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Introduction

The picturesque architecture firstly appeared in gardens and was subsequently developed during decades before eventually being mainly used for private housing. This artistic expression is characteristic of the period between 1860 and 1930 in Europe. A representative example of such architecture is the villa Les Trois Canadas, built in 1905 and located 160 Van Becelaere Avenue in 1170 Brussels.

Firstly, the paper focuses on the villa in the broader context of the development of the rock-workers at that time in the Region of Brussels, notably through historical and practical researches. Secondly, the paper provides information about the constructor of the villa, Alphonse Vasanne. It is indeed necessary to highlight the role of building contractors in the diffusion of reinforced concrete in the early 20th century to get a deeper understanding of this process. Before the First World War, a lot of systems of reinforced concrete existed and were patented in each country. Technical investigations are carried out currently to know whether his system patented in 1902 was applied in the villa.

Thirdly, a brief diagnosis of the current state of conservation is performed. It will clearly stand out that the villa and its garden, including a water tower, deserve specific cares to be preserved in the future.

Rock-works context

Rock-works have existed since the Greco-Roman Antiquity period with some grottos used by men for leisure. They fell into disease during the Middle Age and were rediscovered at the Renaissance period. However, "rocailles" are only used by assembling natural stones, shells, corals, etc. Rock-works represent at that time a certain expression of men organizing nature by its power and arts. With the development of the English garden through Europe in the 18th century, the concept of those rock adjustments was more oriented to Romanticism, implying emotional feelings for the spectator. The blocks of stones are eruditely positioned and surfaces are precisely worked, especially compared to natural geological pattern. The type of realisation became larger and taller, leading to implementation of increasing difficulty. Therefore, at the beginning of the 19th

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In Brussels, a large and amazing amount of rock-works from the end of the 19th century and beginning of the 20th century still exist. Examples of such realisations are numerous. They are usually small, private or public, but often hidden from discerning eyes. A lot of rocks interpretations are centred on a source of water, as in the park des Sources (figure 1). The imitation of timber branches is particularly used for parapets and leisure constructions, as the kiosk in the park Ten Reuken or park Brel (figure 2) but also for
cemetery furniture. The conservators of rock-works Françoise Lombaers and Gabriel Pirlet started in 2003 an inventory for the Region of Brussels. They have already listed more than 150 rock-works /1/.


In the professional Almanac of Brussels /6/, the term rock-worker appeared for the first time only in 1896 and lasted for years. In France, the rubric rock-worker emerged as early as 1845 in the professional yearbook of Paris Didot-Bottin /2/. However, another term, "enrochement", has been existing since 1891 in Belgium and refers also to cement or cement worker/rock-worker. The maximum amount of rock-workers in Brussels was six in 1896, 1900 and 1911. In comparison with Paris where eight rock-workers practised, Brussels showed an impressive number. In 1959, only two names were still mentioned in this rubric. The almanac doubtlessly illustrates the general trend of disappearance of the profession. Traces of such cement workers/rock-workers are visible on pieces of works, advertisements and international or national exhibitions, like Blaton Aubert in 1888, which ensured a high visibility.
This paper focuses on one type of rock-works, inspired from timber branches and commonly used in Brussels. The rock-workers printed their patterns and design when mortar is still fresh. The steel (or iron) bars are used to give the piece of work its shape and are therefore not structural as in the reinforced concrete construction. Sometimes, they were also painted. As for the early constructions of reinforced concrete around 1860-1890, there were various shapes for the steel bars (T, l,...) (visible on figure 2) that kept changing until the round common reinforcement nowadays. However they were seldom notched even if they were round. The bars were attached together with thin iron wire. The type of cement was more heterogeneous than in the early reinforced concrete construction. However the rock-workers mainly used Portland cement with sand and water /1/. Tools used by the rock-workers were simple and are still basic nowadays as metal spatula and trowels.

Characteristics of the villa Les Trois Canadas

History of the property

Alphonse Vasanne (?-1950), a Belgian building contractor, started constructing a row of fifteen joint houses, from 130 to 158 Van Becelaere Avenue in 1905. In October 1905, he constructed a villa named Les Trois Canadas (figure 3) with a storage including henhouse and stables along the railway tracks. In September 1906, he asked the permission to build up a water tower in the garden of his property. The garden was closed by a mortar parapet in 1910 and was embellished through years by sculptures, flower boxes and apple granary, swing, artificial basin (with a rustic parapet nowadays lost) and a little house, called villa of Christiane. All the constructions erected by Alphonse Vasanne in Van Becelaere Avenue have their structure in reinforced concrete. Alphonse Vasanne built this villa for himself and his family. The villa belonged to the relatives of Vasanne until 1975 when the villa was sold and divided into three different apartments. Infrabel, the Belgian railway company, put a compulsory purchase order on the current owner properties at the end of December 2009. Indeed, they must widen the railway tracks for a new line in construction. Therefore, the ancient storage, now used as car parking, will be demolished.

