

# Definition Of The Mechanical And Physical Qualities Of The Hollow Block Of 12 Centimeters, To Evaluate The Convenience Of Its Use

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**Abstract**— The present work aims to develop a comparison between the physical, mechanical and economic properties of hollow concrete blocks of 12 and 15 centimeters. First, the generation of quantitative information is required by means of tests, which were performed on both masonry pieces based on the Mexican Standards for Construction (NMX) according to the corresponding test. Subsequently, other tests are proposed which do not correspond to any NMX, but the realization of these is considered helpful to extend the parameters of the study, and consequently have a more complete final analysis.

With the comparison of the data obtained, the tests carried out on both hollow concrete blocks will determine a criterion that covers both their structural and economic behavior. This will help to determine and guarantee your work convenience, primarily focused on the use of these materials in the load walls for social housing.

**Index Terms**— Comparison, Hollow concrete blocks, Social housing, Work convenience.

## I. INTRODUCTION

The hollow concrete block is one of the most used materials in construction today. According to Bloqueras.org (2018) the first hollow concrete block was designed by Harmon Syvanus Palmer in 1890 in the United States. After 10 years of experimentation this achievement patented its design in the year 1900. Its concrete blocks had the following measures: 8 X 10 X 30 inches, but their pieces were so heavy that they had to be lifted in place with a small crane.

Currently the materials that are used for the development of hollow concrete blocks are sand (although it is frequently omitted in the process of making the block) Portland cement and gravel. All this in a mixture that produces a light gray piece that is generally used as a structural element. You can find pieces of other colors for an apparent finish with a fine texture and a high resistance to compression.

In Mexico, the hollow concrete block has been used structurally in social housing. Mention Pérez, Cabanillas, Hinojosa and Borbón (2010, p.28) that "The block that is used

in Mexico is manufactured in various measures, the most common used in the construction of houses are the 15x20x40 and the 12x20x40 centimeters, the which present two internal hollow cavities of 10x16 and 7x16 centimeters respectively".

Since any Mexican families do not currently have enough economic power to purchase a home, they have begun to use the hollow concrete block of 12x20x40 centimeters as a possible solution due to the lower cost in the market. This piece. Therefore, the objective of this research is to generate information that can support or refute its structural functioning in social housing.

## II. METHODOLOGY

The methodology used in the research is of the correlational, quantitative and applied type. With the intention of establishing a broad comparison between the hollow concrete block of 12x20x40 and 15x20x40 centimeters. The application of the Mexican Standards (NMX) is contemplated, which establish the procedure for the analysis of the physico-mechanical characteristics of the pieces, in order to determine which of the two offers a greater economic, spatial and structural advantage in the construction of the social housing, without compromising the physical integrity of the users. The NMX to be applied in hollow concrete blocks of both sizes are:

The **NMX-C-404-ONNCCE-2012** standard: Establishes the specifications and test methods that must be fulfilled by blocks, partitions, bricks and partition walls for structural use in buildings.

The **NMX-C-082-ONNCCE-2013** standard: Establishes the specifications and test methods for the adherence that the masonry pieces must comply with.

The **NMX-C-037-ONNCCE-2013** standard: Establishes the test method for the determination of the amount of water absorbed by blocks, bricks or concrete, ceramic or any other construction material.

The **NMX-C-036-ONNCCE-2013** standard: Establishes the test method for the determination of the compressive strength of domestically manufactured and imported blocks, partitions, bricks, partitions, lattices and pavers.

In addition, other tests that do not have an NMX will be developed, but the convenience of having them performed, so that the analysis presents a greater detail of each of the characteristics that the hollow concrete block can present. These tests will help in this sense, to have more reference information, which would allow to have a better based

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criterion when determining the advantages of each piece (12 and 15 centimeters) in relation to its resistance, mechanical behavior and economic and temporal impact. Next, the tests that will be carried out are described:

**The Compression test between the concrete block and the mortar joint (CBVSMJ-01):** seeks to measure the resistance of both construction elements and determine which of them fails first or if they do it together.

**The Nail Test (NT-01):** seeks to determine the kilos of pressure necessary for a nail to penetrate one of the faces of the concrete block and analyze the damage it generates in the piece.

**The Economic Test (ET-01):** seeks to analyze the economic difference between both pieces and thus determine which of the two presents an advantage in cost over the other.

**The Proof of Space Percentage (PSP-01):** seeks to compare the percentage of space that will occupy the block wall of 12 and 15 centimeters.

**The Performance Test (PT-01):** seeks to establish the performance of the workforce, for each hollow concrete block expressed in square meters per day.

