DEVELOPMENT OF ARTIFICIAL STONE IMITATIONS AT THE TURN OF THE 20TH CENTURY THROUGH PATENT ANALYSIS IN A BELGIAN CONTEXT

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Abstract
In the late 19th century, the introduction of Portland cement and understanding of hydraulic binders led to innovative compositions towards decorative finishing materials. To avoid grey and dull cement appearances, craftsmen started to manipulate the mortar mixtures by adding mineral particles and pigments, creating a material resembling a particular natural stone. Such a stone imitation could be applied as a render layer on facades or implemented in walls as brick elements, which are respectively known as 'simili-plaster' and 'artificial stone blocks’. Both techniques were developed as a substitute for the more expensive quarried natural stones, like marble, sandstone and limestone when they were locally not available.

Apart from the existence of a few commercialized ready-mix imitation renders, we do not know a lot about the technological evolution of the Belgian stone imitation industry. This knowledge is essential for historical preservation, since these materials were extensively applied in facades during the interwar period and today more and more young heritage needs to be restored. Therefore, the aim of this research was to gain knowledge on the development of these popular artificial stone claddings with an important focus on their manufacturing process. By studying patents requested between 1880 and 1940 in Belgium, original mortar compositions could be determined, and a quantitative analysis sheds light on their glory days and the degree of knowledge transfer from neighboring countries.

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INTRODUCTION

Aiming for aesthetical perfection has always been a key issue throughout history. Since ancient times, facades and finishing materials have been manipulated in order to create the illusion of a perfect appearance. The Romans already decorated their buildings with lime render, containing stone dust and pozzolana, to simulate the texture of real marble stone and giving their cities more prestige (Ward 2008). Also later on this application continued; during the 16th century, plasters were designed to resemble carved marble and rustication work to hide and protect bearing structures (Sandrolini et al. 2010). The idea of imitating stone gradually proliferated across national borders, mainly because architects drew their inspiration from Italian and French examples during the Renaissance and used these foreign influences in their local architecture (Everaert et al. 1994). The Gothic Saint Nicholas’ church in Ghent is one of the few and oldest buildings in Belgium in which traces were found of a stone imitating plaster (Verdonck et al. 2010). Exposure of underlying lime renders revealed the presence of an early 17th century Tournai limestone imitation which was applied on top of a real limestone masonry support. Since the masonry did not meet the aesthetical requirements, an idealized image of brickwork jointing was carefully oil painted onto the render surface. These examples illustrate the widespread use of stone-imitating mortars in historical architecture as a replacement for natural stone. Often due to a local scarcity of quarried stone, economic implications and a substandard masonry support, the design of an artificial substitute seemed to be a logical solution.

Only from the second half of the 19th century, it became actually possible to manufacture stone blocks of considerable hardness, with the emergence of new industrially produced hydraulic binders. Addition of artificial hydraulic lime and cements to traditional mortar mixtures enabled to develop new materials with beneficial properties, such as a faster setting and higher strength capacities (English heritage 2011). Whilst most engineers were mainly interested in the outstanding strength limits of hydraulic binders at the time, lower-quality and cheaper cements were extensively employed to compose decorative blocks. Especially the increased (mass) production of standardized stone elements at higher speed was seen as a valuable supplement or alternative for the time-consuming and expensive traditional render procedures (Ersen et al. 2010). Consequently the term ‘artificial stone’ can be understood as an industrial material to imitate a specific natural stone, either applied directly as a mortar layer on facades or implemented into the masonry as precast ornamental stone.

