

## GHG emissions in KG-CO<sub>2</sub> / M2 generated by a House Type INFONAVIT

### Emisiones de GEI en KG-CO<sub>2</sub> /M2 generados por una Vivienda Tipo INFONAVIT

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#### Abstract

Climate change is one of the main current problems, it concerns the entire human population since its effects are worldwide, especially now we have seen its consequences, according to Menghi (2007), the average global temperatures grew by more than 0.5 °C in the last century, and the glaciers are disappearing from the earth. The greenhouse effect generated mainly by the gases of the same name (GHG), is the fundamental factor of climate change. Construction is one of the ways in which the human being contaminates in a constant way this due to urban growth and the demand for infrastructure that this generates. This research has the purpose of determining the KG-CO<sub>2</sub> / M2 generated by a 44 m2 house of interest type INFONAVIT using the Life Cycle methodology (ACV) of the products or materials, established in ISO 14040, employee an inventory of KG-CO<sub>2</sub> emissions from building materials, obtained from various bibliographic sources and databases and using the work volumes required to build the house. The results obtained of 161.57 Kg-CO<sub>2</sub> / M2.

House, GHG, KG-CO<sub>2</sub>/M2

#### Resumen

El cambio climático es uno de los principales problemas actuales, concierne a toda la población humana ya que sus efectos son de alcance mundial, especialmente en la actualidad hemos visto sus consecuencias, según Menghi (2007), las temperaturas promedio mundiales crecieron en más de 0.5 °C en el último siglo y los glaciares están desapareciendo de la tierra. El efecto invernadero generado principalmente por los gases del mismo nombre (GEI), es el factor fundamental del cambio climático. La construcción es una de las formas a través de las que el ser humano contamina de una manera constante esto debido al crecimiento urbano y la demanda de infraestructura que ello genera. Esta investigación tiene como propósito la determinación de los KG-CO<sub>2</sub>/M2 que genera una vivienda de 44 M2 de construcción interés tipo INFONAVIT empleando la metodología de Ciclo de Vida (ACV) de los productos o materiales, establecida en la norma ISO 14040, empleado un inventario de emisiones de KG-CO<sub>2</sub> de materiales de construcción, obtenidos de diversa Sources bibliográficas y bases de datos y empleando los volúmenes de obra requeridos para construir la vivienda. Los resultados obtenidos de 161.57 Kg-CO<sub>2</sub>/M2.

Vivienda, GEI, KG-CO<sub>2</sub>/M2

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## Introduction

Global warming is the effect caused by the high amount of greenhouse gases (GHG) that accumulate in the atmosphere, preventing the solar rays that enter the earth bounce and escape into the atmosphere, to the contrary, bounce back to the earth's surface thus achieving heat to gather in the earth's crust and the biggest affected are the living beings that live in it, in this work we will focus specifically on the effects on human beings.

The environmental impact that industries have on the environment and natural resources has been considerable, not only as a result of production growth but also because this growth was concentrated in sectors with high environmental impact. (SEMARNAT, 2010). It is important to be aware of the consequences that this may have on our health.

Recent studies have described a significant number of adverse effects of ozone, the most important ones related to the respiratory system, such as decreased lung function, worsening asthma, increased risk of emergency visits, hospital admissions and, probably, an increase of risk of dying. On the other hand, there is some evidence that individuals, especially younger ones, with hyperreactivity of airways, such as asthmatics, constitute a group more sensitive to the effects of ozone (Ballester, 2005).

The ozone concentration has increased in the atmosphere to almost eight times the natural atmospheric concentration, causing in the people respiratory system alterations, headache, burning eyes and skin infections (Montaño & Sandoval, 2007).

The study conducted by Pope and colleagues as part of the II Study for the Prevention of Cancer, which was published in March 2002, concluded that fine particles (PM<sub>2.5</sub>) and sulfur oxides showed an association with mortality for all the causes, for diseases of the circulatory system and for lung cancer. Each 10 µg / M<sup>3</sup> increase in atmospheric levels of fine particles was associated approximately with an increase of 4%, 6%, and 8%, respectively, of the risk of dying from all causes, from the circulatory system and from lung cancer (Ballester, 2005).

Mexico annually emits 188 million tons of carbon (C), that is, about 2% of global greenhouse gas emissions and ranks as the ninth country in this area worldwide. Directly CO<sub>2</sub> causes heart failure, suffocation and even death to exposed people. This occurs because CO<sub>2</sub> replaces the oxygen in the red blood cells and reduces the amount that should reach the cells of the body to keep it alive, so it affects all people, but even more so with those with diseases cardiovascular, cerebral and respiratory. Indirectly, CO<sub>2</sub> favors the increase in temperature to a degree Celsius (°C) which can cause the presence of mosquitoes in regions where the cold prevented them from surviving and reproducing; many of them are vectors of diseases such as: malaria transmitted by the Anopheles mosquito, encephalitis transmitted by the Culex mosquito and dengue virus and Nile fever transmitted by the Aedes aegypti mosquito.

Also, an increase in temperature could allow the appearance of microorganisms that generate new diseases. The increase in temperature also affects agricultural systems, where severe droughts and the emergence of pests can reduce the quantity and quality of food (Montaño & Sandoval, 2007).

The World Health Organization (WHO) has estimated a number of deaths attributable to climate change of 160,000 per year. Heat waves will be more frequent and extreme in some areas of Europe and North America for the second half of the 21st century (Gonzales, Fernández & Gutiérrez, 2013).

For this reason it is considered very important to look for ways to reduce greenhouse gases (GHG), especially CO<sub>2</sub>, which is the most abundant after water vapor. Carbon dioxide (CO<sub>2</sub>) is the second most important GHG since it is added to the atmosphere both naturally and anthropogenically (global warming).

Throughout the history of the Earth, volcanoes have naturally added it, and it has been recycled through multiple natural pathways that carbon follows in nature. Without the presence of CO<sub>2</sub>, the temperature on the Earth's surface would be about 33 ° C lower than the current one, which would be hostile to life. But CO<sub>2</sub> is also added unnaturally, as a result of common human activities, mainly due to the burning of fossil fuels and the destruction (nowadays) of the rainforest.

