Lighthouses in Nautla And Tecolutla: Hennebique and coastal systems at the beginning of Twentieth Century in Mexico

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Out there in the cold water, far from land, we waited every night for the coming of the fog, and it came, and we oiled the brass machinery and lit the fog light up in the stone tower. Feeling like two birds in the grey sky, McDunn and I sent the light touching out, red, then white, then red again, to eye the lonely ships. And if they did not see our light, then there was always our voice, the great deep cry of our fog horn slumbering through the rags of mist to startle the gulls way and make the waves turn high like decks of scattered cards and foam.


These pages are part of a research on reinforced concrete applications in Mexico during the first decade of the twentieth century. The purpose is to present two case studies, the lighthouses built between 1905 and 1906 on the coast of Veracruz, indicating the small ports of Nautla and Tecolutla. Those lighthouses are examples for shaping a landscape, part of a maritime and territorial system for seaside, as well as early examples of the use of a modern construction system, the Hennebique béton armé, in Mexican architecture.

The symbolic nature of the lighthouses

As bridges, lighthouses have historically been structures highly loaded of symbolism. They materialize the fights of human kind against a hostile nature in form of furious winds, violence of the waters or mysteries beneath its surface. The persistence of bridges and lighthouses in their placements are victories against weather and time, when no fire or earthquakes. Tall buildings and long span bridges have been important achievements of human genius against the inexorable force of gravity. In this sense, the image of invincibility of the builders is a kind of romantic heroic quality based on their capability of using science and technology to surpass all the odds. That makes their works such colossal as those odds they have to triumph over. In such a way lighthouses are, at the same time, symbols of romanticism and rationalism.

The light on the highs, often in the middle of fog or darkness, confer to those towers their poetical nature, almost spiritual. They represent the orientation, and many times the salvation of ships and sailors. The lighthouses are linked to dangerous places, initially for navigation, and for flights in modern times, which make them necessary. The light on the highs is, above everything, an advice. The representations of lighthouses in paintings, engravings and photographs, but also in adventure stories and novels,
noticeable from the countries that were joining the growing international trade. The lighting of the coasts has been one of the precautions of all world governments with territorial waters and in active communication with other countries through sea routes.\(^5\)

A project for the "Enlightenment of the Mexican coasts" was presented by engineer Francisco Nicolau, Director of Lighthouses, in 1901, understanding lights system as part of the national modernization. His project included 42 lighthouses fixed or floating in the Gulf coast, 10 in the Caribbean Sea and 21 on the Pacific coast.\(^6\) Some years later the project was a reality that integrated old and new ports as new and old structures to illuminate the coastline of the Mexican Republic.\(^7\)

The illuminated skyline of the Veracruzan coast reported in 1909 was made of signals from lamps of various ranges, on a scale of importance known to sailors, according to the distance to the geographical event or port to be reached.\(^8\) The most important signals were distinguished in the system's guide: "In general is called "lighthouse" a building that has at the top a light used at night as a signal and warning to navigators. But if the lighting device is so small that cannot give a shelter to the employee who maintains it, it is called as "beacon". The lighthouses and the beacons have employees to maintain them who always live at the same emplacement."\(^9\)

The modernization of the lighthouse system was therefore a priority project to protect seamen, ships, and their valuable merchandise. It was also the indication of an inhabited place in the coast, the reference to a system, an inland linked to that point in the coast.

**Between sea and land: A border system**

The whole coastline was lighted from structures announcing ports of varying importance, small islands, sand banks or river estuaries, urban and commercial settlements. Each place had its own identity, according to the signal and the comprehension of the system among the habitual sailors. The lighting geographical system incorporated places on the coast announcing the inner commercial systems, urban or rural. The lighthouses were the visible part, the contact with the sea.