### III. RESULTS AND DISCUSSION

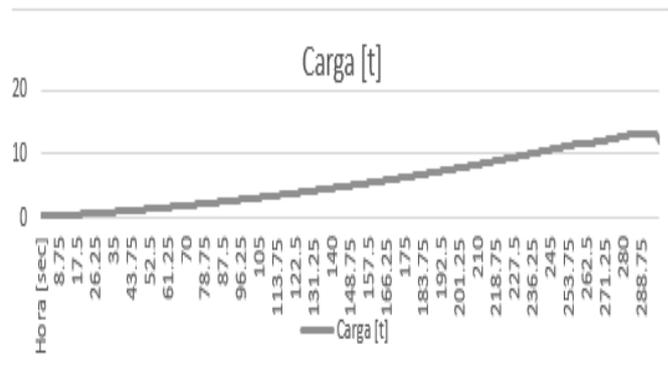
The results obtained from the performance of each of the tests adjusted to an NMX, as well as the tests that do not correspond to a standard, are shown below. Because the research is a comparison, in each trial will appear two results, which correspond to each piece of concrete block (12 and 15 centimeters). The data obtained will be used later to carry out the conclusions of the work.

**NMX-C-404:** When analyzing the compressive strength by means of the corresponding test between the hollow concrete block of 12 x 20 x 40 and that of 15 x 20 x 40 centimeters, it was obtained that the first one has an average resistance of 34.71 kg / cm<sup>2</sup>, while the second gave an average result of 70.77 kg / cm<sup>2</sup>, which means that there is a difference of 36.06 kg / cm<sup>2</sup> in favor of the 15 cm block.

Specimens of hollow concrete blocks of 12-20-40 and 15-20-40 were obtained from a developer of social housing, this in order to analyze the quality of parts occupied against acquired in commercial block, and to determine which is superior by means of those tested. It was found that, the quality of the pieces used by the developer is higher, since the average resistance for the blocks of 15-20-40 was 79.22 kg / cm<sup>2</sup>, while those of 12-20-40 resisted an average of 56.92 kg / cm<sup>2</sup>, that is, there is a difference of 22.3 kg / cm<sup>2</sup> in favor of the 15 cm block.

Calculating the general average between the blocks that were tested at the beginning with those extracted from the developer, it was found that the block of 12-20-40 has an average resistance of 45,813 kg / cm<sup>2</sup>, while that of 15-20-40 resists an average of 74,995 kg / cm<sup>2</sup>, that is, the latter is 29,182 kg / cm<sup>2</sup> more resistant to compression than the first.

The following is shown as an example of the various compression tests performed on the various parts of Figure 1, which shows the test of a block of 12-20-40 centimeters extracted from the developer, which presented a resistance to the compression of 13,269 Tons, that is, the result is expressed in a total of 55,286 kg / cm<sup>2</sup>.

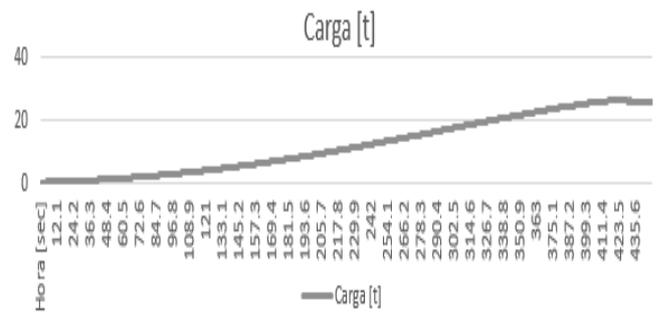


Graph 1: Test specimen compression of 12-20-40. Source: self made.

**NMX-C-082:** The block of 15-20-40 having a greater area of contact has consequently a lower effort to the adherence, than the block of 12 centimeters. That is to say, the lower the level of compressive strength, and the higher the value of effort to adherence. The difference between both pieces is, for the effort of the adhesion 0.1488 kg / cm<sup>2</sup> against the block of 12-20-40. For the resistance to compression it is 0.67 kg / cm<sup>2</sup> in favor of the 15 cm block.

**CBVSMJ-01:** The average resistances obtained are as follows: Specimen with block 12-20-40: 83.33 kg / cm<sup>2</sup> where both the block and the concrete joint fail simultaneously in the three specimens. While the specimen made with blocks of 15-20-40 had a resistance of 92.66 kg / cm<sup>2</sup>, and of the three specimens that were tested, the first failed the concrete block, in the second failure the board and in the third There was a simultaneous failure between the block and the board.

Next, it is shown again as an example the graph 2, which belongs to the test number three to the compression of the test of the block of 12-20-40 centimeters, against the joint of the mortar cement-sand that in proportion 1: 4 It was used, which had a compressive strength of 26,784 tons, that is: 74,399 kg / cm<sup>2</sup>.



Graph 2: Joint compression test specimen of 12-20-40. Source: self-made.