The aspect of the villa is handled as a romantic picturesque cottage. The Swiss cottage style is actually typical of the rustic architecture of the beginning of the 20th century (figure 3). At that time, new category of owner appeared linked to the petit bourgeois class. The aspiration of those owners was to own their personal houses, which should be economic and corresponding to their aesthetic dreams and aspirations. The rock-workers had therefore to deal with the wishes of such landlords. Residential neighbourhoods were developed at the edge of the city, urbanizing rural lands /2/. This is the case for the district of Watermael-Boitsfort. Indeed, the country site with dales and forests attracted a wealthy population in the last third of the 19th century, thanks also to the construction of the railway communication (around 1884). Watermael-Boitsfort saw therefore an urban development mainly made of villas /7/.
The reinforced concrete load-bearing structure of the villa is hidden. The load bearing structure is based on beams and columns in reinforced concrete, much alike the storages.
and the water tower (figure 7). However, positions of the reinforcements in the concrete matrix are completely different, as explained later on.

Between the dark red strips, fair-face cement is worked out as seeds with a lumpy surface. The balustrades render as bark appearance. The beige colour is close to the colour of natural stones and the dark red strips close to the colour of bark and timber. These are the original colours, which is highly unusual.

The water tower is the current property of n°130 Van Becelaere Avenue. However it used to belong to n°160, originally part of the estate of the villa. The water tower has two levels above the ground floor. The water basin lies on the top level. The capacity of the cylindrical tank is over 20m³, with dimensions around 3m of diameter and 2.5m height. The primary function of the water tower, besides rainwater storage, remains mysterious. A circular passage allows an access around the tank at 360°. A ladder, fixed on the water tank, enables to enter the water vat and to circulate on the roof. From a structural point of view, the tank rests on the exterior columns of the floors below. The roof is not supported by the water tank but by slender columns in reinforced concrete (figure 7). Their shape is delicate like a stalk of flower. The beam-column structure of the water tower is in reinforced concrete but the filling is in masonry covered by a layer of plaster. The steel window frames and the entrance door are original and still have their genuine colour which is rare enough to be mentioned. The surface treatment is similar to the villa with beige concretion of cement framed by dark red smoother strips.

The shape of this water tower, although reduced in size, is typical of a kind used in Belgium mainly between 1900 and 1960. At the beginning of the 20th century, Hennebique or Monnoyer were for instance active in building water towers in Belgium. The water tower of Vasanne is part of the 25% belonging to private properties according to the statistics of Van Craenenbroeck /8/. This water tower can be therefore considered as an early reinforced concrete realisation and one of the few which is still standing in Brussels.

**Motivation for a careful protection**

The villa is an outstanding construction in the real estate landscape of the Region of Brussels. Firstly, the villa is a remarkable example of picturesque and rustic architecture, come into fashion in Europe in the late 19th century. Secondly, the use of reinforced concrete for an entire domestic structure is rather innovative at that time. Thirdly, the level of its execution is brilliant, even in the details. Eventually, its program including a complete way of life (with swing, granary, hen house, storage, laundry, etc.) is positively surprising and rare.

The villa of Alphonse Vasanne has an architectural expression which is representative of the philosophy of rock-workers. The desire of playing consistently with the viewer is entrenched in the rock-workers /9/. Therefore, they delude reality by contrasting the characteristics of cement. For instance, in the case of the villa Les Trois Canadas, the surface of the panels is rough while the untreated cement is rather smooth. Cement is a
brittle material but rock-workers treated columns as "trees constructed in iron and cement" (figure 3) /2/.
At the same time, reinforced concrete is considered as a non-noble material. Therefore, it is common to treat the surface in order to change its appearance by a way or another.
Elements of so-called small heritage are in this present case particularly well preserved (window frames, window handles, wallpapers). Generally, those elements are easily damaged, stolen, or changed.