Indeed, the shores of Nautla River were colonized by French settlers arrived in several groups since before the mid-nineteenth century, concentrated in Jicatpec and later in San Rafael. The production of coffee, and vanilla in addition to cattle, defined the distribution of cultivated lands.\(^10\) It was a production system looking for international marketing: "Vanilla was important in the material sphere because of the simple fact that it became the basis of the mercantile economy of the colony. The choice of vanilla was particularly fortunate for the immigrants, since during a long time in the nineteenth century France was the largest market for that product... Even the French Consulate in Port of Veracruz took a dynamic role to publicize and promote that activity."\(^11\)

By 1859 the cultivation of vanilla was almost a monopoly of the French colony at Jicaltepec, part of it with good contacts with the commercial agents of Veracruz. But transportation and communication from within the area linked to the river was a permanent problem. During the second half of the nineteenth century there were no roads and no safe and regular coastal shipping traffic. The trade depended for long years on a port which was far distant. One fact that can illustrate the situation was the purchase by shares of the ship "San Rafael" in 1880, allowing settlers to transport local production to Veracruz.

For the territorial system that matured during the early years of the twentieth century it was sought to incorporate a railway from the center of Mexico to the coast. Its aim was to sustain the trades with the producers in the territory of Veracruz. The railway from Teziutlan would
be complemented with the harbors. The construction of the Port of Nautla, which would be very inexpensive, would bring the exports of the immense production of the warm lands and the mining production to the Southern United States markets, facilitating exchanges that will be the basis of our prosperity.\footnote{12}

Large and small works made a new face to the coast in Veracruz. Their fulfillment sought to integrate these territorial systems to the promising international trade, in which local products would be in good position in exchange for manufactured goods from abroad.

The Gulf of Mexico was the first district of the system controlled by the National Direction of Lighthouses, with thirty-five light signals installed since 1883 until 1911. Most of those lamps, were installed on towers with different iron structures and just three of them were giving out signals from buildings of “reinforced cement” in Nautla, Tecolutla and Tonalá. Particularly in Nautla, the only French system would be the vanilla’s production, consolidated with the colonization of the lands near the river, with houses characterized by traditional Marseilles tiles. The small harbors in Nautla and Tecolutla were nodes between land and sea, each one with its own lighthouse built in béton armé, Hennébique patented system, also a French product.

On experiences: Modern building systems

The lighting on the highs implies tall building which in turn implies experiences with materials, techniques and building systems to make it possible. In its role of strategic buildings for relations between land and sea, lighthouses height, structural shape, technology and material are in a close relation with the building requirements on the emplacement. Speed in construction was often important, because the inaccessibility of the places, on cliffs or rocks affected by the tides. The short life of wood against hard weather conditions facing the sea made it an unprofitable material, while difficulties for transportation of stone to hard emplacements, made slow and expensive building in masonry. That’s why a great number of lighthouses was built with iron structures during the 19th century, since it was soon proved that the new industrial material allowed the assembly to overcome difficulties for complex locations or weather conditions. Transporting iron pieces was easier than stones and materials for masonry to points were the lights were necessary.\footnote{13}

As in Veracruz harbor’s works, Coatzaoolcas, Salina Cruz, Tampico or Tamaulipas, some lighthouses were part of that repertory of works, still experimental, to introduce reinforced concrete in Mexican architecture and engineering. The representation of the French patent of François Hennébique was in the hands of Angel Ortiz Monasterio, Miguel Rebolledo and José Delgado in Mexico City, and also Rafael Quintero in Mérida. Those concessionaries opened a new chapter in the history of Mexican architecture,\footnote{14} which has been barely explored by Israel Katzman and the authors who have followed his research paths.\footnote{15}

Rebolledo, a naval engineer from Veracruz, became the leading figure in introducing reinforced concrete in Mexico during the years 1900-1910, working close to the best known architects in that time. His company would be highly recognized, in the times to come.