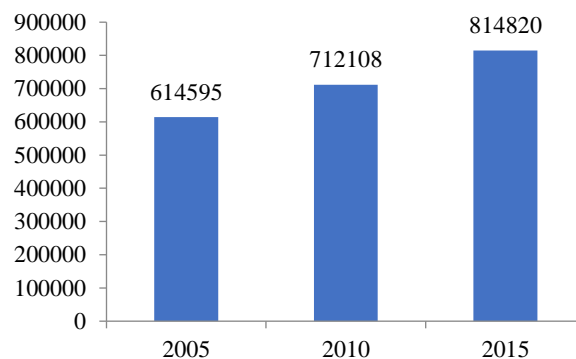
Being the main contributor to global warming with 55% (Echeverri, 2006), it has been decided by different organizations and countries worldwide to focus efforts towards global emissions of CO<sub>2</sub>.

According to the Classification of Individual Consumption According to Purpose (COICOP), more than 80% of the total emissions associated with the private consumption of Spanish households is due to the expenditure incurred in: “transport and communications”, “food, beverages and tobacco”, “leisure, culture and hospitality”, “electricity, gas and other fuels” and “articles of clothing and footwear”. The remaining 20% corresponds to the expenditure on “housing and water”, “other goods and services”, “furniture, equipment and conservation of housing” and “health and education (private)” (Serrano, 2019).

On the other hand Shen. et al. (2005) argues that construction is the main source of environmental pollution compared to other industries. In the European Union the construction sector generates 36% of CO<sub>2</sub> emissions, it is the one that consumes the most energy and the one that generates the most waste, and also uses 60% of the materials that are extracted in the continent (Bravo, 2011).

60% of the materials that are extracted from the lithosphere, are destined for construction. 50% of the CO<sub>2</sub> emissions emitted into the atmosphere have their origin in the construction and use of buildings. 40% of the primary energy consumed on the planet and 75% of the electricity allocated is aimed at buildings. 20% of fresh water is consumed in the use of buildings. 60% of solid waste is produced in the construction and destruction of buildings (Casanovas, 2009).

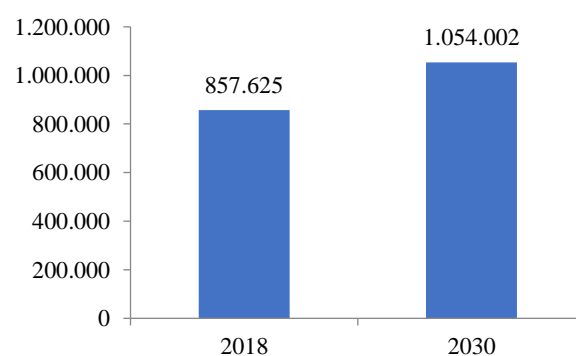
That is why special attention should be paid to the construction sector, in order to predict how many CO<sub>2</sub> emissions could be emitted. Analyzing the Population and Housing Census 2010 and the 2015 Intercensal Survey of INEGI (2015), it can be seen how in those 5 years the number of homes grew by 14.42% in Sonora; the number of dwellings, translated into figures, would be 102,712 new dwellings in a period of 5 years, and if we compare with the II Population and Housing Count 2005 of the INEGI (2005) the same trends are observed, from 2005-2010 the number of housing increase 15.86% or 97.513 housing is the same.



**Graphic 1** Private homes inhabited in Sonora in the period 2005, 2010 and 2015

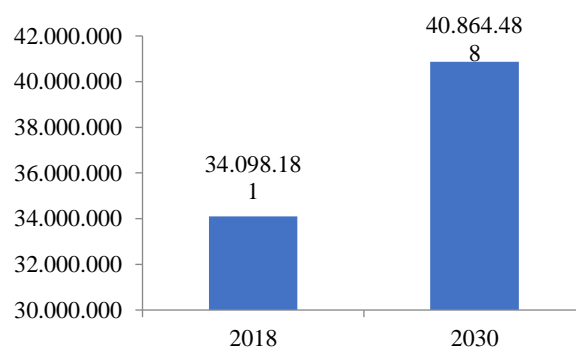
Source: INEGI. II Censo de Población y Vivienda 2005, INEGI. Censo de Población y Vivienda 2010, INEGI(2010). Encuesta Intercensal 2015

In (CONAPO, 2018) “Demographic indicators of Mexico from 1950 to 2050 and of the federal entities from 1970 to 2050” tells us that Sonora has a total annual growth rate of 37,397.5 inhabitants in 2019 and in 2030 that rate will remain positive having a number of 30,267.5 inhabitants. In the “Household Projections” database of the National Housing Commission (CONAVI), the national and state data of the homes estimated until 2030 were obtained.



**Graphic 2** Number of estimated Homes in Sonora in the period 2018 and 2030

Source: Prepared by CONAVI with information on CONAPO projections



**Gráfico 3** Number of estimated homes in Mexico in the period 2018 and 2030

Source: Prepared by CONAVI with information on CONAPO projections

By 2030 there will be an increase in the number of homes nationwide of 6,766,307, and at the state level speaking of Sonora it will be 196,377, compared to 2018 that gives us a great basis to determine the amount of GHG that will be thrown at the atmosphere in the next 12 years.

Several research projects have taken on the task of investigating the environmental impact of the materials consumed in the construction of a house, as is the case of (Mercader, 2012) "Model for quantification of CO<sub>2</sub> emissions produced in buildings derived from resources materials consumed in its execution" where the CO<sub>2</sub> emissions produced in the execution of the usual construction model defined as the residential block destined for official housing are quantified, derived from the manufacturing process of the material resources used in its execution. Others have focused on an economic point of view as in (Estrada, 2014) "implement carbon footprint reduction and compensation measures in their construction projects" where they analyze it with the objective of finding how feasible it is, from the point of technical and economic view, implement carbon footprint reduction and compensation measures in its construction projects.