According to Fratini et al., the architectural application of artificial stone spread out all over Europe with a maximum diffusion reached at the start of the 20th century (Fratini et al. 2009). Unfortunately, the technological development of the stone imitation industry in a Belgian context is not well documented, even though many of these finishes have survived and they still have an important share in the existing Belgian building stock. With regard to historical preservation, more needs to be known about the production procedures of artificial stone to guarantee a sustainable methodology for present restoration campaigns. Therefore, the aim of this research was to cast new light on the development and evolution of these materials in Belgium with a focus on their manufacturing formula. Analysis of conventional historic sources, such as architectural periodicals and professional manuals from that time, only provide respectively a number of advertisements and descriptions concerning the application of these finishing materials on site (Govaerts et al. 2014). Because most composition formulas and production techniques were protected as trade secret, they do not appear in specialized literature of that time. Manufacturer archives may complete this lack of technical documentation, but many of them have been disap-
appeared after closure, such as seen at the NV Dura in Kalmthout and the Léopold Englebert & Compagnie in Brussels (Fig. 1).

Figure 1: Advertisement for artificial stone by Léopold Englebert & Cie (left) (L’émulation, No. 8, August 1923) and Dura stone imitations (right) (Private archive Gilbert Uitdenhouwen, Kalmthout)

For this reason, the main consulted sources are historical patents requested to the Belgian State between 1880 and 1940. Based on the amount of patents, type, applicant and content, an extensive analysis was done to reconstruct the technical background and innovative nature of these finishing materials. Given the substantial influence of neighboring countries on stone imitations, the content of the Belgian patents definitely contributes to the international knowledge-base.

QUANTITATIVE ANALYSIS

Within the time span 1880-1940, a number of 407 official patents was submitted in Belgium, some including the term “artificial stone” (278 patents) and the others containing literally the term “stone render” (129 patents) in the abstract description. These historic documents include manufacturing procedures for artificial bricks and stone imitations, as well as mortar preparation recipes to optimize certain material properties, new designs for moulds and pressing machines, and also guidelines and recommendations for finishing techniques. Sometimes detailed and quantitative interesting explanations are given about the proportions when mixing raw ingredients, but some files are very brief and rather subjective. Figure 2 shows the evolution of the amount of patent requests in time, making a distinction between requests for façade plasters and stone blocks. Apparently cast imitation elements entered the Belgian building industry much earlier in comparison to renders. Whilst the development of stone blocks is clearly situated between 1898 and 1912, the number of patents for facade plasters only starts growing from 1910. However, this ascending evolution is blocked with the outbreak of the First World War. During the interwar period, research into the behavior and improvement of (stone imitating) renders becomes more important than the design of decorative blocks, which gain less attention in these years. It should be noted that there are also ordinary colored renders included within the façade plasters category, next to the simulated stone renders. Sometimes imitation renders are also clas-
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sified under the broad term of “artificial stone” although the latter’s focus is on the production of blocks. Additionally all patent requests related to “other wall claddings” were categorized in order to observe the ratio of stone imitations compared to other new finishing materials, such as interior plasters, wallpapers, mosaics and glass decorations (Fig. 3). Improvement patents for (white) Portland cement, which is often used in compositions for colored plasterwork, are not considered here. Analysis shows that there were issued almost twice as many patents for artificial stone compared to the group of modern and innovative finishing materials, which indicates clearly the potential and thrust in the commercial success of artificial stone.

Figure 2: Evolution of Belgian patent requests (1880-1940) for artificial stone blocks and renders

Figure 3: Evolution of Belgian patent requests (1880-1940) for artificial stone and other wall claddings

We have to keep in mind that patent literature provides a complete picture of all inventions, including less successful products which did not hit the market. A patent merely confirms the existence of a peculiar machine or technique, and certainly not its appropriacy and application in the industry (Dekeyser et al. 2014). Comparison with other sources is therefore necessary to verify the importance and impact of a patent. Unfortunately, most patents provide a general description of their invention and they do not contain any brand names of well-known commercial products, making interlinking difficult. Yet some manufacturers, known for their successful mortars, requested one or more patents, such as the German C.A. Kapferer from Terranova Industries or the Belgian J.B. Soille from the Etablissements L&J Soille Frères, but it is not clear whether the corresponding product is involved.