This quotation of Racine, "More than a style, the "rustic" is a sophisticate way of life which alloys modernity and researches of natural in a same life (...)" /2/, is tailored for the villa. The program of this villa and its garden is a good example of what could be a house of building contractor in the early 20th century. The garden possesses small constructions as useful as entertaining. Moreover, the geographic location of the villa is interesting for a builder: Vasanne had at his disposal connecting roads, as train and road, and some necessary materials for concrete, as sand pit and water.

The future of the function of the villa is uncertain due to the construction work for the railway. As a consequence, vibrations and noise can constitute nuisance for future inhabitants. In any case, the program of the villa and its surrounding has to be compatible with the existing pattern and architecture as well as respectful for the specificities of such particular heritage.

Alphonse Vasanne and the domination of patents

Contractors, craftsmen or workers are often forgotten through time by history. Vasanne is no exception. Therefore, his private life remains unknown as well as a large part of his work.

"Vasanne A." is indicated in the professional yearbook of Brussels in the almanacs, from 1900, first occurrence, to 1922 in several parts of the almanacs and with two surnames, A. and F. /6/. Alphonse Vasanne is mentioned under the title of "building contractor" and never as "rock-worker". In 1905, Vasanne A. is also indexed in the rubric "reinforced concrete ". He was notified at many addresses: Rue de la Poste, 206 (1900, 1903, 1905, 1906, 1911), Boulevard du Nord, 119 (1905), Rue du Monastère, 25 (1906), Rue du Parc, 33 (1910), Avenue Huart Hamoir, 46 (1922). Moreover A. Vasanne signed his patent in 1902 living or/and working Avenue Picard Héger, 11.

From this record, it seems more likely that F. was another member of its family also working in the sector of construction. Regarding the archives of the family, it is known that Alphonse had a cousin called Floriant who was apparently interested by new constructions. Indeed, a picture of the Antwerp Central Station cupola and the accompanying written comment tends to suggest it. Incidentally, it has been confusingly told to generations of Vasanne's descendants that he was the contractor of the dome of Antwerp Central Station. Indeed, this dome is in reinforced concrete dating from 1904.
Moreover, a firm, named *Compagnie Belge des Ciments et Bétons armés*, is written below the picture of the construction site of Antwerp Central Station. *Compagnie belge des ciments armés* is indicated in the year book in 1905 at the same address as Vasanne Boulevard du Nord, 119. Nevertheless, there is no other proof of this affiliation than the aforementioned picture with the signature of Alphonse Vasanne. However, G. Delhumeau reports that Coignet was the builder of this cupola /10/. Moreover, Coignet mostly applied his patent himself without going through concessionaires, leading to some kind of incompatibility. The contractor of this dome, according to this research, is not attested so far.

A. Vasanne-Coenen submitted three patents at the Ministry of Industry and Labour, two on 19 December 1902 and the last one on 31 December 1902 (figure 4) /11/. Two patents, one of innovation and one of improvement, concern a system of piles in reinforced concrete. A. Vasanne therefore developed a technique to drive in piles in reinforced concrete underground by the action of water. The third patent concerns a new system of reinforcement for elements in reinforced concrete, entitled "Nouveau système d'armature pour les pièces en béton de ciment armé". This patent holds in one page coupled with one drawing. The characteristic of the patent is the continuous grid giving a stiff skeleton in the beam and in the slab. The lattice of the beam has an angle of 43° between bars if the drawing is truthful. However, the transversal bars, composing the grid, do not connect the beam with the slab and consequently do not constitute a monolithic construction, oppositely to the famous and largely applied system of Hennebique (1892). A. Vasanne plans to place round bars in iron or steel with different diameter for reinforcement, according only to the positive or negative bending moment.
The years 1880-1900 saw the beginning of the diffusion of reinforced concrete. Standards for this material did not exist in Belgium before the publication of the first French standard of October 1906. This date is considered as a starting point of reinforced concrete as a material and not anymore as a system of construction. A system for reinforced concrete is a particular combination and position of elements (steels bars and concrete) to be applied for a specific purpose (slabs, columns, etc.) or program. The reinforcement made of iron or steel bars, round or flat, was positioned following a particular commercial system, patented by companies or individuals. This way of processing lasted until around the First World War.

The basic positive effects of a patent are economic: stimulating researches and invention; protecting inventors and firms and diffusing innovation /12/. At that time, technical ideas are diffused mainly by persons and therefore, patents played a central role to boost invention and thus progress of techniques and technologies.

