Chapter 4 Construction element from debris and demolition waste as a post-disaster strategy

Capítulo 4 Elemento constructivo a partir de residuos de escombros y demoliciones como estrategia post desastre

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Abstract

In Mexico and the world, the events due to natural disasters that occurred in the last decade have led us to reflect on the commitment of Architecture, it is necessary to understand and measure the responsibility of the architect in disaster areas, it is essential to submit to analysis the teaching of architecture as an agent that generates well-being with social responsibility. The problems that derive from natural disasters, have an impact of considerable duration, the impact of an earthquake for example, not only affects the moment of the event itself, but its consequences infer a wide spectrum of affectations. One of the great concerns is the management and final disposal of waste, in the affected areas of Mexico it is a critical situation, which worsens as the volume of waste generation grows, coupled with it, the customary way its disposal is carried out in open-air dumps, which causes great effects on the natural environment. The environmentally adequate final disposal complicates the capacity of the collection services, the infrastructure and the sanitary landfills, however, the need for their correct handling and control opens the possibility of recycling. This article calls for reflection and presents a research project arising from the classroom, which is based mainly on the design of a mold to create modules as a building element (Block) with the use of construction waste and demolition, as recycled aggregates product of rubble and demolitions, one of the objectives of the project is to verify their effectiveness and thus be able to use them in the reconstruction and construction of another alternative housing at low cost.

Earthquake, Debris, Recycling, Recycling, Modules, Social responsibility

Resumen

En México y en el mundo, los eventos por desastres naturales ocurridos en la última década nos han llevado a reflexionar sobre el compromiso de la Arquitectura, es necesario entender y dimensionar la responsabilidad del arquitecto en zonas de desastre, es indispensable someter a análisis la enseñanza de la arquitectura como agente generador de bienestar con responsabilidad social. Los problemas que se derivan de los desastres naturales, tienen un impacto de considerable duración, el impacto de un terremoto por ejemplo, no solo afecta el momento del evento en sí, sino que sus consecuencias infieren un amplio espectro de afectaciones. Una de las grandes preocupaciones es el manejo y disposición final de los residuos, en las zonas afectadas de México es una situación crítica, que se agrava conforme crece el volumen de generación de residuos, aunado a ello, la forma acostumbrada de su disposición se realiza en tiraderos a cielo abierto, lo que provoca grandes afectaciones al entorno natural. La disposición final ambientalmente adecuada complica la capacidad de los servicios de recolección, la infraestructura y los rellenos sanitarios, sin embargo, la necesidad de su correcto manejo y control abre la posibilidad del reciclaje. Este artículo llama a la reflexión y presenta un proyecto de investigación surgido del aula, el cual se basa principalmente en el diseño de un molde para crear módulos como elemento constructivo (Block) con el uso de residuos de construcción y demolición, como agregados reciclados producto de escombros y demoliciones, uno de los objetivos del proyecto es verificar su efectividad y así poder utilizarlos en la reconstrucción y construcción de otra vivienda alternativa a bajo costo.

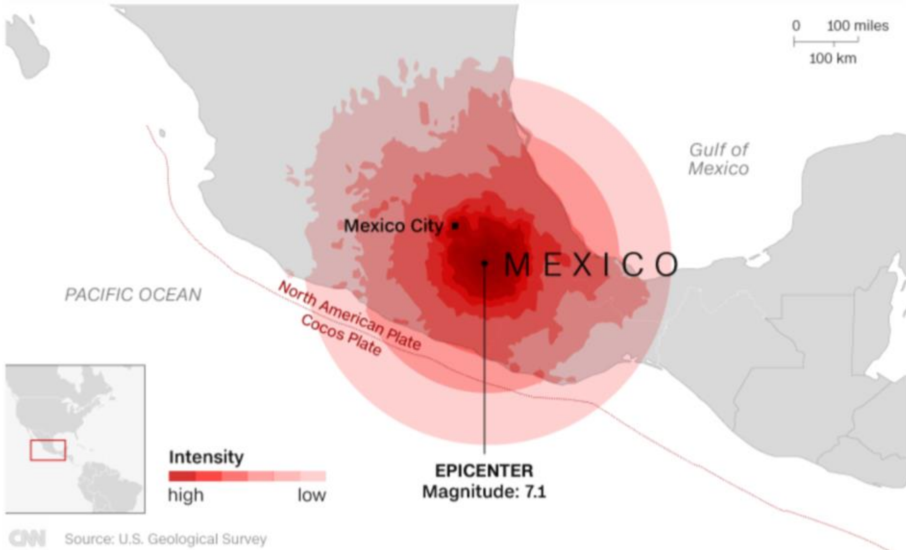
Sismo, Escombros, Reciclaje, Módulos, Responsabilidad social

4.1 Introduction

The earthquakes that have occurred in Mexico and around the world have had an impact not only on the cultural, social and economic spheres, but also on education and architectural practice.

On 19 September 2017 there was an earthquake with a magnitude of 7.1 on the Richter scale with epicentre 120 km south of Mexico City, mainly affecting the States of Mexico, Morelos, Puebla and Mexico City (see figure 4.1), as a result of such movement caused the oceanic tectonic plates of Cocos and North America, to rearrange and fuel the sudden movements of the earth in areas with greater seismicity in Mexico City and other surrounding states, many buildings of more than three levels suffered structural damage in these states, in some cases leaving total collapses due to the deterioration of the buildings themselves or previous deficient construction, although in other cases the damage was only partial or structural, it is known that there is also a serious problem due to lack of compliance with the standards specified in the current building regulations, and consequently, the damage observed is better explained by the lack of compliance with the standards, rather than by possible deficiencies in the current building regulations (Cruz Atienza V, et al, 2017).

Figure 4.1 Location of the epicentre of the earthquake of 19 September 2017



Source: Mexico had two big earthquakes this month. Here's why, Faith Karimi, Chandrika Narayan, 2017, https://edition.cnn.com/2017/09/20/americas/mexico-two-earthquakes-in-one-month/index.html

As a result of any natural catastrophe, various types of waste are generated, such as special handling waste, which cannot be considered solid urban waste or hazardous waste, since solid urban waste is that which originates from domestic and commercial activity in cities and towns, and hazardous waste is solid materials, These materials are corrosive, reactive, explosive, flammable, flammable, biologically infectious, which if not handled properly and not disposed of properly will generate problems that will have a direct impact on the health of the population and on the environment, soil and water.

Among these special handling wastes are construction and demolition wastes; The Mexican Chamber of the Construction Industry of Mexico attributes this to the fact that there are few entities in the country that have adequate infrastructure for its management, and currently only one recycling plant in operation has been identified, It is also estimated that only 20% of the waste is disposed of in authorised sites, and 3% is recycled, with the rest being disposed of for land levelling, landfills and inappropriately in soils that are optimal for nature preservation and conservation. (CMIC, 2018)

In addition, the extraction and introduction of this type of material not only modifies the soil, but also facilitates the entry of materials or substances into the aquifers that can be carried away by runoff or filtration into the subsoil, and these conditions increase the risk of contamination of water sources, the subsoil and the air.