Within the above-mentioned investigations, different ways of determining GHGs are presented, in the first case the steps proposed by the GHG Protocol are followed, which is a model that establishes comprehensive and comprehensive frameworks to measure and manage GHG emissions from operations of the private and public sector, value chains and mitigation actions (World Resources Institute and the World Business Council for Sustainable Development, 2019), when measuring emissions, the protocol indicates that we must add the amount of a specific material and then multiply it by its emission factor. The protocol does not offer emission factors, but mentions that if there are no local, regional or country-specific sources available, predetermined factors of the Intergovernmental Panel on Climate Change should be used. (IPCC).

In the second investigation, the form used to calculate the carbon footprint proposes a series of steps within which they begin with the selection of the calculation methodology, if you have a business approach you should use GHG Protocol, If you focus on a product, you must resort to the PAS 2050 standard.

Then you define the limits for accounting for GHG emissions, according to the selected methodology. Next, any field or record data that allows quantifying the processes and operations defined in the previous step should be collected. And finally, the carbon footprint must be calculated by multiplying the data obtained in the previous step by an appropriate emission factor (Estrada, 2014). It can be observed in both cases the similarity between them in the aspect of quantifying emissions, it is essentially the same even as it is observed both cases are used or considered the GREENHOUSE GAS (GHG) Protocol, which is based primarily on quantifying the total of each material and then multiply by its emission factor.

In an effort to have a better perspective on the amount of emissions produced by the construction industry, it was decided to investigate the amount of emissions that are had in the construction of a house located in Ciudad Obregón, Sonora, in a social interest subdivision with an area of 43.87 M<sup>2</sup>, built with block walls, foundation slab and polystyrene slab and vault slab system, based on the background obtained, we chose to record the emissions by adding the product quantities and multiplying them by their emission factor, considering the materials that are used in quantities of significant enough size in the work. The life cycle analysis (LCA) is considered as an environmental tool that can provide a better understanding of the dimensions of the environmental profile of products, processes and services. It is a suitable tool to compare potential environmental impacts of various product alternatives. Combined with economic and social considerations, life cycle analysis can be used to analyze product sustainability (Anonymous, 2004).

Depending on the processes contemplated by the LCA, it may have different scopes:

- "From the cradle to the grave": Includes the extraction of raw materials and the processing of the necessary materials for component manufacturing, the use of the product and finally its recycling and/or final management. Transport, storage, distribution and other intermediate activities between the life cycle phases are also included when they are of sufficient relevance (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).

- “From the cradle to the door”: The scope of the system is limited from when raw materials are obtained until the product is placed on the market, at the exit of the manufacturing plant (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).
- “From door to door”: Only manufacturing processes are taken into account (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).

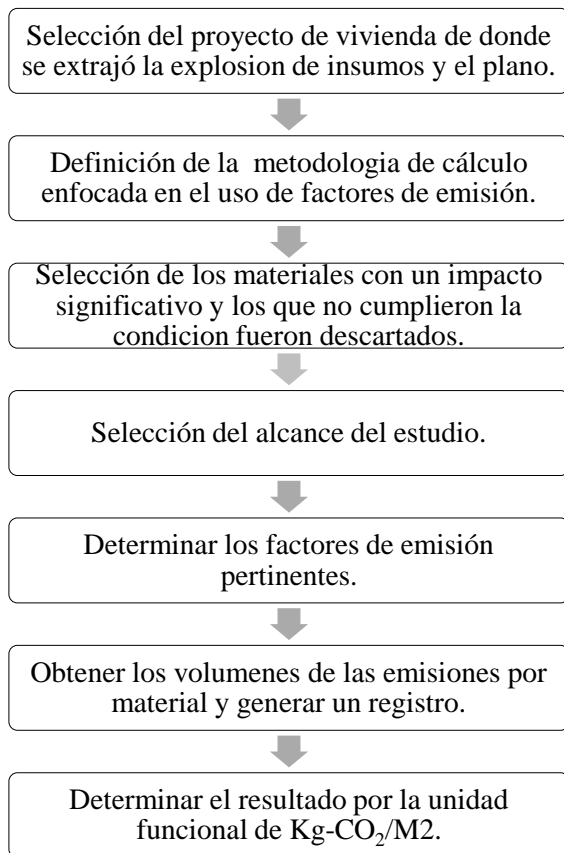
The dwelling studied was taken as a product, to which the LCA was applied, in order to better measure its environmental impact. To achieve a correct methodology with the life cycle, the first thing that was done was to define a calculation method, which depending on the approach can be selected from one of the existing ones. A common dwelling was analyzed and selected in the national context, from which the explosion of inputs (materials, labor, machinery and equipment) required for the construction of the dwelling was obtained, as a result of the quantification of each of them. Finally, the scope of the study (cradle at the door) was selected and the corresponding emission factors were searched and selected. With the results obtained, the damages to which the atmosphere will be exposed can be predicted and in this way actions can be initiated with the purpose of improving the conditions of the atmosphere today. The results can also be applied to the national territory in works of similar characteristics and will be usable information to determine in a practical way the GHG emissions generated in the housing construction stage.

### Methodology

To carry out this project, the participation of a student and civil engineering research professors from the Technological Institute of Sonora was carried out, making the pertinent calculations to obtain results, the materials and equipment used were, the Excel electronic sheet for the visualization of the explosion of inputs and to capture the data created to quantify the CO<sub>2</sub> emissions generated by the construction, interpretation of results. The sources of information were previous works related to the project such as thesis, articles, scientific journals, database of the Mexican government, electronic bibliography in general.