However, it is known that the first building – until now located – of which structure and not only foundation was made with béton armé, was not built by Rebolledo’s company, nor is it in Mexico City.\footnote{16}

It is in Mérida, Yucatán, where is located that important milestone for Latin-American modern architecture: the building of the hardware store “El Candado”. It was closely followed by the foundations, floors and roofs for the Ministry of Foreign Affairs, this one of course in México.
City and built by Rebolledo. Even when everything points to contemporary projects and building processes for the two buildings, 17
A bridge was part of the Rebolledo's early works in Mexico, but he soon had new guinea pigs to experiment in the coasts of his home state. That happened when building the two identical structures for lighthouses in the barriers of Nautla and Tecolutla. Those two particular works in the Gulf of Mexico were important for technical experimentation since there were no compromises with composition, eclectic historicism and academic tradition. Suburban settlements were perfect to validate the rationalism of the new construction system.
Two different sources of information converge to explain the procedures and the contexts in which the lighthouses were built. The best description is contained in the “Papers presented as thesis” by Julio Quiroz en 1907. The student at the National School of Engineers offers the details of the construction system – a very important issue to a young man near to graduation as civil engineer – in addition to his description of the coast line and some references to the territorial production system. Meanwhile, the report in Le Béton Armé, the “corporate” journal of the company headed by François Hennebique, locate the works in its national and international technical context. From this publication it is possible to have a complete approach to the projects and works of the Hennebique System representatives around the world during that time.
Le Béton Armé specifies 27691 as the identification number in the company files for the two buildings, registered as property of the Federal Government, 19 while in México, as part of the Quiroz report, there are drawings with the seal of the Hennebique's representative with the number 34. That high number might be explained because some other projects may not have stepped forward, since the lighthouses are in the first lines on a list of the Mexican buildings with béton armé. 29
Quiroz refers the advantages of building with reinforced concrete in coast places against short life of wood, a material of great advantage for transportation and assembly in those locations. Then, Quiroz described the places where he carried out his practices: “the ports have a coastal trade not very active by now, but indeed growing and consisting in agricultural products as fine woods, tobacco, coffee, banana and some cereals, all exported. The imported items are salt from Campeche, fabrics, haberdashery and manufactures in general, for exchange with other ports in the Gulf.”
The importance of the sea trade was evident to Quiroz when he assesses: “The transportation for this trade are the sea ways, because these ports have not yet reached by any railway or road” 20 With drawings showing the lighthouses location, emphasizing the changes occurred in just 20 years at the barriers, the future engineer was clearly indicating that both lamps would be of fourth class and at the top of two identical buildings: “These lighthouses, designed to be build in wood, were made of reinforced béton (Hennebique system), according to the proposals made to the Government by the engineers Miguel Rebolledo and José Delgado, two of the concessionaries of this system in Mexico. In this way, what the concessionaries had to do, once their proposals were accepted, were the calculations and drawings in correspondence, with no changes in the arrangement o dimensions of the project…” 31
As it was indicated, a couple of years later, in that afore mentioned description of the lighting of the Mexican coasts, 22 the lighthouses in Nautla and Tecolutla correspond to inhabitable structures, houses by the sea, with the correspondent towers and the lamps at the top: “The building has a tower for the beacon, with 14.40 meters high from the foundation, one meter depth, to the base of the lamp… The staircase is inside the tower up to the level of the platform, from where it continues outwardly to reach the beacon.
Attached to the tower is the lighthouse keeper’s house, which has two stories, having on its ground floor a large room for bedroom, plus the dining room, kitchen, oil storage, bath and toilet. The upper floor, destined for office, is surrounded with three corridors at the front, right and left. The unsophisticated dwellings with lights embodied a functional element in accordance to the site and its climate: “The tower is arranged in the bottom in such a way that can collect rain water from the roofs through reinforced concrete canals that descend to the bottom of the tower through galvanized iron pipes. The tank or cistern is formed by the four walls of the tower and its foundation and its roof, which is the first story of the building. It’s divided in four compartments with 0.06 m in thickness and up to the level of the façades, located at 1.60 m high from the bottom, it can store 8 cubic meters.”