Therefore, many communities affected by this type of natural phenomenon do not know the proper techniques for the management of debris or waste, and end up disposing of it in rivers or in certain areas a little far from the communities, causing soil contamination, deterioration of the environment and urban image, but above all causing health problems.

In 2017 the SEMARNAT (Ministry of Environment and Natural Resources) released the criteria for the management of construction and demolition waste generated by the 19 September earthquake for the states of Mexico, Morelos, Puebla and Mexico City. This proposal considers the location and operation of final disposal sites, the use and recycling of construction and demolition waste, and finally the clean-up and closure of final disposal sites.

Regarding the use and recycling of debris, it indicates that demolition waste can be used for recycling, obtained by crushing it.

The recycled stone material products can be used in the following projects (SEMARNAT, 2017):

- Sub-base in roads.
- Sub-base in car Parks.
- Embankment construction.
- Landfill.
- Construction of walkways or cycle paths.
- Construction of pipe beds.
- Construction of curb and pavement bases.
- Filling of embankments.
- Hydraulic bases.

Against this backdrop, it is clear that the profession of architect, originally so closely linked to the earth, has changed in recent times due to social, political, economic and educational changes, the introduction of new materials and new practices.

Today, it is necessary to set up awareness-raising programmes aimed at architecture students to reflect on priority issues such as, in this case, shared responsibility in post-disaster situations, seeking to minimise and control waste and, as far as possible, to reincorporate it into the construction chain, since its integral management is a social co-responsibility and requires the joint, coordinated and differentiated participation of producers, distributors, consumers, users of by-products, and the three levels of government as appropriate, under a scheme of market feasibility and environmental, technological, economic and social efficiency.

4.2 Development

In view of the major problem of debris management in post-disaster situations, the use of construction and demolition waste as recycled aggregates in the production of construction elements has attracted attention in recent years.

It has been observed that after natural phenomenological events such as earthquakes, recycled aggregates such as rubble are not suitable for use as high-strength materials, making it possible to make use of low-quality recycled aggregates for the production of concrete blocks.

Faced with this challenge, it has been proposed to create and implement a new building material that incorporates rubble material, through modules that are structurally strong, affordable and contribute to the restoration of housing in affected areas.

In this paper, we report the results of a comprehensive study to assess the feasibility of using crushed bricks, blocks, blocks, brick veneer, tiles, shredded as coarse and fine aggregates in the production of concrete masonry blocks. The effects of crushed aggregate content on the mechanical properties of the non-structural concrete block were quantified. From the results of the experimental tests, it was observed that the incorporation of these crushed waste aggregates had a significant influence on the properties of the blocks.

4.3 Methodology

In view of the great problem that is occurring in our country and in other parts of the world as a result of natural disasters, this research is based on the awareness of the demand for damaged housing and the need to reuse construction and demolition waste such as rubble, to create a new construction element from modules that incorporate fragments of blocks, partitions, ceramics, concrete and other materials with properties that are suitable for reuse in the construction of housing. As can be seen in figure 4.2, there are many tons of this waste material, and it is a material that will contaminate the land surrounding the disaster area and aquifers, as it is dumped clandestinely in these areas, affecting the image and contributing to further environmental deterioration.

Figure 4.2 Jojutla disaster zone, Morelos state, Mexico

Source of reference: Photo taken on site 21 Oct 2018 almost a year after the disaster.

The experimental research method is presented through the manipulation of an untested experimental variable under controlled conditions, in this case, the tests are carried out in a specialised laboratory, with the aim of describing the way or the causes that produce a particular situation or event. The objective of this research is to study the behaviour of the module or construction element through its subjection to various tests, in this way to know and demonstrate its physical properties, in addition, its comparison with analogous elements, makes it possible to detect similarities and to know its virtues and explore new ways to obtain the best use, functionality and sustainability within the standard.

Within the research strategies:

The management of the time and the planning in each one of the stages of the process is of extreme importance to achieve the attainment of the same one, it is for that reason that this investigation has been structured in three periods the first one to short term is the stage of investigation and analysis, being this the theoretical base of all project, the second period to medium term is the practical stage of experimentation where we are subordinated to factors that in some moment can or not interfere in the process as they could be times of tests in laboratory, or physical times of the own element like forged, dried etc. and the last period is the long term, which is the stage of implementation, comparison and elaboration of the product.

Short term:

- Conduct desk and field research.
- Design instruments, surveys, questionnaires and compile photographic archives.
- Analyse information collected both in the literature and in the field.
- Analyse existing prototypes.

In the medium term:

- Select materials from rubble and demolition and granulometries.
- Execute the experimentation of materials to be used, as well as define the samples and proportions.
- Elaborate prototypes with CDW (Construction and Demolition Waste) material.
- Carry out laboratory tests on the materials and the construction element (prototype), carrying out material resistance tests, resistance to compression with universal press.
- Comparison of results.

In the long term:

- Determine the construction processes.

To put forward proposals for improvement in the constructive aspects of the previous prototypes, to study the possibility of integrating new materials and geometries for the reconfiguration of the design of the constructive element and to create the detailed engineering of each prototype, in order to make the product of this research a reliable alternative for contingencies that generate problems with a very high social cost.

- Compare the costs of the product in the current market.
- Construction and Demolition Waste Material.
- Block made from this material.

4.4 Results and discussion

4.4.1 Experimental part

For the development of the project, the process of recycling rubble or waste construction and demolition material caused by the earthquake was used, such as: brick fragments, roof tiles, ceramic tiles, gravel, block fragments and mortar. Basically, it is based on the selection and separation of the material, which is crushed and screened to obtain recycled aggregate materials.

Subsequently, several tests were carried out on mixtures with different proportions of waste materials, cement and water. Checking their adhesion with the cement and other aggregates to create a homogeneous mixture.

At the same time, it was necessary to work on the type of mould to be used, so it was decided to make a solid block and another with cavities.

4.4.2 Materials from debris and demolition waste

The mixture or mortar with which the construction elements were made is composed of Portland cement, water, stone aggregate, which is the rubble and demolition waste previously selected in different granulometries of 3/8" and ¾", which will later be tested to determine their resistance and can be used as construction material.

4.4.3 Selection and crushing

The rubble and demolition waste RCD was collected and selected with the aim of eliminating residues of rods, wire rods, wire and all impurities not suitable as stone or aggregate material, such as plastic, organic waste, glass, etc.