It is remarkable that most applicants do not specify which type of quarried stone they want to imitate with their invention. Based on the selection of raw materials, it turns out they usually simulate the more prominent French white sandstone, but some formulas prescribe a general preparation for any kind of natural stone by adding crushed rock as aggregate, derived from the reference stone. The manufacture of artificial marble is established in a different way, as the
veins require specific treatments. A quantity of 45 patents, all dedicated to marble imitations, is mentioned separately due to their extraordinary composition. In order to compare the constituent ingredients for composing French white stone, a number of 23 patents was selected for making artificial blocks and 15 instructive patents were found for plasterwork. This selection is based on the interpretation of the patent abstracts, which had to contain an adequate level of detail.

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Table 1: Origin of patent demanders

Comparing the numbers which reflect the origin of applicants (Table 1), Belgian inventions have a considerable share, but the group of foreign applicants is most numerous. Especially the neighboring countries (Germany, France and UK) have an important influence regarding knowledge transfer on the Belgian industry. Due to the relative low taxes and long monopoly periods, Belgium is an attractive and popular country to protect trade secrets (Dekeyser et al. 2014).

The patent type is a valuable indicator for the potential economic successes (Table 2). Belgians Soille (1909) and Marlier (1926) both submit an improvement patent, optimizing their first invention. As such type of certificate is associated with higher administrative costs, this may imply an increased chance of success. Advertisements in professional architectural journals like Bâtir and L’émulation prove the economic application of Soille’s invention between 1920-1935. Within the patent selection, only one foreign improvement patent was submitted (Grote 1894). Requesting an import patent often suggests the existence of a qualitative commercial application in the country of origin. However the list of import documents is limited and they are all published before 1900.

Figure 4: Advertisements by Etablissements L&J Soille Frères – Bâtir, October 1935 (left) and L’émulation, August 1923 (right)

DIGGING INTO COMPOSITIONS

Apparently, the art of creating good stone imitations is not obvious. In 1893, the Brussels industrialist Jean Isecke expresses his displeasure with regard to the general manufacturing procedures for artificial stone, in particular for the imitation of French sandstone, which was widely used on construction sites (Isecke 1893). According to Isecke, a variety of procedures and mortar recipes were already developed, but no professional managed to formulate an easy manufacturing method which results in a durable cohesive stone. On the one hand these modern stones appeared to be brittle with little resistance. On the other hand, the ornamental blocks were far too hard and most of them rather simulated cement instead of a sandstone aspect. The Swiss Wilhelm Schwartz agrees with Isecke’s opinion and regrets the modern industrial character of the
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artificial stone production, especially because nobody succeeded in inventing a uniform and un-discussed substance. An improper moisture content of the sand aggregates combined with insufficient slaked lime would be one of the main reasons why cracks emerged during the hardening process. (Schwartz 1899). Although old architectural periodicals give the impression that white Portland cement is seen as the essential ingredient for stone imitations, patents illustrate that the implementation is not a prerequisite. Each mortar mixture has a binder comprising lime or cement whose detailed properties are not specified. Exceptionally a combination of lime and cement is used as binder material. White cement is only implemented into the fabrication formulas starting from 1912 and no patent prescribes the addition of lime in case white cement is applied. Since white cement only occurs in Belgian requests, the inspiring ideas were presumably brought by immigrated craftsmen and stimulated due to the promotion of white cement by foreign cement manufacturers. Advertisements for Ciment Extra Blanc regularly appeared in prominent periodicals (La technique des Travaux and La Cité) between 1926-1930 and were made by the Société Anonyme des Chaux et Ciments de Lafarge et du Teil from Marseille in France. According to them, this bright cement enabled to create an economic interesting stone of good quality and apparently Ciment Extra Blanc was highly appreciated by foreign stone manufacturers.