Laying the foundations on sea shore sand at the Gulf of Mexico, these two structures were part of Miguel Rebollado’s and his team experiences, but more important, these were among the first buildings built with béton armé during those years in Latin America: “The building is completely of reinforced concrete, except for doors and toilet; but walls, piers, flooring, beams, stairs, bath-tub, balustrades and canals are them all of this material.”

The dimensions that during those years began to make remarkable the structures of béton armé, i.e. distances between columns or walls and cantilevers, were still conservative in these functional lighthouses. The maximum distances were just 5.90 meters, with beams coincident with the walls. But the buildings were a whole monolithic structure: “The thickness of the walls around the main room and the tower is the same at its complete high and it is of 10 centimeters. The walls of the corridor and the kitchen as well as around the bathroom have a thickness of 8 centimeters; and the division between this wall and the small room destined for oil storage is just of 6 centimeters.”

According to the available materials in the construction sites both structures were built with concrete composed just by cement, water and sand. Stone was expensive to get from at least 20 kilometers up from the river in small canoes with daily payed oarsmen. There was plenty of water in wells with less than four meters depth, as sand consisted almost fundamentally the ground around the buildings.

Advantages and disadvantages of that cement were described by Quiroz: “With the béton composed of cement and sand, one has great facility for molding thin pieces, such as canals which in these buildings has 5 centimeters thickness and still could be reduced to just 4 or 3½. It is also very convenient for ornamental pieces, as corbels, keystones and capitals; but considering resistance and economy, it is more convenient the concrete with gravel, which in the works of reinforced béton would have 1 or 2 centimeters.”

After describing the arrangement of the buildings, the material composition, Quiroz explained with details the procedures for building. He described the processes for reinforcing and pouring the mix from the foundations to every element in each level of the buildings, including relations between environmental and soil humidity, specifically for the foundations, and relations between temperature and solidify time. It is also clarified in detail the relationship between the proportions of reinforcing and concrete with their size to avoid the cracks that could cause a violent harden.

The data in Quiroz report coincide with the brief description that accompanied the pictures of the finished buildings published in Le Béton Armé, one of them identical to one included in the student report. The details given by the enthusiastic practitioner are linked to facts that today the history of architecture considers important in the first experiences with reinforced concrete, not just with Hennebique System but about his contemporaries calculation and building procedures in Europe at that time: “Despite all we have seen, Hennebique’s calculation system is empirical... the practical results obtained by the builders, counted by thousands in Europe, have
been entirely satisfactory. A great value technical report, about the described system and about the reinforced 
to, has been published by the "Comité des Ennemis des Armes," named by the French government with the aim 
of establishing the regulation for these building 
systems. That commission doesn't argue about 
Henriques's formulas (who is part of it), but simply compiles the data from his formulas and 
the results obtained in the tests carried to failure 
built for that purpose, like some palace at the 
Universal Exhibition in 1900." 31

Quiroz refers to the publication of Ex-
périences, rapports et propositions, instruc-
tions ministérielles relatives à l'emploi du béton 
armé,32 that were contemporaries to his 
report at the School of Engineers and 
available by the Mexican builders in a 
short time.33 Those were the conclusions of 
a commission designated in late 1900 by the French Ministère des Travaux 
Publics, constituted by the most remark-
able builders at that time of experiences 
with reinforced concrete, among them 
was Henriques himself.34

Julio Quiroz also refers to the tests on 
those palaces in Paris 1900, whose de-
tails were also published by the journal of 
Henriques's company. Indeed, Hen-
riques built and subjected to resistance 
tests until their collapse the structures of 
the Palais du Costume, the Palais des Lettres, 
Sciences et Arts and the Palais Belge, and a 
canopy for the Molyneaux chemin de fer.35

Peter Collins pointed how as well as the 
the awards received for his works in the 
Exhibition, much of the reward for the 
leader of the international construction 
company was in the adoption of his bé-
ton armé system outside France, as it was 
in Italy and the Netherlands.36 Undoubt-
edly, part of the reward for Henriques 
was also in the advertising that the system had 
across the Atlantic Ocean. The tests 
mentioned by Quiroz were not so far 
away from the data available by Miguel 
Rbolledo and Angel Ortiz Monasterio 
and all the Henriques concessionar-
ies around the world, which number in-
creased after 1901.