This selection consisted in the separation of suitable materials, which can be reused and renewed, such as fragments of brick, ceramic tiles, gravel, fragments of blocks and mortars that can adhere to the cement and other aggregates to create a homogeneous mixture with structural properties resistant to those of a commercial block. Finally, the material was subjected to a manual crushing process in order to obtain a similar granulometry to the aggregate commonly used in the manufacture of commercial blocks, which is ¾" gravel and 3/8" gravel, which will be replaced by the RCD (fig. 4.3).

Figure 4.3 Material selection and crushing

Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

4.4.4 Screening and granulometry

The material resulting from the crushing was sieved or mechanically screened with ASTM test sieves to obtain its specific granulometry, which is 3/8" and ¾".

Figure 4.4 Screening of the material and particle size of the stone aggregate or aggregate

Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

4.4.5 Dosage or proportions

According to bloqueras.org on the dosage for the production of concrete blocks (see table 4.1), we took as a basis for the production of the blocks, replacing the gravel with CDW (construction and demolition waste). The rubble was used, previously crushed and screened, with an aggregate of 3/8" and the proportions of cement were varied, from 0.4, 0.8 and 1.2 kg. For the elaboration of a block or test piece.

Table 4.1 Dosage table to produce concrete blocks

Quantity	Mix m^3	Water litres	Cement kg	Sand kg	Gravel kg.	F+G
60	1	40	50	150	200	0,4
120	2	80	100	300	400	0,4
240	3	160	200	600	800	0,4
480	4	320	400	1200	1600	0,4
960	5	640	800	2400	3200	0,4

Source: https://bloqueras.org/bloques-concreto/

On the basis of these data for the elaboration of a block

Table 4.2 Dosage table to produce a concrete block

Quantity	Mix m^3	Water litres	Cement kg	Sand kg	Gravel kg.	F+G
1	0.016	.66	.83	2.5	3.33	0,4

Source: Own elaboration

4.4.6 Mix

Usually, the concrete mixture used to make this type of blocks is a mixture of Portland cement, sand, gravel and water, with the proportions described above, so we proceeded to make the mixtures, having obtained the crushing and selection of each of the materials that had the necessary characteristics and the behaviour of the preliminary mixtures, the experimental design was carried out (mixtures used in the manufacture of the blocks), this design was also based on the principles of handmade manufacture of blocks and bricks, being able to approximate in detail the weights of the materials used. Ten mixtures were designed with variations in proportions and type of material used, the mixtures were defined based on the granulometry of the materials used as aggregates (construction and demolition waste that meet the necessary characteristics of adherence to cement, and the type of material used in the production of the blocks).

Table 4.3 Dosage table to produce RCD mix in percentages

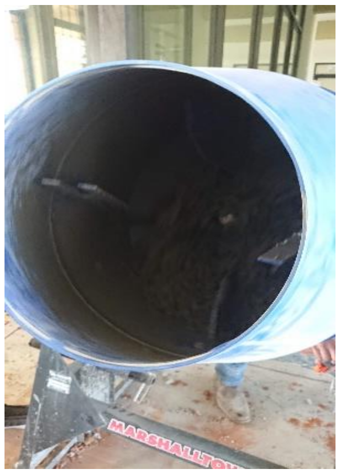
Mix	RCD	Sand	Cal	RP[1]	Cement	Water litres
1	39.21%	16.66%	9.80%	9.80%	24.50%	.66
2	44.44%	35.55%	4.44%	0%	15.55%	.66
3	48.14%	37.03%	3.70%	0%	11.11%	.66
4	58.06%	16.12%	6.45%	0%	19.35%	.66
5	55.81%	13.95%	4.65%	9.30%	16.27%	.66
6	55.31%	14.89%	6.38%	12.76%	10.63%	.66
7	65.35%	16.33%	6.53%	0%	11.76%	.66
8	24.39%	58.53%	4.87%	0%	12.19%	.66
9	65.02%	22.42%	4.48%	0%	8.07%	.66
10	56.45%	32.25%	4.03%	0%	7.25%	.66

Source: Own elaboration

The preparation of this mixture was done mechanically with a mixer with a capacity of 1 bag of cement or 270 litres, the 3/8" RCD waste, cement, lime, sand and water were added, according to the dosage tables (see Table 3). This process requires careful observation of the amount of water needed and the mixing time, which varied from 6 to 8 minutes per mixture according to the observation of the consistency of the mixture.

Plastic waste (rubber).

Figure 4.5 Concrete mixer for the production of concrete mixes



Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

4.4.7 Preparation of the mould

The proposal for the shape of the mould for the block is the conventional one, for which two commercial moulds were bought, one for a solid block measuring 20cm x 40cm x 20cm (MM^{-1}) and the other for a hollow block measuring 20cm x 40cm x 20cm (MH^{-1}). This is in accordance with the Mexican standard NMX-C-038-ONNCCE, which states that the mould should have a dimension of 20 x 20 x 40 cm.

Figure 4.6 Commercial moulds to produce blocks 20 x 20 x 20 x 40 cm

Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

The preparations of the moulds were the application of burnt engine oil on the walls, as this will not allow the mixture to adhere nor alter the content of the preparation poured into it. (See fig.4.7).

Figure 4.7 Application of burnt oil to the metal mould

Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

4.4.8 Pouring the moulds

It is necessary to take care that the mixture is poured immediately into the moulds as it can set very quickly according to the amount of cement and lime, we proceeded to pour the homogeneous mixture and at the same time the air bubbles were eliminated by means of a manual vibration with a rod, putting it in and taking it out constantly, in the emptying it must be taken into account to fill the block completely because if it does not vary in the dimensions of the block, the block must have an adequate compaction, so that it obtains its maximum degree of resistance.

Figure 4.8 Pouring the mixture into the solid mould

Source: Photo taken in the concrete laboratory of the Tecnológico de Estudios Superiores de Jocotitlán, Estado de México

4.4.9 Demoulding

Demoulding is done once the pouring and compacting of the material and the drying of the specimens have been completed, in an appropriate space, free of humidity, with windows that allow air and sunlight to enter.

4.4.10 Waiting time for setting

Waiting time for setting was given for the samples of 28 days to reach the total drying of the samples before proceeding to take them to the laboratory to perform the appropriate tests to see if they comply with the necessary specifications according to NMX-C-038-ONNCCE.

4.4.11 Blocks

According to the Mexican standard NMX-C-404-ONNCCE-2012 which refers to the manufacturing dimension of the solid piece or solid concrete block should have a dimension of 390 mm long, 190 mm, without the thickness of the masonry joint and which should adjust the actual dimension within manufacturing tolerances, for example the common blocks have nominal dimensions of 200mm x 400mm (20cm x 40cm) in height and length respectively.

And the actual dimension is the measurement of each piece obtained by measuring by the test method specified in the Mexican standard NMX-C-038-ONNCCE where it handles tolerances of up to 3mm in any of its dimensions.