### Procedure:

1. It began by choosing a project of a very common INFONAVIT housing in the national context, in order to have a representative figure in the entire national context, from this the explosion of inputs related to the materials used in its construction and the construction Plan of the work.
2. A calculation methodology was defined, as it focused on the use of emission factors, the GHG PROTOCOL and the LIFE CYCLE ASSESMENT ISO 14040 were used as a basis, making the appropriate adjustments to the context of the study.
3. The explosion of inputs of the materials used in a study dwelling was used, then began to discard materials that are used in small quantities and that are not repeated. The remaining materials were ordered and in cases where there are composite materials they were separated into their components and each material was calculated as individual and then assembled into a single concept.
4. The scope of the LCA was selected as “Cradle at the door” since the period of use of the house and the final disposal of waste at the end of its useful life was not contemplated.
5. The emission factors to be used for the calculation of the emission inventory in the established project were determined.
6. The materials relevant to the input explosion were multiplied by their emission factor and recorded in the Excel electronic sheet.
7. The results of Kg-CO<sub>2</sub> / M<sup>2</sup> from the housing input explosion were obtained and the information was therefore interpreted.



**Gráfico 4** Diagrama de flujo de la metodología Source: Own elaboration

### Emission factors

It is explained in a concise manner how the emission factors of each material were chosen, which factors influenced their choice and if they have any conditions in their use.

It was investigated in (Rodríguez, 2010) “Emission factors of construction materials” where the main factors of gray construction materials were obtained from the carbon calculator developed by the author. At the same time in (Argüello, 2008) “Analysis of the environmental impact associated with the construction materials used in the low-cost housing of the 10 x 10 Techo-Chiapas program of the CYTED”, for example, the emission factor used for the steel, where (Mercader, 2012) “Quantification model of CO<sub>2</sub> emissions produced in buildings derived from the material resources consumed in its execution” determines different additional emission factors to obtain a more reliable database. Additionally also in (Suárez, 2014) “Environmental viability of gypsum recycling” the cast factor was specifically sought. Finally, in “Emission factors for the different types of fossil fuels and alternative that is common in Mexico” developed by the Mexican Petroleum Institute in 2014, the wood emission factor was obtained.

Another source that was taken into account was the (SEMARNAT, 2019) National Emissions Registry (RENE) which shows the official steps to register the emissions of the company or organization with the Mexican government, with an updated emissions calculator and with National data provided by the Ministry of Environment and Natural Resources (SEMARNAT) shows indicative results, some emission factors were obtained from it.

An international data source was the (Circular Ecology, 2019) Inventory of Carbon and Energy (ICE) Version 2.0 of the University of Bath, where various emission factors of different materials were found.

Through research in the sources cited and others, the emission factors for each material were reached.

### Composite materials

As mentioned in the methodology, there are some materials that by their nature are composed of various materials such as, the case of concrete that require cement, gravel, sand and water for their preparation or the case of cement-sand mixtures, mortar-sand, lime-sand that also require combining various materials for its preparation and final presentation, in the specific case of this work are the joists from which it was better to separate the different emission factors that are used in the different materials and in the end just show the value of emissions generated.

The joist is composed of a concrete base and a triangular structure of steel rods, so in that case it was counted for the concrete how many M3 would be used and the quantities of material needed to create the concrete were calculated.

Concreto f'c =250 Kg/cm <sup>2</sup> para cada M3			
Tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390 <sup>1</sup>	0.01704	6.65
Grava (kg)	1000 <sup>1</sup>	0.01704	17.04
Arena n°4 (kg)	790 <sup>1</sup>	0.01704	13.46
Agua (lt)	205 <sup>1</sup>	0.01704	3.49

**Tabla 1** Cantidad de material para el concreto de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>CEMEX Concretos, Manual del Constructor.

With the results obtained, their respective emission factor was applied, then multiplied by the number of pieces and concrete emissions were counted.

Concreto f'c =250Kg/cm2 para cada M3			
Tamaño máximo 20 mm (3/4")			
Total	F. Emisión	Nº Piezas	Total CO <sub>2</sub>
6.65*	0.513 <sup>1</sup>	14	47.729
17.04**	0.03 <sup>2</sup>	14	7.157
13.46***	0.03 <sup>2</sup>	14	5.654
3.49****	0.00003 <sup>2</sup>	14	0.001

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 2** Total, de emisión del concreto de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"  
Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

But the steel also makes up the joist, for the steel it was quantified how much steel is needed to meet the specifications of the rods that are needed and the emission factor was applied and the partial emissions of the steel were obtained.

Material	kg/ML	Nº de M	F. Emisión	Total CO <sub>2</sub>
Acero	0.14 <sup>1</sup>	8.52	2.8 <sup>2</sup>	3.34

**Tabla 3** Cantidad de material de acero para la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"  
Source: <sup>1</sup>Salazar. Costo y tiempo en edificación, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Then it was multiplied by the number of pieces and the total CO<sub>2</sub> emissions were achieved.

Material	Total CO <sub>2</sub>	Nº Piezas	Total CO <sub>2</sub>
Acero	3.34	14	46.76

**Tabla 4** Total, de emisión del acero de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"  
Source: Own elaboration

With both calculated emissions, they were added and thus it was possible to have a total emission value for the joist of 107.30 kg-CO<sub>2</sub>, which is not applicable for the other joists, unless they have the same specifications.

Following this methodology with all composite materials, the relevant emissions are obtained. (annexes)

## Results

Next, the data obtained in the study are presented in tables.

Material	Unidad	Factor de emisión
Azulejo cerámico	M2	23.22 <sup>1</sup>
Poliestireno	kg	3.43 <sup>2</sup>
PVC y CPVC	kg	3.1 <sup>3</sup>
Pintura	kg	2.91 <sup>3</sup>
Acero	kg	2.8 <sup>1</sup>
Madera	kg	2.314 <sup>4</sup>
Block 12x20x40 cm	Pieza	0.604 <sup>5</sup>
Cal	kg	0.59 <sup>6</sup>
Cemento	kg	0.513 <sup>6</sup>
Block 12x20x20 cm	Pieza	0.302 <sup>5</sup>
Block 12x10x40 cm	Pieza	0.302 <sup>5</sup>
Mortero	kg	0.2268 <sup>1</sup>
Yeso	kg	0.072525 <sup>7</sup>
Grava	kg	0.03 <sup>1</sup>
Arena	kg	0.03 <sup>1</sup>
Agua	M3	0.03 <sup>1</sup>