The Belgian law legalising patents is entitled "law on the patent of invention" and was published in the Moniteur Belge in 1854. It includes 27 articles. It exits three types of patents for our concerned period (art.1): patent of invention, patent of importation and patent of improvement. They all allow an industrial or trading application. The validity of the patent lasts for 20 years (art.3). Each year, the applicant must pay a progressive tax of 10 BFr. A patent grants the exclusive rights of firstly commercialising the invention and make benefits from it and secondly suing anyone harming to their rights of patent (art.4). Art.2 specifies that no examination of the patent is made when it is submitted at the Ministry of Industry and Labour. Therefore, the quality of patents is rather uneven: "Patents differ greatly in their technical significance. Many of them reflect minor improvements of little economic value. Some of them, however, prove extremely valuable. Unfortunately, we rarely know which are which and do not have yet a good procedure for "weighting" them appropriately" as reported by Griliches /13/. Moreover, the impact of a patent in the economic or industrial field is difficult to evaluate. Brussels has a dominant situation compared to all other cities in Belgium with around 48% of patent submissions in 1900, according to Servais and Peters /12/. A flow of technical idea created probably in Brussels some industrial advances.

To have consulted the archives the Ministry of Economy (OPRI) /14/, more than 230 patents on the topic of reinforced concrete were granted between 1886 and 1913 in Belgium. Moreover, the number of patents submitted related to this topic increases significantly after 1899-1900. Comparing to France, Belgium received an impressive submission of patents. The legal situation in Belgium favoured the importation of techniques in the 19th century, as it was the case of reinforced concrete /12/.

The inventions on reinforced concrete are, in the early stage, more the facts of contractors and builders than engineers or architects /15/. The experimental analysis and
tests prevail indeed over the theory, which is at its first step. Therefore, many systems received the name of their inventors.

Several foreign systems were famous (and also patented) in Belgium but their roots are from abroad, as Monier, Hennebique /16/, Cottancin, etc. However, it is hard to distinguish the patents used in practice in Brussels from the theoretical ones never put into practice in the region. According to the inventory of the early reinforced concrete constructions in Brussels (currently ongoing as an appendix to the PhD work), foreign system implemented in practice in Brussels are for instance Hennebique, Coignet, Siegwart. A few systems count among local individual inventions as Herbst (hollow core slabs), Dumas & Perraud (lattice framework in concrete), Frankignoul (for piles), Monnoyer (chimney disposition), etc.

Furthermore, a few inventions were perhaps even not patented. It is for instance surprising that the contractor A. Blaton does not patent anything about early reinforced concrete. The ancient firm Blaton-Aubert was one of the first to develop the use of reinforced concrete in Belgium and is thus considered as a reference. Indeed, the dog sculptures decorating the garden of the villa are, for instance, similar to models proposed by Blaton.

To summarize, the patents are a primary source of information, both for their technical resource and for the diffusion of such technique. The system of patent in reinforced concrete played a significant role during the 19th century until the start of the 20th century in the industrial implementation of the material. This diffusion had two levels, on one hand the national or international trends and on the other hand specific and local with individual inventors. The study of reinforced concrete is indeed fully representative of this methodology.

Contractors creating rock-works and designing concrete surface were probably self-educated men from the working-class /2/. Vasanne sent out an attitude which is characteristic of a self-man contractor, developing both the technique of reinforced concrete and the visual impact of rustic rock-works. Somehow, he came to a position between building contractor of reinforced concrete and enthusiast of cement decoration as a rock-worker.

**Current technical investigations**

**Examination of the system Vasanne of reinforced concrete**

Following the Charter of ICOMOS of Victoria Falls /17/, the evaluation of a building needs a holistic approach, from acquisition of data to structural behaviour and damages, diagnosis and safety evaluation aiming at defining remedial measures. A historical and structural analysis has been initiated to understand the structural behaviour of the villa and the water tower. However, the study of the villa *Les Trois Canadas* covered so far
partially the scheme. Hopefully, the process will be continued by an analytical approach in the near future. This present study aims to locate as precisely as possible the reinforcing bars to be able to evaluate later the pertinence of the concrete structure.