4.4.12 Laboratory tests

In order to evaluate the feasibility of the project, it was necessary to submit the new construction material to rigorous laboratory tests to determine compliance with structural requirements and to determine the properties of the structural or standard block in accordance with Mexican standards NMX-C-404 -1997-ONNCCE, and NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307.

The tests to which 11 construction elements were subjected (Blocks from sample 01 to 05 are hollow elements, from sample 06 to 11 are samples of solid elements, consisted of breaking load tests (kg), resistance tests (kg/cm^2), as well as the verification of their volumetric weight in the laboratory.

The following are the official reports of the laboratory tests of the hollow and solid blocks of the construction materials laboratory LAMACO Control y calidad S.C. in Santa María Totoltepec, Edo de México.

Figure 4.9 Sample test 01H

LAMACO
CONTROL Y CALIDAD S.C.

REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 JOCOTITLÁN, ESTADO DE MÉXICO

A CONTINUACIÓN REPORTO A USTED RESULTADOS DE RESISTENCIA ALCANZADAS EN BLOCK DE CONCRETO QUE SE SOMETIERON A LA PRUEBA DE COMPRESIÓN AXIAL

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK HUECO (MUESTRA 1)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001				
MUESTRA No.	1				
BLOCK No.	001				
ANCHO (cm).	20.0				
LARGO (cm).	40.0				
ALTURA (cm).	19.0				
PESO DEL BLOCK (kg).	12,160				
ÁREA TOTAL (cm^2).	800.0				
ÁREA NETA (cm^2).	443.3				
PESO VOLUMÉTRICO DEL BLOCK (kg/m^3).	1,443.7				
FECHA DE MUESTREO.	31/01/2020				
FECHA DE RUPTURA.	02/02/2020				
CARGA DE RUPTURA (kg).	14,000				
RESISTENCIA (Kg/cm^2).	17.5				
PORCENTAJE DE ABSORCIÓN (%).	9.8				

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORO.	REVISO.	RECIBIO
LABORATORISTA.	GERENTE TÉCNICO.	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TEC. EMIGDIO GUADARRAMA BERNAL	TEC. VICTORIANO RAMÍREZ TRUJILLO.	EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

PROHIBIDA LA REPRODUCCIÓN TOTAL O PARCIAL SIN LA AUTORIZACIÓN POR ESCRITO DE LAMACO CONTROL Y CALIDAD S.C.

ARTICULO No. 27, Int. 6 Col. La Loma,
Santa María Totoltepec,
Edo de México.
lamaco1966@prodigy.net.mx
TEL. 01 (722) 1 99 3661
2 12 44 46
044 o 045 722 2 45 07 02

Figure 4.10 Sample test 02 H

LAMACO
CONTROL Y CALIDAD S.C.

REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

A CONTINUACIÓN REPORTO A USTED RESULTADOS DE RESISTENCIA ALCANZADAS EN BLOCK DE CONCRETO QUE SE SOMETIERON A LA PRUEBA DE COMPRESIÓN AXIAL

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK HUECO (MUESTRA 2)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001				
MUESTRA No.	2				
BLOCK No.	001				
ANCHO (cm).	20.0				
LARGO (cm).	40.0				
ALTURA (cm).	21.5				
PESO DEL BLOCK (kg).	12,300				
ÁREA TOTAL (cm^2).	800.0				
ÁREA NETA (cm^2).	395.0				
PESO VOLUMÉTRICO DEL BLOCK (kg/m^3).	1,448.3				
FECHA DE MUESTREO.	31/01/2020				
FECHA DE RUPTURA.	02/02/2020				
CARGA DE RUPTURA (kg).	12,300				
RESISTENCIA (Kg/cm^2).	15.4				
PORCENTAJE DE ABSORCIÓN (%).	8.3				

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

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TEC. EMIGDIO GUADARRAMA BERNAL	TEC. VICTORIANO RAMÍREZ TRUJILLO.	EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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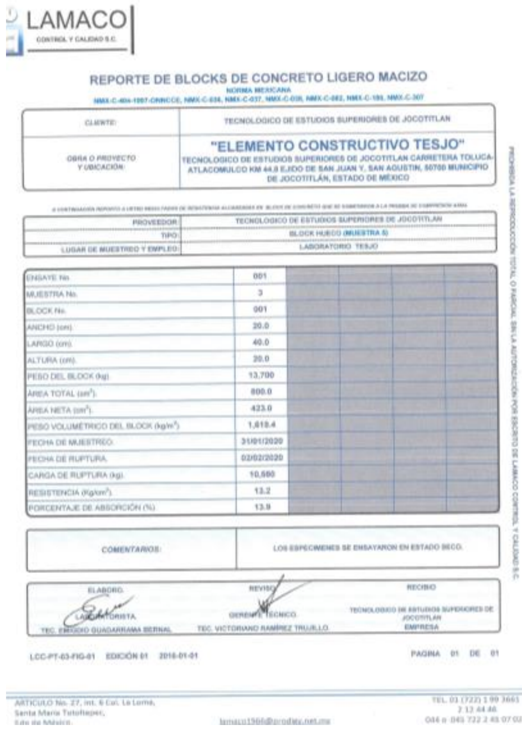
Santa María Totoltepec,
Edo de México.
lamaco1966@prodigy.net.mx
TEL. 01 (722) 1 99 3661
2 12 44 46
044 o 045 722 2 45 07 02

Figure 4.11 Sample test 03 H



LAMACO
CONTROL Y CALIDAD S.C.

REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-193, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
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PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK HUECO (MUESTRA 5)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	3
BLOCK No.	001
ANCHO (cm).	20.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	13,700
ÁREA TOTAL (cm²).	800.0
ÁREA NETA (cm²).	423.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,618.4
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	10,580
RESISTENCIA (Kg/cm²).	13.2
PORCENTAJE DE ABSORCIÓN (%).	13.9

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORO.	REVISO.	RECIBO
LABORATORISTA. TEC. EMIGDIO GUADARRAMA BERNAL	GERENTE TECNICO. TEC. VICTORIANO RAMÍREZ TRUJILLO	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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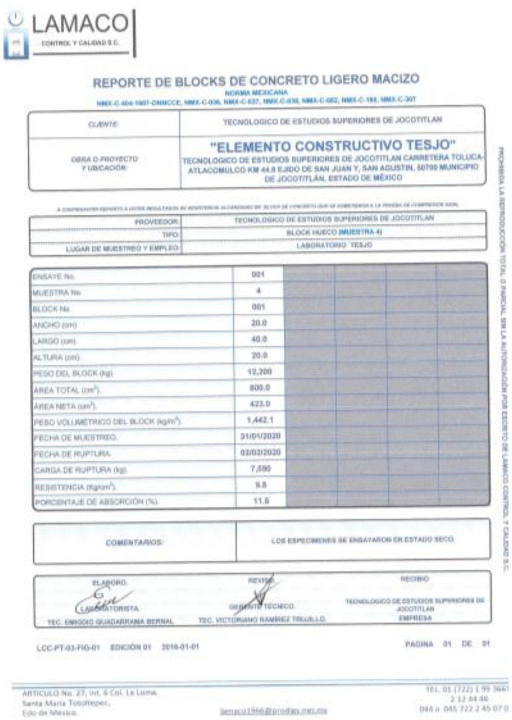
Figure 4.12 Sample test 04 H