When looking at the aggregates, quartz sand is an indispensable component and is often combined in patents with crushed pieces of natural stone, derived from the reference stone. Lots of descriptions refer to general terms as ‘natural stone’ or ‘sand stone’, but some patents mention granite, Euville stone, Porphyry and graphite. Feldspars and shiny muscovite particles which are released by means of the crushing process, contribute to the desired aesthetical appearance (Günther 1912). To optimize colours and workability, and to improve certain characteristics, applicants used a whole arsenal of creative additives, ranging from linseed oil to white lead, varnish, turpentine and siccative to zinc and magnesium derivatives. Without taking into account any mixing proportions, the prescribed raw materials alone are very different compared to each other, especially when considering the additives. In general, there is no big difference between the ingredients for renders and precast blocks. In case of blocks additional chemicals are often mixed to increase the hardness and bearing capacity. Unlike façade plasters, blocks may be subjected to various treatments after the mortar substance is poured into molds. Sometimes the hardening of blocks is influenced by mechanical or atmospheric pressure, or an increase in temperature. Despite the increased interest in render compositions during the interwar period, patent contents indicate that simili plaster was already frequently applied before 1910, but not in its industrial ready-mix shape. In 1911, Kapferer proclaims the emerging trend of preparing prepacked dry mortars in Germany. Instead of mixing slaked lime and cheap additives on site, a ready-mix mortar only needed water to start the binding process, resulting in a uniform quality which was much easier to control. Although Kapferer does not mention his Terranova plaster – one of the most popular and well-known stone imitating ready-mix renders at the time – he claims that modern mortar compositions must include hydraulic lime, granular rock, sand, mineral fragments and linseed oil (Kapferer 1911). Around 1912 wall facings can be finished with simulated white stone such as Plascopierre and Pierreuse, which are valuable alternatives for simili renders and lime plasters according to Pladet (1912) and Soille (1909). Plascopierre can be tooled and chiseled like any genuine white stone, and due to its low price it is favorable both for monumental buildings and ordinary housing, which may raise ethical issues. A few patents encourage the addition of iron filings to the mixture of cement, lime or gypsum with granular materials. Due to oxidation of these iron particles the porous surface will change its colour, giving rise to red and yellow stains which simulate the spots on French sand stone (Parolini 1913). In order to improve the service life and other properties of these materials, research was conducted to gain insight
into the correct proportions between binder and iron filings. In this way, Kleinlogel came to a formula for composing a durable substance. If \( X = \) difference in particle size relative to a grain size of 1 mm, then the weight ratio is defined as \((100+7X)\) grams iron particles to \((54-3X)\) grams binder material. This formula is applicable if the grains are larger than 1 mm, if this is not the case the signs must be reversed (Kleinlogel 1922). Only a few rare patents prescribe an identical composition both for artificial blocks and the render variant. Most inventors consider them as separate materials, but for the *Groupement Professionel des Fabricants de Ciment Portland Artificial de Belgique* stone imitations are composed out of the same raw ingredients and considered as one entity. Their idea of an artificial stone consists of a core containing lower-quality materials or ordinary concrete with a finishing imitation top layer, which can also be applied on facades. However, many patents are talking about a solid core of imitation material, without any coating. This was also the usual manufacturing strategy for blocks at the former Dura company (Fig. 1 - right). During the interwar period an increasing number of concrete walls was covered with decorative layers, known as ‘sierbeton’. As a consequence, the artificial stone industry gradually paved the way for decorative prefabricated concrete.

CONCLUSION

Patents and commercial catalogues between 1880 and 1940 show a period of constant research and innovative ideas in order to develop a convincing stone imitation through artificial blocks or façade renders. Next to the traditional historic sources, patents reveal essential information, such as original formulas and casting techniques, needed for the reconstruction of simulated stone. Although we have found more foreign patents in comparison to Belgian patents, their impact on the industry is questionable, partly due to the relatively low taxes in Belgium. Despite only a few anchor points are found within the existing literature, it is not straightforward to conclude that the development of artificial stone in Belgium is a complete story of knowledge transfer by means of patents. Since the stone imitation industry in Germany started a few years earlier and because of the considerable amount of German applicants, knowledge transfer is certainly an influential part in their evolution, which may have inspired other inventors. However, Belgian requests were more detailed and some of them could be linked with commercial products from the past, which is an indication of success.

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