An electromagnetic cover-meter was used as it is a helpful, moveable and non-destructive device. Basically, this device perceives perturbations created when a magnetic object is located under an electromagnetic field. It can also measure the diameters of the bars and the depth of the covering of concrete /18/. However, this estimation is not reliable with the equipment used at the villa of Vasanne. The limitations of such method are that firstly only the first row of reinforcement is detected, secondly the depth of investigation is around 10 to 20 cm, and thirdly the detection is possible only if the bars are not too close to each other. Other techniques are available to detect the bars such as gamma-radiography, which is more precise but also more expensive. The test was carried out with the help of collaborators of CRIC-OCCN, who lend the cover-meter.

The first test was carried out on an exterior column (figure 5) due to the impossibility of reaching an unobstructed beam inside. The results were difficult to interpret. Indeed, the large number and the positions of steel bars were confusing. Therefore, a strategy was set up to detect the direction of the reinforcements. So the grid was made systematically vertically and horizontally. Moreover, at each matched point, a rotation of the cover-meter determines the direction of the bar. The final sketch is on figure 5, with diagonal bars and two main longitudinal reinforcements. The emerging conclusion is that Vasanne applied his system patented in 1902 for the villa. The column has been extrapolated from the beam and slab drawing. Complementary examinations were carried out to confirm this first deduction. Firstly, the methodology was verified in the laboratory of the ULB and the CRIC-OCCN laboratory. Indeed, the rotation of the cover-meter to detect the direction of the bars is uncommon. Therefore the same system as the one detected was realized in laboratory. A lattice of steel bars from 6 mm and 8 mm diameter is located in a concrete matrix (figure 5). The formwork is a square of 50 cm length and 12 cm thick. The lattice is fixed at 4 cm from one exterior surface and thus 8 cm from the other surface. The results confirm and valid the methodology but show also its limitation. Indeed, the mesh size should have the dimension of the sensor and should be followed systematically in the two directions and additionally in rotation. As expected, the determination of steel reinforcement is directly linked with the covering depth. Therefore the investigation takes a long time and should be accurately done to give any convincing results for the diagonal bars.

Secondly, a new in-situ test in a beam would be very useful to validate that Vasanne put into practice his patent in the villa. This other investigation will be applied on a larger surface and with the same methodology.
A second application of the cover-meter was done on the floor of the balcony. The slab contains a perpendicular grid of longitudinal and transversal bars. The twisted bars mentioned on the patent were not detected.

A third and last survey was carried out on beams and ceiling slab in the first floor of the water tower (figure 7). The beam has 4.1 m length, with 1.7 m for the central span and 1.2 m for the edge spans. The results are easily interpreted, oppositely to the villa. The rectangular beam is composed by three longitudinal bars and one stirrup every 37.5 cm. The slab is composed with a symmetric grid. The eight columns, located at each corner, have a polygonal shape. They are composed of four longitudinal bars helped with stirrup every 25 cm (figure 7). However, the stirrups can have perhaps a different shape than what is represented on the drawing. The covering of the bars is between 3 and 1 cm, this last value being less than the present standards. The bars visible by degradation confirm the detection with the cover-meter.

First of all, according to in-situ investigations, it is clear and confirmed that the villa has a structure in reinforced concrete. Moreover, it seems so far that A. Vasanne adopted his system for the structure of the house. However, the water tower, which was built one year...
after the villa, has a completely different and more rational system of positioning of the steel bars. Vasanne might have modified his system between the two realisations. Unfortunately, no plan, section or any document from the time of the construction is available to confirm our analysis. Therefore, it is important to continue researches in the field but also in laboratory. Others tests could also be done to determine the depth of carbonation, the exact type and grading of aggregates and cement, to assess the void and compaction of concrete, etc. Under visual inspection, aggregates look calcareous and like crushed stones. Moreover, the loads will probably remain similar in the following years if the villa conserves the same type of activities in the future. Therefore the carrying capacity seems adapted. Of course, more investigations should be done to support this idea.

Current conservation state

The conservation state of the villa is rather convincing after 105 years. Some unavoidable damages appeared, like parapets of some balconies that are lost or currently in danger (figure 6). The picturesque architecture and rock-works in general are by nature a fragile heritage.

