, trace 1: 2: 2,4: 1 (cement / coarse sand / gravel 0 / additive).	m <sup>3</sup>	0,32	367,07	117,63
Vertical frame of structural masonry, diameter 10.00mm.	kg	22,4	6,16	137,98
Manual application of acrylic sealer bottom on inner and outer walls of homes.	m <sup>2</sup>	55,19	2,26	124,73
Manual application of cast gypsum (without taliscas) in walls of environment areas between 5sqm and 10sqm, thickness of 0.5cm.	m <sup>2</sup>	106,9	11,9	1.272,11
Manual application of paint with acrylic textured paint on exterior walls of houses, two colors.	m <sup>2</sup>	55,19	15,48	854,34
Manual application of paint with acrylic latex paint on walls, two coats.	m <sup>2</sup>	106,9	6,12	654,23
<b>TOTAL COST</b>			<b>6.458,71</b>	

Source: Author(2016)

Comparing the total costs of the three tables above, it is evident how much the method of structural masonry with the ecological brick is cheaper and cheaper than the others, and can be classified as "The Ideal Constructive Technique" to the Housing Deficit and Environmental Pollution generated by the civil construction in Rondônia.

## VII. FINAL CONSIDERATIONS

In addition to new technologies, methods and construction materials in research and some already developed, which

have been tested and applied, the use of Structural Masonry with Bricks of Cement is one of the steps to success in combating the housing deficit, pollution generated by the construction industry.

The expected results will only be achieved if other supporting measures and even protagonists are adopted, such as: adaptation and / or creation of specific Public Policies synchronized with the true reality of the scenario of its application; reviewing Housing Projects in progress, adapting them to the reality of the housing, civil, social,

economic and political problems of the region of occurrence; revision of the Housing Financing System, with the creation of Incentive Programs for Builders or Individual Builders who will use this constructive technique and / or other innovations, whether in popular housing programs or not.

It will require "political will" and courage from our rulers to take such measures. Only after this action, the constructive techniques and the adequate housing programs will begin to have the effect so desired by the Rondonian society.

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