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-193, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK HUECO (MUESTRA 4)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	4
BLOCK No.	001
ANCHO (cm).	20.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	12,200
ÁREA TOTAL (cm²).	800.0
ÁREA NETA (cm²).	423.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,442.1
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	7,590
RESISTENCIA (Kg/cm²).	9.5
PORCENTAJE DE ABSORCIÓN (%).	11.8

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORO.	REVISO.	RECIBO
LABORATORISTA. TEC. EMIGDIO GUADARRAMA BERNAL	GERENTE TECNICO. TEC. VICTORIANO RAMÍREZ TRUJILLO	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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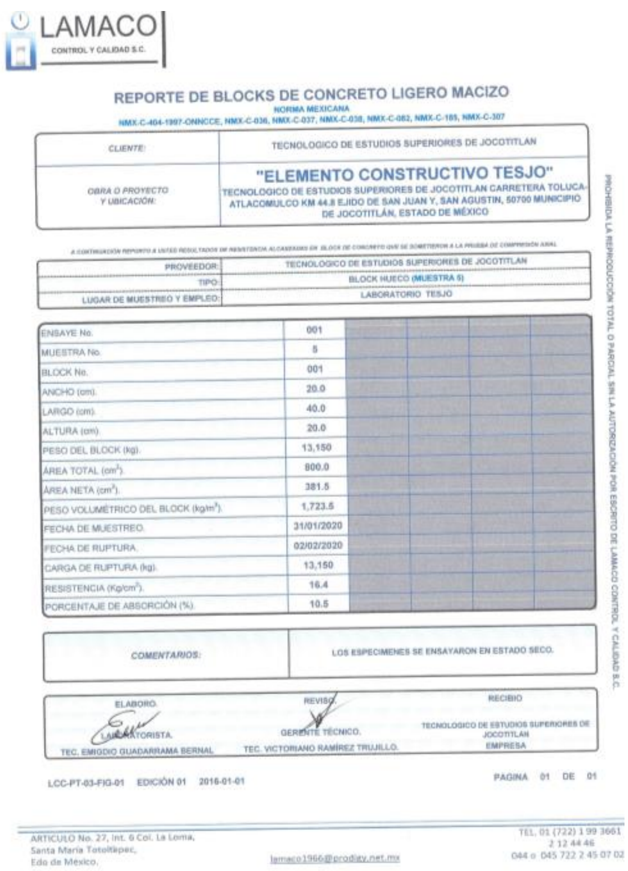
Figure 4.13 Sample test 05 H



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

A CONTINUACIÓN REPORTO A USTED RESULTADOS DE RESISTENCIA ALCANZADOS EN BLOCK DE CONCRETO QUE SE SOMETIERON A LA PRUEBA DE COMPRESIÓN AXIAL

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK HUECO (MUESTRA 5)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	5
BLOCK No.	001
ANCHO (cm).	20.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	13,150
ÁREA TOTAL (cm²).	800.0
ÁREA NETA (cm²).	381.5
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,723.5
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	13,150
RESISTENCIA (Kg/cm²).	16.4
PORCENTAJE DE ABSORCIÓN (%).	10.5

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

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LABORATORISTA.	GERENTE TÉCNICO.	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TEC. EMIGDIO GUADARRAMA BERNAL	TEC. VICTORIANO RAMÍREZ TRUJILLO.	EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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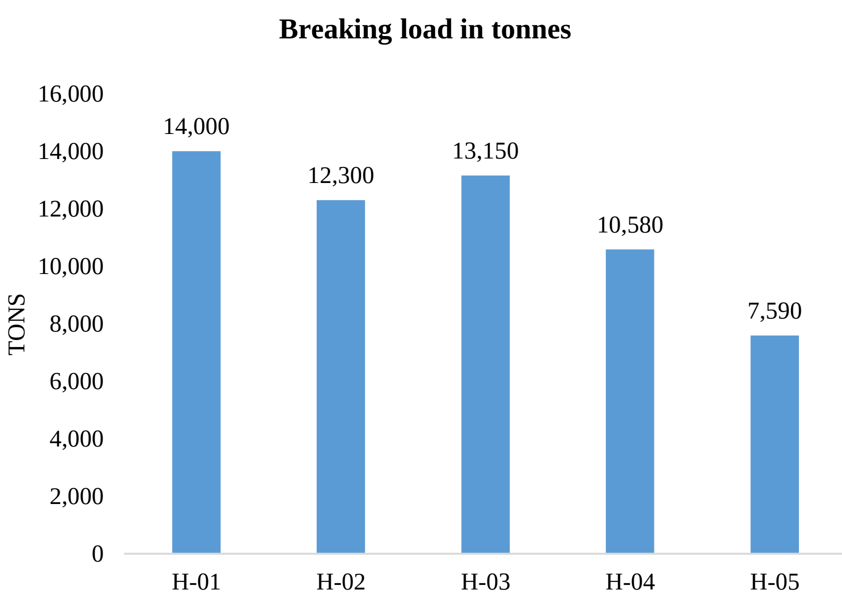
4.4.13 Analysis of the results of the element samples

a. Hollow block

Regarding the tests on the hollow blocks, the laboratory report shows, as shown in graphic 4.1, that Block H-01 obtained the highest resistance to rupture with 14.00 Ton at the maximum degree of rupture.