**Tabla 5** Factores de emisiones en kg-CO<sub>2</sub>/ Unidad de material

Source: <sup>1</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución, <sup>2</sup>Pedreño. Desarrollo de una aplicación para el cálculo de la huella de carbono en proyectos de construcción, <sup>3</sup>Hammond & Jones. ICE, <sup>4</sup>SEMARNAT, Factores de emisión para los diferentes tipos de combustibles fósiles y alternativos que se consumen en México, <sup>5</sup>Rodríguez. Calculadora de carbono para materiales básicos de construcción de obra gris en Costa Rica, <sup>6</sup>SEMARNAT. RENE, <sup>7</sup>Suárez. Viabilidad ambiental del reciclaje del yeso

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Block Entero 12x20x40 (kg)	1	0.604 <sup>1</sup>	834.9	504.28
Block Dala 12x20x40	1	0.604 <sup>1</sup>	145	87.58
Block Esquina 12x20x40	1	0.604 <sup>1</sup>	138.99	83.95
Block Ajuste 12x20x32	1	0.604 <sup>1</sup>	108.99	65.83
Block Mitad 12x20x20	1	0.302 <sup>1</sup>	91.99	27.78
Block Piña 12x10x40	1	0.302 <sup>1</sup>	58.96	17.81
Block Dala 12x20x40	1	0.604 <sup>1</sup>	16	9.66
Block Dala Mitad 12x20x20	1	0.302 <sup>1</sup>	10	3.02
Vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				107.30 <sup>2</sup>
Vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				29.58 <sup>2</sup>
Vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				18.94 <sup>2</sup>
Vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional				2.19

**Tabla 6** Explosión de insumos de los blocks y las viguetas con la multiplicación de factores de emisión

Source: <sup>1</sup>Rodríguez. Calculadora de carbono para materiales básicos de construcción de obra gris en Costa Rica, <sup>2</sup>ver anexos

In (Rodríguez, 2010) "Emission factors for construction materials" the block of measures 12x19x39 cm is mentioned, with an emission factor of 0.604 kg-CO<sub>2</sub> / unit and having great similarity with the housing block obtained from the explosion of inputs that factor was selected, considering that it is practically the same factor for a 12x20x40 cm block.

For the blocks with measures 12x20x20 cm and 12x10x40 cm having half the volume compared to the block 12x20x40 cm, half of the emission factor was taken for these cases, as can be seen in table 6.

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Varilla Corrugada de 1/2"	172.23	2.8 <sup>1</sup>	1	482.24
Varilla corrugada de 3/8"	160.79	2.8 <sup>1</sup>	1	450.21
Malla Electrosoldada 6-6 / 6-6	1.97	2.8 <sup>1</sup>	76.1	419.77
Regla Tubular 1 1/2"x4" (6.1 M)	50.7032	2.8 <sup>1</sup>	1.17	166.1
Malla electrosoldada 6x6-10/10	0.97	2.8 <sup>1</sup>	58.55	159.02
Armex 12x12-4	6	2.8 <sup>1</sup>	8.2	137.76
Alambre recocido	29.98	2.8 <sup>1</sup>	1	83.94
Armex 12-20-4 (tramo 6m)	6.4	2.8 <sup>1</sup>	2.57	46.05
Tubo galvanizado de 3/4"	1.6875	2.8 <sup>1</sup>	6.16	29.11
Perfil Montén 4MT14	18.29	2.8 <sup>1</sup>	0.28	14.34
Regla tubular de 1" x 2" (6.1 M)	25.1259	2.8 <sup>1</sup>	0.2	14.07
Solera de 1 1/4" x 1/4" (6.1 M)	9.48	2.8 <sup>1</sup>	0.47	12.48
Alambrón de 1/4"	3.85	2.8 <sup>1</sup>	1	10.78
Varilla corrugada 3/8"	3.42	2.8 <sup>1</sup>	0.14	1.34

**Tabla 7** Explosión de insumos de elementos constituidos de puro acero con la multiplicación de factores de emisión  
Source: <sup>1</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Table 7 shows how in the case of steel only the weight of each piece of the material was considered, and its resistance was ignored because it does not affect the emission factor.

For the solera and the tubular ruler, the sections were taken with the commercial measures of 6.10 M. For the tubular ruler, the caliber No. 8 was selected for analysis.

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total de CO <sub>2</sub>
Cemento Gris	1000	0.513 <sup>1</sup>	1.55	795.15
Cemento Gris	1000	0.513 <sup>1</sup>	0.25	128.25
Yeso Moczari	40	0.07252528 <sup>2</sup>	6.1	17.70
Cemento Blanco	50	0.513 <sup>1</sup>	0.62	15.90
Calhidra Pimacal	25	0.59 <sup>1</sup>	0.06	0.885
Concreto premezclado Autocurable Fc=200 Kg/cm <sup>2</sup> T.M.A. 1 1/2", REV. 10 cm. +/- 2.5 cm. con Tiro Directo.				1001.18 <sup>3</sup>
Concreto premezclado Fc = 200 Kg/cm <sup>2</sup> T.M.A. 3/4" REV. 10 cm +/- 3.5 cm Incluye servicio de banda olla				719.32 <sup>3</sup>
Concreto premezclado Autocurable Fc = 150 Kg/cm <sup>2</sup> T.M.A. 3/4" Rev. 10 cm +/-2.5 cm.				322.25 <sup>3</sup>

**Tabla 8** Explosión de insumos de la calhidra, cemento, concreto y yeso con la multiplicación de factores de emisión

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Suárez. Viabilidad ambiental del reciclaje del yeso, <sup>3</sup>ver anexos

The cement emission factor observed in table 8 was obtained in the RENE database, the national emission data for each ton of Clinker was determined; considering the ordinary portland cement that is used for the concrete of the beams with a percentage of 95% of Clinker, the emission factor is obtained. Any difference between the emission factors of white cement, gray compared to ordinary portland, was neglected, since they have the same characteristics.