As a conclusion to his report, beyond the 
experience with the lighthouses in which 
he worked, Julio Quiroz settled: "These 
experiences are enough, by themselves, to tilt in fa-
vor of reinforced concrete the most refractory wood 
to this ideal material, which as Henriques sys-
tem and many others are just the first steps on its 
marble. Giant steps that have produced a mul-
titude of buildings that will be seen for several 
generations." 37

The final paragraph in the report of the 
future civil engineer was inscribed among 
the ideas of success for the material that 
by those years had the promoters of rein-
forced concrete, engineers and architects 
who ventured into building with some of 
the available and still experiencing sys-
tems. Among them, the patented Hen-
riques was one of the most successful 
and all of them were still experimental, 
but promising future in the international 
arhitecture.

Between two times: Between coast 
and city

With the experiencing of reinforced con-
crete, as it had happened with metallic 
structures, designers and builders are 
seeking to cover large spans and build 
ever higher buildings.

If François Henriques participated in the 
competition for the tower at the Ex-
hibition in Brussels 1888, as a kind of 
rivalry with the Eiffel Tower in Paris, it 
cannot be seen as an isolated fact.38 The 
neogothic project, perhaps the one ap-
propriated to the verticity of the tower 
was just an advance for the building of a 
new Campanile in the Piazza San Marco, 
Venice, whose height reached one hun-
dred slender meters, according to the 
older tower.39 Projects for tall structures, 
especially lighthouses, were subject for 
several Henriques's concessionaries 
around the world since the beginning of 
the company.40

Naturally, those issues were also impor-
tant for the engineers and architects in 
Mexico and in the same way numerous
articles and brochures were published there, describing the systems available in the country for reinforced concrete—Sistema Garza, Sistema Mellon, etc.—as international references important to compare their own works with their contemporaries. That’s why the lighthouses built by Miguel Rebolledo’s team, Julio Quiroz among them, had not the aim of tall towers with heroic dimensions. They probably knew that just fourteen meters were not enough to reach the heavens of construction history.

Rebolledo’s goal was different. He wanted to succeed with the introduction of a building system internationally increasing and hardly accepted in Mexico City. The soil of the ancient lakes was an enormous difficulty for the builders, fighting to rise up modern structures. In that sense, the experiences making buildings floating like boats on the sands of the coast of Veracruz were the chance for new foundations, alternative to Compressol System, also represented by the engineer in Mexico.

The experiences in Nautla and Tecolutla were important for a naval engineer crossing between two times of professional performance between the labors on the sea and the shores on which he worked in the last years of the nineteenth century, and the urban works he was just starting. Rebolledo was moving his efforts to Mexico City, one of the most representative contexts of modernization among the capital cities in Latin America. There were big differences between those places and works.

Big contrasts were also evident even among buildings in the same typology between the functional lighthouses, experiences for new material and location, and the character of the brand new Lighthouse Benito Juárez in the port of Veracruz, with his façade to the enlarged city and the new harbor. That lighthouse was not only a lamp indicating the renewed port but the largest and most important in the system for lighting the coasts. It was also the office building for the National Direction of Lighthouses, so it had different roles in both directions, toward the sea and the city.

Both structures in Nautla and Tecolutla were far from the possible experiences in tall buildings with reinforced concrete by those years. But rather, compared with the monumental masonry of the grey tower in Veracruz, were just two “houses with tower for beacon”, as they were presented to the international society of Le Béton Armé.