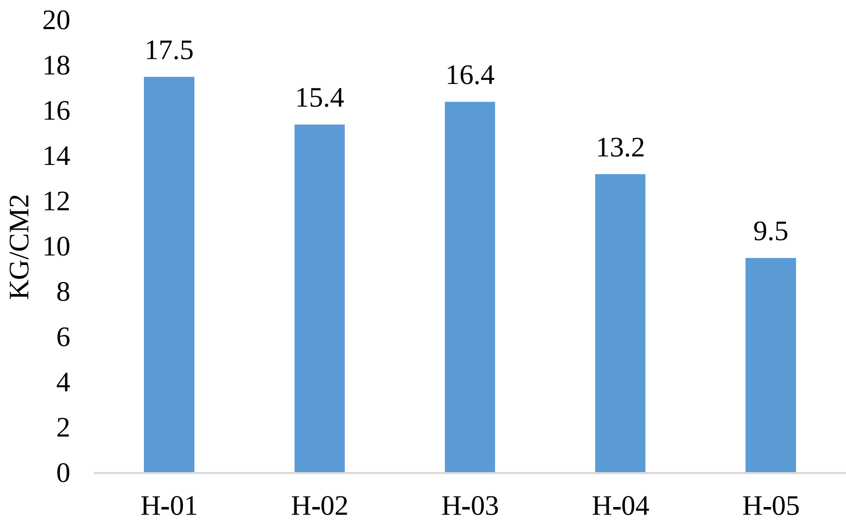
Graphic 4.1 Hollow block breaking load in tonnes



Source: Own elaboration

The data in graphic 4.2, with respect to the resistance test, a point load distributed on the nodding machine is placed on each of the blocks, obtaining a different pressure for each one of them, so it is obtained that in the same way it is block H-01 that obtains greater resistance in comparison to the other blocks.

Graphic 4.2 Hollow block breaking load in tonnes

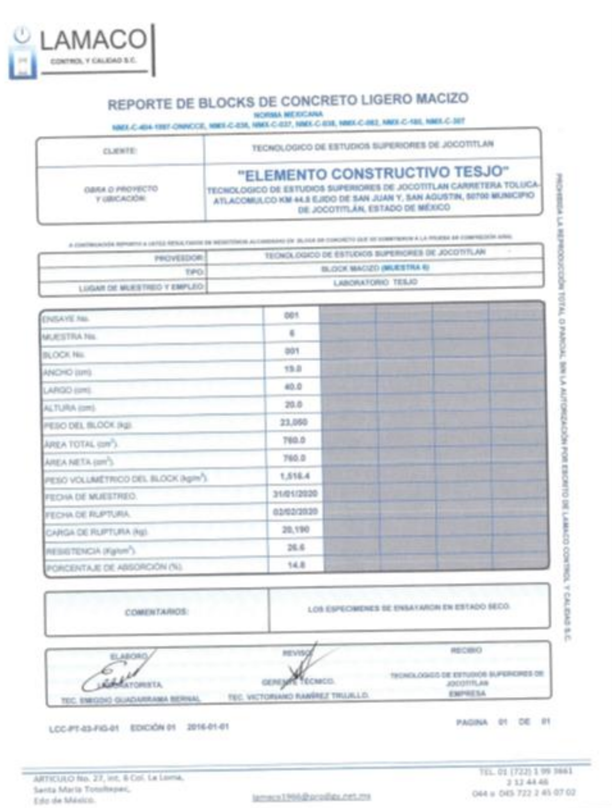


Source: Own elaboration

From the results of the resistances of the five types of hollow blocks that were made, it is concluded that Block H-01 does not fall within the necessary range to be a non-structural block according to the **PROY-NMX-C-441-ONNCCE-2011** standard (Construction industry - masonry - blocks, partitions or bricks and partitions for non-structural use - specifications and test methods), which specifies that a non-structural block must have a compressive strength of 35 kg/cm^2.

Solid block

Figure 4.14 Sample test M-06



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO

NORMA MEXICANA

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 6)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	6
BLOCK No.	001
ANCHO (cm)	15.0
LARGO (cm)	40.0
ALTURA (cm)	20.0
PESO DEL BLOCK (kg)	23,050
ÁREA TOTAL (cm^2)	760.0
ÁREA NETA (cm^2)	760.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m^3)	1,516.4
FECHA DE MUESTREO	31/01/2020
FECHA DE RUPTURA	02/02/2020
CARGA DE RUPTURA (kg)	20,190
RESISTENCIA (Kg/cm^2)	26.6
PORCENTAJE DE ABSORCIÓN (%)	14.8

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ	REVISÓ	RECIBIÓ
LABORATORISTA TEC. EMIGDIO GUADARRAMA BERNAL	GERENTE TÉCNICO TEC. VICTORIANO RAMÍREZ TRUJILLO	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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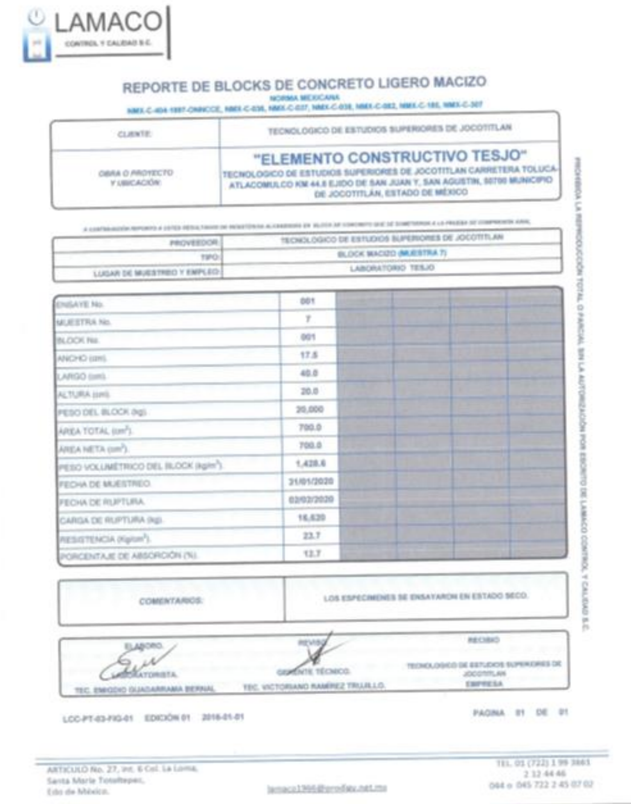
Figure 4.15 Sample test M-07



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 7)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	7
BLOCK No.	001
ANCHO (cm).	17.5
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	20,000
ÁREA TOTAL (cm²).	700.0
ÁREA NETA (cm²).	700.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,428.6
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	16,620
RESISTENCIA (Kg/cm²).	23.7
PORCENTAJE DE ABSORCIÓN (%).	12.7