The mechanisms of physical, chemical or human degradations affecting the durability of rock-works are multiple but well known nowadays. Briefly, the carbonation is the most aggressive attack on rock-works because the covering of the steel bars is quite thin. The process of carbonation is quicker for instance if the content of cement is low or if the mixing water was too high. It implies the corrosion of the reinforcement, which is expansive and consequently spalling of concrete. The actions of chloride, reaction alkali-silica, presence of salts are as much as factors playing part in the destruction of concrete. Other mechanisms exist also as the growing of vegetation or the human interaction through graffiti, vandalism, etc. /1/. The façades of the villa are only attacked by vegetation and atmospheric conditions. Therefore, the process of decay is mainly due to a natural ageing of concrete. The pathologies surveyed in the villa are carbonation, corrosion of the iron bars and spalling of concrete. However, the alterations are superficial. Moreover, the structure of the villa seems safe from damage, except for one ancient crack. No dilatation joint was planned in the villa but an obvious crack appeared on the transversal direction of the house. The crack has been filled by the owners creating at the same time a joint.
Concerning the structural state of conservation of the water tower, many steel bars are visible, concrete peel off, disintegrated or cracked; a plant is growing inside the first floor. The most damaged part is the roof due to a lack of water tightness through years (figure 7). Moreover, a decorative border existed on the top of the water tower. However, the elements disintegrated and fell down which was dangerous for the owners. The owners have now consigned the remained samples to the laboratory of materials of the Université Libre de Bruxelles.

The main problem concerning preservation of rock-works are the lack of regular maintenance, necessary to control vegetation, covering state, etc. It needs a lot of care and maintenance due to their thin structures, easily damaged and destroyed. Therefore, heavy intervention is usually needed to restore such architecture. Consolidation and repairing superficial degradations are also necessary to stop the degradations of the villa. However, the traditional method takes out decayed parts, clean them and later repaired them with a suitable and compatible, but new, material. Conserving as much as possible the genuine material is a priority. Indeed, it is source of design history, of inspiration and of technical investigations to characterise such ferrocement concrete.
Conclusion

This type of heritage, going from rock-works in public gardens to picturesque architecture, is original by both its quality and its abundance in Brussels. However, the state of conservation is poor in many cases due to the oblivion of this artistic heritage. Therefore, urgent restorations are needed to preserve these fragile artwork pieces. Promotions are also necessary to open this original world of rock-works and picturesque architecture to the public, which should as well help to develop conservation in better conditions.
The villa Vasanne gathers two crucial manners of understanding reinforced concrete at the early 20th century. On one hand, it is a new technique of construction, developed through systems combining steel and concrete. This improved concrete structure has to be hidden under covering and layers. On the other hand, the artistic trend led by rock-workers and the development of gardens is highly creative. This ingenuity is expressed on the exterior surface. Therefore, the villa Les Trois Canadas is in line with the picturesque architecture contemporary of its time. The villa is unique by its architecture and its historical and technical levels. As a consequence, more investigations should be carried out to preserve it properly. For instance, the villa should be architecturally and structurally surveyed in order to complement the documentation. Indeed, no plan or section exist yet. Moreover, the examination of the system of A. Vasanne should be followed as explained previously. All those researches will certainly improve our technical and historical knowledge of the picturesque architecture in Brussels.

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References

/1/ F. Lombaers, G. Pirlet. Les rocailles (2004), Collection Art dans la Rue, Carnets d'entretien, Bruxelles.1-25
/3/ G. Wayss. Das System Monier. Eisengerippe mit Cementumhüllung (1887), Berlin. 128
/5/ Archives Blaton. Blaton-Aubert (ciments & bétons). Armand Blaton (successeur). Bétons Agglomérés (1908)
/6/ An. Annuaire du commerce et de l'industrie de Bruxelles et ses faubourgs (1891 to 1959), Mertens et Rozez, Bruxelles.
/7/ S. Jaumain . Histoire et Patrimoine des communes de Belgique. La Région de Bruxelles-Capitale (2008), Ed.Racine, Bruxelles. 327-341
/8/ W. Van Craenenbroeck. La Belgique des Châteaux d'eau, L'unité dans la diversité (2001), Navewa, Crédit communal. 1-189
/11/ A. Vasanne: Archives of the Ministry of Economy, Office de la propriété intellectuelle, Belgium. Patent No. 167372, 167373, 167375 (1902)
/12/ A. Peters. Le système belge des brevets au 19ème siècle (2006), GEHEC Newsletter. 15
/14/ Archives of the Ministry of Economy, Office de la propriété intellectuelle (16, Boulevard du roi Albert II, North Gate III, 1000 Bruxelles) (2009)
/15/ P. Christophe. Le Béton armé et ses applications (1902), Béranger, Liège, Paris. 725
/17/ ICOMOS. Recommendations for the Analysis, Conservation and Structural Restoration of Architectural Heritage (2003), Victoria Falls.