Considering that the two lighthouses were twin buildings, there remains the question about them as, perhaps, a Rebolledo’s proposal and his team to standardize the structures for one of the ranges at the system for lighting the Mexican coasts. An identical building was built in Isla Aguada, in the state of Campeche, neighbor state of Veracruz. It could have been built at the same time as those in Nautla and Tecolutla, or not much later because it’s surprising to find a third identical lighthouse. Its structure is complete after all those years.

Sometime later, a lighthouse in Punta Delgada, built in 1907, had some improvements in comparison with the previous experiences: “it is until today the only one, excepting those in urban settlements, with potable water”. In that case, the tower with the lamp was near but not attached to a large dimensions house, maybe much more traditional on the arrangement but definitely enough comfortable to the lighthouse keeper.

There are more questions about a topic which is just opening to research. The
list in the *sistema de iluminación y balizamien-
to de los Estados Unidos Mexicanos* implies
a long list of structures to know about:
Who built the rest of the lighthouses
in reinforced concrete indicated in the
system for lighting the Mexican coasts?
Which building systems were employed?
How many of them still survive? It is a
research to be done as it is also to explore
the origin of the materials for building,
even the lamps. It is an interesting mat-
ter for industrial archeology that would
help to attach importance to the heritage
link to the sea. The important fact to Re-
bolledo was that the whole structure was
complete even when it was turned almost
upside down.77 The monolithic building
proved its integrity and didn’t break at
all.

**Epilogue**

During the rainy season the calm waters
of the river turned to a mob that often
surpassed its banks, flooding a large zone
in the country and dragging everything in
the rush to reach out the Nautla River’s
bars.88 It might not be the raised river, it
might be a “north wind”, the local called
hurricanes. Until today, there are no more
data: the collapse of Robolledo’s experi-
ences can only be attributed to a storm,
one of those universally linked to the
images of lighthouses. The monolithic
structure, bet against the earthquakes by
Hennebique and all the builders with re-
forced concrete during those years, was
proved in Nautla during twenties. The
lighthouse would overturn, like the hull
of a ship, as indeed it was founded on
the sand. There are the memories of dis-
appeared structures, report about those
systems: the geographical, linked to mar-
time and trading territories, and the build-
ing system. But those lighthouses are the
images about the work of one remark-
able engineer who, with his buildings in
béton armé, was modernizing Mexican
cities and territories during the first de-
cade of the twentieth century.