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ. LABORATORISTA. TEC. EMIGDIO GUADARRAMA BERNAL
REVISÓ. GERENTE TÉCNICO. TEC. VICTORIANO RAMÍREZ TRUJILLO.
RECIBIÓ. TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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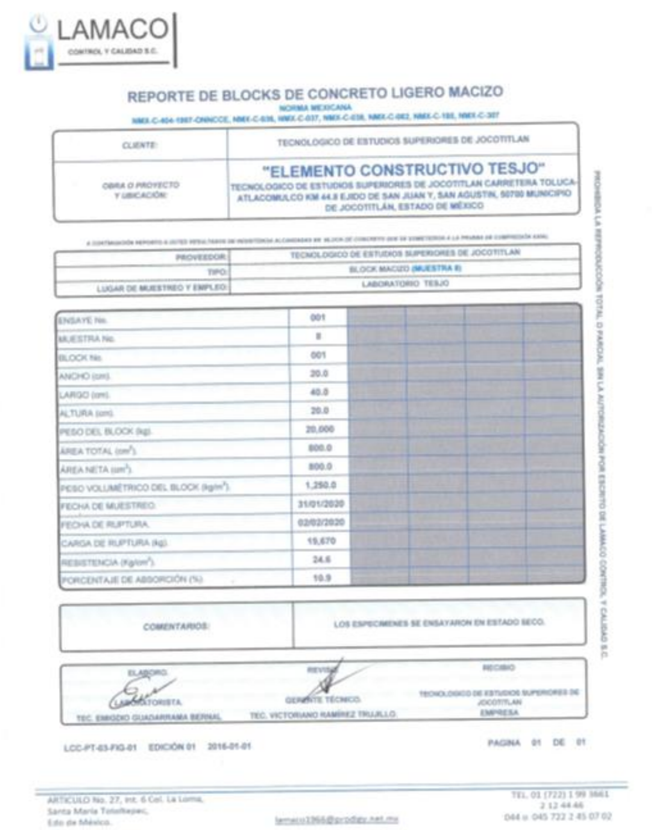
Figure 4.16 Sample test 08 M



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 8)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	8
BLOCK No.	001
ANCHO (cm).	20.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	20,000
ÁREA TOTAL (cm²).	800.0
ÁREA NETA (cm²).	800.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,250.0
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	19,670
RESISTENCIA (Kg/cm²).	24.6
PORCENTAJE DE ABSORCIÓN (%).	10.9

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ. LABORATORISTA. TEC. EMIGDIO GUADARRAMA BERNAL
REVISÓ. GERENTE TÉCNICO. TEC. VICTORIANO RAMÍREZ TRUJILLO.
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LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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Figure 4.17 Sample test 09 M

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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO

NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

A CONTINUACIÓN REPORTO A USTED RESULTADOS DE RESISTENCIA ALCANZADAS DE BLOCK DE CONCRETO QUE SE SOMETIERON A LA PRUEBA DE COMPRESIÓN AXIAL

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 9)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	9
BLOCK No.	001
ANCHO (cm).	16.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	21,900
ÁREA TOTAL (cm²).	640.0
ÁREA NETA (cm²).	640.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,710.9
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	26,820
RESISTENCIA (Kg/cm²).	41.9
PORCENTAJE DE ABSORCIÓN (%).	16.2

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ.	REVISÓ.	RECIBIO
LABORATORISTA.	GERENTE TÉCNICO.	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TEC. EMIGDIO GUADARRAMA BERNAL	TEC. VICTORIANO RAMÍREZ TRUJILLO.	EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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Figure 4.18 Sample test 10 M

LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO

NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

A CONTINUACIÓN REPORTO A USTED RESULTADOS DE RESISTENCIA ALCANZADAS DE BLOCK DE CONCRETO QUE SE SOMETIERON A LA PRUEBA DE COMPRESIÓN AXIAL

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 10)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	10
BLOCK No.	001
ANCHO (cm).	19.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	24,150
ÁREA TOTAL (cm²).	760.0
ÁREA NETA (cm²).	760.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,588.8
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	15,320
RESISTENCIA (Kg/cm²).	20.2
PORCENTAJE DE ABSORCIÓN (%).	10.6

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ.	REVISÓ.	RECIBIO
LABORATORISTA.	GERENTE TÉCNICO.	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TEC. EMIGDIO GUADARRAMA BERNAL	TEC. VICTORIANO RAMÍREZ TRUJILLO.	EMPRESA

LCC-PT-03-FIG-01 EDICIÓN 01 2016-01-01 PAGINA 01 DE 01

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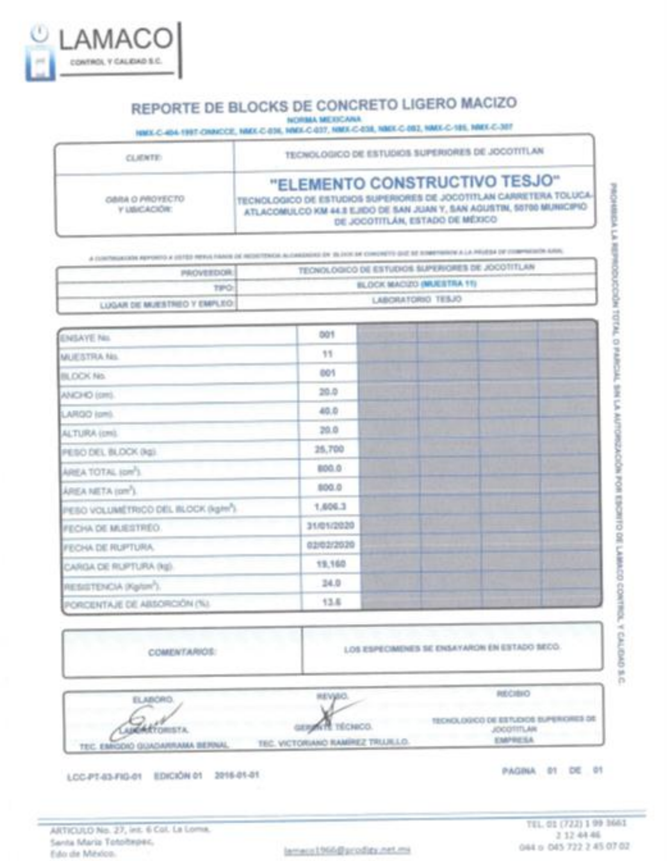
Figure 4.19 Sample test 11 M



LAMACO
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REPORTE DE BLOCKS DE CONCRETO LIGERO MACIZO
NORMA MEXICANA
NMX-C-404-1997-ONNCCE, NMX-C-036, NMX-C-037, NMX-C-038, NMX-C-082, NMX-C-185, NMX-C-307

CLIENTE:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
OBRA O PROYECTO Y UBICACIÓN:	"ELEMENTO CONSTRUCTIVO TESJO" TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN CARRETERA TOLUCA-ATLACOMULCO KM 44.8 EJIDO DE SAN JUAN Y, SAN AGUSTIN, 50700 MUNICIPIO DE JOCOTITLÁN, ESTADO DE MÉXICO

PROVEEDOR:	TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN
TIPO:	BLOCK MACIZO (MUESTRA 11)
LUGAR DE MUESTREO Y EMPLEO:	LABORATORIO TESJO

ENSAYE No.	001
MUESTRA No.	11
BLOCK No.	001
ANCHO (cm).	20.0
LARGO (cm).	40.0
ALTURA (cm).	20.0
PESO DEL BLOCK (kg).	25,700
ÁREA TOTAL (cm²).	800.0
ÁREA NETA (cm²).	800.0
PESO VOLUMÉTRICO DEL BLOCK (kg/m³).	1,606.3
FECHA DE MUESTREO.	31/01/2020
FECHA DE RUPTURA.	02/02/2020
CARGA DE RUPTURA (kg).	19,160
RESISTENCIA (Kg/cm²).	24.0
PORCENTAJE DE ABSORCIÓN (%).	13.6

COMENTARIOS:	LOS ESPECIMENES SE ENSAYARON EN ESTADO SECO.