According to (SEMARNAT & INECC, 2002) "National Inventory of Emissions of Greenhouse Gases 1990-2002" published in 2002, hydrated lime, hydraulic lime and hydrated aerial lime are reported in the same way, so no distinction was made between them and the same factor was used in table 8.

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Casetón 1.22x0.61x0.125	1.1163	3.43 <sup>2</sup>	56	214.42
Azulejo Filadelfia 20x30 cm. Marca PORCELANITE	1	23.22 <sup>1</sup>	5.52	128.17
Azulejo Antiderrapante Venecia/Cabos de 20 cm. x 20 cm Marca PORCELANITE	1	23.22 <sup>1</sup>	1.14	26.47
Malla de Refuerzo (Rollo de 100 m2) KOVER sencilla	3	4.45 <sup>3</sup>	0.55	7.34
Placa de poliestireno (Fajilla 1" x 4" x 1.22 m)	0.037 7	3.43 <sup>2</sup>	48	6.21
Mortero especial para pegue (MORTAR, Línea Cement King) Saco de 25 kg.	25	0.22268 <sup>1</sup>	0.62	3.45

**Tabla 9** Explosión de insumos del mortero, azulejo, casetón, placa de poliestireno y malla de refuerzo con la multiplicación de factores de emisión



Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Pintura Vinílica Rekolor color blanco o pastel Marca Berel.	27.55	2.91 <sup>1</sup>	2.52	202.03
Pintura Elastomérica Berel, color blanco o pastel. (Garantía 3 años)	27.55	2.91 <sup>1</sup>	2.46	197.22
Pintura para molduras	5.49	2.91 <sup>1</sup>	1.23	19.65
Pintura de esmalte anticorrosivo marca Berel línea Qualik	21.85	2.91 <sup>1</sup>	0.04	2.54
Pintura Esmalte color	1.45	2.91 <sup>1</sup>	0.33	1.39

**Tabla 10** Explosión de insumos de la pintura con la multiplicación de factores de emisión

Source: <sup>1</sup>Hammond & Jones. ICE

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Arena	1560	0.03 <sup>1</sup>	3.49	163.33
Barrote 2" x 4" x 12'	1.175	2.314 <sup>2</sup>	4.34	11.80
Tablón de 2" x 8" x 10'	1.1775	2.314 <sup>2</sup>	1.53	4.17
Fajilla de 1" x 4" x 10'	0.9	2.314 <sup>2</sup>	1.52	3.17
Tablón de 2" x 4" x 10"	1.17	2.314 <sup>2</sup>	1.1	2.98
Fajilla de 1" x 4" x 8'	2.5	2.314 <sup>2</sup>	0.39	2.26
Grava	1560	0.03 <sup>1</sup>	0.04	1.87
Pipa de Agua (7.0 M <sup>3</sup> )	7	0.03 <sup>1</sup>	1.4	0.29

**Tabla 11** Explosión de insumos del agua, los áridos y la madera con la multiplicación de factores de emisión

Source: <sup>1</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución, <sup>2</sup>SEMARNAT, Factores de emisión para los diferentes tipos de combustibles fósiles y alternativos que se consumen en México

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Tubo de P.V.C. Sanitario 4" (tramo 6.0 M)	6.925	3.1 <sup>1</sup>	3.17	68.05
Tubo de P.V.C. de 2" (tramo de 6.0 M)	2.275	3.1 <sup>1</sup>	1.85	13.05
Tubo de CPVC de 1/2" (tramo 3.05)	0.38	3.1 <sup>1</sup>	7.87	9.27
Tubo de CPVC. de 3/4" (tramo 6.0 M)	1.24	3.1 <sup>1</sup>	0.91	3.50
Tubo de P.V.C. Sanitario 1 1/2" (tramo 6.0 M)	1.92	3.1 <sup>1</sup>	0.45	2.68
Yee de P.V.C. de 4" a 2"	0.214	3.1 <sup>1</sup>	2	1.33
Tee lisa CPVC 1/2"	0.031	3.1 <sup>1</sup>	12	1.15
Tapón CPVC 1/2"	0.012005	3.1 <sup>1</sup>	24	0.89
Codo de P.V.C. de 2" x 45°	0.135	3.1 <sup>1</sup>	2	0.84
Codo CPVC 1/2" x 90°	0.01	3.1 <sup>1</sup>	25	0.78
Codo de P.V.C. de 2" x 90°	0.05	3.1 <sup>1</sup>	5	0.78
Cople o Adaptador macho CPVC 1/2"	0.011	3.1 <sup>1</sup>	15	0.51
Tee de P.V.C. de 2"	0.07	3.1 <sup>1</sup>	2	0.43
Cople liso CPVC de 1/2"	0.007	3.1 <sup>1</sup>	7	0.15

**Tabla 12** Explosión de insumos del PVC y CPVC con la multiplicación de factores de emisión

Source: <sup>1</sup>Hammond & Jones. ICE

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Se consideró el mismo factor de emisión para el PVC y el CPVC en la tabla 12.

Emisiones totales en la vivienda		
Total en Kg-CO <sub>2</sub>	7087.95	Kg-CO <sub>2</sub>
Emisión por área	161.57	Kg-CO <sub>2</sub> /M <sup>2</sup>

**Tabla 13** Emisiones totales generadas en la vivienda  
Source: Own elaboration

Table 13 shows the total Kg-CO<sub>2</sub> emissions of all the work studied and also shows the result of dividing the previous result in the work area and thus obtaining the emissions in Kg-CO<sub>2</sub> / M<sup>2</sup>.

To carry out this investigation, an area of 43.87 M<sup>2</sup> of total construction was used, which allowed us to obtain the result of 161.57 Kg-CO<sub>2</sub> / M<sup>2</sup>.