**NT-01:** The test already described yielded the following results, for the concrete block of 12.-20-40 466.33 kilograms of pressure are necessary, while for the 15-20-40 block, 243.66 kilograms of pressure are required, According to the above the concrete block of 12 centimeters is 222.67 kilograms of pressure more resistant than the piece of 15 centimeters, however the first one presents more damage on the surface of the block, than the one of 15-20-40.

**ET-01:** The use of the 12-20-40 block represents a saving per square meter of 11.88 pesos (Mexican National Currency or MNX). To analyze the difference in cost between both blocks, a social interest house located in a development of the city of Torreón, Coahuila, Mexico, was taken as a point of reference. Construction with 115 square meters of walls, which multiplied by the savings to use the block of 12-20-40 achieved a decrease of 1,366.66 MNX per house built.

**PSP-01:** According to the data obtained, when using the block of 12-20-40 in the construction of a house on the 15-20-40 one could save up to 15% of the space occupied by the walls. For example, if in a house built with blocks of 15-20-40 the walls occupy a total of 10.05 m<sup>2</sup>, using a block of 12-20-40, only 8.04 square meters would be occupied, thus saving 2.01.

**PT-01:** The hollow concrete block of 15x20x40 centimeters, has a yield of 11.00 M<sup>2</sup> / JO, while that of 12-20-40, being a slightly smaller and lighter piece, offers a yield of 12.00 M<sup>2</sup> / JO. which makes that, in terms of performance this is higher than 15-20-40. The above, affects the unit price reached by each piece.

The final comparison that contains the results of the tests carried out on both pieces, for a simpler and more practical understanding, is shown in tables 1 and 2. In order to evaluate which is the best option for the construction of walls in social housing.

Table 1: Results of the tests of the hollow concrete block of 12 x 20 x 40 centimeters.

NORMA APLICABLE	ESPECIMEN 12X20X40		
NMX-C-404 NMX-C-036	KG: 14.560	TON: 10.995	KG/CM <sup>2</sup> : 45.813
NMX-C-082	TON: 0.643	KG/CM <sup>2</sup> : 2.679	
CBVSMJ-01	TON: 29.998	KG/CM <sup>2</sup> : 83.330	
NMX-C-037	LITROS: 2.333		
NT-01	KILOGRAMOS: 466.33		
ET-01	PRECIO POR M <sup>2</sup> : 200.72		
PSP-01	M <sup>2</sup> : 0.048	PORCENTAJE: 85%	
PT-01	12.00 M <sup>2</sup> /JO		

Table 2: Results of the tests of the hollow concrete block of 15 x 20 x 40 centimeters.

NORMA APLICABLE	ESPECIMEN 15X20X40		
NMX-C-404 NMX-C-036	KG: 16.238	TON: 22.498	KG/CM <sup>2</sup> : 74.995
NMX-C-082	TON: 0.650	KG/CM <sup>2</sup> : 3.349	
CBVSMJ-01	TON: 55.593	KG/CM <sup>2</sup> : 92.660	
NMX-C-037	LITROS: 1.766		
NT-01	KILOGRAMOS: 243.66		
ET-01	PRECIO POR M <sup>2</sup> : 212.60		
PSP-01	M <sup>2</sup> : 0.060	PORCENTAJE: 100%	
PT-01	11.00 M <sup>2</sup> /JO		

#### IV. CONCLUSION

The block of 12-20-40 presents advantages in the price, the percentage of occupation of the space and in the performance of the piece, although it is clear that these advantages over the 15-20-40 are not so considerable and can be considered as not enough if it does not guarantee adequate structural work.

The block of 15x20x40 centimeters, has a great advantage over the 12x20x40 centimeters in each of the tests of compressive strength, adhesion, drilling test, and water absorption. In this way it can be concluded that the hollow concrete block of 15-20-40 has more qualities for its structural use than the 12-20-40, the latter being less recommendable due to its resistance capacity.

It is important to know that, although currently the 12-20-40 block is apparently displacing the 15-20-40 block of social housing because it has a lower cost, the difference between the strength of both pieces is almost double in favor of the hollow concrete block of 15x20x40 centimeters. As a hypothesis of this research, it was believed that the 12-20-40 block could be suitable for the structural work of the load-bearing walls in social housing. However, because this does not have the resistance established by the NMX-C-404 standard for masonry pieces for structural use, the hypothesis turned out to be false.

Regarding the expected scope of the present comparison, it could be said that it was fulfilled with the expected, since an analysis was generated between both blocks, and it was determined that the 12x20x40 centimeters is not appropriate to be used structurally in the social housing. In addition, the strength of the block cannot guarantee a correct structural operation because it does not comply with the resistance required by the corresponding standards. Thus, it can be said that the block of 12-20-40 should not replace the concrete block of 15-20-40, in the construction of economic, popular and traditional housing.

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