ELABORÓ. LABORATORISTA. TEC. EMIGDIO GUADARRAMA BERNAL
REVISÓ. GERENTE TÉCNICO. TEC. VICTORIANO RAMÍREZ TRUJILLO.
RECIBIO. TECNOLOGICO DE ESTUDIOS SUPERIORES DE JOCOTITLAN EMPRESA

PROHIBIDA LA REPRODUCCIÓN TOTAL O PARCIAL SIN LA AUTORIZACIÓN POR ESCRITO DE LAMACO CONTROL Y CALIDAD S.C.

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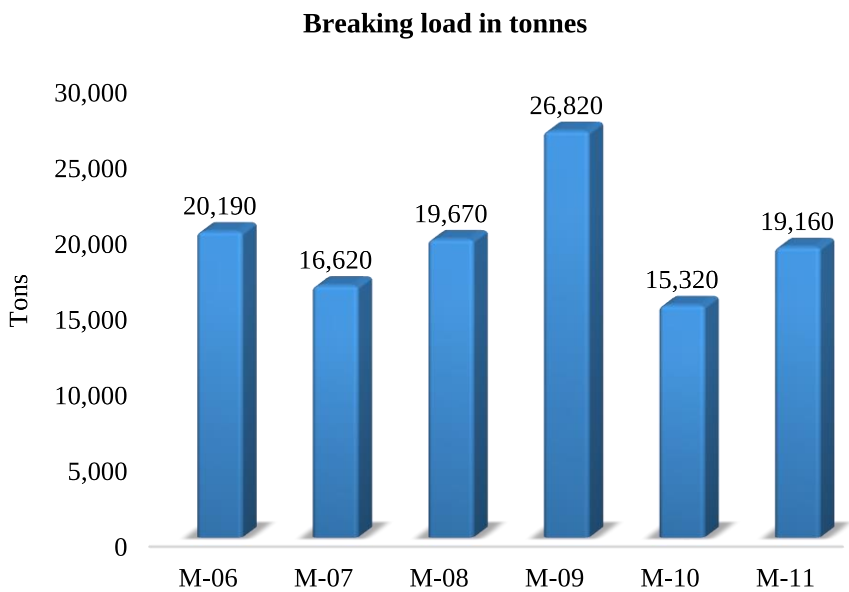
The report of the laboratory tests carried out on the solid Block (see graphic 4.3) indicates that the prototype called Block M-09 obtained the highest compressive strength with 26,820 kg, at the maximum degree of rupture. On the other hand, the average of the six blocks as a whole is 20.45 kg.

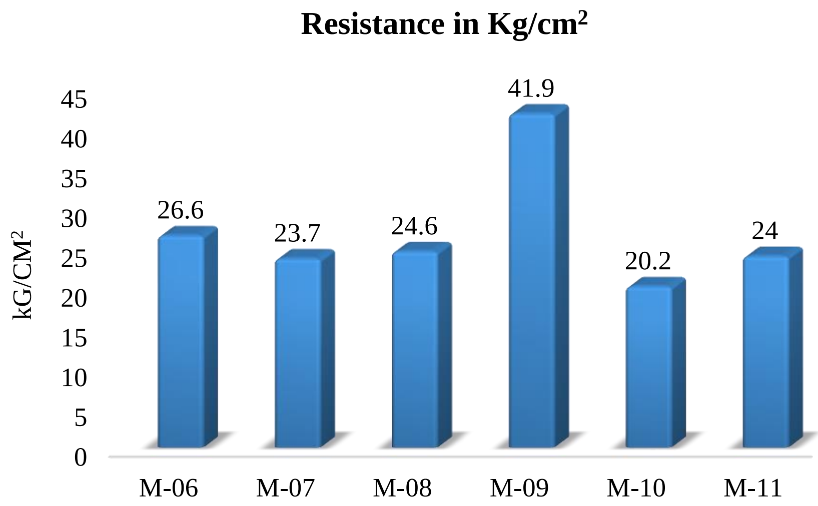
Graphic 4.3 Breaking load of solid block in tonnes



Source: Own elaboration

The data in graphic 4.4 simplifies the strength results of the six solid block samples we made. Similarly, the M-09 block obtained the highest strength compared to the other prototypes.

Graphic 4.4 Resistance of the solid block in tons



Source: Own elaboration

Concluding that Block M-09 falls within the necessary range with 41.9 kg/cm^2 to be a non-structural block according to the NMX-E-441-ONNCEE standard, which specifies that a non-structural block must have a compressive strength of 35 kg1cm2. The average strength of these six blocks is 36.56 kg/cm^2.

4.5 Conclusions

Obtaining the results of the laboratory tests, it has been concluded that the module elaborated with rubble material shows real resistance characteristics, and that it is possible to create a hollow or solid non-structural block with average resistance for minor constructions of one to two levels maximum.

It is inferred that the result can be superior by using special moulds for its production, and also by using vibro-compaction it will increase its resistance up to 60 kg/cm2, which would result in a block with a possible resistance greater than that of a conventional block and therefore present the same, or better benefits than a commercial one.

In Mexico, the construction industry needs to modernise and manage applicable standards for the management of construction and demolition waste. It has been observed that other underdeveloped countries do this and minimise the generation of waste in their cities, as well as helping to reduce the volume of waste in open air dumps, linked to the production of carbon dioxide and care for the environment, which is the main concern in the world today. Finally, it is intended that the project, more than being innovative, will be useful in the future plans of a federal regulation for the adequate management of construction and demolition waste and will serve to promote projects of this type for the academic and professional community.

As a substantive function articulated with teaching and research, interaction between the academic community and society is promoted, with the aim of establishing processes of creation and transformation of society, with the generation of proposals and solutions to the major problems that occur in our country and the satisfaction of needs faced by the community.

However, the concept of linkage is to address the main elements that are defined as:

The presence and academic interaction that an educational institution contributes to society must be critical and creative, leading to achievements in teaching and research. By being aware of the needs of the environment, academic activity is resized as a whole, as a form of ethical-pedagogical learning, which allows the articulation of the theoretical, methodological and professional aspects through the intervention of interdisciplinary programmes to meet the needs and problems of social, housing, industrial, agricultural and other sectors.

4.6 References

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