## Annexes

### Annexe 1

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Malla de Refuerzo (Rollo de 100 M <sup>2</sup> ) KOVER sencilla	3	4.45 <sup>1</sup>	0.55	7.34

**Tabla 14.** Factor de emisión de la Malla de Refuerzo.

Source: <sup>1</sup>Pedreño. Desarrollo de una aplicación para el cálculo de la huella de carbono en proyectos de construcción

### Anexo 2

Material	Peso Volumétrico (kg/M <sup>3</sup> )
Arena grava, seca, suelta	1440-1680 <sup>1*</sup>

\*Se promedia el valor de los rangos inferior y superior.

**Tabla 15** Peso volumétrico de la arena y la grava

Source: <sup>1</sup>Fundidora Monterrey (México). Manual para Constructores

### Anexo 3

Material	Cantidad	N° M <sup>3</sup>	Total
Cemento (kg)	310 <sup>1</sup>	1.5	465.00
Grava (kg)	1000 <sup>1</sup>	1.5	1500.00
Arena (kg)	860 <sup>1</sup>	1.5	1290.00
Agua (lt)	205 <sup>1</sup>	1.5	307.50

**Tabla 16** Cantidad total de material para el Concreto premezclado Autocurable F'c = 150 Kg/CM<sup>2</sup> T.M.A. 3/4" Rev. 10 CM +/-2.5 CM

Source: <sup>1</sup>CEMEX Concretos, Manual del Constructor

## Anexo 4

Total	Factor de Emisión	kg de CO <sub>2</sub>
465.00*	0.513 <sup>1</sup>	238.55
1500.00**	0.03 <sup>2</sup>	45.00
1290.00***	0.03 <sup>2</sup>	38.70
307.50****	0.00003 <sup>2</sup>	0.01
Total		322.254

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 17** Total, de emisiones para el Concreto premezclado Autocurable F<sub>c</sub> = 150 Kg/CM<sup>2</sup> T.M.A. 3/4" Rev. 10 CM +/- 2.5 CM.

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

## Anexo 5

Material	Cantidad	N° M3	Total
Cemento (kg)	305 <sup>1</sup>	4.69	1430.45
Grava (kg)	1000 <sup>1</sup>	4.69	4690.00
Arena (kg)	900 <sup>1</sup>	4.69	4221.00
Agua (lt)	190 <sup>1</sup>	4.69	891.10

**Tabla 18** Cantidad total de material para el Concreto premezclado Autocurable F<sub>c</sub>=200 Kg/CM<sup>2</sup> T.M.A. 1 1/2", REV. 10 CM. +/- 2.5 CM. con Tiro Directo

Source: <sup>1</sup>CEMEX Concretos, Manual del Constructor.

## Anexo 6

Total	Factor de Emisión	kg de CO <sub>2</sub>
1430.45*	0.513 <sup>1</sup>	733.82
4690.00**	0.03 <sup>2</sup>	140.70
4221.00***	0.03 <sup>2</sup>	126.63
891.10****	0.00003 <sup>2</sup>	0.03
Total		1001.178

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 19** Total, de emisiones para el Concreto premezclado Autocurable F<sub>c</sub>=200 Kg/CM<sup>2</sup> T.M.A. 1 1/2", REV. 10 CM. +/- 2.5 CM. con Tiro Directo

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

## Anexo 7

Material	Cantidad	N° M3	Total
Cemento (kg)	350 <sup>1</sup>	3.07	1074.50
Grava (kg)	1000 <sup>1</sup>	3.07	3070.00
Arena (kg)	825 <sup>1</sup>	3.07	2532.75
Agua (lt)	205 <sup>1</sup>	3.07	629.35

**Tabla 20** Cantidad total de material para el Concreto premezclado F<sub>c</sub> = 200 Kg/ CM<sup>2</sup> T.M.A. 3/4" REV. 10 CM +/- 3.5 CM Incluye servicio de banda olla

Source: <sup>1</sup>CEMEX Concretos, Manual del Constructor

## Anexo 8

Total	Factor de Emisión	kg de CO <sub>2</sub>
1074.50*	0.513 <sup>1</sup>	551.219
3070.00**	0.03 <sup>2</sup>	92.100
2532.75***	0.03 <sup>2</sup>	75.983
629.35****	0.00003 <sup>2</sup>	0.019
Total		719.320

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 21** Total, de emisiones para el Concreto premezclado F<sub>c</sub> = 200 Kg/ CM<sup>2</sup> T.M.A. 3/4" REV. 10 CM +/- 3.5 CM Incluye servicio de banda olla

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

## Anexo 9

Concreto F <sub>c</sub> =250 Kg/cm <sup>2</sup> para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390 <sup>1</sup>	0.01644	6.41
Grava (kg)	1000 <sup>1</sup>	0.01644	16.44
Arena n°4 (kg)	790 <sup>1</sup>	0.01644	12.99
Agua (lt)	205 <sup>1</sup>	0.01644	3.37

**Tabla 22** Cantidad de material para el concreto de la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>CEMEX Concretos, Manual del Constructor

## Anexo 10

Concreto F <sub>c</sub> =250Kg/cm <sup>2</sup> para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO <sub>2</sub>
6.41*	0.513 <sup>1</sup>	3.289
16.44**	0.03 <sup>2</sup>	0.493
12.99***	0.03 <sup>2</sup>	0.390
3.37****	0.00003 <sup>2</sup>	0.000

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 23** Total, de emisión del concreto de la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

## Anexo 11

Material	kg/ML	N° de M	F. Emisión	Kg de CO <sub>2</sub>
Acero	0.14 <sup>1</sup>	8.22	2.8 <sup>2</sup>	3.22

**Tabla 24** Cantidad de material de acero para la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>Salazar. Costo y tiempo en edificación, <sup>2</sup>Mercader. Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

## Anexo 12

Kg de CO <sub>2</sub>	N° Piezas	Total de CO <sub>2</sub>
7.39	4	29.58

**Tabla 25** Total, de emisiones de las viguetas V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: *Own Elaboration*

## Anexo 13

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390 <sup>1</sup>	0.0057	2.22
Grava (kg)	1000 <sup>1</sup>	0.0057	5.70
Arena n°4 (kg)	790 <sup>1</sup>	0.0057	4.50
Agua (lt)	205 <sup>1</sup>	0.0057	1.17