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Notes:  
1. “The notions of place - Genius Loci - and system are taken from Christian Norberg-Schulz. Based on Heidegger’s thought, relate to the realization of existential space, according to which “one place is a space endowed with a distinctive character.” This character denotes the general atmosphere, which represents the most comprehensive property from anywhere” given by “the specific form and substance of the elements that define the space” (Norberg Schulz, 1979 p. 18). The notion of system referred to herein is a beautiful parallel in the explanation provided by the author to the implantation of the first Romanesque monasteries: “Geographically, the monasteries were relatively isolated units, but were based on the same fundamental values and in the same way of life, formed a network of similar sites” in terms of existential space, the system of sanctuaries made “visible” events and the history of Christianity and gave the man a new psychological security in a difficult and dangerous world... "During the Middle Ages and formed a sacred landscape" that concretized the action of Christianity in space and time.” (Norberg-Schulz, 1973, p.79).  
2. Notes about the report to the Secretaría de Obras Públicas from engineer E. Nicolau are in "El faro de Santiaguillo". *El Arte y la ciencia 6*, September 1902, 89.  
17. *Le Béton Armé* 60, May 1903; *Le Béton Armé* 63, August 1903; *Le Béton Armé* 66, November 1903; *El Arte y la Ciencia 7*, October 1904.  
20. Quiroz, 1907, p. 74.  
21. Quiroz, 1907, p. 75.  
22. *Estado de la iluminación y baileamiento de las costas de los Estados Unidos Mexicanos*, Secretaría de Comu-
nicaciones y Obras Públicas, 1909 and 1912.
23 - Quirouz, 1907, pp. 75-76.
24 - Quirouz, 1907, pp. 82.
25 - Quirouz, 1907, pp. 70.
26 - Quirouz, 1907, p. 76. The report also indicates: In addition to the parts described there are other with less importance in these buildings, such as balustrades, tub, small water tanks for the bath and the toilet and the brazier, which have not to be calculated because they always have much more resistance than they are required. These are reinforced with small sections bars arranged in a grid of 20 cm and with no stirrups, because the thicknesses of these walls are usually 5 or 6 centimeters only. In those details the Henribique System becomes just like the Montier [system], which seems to be the first in béton armé, Quirouz, 1907, p. 86.
27 - The experience with that type of concrete would be referred on the same day by Alfredo Roizenwerg in the report of his practices building a water tank in Lagos (Roizenwerg, 1907, p. 20).
28 - “Water is found in the vicinity and the place of the lighthouses at any point in which practice a well, whose depth barely reach 4 meters. That is because the only material of the soil is sand (forming beaches with very low elevation) and one side, to the front, is the sea, to the right is the river and to the rear the estuaries and small lagoons or swamps characteristic of this coasts. Quirouz, 1907, p. 79.
29 - Quirouz, 1907, p. 79.
30 - They also coincide pictures of both lighthouses with descriptions in the reports on Estado de la Iluminación y Hidrografía de las costas de los Estados Unidos Mexicanos... (Secretaría de Obras Públicas 1909 y 1912).
31 - Quirouz, 1907, p. 90.
33 - A copy of this report is available in the library of the former Asociación de Ingenieros y Arquitectos, at the Palacio de Minería in Mexico City.
34 - "Le béton armé et le Ministère des Travaux Publics, Le Béton Armé 35, April 1901, pp. 7-8.
35 - "Hemmiboique a l’Exposition, Le Béton Armé 17, October 1899, pp. 6-10. All details of functioning and shortcomings of the structures tested are available in Le Béton Armé 37, June 1901.
37 - Quirouz, 1907, p. 90.
38 - Collins, 2004, p. 64 y fig. 13.
40 - Five projects for lighthouses, from 1897 in such distant places as it were Indochina, Strombollicco Island, Montevideo, Nicolichief and La Coubre, intended to demonstrate the advantages of using concrete and not metallic structures. "Les phares en béton armé", Le Béton Armé 133, June 1909, pp. 81-91.
42 - It is important to mention that some of the engineers that experienced reinforced concrete in Mexico during those years incorporate, as part of their themes, young students from the Escuela Nacional de Ingeniería. The papers of Modesto Rolland and Alfredo Roizenzweig are just two of them, as it was Fortunato Dozal practicing with Edmond Coignet in Paris during 1909.
43 - La modernización del puerto ha sido calificada "entre los mayores éxitos de la modernización porfiriana". Connelly, 1997, p. 349.
44 - "The tower is part of the building for the Dirección General de Faros and it has installed a clock with four faces, one on each façade. In the towers of the building are often installed lighting devices for experiences before taking them to its destination...", Secretaría de Comunicaciones y Obras Públicas, 1912, Golfo de México – Primer Distrito. In the edition of 1909, its describe as the lighthouse in Veracruz was a "Square masonry blue tower, with white columns and green dome... The tower is the old Chich of San Francisco. That light will be turned off when turning on the new lighthouse Benito Juárez", Secretaría de Comunicaciones y Obras Públicas, 1909, Golfo de México – Primer Distrito.
45 - The lighthouse at Isla Aguada, Campeche, was recovered as a communitarian center by the Government of the State in cooperation with the Ports Association.
46 - "Un nuevo faro". El Mundo Ilustrado, April 14, 1907.
47 - Rebolloso, 1952.