**Tabla 26** Cantidad de material para el concreto de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional

Source: <sup>1</sup>CEMEX Concretos, *Manual del Constructor*

## Anexo 14

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO <sub>2</sub>
2.22*	0.513 <sup>1</sup>	1.14
5.70**	0.03 <sup>2</sup>	0.17
4.50***	0.03 <sup>2</sup>	0.14
1.17****	0.00003 <sup>2</sup>	0.00

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 27** Total, de emisión del concreto de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. *Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.*

## Anexo 15

Material	kg/ML	N° de M	F. Emisión	Kg de CO <sub>2</sub>
Acero	0.14 <sup>1</sup>	1.9	2.8 <sup>2</sup>	0.74

**Tabla 28** Cantidad de material de acero para la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional

Source: <sup>1</sup>Salazar. *Costo y tiempo en edificación*, <sup>2</sup>Mercader. *Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.*

## Anexo 16

Kg de CO <sub>2</sub>	N° Piezas	Total de CO <sub>2</sub>
2.19	1	2.19

**Tabla 29** Total de emisiones de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional

Source: *Own Elaboration*

## Anexo 17

Material	kg/ML	N° de M	F. Emisión	Kg de CO <sub>2</sub>
Acero	0.14 <sup>1</sup>	7.02	2.8 <sup>2</sup>	2.75

**Tabla 30** Cantidad de material para el concreto de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>CEMEX Concretos, *Manual del Constructor*

## Anexo 18

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO <sub>2</sub>
5.48*	0.513 <sup>1</sup>	2.809
14.04**	0.03 <sup>2</sup>	0.421
11.09***	0.03 <sup>2</sup>	0.333
2.88****	0.00003 <sup>2</sup>	0.000

\*Cemento, \*\*Grava, \*\*\*Arena, \*\*\*\*Agua

**Tabla 31** Total de emisión del concreto de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: <sup>1</sup>SEMARNAT. RENE, <sup>2</sup>Mercader. *Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución*

## Anexo 19

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390 <sup>1</sup>	0.01404	5.48
Grava (kg)	1000 <sup>1</sup>	0.01404	14.04
Arena n°4 (kg)	790 <sup>1</sup>	0.01404	11.09
Agua (lt)	205 <sup>1</sup>	0.01404	2.88

**Tabla 32** Cantidad de material de acero para la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

## Anexo 20

Kg de CO <sub>2</sub>	N° Piezas	Total de CO <sub>2</sub>
6.31	3	18.94

**Tabla 33** Total de emisiones de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Source: *Own elaboration*

## Conclusions

Based on our results, it was observed that the large emission factors do not influence as much as one would think, but the main factor that manages to increase the total emissions is the volume and quantity of material, since the elements with the greatest amount of weight and / or pieces are those that have a greater number of emissions.

An example was that of sand that even with the lowest emission factor was found well above the average, due to its large volume used.

Material	Peso	CO <sub>2</sub> /Ud.	Pzas.	Total CO <sub>2</sub>
Arena	1560	0.03 <sup>1</sup>	3.49	163.332

**Tabla 34** Emisiones totales de la arena

Source: <sup>1</sup>Mercader. *Modelo de cuantificación de las emisiones de CO<sub>2</sub> producidas en edificación derivadas de los recursos materiales consumidos en su ejecución*

Even so, the materials with the highest emission factor are above the median of the number of emissions. But, taking the above that the amount is more important, we can see the example of the PVC parts used that were still the third largest emission factor are those that least contributed to the total emissions.

Material	Peso	CO <sub>2</sub> / Ud.	Pzas.	Total CO <sub>2</sub>
Cople o Adaptador macho CPVC 1/2"	0.011	3.1 <sup>1</sup>	15	0.5115
Tee de P.V.C. de 2"	0.07	3.1 <sup>1</sup>	2	0.434
Cople liso CPVC de 1/2"	0.007	3.1 <sup>1</sup>	7	0.1519

**Tabla 35** Emisiones parciales de las piezas de PVC y CPVC

Source: <sup>1</sup>Hammond & Jones. ICE

What tells us that it is not enough to have a low emission factor, we must also be responsible for the amount of material that we will use and the opposite case is that elements with high emission factors can be used, if they are used in very small quantities, although it would be best to look for an alternative with a lower emission factor and thus emissions in that case could be almost nil.

In particular, it is likely that the impact of 7087.95 Kg-CO<sub>2</sub> / housing or 161.57 Kg-CO<sub>2</sub> / M<sup>2</sup> are not as representative individually, however, by performing the analysis presented below, we can measure the magnitude of future impacts.

With the results obtained of 7087.95 Kg-CO<sub>2</sub> / per house related to the estimated number of new homes that will be in 2030 compared to 2018 in Sonora, that is, 196,377; The number of new homes in 12 years will generate 1,391,910,357.15 Kg-CO<sub>2</sub> that extrapolated nationally generated emissions pass to critical levels.

So you should start asking and reflecting on what to do to minimize the damage that will cause all these emissions to the atmosphere and the inhabitants of our planet.

Carbon footprint reduction and compensation measures must be implemented in construction projects.

Carbon neutrality is the condition in which the GHG emissions that are reduced and compensated are equal to the GHG emissions generated. Consequently, net GHG emissions are equal to zero.

Another option is to offset their emissions through financial support for some emission reduction project, such as forest conservation and restoration projects, wind farm projects or solar park projects (Estrada, 2014).

It is essential to become aware immediately as global warming can become irreversible, as mentioned in the UN News portal (2019), "The special report of the Intergovernmental Panel on Climate Change revealed in 2018 that it is necessary to limit the global warming at 1.5 ° C to avoid irreversible changes in the life of the planet "; which is an urgent call to take the data provided by that study and begin to design clear strategies, with very well defined objectives, which allow quantifying, reducing and counteracting the emissions that are caused in the construction of houses.

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